Presentation Abstracts

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Part 1: World Forum for Spine Research

Invited Speakers

Disc: Biomaterials

WIN001. Structural and Functional Repair of the Annulus Fibrosus

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Degenerated intervertebral discs (IVDs) are commonly implicated in low back pain and herniation is a direct cause of pain and disability. There are few minimally invasive treatments to treat and repair painful IVD degeneration including annulus fibrosus (AF) defects. Painful IVD injuries and degeneration are associated with structural disruption, chronic inflammation, and neurovascular ingrowth deep into the IVD and all of these conditions must be addressed to enhance function and inhibit painful conditions. Design goals for functional AF repair involve the restoration IVD height and motion segment biomechanics to intact conditions, sealing of defects in the AF, no (or minimal) risk of herniation under high physiological load conditions, and the ability to promote healing. Evaluation methods for AF repair strategies should progress from rapid screening studies to more advanced and rigorous evaluations in situ and eventually in vivo. Multiple hydrogel repair strategies are described including sealants and cell carriers. Fibrin crosslinked with geniplin (FibGen) shows promise for AF repair with good performance biomechanically and in organ culture.

Disclosures: None

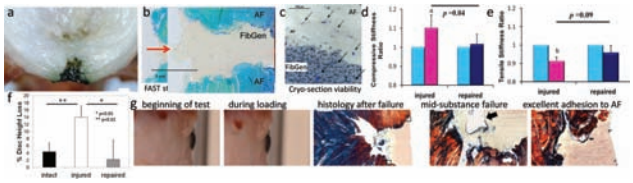

Fig. 1 (a) FibGen repaired a large AF scalpel injury. IVD organ culture experiments showed FibGen (b) retained adjacent AF structure, remained well-adhered to AF tissue, and (c) allowed cell infiltration while maintaining local cell viability (black arrows) after 14,000 compression loading cycles. Biomechanical testing showed FibGen (d) completely restored compressive stiffness, (e) partially restored tensile stiffness, and (f) completely restored IVD height to intact levels. (g) Failure bending tests showed no herniation and excellent adhesion but some midsubstance failure (black arrow).

WIN002. Designing Biomaterials Systems for the Disc Pathology

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Biomaterials are no longer considered innate structures and using functionalisation strategies to modulate a desired response whether it is a host or implant is currently an important focus in current research paradigms. Fundamentally, a thorough understanding the host response will enable to design propoer functionalisation strategies. Using functionalisation strategies such as enzymatic and hyperbranched linking systems, we have been able to link biomolecules to different structural moieties. The programmed assembly of biomolecules into higher-order self-organized systems is central to innumerable biological processes and development of the next generation of functionalized scaffolds. Recent design efforts have utilized a bottom-up approach toward both understanding and engineering supramolecular protein assemblies. These include functionalisation of micro and nanoparticles with biomolecules that include designed peptide motifs, growth factors and a multitude of gene vector systems. Structural moieties have taken a variety of different forms such as nanofibers and nanoparticulate. The talk will elucidate some of these ongoing strategies in our laboratory.

Keywords: biomaterials, intervertebral disc, tissue engineering

Disclosures: None

Disc: Molecular Agents/Degeneration

WIN003. Biologic Targets for Mitigating Age-Associated Intervertebral Disc Degeneration

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Growing old is the greatest risk factor for the development of intervertebral disc degeneration (IDD), an underlying condition of many debilitating spine-related disorders

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including chronic back pain. Understanding the biology of intervertebral disc aging to develop effective interventions to minimize the adverse effects of aging on disc health is imperative, given the rapid global growth of the aging population. Recent research studies have begun to shed light on the basic biological process of disc aging. Accumulation of DNA damage was recently demonstrated as a key molecular driver of aging of the intervertebral discs. This talk summarizes the major findings that shed lights on the molecular mechanisms of how disc DNA damage is induced and the consequences of accumulated DNA damage on disc cell phenotype and extracellular matrix homeostasis. In particular, cellular senescence emerges as a central mediator of age-related disc degenerative changes which originated from DNA damage. The molecular processes of how DNA damage induces disc cellular senescence leading to perturbation of disc matrix homeostasis and matrix proteglycan loss through the NF-kB signaling are discussed in details. Key molecular steps involved in generation of DNA damage, formation of senescence, and activation of NF-kB signaling in disc cells will be highlighted as novel therapeutic targets along with the emerging candidate therapeutics that may mitigate age-associated IDD.

Keywords: intervertebral disc, aging, DNA damage, nf-κ, b, cellular senescence

Disclosures: None

WIN004. Link N as a Therapeutic Agent for Early Intervertebral Disc Degenertion

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Purpose: Although the disc has limited endogenous repair activity, induced repair of disc tissue may be possible by the intradiscal injection of growth factors to stimulate the production of disc matrix. We previously demonstrated that Link N (DHLSDNYTLDHDRAIH), a naturally occurring peptide generated by the N-terminal proteolytic fragmentation of link protein during tissue turnover, can act as a growth factor in the disc. It can stimulate matrix production in vitro, in vivo and in intact ex vivo human intervertebral discs (IVDs). We have recently discovered that AF cells have the ability to proteolytically process Link N resulting in a fragment spanning amino acid residues one-eight (US Patent # 61870394) – short Link N (sLink N). Our in vitro data indicates that the biologically active sequence is preserved within this fragment and, thus, sLink N could represent a potential stable growth factor able to stimulate disc repair. Separately, we developed a long-term organ culture model with vertebral bone. The purpose of the present study was to evaluate the effect of sLink N and compare its efficacy to Link N in this novel organ culture model of early disc degeneration.

Method: Caudal IVDs from the tails of 20–24 months old steers were isolated with adjacent vertebral bone. After seven days of preconditioning in culture, degeneration was induced in IVDs by a single injection of 50 µg trypsin into the NP. Seven days after induced-degeneration, the trypsin-treated discs were injected with either sLink N or Link N (100 µg/disc, n=six discs/group). Four of the trypsin-treated degenerate discs were injected with PBS alone to serve as a control for degeneration while four discs served as non-degeneration controls. At two, four and eight weeks post treatment, two discs from each treatment and control groups were processed for biochemical analyses. Proteoglycan (predominantly aggrecan) synthesis in the NP was monitored as sulfated glycosaminoglycan using dimethylmethylene blue dye-binding assay, and Western blotting was performed to determine the expression of aggrecan and type two collagen in the tissue.

Results: Without intervention, at all time points, the GAG content in degenerate discs dropped to ~50% of that in non-degenerate controls. In contrast, sLink N, significantly increased the GAG and collagen content of the discs compared with that in degeneration control discs.

Conclusion: The results revealed that sLink N has the ability to restore tissue content in an early state of disc degeneration. These results have implications in relation to using either sLink N in regenerating a functional NP in the degenerated IVD or in retarding disc degeneration. Separately, we have developed and validated a novel long-term IVD organ culture model that retains vertebral bone and easy to prepare. Our model is ideal for testing potential drugs and alternate-based therapies, in addition to investigating the long-term effects of loading paradigms on disc degeneration and repair.

Keywords: intervertebral disc degeneration, regeneration, tissue engineering, organ culture, proteoglycans

Disclosures: None

Osteo: Molecular Agents/Cell Based Therapy

WIN005. Future of Biologics for Spinal Fusion

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The use of biologics will grow in the future in terms of bone healing, spine fusion, and disc regeneration. In addition, osteogenic material will always be needed for spinal fusion. The future will be a combination of improvements in bone graft materials that are safe, have no donor morbidity, and have an unlimited supply. This talk will discuss current and future options for bone healing. Bone grafts and bone graft substitutes are generally classified into one or more of the following groups: osteogenic, osteoinductive, osteoconductive, and structural. Structural grafts, such as a tricortical iliac crest graft or femoral ring allograft, provide mechanical support to the construct. Osteoconductive grafts provide a scaffold for bone formation. Osteoinductive grafts are able to induce osteoblastic differentiation of the progenitor cells. Osteogenic grafts are able to directly contribute cells for bone formation. Autograft has long been considered the gold standard as it has all of the above properties. However, limited supply of autograft, as well as the morbidity associated with its harvest, has led to the development of a plethora of bone graft substitutes and extenders which may contain one or more of the above properties. Allografts obtained from cadavers provide an osteoconductive scaffold, and are weakly osteoinductive. These grafts do not have any osteogenic potential, as all the cells are killed during the processing aimed to decrease the risk of infection transmission and antigenicity. Still, a minute risk of viral transmission, such as hepatitis, cytomegalovirus, and human immunodeficiency virus, still exists. Allografts may also undergo further processing such a demineralization, leading to demineralized bone matrix (DBM). DBM lacks the structural support of strut allografts, but still has osteoconductive and osteoinductive properties. Demineralized bone matrix (DBM) is a bone graft substitute with primarily osteoconductive and some osteoinductive properties. It is formed by acid extraction of allograft bone, resulting in the loss of mineralized component of bone while retaining the type 1 collagen framework and many growth factors. The osteoinductive quality of DBM varies among different products due to the variability in their content of the bone morphogenic proteins (BMPs). It is currently available in multiple forms, including putty, injectable gel, and flex strips. Ceramics are an attractive type of bone graft extenders and substitutes for several

reasons. They can be manufactured in large quantities and a variety of shapes and sizes, do not carry a risk of disease transmission, are biodegradable, and are easy to sterilize. On the other hand, they only provide an osteoconductive scaffold, have little shear strength, and are brittle. As such, they cannot be used as structural grafts without the protection of rigid instrumentation. Commercially available forms of ceramics include calcium carbonate and β-tricalcium phosphate.

WIN006. New Therapies for Spinal Fusions: Cells, Molecules and Surfaces

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Osteo: Carriers and Bone

WIN007. Novel Carriers for Growth Factors for Enhancing Spinal Fusion

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Spinal fusion is a well-accepted surgical treatment for many spinal diseases; the costs amount to ~34 billion annually in the US alone, with significant increases projected due to an aging population. Non-unions are a notable complication of spinal fusion surgery. To promote bone regeneration, the FDA has approved rhBMP-2 with a rebsorbable collagen sponge as an alternative to the standard bone graft for spinal fusion. However, adverse events associated with supraphysiological doses, and burst release of rhBMP-2 is a recurring problem for clinicians. Formulations that help regulate the delivery and release profile of growth factors are needed to achieve consistent clinical outcomes. Numerous approaches have been tested, and some of them have shown promising results. Strategies tested for achieving this endeavor include: 1) optimization of cytokine kinetics, 2) combination of different growth factors, 3) utilization of osteoinductive and osteoconductive scaffolds, 4) incorporation of progenitor cells, 5) augmentation of biological activity with tropic bone factors, and, 6) reduction of the endogenous BMP antagonists.

Disclosures: None

WIN008. Bone Healing through Synthetic Scaffolds

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Patients who undergo spine surgery can have suboptimal outcomes postoperatively from pseudarthrosis. Historically, iliac crest bone graft, which provides all of the critical elements of bone repair, has been the gold standard for spine fusion, however, recent studies suggest that less than 6% of the U.S. spine surgeon population utilizes this procedure. Several bone graft substitutes are now available worldwide that obviate the need for the complications from iliac crest harvesting such as growth factors, stem cells, and allograft-based products. Recent developments in the production of biomaterials have highlighted the potential for synthetic scaffolds in providing graft options for surgeons in the future. With novel 3D printing methods, use of peptide amphiphiles, and formulation modifications, we will review the promising technologies that may revolutionize spinal biologics.

Keywords: nanotechnology, nanofiber scaffolds, 3d-printed scaffolds, bone healing

Disc: Cell Based Therapy

WIN009. Mesenchymal Stem Cell Based Therapies for Disc Repair/Regeneration

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Low back pain (LBP) is one of the most common musculoskeletal disorders, with an estimated 84% of the population experiencing LBP at some point in their lifetime. The prevalence of LBP increases with age, suggesting incidences of LBP are likely to increase in the future due to a global aging population, changes in lifestyle and occupational stresses. Although the causes of LBP are multifactorial, increasing evidence implicates intervertebral disc (IVD) degeneration as a major contributor, with loss of IVD integrity leading to destabilization of the spinal motion segment, resulting in pain and disability.

The IVD is a complex structure that allows movement between adjacent vertebrae and sustains the load applied through the spine. It consists of an outer annulus fibrosus (AF), a ligamentous lamellar structure composed predominantly of type I collagen fibers, and a central gelatinous nucleus pulposus (NP) composed predominantly of the proteoglycan aggrecan, interspersed with type II collagen fibers. In degeneration there is an alteration in NP cell biology leading to diminished cell numbers and altered cell function (largely increased catabolism) resulting in an imbalance between matrix synthesis and degradation, particularly within the NP.

Current medical treatments for IVD degeneration rely on conservative therapies (e.g., pain relief, exercise therapy) and, when these fail, surgery. Surgical treatments such as spinal fusion and disc replacement have shown satisfactory results in alleviating pain, but are not devoid of complications and long-term clinical outcomes still remain poor. Thus, there is an urgent need for alternative therapies focused on correcting the underlying pathogenesis and aberrant cell biology of IVD degeneration. As such many researchers, including ourselves, are focusing on the development of novel cell-based therapies. However, in order for these to be successful an appropriate cell source for implantation, together with a suitable growth factor to direct cell differentiation and formation of a functional matrix formation must be identified. Additionally, extensive in vitro studies are needed to establish and support further pre-clinical and potential commercial development.

Having characterized the phenotype of human NP cells (a prerequisite for tissue engineering/regenerative strategies to ensure correct differentiation of cells to the target native cell) we have applied this knowledge to demonstrate that both bone marrow MSCs (BM-MSCs) and adipose-derived MSCs (AD-MSCs) are capable of differentiation toward an NP-like phenotype. Specifically, we have demonstrated that stimulation of both BM-MSCs and AD-MSCs with GDF6 (compared with other members of the TGF-β superfamily) results in improved differentiation to an NP-like phenotype and, importantly, synthesis and deposition of an extracellular matrix, rich in proteoglycan and having micromechanical properties akin to the native healthy NP. Significantly, these studies have highlighted that AD-MSCs (rather than BM-MSCs) are the more appropriate cell source for NP regeneration and that GDF6 (alias CDMP-2 or BMP-13) is the most suitable growth factor for directing differentiation. Additionally we have shown that factors in the IVD niche, namely, hypoxia and load can modulate AD-MSC differentiation and that when these factors are combined they act synergistically to promote matrix formation and increase proteoglycan synthesis. For

regeneration strategies, MSCs will be implanted into the degenerate IVD niche which is a milieu of catabolic and pro-inflammatory cytokines, particularly IL-1, and thus their response such pro-inflammatory factors needs to be ascertained to ensure that catabolic events are not exacerbated. Interestingly, when AD-MSCs that have been differentiated to NP-like cells (i.e., aNPCs) are exposed to IL-1, there is no significant fold changes in gene expression for the matrix molecules (ACAN, COL2A1), matrix degrading enzymes (MMP3, MMP13), or proteoglycan synthesis when compared with untreated aNPCs. This suggests that these cells may be able to withstand the effects of the catabolic milieu in the degenerate IVD niche.

Furthermore, our studies have shown that GDF6 has anabolic effects on degenerate human NP cells, stimulating adoption of a more normal NP phenotype and increasing appropriate matrix synthesis. This suggests that delivery of GDF6 as part of an MSC-based regenerative therapy may be beneficial both in directing appropriate, lineage-specific MSC differentiation, but also in restoring a healthier, more anabolic phenotype in native NP cells, thereby having a dual regenerative effect.

Importantly, these in vitro studies demonstrating that GDF6 promotes AD-MSC differentiation to NP cells and synthesis of an NP-like matrix, as well as potential effects of GDF6 on resident NP cells, suggests that our proposed combined biologic and cellular therapy can provide a significant step-change from existing interventions, potentially bridging the gap between symptomatic care and aggressive surgical interventions.

Keywords: IVD degeneration, regeneration, mesenchymal stem cells, GDF6

Disclosures: None

WIN010. Repair of the Degenerated Disc: A Perspective Derived from Cell-Based Studies

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Like articular joints, intervertebral discs (IVD) suffer from degeneration which is thought to be irreversible after initiation. Disc degeneration is associated with low back pain, and the degenerative IVD can be a source of irritation. While the cause of IVD degeneration is not entirely understood to date, both genetic and environmental factors have shown contribution to its etiology. Various studies investigated disc repair or regeneration via cell-based approaches. These findings help us to derive new insights or principles about the degeneration, and the use of related therapies in future.

Nucleus pulposus (NP) has a role in disc height maintenance and supporting motion of spinal segment. The loss of NP integrity is one of the earliest events of disc degeneration, implying a critical function of NP in IVD homeostasis. Recovery of the NP function is therefore an important goal in treating disc degeneration. Transplantation of chondrocytes or NP cells has shown some extent of reparative capacity. Nevertheless, the use of mesenchymal stromal/stem cells (MSCs) in treating IVD degeneration has drawn much attention in the last decade. Studies have attempted to engineer MSCs into NP-like cells directly for de novo disc engineering or disc implantation, aiming to restore the matrix and hence recover the native NP function. This includes the use of growth factors such as TGF-beta, GDFs, and BMPs to induce MSC differentiation in vitro. MSCs may also be delivered directly into the disc where the engrafted MSCs acquire a differentiated phenotype to benefit NP function. Results from pilot clinical trials support that intradiscal MSC implantation may alleviate symptoms and possibly delay IVD degeneration progression.

While the use of models and regime of MSC introduction may vary, the results from the in vivo studies have laid important foundation to our understanding in the capacity and mechanism of MSC-based therapies. One school of thoughts is that MSCs can attain a collage II and proteoglycan expressing phenotype in the degenerated discs. However, other reports have also suggested that MSCs and NP cells can mutually exchange biological information and promote anabolic activities through cell-cell contact or paracrine action. Therefore MSCs may contribute to disc repair via pathways other than direct differentiation. MSCs may have other capacities in alleviating disc degeneration. Autopsy and surgical specimens show evidence of fibrosis in the majority of degenerated discs. We recently show that human IVD degeneration exhibits features of fibrosis and that a rabbit disc degeneration model shows similar features. Implantation of bone marrow-derived MSCs can inhibit fibrosis-related events in the degenerative NP and effectively preserves its mechanical characteristics and the overall motion segment function. MSCs may achieve this by repressing the profibrotic mediators that are implicated in mediating collagen anomalies in fibrotic diseases. Altogether, these support a model where MSCs may have a capacity in actively modifying the local microenvironment to potentiate resident progenitor function for tissue repair.

Keywords: intervertebral disc, stem cells, regeneration

Disclosures: None

Disc: Degeneration and Pain

WIN011. Pain: Insights from the Disc and Other Spinal Tissues

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Persistent pain is a common symptom of both trauma and degeneration induced conditions in the spine. During both cases, the spine can undergo abnormal motions and tissue injury. Under such pathophysiological loading, peripheral and central neuroimmune and nociceptive signaling cascades are initiated that can, under certain conditions, lead to the onset and maintenance of pain. Pain sensation includes both sensory and emotional experiences, but 'nociception' refers to the physiological responses and signal transmission that encodes pain. Typical behavioral signs and symptoms are exhibited clinically by patients with spinal pathologies, including allodynia and hyperalgesia to mechanical and thermal stimuli. These signs are quantifiable and have been used in both clinical studies and animal models of pain, using dermatomal mapping between species.

An overview of the anatomy and physiology of spinal tissues with the potential for pain generation will be reviewed, together with the relationships between tissue loading, nociceptive signaling and pain. These will be addressed from macroscopic points of view to cellular injuries, and incorporating both neuronal and associated immune and other physiological cascades which can complicate the pain response. Building off of that work, findings from in vivo models will be reviewed, particularly those that incorporate methods to understand the spatio-temporal mechanisms of pain production, both at the site of pain origin and in the central nervous system (CNS). Findings regarding pain symptoms will be related to the physiological cascades in both the periphery and the central nervous system. Nociceptive signaling can lead to sensitization, which is increased responsiveness of neurons

to their normal input or recruitment of a response to normally subthreshold inputs. Sensitization can occur in the periphery or in the CNS. Peripheral sensitization leads to altered nociceptive responses at the injury site, including decreased thresholds for afferent firing and increased responsiveness of peripheral nociceptive neurons; central sensitization involves the increased spontaneous activity and responsiveness of nociceptive neurons in the CNS, which results in increased nociception at secondary sites that have no tissue damage. These will be reviewed in the context of our models of neuropathic and ligament based pain in the rat. Given the challenges in measuring ligament damage other than gross tissue responses in vivo, we separately present studies that further investigate local mechanotransduction processes by highlighting relationships between locally-induced biomechanical deformations and microstructural changes, and the release of pain mediators. Lastly, early findings related to measuring the affective components of pain in the rat, along with work highlighting the importance of some of these findings for pain therapies and interventions that specifically target those spatiotemporal neuroimmune cascades will be presented to provide context for the other presentations.

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Disclosures: None

Oral Presentations

Disc: Biomaterials

WO001. Annulus Fibrosus Repair using Genetically Engineered Silk and Genipin-Enhanced Fibringel

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Introduction: Almost 80% of the population suffers from low back pain at least once in their life causing a high socio economic burden. Often these pains originate from a trauma resulting in disc herniation and /or disc degeneration. Despite this high prevalence and associated costs, a satisfying treatment method is not yet on the market. Here we aimed to develop a new method to seal and repair annulus fibrosus (AF) injuries by using genetically engineered silk carrying GDF-6 a growth factor known to lead stem cells toward an intervertebral disc (IVD)-like phenotype and a genipin-enhanced fibrin hydrogel.[1]

Materials and Methods: Bovine IVDs of 14–17 month old animals were harvested under aseptic conditions.[2] After inducing an injury by a circular 2mm biopsy punch (Polymed, Switzerland) the defect was filled up with a commercial human based fibrin hydrogel (Baxter Tisseel, Switzerland) enhanced with 4.2mg/ml of the cross linker genipin (Wako Chemicals GmbH, Germany). For closure and acceleration of repair a silk membrane-fleece composite (Spintec Engineering GmbH, Germany) was put on the defect and hold in place by the hydrogel. After 15 minutes allowing for cross linking in vitro organ culture of bIVDs started for 14 days under three different loading schemes 1) dynamic load 0.2MPa load and $\pm 2^\circ$ torsion at 0.2Hz for 8h/day 2) static diurnal load of 0.2MPa or 3) free swelling. For dynamic loading a custom built two-degree of freedom bioreactor was used.[3] At the end of culture discs were checked for seal failure by the eye, disc height, metabolic activity (alamar blue), cell death by necrosis (LDH assay) and apoptosis (Caspase 3/7), DNA, GAG and collagen content (via hydroxyl proline = HYP) and RT-qPCR was performed.

Results: Throughout the 14 days of culture the silk composite maintained its position under all three loading schemes. Although repaired discs performed slightly lower in alamar blue, DNA and GAG content were in the range of the control. Also LDH resulted in similar values compared with control discs. Height loss in repaired discs was in the same range of static diurnal loaded control samples. Dynamically loaded discs decrease to the level of injured, unrepaired discs. In general discs suspended to dynamic loading showed slightly higher expression of inflammation marker genes measured relative to control discs when compared with free swelling samples.

Conclusion: Silk-genipin-fibrin reinforced hydrogel is a promising approach to close AF defects as instant loading was possible and composite remained on its position. Further experiments focus on cytocompatibility of genipin-enhanced fibrin hydrogel and organ culture of silk containing covalently linked growth factors.

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WO002. Polyethylene Glycol and Poly (Trimethylene Carbonate) Block Copolymers for Annulus Fibrosus Repair have High Cytocompatibility, Restore Axial Range of Motion and have Some Herniation Risk

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Introduction: There is a clinical need for annulus fibrosus (AF) repair to reduce re-herniation risk, restore intervertebral disc (IVD) biomechanics and promote regeneration of the IVD following herniation and discectomy surgery. Functionalized polyethylene glycol with poly(trimethylene carbonate) block copolymers (PEG-TMC3) can strongly adhere to native AF tissue. This multi-scale study evaluated PEG-TMC3 for adhesion, cytocompatiblity, biomechanics restoration and herniation risk using cell and organ culture experiments and 2 ex vivo biomechanics studies to assess (1) cytocompatibility, (2) biomechanics, (3) organ culture, and (4) failure strength. We hypothesized PEG-TMC3 allows greater AF cell proliferation rates than Dermabond (i.e.,

cyanoacrylate); restores IVD biomechanics to intact levels; does not herniate under rigorous IVD organ culture loading; and that IVDs repaired with PEG-TMC3 fails at levels similar to intact conditions.

Material and Methods: (1) For cytocompatibility tests, bovine AF cells from three donors were seeded in triplicate in 48 well plates; the wells were either coated with PEG-TMC3 or Dermabond, or left uncoated (No Adhesive). Cells were cultured for 1, 3 or 7 days at 37°C, 5% CO_2 and ambient oxygen. Cells were then lysed and the DNA content was quantified by PicoGreen. (2) For biomechanical tests, vertebra-IVD-vertebra segments were tested under axial (0.25MPa to -0.50MPa) and torsional loading (±4°) in a repeated measures study design with Injured Control and PEG-TMC3 Repair groups ($n = 6$). (3) For organ culture validation tests, bovine IVDs with endplates were randomly distributed among 3 groups: Intact, Injured and PEG-TMC3 repair ($n = 3$). IVDs were then cultured for 4 days with 2 daily bouts of rigorous loading and a diurnal cycle (total 10,800 cycles) [4]. (4) For failure strength tests, vertebrae-IVD-vertebrae segments of Intact, Injured and PEG-TMC3 groups ($n = 9$) were subjected to increasing axial force under a fixed 5° bend until failure or nucleus pulposus extrusion was observed. Force and subsidence were measured through the test and extrusion was monitored by video. ANOVA with Tukey's post-hoc assessed differences between groups and time points for DNA concentration, failure strength and subsidence. Repeated measures ANOVA with Tukey's post-hoc assessed torque range and axial range of motion. $p < 0.05$ was significant.

Results: (1) DNA concentration significantly increased from Day 1 to 7 for PEG-TMC3 and No Adhesive groups, while no changes in DNA content was observed for Dermabond treated cells which tended to decrease. Further, DNA concentration was higher for PEG-TMC3 and No Adhesive compared with Dermabond at each time point. (2) Biomechanically, injury increased axial range of motion and torque range. PEG-TMC3 repair restored axial range of motion to intact levels and increased torque range from injured levels but not to intact levels. (3) In organ culture, 2 of 3 PEG-TMC3 repairs herniated after 4 days of culture. (4) In failure testing, PEG-TMC3 did not significantly increase herniation stresses compared injured.

Conclusion: PEG-TMC3 showed high cytocompatibility, restored axial range of motion to intact conditions and increased torque range from injury conditions, suggesting it is a good candidate for AF repair. However, the high herniation risks under cyclic organ culture and failure testing conditions indicated further optimization is necessary to prevent herniation after many cycles of loading.

WO003. Annular Repair Using High-density Collagen Gel with Riboflavin Crosslinkage: Preliminary Data from an in vivo Ovine Model

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Introduction: Discectomy of herniated intervertebral discs (IVDs) successfully alleviates neurological symptoms but fails to repair the iatrogenic annulotomy. This persistent annular defect post-discectomy is associated with increased risk of reherniation, progressive IVD degeneration, and chronic low back pain. Previously we demonstrated the ability of high-density collagen (HDC) gels to facilitate annular repair in a rodent model.[1,3] This study aims to use HDC gel in an ovine model which has previously been used as a surrogate for the human spine.[2] The goal of this study is create an effective ovine model for a herniated nucleus pulposus through a generated annular defect and to show that our HDC helps induce annular repair reduces the degenerative changes.

Methods: Sheep have had intervertebral discs violated to create an annular defect and induce a herniated nucleus pulposus. These sheep were laid in a lateral position with their right-side up. A longitudinal incision was made from their most caudal rib to their iliac crest 1-cm ventral to their transverse processes. Using a lateral approach, the soft tissue and muscle were dissected of their transverse processes to expose their vertebral bodies. The annular fibrosis (AF) defect was created with a 3.2 mm drill inserted to a 9–11 mm depth and then an 18-gauge needle was inserted to a maximum depth of 9–10 mm to injure the nucleus pulposus (NP) and induce a herniation through the annular defect. The violated IVDs were then randomized to either treatment with riboflavin-crosslinked HDC gel or no treatment. Thus far 4 IVDs were randomized to the control group and 4 IVDs to the treatment group. An in vivo MRI and post-mortem MRI were performed 6 weeks after the surgery to assess the degree of herniation of the nucleus pulposus. A post-mortem X-Ray was also obtained 6 weeks after the surgery to assess for any changes in disc height, which is a surrogate for degenerative disc changes.

Results: Of the 8 intervertebral disc which we induced an annular defect, we were able to induce nucleus pulposus herniation through the annulotomy in all levels as in the example in Fig. 1. Our preliminary data so far shows no difference in the disc height index of the intervertebral discs that received HDC versus those that received no treatment at 6 weeks after the surgery. The average disc height index of the treated intervertebral discs was 0.78 ± 0.005, 0.77 ± 0.004 for the untreated, puncture-only intervertebral discs, and 0.82 ± 0.006 for the healthy discs.

Conclusion: Lumbar discectomy to treat disc herniation is one of the most commonly performed spinal procedures,[1] with an estimated 300,000 cases per year in the United States.[2] A ~5% to 15% of discectomy cases result in a reherniation of their nucleus pulposus[3] through the annulotomy and is associated with compromised patients outcomes and increased health care costs.[4] Our preliminary data show that we are able to effectively use an ovine model to simulate a herniated nucleus pulposus via a lateral approach to the lumbar vertebral. Experiments are ongoing to analyze the disc levels using T2 mapping on MRI to assess changes in the NP hydration and overall area as our group has done previously in the rat-tail model.[5] If HDC is found to be efficacious in inducing annular repair in a large mammal model, the next step would be to progress to clinical trials in humans.

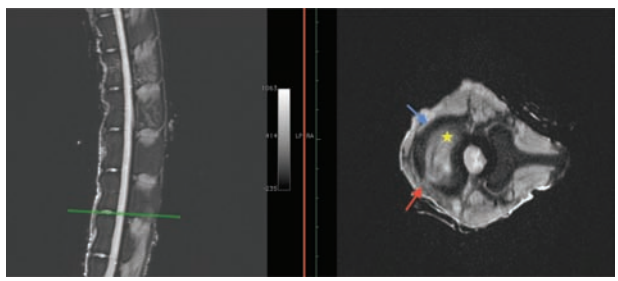

Fig. 1 L4/5 Disc level on sheep A showing annulus fibrosis (blue arrow), nucleus pulposus (star), and the annular defect with herniating nucleus pulposus (red arrow).

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WO004. Modulation of Extracellular Matrix Activity, Neurotropic Factors and Sensory Innervation Associated Pain in Intervertebral Disc Degeneration using a Hyaluronic Acid Hydrogel

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Introduction: Painful intervertebral disc (IVD) degeneration is mediated by inflammation, increase catabolic processes and neurotrophin production that sensitize innervation in the disc and leading to back pain. High molecular weight hyaluronic acid (HA) hydrogels demonstrate potential as bioactive materials for disc regeneration as they exhibit an anti-inflammatory effect,[1] reduce pain,[2] and mimic the native environment of the disc.[3] It is hypothesized that cellular HA/collagen hydrogels modulate extracellular matrix activity and neurotrophin expression in a 3D in vitro inflammation model and that acellular HA hydrogel inhibits in vivo hyper-innervation associated pain in an rat-tail injury model.

Material and Methods: The density of 4×10^6 /ml inflamed nucleus pulposus (NP) was encapsulated in HA/collagen type II hydrogels during the synthesis. Hydrogels were incubated in media with/without IL-1β (10 ng/ml) until 3 day culture. Expression of NGF and BDNF, and the matrix component of aggrecan and collagen in NP cells were analyzed by qRT-PCR. All animal protocols were pre-approved by institutional Animal Care Research Ethics Committee (ACREC). Eight (8) Sprague Dawley rats were used in this study. The experimental group of sham (control), injury (untreated) and injury with acellular HA hydrogel implanted (treatment) were performed on disc Co4-Co5, Co5-Co6 and Co6-Co7. The coccygeal disc's of rat-tail were identified under an X-ray image intensifier and excising out 1 mm^3 size of AF tissue then induced injury. The rats were kept in recovery and assessing for nocifensive behaviors in response to thermal, cold and mechanical hyperalgesia/allodynia until 10 weeks post-operative. The rats were then sacrificed to harvest the discs and spinal cord so as to determine expression of GAP43, CGRP and c-fos for assessing sensory innervation and pain neuropeptide markers in the disc and dorsal horn of spinal cord respectively.

Results: The collagen and aggrecan were up-regulated in the acute event of inflammation and down regulated as inflammation progressed in NP cells. Up-regulation of NGF and BDNF was evident in NP cells. Acellular HA hydrogel in the in vivo injury model revealed a significant decrease of sensory innervation in NP and AF tissue.

Conclusion: The cellular 3D hydrogel platform mimics the native extracellular matrix of NP. The therapeutic effect of HA hydrogel was shown with down-regulation of neurotrophins and suppression of hyper-innervation in the inflammation and injury model respectively.

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WST001. Annular Repair Using Cross-Linked High Density Collagen Gel Seeded with Fibrochondrocytes: In Vivo Outcomes of a Rodent Disc Study

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Introduction: Despite alleviating associated neurological symptoms, discectomy of herniated intervertebral discs (IVDs) fails to repair the underlying degenerative process. Persistent annular defect post discectomy is associated with increased risk of reherniation, progressive IVD degeneration, and chronic low back pain.[1–7] Although many studies have previously employed cell transplantation to regenerate the nucleus pulposus (NP), few have focused on annulus fibrosus (AF) repair. Recently, we demonstrated the ability of riboflavin crosslinked high-density collagen gels (HDC) to facilitate annular repair in vivo.[8,9] In this study, we assessed the in vivo efficacy of AF fibrochondrocytes seeded in a gel scaffold at enhancing the the repair of an annular defect to prevent further degenerative changes in a post-puncture rat-tail model.

Material and Methods: 38 athymic rats, punctured with an 18-gauge needle in the tail disc, were divided into 3 groups: untreated ($n = 6$), injected with crosslinked HDC ($n = 16$), and injected with fibrochondrocyte-laden crosslinked HDC ($n = 16$). At 1, 2, and 5 weeks postoperatively, a

series of in vivo images with X-ray and 7T MRI were conducted to determine the disc height index and nucleus pulposus (NP) size and hydration, respectively.[8,10,11] Histological assessments were performed to evaluate the viability of implanted cells, degree of annular repair and secondary disc degeneration. The study was approved by and undertaken in accordance with guidelines outlined by the Hospital for Special Surgery Institutional Animal Care and Use Committee and New York State. For the analyses of continuous outcomes in disc height index, NP size, and NP hydration, we employed linear regression models with a generalized estimating equation and robust standard errors to estimate differences in mean changes from baseline controls (discectomy) across displaced and stable implantation groups. P values < 0.05 were considered statistically significant.

Results: The untreated discs showed substantial NP herniation at two weeks and NP absence with signs of degeneration by five weeks, resulting in 40% loss of disc height. Both HDC gel groups, cellular and acellular, had significant retention of disc height and NP voxel count over the course of five weeks. Average NP voxel counts of cellular gels were higher than those of acellular gels at all time points and statistical significance was achieved at 1 week. Only the cellular group restored NP hydration relative to that of the adjacent healthy control. Further histological assessments indicate that while HDC gels influence the sealing of the defect, the addition of cells generates abundant tissue growth and extracellular matrices at the site of the annular defect, accelerating the reparative process. Disruption of endplate was observed in the puncture group, but not in the treated segments.

Conclusion: In vivo studies on the cell-based annular repair are few in number. Our preliminary findings suggest that fibrochondrocytes can potentially improve HDC gel-based annular repair. A long term study with sufficient sample size are necessary to confirm these results.

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WST002. BMP 2/7 Release System for Nucleus Pulposus Regeneration

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Introduction: Nucleus pulposus (NP) replacement offers a novel therapy for degenerative disc disease (DDD). Previously a novel polyurethane scaffold (PUS) and a fibrinogen-hyaluronic acid (FBG-HA) conjugate based hydrogel were developed.[1,2] The aim of this *ex vivo study (EVS)* was to evaluate the regenerative potential of the PUS and the FBG-HA hydrogel with/without transglutaminase (TG) crosslinked bone morphogenetic protein (BMP)-2/7 heterodimer in an organ culture system (OCS). Additionally an in vitro *study (IVS)* was conducted to evaluate the anabolic stimulus and biocompatibility of FBG-HA conjugate cell constructs containing different concentrations of covalently bound BMP-2/7.

Material and Methods: IVS: Bovine NP cells were seeded into FBG-HA conjugate hydrogel beads at $1.2x10^5$ cells per bead ($4x10^6$ cells/ml). Each bead was prepared by suspending $1.2x10^5$ NP cells in 20µl of FBG-HA conjugate. Finally 10µl of thrombin (5.2 U/ml) containing 0, 1000, or 5000 ng/ml TG-BMP-2/7 were added ($n = 6$/group). Beads were cultured for 7 or 14 days. Conditioned medium was collected for biochemical analysis. Gene expression was analyzed and DNA- and GAG content of the samples was measured. For the *EVS*, discoid/ravioli shape PUS were manufactured as previously described [1, 2]. Bovine IVDs with endplates were nucleotomized and refilled with either (1) PUS, (2) PUS surrounded by 50–80 µl FBG-HA or (3) PUS surrounded by 50–80µl FBG-HA containing 5000 ng/ml TG-BMP-2/7 ($n = 8$/group). Empty discs served as controls. Biomaterials were evaluated in an OCS under dynamic load for 14 days at 0–0.1 MPa, 0.1 Hz for 3 hour/day. Disc height was recorded after load and recovery at day 1, 7 and 14. Disc tissue was harvested after 14 days and gene expression was analyzed. GAG and Collagen-content of the disc tissue was assessed and Proteoglycan synthesis was analyzed by Sulfur-35 (^{35}S) incorporation measurement. Histology was performed using Safranin O/Fast Green staining. One-way ANOVA was used to determine statistical significance.

Results: IVS: A trend of higher Aggrecan expression in hydrogels with 5000 ng/mL of TG-BMP-2/7 was observed on day 7 compared with hydrogels without ($p = 0.065$) and with 1000 ng/mL ($p = 0.067$) of TG-BMP-2/7. On day 14, there was a trend of higher Collagen 2 expression in hydrogels with 5000ng/mL of TG-BMP-2/7 compared with hydrogels without ($p = 0.085$) and 1000 ng/mL ($p = 0.053$) of TG-BMP-2/7. GAG/DNA ratio was significantly higher in NP cell-seeded FBG-HA

hydrogels containing 1000ng/ml and 5000ng/ml TG-BMP-2/7 compared with control after 7 days. *EVS:* All 3 implant groups maintained their disc height after dynamic load, while it dropped by 7% in empty controls ($p < 0.001$ versus implant groups). When FBG-HA hydrogel containing TG-BMP-2/7 was implanted, the gene expression of Aggrecan in NP tissue increased 4.5-fold ($p = 0.083$). GAG/DNA ratio increased by 46% in the remaining NP tissue when TG-BMP-2/7 was applied ($p = 0.113$).

Conclusion: The PUS is able to restore the disc height of nucleotomized discs; addition of FBG-HA hydrogel does not affect the swelling capacity of the PUS in situ. Due to their stimulation of anabolic gene expression and production of NP ECM components the FBG-HA hydrogel and TG-BMP2/7 may support biological repair of NP tissue.

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Disclosures: None.

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WST003. A Nanotechnology-Based Therapy to Target Inflammation in Degenerated Intervertebral Disc: First Results from an ex vivo Disc Organ Culture

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Introduction: Resolution of intervertebral disc (IVD) degeneration-associated inflammation is a pre-requisite for tissue regeneration. Here, a pro-inflammatory disc organ culture model from bovine origin was established,[1] and a therapy based on the intra-discal delivery of an anti-inflammatory drug (diclofenac).

Material and Methods: Bovine caudal IVD punches were needle-punctured and additionally stimulated with lipopolysaccharide (10 µg/mL) or interleukin-1β (IL-1β, 10–100 ng/mL) for 48 hours. An intradiscal therapeutic approach was tested based on a non-steroidal anti-inflammatory drug, diclofenac (Df), alone or incorporated into nanoparticles, previously developed.[2]

Results: IL-1β-treated IVD organ cultures showed a statistically significant up-regulation of pro-inflammatory markers (IL-6, IL-8, PGE_2) and metalloproteases (MMP1, MMP3) expression while ECM proteins (Collagen II, Aggrecan) were significantly down-regulated. The injection of the anti-inflammatory drug was able to reduce the levels of pro-inflammatory cytokines and MMPs and surprisingly increased ECM protein levels.

Conclusion: These results point the intradiscal application of anti-inflammatory drugs as promising therapeutics for disc degeneration. Moreover, the organ culture model established could be used to address cellular/molecular mechanisms that regulate inflammation and IVD degeneration, and moreover to test novel therapeutic drugs, thus reducing the number of animals in in vivo experimentation.

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WST004. Collagen Microspheres: A Three-Dimensional Culture System for Notochordal Cells

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Introduction: The notochord plays a crucial role in the formation and patterning of axial skeleton. Notochordal cells (NCCs) have drawn increasing attentions from developmental biology, stem cells research and tissue engineering in these years as they are important in development and maintenance of NP. However, it is difficult to maintain their survival and phenotype in 2D culture for long term, making it difficult to understand their fate and functional maintenance during intervertebral disc development. This project is to develop a better culture system that is able to maintain the survival and phenotypes of NCCs.

Materials and Methods: $Foxa2^{mNE}$–Cre/Z/EG heterozygous embryos were developed and NCCs could be identified EGFP signal. NCC isolated with or without FACS-sorting, notochord segments at the anterior, trunk and posterior regions, and whole notochord pulled out from embryo were microencapsulated respectively in type I collagen microspheres and cultured for up to 1 month before characterization for survival and phenotype maintenance.

Results: EGFP signal of sorted cells could be maintained after 4 weeks. The EGFP positive cells in collagen microspheres showed colocalization with foxa2 and brachyury, which were considered as markers of NCCs, indicated that they were still NCCs. However, areas with these merged were very rare. EGFP signal of unsorted cells could be maintained and clusters of EGFP positive cells were showed during 4-weeks culture. When the notochord segments were cultured in collagen microspheres, clusters of round EGFP positive cells co-expressing with major NCC markers were found after 1 month, suggesting that NCC phenotype was maintained. Moreover,

the number of EGFP positive cells was increased during culture. In the other hand, when the notochord was cultured in collagen microsphere, it started pinching and the pinching region seemed growing at day 28.

Conclusion: Type I collagen microspheres present a potential culture system for increasing cell number with EGFP positive signal for at least 4 weeks. NCCs entrapped in type I collagen microspheres could maintained the NCCs phenotype. Comparing with FACS-sorted NCCs, there was increasing number of NCCs in unsorted group, segment culture and whole notochord culture, suggesting that the presence of niche cells, extracellular matrix, and native configuration of notochord may be important to support NCCs growth and phenotype maintenance.

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Disclosures: None

WST005. Compression Induced Stress Response of Nucleus Pulposus Cells in 3D Collagen Gel

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Introduction: The cause of degenerative disc disease is multi-factorial and is often associated with mechanical loading. However, mechanism of the cells' response to compressive loading is not fully known. It was demonstrated that in mechanical force can induce chondrocytes to upregulate expression of heat shock proteins (HSPs) as a form of cellular stress response.[1] Similarly, stretching annulus fibrosus cells was found to upregulate endoplasmic reticulum stress markers.[2] However, it is unclear that whether cells in the intervertebral disc (IVD) would experience compressive force as cellular stress in 3D environment. The objective of this study is to investigate the stress response of nucleus pulposus cells (NPCs) during compression in 3D culture environment.

Materials and Methods: To simulate the condition in the IVD, NPCs were isolated from bovine caudal disc and encapsulated in 3D collagen gel as described previously.[3] The culture system was shown to be able to maintain NPCs' phenotype.[4] The cell-encapsulated gels were cultured for 4 days and then compressed with different types of loading (static and dynamic loading), different strains (10% - 70%) and different durations (2h - 8h). Samples were retrieved to study the expressions of stress response genes in two groups: Heat Shock Response (HSP70, HSP27, HSP90 and HSF1) and Unfolded Protein Response (GRP78, GRP94, ATF4 and CHOP).

Results: Encapsulation in 3D collagen gel was found to upregulate HSP70 in NPCs. Compression further induced stress response of NPCs which depended on multiple factors. The upregulation of stress response genes was generally insignificant with increasing loading strain in short duration. However the upregulations increased with longer duration where increasing loading duration has a larger effect in the upregulation of HSP70 and HSP27. When high static strain was applied, the expressions of Heat Shock Response genes were continued to be upregulated with time after the load was removed while Unfolded Protein Response genes were down-regulated with incubation duration. The changes in expression with incubation duration show that cellular stress response may play a role in NPC survival and protein homeostasis post-loading.

Conclusion: The NPCs demonstrated cellular stress response during compression in collagen gel. The expression of stress response genes were mainly affected by loading duration and incubation duration after loading. This study helps us to understand how the NPCs cope with mechanical stress.

Acknowledgments: This project was funded by TBRS (T12–708/12-N).

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Disc: Molecular Agents/Degeneration

WO005. The Species-Specific Regenerative Effect of Notochordal Cell-conditioned Medium on Degenerated Human Nucleus Pulposus Cells

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Introduction: During human intervertebral disc (IVD) degeneration, the main cell type shifts from notochordal cells (NCs) to nucleus pulposus cells (NPCs). NCs secrete factors with regenerative potential, making them an interesting focus for regenerative strategies. Research into these strategies employs non-human donors due to easy availability of their NC-rich nucleus pulposus (NP) tissue. To determine the feasibility of translating these strategies toward clinical application, this study aimed to delineate whether NC-secreted factors of different species have a cross-species regenerative effect on degenerated human NPCs.

Material and Methods: Healthy human, porcine and canine NC-rich NP tissues (derived from Thompson grade I IVDs) were compared by histology, collagen, DNA and glycosaminoglycan (GAG) content per mg wet tissue weight. NP tissue of each species was cultured for 4 days and NC-conditioned medium (NCCM) was collected. Human NPC micro-aggregates from degenerated IVDs (Thompson grade III) were cultured for 28 days in human, canine or porcine NCCM. GAG content (corrected for DNA) was determined, and Safranin O/Fast Green staining, collagen type I, II and X IHC and gene expression profiling were performed.

Results: Canine and porcine NPs were richer in NCs than human NPs. Human NPs contained the highest collagen content, whereas the DNA and GAG content of canine NPs was significantly higher than human or porcine NPs. NCCM from all species significantly increased the DNA and GAG content of the human NPC micro-aggregates. Porcine and canine NCCM

were significantly more potent than human NCCM in inducing GAG deposition, whereas only human NCCM induced collagen type II production.

Conclusion: Secreted factors from human, canine and porcine NC-rich NPs exerted regenerative effects on human NPCs, indicating a cross-species effect. The species-specific NP properties appear to influence the regenerative capacity of NCCM on human NPCs. Bioactive compound(s) with treatment potential for human IVD degeneration are present in NCCM of different species, implying that strategies based on NC-technology employing canine or porcine models have potential for successful translation into humans.

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WO006. TGFbeta Cross-linked to Microcarriers as Injectable IVD Therapy in Dogs and Humans

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Introduction: Studies designed to use large canine models and translate the results to human practice must take into account the ex vivo and in vitro differences in the bone marrow derived stem cells(MSCs) and their response to a covalently bound growth factor.

Methods: We analyze the activity of transforming growth factor-β1 (TGF-β1) covalently immobilized on microcarriers either by 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide/N-hydroxysuccinimide (EDC/NHS) or riboflavin/UV (RB/UV) light-mediated cross-linking. Collagen microcarriers cross-linked with TGF-β1 were used for chondrogenic differentiation of human or canine mesenchymal stem cells. Evaluation methods included cell viability test, chondrogenic marker expression (aggrecan and collagen type I and type II), histological detection of proteoglycans, and immunohistochemical analysis.

Results: Cross-linking strengthened the collagen structure of the microcarriers and reduced collagenase-mediated degradation. Chondrogenic differentiation of MSCs was induced by TGF-β1 cross-linked on microcarriers, promoting gene expression and protein accumulation of aggrecan and collagen type I and type II, as well as proteoglycans. Cross-linking by RB/UV enhanced chondrogenesis more than any other group. In addition, cross-linking reduced scaffold shrinkage exerted by MSCs during chondrogenesis, a desirable feature for microcarriers if used as tissue defect filler.

Conclusion: Cross-linking of TGF-β1 to collagen microcarriers supported chondrogenesis. Current veterinary clinical trial will show if such approach will lead a step closer to development of a cost-effective and locally acting device for cell-based therapy.

WO007. Anti-Inflammatory Agents Prevent Intervertebral Disc Cell Mechanobiological Alterations

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Introduction: Intervertebral disc (IVD) degeneration (DD) is characterized by increased catabolic activity, ECM breakdown, and elevated levels of pro-inflammatory cytokines, particularly TNF-α and IL-1β. DD also alters hydrostatic pressure and biomechanical loading in the nucleus pulposus (NP), potentially leading to an altered biomechanical microenvironment around the NP cells. In a previous study we have shown that stimulation of isolated NP cells with the inflammatory cytokine TNFα, or activation of innate immune signaling via toll-like-receptor-4 (TLR4) with the ligand LPS, causes significant increases in both cell volume and hydraulic permeability of the cell. The goal of the current study is to examine the effects of anti-inflammatory drugs on mitigation of inflammatory induced biophysical changes of NP cells.

Material and Methods: NP tissue was isolated from bovine lumbar discs. Inflammatory stimulation was performed with either TNFα (10ng/ml) or LPS (0.1 μg/ml) for 24 hours. To inhibit the effects of TNFα, cells were pre-treated with dexamethasone (DEX, 1 μg/mL) for 90 minutes prior to inflammatory stimulation. For TLR4 inhibition groups, cells were pre-treated with TAK-242 (1μM), an intracellular inhibitor of TLR4, for 1 hour prior to addition of LPS. Supernatants were collected and nitrite (NO) concentration was measured. Cell osmotic properties were also measured using a custom Y-shaped microfluidic channel. Cells were equilibrated in a 333 mOsm/L NaCl solution after which a single hyper-osmotic loading followed by a hypo-osmotic loading step was applied with NaCl solutions at 466mOsm/L followed by 333 mOsm/L. During osmotic loading, cells were imaged using DIC and volume response was computed over time for each cell. Volume response was curve fitted to a mixture theory framework to determine biophysical properties for each cell including membrane hydraulic permeability (Lp), and reference intracellular water content (Φ_{ir}). Data was analyzed with ANOVA and Fisher LSD post-hoc test ($p < 0.05$ considered significant).

Results: DEX and TAK-242 significantly inhibited TNFα and LPS induced nitrite release, respectively. Both TNFα and LPS stimulation significantly increased cell size at 24 hours post treatment. Hydraulic permeability (Lp) of cells significantly increased for both osmotic steps. Treatment of cells with anti-inflammatory drugs significantly reduced Lp back to baseline levels in both TNFα and LPS groups. No significant changes in Φ_{ir} were observed due to inflammatory simulation.

Conclusion: The goal of this study was to investigate the effects of anti-inflammatory drugs on the biophysical properties of isolated NP cells. DEX, an anti-inflammatory glucocorticoid, and TAK-242, a small molecule TLR4 inhibitor, were both found to decrease TNFα and LPS induced NO release respectively. TNFα and LPS each increased Lp in NP cells, consistent with our previous findings. Interestingly, treatment of cells with anti-inflammatory drugs inhibited TNFα and LPS induced changes in Lp, where Lp was found to be comparable to baseline control levels. These findings indicate that anti-inflammatory drugs may prevent alterations in cell biomechanical properties and protect the mechanobiological function of NP cells from inflammatory changes. Our findings identify potential targets and therapeutic biologics agents for further consideration in the treatment of disc degeneration.

WO008. Synergistic Effect of Nerve Growth Factor and Insulin-Like Growth Factor-1 on Anti-Apoptosis and Extracellular Matrix Synthesis of Rat Intervertebral Disc Cells

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Introduction: Decreased cellularity due to excessive apoptosis of disc cells is a major predisposing factor for disc degeneration. Therefore, the inhibition of apoptosis of disc cells might be a possible therapeutic approach for modulating the process of disc degeneration. The purpose of the current study was to investigate the effect of nerve growth factor (NGF) and insulin-like growth factor-1 (IGF-1) in preventing apoptosis and increasing extracellular matrix synthesis in rat intervertebral disc cells.

Material and Methods: Expression of tropomyosin-related kinase A (TrkA) receptor for NGF and IGF-1 receptor (IGF-1R) for IGF-1 was examined in rat annulus fibrosus cells. In addition, rat annulus fibrosus cells were isolated, cultured, and placed in either 10% (normal control) or 0% (apoptosis-promoting condition) fetal bovine serum (FBS). We identified and quantified the degree of expression of TrkA and IGF-1R and apoptosis of the cells. Finally, we analyzed the effect of NGF (100 ng/ml) and IGF-1 (500 ng/ml) in preventing apoptosis and increasing synthesis of extracellular matrix proteins, such as aggrecan, collagen-1 and -2, in the cells, in 0% FBS.

Results: In situ expression of TrkA and IGF-1R was identified in rat annulus fibrosus cells. In addition, the degree of expression of TrkA and IGF-1R was decreased in the cells treated with 0% FBS but some degree of expression was still maintained. Apoptosis of the cells was increased in 0% FBS compared with 10% FBS ($p < 0.001$). Despite extreme survival condition (0% FBS), each application of NGF (100 ng/ml) and IGF-1 (500 ng/ml) reduced apoptosis of the cells by 2% and 5%, respectively, which led to subsequently increased synthesis of aggrecan, collagen-1 and -2 (all, $p < 0.05$). The combined application of NGF (100 ng/ml) and IGF-1 (500 ng/ml) more significantly decreased apoptosis of the cells by 9% and increased synthesis of aggrecan, collagen-1 and -2 in the cells (all, $p < 0.01$).

Conclusion: The current findings demonstrate that apoptosis of intervertebral disc cells can be attenuated by NGF and IGF-1, which lead to increased extracellular matrix synthesis. Combined application of NGF and IGF-1 has a synergistic effect than single use of NGF and IGF-1. Our result suggests that NGF and IGF-1 may play a therapeutic role in slowing disc degeneration, which is due to inappropriate or excessive apoptosis of intervertebral disc cells.

WST006. The Effect of Bone Morphogenetic Protein-2 on Chondrocyte-like Cells Derived from Degenerated Human and Canine Intervertebral Discs

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Introduction: Both humans and dogs experience low back pain, which is related to intervertebral disc (IVD) degeneration. Biologic repair of the degenerated IVD is mainly based on growth factors that exert anabolic matrix effects, and mesenchymal stromal cells (MSCs) to replenish the cell population of the degenerated IVD. Thus far, the anabolic effects of different growth factors have not been compared. The aim of this study was to study the effect of the frequently used growth factors transforming growth factor β 1 (TGF-β_1) and bone morphogenetic protein-2 (BMP-2) on canine and human chondrocyte-like cells (CLCs) from degenerated IVDs alone and in combination with MSCs.

Material and Methods: CLCs from degenerated human, canine chondrodystrophic (CD) and non-chondrodystrophic (NCD) IVDs (Thompson score III) were cultured in micro-aggregates in base culture medium (negative control), or supplemented with TGF-β_1 (10 ng/mL) or BMP-2 (100 or 250 ng/mL) for 28 days. The additive effect of MSCs was studied in CD CLCs. Canine male CD CLCs were cultured in an albumin-based hydrogel ($3*10^6$ cells/mL) with or without the addition of female bone marrow-derived MSCs (BMSCs) (CLC:BMSC 1:1) in control or 250 ng/mL BMP-2-supplemented culture medium for 28 days. Read out parameters were extracellular matrix (ECM) production (RT-qPCR, glycosaminoglycan (GAG) production, Safranin O/Fast Green staining, immunohistochemistry), cell proliferation (DNA content, RT-qPCR) and apoptosis (RT-qPCR).

Results: TGF-β_1 treatment increased GAG deposition in human and canine CLC micro-aggregates, but also induced collagen type I deposition and a fibrotic rim. The latter was not observed in BMP-2-treated micro-aggregates. 250 ng/mL BMP-2 was more potent than 100 ng/mL BMP-2 in increasing GAG deposition and DNA content in canine and human micro-aggregates. Similarly, in the hydrogel culture system, BMP-2 induced GAG and collagen type II deposition and a higher DNA content compared with untreated controls. DNA and GAG content of BMSC+CLC hydrogels was higher than hydrogels with CLCs alone in the absence of BMP-2. In the BMP-2-treated hydrogels, DNA content of BMSC+CLC was higher than hydrogels with CLCs alone; GAG deposition or release was comparable between BMSC+CLC and CLC alone in the presence of BMP-2.

Conclusion: In two different 3D culture systems, BMP-2 exerted comparable regenerative effects as TGF-β_1 on human and canine CLCs in terms of GAG deposition and cell proliferation, but BMP-2 did not induce fibrotic (re)differentiation as observed with TGF-β_1 treatment. Moreover, in the BMP-2-treated BMSC:CLC-containing hydrogels, where only half of the amount of CLCs were seeded compared with CLC alone, the DNA content was higher and an equal amount of GAGs was deposited, indicating that the BMSCs exerted an additional, regenerative effect in addition to BMP-2 treatment. PCR for SRY:GAPDH genes on DNA will indicate the ratio male(CLCs):female(BMSCs) present at the end of the study. This will indicate whether the BMSCs exerted trophic effects or chondrogenically differentiated.

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WST007. The Role of Diabetes Type I in Intervertebral Disc Degeneration

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Introduction: Diabetes Mellitus (DM) affects 25.8 million people of all ages. Previous studies suggest a link between

DM and several connective tissue pathologies including those of cartilage and bone, however the role of DM in intervertebral disc degeneration (IDD) is unclear. The goal of this study was to measure disc degenerative changes in a murine model of human type I diabetes to establish the contributive role of DM in IDD.

Material and Methods: Intervertebral discs (IVDs) were obtained from spines of Wt (C57Bl/6) mice and B6 Akita mouse model of type I DM. B6 Akita mice are hyperglycemic due to the Ins2Akita insulin mutation, which causes the insulin producing β cells to undergo apoptosis. Total disc proteoglycan (PG) content was measured by DMMB assay and safranin O/fast green histology. Glut1, a major glucose transporter in discs, was measured by quantitative RT-PCR, and cell death was assessed by TUNEL assay.

Results: DMMB assay and Safranin-O staining both showed decreased disc GAG content in diabetic B6 Akita mice compared with that in age-matched nondiabetic Wt controls. Discs of B6 Akita mice also exhibited decreased level (~5 fold) of Glut1 mRNA and increased level of TUNEL-positive cells.

Conclusion: IVDs of diabetic B6 Akita mice exhibit an overall decrease in PG content and increased cell death. These changes correlate with a decrease in Glut1 gene expression. Experiments are being done to evaluate that increased cell death in the IVDs of B6 Akita mice is a result of diminished glucose uptake (decreased Glut1) in disc tissue. These diabetic mice may represent a useful model to explore the mechanism of how diabetes affects IDD through its impacts on glucose metabolism in disc tissue.

WST008. Serum Levels of the Pro-Inflammatory cytokines IL-6 and TNF-alpha Vary Based on Diagnoses in Individuals with Low Back Pain

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Introduction: Many intervertebral disc diseases cause low back pain (LBP). Pro-inflammatory cytokines and matrix metalloproteinases (MMPs) participate in disc pathology. This study examines levels of serum cytokines and MMPs in human subjects with diagnosis of disc herniation (DH), spinal stenosis (SS) or degenerative disc disease (DDD) relative to levels in control subjects. Comparison between subjects with DH versus other diagnoses (Other Dx, grouped from SS and DDD) was performed to elaborate a pathological mechanism based on systemic cytokine levels.

Material and Methods: Study participants were recruited from a spine neurosurgery practice ($n = 80$), back pain management practice ($n = 27$), or a control cohort ($n = 26$). Serum samples were collected prior to treatment and were assayed by multiplex assays for levels of IL-1β, IL-2, IL-4, IL-6, IL-8, IL-10, IL-12p70, IL-13, IFN-γ, TNF-α, MMP-1, MMP-3 and MMP-9. Inflammatory and degradative mediator levels were compared between diagnosis and treatment groups. Multivariate regression for relationships with age, BMI, pain duration and smoking history were also performed.

Results: Serum levels of IL-6 were significantly higher in LBP participants compared with controls. Participants with LBP due to Other Dx had significantly higher levels of IL-6 and TNF-α compared with DH and controls. Positive correlations were found between BMI and IL-6 levels, and TNF-α levels were positively correlated with age and BMI.

Conclusion: The findings of the current clinical study are the first to examine systemic cytokine levels in DDD and SS and provide evidence for a more extensive role of IL-6 and TNF-α in disc diseases and LBP, where patients with DDD or SS have even higher serum cytokine levels compared with those with DH or control subjects. These findings may assist in refining personalized diagnosis using systemic biochemical profiling of disc diseases.

WST009. Compression Loading Induced Cellular Stress Response of Intervertebral Disc Cells in Organ Culture

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Introduction: Mechanical stress is often associated to interverterbal disc (IVD) degeneration and the effect of mechanical loading on IVD has been studied and reviewed.[1,2] Previously, expression of heat shock proteins, HSP70 and HSP27 has been found in pathological discs.[3] However, there is no direct evidence on whether IVD cells respond to the mechanical loading by expression of HSPs. The objective of this study is to investigate the stress response of IVD cells during compressive loading in an organ culture.

Materials and Methods: Fresh adult bovine caudal discs were cultured with compressive loading applied at physiological range. Effect of loading type (static and dynamic) and repeated loading (2 hours per day for 2 days) were studied. Nucleus pulposus (NP) and annulus fibrosus (AF) of the IVD were retrieved at different time points: right after loading and right after resting. Positive control discs were heat shocked (43°C). Cell activity was assessed and expression of stress response genes (HSP70 and HSF1) and matrix remodeling genes (ACAN, COL2, COL1, ADAMTS4, MMP3 and MMP13) were studied.

Results: Cell activity was maintained in all groups. Both NP and AF expressed high level of HSP70 in heat shock groups, confirming their expression in response to stress. In NP, expression of HSP70 was up-regulated after static loading and dynamic loading with higher fold change was observed after static loading. During repeated loading, HSP70 appeared to be upregulated right after loading and decreased after resting. Such trend was not observed in AF and HSF1 levels. Expressions of matrix remodeling genes did not change significantly with loading except ADAMTS4 decreased in AF during static loading.

Conclusion: This study demonstrated that NP cells upregulate expression of HSP70 in response to loading induced stress without changing cell activity and matrix remodeling significantly.

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WST010. Aberrant DNA Methylation Important Factor in Intervertebral Disc Pathophysiology

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Introduction: Intervertebral disc (IVD) degeneration is one of the most important aging health problems and a leading cause of disability. However, little is known about pathophysiology of this condition. This study investigates the role of epigenetic factor in intervertebral disc gene regulation.

Material and Methods: IVD tissues were obtained from donors undergoing anterior lumbar discectomy procedures. The collected tissues were minced and immediately used for cell isolation by sequential enzyme digestion. The demethylation agent 5-azacytidine (5-AzaC) was used to inhibit DNA methylation in IVD cells. The cells were then analyzed for change in DNA methylation using Methyl-Profiler PCR array. We used Methyl-Profiler PCR array containing developmental and cell cycle regulatory genes. The Methyl-Profiler PCR arrays were performed as per manufacturer's instructions. Briefly, the cells were treated with and without 5-azaC for 4 days, and genomic DNA were isolated. Then the equal amounts of genomic DNA were overnight digested with methyl-specific restriction digestion enzyme, nonspecific restriction enzyme, a combination of methyl specific and non-specific, and a control mock digestion. Following digestion, real time PCR was performed using biorad-MyiQ cycler. The data was analyzed according to manufacturer's instructions.

Results: Methyl-Profiler PCR array showed novel genes hypo-methylated following 5-azacytidine treatment. We found that around 6 genes' promoters differentially methylated after experimental demethylation in IVD cells. The genes differentially methylated are CCND2, CDH1, HIC1, MGMT, PRDM2 and TP73. Real time PCR showed these genes were differentially regulated relative to control.

Conclusion: There are reports that these differentially methylated genes have a role in various age related degenerative diseases. We speculate that these genes may also play an important role in intervertebral disc degeneration. It would be interesting to investigate the expression of these genes and their methylation pattern in aging human degenerative IVD. In summary, our results suggest that demethylation of IVD cells may be one of the factors involved in IVD degeneration. Further studies are required to confirm our findings and to better understand the effects of aberrant DNA methylation on IVD biology and disease pathophysiology.

Osteo: Molecular Agents and Cell Based Therapy

WO009. Safety and Efficacy of i-FACTORTM Bone Graft in Anterior Cervical Discectomy and Fusion: A Prospective, Randomized, Controlled, Multi-Center, Investigational Device Exemption Study

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Introduction: The objective of the study was to evaluate i-FACTOR Putty and local autologous bone in a non-inferiority model when applied in instrumented ACDF using a structural allograft ring in subjects with cervical degenerative disc disease. I-FACTOR Putty is a composite bone graft material consisting of a synthetic peptide (P-15) adsorbed onto anorganic bone mineral (ABM). The P-15 fragment is a short chain peptide that mimics a cell binding domain of Type I collagen, that facilitates cell attraction, attachment and activation on the ABM scaffold.

Material and Methods: A prospective, randomized, controlled, multi-center trial was designed to investigate the safety and efficacy of i-FACTOR Putty against an autograft control group. The pre-determined statistical plan was that the i-FACTOR Putty was non-inferior to autologous bone. Twelve-month evaluations were considered to be the primary endpoint. Primary endpoints chosen for the purpose of this study included radiographic evidence of fusion, neurological, outcomes, functional outcomes, and assessment of complication rates. A blinded, independent third party was utilized to assess safety, radiologic outcomes, and neurologic outcomes.

Adult patients with radiographic evidence of degenerative disc disease and with evidence of a history of arm/shoulder pain, decreased reflexes, decreased strength, and/or abnormal sensation were randomized for inclusion in this trial.

Surgeons performed an anterior cervical discectomy. The control arm received an allograft ring filled with autologous bone. The investigational arm received an allograft ring filled with i-FACTOR Putty. Successful arthrodesis was based upon radiographic examinations and neck disability index (NDI) was scored as the absolute difference between the baseline and the 12-month scores. Neurological status was determined by comparing the preoperative status to maintenance or improvement over the twelve-month period. Adverse outcomes were also assessed. Overall success was judged by success in all primary endpoints.

Results: A total of 313 patients participated in the study (161 pts.-i-FACTOR Putty: 152 pts.-Autologous bone). Preoperative patient demographics were statistically similar in both populations. The study demonstrated the non-inferiority of i-FACTOR Putty compared with autologous bone for fusion status, change in NDI, and neurological success at 12 months. Fusion rates were 89% in the i-FACTOR Putty group and 86% in the Autologous bone group ($p = 0.0004$ for non-inferiority test). NDI scores improved a mean of 29 points in the i-FACTOR Putty group and 27 points in the Autologous bone group ($p < 0.0001$ for non-inferiority test). The neurological success rates was 94% in the i-FACTOR Putty group and 93% in the Autologous group ($p < 0.0001$ for non-inferiority

test). The proportion of subjects with any adverse event at 12 months was not different between both groups ($p = 0.8814$). The overall success rate was significantly higher in the i-FACTOR Putty group than the Autologous bone group. The proportion of subjects who achieved fusion success, NDI success, neurological success, and safety success was 69% in the i-FACTOR Putty group and 58% in the Autologous bone group ($p = 0.0382$).

Conclusion: In summary, the above data strongly support the safety and effectiveness of i-FACTOR Putty for its anticipated intended use. The i-FACTOR Putty subjects demonstrated a high rate of fusion, improvement in pain and function, similar adverse event rates to the Control group, and a low rate of subsequent surgeries or device-related adverse events.

WO010. Mesenchymal Stem Cells Harvested from Vertebral Body and Iliac Crest Bone Marrow: Are They Equally Good? Comparison of Two Tissues and Two Harvesting Techniques

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Introduction/Objectives: Clinical applications of Mesenchymal Stem Cells (MSCs) harvested from bone marrow (BM) are well established. Iliac crest (IC) is considered to be the gold standard. Vertebral body (VB) BM represents an alternative source, promoting bone fusion in spinal operations. Existing literature, comparing ICBM and VBBM MSCs, presents limitations. Density gradient centrifugation (lymphoprep, Lmp) for BM processing is used, despite the known effectiveness on ICBM, of the red cell lysis technique (ammonium chloride, AC). This study compared the yield and differentiation capacities of MSCs in VBBM and ICBM, and evaluated the effectiveness of two harvesting procedures on both BM sources.

Patient/Methods: Eighteen patients undergoing idiopathic scoliosis surgery were recruited (median age 15.4 years, range 13–17). BM was aspirated intraoperatively from IC (10ml) and 12th thoracic vertebra (10ml). Aspirates were processed using AC and Lmp. MSCs were enumerated using standard CFU-F assay. Colony areas, MSCs doubling rates and outcomes of the differentiation assays were statistically analyzed.

Results: AC yielded more leukocytes from ICBM ($23x10^6$cells/ml), compared with VBBM ($14.4x10^6$cells/ml, $p = 0.013$). Lmp yielded similar numbers of mononuclear cells from ICBM ($7.5x10^6$cells/ml) and VBBM ($5x10^6$cells/ml).

More MSCs were harvested from 1ml of BM aspirate using AC technique, from both anatomical sites (IC: Lmp 199MSCs/ml, AC 367MSCs/ml, $p = 0.012$; VB: Lmp 296MSCs/ml, AC 440MSCs/ml, $p = 0.043$). There were no significant differences in MSC numbers/ml and average colony areas between the sites (IC: AC 14mm^2, Lmp 15mm^2; VB: AC 11mm^2, Lmp 13mm^2) or MSCs doubling rates in days (IC: AC 2, Lmp 1.9, VB: AC 1.9, Lmp 1.8).

Calcium production, after 14 days of osteogenic induction, was higher in VBBM MSCs with both harvesting methods (AC: 15-fold, $p = 0.003$, Lmp: 6.6-fold). Adipogenic differentiation, measured by Nile-Red absorbance on day 21 post-induction, was not significantly different between two BM sources. Glycosaminoglycan (GAG) production, after 21 days of chondrogenic induction, was higher in VBBM MSCs (AC 2.1µg/ml, Lmp 3.7µg/ml) compared with ICBM (AC 1.2µg/ml, Lmp 2.9µg/ml), but not statistically significant.

Conclusion: AC results in more effective MSC isolation and does not affect MSCs' proliferation and differentiation. Compared with ICBM, VBBM is richer in MSCs with osteo- and chondrogenic differentiation capacities and can therefore represent the first choice for MSC harvesting in spinal surgery.

WO011. Generation of a Vascularized, Scaffold Free Bone Graft by Direct Transdifferentiation of Fat Tissue

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Introduction: Bone grafts play an important role in spinal fusion surgery. Despite tremendous research efforts, synthetic or biological grafting materials equaling autologous bone habe not been developed so far. One of the major reasons is the achievement of sufficient graft vascularization. Aim of the presented study ist to test the concept of an autologous, scaffold-free, vascularized bone graft by converting the patient´s fat tissue into bone.

Methods and Materials: 10 fat tissue biopsies deriving from surgical waste material were used for the experiments. Samples were washed in sterile saline solution and divided into two parts. Part A served as control group and was cultivated in DMEM-F12 medium supplemented with 10% fetal calf serum and 2 mM L-Glutamine. Part B was transdifferentiated in toto using osteogenic differentiation medium and cultivated at 37°C, 95% humidity and 5% CO_2 for 3 weeks. Histological evaluation of tissue mineralization was performed using H/E, van Kossa and Alizarin Red staining. Mineralization was quantified and angiogenesis and tissue integration were evaluated using the chick chorionallantoic membrane assay. Quantitative analysis were performed in triplicates. Statistical evaluation was performed using the Student´s T-Test at a 0,05 level of significany.

Results: The osteogenic transdifferentiated fat graft showed an increase in collagen content and signs of mineralization as indicated by positive van Kossa and Alizarin Red staining. Average Calcium OD/mm sample was 50 for the transdifferentiated grafts after 3 weeks vs 24 for the corresponding control tissue ($p < 0{,}005$). Transplantation onto the chick chorionallantoic membrane demonstrated excellent tissue integration and connection to the recipients vascular system after 5 days in vivo. Numerous small blood vessels were visible within the graft. Despite the deprivation of osteogenic differentiation factors, the osteogenic phenotype was maintained after heterotopic implantation.

Conclusion: The patient´s own fat tissue can be transdifferented toward an osteogenic phenotype i*n vitro* and demonstrates excellent angiogenetic properties after in vivo implantation without losing the osteogenic phenotype. A transdifferentiated fat pat might therefore have the potential to serve as a fully autologous, vascularized graft to enhance osteogenesis in spinal fusion surgery.

WO012. Role of Bone Marrow Mesenchymal Stem Cells Concentrate Using Selective Retention Cell Technology in Posterolateral Spinal Fusion

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Introduction: With increasing rate of spinal fusion, the problem of pseudarthrosis which contributes to recurrent pain with patient disability is considered to be the most common cause of revision lumbar spine surgery. Intensive research is being performed to develop an alternative source of bone grafting and improve the spinal fusion rate.

Purpose: Was to evaluate the long-term clinical and radiological outcome of the use bone marrow mesenchymal stem cell concentrate obtained with selective cell retention technology using Cellect (Depuy Spine, USA) with a particular collagen scaffold, Healos (Depuy Spine, USA) for posterolateral spinal fusion.

Patient and Methods: Retrospective review of the hospital records was performed. Then, the identified patients were contacted to have a clinical and radiological evaluation follow-up visit. Demographic data were reported. Preoperative diagnosis, surgical procedure report, previous spine surgery, postoperative complications and any re-operations were registered. Clinical outcome was evaluated using visual analog scales for the back pain (VAS), Oswestry Disability Index (ODI) scores, and quality of life (EQ-5D) questionnaire. Radiological outcome was evaluated by performing plain radiographs including anterior-posterior and dynamic flexion/extension lateral views. Segmental Cobb angle of the fused segment was calculated in the flexion/extension lateral views. Any implant associated complication, development of adjacent segment degeneration and any alteration of normal spinal curvature were reported. Computed tomography (CT) scans were also performed.

Results: All patients (100%) achieved successful fusion. The mean difference of the segmental Cobb angle was 0.5°, ranging from 0.3°-0.7°. CT scans showed solid bilateral fusion with bridging bone (Grade I) in all patients but solid unilateral fusion with bridging bone (Grade II) was detected at 1 patient at one level. Patients started to resume working activities within a mean period of 3.5 months. The VAS score for the residual back pain was 4.2 ±2 while the ODI was 10.7± 5.6 points with the mean disability index was 21.4%.

Conclusion: The use of bone marrow mesenchymal stem cells concentrate obtained with selective cell retention technology is shown be an effective mean for augmentation of spinal fusion.

Osteo: Carriers and Bone

WO013. The BMP2-variant L51P Enhances the Osteogenic Differentiation of Human Mesenchymal Stromal Cells in the Presence of Intervertebral Disc Cells

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Introduction: Discectomy and spinal fusion represents the gold standard treatment for spinal surgery to relieve pain. Fusion can be hindered, however, for yet unknown reasons that lead to non-fusions with pseudo-arthrosis. We previously showed that the intervertebral disc (IVD)-derived cells hinder the ossification process of human bone marrow-derived stromal cells (hMSC).[1] Within this study, we hypothesized that BMP-antagonists secreted by IVD cells are the factors responsible for such inhibition and this can be reversed by addition of L51P. L51P is an engineered BMP2 variant that has been recently demonstrated to be a generic antagonist of a variety of BMP-inhibitors that control osteoinduction of bone.[2,3]

Material and Methods: The experimental work was ethically approved and written consent of patients was obtained. hMSCs, primary nucleus pulposus (NPC) and annulus fibrosus cells (AFC) ($N = 6$) were obtained from patients undergoing spinal surgery, isolated and expanded in monolayer cultures up to passage 3. IVD cells were seeded in 1.2% alginate beads (4M/mL) and separated by culture inserts from MSCs in a co-culture (CC)-set-up. The allogenic CCs were paired in 11 repeated experiments. MSCs were kept in 1: control medium (±alginate beads), 2: osteogenic medium+NPC (±100ng/mL L51P) and 3: osteogenic medium+AFC (±L51P) for 21 days. Relative gene expression of bone-related markers and of BMP antagonists such as noggin and members of the DAN (differential screening selected gene aberrative in neuroblastoma) family were quantified with qPCR, and histological staining for calcium deposition and Alkaline Phosphatase (ALP) assay were performed. The endogenous expression of the BMP-antagonists in IVD cells (passage 1) was evaluated by immunohistochemistry.

Results: Osteogenesis of MSCs was hindered as shown by reduced alizarin red staining in the presence of NPC and AFC. However, L51P added to CCs of MSCs with either NPC or AFC induced mineralization by blocking the activity of the IVD cell's secreted BMP-antagonists. It was noted that L51P caused a general reduction in ALP activity in all experimental groups. ALP activity was significantly up-regulated in positive control, CCNPC, and in CCAFC+L51P relative to negative controls, suggesting osteogenesis in these groups. CCNPC+L51P was significantly different from positive control but not CCNPC+L51P and CCAFC+L51P suggesting a reduction of the ALP activity. For the relative gene expression of potential BMP inhibitors (i.e., chordin, gremlin, noggin and TWSG-1), RNA and protein level using qPCR and immunohistochemistry confirmed expression of these BMP-antagonists inside the cells.

Conclusion: Alizarin red staining revealed an inhibition of the osteogenic differentiation of MSCs in CC with NPC or AFC. L51P could rescue osteogenesis of MSCs in the presence of NPC and AFC. Addition of L51P caused a general reduction in the ALP activity after 21 days of culture. L51P could thus be an attractive therapeutic treatment for spinal fusion, where it

could enhance bone formation in the presence of NP and AF tissue.

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WO014. Postoperative Complications Associated with rhBMP2 use in Posterior Lumbar Fusion

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Introduction: The growing number of degenerative conditions in aging population has contributed to the increased rates of lumbar posterior spinal fusion (PLF). While PLF has been shown to be effective for the treatment of various different spinal disorders, variations in surgical technique (such as bone graft used) for PLF have potential for different complication profiles. Human recombinant bone morphogenetic protein 2 (rhBMP2) is a bone graft material commonly used in the US to enhance spinal fusion rates after PLF. There are some reports of complications related to the use of rhBMP-2 in PLF arising from relatively small case series. Aim of our study was to quantify the frequency of various complications in elderly patients undergoing PLF with and without rhBMP2.

Material and Methods: We queried the orthopaedic subset of the Medicare database (PearlDiver) between 2005 and 2011. Current Procedure Terminology (CPT) codes were used to identify patients undergoing PLF procedures with and without rhBMP2, and International Statistical Classifcation of Diseases 9 (ICD-9) codes were used for complications. Complication and re-operation rates were analyzed within 1 year after the index procedure. Complications included: Acute Renal Failure, Deep Vein Thrombosis, Dural Tear, Hematoma, Heterotopic Ossification, Incision and Drainage, Myocardial Infarction or other cardiac complication, Nerve, Osteolysis, PLF Reoperation, Pneumonia, Pseudoarthrosis, Pulmonary Embolism, Radiculopathy, Respiratory Complications, Sepsis, Urinary Retention, Urinary Tract Infection, Mechanical (failure of other internal orthopedic device, implant, and graft) and Wound Complications. Chi-square analysis was used to calculate the complication differences between the groups.

Results: There were 20,143 patients who underwent a PLF from 2005–2011, and 27% (5421) of those cases received rhBMP2, while 73% (14722) had the PLF procedure without it. The majority of PLF cases were female (62%) and 65–69 years of age (27%) patients. The overall complication rate was similar between the rhBMP2 and no-rhBMP2 groups, 78.8% and 76.4%, respectively. However, most of the complications had a significantly lower rate in the rhBMP2 group compared with the no-rhBMP2 group (Dural tear 2.2% versus 3%; Incision and Drainage 6.9% vs 7.8%; Myocardial Infraction 3.8% vs 4.4%; Nerve 1.1% vs 2%; Pulmonary Embolism 2.2% vs 2.8%; Radiculopathy 9.4% vs 11.1%; Sepsis 3% vs 3.9%; Wound 8.2% vs 9.6%, respectively). Complications that were in the rhBMP2 group were Mechanical 8% vs 6.2%; Pseudoarthrosis 3% vs 1.8%; Urinary retention 9.9% vs 8.7% ($p < 0.05$) and Urinary Tract Infection 30.30% vs 29.60%. Interestingly, heterotopic ossification, demonstrated less than 11 patients in both groups.

WO015. Peptide Amphiphile Nanogel as an Improved BMP-2 Carrier for Spinal Arthrodesis

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Introduction: Advances in biologics have led to improvements in spine fusion rates, but a commercially available bone graft substitute that elicits high bony fusion rates with minimal adverse effects is yet to be developed. Recombinant human bone morphogenetic protein-2 (rhBMP-2) is FDA-approved for delivery on an absorbable collagen sponge (ACS), and promotes spine fusion at rates of $> 90\%$ in humans. However, the supraphysiologic dose required to elicit these high rates of fusion can lead to serious complications. In prior work, we found that nanofiber scaffolds composed of self-assembling peptide amphiphiles (PA) are improved carriers relative to ACS, with the ability to reduce the dose of exogenous growth factor necessary for spine arthrodesis by a factor of 10. We have also shown that assembling a PA nanogel on ACS improves the handling properties of the nanogel without compromising bioactivity. The purpose of this study was to develop a novel PA-based growth-factor carrier that would further reduce the amount of rhBMP-2 necessary to achieve high spine fusion rates, while simultaneously improving ease-of-delivery. We hypothesized that assembling a carboxyl-rich E3-PA nanogel with a slurry of Type I collagen particles would yield a malleable paste with improved growth factor delivery in a spine fusion setting.

Material and Methods: Female Sprague-Dawley rats underwent L4-L5 posterolateral spine fusion (PLF) with one of two experimental scaffolds: 1) E3PA-collagen slurry scaffold; or 2) E3PA/ACS. Scaffolds were preloaded with either saline or 100 ng rhBMP-2 (per animal). A negative comparative control group received ACS + 100 ng rhBMP-2. Bone regeneration and spine fusion were assessed using radiographs, fusion scoring, microCT imaging, and histology. Fusion scores were determined by blinded manual palpation using an established scoring system: 0 = no bridging bone, 1 = unilateral bridging,

and 2 = bilateral bridging bone. Spines with an average score of $\geq$ 1.0 were considered successfully fused.

Results: When preloaded with 100 ng rhBMP-2, the E3PA/collagen slurry elicited a significantly higher mean fusion score relative to both equivalently pre-loaded ACS ($p < 0.001$) and E3PA/ACS ($p < 0.01$). Successful fusion was seen in 100% of animals treated with E3PA-collagen slurry + 100 ng rhBMP-2 (12/12 animals), which was significantly higher than fusion rates of both ACS + 100 ng rhBMP-2 (0%) and E3PA + 100 ng rhBMP-2 (8%) treatment groups. Use of the E3-collagen slurry for rhBMP-2 delivery reduced the growth factor requirement by 100-fold relative to the positive control in this model (10 µg rhBMP-2/ACS, which yields a fusion rate of 100% in the rat).

Conclusion: Exogenous growth factors, such as rhBMP-2, have the potential to significantly improve bony fusion rates. However, concerns regarding the safety of supraphysiologic concentrations of rhBMP-2—which are required for efficacy when delivered on ACS—make the development of improved growth factor delivery systems attractive. This study examined the growth factor delivery capacity of a PA nanogel/collagen slurry composite scaffold in a lumbar spine fusion setting. We found that delivery of rhBMP-2 using an E3PA-collagen slurry scaffold reduces the requirement for growth factor by a 100-fold relative to ACS in the rat PLF model.

WO016. Effect of Riluzole on Human Bone Marrow Stromal Cells and Osteoblasts

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Introduction: Acute spinal cord injuries (SCIs) cause significant worldwide morbidity and mortality, with an overall prevalence of ~750 injuries per 1,000,000 people. Currently no pharmacologic adjuvant has been repeatedly demonstrated to lead to improved neurologic outcomes after these injuries, however preliminary studies suggest that Riluzole, a sodium channel-blocking medication, may be neuroprotective in patients with an acute SCI. Because long-term outcomes after an SCI may be compromised if a solid fusion is not achieved, it is critical to determine the effect of riluzole on bone formation. This study investigated the effects of riluzole on human bone marrow derived mesenchymal stromal cells (MSCs) and human primary osteoblasts (OBs).

Material and Methods: For cell viability testing MSCs and OBs were seeded in 96-well plates at 7,500 cells/cm^2. After 24 hour, the cells were treated with osteogenic medium containing different concentrations of riluzole (50 ng/mL; 150 ng/mL; 450 ng/mL). Control groups of MSCs and OBs were cultured without riluzole. After two and seven days, cell viability was determined using the Cell Titer Blue assay (Promega).

For quantification of Alkaline Phosphatase (ALP) activity, MSCs and OBs were plated in 24-well plates (10,000 cells/cm^2) and cultured for 2 days in basal medium. Then they were treated with standard osteogenic differentiation medium. Control groups and experimental groups that were exposed to different concentrations of riluzole (50 ng/mL; 150 ng/mL; 450 ng/mL) were cultured. After 7, 14, 21 and 28 days, the cell layers were extracted with 0.1%Triton-X in 10 mM Tris-HCl (pH 7.4), and ALP activity was measured using the Sigma Kit (No.104) according to the technical protocol. ALP activity was normalized to the DNA content of the respective sample (CyQuant, Invitrogen). All experiments were performed in triplicate for two MSC donors and two OB donors.

Results: The applied concentrations of riluzole had no influence on the cell viability of MSCs or osteoblasts after seven days. There was also no clear effect of riluzole supplementation on the proliferation of the MSCs or OBs. In MSCs, the ALP activity per DNA appeared to peak one week earlier with lower doses of riluzole compared with the highest dose of riluzole used in the study; while this trend was not observed in the case of OBs. For MSC donor 1, highest levels of ALP/DNA were noticed at day 7 (70.2 ± 30.4 and 60.8 ± 11.9 mmol/g*min for 50 and 150 ng/mL riluzole, respectively); for MSC donor 2, ALP/DNA levels peaked at day 21 (43.0 ± 8.6 and 80.6 ± 26.5 mmol/g*min) for 50 and 150 ng/mL riluzole groups, while in the 450 ng/mL group highest levels were observed at day 28.

Conclusion: Early clinical trials suggest that riluzole may lead to improved neurologic function in patients who sustain an acute SCI, and the results of the current study suggest that low dose riluzole has no effect on the viability or function of either MSCs or OBs; however, the delayed peak of ALP in MSCs exposed to a high dose of riluzole may indicate that high doses of riluzole may slow osteogenic differentiation.

Disc: Cell-Based Therapy

WO017. Disc Regeneration Using MSC Transplanted via the Endplate Route

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Introduction: Stem cell based intervertebral disc (IVD) regeneration is quickly moving toward clinical applications.[1] However, many aspects need to be investigated to routinely translate this therapy to clinical applications, in particular, the most efficient way to deliver cell to the IVD. Cells are commonly delivered to the IVD through the annulus fibrosus (AF) injection. However, recent studies have shown serious drawbacks of this approach[2–4] suggesting that intradiscal injection through the AF route itself is not completely innocuous and may disable the treatments to therapeutic agents delivered. As an alternative we have described and tested a new surgical

approach to the IVD via the endplate-pedicles (transpedicular approach). The Purpose of the study was to test MSCs/hydrogel transplantation for IVD regeneration in a grade IV preclinical model of IDD on large size animals via the transpeducular approach[5] with cell dose escalation.

Material and Methods: Adult sheep ($n = 18$) underwent bone marrow aspiration for autologous MSC isolation and expansion. MSC were suspended in autologous PRP and conjugated with Hyaluronic Acid and Batroxobin at the time of transplant (MSCs/hydrogel). Nucleotomy was performed via the transpedicular approach under fluoroscopy[6] in four lumbar IVDs and that were injected with 1) hydrogel, 2) Low doses of MSC/hydrogel [5x10^6 cell/ml] 3) High doses of MSC/hydrogel [1x10^7 cell/ml], 4) no injection (CTRL). The endplate tunnel was sealed using a polyurethane scaffold.[7] X-ray and MRI were performed at baseline and 1,3,6,12 months. Disc height and MRI indexes were calculated at each time point. Disc macro- and micro-morphology were analyzed at each time point.

Results: The MRI index showed a significant decrease in the untreated group, the disc injected with hydrogel and those injected with low MSC dose compared with healthy discs in all time points. The discs treated with high dose of MSC showed maintenance of the MRI index compared with the healthy disc. Morphologically, the grade of degeneration evaluated using the Thompson grade system[8] was in agreement with the grades observed at the MRI. The High MSC dose treated discs demonstrated abundant cartilage formation at 3 months, and to a lesser extent at 6 and 12 months. For the carrier and low MSC dose treated groups, however, there was less proteoglycan matrix.

Conclusion: An effective dose of autologous MSC [1x10^7 cell/ml] delivered via the alternative transpedicular approach regenerates the NP in a preclinical model of grade IV IDD. These data highlight as the disc regeneration can be achieved maintaining the AF intact via the end-plate route. This preclinical study has high translational value as large animal model with the long fallow up were used, MSCs were expanded in GMP facility simulating the clinical scenario, and the hydrogel were composed of clinically available drags and materials.

This study bring a significant contribution toward the translation of regenerative therapies for the biological restoration of degenerative changes in the IVD, which is crucial to improve present clinical treatment and life quality of several patients.

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WO018. Heterochronic Parabiosis Approach: is it Possible to Interrupt the Aging Process of the Intervertebral Disc Degeneration? An in vivo Experimental Study

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Introduction: Low back pain is a chronic health problem. It is the most common cause of limited activity. 90% of people worldwide will develop low back pain during their life. It is due, in the most cases, to the intervertebral disc degeneration (IDD). The first cause of IDD is aging. In all tissues aging is a condition characterized by mutations and genome instability, mitochondrial dysfunction, oxidative damage and consequential decline of cellular functions. Decline in tissues function is related to the loss of stem cells. These characteristics translate into different pathologies, with increasing costs for the healthcare system. In 2050 around 2 billion people worldwide will be older than 65. People are living longer but they are not healthier. Worldwide research is focused on identify the molecular pathways that can regulate expression of pro-survival networks. The purpose of this study was to determinate whether blood chimerism with a young wild type mouse (WT) could delay or reverse aging in a prematurely aging mouse model (Ercc1-/Δ). Blood chimerism was obtained by way of parabiosis, an experimental method in which two animals are surgically connected and develop a united circulation.

Material and Methods: 3 kinds of parabiotic pairs were generated: WT + WT at 40 days old (hisochronic parabiosis), Ercc1-/Δ + Ercc1-/Δ at 64 days old (hisochronic parabiosis) and WT + Ercc1-/Δ (heterochronic parabiosis). After surgery the couples develop anastomosis that make possible the blood chimerism. Administration of a dye (Evans blue) and fluorescent nano-beads into a single symbiont animal were used to test shared circulation in the parabiosis couples. Mice were sacrificed after 4 weeks; entire intervertebral discs were removed from the surrounding vertebral bodies by an incision along the endplate. Lumbar discs from each mouse were analyzed histologically and for nucleous polposus protein content. Expression of pro-survival networks in senescent cells and in stem cells were analyzed.

Results: Compared with the hisochronic controls, Ercc1-/Δ mice heterochronically paired with young WT mice had a significally improved protein content in the disc (95% CI). Histological analysis (EE & SaffO) revealed an improvement in the disc for the Ercc1-/Δ individual in the

heterochronic pair relative to the hisochronic ones. We observed a reactivation of stem cells when exposed to younger serum and a migration of young stem cells to the old mice (using GFP protein expressed in the younger mouse). Furthermore μCT highlighted an improvement of the bone quality.

Conclusion: These results indicate that spine of the progeroid mice were rejuvenated in the older mice when exposed to a serum derived from younger organism. Senescent cells secrete pro-inflammatory cytokines, and chemokines, which together constitute the senescence-associated secretory phenotype. We believe that stem cells are quiescent in old organism and that the environment can reactivate them. Moreover this factor can attract young stem cells from the young mice. The factor responsible for this, this elixir of youthful, although currently unidentified, could potentially be used as an effective treatment to rescue IDD as well other pathologies connected to aging.

WO019. Mesenchymal Stem Cell Treatment of Disc Lesion Prevents Fatty Infiltration and Fibrosis, but not Muscle Fibre Transformation of the Multifidus Muscle

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Introduction: The multifidus muscle undergoes structural and behavioral changes with back pain and injury. After intervertebral disc (IVD) lesion in animals the multifidus muscle undergoes a transformation of muscle fiber types from slow-to-fast, and extensive structural remodelling with increased adipose and connective tissue. Increased expression of pro-inflammatory cytokines (tumor necrosis factor (TNF) and interleukin 1β (IΛ−1β)) parallel these changes and may be responsible. Treatment of IVD lesions with mesenchymal stem cells (MSC) prevents or restores loss of IVD height and proteoglycans in the nucleus pulposus, depending on the timing of application. Whether the resolution of IVD changes by MCS treatment prevents or restores changes in the multifidus muscle structure and muscle fiber composition is unknown. This study aimed to investigate whether muscle changes are prevented or restored by early or late MSC treatment of the IVD lesion, respectively, and whether this is related to modification of inflammatory cytokine expression.

Material and Methods: The L1–2 and L3–4 IVDs of 18 sheep received left anterolateral partial thickness annular lesions. Six control sheep underwent no surgery. At four (3-month ($n = 6$) and 6-month acute ($n = 6$) treatment groups) or twelve (established ($n = 6$) treatment group) weeks after initial surgery, animals received MSC injections (0.2ml) to the operated IVD. Three (3-month acute treatment group) and six (6-month acute and established treatment groups) months after initial surgery the L4 multifidus muscle was harvested for muscle fiber type analysis using immunohistochemistry and evaluation of cross sectional area (CSA) of muscle, adipose and connective tissue using standard histology. L2 muscle was harvested for quantitative PCR measures of pro-inflammatory cytokine gene expression (TNF, IΛ−1β).

Results: Unlike the response to IVD lesion without MSC treatment (increased connective tissue and adipose CSA), acute MSC treatment prevented increase in adipose (acute treatment=control at 3- and 6-months; $p = 0.28$ and $p = 0.07$) and connective tissue CSA (acute treatment < control at 3-months; $p < 0.001$, acute=control at 6-months; $p = 0.39$). This paralleled reduced expression of IL-1β at 3-months (acute treatment versus control; $p < 0.001$). MCS treatment of established treatment animals restored adipose and connective tissue CSA (established treatment=control at 6 months; $P > 0.60$). The effect of MSC on muscle CSA depended on the treatment timing. At 6 months, acute treatment animals had *larger* whole muscle CSA than controls ($p = 0.002$). Control and established treatment animals did not differ ($p = 0.73$). Despite optimistic data for tissue CSA, muscle harvested at 6 months showed reduced proportion of slow muscle fibers and increased intermediate fibers throughout the multifidus muscle (acute and established treatment group versus control; $p < 0.05$). TNF expression was greater at 6 months in acute and established treatment groups than control ($p < 0.001$).

Conclusion: These results indicate that MSC treatment of the IVD lesion prevents and restores muscle structural changes, but is unable to prevent changes to multifidus muscle fiber type. This is likely to have functional relevance for neuromuscular control of the healed IVD. MSC appear to have and anti-inflammatory effect on muscle in the early phase when IVD is healing, but cannot influence the later elevation of TNF, which appears destructive for muscle fibers.

WO020. Tissue-engineered Total Disc Replacement: In vivo Outcomes of a Canine Cervical Disc Study

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Introduction: Despite being effective, the most commonly performed treatments for degenerative disc disease (DDD), fusion and prosthetic total disc replacement, still pose risks of pseudoarthrosis, implant dislodgement, and adjacent segment disease.[1–3] Tissue engineered intervertebral discs (TE-IVD) are an alternative treatment option for DDD, and have been previously developed by our group as a biological TDR device.[4] Presently, we evaluate the surgical conditions that promote implant stability and in-vivo efficacy of our TE-IVDs in a translational beagle cervical spine model.

Material and Methods: TE-IVD Construction: TE-IVD components were constructed in vitro using either annulus fibrosus (AF) or nucleus pulposus (NP) cultivated canine disc cells; the collagen gel based composite AF enclosed an alginate gel based composite NP, as previously described.[4] *Experimental and Surgical Protocol:* 14 skeletally mature beagles underwent discectomy with whole IVD resection at a level between C3/4 and C6/7, and were divided into two groups: a solely discectomized control ($n = 2$) and a TE-IVD implanted group ($n = 12$). Discectomy and TE-IVD implantation were performed under segmental distraction. Implant stability was evaluated upon distraction release at the end of the procedure. *Imaging:* Postoperative imaging was performed with conventional X-rays and high-resolution 3-Tesla MRI under full anesthesia. Disc height indices were measured on X-rays using a pre-established method. [5] All MRIs were analyzed both qualitatively and quantitatively in accordance to T2-weighted images. Utilizing a novel algorithm developed by our group, we filtered out all MRI voxels unrepresentative of NP tissue using their T2-relaxation time (T2-RT), sequestering the extent of NP hydration based on the mean T2-RT within the NP voxel.[6] *Histological assessment:* Animals were sacrificed either at 4 or 16 weeks. Histological staining was obtained using Safranin-O for proteoglycans. *Statistics:* A Chi-Squared test was performed to determine the correlation between implant stability and surgical level or posterior longitudinal ligament (PLL) resection. For the analyses of continuous outcomes in

disc height index, NP size, and NP hydration, we employed linear regression models with a generalized estimating equation and robust standard errors to estimate differences in mean changes from baseline controls (discectomy) across displaced and stable implantation groups.

Results: TE-IVDs that demonstrated displacement of over 25% TE-IVD volume upon distraction release were defined as "displaced" implants and the remaining were termed as "stable" implants. There was a correlation between implant stability and surgical level but not between implant stability and PLL resection, with implants at C3/4 having the greatest stability ($p < 0.05$). Quantitative X-ray and MRI assessments showed that only the stable implants had significant retention of disc height and NP size as well as NP physiological hydration compared with discectomy controls. Both 4- and 16-week histology demonstrated that implanted TE-IVDs yielded AF-like and NP-like tissues in the treated segment. Integration into host tissue was confirmed over 16 weeks without any signs of immune reaction.

Conclusion: Despite significant biomechanical demands of the beagle cervical milieu, our in vivo TE-IVDs, when implanted successfully, maintained their position, structure and hydration in addition to disc height over 16 weeks.

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WO021. Improvement of Bovine Nucleus Pulposus Cells Isolation Leads to Identification of Three Phenotypically Distinct Cell Subpopulations

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Introduction: Strategies to promote intervertebral disc (IVD) regeneration have been hindered by the lack of knowledge of IVD fundamental cellular/molecular components. One of the key points to be addressed is the characterization of nucleus pulposus (NP) cell population(s). This study establishes an improved method for bovine NP (bNP) cell isolation, whose procedure is still not consensual among the literature, allowing a thorough characterization of cell (sub)populations that exist in the young NP.

Material and Methods: bNP was digested with distinct enzymes (collagenase-type-I, collagenase-type-II, and collagenase- type-XI) at different concentrations (0.5, 1.0, and 2.0 mg/mL), for 4 and 19 hour. Cell yield, viability/apoptosis, and morphology were analyzed by flow cytometry and imaging flow cytometry. Identification of cell subpopulations within NP and its phenotype was investigated by assessing expression of CD29, CD44, CD45, CD34, CD146, and Brachyury.

Results: It was found that bNP cells present a similar morphology independently of the digestive enzyme used. However, cell yield was greatly improved by Coll-XI (2 mg/mL) treatment for a short digestion period. Interestingly, three subpopulations, with different sizes and auto-fluorescence, were consistently identified by flow cytometry. And crucially, differential expression of cell markers was found among these subpopulations.

Conclusion: This study demonstrated that collagenase-type-XI is an efficient enzyme that is used for digesting bNP. And most importantly, three phenotypically distinct subpopulations of cells where identified within the bNP. Such knowledge is key for a better understanding of NP cell biology and its potential endogenous regenerative capacity.

WO022. Contribution of Hypertrophic Chondrocytes to the Homeostasis of Annulus Fibrosis in Normal and Degenerative Intervertebral Discs

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Introduction: Annulus fibrosis (AF) is a lamellar structure surround the central nucleus pulposus (NP) in the interverterbral discs, the outer AF composed of fibroblast-like cells and anchored to the bone of the vertebral body and the cells within inner AF (iAF) is more chondrogenic and the lamellae are anchored onto the cartilage endplate (cEP). From histology of human, rabbit and mouse IVDs, there appears to be a continuum of cells invading from cEP to iAF. Degenerative conditions such as compressive loading may lead to cell death in AF, however, how the cells are replenished in the damaged tissue is not understood. Using genetic tools in mice, we show that hypertrophic chondrocytes (HCs) in the cEP are a source of iAF cells in postnatal life of mouse and in repair processes following static compression of the disc.

Material and Methods: Cell lineage tracing in mice was performed using a tamoxifen-inducible Cre recombinase (CreERT) under the regulation of the endogenous Col10a1 promoter with specific expression in HCs in the cEP. When crossed with Rosa26lacZ reporter mice, a single dose of tamoxifen injection will labeled a specific pool of HCs and their date followed in vivo. Snail2, Twist1, E47-E2A and Tgfb2 (genes in the EMT pathway) were analyzed by immunohistochemistry. For static compression, tail of 8-week-old Col10a1-Cre; ROSA-tdTomato double mutant mice were bend laterally, the distal coccyx (level 13) was affix with the proximal coccyx (level 5) forming a loop and maintained for 5 weeks to apply an asymmetrical loading to the discs. Apoptosis were detected with the TUNEL assay and the HC-descendent cells (tdTomato+) were visualized with fluorescent imaging.

Results: One week after injection of tamoxifen to Col10a1-CreERT; Rosa26lacZ mice, only round cells (HCs) in the cEP were detected to be lacZ+, no cells in the iAF was labeled. Three weeks after injection, flattened lacZ positive cells were detected in the iAF, indicating these cells are originated from the cEP. These cells become more migratory, with rearrange cytoskeletal structure, becoming flattened cells and reside within the iAF. These cellular morphological changes are consistent with the criteria of EMT that are involved in various developmental processes and key markers such as Snail2, and Twist1 are all positive to the cells undergoing this HC-iAF transition. In the asymmetric tail-looping model, robust apoptosis of iAF cells was detected in the compressive side but not the extended side after 5 weeks of looping. More HC-descendent cells (tdTomato+) transited from the cEP to the iAF compare with the control disc without looping during the compression period.

Conclusion: We demonstrated that HCs in cEP act continuously as the progenitor cells contributing to the iAF during normal development. We showed an EMT-like mechanism might be involved to this HC-iAF transition. Mechanical compression but not distention induces cell death in the AF, but more HC transit to iAF as part of the repair process in the unlooping period. Thus, HCs in the cEP may act as source of progenitor cells for iAF. Understanding the differentiation of these cells will provide valuable information for therapeutically treatment for disc repair or bioengineering of AF tissues in the future.

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WST011. Intervertebral Disc Maintenance and Repair Potential in Mice with Different Repair Potential

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Introduction: Intervertebral disc (IVD) degeneration is a major cause of back pain, affecting quality of life. Current treatments are limited to salvage surgical operations. Biological treatments to relieve symptoms or restore disc are not available as we know little about the biology of disc degeneration and its potential to repair/regeneration. While most people will develop disc degeneration with aging, there are individuals who are protected even at old age, suggesting the presence of protective genes. Progenitor cells within the IVD are thought to play important roles in disc homeostasis. A hypothesis is that genetic factors can confer a protection against disc degeneration via better maintenance of endogenous progenitor cells. There exist strains of "healer" mice (LG/J, MRL/MpJ) with superior repair potential of cartilaginous tissues. We propose to study the maintenance of the IVD tissues in healer mice and assess potential relationship to progenitor cells, extracellular matrix and inflammatory response changes, to degeneration and repair/regeneration processes.

Materials and Methods: "Healer" (MRL/MpJ) and "poor healer" (C57/BL6C) mice were used in this study. Histological comparison of tail disc was assessed from 8 to 24 weeks of age. Different NP cell populations and ECM markers were assessed using immunohistochemistry with specific cell markers. Tail-looping at 8-week of age for a fixed period was used as an environmental perturbation that will induce degeneration. Unlooping the tail after certain period of looping can assess repair processes with appropriate controls.

Results: A comparison of MRL and C57 mice showed neither observable histological differences, nor signs of degenerative processes from 8-week to 24-week of age. Following tail looping for 4, 5, 6 and 8 weeks, there were significant distortion of the annulus fibrosus (AF) and NP at the compressed side, in terms of NP cell loss, AF tears and ruptures, and cell death in the AF. After the tails were unlooped for 4 weeks or 8 weeks, there were restorations of NP and AF structures in both strains of mice. However, superior repairing was seen in MRL mice at all time-points studied, in which the disc structure restored better via continuous expansion of NP region, cell repopulation and lamellae orientation recovered in the compressed AF sides with a clear NP-AF boundary. In C57 mice, the AF lamellae structure remained disorganized following unlooping. NP cell population analysis including Tie2, GD2, Sox9 and T showed different expression pattern in MRL and C57, from which showed that GD2 positive cells may be the functioning NP cell in disc maintenance. Besides, MRL maintained better Col I, Col II and aggrecan content during the repair processes. Interestingly, lower IL-1β was found in the "healer" mice, which suggested less inflammatory response may contribute to a better disc recovery after injury.

Conclusion: By comparing the genetically different "healer" and "poor healer" mice, we showed a population of novel marked NP progentiors that may play important roles in the maintaining and repair/regenerative of IVD. The better repairing features in the "healer" mice are associated with better functional cell population maintenance and less inflammatory response.

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WST012. Evaluation of Tissue Repair Using MRI Imaging of Human Intervertebral Discs Cultured in a Bioreactor

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Introduction: Low back pain is a major problem worldwide, affecting the quality of life for millions of people. Low back pain also has a tremendous impact on direct and indirect global healthcare costs. Intervertebral disc (IVD) degeneration has been strongly associated with low back pain. Long-term organ culture of human IVDs is essential to study IVD degeneration and repair. Using an ex vivo approach, the relationship between mechanobiology, disc matrix composition and metabolism can be better understood in the context of degenerative disease. We have developed a bioreactor where intact human discs can be cultured in a controlled dynamically loaded environment. Here, we aimed to determine the most suitable loading parameters for human discs culture by assessing IVD tissue integrity and cell viability under low, medium and high magnitude cyclic load. Furthermore, we investigated the suitability of this model toward cell supplementation strategies for tissue repair and developed a novel, single disc MRI imaging sequence aimed at direct visualization of tissue repair.

Materials and Methods: Human IVDs were isolated from lumbar spine segments as previously described. Spines were obtained with consent through the Transplant Quebec Organ Donation Program from individuals who had undergone sustained brain death. Discs were cultured under 3

different loading schemes to mimic a sedentary lifestyle: low 0.1–0.3, medium 0.1–0.6 and high 0.1–1.2 MPa loads. Cell viability and matrix stability was assessed following 10 days of loading. Feasibility of cell/hydrogel implantation was determined over 14 days of medium dynamic loading. To determine whether isolated discs could be imaged by MRI, extracted individual discs were visualized for T1 and T2 signals using a novel sequence using a small animal Bruker 7.5 Tesla MRI.

Results: Cell viability was maintained at greater than 80% throughout the discs at low and medium loads. Viability dropped to ~60–70% throughout the discs under high loads. Proteoglycan content remained stable in all loading protocols (~50 µg sGAG/mg tissue), as did CHAD and newly synthesized collagen II protein. To test for feasibility of cell therapies in the bioreactors, NP cells combined with a hydrogel were injected into discs and cultured under medium load. 14 days after dynamic culture, the injected cells were mainly localized to the NP region with greater than 90% viability. The small animal MRI was able to obtain well-defined images of isolated discs, with details of tissue integrity and proteoglycan content.

Conclusion: Our ex vivo model of dynamic human IVD culture can be used as a platform on which to study mechanisms of degeneration as well as for novel avenues aimed at biological repair using bioactive substances or cell based therapies. Cells and bioactive substances can be administered within hydrogels thereby enhancing the reparative properties. Furthermore, it is feasible to assess repair potential of the therapies by comparing MRI scans pre- and post-therapy.

WST013. Reproducible Disc Degeneration Scale in a Large Animal Model

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Introduction: To study the efficacy of novel regenerative strategies is necessary to develop new models that do not implement annulus fibrosus (AF) damage. We hypothesize an ideal preclinical model to study novel biological therapies for nucleus pulpous (NP) regeneration can be achieved by approaching the NP via the endplate (EP) route through a minimal invasive transpedicular approach.[1] The aim of the study is to characterize a preclinical ovine model triggering EP damage and repair with or without mechanical nucleotomy, while keeping the AF intact.

Material and Methods: Sheep ($n = 12$, 3 years old), were used. Throughout the transpedicular approach, a 2mm tunnel was drilled to the NP. Nucleotomy was performed using a shaver resector. The tunnel was sealed using a press-fit porous polyurethane (PU) cylinder. Five lumbar discs were assigned to different groups: EP tunnel (A); EP tunnel + nucleotomy (B); EP tunnel + repair with PU scaffold (C); EP tunnel + nucleotomy + repair (D); no treatment (E). X-ray and MRI was performed at 0, 1, 3 and 6 mths after. Disc height and MRI indexes were calculated and disc macro- and micromorphology were analyzed. MRI images and gross anatomy photographs were graded using both Pfirrmann[2] and Thompson[3] grading systems.

Results: MRI analysis showed a progressive decrease of NP signal intensity with different degrees of degeneration. According to Pfirrmann degenerative grade, the C group showed a grade II, group A appeared as grade III, group D looked as grade IV and group B appeared as grade V. Morphologically, all stages of the degenerative process from Thompson grade I to grade V were also observed with the same association. Histological analysis revealed progressive disc narrowing, fragmentation of the NP matrix in D and B group. The scaffold in the tunnel of C and D groups appeared colonized by cells without sign of bone formation at all time point. NP tissue was in the tunnel with infiltration of inflammatory cells in A and B groups.

Conclusion: A new preclinical model to study tissue-engineering strategies for NP regeneration has been developed and characterized by approaching the NP via the EP route through a minimal invasive transpedicular approach [1]. Keeping the AF intact, the different degrees of IDD have been observed according to Pfirrmann and Thompson grading system. The sealing of the tunnel prevents the NP to leak out of the disc space.

This represents a significant contribution toward the translation of new regenerative strategies for biological restoration of early and mild IVD degenerative.

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WST014. The Effect of Iodixanol on Human Intervertebral Disc Cells in vitro

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Introduction: The diagnostics of discogenic low back pain may employ also radioopaque contrast agents, such as iodixanol, which may cause cytotoxicity to intervertebral disc cells following the intradiscal injections, provoking or accelerating the degeneration process. As many studies so far have been accomplished on animal cells, the potential effects of these agents in humans still remain unclear. The study aim was to evaluate the effect of iodixanol on human intervertebral disc cells in vitro and to compare its cytotoxicity to saline solution control.

Material and Methods: From human lumbar intervertebral disc fragments obtained during discectomis, annulus fibrosus and nucleus pulposus cells were isolated, cultured on the microtiter plates and exposed to various concentrations of iodixanol. Saline was used as a control. Three different dilutions (undiluted, 1:2 and 1:4) of iodixanol were tested. After 6, 24 and 48 hours, viability was determined.

Results: A time and dose depended response to iodixanol exposure was observed. The nulceus pulposus cells were more susceptible than annulus fibrosus cells to its toxic effects. Iodixanol was cytotoxic in all three tested concentrations (undiluted, 1:2 and 1:4) with the cell survival of 0%, 8% and

14%, respectively. Necrosis, rather than apoptosis, was the main reason for such devastating effects.

Conclusion: In iodixanol, commonly used for discography, the cytotoxic effects were observed in a dose- and time-dependent manner. According to our study, concentrated iodixanol is best avoided due to its high toxicity. Although 1:4 dilution was least toxic and may be thus recommended for the intradiscal diagnostics, the high dilutions are questionable due to loss of resolution yield. We assume the toxic effects of the contrast agents used may also contribute to disc degeneration, culminating to progressive tissue damage after the diagnostic measures.

WST015. The Expression of Keratin 19 in Intervertebral Disc Degeneration and Aging

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Introduction: Low back pain (LBP) affects 80% of the whole population around the world and causes great social-economic burden. Intervertebral disc (IVD) degenerates with aging and is a major contribution to LBP. Mature NP (nucleus pulposus, the center part of IVD) cells are similar to, but not the same as, chondrocytes. The search for NP markers has prompted the proposal of keratin-19 as one of the NP markers mainly based on its transcriptional level.[1] In our previous study, among all the investigated. keratin-19 is the most downregulated gene in degenerated human NP. [2] In this study, we aim to track the changes in the protein expression of keratin-19 in disc degeneration and aging process with human clinical specimens and rodent models of induced degeneration and natural aging.

Material and Methods: The corresponding informed patient consent and institutional review board (IRB) approval and animal ethics approval was obtained from the relevant committee. Human IVD were collected from patients with disc degeneration (graded IV-V at the Schneiderman scale) undergoing discectomy or during corrective scoliosis surgery. Rat induced degeneration model was established by needle puncture as described previously.[3] Mice ranged from date of birth to 2 years old were used to represent natural aging in rodents. The expression of keratin-19 was investigated by immunochemical staining. Keratin-19 positivity was determined as the number of keratin-19 positive cells divided by the total number of cells per whole section.

Results: Keratin-19 expression was detected in both NP and AF (annulus fibrosus) of degenerated and non-degenerated human IVD. The signal of Keratin-19 was exclusively intracellular. Cells within a cluster showed heterogeneous expression for Keratin -19. Degenerated human NP contains significantly less Keratin-19 positive cells when compared with non-degenerated human NP (D-NP versus ND-NP: 13.87 $\pm$ 1.27% versus 29.99 $\pm$ 4.68%, $p = 0.016$). In healthy rat, Keratin-19 was found to be strongly expressed in the NP but not in the AF. A minor portion of cells in the cartilaginous EP (endplate) was also Keratin-19 positive. Keratin-19 positivity remained at a similar level post injury in the NP, but were induced in the AF after puncture. In aging mice, at P0, Keratin-19 showed strong expression in the vacuolated notochordal NP cells and in the cartilage anlage of vertebrae bodies, with no expression in the AF. From P0 to 18 months of age, Keratin-19 remained expressed at a relatively constant level in the NP constituted by large vacuolated notochordal cells. By 24 months of age, Keratin-19 expression decreased in the NP.

Conclusion: We found that although Keratin-19 was significantly decreased in human degenerated NP, it only showed a mild decrease or otherwise unchanged expression in rodent models of progressive disc degeneration and aging. Since Keratin-19 is also a notochordal cell marker,[4] it may reflect that notochordal cells are still present in the aged mouse NP and during the mild stage of degeneration in the rat model. To our knowledge, this is the first investigation into the expression and location of keratin-19 in different IVD aging/degeneration systems.

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WST016. Radiological, Histological and Biochemical Characterization of a Novel Ovine Lumbar Intervertebral Disc Injury Model

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Introduction: Numerous animal models of degenerative disc disease exist. Debate exists as to the ideal animal model and optimal method of inducing degeneration. The ovine lumbar spine is one accepted animal model of degenerative intervertebral disc disease. The goal of this study is to describe and characterize a novel, simple, reproducible ovine disc-injury model utilizing a drill bit inserted into the lumbar intervertebral disc to mimic disc degeneration.

Material and Methods: Six female sheep underwent pre-operative MRI followed by lumbar intervertebral disc injury at two levels via insertion of a 3.5mm diameter drill bit to a depth of 12 mm via a lateral retroperitoneal approach. Necropsies were performed two months following injury. Lumbar spines were explanted and underwent 9.4T MRI, radiographic imaging, gross morphological, histological and biochemical analysis. Gross morphologic assessment consisted of horizontal section of the intervertebral disc, digital photography of the surfaces. Biochemical analysis was performed for sulphated glycosaminoglycans, type I and type II collagen and DNA. Histological analysis utilized a semiquantitative grading system.

Results: There was no evidence of disc degeneration on pre-operative MRI. Drill bit injured discs demonstrated increased Pfirrmann degenerative scores relative to controls and pre-operative scores. Injured levels demonstrated significantly greater reductions in Disc Height Index than control levels. Gross morphological assessment similarly revealed significantly higher degenerative morphological scores in injured disc relative to pre-operative scores and controls. On biochemical analysis the annulus fibrosus (AF) at the entry point in injured discs contained less type II collagen and proteoglycans than the AF of non-injured control discs. Histological

assessment demonstrated increased degenerative scores in injured disc on semiquantitative scoring.

Conclusion: These finding demonstrate that the 3.5mm drill bit ovine lumbar intervertebral-disc injury model produced macroscopic, radiological, biochemical and histological changes consistent with disc degeneration.

WST017. Hif-3α Fine-tunes Extracellular Matrix Production in Nucleus Pulposus Cell under Hypoxia

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Introduction: Nucleus pulposus (NP), the gelatinous tissue core in the intervertebral disc (IVD), is enriched with extracellular matrix type II collagen (encoded by *COL2A1*) and aggrecan (encoded by *AGC1*). Dysregulation of extracellular matrix proteins in the NP is tightly associated with disc degeneration, ultimately leading to a loss of mechanical function in motion segments.[1] Expression of SOX9, the major chondrogenic transcription factor for *COL2A1* and *AGC1* gene activation, was evidenced in the normal and degenerated human NP, but weak in the annulus fibrosus (AF) region.[2] Considering the virtually avascular characteristic of the NP, NP cells are regulated within a hypoxic microenvironment. Among the family of hypoxia inducible factor-α subunits (HIF-α), HIF-1α and HIF-2α (EPAS1) have been well illustrated as important transcription factors in maintaining disc cell and matrix homeostasis, particularly in the NP.[3–5] However, the understanding of HIF-3α, the dominant negative regulator of HIF-1α,[6] in IVD is limited. Here, we hypothesized that HIF-3α may regulate the SOX9-dependent transcription of the extracellular matrix genes in NP cells under hypoxia. We aimed at characterizing the sub-cellular expression patterns of HIF-1α and HIF-3α in mouse IVD tissues and human NP cells cultured under different oxygen tensions. Moreover, we tested the modulatory effects of HIF-1α/HIF-3α on the expression of *Col2a1* and *Agc1* using Sox9-expressing mouse prechondrocytic cells as a model.

Materials and Methods: All animal and human works were approved by local ethical committee. IVD were harvested from wild-type C57BL/6N mice at 3 and 6 months-old. Lumbar IVD of scoliosis patients were collected under informed consent. Cells were harvested by digestion with 0.5 × of TrpLE Express (*Gibco*) 37°C, 30 minute and 0.25mg/ml Collagenase II (*Gibco*) 37°C, 90 minute in DMEM-HG (*Gibco*). Human NP cells were expanded in DMEM-HG supplemented with 10% fetal bovine serum. Subsequently, human NP cells were subjected to ambient oxygen tension (21% O_2) or intermediate hypoxia (5% O_2) or extreme hypoxia (1% O_2) for 72 hours prior to fixation or RNA collection. Immunohistochemistry staining of Hif-1α and Hif-3α was studied with mouse IVD paraffin sections and different sub-cellular locations of HIF-1α, HIF-3α and SOX9 expression were identified by immunofluorescence in human NP cells cultured under different oxygen tensions. To determine transcriptional activity of *Col2a1* and *Agc1*, luciferase-based promoter assays on specific *Col2a1* or *Agc1 cis*-acting elements with the overexpression for each of the HIF-α subunits and/or Sox9 in ATDC5 cells were performed.

Results: Hif-1α and Hif-3α expression pattern was identified in mouse NP, AF and endplate (EP) tissue. Expression of HIF-1α and SOX9 was detected in the nuclei of human NP cells independent of different oxygen tensions. Strikingly, induction of HIF-3α expression in nuclei was observed in human NP cells cultured under hypoxia (5% and 1% O_2) versus normoxia (21% O_2). Additionally, *AGC1* gene expression was reduced in human NP cells cultured under hypoxia in comparison with normoxia. Furthermore, luciferase-based promoter assay showed that Hif-3α overexpression inhibited the Sox9–dependent transcriptional up-regulation of *Col2a1* and *Agc1*.

Conclusion: Our findings illustrated that induction of HIF-3α in human NP cell nuclei was evidenced in hypoxia versus normoxia. We further demonstrated that Hif-3α has a function in inhibiting Sox9-mediated transcriptional regulation of *Col2a1* and *Agc1* in prechondrocytic cells, implicating a possible role of HIF-3α in fine-tuning the extracellular matrix protein production in NP cells under hypoxia. Detailed molecular mechanism of HIF-3α in regulating human NP cell and matrix homeostasis under hypoxia warrants further investigations.

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WST018. The Relationship between HELQ Expression and Intervertebral Disc Degeneration

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Introduction: Degeneration of the intervertebral disc, mainly of nucleus pulposus, is strongly implicated as a cause of low back pain. However, the mechanism of disc degeneration is not clear. This study is to investigate the expression level of HELQ protein in nucleus pulposus tissues and the relationship between HELQ expression and intervertebral disc degeneration.

Materials and Methods: A total of 84 samples of lumbar intervertebral disc degenerated of different degree were obtained from patients undergoing lumbar spinal surgery for low back pain. Degeneration degrees of all samples were classified by radiological and histopathologic methods. Immunohistochemistry (IHC) staining was performed to evaluate the expression level of HELQ protein in nucleus pulposus tissues. And the relationship between HELQ expression and

radiological degeneration grades, histopathological degeneration grades of nucleus pulposus were analyzed.

Results: HELQ was expressed in human nucleus pulposus. The expression level of HELQ protein was significantly lower in nucleus pulposus with higher degeneration degree than those with lower degeneration degree. And HELQ expression level had significantly negative correlation with radiological degeneration grades($r = 0.333$, $p =$ yyyy0.002) and histopathological degeneration grade ($r = -0.519$, $p = 0.000$).However, no correlation were detected between HELQ expression and age ($p = 0.374$), gender ($p = 0.063$) or segments ($p = 0.676$).

Conclusion: The results indicated that down-regulated expression of HELQ is a possible reason of intervertebral disc degeneration. Thus, targeting HELQ gene will be a new therapeutic strategy for patients with intervertebral discs degeneration.

Keywords: intervertebral disc degeneration, nucleus pulposus, HELQ, immunohistochemistry

WST019. The Intervertebral Disc Functional Cell Models: a New Revolution for in vitro Toxicology Testing

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Introduction: For diagnostics of discogenic low back pain, local anaesthetics are often used, which may be cytotoxic to intervertebral disc cells. Studies so far have been mainly performed on animal cells. The study aim was to evaluate the effect of local anaesthetics on human intervertebral disc cells in vitro.

Material and Methods: Annulus fibrosus and nucleus pulposus cells were isolated from human lumbar intervertebral disc fragments and exposed to various concentrations of lidocaine, bupivacaine and their mixture. Saline solution was used as a control. Three different dilutions (undiluted, 1:2 and 1:4) of anaesthetics were tested. The cells were treated for 6, 24 and 48 hours and examined with for viability.

Results: Nulceus pulposus cells were more susceptible than annulus fibrosus cells to the toxic effects of both anaesthetics. Lidocaine was more toxic with the final cell survival fraction of 0%, 10% and 20%. Bupivacaine presented less cytotoxicity with the final survival of 10%, 60% and 80%. Lidocaine-bupivacaine mixture showed an intermediate toxicological effect.

Conclusion: Human intervertebral disc cells in vitro are useful for various toxicology tests. They are a valuable model for testing of anesthetic agents. According to the analysis, lidocaine and its mixtures should be avoided due to its high toxicity to the intervertebral disc cells. Bupivacaine was less toxic, especially in 1:4 dilutions and may be recommended for the intradiscal diagnostics.

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WO023. Exploratory Study for Identifying Systemic Biomarkers that Correlate with Pain Response in Patients with Intervertebral Disc Disorders

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Introduction: Molecular events that drive disc damage and low back pain (LBP) may precede clinical manifestation of disease onset and can cause detrimental long-term effects such as disability. Biomarkers serve as objective molecular indicators of pathological processes. The goal of this study is to identify systemic biochemical factors as predictors of response to treatment of LBP with epidural steroid injection (ESI). Since inflammation plays a pivotal role in LBP, this pilot study investigates the effect of ESI on systemic levels of 51 inflammatory biochemical factors (cytokines, chemokines, and growth factors) and examines the relationship between biochemical factor levels and pain or disability in patients with disc herniation (DH), or other diagnoses (Other Dx) leading to low back pain, which included spinal stenosis (SS) and degenerative disc disease (DDD).

Material and Methods: Study participants ($n = 16$) were recruited from a Back Pain Management practice. Pain numerical rating score (NRS), Oswestry Disability Index (ODI), and blood samples were collected pre- and at 7 to 10 days post treatment. Samples were assayed for inflammatory mediators using commercial multiplex assays. Mediator levels were compared pre- and post-treatment to investigate the potential correlations between clinical and biochemical outcomes.

Results: Our results indicate that a single ESI significantly decreased systemic SCGF-β and IL-2 levels and increased levels of MMP3. Improvement in pain in all subjects was correlated with changes in chemokines (MCP-1, MIG), hematopoietic progenitor factors (SCGF-β), and factors that participate in angiogenesis/fibrosis (HGF), nociception (SCF, IFN-a2), and inflammation (IL-6, IL-10, IL-18, TRAIL). Levels of biochemical mediators varied based on diagnosis of LBP, and changes in pain responses and systemic mediators from pre- to post treatment were dependent on the diagnosis cohort. In the DH cohort, levels of IL-17 and VEGF significantly decreased and levels of MMP-3 and MMP-9 significantly increased post treatment. In the Other Dx cohort, levels of IL-2Ra, IL-3 and SCGF-β significantly decreased post treatment. To determine if mediator changes were related to pain, correlations between change in pain scores and change in mediator levels were performed.

Conclusion: Subjects with DH demonstrated a profile signature that implicated hematopoiesis factors (SCGF-β, GM-CSF) in pain response, while subjects with Other Dx demonstrated a biomarker profile that implicated chemokines (MCP-1, MIG) and angiogenic factors (HGF, VEGF) in pain response. Our findings provide evidence that systemic biochemical factors in patients with LBP vary by diagnosis, and pain response to treatment is associated with a unique profile of biochemical responses in each diagnosis group. Future hypothesis-based studies with larger subject cohorts are warranted to confirm the findings of this pilot exploratory study.

WO024. Analysis of Serum C-reactive Protein in Patients with Lumbar Disc Herniation

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Introduction: We measured the serum concentration of C-reactive protein (CRP) by a high-sensitive method in patients with lumbar disc herniation. The level and type of herniation were evaluated. Inflammatory cytokines, such as interleukins are produced at the site of disc herniation and are now considered responsible for the pain perceived by the patient.Thus, purpose of this study is to test whether HSCRP can stand as an objective tool to predict postoperative recovery in patients undergoing lumbar discectomy. That is, to study association between preoperative HSCRP blood level and postoperative recovery with the help of modified Oswestry Back Disability Score.

Materials and Methods: A study group consisting of 50 cases of established lumbar disc disease and control group of 50 normal subjects, matched with the study group. Both the study and control groups were subjected to detailed evaluation with the help of modified Oswestry Low Back Pain Scale both pre andpostoperatively at 4 months, 8 months and 1-year. The preoperative blood samples were analyzed to assess the HSCRP concentration. All the cases underwent surgery over a period .

Results: The level of HSCRP in the study group was between 0.050– and 0.710 mg/dL and in the control group, 0.005–0.020 mg/dL. There was highly significant positive correlation between preoperative HSCRP level and postoperative score at $p < 0.005$. Cases with HSCRP level in the range of 0.1820 ± 0.079 mg/dL, showed better recovery (score improved > 10 points), while those with HSCRP level in the range of 0.470 ± 0.163 mg/dL, showed poor recovery (score improved < 10 points).

Conclusion: The significantly high concentration of serum hs-CRP might indicate a systemic inflammatory response to impingement of the nerve root caused by disc herniation and might be a predictor of recovery after operation.

WO025. Proteomic Analysis of Degenerated Intervertebral Disc- identification of Biomarkers of Degenerative Disc Disease and Development of Proteome Database

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Introduction: Low back pain (LBP) is a leading cause of disability resulting from musculoskeletal disorders among general population. The life time prevalence of single episode of low back pain in general population is reported to be around 80%. It is a leading cause of loss of productivity and the resulting economic burden due to loss of productivity is enormous. Degenerative disc disease (DDD) is a leading cause for LBP however,molecular mechanism underlying DDD are largely unknown. To date, there are few reports available on Intervertebral Disc (IVD) proteomics.Hence, weundertook the analysis of the intervertebral disc using a proteomic based approach to develop a database which may be helpful to isolate probable biomarkers and better understand the molecular basis of DDD.

Methods: Sample for proteomic analysis was obtained during lumbar discectomy in a case of intervertebral disc prolapse from a 50 year old female. IVD tissue sample was pulverizedusing liquid nitrogen and proteins were extracted. Extracted proteins were subjected to Two-Dimensional Polyacrylamide Gel Electrophoresis (2D-PAGE) analysis. Reproducible and abundantly expressed proteins were analyzed using Matrix Assisted Laser Desorption/Ionisation- Time of Flight (MALDI-TOF)Mass Spectrometry. The peptide mass fingerprinting data from the MALDI-TOF were analyzed by MASCOT online tool for the identification of proteins. Database was developed based on the results obtained from the MASCOT analysis.

Results: Thirty protein spots were identified from the degenerated IVD tissue by proteomic profiling techniques. Out of these 30 proteins, 25 proteins showed significant matches against human proteins in the NCBI database; remaining 5 spots did not generate any significant matches. The proteins which showed a significant match provide authentic evidence of the presence of these proteins in the IVD. The database was developed based on a three layer architecture model which could help investigator identify target proteins consisting of presentation layer, application layer and the data storage layer. This database would prove useful in future proteomic research into DDD.

Conclusion: Following the genomic era, molecular analysis at the proteomic level is a developing technology. This technology has the scope to identify the functions of the differently expressed proteins, from control and degenerated discs and may provide an opportunity to design novel strategies to treat degenerative disc disease in the future. Our study provides early data in the field of proteomic profiling in the clinical disease scenario of DDD.

WO026. Intradiscal Injection of a Slow Release Formulation of Celecoxib for the Treatment of Dogs with Low Back Pain

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Introduction: Intervertebral disc (IVD) disease characterized by low back pain is common in both humans and large breed dogs. Inflammatory mediators such as prostaglandin E2 (PGE2) play a key role in IVD degeneration, causing structural changes of the IVD and low back pain. The current conservative and surgical treatment modalities do not reverse IVD degeneration and have certain drawbacks. Long term systemic administration of non-steroidal anti-inflammatory drugs can cause gastro-intestinal side effects. Decompressive surgery is effective in over 80% of the patients, but is rather costly and has a long recovery period. Injectable formulations that enable local sustained release of anti-inflammatory drugs aim at decreasing inflammation and thereby inhibiting degeneration and pain. In vitro, controlled release of celecoxib, a COX-2 inhibitor, from a thermoreversible acetyl-capped PCLA-PEG-PCLA hydrogel inhibited PGE2 production and enhanced matrix production for 28 days in 3D culture of canine nucleus pulposus cells that were subjected to the catabolic effects of TNF-α. In vivo, sustained release of celecoxib by the hydrogel for up to 60 days was shown and safely applied intradiscally in laboratory dogs with naturally occurring IVD degeneration. The aim of the present study is to report the safety and feasibility of intradiscal application in client-owned dogs with low back pain related to IVD degeneration.

Material and Methods: Client-owned dogs with low back pain were diagnosed by MRI with degenerative lumbosacral stenosis marked by mild to moderate IVD degeneration and protrusion. The dogs were surgical candidates but were offered intradiscal injection. The PCLA-PEG-PCLA thermogel, loaded with 0.013mg/ml celecoxib, was percutaneously injected into the nucleus pulposus of L7-S1 under fluoroscopy guidance. Follow-up consisted of clinical examination, owner questionnaires, and objective gait analysis by measurement of ground reaction forces (GRFs) using force plate analysis (FPA) at 6 weeks, and 3 and 6 months after injection. MRI was repeated after 3 months and included T2- and T1-weighted images and T2-mapping.

Results: Ten dogs with DLLS were injected with the celecoxib-loaded hydrogel. None of the dogs showed adverse reactions after intradiscal injection. Follow up MRI showed no worsening of the IVD degeneration. Clinical improvement was achieved by reduction of low back pain in 9/10 dogs, as was

shown by clinical examination, force plate analysis and owner questionnaires. In 3/10 dogs low back pain recurred at 3 months and they subsequently underwent standard-of-care surgical treatment.

Conclusion: This study showed the safety and feasibility of intradiscal injections with a thermoresponsive hydrogel loaded with celecoxib. Ongoing studies concentrate on the long term clinical follow up of these patients. Future studies will determine the optimal loading dose of celecoxib for clinical efficacy. In this setup, the dog can be used as a model for the development of novel treatment modalities in both canine and human patients with chronic low back pain.

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WO027. Degradome of the Interverteral Disc

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Introduction: The intervertebral disc (IVD) is a complex structure consisting of the nucleus pulposus (NP), annulus fibrosus (AF) and cartilage endplates (EP), which work collectively for proper disc function. Both aging and degeneration alter the biochemical and mechanical function of the IVD – potentially leading to degeneration, which is still not fully understood. In human IVD, sparsely populated cells embedded within the matrix are responsible for the production of matrix, of which its upkeep is important for disc maintenance and function. However, the processes involved with disc maintenance in the non-degenerated condition, versus those that lead to IVD degeneration remain to be identified. Moreover, the presence of reported enzymes in the IVD are likely to contribute to matrix changes by cleaving proteins, thereby altering protein function, and potentially disc function. Studying the degradome of the IVD may identify fragmented proteins and enzymes that degrade these proteins and elucidate events that occur in IVD maintenance versus IVD degeneration, of which cannot be identified by conventional mass spectrometry techniques. Here, we examined the degradome of non-degenerated and degenerated IVD using Terminal Amine Isotopic Labeling of Substrates (TAILS) which facilitates the enrichment of N-termini peptides of degraded protein fragments.

Material and Methods: NP and AF isolated from three non-degenerated IVD and three degenerated IVD were snap frozen and pulverized in liquid nitrogen. Samples were extracted with 1% SDS with protease inhibitor. N-terminal peptides were enriched using the TAILS method. Briefly, each sample was individually labeled with a Tandem Mass Tag (TMT) and mixed together at equal ratios. The pooled sample was digested with trypsin, and the peptides containing free amines were depleted by polymerization. Samples were analyzed by mass spectrometry (Bruker Daltonics Impact II QTOF), and data analyzed using Scaffold Software.

Results: Sixty-one peptides (corresponding to 61 protein fragments) were identified in the NP samples. Degenerate NP had more cleaved matrix proteins, including fibronectin, COMP, and lubricin. In non-degenerated NP, the cleaved proteins included collagen II and lysozyme. Ninety-one peptides (corresponding to 91 protein fragments) were identified in the AF samples. Degenerated AF had more cleaved matrix proteins including COMP and fibronectin, in addition to CILP and HAPLN1. Non-degenerate AF had more cleaved collagen I, II, and VI.

Conclusion: In degenerate AF and NP, the presence of more cleaved matrix proteins, particularly those that are associated with stability, can potentially lead to alterations in the mechanical properties and function of the IVD. Conversely, the cleaved proteins in the non-degenerate tissue could indicate turnover of proteins associated with maintaining a non-degenerate disc environment (such as collagen II in NP, and collagens I and II in AF). Understanding the degenerative process and maintenance of the disc via analysis of the degradome can highlight events that are occurring in health and in degeneration, in addition to the identification of enzymes that cleave these proteins, of which are currently in progress.

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WO028. Toll-like Receptor 2 Regulates Nerve Growth Factor Synthesis via NF-κB Signaling in Human Intervertebral Disc Cells

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Introduction: Intervertebral disc degeneration is a leading cause of chronic low back pain (LBP), but how degeneration contributes to LBP is poorly understood. Nerve growth factor (NGF) levels increase during disc degeneration and evidence suggests NGF promotes disc innervation, neuronal sensitization and low back pain, making NGF a possible therapeutic target. However, current anti-NGF therapeutics have limited efficacy and safety concerns. Mechanisms leading to increased NGF in the disc are poorly understood and the molecular signaling mechanisms regulating NGF in inflammatory mediator rich environments, such as a degenerating disc, are unknown. During degeneration, proteoglycans and extra-cellular matrix (ECM) proteins are degraded and fragmented. ECM fragments can act as endogenous danger signal ligands for toll-like receptors (TLR). TLR activation induces cytokine and chemokine expression, and could thus regulate expression of inflammatory mediators, such as IL-1β or TNFα, during disc degeneration. NGF is often increased in environments with elevated levels of inflammatory mediators. Therefore, we hypothesized that TLR activation in the disc induces NGF expression.

Materials and Methods: Non-degenerate human intervertebral discs from organ donors without a history of low back pain were collected for cell isolation. NP and AF tissues were separated and enzymatically digested. Cells were treated with IL-1β (control), peptidoglycan (PGN, TLR2 agonist) and lipopolysaccharide (LPS, TLR4 agonist). Neutralizing antibodies against TLR2 were used to prevent TLR2 activation. Activated cell-signaling pathways following IL-1β and PGN treatment were evaluated by western blot and immunofluorescence. Small molecule inhibitors blocking p38 MAPK (SB203580) and NF-κB (BMS-345541) activity were added to cell cultures in combination with IL-1β and PGN. NGF gene expression was evaluated by qRT-PCR after 6, 12 and 24 hours, and NGF protein levels were examined by western blot and ELISA after 48 hours.

Results: TLR 2 activation significantly increased NGF gene expression in NP and AF cells following 6, 12 and 24 hours of treatment, while TLR 4 activation had little effect on NGF expression. TLR 2 activation significantly increased NGF protein secretion after 48 hours in NP and AF cells while TLR 4 activation did not increase NGF protein levels. TLR 2 neutralization with antibodies showed that TLR 2 is required for PGN induced NGF expression. TLR 2 activation of the p38 MAPK, ERK1/2, JNK and NF-κB signaling pathways was analyzed using phosphorylation specific antibodies. TLR activation increased p38 MAPK, ERK1/2 and p65 (NF- κB pathway) phosphorylation in disc cells compared with untreated cells. Furthermore, immunofluorescence found that TLR activation induces p65 translation to the nucleus, indicative of NF-κB signaling. Inhibiting NF-κB signaling decreased TLR 2 induced NGF expression.

Conclusion: This study found that TLR 2 activation directly regulates NGF expression via NF-κB signaling in human intervertebral disc cells. These findings represent a novel regulatory mechanism of NGF in the IVD. In the central nervous system NF-κB distinct signaling pathways regulate NGF. Therefore, these finding may provide therapeutic strategies to target NGF and low back pain without affecting the central nervous system.

WO029. Differential Gene Expression Profiles of Cells from Normal, Traumatic and Idiopathic Scoliotic Discs Identify Molecular Dysregulation in Scoliosis

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Introduction: The etiology of the spinal deformity in idiopathic scoliosis is unclear to date, both with respect to initiation and progression of the disease. While the influence of certain genetic factors has been established, the role of the intervertebral disc (IVD) in the development of idiopathic scoliosis has scarcely been investigated. The aim of this study was to identify molecular differences between disc cells from patients with idiopathic scoliosis in comparison with trauma patients and healthy individuals. To address this aim, cellular gene expression profiles were analyzed by microarray and quantitative RT-PCR.

Material and Methods: Surgical samples from IVDs of patients with idiopathic scoliosis were obtained after informed consent and approval of the local ethical commission at the time of discectomy during spinal fusion surgery. The disorder and exact curve pattern were documented for further records. Control disc samples were obtained from trauma fusion cases and from organ donors with no known disc disorders according to local and institutional ethical guidelines. Annulus fibrosus (AF) and nucleus pulposus (NP) tissues were separated and cells were isolated by enzymatic digestion within 24 hours. Total RNA was extracted from the cells and subjected to Affymetrix GeneChip® expression profiling. Genes with significant differences between scoliotic and control samples were further analyzed using real time RT-PCR.

Results: After exclusion of RNA samples with insufficient quality or quantity, the following numbers of samples were used for microarray profiling: 10 AF and 6 NP samples from scoliotic discs; 5 AF and 4 NP samples from traumatic discs; 4 AF and 4 NP samples from healthy discs of organ donors. Microarray data revealed that 52 genes were more highly expressed in scoliotic *vs*. healthy AF and 26 genes in scoliotic *vs*. traumatic AF, whereby 21 genes showed higher expression in scoliotic AF compared with both control groups. In addition, 116 genes were more highly expressed in scoliotic *vs*. healthy NP, 45 genes in scoliotic *vs*. traumatic NP, and 40 of those in scoliotic NP compared with both control groups. Quantitative gene expression analysis by real time RT-PCR ($n = 6$ per group) confirmed significantly increased mRNA levels of S100A8, S100A12, MMP8, MMP13 and Collagen X in annulus fibrosus cells from scoliotic discs ($p < 0.05$; Kruskal-Wallis test of log2 transformed data).

Conclusion: Results of this study reveal significant changes in the gene expression profile of IVD cells from patients with idiopathic scoliosis compared with patients with traumatic disc damage or donors with no known disc disorders. MMP8 and MMP13 are important collagenases involved in disc matrix degradation; while elevated S100 calcium binding proteins may indicate an inflammatory reaction. Interestingly, MMP13 has also been up-regulated by imbalanced loading in an IVD organ culture model. Better knowledge of the dysregulation of structural or regulatory molecules may identify underlying mechanisms of spinal deformities, which will help defining new targets for early therapeutic intervention.

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WO030. Effects of Asymmetric Dynamic Loading on Intervertebral Disc – towards a Scoliosis Mimicking Organ Culture Model

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Introduction: The etiology of spinal deformity in idiopathic scoliosis is unclear to date. One of the suspected influences is the asymmetric loading condition involved in the disorder. The aim of this project is to test the hypothesis that asymmetric dynamic loading influences the morphological and biological characteristics of the intervertebral discs in scoliosis. The study is performed with organ cultured discs by using a custom-designed asymmetrical loading device.

Material and Methods: Bovine caudal discs (6–10 months) were used in current study. For symmetric dynamic loading (Parallel), discs were placed in custom-designed chambers, and compressed by parallel metal plates in a Bose mechanical testing device. For asymmetric dynamic loading (Wedge), a 10° wedge was placed underneath the discs to mimic the load bearing condition of discs in scoliotic patients. The discs were submitted to 2 different load regimes: (1) 1 hour dynamic loading (0.02–0.4 MPa, 1Hz) and 23 hours free swelling culture for 7 days; (2) 1 hour dynamic loading (0.02–0.4 MPa, 1Hz) and 23 hours static loading (0.2 MPa) for 7 days. Disc heights were measured with caliper before and after each loading. After 7 days of culture, gene expression levels of aggrecan (ACAN), type I and II collagen (COL1 and COL2), IL1, IL6, and MMP1 in the annulus fibrosus was analyzed by real-time PCR. Genes that have been found dysregulated in human scoliotic discs compared with healthy controls were also measured in the organ cultured discs, including MMP13, type X collagen (COL10), CXCR4, BMP3, S100A12, and S100A8 ($n = 8$).

Results: Disc height showed a constant drop in load regime 2, while a temporary decrease after 1h dynamic loading followed by free swelling recovery was noted in load regime 1. After 7th dynamic loading, the change in shape was greater in load regime 2 (disc height ratio wedged to non-

wedged side of 0.81), than that in load regime 1 (height ratio of 0.87, $p < 0.05$).

Under load regime 2, MMP13 gene expression level increased 6.1-fold in Wedge disc compared with Parallel disc, while gene expression levels of COL10, CXCR4, BMP3, S100A12, and S100A8 were not affected. Gene expression levels of ACAN, COL1 and COL2 under load regime 1 were significantly higher compared with load regime 2. Moreover, discs under load regime 2 showed a trend in higher IL1, IL6, and MMP1 gene expression compared with regime 1.

Conclusion: Diurnal dynamic loading and free swelling recovery could maintain the gene expression of organ cultured discs at their physiological level. Diurnal dynamic loading followed by static loading mimicked a degenerative condition, as indicated by lower anabolic and higher catabolic gene expression. These results suggest that recovery of disc height and morphology after dynamic load may help to prevent degeneration of discs under constant loading. Asymmetric dynamic and static loading regime induces an increase in MMP13 gene expression compared with symmetric loading, which was also observed in a human scoliosis sample dataset. These results indicate that short-term asymmetric loading may be used to mimic early changes associated with the onset of scoliosis.

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Posters

Basic Science: Other

WP001. Histopathological Features of Facet Osteoarthritis in Patients with Lumbar Spinal Stenosis

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Introduction: Lumbar spinal stenosis (LSS) is a degenerative, age-related narrowing of the lower spinal canal that causes pressure on the nerves, leading to pain and reduced mobility. Hypertrophy of ligament flava and facet joints combined with disc protrusions are a causative for LSS. Osteoarthritic changes to the facet joint, including joint space narrowing, subchondral cysts and osteophyte formation are commonly detected using magnetic resonance imaging (MRI) and computed tomography (CT) scanning. However, the pathomechanisms of facet joint osteoarthritis (OA) at a cellular and molecular level are poorly understood and have been scarcely studied. In this study we sought to investigate the histological features and to uncover cellular pathomechanisms of facet joint OA.

Material and Methods: Fifteen patients undergoing surgical decompression due to degenerative LSS were included in this study (9 female/6 male, median age 66, range 49–85). Routine preoperative X-ray and MRI scanning of the lumbar spine was performed in all subjects. Severity of facet joint OA was assessed in MRI images using the Weishaupt grading system for the lumbar spine. The medial portion of facet joints was collected during surgical decompression of the spinal canal and processed for tissue histology. Tissue morphology was evaluated using haematoxylin and eosin (HE), Safranin-O and van Gieson`s stains. The presence of macrophages, blood vessels and nerve fibers was investigated using immunohistological staining for their respective markers CD68, CD34 and PGP9.5. Functional osteoclasts were visualized using tartrate-resistant acid phosphatase (TRAP) staining. Subchondral bone area fraction (B.Ar/T.Ar) was determined using the ImageJ-plugin BoneJ.

Results: OA was evident in MRI images characterized by joint space narrowing, bone edema and cysts and hypertrophy of articular processes. The severe OA phenotype in facet joints from LSS patients was confirmed at a histological level by complete loss of proteoglycan staining, CD34+ vessel penetration, and fissuring of cartilage tissue. Subchondral B. Ar/T.Ar ranged between 0.6 and 0.8. In all samples, subchondral marrow spaces contained CD34+ blood vessels and CD68+ mononuclear macrophages. CD68+ multinucleated osteoclasts were detected in resorption pits at the bone surface in 80 percent of the patients. Functionality of osteoclasts was confirmed by positive staining of multinucleated bone cells for TRAP in serial sections. Osteoblast activity was demonstrated in 60 percent of the patients and predominantly characterized by large areas of intramembranous bone formation near the osteochondral junction. Formation of an osteoclast-rich pannus-like tissue was seen in one sample. Innervation of subchondral marrow spaces by PGP9.5-positive nerve fibers was scarce and exclusively found in the vicinity of arterioles.

Conclusion: Facet joints in LSS patients display radiological and histopathological features of OA. Two major OA phenotypes can be distinguished based upon cellular pathomechanisms in subchondral bone tissue: 1) osteoblast-rich intramembranous bone formation and 2) osteoclast/macrophage rich remodeling. Osteoimmunological mechanisms, specifically the interaction of CD68+ macrophages with bone-resident cells, play a – previously unknown – role in regulating subchondral bone sclerosis in progressive osteoarthritis. Targeting osteoimmunology might hold potential as a disease-modifying treatment for osteoarthritis.

Biomechanics: Other

WP002. Static Test of Flexo Compression in Posterior Thoracolumbar Spinal Fixation with Conical Cylindrical Screws

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Introduction: The aim of this paper is to describe the results obtained of a static test of flexo compression in polyaxial transpedicular conical cylindrical screws; which we have used for more than 20 years; in posteriors thoracolumbar spine fixings based on the ASTM F 1717–04 standard. This trial was made at the National Institute of Industrial Technology at its Center for Research and Development in Mechanical in Buenos Aires, Argentina.

Material and Methods: Two spinal fixation systems were evaluated, both composed by transpedicular conical soul and cylindrical thread screws, bars and tulips. In Table 1 the information provided by the manufacturer of the screws and identification adopted in the test for each sample is presented.

Table 1 Sample identification

APPLICANT IDENTIFICATION	QUANTITY	MATERIAL	CODE	LOT	DIMENSIONS	IDENTIFICATION ADOPTED
PEDICULAR SCREW	4	TITANIO GRADO 5 F136	M22-0645	M22-PG212	DIAMETER 6,5 mm LENGHT= 45 mm	O18565-1
BAR	2	TITANIO GRADO 5 F136	MBT-05120	MBT-H0112	DIAMETER = 5,0 mm LENGHT = 120 mm	
TULIPS	4	TITANIO GRADO 5 F136	M22-CP	M22-CP0122	SHORT	
PEDICULAR SCREW	4	TITANIO GRADO 5 F136	M22-0645	M22-PG212	DIAMETER = 6,5 mm LENGHT= 45 mm	O18565-2
BAR	2	TITANIO GRADO 5 F136	MBT-05120	MBT-H0112	DIAMETER = 5,0 mm LENGHT= 120 mm	
TULIPS	4	TITANIO GRADO 5 F136	M22-CP	M22-CP0122	SHORT	

A universal testing machine Tinius Olsen H50-KT was used for the study. The proposed paragraph 8.1.1 of ASTM F1717–04 procedure was followed. The assembly of the samples was performed using the steps proposed by us, the tulips were set at the distance established by the Standard and the terminal screw of them was set by applying a torque of 10 Nm. The assays were performed at a speed of 10 mm / min and were interrupted when the load drop was observed in the instant graphic verifying in this way the loss of poliaxiality. The test setup used and the location of the devices during the test are shown in Fig. 1.

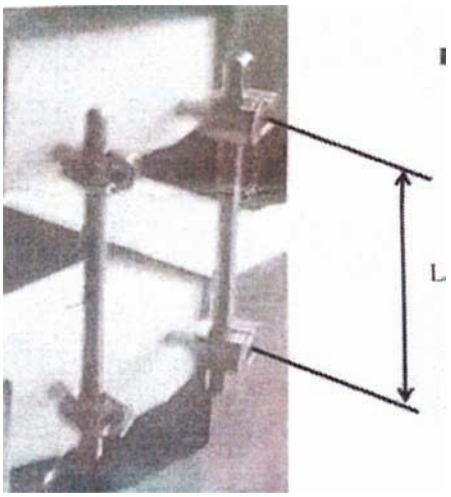

Fig. 1 Test configuration used.

The active length of longitudinal component (L) was revealed (see Fig. 1). From this value the corresponding displacement of 2% of the permanent deformation was calculated, Point B =Lx 0, 02 (see Fig. 2). From the assay were obtained (see Fig. 2): The Load-displacement curve; The fluence load flexo-compression (N) (point D); The fluence displacement 2% (mm) (point A)

the elastic displacement (mm): difference between the value of point A and point B.

Elastic displacement = Point A-Point B

the flexo-compression rigidity (N / mm): ratio between the loading of flexo-compression fluence and the elastic displacement.

Rigidity = Point D

Point A – Point B

the final displacement (mm), and

the final load (N)

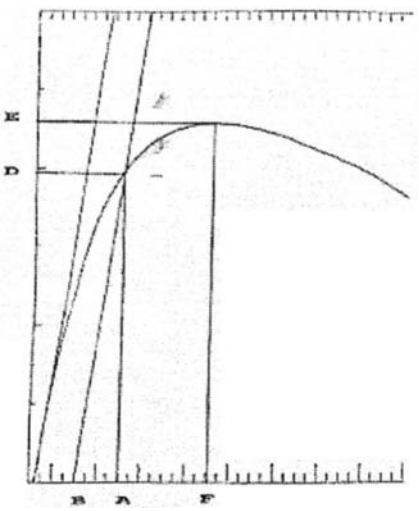

Fig. 2 Typical load-displacement curve.

Results: Fig. 3 shows the curve Load versus Displacement obtained for samples 018565- (1–2)

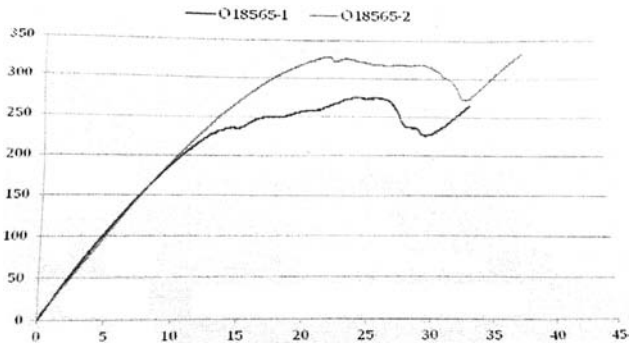

Fig. 3 Curve load versus displacement obtained.

In Table 2 the results are described.

Table 2 Assay results

SAMPLE	L	MOVEMENT 2% OF L	FLUENCE LOAD	FLUENCE MOVEMENT	ELASTIC MOVEMENT	MOVEMENT FOR MAX. LOAD	MAX. LOAD	RIGIDITY	MAX. LOAD WITHOUT LOSING POLIAXIALITY
	[mm]	[mm]	[N]	[mm]	[mm]	[mm]	[N]	[N/mm]	[N]
O18565-1	76,0	1,52	227	12,9	11,4	25,4	275	19,9	237
O18565-2	76,0	1,52	263	14,8	13,3	38,8	333	19,8	327
AVERAGE	-	-	245,0	-	-	-	-	19,85	282
DEVIATION STD	-	-	25,45	-	-	-	-	0,070	63,64

Conclusion: Screws and prisoners remained adjusted and there were not apparent permanent deformation in any of the system components. Its cylindrical thread and conical soul provides a high strength profile improving primary fixation and the resistance to the pull out. The major diameter of the soul in the pedicle region increases the bending and the resistance in fixations without arthrodesis preventing the breaking of the screw. All tests were performed within the framework of Management System for Quality Assurance of INTI-Mechanics.

Degenerative Lumbar

WP003. Utility of Fusion Surgery in Patients with Degenerative Lumbar Spondylolisthesis and their Outcome

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Introduction: Degenerative Spondylolisthesis refers to slip of one vertebral body over the one below as a result of degenerative changes in the spine. Mild to moderate symptoms are initially treated by conservative means such as NSAIDs, epidural injections, physiotherapy, etc. But once patient suffers from severe neurological symptoms like intermittent claudication or vesico-rectal disorder due to spinal stenosis, it leads the patients to experience surgical procedures. There is no uniform agreement among surgeons about the optimal treatment. But our experience along with several high quality studies indicate that surgery provides better clinical outcome for degenerative spondylolisthesis & that fusion provides better outcome than decompression alone which also results a safety profile.

Material and Methods: A prospective study was designed over 82 patients who had degenerative lumbar spondylolisthesis with severe neurological symptoms. The study time was from January 2003 to July 2014 in NITOR & BSOH, Dhaka. We selected the patients for surgery depending on two major criteria: (1) The patient has clinically important & significant pain or neurological symptoms; (2) The patient has not shown sufficient clinical improvement despite conservative care at least for 3 months. But we tried to manage those having significant osteoporosis & infection through conservative treatment despite fulfilling the above criteria. Our choice of surgery was TLIF for each patient. The steps included laminectomy, insertion of cage in the disc space, interbody chips bone graft surrounding the cage & posterolateral bone grafting with fixation of spine by transpedicular screws & rods. Total follow up time was 11 years & the minimum follow up time was 6 months. Evaluation of the patients was done comparing their pre & post-operative states which included clinical evaluation, X-ray showing gradual fusion with special investigation including CT scan & MRI

Results: 82 patients (Female- 51 & male-31) with average age of 59 years (41–76 years.) having degenerative lumbar spondylolisthesis with severe neurological symptoms met the inclusion criteria. Among the patients, 57 had osteoarthritis. Total follow up time was 11 years & minimum 6 months. The potential side effects included bleeding, postoperative infection, nonunion, residual deformity with spinal stenosis & malposition of screws & rods. The mean anterior slip was 26.1% (0–50%) prior to surgery & 24.8% at the final follow up. The longer was the duration of pre-operative insult to the spinal cord or nerve root, the slower was the rate of recovery. According to these, the excellent outcome was seen in 69 patients (84% of cases), fair result was seen in 4 (5%), good in 5 (6%) & poor result in 4 (5%) cases. Nonunion after surgery was observed in 3 patients. The Oswestry Disability Index Scores averages 11.1% (Range 0–62).

Conclusion: Though surgical procedures cannot confirm lifelong recovery of the patients with symptoms, but does ensure a better and comfortable lifestyle with potential improvement of leg symptoms in case of degenerative spondylolisthesis. Inspite successful fusion is achieved, better outcome will be ensured if any kind of activity that may overload the back is avoided.

Keywords: degenerative spondylolisthesis, selection criteria, surgery

WP004. Spontaneous Resolution of Sequestrated Lumbar Disc Herniation: A Prospective Cohort Study

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Objective: Spontaneous regression of sequestrated lumbar disc well known entity. But, the current reports about this scenario are confined to case reports or small case series. To assess the chance of complete spontaneous resolution of sequestrated lumbar disc herniation and to report the outcome of regressed cases in a prospective study.

Method: From January 2010 to July 2015, 103 patients with acute lower limb mono-radiculopathy, but without neurological motor deficit secondary to a migrated lumbar disc herniation thought to be a sequestrated free disc fragment were prospectively studied for the possibility of their spontaneous regression with time. All the qualified patients initially fulfilled the study criteria. But seven patients were lost to follow up and 9 more cases preferred to do surgery within a few days to three weeks after clinical trial. Eighty seven patients remained for clinical evaluation and periodic magnetic resonance imaging for the possibility of spontaneous regression. These patients include 39 males and 48 females. The age of the patients ranged from 22 to67 years with the mean of 42.96, SD= 10.65.

Results: In 75 of these cases complete resolution of the offending disc occurred. This was associated with marked improvement or even disappearance of pain intensity in short and mid-term follow-up. Furthermore, where a case of same level contralateral disc herniation was seen,not a single case of same level same side recurrence could be encountered. The cost of treatment and work status of the patients were significantly better than surgically treated patients according to previously published reports . In mid-term follow, recovery rate (McNab Criteria %) of these 75 patients was either good or excellent. All these were satisfied and recommend this type of treatment for similar patients. The remaining 12 patients, ultimately underwent surgery. Surprisingly, all had subligamentous location

Conclusion: This study clarifies that conservative management might be considered as an appropriated cost-effective option in treatment of sequestrated lumbar disc herniation in the patients with minimal neurological impairment, with probably high chance of spontaneous regression of the offending disc. However, to compare conservative versus surgery, in this sub-type of disc herniation, further clinical trials are recommended.

Disc Biologics: Clinical

WP005. Modic Changes in Lumbar Spine: Prevalence and Genetic Association Analysis through Single Neucleotide Poymorphism Analysis of 71 Polymorphisms

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Introduction: A significant association between nonspecific low back pain and Modic changes (MC) have been described. We hypothesied that a single nucleotide polymorphisms(SNP) may be involved in matrix and bone metabolism associated changes with modic changes. The present study purports to evaluate the prevalence of MC and the role of genetic polymorphisms in 40 candidate genes (including 71 SNPs).

Methods: The study was a cross sectional study performed on 809 patients irrespective of back pain status. Assessment was performed with MRI evaluation and genetic association analysis of 71 SNPs belonging to 40 genes. Inclusion criteria for patients were both sexes, age of 18 to 70 years, no evidence of other spinal diseases, previous surgery & trauma. The MRI included T1 and T2 sagittal sections of the lumbar spine.The presence and type of Modic changes & the genetic association analysis of 71 SNPs was made with reference to the presence or absence of Modic Changes. Genotyping of SNPs was performed using the Sequenome® platform.

Results: 809 individuals of mean age 36.7 $\pm$ 10.8 years were studied. Based on the presence of MC, the group was divided into 702 controls and 107 cases. 64 patients had single level MC (7.9%), 32 had double level (3.9%), 5 had three and four level MC (0.6%) and one had multi-level MC. Modic changes were identified in 251 of the 1070 endplates (EP). MC was more commonly situated in the lower EP (149, 59.4%) than in the upper EP (102, 40.6%). L4–5 EP were the most commonly affected level ($n = 77$, 30.7%) followed by L5-S1 (26.3%), L3–4 (23.9%), L2–3 (12.4%) and L1–2 (6.8%). Type 2 MC was the most commonly observed pattern ($n = 206$, 82%), followed by Type 1 ($n = 27$, 10.8%) and Type 3 ($n = 18$, 7.2%). Mirroring endplate MC was observed in 75 discs (29.8%) among the total 535 discs. SNPs of Vitamin D receptor gene (VDR) and Matrix Metallo proteinase (MMP20) ($p = 0.03$)

were significantly associated with MC. SNP of cyclo-oxygenase gene(COX2) and Insulin Growth Factor Receptor(IGF1R) ($p = 0.03$) were significantly associated with Type 2 MC.

Conclusion: The study identifies genetic polymorphisms of VDR, MMP 20, COX 2 and IGF1R to be significantly associated with MC and have not been reported previously. Understanding the etiopathogenetic of Modic changes would help us to plan preventive and therapeutic strategies

Disc Biologics: Nonclinical

WP006. Genetic Contribution to Degeneration and Repair Potentials of the Intervertebral Disc in Mice

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Introduction: Intervertebral discs degenerate with age affected by environmental and genetic factors. Presently, there are no direct biological cures as the etiology of disc degeneration is still not well understood. Enchantingly, nearly 10% population are "protected" from intervertebral disc degeneration even above the age of 50. It is most possibly ascribed to genetic causes manipulating disc homeostasis, maintenance or repair mechanism. The LG/J mice possess outstanding healing capability for damages to elastic and articular cartilages, in contrast to the poor healer SM/J mice. Using these parental strains of mice and the recombinant inbreeds, we assessed the potential genetic contributions to degenerative and protective effects on the intervertebral disc.

Material and Method: The parental LG/J and SM/J mice together with recombinant inbreeds (RI) LGXSM-6 (80% of LG/J, 20% of SM/J) and LGXSM-33 (50% of LG/J, 50% of SM/J) were studied. Tail discs at P10, 4 weeks and 8weeks of age were assessed with a quantitative histological degeneration scoring system that has been established. The genetic regions common to parental and RIs were assessed with SNP markers for potential degenerative and protective genes, and functional relationship to disc biology assessed using gene ontology and gene network association with the variants from the RI mouse panel.

Results: In the absence of any environmental perturbation, SM/J mice display early signs of disc degeneration. In contrast, the IVD in LG/J mice remained "healthy" at the same age with vacuolated NP cells, while the nucleus pulposus (NP) in SM/J are degenerative in nature with an undefined NP structure that appear fibrotic. Both LGXSM-6 and LGXSM-33 have even higher degenerative scores than SM/J, suggesting that part of the "protective" loci from LG/J may be absence in these RIs. A more detailed analysis of the overlapping genetic region (less than 20% of the whole genome) contains 178 SNP makers (Herbek et al., 2006) on 87 nearby genes. Unsupervised Gene Ontology analyses identified multiple biology processes enriched in transportation of ions and lipid, channel activity and membrane, cytoskeleton organization, immune response, cell adhesion, migration, cell cycle progression and posttranslational protein modifications for the set of genes. Genes that correlated to immune system and skeletal development included VDR, Ano6, Mttp, Bmpr, and Cep112 informed to be share high associated or have frequent variation.

Conclusion: LG/J mice have enhanced disc homeostasis and superior healing potential, with a protective effect against disc degeneration. Preliminarily analysis of the gene set (87 genes) suggests changes in the transportation of ions and lipid, and membrane and channel activity may involve in disc function and maintenance. The genomic data can also be used for advanced mapping of the susceptible healing genes identified in articular cartilage repair. It is also promising to map this set of genes across the human whole exome sequencing data that we have generated from 750 individuals for disc degeneration in our population cohort, including elderly with a normal (protect) disc to assess their relevance in our human population study.

Acknowledgment: This worked is supported by funding from AOSPINE(SRN2012_8), and China's National strategic basic research program("973") Grant2014CB942901.

Disc Degeneration: Clinical

WP007. Outcome and Differences in the Clinical Results of Three Different Surgical Methods for Lumbar Disk Herniation

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Introduction: We aimed to study the following gaps in the literature. (1) Clinical results of spinous process osteotomy for the treatment of LDH is scarce in the literature. (2) Studies comparing clinical outcomes between laminectomy and osteotomy have not been reported. (3) Results of MAPN with open techniques have not been compared.

We sought to study the outcome of surgery for LDH by conducting a comparative study between three different surgical techniques; we aimed to find whether any of these approaches were more efficacious in reducing pain or improving patients' quality of life. In addition, factors that could predict the outcome of LDH surgery were assessed.

Materials and Methods: We evaluated 148 patients who had operations for lumbar disk herniation from March 2006 to March 2011 using three different surgical techniques (laminectomy, microscopically assisted percutaneous nucleotomy, and spinous process osteotomy) by using Japanese Orthopaedic Association (JOA) Back Pain Evaluation Questionnaire, Resumption of Activities of Daily Living scale and changes of visual analog scale (VAS) for low back pain and radicular pain. Our study questionnaire addressed patient subjective satisfaction with the operation, residual complaints, and job resumption.

Results: Ninety-four percent of our patients were satisfied with the results of their surgeries. VAS documented an overall 93.3% success rate for reduction of radicular pain. Laminectomy resulted in better outcome in terms of JOA Back Pain Evaluation Questionnaire. The outcome of surgery did not significantly differ by age, sex, level of education, preoperative VAS for back, preoperative VAS for radicular pain, return to previous job, or level of herniation.

Conclusion: Surgery for lumbar disk herniation is effective in reducing radicular pain (93.4%). All three surgical approaches resulted in significant decrease in preoperative radicular pain and low back pain, but intergroup variation in the outcome was not achieved. As indicated by JOA Back Pain Evaluation Questionnaire–Low Back Pain (JOABPQ-LBP) and lumbar function functional scores, laminectomy achieved significantly better outcome compared with other methods. It is worth mentioning that relief of radicular pain was

associated with subjective satisfaction with the surgery among our study population.

WP008. Phenotype Standardization is the Urgent Need in Genetic Association Studies of Disc Degeneration - Results of Analysis of Genetic Association of 71 SNPs with Highly Specific Phenotypes in 809 Subjects

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Introduction: Although the influence of genetics on etio-pathogenesis of disc degeneration is well recognized, there is a wide variation in the different genes observed to have association with disc degeneration. The clinical and radiographic features of disc degeneration used as *phenotypes* are quite variable in previously published studies. It is unclear whether the variations in genetic association studies depict variations in ethnicity or selection of phenotypes.

Methods: The purpose of the study was to evaluate the allelic diversity of 71 SNPs related to six different MRI markers of lumbar degenerative disc disease (annular tear, Pfirmann's grading, Schmorl's nodes, Modic changes, Total Endplate Damage score and disc bulge) in a single study population, and analyze how genetic associations can vary in the same study subjects with the choice of phenotype, based on age and sequence of selection of study subjects. Genotyping of cases and controls was performed on Genome wide SNP array to identify potentially associated disease loci. The results from the GWAS were then used to facilitate SNP selection and genotype validation was conducted using Sequenom based genotyping.

Results: The mean age of 809 subjects (M: 455, F:354) was 36.76 $\pm$ 10.8 years (range 10 – 80). Highly significant association ($p < 0.01$) was observed with three SNPs of *CILP* for disc bulge and rs2249350 of ADAMTS5 and rs11247361IGF1R for annular tears. Significant association ($p < 0.05$) was observed with polymorphisms of VDR and MMP20 for Modic changes, three SNPs of MMP20 for Schmorl's node and SNPs of CALM1 and FN1 for Pfirmann's grading. None of the SNPs had significant association with TEPS. Subgroup analysis based on age ($<$30, 30–40 and $>$ 40 years) showed new set of genetic associations for all the six radiographic parameters. Similarly the population was divided into two groups based on numerical order and the association patterns completely differed as compared with the total group.

Conclusions: In the same study population with DDD, SNP associations completely change when phenotypes changed. Variations in age, sequence of study subjects, number of population apart from radiographic description of DDD significantly change the genetic association. Based on current results, it is difficult to consider one set of genes as responsible for disc degeneration considering these variations. Our study results demand an urgent need for standardizing the description of DDD, phenotype selection, and study criteria for genetic association studies.

WP009. Long-Term Follow-up of Disc Degeneration after Discography: Minimum 5-Year Follow-Up at a Single Center Experience

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Introduction: Experimental studies have demonstrated accelerated disc degeneration after various intradiscal procedures. However, there are only a few long-term follow-up studies using MRI images to confirm the progressive disc degeneration after discography. The aim of this study is to evaluate disc degeneration after discography over 5-year follow-up and to determine possible risk factors for enhancing disc degenerations after discography

Material and Methods: 239 subjects with chronic low back pain underwent multi-level discography to confirm discogenic pain in our institute from January 2006 to June 2009. Thirty-eight subjects who did not operate due to negative study with normal (Grade 1 and 2) to moderate (Grade 3) disc degeneration prior to discography and followed for more than 5 years were enrolled in our study. The routine multilevel discography technique and determination of positive study using original work by Walsh et al was performed in all study subjects. Pre- and post-discography MRI and CT scan were analyzed by two blind independent observers to evaluate degree of disc and endplate degenerations. The progression of disc degeneration was analyzed for correlation with 1) subjects demographic data, 2) pre-discography disc degeneration, 3) levels of discography and 4) discography findings.

Results: Mean age of the subjects at time of discography was 38.1 $\pm$ 6.4 years and mean time to final MRI follow-up was 68.0 $\pm$ 3.1 months. 2-level discography was done in 19 subjects and 3-level in 18; total 92 disc (L2/3: 5, L3/4: 30, L4/5: 36, L5/S1: 21) There was progression of disc degeneration in 23 disc (23.9%); 5 (6.4%) from normal and 18 (19.5%) from moderate disc degeneration group. There were 16 (17.3%) new disc herniation and 9 (9.7%) new HIZ, however, there was no significant difference between the locations of herniation. Moreover, the differences of mean disc height and endplate degeneration were not statistically significant. The progression of disc degeneration was significantly higher in young age group ($<$35 years), lower level disc group (L4/5 and L5/S1) and moderate (Grade 3 to 4) disc degeneration group. Multi-level injection, failed discography (annulography) and higher grade of discography findings revealed no positive correlation with progression of disc degeneration.

Conclusion: Diagnostic discography resulted in accelerated disc degeneration in 5-year follow-up study. However, MR findings suggested that annulus puncture with small gauze needle may not be the cause of new disc herniation. Younger age, lower level disc and advanced degeneration prior to discography were the risk factors for progression of disc degeneration. Careful consideration of risk and benefit should be used in recommending procedures involving disc injection.

WP010. Use of an Interspinous Device above the Level of Interbody Fusion: Does it Reduce the Worsening of Adjacent Segment Degeneration?

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Introduction: Lumbar fusion in degenerative conditions has universally provided good results. However, adjacent segment degeneration, either afresh or worsening of a low grade degeneration in the segment above has been indicated

for the pain and low functional outcome on long term follow-ups. Interspinous implants have been used to off load the facets and prevent spinal canal narrowing in stenosis with good results. This paper analyses the novel idea of using an interspinous device above the level of fusion to decelerate the physiologic process and reduce the incidence of adjacent segment degeneration (ASD).

Material and Methods: 12 patients were analyzed in the study. The inclusion criteria for the study was degeneration of the disc above the level of intended fusion with no or less than 50% disc height reduction and no nerve root compression. Patients with more than 50% height reduction or severe arthritic facet joints underwent fusion at two levels and were excluded from the study. Patients with failed back syndrome and significant osteoporosis were also excluded from the study. Coflex (Paradigm) interspinous device was used in the level above the fusion in all cases. Clinical and radiographic criteria for ASD was assessed at the latest followup. VAS and ODI functional outcome was analyzed.

Results: 12 patients with mean age of 63 years who underwent surgery between September 2012 and March 2014 were analyzed in the study. Mean followup was 27 months (Range 18–36 months). Single level fusion was performed in 9 cases and Two level fusion in 3 cases. Coflex device was implanted at L3–4 in 8 cases and L4–5 in 4 cases. All 12 patients had a good fusion in the 6 months radiograph. Disc height improvement was seen in the level above, with no evidence of stenosis or listhesis at the latest followup. Worsening of already existant ASD in one patient was noticed but did not require surgical intervention. VAS and ODI showed significant ($p < 0.05$) improvement postoperatively. No infection or reoperation was needed in any of the 12 patients.

Conclusion: ASD remains a significant reason causing failed back syndrome requiring reoperations in lumbar fusion. Use of interspinous device not only preserves a motion segment from fusion, but also shows promise in reducing the incidence of degeneration above the level of fusion. Further studies with larger sample size and long term follow-up is necessary to support the conclusion.

WP011. Surgical Strategy for Thoracic Disc Herniation: Analysis of 27 Cases Managed with Transthoracic Microdiscectomy, Lateral Extracavitary Approach and Arthropediculectomy

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Introduction: Surgical management of symptomatic thoracic disc herniation (TDH) has historically been problematic and technically demanding. Numerous surgical approaches currently used for the management of TDH can be categorized as posterolateral, lateral extracavitary and anterolateral. The latter group of approaches has optimal characteristics for the ventral exposure of the spinal channel and is best suited for resection of central or calcified TDH. However, posterolateral approaches are still widely used by neurosurgeons due to familiarity of the anatomy and less invasive characteristics. We present an analysis of eight year experience in the surgical management of TDH, utilizing transthoracic microdiscectomy (TTM), lateral extracavitary approach (LEA) and arthropediculectomy (APE), emphasizing the criteria for selecting an appropriate surgical method.

Material and Methods: The case series included 27 patients operated on between 2009 and 2015. The group was comprised of 16 men and 11 women, ages 41–66 (mean 52). Twenty four patients were diagnosed with thoracic myelopathy presenting as weakness in the lower limbs and (or) pelvic organ dysfunction, three patients presented with radiculopathy. Neuroimaging studies included CT and MRI in all patients. Six patients required MRI with contrast for the differential diagnosis. Indication for the operation were radiologically established compression of the spinal cord and it's neurovascular deravates by the TDH with the clinics of myeloradiculopathy Seven patients underwent TTM, six patients underwent LEA and fourteen patients were operated utilizing APE. Consideration factors in the selection of the surgical method included: 1. Neurological symptoms; 2. Type, size, location and lateralization of the TDH; 3. Consistency of the TDH; 4. The extent of the spinal cord compression with TDH; 5. Touch area between TDH and ventral aspect of the spinal cord; 6. Signs of TDH with dural adherence or transdural penetration; 7. Comorbidities and body habitus. Patients with lateral TDHs underwent APE. The ones with medial/mediolateral TDHs were stratified based upon the extent of TDH calcification. Patients with soft herniations were operated on via LEA. Those with heavily calcified, large or multiple TDHs were candidates for microdiscectomy via TTM. In patients with strict contraindications for thoracotomy, APE was performed.

Results: Analysis of preoperative and final follow-up Frankel grades showed difference in the functional outcomes of patients after different surgical approaches. Of the 7 patients after TTM, the Frankel grade improved to E in 5 (74%), reached grade D in 2 (26%) and worsened in 0%. Results of LEA showed improvement to grade E in all 6 (100%) patients. Ten (72%) patients operated via APE improved to grade E, 3 (28%) patients improved to lesser degree. The approach associated morbidity in our series averaged 7% for TTM, 6,5% for LEA and 5,5% for APE ($p > 0,05$).

Conclusion: TTM allow excellent exposure of the mediolateral TDHs and is also the best choice for multiple/calcified TDHs in association with osteophytes. LEA provides more lateral access to TDH but entails larger osteoligamentous resection and blood loss, leading to high morbidity. APE is best suited for lateral, soft TDH or for medically compromised patients with contraindication for thoracotomy.

WP012. Microdiscectomy Results using the Caspar Technique

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Introduction: The degenerative disease of the intervertebral disc and back pain are chronic conditions and represent an important cause of morbidity and mortality. Treatment of lumbar radicular compressive syndromes is described, as well as the success of microsurgical procedure according to the Caspar technique.

Material and Methods: In the prospective study, 100 patients were included. All suffered from the radiculopathy due to the nerve compression. Conservative treatment was not successful and operation was then performed. The follow up of patients was evaluated from 1 to 3 years after the operation, the average time was 17 months.

Results: The results showed excellent outcome in 67%, good outcome in 28%, fair in 1% and poor in 3% of patients. One patient died one month after the operation due to unrelated reasons and was not included in the final assessment. Thus, the total result was satisfactory in 95%.

Conclusion: The results of microsurgical approach showed that the efficiency of such operation in this series can be compared with similar results elsewhere according to the international criteria (88% to 98%). The successfulness of the microsurgical method is due to gentle tissue handling,

especially with respect to the nerve structures in the spinal canal and considerably smaller injury if muscles and bone. This is achieved by better visibility and field magnification with the operative microscope.

WP013. The Stand-Alone Cervical Cages with Integrated Screw Fixation: Results in 315 Consecutive Operated Levels

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Introduction: Background: Cervical disc disease at C2/3, C3/4 and C7/T1 is less common. Fusion with cages & plating is the standard treatment at these levels and in multi-level disc disease. This is not without significant risks related to the need of larger exposure and anterior muscular dissection. Stand-alone cages with integrated screw fixation obviate the need for plating and larger exposure.

Material and Methods: To assess the exposure / cage related morbidities and fusion rates in Stand-Alone cervical cages with Integrated Screw Fixation. Design: Retrospective chart review. Subjects: 315 levels were operated in 253 patients from February 2009 to February 2015. Single and Multilevel cages were performed in 201 and 52 patients respectively. 201 of the 253 patients underwent single level discectomy with Stand-Alone cervical cages with Integrated Screw Fixation at C3/4 and C7/T1 levels. 52 patients underwent 114 multi-level discectomies with Stand-Alone cervical cages with Integrated Screw Fixation

Results: Operative time was shorter. There was no reported permanent exposure/ cage related morbidities in all operated levels. 3 patients with traumatic disc disruption required further surgery for lateral mass fixation. 12 patients had mild dysphagia that resolved during follow up with no patient having complains of dysphagia at 3- months follow up. Fusion rates were 95% at single level and 90% at multi-level discectomies at the last follow up. No patient required cage related surgical revision.

Conclusion: The current results support the use of Stand-Alone cervical cages with Integrated Screw Fixation especially at difficult levels at C3/4 and C7/T1 and in multi-level discectomies as it obviate the need for plating and larger exposure with less reported dysphagia and implant related complications.

Disc Degeneration: Nonclinical

WP014. Discectomy-Related Information on the Internet: Does the Quality Follow the Surge?

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Introduction: Over 2.5 billion users search the internet world wide. 70%- 80% look at health related information, yet no standards exist regarding the publication of medical literature on the internet. The quality of health information is of much concern and an emphasis on appraisal of internet Web sites is needed. We aim to look at the quality of health information on the internet relating to discectomy using various standardised tools and scoring systems.

Material and Methods: The three most commonly used search engines were identified and a search for "Discectomy" was performed on each. Two reviewers categorized the most popular Web sites according to their types and the quality of each was assessed using recognized scoring systems including the Journal of the American Medical Association (JAMA) benchmark, DISCERN and a novel Discectomy-specific content score. The quality of the information was also assessed according to the presence or absence of the Health on the Net (HON) code, a reported quality-assurance marker.

Results: Results confirmed that 53 websites were identified, and analyzed. Commercial Web sites were predominant at 24, 7 were governmental, 6 were produced by physicians, none were produced by allied health professionals, 3 were academic, 4 were public health information Web sites, 4 were attached to social media and discussion groups, 3 were media related, and 2 were unspecified. Using the 3 scoring systems mentioned above as a quality marker, internet sites with a 'Health on the Net' (HON) code demonstrated significantly higher quality than those without the code ($p < 0.0001$). Public health information Web sites attained the highest overall DISCERN and Discectomy-specific scores followed by the Governmental & Non-Profit Organizations Web sites.

Conclusion: The overall quality of information regarding discectomy remains poor and variable despite an exponential increase in the number of users and Websites, with a slight trend toward improvement. Only 20% to 30% are of good quality, compared with that 10 years ago (<10%). Presence of Health on the Net code is a very reliable marker for health information quality.

WP015. The Role of Caveolin-1 in Intervertebral Disc Degeneration and Regeneration

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Introduction: During intervertebral disc (IVD) degeneration, the main cell type in the nucleus pulposus (NP) shifts from notochordal cells (NCs) to chondrocyte-like cells (CLCs). Microarray analysis revealed that caveolin-1 expression was correlated with IVD degeneration. The aim of this study was to determine the role of caveolin-1 in NC and CLC physiology to assess its potential role in IVD regeneration.

Material and Methods: Protein expression (caveolin-1, apoptosis, progenitor cell markers, extracellular matrix, TGF-β-signaling pathway) was determined in IVDs of wild type (WT) and caveolin-1 knockout (KO) mice and canine IVDs of different degeneration grades (immunofluorescence, immunohistochemistry, TUNEL assay). Micro-aggregate cultures of CLCs from canine and human degenerated IVDs (Thompson grade III) were treated with chondrogenic medium (incl. TGF-β_1) alone or in combination with (a) caveolin-1 scaffolding domain peptide (CSD) and/or (b) siRNA against caveolin-1. DNA, glycosaminoglycan (GAG) content, collagen type I and II immunohistochemistry and gene expression profiling (RT-qPCR) for extracellular matrix production/degradation-, cell proliferation- and apoptosis markers was performed.

Results: The NP of WT mice was rich in viable NCs, whereas the NP of caveolin-1 KO mice contained more collagen type II-rich matrix and less cells together with an increased progenitor cell surface marker (Tie2+/GD2+) expression and a higher apoptotic activity. Caveolin-1 expression increased in the later stages of canine IVD degeneration,

together with a significantly increased apoptotic activity. Caveolin-1 knockdown significantly decreased GAG deposition in the CLC aggregates (6–14%), whereas CSD treatment significantly rescued and increased GAG deposition (11–16%).

Conclusion: Caveolin-1 plays a crucial role in preservation of NCs, underscored by the NP phenotype of caveolin-1 KO mice. Caveolin-1 may be related with cell senescence given its increased expression in degenerated IVDs. However, caveolin-1 knockdown decreased extracellular matrix production, while CSD supplementation rescued this effect. The latter implies that CSD may be a useful disease modifying agent since it is known to influence degeneration-related signaling pathways (incl. TGF-β signaling). Altogether, this indicates that the increased caveolin-1 expression during IVD degeneration may also be a repair mechanism rather than being merely a senescence marker.

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Imaging

WP016. New 5-Grade Scale for Anterior Fusion Estimation: Validation for Infectious Spondylitis

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Introduction: Fusion status assessed using plain radiograph or CTs, according to the 4-grade scale published by Bridwell et al (1995). Unfortunately, this method is based on the measuring of bone density and bone sclerosis and it's not completely definite for dynamic analysis, especially for early post-op period.

Methods: 5–grade scale based on the quantities evaluation characterized by implant's position between vertebral bodies and descriptive characteristic of the zone between transplant(implant) and implant site. 1 grade – dislocation of the transplant (implant): one or both ends are dislocated from the vertebral end plate(s); 2 grade – transplant (implant) is located between vertebral bodies, the size between blocked vertebra and end of transplant $\geq$ 3 mm; 3 grade – transplant (implant) is located between vertebral bodies, the size between blocked vertebra and end of transplant $1 \leq \ldots \leq 3$ mm; 4 grade – the diastasis between vertebra and transplant (implant) is not visualized; non-clear bone structure of fusion zone; with local sclerosis (similar to the grade 2 according Bridwell's scale); 5 grade – structural bone block with a clear bone trabeculars between transplant (implant) and contacted vertebral body (similar to the grade 1 according Bridwell's scale).

Results: 109 patients aged from 21 till 76 years (average - 59,2 years) were included into prospective CT-study 3, 6, 12 months post-op. All patients were consequently operated between 2010 – 2013 in one clinic. Indications for surgery was chronic spinal infections (TB or osteomyelitis) with un-effective previous course of conservative treatment. According to the variant of anterior fusion patients were divided into 2 groups: group 1 ($n = 40$) - autologous bone graft; group 2 ($n = 69$) – autologous bone graft inserted into the titanium mesh cage. Fusion was estimated separately for cranial and caudal contact zone. Statistically confirmed differences between compared groups in fusion status in early post-op (3 and 6 month) evaluation. The results were more differential in compare with Bridwell's scale. The differences completely disappeared till 12 month after surgery.

Conclusions: New 5-grade scale for anterior fusion estimation doesn't depend on the technical characteristic of CT-images; it is more objective for estimation of early results of spinal reconstruction. The proposed method could be more informative for comparative studies of the different spine pathologies.

Novel Technologies: Clinical

WP017. The Experience of Eggshell Technique during Kyphoplasty to Prevent Cement Leakage in Treatment of Osteoporotic Vertebral Fracture

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Introduction: Osteoporosis is the big problem in the aging human. Among these osteoporotic related fractures, vertebral compression commonly is the main one. Pain and disability pose major problems in these patients. To restore the vertebral height for driving physical stiffness, and loading bearing toward normal limited and control the pain, kyphoplasty with variable filling materials (PMMA, CPC etc.) have been used for the treatment. For decreasing the rate of PMMA leakage in various wall injuries in vertebral compression fracture, we performed kyphoplasty with modified eggshell technique in different characteristics of vertebral wall.

Material and Methods: Twenty-four symptomatic vertebral fractures were enrolled. Visual Analogue Scale, the Oswestry Disability Index and Vertebral Wall Injury Score were assessed. The vertebral height loss and changes of kyphotic angle were also recorded by plain X-ray. Three-dimensional CT will be arranged for evaluating the condition of deficiency vertebral wall and central body collapse if need. After creating cavity by percutaneous bipedicular balloon device, PMMA was injected into weak wall site according the pre-operative evaluation or intra-operative finding. The balloon was once again introduced into the created cavity and inflated to achieve the PMMA shield (regional egg-shell method). Then the PMMA or other materials as CPC materials will be continuously to be fill into the left space. Outcome, fill materials leakage condition, X-ray and CT were reviewed postoperatively.

Results: Symptomatic cement extravasation related complications or leakage on X-ray were not observed in follow up. Only one adjacent compression fracture was happened in one month. Improvement in vertebral height and the mean kyphotic angle was also noted. The mean VAS and ODI decreased significantly from pre-operation to post-operation ($p < 0.05$). The Vertebral Wall Injury Score reviews also told us the eggshell technique is fit for multiple conditions of wall injury

Conclusion: It's always concerned for the leakage of PMMA during spine surgery. There are many options of new implant for decreasing the rate of leakage. Greene introduces the eggshell technique in 2007, they used the eggshell idea to cover the possible leakage site. They had only 7 patients and those possible cortical defects were noted over superior endplate or lateral wall in their paper. According to our experiences in kyphoplasty with this regional eggshell technique in our 24 patients with various wall injuries. The technique is a safe and significantly functional works for decreasing the leakage of PMMA in various wall injury conditions with experienced surgery operator.

Spine Biologics, Bone: Clinical

WP018. A Study of Sacral Anthropometry to Determine S1 Sacral Screw Placement for Spinal Lumbosacral Fixation in the Korean Population

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Introduction: There are various methods of S1 pedicular screw fixation, and every method has its own advantages and disadvantages. But, anatomical variation of the posterior superior iliac spine (PSIS) was not considered in any method. Therefore, little is known about the safe angle for screw fixation in the Asian population.

Material and Methods: We performed our study in 160 sacra including the pelvic ring obtained from 80 Korean cadavers. The bony measurements were obtained by performing 1 mm computed tomography (CT) cuts from the L5 lumbar vertebra to the pelvic ring and excluding other structures. We evaluated the incidence of anatomic variation of the PSIS and measured the safe marginal length and angle for screw fixation considering the PSIS and course of the external iliac vein, using a Korean sacrum model.

Results: Our study showed that the closed type of PSIS is more frequent in males than in females. The optimal angle for screw fixation is 16.91 $\pm$ 6.85 (°), while the Lt. side S1 pedicle insertion angle (SPIA) is 16.00 $\pm$ 6.20 (°). The average Korean optimal screw length is 58.35 $\pm$ 14.90 (cm) for the Rt. Side and 55.89 $\pm$ 16.16 (cm) for the Lt. side.

Conclusion: With reference to these parameters, the optimal screw length and angle can be chosen and bicortical anteromedial screw fixation can be easily and safely performed.

Spine Biologics, Bone: Nonclinical

WP019. Effects of Long-Term Exposure of Exogenous Advanced Glycation Endproducts on Vertebral Bone Microarchitecture; Sex-Differences on Structure Derived Mechanical Properties

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Introduction: Accumulation of advanced glycation end products (AGE) are commonly associated with diabetic complications, including increased painful intervertebral disc pathologies, osteoporosis, and bone fracture risk. Exogenous AGEs develop by processing food at high temperatures and can accumulate in bone where they crosslink collagen. A clinical study reported association of increased serum AGE levels with vertebral fracture risk in women but not in men, highlighting gender effects. The purpose of this study was to investigate the sex-dependent effects of exogenous AGEs on vertebral bone quantity, quality, and mechanical behavior.

Material and Methods: C57BL/6 mice (female, $n = 8$/group; male, $n = 4$/group) were pair-fed isocaloric diets containing low AGE amounts (LAGE, 7.6 µg/mg chow) or high AGE amounts (HAGE, 40.9 µg/mg chow) for 6 months; after euthanasia, blood glucose and serum AGEs were analyzed. Lumbar spines were µCT-scanned (resolution=4.9µm; SkyScan 1172, Bruker Corp., Belgium). Hydroxyapatite phantoms were similarly scanned for density calibration. Cortical bone analysis included tissue mineral density (TMD), BMD, cross sectional thickness (Ct.Th), bone surface are (BSA) and porosity. Trabecular bone analysis included trabecular thickness, separation (Tb.Sp), number (Tb.Nm), TMD, BMD, BVF, bone surface to volume ratio (BS/BV), Structure Model Index (SMI) and fabric anisotropy. A validated analytical model was used to calculate trabecular bone anisotropic compressive and shear moduli. Male/female and HAGE/LAGE differences were analyzed via Student's *t*-tests ($p < 0.05$). All experiments were approved by the Institutional Animal Care and Use Committee.

Results: Serum AGE levels were significantly increased in female HAGE mice compared with LAGE mice ($p < 0.01$). No differences were observed between blood glucose levels among groups. Dietary comparisons indicated that female trabecular BS/BV and porosity were significantly increased by HAGE-diet whereas trabecular BMD, compressive and shear moduli, and cortical BMD were decreased. In males dietary comparisons revealed only a significant increase in trabecular porosity. Male cortical bone remained unchanged. Sex comparisons within LAGE-diet group revealed that female trabecular bone had significantly reduced Tb.Nm, BMD, degree of anisotropy, compressive and shear moduli, and significantly increased Tb.Sp, porosity, and SMI compared with LAGE males. LAGE females also had significantly decreased cortical BSA and significantly increased Ct.Th compared with LAGE males. Sex comparisons of female versus male HAGE-diet groups revealed no significant differences.

Conclusion: Results indicated more pronounced detrimental effects on cortical and trabecular bone in females on HAGE-diet than in males. These sex-dependent effects suggest that AGEs effects on vertebral bone may be hormonally mediated. This work showed for the first time significant alterations to the elastic compressive and shear properties of vertebra following variations in dietary AGE levels. Changes in trabecular architecture and density manifested as functional changes, especially in females, warranting further post-yield and fracture analysis. Importantly, this study investigated the sex dependent effects of AGEs on vertebral bone quality and quantity independent from serum glucose (diabetes). Further research of AGE effects on cell turnover and cellular modifications to bone microarchitecture and mineralization is necessary to validate the link between changes in bone quality, quantity and function.

Spine Biologics, Other: Clinical

WP020. Neural Stem Cells Transplantation as a Neuroprotective Strategy for Amyotrophic Lateral Sclerosis (ALS)

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Introduction: Amiotrophic lateral sclerosis (ALS) is a neurodegenerative disease with a prevalence rate of up to 7.4/100,000 and the overall risk of developing ALS over a lifetime is 1:400. Most patients die from respiratory failure following a course of progressive weakness. There is no effective therapy. Novel therapeutic strategies might be directed at replacing or repairing the damaged motor neurons; Cell therapy is emerging as a potential therapeutic option in ALS. The primary

objective of our study was to verify the safety and tolerability of transplantation of human fetal neural stem cells (hNSCs) directly into the spinal cord of humans. The study was approved by the SuperiorNational Health Institute.

Material and Methods: 18 patients with definite ALS were recruited and treated. Patients were included if they had ALS of spinal onset with severe functional impairment of the lower limbs and mild functional impairment of the upper limbs without signs of respiratory failure. The patients were monitored by clinical evaluation which included the ALS-FRS scale, Norris score, bulbar score, and MRC strength scale. Respiratory assessment included clinical evaluation, pulmonary function tests, arterial blood gases analysis, and nocturnal cardio-respiratory monitoring. Neurophysiological assessments were made including EMG, and somatosensory evoked potentials. The neuroradiological assessment consisted of MRI of spinal cord and brain before and after Gadolinium DTA infusion. A clinical psychologist performed psychological evaluation including an interview and psychological tests. Human fetal brain tissue specimens, all derived from the forebrain, were routinely collected from fetuses at gestational ages greater than the 8th post-conceptional week. They were immediately dissected and used to generate hNSC lines under sterile conditions. Dissociation of brain tissue, primary culturing and cell propagation were performed according to the procedure described previously by Vescovi and colleagues. Six patients received hNSCs microinjections into the dorsal (T7-T9) cord tract (3 of them received unilateral hNSCs microinjection while the remaining ones received bilateral microinjections); the other twelve patients received hNSCs microinjections into the cervical (C5-C6) cord tract (3 of them received unilateral hNSCs microinjection while the remaining ones received bilateral microinjections).

Results: No patients manifested severe adverse events such as death, respiratory failure or permanent post-surgical neurological deficits. Minor adverse events were: intercostal pain (2 patients) which was reversible after a mean period of 3 days after surgery, arm and leg sensory dysesthesia (6 patients) which was reversible after a mean period of 6 weeks after surgery. No patient manifested bladder and bowel dysfunction, or arm and leg motor deficit. All patients showed a good acceptance of the procedure and no significant modifications of the psychological status or quality of life were observed.

Conclusions: Our results appear to demonstrate that the procedures of fetal stem cells transplantation into the spinal cord of humans are safe and well tolerated by ALS patients. The minimal side effects and the absence of detrimental effects on neurological function support further research in stem cell transplantation in carefully monitored patients with ALS.

Surgical Complications

WP021. Neurological Complications of Multisegmental Spine Reconstruction in Children: Post-Op Spinal Cord Electrical Stimulation (SCES) and Training Decrease Motor Deficit

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Introduction: Risk of severe neurological complications after spinal reconstruction depends on the age of patient, plane, magnitude and rigidity of deformity; repeated operation and pre-op myelopathy increases the risk of complications up to 25% (L.G.Lenke, 2011). Reversibility of severe myelopathy is still under discussion. The purpose of study is to present method and outcomes of intensive post-surgery rehabilitation performed in 9 children with neurological complications of spine reconstruction.

Material and Methods: Design: prospective one-center observations study. 8 cases of post-op myelopathy were revealed after 112 multisegmental (two and more segments) spinal reconstructions in patients aged from 1 till 15 years during 2012–2015. One more patient was admitted from another hospital. Reconstruction was done in cervical-thoracic (3), thoracic (5) and lumbar (1) spine including TB spondylitis (5), neurofibromatosis NF1 (1), congenital abnormality (2), and aggressive hemangioma (1). Pedicle screw malposition caused complication in one case, no surgical mistake was found in others. Neurological deficit preexisted in 6 and appeared in 3 patients reaching after surgery type A (7), type B (1) and C (1) on Frankel scale. Rehabilitation was begun on the second/third weeks after surgery in 5, a month or later - in 4 patients. Course lasted 3 weeks (2), 5–10 weeks (6), and more (1). Neurological changes was assessed by Frankel, ASIA, Ashworth scales; excitability of spinal motoneurons - by H-reflex and posterior root polysegmental responses. Voluntary and stimulation-evoked movements were documented by video and EMG-records.

Results: The program included the spinal cord electrical stimulation (SCES) (except 2 patients with NF1 and hemangioma), apparatus-performed afferent stimulation of the foot supporting zone ("Korvit," Russia), and muscle spindles activation by the rhythmic passive legs "stepping" ("KRV-4," Russia). SCES was performed transcutaneously via two channels: 1) upper and lower to the damage zone, with cathode (-) at the C6–7 and anode (+) at the Th11 vertebrae level; 2) to the locomotor zone in lumbar enlargement, with (-) at Th12 and (+) on the abdomen, with rectangular pulse (0.5 milliseconds duration) by the rates 1 and 3–5 Hz, with power of 1.4 -1.8 MT (65–45mA), 40–60 minute per session (patent RU 2204423 C2). Motor program included tetra- and bipedal treadmill and ground walk, cycling and postural training with full and limited body weight support, with total duration 2–6 hours a day. All patients transferred from flaccid to spastic state, with increase of reflexes and muscle tone. Ability for tetrapedal stand and walk were reached in 9/9 cases, for supported stand in 7/9. The patient with incomplete paralysis improved from C to D on Frankel. Initially completely paralyzed patients restored locomotor ability up to overground and upstairs walk (A to D, 3 pts), supported treadmill walk (A to C, 2 pts), with ASIA motor scale increase to 14–18 points. Two patients transferred from A to B grade only.

Conclusions: SCES combined with afferent stimulation and intensive training being performed at early post-op period decrease neurological deficits and contribute to the motor recovery in children with neurological complications caused by spinal reconstruction.

Part 2: Global Spine Congress

Oral Presentations

Best Papers: Deformity

GO001. Characterization of Distribution of Segmental Changes in Cervical Alignment after Lumbar Pedicle Subtraction Osteotomy

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Introduction: Adult spinal deformity (ASD) patients with positive sagittal malalignment develop compensatory cervical hyperlordosis to maintain horizontal gaze, which spontaneous improves following lumbar PSO. We sought to characterize the segmental distribution and characteristics of these reciprocal changes in a similar patient group.

Material and Methods: Change in cervical radiographic measures from baseline to 6 weeks postop in 27 patients who underwent lumbar pedicle subtraction osteotomy (PSO) for correction of sagittal malalignment was assessed. Parameters included: C2–7 sagittal vertical axis (C2–7 SVA), C2-S1 SVA, C7-S1 SVA, pelvic incidence-lumbar lordosis mismatch (PI-LL) pelvic tilt (PT) and T1 and T9 spino-pelvic inclination (SPI). The cobb method was used for: occiput (C0)-C2, C2-T1, C2-C7. Harrison method for: Segmental angles between C2-T1. Vertebral body slopes were measured at the occiput (C0S), axis (C2S), T1 (T1S) and S1 (SS).

Results: All thoracolumbar parameters significantly improved to below established alignment thresholds: C2-S1 SVA (146/47mm), C7-S1 SVA (119/17mm), PI-LL (34.9/1.3 deg), PT (30.2/19.7 deg) ($p < 0.001$). C2–7 SVA did not significantly change. Mean cervical lordosis (C2–7) decreased (19.9–14.1,$p = 0.05$, range 27.4, -40.9). Majority of the reciprocal decrease in C2–7 occurred at C3–4 (59.1%) and C4–5 (27.2%, Figure) with little at C5/6 (13.6%) and none at C6/7. Mean lordosis increased 1 deg at C2/3. There was an additional 1.3 deg decrease at C7-T1, accounting for 16.5% of the total decrease in C2-T1 angle (-6.9 deg). The C0-C2 angle increased 1.6 degrees. C2S and SS increased 5.8 and 10.3 deg, respectively ($p < 0.005$) whereas C0S and T1S did not change significantly.

Conclusion: Following successful correction of positive sagittal malalignment, reciprocal changes in cervical alignment ensue. The majority of relaxation in hyper-lordosis occurs at C3–4 and C4–5. The angle between the occiput and C2 increased slightly to maintain head balance in response to decreased subaxial lordosis.

GO002. Effect of Topical versus Parentral Tranexamic Acid on Blood Loss in Spinal Deformity Surgery. A Prospective Randomized Controlled Trial

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Introduction: Massive hemorrhage and massive blood transfusion are not uncommon in spinal deformity surgery. There are many factors which may affect the perioperative blood loss. Multiple studies showed the beneficial effects of parentral tranexamic acid (TXA) in decreasing intraoperative blood loss but there is a lack of knowledge about the effect of topical use of tranexamic acid. The aim of this study is to evaluate the effect of using tranexamic acid topically versus parentrally on the amount of intra operative blood loss.

Material and Methods: Between 2011 and 2014, eighty three patients (49 females/34 males, mean age 17 $\pm$ 4 ys, body weight 49 $\pm$ 6 kg) underwent correction (in the form of multiple Ponte osteotomies, PSO, PVCR) and posterior spinal fusion for spinal deformity (57 AIS, 14 congenital scoliosis, 12 syndromic). These patients were randomized into one of three groups. In group 1 ($n = 31$ patients), TXA was used topically. TXA was sprayed directly in the wound and sponges soaked with it were used. In group 2 ($n = 29$ patients), intravenous TXA was used intra-operatively. In group 3 ($n = 23$ patients), TXA acid was used neither topically nor systemically. Intraoperative blood loss and the number of blood units transfused were recorded for all patients. The three groups were comparable in the mean age, body weight, operative time, type of deformity, type of osteotomy, number of fused segments, number of screws used.

Results: The mean operative time was (240 minute $\pm$ 50). The mean blood loss in group 1 was 1353 $\pm$ 273 cc, 1271 $\pm$279 cc in group 2, and 1430 $\pm$ 311 cc in group 3. The mean number of blood units transfused in group 1 was 2.65 $\pm$ 0.587, 2.3 $\pm$ 0.571 in group 2, and 3.4 $\pm$ 0.5 in group 3. There were no significant differences in intraoperative blood loss and number of units of transfused blood between the first and second groups while there was a significant difference between them and the control group. One patient developed DVT in the intravenous TXA group.

Conclusion: Topical TXA is as effective as intravenous TXA and may be used safely to decrease the need for blood transfusion and intraoperative blood loss.

GO003. Analysis of Lumbar Foramina Size Change in Patients with Lumbar Spondylolisthesis using Kinetic Magnetic Resonance Imaging

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Introduction: The pathology of lumbar spondylolisthesis contributes to lumbar instability and significant clinical symptoms. However, the effect on intervertebral foraminal area (FA) during motion change is not well understood.

Material and Methods: In this study we used 107 patients diagnosed with single or multiple level lumbar spondylolisthesis at L3–L4, L4–L5 or L5–S1. All patients were initially divided into two groups: group A (sliding percentage 0–3%) and group B (sliding percentage $\geq$4%). Sliding percentage and FA size in neutral, flexion and

extension were measured using kMRI. The FA change in different sliding groups at L5-S1 level was further analyzed.

Results: The number of patients in the group A (sliding percentage 1–3%) was 68 at L3–4, 38 at L4–5 and 32 at L5-S1 spine levels. The number of patients in the group B (sliding percentage $\geq$4%) was the following: 39 at L3–L4, 69 at L4–L5 and 75 at L5–S1. The mean FA in both groups changed with different spine positions. When considering all levels, the average FA increased ~17% from neutral to flexion and decreased ~21% from neutral to extension. Similarly, there was a significant difference in FA in flexion at L5-S1 ($p < 0.004$) between the groups. For L5/S1 patients, 104 patients were divided into three sub-groups according to the sliding percentage (group I (0–9%), group II (10–19%) and group III (20–29%)). The FA was significantly increased in the flexion position and decreased in the extension position in all three groups. In group III FA size was significantly decreased from neutral to flexion when compared with Group I ($p < 0.022$). The FA size was significantly increased from neutral to extension when group III was compared with groups I and II ($p < 0.000$ and $p < 0.017$, respectively).

Conclusion: Our kMRI study revealed position-dependent changes of the intervertebral foramen. In patients with severe sagittal subluxation the change in FA from neutral to extension position demonstrated the largest decrease. This change may also correlate with changes in neuroforaminal stenosis and nerve root compression and its associated symptoms and should be taken in consideration when choosing the treatment option.

GO004. New Motor Deficit After Adult Spinal Deformity Surgery Leads to Worsened Early HRQOL: Subanalysis of 273 Patients from Scoli Risk 1 Prospective Study

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Introduction: An International, ambispective, multicenter observational cohort study (Scoli-Risk-1) was completed to determine the impact of neural injury on Health-related Quality of Life scores (HRQOLs). 30.9% of patients suffered any ASIA lower extremity motor score (LEMS) worsening during the first 6 months after surgery. The purpose of this analysis is to define the impact of new LEMS deficit on HRQOL metrics and recovery of those measures after surgery in the first 6 months. We hypothesized that new motor deficits (defined by LEMS worsening) will lead to worsened HRQOL scores, after correction of adult spinal deformity.

Material and Methods: Patients aged 18–80 years with a diagnosis of adult spinal deformity were eligible for enrollment at 15 sites worldwide. Other inclusion criteria included major Cobb $>$ 80 degrees, C7-L2 curve apex, and any patient undergoing 3 column osteotomy. ASIA scores and standard HRQOL scores (ODI, SRS, SF-36 mental, and SF-36 physical) were recorded pre-op, 6 weeks and 6 months. Patients were subdivided into three subcategories of LEMS change ($\geq$2 points worsening, 1 pt worsening to no change, or LEMS improvement).

Results: 273 complex adult spinal deformity (ASD) patients enrolled, with 184 female (67%) and 89 male (33%) patients. Mean age was 56.9 years (SD 15.3, range 18–81). 30.9% of patients suffered a worsening of LEMS within the first 6 months post-surgery. HRQOL scores worsened as LEMS worsened. The 6 week HRQOL changes for LEMS $\leq$2 patients vs LEMS -1 to 0 vs improved LEMS patients were: ODI (11.6 vs 0.7 vs -0.6), SF-36 physical (-3.9 vs -1.6 vs 1.0), SF-36 mental (-1.5 vs 1.4 vs 0.6), and SRS total change (0 vs 0.4 vs 0.5), respectively. The 6 month HRQOL changes for LEMS $<$ =2 patients vs LEMS -1 to 0 vs improved LEMS were: ODI (-6.8 vs -9.5 vs -14), SF-36 physical (0.6 vs 2.6 vs 6.2), SF-36 mental (-1.1 vs 3.8 vs 5.9), and SRS total change (0.3 vs 0.7 vs 0.8), respectively. Table 1 shows these data. While the database is not yet locked, these data are subject to minor changes.

Conclusion: In the subgroup of patients who developed a new lower extremity motor deficit after adult spinal deformity surgery, total HRQOLs and HRQOL changes were negatively impacted. Patients with 2 or more points of LEMS worsening had the worst HRQOL changes. However, even these patients showed overall improvement in ODI, SF-36 physical and SRS total scores at 6 months compared with pre-op baseline.

Deformity Thoracolumbar Adolescent 1

GO005. Prevalence and Significance of Vitamin D deficiency in Patients with Idiopathic Scoliosis Requiring Corrective Surgery

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Introduction: Vitamin D deficiency may affect children in terms of growth disturbance, deformity and metabolic disease. The senior authors have felt significant difference in bone quality intra operatively and wondered if vitamin D status was relevant in this. The aim was to assess the prevalence of vitamin D deficiency in a cohort of patients undergoing scoliosis correction surgery for adolescent idiopathic scoliosis (AIS) and to assess if Vitamin D deficiency had any significance/correlation to the pre-operative cobb angle or pain scores.

Material and Methods: Any patient undergoing corrective surgery for AIS who had pre-operative Vitamin D sample taken. From January to December 2014 a total of 69 records were assessed yielding a cohort of 41 patients undergoing surgery for Adolescent Idiopathic Scoliosis (AIS) with a recorded pre-operative total 25-OH vitamin D level. Three tiers

of Vitamin D level were assessed including normal > 50nmol/L, insufficiency < 50 but > 25nmol/L and deficiency < 25 nmol/L as per local guidelines for Vitamin D deficiency in children. Patients' age, sex, pre-operative vitamin D levels, Cobb angles at time of surgery, pre-operative back pain scores were recorded.

Results: 41 Children with a recorded Vitamin D level pre-operatively were analyzed. There were 4 male and 37 females. The average age at surgery was 15 years,(range 12 – 17). Of the 41 patients 9 (22%) were Vitamin D Deficient (range 10–25), 14 (34%) were insufficient (range 29.3–49.8) and 18 (44%) were above the treatment level (range 54.8 – 139.1). The average pre-operative Cobb angle for the deficient patients was 68 (range 50–89) compared with 64 (range 48 – 85) for the insufficient patients and 62 (range 44–76) for the patients with normal Vitamin D levels. The pain scores for each of the 3 groups revealed that the patients in each group complained of a similar (moderate) amount of back and rest pain pre-operatively.

Conclusion: Vitamin D deficiency in children leads to reduced calcium absorption from the bowel and may lead to skeletal deformity and rickets. The effect on bone healing of Vitamin D deficiency may have an affect on the quality of spinal fusion required as part of the surgical treatment for AIS and it is not known whether those patients undergoing surgery have adequate levels. This study reveals that 56% of patients had Vitamin D levels requiring supplementation. Further work is being undertaken to evaluate pain values, fusion time and deformity correction in those children with insufficient or deficient levels of vitamin D.post-op complications and hospitalisation

GO006. Efficacy of En Bloc Direct Vertebral Body Derotation (Dvbd) in Idiopathic Scoliosis Treatment

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Introduction: Vertebral axial rotation in horizontal plane is a component of spinal deformity in scoliosis. Greater axial rotation is related with inclination to curve progression, contributes to rib hump development. Therefore the correction of axial deformity appears as an obvious component of scoliosis correction. However clinical efficiency and complication risk of derotation maneuvers is still not established. The object of the study was to assess horizontal correction obtained with en bloc direct vertebral body derotation (DVBD) and the influence of the maneuver on coronal and sagittal correction of the spine in patients undergoing surgical scoliosis correction.

Material and Methods: 36 patients after surgical correction of idiopathic scoliosis were included into study. Authors analyzed two groups; adolescents and adults. All patients underwent posterior fusion with pedicle screws only instrumentation. 15 (20 curves) patients were corrected by rod derotation only and 21 (26 curves) underwent rod derotation and direct en bloc vertebral derotation (DVBD). Measurements according to Cobb method were performed on X-rays obtained before and post surgery - coronal plane curves, sagittal profile (T2-T12, T5-T12, L1-S1). Spine flexibility was assessed of prone bending X-rays. Axial rotation was determined on CT scans obtained intraoperatively (O-Arm, Medtronic) and postoperative CT scan. Rotation assessment was done according to the method described by Aaro and Dahlborn.

Results: The comparison of axial rotation prior to correction and post correction revealed decrease of axial apical vertebral rotation in both DVBD and non DVBD groups. However in DVBD group vertebral derotation was greater than in non DVBD group and it was confirmed in statistic analysis. Amount of axial derotation was similar in both adults and adolescents. Analysis of coronal curves showed statistically significant better correction in (DVBD) group and obviously better correction was possible in flexible than stiff curves. DVBD did not improve but also did not decrease kyphosis comparing to pre op measurements and results from non DVBD group. This statement concerned both T2-T12, T5-T12 measurements. Neither flexibility nor stiffness of the curves influenced kyphosis results.

Conclusion: Direct vertebral body derotation is a relevant maneuver to improve correction in idiopathic scoliosis, either in coronal or sagittal plane. It may be useful technique in adolescent as well as adult patients.

GO007. The Effect of Post-Operative Complications in Complex Adult Spinal Deformity Surgery on Surgical Outcomes: an International, Large-scale, Prospective Multicenter Study

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Introduction: This large-scale study aimed to determine the effect of non-neurological complications in complex adult spine deformity surgery upon post-operative functional/disability profiles.

Methods: This is an international prospective multicenter study involving 15 sites from North America, Europe, and Asia. Adult patients with severe spinal deformity were assessed at 6 weeks and 6 months post-operatively. Non-neurological complications were recorded and grouped into intraoperative events, minor and major complications. Post-operative functional/disability outcomes were evaluated by Oswestry Disability Index (ODI) and SRS-22 pre-operatively and at each follow-up (Fig. 1).

Results: 269 subjects were included (68% women and 32% men; mean age: 57.8 years). There were no significant differences in pre-operative ODI and SRS-22 scores between patients with and without major complication. At 6 weeks and 6 months after surgery, patients with major complications had significantly worse ODI and SRS-22 scores compared with patients without major complications ($p < 0.005$). Both groups with and without major complications showed statistically significant functional improvement 6 months after

surgery ($p < 0.0001$). Improvement in functional scores were similar in patients with and without intra-operative events and/or minor complications ($p > 0.05$).

Conclusion: Based on the largest, multi-center study addressing complex adult spine deformity patients, worse post-operative functional/disability profiles were noted up until 6 months follow-up in patients who experienced major complications than those that did not. Similar functional/disability profiles were noted in patients who experienced intra-operative or minor complications. This study further broadens the understanding of postoperative surgical outcomes, risk profiles, and clinical/patient expectations following such deformity surgeries.

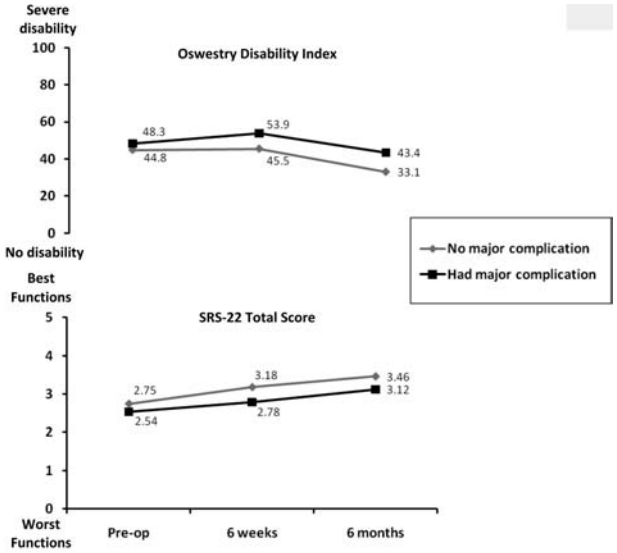

Fig. 1 Mean ODI and SRS-22 total score at pre-operation, 6 weeks and 6 months follow up.

GO008. The Rib Construct (RC) has Provided Secure Proximal Fixation for Management of Patients with EOS and Severe Thoracic Hyperkyphosis

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Introduction: Thoracic hyperkyphosis, described as greater than 20 degrees of kyphosis from T1–5, and/or 40 degrees from T5–12, or greater than 50 degrees of maximum total kyphosis, has been associated with poor outcomes when treating EOS. For such patients, decision making between spine based and rib based proximal fixation has been graded as being among the areas of greatest clinical uncertainty at present for surgeons treating EOS. We address this uncertainty by reporting our results of rib based fixation in patients with EOS and thoracic hyperkyphosis. We chose a minimum of 70 degrees of kyphosis between T5–12 for inclusion, rather than 50, to focus further on the management of severe hyperkyphosis.

Material and Methods: Ongoing data collection of surgical management of 13 children with EOS and greater than 20 degrees of kyphosis between T1–5 and/or 70 degrees between T5–12, and at least 24 months of followup was compiled. The (RC) was used for proximal fixation in all cases.

Results: 5 syndromic,5 congenital/structural, 1 idiopathic. 9 had prior spine surgery. Average age at initial surgery 84 months; followup averaged 47 months (24–77). 5 had T1–5 kyphosis, average 29 degrees, postop 26. 9 had T5–12 kyphosis, average 96 degrees, postop 56. Average preop thoracic scoliosis 68 postop 44; preop lumbar scoliosis 39, postop 38. Average preop spine length 22.9 cm, postop 29.2. Average preop coronal balance 11.3 cm, postop 13.1. Average preop sagittal balance 39, postop 27. Complications included 3 proximal hook dislodgments, 5 distal anchors, 1 delayed deep wound infection with removal and subsequent replacement of instrumentation, 3 rod failures, 1 PJK. As a group, there were 63 subsequent planned procedures, and 18 unplanned.

Conclusion: The RC provides reliable proximal fixation for EOS patients with severe thoracic hyperkyphosis, especially for those with hyperkyphosis from T5–12.

GO009. The Convex Manipulation: An Alternative Technique in Surgical Treatment of Adolescent Idiopathic Scoliosis

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Introduction: Concave derotation is the traditional correction maneuver in adolescent idiopathic scoliosis surgery. However, the positioning of thoracic pedicle screws at concave side of the curve can be quite challenging, because of the small pedicle size and the wide variation in its morphological characteristics, due to the vertebral dystrophy observed in scoliotic patients. Then, to reduce risks of neural damages, and ensure the same strenght of derotation maneuver, a convex manipulation through an all-level pedicle screws convex instrumentation can be performed. We report perioperative and 2-year results in a consecutive series of patients treated by convex manipulation through an all-level pedicle screws convex instrumentation.

Material and Methods: From January 2013 to January 2015 we surgical treated 36 consecutive patients (28 F, 8 M, mean age 13 years) affected by thoracic adolescent idiopathic scoliosis (Lenke type 1, 27 patients, and Lenke type 2, 9 patients). Mean pre-operative Cobb angle was 56°±6° in Lenke type 1 group and 51°±4° plus 32°±3° in Lenke type 2 group. We performed a posterior access only in all patients using polyaxial pedicle screws at each level on the convex side of the curve. Derotation and manipulation maneuvers were performed on the convex prebent rod. In all cases motor-evoked potentials monitoring was used. Mean follow-up time was 27 months.

Results: The average percentage of coronal correction was 76 ± 5% (mean post-operative Cobb angle 15°±4°), with no neurological complications. Concerning the post-operative kyphosis, we observed a slight decrease of mean values compared with pre-operative measurements (mean reduction of thoracic kyphosis 5°±2°). At 2-year follow-up no changes in coronal nor in sagittal plane were observed. The mean operative time was 210 ± 30 minutes, with a mean blood loss of 500 ± 100 ml. Using the free-hand technique, the mean time of pedicle screws positioning in the thoracic area on the convex side was 2 ± 1 minutes from T6 to T12, and 4 ± 1 minutes from T3 to T5. Whenever included in the area of arthrodesis, T2 was usually instrumented with the Universal Clamps, to reduce the stiffness of the construct. Instead, T1 has never been included in the arthrodesis area.

Conclusion: This case-series study shows the effectiveness and the safety of convex manipulation in Lenke type 1 and type 2 scoliosis. The coronal correction obtained with this technique is comparable to that obtained with the traditional concave derotation. Other advantages are the short operative time, the low intra-operative blood loss and, mostly, a lower risk of neurological complications.

GO010. Can EOS 3D Morphological Analysis Better Correlate with Pain Patterns than the Lenke Classification

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Introduction: Adolescent Idiopathic Scoliosis (AIS) has been thought to be a relatively painless three dimensional (3D) deformity of the spine, but some studies has shown that the incidence of mild to moderate pain in AIS ranges from 25 to 50%. With the arrival of the new low dose radiation EOS technology, it is now possible to quantify intersegmental changes of the scoliotic spine in an upright position that could be related to pain.

Hypothesis: EOS 3D morphological analysis of AIS patients will better correlate with presence of pain than the Lenke classification.

Methods: Fifty-nine patients (7 male/52 female, mean age of 14.3 years old) who were scheduled for elective posterior spinal fusion with diagnosis of AIS. Preoperative clinical pain data recorded consisted of: 1) numerical visual analogue (VAS) pain scores quantifying patients average and worst pain over the preceding month; 2) SRS22 scores. Preoperative PA and lateral imaging were utilized to reconstruct and generate 3D models using the EOS software. Global and segmental intervertebral orientation in all three planes including the Da Vinci diagram identifying maximal deformity orientation were generated and correlated with patients' clinical presentation. In addition, standard curve magnitude, curve classification (Lenke) and pelvic parameters were also analyzed to observe their association to pain. Statistical analysis was performed with GraphPad Prism 6.

Results: Lenke classification and its subtypes did not correlate with pain, nor did any of the classic curve parameters, with the exception of the presence of hyper lumbar lordosis (>60 degrees) ($r = 0.32$, $p = 0.06$). Hyperlordotic patients reported greater pain intensity than normal lordotic patients ($U = 81.50$, $p = 0.04$). Additional new 3D parameters from both global and intersegmental vertebral orientations in space were investigated. With the exception of high intervertebral frontal, lateral tilt of L4 over L5, no 3D correlations with pain patterns were observed.

Conclusion: Despite the additional 3D morphological analysis generated by the EOS imaging, we were not able to identify anatomical characteristics associated to the pain experience reported by patients, with the exception of hyperlumbar lordosis.

Infections 1

GO011. Simultaneous Video-Assisted Thoracoscopic Debridement/ Fusion and Percutaneous Transpedicular Instrumentation in Prone Position for Thoracic and Thoracolumbar Infections

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Introduction: The incidence of vertebral osteomyelitis is reported to range between 2–7% of all cases of bone infection. Spinal infection is age-related and has been on the rise over the last decades. Thus, it occurs frequently in elderly and debilitated patients who have significant medical comorbidities and predisposing factors for spinal infection. The thoracic spine and thoracolumbar junction are areas frequently involved in various types of spinal infections. The aim of surgery in spinal osteomyelitis is to relieve pain by eradication of the infection, reconstruction of the defects and restabilization of the spine. Anterior radical debridement and spinal fusion is advocated as an effective treatment of these infections. Video assisted thoracoscopic surgery (VATS), in cases of thoracic and thoracolumbar spinal infection, is a good alternative to conventional thoracotomy with minimal morbidity, although surgically demanding. There are few reports in the literature of VATS performed on prone patients. This study analyses prospectively 61 patients, who were operated upon for thoracic or thoracolumbar spinal infection in a single tertiary-care referral hospital, between May 2010 and May 2013 using VATS combined with percutaneous fixation in all patients while the patient positioned prone.

Material and Methods: Between May 2010 and May 2013, 61 patients with spinal infections at the thoracic and thoracolumbar junction were operated upon in our hospital. Those patients underwent anterior thoracoscopically assisted debridement and fusion plus posterior percutaneous stabilization in prone position. The clinical and radiological assessments of these patients were evaluated preoperatively and postoperatively with mean follow up of 37.7 months. The clinical outcomes data were assessed postoperatively and final follow-up by use of VAS and subjective clinical results. Plain X-ray in two views was used for the radiological outcome evaluation.

Results: Sixty one consecutive patients were included (38 males and 23 females) with mean age of 67.5 years, 78% were older than 60 years. More than 80% of the patients had associated comorbidities. The mean operative time was 195.49 ± 41.60 minutes, for thoracoscopic anterior surgery was 100.57 ±29.14, and for posterior surgery was 94.92 ± 28.35 minutes. The average blood loss was 597.54ml. Thirty two patients (52%) had preoperative neurological deficits ranging from Frankel A to D. One patient (Frankel A) did not show any neurological improvement at the final follow-up. The mean VAS at final follow-up was 1.03/10 (preoperative 7.89). The mean preoperative kyphosis angle was 17.11°, improved to 6.51° postoperatively and reached 8.48° at the final follow-up. First year mortality rate was 6.5% (4 patients).

Conclusion: Minimal invasive spinal techniques including thoracoscopic debridement and fusion and posterior percutaneous instrumentation showed good clinical and radiological outcomes and can be considered as alternative to open procedures with decreased rates of morbidities in managing thoracic and thoracolumbar infections in elderly patients.

GO012. To Evaluate Post-operative Functional and Radiological Outcomes of Patients with Dorsal and Dorsolumbar Pott's Spine Who Underwent Anterior Decompression and Posterior Instrumentation, through Only Posterior Trans-Pedicular Approach

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Introduction: Approach for surgical treatment of Thoraco-lumbar tuberculosis has been always controversial. Traditionally, the anterior approach has been preferred throughout the spine to achieve these goals. A combined anterior plus posterior approach helps to overcome stability related drawbacks of anterior approach alone. Posterior approach has gained popularity in the last decade as it provides

excellent exposure for circumferential spinal cord decompression and also allows posterior instrumentation to be extended for multiple levels above and below the level of pathology with less morbidity, less duration of surgery as well as less amount of blood loss as compared with combined anterior and posterior approach.

Material and Methods: The study was conducted at Indian spinal injuries center, New Delhi during the period from June 2014 to June 2015 and included all patients of thoracic and Thoraco-lumbar Pott's disease who were operated by posterior trans-pedicular approach procedure from January 2009 to January 2014. Out of 560 patients who underwent surgery only 60 patients were included in the study who satisfied the following criteria: Age $\geq$ 18 years.and minimum up to 12 months of clinic-radiological follow up. Following data were collected and analyzed: Average operative time, pre and post AIS grading, bony fusion, pre-op, post op and last follow up angles of kyphosis, loss of kyphotic correction, cage subsidence, implant loosening, implant failure, ODI and VAS scores at 6 months interval and final follow up. The pre-op, post op and last follow up angles were compared for dorsal and lumbar separately using paired *t*-test or Wilcoxon Signed rank test (if data are non parametric) and was corrected using Bon-ferroni for multiple comparisons.

Results: Patients were followed up for at least twelve months, with an average of 16.81 months (range 12–40months). The mean operation time was 260 $\pm$ 30 minute (range 180– 540 minute). 55 patients presented the evidence of successful bony fusion within a mean time of 6 $\pm$ 1.5 months. Dorsal ($n = 50$): The pre op angles (19.85 $\pm$ 14.17) were significantly larger than the post op angles (6.96 $\pm$ 14.8) ($p < 0.00001$) and smaller than the last follow up angle (9.29 $\pm$ 16.19) ($p < 0.0001$) as tested by Wilcoxon Signed rank test. Lumbar ($n = 10$): The pre op angles (21.45 $\pm$ 7) were significantly larger than the post op angles (11.6 $\pm$ 4.4) (t score = 4.01, $p = 0.003$) and smaller than the last follow up angle (13.4 $\pm$4.1) (t score = -3.668, $p = 0.005$). Pre op VAS scores (8.15 $\pm$0.9) was higher than the post op values (2.18 $\pm$ 0.9) (t score =52.38, $p < 0.00001$) and the last follow up (0.833 $\pm$ 0.88). Pre op ODI scores (32.5 $\pm$6.4) was higher than the post op values (13.4 $\pm$ 5.8) ($p < 0.00001$) and at last follow up (3.966) as tested by Wilcoxon Signed rank test.

Conclusion: Anterior decompression and posterior instrumentation through only trans-pedicular approach is a safe surgery with less intra operative surgical duration and improve neurological, radiological, pain and functional scores significantly with significant fusion rates and less post operative morbidity. Limitation of the study are retrospective study, small sample of 60 patients and radiographs used to assess fusion instead of CT scan.

GO013. Surgical Site Infection in Spinal Operations A Tertiary Centre Review of 4557 Consecutive Procedures over 5 Years

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Background: Surgical Site Infection (SSI) is a potential inherent risk of any surgical intervention. SSI can pose significant consequences especially in spinal surgery. Previous research showed that there are seasonal variations in the incidence of SSI with numbers peaking in summer months.

Objective: To evaluate (1) incidence of Surgical Site Infection (SSI) for consecutive operations in a tertiary center, (2) the commonest pathogen, (3) The management in our unit and its long-term outcome, and (4) Effect of seasonal change on SSI.

Methods: Consecutive spinal operations ($N = 4557$) between Jan 2007 – Jan 2012 were studied looking for SSI using the Centres for Disease Control National Health Safety Network criteria. All patients with SSI positive criteria were included in the study. Further evaluation was based on the study objectives.

Results: 4557 procedures were assessed, of which 30.5% were Decompressions, Variable Thoraco-Lumbar Fusions (inc. ALIf, TLIF, XLIF, Deg. Scoliois correction) 25.8%, Cervical operations 18.8%, Scoliosis operations 10.5%, Decompressions and Interspinious spacers 6.9%, and miscellaneous procedures were 7.5%. In total 8.5% of cases were revision surgeries. The incidence of SSI was 4.9% with 62.1% Male and 37.9% Females. Commonest organisms were Coagulase Negative Staph 31.7%, Staph Aureus 26.8%, Pseudomonas 7%, MRSA 4%, and polymicrobial 30.5%. The average time to detection of infection was 23 days (3–200). Of the positive SSI cases, 9.75% needed surgical debridement. 2.4% needed removal of metal work/Replacement. They all made uneventful long-term recovery. 54.9% of SSI had their operations in the summer months, while 45.1% were operated in the Autumn/Winter months.

Conclusion: Bearing in mind the low infection rate of deep surgical site infections we encountered: Most of the SSI cases were effectively treated in our unit by using antibiotics only; The close liaison with our microbiology unit was and remains of paramount importance; There is no clear difference found in our study between Summer/Spring and Autumn/Winter months in the rate of developing SSI.

GO014. Radical Debridement and Spinal Reconstruction using Titanium Mesh Cages (TMC's) in Pediatrics Patients with Pott's Disease and Vertebral Osteomyelitis

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Introduction: TB spondylitis and vertebral osteomyelitis frequently occur in the patients of early ages. The tendency to the multilevel damage with total or subtotal lesions of several vertebral bodies leads to the spine collapse and early kyphosis. Radical debridement and autogenous strut-graft fusion have become the "gold standard" for surgery. The introduction of the TMC in adult's spinal surgery has opened up a variety of applications that are realizable as a result of the versatility of the implant. But the use of TMC in pediatrics spinal surgery is controversial, and results have not been published to date.

Patients and Methods: Study design: cohort analysis. 74 children aged from 7 months till 17 years underwent spinal reconstruction: 5 (10%) in the cervical spine, 32 (46%) in the thoracic spine and 37 (44%) in the lumbar spine. Clinical series include 18 early age patients under 3 years old. Group 1 (n1 = 25) – tuberculous (TB) spondylitis; group 2 (n2 = 49) – chronic nonspecific spondylitis (CNS) and its consequences, including 16 patients with spondylodiscitis. Disease duration in all patients was at least 4 months prior ineffective antimicrobial therapy. The indications for surgery were destruction with vertebral deformity progression, neurological disorders and ineffective chemotherapy with continuing abscesses. All patients had debridement with anterior column reconstruction, posterior instrumentation and fusion by TMC's with bone auto-grafts. The rate of the fusion was assessed by CT at 6 and 12 months after surgery according to the new rating scale graded from 1 (incorrect implant position) to grade 5 (solid fusion with a structural bone block).

Results: The number of stabilized spinal segments ranged from 2 to 5. Etiology of spondylitis was identified due to bacteriological, molecular genetics and morphological studies of the operational material. No operative complications and no implant-related complications were recorded in the postoperative period. The fusion rate corresponded to grade 3 in 91,1% ($n = 68$) at 6 mns post-op and as grade 4 in 93,2% ($n = 69$) at the 12 mns post-op. Till the final follow-up (M 36 - mns, min 12 - mns, max – 4 years) a mean segmental loss of correction was 3,7 ($0 \div 7$) degrees. Destabilization of TMC's was detected after surgery only in two cases due to the late infection's reactivation.

Conclusion: The anterior interbody fusion by TMC's with bone auto-grafts in pediatric spine reconstruction provides reliable spinal stability in both the short-term and long-term period and does not increase the risk of infectious complications in cases of infectious spondylitis' surgery. TMC produce the early anterior fusion and provide the possibility to earlier removing of posterior instrumentation before the disk degeneration inside the instrumented zone in growing spine.

GO015. Functional Outcome after Anterior Decompression and Stabilization using Locally Made Stand-alone Titanium Cage with Bone Graft in Caries Spine: An Experience of 600+ Cases at Ghurki Hospital

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Introduction: Tuberculosis is the leading cause of death in third world countries, from a single infectious disease. It paralyses the society when it affects the spine due to its residual neurological deficit in the form of Quadriplegia, paraplegia, loss of bladder and bowel control, bedsores, as well as from continuous financial burden it exerts on the affected family and whole society. Early spinal decompression and stabilization with a locally made stand alone cage have dramatic results in terms of improvement in neurology, relief of pain and correction of deformity as well as improvement in the patient's quality of life.

Methods: The objective of the study is to determine the outcome after Anterior Decompression and Stabilization with locally made stand alone Cage & Bone Graft in caries spine in terms of improvement of neurology, relief of pain, improvement of Kyphotic angle as well as quality of life improvement. It is a prospective case series study including 600 cases, which were treated at GTTH from 2005–15. After pre-operative assessment of pain, neurology, measurement of angle of deformity, and QOL analysis using the SF-36®, all patients were treated with Ant. Decompression and then stabilization was achieved using morcellized bone graft with a locally made stand alone cage. After surgery patients were followed at 06 weeks, 03 months, 06 months & 01 year to assess neurology, relief of pain and Kyphotic angle and their SF-36® scores.

Results: Neurology improved in 88% of patients, pain was relieved in 92% of cases and there was mean correction of 18° in Kyphotic angle at the end of 01 year follow up with a significant improvement in the patient's quality of life.

Conclusion: Early diagnosis and early intervention gives excellent results in Tuberculosis of the spine. After anterior decompression, stabilization with cage and bone graft results in significant improvement of neurology, relief of pain and correction of Kyphotic deformity, as well as the patient's quality of life. There is no need for added instrumentation.

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GO016. Surgical Results of 135 Thoraco-Lumbar Fractures Treated with Open Posterior Multi-Level Segmental Fixation: A Single Center Experience

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Introduction: Surgical treatment strategies for thoraco-lumbar spine fractures differ widely around the world. Choice of operative approach varies depending on many factors including fracture classification, presence of spinal cord injury and whether subluxation or dislocation is present. Combinations of anterior and posterior approaches vary depending on surgeon choice, available resources and fracture morphology. We reviewed our experience of thoraco-lumbar vertebral fractures treated at our institution from Jan 14 – May 2015 to determine if our policy of posterior multi- level segmental fixation produced acceptable restoration of spinal alignment and reduction of kyphosis.

Materials and Methods: A retrospective cohort review was performed using the hospital electronic medical records system (Cerner, USA). All surgical cases were identified from the operating theater records. Only fractures from T1 to L5 were included. Imaging was reviewed using the hospital PACS system and classified according to the AO thoraco -lumbar classification system. Spinal cord injury was classified according to the ASIA scale.Post-operative images were reviewed and levels of fixation recorded. Accuracy of screw placement was assessed. Neurological status at discharge was recorded.

Results: 135 cases of TL fracture underwent surgery via an open posterior approach. Screw placement was performed using C-arm fluoroscopy.Data on the extent of kyphosis reduction is presented. Post-operative results in cases of vertebral subluxation and dislocation are presented. Early surgical outcome in cases with spinal cord injury are presented.Due to the high level of loss to follow up in our region we were unable to carry out longitudinal outcome studies.

Conclusion: The majority of thoraco -lumbar fractures can be managed by posterior approaches alone with good surgical outcomes. Type C fractures and fractures with dural tears and nerve damage can be adequately dealt with via this approach. The majority of cases had pedicle screw fixation two levels above and one level below the affected level. This strategy allowed good reduction of deformity, especially for fractures at L1, where fixation only to T12 can be associated with late onset of adjacent segment degeneration.The inability to carry out longitudinal outcome measures is an acknowledged weakness of our study, but the short-term surgical results are comparable to those in the literature using other surgical strategies.This retrospective cohort review supports our continuing use of the posterior multi-level segmental approach for T-L fractures irrespective of fracture type.

GO017. Thoracoscopic Vertebral Body Replacement of Burst Fractures in the Thoracolumbar Spine with a Distractable Titanium Cage

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Introduction: The treatment of burst fractures in the thoracolumbar spine is controversially discussed. Therapeutic options reach from conservative measures up to the meanwhile established approach through dorsoventral stabilization. Thoracoscopy-assisted operation methods have been

applied to restore the anterior column in the ventral spine for a couple of years. This approach helps to avoid invasive thoraco- and laparotomies and prolonged healing periods. These procedures are associated with certain complications such as chronic pain syndrome in over 50% of affected individuals. The Hydrolift (B. Braun Aesculap) is an infinitely variable, expandable vertebral body replacement available for thoracoscopy-assisted implantation. The aim of this study was to evaluate the clinical and radiological outcome, patients' reintegration in the working environment and possible restrictions during athletic and daily-live activities.

Materials and Methods: We performed a retrospective analysis including 30 patients (m:f = 24:6, average age: 56 years) with fractures of the vertebral bodies Th12 and L1 (3 A3.2, 23 A3.3, 4 B2.3), that have been treated with an infinitely variable, expandable vertebral body replacement (Hydrolift, B. Braun Aesculap) and an axis-stable plate (MACS, B. Braun Aesculap) in the Department of Traumatology of the University Hospital Salzburg, Austria between 03/2009 and 09/2013. A clinical follow-up, an assessment of the impairment through questionnaires (Oswestry Disability Index and VAS Spine) and a radiological evaluation of the position and osseous integration of the cage through CT have been collected after an average of 22 (18–47) months.

Results: 11 out of 30 patients have the same quality of life as prior to the injury, 13 have low-grade restrictions. After an average recovery period of 5 months, 56,7% of the patients are 100% reintegrated in their previous working life, 36,7% can continue working up to 75%. 1 Patient has changed his profession to a physically less challenging field, 1 patient is unable to work. 5 patients were retired prior to the accident. The outcome of the Oswestry Disability Index shows a low-grade impairment in everyday life with an average of 12,9% (0–40%). The analysis of the VAS Spine shows scores between 47,4% and 96,0%, with an average of 80,5%. A correction of 11,4° could be achieved after dorsoventral stabilization. The correction loss after reconstruction of the ventral spine with Hydrolift amounts to 1,8°. An osseous integration of the implants was observed in 96,7% of the patients. Two cases of a mild dislocation of the Hydrolift into the adjacent vertebral body took place, without any clinical relevance.

Conclusion: A stable treatment of burst fractures in the thoracolumbar spine can be achieved through a ventral spondylodesis with the Hydrolift and axis-stable MACS plate. The thoracoscopy-assisted operative treatment with Hydrolift is a successful method, due to stability, low additional morbidity, a high reintegration rate in the patients working environment (96%) and a high continuation of their familiar athletic activities.

GO018. Surgical Treatment of Burst Fractures of the Dorsolumbar Spine by Short Segment Posterior Instrumentation. To Fuse or Not to Fuse?

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Introduction: The concept of 'Ligamentotaxis' using short segment posterior instrumentation and fusion is widely accepted for managing unstable burst fractures of the dorsolumbar spine. The aim of this work is to study the possibility of performing this procedure without fusion.

Materials and Methods: This is prospective randomized study included 54 patients with burst fractures of the dorsolumbar spine treated with short segment posterior instrumentation without fusion (Group 1); compared with a similar group of 47 patients that were treated by the same technique with posterolateral fusion using iliac crest autograft. Patients were followed up for an average of 5y.

Results: In Group 1, all patients with neurological impairment improved 1 to 2 Frankel grades; the VAS improved from an average of 7.8 to 1.3 and the overall complications were 4/54. The kyphotic deformity was corrected from an average of 22.6 degrees to an average of 3.1 degrees; the average anterior height of the fractured vertebrae was corrected from an average of 65% to an average of 92% and the compromise of the spinal canal improved from an average of 42% to 14%. Implant failure occurred in 2 patients. There was no significant difference in these parameters between Groups 1 and 2. In Group 2 there was significantly more operative time, blood loss, hospital stay and 10/47 complications including 2 implant failures.

Conclusion: Short segment posterior instrumentation without fusion is a safe efficient procedure with significantly less operative time, blood loss, hospital stay and complications than when fusion was performed.

GO019. Direct Spondylolysis Repair in Young Adults

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Introduction: Spondylolysis is a common problem affecting all ages but in adolescent and young adult specially the athletes it represent a significant dilemma as most of them starting their life and need a stable free spine, a minority of old people affected by this disease need medical care, and only a few require surgery but in athletes and young adult surgery usually the role. Reconstruction of the pars interarticularis is an alternative to segmental fusion; this technique has the advantage of preserving segmental motion. Most authors report good results for young patients without intervertebral disc or facet affection

Material and Methods: In this study the fixation of the isthmus was done with a pedicle screw hook system. This stable and strong device is easy to use, allows an anatomic pars interarticularis reconstruction and avoids a postoperative bracing and allow early ambulation. 9 patients were assessed in this study, the mean age at operation was 24 (range 16–32 years) and the average follow-up was for 24 months (range 6–36 months). 7 patients showed no preoperative degenerative disc disease and 2 patients had grade 1 changes. The visual analogical scale, the Oswestry disability index (ODI were used for assessment of pain and clinical outcome before and after surgery.

Results: The results were from "excellent" to "good" for 8 patients and "fair" for one of them. The fusion rate was observed in all cases. Among patients results are from "good," to "excellent" in all cases and consolidation was always observed. All of them showed normal disc height after the surgery.

Conclusion: Direct spondylolsis repair by pedicle screw hook system is an excellent and reliable method in management of spondylolysis especially in intact disc in young adults

GO020. Long Segment Posterior Instrumentation with Interbody Fusion using Locally Harvested Bone Graft for Fracture Dislocations of Thoraco Lumbar Spine: An Outcome Study of 60 Cases

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Material and Methods: Sixty (60) cases of Fracture Dislocations of thoraco lumbar spine were treated at JPN

Apex level one Trauma Center, A.I.I.M.S., New Delhi, from Jan. 2008 to April 2014. All the cases were treated by long segment pedicle screw constructs, two levels above and below the dislocation level, from a posterior approach. A combined posterior and postero lateral decompression from posterior approach was done in 56 cases. In 3 cases, only posterior decompression by complete laminectomy was done. In one case only, additional anterior decompression from anterior approach was done along with posterior approach. Partial corpectemy and interbody fusion using Harms type mesh cage was done in 20 cases. Complete Discectomy at the dislocation level and Interbody Fusion, using locally harvested bone graft (Spinous process and Lamina) from the posterior decompression was done in 32 cases. A partial corpectemy and interbody fusion using the TLIF banana type cages was done in 4 cases. In Situ postero lateral fusion was done in 3 cases. In one case, additional anterior surgery along with posterior surgery was done to achieve anterior reconstruction with expandable cage.

Results: Follow up of cases ranged from one year to six years. There was no case of implant failure or loss of fixation, in any of the 60 cases. Fusion was achieved in all cases, as evidenced by direct and indirect markers. All patients achieved at least a sitting balance. 20 patients were ambulating on wheel chair, while 40 patients achieved independent mobilization, with or without the help of calipers and braces. Neurologic recovery of one ASIA grade was seen in 15 patients, and two ASIA grades was seen in 20 patients. There was no neurologic recovery seen in 25 patients. There was deep seated infection, in two cases, which resolved with debridement and antibiotics. Sacral bed sores developed in six cases, which were treated by local flaps.

Conclusion:: Long segment posterior fixation, two levels above and below the injury from a posterior only approach is sufficient and adequate treatment for fracture dislocation injuries of thoraco lumbar spine. Interbody Fusion using locally harvested bone graft is a novel technique to enhance the fusion rate and minimize instrumentation failures.

GO021. Posterior Spinal Fixation with Fusion versus without Fusion in Treatment of Dorsolumbar and Lumbar Fractures

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Introduction: Operative treatment in the form of posterior fixation with or without fusion has moved to the forefront of fracture management as it helps decreasing morbidity and mortality with better return to work and satisfactory functions. The aim of the study is to compare the results of posterior spinal fixation with fusion versus without fusion in cases of dorsolumbar and lumbar fractures both clinically and radiologically.

Material and Methods: A randomized clinical trial conducted on 60 patients in Ain Shams University Hospitals in two groups: Group (A): posterior spinal fixation with fusion (30 patients); Group (B): posterior spinal fixation without fusion (30 patients). All patients have dorsolumbar and/or lumbar spine fractures and are candidates for posterior spinal fixation. Inclusion criteria: Age group (<45 years). Both sexes. Neurologically intact patients with kyphotic angle more than 20° or decreased vertebral body height more than 50% or a canal compromise more than 50%. Single or multilevel spinal injury. Exclusion criteria: Any patient who will need anterior fusion according to load sharing classification (≥7). Incomplete or complete neurological deficit. Advanced spondylosis. Fracture of pars interarticularis. Fracture of facet joints. Preoperative evaluation includes history, examination, and radiological evaluation. All patients were done under general anesthesia in prone position. A standard midline posterior approach was used to expose the desired levels for fixation. Posterior instrumentation using pedicular screws (in non-fusion group, only top loading rod systems were used as side loading and plate systems may damage facet joints). Posterior and intertransverse fusion was used in fusion group.

Results: Operative time was shorter in non-fusion group (107.5 minute) than fusion group (140.83 minute). Intraoperative blood loss was less in non-fusion group (330.33 ml) than fusion group (368.33 ml). The mean of lost correction of vertebral body height % in fusion group was 7.9 while the mean of lost correction of vertebral body height % in non-fusion group was 8.07. This is statistically not significant with P-value > 0.05 (0.917). The mean of lost correction of Cobb angle in fusion group was 6.7° while the mean of lost correction of Cobb angle in non-fusion group was 8.65°. This is statistically significant with P-value < 0.05. The mean segmental motion after removal in fusion group was 1.73° while the mean segmental motion after removal in non-fusion group was 11.62°. This is statistically significant with P-value < 0.001.

Conclusion: Posterior spinal fixation without fusion yielded satisfactory results similar to those of posterior spinal fixation with fusion in patients with dorsolumbar fractures with a load sharing score < 7.

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GO022. Single Stage Hemivertebra Excision and Correction of Congenital Scoliosis

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Introduction: Congenital scoliosis isa progressive three-dimensional deformity caused by congenital anomalies of vertebrae that result in an imbalance of the longitudinal growth of the spine. Failure of the vertebral formation if complete will produce hemivertebra with unilateral pedicle

Material and Methods: The study included 30 patients with thoracic (16)and lumbar (14) hemivertebra. Posterior only hemivertebra resection with correction by short segment fixation was done for all cases. Intr-operative monitoring was used in (11) cases.

Results: Full correction was achieved in all cases. Temporary neurological deficit occurred in only two cases.

Conclusion: Because of the development in anesthesia and post-operative care, today posterior hemivertebra resection has become the standard treatment method for the single hemivertebra of the thoracolumbar and lumbar region.

GO023. Prognostic Factors of Thoracic Hypokyphosis after Posterior Spinal Fusion in Adolescent Idiopathic Scoliosis using by All Pedicle Screws Instrumentation

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Introduction: The use of pedicle screws has spread as a method of correction of scoliosis, by his great power correction in the coronal plane and low failure rate . The problem with pedicle screws in scoliosis correction is possible to produce hypokyphosis (thoracic kyphosis < 20 °) leading to the disappearance of the lumbar lordosis, increased junctional kyphosis in cervicothoracic union and impairment of respiratory function. Our goal is to determine the degree of

postoperative kyphosis and the factors that influence the correction of such deformity in the sagittal plane.

Material and Methods: We present the results of a retrospective analysis of 202 patients with adolescent idiopathic scoliosis after surgery. 64 patients were selected with an average age of 13 years with two years of follow-up. Inclusion criteria were: patients undergoing adolescent idiopathic scoliosis, by the same surgical team using instrumented posterior fusion with all pedicle screws using 3 different types of instrumentation (different hardness and diameter). They were evaluated pre and postoperative radiographic parameters. We performed an univariate analysis to quantify the preoperative and postoperative kyphosis, and performed a multivariate binary logistic regression analysis of the factors influencing the postoperative kyphosis with a statistically significant association ($p < 0.05$ or OR when this interval does not contain 1). The parameters considered are: demographic, kyphosis (T4-T12) and lordosis (T12-S1) pre and postoperative, Cobb angle pre and postoperative main curve, type of instrumentation and fusion levels Hypokyphosis postoperative consider if it is < 20 ° or if no improvement > 5°.

Results: The mean preoperative kyphosis is 27 ° (6 ° -45 °) and postoperative is 21 ° (10 ° -40 °), decreasing an average of 6°. In the preoperative study 15 patients (23.4%) had hypokyphosis, 6 patients (9.4%) hyperkyphosis and 43 patients (67.2%) normal kyphosis. 47% of patients with preoperative hypokyphosis remained postoperative hypokyphosis, and 46.5% of patients with preoperative normal kyphosis ended in postoperative hypokyphosis. Variables showing a statistically significant effect for the occurrence of postoperative hypokyphosis: young patients, the worse correction in coronal plane, and type of instrumentation used (smaller diameter and low hardness) ($p < 0.05$ OR 0.98). No statistical occurrence ratio of postoperative hypokyphosis to the number of fusion levels or cobb angle of the main curve ($p > 0.05$)

Conclusion: The pedicle screws hold prior to surgery thoracic kyphosis in 87%. The use of rigid and larger diameter bar appears important in preventing hypokyphosis factor associated with scoliosis. Minimize the risk of the presence of hypokyphosis and therefore improve postoperative sagittal profile is related to the type of instrumentation, the correction in the coronal plane and the age at which the patient is performed to the correction of the deformity. The limitations of our study are the selection and limited number of cases, intraobserver variability in measurements and the lack of clinical and functional impact of the results.

GO024. Should the Spinous Process be Harvested as Bone Graft in Idiopathic Scoliosis Surgery?

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Introduction: The spinous process is commonly resected during posterior fusion of adolescent idiopathic scoliosis (AIS) to allow for a wider fusion bed and more local autologous bone graft. However, the spinous process is an important structure in the posterior ligament complex and anchors paraspinal muscles. With the development of pedicle screw instrumentation and the potential fusion ability in adolescents, the need for resecting the spinous process in this procedure should be further investigated. The purpose of this study is to compare the fusion rate, duration of surgery, blood loss, surgical outcomes and complications between harvesting and preserving the spinous process in posterior spinal fusion of AIS.

Material and Methods: From January 2003 to December 2008, 104 consecutive AIS patients who underwent primary posterior fusion with local autologous bone grafts and who were followed for a minimum of 24 months were reviewed. The patients were divided into a harvesting group ($n = 61$) who had the spinous process harvested, and a preserving group ($n = 43$) who had the spinous process preserved. Radiographic assessments of structural curves were reviewed pre-operatively, 3 days, and 3 and 6 months post-operatively, and then annually. Blood loss, duration of surgery, pseudoarthrosis, post-operative back pain and other complications were also recorded at these time points and compared between the two groups.

Results: There were no significant differences in the duration of surgery between the harvesting and preserving groups (216 ± 47 versus 224 ± 50 minutes, $p = 0.40$), however blood loss was significantly higher in the harvesting group was statistically higher (983 ± 446 ml) than in the preserving group (824 ± 361 ml; $p = 0.048$). The pre- and post-operative Cobb angles, correction rates, and loss of correction of the structure curves were similar in both groups. Based on radiographic evaluation, the incidence of pseudoarthrosis was similar in both groups (3/58 versus 2/41; $p = 0.95$). Post-operative back pain or soreness was significantly higher in the harvesting group (16/58 versus 4/43; $p = 0.03$).

Conclusion: The surgical outcomes and fusion rates between harvesting and preserving the spinous process were comparable, despite significantly lower blood loss and less back pain or soreness in the preserving group. Thus, resecting the spinous process as local autologous bone graft may not be necessary in posterior fusion for AIS patients.

GO025. Near Preoperative Shoulder and Trunk Range of Motion during Gait after Surgical Correction of Adolescent Idiopathic Scoliosis

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Introduction: Surgical correction for adolescent idiopathic scoliosis (AIS) results in a good correction of the deformity, but it was previously shown that the motion of the spine is diminished during stationary bending movements.[1,2] It is unknown whether this is also true for spinal motion during gait and whether the unfused segments and shoulders compensate for the loss of motion of the fused segments. Therefore, this study aimed to identify whether a reduced range of motion (ROM) of the fused segments during gait can be demonstrated, and if and how this is compensated in the unfused spinal segments, and/or shoulders.

Material and Methods: Twelve AIS patients who underwent a surgical scoliosis correction underwent gait analysis preoperatively and at three and twelve months follow-up. The ROM of the shoulders and the trunk at T5-T7, T10-T12, L1-L3 and L3-L5 relative to the pelvis was measured during gait on a treadmill at 5 km/h The ROM was measured in the frontal, sagittal and transverse plane using retro-reflective skin markers (VICON). Spinal levels above T5 and below L3 were left unfused. A two-way repeated measures ANOVA with factors surgery and trunk locations was performed. For the shoulders, a one-way repeated measures ANOVA with factor surgery was used. Post hoc Bonferroni tests were used to

analyze differences between pre-operative, 3 months and 12 months follow-up measurements.

Results: At the measured trunk locations, ROM relative to the pelvis showed a significant decrease after surgery in the sagittal ($p = 0.027$) and transverse planes ($p = 0.004$) and an increase in the frontal plane ($p = 0.049$). No interactions between surgery and trunk location was found, indicating that the effects of surgery on the ROM did not differ between the fused and unfused trunk locations. Post hoc analysis revealed a small but significant decrease of the mean ROM of the trunk locations only in the transverse plane ROM from 7.1 degrees (SD=2.1) pre-operative to 5.1 degrees (SD=1.5) at 3 months ($p = 0.004$) and 5.1 degrees (SD=1.9) at 12 months follow-up ($p = 0.012$). A significant effect in shoulder ROM after surgery was found in the transverse plane ($p = 0.024$) but not in the frontal ($p = 0.20$) and sagittal planes ($p = 0.25$). Shoulder ROM in the transverse plane decreased from 11.2 degrees (SD=4.3) pre-operative to 8.2 degrees (SD=3.7) at 3 months follow-up ($p = 0.005$). Though, at 12 months follow-up the decrease in ROM was not significantly different in comparison to pre-operative with a ROM of 9.4 degrees (SD=2.9).

Conclusion: Spinal fusion resulted in a small decrease in sagittal and transverse plane ROM of the trunk segments and the shoulders during gait, whereas frontal plane ROM increased. Shoulder ROM in the transverse plane recovered to pre-operative values at 12 months follow-up. The decrease in trunk ROM occurred in both fused and unfused spinal segments. No increased compensatory motion was detected at the unfused areas of the spine or the shoulder girdle. Adolescent patients manage to maintain near pre-operative trunk and shoulder ROM during gait despite long spinal fusion. This may well explain why patients function so well in daily life after surgery.

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GO026. The Development of a Core Outcome Set for Adolescents Undergoing Spinal Deformity Surgery: An AOSpine Knowledge Forum Deformity Initiative

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Introduction: Routine patient-related outcome monitoring is gaining importance in medical care. Health care providers are putting more emphasis into assessing the value (health gain per unit cost) of treatment provided. Outcome registries including patient-reported outcome (PROMs) data such as patient satisfaction, patient expectations, and health-related quality of life, can provide evidence and insight into the quality of care within and between care facilities and in comparing different treatment strategies. In particular for spinal deformity surgery where randomized controlled trials (RCTs) are unethical and not practical, and there is tremendous variability in management strategies, outcome monitoring by the means of outcome registries would be of value. Outcome registries are most valuable if they are comparable between countries and include outcomes that are relevant to the patient population of interest. Therefore, it is of utmost importance to internationally agree upon the most important outcomes and candidate predictors of outcomes to measure. The COSSCO1 (Core Outcome Set for SCOliosis) project aims to reach consensus across the Nordic Spinal Deformities Society (NSDS; Sweden, Denmark, Finland, Norway, and the Netherlands) about which patient relevant outcome domains are to be included in outcome registries for adolescents (10–25 years) undergoing spinal deformity surgery (e.g., adolescent idiopathic scoliosis, Scheuermann kyphosis), from both the patients' and clinicians' perspective.

Material and Methods: A spinal deformity surgeon representative from each of the NSDS registries was invited to participate in a modified Delphi study with three consensus rounds. Using the World Health Organization's International Classification of Functioning, Disability and Health (ICF) framework, a list of 39 potential core domains was drafted based on a systematic review of the literature and presented to the Delphi participants who were asked to vote which domains were essential. A threshold of 70% consensus was used. The first consensus round was held face-to-face during the NSDS-meeting in August 2015. The second and third consensus rounds will be completed through web-based surveys before the end of 2015. In each round suggestions about overlap, aggregation, or additional core domains are used as input for subsequent rounds. After consensus is reached about which domains are "core," further consensus rounds will be initiated on the appropriate measurement instruments to measure the core outcome domains and on the factors that contribute to these core outcomes (predictive factors).

Results: COSSCO1 will be completed in February 2016. These results will then be validated among patients (and their parents) and translated into a uniform outcome instrument that will be implemented in the five Nordic national spine registries.

Conclusion: The development of this outcome set will facilitate comparisons across studies, registries, and nations to improve the quality of daily clinical practice in adolescents undergoing spinal deformity surgery.

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GO027. Apical Vertebral Rotation Assessment in AIS: What is the Best Method Scoliometer, X-ray or MRI?

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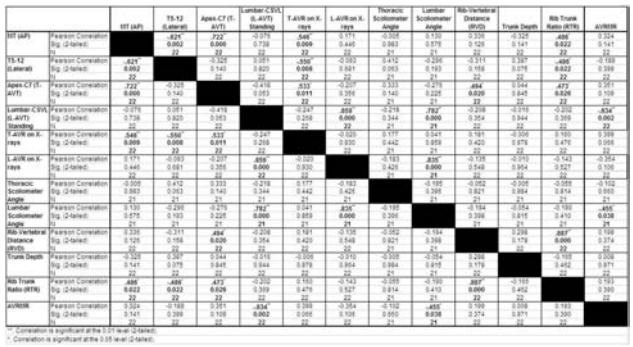
Introduction: There are many factors correlated to the vertebral rotation in AIS patients such as the distance between the apex of rib and vertebra (rib-vertebral distance: RVD) on lateral X-rays, MRI or the Scoliometer measurement. However, no study has shown the relationship between those factors and the apical vertebral rotation.

Methods: Out of 380 consecutive AIS patients who underwent corrective surgery, 22 patients who had preoperative MRI and complete radiographic images stored in PACS were identified. Various angles and distances including Main Thoracic curve (MT), T5–12 sagittal profile, Apical Vertebral Translation (AVT), Apical Vertebral Rotation (AVR), RVD, trunk depth, and axial rotation of apical vertebra on MRI (AVRMR) were measured. Scoliometer angles (SA) for these patients were found in the charts as well. Rib Trunk ratio (RTR) was calculated by RVD/trunk depth. Each paired value was compared with find any significant correlation.

Results: The radiographic measurement and correlation values are shown in the table. There was no significant correlation between thoracic and lumbar parameters while the larger curves had the greater rotation. RTR was correlated with MT, T5–12 and T-AVT, but not T-AVR. MRI and Scoliometer could not predict the T-AVR as well.

Conclusion: This study shows that we can predict the amount of coronal and saggital deformities from lateral X-rays, but not the axial rotational deformities. Supine MRIs cannot predict AVR and standing MRIs may be helpful. Scoliometer angles predict L-AVR, but not T-AVR probably due to the combination of rib cage deformity and vertebral rotation. During the corrective surgeries in AIS, deformity surgeons may still need to consider the deformity of rib cage itself, even with the direct derotation of vertebral column.



Novel Technologies 1

GO028. Predicting High Surgical Treatment Costs at Primary Spinal Tumor Patients

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Introduction: Surgical treatment cost of primary spinal tumors -due to the complexity and magnitude of the surgery- can be high. From a healthcare provider perspective being aware of those factors that influence treatment cost is essential for the best hospital resource management. However the impact of the individual patient characteristics on direct medical costs is unknown. Our objective was to identify those preoperative factors that predict a high direct cost at patients with surgically treated primary spinal tumors.

Material and Methods: A retrospective micro-costing study was conducted from a healthcare provider perspective. Total cost per patient resulted from the aggregation of inpatient-days costs, ICU days costs, OR time costs (surgery and anesthesiology), medication costs, blood transfusion costs and other material costs, including appropriate allocation of overheads. Patients with primary spinal tumors operated in the National Center for Spinal Disorders between 2011 and 2014 were selected. The prognostic value of ten preoperative factors (dignity, previous surgery, pathological fracture, neurological dysfunction, age, spinal level, ASA score, Charlson Comorbidity Index, BMI, tumor volume) was investigated in linear regression modelling.

Results: 72 surgically treated primary spinal tumor patients were included in the study. Median length of hospital stay was 12 days (3–115), the median ICU treatment was 1.4 days (0–21.7), the median OR time was 2.8 hour (0.4–20.4). Median cost per patient was 3,088.5 (537.7 to 21,860.6). In the univariate analysis only ASA score, Charlson Comorbidity Index and pathological fracture were not significantly associated with higher cost. The seven significant variables were further assessed in a multivariate model. Dignity, previous surgery, spinal level and tumor volume were associated with high cost and preoperative neurologic dysfunction showed only a trend toward significance (whole model: R=0,69, R^2=0,44, df=5, F=12,34 $p < 0{,}001$).

Conclusion: The present study identifies four predictive variables for high hospital cost related to primary spinal tumor surgery. Malignant tumors, previous surgery, sacral involvement and large tumor volume significantly increase the cost of treatment. This method of cost analysis provides useful insights for resource management in the surgical treatment of spinal tumors.

GO029. A Novel Technique to Reconstruct Anterior Cervical Spine after Total Removal of C2 and C3 Vertebrae

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Introduction: Reconstruction of C2 body in cases who need removal of C2 body and Axis is a challenging issue, due to difficult approach and small area for instrumentation and grafting, especially in pediatric age group.

Material and Methods: Our patient underwent a two-stage surgery. During the first operation via a posterior approach, a subtotal resection of a C2 bony mass was performed. C3 was also subtotally resected due to tumor extension. Posterior fixation of C1–C5 was performed by C1 sublaminar hooks and C4 and C5 lateral mass screws. Ten days later, a total resection of the residual bony mass was performed through an anterior approach (between the sternocleidomastoid muscle and carotid sheath). Reconstruction of C1–C3 was performed with C1 anterior sublaminar wiring and an expandable titanium cage.

Results: Successful reconstruction of C2–C3 vertebral bodies was achieved. At 2-year follow-up, the child was symptom-free. Imaging studies revealed no recurrence of tumor or instability.

Conclusion: A novel technique for reconstruction of C2–C3 vertebral bodies is demonstrated for the youngest case (a 6-year-old boy) of osteoblastoma in the literature. We recommend this approach for cervical spine reconstruction in patients who have an intact C1 arc and resected lower bodies.

GO030. Augmented Reality Mobile Applications to Interactively Show Complex Spine Pathologies: First Version

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Introduction: Visualization of complex human body structures such as the spine and his malformations such as,

foraminal stenosis, spine stenosis, and herniated disk is a challenge. Augmented Reality is the combination of a real scene supplemented, or augmented, by computer generated information, such as image, video or graphical animations. Android and iOS based mobile devices such as smartphones and tablets are being increasingly massive adoption and with higher performance characteristics.

Material and Methods: Sagittal 2D T2w TSE sequence MRI (TR 4420 milliseconds, TE 130 milliseconds, FoV 320x320, Matrix 448x448, Voxel Size 0.7x0.7x3 mm) and sagittal CT (kVp 140, 1 mm slice thickness, 0,30x0,30 mm pixel spacing, B31s kernel) images were scanned in a 57 years old male patient. Both images were co-registered using "Linear registration" algorithm of 3D Slicer v 3.6 software. CT image was segmented using threshold option (113–1303 Hounsfield units) of 3D Slicer and then L4-L5 vertebral bodies was extracted manually using ImageJ v1.49n version. The L4-L5 intervertebral disk was segmented using "simple region growing" algorithm of 3D Slicer, and then was cleaned manually using ImageJ software. Mesh of L4-L5 and intervertebral disk was generated using 3D Slicer "Model Maker" algorithm with default options, and HC Laplacian smoothing (MeshLab software). The iOS-Android application were created using C# language and software tools: Unity 4.5x (graphic engine; www.unity3d.com), 3Ds Max (www.autodesk.com), Visual Studio 2013 (www.microsoft.com), and Qualcomm Vuforia for Unity Android & iOS (Augmented Reality, developer.vuforia.com).

Results: By focusing the printed target image using iOS-Android app,L4-L5 vertebral bodies and the intervertebral disk of the patient was shown in 3D. The user can rotate the spine with the two-finger twist gesture, by rotating the view angle over the target image, or rotating the target image itself. The size of the spine can be changed by modifying the distance between the mobile device and the target image, or by the pinch gesture. Augmented reality demonstrated new views from inside spine (using total immersion feature of augmented reality) and relationship of normal structures and different pathologies.

Conclusion: The application described here demonstrates the use of augmented reality technique with medical images of patients with spine pathologies. The application shows how to use ubiquitous mobile devices to display advanced medical information in a 3D interactive application. The application is useful to show, explain and describe in a 3D, interactive and immersive way the spine pathology that the patient has. More work must be done to create an automatic CT-MRI registration, segmentation, creation of mesh, smoothing and decimation of vertebral bodies and an intervertebral disk.

GO031. Psychosocial Representations of the Illness before Lumbar Spine Surgery and Their Effects on Recovery

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Introduction: Psychosocial representation of the illness means those personal and mental meanings and thoughts which the patient connects with his/her own condition. The examination of representation of the illness is very important to understand the behavior of the patients because these representations contain of the patients' beliefs about their illness or injury. These beliefs influence the cure, the duration of recovery and these beliefs affect the strategies, which the patients use to cope with the illness. In clinical environment, the nonverbal methods help the exploration of representations of the illness, since the physical status can hamper the verbal expression of burdens (for example: pain, suffering). In such cases, we can use the PRISM task (Pictorial Representation of Illness Self-Measure) to measure the burden of suffering.

Methods and Materials: In our research, there have been 110 inpatients (52 men). We have examined the patients before lumbar surgery, using the following tests: Psychological Vulnerability Questionnaire, Hospital Anxiety and Depression Scale, Somatosensory Amplification Scale and PRISM-D (drawing version of PRISM task) and we followed how many days the patients stayed at the clinic after the operation. Using the PRISM-D, we are observing the patients drawing the in some spatial formations, which are the following: 1. *Self-shield* (the patient draws the important things around herself/himself), 2. *Illness-shield* (the patient draws the important things around the illness), 3. *Protective line* (the patient draws the important things in horizontal or/and vertical line), 4. *Network* (the important things and the illness are diffused in space of the current life), 5. *Fusion* (the important things and the illness intersect with the self or every circle intersect with each other), 6. *Self-part* (the illness is drawn in the self and the other important things are located far away from the self).

Results: We have found that those patients who have drawn their illness in their own Self (*Self-part*), went home later than the other patients (Self-shield: $p = 0{,}004$, Fusion: $p = 0{,}026$, Illness-shield: $p = 0{,}008$, Protective line: $p = 0{,}036$, Network: $p = 0{,}004$). But those patients, who represented their illness in Self-shield spatial formation, went home earliest (mean: 4,14 days). Although, these patients were the most vulnerable in the whole population.

Conclusion: Our results suggest the illness modifies the self-identity because the information related to the pain becomes the most essential in the organization of the self. It could be problematic, if majority of the self-scheme consists of illness-scheme. We can see this in Self-part spatial formation, thus it is affirmable if the illness-scheme increase within the Self, the recovery will slow down. This is often the case with the patients having low back pain.

GO032. The Shilla Growth Guidance Technique for Paediatric Scoliosis at 3-year Follow-up: a Preliminary Report

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Introduction: To present the technique and the outcomes of the use of the Shilla system in children scoliosis.

Materials and Method: The Shilla system has been used in 4 children of 5 ½ -8 years old to treat scoliosis of 60°-70°. To place the system, a subperiosteal approach of the apex and a percutaneous approach of the curve extremities had been performed. In that way, a spontaneous spinal fusion is avoided. The edging screws can slip on the rod and permit spine to grow-up. Cobb angle, screw slipping, T1-S1 lengthening, and complications had been recorded.

Results: The Cobb angle average improved to 22° from (65°) and the T1-L1 lengthening average was 6,8 cm. No spontaneous spinal fusion has been noted. In 2 children, a

revision surgery to replace the upper thoracic screw and the rod had been performed. A left leg neurapraxia happened, which resolved after 1 week. A preserved sagittal balance of the spine was observed during the 3 years of follow-up.

Conclusion: The percutaneous placement of the thoracic screws is used to avoid spontaneous fusion, but this is challenging and increases the risk of complications. Despite the complications, in all the children, a good surgical correction of the scoliosis was done, a normal grow-up has been noted, and the sagittal balance was preserved instead of other expandable systems, which are fixed only at the curve extremities.

GO033. Cell Salvage Use, Benefits, and Costs at Ipswich Hospital Spinal Unit UK

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Introduction: Blood Transfusions cost £122 per unit in the UK but they have other costs including 1:13000 incorrectly transfused. 1:7000 risk of adverse reaction. Infection in the UK overall is 1:1.2milliion for hepatitis B and 1:7million for HIV with a risk of 1:28million for hepatitis C.

Methods: We analyzed the use of cell saver and blood transfusion in the Ipswich Spinal Unit (UK). Identifying all cases in which cell saver might be used. Looking at the volume collected and re-infused to the patient, the pre- and post operative haemoglobin and the need for blood transfusion

Results: We found that Cell saver was being used for a variety of cases including Trauma, Revision surgery, Deformity Correction, Anterior Lumbar fusions, Trans-laminar interbody fusions and tumor work. Revision surgery alone did not have a significant need for blood transfusion and cell saver use in these cases was often (66%) of the time not required. ALIF surgery only utilized salvaged blood in 10% of cases but the bleeding in this case was significant and therefore the unit decided cell salvage would continue to be routine. Overall we found that the average drop in haemoglobin was comparable between those patients who had cell salvage technology utilized during their surgery compared with those who did not, this was echoed in the post operative blood transfusion rates. A cost analysis based upon the cost of cell salvage use vs the cost that would have theoretically been incurred if the same volume of donated blood had been used showed cell salvage to cost 43% more that the use of donated blood products.

Conclusion: Cell salvage is a more financially costly technology than transfusion from the blood bank. There are some procedures in which the routine use of cell salvage should be reserved for specific cases and some where the use in a small percentage is so beneficial that cell salvage will continue to be used despite a low overall re-infusion rate. The additional costs to the patients is to be considered when discussion donated blood transfusion. The Ipswich Spinal Unit believes more judicious use of cell salvage technology concentrating on the cases in which we found utilization to be highest would make it more cost effective.

Trauma Thoracolumbar 2

GO034. Epidemiolgy of Multiple Contiguous and Non-contiguous Thoracolumbar Fractures in a Level 1 Trauma Center in Upper Egypt

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Introduction: Multiple level fractures of the thoracolumbar spine are not uncommon nowadays particularly after increased magnitude of trauma and the availability of screening facilities. However only few studies have reported its descriptive epidemiology. The aim of this study is to analyze the incidence, the characteristics of the patients, surgical incidence and mortality rate among hospitalized patients with multiple level thoracolumbar fractures in a level 1 trauma center in upper Egypt

Material and Methods: Out of 471 patients with thoracolumbar fractures admitted in Assiut University Hospital during the year (2014), there were 50 patients with multiple level fractures. The epidemiology of these 50 patients was described and analyzed including the method of treatment, complications and mortality rate.

Results: There were 21 males and 29 females. The mean age was 28.9+12.8 years. The commonest associated injury was fracture calcaneus in 20 patients. 43 patients had contiguous thoracolumbar fractures while 7 only had non contiguous fractures. The commonest mechanism of injury was falling from height in 41 patients.42 patients were neurologically free. 6 patients were treated conservatively while 44 patients received surgical treatment.

Conclusion: Treatment for the multilevel thoracolumbar fractures must follow the same guidelines for treatment as for the isolated fracture in the majority of circumstance; however, it requires particular attention and must be individualized.

GO035. Damage Control Surgery for Thoracolumbar Spine Fractures by Percutaneous Pedicle Fixation in Polytrauma Patients: Initial Experience

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Introduction: Spine fractures in polytrauma patients are relatively common. About one third require surgical treatment. Open surgical stabilization in these patients may increase morbidity and mortality associated with prolonged surgical time, bleeding and hypothermia. Internal fixation with minimally invasive techniques is an alternative for the treatment of vertebral fractures in polytrauma patients, diminishing local and systemic risks associated with open techniques.

Material and Methods: Polytrauma patients with unstable thoracolumbar spine fractures, treated by percutaneous pedicle fixation techniques, between June 2013 and March 2015.

Results: 5 patients. Injury mechanisms involved: height fall, height fall associated with extensive skin burn of dorsal region and motor vehicle accidents. Fracture level where between T6 to L5. According to AOSpine trauma classification: 3 B2, 1 B3 and 1 A4. Surgery was performed on an average of 5 days since trauma. 2 levels were fixated in 2 patients, 3 in other 2 patients and one patient had a lumbopelvic fixation. The average of intraoperative bleeding was 70 ml and of operative time was 100 minutes. No patient had postoperative local infection or complications from surgery. No patients required revision surgery or deferred anterior

column stabilization surgery. All patients had at least 6 months follow-up.

Conclusion: Percutaneous pedicle fixation is an alternative for treatment of unstable vertebral fractures in polytrauma patients with poor general or local conditions. The results in this series are encouraging in the sense of accomplishing stabilization without increasing the morbidity and mortality associated to basal conditions.

GO036. Outcome after Implantation of a Hydraulic Vertebral Body Replacement in Traumatic Vertebral Fractures

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Introduction: The dorso-ventral stabilization is a frequently used procedure in traumatic vertebral body fracture treatment. The aim of the study was the analysis of radiological images and clinical outcome 3 years after implantation of an innovative hydraulic vertebral body replacement following a traumatic vertebral body fracture in the thoraco-lumbar spine.

Materials and Methods: The study includes all patients of our Level I trauma center which suffered a singular traumatic fracture of a thoracic or lumbar vertebral body (Th 5 - L 5) in the period from 11/2009 until 12/2010, that (i) underwent dorsal instrumentation and (ii) afterwards underwent implantation of a hydraulically expandable vertebral body replacement. The following radiological findings of all patients were evaluated (pre- and post-operatively and 3 years after implantation): sagittal angle, implants' subsidence and implants' position. Moreover, the clinical outcome 3 years after implantation was analyzed by the VAS spine scoring system. Details about trauma mechanism, current occupation, etc. were also documented. Statistical Analysis was performed with the software SAS 9.2.

Results: During the above mentioned period, $n = 50$ patients could be included in the study. The complete follow-up including the data 3 years after implantation of the vertebral body implant was successful for $n = 47$ (male: 26; female: 21) patients (follow-up rate: 89%). The mean age of all patients was 46.5 ± 17.0 years. The main reasons for spinal trauma were falls ($n = 28$) and traffic accidents ($n = 14$). The analysis of the radiological data showed an average sintering of the implants of 1.1 ± 1.2 mm (range 0.0 - 5.0 mm). After the initial operation, the local sagittal angle remained stable in the 3-years-follow up at thoracic spine (5.4 ± 4.8 ° versus 5.2 ± 4.8 °; $p = 0.451$) and lumbar spine (-7.2 ± 6.0 ° versus -7.0 ± 6.0 °; $p = 0.451$). Furthermore, no change in the implants' position could be observed. Most of the patients ($n = 40$) were "generally satisfied" or "very satisfied" with their outcome. The mean rating of the VAS spine score was 65.2 ± 23.1 (range: 20.5 - 100.0). Activities of daily life are less limited (83.0 ± 21.8) than activities concerning the patients' profession (49.5 ± 37.3). Taking analgesic medication is of clear effect (72.4 ± 27.4) and has a positive correlation ($p = 0.001$) to a higher rated VAS spine score.

Conclusion: In summary, the current study shows that the implantation of that innovative hydraulic vertebral body replacement allows a permanent stable fixation after traumatic fractures of the thoracic and lumbar spine. General complications are rare and the local sagittal angle is fixed after 3 years. Secondary dislocation and serious sintering of the implant were not observed. The clinical outcome after implantation of the hydraulic vertebral body replacement is comparable to the outcome after the ventral stabilization with an iliac crest bone graft. Nevertheless, there is an obvious reduction in the VAS spine score after dorso-ventral stabilization in comparison to the healthy public.

GO037. Spinal Canal Decompression and Neurological Outcome in Thoracolumbar Burst Fractures; A Review of Evidence- Based Data

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Background: The association between neurologic recovery and initial compromise of spinal canal has not been frequently documented and the controversy persists regarding the management of bone fragments within the spinal canal after thoracolumbar burst fractures. Although, the surgical clearance of the spinal canal, either by direct removal of bone fragments or by ligamentotaxis, is generally accepted as the treatment of choice for burst fractures, debate persists as to whether surgical decompression is necessary to treat burst fractures.

Objective: To better understand whether the degree of neurologic recovery from thoracolumbar burst fractures is affected and predicted by initial compromise of spinal canal and to which extent the decompression is helpful, via reviewing the evidence-based data of the literature.

Methods: Up-to-date, the experimental and clinical literature concerning the role of, and the biological rationale for, surgical decompression after acute Spinal Cord Injury (SCI) were reviewed. Evidence from clinical trials was categorized as Class I (well-conducted randomized prospective trials), Class II (well-designed comparative clinical studies), or Class III (retrospective studies).

Conclusion: Although, there is a biological evidence from experimental studies in animals that decompressive surgery may improve neurological recovery after SCI, the role of surgical decompression in patients with SCI is only supported by Class III and limited Class II evidence. Accordingly, decompressive surgery for thoracolumbar burst fractures can only be considered a practice option.

GO038. Posterior Vertebral Column Resection: A Salvage for Thoracolumbar Kyphosis after Failed Anterior Instrumented Fusion

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Introduction: Anterior thoracolumbar spine surgery is typically indicated for restoration of structural stability and /or decompression of neural element secondary to trauma, tumor or infection. But postoperative complications especially kyphosis poses distinct challenges to the spinal surgeon. The aim of this study was to explore the effects of posterior vertebral column resection of thoracolumbar kyphosis after failed anterior instrumented fusion.

Material and Methods: A retrospective study was conducted of 10 patients of kyphotic deformity with previous failed anterior surgery in our department from October 2005 to December 2009. The indications for revision surgery included pain refractory to conservative treatment, progressive neurological deficit and kyphosis. Anterior removal of the implant and posterior vertebral column resection (PVCR) was performed. Mean operating time, average intraoperative blood loss, kyphosis angle, the visual analog scale (VAS), Oswestry disability index (ODI), bone fusion time and complications were used for clinical assessment in a minimum 18-month follow-up (18 – 60 months).

Results: The mean age was 38.7 years old (ranging from 24 to 56 years old) and the average kyphosis angle was 54.60 (ranging from 45 0 to 74 0). Mean operating time was 323.5 (range 245 minute to 420 minute) with average intraoperative blood loss of 1189 ml (range 850 ml to 1550 ml). After revision surgery, Kyphosis angle was 4.800 (range3- 70) immediately and 6.80 (range 5 to 90) at the 18 months follow-up and there was good bony fusion in every case. The average time of bony fusion was 6.8 months (range 5–9 months). All patients had satisfied spinal sagittal and coronal balance at the last follow-up. None of our patients experienced implant failure. The average preoperative VAS was 6.2, falling to 2.6 at the 18 months follow-up with significant improvement. None of the patients suffered any surgery-related neurological deterioration and one patient whose neurological status was Frankel Grade C improved to Grade D. The ODI changed form a mean value of 39.8 (rang 31–48) preoperatively to 24.5 (rang 15–29) at the final follow-up. The difference was statistically significant. Complications occurred in four patients (40%); these included three with tearing of the lung and one with a superficial wound infection.

Conclusion: Despite the technically demanding procedure, anterior removal of the implant and posterior vertebral column resection was a safe and effective revision surgery for patients with prior anterior fusion with rigid post-surgical deformities

GO039. The AOSpine Sacral Fracture Classification

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Introduction: Sacral fractures are complex and heterogeneous injuries that often include involvement of the lumbar spine and/or pelvis. Due to their complex nature, no comprehensive classification system has been accepted.

Material and Methods: The AOSpine Trauma Knowledge Forum partnered with orthopaedic traumatologists from AOTrauma to develop a straightforward, hierarchical classification system for sacral fractures. The classification was developed via a consensus process of clinical experts, and, prior to finalizing the classification system, a survey was sent to all members of AOSpine and AOTrauma asking for their input on key parts of the classification.

Results: The new AOSpine Sacral Classification is a hierarchical classification that follows the same structure as the subaxial and thoracolumbar classifications. First injuries are broadly divided into three types: Type A—Lower Sacrococcygeal Injuries; Type B—Posterior Pelvic Injuries and Type C—Spino-Pelvic Injuries. Type A injuries have no impact on posterior pelvic or spinopelvic instability, however higher grade injuries may be associated with neurologic injuries. Type A injuries are divided into three subtypes; A1—Coccygeal or compression injuries as well as ligamentous avulsion fractures; A2—Non-displaced transverse fractures below the Sacroiliac (SI) joint, and A3—Displaced transverse fractures below the SI joint. Type B injuries are unilateral longitudinal sacral fractures in which the ipsilateral superior S1 facet is not discontinuous with medial portion of the sacrum. These injuries primarily impact posterior pelvic stability and have minimal impact on spino-pelvic stability. Type B injuries are divided into three subtypes based on the likelihood of neurologic injury, and while this is similar to the Denis classification, because B-type injuries exclude fractures with a transverse component, there is little risk of a neurologic injury with an injury medial to the foramen. The three sub-types of B injuries are: B1—Longitudinal fracture medial to the foramen; B2—Longitudinal fracture lateral to the foramen and B3—Longitudinal injury thought the foramen. Type C injuries are Injuries that result in spino-pelvic instability. They are divided into four subtypes: C0—Non displaced sacral U fracture (commonly seen in low energy insufficiency fractures); C1—Any unilateral B-subtype where the ipsilateral superior S1 facet is discontinuous with the medial portion of the sacrum; C2—Bilateral complete B type fracture without a transverse component, and C3—Displaced sacral U type fracture. In addition to the fracture morphology, the new classification also formally considers the neurologic status of the patient: Nx—The patient cannot be examined; N0—No neurological deficits; N1—Transient neurological injury; N2—Nerve root injury and N3—Cauda Equina Syndrome. Lastly there are four patient specific modifiers that may alter the treatment of these fractures: M1—Significant soft tissue injury; M2—Metabolic bone disease; M3—High-energy injury that may be associated with an anterior pelvic ring injury, acetabular fracture or vascular injury, and M4—Altered anatomy of the lumbosacral junction (may be due to a prior fusion or transitional anatomy).

Conclusion: The AOSpine sacral fracture classification is the first comprehensive sacral classification to consider posterior pelvic and spino-pelvic instability patterns, and validation studies are ongoing.

Degenerative Lumbar 1

GO040. Prevalence and Clinical Relevance of Sacroiliac Joint Pain Secondary to Lumbar Fusion Procedures

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Introduction: Lumbar fusion procedures for the treatment of appropriately selected cases of degenerative lumbar spine disease are rapidly increasing, with reported good overall results. However, an estimated 5 to 30% of these patients may suffer from significant persisting low back pain, despite technically successful surgery. In this setting, sacroiliac joint (SIJ) dysfunction has been postulated as possible underdiagnosed cause for these persisting symptoms. We aimed to assess the prevalence, associated risk factors and clinical impact of SIJ pain after lumbar fusion procedures.

Material and Methods: Retrospective observational study of consecutive patients undergoing lumbar fusion at a single center between September 2012 and January 2014. A transversal evaluation through telephone interview was conducted, investigating the presence and characteristics of residual low back pain. Numeric pain rating scale (NPRS) for low back pain and Oswestry Disability Index (ODI) were collected for each patient. General demographic and surgery related data, including gender, age, body mass index, smoking status, number of segments fused and levels of fusion (including or not S1 level) was also noted. Selected patients with residual pain suspected to be of SIJ origin underwent clinical evaluation with a battery of 6 widely accepted SIJ provocative tests (FABER, SIJ sulcus tenderness, Gaenslen's test, Yeoman's test, compression test and sacral thrust). Those with 3 or more positive tests were considered to suffer from SIJ originated pain (SIJ-pain group). Statistical analysis comparing this group with the non-SIJ pain group (patients presenting with residual pain without clinical evidence of SIJ origin) regarding the collected variables was performed using SPSS 19 software.

Results: From a total of 89 patients that underwent surgery in this period, 52 patients were available for interview (mean age 59 years, 36.5% male, 63.5% female). Eight patients (15.4%) were completely asymptomatic, whereas 44 patients (84.6%) reported some degree of residual pain (mean NPRS of 4.73, mean ODI of 29.81%), although most reported clinical improvement and pain decrease with surgery. It was possible to clinically evaluate a final sample of 32 patients with residual pain (mean follow-up of 22.7 months). In 15 cases (46.9%) there was evidence of SIJ originated pain, as indicated by positiveness to 3 or more SIJ provocative tests. Presence of SIJ-pain was significantly associated with higher ODI scores (Mann-Whitney U 58.5, $p = 0.009$), and also tended to associate with higher NPRS scores (Mann-Whitney U 80, $p = 0.071$). Predictors for SIJ-pain development after surgery were not found, as there were no associations between the presence of SIJ-pain and the initially retrieved demographic and surgery related data, such as age, gender, BMI, smoking status, fusion to the sacrum and number of fused segments.

Conclusion: In the post-lumbar fusion patient population that remains symptomatic after surgery, SIJ dysfunction and pain may account for a large proportion of cases, as illustrated by the impressively high rate of residual low back pain compatible with SIJ-pain found in this study (46.9%). Moreover, it may significantly affect functional outcome and surgery success rates, as patients in the SIJ-pain group presented worse ODI e NPRS scores than those with non-SIJ residual pain.

GO041. Patient-reported Outcomes Following Elective Surgery for Lumbar Degenerative Disease: Effect of Perioperative Complications on Outcomes

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Introduction: There is a paradigm shift toward rewarding providers for quality rather than volume. Complications appear to occur at a fairly consistent frequency when looking at large aggregate datasets. Understanding how complications affect long-term patient reported outcomes (PROs), following degenerative lumbar surgery, is vital. Our hypothesis was that 90-day complications would adversely affect long term PROs compared with a cohort that did not experience a complication.

Methods 906 consecutive patients undergoing elective surgery for degenerative lumbar disease over a period of four-years were enrolled into a prospective longitudinal registry. PROs: ODI, NRS-Back and leg pain (BP, LP), Quality of life (EQ-5D), and NASS satisfaction questionnaire were recorded at baseline and 12-month follow-up. Complications were divided into major (surgical site infection, hardware failure, new neurological deficit, pulmonary embolism, hematoma and MI) and minor (urinary tract infection, pneumonia and deep venous thrombosis).

Results: Thirteen percent (118) of patients developed complications: (major-12% (108) and 8% (68)-minor) within 90-days after surgery. The patients with complications had significantly higher ODI scores at 12-months (29.43 ± 17.7 versus 25.2 ± 18.33, $p = 0.02$) after surgery. In a multivariable linear regression analysis, after controlling for array of preoperative variables, the occurrence of a major complication was not associated with worsening ODI scores 12-month after surgery. There was no difference in the percent of patients achieving minimal clinically important difference MCID for disability (66% vs 64%), back (55% vs 56%) and leg pain (62% vs 59%), quality of life (19% vs14%) and patient satisfaction rates (82% vs 80%) between those without and with major complications.

Conclusion: The occurrence of major complications did not significantly affect the PROs 12-month after surgery. These patients achieve clinically meaningful outcomes and patient satisfaction, as much as those without complication. This information allows a physician to council patients on the fact that a complication creates frustration, cost, and inconvenience, however it does not appear to adversely affect clinically meaningful long-term outcomes and satisfaction.

GO042. Low Back Pain- How Significant are the Spinopelvic Parameters?

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Introduction: Since the discovery of pelvic incidence by Legaye et al. in 1998, many other sagittal spinopelvic radiographic parameters have been described as determinants of good sagittal balance. Alteration in these parameters has been linked to various spinal ailments producing degeneration to deformity. This have been proved by Roussouly et al. in his landmark paper, which showed a positive correlation between PI and Low Back Pain (LBP). However in the subsequent studies the same correlation could not be derived. Thus, we aim to study the role of high PI as a causative variable for Low back pain in our population.

Materials and Methods: The study was approved by our institute review board and the ethical committee. We included all the patients visiting our OPD with complaints of LBP for more than three months and giving consent for the study. All patients underwent a thorough clinical and radiological examination, to rule out any apparent cause of LBP. We excluded patients with spinal deformity, fracture, infection, malignancy and with a history of previous spine surgery. A total of 67 patients were thus included in the study. Another age and sex matched group of asymptomatic volunteers ($n = 75$) were also recruited as a control group. All the patients and volunteers underwent a standardized lateral sagittal digital radiograph of the whole spine including the base of the skull till the proximal ⅓ thigh (subject naturally standing up, looking horizontally, hands resting on a vertical support, upper limbs

relaxed and elbows half bent). All the subjects were at a specific distance from the radiographic source and a single shot of x- rays have been used centering around D12.The sagittal spinopelvic parameters were measured using the Surgimap spine software version 2.1.2 by a single observer. The parameters measured were pelvic incidence PI, pelvic tilt PT, sacral slope SS, thoracic kyphosis TK, lumbar lordosis LL, lordotic and kyphotic vertebra. The comparisons were drawn between the patients and controls using appropriate statistical methods.

Results: The mean values obtained in patients with low back pain were PI-48.04, PT-12.61, SS-35.5, LL-50.57 and TK-26.79. Corresponding values in healthy volunteers were PI-47.85, PT-13.03, SS-34.8, LL-54.68 and TK-24.03. We have found no statistically significant difference in the values of any sagittal spinopelvic parameters measured between the two groups.

Conclusion: Based on the results derived from our study we conclude that there is no statistically significant correlation between any of the measured sagittal spinopelvic radiographic parameters and the occurrence of LBP.

GO043. Transforaminal Lumber Interbody Fusion (TLIF) Clinical and Radiological Outcome

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Objective: To evaluate the clinical and radiological outcome of TLIF in the treatment of Spondylolisthesis, degenerative disc disease and recurrent herniation of lumber disc.

Methodology: A retrospective study, between Jan 2009 and December 2011.The patients with chronic back pain (more than 6 months of disability and refractory to conservative management) with or without leg pain / neurological deficit due to degenerative spondylolisthesis, degenerative disc disease and recurrent lumber disc herniation treated with Transforaminal Lumber Interbody Fusion (TLIF) were included. It was a retrospective review of the patient files to assess the pre and postoperative symptomatology, findings on clinical examination, radiological characteristics. The same procedure was performed in all cases by a single spine surgeon.The clinical outcome was assessed using Oswestry Disability Index (ODI) scoring system. Bony fusion was assessed based on a pre-set criteria on plain radiographs at 18 months postoperatively.

Results: Of 25 there were 16 male (64%) and 9 female (36%) patients with a mean age of 40 years (range: 20–60), who underwent TLIF (Transforaminal Lumber Interbody Fusion). 9 patients diagnosed as degenerative disc disease, 12 with spondylolisthesis and 4 having recurrent disc herniation. Of the 25 patients who underwent TLIF, in 14 (56%) cases fusion was performed at L5-S1, in 9 (36%) at segment L4-L5 and in 2 (8%) at L3-L4. We found subjective improvement in symptoms of back pain in 19 (76.0%) of 25 patients, leg pain in 15 (83.3%) of 18, and 04 (66.67%) & 02(40.0%) improvement in sensory and motor deficit respectively postoperatively. Based on the Oswestry Disability Index (ODI) and Visual Analog Pain Scale (VAS), showed significant improvement from preoperative 7.1 & 42.3 to 2.5 & 17.5 ODI and VAS scores at 18 months postoperatively respectively, with an overall improvement of 4.6 VAS and 24.8 ODI scores. A radiological fusion was observed at 18 months postoperatively on anterio-posterior (AP) and lateral X-rays following the pre set criteria in 23 of 25 patients (92.00%).

Conclusion: TLIF is a safe and effective method to treat chronic low back pain in patients with spondylolisthesis, degenerative disc disease and recurrent disc herniation. Our results confirm that TLIF is an option that is associated with good clinical and radiological outcome.

GO044. Psychological Distress can be Determined before Lumbar Surgeries with a Clinically Applicable, Easy-to-use Tool: the Short form of the DRAM

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Introduction: The Distress and Risk Assessment Method (DRAM) is a tool for measuring the psychological risk factors in low back pain patients. In our previous study, the DRAM scale, its categories as well as its components (Zung Depression Scale (ZDS) and Modified Somatic Perception Questionnaire (MSPQ)) proved to be significant predictors for global treatment outcome in routine lumbar degenerative surgeries. On the other hand, the original DRAM has to be calculated from 45 items making that a long and clinically impractical tool. The aim of the study was to develop and validate a short form of the DRAM (sDRAM) and to determine the prognostic power of the new version in terms of the global treatment outcome.

Material and Methods: Classic Test Theory were applied for item reduction after the exploratory factor analysis of ZDS and MSPQ on the dataset of a large ($N = 1837$) cohort of surgically treated low back pain patients. Internal consistency and the correlation of the shortened DRAM (sDRAM) with the original scale were analyzed. After that, a two-step cluster analysis of sDRAM was applied to determine the cut-off scores. The prognostic value of the scale and its categories was tested on a prospective cohort of routine lumbar degenerative surgeries ($N = 445$) where global treatment outcome was assessed two years after the surgery by a Likert scale.

Results: The sDRAM consisted of five ZDS items (1, 6, 7, 12, 18) and three MSPQ items (3, 9, 11) preserving the original item-distribution ratio. sDRAM scale (range: 0–24) was highly correlated with the DRAM scale (range: 0–99) (r=0.88). Cluster analysis of the patients showed a four-cluster structure in the cohort similarly to the original questionnaire. Cut-off scores (sZDS > 6, sMSPQ > 2) were used to formulate the sDRAM categories (Normal, At risk, Distressed). The sDRAM scale showed a significant association with the global treatment outcome in a logistic regression model ($p < 0.001$, B=0.258, OR=1.3) and in ROC analysis (AUC=0.744, $p < 0.001$) and it was similar to the original DRAM ($p < 0.001$, B=0.066, OR=1.07 as well as AUC=0.72, $p < 0.001$). Risk for poor outcome was significantly associated with the suggested categories of sDRAM (6%, 20%, 39% of poor outcome in "Normal," "At Risk" and "Distressed" subgroups, Chi-square=38.9, df=2, $p < 0.001$).

Conclusion: A shorter, clinically applicable method for the assessment of DRAM has been developed. The sDRAM consists of 8 items and correlates with the original questionnaire. sDRAM and its categories proved to be significantly associated with global treatment outcome. The tool can be used for preoperative risk assessment and reduction strategies, however, further validation is needed to show its utility in different, wider patient-groups.

GO045. Lumbar Total Disc Replacement: 9th after the Operation, is it the Breakpoint for Clinical Deterioration and Spontaneous Fusion?

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Introduction: Total disc replacement (TDR) is one of the treatment options in the degenerative disc disease (DDD), presuming to preserve segmental range of motion and prevent development of ASD. There are many arguments arising against TDR´s benefits, mostly in long-term period. We performed a single-center retrospective clinical–radiological study to evaluate the long-term results and safety of TDR operation.

Materials and Methods: Our cohort included 222 patients treated for moderate or severe DDD by single or two-level implantation of TDR between January 2002 and January 2011. An average follow-up was 8.2 ± 3.1 years. Clinical evaluation constisted of visual analog scale and postoperative Odom´s outcome score. We analyzed the progress of radiologic adjacent segment degeneration (rASD) and heterotopic ossifications (HO).

Results: We found that Odom´s scores for low back pain and leg pain both decrease lineary in time, with with cut-off and rapid deterioration of low back pain after the 9th year from surgery(p=.00001). We assume that this might be related to natural progression of initial DDD or development of ASD favored by HO and spontaneous fusion in TDR level. In agreement with this assumption, we have found that heterotopic ossifications have a triphasic course of progression, with plateau between 4th and 8th year after TDR($p = 0.00001$). After the 9th year we observed an accelerated progression to bridging HO, resulting in the loss of movement. We demonstrated that our patients with fusion in TDR level had significantly higher incidence of rASD and significantly worse clinical outcome, for both low back pain and leg pain ($p = 0.000324$). Similarly to other authors we conclude that dynamic TDR might prevent or delay rASD. We found interesting that using two independent measurements, clinical outcome and HO/range of movement, we determined the same approximate cut-off deterioration by the 9th year after the TDR operation. We didn´t find significant effect of HO on clinical outcome. Implantation of TDR resulted in a 15.8.% of spontaneous fusion in our series. We found quite important rate of radiologic adjacent degeneration, 23.85%,still within the range of literature. Incidence of delayed reoperations was 12.2%, mostly because of adjacent-segment disease, with the mean time 4.1 years after TDR. These patients were significantly less satisfied. According to risk factors, we found previous discectomy is significantly related with higher incidence of leg pain, which might be explained due to nerve root traction within preexisting scar tissue. Patients with higher initial BMI had significantly higher incidence of segmental fusion. We found worse outcome for bisegmental and L5/S1 TDR, both nonsignificant. At last follow-up (5–14 years postsurgery), excellent and good outcomes were achieved in 66.9% patients for low back pain, and 72.4% for leg pain.

*Conclusion***s:** According to our results, we estimate that approximately after the 9th year after TDR, loss of segmental movement due to bridging ossifications might accelerate naturally occurring adjacent segment degeneration and leads to worse clinical outcome, mostly low back pain. We are still persuaded that despite technical difficulty, TDR has its place in lumbar DDD surgery. Reasonable indication and optimal placement of TDR are crucial. We need more prospective studies of long-term to understand.

Diagnostics Clinical

GO046. Preoperative Norepinephrine Levels in Cerebrospinal Fluid and Plasma of Pediatric Patients Predict Postoperative Pain Intensity after Spinal Fusion Surgery

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Introduction: The purpose of the present study was to investigate if preoperative concentrations of monoamine neurotransmitters that are known to be involved in descending pain modulation are associated with perioperative pain intensity in a pediatric cohort of patients with idiopathic scoliosis scheduled for elective spinal fusion surgery.

Material and Methods: Patients scheduled to undergo spinal surgery for Adolescent Idiopathic Scoliosis (AIS) between the ages of 12 and 18 years were recruited from the outpatient clinic of the Shriners Hospital for Children ($n = 50$). Plasmatic and cerebrospinal fluid concentrations of epinephrine (EPI), norepinephrine (NE), and their respective metabolite metanephrine (ME) and normetanephrine (NME), were assessed. Five mL of blood were collected for study analysis in an EDTA-coated collection tube after the anesthesia induction. Prior to the intratechal epimorphine injection, 2 mL of cerebrospinal fluid was collected in a low binding protein tube. Monoamine neurotransmitters were derivatized by reductive diethylation analyzed by liquid chromatography coupled with tandem mass spectrometry on TripleTOF 5600 mass spectrometer. At all time points throughout the study (preoperative, first postoperative 24 hours = postoperative day 1 (POD1), second 24 hours = postoperative day 2 (POD2) and postoperative 6 weeks follow-up visit), pain intensity was rated with the use of the Faces Pain Scale-Revised (FPS-R). Linear regressions were performed to assess the predictive role of catecholamine levels for postoperative pain. The Mann-Whitney-U test was used to assess differences in baseline characteristics between patients reporting presence of pain and pain-free patients as well as for all other comparisons other than correlations.

Results: Our results demonstrate that patients reporting persistent postsurgical pain 6 weeks after surgery have greater preoperative peripheral and/or central norepinephrine (NE) and normetanephrine levels when compared with patients reporting no pain at follow-up. Likewise, in the acute postoperative period, patients reporting moderate-to-severe pain intensity had higher preoperative central NE levels.

Conclusion: These results support the evidence for a potential role of catecholamine levels in predicting postoperative pain intensity and sympathetically maintained pain, which could place pediatric patients at risk for the development of chronic postsurgical pain. Incidence and severity of persistent postoperative pain may be reduced by specific NE preoperative interventions.

GO047. Comparative Study of Treatment of High Grade Spondylolisthesis—Reduction Vs In-situ Fusion: Do we Need to Rethink Assessment of Pelvic Parameters?

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Introduction: Reduction of high grade spondylolistheisis is considered to be the ideal treatment surgical treatment strategy on the premise that it restores spine biomechanics and altered sagittal balance. However it has been noted that in-situ fusion strategy also provide satisfactory result for high grade spondylolisthesis. In view of this observation we propose a hypothesis that following fusion L5 stands to be a part of the pelvis and pelvic parameter assessment should be considered with S1 pre-operatively and L5 post-operatively as the base of the pelvis. We assessd the pelvic parameters in this manner to guage the improvement in the pelvic parameters in both surgical groups (In –situ fusion Vs Reduction and fusion).

Methodology: A retrospective review was conducted on 26 cases of high grade spondylolisthesis (defined as slippage $>$ 50%) undergoing surgical treatment. Patients were divided into two groups; group one had undergone in-situ fusion and group two had undergone reduction with fusion. Spinopelvic parameters assessed for each group included; pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbar lordosis (LL), lumbo-sacral kyphosis angle (LSK) and sacral femoral distance (SFD). Pre-operative spinopelvic parameters calculated with S1 were compared post-operatively with L5 as base of pelvis. Post-operative clinical outcomes were evaluated with Oswestry disability index (ODI score), Short form 12(SF 12) and visual analogue score (VAS score) for both groups.

Results: Mean age was 34.1 years and mean follow-up was 24.5 months. Following surgery, VAS and ODI improved from 7.7 to 1.8 and from 62.6 to 14.7% respectively with no difference between two groups. One patient had transient L5 deficit in the reduction groupne procedure over the other. The mean pelvic parameters preoperatively were PI - 68.5°, PT - 26.7°, SS - 41.7°, LL - 51.4°, SFD - 63.0 mm, shift of L1 plumb line - 63.9 mm and LSK - 67°. With L5 as the new sacrum, in reduction group, significant changes were noted in PT (60.4%), SFD (45.25%) and LSK (46.6%) ($p < 0.05$ for all). Similar significant changes were noted in insitu fusion also in PT (58.6%), SFD (41.2%) and LSK (68.6%) ($p < 0.05$ for all). In both groups, the changes in PI, SS and lumbar lordosis were not significantly changed. The above results show that insitu fusion achieves the same changes in sagittal parameters when L5 is considered as part of the new sacrum.

Conclusions: The spinopelvic parameters for in-situ fusion and reduction with fusion groups, when utilizing the superior endplate of L5 did not show significant change in PI, SS and LL for both groups. Three parameters changed significantly post-operatively in both procedures and showed comparable changes – PT, SFD and LSK. This may suggest that the improved clinical outcomes for both treatment strategy may co-relate to changes in PT, SFD and LSK. The findings call for reevaluating the need for risky reduction procedures to establish normal pelvic parameters.

GO048. What is More Effective Treatment Option for Discogenic Low Back Pain -Thermocoagulation or Nonoperative Treatment?: A Systematic Review and Meta-analysis

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Study Design: Systematic review and meta-analysis of randomized controlled trials, case control and cohort studies.

Introduction: To evaluate the current evidence comparing Thermo-coagulation intradiscal techniques to nonoperative treatment options for the treatment of chronic Discogenic low back pain. Discogenic low back pain is a common disabling condition and major health care concern. However, it has been controversial in diagnosis and treatment.

Methods: We searched PubMed, EMBASE, Cochrane Library, KoreaMed and Korean Medical database (KMbase) to find out clinical studies for evaluating the effectiveness of Radiofrequency and Intradiscal electrothermal therapy for the treatment of Discogenic low back pain which were published until June 2015. Randomized controlled trials, case control and cohort studies comparing Thermo-coagulation intradiscal techniques with nonoperative treatment options were selected. Duplicate citations were removed and a total of 13,464 articles were acquired, from which 6 articles were identified for meta-analysis.

Results: A total of 6 citations were found and screened to determine if they would meet our inclusion criteria. Finally, 4 randomized controlled trials and 1 case-control and 1 cohort study comparing the effectiveness of thermo-coagulation and nonoperative treatment options were selected for meta-analysis and risk of bias was evaluated as assessed in accordance to guidelines following the Cochrane Collaboration's tool for assessing risk of bias in randomized trials and Newcastle-Ottawa Scale (case control and cohort studies). In meta-analysis, clinical outcomes such as Visual Analogue Scale, Oswestry Disability Index and Short Form-36 (physical functioning and bodily pain) values were evaluated and the forest plot provided a visual representation of each study and all studies combined with individual confidence intervals. Based on meta-analysis, the pooled mean difference in Visual Analogue Scale (pre – post outcomes) between the thermo-coagulation and nonoperative treatment options in all 3 randomized controlled trials, 1 case control and 1 cohort study was 2.44 points (95% confidence interval: 1.01, 3.88, $p = 0.0009$) in favor of thermo-coagulation procedures within 7.8 month mean follow-up periods. However, within 3 months after treatments, there was no statistically significant difference in the two treatment options. In the outcomes of meta-analysis after 3 months of treatment, thermo-coagulation procedures showed to be more favorable with MD = 2.88 points (95% confidence interval: 1.05, 4.71, $p = 0.002$) In Oswestry Disability Index, the pooled mean difference (pre – post outcomes) was 2.86 points (95% confidence interval: -2.40, 8.13) in favor of thermo-coagulation procedures which was not statistically significant ($p = 0.29$) with 4.7 month mean follow-up periods. However, thermo-coagulation procedures were more favorable with MD = 5.10 points (95% confidence interval: 0.44, 9.76, $p = 0.03$) only in the outcomes of meta-analysis after 6 months of treatment. The pooled mean difference (post – pre outcomes) in Short Form-36 including physical functioning and bodily pain was 7.55 points (95% confidence interval: -0.69, 15.80) and 6.47 points (95%

confidence interval: -1.09, 14.04) in favor of thermo-coagulation procedures, however, they were not statistically significant ($p = 0.07$ and $p = 0.09$) with 5.3 month mean follow-up periods, respectively.

Conclusion: It was demonstrated from this systematic review and meta-analysis that the two treatment options had no statistically significant difference in Visual Analogue Scale scores within 3 months after treatments for the patients with discogenic low back pain, however, thermo-coagulation therapies showed a statistically significant favorable effect after 3months. In Oswestry Disability Index, there was a statistically significant favorable outcome only after 6 months of treatment. Short Form-36 (physical functioning and bodily pain), it failed to find significant differences between the two treatment options despite more favorable outcomes in thermo-coagulation therapies.

GO049. Are Tarlov Cysts Being Identified and Reported on Lumbar Spine MRI Scan in Patients with Sciatica

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Introduction: Following advances in surgical technique sacral Tarlov Cysts (TCs) are now a treatable cause of back pain and sciatica.[1,2] However many surgeons and radiologists still view them as an incidental finding. This audit was performed to raise awareness of TCs within the hospital and further afield, assess the extent to which TCs are present in patients with sciatica and assess if they are being identified and reported by the radiologist and surgeon in every case.

Material and Methods: Following a literature review a list of all spinal MRI scans requested by the three consultant spinal surgeons working at the hospital between 1/1/2013 – 31/12/2014 was compiled by the radiology department. All patients with complaints of radicular pain or altered sensation in one or both lower limbs in their initial clinic letter then had their MRI scan reviewed using the hospital PACS system for the presence of TCs. The radiologist's report and follow-up clinic letter were then reviewed in patients with a TC present on their scan to see if it was reported by the radiologist and surgeon. Any patient who's scan or clinic letters were not were removed from the audit.

Results: In total 1499 patients underwent lumbar-sacral MRI scan under the care of the spinal surgeons. Of these, 1070 fitted the inclusion criteria. 6 MRI scans were not accessible, in total 1064 MRI scans were reviewed for the presence of TCs. 158 scans showed sacral TCs present, an incidence of 14.85%. Of the 158 only 33 (21%) had TCs in the radiologists' report. 4 were reported as possibly symptomatic and the rest as an incidental finding. Only the 4 potentially symptomatic TC patients were notified of the presence of the cysts during their clinic appointment following the MRI scan. No other patients notified of the presence of TCs on their MRI. Therefore of the 158 patients with sacral TCs present only 4 (2.5%) were made aware of the lesion. Only one case of symptomatic cyst was identified as the patient's symptoms decreased following excision of the cyst.

Conclusion: Several things were apparent from the literature review; the exact anatomical area supplied by each of the lumbar-sacral dermatomes is not known and as such pathology compressing the S2 nerve root can cause symptoms suggestive of an S! or even L5 radiculopathy,[3] TCs can be progressive in nature,[4] microsurgical treatment gives the best relief of symptoms and can give complete relief of symptoms,[5,6] early intervention gives the best prognosis.[1]

From the audit it was apparent that in almost 80% of cases TCs were not being reported, this could potentially lead to patients continuing with symptoms, or developing them as the cyst progresses. A delay in diagnosis and therefore treatment of a symptomatic TC could lead to a poorer prognosis. It seems that for many Tarlov Cysts are still viewed as an asymptomatic incidental finding, until this opinion is changed it will continue to be under reported and patients will continue to suffer a potentially treatable spinal pathology.

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GO050. Test Score (SI5): Assess Diagnostic of Sacroiliac Joint Dysfunction

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Objective: The sacroiliac joint dysfunction is a known cause of low back pain. We think that a test score (SI5) may be performed to assess diagnostic utility of clinical signs of sacroiliac joint dysfunction. The primary aim of the present study was to conduct conducting the pilot study of our new test score SI5.

Methods: After reviewing the literature about of clinical characteristic, diagnostic test and imaging of the sacroiliac joint; we evaluated diagnostic utility of these aspects and developed the SI5 test score. The SI5 test score was performed in 22 patients with low back pain including completion of a standard questionnaire, history, physical examination performed by a physician, and evaluation of the results.

Results: The most sensitive clinical tests for diagnosing of sacroiliac joint dysfunction were Laguerre Test, sacroiliac rocking test and Yeomans test (Greater than 80% sensitivity). The tests with greater specificity ($>$ 80%) were Lewitt test, Piedallu test and Gillet test. The test score SI5 showed sensitivity of 73% and specificity of 71%.

Conclusions: Sacroiliac joints have been shown to be capable of producing pain in the low back; however, the

diagnostic value of examination tests for sacroiliac joint pain has been questioned previously by other authors. The pilot study of SI5 test score showed good sensitivity and specificity. This study required statistical procedures that yield appropriate results.

Keywords: sacroiliac joint, sacroiliac joint dysfunction, low pain back, diagnostic test, sacroiliac joint block, diagnostic gold standard

GO051. Predictive Factors for the Outcome of Surgical Treatment of Lumbar Spondylolysis in Young Sporting Individuals

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Introduction: Only few sporting individuals with symptomatic lumbar pars injuries require surgical repair and it is often difficult to predict the outcome following surgery. The results on predictive factors of outcome after direct repair of pars defect have not been studied.

Material and Methods: 52 consecutive young sporting individuals with a mean age of 19 years (range 8–35years) were treated surgically for lumbar pars defect confirmed on imaging studies (i.e., SPECT, CT and MRIscans). 50 patients completed the VAS (visual analogue scores), ODI (Oswestry Disability Index) and SF-36 (Short Form) questionnaires as a part of their assessment. Preoperative background variables were used in a multiple regression model to find the strongest predictor of post-operative outcome as measured by ODI.

Results: Buck's screw repair of the pars defect was performed in 44 patients (33M: 11 F). Unilateral in 8 patients (7M: 1F) and bilateral in 36 patients (26M: 10F). Although age at surgery showed linear co-linearity (ρ=0.32, $p < 0.05$), it was not significant in the model. The most consistent association with the preoperative VAS score were the pre and post operative ODI scores i.e., ρ =0.51 ($p < 0.01$) and ρ =0.33 ($p < 0.05$) respectively. In the bilateral group, with Buck's repair at a single level i.e., 33/36 (93%) patients had returned to sports at a mean time of 7.5 months (range 6–12months). Overall, 44/52 (84%) individuals had returned to their sports with post-treatment ODI score of < 10. The stepwise regression modeling suggested six independent factors (pre-operative ODI, pre-operative SF36pcs, Buck's repair, multiple operations, professionalism and pars defect at L3), as the determinants of the outcome (i.e., post-operative ODI.) in 80.9% patients (R^2=0.809).

Conclusion: The outcome after direct repair of pars defect below 25 years of age runs a predictable course. Professionalism in sports has a high impact on the outcome. Preoperative ODI and SF-36 pcs scores are significant predictors of good functional outcome. The regression equation can predict the outcome in 80.9% sporting individuals undergoing Buck's repair.

Trauma Cervical 1

GO052. Transpedicular Screw Placement for Subaxial Cervical Trauma with Neuronavigation. Experience in a Third World Country. Hospital Santo Tomas. Panama

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Introduction: Hospital Santo Tomas is a tretary trauma center in Panama. Subaxial cervical trauma represents a major issue in the care of patients admitted to the neurosurgery department. Lateral mass screw placement is commonly used for posterior fixation. The aim of this abstract is to present our experience not only with transpedicular screws but also doing this with a neuronavigation system and to evaluate the associated risks.

Materials and Methods: 19 patients in need of posterior fixation with subaxial cervical trauma were stabilized by transpedicular screws from 2010 to 2012 were included. The patients were all male between 20 and 34 years of age. After hemodynamics parameter were assessed and other major trauma was ruled out the neurologic assessment was made. We used the Frankel grading scale and 10 patients were graded A, 4 graded C, 3 graded D an 2 graded E. By this moment a whole body CT was already done. 12 patients have C4-C5 subluxation and the remain had subluxation elsewhere in the subaxial cervical spine. 13 patients needed closed reduction which was assessed by plain films. All patiens had thin cut CT and navigation was planned. All patients were induced by a nueroanesthesiolgy. A three pin head holder was applied and the patients were put in a down face position. Calibration of the navigation system was performed and a standard posterior cervical spine with laminectomy was done. Our hospital does not count until that moment with the aid of intraoperative neurophysiological monitoring. The average surgical time was 3 hours and the blood loss was 750 cc in average. In total 52 screws were placed. All the patients went to a immediately postoperative CT scan. And the screws placement was assessed. No screw mal placement was and no complications during the placement were recorded . The patients were managed in the neurosurgical ward and were discharge 48 hours after the operation with a cervical collar . They were assessed one week after the intervention to review the surgical wound and to preformed a neurological exam. All patients were follow in the outpatient clinic and all were given physical therapy that initiated in the immediately postoperative period.

Results: Of the Frankel a group three of went on to have grade C, two were graded B and the remain did not improve. One patient in the Frankel C and one in the Frankel D group did better during follow up. No surgical wound infections were recorded. Only one of the patients died from and unrelated cause of pneumonia. All patients were assessed with dynamic films and show no movement. The follow up was up to a year. No patients were lost during that time in the follow up.

Conclusion: Tanspedicular screw placement is a safe option for posterior fixation. Neuronavigation is and excellent tool for avoiding complications.

GO053. Dorsal Fusion as Correction of Craniocervical and Atlantoaxial Instability in Patients with Benign and Malignant Lesions using O-Arm System

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Introduction: A retrospective and prospective analysis of the surgical treatment and results of 99 patients with

benign and malignant craniocervical, atlantoaxial and high cervical lesions operated during 36 – month period (2011–2014) at the Department of Neurosurgery, Klinikum Fulda gAG, Germany was performed. The aim of the analysis was to assess the factors affecting dorsal fusion as correction of craniocervical and high cervical instability.

Material and Methods: The mean age of the patients was 57 years. The female to male ratio was 1:1,3. The most frequent neurological symptoms were quadriparesis, discoordination, cranial and spinal nerves palsy and local pain. We analyzed 67 patients with traumatic lesions, 10 patients with inflammatory lesions, 8 patients with degenerative instability, and 14 patients with high cervical tumors. In the subgroup of patients with traumatic lesions we found 39 odontoid fracture II Type, 11 Hangemann fracture and 17 combined cervical fracture; in the subgroup of patients with tumors we observed 3 cases with plasmocytoma, 3 case with chordoma, 1 case with C2–3 schwanoma, and 7 cases with metastatic lesions; in the inflammatory subgroup we analyzed 6 cases with RA and 4 cases ankylose spondylitis.

Results: In 99 patients we performed 129 operations. We used posterior cervical, and craniocervical median approach. Because of craniocervical/cervical instability we made posterior screw fixation in all of 99 patients. In 47 patients we performed additionally decompressive laminectomy. To improve screw placement accuracy we performed intraoperative O-Arm in 82 cases. The operative duration was 2.25 hour. in O-Arm operations and 4.35 hour in C-arm operation. The most common operative complications were: CSF leak – in 2 cases, postoperative infection – in 4 cases, and without early operative mortality. The 12-monts follow-up showed good recovery in 65 patients, moderate disabling – 25 patients, severe disabling – 5 patients, vegetative state – 4 patients, death 3 patients with malignant lesions.

Conclusion: Early correction of craniocervical and high cervical instability facilitated neurological recovery by preserving the existent neurological function. Using of O-Arm increase operative screw placement accuracy, and preserve intraoperative nerve and vertebral artery injury. Recently because of the improvement of neuroimaging techniques, operative approaches, surgical techniques and neurointensive care the results of treatment of these lesions are optimal.

GO054. Safety and Efficacy of Harms' Technique in the Management of Atlantoaxial Instability. A Single Institution Experience and Review of the Literatures

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Introduction: various procedures for the management of atlantoxial instability have reviewed in the literatures. Advantages and disadvantages of these procedures have been stressed. Harms' procedure is one of the recently introduced techniques. This is a retrospective descriptive clinical case study to evaluate the safety and efficacy of Harms' technique.

Patients and Methods: we reviewed our hospital medical records between 2009 and 2014. We were able to track 19 patients treated for atlantoaxial instability using Harms' technique with complete records. Patients' mean age was 19.6 years. Twelve were males and 7 were females. Surgical indications included: atlantoaxial ligamentous instability in 2, Os Odentadium in 2, Downs' syndrome in 3, type-II dens fracture in 5, atlantoaxia rotatory fixation in 7. All patients had plain radiography, CT scan, and MRI. According to the JOA-score 15 were normal, 3 were grade-1 and one was grade-2. All patients were operated with Hams' technique with iliac Bone graft. The following factors were evaluated; age, sex, pathology, neurological status, operative time, blood loss, hospital stay, morbidity, screw purchases, stability, fusion, and clinical outcome.

Results: mean operative time was 125 minute. Mean blood loss was 350 ml. Hospital stay was 4 days. Screw purchase was adequate in all cases but one. Stability was adequate in all. Fusion was sound in all but two. All intact patients remained intact. Other patients improved at least one grade on JOA-Score. One patient had vertebral artery perforation by a low seated screw. There were no added neurological deficits in any of our patients.

Conclusion: our experience demonstrates the safety and efficacy of the Harms' technique in the management of atlantoaxial instability. Meticulous technique and anatomical knowledge are mandatory for optimizing outcome.

GO055. Treatment Options for Odontoid Fractures. A Comparasion between Anterior and Posterior Approaches

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Introduction: Odontoid fractures account for 9% to 15% of adult, cervical spine fractures, and are the most common fractures in the geriatric cervical spine. The mechanism of injury generally results from hyperflexion or hyperextension of the cervical spine during low-energy impacts in the elderly or high-energy impacts in the young and middle aged. No consensus exists on the optimal treatment (surgical or conservative) and the most relevant outcome parameter (osseous union, fracture stability or clinical outcome). Neurologic injuries associated with these fractures are rare.

Material and Methods This study was a retrospective chart review of 13 patients who were treated for odontoid process fractures between November 2010 and May 2015. Inclusion criteria: Patients with odontoid fractures submitted to surgical treatment. Data were obtained from medical charts and spinal column imaging reports. Medical charts, imaging studies and the patient's outcomes were submitted to descriptive analysis in the pre-operative and post-operative period. The data submitted to descriptive analysis were: Fracture gaps; the direction and degree of odontoid process displacement; the odontoid fracture line anatomy; the degrees of the atlantoaxial instability; and the contact between the fractured odontoid and the axis vertebrae. We used conventional radiographs, three-dimensional computed tomographic (3D-CT) scans, and magnetic resonance images. We used the Grauer Algorithm for defining the surgical treatment modality. We identified the solid bone union through the presence of bony bridges and the definite continuity of cortical bone.

Results: A total of 13 patients who underwent surgical treatment for odontoid fracture were identified. The patients were 76.9% men, the mean age = 32.92 years. Traffic accidents (69,2%) were the most common cause of trauma. The main symptom was pain (84.6%) in the posterior cervical region. The elapsed median time from accident to surgery was 30 days. Mean follow-up was 20 months. Odontoid screw technics (38,4%) and Harms posterior technic (38,4%) were the most common surgical treatment adopted as primary surgical treatment. The most common Grauer's line fracture type was type B on 8 cases. 2 patients referred chronic cervical pain after surgery, 1(20%) were submitted to anterior technic and 1 (12,5%) posterior technic. We had 2 cases with complications,

all submitted to posterior technic, 1 with CSF leak and 1 with vertebral artery lesion. No mortality was observed.

Conclusion: There was no difference between anterior or posterior approach when analyzing the cervical chronic pain and mortality. However, there were more complications in cases covered by the posterior approach. A well-designed prospective study with a larger number of cases is needed to better elucidate optimal treatment algorithms from both an outcomes and cost-effectiveness perspective.

GO056. Teriparatide (rhPTH1-34) Anabolic Therapy for Treatment of Type II Dens Fracture Non-union in Elderly Patients: Report of 5 Cases

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Introduction: Type II dens fracture is the most common cervical spine fracture type in elderly patients. Treatment options for this common injury include conservative management (i.e., hard collar or Halo Vest immobilization) or surgery. Delayed union or non-union is a frequent complication in elderly patients and is associated with an increased morbidity and mortality due to prolonged immobilization and hospitalization. The rhPTH1–34 (Teriparatide) is the recombinant form of the biologically active component of the human parathyroid hormone, currently approved for treatment of severe postmenopausal osteoporosis. However many in vitro studies have also demonstrated the efficacy of rhPTH1–34 in stimulating osteogenesis and bone healing and a few case reports have been published on its use in humans for treatment of fracture non-unions. The aim of this study is to report our successful experience with the use of rhPTH1–34 in the treatment of 5 cases of dens fracture non-union in elderly patients.

Material and Methods: Five patients (age $>$ 70, all females) diagnosed with type II C2 dens fracture non-union (no neurological compromise) were enrolled in this study. Fracture non-union was defined as non- healing at 9 months after injury and radiographic evidence of failed healing progression over the last 3 months. All patients had been treated conservatively with a hard collar. Patients were started on anabolic drug therapy with daily subcutaneous injection of rhPTH1–34 (Teriparatide, 20 ng/die) for 3 months. Regular clinical assessments and monitoring of serum levels of calcium, phosphorus, vitamin D, and alkaline phosphatase were undertaken throughout the treatment period. We describe the evolution of our cases over time with serial CT scan imaging as well as HRQoL questionnaires (VAS, SF-12, and Eq. 5D).

Results: Successful complete fracture healing was achieved in all patients at 74.5 $\pm$ 4.4 weeks after the injury and at 10.2 $\pm$ 3.8 weeks after the start of the anabolic therapy. Mean VAS score at the end of the treatment was 2.4 $\pm$ 1.3 (from a baseline value of 6.8 $\pm$ 2, $p < 0.02$) in all patients, while the average SF-12 score was 42 $\pm$ 3.7 (PCS) and 61.5 $\pm$ 2.11 (MCS) (from a baseline value of 25.1 $\pm$ 2.12 and 43.2 $\pm$ 1.49, $p < 0.04$) and Eq. 5D was 0.798 $\pm$ 0.044 (from a baseline value of 0.396 $\pm$ 0.198, $p < 0.03$). Patients had normal serum calcium level (9.1 $\pm$ 0.9 mg/dl). No side effects related to the use of the anabolic therapy were noted in our patients.

Conclusion: Our case series shows that rhPTH1–34 has induced successful bone healing in all our cases of type II dens fracture non-union. Bone healing has been demonstrated through CT imaging and also confirmed by clinical improvement of HRQoL measures. This is a potentially groundbreaking finding in management of elderly patients with upper cervical injuries and will deserve further study in future.

GO057. Outcome of Patients with Occipitocervical Fusion for Acute Craniocervical Instability

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Introduction: Occipitocervical fusion (OCF) is a safe and reliable method for stabilization of craniocervical instabilities caused by different mechanisms. Especially patients with acute instabilities and unaffected previous range of motion of the cervical spine, may be affected by the fusion procedure. The purpose of this study was to evaluate retrospectively surgical outcome and patient disability after OCF procedure for acute instabilities.

Methods: Over a 5-year period, 2009–2014, 33 consecutive patients from one academic trauma center were retrospectively identified as having been treated with OCF. Of these, 29 patients were diagnosed with traumatic or pathologic fractures or nonunion after previously failed surgical intervention. Average follow up was 25 months (range 4–55 months). Demographics were assessed. Fixation constructs were delineated. Nonunion, infection, implant failure, neurologic disabilities, and deaths were used as complication variables. Patient disability was addressed by the Neck Disability Index (NDI) and persistent pain (VAS).

Results: Traumatic and pathologic fractures were the main reason (90%) for an OCF procedure in our study population. Three patients (10%) suffered from a persistent instability after previously failed surgical stabilization. Fracture location was the odontoid process of C2 in 69% of the patients and 31% had a combined injury to C1 and C2. Fusion was performed between the occiput and C4 in 55%, C5 in 28%, and C3 in 17%. Fusion was enhanced by autologous bone in 14 patients (48%). 3 patients (10%) underwent a surgical revision due to screw misplacement (1) and infection (2). Related to the advanced patient age, 15 patients died before the evaluation. One patient died during hospital stay related to his preoperatively existing comorbidities. Fourteen patients were evaluated. Average age was 74.2 years (range 18–95 years). Regarding the clinical outcome, pain averaged 2.5 on the VAS (median 2). 64% of the patients reported no or minimal pain (VAS 0–2), 23% complained of mild pain (VAS 2–4). The NDI averaged 42% (range 16 – 80%).

Conclusion: OCF is a reliable and safe procedure for the treatment of craniocervical instabilities caused by different injuries and diseases. Overall, pain reduction was effective. Patients reported no or only mild pain (VAS 0–4) in 86% during our evaluation. Functional disability averaged 42% utilizing the NDI, which is rated as "medium disability." The rate of 52% deceased patients reflects the fact that OCF is performed in our institution especially in elderly and patients with increased rates of comorbidities.

Degenerative Lumbar 2

GO058. Predictors of Discharge Destination after Lumbar Spine Fusion Surgery

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Introduction: Lumbar spine fusion surgery is a common surgical procedure used to treat a variety of lumbar spine conditions. A great number of patients fail to go home after surgery and require transfer to a rehabilitation center. Many

Patients requiring transfer to rehabilitation centers often have an extended hospital length of stay due to lack of beds at rehabilitation centers. Each extra day spent at the hospital costs the health system approximately $1000 USD. The aim of this study was to identify predictive factors for discharging patients to an inpatient rehabilitation center after undergoing lumbar spine fusion surgery.

Methods: We retrospectively identified a total of 15,092 patients undergoing lumbar spine fusion from 2011 to 2013 using the ACS-NSQIP database. Patients were dichotomized based on discharge destination to patients who were discharged home ($N = 12,339$) and others who were discharged to a rehabilitation center ($N = 2753$). Outcomes included patient demographics, comorbidities, and clinical characteristics. A multivariate logistic regression was used to identify whether outcomes studied were predictive factors for discharging patients to a rehabilitation center after lumbar fusion surgery.

Results: Majority of patients were discharged home after lumbar fusion surgery (81.76%) with only some discharged to a rehabilitation center (18.24%). Multivariate analysis identified age $\geq$40, female gender, comorbidities (diabetes, COPD, CHF, and obesity), minor and major complications, hospital length of stay (LOS), operative time $\geq$ 259 minutes, multilevel surgery, and return to the operation room as significant predictive factors of discharging patients to a rehabilitation center after lumbar fusion surgery.

Conclusion: The identified predictive factors can help the health system in developing an algorithm for early recognition of patients requiring postoperative admission to a rehabilitation center and possibly decreasing their hospital LOS. This can significantly decrease the hospital costs for such patients.

GO059. Prediction of Treatment Outcomes for Patients with Chronic Low Back Pain: the Development of a Clinical Decision Guideline for Spine Surgeons

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Introduction: Low back pain (LBP) is responsible for the greatest burden of all diseases.[1] Chronic Low Back Pain (CLBP) is among the most common reasons why patients visit a spine surgeon. As the CLBP population is heterogeneous, it remains a challenge to address etiology and to suggest treatment options. Evidence[2–4] recommends developing a decision tool to triage toward either surgical or nonsurgical interventions. The Nijmegen decision tool, consisting of a web-based questionnaire, a systematic follow up of outcomes built in the patient-based system of the SweSpine Registry,[5] is developed to support patient-triage and is based on evidence and professional (Delphi) consensus. Since April2012 all new patients complete the questionnaire, consisting of 47 indicators potentially predicting successful treatment outcome or persistence of pain complaints, and are systematically followed over time.[5] In this study pre-intervention patient profiles have been determined and a decision algorithm has been developed, based on indicators predicting successful one-year follow-up outcome of spine surgery and of a nonsurgical, multidisciplinary Combined Physical and Psychological (CPP) program.

Material and Methods: A consecutive cohort study was performed. Diagnostics and decision-making were performed 'as usual'. Data of patients were included who completed the one-year follow-up assessment: 219 had surgery and 171 followed a multidisciplinary CPP-program. The outcome was functional status (Oswestry Disability Index v2.1a [ODI]) and being successful was defined as one-year improvement to an absolute ('normal'/healthy) ODI-threshold (value$\leq$22). The 47 potential predictive indicators included indicators in the sociodemographic, pain-related, somatic, psychological, functional and quality of life domains.[5] After data-cleaning and having fulfilled all assumptions for analyses, for each cohort a separate multiple logistic regression analysis was performed.

Results: Probability of successful surgical outcome: the prediction model (R^2=31%) included pre-treatment previous surgery(OR 0.390 [95%CI 0.201–0.757]), expectations of recovery (OR 2.830 [95%CI 1.391–5.756]), expectation of work return (OR 0.824 [95%CI 0.706–0.960]), pre-treatment functioning (OR 0.961 [95%CI 0.939–0.984]), and 'red flag' for age (pain started age $<$ 20 or $>$ 50 years; OR 2.321 [95%CI 1.214–4.435]). *Probability of successful CPP-program outcome:* the prediction model (R^2=26%) included pre-treatment functioning (OR 0.963 [95%CI 0.937–0.990]), catastrophizing (OR 0.199 [95%CI 0.065–0.610]), and depressed mood (OR 0.205 [95%CI 0.063–0.665]). Interpretation Odds Ratio (OR): OR $>$ 1=increased probability to success; OR $<$ 1=reduced probability to success)

Conclusion: This is the first clinical decision tool available, created with a rigorous scientific basis that is designed for patient-triage. Different patient profiles predicting either a successful outcome for spine surgery or for CPP program are determined. The presented profiles are based on first analyses, after final analyses the two prediction models will be converted to probability formulae and built in the online tool. For every new patient the probabilities for treatment success will be available in the electronic patient file. The next step is to validate the tool in different hospitals. We expect that this relatively simple tool, based on validated questionnaires and current evidence, will considerably help in daily spine practice to guide the right patients to the right practitioners and to enhance personalized care. We will present the final prediction models at the Global Spine Congress.

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GO060. Pelvic Incidence as a Prognostic Variable to Assess the Outcome of Conservative Treatment in the Patients with Spondylolisthesis

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Introduction: Spondylolisthesis is defined as slippage of one vertebra over the below one. Ever since the discovery of pelvic incidence by legaye et al. in 1998 and as well as documentation of the other parameters for spinopelvic balance, the slippage in listhesis has been attributed to these parameters. Many studies were done in the Caucasian population, which implicates high pelvic incidence as a causative factor for the listhesis. But to our knowledge, no study has described the implication of these parameters in the progression of listhesis. The main aim of our present study was to know the importance of the spinopelvic parameters in the causation and progression of the listhesis and also to know the response to conservative treatment.

Materials and Methods: The study was approved by our institute review board and the ethical committee. We included all the patients visiting our OPD with complaints of LBP for more than three months, whose X-ray shows spondylolisthesis and who gave consent for the study. All patients were advised conservative treatment (NSAIDS, physiotherapy and short wave diathermy) and were followed once in 2 weeks regularly and were evaluated once in 6 weeks with the help of modified Oswestry questionnaire. At the end of 6 months, patients who were improved were advised the same conservative treatment and followed up. Those who have not improved were suggested repeat X-rays and the parameters and grade of listhesis recalculated. A total of 79 patients were thus included in the study. Another age and sex matched group of asymptomatic volunteers ($n = 75$) were also recruited as a control group. Out of the total of 79 patients, 35 were followed for six month period of which 27 improved and in 8 there was no improvement. 25 have lost follow-up and in 19 follow-up was still pending. All the patients and volunteers underwent a standardized lateral sagittal digital radiograph of the whole spine including the base of the skull till the proximal ⅓ thigh.The sagittal spinopelvic parameters were measured using the Surgimap spine software version 2.1.2 by a single observer. The parameters measured were pelvic incidence PI, pelvic tilt PT, sacral slope SS, thoracic kyphosis TK, lumbar lordosis LL, lordotic and kyphotic vertebra. The comparisons were drawn between the patients and controls using appropriate statistical methods.

Results: The mean values in the asymptomatic group are PI-47.85, PT-13.03, SS-34.8, LL-54.68, TK-24.03. In the listhesis group are PI-65.32, PT-21.30, SS-44.13, LL-54.08, TK-25.49. There was a significant difference between the normal and the listhesis groups among PI, SS, PT ($p < 0.001$). There was no significant difference in pelvic incidence between the patients with high-grade(grade 3,4,5) and low-grade listhesis(grade 1,2).

Conclusion: The progression of slip and the response of the conservative treatment depends on- pelvic incidence, initial grade and how many levels of slip and finally on the sagittal vertical axis and its distance from the posterior superior corner of sacrum.

GO061. Does the Position of the Spacer in Tlif have an Influence on Anatomical Parameters Such as Segmental Lordosis, Foraminal Height? A Prospective Randomized Study

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Introduction: In a prospective randomized trial we aimed to validate PMMA spacer in TLIF. Compared with standard, preformed PEEK spacer we didn't find significant difference regarding the clinical outcome, completed bony fusion, subsidence or loosening. When performing TLIF there are different arguments to position the intervertebral spacer in different position (anterior or posterior) In this prospective, randomized study we would like to compare the segmental anatomical changes following the position of a custom made PMMA spacer in monosegmental TLIF.

Material and Methods: In our study we planned to collect 60 consecutive patients to whom we perform one level TLIF in the lumbar spine. The patients are randomized in two groups by the GraphPad QuickCalcs software. Group A is standard TLIF with PMMA spacer placed in the anterior part of the intervertebral space. Group B is standard TLIF with PMMA spacer positioned in the posterior part of the intervertebral space. Patients between 18–65 years/o were inclouded. Patients with a high grade spondylolisthesis, metabolic bone desease, spinal infection, cancer, severe scoliosis (Cobb over 30°) were excluded. We evaluate changes in segmental, and overall lordosis and in the height of the neuroforamen according to the position of the spacer.

Results: 58 patients, 31 in group A and 27 in group B, has a minimum of one year follow up. In both groups the segmental lordosis increased. The mean change was 6° in group A and 4° in group B, the difference was not significant. The foraminal height also increased in both groups, the mean change was 18% in group A and 27% in group B but this difference was not significant eather.

Conclusion: Anterior position of the intervertebral spacer seems to provide more possibility to correct lumbar lordosis, but the advantage on posterior position hasn't been shown significant in this study. Better foraminal height restoration was found in the posterior position of the spacer, but there was no correlation of this parameter to the clinical outcome. We can conclude that both positions provide good radiological and clinical result.

GO062. Outcome Prediction in Elective Spine Surgery: A Prospective Cohort Study

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Objectives: To identify associations between demographic characteristics, anxiety, depression, social support, psychological and physical health in relation to self reported disability following elective spine surgery.

Methods: Study design: Prospective cohort study. Patients were asked preoperatively to complete a series of questionnaires, including the Oswestry Disability Index (ODI), the anxiety sensitivity index (ASI-3), the SF-36, the visual analogue scale for pain (VAS), the Berliner Social Support Scale, the PTSS-10 for PTSD symptoms and indicate demographic variables concerning education or partnership for example. The evaluation was based on the ODI filled out 3 months postoperatively. The univariate and multivariate

analysis between risk factors and outcome parameter (ODI) was assessed with correlation coefficients and multivariate logistic regression.

Results: 144 patients met all inclusion criteria, 54% were male, 46% were female. Regardless of the operation dimension 75% had a lower ODI score at 3 months postoperatively compared with preoperatively and hence had a higher functionality after the operation. Preoperatively high values in age (r=0,153; $p = 0{,}087$), pain (VAS) (r=0,287; $p = 0{,}01$), trait anxiety(r=0,197; $p = 0{,}027$), PTSS (r=0,163; $p = 0{,}069$), ODI (r=0,459; $p < 0{,}001$) and low levels of social support (BSSS) ($r = -0{,}148$; $p = 0{,}099$) and education ($r = -0{,}156$; $p = 0{,}098$) correlated with high levels of ODI postoperatively which identifies all the mentioned variables as potential risk factors. A stepwise logistic regression model showed significant association with age, pain (VAS), state anxiety (STAI-S), and depression symptoms (ADS-K) ($p < 0{,}000$).

Conclusion: Preoperative psychological status is associated with worse clinical outcome following elective spine surgery. A screening instrument allowing the identification of such patients is feasible.

GO063. Expectations of Pain Improvement and Actual Pain Improvement: A Prospective Comparison for Lumbar Spine Surgery

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Introduction: Patients undergo lumbar spine surgery because they expect improvement in pain and function. Traditionally, pain outcomes have been measured with numerical scales that capture pain intensity. Fulfillment of the expectation for pain improvement is another outcome that captures additional components of pain. This study compared patients' preoperative expectation of pain improvement with their actual pain improvement two years after surgery and identified variables associated with postoperative pain and unfulfilled expectations of pain improvement.

Methods: Several days before surgery patients completed a multi-item expectations survey specific to lumbar spine surgery that is valid and reliable. One item asked patients how much pain improvement they expected with response options ranging from "complete improvement" to a "little improvement." Patients also rated pain intensity on a numerical scale (0 (none), 10 (worst)) and completed standard surveys for psychological well-being and disability due to lumbar pain. Two years after surgery patients were asked how much pain improvement they actually received with response options ranging from "complete improvement" to "no improvement." Patients were not reminded of their preoperative responses. They also reported current back and leg pain intensity with the numerical scale.

Results: In total, 422 patients (87% of those eligible) completed the follow-up a mean of 2.2 years after surgery; mean age was 56 years, 55% were men, 78% had a degenerative spine condition, 44% were taking opioids, and median back and leg pain intensities were 7 and 6, respectively. Most patients expected a lot (44%) or complete (45%) pain improvement preoperatively. Regarding postoperative pain improvement at two years, 11% reported no improvement, 28% reported a little to moderate improvement, 44% reported a lot of improvement, and 16% reported complete improvement. In multivariable analysis, patients were more likely to report less improvement if, before surgery, they expected greater pain improvement (OR 1.4; CI 1.1–1.9; p=.001), had symptoms longer (OR 1.6; CI 1.0–2.5; p=.06), had a positive screen for depression (OR 1.7; CI 1.2–2.5; p=.005), were having revision surgery (OR 1.6; CI 1.0–2.6; p=.04), had surgery at L4 or L5 (OR 2.5; CI 1.3–4.7; p=.004), and had a degenerative diagnosis (OR 1.6; CI 1.0–2.6; p=.05). They also had less pain improvement if they had a subsequent (repeat) surgery (OR 2.8; CI 1.7–4.7; $p < .0001$) and had less decrease in back (OR 1.3; CI 1.2–1.3; $p < .0001$) and leg pain (OR 1.1; CI 1.0–1.1; p=.004) based on the numerical scale. The proportions of patients who had their expectation fulfilled were 23% for those who expected complete improvement, 60% for those who expected a lot, 60% for those who expected moderate, and 71% for those who expected a little improvement. The variables associated with an unfulfilled expectation in multivariable analysis were greater preoperative expectations (OR 6.0; CI 3.9–9.2; $p < .0001$), a positive screen for depression (OR 1.9; CI 1.2–3.1; p=.01), surgery at L4 or L5 (OR 3,6; CI 1.6–8.5; p=.003), repeat surgery (OR 3.6; CI 1.8–7.5; p=.0005), and less decrease in back (OR 1.2; CI 1.2–1.4; $p < .0001$) and leg (OR 1.1; CI 1.0–1.1; p=.02) pain based on the numerical scale.

Discussion: Back pain is common two years after lumbar spine surgery with most patients having less improvement in pain then they expected preoperatively. Postoperative lumbar pain is a complex phenomenon due to an interrelated network of clinical, technical, and psychological variables. Surgeons should preoperatively ascertain patients' expected level of pain relief and particularly council those who expect complete improvement in pain.

Diagnostics

GO064. Verification of Nerve Decompression Using Mechanomyography

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Introduction: Assessment of nerve root decompression in surgery is largely based on visualization and tactile feedback. Often times, visualization can be limited, such as in minimally invasive surgery, and tactile feedback is a subjective assessment that makes the evaluation of successful nerve decompression difficult. Electromyography (EMG) has been proposed as an assessment tool but EMG responses are often difficult to quantify. Alternatively, mechanomyography (MMG) provides a quantifiable response with minimal signal to noise ratio compared with EMG. MMG provides a sensitive tool to accurately quantify mechanical responses to motor action potentials generated by electrical stimulus, allowing more reliable assessment of nerve decompression. The objective of this study was to assess the ability of mechanomyography to quantitatively demonstrate successful nerve root decompression.

Materials and Methods Seventy-two (72) nerves roots in 46 patients undergoing lumbar decompression procedures were examined using MMG. Nerves were stimulated upstream from the compression site and the lowest threshold current needed to generate a muscle response was determined. Signal response sizes were recorded before and after decompression. Visual-analog scale (VAS) scores were collected pre and post-operatively.

Results: Ninety percent (90%) of patients (65/72) had elevated stimulation thresholds (>1mA) prior to decompression. After decompression, 98% of patients (64/65) with

elevated current thresholds exhibited a drop in threshold of ≥ 1mA ($p < 0.001$). A post-decompression increase in response amplitude was recorded in all patients. VAS scores improved post-decompression (6.8 versus 1.1, $p < 0.001$) with a positive correlation between decreased stimulation thresholds and improved VAS scores ($p < 0.001$).

Conclusion: MMG is an effective tool that can be used to differentiate normal and compressed nerves by quantifying the mechanomyographic response to a stimulating current. MMG allows one to measure the effect of decompression, judge its effectiveness in real time, and eliminate the subjectivity seen in tactile feedback methods. When the adequacy of decompression is uncertain, MMG can guide the surgeon toward additional or alternative procedures to ensure complete nerve root decompression.

GO065. Morphometric Analysis of Pedicle and Lateral Mass of C1 Vertebra in Indian population using 3D Reconstructed Computerized Tomographic Images, with Comparative Analysis of the Feasibility and Safety of two Proposed C1 Pedicle Screw Trajectories in Relation to Vertebral Artery and Internal Carotid Artery

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Introduction: Lateral mass screw fixation has been considered the gold standard in the instrumentation of C1 vertebra since its introduction by Goel and Laheri. The morphometry of pedicle and pedicle screw fixation in C1 vertebra is poorly illustrated in literature. Further biomechanical studies have proved better pullout strength in C1 pedicle screws compared with C1 lateral mass screws. Here we analyze the morphometry of C1 pedicle and lateral mass in Indian population, with comparison of two proposed pedicle screw trajectories.

Materials and Methods 3D CT reconstructed images of C1 vertebra of 100 adult Indian population(50 male and 50 female) were analyzed for 22 parameters(200 pedicles, 4400 measurements). The anatomic parameters include pedicle height(PH), pedicle sagittal angle(PSA), lateral mass height, length, width(LH,LL,LW). Two pedicle screw trajectories, straight(S) and medially angulated(M) were defined and comparative analysis were done using following parameters, entry point midline distance(SEMD,MEMD), axial length(SAL, MAL), pedicle length(SPL,MPL), distance from vertebral foramen(SVD,MVD), angle of freedom from vertebral foramen for screw trajectory(SVAF,MVAF), pedicle screw trajectory width (SPW,MPW), medially angulated pedicle screw transverse angle(PTA), shortest distance from internal carotid artery (ICA) to screw exit point in anterior cortex(SID,MID), angle of freedom from ICA for screw trajectory(SIAF,MIAF).

Results: All 22 parameters were analyzed using SPSS software with mean PH 3.4, PSA 19°, LH 11.3, LL 15.2, LW 13.1, SEMD 18.7, MEMD 21.7, SAL 24.9, MAL 25.4, SPL 9.6, MPL 6.6, SVD 3.3, MVD 4.1,SVAF 12.1°, MVAF 24.5°, SPW 6.6, MPW 8.3, PTA 22.3°, SID 5.8, MID 9.9, SIAF 5.2° and MIAF 20.3°(all linear measurements in mm). PW, PSA, LH, LL, LW, SEMD, MEMD, SAL, MAL, MVD, MVAF, MPW and SID were significantly dependant on sex. There was a statistically significant difference in values of measured parameters between both trajectory S and M. All parameters except MPL are quantitatively greater in trajectory M than S.

Conclusion: Out of 200 pedicles studied the PH of only 89 are ≥ 3.5mm, and 154 are ≥ 3mm. So ¾ of Indian C1 pedicles can accommodate only a 3mm screw. A preoperative CT analysis is necessary in all patients to evaluate the feasibility of C1 pedicle screw and for neurovascular safety. A medially angulated C1 pedicle screw with more lateral entry point is more accommodative and safer in respect to ICA and vertebral artery than the straight screw. Also a bicortical screw purchase is safer in a medially angulated screw than a straight screw, which is comparatively at a higher risk of injuring ICA. Still biomechanical studies have to be done comparing both screw trajectories.

GO066. Significant Alerts in Intraoperative Neurophysiologic Monitoring during Severe Spinal Deformity Surgeries- A Categorical Description Experience in Tertiary Care Referral Center from the Subcontinent

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Introduction: Intraoperative Neurophysiological monitoring (IONM) has become a standard of care in spinal deformity surgeries to minimize the incidence of new onset neurological deficit. It has largely averted the use of historic intraoperative wake-up test. The risk of new neurologic deficit, in such cases, is high and frequency of significant alerts in neuro-monitoring can distress the surgeon so it is essential for the surgeon to know about the various categories of alerts and their management.

Study Design: Retrospective review of all spinal deformity surgeries performed with IONM in an Indian hospital over a period from 2011–2015.

Material and Methods: All except two patients were subjected to IONM by transcranial electrical motor evolked potentials (TCeMEP) during the spinal deformity surgery. These two patients were monitored with SSEP. Patients were included in the study only if complete demographic data, operative reports and neuromonitoring data and postoperative neurological data were available for review. A significant IONM alert during MEP monitoring was defined as 80% or more decrement in the MEP amplitude, or Increase in threshold of 100 V or more from baseline. During SSEP monitoring, significant alert was defined as 50% or greater decrease from baseline in the amplitude or latency prolongation by 10% or more. A full neurologic recovery was defined as a return to baseline for all MEP and SSEP signals. The systemic and surgical causes of IONM alerts and the postoperative neurological status were recorded.

Results: Total 43 patients underwent the surgery for severe spinal deformities with neuromonitoring. The average age was 13.2 years (6–38), and male:female ratio was 11:32. Diagnoses included idiopathic scoliosis (26), congenital scoliosis (6), congenital kyphosis (5), congenital kyphoscoliosis (2), post-infectious kyphosis (3), and post-traumatic kyphosis (1). The average kyphosis was 84; (45–136); the average scoliosis was 89; (62–128). There were total 21 IONM alerts in 16 patients (37%). The most common causes were Hypotension (5), drug induced (4), distraction (4), deformity correction (3), SPO/Ponte/PSO osteotomies (2), Tachycardia (2) and Screw placement (1). Reversal of the inciting cause resulted in complete reversal of the alert in 90% of the times. Two patients wake up with neurodeficit (Screw placement and deformity correction) which recovered over few weeks. One patient showed persistent alerts but wake up without any deficit.

Conclusion: IONM alerts are frequent during severe spinal deformity surgery. In our study more than 50% of the alerts were associated with anesthetic management (hypotension, drugs and tachycardia). So in case of significant alert, surgeon should not get stressed out but to analyze whether the cause is systemic and the first step is to maintain the mean blood pressure. However, the most common cause of

persistent IONM alert were screw malposition and deformity correction. Careful surgical technique supported by IONM and their interpretation can reduce neurologic mishaps.

GO067. Movement along the Spine Induced by Transcranial Electrical Stimulation (TES) Related to the Montage of Electrodes

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Introduction: Transcranial Electrical Stimulates Motor Evoked Potentials (TES-MEP) is a safe technique for neuromonitoring during spinal surgery. However induced movement can cause injuries and delay surgical procedures. When TES movements are evoked by other than monitored muscles, one may expect that adjustments in stimulation paradigms and electrode montages may minimize movement while preserving quality of monitoring. In this study, TES evoked seismic evoked responses (SER) are studied at different electrodes montage during spinal deformity surgery.

Materials and Methods: In 12 patients undergoing corrective spine surgery, intra-operative TES-MEP was performed. Accelero transducers recorded SER in two directions at 4 different locations of the spine for TES-electrode montages groups Cz-Fz and C3-C4. A resulting acceleration value, SERr, was computed. A paired *t*-test was used to compare the means of SER and the relationship between movement and TES electrode montages.

Results: SER's are the strongest in the upper body. All mean SER's values of the Cz-Fz group are up to 5 times larger when compared with the C3–4 group. However, there are no differences between the C3-C4 and Cz-Fz groups in the lower body locations. Both electrode montage groups show gradual decreasing steps of all mean SER values along the spine from cranial to caudal. For the upper body locations there were no significant correlations of SERr between both montages, whereas in contrast, a significant correlation of SERr exists at the lumbar region.

*Conclusion***s:** At supramaximum levels, movements resulting from multipulse TES is likely caused by relative strong contractions from muscles in the neck resulting from extracranial direct stimulation. When interchanging electrode montages in individual cases, the movement in the neck may become reduced. At lumbar levels transcranial evoked muscle contractions dominate movement in the surgical exposed areas likely dominated by local muscles.

GO068. The Relationship between Increased Signal Intensity on t2-weighted Magnetic Resonance Imaging and the Entropy of Gait Analysis in Cervical Spondylotic Myelopathy

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Objective: To determine relationships between increased signal intensity (ISI) on T2-weighted cervical spine magnetic resonance imaging (MRI) and parameters of gait analysis in patients with cervical spondylotic myelopathy (CSM).

Methods and Materials: Patients were evaluated by using the Nurick scale, cervical spine MRI, and gait analysis. The signals of 3-axis accelerometer was collected during the gait analysis, and then the entropy of frequency (EF)and amplitude (EA) of vertical axis was measured The increased signal intensity on the spinal cord was determined by two neurosurgeons.

Results: 7 CSM patients with ISI on the spinal cord and 2 CSM patients without ISI were included. In addition, 7 health subjects were recruited as the control group.Relative to patients without ISI and the control group, those with ISI showed significantly higher EAs of vertical axis signal ($p < .05$), but not EFs. Moreover, postoperative EAs significantly decreased compared with preoperative EAs. The Nurick scales significantly correlated with EA.

*Conclusion***s:** The gait analysis showed that EAs of vertical axis were significantly higher in CSM patients with ISI and in preoperative gait analysis of those patients. EA of vertical axis also correlated well with the Nurick grades . EA of vertical axis in gait analysis may be a useful tool for evaluating gait functions in cervical myelopathy.

GO069. Less False Negative in Neuromonitoring Lumbar Screws

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Introduction: IOM is a standard care in cases of scoliosis.. there is more controversial their use in mubar pathology.. there are 5% lessions of nerve roots. There is a debate about the stimilation thresholds, to evaluate possibilities of medial positioning pedicular screws. The objetive of this paper is Evaluation of the effect of chronic compression of the lumbar roots in relation to thresholds direct stimulation.

Material and Methods: Study Design:• prospective case series with measurement and threshold register direct stimulation of lumbar roots.• 80 patients (43 women and 199 nerve roots) consecutive undergoing spinal surgery in a period of six months (January to October 2014), 7 surgeons and one neurophysiologist.• Average age: 52.87 (SD = 14.9)• 199 were stimulated nerve roots formDirect recording their stimulation threshold.

Results: Stimulating a nerve roots 199 average 2.82 per patient (SD = 1• 52 (26.1%) were considered preoperatively chronically compressed. No differences were found in thresholds stimulation of different lumbar levels (e.g., L2, L3, L4, L5 and S1) or chronically compressed roots or non-compressed (ANOVA, $p > 0.05$; $p = 0.190$). Average maximum stimulation intensity 6.34 mA (SD = 7.2). Nerve roots uncompressed presented a average intensity threshold stimulation 4.33 mA (SD = 3.6) chronically compressed nerve roots. They had an average intensity thresholdstimulation of 11.93 mA (SD = 10.9). This difference was statistically significant (TStudent, $p < 0.0001$). No association was found between age and theaverage intensity of stimulus or between roots chronically compressed or non-compressed.

Conclusion: If you are using direct stimulation path of the pedicle and / or to confirm the screw indemnity pedicle, we bear in mind theexistence of symptoms of nerve root compression previously. As shown in this study, these variables determine a threshold stimulation intensity greater root to confirm the proper positioning screw. We could generate false negative results, and thus to detect a possible improper positioning intrapedicular screw.

Trauma Cervical 2

GO070. Ilio-sacral Stabilization of Sacral Jumper's Fractures using the AO-Spine Fracture System: A Novel Surgical Technique

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Introduction: Jumper's fractures are severe dissociation injuries of the spinopelvic junction. These U-shaped fractures are due to an axial trauma. The treatment of these fractures associated with neurological complications includes emergency decompression combined with reduction and stabilization of the fracture-dislocation. Usually, stabilization from L4 or L5 to the ilium combined with decompression of the spinal canal is advocated, thus fusing one or two additional healthy lumbar motion segments. We report on three patients with jumper's fractures, in whom we successfully performed a posterior decompression and open stabilization from S1 to the ilium, therefore sparing the motion segments L4/S1.

Material and Methods: 3 patients (40, 45 and 49 years old) had been admitted to the emergency room after they attempted suicide and jumped from a greater height. All three had a jumper's fracture with fragments into the sacral canal and epidural hematoma. Indication for emergency decompression was present. In prone position a midline incision was performed and decompression of the sacral canal was achieved. After decompression bilateral long monoaxial USS II screws were placed into the ilium. Schanz' screws from the USS fracture system were then introduced bilaterally in S1. The rods were rigidly mounted to the monoaxial ilium-screws. Fracture reduction and stabilization was performed under fluoroscopic control with the same maneuver as used for reduction of lumbar burst fractures. Fracture reduction and healing was examined with postoperative CT scan and controlled after 3 and 9 month.

Results: Bony healing was achieved in all three patients. In all 3 cases implant removal was performed after bony healing was proved as seen in computed tomography. At 1 year follow-up, neurological exam was normal in 2 patients. 1 patient still had persistent incomplete bladder and bowel function disorders. All patients were able to walk without assistance.

Conclusion: Ilio-sacral stabilization seems to be a reliable way of achieving reduction and bony healing in jumper's fractures. The reduction manoeuver is the same as described by Magerl and later on by Dick for lumbar burst fractures. As the lumbosacral motion segments (L4/5 and L5/S1) remain untouched, this technique offers the advantage of sparing important motion segments of the lumbar spine, thus being less invasive than the usually advocated techniques. However, this technique only is possible, if the segment L5/S1 is intact.

GO071. Development of a Universal Disease-Specific Outcome Instrument for Spine Trauma Patients – The AOSpine Patient Reported Outcome Spine Trauma (AOSpine PROST)

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Introduction: In the absence of an outcome instrument specifically designed and validated for traumatic spinal column injury patients, it is difficult to measure the effect size of various treatment options in a variety of traumatic spinal column injuries. In reflection of this dilemma, the AOSpine Knowledge Forum Trauma initiated a project to develop and validate universal disease-specific outcome instruments for adult spine trauma patients that include both the patients' and clinicians' perspective. The International Classification of Functioning, Disability and Health (ICF) is used as the basis for the patient reported part of this outcome instrument, named AOSpine Patient Reported Outcome Spine Trauma (AOSpine PROST).

Material and Methods: Based on the results of 4 preparatory studies and a consensus conference using the ICF methodology, 25 ICF categories were selected as core categories for patient reported outcome measurement in adult traumatic spinal column injury patients. The response scale for use agreed on was the Numeric Rating Scale 0–100, with 0 indicating no function at all and 100 indicating the pre-injury level of function. These results formed the basis for the development of the AOSpine PROST. The first draft of the Dutch version was pilot tested among a consecutively selected representative sample of 25 traumatic spinal column injury patients from a level-1 trauma center in the Netherlands. The 'think aloud' and 'probing' methods were used to evaluate the comprehensibility, relevance, acceptability, feasibility, and completeness of the AOSpine PROST. Subsequently, this draft version was cross-culturally translated and adapted into English according to established guidelines. This process consisted of multiple stages, including forward-translations, synthesis, back-translations, and an expert committee meeting to reach consensus on any discrepancies and to develop a final English version of AOSpine PROST.

Results: Out of the 25 core ICF categories, 9 related to *body functions*, 14 related to *activities and participation*, and 2 related to *environmental factors*. Implementing those 25 core categories into the selected response scale resulted in a draft version of AOSpine PROST, consisting of the following 19 items: household activities, work/study, recreation and leisure, social life, walking, travel, changing posture, maintaining posture, lifting and carrying, personal care, urinating, bowel movement, sexual function, emotional function, energy level, sleep, stiffness, loss of strength, and pain. Very satisfactory results were obtained from the pilot study, and only some minor adaptions were needed. Statistical analysis showed a high level of internal consistency (Cronbach's $\alpha = 0.926$).

Conclusion: Using the ICF methodology and based on the results of 4 different preparatory studies and a consensus conference, a disease-specific patient reported outcome instrument for traumatic spinal column injury patients has been developed. Very good results were obtained from a pilot study, and currently the Dutch and English versions of AOSpine PROST are being subjected to further validation in an international multicenter study. Ultimately, the AOSpine PROST will be a helpful tool to compare various treatments and improve the quality of health care.

GO072. Surgical Outcomes after Traumatic Spinal Injury in Patients with Ankylosing Spondylitis - A Review of Ireland's National Spinal Unit

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Introduction: Patients with ankylosing spondylitis have a significantly increased risk of spinal injury when compared with the general population. Due to the pathogenesis of this condition, they are prone to spinal fractures even with low-energy mechanisms of injury. Since being

established, the National Spinal Unit has admitted a significant number of these patients with a wide range of spinal injuries for surgical management. In this study, we reviewed fractures in patients with ankylosing spondylitis to better define the mechanism of injury, associated neurological deficit, predisposing factors, management strategies, and clinical outcomes.

Material and Methods: Between January 2005 and September 2015, 28 patients with fractures were treated in the Unit. Imaging evaluation was obtained in all patients by using plain radiography, CT scan, and MRI. The ASIA Impairment Scale was used to evaluate the neurologic status of the patients. Management was based on the presence or absence of spinal instability. A retrospective chart review was performed to determine patient factors, mechanism of injury, pre-operative status, management, and post-operative course.

Results: Of 28 patients reviewed, 21 cervical fractures and 8 thoracic fractures were identified. 14 cases were caused by minor trauma. Post-traumatic neurological deficits demonstrated by ASIA assessment in 15 patients with neurological improvement seen in 8 of these cases.

Conclusion: Patients with ankylosing spondylitis are highly susceptible to spinal fracture and spinal cord injury even after only mild trauma. Initial CT or MR imaging of the whole spine is recommended even if the patient's symptoms are mild. The patient should also have early surgical stabilization to correct spinal deformity and avoid worsening of the patient's neurological status.

GO073. Outcomes of Lumbopelvic Fixation in the Treatment of Complex Sacral Fractures Using Minimally Invasive Surgical Techniques

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Introduction: Complex sacral fractures with vertical and anterior pelvic ring instability treated with traditional fixation methods are associated with high rates of failure and poor clinical outcomes. Supplemental lumbopelvic fixation (LPF) has been utilized for additional stability to help with fracture union. The purpose of this study was to determine if minimally invasive LPF provides reliable fracture stability and acceptable complication rates in complex sacral fractures.

Methods: Twenty-eight patients were retrospectively chosen from a pool of 105 at our level 1 trauma center (2008–2014) who had undergone LPF. Patients underwent posterior sacroiliac fixation, with or without anterior fixation, followed by minimally invasive LPF. Main outcomes were return to the operating room (OR) for instrumentation revision secondary to loss of correction or failure of fixation, return to the OR for treatment of infection, radiographic evaluation to assess for loss of reduction. ISS score, transfusion requirements, length of hospital stay, postoperative day at mobilization, and mortality were also evaluated.

Results: Three patients returned to the OR for infection (11%). One patient required revision surgery for instrumentation malposition and neurologic deficit (3.5%). No patients required return to the OR for revision due to failure of instrumentation or loss of correction. The average length of surgery was 3.9 hours and estimated blood loss was 192 mL. The average transfusion requirement was 2.2 units of packed red blood cells and the majority of patients were mobilized at postoperative day 4. There were no mortalities.

Conclusion: This is currently the largest series of high energy complex sacral fractures treated with minimally invasive LPF. The results demonstrate reliable maintenance of reduction with a low complication rate.

GO074. Non-contiguous Cervical Spine Injury in a 14-month old Child; Case Report and Review of the Literature

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Introduction: Cervical spine injuries in children are relatively rare. Pattern, severity and level of these injuries are age dependant. Most of the available literature differentiates between two age groups, younger and older than 8 years. The incidence of upper cervical injuries is higher among children younger than 8 years. Most of the available literature is retrospective analysis of databases or case reports.

Patients and Methods: a 14-month old child was presented to our emergency unit after involvement in a road-traffic accident. A stiff neck cervical collar was applied at the accident scene. The child was conscious, oriented. He had tendency to move the right upper and lower limb better than the left side. He had torticollis with the head rotated to the left side. Neurological examination revealed a left-sided hemiparesis. He had no other injuries. Under general anesthesia CT and MRI of the skull and the cervical spine were done. These investigations showed a fracture of the axis with a rotary subluxation of C1/2, cord edema at the level of C1 predominantly on the left side and a disco-ligamentous injury at the level of C3/4. Controlled closed reduction under image intensifier and Minerva cast was applied for 3 weeks, and then replaced with a modified Minerva-Hartmann orthosis for another 3 weeks. A review of the literature for patients below the age of 3 years with cervical spine injuries was done in a trial to define an algorithm to clear the cervical spine and to outline the management of this age group.

Results: The patient was followed for one year with normal MRI findings at 6 months and normal clinical findings at one year follow-up with complete improvement of the neurological deficits.

Conclusion: Clearance of the cervical spine after trauma in children below the age of 3 is challenging. Articulation and cooperation during clinical examination and imaging investigation is limited. Imaging should be done under general anesthesia. Immobilisation is also demanding and definitive immobilisation for conservative treatment is usually using custom-made orthoses. results of conservative treatment are excellent if closed reduction and immobilisation were achieved.

GO075. Surgical Protocol Based on Radiological Patterns in Osteoporotic Fractures (OPF) with Neurology

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Introduction: Neurological affection in OPF depicts dynamic instability in the fractured vertebral body. Surgical treatment favors posterior instrumentation in most reports, while hinting toward anterior decompression in selected cases. Guidelines for radiology-based selection of surgical protocol is lacking in literature. We propose a radiological classification and results of surgical treatment of OPFs.

Study: Prospective, clinical case series (Level 3).

Material and Methods: 50 consecutive patients (M: F 21:29, average age 69.8) were grouped into 5 radiological patterns. Average BMD was -2.7 (-1.8 to -3.4). Radiological assessment was X-rays, MRI and CT scan. 1. Burst Fracture

with retropulsion (23). 2. Tri-columnar instability (13). 3. Circumferential stenosis (9). 4. Intra-vertebral instability post vertebroplasty (2). 5. Unstable disc adjacent to OPF (2). 6. Progressive deformity (1). Average duration of fracture was 2.3 months (0.5 – 6) and neuro-deficit was 0.98months (0.25-3). Fracture distribution (53 OPF) was D5 (2), D7 (1), D10 (4), D11 (5), D12 (18), L1 (11), L2 (4), L3 (5), and L4 (3). Surgical Protocol was: Pattern 4: Only Posterior stabilization (PS); Pattern 2: PS and VP; Pattern 1: PS and Vertebroplasty (VP) in 17. Posterior decompression (PD) 6; Pattern 3: PS, PD, VP (9), Inter-body cage (4); Pattern 5: PS, TLIF; Pattern 6: PSO.

Result: Average follow-up was 2 years (2008–2014). 47 completed study. Average pre & post treatment and final kyphosis was 27.8 degrees (10- 62), 15.7 degrees and 20.9 (loss of correction 5.2) degrees. Average Pre & post procedure and 2 year VAS pain scores were 8.2, 3.5 and 5.2 respectively. The pre-op ASIA grades were B (4), C (13), D (27). Final ASIA grades were A (1), B (1), C (9), D (32), E (4). Fracture above fixation caused paraplegia in one patient that did not improve. Implant loosening was seen in 19 (40.42%) and 7 (12.76%) required revision. Proximal junctional kyphosis occurred in 2. Pattern 1–4, PS & VP provided stability and clinical improvement. PD was required in 10 (21.27%) only (Specific root decompression in 4). Inter-body cage was used in 6 (early part of series). Authors believe vertebroplasty restores anterior stability and cage should be carefully selected. Pattern 3 is seen with severe degenerative or inflammatory arthropathy. PD sufficed and anterior approach was never preferred. Pattern 5 has not been described in literature. In 2 cases, the disc adjacent to the fractured end plate herniated 3 months after the fracture pain had resolved. Authors hypothesize that impairment of nutrition and stability both contributed to herniation and is a complication of OPF. Pattern 6 was a progressive lumbar kyphosis due to L3 and L4 collapse leading to posterior element failure. Pattern 4 is persistent intravertebral instability after vertebroplasty. The posterior osteo-ligamentous complex remained normal. Neurological deficit occurred 6 weeks after vertebroplasty. In contrast Pattern 2 was a combination of Pattern 1 with posterior element injury.

Conclusion: Identifying radiological pattern helps understanding mechanism of injury and formulates a simplistic surgical protocol that alleviates pain and helps neurological recovery.

Deformity Cervical

GO076. The Pathoanatomy of Congenital Cervical Stenosis: The Triangle Model

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Introduction: Congenital cervical stenosis (CCS) describes a patient with a decreased spinal canal diameter at multiple levels of the cervical spine in the absence of degenerative changes. Despite recognition of CCS throughout the literature, the anatomical features that lead to this condition have not been established. Knowledge of the pathoanatomy behind CCS may lead to alterations in surgical technique for this patient population that may improve outcomes.

Methods: From 1,000 cervical MRIs between January 2000 to Dec 2014, CCS was identified in 68 patients using a strict definition of age less than 50 years with mid-sagittal canal diameters ($<$10 mm) at multiple sub-axial cervical levels (C3-C7). A total of 68 patients met the inclusion criteria for this group. Fourteen controls with normal SCDs ($>$14 mm) at all cervical levels were used for comparison. Anatomic measurements obtained at each level (C3-C7) included: coronal vertebral body, AP vertebral body, pedicle width, pedicle length, laminar length, AP lateral mass, posterior canal distance, lamina-pedicle angle and lamina-disc angle. Statistical significance was defined as $p < 0.01$.

Results: CCS patients demonstrated significantly different anatomical measurements when compared with controls. Significantly smaller lateral masses, lamina lengths, lamina-pedicle angles and larger lamina-disc angles were identified at levels C3-C7 in the CCS group ($p < 0.01$). These anatomic components form a right triangle that illustrates the cumulative narrowing effect on space for the spinal cord.

Conclusions: The pathoanatomy of CCS is associated with a decrease in the lamina-pedicle angle and an increase in the lamina-disc angle. These changes in the alignment of the bony posterior elements lead to decrease in lamina length and ultimately to a smaller cross sectional area for the spinal cord. The global changes in CCS are best illustrated by this triangle model and driven by the posterior elements of the cervical spine.

GO077. Prospective Multicenter Assessment of Early Complication Rates Associated with Adult Cervical Deformity (ACD) Surgery in 78 Patients

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Introduction: Although adult cervical deformity (ACD) can have profound impact, few reports have focused on the treatment of these patients. We present early complication rates associated with surgical treatment for ACD based on a prospective multicenter cohort.

Material and Methods: Prospective multicenter database of consecutive operative ACD patients was reviewed for early ($<$30 days from surgery) complications. Enrollment required at least one of the following: cervical kyphosis $>$ 10°, cervical scoliosis $>$ 10°, C2–7 SVA $>$ 4cm or chin-brown vertical angle $>$ 25°.

Results: 78 patients (59% women) underwent surgical treatment for ACD and had a mean age of 60.7 years and previous surgery in 52%. Surgical approaches included anterior-only (A, 14%), posterior-only (P, 49%), anterior-posterior (AP, 35%) and posterior-anterior-posterior (PAP, 3%). Mean numbers of fused anterior and posterior vertebral levels were 4.7 and 9.4, respectively. A total of 52 early complications (Figure) were reported, including 26 minor and 26 major

(Table) for an overall complication rate of 66.7%. 22 (28.2%) patients had at least one minor complication, and 19 (24.4%) had at least one major complication. Overall, 45 (57.7%) patients had at least one complication. The most common complications included dysphagia (11.5%), deep wound infection (6.4%), new C5 motor deficit (6.4%) and respiratory failure (5.1%). One mortality (1.3%) was reported. Overall early complication rates were significantly different based on approach: A (27.3%), P (68.4%) and AP/PAP (79.3%) ($p = 0.007$).

Conclusion: Among 78 patients treated for ACD and prospectively followed, a total of 52 early complications were reported (26 minor, 26 major). Overall, 45 (57.7%) patients had at least one complication and 24.4% of patients had at least one major complication. Significantly higher rates of complications were associated with combined and posterior-only approaches compared with anterior-only approaches. These findings may prove useful in treatment planning and patient counseling.

GO078. Six Different Vertebral Artery Configurations,in Three Subjects Commanding Different Approaches for C1-C2 Distraction and Fixation in Cases of CVJ Anomaly: A Case Series

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Introduction: There are various choices to fix up Atlanto-Axial dislocation (AAD) and Basilar invagination (BI), it may be Posterior only, Anterior only or Combined. Many surgeons refrain from "posterior only" approach of C1-C2 distraction (as described by Atul Goel and Lahiri) because of the fear of Vertebral artery (VA) injury and it's poorly understood course between C1, C2, and Occipital condyles. We describe details of preoperative work and subsequently adopted, customized surgical plans, as per VA configuration to distract & fix the C1-C2 joint to achieve reduction in AAD and BI without harming the Vertebral artery. This case series covers most of the variations of VA around C1-C2 for learning purpose. After seeing this work up, many surgeons may allay their anxieties and take up this single stage corrective measure to achieve correction of deformities in cases of AAD & BI. In the due course author will also explain different variations of Vertebral artery not only in different individuals, but also in same subject on either sides. We describe the adaptive surgical methods taken based on these data to avoid injury to VA, and still achieve a firm distraction and fixation at C1-C2 with this single stage. The technique can thus be extrapolated in various other cases of AAD and BI with hardly any exception.

Material and Methods: Three serial patients with an established diagnosis of Atlanto-axial dislocation and Basilar invagination are described. All three were evaluated with 3-D MPR CT with vertebral artery angiography (CTA-VA), and MRI at Cervico-medullary junction (MRI-CMJ). The VA in one subject was going through pedicle on one side and in another subject, it was going around the C1-C2 facet joint, while in another case it was entirely intra-spinal. The radiological evaluation was done in both pre and post operative period to describe anomalies of CVJ, different courses of VA and vectors thus used for potential instrumentation. Postoperative scans were used to see adequacy of fixation.

Results: There was a clear evidence of highly variable course in VA of all three subjects. There were different courses in right and left VAs as well, commanding different choices of instrumentation on both sides in a single individual. All patients achieved reduction of AAD & BI and there was no injury to the vascular structure in question. They all improved in clinical signs and symptoms in the due course.

Conclusion: Authors conclude that it's mandatory to subject all patients to CT angiography in an order to view the Vertebral artery course *wrt* C1-C2 facets, which is not only variable in different individuals but also, on both sides in same individual, hence even in a single patient we may need different instrumentation to achieve the same goal. The authors also conclude that instrumentation at C1-C2 without CTA-VA is not only dangerous but can be fatal as well, hence instrumentation done without the above mentioned study should be considered a mandatory practice in the safest interest of patients and to achieve optimum and customized instrumentation.

GO079. Berry's Ligament and the Inferior Thyroid Artery as Reliable Anatomical Landmarks For The Recurrent Laryngeal Nerve (RLN) - A Fresh Cadaveric Study Relevant to the Cervical Spine

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Introduction While most cadaveric studies of the Recurrent Laryngeal Nerve (RLN) have focused on course variations as a suitable guide for Right versus Left RLN, they have mostly been done on preserved (fixed) cadavers which renders the RLN immobile. Our aim was to perform anterior cervical exposures from C2 to T2/3 with particular attention to the course of the RLN on right and left sided exposures in fresh cadaveric specimens. In addition, we aimed to expose the entire course of the RLN. Finally, we wanted to show the position of the RLN in relation to the trachea-oesophageal groove, inferior thyroid artery and Berry's ligament.

Methods: Eight fresh cadavers had extensive layer by layer dissections performed by 2 surgeons (one of whom has extensive experience as an anatomy demonstrator and dissector). The RLNs were exposed in their entire length and relationship to different landmarks recorded. Photographs were taken at each stage of the exposure.

Results: In all specimens, we were able to demonstrate the entire course of both RLNs from origin to insertion. The RLNs were consistently associated with the inferior thyroid artery and Berry's ligament bilaterally with the RLNs passing at almost perpendicular to these structures.

Conclusion: The near horizontal direction of the Berry's Ligament in the cervical tissue planes exposed during anterior cervical exposures enables the surgeon to reliably identify the expected position of RLN at its medial end and hence avoid it prior to visual observation of the nerve on either side. We found that the most reliable anatomical landmark bilaterally for the RLN was the inferior thyroid artery and Berry's ligament both of which would be encountered in anterior surgical exposure prior to the nerve itself. We believe that this will help spinal surgeons refine their surgical technique to identify this nerve where necessary and thus reduce the incidence of iatrogenic injury.

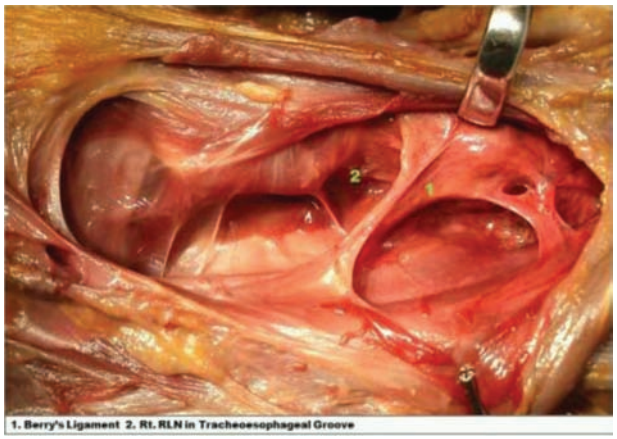

Figure 1

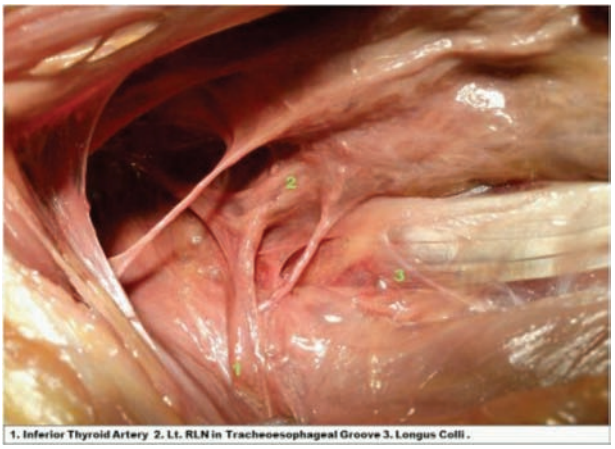

Figure 2

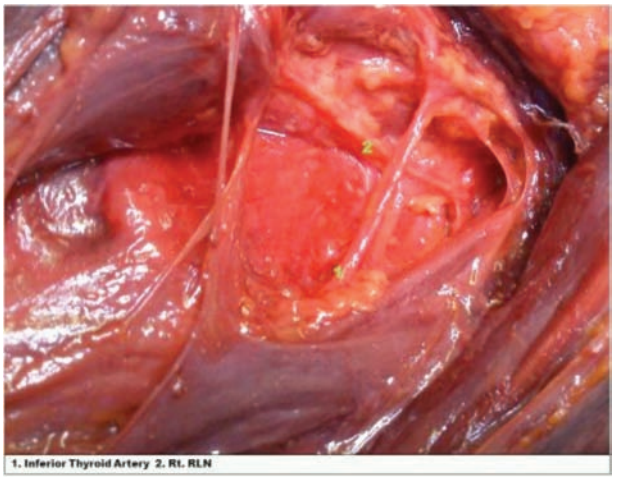

Figure 3

GO080. Distraction Arthrodesis of the Atlantoaxial Facet Joint with Preservation of the C2 Root for the Management of Intractable Occipital Neuralgia Caused by C2 Root Compression

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Introduction: Vertical collapse of the C1-C2 facet joint may cause narrowing of the C2 root foramen with root compression, resulting in severe occipital neuralgia. The purpose of this study was to evaluate the prospectively collected outcomes data of a distraction arthrodesis surgical group (Study group) in comparison to a Control group in a non-randomized design.

Material and Methods: The Study group underwent intraoperative skeletal traction, preservation of the C2 nerve roots, facet joint distraction and insertion of a bone block and cancellous bone into the joint along with posterior fusion, and segmental screw fixation using posterior C1 arch screws instead of lateral mass screws. The Control group had C2 root transection with C1-C2 segmental screw fixation and arthrodesis. Inclusion criteria for both groups were (1) occipital neuralgia caused by C2 root compression confirmed by clinical manifestation and imaging studies including radiographs, CT scan, and MRI, (2) intractable pain (VAS$\geq$7) unresponsive to nonoperative treatment, and (3) follow-up period $\geq$12 months. We compared the preoperative and postoperative 10-point VAS scores for occipital neuralgia and neck pain; NDI; and JOA scores and recovery rates.

Results: There were 15 patients in the Study group and 8 in the Control group. All had facet joint destruction and/or collapse caused by underlying disorders including rheumatoid

arthritis (Study group: 5 ; Control group: 3), rheumatoid arthritis with odontoid nonunion (2, 0), odontoid nonunion (3, 1), unifacet spondylosis (3, 2), os odontoideum (2, 1), and cerebral palsy (0, 1). There was no significant difference in age (61 ± 6, 62 ± 9), gender (4 and 3 men, respectively), and the number of cases with accompanying myelopathy (5, 2) between the 2 groups. The follow-up period averaged 21 ± 12 versus 33 ± 25 months, respectively. There was no significant difference in the VAS score for the preoperative occipital neuralgia (8.2 ± 0.9, 7.9 ± 0.6, $p = 0.39$). However, it was significantly lower in the Study group at 1, 3, 6, and 12 months postoperatively ($p = <0.01$, respectively). At 12 months, the VAS was 0.4 ± 0.6 versus 2.5 ± 2.6 ($p = 0.01$). In the Study group, all patients had little or no pain (VAS ≤ 2) while 2 patients (25%) in the Control group were still on medication (Gabapentin) with moderate to severe pain (VAS 4 and 8 respectively). There was no significant difference in preoperative and postoperative VAS scores for neck pain, NDI, and JOA scores and recovery rate, since these values are minimally influenced by occipital neuralgia.

Conclusion: Our results suggest that our novel technique of distraction arthrodesis can be an effective option for the management of intractable occipital neuralgia caused by C2 root compression. Prospective randomized studies are required for better evaluation.

GO081. Cervical-thoracic Spine Inclination (CTSI): Anatomy Peculiarities and Surgical Options

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Introduction: The bayonet congenital abnormality of cervical-thoracic spine was previously described as a rarest clinical case under the title "congenital upper spine spondylolisthesis " (Tokgozoglu AM et all., 1994) or "congenital dislocation of the cervical spine" (Shintaki M et all., 2013) without detailed description of anatomy and principles of surgical treatment. Our series include analysis of 10 CTSI cases from 4 clinics.

Material and Methods: Clinical, X-ray, CT and MRI peculiarities of 10 patients aged from 1 year 8 mns till 15 years were analyzed. The repeated cervical-thoracic abnormality included antero-posterior and cranial-caudad shift of the spine into the cervical spinal canal. All patients had arcs dysplasia, but any case has a complete posterior segmental defects, MMC or split spinal cord syndrome.

Results: According to Frankel scale the neurological status was estimated as a type E in one patient, type D – in 4, type C - in 4 and type B in one, incl. two paraparesis and 7 tetraparesis cases. Cranial spine was formed by 4 till 8 vertebrae (max – 6 vertebrae in 5 cases). Abnormality was accompanied by Sprengel disease in 2, by neurofibromatosis type I in one, by failure of segmentation (Klippel-Feil syndrome) in 5 and neural arc dysplasia in 10 cases. 9/10 patients were operated. The operations included circular decompression of spinal cord and posterior instrumentation; 8 operations were done from posterior approach only, 1 - from anterior and posterior approaches. Four procedures were done with Halocast fixation to produce pre-surgical local spinal stability. The post-op follow up floated from 7 month till 5 years. 6/9 patients demonstrated significant improvement in neurological sighs (one or more steps in Frankel scale) ; the neurological deterioration was occur in 2/9 cases, followed by a partial recovery in one and complete in another.

Conclusion: Our 10 cases series demonstrates a extremely rare type of the cervical-thoracic spinal abnormality. We the term "the cervical-thoracic spine inclination (CTSI)" because it reminiscent the cranial-vertebral pathology known as "the inclination of dens of C2 into foramen magnum." From our point of view ***the inclination*** is a combined type of pathology which included an anterior-posterior and cranial displacement of caudal spinal segment(s); this pathology typical for transitional spinal zones and looks like spinal segmental dysgenesis but differ due to the absence of circular spinal column defect despite the combination of different types of vertebral abnormalities. CTSI is a repeated spinal syndrome which has a high risk of neurological complications. The spinal cord decompression and instrumentation are mandatory for this abnormality; the surgery could be done from the posterior approach only.

Imaging 1

GO082. Dedicated Spine Measurement Software Quantifies Key Spino-Pelvic Parameters More Reliably Than Traditional PACS

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Introduction: Accurate radiographic measurement of sagittal alignment is essential for evaluating adult spinal deformity (ASD) and pre-operative planning. However, the limited capabilities of traditional picture archiving and communication systems (PACS) often necessitate rudimentary techniques and estimations of anatomic landmarks and angles. Though dedicated spine measurement software (SMS) has been studied and validated, there are no direct comparisons PACS to SMS.

Material and Methods: Eleven independent observers (7 surgeons, 4 researchers) with varying levels of experience digitally measured 20 primary and revision ASD patient radiographs for pelvic incidence (PI), pelvic tilt (PT), lumbar lordosis (LL), PI-LL mismatch, thoracic kyphosis (TK), and

sagittal vertical axis (SVA) in 2 rounds. Round 1 used basic line and angle tools in traditional PACS; Round 2 used the sagittal alignment tool in a validated software dedicated to spine measurement and operative planning. SMS automatically calculates spino-pelvic parameters from 6 user-identified anatomic landmarks, including outlines of femoral heads and vertebral endplates. Results were analyzed for means, standard deviations, coefficient of variation (CV), and intra-class correlation (ICC).

Results: Mean values for PACS measurements were significantly greater than SMS for PI, PT, PI-LL, and TK (all $P < 0.010$), though differences were within previously described margins of error. The standard deviations were also significantly larger for the PACS measurements in all parameters ($P < 0.012$ for all) except TK. Excluding TK, the variation in measurement was significantly greater for PACS (CV=14–34%) versus SMS (CV=11–23%). The ICC values for all parameters were greater than 0.64, and when PI was excluded, all were greater than 0.92. Inter-rater reliability was greater in SMS compared with PACS for nearly all measurements: PI, PT, PI-LL, LL, and SVA. For both SMS and PACS, the lowest ICC was observed in PI, and the highest ICC was seen in SVA. The parameters with the greatest differences in inter-rater reliability between PACS and SMS were PI (PACS ICC: 0.647 vs SMS ICC: 0.810) and PI-LL (PACS ICC: 0.921 vs SMS ICC: 0.970). TK had the most similar ICC values between PACS (0.955) and SMS (0.945), and was the only parameter for which the PACS ICC was greater than the SMS ICC. When only the surgeons' measurements were considered, the differences between PACS and SMS ICC were substantially greater. Among the surgeons, SMS had higher ICC than PACS for all parameters (ex. PI-LL: 0.957 vs 0.896). PI still had the lowest inter-rater reliability (PACS ICC: 0.505 vs SMS ICC: 0.752) and SVA had the highest (PACS ICC: 0.985 vs SMS ICC: 0.994).

Conclusion: SMS measurements provide significantly more accurate and reliable measurements with less variation than PACS. The greater reliability of SMS is amplified in surgeon-only analyses, demonstrating the clinical utility of SMS versus traditional PACS. Accurate interpretations of sagittal alignment are critical because poor measurements may lead to insufficient or overly aggressive operative plans, and thus undesirable clinical results. Consistent use of SMS in the clinical evaluation and operative planning of ASD patients would be advantageous given the significant differences in values, variance, and reliability between PACS and SMS.

GO083. Validity and Reliability of Spine Raster-stereography in Adolescent Idiopathic Scoliosis Patients

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Introduction: Previous studies have evaluated the validity and reliability of the Formetric-4D system. They concluded to a good accuracy compared with radiographs and a high intra- and inter-day reliability in healthy volunteer patients. However, to the best of our knowledge, the validity and reliability were not assessed on patients with Adolescent Idiopathic Scoliosis (AIS). Therefore, the aim of this study was to evaluate the validity and reliability of the Formetric 4D system on AIS adolescent patients with Cobb between 10¡ and 40¡ in terms of sagittal, frontal and transverse parameters.

Materials and Methods: This study included 35 AIS adolescents (male=13) aged 13.1 ± 2.0 years. To evaluate the validity of scoliosis angle (SA) provided by the Formetric-4D System, a comparison was performed with the Cobb Angle of major curve (CA) on a 2D EOS¨ radiography (XR). Mean differences of measurements computed by each system were evaluated using paired Student *t*-test and Pearson correlation coefficient. To evaluate interrater reliability three repeated-measurements were independently performed in a neutral orthostatic position using the Formetric-4D System by two operators the same day. To evaluate the intrarater reliability three more repeated-measurements were performed by the first operator one week later. The parameters measured were vertebra surface rotation, thoracic kyphosis, lumbar lordosis, pelvic obliquity, trunk length and the scoliosis angle. The data analyses used were Intraclasse Correlation Coefficients (ICC).

Results: The 2D radiographic Cobb Angle (CA) and its rasterstereographic equivalent Scoliosis Angle (SA) were strongly correlated (R = 0,70) with a non-significant difference. The ICC for intrarater (same day: ICC (1, 1), $n = 35$, one week later: ICC (1, 3), $n = 29$) as interrater reliability coefficients (ICC (3, 3), $n = 16$) were excellent (ICC > 0.75) for all variables except for pelvic obliquity with the highest for sagittal and rotation parameters and lowest for the pelvis obliquity.

Conclusion: This study showed that the Formetric 4D system allows evaluating AIS patients with a good validity and an overall excellent intra- and interrater reliability. Based on these results, this automatic, fast and non-invasive system will not replace XR clinical analysis but it can reduce the exposure to radiation for the patients and can improve the monitoring of scoliosis evolution with no limits of use, no risks for patients and at lower price than XR.

Keywords: rasterstereography, formetric 4D, intra and interrater reliability, adolescent idiopathic scoliosis

GO084. Anatomic Guideline for Approach to Lateral Thoraco-Lumbar Interbody Fusion

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Summary: The decision making process for incision location during the course of lateral thoraco-lumbar interbody fusion (LLIF) at 857 levels was evaluated retrospectively, in an attempt to develop a clinically robust anatomic guideline.

Introduction: The minimally invasive technique of LLIF has shown powerful segmental deformity correction, with excellent fusion rates and minimal morbidity. However, in certain settings, adequate lateral access to permit a proper working angle into the disc space may be difficult to achieve. The purpose of this investigation was to establish a clinically robust anatomic guideline for incision location, with respect to laterality and level.

Methods: The operative reports and plain films of the thoraco-lumbar spine of 512 consecutive patients undergoing LLIF at our institute between 2009 and 2011 by the mini-open transpsoas method were reviewed.

Results: Distribution of operative levels is depicted in Table 1.

Table 1

T9–10	1
T10–11	2
T11–12	3
T12-L1	8
L1–2	80
L2–3	214
L3–4	286
L4–5	262
L5-S1	1
Total	857

Level of approach:T11–12 and above: transthoracic approach.T12-L1: 10th intercostal space (retropleural/retroperitoneal approach).L1–2: 11th intercostal space (retropleural/retroperitoneal approach).L2–3: below 12th rib (retroperitoneal approach).L3–4: midway between costal margin and iliac crest (retroperitoneal approach).L4–5: above iliac crest (retroperitoneal approach).L5-S1: not recommended, even when accessible.

The primary determinant of laterality (side) of operative approach involving the L4–5 disk space was coronal angulation of the L4–5 disk space, as depicted on 15° up-tilt view. A secondary determinant of feasibility of accessing the L4–5 disk space is a line drawn through the center of the L4 vertebra, parallel to the inferior end plate of L4. Extension of this line cephalad to the ipsilateral iliac crest indicates that this level will be surgically accessible. In the absence of segmental coronal angulation, the symptomatic side was chosen. In the setting of regional scoliosis, the concavity was the preferred side of approach, as up to three levels can be reached through a single small incision. There were no instances of approach failure using the method outlined above.

Conclusion: A clinically robust and worthwhile anatomic guideline to LLIF, with respect to level and laterality of incision placement, is presented.

GO085. Measuring Cobb's Angle in Scoliosis: Can Smartphones Match Manual Methods and Software Based Analysis? A Three Way Crossover Study

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Introduction: Cobb's angle in scoliosis has been widely accepted to analyze the extent of deformities and can be used as an indicator of the degree of correction obtained following a corrective surgery. Measurement has traditionally been manual using a pencil and protractor on radiographs. Smartphones have changed the way we live in every field of life. Use of apps in smartphones with accelerometers aids to measure the angle quickly. This study analyzes the accuracy and efficiency of the inclinometer app in smartphones to measure cobb's angle in scoliosis.

Material and Methods: We analyzed cobb's angle in scoliotic patients who underwent robotic guided corrective surgery at our center over the past 2 years. The Cobb angle measure tool in the software used in robotic surgery (Renaissance, Mazor robotics) was used as the gold standard (GS) as it was software based analysis. Clinometer app was used in the smartphone by the primary observer over the computer screen to measure the cobb angle and then manual method was used. Time taken to measure using both the techniques was noted by other observers. Another two observers then independently measured the angle using their smartphones to assess the interobserver variability. Data was tabulated and analyzed by a biostatistician.

Results: Cobb angle of 25 patients with mean age of 14.1 years were analyzed for primary and secondary curves separately. The mean Cobb angle of all measured X-rays was 48.9 degrees in the manual set and 47.9 degrees in the smartphone set as compared with 48.2 degrees as per GS. The mean time consumed was 13.5 seconds for the smartphone set, significantly shorter than that of the manual set which was 36.2 seconds (statistically significant – $p < 0.05$). 95% confidence intervals for inter-observer variability using smartphones were $\pm$1.5degrees.

Conclusion: Cobb angle measurement using the smartphones was more accurate than the manual methods in our study. With significant time difference between the methods indicating the simplicity of the use of apps in our daily use and the minimal interobserver variability, smartphones indeed can replace the manual methods and can be a reliable tool in the hands of spinal deformity surgeons.

GO086. Case Series of First Trolley Gliding Vehicle Device used in Patients with Early Onset Scoliosis as a Growth Guiding System

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Introduction: Current surgical treatment modalities available for the treatment of early onset scoliosis, either spine based Duel Growing Rods, or rib based VEPTR construct, require repetitive lengthening surgeries with no apical control of the deformity. The overall results of these techniques have shown to provide some benefits. However they remain with a high rate of complications, in part related to frequent repetitive surgeries. A new gliding spinal anchor know as Trolley Gliding Vehicle (TGV) and a new surgical technique has been developed with the hope to address some of these short coming. Here we present this innovative device and the new surgical technique.

Material and Methods: Six patients with Early Onset Scoliosis were treated with TGV by a single surgeon at three institutions. The implant was made available via a special access program from Health Canada, as the implant is only available in Europe (CE mark). Patient perioperative data was collected for all patients. Any intra-operative or immediate post-operative complications were also documented.

Results: The average age of the patients was 8.3 years of age. The pre-operative diagnoses included congenital myopathy, congenital idiopathic scoliosis, Padder Willi syndrome, cerebral palsy, "cri du chat" syndrome, and idiopathic early onset scoliosis. The average age of the patients at time of surgery was 8.3 years of age (5–14 years old). The average follow-up was 6 months. The average pre-operative Cobb angle was 71.33 degrees with average correction at last follow up equal to 29.66 degrees. No intra-operative complications were noted. One patient required one revision surgery consisting of adding TGV for fluctuating bursa over distal fixation due to excessive motion.

Conclusion: We present early results of a new spinal gliding implant in six patients. The Trolley Gliding Vehicle showed good correction of spinal deformity with low short-term complications rate. Results cannot provide any long term conclusion. A prospective clinical study has been started in

Europe and will be undertake in Canada once Health Canada approves the implant.

GO087. Morphometric Study of Lumbar Vertebrae Pedicle through Tomographic Exams of Outpatients from a Brazilian University Hospital Center

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Introduction: The knowledge of the pedicle size in the lumbar vertebrae is important for safe and effective placement of screws in cases of instrumentation in this region. This importance is even more relevant when it is about fixing through a minimally invasive way. Most of the minimally invasive techniques for lumbar spine instrumentation is described recommending parameters for introduction of pedicle screws (25mm) based on measurement of the pedicle length in model populations (North American / European mostly). It is our purpose in this work to establish the morphometric parameters of the lumbar vertebrae pedicles in the Brazilian population, which has no such parameters well studied yet.

Material and Methods: Cross-sectional study of 100 adult patients (between 26 and 90 years old), 50 males and 50 females (all without trauma, tumor, inflammatory / infectious diseases or post-surgical condition) who underwent simple tomography of the lumbar spine from January to December 2012 at the Institute of Radiology of the Hospital of São Paulo in Brazil, 1000 pedicles of lumbar vertebrae were evaluated. And Literature Review conducted by PUBMED by Keyword: Lumbar Spine pedicles

Results: We describe for each lumbar level (L1 through L5) two measure: (Measurements made for both sides (left / right) of each pedicle): Measure A (length of the longitudinal axis of the pedicle base to the intersection of 90 ° with the imaginary line that goes from the anterior border of the spinal foramen) / Measure B (length of the longest longitudinal axis of the pedicle, the base to the junction with the anterior cortex of the vertebral body, line tangential to the spinal foramen and without crossing the midline). Measurements were obtained by electronic measurement system in iSITE Radiology in the axial plane of the major axis of each pedicle on CT scans without contrast cut standard 0.5mm Based on this assessment, we noticed that the average measure (to measure A) of the pedicles in the studied population was 17,12mm to L1, L2 to 16,22mm, 15,40mm to L3, 14,83mm to L4, L5 to 14,64mm

Conclusion: Thus the measure advocated for introduction of pedicle screws in minimally invasive techniques is appropriate for this population

Novel Technologies 2

GO088. PEEK Rods for Posterior Lumbar Fixation: Pros and Cons: The First French Series

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Introduction: The ideal lumbar spine fixation system should provide sufficient stability while preserving natural posturing and spinal alignment with limited risk of adjacent level degeneration. While rigid fixation systems may contribute to stress shielding in anterior column increasing consecutively adjacent segment degeneration, Polyetherethrketone (PEEK) Rods provide a modulus of elasticity close to cancellous bone that may decrease these risks. Biomechanical studies comparing rigid fixation using titanium Rods with PEEK Rods posterior systems have shown a comparable intervertebral stability with the two systems nevertheless PEEK was associated with a lower risk of screw mobilization in poor bone, an increased anterior physiological load and a reduced stress on bone-screw interface that may predict lower risk of adjacent level degeneration. We performed a retrospective study in a french cohort of patients who underwent posterior lumbar fixation using PEEK Rods to investigate clinical indications and clinical outcomes in real life settings.

Material and Methods: Between June 2011 and July 2014, 48 patients who underwent posterior lumbar fixation using PEEK Rods were included in our study for retrospective review. Surgery was performed using 5,5mm pre-bent PEEK Rods with Titanium monoaxial screws for 1 to 4 level posterior lumbar fixation with a maximum length of 160 mm. Clinical outcomes were assessed using Oswestry Disability Index (ODI), reoperation rate, complications, radiographs and MRI. The patients satisfaction was also evaluated using the Patient Satisfaction Index (PSI).

Results: The population included 28 males and 20 females with an average age of 61 years. The main indication for surgery was spinal decompression with stabilization (44,6%). A majority of patients (29/60,4%) presented surgical antecedents including recurrent disc herniation, posterior decompression, posterior fusion with instrumentation and stabilization with interspinous devices. Patients underwent surgery on one (18/37,5%) or multiple levels (30/62,5%). Patients had surgery with anterior cages for fusion (PLIF), posterior dynamic fixation or hybrid systems combining fusion and non-fusion. The most frequent surgeries were performed on L4L5S1 as hybrid systems. At 2 years follow-up, the mean ODI score was improved by 29% (from 67% to 38%) and the mean PSI was 1,8 on a scale ranging from 1 to 4 (1: completely satisfied . 4: same or worse condition than before surgery). There was no reoperation for 89,7% patients, no migration for 94,7%, no screw breakage for 84,2% (never for one single level fixation) and no rod breakage. We reported 15% patients with post-operative adjacent level degeneration. For 21% patients with pre-operative signs, the degeneration was no more observed on the last MRI evaluation after 2 years.

Conclusion: PEEK Rods provide a safe and effective system that can be either used as a fusion system promoting anterior fusion with decreased risk of implant failure, as dynamic system protecting adjacent levels, or as hybrid system combining both advantages, with a stability comparable to Titanium rods. Further studies on larger populations and longer term follow-up are needed to confirm these data.

GO089. Informed Consent for Lumbar Fusion Aided by Tablet-PC: A Prospective, Randomized, Controlled, and Blinded Comparison

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Introduction: With increasing work load and medico-legal obligations for documentation, an increased efficiency of recurrent tasks, like the informed consent of a surgical patient, is essential. The better the preoperative knowledge about the procedure, the higher the satisfaction will be. The complexity of today's surgical procedures is continuously increasing. These procedures are therefore difficult to explain to the patient during the informed consent process. Tablet-PCs are a widespread medium, which make it possible to present multimedia content at the point-of-care. So these devices are ideal for aiding the explanation of complex procedures. The aim of this study was to investigate, whether an informed

consent aided by a multimedia app on the tablet-PC could increase the process efficiency and if this app was able to influence the patients' satisfaction in spinal surgery.

Material and Methods: We conducted a prospective, randomized, blinded pilot trial. Elective spine surgery patients, which were scheduled for either mono- or bisegmental TPLIF surgery, were randomized to one of the two groups "TABLET" (study group) or "PAPER" (control group). Patients in the control group received a standard informed consent process based on a conventional premanufactured paper form (Thieme compliance, Thieme GmbH, Stuttgart) and an individual interview with a spinal surgeon. In the TABLET group, a special multimedia informed consent app (iSpine Operations; AnatomateApps, Australia), was additionally demonstrated to the patients. This included a computer animation of goals and technique of the TLIF procedure as well as information on therapeutic alternatives and possible complications. The further consent process was identical to that of the control group (paper form and interview). The interviewing surgeon was blinded to the group allocation, to prevent an intentional influence on the interview duration. Primary endpoint was the duration of the interview (min). Secondary endpoints were the number of questions, which remained after the interview, patients' satisfaction with the informed consent process in total and with the interview itself.

Results: We could include 40 Patients (23 female, 17 male) with an average age of 62 (27–79) years in this study. The median duration of the interview was 18 minutes (IQR 13–22 minute). The difference between the groups was statistically significant: TABLET 15 (11–20) minutes, PAPER 20 (14–25) minutes, $p = 0{,}041$ (Mann-Whitney-U). Patient satisfaction with the informed consent process in total was high (VAS: 9,75/10) and was nearly identical in both groups PAPER (VAS: 9,75/10) and TABLET (9,75/10; $p = 0{,}9$). The satisfaction with the doctor's interview itself was 9.5/10 in the PAPER group and 10/10 in the TABLET group ($p = 0{,}74$). The mean number of remaining questions was 3.1 in the PAPER group and 1.4 in the TABLET group ($p = 0{,}16$).

Conclusion: These data show, that by the aid of a special animated app the efficiency of the informed consent process for mono- and bisegmental TPLIF surgery can be enhanced, even if the interviewing surgeon is blinded to the use of this aid.

GO090. A Novel Quantitative Automated Measurement of CSF Area for the Diagnosis of Lumbar Spinal Stenosis

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Introduction: A grading system for LSS is needed to allow precise communication between clinicians and for assessment of treatment responses. At present, there are two categories of grading systems- qualitative and quantitative. However, there are always individual subjectivity of radiologists in those qualitative classifications systems. The quantitative classifications systems are time-consuming and not relevant to clinical symptoms even with the same values for DSCSA or DSAPD. Herein, we propose a novel quantitative automated method to measure the cross-section area of the CSF. This study is to introduce this novel quantitative automated method, evaluate its reliability, and compare it to other two semiquantitative CSF-based classification systems.

Methods: All lumbar MRI studies were selected at random. Each study included T1/T2-weighted axial and sagittal images taken between April 2012 and July 2013. Two practicing neurosurgeons with spine specialty participated in this study and did the reviews of the grading for each disc level. Each of two neurosurgeons independently measured DSCSA (dural sac cross-sectional area, mm2) on T2-weighted axial images manually. The final DSCSA were the average of two results at each disc level of the lumbar spine. They also graded each disc level according to the qualitative grading system- the Lee's and Schizas' grading systems. The final grading of each disc level of the lumbar spine was determined by the most consistent grade out of the four results obtained from the two trials of two neurosurgeons. CSF area of each disc level (ACSFA) was calculated automatedly by the algorithm we developed. For each disc level, linear regressions were performed between DSCSA and ACSFA, and ACSFA was categorized based on the final grading of Lee's and Schizas' grades.

Results: Seventeen female and six male patients were studied (mean age, 65.21 $\pm$ 12.1years). The inter-reader reliability of Lee's and Schiza's grading systems were "moderate" and "good" (o.437 and 0.739), respectively. ACSFA was correlated well with DSCSA linearly (r=.8988,p,.001)(Fig. 1). Using one-way ANOVA, ACSFA was able to differentiate each grade of Lee's or Schizas' systems ($p < .0001$ and $p < .0001$) (Fig. 2 & 3).

Conclusion: This novel automated quantitative measurement of CSF area can provide at least the some diagnostic value for the diagnosis of LSS, and, at the same time, it avoids the variability of the quantitative system between readers and overcomes the disadvantages of the present qualitative system (DSCSA). This method can serve as a useful diagnostic tool for the clinicians.

GO091. Treatment of Osteoporotic Vertebral Fractures with Elastoplasty: 1-year Results

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Introduction: Vertebral compression fractures (VCF) are an increasing problem. Common surgical treatments are vertebroplasty and kyphoplasty. Both are mainly performed with PMMA bone cement. Recently a new elastomer (VK100) was developed as optional material for kyphoplasty instead of PMMA. This study investigated the outcome and safety of balloon kyphoplasty performed with the VK100 Vertebral Augmentation System over a follow-up period of 12 months.

Material and Methods: The study includes patients with osteoporotic fractures of one or two vertebrae. All patients were treated with balloon kyphoplasty using VK100 (Bonwrx, Lansing, Michigan, USA) instead of PMMA. VK100 is a radio opaque, bone adherent, non-exotermic elastomer, which is less stiff as PMMA and therefore more comparable to the natural bone. VAS and ODI of all patients was measured preoperative, postoperative, at 12 months. Additional cement leakage and additional fractures were documented.

Results: 82 patients were included in the study (age: 63.69 $\pm$ 7.54). VAS improved significantly from preoperative 82.9 $\pm$ 10 mm to postoperative 18.3 $\pm$ 10.2 mm ($p = 0.0015$) and improved significantly from postoperative to 8.92 $\pm$ 11.5 mm at the 12 months follow up ($p = 0.0163$). ODI improved significantly from preoperative 72.92 $\pm$ 14.6% to postoperative 47.08 $\pm$ 16.35% ($p = 0.0015$) and from postoperative to 20.15 $\pm$ 7.56 at 12 months ($p = 0.0022$). There were no complications due to leakage. Patients showed no additional fractures within the follow up period.

Conclusion: VK100 showed good results in terms of VAS and ODI improvement and occurrence of adverse events.

VK100 is an alternative to PMMA bone cement augmentation. Further studies are needed for longer implantation years.

GO092. Development and Implantation of an Individualized 3D Printed Titanium Cage for Cervical Fusion

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Introduction: At present, all available cervical fusion cages have standardized sizes and mimic the anatomy of the intervertebral disc space more or less. Usually, the patient's anatomy is adapted during the surgery to the cage. Our idea was to respect the individual patient's anatomical situation and manufacture an individual cage with a perfect fitting accuracy. The production of individualized cages might be the next step for further improvement of spinal implants due to their perfect fit and improved load bearing surface.

Material and Methods: The computer-assisted planning, manufacturing, and implantation of the individualized cervical cage was performed in close co-operation with 3D-Systems Corporation, Rock Hill, SC 29730, USA and EIT Emerging Implant Technologies GmbH, Tuttlingen, Germany. A 3D model of the patient´s cervical spine obtained from CT data was rendered. This model is the basis for the exact simulation of the operation. The newly developed 3D planning algorithms and special reconstruction software implemented in a high-end image-processing computer allow a virtual surgical procedure. The correction of degenerative deformities by repositioning of vertebrae and also the virtual resection of osteophytes is possible. The cage implantation can be simulated to check the accuracy of fit. These data are the basis for the production of the cage. This custom-made cage is manufactured of trabecular titanium by selective laser melting (3D printing procedure).

Results: The pilot project of the first implantation of an individualized cervical cage ever resulted in a high accuracy of fit of the implant. During surgery the cage 'found' its correct position after suspending disctraction due to its unique endplate design. Furthermore, it was impossible to move the cage in any direction. Thus, it can be assumed that the individualized cervical implant provides excellent primary fitting accuracy and stability.

Conclusion: Preconditions for the manufacturing of individualized cervical fusion cages using specific patient data are given. The implantation is uncomplicated. The improved load-bearing surface will lower the rate of implant dislocation and subsidence. The next essential steps will be to improve the workflow of the surgical simulation and shorten the time of the overall production process. The manufacturing of individualized cages at a reasonable price has to be figured out by spine surgeons and the industry.

GO093. Magnetically Controlled Growing Rods for the Management of Early-onset Scoliosis: Results and Complications at 3-year Follow-up

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Introduction: A new method for the management of early-onset scoliosis (EOS) has been recently introduced: it consists of a magnetically controlled growing rod (MCGR) that allows gradual outpatient distractions under control of an external remote device. We present a series of 14 patients with EOS managed with MCGR (Ellipse TM MAGEC System, Irvine, CA).

Material and Methods: We implanted MCGR in 14 patients affected by EOS with various etiology. Scoliosis and kyphosis angles, T1-T12 and T1-S1 length were evaluated preoperatively, postoperatively, and at the last follow-up. A visual analogue scale score was used to evaluate pain during outpatient rod distraction procedures. The mean follow-up is 34 months. All patients attended distractions of the magnetic rod through an external remote control every 3 months. The mean predicted distraction was 3 mm at each lengthening session.

Results: The mean Cobb angle value was 64.7 $\pm$ 17.4 degrees (range, 45 to 100 degrees) preoperatively and 28.5 $\pm$ 13.9 degrees (range, 15 to 59 degrees) at the latest follow-up. The mean T1-S1 length value was 27.1 $\pm$ 5.4 cm (range, 16 to 34.8 cm) preoperatively and 32.8 $\pm$ 4 cm (range, 26.5 to 39 cm) at the latest follow-up. The mean T1-T12 length value was 16.2 $\pm$ 2.7 cm (range, 10 to 19 cm) preoperatively and 20.6 $\pm$ 2.9 cm (range, 15.5 to 23.5 cm) at the latest follow-up. The average monthly T1-T12 height increase was 0.8 mm, whereas the average monthly T1-S1 increase was 0.9 mm. Two patients experienced a rod breakage and 1 patient had a pull-out of the apical hooks. In cases of rod breakage, the magnetic rod was removed and replaced. In case of pull-out, apical pedicle screws have been positioned in substitution of hooks.

Conclusion: Although implant-related complications could occur, as in all EOS growing rods procedures, MCGR can be effectively used in patients with EOS. This spinal instrumentation can overcome many of the complications related with the traditional growing rods implants. In our experience, rod breakage occurred only in patients with a single magnetic rod instrumentation. First case was a patient with a severe thoracic kyphosis. In effect, the management of kyphosis with the MCRG is quite challenging. Moreover, a marked kyphosis was also the cause of pull-out of the apical hooks. Instead, in the second case of rod breakage, we reported a failure of the internal magnet of the rod. In conclusion, this procedure can be effectively used in outpatient settings, minimizing surgical scarring, surgical site infection, and psychological distress due to multiple surgeries needed in the traditional growing rods system, improving quality of life, and saving health care costs.

Imaging 2

GO094. Indications for Use of Dynamic Four-dimensional Computed Tomography in Diagnosing Instability in Spinal Cervical Conditions

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Introduction: Cervical spinal instability is a pathological consequence of a variety of spine disorders such as trauma, malignancy and degenerative conditions. If left undiagnosed, cervical spinal instability can lead to compressive cervical myelopathy and devastating consequences such as quadriplegia and death. Although dynamic cervical X-ray is traditionally used to detect cervical instability, it provides only two static views and there is no gold standard in diagnosing such condition. Dynamic four-dimensional computed tomography (4DCT) is a non-invasive method that provides functional assessment of cervical motion in high resolution, throughout

the entire range of motion. It has been previously shown to be clinically useful in assessing instability and impingement evaluation of the shoulder and finger joint. This is the first early case series utilizing dynamic 4DCT to assess cervical instability in various spinal pathologies.

Material and Methods: Six elderly patients who presented with neck pain and suspected instability in cervical spine from a major Australian academic hospital were included. In addition to routine imaging modalities, dynamic 4DCT of cervical spine was performed using a 320 × 0.5mm detector multislice-CT (Aquilion One, Toshiba Medical Systems, Japan) with consent. With gantry rotation speed of 275 milliseconds, scans were conducted without table motion with patients in the lateral-decubitus position, capturing approximately seven volume datasets per second. Patients were instructed to continuously move their necks between flexion and extension. Cine movie files were generated from the volume datasets.

Results: The mean age of the cohort was 69 years old. There was equal male:female ratio. All patients presented with neck pain. Two presented acutely after trauma: one with suspected ligamentous instability at C1/C2; the second presented after recurrent falls with suspected fracture of odontoid process. Four patients had neck pain of more than 6 months at presentation: one had severe rheumatoid arthritis with suspected C1/C2 instability; three patients had cervical spondylotic changes, with one having had a previous anterior cervical discectomy and fusion(ACDF). Before employing 4DCT, MRI and static CT of occipito-cervical regions were performed in five patients; dynamic X-ray of cervical spine at flexion and extension were performed in four patients. Interpretation of the imaging finding in all cases by neuroradiologist and neurosurgeon was found to be equivocal for stability. Dynamic 4DCT confidently ruled in or ruled out cervical spinal instability in all cases: one case was confirmed to have instability; five cases were confirmed to be stable. The one unstable case with severe cervical spondylosis was demonstrated on 4DCT to have instability at C3/C4 level and incomplete fusion from previous ACDF at C5/C6 level and a cervical stabilization procedure was offered. The remaining stable cases included all the trauma cases with a case of os odontoideum diagnosed on 4DCT. Conservative management was prescribed confidently

Conclusion: Dynamic 4DCT can be used to detect and confirm subtle cervical spinal instability (or lack thereof) with relative ease in various cervical spinal pathologies such as rheumatoid arthritis, cervical spondylosis, os odontoideum and trauma. We propose that dynamic 4DCT has an important role in detecting cervical spinal stability and further studies using this technique are warranted.

GO095. Pendulum Rule versus Spinopelvic Parameters How the Explain the Sagittal Shape of the Spine?

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Introduction: Usually, the analysis of the spinal sagittal shape is based on a vertebral semantic, focusing on the curves (lordosis, kyphosis) and the spinopelvic parameters (pelvic incidence, sacral slope, pelvic tilt, sagittal balance). This analysis failed in defining a normal shaped spine, and in relating strictly the incidence to the lordosis. The author proposes a very different analysis of the sagittal spinal shape, named " the Pendulum Law." It enables to define an ideal biomechanical shaped spine and classify the sagittal shape precisely.

Material and Methods: 300 sagittal shapes have been studied. A vertical analysis (according to gravity) is performed, reintegrating the spine into an analysis of the muscular body's scheme and relating it to the respiration. The biomechanical spine is assimilated to three intricated Mongol bows. Different apex (contact between the vertebral body and the plumb line) are defined. They are related to muscular tension lines or attaches. The lungs apex are paramount to explain the spine. The trunk is always swaying but lungs pressure (when breathing in) stabilizes it either in an anteroposterior plan or in the sagittal plane. The repartition of the apex has been assessed in all the spine drawing specific lines.

Results: More than 95% of the studied spine abide by the "Pendulum law" which states that: " whatever the spine is (including the common variation or abnormalities), the standing position consists in placing the Superior Lung apex according to the following rules: In the anteroposterior view: the plumb line equidistant from the lung apex is maintained above the sacral apex. In the sagittal view: the plumb line from the superior lung apex is equidistant of the thoracic apex and the lumbar apex. The two Pelvico-thoracic lines (the line linking the sacrum apex to the antero-inferior lung apex and the line linking the center of the femoral head to the postero-inferior lung apex) cross each other in the point "E," exactly above the plumb line dropping from the superior lung apex and in front of the lumbar apex. Therefore, the Pendulum Law relates the sagittal shape to the gravity, the muscular body's scheme and the breathing. An ideal biomechanical sagittal shape lines up the thoracic apex and the sacral apex vertically. The alignment of the symphysis, the lumbar apex and the thoracic apex cross the vertebral bodies obliquely and harmoniously. The lumbar apex (in front of the upper plate of L4) is placed above the center of the femoral head.

Conclusion: The Pendulum Law relates the sagittal shape to gravity, the muscular body's scheme and respiration. Most of the commons Abnormalities are integrated according to this rule. The Pendulum is the "vertical tension" of the body's scheme that enables us to move harmoniously. (As the length of the femur is strictly related to the ideal flexion/extension of the Knee). Lordosis is related to pneumatic stabilization of the trunk and *definitively not to the pelvic incidence.*

GO096. An imaging Study of Partiallythreaded Screw Fixation of C2 Pedicle Fracture

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Introduction: The purpose of this study was to observe the imaging features of partiallythreaded screw fixation using in various kinds of C2 pedicel fracture.

Material and Methods: CT image materials of 160 Chinese Han patients who suffered from atlantoaxial injury without vertebral body and pedicle fracture of C2 was included in this study,including 120 males and 40 females.Pedical trajectory selected according to Ebraheim method in three dimensional CT reconstruction was analyzed in ADW 4.4 workstation.The posterior wall fracture of C2 vertebral body,isthmus fracture and fractures under C2 laminar were simulated according to clinical observation.The trajectory length(partially threaded screw length)from entry point to anterior cortical bone of C2,bolt shank length from entry point to fracture line simulated and fillet of screw length from fracture line to anterior cortical bone of C2 were measured. Relations between height gender and partiallythreaded screw length bolt shank and fillet of screw length was evaluated.

Results: Male height was 167.0 ± 7.9cm on average and female was 156.0 ± 6.6 cm.The length of partiallythreaded screw was 29 mm in male and 25 mm in female on average. Height and gender was positively correlated with partiallythreaded screw length.In posterior wall fracture of C2 vertebral body,length of bolt shank was an average of 17 mm in male and 15mm in female,while fillet of screw length was 12 mm in male and 10 mm in female.The mean length of bolt shank was 14mm in male and l 3 mm in female.while mean fillet of screw length was 15 mm in male and 12 mm in female in isthmus fracture.In fractures under C2 laminar,length of bolt shank was 10 mm in male and 9 mm in female on average. while mean fillet of screw length was 18 mm in male and 15mm in female.

*Conclusion:*The length of partiallythreaded screw used in posterior axial pedicle fracture may have a close correlation to length and height.The length of bolt shank and fillet of screw was different aecording to the position of the fracture.

GO097. Image of Slack Spinal Cord

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Introduction: In general, the spinal cord was constricted at the level of spinal canal stenosis. Rarely, spinal cord curved above the level of stenosis like the slack rope. There was no report about this image we called slack spinal cord.

Material and Methods: Slack spinal cord was shown in 7 patients. The average age was 70 years old. Multiple spinal canal stenosis were shown at the junction of thoracolumbar spine. The level of the most cranial stenosis was L1/2; 4 patients and Th12/L1; 3 patient. 5 patients of them presented a symptom of lumbar spinal canal stenosis. 2 patients presented myelopathy.

Results: Laminectomy was performed for them. Slack spinal cord was improved after operation. The reasons of slack spinal cord were considered as moving the spinal cord to the cranial side or compressed by redundant spinal nerve roots. The denticulate ligaments are fibrous spinal structures that are generally believed to stabilize the spinal cord within the vertebral canal. In anatomical study, the structures of these ligaments were different in the spinal level. At the lower thoracic level, the denticulate ligament is thin and long band. Furthermore, the strength of this ligament is decreased at the lower spinal levels. Considering these anatomical characteristics and slack spinal cord is shown commonly at the caudal site of spinal cord, we guess the conus medullaris move to cranial side like redundant nerve root.

Conclusion: Slack spinal cord is rarely observed as the secondary change with spinal canal stenosis.

GO098. Validity of CT Scan Measurements of Thoracic and Lumbar Pedicle Dimensions

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Introduction: The transverse and sagittal inner and outer pedicle diameter of thoracic and lumbar vertebrae were measured with an electronic caliper and with CT scan. To determine the validity of CT scan measurements, comparing with those taken by an electronic caliper.

Material and Methods: A total of 12 anatomic skeletal specimens were acquired from T1 to L5 in the mean age of 69.6 years. Each vertebral pedicle was measured with an electronic caliper and CT scan. A total of 1632 measurements of 408 pedicles were taken. The data were collected and analyzed using the *t*-test. The comparison of the measurements between left and right pedicle, males and females, as well as between electronic caliper and CT scan was evaluated.

Results: The sagittal diameter of the pedicle was always bigger than 7mm. In the mid-thoracic area (T3-T8), the transverse outer diameter could be less than 4mm, so there is need of use of pediatric screws (<4mm). In the opposite, caudally of T11, the transverse outer diameter was at least 7mm.

Conclusion: Significant statistically difference was found between the two genders, while pedicles from male spines were bigger. Additionally, the CT scan was proved to be precise and valid for the measurement of the transverse outer diameter of the pedicle. For this reason, this method becomes valuable for the preoperative evaluation of the pedicle dimension, especially in scoliosis surgery, helping the surgeon to choose the appropriate size of the screws.

GO099. Interspinous Motion Assessment in Anterior Cervical Discectomy and Fusion: Anterior Plate versus Zero Profile Implant

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Introduction: Anterior cervical discectomy and fusion's (ACDF) reported pseudarthrosis rate rises up to 20% for single-level and 50% for multi-level procedures. Interspinous motion based on functional cervical spine X-rays analysis has been proposed as tool for assessing spine fusion. Previous studies comparing this assessment with direct intra operative visualization during ACDF revision surgery in patients treated with an anterior plate report that an interspinous motion of less than 1 mm correlates with complete fusion. To our knowledge, there is no literature regarding this assessment in patients undergoing an ACDF using zero profile implants. The purpose of this study is to compare interspinous motion in patients treated with an ACDF using zero profile implants to those operated with an anterior plate, after complete spinal fusion confirmation with a computed tomography (CT).

Material and Methods: Cross-sectional study of 22 patients with a CT-confirmed spinal fusion after ACDF. Twelve patients (16 levels) were treated with an anterior plate, while a zero profile implant was used in the remaining ten patients (17 levels). Interspinous motion at the instrumented levels was evaluated in functional cervical spine X-rays for both groups, stratified by fused level (Student's *t*-test, ANOVA, Stata 12). Motion values were obtained independently by a radiologist and an orthopedic surgeon, following Song's guidelines (Song et al. J Bone Joint Surg Am 2014;96:557–63).

Results: Patients treated with an anterior plate had an interspinous motion of less than 1 mm, while those patients in which a zero profile implant was used presented a statistically significant greater motion at the fused level ($p = 0.0082$). The instrumented level did not affect interspinous motion ($p > 0.05$).

Conclusion: Patients treated with an anterior plate had an interspinous motion of less than 1 mm, while those patients in which a zero profile implant was used presented a statistically significant greater motion at the fused level

($p = 0.0082$). The instrumented level did not affect interspinous motion ($p > 0.05$).

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GO100. Chronic Painful Osteoporotic Vertebral Compression Fractures (OVCFs) of Thoracolumbar Spine: Percutaneous Vertebroplasty versus Conservative Management among Egyptian Patients

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Introduction: Vertebral augmentation procedures are widely used today in treating Osteoporotic vertebral compression fractures (OVCFs) especially in acute and subacute fractures. However, percutaneous vertebroplasty for patients with chronic painful OVCFs has been less well studied. The purpose of this study is to compare the efficacy and safety of percutaneous vertebroplasty with conservative management for the treatment of chronic painful OVCFs in the thoracolumbar spine among Egyptian patients.

Patients and Methods: This prospective cohort study included 60 patients with chronic OVCFs (38 females, 22 males, mean age: 65.42 ± 8.63) who presented with severe back pain to the outpatient clinic during the period from October 2005 to December 2011. Twenty-eight patients were treated with percutaneous vertebroplasty (vertebroplasty group). Thirty two patients refused surgical treatment and constituted the control group (Conservative group). The inclusion criteria included: Chronic painful OVCFs (at least 3 months), at least 50 years old, T5 to L5, osteoporosis (T-score -2.5 or lower), Visual Analogue Scale (VAS) at least 5, and absence of neurological deficits. At presentation, all patients of both groups received back brace, analgesics, anti-osteoporosis therapy. All patients were evaluated with X-rays and CT scan, where Cobb angle and the anteroposterior height comparison (APHC) were measured. Overall pain and quality of life were assessed with the Visual Analogue Scale (VAS) and Oswestry Disability Index (ODI).

Results: All patients were followed for at least 12 months (range, 12 to 28). Statistical analysis of the demographic data of the two groups could not reveal any significant differences. At latest follow up, there was significant improvement in Cobb angle and APHC in vertebroplasty group compared with conservative group ($p < 0.05$). Twenty nine patients (90.63%) showed complete union in the conservative group while all patients (100%) showed complete union in the vertebroplasty group at latest follow up. VAS and ODI were significantly better in vertebroplasty group than conservative group ($p < 0.05$) at latest follow up. Cement extravasation into the disc occurred in 2 patients (5.41%), and into the paravertebral tissue in 3 (8.11%); none was associated with neurological symptoms, cement embolism, or infection. Recent fracture occurred adjacent to the formerly cemented ones in 2 patients (7.14%) and in non-adjacent level in one (3.57%). In conservative group, 3 patients (9.37%) presented with new osteoporotic vertebral fractures in adjacent levels and 2 (6.25%) in non adjacent levels. Three patients (9.37%) showed non union.

Conclusion: Percutaneous vertebroplasty is safe and effective in treatment of symptomatic chronic osteoporotic vertebral compression fractures with significantly better clinical and radiological outcomes when compared with conservative management.

GO101. Does Level of Response to SI Joint Block Predict Response to SI Joint Fusion?

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Introduction: The threshold percent pain relief required to diagnose sacroiliac joint (SIJ) dysfunction during a diagnostic SIJ block (SIJB) is not known. Although there is no gold standard, one reference standard is response to definitive treatment.

Methods: Subgroup analysis of 320 subjects in two prospective trials of SIJ fusion: INSITE (NCT01681004) a randomized trial versus nonsurgical management (NSM) and SIFI (NCT01640353), a singlearm study. All participants were diagnosed with SIJ dysfunction via history (buttocks/leg pain and a positive Fortin finger test), at least 3 positive provocative physical examination signs, and a standardized diagnostic SIJB using fluoroscopically guided injection of local anesthetics in the target joint with a reduction of at least 50% in pain at 30 or 60 minutes after SIJB. The degree of improvement in VAS SIJ pain and Oswestry Disability Index (ODI) scores, expressed as absolute or percentage improvement from baseline, was correlated with the average acute improvement in SIJ pain during the SIJB, calculated as per Cohen et al.

Results: The average pain reduction during the first hour after SIJB was 79.3%. Pain reduction during block was unrelated to standard demographic predictors. Six months after SIJ fusion, the mean VAS SIJ pain reduction was 50.9 (28.6) points and the mean ODI reduction was 24.6 (20.5) points. SIJ pain and ODI reductions at 12 months in the SIJ fusion group were 50.8 (29.2) and 25.8 (20.5) points, respectively. There was little correlation in 6 or 12month improvements in SIJ pain or ODI with average reduction in pain during SIJB. In the SIJF group, the proportion of subjects achieving meaningful reductions in SIJ pain and ODI scores did not vary by average response during SIJB ($p = 0.8407$ and 0.3069, respectively for 6 month changes, and $p = 0.6368$ and 0.5913). Similarly, response during SIJB did not predict the proportion of patients with followup pain scores < 30 or ODI < 20.

*Conclusion***s.** In this study of > 300 patients with carefully diagnosed with SIJ dysfunction, the degree of improvement in acute pain during an SIJB did not predict 6month improvements in VAS SIJ pain or ODI score. Based on our study, a 50% acute pain reduction threshold during SIJB was resulted in excellent postsurgical results. The use of overly stringent selection criteria for determining which patients should undergo SIJF may serve to withhold a beneficial procedure from a substantial number of patients with SIJ dysfunction.

GO102. Treatment of Thoracolumbar Osteoporotic Vertebral Compression Fractures with Vertebral Body Stenting: A Prospective Study

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Introduction: Balloon kyphoplasty is a procedure to stabilize osteoporotic and/or cancer related VCFs. However, there is a technique inherent problem with the amount of reduction; when filling the balloons, an acceptable reduction is achieved . However, the resulting final reduction after

cementing is ~25% lower due to the partial collapse after balloons deflation. To avoid loss of reduction, a newer technique has been introduced, based on the principles of balloon kyphoplasty and vascular stenting.

Methods: A prospective cohort study of clinical and radiographic results after vertebral body stenting(VBS) for treatment of vertebral compression fractures(VCFs). To evaluate effectiveness of VBS as a new technique to treat symptomatic VCFs. A total of 33 patients with 52 symptomatic VCFs were enrolled in a prospective study of VBS. Clinical outcomes were measured pre- and postoperatively using the visual analogue scale (VAS), Oswestry Disability Index (ODI) and ambulatory status (AS). All outcomes were assessed before the procedure, and at 1, 12, 24, and 36 weeks after the procedure .

Results: The median VAS scores went from 10.0 preoperatively to 1.0 at last follow-up. The pre-operative ODI score was 80 preoperatively, improved to 18 at last follow up. The ability to move independently and ease of ambulation significantly improved after the procedure (P 0.001). The median kyphosis angle was 15.0 degrees preoperatively and decreased by a median of 4.5 degrees postoperatively .

Conclusions: Patients with symptomatic VCFs had significant improvements in back pain, function, and quality of life following VBS. The results of percutaneous vertebral body stenting in osteoporotic fractures may encourage surgeons in future to widen the indications and use these techniques to successfully restore anterior column in traumatic non-osteoporotic fractures in conjunction with posterior instrumentation.

GO103. Combined Endovascular and Surgical Treatment of Spinal Dural Arteriovenous Fistulas

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Introduction: Type I spinal dural arteriovenous fistulas (SDAVFs) are the most common form of spinal vascular malformations. Even so, they are rare and still underdiagnosed. They are low-flow vascular shunts fed by radicular arteries in patients who most often present with myelopathy. Left untreated, they can lead to progressive neurological decline and considerate morbidity. We present our experiences and results in combined endovascular and surgical treatment of such lesions.

Material and Methods: We conducted a retrospective review of data from 14 adult patients with the diagnosis of SDAVFs who underwent treatment at University Hospital Center Rebro Zagreb between January 2012 and June 2014. We compared complication rates, recurrence rates and data on clinical and imaging follow up in these patients.

Results: 12 out of 14 patients underwent endovascular embolization (Onyx was used in 1 patients and NBCA in 11 patients) as the first line therapy. Two patients underwent surgical ligation as initial therapeutic modality. Patients in both groups showed significant improvement in clinical status after treatment (using the Aminoff-Logue Scale score). One patient in endovascular group developed spinal infarction due to accidental embolization of posterior spinal artery. Six patients in embolization group had recurrence of fistula during the course of follow up requiring surgical ligation. Two patients in surgical group had recurrence of fistula during the course of follow- up and were reoperated.

Conclusion: Despite most fistulas are amenable to endovascular embolization, microsurgical obliteration is the treatment of choice in specific anatomic situations and usually the only solution in recurrent cases. A combined approach offers the best results after careful selection of patients based on imaging.

GO104. "Capac Ñan" Stairway Fashion Hemilaminectomy: A New Minimally Invasive Multilevel Option to Treatment of Cervical Stenosis. A Study with 24 Months of Follow-Up

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Introduction: There are many options to decompress the cervical spine on posterior way in multilevel disease, however the muscular injury and instrumentation is a big problem in traditional surgery, the minimally invasive procedures can achieve optimal decompression without muscle injury, preserving the posterior ligamentous tension band with less pain, bleeding and hospitalization, providing improvement in short time.

Materials And Methods: We present an study with 15 patients with symptoms of multilevel cervical stenosis and MRI shows multilevel stenosis too, All the patients underwent minimally invasive uniportal multilevel decompression. We use VAS, Neck Disability index and Nurick clinical scale with follow up of 24 months. We made POP early (2 weeks) MRI and dynamics rx.

Results: The Vas preop was mean 9 and 2 on 24 monts. Neck Disability index was 20 preop and 10 POP 24 months. The Nurick clinical scale shows improvement of one time line. The surgical time was mean 22 minute(mean) each level, blood lose 11cc (mean) each level, hospital discharge on 23 hours after surgery and return to daily activities mean 10 days.

*Conclusion***s:** The "Capac Ñan" starway fashion minimally invasive hemilaminectomy procedure can be safe and efective to decompress a cervical spinal cord on multilevel disease without instability, muscular injury and let a better time to recovery and return to daily activities. We need more experience to make a final conclusions.

GO105. Vertebroplasty Injections Using High Viscosity Cement: a Cadaveric Study

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Introduction: Vertebral compression fracture (VCF) is a unique type of fractures involving the body of vertebrae. It is associated with a significant decline in functionality and poor quality of life. Osteoporosis, or decreased bone density, is one of the leading causes of VCF. It is commonly seen amongst elderly, especially in post-menopausal women. Vertebroplasty (VP) is a minimally invasive percutaneous technique that involves injecting cement into a pathologic vertebral body, with the aim of pain relief and deformity correction. It is considered the best next line of management when conservative management fails to control symptoms. Although considered minimally invasive, VP has ~1 to 5% risk of clinically evident complications. Where, cement extravasation is the

most commonly reported in the literature. Cement viscosity is considered the single most important predictor of the risk of extravasation. Unfortunately, injecting high viscosity cement is difficult to utilize in real practice. We invented a new device capable of injecting high viscosity with ease and at a distance to avoid radiation. The aim of this study is to confirm the efficacy and safety of the new device on cadaveric vertebrae.

Materials and Methods For this prospective case-control cohort study, 126 osteoporotic vertebral bodies were harvested form 14 fresh whole human cadavers. DEXA scan and simple X-rays were performed on all specimens to confirm the diagnosis of osteoporosis, and to rule out any pre-existing fractures. A total of 80 vertebral were included in the study. Computer-randomization software was used to allocate specimens over two main groups, Conventional VP and New Device. Both groups were further subdivided into two subgroups, High-Viscosity and Low-Viscosity. A custom device was used on each vertebra to induce a compression fracture. All augmentations were done following the same method commonly practiced in clinical treatment. X-ray radiographs were used to measure and compare cement distribution within the body between groups.

Results: Injecting high viscosity cement was associated with a lower leakage volume compared with low viscosity cement, with a mean of 0.06cc for the Conventional VP and 0.08cc with the New Device. High viscosity cement was associated with no leakage into the spinal canal. It was also associated with a low incidence of vascular extravasation ($p < 0.001$). The mean volume of cement leakage in the low viscosity group was 0.23cc and 0.15cc, for the Conventional VP and New Device respectively. In both groups, the most common site for leakage was the vertebral end plate, which was exhibited more in the low viscosity group (71.5%) compared with the high viscosity group (42.5%). The preset target amount of cement to be injected was reached in 99% of the time when injecting high viscosity cement with the New Device, compared with 62% using the Conventional VP. In both groups, there was no correlation between the amount of cement injected and the amount of leakage.

Conclusion: The new device is capable of injecting high viscosity cement easily, with a lower incidence of cement leakage. It also minimized the risk of radiation exposure to the surgeon.

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GO106. Double Blind Placebo-controlled Trial of Percutaneous Vertebroplasty (VOPE)

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Introduction: Osteoporotic vertebral compression fractures (VCF) affect ~20% of postmenopausal women and can lead to long-term disability. Since two double-blind RCTs in 2009, there has been a debate, whether Percutaneous Vertebroplasty (PVP) has any beneficial effects in treating acute osteoporotic VCFs. The two studies have been criticized in order of design and possible bias in results. PVP is a minimally invasive procedure, primarily used in patients with severe pain after VCF. Our objective was to investigate the clinical effects of PVP compared with a SHAM procedure when treating acute osteoporotic VCFs, with intense focus on VAS-activity and the first 3 months postoperative.

Material and Methods: Study Design - Double-blind randomized controlled trial. 52 patients were included in the study, and they were randomized to either PVP or SHAM, at the Center for Spine Surgery and Research, Middelfart Hospital. During the trial period 4 patients were excluded due to need for further spine surgery, and 2 patients excluded due to malignancy in peroperative biopsy. During the trial patients, investigators collecting data, and the statisticians were blinded.

Results: 46 patients were eligible for statistical analysis, 22 patients in the PVP group and 24 patients in the SHAM group. In both groups the VAS-scores, and health related Quality of life scores (SF-36; PCS-score and Eq. 5D-scores) improved significantly from baseline values ($p < 0.05$). There was a statistical significant higher VAS-score in the SHAM-group throughout the trial period ($p = 0.001$), with the main contribution from the VAS-activity.

Conclusion: Our study shows a statistical significant higher VAS-score in the SHAM group during the trial period, both groups improved significantly in all clinical parameters. Focus in the future of PVP and acute OVCFs must be on the 3 months convalescence period and the cost benefit analysis of early mobilization.

GO107. Results of Ballon Kyphoplasty in Osteoporotic Fractures with Posterior Wall Injury

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Introduction: Cement augmentation techniques are standard treatment for cases of osteoporotic vertebral fractures. Compared with vertebroplasty, kyphoplasty is associated with decreased rates of cement leak. Cases with posterior wall fractures are relative contraindications for both techniques. The aim of this study was to evaluate the results of balloon kyphoplasty in cases of osteoporotic fractures with posterior wall involvement

Patients and Methods: Forty-eight patients with osteoporotic fractures with injury of the posterior vertebral wall were included. Fractures between T4 and L5 were included. Cases with posterior ligamentous complex injury were excluded. Preoperative evaluation included plain X-rays, CT, MRI, and laboratory diagnosis of osteoporosis. All cases were operated upon with balloon kyphoplasty. Bilateral (bipedicular) approach was used in all cases. Injected cement volume and incidence of cement leak were evaluated. The minimum follow-up period was 6 months.

Results: 18 males and 30 females were operated upon. The average age was 72.4 years. The most common affected vertebra was T12 in 19 patients. The average volume of injected cement was 6.2 ml. Posterior cement leak (in spinal canal) occurred in 2 cases and was asymptomatic. There were no neurologic or embolic complications.

Conclusion: Balloon kyphoplasty is safe in cases of osteoporotic fractures with posterior wall fractures. Type A3 and A4 fractures (according to AO classification) were not associated with increased incidence of cement leak in spinal canal. The volume of injected cement should not exceed the volume injected to inflate the ballon.

GO108. Influence of PMMA Screw Augmentation on the Primary Stability of an Anterolateral Plating System in Osteoporotic Vertebrae

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Introduction: Expandable anterolateral plates facilitate the reduction of posttraumatic deformities of thoracolumbar spine injuries and are commonly used in cases of unstable injuries or compromised bone quality. In this human cadaver study, the craniocaudal yield load of the bony fixation of an anterior angle stable plating system and the influence of Polymethyl Methacrylate (PMMA) augmentation on the primary stability of the screw–bone interface during kyphosis reduction was evaluated in twelve osteoporotic thoracolumbar vertebrae.

Material and Methods: The anterolateral stabilization device used for this study is comprised of two swiveling flanges and an expandable midsection. It facilitates the controlled reduction of kyphotic deformities in situ with a geared distractor. Single flanges were attached to twelve thoracolumbar vertebrae. Six specimens were augmented with PMMA by means of cannulated bone screws. The constructs were subjected to static, displacement controlled craniocaudal loading to failure in a servohydraulic testing machine.

Results: The uncemented screws cut out at a mean of 393 +/− 66 N, whereas the cemented screws demonstrated significantly higher yield load of 966 +/− 166 N ($p < 0.02$). No significant correlation between bone mineral density and yield load was detected in this setting.

Conclusion: The results of this study indicate that PMMA augmentation is an effective method to increase two- to 3-fold the primary stability of the screw–bone interface of an anterolateral spine stabilization system in osteoporotic bone. We recommend the system in cases of severely compromised bone quality to reduce the risk of screw loosening during initial kyphosis correction and to increase long-term construct stability.

GO109. Treatment of Vertebral Body Metastases in Palliative Patients: Radiofrequency Ablation, a New and Secure Treatment Option

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Introduction: About a quarter of all people dying in germany succumb to cancer. In 40% metastases of the spine are present. Potentially vertebro- or kyphoplasty in combination with a tumorablation may be a treatmentoption in painful metastases or metastases with fractures. Cementing alone leads to dislocation of metastases and scattering of tumoral mass in the patient. (Principle of Archimedes) Therefore local reduction of tumoral mass should be performed whenever possible.The use of ablation systems in the vicinity of nervous and vascular structures is potentially dangerous.The presented observational study is to assess the security and effectivity of a new spinal intravertebral radiofrequency-ablation sonde.

Materials and Methods: During the period from 11/2013 until 6/2015 we treated 24 patients (14f, 10m) with 58 vertebral bodies with the radiofrequency-ablation system followed by radiofrequency-kyphoplasty. The mean follow-up was 7,04 months (total 169 mon.). Mean age 67 years (Range 51–84 years). All vertebral bodies were treated unipedicular. Cancers treated were breast cancer (8), multiple myeloma (7), lung cancer (3), chondrosarcoma (1), prostate (1), urothel (1), cancer of unknown primary (1), gastric cancer (1) and fibrous dysplasia (1). In two patients this technique was combined with minimal-invasive percutaneous osteosynthesis. The ablationsystem contains a navigable, bipolar electrode with two temperature detection sondes, which allow for real-time temperaturemonitoring at the proximal end of the ablation zone. The ablation zones were planned preoperatively via computertomography and mri. Patients were examined for neurological or other deficits postopertively and during follow-up outpatient clinic visits.

Results: The ablation of the preoperatively determined areas were intraoperatively radiologically and via monitoring of temperature securely performed. The maneuverability of the ablation device allowed via unipedicular access the exact positioning of the device in the planned ablation zone. No patient presented neurological deficits or vascular lesions due to radiofrequency-ablation. One cementextravasation, while performing kyphoplasty at a site where the lateral wall of the vertebral body had already been preoperatively destroyed by the tumor, lead to affection of a peripheral nerve with intercostal neuralgia (<7 days).

Conclusions: The treatment of 24 tumorpatients in the advanced stadium of the cancer disease with percutaneous, minimally-invasive radiofrequency-ablation followed by cementaugmentation could be verified as secure treatmentoption for vertebral body metastases. The combination of a unipedicular access for radiofrequency-ablation and –kyphoplasty facilitates the careful and safe treatment of palliative cancer patients.

GO110. Routine Bone Biopsy during Percutaneous Vertebroplasty or Kyphoplasty in the Treatment of Osteoporotic Vertebral Fractures. Does It Change the Management Plan? Do We Know the Costs?

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Introduction: According to the WHO, osteoporosis causes more than 8.9 million fractures annually worldwide. The lifetime risk for a wrist, hip or vertebral compression fracture (VCF) has been estimated to be in the order of 30% to 40% in developed countries. It is estimated that up to 2 people per 100,000 in England are currently treated with percutaneous vertebroplasty and percutaneous balloon kyphoplasty. There are other causes of vertebral compression fractures, and therefore a bone biopsy is recommended to rule out pathologies such as malignancy. There is debate about the necessity of routine biopsy and its cost- effectiveness.

Material and Methods: We conducted a retrospective study on a cohort of consecutive patients undergoing vertibroplasty/kyphoplasty and bone biopsy over a 2 year period between 2013 and 2015 at The Ipswich Spinal Unit. Patient's demographics, indication for surgery, level of augmentation, histopathology results, complications and outcomes were extracted from electronic records. Patients were grouped in to 2 major groups; suspected malignancy and unsuspected malignancy group. Subgroups included non-biopsy group, and routine biopsy group. The non-biopsy group was followed up until last point of care. Cost of a routine biopsy was calculated based on theater, surgeon, consumables and histopathology costs.

Results: 64 patients, Mean age of 64, 129 levels were augmented, length of stay of 3 days, follow up of 22 weeks, and mean last point of care was 60 weeks . All underwent imaging and were discussed in a multi-disciplinary meeting (MDT). Out of the 64 patients, 22 malignancy group, 18 patients underwent biopsy. Out of the 42 patients in whom malignancy was not suspected, routine biopsy was performed in 17 patients. No malignancies (0%)found in the unsuspected malignancy group vs 5 positive samples in the suspected group. Routine biopsy did not change the management plan. Average Total cost of a routine biopsy was between £210 and £310.

Conclusion: Contrary to the previously published reports, our study shows that there is no specific role for routine biopsy during vertebroplasty procedure. This is a reflection of our MRI reporting and MDT approach. Therefore, we believe selective biopsy is more cost effective and value added approach in vertebral compression fractures.

GO111. Spinal Osteotomy for Sagittal Deformities using "Posterior Only Approach": A Novel Classification System

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Introduction Numerous types of posterior approach based osteotomies have been described but often there is a loss of clarity on the best osteotomy for each patient. We have proposed a morphological classification of sagittal deformities based on the status of the anterior and posterior column, the extent of column deficiency and the flexibility of the deformity. This classification will be useful as guideline for osteotomy selection and for comparing the practice preferences and outcomes between different institutions.

Methods: We analyzed retrospectively collected data for 187 posterior based osteotomies for sagittal deformity. A morphological classification of sagittal deformity was created on basis of collected data. The deformities with intact anterior and posterior column was Type I, where 1A had mobile disc spaces and 1B ankylosed segments.Type II had deficiency of any one column with IIA having a deficiency of posterior column only and Type IIB of anterior column only. Type III had an insufficiency of both columns with Type IIIA being less than 60°, IIIB $>$ 60° and IIIC having buckling collapse. We then prospectively analyzed this morphological classifcation in seventy-five patients with sagittal deformity who underwent various osteotomy procedures for different pathologies. We matched all the cases for six types of anatomical spinal osteotomies and one salvage procedure (anterior strut fusion). The osteotomy procedures considered were partial facetectomy, Ponte's osteotomy, pedicle substraction osteotomy, disc bone osteotomy,single vertebrectomy, multilevel vertebrectomy and salvage procedure in the form of anterior strut grafting.

Results: The mean age was 20.1years and mean sagittal deformity was 67.70°(28–129°). An average correction of 41% (11 to 78%) was achieved and an association of more complex osteotomies for higher class of deformities was noted. The inter-observer agreement for four spine surgeons classifying the 75 deformities was noted to be high (agreement rate K-0.83) using the above morphological classification. A chi-square analysis performed to test the association between the classification and the type of osteotomy, which showed an observable trend with a highly significant association ($p < 0.001$) showing that the type of osteotomy to be performed could be predicted by the classification.

Conclusion: The proposed classification of the sagittal deformity had a high inter-observer agreement and was useful in predicting the type of osteotomy. The classification would be valuable in training and teaching purposes. This classification could also be used for comparing the osteotomy selection and outcomes between different institutions.

Best Papers: Degenerative

GO112. Does Age Affect Surgical Outcomes in Patients with Degenerative Cervical Myelopathy?: Results from the Prospective, Multicenter AOSpine International Study on 479 Patients

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Introduction: Currently, the global population is experiencing a shift in its age structure. With this aging of the population, clinicians worldwide will be required to manage an increasing number of patients with degenerative cervical myelopathy (DCM). However, there is controversy whether surgical decompression is equally effective and safe in elderly patients as it is in younger patients. This study aims to determine whether age truly is an independent predictor of surgical outcome and to provide evidence to guide practice and decision-making.

Material and Methods: A total of 479 symptomatic DCM patients were prospectively enrolled in the CSM-International study at 16 centers. Our sample was divided into a younger ($<$65years) and elderly ($\geq$65years) group. Each subject was neurologically examined at baseline and 24-months postoperatively and evaluated using a variety of functional outcome measures, including the Neck Disability Index (NDI), SF-36 physical component summary (PCS) and mental component summary (MCS), and the modified Japanese Orthopaedic Association scale (mJOA). A mixed model analytic approach was used to evaluate differences in these outcome measures between groups. We first created an unadjusted model between age and surgical outcome and then developed two adjusted models that accounted for variations in 1) baseline characteristics and 2) both baseline and surgical factors.

Results: Of the 479 patients, 360 (75.16%) were $<$ 65 years and 119 (24.84%) were $\geq$65 years. There were no significant differences in gender ($p = 0.82$) or duration of symptoms ($p = 0.82$) between the two age groups. However, elderly patients had a significantly higher number of comorbidities ($p < 0.0001$). In addition, elderly patients were functionally more impaired preoperatively based on the mJOA ($p < 0.0001$) and Nurick ($p < 0.0001$) scales and had a lower SF-36 PCS ($p = 0.048$). The majority of younger patients (64.96%) underwent anterior surgery, whereas the preferred approach in the elderly group was posterior (58.62%) ($p < 0.0001$). Elderly patients had a greater number of decompressed levels (4.14 $\pm$ 1.30) than younger patients (3.50 $\pm$ 1.23) ($p < 0.0001$). Three hundred and eight-nine patients (81.21%) attended their 24-month follow-up appointment. Younger patients achieved a higher postoperative mJOA ($p < 0.0001$) and a lower Nurick score ($p < 0.0001$) than elderly patients. SF-36 PCS scores were also significantly higher in the younger group ($p = 0.033$). There were no significant differences in postoperative NDI or SF-36 MCS between age groups. After adjustments for patient and surgical characteristics, these differences in postoperative outcome scores decreased but remained significant. On average, elderly patients had a significantly longer length of postoperative hospital stay (12.99 $\pm$ 13.56 days) than younger patients (9.53 $\pm$ 8.67 days) ($p = 0.0086$). There were no significant

differences between the two age groups with respect to rates of perioperative complications ($p = 0.47$).

Conclusion: Older age is an independent predictor of functional status in patients with DCM. However, patients over 65 with DCM still achieve functionally significant improvement after surgical decompression. Potential explanations for this lower functional outcomes in older patients include that the elderly 1) increased degenerative pathology, including a decrease in number of anterior horn cells and number of myelinated fibers 2) co-morbidities, 3) reduced physiological reserves and 4) age-related changes to the spinal cord.

GO113. Is Preoperative Duration of Symptoms a Significant Predictor of Functional Status and Quality of Life Outcomes in Patients Undergoing Surgery for the Treatment of Degenerative Cervical Myelopathy?

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Introduction: Longstanding compression of the spinal cord in patients with degenerative cervical myelopathy (DCM) may result in irreversible neural tissue damage. This study aims to analyze whether a longer duration of symptoms is associated with poor surgical outcomes and to determine the optimal timing for decompressive surgery.

Material and Methods: Three hundred and fifty patients with symptomatic DCM were prospectively enrolled in either the CSM-North America or International study at 12 sites in North America. For each patient, extensive demographic information was collected, including age, co-morbidities, and a self-reported estimate of preoperative duration of symptoms. Postoperative functional status and quality of life were evaluated at 6-, 12- and 24-months using the modified Japanese Orthopaedic Association (mJOA), Nurick grade, Neck Disability Index (NDI) and Short-Form-36 (SF-36) Physical (PCS) and Mental (MCS) Component Scores. Change scores between baseline and 12-month follow-up were computed for each outcome measure. Duration of symptoms was dichotomized into a "short" and "long" group at several cut-offs. An iterative mixed model analytic approach procedure was used to evaluate differences in change scores on the mJOA, Nurick, SF-36 MCS and PCS and NDI between duration groups in 1-month increments. Two models were constructed: 1) an unadjusted model between duration of symptoms and surgical outcome and 2) a model adjusting for significant independent covariates identified through stepwise regression analysis.

Results: Our cohort consisted of 201 (57.43%) men and 149 (42.57%) women, with a mean age of 57.49 ± 11.77 years (range: 29–87 years). The mean duration of symptoms was 25.71 ± 36.68 months (range: 1–240 months). In unadjusted analysis, patients with a duration of symptoms shorter than 4 months had significantly better functional outcomes based on the mJOA ($p = 0.04$) than patients with a longer duration of symptoms (>4 months). On average, patients with a shorter duration of symptom improved by 3.71 on the mJOA, whereas those with a duration 4 months or longer only exhibited a 2.96 mean gain. Twelve months was identified as the next important cut-off beyond which patients had a significantly worse outcomes on the mJOA; however, this difference was smaller. Following adjusted analysis, cut-offs of 4 and 12 months remained significant. Duration of symptoms was not associated with Nurick or SF-36 PCS or MCS in either the unadjusted or adjusted models.

Conclusion: Patients who are operated on within 4 months of symptom presentation have better mJOA outcomes. It is recommended that patients with DCM are diagnosed in a timely fashion and referred early for surgical consultation. Our study does not support the traditional conservative "watchful waiting" approach to symptomatic patients with DCM.

GO114. Lumbar Spondylolisthesis: Radiographic Criteria of Instability

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Introduction: The goal of this study was to compare the radiographic criterias of "static" and "dynamic" lumbar degenerative spondylolisthesis. The sensitivity of standing lateral flexion/extension (SLFE) radiographs and magnetic resonance imaging (MRI) was used to categorize the spondylolisthesis to provide the patient with the ideal treatment.

Material and Methods: Prospective study where patients were screened using standing lumbar spine SLFE radiographs and MRI. They had their plain films assessed for the degree of spondylolisthesis and were designated "dynamic" or "static" based on the current literature criteria. Axial and sagittal T2 MRIs were evaluated for associated facet fluid (FF) and interspinous fluid (ISF). We compared then the radiographic results with our per-op findings and studied the sensitivity of SLFE radiographs and MRIs.

Results: 22 patients were included and evaluated for the presence of spondylolisthesis. Patients with greater than 3mm of instability on SLFE films were more likely to have FF ($p = 0.026$) and ISF ($p = 0.027$). If ISF was present on MRI, there was a positive predictive value (PPV) of 83.3% that there would be greater than 3mm instability on plain films. Absence of FF on MRI has a PPV of 75% for instability less than 3 mm on plain films. If ISF is present on MRI, the likelihood ratio of finding greater than 3mm instability on plain films was 3.45. The presence of FF on MRI had a likelihood ratio of 2.53 for instability. The presence of both parameters FF and ISF increased the likelihood ration to 5.08.

Conclusion: The presence of FF and/or ISF on MRI is associated with instability greater than 3mm on SLFE films. The presence of 1 or more of the following criteria: slip distance greater than 3mm, FF greater than 3mm and positive ISF permit us to consider the spondylolisthesis as dynamic and allow us to perform a posterior spinal fusion.

GO115. Computational Anatomy of C2 Based on Quantitative Computed Tomography and its Implications for Screw Positioning

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Introduction: Surgical fixation of the axis (C2) includes screw positioning through bony corridors close to vital structures. However, human bones exhibit large variations in size and shape across individuals and populations. A 3D statistical model of C2 using Quantitative Computed Tomography (QCT) was created to analyze the anatomical variations and to understand their implications for screw positioning.

Material and Methods: 106 standard clinical QCTs from 46 adult female and 60 male European patients, aged 52.0 years ± 19.9 years, with intact C2s have been included in this study. The mean image resolution was 0.5mm × 0.5mm in the axial plane and 0.6mm in craniocaudally direction. After anonymization 3D statistical modeling of C2 was performed. This included the computation of averaged 3D surface and volumetric bone mineral density (vBMD) models and principal component analysis (PCA). Transpedicular and odontoid screw templates were virtually implanted and their corridors were analyzed.

Results: PCA revealed a highly variable anatomy of C2 in which size was the predominant variation in the 1st principal component (PC), whereas shape changes were primarily described by the remaining PCs. The largest shape variation was observed at the spinous and transverse processes and the transverse foramina. Comparison of the averaged 3D surface models of C2 for men and women separately revealed mainly a difference in size: The model for males was ~7% larger in the axial plane (anterior-posterior and left-right directions) and ~9% in craniocaudal direction. 3.5mm odontoid screw templates could be virtually implanted in all C2. The average corridor length was 39.2mm ± 2.8mm and the median screw length 38mm. The average corridor length difference between the genders was ~8%. The corridor exhibited the lowest average vBMD value (199.0 mgCaHA/ml) underneath the basis of the odontoid process and a maximum value (911.2 mgCaHA/ml) at its upper part near the cortical shell. Virtual implantation of a 3.5mm C2 pedicle screw with 1mm safety zone was not possible in 31.1% due to interference with the vertebral artery. In 26.4% a 3.5mm screw and in 42.5% a 4.5mm screw could be positioned. The median screw length was 32mm. The average pedicle corridor length was 28.7mm ± 1.9mm with an average convergence of 21.0° ± 3.6° to the sagittal plane and an average ascent of 18.7° ± 3.5° in cranial direction. The lowest average vBMD value for the corridor was located in the trabecular bone of the vertebral body (314.8 mgCaHA/ml) whereas the maximum value (689.2 mgCaHA/ml) was measured near the anterior cortical shell of the vertebral body. The average entry point was ~5mm lateral from the medial border of the inferior articular process and ~10mm cranial from its caudal border.

Conclusion: We established a 3D statistical model of C2 using QCTs. It revealed largely variable surfaces, bone quality and corridor dimensions and allowed the efficient 3D assessment of parameters relevant for screw positioning. There are anatomical conditions that allowed/not allowed for screw positioning. Surgical decision making must rely on both, a thorough anatomical understanding and the given individual situation.

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Deformity Thoracolumbar Adolescent 3

GO116. Posterior Only Vertebral Column Resection (PVCR) for Fixed Angular Kyphosis (FAK)

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Introduction: VCR is the most suitable osteotomy for rigid angular kyphosis especially if the correction needed is high. The prospective cohort study assessed the efficacy of Posterior Vertebral Column Resection (PVCR) in management of Fixed Angular Kyphosis (FAK).

Patients and Methods: Thirteen cases of FAK managed by PVCR in Assiut University Hospital and followed up for a mean of 20.31 (12–48) months. Seven cases (53.8%) were females and six cases were males, the mean age was 13.77 years. Eleven cases were congenital (84.6%) and two cases were post tuberculous. Five cases (38.5%) affected the thoracic region, six cases (46.2%) affected thoracolumbar region and two cases (15.4%) affected lumbar region. VAS, ODI, SRS-22, and neurology together with local kyphotic angle were compared pre, post and at last follow up visit. One case suffered progressive paraplegia.

Results: Five osteotomies were at L1; four at D11, and one osteotomy at D10, D12, L2 and L3. The VAS improved from 6.57 ± 2.14 to 1.29 ± 0.75 ($p = 0.001$). The mean ODI improved from 56.22 ± 20.59 to 22.81 ± 11.33 ($p = 0.001$). Total SRS-22 score improved from 2.11 ± 0.60 to 3.35 ± 0.65 ($p = 0.002$). The mean local kyphotic angle improved from 65.38°±29.95 to 14.69°±19.78 ($p = 0.001$), the mean operative time was 465.38 ± 76.44 (320–600) minutes and the mean blood loss was 3323 ± 934.6 (1600–4500) cc. The preoperatively neurologically impaired case recovered completely. Four cases suffered complications (30%), one case suffered postoperative weakness of quadriceps which improved with physiotherapy, two cases suffered asymptomatic proximal junctional kyphosis and one case experienced pull out screws which was revised.

Conclusion: PVCR seems to be highly effective tool for correction of fixed angular kyphosis avoiding the morbidity of anterior or combined approaches.

GO117. Long Term Experience with Reduction Technique in High Grade Spondylolisthesis in the Young

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Introduction: Surgical management of high grade spondylolisthesis in the young is not only challenging but also controversial, from in-situ fusion to complete reduction. It is fraught with dangers such as neurological injury, pseudoarthrosis and progressive deformity with subsequent global sagittal imbalance. We describe our experience of progressive reduction technique and restoration of lumbosacral alignment.

Material and Methods: A retrospective review of patients who underwent surgery between 1998 and 2012. The surgical technique involved positioning the hips in extension with traction, pedicle screw fixation, correction of lumbosacral kyphosis with a specific distraction maneuver, wide decompression, and gradual reduction of the deformity and maintenance of reduction with interbody fusion. All patients were serially assessed at 1, 3, 6 months and yearly thereafter with clinical, radiological and outcome measures (ODI and VAS).

Results: 27 patients with high grade spondylolisthesis at L5-S1 (3 cases Grade 3, 7 Grade 4, 17 Grade 5) with an average age of 13.9 years were reviewed. Mean follow-up was 120 months (range 24–192). All patients presented a solid fusion at the 6 month visit; mean slip percentage was reduced from 89% to 23%, with all cases reduced to grade 2 or less. The slip angle improved from 45° to 3° postoperatively, with improvement in sacral slope from 13° to 35°. 4 spondyloptosis patients had concomitant scoliosis which corrected spontaneously after the surgery and did not need further intervention. All but one patient (96.2%) had good functional outcomes and returned to their full normal activities. One patient

developed a deep infection necessitating implant removal, with eventual deformity progression leading to a poor outcome. Three patients (11.1%) suffered partial drop foot that resolved in full by 12 weeks.

Conclusion: Our technique demonstrated a significant reduction of high grade spondylolisthesis, with restoration of global sagittal balance via correction of the lumbosacral kyphosis. Though surgically demanding, it is safe, reproducible and gives satisfying outcomes.

GO118. The Correlation of Anchor Density and the Curve Correction of Adolescent Idiopathic Scoliosis Surgery

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Introduction: Pedicle screw instrumentation has been shown to provide better curve correction with solid three-column fixation in adolescent idiopathic scoliosis (AIS) surgery. The levels of spinal segments to be fused are based on Lenke classification. However, the optimal anchor density of fixation points in AIS surgery to achieve cost effective curve correction remains unclear. The purpose of the study is to analyze the correlation between curve correction and anchor density in pedicle screw based posterior fusion of AIS.

Material and Methods: From Jan. 2003 to Dec. 2008, 121 consecutive AIS patients underwent primary posterior fusion with pedicle screw based fixation and followed up for a minimum of 24 months were reviewed. Anchor density was defined as the number of screws per fused spinal segment. Radiographs were assessed at preoperative, postoperative 0, 3, 6, 12 and every 12 months until last follow up. The relation between anchor density and correction rate in Lenke subgroups were analyzed.

Results: There were 14 male and 107 female patients enrolled and aged 14.1 years old at the time of surgery. The number of Lenke type 1, 2, 3, 4, 5 and 6 curve patients were 67, 22, 9, 2, 14 and 7 respectively. For all patients, the mean correction rate was 63.1 $\pm$ 15.8% in all structural curves and 67.0 $\pm$ 12.0% in major curves only. The mean anchor density was 1.30 $\pm$ 0.18. There was no correlation between anchor density and major curve correction rate (r=0.24, $p = 0.01$). Patients of anchor density >1.30 (=mean anchor density of all patients) had similar correction rate with patients of anchor density <=1.30 in the major curves (67.9 $\pm$ 13.2% vs 66.0 $\pm$ 10.4%, $p = 0.38$). For Lenke type 1, 2 and 3 curves, there was no correlation between major curve correction rate and anchor density (Lenke 1: r=0.02, $p = 0.88$; Lenke 2: r=0.30, $p = 0.18$; Lenke 3: $r = -0.20$, $p = 0.60$) with mean anchor density of 1.29 ± 0.15, 1.23 ± 0.17 and 1.23 ± 0.10 respectively. For Lenke type 5 curves, the major curve correction rate was positively correlated with anchor density (r=0.61, $p = 0.02$) with mean anchor density of 1.51 $\pm$ 0.23.

Conclusion: There was no significant correlation between curves correction rate and anchor density in pedicle screw based instrumentation of adolescent idiopathic scoliosis surgery. Although for major thoracolumbar/lumbar curves, anchor density may play a role in curve correction, further investigation is still needed.

GO119. VEPTR: Single Centre Experience of 9 Years

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Introduction: The operative treatment of scoliosis with vertical expandable prosthetic titanium rib (VEPTR) implants has been established in Europe since 2002. Between 2005 and 2014, we have treated 72 scoliosis patients with VEPTR implants.

Methods: This is a prospective uncontrolled study in a single scoliosis center. Of 72 cases; 51 were females and 21 males, with a mean age of 7.5 years (3–13 years). The underlying pathology was congenital scoliosis in 39 cases, neuromuscular scoliosis in 21 and early-onset scoliosis in 12. The grade of the deformity has been measured according to Cobb method of anteroposterior radiographs; pre- and postoperatively, and after every distraction of the rods. This took place every 6–9 months until post-pubertal end-fusion operation. The evaluation included patient (or parents') satisfaction score, complication rate and growth of the patient. Of 72 children, 10 have been already operated before.

Results: The primary deformity ranged from 45° to 130° with a mean of 65°. After the first correction, the mean Cobb angle was 32° (25°- 75°). No complications occurred during the instrumentation surgery. The mean operative time was: 95 minute. (65–175 minute.), with a mean blood loss of 125 ml. In all cases, intraoperative neuromonitoring with SEP and MEP has been performed. In 29 cases, a "rib-to-lumbar spine-hybrid" has been used, and combined with a "rib-to-rib" in 32 cases. In the other 11 cases, a "rib-to-pelvis" construct has been used. Delayed wound healing occurred in 4 patients, another patient had pneumonia, that was successfully treated. Proximal hook dislocation occurred in 14 cases after distraction. Skin perforation complicated 10 cases and needed partial removal of implant. No neurological complications or deep spinal infection occurred. The mean hospital stay was 18 days after first implantation (14–31). One to 12 distraction operations have been done in 52 patients. A deformity correction with a mean of 15,7° grades have been achieved (19.8%). In 20 cases, the secondary scoliosis have been later instrumented. In 12 cases, the implant has been removed and replaced by pedicular-screw growing rod system. The end-fusion operation has been already performed in 12 cases.

Conclusion: The early results have been considerable. Yet after 9 years of experience with the VEPTR systems, some major problems occurred with the proximal junctional kyphosis and with implant-related complications. Like other growth-sparing systems, the VEPTR implant showed a complication-rate of 29%

GO120. Health-related Quality-of-life in Adolescent Idiopathic Scoliosis Patients 25 years after Treatment

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Introduction: The purpose of this study was to evaluate the long-term clinical outcomes using validated measures of health-related quality of life (HRQOL), 25 years after termination of scoliosis treatment, in a cohort of Adolescent Idioapthic Scoliosis Patients.

Material and Methods: 219 consecutive patients treated with Boston brace or posterior spinal fusion using Harrington-DTT between 1983–90, were invited to participate in a long-term evaluation study. A validated Danish version of

the Scoliosis Research Society 22R (SRS22R) and Short Form-36 (SF36V1) were administered to the patients two weeks before the clinical and radiological examination.

Results: 159 (72,6%) patients participated in the clinical follow up and questionnaires, 11 patients participated only in the questionnaires, 8 emigrated, 4 were excluded due to progressive neurological disease and 2 were deceased. The total follow up was 170 patients (83%), average follow up was 24,4 years (22–30 years). SRS 22-R domains scores were within the range described as normal for the general population with no statistical difference between the two treatment groups except in the Satisfaction domain, were the PSF group had better scores than the braced group. The SF 36 PCS and MCS scores in both AIS cohorts were similar to the scores for the general population.

Conclusion: HRQOL, as measured by the SRS 22-R and SF-36, of adult AIS patients treated with Boston brace or PSF during adolescents were similar to the general population. No clinical progression of the deformity has been detected during the 25-follow up period. The PSF group had a small but statistical significant higher score in the Satisfaction domain compared with the braced group.

GO121. Quality of Life after Scoliosis Surgery in Cerebral Palsy

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Introduction: Radiological correction of scoliosis in quadriplegic cerebral palsy (CP) after posterior instrumentation is well established but patient and caregiver outcomes are required to justify this high risk and high cost surgery. The aims of surgical correction is to improve the patients sitting postion and pain from costo-pelvic impingement by reducing the spinal deformity and pelvic obliquity.

Material and Methods: To use the modified DuPont Hospital questionnaire to evaluate the quality of life, physical function and caring demands of patients who had undergone instrumented scoliosis correction for CP. Patients were identified and after initial contact, the parent completed the modified DuPont Questionnaire. The outcome measures were DuPont Questionnaire, Cobb angle and pelvic obliquity from radiographs before and after surgery.

Results: Between Jan 2003 – Sept 2013, 83 operations were undertaken by 4 Spinal Surgeons at Sheffield Children's Hospital in patients with quadriplegic CP. Two died during surgery (cardiac arrest) and two had died by follow-up from causes unrelated to the surgery. 79 families were contacted and 63 families agreed to be involved (80% return rate). 87% felt that their child's deformity was very much improved. 77% felt that their child's overall appearance was much improved. 60% felt it had improved their child's ability to feed and breathe. 64% felt that it was easier to bathe and dress their child. 94% said they would recommend surgery to another member of their family in similar situation. Cobb angle improved from 70° to 30° (47%) and pelvic obliquity from 24° to 11° (46%).

Conclusion: Surgical correction is still reserved for significant and progressive deformity with decreasing function. This remains a high risk intervention in patients at the severe end of CP spectrum with an on table mortality of 2%. Parental satisfaction scores were high and similar to currently published literature. High Satifcaction levels were found in those families who chose to undertake surgery.

GO122. Tranexamic Acid Administration in Adolescent Idiopathic Scoliosis Surgery Reduces % Total Blood Volume Loss

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Introduction: Multilevel spinal fusion surgery for adolescent idiopathic scoliosis (AIS) is typically associated with significant blood loss. Antifibrinolytics such as tranexamic acid (TXA) have been proposed to reduce both blood loss and the need for transfusions. This study compares the blood loss and % total blood volume loss of AIS surgery patients with or without tranexamic acid.

Materials and Methods: A retrospective comparative case-control study design was used to evaluate multilevel spinal fusion operations for AIS by a single surgeon from October 2011 to August 2014. Efficacy of TXA was evaluated by comparing mean estimated blood loss (EBL) and %TBV loss (calculated by Nadler's formula: males = 0.3669 * Ht m3 + 0.03219 * Wt kg + 0.6041; females = 0.3561 * Ht m3 + 0.03308 * Wt kg + 0.1833). Clinical factors including number of levels fused and length of operation were tested for correlation with % TBV loss.

Results: From 2011 to 2014, 36 adolescents underwent AIS surgery (18 with and 18 without TXA). Mean age was 16 (±3) years and 86% (31/36) were female (controls 15/18 and TXA 16/18). There were no statistically significant mean differences between the ()TXA and (+)TXA groups in terms of the following: BMI (20.2 vs 22.2); estimated blood volume (3380 mL vs 3797 mL); levels fused (9.6 levels vs 10.5 levels); EBL (583 mL vs 474 mL) ($p = 0.18$); and EBL per level fused (61 mL/level vs 43 mL/level). Percent total blood volume loss and % TBV per level fused was significantly less in the TXA group (12% and 1%) compared with control group (17% and 2%) ($p < 0.05$). There was a moderate but significant direct correlation between number of levels fused ($p = 0.024$) and length of operation ($p = 0.007$) with % total blood volume loss.

*Conclusion***s:** Administration of TXA during pediatric scoliosis surgery reduced % total blood volume loss by 30% compared with no TXA.

GO123. Posterior Selective Fusion with Pedicle Instrumented Correction in Thoracic and Thoracolumbar Idiopathic Scoliosis

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Introduction: To evaluate clinical and radiological outcome of selective fusion for adolescent idiopathic scoliosis (AIS) in thoracic and thoraco-lumbar curves i.e., Lenke 1C and 5C curves.

Material and Methods: 32 consecutive patients (22 females, 10 males) with 20 Lenke 1 C and 12 Lenke 5C were operated through posterior approach for AIS . Risser stage at the time of operation was 0–3 in 24patients and more than 3 in 4patients. Mean age was 13.5 years. Not every vertebra was instrumented with pedicle screws. Apical vertebral derotation and translation on the concave side were performed for correction. All patients underwent a selective fusion (1C only thoracic curve fused; 5C only thoracolumbar/lumbar curve fused). The data were prospectively collected

preoperatively and at 6 weeks, 1year and 2 years post-operatively. Cobb angle, sagittal and coronal balance, and lowest fused vertebral tilt were documented at all time-points. Uninstrumented compensatory curves were measured at all time points.

Results: Lowest instrumented vertebra (LIV) was distal end vertebra in 15 patients and was one below distal end vertebra in 3 patients in Lenke1C curves. The main thoracic curve correction in Lenke1C was 66%, from 60° ± 12° preoperative to 20° ± 7° at 6 weeks. The Cobb angle was 20° ± 10° at 1 years and 24° ± 10° at 2 years. The apical vertebral rotation improved by 38%, the non-instrumented lumbar curves improved 50%. The last instrumented vertebral tilt decreased from 22° ± 8° preoperatively to 5° ± 5° postoperatively. The average thoracolumbar/lumbar (TL/L) preoperative Cobb angle in Lenke5C curves was 46° ± 8° which was corrected to 14° ± 7° (70% correction) at a 2-year follow-up. 25% of the uninstrumented thoracic curve had spontaneous correction. The coronal balance improved significantly ($p < 0.05$) and remained stable from the first postoperative visit to the 2-year follow-up visit. The SRS-22 total scores improved significantly from before surgery to 2years after surgery ($p < 0.0001$). No pseudarthrosis or reoperation was observed. One 12 girl with Lenke1C (65°) had intra-operative loss of neural monitoring signals who was paralysed postoperatively for a period of 2 weeks. She recovered completely by 2 months.

Conclusion: Posterior correction of thoracic and thoracolumbar AIS with pedicle screw instrumentation is safe and produces a long-term stable correction and high patient satisfaction. In Lenke 1C and 5C AIS deformity patterns fused selectively, the uninstrumented compensatory curves do not seem to progress. Selective fusions, when successfully performed, will optimize mobile segments of the spine in AIS patients.

GO124. Treatment of Early Onset Scoliosis - An Early Experience of Growing Rod Insertion and Lengthening

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Introduction: Early onset scoliosis normally found in children from the age of birth till 10 years old with female preponderance. Any lateral spinal curvature of 10 degrees or more by reference to Cobb's angle measurement is diagnosed as scoliosis. The deformities is three dimensional thus affecting spinal growth in multiple planes. Scoliosis has been classified based on it's underlying causes such as congenital, idiopathic and also secondary causes as neuromuscular scoliosis or syndromic scoliosis.

Material and Methods: A retrospective study of patients seen in Orthopedic and Traumatology department of Hospital Kuala Lumpur. The age of patients ranges from 8 to 13 years old and are diagnosed with scoliosis regardless of the etiology. Twenty two patient (nine males, thirteen females) whom underwent surgical intervention are the subjects of this study. Spine correction details includes Cobb'sangle, T1-S1 length, Coracoid Height Difference (CHD), Clavicle Ribcage intersection point Difference(CRID), Clavicular Tilt Angle Difference(CTAD), Vertebral height, Apex distance from CSVL and rate of lengthening were collected. Data were then statistically analyzed.

Results: The results obtained after data analysis were as followes: Mean age of surgery is 11.1(between 13 and 7.7). Improvement of Cobb's angle immediately post op is 33.71% (between 54.55 and 15.56). Final improvement is 48.66 (between 69.09% and 27.59%). T1S1 length improved immediately post operatively by 12.28% and at final lengthening was 26.41%. An improvement of shoulder CHD immediately post op by 38.33% and at final by 51.96% was observed. Balance CRID improve post operatively 35.21% and final 31.86%. Balance CTAD showed improvement post operatively by 24.38% and final by 23.64%. Overall shoulder balance improved post operatively by 32.64% and final was 35.72%. Reduction of coronal distance immediate postoperatively by 36.30% and final at 54.89%.

Conclusion: Growing rod is not only one of the best option to prevent the progression of curvature, it is also a good method in correcting the co-existing curvature. With a good correction of curvature, it will facilitate in achieving the maximal correction for definitive fusion later. The outcome of our center is comparable with the results published by other international studies. Treatment of Early Onset Scoliosis with growing rod technique is safe and effective.

Degenerative Cervical

GO125. A Clinical Prediction Rule for Functional Outcomes in Patients Undergoing Surgery for Severe Degenerative Cervical Myelopathy: Analysis of an International AOSpine Prospective Multicentre Dataset of 254 Subjects

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Introduction: Patients with cervical spondylotic myelopathy (CSM) may be severely impaired, have reduced quality of life and present with deleterious signs and symptoms. Patients with severe myelopathy (mJOA < 12) often improve following surgery; however, some may not achieve a minimum clinically important difference (MCID), whereas others may have exceptional outcomes. Due to varying prognoses among this group, it is important to predict outcome in these patients and use this knowledge to manage expectations. This study aims to determine the most important clinical predictors of surgical outcome in patients with severe CSM.

Material and Methods: Of the 757 patients enrolled in the CSM-North America or International studies, 254 (33.55%) presented with severe myelopathy as classified by a mJOA < 12 points. A prediction model was developed to distinguish between patients who improve to mild or moderate myelopathy postoperatively (mJOA≥12) and those who remain significantly impaired (mJOA < 12). Univariate analyses evaluated the relationship between this outcome and various clinical predictors. Multivariate Poisson regression was used to formulate the final prediction model and to compute the relative risks. A secondary model was constructed to predict which patients would achieve a MCID on the mJOA, defined as a change score of three or more points in patients with severe disease.

Results: Our cohort consisted of 153 men and 101 women with ages ranging from 28 to 86 (mean: 60.09 ± 12.06 years). The mean preoperative mJOA was 9.42 ± 1.67. One hundred and fifty-four (60.63%) patients improved to a score

≥12 at 1-year postoperative, whereas 145 (57.09%) achieved a MCID on the mJOA. Baseline severity score (RR: 1.07, 95%C.I.: 1.02–1.13), hyperreflexia (RR: 0.83, 95%C.I.: 0.72–0.96), lower limb spasticity (RR: 0.75, 95%C.I.: 0.65–0.86), and age (RR: 0.97, 95%C.I.: 0.95–0.99) were significant predictors of a mJOA≥12 following univariate analysis. The final model consisted of three statistically significant variables and one clinically relevant predictor: baseline severity score (RR: 1.09, 95%C.I.: 1.03–1.15), duration of symptoms (RR: 0.94, 95%C.I.: 0.89–0.99), co-morbidity score (RR: 0.96, 95%C.I.: 0.91–1.00) and the sign lower limb spasticity (RR: 0.76, 95% C.I.: 0.66–0.87). The AUC for this model was 0.75 (95%C.I.: 0.67, 0.83). Improvement by the MCID could not be effectively predicted by a combination of clinical variables.

Conclusion: Severe patients were more likely to achieve a score ≥12 on the mJOA if they had a higher preoperative mJOA score and a shorter duration of symptoms; a lower co-morbidity score (fewer and less severe concomitant disease); and did not have lower limb spasticity.

GO126. The Relationship between Preoperative Clinical Presentation and Quantitative MRI Features in Patients with Degenerative Cervical Myelopathy

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Introduction: Degenerative Cervical Myelopathy (DCM) encompasses a group of degenerative conditions of the cervical spine, including cervical spondylotic myelopathy (CSM) and ossification of the posterior longitudinal ligament (OPLL), that result in spinal cord pathology through static and dynamic injury mechanisms. While there are a constellation of degenerative findings that present in patients with DCM on MRI, large studies have shown that cervical cord compression and signal changes on MRI can present in asymptomatic or population based cohorts as well. It is therefore the objective of the present research to investigate the correlations between clinical and MRI findings and address this area of controversy.

Material and Methods: One hundred and fourteen patients enrolled in the prospective and multicenter AOSpine CSM North American study with complete MRI and clinical data were evaluated. Patients were enrolled if they had ≥1 clinical signs of myelopathy. Mid-sagittal MRIs were assessed for maximum spinal cord compression (MSCC) and maximum cord compromise (MCC). Additionally, the presence of T1 and T2 signal changes assessed, and the degree of T2 signal hyperintensity deviation was evaluated by computing a signal change ratio (SCR). MRI features were then statistically related with the presence of upper and lower limb neurological symptoms as well as generalized neurological dysfunction using *t*-tests. The relationship between duration of symptoms and quantitative MRI features was assessed using Spearman's rank correlation coefficient.

Results: The average T2 signal change ratio at the region of interest was 1.31, and the mean MCC and MSCC were ~49% and 34%, respectively. Numb hands ($p = 0.01$) and Hoffmann's sign ($p = 0.003$) were associated with greater MSCC; broad-based, unstable gait ($p = 0.042$), impairment of gait ($p = 0.008$) and Hoffmann's sign ($p = 0.013$) were associated with greater MCC; Numb hands ($p = 0.037$), Hoffmann's sign ($p = 0.017$), Babinski sign ($p = 0.002$), lower limb spasticity ($p = 0.011$), L'Hermitte's phenomena ($p = 0.045$), hyperreflexia ($p = 0.004$), and presence of T1 hypointensity were associated with a greater deviation of signal intensity on T2 MRI. Patients with the presence of T2 signal hyperintensity also had greater MSCC ($p < 0.001$) and MCC ($p < 0.001$). Patients with L'Hermitte's phenomenon had a statistically significant lower SCR ($p = 0.045$), indicating that they more commonly presented with diffuse and faint, or absence of T2 signal hyperintensities.

Conclusion: MSCC and MCC were predominately associated with upper limb and lower limb manifestations, respectively. SCR was associated with upper limb, lower limb and general neurological deficits. Hoffmann's sign was the only clinical parameter which occurred more commonly in patients with a greater MSCC, MCC and SCR, supporting its role as a sensitive diagnostic tool. L'Hermitte's phenomenon presented more commonly in patients with a lower SCR and thus may serve to indicate mild pathology and potential for reversibility. Going forward, it would be interesting to investigate these correlations over multiple preoperative time periods to evaluate the validity and evolution of these relationships. Ultimately, the culmination of such research may serve as a prelude to the construction of an evidence based prediction model that may help to differentiate between patients that remain stable and identify those who are likely to deteriorate without surgical intervention.

GO127. CT-Myelogram Predictors of Outcome in Patients with Cervical Spondylotic Myelopathy: Results of a Systematic Review

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Introduction: Magnetic resonance imaging (MRI) is used routinely to diagnose cervical spondylotic myelopathy (CSM). However, in cases where MRI is contraindicated, CT myelogram remains the preferable imaging modality for the diagnosis of CSM. There remains no confirmed consensus on the use of specific CT myelogram parameters and their relationship with regards to CSM disease severity, clinical presentation and prognosis after surgical treatment. The purpose of this study is to determine the CT myelogram imaging parameters in patients diagnosed with CSM that correlate with severity of CSM and predict postoperative patient outcome

Materials and Methods: An electronic database search was performed using Ovid Medline and Embase. CT mylogram studies investigating the correlation between imaging characteristics and CSM severity or postoperative outcomes were included. Two independent reviewers performed citation screening, selection, qualitative assessment and data extraction using an objective and blinded protocol. All authors involved in the study have no disclosures related to present study. No funding was needed for this study.

Results: We found no studies investigating the correlation between CT myelogram parameters and CSM severity. A total of 5 studies (402 patients) were included in this review and investigated the role of CT myelogram parameters in predicting outcome after surgical treatment. All studies were retrospective cohort studies. CT mylogram characteristics included the transverse area of the spinal cord at maximum level of compression, spinal canal narrowing, number of blocks, spinal canal diameter and flattening ratio. There is low evidence suggesting that patients with a transverse area

of the spinal cord >30 mm2 at the level of maximum compression have better postoperative recovery and outcome.

Conclusion: Patients with greater transverse area of spinal cord at the level of maximum compression on CT myelogram are more likely to have better neurological outcome after surgery. There is insufficient evidence to suggest that any of the other CT mylogram parameters investigated are predictors of postoperative outcomes in patients with CSM.

GO128. C5 Palsy after ACDF: Topographic Correlation with Chassaigne's Tubercle (C6)? A Fresh Cadaveric Study

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Introduction Our aim was to explore the possible topographic correlation of C5 nerve root with regards to its course and regional relation to C6 tubercle. We hypothesized that etiologic mechanisms proposed thus far in the current literature although may have some plausible explanation, however they still cannot explain why C5 and not any other adjacent level suffer a post-operative palsy.

Materials and Methods Fresh cadaver had extensive layer by layer dissection performed by 2 surgeons (one of whom has extensive experience as an anatomy demonstrator and dissector). Roots of Brachial plexus were exposed in relationship cervical transverse processes. Photographs were taken at each stage of the exposure.

Results: We observed a close relation of path of C5 root with the C6 tubercle bilaterally, moreover we noted a sharper decent of C5 in comparison with the other adjacent roots.

Conclusion: Sharper angle of C5 nerve root, variations in intra-operative neck position and shoulder pull may play a role in predisposing the nerve root to neuropraxia against this most prominent lateral cervical boney element. We speculate that C5 nerve palsy may be related to the close association of the C5 nerve with Chassaigne's tubercle (C6). We would suggest a closer analysis of the C5 nerve in this region using finite element analysis with emphasis on the close proximity of the nerve and changes due to cervical motion.

Figure 1

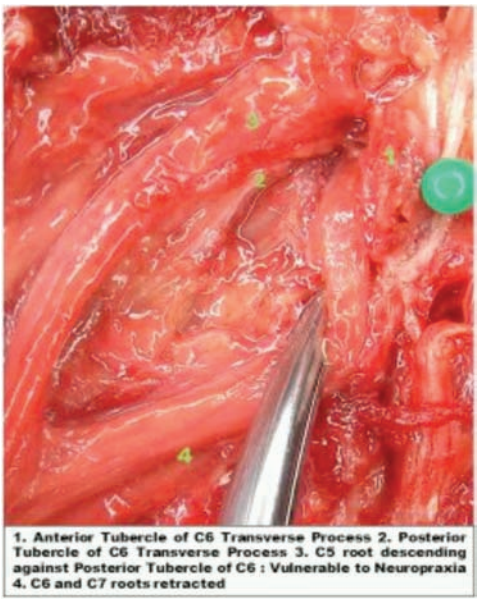
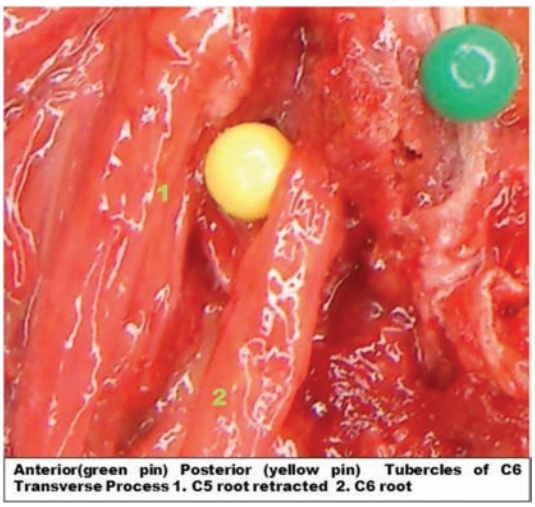


Figure 2

Figure 3



Anterior(green pin) Posterior (yellow pin) Tubercles of C6 Transverse Process 1. C5 root retracted 2. C6 root

Figure 4

GO129. Do Racial Differences Affect Surgical Outcomes in Patients with Degenerative Cervical Myelopathy?: Results from the Prospective Multicenter AOSpine International Study on 479 Patients

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Introduction: Degenerative cervical myelopathy (DCM) is the most common disease of the cervical spine in the elderly worldwide, and surgical decompression is a widely accepted procedure to prevent neurological deterioration. Although racial background affects clinical outcomes in various medical conditions and diseases, few studies have evaluated the impact of racial differences on surgical outcome after DCM. The purpose of this study is to comprehensively evaluate whether racial background is an independent predictor of surgical outcomes for DCM.

Material and Methods: A total of 479 patients with symptomatic DCM were prospectively enrolled in the AOSpine CSM-International study at 16 global sites. Patients' functional status were evaluated using the modified Japanese Orthopedic Assessment scale, the Nurick score, the Neck Disability Index, and the Short- Form 36 (SF-36) Health Survey. Improvements in functional status and QOL were assessed between baseline and 24-months follow-up. A mixed model analytic approach was used to evaluate differences in surgical outcome between races, while controlling for relevant baseline characteristics and surgical factors.

Results: Of the 479 DCM patients, 324 (67.64%) and 106 (22.13%) were Caucasians and East Asians, respectively. Other races were excluded as there were too few patients to conduct separate analyses. There was no difference in the incidence of ossification of the posterior longitudinal ligament (OPLL) between the two races; however a greater percentage of Caucasians in India (46.15%) and Turkey (41.38%) exhibited OPLL than Caucasians at sites in other regions. The frequency of spondylosis was significantly higher in Caucasians ($p < 0.0001$). Caucasians had a significantly longer duration of symptoms ($p = 0.0002$), a greater number of co-morbidities ($p = 0.0288$), and a lower preoperative score on the SF-36 Physical Component Score ($p = 0.0002$) than East Asians. At 24-months postoperative, there were no significant differences in functional status or QOL between East Asian and Caucasian patients, after adjusting for variations in baseline characteristics, surgical preferences and disease causation. In addition, rates of perioperative complications were not significantly difference between the races ($p = 0.261$).

Conclusion: Although the frequency of subcategories of DCM differs between racial backgrounds, this does not affect surgical outcomes for DCM. Decompressive surgery for DCM is equally safe, and provides comparable functional gains both in Caucasians and East Asians. Although the prevalence of OPLL in East Asians has generally been thought to be higher than amongst Caucasians, our findings indicate that individuals from India and Turkey may also be at a high risk of OPLL development.

GO130. Clinical Outcome of Anterior vs Posterior Approach for Cervical Spondylotic Myelopathy

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Introduction: Cervical spondylotic myelopathy is a common cause of neurological morbidity. The decompression of the neural elements is the gold standard procedure for this pathology, but there is still a lot of controversy for the selection of the approach, anterior, posterior or combined.

Methods: 42 patients were enrolled with the diagnosis of cervical spondylotic myelopathy, the 42 underwent surgery with either anterior or posterior approach at the hospital Centro Médico Nacional de Occidente, Guadalajara, México, a follow up for up to one year was made, comparing the results with the modified score for the Japanese Association of Orthopaedics (mJAO) and the Nurick score.

Results: Patients were divided into two groups. homogeneity analysis were made, finding similar results between both groups ($p < 0.05$) Group A. 19(45%)patients received surgery by an anterior approach (Corpectomy with expandable cage and anterior plate fixation) and group B. 23 (55%) underwent posterior approach, from this 23 patients, 18(43%) had a laminectomy with posterior instrumentation and fusion, and 5 (12%) had a laminoplasty. 38% female patients and 62% male patients, median age was 75 years old. Functional outcomes were measure with the modified score for the Japanese Association of Orthopaedics (mJAO) for up to one year follow up. Group A had a lower score (x:15.52) compare with group B (x:17.13) (15.52 versus 17.13, $p < 0.05$. While in the Nurick score Group B got a higher score (x:0.73) compare with group A (x:0.30) (0.73 vs 0.30, $p < 0.05$).

*Conclusion***s:** The election of the surgical approach in the cervical spondylotic myelopathy should be individualize according to the characteristics of the injured elements, it should be focused in the decompression of the neural elements and the recovery to the sagittal balance. In this study a statistical difference was found according to the mJAO and the Nurick scale in favor of the posterior approach, but the anterior decompression may also have good results according to the one year follow up ($p < 0.05$). More studies should be made with a bigger population and a longer follow up

Keywords: anterior approach, posterior approach, cervical spondylotic myelopathy, cervical functional scales.

GO131. The Minimum Clinically Important Difference of the modified Japanese Orthopaedic Association Scale in Patients with Degenerative Cervical Myelopathy

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Introduction: The modified Japanese Orthopaedic Association (mJOA) score is the most frequently used clinician-administered tool to assess functional status in patients with degenerative cervical myelopathy (DCM). By defining the minimum clinically important difference (MCID) for this scale, clinicians can evaluate treatment outcomes for this condition and better interpret evidence from clinical studies. This study aims to establish the MCID of the mJOA in patients with CSM.

Material and Methods: Three different methods were used to determine the MCID of the mJOA: 1) distribution-based, 2) anchor-based and receiver operating characteristic (ROC) analysis and 3) professional opinion. The first two methods were accomplished using data from 517 patients enrolled in the AOSpine CSM-North America or CSM-International studies. Distribution-based methods were used to estimate the MCID by computing the half standard deviation and standard error of measurement. Using anchor-based methods, mJOA at 12-months after surgery was compared between patients who "slightly improved" on the Neck Disability Index (NDI) and those who were "unchanged." ROC analysis was then performed to compute a discrete integer value for the MCID that yielded the smallest difference between sensitivity and specificity. Finally, MCID estimates were obtained by surveying members of AOSpine International. We repeated the anchor-based methods for patients with mild (mJOA: 15–17), moderate (mJOA: 12–14) and severe disease (mJOA < 12).

Results: Our cohort consisted of 315 men and 202 women, with ages ranging from 21 to 86 years (mean age: 56.37 $\pm$ 11.60). The mean baseline mJOA score was 12.48 $\pm$ 2.71. One hundred and twenty-nine patients were classified as mild (mJOA=15–17) preoperatively, 208 as moderate (mJOA=12–14) and 180 as severe (mJOA < 12). Based on the NDI at 12-months following surgery, 76 (14.70%) patients worsened (NDI < -7.5), 130 (25.15%) were unchanged ($-7.5 \leq$NDI < 7.5), 87 (16.83%) slightly improved ($7.5 \leq$NDI < 15) and 224 (43.33) showed marked improvements ($15 \leq$NDI). The half standard deviation of the baseline mJOA was 1.36 and the standard error of measurement was 1.21. The difference in mJOA between patients who "slightly improved" on the NDI and those who were "unchanged" was 1.11. ROC analysis yielded a value of 2 for the MCID (Fig. 1). The survey of 416 spine professionals confirmed these estimates: The mean response was 1.65 $\pm$ 0.66, although the most commonly selected answer was 2 (39.42%). The MCID significantly varied depending on myelopathy severity: ROC analysis yielded a threshold of 1 for mild patients, 2 for moderate patients and 3 for severe patient.

Conclusion: The MCID of the mJOA is estimated to be between 1 and 2 points and varies significantly with myelopathy severity. This knowledge will enable clinicians to identify meaningful functional improvements in surgically treated CSM patients.

GO132. Spinal Cord Drift after Non Instrumented Posterior Cervical Laminectomy

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Objective: To assess the mean value of spinal cord drift after laminectomy for cervical spondylitic myelopathy and its relation to preoperative alignment and postoperative neurologic recovery rate.

Materials and Methods: 35 patients with a mean age of 62 were operated for cervical spinal myelopathy (CSM) by laminectomy with evaluation of preoperative and postoperative MRI (Min 6 months). Functional outcome was measured (Japanese Orthopedic Association score (JOA), Nurick score, and recovery rate) and radiological analysis was also made (Cobb angle and postoperative cord migration). The mean follow up period was 58.7 months

Results: The mean preoperative JOA score was 11.3 and the mean postoperative JOA score was 14.6 with a mean recovery rate of 63%. The Nurick score went from 2.11 to 0.65 with a recovery rate of 69%. The postoperative cord migration was 3.82 mm. Younger age, more than four level laminectomy were correlated with better prognosis. While spinal cord drift to more than 3 mm was correlated with better outcome and to the extent of the laminectomy

Conclusion: Cervical laminectomy is an indirect way of relieving the anterior compression since it allows posterior spinal cord displacement while widening of the canal. This displacement is greater when lordosis rather than kyphosis is present with positive correlation with neurological outcome.

GO133. Degenerative Changes in the Cervical Spine are More Common in Middle-aged Patients with Thalidomide Embryopathy than in Healthy Individuals

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[3]

Introduction: The aim of the study was to compare the degree of degenerative changes in the cervical spine of thalidomide embryopathy (TE) patients—in whom upper limb malformations often necessitate help with grip function through the mouth or by head motion, and may thereby add extra load to the spine—with that in a control group (CTR).

Material and Methods: Twenty-seven middle-aged TE patients and 27 age- and gender-matched healthy CTR were examined by cervical MRI. The presence of malformations, disc herniations, osteophytes, nerves and medullary compression, were evaluated. Disc degenerations (DD), were graded according to the Pfirrmann classification.

Results: Similar frequencies of disc herniation and disc space narrowing were observed in both groups, but there was more foraminal narrowing in the TE group ($\rho < 0.002$). Significantly more DD were seen in the TE group than in the controls ($\rho < 0.001$). Evaluation of all discs ($n = 135$ per group) showed Pfirrmann grade I in 0% of the TE group and 2% of the controls. Grade II was found in 3% and 36%, respectively, grade III in 46% and 50%, grade IV in 38% and 11%, and grade V in 13% and 0% ($\rho < 0.001$). DD were observed frequently at all levels for the TE group, however mainly in the two lower levels for the CTR.

Conclusion: The more frequently observed degenerative changes of foraminal narrowing and disc signal changes in

the TE group support the theory that a higher load on the cervical spine leads to earlier development of DD.

Infections 2

GO134. Surgery for Spinal Tuberculosis: A Multi-Center Experience of 582 Case

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Introduction: Tuberculosis of the spine is a common form of TB infection for 50% to 60% of osseous tuberculosis. Although uncommon, spinal TB still occurs in both developed and developing countries. The diagnosis of spinal tuberculosis is difficult and it commonly presents at an advanced stage. Delays in establishing diagnosis and management result in complications such as spinal cord compression and spinal deformity.

Material and Methods: A total of 582 patients with tuberculosis of the cervical, thoracic and lumbar spine with moderate to severe cord compression were studied. Variable degrees of neurological deficit with deformity were treated from January, 2003 to July, 2014. Thoracotomy along with anterolateral decompression and autogenous strut bone grafting with simultaneous fixation by screws and rods were done in 113 cases. Posterior decompression, posterior interbody and posterolateral fusion by bone graft with stabilization by transpedicular screws and rods were done in the remaining 469 cases. Appropriate anti TB drugs were given to all patients for 18–24 months. The follow-up period was 3 months to 10 years.

Results: The average age was 32.5 years. All patients survived surgery. There were 7 cases of superficial infections (1.2%) while there were 4 cases (0.7%) of deep infections. Revision surgery was performed in 6 patients (1.0%). Implant failure occurred in 4 cases (0.7%) while malposition of screws occurred in 12 cases (2.1%). Perioperative bleeding complications were reported for 4 patients (0.7%). Neurological improvement occurred in all patients except for 2 cases (0.3%). Preoperatively, the majority of patients ($n = 221$, 38%) were classified with Class A on the American Spinal Injury Association (ASIS) neurological impairment scale. This was significantly reduced postoperatively to 0.4%.

Conclusion: For patients with spinal tuberculosis anterior debridement, auto graft bone fusion, anterior or posterior fixation appears to be effective in arresting disease, correcting kyphotic deformity and maintaining correction until solid spinal fusion.

Keywords: thoracolumbar spinal tuberculosis debridement, bone graft, stabilization

GO135. Spinal Osteomyelitis as a Manifestation of Neonatal Sepsis: the Time Bomb

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Introduction: Infection of the spine complicates neonatal sepsis very rare; to date there are only few case reports of this pathology. The purpose of the study is the analysis of nonspecific spondylitis as a manifestations of neonatal sepsis.

Material and Methods: 9 cases of neonatal sepsis, operated for the kyphosis due to the spinal osteomyelitis.

Results: All patients were admitted to the hospital with the consequences of destructive lesions of the spine with no signs of active infection according to clinical and laboratory examinations. Sepsis occurred at the age of 5 days to 2.5 months. All cases had multiple foci of infection: pneumonia - 7/9, coxitis - 2/9, rib osteitis - 1/9, soft-tissue infection - 2/9, intestinal infection - 2/9. In 2/9 cases the microbiota was found - Staphylococcus sp. (from feces) and Klebsiella pneumonie (from the tracheobronchial tree). All patients received parenteral antibiotics. Spondylitis was diagnosed 3–12 months after the onset of the disease due to the progressive kyphotic spinal deformity. All cases had paravertebral and epidural abscesses with the compression of the dural sac, during prolonged antibiotic treatment the abscesses significantly reduced (6/9) or resolved (3/9). All children had total destruction of 2–3 vertebral bodies in the thoracic region (Th4 - Th11) that led to the formation of sharp angular kyphosis ranged 44–80 degrees of Cobb angle. At the time of surgery children were aged 7 to 19 months. All cases were neurologically intact. 8/9 patients had one-day surgical procedure - anterior fusion (4 using titanium mesh) and posterior instrumentation of the spine (⅞ – anterior and posterior approaches; ⅛ – only posterior), 1/9 had staged surgery (due to the cardiac problems – congenital heart defect). Postoperative neurologic status was intact in all children. Histologic exam of pathologic material showed signs of nonspecific inflammation of bone tissue in all cases. No microbiota, including mycobacteria, were found in the operating material (by microscopy and cultural methods). The absence of Mycobacterium tuberculosis DNA was confirmed by RT-PCR in 8/9 patients.

Conclusion: Infections of the spine as a manifestation of neonatal sepsis are rare, and are diagnosed after the onset of kyphosis. The disease is characterized by extensive destruction of the vertebral bodies and the formation of paravertebral and epidural abscesses without neurologic complication despite the pronounced compression of spinal cord in especially vulnerable to ischemic complications area of mid-thoracic spine. In the majority of patients verification of the causative microbial agent of sepsis and spondylitis was not possible. The angular deformity of the spine in young children due to the destruction of the vertebrae makes it necessary to rule out the spinal tuberculosis as the most common cause of acquired kyphosis in children. Surgical treatment of spondylitis as a sequela of neonatal sepsis is performed when the infection is under control. The goals of surgery are the anterior column reconstruction and kyphotic deformity correction.

GO136. Post-traumatic Spondylodiscitis. Update, Series of 17 Patients and Review of the Literature

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Introduction: With increased risk and predisposing factors, the incidence of pyogenic spondylitis is rising. The term locus minoris resistentiae is defined as a place of less resistance, any part or organ which is more susceptible than others to the attack of a morbific agent. Hence the posttraumatic spondylodiscitis becomes not uncommon with acute or chronic presentation. In the literature only 17 publications (1939–2012) are reporting on a total of 20 cases.

Material and Methods: A retrospective uncontrolled clinical case-series in a single institution. Between January 2000 and May 2015, 17 patients were operated due to vertebral osteomyelitis after spinal fracture. We have analyzed the preoperative condition, risk factors, diagnostic findings, time between fracture and presentation, causative organism, treatment and outcome

Results: Total of 17 patients; 9 males and 8 females with mean age 68 years (44–81). High energy Trauma was reported by 5 patients. The mean interval between the fracture and spinal infection was 111.6 days (5 - 601). Twelve patients presented within less than 3 months of the fracture, whereas 5 presented later. Affected region was lumbar in 12, thoracic in 4 and cervical in one patient. Comorbidities were found in 94% of the patients: DM in 9 cases, renal insufficiency in 6 and cardiac diseases in 8 cases. Associated infections had been detected in 12 (71%). Mean CRP at time of presentation was 115 mg/l, WBCs $11x10^3/mm^3$ and ESR 81 mm/hr. The most common isolated organism was Staph. aureus in 9 cases (53%). Mean VAS after injury was 6.8/10 and at the time of presentation with spinal infection was 7.8/10. The most common presenting symptoms were increased local pain in all patients, fever in 11 and neurological manifestations in 6 patients. All patients except 2 patients, who died preoperatively, had been treated surgically (anterior Debridement and posterior stabilization).

Conclusion: Spinal osteomyelitis is commonly caused by hematogenous seeding. Predisposing factors that compromise the immune system render the host more susceptible to spinal infection. The fracture hematoma represents a suitable site for inoculation and development of infection and this can explain the acute presentation. The altered local vascularity at the fracture site can lead to blood stagnation and facilitate the bacterial seeding. Inflammatory parameters can be mildly elevated after trauma and should be differentiated from increase due to infection.

GO137. Spondylodiscitis 10 Years Experience of 40 Cases in a Third Level Hospital in Bogotá, Colombia

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Introduction: Spondylodiscitis is an infrequent pathology and may be overlooked in clinical practice. Diagnosis requires a high level of suspicion by physicians; a multidisciplinary approach is essential. The objective was to describe the incidence, risk factors, clinical characteristics, management and outcomes of patients with spontaneous spondylodiscitis.

Material and Methods: Medical records of patients treated for infectious discitis at a third level hospital in Bogotá, Colombia, between January 2003 and August 2014 were reviewed. Postoperative infections and vertebral osteomyelitis were excluded.

Results: Spontaneous spondylodiscitis was diagnosed and treated in 40 patients (mean age 60,8 years, 60% male, 40% female). Most patients presented with subacute pain, 25% with fever, one patient with hypoesthesia in both legs, normal physical exam was observed in 24% of patients and no patient had paresis/paralysis. Among comorbid diseases, type 2 diabetes mellitus was the most relevant (20%). Concomitant infection at diagnosis was present in 7.5% of patients. WBC count and PCR were the most frequent laboratory test and MRI the most performed radiological test being positive in all cases. Procalcitonine was assessed in 10% of patients. Lumbar segments were involved in 62,5% of patients. S. Aureus and S. Epidermidis were the most common isolated microorganism (10% of patients) 55% of patients received I.V. inhospital antibiotic for less than 1 month, followed by 2–6 weeks of oral antibiotics in 75% of patients. Linezolid, Rifampicin and Vancomycine were the most frequently used antibiotics (alone or in combination). 20% of patients underwent surgical treatment. Abscess was observed in 7 patients (17,5%) all of whom went to surgical treatment. 2 patients developed infectious endocarditis and 1 patient died. 8 patients presented recurrence of the disease. Mean inhospital length was 30 days.

Conclusion: Spondylodiscitis diagnose must be suspected in patients presented with persistent back pain and specific risk factors (i.e., Diabetes Mellitus, Immunosuppression). Appropriate images and laboratory tests (MRI, WBC count, PCR and procalcitonine) must be assessed to reach an early diagnosis and antibiotic treatment guided by causative organism. Surgical treatment must be considered in specific cases. Recurrence is not common and must be prevented.

GO138. Demographics of Tuberculosis of Spine and Factors Affecting Neurological Improvement in Patients Suffering from Tuberculosis of Spine - A Retrospective Analysis of 312 Cases

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Objective: The purpose of the study was to study demographics of tuberculosis of Spine and analyze factors that might affect neurological improvement in patients suffering from tuberculosis of spine.

Materials: Of the 638 suspected cases of spinal tuberculosis, 312 cases with confirmed diagnosis with at least one year follow up were selected for retrospective analysis. 200 cases that presented with neurological deficit were further divided into three groups- completely improved, partially improved, and no improvement according to AIS (American Spinal Injury Association impairment scale) grading. All continuous variables and categorical variables were compared across groups.

Results: 66.99% patients had typical clinical presentation. 84.62% had typical MRI presentation. Thoracic levels (T1–10) were most commonly affected in 45.78% followed by thoracolumbar levels 27.52%(T11-L2). In 80.32% disease was restricted to one or two adjoining vertebrae. At presentation 35.89% patients were neurologically intact whereas 31% were AIS-D, 20.83% were AIS-C, 2.5% were AIS-B and 9.61% were AIS-A. The three groups of patients with complete improvement, partial improvement, and no improvement were significantly different in their levels of vertebral involvement, AIS grade at presentation, bladder and bowel involvement and its duration on statistical analysis.

Conclusion: Age, sex, radiological presentation, co–morbidities and presence of pulmonary tuberculosis has no significant effect on neurological improvement. Levels of vertebral involvement, AIS grade at presentation, bladder and bowel involvement and its duration significantly effects the final neurological improvement in cases of tuberculosis of spine.

GO139. Anterior Coloumn Reconstruction with Stand Alone Titanium Cage, without Anterior Plating in Tuberculosis Cervical Spine. An Experience of 47 Patients

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Introduction: Tuberculosis is a common problem specially in under developed countries. Tuberculosis of the vertebral column constitutes nearly 50% of all lesions of

osteoarticular tuberculosis. The commonest site for the disease is in the peridiscal region. Treatment option usually is anti tuberculous chemotherapy but in some patients usually with severe pain and involving neurology, instability, large abcess, surgery is recommended.To our knowledge there is not a single publication in literature in which standalone titanium cage and bone graft without anterior plating is used in the treatment of TBS. The aim of this study is to evaluate the efficacy of standalone titanium mesh cages in TB cervical spine.

Material and Methods: A retrospective study of 47 patients with cervical tuberculous spondylitis (TBS) was performed at Ghurki trust teaching hospital. This study approved by the Institutional Review board and the ethics committee, included 47 patients with TBS of cervical spine who gave their informed consent to be included in the research. All patients had radical debridement, decompression, anterior coloumn reconstruction and instrumentation with standalone titanium cage without anterior plating filled with autologous iliac bone graft. The diagnosis of TBS was based on clinical correlation including night fever, loss of weight, fatigue and neck pain, laboratory investigations including ESR, CRP and tuberculin test were done in all patients. Visual analogue score (VAS) and frankel scoring system was used to score pain severity and grade neurological status. ATT was started preoperatively. The radiographic assessment included preoperative standard anteroposterior and lateral views. Cobbs methos was used to measure the sagittal profile.

Results: 61.6% patients fell in age group 3–35 years and 28.4% fell in group 36–70 years of age. 26 were men and 21 were women .Out of all patients 26 had pre op frankel grade E and 4pts had grade D and 10 pts had grade C and 2 pts had grade B and five pts had grade A preoperatively. Post operatively one patient of grade A remained same while other four improved to grade C in follow up and rest of all pts. improved to grade E in two year follow up. Pre-op cob's angle was 39.06 $\pm$ 10.92 (Mean$\pm$SD) which improved to -5.51 $\pm$ 4.77 (Mean$\pm$SD). P value is < 0.05. In comparison of visual analogue score there is also statistically significant difference in pain improvement. All patients had single stage radical debridement, decompression and instrumentation. Anterior coloumn reconstruction was done in all patients using standalone titanium cage.

Conclusion: The use of titanium cages effectively restores the sagittal deformity in TB spine with no donor site morbidity.

GO140. Anterior Column Reconstruction with Bundled Autologous Rib Graft after Thoracic Spinal Tuberculosis Debridement

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Introduction: Vertebral defects are created after radical debridement for spinal tuberculosis, which often require anterior spinal column reconstruction with a strut graft. Autologous rib can be harvested through the same skin incision and can be exploited to reconstruct anterior column defect for thoracic spinal tuberculosis. The purpose of this study was to assess the clinical efficacy of bundled autogenous rib graft for anterior column reconstruction after thoracic spinal tuberculosis debridement.

Material and Methods: Fifty-eight patients with a confirmed diagnosis of thoracic vertebral tuberculosis (T4-T11) between January 2008 and December 2013 were analyzed retrospectively. All patients underwent anterior radical debridement and immediate reconstruction using bundled autologous rib with anterior instrumentation. We retrospectively analyze the clinical and radiographic data.

Results: All patients were followed 24–42 months and achieved solid bony fusions. There was no slide, subsidence, migration and breakage of bundled autogenous rib and screw-rod system. No significant loss of deformity correction was noted. Spinal cord function was effectively improved in all patients who had incomplete paralysis before surgery. There was no recurrence of tuberculosis. Pleural damage occurred in 10 ases while the rib was harvested. They were treated successfully with repair and closed drainage after operation. Two patients suffered from intercostal neuralgia postoperative and were relieved using non-steroidal anti-inflammatory (NSAID). The length of the rib harvested intraoperative was 15–22 cm with an average of 17.1 cm. Length of bundled autologous rib was 1.5–4.6 cm with an average of 3.7 cm. Cross-sectional area of bundled autologous rib accounted for an average of 35% of the endplate area adjacently.

*Conclusion***s:** This case series demonstrates anterior radical debridement, graft and instrumentation are safe and effective methods for thoracic tuberculosis.The bundled autogenous rib graft and anterior instrumentation could work effectively to provide immediate stabilization for reconstruction of anterior column defect created by radical debridement for thoracic spine.

GO141. Classification of Dorso-lumbar Tuberculous Lesions. Prospective Analysis of 270 Radiological Lesions

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Introduction: Classification systems allow categorization of radiological similar lesions. Evaluation of differing clinical treatment modalities, helps formulate protocols. However no classification systems exists for dorso-lumbar (DL) tuberculous lesions, though surgeons continue to debate treatment strategies.

Material and Methods: 270 dorso-lumbar tuberculous lesions were surgically treated between 2001–2011. Preoperative radiology included X-rays (D1-S1), MRI and CT scan in all patients. Cervico-dorsal lesions were excluded. Categorization was based on anatomical location, extent of anterior osseous disease (AD), posterior element disease (PD) and site and matching of epidural disease (ED). Anatomical location: 1. Dorsal between D1 and D12 (117); 2. Lumbar between L1 and L5 (46); 3. Sacral: S1-S4 (6); 4. Cross over lesions: (DL 48, LD 29, LS 15, SL 9). If major AD was in L1 and lesser in D12 the lesions were called "Lumbo-Dorsal" cross over and vice versa. The terminology changed accordingly at Lumbo-sacral junction. Extent of Anterior Destruction: Distance between proximal and distal normal bone gave estimate of anterior defect (AAD) that requires reconstruction. There was statistically significant increase in AAD from Type 1 to 3. *Type 1 ($n = 37$):* Paradiscal erosion cavitation restricted to less than 50% of body-height. AAD was 2.7cms (1.8–3.2). *Type 2 ($n = 33$):* Central osseous destruction with cavitation reaching both end plates. AAD was 3.34cms (2.8–4.0). *Type 3 A ($n = 82$):* Less than 50% destruction in one and more than 50% in the other body. Significant cavitation reaching far end plate. Less than 50% circumference available for reconstruction. AAD 3.69cms (2.9 – 4.2). *Type 3 B ($n = 79$):* More than 50% destruction in both bodies. AAD 4.98cms (4.0 to 6.2 cms). *Type 4 ($n = 28$):* This includes types 1,2 and 3 with PD. *Type 5 ($n = 11$):* AD affecting more than 2 bodies in continuity. PD may or may not be present. AAD varies with each case and should be studied on the CT scan picture. *Site of ED:* This was predominantly anterior (152), posterior (21), hemispherical

(42), circumferential (30) or mixed pattern (25). Matching ED with AD: Matched ED ($n = 227$) meant that the site of ED was adjacent to osseous destruction; Un-matched ED ($n = 43$); Anterior unmatched compression (38). Anterior ED extended proximal or distal to AD; Posterior un-matched compression (6). ED was posterior when the lesion was anteriorly located.

Results: Inter-observer variability. 25 radiology sets were distributed to 4 authors. All recorded type 1,2,4 and 5 correctly on X-ray and MRI. Statistically significant variation was recorded between types 3A and B (7/15 type 3). CT scan, reduced variation significantly (2/15) Better delineation of AD aided decision-making. Variation in noting ED was insignificant. Four most common patterns were: 1. Dorsal, Type 3 A, anterior matched ED (42); 2. Dorsal, Type 3 B, anterior matched ED (30); 3. Dorso-Lumbar, Type 2, matched anterior ED (22); 4. Lumbo-Dorsal, Type 4, anterior matched ED (18).

Conclusion: Classification allows categorization of lesions and comparison of treatment outcomes. Improvisation in posterior surgery has intensified the on-going debate between anterior and posterior surgical approaches. Irrespective of approach, classification defines AD and PD that allows the surgeon to plan an approach that would provide a adequate spinal cord decompression and stable construct. The author's recommendations are: 1. Type 1, 2, 3A: anterior decompression and reconstruction; 2. Type 3 B and type 4 anterior reconstruction and posterior stabilization. CT scan is a useful to assess AD and planning reconstruction. The new classification is the first of its kind that promises comparison of radiological data.

GO142. Single Stage Anterior Corpectomy and Posterior Instrumentation in Tuberculous Spondylitis with Varying Degrees of Neurological Deficit

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Introduction: The study is an outcome of patients with tuberculous spondylitis, progressive neurologic deficit, and kyphotic deformity, who underwent single stage anterior corpectomy and posterior decompression with instrumented fusion

Material and Methods: 20 (6M:14F) patients with spinal TB and varying degrees of motor deficits underwent surgery during the past 7 years. The range of age was from 2 to 65 years old (mean age of 34.8 years).The average duration of symptom was seven months (ranging from 3 months to 1 year). Anti-tuberculosis chemotherapy was initiated in all patients and continued for more than four weeks until ESR $<$ 40mm/H before surgery. All had a minimum of 12 months of follow up (mean follow-up period 16 months). One patient had upper cervical disease, 10 patients had thoracic disease and 8 patients had lumbar or lumbo sacral involvement. The disease in 7 patients was characterized by Frankel Grade A/B (Medical Research Council Grade 0/5), in 8 patients by Frankel Grade C (unable to walk even with support) and 4 patients had Frankel Grade D (walk with support but weak legs) on admission. The kyphotic angle ranged from 5° to 40° before operation, with an average of 18° $\pm$ 12°. Three children below 10years of age underwent anterior corpectomy and debridement with rib or fibular grafts and posterior instrumented fusion. All the 17 patients underwent anterior corpectomy, debridement with cage insertion and posterior instrumented fusion. Physiotherapy was instituted in all patients.

Results: Local symptoms of pain were relieved significantly by three weeks postoperatively (mean VAS scores reduced from 6.8 to 2.7). 17/19 patients (89.4%) neurological deficit had excellent or good clinical results ($P > 0.05$). 6/7 patients improved from Frankel A/B to Frankel E (normal activity), ⅞ patients improved from Frankel C to Frankel E and all 4 patients with Frankel D became normal to Frankel 5. The average ESR was normal (10 $\pm$ 5mm/h) within 6 months in all patients. The average kyphotic angle decreased to 7 ° $\pm$ 5° postoperatively. Solid fusion was achieved in all cases. No significant loss of deformity correction was noted in these patients. Only one patient with lumbo-sacral disease showed recurrence after 18months of disease free interval.

Conclusion: Single stage anterior corpectomy with autogenous rib grafts or cage insertion and posterior instrumentation are safe and effective methods in the surgical management of spinal tuberculosis with neurological deficit. Combined single stage surgery helps to correct and maintain the deformity, foci clearance, spinal-cord decompression and pain relief in the treatment of tuberculous spondylitis.

Arthroplasty Cervical

GO143. Determination of the Center of Rotation for Flexion/Extension Before and after Insertion of 3 Different Types of Disc Prostheses, and Comparison with In-Vivo MRI-Derived Data from Healthy Volunteers

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Introduction: An in-vivo biomechanical study is presented investigating the Center of Rotation (COR) for flexion/extension before and after insertion of 3 different types of cervical disc prostheses. The aim of the study was to investigate whether the pre-operative coordinates of the COR deviate from that of Healthy Volunteers (COR-HV), and further whether and how the COR-coordinates change after insertion of the different disc prostheses.

Material and Methods: 15 healthy volunteers underwent MRI-investigation of their cervical spines. Data for flexion/extension were collected in 5 different positions from maximum extension to maximum flexion for determination of the COR-HV. Further, from 30 patients with a one-level cervical disc prosthesis (10 respective patients who received a Bryan-, Discover- or Prestige-prosthesis) the routinely taken pre- and post-operative cervical flexion/extension X-rays underwent graphical analysis for determination of the respective COR from C3/4 to C6/7. The pre- and post-operative CORs were compared with the corresponding CORs-HV.

Results: Concordant to the literature a different COR-HV was determined for each respective level from C3/4 to C6/7, and it could be demonstrated that the COR for flexion/extension shows migration during motion. In the patient-study, in all 3 subgroups (Bryan-, Discover-, Prestige-prosthesis) the pre-operative COR for flexion/extension deviated considerably from the COR-HV. After prosthesis insertion the coordinates of the COR changed in all levels from C3/4 to C6/7 regardless of the operated segment; in the Bryan-group the COR was shifted toward the COR-HV; in the Discover-group it was shifted away from the COR-HV; and in the Prestige-group it was shifted partly toward and partly away from the COR-HV.

Conclusion: It must be presumed that in patients who are candidates for cervical arthroplasty the COR is not congruent anymore with the COR in healthy individuals. Further,

the insertion of a disc prosthesis can change the position of the COR in all levels of the lower cervical spine, irrespective from the level of insertion. It seems that the biomechanical design of the implant can considerably influence the way how the COR changes its position: prosthesis with a simple ball-socket design could shift the already abnormal COR to an even more unphysiological position; devices with a more flexible biomechanical design however can contribute to normalize the COR toward the coordinates that were found in healthy individuals. Further studies on this topic with higher numbers of datasets should be undertaken to support the improvement of the biomechanical design of cervical disc prostheses.

GO144. Early Clinical and Radiographical Results of Single Level Cervical Arthroplasty with Discocerv®

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Introduction: Cervical disc arthroplasty has been shown to be as effective as fusion in radiculopathy in appropriately selected patients. Discocerv(Alphatec Spine,Carlsbad, USA) was introduced to reduce the difficulty of end plate preparation. Aim of this study is to evaluate the early results of clinical and radiographic outcome in patients implanted with Discocerv, which is semiconstrained mobile prosthesis made of ceramic bearings.

Material and Methods: From December 2008 to June 2012, 14 patients were enrolled in this retrospective study. They all suffered from single level radiculopathy due to acute disc rupture, and underwent total disc replacement with Discocerv. The mean follow-up period was 28 months (12~60 months). There were 8 males and 6 females and the mean age was 46.9 years old (39–66). The clinical outcomes were analyzed by using preoperative and postoperative follow up Korean version of neck disability index(K-NDI) and visual analogue scale(VAS). Also segmental motion was assessed by using dynamic flexion –extension lateral view, and heterotopic ossification or other complications were assessed.

Results: The mean VAS score improved significantly from 8 preoperatively to 0.3, 0.6 at one year, two years respectively and mean NDI score also improved from 28 preoperatively to 9, 6.4, 8.75 at three months, one year, two years respectively after operation. The mean segmental motion was 3.2 degree preoperatively and 4.7, 4.6, 6.6 degree at postoperative six months, one year, two years respectively and after 3 years, mean segmental motion decreased to 3.1 degree and to 1.9 degree at four years. Heterotrophic ossification was not detected in all cases, but anterior osteophyte formation at implanted segment was seen in 3 cases after three years. There was no radiologic complication related to wear. But 2 patients complained subjective discomfort as if they felt friction sound of their artificial joint.

Conclusion: Single level cervical arthorplasty with Discocerv showed good clinical outcomes and motion preservation sustained up to postoperative 3 years. Also, there were no major complications or no heterotopic ossification. However, 14% of patients felt friction sound by themselves.

GO145. Hybrid Constructs in the Surgical Treatment of Degenerative Cervical Disc Disease – Five-Year Clinical and Radiological Follow Up

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Introduction: In most of the patients with multisegmental cervical degenerative disc disease the certain segments can show different stages of degeneration and instability. This condition may require an individual surgical strategy and the use of hybrid constructs with the combination of fusion and motion presevation implants. Our study was designed to investigate the clinical and radiological outcome of the combination of cervical fusion and arthroplasty in a prospective cohort.

Material and Methods: 36 patients with symptomatic cervical radiculopathy and/or myelopathy underwent hybrid cervical surgery between 2007 and 2010 (14 two-level, 16 three-level and 6 four-level surgeries were performed). VAS for pain, Neck Disability Index, neurologic function and the radiographic parameters (range of motion at the level of prosthesis and the cranial adjacent segment, the intervertebral disc height of the adjacent segment, cervical lordosis, heterotopic ossification) were evaluated during the study period.

Results: Improvement in pain was significant and sustained 5 year after the surgery (dVAS= 5.0, $p < 0.05$). The segment of the prosthesis ultimately showed the preservation of motion when compared with preoperative values (the preoperative mean flexion/extension ROM was 8.2° while the postoperative ROM was 7.6°). The mean cervical spine lordosis was preoperatively 1.7°, postoperatively 16.2° ($p < 0.05$). None of the patients has required further surgery because of symptomatic adjecent segment disease.

Conclusion: The results of the study support the theoretic advantage of the use of hybird constructs in selected cases. In our cohort, the 5-year clinical and radiological outcome of the multilevel cervical hybrid surgeries are promising. However, long-term follow up studies are required to prove its role in the surgical treatment of the multisegmental degenerative cases.

GO146. Adjacent Segment Degeneration and Adjacent Segment Disease in Patients with Cervical Arthroplasty with 5 Years Follow-Up

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Introduction: Among the practical advantages of the cervical arthroplasty, the preservation of the movement could reduce the presentation of cases of adjacent segment disease and adjacent segment degeneration compared with anterior cervical fusion. It is estimated that ~90% of patients managed with anterior cervical fusion will present a new onset or progression of a degenerative adjacent levels, exhibiting symptoms during the first 10 years. Currently there are reports of reoperation of cases treated with this technique due to the presence of nonunion, bone collapse, migration of the implants and the development of adjacent segment disease.

Material and Methods: During the period between January 2005 and July 2010 were included 153 patients with an average age of 47.69 years (range 40–60 years, 56 men), who had a diagnosis of symptomatic cervical disc disease of 1 or 2 levels. All were treated by cervical arthroplasty prosthesis using the Mobi-C, Activ-C and ProDisc-C systems, searching for the presence of adjacent segment disease or degeneration according to the classification of Hillbrand. The monitoring was performed with clinical examination and radiological control in all patients with visits at 15, 30 and 60 days and periodically thereafter 6 months.

Results: The follow-up time was 60 months and only 11 cases (9.40%) of the 117 patients who were managed with

radiculopathy in 1 level showed adjacent segment degeneration during the 5 years of follow up. The average time that the degeneration was observed was 30 months, without observing changes in the first year of follow-up in any of the cases. In patients where 2 levels were handled, we found 3 cases of degeneration (8.33%), drawing attention that these were presented earlier manner (12–18 months) compared with only 1 level affected group. We found 7 cases (5.98%) in which adjacent segment disease was presented in patients with 1 level affected and 4 cases (11.11%) of involvement in patients with 2 levels affected. It was observed that 81.81% occurred in the upper segment and 18.19% in the lower segment. All patients who developed adjacent segment disease required revision surgery (11 cases), showing a positive trend during the monitoring period. No infections, spinal injuries or dural tears occurred. We did not observed the presence of collapse or migration of the implants. No mortality was documented during the study.

Conclusion: Cervical arthroplasty is an excellent tool for management of cervical radiculopathy, favoring the intervertebral movement and reducing stress, whereby the occurrence of adjacent segment degeneration and adjacent segment disease are diminished compared with anterior cervical fusion according to that reported in the literature.

GO147. Clinical and Radiological Outcome at the 10 Year Follow Up of Total Cervical Disc Replacement

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Introduction: There is still a lack of facts about long term impacts after implantation of a total cervical disc replacement (cTDR). The aim of this current analysis was to evaluate the long- term clinical results and efficacy, the radiographic findings of the index level as well as the adjacent level in a cohort of cTDR patients treated with ProDisc C (Synthes, Paoli, USA) 10 years after surgery.

Material and Methods: Clinical outcome scores and patient satisfaction rates were acquired within the framework of an ongoing single center prospective non randomized clinical trial. The patient`s employment status, complications, reoperations and further treatments due to symptomatic adjacent segment disease (ASD) were recorded. X-ray evaluation included the incidence of heterotopic ossifications (HO) according as well as the rates and timing of ASD. Follow up was recorded 1, 5 und 10 years after surgery.

Results: 38 patients were available for final FU, resembling a 80,8% FU rate after a mean FU of 122,9 months. The overall results revealed a highly significant improvement from baseline VAS and NDI levels at all postoperative FU stages ($p < 0{,}0001$). VAS scores demonstrated a statistically significant improvement (VAS neck 6.4 to 1.9; VAS arm 6.3 to 2.1 at the last FU). The NDI baseline values showed a stable improvement (21/50 to 6/50). Patient satisfaction rates remained stable throughout the postoperative course, with 78.9% of patients reporting a `highly statisfactory`or a `satisfactory´ outcome in 21,1%. The radiographic results demonstrated a noteworthy incidence of HO as well as a progression of the HO in process of time. HO Grade I appeared in 10%, Grade II in 10%, Grade III in 32%, and Grade IV in 26%. The overall complication rate (excluding HO) was 12%. The incidence of ASD was 32.3%. 70% of ASD were asymptomatic, none of the ASD patients need further surgery. Within this group of patients with ASD 80% of the patients presented with a high-grade HO with loss or reduced function of the prosthesis in the 5 year FU.

Conclusion: The results demonstrate that cTDR is a viable treatment option resulting in improved clinical outcomes and low rates of subsequent surgical procedures. The progression of HO with a high amount of non functional TDR may leads to the high figures of ASD.

GO148. Revision Surgeries Following Artificial Disc Replacement of Cervical Spine: Analysis of 21 Cases

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Introduction: The use of artificial disc replacement of cervical spine (C-ADR) has been advocated to preserve segmental motion and to prevent adjacent segment disease as an alternative to anterior cervical discectomy fusion (ACDF). Previous studies reported satisfactory clinical and radiological outcomes of C-ADR compared with ACDF. However, some patients with C-ADR undergo revision surgeries due to failure of C-ADR, such as persistence or recurrence of symptoms and complications. Therefore, we performed the current study to investigate causes and results of revision surgeries following C-ADR.

Material and Methods: Twenty-one patients (13 males and 8 females) were treated with revision surgeries for failure of C-ADR and had a minimum 2-year follow-up. Causes for revision surgeries were at least one of the following: 17 poor patient selections (severe spondylosis), 7 insufficient decompressions, 7 malpositions, 6 subsidences, 3 osteolysis, and 1 infection. The mean age was 52.8 years (range, 43–63 years) and mean time to revision surgery was 21 months (range, 4–84 months). During their initial surgeries, 14 patients underwent single-level C-ADR, 2 two-level C-ADR, and 5 two-level hybrid surgery for 16 radiculopathy, 3 myelopathy, and 2 adjacent segment disease. Clinical evaluation was done by neck and arm visual analog scales (VAS) and Neck Disability Index (NDI) score. Fusion status was evaluated by plain radiographs including flexion and extension lateral radiographs. Follow-up measurements were taken before surgery and postoperatively at 1, 3, 6, and 12 months, 24 months as well as at last follow-up. At the 24-month fololow-up, patients' overall satiafaction and final fusion status were evaluated by Odom's criteria and CT scan, respectively.

Results: Sixteen patients underwent anterior removal of C-ADR (8 MobiC, 4 Discovery, 2 Bryan, 1 Prodisc-C, and 1 Prestige LP), one-level discectomy and fusion with plate ($N = 11$), two-level discectomy and fusion with plate ($N = 3$) or corpectomy and two-level fusion with plate ($N = 2$). Three patients with keel types of C-ADR (2 Prodisc-C and 1 Prestige LP) and extensive heterotopic ossification were treated by laminoforaminotomy with posterior fusion. Two patients (2 Discovery) with kyphosis and severe bone loss due to infection or severe subsidence were treated by combined anterior and posterior approaches. NDI score and neck and arm VAS were improved after revision surgeries at each time point of follow-up. At the 24 months of follow-up, 86% ($N = 18$) of the patients was satisfied and 91% ($N = 19$) achieved solid fusion. However, 2 patients with pseudoarthrosis did not have sufficient pain to warrant the operative repair of the psuedoarthrosis. No major neurologic and wound complications were developed except transient dysphagia in 6 patients with mean recovery time of 1.7 months (range, 1–4 months).

Conclusion: Revision surgeries can provide successful outcomes in failure of C-ADR without major neurologic and

wound complications. Our results suggest that careful patient selection and meticulous surgical techniques, such as adequate decompression, proper positioning of C-ADR, and preservation of subchondral bone, are important to avoid revision surgeries for failure of C-ADR.

GO149. Surgical Treatment for Cervical Dislocation with Quadriplegia in a Young Child Aged 5 Years Old: a Case Report and Review of the Literature

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Introduction: Cervical dislocations with quadriplegia are extremely rare in young children (5 years and less) and many surgeons have no experience with this type of injury. Here we report on a case of a boy 5 years old with dislocated C3/C4 with incomplete quadriplegia and its treatment.

Material and Methods: The clinical and radiological findings were described. Because closed reduction failed, we decided to perform open reduction and fixation with a simple wiring technique through a posterior approach. We also reviewed the related literature.

Results: There was a significant improvement in neurological function during the follow-up period, and no complications developed. The boy was able to walk supported after 3 month although there is some residual spasticity

Conclusion: Cervical dislocation with quadriplegia in young children is a great challenge. Closed reduction and rigid immobilization remains the 1st choice, however surgery may be indicated in children if closed reduction fails, marked instability or neurological deterioration.

GO150. Predictors of Extended Hospital Stay after Cervical Disc replacement or Anterior Cervical Discectomy and Fusion: Results from 1,004 Patients in an FDA Trial

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Introduction: Extended hospital stay after surgery is costly to the healthcare system and can be distressing to the patient and family. While many studies have shown that the type of surgery influences length of hospital stay, there is a paucity of data on factors that extend hospital stay after single level anterior cervical surgery. We used the data from a large series of patients involved in two FDA Trials comparing one level cervical disc replacement to one level ACDF to identify factors that contribute to prolonged hospital stay.

Materials/Methods: Data from 1004 patients involved in the Investigational arm ($n = 518$) and Control arm ($n = 486$) of the Brian/Prestige CDR Trial were analyzed. The dependent variable of this analysis was LOS (length of hospital stay). The independent variables analyzed for their affect on LOS after CDR/ACDF included the following: *Demographic characteristics*, *Preoperative efficacy measurements* (NDI, SF-36, etc.) *Preoperative medical conditions and medication, Preoperative Neurologic Status* (motor function, Nurick-Gait, etc.) and *Intraoperative factors* (Operative time, EBL, etc.) Subjects with a LOS (defined as date of discharge - date of initial surgery) of zero days (same day discharge) or one day (over-night discharge) were compared with those with a length of stay greater than one day.

Results: An initial logistic regression analysis was performed. Treatment group was found not to be a significant factor in length of hospital stay between CDR and ACDF. Because of this, a second logistic regression model was created using all-comers data and included eight independent variables (Race, Tobacco Used, Weak Narcotic Medications, Arm Pain Score, SF-36 MCS, Preoperative Sensory, Gait and Operative Time) identified to be significant (p-value < 0.05) in the preliminary analysis. A total of 912 (90.84%) patients had a Length of stay less than or equal to one day (one midnight) and 92 patients (9.16%) had an extended length of stay greater than one day (two or more midnights). Three variables were determined to have a significant affect on increasing the length of hospital stay: Weak Narcotic Medications Usage (P=.021, O.R. 1.72), Nurick-Gait (P=.019, O.R. 1.796), and Operative Time. In particular, Operative Time is was found to be highly significant with p-value < 0.0001. With a one-hour increase in the operative time, the odds of longer hospital stay increase by 2.062. Comorbid factors such as Cardiac, DM, other diseases were found not to affect the hospital length of stay after CDR and ACDF.

Conclusion: We used the high quality data from a large cohort of patients involved in FDA trials and found Nurick-Gait, Operative Time, and History of Weak Narcotic Usage to be drivers of extended hospital stay. Importantly, we also found that there is no correlation between comorbidities such as Cardiac, DM, other diseases with length of hospital length of stay after CDR and ACDF. These data may be useful in preoperatively counseling patients, developing quality metrics for hospitals, and to help create financial models for cost/DRG reimbursement for single level anterior cervical surgery.

GO151. A Five-year Prospective Clinical and Radiological Review of a Semi-constrained Ceramic-Ceramic Cervical Disc Replacement

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Introduction: Artificial cervical disc replacement [CDR] has emerged as a viable treatment alternative to fusion for the management of symptomatic compressive radiculopathy and / or myelopathy. This paper evaluates the clinical and radiological outcomes of patients treated with a second generation semi-constrained CDR with a ceramic-ceramic articulation.

Material and Methods: We conducted a prospective cohort study of all patients undergoing a cervical disc replacement for cervical disc pathology, during the period from April 2007 to April 2010 using the Discocerv ceramic disc replacement. 42 patients were available for final clinical and radiological follow-up. Both, clinical and radiological evaluation was performed at each clinical visit at 6 weeks, 6 months, 12 months and 2 years and 5 years.

Results: Three patients were lost for follow-up. C5-C6 was the commonest level. There were 34 single level cases and 8 two level cases. The NDI improved significantly ($p < 0.05$) from a mean preoperative score of 56% to a score of 20% at final follow-up. The mean preoperative mobility at the index level unit was $12.2 \pm 4.5°$, this decreased to $7.9 \pm 3.2°$ at six weeks, but slightly increased to $12.9 \pm 2.9°$ at 1 year (gain not significant). Heterotrophic ossification [HO] was noted in 10 [23%] patients.

Conclusion: Based on our study of cervical disc replacement with a ceramic-ceramic bearing surface, this appears to be a viable option in the treatment of variety of cervical pathologies. This ceramic-ceramic interface eliminates potential problems like metallosis but further longer-term results should be reported.

Deformity Thoracolumbar Adolescent 4

GO152. Asymmetry of the Vertebral Body and Pedicles in the True Transverse Plane in Adolescent Idiopathic Scoliosis

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Introduction: Several studies have reported asymmetry of the vertebral bodies and between the concave and convex pedicles in AIS. There is ongoing debate about its magnitude and whether this caused by a primary growth disturbance, or is secondary to inherent asymmetrical loading within the curvature. The objective of this study is to quantify the asymmetry of the vertebral bodies and pedicles in the true transverse plane in adolescent idiopathic scoliosis (AIS) and to compare this with normal anatomy.

Materials and Methods: Vertebral body and pedicle asymmetry in the primary thoracic and lumbar curves were evaluated in the true transverse plane of the vertebral bodies on computed tomographic scans of 77 AIS patients with primary curves between 51–105° (thoracic) and 41–88° (lumbar). Magnitude of asymmetry was compared with the corresponding vertebrae in 32 non-scoliotic controls. Vertebral body asymmetry was defined as the percentage of left-right overlap of the vertebral endplates (i.e., 100% indicating perfect symmetry, 0% complete asymmetry). Additionally, the pedicle width and length, length of the ideal pedicle screw trajectory, transverse pedicle angle as well as amount of axial rotation were calculated for each level.

Results: Vertebrae showed asymmetry both in scoliotics and controls. In thoracic scoliosis, throughout the curve from end vertebra to end vertebra, there was on average significantly more asymmetry than in the controls over the same vertebrae (96.0% in AIS versus 96.4% in controls; $p = 0.005$). The asymmetry was more pronounced around the apex (95.8%) than at the end vertebrae (96.3%; $p = 0.031$). The lumbar vertebral bodies in AIS showed a similar pattern, with asymmetry being more pronounced than in controls (95.8% versus 97.2%; $p < 0.001$), but without significant difference between the apex and the end vertebrae. In the thoracic apex; the concave pedicle was significantly thinner (4.5 versus 5.4mm; $p < 0.001$) and longer (20.9 versus 17.9mm; $p < 0.001$) than the convex one, the length of the ideal screw trajectory was longer on the concavity (43.0 versus 37.3mm; $p < 0.001$) and the transverse pedicle angle was greater (12.3 versus 5.7°; $p < 0.001$). In the lumbar apex, the concave pedicle was shorter than convex (21.9 versus 24.5 mm; $p < 0.001$) and its transverse pedicle angle was greater (16.5 versus 9.5°; $p = 0.015$), there was no significant difference in pedicle width and the length of the ideal screw trajectory between concave and convex in the lumbar apex. The amount of axial rotation within the curve did not correlate with the vertebral asymmetry.

*Conclusion***s:** Even in non-scoliotic controls, there is a slight degree of asymmetry in the true transverse plane of vertebral bodies and pedicles. This vertebral and pedicle asymmetry, however, was slightly more pronounced in moderate to severe scoliosis patients, mostly around the rotated apical zones, with concave pedicles being thinner and longer. No linear relation between the amount of axial rotation and asymmetry could be observed in these severe AIS patients, suggesting that asymmetrical vertebral growth does not initiate rotation, but rather follows it as a secondary phenomenon.

GO153. Correlation between Spinal Coronal Profile and Proximal Femur Bone Mineral Density in Adolescent Idiopathic Scoliosis

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Introduction: Although Adolescent Idiopathic Scoliosis patients have lower Bone Mineral Density (BMD) but relationship between BMD and curve pattern, intensity of curve, or its progress in these patients is controversial. Some studies have shown a significant difference between left and right proximal femur BMDs in AIS patients. Since the curve pattern relationship with density of bilateral proximal femur has not been identified, this study aims to investigate the relationship between Spinal Coronal Profile and differences in BMD on either sides of proximal femur in patients with AIS.

Material and Methods: This study is prospective and included 50patients with AIS who underwent posterior or anterior and posterior correction and fusion surgery between December 2013 and december 2014. The mean age at the time of surgery was 16.6 ± 5.8 years. Bilateral proximal femur BMD and Z-score was calculated before surgery by dual-energy X-ray absorptiometry. We evaluated correlations between coronal parameters, obtained from preoperative radiographs, and the BMD ratio using Paired Samples Test analysis.

Results: Patients with Lenke type 1 curve (28; all with a right convex curve)have no significant difference between bilateral proximal femur density but in patients with Lenke type 5curve(22;all with a left convex curve)have greater bone mineral density on right side(concave).

Conclusion: The bilateral proximal femur BMD difference was significantly correlated with the coronal balance in AIS patients. When the patient have coronal imbalance the proximal femur BMD was greater in the concave side.

GO154. The Choice of Lower Instrumented Vertebra in AIS Comparison of Lenke, Suk and Dubousset Criteria

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Background: Distal extension of the selective fusion in AIS is currently among the most explored topics in literature especially for Lenke type 1 and 2 curves and a lot of variability in the distal extension of the fusion is noted among different specialized centers around the world.

Methods: This is a retrospective descriptive study examining 41 Adolescent Idiopathic Scoliosis (AIS) cases (Lenke type I or II curves) undergoing posterior selective fusion with a minimum follow up of 2 years. We assessed the concordance between Dubousset's, Lenke's and Suk's criteria in the choice of the Lower Instrumented Vertebra (LIV). Baseline and post-operative X-rays of 41 AIS patients presenting with Lenke type I or II curves treated with selective fusion were studied. For each patient, the LIV is determined according to Dubousset's, Suk's and Lenke's criteria. Based on these results, patients are divided into two groups. "Group 1" includes patients where LIV designated by Dubousset's criteria is identical to the LIV designated by Lenke's or Suk's criteria. "Group 2" includes patients where the LIV dictated by Dubousset's criteria is more distal when compared with the LIV

dictated by Lenke's and Suk's criteria. The charts of those 41 patients are reviewed at their last post-operative follow-up. The primary outcome measure used to compare those different groups is the frontal balance. The secondary endpoints are the (1) AP Cobb angle of the thoracic curve, (2) the AP Cobb angle of the lumbar curve, (3) the improvement of the Cobb angle of the thoracic curve (% ACT), (4) the improvement of the Cobb angle of the lumbar curve (% ACL), (5) the AP and lateral inclination of the LIV, (6) the AP lumbar Apical Vertebral Translation (AVT-L) and (7) the lateral Cobb angle of D5-D12.

Results: The LIV recommended by Lenke and the one recommended by Suk's criteria are identical in 70% of cases. The match between the choice based on Dubousset's criteria and the choice accounted by Lenke's or Suk's criteria is obtained for 70% of patients also. In 20% of cases, the LIV recommended by Dubousset's criteria is more distal than the one recommended by Lenke and Suk. Groups' comparison. Preoperatively, the comparison between groups 1 and 2 for the frontal balance and for the secondary endpoints shows no difference. Similarly, non-statistically significant difference was found between both groups for the primary and the secondary endpoints in the immediate post-operative setting and on the last follow-up.

*Conclusion***s:** The 70% accordance rate between Dubousset's criteria and those of Lenke and Suk attributes some validity to Dubousset's criteria. Thus, the statistical study showing no evolution toward a postoperative coronal imbalance or toward a worsening of other structural criteria of the spine curvatures in group 2, which is discordant with the recommendations of Lenke and Suk, prove the validity of the selection criteria of the LIV according to Dubousset. These same results also show that a more extensive distal correction-fusion does nothing for the frontal balance in the immediate postoperative setting, and even after several months of follow-up.

GO155. Low-density Pedicle Screw Constructs for Adolescent Idiopathic Scoliosis: Evaluation of Effectiveness and Cost

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Introduction: Optimal screw density and technique in treatment of idiopathic scoliosis remain unknown. We sought to find if low-density (LD) screw construct can achieve curve correction similar to that achieved with high-density (HD) constructs in adolescent scoliosis at substantial cost savings.

Materials and Methods: Patients treated operatively for idiopathic scoliosis at our center between 2007 and 2011 were identified through a retrospective database review. Each patient was treated with an LD screw construct. Radiographic outcomes included assessment of screw density, percent correction of major and fractional lumbar curves at follow-up, T5–T12 kyphosis, and angle of lowest instrumented vertebra (LIV). Costs were calculated and compared with costs of HD constructs.

Results: Forty-five patients met inclusion criteria. Ages ranged from 12 to 19 years (mean age, 14.9 years). Average construct density was 1.2 screws per fused level (range, 1.07–1.33 screws). Mean percent curve correction at latest follow-up: major curve, 67.2%; fractional lumbar curve, 69%. Average postoperative thoracic kyphosis: 30 degrees. Mean LIV angle: 5.6 degrees. Total screw cost was $13,370 per case in the LD group compared with $22,340 per case if all levels had been instrumented with 2 screws.

Conclusions: Our LD screw construct is among the lowest density constructs reported in the literature and achieves curve correction comparable to that reported for HD constructs at substantially lower cost.

GO156. The Physical and Mental Health in the Conservative Treatment of the Idiopathic Scoliosis

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Introduction: Idiopathic scoliosis may lead to physical and psychosocial impairment as it mostly appears before and/or during puberty. Both ability of young patients to confront the stress of a chronic disease and self esteem, affect their psychosomatic development and their future quality of life. Purpose of this study was to describe and evaluate health associated quality of life in patients with idiopathic scoliosis.

Material and Methods: In this study the physical and mental health of 69 young patients with idiopathic scoliosis was compared with a control group of the same age. The patients were treated with a Cheneau brace because of Idiopathic scoliosis with Cobb angles between 15°and 40°. We used a modified short form 36 questionnaire. We evaluated the eight sections of the SF-36 questionnaire in both groups (vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, mental health). The statistical analysis was performed with the Sigma Plot software.

Results: In comparison to the coeval control group (mean age 17,9 years) the group with idiopathic scoliosis (mean age 18,1 years) showed significant higher bodily pain levels. We did not observe any significant differences between the two groups in the sections of vitality, physical functioning, general health perceptions, physical role functioning, emotional role functioning, social role functioning and mental health.

Conclusion: According to our results, bodily pain is more intense by conservative treated patients with idiopathic scoliosis as in the control group. Nevertheless, psychological and psychosocial adjustment of these patients is the same as their contemporaries without significant differences.

GO157. Comparison of Surgical Outcomes by the Age at the Time of Surgery in the Treatment of Congenital Scoliosis: More than 10-year Follow-up

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Introducion: There is little information reported about the long term follow-up of surgical outcomes that pertain to the timing of surgery for congenital scoliosis in children under age 20 years. This study is to compare the surgical outcomes of posterior vertebral column resection (PVCR) for congenital scoliosis in children less than 20 years of age.

Materials and Methods: Forty-five congenital scoliosis patients ($N = 45$) under age 20 at the time of surgery were

treated by PVCR and fusion with PSF. These cases were retrospectively studied and had a minimum 10-year follow-up. We assigned patients into two groups: Group 1 ($N = 19$) patients who had surgery before 10 years of age, Group 2 ($N = 26$) those who had surgery after 10 years of age.

Results: In Group 1, the mean Cobb angle of the main curve was 44° before surgery, 10.2° after surgery, and 14.2° at last follow-up. In Group 2, the mean Cobb angle of the main curve was 48.7° before surgery, 17.2° after surgery, and 20.4° at last follow-up. The mean operative time was 189 minute (range: 70 to 405 minute) in Group 1 and 245 minute (range: 80 to 395 minute) in Group 2. The mean estimated blood loss (EBL) was 1285 mL (range: 270 to 3000 mL) in Group 1 and 2376 mL (range: 600 to 6000 mL) in Group 2. The mean fused segments were 3.3 in Group 1 and 4.6 in Group 2.

*Conclusion*s**:** In congenital scoliosis patients, PVCR is an effective procedure for the management of congenital scoliosis under age 20. PVCR and fusion with PSF for congenital scoliosis before the age of 10 years had significantly better deformity correction compared with the group after the age of 10 years and did not cause crankshaft phenomenon. The mean operative time and EBL in children under age 10 were both significantly less compared with children between 10 and 20 years of age.

GO158. Coronal and Sagittal Plane Correction in Adolescent Idiopathic Scoliosis (AIS) using All Pedicle Screw versus Hybrid Instrumentation. A Systematic Review

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Introduction: Using all pedicle screw (APS) technique for the treatment of AIS is said to be more effective than hybrid instrumentation (HI). However this has not been proven yet. This systematic review on studies comparing all pedicle screw and hybrid instrumentation in the treatment of AIS tries to answer this question.

Material and Methods: Pubmed and Medline Databases have been searched for articles from 1990 to June 2015 using the keywords "adolescent idiopathic scoliosis," "hybrid" and "screw." Only papers with full text in English were reviewed. Eleven articles met the inclusion criteria (only adolescent idiopathic scoliosis, main thoracic and thoracolumbar curves, posterior instrumentation and fusion only i.e., no anterior release, at least 2 of the parameters evaluated is mentioned preoperative and at final follow up "one coronal plane parameter and one sagittal plane parameter"). Ten of the articles were retrospective cohort studies and one was a prospective cohort study. Level of evidence for all of them was 3. The following parameters were evaluated preoperative and at final follow up: thoracic kyphosis, main thoracic Cobb's angle, coronal correction ratio, global sagittal balance and global coronal balance. The follow up duration ranged from 2 – 5 years. Meta-analysis could not been performed because of the heterogeneity of the data.

Results: The total number of patients was 614 (306 APS, 308 HI). The only significant difference found was the coronal correction ratio (67.71% in APS vs 58.34% in HI, $p = 0.001$). Thoracic kyphosis changed from 24.5° to 21.3° in the APS group and from 25.4° to 23.6° in the HI group ($p = 0.419$). Global coronal balance changed from 15mm to 8.8mm in the APS group and from 14.6mm to 8.9mm in the HI Group ($p = 0.811$). Global Sagittal Balance changed from (-7) mm to (-4.6)mm in the APS and from (-1)mm to (-3.6)mm in the HI group ($p = 0.344$).

Conclusion: Using all pedicle screw technique for the treatment of AIS may achieve better coronal plane correction. Contrary to the common belief, the use of Hybrid instrumentation does not lead to a better sagittal correction than all pedicle screw technique.

GO159. Selection of Lowest Instrumented Vertebra in the Management of Thoracolumbar and Lumbar Adolescent Idiopathic Scoliosis using Pedicle Screw Instrumentation

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[2]

Introduction: The aim of surgical treatment for adolescent idiopathic scoliosis (AIS) is correction of the three dimensional deformity, achievement of stability and preservation of as many distal motion segments as possible. In Thoracolumbar/ Lumbar adolescent idiopathic scoliosis (TL/L AIS) correction of C-shaped coronal curve into S-shaped saggital curve is a considerable challenge to a spine surgeon. In this regard, selection of Lowest Instrumented Vertebra (LIV) is of particular importance and remains controversial in literature. We conducted a retrospective study involving Lenke V patients to determine the exact distal fusion level (LIV) in the management of thoracolumbar/lumbar adolescent idiopathic scoliosis (TL/L AIS) using pedicle screw instrumentation.

Material and Methods: Analysis of radiographic parameters of 32 TL/L AIS was done. The patients were grouped according to the Lowest Instrumented Vertebra; Group I (fusion to L3, $n = 25$) and Group II (fusion to L4, $n = 7$). The Group I was subdivided into Group IA (L3 crosses the mid-sacral line with rotation of less than grade II on bending films, $n = 14$) and Group IB (L3 does not cross the mid-sacral line or rotation is grade II or more on bending films, $n = 11$). All of the patients in the Group II had the same location and rotation of L3 in bending films as that of patients in the Group IB. Patients with lowest instrumented vertebral tilt (LIVT) of more than 10° or coronal balance of more than 15 mm were considered to have unsatisfactory results.

Results: In these 3 groups, there was a significantly lesser correction in the TL/L curve and LIVT in the Group IB. Unsatisfactory results were obtained in 1 patients (7.1%) of the Group IA, in 7 patients (63.3%) of the Group IB, and in 1 patient (12.5%) of the Group II, which was found to be statistically significant.

Conclusion: In TL/L AIS patients undergoing treatment with pedicular screw instrumentation, the curve can be fused to L3 with good radiographic outcomes when L3 crosses the mid-sacral line with rotation of less than grade II on bending films. Otherwise, L4 should be selected as the Lowest Instrumented Vertebra.

GO160. Postoperative Evaluation of Sagittal Spinal Balance in Lenke 1A and 5C Type of Adolescent Idiopathic Scoliosis: A Prospective Study

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Introduction: The aim of the study to evaluate the effect on sagittal spinal balance parameters postoperatively between short segment Bone-On-Bone anterior spinal fusion (ASF) and selective posterior spinal fusion (PSF) treated adolescent idiopathic scoliosis (AIS) (Lenke1A & 5C) patients.

Material and Methods: This prospective study evaluates radiographs (lateral and AP view) for sagittal spinal balance parameters pre and postoperatively on 36 AIS (Lenke1A & 5C) patients, who were divided into two groups of 18 each according to the treatment underwent in a single clinical institute since 2006–2013.Group 1 underwent short segment Bone-On-Bone ASF (mean age 17 years, 12–25) and Group 2 with selective PSF (mean age 16 years, 12–27).

Results: In Group 1, lumbar lordosis and sacral slope decreased (mean pre-op 50.4 & 38.6 to mean post-op 36.0 & 35.4), pelvic tilt increased (mean pre-op 12.8 to mean post-op 14.5), whereas thoracic kyphosis and pelvic incidence were similar enough to pre-op values.

In Group 2, lumbar lordosis, sacral slope, pelvic incidence and pelvic tilt were decreased(mean pre-op 41.9, 35.5, 56.1 & 16.0 to mean post-op 34.1, 29.7, 52.7 & 12.1), whereas thoracic kyphosis similar enough to pre-op value.

Conclusion: According to our study, no significant difference found in sagittal spinal balance parameters postoperatively on radiographs between two groups except with slight decrease in lumbar lordosis post-op mean value in both groups. So, our study suggest that short segment Bone-On-Bone ASF and selective PSF procedures do not affect the sagittal spinal balance significantly in the treatment of Lenke1A and 5C type AIS cases postoperatively.

Surgical Complications 1

GO161. Junctional Kyphosis after Long Segment Fusion

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Introduction: The incidence of junctional kyphosis (JK) varies in the literature from 7% to 40%. We here present our experience with JK. The aim of this work is investigate the incidence of JK after long spinal segment fusion, to identify the underlying factors leading to its development, and to discuss treatment outcome.

Patients and Methods: This combined retrospective/prospective cohort study included sixty-four consecutive patients (40 women and 24 men) with a mean age of 20.7 years, who underwent long segment spinal fusion ($\geq$ 5 vertebrae) for treatment of spinal deformity. The average length of follow-up was 2 years. Risk factors analyzed included patients' factors, surgical factors, and radiographical parameters such as thoracic kyphosis (TK), lumbar lordosis (LL), sagittal vertical axis, pelvic tilt, and pelvic incidence.

Results: Radiological JK occurred in 14 patients (22%). Ten cases were proximal junctional kyphosis (PJK), two cases were intercalary junctional kyphosis (IJK), and two cases were distal Junctional Kyphosis (DJK). Only seven patients (50%) out of the 14 with JK were symptomatic. Six cases have undergone revision surgery. In nine cases, the original deformity was kyphosis (1 Ankylosing spondylitisS, 1 post-tuberculous, 3 Sheuermann's kyphosis, 4 congenital kyphosis). The other 5 cases were scoliosis (3 idiopathic and 2 congenital). Preoperative TK more than 40 ° was associated with PJK. In all cases PI, PT, SS, SVA were within normal range, but it was noticed that SVA had negative values in 5 cases. LIV in the dorsolumbar junction was associated with DJK.

Conclusion: Pre-existing TK more than 40°was identified as an independent risk factor. Negative sagittal balance may be a risk factor for PJK. A surgical strategy to minimize Junctional kyphosis may include careful preoperative planning for reconstructions with a goal of optimal postoperative alignment.

GO162. Intra- and Perioperative Complications with the Minimally Invasive Antero-lateral Approach (OLIF) to the Lumbar Spine

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Introduction: Anterior lumbar fusion is a common treatment option for a variety of pathologies. In the last years minimally invasive anterior approach techniques are considered standard. One of them, the extreme lateral transpsoas approach (XLIF) has become popular in the last years. Within this XLIF-approach neuromonitoring is considered mandatory to avoid neurological complications. An alternative lateral, oblique, psoas-sparing approach has been described in 1997. This approach, recently named OLIF (oblique lumbar interbody fusion), has been routine in our center over 15 years. The aim of the study was to evaluate the rate of intraoperative and perioperative complications of this antero-lateral ante psoas approach.

Material and Methods: A retrospective chart review was performed in a consecutive series of 812 patients who underwent minimally invasive anterolateral lumbar fusion in our institution between 1998 and 2010. Each patients record was reviewed by an independent observer. Patients demographics, diagnosis, co-morbidities, operative procedures, levels of surgery, operating time, intra- and perioperative complications etc. were analyzed.

Results: All patients were operated through a left-sided minimally invasive retroperitoneal oblique approach (OLIF) between L1 and L5. Indications for surgery were DDD, vertical and translational instabilities, tumor, fracture and revision surgeries. The mean age of patients was 61.5 years (16–88; 317 females, 495 males). Surgery was performed in 1205 levels and 62.3% were single level ($n = 506$) procedures. In the majority of the cases OLIF was part of a 360° fusion either dorsoventral ($n = 729$) or ventrodorsal ($n = 65$). In 18 cases a stand-alone anterior procedure was performed. Operating time averaged 110 minute. (range 30–410 minute) including the multilevel cases. The overall complication rate in direct relationship to the OLIF approach was 3.7% (30/812). The access-related intraoperative complications consisted of 3 vascular injuries (0.37%) and 3 radicular sensomotoric deficits (0.37%). In 6 cases (0.74%) we observed sensoric deficits combined with pain as donorside morbidity while harvesting a tricortical bone block out out the anterior iliac crest within the same approach. There were no abdominal or urological injuries. In the early postoperative period we experienced 2 superficial (0.24%) and 3 deep (0.37%) wound infections, 5 superficial (0.62%) and 6 deep (0.74%) hematomas. In 2 cases a postoperative paralytic ileus occurred.

Conclusion: This retrospective study reports about the access-related intraoperative complications of a large series of OLIF cases of the levels L1-L5 performed in a single center through a standardized left sided approach. The risk of neurolgical complications seems to be significantly lower compared with what is described with the extreme lateral transpsoas approach (XLIF). The risk of vascular, abdominal or urogenital injuries is low. There was no necessity for intraoperative neuromonitoring nor was there a necessity for a vascular surgeon. The OLIF is an easy and safe appoach for anterior lumbar interbody fusion from L1-L5 for a variety of pathologies.

GO163. Vertical Expandable Prosthetic Titanium Rib (VEPTR) Complications

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Introduction: This retrospective study evaluates the complications and radiographic results of 30 patients treated with VEPTR for correction of complex spine deformities in children.

Material and Methods: 30 cases of spine deformities followed up for a minimum of 2 year and maximum of 7 years, were retrospectively reviewed. 8 congenital malformation of spine, 3 infantile scoliosis and the others were spinal deformities associated with; spinal cord tumors, osteogenesis imperfecta, Jarcho Levin syndrome, spinal muscular atrophy, arthrogriphosis, myelomeningocele and congenital myopathy. The age at surgery varied between 2 and 12 years (6.65). We studied the postoperative change in cobb's angels (in antero-posterior and lateral views), space available for lung (SAL) and complication patterns in relation to number of lengthening operations.

Results: Complications: the complications rate was (36.6%). Complications varied from mortality "one case (3.3%)" to skin sloughing, surgical site infection, junctional kyphosis, metal failure, and pelvic hook migration. The average Cobb's angles preoperatively in the antero-posterior view were 86.8°, while the postoperative average was 55° (average correction 31.8°). The average (SAL %) was 82.3% preoperatively, and has been improved to become 93.5% postoperatively.

Conclusion: VEPTR represents a good alternative to "spine to spine growing rod techniques" and vertebral column resections "VCR" in spite of its complications rate with regard to the nature of deformity and number of "lengthening reoperations," however it should be used in well selected cases.

GO164. Why Does C5 Palsy Occur After Prophylactic Bilateral C4-5 Foraminotomy in Open-Door Cervical Laminoplasty? A Risk Factor Analysis

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Introduction: Prophylactic bilateral foraminotomy has been shown to reduce the risk of C5 palsy after open-door laminoplasty surgery. However, it does not totally eliminate it. Other factors such as inherent cord pathology may play a role in its development.

Material and Methods: A retrospective review to evaluate the efficacy of bilateral C4–5 foraminotomy in preventing occurrence of postoperative C5 palsy and to identify possible risk factors for its development was performed. A total of 70 consecutive patients who underwent open-door laminoplasty with bilateral C4–5 foraminotomy were included. Clinical, radiographic, and operative data were reviewed. Development of postoperative C5 palsy was analyzed.

Results: Fifty-four males and 16 females were reviewed. Mean age was 56 years (range, 30–86 years). The primary pathology was spondylosis in 76% of cases and ossified posterior longitudinal ligament in 21%. Radiographic evidence of C4–5 foraminal stenosis was seen in 81% of the patients. The mean duration of preoperative symptoms was 7 $\pm$ 19 months. Four (5.7%) out of 70 patients developed C5 palsy after open-door laminoplasty with bilateral C4–5 foraminotomy. Multivariate analysis showed that a long duration of preoperative symptoms (> 12 months) and the presence of preoperative C4–5 T2-MRI cord signal change were statistically significant risk factors for the development of C5 palsy even after bilateral C4–5 foraminotomy in open-door laminoplasty ($p < 0.0001$ and P 0.036 respectively).

Conclusion: While bilateral C4–5 foraminotomy may reduce post-laminoplasty C5 palsy when compared with the historical cohort, foraminotomies do not eliminate C5 palsy occurrence. Prolonged duration of symptoms and presence of preoperative T2-MRI cord signal change increased the risk for developing postoperative C5 palsy in laminoplasty patients who underwent bilateral C4–5 foraminotomy.

GO165. Efficacy of a Postoperative Infection Prevention Protocol in Spine Surgery

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Introduction: post operatory wound infection is an unwanted complication of spine surgery. Infection rate ranges from 2.1 to 5.5%, and the consequences in some cases can be devastating for the patient and for the medical team.

Material and Method: we compare post-operative wound infection incidence before and after the implementation of a wound infection prevention protocol specific for major spine surgery established in our Center in collaboration with the HealthCare Associated Infection Committee (HCAIC). Post operatory wound infection incidence was reviewed for 4 years after implementation. The protocol consisted on a 28 point check list, that included: skin preparation with chlorhexidine one day before surgery at home, and at entrance the morning of the surgery; strict control of blood glucose under 200mg/dL before surgery; programming instrumented surgeries preferably as the first surgery of the Operating Room (OR); OR with laminar air flow; OR temperature between 18°-22°C during surgery (64.4°-71.6°F); skin preparation with alcohol-based chlorhexidine and covering with adherent antimicrobial incise drapes at surgery; Cefazolin prophylaxis (or Clindamycin in case of β-lactam antibiotics allergy) no more than 60 minutes before skin incision and a new dose every 3 hours during surgery; strict control of patient temperature at 36°C(96.8F) with the aid of warming blankets (Bair Hugger®); maintaining a target Hemoglobin of 7–9 g/dL with restriction of blood transfusion indication; hematocrit and glycemia control after surgery and the morning after.

Results: After the introduction of the protocol we found a progressive reduction in the post operatory wound

infection rate in spinal surgery from 2.89% in 2009 (before the protocol), to 2,5% in 2010, 1,71% in 2011 and 1.56% in 2012. During the surveillance made by the HCAIC, we observed a rise in the infection rate during 2013 (2.02%) which was associated with breaches in protocol adhesion. The relevance of the check list control by the OR nurse was reinforced and the strict control of patient temperature at 36°C(96.8F) with warming blankets used before, during surgery and in recovery room was added. With this new update and more strict control of protocol adhesion, we reduced the infections rate to 0.95% in 2014.

Conclusion: We consider that a wound infection prevention protocol specific for spine surgery, with proper surveillance and strict follow-up, is an effective way for reducing the infection rate in spine surgery. Although, the microbiological environment for every center is different, we think that this protocol can be used as a guide for centers were this complication becomes an issue.

GO166. Intra-wound Vancomycin Reduces the Infection in Growth-Friendly Spine Surgery

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Introduction: Patients with Early Onset Scoliosis (EOS) who require growth-friendly spine surgery are known to be at high risk for infections and/or wound dehiscence. Several studies in pediatric and adult patients undergoing spine surgery have shown that vancomycin powder applied to the wound before closure significantly reduces the risk of postoperative infection. There are currently no studies that evaluate the efficacy of intra-wound vancomycin in reducing infection for patients undergoing growth-friendly spine surgery.

Methods: Data from 116 patients in a prospectively collected database with EOS of multiple diagnoses were reviewed. Patients were divided into two groups. From May 2002 through June 2013, there were 1036 VEPTR procedures in which no patient received intra-wound vancomycin. Beginning in June 2013, there were 161 consecutive EOS procedures having VEPTR surgery and all had intra-wound vancomycin powder. Patient groups were compared based on age, gender, diagnosis, type of surgery, ambulatory status, and bowel/bladder incontinence. Additionally, complications related to intra-wound vancomycin powder were reviewed.

Results: The pre- and post-vancomycin groups were similar with regard to age, gender, diagnosis, ambulatory status, and bowel/bladder incontinence. The groups were significantly different with regard to type of surgery (Table 1). Prior to the use of intra-wound vancomycin, the infection rate in VEPTR surgery was 5.7%. The patients receiving intra-wound vancomycin had a significantly reduced infection rate of 1.2%. ($p < 0.031$). Using multivariate logistic generalized estimating equation model to control for surgery type, infection rate was lower in the patients who received intra-wound vancomycin as compared with the patients who did not receive intra-wound vancomycin (1.2% versus 4.4%, $p = 0.066$). There were no complications related to the administration of intra-wound vancomycin.

Conclusion: Intra-wound vancomycin is safe and reduces infection rates for patients undergoing growth-friendly spine surgery.

GO167. Factors Leading to a Poor Functional Outcome in Spinal Meningioma Surgery: Clinical and Surgical Remarks on 173 Cases

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Introduction: Spinal meningiomas are common spinal tumors in most cases benign and with a good surgical prognosis. However, specific location, infiltration of spinal cord, vascular encasement or spinal root involvement can bring to a less favorable prognosis. Aim of this work is to systematically the influence of this factors in the neurological outcomes of our patients.

Matherial and Methods: 224 consecutive patients with spinal meningiomas treated from 1976 to 2013 in our institution were analyzed; among these 51 were excluded for incomplete clinical data or follow up. The remaining 173 cases were classified regarding to: sex, age, symptoms, axial location, Simpson Grade resection, Functional pre/postoperative status.

Results: Most recurring onset symptoms were pain (32,9%) and motor deficit (31,8%); Thoracic spine was the most severely affected (69,8%). The functional improvement on the follow up was observed in 86,7% of cases, 6,4% of patients resulted stable and 6,9% worsened; a low functional grade before surgery was connected to a lesser improvement after. Anterolateral meningiomas were the most represented (42,2%); a gross total resection (Simpson Grade I and II) was conducted in 98,8% and a macroscopically complete removal without dural resection or coagulation (Simpson III) was performed in 1,2%. 98,3% of meningiomas were classified as Grade I WHO. Recurrence rate was of 2,3% and 7 cases presented complications (4 of 7 required surgical procedure).

*Conclusion***s:** We can adfirm that negative prognostic factors in our study were: anterior or antero-lateral axial topography, long-lasting symptoms before diagnosis, WHO Grade > I, Simpson Grade resection II and III, sphincter involvement and worse functional grade at onset.

GO168. Incidental Dural Tears during Lumbar Surgery: Incidence and Management

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Background: In spite of the fact that Incidental dural tears (IDTs) is being a well known intra-operative complication during lumbar surgery, true incidence is not accurately known, and different techniques have been suggested for management.

Aim of the Work: Detect incidence of incidental dural tears (IDTs) in lumbar surgery with evaluation of our intra-operative technique used for management.

Materials and Methods: A total number of 834 degenerative lumbar spine cases were reviewed, during the period from 2008 till 2013 in our institutions. Among those cases 191 were recurrent cases. Cases complicated with IDTs were identified, managed intra-operatively using our technique that was based on many layers tight closure, cases with persistent leak that needs re-operation are identified and reviewed.

Results: The incidence of ITDs during lumbar surgery in our series was 7.3% (61 of 834 cases) During primary surgery it was 5.9% (38 of 643 cases), among recurrent cases it was 12% (23 of 191 cases), all cases were repaired intra-

operative using 3–0 vicryle suture and a muscle graft was sutured as an enforcing layer, tight closure of fascia, subcutanous, subcuticular layers and skin, no sub-fascial drains used. One case showed persistent leakage and 2 cases complicated with pseudomeningocele, cases of pseudo meningocele were managed conservatively and the case of leakage re-operated, with no further complications.

Conclusion: IDTs is a common complication in lumbar surgery with a higher incidence in recurrent cases. The corner stone in the management of IDTs is intra-operative identification and tight closure in many layers that was proved by our surgical technique, a success rate was 98.4%, one case of 61 cases (1.6%) needed a second operation.

Keywords: degenerative lumbar spine, dural tears, complication of lumbar surgery, CSF leakage

GO169. Spine Surgery under Spinal Anaesthesia

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Introduction: Spine surgery like discectomy, decompression and lumbar fusions are most commonly performed under general anesthesia, which can be associated with several perioperative morbidities including prone positioning morbidities (for example ocular complications especially in patients with single precious eye), nausea, vomiting, lung atelectasis, pulmonary aspiration, prolonged post-anesthesia recovery and special complications for high risk patients as those with chest problems and or liver problems. It may be possible to reduce general anesthesia complications rate if the procedure is performed under spinal anesthesia.This may also remarkably reduce postoperative pain.

Material and Methods: To investigate the safety and efficacy of spinal anesthesia in elective lumbar spine surgeries. A prospective study evaluating the relative morbidities associated with Spinal anesthesia for lumbar and lower dorsal spine surgery. 174 patients scheduled for spine surgery. 172 patients scheduled for lumbar surgery(revision posterior spinal fusion 11 patients, removal of instrumentation 5 patients, vertebroplasty 25 patients, 15 patients for soft TLIF, 23 patients for Posterolateral fusion, 26 for TLIF, 37 for decompression and 30 patients for discectomies). Two patients scheduled for dorsal 10–11–12 decompression and posterolateral fusion. The clinical outcome was determined by the presence of postoperative pain, the absence of anesthesia-related complications, and the overall postoperative recovery.patients satisfaction was evaluated by asking questions about their experience. 174 patients agreed to receive spinal anesthesia for the procedure . Recorded data for all patients included: age; total surgical time; occurrence of nausea, vomiting, atelectasis, or cardiopulmonary complication; ability to arise out of bed on the day of surgery; and the total number of inpatient hospital days. Postoperative pain and satisfaction were assessed Formularbeginn.

Results: There were a total of 174 patients, with a mean age range from (16–75 years). The patients undergoing spine surgery with spinal anesthesia.operative time range from (45–300 minutes) The spinal anesthesia were different with respect to the expected surgical time, pain assessed with a linear visual analogue scale, hospital stay, or the likelihood of arising out of bed on the day of surgery. There were no major cardiopulmonary complications. Patients with spinal anesthesia had no nausea and vomiting.spinal anaesia produce hypotension and decrease blood loss. These patients were able to help us at positioning at the beginning of surgery. Intraoperative talks or interactions was possible. Blood loss range (50cc-1200cc) We need to inject extra dose during surgery in 7 cases and only one 3 level revision lumbar case last for 5 hours we need to convert after 3 hours to general anesthesia . Postoperative patient can eat immediately. Delayed assessment of the full neural recovery is the only drawback.

Conclusions Lumbar spine anesthesia as an alternative to general anesthesia in spine surgery has shown less blood loss, better surgical field better postoperative pain control, less postoperative nausea and vomiting and less positioning complications.

Basic Science 1

GO170. The 10,000-Fold-Effect-Retrograde Neurotransmission-a Newer Concept for Paraplegia's Physiological Revival-use of Intrathecal Sodium Nitroprusside in 100 Cases-A Priliminary Report

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Background: Methylprednisolone has shown level-1-benefit (20%) in traumatic paraplegia cases (but within-8hrs) yet disproved by many studies. Patients wait long for physiological recovery. Intrathecal-Sodium-Nitroprusside (ITSNP) has been used in literature to relieve vasospasm-due-to-subarachnoid-hemorrhage. ITSNP has been studied here for physiological recovery in paraplegia cases of various etiologies in a wide-window-period-range.

Two mechanisms for acute-cases and one-mechanism for chronic-cases, which are interrelated, are being proposed for physiological recovery. (a) Retrograde-Neurotransmission (acute-cases). 1. *During Normal excitatory impulse:* at synaptic-level, glutamate activates NMDA-receptors, having Nitric-Oxide-Synthetase(NOS) on postsynaptic-membrane, for further propagation by calcium-calmodulin-complex. Nitric-Oxide (NO produced by NOS) travels backward across chemical synapse, binding to axon terminal (NO-receptor/sGC) of presynaptic-neuron, regulating-Anterograde-Neurotransmission (ANT) called Retrograde-Neurotransmission (RNT).The-haem is the ligand binding site of NO receptor/sGC. The affinity of haem exhibits 10,000-fold excess for NO than Oxygen (THE=10,000-FOLD effect) completes in 20msec. 2. *In Pathological conditions:* normal-ANT, synaptic-activity including-RNT is-absent. NO-donor(SNP) release NO from NOS at postsynaptic-region. NO travels backward across a chemical-synapse to bind to the haem of NO-receptor at axon-terminal of a presynaptic-neuron, generates-impulse, as in normal-condition. (b) Vasospasm (acute-cases). Perforators show vasospastic activity. NO vasodilates the perforators by NO cAMP pathway. (c) Long Term Potentiation (LTP) (chronic-cases). NO–cGMP-pathway plays a role in LTP at many synapses throughout the CNS, and at neuromuscular junction. The LTP has been reviewed both generally and with respect to specific brain regions for memory/learning. LTP plays an important factor for relief from paraplegia in chronic cases.

Aims/Study Design: Principle of "generation-of-impulses from presynaptic-region to postsynaptic-region by-RNT, vasodilatation of arteriolar-perforators and LTP is the basis-of-authors' hypothesis to treat-acute-and-chronic-paraplegia-cases. Case-control-prospective-study.

Material/Methods: 200 paraplegia patients {100 patients taken as control (50 with no superfusion and 50 with dextrose 5% superfusion) and 100 patients taken as in ITSNP-group} were studied here. The mean time for superfusion was 14.11 days. ITSNP administered at a dosage of 0.2 mg/kg bo wt at L3/4 level by 24 G LP needle. Pre and post ITSNP was monitored by SSEP/MEP.

Results: AFTER-2-HOURS in ITSNP-group MEAN-CHANGE-FROM-BASELINE-ASIA MOTOR/SENSORY-SCORE 13.84%/13.10%, after-24 hours MOTOR-1.27-points decrease (3.77%) and SENSORY 10.5 points-increase(6.22%)as compared with Control-group no-change noted upto 24 hours, At-7days ITSNP motor/sensory;11.56%/6.22% as compared with Control-group 7.60/4.48%, At-2months in ITSNP 27.69%/6.22% as compared with Control-group 16.02/4.5%. SSEP/MEP-documented-improvements-noted.

Conclusions: ITSNP, a-swift-acting-drug in treatment-of-paraplegia, is effective within-two-hours (mean-change-MOTOR-13.84%andSENSORY-13.10%) on-mean14.11th post-paraplegia-day with a small-detrimental-response after-24 hours which-recovers-fast

GO171. An Experimental Study on the Treatment of Spinal Cord Injury in Rats by Tissue Engineering Method that Uses ADSCs Modified by BDNF and NT-3 Double Genes Combing the use of SFCS

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Introduction: Adipose-derived stem cells (ADSCs) possess the potential of multi-differentiation which could differentiate into neuronal cells and Schwann cells under certain conditions. If we inoculate the ADSCs modified by Brain derived neurophic factor(BDNF) and Neurotrophin-3(NT-3) double genes on the silk fibroin/chitosan (SFCS), and transplant it into 2 mm pre-made spinal cord transection animal model, we can take advantage of the characteristic of ADSCs which could express BDNF and NT-3 stably after being double gene modified and the advantage of tissue engineering, we look forward to providing a new treatment method for spinal cord injury (SCI), which thereby could reduce SCI morbidity and mortality rate, so as to build up a solid theoretical foundation for the clinical treatment of SCI.

Material and Methods: According to the preliminary design, animal experiment is divided into seven groups: Group A: SFCS/ADSCs/Lenti-BDNF-GFP-NT-3-RFP, namely, BDNF and NT-3 double genes co-transfect ADSCs combining SFCS group; Group B: SFCS/ADSCs/Lenti-BDNF-GFP, namely, BDNF single gene transfect ADSCs combining SFCS group; Group C: SFCS/ADSCs/ Lenti-NT-3-RFP, namely, NT-3 single gene transfect ADSCs combining SFCS group; Group D: SFCS/ADSCs/Lenti-eGFP, namely, empty vector transfect ADSCs combining SFCS group; Group E:SFCS, namely, single SFCS group; Group F:only cut off spinal cord and without treatment; Group G: normal control group, just open the vertebral plate without any treatment. Group A, B, C, D and E transplant the scaffold into 2 mm spinal cord transection defect rat model. Group F cuts off spinal cord and makes 2 mm defect, Group G is normal group. Do a BBB scoring at 1 w, 4 w, 8 w and 12 w after surgery to analyze functional recovery, execute the rats 12 w later, take out the scaffolds, test them by HE staining, immunehistochemical staining (NSE, GAP-43, Caspase-3, GFAP), LFB staining, RT-PCR and Western blot, the purpose of which is to observe the effect of tissue engineering on the recovery of SCI.

Results: Group A (BDNF and NT-3 double genes modified ADSCs combining the use of SFCS group) has a better repair effect on rats spinal cord transection injury treatment, which reveals higher BBB scores, increased GAP-43 expression, more positive NSE cells, decreased expression of GFAP and Caspase-3. At the same time denser regenerating nerve fiber could move through the scaffold, and the most important thing is the repair effect of Group A is better than single gene modified Group B and Group C, which is better than Group D (empty vector transfect ADSCs combining SFCS group), which is better than Group E (single use SFCS), which is better than Group F (just cut off spinal cord and without treatment).

Conclusion: Under the guidance of tissue engineering method, ADSCs modified by BDNF and NT-3 double genes combining the use of SFCS can significantly reduce the inflammatory response after injury, inhibit scar hyperplasia and cell apoptosis and promote nerve fibers regeneration and the differentiation of ADSCs into neurons in vivo, so as to improve the repair effect of rat spinal cord transection injuries, which provides a new method for the treatment of SCI.

GO172. Does the Location of Prophylactic Vertebral Cement above Long-Segment Fusion Constructs Effect Endplate Stress: A Finite Element Model

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Introduction: Proximal junction kyphosis (PJK) is a well-described post-operative complication associated with long-segment fusion constructs often utilized in the treatment of kyphotic and scoliotic deformities. The surgical creation of a stiff upper segment along with patient osteoporosis has been suggested as etiologies. Prophylactic vertebroplasty has been proposed to reduce the rate of PJK, but results in the transfer of force to the next cranial unadulterated vertebral level, which is at risk of failure. An in vitro biomechanical study has already been performed using 15 fresh frozen T6-pelvis specimen, which were instrumented from T10-S1 and a tapered dose of prophylactic vertebral cement was injected into T10 (UIV), T9 (UIV +1), and T8 (UIV + 2) and loaded in flexion until failure. Results demonstrated tapering the dose of vertebral cement significantly reduced the rate of vertebral fractures. In this present study, an experimentally validated finite element (FE) model was used to explore the hypothesis that the location of the tapered cement within the vertebral bodies may further influence the rate of PJK.

Materials and Methods: A validated FE T6-pelvis spinal model was used for the analysis. An osteoporotic model was developed and modified by the insertion of screws and rods from T10-S1, and the placement of a tapered dose of vertebral cement into T10 (UIV, 4cc), T9 (UIV + 1, 3cc), and T8 (UIV + 2, 2cc). Various cement locations (anterior, right lateral, and left lateral; Fig. 1) and configurations (staggered; Fig. 2) were analyzed and compared with the surgically accepted gold standard of central cement placement within the vertebra. Load was applied 10mm anterior to the center of the T6 vertebrae to simulate a flexion moment and the pelvis was fixed (Fig. 3). Endplate stresses (T7-T10) along with posterior ligamentous strain were recorded.

Results: Anteriorly placed cement at T8 resulted in a 21% decrease in maximum superior endplate stress as compared with as the surgically accepted gold standard of

centrally located cement. Anteriorly placed cement at T9 resulted in a 26% decrease in maximum superior endplate stress when compared with centrally placed cement. Maximum stress at the superior and inferior endplates of T7 was similar for anterior versus centrally placed cement. There was no benefit in staggering the cement and resulted in T7-T10 endplates stress and ligament strain that were similar to centrally placed cement. Posterior ligamentous strain was reduced ~2% at the T8-T9 level with anterior placement of cement when compared with centrally located cement.

Conclusions: Parametric analyses afforded the ability to simulate different cement configurations. The results demonstrate that anterior placement of prophylactic vertebral cement is potentially advantageous when compared with the surgical gold standard of centrally placed cement in this FE model. A decrease in maximal endplate stress is beneficial, and translates to an increase in force required for endplate failure. Stresses at the endplates of T8 and T9 reduced considerably with anteriorly placed cement, and one could extrapolate that these vertebral bodies would be less prone to fracture and PJK. Posterior ligamentous strain was also reduced with anteriorly placed cement. However, alternating or staggering cement placement did not affect endplate stress or ligamentous strain. This study may benefit patients and surgeons when long-segment fusion constructs are indicated. The effect of anterior cement placement when prophylactic vertebroplasty is utilized may result in a biomechanical advantage reducing endplate stress and rates of PJK, proximal junctional failure (PJF), and revision surgery. Further clinical evaluation is required.

GO173. Assessment of a Learning Strategy among Spine Surgeons

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Introduction: AOSpine educational program was developed to expand knowledge and to promote integration among spine surgeons around the world. Nowadays, however, there are no available data of the effectiveness of the learning process and the level of competence acquired by participants in such activities. The aim of this study is to evaluate, objectively, the knowledge transfer provided thorough theoretical and practical activities during AOSpine courses for spine surgeons.

Material and Methods: During two principles courses of spine surgery, sixty-two participants underwent to precourse assessment about their professional experience and preferences of adolescent idiopathic scoliosis (AIS) classification, as well as a test of curves by means of Lenke classification of two AIS clinical cases. Two learning strategies were used during the course: oral lectures and practical exercises. A postcourse questionnaire was applied to retest the same deformity cases. Differences of correct answers of clinical cases between pre and post course were analyzed, revealing the number of participants who improve in the accuracy of the classification after the course.

Results: A total of 62 participants were included in the study, wherein 51 (82%) were orthopedic surgeons and 11 (18%) neurosurgeons. Analysis showed a decrease in the number of participants with wrong answer in both cases, after the course. In the first case, statistical significant differences were observed in both, curve pattern (83.3%, $p = 0.005$) and lumbar spine modifier (46.6%, $p = 0.049$). No statistical significant improvement was seen in sagittal thoracic modifier (33.3%, $p = 0.309$). On the second case, statistical improvement was obtained in curve pattern (27.4%, $p = 0.018$). No statistical significant improvement was seen regarding lumbar spine modifier (9.8%, $p = 0.121$) and sagittal thoracic modifier (12.9%, $p = 0.081$).

Conclusion: This study showed, objectively, that learning strategies used during AOSpine courses, improved the knowledge of participants. This knowledge acquisition was demonstrated through the decreased number of participants with wrong answers of two clinical cases, after the course. Teaching strategies must to be continually improved to ensure optimal level of knowledge transfer.

GO174. Polymorphism in the C-terminal Cytoplasmic Site, Arginine Phosphorylation Site and 3′UTR of Connexin 43 and its Association with the Progression of Disc Herniation

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Introduction: Intervertebral disc being an avascular tissue, the gap junction protein connexin play an important role in nutrient and extracellular matrix protein play a major role in its structural stability.The pathophysiology underlying the process of Disc Herniation is still not clear but genetic factors play a vital role in the early occurrence of the disease. The study was initiated to determine the association of Connexin 43 gene polymorphisms and protein levels in Disc herniated patients in comparison to healthy individuals in Indian population.

Methods: Pre Operative blood samples were collected from 20 patients undergoing surgery for disc herniation between the age group of 20–60years and 10 samples from healthy individuals with no history of Intervertebral disc disease. DNA was isolated, primers designed for exonic and UTR regions of Connexin 43 performed PCR and samples sequenced for analysis of polymorphic variants. Genotypic and phenotypic distributions were compared with Healthy controls. Hardy Weinburg calculations were done to correlate the allelic/genotypic frequencies in the both study groups. Levels of Connexin 43 were assayed by sandwich ELISA by utilizing a standard Streptavidin-HRP format.

Results: The sequencing of amplified PCR product of connexin 43 resulted in identification of 14 variants in the cytoplasmic region and 6 variants in the 3′UTR. The variant thr326pro, arg362 gln, arg366lys and arg376 gln were statistically significant. In the 3′ UTR there were 6 variants and almost all the herniated samples had 1 or 2 variants with C12508T statistically significant.There were multiple variants in individuals below the age of 40 years. Genetic variants both homozygous as well as heterozygous were more common in lower age groups of 20–40. The levels of connexin 43 were

very high in herniated samples as compared with control ($p < 0.0453$).

Conclusion: Connexin43 polymorphisms at amino acid position 362 CGA-CAA (arginine to glutamine) and 376 CGG-CAG (arginine to gluramine) in herniated samples could hinder the hexamerisation of Connexon gap junction channel .The amino acid 362 and 376 are the binding sites for connexon hexamers after phosphorylation at the C- terminal region of the transmembrane protein.The functional connexin 43 is a transmembrane form. This shows that the 3′UTR polymorphism increases their expression but the protein does not get incorporated into the membrane due to polymorphic variants at the site of Arginine phosphorylation (position 362 and 376) and therefore is not physiologically functional. This profound reduction in gap junction channels could cause both nutrient and oxidative stress as the disc tissue is an avascular tissue the mode of channelizing between tissues is via the connexin gap junctions. The 3′UTR variants of connexin 43 can induce an increased expression of the mRNA . This study was further extended to check the levels of the protein in the disc lysates of herniated and control samples by ELISA. The Connexin 43 levels were very high in diseased samples ($p < 0.0453$) which can be hypothesized as biophysically nonfunctional gap junctional protein localized in the cytoplasma due to polymorphic variants at the site of Arg phosphorylation site which is one of the post translational requirements for hexamerisation of the connexin 43 and insertion into the membrane as channels. This is the first study to report a SNP associated mutation in *gap* junction protein Cx43.

GO175. Effect of Posterior Dynamic Instrumentation on High-Intensity Zone in Lumbar Degenerative Disc Disease

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Introduction: To investigate high-intensity zone (HIZ) changes after lumbar posterior dynamic instrumentation.

Material and Methods: Our study included 53 patients: 27 patients in group 1, 26 patients in group 2. All patients had one or two levels of degenerative disc disease with an HIZ confirmed by magnetic resonance imaging (MRI). Group 1 underwent one- or two-level dynamic lumbar posterior instrumentation. Group 2 was treated conservatively with an exercise program. Patients were evaluated using MRI, a numerical visual analog pain scale (VAS), and the Oswestry Disability Index (ODI) at baseline, at 1 year after surgery, and at final follow-up evaluation.

Results: The mean duration of follow-up was 49.3 months in group 1 and 47.19 months in group 2. The baseline VAS and ODI scores were similar for both groups. The mean VAS score of group 1 was significantly improved at 1 year after surgery and at final follow-up. The mean ODI value was lower in group 1 than in group 2 at 1 year and at final follow-up. Pfirrmann grades in group 1 significantly differed at 1 year and at final follow-up but did not change in group 2. The number of HIZs significantly decreased in from baseline to 1 year and from baseline to final follow-up in group 1 but did not differ in group 2.

Conclusion: Dynamic lumbar stabilization systems are promising. Observations such as Pfirrmann grade improvements and disappearance of HIZs are concordant with improvements in VAS and ODI scores demonstrate that dynamic stabilization systems may provide an environment for regeneration.

GO176. Innate Lymphoid Cells are Present at Healthy Patients Spinal Enthesis, Providing a Potential Mechanism for Spondyloarthropathy Pathogenesis

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Background: The pathogenesis of murine spondyloarthropathy (SpA) has been intimately linked to the presence of Interleukin(IL)-23 responsive, innate like lymphocytes at different anatomical regions including spinal enthesis. Human SpAs are associated with Single nucleotide polymorphisms (SNPs) in genes related to the IL-23 pathway and drugs that block IL-12/23 have shown efficacy. We hypothesized that the normal human enthesis has a population of resident innate lymphoid cells (ILCs) that could be involved in governing entheseal immune homeostasis. In particularly entheseal resident type 3 ILCs (ILC3s) may be critical, since ILC3s in other tissues have been shown to produce inflammatory cytokines in response to IL-23.

Methods: Normal spinal enthesis were harvested from healthy patients undergoing spinal surgery and enzymatically digested prior to fluorescence activated cell sorting (FACS). Cellular immunophenotyping and cell sorting was performed on enthesis samples harvested from 6 patients; ILC3s, were identified as lineage (CD3- TCRγδ- TCRαβ- CD19- CD14- CD11c- CD1a- CD303- FcεRI- CD34- CD123-) and cellular surface marker CRTH2 negative with positive expression of CD45, CD127, CD117. ILC2s, which have been linked to fibrotic reactions, were identified as lineage negative with positive expression of CD45, CD127 and CRTH2. The expression of RORγt transcript was tested in sorted populations by RTqPCR. Anterior cruciate ligament (femoral enthesis) was obtained from subjects with knee OA and injured enthesis undergoing repair were also collected and analyzed by immunohistochemistry (IHC).

Results: All sorted samples contained ILC3s, median proportion 0.09% (range 0.015–0.63). Transcript analysis confirmed the expression of RORγt, transcript, an ILC3 related transcription factor, in sorted ILC3 populations, with ILC3s expressing 51-fold greater relative expression in comparison to unsorted digests. 5 of 6 sorted samples contained ILC2s, median proportion 0.20% (range 0–0.49). RORγt expression was detected in knee OA and there was widespread expression of RORγt in inflammatory infiltrates in injured enthesis as shown by IHC.

Conclusions: Our findings show that ILCs are present in the normal human spinal enthesis and may be greatly increased in frequency following injury. These findings provide strong evidence of ILC presence in normal human enthesis and suggest a potential link between cellular dysregulation of the IL-23/17 axis and SpA pathology at sites of micro damage.

GO177. Adipose-derived Stem Cells as a Potential Additive Therapy in Chronic Compression Neuropathy in Rodents: a Diffusion Tensor Imaging Study

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Introduction: Compression neuropathy and nerve root compression are a leading cause of morbidity as well as a major cause of work impairment. Surgical and conservative treatments are widely used but there is still a lack of long-lasting effects. We seek to provide an additive therapy consisting of injected adipose-derived stem cells (ASCs) in the epineurium of a chronic nerve compression rodent model.

In animal studies, evaluation of peripheral nerve injury and therapy monitoring is commonly performed using clinical scoring and histopathological workup. Recent developments in magnetic resonance imaging allow for the direct evaluation of nerve fiber integrity. Here we present the evaluation of this imaging method, diffusion tensor imaging (DTI) in the context of chronic sciatic nerve compression.

Material and Methods: We created a compressive lesion with a polymer clip on the left sciatic nerve of Sprague-Dawley rats. 0.5 million ASCs were injected in the epineurium under ultrasound guidance two weeks after the crush injury in a first group. The second group was injected with culture medium as control. The clips were removed in a third group who benefited from an intraoperative injection of ASCs and a fourth group underwent the same procedure but received the sham injection. Gait analyses with calculation of the Sciatic-Function-Index using a computed track were performed before the cells or sham injections as well as after two and four weeks. Two weeks post injection, respectively four weeks, post-mortem imaging was acquired on a 3-Tesla scanner. The Fractional Anisotropy (FA), a measure of fiber integrity, was measured for the proximal and distal part of the lesion and for the contralateral nerve. Afterwards, histomorphometry of cross sections of the nerve, histochemistry for muscle fiber typing and calculation of the gastrocnemius muscle weight ratio were undertaken.

Results: The FA showed no differences between the injured and uninjured side at the proximal site. Distally, the FA was clearly reduced on the injured side. The FA in the group treated with ASCs who underwent clip removal was significantly higher as well as the FA ratio (distal value/ proximal value). These findings could be correlated with clinical and histological analyses that showed faster regeneration and faster clinical recuperation in this group associated with reduced muscle atrophy.

Conclusion: ASCs alone seem to be insufficient to provide a clinically relevant treatment in this context of severe crush injury. Nonetheless, regenerative cells could be an interesting additive therapy after surgical decompression. Furthermore, our results indicate that DTI may be used to quantitatively assess sciatic nerve injury after treatment using ASCs in a rat model.

Cervical Fusion

GO178. Right versus Left Sided Exposures of the Recurrent Laryngeal Nerve (RLN) and its' Branches- A Fresh Cadaveric Study Relevant to the Cervical Spine

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Introduction The higher vulnerability of RLN in anterior approach to the cervical spine on the right versus left sides is the subject of ongoing debate. While most cadaveric studies have focused on in situ variations in course and local structural relations of the RLN as a suitable guide, they have mostly been done in preserved (fixed) cadavers or without relevance to the needs of spinal exposure.

Our aim was to perform surgically relevant exposures of the anterior cervical spine with particular attention to observing the potential vulnerabilities of the RLN on right and left side in fresh cadaveric specimens. In addition, we aimed to explore its branches.

Materials and Methods: 12 cadavers had extensive layer by layer dissections by 2 surgeons (one with extensive experience as anatomy dissector). The RLNs and its branches were exposed in their entire length and explored for vulnerability. (Each stage was photographed)

Results: In all specimens, we demonstrated that right sided approach clearly causes undue stretch of the nerve and its branches particularly below C5 (photographed). The left side provided a good exposure without undue traction on the nerve. However, the terminal oesophageal branches of the nerve were especially vulnerable to this stretch or direct pressure on the left side.

Conclusion: Traction neuropraxia of the upper oesophageal branches of the RLN nerve may provide an alternative explanation for the transient post-op dysphagia (upto 60%). The laryngeal supply of the RLN benefits from Galen's anastomotic nerve supply of SLN (Ansa of Galen) and hence the neuropraxia of the nerve is less frequently symptomatic. Below C5, the left sided anterior cervical approach permits a wider access to the entire anterior cervical spine with less risk to the RLN. Neuropraxia induced on the oesophageal branches (directly by retractors or indirectly by traction) could provide a possible explanation for transient post-op dysphagia. We believe that this will help spinal surgeons to refine their surgical technique and thus reduce the incidence of iatrogenic injury.

Figure 1

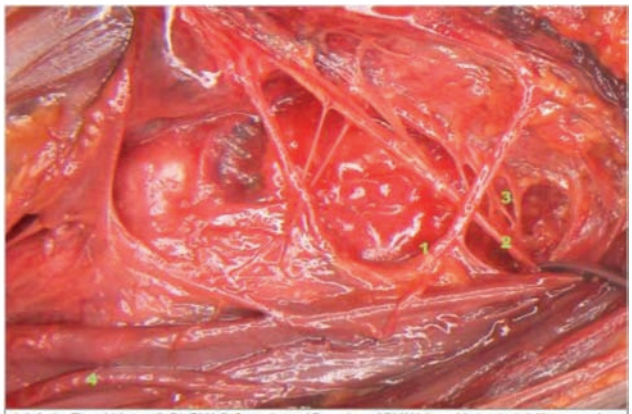

Figure 2

Figure 3

Figure 4

GO179. Plate Construct versus Cage alone in ACDF. Does the Plate Maintain a Sagittal Plane Correction- Clinical Outcome and Radiological Findings Correlation

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Introduction: Anterior cervical decompression and fusion is the treatment of choice of Cervical degenerative disc disease which cause neurological symptoms include radiculopathy and myelopathy, and it can be done by different techniques which includes several options for implants like disc spacers made of autograft or allograft bone, porous metal, polyether ether ketone (PEEK) and anterior plates and screws. The purpose of this study is to compare the role of anterior plate constructs (ACDF-CPC) and stand cage alone (ACDF-CA) in maintain of Sagittal plane correction, clinical and radiological findings.

Material and Methods: Retrospective study for 24 patients underwent to ACDF in Hamad General Hospital, 16 cases with ACDF-CA and 8 cases ACDF-CPC.

Radiological findings (cervical lordosis, segmental lordosis, cage subsidence, disc height) and clinical outcome (Odom's criteria, dysphagia and swallowing problems) are compared (pre-op, 3–6 months post op, 12–18 months post op).

Results: Cervical Lordosis, segmental lordosis, and disc space height at the operated levels increased an average of 5.4°, 3.1°, and 1.5 mm in ACDF-CA and 3.2°, 3.4°, 3.5 mm in ACDF-CPC, with good to excellent result in ACDF-CA and fair to good result in ACDF-CPC according to Odom's criteria, with more dysphagia and dysphonia in ACDF-CPC. The maintaining of sagittal plan correction, disc space height, and cage subside are decrease during follow up in both groups, but clinical outcome was stable in most of the cases comparing to immediate post op finding.

Conclusion: Anterior cervical decompression and fusion by stand cage alone or anterior plate is achieved good clinical outcome and significant correction in sagittal plane and disc space height, but no significant difference between two groups in maintaining the sagittal plane correction and disc space.

GO180. Cost Per Quality Adjusted Life Years gained for Anterior Cervical Discectomy and Fusion for Degenerative Spine Disease in Elderly Population

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Introduction: Anterior cervical decompression and fusion (ACDF) is a most commonly used intervention in patients with myelopathy and radiculopathy. With growing elderly population and increasing rates of spinal surgery in this age group it is vital to understand the value of ACDF in this population. The aim of present study was to determine the cost-utility following ACDF for myelopathy and radiculopathy in elderly patients.

Methods: A total of 299 patients undergoing elective ACDF with or without fusion for degenerative cervical pathology over a period of two-years, that were enrolled into prospective longitudinal registry were included in the study.

PRO instruments: NDI, numeric rating scale-neck and arm pain (NP, AP), general health and quality of life scores via EQ-5D and SF-12 were recorded at baseline, 12-month and 24-month after surgery. One and two-year medical resource utilization, missed work, and health state values (quality-adjusted life years [QALYs], calculated from the EQ-5D with US valuation using time weighted area under the curve approach) were assessed. Two-year resource use was multiplied by unit costs based on Medicare national allowable payment amounts (direct cost). Patient and caregiver workday losses were multiplied by the self-reported gross-of-tax wage rate (indirect cost). The direct cost and total cost (direct + indirect) was used to assess mean total 2-year cost per QALY gained after surgery. The patients were divided into age groups (younger) $<$ 65 years, and $\geq$ 65 years (older) to compare the QALYs gained and the cost-utility in this age groups.

Results: There was a significant improvement in pain (NP, AP), disability (NDI) and general health scores (EQ-5D and SF-12) among all age groups 2-year after surgery ($p < 0.0001$). Fifty-two percent (155) of patients underwent ACDF for myelopathy and 48% (144) underwent ACDF for radiculopathy; there was no significant difference in the number of patients with radiculopathy (42% vs 49%) and myelopathy (58% vs 51%) in patients $\geq$ 65 years compared with those $<$ 65 years. The mean direct cost, and total cost at 24-month was $18,828 and $23,579 for younger patients and $19,241 and $21,197 for older patients. Younger patients had higher total cost at 24month due to higher workday losses; the direct cost was however higher in the older age group which was found to be associated with a higher mean number of co-morbidities (1.5 vs 2.7, $p = 0.02$) and mean longer hospital stay (1.2 vs 2.3 days, $p = 0.018$). Patients over 65 years old had a 33% preoperative gainful employment compared with 62% patients with age $<$ 65 years. There was no statistically significant difference in mean direct cost among the younger and older patients. The younger patients had higher mean cumulative 2-year gain of 0.47 QALYs compared with 0.28 QALYs in older patients. The two-year direct cost-utility and total cost-utility in patients age $<$ 65 years was $40,059 and $50,168/QALY compared with $68,717/QALY and $75,703/QALY in those $\geq$ 65 years.

Conclusion: ACDF provided a significant gain in health state utility in elderly patients with degenerative cervical pathology, with a mean cumulative 2-year cost per QALY gained of 75703/QALY, which can be considered moderately cost-effective as per the threshold of $100,000/QALY gained. Elderly patients do not see the degree of improvement as their younger counterparts; however, surgery does provide a clinically meaningful improvement.

GO181. Stand-Alone Cages in Anterior Cervical Discectomy & Fusion: Mid-term Outcomes

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Introduction: To review and analyze the clinical outcome and radiological changes of one-level and two-level anterior cervical discectomy and fusion (ACDF) with stand-alone Trabecular Metal™ cages. ACDF using a stand-alone cage is a popular procedure with little published long-term follow-up, we reviewed our cases performed between 2001–2011.

Material and Methods: Patients between 36 and 64 years of age, diagnosed with cervical radiculopathy, who underwent ACDF were available for at least 3 years follow-up and included in this study. All levels were low-cervical (below C4). Clinical outcomes were assessed using Odom's Criteria, VAS, and by assessing axial neck pain, radicular arm pain, upper extremity weakness, and upper extremity numbness. Fusion was assessed by lateral radiographs looking for bone breaching and radiolucent lines around the device, in addition to dynamic radiographs, postoperative cervical lordosis was measured by the Drexler Method

Results: Ninety patients were included in the study, 51 patients underwent two-level ACDF modified Robinson approach, and 39 patients underwent one-level ACDF. Mean age was 44 $\pm$ 10.4 years and mean follow-up time was 4.5 $\pm$ 2.6 years. Patients reported excellent or good outcomes (90%), VAS improved in 90% of patients from a mean of 3 preoperatively, to a mean of 9 at 1 year, and a mean of 8 at 3 years follow up. Improvement in axial neck pain (80%), radicular arm pain (95%), upper extremity weakness (85%), and upper extremity numbness (90%). No cage extrusion or migration occurred. Subsidence occurred in 8% of levels fused. Clinical improvements were not related to the occurrence of subsidence. Radiographs confirmed restoration of cervical lordosis above 45 degrees, with maintenance over the follow up period. There was symptomatic anterior osteophytes formation or calcifications of anterior longitudinal ligament in 25% of patients at the final follow-up; the reoperation rate was 3.6%. There was no persistent dysphagia, or voice complaints, no dural tear, tracheal or oesophageal perforation. One patient developed deep MRSA infectious infarction of spinal cord, treated with antibiotics, and recovered totally upon one-year follow up. Based on the 3 criteria for fusion, 90% of patients confirmed fusion at 1 year follow up.

Conclusion: Mid- to long-term results show that ACDF with Trabecular Metal™ cages is safe and effective treatment of single and two-level cervical disc radiculopathy and neck pain.

GO182. A Biomechanical Evaluation of a Versatile and Novel Anterior Cervical Fusion Device Possessing Modular and Integrated Fixation Capabilities

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Introduction: A novel ACDF (anterior cervical discectomy and fusion) construct possessing integrated screw and modular plate fixation (MPF) capabilities has been introduced in an effort to provide versatility when selecting a stabilization mechanism. Construct features allow the surgeon to switch between zero-profile (2 screws), half-plate (3 screws), and full-plate (4 screws) system. Inherently, the device can be readily adapted to the patient's anatomical landscape, accommodating adjacent level fixation, as well as diminishing hardware prominences when necessary. Additionally, the MPF technology, which creates a singular rigid body about the index level, affords ideal plate orientation/alignment, eliminates potential for cage migration/subsidence, and ensures physiological compression of the cage/graft. However, the translated effects of such novel features on segmental stability have not yet been characterized in the literature. The objective of this study was to assess the segmental rigidity achieved by the novel ACDF device iterations as compared with traditional ACDF (cage and anterior cervical plate system) and supplementation with posterior cervical constructs with lateral mass screws (LMS).

Material and Methods: Eighteen human cervical spine specimens (C3-T1) were tested. Osseous integrity was confirmed via DEXA scans and radiographs. Specimens were divided into three groups ($n = 6$) such that the mean bone

quality across each group was consistent. The C3 and T1 vertebral bodies were potted. Each spine was first tested in an intact state. An anterior discectomy (C5/C6) was then performed, followed by sequential iterative construct instrumentation and testing (see Results for sequence). The three group protocol was executed such that each respective group would receive only integrated zero-profile, integrated half-plate, or integrated full-plate fixation (Alta ACDF System – Zimmer-Biomet Spine); diminishing vertebral body compromise due to excessive screw removal/placement. For posterior supplemented constructs, lateral mass screws (Lineum – Zimmer-Biomet Spine) were placed bilaterally at the index level. A 2Nm moment was applied in flexion-extension (FE), lateral-bending (LB), and axial-rotation (AR) using a six degree-of-freedom Bionix® Spine Kinematics System (MTS, Systems, MN). Segmental range-of-motion (ROM) was tracked using Optotrak Certus (NDI, Inc, Canada) motion analysis software. Mean ROM relative to intact conditions (100%) was measured.

*Result***s:** ROM (% Intact): FE/LB/AR. Integrated Zero Profile ACDF ($n = 6$): 69 / 48 / 76. Integrated Half-Plate ACDF ($n = 6$): 42/ 25 / 67. Integrated Full-Plate ACDF ($n = 6$): 32 / 29 / 40. Traditional ACDF ($n = 18$): 37 / 39 / 61. Traditional ACDF + LMS ($n = 18$): 12 / 11 / 22. Integrated Zero Profile ACDF + LMS ($n = 6$): 14 / 13 / 31. Integrated Half-Plate ACDF + LMS ($n = 6$): 18 / 10 / 31. Integrated Full-Plate ACDF + LMS ($n = 6$): 12 / 10 / 16.

Conclusion: The full-plate and half-plate constructs both appeared advantageous in comparison to the traditional ACDF construct (MaxAn – Zimmer-Biomet Spine) when used without posterior supplementation, demonstrating an inherent benefit of the MPF technology. Motion reductions with zero-profile fixation were not as robust; however, it can be argued that clinically significant stability was still achieved. Lastly, supplemental fixation with LMS appeared to be a clear leveling factor across all constructs, facilitating significant motion reduction in all directions.

GO183. Safety and Efficacy of Local Bone with PEEK Cage versus Iliac Bone Graft in Anterior Cervical Discectomy and Fusion: A Prospective Study

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Introduction: A prospective study was performed to compare the clinical and radiological results between the use of local bone graft with a PEEK cage versus an iliac bone graft in anterior cervical discectomy and fusion (ACDF).

Materials and Methods: A total of 60 consecutive patients who underwent ACDF were evaluated from January 2010 to January 2013. 29 patients received an ACDF with a PEEK cage combined with local bone graft (local bone cohort) and 31patients received an ACDF with tricortical iliac bone graft (iliac bone cohort). The intraoperative and perioperative complications of both cohorts were recorded. Preoperative and postoperative radiographs were taken to calculate the ratio of interbody height to the disc height and the interbody bony fusion rate. The Japanese Orthopedic Association (JOA) score and visual analogue scale (VAS) were used to estimate postoperative clinical outcomes.

Results: The mean follow-up time was 25.0 ± 3.8 months in the local bone cohort and 24.4 ± 3.4 months in the iliac bone cohort ($p = 0.56$). Although there was no statistically significant difference between the two cohorts in terms of blood loss ($p = 0.17$), the length of surgery was significantly less in the local bone cohort compared with that of the iliac bone cohort ($p = 0.01$). Postoperatively, VAS scores were significantly decreased, and JOA scores were improved in both cohorts. However, no statistically significant difference was found between the two cohorts at final follow up ($p = 0.45$, $p = 0.93$). The disc space height and segmental interbody angle at the surgical segment were greater in local bone cohort than those in the iliac bone cohort ($P < 0.001$ and $P < 0.001$). The fusion rates were 93.1% (27/29) in local bone cohort and 90.3% (28/31) in the iliac bone cohort at last follow up ($p = 0.70$). Perioperative complication rates in local bone cohort and iliac bone cohorts were 6.8% and 29%, respectively ($p = 0.04$).

*Conclusion***s:** In a prospective study of 60 patients receiving ACDF with either local bone graft with a PEEK cage or an iliac bone graft alone, the former had a statistically shorter operation time, lower perioperative complications rate, and better radiological results. Although further long-term studies will delineate whether these improved radiographic findings will translate into better clinical outcomes, the local bone graft with a PEEK cage appears to be a safe alternative to the iliac bone graft during the perioperative period.

GO184. Long-term Clinical and Radiological Outcome Evaluation of 3- and 4 Level ACDF with a Zero-profile Implant. Impact of Cervical Sagittal Alignment on Clinical Outcome

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Introduction: Concerns remains on the role of ACDF in multilevel cervical disease as opposite to posterior approaches, and on the importance of cervical sagittal alignment in influencing long-term clinical outcome. We aim to analyze the efficacy of 3- and 4-level ACDF with a zero-profile implant in restoring cervical sagittal alignemnt as well as the impact of alignment on clinical outcome, both at early and long-term follow-up. And also to evaluate type and rate of complications.

Material and Methods: 24 patients (14 male), ranging in age from 41 to 77 years (mean 58.4) and suffering from multilevel spondylosis, were enrolled. Neurological improvement was graded according to the Nurick scale. NDI, VAS and SF-36 were used for pre- and postoperative functional evaluation. Imaging included X-rays, CT and MRI before surgery; X-rays were obtained at every follow-up visit and CT scan at last follow-up. Sagittal alignment was assessed before and after surgery using the Cobb method. Fusion rate was studied on both X-rays and CT scan. Complications were analyzed and dysphagia evaluated using the Bazaz scale.

Results: Mean follow-up ranges from 24 to 72 months (mean 39). No intra- or postoperative complications, either related to surgical technique or to devices implanted, were encountered. Mean neck pain VAS score decreased from a 6.7 ± 2.9 to 1.6 ± 2.3 ($p < 0.01$). Mean arm pain VAS score decreased from 5.9 ± 2.9 to 0.9 ± 1.4 ($p < 0.01$). There were significant improvements ($p < 0.01$) in SF36 and NDI following surgery. Five patients complained of mild dysphagia (20.8%). Three of them (12.5%) showed complete resolution within two months (short-term dysphagia); the other two (8.3%) within six months (medium-term dysphagia). No case of long-term dysphagia (more than 6 months) was observed. According to Pitzen criteria, radiographic fusion was achieved

in 90% of patients. Cobb angle had a significant improvement both after surgery and at long-term follow-up.

Conclusion: 3- and 4-level ACDF with a zero-profile device is safe and effective. It allows satisfactory neurological and functional outcome as well as interbody fusion. Multilevel anterior approach provides satisfactory sagittal alignment restoration, and this is associated with persistent clinical improvement at long-term follow-up.

GO185. Anterior Cervical Discectomy and Fusion Using an "Oversized" PEEK Cage: Radiological and Clinical Outcome

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Introduction: There has been controversial data about the effect of cage size on radiological and clinical outcome of anterior cervical discectomy and fusion (ACDF). Oversized cages have been linked to higher incidence of non-union, adjacent segment disease, and unfavorable clinical outcomes. The aim of this work is to evaluate the effect of an oversized PEEK cage on the radiological and clinical outcomes in ACDF.

Patients and Methods: Between January 2012 to July 2014, 57 patients (29 single level, 15 double levels, 8 three levels, 5 four levels) underwent ACDF using a stand-alone oversized PEEK cages. They were 35 males and 22 females with mean age 56 ± 13.5 years. The minimum follow up period is one year. The following parameters were measured preoperatively, postoperatively and at final follow up: cervical lordosis (in degrees), disc height (in mm), motion at operated level (in degrees), radiological ASD (present or not) and VAS for neck pain, VAS for arm pain. All complications were as well recorded.

Results: The mean cervical lordosis changed from 25°± 5.5 postoperative to 7°±4.5 at final follow up. The mean disc height was 5± 2 mm preop, 7 ± 1.5 mm postop and 6 ± 1 mm at final follow up. Residual motion at operated level was observed at 1 year follow up X-rays in 2 patients (one double level and one 3-level) with average 5°. None of them had neck pain and no revision was required. In the postoperative X-rays, the suprajacent level was always observed to be slightly narrowed; this narrowing gradually diminished during the follow up. Radiological ASD developed in 9 patients (16%), all of them remained to date asymptomatic. The average improvement in VAS for neck pain was 27%±8.5 and the average improvement in VAS for arm pain was 33%±9.5. At the final follow up, fusion was achieved in 55 patients (96%) and clinical outcome was excellent. Radiological loss of the postoperative disc height and cervical lordosis and development of radiological ASD did not correlate to poor clinical outcome. No single case of cage dislodgement was observed in this series.

Conclusion: The use of a stand-alone oversized PEEK cage in ACDF seems to minimize the incidence of cage dislodgment even in multiple levels ACDF. Despite some radiological settlement and loss of cervical lordosis, an excellent clinical outcome was maintained.

Deformity Thoracolumbar Adult 1

GO186. Adult Spinal Deformity in the Elderly. Preliminary Clinical and Radiological Results in 22 Patients Treated by a Two Times Minimally Invasive Spine Surgery

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Introduction: The adult spinal deformity (ASD) seems, in the last years, in a progressive increment. It should be in relation to the aging of the population. This trend leads to a progression of the disability and the reduction of the quality of life of these patients. The surgical correction of the ASD obtained by a traditional "open" surgery can often be incompatible with the co-morbidities of these patients. The minimally invasive surgery for correction of the deformities (MISDEF) can offer technical nuances, such as reduce of intraoperative blood loss and quickly recovery, which can lead the opportunities for these patients to approach the surgery. We present the preliminary results of our observational study on the radiological correction and clinical results of old patients affected by ASD treated by MISDEF.

Methods: Observational study with 20 months of follow-up. Twelve patients affected by low-back pain, sciatalgia and/cruralgia, neurological claudication were enrolled in this study. All the patients underwent to a MISDEF based on a percutaneous transpedicular stabilization plus a lateral or transforaminal interbody fusion. We collected all the radiological datas, such as sagittal vertical axis (SVA), sacral slope (SS), pervic tilt (PT), pelvic incidence (PI), lumbar lordosis (LL) and coronal cob (CC) and the clinical status, oswestry disability index (ODI) and SF-36.

Results: The mean age was 70 years (65 – 78 years), 3 men and 9 women. 7 patients presented a lumbar left side convex scoliosis, while 5 patients presented a right side one. All the patients underwent to a 2 times surgery: the first time was a lateral access, the second time was the posterior access. The side for the lateral interbody fusion was the concave side of the scoliosis. L4L5 segment was always been approached for a transforaminal interbody fusion. The proximal strumental vertebra was T10. The mean intraoperative blood loss was 500 cc. All the patients were mobilized within 2 days. The ODI and SF36 evidenced a statistically improvement ($p < 0,05$). No evidence of infections, neurological deficit, failure of the implant and/or loosening of correction were documented in the follow up.

*Conclusion***s:** The MISDEF offers, even for elderly patients with co-morbidities, a valid and secure surgical solution for the correction of the ASD. From the results of our study appeared a good compliance of these techniques for all the patients, with a good result even at 20 months of follow-up. We considered that the opportunity to separate the surgical correction of the deformity in 2 times surgery seems to be a better and secure solution especially for elderly patients.

GO187. Pelvic Incidence is Not Constant

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Introduction: The pelvis is a very important component in the overall balance. It changes its orientation in space aiming at compensation for any sagittal imbalance. Three pelvic parameters were recognized as descriptive tools for pelvic status. Pelvic incidence (PI) is considered as a constant value after maturity which changes only in pelvic trauma. This work aims to evaluate if the surgical correction of the fixed sagittal imbalance has any effect on the pelvic incidence.

Patients and Methods: Twenty seven cases with fixed sagittal imbalance were corrected surgically by posterior spinal osteotomies and prospectively followed for at least one year. Pelvic Incidence (PI), Sacral Slope (SS), Pelvic Tilt (PT), Lumbar Lordosis (LL), Thoracic Kyphosis (TK) and Sagittal Vertical Axis (SVA) were compared between preoperative,

postoperative and last follow up long standing lateral whole spine radiographs. Measurements were taken by three experienced spine surgeons independently.

Results: Twenty four cases were included, half of them were males, and the mean age was 16.3 (5–46) years. PI was fixed or changed by five degrees or less in seventeen cases (70%). PI increased in four patients (16%) by more than five degrees and decreased by more than five degrees in three cases (12,5%). The mean increase in the PI was 11.75° (6–20°) and 11.2° (7–23°) postoperatively and at last follow up respectively.

*Conclusion***s:** Despite that the PI is fixed or minimally changes (five degrees or less) in most of the cases of surgically corrected fixed sagittal imbalance, it is increased in some patients and decreased in others. The long term effect of this observation and its implication on surgical planning is yet to be determined.

GO188. Cognitive Impairment Following Adult Spinal Deformity Surgery

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Introduction: Elderly patients undergoing major surgery may experience cognitive deterioration due to lesser plasticity in their brain tissue. This so called postoperative cognitive dysfunction (POCD) syndrome is characterized with non-specific dysfunction in memory, concentration and analysis skills. It is not known whether adult spinal deformity (ASD) surgery is associated with POCD. Purpose of this study is to analyze the cognitive abilities of older patients undergoing spinal deformity surgery before and after the surgery so as to understand whether ASD surgery is associated with POCD.

Material and Methods: A prospective longitudinal study was performed on surgical patients older than 50 years enrolled in a prospective multi-centric database. Mini mental state examination (MMSE) was performed to assess cognitive functions in addition to the health related quality of life (HRQOL) tests (SF-36, ODI and SRS-22) at preoperative, post-operative 6th week and 6th month points. Demographics, preoperative health status, comorbidities, surgical characteristics were also analyzed. Descriptive statistics and repeated measures of variance analysis were performed.

Results: A total of 90 patients with a mean age of 67.4 $\pm$ 8.2 were enrolled in the study; all had 6th week and 58 had both 6th week and 6th month follow-up MMSE evaluations. Averages (standard deviation) of surgical time, estimated blood loss (EBL), number of screws used and hospital stay were 240.1 (111.9)min, 1621.2 (1058.7)ml, 11.2 (4.4) and 14.2 (11.45)days respectively. On analysis, it was seen that there was even a slight increase in mean MMSE score ($p > 0.05$) between time points (Table 1). There was a decrease of > 2 points (3 or 4 points) in 6 patients (6.7%) at both time points.

Conclusion: Although ASD surgery in older patients is recognized as challenging, this study suggests that it is not necessarily associated with a significant deterioration in the cognitive abilities of patients undergoing it. These results are different compared with those reported for other major surgical interventions. This may be due to the relatively minor influence of ASD itself on the cognitive abilities of the patients involved as well as to the relatively stable hemodynamic conditions obtainable during modern ASD surgery.

GO189. Identifying the Best Treatment in Adult Spinal Deformity: A Decision Analysis Approach

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Introduction: Adult spinal deformity (ASD) is a major public health problem. There are pros and cons of the available treatment alternatives (surgical or non-surgical) and it had been difficult to identify the best treatment modality. Aim of this study is to construct a statistical decision analysis (DA) model to identify the optimum overall treatment in ASD.

Material and Methods: From an international multicentre database of ASD patients (968 pts), 535 who had completed 1 year follow-up (371 non-surgical –NS), 164 surgical –S), constitute the population of this study. DA was structured in two main steps of: 1) Baseline analysis (Assessing the probabilities of outcomes, Assessing the values of preference –utilities-, Combining information on probability and utility and assigning the quality adjusted life expectancy (QALE) for each treatment) and 2) Sensitivity analysis.

Results: 432 patients (309 NS, 123 S) had baseline and 1 year follow-up ODI measurements. Overall, 104 (24.1%) were found to be improved (a decrease in ODI > 8 points), 225 (52.1%) unchanged ($-8 >$ ODI > 8) and 65 deteriorated. Surgery presented with a higher chance of improvement (54.2%) versus NS (9.7%) (Table 1a). The overall QALE ranged from 56 to 69 (of 100 years) and demonstrated better final outcomes in the NS group, although this group had also started with higher QALE. There were improvements in overall QALE in both groups but this was significant only in the surgical group (Table 1 b). In addition, in the subgroup of patients with significant baseline disability (ODI > 25) surgery appeared to yield marginally better final QALE (Table 1 c).

Conclusion:: This study demonstrated that a single best treatment modality for ASD may not exist. Conservative treatment appears to yield higher (up to 6%) QALE compared with surgery, probably secondary to a higher baseline QALE; except in patients with significant disability at baseline. On the other hand, surgery provides a significantly higher increase in QALE and chances of improvement at 1st year are significantly lower with NS treatment.

GO190. Reduction of Pelvic Tilt after Surgical Correction of Low-grade Isthmic Spondylolisthesis is Correlated with Rather Improvement of Back Pain than Quality of Life

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Introduction: It is generally believed that the restoration or improvement of sagittal spino-pelvic alignment may impact clinical outcomes of surgical treatment of high-grade isthmic spondylolisthesis. Little is known about the impact on low-grade slips. The purpose of the study was to determine whether clinical outcomes are correlated with the restoration

or improvement of pelvic balance after surgical correction of low-grade isthmic spondylolisthesis.

Material and Methods: Prospective non-randomized study based on a single-institution series of consecutive patients with isthmic spondylolisthesis during a 10-year period from 2002–2012. 63 adult patients with a low-grade isthmic slip and adequate pre- and postoperative radiograms were available for measurement of spino-pelvic parameters and final assessment of their clinical outcomes. The latter were assessed at least 1 year after the surgery with the use of the Oswestry Disability Index (ODI) and a back pain visual analogue scale. Pelvic incidence (PI), pelvic tilt (PT), sacral slope (SS), lumbosacral angle (LSA) and lumbar lordosis were measured on standing lateral view radiograms. We assumed postoperative reduction in pelvic tilt (PT) to reflect improvement in pelvic balance. The Spearman's rank correlation test was used to assess the correlation between the improvement in pelvic balance and the improvement in ODI and back pain. The Mann–Whitney *U* test was used to identify significant differences in clinical outcomes between patients (i) with a balanced and unbalanced pelvis postoperatively, (ii) who regained and did not regain pelvic balance postoperatively, (iii) who maintained and lost pelvic balance postoperatively, and (iv) with an improved (reduced PT) and worsened (increased PT) pelvic balance postoperatively.

Results: There were no significant differences in clinical outcomes between patients with a balanced and unbalanced pelvis postoperatively regardless of whether they lost, maintained, or regained pelvic balance after the surgery. However, we found a weak (R= -0.3) but statistically significant ($p = 0.035$) negative correlation between the degree of reduction in pelvic tilt and intensity of postoperative back pain and a weak (R=0.2) but statistically significant ($p = 0.034$) positive correlation between the degree of reduction in PT and reduction in back pain. No correlation was found between improvement in pelvic balance and quality of life

*Conclusion***s:** Postoperative reduction of pelvic tilt may impact improvement of rather back pain than quality of life in low-grade isthmic spondylolisthesis. The latter might be a result of rather neural decompression and stabilization of the affected segment than improvement of pelvic balance.

GO191. Spinopelvic Alignment and Functional Outcome after Circumferential Fusion for Low-grade Isthmic Spondylolisthesis

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Introduction: Functional outcomes after surgery for low-grade isthmic spondylolisthesis(LGIS) is reported limitedly for combined posterior and anterior approach procedures. Imbalances in the sagittal alignment of spine and pelvis are increasingly seen as the reason for the development and progression of LGIS. Aims of this study: 1) functional outcome, 2) the effects on spinopelvic alignment, after circumferential fusion. Surgical treatment goals are restoration of stability, reduction of slippage, restoration of disc height and angulation, correction of spinopelvic parameters toward neutral values, and improve functional status. We hypothesized 1) a significant improvement on clinical outcome at 2-year follow-up and 2) a stable post-operative situation around the targeted vertebrae and restoration of the spinopelvic parameters to values seen in healthy subjects.

Materials and Methods: 43 subjects enrolled with LGIS at L5-S1. Each subject received a posterior decompression and pedicle screw instrumentation followed by an instrumented anterior lumbar interbody fusion in two separate procedures. (1) Outcome measures were registered pre-operative and after 12 and 24 months. Primary outcome was functional status (ODI). Secondary outcomes: Quality of Life (SF-36 subdomains, EQ-5D subscales), and pain intensity (VAS back and leg pain). (2) Full spine radiographs were taken pre-operative and after 3, 12, and 24 months postoperative. Obtained spinopelvic parameters are: sacral slope, pelvic tilt, pelvic incidence, thoracic kyphosis, L5-S1 lordosis, L1-S1 lordosis and sagittal vertical axis. The degree of slippage reduction and L5-S1 angular motion was measured. To evaluate both study aims a repeated measures ANOVA was used to indicate differences over time.

Results: 42 patients (25 female), average age 39,0 (25–51) with an average BMI 25,8 (21,5–30,4) participated in the study. Functional results are given as means with (standard deviation) pre-operative, at 12 months and 24 months post-operative for ODI: 35,0 (14,4); 10,0 (15,0); 9,5 (15,3); for SF-36 PCS: 42,0 (12,7); 70,5 (21,0); 71,5 (21,5); for SF-36 MCS: 64,0 (16,6); 81 (19,4); 81,5 (19,5); for EQ-5D: 0,56 (0,29); 0,84 (0,28); 0,83 (0,240); for VAS (back pain): 64,5 (26,2); 16,0 (32,2); 22,0 (23,9). Degree of slip decreased significantly from 27,0% (11,9%) to 7,4% (11,7%) postoperatively. Angular motion decreased statistically significant immediately postoperative and remained stable thereafter. L5-S1 and L1-S1 lordosis and sacral slope showed a significant increase postoperatively, whereas the pelvic tilt and sagittal vertical axis significantly decreased.

Conclusion: Circumferential instrumented fusion for LGIS via combined approach improves functional outcome at short term follow-up. After careful patient selection and unsuccessful conservative management surgical treatment is a suitable alternative with predictable short term outcome. Circumferential fusion corrects deformity and creates a stable situation in LGIS. We find that sagittal alignment is probably influenced positively, by bringing the SVA in a more neutral position.

GO192. Global Tilt: A Single Parameter Incorporating the Spinal and Pelvic Parameters Correlates with Health-Related Quality of Life Parameters

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Introduction: Surgical goals and alignment objectives mostly depend on sagittal plane parameters. SVA, C7 tilt and T1 tilt account for spinal balance and PI, PT, SS, PI-LL account for pelvic compensatory mechanism, which are all affected by patient positioning. GT is the angle between the line drawn from the center of C7 to the center of the sacral endplate and a line drawn from the center of the sacral endplate to the center of the femoral head. GT is a single parameter that takes both balance and pelvic compensation into account as a single parameter. GT has been shown to be less affected by patient positioning compared with SVA and PT. Aim was to analyze the correlation of GT with HRQoL parameters and compare with other sagittal plane parameters.

Material and Methods: A retrospective analysis of a multicenter, prospective, consecutive patient series. 337 patients (285F,52M) with adult spinal deformity were included, (mean age: 58.2± 15.7). Pelvic parameters (PT, PI, SS), sagittal balance parameters (SVA, T1 tilt), GT and lordosis gap(LGap) were measured by using Surgimap. HRQoL instruments included: Oswestry Disability Index(ODI), Short Form-36, SRS-22. Correlation analysis between radiographic pelvic and sagittal balance parameters, GT and LGap was pursued. Kruskal-Wallis test was used to compare GT, SVA and PT for ODI < 20, 20–40 and > 40 disability groups.

Results: Global tilt significantly correlated with ODI, SRS-22 pain, function, self image, and subtotal scores and SF-36 PCS ($p < 0.01$) similar to SVA, PT and LGap. None of the radiographic parameters correlated with SRS-22 mental health or SF-36 MCS (Table 1). GT was more sensitive in detecting ODI disability groups when compared with SVA and PT ($p < 0.01$)

Conclusion: GT has a similar or better correlation with HRQoL domains compared with PT and SVA. This information adds another important feature of this parameter in addition to being a single parameter taking into account both the spinal balance and pelvic compensation and being less affected by patient positioning.

GO193. Is Sacro-femoral-pubic Angle a Good Indicator of Pelvic Tilt?

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Introduction: The spino-pelvic alignment is increasingly recognized as crucial in the assessment of patients with spinal deformities. Three pelvic parameters originally described include pelvic incidence (PI), pelvic tilt (PT) and sacral slope (SS). PT, a positional parameter, has been demonstrated to correlate with quality of life and clinical outcomes. Although measuring the PT on sagittal radiographs is simple, underexposed films and malposition of X-rays often result in poor visibility of the femoral heads. In 2012, a novel measurement, the sacro-femoral-pubic (SFP) angle was introduced to estimate the PT using coronal films. The formula PT = 75 – (SFP angle) was derived to correlate the two parameters. Subsequently, the formula was validated in predicting the pelvic tilt in patients with lumbar and thoracic scoliosis. However, more recently another study showed that the SFP angle correlated poorly with the PT. The objective of our study was to analyze whether a correlation exists between the SFP angle and PT in our patient population and to validate the conventional formula (PT = 75 – (SFP angle). We also aimed to identify factors that may contribute to the formula if our data sample fails to validate the formula.

Materials and Methods: A retrospective chart review was performed on 106 adult patients who visited an orthopedic spine surgeon of a university hospital. Entire spine posteranterior and lateral spine radiographs were used to measure the PT and SFP, and correlation between PT and SFP was calculated. The validity of the conventional Eq. (75 - SFP =PT) was also tested. In addition, clinical data including age, body mass index (BMI), and gender and other radiographic data including PI, sagittal balance, and presence of scoliosis were analyzed to see if there was any influence of those on using the formula.

Results: The conventional Eq. (75 - SFP =PT) did not fit our data. However, the regression model to correlate PT and SFP angle yielded the following formula: PT = 62 – 0.72*SFP (R-square = 0.36). The higher the PI, the greater the tendency of the conventional formula to underestimate the PT and with a lower PI, the conventional formula tended to overestimate the PT ($R = -0.38$, $p < 0.001$). Age, BMI, and gender and sagittal balance did not determine significantly whether the conventional formula worked or not. The conventional formula worked poorer on the patients with scoliosis than patients without scoliosis.

Conclusion: The conventional Eq. 75 - SFP =PT did not match our data. However, SFP angle may correlate with PT, but possibly by a nonlinear formula which indicates that there might be additional factors that can contribute to creating such formula such as PI. In reality, however, like PT, PI is obtained from lateral view X-rays. Therefore, a lateral X-ray image with good visibility of the femoral heads would be the best way to measure the PT.

Degenerative Lumbar 3

GO194. Fulfillment of Expectations Two Years after Lumbar Spine Surgery

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Background: Patients have multiple expectations of lumbar surgery and fulfillment of expectations is an important but infrequently studied outcome. The objective of this study was to compare patients' preoperatively cited expectations with their postoperative ratings of fulfillment of expectations.

Methods: A longitudinal cohort with 2 year follow-up at a tertiary spine center of 366 patients before and 2 years after surgery was conducted. 422 patients preoperatively completed a valid survey measuring amount of improvement expected from lumbar surgery for 20 items addressing symptoms, function, and mental well-being. Function was measured with the modified Oswestry Disability Index (ODI), and psychosocial variables, including depressive symptoms, were measured with valid scales. Two years after surgery patients were asked how much improvement they actually received for items listed in the survey. The proportion of fulfilled expectations was calculated as the sum of improvement received divided by the sum of improvement expected (0%= expectations completely unfulfilled, 100%=expectations completely fulfilled, $> 100\%$= expectations surpassed). Additional patient-centered postoperative variables were the ODI and overall satisfaction with the outcome of surgery.

Results: 401 patients were contacted 2.1 years postoperatively (range 1.9–3.1 years). Of these 366 participated in a postop interview to rate fulfillment of expectations (mean age 55 years, 57% men, 78% degenerative conditions). Mean proportion of fulfilled expectations was 66% (range 0–200%). Greater preoperative expectations were associated with lower proportions of fulfilled expectations postoperatively (p=.002). Other preoperative variables associated with lower proportions of fulfilled expectations were: surgery for a degenerative spine diagnosis [OR 2.8 (1.6–5.0), p=.003]; revision surgery [OR 2.2 (1.4–3.8), p=.006]; more vertebral levels involved [OR 1.5 (1.3–1.8), $p < .0001$]; more depressive symptoms [OR 2 (1.3–3.10, p=.001]; and not being employed [OR 2.8 (1.8–4.5), $p < .0001$]. Postoperative variables associated with lower proportions of fulfilled expectations were: less pre-to-postoperative improvement in ODI scores [OR 9 (5–17), $p < .0001$]; having a postoperative fracture or infection [OR

4.2 (1.5–11.9), p=.007]; and having a subsequent repeat surgery [OR 3.6 (2.1–6.5), $p < .0001$]. There were no differences based on age, sex, marital status, use of narcotics, and whether a fusion was performed. In multivariable analysis, greater preoperative expectations, not being employed, revision surgery, more levels involved, less improvement in ODI score, and having a subsequent repeat surgery remained associated with lower proportions of fulfilled expectations ($p \leq .03$ for all variables). Overall 73% of patients were satisfied with the results of surgery; the proportion of expectations fulfilled was highly, but not completely, associated with satisfaction (r=.72).

*Conclusion***s:** Fulfillment of expectations varied widely two years after lumbar surgery. Patients with greater preoperative expectations were more likely to have lower proportions of fulfilled expectations postoperatively. Both pre- and postoperative functional and surgical variables were associated with fulfillment of expectations. Fulfillment of expectations and satisfaction were associated but remained distinct patient-centered outcomes.

GO195. 6-Minute Walk Test: A Simple Objective Test in Screening and Monitoring of Spinal Claudication: Prospective Study on 1182 Patients

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Introduction: The diagnosis, disease severity and outcome assessment of spinal claudication depend on patient's subjective report. In the past, the gold standard for diagnosing and screening for troubling spinal claudication was lacking. Quantify severity of claudication by standing and walking tolerance test used to be the best measure but was tedious. Simple quantitative test is lacking. The present study uses 6-minute walk test (6MWT) to solve these problems.

Material and Methods: Patients suspicious of spinal claudication were prospectively tested on standing and walking ability. Time when symptom becomes intolerable constituted the tolerance time. They were tested on distance (6MWD) they can maximally walk on level ground in shuttle between a 15m-distance in 6 minute; and screened for standing and walking instability with Tinetti score. Patients underwent surgery were monitored. The study was conducted in 2 stages. The first stage is a pilot study on a small group of patients which aim to establish the correlation among the different tests modality; standing tolerance test, walking tolerance test, 6 minute walk test, tinetti gait and balance test. After the best correlated tests modalities were found, the study was modified. The standing tolerance test and the 6 minute walk test were performed on a larger group of patients to generate sizable database.

Results: Since 2004, 1182 patients were included. The age-matched 6MWD correlate with 20 minute standing tolerance well with sensitivity and specificity above 0.7. Using ROC curve, 6MWD that distinguish 20 minute claudication tolerance are: 392m (age: 41–50); 377m (age: 51–60); 330m (age: 61–70); 267m (age: 71–80); 236m (age: 81–90). These findings agreed with the findings of another study on the reference values of 6MWD for normal Chinese subjects. That study showed that the minimal value of 6MWD for normal Chinese adults of different age groups was 330m. For those who underwent surgery, their standing and walking tolerance significantly improved in first 3 months but not later. The balance and gait score improved significantly only after 3 months post-operatively. The 6MWD increased significantly at both 3 and 6 months post-operatively, implying that 6MWD is more sensitive in picking up changes.

Conclusion: 6-minute walk test is a simple, practical method in screening for spinal claudication. The age matched 6MWD for incapacitating claudication was found. The 6-minute walk test also provides useful quantitative data for disease progression and treatment outcome monitoring. In the present study, we were able to demonstrate that 6MWD increased significantly at 3 months post-operative period comparing to pre-operative status and at 6 months post-op comparing to 3 months post-op period. The improvement of 6MWD was a reflection of improvement of walking tolerance and standing tolerance since both tolerance time increased significantly at 3 months after surgery. The improvement from 3 months to 6 months post-op was on the other hand a reflection of the improvement in gait pattern and balance ability instead, since only the 6MWD, Tinetti balance and gait score improved significantly during this period.

GO196. Analysis of Risk Factors for Early Adjacent Segment Disease Underwent Revision Surgery within 5 Years after Lumbar Spinal Fusion

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Introduction: There are many concerns about adjacent segment disease after lumbar spinal fusion using pedicle screws. Of them, we have a question which occurs early adjacent segment disease(EASD) within 5 years. We analyze the risk factors about EASD in patients who underwent revision surgery within 5 years from first operation.

Materials and Methods: From August 1988 to December 2007, 657 patients underwent lumbar spinal fusion of 3 and less segment to treat degenerative lumbar disease. Among them, 137 patients underwent revision surgery within 5 years due to adjacent segment disease or previously followed more than 5 years were included in this study. Gender, age, fusion method, preoperative diagnosis, number of fusion segments and radiological measurements were analyzed. In radiological measurement, pre-& post-operative lumbar lordotic angle (LLA), pre-& post-operative fusion segment lordotic angle (FSLA), pre-& post-operative FSLA per level, correction of LLA, correction of FSLA, and correction of FSLA per level were estimated. Statistical univariate analysis was performed with the Chi-square test and multivariate logistic regression analysis was done by using SPSS 14.0.

Results: There were 13 patients with revision surgery due to EASD. 6 patients were operated by decompression or discectomy and 7 patients needed additional fusion. In univatiate analysis, there was little relationship between EASD and gender, age, preoperative diagnosis, number of fusion segments, pre-& post-operative LLA, pre-& post-operative FSLA, pre-& post-operative FSLA per level, correction of FSLA and correction of FSLA per level. However, the frequency of EASD was significantly high in cases where PLIF was more than PLF($p = 0.023$), correction of LLA was $> 15°$($p = 0.021$) and correction of FSLA per level was $> 5°$($p = 0.049$). In multivariate logistic regression analysis, the frequency of ESAD was significantly high in case where PLIF was more than PLF(odd ratio=17.866) and correction of LLA was $> 15°$ (odd ratio=19.282).

*Conclusion***s:** There was no statistical significance between EASD and gender, age, preoperative diagnosis, number of fusion segments, pre-& post-operative LLA, pre-& post-operative FSLA, pre-& post-operative FSLA per level, correction of FSLA and correction of FSLA per level. However, PLIF and correction of LLA more than 15 degree increased risk of EASD.

GO197. A Multicenter Prospective Randomized Controlled Clinical Trial to Evaluate the Effectiveness and Safety of a Standalone Percutaneous Interspinous Spacer versus Decompressive Surgery in Degenerative Lumbar Spinal Stenosis with Neurogenic Intermittent Claudication

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Introduction: The objective of this study is to show that a minimally invasive percutaneous IPD is safe and non-inferior to SDS with regards to clinical outcomes in patients suffering from Degenerative Lumbar Spinal Stenosis with NIC (Neurogenic Intermittent Claudication), relieved by flexion. (Design: Multicenter international randomized controlled trial)

Methods: One hundred and sixty three patients enrolled by 19 sites across 10 countries (mean age 65 ± 11 years, 51% female, mean duration of leg symptoms 2.5 years) were randomly assigned to IPD or SDS group and are followed until 24 months. Physical function, symptom severity and patient satisfaction were assessed by Zurich Claudication Questionnaire (ZCQ) at baseline, 14days, 6 weeks, 6 months and 12 months follow-ups. Leg, buttock/groin and back pain were assessed by VAS scores. SF-36v2 questionnaire was used to assess quality of life. In addition, physical examination data was collected at all-time points. Percentage of re-operations at index level at follow-up was determined. (Trial registration NTC00905359)

Results: ZCQ physical function mean percentage change from baseline to 12 months (primary outcome variable) decreased equally and without statistically significant difference over all points in time for IPD and SDS group (respectively, -32 ± 32%, -37 ± 23%, $p = 0.158$, CI -5, +15). As for secondary outcomes the IPD group showed lower mean surgical time and mean blood loss (respectively, 24 ± 11 minutes and 6 ± 10 ml, $p < 0.001$) compared with the SDS group (70 ± 39 minutes and 157 ± 145 ml, $p < 0.001$). Symptom severity improved in both groups equally (-31 ± 27%, -36 ± 25%, $p = 0.140$, CI -4, +14). No differences in patient satisfaction were observed. VAS leg pain score improved with 59% for the IPD and 66% for the SDS group from baseline to 12 months follow-up. SF-36 v2 physical and mental aggregated score improved equally over time for both treatment groups. At 12 months, 47 SAEs were reported, in 36 patients. Re-operations at index level occurred in 9% of the patients in the IPD group and in 7% in the SDS group. In 6 patients the IPD was explanted.

*Conclusion***s:** This study confirms two prior recent RCTs. Implantation of an IPD as well as open decompression achieve both equally satisfying results in patients with NIC. Both seem to be appropriate procedures with an advantage in some secondary outcomes for IPDs. So far the significantly higher reoperation rate for IPDs could not be confirmed in this study, which opens a window of indication in a subset of patients with NIC, i.e., those with cardiac or other comorbidities.

GO198. Comparison of Three Doses of Epidural Steroid Injection with Single Dose of Epidural Steroid Injection for Lumbar Radicular pain in Spinal Stenosis Patients

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Introduction: Low Back pain and lumbar radicular pain due to Lumbar spine stenosis is one of the most common complaint in the Spine outpatient department or hospital admissions. Epidural steroid injection have well established role in the treatment of lumbar radicular pain, but the exact dose of Epidural Steroid injection has yet to be decided. The aim of this study is "To Compare three doses of epidural steroid injection with single dose of epidural steroid injection for Lumbar Radicular pain in spinal stenosis patients."

Materials and Methods: 95 patients with lumbar radicular pain due to spinal stenosis were randomly allocated into 2 groups. In group A 42 patients were given 120 mg of Depomedrol (40 mg per day for 3 days) and in group B, 43 patients were given 40 mg of Depo-medrol as a single dose. Both group A and Group B were matched in terms of age and gender. On visual analogue score pain was assessed after 2 weeks, 3 months and 6 months.

Results: In group A (3 doses of depomedrol) VAS improvement at 2 weeks, 3 months and 6 months were more than group B(single dose of depomedrol) which was statistically significant ($p < 0.05$). There were no major complications like epidural hematoma or abscess formation in both groups. The overall minor complications like flushing, transient hyperglycemia and headache due to CSF hypotension were more in Group A than Group B but statistics shows no significant difference. All the complications resolved without any morbidity and no patient required further hospitalization.

Conclusion: In the case of lumbar radicular pain, Epidural Steriod Injection with 3 doses of Depo-medrol is more effective than a single dose of epidural steroid without significant increase risk of complications.

GO199. The Prevalence of High-Intensity Zone in Symptomatic Patients and Its Correlation with the Disc Degeneration and Segmental Motion

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Introduction: The high intensity zone (HIZ) represents a high signal change on lumbar spine T2 MRI images. HIZ has been involved in disc degeneration and its presence was associated with inflammation and vascular granular tissue within the annulus fibrosus. Aim of our study was to investigate the HIZ prevalence, its relationship with disc degeneration and the effect on lumbar segmental motion using kinetic magnetic resonance imaging (kMRI).

Material and Methods: kMRI images of 353 symptomatic patients were analyzed. Data including age, gender, and radiologic assessments based on neutral images including disc degeneration grade of all lumbar spine units from L1/2 to L5/S1 and the presence of HIZ were recorded for all the patients. Demographics and disc degeneration were used for

calculating HIZ prevalence. Dynamic flexion and extension images from 168 patients were used for segmental motion comparison between the discs with HIZ and without HIZ. Patients with isthmic or degenerative spondylolisthesis grade 2 or higher, Modic disc or Schmorl's node were excluded due to the potential effect on lumbar kinematics. We used chi-square test and multivariate logistic regression for our statistical analysis.

Results: Among 353 patients, 107 had HIZ in at least one lumbar disc. The overall HIZ prevalence was the highest in age group 40–49 years of age, followed by 50–59 years irrespectively of disc level. The HIZ prevalence was the highest in grade IV degenerative discs, followed by grade III degenerative discs. For L4/5 segment, HIZ prevalence was the highest in age group 50–59 years and disc degeneration grade IV. For L5/S1 segment, HIZ prevalence was the highest in age group 40–49 years and disc degeneration grade III. The multivariate logistic regression model indicated that the age groups (30–39 and 40–49 years), levels (L4/5 and L5/S1) and disc degeneration grades (III and V) were risk factors for HIZ. The segmental angular motion was signicantly greater in discs with HIZ than those without HIZ on L4/5 and L5/S1. However, the differences were reduced to insignificant when adjusted for disc degeneration grade.

Conclusion: HIZ prevalence was the highest in the middle age patients (30–39 and 40–49 years) and in the moderately degenerated discs (III and IV). The lower prevalence was observed in the older patients and grade V degenerative discs. The possible reason of increased segmental angular motion at L4/5 and L5/S1 discs with HIZ may be due to the moderate disc degeneration than HIZ itself.

GO200. Concordance between Patients' and Surgeons' Expectations of Lumbar Spine Surgery

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Background: Patients undergo lumbar surgery because they expect improvement in physical and psychological symptoms. Patients and surgeons need to share an understanding of what are possible, probable and realistic expectations so they can work toward the same goals. The objective of this study was to compare concordance (agreement) within the patient-surgeon pair regarding expectations of lumbar surgery. A cross-sectional study of 184 patients scheduled for lumbar surgery and their surgeons performed at a tertiary spine center

Methods: Patients scheduled for lumbar surgery were recruited from the practices of 5 spine surgeons and interviewed in person several days before surgery with several patient-centered questionnaires including the modified Oswestry Disability Index (ODI) (score range 0–100, higher is worse), the Geriatric Depression Scale (score range 0–30, $\geq$11 is a positive screen for depression) and the valid Lumbar Spine Surgery Expectations Survey. The 20-item Expectation Survey addresses symptoms, physical function, and psychological well-being, and asks how much improvement is expected with response options of "complete" (=4 points), "a lot" (=3 points), "a moderate amount" (=2 points), "a little" (=1 point), or "no improvement/this expectation does not apply to me" (=0 points). An overall score is calculated as the sum of all responses (range 0–100, higher is greater expectations); a clinically important difference is 20 points. Before surgery, surgeons completed an identical survey asking them to rate how much improvement they expected for each item for each of their patients. The surgeon's survey is scored similarly to generate an overall score (range 0–100). Concordance between scores for each patient-surgeon pair was measured with the intraclass correlation coefficient (ICC) for continuous data [range -1 (perfect disagreement), 0 (agreement no better than chance); +1 (perfect agreement)].

Results: Patients completed the Expectations Survey a mean of 10 days before surgery; mean age 54 years, 51% men, mean ODI score 54 $\pm$ 13, 33% had a positive screen for depression, 16% had a diagnosis of acute herniated nucleus pulposus, and 84% had a degenerative condition. The 5 surgeons were age 37–59 years, in practice for 4–27 years, and all had completed a spine fellowship. The number of patients per surgeon ranged from 22–57. The mean Expectation Survey score was 73 $\pm$ 19 for patients and 57 $\pm$ 16 for surgeons. 87% of patients had higher scores (i.e., greater expectations) and 11% of patients had lower scores (i.e., lesser expectations) than their surgeons, and for 43% the difference exceeded a clinically important difference. The concordance in scores (ICC) between patient-surgeon pairs for the entire sample was 0.37. There were differences in ICC based on: demographic characteristics [men (0.47) versus women (0.27)]; diagnosis [acute herniated nucleus pulposus (0.55) versus degenerative condition (0.32)]; psychological status [negative screen for depression (0.43) versus positive screen for depression (0.22)]; and disability [better ODI score (0.46) versus worse ODI score (0.23)].

***Conclusions*:** There was wide variation in expectation scores between patients and their surgeons and for more than one third of patients this exceeded a clinically important difference. Lower concordance was not exclusively related to any particular feature but was associated with demographic, diagnostic, and clinical characteristics.

GO201. A Radiological Evaluation of Effect of a Single Level Trans-Foraminal Lumbar Interbody Fusion (TLIF) on Lumbar Sagittal Parameters

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Aim: To investigate the effect of a primary single level TLIF on the lumbar sagittal profile (segmental lordosis and total lumbar lordosis) comparing pre-operative, intra-operative and post-operative radiographs in patients with lumbar spine degenerative disease.

Methods: Patients over the age of 16 who underwent a single-level interbody fusion for degenerative stenosis and/or spondylolisthesis without scoliosis between March 2008 and March 2014 were reviewed. Age, gender, surgical level, surgical approach, facetectomy (unilateral vs bilateral) were recorded. Standardized pre and early and 6 month postoperative upright radiographs as well as an intra-operative lateral radiographs were analyzed for the pelvic incidence (PI), segmental lordosis (SL) at the TILF level and total lumbar lordosis (TL). Data analysis was performed after confirming normality using a paired *t*-test and is presented as mean (SD). p-value < 0.05 was considered significant.

Results: 69 patients were reviewed. The mean age was 58.6 (13.6) years, 39 males (56.5%), a Wiltse approach was used in 30 (43.5%) while 39 had a midline posterior approach. Segments operated were L2/L3 (1 case), L3/L4 (6), L4/L5 (43), L5/S1 (19) and bilateral facetectomy was performed in 13 (18.8%). SL changed from 15.2° (7.3) preoperatively to 20.4° (7.7) intraoperatively (p-value < 0.0001) but measured 17.9° (7.2) (p-value < 0.0001) on early postoperative images and 17.2° (7.3) at 6 months follow up (p-value= 024). The total improvement in SL at 6 months was 2° (6.7), (p-value= 0.001). TL change was insignificant on the early postoperative X-rays (48.5° (12.4) to 47.2° (11.3), p-value= 0.37) but significantly

increased to 53.1° (11.5) at six months (p-value < 0.0001) with a total improvement of 4.6° (10) (p-value= 0.001). The mean pelvic incidence was 59.7° (11.2). The cage subsided in 11 (15.9%) cases and we had no metal work loosening.

Conclusion: At the level of the TLIF, much of the lordosis achieved intra-operatively is lost once the patient mobilizes. An improvement in the total lumbar lordosis at 6 months following surgery is likely to be due to the decompression component of the surgical intervention.

Basic Science 2

GO202. Novel Circulating microRNA Signature as a Potential Non-invasive Test in LDH Patients: a Cohort Study

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Introduction: Lumbar disc herniation (LDH) is one of the major causes for back and sciatic pain that costs large medical expense. Accumulating evidence has indicated that microRNAs (miRNAs), a small non-coding RNA molecule, are associated with disc degeneration, the profile of miRNAs in the LDH patients with indication for laminectomy remains unclear.

Material and Methods: MicroRNA profiling was performed on plasma samples of 4 groups: LDH-young group ($n = 8$, average age is 31), LDH-old group ($n = 8$, average age is 56), healthy control-young group ($n = 4$, average age is 20), healthy control-old group ($n = 6$, average age is 58). The miRNAs expression were further validated by qRT-PCR.

Results: The miRNAs with p-values < 0.05 and fold change values ≥ 2 or ≤ 0.5 compared with healthy control were regarded as dysregulated miRNAs. 61 miRNAs were upregulated and 302 were downregulated in LDH-young group compared with healthy control-young group. In addition, there are 46 upregulated miRNAs and 115 downregulated in LDH-old group compared with healthy control-old group. In particular, 12 upregulated and 71 downregulated miRNAs expressed significant differences both in the LDH-young group *vs* healthy control-young group and the LDH-old group *vs* healthy control-old group. Among them, miR-224 was upregulated 4.04-, 16.99-fold in LDH-young and LDH-old groups compared with healthy control-young and healthy control-old groups, respectively ($p < 0.01$ for both). Besides, relative to old groups, miR-130b and miR-147b were downregulated significantly in young groups, both of which were reported to be associated with disc degeneration.

Conclusion: The selected miRNAs might play a vital role in the molecular pathogenesis of LDH and further research for the understanding of the functionality and pathological mechanism of the miRNAs in LDH is important and would shed new light on LDH.

GO203. Association Analysis of Col9A1, Col9A2, Col9A3, Aggrecan and TNF-α Gene Polymorphisms with Early Onset of Disc Herniation in Indian Population

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Introduction: Intervertebral disc being an avascular tissue,the extracellular matrix protein play a major role in its structural stability. The pathophysiology underlying the process of Disc Herniation is still not clear but genetic factors play a vital role in the early occurrence of the disease.The study was initiated to determine the association of Collagen9A1, Collagen9A2, Collagen9A3 and TNF-α gene polymorphisms in Disc herniated patients in comparison to healthy individuals in Indian population.

Methods: Pre Operative blood samples were collected from 20 patients under going surgery for disc herniation between the age group of 20–60years and 10 samples from healthy individuals with no history of Intervertebral disc disease. DNA was isolated, primers designed for selected exonic regions in the triple helical binding sites for Collagen and for complete 2763 bp of TNF-α and VNTR in exon 12 for aggrecan, performed PCR and samples sequenced for analysis of polymorphic variants. Genotypic and phenotypic distributions were compared with Healthy controls. Hardy Weinberg calculations were done to correlate the allelic/genotypic frequencies in the both study groups.

Results: The PCR sample analysis resulted in identification of 11 variants in complete TNF-α gene, 8 variants in Col9A1, 6 variants in Col9A2 and 3 variants in Col9A3 gene. Polymorphic variants pro620thr,gln621arg and a splicesite variant at intron-exon29 A > C for Col9A1,gln326arg for Col9A2 and ser2 gly and ala16 to arg for TNF-α were statistically significant. These variants were predominant in lower age groups of 40 years .Aggrecan showed the allele 14 and 15 to be common among both the study groups.The healthy subjects for Collagen9 did not show any variant where as TNF-α showed 3 variants which were not statistically significant.

Conclusion: The SNP at amino acid proline 620, glutamine 621 in Col9A1, glutamine 326 in Col9A2 and arginine 103 for Col9A3 are important for the stability of the triple helical structure of collagen9 and can be directly corelated to the early occurrence of the disease in younger patients. There was no association between an aggrecan VNTR polymorphism and disc herniation. The TNF-α gene variants were not directly correlated to the onset or progression of the disease but could influence their expression levels which could trigger additional inflammatory response as in rheumatoid arthritis. PCR genetic markers can be used as a diagnostic tool to identify the progression of the disease as in Ankylosing spondilosis. This is a first report on Indian population in Disc Herniated patients.

GO204. Anatomical Safety of the U.S.S. Pedicular Hook-Screw in the Adult Thoracic Spine

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Introduction: Pedicle hooks have been extensively used in spine surgery. One of the major concerns of such instrumentation is the pullout of the implants. Recently, a screw that anchors the pedicle was added to secure the hook, and to improve both pullout strength as well as purchase. An anatomical study was performed on human cadavers to assess the anatomical safety of these implants. From this study, we can conclude that the use of screws to hold the pedicle hooks is generally safe. Further studies should be done to assess this in deformed spines.

Materials & Methods: Eleven embalmed human cadavers with a mean age of 76 years (6 male bodies and 5 female bodies) were used for this study. The same staff spine surgeon performed all surgical procedures. The thoracic pedicles were instrumented bilaterally starting from T1 down to T12 with an AO Universal Spine System Pedicular Hook Screw. Abandoning the procedures was permitted whenever the safety of any neural structures was jeopardized or the implant could not be placed correctly. The surgeon's comments were documented. For subsequent analyses after instrumentation, the spines were harvested en-bloc and later dissected into individual vertebrae. Two independent blinded observers did a visual inspection to grade the hook and screw positions. All specimens were then radiographed individually in three dimensions (antero-posterior, medio-lateral & cranio-caudal). Two blinded observers independently evaluated the hook and screw positions following the visual classification system. Only the antero-posterior and lateral radiographs were provided, because only these would be available in a clinical situation.

Results: Thirty-five implant placements (ten in T11, eighteen in T12 and seven in all other levels) were abandoned prior to the surgical procedure. Six hooks were requested to be repositioned. Four implant placements were abandoned after drilling the screw hole (three screws with a medial deviation, and one screw with a lateral deviation). Of the remaining 225 implants, 29 were lost during harvesting and preparation, leaving 196 implants for further evaluation. One hundred and eighty three implants were considered safe by the surgeon at the end of the surgical procedure, 13 were believed not to be safe and were removed. No screws were found to be disrupting the integrity of the neural structures in the canal or in the foramen. A comparison between the visual and radiological evaluations of both the screw and hook positions was performed. The visual evaluation showed an inter-observer agreement of 85% for the hooks and 78% for the screws. The radiographic evaluation showed an agreement of 75% for the hooks, and of 43% for the screw between observers, a value considerably lower than expected. When comparing each of the two radiological evaluations to the "gold standard," only 62% to 67% of the hooks and 42% to 48% of the screws had an agreement.

Conclusion: Overall, the use of U.S.S. pedicle hook-screws is suggested to be safer than either the conventional pedicle hook, which is often malpositioned inside the canal, or the classical pedicle screw, which is too large for the thoracic pedicles.

GO205. Results after Lumbar Discectomy for Herniated Disc in Worker's Compensation Patients: more than 15 Years of Follow- up

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Introduction: Published literature has identified worker's compensation population to have worse results after lumbar discectomy for herniated disc compared with general population. However the advantage of complete follow-up due to its captive population is well know. This study aims to evaluate lumbar discectomy outcomes, prognostic factors and recurrence rate after more than15 years of follow-up.

Material and Methods: A retrospective review of 50 worker's compensation patients operated consecutively between 1997–1998 in *Hospital del Trabajador* for primary herniated lumbar disc was performed. Electronic medical records analysis was conducted until June 2015. Primary outcomes were surgical complications, sick leave, return to work, work compensation, chronic postoperative low back pain and reoperation for recurrent lumbar disc herniation. Statistical analysis looking for prognostic factors in lumbar discectomy evolution was realized.

Results: We found 44 men and 6 women with a mean age of 36.5 (22–66) years. One hundred percent follow-up was achieved with a mean time of 18 (17.5–18.5) years. Most patients were light workers (58%). Lumbar herniated discs were mostly located at L5-S1 ($n = 35$) followed by L4-L5 ($n = 12$). 74% were posterolateral disc herniations and 22% were central. Mean preoperative, postoperative and total sick leave was 37.9 (1–109), 57.7 (28–175) and 95.6 (35–203) days respectively. An intraoperative complication rate of 2% was seen, while no infectious complications were reported. All patients returned to work, most of them to the same work (88%). 10% received work compensation. During follow up, 32% (16/50) required a new period of sick leave with a mean sick free time of 64.4 (4–135) months. 8 of these were due to a new episode of low back pain. The rest were 6 recurrent disc herniations and 2 other level disc herniations that required new surgery. At 5, 10 and more than 15 years of follow-up recurrence rate was 8%, 12% and 12% respectively, while chronic low back pain was 8%, 10% and 12% respectively. Psychological disorders found in 18% patients were associated with longer sick leave (62.8 versus 56.6 days. $p < 0.05$) and higher need of work compensation (33% versus 4.9%, $p < 0.05$). Patients with preoperative infiltrations (33/50) required more new periods of sick leave (33% versus 5.9%, $p < 0.05$). Age, type of work, previous low back pain episodes, disc herniation characteristics and preoperative sick leave showed no statistically significant association with postoperative evolution.

Conclusion: As found in previous study, the presence of physiological disorders, also known as non-organic symptoms, and preoperative infiltrations were associated with worse results after lumbar discectomy. This manifested as longer sick leave periods and higher need of work compensation. Age, type of work, disc herniation characteristics and preoperative sick leave did not represent bad prognostic factors. Disc herniation recurrence rate increased from 8% at 5 years of follow-up to 12% at 10 and over 15 years of follow-

up. This recurrence rate is similar to the one reported in literature. Ten percent of postoperative chronic low back pain at 10 years and 12% with more than 15 years of follow-up was observed.

GO206. Functional Outcomes of Microdiscectomy- Does Obesity affect Early Postoperative Outcomes?

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Introduction: Lumbar Disc pathology remains one of the leading causes of back pain with a multitude of surgical options. Choosing the best management option remains a challenge for many practitioners due to the individualized needs and variables of each patient. Obesity poses a challenge to surgeons regarding anesthesia, positioning and adequate exposure which required longer incisions. Studies showed that in selected patient population, microdiscectomy achieved favorable short and long term outcomes with most patients achieving a good to excellent recovery on Macnab Classification up to 10 years post operatively. Studies also showed that obesity was not associated with increased risk of herniated nucleus pulposus after microdiscectomy, However, increased BMI was associated with significantly increased estimated blood loss (EBL) and operative time without affecting the surgical outcomes such as length of hospital stay, recurrent disc herniation, and intra-operative durotomy.

Methods: Study subjects were identified through the microdiscectomy registry at Hamad Medical Corporation. 50 patients who had microdiscectomy over one year prior to the closure of the study were enrolled. The study population was divided into two groups according to their BMI. Group A had BMI less than 25 kg/m^2while group B included those with a BMI equal to and above 25 kg/m^2. Patients' medical records were reviewed for demographics, complications and radiographic findings. Patients were interviewed and Short Form 12 (SF-12) and Visual Analogue Scale (VAS) scores were obtained and compared with their preoperative counterparts.

Results: Statistical analysis showed no significant differences in SF-12 or VAS scores between the 2 groups at one year follow up.

Conclusion: In the early post operative period, quality of life and pain following microdiscectomy is not affected by the patient's BMI.

GO207. Treatment of Gait and Sensory Changes in Experimental Disc Herniation Radiculopathy by Local and Sustained Anticytokine Delivery

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Objective: Disc-herniation induced radiculopathy arises from both mechanical compression and biochemical inflammation of apposed neural elements. The mechanisms that underlie evolution of a painful neuropathy remain undefined. This in vitro and in vivo study demonstrated the effect of nucleus pulposus (NP) material toward inflammatory activation and defined the need for intraneural macrophage migration after placement heterotopic disc tissue to generate the painful neuropathy phenotype.

Methods: In vitro analysis involved evaluating the mouse peritoneal macrophage response to NP-conditioned media for neurotrophin expression (mRNA by PCR) and inflammatory activation (nitric oxide by Greiss reaction). In vivo work involved C57BL/6 mice underwent a surgical procedure with mid-thigh exposure of the sciatic nerve. Control animals underwent exposure only ($n = 12$) and experimental animals underwent placement of littermate tail nucleus pulposus (NP, $n = 12$). Animals were evaluated throughout one week for mechanical allodynia by Von Frey testing, thermal hyperalgesia by heat withdrawal latency, cold allodynia by acetone testing, and gait stability by RotaRod testing. At sacrifice, immunohistochemistry was performed to identify perineural and intraneural macrophage and lymphocyte presence. Necessity of intact macrophage activity was tested using a tamoxifen-induced CreER macrophage-selective BDNF knockout system and bisphosphonate-induced macrophage depletion.

Results: Peritoneal macrophages exposed to NP-conditioned media exhibited progressively heightened levels of nitric oxide production as well as heightened neurotrophin expression at 72 hours. Mice exposed to heterotopic NP stimulation demonstrated substantial mechanical allodynia, thermal hyperalgesia, and cold allodynia compared with controls. Intraneural macrophage infiltration was observed in this group, alongside associated autoreactive lymphocytes at the disc-nerve interface. Macrophage depletion using bisphosphonate-containing liposomes prevented both perineural accumulation and intraneural migration of macrophages as well as evolution of the painful phenotype. Knocking out inflammatory cell BDNF activity in the CreER animals still permitted perinenural macrophage accumulation but eliminated intraneural macrophage migration as well as evolution of the painful phenotype.

Conclusion: Disc NP material induces inflammatory activation among macrophages as well as upregulated neurotrophin expression. Non-compressive disc herniation leads to altered behavior in this animal disease model, with demonstrated need for intraneural macrophage migration. Strategies to decrease perineural inflammation or maintain integrity of the blood nerve barrier may be effective in treating painful disc-herniation radiculopathy.

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Degenerative Lumbar 4

GO208. Efficacy and Safety of Minimally Invasive Axial Presacral L5-S1 Interbody Fusion in the Treatment of Lumbosacral Spine Pathology: A Retrospective Clinical and Radiographic Analisis

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Introduction: The surgical treatment of disc disease L5-S1 is considerably controversial and a source of debate and applied research. The*AxiaLif® Technique (Trans1, Wilmington, NC)* involves the fusion of the anterior segment L5 -S1 using a minimally invasive pre-sacral approach. It consists of a short parasacral distal incision, the cut of the sacro-coccygeal ligament and the gradual detachment of the mesorectum from the front wall of the sacrum. Through a dedicated minimally invasive system S1 is reached and a simple guide set enable the surgeon to perform discectomy and prepare the disc space for the graft filling and house the screw. In selected cases is

possible to perform a circumferential fusion through posterior fixation with percutaneously inserted systems such as either trans – articular screws or pedicle screws/rods.

Materials and Methods: From 2009 to 2013 a total of 52 patients have been treated with L5-S1 interbody fusion through *AxiaLif® Technique (Trans1, Wilmington, NC). The* patients cohort is subdivided in 12 males and 40 females, mean age 46.3 years (range 21–67). Diagnosis included L5 isthmic spondylolisthesis low-grade dysplasia, primary degenerative disc disease, disc disease secondary to previous discectomy. Exclusion criteria included previous abdominal surgery and anatomical anomalies of the sacrum (curvature of the sacrum did not allow an ideal passage of the probe). 43 patients have been followed for at least 2 years. Baseline imaging included plain and dynamic radiographs and MRI. Fusion assessment was based on plain radiographs and Brantigan fusion criteria at 1, 6, 12 and 24 months after surgery. In addition, all patients completed the VAS and ODI at baseline through last follow-up.

Results: The clinical results showed a good resolution of painful symptoms and a good recovery of the quality of life. VAS back demonstrated an average reduction over baseline of 50%, 57%, 71%, 77% at 3 month, 6 month, 12 month and 24 months, respectively ($p < 0.001$). ODI demonstrated an average reduction over baseline of 38%, 51%, 67%, and 72% at the same time points ($p < 0.001$). There were 27 subjects with 36 month data that demonstrated an average 80% reduction in pain and a sustained reduction in ODI by 73%. Complete fusion was demonstrated in 65% of cases, 30% partial fusion and 5% in the absence of bony bridges visible radiographically. Two major complications: 1 retroperitoneal hematoma, requiring surgical evacuation and 1 spondylodiscitis due to Staphylococcus aureus, resulting in the removal of the axial screw and targeted antibiotic therapy, with complete recovery at the end. One minor complication, a superficial infection of the surgical wound, which resolved with antibiotic therapy.

*Conclusion***s:** The surgical treatment of disc disease at L5-S1 with minimally invasive technique Axialif has led to good clinical outcomes. In our opinion, this method can be a good alternative to more aggressive approaches such as either the anterior retroperitoneal one or the posterior one. The first option actually could led to higher risk of complications and the frequent need of the vascular surgeon assistance. The second option is destructive for the lumbar muscles and requires a longer recovery period. In the case series presented, the low rate of complications, the high value of patient satisfaction and the efficacy of radiographic fusion justify the choice of this type of L5S1 arthrodesis. Moreover, shorter hospitalization and faster functional recovery are adding factors to choice this technique in selected cases.

GO209. Thoracic Disc Herniation: 20 Years Experience in 82 Cases

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Objective: Thoracic disc herniation in uncommon though its surgical management remains challenging topic. Surgery of such disc herniation represents less than 1%to 2% of operation for all disc disease. However, there is no consensus on the best approach and reports are based on small series.

*Method:*This study includes 82 patients with thoracic disc herniation operated in the past 20 years. 71 cases were operated via transthoracic or retopeitonral subdiphargmatic approach and nine through transfacet pedicle sparing route and Two with T1-T2 through low suprasternal notch corridor. In 12 instances two level discs were approached and in one three level, corpectomy was done in 3 cases. Autogenous graft was used in 18 cases, simple cages in 36, expandable cage in three and allograft in the remaining cases.

Result: Clinical outcome according to the thoracic JOA Score showed significant postoperative improvement. All transfacet pedicle sparing cases and two cases with isolated T1-T2 showed excellent result. six of the anterior group cases were complicated with unilateral paralysis of abdominal wall muscles. Intraoperative dural tear occurred in 4 cases which were sutured . All the patients in this group showed marked recovery except one who was temporarily deteriorated but gradually became better but not fully yet . In two other patients who were wrongly operated with laminectomy and screw fixation no recovery was seen in one but the other one has shown some recovery. In one case where the dura was covered with a thin layer of free fat graft for control of bleeding, overgrowth of fat was observed without any neurology till now .

Conclusion: Surgery of thoracic disc pose a challenge to the surgeon. The type of the surgery depends on the location of the disc .Centrally located ones and calcified hard ones are best achieved anteriorly But does located laterally via transfacet pedicle spring.Clinical outcome after surgery of a herniated thoracic disc proved successful, especially when the disc consistency, is evaluated before surgery and the affected level intraoperatively. Microscope, patience and the learning curve are important in achieving good result.

GO210. Qualitative Grading on Magnetic Resonance Imaging as a Tool for Decision Making in Lumbar Spinal Stenosis

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Introduction: Several parameters exist for assessment of lumbar spinal stenosis (LSS) but none has shown to be an absolute criteria for defining the condition. Moreover these parameters lack clinical correlation to help physicians to decide on the plan of management.

Aim: To assess the clinical relevance of the qualitative grading described for LSS and to formulate a protocol for management of these group of patients.

Materials and Methods: A prospective study was undertaken between the period of 2014–15 using the qualitative grading based on T2 weighted MRI[1] to assess the clinical outcome of 83 patients with clinical signs and symptoms suggestive of lumbar spinal stenosis at a single level to divide them into 7 morphological categories A 1–4,B, C, and D. Patients with more than two level stenosis, congenital stenosis, instability, having undergone previous surgery, other neurological disease were excluded. The diagnosis and the qualitative grading was done by a Senior surgeon not part of the study. Irrespective of the grade every patient underwent a minimum three month period of conservative management after which depending on the Oswestry Disability Index (ODI) and Visual Analogue Scale (VAS) for pain was grouped into success or failure and the failed patients were advised for decompression surgery in form of laminectomy at the involved level. These patients were further grouped into success or failure after a period of three months after surgery. A 15 point decrease in ODI and a VAS scale of less than 5 on admission into the study was considered as a success.

Results: Out of the 83 patients there were 57 failure in conservative group while out of these 50 were operated of which only 10 did not match the success criteria, while the other 7 either refused surgery or were lost to follow up. As per the grading in types A1 and 2 only 2 patients out of 17 failed

conservative trial while in all the other grades from A3 to D there was a gradual decline in success of conservative trial. In patients with grades C and D all patients failed conservative trial and required surgery. In comparison for grades A3 to D operative outcome had a significantly better outcomes as measured by the Chi-square test with p-value < 0.05 considered significant.

Conclusion: We conclude that the qualitative grading can be used as a tool for decision making in LSS . Patients with grade A4, B, C and D should be advised for an early surgery to achieve a good functional outcome as there was a high incidence of failure of conservative management in these patients. While in patients with grade A1 to A3 a conservative management is to be recommended.

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GO211. The Surgical Management of Low Grade Single Level Adult Degenerative Spondylolisthesis: Posterolateral Fusion versus Posterior Lumbar Interbody

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Introduction: Posterolateral Fusion (PLF) and Posterior Lumbar Interbody Fusion (PLIF) are procedures that can be undertaken for the surgical management of degenerative low grade spondylolisthesis. Although there is tentative evidence in the literature that PLIF provides an increased fusion rate and therefore an improvement in symptomology, PLIF surgery does carry an increased peri- and post-operative complication rate. The aim of this study was to establish which surgical intervention has the better outcomes.

Materials and Method: A prospective cohort study was undertaken of patients who underwent a single level instrumented fusion for low grade degenerative lumbosacral spondylolisthesis between 2008 and 2010. There were 56 patients in total, with 36 patients in the PLF group (group1), and 20 patients in the PLIF group (group 2). Follow-up was at 3 month, 1 year and 3 year post operatively. Visual analogue leg pain score (VAS), Oswestry Disability Index (ODI) for back pain, and SF 12 Health Survey were measured pre and 3 year post operatively. All patients were assessed by MRI scans preoperatively. Standardized lumbosacral radiographs were taken preoperatively, and at 3 month, 1 year and 3 year postoperatively, to assess radiological union.

Results: In the PLF group, the VAS score improved from 8 to 2, the SF 12 score from 25 to 76, and the ODI score from 36 to 8. In the PLIF group, the VAS score improved from 8 to 4, the SF 12 score from 27 to 72, and the ODI score from 38 to 12. All improvements were statistically significant. There was a statistically larger improvement margin in all scores in the PLF group than in the PLIF group. Radiological union was demonstrated in 91% of all patients, with 95% of patients in each group demonstrating at least, unilateral lateral mass bone graft incorporation.

Conclusion: We conclude that PLF surgery is superior to PLIF surgery for the surgical management of low grade single level degenerative spondylolisthesis

GO212. How Lumbar Disc Geometrics Affect the Risk for Rod Fracture in Patients Undergoing Adult Spinal Deformity Surgery: An Initial Report

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Introduction: Rod fracture (RF) may have significant consequences for patients, including pain, loss of deformity correction, and the need for revision surgery. Risk factors associated with RF includes age, previous spine surgery, insufficient sagittal plane correction, rod material and bending, and pedicle subtraction osteotomy (PSO). Lumbar disc geometrics, regardless of PSO, may be a risk factor affecting RF rates. Out Objective is to evaluate disc geometrics as a risk factor for RF in patients undergoing surgical correction for adult spinal deformity (ASD).

Materials/Methods: A retrospective review of a single surgeon's practice from 2010 to 2014 was performed. All patients who underwent long fusion constructs for adult deformity with a minimum of 2-year follow-up with radiographs were included. Patients were divided into 2 Groups: Group 1 (RF) - patients who sustained a rod fracture, Group 2 - patients without RF.

Results: Thirty-seven of 41 patients met inclusion criteria. Group 1 - included 11 patients (30%) with RF, all requiring revision surgery. Group 2 - included 26 patients (70%) who did not have evidence of RF at 2-year follow-up. There was no significant difference between the 2 Groups regarding age, weight, construct length (12 versus 11 levels), apical lordosis level (L3), pre or post-operative lumbar lordosis, or mean number of non-fused lumbar discs (3). Twenty-one of the 37 patients (54%) had a PSO performed. There was no difference in the prevalence of PSO between the 2 Groups: 5/11 patients (45%) in Group 1 (RF) versus 17/26 patients (65%) in Group 2. Nineteen of the 37 patients (51%) had previous lumbar spinal surgery. Measurements comparing intervertebral disc geometry 2 levels immediately cranial and caudal to the PSO or the apical lumbar vertebra were noted to have a significant difference in the mean cranial disc height (9.5mm versus 6.5mm, $p < 0.01$), mean cranial diameter (40mm versus 34mm, $p < 0.01$), mean cranial volume ($13284mm^3$ versus $8145mm^3$, $p < 0.01$), and mean caudal volume ($10635mm^3$ versus $7771mm^3$, $p = 0.02$). Caudal disc heights and diameters were larger in the RF group, but did not reach statistical significance.

*Conclusion***s:** The overall prevalence of RF was 27% with no difference in PSO rate between the 2 Groups. Patients with RF had significantly larger non-fused disc heights, diameters and volumes. The increased disc geometrics may allow for increased micro-motion in the anterior column resulting in increased failure rates. Lumbar interbody support in those discs at risk may improve stability and decrease RF rates. Further data analysis and clinical correlation is required.

GO213. Long-term follow-up Results of a Combined Physical and Psychological Program for Patients with Chronic Low Back Pain

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Introduction: For patients with persistent and disabling chronic low back pain (CLBP) who failed to improve after less intensive interventions, a combined physical and psychological (CPP) program including exercises and a cognitive behavioral approach, is recommended.[1–3] These patients with CLBP participating in a two-week CPP-program improve in functional status and quality of life during the program and these positive results are maintained at one[4] and at two-year follow-up assessment.[5]

Purpose: To evaluate the long-term results of a short, intensive, evidence based CPP-program.

Material and Methods: A consecutive cohort study with a mean follow up of 6.5 years (range: 5.5–7.5) was performed. At follow up a response rate of 85% ($n = 277$) was achieved. Primary outcome was functional status (Oswestry Disability Index [ODI;0–100]). Secondary outcomes were pain intensity, quality of life, and patient reported satisfaction. A Repeated Measures analysis of variance was used to identify changes over time. The two-week residential program is in line with recommendations in international guidelines[1–3] and provided in collaboration with orthopedic spine surgeons at Sint Maartenskliniek Nijmegen, The Netherlands.

Results: At pre-treatment assessment the mean age was 46.1years (SD9.3) and the mean CLBP-duration 12.3 years (SD10.9). The mean ODI-score showed improvement at post-treatment and maintenance of results over time (ODI df [1,276],$F = 0.146$,$p = 0.703$). Secondary outcomes showed the same pattern. At long-term follow up more than half of the CLBP-patients (59.2%) showed a clinically relevant improvement of $\geq$10 points on the ODI and 45.3% of the patients reached a functional status equivalent to an acceptable, normal healthy population value (ODI $\leq$ 22). This is comparable to the one-year follow-up assessment. 80.1% of the participants are satisfied with the treatment results and 76.2% would recommend the program to family/friends.

Conclusion: The positive short-term effectiveness at one-year follow up of a two-week CPP-program is demonstrated to maintain over time. Patients demonstrate continued improvement of functional status and quality of life after 6.5 years of follow up. Moreover, at long-term follow up a high percentage of patients were satisfied with the results of the program and they would recommend the program to family and/or friends.

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Novel Technologies 3

GO214. A Novel, Objective, Quantitative Method of Evaluation of the Pain Component and Paresthesia Coverage using Comparative Computerized Multiparametric Tactile Mapping and Database Analysis: The "Neuro-Mapping-Tools" Software (N3MT)

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Introduction: One of the major challenges of neurostimulation is actually to address the back pain component in patients suffering from refractory chronic back and leg pain. Facing a tremendous expansion of neurostimulation techniques and available devices, implanters, patients and even industrial companies can still remain confused as they need to select the right tool for the right indication. To be able to evaluate and compare objectively patient outcomes, depending on therapeutical strategies, it appears essential to develop a rational and quantitative approach to pain assessement and neurostimulation outcomes for those who undergo neurostimulation implantation.

Material and Methods: Our neuroinformatics laboratory (N^3Laboratory) located in Poitiers University Hospital, Department of Neurosurgery, enabled us to develop the Neuro-Mapping Tools software (N3MT) (Inter Deposit Digital Number: IDDN FR 001–1600002–000-R-P-2013–000–31230; Patent Applications n°PCT/EP2014/067231, n°PCT/FR 14/000 186 and n°PCT/FR 14/000 187). This tool consists of touch screen mapping, allowing the patient and/or the physician to interact by means of a tablet computer to delineate painful zones and paraesthesia coverage in the thoracolumbar region and legs.

Results: The Neuro-Mapping Tools software (N3MT) (Neuro-Pain'T, the Neuro-Mapping Locator and the Neuro-Data-Base) have been put together and used in more than 190 patients since 2012, leading us to describe new measurement parameters, divided into two categories: (1) Technical parameters, evaluating the implanted device itself, as "Device Performance, X_P," "Device Specificity, X_S" and "Persistence of the Paresthesia Perception" on the long term (X_{P3}). (2) Clinical parameters, evaluating patient response to the therapy: (a) pain surface reduction. This parameter is called Y_S. (b) pain intensity reduction. This parameter is called Y_I. (c) pain characteristics redistribution after implantation. This parameter is called Y_{PC}.

Conclusion: The N3MT software could help to guide tomorrow's treatment options by transforming personal

convictions into a more robust scientific rationale based on data collection and data mining techniques.

GO215. Thinning, Peeling and Carving Technique for the Treatment of Thoracic Myelopathy Caused by Ossification of Ligamentum Flavum

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Introduction: To introduce a novel technique of thinning, peeling and carving to remove the ossification ligamentum flavum(OLF) nidus easily, safely and completely for the treatment of thoracic myelopathy caused by OLF. This surgical procedure avoids aggressive irritating the most seriously compressed spinal cord caused by OLF nidus especially. The epidural venous plexus bleeding and the bleeding from the pedicle can be seen clearly and controlled easily during the decompression.

Material and Methods: Thoracic myelopathy caused by OLF was diagnosed in 28 patients using plain radiography, 3D CT, and MRI from January 2009 to January 2012. The lamina, the lower and the upper facet joint of the involved segment were thinned with the bigger neuro drill(diameter 3.5mm) first, The shell was so thin that the feeding blood vessels of the dura can be seen clearly. Second, the thinned shell was peeled off with the curette piece by piece. The upper facet joint and the OLF nidus were carved by the smaller neuro drill (diameter 2.5mm)and the thinned bony nidus compressing the spinal cord was removed finally, Spinal cord monitoring (SEP and MEP)was performed intraoperatively in all cases. The operating time and blood loss were recorded during the operation. The Frankel scoring system was used to assess the neurological status before the operation and in the follow up. The S F-36 were also used to assess the general health status.

Results: Of the 28 cases of OLF,3 were single level, 10 were double level, and 15 were multilevel. Of the 71 ossified segments in this study, 16 (22.5%) were located in the upper thoracic spine (T1–4), 9 (12.7%) were located in the midthoracic spine (T5–8), and 46 (64.8%) were located in the lower thoracic spine (T9-L1). The mean operating time was 145 ±32min.The mean intraoperative blood loss was 280 ± 48.6 ml. The neurological status improved during follow-up (mean 46.1 months) from a preoperative mean mJOA score of 5.39 ± 1.52 to 8.97 ± 1.22 points ($t = 18.39$, $p < 0.05$). The neurological function recovery rate ranged from 28.6% to 100%.

Conclusion: Thinning, peeling and carving technique was effective, safe and may be a reasonable choice for the treatment of thoracic myelopath y caused by OLF

GO216. Preoperative Prone Position Exercises: A Simple and Novel Method to Improve Tolerance in Kyphoplasty for Treatment of Single Level Osteoporotic Vertebral Compression Fractures

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Introduction: To evaluate the effect of preoperative prone position exercises(PPPE) on patient tolerance to percutaneous kyphoplasty(KP) and to determine if such exercises will improve postoperative clinical outcome.

Material and Methods: Eighty-three patients with single level osteoporotic vertebral compression fractures (OVCFs) were nonrandomly assigned to undergo KP under local anesthesia with PPPE or without. The number of procedure with or without a pause, need for intravenous sedation, and patient satisfactory were recorded and analyzed. Clinical outcomes were assessed using the visual analog scale and the Oswestry Disability Index. The follow-up time was 6 months.

Results: The baseline characteristics of both groups were comparable. The number of procedure without a pause in the exercises group was more than the control group (30/42 patients vs 10/41 patients, respectively, $P < 0.001$),and fewer patients required intravenous sedation in the exercises group (7/42 vs 28/41, respectively,$P < 0.001$). Patients in the exercises group were more satisfied compared with the control group (41/42 vs 32/41, respectively, $P < 0.01$).There were no significant differences between the two groups with regard to improvement in pain and functional scores at all postoperative intervals.

Conclusion: PPPE improves patient tolerance and satisfaction and decreases the need for intravenous sedation for patients with single level OVCFs undergoing KP under local anesthesia. To confirm and validate the results of our study,a large multi-center randomized controlled trial (RCT) study should be conducted.

GO217. Facet Joint Manipulation for Craniovertebral Junction Arthrodesis. Worth the Extra Effort?

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Introduction: The goal of arthrodesis is bone fusion, effected at the craniovertebral junction through onlay of either morselized iliac crest autograft (ICAG), or posterior structural unicortical ICAGbetween posterior elements. As an alternative, facet manipulation (FM) with C1-C2 or C0-C1 facet decortication and "jamming" of bone spacers into the articular space (C1-C2) has been described. We describe a series of 79 cases of surgical fusion of at least 1 component of the CVJ. FM was used in 65 cases requiring arthrodesis. Among these, we describe 14 cases using cages placed in the atlanto-axial joints (Cage assisted facet arthrodesis CAFA). To examine the efficacy of FM, we look specifically at CT documented fusion, and time to fusion using this technique.

Material and Methods: Retrospective review of medical records of 88 patients undergoing posterior arthrodesis of the craniovertebral junction (CVJ) at our unit from May 2004 to December 2013 was performed. 4 patients were excluded in case of early postoperative death (up to 30 days after the surgery). 5 patients had insufficient radiological follow-up data (follow-up < 6 months). Construct length is detailed in Table 1. *Fusion – pseudarthrosis*. Fusion was considered successful on CT if there was visible bridging trabeculations with or without bony remodeling and callus formation, across at least one of C1/C2 facets, and absence of pseudoarthrosis. Criteria for pseudoarthrosis were construct failure, or bone lucency around the screws. Time to fusion was defined as months between surgery and the earliest radiological assessment confirming solid fusion.

Results: *Fusion rate and time to fusion*. Sixteen patients were not considered for fusion analysis ($N = 6$ not grafted), or insufficient follow-up ($N = 10$). A solid fusion was achieved in 55 (87.3%) patients. Fusion rate was strongly associated with age.

Table 1 Detailed construct length grouping in analyses

Construct length	N (%)	Group
C0 – C1	2 (3%)	C0 – Cx
C0 – C2	5 (6%)	
C0 – C_{SA}	9 (11%)	
C1 – C2	50 (63%)	C1 – Cx
C1 – C_{SA}	3 (4%)	
C2 Direct	3 (4%)	C2 – Cx
C2 – C_{SA}	7 (9%)	

SA = subaxial.

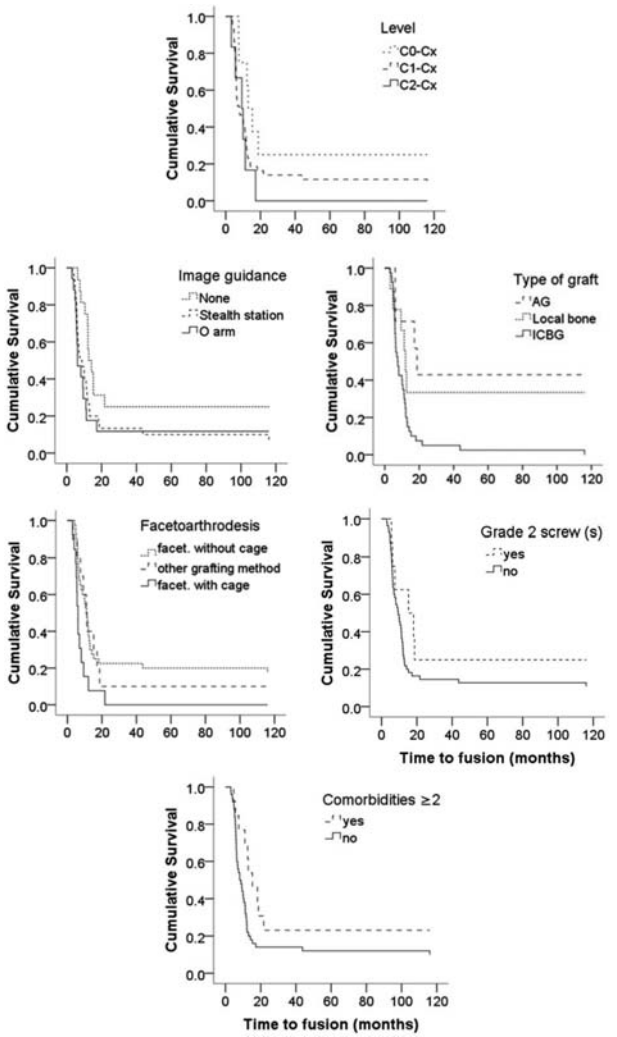

Fig. 1 Kaplan-Meier probability of solid fusion in patients with C0-Cx, C1-Cx and C2-Cx surgery (upper), using Stealth station, O arm or without image guidance (2nd left), with allograft (AG), local bone and iliac crest bone grafting (ICBG) (2nd right), Facet manipulation C1-C2 with or without cage (3rd left), with or without grade 2 screw(s) (3rd right), and with or without multiple comorbidities (lower).

Conclusion: Many techniques are used to achieve solid bony fusion in the upper cervical spine. Facet manipulation, first described by Goel should be the ideal fusion bed but has not been widely used. We report our experience using FM as a fusion technique to highlight its usefulness as a primary means of achieving fusion. It exploits the weight bearing part of the spine, the volume of bone graft materiel is very small compared with other techniques, it can be used when there are no posterior elements. Cage assisted facet arthrodesis (CAFA) may accelerate time to fusion, and may enhance fusion rates.

GO218. Two Level Anterior Cervical Arthrodesis with Integrated Spacer and Plate versus Traditional Anterior Spacer and Plate System

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Introduction: Anterior cervical discectomy and fusion (ACDF) is one of the most common spinal procedures performed by spine surgeons to treat cervical degenerative disc disease. Use of anterior spacer and plate system (ASPS) results in increased disc height, a higher fusion rate, a lower subsidence rate, and a lower complication rates than a spacer alone.[1,2] However, anterior cervical plating (ACP) is associated with significant complications, such as dysphagia, plate screw dislodgement, soft tissue injury, esophagus perforation, and neural injury.[3–9] Integrated spacer and plate (ISP) or zero-profile cage systems have recently gained popularity among spine surgeon to reduce the drawbacks of the ASPS technique. The objective of this study is to retrospectively evaluate and compare clinical and radiographical outcome of patients after two-level ACDF with IPS and traditional two-level ASPS.

Materials and Methods: From January 2007 to October 2014, a total of 84 consecutive patients with cervical degenerative disc disease who underwent two-level ACDF using the ISP or the ASPS were reviewed for clinical and radiographical outcomes. Patient reported VAS and NDI scores, fusion rates, hardware failure were recorded at 1, 3, 6, 12, and 24 months after surgery.

Results: Forty-three patients received ISP and forty-one patients received ASPS. There were no statistical differences in patient demographics between the two groups. In regards to operative details, there was no statistical differences except ISP were done almost exclusively with autograft and ASPS with allograft. Overall, there were no statistical differences in VAS scores, NDI scores and fusion status between the two groups ($p > 0.05$). At the proximal surgical level, there was a trend toward an earlier observed radiographic fusion rate in the ASPS group, 6.8 ± 5.4 months compared with ISP group, 8.3 ± 5.5 months ($p = 0.09$). Similarly, the observed radiographic fusion rate at the distal surgical level in the ASPS group was 7.0 ± 6.2 months and in the ISP group was 8.1 ± 5.5 months ($p = 0.12$). One case of long-term dysphagia (> 3 months) was reported in each group. Both groups had no reports of implant failures.

Conclusion: The integrated spacers and plate for two-level ACDF compared with traditional anterior spacer and plate system may provide comparable clinical and radiographical outcome at two years. However, there may be an earlier observed radiographical fusion in the ASPS group and no difference in long-term reported dysphagia rate.

GO219. Validation of Positioning, Lordotic Correction and Lack of Endplate Damage When using a New Expandable Articulated Lumbar Intervertebral Fusion Cage; A Cadaver Study

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Introduction: Intervertebral lumbar fusion cages became nowadays a useful tool by preserving disc space height, retaining proper tension of ligaments and providing better anterior column support with contained bone graft. Expandable cages, a new available category, help to approach the disc space with less invasive techniques adjusting its height to the local anatomy. There's need in using cages with the widest footprint, able to expand to increase disc height up to normal correcting lordotic alignment, particularly at L4–5 and L5-S1 levels, without damaging the endplates in the process and reducing pre-stress of posterior instrumentation. A 3-dimensional articulated expandable cage was tested in cadavers to verify: its effect on positioning in the disc space, by navigating its two-linked segments in the transversal plane; its expansion without endplate violation and its resultant lordotic correction in the sagittal plane.

Material and Methods: Five fresh-frozen human cadaver specimens were randomly assigned to two surgeon teams for discectomy and implantation of this new expandable titanium-alloy FLXfit cage through one-sided TLIF approach using fluoroscopy and standard spine instrumentation . No facetectomy or posterior instrumentation were performed. Every cadaver underwent a two level procedure, L2–3 and L5-S1. Each cage allowed a lordotic angled expansion of up to 10° with a dedicated cage tool. After implantation, all specimens were dissected and disc spaces incised for evaluation of positioning and endplate condition as result of expansion. Final positioning was documented with X-rays and lordotic angles were measured. Lordotic increments were calculated by level from pre and post-operatory measurements. Each surgeon rated his experience in designated questionnaires.

Results: Ten expandable cages of various sizes were implanted according to trial measurements obtained during the procedure. Surgeons successfully inserted, positioned and expanded the cages based on surgical technique . The procedure was reported as being easy to perform by the surgeons. Implant positioning was consistently accomplished in the anterior two-thirds of the disc space near the apophyseal ring due to the articulated feature covering a large footprint. Gradual cage angular expansion was performed till the maximal degree allowed in all cases, customized to each level treated. Analysis of dissected cadavers revealed an effective discectomy with preservation of the annulus except the entry portal. No endplate violation was reported in all specimens. On lateral X-rays, lordotic increment from preoperative values was significantly higher in L2–3 discs, being 7.8°±2.2 (from 5 to 10°). On L5-S1 discs the increase was 4.8°±1.3 (from 4 to 7°). The overall added lordotic correction was on average 12.6°± 2.5 per spine .

Conclusion: The use of 3-dimensional expandable cages in this cadaver study allowed better endplate bone contact with a well-fitted adjustment, according to the level treated without endplate damage. Lordosis correction was achieved differentially depending on the level and original values of alignment. Added up individual correction was shown on overall sagittal correction using two cages, which would be likely enhanced with facet resection and posterior instrumentation. The use of well positioned, large footprint, expandable lordotic correcting cages may lead to a more biomechanically balanced results in lumbar spine fusion.

Tumors 1

GO220. Preoperative Embolization in Spinal Tumour Surgery

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Introduction: Preoperative embolization has been shown to be effective in reducing intraoperative blood loss during metastatic spinal tumor surgery. However, the majority of studies investigating preoperative embolization for spinal metastases have preferentially selectedsecondaries fromrenal and thyroid as these are highly vascularized tumors. There is paucity of literature describing utility of embolization in other tumors. We aimed to determine the effect of preoperative embolization on intraoperative blood loss indifferent spinal tumors by type of surgical approaches.

Materials and Methods: We retrospectively evaluated 221 patients undergoing surgery for primary or metastatic spine tumors. Patients were analyzed for the effect of embolization agents, extent, level of embolization and timing between embolization & surgery, on estimated blood loss. Estimated blood loss and transfusion requirements were compared between embolized and non-embolized cases for different types of spinal tumor (metastatic lung, breast, renal, hepatocellular, thyroid, other epithelial tumors, myeloma/lymphoma and primary spine tumors) and surgical approaches (Type I: Cervical spine surgery either anterior and/or posterior stabilization with or without corpectomy, Type II: Thoracolumbar posterior instrumentation and decompression, and Type III: Thoracolumbar corpectomy).

Results: Preoperative embolization was performed in 48 patients. Hypervascular angiographic appearance was found in 22 (46%) and capillary blush in 26 (54%) embolized patients. Total embolization (>80% reduction of tumor blush) was achievable in more than half of the embolized patients (61%), and less amount of blood loss was observed in these patients (median blood loss = 900ml) compared with those who achieved partial (<50%) and subtotal (50–90%) embolization (1600ml and 1350ml respectively).Blood loss was also lower in those who achieved proximal embolization and those who underwent surgery between 13–24 hours after embolization. When stratified by type of tumor and surgical approaches, blood loss and transfusion requirement were lower in embolized cases of spinal secondaries from HCC & thyroid; and primary spine tumors. In multivariate linear regression, after adjusting for tumor type, type of surgical procedure, invasiveness index, preoperative haemoglobin and operative time, there were no significant differences in the blood loss as well as blood transfusion units between embolized and non-embolized groups.

*Conclusion***s:** Success of embolization in reducing blood loss depends on the extent of embolization, which should be total; and time interval between embolization and index surgery, which should be within 13–24 hours. Preoperative embolization is a useful modality in decreasing intraoperative blood loss in cases of spinal metastases from HCC, thyroid and primary spine tumors.

GO221. The Relation between Spinal Instability and Response to Palliative Radiotherapy for Symptomatic Spinal Metastases

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Background and Purpose: Up to 70% of cancer patients with terminal illness have bone metastases, with the spinal column being most affected. The standard local treatment for painful spinal metastases is conventional external beam radiotherapy. However, ~30–40% of the patients do not achieve adequate pain relief. It is not well understood why some patients respond and others do not. Considering the limited life expectancy of these patients it is crucial to optimize treatment selection to ensure fast, effective and lasting symptom relief. We hypothesized that pain resulting from mechanical instability of the vertebra responds less well to radiotherapy than pain originating from local tumor effects. The aim of this study was to investigate the relationship between spinal instability, defined by the Spinal Instability Neoplastic Score (SINS), and the response to palliative radiotherapy for symptomatic spinal metastases.

Material and Methods: A prospective international multicenter observational study of patients who underwent irradiation of symptomatic spinal metastases was performed between January 2013 and December 2014. Patients were excluded if they were diagnosed with multiple myeloma, if they had previous surgery on the same level or if they had substantial neurological deficits (ASIA $\leq$C). The SINS was calculated by an observer blinded to outcome using the radiotherapy planning computed tomography scans. Pain response was rated using the International Bone Metastases Consensus Working Party Endpoints. The association between SINS and response was estimated by multivariate logistic regression analysis.

Results: A total of 155 patients were included, 91 male and 64 female (mean age 66 $\pm$ 11 years). Thirteen patients (8%) died within four weeks following treatment, 18 (12%) patients were lost to follow-up. Neither median nor mean SINS was significantly different for patients with or without response. In multivariate analysis, the SINS was not significantly associated with response (adjusted odds ratio 0.94; 95% confidence interval 0.81–1.10; $p = 0.449$). The WHO performance score, however, was related to radiotherapy response.

Conclusion: No significant relationship was observed between degree of mechanical spinal instability, as reflected by the SINS, and response to radiotherapy. Trying to explain our findings, it can be argued that some components of SINS reflect current mechanical instability while other components are indicative of impending instability. Future studies should aim to optimize the definition of instability to better predict treatment outcome.

GO222. Operative Management of Post-tumor Spinal Deformity

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Introduction: The purpose of our research is evaluation of the outcome after surgery and health-related quality of life (HRQOL) parameters in patients with post-tumor spinal deformity.

Material and Methods: Retrospective clinical and radiographic data were collected for 33 patients (15 male and 18 female, average age of 61.4 years) with spinopelvic malalignments (SRS-Schwab sagittal modifiers: 2 grade and more) who underwent spinal deformity surgery. Patients were divided into two groups. The first group included 13 patients ($n = 12$ after chemotherapy of plasmacytoma, $n = 1$ patient after radiotherapy of cervix uteri cancer metastasis) with confirmed spinal oncology diagnosis by biopsy. All patients have had oncology remission with a 3-year minimum follow-up. Spinal deformity was developed in the period between 1 and 6 years after conservative treatment. Repeated biopsy did not show tumor cells, this was evaluated as local control of tumor. Low scores of HRQOL and unsuccessful nonoperative approach were indications for surgical intervention. The second comparative group consisted of 20 patients with "de novo" degenerative or posttraumatic spinal deformity. The aim of surgical management was to achieve sagittal balance, using osteotomies and transpedicular instrumentalization. Groups were evaluated with HRQOL-scales including VAS, ODI, SF36 and SRS-24. Radiographical assessment included Cobb coronal angle, thoracic kyphosis (TK), lumbar lordosis (LL), pelvic incidence (PI), pelvic tilt (PT) and sacral slope (SS), sagittal vertical axis (SVA). Radiographical, HRQOL-parameters and complications were analyzed and compared between two groups. The comparisons were done by using independent sample Student *t*-test. A p-value of less than 0.05 was accepted as significant.

Results: Both groups showed a restoration of global spinal alignments without significant differences in TK, LL, PI, PT, SS, SVA parameters ($p > 0.05$). In addition, HRQOL-scores (VAS, ODI, SF36, SRS-24) of the patients were increased after operation. The HRQOL-scores after 2 years are slightly higher in the first group, but we did not get significant difference between groups ($p > 0.05$). The number of complications in the form of implant instability, proximal and distal junctional disorders was comparable ($p > 0.05$). However, general medical complications in the first group was significantly higher than in the second one ($p < 0.05$). It is important that no patients had local recurrence or metastasis of tumor during follow-up in the first group.

Conclusion: Spinal tumor under local control is not contraindication for spinal deformity surgery. Realigning of the sagittal plane is paramount, especially because of the sagittal balance impact on quality of life.

GO223. Survival and Clinical Outcomes in Patients with Metastatic Epidural Spinal Cord Compression: Results from the AOSpine Prospective Multi-Centre Study of 142 patients

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Introduction: Although surgery is being increasingly used in patients with Metastatic Epidural Spinal Cord Compression (MESCC) as a complementary strategy to radiation and chemotherapy, the impact of surgery on quality of life (QoL) is not well established. This study aimed to prospectively evaluate survival, neurological, functional, and QoL outcomes in MESCC patients undergoing operative management.

Material and Methods: A total of 142 surgically treated patients with a single symptomatic MESCC lesion enrolled in a prospective North American multi-center study were followed for 12 months. Clinical data, such as Brief Pain Inventory (BPI), ASIA, SF-36, Oswestry Disability Index (ODI), and EQ-5D scores, were obtained both pre- and post-operatively.

Results: The median survival was 7.7 months. The 30-day and 12-month mortality rates were 9% and 62%, respectively. Six weeks post-operatively, ambulatory status ($p = 0.02$) and bladder control ($p = 0.03$) were significantly improved. Overall, 67.5% of ASIA B, C, or D patients gained at least 1 grade after surgery, 25% remained stable, and 7.5% deteriorated. ODI, EQ-5D, BPI scores were significantly improved at each follow-up ($p \leq 0.01$). SF-36 scores were generally higher after surgery for mental and physical components, and for all domains except energy/fatigue. The incidence of wound complications was 10% and 2 patients required a second surgery (screw malposition and epidural hematoma).

Conclusion: Surgical intervention, as a complementary adjunct to radiation and chemotherapy, provides immediate and sustained improvement in pain, neurological, functional, and QoL outcomes with acceptable risks in patients with a focal symptomatic MESCC lesion.

GO224. Prognostic Factors for Survival in Surgical Series of Symptomatic Metastatic Epidural Spinal Cord Compression: A Prospective North American Multi-Centre Study in 142 Patients

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Introduction: Symptomatic Metastatic Epidural Spinal Cord Compression (MESCC) afflicts up to 10% of all cancer patients and is associated with shortened survival and worsened quality of life. This study aims to identify the key survival prognostic factors in MESCC patients who were surgically treated for a single symptomatic lesion.

Material and Methods: 142 MESCC patients were enrolled in a prospective North American multi-center study and followed postoperatively for 12 months. Using univariate analyses, Kaplan-Meier methods, and log-rank tests the prognostic value of various clinical predictors were assessed. Non-collinear predictors with $p < 0.05$ in univariate analyses were included in the final Cox proportional hazards model.

Results: The overall median survival was 7.7 months (range: 3 days – 35.6 months); breast cancer had the longest median survival (12.1 months). Ten patients (7%), whose primary cancer were lung (3), kidney (3), sarcoma (2), prostate (1), and breast (1), died within 30-days postoperatively and 88 had died at 12 months (62%). Univariate analyses yielded eight significant predictors for survival: the growth of primary tumor (Tomita Grade 1 vs Grade 2 and 3), BMI, gender, preoperative SF-36 physical component, EQ-5D, and ODI scores as well as the presence of either visceral or extraspinal bony metastasis. The multiple regression analysis revealed that the Tomita grade (Grade 1 vs Grade 2 and 3; HR: 2.81, $p = 0.007$), the absence of visceral metastasis (HR: 2.01; $p = 0.0044$), and higher score on SF-36 physical component (HR: 0.95, $p < 0.0001$) were independent predictors for longer survival regardless of the selection method used (backward, forward, or stepwise).

Conclusion: Slow growing tumor (Tomita Grade 1), absence of visceral metastasis, and lower degree of preoperative physical disability, as reflected by a higher score on the SF-36 physical component questionnaire, are good prognostic factors for survival in selected patients who underwent surgical treatment for a focal symptomatic MESCC lesion.

GO225. Surgical Treatment of a C3-osteoblastoma with Cord Compression and Encompassing the Vertebral Artery via Combined Approach

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Background: Osteoblastoma is a rare and benign osteoid-producing primary bone tumor that affects mainly the long bones. 36% of these tumors are observed around the spine and the vast majority arises around the posterior.

Case Presentation: This report describes a case of C3 osteoblastoma occurring in a 22-years old male. He represented with cervical pain and quadriparesia.Cervical CT and MRI demonstrated an osteolytic mass that invade anterior and posterior elemant of C3 and cause severe cord compression. Because of the close proximity of the osteoblastoma to the vertebral artery canal and cord total resection of tumor was a challenging decision. To prevention of vertebral artery injury, laminectomy and partial resection of tumor was done with posterior approach and bilateral vertebral arteries preserved and then fussed with lateral mass screw. For best reconstruction and stability, total C3 corpectomy and anterior fusion with allograft and plate was done via anterior cervical approach.

Conclusions: Osteoblastoma in cervical spine with involvement of anterior and posterior part of vertebrae is a rare pathology and can encase vertebral artery. This case has favorable prognosis after 2 sessions surgery and adequate rehabilitation.

Basic Science 3

GO226. Polymer-based Silver Nanoparticle Coated Pedicle Screws Inhibits Biofilm Formation-a Novel Experimental Model in Rabbits

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Introduction: Infection in spinal implant is of great concern. Anti-infection strategies must be tested in relevant animal models that will lead to appropriate clinical studies. A novel spine implant model was designed to study the antimicrobial effect of a modified Titanium (Ti) pedicle screws with methiciline resistant Staphyloccoccus Aerous (MRSA) in multiple surgical sites in the lumbar spine of a rabbit.

Material and Methods: Twenty two New Zealand White rabbits were divided into two groups: group 1: infected unmodified Ti screw group ($n = 10$), group 2: infected polyethylene glycol grafted polypropylene based Silver nanoparticle (PP-g-PEG-Ag) covered Ti screw group ($n = 10$), and two rabbits as control-sterile group. In all groups left L4- right L6 vertebra levels were exposed and screws were drilled to transverse processes after contamination of burr holes with 0.1 ml of 10^6 CFU MRSA solutions in group 1 and 2. After 21 days, samples were collected and infection was analyzed via light and scanning electron microscopy and culturing. Silver nanoparticles (Ag-NP) on the screws and tissues were assayed pre and postoperatively.

Results: The bacterial colony count for modified-Ti screw group was lower compared with unmodified Ti screw (17,2 vs 200 $\times$ 10^3 CFU/mL, $p = 0{,}029$) with less biofilm formation. There was no difference in duration of surgery among groups and within the surgical sites. Ag-NPs were detected on the screw surface postoperatively.

Conclusion: This novel experimental design of implantation in rabbits is easy to apply and resembles human stabilization technique. Modified Ti screws were shown to have antimicrobial effect with especially inhibiting the biofilm formation. This anchored Ag NPs which remained after 21st day of implantation shows that it is resistant to tapping forces of the screw.

GO227. Morphology and TGF-beta1 Concentration's Analysis of Ligamentum Flavum of Patients with Lumbar Canal Stenosis and Lumbar Disc Herniation

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Introduction: The most common spinal disorder in elderly patients is lumbar spinal canal stenosis, causing low back and leg pain, and paresis. The etiology of degenerative changes occurring in lumbar stenosis still remain unclear: some authors hypothesize the hyperplasia and others the hypertrophy of Ligamentum flavum (LF). The change of LF is known to be related to degenerative changes that are secondary to the aging process or mechanical instability. The study's objective is to analyze the LF of patients with lumbar canal stenosis and lumbar disc herniation to evaluate the morphology and the concentration of the Transforming Growth Factor-β 1 (TGF-β 1).

*Material and Method:*The study is characterized by three phases: (A) Measurement of the thickness of the LF of patients with lumbar stenosis and/or herniated lumbar disc through the axial, T1 weighted images of the lumbo-sacral magnetic resonance imaging (MRI); (B) Removal of LF in patients undergoing intervention for lumbar stenosis and lumbar disc herniation (control group); (C) Optical microscopy study of the morphology of degenerated ligamentum and immunohistochemical analysis to assess the concentration of TGF-β 1 in the same. The analysis of the morphology of the ligamentum (meant as the increase of the fibers number or distension and relaxation of the same as a result of degenerative processes) and the presence or absence of a high concentration of TGF-β1 (then more fibroblasts involved in the degenerative process) can be important to clarify if there is an hypertrophy or hyperplasy of ligamentum flavum in lumbar canal stenosis.

Results: In the current study we have showed that decreased elasticity of LF in the elderly is due to the loss of elastic fibers that are degenerated and a concomitant increase of collagenous fibers (hypertrophy); the concentrations of TGF-β1 of the LF measured in both lumbar spinal stenosis and disc herniations was higher than that of the latter.

Conclusion: The current results suggest that LF of lumbar canal stenosis is hypertrophic: LF hypertrophy could be due to the thickening of the normal elastic layer as well as of the abnormal collagenous layer and to higher expression of TGF-β 1 by fibroblasts

GO228. An Analysis of the Spinal Nerve Roots in Relation to the Adjacent Vertebral Bodies with Respect to a Posterolateral Vertebral Body Replacement Procedure

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Introduction: This study aims to improve the understanding of the anatomic variations along the thoracic and lumbar spine encountered during an all-posterior vertebrectomy, and reconstruction procedure. This information will help to improve our understanding of human spine anatomy and will allow better planning for a vertebral body replacement via either a transpedicular or costo-transversectomy approach, The major challenge to a total posterior approach vertebrectomy and vertebral body replacement in the thoracolumbar spine lies in the preservation of important neural structures.

Materials and Methods: Retrospective analysis of 100 normal MRI spinal studies (T1-L5) on sagittal T2 weighted MRI images were studied to quantify: 1) mid-sagittal vertebral body (VB) dimensions (anterior, midline and posterior vertebral body height); 2) midline VB and associated intervertebral discs height; 3) mean distance between adjacent spinal nerve roots (DNN) and mean distance between the inferior endplate of the superior vertebrae to its respective spinal nerve root (DNE) and 4) posterior approach expansion ratio (PAER).

Results: 1) The mean anterior VB height gradually increased cranio-caudally from T1 to L5. The mean midline and posterior VB height showed a similar pattern up to L2. Mean posterior VB height was larger than the mean anterior VB height from T1 to L2, consistent with anterior wedging, and then measured less than the mean anterior VB height, indicating posterior wedging. 2) Midline VB and intervertebral disc height gradually increased from T1 to L4. 3) DNN and DNE were similar, whereby they gradually increased from T1 to L3. 5) Mean PAER varied between 1.69 (T12) and 2.27 (L5) depending on anatomic level.

Conclusions: The dimensions of the thoracic and lumbar vertebrae and discs vary greatly. Thus, any attempt at carrying out a VB replacement from a posterior approach should take into account the specifications at each spinal level.

GO229. An In-vitro Study on The Effects of Spinal Canal Curvature on Cord Interstitial Pressure during Spinal Cord Distraction

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Study Design: This is an in-vitro study examining the effect of spinal canal curvature on spinal Cord Interstitial Pressure (CIP) during porcine spinal cord distraction. In this study we examined CIP developed in spinal cords during distraction in three conditions: 1) linear cord distraction (stretch) 2) simulated 45 degree scoliotic curve and 3) simulated 90 degree scoliotic curve.

Summary of Background Data: Spinal cord distraction is a known cause of spinal cord injury (SCI). Several papers published on the pathophysiology of the cord distraction injury suggest that the underlying mechanism of injury is a micro-vascular ischemic event[4]. We have previously described an increase in CIP with spinal cord distraction,[12,18] and have shown that spinal cord distraction can lead to spinal cord injury in live animal experiments[13]. Distraction spinal cord injury is known in scoliosis correction but rare in other spine injuries. With this experiment we wish to determine if simulated spinal curvature may potentiate the spinal cord distraction elevation in CIP noted during our experiments.

Objectives: To determine if increasing degrees of spinal curvature lead to increasing CIP during in-vitro spinal cord distraction.

Methods: Ten freshly thawed porcine spinal cords were tested in a saline bath in linear, 45° degree and 90° degree curved surfaces while CIP was monitored using the modified Whitesides technique[27]. Multiple linear regressions were then performed.

Results: We noted a close correlation between applied tension (T) and CIP. The greatest pressure elevations were noted for the 90° curve mode, intermediate elevations were noted for the 45° curve modes and the smallest pressure elevations were noted for the linear mode of distraction ($p < = 0.05$).

Conclusion: High CIP can be achieved through spinal cord distraction. This CIP is not only directly proportional to tension, but also proportionally increased by the degree of spinal curvature. This may suggest that spinal curvature may tend to increase generated CIP during distraction, and be a potentiating factor for spinal cord injury during scoliosis correction.

Keywords: spinal cord, cord interstitial pressure, CIP, spinal cord distraction, tension, curvature

GO230. Biomechanical Evaluation of the Transpedicular Nucleotomy with Intact Anulus Fibrosus

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Introduction: Mechanical loading represents a crucial part of intervertebral disc (IVD) homeostasis. However, traditional regenerative strategies require violation of the annulus fibrosus (AF) resulting in significant alteration of joint mechanics. The transpedicular nucleotomy represents a suitable method to create a cavity into the nucleus polposus (NP), as a model to study IVD regeneration with intact AF. The aim is to study how the transpedicular tunnel (TT) and the novel mechanical nucleotomy affects the biomechanics of the NP.

Material and Methods: 60 ovine lumbar FSUs (L1-L6) randomly assigned to 5 groups: Control; TT; TT + polymethylmethacrylate (PMMA), to repair the bone tunnel; Nucleotomy; Nucleotomy + PMMA. The robotic spine testing system consists of a robotic manipulator (Staubli RX90) and a six-axis load cell (JR3 Inc.). Flexion/extension, lateral bending and axial rotation were evaluated under adaptive displacement control. Axial compression was applied for 15 cycles of preconditioning followed by 1 hour of constant compression. Viscoelastic properties were determined.

Results: TT has minimal effects on rotational biomechanics. The nucleotomy increases ROM and NZ displacement width while decreasing NZ stiffness. TT + PMMA has small effects in terms of ROM. Nucleotomy + PMMA brings ROM back to the control, increases NZ stiffness and decreases NZ displacement width. The nucleotomy tends to increase the rate of early creep. TT reduces early and late damping. The use of PMMA increased late elastic damping (S2) and reduced viscous damping (η2) culminating in faster resolution of creep.

Conclusion: Biomechanical properties of NP are crucial for IVD repair. TT does not affect rotational stability. Mechanical changes that occur with nucleotomy are similar to those

characteristics of early degeneration. These findings confirm that the NP is crucial for segmental stability in physiologic rotations.

GO231. Review of Patient Transfers from Spinal Surgery to the Spinal Injuries Unit

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Introduction: To review the length of time patients are awaiting spinal injury reviews on the spinal surgery ward and awaiting beds on the spinal injuries unit.

Materials and Methods: A list of all spinal surgery patients with a spinal injuries episode within the same spell during the period 01/04/12 to 26/11/14 were gained by coding ($n = 37$). Three patients were excluded from the data (one under neurosurgery, two were transferred from the spinal injuries unit (SIU) and were both discharged from the spinal surgery ward) ($n = 34$). Data was obtained via a case note review.

Results: The mean number of days patients were awaiting a SIU bed (calculated from spinal injuries review to transfer) was 19 (+/−14). The maximum time waiting on the spinal surgery ward was 39 days, and one patient waited 48 days for a ventilator bed. The later the admission the longer patients were waiting, with a positive correlation but this was not significant (r=0.28, $p = 0.18$). The mean waiting time was 9 days in 2012, 17 days in 2013 and 24 days in 2014. There was a positive correlation between the length of time patients were awaiting a SIU bed and their length of spinal injuries stay (r=0.105, $p = 0.39$). The mean time awaiting a spinal injuries review was 5.9 days. However often there was limited documentation regarding how patients were referred and so was not clear when referrals were received by the spinal injuries team. Two patients had no documented review before transfer . The most frequent type of injury which resulted in patients requiring transfer for rehabilitation was fracture (44%), followed by infection (29%). 47% of injuries were in the thoracic spine. 71% received surgery during their admission.

*Conclusion***s:** This review shows patients are waiting considerable amounts of time awaiting SIU beds and the delays are increasing each year. Delays cause significant implications for patients such as psychological issues and risk of complications including pressure sores, contractures and infections, all of which can impact on functional outcomes. Delays are a high cost to the NHS (the cost of a critical care bed is over £800 more than a ventilated SIU bed). Further work can be performed reviewing reasons for delays and to look at delays in SIU discharges. Patients could benefit from an increase in spinal injury reviews while beds are awaited. An audit on the management of SCI patients while they are on an orthopaedic ward could ensure care meets current recommendations.

Deformity Thoracolumbar Adult 2

GO232. Is It Necessary to Fuse to S1 for the Tilted L5 in the Treatment of Adult Degenerative Scoliosis?

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Introduction: The extension of fusion to S1 compared with L5 and lower thoracic levels compared with L1 remains a highly controversial topic in the surgical treatment for adult degenerative scoliosis (ADS). As one of the criterion, if the tilted L5 were over 15°, the distal fusion level should extend to the sacrum. Could the tilted L5 be neutralized and the L5S1 be saved in the ADS correction?

Material and Methods: Posterior one stage of facetectomy and interbody release combined with key segment anterior structural column support were used to treat 32 ADS cases. The thoroughly interbody release and fusion were done with both side in all involved segment, a little bigger inserter were inserted into L3,4 and L4,5 cave side to neutralize the tilted L5 maximally. The operating time and the blood loss were recorded. Mean follow-up was at least two years. All the subjects were analyzed by visual analog scale, Oswestry Disability Index (ODI), and SF-36 scores, SRS 22 before and after surgery and at follow-up. The scoliotic curve, thoracic kyphosis, lumbar lordosis, pelvic incidence (PI), pelvic tilt (PT), sacral slope, and C7 plumb line were measured. For the statistical analysis, multivariate multiple regression models were formulated, considering as significant ($p < 0.05$).

Results: The average operating time were 150min and the mean blood loss were 520ml. A statistically significant clinical and radiological amelioration was noted after surgery and at final follow-up. The ODI, and SF-36 scores, SRS 22 improved. The Cobb angle of lumbar lordosis (7 plumb line) and spino-pelvic parameters (PI, PT, sacral slope) returned to the normal range after surgery. L5S1 radiological adjacent segment pathology (RASP) happened in two cases at the follow-up, one was extended to the S1,there is no symptom in another case.

Conclusion: The tilted L5 can be neutralized and the L5S1 can be saved in the ADS correction. Even with a little movement, the saved L5S1 is important for a whole body to balance.

GO233. Effect of Treatment Complications on the Outcomes in Adult Spinal Deformity: A Decision Analysis Approach

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Introduction: Treatment of adult spinal deformity (ASD) is known to be associated with a fairly high rate of complications whereas the impact of these complications on treatment outcomes is less well known. Aim of this study is to analyze the impact of treatment complications on outcomes in ASD using a decision analysis (DA) model.

Material and Methods: From an international multicentre database of ASD patients (968 pts), 535 who had completed 1 year follow-up (371 non-surgical –NS), 164 surgical –S), constitute the population of this study. DA was structured in two main steps of: 1) Baseline analysis (Assessing the probabilities of outcomes, Assessing the values of preference –utilities-, Combining information on probability and utility and assigning the quality adjusted life expectancy (QALE) for each treatment) and 2) Sensitivity analysis. Complications were analyzed as life threatening (LT) and non-life threatening (NLT) and their probabilities were calculated from the database as well as a thorough literature review. Outcomes were analyzed as improvement (decrease in ODI > 8pts), no change and deterioration (increase in ODI > 8pts). Death/complete paralysis was considered as a separate category.

Results: All 535 patients (371 NS, 164 S) could be analyzed in regard to complications. Overall, there were 78 NLT and 12 LT complications and 3 death/paralysis. Surgical treatment was significantly more prone to complications (31.7% versus 11.1%, $p < 0.001$) (Table 1 a). On the other hand, presence of complications did not necessarily decrease the chances of improvement, surgical patients tending to rate better in this respect (Table 1b). Likewise, QALE was not particularly affected by the presence or absence of complications regardless of the type of treatment (Table 1c).

Conclusion: This study has demonstrated that surgical treatment of ASD is more likely to cause complications compared with non-surgical treatment. On the other hand, presence of complications neither has a negative impact on the likelihood of clinical improvement nor affects the QALE at the first year detrimentally.

GO234. Multilevel XLIFs, TLIFs and Grade 2 Posterior Osteotomies for Surgical Correction of Compensated Sagittal Imbalance: Outcomes in 25 Consecutive Adult Degenerative Deformities at Minumum 2 Years Follow-up

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Introduction: Sagittal imbalance in the adult degenerative spine requires surgical correction to improve pain, mobility and quality of life. Aim of our surgery is to obtain a harmonic, balanced sagittal profile operating a series of adult degenerative kyphoscoliosis by means of XLIFs, TLIFs, SPOs and posterior pedicle screws. Actually, XLIF seems to be the less invasive alternative to PSO to restore LL and achieve anterior fusion, while Grade 2 posterior osteotomies can be useful to further decrease kyphosis.

Material and Methods: We treated by XLIFs, SPOs and pedicle instrumentations 25 thoraco-lumbar and lumbar degenerative deformities, characterized by a sagittal compensated imbalance (SVA $<$ 50mm), with or without coronal deformity, and distinguished according to the SRS-Schwab classification. All patients were submitted to X-ray screening during pre, post-operative and follow-up periods.

Results: Mean age was 64 (50–74; M/F 1: 4). Sixteen deformities were type L and 9 type N. Loss of LL was moderate (+) in 14 cases and marked (++) in 11. We performed 50 XLIFs, 15 TLIFs, 48 SPOs. Complication rate was minimal. PT, LL, SVA and TK improved ($p < 0.05$), post-operative values were similar to those pre-operatively calculated in 90% of cases and clinical follow-up (mean 29.5; range 24–36), scored using VAS and ODI, was satisfactory in all cases, except for two due to sacro-iliac pain.

Conclusion: Current follow-up does not allow definitive conclusions. However, the surgical approach proposed seems to be a viable choice usable in these compensated adult deformities, avoiding risks and complications of aggressive PSOs.

GO235. Primary versus Revision Surgery for Adult Spinal Deformity: An Analysis of Cost Effectiveness

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Introduction: Spinal deformities affect 3–50% of the population, with the number of spinal fusions performed in the USA rising each year. After undergoing surgical management for adult spinal deformity, 9–19% of patients may require revision procedures for failure of bony fusion, implant complications, refractory pain, and deformity progression. Rising healthcare costs, and a focus shift to achieving significantly better health outcomes per dollar spent, have led to increasing interest in determining the value of complex spine surgeries. Despite mounting scrutiny of increasing costs, data evaluating cost effectiveness of primary and revision surgery for adult spinal deformity (ASD) is sparse. Investigation is particularly needed in the revision surgery population, where complication rates may be higher. In this regard, our goal was to assess the functional outcomes, two-year comprehensive costs, and cost effectiveness of primary and revision arthrodesis for ASD.

Material and Methods: We retrospectively reviewed 119 consecutive patients who had undergone primary (fifty-six patients) or revision surgery (sixty-three patients) for ASD, with $>$ five levels fused at their index surgery, and who were followed for a minimum of two years. Two-year total spine-related medical resource utilization was confirmed via retrospective analysis of hospital records. Costs were derived from data maintained within our institution's finance sector, and reflected the hospital perspective. Functional outcome scores were extracted from prospectively collected patient data. QALY units were derived from SF-36 scores mapped to EQ-5D. Cost effectiveness was assessed using a threshold of $159,126/QALY gained, three times the US per capita GDP in 2013.

Results: Both the primary surgery cohort ($n = 56$: 41F, 15M) and the revision cohort ($n = 63$: 48 F, 15M) demonstrated statistically significant improvement in health related quality of life scores at two years. Median surgical and follow-up costs over two years were $137,990 for primary surgery versus $115,509 for revision surgery, and were not significantly different between the two groups ($p = 0.12$). We report a two-year QALY gain of 0.36 (IQR 0.01-.62) in the primary surgery cohort, versus 0.40 (IQR 0.01-.80) in the revision group ($p = 0.71$). Primary instrumented arthrodesis was associated with a two-year cost per QALY of $197,809 versus $129,950 for revision surgery ($p = 0.31$).

Conclusion: We found that revision surgery for ASD had a lower two year total cost, and higher two year QALY gains than primary surgery, though not significant. While revision surgery for spinal deformity in adults is known to be technically challenging and may have a higher rate of complications than primary surgery, revision surgery was more cost effective than primary surgery at two years. A history of failed spinal surgical procedures should not by themselves be considered to render future reconstructive procedures non-cost-effective. To our knowledge, this is the first description of the cost effectiveness of revision surgery for ASD, as well as the first for primary surgery utilizing two year spine care-related cost data from a hospital perspective.

GO236. Sagittal Plane Correction Using Lateral Transpsoas Approach: Effect of Cage Angulation and Surgical Technique on Segmental Lordosis

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Introduction: Lordotic cage insertion through lateral transpsoas approach is being used increasingly for restoration of sagittal alignment. However, the degree of correction achieved by varying cage angle as well as ALL release and posterior element resection is not well defined. The objective of this study is to determine the degree of segmental correction which could be achieved through lateral transpsoas approach by varying cage angle as well as adding anterior

longitudinal ligament (ALL) release and posterior element resection.

Material and Methods: Thirteen human cadaveric lumbar motion segments between L1 and L5 were dissected into single motion segments. Segmental angles and disk heights were measured under both 50N and 500N loads under the following conditions: Intact specimen, discectomy (collapsed disk simulation), insertion of parallel cage, 10° cage, 30° cage with ALL release, 30° cage with ALL release and spinous process (SP) resection, 30° cage with ALL release, SP resection, facetectomy and compression with pedicle screws.

Results: Segmental lordosis was not increased by with either parallel or 10° cages as compared with intact disks, and contributed small amounts of lordosis when compared with the collapsed disk condition. Placement of 30° cages with ALL release increased segmental lordosis by 10.5°. Adding SP resection increased lordosis to 12.39°. Facetectomy and compression with pedicle screws further increased gains in lordosis to 26.4° in the 50N group and 25.8° in the 500N group. Neither group experienced a decrease in either anterior or posterior disk height.

Conclusion: Insertion of parallel or 10° cage has little effect on lordosis. 30° cage insertion and ALL release resulted in an increase of lordosis by ~10.5°. The addition of SP resection and facetectomy allowed increases in correction of up to 26.4°. No interventions resulted in decrease in either anterior or posterior disk height suggesting gains were achieved without causing foraminal stenosis.

GO237. Which Factors Influence the Surgery vs. Non-surgery Decision for Adult Idiopathic Scoliosis Patients with Gray Zone (40-55°) Main Thoracic Curves?

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Introduction: To analyze the factors that may influence surgical vs non-surgical treatment for AdIS patients within gray zone (40–55°) main thoracic (MT) curves.

Material and Methods: A retrospective analysis of a multicenter, prospective, consecutive patient series. Inclusion criteria were: AdIS, ≥18 years of age, major curve to be MT, Cobb between 40 and 55°. Ninety-one patients (69 Non-surgical and 22 Surgical) were included. Non-surgery group had 57F and 12M; mean age: 28.3 (18–47), mean Cobb: 46.8° (40- 55). Surgery group had 19 F and 3M; mean age: 31.1 (18–71), mean Cobb: 49.2°(42–55). All patients completed SF-36, SRS-22 and ODI when they were first seen in the clinic. AP and lateral Cobb measurements and sagittal plane parameters were measured. Independent samples *t*-test was used to compare groups. Variable importance analysis was done using classification and regression tree algorithm to predict factors that influence surgical decision.

Results: ODI, SF-36 PCS and SRS-22 subtotal, function, pain, self-image scores were significantly different between the groups ($p < 0.05$). Age, MT curve Cobb, Lumbar curve Cobb, trunk shift, SVA, coronal balance, SF-36 MCS and SRS22 mental health were not statistically different ($p > 0.05$). Most important variable that created a tendency toward surgery was SRS-22 functional status followed by ODI, SRS-22 pain score, SF-36 PCS and SRS-22 self image score (Fig. 1).

Conclusion: AdIS patients having a curve magnitude in the gray zone (40–55°) with decreased SRS-22 function, pain, self-image and SF-36 PCS and increased ODI scores had a predilection toward surgery. Most important variable was SRS-22 function score.

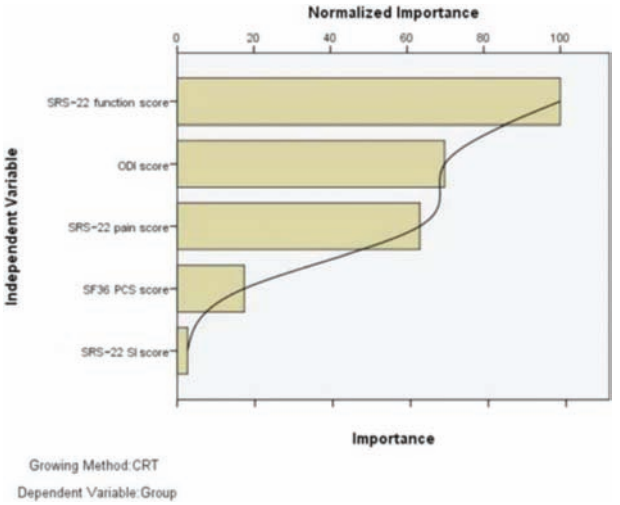

Figure 1

Novel Technologies 4

GO238. Increased Apoptosis, Expression of Matrix Degrading Enzymes and Inflammatory Cytokines of Annulus Fibrosus Cells in Genetically Engineered Diabetic Rats: Implication for Intervertebral Disc Degeneration

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Introduction: Diabetes mellitus is thought to be an important etiologic factor in intervertebral disc degeneration. However, what is little known is whether diabetes has an effect on annulus fibrosus (AF) cells. The purpose of our study was to investigate the effect of diabetes mellitus on apoptosis, expression of matrix degrading enzymes and inflammatory cytokines of AF cells in age-matched genetically engineered OLETF (diabetic) and LETO (control) rats.

Material and Methods: Lumbar disc tissues (L1–2 through L5–6) were obtained from 6-month old OLETF and LETO rats (10 each). We examined the AF cells and tissues using Masson trichrome stain, TUNEL, Western blotting, and reverse transcription polymerase chain reaction. The apoptosis index and the degree of expression of matrix degrading enzymes and inflammatory cytokines of AF cells were evaluated by semiquantitative method.

Results: OLETF rats showed increased body weight and abnormal 2-hour glucose tolerance tests compared with LETO rats. The apoptosis index and the degree of expression of Fas of AF cells were statistically higher in the OLETF rats. The degree of expression of matrix metalloproteinase-1, -2, -3 and -13 and tissue inhibitor of metalloproteinase-1 and -2 was statistically higher in the OLETF rats. The expression of interleukin-1 and -6 and tumor necrosis factor-α was statistically higher in the OLETF rats. Finally, histological analysis showed more severe fibrosis and loss of lamellar pattern in AF tissues of OLETF rats.

Conclusion: Our results suggest that diabetes mellitus is associated with increased apoptosis and expression of matrix degrading enzymes and inflammatory cytokines in AF cells. This results in more severe fibrosis and loss of lamellar pattern of AF, which leads to intervertebral disc degeneration. Strict DM control might be important to delay or prevent early intervertebral disc degeneration in patients with DM.

GO239. Surgical Management of Spinal Dural Arteriovenous Fistulae with Intraoperative Indocyanine Green Angiography: Single Institute Experience

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Introduction: Spinal dural arteriovenous fistula (DAVF) is the most common vascular malformation of the spinal cord. We performed an observational study of patients with spinal DAVF who were treated by microsurgical obliteration with intraoperative indocyanine green (ICG) angiograph with the aim of complete obliteration of the fistulae.

Material and Methods: 10 patients were included from May 2012 to May 2015. They were treated surgically with intraoperative intravenous administration of ICG. Direct microsurgical exploration was employed to identify the intradural fistulous connection and intravenous ICG was then injected to verify the identification of the lesion. Repeat ICG angiography was performed after the fistula had been obliterated using bipolar electrocautery.

Results: In all patients, ICG angiography correlated reliably with preoperative catheter angiography and intraoperative direct visualization and the fistulous connection was identified and successfully treated surgically.

Conclusion: ICG angiography in the setting of surgical management of spinal DAVF is a simple and effective technique for intraoperative confirmation of the relevant lesion. Post resection ICG angiography reliably demonstrated technical success and may replace formal postoperative catheter angiography

GO240. Development of a Whole Bovine Long-term Organ Culture System that Retains Vertebral Bone for Intervertebral Disc Repair and Biomechanical Studies using PrimeGrowth Media

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Introduction: Testing potential therapeutics in the regeneration of the disc requires the use of model systems. Although several animal models have been developed to test intervertebral disc (IVD) regeneration, application becomes costly when used as a screening method. The bovine IVD organ culture system offers an inexpensive alternative, however, in the current paradigm, the bony vertebrae is removed to allow for nutrient diffusion to disc cells. This provides limitations on the conditions and strategies one can employ in investigating IVD regeneration and mechanisms in degenerative disc disease (i.e., combination of axial and torsional loading). Although one method has been attempted to extend the survival of bovine vertebrae containing IVDs (vIVD) cell viability declined after two weeks in culture. Our goal was to develop and validate a long-term organ culture model with vertebral bone, which could be used subsequently for studying biological repair of disc degeneration and biomechanics.

Material and Methods: Preparation of vIVDs: Tails of 22- to 28-month-old steers were obtained from the local abattoir within 4h of slaughter. The largest IVDs ($n = 16$) were prepared for organ culture by parallel cuts through the adjacent vertebral bodies at 1 cm from the endplates using an IsoMet®1000 precision sectioning saw (Buehler, Germany). vIVDs were split into two groups (PrimeGrowth or DMEM): eight were treated with PrimeGrowth Media kit (developed by Intervertech and licensed to Wisent Bioproducts) and eight with DMEM. The PrimeGrowth group was incubated for 1h in PrimeGrowth Isolation Medium (Cat# 319–511-EL) and the DMEM group for 1h in DMEM. After the isolation step, discs were washed 3 times in PrimeGrowth Neutralization Medium (Cat# 319–512-CL) while the other 8 IVDs were washed thrice in DMEM. The discs isolated with PrimeGrowth and DMEM were cultured for up to 5 months in sterile vented 60 ml Leakbuster™ Specimen Containers (Starplex) in PrimeGrowth Culture Medium (Cat# 319–510-CL) and DMEM with serum and antibiotics, respectively. Culture medium was replaced every three days with no mechanical load applied. *Live/Dead Assay:* vIVDs cultured for 1 or 5 months were dissected to separate NP, inner AF (iAF) and outer AF (oAF) regions. A 4 mm biopsy punch was used to prepare specimens for cell viability using a live/dead fluorescence assay (Live/Dead®, Invitrogen) and visualized by confocal microscopy. *Glucose Diffusion:* After one month of culture, vIVDs were incubated for 72h in diffusion medium containing PBS (1x), $CaCl_2$ (1mM), $MgCl_2$ (0.5mM), KCl_2 (5mM), 0.1% BSA and 150µM 2-[N-(7-nitrobenz-2-oxa-1,3-diazol-4-yl)amino]-2-deoxy-D-glucose (2-NDBG), a D-glucose fluorescent analogue. Discs were dissected and NP, iAF, oAF regions were incubated in guanidinium chloride extraction buffer. Extracts were measured for fluorescence.

Results: After 5 months of organ culture, vIVDs prepared with PrimeGrowth Media kit demonstrated ~95% cell viability in all regions of the disc. However, dramatic reductions (~90%) in vIVD viability were measured in DMEM-treated discs after 1 month. Interestingly, vIVD viability was related to the amount of 2-NDBG incorporated into the disc tissue.

Conclusion: We have developed a novel method for isolating IVDs with vertebral bone capable of long-term viability. This method may not only help in the discovery of novel therapeutics in disc regeneration, but could also advance our understanding on complex loading paradigms in disc degeneration.

GO241. Vertebral Endplate Changes / Modic Changes: An Audit Study Using Antibiotics in 147 Chronic Low Back Pain Patients

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Introduction: Vertebral endplate changes/Modic changes (MC) are the MRI-image of inflammatory vertebral endplate damage.[1] In patients with chronic back pain, the prevalence of (MC) is 40%.[2] MC are most often related to general disc degeneration or herniation.[3] However, in a subgroup of patients, disc infection may be involved.[4,5] In one high quality RCT more than 50% of patients with persistent pain and prolapsed discs showed clinically significant improvement after treatment with a broad spectrum antibiotic at 6 Month Follow Up (6MFU).[6]

Material and Methods: A cohort study was established to evaluate the effect of treatment with Amoxicillin/

Clavulanic Acid for 3 months. 70 patients were treated with 1 1/2 g per day for one month followed by 3 g per day for 2 months (HighDose). Another 77 patients were treated with 2 g per day for 3 months (LowDose). The clinical profile of the included patients: referred to a secondary care outpatient Spine Centre with persistent low back pain and lumbar MC Type 1 and no effect of other non-surgical treatment forms. Main outcome measures at 6MFU: Patient's global assessment (Global), change in spinal pain intensity on a 0–10 numerical rating scale (DeltaPain) and Number of Days with Pain (DaysPain) over a 14 day period. Responders were compared with non-responders.

Results: 147 patients (95 females) were included. The outcome analysis compares the treatment effect of the responders to the non-responders. Overall, 78/147; 53.01% of the patients stated a positive responder treatment effect after 6 months. DeltaPain in 'the responder group' at 6 months follow up was -29.96%[SD 36.2%] and in 'the non-responder group' 2.16% [SD 43.3%]. DaysPain *decrease* in 'the responder group' at 6MFU were 22.17% [SD 60.3], and in 'the non-responder group' an *increase* of 28.07%[SD 153.6]. Substantial side effects were noted in 17/70(24%) patients in HighDose and 12/77 (16%) in LowDose patients. Minor side effects: 17/70(24%) of patients in HighDose and 14/77(18%) patients in LowDose. No difference in responderrate were seen between HighDose/ LowDose; 52.9%/53.3%.

Conclusion: The antibiotic treatment regime in this group of low back pain patients represented positive outcome results for 53% of the patients. At 6MFU clinically relevant improvements regar- ding pain intensity were obtained and numbers of days with pain was reduced by 22%. A higher number of side effects was seen using HighDose antibiotics compared with LowDose, but there was no difference in treatment efficacy.

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GO242. The Effect of Post Operative Sand Bag Pressure on CSF Leak after Spinal Surgery

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Introduction: Dural tears are most common complications of lumbar spine surgery and have been successfully managed using several techniques. These include primary repair, closed subarachnoid drainage, tissue grafting, fibrin-adhesive sealant, and bed rest. In this study a new method with post operative sand bag pressure to prevent Cerebrospinal fluid (CSF) leak is used.

Methods: A prospective study of 96 patients admitted to the Department of Neurosurgery at the Alsadr Teaching Hospital in Basrah/Iraq had CSF leak following different lumbar spine surgeries. Fifty two patients between March 2006 and March 2010 treated with the classical methods and 44 consecutive patients who had a post operative CSF leak between March 2010 and March 2013 treated with sand bag pressure.

Results: Classically treated group (13.5%) patients stopped CSF leak as compared with post operative sand bag pressure group (68.2%) patients stopped CSF leak in the first day. Regarding post operative complications, classically treated group had headache (55.8%), Photophobia (25.0%), nausea (32.7%), vomiting (15.4%), meningitis (5.8%) and revision surgery (9.6%) while post operative sand bag pressure group had headache (20.5%), Photophobia (9.1%), nausea (11.4%), vomiting (2.3%), meningitis (2.3%) and revision surgery (0%).

*Conclusion***s:** and bag pressure is an excellent method to decrease duration and complications of CSF leak.

Keywords: postoperative, CSF leaks, sand bag

GO243. Early Vertebrectomy (Performed in First 72 Hours after Delivery) as a Treatment Method of Vertebral Column Deformation in Patients with MMC

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Introduction: 8–12% of all dysraphic defects are accompanied by vertebral column deformations like gibbus, that makes a skin closure a very complicated procedure. The presence of lumbar kyphosis in children who suffered from myelomeningocele increases thread of wound dehiscence, large skin necrosis, CNS infections, decubitus ulcer etc. Operative treatment of vertebral column deformations comprise reduction of pathological curvature to: reach a physiological balance of acting forces on vertebral column axis during upright position of a body, reduce a rate of vertebral column kyphosis increasing, minimize a skin tension over a gibbus, increase abdomen cavum capacity and improve breathing 72 hours after delivery is concerned as a critical moment of surgical management, that should not be exceeded. The main goal of the work is to asses efficiency of an early vertebrectomy performed during surgical management of dysraphic defect that makes possible: prevention from mentioned above complications, avoiding further surgical management and spine stabilization in the future.

Material and Methods: In Polish Mother's Memorial Hospital (PMMH) 572 surgical managements of dysraphic defects were performed between year 1992 and 2015. In 89 (15,6%) cases coexistence of pathological spine kyphosis was diagnosed. Myelomeningocele aperta was found to be most common type of DD in our material. All our procedures were performed in first 48 hours after delivery. In 15 cases it was in first 24 hours and in 16 it was in second 24 hours of living. During surgical management of Dysraphic Defect form 1 to 3 vertebral bodied were removed. Spine kyphosis side angle and height were measured. Height of gibbus was measured according to K-C straight and side angle was measured with Cobb-4 method

Results: After such a surgical management we achieve possibility to close skin defect with possible low tension and reduction of pathological spine kyphosis without any foreign

material stabilization of the spine. By our surgical management we managed to reduce in average the side angle of the kyphosis by 52,4% and reduce the height in average by 48,06%. Height reduction of pathological spine kyphosis depends on height of pathological spine kyphosis before the surgical management. Side angle quantity of pathological spine kyphosis before the surgical management has statistically significant influence both on height of pathological spine kyphosis and quantity of height reduction after surgical management. Trophic disorders of postoperative wound right after surgery occurred in 12,9% of cases (4 patients) In all catamnesis period it occurred only in 7 cases that was 22,6% of all patients.

Conclusion: Early performed vertebrectomy with gibbus reduction in first 48 hour after delivery allow to: (1) Close dysraphic defect with coexisting large skin loss; (2) Reduce possibility of recurrent postoperative wound trophic disorders; (3) Reduce the growth rate of pathological spine kyphosis during child genesis. The severity of pathological spine kyphosis and occurrence of early postoperative wound trophic defects are predictors in dysraphic patients.

Tumors 2

GO244. Vertebroplasty and Kyphoplasty for Metastatic Spinal Lesions: A Systematic Review

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Introduction: The spine is the most common site of bone metastases, with 33–70% of cancer patients acquiring spinal metastasis during the course of their disease. Vertebroplasty (VP) and Kyphoplasty (KP) have been proposed as potential minimally invasive therapeutic options for metastatic spinal lesion (MSL) pain. However, the efficacy of VP and KP on MSL pain is currently unclear. The Objective of the present review was to assess the effects of VP and KP on pain, disability and quality of life following MSL.

Material and Methods: We included randomized controlled trials (RCTs) and controlled clinical trials (CCTs) assessing VP or KP for the treatment of pain following MSL without cord compression. We searched MEDLINE, EMBASE and CENTRAL with no limitation in terms of study status (ongoing or completed), publication date, type or language.

Results: The literature search revealed 387 citations. Of these, nine trials met all eligibility criteria and included in the qualitative analysis. In total, there were 622 patients enrolled in the trials and of these 432 were in surgical treatment group (92 received KP, 97 received VP, 134 received VP and chemotherapy, 68 received VP and radiotherapy and 41 received KIVA implant) and 190 were in non-surgical treatment group (83 received chemotherapy, 46 received radiotherapy and 61 received other treatment). Using the grade approach, there is low quality of evidence that VP plus chemotherapy improve MSL pain and functional score more than chemotherapy alone (Pain: mean difference (MD): -3.01; 95%CI: -3.21 to -2.80; functional score: MD: 15.46; 95%CI: 13.58 to 17.34)

Conclusion: Pain and functional score improved more in VP plus chemotherapy group than in the chemotherapy group. Based on the analysis of published trial data, it is not known whether VP for MSL provides benefits over KP.

GO245. Evaluation of the safety of Intraoperative Salvaged Blood by using Microwell based Culture

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Introduction: Intraoperative cell salvage (IOCS) in metastatic spine tumor surgery (MSTS) is a novel alternative for addressing the potential side effects related to ABT. However, it has not been widely adopted in oncological surgery due to the hypothetical concern of reinfusing tumor cells to the patients. Despite the emerging evidence of the safety of IOCS especially in combination with leucocyte depletion filter (LDF), most surgeons are still doubtful about using IOCS during oncological surgery. We aimed to evaluate the feasibility of using intraoperative cell salvage (IOCS) in combination with leucocyte depletion filter (LDF) in eliminating cancer cells from blood salvaged during metastatic spine tumor surgery (MSTS). We hypothesized that tumor cells, even if left in the salvaged blood, are incapable of seeding and replicating due to potential damage to the cell membrane or the contents during suction, centrifugation and filtration during cell saver processing and hence, making the salvaged blood safe to be reinfused.

Methods: Patients with known primary epithelial tumor, who were offered surgery for metastatic spine disease at our university hospital, were recruited. Blood samples were collected at five different stages during surgery: Stage A: venous blood from the patient during induction by anaesthetist, Stage B: venous blood from the patient during maximum tumor manipulation by the surgeons, Stage C:blood from operative field prior to IOCS processing, Stage D: salvaged blood after IOCS processing and stage E: salvaged blood after IOCS-LDF processing. Blood samples(5 ml) were taken at each stage. Samples were sent for preparation of microwell-based culture assay for detection of primary circulating tumor cells (CTCs).

Results: We recruited 13 patients of which 12 were included in final analysis. There were 7 females and 5 males. The median age of the patients was 61 years (range: 48 - 76 years). The commonest primary tumor was lung, followed by breast, hepatocellular and renal cell carcinoma. The median blood loss was 800 ml (range: 300 – 1500 ml). Analysis of the cultured samples showed that clusters or CK+ CTCs (cytokeratin positive CTCs) were found in the samples taken from stage A in three patients, stage B in three patients and stage C in one patient. However, none of the samples D and E from any patients generated viable tumor clusters or CK+ CTCs after culture.

*Conclusion***s:** The present study proved that our hypothesis was correct. The findings supported the notion that IOCS-LDF combination works effectively in eliminating/destroying tumor cells from salvaged blood. The absence of viable CTCs in the samples taken from salvaged blood (stage D) provided the fact that salvaged blood even without filtration is safe for reinfusion in cancer patients. This IOCS technique can be applied in MSTS and even musculoskeletal oncological surgery. The concept can then be extended to other oncological surgeries in general with further appropriate clinical studies.

GO246. Lateral Approach for Anterior and Anterolateral Placed Cervical Meningioma or Schwannoma

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Introduction: Cervical meningioma and schwannoma are benign tumors that may present with a wide variety of clinical features. Surgical treatment of those tumors carries a risk of neurological complications and spinal deformities. Surgical approaches include posterior, anterior, or anterolateral options. This is a Descriptive retrospective clinical case series to evaluate the lateral surgical approach in these tumors.

Patients and Methods: We reviewed patients who underwent lateral surgery for anterior and anterolateral placed cervical meningioma or schwannoma through the past 7 years. A total of 23 patients including 15 females and 8 males were reported. Mean age was 46 years. The average duration of history was 14.9 months. Fourteen patients had meningioma and 9 had schwannoma. According to the JOA-score 15 were normal, 5 were grade-1 and 3 was grade-2. The following factors were evaluated; age, sex, duration, pathology, levels, topographical locations, neurological status, operative time, blood loss, hospital stay, morbidity, and clinical outcome.

Results: All patients were operated through the lateral cervical approach. All patients but three had total tumor removal where small fragment were lift due to technical reasons. According to the JOA-score the 15 normal patients remain the same, the 5 grade-1 improved to normal, and the 3 grade-2 patients improved to normal in one and to grade-1 in another. There was no reported major morbidity or mortality. CSF leak into the closed drainage system was reported in 5 patients without serious effects.

*Conclusion***s:** The lateral approach allows for safe and effective removal of anterior and anterolateral placed cervical meningioma or schwannoma. It gives a direct access to tumor without risk of cord manipulation or destabilizing the spine. In addition it gives the same clinical results.as the standard posterior approach.

GO247. Primary Malignant Spinal Tumors in Children: 21-years Retrospective Single Surgical Clinic Study

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Introduction: Primary malignant spinal tumors in children are difficult due to the rarity, the lack of specificity of signs and controversial treatment strategy [Belogurova M.B. 2002]. Pain prevails in children (more than 80%); spinal deformity, neurological deficits, bladder and bowel dysfunction occurred more than 50% of cases [Walker D.A., et al., 2004; Huisman TA., 2009]. The radical surgery has a prevalence for a long-time surveillance, but the results of the treatment not frequently discuss.

Material and Method: The retrospective study includes 28 patients aged from 1 year 6 months till 17 years who were consequently admitted from 1993 till 2014 into single clinic which specialized on the surgical treatment of skeleton destruction in children. The radiation study included X-ray, CT and MRI for indication of tumors borders, degree of vascular support, the presence of necrotic focuses and oncology staging according to Enneking. The radiation scanning with Tc99 was done for patients above 4 years old. Neurological status was estimated by ASIA and Frankel scale. The results of the complex (ChT + Surgery) treatment were studied with FU no less than 1year.

Results: The *malignant* Hodgkin's and non-Hodgkin's *lymphomas* were the most frequent in children (15 cases, incl. 10 boys and 5 girls). The cervical, thoracic, lumbar and sacral spine were affected in 1, 9, 12 and 2 cases respectevely. 9 patients (60%) had multi-level lesions. *SaEwing/PNET* was verified in 8 *(*3 boys and 5 girls). The cervical, thoracic, lumbar and sacral vertebrae were affected in 3, 1, 5 and 2 patients respectively. The multi-level lesion was in 3 cases (37%). *The other sarcomas (*polymorphous, epithelioid, histiocytic and angiosarcoma) were in 4 patients, incl. 2 cases of cervical lesion and one with thoracic and lumbar spine. The thoracic spine malignant histiocytosis was in one case. The pain, spinal deformity and neurological symptoms were dominant in 25 (89%) cases; the high temperature and weakness - in 3 (11%). The diagnosis was confirmed by trans-cutaneous fluoroscopic (C-arm)-navigated biopsy followed by cytology and morphology; the open biopsy used only in 3. The decision for spine reconstruction was accepted together with oncologists after chemotherapy in 18 children (64.2%) (8 - lymphomas, 6 - SaEwing/PNET, 4 - other Sa). According to the retrospective study all operated patients were estimated as 7 and more degrees according to SINS. En block resection was done in 5. The 5-year survival rate after spinal reconstruction was 66,6% (12 from 18). Among the dead 2/6 had lymphomas, 3/6 - SaEwing/PNET and one – polymorphous cells Sa. Parents regrets complex chemotherapy in 2/6.

*Conclusion***s:** Surgical treatment for malignant spinal tumors in children has to be included into complex therapy with chemotherapy and, perhaps, radiation therapy, but the data of RT' in children still controversies. The time and volume of surgery have to be adopt together with pediatric oncologist and spinal surgeon. Radical surgery with restoration of spinal stability significantly improves the long-time survival rate as a functional and motion activity in pediatric patients even with a high malignant spinal tumors.

GO248. Evaluation between the Sins Score, Vas and Neurological Status for Spinal Metastatic Tumors

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Introduction: Spinal metastases occur in 20% of the cancer patients being of those only 5–10% develop spinal cord compression. The basic surgical principle of the treatment is palliative due to multicentric and advanced stage when metastases are found in the bone. In this context, select an appropriate patient for surgery is challenging, because this is based on clinical conditional, clinical presentation and oncological status. Since the SINS classification has been published in 2010, it has become an important tool for surgical standpoint to define which type of tumor's fracture is potential or unstable and facilitates the communication between oncological team. Herein, the aim of this paper is to evaluate the association between SINS score and VAS preoperatively, ASIA pre and postoperatively, the relation between SINS and specific kind of tumors, VAS pre and postoperative, and overall survival.

Material and Methods: This study is a prospective cohort. The authors analyzed 79 patients who presented with spinal metastatic disease (excluding 15 hematological

cases and 10 cases that the data were lost) and that underwent spinal surgery decompression. The criteria for surgery were clinical condition, oncological status, the SINS score and/or spinal cord compression. The data was collected from June, 2012 to March, 2015. The SINS (Spinal Instability for Neoplastic Score), VAS (Visual Analogue Scale) pre and postoperatively (0–3 months) after surgery), ASIA (American Spinal Cord Injury Association) scale pre and post operatively (0–3 months) data was collected. The authors analyzed the association between SINS score and VAS preoperatively, ASIA preoperatively and postoperatively, SINS and specific types of disease, VAS pre and postoperatively and the overall survival after surgery. The Pearson test association, chi-square test and Kaplan-Meyer curve were applied.

Results: Utilizing Pearson association test we found 70.7% of patients with VAS (9–10), had a SINS score (13–18) against one with VAS (0–4) had SINS (7–12) $p = 0.02$. An analysis of ASIA preoperatively and post operatively (3 months), we found 59.57% (28 patients) ASIA B-D became postoperatively ASIA E, 36.17% (17 patients) showed no change; 71.43%(5 patients) ASIA A became ASIA B-D, it was correlated with $p < 0.001$. Comparison with higher SINS (13–18) with breast and lung spinal metastases showed 73.68%(18 patients) and 85.71%(8 patients) respectively, $p = 0.03$ (weak correlation. From 69 patients preoperatively VAS (9–10) and 8 patients VAS (5–8) all of them became VAS (0–4) making the statistical analysis not possible. The global overall survival was 10.78 months. ASIA E patients were 12.38 months IC 95% ((9.05–15.65), and ASIA A were 2.75 IC 95%(0.745–4.75).

Conclusion: The utilization of the SINS score to determine instability is reliable and related to increase of the pain at the VAS preoperatively; the surgery improves neurological function (ASIA) statistically significant and VAS postoperatively without statistical significance. It was found that there was a weak relation between higher SINS and breast cancer patients who present spinal cord compression in our series. Based on our patients overall survival we conclude that surgery is an important tool for patients who present clinical conditions and spinal instability.

GO249. Prevalence of Unsuspected Malignancy in Patients with Vertebral Compression Fracture undergoing Percutaneous Vertebroplasty

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Introduction: Osteoporotic vertebral compression fractures (VCF) affect ~20% of postmenopausal women and can lead to long-term disability. Percutaneous Vertebroplasty (PVP) is a minimally invasive procedure, primarily used in patients with severe pain after VCF. Even with a thorough clinical examination, MRI scans and blood samples, some fractures maybe caused by an underlying malignant disease. Objectives were to determine the prevalence of malignancy and histology in bone biopsies obtained during PVP for osteoporotic VCF.

Material and Methods: Study design - Retrospective study of a prospective collected cohort. 144 consecutive patients underwent PVP for painful VCF, at the Center for Spine Surgery and Research, Middelfart Hospital. All patients had bone biopsies obtained during the PVP, and these biopsies were sent to the Department for Pathology at Vejle Sygehus for histologic diagnosis.

Results: 144 patients were included in this study. The majority of the biopsy specimens (137, 95,1%) were acceptable for histological diagnosis. 129 (89.6%) of the biopsies showed no signs of malignancy. Seven (4,9%) were positive for malignancy. 1 biopsy was positive for MGUS. Seven (4.9%) of the biopsies were unsuitable for histologic diagnosis.

Conclusion: Our study shows a prevalence of unsuspected malignancy in biopsies during PVP of 4.9%. Conservative treatment with analgesics and brace can potentially delay diagnosis and treatment of underlying malignant disease. We recommend biopsy during PVP as a standard-procedure, to insure not to overlook any underlying malignancy despite the MRI-scan, blood analysis and clinical examination being inconspicuous.

Best Paper: Trauma

GO250. Development of a Universal Disease-Specific Outcome Instrument for Spine Trauma: The AOSpine Clinician Reported Outcome Spine Trauma (AOSpine CROST)

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Introduction: The AOSpine Knowledge Forum Trauma initiated a project to develop and validate universal disease-specific outcome instruments for adult spine trauma patients. Besides a patient reported outcome measure, the objective is to develop and validate a clinician reported outcome (AOSpine CROST) for this specific patient population. The AOSpine CROST is needed to formalize the most relevant clinical and radiological assessment parameters as a simple, reliable and quick to administer tool that is completed by the treating surgeons, and enables them to evaluate and predict the clinical and functional outcomes of spine trauma patients on the short term (3 months-2 years) and long term ($\geq$2 years) time periods post-trauma, independent of the patient reported outcome. To identify relevant parameters, 2 separate surveys were conducted.

Material and Methods: The 2 international cross-sectional web-based surveys were conducted among highly experienced spine surgeons from the 5 AOSpine International world regions, consisting of members of AOSpine International and International Spinal Cord Society (ISCoS). The first survey focused on identifying relevant parameters for the thoracic and lumbar spine (TL-survey), the second survey on the subaxial cervical spine (C-survey). Participants were asked to give their opinion on the relevance of a compilation of parameters on a 5-point scale. Those parameters were based on a systematic review, the recently developed AOSpine Subaxial Cervical Spine and Thoracolumbar Spine Injury Classification Systems, as well as expert interviews. In total, 16 parameters were included in the TL-survey, and 21 in the C-survey. Furthermore, participants were asked to indicate the age that may have an influence on patients' outcome. The responses were analyzed using descriptive statistics, frequency analysis and Kruskal-Wallis test.

Results: Out of the 279 invited spinal surgeons, 118 (42.3%) participated in the TL-survey and 108 (38.7%) in the C-survey. Combining the results of both surveys, 5 parameters were identified as relevant by at least 70% of the participants for all spine regions and time periods post-trauma. Neurological status was identified as the most relevant parameter. In contrast, 5 parameters were not deemed relevant. Pain and mobility of the spine were more relevant for the thoracolumbar- and lumbar spine region, while 3 parameters were more relevant for the cervical spine. Five parameters were identified as relevant for the short term, while bony fusion was the only

identified parameter for the long term. The identified missing parameter was bone quality. No large differences were observed for the age that may have an influence on patients' outcome (mean range: 50.1–58.2 years). Only minor differences were observed in the response patterns between the world regions, or spine surgeons' degree of experience.

Conclusion: These studies identified clinical and radiological assessment parameters considered as most relevant by a worldwide panel of highly experienced spine surgeons to evaluate and predict outcomes of spine trauma patients. After formalizing these parameters and conducting pilot tests, a final version of the AOSpine CROST has been developed, consisting of 10 items. Once subjected to further validation, the AOSpine CROST will be a helpful tool in research and clinical practice.

GO251. The Development of a Universally Accepted Sacral Fracture Classification: A Survey of AOSpine and AOTrauma Members

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Introduction: Sacral fractures are complex injuries that pose diagnostic and technical challenges for surgeons. While multiple classifications have been proposed, there is not a comprehensive, universally accepted classification. The AOSpine Trauma Knowledge Forum partnered with orthopaedic traumatologists from AOTrauma to develop a straightforward, hierarchical classification system for sacral fractures. While the classification was developed via a consensus process of clinical experts, the authors solicited input from the global community to ensure that the proposed classification could achieve global acceptance.

Material and Methods: Prior to finalizing the new AOSpine Sacral Injury Classification System, a survey was sent to all members of AOSpine and AOTrauma. The survey included the preliminary sacral classification as well as questions asking for their input on key parts of the classification. Along with demographic information, the following four questions were asked: (1) Since type B injuries in the new AOSpine sacral classification refer only to vertical fracture patterns and exclude injuries with a transverse component, do you agree that there is an increase in the risk of neurologic injury as the B subtype increase: B1—an injury medial to the foramen; B2—an injury lateral to the foramen and B3 an injury through the foramen. (2) Do you think the hierarchical nature of the sacral classification is appropriate with: A = transverse; B = Unilateral vertical fracture; C = Any fracture that leads to spinopelvic instability. (3) Do you think the integrity of the L5/S1 facet is adequately considered in this classification system? (4) Do you think C0 (a non-displaced sacral U fracture that may be seen in low energy insufficiency fractures) is a clinically relevant entity that deserves its own spot in the classification?

Results: A total of 596 surgeons from all six AO regions of the world responded to the survey. 70.9% of respondents were orthopaedic trauma surgeons, 18.5% were orthopaedic spine surgeons and 4.7% were neurosurgeons. Overall 78.1% of respondents agreed that the B subtypes were correctly ordered for an increase in the risk of a neurologic injury. 86.1% of respondents felt that the hierarchical nature of the classification was appropriate. 82.9% of respondents felt that the L5/S1 facet was adequately considered in the classification, and 84.1% of surgeons felt that C0 is clinically relevant entity that deserves its own spot in the classification. When surgeons were stratified as either a trauma surgeon or a spine surgeon (orthopaedic or neurosurgeon), significantly more spine surgeons than trauma surgeons agreed with the organization of B type injuries (84.7% versus 75.4%, respectively, $p = 0.03$); however, still more than 3 in 4 trauma surgeons agreed with the organization of B type injuries. No other significant difference was identified by specialty. Additionally, no significant difference ($p > 0.39$) was found when respondents were grouped by years in practice (0–10 years, 11–20 years and >20 years).

Conclusion: While validation studies are ongoing for the new AOSpine sacral fracture classification, the classification is designed such that worldwide acceptance from both spine surgeons and trauma surgeons may be possible.

GO252. 3D-Navigation Reduces Radiation Exposure and Operative Time in Lumbopelvic Fixations

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Introduction: Management of unstable sacral fractures has evolved from non-operative treatment to relatively rigid internal fixation. Multidirectional instability of the posterior pelvic ring and lumbopelvic junction may be stabilized by lumbopelvic fixation. This technique decreases the load to the sacrum and SI joint and transfers axial loads from the lumbar spine directly onto the ilium, which allows early full weight bearing and therefore reduces prolonged immobilization. One of the keystones for lumbopelvic fixation is the placement of the iliac screws. The iliac screws are directed from the posterior superior iliac spine (PSIS) to the anterior inferior iliac spine (AIIS). The optimal osseous corridor for iliac screw placement requires multiple posteroanterior and lateral views with additional obturator outlet and obturator inlet views. Obtaining the correct views results in increased OR times, fluoroscopy times, and radiation exposure of the patients and OR personnel. The purpose of this study was to evaluate if a better intraoperative visualization of bony structures utilizing a 3D-navigation system can reduce operative time, fluoroscopy time, and radiation exposure.

Material and Methods: From one academic trauma center, 44 consecutive patients were retrospectively identified as having been treated with lumbopelvic fixation between July 2011 and June 2015 (4 years). Of these, 10 patients were excluded because of only a unilateral triangular fixation. 34 patients (61.8% female) met the inclusion criteria. Patients had an average age of 58.9 years (range 18–87 years).

Lumbopelvic implants (USS II, DepuySynthes, Germany) were inserted as described by Schildhauer. A passive optoelectronic navigation system (Brainlab, Germany) was utilized for navigated iliac screw placement. Surface registration of L4 was performed for the matching procedure. To compare groups, demographics were assessed, operative time, fluoroscopic time, radiation, and screw malpositioning were delineated.

Results: During the study period, 24 patients underwent bilateral lumbopelvic fixation utilizing conventional fluoroscopic imaging alone and 10 patients underwent the procedure with 3D navigated iliac screw placement. No differences were found between the two groups regarding age (60.3 versus 55.6 years; $p = 0{,}553$), BMI (25.65 versus 25.17 kg/m^2; $p = 0.808$), gender (62.5% versus 60% females; $p = 0.891$), or length of hospital stay (39 versus 26 days; $p = 0.089$). Comparing screw length and diameter, the median was 110 mm and 8 mm, respectively in both groups. Utilization of 3D navigation led to a fluoroscopy time reduction of more than 50% (3.47 versus 8.32 minute.; $p = 0.004$) resulting in a significantly reduced radiation (4980 versus 2665 Gy*cm^2; $p = 0.032$). Operative time was reduced in the navigation group (177 versus 234 minute; $p = 0.028$) despite the necessity of additional surface referencing.

Conclusion: Fixation of sacral fractures continues to be challenging due to complex local anatomy. Especially in severe comminuted sacral fractures lumbopelvic fixation provides superior stability and allows immediate weight-bearing. For iliac screws, identifying the correct entry point and angle of implantation in all planes requires detailed anatomic knowledge and multiple radiographic views. In the current study, 3D navigation helped to reduce operative time and fluoroscopy time resulting in a significant reduction of radiation exposure for the patient and OR personnel.

GO253. Methylprednisolone for the Treatment of Patients with Acute Spinal Cord Injuries: A Systematic Review and Meta-analysis

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Introduction: Previous meta-analyses of methylprednisolone for patients with acute traumatic spinal cord injuries (TSCIs) have not addressed confidence in pooled effect estimates and new primary studies have been recently published. We performed a systematic review and meta-analysis to determine whether methylprednisolone improves motor recovery and is associated with increased risks for adverse events.

Material and Methods: We searched MEDLINE, EMBASE, and The Cochrane Library for eligible randomized controlled trials (RCTs) and controlled observational studies. Two reviewers independently screened articles, extracted data, and evaluated risk of bias. We pooled outcomes from RCTs and controlled observational studies separately using random effects models. We quantified heterogeneity using the chi-squared test and the I-squared statistic, and we prespecified subgroup hypotheses to explain potential high heterogeneity. We used the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach to evaluate confidence.

Results: We included four RCTs and 17 observational studies. Methylprednisolone did not increase long-term motor score recovery (two RCTs: 335 participants, mean difference [MD] -1.11, 95% CI -4.75 to 2.53, $p = 0.55$, low certainty; two observational studies: 528 participants, MD 1.37, 95% CI -3.08 to 5.83, $p = 0.55$, very low certainty) or improvement by at least one motor grade (three observational studies: 383 participants, risk ratio [RR] 0.84, 95% CI 0.53 to 1.33, $p = 0.46$, very low certainty). Evidence from two RCTs demonstrated superior short-term motor score improvement if methylprednisolone was administered within eight hours of injury (two RCTs: 250 participants; MD 4.46, 95% CI 0.97 to 7.94, $p = 0.01$; low certainty), but risk of bias and imprecision limit confidence in these findings. Observational studies demonstrated a significantly increased risk for gastrointestinal bleeding (eight studies: 2727 participants, RR 2.53; 95% CI 1.48 to 4.32; $p < 0.01$, very low certainty), but RCTs did not. Risks for other adverse events were not significantly increased.

Conclusion: Methylprednisolone does not provide significant long-term benefit to patients with acute TSCIs and may be associated with increased gastrointestinal bleeding. These findings support current guidelines against routine use, but strong recommendations are not warranted because confidence in the effect estimates is limited. This meta-analysis advances current understanding because it includes recent studies not pooled previously and it is the first to consider confidence in the pooled effect estimates. Further research could increase confidence and clarify the influence of potential confounders or effect modifiers.

Deformity Thoracolumbar Adolescent 5

GO254. Reducing Rod Breakage and Pseudarthrosis in Pedicle Subtraction Osteotomy: The Importance of Rod Number and Configuration in 264 patients with 2-Year Follow-Up

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Introduction: Pedicle subtraction osteotomies (PSO) can provide substantial realignment, but are associated with pseudarthrosis and rod failure. The addition of supplementary rods and interbody fusion (IBF) may decrease the failure rate.

Material and Methods: Adult spinal deformity patients with $\geq$1 lumbar PSO and 2-year follow-up were included. Demographic, operative, and outcomes data were collected.

Radiographs were assessed for implant failure; IBF; and rod number, material, and diameter. Multiple (> 2) rod configuration was described as Accessory (connected to primary rods) or Satellite (independently anchored in the pedicles). Potential risk factors were evaluated for PSO site failure (rod breakage or revision for pseudarthrosis).

Results: From 264 patients included, there were 190 with 2 rods (2R), 36 with 3R, and 38 with 4R. There were no differences in demographics or baseline radiographic parameters across groups. 2R-3R constructs had a trend of higher rates of failure at the PSO site (28%, 29%) than 4R constructs (18%; $p = 0.128$). The 3–4R patients had significantly fewer revisions for instrumentation failure and/or pseudarthrosis than the 2R group (15% versus 26%; $p = 0.035$). There were 45 Accessory rods (61%) and 29 Satellite rods (39%). Satellite rods failed significantly less at the PSO site than Accessory rods (10% versus 31%; $p = 0.034$). Satellite configurations also had significantly fewer revisions for instrumentation/pseudarthrosis (0% versus 23%; $p = 0.009$) and fewer revisions for all causes (8% versus 50%; $p < 0.001$) than Accessory rods. 3–4R Accessory constructs were similar to 2R in failures (31% versus 29%; $p = 0.452$), revisions for implant failure/pseudarthrosis (23% versus 26%; $p = 0.388$). There were no significant differences in failures across all rod diameters (4.5, 5.5, 6.0, 6.35mm; $p = 0.183$). Small rods ($\leq$5.5mm) had a trend of higher failure rates than large ($\geq$6mm) rods (30% versus 18%; $p = 0.052$). In 3–4R constructs, large rods had a significantly lower rate of failure than small rods (5% versus 33%; $p = 0.009$). Titanium rods had a significantly higher failure rate (39%) than Cobalt Chrome (27%) and Stainless Steel (19%) rods ($p = 0.027$). In 2R constructs, Titanium rods failed significantly more (44%) than Cobalt Chrome or Stainless Steel (25%, 24%; $p = 0.037$). In 3–4R constructs, the trend continued but was not statistically significant ($p = 0.127$). IBF (graft or cage) at the PSO level resulted in fewer failures than patients with no IBF (21% versus 33%; $p = 0.046$). In 4R constructs with fusion above and below the PSO site, there were 0 failures at the PSO site, compared with 22% in 2R with IBF, and 34% in 2R constructs with no IBF at all. There were 0 failures in Satellite rods with IBF, compared with 27% failure in S constructs without interbody fusion ($p = 0.05$).

Conclusion: This study confirms a high rate of pseudarthrosis and rod breakage in the first 2 years following lumbar PSO surgery. The lowest rates of rod failure/pseudarthrosis were found in constructs with Satellite rods, IBF adjacent to the PSO, avoidance of Titanium rods, and larger diameter rods.

GO255. Intrathecal Baclofen Pumps do not Accelerate Progression of Scoliosis in Quadriplegic Spastic Cerebral Plasy

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Introduction: Intrathecal baclofen pumps are an effective treatment for spasticity in patients with cerebral palsy. Recently, concerns have been raised regarding the potential for intrathecal baclofen pumps to accelerate scoliosis progression and increase the need for spinal fusion surgery. To date the literature remains unclear, with studies often failing to account for the natural history of scoliosis progression in this population when assessing the influence of baclofen pumps. We aim to clarify matters by comparing progression of scoliosis in quadriplegic spastic cerebral palsy with and without intrathecal baclofen pumps.

Material and Methods: Design: Retrospective matched cohort. *Patients:* Inclusion criteria: Quadripegic spastic cerebral palsy, GMFCS level 5, follow up > 1 year, adequate radiographic/clinical data. *Methods:* Suitable patients who underwent intrathecal baclofen pump insertion were matched to cases with the same diagnosis and function level with comparable age and baseline Cobb angle but without intrathecal baclofen pumps. *Outcomes:* Primary: Sequential radiographs measured to assess annual coronal curve progression and peak curve progression. Secondary: Need for spinal fusion for curve progression. *Analysis:* Between group comparisons made with paired *t*-tests and chi square tests.

Results: Baclofen group: 17 patients (7 female), mean age at insertion of pump 9.4 (3.6), 10 cases with a scoliosis $> 10°$ at baseline. Initial Cobb angle 21° (21) and Risser grade 0.8. Twelve cases had hip subluxation/dislocation at baseline. Mean follow up 4.7 (1.3–8.8) years. Mean Cobb angle at final follow up was 77° (27). *Non-baclofen group:* 17 patients (10 female), mean age at baseline 9.5 (3.7), 12 cases with a scoliosis at baseline. Initial Cobb angle 25° (20) and Risser grade 0.9. Three cases had hip subluxation/dislocation at baseline. Mean follow up 3.6 (1–7.5) years. Mean Cobb angle at final follow up was 67° (30). The two groups were statistically similar in terms of age, initial Cobb angle, Risser grade and presence/absence of scoliosis at baseline. The baclofen group had a higher proportion of hip subluxation/dislocation at baseline ($p = 0.006$). Mean annual curve progression was 13.4° (7.2) for the baclofen group vs 13.6° (9.1) for the non-baclofen group ($p = 0.8$). Mean peak curve progression was 31.7 (34) for the baclofen group and 27.1 (18) for the non-baclofen group ($p = 0.95$). 4 patients with baclofen pumps and 5 without required spinal fusion for curve progression during follow up. All patients, aside one non-baclofen case, had developed a scoliosis by follow up; mainly thoracolumbar/lumbar collapsing C curves.

Conclusion: Patients with quadriplegic spastic cerebral palsy with and without baclofen pumps showed significant curve progression over time. Intrathecal baclofen pumps do not appear to alter the natural history of curve progression in this population.

GO256. Upright, Prone, and Supine Spinal Morphology in Adolescent Idiopathic Scoliosis

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Introduction: Adolescent idiopathic scoliosis patients are exposed to ten times more radiation as compared with healthy adolescents, this leads to increased risk of developing malignancies. To minimize the radiation exposure, non-ionizing imaging modalities, such as MRI, can be used, but this is acquired in supine positioning, unlike the standing X-rays that are the gold standard. As far as we know, this is the first study to compare the 2-D morphology of the spine on conventional radiographs with the 3-D morphology on supine MRI and prone CT images. The objective is to evaluate the correlation between the morphology of the spine on conventional radiographs in the upright position and 3-D supine and prone imaging modalities in patients with adolescent idiopathic scoliosis.

Material and Methods: 62 adolescent idiopathic scoliosis patients planned for scoliosis surgery and had undergone

standard pre-operative work-up (upright radiographs, supine MRI for exclusion of neural axis abnormalities and prone CT for navigation surgery for posterior pedicle screw fixation) were included. In all three positions, Cobb angles, thoracic kyphosis, lumbar lordosis and apical vertebral rotation (2-D X-rays: method of Perdriolle, 3-D scans: semi-automatic software) were determined. In addition, on reconstructed 3-D MR and CT images, the true sagittal and coronal morphology were measured semi-automatically (previously validated technique). Chi-square tests were used for correlation analysis between the positions.

Results: In the thoracic and (thoraco)lumbar curves, Cobb angles correlated significantly between conventional radiographs (68 ± 15° and 44 ± 17°), supine MRI (57 ± 14° and 35 ± 16°) and prone CT (54 ± 15° and 33 ± 15°; $r \geq 0.89$; $p < 0.001$). In the axial plane, the apical vertebral rotation showed a good correlation between the positions (upright, 22 ± 12°; prone, 20 ± 9° and supine, 16 ± 11°; $r \geq 0.56$; $p < 0.001$). The thoracic kyphosis and lumbar lordosis on the conventional upright X-rays did not correlate with the true sagittal morphology on MRI or CT. The relation of the thoracic Cobb angle between the standing X-rays and the lying down images of moderate to severe patients is expressed by the formula: upright radiograph (°) = 10.81 + 1.01*supine MRI(°) and prone CT(°) = -3.02 + 1.00*supine MRI(°).

Conclusion: Although there is slight underestimation of the morphology of the 3-D spinal curvature in the supine position as compared with upright, there is a significant correlation of the deformation in all three dimensions between the different body positions and imaging modalities. Therefore, accurate estimation of the upright morphology of adolescent idiopathic scoliosis is possible, using non-ionizing supine MRI or prone CT scans.

GO257. Larger Curve Magnitudes (> 70 Degrees) in Adolescent Idiopathic Scoliosis are Associated with Significantly Higher Cost of Surgical Treatment and a Delayed Return to Function

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Introduction: Surgical procedures to correct larger curve magnitudes >70°in patients with adolescent idiopathic scoliosis (AIS) are still common globally. Despite the increased complexity associated with surgical correction of these curves, there is limited evidence available assessing the effect of preoperative curve severity on clinical or economical outcomes. This study aimed to examine the impact of preoperative curves >70° versus those ≤ 70° on perioperative, functional and financial outcomes in patients with AIS undergoing posterior spinal fusion (PSF).

Material and Methods: Seventy seven eligible AIS patients who underwent PSF were prospectively followed-up, until return to postoperative function was reported. Preoperative curves > 70° versus ≤ 70°, were analyzed in relation to surgical duration, estimated blood loss, perioperative complications, length of hospitalisation, return to function and cost of surgical treatment per patient.

Results: Severe preoperative curves greater than 70°, identified in 21 patients (27.3%), were associated with significantly longer surgical duration (median 6.5 hour versus 5 hour, $p = 0.001$) and increased blood loss (median 1,250ml versus 1,000ml, $p = 0.005$) – these patients were 2.1 times more likely to receive a perioperative blood product transfusion (Relative Risk 2.1, Confidence Interval 1.4–2.7, $p = 0.004$). Curves greater than 70° were also associated with a significantly delayed return to school/college, and an increased cost of surgical treatment (33,730 versus 28,620, $P < 0.0001$).

Conclusion: Surgeons can expect a longer surgical duration, greater intraoperative blood loss and double the blood product transfusion risk when performing PSF procedures on AIS patients with curves greater than 70°versus those ≤ 70°. Surgical correction for curves > 70°, often as a result of lengthy surgical waiting lists, also incurs added expense and results in a partial delay in early functional recovery.

GO258. Is There a Difference in Outcome between Top and Side Loading Instrumentation System Used for the Surgical Treatment of Adolescent Idiopathic Scoliosis (AIS)

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Introduction: Different Instrumentation systems has been developed for the surgical correction of Adolescent idiopathic Scoliosis (AIS) with different deformity correction techniques.

Material and Method: The purpose of this retrospective study was to compare top loading to side-loading instrumentation systems used in the surgical treatment of AIS looking at the clinical, functional and radiological outcomes as well as the cost difference between different systems. Thirty matched surgically treated female patients were assigned to 2 groups, group one were treated using a top loading system and in group 2 a side-loading spinal instrumentation system was used. The groups were evaluated for curve magnitude, percent correction, functional outcome using the scoliosis research society questionnaire-30.

Results: both groups were similar in their demographic data, preoperative clinical and functional variables. The cost of instrumentation was significantly higher in group 2. At 2 years follow up: both groups have significant improvement in all domaines of Scoliosis Research Society score-30. Group 1 had a better (not significant) correction of the rib hump and both groups had similar percent correction of the main curve.

Conclusion: The surgical treatment of AIS with side loading systems was significantly more expensive but had statstically similar functional and radiographic results to the top loading system.The top loading system achieved better correction of the rib hump.

GO259. Posterior Spinal Osteotomies for Sagittal Imbalance

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Introduction: Surgical treatment of spinal deformity offers superior clinical and radiographic outcomes than non operative approaches. This prospective study aimed at assessment of outcomes of posterior only spinal osteotomies in treatment of sagittal imbalance.

Patients and Methods: Thirty cases of symptomatic sagittal imbalance were managed with posterior spinal osteotomy in Assiut University Hospitals. Half of them were males, age ranged from 5–57 years (20 ± 12.9). Eleven cases were congenital (36.7%) and five cases were Scheuermann kyphosis (16.7%), with other causes (46.7%) including degenerative, junctional, ankylosing spondylitis, post tuberculous, neuromuscular and Idiopathic types. Curves were angular in

14 cases (46.7%) and smooth in sixteen (53.3%). Ten cases (33%) were thoracic, eight (27%) were thoracolumbar, six (20%) were lumbar and six cases were diffuse. VAS, ODI, SRS-22, neurology, and radiological parameters (SVA, TK, LL T1SPA, PI, PT and SS using Surgimap 2.0.8.4664) were compared pre, post and at last follow up visit. Operative time, bleeding amount, and correction achieved were compared. The mean follow up was 21 months (12–60 months).

Results: Seventy five osteotomies (59 Ponte Osteotomies "PO" in 19 cases, Six Pedicle Subtraction Osteotomies "PSO" in 4 cases and ten Posterior Vertebral Column Resections "PVCR" in10 cases) had been done. Thirty nine osteotomies (52%) were thoracic, 17 thoraco-lumbar and 19 were lumbar. The VAS, ODI and total SRS-22 were improved ($p = 0.001$) with no difference between the three osteotomy types. The local kyphosis improved from 61° to 10.57° ($p = 0.001$) with 82.7% final correction and no difference between PVCR and PO ($p = 0.017$). TK improved from 43.86° to 30.47 ° ($p = 0.020$). The mean SVA improved from 54.68 mm preoperatively to 33.48 mm postoperatively and was 35.16 mm at final follow up ($p = 0.023$). The amount of blood loss and the mean operative time was less with PO than PSO and VCR ($p = 0.001$ and $p = 0.039$). Two cases developed deep infection and were successfully managed with debridement and antibiotics. Four cases developed asymptomatic proximal junctional kyphosis. Two cases with postoperative neurological complications were encountered. One of them recovered spontaneously during the follow up. The other one had proximal junctional failure and atraumatic subluxation of the upper dorsal spine. Urgent reduction and proximal extension of the fixation and fusion was done. Complete neurological recovery was observed during the follow up.

Conclusion: Posterior only spinal osteotomies appear to be highly effective in correcting sagittal imbalance and may avoid the morbidity of anterior or combined approaches.

GO260. Three Dimensional Correction of Severe Rigid Neurofibromatosis Scoliosis

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Introduction: The surgical management of severe rigid dystrophic neurofibromatosis curves is a demanding procedure with uncertain results. Several difficulties are present in such patients including a poor bone stock, sharp angulation of these curves and the delicate nature of the dural sac. The aim of this work is to review the clinical and radiographic outcome of three-dimensional correction of severe rigid neurofibromatosis curves analyzing its efficacy, safety and possible complications.

Materials and Methods: The results of 32 patients with severe rigid neurofibromatosis deformities were retrospectively reviewed. Patients were followed-up for a minimum of 3 years; an average of 6.5y (range 3 – 9y). The average age was 14 years (range 11 - 19y). All patients had typical dystrophic curves and the apex of the deformity was dorsal (13 patients); dorsolumbar (14 patients) and lumbar (5 patients). All patients had a two staged procedure; an anterior release followed by posterior instrumentation augmented by sublaminar wires. The wires were placed immediately below the proximal anchor and several sublaminar wires at the apex of the deformity. There were a total of 142 wires with an average of 6.5 wires/ patient (range 5 – 8 wires).

Results: The mean Cobb angle of the main curve was 102° before surgery corrected to an average of 39° and the loss of correction had an average of 4°. Sagittal alignment improved from an average of 12° to an average of 47° and rotation was corrected by an average of 34%. There were no dural tears during passage of the sublaminar wires and no neurological or implant related complications.

*Conclusion**s**:* The use of extensive and vigorous anterior release with posterior hybrid instrumentation has proved useful and effective in the treatment of these difficult cases; sublaminar wires allow safe gradual correction and even distribution of forces over multiple anchor points improving the correction achieved and decreasing implant related complications.

GO261. Incidence of Cancer and Infertility, in Patients Treated for Adolescent Idiopathic Scoliosis 25 Years Prior

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Introduction: Adolescent females with idiopathic scoliosis are exposed to substantial amounts of radiation during treatment and follow-up for AIS.The purpose of this study was to determine the amount radiation exposure patients received during treatment for AIS and report the incidence of infertility and cancer in adulthood.

Material and Method: 219 consecutive AIS patients treated at Rigshospitalet, Copenhagen between 1983 and 1990 were identified and requested to return for clinical and radiographic examination. The incidence of cancer was determined through chart review and follow-up interviews. In addition, the subjects and age-matched controls were queried regarding infertility, age at first pregnancy and spontaneous abortions. Using X -ray reports that included patient position, mAs and kV used and the number of X-rays taken, a radiation physicist calculated the total radiation dose during treatment and follow-up adjusted for BMI and sex.

Results: 159 (78%) patients participated in the follow up study, and medical charts were available in 209 patients. 2 patients had passed away, one due to cardiac arrest and one to breast cancer. 8 patients had emigrated. Radiation information was available in 211 patients. The mean calculated mean total radiation exposure was 1.58 mSv (0,44–6,9).An average of 16.3 (range, 8–34) X-rays were taken during treatment. The rate of infertility (10%) and spontaneous abortion (23%) is similar to the normal controls. The AIS patients had an average of 1.4 children, which is 1 child less than the 2.5 children in the control cohort. Nine (4.3%) AIS patients developed cancer, mostly breast (3) and endometrial (4). Risk Ratio for cancer = 20.93 (95% CI:2.67–164.19) $p = 0.000132$. The patients with endometrial cancers have a low BMI 16.4 (15.9–16.6) at first radiation exposure, and the patients with breast cancers were older with BMI 20.4 (18.0–22.4). The incidence of cancer in this cohort is 17 times greater than the incidence of 0.25% in an age-sex matched cohort from the Danish Cancer Society Annual Report.

Conclusion: The infertility and spontaneous abortion rate was similar between AIS patients and an age matched cohort. The cancer rate in the AIS patients is 17 times higher than expected compared with the age-matched Danish population.

Table 1 Summary of demographic characteristics

	AIS patients	Controls	Total
N	165	100	
Responders	95 (57,6%)	65 (65%)	
Female	91	59	
Age at end of treatment	14,3 years (12–18 years)		
Age at questionnaire	37,6 years (33–47 years)	37,5 years (26–54 years)	
Have you been pregnant	85 (89,5%)	54 (91,5%)	
Infertility	11* (10,6%)	8 (12,3%)	
Partner infertile	6* (6,3%)	5 (7,6%)	
Spontaneous abortion	22 (22,9%)	14 (21,5%)	
Age at 1 pregnancy	23,0 years (16–41 years)	26,0 years (20–40 years)	
N of children	1,4 (1–4 children)	2,5 (1–4 children)	

*Both patient and partner infertile.

Table 2 Summary of demographic characteristics

	AIS patients
N	219
Data available	209*
Female	199
Age at follow-up	37,6 years (33–47 years)
BMI at treatment	19,56 (12,26–27,85)
N X-rays during treatment	16,3 (8–34)
Radiation dose pr exam	0,8–1,4 mSv
Cummulative radiation dose per year	2,4–5,6 mSv
Number of cancer	9
Endometrial cancer	4
Breast cancer	3
Lymphoma	1
Glioma	1

Epidemiology

GO262. Analysis of Normal Values of Sagittal Spinopelvic Radiographic Parameters in Indian Population

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Introduction: Ever since Legaye et al. in 1998 first described the importance of pelvic incidence as an important determinant of sagittal spinal balance, several other radiographic spinopelvic parameters have been defined. There are an increasing number of reports and studies from around the world signifying the role of these parameters in the maintenance of global spinal balance. Alteration in the normal values of the spinopelvic parameters has been implicated in causing accelerated degeneration, low back pain and even sagittal plane deformities. The recent literature has suggested that the best functional outcomes after any spinal surgery were achieved when these parameters have been normalized. In this setting, it is extremely important to know the normal values of these parameters in the target population. Though these values have been well quantified in the Caucasian population, there is a dearth of information in other racial groups. A few studies done in other population groups have shown some ethnic differences in the normal values of these parameters. Thus in our study we aim to quantify the normal values of sagittal spinopelvic radiographic parameters in Indian population.

Materials and Methods: The study was approved by our institute review board and the ethical committee. A total of 75 young, healthy and asymptomatic volunteers were enrolled into the study after taking a formal consent. There were 21 male and 54 female volunteers. Lateral sagittal digital radiographs of the whole spine including the base of skull up to the proximal ⅓ thigh were taken in standing position (patient is naturally standing up, looking horizontally, hands resting on a vertical support, upper limbs relaxed and elbows half bent).All the subjects were at a specific distance from the radiographic

source and a single shot of X-rays have been used centering around D12. The parameters measured were pelvic incidence PI, pelvic tilt PT, sacral slope SS, thoracic kyphosis TK, lumbar lordosis LL, lordotic and kyphotic vertebra. All measurements were performed by two independent observers using the Surgimap spine software version 2.1.2.The values thus obtained were compared with the values described in other population groups.

Results: The mean values obtained in our population group were PI-47.85, PT-13.03, SS-34.8, LL-54.68, TK-24.03. A significant correlation was found between SS-LL (r-0.817), PI-SS(R-0.813), PI-LL(r-0.692), PI-PT(r-0.589), LL-TK (r-0.505). Comparing our data with European data, the pelvic incidence of our study was lower. We also found that the values of spinopelvic parameters did not vary much between males and females except PT, which was found to have a statistically significant difference between sexes ($p = 0.019$).

Conclusion: The study demonstrated that pelvic incidence of the Asian population varied when compared with that of the Caucasian population. The pelvic incidence of our present study was similar to Japanese and Korean population. It was lower than that of the Caucasian population.

GO263. Trends in Hospital Admissions and Surgical Procedures for Degenerative Lumbar Spine Disease in England: a 15 Year Time-series

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Introduction: Low back pain (LBP), from degenerative lumbar spine disease, represents a significant burden on healthcare resources. Studies worldwide report trends attributable to their country's specific demographics and healthcare system. Considering England's specific medico-socioeconomic conditions, we investigate recent trends in hospital admissions and procedures for LBP, and discuss the implications for the allocation of healthcare resources.

Material and Methods: Retrospective cohort study using Hospital Episode Statistics (HES) data relating to degenerative lumbar spine disease in England, between 1999 and 2013. Regression models were used to analyze trends. Outcome measures include trends in the number of admissions and procedures for LBP, mean patient age, gender and length of stay.

Results: Hospital admissions and procedures have increased significantly over the study period, from 127.09 to 216.16 and from 24.5 to 48.83 per 100,000, respectively ($p < 0.001$). The increase was most marked in the oldest age groups with a 1.9 and 2.33 fold increase in admissions for patients aged 60–74 and $\geq$75 years respectively, and a 2.8 fold increase in procedures for those aged $\geq$60 years. Trends in hospital admissions were characterized by a widening gender gap, increasing mean patient age, and decreasing mean hospital stay ($p < 0.001$).Trends in procedures were characterized by a narrowing gender gap, increasing mean patient age ($p = 0.014$) and decreasing mean hospital stay ($p < 0.001$). Linear regression models estimate that each hospital admission translates to 0.27 procedures, per 100,000 (95%CI 0.25–0.30, r 0.99,$p < 0.001$). Hospital admissions are increasing at 3.5 times the rate of surgical procedures (regression gradient: 7.63 versus 2.18 per 100,000/year).

*Conclusion*s: LBP represents a significant and increasing workload for hospitals in England. These trends demonstrate an increasing demand for specialists involved in the surgical and non-surgical management of this disease, and highlight the need for services capable of dealing with the increased co-morbidity burden associated with an aging patient group.

GO264. Socio-Economic Impact of Cervical Spinal Cord Injury Operated in Patients with Lower Income Group

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Introduction: None of study reviewed on socio-economic impact after cervical spine surgery in patients with cervical spine injury or myelopathy. Aim was to study clinico-radiological results and socio-economic impact even after radiologically successful surgery.

Methods: After board approval, 104 participants (56 traumatic, 48 myelopathy) were included. All patients were operated at a single institute between 2007 and 2014 with anterior cervical approach. Patients who were expired after surgery and other pathology were excluded, as aim was to study socio-economic aspect. Nurick scale was used to assess the degree of loss of function in individuals and roentograms for fixation assessment.

Results: The average age of study group was 46.65 years with 58% comprising of males($n = 63$). About 46.7% of the study group were laborers or farmers, majority of whom lost their jobs (47%) post injury. None of the patient had medical or life insurance. Average expenditure per family of $<$ 40USD per month. About 19% of the monthly expenditure was spent on their illness; still majority (56%) had aspirations to get the government support in form of financial help or rehabilitation. The Nurick scale did not show any significant change in pre and post operative periods (3.06 v/s 2.83, $p > 0.05$). Despite good radiological results; the socio-economic burdens in study group had little impact.

Conclusion: Study shadowed socioeconomic impact after cervical spine injury and are first of its kind in lower income group. Such studies may further throw light in future management of cervical spine injuries in developing versus developed world.

GO265. Epidemiology of Traumatic Spinal Cord Injury in Tehran, Iran: A Hospital-based Study

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Introduction: Spinal cord injury (SCI) is a devastating condition with enormous personal and social costs. To develop preventive strategies, the determination of epidemiological features and causes is required. The aim of this study was to describe the hospital-based incidence of traumatic spinal cord injury in Tehran, Iran.

Material and Methods: In a retrospective study in Tehran hospitals, the records of traumatic SCI patients, admitted between March 2010 and July 2011 were surveyed.

Results: 138 cases of traumatic spinal cord injury were identified. The majority of patients were male (84.8%). The mean age was 33.2 $\pm$ 14.3 years. 54.3% patients were residing in Tehran and the others were referred from other cities. The mean annual incidence of hospitalized traumatic spinal cord injury patients of Tehran was 10.5/1,000,000/year (95%

confidence interval: 9–12). Fall was the leading cause of injury (45.7%), followed by road traffic crash (40.6%). The most common cause of tetraplegia (cervical traumatic spinal cord injury) was road traffic crash. The duration of hospital stay for tetraplegia and paraplegia (thoracic and lumbar traumatic spinal cord injury) was 22.7 ± 23.7 and 12.5 ± 7.5, respectively ($p < 0.001$). Early surgery (surgical decompression within 24 hour) was done for 19% of the patients. The median day of hospitalization for early and late surgery was 7.5 and 12, respectively ($p = 0.044$).

Conclusion: Preventing traumatic spinal cord injury should focus on males, age group of 21–30 years, falls and road traffic crash. More studies are suggested to evaluate the incidence of non-hospitalized traumatic spinal cord injury patients.

GO266. Nutritional and Vitamin D Status in a Brazilian Sample of Patients Undergoing Spinal Surgery

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Introduction: Several systemic parameters can affect the rate of complications in spinal surgeries and then have influence in the clinical outcomes. Among these parameters the nutritional status, which may be detected by the serum albumin concentration, is primordial. The vitamin D is a fat-soluble steroid hormone with important function at the bone metabolism and homeostasis, also diminishing surgical complications as bone mineral density compromises fixation. The aim of the study was to evaluate the epidemiologic profile of a Brazilian population sample specifically undergoing spinal surgery about malnourishment, identified by hypoalbuminemia, and vitamin D.

Material and Methods: This is a prospective observational study including patients undergoing spinal surgery in an only spine center. There were no exclusion criteria. The patients had a preoperative serum albumin and vitamin D concentration analysis on the day before their surgical procedure. Demographic variables were extracted. The results of the preoperative analysis were correlated with the demographic variables using the ANOVA and T-student's test, with the threshold of significance was set at $P < 0.05$.

Results: A total of 75 patients were included, 47 women (62.7%) and 28 men (37.3%). 74 had albumin concentration analysis and 64 vitamin D. The mean of the serum albumin result was 3,76 g/dL (DP: 0,53 g/dL), with 70.3% of the patients considered normal and 29.7% presenting hypoalbuminemia. About vitamin D, the mean of the value was 16,64 ng/mL (DP: 7,43 ng/mL), with 64.1% of patients considered deficient, 32.8% inadequacy and only 3.1% considered normal. There was a significant difference in the albumin concentration related with age ($p = 0.007$), with older age group presenting poorer albumin levels. The hypoabluminemia occurrence was significantly higher in patients with 60 years or older ($p < 0.001$). There wasn't correlation between vitamin D and age ($p = 0.603$). The correlation analysis between the exam results and the gender didn't show any significant difference in none parameter.

Conclusion: Our study presented data about the serum albumin and vitamin D status in a Brazilian population sample of patients undergoing spinal surgery, information still unpublished. There was correlation between hypoalbuminemia, representing malnourishment, with patient in higher age groups. Almost all the patients presented some degree of hypovitaminosis D, without correlation with age.

GO267. The Impact of Low Back and Neck Pain on Dentistry Students in Northern Greece

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Introduction: Dentistry students and dentists comprise a unique group of professionals, whose everyday professional activity requires long hours of standing and working in position considered "unhealthy" for low-bask and neck. The aim of this cross-sectional study was to explore the factors involved in the appearance of low-back and neck pain in dentistry students, as well as the impact of the pain on the students' professional and everyday activities.

Materials and Methods: A questionnaire was sent via e-mail to all dentistry students of the 7th, 8th, 9thand 10th semesters (years of clinical practice) of our university. The questionnaire included 43 questions regarding demographical data, history (spinal injury, other comorbidities), daily activities (exercise, smoking, alcohol and caffeine consumption, use of cell phone, etc), professional activities (length and type of dental work), pattern and intensity of pain and personal pain evaluation. A statistical analysis of the gathered data was performed.

Results: All students having suffered a spinal trauma or indicating any other comorbidities that could cause severe pain of the spine were excluded from the study. 55 students (21 male, 34 female) were included in the study. Our data showed that increased alcohol consumption and prolonged use of cell phone were connected to increased levels of pain. The students reported that the most frequent onset of pain was one hour after starting to work in standing position, while the majority believed that their working habits were involved in the appearance and the intensity of neck and low-back pain.

Conclusions: Our findings indicate that among dentists and dentistry students there appears to be a causative relation between their professional activities and the experienced spinal pain. These findings may be useful in a possible future restructuring of the educational program in dental schools, as well as in improving the ergonomics of dentistry working units.

GO268. Spinal Fusion Surgery: Epidemiologic and Economic Burden Attributable To First Intervention

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Introduction: Low back pain (LBP) is the single most common cause for disability in individuals aged 50 years or younger with a high socioeconomic impact. In USA, LBP costs are estimated to exceed $100 billion per year and are mainly related to lower productivity. Degenerative disc disease is one of the main causes of LBP and ways of limiting disc degeneration or even inducing disc regeneration are still desirable goals

in its treatment. Spinal fusion surgery is a recognized treatment option of degenerative disc disease, however no adequate data are available about the epidemiology of spinal fusion surgery and its economic impact in Italy. The objective of this analysis was to assess the epidemiologic and economic burden of arthrodesis from a large population based-study

Material and Methods: Lombardy Region includes around 9.9 million individuals. The study population was identified through a data warehouse (DENALI), which matches with a probabilistic linkage demographic, clinical and economic data of different Healthcare Administrative databases. The study population was made by all subjects who, during the period January 2001–December 2010, underwent a spinal fusion surgery identified by one of the following codes ICD9-CM: 81.04, 81.05, 81.06, 81.07 and 81.08. The first procedure was used as index event. We estimated the incidence of first spinal fusion surgery, the population and surgery characteristics and the healthcare costs from the National Health Service's perspective.

Results: During the study period, 17,772 (mean (SD) age 52.0 (17.2), 53.2% female) spinal fusion surgeries were detected. Almost 67% of patients underwent spinal fusion reported a Lumbar Degenerative Diseases. The incidence rate of interventions increased from 12.6 to 19.1 per 100,000 person-year in the observational period between 2001 and 2006. During the past 4 years of observation, the incidence was above 20.0 per 100,000 person-year. The results showed an increasing constant patients' median age during the time period considered from 49.9 to 58.4 years. The average hospital length of stay reported for the index event was 17.1 days in the 2001 and decreased until 11.0 days in the 2004. The average cost of the spinal fusion surgery increased during the observational period, from 4.381 up to 9,388.

Conclusion: The study showed an increasing incidence of spinal fusion surgery and costs from 2001 to 2010 in the Italian Lombardy Region. Almost 67% of patients had a Lumbar Degenerative Diseases and the majority of them are in a working-age with a possible association to high productivity loss. These results can be used to better understand the epidemiological and economic burden of these types of interventions, and associated with quality of life and loss of productivity information could help to optimize the resources available considering the different surgical procedures available today.

GO269. Length of Stay and Post-operative Complications and Their Relation with the Glucose Level Preoperatively in Diabetic and Non-diabetic Patients Undergoing Spinal Surgeries

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Introduction: Hyperglycemia in diabetic patients is a well-known risk factor for many perioperative morbidity and mortality, as it alters the normal physiology of the patients responding to many stressors like surgery, it therefore tends to increase the patients' costs and length of stay in the hospital. Other studies have showed the relation between glycemic instability with the adverse events following spinal surgeries, showing as high as 19% non-diabetic patients, had hyperglycemia and considering it as a risk factor for many adverse events like surgical site infections and sub-optimal wound healing and for the increasing rates of surgical revision, matching our hypothesis of the positive correlation between glycemic instability and the rate of adverse events. The purpose of this study was to expose the effect of glucose level preoperatively on the patient complications and length of stay in the hospital, and to compare between diabetics and non-diabetics with hyperglycemia preoperatively regarding complications and length of stay.

Material and Methods: Of the 129 patients who underwent spinal surgeries at King Saud University Medical City, Riyadh SA, during two years period (2013–2015) exclusion and inclusion criteria were applied including only the patients whom their preoperative glucose level was documented and a total number of 106 patients were enrolled in a retrospective analysis study design. Each of the patients' records underwent a comprehensive and complete review.

Results: 34 (32.1%) of our patients were diabetic, 13 (12.2%) of all patients had hyperglycemia, 6 (46.2%) of the hyperglycemic patients had at least one post-operative complication, compared with 9 (10.5%) among the euglycemics (*P* value 0.004), having most commonly infections and suboptimal wound healing (23.1%, n 3, *P* value 0.094, 0.192, respectively), with an increase in length of stay by an average of 4.37 days (*P* value 0.256) and the incidence of complications among the hyperglucemic ptients seen in 5 (55.6%) of the diabetics and in 1 (25.0%) of the non-diabetics(*P* value 0.343).

Conclusion: Pre-operative hyperglycemia is associated with more adverse events post operatively (seen more in diabetics in this study), hence, along with other factors, increasing patients' length of stay in the hospital which adds to the financial costs as well as predisposing to more infections. However, the number of diabetic patients examined in this study was limited, demanding for more extensive researches addressing the same topic.

Navigation

GO270. Complications with and without the Use of Computer-Assistance in Lumbar Fusion Surgery: Analysis of 15,222 Patients in ACS-NSQIP Database

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Introduction: The objective of this paper is to demonstrate the difference in post-operative complication rates between Computer-assisted surgery (CAS) and conventional techniques in spine surgery. Several studies have shown that the accuracy of pedicle screw placement significantly improves with use of CAS. Yet, few studies have compared the incidence of post-operative complications between CAS and conventional techniques.

Material and Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent posterior lumbar fusion from 2011 to 2013. Multivariate analysis was conducted to demonstrate the difference in post-operative complication rates between CAS and conventional techniques in spine surgery

Results: Out of 15,222 patients, 14,382 (95.1%) were operated with conventional techniques and 740 (4.90%) were operated with CAS. Multivariate analysis showed that patients in the CAS group had less odds to experience adverse events post-operatively (OR 0.57, $p < 0.001$). Minor adverse events occurred in 2905 (20.2%) patients in the conventional group and 98 (13.2%) patients in CAS group (OR=0.57, $p < 0.001$). Blood transfusion was present in 2488 (17.3%) of the patients in the conventional group compared with 98 of the patients in CAS group (10.95%)(OR=0.56, $p < 0.001$). The mean operative

time in the conventional group was 205.2 ± 106.1 minutes, and 227.0 ± 111.9 minutes in the CAS group. This difference was statistically significant (r=20.14, $p < 0.001$).

Conclusion: This paper examined the complications in lumbar spinal surgery with or without the use of CAS. These results suggest that CAS may provide a safer technique for implant placement in lumbar fusion surgeries.

GO271. A Novel Approach to Navigated Implantation of Thoracic and Lumbosacral Pedicle Screws Using Inertial Measurement Units

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Introduction: A novel method of intraoperative navigation with inertial measurement units was developed to implant pedicle screws in the thoracic and lumbosacral human spine. This was compared with a freehand technique. IMUs house accelerometers and gyroscopes to measure acceleration and angular rotation. Among the many applications, IMUs control and detect motion and orientation of tablet computers and smartphones.

Material and Methods: The study was done on 9 human cadavers. A preoperative CT was performed to measure the axial and sagittal tilt angles of the pedicle screw trajectories from T1 to S1. After defining the entry points on the exposed spine, the IMU-equipped pedicle finder and screwdriver were used to reproduce these tilt angles and implant one half of the screws. The other half was implanted with a freehand technique. Fluoroscopy was not used in any of the procedures. In addition to adhering to anatomic landmarks, the entry points of the last 216 screws of the study were found by intraoperatively reproducing the distance between the left and right pedicle with a divider. The screw trajectories were analyzed and compared on postoperative CTs.

Results: 162 screws were implanted with use of the IMUs and 162 screws were implanted with a freehand technique. In relation to the preoperatively planned trajectories, the IMU-guided technique performed significantly better than the freehand technique (axial tilt $p = 0.000001$, sagittal tilt $p = 0.0000000003$): With the IMU-guided technique, the mean offsets between the planned and postoperatively measured tilt angles of the screws were for the axial plane 3.3° ±3.5° (median 2°, range 0° - 23°) and for the sagittal plane 3.4° ±3° (median 3°, range 0° - 13°). For the freehand techniques the mean offsets between the planned and postoperatively measured tilt angles of the screws were for the axial plane 5.6° ±4.5° (median 5°, range 0° - 31°) and for the sagittal plane 6.7° ±5.4° (median 6°, range 0° - 33°). Evaluation of the overall screw position showed that the IMU-guided technique in combination with the divider scored significantly better than the freehand technique plus divider ($p = 0.006$).

Conclusion: Inertial measurement unit–based intraoperative navigation may provide a more reliable implantation of pedicle screws in the thoracic and lumbosacral spine than a freehand technique. Furthermore, adding a divider to intraoperatively reproduce the interpedicular distance of a given level may further improve this novel technique. Translating this rather low-cost technology from consumer electronics to a clinical spine scenario may assist implanting thoracic and lumbar pedicle screws with minimal to no fluoroscopic guidance, yet at no loss of precision.

GO272. Accuracy and Safety in Screw Placement in the High Cervical Spines: Retrospective Analysis of O-arm® based Navigation-assisted C1 lateral Mass and C2 Pedicle Screw

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Introduction: High screw misplacement rates, various pedicle morphometry and vertebral body size variations have led to a search of image-guided systems to improve the surgical accuracy of screw insertion in high cervical spine. With the advances and improvement of computer-assisted surgery (CAS) devices, image-guided screw insertion technique has been applied to the fields of spine surgery. The use of O-arm® has been proposed for more accurate and efficient spinal instrumentation. The purpose of present study was to evaluate accuracy, efficiency and safety of intra-operative O-arm® based navigation system for the placement of C1 lateral mass and C2 pedicle screws in high cervical spine operations. To our knowledge, this is first report of O-arm® based navigation-assisted screw placement in high cervical spine.

Material and Methods: Between June 2009 and August 2013, a total of 24 patients with atlantoaxial instability were surgically treated using the image guidance system. To reconstruct atlantoaxial instability, we have been using Harm's technique of C1 lateral mass and C2 pedicle screw fixations. A frameless, stereotactic O-arm® based image-guidance system was used for correct screw placement. Postoperative CT scan with multi-planar reconstructions were used to determine the accuracy of the screw placement. Two independent observers evaluated the CT images with detailed descriptions of the accuracy of screw placement, number of misplaced screws, grade and type of screw perforation. The accuracy of screw placement was assessed using a grading system proposed by Gertzbein and Robbins.

Results: A total of 91 screws, including 45 C1 lateral mass and 46 C2 pedicle screws were inserted using image-guidance system respectively. 3 C1 lateral mass and 2 C2 pedicles were excluded due to anatomic anomalies. In 5 cases, perioperative reposition of screws was done due to wall perforation detected with intraoperative O-arm scan immediately after initial screw insertion. Accuracy of screw placement was as follows: C1 lateral mass screws showed 39 grade A (86.6%), six grade B (13.3%), two grade C (4.4%) and no grade D or E. C2 pedicle screws showed 31 grade A (67.4%), 10 grade B (21.8%), three grade C (6.5%), two grade D (4.3%) and no grade E. Mean time required for inserting a screw was 4.8 minutes and mean time required for preparation of screw placement was 4 minutes. Postoperative radiological evaluations revealed that 3 (3.3%) screws inserted had perforated the vertebral artery canal more than 25% (critical breach) and iatorgenic VA stenosis was proved with postoperative CT angiography. No patients underwent reoperation for screw reposition.

Conclusion: In this study, the authors demonstrated that image-guidance systems could be applied safely to the atlantoaxial instabilities. However, incidence of screw perforation does not disappear completely due to the close proximity to spinal canal and surrounding vessels. Therefore, because of theses potential risk of injury to the vertebral artery and neural elements, the use of image guidance system seems to be beneficial, especially for high cervical instrumentations which require much experience and steep learning curves.

GO273. Finite Element Analysis Based Lumbosacral Revision Surgery Using an Individual Navigation Template

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Introduction: A revision surgery in case of a lumbosacral non-union can be challenging especially if an implant related failure (e.g., a broken S1 screw) is complicating the clinical situation. Removal of the broken screw impairs the local bony enviroment jeopardizing the outcome of the revision. In the S1 segment the convergent bicortical screw trajectory provides a superior anchoring compared with any other directories (e.g., sacral ala screw), but the proper insertion of the new screws in a revision surgery can be impossible with freehand or fluoroscopy-guided technique. In this paper, we present a case suffering from a lumbosacral non-union complicated with a broken sacral pedicle screw what has been surgically managed by the application of a CT based 3D reconstruction method combined with finite element analysis (FEA) and computer assisted design (CAD).

Method: A step-by-step approach was developed and performed to manage the clinical problem. (1) Quantitative computed tomography (QCT) based patient-specific FE model of the sacrum was created. (2) To plan the revision surgery CAD model of the pedicle screw was inserted in the sacrum model in a bicortical convergent and a monocortical divergent position. (3) According to the two screw insertion scenarios two static FEAs were performed using 500 N tensile load applied to the screw head. (4) A template with the two screw guiding structures designed to fit on the bone surface was created for the sacrum using 3D design and photoactive 3D printing technology. The final template was made by cobalt chrome. (5) The revision screw has been implanted into the biomechanically optimal position guided by the patient- and condition-specific template. Postoperative CT scan was used to evaluate the accuracy of the pedicle screw placement.

Results: Based on the FEA results the modified bicortical convergent screw had better stability resulting in optimal von Misses stress distribution and less displacement compared with the monocortical divergent placement. Preoperatively the template was found to fit exactly on the printed plastic sacrum model, and screw insertion simulation was successfully performed. The design concept was proved to be accurate based on the CT scan and virtual model comparison. Intraoperatively the template also fitted on the bone surface and screw insertion was completed successfully. Postoperative CT scans confirmed that the inserted pedicle screw reached the virtually planed position.

Conclusion: The intraoperative pedicle screw navigation provided by a patient specific screw-guiding template allows the surgeon to insert the screw into its optimal position considering the local bone material property and the challenging geometrical situation. This technology for the surgical navigation can be widely accessible in the future through dedicated knowledge providers. Its advantages compared with the conventional surgical navigation techniques are the relatively low cost, minimized intraoperative X-ray exposure and the possibility for the consideration of the patient-specific biomechanics. This new patient- and condition-specific approach can be widely used in revision spine surgeries or in challenging primary cases after its further clinical validations.

GO274. Surgical Technique for Cervical Pedicle Screw Insertion using O-Arm

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Introduction: Posterior cervical fixation using lateral mass screw and cervical pedicle screw (CPS) is getting available for various disorders such as trauma and degenerative disease and so on. The purpose is to report our detail surgical technique for CPS insertion using O-Arm, about cannulated CPS particularly.

Material and Methods: Consecutive one hundred twenty patients underwent posterior cervical fixation using CPSs since January 2007. Preoperatively we made further evaluation of the each patient's radiological condition including collateral circulation using MRI and MR angiography and CT angiography. We evaluated local instability with dynamic cervical radiography at each. During making pilot hole of CPS, usually we have felt resistant strong force which cervical back muscles and subcutaneous tissues have produced. So if we made short midline skin incision in particular, CPS underwent through the bilateral another skin incision which we made at the paramedian area. Using O-arm, CPSs were inserted slowly and intermittently taking care not to produce axial rotation or sagittal bending of the cervical spine, which related to the screw malposition including VA injury. And recently we used to use the cannulated screw.

Results: We inserted 668 CPS and classified their position with Neo's classification using postoperative CT scan, grade 0 (635 screws, 95.0%), grade 1 (27 screws, 4.0%), grade 2 (6 screws, 0.9%), grade 3 (0 screws). No neurovascular complications associated with surgery were encountered.

Conclusion: We believe what is the most important for safe CPS insertion is preoperative detail further evaluation including the indication of CPS. We think our procedure and techniques for CPS insertion are useful and safe.

GO275. Differences between Manufacturers of CT-based Computer Assisted Surgery Systems Do Exist: A Systematic Literature Review

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Summary of Background Data: Several studies have shown that the accuracy of pedicle screw placement significantly improves with use of CT-based navigation systems. Yet, there has been no systematic review directly comparing accuracy of pedicle screw placement between different CT-based navigation systems. The aim of this study was to review the results presented in the literature and compare CT-based navigation systems relative to screw placement accuracy.

Methods: A systematic review of the literature was preformed using CENTRAL, Medline, PubMed and Embase databases. Studies included were randomized clinical trials, case series, and case control reporting the accuracy of pedicle screws placement using CT-based navigation. Two independent reviewers extracted the data from the selected studies that met our inclusion criteria. Papers were grouped based on the CT-based navigation system used for pedicle screws placement.

Results: 33 Papers met all of our inclusion criteria and were included in the final analysis, which showed a significant statistical difference ($P < 0.0001$) in accuracy of pedicle screws placement between three different CT-based navigation systems. The mean (weighted) accuracy of pedicle screws placement based on the CT-based navigation system was found to be 96.8% $\pm$ 3.8% in StealthStation, 96.07% $\pm$ 3.8% in

VectorVision and 97.7% ± 1.7% in SurgiGate. Post hoc analysis showed a significant statistical difference between StealthStation vs VictorVision ($p < 0.0001$) and StealthStation vs SurgiGate ($p < 0.0001$) as well.

Conclusion: This paper summarizes results presented in the literature and compares screw placement accuracy using different CT-based navigation systems. The differences in accuracy demonstrated in this review should be considered by spine surgeons, and need to be validated for effects on patients' outcome.

Level of Evidence: Level I.

GO276. The Comparison between O-Arm Navigation System and C-Arm Fluoroscopy Navigation System for the Amount of Radiation Exposure in Balloon Kyphoplasty

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Introduction: Recently,balloon kyphoplasty(BKP) is widely used for osteoporptic vertebral fracture. In this study,we compare the amount of the radiation exposure between O-arm navigation system and C-arm fluoroscopy navigation system in BKP.We consider further review for the radiation exposure in BKP from here on.

Material and Methods: 63 patients with vertebral fracture is recruited from Kansai Erectronic Power Hospital between March 2011 and June 2014. In all cases,we monitored the amount of radiation exposure by each device.In 63 cases,10 is O-arm navigation system and 53 is C-arm fluoroscopy navigation system.

Results: The average amount of the radiation exposure is 35.994mGry (range 0.52–97.27) in O-arm and 17.284mGry (range 2.69–86.6) in C-arm.The average radiation time is 35.227 second (range 1.9–57.71) in O-arm and 94.886 second (range 25–319) in C-arm.

Conclusion: O-arm navigation system use is shorter in radiation time and larger in radiation exposure than C-arm fluoroscopy navigation system. However, the amount of the radiation exposure per unit time in O-arm navigation system is larger than in C-arm fluoroscopy navigation system. We should consider the way to reduce the radiation exposure by stepping down the output power in O-arm.

GO277. O-arm Imaging and Naviation Systems for Transvertebral Anterior Cervical Foraminotomy

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Introduction: Anterior cervical discectomy and fusion (ACDF) results in excellent initial clinical results for herniated cervical disc and an osteophyte. On the other hand, the development of adjacent segment disease after ACDF is well recognized. However, most patients do not require total discectomy and vertebral fusion because most radiculopathies are caused by focal lesions of the intervertebral foramen. Especially, in patients who have unilateral radiculopathy with physiological alignment, we should avoid removal of healthy discs. Transvertebral anterior cervical foraminotomy (TVACF), nonfusion and nondiscectomy technique, can preserve intervertebral disc and reduce adjacent intervertebral degeneration compared with intervertebral fusion. Therefore, we have reported the advantages and usefulness of TVACF. However, TVACF requires skillfulness, especially for the appropriate drilling direction control for the keyhole. Recently, O-arm imaging and navigation systems were progressed. This navigation systems help to make the correct direction of the keyhole.

Material and Methods: We have performed TVACF under O-arm imaging and naviation systems. The patient was placed in the supine position. A lateral radiograph was used to identify the skin incision level. A 3.5cm transverse skin incision was made at half a level higher than the affected disc level. We approached the anterior surface of the vertebra from the affected side. After then, O-arm imaging and navigation systems were applied. We determined the appropriate keyhole position under the navigation. The lateral and caudal side trajectory of the tunnel was also decided under the navigation. The tunnel was ~6 mm in diameter.

Results: Under O-arm imaging and navigation systems, we were able to easily determine the appropriate keyhole position and the lateral and caudal side trajectory of the tunnel. Intraoperative findings and postoperative computed tomography imaging showed the accuracy of keyhole position.

Conclusion: Successful surgery is possible with using O-arm imaging and navigation systems. This navigation facilitate TVACF. As a result, TVACF is able to be more widely used among spinal surgeons in safe.

GO278. Pedicular Screw Placement Accuracy with O-Arm Based Navigation in Patients with Scoliosis

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Introduction: Application of transpedicular screws to obtain posterior spinal fusion in thoraco-lumbar spine has become standard in spinal surgery. However technique of screws insertion is demanding and not free of complications. Positioning is particularly challenging in pediatric patients with spinal deformity. Navigation systems based on intraoperatively obtained 3D image seem to be very promising solution to prevent or at least minimize screw misplacements. Although still lack of data confirming superiority of navigation above other techniques. The study was designed to assess the accuracy of transpedicular screws placement with O-arm and navigation in patients who underwent surgery for idiopathic scoliosis.

Material and Methods: 451 screws in 27 patients were evaluated. All the screws were positioned by two surgeons (WU, WJ) with aid of navigation (Stealth Station, Medtronic) based on 3D image obtained during surgery (O-ARM, Medtronic). The accuracy was described separately for each screw based on postoperatively obtained CT scans. The assessment was made according to widely accepted grading system: grade 0 – no pedicle wall violation, grade 1 = < 2 mm perforation, grade 2 – wall perforation with half of the diameter of the screw outside of the pedicle (= < 4 mm), grade 3 complete perforation of the pedicle (>5 mm). The comparison of accuracy was made between adults (13 patients) and adolescents (14 patients).

Results: In the study authors reported overall accuracy of 96% correctly positioned pedicle screws (83% grade 0 and 13% grade 1). No grade 3 screws were reported. Statistical analysis confirmed decreased accuracy in upper thoracic level (82% of grade 0 and 1). No statistically significant differences

in implant accuracy were observed between adults (96.2% of grade 0 and 1) and adolescents (95.3% of grade 0 and 1).

Conclusion: The application of navigation system is a safe method of pedicle screws introduction either in adults or adolescents. However the technique does not eliminate misplacement. Significant misplacement rate is still observed in upper thoracic spine.

Trauma Cervical 3

GO279. Intramedullary Lesion Length has a Negative Effect on Neurological Recovery in Cervical Spinal Cord Injury Patients with AIS Grades A-C

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Introduction: Experimental spinal cord injury and clinical studies indicate a relationship between MRI lesion length and outcome. In patients with AIS grades A-B, IMLL expands at a rate of 900 μm/hour, culminating in an intramedullary lesion (IML) which measures ~50 mm at 3 days post-injury. We performed a retrospective analysis to measure the effect of IML length on long-term neurological recovery and to determine the significance of intramedullary lesion length (IMLL) in long-term AIS grade conversion in traumatic cervical spine injury (TCSI).

Methods: Ninety-five adult patients who underwent decompressive surgery for cervical TSCI were included. Post-decompression IML length was measured and long-term AIS grades were recorded. A regression analysis was performed.

Results: AIS grade was A in 51, B in 26, and C in 18 patients. Mean IML length on postoperative MRI imaging was 72.6 mm. AIS grade conversion was noted in 46 (48.4%) patients. Conversion was noted in 27.5% of AIS grade A, 65.4% of AIS grade B and 83.3% of AIS grade C patients. Timing of decompression (18.2 hours) had no effect on AIS grade conversion, but conversion was significant in older patients, those with higher ASIA motor score, lower injury severity score, shorter IML length and better evidence of decompression on postoperative MRI. Regression analysis indicated a significant relationship between AIS grade conversion and IML length on postoperative MRI (OR 0.953, 95% CI=0.9313–0.9761, $p = 0.001$).

*Conclusion***s:** In AIS grades A-C cervical TSCI, post-decompression rostrocaudal IML length was significant predictor of AIS grade conversion and neurological recovery. The timing of decompression did not correlate with recovery of function.

GO280. Neurological Recovery after Traumatic Cervical Spinal Cord Injury is Superior if Surgical Decompression and Instrumented Fusion are Performed within 8 h versus 8–24 h after Injury: A Single Centre Experience

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Introduction: Traumatic spinal cord injury (tSCI) is a catastrophic event with enormous personal, social and economic impact. Despite recent progress in understanding the pathophysiology of acute tSCI and the positive effects of acute spinal cord decompression on neurological recovery reported in standardized preclinical studies, neurological benefits of early surgical decompression (SD) remain elusive in the clinical setting.

Material and Methods: A prospective study was performed to evaluate the impact of SD and instrumented fusion within 8 hour versus 8–24 hour after injury on neurological recovery after cervical tSCI in patients operated on in the UMC Ljubljana, Slovenia. Only patients with the ASIA Impairment Scale (AIS) grades of A through C and with MRI-confirmed spinal cord compression were enrolled. The primary outcome was the change in AIS grade at the six-month follow-up.

Results: Of the 48 enrolled patients, 22 patients who underwent surgery within 8h (Group-8h) and 20 patients who underwent surgery between 8 and 24h (Group-8–24h) after injury concluded the study. At admission, there was no statistically significant difference in AIS grade between the study groups. At the six-month follow-up, an improvement of at least two AIS grades was found in 45.5% of patients in Group-8h and in 10% of patients in Group-8–24h ($p = 0.017$). In a multivariate analysis, adjusted for the preoperative AIS grade and the degree of spinal canal compromise, the odds of an at least two-grade AIS improvement were at least 106% higher for patients in Group-8h than for patients in Group-8–24h (OR = 11.08, $p = 0.004$). No statistically significant difference was found in the rate of pneumonia, the number of ventilator-dependent days or the mortality between the groups.

Conclusion: Our results suggest that the patients with tSCI who undergo SD within 8h after injury have superior neurological outcomes than patients who undergo SD 8 to 24h after injury, without any increase in the rate of adverse effects.

GO281. The Sympathetic Nervous System Mediates Functional and Robust Respiratory Recovery Following Acute Cervical Spinal Cord Injury

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Introduction: The organization of the respiratory network has traditionally been described through descending medullary tracks. The diaphragm is innervated by the phrenic nucleus (C4-C6). However, the intercostal muscles are innervated by the intercostal motor nucleus (T1-T11) located at the thoracic spinal cord segments. Therefore, cervical spinal cord injury (SCI) can typically cause respiratory motor system dysfunction. From the literature, ventilation failure within the human lower cervical SCI population typically occurs 4.5 ± 1.2 days after injury, affecting 26.6% of patients. Also, the risk of apnea following low cervical SCI is increased during sleep. However, while intercostal muscles contribute to respiratory

recovery post injury the pathways mediating this effect have never been fully elucidated.

Methods: Following complete C7 spinal cord transection in rats, we demonstrated the presence of intercostal-EMG activity synchronized to the inspiratory bursts of the diaphragm. We explored the anatomical, and latent, pathway that enables synchronized activation of the intercostal muscles after complete cord transection. Experimental work, in the form of bilateral dorsal/ventral rhizotomies, unilateral transection of the phrenic nerve and sympathetic chain ganglia and systemic application of salubutamol, suggested that intercostal activities is mediated through the sympathetic chain ganglion by means of connection to the ipsilateral phrenic nerve.

Results: In anesitised and unventilated rats, rhythmic inspiratory activity was present in the intercostal muscles following acute C7 transection and bilateral dorsal/ventral rhizotomies. This activity persisted up to five days following the initial trauma. Unilateral transection of the phrenic nerve and sympathetic chain ganglia eliminated ipsilateral intercostal motor activity. Systemic application of salubutamol (β2-agonist), not only increase intercostal activity but also restored it in transected rats which had not retained this activity following transection.

Conclusions: These data provide the first evidence of sympathetic nerve activity mediating synchronized and robust intercostal inspiratory muscle activity following severe, lower cervical transection. This activity occurs up to 5 days following trauma, an effect which correlates with the induction of ventilation failure and respiratory dysfunction in human patients with SCI. The clinical implications of this finding are provocative. 60% of patients undergo some degree of respiratory distress following acute C5–8 injuries. Using this pathway, it may be possible to modestly stimulate or activate sympathetic activity to further aid intercostal muscle activity and respiratory function following acute SCI. This thus represents a novel target for the treatment of respiratory dysfunction following spinal trauma.

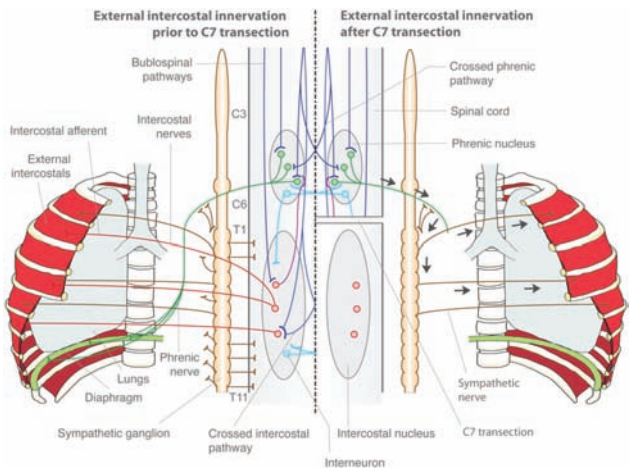

Fig. 1 Diagram illustrated the phrenic-intercostal neuronal connections and circuits.

GO282. Early Decompression (<8h) versus Delayed Surgical Management Improves Functional Outcome after Traumatic Cervical Spinal Cord Injury

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Introduction: Traumatic cervical spinal cord injury affects the individual in a multi-faceted way. Early decompression of the spinal canal is recommended. The optimal time point for this intervention has been under debate for decades. This study compares a variety of neurologic, radiologic and functional outcome parameters between patients after early (<8 hour) versus delayed decompression.

Materials and Methods: We performed a retrospective analysis at the Center for Spinal Cord Injuries (Trauma Center Murnau, Germany), an over-regional level-I trauma center. Follow-up data was collected prospectively for one year after injury, according to institutional and international consensus criteria. We included data acquired over a 10-year period (2004 – 2014). We only analyzed patients over 18 years with traumatic cervical spinal cord injury without concomitant extremity injury, traumatic brain injury or central cord injuries.

Results: We identified 70 patients (59 males), who met in- and exclusion criteria. Out of this population, 35 patients were decompressed within the first 8 hour (average: 4.36 hour after the insult) (= early group). After one year, patients from the early group showed a significantly higher gain in total motor score (TMS) points and upper extremity motor score (UEMS) points. Additionally, this patient cohort showed significantly better grades on the American Spinal Injury Association Impairment Scale (AIS) and a significantly higher AIS conversion rate. Furthermore, they were more likely to experience a significant greater difference in the Spinal Cord Independence Measure (SCIM) within the follow-up period.

Conclusion: This study shows that an early surgical decompression not only leads to higher AIS conversion rates, but – most importantly – also to a better functional outcome (as indicated by the SCIM score).

GO283. New Surgical Attitude in Complete Acute Traumatic Spinal Cord Injury

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Introduction: Studies have shown the values pattern of the phosphorylated form of the high-molecular-weight neurofilament subunit (pNF-H) in CSF is a predictive biomarker for acute traumatic spinal cord injury (SCI).

Materials and Methods: A previous study of pNF-H in CSF of patients with SCI showed it is a specific biomarker for SCI, it can distinguish the severity of SCI and it is a predictive biomarker because of its values pattern can show the reducing or stopping of the secondary lesion and a favorable result. At 22 subjects with acute traumatic SCI we correlated the pNF-H concentration in CSF with the MRI, with the diffusion tensor tractography on the SCI site and with the clinical evolution. All patients underwent surgery during the first 24 hours (decompression, stabilization). In two cases with unfavorable pattern of pNF-H after 4 and 7 days, MRI identified the SCI site with an extensive spinal cord edema and a necrotic cavity. A second microneurosurgery was done: opening the dura 5 levels, duraplasty and opening the spinal cord in the midline and debridement of the necrotic tissue .

Results: Complete SCI cases had a specific pattern of values of pNF-H correlated with the MRI and the clinical evolution. A second microneurosurgery solved the cord edema and the spinal cord laceration. One case has improved progressively after 6 months and the other case - no neurological improvement after one year of rehabilitation.

Conclusions: Patients must undergo surgery during the first 24 hours: a large decompression on 5 – 7 levels with duraplasty and stabilization. After these we can use the predictive unfavorable pattern of pNF-H correlated with MRI and a second microneurosurgery in SCI site must be done: opening the spinal cord in the midline and microsurgical debridement of the necrotic tissue. This surgical attitude can create favorable conditions for functional recovery of the remaining spinal cord.

GO284. A Systematic Review of the Measurement Properties of Patient-Reported Outcome Measures in Spinal Cord Injury

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Introduction: Over the past decades, a large number of patient-reported outcome measures (PROMs) have been developed for use in spinal cord injury (SCI) research and practice, which evaluate the patient's own perceptions and opinions. However, little is known about the measurement properties of the PROMs used in this population. The objectives of this systematic review were to appraise the methodological quality of the studies on reliability, validity, responsiveness and interpretability of the patient-reported SCI outcome measures and to evaluate and summarize the quality of the measurement instruments.

Material and Methods: A systematic search of literature in EMBASE, MEDLINE, PsycINFO and CINAHL was performed. Articles were included when they concerned the development of PROMs or the evaluation of their measurement properties in SCI population. Methodological quality of the studies was evaluated using the four-point rating system of the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) checklist. The overall quality of the measurement instruments was rated using a pre-defined criteria. The selection process, data extraction and quality assessment were performed by two independent reviewers and disagreements were resolved by consensus. In case of remaining controversy, a third reviewer made the final decisions.

Results: A total of 9337 articles were screened for eligibility. A wide variety of PROMs measuring different constructs, including quality of life, participation, physical activity, rehabilitation needs, pain, and spasticity were identified. Reliability was the most frequently evaluated measurement property. There was a paucity of literature addressing the responsiveness, measurement error, content and cross-cultural validity of the PROMs. The methodological quality of a majority of the studies was fair to poor and small sample size was a common drawback among the low quality studies. There were many validity studies with indeterminate results due to lack of pre-defined hypotheses.

Conclusion: There is an urgent need for high quality studies on measurement properties of PROMs in SCI population. Considering the importance of scientifically sound measurements, cautious use of the PROMs is advised until further evidence is available.

GO285. Traumatic Spinal Cord Injury: the Impact of Timing. A Prospective Cohort Study to Evaluate Outcomes after Early Surgery (and Reasons for Delays)

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Introduction: Traumatic spinal cord injury (tSCI) is a devastating condition affecting mostly young adults.[1] Unfortunately, to date there are no standardized guidelines for treating these patients in the early phase and initial management can vary widely.[2] Surgical decompression is considered to be a valid approach, however conclusive data regarding the best timing to perform it are still missing.[3] The STASCIS trial evaluated the effect of surgical decompression pre- or 24 hours post-injury,[4] however some aspects of its design have been criticized. The clinical study SCI-POEM aims to fill the gap of missing evidence by comparing the effect of early ($<$12 hour after injury) versus delayed (12 hour to 14 days after injury) surgical treatment.[5]

Material and Methods: This is a prospective, multicenter, cohort study to test the superiority of early versus late surgery measured by the American Spinal Injury Association (ASIA) lower extremity motor score (ASIALEMS) pre-surgery and after 1 year. Inclusion criteria: Patients $>$ 18 years old with tSCI, AIS grade A-D and indication of surgical management by the treating physician. To detect 6 points of difference in ASIALEMS with a power of 80%, a total of 300 patients are planned to be recruited in 17 clinics in 12 European countries within 3 years, assuming a 1:2 ratio of early vs delayed surgeries. Secondary outcome measures include different functional outcome scores and adverse events. Details about work, injury, main reason associated with a delayed surgery and steroid use are also collected.

Results: The study started recruitment in March 2013 and until August 2015, 137 eligible patients had been enrolled: 112 (81.8%) men and 25 (18.2%) woman with ages ranging from 18 to 89. Mechanism of injury was low energy trauma in 42 (30.7%) cases and high energy trauma in 95 (69.3%) cases. In 67 (48.9%) patients, traumatic lesion occurred at a single level. One third of cases suffered a complete spinal cord injury (ASIA A, postsurgery measurement). About 50% of decompression surgeries were performed within 12 hour after injury. Unwanted delays for tSCI treatment (as judged by the local investigator) occurred in 36 (26.3%) cases, of which 25 (69.5%) were caused by logistical issues (bed or imaging availability, transfer, etc) and 11 (30.5%) were due to medical reasons.

Conclusion: In our study, nearly two third of the cases had an incomplete spinal cord lesion (ASIA B-D), which highlights the relevance of appropriate and timely treatment to improve this situation. Strikingly, the actual rate of early vs delayed surgery is better than the anticipated 1:2 ratio. Even though 50% of the patients underwent early decompression, there was a considerable number of unwanted delays in the treatment of tSCI patients. The reasons for these delays are in most cases due to circumstances beyond the physician's control, such as time for transfer, availability of material resources or the medical condition of the patient. This

information is important for future resource planning and suggests that improvements in material resources are needed across Europe.

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GO286. Diagnostic Work-Up and Treatment of Traumatic Spondylolisthesis of the Axis: Case Series and Literature Review

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Introduction: Traumatic spondylolisthesis of the axis represents a spectrum of injuries affecting the C2-C3 level, secondary to bilateral fracture of the pars of C2 due to extension and/or compression forces. The integrity of the C2-C3 disc and the posterior longitudinal ligament are key elements for segmental stability and should be thoroughly assessed before deciding the treatment modality. The aim of this study is to describe the diagnostic work-up and treatment decision in a case series of patients with traumatic spondylolisthesis of the axis. We also present a review of the available literature about this type of injuries.

Material and Methods: We reviewed the medical records and images of patients with a traumatic spondylolisthesis of the axis treated in two centers between January 2008 and March 2015. Details regarding demographics, injury mechanism, type of lesion (using the Levine & Edwards classification) and treatment modality (surgical or non-surgical and its justification) were analyzed. We also performed a literature review, focusing on the diagnosis and treatment of these injuries.

Results: Case series including 7 patients (4 males, mean age at the time of the injury of 37.9 years [23–55]). Six patients (85.7%) were injured in a motor vehicle accident and 28.6% (2/7) presented other spine fractures. All of the patients were neurologically intact. Five cases (71.4%) had a type I injury. Magnetic resonance imaging was obtained as part of the initial assessment in 5 patients (71.4%), none of these patients were considered to have a disrupted posterior longitudinal ligament, while 2 (28.6%) presented hyper intensity at the C2-C3 disc on T2-weigthed images. Surgery was promptly indicated only in one case (type III lesion with a disrupted C2-C3 disc on magnetic resonance imaging, in which an instrumented posterior C2-C3 fusion was performed). The remaining 6 patients (85.7%) were originally treated non-surgically with a hard collar, but 2 of them (both with type I injuries) had surgery one week after the accident (one anterior and one posterior instrumented C2-C3 fusion) due to progressive listhesis and angulation at the C2-C3 level. No treatment-related complications were identified in both surgically and non-surgically treated patients. The available literature emphasizes the importance of the assessment of the C2-C3 disc and the posterior longitudinal ligament via magnetic resonance imaging before deciding the treatment modality in these patients.

Conclusion: Initial imaging work-up, particularly regarding the C2-C3 disc and posterior longitudinal ligament´s integrity on magnetic resonance imaging, together with close radiological follow-up are key elements to consider in the treatment of traumatic spondylolisthesis of the axis.

GO287. Efficacy and Safety of Riluzole in Acute Spinal Cord Injury (SCI). Rationale and Design of AOSpine Phase III Multicenter Double Blinded Randomized Controlled Trial. (RISCIS)

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Introduction: There is convincing evidence from the preclinical realm that the pharmacologic agent riluzole attenuates certain aspects of the secondary injury cascade leading to diminished neurological tissue destruction in animal SCI models. The safety and pharmacokinetic profile of riluzole have been studied in a multicenter pilot study in 36 patients. Efficacy of riluzole in acute human SCI has not been established

Material and Methods: This ongoing multi-center, international double-blinded phase III RCT will enroll 351 patients with acute C4—C8 SCI and ASIA Impairment Grade A, B or C randomized 1:1 to riluzole and placebo. Primary outcome is the change in ASIA Motor Score (AMS) between baseline and 180 days. Other outcomes include ASIA Upper and Lower Extremity MS; ASIA Sensory Score; ASIA grade; SCIM); SF-36v2; EQ-5D and GRASSP. Two-stage sequential adaptive trial statistical design has 90% power to detect 9 points difference in the ASIA Motor Score at one-sided $\alpha = 0.025$.

Results: A matched cohort analysis performed in the Phase I study showed that riluzole treated cervical SCI patients experienced an additional 15.5 points in AMS recovery at 90 days post injury. Although the phase I study was underpowered to investigate efficacy the current phase III study is poised to definitive address this question. Subject enrollment for this trial began on October 1, 2013 in 11 international centers. To date, 31 subjects have been enrolled. Average age of the enrolled subjects is 49 years (SD 16.9); 83.9% males. ASIA at arrival and Pre-Injury status, ASIA Grade A (45%), B (29%), C (26%). GRASSP 54.1 (SD 12.8), SF35v2 PCS 52.6 (SD 9.0) SF36v2 MCS 55.6 (SD 12.8).

Conclusion: This is a Phase III study of riluzole in acute SCI.

Cervical Surgery

GO288. Fulfillment of Patient Expectations Two Years after Cervical Spine Surgery

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Introduction: Patients have multiple expectations of cervical spine surgery that encompass physical and psychological well-being. Assessment of fulfillment of expectations is an important but infrequently studied outcome. The objective of this study was to compare patients' preoperatively cited expectations with their postoperative ratings of fulfillment of expectations.

Materials and Methods: A longitudinal cohort study with 2 year follow-up at a tertiary spine center was conducted of 133 patients before and 2 years after surgery.150 patients preoperatively completed a valid survey measuring amount of improvement expected from cervical surgery for 20 items addressing symptoms, function, and mental well-being. Function was measured with the Neck Disability Index (NDI), and psychosocial variables, including depressive symptoms, were measured with valid scales. Two years after surgery patients were asked how much improvement they actually received for items listed in the survey. The proportion of fulfilled expectations was calculated as the sum of improvement received divided by the sum of improvement expected (0%= expectations completely unfulfilled, 100%=expectations completely fulfilled, >100%= expectations surpassed). Additional patient-centered postoperative variables were the NDI and overall satisfaction with the outcome of surgery.

Results: 149 patients were contacted 2.1 years postoperatively (range 1.9–2.7 years). Of these 133 participated in a postop interview and rated fulfillment of expectations (mean age 54 years, 62% men, 67% had radiculopathy, 26% had myelopathy, and 7% had other conditions). Mean proportion of fulfilled expectations was 78% (range 0–216%). Greater preoperative expectations were associated with lower proportions of fulfilled expectations postoperatively (p=.001). Having revision surgery also was associated with a lower proportion of fulfilled expectations (58% versus 82%, p=.03). Postoperative variables associated with lower proportions of fulfilled expectations were less pre-to-postoperative improvement in NDI scores (51% versus 91%, $p < .0001$) and more depressive symptoms (31% versus 88%, $p < .0001$). Prolonged dysphagia after surgery (i.e., to more than 6 months) also was associated with a lower proportion of fulfilled expectations (60% versus 80%). There were no differences based on age, sex, use of narcotics, or number of vertebral levels involved. Although preoperative expectations were higher in patients with radioculopathy versus myelopathy, the percent of fulfilled expectations was similar (77% versus 81%, p=.61). Overall 83% of patients were satisfied with the results of surgery; the proportion of expectations fulfilled was highly, but not completely, associated with satisfaction (r=.61).

*Conclusion***s:** Fulfillment of expectations varied widely two years after cervical spine surgery but most expectations were fulfilled. Patients with greater preoperative expectations were more likely to have lower proportions of fulfilled expectations postoperatively. Both pre- and postoperative functional and surgical variables were associated with fulfillment of expectations. Fulfillment of expectations and satisfaction were associated but remained distinct patient-centered outcomes.

GO289. Does Improvement of Spine Alignment Lead to Relief of Neck Pain Associated with Scoliosis at Adults?

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Introduction: Patients with scoliosis complain of neck pain very often. MRI demonstrates an availability of disc degenerative disease without the compression of the neural structures. The purpose of research determines correlation between the improvement of spine alignment and the relief of neck pain.

Material and Methods: This retrospective study evaluated 38 patients underwent the correction of the deformity and multilevel fusion surgery and from 2005 to 2012 for the treatment of AIS. There were 58% females. Mean age of 38 years (range 20–55). Mean follow-up of 3 years (2–5 years). Long cassette standing anteroposterior and lateral radiographs were performed on the preoperative, postoperative and follow-up visits. In all cases we studied preoperative, postoperative, and follow up sagittal plane alignment according to Schwab sagittal modifiers and coronal plane to all the patients. Degenerative disc disease of grade I-II was confirmed by MRI (Pfirrmann classification). All our patients before surgery treatment besides main complains inform about neck pain. The patients were divided into two groups depending on changes of spine alignment after surgery. Was evaluated sagittal (Sagittal vertical axis), coronal balance (central sacral vertical line). Visual Analog Scale (VAS) was used for evaluating of the neck pain, all 38 patients rated neck pain more than moderate (VAS > 5). Full correction of sagittal balance (postoperative SVA: N) was achieved at the first group for all 21 patients and 12 of them didn't achieved satisfactory results of coronal balance (CSVL > 2 cm). There were 17 patients at the second group. The correction of sagittal balance for everyone at the 2nd group wasn't complete (SVA: P, VP) and 11 patients got good correction of the coronal balance (CSVL < 2 cm).

Results: One year after surgery 78% ($n = 7$, $p > 0{,}05$) from sagittal and coronal balanced patients of the second group ($n = 9$, $p > 0.05$) evaluated reduce of the neck pain (VAS < 5). 9 of the 12 patients with coronal imbalance reported worsening of neck pain (VAS > 8). All patients from the second group also demonstrated remaining of neck pain. But all patients with full correction of coronal balance ($n = 11$) got reduction of pain intensity, neck pain was evaluated less then moderate (VAS < 5). In both groups patients with coronal imbalance demonstrated worse results about current of neck pain, despite the good result of sagittal balance ($p > 0.05$). And patients with sagittal imbalance, but balanced in a coronal plane got relief of pain. Follow-up studying (2–5 years) demonstrated progression of degenerative disk disease, confirmed using MRI (detection grade IV degenerative changes of discs) followed by surgical treatment of the cervical spine to some patients in both groups. In a first group 14% ($n = 3$, $p > 0.05$). In a second group 12% ($n = 2$, $p > 0.05$). There are slightly higher in the first group, but we did not get significant difference between groups ($p > 0.05$).

Conclusion: Correction of coronal balance is very important for the surgery treatment of the adult patients with scoliosis associated with degenerative disk disease of cervical spine. A greater number of such cases are required for obtain of the reliable results.

GO290. Quality of Life and Functional Outcomes after Surgical Decompression in Patients with Cervical Ossification of the Posterior Longitudinal Ligament: Results from the Prospective, Multicenter AOSpine International Study on 479 Patients

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Introduction: Degenerative cervical myelopathy (DCM) is an umbrella term that includes cervical spondylotic myelopathy, ossification of the posterior longitudinal ligament (OPLL) and other forms of degenerative changes to the spinal axis. The surgical management of OPLL can be technically challenging for spine surgeons and may result in a higher incidence of perioperative complications than surgery for other forms of DCM. It is unclear whether surgery is equally effective and safe in patients with OPLL as it is in other forms of DCM. This study aims to compare the impact of cervical decompressive surgery on functional status and Quality of Life (QOL) outcomes in patients with OPLL and those with other forms of DCM.

Material and Methods: 479 surgical patients with symptomatic DCM were prospectively enrolled in the CSM-International study at global 16 sites. Patients' functional and neurological status were evaluated using the modified Japanese Orthopedic Assessment scale (mJOA) and the Nurick score. QOL was assessed using patient-reported outcome measures, including the Neck Disability Index (NDI) and the Short- Form 36 (SF-36) Health Survey. Improvements in functional status and QOL were assessed between baseline and 1- and 2-year follow-ups, and relative gains were compared between patients with and without OPLL. A sub-analysis was conducted in patients with "severe" myelopathy (a preoperative mJOA < 12) to determine whether surgical outcomes differed between patients with severe OPLL and those with other forms of severe DCM. Improvements in preoperative functional status and QOL at 2-years follow-up were compared between the two diagnosis groups, while controlling for relevant confounding variables.

Results: Of 479 patients, 135 (28.2%) exhibited evidence of OPLL and 344 (71.8%) displayed other forms of degenerative changes. There were no significant differences in demographics, surgical approach, or baseline severity scores between patients with OPLL and those with other forms of DCM. Patients with OPLL achieved similar functional outcomes at 1- and 2-years following surgery when compared with patients with other forms of DCM. With respect to QOL, the NDI and most subscales of the SF-36, there were no differences between the two diagnosis groups. However, the SF-36 Role Limitation Physical subscale ($p = 0.0091$) at 1-year and the SF-36 Social Functioning subscale at 1- and 2-years ($p = 0.014$, $p = 0.018$) were significantly lower in OPLL patients. In patients with severe myelopathy (preoperative mJOA < 12), 49 (28.65%) presented with OPLL and 122 (71.35%) with other forms of DCM. There were comparable improvements between preoperative and 2-year postoperative scores across all outcome measures (mJOA, Nurick, NDI, and SF-36) in patients with severe myelopathy due to OPLL and other forms of DCM. Finally, there was a significantly higher rate of perioperative complications in the OPLL group ($p = 0.054$). This significant difference was mainly due to a higher incidence of superficial infection ($p = 0.0067$), new neck pain ($p = 0.079$) and dural tear ($p = 0.076$) in the OPLL group. However, rates of neurological complication did not significantly differ ($p = 0.73$).

Conclusion: Surgical decompression for the treatment of OPLL results in significant improvements in functional status and QOL, comparable to gains seen in other forms of DCM.

GO291. Safety and Efficacy of Anterior Cervical Discectomy and Fusion with Stand-alone Polyetheretherketone (PEEK) Cages

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Aim: To evaluate long-term results after one- and two-level anterior cervical discectomy and fusion (ACDF) with stand-alone polyetheretherketone (PEEK) cages.

Methods: We performed a retrospective review of a consecutive patient cohort with degenerative disc disease that underwent ACDF with stand-alone PEEK cages between 2007 and 2013 with a minimum follow-up of 12 months. Radiographic follow-up included static and flexion/extension radiographs. Changes in the operated segments were measured and compared with radiographs directly after surgery. Clinical outcome was evaluated by a physical examination, pain visual analog scale (VAS) and health-related quality of life (HRQL) using the EuroQOL questionnaire (EQ-5D).

Results: Of 667 consecutive cases, 554 met all inclusion criteria. Follow-up data were obtained from 439 (79.2%) cases. The mean age at presentation was 55 years and 237 patients were male (54%). 220 and 219 patients had one- and two-level surgeries, respectively; 220 (50%) presented with spondylotic cervical myelopathy and 219 (50%) with cervical radiculopathy. Fusion was achieved in 85.9% and 86.3% of segments in one- and two-level surgeries, respectively. Cervical alignment was better in 37% and 40%, same 32% and 43%, worse in 30% and 17% in one- and two- level surgeries, respectively. Subsidence was observed in 27.7% and 26.5% of segments in one- and two-level surgeries, respectively. Follow-up operations for symptomatic adjacent disc disease and implant failure at index level were needed in 34 (7.7%) and 22 (5%) cases, respectively. Mean VAS declined from 5.3 ± 3.5 to 2.6 ± 2.3 ($p < 0.001$) and 4.5 ± 3.7 to 2 ± 2.5 ($p < 0.001$) for neck and arm pain, respectively. Health-related quality of life (HRQL) as measured by the EuroQOL questionnaire (EQ-5D) improved most cases.

*Conclusion***s:** One and two level ACDF with stand-alone PEEK cages achieved very high fusion rates and a low rate of follow-up operations. The rate of good clinical outcome is highly satisfactory.

GO292. Dysphagia Due to Ossification of the Cervical Anterior Longitudinal Ligament. Report of Three Cases

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Introduction: Symptomatic ossification of the anterior longitudinal ligament is rarely pathology. Diffuse idiopathic skeletal hyperostosis (DISH) is a common condition in the aging spine. DISH, also called with the eponym Forestier's disease, is a clinical syndrome characterized by the abnormal formation of osteopytes involving the spine. These are largely asymptomatic, however are recognized as an unusual cause of dysphagia, which may occur secondary to the mechanical compression with partial obstruction or perioesophageal inflammation caused by pharyngo- esophageal motion over the osteophytes. Dysphagia is reported in up to 28% of patients. Surgical treatment is advocated only after failure of conservative therapies. Conversely, in absence of relevant

clinical signs due to the presence of DISH, surgery is not considered mandatory. However, surgical resection of the osteophyte has been reported to be an effective treatment for severe cases. Therefore, from 1995, we started to observe long-term postoperative courses of DISH patients with recalcitrant dysphagia who underwent surgical resection of osteophytes. The purpose of this study was to examine these surgical outcomes and literature review.

Material and Methods: Case 1. A 70-year-old man referred to our clinic because of progressive dysphagia for solids and liquids and cervical pain. A lateral cervical spinal X-ray and cervical MRI revealed giant cervical osteophytes at the ventral portion of the C 2/3/4 vertebral bodies and contiguous calcification of the anterolateral cervical vertebral bodies. *Case 2*. A 57-year-old man presented with a 1.5-year history of increased difficulty swallowing. A plain lateral radiograph revealed OALL ventral to the C3–5 vertebral bodies. Three-dimensional computerized tomography studies further demonstrated extensive C3–5 OALL. *Case 3*. A 75-year-old white man was seen at Hospital with the main complain of increased difficulty in swallowing solid food over the past two years. Routine cervical spine films revealed prodigious osteophytes of the cervical spine involving the bodies of C-2, C-3, C-4, C-5 and C-6 consistent with DISH. A magnetic resonance imaging (MRI) scan of the cervical spine revealed an elongated ossification of the frontal planes of the vertebral bodies, with spurs projecting into the soft tissues of the neck.

Results: The three patients underwent uneventful operative excision of the anterior cervical osteophytes. Surgery was performed with an anterolateral approach. They had marked improvement in swallowing function and were able to resume a normal diet after one to two months.

Conclusion: Diffuse idiopathic skeletal hyperostosis or Forestier's disease is an uncommon etiology of progressive dysphagia. This unrecognized condition may provide a new challenge for spine surgeons who are not as familiar with DISH as rheumatologists. Surgical decompression through osteophytectomy is effective for patients who fail conservative treatment

GO293. Study of Functional Outcome of Anterior Cervical Decompression and Fusion Using Tricortical Iliac Bone Graft for Degenerative Cervical Spondylotic Myelopathy with Modified Japanese Orthopedic Association Score

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Objective: To determine functional outcome of anterior cervical decompression and fusion using tricortical iliac bone graft (ACDF) for degenerative cervical spondylotic myelopathy with modified Japanese orthopedic association score (MJOA).

Materials and Methods: 60 diagnosed cases of one and two levels cervical myelopathy were prospectively analyzed preoperatively and at 3 months, 6 months, 1 year using MJOA.

Results: 46 patients underwent Single level ACDF with C5-C6 the commonest level to be affected. The correlation between Duration of Symptoms to Preoperative and postoperative MJOA was statistically significant. We noted statistically significant improvement in symptoms of axial neck pain, radicular arm pain, clumsy hand, and gait disturbances post operatively at one year. Statically significant difference was noted while comparison MJOA of Pre-operative to 6 months and 1 year, and 3 months to 6 months and 1 year. Statistically significant difference in blood loss and anesthesia time for one level fusion compared with two level fusions was also noted. The fusion rate for single level ACDF was 95.65% compared 71.42% for two levels.

Conclusion: Functional outcomes in operated patients at 1-year follow up are better if ACDF surgery is done early. Symptoms of axial neck pain; radicular arm pain, clumsy hand and gait disturbances show significant improvement at one year follow up. While bladder and bowel involvement showed the least recovery. Significant improvement in function occurs postoperatively between 3 and 6 months, and then it plateaus from 6 months to 1 year. Fusion rates for single level ACDF are better than two levels ACDF.

GO294. Role of Spinal Diffusion Tensor Imaging in Predicting Post-operative Outcome in Cervical Degenerative Pathologies

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Introduction: Predicting post-operative recovery after surgery for cervical spondylotic myelopathy (CSM) is challenging. The authors performed a systematic review of the literature evaluating the diagnostic ability of DTI in CSM, and its ability to predict post-operative outcome.

Material and Methods: A systematic PubMED search adherent to PRISMA guidelines included relevant clinical studies reporting use of DTI in adult humans undergoing operative management for CSM from 1980 onwards. Available data on pre-operative clinical status and imaging and post-operative clinical outcomes were abstracted.

Results: Six of 562 studies were eligible for detailed review. There were 112 patients with CSM and 45 healthy controls. Seventy-three (59.8%) underwent operative management with mean follow-up time 90–730 days . Fractional anisotropy (FA) was significantly lower in patients compared with controls across multiple studies, and correlated with pre-operative assessment (modified Japanese Outcome Assessment). FA and fiber tractography ratio (FTR) correlated with post-operative clinical assessments, with FA independently predicted surgical need and good outcome post-operatively.

Conclusion: DTI may be a valuable tool in identifying patients in need of surgical decompression and predicting post-operative outcome. Future prospective studies are required for choosing optimal DTI parameters, anatomic levels and acquisition techniques.

GO295. Single-Level, Multi-Level (Two, Three and Four Levels) and Hybrid Cervical Disc Arthroplasty: Age and Sex-Weighted Linear Regression Analysis, Results from a Single Centre

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Introduction: The clinical outcomes of single, multi-level and Hybrid cervical disc arthroplasty are reported in the literature. However, there is less detail on the outcome results related to age and sex on these groups. We reviewed 405 patients who had single level, multi-level (two, three & four) and Hybrid cervical disc arthroplasty at our center.

Methods: The study involved a retrospective review of prospectively collected data on single level, multi-level (two, three & four) and Hybrid cervical disc arthroplasty patients

with an average age of 54.64 (range: 34–80). 405 patients were followed up for 2 to 8 years based on clinical outcomes scores. These included NDI (Neck Disability Index), Visual Analogue score for Neck (VAS Neck), and Visual Analogue score for Arm (VAS Arm). Scores were collected pre-operatively and at each follow up at 3 months, 6 months, 1st and yearly afterwards. Linear Regression Analysis was performed to look at the impact of age and Two sample T-Test was used to look at the difference between males and females.

Results: The study consisted of 215 females and 190 males. The duration of symptoms was on an average 60 months. The indication for surgery was radiculopathy and a combination of radiculopathy and myelopathy. Linear Regression Analysis for NDI and age showed a Pearson correlation r of 0.002; P Value: 0.968; for sex difference - P value of 0.730 showed no statistically significant differences between male and female groups. For VAS Neck, the Pearson correlation was r = 0.008; P Value: 0.873; for sex difference – P value of 0.178 showed no statistically significant differences between male and female groups. For VAS Arm, the Pearson correlation was r = 0.064; P Value: 0.198; for sex difference – P value of 0.953 showed no statistically significant differences between male and females.

Conclusion: Our results suggest that there is no correlation between age of the patient and their NDI, VAS Neck and VAS Arm scores for all groups of Cervical Disc Arthroplasty. Similarly, there were no statistically significant differences in the outcomes between males and females.

GO296. Successful Treatment of Severe Occipitocervical Pain from C1-C2 Osteoarthritis Using a Modified Harms Technique

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Introduction: C1-C2 fusion with instrumentation is an established treatment for C1-C2 instability due to trauma or inflammatory disease. C1-C2 fusion for debilitating occipitocervical pain secondary to C1-C2 osteoarthritis has been reported in a small number of patients. Here we report the successful treatment of three patients that underwent C1-C2 instrumented fusion using a modified Harm's technique for medically refractory occipitocervical pain.

Materials and Methods: Between August 2012 and July 2015, three consecutive patients with debilitating, unilateral occipitocervical pain and radiographic C1–2 osteoarthritis, underwent posterior instrumented C1-C2 arthrodesis using bilateral polyaxial C1 lateral mass and C2 pedicle screw and rod constructs (modified Harms technique). All three patients failed preoperative conservative treatment including therapy, medical management and interventional pain management including facet joint injections. In all three patients, the source of occipitocervical pain was confirmed preoperatively with direct C1-C2 joint injection using 0.5ml of a mixture of 2% lidocaine/0.5% Marcaine/10mg kenalog. All three patients had immediate but temporary relief of their occipitocervical pain from the diagnostic C1-C2 joint injection. Preoperative CT scan confirmed the presence of C1-C2 osteoarthritis on the symptomatic side. Outcome measures include pre and post-operative VAS, patient reported resolution of pain, hospital LOS, EBL and complications.

Results: Each of the three patients surgically treated had complete resolution (100%) of their preoperative occipitocervical pain beginning immediately after instrumented posterior fusion of C1–2. Average VAS improved from 8.3 preoperatively to 0.0 postoperative for the cohort. Average follow up is 33 months. Average age for the group at the time of surgery was 75 years old and the M:F ratio is 1:2. Hospital LOS was 1 day for each patient. EBL was 45ml on average with a range of 15ml - 75ml. There were no postoperative complications.

Conclusions: Instrumented posterior C1-C2 fusion, using a modified Harms technique, is a safe and effective treatment for refractory occipitocervical pain secondary to C1-C2 osteoarthritis. The source of pain should be confirmed preoperatively with both CT scan and diagnostic joint injection.

Deformity Thoracolumbar Adult 3

GO297. Reduced Rate of Proximal Junctional Fractures Above Long-Segment Instrumented Constructs Utilizing a Tapered Dose of Bone Cement for Prophylactic Vertebroplasty, A Biomechanical Investigation

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Introduction: PJK is a well-described post-operative complication associated with long instrumented fusion constructs. The surgical creation of a stiff upper segment along with patient osteoporosis has been suggested as etiologies.

Materials and Methods: Fifteen fresh-frozen ligamentous T6 - pelvis specimens were divided equally into three Groups: Group 1 - Bilateral pedicle screw and rod instrumentation from T10 to S1, no cement; Group 2 - Instrumentation + 4cc of cement injected into T10 (UIV) and 4cc into T9 (UIV + 1), 2cc of cement injected through each pedicle; & Group 3 - Instrumentation + 4cc of cement in T10 (UIV), 3cc total in T9 (UIV + 1), and 2cc total in T8 (UIV + 2). The pelvis and T6 vertebra were potted. Eccentric axial compression was applied 10mm anterior to the center of T6 using an MTS actuator. Maximum load to failure was measured in newtons (N). The spines were evaluated using fluoroscopy and CT.

Results: There was a significant reduction in the number of fractures in Group 3 versus Groups 2 and 1 ($p = 0.0019$). There was only one fracture in Group 3, which occurred at T8 (UIV + 2); all five specimens suffered a fracture in Group 2; and five in Group 1. Posterior ligamentous rupture occurred in four specimens in Group 3; three in Group 2; and only one in Group 1. The mean peak load-to-failure values showed an increasing trend from Groups 1 to 3 ($p = 0.38$). There was no difference in specimen DEXA values ($p = 0.71$). There was no hardware failure in any Group. FEA mirrored the cadaveric data and the maximum load to failure increased from Group 1 to 3. Endplate stresses were reduced in Group 3 versus Groups 1 and 2.

Conclusions: In both cadaveric and FEA models, this novel technique of tapering the dose of prophylactic vertebroplasty cement in the UIV, UIV + 1, UIV + 2 decreased the endplate stresses, increased the load required for failure, and significantly reduced the incidence of VCFs above long-segment instrumented constructs. Clinically, this technique may reduce the risk of PJK, PJF, and revision surgery.

GO298. Impact of the Intraoperative Neurophysiologic Monitoring in Idiopathic Scoliosis Surgery

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Objective: The aim of this study is to analyze the use of intraoperative neurophysiological monitoring (MNIO) in idiopathic scoliosis correction surgery.

Methods: Retrospective study of 80 patients undergoing idiopathic scoliosis correction surgery between December 2008 and January 2015 using the MNIO. Among the patients, 85% were female ($n = 68$) and 15% males ($n = 12$), the average age on the day of surgery was 17 years and the prevalent type of scoliosis curve classification was Lenke 1-A-N (37.5% / $n = 30$). We reviewed the significant changes in MNIO, duration of surgery, number of pedicle screws needed to correct deformities, screw time, onset of neurological deficits, Coob angle and effectiveness of MNIO.

Results: There were significant changes or loss of the MNIO data in 15 patients (18.75%). Complete recovery after intervention was seen in 12 patients (80%). Three patients (20%) had some neurological deficit in the immediate postoperative period. The mean duration of surgery was 320.76 minutes and were used on average 18.84 screws to correct deformities, with an average time of 8.27 minutes for the passage of each pedicle screw. The thoracic curves averaged 52.80 degrees and 47.40 degrees for lumbar curves.

Conclusion: Long constructions, osteotomies and more severe curves are related to most of the changes found in evoked potentials. The joint use of somatosensory evoked potentials and motor allows a direct evaluation of sensory and motor functions of the spinal cord and dramatically increased the sensitivity and specificity in the detection of neurophysiological changes, helping in decision making during surgery. The interpretation in real time by neurophysiologist possible interruption of operations by temporarily verge of nerve injury with immediate change of the surgical strategy.

Keywords: column, idiopathic scoliosis, intraoperative neurophysiological monitoring, deformity correction surgery, thoracic/lumbar vertebrae

GO299. What Extent a Higher Implants Density Gives More Correction? Correlation of Scoliosis Curve Correction with the Type and Density of Implants

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Introduction: Corrective Surgery for Adolescent Idiopathic Scoliosis (AIS) has evolved with the utilization of more sophisticated implants and higher implants density looking forward a better correction though a posterior approach. But, is this correction myth or reality? Our objective is to analyze the relationship between implant density and deformity correction, comparing two different instrumentations.

Materials and Methods: A retrospective cohort study was performed using patients from the database of our institution between 2009–2012. Inclusion criteria were diagnosis of AIS, age between 12–18 year-old, surgeries performed in our institution, complete radiological study and a minimum follow-up of two years. No curve restriction was considered. Analysis of radiology was done in three different moments for each patient: pre-op, first control after surgery and one year follow-up. Coronal and sagittal parameters were considered to evaluate deformity severity. Pre-op bending X-rays were analyzed for flexibility measurement. Post-operatively they were measured implant density for each group, fusion levels and deformity correction for both coronal and sagittal planes. Patients were classified following Lenke and divided in two groups: all pedicle screws instrumentation (APS) and hybrid instrumentation (HY). Statistical study was made using the T-Student test to analyze differences between cohorts and Pearson´s Test for correlating variables.

Results: They were collected in total 82 cases, 67 of which were females. The mean age was 16 year-old. The 61% of total patients presented a Lenke type 1 curve. 35 patients were treated with APS instrumentation and 47 using a HY construction. Values for Cobb angle, flexibility and T5-T12 kyphosis pre-op were homogeneous between both groups. Post-operatively there were no significant statistical differences comparing fusion levels and percentage of coronal deformity correction between the two groups. Nevertheless, they were remarkable the 40% of implant density difference and the higher loss of kyphosis in APS group as compared with HY. Pearson´s test evidenced that, in general, the only variable, which was statistically significant correlated with a higher coronal deformity correction, was pre-op flexibility; not implant density, fusion levels or type of instrumentation used. Significant differences were found comparing loss of thoracic kyphosis after surgery between groups, finding a significant correlation which indicated that using pedicle screws the higher implant density used, the bigger the loss of kyphosis. Loss of kyphosis was not statistically significant when correlated with percentage of coronal deformity correction. One-year follow-up X-ray did not show significant differences when values of Cobb angle and thoracic kyphosis were analyzed among groups.

Conclusions: Both hybrid and all pedicle screws instrumentations achieve equal coronal deformity correction operating on flexible curves, we do not obtain a bigger deformity correction with a higher implant density all pedicle screws instrumentation produce a higher loss of thoracic kyphosis.

GO300. The Establishment of a Predictive Model for Major Postoperative Complications in Spine Deformity Surgery and Evaluation of Its Clinical Application

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Introduction: Spinal orthopedic surgery is a risky method for the treatment of spinal deformity. Over the past years, despite of the remarkable progress in the field of spinal surgery, the major complications from spinal surgery still occur. The aim of this study was to establish a predictive model (The Chaoyang risk score) for major complications after surgery to treat spine deformity disease and evaluate its effect for clinical application.

Methods: Data were collected retrospectively from 245 consecutive patients who underwent surgery for spine deformity disease. We defined the major postoperative complications as the occurrence of infection, nerve injury, organ dysfunction, or death after surgery. The logistic coefficient, and the additive score by odds ratio was used to calculate logistic score. The Chaoyang risk score were applied to predict Postoperative Complications. A C statistic (receiver operating characteristic curve) was used to test discrimination of the model. Calibration was assessed by Hosmer-Lemeshow goodness-of-fit statistic.

Results: The result of logistic regression showed that preoperative nerve injury, medical history of spine deformity (> 10years), time of surgery(>5hours), Maximal voluntary ventilation observed/predicted < 50%, intraoperative osteotomy were independent factors for the complications. The simple logistic model of the Postoperative Complications risk score showed very good discriminatory ability (C statistic=0.866 > 0.75) and calibration (Hosmer-Lemeshow, $p = 0.978 > 0.05$) in predicting Postoperative Complications.

Conclusion: The logistic algorithm of the Postoperative Complications risk score is a simple, objective, convenient and accurate scoring system which may be used to predict Complications after surgery to treat scoliosis disease.

Keywords: spine deformity, predictive model, complication

GO301. Prognostic Factors for Curve Progression in De-novo Degenerative Lumbar Scoliosis: A Systematic Review on Observational Studies

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Introduction: De-novo degenerative lumbar scoliosis (DNDLS) causes an increasing burden on society in aging populations, in particular reducing the overall quality of life due to severe back and leg pain. DNDLS has been reported to undergo unpredictable curve progression.[1] To date, little is known about progression in DNDLS and it is unclear what factors play an important role in the process. Indications whether a degenerative scoliotic spine will undergo curve progression forms an ever-increasing challenge for health care providers to determine the optimal timing for therapeutic interventions. Existing reports on this continuously expanding societal problem are inconsistent. Therefore, the aim of this study was to perform a systemic review of the literature to identify prognostic factors for DNDLS curve progression.

Material and Methods: systematic searches were performed in the bibliographic databases PubMed and EMBASE prior to June 2015. The following inclusion criteria were applied: (1) de novo degenerative lumbar scoliosis, (2) adult scoliosis, (3) curve progression, (4) study population of $N \geq 10$, and (5) studies published in the English language. Exclusion criteria were: (1) animal studies, (2) biomechanical studies, (3) prior juvenile, adolescent, associated congenital, developmental, or neuromuscular spinal abnormalities, and (4) history of spinal surgery. Studies that met our inclusion criteria were assessed for methodological quality by two authors (XX and XX) based on: study population, follow-up time, exposure, outcome, and statistical analysis.[2] Data was extracted and presented according to a best evidence synthesis which has been adopted and modified from previous studies on prognostic factors in knee and hip arthritis.[3,4]

Results: The literature search generated a total of 2696 references: 1323 in PubMed and 1373 in EMBASE. After removing duplicates and articles that did not meet inclusion criteria, 12 studies were included. Because a large heterogeneity was encountered in measurement methods, statistical analyses, sample sizes, variations in definition of DNDLS and curve progression, pooling was not possible. In total 33 determinants were obtained and grouped into two categories: patient and radiographic characteristics. Strong evidence indicates that intervertebral disc degeneration, lateral vertebral translation ≥6mm, and an intercrest line through L5 are associated with DNDLS curve progression. Further, moderate evidence suggests that apical vertebral rotation grade II or III is associated with curve progression. For the majority of determinants, limited, conflicting, or inconclusive evidence was found.

Conclusion: Strong evidence was found for several radiographic prognostic factors for DNDLS curve progression. A large variety in definitions of DNDLS and curve progression remains, which made pooling impossible. Additionally, because the sample sizes in the included studies were often small, these results may not be applicable to the individual patient. Large patient registries have shown to provide relevant information about the outcome after surgery for specific patient categories. Similarly, untreated patients with DNDLS should be included in similar registries or long-term prospective trials to be able to identify prognostic factors and to help understand the pathophysiology of curve progression in DNDLS. This is crucial to establish optimal follow-up strategies and timing for therapeutic interventions for this ever-increasing group of patients.

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GO302. Multiple Adjacent Level with Pott's Disease with Sever Vertebral Sequestration (Case Presentation)

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Pott's disease is a known disorder that affects the spine causing various degree of disability for the patients that ranges from mild to severe kyphosis with or without neurological deficits. In most cases single level is affected and in fewer numbers two levels are affected. Rarely more than two levels are affected. In this case we present a case of Pott's disease affecting five adjacent segments with vertebral sequestration. This is 43 years old female patient presented to Assuit university hospital with history of repeated attacks of back pain and mild fever since 4 years the patient received empirical antibiotic after which she said that she partially improved and after then the patient became accustomed to repeat the antibiotic with no medical consultation. Later on the pain became sever but no neurological manifestations then she had X-ray and MRI with diagnosis of long segment vertebral osteomyelitis affecting T7-T12. Posterior costotransversectomy approach was done and the sequestrated vertebral bodies and intervening discs were excised and sent for culture sensitivity and biopsy and mesh cage was applied to bridge the defect and pedicle screws are inserted from T5 to L2, and later on antituberculous regimen was started after the diagnosis was established. Postoperatively the neurological status was intact and the pain improved; 6 month follow up showed good bone healing. Stable cage and pedicle screws and much improvement in the general status of the patient.

GO303. An International Consensus on the Appropriate Treatment for Adults with Spinal Deformity: An AOSpine Knowledge Forum Deformity Study

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Introduction: Appropriate care for adults with spinal deformity should be responsive to considerations of the patient, care provider, and healthcare system. The healthcare burden of adult spinal deformity is increasing significantly and re-operation rates are high (up to 50%). The objective of this study was to identify goals of care and management strategies that are appropriate, reasonable, and inappropriate to guide decision-making and patients' informed choice.

Material and Methods: The AOSpine Knowledge Forum Deformity performed a modified Delphi survey of 53 experienced spine deformity surgeons (panelists) from 24 countries. Panelists rated appropriateness of procedures and management strategies for multiple clinical scenarios. Strategies were rated on a 9-point rating scale, collapsed into three categories: 'inappropriate' - expected negative consequences exceed the expected health benefit; 'reasonable' -balance of risk and benefit is unknown, but there is a reasonable chance of positive benefit; and 'appropriate' -expected health benefit exceeds the expected negative consequences by a wide margin. There were three anonymous web-based surveys and one physical meeting. Consensus was defined as $\geq$70% agreement.

Results: Panelists ranked the most important goals of surgery as; improvement of function, pain, and neural symptoms. Regarding preoperative evaluation, there was consensus that: it is appropriate to record severity and duration of symptoms, previous spinal surgeries, comorbidities (94%), and smoking status (87%) as part of the history; and perform a physical examination including, neurologic examination (96%), vascular status (77%), and hip ROM (92%). Pulmonary and cardiovascular tests are appropriate for patients at risk. It is appropriate to obtain full spine standing radiographs (89%) and MRI for all indications, and BMD (DEXA) for patients with risk factors for osteoporosis ($\geq$89%). Intraoperatively: it is inappropriate to perform a decompression alone where there is a progressive (72%) or large curve (70%) or sagittal imbalance (75%). When long fusion is performed, it is appropriate to instrument to the ilium in large curves, osteoporotic bone, and sagittal imbalance; and inappropriate to fuse to L5 in case of L5-S1 disc degeneration (88%). It is inappropriate to augment the UIV (81%) or UIV+1 (79%) with cement if there is no osteoporosis. Long fusion is appropriate when there is sagittal imbalance (85%) or large curves (87%), when performed; L5-S1 interbody support is appropriate (90%). There was no consensus whether a unilateral decompression alone should be performed in a stable sagittally balanced 30° curve. Grafting with local bone is appropriate, as is neuromonitoring with MEP and SSEP. Postoperatively: mechanical DVT prophylaxis is appropriate for all patients and chemical prophylaxis for high-risk. Return to sedentary work is appropriate within 3 months where $<$ 5 segments are fused.

Conclusion: Management of adult spinal deformity is characterized by significant variability. We have been able to identify several pre-, intra- and post-operative management strategies that constitute (in-) appropriate care based on the consensus of experienced surgeons. Decision-making is driven not only by features of the deformity (e.g., curve magnitude, sagittal imbalance), but also by patient characteristics (e.g., osteoporosis, cardiac comorbidities, smoking) and some factors may indicate that surgery is not appropriate.

GO304. Development of Validated Computer-Based Preoperative Predictive Model for Proximal Junction Failure (PJF) or Clinically Significant PJK with 86% Accuracy based on 510 ASD Patients with 2-year Follow-up

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Introduction: Proximal Junction Failure (PJF) and Proximal Junction Kyphosis (PJK) are significant complications. It remains unclear what are the specific drivers behind the development of either. This study attempts to develop a preoperative predictive model to identify patients at risk to develop PJF or PJK.

Material and Methods: Inclusion criteria: age $\geq$18, adult spinal deformity (ASD), $\geq$4 levels fused. Variables included in the model were: demographics, primary/revision, use of 3-column osteotomy, UIV/LIV levels and anchor (screw, hooks), number of levels fused, and baseline sagittal radiographs (PT, PI, PI-LL, TK, and SVA). PJF was defined as requiring revision for PJK and PJK was defined as an increase from baseline of PJK $>$ 20° and with deterioration by at least 1 SRS-Schwab sagittal modifier grade from 6wks postop. An ensemble of decision trees were constructed using the C5.0 algorithm with 5 different bootstrapped models, and internally

validated via a 70:30 data split for training and testing. Accuracy and the area under a receiver operator characteristic curve (AUC) were calculated. Final model utilized 13 preoperative variables.

Results: 510 patients were included, with 357 for model training and 153 as testing targets (PJF: 37, PJK: 102). The overall model accuracy was 86.3% with an AUC of 0.89 indicating a good model fit. The 6 strongest (importance $\geq$0.95) predictors were (% target): age (>64yrs, 41.4%), PI-LL (>48.7deg, 35.6%), UIV (T10-L3, 35.1%), SVA (>13.5cm, 32.5%), LIV (sacroiliac, 31.6%), and UIV Type (screws, 29.8%). If a patient met these criteria, they had a 66.7% chance of developing PJF or PJK with deterioration of sagittal alignment.

Conclusion: A successful model (86% accuracy, 0.89 AUC) was built predicting either PJF or clinically significant PJK. This model can set the groundwork for preoperative point of care decision making, risk stratification, and need for prophylactic strategies for patients undergoing ASD surgery.

GO305. Transpedicular Wedge Opening (TWO) Osteotomy for Post-Traumatic Kyphosis (PTK): Own Technique and Preliminary Results

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Introduction: Management for symptomatic post-traumatic kyphosis always has presented a challenge to orthopedic surgeons. The management for post-traumatic kyphosis remains controversial: Anterior, posterior, or combined anterior and posterior procedures have been advocated by different authors and show various degrees of success. All of these techniques end in abnormal morphology of the affected vertebra, so in this technique we try to restore the normal sagittal balance by restoring the normal morphology of the affected vertebra (natural kyphoplasty).

Material and Methods: Between May 2010 and Jun 2014 30 patients with symptomatic kyphotic deformity were treated with TWO osteotomy. Twenty-two are males and eight are females. The mean age of patients was 37 years (range 18-62 years). All patients had history of old trauma with time lag till surgerical interferance was 10 months in average (3m-12y.). They underwent TWO osteotomy of the wedged VB bisegmental TPSF through posterior-alone approach The clinical evaluation throughout the study entailed visual analogue scale (VAS) and Oswestry disability index. The local kyphotic angel (LKA), sagittal balance (SB) and sagittal index (SI) were measured preoperatively, postoperatively and during the follow up visits. Radiographic bony healing of the v-shaped VB defect which left after the TWO osteotomy is confirmed by MSCT.

Results: The mean follow up period was 26.5 months (range12- 48 m.). TWO osteotomy was done for wedged VB between D10 and L2. The mean operative time was 110 minutes (range 70- 180 minute.) and the mean intraoperative blood loss was 625 cc (range 400- 1700 cc). The mean preoperative LKA was 28.7° (range 20- 56°) that had been improved to -2° (range 8°- (-10°)) postoperatively. Lordotic correction of 30.8° (range 22–48°) was achieved with minimum loss of correction (range 0- 8°) through the period of follow up. The mean period required for radiographic bony healing of the osteotomy was 7 months (range 3–15m.). The VAS &ODI had been improved significantly (p.005) in comparison to preoperative values. Excellent clinical and radiographic outcomes were achieved in 92% of cases with no major complications.

Conclusion: Spontaneous bony healing after TWO of wedged VB occurs without doubt. This study evoked the concept of "**Natural Kyphoplasty**" for treatment of certain cases of PTK. Although it is a newly described technique, it was proved to be safe and effective method for treatment of symptomatic thoracolumbar PTK.

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GO306. Biomechanical Evaluation of the Use of PEEK versus PMMA Intervertebral Spacers in Lumbar Stabilization: the Influence of Bone Mineral Density and Vertebral Geometry

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Introduction: Degenerative spinal changes are often accompanied by osteoporosis in elderly patients. In these cases traditional interbody devices can strongly subside into the irregular deformed endplates and vertebrae during or after the surgical stabilization. To avoid implant subsidence, a new technique is developed where PMMA bone cement is applied as a custom-made interbody device providing better contact and more even load transfer along the vertebra-implant interface. The aim of this study was to compare the biomechanical properties of the two different spacer types. In this presentation, we focus on the connection between the bone mineral density and geometrical parameters of vertebrae and the compression failure of the spinal segment.

Materials and Methods: 22 monosegmental human cadaveric lumbar specimens were included in the analysis (Group "C" - cement: $N = 12$, Group "S" - spacer: $N = 10$). There were 8 steps to prepare the specimens: 1, isolation of a human cadaveric lumbar segment; 2, parallel embedding of cranial and caudal free endplates; 3, qCT scanning and vBMD measurement before applying interbody device; 4, introducing either a D-shaped PEEK spacer (Sanatmetal) or a custom made PMMA (Cemex) spacer as interbody device; 5, CT scanning after applying interbody device; 6, performing uniaxial compression tests (Instron 8872) and analyzing results (failure load and displacement, stiffness, elastic limit load and displacement); 7, CT scanning after the compression test; 8, finite element model was built to analyze the failure process using CT data.

Results: Comparison of initial geometrical data (vertebral cross sectional area, height, volume) and vBMD of "C" and "S" groups showed no significant difference. Failure load was similar in both groups. However, in the "S" group, there was a significant correlation between vBMD and failure load (R=0.73, $p < 0.05$), while such correlation was not observed ($R = -0.04$, $p < 0.90$) in the "C" group. The same association was observed for vertebral cross sectional areas ("S": R=0.78, $p < 0.01$; "C": $R = -0.47$, $p < 0.20$), vertebral height ("S": R=0.94, $p < 0.00$; "C": $R = -0.27$, $p < 0{,}50$), volume ("S": R=0.85, $p < 0.00$; "C": $R = -0.49$,$p < 0.20$) and failure load.

Conclusion: Analysis of mechanical test results showed that application of a PMMA cement spacer yields a significantly stiffer construct with smaller risk for subsidence compared with a PEEK spacer. However, load, that caused irreversible mechanical failure of the segments, were similar in both groups. In case of the PEEK spacer, the failure load does not depend on bone quality only, but on vertebral size parameters as well. In case of the PMMA cement spacer, such correlations were not observed. Finite element models showed completely different load transfer and failure process in the two groups. This difference is in line with our results

above. In case of a relatively small vertebral size and poor bone quality, a prefabricated PEEK intervertebral cage may be associated with higher risk of mechanical failure then the use of PMMA as an interbody device.

GO307. Interbody Fusion in Low Grade Lumbar Spondylolsithesis: Clinical Outcome Do Not Correalte with Slip Reduction and Neural Foraminal Dimension

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Introduction: There is no consensus in literature whether a beneficial effect of reduction on outcome can be expected following reduction and surgical fusion for low grade lumbar spondylolisthesis. This prospective study was designed to find a possible correlation between the clinical outcome and extent of lumbar spondylolisthesis reduction.

Material and Methods: 52 patients (age 17–48 years) with isthmic spondylolisthesis underwent interbody fusion with cages with posterior instrumentation (TLIF or PLIF). Clinical outcome was measured using Visual Analogue Scores (VAS) and Oswestry Disability Index (ODI). Foraminal dimensions and disc heights were measured in standard digital radiographs. These were analyzed at baseline and at 1 year after surgery and changes were compared. Radiographic fusion judged with CT scans at 1 year.

Results: 90 percent of the patients in the study had good or very good clinical results with fusion and instrumentation. The baseline and at one year postoperative, the mean VAS scores were 6.39 (range 5–8) and 0.81 (range 0–3) respectively ($p = 0.004$). The baseline and at one year postoperative, the mean ODI scores were 48 (range 34–58) and 9.8 (range 4–22) respectively ($p < 0.001$). A mean spondylolisthesis slip of 33.2% was reduced to 6.7% at 1 year. Average anterior disc height, posterior disc height, C distance, F diameter improved from 9.4mm to 11.7mm ($p = 0.005$), from 4.3mm to 5.8mm($p = 0.004$),from11.2mm to 12.0mm ($p = 0.002$), from 18.5mm to 19.4mm respectively ($p < 0.001$).The fusion rate was 66% with PLIF and 75% with TLIF. There is no significant correlation between the improvements of ODI scores and the extent of slip reduction.

Conclusion: Neural decompression and interbody fusion significantly improved pain and disability but the clinical outcome does not correlate with radiological improvement in neural foraminal dimension.

GO308. Transforaminal Lumbar Interbody Fusion or Posterior Lumbar Interbody Fusion: Which is Better? A Single-Centre Study

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Introduction: The first lumbar spinal fusion was introduced over 70 years ago and techniques have been evolving since then. Two popular techniques are Transforaminal Lumbar Interbody Fusion (TLIF) and Posterior Lumbar Interbody Fusion (PLIF). However, it is still controversial which is better. The aim of this study was to compare the clinical and radiological outcomes of those techniques.

Material and Methods: We retrospectively reviewed our spinal unit database to identify the patients who underwent TLIF and PLIF over the last 1 year. A hundred and ten patients were identified (54 TLIF, 56 PLIF). Demographics, Visual analogue score for leg and back pain and SF36 scores were analyzed preoperatively, at six weeks, six months and twelve months postopertively. Two independent reviewers assessed the X-rays for fusion at twelve months postoperatively using the Brantigan-Steffee classification.

Results: With regards to the clinical outcomes, TLIF patients had significantly better outcomes at six weeks with lower visual analogue scores (VAS) and better SF36 scores. The difference between the two groups has significantly reduced after one year. Both TLIF and PLIF patients had excellent lumbar spine fusion on X-rays at one year with good interobserver reliability (Kappa = 0.95)

Conclusion: Both TLIF and PLIF are excellent techniques for lumbar spinal fusion. There are no significant differences in the clinical and radiological outcomes between the two techniques at one year.

GO309. The Quantitative Observation of Interbody Fusion with Local Autogenous Bone Harvested from Single Interlaminar Fenestration in PLIF

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Introduction: Local autogenous bone (LABORATORY) harvested from interlaminar fenestration or total facetectomy has been widely applied in interbody fusion of lumbar disc degenerative diseases (DDD) with satisfactory clinical results . However, there was lack of weight and volume observation of LABORATORY harvested from single interlaminar fenestration (SIF) . The aim of this study was to quantitative observe the interbody fusion feasibility with LABORATORY harvested from SIF in PLIF.

Materials and Methods: 107 patients were undergone PLIF only by LABORATORY+one cage at L4/5 and/or L5S1 due to DDD. The weight and volume of LABORATORY from SIF were measured by analytical balance and 5ml disposal sterile syringe. The height of cages used intraoperative were recorded. The area of endplate (Se) and the contact area (Sc) between the cartilaginous endplate and LABORATORY +cage at every intervertebral space was measured and calculated by PACS of CT workstation. The clinical results and fusion status were estimated by JOA score and 3D-CT at 12, 18 and 24 months postoperative.

Results: 113 segments of 107 patients were successfully fused only by LABORATORY harvested from SIF. The weight and volume of LABORATORY from SIF showed no significant differences at different ages, genders, segments and type of DDD, and the same result exists about Se and the height of interbody space in L4/5 or L5S1 segments. The mean volume and weight of LABORATORY were 3.1ml and 3.7 g from SIF. The packing ratio (PR) of LABORATORY+one cage was 38.1%.The volume and weight to reach 30% PR needed ~2.5ml and 3.0 g LABORATORY. 94 cases (98 segments) were followed up for average 24 months postoperative. The improvement rate of JOA score was 82.5%, and the fusion rate was 92.9%.

Conclusion: SIF can provide enough LABORATORY for one interbody fusion in PLIF. The average volume and weight of LABORATORY from SIF were 3.1ml and 3.7 g respectively. 38% PR, including one cage, is achievable at fusion segment in

present study. 2.5 ml (3.0 g) LABORATORY+one cage can perform ~30% PR.

GO310. Comparison of NPY Y1 Receptors in the Spines of Ovariectomized and Ovary Intact Rats

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Introduction: Neuropeptide Y (NPY) is a 36-amino acid neuropeptide that acts as a neurotransmitter in the brain and in the autonomic nervous system of humans. In the autonomic system it is produced mainly by neurons of the sympathetic nervous system and serves as a strong vasoconstrictor. Recently, NPY has been shown to increase during stress and in patients with chronic back pain. NPY has the potential to innervate 5 subtypes of receptors Y1-Y5. The Y1 receptor has been shown to play a role in cell survival and contribute to pain hypersensitivity. In addition, Y1 receptors are also thought to contribute to bone loss leading to disc degeneration in osteoporosis. The goal of our study was identify the location of the Y1 receptor in the disc of osteoporotic animals and to compare those to ovary intact control.

Methods: Eight OVX animals and eight ovary intact control animals were followed weekly for 8 weeks. Four animals in each group were sacrificed at 4 and 8 weeks and blood and spines were harvested. Spines were decalcified and processed for histological analysis. Routine hematoxylin and eosin staining along with immunhistochemical analysis of the spine Y1 receptors.

Results: The results showed the intervertebral discs in the control group appeared normal. The nucleus pulposus contained abundant notochordal cells, surrounded by large zones of extracellular matrix, and the cartilage endplates were hyaline cartilage composed of chondrocytes. In the OVX animals, the discs showed degenerative changes, where the nucleus pulposus appeared reduced in size and comprised relatively few, chondrocyte-like cells. Mucoid degeneration could also be seen. An increased number of small chondrocytes appeared in the inner layer of the annulus. Bony tissues that contained bone marrow, hematopoietic lineage cells and mineralized bone, became more obvious in the deep zone of middle cartilage endplate. Immunohistochemical analysis for Y1 receptors showed positive staining in the outer annulus in the control with defined staining of chondrocyte cells. Y1 receptor staining was diminished in the OVX animals. Higher levels of circulating NPY was found in the plasma of OVX animals and may contribute to internalization of the Y1 receptor as a compensatory mechanism.

*Conclusion***s:** Y1 receptors are located in the outer portion of the annulus of rats. The portion of cellular staining differed between the OVX and intact ovary control animals. More experiments are needed to clarify the role of NPY in the normal and osteoporotic spine.

GO311. Early Adjacent Segment Degeneration after Short Lumbar Fusion

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Introduction: Today in a review of the world literature there is no consensus about the main risk factor for the symptomatic adjacent segment disease, as well as the terms and conditions of its occurrence. Furthermore there are more and more questions about the reasons for the early development of ASD in the event of a short fixation, which according to some authors, should be associated with the wrong tactics of treatment and regarded as a complication of surgery.

Material and Methods: This study evaluated 146 patients who underwent one level 360° fusion lumbar surgery from 2005 to 2012 for the treatment degenerative conditions of the lumbar spine. It should also be noted, that patients with L5-S1 fusion were excluded from the study due to the peculiarities of the biomechanics of the segment. So we compare 2 groups according to the presence and extent of initial degenerative changes in the adjacent upper segment. These groups were similar of major risk factors for ASD, such as obesity, age, smoking, menopause, global balance disturbance. Patients in both groups had no significant differences in sex and age composition, the level of quality of life and daily physical activity. First group include 86 patients with no pre-existing or 1 to 3 stage degenerative changes by Pfirrmann modified, second group include 60 patients with initial adjacent disk degenerative changes of stage 4 and above according Pfirrmann modified classification. The average follow-up period was 42.2 months (range, 28–112 months).

Results: In the I group symptomatic ASD was found in 14 (16,3%) cases and ASD average development time was 35 (8–56) months. In the II group during the follow-up period 24 (40%) patients had ASD with average development time 21,5 (3–46) months. Symptomatic adjacent segment pathology was significantly more frequent in the II group ($p < 0.05$). The timing analysis of the symptomatic ASD showed statistically significant data on the earlier development of this disease in the second group ($p < 0.05$).

Conclusion: Patients with pre-existing degenerative changes in adjacent levels above stage 3 by Pfirrmann must be assigned to a high risk group for early ASD development even in the short lumbar fusion.

GO312. Long-term Results of Implant Related Complications after Lumbar Fusion Using a Non-rigid Transpedicular Pedicle Screw-Rod System

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Introduction: Transpedicular fixation is associated with the risk of hardware failure, such as screw/rod breakage and/or loosening at the screw-rod interface and difficulties in the system assembly, which remains a significant clinical problem. Removal or revision of the spinal implants is often required. This is a retrospective radiological study of the single- and two-level lumbar stabilization procedures (TLIF, PLIF or PLF) performed from January 2002 to December 2012 using a non-rigid transpedicular implant system. The purpose of this study was to retrospectively analyze the radiological outcome of 1280 patients focusing on implant related complications.

Material and Methods: 1280 patients were included into the study. The female/male ratio was 56%/44%, the mean age was 59 years (18–88), the mean FU time was 32 months.

Indications for surgery were DDD, FBS and spondylolisthesis (DDD: 77%, FBS: 18%, spondylolisthesis: 5%). There were 727 single-level stabilizations and 553 two-level stabilizations in this cohort. The radiological status of the implants was assessed on lateral and AP X-rays and available CT scans by independent radiologists. We investigated the occurence of screw breakage, screw loosening and element rod breakage, rod slipping and movement.

Results: In the single-level group 8 screw breakage (1.1%), 27 screw loosening (3.7%), 9 element rod breakage (1.2%) and 47 element rod slippage or movement (6.5%) were detected. In the two-level group 9 screw breakage (1.6%), 30 screw loosening (5.4%), 14 element rod breakage (2.5%) and 37 element rod slippage or movement (6.7%) were present.

Conclusion: Comparing the result of this retrospective radiological study with the available literature data, we can state that the rate of implant related failures in case of the nonrigid transpedicular system is lower than in the previously published studies. Low implant complicationn rate can be associated with the effect of the non-rigid stabilization on bony remodelling at the surroundings of the transpedicular screws. The influence of non-union rate and sagittal alignment on the outcome needs further evaluations.

GO313. The Outcome of Using Closed Suction Wound Drains in Patients Undergoing Lumbar Spine Surgery: a Systematic Review

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Introduction: Wound suction drains have been used to decrease the rate of post-operative hematoma formation and thus wound infections for many years throughout all surgical subspecialties. In spine surgery, controversy is profound as on one side it decreases the rare but devastating complication of post-operative epidural hematoma, while it may have a hypothetical increase in the risk of infection. In the spine literature the incidence of epidural hematoma in the post-procedural period ranges from 0.2–2.9%, while post-operative wound infection is in the 0.7–16%, thus identifying a method that can decrease the incidence of these complications would be of uttermost benefit. To help address this debate, we conducted a systematic review discussing the use of these drains and to extensively explore the efficacy and safety of closed suction wound drainage in spine surgery in the post-operative period.

Materials and Methods: Electronic databases and reference lists of key articles were searched up through January 22nd 2015 to identify studies comparing the use of closed suction wound drains with no drains in spine surgery for lumbar degenerative conditions. Outcomes assessed included the cumulative incidence of epidural hematoma, superficial and deep wound infection and postoperative blood transfusion. The overall strength of evidence across studies was based on precepts outlined by the Grades of Recommendation Assessment, Development and Evaluation (GRADE) Working Group.

Results: Five heterogeneous studies, three randomized controlled trials (RCT) and two cohort studies, form the evidence basis for this report. There was no difference in the incidence of hematoma, superficial wound infection, or deep infection in patients with or without closed suction wound drains after lumbar surgery. The upper bounds of the 95% confidence interval for hematoma ranged from 1.1 to 16.7%; for superficial infection, 1.0 to 7.3%; and for deep infection, 1.0 to 7.1%. One observational study reported a 3.5-fold increase in the risk of blood transfusion in patients with a drain. The overall strength of evidence for these findings is considered LOW or INSUFFICIENT.

Conclusions: Conclusions from this systematic review are limited by the quality of included studies that assessed the use of closed suction wound drains in lumbar spine surgeries for degenerative conditions. We believe that spine surgeons should not routinely rely on use of closed suction wound drains in lumbar spine surgery until higher level of evidence becomes available to support its use.

GO314. Reoperation Rates Following Single-Level Discectomy

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Introduction: Lumbar discectomy is the most commonly performed procedure for treatment of radiculopathy due to lumbar disc herniation. Randomized trials have demonstrated the advantage of surgical removal of herniated disc material over non-surgical treatment options, allowing for a more rapid reduction in symptoms and return of function. Many small-size studies suggest that long-term outcomes for patients treated with discectomy and non-operative management are similar. Additionally, treatment of recurrent lumbar disc herniation is not standardized. Population-level data regarding reoperation following single level hemilaminotomy and discectomy is limited.

Material and Methods: Data was collected and analyzed for 13,654 patients undergoing single-level lumbar discectomy between January 2007 and December 2010 using the commercially available PearlDiver software (PearlDiver, Inc., Fort Wayne, IN, USA). The nationwide Humana private insurance database was queried for patients billed with the Current Procedural Terminology (CPT) code for our index procedure, hemilaminotomy and removal of disc material (CPT-63030). Patients receiving concurrent lumbar surgeries were excluded from the index group. The index group was then followed in retrospective cohorts for 3 months, 6 months, 1 year, 2 years, and 4 years for recurrent lumbar surgery, including spinal fusion, laminectomy, and additional discectomy.

Results: Patients received additional lumbar surgeries following single-level discectomy at a rate of 3.95% (539/13654) within 3 months and 12.2% (766/6274) within 4 years of the index procedure. Lumbar spinal fusion was performed on 5.90% (370/6274) of patients within 4 years, with interbody fusion in 75.4% (279/370) of cases and multi-level fusion in 47.0% (174/370) of cases. Reoperation for re-exploration discectomy at the same level as the index procedure with no subsequent surgeries occurred in 2.71% (170/6274) of patients followed out to 4 years. Patients who received a re-exploration

discectomy at the same intervertebral level within 2 years of the index procedure went on to receive lumbar fusion at a rate of 38.4% (48/125) within the 4 years following the re-exploration discectomy.

Conclusion: Data in our study demonstrated a reoperation rate of 12.2% after single level discectomy, a routinely performed procedure for the treatment of symptomatic lumbar disk herniation. Moreover, we show that the rate of progression to lumbar fusion after a re-exploration discectomy was 38.4% within 4 years of reoperation. These data should help surgeons in their operative decision-making and counseling recommendations to patients. To our knowledge, this is the largest population study delineating reoperation rates across the US after single-level lumbar discectomy. Further studies are needed regarding the best treatment algorithm in patients with re-herniation or iatrogenic instability following lumbar discectomy.

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GO315. Postoperative Complications in Patients Undergoing Minimally Invasive Sacroiliac Fusion

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Introduction: Minimally invasive sacroiliac (SI) fusion has become increasingly popular as a treatment for non-traumatic sacroiliac joint pain in recent years. This has created significant need for reliable data addressing risks associated with the procedure. Initial investigations have focused primarily on efficacy and patient satisfaction with small sample size. Furthermore, the majority of past studies have been primarily single center or case series investigations and as such their findings were limited to their sample populations. The aim of this study was to analyze complications associated with minimally invasive SI fusion using a large medical record database that more closely and accurately models the American population as a whole.

Material and Methods: Patients undergoing minimally invasive SI fusion from 2007–2014 were selected from records of the nationwide private insurance provider Humana. Using the Pearl Diver patient records database (Pearl Diver Technologies, West Conshohocken, PA, USA), patient data on age, procedure date, and medical diagnoses before and after the procedure was acquired. ICD-9 diagnosis codes (International Classification of Diseases 9th edition) were used to reveal incidence of post-operative complications including infection, pain, osteomyelitis, joint derangement, uterine tract infection (UTI), and nerve pathology. Cases of pre-existing conditions were excluded from the analysis. The data was also examined for incidence of patients with diagnoses of new lumbar pathology following the procedure. Patients undergoing SI fusion for surgical revision, neoplasia, or pelvic ring trauma were excluded from the study.

Results: Data from 469 patients (305 female; 164 male) showed a substantial increase in the number of minimally invasive sacroiliac fusion procedures performed from 2007–2014 [$p < .05$]. Among these patients, an overall complication rate of 13.2% was seen at 90 days and 16.4% at 6 months post-op. Rates of individual complications were as follow. Infection: 30 days = 3.0%, 90 days = 3.6%, 6 months = 4.1%. Pain: 90 days = 2.6%, 6 months = 4.1%. UTI: 90 days = 3.8%, 6 months = 4.9%. Nerve pathology: 90 days = 4.3%, 6 months = 6.2%. Incidence of novel lumbar pathology was 3.6% at 90 days post-op and 5.3% at 6 months. Males experienced diagnoses of novel lumbar pathology at higher rates than females at both 90 days (M=6.7%; F≤3.3%) and 6 months (M=9.1%; F≤3.3%) [$p < .01$].

Conclusion: The results of this study show that minimally invasive SI joint fusion may carry higher risks of complications than previously stated, including a possible association with the development of lumbar pathology. These finding are critical for physicians and patients considering minimally invasive SI fusion as a treatment for chronic SI joint pain, and should be taken under careful consideration when deciding if surgical treatment is warranted.

GO316. Lumbar Spinal Stenosis Associated with Degenerative Lumbar Spondylolisthesis: A Systematic Review and Meta-analysis of Secondary Fusion Rates Following Open vs. Minimally Invasive Decompression

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Introduction Decompression surgery plus instrumented fusion is the gold standard in patients with lumbar spinal stenosis (LSS) associated with degenerative spondylolisthesis (DS) when conservative treatment has failed. Open laminectomy (OL) alone is an option in patients with stable low-grade DS, but progressive instability contributes to significant secondary fusion rates and compromises patient outcome. A minimally invasive unilateral laminotomy (MIL) for "over the top" decompression is a potentially less destabilizing alternative. The aim of our systematic review and meta-analysis was to analyze secondary fusion rates after open laminectomy and minimally invasive laminotomy in patients with LSS associated with DS.

Material and Methods: We performed a systematic literature search in the National Center for Biotechnology Information Database (Pubmed/MEDLINE) using the keywords "lumbar spondylolisthesis" and "decompression surgery." All studies that separately reported the outcome of patients with LSS associated with DS that were treated by decompression surgery only were included. The accepted decompression techniques were 1.) open laminectomy and 2.) microsurgical transmuscular or subperiosteal unilateral laminotomy with "over the top" decompression. The primary end point was secondary fusion rate. Secondary end points were total reoperation, complications, postoperative progression of listhetic slip, and patient satisfaction.

Results: We identified 37 studies with a total number of 1156 patients that were published between 1983 and 2015. 19 studies reported the outcome after OL, and 18 after MIL. There were two randomized controlled trials, 8 prospective, and 24 retrospective cohort studies or case series. In two trials the study design was unclear. None of the trials compared OL to MIL. The pooled secondary fusion rates were 12.8% in the OL cohort, and 3.3% in the MIL cohort; the pooled total reoperation rates were 16.3% after OL, and 5.8% after MIL. The complication rate ranged from 0–5.4% in the OL cohort, and from 0–8.1% in the MIL cohort. Surgery-related deaths, major permanent complications, or medical complications were not reported by the studies. In the OL cohort 72% of the studies displayed a slip progression compared with 0% in the MIL cohort, respectively. After OL the pooled analysis of satisfactory outcome was 62.7% compared with 76% after MIL.

Conclusion: In patients with LSS associated with DS a minimally invasive laminotomy is associated with lower reoperation and fusion rates, less slip progression and greater patient satisfaction than open surgery. Better quality studies are needed to corroborate these results. These results also indicate that routine fusion may not be necessary in all patients with LSS and DS.

GO317. Short Percutaneous Posterior Instrumentation: a Reliable Option in the Treatment of Thoraco-lumbar post-traumatic Spinal Fracture

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Introduction: There are several options to treat instable thoraco-lumbar spinal fractures without spinal cord involvement. A short percutaneous posterior instrumentation [SPPI] (i.e., involving only one level up and one level below the lesioned level) is a fast choice, safer than other more invasive options at the cost of an apparent less efficacy in restoring proper alignment or in the ability to maintain good results in the long term. Aim of our present contribution is to report the incidence of worsening during time of spinal alignment features in patients treated with SPPI.

Material and Methods: Between September 2010 and August 2015, among 230 consecutive operations for instable post-traumatic thoraco-lumbar spinal fractures, we performed 47 SPPI and 130 other percutaneous instrumentations (4 levels or more). Fractures were defined according to the AO classification; vertebral body index [VBI], vertebral body angle [VBA] and Cobb's angle [CA] were measured before, immediately after operation (i.e., in the first two post-op days) at 1 month- and at 12 month-follow-up. All data were drawn from multi-slice high-definition CT-scans. Local ethical committee approved the study design. Results were also stratified according to the class of fracture and number of blocked levels (3, 4 or more).

Results: In the SPPI-cases we found preop the following mean values: VBI 0,67, VBA -16,5, CA -9,5; at 12 months follow-up (26 patients out of 35) mean values were: VBI 0,84, VBA -14,8 and CA -5,4 with changes statistically non significant between immediate post-op and 1 year follow-up.

Conclusion: In our hands SPPI proved to be an effective therapeutic option. No significant kyphotic worsening was observed during the first year post-op. Parallel sections of the present study and prolongement of the observational time will allow us to compare SPPI with longer posterior instrumentations in non spinal cord-lesioned thoraco-lumbar fractured patients.

GO318. How to Minimize Complications Of Classic Decompression and Fusion in Lumbar Spinal Stenosis: is a Complemental Interspinous Fusion an Alternative?

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Introduction: Lumbar spinal stenosis (LSS) is the most common reason for back surgery in patients over 50 years. LSS decompression may cause an instability or deteriorate it. A classic fusion with pedicle screws enhances the hazard of the surgery in geriatric patients. The goal of the study was to find out, if the additional interspinous fusion (partly combined with interbody fusion) with a rigid intespinous device can minimize the risk of classic procedure.

Material and Methods: 94 patients (44 men and 46 women) in age of 49- 88 years (mean 69) underwent LSS decompression with interspinous fusion, some of them additionally with intervertebral cages. Interspinous rigid fusion device were used to provide fusion. Demographic data, indications, operated levels, results in terms of approval of ODI, VAS back and legs, walking distance and satisfaction were analyzed. Blood loss, OP-, fluoroscopy time and complications were registered. Fusion was determined by CT performed at least 6 months post OP and X- rays.

Results: 78 patients (83%) were operated with stand alone interspinous fusion device and 16 (17%) received additionally an intervertebralcCage. The follow- up was 6 to 36 months (mean 20). Indications: LSS with instability 41, LSS 28, LSS with disc herniation 19, deformity 3 and adjacent segment disease 3. The Op time ranged from 35 to 209 minutes (mean 82). The blood loss was between 10 to 450 ml (mean100ml). The fluoroscopy time reached from 2 to 18 seconds (mean 6). Mean values for ODI and VAS are presented in
Table 1.

	pre OP	3 months	6 months	12 months	24 months
ODI	54	32	20	24	24
VAS back	5,8	2,0	2,1	2,9	2,9
VAS legs	7.9	1,9	3,2	2,3	2,2

2 years post OP the improvement of ODI was 54%. VAS back 50% and VES legs 72% respectively. The walking distance increased at least at 50% in 86 patients (91,5%). Concerning the satisfaction 90 patients (96%) would undergo the surgery once more, 4 of them (4%) not. Following complications were observed: cage subsidence (3), cage dislocation (1), epidural hematoma (2), wound infection (1), deep infection (1), dural tears (7), seroma (4). It means all in all 19 adverse events (20%). Only in 10 patients (11%) they had a consequence with revision surgery. Radiological criteria of the fusion had 59% of the patients with 6 months follow up, in 94% patients with 12, 98% with 24 and 100% with 36.

Conclusion: The results of the study show, that the LSS decompression can be supplemented using an interspineous rigid device to provide a fusion without significant extending the Op time. More extended surgeries with pedicle screw fixation can be avoided and thus the complication rate reduced. 11% of complications, which require a repeat surgery are acceptable in population of aged patients with comorbidities. The advantage is the less invasive technique with less blood loss and only 0,1 minutes fluoroscopy time. We found no real liminations in decision making for the surgery. There were 22 drop outs.

GO319. Morphometric Measurement of the Lumbosacral Spine for Minimally-Invasive Cortical Bone Trajectory Implant Using Computed-Tomography

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Introduction: The cortical bone trajectory (CBT) is a novel lumbar pedicle screw trajectory. There is a dearth of literature on CBT screw insertion techniques. The aim of this study was to conduct a detailed morphometric measurement

of the lumbosacral spine for CBT pedicle screw starting point, trajectory, length and diameter, using the inferior facet of the cephalad level as a bony landmark.

Methods: The 3-dimensional reconstruction computed tomography (CT) scans of 86 adults who underwent examination of the lumbosacral spine were studied. The junction of the inferior and medial border of the smallest coronal section of the lumbar pedicle was traced in lumbar segments while the junction of the medial border of the sacral 1 (S1) pedicle and the inferior border of the L5 inferior facet was traced in S1 segments. The starting point was defined to be the projective point on the vertebral plate by this junction. The distances from the starting point to the inferior, lateral and medial border of the inferior facet of the cephalad level, and the inferior border of the transverse process were measured. The trajectory of pedicle screws for the lumbar and S1 segments was determined in the axial and sagittal planes. The angle formed between this trajectory and a line from the vertebral midline was defined as the transverse angle (TA). The angle formed between this trajectory and a line from superior margin of the vertebral body was defined as the cephalad angle 1 (CA1). Cephalad angle 2 (CA2) was defined as the angle formed between the same trajectory on the sagittal plane and a line from the posterior margin of the pars interarticularis. The maximum pedicle screw diameter, as well as the maximum pedicle screw length of the lumbosacral segments was measured on axial and sagittal CT scans, respectively.

Results: The distances from the inferior border of inferior facet to the starting point from L1 to S1 were 8.9, 6.3, 4.1, 2.9, 1.4 and 0 mm, respectively. The distances from the medial border of the inferior facet to the starting point from L1 to S1 were between 3 to 4mm. The percentages of the distance from the starting point to the medial border of the inferior facet from L1 to S1 were 80.5, 70.1, 61.6, 48.6, 40.8 and 29.3%, respectively. TA from L1 to S1 were 9.0, 9.6, 11.3, 13.5, 15.5, and 8.2 degrees, respectively. CA1/CA2 from L1 to S1 were 26.7/38.7, 26.0/38.7, 26.9/38.0, 24.4/37.2, 22.9/35.1 and 18.4/47.8 degrees, respectively. The maximum diameters of the trajectory from L1 to S1 were 4.8, 5.1, 6.1, 6.8, 7.8, and 6.1mm, respectively. Twenty-five mm was a safe border as the maximum length of the pedicle screw from L1 to S1.

*Conclusion***s:** The inferior facet of the cephalad level is an attractive bony landmark for establishing a starting point of CBT for minimally-invasive spine surgery.

Keywords: cortical bone trajectory, pedicle, lumbosacral spine, facet

GO320. Comparison between Minimally Invasive Versus Open TLIF in Treatment of Spondylolisthesis

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Introduction: Fusion has gained popularity for surgical treatment of adult spondylolisthesis in patients with chronic persistent pain. Several fusion methods have been reported for adult isthmic and degenerative spondylolisthesis via various techniques including minimally invasive and traditional open surgery. However, the choice of lumbar fusion technique must be individualized based on the clinical needs of each patient, the surgical outcomes for each procedure based on published literature, and the individual skills and the surgeon's preference. Much has been reported about the advantages of each approach. The present study was undertaken to evaluate retrospectively the results obtained in patients undergoing mini-TLIF compared with open TLIF, with a goal of helping in the selection of treatment options. We present the clinical and operative results obtained during the postoperative period.

Objective: To evaluate the results of minimally invasive versus open TLIF in adult lytic and degenerative spondylolisthesis .

Methods: Between November 2012 and August 2015, 85 consecutive patients underwent minimally invasive transforaminal lumbar interbody fusion (mini-TLIF) (group I) and 49 consecutive patients underwent open TLIF(group II) at Agouza Spine Surgery Center Of Military Forces, Cairo, Egypt. The mean follow-up periods were 18.2 and 20.4 months, respectively.

Results: The mean age was 51,16+12.76 in mini-TLIF AND 50,67+11.33 in open TLIF with sex distribution (41/44) and (24/25) male to female in mini-TLIF and open TLIF respectively. The mean operative time in mini-TLIF was 190.5 minute and 153.5 minute in open TLIF and the difference was statistically significant. The mean blood loss was 168ml and 476ml in mini-TLIF and open TLIF and was significant statistically. The hospital stay mean difference between both groups was statistically significant (2.88 and 5.12 days respectively). Mean visual analog scale (VAS) scores for back and leg pain decreased, respectively, from 6.66 and 7.44 to 2.58 and 2.07 in short-term follow up and to 1.38 and 0.78 in long-term follow up in group I and from 7.17 and 7.96 to 2.79 and 2.31 in short-term follow up and to 1.37 and 0.86 in long-term follow up in group II. Mean Oswestry disability index (ODI) improved from 54.07% to 27.82% in short-term follow up and to18.33% in long-term follow up in group I and from 60.5% to 2381% in short-term follow up and to 14.48 in long-term follow up in group II. In both groups, VAS and ODI scores significantly changed from pre- to postoperatively ($p < 0.001$), but postoperative outcome between groups was statistically not significant. Regarding the operative complications, there was no nerve root injury in both groups. The incidence of dural tear was 3.5% in group I and 11.11% in group II. The incidence of superficial and deep infections, respectively, was (3.5% and 1.1%) in group I and (12.2% and 4.1%) in group II. There was no screw loosening or slipped cage in group I but screw loosening was reported in 2 cases (4.1%) and also cage slippage was reported in 2 cases(4.1%) in group II.

Conclusion: Clinical and functional outcomes demonstrate no significant differences between groups in treating back and leg pain of adult patients with spondylolisthesis. However, in terms of operative blood loss, dural tear, infection, hospital stay and instrument failure (screw or cage) mini-TLIF demonstrated better results. On the other hand, mini-TLIF showed more operatve time that can be overcomed with growing learning curve and advancing system designs.

Keywords: spondylolisthesis, transforaminal lumbar interbody fusion (TLIF), mini-TLIF, open TLIF

GO321. Minimally Invasive Spine Surgery in Patients Who Present Late for Surgery; Doing Too Good, Too Late

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Introduction: There remains a huge reluctance to undergo spine surgery in Jordan, which is probably related to misbeliefs and/or bad experiences. Recently, there has been a surge in Minimally Invasive Spine Surgery (MISS) procedures with patients specifically requesting to have their operations done using this technique. However, this often happen after many years of pain, disability and even weakness in muscle power. We reviewed patients who underwent either MISS discectomy or MISS decompression to assess whether

delayed presentation for surgery had a negative impact on outcome.

Materials and Methods: We retrospectively reviewed 172 patients who underwent MISS discectomy or MISS decompression at a single center between 2013 and 2014. Procedures included 114 discectomies and 58 decompressions, using the cross over unilateral technique. All patients had a minimum of twelve months follow up and all procedures were done using a tubular retractor, microscope and general anesthetic. Pain and functional outcomes were assessed using VAS for back and leg pain and Eq. 5D. We then compared outcome measures between patients who had symptoms for less than twelve months prior to surgery with those with twelve months or more. Statistical analysis was done using independent *t*-test. We also looked at a subgroup of patients who presented with neurological deficit.

Results: A total of 172 patients were reviewed. There were 97 (56%) males and 75 (44%) females with a mean age of 47.6 years. All patients in discectomy and decompression groups significantly improved post operatively in all three outcome measures (VAS back pain mean pre op 49.4, post op 7.7, VAS leg pain mean pre op 78.8, post op 29.7, Eq. 5D mean pre op 0.31, post op 0.72 with P value < 0.001 for all measures). Duration of symptoms prior to surgery ranged from 1 month to 144 months (mean 16.8 months). Almost one third (31%) of the patients waited more than twelve months before they had their operations. Nevertheless, they still had outcome comparable to patients who waited less than twelve months (P value 0.883). The exception to this was the group of 14 patients who presented with painful foot drop from L4/5 disc herniation (9 patients) or lateral recess stenosis (5 patients). Two patients only had the surgery within 4 weeks from the onset of weakness and both fully recovered. Half (6) of the remaining patients presented after one year from onset of foot weakness, strongly indicating reluctance to undergo surgery. Of those, only two showed partial recovery. Interestingly, more than half of the 172 patients (52%) would have still categorically refused surgery if it was not offered with MISS techniques, and would have continued to suffer with pain and disability.

Conclusion: Deeply rooted reluctance to undergo spine surgery in general often results in several years of chronic pain, disability and even neurological deficit. When those patients eventually agreed to undergo MISS procedures, results were very satisfactory and comparable to those who agreed to surgery when first recommended. This may be explained by high level of satisfaction following years of pain, frustration and disability. The same however cannot be said in cases of neurological deficit, which should continue to be done urgently.

GO322. Looking at the Future of Motion Preservation Surgery in the Lumbar Spine with the Experience of the Past

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Introduction: In the 1970's, Kirkaldy-Willis first described the "Degenerative Cascade" of DDD. Observation of demographic studies shows more back pain in younger adults (30 to 50 years) than in elderly adults (over 60 years) in which osteoarthritis problems are prevalent to disc problems. The aim of this study is to demonstrate if and when an interlaminar elastic motion preservation device for disc assistance can stop or reverse the degenerative cascade of the lumbar spine in younger adults. We used in this study a new motion preservation device not interspinous but interlaminar. The IntraSpine® device (Cousin Biotech, France), is manufactured in medical silicon 65 shore coated by an adherent pure polyester terephtalate sleeve and the frontal extremity is further covered by a silicone film that prevents adhesion to the neural structures in cases of surgical bone or soft tissue removal.

Material and Methods: Group 1: 60 patients (mean age 34.5 years, 38 female an 22 male) affected from back pain from a minimum time of two years and after the failure of conservative treatment for at least 6 months, received a minimally invasive surgical procedure implanting this IntraSPINE® device at one or two levels. Group 2: 54 patients (mean age 32,6 years, 24 male and 16 female) affected from big extruded disc hernia received the some implant after the removal of the hernia in the some surgical procedure at one level, to prevent the subsequent chronic LBP due to a rapid collapse of the disc height. From the literature we know that in this young group of patients the percentage of the chronic LBP in the late follow up (5 years) it's ~70%. The results with a minimum follow-up of 4 years were evaluated from the clinical point of view regarding the LBP with VAS and ODI tests. All patients were also subjected to an MRI control. The surgical procedure was performed by monolateral approach and in many cases in local anesthesia in group 1 and in general anesthesia and equally by monolateral approach in group 2. The source of the pain in this group of patients (facet joint pain) was demonstrated by a positive response to the facet joint block test (The response was considered positive for a transient reduction of pain at least of 70%). Prior to surgical procedure, all patients underwent an MRI, a CT Scan and a dynamic X-ray of the lumbar spine. The stage of the degenerative cascade was between grade III and IV according to Pfirrmann.

Results: Group 1:in ~20% also in presence of good clinical results we highlighted a moderate progression of the cascade, in about the 50% the Pfirrmann grade was unchanged, but in ~30% we highlighted a partial rehydration of the disc which means a initial reversion of the degenerative cascade (patients with the lower grades of degeneration). Group 2: the percentage of a very uncomfortable LBP in this group was 24%, and the number of the recurrences was 2 (5%) and in only 1 case we performed a new surgical procedure. The maximum amount of blood lost in both group was 80 cc and the mean time of the surgical procedure was 28 minutes (from 18 to 37) in the group 1 and 41 minutes (from 34 to 46) in the group 2.

Conclusion: The close observation of the right indications and the proper selection of patients is strictly recommended. The mininvasive and relatively easy surgical procedure do not induce the surgeons of an indiscriminate use of this device. The wrong level implant is the mast frequent mistake. From the observation of these very important points we believe that are obtained this very good results even should be necessary a big number of case study, a longer follow up and a randomized multicenter study. The absence of major complications, the minimally invasive surgical procedure and the good clinical results allow us to say that with a correct patient selection we can prevent that this disease from acute becomes chronic, and thus its natural progression. Last but not least if we performed this surgical procedure in the earliest stages of the degenerative cascade, we can reverse its trend.

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GO323. Better Height Restoration and Kyphosis Correction of Osteoporotic Vertebral Compression Fractures Using Intravertebral Reduction Devices (SpineJack): One Year Follow Up

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Background: Transpedicular cement augmentation has became a significant treatment for osteoporotic vertebral compression fractures with the evident effect of pain-relief. However, height restoration and kyphosis correction of the spinal column following transpedicular cement augmentation are not satisfying. SpineJack, one of intravertebral reduction devices, has been proved to has better height restoration and kyphosis correction in a cadaveric study. It also has been reported to has good outcomes for treating spine trauma. However, for treating osteoporotic vertebral compression in the elderly, the role of SpineJack is still unknown. This clinical study was conducted to compare the radiological and clinical outcomes between transpedicular cement augmentation with/without SpineJack for osteoporotic vertebral compression fracture in the elderly.

Materials and Methods: 75 patients with osteoporotic vertebral compression were included and treated with transpedicular cement augmentation with/without SpineJack during Sep. 2013- May. 2015. The radiological outcomes, including the anterior, central, posterior body height, and kyphotic angle, were measured on flexion/extension lateral lumbar X-ray at the time points of pre-operatively, post-operatively 1 week, 3 month, 6 month, and 1 year. The clinical outcomes, including VAS for pain, SF-36, complications were recorded by reviewing the charts retrospectively. The incidences of adjacent and non-adjacent fracture in both groups were also recorded.

Results: 36 patients was treated with SpineJack and 39 without SpineJack (Vertebroplasty group). The age, bone marrow density, body mass index, sex ratio, fracture level, the use of steroid and anti-osteoporosis medication were comparable in two groups ($p > 0.05$). The pre/post- VAS for pain, SF-36, or complication was similar in two groups ($p > 0.05$). The incidences of adjacent and non-adjacent fracture were also comparable in both group ($p > 0.05$). The restoration of anterior/middle body height and kyphotic angle in SpineJack group were significantly better than that in Vertebroplaty group at post-op 1 week, 3m, 6m, and one year ($p > 0.05$). The restorations maintained at least for 1 year in SpineJack group ($p > 0.05$), while the restorations in Vertebroplasty groups only maintained for 3 months.

Conclusion: Based on this study, height restoration and kyphosis correction were significantly better in the SpineJack group at least for one year for treating osteoporotic compression fractures in the elderly.

GO324. Complications after Percutaneous Pedicle Screw Fixation for the Treatment of Unstable Spinal Metastases

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Background: Up to 70% of all cancer patients have bone metastases, with the spine being the most common location. Standard treatment of painful biomechanically unstable spinal metastases is surgical stabilization with or without cement augmentation. An extensive open surgical procedure may often not be warranted considering the palliative treatment intent. Minimally invasive surgical techniques such as percutaneous pedicle screw fixation have become available in the last decade and may be more suitable for these patients. Therefore, the aim of this study was to report the characteristics and complications after percutaneous pedicle screw fixation (PPSF) for the treatment of unstable spinal metastases. The secondary objective was to identify factors associated with the occurrence of complications and survival.

Methods: A national multicenter ambispective review of patients who underwent PPSF for the treatment of unstable spinal metastases was performed. Patients were excluded if they were diagnosed with a primary spinal tumor, an intradural spinal tumor, or if additional (minimal access) spine surgery was performed. Patient data pertaining demographics, diagnosis, treatment, neurological function, complications, and survival were collected.

Results: Between 2009 and 2014, 101 patients (56 female, mean age 60.3 ±11.2 years) underwent PPSF for the treatment of unstable spinal metastases. Median operating time was 122 minutes (range 57–325) with a median blood loss of 100ml ($N = 41$, range 50–500); none of the patients required blood transfusion postoperatively. Median length of stay was 7 days with 78% of the patients ambulating within the first three days post-operative. The presence of complications ($p = 0.003$) and need for re-operation ($p < 0.001$) were associated with increased length of hospital stay. A total of 30 complications occurred in 18 patients. Operating time was the only factor associated with the presence of complications ($p = 0.041$). Non-surgical adverse events (9%) were the most common complications followed by postoperative neurological deterioration (6%) and revision surgery (6%). Three out of six patients suffered neurological deterioration due to local tumor progression. The remaining three patients suffered surgical related neurological deterioration. Mean survival time was 11.0 months, with 78% of the patients being alive at three months post surgery. Univariate analysis demonstrated that a lower performance status ($p = 0.043$), primary tumor type ($p < 0.001$), the presence of node and/or visceral metastases ($p = 0.019$) and no administration of postoperative chemotherapy ($p = 0.007$) negatively influenced three months survival. Using multivariate analysis only no administration of postoperative chemotherapy ($p = 0.017$, HR 5.8, 95%CI 1.79 – 18.77) demonstrated to be independently associated with impaired survival at three months.

Conclusion: Minimally invasive surgery for the treatment of spinal metastases demonstrates to be safe and has promising clinical outcomes in terms of minimal blood loss

during surgery and high rates of early post-operative ambulation. In addition, no administration of postoperative chemotherapy was associated with impaired three months survival.

GO325. Minimally Invasive Spine Surgery for Intracanal Tumor Resection. Clinical Study and Surgical Results

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Introduction: Neuroimaging technology, micro-surgical instruments and minimally invasive techniques have allowed the development of new approaches that maintain favorable neurological outcome obtained by conventional techniques in resection of spinal neoplasm. Our work describes a new surgical technique for patients with spinal intracanal neoplasms in order preserve muscle tension band posterior ligamentous and assessed the results.

Material and Methods: Our surgical technique proposes a para-median posterior minimally invasive approach from linear incision of 2.5 cm ipsilateral to the site of the lesion trough an expandable tubular retractor. Patients were followed prospectively with visits at one, three, six and twelve months after surgery. Surgical time, blood loss, intra-operative and post-operative complications, hospital length of stay, pre and post-operative neurological status were assessed.

Results: We describe the surgical treatment technique in twenty one patients diagnosed with spinal intra-canal compressive lesions, which underwent surgical resection between January 2010 and July 2015. The Meningioma was the most frequent neoplasm. The means surgical time was 148 minute. The average intraoperative bleeding was 217 ml. Patients experienced minimal postoperative pain and they were discharged in average 31 hours after surgery. There were no intraoperative complications; though two patients developed complications in the late postoperative period. A patient had cerebrospinal fluid leak and other patient developed myelopathy secondary to non-infectious arachnoiditis.

Conclusion: This type of approach technique provides adequate visualization and microsurgical resection of the intra-canal tumor lesions, with reduced muscle denervation and devascularization by preserving the tension of the ligament complex. These results correlate with previous studies of minimally invasive techniques for spinal neoplasms.

GO326. Assessment of Postoperative Epidural Hematoma after Lumbar Microendoscopic Surgery

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Introduction: Symptomatic postoperative spinal epidural hematoma (SEH) is observed occasionally but rarely gets into serious complication after lumbar spinal surgery. It is also known that SEH occurs even in the endoscopic surgery. The purpose of this study is to assess characteristics and outcome of those cases which had SEH treated surgically after the initial microendoscopic surgery in the lumbar spine.

Method: From 2003 to 2015, total of 1249 patients with lumbar disc herniation or canal stenosis underwent microendoscopic discectomy or laminectomy in our institution. Traditional open spinal surgeries were compared with those microendoscopic surgeries. Six patients after microendoscopic surgery in the series required evacuation of SEH after the initial surgery were included in this study. Preoperative characteristics of the patients, clinical outcome and postoperative course were assessed.

Result: The incidence of SEH after microendoscopic surgeries required additional treatment was 0.48% (6 of 1249). The incidence of SHE after open spinal surgeries were 0.77% (11 of 1421). The initial procedure was microendscopic discectomy in three cases and microendoscopic laminotomy in three cases. One patient had hypertension, two patients had prediabetes and one patient had thrombocytopenia (12.1^{10*3}/µl) by hepatitis. Three cases were treated in the acute stage (within 24 hours after the surgery) and three cases were treated in the subacute stage (between 3 and 7 days after the surgery). In all cases, severe leg pain was appeared in short time. Two patients got muscle weakness. After the surgical evacuation of hematoma, all cases recovered from neurological symptoms and leg pain immediately. But one patient had repetitive leg pain after the evacuation with local anesthesia or general anesthesia. Finally Blood transfusion and factor VIII were required to stop SEH. Factor VIII activity of the patient was 58% at two days after the initial surgery. The patient fully recovered at six months after the initial surgery.

Conclusion: The incidence of SEH was not significant in comparison with a conventional method. It was considered that narrow epidural space by microendoscopic surgery affected dural compression by even a little bleeding. Basically, in preventing SEH, preoperative bleeding tendency, intraoperative bleeding, postoperative blood pressure and drainage should be confirmed. Even though, it was very difficult to detect the crucial factor of the symptomatic SHE, patient factor like bleeding and cerebrospinal pressure or iatrogenic factor like redundant invasion may lead to symptomatic SHE. Prompt treatment for symptomatic SEH was necessary.

GO327. Perioperative Morbidity in Overweight or Obese Patients after Minimally Invasive Lumbar Spine Surgery

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Introduction: Obesity is a known risk factor for many medical complications. Spinal surgery in overweight or obese patients poses specific challenges related to technical difficulties and risks of complications. Minimally invasive spinal (MIS) surgery has been developed with the purpose of decreasing post operative pain, operative blood loss and to promote early ambulation while offering the same outcomes of traditional open techniques. Nonetheless, there is a paucity of information as to whether these techniques are safe and their results reproducible in overweight or obese patients. We report perioperative outcomes in a retrospective cohort of overweight or obese patients after minimally invasive lumbar spine surgery.

Material and Methods: Retrospective chart analysis of patients treated with minimally invasive techniques for lumbar spinal pathology was performed, starting from January 2007 to December 2011. Fifty – seven patients with a body mass index (BMI) greater than or equal to 25 kg/m^2 were included for analysis. 40 patients with a BMI lower than 25 kg/m^2 were included for comparison. Multivariate logistic regression analysis was performed.

Results: Out of the 97 patients included in the study, 9 presented complications. These were distributed by BMI groups as follows: Two patients in the group below BMI 25 kg/m^2; five patients in the group between 25 and 29.9 kg/m^2, and two patients in the group above BMI 30. There were no reported mortality cases. After multivariate logistic regression analysis, none of the variables observed (BMI, age, gender, type of fusion) demonstrated a statistically significant increase in morbidity.

Conclusion: MIS surgery doesn't appear to have a higher risk of perioperative complications in overweight or obese patients with lumbar spine pathology.

Surgical Complications

GO328. Prospective Multicenter Assessment of Intraoperative and Perioperative Complication Rates Associated with Adult Spinal Deformity (ASD) Surgery in 558 Patients

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Introduction: Few previous studies have focused on early (intraoperative and perioperative) complication rates for ASD surgery, with reported overall rates ranging from ~10% to 75%. However, most available studies are relatively small single- center series and likely underestimate complication rates due to retrospective design and lack of rigorous collection of complications. Accurately defining the early complication rates is particularly important for patient counseling with regard to the risks and benefits of surgical treatment.

Material and Methods: As part of a prospective ASD database, standardized collection forms, on-site coordinators and auditing helped ensure complete capture of complications. Intraop and periop (<6 wks) complications were collected for all patients with these available data, regardless of subsequent length of available follow-up.

Results: 558 patients underwent surgical treatment for ASD and had a mean age of 57 years, mean Charlson Comorbidity Index of 1.5 and previous surgery in 48%. The majority (98%) of patients had treatment including a posterior instrumented approach and included a 3-column osteotomy in 22% of patients. A total of 171 intraoperative complications (69 major, 102 minor) affected 127 (22.8%) patients, and a total of 272 perioperative complications (133 major, 139 minor) affected 185 (33.2%) patients. Collectively, 443 early complications (202 major, 241 minor) were reported, with 264 (47.3%) patients experiencing one or more complication. The overall mean numbers of intraoperative, perioperative and total complications per patient were 0.31, 0.49 and 0.79, respectively.

Conclusion: ASD surgery is associated with high rates of early complications, with 47.3% of patients having at least one complication. These rates are substantially higher than previously reported. These finding may prove useful in treatment planning and patient counseling.

GO329. Vertebral Artery Injury in Cervical Spine Surgery: Results from AOSpine North America Multicenter Study on 16,582 Patients

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Introduction: Vertebral artery injury is a rare but serious complication of cervical spine surgery with an overall incidence rate of 1.4% (Rampersaud, 2006). Iatrogenic injury of the vertebral artery can lead to serious complications including lateral medullary (Wallenberg) syndrome, quadriparesis, and mortality. The high rate of vertebral artery anomalies in the general population mandates assessment via advanced imaging modalities in the preoperative period (Schroeder, 2013). The rarity of this complication makes it difficult to set expectations after an injury is encountered. This study utilized a multi-center database to compile outcomes data after vertebral artery injury during a cervical spine procedure.

Materials and Methods: A multi-center retrospective case series was compiled involving 23 medical institutions. Inclusion criteria included patients who underwent cervical spine surgery between 2005–2011 and who sustained a vertebral artery injury. IRBs were obtained from all institutions and data was sent to a private research organization that collected and collated all of the data. Patients were evaluated on the basis of condition-specific functional status using the Neck Disability Index (NDI), modified Japanese Orthopaedic Association (mJOA) score, the Nurick scale, and the 36-Item Short-Form Health Survey (SF-36).

Results: Vertebral artery injuries were identified in a total of 14 of 16,582 total patients screened (8.4 per 10,000). The mean age of patients with vertebral artery injury was 59 years (+/− 10) with a female predominance (78.6%). Diagnoses of affected patients included 7 with myelopathy, 3 with radiculopathy, 1 with cervical instability, and 2 with metastatic disease. The mean duration of operative time for cases was 4.7 hours (+/− 1.8). Vertebral artery injury was also associated with substantial blood loss (770 mL), although only 3 cases required transfusion. Of the 14 cases, 7 occurred with an anterior only approach, 3 cases with posterior only approach, and 4 during circumferential approach. Average length of hospital stay for these patients was 10 days (+/− 8). Notably, 13 of the 14 (92.86%) cases reportedly resolved without residual deficits. Compared with preoperative baseline NDI, Nurick, and SF-36 physical and mental component

scores for these patients, there were no observed changes after surgery ($p = 0.20$ Ð 0.94).

Conclusion: Vertebral artery injuries are potentially catastrophic complications that can be sustained from either anterior or posterior cervical spine approaches. This adverse event is associated with an increase in hospital stay and functional disability measured on NDI score. However, the data from this study suggests that with proper steps to ensure hemostasis, patients recover function at a high rate and do not exhibit residual deficits (13 out of 14). Preoperative imaging studies may provide insight into VA anomalies and anatomic variations and are vital to the preoperative assessment. Furthermore, although surgeons should expect increased blood loss once a vertebral artery injury is encountered, patients do not often require a blood transfusion.

GO330. Frailty and Postoperative Outcomes in Patients Undergoing Surgery for Degenerative Spine Disease

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Introduction: Frailty is defined as a state of decreased reserve and susceptibility to stressors. The relationship between frailty and outcomes after degenerative spine surgery has not been studied.

Objectives: (1) Determine prevalence of frailty in the degenerative spine population; (2) Describe patient characteristics associated with frailty; (3) Determine the ability of frailty to predict postoperative outcomes.

Material and Methods: We analyzed 52,671 patients in the National Surgical Quality Improvement Program who underwent degenerative spine surgery. A modified frailty index (mFI) was used to determine the prevalence and severity of frailty as previously described. The association of frailty with postoperative outcomes was determined using multivariate logistic regression.

Results: Frailty was present in 2,041 patients within the total population (4%), and 8% of patients older than 65 years. Frailty severity increased with increasing age, male sex, African-American race, higher body mass index, recent weight loss, paraplegia or quadriplegia, ASA score, and pre-admission residence in a care facility. Frailty severity was an independent predictor of major complication (OR 1.15 for every 0.10 increase in mFI, 95%CI 1.09–1.22, $p < 0.0005$), and specifically predicted re-operation for post-surgical infection (OR 1.3, 95% CI 1.16–1.46, $p < 0.0005$). Prolonged length of stay and discharge to a new facility were also independently predicted by frailty severity ($p < 0.0005$). Frailty severity predicted 30-day mortality on unadjusted (OR 2.05, 95%CI 1.69–2.47, $p < 0.0005$) and adjusted analysis (OR 1.44, 95%CI 1.15–1.81, $p < 0.005$).

*Conclusion***s:** Frailty is an important predictor of postoperative outcomes following degenerative spine surgery. Preoperative recognition of frailty may be useful for perioperative optimization, risk stratification and patient counseling.

GO331. Neurological Outcomes Following Iatrogenic Vascular Injury during Posterior Atlanto-axial Instrumented Fusion

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Introduction: Iatrogenic vascular injury is a feared complication of posterior atlanto-axial instrumented fusion. A better understanding of clinical course following this injury will allow surgeons to better care for these patients. The object of the study was to systematically review the neurologic outcomes after iatrogenic vascular injury during atlanto-axial posterior instrumented fusion.

Methods: A systematic review of the PubMed database was performed, following the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The extracted data was recorded in an excel spreadsheet. To be included, the patients must have undergone fusion of the C1/C2 joint using posterior instrumentation with injury to an arterial vessel directly attributable to the surgical procedure.

Results: 86 incidences of vascular injury were found in 41 articles with 11200 patients. The average age of included patients was 46.4 +/− 24.1 for the screw rod construct (SRC) group and 36.2 +/− 28.2 for the transarticular screw (TAS) group. Vascular injury in SRC cases resulted in ipsilateral stroke in 15.9% ($n = 7/44$) of patients and neurologic deficit in 22.7% ($n = 10/44$) of patients with a permanent neurologic deficit occurring in 11.4% ($n = 5/44$) of patients. Vascular injury following TAS fixation resulted in ipsilateral stroke in 11.9% of cases ($n = 5/42$) and neurologic deficit in 23.8% of cases with the deficit being permanent in 9.5% ($n = 4/42$) of cases. Death was the result of injury in 9.1% ($n = 4/44$) of SRC cases and 7.1% ($n = 3/42$) of TAS cases.

*Conclusion***s:** Neurological morbidity after iatrogenic vascular injury during posterior C1/2 fixation is higher than previously reported in literature. There has been no large-volume studies aimed at identifying a rate of neurologic complications after iatrogenic injury. Surgeons should be aware of the normal and anomalous vertebral artery anatomy to avoid this potentially catastrophic injury.

GO332. Mortality and Causes of Death in Patients Requiring VEPTR Surgery

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Introduction: The VEPTR device is used to treat a heterogeneous population of children with EOS and TIS. Complications associated with this treatment are known to be high, but there is limited documentation regarding risk of mortality in this population while undergoing treatment. The objective of this study is to report the 14 year mortality and cause of death from 4 major centers treating patients with TIS. This is a retrospective review of patients treated at 4 institutions for EOS and TIS. All patients were treated or had planned treatment with VEPTR instrumentation.

Methods: 295 consecutive patients with EOS treated with VEPTR between 2000 and 2014 were reviewed. All patients were entered into a prospectively collected database. For the patients who died during or awaiting treatment, medical records were reviewed to determine the age and cause of death.

Results: 292 patients treated with VEPTR and 3 patients awaiting surgery were included. 17 patients died during the study period, for an overall mortality rate of 5.76%. The etiology was varied in the patients who died (congenital/structural-1; neuromuscular-8; syndromic-5; idiopathic-3). There were 1261 total VEPTR-related procedures completed. Causes of death included: respiratory failure-8; shunt complications-2; cardiac failure-4; and GI complications-3. Two children died of pulmonary and nutritional complications while awaiting surgery. One patient died of a cardiac arrhythmia in the operating room.

Conclusion: EOS occurs in a complex heterogeneous group of children and is associated with multiple co-morbidities. The 2010 combined mortality rate for children 1–19 years of age was 54.1/100,000 while the rate for this group was 823.2/100,000 suggesting the long term natural history of this condition is associated with significantly increased mortality. While the aggressive surgical management of EOS compared with the natural history is not debated, there is clearly a need for a better understanding of the mortality risk over time for this patient population.

GO333. Frequency of Post-Operative Hematoma in Lumbar Disc Excision Through Fenestration without Closed-Suction Drainage

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Introduction: Spinal epidural hematoma is a well-known complication of spinal surgery. To prevent hematoma formation its routine that suction drain is placed for 24 to 48 hours after laminectomy. But Clinically insignificant small epidural hematomas develop after Lumbar disc excision through interlaminar fenestration. The aim of this study is to find out Frequency of Post-Operative Hematoma in Lumbar Disc Excision through Fenestration without closed-suction drainage.

Materials and Methods: This was a descriptive case series done at Ghurki trust teaching hospital Lahore from from January 2009 to January 2014. Total 423 cases who underwent Lumbar Disc Excision through Fenestration were included in the study. All the patients were followed for 7 days for postoperative Spinal Hematoma Formation which was considered positive in patients who either develop a new post-operative neurological deficit or pain and on mri shows Spinal Epidural Hematoma at the site of surgery.

Results: Frequency of post-operative hematoma after lumbar disc excision through fenestration without using closed-suction drainage reveals 2.13%($n = 9$) while 97.87% ($n = 414$) had no findings of hematoma.

Conclusion: We concluded that frequency of post-operative hematoma after lumbar disc excision through fenestration without using closed-suction drainage is determined as insignificant.

Trauma Cervical 4

GO334. Assessing Transverse Ligament Integrity Throught a New CT Based Alternative

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Objectives: The Rule of Spence for assessing integrity of the transverse atlantal ligament (TAL) suffers from poor specificity and sensitivity, frequently incorrectly reflecting the condition of the TAL. Since CT scans are quickly and easily obtained in trauma centers, we propose using a special sequence of two CT scans for more accurate diagnosis of injury to the TAL. We sought to assess the sensitivity of the CT method for TAL injury diagnosis in a laboratory setting.

Materials and Methods: Ten human cadaveric specimens were mounted horizontally in a supine posture with wooden inserts attached to the back of the skull to maintain neutral or slightly flexed (10°) postures.Specimens were scanned in neutral and flexed postures in four conditions: intact ($N = 10$), after simulated Jefferson fracture with TAL intact ($N = 5$),after TAL disruption without fracture ($N = 5$), and after TAL disruption with simulated fracture ($N = 10$). Atlanto-dens interval (ADI) from sagittal slices of the CT image was measured to assess anteroposterior instability of C1-C2; cross-sectional canal area was measured to assess canal encroachment caused by the flexed posture.

Results: In going from neutral to slight flexion, ADI increased by 0.02 mm (2.5%) in intact spines, 0.08 mm (6.25%) after Jefferson fracture without TAL disruption, 0.4 mm (34%) after TAL disruption without fracture, and 0.42mm (25%) after TAL disruption with fracture (Fig. 1). ADI increases from neutral to flexed were not significant ($p > 0.33$, paired Student's *t*-test) in normal condition or with fracture.without TAL disruption. However, ADI increases were significant with TAL disruption or TAL disruption+fracture ($p < 0.035$). Increases in canal area were $< 0.8\%$ and were not significant ($p > 0.74$).

Conclusions: This study explores the possibility of utilizing two CT scans to evaluate TAL integrity. The change in ADI between these two postures was very sensitive in distinguishing TAL injury from atlas fracture. The results of this study indicate that this method should be more sensitive than the Rule of Spence for evaluating TAL integrity. By the conclusion of this session, participants should be able to identify tranverse ligament injury with a new proposed CT based method.

GO335. Should We Remove Bullets From The Spinal Cord?

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Introduction: To discuss a case and review evidence for and against intra-dural bullet removal.

Materials and Methods: A 45 year-old gentleman presented with gunshot wound, with a loss of sensation below his chest and loss of power in his lower limbs. On examination there was a single 1cmx0.5cm bullet entry wound on the anterolateral aspect of the left shoulder, with a T3 motor and sensory level. PR revealed reduced tone and no squeeze. A full body CT showed a bullet within the spinal canal adjacent to the T3 vertebral body. The spinal injuries team diagnosed a T3 complete ASIA A paraplegia. He underwent a posterior

decompression of T3 and intra-dural bullet removal with dura repair on the same day. Surgery revealed a dural tear and an intra-dural bullet with obvious cord damage. This was removed with rubberised forceps and handed to police for ballistics. He was given flucloxacillin and transferred to the spinal injuries unit for rehabilitation. He made no neurological recovery but did not develop any further complications.

Results: A thorough literature search revealed the role of surgery in gaining lost neurological function remains ambiguous. Indications for bullet removal include acute neurological deterioration and CSF fistulas. Epidural haematoma/abscesses, radiological compression or a destabilized spine are also considerations. Removals of bullets below T12 have had an effect on motor recovery. However similar neurological recoveries have been reported in both surgical and conservative management of incomplete deficits. Compete deficits are unlikely to improve neurologically regardless of surgical intervention, however cervical injuries with early detection of compressive pathology should be considered. Complication rates are reported to be higher if operated. Prophylactic antibiotics should be started immediately on admission. Surgery does not reduce the incidence of infection. Pain may be intensified when caused by a gunshot injury, but there is no evidence of improvement with bullet removal. One indication for surgery in this case was to prevent post traumatic syringomyelia (PTS). The incidence is 0.3–3.2%, however radiological/autopsy studies suggest up to 22%.There has been one prior reported case where a patient developed symptoms 14 months following initial gunshot injury. However due to lack of data it is uncertain if initial surgical management reduces development of future syrinxes.

Conclusions: This appears to be the first reported case of an intra-dural bullet in the UK. Treatment should be focused on ensuring spine stability, enhancing potential for neurological recovery and preventing complications. The role of surgery versus non-surgical treatment is still debate.

GO336. Factors Influencing Outcomes during and Post Hospitalization in Geriatric Cervical Spine Injuries- do the Young and Old Elderly Differ?

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Introduction: Geriatric patients with cervical spine injuries are known to have high morbidity and mortality. Our aim was to evaluate the acute outcomes of geriatric cervical spine injuries in terms of morbidity, mortality, and factors influencing it during hospitalization and after discharge, and the differences between young and old elderly patients.

Material and Methods: Hospital records of 62 geriatric patients with cervical spine injuries from 2003–2014 were retrospectively reviewed and telephonic interview after discharge were done. Patients were divided into young (65-74yrs) and old (>74yrs) elderly groups. Demographics, mechanism and level of injury, duration of stay (ward/ICU), radiographic findings, neurological deficits, comorbidities, type of management, mortality, factors influencing mortality and complications rates were studied.

Results: 45 patients were young elderly and 17 old elderly. Mean age was 70.46 years. 39 sustained high velocity injury and 23 low velocity. C4–5 was the most common injured level. 34 patients had preexisting co-morbid conditions, cardiac was most common. 34 patients underwent surgery. Mean ICU stay was 16.93 days and ward stay 43.94 days. Pulmonary complications were most common in old elderly. Tracheostomy was required in 20 patients and ventilator support in 24 patients. 28 patients had complete deficit, 27 had incomplete neurology and 7 had normal neurology. Mean duration of follow up was 3.2 years. 14 patients died in our series. 10 patients had returned to preinjury functional level. Mortality was more common in old elderly patients with conservative treatment, patients with higher level of neurological deficit, multiple comorbidities, and ventilator dependancy.

Conclusion: Differences exist between young and old elderly with cervical spine injuries, and there are high morbidity, mortality rates. Efforts should be made to reduce pulmonary complications in this age group of patients. Surgical management can be performed reasonably safely when indicated.

GO337. Traumatic Atlantoaxial Rotatory Fixation (AARF) with Odontoid Fracture, Case report

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Introduction: Atlantoaxial rotatory fixation (AARF) is also known as rotatory subluxation, rotatory displacement, rotary deformity, rotational subluxation, and is characterized by incomplete dislocation of the inferior atlantal and superior axial articular facets.[1] AARF in combination with odontoid fracture is an extremely rare injury.[2–6] Atlantoaxial injuries can be classified according to Fielding [1] or White and Panjabi[7] classification. The management of this combination is a matter of debate. [1,8,9]

Material and Methods: We present a case of a 78 years old woman who sustained a fall on the ground from a couch directly on her forehead, resulting in atlantoaxial dislocation with type II odontoid fracture accompanied with left sided hemiparesis ASIA type C.

Results: After failure of closed reduction, the treatment plane was to achieve reduction under anesthesia and C1–2 fusion, but again reduction was not possible. Occipitocervical fusion to C3 was done to have better stability in osteoporotic bone. Successful reduction was achieved during rod reduction from the occiput to C2 pedicle screw and C3 lateral mass screw. Cervical collar was advised for 3 months, and good fusion and improvement of the neurological status to ASIA type D was achieved after 6 month.

Conclusion: AARF with Odontoid Fracture is a rare combination and reduction may be impossible. Occipitocervical fusion is a good option in such case as C1–2 reduction is a prerequisite for transarticular screw. C2 pedicle screw offers good purchase even in osteoporotic bone which enabled reduction after rod repositioning.

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GO338. Management of Cervical Lateral Mass Fractures

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Introduction: Cervical lateral mass fractures are frequent injuries encountered in a spine trauma practice. The aim of this study was to define outcomes for operative versus non-operative management by reviewing our experience with these injuries.

Material and Methods: The design of this study was retrospective. It was conducted at University of Alabama Hospitals, USA. Institutional Review Board approval was duly obtained. We used electronic records and ICD codes to identify 34 consecutive cases, presenting to this hospital in the year 2011.

Results: The age range was 22–88 years (mean=45). Most injuries were due to motor vehicle accidents. C7 facets were the most frequently injured ($n = 22$). The injuries were grouped by fracture orientation into: Coronal split fracture $n = 19$, sagittal split $n = 8$, comminuted $n = 4$, floating (fractured pedicle and lamina) $n = 3$. Surgical intervention was performed in 16 patients (47%) and non-surgical (rigid collar/halo) in 18 patients (53%). Of surgical cases, 14 received ACDF and 2 received posterior constructs. The follow-up duration was 2 weeks to 12 months (mean 3.2 months). In the surgical group 8 patients were asymptomatic at follow-up, and 8 patients had neck pain. In the non- surgical group 11 patients were asymptomatic and 2 patients had neck pain. In the surgical group definite evidence of fusion was seen on follow-up radiographs in 7 patients and a further 6 patients did not have any movement on flexion extension views. One patient in the surgical group had post-op movement on dynamic X-Ray. In the non-surgical group, 10 patients had no movement on flexion extension views, one patient had minor movement, and no X-Rays were available in the remaining cases.

Conclusion: Clinical outcomes were similar in both surgical and non-surgical groups of facet fractures, with about half in each group being pain free at follow-up. Similarly radiological studies demonstrated good spinal stability in the majority of both surgical and non- surgical groups. There is no clear consensus in the literature regarding the treatment paradigms for cervical facet fractures. Our retrospective data suggests equivalent outcome with both surgical and non-surgical treatment modalities. Further randomized prospective studies are warranted.

GO339. Anterior Cervical Decompression, Fusion, and Stabilization by Cervical Plate and Screw for Traumatic Lower Cervical Spinal Injury: A Series of 62 Patients

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Introduction: Acute cervical spinal injury is one of the most common causes of severe disability and death following trauma. Though treatment of cervical spine injury is controversial but anterior cervical surgery has still a better outcome then any other method.

Material and Methods: A prospective study was done in NITOR and other private clinics at Dhaka from July 2009 - September 2014. Discectomy or corpectomy was done for decompression, tricortical bone graft or cage with bone graft was used for fusion. Cervical plate was used in all. Total case was 62 (M-46, F-16). Age ranging from 14 – 52 years. Total follow up time was 3 Months to 48 Months. Quantification of deficit and neurological outcome was rated by ASIA impairment scale.

Results: The results shows that peak incidence was in 3rd decade. Falling due to slip while carrying heavy load on head was the most common cause. The commonest skeletal level was C5/C6. Among 62, during the pre operative period, 6 patients had ASIA impairment scale A, 25 patients had ASIA impairment scale B, 28 had ASIA impairment scale C & 3 had ASIA impairment scale D. At follow up, 22 of ASIA B changed to ASIA D, 3 of ASIA B changed to ASIA E, 18 of ASIA C changed to ASIA D, 10 of ASIA C changed to ASIA E, 3 of ASIA D changed to ASIA E & 6 of ASIA A remain unchanged. None had worsening of neurodeficit due to surgery.

Conclusion: For better outcome, proper selection of case is very important. As no neurological recovery occurs in complete lesion but for early mobilization and prevention of further complication- surgery may be considered.

Keywords: cervical spinal injury, ASIA impairment scale, neurological outcome, anterior decompression and stabilization

Tumors 3

GO340. Posterior Transpedicular Approach for Circumferential Decompression and Anterior Reconstruction Using Trabecular Metal Mesh Cage in Patients with Metastatic Spinal Tumor

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Introduction: The goal of surgical management for metastatic spinal tumors is to remove the tumor mass, restore the spinal stability and alignment, and provided better quality of life. Posterior transpedicular approach for circumferential decompression and reconstruction was proposed in concern of the morbidity related to anterior approach. We used this unique technique with trabecular metal (TM) mesh cage for anterior reconstruction to treat the patients with metastatic spinal tumor. Our purpose is to evaluate the feasibility and efficacy of this method as an alternative procedure for managing metastatic spinal tumors.

Methods: From January 2009 to December 2012, we performed single stage circumferential debridement and reconstruction with TM mesh cage through single posterior approach to treat 20 patients with metastatic spinal tumors. The visual analog score (VAS), neurologic status, vertebral body reconstruction, operation time, blood loss, and complications were recorded. The patient's conditions were

evaluated on the basis of modified Brodsky's criteria which categorized them as excellent, good, fair, or poor.

Results: The average VAS score was 8.2 (range, 7 to 9) before surgery, which was significant decreased to 3.2 (range, 2 to 4) after surgery ($p < 0.001$). The average cobb's angle correction was 12 degree (range, 3 to 29). The neurologic status which classified by Frankel's scale was significant improved after surgery ($p < 0.001$). No one experienced severe complication such as deep infection or neurologic deterioration. Three patients experienced long-term paresthesia around nerve roots territory. Eighteen patients could achieve good or excellent outcome based on modified Brodsky's criteria and the improvement showed significant difference after surgery ($p < 0.001$). The blood loss and operative time in the last 10 cases was significantly decreased while comparing to the initial 10 cases ($p = 0.007$ for blood loss and $p = 0.005$ for operative time). No significant difference in clinical outcome which classified by Macnab criteria between the initial and last 10 patients ($p = 0.654$).

*Conclusion***s:** In our case series, good functional outcome and low complication rate could be achieved by single-stage posterior transpedicular approach. It could be an alternative method to manage the patients with metastatic spinal tumors.

Keywords: posterior transpedicular approach, spinal tumor, TM mesh cage, metastasis

GO341. Management of Spinal Degenerative Stenosis in Patients with Spinal Tumors

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Introduction: The evolution of conservative treatment, such as radiation therapy, chemotherapy has prolonged significantly life expectancy of patients with spinal tumors. Paradoxically, the complexity of decision making for this patient population increased due to chronic disease management. The purpose of our research is evaluation of health-related quality of life (HRQOL) parameters in patients with spinal tumors and degenerative spinal stenosis.

Material and Methods: Retrospective data were collected for 17 patients with spinal tumors (multiple myeloma ($n = 7$), metastasis of breast cancer ($n = 5$), renal cell carcinoma ($n = 4$), bladder cancer ($n = 1$)). Inclusion criteria were the following: spinal tumor lesions with 0–6 scores in Spinal Instability Neoplastic Score (SINS), degenerative spinal stenosis with neurological deficit (Frankel grade C-D), unsuccessful nonoperative treatment of degenerative disease (VAS 7–9). According to revised Tokuhashi scoring system, patients were divided into two groups. The first group included 11 patients with 0–8 scores (good prognosis). The second group consisted of 6 patients with 9–11 scores (moderate prognosis). All patients underwent degenerative stenosis surgery using foraminotomy and instrumentalization. Groups were evaluated with HRQOL-scales including VAS, ODI and Frankel. HRQOL-parameters and complications were analyzed and compared between two groups. The comparisons were done by using independent sample Student *t*-test. A p-value of less than 0.05 was accepted as significant.

Results: HRQOL-scores (VAS, ODI, Frankel) of the patients were increased after operation in both groups. The HRQOL-scores after 18 months are slightly higher in the first group, but we did not get significant difference between groups ($p > 0.05$). The number of complications in the form of implant instability, proximal and distal junctional disorders was comparable ($p > 0.05$). No patients had progression of oncology disease or new metastasis of tumor during follow-up in the first group. In the second group tumor came out of remission in 1 case (new visceral and bone metastasis).

Conclusion: Management of spinal degenerative stenosis in patients with spinal tumors provides to increase quality of life. We believe that degenerative stenosis surgery does not affect on progression of oncology disease.

GO342. Surgical Management of Spinal Osteoblastomas

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Introduction: Primary spinal osteoblastomas are rare benign neoplasms which often behave more aggressively than other benign tumors and can present as malignant transformations. Optimal surgical treatment strategies and risk factors for local recurrence and mortality of spinal osteoblastomas remain unclear. The aim of this multicenter cohort study was to assess rates of local recurrence and mortality following surgical intervention for spinal osteoblastomas and to evaluate whether the application of the Enneking classification in the management of these tumors influences local recurrence and mortality.

Methods: The AOSpine Knowledge Forum Tumor developed a multicenter ambispective database of patients who underwent surgical intervention for spinal osteoblastoma. Patient demographic, diagnosis, treatment, cross-sectional survival, and local recurrence data were collected. Patients were analyzed in two cohorts based on the Enneking classification of the tumor: Enneking appropriate (EA) and Enneking inappropriate (EI). EA was defined by the final pathology margin matching the Enneking recommended surgical margin, if otherwise, it was defined as EI.

Results: Between November 1991 and June 2012, a total of 102 patients diagnosed with a spinal osteoblastoma were identified. Twenty-eight patients were omitted from the analysis due to insufficient follow-up (<12 months) or incomplete survival data, leaving 74 patients for final analysis. The mean follow-up was 4.3 ± 2.8 years in the EI and 4.5 ± 3.3 years in the EA group. Thirteen (18%) patients suffered a local

recurrence and six (8%) patients died during the study period. Local recurrence was strongly associated with mortality with a relative risk of 9.4 ($p = 0.007$). When adjusting for Enneking appropriateness, the result was not significantly altered. Significant differences were not found between the EA and EI groups for local recurrence and mortality.

Conclusion: Upon evaluating the largest multicenter cohort of spinal osteoblastomas to date, the application of the Enneking classification as treatment guide for spinal osteoblastomas could not be confirmed. Considering the consequences of a local recurrence and the strong association of local recurrence with mortality even after adjusting for Enneking appropriateness, en bloc or marginal resection is nevertheless the recommended surgical treatment strategy for spinal osteoblastoma.

GO343. Lumbo-iliac Reconstruction after Total Sacrectomy

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Introduction: Giant sacral tumors often require a radical and extensive surgical approach. En bloc–sacrectomy implies a surgical challenge for the anatomical stability of the spino-pelvic joint. Different fusion approaches have been used to address this situation. We describe the surgical technique and summarize the clinical outcome after a total resection of giant sacral tumors and a transpedicular lumbo-iliac fusion.

Material and Methods: Case report of three patients who underwent an En-bloc sacrectomy between february of 2013 and February 2015. A combined extraperitoneal and posterior approach was used headed by a multidisciplinary surgical group of neurosurgeons, colorectal and plastic surgeons.We used a transperitoneal approach for anterior and lateral tumor isolation and for sacral dissection from ligaments and muscle insertion sites. Subsequently a posterior approach was used through which an L5-S1 diskectomy was performed followed by lateral osteotomies for sacral wing separation and bilateral S1 pedicle and laminae osteotomies with intact preservation of S1 nerve roots. Then the dural sac was ligated and the sacrum was amputated.For reconstruction of tumor site, a lumbo-iliac arthodesis was performed using polyaxial bilateral pedicle screws in L3, L4, L5 and two bilateral Transiliac Monoaxial screws. Vertical rods placed alongside the spine bylaterally maintaining lorditic axis, Cross links to connect the two vertical rods and Heterologous bone grafts were used.

Results: The three patients underwent a successful en bloc sacrectomy and lumbo-Iliac reconstruction without perioperative mortality and significant morbidity. Total tumor resection was performed in the three patients. None of the patients had gait disturbances after surgery. Patients were followed 6 to 30 months after surgery and at the final checkup there were no local recurrence reported and no instrumentation failure were noted.

Conclusion: Lumbo-iliac reconstruction through screw assisted transpedicular L3, L4, L5 and transiliac stabilization system after total oncologic sacrectomy provided spino-pelvic stability maintaining functional gait.

GO344. Malignant Osteolytic Lesions in the Sacrum (S1-S3) Treated by Targeted Radiofrequency Ablation: A New Option for Metastases in the Sacrum

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Introduction: Sacral metastases and myelomatous lesions often result in debilitating pain and significant morbidity in patients with prolonged life expectancy. Radiation therapy and cement augmentation are well described local therapies for controlling cytokine mediated osteolytic bone resportion and skeletal related events associated with metastatic and myelomatous sacral lesions. Ablative therapy has been reported in recent years as a minimally invasive therapy permitting both local treatment of bone lesions and immediate stabilization, when followed with cement augmentation. This case study reports multimodality minimally invasive treatment of patient with multiple painful osteolytic lesions using a novel articulating bipolar RF ablative therapy and an ultrahigh viscosity cement.

Material and Methods: A 75-year-old-patient with history of multiple myeloma and significant lumbar back pain presented with diffuse lytic spinal disease throughout the thoracolumbar and sacral spine. Following review by multidisciplinary tumorboard, percutaneous targeted radiofrequency ablation (t-RFA) was performed in T12-L4 and a unilateral sacral lesion (S1-S3) using an articulated bipolar electrode containing thermocouples to assess real time growth of the ablation zone followed by delivery of ultrahigh viscosity cement using RF energy warmed cement (RF-Targeted Vertebral Augmentation, RF-TVA). Pain was demonstrated preoperatively with 9 using the visual analog scale for both locations. On the first postoperative day pain was at 4(VAS), in the 6 weeks control pain was at 2(VAS). At the 3 months control pain was at 2(VAS).

Results: The combined approach of t-RFA and RF-TVA in the sacrum was technically and clinically feasible with an immediate pain reduction, improvement in quality of life and functionality at 6 weeks and 3 months after the procedure and no complications. CT performed 6 weeks post procedure confirmed the absence of cement leakage.

Conclusion: t-RFA combined with RF-TVA of the sacrum can be safely and effectively performed via a single access port resulting in significant palliative relief and functional improvement. In combination these procedures may provide an alternative palliative, minimally invasive treatment option for painful osteolytic lesions in the sacrum(S1-S3) requiring stabilization for patients in which radiation therapy may not be an option.

GO345. Surgical Treatment of Solitary Spinal Plasmacytoma

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Introduction: Solitary plasmacytoma of the vertebra is a rare condition. Treatment options include radiotherapy, surgery, radiotherapy combined with surgery, and vertebroplasty or kyphoplasty. Although radiotherapy is the treatment of choice for solitary plasmacytoma of the spine, recommendations for treatment have been based on limited data from retrospective studies.

Material and Methods: Thirteen patients of solitary spinal plasmacytoma were treated at Sohag University

Hospital between 2003 and 2014. Patients were 12 males and 1 female. Age ranged between 35 and 74 (mean 57.7) years. Lumbar spine was affected in 7 patients and thoracic spine in 6 patients. Pain was assessed on Denis pain scale. On presentation 8 patients had pain grade P5, 4 patients had pain grade P4 and 1 patient had pain grade P2. The Frankel grading system was used to assess the neurologic outcome. On presentation, 6 patients had neurological deficits; 3 Frankel grade C, and 3 Frankel grade D. Indications for surgery included pathological fracture (9 patients) and neurological compromise (6 patients). All patients received operation through a single posterior exposure. The lesion was curetted and anterior reconstruction was achieved by spinal shortening (5 patients), or anterior bone grafting (6 patients), and anterior reconstruction was not needed in 2 patients. Then posterior fusion was performed. Radiotherapy began 3 weeks after the operation.

Results: All patients got neurological recovery to Frankel grade E and improvement of pre-operative pain (6 patients to P1, 5 patients to P2 and 2 patients to P3). No local recurrence occurred after follow up for 7–102 (mean 36.9).

Conclusion: Gross-total tumor resection on piecemeal basis with post-operative adjuvant radiotherapy for solitary plasmacytoma of the spine gives long-term local control of the tumor. It can help to improve patient's quality of life.

Deformity Thoracolumbar Adult 4

GO346. The Effect of Prophylactic Vertebroplasty on the Incidence of Proximal Junctional Kyphosis and Proximal Junctional Failure Following Long Posterior Spinal Fusion in Adult Spinal Deformity: A Five-Year Follow-up Study

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Introduction: Proximal junctional kyphosis (PJK) is a well-known complication following long posterior spinal fusion (PSF) for adult spinal deformity and occurs in 9–46% of surgeries. A subset of these develop proximal junctional failure, resulting in a 26–39% revision rate within the first six months postoperatively. Risk factors for development of PJK include age $>$ 55, osteopenia, and global sagittal imbalance. We have previously described a technique for prophylactic vertebroplasty to minimize the incidence of PJF/PJK for long-segment thoracolumbar fusion surgery. Here, we present the results of this technique at five year follow-up.

Material and Methods: We reviewed clinical and radiographic data for 41 adult patients treated with PSF that received prophylactic vertebroplasty at the upper instrumented vertebra and supra-adjacent vertebrae. PJK was defined as a change in the PJK angle $\geq$10 degrees between the immediate post-operative and the final follow-up radiograph. PJF was defined as proximal junctional fracture, fixation failure, or kyphosis that required extension of the fusion.

Results: There were 5 males and 36 females. Average age at the time of initial surgery was 65.6 years (range, 41–87). 33 patients had complete five year follow-up radiographic and clinical data available and were included in the analysis. The average follow-up was 72.3 months (range, 34–124). 30.3% developed PJK (10/33), not requiring revision surgery. 9.1% developed PJF (3/33) requiring revision surgery, and extension of fusion. Of the three patients that developed PJF requiring revision surgery, none had junctional fractures that could explain the PJF. One developed PJF within six weeks of the initial surgery, one three years after, and one five years after. None of the 33 patients had evidence of vertebral fractures adjacent to cement augmented vertebrae. Health related quality of life (HRQoL) data was available for 30 patients at five year follow-up. There was no significant difference in Oswestry Disability Index, Short Form 36, or SRS-22 scores between those with and without PJK/PJF ($P > 0.05$ for all comparisons). Mean coronal alignment was comparable between patients who developed PJK/PJF (19 mm) and those who did not (20 mm) ($p = 0.64$). Mean sagittal alignment was more positive in patients who developed PJK/PJF (97 mm) compared with those who did not (79 mm), but this was not significant ($p = 0.42$). There were no significant differences in thoracic kyphosis ($p = 0.39$) or lumbar lordosis ($p = 0.93$) between the two groups.

Conclusion: The incidence of PJK was 30.3% and the incidence of PJF was 9.1% at five year follow-up. There were no junctional fractures in this population, and no clinically significant long term complications from the use of vertebroplasty. Prophylactic vertebroplasty in long PSF for adult spinal deformity is a safe and effective method to minimize the incidence of PJF.

GO347. Incidence, Predictors and Post-Operative Complications of Blood Transfusion in Thoracic and Lumbar Fusion Surgery: An Analysis of 14,249 Patients from the ACS-NSQIP Database

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Introduction: Hemorrhage and transfusion requirements in spine surgery are common. This is especially true for thoracic and lumbar fusion surgeries. There is limited data in the literature concerning predictive factors for transfusion and their effect on short-term post-operative outcomes.

Material and Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent lumbar or thoracic fusion surgery from 2010 to 2013. Univariate and multivariate regression analysis was used to determine predictive factors and post-operative complications associated with transfusion.

Results: A total of 14,249 patients were included in this study; 13,586 had lumbar fusion and 663 had thoracic fusion surgery. The prevalence of transfusion was 35% for thoracic fusion and 17.5% for lumbar fusion. The multivariate analysis showed that age between 50–60 (OR 1.38, CI: 1.23–1.54), age between 61–70 (OR 1.65, CI: 1.40–1.95), dyspnea (OR 1.11, CI: 1.02–1.23), hypertension (OR 1.14, CI: 1.02–1.27), ASA class (OR 1.73, 1.18–1.45), pre-operative blood transfusion (OR 1.91, CI: 1.04–3.49), and extended surgical time (OR 4.51, CI: 4.09–4.98) were predictors of blood transfusion requirements for lumbar fusion. While only pre-operative BUN (OR 1.04, CI: 1.01–1.06) and extended surgical time (OR 4.70, CI: 3.12–6.96) were predictors of transfusion for thoracic fusion. In contrast, higher pre-operative hematocrit was protective against transfusion. Patients transfused who underwent lumbar fusion had an increased risk to develop superficial wound infection, deep wound infection, venous thromboembolism, myocardial infarction and had longer length of hospital stay. Patients transfused who underwent thoracic fusion were more likely to have venous thromboembolism and extended length of hospital stay. However, mortality was not associated with blood transfusion.

Conclusion: This study used a large database to characterize the incidence, predictors and post-operative complications associated with blood transfusion in thoracic and lumbar fusion surgeries. Pre- and post-operative planning for patients deemed to be at high-risk of requiring blood

transfusion should be considered to reduce post-operative complication in this population.

GO348. Predictors of Neurological Motor Decline in Complex Adult Spinal Deformity Surgery: Results of the Prospective, International, Multicenter Scoli-RISK-1 Study

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Introduction: Significant variability in neurologic outcomes following surgical correction for ASD has been reported. Risk factors for decline in neurologic motor outcomes are poorly understood. The objective of this prospective, multicenter, international cohort study in 15 sites is to evaluate the incidence and risk factors for postoperative neurological motor decline in patients undergoing surgery for complex adult spinal deformity (ASD).

Material and Methods: From September 2011 to October 2012, 273 consecutive patients were prospectively enrolled. One patient lacked baseline ASIA lower extremity motor score (LEMS), and one patient did not have follow-up LEMS leaving 271 (99.27%) subjects for analysis. Decline in neurologic motor outcomes was defined as deterioration in any of discharge or 6 weeks American Spinal Injury Association (ASIA) Lower Extremity Motor Scores (LEMS) compared with pre-operative status. To identify risk factors associated with decline in LEMS, two step statistical analysis was performed. First, 128 candidate variables consisting of demographics, comorbidities, treatment history, disease severity, radiologic parameters and surgical details were screened in bi-variate models. Then, 53 variables that had a p-value of 0.2 or less were included in a multivariate logistic stepwise model.

Results: 70 (25.93%) patients showed decline and 200 (74.07%) had no decline in LEMS. Of those with a decline, nine patients (overall rate of 3.33%) had a severe deterioration of $>$ 10 points on LEMS scale. Key factors associated with postoperative neurological deterioration included older age, non East Asian ethnicity, cardiovascular disease, preoperative motor weakness, kyphosis on T12 – S1, focal severe deformity angle, pedicle subtraction osteotomy, thoracic level fusion and intraoperative motor evoked potential change.

Conclusion: Although complex ASD surgery can enhance the quality of life of adult patients with severe deformity, a significant portion of patients with ASD experience a postoperative decline in LEMS. The risk factors identified in this study are useful to help clinicians to anticipate and potentially develop strategies to reduce the risk of postoperative neurologic complications.

GO349. Defining Normative Quality Metrics in Complex High-Risk Deformity Cases: Results from the Scoli-Risk 1 Study

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Introduction: Quality metrics are a component of the value calculation, and reflect the risk of care. There is significant variability in complication rates, and quality metric standards in spinal surgery. Case complexity or surgical invasiveness is an important predictor of perioperative complications, and normative standards for quality metrics should be stratified by case complexity. The purpose of this study is to define normative quality metrics for complex, high-risk spinal deformity cases, and to provide a standard and baseline data that may guide quality improvement in comparative research.

Material and Methods: Secondary analysis of a prospective, international multicenter observational study (Scoli-Risk1) The study cohort included adults with spinal deformity in the cervicothoracic or thoracolumbar regions. Quality metrics include cumulative readmission and reoperation rates (30, 90, 180 days), wound infection, and DVT rates. Chi Square analysis is used to measure the relationship between osteotomy type and readmission and reoperation. Linear regression is used to determine the association of age and procedure with readmission and reoperation.

Results: 273 patients from the Scoli-Risk 1 study were included in the analysis. Cumulative readmission rates were 7.7 (4.8;11.5), 13.2 (9.4;17.8), 16.5 (12.3;21.4) percent at 30, 90 and 180 days after index surgery. Reoperation rates were 14.7 (10.7;19.4), 17.6 (13.3;22.6), 20.1 (15.6;25.4) percent at

30, 90 and 180 days after index surgery. Age was a significant predictor of readmission during the first 180 days after surgery (OR1.388 (1.068;1.803)), but not a significant predictor of the need for reoperation (OR=1.109 (0.903;1.361)). Osteotomy type (PSO/VCR vs SPO) was not a significant predictor of the need for readmission ($p = 0.986$) or reoperation ($p = 0.753$). The overall infection rate was 7.0%, including 3.3% deep infections. The rate of DVT was 3.7%.

Conclusion: Normative quality metrics are not established for complex deformity surgery in adult patients. This paper demonstrates that readmissions and reoperations in complex spinal reconstruction in adults occur at a higher rate than expected rates in less complex spine procedures. Age is an important independent predictor of readmission, but not the need for reoperation. For each decade older, patients are 1.4 times more likely to be readmitted within 6 months of surgery. This data may be useful to provide normative data for comparative studies of surgical outcomes with similar magnitude of deformity treated with operations of comparable invasiveness.

GO350. Correlation between Lumbopelvic and Sagittal Param- eters and Health Related Quality of Life in Adults with Lumbosacral Spondylolisthesis

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Introduction: The impact of sagittal plane imbalance has been demonstrated for adult deformity and pediatric spondylolisthesis. The association between lumbopelvic parameters, global sagittal balance, and health status has not been well-defined in adults with lumbosacral spondylolisthesis. The role for deformity reduction in lumbosacral spondylolisthesis in the adult has not been well-defined. The purpose of this study is to evaluate the impact of sagittal alignment and lumbosacral parameters on health status in adults with L5-S1 spondylolisthesis.

Methods: Secondary analysis of data from a multicenter, prospective study. Health status measures included SF-12 and SRS-30. Radiographic predictor variables included: C7 sagittal vertical axis deviation (SVA), T1 and T9 spinopelvic inclinations, pelvic tilt (PT), pelvic incidence (PI), sacral slope (SS), slip angle,Meyerding slip grade, and Labele classification. Pearson's correlations were calculated between each radiographic parameter and health status measure.

Results: Forty-five patients were included (male 15, female 30; average age 40.5 ± 18.7) as summarized in Table 1. For low-grade slips, SVA had strong negative correlations with SF12-MCS, SRS-30 appearance, mental, and satisfaction domains (-0.57, -0.60, -0.58, -0.53, respectively; $p < 0.05$). PI had strong negative correlations with SRS-30 total, mental, and subscore domains (-0.57, -0.53, -0.57, respectively; $p \leq 0.05$). SS also had a strong negative correlation with SF12-MCS (-0.61; $p = 0.02$), while thoracic kyphosis had a strong positive correlation with SRS-activity (0.62; $p = 0.02$). For high-grade slips, slip angle had a moderate negative correlation with SF12-MCS (-0.36; $p = 0.05$). SVA had strong negative correlations with SF12-PCS, SRS-30 appearance, activity domains (-0.48, -0.48, 0.45; $p < 0.05$) and a moderate negative correlation with SRS-30 subscore (-0.37; $p < 0.05$). T1PI had a moderate negative correlation with SF12-PCS and SRS-22 appearance (-0.37, -0.36; $p \leq 0.05$).

Conclusion: Lumbosacral spondylolisthesis in adults negatively impacts mental and physical HRQoL. While HRQoL are similar between patients with low- and high-grade slips, multiple global and local radiographic sagittal parameters negatively impact HRQoLs for both groups. Improvement of global sagittal balance and lumbopelvic parameters in adults with lumbosacral spondylolisthesis may be useful in improving health status in adults.

GO351. Recovery Pattern in Surgical Management of Late Onset Myelopathy Due to Spinal Deformity

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Introduction: Late onset paraplegia due to spinal deformity heralds a progressive death of neurological function. Evidence suggests that decompression and deformity correction offers a promising result.

Aims: To analyze recovery patterns after surgery for late onset myelopathy.

Methods: 25 consecutive patients were reviewed. Average age was 17.84yrs and duration of pre-operative deficit was 4.6months. 18 patients had paraparesis and 7 quadriparesis. The average JOA score was 4.85/17 in quadriparetic and 5.33/11 in paraparetic patients. The average Nurick's grade was 2.7.The average spasticity was 2.2 (1- 4) as per Ashworth scale. 13 patients had bladder dysfunction. Deformity apex was cervical, cervico-dorsal, upper-dorsal and dorsal in 5, 4, 2 and 14 patients. 19 had kyphosis and 6 had multi-planar deformity. Vertebral resection osteotomy was performed in 13 and decompression alone in 12. Methodology: The records were obtained from software Horizon CSR used to register all patients form 2000–2009. The final follow-up was obtained by direct patient interview in 11, telephonic interview 5 and via email in 9.

Results: At 1year, significant improvement in JOA scores were seen recovery patters. Of the2 patients, 2 patients, 14 had immediate recovery (4 Weeks), delayed recovery (4 -12 Weeks) was seen in 9 patients and 2 patients developed deterioration after surgery. Out of the 13 patients with bladder dysfunction, 2 developed worsening post surgery. Average Nurick's grade improved from 2.7 to 2.3. Complications: Pulmonary complications developed in 5 patients, 4 patients had wound dehiscence, 2 patients showed Myelopathy progression, 1 patient developed Brachial plexus paresis and progression of deformity was observed in 6 patients.

*Conclusion*s: (1) Severity and duration of pre operative deficit correlate with neurological outcome (correlation coefficient(r value) = 0.72). (2) Safe correction of deformity provides a better mechanical and physiological environment for lasting results.

Table 2

	Total	Low grade	High grade	*P*-value
N	45	14	31	n/a
Age	40.5 ± 18.7	51.9 ± 17.6	35.3 ± 16.9	<0.01
Gender				
Male	15	5	10	
Female	30	9	21	
Meydering Grade				
1	0	0	n/a	n/a
2	14	14	n/a	n/a
3	20	n/a	20	n/a
4	9	n/a	9	n/a
5	2	n/a	2	n/a
Labele*				
1	0	0	n/a	n/a
2	1	1	n/a	n/a
3	12	12	n/a	n/a
4	16	n/a	16	n/a
5	13	n/a	13	n/a
6	1	n/a	1	n/a
Radiographic				
PI	79.6 ± 10.7	79.4 ± 11.0	79.7 ± 10.7	0.94
SS	50.7 ± 10.3	49.5 ± 9.2	51.2 ± 10.9	0.63
PT	29.5 ± 6.2	29.9 ± 6.6	29.2 ± 6.2	0.74
LL	66.6 ± 16.0	62.2 ± 16.9	68.7 ± 15.4	0.21
TK	44.5 ± 11.0	49.5 ± 8.2	42.2 ± 11.4	0.04
SVA	26.0 ± 51.4	20.2 ± 55.3	28.7 ± 50.4	0.61
Slip angle	5.5 ± 14.5	-4.26 ± 7.8	9.8 ± 14.7	<0.01
T1PI	-5.7 ± 3.9	-5.9 ± 4.4	-5.6 ± 3.7	0.83
T9PI	-8.6 ± 4.9	-10.5 ± 4.2	-7.7 ± 5.0	0.08
Outcomes				
SF-12				
PCS	36.4 ± 8.1	34.4 ± 8.8	37.3 ± 7.6	0.28
MCS	47.9 ± 11.5	46.5 ± 10.4	48.5 ± 24.4	0.58
SRS-30				
Pain	2.5 ± 0.8	2.2 ± 0.6	2.6 ± 0.8	0.08
Appearance	2.9 ± 0.7	3.0 ± 0.9	2.8 ± 0.6	0.55
Activity	2.9 ± 0.8	2.7 ± 0.9	3.0 ± 0.8	0.19
Mental Health	3.4 ± 0.9	3.3 ± 0.9	3.5 ± 0.9	0.46
Subscore	2.9 ± 0.6	2.8 ± 0.7	3.0 ± 0.6	0.29
Satisfaction	3.0 ± 1.3	3.0 ± 1.5	3.0 ± 1.3	0.84
Total	2.9 ± 0.6	2.8 ± 0.7	3.0 ± 0.6	0.37

Abbreviations: LL, lumbar lordosis; MCS, mental component score; PCS, physical component score; PI, pelvic incidence; PT, pelvic tilt; SS, sacral slope; SVA, sagittal vertical axis deviation; T1PI, T1 pelvic inclination; T9PI, T9 pelvic inclination; TK, thoracic kyphosis.
*2 patients without Labele classification.

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GO352. The Prevalence of Vitamin D deficiency in Elective Spine Surgery: A Study in Three Orthopaedic Centers

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Introduction: Decreased bone mineral density due to osteoporosis and osteomalacia pose a significant risk for instrumentation failure and adjacent fractures in elective spinal surgery. The purpose of this study was to evaluate serum levels of 25hydroxyvitamin D (25OH D) in patients presenting for elective spine surgery and to determine whether patients with degenerative spinal disease and spinal instability need a perioperative treatment with Vitamin D substitution.

Material and Methods: Serum 25-OH vitamin D levels were evaluated postoperatively (<72 hours) in patients undergoing elective spinal fusion in three orthopaedic centers, in Germany and in Greece. Patients with diagnosis of spinal instability as well as with degenerative spine disease were treated with spinal fusion.

Results: 369 consecutive patients (mean, 68.3 ± 15.4 years) were admitted for elective spine surgery. Mean 25-OH vitamin D level was 19,44 ± 11,52 ng/mL (range, 4–71,8 ng/mL). 228 (62.0%) patients were diagnosed with vitamin D deficiency and 87 (38.9%) were diagnosed with vitamin D insufficiency (20–30 ng/mL). There was no statistically significant difference between men and women. There was also no significant difference between the patients of the three centers.

Conclusion: Vitamin D deficiency is very common in patients with spinal instability as well as with degenerative spine disease. Therefore an algorithm of treatment as well as a preoperative control of the Vitamin D values is required before spine fusion surgery is performed, to enhance bone mineral density and thus better pedicle screw fixation.

GO353. Unilateral Approach for Bilateral Microsurgical Decompression of Lumbar Spinal Stenosis: Synopsis of 15 Years of Experience with This Surgical Method

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Introduction: The surgical aim in the treatment of symptomatic lumbar spinal stenosis is the relief of the patient's complaints by an adequate neural decompression. In a preliminary cadaver study the unilateral laminotomy for bilateral access to the lumbar spinal canal was investigated, and the experiences were evaluated in a clinical study.

Material and Methods: Microsurgical decompression was performed by partial resection of the ipsilateral facet, the medial portion of the laminar arch, the contralateral facet and by complete removal of the ligamentum flavum bilaterally. Anatomical, radiological and morphometrical studies on 4 adult cadaver spine specimens have proved the feasibility of this unilateral approach. Complete bilateral flavectomy and partial bilateral facetectomy were the essential surgical steps for an adequate operative decompression. The clinical practicability in the treatment of lumbar spinal stenosis was initially confirmed in 254 patients.

Results: The postoperative morphometric evaluation in the cadaver study clearly demonstrates that bilateral ligamentectomy and recess decompression were adequately and successfully achieved via unilateral approach. The clinical evaluation of this technique was performed in 254 patients with symptomatic mono- or multisegmental lumbar stenosis. Postoperatively, 229 of the 254 patients with neurogenic claudication (90.2%) demonstrated a marked improvement of the walking distance. The follow-up of 249 patients (mean follow-up time was 37 months) demonstrated an excellent result without pain in 77 patients (30.9%); a good outcome with mild residual pain, but a normal working capacity in 130 patients (52.2%); and a fair outcome with unchanged postoperative low-back pain but markedly improved working capacity and walking distance in 41 patients (16.4%). There was only one patient with surgically induced, permanent neurological deterioration (0.5%). In nine patients, an inadvertent dural tear occurred, and due to unchanged symptoms three patients with a multisegmental stenosis had to be re-operated on at an additional level. During the past 15 years the author has experience with this method in over 1600 microsurgical decompression procedures.

Conclusion: Unilateral laminotomy and bilateral spinal canal decompression represents a safe, effective and minimally invasive surgical method and meanwhile is a routine microsurgical strategy for the treatment of patients with lumbar spinal stenosis.

AGO354. Adjacent Segment Degeneration after Lumbar Spinal Fusion Compared with Motion-Preservation Procedures: A Meta-analysis

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Introduction: Adjacent segment degeneration (ASDeg) or adjacent segment disease (ASDis) is a matter of concern after lumbar fusion. Whether the motion-preservation procedures could reduce the prevalence of ASDeg or ASDis is still controversial. This meta-analysis aimed to evaluate the efficacy of motion-preservation procedures preventing the ASDeg or ASDis compared with fusion in lumbar spine.

Methods: PubMed, Embase, the Cochrane Library were comprehensively searched and a meta-analysis was performed of all randomized controlled trials (RCTs) and well designed prospective or retrospective comparative cohort studies assessing the lumbar fusion and motion-preservation procedures. We compared the ASDeg/ASDis rate, reoperation rate, operation time, blood loss, length of hospital stay and VAS/ODI improvement of the two procedures.

Results: A total of 15 studies consisting of 1474 patients were included in this study. The meta-analysis indicated that the prevalence of ASDeg, ASDis and reoperation rate on the adjacent level were lower in motion-preservation procedures group than in the fusion group ($p = 0.001$;$p = 0.0004$; $p < 0.0001$). Moreover, shorter length of hospital stay was found in motion-preservation procedures group ($p < 0.0001$). No difference was found in terms of operation time ($p = 0.57$), blood loss ($p = 0.27$), VAS ($p = 0.76$) and ODI improvement ($p = 0.71$) between the two groups.

Conclusions: The present evidences indicated that the motion-preservation procedures had an advantage on reducing the prevalence of ASDeg, ASDis and the reoperation rate due to the adjacent segment degeneration compared with the

lumbar fusion. And the clinical outcomes of the two procedures are similar.

GO355. Anterior Lumbar Interbody Fusion (ALIF): Biometrical Results and Own Experiences

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Introduction: Lumbar fusion is a mainstay in the treatment of low back pain resulting from degenerative disc disease. Of the various fusion techniques available, anterior lumbar interbody fusion (ALIF) has become a good treatment technique to achieve this goal. Our aims were to describe our experience with lumbosacral ALIF performed in cooperation of neurosurgeons and vascular surgeons and analysis of improvement in function and a biometrical aspects.

Material and Methods: From 2011–14, 33 patients underwent ALIF, 45 were identified as having a single level procedure at L5-S1 from a mini-open retroperitoneal approach. The cases were reviewed to determine fusion status, incidence of complications and length of stay. Disc space heights were determined using a ratio of disc space height to superior end plate length. For each treatment group, anterior and posterior disc space measurements were collected on a lateral radiograph and averaged to obtain a measure for disc space height. Statistical analysis was performed using Statistica 8.0.

Results: The average length of hospitalization was 4 days. Most of patients had spinal cord stenosis. 3 patients had early complications like parestesis of lower limbs, but there were no major complications. Blood loss was less than 75 cc in all cases. The SynFix-LR implants were used for all - average size 12,31 mm and angle 11,61. The pre-op angle of lordosis was 12,3° and post-op +8,9° added. The average disc space before treatment was 10 mm and after +7,17mm added.

Conclusion: The mini-open ALIF approach for L5-S1 fusion is a reasonable alternative to the more extensive posterior approaches. Although no direct comparison with the more extensive approach has been performed, our initial experience suggests that this procedure may reduce pain, blood loss, complications and length of hospital stay. ALIF significantly restores the height of the intervertebral disc and provides stability. Based on these results, it would appear that in properly selected patients ALIF with neurosurgeon-vascular surgeon cooperation raises the standard of comparison for nonfusion methodologies with regards to short and long-term pain relief and functional recovery.

GO356. Spondyloptosis Reduction and Fixation in 25-Year-Old Male

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Introduction: Spodyloptosis is a quite difficult situation to be confronted with. All it is solutions are very challenging ranging from non-anatomical insitu fusion to hard and hazardous anatomical reorientation.

Material and Methods: Male patient 25 years old with spodyloptosis of L5 vertebral body was treated all from posterior by disc exaction, nerve release, reduction and fixed with transpedicular screws augmented by S2 iliac screws.

Results: Reasonable reduction of L5 over S1 was achieved from the posterior aspect and realignment of the spine with good fixation.

Conclusion: Still reduction of spodyloptosis from posterior is ideal option in treatment with attention for the neural tissues and good release and fixation.

GO357. Use of Neuropathic Pain Questionnaires in Predicting the Development of Failed Back Surgery Syndrome Following Lumbar Discectomy for Radiculopathy

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Objective: Failed back surgery syndrome has been historically used to describe extremity neuropathic pain in lumbar disease despite structurally corrective spinal surgery. It is unclear whether specific preoperative pain characteristics predict patients prone to such postoperative disabling symptoms. Clinical predictors of patients unlikely to improve following surgical intervention has significant implications on patient selection to undergo spinal surgery.

Methods: This prospective study analyzed consecutive surgical microdiscectomy patients treated for lumbar degenerative painful radiculopathy. Clinical parameters included general demographics, preoperative and postoperative clinical examination, self-reported pain and disability scores, and neuropathic pain scoring. The neuropathic pain screening tests used in this study were the Douleur Neuropathique 4 (DN4) and Leeds Assessment of Neuropathic Symptoms and Signs (LANSS), with correlation tested using Spearman's correlation coefficient for ordinal score and screen positivity. Multiple logistic regression analysis was used to define predictors of postoperative symptomatology.

Results: Twelve percent of the 250 surgical radiculopathy patients underoing microdiscectomy experienced persistent postoperative neuropathic pain (PPNP) with only modest if any relief of leg pain. The condition was highly associated with abnormal preoperative screens for neuropathic pain, but not gender, smoking status, or preoperative pain severity (α=0.05). Good correlation was seen between the two screening tests used in this study for both absolute ordinal score (Spearman's ρ=0.84, $p < 0.001$) and thresholding for terming the patient as having neuropathic pain features (Spearman's ρ=0.48, $p < 0.001$). Younger age at treatment also correlated with a higher likelihood of developing PPNP ($p = 0.03$). With regards to predictive value, the positive and negative predictive values for FBSS are 40% and 97% for the DN4 and 70% and 96% for the LANSS respectively.

Conclusion: This cohort of surgical patients was evaluated using validated neuropathic pain screening tools to understand the presence of these features among lumbar radiculopathy patients. Good correlation was seen between both DN4 and LANSS screening tools, suggesting that neuropathic pain diagnosis does exist among a surgical cohort of lumbar radiculopathy patients, with further findings that exceeding established threshold values portends worse prognosis for postoperative recovery. These findings will better inform both patient and surgeon with regards to surgical expectations and decision-making for cases where neuropathic pain features exist, and screening for such diagnosis is recommended in a complete evaluation of the spine surgical patient.

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GO358. Maximal Access Surgery for Posterior Lumbar Interbody Fusion (PLIF) with Divergent, Cortical Bone Trajectory (CBT) Pedicle-screws: a Good Option for Minimizing Spine Access and Maximizing the Field for Nerve Decompression. Our Experience in a Case Series

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Introduction: First advocated by Santoni et al. in 2009, the cortical bone trajectory (CBT) pedicle screw technique is an alternative to the traditional, convergent technique that shows comparable biomechanical features and potentially requires less aggressive tissue retraction. Aim of this therapeutical note is to describe this new technique focusing on main advantages and limitations.

Material and Methods: The authors provide a detailed description of the surgically relevant anatomy focusing on the positioning of the cortical trajectory screws. The surgical technique is then described in a precise step-by-step manner, stressing complication avoidance.

Results and Conclusion: The maximal access surgery PLIF approach is a safe, reproducible procedure allowing for a traditional lumbar spine approach with the benefits of minimal facet joint manipulation and potentially preserving part of their neural innervation and a large part of the paraspinous musculature. A dedicated self-retaining retractor and directional neuromonitoring may guide surgeons during the procedure. Nevertheless, the surgeon's knowledge of anatomical landmarks, response to visual and tactile cues and intraoperative decision-making skills remain of paramount importance.

GO359. Extreme Lateral Interbody Fusion Using Bone Marrow Aspirate Combined with a Porous Hydroxyapatite/Collagen Composite

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Introduction: Extreme lateral interbody fusion (XLIF) has been popular as a safe and reproducible method to obtain minimally invasive anterior spinal fusion. Autogenous bone, commonly from the iliac crest, constitutes ideal grafting . However, the amount of iliac crest bone available is limited and its harvesting is associated with significant donor site morbidity. Recently a porous hydroxyapatite/collagen (HAp /Col) composite has been developed as a substitute for conventional corticocancellous autografts. The aim of this study is to investigate the efficacy of a porous HAp /Col composite for XLIF.

Material and Methods: From November 2011, 15 consecutive patients (21 levels) underwent XLIF for lumbar degenerative diseases. In all cases, titanium cages filled with hybrid grafts using bone marrow aspirate (BMA) combined with a porous HAp/Co composite were inserted as intervertebral spacers and supplementary stabilization with posterior instrumentation were performed. In 4 cases (4 levels) pedicle screws (PS) were inserted unilaterally, and in 11 cases (17 levels) PS were inserted bilaterally. Fusion status was assessed using computed tomographic (CT) scans. A solid fusion was defined by the presence of bony bridging on 2 consecutive sections in at least 2 plains on CT imaging.

Results: At a follow up of 15.4months (minimum: 6 months), 66.7% of all patients (10 of 15) and 76.2% of all levels (16 of 21) were evaluated as solid fusion. In cases with bilateral PS, fusion rates were 81.8% of patients (9 of 11) and 88.2% of levels (15 of 17) respectively. Only one case with unilateral PS was evaluated nonunion due to PS loosening. No revision surgery for nonunion were requested.

Conclusion: Hybrid grafts using BMA combined with a porous HAp /Col composite were efficacious for XLIF as substitutes for conventional autografts. Rigid supplementary stabilization was considered necessary to obtain high fusion rates.

GO360. Multicolumn Spinal Cord Stimulation Surgical Lead Implantation Using an Optic Transligamentar Minimally Invasive Technique

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Introduction: A new generation of neurostimulation surgical leads is used to increase the success of spinal cord stimulation (SCS) in difficult-to-treat indications such as Failed Back Surgery Syndrome (FBSS). This makes the implant procedure more invasive, which is likely to be a determinant factor in clinical and functional outcomes. Minimal access spinal technologies (MAST) have been previously used for surgical lead implantation. However, only a unilateral approach was described, causing some difficulties for median lead placement and not always preventing laminectomy. A recent MAST technique can be used to implant SCS leads without these limitations, which seems to be key in the positive outcomes experienced. The objective is to describe the original MAST technique used in the pilot study.

Material and Methods: Twenty-four consecutive patients were implanted with a multicolumn surgical lead for refractory chronic back and leg pain using the optic transligamentar MAST technique described extensively. Clinical outcomes, functional ability and adverse events (AEs), were recorded for up to 12 months after surgery.

Results: The MAST technique allowed median lead placement, facilitated visualization of the spine and permitted transligamentar insertion that minimized scarring and muscle damage, intraoperative blood loss and postoperative functional complications. Back pain decreased significantly at all follow-up, while functional status improved significantly at 1 year. No technique-related AEs were reported.

Conclusion: Use of MAST approach could be useful in safe implantation of multicolumn surgical leads and confer major advantages in difficult-to-treat refractory lower back pain conditions such as FBSS

GO361. How Safe is the XLIF Approach for a Skilled Surgeon, When He Starts to Perform It

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Introduction: The XLIF (extreme lateral interbody fusion) was introduced in 2001. It is useful as an alternative to ALIF approach especially in obese patients or in case of repeat surgeries to avoid vascular complications. This minimally invasive spine surgery allows to place big foot print implants, minimizing their subsidence and allows even to correct severe deformities. On the other side it is sophisticated, requires special instruments and neuromonitoring. One of the biggest disadvantages is a neurological deficit caused by the transpsoas access, despite of neuromonitoring. The incidence of mostly transient weakness and numbness reaches in the reports from 0,6 to 33%. The goal of this study was to estimate, if most of the reports were enthusiastic in terms of persistent deficits and if it is possible for a skilled surgeon to learn it in relatively short time.

Material and Methods: 40 patients (23 men and 23 women) in age of 25- 86 years (mean 63) underwent XLIF surgeries from march 2014 to august 2015 in our institution. All of them had neuromonitoring intraoperatively. Demographic data of the patients, indications, Op time, blood loss, outcome concerning neurological deficits and early complications were analyzed. The patients with deficit had at least 12 months follow up. We checked, if the surgery time becomes shorter, the more experience is present (4 skilled surgeons performed the procedures) and if deficits occur in the beginning of the learning curve.

Results: Most surgeries were monosegmental (37). Operated levels: L4/5: 26, L3/4: 9, L2/3: 5, L1/2: 3. Follow-up time was between 1 to 18 months (mean 7). Indications: instability: 15, degenerative: 13, discitis: 6, fractures: 4, deformity: 2. The Op time ranged from 37 to 134 minutes (mean76). In all patients the blood loss was not higher than 150 ml. 5 patients developed postoperatively motor neurological deficit. In 2 cases it was persistent (follow up time 13 and 12 months). The others were transient and resolved after 3 months. There were primarily 2 malpositions of implants (introduced into vertebral body of L 5 due to the angle of insertion), which leaded to 1 revision surgery. Persistent deficits occurred in 6. and 10. operated patients in the list, the transient in 18., 24. and 32. patient. 2 surgeries had to be abandoned due to the anatomical situation to avoid the iatrogenic nerve root damage.

Conclusion: The study shows, that even despite of correct neuromonitoring, neurological deficits can appear in XLIF approach. This complication seems to be dependent to the time of the retraction of the prevertebral structures. The longer the OP time (persistent weakness was associated with OP time longer than 120 minutes), the hazard of neurological arises (in transient ones Op times respectively: 58, 73 and 82 minutes). New technologies create often reluctance for many surgeons to accept it, as the learning curve may be long and complications rate high. After 4 surgeries the duration of the procedure was reduced at 35%. Compared with the data in the literature in own series, the neurological deficits were not higher and the learning curve relatively short. The accuracy of the approach (respecting the endplates space to avoid malpositioning) and the OP time has to be respected to avoid a nerve root damage. Reduction maneuvres and more manipulation may arise the ratio of complications. A skilled surgeon should be able to start performing the XLIF access without high rate of complications and become familiar with it after 4–5- surgeries.

Keywords: XLIF, neurological deficit, neuromonitoring, minimally invasive surgery

GO362. Uncommon Intradural-Extramedullary Lesions Removed by Direct Uniportal Minimally Invasive Technique: Clinical and Radiological Results. A Study with 24 Months of Follow-up

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Introduction: Intradural extramedullary cervical lesions usually cause pain or neurological deficit secondary to neural compression. Traditional treatment of these tumors includes standard fashion cut incision, open laminectomy and some cases fusión with a delayed recovery and return to daily activities.

Material and Methods: We present seven patients (four woman and tree man) with symptoms include radicular pain and/ or neurological deficit, due intradural-extramedullary cervical lesion. All the patients underwent total resection with minimally invasive uniportal technique using a tree blade MAXCESS retractor system (Nuvasive, Inc) and surgical microscope. We measured a VAS, Nurick scales preop and with follow up of 6 weeks, 3,6, 12 and 24 months of follow up. Surgical time, blood loss and time to discharge. All the patients was underwent control MRI postoperatively.

Results: Histologically report: Two patients neurenteric cyst, four patients: neurocisticercosis and the last: epidermoid cyst. The VAS and Nurick scales was decreased over the time line. The surgical time was 140 minutes mean, blood loss 30cc mean, All the patients was discharged 47hours mean and return to daily activities 10 days mean.

Conclusion: Intradural-extramedullary lesions can be safely and effectively treated with minimally invasive techniques. Potential reduction in blood loss, hospitalization, disruption to local tissues and return to daily activities suggest that, this technique may present an alternative to traditional open resection with excellent follow up.

GO363. Inflammatory Profiling of Patients Undergoing Lumbar Interbody Fusion by Different Approaches: In Search for Markers of Mini-invasiveness

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Introduction: Minimally-invasive surgeries have become routinely adopted due to reduced tissue trauma and damage. In spine surgery, and particularly lumbar interbody fusion (LIF) procedures, several minimal invasive approaches are available.[1–3] Although these approaches are thought to be less traumatic, and thus less pro-inflammatory, currently there are no scientific evidences about it.[4] Creatin kinase (CK), C-reactive protein (CRP), interleukin (IL)-6 and IL-10, have been proposed as molecular discriminants between mini-invasive and conventional procedures.[5] The aim of this work was to investigate how different approaches in LIF

differed in inflammatory profiles over the immediate perisurgical period.

Material and Methods: Seventy consecutive patients affected by degenerative discopathy were prospectively enrolled. To better characterize the approach-dependent effects, very strict inclusion (single-level discopathy L3-to-S1, healthy status) and exclusion criteria (chronic pathologies, or recent illnesses) were applied. Seventeen patients underwent to anterior LIF (ALIF), 20 to transforaminal posterior LIF (TLIF), and 26 to far-lateral LIF (XLIF). Patients were sampled, by standard venipuncture, 24h pre-surgery (T0), and 24h (T1) and 72h (T2) post-surgery. Blood was collected into serum and plasma (Becton Dickinson & Co., Franklin Lakes, NJ, USA) tubes. Serum and plasma, obtained by centrifugation (1200 g, 10 minute, 4°C), were stored at -80°C until assayed for a panel of 37 molecules involved in inflammation (including cytokines, soluble cytokine receptors and metalloproteinases) were tested by a fluorescent bead-based multiplex system (Bio-Plex®, Bio-Rad Laboratories, Inc., Hercules, CA, USA). One-way ANOVA was used to study within-group time-dependent changes (repeated measures) and between-groups changes, at each time points (Prism v6, GraphPad Software, La Jolla, CA, USA). Significance was set at $p < 0.05$.

Results: At baseline no differences were found in any of the subgroup, indicating homogeneity in pre-surgical conditions. In general, the inflammatory responses to ALIF and TLIF were comparable being characterized by an increase from T0 to T1 and a decrease from T1 to T2. Instead, in XLIF we found a stabilization, or even an increase, from T1 to T2. Interestingly, in all the procedure IL-10, IL-26, osteocalcin, osteopontin, pentraxin, and sTNFR-1 showed a linear increase, although delayed in XLIF. By comparing the amplitude of changes between the time-points, both ALIF and TLIF induced significantly much more sCD163, MMP-2, MMP-3, compared with XLIF. XLIF, instead, was more effective in inducing sCD30, IFN-α2, IFN-γ, IL-2, sIL-6R, sIL-6Rβ, IL-8, IL-10, IL-12p40, MMP-1, osteopontin, sTNFR-1, and sTNFR-2.

Conclusion: Our preliminary results indicate that: i) ALIF and TLIF are comparable in terms of inflammatory profile; ii) the amplitude of changes induced by surgery is greater in XLIF for the majority of the tested molecules; iii) XLIF is more effective in inducing anti-inflammatory mediators. Additional work is evaluating the relationship between the changes observed in these parameters and those recorded in analytes routinely measured in these settings (martial status, muscular enzymes). To have a panel of markers predicting the response of the patients to different surgical approaches could give the surgeon a valuable additional tool in deciding the optimal approach.

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Tumors 4

GO364. Outcome of Posterior Stabilisations for Metastatic Spinal Lesions

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Introduction: The objective of this study was to determine whether posterior only stabilization of metastatic spinal lesions provides adequate stability over the life span of the recipient patient. There are no gold standards for surgical stabilization of metastatic spinal lesions however National Institute of Clinical Excellence guidelines (UK) state that anterior reconstruction should be considered in patients with metastatic spinal cord compression who are likely to survive a year. Standard practice in our regional unit has been to stabilize metastatic spinal lesions through a posterior only approach. Our rationale is that posterior stabilization provides sufficient stability while avoiding the additional risks, time, and cost of anterior stabilization.

Materials and Method: Retrospective review of all cases of posterior only spinal stabilization performed for metastatic disease over a 5 year period. Patient demographics, pathology and metal work construct including number of levels stabilized was recorded. All post-operative imaging was reviewed. Failures and revisions were recorded. Clinical notes were reviewed for surviving patients.

Results: Of the 94 cases 49 were male, average age at time of surgery was 62. 77 (81.9%). Of the patients who were deceased by the study end date mean time from surgery to death was 504 (15 to 1865) days. 72 (93.5%) of constructs remained stable until death. 5 patients required further surgery. 3 had broken rods requiring revision and 2 required anterior decompression and stabilization for disease progression. None of the 17 alive patients required further surgery and all remained neurologically intact.

Conclusion: This case series revealed very low rates of posterior construct failure or need for further surgery for disease progression. This indicates that posterior only stabilization is a safe and effective surgical management option for metastatic spinal lesions.

GO365. Characteristics of Patients Who Survived Less Than Three Months or Greater Than Two Years after Surgery for Spinal Metastases: Can We Avoid Inappropriate Patient Selection?

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Introduction: The survival of patients with metastatic cancer has improved at the cost of increased presentation with metastatic spinal disease. For patients with (impending) pathological spinal fractures and/or spinal cord compression, surgical intervention may relieve pain and improve mobility and quality of life. It is generally accepted that surgery is inappropriate if anticipated survival is less than three months, and survival greater than two years is uncommon. The aim of this international multicenter prospective cohort study was to analyze data from surgical patients who died within three months, or after two years from surgery, to identify any

preoperative factors which might be associated particularly with poor survival, to avoid inappropriate selection of patients for surgery in the future.

Patients and Methods: A total of 1266 patients were treated surgically for (impending) pathological fractures and/or neurological deficits and were prospectively followed. Data collected included tumor characteristics, preoperative fitness (ASA), neurological status (ASIA), performance status (KPS), and quality of life (EQ-5D). Primary outcomes were survival at three months and two years postsurgery. Univariate and multivariate logistic regression analysis were used to find preoperative factors associated with short- and long term survival.

Results: In univariate analysis age, emergency surgery, KPS, EQ-5D, ASA, ASIA, and Tokuhashi/Tomita scores were all significantly associated with short survival. In multivariate analysis, however, only KPS was significantly associated with short survival (OR 1.40; CI 1.18–1.67). Associated with longer survival in univariate analysis were age, number of spinal levels included in the surgery, KPS, EQ-5D, ASIA, and Tokuhashi/Tomita scores. In multivariate analysis, only the number of affected spinal levels included in the surgery was significantly associated with longer survival (OR 1.21; CI 1.03–1.41).

Conclusion: Poor performance status at presentation is the strongest indicator of poor survival (less than 3 months), whereas a low disease load with fewer involved spinal levels is strongly associated with longer term survival.

GO366. Percutaneous Decompression and Fixation on Complex Spinal Metastases

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Materials and Methods: Retrospectively analyzed the postoperative results of a series of 6 patients with vertebral metastases, with complicated mechanical pain and neurological involvement using a decompression technique and percutaneous fixation. Discuss the results with the literature.

Results: Total of 6 cases, 3 men and 3 women. Average age: 67.8 years (66–85), all with known primary tumor: 2 lungs tumor, 2 breast tumor, 1 prostate tumor and 1 renal tumor. Neurological compromise: L5 radicular pain paresis and one progressive thoracic myelopathy. SINS: 8,9,10,12,13,13. Tomita: 3,5,5,6,10,10. Surgical technique: posterolateral decompression, tube 5 Kapener decompression tube type 1, all percutaneous pedicle fixation. Complications: 1 patient L5 lumbar epidural hematoma resolved with surgical evacuation. Five of six went to early radiotherapy Evolution: In all of them neurological recovery and relief of mechanical and radicular pain.

Conclusions: Conventional treatment of patients with neurologic involvement secondary to vertebral metastasis is surgical decompression and open setting, this depending on the vital prognosis and patient status as mayor surgeries. The high rate of complications and fixing decompression percutaneous seem to offer an effective alternative in the management of the complication with minimal complications.

GO367. A Systematic Review and Expert Opinion of Preferred Reconstructive Techniques after Enbloc Spinal Column Tumor Resection

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Introduction: Primary tumors of the spine requiring enbloc resection are rare. Most published reports are small and focus on disease free survival and recurrence rates. Very few studies focus on the various anterior and posterior reconstructive options and subsequent outcomes with respect to fusion rates and need for revision due to hardware failure. The objective of this review was to (1) summarize the published literature and (2) report the failure rates of various anterior and posterior reconstructive techniques after enbloc resection of spinal tumors and (3) supplement the deficiencies in the available published literature with expert opinion for reconstructive options from a group of experienced international spine tumor surgeons.

Material and Methods: An electronic search of the literature was undertaken from January 1990 – December 2013 evaluating specific reconstructive techniques of the spine after primary tumor enbloc resection. Prospective/retrospective trials and case series were included in the final analysis when fusion rates or failure rates were reported. The data available for each reconstructive technique was then combined and construct survivorship was summarized. In addition, a questionnaire was administered to a group of 20 international spine tumor surgeons evaluating specific reconstructive preferences at different regions of the spine based on the number of vertebrae resected and whether post-operative radiation was planned.

Results: The initial search yielded 381 articles with 31 subsequently included for full text review. Fourteen articles were included in the final analysis. There were 146 patients included for final review. There were 2/9 (22%) patients revised from short to long segment constructs and 3 reports of broken pedicle screws with only one requiring revision in longer constructs. Rates of revision for anterior reconstruction were similar for autogenous strut grafts (10%), cages (7.7%) and allograft strut grafts (8.3%). No surgeons responding to the questionnaire recommended short segment posterior constructs. For anterior reconstruction, cages packed with morcellized allograft and autograft were preferred (75%, $p < 0.05$) while strut bone grafting was choosen more often at the cervicothoracic junction (65%, $p < 0.05$) and when more than one vertebrae was resected in the mid thoracic spine (75%, $p < 0.05$). Few surgeons changed their anterior reconstructive technique (15%) or posterior reconstructive technique (10%) when post-operative radiation was planned.

Conclusion: The literature and consensus opinion supports posterior reconstruction with at least two vertebral levels of support above and below. For anterior vertebral

column reconstruction, structural allograft, autograft and cages packed with morcelized bone have shown similar rates of fusion and failure. Expert opinion, however, suggests that structural autograft or potentially vascularized strut grafts should be used when spanning a defect greater than 2 vertebral bodies especially at the cervicothoracic junction.

GO368. Incidence and Risk Factors for Adverse Outcomes after Open Surgery for Spinal Metastatic Fractures

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Introduction: Several scoring systems have evolved to estimate life expectancy in the setting of spinal metastases. However, neither overall mortality rate nor risk factors for complications in open surgery for spinal metastatic fractures have been well defined. We hypothesize that the mortality risk for these patients is high, and that additional medical comorbidities add substantially to the risk of early postoperative death. Understanding these risks will help us to choose surgical candidates with more carefully.

Methods: A national database, the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) files, from 2011–2013 were queried for patients who underwent open surgery for pathologic vertebral fracture in the setting of metastatic cancer. Patients were analyzed for rates of any adverse event (AAE), readmission, reoperation, and mortality. Bivariate and multivariate analyses were performed to determine independent risk factors for these events.

Results: Of the one hundred and fifty three patients identified, seventy-eight (51%) experienced AAE, fifteen (9.8%) required reoperation, thirty (19.6%) were readmitted, and nineteen (12.4%) died within 30 days. Risk factors for AAE included pulmonary comorbidity ($p = 0.049$, OR=3.87) and chronic steroid use ($p = 0.045$, OR=2.28). Reoperation risk factors included male gender ($p = 0.038$, OR=4.00). No risk factors were identified for readmission. Regarding mortality, identified risk factors included dependent functional status ($p = 0.009$, OR=5.75), diabetes ($p = 0.004$, OR=5.55), and pulmonary comorbidity ($p = 0.041$, OR=4.23).

Conclusion: Open surgery for spinal metastatic fractures carries significant morbidity and mortality. Greater than half of patients in this cohort experienced an adverse event, nearly 20% were readmitted, and greater than 10% died within 30 days. Patient factors, including pulmonary disease, diabetes, and dependent functional status, were identified as risk factors for poor outcomes. Thorough preoperative counseling should be performed for patients with our proposed risk factors, and the risk of mortality in surgery must be carefully weighed against life expectancy and neurological deficits.

E-posters

Back/Neck Pain: Clinical

GP001. A Study of the Modified Quebec Task Force Classification of Chronic Low Back Pain with Regards to Activity Limitation, Global Percieved Effect, Sick Leave, and its Prognostic Implications

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Introduction: The Quebec Task Force(QTF) on activity related spinal disorders was a group of experts in various fields brought together by the Quebec Worker's Health and Safety Commission.It formally recognized that clinicians couldnot reliably differentiate between different patho anatomic causes of low back pain(LBP). Classifying patients as described by the QTF has shown associated differences on several characteristics which showed increasing severity from category 1(local LBP) across the categories of LBP+radiation above knee (category 2), LBP+radiation below knee (category 3) to LBP+neurological signs (category 4).The objective of the study is to determine the prognostic significance of the QTF classification in patients with chronic LBP and to compare the efficacy of the chronic LBP rehabilitation protocol among various categories of QTF.

Material and Methods: Routine data was collected at the time of presentation to an outpatient department of a tertiary care center in India. After taking a detailed history and clinical examination, the pain severity is assessed by Low Back Pain Rating scale (LBPRS) and the activity limitation is assessed by Roland Morris Disability Questionnaire (RMDQ). The patients were advised treatment according to the common standard rehabilitation protocol.The patients were followed up every 6 weeks to check for the progression of symptoms clinically and for the compliance with the rehabilitation protocol. The patients were evaluated at 3 months and again at 6 months for Global Perceived Effect (GPE), activity limitation (RMDQ questionnaire) and sick leave status along with LBPRS.

Results: A total of 188 patients were included with 75% 3 month and 70% 6 month follow up.category 1 had the least and category 4 had the most severe activity limitation at all time points.Patients in category 4 improved the most at the end of 6 months with the common rahabilitation protocol. Patients in category 4 landed up more frequently in surgery compared with others.There were no significant differences in comparisions between category 2 and category 3

Conclusion: Categorizing patients based on QTF classification has shown significant association with activity limitation.Prognosis of the patient's condition based on the symptoms at presentation can be roughly estimated using the QTF classification.However,differentiating patients based on radiating pain above or below the knee has no significant prognostic implications.It was found difficult to establish a diagnosis based on symptoms alone.Hence,targeted treatment based on the QTF classification may have a potential role in better management of patients with chronic LBP.

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GP002. Low Back Pain and Sciatica as The Prominent Clinical Manifestations of Pelvic Venous Congestion Syndrome. A Case Report

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Introduction: Although back pain / sciatica are common conditions in the general population and their etiology is very well understood, there is a strong interest in non-musculoskeletal origins of pelvic pain masked by symptoms resembling radicular pain such as in the case of circulatory disorders in anatomic sites beyond the spine. This study presents a particular case of low back pain & sciatica as the main symptoms of pelvic venous congestion syndrome.

Material and Methods: A 25 year old female presented to the Spine Institute of New England complaining of 90% low back pain and 10% right lower extremity constant pain affecting the lateral aspect of her thigh and averaging around 6/10 with reported flare-ups up to 10/10 especially at the end of a long day full of activities and with prolonged standing. She has also been complaining of sleep disturbances over the last 6–9 months. She has tried land physiotherapies in the past unsuccessfully. She complained of mild dyspareunia as well. Clinical assessment suggested pain of discogenic and/or facetogenic nature, questionable meralgia paresthetica, and sciatica; however, plain radiographs were equivocal. One month prior to the patient's visit to our clinic, Gynecological laboratories ordered by primary care physician were unremarkable. The patient followed a conservative treatment plan consisted of simple analgesics, non-steroidal (Meloxicam), and steroidal (Methylprednisolone) anti-inflammatory medication, antidepressant (Fluoxetine) and antiepileptic drugs for neuropathic pain (Gabapentin). One month later, she reported no significant improvement especially on her right thigh stating that cortisone has helped initially; NSAID's were somehow helpful unlike Gabapentin, which did not help at all. The patient was followed up with MRI, which demonstrated a tubular fluid-filled structure in the region of the right adnexa in addition to mild effacement of the thecal sac at the L3-L4 level, not a strong evidence of discogenic/radicular pain. Subsequently, a transabdominal US revealed prominent pelvic veins bilaterally – more pronounced on the right side – reflecting the likelihood of pelvic venous congestion syndrome. EMG excluded nerve root compression at the spinal level, while a thorough gynecological clinical examination confirmed the aforementioned diagnosis at initial stage due to hormonal dysfunction.

Results: The patient has been placed on cortisone treatment for ovarian function suppression showing encouraging early outcomes.

Conclusion: Even though pelvic venous congestion syndrome is diagnosed via exclusion of other pathological conditions that most likely cause symptoms of low back pain and/or sciatica, this case report comes to highlight the importance of integrated initial systemic clinical assessment, particularly when more than one medical specialties are involved in the region of interest.

GP003. Multicolumn Spinal Cord Stimulation for Significant Low Back Pain in Failed Back Surgery Syndrome: A National, Multicentre, Randomized, Controlled Health Economics Study (Estimet)

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Introduction: Many studies have demonstrated the efficacy of spinal cord stimulation (SCS) for chronic neuropathic radicular pain over recent decades. But despite global favorable outcomes in Failed Back Surgery Syndrome (FBSS) with leg pain, the back pain component remains poorly controlled by neurostimulation. Technological and scientific progress has led to the development of new SCS leads, comprising a multicolumn design and a greater number of contacts. Their efficacy of multicolumn SCS lead configurations for the treatment of the back pain component of FBSS has recently been suggested by pilot studies. However, a randomized controlled trial must be conducted to confirm the efficacy of new generation multicolumn SCS. ESTIMET is a multicentre, randomized study designed to compare the clinical efficacy and health economics aspects of mono vs multicolumn SCS lead programming in FBSS patients with radicular pain and significant back pain.

Material and Methods: FBSS patients with a radicular pain VAS score $\geq$ 50mm, associated with a significant back pain component were recruited in 14 centers in France and implanted with multicolumn SCS. Before the lead implantation procedure, they were 1:1 randomized to monocolumn SCS (group 1) or multicolumn SCS (group 2). Programming was performed using only one column for group 1 and full use of the 3 columns for group 2. Outcome assessment was performed at baseline (pre-implantation), and 1, 3, 6 and 12 months post-implantation. The primary outcome measure was a reduction of the severity of low back pain (bVAS reduction $\geq$ 50%) at the 6-month visit. Additional outcome measures were changes in global pain, leg pain, paraesthesia coverage mapping, functional capacities, quality of life, neuropsychological aspects, patient satisfaction and healthcare resource consumption.

Results: Trial recruitment started in May 2012 and closed in October 2013. The 14 study centers have been initiated. The last visit last subject was performed in January 2015. This study received funding in 2012 from the French government NHS program "PSTIC 2011" (Program de Soutien aux Techniques Innovantes et Coûteuses). Each patient provided informed consent and approval was requested and obtained from the Poitiers University Hospital Ethics Committee (CPP Ouest III), the French National Agency for Medicines and Health Products Safety (ANSM) and the French Data Protection Authority (CNIL, No. 70108724P).

Conclusion: Preliminary results are expected to be analyze for the end of 2015 and published at the start of 2016.

GP004. Subcutaneous Peripheral Nerve Stimulation as "Hybrid Stimulation" after Failure of Spinal Cord Stimulation to Control the Back Pain Component in Failed Back Surgery Syndrome Patients. A Randomized Controlled Study (Cumpns)

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Introduction: Despite globally favorable outcomes of SCS, a significant proportion of FBSS patients do not obtain adequate coverage of low back pain. PNS has obtained the CE mark in Europe for the treatment of chronic refractory neuropathic pain and is now commonly used in some countries to target back pain. However, the potential value of combining SCS and PNS as "hybrid stimulation" remains poorly described with only isolated case reports or limited experience in various indications. The "CUMPNS" comparative randomized study is designed to demonstrate the potential analgesic efficacy of PNS in addition to previously implanted SCS, to treat the residual low back pain component pain in refractory FBSS patients.

Material and Methods: All patients are randomized 1:1 in to 2 groups (SCS+PNS vs SCS). Group 1 (SCS+PNS) receives "hybrid stimulation" with PNS implantation one month after the inclusion visit. In the second group, patients continue to be treated with SCS alone for 4 months post-inclusion before having access to PNS. The main objective of this study is to demonstrate the added value of subcutaneous PNS by comparing the ability of hybrid stimulation (SCS+PNS) versus SCS alone to improve analgesic efficacy, functional outcome on quality of life and coverage of the residual low back pain component at three months. This variation in the pain surface area covered is evaluated by mapping, using the Neuro-Mapping Tools software (N3MT).

Results: Patient recruitment in the CUMPNS trial began in February 2013. The inclusion period will end in February 2015 and primary endpoint findings will be available at the end of 2016. To date, five patients have been included and four have been implanted. Neuromodulation is one of the most rapidly growing fields of medicine, involving many diverse specialties and impacting on hundreds of thousands of patients with numerous disorders worldwide. In addition to the development of SCS, PNS appears to be an interesting option that can be considered in several specific indications, especially refractory focal pain and axial pain. PNS npresents several advantages, including easy repositioning in the case of lead migration and constitutes a minimally invasive technique. Stimulation is applied directly over the area of pain, and the use of multichannel lead arrays allows flexible programming. Coverage can be easily adjusted over time according to variations in pain. PNS also has other advantages, as it is safe, with no risk of neurological sequelae such as cerebrospinal fluid leak or meningitis due to dural puncture, paralysis due to spinal cord injury, etc.

Conclusion: The present study should provide an opportunity, for the first time, to prospectively evaluate and objectively compare the ability of a combined hybrid neurostimulation technique to increase the coverage of painful areas and to try to correlate this coverage with clinical outcomes.

GP005. Influence of Psychiatric Comorbidities on Clinical Outcome Before and After Elective Spine Surgery. A Prospective Observational Study

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Introduction: It is widely accepted that psychiatric comorbidities have a negative influence on health-related quality of life and long-term outcomes following spine surgery. However, most published data are restricted to postoperative measurements and data from preoperative settings in lacking. Aim of this study was to assess the incidence and influence of psychiatric comorbidities on clinical outcome in patients undergoing elective spine surgery.

Methods: A prospective study of patients undergoing elective spine surgery was performed. Evaluation for depression (ADS-K score) and anxiety (STAI-S, STAI-T and ASI-3 scores) before surgery and at three months follow up were done. In addition SF36 physical composite score (PCS), Oswestry Disability Index (ODI) and pain visual analog scale (VAS) were completed preoperatively and 3 months postoperatively. Incidence and influence of these psychiatric comorbidities on clinical outcome were examined.

Results: 144 patients met all inclusion criteria. 78 patients were male (54,2%); mean age was 59.49 years. Most patients were married or in a steady relationship (77,8%). Abnormal STAI-S, STAI-T and ASI-3 anxiety scores were encountered preoperatively in 51,4%, 39,6% and 11.8% of cases but resolved in 38,6%, 31,9% and 11,1% of cases at 3 months follow up. 17,36%, 11,11%, 5,55% reported abnormal STAI-S, STAI-T and ASI-3 anxiety scores only following surgery, respectively. Abnormal ADK-S score were seen in 25% of cases before surgery and resolved in 14,6% of cases at 3 months follow-up. 5.55% of patients showed abnormal ASD-K scores only following surgery. Patients with an anxiety disorders at follow up had a worse clinical outcome compared with there counterparts (ODI: 43.07 vs 35.67, $p = 0{,}304$; VAS pain: 43.07 vs 5.54, $p = 0.000$, PCS: 42.08 vs 41.83, $p = 0.949$). Pathologic depression scores also had a negative influence on most clinical outcome measurements (ODI: 10.44.3 vs 26.4, $p = 0.000$; VAS pain: 10.49 vs 3.97, $p = 0.000$, PCS: 10.03 versus 48.93, $p = 0{,}000$).

Conclusions: The incidence of depression and anxiety disorders in patients undergoing elective spine surgery is very high. This was also associated with unfavorable outcome. Most cases of depression and anxiety were present prior to surgery. More patients are needed to asses the possibly of preoperative screening for such comorbidities as many of the patients psychiatric problems resolved after surgery.

GP006. Post Traumatic Stress Disorder Symptoms following Elective Spine Surgery. Is Surgery Really the Reason?

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Introduction: Recently, posttraumatic stress disorder symptoms (PTSD) were found in 20% of cases following elective spine surgery. PTSD was therefore attributed to surgery. Furthermore, PTSD symptoms were associated with reduced clinical benefit. However, PTSD is seen in up to 10% of the normal population. Aim of this study is to evaluate the incidence of PTSD before and after elective spine surgery and the influence of PTSD on clinical outcome.

Methods: A prospective study of patients undergoing elective spine surgery was performed. The patients were evaluated for PTSD using the PTSS score before surgery and 3 months postoperatively. In addition SF36 physical composite score (PCS), Oswestry Disability Index (ODI) and pain visual analog scale (VAS) were completed preoperatively and at 3 months postoperatively. Incidence and influence of PTSD symptoms on clinical outcome were examined.

Results: 144 patients met all inclusion criteria. 78 patients were male (54.2%); mean age was 59.49 years. PTSD symptoms were reported in 59 patients (41%) before surgery. However, only 32 patients (22.2%) still had abnormal PTSS scores at 3 months follow up. Only 6 patients (4,17%) developed PTSD symptoms following surgery. PTSD was associated with worse clinical outcome before surgery in the ODI score (ODI: 18.45 versus 43.16, $p = 0.000$). There were also statistically significant differences in mean SF36 PCS score ($p = 0.000$) and pain VAS ($p = 0.000$) between both groups. At three months follow up patients with PTSD showed worse clinical outcome in the ODI score and VAS pain (ODI: 10.89 vs 28.43, $p = 0.000$; VAS: 11 vs 4.26, $p = 0.000$) and also in the SF36 PCS score ($p = 0.000$).

Conclusions: PTSD symptoms are associated with worse outcome following elective spine surgery. However, the vast majority of patients with PTSD symptoms exhibit symptoms before surgery and only a small minority develop PTSD symptoms after surgery.

GP007. Episacral Lipomata as a Cause of Lower Back Pain: Series of Cases Managed by Excision

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Introduction: Episacral Lipomata or the "back mouse" is a tender, fibro-fatty subcutaneous nodule found in the thoracolumbar fascia area in up to 16% of people. The "back mouse" can be a cause of significant low back pain in patients with associated disc disease, nerve root compression and facet hypertrophy. This is due to the particularly dense innervation with substance P positive free nerve endings in the posterior layers of the fascia.

Material and Methods: We studied the outcome of removal of the 'back mouse' in nine patients with twelve lipoma's (three had bilateral lipoma's). The diagnosis was made by clinical examination and all of the excised nodules were confirmed to be episacral lipoma on histo pathological examination subsequently. The outcome was measured with Visual Analog Scale (VAS) scores and Oswestry Disability Index (ODI) scoring. The average VAS reduced from 7.8 pre operatively to 4.8 post operatively.

Results: Six patients had improvement in ODI from moderate to minimal disability, one patient had improvement from severe to moderate disability and the ODI in three patients were unchanged. Seventy percent of the patients were happy with the outcome as the symptoms had significantly reduced despite having some other underlying spinal pathology.

Conclusion: In our opinion, episacral lipoma may be an unrecognized entity by both specialists and generalists and can be a treatable cause of low back pain. The excision provided relief to the compressive effect it had on the middle and posteriro layers of the lumbar fascia and the muscles it encloses. Marginal excision of a painful episacral lipoma may provide pain relief and improved lower back function in patients who are carefully selected for this procedure,

GP008. Diagnostical Challenges of Tumor-Like Conditions of Cervical Neural Arch in Childhood

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Introduction: Neck pain is a rare symptom in childhood. However, if exists permanently, require a thorough checkup, because very often some serious pathology it is in the background. We present two consecutive cases of young patients with neck pain, where the differential diagnosis was challenging, and has proved two different tumor-like pathologies.

Material and Methods: The first case concerns a 17 years old boy, who represents a pain localizing to the scruff region, mainly during night and to have a rest. MR imaging showed a high intensity changes on T2-weighted, and low intensity changes on T1-weighted pictures at the top of C.7. spinous process. According to SPECT/CT and bone scan an osteoid osteoma was suspected. The second case concerns a 7 years old boy, who had been complaining for few months a temporary, however a sharp pain also at the scruff region, consequently during extension of the neck. MR showed especially on STIR pictures edema at the region of C.4, 5. spinous process. Bone scan proved a slightly increased uptake, also with the suspicion of osteoid osteoma, however the CT scan was negative.

Results: In the first case, based on the results of the radiological examinations, we have decided on "en bloc" resection of the malformation. The histology revealed *pigmented villonodular synovitis* (PVNS), which is according to the literature a really rare finding in this region, and require surgical solution. After the surgery, the patient became complaint free, with full function of his neck. On one year follow up MRI was negative regarding recurrence. On the second case pediatricians have excluded any organic rheumatologic disease, and although the inflammatory laboratory tests (We, CRP) were negative, they reckon the malformation as a chronic osteomyelitis and administered a prolonged antibiotic course under strict control for ten weeks. Because of the continuous improvement of the young boy during this therapy, biopsy was not necessary. After three months the patient became also complaint free, and the one year follow up MRI also revealed a normal status.

Conclusion: In case of permanent neck pain in childhood it is mandatory to perform a thorough checkup to find the reason behind these complaints to be able to exclude any tumor, or tumor-like malformations. If there are any morphological changes on the radiological examinations, the differential diagnosis could be very challenging, requiring individual therapeutical plan. The first proposed examination should have to be MR imaging.

Basic Science: Other

GP009. Thoracic Volume Progressively Decreases in a Virtual Osteoporotic Vertebral Wedging Model with Increasing Severity of Kyphotic Deformity

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Introduction: Osteoporotic vertebral fractures commonly result in increased kyphotic angle. Several studies have shown that compared with controls increasing severity of osteoporotic kyphosis significantly decreases volumetric parameters of pulmonary function such as vital capacity. However the effect on the thoracic volume has been less fully studied. With the ability to accurately model thoracic volumes, we are now capable of virtually modeling the effect of increasing kyphosis on thoracic volume through the computer graphical software, Blender. We hypothesize the computed thoracic volume measured from a 3D virtual model decreases with progression of kyphosis from 50 to 100 degrees and the wedging fracture vertebrae only occur in sagittal plane.

Methods: Free opensource Blender software was used to create threedimensional thorax models with normal coronal and sagittal balance. By virtually wedging the vertebral bodies, the virtual osteoporotic models were progressively deformed by 10 degrees from 50100 degrees of kyphosis. Thoracic volume was simulated and measured via shrinkwrap modifier (Blender built-in function) applied to a sphere-shaped object within the virtual thoracic cavity.

Results: Virtual wedging of vertebral bodies was necessary to achieve virtual progression of sagittal curve. As kyphotic angle increased, more vertebral segments had to be virtually wedged. Thoracic volume in the virtual adult thorax with a 50 degrees kyphosis was 3643cc. The thoracic volumes approximately decreased in a linear fashion by means of 6.4% for every 10 degrees more of kyphosis. The final thoracic volume was 2472cc at 100 degrees of kyphosis, which was a 32.2% decrease in volume from baseline.

Conclusion: As the deformity progresses from 50 to 100 degrees, there is an overall 32.2% decrease in thoracic volumes. The decrease appears approximately linear. Although there is not a direct relationship between thoracic volume and pulmonary functions, adequate thoracic volume is a necessary condition for adequate pulmonary function. This study helps establish the relative magnitude of thoracic-volume decrease based on the sagittal Cobb angle.

GP010. Thoracic Volume Modeling in Virtual Sagittal Curve Progression

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Introduction: Scheuermann's kyphosis is a primary sagittal plane deformity that manifests in adolescence. The wedged vertebrae cause increased thoracic kyphosis and a foreshortened thoracic length. The effect on the thoracic volume has been less well studied. With the ability to accurately model thoracic volumes, we are now capable of virtually modeling the effect of increasing kyphosis on thoracic volume. Virtual modeling may allow us to determine the point of diminishing returns in deformity correction when trying to improve pulmonary status. We hypothesize the computed thoracic volume measured from a 3D virtual model decreases with progression of kyphosis from 50 to 100 degrees.

Methods: Blender software was used to create a three-dimensional thorax model with normal coronal and sagittal balance. Virtual wedging of vertebral bodies was performed for the model to be progressively deformed by 10 degrees from 50100 degrees of kyphosis. Thoracic volume was calculated via shrinkwrap modifier applied to an uvsphere within the thoracic cavity.

Results: Virtual wedging of vertebral bodies was necessary to achieve virtual progression of sagittal curve. As kyphotic angle increased, more vertebral segments had to be wedged (>5 degrees). Thoracic volume in the virtual adult thorax with a 50degree kyphosis was 1679cc. This volume decreased in a linear fashion by a mean of 5.4% for every 10 degrees more of kyphosis. The final volume was 1218cc at 100 degrees of kyphosis, which was a 27% decrease in volume from baseline.

Conclusion: As the deformity progresses from 50 to 100 degrees there is a 27% decrease in the thoracic volume. The decrease appears linear. While there is not a direct relationship between thoracic volume and pulmonary functions, adequate thoracic volume is necessary for adequate pulmonary function. This study helps to establish the relative magnitude of volume decrease based upon the sagittal Cobb angle.

GP011. Proposal of a New Trajectory for Screws in the Lateral Mass of the Cervical Spine

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There are several trajectories described for the insertion of screws in the lateral facets of the cervical spine (Magerl, An, Anderson, based on spinous processes,..), they all rely on milimeters and precise angles; but anatomical variety (osteophytes, mass anatomy, spinous process deformities...) might render them not fully reproducible. It is proposed to consider the lateral mass as an slanted cube rotated to present a crest stright posterior, and define a trajectory as close to the 3D diagonal as possible from inferomedial corner at dorsal-medial facet to the anterosuperior cornar of the antero-lateral facet of such a cube.

Hypothesis: That trajectory is free of biass and represents the longest posible one in a cubic body, so obtaining the strongest anchor possible.

Material and Methods: 10 cervical spines (dry bone) from thew Anatomy Department of Santiago de Compostela University were gathered and 4 different trajectories were developed in each lateral mass from C3 to C6 (both sides) so getting 320 different trajectories. A Kirschner Wire 0.9 mm in diameter with an "ad hoc" guide were used to avoid destruction of the specimen. Spines were fixed to a table by a sargent clamp with the dorsal surface upwards, resembling an OR situation. The 4 trajectories tested were after the techniques originally published by Magerl, An and Anderson, and then, the new one (N), based on the spatial isolation of the lateral mass for the 3D diagonal. Variables: a) the length of each trajectory, b) violations of facet joint, c) potential injuries to vertebral artery (defined by a 3 mm wire passed through the tranverse processes) and d) potential injuries to the root (defined by the same kind of wire set exiting through the foramen). Then the results in each variable was compared among all trajectories to define the longest one and the safest one. Statistics: Linear model of mixed effects, REML adjusted for "length" and adjusted to the major probability (Laplace) for all lesions.

Results: a) Length: N longer than any and against each one. 16 mm vs <15 mm ($p < 0.0001$) at C6 the longest one with any trajectory ($p < 0.001$). b) facet violations: none. c) potential vertebral artery injury: 8/320, all right sided. N technique: 0; An technique:0. d) potential root injury: N the safest nad against each one ($p < 0.02$), followed by An technique right side had a higher risk $p = 0.001$.

Conclusions: A new technique (N) is presented that allows for a longer screw insertion. Besides being longer, N technique is safer than any other relating to potential root injuries and also safer than Magerl and Anderson for potential vertebral artery injury. Right side seems more prone to both potential vertebral artery and root injury

Biomechanics: Other

GP012. Morphometry of Vertebrae in Saudi Population with a Comparison to Other Population

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Introduction: Precise anatomical knowledge of human vertebra is necessary for the safe placement of screws, pre-surgical planning and designing surgical instruments. There are no existed reports about the morphometry of vertebrae in Saudi population.

Methods: This is a descriptive study. A total of 50 spine CT was collected from the PACS system and reviewed for any abnormal pathology. Any CT with major pathology like tumor, fracture and deformity was excluded. Each vertebra was measured for the following parameters: 1- Pedicle Width. 2- Distance from Pedicle to Ant. Vertebrae. 3- Ant. Vertebrae width. 4- Canal Diameter. 5- Height of Pedicle. 6- Angle of Pedicle. All data was entered in statistical analysis program (SPSS) and compared with the existed date of other population.

Result and Conclusion: The values of the parameters with the standard deviation have been concluded and compared with the Korean, Mexican, Israeli and Indian populations which shows remarkable difference and characteristic pattern important to be addressed in safe placement of screws, pre-surgical planning and designing surgical instruments.

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GP013. Biomechanical Study Examining the S2 Alar Iliac Screw Insertional Torque

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Introduction: Prior biomechanical studies have examined the role of the iliac screw in lumbosacral fixation [Lebwohl, 2002; Cunningham, 2010] and while found to be

significant, the ideal screw device and fixation technique have yet to be identified. An initial effort to define this biomechanical fixation includes measurements of current screw insertion torque across screw length was developed. The objective of this study was to measure the intraoperative torque required to place an S2-Alar iliac screw for spino-pelvic fixation. This fixation method often results in variable screw fixation strength and an improved understanding of the local torques required along the length of the screw will aid in improving this surgical fixation.

Materials and Methods: This IRB approved study involves obtaining informed consent of patients receiving long spinal fusions either for adult deformity. The surgical trajectory for the S2-Iliac screw will be identified as is currently practiced using O-arm Stealth Navigation. Next, the insertion torque of the iliac screw will be measured using the standard driver handle fitted with a torque cell sensor by the surgeon under 3D navigation (Stealth).

Results: There were 6 patients who underwent spinopelvic fixation. 12 S2-Iliac screws were placed however Insertional torque was recorded in only 6 screws. Screw maps show that peak torques range from 0.71 to 9.73 Nm. Highest torques recorded were when the head of the screw approached the bone during insertion. These peak torques recorded are 1.91 times higher than Iliac screw insertional torques reported in a previous study.

Conclusion: Peak insertional torques range from 0.71 to 9.73 Nm and occurred as head of the screw approached the bone during insertion. However higher insertional torques were not recorded because it went beyond the capacity of the driver.

Deformity: Cervical

GP015. Results of Posterior Occipito-Cervical Decompression and Fusion in Case of Basilar Invagination: A Case Series

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Introduction: The term "Craniovertebral Junction" includes bony and neuro-vascular structures from base of occiput to 2nd cervical vertebrae. The subject of CV junction anomalies is under discussion and evaluation for over a century. Several classical reviews have attempted to clarify a variety of complex associated issues. Despite the volumes of publications on the subject, it appears that the last word has not yet been said. Basilar invagination is the most common craniovertebral junction anomaly. Basilar invagination implies that the floor of the skull is indented by the upper cervical spine, & hence the tip of odontoid is more cephalad protruding into the foramen magnum which causes the compression of medulla and brainstem. There are two types of basilar invagination: primary invagination, which is congenital or developmental and more common, and secondary invagination, which is acquired mostly due to trauma. Primary invagination can be associated with occipito-atlantal fusion, hypoplasia of the atlas, a bifid posterior arch of the atlas, odontoid anomalies. In basilar invagination, all three parts of the occipital bone (basiocciput, exoccipital & squamousoccipital bone) are deformed.

Material and Methods: Our study is short term prospective study. Study period extends from July 2012 to May 2015.Total 20 patients {male+female} of various age group {8 year to 65 year} with diagnosed cases of basilar invagination were taken for study purpose.

Results: Clinical outcomes: 17 patients showed improvement in their symptoms or gait with improved mJOA score, RANAWAT's neurological class and NURICK'S functional scale. 2 patients did not show any signs of improvement. 1 patient who had severe basilar invagination with os odontoideum with kyphotic deformity expired on 3rd postoperative day due to respiratory insufficiency. 1 patient had wound related complication with opening of stitches and exposed implant which required excision of exposed implant and wound recovered by secondary healing. On long term follow up 1 patient had loosening of implant from occiput bone on X-ray but she had no any clinical symptoms. Rest of patients had no long term complications. Radiologically: Using Mcrae, chamberlain line and Ranawat index, all 19 patients had reduction of dens below foramen magnum. Bone graft fused in all 19 patients between 6 to 8 months. So all over mortality rate of our study was 5%.

Conclusion: Basilar invagination anomalies are commonly occurring but rarely diagnosed anomalies. Developmental and congenital anomalies are more common than traumatic events. As per our prospective study excellent to good short term results can be achieved with acceptable safety but it needs further long term follow up in larger series to confirm good long term results. Good results depend on proper patient selection, good surgical skill, proper use of implants and post operative care.

Deformity: Thoracolumbar (Adolescent)

GP0116. Evaluation of the Shoulder Imbalance Angular Parameters and the Usage of Midtrapezial Angle Clinically and Radiologically in Adolescent Idiopathic Scoliosis (AIS) Cases

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Introduction: Evaluating AIS patients with shoulder imbalance, radiologic angular parameters generally used are: radiographically costoclavicular intersection angle (CCA), angle of the line connecting the coracoids (Corac), the angle of line connecting the upper limit of the first costal angle (FRA), and the tilt angle of the first thoracic vertebra line (T1T). The angles shown on digital photographs are axillary folds line (ax), deltoids peak line (d) and midtrapezial line angle (tra) between the horizontal line.

Material and Methods: A total of 29 cases with AIS are separated into two groups, having distance of horizontal lines drawn from coraciods with 2cm shoulder height differences (SHD) and others. Statistics; paired-samples *t*-test or wilcoxon tests are used depending on normalization of variables. For each variable ROC analysis is performed. Pearsons correlation analyses used with the changes of shd valvues for each parameter.

Results: Sensitivity of ax is the highest value with 90% than to tra and cca of 80%. Tra and cca angles has highest spesifity valvues with 63.16% than to ax of 57,89%. All radiologic parameters changes found strongly correlated with the changes of shoulder height differences.

Conclusion: The mid trapezial and axillary fold angles over 2,8 and 2,9 degrees respectively is found in shoulder imbalance by cosmetic parameters. The costoclavicular intersection angle over 4 degree is found to be the radiologic shoulder imbalance parameter for ais. These cut off valvues can be usefull for determining the the shoulder imbalance for selection of upper enstrumantation levels in AIS. Midtrapezial angle can be used as a parameter of clinical cosmetic shoulder imbalance in adolescent idiopathic scoliosis. Axillary fold

angles and costoclavicular intersection angle can also helpfull for defining shoulder imbalance in adolescent idiopathic scoliosis.

GP0017. Pedicle Morphometric Analysis in Adolescent Idiopathic Scoliosis: Importance of Surgeon Familiarity with Patient Specific Variables

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Introduction: A morphometric analysis of convex and concave pedicles in scoliotic spines depends on the three-dimensional reconstructions of the spine. As the standard of care relies on two-dimensional X-rays, there have been few reports on this topic and an underestimation of the morphological irregularities. We present our data of AIS patients who underwent HRCT as part of the preoperative planning for robotic-guided corrective surgery.

Material and Methods: A retrospective study of adolescent idiopathic scoliosis patients indicated for corrective surgery at our center. All patients underwent a CT scan with 1-mm slice thickness as part of their preoperative planning. The morphometric parameters documented were: transverse pedicle width, pedicle angle and maximum chord length in both convex and concave sides of the curve and were analyzed in the software (Renaissance) used for robotic guidance.

Results: We reviewed charts of 23 patients with an average age of 14.9 years. Average Cobb angles of the major curve measured 48.4° (Range 27.7° to 82.8°). There were 7 type 5 Lenke curves, 6 type 3 and type 1, and 4 cases of type 6. On the concave side 247 pedicles were measured, of which 104 (42%) were hypoplastic (i.e., transverse pedicle width <4 mm). Of the 249 convex pedicles measured, 74 (30%) were hypoplastic ($p < 0.005$). Mean concave pedicle angle was $15.6 \pm 3.8°$ and maximum chord length was 40.9 ± 7.1 mm, while the convex pedicle angle was $16.1 \pm 3.9°$ ($p = 0.22$) and maximum chord length was 40.8 ± 6.4 mm ($p = 0.82$).

Conclusion: Knowledge of patient-specific anatomical variances is critical when instrumenting scoliotic vertebrae. Based on our findings, despite the patient's added exposure to radiation, we advocate the use of CT-based preoperative planning to maximize safety of the instrumentation and emphasize the importance of Surgeon familiarity with patient specific anatomic variances in instrumentation of scoliotic vertebrae.

GP018. The Choice of Upper Instrumented Vertebra in AIS and Shoulder Balance

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Background: The choice of the upper instrumented vertebra has long been debated. With little proof regarding the best fusion level, scarce information about the final outcome and lack of consensus, four criteria were used to study each AP and lateral films to choose the most optimal level. The author's used criteria were (1) the positive shoulder sign defined as the contralateral shoulder to the main curve being the highest, (2) a proximal curve that is stiff on reduction maneuvers only to be corrected less than 30% a junctional kyphosis on lateral view between the main, (3) the proximal curve and finally a long proximal curve accounting for 5 and more vertebrae and (4) the final outcome being shoulder balance. The objective of this study is to study the concordance between these criteria used by our surgeons and those defined by Lenke in 2001 to select the most conservative posterior fusion possible to achieve coronal and shoulder balance in AIS.

Methods: Thirty Lenke type I AIS deformity patients, with a minimum postoperative follow up of 2 years, were divided according to the proximal fusion level with group 1+ being all patients who have a fused proximal thoracic curve and group 1- being all patient whose proximal thoracic curve wasn't included in spinal arthrodesis. Then a comparative study between the two groups was made, accounting for shoulder balance as the main outcome by measuring coracoid height, T1 tilt and clavicle angle between the two groups and comparing the results whether the proximal thoracic curve was included or not.

Results: The two groups were initially similar ($p > 0.05$) and remained equivalent having an appropriate shoulder balance in the immediate post-operative period and at last follow up without a significant difference in shoulder balance ($p > 0.05$) (coracoids difference, T1 tilt and clavicle angle). The study showed an average correction of 60% in the proximal thoracic curve and 70% in the main thoracic curve whether PT was included or not. A similarity study between Lenke criteria and the authors' criteria showed no difference between the two with the exception of a PT bigger than 5 vertebrae. Having a PT bigger than 5 vertebrae did not influence shoulder balance in AIS type I. The study showed a concordance of 74% between Lenke criteria and the authors'.

Conclusion: There is a high level of concordance between the authors' criteria and those defined by Lenke showing that whether to include the proximal curve or not depends on establishing whether the proximal curve is stiff i.e structural or not.

GP019. Shilla Procedure and Crankshaft Phenomenon

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Introduction: To evaluate in a retrospective study the capability of Shilla technique in preventing the crankshaft phenomenon in the treatment of the severe scoliosis in young children.

Methods: 11 scoliotic children (3M, 8F), Tanner 0, aged from 4 years 6 months to 11 years 6 months were operated by Shilla procedure and were reviewed with a followup from 3 years to 6 years 4 months.7 patients had their final fusion . The number of procedure, except for final arthrodesis was one in 5 patients and two in 6 patients.

Results: The mean preoperative Cobb angle was 57° (thoracic curve 67°, lumbar curve 55°). The growth continued in all children from 67 cm of the sitting height on initial examination to 72.5 cm at final follow-up. For the coronal angle, it was corrected form 57° to 34° at immediate post-op than an increase to 50° at final follow-up. In 7 children, the initial post-op correction was not maintained due to the crankshaft phenomenon observed in both fused instrumented apex curves (67° → 35° (immediate post op) → 51° on final follow-up) as well as in the non-fused non instrumented apex curves (54° → 40° (immediate post op) → 55° on final follow-up).

Discussion and Conclusion: If the crankshaft was expected in bridged curves it also occurred in the apex fused-instrumented curves. Age of the children of 10 years 9 months, right in the growth spur appears to be its main cause. The children with controlled curves had a mean age of 7 years 8 months. In conclusion, the Shilla technique, even in apex fused instrumented curves was not able to control the crankshaft phenomenon during growth spurt. This should be taken in consideration for the timing of the final fusion.

GP020. Is There a Correlation between the Apical Vertebral Rotation and the Pelvic Incidence in Adolescent Idiopathic Scoliosis?

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Background: Vertebral rotation is an important parameter in adolescent idiopathic scoliosis as it affects the hump and thus the esthetic aspect of the deformity. Nonetheless, it is one of the least explored parameters due to the difficulty of assessment using conventional AP and lateral standing radiographs and the high radiation of CT-scans. With the advent of EOS® technology, vertebral rotation is easily assessed using the 3D reconstruction with high accuracy and low irradiation. The objective of this study is to evaluate the apical vertebral rotation and study its correlation to the pelvic parameters.

Materials and Methods: This is a descriptive transversal study. 73 patients with adolescent idiopathic scoliosis patients (Cobb $> 10°$) aged between 9 and 36 years old with no prior history of spinal operation at initial examination were included. Subjects underwent antero-posterior and lateral radiographs of the whole spine and pelvis using the EOS® system. On the AP radiograph, the thoracic curve angle, the lumbar curve angle and the number of the involved vertebrae were measured. On the lateral view, pelvic incidence was measured. The rotation of the apical vertebra was obtained by stereoradiographic 3D reconstruction of the spine.

Results: The mean age of the cohort was 14 years and 11 months and 90% were females. The mean Cobb of the primary curve was 38.98 (16.9–104) with a mean vertebral rotation of 15.5° (0.3–43.5°). The mean Cobb of the compensatory curve was 31.35 (9.2–64°) with a mean vertebral rotation of 9.32° (0.1°-40.5°). While the apical vertebral rotation showed a strong correlation to the Cobb angle of the affected curve ($r = 0.72$, $p < 0.001$ for the main curve; $r = 0.74$, $p < 0.001$ for the compensatory curve), it correlated moderately to the pelvic incidence ($r = 0.31$; $p < 0.05$). Furthermore, apical vertebral rotation had the most strong correlation to pelvic incidence in thoracic curves (apex T5-T10; r=0.4, $p < 0.05$), whether in lumbar curves (apex L2-L4) there were a tendency to a negative correlation ($r = -0.2$, $p > 0.05$). Finally, the pelvic incidence did not correlate to the curve Cobb angle ($r = 0.34$, $p = 0.08$ for the primary curve; $r = 0.27$, $p = 0.055$ for the compensatory curve)

Conclusions: To our knowledge, this is the first study evaluating the correlation between apical vertebral rotation and pelvic incidence. Pelvic incidence is a well-known pelvic parameter that correlates significantly to the apical vertebral rotation in adolescent idiopathic scoliosis.

GP021. Preliminary Results of Treatment of Early Onset Scoliosis using Magnetic Growing Rods

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Introduction: One of the major disadvantages of traditional growing rod systems is the requirement for multiple surgical procedures to lengthen the rods as the patient grows. This has been avoided by introduction of magnetically controlled growing rod (MCGR).

Materials and Methods: A prospective uncontrolled, single-center, single-surgeon, clinical and radiological study. Between November 2012 and August 2015, 16 children with EOS were treated using MCGR. Preoperative, postoperative and final follow-up (FFU) whole spine radiographs were reviewed to determine the degree of spinal deformity and correction, measured using Cobb angle. T1–S1 length was calculated. Clinical notes to determine number of rod lengthening procedures using remote control device and to record any complications during surgery or FU period. Mean age was 11.6 years, 3 boys and 13 girls; 11 children had primary correction by MCGR; 7 of them had neuromuscular, three infantile and one congenital scoliosis. All had a dual MCGR implanted. The remaining five patients had previously undergone other growing rod operation before converting to MCGR implant.

Results: Mean pre-operative Cobb angle of the primary group was 63.2°, postoperative 35.6° (40.5% correction), FFU 39°. Mean initial percentage of the lengthening was 14.8%. Thoracic kyphosis changed from preoperative mean of 49.1° to 34.1° postoperatively. One patient had wound infection, three had pull-out of proximal screws/hooks, one sustained a breakage of a single-rod construct 6 months after surgery and was replaced by a double magnetic-rod construct. A total of 40 distractions have been performed. Mean FU was 15.5 months.

Conclusions: In our consecutive series of patients treated with MCGR we found that scoliosis was well controlled. Cobb angle was significantly reduced following surgery in patients who had MCGR performed as a primary procedure. Generally, the correction was maintained at FFU. Despite the relatively high complication rate, comparing our results for MCGR and other growing rod techniques, they are comparable, without need to repeated surgery.

GP022. Conversion of Implant Failure in Early Onset Scoliosis to Magnetic Growing Rod. A Series of Five Cases

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Introduction: Conventional growing systems allow spinal growth to continue and prevent curve progression but need multiple interventions that increase the risk of infection, complications of anesthesia. A more advanced, less invasive method is the remotely distractible, magnetically controlled growing rod (MCGR) system which has been developed to allow frequent non-invasive distractions. This is the first series focusing on the conversion of failed growing implant to MCGR.

Materials and Methods: A prospective single center study from 11/2012 to 8/2015 with consecutive patients with progressive deformity and implant failure. Five children have been converted to MCGR; one boy and 4 girls; mean age 11.9 years. The scoliosis was infantile in two and neuromuscular in 3 cases. Four patients had VEPTR and one had a conventional growing rod.

Results: Mean preoperative Cobb angle was 56.6°, thoracic kyphosis 59.6° and spinal length (T1-S1) 339mm. The upper fixation level was T3-T5 with a lower fixation to T11 and L2 in the infantile scoliosis and L3 in two neuromuscular cases. One neuromuscular scoliosis was fixed with hooks to the iliac crest. Mean operative time was 135 minutes and blood loss 217 ml. Mean postoperative Cobb angle was 48.1°, thoracic kyphosis of 49.8% and spinal length 379mm. During this study a total of 15 distractions have been performed to all children. At final FU (mean of 21.8m), mean Cobb angle was 48° (total additional correction of 2.5°), thoracic kyphosis of 51.5° (total additional correction of 3.2°) and spinal length of 387 mm (total spinal growth of 33 mm). One case reached to final fusion after 2 distractions. Double rods have been the rule with exception of one neuromuscular case. This single rod

was broken after 6 months and replaced by a double rod system. The other complication was a proximal junctional kyphosis (PJK) that occurred primarily after VEPTR and again after magnetic rod.

Conclusion: Although conversion of implant failure from VEPTR and growing rod systems to MCGR is a good option to allow growth of the instrumented segment, this gives limited results when performed at a relatively older age. The postoperative correction in these cases is relatively limited due to prior correction by the older systems. One complication related to the implant occurred with single rod construct. Correction by MCGR will face the same challenge to prevent PJK, like other growing rod systems. The new technique provided a non-surgical repeated (sometimes outpatient) distractions.

GP023. Three Column Fixation: A Dynamic Method in Scoliosis Surgery

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Introduction: Scoliosis is a complex three dimensional deformity characterized by coronal, sagittal and horizontal plane deviation. Non operative treatment is a widely accepted approach. A significant number of cases need surgical intervention. Revolutionary design & capability of spinal instruments have drastically changed the principle of scoliosis correction by surgical intervention.

Material and Methods: During the period February 2009 to November 2014, 64 cases of different types of Scoliosis underwent surgical intervention at NITOR, BSOH and other private hospitals in Dhaka. 45 were female and 19 were male and age ranged from 14 to 38 years.

Results: The pedicle is a power nucleus of the vertebra and offers a secure grip of all 3 columns. Pedicle screw instrumentation has advantages of rigid fixation with improved 3D correction and it has been accepted as a reliable method with a high margin of safety. Accurate placement of the pedicle screws is important to reduce possible irreversible complication. So, all cases were corrected by transpedicular screws and rods and 1 case stabilized by sub laminar wring. 61 cases were managed by only posterior approaches and 3 cases required both anterior releases, costoplasty, posterior stabilization as well. In every case fusion was done in selected segments.

Conclusion: Total follow up time was ~5 years (6 months-5yrs). All patients were assessed in terms of correction of deformities, cosmesis, and functional outcome. 64 patients had average coronal plane cobb's angle measuring ~70 degree pre-operatively and 17.12 degree immediate post-operative period. 4 patients (5.7%) developed neurological deficit. 3 regained completely but another one regaining her neurological deficit very slowly. There were malposition of screws in 9 (14%) cases, Painful prominence of screws in 6 cases (9%), full flexion lack in 8 cases (12.5%) & superficial infection in 1 case (1.5%). 80% patients improved cosmetically.

Keywords: scoliosis surgery, three column fixation, posterior approach

GP024. Preoperative LIV Tilt Affects Post Operative Coronal Imbalance in Patients with Lenke 5C Scoliosis

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Introduction: Lenke 5C curves are increasingly being treated through posterior pedicle screw based correction techniques. We evaluated different preoperative radiological parameters which could affect post operative coronal imbalance (POCI) in patients with Lenke 5C scoliosis treated with posterior instrumented correction.

Methods: We retrospectively evaluaed twenty-three cases with Lenke 5C scoliosis who underwent selective posterior pedicle screw based deformity correction. Fusion was performed from proximal neutral to distal stable vertebra. Preoperative, immediate post operative and final whole spine standing radiographs were analyzed. The pre-operavtive radiological parameters were assessed including lower instrumented vertebra(LIV) tilt and translation, Cobb angle,C7 offset from CSVL, lumbar lordosis and upper instrumented vertebra (UIV) tilt and translation. Post-operatively we assessed the correction in cobb angle and post-operative coronal imbalance.

Results: Twenty -three patients had a mean age: 11.8 ± 4.6 years, with 4 males and 19 females. There was a significant improvement in Cobb angle from mean of $55 \pm 13.3°$ to mean of $14.7 \pm 8.8°$. Nineteen patients had lower instrumented vertebra at L4, 3 at L3 and one at L5. Correction was maintained with no significant loss in the late post op period (15.2 ± 8.9 degrees). The mean pre op C7-CSVL distance was 24.7 mm While eight patients had immediate post operative coronal imbalance (POCI), six of them balanced at a mean 8.2 months. Four patients had POCI at the time of final follow-up including two, who developed late imbalance. POCI correlated with pre operative LIV tilt only $> 25°$ ($p < 0.05$) and not with LIV translation, UIV tilt or translation. Five of the eight patients with immediate POCI and all four patients with late POCI had preoperative LIV tilt $> 25°$.

Conclusion: In Lenke 5C scoliosis treated by posterior pedicle screw instrumentation, patients with a preoperative LIV tilt ($>25°$) have a risk of developing POCI.

GP025. Video-Assisted Thoracoscopic Surgery (VATS) for Anterior Release of Rigid Thoracic Scoliosis

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Introduction: Standard anterior approach to the dorsal spine using thoracotomy carries a great morbidity; video-assisted thoracic surgery (VATS) has been used as a less invasive approach for many intrathoracic disease processes; among which anterior releases in rigid dorsal scoliosis. The authors performed (VATS) in patients with Adolescent Idiopathic Scoliosis (AIS), attempting to reduce the morbidity attributable to standard open thoracotomy surgery for anterior curve release; reporting their experience with thoracoscopy as part of the treatment for adolescent idiopathic scoliosis with rigid thoracic curves.

Material and Method: A prospective randomized study of 34 cases of AIS with rigid thoracic curves underwent VATS for anterior release surgery between March 2008 and April 2013 was performed. The ages of the patients ranged from 11 to 27 years with a mean of 16.3 +/− 4.2 SD years. Spinal flexibility was assessed by the fulcrum bending technique. Cobb angle before and after the anterior release was compared. All patients had an anterior spinal release and posterior

spinal fusion at two separate surgeries to evaluate the flexibility after anterior release without posterior instrumentation.

Results: The average follow up ranged from 22.3 to 39.2 months (mean 30.33 +/− 4.64 SD months). The mean preoperative Cobb angle was 78.4° +/− 8.87° SD on standing radiographs and 70.3° +/− 8.48° SD with the fulcrum-bending radiograph. After anterior release, the fulcrum bending radiograph showed reduction of mean Cobb angle to mean angle of 41.6° +/− 6.98°. The mean fulcrum bending flexibility index was improved from 10.41% +/− 3.97 SD (prior to VATS release) to 46.97% +/− 5.23 SD after release. VATS was successfully completed in all patients without major morbidities. The mean operative time for the anterior procedure was 123.96 minutes +/− 28.77 SD. The average number of excised discs was four.

Conclusion: Anterior spinal release using VATS may reduce postoperative morbidity and produces satisfactory degree of flexibility for rigid thoracic curves. It can be considered as a good and safe alternate to open thoracotomy for anterior release.

GP026. 2-Year Outcome of a New Modified Luque Trolley Technque versus Traditional Growing Rods in the Management of Progressive Juvenile Onset Scoliosis

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Introduction: Our objective was the long term evaluation of a new growth guidance technique compared with growing rods for posterior instrumentation of scoliosis. We performed a retrospective review of patient records and radiological imaging. A traditional Luque Trolley construct uses wires to hold growth guidance rods together. We describe a new technique which uses Domino end to side connectors in place of the wires with the aim of providing a stronger construct to limit curve progression. From a group of 28 patients treated with this technique we review 23 patients with a minimum of 2 year follow up. The mean age at surgery was 7.3 years (10 Male and 18 Female). The mean preoperative Cobb angle was 69.1 degrees. All patients had posterior correction and modified Luque trolley construct with domino. We compared this to a group of 6 patients with a minimum 2 year follow up who were treated with growing rods. The mean age of this group was 7 years (2 Male 4 Female). The mean pre-operative Cobb angle was 56.5 degrees. All of these patients had posterior correction with growing rods.

Materials and Methods: Sequential measurement of Cobb angle and length of rods was performed, with recording of further surgical procedures and associated complications. This enabled us to demonstrate curve progression and growth of the construct in both patient groups.

Results: In the domino group the mean pre-operative curve was 69.1 degrees corrected to a mean post-operative angle of 36 degrees showing a mean percentage correction of 48.9%. This compared with a mean pre-operative curve of 56.5 degrees in the growing rods group, which was corrected to a mean post-operative angle of 36.1 degrees showing a mean percentage correction of 41.3%. In both groups the curves progressed despite surgery with a mean progression of 10.9 degrees after 1 year and 15.7 degrees at year 2 in the domino group and a mean progression of 3.3 degrees after year 1 and 14.9 degrees at year 2 in the growing rod group. In both groups the constructs had limited growth. The mean amount of growth at 2 years was 3.7mm (~0. 19cm per year) in the domino group and 10.8mm (~0.54cm per year) in the growing rod group.

Conclusion: Both techniques do not completely prevent progression of scoliosis. Our new domino technique demonstrates as good a capacity for initial curve correction and limiting further curve progression as a growing rod technique but has a more limited capacity for further longitudinal growth. However the new domino technique is vastly cheaper and avoided a mean of 3.4 surgeries in the 2 year period compared with the growing rods.

GP027. The Effect of Waiting for Surgery on Patients with Adolescent Idiopathic Scoliosis

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Introduction: The waiting time for surgical procedures is becoming longer in most specialities. This may have adverse effect on patients with Adolescent Idiopathic Scoliosis (AIS) with additional procedures being required or more complex surgery being performed.

Material and Method This retrospective study was performed in the period between December 2007- January 2010 looking on the surgical waiting time on patients with AIS and its effect on curve progression and the type of surgery performed and the final outcome.

Results: 215 patients met the inclusion criteria and have complete medical records to be included in the study. Mean age was 13.6 years, 184 patients (86%) were females, 172 were treat in public hospitals and 43 in a private hospital, mean cobb angle of the main curve was 71°. During the study period, 55 patients underwent surgery for scoliosis correction, with a statistical difference in the waiting time between public and private hospitals (36 and 9 weeks respectively), average curve progression was 24° during the waiting period with additional fusion levels being required in 15 cases. Patients with underlying intra spinal pathology and young patients showed the most significant curve progression.

Conclusion: Our study support the previous report of the optimal waiting time for surgical correction of scoliosis being less than 6 months and it suggest that younger patients and those with intra spinal pathology and the ones at higher risk for progression.

Keywords: idiopathic scoliosis, surgical waiting, curve progression

GP028. Management of Children with Complicated Spinal Deformities in Countries with Minimal Resources

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Introduction: It is conceded that complicated spinal deformity in underdeveloped countries presents specific obstacles, but these are often made into "using cheaper screws" and being cost effective. In fact, this has become the main discourse for addressing scoliosis in the global South. It is not simply an extra problem on the margin but a fundamentally different institutional context which presents unique constraints and requires innovative solutions. We can innovate ways to make the surgery have less operative and postoperative demands, or to make those demands easier to deal with GIVEN the adverse institutional context. This is precisely where hybrid construct comes in as a surgical choice that is

used for complicated spinal deformity in developing country with minimal resources for more than 5 years now.

Material and Methods: 13 cases presented with severe spinal deformity, all previously surgically treated for scoliosis, 7 congenital, 3 iatrogenic, 2 syndromic, 1 idiopathic . 8 of them with other associated problems, 6 with scoliosis, 6 with kyphoscoliosis and 1 with kyphosis. The surgical management before the hybrid construct were 28 procedures done, 4 posterior fusion with instrumentation, 3 posterior fusion in situ,2 anterior and posterior fusion in situ, 2 growing rods, 1 VEPTER, 1 posterior fusion and instrumentation with removal of the implants in same day .

Results: Mean age at surgery with hybrid construct 10.5 years, with mean followup time 34 months, all were done with rib hooks proximally and pedicular or iliac screws distally . mean preoperative thoracic scoliosis was 83 became 66, thoracic kyphosis 113 became 70, thoracolumbar scoliosis 60 became 40, thoracolumbar kyphosis 63 became 22 .Complications, 8 complications were detected 2 infection, 1 proximal hook dislodgment, 1 implant exposure, 2 broken rod, 1spinal stenosis, 1 died from non-surgical related cause.

Conclusion: With this complex and demanding medical condition in developing countries, we think that hybrid construct may be a good and safe surgical option.

GP029. Impact of Longer Surgical Wait-List Times on Length of Hospitalisation, Return to Function and Cost of Surgical Treatment in Patients with Adolescent Idiopathic Scoliosis undergoing Posterior Spinal Fusion

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Introduction: Despite the known clinical and functional benefits of timely surgery in adolescents with idiopathic scoliosis (AIS), several patients still undergo surgery for scoliotic deformity correction when curves have progressed beyond 70°. More evidence is needed assessing the effect of long surgical wait-list times on patient outcomes including return to function, intrasurgical factors and cost of surgical treatment. This study aimed to report on surgical wait-list times in a cohort of patients with AIS undergoing posterior spinal fusion (PSF), and examine potential correlations with selected patient outcomes including: intrasurgical factors, length of hospitalisation, return to function and cost of surgical treatment.

Material and Methods: A prospective longitudinal cohort study involving the recruitment and follow up of 77 consecutive and eligible patients with a diagnosis of AIS, from two tertiary centres, over a two year period, until return to function (e.g., school/college, physical activity) was reported. Surgical wait-list times were analyzed in relation to timing of return to function, cost of surgical treatment (), intrasurgical factors (surgical duration, estimated blood loss) and length of hospitalisation. In accordance with local criteria, a long surgical wait list time was defined as 'greater than 6 months'. SPSS® was used to analyze the data; non-parametric Spearman correlation coefficient was used in all correlation analyses (r_s).

Results: The median surgical wait-list time in the cohort was 33 weeks (interquartile range 19–56 weeks). Almost two thirds of patients waited beyond 6 months for surgery (62.3%; $n = 48$); twelve patients (15.5%) waited beyond 18 months. Patients who waited beyond 6 months had a significantly larger preoperative curve (65° ± SD 14 versus 58° ± SD 10) and the cost of surgical treatment per patient was significantly greater (mean 32,652 versus 27,629, $P < 0.0001$). In addition, longer surgical wait list times strongly correlated with a significantly longer surgical duration ($r_s = 0.565$, $P < 0.0001$) and higher blood loss ($r_s = 0.27$, $p = 0.044$). No significant correlations were found between surgical wait-list times and length of hospitalisation, timing of return to school/college or physical activity.

Conclusion: Efforts to support waiting list initiatives in the AIS population are likely to give rise to significantly reduced surgical cost, less complex surgeries and more manageable curvatures being dealt with in a timely fashion.

GP030. Intraoperative Electromyography and Instrumentation in Patients with Idiopathic Scoliosis

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Introduction: The objective of this study is to relate the use of intraoperative electromyography surgical time, proper placement of screws, type of curve and time for screw in idiopathic scoliosis correction surgery in a group of surgeons of Belo Horizonte.

Methods: This was a retrospective study of 80 patients undergoing surgical treatment for idiopathic scoliosis correction between December 2008 and January 2015. All patients was performed electromyographic monitoring (EMG) intraoperative by a single column group of surgeons Belo Horizonte. EMG was performed with stimulation of pedicle screws in patients undergoing instrumentation using pedicle screws and fasteners.

Results: It was observed that 85% were female, with a mean age of 17 years (minimum of 6 years and maximum of 34 years), 37.5% of the cases represented the curve was idiopathic Lenke 1AN. 60.0% of all surgical cases had EMG change, and of these 1.3% had already had deficits Pre-procedure and 3.75% of cases post deficits. Of the total cases analyzed 66.3% were positive for real results.

Conclusion: Intraoperative monitoring with EMG is a very important tool for the surgical treatment of patients with scoliosis patients with instrumentation with pedicle screws. Through this feature you can check if the screw is on the correct path contributing to decrease the error rate, post surgical arthrodesis allowing the change in surgical strategy. Besides contributing to the positioning time reduction of the screw and the end of the surgical time.

GP031. Comparison of the DIERS Formetric 4D Scanner and Plain Radiographs in Terms of Accuracy in Idiopathic Scoliosis Patients

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Introduction: Comparison of the DIERS Formetric 4D Scanner and plain Radiographs in terms of accuracy in AdolIdiopathic Scoliosis (AIS) Patients. This project aims to determine the accuracy of the DIERS scanner and help decide whether it could be used instead of radiographs for some, or all, AIS patients.

Material and Methods: Two patient lists were combined; both patients who underwent an operation between

2011–2014 and patients on the Spinecor bracing program. Only preoperative radiographs were used of the operative group. Both DIERS Formetric scan and radiograph were be taken on the same day to prevent time related changes to scoliotic curve. Patients were excluded if they had had an operation to treat their scoliosis. Patients with braces were included so long as their X-ray was of them not wearing the brace. There was no restriction on BMI. Some patients had a double curve (thoracic and lumbar) and it was decided to only compare the greater curve. The radiographs were assessed to show the Cobb angle and the position of the greatest scoliotic curve. To confirm the accuracy of measurements, a senior consultant remeasured a total of 50 X-rays. The results he found averaged a 3.1 degree difference to that measured by the medical students. It was decided that this showed sufficient correlation that not all of the Cobb angles needed to be re checked. Following the radiograph assessment the DIERS Formetric scans were reviewed.

Results: A total of 85 patients (41 Spinecor, 44 preoperative) were measured providing a total of 236 X-rays. 71 X-rays were excluded: 3 due to the Cobb angle not indicating scoliosis (<10°) and 68 due to a DIERS scannot being performed on the same day. A total of 165 X-rays remained for comparison. The range of Cobb angles was between 10.3 and 82 degrees. The DIERS scanner averaged a Cobb angle of -3.49° below that measured on the X-ray. However, although this result seems very good, it is not pure correlation that needs to be taken into account. It would be expected that correlation would be found but, more importantly is the difference between the angles measured on X-ray when compared with DIERS. Interestingly the scanner seemed to overestimate curves of a small severity and underestimate larger curves.

Conclusion: Overall the Formetric scanner did average a small underestimate of the Scoliosis angle measured, and showed a good correlation when compared with X-ray. However, especially in severe curves (>65°) the level of accuracy deteriorated rapidly. It could be concluded that the Formetric scanner could replace X-rays for follow up patients within boundaries of magnitude of curve, but that it could not replace X-rays for early diagnosis or when the patient is having a preoperative assessment.

GP032. Is Radiographic Control Necessary After Every Lengthening of Magnetically Controlled Growing Rod?

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Introduction: A well-accepted imaging follow-up protocol to confirm the amount of lengthening, and check for the curve and the status of the implants for MCGR is not yet established. AP-lateral XR after each lengthening (usually every 2–3 months) is suggested. The aim of this study was to find out whether radiation exposure after every lengthening can be justified or not.

Material and Methods: A retrospective analysis of 14 consecutive patients (12F, 2M) with EOS of different etiologies treated by MCGR. Mean age was 7 (3–10). Examination of the back in terms of implant prominence was done carefully after each lengthening. Lengthening interval was 2–3 months. Patients had pre- and post-lengthening AP-lateral XR in every visit in the beginning of experience and this was subsequently changed to only AP post-lengthening XR. The XR were analyzed for the presence of failure to lengthen, collapse between 2 procedures and incidental mechanical failures such as rod breakages, hook/screw pullout.

Results: Mean preop coronal Cobb of 69.6° (38–101) was corrected to 39.1° (16–76) at the final follow-up. Average followup was 24 months (6–52). A total of 101 lengthenings were performed. 173 pre- and post-lengthening XR (110 AP, 63 lateral) were taken. There were a total of 5 mechanical failures in 2 pts. 4 were rod or substance breakages and 1 was hook dislodgement. All 5 were diagnosed in a non-planned control with the patient applying for either prominence of implants and/or history of trauma or unremitting pain. No other incidental mechanical failures were noted in any routine XR.

Conclusion: Routine XR taken before and after each lengthening procedure of a MCGR is not likely to reveal any significant findings. Post-lengthening AP XR with a decreased frequency (every 6 months) and AP-lateral XR only after a significant complaint or clinical findings should be considered.

GP033. All Pedicle Screw Instrumentation for Scheuermann's Kyphosis Correction

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Introduction: Scheuermann's kyphosis has long been treated by a two staged fusion and instrumentation with a hybrid construct using hooks, pedicle screws and sublaminar wires. Interest in all pedicle screws constructs led to its use in the treatment of Scheuermann's kyphosis.

Materials and Methods: The study included 18 patients who underwent a single stage correction by segmental all pedicle screw constructs (Group 1) and 17 who underwent a two staged fusion and instrumentation with a hybrid construct (Group 2). The average age was 16y+3m and 16y+8m respectively. The average preoperative dorsal kyphosis was 88 degrees (Group 1) and 80 degrees (Group 2).

Results: Both groups were followed for a minimum of 2 years. The deformity correction of Group 1 had an average of 57% postoperatively with 2.2% loss at final follow-up in comparison to Group 2 where the correction was 48% postoperatively with 3% loss at final follow-up. The operative time was considerably less in Group 1 with an average of 3.5 hour than Group 2 with an average of 5.15 hour. The average blood loss was 550 cc in Group 1 and 910 cc in Group 2.

Conclusions: The use of multiple levels all pedicle screws technique allowed a rigid anchor for posterior correction of the deformity with less operative time, blood loss, hospital stay without the need for anterior release.

GP034. Posterior Vertebral Column Resection (PVCR) in Early Onset Spinal Deformities (EOSD)

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Introduction: Early onset spinal deformities (EOSD) are spinal deformities before five years. Early surgical intervention is often necessary to avoid the eventually disastrous complications due to deformity progression like restrictive pulmonary functions. Posterior vertebral column resection (PVCR) achieves the best correction in severe and complex deformities. We present our experience in PVCR in five cases with EOSD.

Patients and Methods: PVCR was done in five cases (2 males and 3 females) with congenital hemivertebra with a mean age of 4.3 years. Two cases were only kyphotic while the other three cases had additional scoliosis. One case presented

with progressive lower limb spasticity. All cases were managed by one level PVCR. Shilla growth guiding technique was done in two cases to allow future growth. One patient had short segment fusion, and two had long segment fusion. The patients were followed up for a mean of 21 (12–36) months.

Results: The patient with paraplegia improved completely over the three postoperative months. The local kyphosis improved by 92% (59° to 4.5°). The mean thoracic kyphosis improved by35% (38.25° to 24.5°). The mean sagittal vertical axis decreased by 71% and 19% (38.37 to 11 to 30.8 mm) postoperatively and at last follow up respectively. Lumbar lordosis reduced by 22% (47.5° to 37°). The associated scoliosis completely corrected from 29° to 0°. The mean operation time was 482.5 minute, with 3075 ml blood loss. One patient with myelocele had pseudarthrosis and metal failure necessitated revision. The patient with short segment fixation developed an asymptomatic, non-progressive proximal junctional kyphosis immediately postoperatively. No revision or extension of fusion was needed.

Conclusion: PVCR appears to be an effective technique to treat severe EOSD with limitation of fused segments to allow further growth.

GP035. Management of Early Onset Scoliosis using Growing Spine Profiler (GSP)

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Introduction: Achieving adequate surgery for early onset scoliosis (EOS) is difficult because of many challenges including the need to correct the deformity, the need to allow adequate spine growth, to allow adequate lung development, and the need to minimize complications. GSP system was found to solve these troubles with minimal complications in comparison with other techniques. This is a preliminary analysis and report about the efficacy and safety of GSP system in treating patients with early onset scoliosis

Patients and Methods: This is a combined prospective and retrospective study of 15 patients (9 females and 6 males) with EOS. The age ranged between 3.5 and 7 years old. All patients were treated with GSP system in our hospital and were prospectively followed for a minimum of 1 year. The following parameters were measured both preoperatively and posteoperatively and at each follow up visit. 1- Cobb's angle correction. 2-T1-S1 height. 3-apical vertebral translation (AVT). 4-space available for the lung (SAL) ratio. 5-shoulder and pelvic balance. Also all surgical details were recorded including, single or dual rod technique used, operative time, blood loss, and intraoperative complications. Post-operative follow up schedule at 8 weeks and every 6 months for serial lengthening and assessment of the previous parameters after each lengthening. Any complication during follow up is recorded. This group was compared with a similar historical cohort treated earlier by Growing Rods.

Results: Surgical details -blood loss 90ml (80–300). -operative time 1.5 hours. -number of rods (3 cases single rod and 7 cases dual rods). -number of lengthening procedures 0–4 times. -number of additional procedures 4. Follow up - Mean follow up 4months (3–18) months. - Cobb's angle corrected from (90.4) to (44). -AVT improved from 54mm to 34mm -T1-S1 height improved from 210mm to 305mm. -SAL ratio improved from 89% to 84%. Intraoperative complications. -pleural injury 5 cases. -others 0. Postoperative complications -Screw pull-out 2 cases. -hook dislodgement 0. -neurological injury 0. -infection 2 cases (superficial wound infection). -prominent metal 1 case. -metal failure 2 cases (single rod group)

Conclusion: GSP seems to be a good and economic option for management of EOS with proper patient selection and proper surgical technique

GP036. Posterior Selective Fusion with Pedicle Instrumented Correction in Thoracolumbar Adolescent Idiopathic Scoliosis (AIS)

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Introduction: To evaluate clinical and radiological outcome of selective fusion for adolescent idiopathic scoliosis (AIS) in thoraco-lumbar curves i.e., Lenke 5C curves.

Material and Methods: Twelve(12) patients with Lenke 5C curves were operated through posterior approach for AIS . Risser stage at the time of operation was 0–3 in 6patients and more than 3 in 4patients. Mean age was 13.5 years. Not every vertebra was instrumented with pedicle screws. Apical vertebral derotation and translation on the concave side were performed for correction. All patients underwent a selective fusion (5C only thoracolumbar/lumbar curve fused). The data were prospectively collected preoperatively and at 6 weeks, 1year and 2years post-operatively. Cobb angle, sagittal and coronal balance, and lowest fused vertebral tilt were documented at all time-points. Uninstrumented compensatory curves were measured at all time points.

Results: The average thoracolumbar/lumbar (TL/L) preoperative Cobb angle in Lenke5C curves was 46° ± 8° which was corrected to 14° ± 7° (70% correction) at a 2-year follow-up. 25% of the uninstrumented thoracic curve had spontaneous correction. The coronal balance improved significantly ($p < 0.05$) and remained stable from the first postoperative visit to the 2-year follow-up visit. The SRS-22 total scores improved significantly from before surgery to 2years after surgery ($p < 0.0001$). No pseudarthrosis or reoperation was observed.

Conclusion: Posterior correction of thoracolumbar AIS with pedicle screw instrumentation is safe and produces a long-term stable correction and high patient satisfaction. In Lenke 5C AIS deformity patterns fused selectively, the uninstrumented compensatory curves do not seem to progress. Selective fusions, when successfully performed, will optimize mobile segments of the spine in AIS patients.

GP037. Quality of Life of Children and Adolescents with Idiopathic Scoliosis Treated Conservatively with DoboMed Method

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Introduction: The purpose of this study was to determine the Quality of Life of children and adolescents with IS (idiopathic scoliosis) treated conservatively with DoboMed method.

Material and Methods: We examined group of 63 patients (54 girls) with mean age (14,7 years) – 32 were

treated with a DoboMed method only and 31 were treated both with DoboMed method and with Cheneau brace. Mean patients' Cobb angle was 24,2° and mean apical vertebral rotation (AVR) was 11,4°. We also analyzed the patients' BMI (body mass index) z-score, the age of the diagnosis, the deformity location and the duration of brace application. Two questionnaires were used: BSSQ-Deformity and BSSQ-Brace, patients were examined twice at the beginning and at the end of hospitalization.

Results: At the beginning of hospitalization, the median value of BSSQ-Deformity was 18 and for BSSQ-Brace 9,5. Statistically significant correlations between BSSQ-Deformity results and patient's age, BMI z-score and numer of hospitalizations in the Department were observed. In the group of patients treated with a DoboMed method and a brace, we observed the higher level of stress associated with application of the brace (median=9,5) than the level of stress associated with a deformity (median=16) ($p = 0{,}0001$). This group presented also a higher level of stress evaluated with BSSQ-Deformity than group treated only with DoboMed (median=19) ($p = 0{,}041$).

Conclusion: Children and adolescents with a scoliosis treated with a DoboMed method presented a low or moderate level of stress associated with the deformity. Higher observed the level of stress was significantly correlated with an older age of patients, a higher BMI z-score value and more hospitalizations in the Department. There was no correlation between the patients' quality of life and the duration of a brace aplication. Group of patients treated with both: the physiotherapy and brace presented the higher level of stress associated with deformity. The level of stress associated with the brace usage (BSSQ-brace) is higher than a stress associated with deformity (BSSQ-deformity) in a group treated with the Chenau brace.

GP038. Posterior based 2 or 3 Column Spinal Osteotomies and Release followed by a Controlled Halo-Pelvic Distraction in the Management of Neglected and Complicated Spinal Deformities: A Safe and New Technique

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Introduction: Neglected severe and rigid spinal deformities pose a big challenge to spine surgeons. The neglect adds other risk factors like decompensated respiratory function, fused rigid curve and neurological deficit to an already complex problem. Single stage and anterior surgery are fraught with complications in an already compromised lung condition. The visco-elastic properties of spine utilized through awake halo-pelvic distraction aided by posterior release and a posterior based 2 or 3 column osteotomy allow safe correction of deformity before a definitive procedure is planned. We present our experience of treating 3 such cases.

Materials and Methods: Retrospective review of hospital records identified three patients. Two patients had neglected early onset congenital spinal deformity with intraspinal anomaly. The third patient was an old operated case of neuromuscular scoliosis with fused spine with crankshaft phenomenon. All three patients presented with a poor pulmonary function on admission. The curves were severe($> 90°$) and rigid with flexibility of only 10%. All three patients were managed by posterior release and periapical posterior based 2 or 3 column osteotomies with halo-pelvic distraction and finally posterior spinal instrumentation and fusion.

Results: Mean preoperative coronal cobb's angle 102° corrected to 72.33° after posterior based osteotomies and halo-pelvic distraction alone and was 56° after final posterior instrumentation with or without intraoperative manoeuvring. The results were encouraging at three years follow-up, with improved pulmonary function.

Conclusion: Staged surgeries with controlled and awake, axial distraction using halo-pelvic apparatus with posterior based spinal osteotomies and release offer a safe and effective option in the treatment of severe rigid three plane deformities of the spine with severe respiratory compromise.

GP039. A Comparison of Stryker Xia3 and Depuy Expedium FAS Instrumentation for the Correction of Adolescent Idiopathic Scoliosis

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Introduction: In 2012, our institution held a tender for the supply of its instrumentation which resulted in a majority supply being awarded to Stryker for Xia3 spinal instrumentation. Prior to this we had been using Depuy Expedium FAS for the preceding 5 years. As the surgeons would have to go through a learning curve for the use of the instrumentation system, we felt it important to demonstrate that the correction of curve obtained and the intraoperative risks were the same for each from the outset of the change.

Material and Methods: We examined the post-operative X-rays of our patients who had adolescent idiopathic scoliosis corrected in our institution using Expedium FAS and Xia3 instrumentation between 2011 and 2014. We excluded curves that had previously had growing rods, previous pseudarthrosis or other spinal complication, anterior spinal surgery, implant removal, and incomplete records. Patients were identified using our hospital's theater management software. We measured the pre- and postoperative and 1 year follow up Cobb angle on our PACS system. Blood loss and transfusion requirements were obtained from our cell-saver and blood bank database, and other information was obtained from the clinical notes.

Results: 173 patients were identified. 53 had incomplete datasets. 22 were excluded due to having previous growing rod, combined anterior/posterior procedure, or a Skagg's Procedure. 63 cases using Expedium FAS and 35 of Xia3 were found. Expedium had 59 (21–99)% curve correction, 5.40 (2–12.5) hours operative time, 0.87 (0.2–1.5)l intraoperative blood loss and 8.5 (5–42) days hospital stay. The Xia3 group had 63 (34–90) % curve correction, 4.87 (3–7.5) hours operative time, 1.6L (0.4–2.5)l blood loss, and 10 (5–42) days LOS. Only the difference in blood loss reached statistical significance, however transfusion rates were the same.

Conclusion: Despite being at different parts of the learning curves with each instrumentation systems, a group of 4 experienced scoliosis surgeons were able to achieve equal correction of scoliosis using either instrumentation systems in all variables except for blood loss. Moving instrumentation systems can be daunting, however can be done safely if managed in a proactive manner.

GP040. Low Body Weight in Pacients with Adolescent Idiopathic Scoliosis

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Introduction: Scoliosis is a three-dimensional deformity of the spine that leads to more than 10° in the frontal plane. In adolescent idiopathic scoliosis (AIS) does not know the cause of the condition, and the search of the pathology source settings may involve the analysis of the nutritional status of patients. This study aims to investigate the nutritional status of patients (AIS) compared with asymptomatic population in the same age group.

Methods: A prospective, descriptive and comparative study with a sample of 60 subjects divided equally into two groups. The AIS group ($n = 30$) represented by holders of AIS and control group ($n = 30$) comprised healthy subjects both sexes and groups with equivalent age. We analyzed age, gender, menarche, weight, height and BMI.

Results: In terms of age: AIS Group: 14.3 ± 1.97 years; Control group: 14.23 ± 1.79 years. Regarding weight: Group AIS: 47.4 ± 13.8 kg; Control group: 55.6 ± 11.63 kg As for height: AIS Group:. 1.6 ± 0.1 m; Control group: 1.64 ± 0.08 m. As for BMI: AIS Group: 18.5 ± 3.7 kg / m2; Control group: 20.79 ± 2.92 kg / m2. Age and height did not achieve statistical difference when compared with the different AIS and control groups ($p > 0.05$). While statistically significant difference of body weight ($p = 0.01$) and BMI ($p = 0.01$) when comparing the AIS and control groups.

Conclusion: Patients with AIS have a low body weight.

Keywords: scoliosis, body weight, height, BMI, height-age

GP041. Analysis of Curves of Allowances Submitted to Patients Arthrodesis Selective in Curves Lenke Type 1: Fellow up Two Years

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Introduction: Adolescent idiopathic scoliosis (AIS) is the most common form of spinal deformity, by definition is in the coronal plane deformity greater than 10 °, associated with the rotation of the vertebrae and costotransversais joints presents no definite etiology. The treatment of such deformity depends on the magnitude and location of the curve and be in accordance with the degree of growth potential of the patient. The goals of surgery are to correct the curve, restore balance in the coronal and sagittal plane, prevent progression and possible cardiopulmonary complications and consequently a cosmetic improvement.

Objective: To evaluate radiographically the behavior of the secondary curves in the coronal and sagittal plane in AIS patients classificad as Lenke I, who underwent surgical treatment of posterior arthrodesis selective in fellow up the two years.

Methods: A prospective study where of analyzed 40 patients with AIS, 33 female. The measurement of used radiographic parameters followed the recommended by Cobb with fellow up the 2 years.

Results: The mean Cobb index in the anteroposterior radiographs preoperatively examination was 29.97 ° for proximal thoracic curve, 59.08 ° for main thoracic curve and 35.26 ° for lumbar curve. The average postoperative was 19,56°, 14,73° and 12.5 ° respectively, with percentage of 34.73% correction, 75.06% and 64.64% for the respective curves

Conclusion: Surgical treatment by selective arthrodesis AIS Lenke type I provides correction of compensatory curves in the coronal and sagittal plane maintenance in fellow up the two years.

GP042. Intrinsic Sacral Deformity in L5 Istmic Lythic Spondylolysthesis

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Introduction: A deformity in the sacrum has been reported in patients with spondylolysthesis (Antoniades, Spine 2000)

Hypothesis: Besides sagittal profile, the sacrum in itself is deformed, probably due to a fixed point in the sacoiliac joints acting as fulcrum and deforming force from ventral displacement of gravity line.

Matherial and Methods: A control group (group C), matchable for age and gender, was compared with a series of 83 patients with L5 istmic lythis spondylolysthesis (group A), which was later subdivided in low grade (Meyerding types I and II, group A1, $n = 67$) and high grade (Meyerding III or IV, group A2, $n = 16$)

Variable: Proximal sacral kyphosis measured by the angle formed by the S1 posterior wall and the S2 posterior wall, if S1 was kyphotic on S2 then it was considered a positive angle, other wise being negative.

Statistics: SPSS 21.0, working with means or medians and appropriate tests after studying whether the variable showed a normal distribution.

Results: Group C lordosis -2° (minimum -8°; maximum +7°). Group A kyphosis +10° (minimum -11°; maximum +30°). And then: Group A1 kyphosis +10° (minimum -11°; maximum +30°). Group A2 kyphosis +15° (minimum +5°; maximum +26°). There were statistically relevant differences between group C and group A and also between groups A1 and A2.

Conclusion: Besides spinopelvic balance issues, there is an intrinsic deformity in the sacrum of patients with L5 istmic lythic spondylolysthesis, even more in high grade lysthesis.

GP043. Proximal Junctional Kyphosis in Pediatric Deformity: Analysis of Management with a Surgical Technique Limiting Cervical Extension

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Introduction: Proximal junctional kyphosis (PJK) is a relatively frequent complication of spinal deformity surgery which can result in significant symptoms and potential neurological compromise. Reconstruction of PJK in the cervicothoracic junction usually entails proximal extension of

fixation to the cervical spine, with a compromise of function in this young population.

Material and Methods: We designed a retrospective review of clinical and radiological features in a consecutive series of patients treated for PJK of the upper thoracic spine. Objective: discuss the use of an anterior plus posterior reconstructive technique which aims to avoid proximal extension into the cervical spine for the management of PJK in the pediatric deformity population. Patients: Three patients with spinal deformity (neuromuscular scoliosis 2, Scheuermanns kyphosis 1) developing progressive PJK were operated with an anterior and posterior reconstruction. Clinical and radiographic follow-up is analyses with a minimum of 9 months.

Results: All patients were successfully managed with adequate control of the progressive deformity and proximal extension into the cervical spine was significantly limited with this anterior and posterior approach.

Conclusions: For this selected group of patients with upper thoracic PJK, an interior and posterior surgical reconstruction was successful in managing the condition with limited extension into the cervical spine, thus avoiding greater future functional compromise.

Deformity: Thoracolumbar (Adult)

GP044. Anterior Hyperlordotic Cages: Early Experience and Radiographic Results

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Introduction: The mainstay of correction for hypolordotic lumbar deformities has been posterior osteotomies, such as the Smith Petersen, or three column osteotomies (TCO). TCO's while very powerful, are associated with significant neurological complications, variable lordotic correction, pseudarthrosis and loss of correction. We hypothesize that the advent of Hyperlordotic Cages (HLC) (cages with 20 or 30° of built in lordosis) will allow significant restoration of lumbar lordosis, and good predictability of the correction from an anterior approach, thus obviating the need for TCO's.

Material and Methods: We conducted a retrospective review of a single surgeon series of consecutive adult patients, undergoing Anterior Lumbar Interbody Fusion (ALIF) with HLC for degenerative spinal conditions or sagittal imbalance over a 15-month period. Patients had either a standalone ALIF or ALIF followed by posterior instrumented fusion, depending on underlying pathology. The anterior approach involved a retroperitoneal pararectus approach with resection of the anterior longitudinal ligament. Electronic medical records were reviewed for evidence of perioperative complications. Digital lateral spine radiographs were also reviewed to assess for Segmental Lordosis (SL) and its stability over time. Classic deformity measurments were also recorded.

Results: 69 HLC's inserted into 41 patients met our inclusion criteria, with a mean follow up of 8 months. Average age of patients was 55 years (23–76), and 29 were female. We implanted twenty-seven 30° HLC's, and forty-two 20° HLC's. The mean pre op lumbar lordosis of our cohort was 39°, post operatively this increased to 59° ($p < 0.01$). In 21 levels without spondylolisthesis, the 30° HLC's produced a mean SL of 28° (26–34). In 45 levels without spondylolisthesis the 20° HLC produced a mean SLC of 19°(16–22) $p < 0.01$. In 7 levels with greater than grade 1 spondylolisthesis, 30° HLCs achieved 19° of SL (14–21) ($p < 0.01$). The majority of HLC's were placed in lower lumbar spine, 34 at L5/S1, and 23 at L4/5. Six (9%) HLC's displayed loss of correction (defined as SL loss $> 2°$). The mean loss of SL was 4.5°(3–10). Complications included two transient neurological deficits (4.4%), one L5 palsy, and one L4 hyperesthesia, both observed after posterior instrumentation, 2 retroperitoneal collections, one requiring incision and debridement, 2 lymphoceles, both requiring laparoscopic fenestrations, and one enterocutaneous fistula requiring intervention. Average blood loss was 240ml(50–900).

Conclusion: Anterior insertion of HLC's is a predictable and reproducible method to correct lordosis, and therefore sagittal balance in complex deformities. The amount of SL obtained with a 30° HLC is comparable to TCO's but the 20% total complication rate is significantly lower than the 58% reported for TCO's in the literature. The ability to implant hyperlordotic cages at lower lumbar levels than traditional L2 or L3 level TCO enables a more anatomic restoration of the lumbar lordosis. Direct lateral cages have failed to demonstrate recreation of lordosis, but anterior insertion does appear to efficiently correct lordosis. Our blood loss (250ml) also compares favorably with reported values for TCO's. The authors therefore advocate the use of HLC's for ALIF to recreate lumbar lordosis.

GP045. The Use of MAGEC Growing Rods as a Temporary Distraction Rod in Severe Kyphoscoliosis: A Case Report

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Background: The acute correction of severe spinal deformity can be associated with significant neurologic risk. Halo traction can be used as a method to slowly correct deformity while allowing for close neurologic monitoring during correction. However, this typically requires a prolonged hospital stay and significant costs.

Methods: This case reports using a magnetically controlled growing rod (MCGR) to continue correction of a severe spinal deformity after an initial period of halo traction to allow for safe correction a severe kyphoscoliosis.

Results: The patient is a female child, adopted from Ethiopia, with an estimated age between 10–13 years. She presented with a severe kyphoscoliosis measuring greater than 135 degrees. She is otherwise healthy. An MRI showed no abnormalities of the spinal cord. Due to the severity of her curve, we elected to use halo-gravity traction for 4 weeks. During that time, she gained 7 inches in height and her curve improved to 100 degrees. To continue her correction, we then placed a Magnetic Growing rod from T1-L3/4, and distracted on a monthly basis for 6 months; resulting in correction of her curve to 80 degrees. The patient then underwent removal of the MCGR, and had definitive posterior spinal instrumentation and fusion from T2-L4 with apical Ponte osteotomies. Her scoliosis corrected to 47 degrees and her kyphosis to 42 degrees. She was left with a visible cervical deformity that is currently asymptomatic.

Conclusion: Multiple authors have reported the use of traction as part of the treatment of severe scoliosis as a means to reduce neurologic risk during deformity correction.[1,2] Surgical placement of temporary distraction rods have also been reported as part of a staged correction of severe scoliosis but is associated with loss of neuromonitoring signals in 41% of patients. These changes were reversible if the temporary traction was reversed. Cheung et al reported the use of a MCGR in a girl with severe spinal deformity where distractions were made daily for 2.5 months prior to definitive correction.[3] The MCGR offers a safe option as a temporary distraction rod that can be lengthened gradually on an outpatient basis. This

allows for neurological monitoring during gradual correction of the curve in anticipation of definitive correction.

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GP046. How Much Deformity Correction and Maintenance Can We Obtain by LLIF and Will It Be Affected by Approach Side or Levels?

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Introduction: Lateral lumbar interbody fusion (LLIF) is one of the minimally invasive surgeries that have shown the successful surgical outcome. The purpose of this study is to report the amount of deformity correction achieved with LLIF, and to compare the effect of convex versus concave approach side on the magnitude of correction.

Methods: Out of 512 LLIF cases, 100 stand-alone LLIF cases for degenerative lumbar scoliosis were identified after excluding previous fusion, posterior fixation, and cases without scoliosis. Radiographic and clinical data were analyzed retrospectively. In each patient, *overall* and *segmental* deformity correction (difference between postop and preop) and maintenance (difference between final and postop) were measured, and the amount of *segmental* correction and maintenance was compared in terms of approach side (convex versus concave). Also, correction was compared between groups with or without end plate fracture, and maintenance was compared between the groups with or without subsidence.

Results: Total 34 patients with follow up were included, and a total of 86 levels were treated. The amount of overall and segmental correction and maintenance is illustrated in Table 1. *Overall* and *segmental* scoliosis correction was more predictable than lordosis creation. The upper levels had the tendency of more segmental scoliosis correction, but not significant. There was no difference in the amount of *segmental* correction and maintenance in between convex and concave side. The group without the endplate fracture showed more *segmental* scoliosis correction significantly, the group without the subsidence showed more *segmental* scoliosis and lordosis maintenance significantly.

Conclusion: We report the amount of *overall* and *segmental* deformity correction and maintenance by LLIF procedure. *Segmental* scoliosis correction is very predictable unless endplate breakage occurs during surgery. *Segmental* deformity correction maintained well until final follow up unless subsidence occurs. *Overall* or *Segmental* lordosis creation is less predictable as we proposed it is dictated by the position of the cage. There was no difference in the amount of *segmental* correction and maintenance in between convex and concave side.

	Preop	Postop	Final	Correction	Maintenance
Coronal balance (Cm)	0.29	-0.70	-0.43	-0.99	0.27
Overall scoliosis (°)	25.11	13.33	15.22	-11.78	1.89
Saggital balance (Cm)	5.19	3.80	5.00	-1.39	1.20
Overall lordosis (°)	-50.78	-56.33	-55.33	-5.56	1.00
Pelvic tilt (°)	21.67	24.13	22.50	2.46	-1.63
Sacral slope (°)	37.78	38.00	39.44	0.22	1.44
	Segmental Scoliosis (°)			Segmental Lordosis (°)	
	Preop	Postop	Correction	Preop	Postop	Correction
L1-2 (n=2)	10.50	-3.50	-14.00	3.00	0.00	-3.00
L2-3 (n=22)	16.45	7.00	-9.45	-4.82	-7.05	-2.23
L3-4 (n=30)	12.07	3.80	-8.27	-12.63	-15.10	-1.97
L4-5 (n=32)	10.91	3.31	-7.59	-22.84	-25.63	-2.78
All levels (n=86)	12.72	4.27	-8.45	-14.07	-16.62	-2.36
L2-3 Convex (n=4)	12.25	2.50	-9.75	-5.75	-4.50	1.25
L2-3 Concave (n=18)	17.39	8.00	-8.65	-4.61	-7.61	-3.00
P-value	0.23	0.06	0.93	0.84	0.40	0.29
L3-4 Convex (n=8)	10.13	3.25	-6.88	-19.25	-16.88	4.50
L3-4 Concave (n=22)	12.77	4.00	-8.77	-10.23	-14.55	-4.32
P-value	0.34	0.72	0.42	0.02	0.52	0.03
L4-5 Convex (n=24)	10.92	3.08	-7.83	-23.33	-25.96	-2.63
L4-5 Concave (n=8)	10.88	4.00	-6.88	-21.38	-24.63	-3.25
P-value	0.99	0.64	0.66	0.64	0.72	0.80
All levels without endplate Fx (n=78)	12.92	3.88	-9.04	-14.28	-17.27	-2.77
All levels with endplate Fx (n=8)	10.75	8.00	-2.75	-12.00	-10.38	1.63
P-value	0.41	0.03	0.00	0.62	0.09	0.13
	Segmental Scoliosis (°)			Segmental Lordosis (°)		
	Postop	Final	Maintenance	Postop	Final	Maintenance
L1-2 (n=2)	-3.50	0.00	3.50	0.00	5.00	5.00
L2-3 (n=22)	7.00	7.67	0.32	-7.05	-6.45	0.59
L3-4 (n=30)	3.80	4.41	0.47	-15.10	-13.43	1.10
L4-5 (n=32)	3.31	3.34	0.03	-25.63	-25.28	0.34
All levels (n=86)	4.27	4.71	0.34	-16.62	-15.63	-0.38
L2-3 Convex (n=4)	2.50	3.50	1.00	-4.50	-4.50	0.00
L2-3 Concave (n=18)	8.00	8.65	0.17	-7.61	-8.89	0.72
P-value	0.06	0.13	0.61	0.40	0.50	0.72
L3-4 Convex (n=8)	3.25	4.29	0.50	-16.88	-15.50	-0.75
L3-4 Concave (n=22)	4.00	4.45	0.45	-14.55	-12.68	1.77
P-value	0.72	0.94	0.96	0.52	0.42	0.09
L4-5 Convex (n=24)	3.08	3.00	-0.08	-25.96	-25.38	0.58
L4-5 Concave (n=8)	4.00	4.38	0.38	-24.63	-25.00	-0.38
P-value	0.64	0.53	0.58	0.72	0.92	0.48
All levels without Subsidence (n=78)	4.43	4.68	0.13	-16.59	-16.29	-1.05
All levels with Subsidence (n=8)	3.18	4.91	1.73	-16.82	-11.09	4.18
P-value	0.46	0.90	0.03	0.95	0.16	0.00

Figure 1

Figure 2

GP047. Influence of the Level of Pedicle Subtraction Osteotomy on Pelvic Tilt Change in Adult Spinal Deformity

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Background: Spine osteotomy is used for patients with rigid severe spinal deformity. Pedicle Subtraction Osteotomy (PSO) is performed by removing the posterior elements and

both pedicles, removing a wedge from the vertebral body, and closure of the osteotomy by hinging on the anterior cortex. This technique is demanding and have very steep learning curve. We analyze the effect of the level of PSO on the change of pelvic tilt

Methods: this is a retrospective study of 35 patients (mean age, 60.7 years; range, 45–81 years) undergoing thoracolumbar PSO at a single institution in the past 4 years. One patient underwent PSO at T11, two patient underwent PSO at L2, and 16 patients underwent PSO at L3 and 16 at the L4 level. Seventy percent of the patients had undergone at least one previous spine surgery in the region of the PSO.

Results: the mean pelvic incidence in the cohort was 54.5. There was no change in the pelvic tilt between the preoperative and postoperative state (24.8 vs 22; $p > 0.05$). On the other hand, lumbar lordosis (26 vs 44), thoracic kyphosis (27 vs 38.8) and T1 pelvic angle (26.6 vs 14.7) had all significant improvement. Mean PSO resection was 35°. With subgroup analysis, mean pelvic tilt change -3.3° at the L3 level and -8.6 ° at the L4 level.

Conclusions: The degree of PSO resection correlates greatly with spinopelvic parameters (lumbar lordosis, thoracic kyphosis, and T1PA). More importantly, PSO level impacts postoperative PT correction; L4 level PSO have shown a better correction of the pelvic tilt than L3 PSO.

GP048. How Reliable is the Surgeon's Ability to Differentiate between Idiopathic and Degenerative Deformity in Adults; What Parameters Help them Decide?

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Introduction: Adult spinal deformity (ASD) may be classified as idiopathic (I) or degenerative (D) (or other) based on classifier's perception, the reliability of and factors inherent to which remain unknown. Aim of study is to evaluate the inter and intraobserver reliability of surgeons' perception in differentiating I from D ASD and to identify the determinants of it.

Material and Methods: From a multicentric prospective database, 179 patients were identified with the diagnosis of I ($n = 103$) or D ($n = 76$); no previous surgery; and a lumbar coronal curve $> 20°$. Standing AP and lateral X-Rays were sent to five experienced spine surgeons to be identified as D or I (or other); followed by a second round after reshuffling. Weighted Kappa statistics was used, after which the patients were stratified by number of agreements as perfect (10/10) and very good ($\geq$8/10); these were further compared for additional radiological parameters.

Results: Four observers completed both rounds while the 5th did only the first (a total of 10 observations/pt including the record). Agreement levels were moderate to good for intra but fair to moderate for interobserver comparisons (Table 1). There were 42 perfect and 80 with very good agreements for I patients but only 6 perfect and 17 very good agreements for D. Upon comparison of these, it was seen that they were different for some coronal parameters such as lumbar Cobb angle (larger in I, $p < 0.001$), CSVL modifier (C more common in I, $p = 0.007$) and presence of rotatory subluxation (less common in D, $p = 0.017$) but very different for sagittal parameters (lumbar lordosis, sagittal vertical axis, T2-sagittal tilt, pelvic tilt, sacral slope and global tilt; increased sagittal imbalance in D, all $p \leq 0.001$).

Conclusion: Surgeons in this study demonstrated reasonable intraobserver agreement but only fair agreement amongst them. These findings suggest that especially in patients with significant coronal curves, determination of curve etiology with only radiological data may not be accurate. In patients with good agreement, the most consistent radiologic determinant appeared to be the presence of sagittal imbalance.

GP049. Multiple Regression Analysis of Factors Affecting the Mental Component Score Constituents of SF-36 in Adult Spinal Deformity

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Introduction: As surgical decision-making and preoperative planning for adult spinal deformity (ASD) need strongly be interrelated to health related quality of life (HRQOL), there are multiple studies focusing on factors with an impact on it. Based on the general perception of association between the treatment results and the psychological condition of patients with ASD, analyzing the factors governing the baseline psychological status of this group may be worthwhile. Aim of study is to develop an understanding of which factors have a greater impact on the SF-36 mental component score (MCS) and to establish a hierarchy of these parameters through multiple regression analysis.

Material and Methods: Prospectively collected data from a multicentric adult deformity database was analyzed using multiple regression analysis with SF-36 MCS designated as the dependent variable and demographic, radiological and the HRQOL parameters as independent variables. The regression model was started with a correlation analysis between SF-36 MCS and all independent variables then conducted by introducing the variables with the highest correlation with SF-36 MCS, sequentially.

Results: A total of 229 patients (181♀, 47♂) with a mean age of 49.4 (18– 85) years, were analyzed. A strong correlation between SF-36 MCS and Scoliosis Research Society (SRS)-22, Oswestry Disability Index (ODI), gender, and diagnosis were found ($p < 0.05$). The distribution graph and results of regression analysis are summarized in Fig. 1. The overall R2 of this model was 0.254 ($p < 0.001$).

Conclusion: This study has demonstrated that, among the evaluated parameters, the overall HRQOL (SRS-22 and ODI) as well as thoracic kyphosis (TK) and gender are the most important parameters affecting the mental component summary of SF-36 in ASD population. Although the strong association with SRS-22 and/or ODI was to be expected, less strong associations with TK (as a token of appearance?) and gender (due to different mechanisms of coping with disability?) were less expected and may warrant further consideration in our understanding of the population of ASD.

GP050. Mental Health and Self Image Perception of Non-disabled Adult Idiopathic Scoliosis Patients Having Mild to Moderate Curves Compared to Normal Population

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Introduction: There is little information about the effects of scoliotic curves on self image (SI) and mental health (MH) based on validated questionnaires. Aim was to analyze the effect of scoliosis on MH and SI in a non-disabled adult idiopathic scoliosis (AdIS) population having curves under surgical indication threshold (Main Thoracic (MT) Cobb ($\leq$ 55°), and Thoracolumbar/Lumbar (TL) curve ($\leq$ 45°).

Material and Methods: A retrospective analysis of a multicenter, prospective, consecutive patient series. Inclusion criteria were: non operated AdIS, $\geq$ 18 years of age, MT Cobb 20–55°, TL Cobb 20–45°, ODI <20, SRS 22 Pain score > 4. ODI and SRS22 pain score were used to distinguish patients that have pain and disability from the ones that do not. SRS- 22 and SF-36 normative data for different age groups were used for comparison. AP and lateral Cobb measurements, sagittal plane parameters and demographic data were analyzed in terms of correlations with SI and MH parameters.

Results: 76 patients (64F, 12M) met the inclusion criteria. Mean age was 25.9 (18–44), mean MT Cobb was 38.5° (21–55) and TL Cobb was 34.6° (25–44). SRS-22 MH, SI and other domains were similar with SRS normative data ($p > 0.05$). SF-36 MCS and PCS domains for age groups 18–24, 25–34 and 35–44 were not significantly different than normative data ($p > 0.05$). None of the demographic and radiographic parameters were correlated with changes in SRS-22 function, SI, MH and SF 36 MCS, PCS parameters.

Conclusion: AdIS does not affect mental health and self-image in non-disabled patients with curve magnitudes below the surgical threshold.

		18 - 24 age			25 - 34 age			35 - 44 age		
		Mean	SD	P	Mean	SD	P	Mean	SD	P
SF 36 MCS	Study data	48.73	7.18	0.96	48.22	8.43	0.74	55.67	5.70	0.97
	Normative data	46.19	10.40		49.20	9.42		49.08	10.05	
SF 36 PCS	Study data	49.46	7.40	0.35	52.02	6.02	0.88	51.15	7.37	0.61
	Normative data	53.5	7.11		53.57	7.27		52.56	8.16	

Figure 1

GP051. Postoperative Spine and Spinal Implants Instability as Complications of Treatment of the Rigid Scoliotical Deformation in Adult and Elderly Patients

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Purpose: The aim of this study was to assess the rate of complications of surgical treatment of rigid scoliotical deformation correction and stability of the fixation in adults and elderly.

Material and Methods of Studies: A retrospective study of 60 patients (age 65 – 83 years) with rigid scoliotical deformation. Mean follow-up period was 5 years (2–8 years). Retrospectively we evaluated the deformation according to SRS-Schwab Based on HQROL Classification of Adult Deformity studying in all cases long cassette standing anteroposterior and lateral radiographs. Type L,A,L,P for 19 patients; type L,C,M,VP for 21 patients; type S,B,M,VP for 13 patients; type S,C,H,P and T,A,M,P for 7 patients equally. The main indications for surgery were static and biomechanical spinal disorders with pain (100%) and neurological syndrome (74.3%). All patients were divided into 2 groups based on the extent of surgical treatment and the severity of concomitant somatic pathology. The first group include 28 patients with high risk of cardiovascular complications who were undergone the correction of deformation by transpedicular screw fixation, multilevel SPO and TLIF. The second group include 32 patients with the correction of deformation by multilevel fixation, SPO, TLIF and PSO despite the possible risks of cardiovascular complications.

Results and Discussion: In the first group in 13 cases we did not achieve a full postoperative restoration of the sagittal & coronal balance. In 6 patients the displacement of the screws was found in the postoperative period. In 5 cases the metal construction was broken. In 3 cases the terminal vertebras fractures with the displacement of the screws marked one year after the operation. These complications led to a loss of correction, which required a reoperation in all cases. In the second group a full restoration of the sagittal & coronal balance was achieved. In 1 case there was a screw migration due to osteoporosis. The rate of complications of the deformity correction in the first group was statistically significant higher than in the second group ($p < 0.01$).

Conclusions: The study showed that the transpedicular fixation during the correction of a rigid deformation in patients requires the full restoration of sagittal balance. The surgical treatment of scoliotical deformation with PSO, TLIF and SPO showed an improvement of the long-term results. The aim of this study was to assess the rate of complications of surgical treatment of rigid scoliotical deformation correction and stability of the fixation in adults and elderly. A retrospective study of 60 patients (age 65 – 83 years) with rigid scoliotical deformation. The study showed that the transpedicular fixation during the correction of a rigid deformation in patients requires the full restoration of sagittal balance. The surgical treatment of scoliotical deformation with PSO, TLIF and SPO showed an improvement of the long-term results.

GP052. Pedicle Subtraction Osteotomy in Management of Rigid Thoracolumbar Kyphosis in Adults

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Introduction: Thoracolumbar kyphosis represent a big challenge for spine surgeons specially if the case is of significant deformity which may affect patients life, Pedicle subtraction osteotomy (PSO) is one of the best methods that cane correct the deformity and give satisfactory result to the patients as it corrects the deformity and allow the patients to gain near normal daily activity.

Material and Methods: Four patients were treated by this method by PSO of lumbar 2 vertebra, 3 of them complaining of ankylosing spondylitis and one post traumatic, all patients are neurologically stable. All are assisted by X-ray and MRI preop. PSO is carried through a posterior midline approach with fixation of D12 to L4

Results: All patients are satisfied with near full correction average 90%.

Conclusion: PSO is an excellent method for management of rigid thoracolumbar kyphosis in adults

Degenerative Cervical

GP053. Prevalence and Complications of Post-Operative Transfusion for Cervical Fusion Procedures in Spine Surgery; an Analysis of 11,588 patients from the ACS-NSQIP Database

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Introduction: Cervical spine fusion have gained interest in the literature since these procedures are now ever more frequently being performed in an outpatient setting with few complications and acceptable results. The purpose of this study was to assess the rate of blood transfusion after cervical fusion surgery, and its effect, if any on complication rates.

Material and Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was used to identify patients that underwent cervical fusion surgery from 2010 to 2013. Univariate and multivariate regression analysis was used to determine postoperative complications associated with transfusion and cervical fusion.

Results: We identified 11,588 patients who had cervical spine fusion between 2010 and 2013. The overall rate of transfusion was found to be 1.47%. All transfused patients were found to have increased risk of: venous thromboembolism (TBE) (OR 3.19, CI: 1.16–8.77), myocardial infarction (MI) (OR 9.12, CI: 2.53–32.8), increased length of stay (LOS) (OR 28.03, CI: 14.28–55.01) and mortality (OR 4.14, CI: 1.44–11.93). Single level fusion had increased risk of: TBE (OR 3.37, CI: 1.01–11.33), MI (OR 10.5, CI: 1.88–59.89), and LOS (OR 14.79, CI: 8.2–26.67). Multilevel fusion had increased risk of: TBE (OR 5.64, CI: 1.15–27.6), surgical site infection (OR 16.29, CI: 3.34–79.49), MI (OR 10.84, CI: 2.01–58.55), LOS (OR 26.56, CI: 11.8–59.78) and mortality (OR 10.24, CI: 2.45–42.71). ACDF surgery had an increased risk of: TBE (OR 4.87, CI: 1.04–22.82), surgical site infection (OR 9.73, CI: 2.14–44.1), MI (OR 9.88, CI: 1.87–52.2), LOS (OR 28.34, CI: 13.79–58.21) and mortality (OR 6.3, CI: 1.76–22.48). Posterior fusion surgery had increased risk of: MI (OR 10.45, CI: 1.42–77.12) and LOS (OR 4.42, CI: 2.68–7.29).

Conclusion: Our results demonstrate that although cervical fusions can be done as outpatient procedures special precautions and investigations should be done for patients who receive transfusion after cervical fusion surgery. These patients are demonstrated to have higher rate of MI, DVT, wound infection and mortality when compared with those who do not receive transfusion.

GP054. Laminoplasty for the Treatment of Cervical Myelopathy. 5 Year Experience at University Clinic Colombia

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Introduction: Cervical myelopathy affects primarily elderly people, caused mainly by a degenerative process of spondylosis in which both static (disc, ligament ossification, congenital stenosis, tumors) and dynamic (flexion-extension of cervical spine adaptive changes, nervous fiber elasticity, ischemia, trauma) factors that lead to the compression and diminished blood supply of the spine cord. The symptoms can range from mild paresthesias according to the compromised cervical level, gait disturbances, pain to as severe as paraplegia, with a natural history of chronic progression, Surgical treatment of this entity include anterior or posterior decompression with arthrodesis and laminoplasty. In this study we aim to report the result obtained with Cervical Laminoplasty described by O'brien during de years 2010 to 2015.

Material and Methods: An observational retrospective descriptive study was performed, reviewing the clinical records from preop to postop of patients with cervical myelopathy, Functional information was gathered using the scale of the Japanese Orthopaedic Association and Pain Analog Visual Scale. X-rays were evaluated measuring canal diameter, Chiba's line, Pavlov index and signs of instability. MRI studies were used to measure canal diameter in the axial plane and to identify signs of myelopathy. Inclusion criteria were patients older than 18 years, that had both clinical and image diagnosis for cervical myelopathy in which the O'brien laminoplasty was performed

Results: 10 patients with an average age of 74 (64 to 84yrs) completed follow up according to our inclusion criteria. AVS improved from 7 to 3. The JOA Scale showed improvement in all the patients from 10 to 14 in the global score, which corresponds to a progression from a Functional class II to I. Images evaluation showed widening of the cervical canal as seen with a 0.76 Pavlov index preop to 0.96 postop and a 33% widening in the MRI sagittal view.

Conclusion: For the management of cervical myelopathy, proper documentation of the pathology both clinical and images allows to decide the adequate management of the patient. The O'brien technique for cervical laminoplasty proved to be an effective alternative in the treatment of this entity.

GP055. Evaluation of Effectiveness of Riluzole in the Treatment of Early Cervical Spondylotic Myelopathy using Diffusion Tensor Imaging- A Double Blinded, Placebo-Controlled Randomised Controlled trial

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Introduction: Treatment strategies in early cervical myelopathy have not been adequately outlined and considerable controvery exsists regarding best treatment options in such scenarios. There is inadequate evidence to suggest superiority of surgical Vs Conservative management in such cases with minimal dysfunction. Even with conservative treatment no gold standard has been identified. We assessed the efficacy of neuroprotective drug Riluzole in the treatment of early cervical myelopathy. Benefits were assessed using change in objective clinical scores, functional outcome and analysis of diffusion tensor imaging which reflect the qualitative and quantitative effects resulting from altered diffusion characteristics in the myelopathic cord.

Material and Methods: Patients presenting with early cervical myelopathy defined as Modified Japanese Orthopaedic Association (MJOA) scores of 13 or more were recruited for the double blinded, placebo controlled randomized control trial. Total of 30 patients were studied with 15 patients each in the test and placebo group. The subjects were analyzed with diffusion tensor imaging(DTI) and clinical evaluation, pre and post institution of Na^+ channel blocker Riluzole for a period of 1 month (50 mg twice daily) for the test group and the placebo

group received multivitamin tablets. Clinical assessment included comparison of Nurick grade, MJOA scores, Neck disability index (NDI) and SF-12 scores pre and post drug institution. Diffusion co-efficients fractional anisotrophy (FA), apparent diffusion co-efficient(ADC), volume ratio(VR), relative anisotrophy (RA) and eigenvectors were calculated pre and post drug therapy. The DTI datametric for diffusion co-efficient generated were analyzed against placebo group.

Results: The mean MJOA score was 15.6 (13–17) with no significant difference in the MJOA scores in either group. None of the participants showed a change of Nurick grade during the course of the study duration of 1 month. The mean SF-12 score was 35.54/40.14(PCS/MCS) and changed to 37.47/41.09(PCS/MCS) in the Riluzole group. The mean scores for SF-12 and NDI for the Riluzole group did not show a significant change following institution of drug. The mean ADC, FA values were 1533.36(1238–1779) and 494.36(364–628) and changed to 1531.57(1312–2091) and 484.86(294–597) in the Riluzole group. However, the changes in the values of ADC,FA in the two groups were not statistically significant. Datametric evaluation of the other diffusion co-efficient did not show significant change following drug therapy.

Conclusions: This study could not identify a significant change in the clinical outcomes and DTI indices with the use of Riluzole as a standalone pharmacotherapeutic agent for early cervical myelopathy. Further investigation may be required to confirm the effectiveness of neuroprotective drug Riluzole for the treatment of cervical myelopathy.

GP056. Rationale, Design and Early Trial Performance of AOSpine North America Multi-Center Double Blind Randomized Controlled Trial of Safety and Efficacy of Riluzole in CSM (CSM – Protect Trial)

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Introduction: While surgical decompression is an effective treatment for CSM, many patients have substantial residual neurological and functional impairment. Compelling evidence from preclinical models suggest a benefit of adding a neuroprotective drug which targets sodium/glutamate excitotoxicity to the treatment of patients with CSM.

The purpose of this study is to evaluate efficacy and safety of sodium-glutamate antagonist riluzole in improving neurological outcomes in patients with cervical spondylotic myelopathy (CSM) undergoing surgical treatment.

Material and Methods: Prospective multi-center double-blind randomized controlled trial in which a total of 300 patients undergoing surgical decompression for CSM will be randomized 1:1 to riluzole 2x50mg daily for 14 days before the surgery and 28 days after the surgery or to the placebo. Primary outcome measure is change in mJOA between baseline and 6 months. Secondary outcomes include ASIA, SF36v2, NDI, Eq. 5D, Pain VAS and complications. The sample size of 270 completed subjects will have 80% power to detect absolute difference of 0.9 in mJOA score between the investigational and the control group. The statistical analysis is organized as a sequential adaptive trial with one interim analysis at 65% of the accrued sample for early futility and efficacy. Adaptive statistical design allows for sample size adjustment at the time of interim analysis.

Results: To date, 212 subjects have been enrolled. Average age of the enrolled subjects is 58.1 years (SD 10.2); 56% males. The baseline mJOA is 11.9 (SD 1.5). Baseline NDI is 42.5 (SD 20.4) and the baseline SF36v2 Physical Component Score (PCS) is 32.8 (SD 9.9).

Conclusion: In spite of the benefits of the surgical intervention, patients with CSM experience significant residual impairment and neurological compromise. Adding neuroprotective treatment with riluzole may improve outcomes of surgery.This talk will emphasize the unique study design and the biological rationale for considering riluzole as a potential neuroprotective adjunct for patients undergoing surgery for CSM

GP057. Results of Multi-Level (Three and Four Levels) Cervical Disc Arthroplasty: Age-Weighted Linear Regression Analysis: Results from a Single Centre

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Introduction: The clinical outcomes of Multi-level disc arthroplasties are variable in the literature. However, the outcome results related to age would have a significant bearing on our decisions in considering patients for surgery. We reviewed 51 patients who had 3 & 4-level cervical disc arthroplasties at our center.

Methods: The study involved a retrospective review of prospectively collected data on Multi-level (three and four levels) cervical arthroplasty patients with an average age of 54.64 (median age: 52, range: 34–80). Fifty one patients were followed up for 2 to 5 years based on clinical outcomes scores which were reviewed using data including NDI (Neck Disability Index), Depression, Anxiety, Bodily Pain, Visual Analogue score for Neck (VAS Neck), and Visual Analogue score for Arm (VAS Arm). Scores were collected pre-operatively and at each follow up at 3 months, 6 months, 1st and yearly afterwards. Linear Regression Analysis was performed to look at the impact of age on these scores.

Results: The study consisted of 24 females and 27 males. The average duration of symptoms was ~62 months (range: 0–300months) for Multilevel Cervical Arthroplasty patients. The indication for surgery was radiculopathy and a combination of radiculopathy and myelopathy. Linear Regression Analysis for NDI and age showed a Pearson Co-relation ($r = 0.243$); P Value: 0.051, for VAS Neck ($r = 0.251$); P Value: 0.044, VAS Arm ($r = 0.392$); P Value: 0.001. The slope on the scatter plots for these 3 outcome scores showed there was a better outcome with age. There was significant improvement in the score with age (< 0.05).

Conclusion: Our results indicate that there is a strong co-relation between age of the patient and their NDI, VAS Neck and VAS Arm scores in Multi-level Cervical Disc Arthroplasty. It would appear that the advancing age results are better. The reason is most likely multifactorial including duration of pre op symptoms, severity of pathology and patient expectations.

GP058. Surgical Management of Recurrent Compressive Myelopathy after Anterior Cervical Discectomy and Fusion

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Introduction: Recurrent myelopathy after anterior cervical discectomy and fusion is a rare condition, the literature in this entity were limited. This recurrence may occur at the same level or in adjacent level/s, usually the proximal level, the compressing element either anteriorly by a newly prolapsed disc or posteriorly by enfolding of the ligamentum flavum

Material and Methods: From 2008 to 2012, 9 cases of recurrent cervical myelopathy were treated surgically at Bab El-Sheria university hospital, all of them had an anterior cervical discectomy before with a good improvement after surgery. All patients were evaluated clinically by both JAO score and Nurick's grades and radiologically by plain X-ray and MRI, In MRI the pattern of compression were evaluated in T2 waited image and the cord was evaluated according Yasutsugu classification. . 6 out of the 9 cases were operated through anterior approach and 3 via posterior approach. The mean follow up period was 30.7 months.

Results: All cases in this study were improved clinically and radiologically, the average time of surgery were 65 minutes (45–80), the average blood loss 140cc (100–170cc), non of patient develop any major complication, only 4 cases suffering mild dysphagia which improved spontaneously, Improvement of JAO score was evaluated by the Recovery rate (RR), according to Hirabayashi's method. All patients were satisfied as they regain all or most of their previous activity and work. 7 out of 9 cases (77.8) classified as excellent result according to improvement of JAO, RR 70%. Other 2 cases classified as good result

Conclusion: Excellent results could be obtained through this procedure, improvement in clinical outcome and cord condition was evident.

GP059. Stand Alone Anterior Multiple Levels Cervical Cage

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Introduction: Anterior cervical discectomy and fusion is common surgical procedure for treatement of cervical spondylotic radiculopathy and or myelopathy after failure of conservative management. Previous studies of multilevel cervical discectomies and fusions have shown decrease fusion rates with increase number of surgical levels .fusion rate and sagittal contour is better with anterior plating but complications like increase dysphagia rates, tracheoesophageal lesions, plate malposition and accelerated adjacent disc degeneration, even when low-profile plates are used. Further To avoid the adverse effect of autograft harvesting techniques Allograft can be used. Cages were used to add stability and prevent graft complications.Stand alone PEEK cages filled with Allograft were used in 3–4 levels anterior cervical discectomy and fusion .

Material and Methods: 33 patients 18 males 15 females 28 with cervical spondylotic radiculopathy and 5 With cervical spondylotic myelopathy was treated with multiple levels anterior cervical discectomies and fusion using stand alone PEEK cages filled with Allograft. Total numbers of levels114, 18 patient operated for 3 levels ACDF and 15 patients operated for 4 levels .Clinical evaluation using visual analogue scale (VAS), neck disability index (NDI), and patient satisfaction were analyzed . Cervical lordosis, cervical fusion and complications were assessed.

Results: Improvement of the clinical outcome and the radiological parameters were detected

Conclusion: 3–4 levels anterior standalone PEEK cages filled with allograft is very good option for treatment of degenerative cervical disc disease with low complication rate, good clinical and radiological outcomes.

GP060. Reliable Measure of Safe Zone for Cervical Spinal Surgery in Keeping of the Embryologic Origins of the Course of the Recurrent Laryngeal Nerve (RLN) on Right and Left

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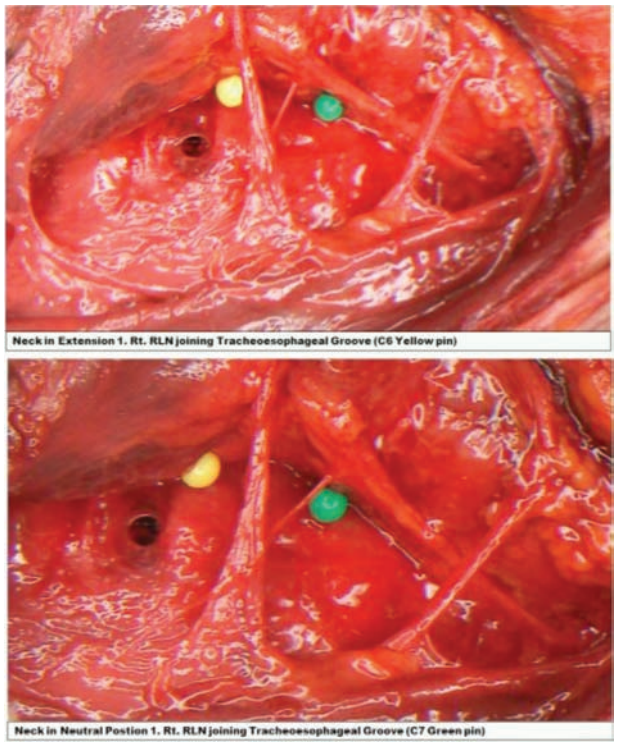
Introduction: Considerable variations are observed of a "safe zone" for avoiding RLN injury during anterior cervical exposures. Most studies have attempted to accurately measure RLN versus the background of cervical vertebrae level. However all studies so far have not factored-in the unique embryology of RLN following the descent of the aortic arches. Thus, making it a floating structure separate from the bony spine. We aimed to measure the positional variation of this floating complex (RLN, Larynx, Esophagus) in fresh cadavers that are not yet fixed.

Methods: 8 fresh cadavers were dissected to measure the point at which RLN on the right and left sides joined the tracheoesophageal groove TEG medially (considered safely protected) thence ascending to enter larynx. This was also measured against backdrop of the cervical level with neck in neutral and extension.

Results: The RLN joins the TEG 4.45 cm vertically inferior to laryngeal prominence on the right and 7.7 cm on the left (Range of +/− 0.5 cm). There were significant variations of this point (RLN joining TEG) measured with neck in neutral and extension by ~1.8 cm (+/− 0.3 cm) (the length of one vertebral level (Photographed).

Conclusion: While the use of vertebral level landmarks may work well for nerve structures exiting or attached to the "fixed" spine, landmarking of a totally free floating nerve, such as the RLN is not practical. This nerve is closely related embryologically to that of the pharyngeal pouches and aortic arches and can undergo positional variation as described. Neck positioning during anterior cervical procedures can produce variations in the location of the recurrent laryngeal nerve. This is due to this structure as a "free floating nerve" and its different embryological origins (to the spine). The RLN joins the TEG ~4.5cm and 8 cm below the laryngeal prominence on the right and left sides respectively.



GP061. Surgical Outcome of the Selective Posterior Spinal Fusions for Ossification of Posterior Longitudinal Ligament in the Cervical Spine

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Introduction: It is widely known that laminoplasty (LP) and anterior cervical fusions have been performed for ossification of posterior longitudinal ligament (OPLL). But progression of kyphosis and development of the ossification after surgery sometimes cause aggravation and revival of the symptoms. Recently, several authors reported that posterior cervical spinal fusion (PSF) for patients with OPLL. The purpose of this study is to assess surgical outcome of the selective spinal fusions for OPLL in the cervical spine.

Method: From 2010 to 2014, twenty seven patients with OPLL (mean age 68 years) who underwent surgical treatment with LP (14 patients) or PSF (13patients) were included in this study. Surgical outcomes were assessed by operative time, amount of bleeding and complications.Radiographic measurement included change of the alignment in C2/C7 (cervical lodosis), range of motion of cervical spine. Neurological function was assessed using a Japanese Orthopaedic Association Scale (JOA).

Result: Mean follow-up period is one year. The operative time was slightly longer in PSF group, but amount of bleeding was not significance. One patient had C5 paralysis in PSF group. In fixed range at PSF group, one interbody fixation was three cases, two fixations were seven cases and three fixations were three cases. On radiographic analysis, the mean change of alignment at last follow-up period were 2.8° ± 6.5° (LP) and 1.6° ± 6.9° (PSF). Range of motion of cervical spine were 8.6° ± 9.6° (LP) and 9.9°±7.6°(PSF). There was not significant difference between two groups at pre-operative JOA score. Improvement rate of JOA score were 55.7% ± 32.2% (LP) and 42.3% ± 25.4% (PSF). There was no significant difference between both groups in all categories.

Conclusion: It is natural to preserve as much as possible mobility in cervical spine. On the other hand, there is another opinion that instability of the cervical spine at boundary of ossification zone is related to development of ossification. It may prevent ossification to obtain stability of the cervical spine. In comparison with the LP, PSF did not adversely affect the clinical and radiographic outcomes in this study. This result suggested the possibility that PSF maintains a function of the cervical spine and prevents ossification. Limitation of our study include the short follow-up period and various fixed range. It is necessary to observe long-term progress.

GP062. The Modified Japanese Orthopaedic Association Scale: Establishing Criteria for Mild, Moderate, and Severe Disease in Patients with Degenerative Cervical Myelopathy

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Introduction: The modified Japanese Orthopaedic Association (mJOA) score is a validated, investigator-administered tool used to evaluate functional status in patients with degenerative cervical myelopathy (DCM). This scale is increasingly used in this population to measure baseline myelopathy severity, postoperative improvements and social independence. There is, however, no study that determines what scores on the mJOA constitute mild, moderate and severe disease. Patients in different severity categories are managed differently both intraoperatively and postoperatively; therefore, establishing this criteria has clinical value across the whole spectrum of care. This study aims to determine appropriate cut-offs between mild, moderate and severe myelopathy and to examine the construct validity of these definitions.

Material and Methods: Between December 2005 and January 2011, 757 patients with clinically-diagnosed and imaging-confirmed CSM were enrolled in either the prospective, multicenter CSM-North America (n=278) or CSM-International (n=479) study at 26 global sites. Functional status and quality of life were evaluated in these patients at baseline and at 6-, 12- and 24-months postoperative using a wide variety of outcome measures, including the mJOA, Nurick score, Neck Disability Index (NDI) and Short-form-36 (SF-36). Using the Nurick grade as an anchor, ROC analysis was conducted to determine the cut-offs between mild and moderate myelopathy and between moderate and severe disease. These cut-offs were validated by developing and testing various constructs. Specifically, we examined whether patients in different severity groups had significantly different functional impairment, disability, symptomatology, imaging findings and post-treatment improvements. Finally, members of AOSpine International were surveyed to see what professionals viewed as appropriate cut-offs between severity categories.

Results: In ROC analysis, a mJOA of 14 was determined to be the cut-off between mild and moderate myelopathy and a score of 11 as the score between moderate and severe disease. Patients in the severe myelopathy group (n=254) had significantly reduced quality of life and functional status and a greater number of signs and symptoms than patients

classified as mild (n=193) or moderate (n=296). Furthermore, severe patients required greater improvements on the mJOA to achieve a minimum clinically important difference. From our survey, a score of 15 (n=143, 34.38%) was the most commonly selected cut-off between mild and moderate myelopathy (mean 14.38). The majority of respondents selected 10 (n=178, 42.79%) as the mJOA cut-off between moderate and severe myelopathy (mean 11.26)

Conclusion: Based on our results, mild myelopathy can be defined as a mJOA=15-17, moderate as mJOA=12-14 and severe as mJOA $<$ 12. These categories are the same as those established by the AOSpine study group for the purpose of the CSM-North America study.

GP063. Change in Function, Pain, and Quality of Life following Structured Nonoperative Treatment in Patients with Degenerative Cervical Myelopathy: A Systematic Review

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Introduction: The role of structured nonoperative treatment for the management of DCM is not well defined, and surgery is typically recommended as the default treatment option for patients with moderate and severe myelopathy. This study aims to conduct a systematic review of the literature to determine (1) the change in function, pain and quality of life following structured nonoperative treatment for degenerative cervical myelopathy (DCM); (2) the variability of change in function, pain and quality of life following different types of structured nonoperative treatment; (3) the differences in outcomes observed between certain subgroups (i.e baseline severity score, duration of symptoms); and (4) negative outcomes and harms resulting from structured nonoperative treatment.

Material and Methods: A systematic search was conducted in Embase, PubMed, and the Cochrane Collaboration for articles published between January 1, 1950 and February 9, 2015. Studies were included if they evaluated outcomes following structured nonoperative treatment, including therapeutic exercise, manual therapy, cervical bracing and/or traction. Outcomes of interest were functional status (Japanese Orthopedic Association (JOA), Nurick), pain in upper extremities and neck, quality of life (Neck Disability Index), and/or conversion to surgery. The quality of each study was evaluated using the Newcaste-Ottawa Scale and the strength of the overall body of evidence was rated using guidelines outlined by the Grading of Recommendation Assessment, Development and Evaluation Working Group.

Results: Of the 570 retrieved citations, eight met the inclusion criteria and were included in this review. There is very low evidence to suggest that structured nonoperative treatment for DCM results in a positive or negative change in function, pain and quality of life as evaluated by the JOA score. There is also limited evidence from three studies indicating that early structured nonoperative treatment (duration of symptoms $<$ 1 year) may be associated with positive clinical outcomes. There were no studies that directly compared structured nonoperative treatment types and no studies that explored outcomes based on patient subgroups. The rate of conversion to surgery was reported to be between 23-54% in mostly cases of mild or moderate myelopathy (JOA$\geq$12).

Conclusion: There is a lack of evidence to determine the role of nonoperative treatment in patients with DCM. However, in the majority of studies, patients did not achieve clinically significant gains in functional status following structured nonoperative treatment. Furthermore, rates of failed conservative treatment were between 23-54%.

GP064. Change in Impairment Following Operative Treatment of Degenerative Cervical Myelopathy: A Systematic Review and Meta-Analysis

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Introduction: The primary objective of this work was to define the neurological benefit conferred by surgical intervention to patients with degenerative cervical myelopathy (DCM). Secondary objectives included assessing how preoperative disease severity and duration impacted on that benefit and defining the surgical complications encountered by these patients.

Material and Methods: A search was undertaken for articles published until May 2015 evaluating the operative treatment of DCM using electronic databases. Prospective studies of adult surgical myelopathic patients were included. Extracted data included study design, patient demographics, diagnosis, surgical approach, preoperative and postoperative neurological status (mJOA, NDI, Nurick, VAS), and complications. Preoperative disease severity and duration of symptoms were recorded. Risk of bias (Newcastle-Ottawa Scale) and quality of evidence (Grades of Recommendation Assessment, Development and Evaluation) were assessed. Primary outcomes included assessment of change in neurological (graded by mJOA, NDI, and Nurick scores) and pain (graded by VAS score) following surgical intervention for myelopathic patients. Secondary outcomes were also assessed for dependency on preoperative duration of symptoms and preoperative disease severity. Safety of surgery was assessed by pooled estimates of perioperative complications encountered.

Results: Among 32 included studies, surgical intervention for DCM patients provided clinically-significant improvement in neurological dysfunction and pain. This improvement occurred at short-term assessment (fewer than 12 months) and was durable in longer-term (greater than 36 months), consistent over several different scoring systems. Shorter duration of symptoms may be associated with a higher likelihood of neurological recovery.

Conclusion: Surgical intervention for DCM is an appropriate evidence-based therapy with an acceptably low rate of perioperative complication. Further work is important to define optimal surgical approach and timing.

GP066. Mini Anterior Lumbar Interbody Fusion: One Year Follow Up for a Novel Device

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Introduction: This study is a prospective cohort observational trial, to evaluate the ROI-A (Radiolucent Open Implant-ALIF) and VerteBRIDGE plate construct, in the treatment of symptomatic lumbar degenerative disc disease. The principal advantage of anterior approach is that the risks associated with exploration of the spinal canal through a posterior approach can be avoided and damage to the muscles of the back is eliminated. The anterior approach offers superior visualization of the disc space itself, and can be done without disruption of the otherwise healthy posterior elements. The Mini ALIF retroperitoneal approach facilitates rapid patient recovery.

Materials and Methods: The ROI-A (Radiolucent Open Implant-ALIF) is made from PEEK (Polyetheretherketone), a medical grade plastic, and two metallic anchoring plates, marketed as VerteBridge, which provide both stability at the site of desired bony fusion and fixation of the implant to the vertebrae adjacent to the interbody device. *Inclusion Criteria:* 18 patients between the ages 31 and 65 years of age; Disc disease between L2-S1; Patients may have up to grade I spondylolisthesis or retrolesthesis at the involved site; Maximum two diseased vertebral motion segments to be instrumented; Has had no more than two previous non-fusion surgeries to the lumbar soine at the same level(s); Has failed to respond to an appropriate attempt at conservative treatment. *Exclusion Criteria:* More than two vertebral motion segments involved; Prior anterior, retroperitoneal approach; Has had previous anterior instrumented fusion at the proposed operative level; Higher than grade I spondylolisthesis or retrolisthesis at the involved level(s); Has reported active malignancy, localized or systemic infection; Morbid obesity, as defined by NIH Clinical Guidelines Body Mass Index (BMI > 40); Patients with a diagnosis of osteoporosis, osteopenia, Paget's or other metabolic bone disease; Patients who smoke more than 1 pack per day; Has an active workers compensation claim relative to the involved part. *Outcome Measures:* Subjects are evaluated clinically pre-operatively, 6 weeks and 12 months post op by the pain questionnaire (VAS), and function questionnaire (ODI); The radiological measures included the segmental lordosis, integrity of the construct, and presence of bridging bone; Fusion success is defined as presence of bridging bone, and postoperative intervertebral motion at 12 months which is less than 5 degrees, via manual radiographic angular measurements (Cobb Method) of the implanted level(s) on flexion and extension radiographs at the 12 month follow up visit.

Results: The VAS has improved from an average of 9 preop to an average of 2 postop. ODI score has reduced an average 30 points from preop measurement. 83% (15 patients) went on bony fusion at the radiological assessment 12 month post op. None of the patients underwent revision, removal of implant, supplemented fixation, or re-operation. One patient developed mechanical ileus for 48 hours postop, resolved with NG tube.

Conclusion: Mini anterior inter-body fusion is a valid option when treating degenerative/discogenic back pain, the ROI-A implant is a safe and simple, with satisfactory results up to 12 month, according to our pilot study.

GP067. Radiological Outcome of Lumbar Lordosis Restored following Extreme Lateral Interbody Fusion (XLIF) Plus Pedicle Screw Insertion (PSI)

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Introduction: Radiological outcome of Lumbar Lordosis restored following Extreme Lateral Interbody Fusion (XLIF) plus Pedicle Screw Insertion (PSI). Improving sagittal alignment in the lumbosacral spine following fusion for degenerative spinal disease remains an important goal of surgery. Numerous surgical techniques have been promoted as improving lumbar lordosis, elevating the height of the disk, and facilitating the decompression of the neural elements. Interbody support techniques are frequently cited as a reliable method of maintaining or improving segmental sagittal profile. The historical use of structural autograft has recently been supplemented by the increasing popularity of synthetic cages. Numerous cage configurations are available. Wedge-shaped cages are generally preferred because studies have shown this geometric shape to have a significant impact on the improvement of lordosis. Anterior cages have been cited as the most reliable method to restore anterior lordosis and disk space height. Posteriorly placed wedged cages have been shown in a prospective randomized study to maintain but not improve segmental lordosis following a posterior lumbar interbody fusion combined with pedicle instrumentation. In his study we observed that XLIF cages increases disc height, opening neural foramen, indirectly opening spinal canal by stretching out retrobuldged posterior longitudinal ligament and restoring biomechanics by correcting lumbar lordosis

Material and Methods: This is a retrospective study to review all cases of degenerative disc disease of lumbar spine that underwent Extreme Lateral Interbody Fusion (XLIF) and Pedicle Screw Insertion (PSI) from 1st June 2009 to 31st May 2011. From June 2009 to May 2011, 17 patients (14 female, 3male) were included. The electronic patient record which includes preoperative and postoperative radiographic results were reviewed and abstracted into an electronic database. Data entered in Data Form then in Excel sheet,, number of disc involved, type of surgery anterior instrumentation (Extreme lateral Interbody fusion XLIF), posterior instrumentation (pedicle screw fixation PSF), Posterolateral bone grafting, both Pre & immediate postsurgical Cobb angles and disc heights were measured.

Results: From June 2009 to May 2011, 17 patients (14 female, 3male) were included. The mean patient`s age at surgery was 61.88years (range 47–80). The mean of Preop disc height was 8.54mm and the mean Post XLIF disc height was 13.01mm. The mean of Preop Global Lumbar Lordosis (Cobb Angle) was 30.72° (range 7.80°-54°.90°) as well as the mean of Post XLIF Global Lumbar Lordosis (Cobb Angle) was 29.48° (range 9.70°-59°). The number of disc involved was one in 12 cases, two in 2 cases and three in 3 cases. Sixteen cases were underwent Anterior and Posterior instrumentation except one patient who underwent stand alone XLIF cage. The Posterolateral bone grafting was done in four cases. Through using a McNemar-Bowker Test, there is a strong association between the Pre-Op Disc Height and the Post-XLIF Disc Height, P –value < 0.05. In addition, There is a strong association between the PRE-OP GLOBAL LUMBAR LORDOSIS (Cobb Angle) and the POST- XLIF GLOBAL LUMBAR LORDOSIS (Cobb Angle) P-value < 0.05.

Conclusion: XLIF cages increases disc height, opening neural foramen, indirectly opening spinal canal by stretching out retrobuldged posterior longitudinal ligament and restoring biomechanics by correcting lumbar lordosis

GP068. Influence of Lumbar Lordosis Restoration on Clinical Outcome in Degenerative Lumbar Patients from the "Pre-Balance" Period: Ex Post Analysis of Spinal Parameters Restoration and Clinical Outcome in a Medium Follow-Up

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Introduction: Restoration of spinal balance is a widely accepted principle of spinal surgery planning. There is a huge amount of data supporting the correlation of clinical outcome and the restoration of theoretical physiological curves of the spine. Flat or hypolordotic fixations are rarely seen today, but there is someone who claims that spinal balance principles are too often pushed to extremes and, surprisingly, there is still some resistance to accept the routinary application of these concepts in the "simple" degenerative surgery, claiming that in short fixations for degenerative lumbar spinal disease it is not mandatory to be strict in the restoration of correct, theoretical spinal parameters to achieve satisfactory clinical results. In this study we present a homogeneous population of patients, operated by a single surgeon in a 3 years time, 7 to 10 years ago, with homogeneous degenerative pathology and similar constructs (2 to 4-level fixations). The peculiarity of this study is that all the patients have been operated regardless to spinal parameters restoration, because at the time of surgery the presurgical planning of spinal curves was not being sistematically adopted. The population is therefore a kind of spontaneous randomization, with patients with a good restoration of spinal theoretical curves and patient who didn't get any correction of sagittal curves.

Material and Methods: 36 patients with homogeneous diagnosis of degenerative spinal disease, operated by a single surgeon with a 2 to 4-level fixation until 2010 has been selected. ODI and Prolo scales has been used for direct clinical evaluation. The mean last follow-up was 4 years 4 months, with a minimum of 3 years. Radiological assessment has been performed by lumbar standing XRays AP and LL pre and postop, and PI-LL mismatch and the difference between theoretical lordosis and effective postoperative lordosis have been calculated. Statistical evaluation used Spearman correlation test between PI-LL mismatch and clinical scales values.

Results: Statistical correlation exists between clinical scale values and PI-LL mismatch. As a qualitative result, we observed that the higher is the difference between theoretical lordosis and effective postsurgical lordosis, the higher is the incidence of construct failure.

Conclusion: According to the results of this study, respect of the spinal balance principles seems to be helpful to achieve good clinical results in a medium follow-up for lumbar degenerative patients. These results come from a dataset that is not culturally influenced by spinal balance principles, coming from the past. Additionally, the single-surgeon, single-observer and single-center experience is somehow minimizing the confounding factors that usually affects this kind of studies.

GP069. Is there Sacral Defromity Predisposing to L4 Degenerative Spondylolysthesis?

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Introduction: Degenerative spondylolysthesis results from anteroposterior instability, giving rise to a facet remodeling, generally at the L4L5 level. For istmic lythihc spondylolydsthesis an intrinsic sacral deformity has been described (Antoniades Spine 2000, Díez-Ulloa Proc Geer 2007). This sacral kyphosis, if present could contribute to a disbalance scenario that would render L4 more prone to olysthesis.

Hypothesis: A sacral kyphosis S1S2 could be a contributing factor to degenerative spondylolysthesis at L4L5.

Matherial and Methods: A control group (group C), matchable for age and gender, was compared with a series of 83 patients with L5 istmic lythis spondylolysthesis (group D). Proximal sacral kyphosis measured by the angle formed by the S1 posterior wall and the S2 posterior wall, if S1 was kyphotic on S2 then it was considered a positive angle, other wise being negative.

Statistics: SPSS 21.0, working with means or medians and appropriate tests after studying whether the variable showed a normal distribution.

Results: Group C lordosis -2° (minimum -8°; maximum +7°). Group D kyphosis +2° (minimum -14°; maximum +22°). There were statistically relevant differences between group C and group D.

Conclusion: An intrinsic sacral deformity might be a contributing factor to L4 degenerative spondylolysthesis in a degenerative environment.

GP070. Degenerative Scoliosis de Novo: Prospective Study of 50 Cases Operated with Stand-Alone ALIF with One Years Minimum Follow-Up

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Introduction: Posterior approach in degenerative scoliosis de novo is related to high rate of complications in elderly people. In a previous retrospective and comparative report in 2009 (French Spinal Society), Stand alone ALIF/OLIF proved a less iatrogenic procedure to relief the pain and meet patient's expectations. A prospective study including 50 patients has been performed to confirm this previous report, with at least one-year follow-up.

Material and Methods: The indications are based on a specific classification according to the biomechanism of the rotatory discogenic collapse. Therefore, two homogenic groups are compared. The details of the procedure are important with elderly people to avoid vascular complication or subsidence (preventive vertebral augmentation) due to osteoporosis. Stand alone ALIF/OLIF using a Peek cage .The cage and disk space are filled with nanoparticles of HAP. The outcomes are assessed with VAS, ODI, Kim&Kim score, standard radiography and spinogram at two, six and twelve-month follow-up periods.

Results: The two groups have specific physiopathology and epidemiology. But, outcomes are very similar after one-year follow-up. Surprisingly, it is not related to the number of disk's levels (1 to 4) operated on. According to Kim&Kim score: 30% have excellent outcome, 60% good result. VAS drops from 7/10 to 2/10 at one year. Complications (10% poor results) are

mainly related to vertebral body fractures (upper endplate of L5). Posterior Vertebral augmentation was not efficient to improve the score. Symptomatic effect of sympathectomy is noted (8%) but with good acceptance. Revision rate is 6% mainly due to the persistence of a radiculopathy linked to posterior stenosis. A posterior decompression was performed after 4 months and relieved the symptoms. Radiologic fusion rate is 90% with HAP nanoparticles. It proves a low cost, less iatrogenic than BMP 2 and efficient solution in elderly people.

Conclusion: This prospective study confirms that Stand alone ALIF/OLIF is a better procedure to relieve the pain and meet patient's expectation compared with posterior instrumented surgery. Preserving posterior musculature and reshaping the anterior "lumbar arch," Stand alone ALIF improves the sagittal balance in a physiological way. Osteoporosis required a "systematic" vertebral augmentation by anterior approach to lower subsidence or vertebral body fractures rate.

GP071. Lumbosacral Parameters and Intervertebral Disc Changes in Adult Patients with Pars Defects

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Introduction: Pars defect refers to fracture in the pars inter articularis and is believed to be one of the leading cause of back pain. Pars defects usually acquired and caused by microtrauma. Spondylolysis is seen in 4–6% of population. 82% occur at L5/S1 and 11% occurs L4/5 (11%).

Materials and Methods: Between March 2013 and April 2014, we collected particulars of all patients presenting with low back pain with pars defects on standing erect lumbosacral spine X-rays. Patients were excluded if they had (1) Deformity, (2) Non availability of MRI. 57 patients were included. Their X-rays and MRI were studied by two orthopedic surgeons measuring: Lumbar lordosis and Sacral slope on Plain Xrays; Lumbar slip according to meyereding grading; Intervertebral disc status on MRI: (1) Disc degeneration according to Pfirmann's grading, (2) Degree of disc prolapsed.

Results: 57 subjects had their data reviewed: 30 males, 27 females; ages ranged between 15 and 65 years (mean age = 40 years). Data was collected and cleaned using Microsoft Excel .Then analysis done using SPSS ver.17.characteristics of the sample population were displayed in frequency tables while testing for correlations as wellas student *t*-testwere taken as significant for P values < 0.05. There's a significant difference between males and female ages (p-value 0.01); males were younger with a mean age of 37 years versus 45 years. Sacral Slope: Ranged between 17 – 64 degrees (Mean = 38 degrees). Lumbar Lordosis: ranged between 15 – 77 degrees (Mean = 52 degrees). Slip degree according to myerdings grading: Grade 0 = 38%, Grade 1 = 58%, and Grade 3 = 4%. On MRI disc changes according to Pfirmann's grading was grade 1 26%, grade 2 5%, grade 3 24%, grade 4 32%, grade 5 11%. And finally the disc prolapse severity wasas under: (1) No bulge 32%, (2) Bulge 29%, (3) Extrusion 34%, (4) Sequestration 4%. Statistically significant correlation found between: (1) Age and degenerative disc changes; cor. coefficient 0.43 and p value 0.001; (2) Age and prolapsed disc; cor. coefficent 0.39 and p value 0.003; (3) Degenerative disc changes and prolapse; cor. coefficient 0.83 and p value < 0.001; (4) Between sacral slope and lumbar lordosis; cor. coefficient 0.72 and p value < 0.001.

Conclusions: There is increased prevalence of disc degeneration in patients with pars defect. There is direct correlation between age and disc degeneration plus degree of disc prolapse. Severity of degeneration is directly related to degree of disc prolapse. The lumbar lordosis and sacral slope were not found be statistically related to degree of spondylolisthesis. The disc is not protected in patients with defect.

GP072. Stand Alone ALIF for Degenerative Lumbar Spine Diseases

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Introduction: With progress continuing in the development of anterior lumbar constructs, the need for complete anterior access to the lumbar spine continues to increase.

Material and Methods: The study included 18 patients with various types of degenerative lumbar spine diseases as degenerative disc lesions with or without hernias (15), degenerative spondylolisthesis (2) and degenerative stenosis (one case). The follow up period was 6 months.

Results: Back and leg pain have been markedly improved and assessed by ODI.

Conclusion: With various techniques evolving over the years, the mini-open retroperitoneal approach is becoming the standard, with decreased complication rate, better cosmesis and less abdominal wall disruption to provide exposure to the lumbar spine.

GP073. Unplanned Reoperation of Lumbar Spinal Surgery during the Primary Admission: A Multicenter Study Based on a Large Patient Population

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Introduction: Unplanned reoperation is suggested to be a useful quality indicator for spinal surgery. However, the rates of unplanned reoperation in patients underwent lumbar spinal surgery during the primary admission are not well established. The purpose of this study was to identify the rates and reasons, also the risk factors for unplanned reoperation of lumbar spinal surgery during the primary admission in terms of a multicenter and a large patient population study.

Materials and Methods: A retrospective study was performed to review all the patients who underwent lumbar spinal surgery at three institutions from January 2010 to April 2015. Patients with unplanned reoperations after primary surgery during the same admission were included in this study. The demographics, diagnosis, surgical procedure and complications of patients were reviewed and statistical analysis was performed to investigate the incidences and risk factors of unplanned revision.

Results: A total of 3936 patients who underwent lumbar spinal surgery from three institutions were reviewed, and 82 (2.08%) required unplanned reoperation during the primary admission because of wound infection (0.94%), screw misplacement (0.53%), cerebrospinal fluid leakage (0.27%), wound hematoma (0.18%) and neurologic deficit (0.15%). For the diagnosis, patients with lumbar spinal spondylolisthesis had a much higher rate of reoperation (4.3%) than those of lumbar stenosis (2.3%), vertebral tumor (2.2%), vertebral fracture (1.2%) and disc herniation (1.1%) with a significant difference ($P < 0.001$). The revision rate was significantly higher in patients underwent posterior lumbar interbody fusion (PLIF) than those received transforaminal lumbar interbody fusion (TLIF) ($p = 0.007$).

Conclusions: Unplanned reoperation rate of lumbar spinal surgery was 2.08% and the most common reasons for it were wound infection and screw misplacement. Patients with a diagnosis of lumbar spinal spondylolisthesis or who

underwent PLIF were more likely to required unplanned reoperation during the primary admission.

Keywords: reoperation, lumbar spine, risk factor, complications

GP074. Clinico-Radiological Evaluation of Unilateral Single Cage filled with Local Morselized Bone Graft in Posterior Lumbar Interbody Fusion (PLIF) for Degenerative Lumbar Disc- Retrospective Study Suresh Kumar B.C, Navaladi Shankar, Rampathy Reddy

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Introduction: Retrospective clinico-radiological evaluation of 200 patients who underwent posterior lumbar interbody fusion(PLIF) using unilateral single cage filled with local morselized Bone graft for degenerative lumbar disc.

Material and Methods: 200 patients who underwent PLIF with a unilateral single cage filled with local morselized bone graft of which 182 patients were single level and 18 patients two levels, during the year, january 2010 to january 2015 were enrolled in this study. The average follow-up duration was 2years. The clinical outcomes were evaluated with, using the visual analogue scale (VAS) and Oswestry Disability Index at the pre-operative period, and Oswestry Disability Index at 1month, 3 months, 6 months, 12months and 24 months year post-operative period. The radiological outcomes were evaluated according to bone fusion and bony bridging, the radiolucency, the instablity and the disc height.

Results: Clinical outcome for pain was evaluated using the visual analogue scale (VAS) and Oswestry Disability Index along with functional evaluation showed excellent results and radiological outcomes were evaluated according to bone fusion, disc height, instability and bony bridge, showing no cage back out or implant loosening or screw back out or implant breakage.

Conclusion: PLIF using a unilateral single cage filled with a local morselized bone graft was found to be good and has the advantages of a shorter operation time, less blood loss and a shorter hospital stay, low cost, less complications like dural tear, as compared with the PLIF using bilateral cages, for treating degenerative lumbar spine disease. This technique also provides excellent outcomes according to the clinical and radiological evaluation.

GP075. Radiological Assessment of Bilateral Decompression through Unilateral Approach for the Treatment of Lumbar Spinal Canal Stenosis

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Introduction: Various surgical techniques have been introduced to establish less invasive procedure for the treatment of lumbar spinal canal stenosis (LSCS). Bilateral decompression through a unilateral approach (BDUA) is one of those techniques. This retrospective study was designed to evaluate radiological changes of lumbar spinal alignment after BDUA and to compare with those of conventional fenestration.

Material and Methods: A consecutive 73 patients (53 males, 20 females; mean age, 71yrs.) underwent BDUA from 2004 to 2012 were included in this study and conventional fenestration (CF) group consisted of 25 patients (12 males, 13 females; mean age, 72yrs.) treated from 2000 to 2012 at the same hospital. Mean number of decompressed level were 2.5 in BDUA and 2.0 in CF. To investigate radiological change of lumbar spine, following parameters were measured on X-rays of pre-op, one year (1Y), and two year (2Y) after surgery: Disc angle and ROM of L4–5, Lumbar lordosis (LL, sagittal angle of L1–5), coronal alignment of L4–5, and L1–5. Clinical results were assessed by Japananese Orthopaedic Association Scoring System (JOAS).

Results: Preoperative[Q3] disc angle of L4–5 was 7.4 in BDUA and 7.3 in CF and changed to 8.1 , 8.3 at 1Y, 7.6 , 8.8 at 2Y respectively. A comparison between two groups showed no significant difference at each point. ROM of L4–5 in both group also showed no significant difference at each point; pre-op: 7.3 , 6.9 , 1Y: 6.1 , 6.0 , 2Y: 7.0 , 5.7 . Preoperative LL was 18.7 in BDUA and 21.8 in CF and changed to 19.5 , 23.7 at 1Y, 19.5 , 23.5 at 2Y respectively. There was no significant difference between two groups at each point. In the coronal plane, L4–5 wedging angle varied from 0 to 7 in BDUA and from 0 to 4 in CF preoperatively. The amount of L4–5 wedging change in two years was 1.4 in BDUA and 1.1 in CF, showing no significant difference. There was no peculiar tendency in coronal change of L4–5 or L1–5 lumbar alignment depending on approach side. JOAS improved significantly after surgery in both group (Recovery rate: 62.5% in BDUA, 56.5% in CF) and was well maintained at 2Y. A comparison of JOAS revealed no significant difference in two groups preoperatively and 2Y; pre-op: 12.7, 2Y: 23.7 in BDUA, pre-op:11.9, 2Y: 21.5 in CF.

Conclusions: Decompression through unilateral approach has been widely accepted for the treatment of LSCS. This method spares dissection of paraspinal muscle of contralateral side and has an advantage of preservation of contralateral facet joints. On the other hand, especially in multiple decompression, the influence to the muscle balance or to alignment change remains concerns. Current study showed favorable clinical results in both group. There was no particular tendency of alignment change in the coronal plane. These changes seemed to be mainly based on the degeneration process of lumbar spine.

GP076. Predicting Factors for Patient Reported Satisfaction after Transforaminal Lumbar Interbody Fusion: A Two-Year Follow-Up

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Introduction: Transforaminal lumbar interbody fusion (TLIF) is an effective treatment of degenerative lumbar spine conditions, to reduce pain and improve function. Understanding predictors of post-operative patient satisfaction is important for better management of patient groups at high risk of dissatisfaction. This study aims to determine the pre-operative predictors of post-operative satisfaction in TLIF surgery.

Material and Methods: We retrospectively reviewed prospectively collected data on patients who underwent open TLIF for degenerative scoliosis, spondylolisthesis and spinal stenosis from the database of a tertiary hospital between 2008 and 2012 with 2 years follow-up. Clinical outcome was evaluated using Oswestry Disability Index (ODI), North American Spine Society (NASS) Neurogenic Symptom Score (NSS), SF-36 (mean Physical and Mental Health scores), numerical pain rating scale (NPRS) for back and leg pain and two questions from NASS Questionnaire: ((1) Has the surgery met the patient's expectations? (2) How would the patient rate the overall results of treatment?). Paired *t*-test was used to compare the clinical scores pre-operation and post-operatively at 6 months and 2 years. Univariate and multivariate analyses were conducted to determine significant pre-operative predictors of patient satisfaction at 2 years.

Results: 217 patients underwent TLIF by a single surgeon during the 5-year period. Mean pre-operative age was 61 and BMI was 25.9. 182 and 35 patients underwent primary TLIF and revision TLIF respectively. 140, 68 and 9 patients underwent single-level, two-level and three-level TLIF respectively. Significant improvement was seen in the post-operative ODI ($p < 0.001$), NSS ($p < 0.001$), SF-36 (mean physical score; $p < 0.001$ and mean mental health scores; $p < 0.001$) and NPRS (back pain; $p < 0.001$ and leg pain; $p < 0.001$) scores at 2 years follow-up. 86.8% of patients had their expectations of surgery met and 94.7% of patients were satisfied with the results of treatment at 2 years. Possible indicators identified by univariate analysis for post-operative patient satisfaction ($p < 0.2$) were pre-operative scores (NPRS leg pain score, SF-36 Physical Function score, mean Physical Health score and ODI). From multivariate regression model, patients with higher pre-operative NPRS pain score (OR, 1.323; 95% CI, 1.071–1.633; $p = 0.009$) was more likely to be satisfied at 2 years.

Conclusion: TLIF surgery provided significant health-related quality of life scores and symptoms improvement in terms of SF-36, ODI, NSS and NPRS (both back pain and leg pain). However, patient reported satisfaction is multi-factorial and their post-operative satisfaction may be largely influenced by expectations of surgery being met and improvement of pain. This highlights the importance of managing patients' expectation pre-operatively as a means of improving post-operative patient satisfaction.

GP077. Overpowering Posterior Instrumentation and Fusion using a Modified Anterior Lumbar Interbody Fusion Technique, An Experience of 11 Cases

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Introduction: Restoration of sagittal balance is paramount in any type of spinal reconstructive surgery. Recent work has demonstrated that the failure to maintain lumbar lordosis following fusion not only accelerated adjacent degeneration (Umehara S. et al., Spine. 2000; Rothenfluh D.A. et al., Euro Spine. 2015), but also has a strong correlation to patient's clinical symptomatology, quality of life, and overall function (Glassman S.D. et al., Spine 2005; Schwab F. et al., Spine. 2010). As such, postoperative hypolordosis in the presence of posterior instrumentation and fusion has become a growing problem and presents the operative surgeon with a difficult challenge. In this study we describe our early clinical experience with using a modified anterior lumbar interbody fusion (ALIF) technique for the purposes of increasing lumbar lordosis and improving sagittal imbalance in revision adult spinal deformity patients.

Material and Methods: We present a retrospective case series of 11 patients that developed pain and disability following previous instrumented posterior lateral spinal fusion. All patients were diagnosed with either a posterior pseudoarthrosis and/or a lumbar segment fused with non-anatomic segmental lordosis. All patients underwent ALIF with either anterior wedge allograft or hyperlordotic cages and posterior instrumentation and fusion. Distraction of the disc space and obtainment of the desired lordosis was achieved by using the jackknife capability of the OR table (the patients lumbosacral junction was positioned at the level of the hinge of the table and during the discectomy the table was "jackknifed" into further lordosis). This provided a gradual, and controlled generation of a more anatomic lordosis. Digital standard upright lateral radiographs were used to measure spinopelvic parameters on all patients both pre-, and post-operatively. Two independent observers reviewed each radiograph.

Results: From 2014 to 2015, 11 patients underwent revision surgery utilizing this modified ALIF approach with hyperlordotic graft insertion and revision posterior fusion for the treatment of symptomatic sagittal imbalance. Mean patient age was 50.1 years (range 30 – 62). All patients had 30-degree hyperlordotic cages placed while three had an additional standard 20-degree cage placed at an additional lumbar level (average 1.3 per patient). Although preliminary, early postoperative radiographic assessment has shown average increase in L5/S1 segmental and global lumbar lordosis exceeding 20 and 7 degrees, respectively. Additionally, pelvic incidence was found to be increase by an average of 5 degrees.

Conclusion: The ability to overpower the posterior instrumentation and to generate added lordosis while fusing the anterior spine is an appealing prospect. In our small series, no loosening of the pedicle screws, or fracture of the pedicles/posterior fusion was observed. We hypothesize that the correction occurs due to flexibility of the titanium bars. Although this is a small series and caution should be exercised before widespread uptake, it does illustrate the potential use of this technique to further address this challenging patient population.

GP078. Annulo-Nucleoplasty using Disc-FX® in the Management of Lumbar Disc Pathology: Early 2 Year Results

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Introduction: Back pain due to Lumbar Disc Disease is a major clinical problem. The treatment options range from physiotherapy to fusion surgery. Several minimally invasive procedures have also been developed in the recent past for its management. Disc-FX® is a new minimally invasive technique that combines percutaneous discectomy, nuclear ablation and annular modification.

Methods: We studied 22 consecutive patients who underwent Disc-FX for lumbar disc pathology non-responsive to non-operative treatment for at least 6 months. Based on MRI, these patients fell into 2 groups – 11 with degenerative disc disease (DDD) and 11 with a contained lumbar disc herniation (CLDH). They were evaluated using Visual analogue scale (VAS), Oswestry Disability Index (ODI) and Short Form-36 (SF-36) scores preand postoperatively.

Results: Overall rate of re-intervention for persistent symptoms was 18.18% (4/22) - all in CLDH subgroup (4/11, 36.36%). At 6 months, mean pre-op VAS improved from 6.1 (2–8) to 3.42 (0–7), ODI reduced to 28.21 (2–68.9) from 37.64 (2–71.1) and SF-36 improved from 35.57 (24.1–56.8) pre-op to 40.463 (24.1–56.8). 9 (42.85%) patients (4 with CLDH, 4 with DDD and 1 with both) said that they were not satisfied with the treatment and would not recommend it. 8 (38.09%) patients (5 with DDD, 2 with CLDH and 1 with both) who had partial to complete pain relief were satisfied and would recommend the procedure. 4 (19.04%) patients (1 with DDD and 3 with both) were not sure. 3 were advised fusion or disc replacement. The only complication of this procedure was inability to access the L5-S1 disc space in 3 patients.

Conclusions: Our study suggests thatDisc-FX®is a reasonable treatment option for patients with back pain due to lumbar disc disease, especially with DDD who fail conservative treatment. It could be an alternative to procedures like fusion or disc replacement. Longer term prospective studies are needed to prove its role in treatment of patients with CLDH.

GP079. The Influence of the Fusion Degree of the Vertebrae on the Process of Destabilization of the Pedicle Fixation System after TLIF and PLIF

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Introduction: The stability of the PSF system in the postoperative period of time is an important component of well-being of the patients. In case of destabilization of PSF systems revision surgery is often required and brings high costs and has increased number of complications. The main reasons for the destabilization of the rigid stabilization systems are: osteoporosis, non fusion, pseudarthrosis, a violation of the prescribed protective regime

Material and Methods: 409 patients after decompressive-stabilizing operations on the lumbar spine type TLIF or PLIF. All patients were operated because of spinal stenosis in the period since 25.12.2012 till12.27.2013 by five surgeons working in the same department. There were 235 male (57.5%) and 174 female (42.5%) aged 18–75 (50,3 $\pm$ 1,2). There were one-level process - 296 (72.4%), two-level process - 98 (23.9%), a three-level process - 11 (2.6%), more than 3 levels - 4 (1.1%). Totaly 539 segments were operated. We used following cages as interbody implants: Leopard – 65 (12%), Concorde – 92 (17%), Capstone – 156 (29%), Surgical Titanium Mesh – 226 (42%). Cages were filled with autologous bone graft. Crushed bone stacked densely around the cage. After installation cage we performed compression on the elements of PSF system. Follow-up period was of 2 years. Formation of the bone block was evaluated by Bridwell classification

Results: Complete regression of the initial neurological symptoms as a result of the decompression achieved in 325 (79,5%) patients, partial – 58 (14%), no change – 20 (5%), the deterioration – 6 (1.5%). Post-operative examination and X-ray and CT control were delivered within 3–6-12 and 24 months. 335 (82%) patients were control examined after 1 year, 258 (63%) after 2 years. After 1 year the 1st Bridwell fusion grade was marked at 325 (79.6%) patients, grade 2 – 60 (14.7%), grade 3 – 13 (3.2%), grade 4 – 10 (2.5%). The material of the implant had no effect on the fusion. Among patients (23 patients total) with 3 and 4 Bridwell grade of fusion we used as interbody implant: Peek 7 (30,6%), Carbon 8 (34,7%), Surgical titanium mesh 8 (34,7%). It is obvious that the reason of non fusion is not the material of the implant, and other factors (quality of treatment interbody gap, cage height and the degree of contact with the endplate vertebral body, especially vertebral vascularization, surgical technique, and others). Instability and fractures of nodes of PSF system for two years after surgery were found in 13 (3,17%) patients. This revealed that the destabilization or fracture structure were determined just in cases of pseudarthrosis (3 and 4 Bridwell grade)

Conclusion: The main goal of TLIF and PLIF is fusion in operated segment. Non fusion with pseudarthrosis cause instability and fracture of PSF in most cases. The interbody implant material does not matter. Quality of treatment interbody gap and degree of contact with the vertebral endplates, cage and bonegraft are most important.

GP080. Cost per Quality Adjusted Life Years Gained Following Anterior Cervical Discectomy and Fusion in Elective Degenerative Pathology in Obese and Non-Obese Paients

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Introduction: Obese patients are at increased risk of comorbidities and complications after spine surgery, which might result in increase cost and lower quality of life compared with their non-obese counterparts. The aim of present study was to determine the cost-utility following anterior cervical discectomy and fusion (ACDF) in obese patients.

Methods: A total of 299 consecutive patients undergoing elective ACDF for degenerative cervical pathology over a period of four-years were included in the study. One and two-year medical resource utilization, missed work, and health state values (QALYs), calculated from the EQ-5D with US valuation using time weighted area under the curve approach) were assessed. Two-year resource use was multiplied by unit costs based on Medicare national allowable payment amounts (direct cost). Patient and caregiver workday losses were multiplied by the self-reported gross-of-tax wage rate (indirect cost). Total cost (direct + indirect) was used to compute cost per QALY gained. Patients were defined as obese for body mass index (BMI) $\geq$35 based on the WHO definition of class-II obesity. A subgroup analysis was conducted in morbidly obese patients (BMI$\geq$ 40).

Results: A significant improvement in pain (NP/AP), disability (NDI) and quality of life (EQ-5D and SF-12) was noted 2-year after surgery ($p < 0.0001$). Mean total 2-year cost was \$24524 for obese patients and \$22492 for non-obese patients ($p = 0.06$). Obese patients had lower mean cumulative 2-year gain in QALYs versus non-obese patients (0.39 versus 0.47 QALYs, $p = 0.19$, Fig. 1). Two-year cost-utility in patients obese versus non-obese patients was \$65,805/QALY versus \$47,634/QALY. Morbidly obese patients had significantly lower (0.15) QALYs gained and significantly higher cost \$168,915/QALY gained at 2-years ($p < 0.0001$) (Table 1).

Conclusion: ACDF provided a significant gain in health-state utility in obese patients, with a mean 2-year cost-utility of \$65,805/QALY gained, which can be considered moderately cost-effective. Morbidly obese patients had lower cost-effectiveness; however, surgery does provide a significant improvement in outcomes. Obesity needs to be taken into consideration as physician and hospital reimbursements move toward a bundled mode

GP081. Intraoperative Electrophysiological Monitoring Navigation Results during Sagittal Anterior Reduction Maneuver of High Grade Spondylolisthesis L5-S1 using an ALIF Surgical Technique

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Introduction: Unstable isthmic spondylolisthesis is a common disease. Treatment of high-grade dysplastic spondylolisthesis remains challenging. According to the literature, decompressive laminectomy and posterolateral screws fusion

is preferred by most surgeons. Surgical treatment of spondylolisthesis has been recommended in patients with pain refractory to conservative treatment, slippage progression, or severe slippage on presentation. Controversy exists as to the optimal surgical approach for high-grade spondylolisthesis. Moreover, some authors reported the incidence of L5 root palsy during the reduction procedure. We believe that satisfactory nerve root decompression may be achieved by complete anterior discectomy and restoration of disc height (Indirect Decompression), followed by ALIF graft and posterior pedicle screws

Material and Methods: We performed a prospective study of 23 cases of surgical treatment using intraoperative electrophysiological monitoring for patients with high-grade spondylolisthesis. Each patient received treatment consisting of anterior retroperitoneal approach and indirect nerve decompression with anterior sagittal progressive realignment maneuver, and circumferential fusion with ALIF cage and L5-S1 minimally invasive pedicle fixation with intraoperative neurological monitoring with transcranial electric motor evoked potentials and continuous spontaneous electromyography recording.

Results: Intraoperative monitoring did show different transitory patterns with no any final abnormal changes. The patients got well after surgery, and they showed no postoperative sensory changes and motor paralysis of the extremities. A postoperative X-rays films showed suitable reduction of the slippage.

Conclusion: This report describes 23 cases of surgical treatment using intraoperative electrophysiological monitoring with transcranial electric motor evoked potentials and continuous spontaneous electromyography for patients with high-grade dysplastic spondylolisthesis. We successfully perform anterior sagittal reduction maneuvers without any neurological deficit using intraoperative electrophysiological monitoring.

GP082. Risk Factors for Adverse Events and Reintervention after Surgery for Lumbar Spine Stenosis. A 10-Year Experience of Clinical Practice in a Third Level Hospital from Bogotá, Colombia

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Introduction: Degenerative lumbar spinal stenosis is present in patients around 50 to 60 years old. It is the most common spinal surgical indication in patients over 65 years old. The aim of this study was to determine the risk factors associated with adverse events and reintervention after surgery for degenerative lumbar spinal stenosis, based on a 10-year retrospective analysis of clinical records in a third level hospital in Bogotá, Colombia.

Material and Methods: An analytical prevalence study was developed through 429 clinical records of patients who underwent surgery for degenerative lumbar spinal stenosis.

Results: 429 clinical records were reviewed. 55% were female; the mean age was 55 years +/−16,5. The average follow up was 33,8 months. Adverse events were present in 17,2% of patients. Dural lesion was the most frequent complication (9.8%). Multivariate analysis showed a relation between complications and BMI (OR 1,8; $p = 0{,}029$), duration of symptoms (OR 1,08; $p = 0{,}047$), length of stay (OR 1,67; $p = 0{,}023$) and multi level surgery (OR: 2.99; $p = 0{,}015$). 4.7% of patients required early reintervention after surgery and 16,1% required it during follow-up. The most common late reintervention cause was re-stenosis of the same segment (7%). Adjacent segment disease was present in 6,1% of patients.

Conclusion: BMI, duration of symptoms, length of stay and multi level surgery were identified as risk factors for adverse events and reintervention after surgery for degenerative lumbar spinal stenosis. Mitigation of these risk factors before surgery for degenerative lumbar spinal stenosis, may decrease the proportion of complications and reinterventions in our institutions.

GP083. Value of Combination of Two Minimal Invasive Techniques in Elderly Patients with Multisegmental Lumbar Canal Stenosis and Spondylosis. Midterm Results

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Introduction: Lumbar canal stenosis (LCS) and spondylosis are the major causes of morbidity among the elderly. LCS remains the most common indication for spinal surgery in elderly patients. These patients are complaining from neurogenic claudication as well as back complaint. LCS remains the most common indication for spinal surgery in elderly patients. These patients are complaining from neurogenic claudication as well as back complaint. Although the decompression Procedures improve the claudication, the back complaint persist or even increase. We assess the efficacy of combination of microscopic assisted percutaneous decompression (MAPD) and percutaneous transpedicular screw fixation (TPSF) with PEEK rod.

Material and Methods: Prospective study. Between 2009 and June 2012, 20 Patients with LCS and lumbar spondylosis were included in this study. We reviewed demographic information, preoperative (preop.) and postoperative (postop.) Visual Analog Scale (VAS) and Oswestry Disability Index (ODI).

Results: 20 patients (14 males and 6 females; mean age 69.2 years), mean follow-up 14.2 months, co-morbidities are found in patients (cardiac 8, DM in 4, renal insufficiency in 4), ASA Score (Class I in 8, III in 10, III in 2). BMI; normal weight (7), overweight (6) and Obesity (7). Mean preop. VAS (back and leg) was 5.5 and 5.6 respectively; ODI was 57.2%, 3 months postop. VAS (2.65 and 1.3), ODI 26.4% and 18.2% at the last follow-up. The operated levels were (one level in 2 patients, two levels in 7, three levels in 7 and four levels in 4), eight patients with degenerative scoliosis (more than 10°) with mean cobb- angle of 15.4° preop. and postop. 5.75°. Mean Lumbar lordosis was 35.6° preop. and 39.5° postop. Sacral Slope was 27.8°preop. and postop. 30.3°. Mean operative time was 196 minutes and blood loss was 233.5 ml. Intraop. complications included 2 patients with dural injuries, no wound healing, Follow-up complications included one case with screw loosening.

Conclusion: Elderly patients are considered good candidates for lumbar surgical decompression using minimally invasive techniques. MAPD is a minimally invasive treatment option that affords a high level of safety, improved functions and decreased pain score. The spinal stabilization using PEEK rod possesses a good solution for spondyolotic back pain not

Degenerative Lumbar

GP084. Use of a Sublaminar Decompression as an Alternative to Traditional Laminectomy in Degenerative Disorders of the Lumbar Spine

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Introduction: The traditional treatment for lumbar stenosis with instability is laminectomy and posterolateral arthrodesis, ± interbody fusion. However, laminectomies remove the posterior elements and decrease available surface area for spinal fusion. A sublaminar decompression can achieve adequate decompression while preserving bone surface area to enhance spinal fusion.

Material and Methods: A retrospective review of 72 patients with degenerative pathology who underwent sublaminar decompression by a single surgeon at a single institution was performed. Data collected included baseline demographics, preoperative symptoms, operative data, symptoms at last follow-up (LFU), time to fusion, fusion rate, and radiographical measurements, consisting of thecal sac cross-sectional area, bilateral lateral recess height, and bilateral foraminal diameter on preoperative and postoperative scans. Paired t-tests were used to test significance of these changes.

Results: 31 males and 41 females with median age 60 (range: 19-78) years underwent sublaminar decompression with fusion. A mean of 1.9 levels were fused. The mean VAS pain score improved from 6.8 preoperatively to 3.0 at last follow-up. Fusion imaging was available for 44 patients, with a fusion rate of 91%, and median time to fusion of 10.7 (range: 3.2-17.4) months. Preoperative and postoperative mean thecal sac cross-sectional area, right lateral recess height, left lateral recess height, right foraminal diameter, and left foraminal diameter were 153 and 209 mm^2 ($p = 0.000012$), 5.9 and 5.9 mm ($p = 0.5$), 5.7 and 6.3 mm ($p = 0.014$), 4.6 and 5.2 mm ($p = 0.0084$), and 4.2 and 5.2 mm ($p = 0.00012$), respectively.

Conclusion: This study demonstrates that patients had sufficient decompression, as evidenced by improvement in clinical symptoms and statistically significant increases in thecal sac cross-sectional area and bilateral foraminal diameter. Therefore, sublaminar decompression may be an effective alternative to laminectomy in treating central and foraminal stenosis. Fusion rates in this study also compare favorably to traditional posterolateral technique with radiographic pseudoarthrosis occurring in only four patients.

Diagnostics: Clinical

GP085. The SpineCor Brace in 2015: A Form of Chiropractic Child Abuse? A Report of Three Cases

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Background: When the SpineCor brace was introduced ~15 years ago, it touted promise that a flexible, patient friendly brace could arrest curve progression during growth similar to that documented for a rigid Boston-type brace. Subsequent experience with this brace demonstrated that failure rates were similar to the group randomized to no brace in the study by Weinstein et al. Most orthopedic surgeons have abandoned its use. However, Chiropractors have recently advocated that this "new and amazing flexible" brace cannot only control scoliosis but with spinal manipulation, but also correct the curve. This is a report of three cases treated with the SpineCor brace.

Case Studies: Patient one is a 15 years/o pre-menarche female who presents with a right thoracic curve of 56 degrees. Surgery was recommended. The family chose to use the SpineCor brace and multiple chiropractic manipulations with a guarantee that surgery could be avoided. Two years later, the family returns to clinic with a curve measuring 110 degrees. Patient two is a 12 years/o female who presents with AIS measuring 54 degrees. Surgery is recommended. The father chose to go with a SpineCor brace, traction Table 4X per week, muscle therapy, a vibration bed, and nuchal therapy for four years. After "tens of thousands of dollars," the child returns at age 16 with a thoracic curve measuring 115 degrees. Patient three is a 10-year-old female who presents with an AIS curve measuring 32 degrees. Rigid bracing is recommended but the family chose Chiropractic and a SpineCor brace and a promise that the curve could be corrected. She returns at age 13 years with a curve of 75 degrees and surgery is recommended.

Conclusion: There is no credible data that would support the use of a SpineCor brace as an effective alternative to rigid bracing, or that this brace can actually correct a curve. In addition, there seems to be no consequences or accountability for prescribing chiropractors when the brace fails, leaving children with severe, high-risk curves. As Orthopedic surgeons, we have a responsibility to educate the public and no longer ignore the misleading information that our patients are receiving about "complimentary" therapies.This is a small series of cases and probably missed all of the successes of the SpineCor brace.

GP086. A CT-Based Analysis of Implant Position of Sacroiliac Joint Fusion: Is There a Learning Curve for Safe Placement?

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Introduction: Diagnosis of degenerative sacroiliitis and surgical interventions are increasing. Open and minimally invasive sacroiliac joint (MIS SIJ) techniques exist. Optimal rod placement requires adequate training to minimize risk of breaching vital structures such as sacral anterior cortex (AC) and neural foramina (NF). CTbased image guidance navigation increases accuracy of rod placement. This study describes a retrospective singlesurgeon postoperative assessment of implant position in navigated MIS SIJ fusion procedures over a 5-year period.

Materials and Methods: Early (1st 3 years) versus late (past 2 years) cases were evaluated to assess learning curve of implant placement accuracy. Grading scheme was created to assess SIJ fusion rod placement and potential risk of guide pin breaching either AC and/or NF. Grade 1 denotes least risk of breach; Grade 2 denotes partial risk of breech by the implant but not the guide pin; Grade 3 denotes risk of breach of both pin and implant; Grade 4 denotes actual breach. Rod fixation grading was based on bony purchase ratio between iliac and sacral side of the joint where: Grade 1: $>$ 50% of rod occupies sacral side; Grade 2: 50% of rod is fixed on sacral side; Grade 3: $<$ 50% of rod is fixed on sacral side and Grade 4: rod does not cross SIJ.

Results: From 2010 to 2014, 110 implants in 39 SI joint fusions in 33 patients were assessed. Of these 55% were placed atS1 level, 40% were S2 and 5% were in S3. Majority of rods were placed in optimal position (Grade 1 40%68%).The position of 48 rods in 1st 3 years were compared 62 rods in past 2 years. Greater percentage of rods were classified as Grade 1 in the last two years (68%, 65%) compared with the first 3 years

(56%, 33%, 25%) indicating a learning curve and improved safety profile of rod placement over time.

Conclusions: This study demonstrates that a learning curve exists with the use of 3D CT guidance for SI joint implant placements. This proposed grading system can be used to aid in optimal placement of SI joint implants.

GP087. Sacral Bone Mineral Density Using Opportunistic CT Scans: A Retrospective Cross sectional Analysis

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Introduction: Sacral bone mineral density may play a role in the rate successful sacroiliac and lumbosacral fusions. There are currently no easy methods for evaluation of sacral bone mineral density. Lumbar CTattenuation has previously been shown to relate to bone mineral density as assessed by DXA. This study aims to establish an accessible method for sacral bone mineral density analysis.

Study Design/Setting: A retrospective review of renal-protocol CT scans performed for any indication over a three-month period in 2014. CTattenuation was analyzed at several regions of interest within each scan.

Materials and Methods: A retrospective review of renalprotocol CT scans performed for any indication over a three-month period in 2014. A series of 223 consecutive renalprotocol CT scans were analyzed using basic image viewing software. Sacral CTattenuation at multiple regions of interest (ROI) were compared with the L1 attenuation to determine if a correlation existed. The sacral ROI were analyzed to determine regions of higher and lower attenuation. Sacral attenuation was also analyzed by age and sex.

Results: All sacral ROI had strong correlations with lumbar spine attenuation values, and these values became even stronger when transitional vertebrae were excluded. Sacral attenuation values varied predictably by location. Sacral attenuation was inversely related to age. No difference was found in sacral attenuation by sex.

Conclusions: Sacral CTattenuation can be used in opportunistic CT scans to determine sacral bone mineral density. This method can be used in the future to evaluate the impact of sacral bone mineral density on successful sacroiliac and lumbosacral fusions.

GP088. The Validity of Rasterstereography: A Systematic Review

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Introduction: To investigate and monitor the progression of scoliosis and other spinal deformities in patients following idiopathic scoliosis (IS), non-invasive and radiation-free techniques are recommended because of the need for repeated radiographs. In a clinical setting, spine parameters can be quickly, cheaply and easily assessed using rasterstereography (RS). The objective of this paper was to assess the validity of the radiation-free technique RS based on surface topography compared with radiographs.

Material and Methods: MEDLINE, the Cochrane Library and EMBASE were systematically searched for studies which investigate the validity of rasterstereography compared with X-ray measurements. Studies published between January 1, 1990 and July 31, 2013 in English, German and French were included. Studies dealing with magnetic resonance imaging were excluded.

Results: Twelve studies with 570 patients were included; these articles were published between 1990 and 2013. The majority of studies investigated patients with IS, but other spinal pathologies included were thoracic hyperkyphosis and Scheuermann's disease. With regard to the quality assessment criteria for the included studies, three out of twelve studies were evaluated using a twelve point scale and two used a scale with eleven points.

Conclusions: RS facilitates clinical practice by analyzing the spinal column. It is completely radiation-free and could help to monitor scoliosis progression.

GP089. Reconsideration of the Definition of Chiari Malformation Type 1 Radiologically and Clinically

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Introduction: Chiari malformation type 1 (CM-1) is diagnosed by more than 3 or 5 mm caudal displacement of the cerebellar tonsils through the foramen magnum. This definition is a simple and easy method neuroradiologically, but it is obscure which is 3 or 5 mm. The purpose of this study is to analyze their clinical symptoms and radiological features.

Materials and Methods: We had 7788 new outpatients in our neurosurgical hospital in 2013 and 2014. In whom, patients undergone head CT or MRI were examined retrospectively. We diagnosed chiari marformation type 1 using more than 3 mm tonsillar herniation. Their clinical symptoms and the following measurements were analyzed: the distances from the pontomedullary junction (PMJ) to the basion (PMJ-Ba), PMJ to the basion-opisthion (PMJ-BO), the distances from the basion-opisthion to tip of the cerebellar tonsil, from BO to the obex (BO-obex), and from basion to opisthion, the clivo-axial angle, and the length of the clivus using T1-weighted sagittal images.

Results: There were 32 patients with CM-1 aged from 10 to 78 years (mean: 37.6 years) consisted of 8 men and 24 women. In whom 20 patients with tonsillar herniation of less than 5 mm were determined as T-3 group (T-3) and remained 12 patients as T-5 group (T-5). No patients had syringomyelia. Headache was the most common symptom. Four patients in T-3 group were diagnosed incidentally, 3 in head injury and one in memory disturbance. The distances of PMJ-Ba, PMJ-BO, BO-obex, BO, the clivo-axial angle, and the length of the clivus were similar between both groups.

Conclusions: The patients in both groups had similar sympotms and posterior cranial fossa structures, however, patients in T-3 group without symptoms associated with CM-1 were diagnosed incidentally. Chiari malformation type 1 should be diagnosed based on not only tonsillar herniation but also clinical symptoms and other MRI findings such as brainstem ptosis.

Keywords: Chiari malformation type 1, tonsillar herniation, pontomedullary junction

GP090. Evaluating Sagittal Balance with Lumbopelvic Parameters: A Single-Center Performance Improvement Project

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Introduction: Neutral sagittal balance is key for painless upright posture and a large offset of sagittal balance may cause low back pain and correlates with impaired quality of life. Lumbar sagittal balance can easily be assessed on a standing X-ray, however, it is still a new concept to many spine specialists and radiologists.

Materials and Methods: A performance improvement program was developed to enable radiologists and neurosurgeons to quickly assess lumbar sagittal balance. Baseline knowledge and reporting were analyzed. Clinical tools to measure lumbar sagittal balance were taught with a 30-minute presentation. Following this, a spine surgeon helped colleagues measure their first patients.

Results: At baseline, 42% of 75 patients showed problems with lumbar sagittal balance but basic knowledge of sagittal balance was low: only 10% of pre- and post-treatment X-ray reports and only 1% of neurosurgical reports included information on sagittal balance. The 30-minute presentation empowered the target audience with the clinical skills to measure, interpret, and report lumbar sagittal balance on a standing X-ray. Intermittent encouragement and support from a spine surgeon helped colleagues to evaluate lumbar sagittal balance in their patients. In the first three months following the presentation, the neurosurgeons documented pelvic parameters in 48% of patients (14 of 29) and the radiologists reported the pelvic parameters on all new lumbar X-rays. Assessing and reporting sagittal balance has become a routine procedure beyond the study period and has led to more profound understanding of deformity induced pain and disability, not only by doctors, but also by patients to whom the origin of their back pain can be explained.

Conclusions: A short teaching presentation on a poorly known yet important clinical concept enables radiologists and spine specialists to easily measure and interpret heretofore underused information from the standing lumbar X-ray. Performance improvement programs are a valuable educational intervention for surgeons and to engage teams in interdisciplinary learning.

Epidemiology

GP091. Contribution of Arab Researchers to the Spine Literature over the last 20 years

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Introduction: Although the ancient Egyptian Imhotep was the first to report a document on spinal injuries, the Edwin Smith Papyrus dating 3000–2500 BC, actual contribution of Arab spinal surgeons to spine research is limited. The aim of this study was to assess the contribution of Arab spine surgeons to spine research in the last two decades.

Methods: A systemic review of PubMed/Medline including spine-related articles published in journals specialized for spine, orthopaedics and traumatology or neurosurgery, since 1985. Journals focusing mainly on radiology, physical medicine, general medicine, general surgery and others have been excluded. Articles published before the end of July 2015 have been included. At least one affiliation or one author must be based in one of the 22 Arab countries. Bibliometric analysis of the number of articles published from each country, type of study, institution, impact factor (JCR 2014) and trend of publications frequency over 20 years. Quality of publications was assessed by number of citations and level of evidence of clinical studies (LOE).

Results: The review revealed 445 articles; 66 of them have been excluded being published in non spine-related journals, as well as 10 letters to the editors. Of 369 remaining publications, 115 were case reports with a mean of 1.32 citations/case report, mostly originated from Morocco (38), Lebanon (24), Saudi Arabia and Tunisia (14). The remaining 254 original articles have been analyzed; most frequently clinical studies (228 articles). Of these, 8 articles have been published in German and 5 in French. Spine was the favorite journal of Arab scientists with 47 publications, followed by ESJ with 32, ASJ, International Orthopaedics and Bone Joint Spine with 14 articles each. Articles published in Spine were also most frequently cited, 4.89 times on average, Bone Joint Spine 3.43 and ESJ 3.41 citations/article. Most of publications originated from the university: 192 articles, followed by public hospitals with 36 articles, military hospitals 13 and private sector with 13 articles. Egyptian authors published 120, Saudis 35 and Lebanese 32 articles. Institutionally, University of Alexandria published highest number of spine-related articles; 40, followed by Cairo University with 38, the American University in Beirut 16 and Assiut University 14 Articles. Of original articles, a mean of 2.47 citations/article has been calculated. Studies with LOE I had a mean of 5.25 citations/article. Publications from non-surgical departments had a higher citation rate than surgical departments. Tunisian publications have highest rate of citations/article: 4, followed by Kuwait 3,75 and Saudi Arabia 3.71. Riyadh-based publications have been cited 4.94 times in average, followed by those from Kuwait City 3.75 and Jeddah 3.6 citations/article.

Conclusion: The Trend is a progressively increasing contribution of Arab spinal researchers to the global spine research over the last two decades. It is not only the absolute number of published articles but also the percentage related to the global research is increasing. Institutions should emphasize the importance and increase awareness of researches about the value of peer-reviewed publications.

GP092. Oswestry Disability Index: Is Telephonic Administration Valid?

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Introduction: The Oswestry Disability Index (ODI) is a patient reported outcome questionnaire that assesses the functional status of a patient with back pain. It is widely used to assess the effectiveness of interventions for low back pain. The ODI is currently administered in outpatient clinics on a face-to-face basis, which can be expensive and time consuming. Telephonic administration of ODI, if valid, can be more convenient, may improve follow-up rates, and reduce costs. The objective of this study is to validate telephonic administration of ODI compared with face-to-face administration. Study

Methods: A convenience sample of employees and patients in an academic medical building were recruited.

Face-to-face administration of ODI was done then retested 24 hours later over the phone. Reliability of each response from each section and overall scores were compared with determine test retest reliability by calculating the intraclass correlation coefficient.

Results: 22 individuals completed the ODI questionnaire face to face, then via telephone 24 hours later. There was a mean 2%(±3) intrarater ODI score difference, range 0% to 12%. The Intraclass correlation coefficient overall was 0.98 (95%CI: 0.96, 0.99, $p < 0.001$) with a range of 0.95 to 1.0 revealing near perfect testretest reliability.

Conclusions: Administration of ODI questionnaire over the phone has excellent testretest reliability compared with face-to-face administration.

GP093. Growing Trend of the Arab Surgeons' Contribution in Spine Surgery: A Systemic Review of the Top-Ranked Spine Journals

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Introduction: Spine surgery is a very rapidly developing subspecialty worldwide. Although through history, Arab surgeons have made valuable contributions to medicine and surgery, the quantity and quality of modern research production of the Arab spine surgeons is unclear. This study aimed to investigate the contribution of the Arab surgeons to this field.

Methods: A systemic review of the PubMed/Medline including the top 5 spine journals: Spine, The Spine Journal (TSJ), European Spine Journal (ESJ), Journal of Neurosurgery; Spine (JNS) and Journal of Spinal Disorders and Techniques (its older version Journal of Spinal Disorders, as well) (JSD). Articles published before the end of July 2015 have been included. At least one affiliation or one author must be based in one of the 22 Arab countries. Analysis of the number of articles published from each country, type of study, institution, impact factor (JCR 2014) and trend of publications frequency over years. The quality of research publications was assessed by number of citations and level of evidence (of clinical studies). Number of publications of the Arab World will be compared with those of other top countries, who contributed to these 5 journals over time, as well as rate of publication in relation to every one million inhabitants.

Results: The review revealed 175 articles; Spine 81, TSJ 24, ESJ 49, JNS 9 and JSD 12 articles. Most frequently clinical studies (90 articles, 51%). Most publications originated from the university: 199 articles (68%). Egyptian authors published 58, Lebanese 36, Saudis 27 articles. Egyptian authors mainly published retrospective studies (26, 45%) and prospective uncontrolled studies (17, 29%). Those from Lebanon published 14 case reports (39%) and 13 retrospective studies (36%). Saudi affiliations similarly published 8 case reports (30%) and 6 retrospective studies (22%). Moroccan and Tunisian publications were mainly case reports; 14 (78%) and 7 (54%), respectively. Institutionally, Cairo University published the highest number of articles; 24, followed by the American University in Beirut 23 and University of Alexandria with 20 Articles. A mean of 2.86 citations/article of all publications has been calculated. Articles published in Spine had the highest citation rate: 3.85, followed by those of ESJ: 2.71 citations/article. According to study type, clinical studies were most frequently cited with a mean of 4.5 citations/article. Of these, studies with LOE I had a mean of 8.33 citations/article. Publications from non-surgical departments had a higher citation rate than surgical departments. Although Kuwait-based authors published only 4 articles, they have the highest rate of citation per article: 6, followed by Lebanon: 4.33, Saudi Arabia: 3.89 and Egypt: 2.62. As well, Kuwait City and Jeddah were the cities on the top with a mean of 6 citations/article.

Conclusion: Over three decades, there has been a continuous increase in frequency of publication. Despite this increase, the relation of this contribution to the global contribution to these 5 journals did not change since the first publication in 1986. Systematic institutional and national policies and measures should be taken to improve this contribution.

GP094. Spinopelvic Parameters Evaluation in a Brazilian Population Sample: A Systematic Review

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Introduction: The morphology of the spine is variable within a population and its maintenance in appropriate values implies a decrease in the energy expended. We need to know their normal values in population. This study aims to carry out a literature review and evaluate published papers on spinopelvic parameters in a Brazilian population sample.

Methods: 11 potentially eligible papers were initially identified for inclusion in this review: 3 papers from Pubmed and 8 from Medicine®. Out of these, only 5 papers contained methodology and relevant significance level, and therefore they were included in the final analytical run.

Results: According to a Brazilian study, Pratali mentions no significant difference in the average values of spinopelvic balance in the Brazilian population and those found in the literature; there was also no significant difference comparing Brazilian and Korean population, however, was found difference in comparison with European population regarding PI parameters and SS, but the latter with higher values. According to Kulcheski in 2013, the values of pelvic tilt in the Brazilian population evaluated in his research were 19° (10–35°) and the sacral inclination was 38° (30–55°), presenting similar values concerning the European population. In another Brazilian paper, Oliveira reports that the researched population had PI average of 45° (41.9 to 48.1°).

Conclusions: The values obtained are relatively minor when compared with the European population. However, all of these are within the normal margin considered in the worldwide literature.

GP095. Comparative Analysis of Evaluation of Lumbar Lordosis Measured in the Standing Positions Radiography and Magnetic Resonance Imaging

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Introduction: Research of degenerative diseases of the spine it is recommended performing radiographs and magnetic resonance imaging (MRI). Physiological curvature of the lumbar spine varies from 35 to 50. Changes sagittal alignment can lead to changes in the lumbar spine kinematics, having influence on the support and load distribution on the spine, causing low back pain.

Methods: 100 patients with chronic low back pain (51 men and 49 women), being evaluated degree of lumbar lordosis by three independent examiners by radiography in the standing position and MRI in supine position with flexed lower limbs. Measurement of lumbar lordosis by the Cobb method (L1 to L5 levels) in lumbar radiographs in profile and in the sagittal plane in lumbar MRI.

Results: Average of lumbar curvature on X-rays and the MRI cushion was 42,2° and 31,5°, respectively (p value < 0.001). Average angles of lumbar lordosis by MRI underestimates by 25% compared with lumbar radiographs.

Conclusion: MRI is insufficient for evaluation of lumbar lordosis, it underestimates the true lumbar lordosis. Thus, the lumbar radiological evaluation is essential in assessing the true lumbar lordosis.

Imaging

GP096. Sacro-pelvic Tilt as a Predictor for Optimal Lumbar Lordosis

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Introduction: Spino-pelvic parameters are crucial to address the spinal sagittal balance; such measurements require standardized lateral x-ray views that include the spine as well as the hips, which are not always available upon referral of cases, where instead, shorter films for the lumbo-sacral spine are requested. We aimed to describe a pelvic radiological reference points that could provide comparatively sound sagittal balance estimates, from conventional lumbo- sacral lateral x-ray views. The iliopectineal line was addressed as a radiological reference in the pelvis, that along with the horizontal line, and the upper endplate of the first sacral vertebra, provide two angles, the Iliopectineal inclination (Doha angle; DA), and the Sacro-pelvic tilt (Baco angle; BA), respectively.

Material and Method: Radiological images for 96 adult subjects, aged between 20 – 80 years, with suspected or established diagnosis for spine problem. Readings were taken from the institute's digital radiology library, blinded to personal and clinical data. Frequency tables, correlations and test of difference were tested, taking (p-value < 0.05) as cut-off for significance. Correlation to the conventional Pelvic Incidence (PI), Pelvic tilt (PT), and the Sacral slope (SS), measured for the same patients, and from the same standardized standing lateral views that include the femoral heads.

Results: Readings of the new angles were found to be practically easy and reproducible. The iliopectineal inclination (Doha angle) readings averaged 61 +/- 9 degrees, indirectly proportional to the pelvic tilt ($r = -0.46$, P-value 0.000), along with its averaged 7 degree difference from the mean Pelvic incidence (54 +/- 8.9 degrees), DA (practically the sum of SS + BA) corresponded to the described lumbar lordosis values in the literature, as well as the estimated lumbar lordosis by Schwab's formula for the study sample. On the other hand; the Sacro-pelvic tilt (BA) had readings of 24 +/- 8 degrees, and a highly significant, yet weak negative correlation with the sacral slope (P-value $= 0.001$, $r = -0.266$). Having the Sacral slope as a common component for both DA and PI; those 7 degrees difference seem to reflect an actual upper sacrum retroversion, relative to the pelvis, which had a significant difference in age terms; those with sacral retroversion >7 and <7, for average age of 31 yrs, 40 yrs, respectively (P-value $= 0.000$) and seem to contribute to maintaining the spinal sagittal balance, that becomes more profound by the age of 50 years (averaged 2 degrees for over 50 years, in comparison to 8 degrees for youngers).

Conclusion: The iliopectineal lines provide reproducible readings, closer values to the lumbar lordosis, and addresses sacroiliac contribution to the sagittal balance, that regresses by middle age.

Infections

GP097. Challenges in Spine: Management of Spinal Infections. A Flow-Chart to Guide Decision Making

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Introduction: Spinal infections are rare diseases, whose management highlights the importance of a multidisciplinary approach. Although treatment is based on antibiotics, always selected on coltural and antibiogram tests, surgery is required in case of development of spinal instability or deformity, progressive neurological deficits, drainage of abscesses, or failure of medical treatment. The first step of the algorithm is diagnosis, which is established on MRI with contrast, PET/CT scan, blood tests (CRP and ESR) and CT-guided needle biopsy. Evaluation of response to the specific antibiotic therapy is based on variations in Maximum Standardized Uptake Value (SUVmax) after 2 to 4 weeks of treatment. In selected cases, early minimally invasive surgery was proposed to provide immediate stability and avoid bedrest.

Material and Methods: From 1997 to 2014, 182 patients affected by spinal infections have been treated at the same institution (Istituto Ortopedico Rizzoli – Bologna, Italy) according to the proposed algorithm. Mean age was 56 years (range 1 - 88). Male to female ratio was 1,46.

Results: Minimum follow-up was 1 year. Infections were mostly located in the lumbar spine (57%) followed by thoracic (37%) and cervical spine (6%). Conservative treatment based on antibiotics needed surgery (open and/or percuteneous minimally invasive) as an adjuvant in 83 patients out of 182 (46%).

Conclusion: Management of spinal infections still remains a challenge in spinal surgery and multisciplinary approach is mandatory. This algorithm represents the shared decision making process from diagnosis to the most appropriate treatment, led to successful outcomes with a low-complication rate.

GP098. Kyphotic Deformity Associated with Acute Tubercular Spondylodiscitis Treated by Single Stage Posterior only Surgery

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Introduction: Acute tuberculous spondylodiscitis with thoracic kyphosis is conventionally treated by anterior or combined reconstruction techniques. Posterior based sagittal correction in active tubercular infection is an emerging alternative technique. Our aim was to evaluate posterior only

deformity correction technique in acute tuberculosis kyphosis for safety and outcomes.

Methods: Sixty-seven patients with acute thoracic kyphosis due to tuberculosis were treated by all-posterior deformity correction with or without an anterior cage. Perioperative complications, neurological improvement, pain scores, kyphosis correction, final deformity at last follow up and fusion were studied pre-operatively, immediately after surgery and at last follow up.

Results: The mean age was 47.6 ±12.2 years. Indications for surgery were persistent pain ($n = 12$), neurological deficit ($n = 27$) and kyphosis ($n = 28$). The mean follow-up was 36.4 ± 12.1 months. The mean VAS improved from 7.2 ±1.2 to 1.6 ±0.9. The mean kyphotic angle improved from 26.4 ±4.6° to 12.4 ±2.4°. There was loss of correction by 2.7° and the final kyphosis was 15.2 ± 1.8°. Neurology improved in all patients by at least one ASIA grade. The mean vertebral body loss was 0.8 ± 0.4 (where 1=one vertebral body). Thirty seven patients with vertebral loss > 0.5 or pre-operative kyphosis > 30 degress had transpedicular/transformaninal reconstruction of anterior column with a cage while the remaining thirty had posterior shortening only. Bony fusion was obtained in all patients. There were no implant failures. Post-operative complications included dural tear ($n = 2$), temporary neural deficit ($n = 2$), wound infection ($n = 4$), girdle paresthesia ($n = 3$), lumbar hernia ($n = 2$), disease recurrence ($n = 1$).

Conclusion: All-posterior single stage kyphosis correction and global reconstruction in acute tuberculous kyphosis is a safe technique with good functional and radiological outcomes. The use of titanium cages and pedicle screws in the infected vertebral body milieu was observed to be safe.

GP099. The Role of Vancomycin Powder to Prevent Wound Infection in Spine Surgery: Protocol of Randomized Control Trail

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Introuduction: Postoperative surgical site infection (SSI) continues to be an important problem after orthopedic procedures, especially spine surgery. Reported incidences of surgical-site infection among patients who undergo spine surgery range from 2% to 6% and > 10% after instrumented fusions. Postoperative surgical-site infection is associated with an important rate of complications and cost. One of the methods to decrees the incidence of SSI is using intrawound local vancomycin. The current evidence supporting the use of intra wound vancomycin powder in surgical wounds is limited and controversial

Material and Methods: A prospective, single-center, randomized, parallel group controlled trial will conduct in orthopedic department, Hamad General Hospital. 198 patients, 18 years or older patients, will undergo to open spine surgery with or without instrumentation, will be randomly assigned to receive intrawound vancomycin as intervention group or systemic antibiotic (stander of care) as control group. Exclusion criteria include hypersensitivity to vancomycin, Immune compromised status, Unable to continue in follow up.

Result: Primary outcome is the incidence of wound infection after open spine surgery for adult patients, and the secondary outcomes are total infection-related medical cost compared with the cost of vancomycin powder, Adverse effects of local vancomycin, Length of hospitalization. Wound infection will assess according to ASEPSIS score. Results will be analyzed using SPSS software (SPSS), Differences between two groups (control-intervention) will be tested using of *t*-test, Fisher's exact test.

Conclusion: The aim of this study is to detect the effectiveness of local vancomycin (intra-wound) in decreasing the post op surgical site infection in open spine surgery with or without instrumentation, and possible implanted as stander of care in Hamad General Hospital.

GP100. Long-Term Outcome following Surgical Treatment for Spondylodiscitis in 211 Cases

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Aim: To determine the safety and efficacy of surgical debridement with instrumentation in treating pyogenic infection of the spine.

Material/Methods: Between June 2006 and December 2013, 229 consecutive patients suffering from spondylodiscitis were admitted to our department. 211 (92%) underwent surgical debridement and instrumentation while 18 were treated conservatively. Surgically treated patients were analyzed. Clinical outcome was assessed with neurological and laboratory examinations at 3 months following surgery. Long-term clinical outcome was assessed at a minimum of 12 months following surgery with a telephone interview.

Results: The mean age at presentation was 67 years, 139 patients were male (66%). Distribution of the inflammation was lumbar in 134 (63%), thoracic in 37 (18%) and cervical in 30 (14%) cases. Ten patients (5%) had two concomitant non-contiguous spondylodiscitis in different segments of the spine. Epidural abscess was found in 74 patients (35%). 191 patients (90%) had pain. Neurological deficit was found in 96 patients (45%). In the thoracic and lumbar cases, dorsal instrumentation alone was considered sufficient in 34 cases, additional interbody fusion from dorsal was performed in 86 cases. 360-degree instrumentation was performed in 53 cases. In the cervical cases, ventral spondylodesis was performed in 13 cases and ventral plating, dorsal instrumentation alone in 8 cases and 360-degree instrumentation 13 cases. Postoperative intravenous antibiotics were administered for 13,6 ± 8,2 days followed by 3.0 ± 0.9 months of oral antibiotics. Complete healing of the inflammation was achieved in 204 (97%) of cases. Only 4 patients had a relapse of the inflammation, in 3 cases following dorsal instrumentation alone and in one case after additional interbody fusion with a PEEK cage from dorsal in the lumbar spine. This was followed by debridement and anterior interbody fusion upon relapse. Five patients died due to septic shock (two because of fulminant endocarditis and three by multiple organ dysfunction syndrome). 1 patient died postoperatively due to pulmonary embolism. From the 96 patients with neurological deficit, 44 (46%) had full recovery and 33 (34%) had improved incompletely after surgery.

Conclusion: Surgical debridement and instrumentation is relatively safe and very effective approach to achieve complete healing of spinal inflammation. Thereby, a short period of intravenous antibiotics of 1–2 weeks is followed by 3 months of oral antibiotics is appropriate in most cases.

GP101. Bacterial Contamination in Osteosynthesis Material Removed after 6/8 Months Postoperative

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Introduction: The aim of this paper is to describe the results obtained in 26 patients, which their osteosynthesis

material was removed after 6–8 months of their first surgery following the surgery standards of temporary fixation of our service. They were operated between November 2014 and July 2015 in our department of Orthopedics and Traumatology in Corporación Medica of General San Martin in Buenos Aires, Argentina. All the patients were operated by the same surgeon, the same assistants and the same surgical scrub nurse. In all cases we used the same technique, which consists in a lozenge on the previous surgical wound and the removal of the polyaxial pedicle screws and the corresponding bars. After the removal of the material we proceeded to send one screw of each patient for cultivation and subsequent antibiogram. The results were surprising because in three cases our bacteriology service found a germ growth. None of the 26 patients studied presented during the 6–8 months that the osteosynthesis material was placed any signs or symptoms of infection.

Material and Methods: 26 patients, 18 men and 8 women were evaluated in which the osteosynthesis material was removed according to the established protocols. All patients were studied by MRI and Rx and treated by the same surgeon, assistants and scrub nurse. In all cases the cultivation and antibiogram was performed by the same laboratory and the preliminary results were always between 72–96 hour. Surgical technique: Posterior approach, lozenge on the previous surgical wound and the subsequent removal of the polyaxial pedicle screws and the corresponding bars.

Results: In 3 of the 26 cases sent for cultivation and antibiogram we found positive samples. In one case the cultivation was for Pseudomonas aeruginosa and the remaining two cases were positive for Staphylococcus aureus. The rest of the samples sent were negative. None of the patients had postoperative complications. The entire surgical wounds healed normally, without any secretions or phlogosis. No patients required antibiotic therapy in the immediate postoperative nor in the following months. The following of them was held up to 6 months post surgery.

Conclusion: After an exhaustive study of each of our patients we conclude that in most cases where a postoperative infection occurs it is more due to patient factors such as nutritional status thereof; which keeps a close relationship with the immunological response of the patient; malnutrition or immunosuppression due to diabetes mellitus, alcoholism, chemotherapy agents or tumors than to factors which depend directly to the surgeon like the skin preparation or the operating room environment factors. Due to the type of sample sent; even though we took the necessary precautions; we cannot dismiss skin contamination.

GP102. Are ESR and CRP Acceptable Predictors for Early Post Spinal Surgery Infectious Complication?

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Introduction: ESR and CRP are nonspecific markers of inflammation, used to evaluate post operative infection. CRP is a predictable consisting of a post operative rise and a peak followed by a decrease toward the normal value. Deviation from normal kinematics may be an indication of infection

Material and Methods: ESR and CRP collected before surgery – 1 – 3 – 7 – 14 – 30 – 45 days post operative in consecutive patients. All infection and abnormal elevation recorded. 60 patients collected with below criteria's (age – sex – etiology – blood loss –Hb – operation time – ESR & CRP before and after operation- temperature – levels of operation - anatomic area and operation approach).

Results: CRP increased post operative and then decreased slowly during 30 days post operatively, second rise or failure to decrease was not specific in our study. More than 80% of our patients had CRP & ESR elevated more than 30 days without symptoms and signs of infection. We had one superficial. CRP++ or+++ can be for 30 days and ESR more than 20 mm Hg can be 40 days without early post operative infection in spinal surgery. There were correlation between soft tissue damage (long op time – number of levels – combined ASF & PSF) and increased CRP and ESR. ASF alone had no high rise in CRP. In Lumbar PSF operation CRP riser was more than thoracic – cervical or ASF alone.

Conclusion: ESR and CRP are not predictable factors for early post spinal surgeries infection diagnosis, but specificity and sensitivity of CRP is higher than ESR, when a second rise will be happen.

GP103. Anterior versus Posterior Approach in Surgical Treatment of Tuberculous Spondylodiscitis of Thoracic and Lumbar Spine

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Introduction: The aim of this study is to compare the clinical, radiological and functional outcome of anterior versus posterior surgical debridement and fixation in patients with thoracic and lumbar tuberculous spondylodiscitis.

Material and Methods: A total number of 42 patients with tuberculous spondylodiscitis of the thoracic and lumbar spine treated surgically were included in this study. Twenty patients (group A) underwent anterior debridement, decompression and instrumentation by anterior approach. Twenty two patients (group B) were operated by posterolateral (extracavitary) decompression and posterior instrumentation. Operative parameters, clinical, radiographic and functional results for the two groups were analyzed and compared.

Results: The average follow up period was 15 months (range, 12 to 24) in both groups .The average operative time, blood loss and blood transfusion of anterior group were significantly less than the posterior one. There was significant better back pain relief, kyphotic angle correction and less angle loss in the posterior group than anterior. There was no significant difference between the 2 groups regarding neurological recovery, functional outcome and fusion rate.

Conclusions: Both anterolateral and posterolateral approaches are sufficient for achieving the goals of surgical treatment of thoracic and lumbar pott's disease but posterolateral approach allows significant better kyphotic angle correction, less angle loss, better improvement in back pain but unfortunately more operative time and blood loss.

GP104. Debridement, Internal Fixation and Interbody Fusion to Treat Single Level Thoracic Tuberculosis via Anterior Approach Only

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Introduction: Tuberculosis of the dorsal spine is a very serious situation which may cause paraplegia and disability Purpose: We evaluated the clinical efficacy and feasibility of one –stage anterior debridement, internal fixation and interbody thoracic fusion in the treatment of single level thoracic tuberculosis.*Materials and Methods:* Forty three adult patients (mean age: 49.5-years) fixed with Z-plate by anteriortransthoracic-transpleural approach. Assessment was done using Frankel classification, blood-loss, operative-time, Cobb-angle, correction loss, union and Oswestry disability index (ODI).

Results: All cases were followed up for 48.5 weeks on average. Average mean operative time was167min,evaluated

blood loss during surgery 1015 ml, rate of kyphosis correction79.2%, loss of corrected angle 0.8 ± 1.2° and Cobb-angle improved from 36.6 ± 8.4° to 7.5 ± 2.3° . Postoperative Cobb-angles were significantly better than preoperative ones. ODI was 3.4 ± 4.1. All patients achieved union with 100% cure rate. All but one patient achieved full neurological recovery. No severe complications or spinal cord injury occurred. Superficial infection. Occurred in one case. Lung parenchymal injury in two case and DVT in one case.

Conclusions: This approach can directly and successfully remove the focus of tuberculosis and give very good union and kyphosis correction rate that were maintained overtime.

GP105. Simultaneous Anterior Debridement and Posterior Instrumentation for Multiple Level Tuberculous Spondylodiscitis

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Introduction: The incidence of tuberculosis has rapidly increased in the last decade. The aim of this work is to compare the results of iliac crest and rib grafts and to assess the role of short segment posterior instrumentation in patients with multiple level affections.

Materials and Methods: The results of 48 patients with multiple level resistant tuberculous spondylodiscitis surgically treated were retrospectively reviewed. Patients were followed-up for an average of 6.5y. The average age was 47y and 27 patients had an associated neurologic deficit. The disease affected two levels (36 patients) and three levels (12 patients). All had anterior debridement and bone grafting by iliac crest autograft in 26 patients (Group 1) and rib autograft in 22 patients (Group 2); followed simultaneously by posterior short segment instrumentation.

Results: Postoperatively, the kyphotic deformity was corrected from an average of 41 degrees to an average of 5 degrees (Group 1) and from an average of 47 degrees to an average of 6 degrees (Group 2). At the last follow up, both groups had a similar fusion rate (95% and 96% respectively) and loss of correction (averaged 2.4 degrees and 2.1 degrees respectively). Group 1 patients had 7 donor site complications. All patients except one had an improvement in their neurologic status.

Conclusions: Radical anterior debridement of multiple level spondylodiscitis eradicated the infection; short segment posterior instrumentation applied immediate stability, allowed adequate graft uptake and long term correction of the kyphotic deformities.

GP106. Instrumented Circumferential Fusion for Tuberculosis of the Dorso-Lumbar Spine. A Single- or Double-Stage Procedure?

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Introduction: The purpose of this study was to present our experience in treating dorso-lumbar tuberculosis by one-stage posterior circumferential fusion and to compare this group with a historical group treated by anterior debridement followed by postero-lateral fusion and stabilization.

Material and Methods: Between 2003 and 2012, 43 patients with active spinal tuberculosis were treated by one-stage posterior circumferential fusion and prospectively followed for a minimum of two years. Pain severity was measured using Visual Analogue Scale (VAS). Neurological assessment was done using the Frankel scale. The operative data, clinical, radiological, and functional outcomes were also compared with a similar group of 25 patients treated with anterior debridement and fusion, followed 10–14 days later by posterior stabilization and postero-lateral fusion.

Results: The mean operative time and duration of hospital stay were significantly longer in the two-stage group. The mean estimated blood loss was also larger, though insignificantly, in the two-stage group. The incidence of complications was significantly lower in the one-stage group. At final follow-up, all 38 patients with pre-operative neurological deficits showed at least one Frankel grade of neurological improvement, all 68 patients showed significant improvement of their VAS back pain score, the mean kyphotic angle has significantly improved, all patients achieved solid fusion and 53 (78%) patients returned to their pre-disease activity level or work.

Conclusion: Instrumented circumferential fusion, whether in one or two stages, is an effective treatment for dorso-lumbar tuberculosis. One-stage surgery, however, is advantageous because it has lower complication rate, shorter hospital stay, less operative time and blood loss.

GP107. Medium-Term Outcome of Posterior Surgery in The Treatment of Non-Tuberculous Bacterial Spinal Infection

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Q4

Introduction: The aim of this study is to evaluate the outcome after posterior spinal stabilization surgery for the management of de novo non-tuberculous bacterial spinal infection.

Materials and Methods: Patients presenting to a single tertiary referral spinal center between August 2011 and June 2014 were included in the study. 21 patients with non-tuberculous bacterial infection were identified and included in the study. All patients were managed surgically with posterior stabilization, with or without neural decompression, without debridement of the infected tissue. Neurological state was assessed using the Frankel Grading System before and after surgery. medium-term follow-up data was collected using Spine Tango COMI questionnaires and Euro Qol EQ-5D system with a mean follow-up duration of 20 months postoperatively.

Results: The mean improvement in neurological deficits was 0.91 Frankel grade (range 0–4). At a 20 month mean final follow-up, mean COMI score was 4.59, average VAS for back pain was 4.28. These symptoms had no or minor effect on the work or usual activities in 52%. 38% of patients reported a good quality of life. The average EQ-5D value was 0.569. There were no problems with mobility in 44% of patients. In 72% there were no problems with self-care.

Conclusions: Our study has shown that posterior surgery for the management of bacterial, nontuberculous spinal infection can improve neurological outcome in approximately

half of the patients. At medium-term follow-up, around 50% of patients were able to return their pre-morbid work or usual activities. Outcomes were comparable to other techniques including anterior or combined surgery.

GP108. Early Diagnosis and Operative Management in Non Tuberculous Spondylodiscitis - Outcome in a Case Series of 34 Patients

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Introduction: With the high prevalence of tuberculous spondylodiscitis in India and the tendency to label all spondylodiscitis astuberculous, it is prudent to have a high index of suspicion for non tuberculous infections and treat them accordingly. With the concern on the usage of metal implants in the infected spine, we study the safety and efficacy of debridement and stabilization with metal implants in infective spondylodiscitis.

Material and Methods: Patient records and radiographs of 34 patients of non tuberculous spondylodiscitis who were operated between 2003 and 2013, were reviewed. All the patients were managed with debridement of the infected segment, reconstruction and stabilization of the spine using titanium pedicle screws with interbody spacers. Clinico-radiological follow up was done at 1, 3, 6 and then yearly thereafter.

Results: 34 patients (M:23, F:11) with an average age of 48 years (20–68yrs)operated between 2003 and 2013. Low back pain with left radiculopathy for an average duration of 4 months (1–12months) was the most common presentation. Neurological involvement was seen in 12 patients (Foot drop-8, Paraparesis-2 and Sensory deficits - 2). The pathology was monosegmental in 27 patients (L5-S1:10, L4–5:13, L3–4:2, L2–3:2). The infection was hematogenous in 18, post surgery (discectomy/laminectomy) in 15 and post UTI in 1 patient. The surgical isolates were mainly Staphylococcus aureus-17, E.coli and Gram negative bacilli-7, MRSA-5, Pseudomonas-1 and Fungal-4. 28 patients underwent posterior procedure, 1 anterior alone and 5 underwent combined anterior and posterior procedures. All the patients had appropriate antimicrobial therapy and mobilized as early as tolerated. All patients had excellent to good functional results and no evidence of infection at average follow-up of 72 months (27–130 months). ODI and Kirkaldy-Willis criteria showed significant improvement of function postoperatively. All the blood parameters were normalized in 3 months. 1 patient had dural tear which was repaired peroperatively without sequelae, 2 cases required wound exploration and lavage. No other major complications were encountered. All cases showed radiological fusion and no evidence of metal related complications at the latest followup.

Conclusion: Thorough debridement of necrotic material creates a good vascularised environment and restoring stability compromised by either infection or prior surgery helps in healing process and reduces morbidity of patients, with early return to normal activity. The use of metal implants is safe and efficacious even in the presence of infection.

GP109. Post Operative Comparison of the Results of the Use of Antibiotic Prophilaxis One and Five Days in Patients Undergoing Lumbar Arthrodesis

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Introduction: antibiotic prophylaxis for patients undergoing lumbar spine arthrodesis is controversial in the literature. The objective of this article is comparing the results of post-operative patients undergoing lumbar spine arthrodesis using first generation cephalosporin antibioticoprofilaxiacom by one and five days.

Methods: we evaluated 43 patients aged between 16 and 76 years (mean 49.9 years), prospectively randomized, undergoing lumbar arthrodesis of 01 to 03 levels between November 2012 and April 2014, divided into two groups. At first it was used a period of antibiotic prophylaxis of a day and, in the second group, prevention was kept by 05 days. Following clinical and laboratory criteria were evaluated.

Results: the prevention of surgical infections requires far beyond the administration of antibiotics, according to the CDC's latest update, however, the dose, spectrum and time of use thereof remain controversial in the literature. The current recommendation for antibiotic prophylaxis in clean surgery of column is of single dose and, if a new dose is added, this should not exceed 24 hours the post-op.

Conclusion: A single dose of antibiotic prophylaxis with 1st generation cephalosporin is as effective as multiple doses scheme pre and post operative in lumbar arthrodesis surgery up to three levels, not justifying the costs and risks of submitting the patient hospitalization under medicated wide.

GP110. Posterior Transpedicular Decompression and Pedicle Screw Fixation for Early Stage Thoracic, Thoracolumbar and Lumbar Tuberculosis

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Introduction: Anterior decompression and fixation has been long considered as the gold standard for treatment of tuberculosis of spine. Recently the posterior approach surgery has gained popularity, based on the principle of adequate debridement and stable xation with much lower complication rates. This retrospective study aims at evaluating the role of a posterior transpedicular decompression and pedicle screw fixation for early stage thoracic, thoracolumbar and lumbar tuberculosis.

Material and Methods: Retrospective study of 55 patients treated with posterior transpedicular decompression and pedicle screw fixation for tuberculosis of spine between Jan 2009 to May 2014 and had a minimum of 18 months follow up were included in the study. Their functional outcome (VAS score), neurological outcome (ASIA grading) and radiological outcome (xray and MRI) were assessed. Patients with kyphotic angle $>$ 30 degrees, more than 3 contiguous discal involvement and multifocal lesions were excluded from the study.

Results: Thoracic spine was involved in 29, thoracolumbar in 16 and lumbar in 10 patients. Mean follow up was of 30.6 months. Mean age of patients was 47.2 years. Most common indication for surgery was instability pain. VAS score improved from an average of 9.2 to 2.4 in post operative period and 3.2 at follow up. Neurological improvement was seen in all patients with neurological deficits preoperatively. Mean kyphosis angle was 20.6 $\pm$ 4.8 degrees and was corrected postoperatively to 7.4 $\pm$ 3.2 degrees ($>$50%). At the latest follow-up there was mean loss of correction of 3.4 degrees resulting in 6.5 degrees of final correction. Bony fusion was achieved in 78% patients with no patient having any clinical signs of psuedoarthrosis.

Conclusion: Posterior transpedicular decompression and pedicle screw fixation accompanied by chemotherapy,

has shown an improvement in the functional outcome and the neurological status in most of the patients with good maintenance of spinal alignment without the need of an anterior decompression and fusion. Hence this can be considered as a relatively simple surgical option for early stage tuberculosis of spine.

Medical Economics

GP111. The Development of Cell Salvage as a Technique within Adult and Pediatric Spinal Surgery - A Small Retrospective Study

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Introduction: Cell salvage is currently one of the main methods for blood conservation peri-operatively. This procedure derives the red cells from suctioned blood, washes them and re-suspends the cells in saline which allows the red cells to be transfused back to the patient. The aim of this study was to evaluate the use of a cell saver peri-operative management and its impact on amount of allogenic blood transfused to the patients during adult and pediatric spine surgeries. This is a retrospective study which reviews data of patients who underwent spine surgery during the years 2010 to 2012 at King Faisal Specialist Hospital and Research Centre in Riyadh.

Material and Method: A total number of 142 spine surgery patients had been included in this study. The adult group consisted of 78 patients who were further divided into group A (39 pt.) without use of cell saver peri-operatively and group B (39 pt.) with use of cell saver. In the pediatric group there were 64 patients. Group A (32 pt.) relayed solely on use of allogenic blood from blood bank, patients in group B (32 pt.) used cell saver peri-operatively. The machines used were a mix of Haemonetics Corps Cell Saver 5 and Haemonetics 5. The size of recuperation bowl we used were 70ml, 125 ml and 225ml. Swabs washing was also instituted to improve the yield. The parameters collected were the amount of blood transfused intra-operatively, within 24 hours post-operatively and as a total. The number of patients who received transfusion was counted as well as number of patients who were able to avoid any transfusion. Considering the cost effectiveness of blood management we have estimated our results on the cost of cell saver disposable and price per unit of blood in the year 2012. For statistical purpose we had chosen unpaired student *t*-test, chi squared test and the Mann Whitney test.

Results: There had been found no statistically significant difference in the groups A and B of the Adult group intra-operatively, post-operatively and as a total by analyzing the use of blood. In parameters showing the avoidance of transfusions there had been also found no statistically significant differences. In the Pediatric group of patients there was found to be statistically significant difference between groups A and B during intra-operative phase and as a total. Post-operatively there was no significant difference in the blood use. The same applies to the avoidance of transfusions. Economical analysis of the blood management showed positive numbers for both groups – Adult and Pediatric, when more than 1 unit of blood was to be transfused.

Conclusions: Statistical analysis had discovered efficacy and cost effectiveness of peri-operative use of cell salvage during Pediatric spine surgery. Its efficacy, concerning our data, in the Adult spine surgery is questionable. But if taken on a whole the use of cell salvage within spine surgery had been seen to have positive impact on both blood management and patient´s recovery.

Minimally Invasive Spine Surgery

GP112. Complications and Re-operation Rate after Extra-foraminal Microscopic-Assisted Percutaneous Nucleotomy

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Introduction: Foraminal and extra-foraminal lumbar disc herniations are uncommon. Main presentation is radicular pain related to the exiting nerve root in the affected level. Different approaches for surgical intervention include median or para-median open microscopic-assisted techniques, endoscopic approach or trans-tubular microscopic-assisted percutaneous technique.

Patients and Methods: Between October 2012 and March 2014, 40 patients (18 females and 22 males) with foraminal or extra-foraminal lumbar disc prolapse were operated on in our center. Extra-foraminal percutaneous transtubular microscopic-assisted approach was used. Preoperative investigations included plain radiographs and MRI. Preoperative clinical evaluation included Visual Analogue Scale (VAS) for radicular pain and neurological state. The mean follow up period was 18 months (range 12 - 30).

Results: The mean age was 56 years. The most commonly affected level was L4/5 (22 patients = 55%). The mean preoperative VAS for leg pain was 82 mm, improved to 15 postoperatively. The average operative time was 69 minutes. There were no intraoperative complications. One patient had temporary postoperative quadriceps weakness (L4 radiculopathy) that was completely improved at 3 months follow up. Another patient had deep venous thrombosis after discharge and he was readmitted. Two patients had recurrence within the first 6 months postoperatively. They were re-operated using the same technique without complications. Both were followed up for one year without a second recurrence. Two patients with primarily severe degenerative changes and neuroforaminal stenosis had recurrence of symptoms with back pain and leg pain, re-operation as Transforaminal Lumbar Interbody Fusion (TLIF) was done

Conclusion: Trans-tubular percutaneous extra-foraminal microscopic-assisted nucleotomy is advantageous for foraminal and extra-foraminal disc herniations. It is a muscle splitting minimal-invasive approach with minimal morbidity. Re-operation rate is not different compared with microsurgical open or endoscopic techniques. Results seems to be better in cases with sequestrated disc lesion rather than degenerative neuroforaminal stenosis.

GP113. Randomized Controlled Trial of Minimally Invasive Sacroiliac Joint Fusion Using Triangular Titanium Implants vs. NonSurgical Management for Sacroiliac Joint Dysfunction

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Introduction: Sacroiliac (SI) joint dysfunction is a prevalent cause of unremitting low back pain. Does minimally invasive SIJ fusion provide superior outcomes compared with nonsurgical treatment?

Methods: 148 subjects with SI joint dysfunction were randomly assigned at 19 US centers to minimally invasive SI joint fusion with triangular titanium implants ($N = 102$) or nonsurgical management (NSM, $n = 46$). Pain, disability and quality of life scores were collected at baseline and at 1, 3, 6 and 12 months. Success rates were compared using Bayesian methods. Crossover from nonsurgical to surgical care was allowed after the 6month study visit was complete.

Results: Sixmonth success rates were higher in the surgical group (81.4% versus 26.1%, posterior probability of superiority > 0.9999). Clinically important ($\geq$15 point) ODI improvement at 6 months occurred in 73.3% of the SIJ fusion group versus 13.6% of the NSM group ($p < 0.0001$). Improvements in SIJ pain and ODI were sustained at 12 months in the surgical group. Subjects who crossed over had improvements in pain, disability and quality of life similar to those in the original surgical group. Adverse events were slightly more common in the surgical group (1.3 versus 1.1 events per subject, $p = 0.3063$). One patient underwent immediate revision surgery for neuropathic pain related to implant malposition. 77 and 78% of subjects assigned to SIJ fusion were "very satisfied" with SIJ fusion at 6 and 12 months, respectively.

Conclusions: In this study, minimally invasive SI joint fusion using triangular titanium implants was more effective than nonsurgical management at one year in relieving pain, improving function and improving quality of life in patients with SI joint dysfunction.

GP114. Microdiscectomy Reduces Back Pain in Patients with Lumbar Disc Herniation

Charbel Jacob Junior[1], Igor Machado Cardoso[1], Jose Lucas Batista Junior[1], Thiago Cardoso Maia[1], Marcus Alexandre Novo Brazolino[1], Tadeu Gervazoni Debom[1], Bruno Roncaglio
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Introduction: It is estimated that ~80% of the population will present back pain, which can be caused by lumbar disc herniation, impairing quality of life of patients. Surgical intervention may be necessary in some cases, although there are discussions about the effectiveness of different interventions possible. We aimed therefore to evaluate the influence of microdiscectomy in quality of life of patients with low back pain and lumbar disc herniation.

Methods: Prospective and comparative study, in which we compared the results of questionnaires for quality of life (SF-36) and low back pain (Roland Morris) in patients in the pre and postoperative microdiscectomy, through Student *t*-test, $p < 0.05$.

Results: We evaluated 25 patients, 16 men and 9 women, with mean age 32,8 years. Improved quality of life as indicated by the increase in all eight components of the questionnaire SF-36: 1) functional capacity: 15.4 to 82.1; 2) physical aspects: 0 to 83.3; 3) pain: 16.6 to 80.9; 4) general state: 56.2 to 80.3; 5) vitality: 50.6 to 78.8; 6) social aspects: 32.3 to 88.5; 7) emotional aspects: 20.8 to 81.9; 8) mental health: 60.2 to 79.5. Furthermore, there was significant reduction in Roland Morris questionnaire scores (preoperative: 17.5 ± 5.1 versus postoperative: 0.9 ± 2.2), reflecting a reduction of low back pain during the postoperative period.

Conclusion: We conclude that low back pain is present and often debilitating for patients with disc herniated and, aftes lumbar microdiscectomy occurs decline or absence of back pain.

GP115. The Role of Minimally Invasive Spine Surgery for Thoraco-Lumbar Fractures in Patients with Ankylosing Spondylitis and Diffuse Idiopathic Skeletal Hyperostosis (DISH)

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Introduction: Unstable spine fractures commonly occur in the setting of a poly-traumatized patients. The aim of management is to balance the need for early stabilization with quick patient's mobilization and reduction of additional trauma due to the major open surgery.

Material and Methods: To assess the operative data, clinical and radiological outcomes of patients undergoing minimally invasive management of Thoraco-lumbar fracture.

Design: Retrospective review of prospectively collected data.

Methods: 101 patients underwent minimally invasive percutaneous fixation of Thoraco-lumbar fractures percutaneous fixation with or without vertebroplasty. All patients were post-operatively either neurologically intact or improved. There were 60 males and 41 females with an average age of 44 years.

Results: The mean follow-up was 18 months (3–44 months). The mean operative time was 100 minutes (range 35–240 minutes) and the mean blood loss was < 100mL. VAS was significantly improved from 8.7 to 1 at last follow-up. No patient worsened his or her neurological condition postoperatively.

Conclusion: Minimally invasive percutaneous fixation of Thoraco-lumbar fractures in poly-traumatized patients appears to be a safe and effective technique to manage Thoraco-lumbar fractures without neurological impairment and allowing early rehabilitation.

GP116. Minimally Invasive Percutaneous Fixation of Thoraco-Lumbar Fractures in a Major Trauma Centre and Single Institute Experience

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[2]*Department of Neuroradiology, University Hospitals, Coventry, United Kingdom*

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Conclusion: Minimally invasive percutaneous fixation of Thoraco-lumbar fractures in poly-traumatized patients appears to be a safe and effective technique to manage Thoraco-lumbar fractures without neurological impairment and allowing early rehabilitation.

Navigation: Clinical

GP118. Stimulation EMG Thresholds During Percutaneous Robotic Assisted Pedicle Screw Placement

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Introduction: Robotic assisted placement of pedicle screws has become increasingly popular in minimally invasive lumbar surgery (MIS). Stimulated EMG measurements during robotic pedicle cannulation have previously not been possible. Although often performed as a second step during subsequent tapping, this tapping may result in the destruction of the pedicle and a breach if too medial. We developed an insulated cannulation tube for electrical measurements to increase patient safety.

Methods: We developed a custom insulated cannulation tube for robotic assisted pedicle screw placement. This was coated with a micron thick non-conductive coating with 3cm of exposure at the distal tip corresponding to the length of the pedicle. This was then used in surgery and stimulated EMG thresholds were take prior to and after tapping (with a 4.5mm tap) during robot assisted surgery. Measurements were taken using in house neural monitoring as well as using the Nuvasive NVM5 system.

Results: 34 levels were cannulated using the Mazor Renaissance Robotic system in a percutenous MIS approach. No breaches were identified by stimulation criteria. (i.e all stimulation EMG thresholds were greater then 10 in all groups). The difference (absolute value) between the cannula and tap was 5.3 +/− 0.3 mA. The tap had equal or lower thresholds 75% of the time (relative to the insulated cannula) and higher values in 25% of the stimulations. When comparing between the two monitoring techniques, the variability was consistent, 3.8 +/− 0.3mA

Conclusions: An insulated cannula during percutenous robotic assisted pedicle cannulation provides accurate and reliable measures of stimulated EMG thresholds. These measurements were consistent with subsequent tapping with only small variation. Measurements between in house monitoring and Nuvasive monitoring were consistent with only slight variation.

Nonoperative Clinical Treatments

GP119. Clinical Outcomes among Patients with Chronic Low Back Pain Treated with Pregabalin Monotherapy in Fort Portal Regional Referral Hospital in Western Uganda: Case Series Report

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Introduction: Chronic low back pain associated with rediculopathy is a common reason for physician visits but no guidelines are available for management of these patients in Uganda. A placebo controlled trial on efficacy of Pregabaline among patients with lumbosacral radiculopathy in Germany was inconclusive on the benefit of Pregabaline[1] in reducing pain. In another study in USA using Pregabaline showed inferior effect of Pregabaline monotherapy to combination with Celecoxib on resolution of symptoms.[2] We evaluated clinical response to Pregabaline monotherapy on low back pain associated with radiculopathy at the Orthopedics clinic of Fort Portal Regional Referral Hospital in Western Uganda.

Methods: In this prospective study conducted from February to July 2015, 15 patients with chronic low back pain associated with rediculopathy exceeding 3 months were seen in the orthopaedic outpatient clinic at Fort Portal Regional Referral and all were treated with a 4 week course of oral Pregabaline (75mg taken once a day) and evaluated for clinical improvement. Visual Analogue Score (VAS) for pain was used to assess the degree of pain among patients after 4 weeks of treatment. Structured questionnaires were used to capture sociodemographic and clinical data.

Results: Of the 15 patients 10 were females and 5 were males, with age range of 28 -75 years and mean age 53 years. Three patients were unable to walk before treatment due to pain. Before treatment with Pregabaline all the patients had Visual Analogue score of 8–10. After 4 weeks of treatment with oral Pregabaline 13 patients showed significant improvement with reduction in the Visual Analogue score to 0–2 while 2 patients had modest reduction in Visual Analogue score of 6–8.

Conclusion: Oral Pregabaline has good effect on the treatment of patients with low back pain associated with rediculopathy. However further research is needed with sufficient sample, randomization and longer follow up.

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Novel Technologies: Clinical

GP120. Radiation Exposure in Single Level Lumbar Fusion: Our Experience in Robotic Guidance Compared to Literature Review of Minimally Invasive Fusions

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Introduction: Lonizing radiation used in fluoroscopy leads to significant radiation exposure to the surgeon, operating room staff, and the patient. Low dose exposure can cause

skin burns, nausea, and cataracts where as in sufficient doses increase the lifetime risk of cancer among spine surgeons and patients. Moreover, accumulating low dose exposure over a lifetime may lead to heritable changes at a genetic level. Minimally invasive lumbar fusion, though becoming increasingly popular has significant exposure to radiation. Robotic guidance is the latest tool in spinal fusions and this study focuses on radiation exposure in single level lumbar fusions performed at our institution as compared with literature data.

Material and Methods: Seventy patients who underwent robotic guided lumbar fusion (Renaissance, Mazor robotics) performed by a single surgeon were analyzed retrospectively for radiation exposure. The age of patients ranged from 38 to 80 (mean, 56 years). Robotic guidance data included execution rate, accuracy of guidance, total surgical time, and time required for robotic guidance. Radiation-related data included the average preoperative computed tomographic effective dose, radiation dosage for calibration, registration, placement of Kirschner wires, and total procedure radiation time.

Results: Average operative time was 134.7 minutes (82–150).Mean robotic guidance took 16 minutes. Average operative radiation time was 6.2 seconds (5.2–8.6). The screw execution rate was 99%, with an accuracy of 99.5%. Mean radiation exposure dosage to the operating room was 3.7 mgy (3.1–5.2mgy) in robotic guided patients. This exposure is relatively 20 times lesser when compared with published data on radiation exposure in minimally invasive lumbar fusions.

Conclusion: Radiation exposure to the surgeon and the operating room staff in our series of single level lumbar fusion using robotic guidance was significantly lower than other published results on fluoroscopy guidance and navigated fusion. Robotic guidance reduces the radiation exposure maintaining a high accuracy rate, thereby promising as a safer alternative.

GP121. Accuracy of Robotic Guidances in Transpedicular Spinal Screw Placement: A Series of 93 Patients for the First Time in Vietnam

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Introduction: The Renaissance Robotic System is a technology used to guide screw placement through thoracic and lumbar spinal pedicle with high accuracy. This research introduces evaluation of the first series of 93 patients used this system in Vietnam for further evaluating the accuracy of the robotic guidance system for spinal surgery.

Material and Methods: Patients underwent spinal surgery using pedicle screws placement are main subjects of this research. Total 93 patients were divided into 2 groups (MIS group and classic procedure group). Among each group, the first 10 cases were studied and compared with the remaining cases. The accuracy of 1003 pedicle screws inserted in 93 patients was measured via postoperative CT scans system. The result based on the position of screw was evaluated in 3 aspects: axial, lateral and A-P.

Results: 93 patients under this research include 6 patients of trauma case, 29 patients of scoliosis case, 58 patients of spondylolisthesis case. Measurements derived from postoperative CT scans demonstrated the fact that 98.3% of the screws fell within the safe zone (Group A and B), where 90.3% were completely within the pedicle (Gertbein and Robbins classification). The MIS procedure was performed on 33 patients. Among these 33 patients, there appeared a significantly different accuracy between the first ten patients to the remaining of each group (accuracy change from 80% of Group A to 95.7% of Group B, $p = 0.05$). Among patients group underwent the classic procedure, the accuracy between the first ten patients to the remaining of the group also showed significant difference (accuracy changed from 96.5% of Group A to 99.3% of Group B, $p = 0.05$). 7/1003 pedicle screws were reinserted by free hand technique. On axial aspect, 915 (91.2%) screws were totally inserted inside one half of vertebrae and did not pass the middle line. On lateral view, 883 pedicle screws (88%) were inserted at medial position of vertebrae. No neurological deficit was recorded. Average time spent for each screw is 4 minutes.

Conclusion: The Robotic Guidance enhances performance in spinal surgery by increasing the accuracy for pedicle screws placement and reducing neurologic risks. In addition, 33 cases used a percutaneous approach reported herein remark great contributions of Robotic Guidance in procedures without anatomic landmarks.

GP122. Application of the Ultrasonic Bone Shaver in Spine Surgery: Experience in 307 Patients

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Introduction: Spinal surgery requires microscopic bone removal, in which high speed drills are used. However, the spinning and increased heat production when drilling with diamond burrs under the microscope may cause damage to the soft tissues such as the dura, nerve roots, the cord and vessels. Ultrasonic bone removers have been introduced to spine surgery recently. We review the clinical application of different types of ultrasonic bone removers in spine surgery and discuss technical points, the safety and efficacy of ultrasonic bone shaver in various spinal surgeries.

Material and Methods: Between June 2010 and January 2014, 307 patients with various spinal diseases were operated with the use of Misonix ultrasonic bone curette with microhook shaver (MUBS). Patients' demographics, disease type, surgery performed and complications and follow up were recorded.

Results: Among the 307 patients, 33 (10,7%) cases had cervical disorder, 17 (%5,5) thoracic disorder, 3(0,9%) foramen magnum disorder and 254 (82,7%) cases had lumbar disorders. Hemilaminectomy, limited-extended foraminotomy, revision lumbar disc surgery, corpectomy, osteophytectomy and laminoplasty were performed either assisted-or alone by MUBS. The duration of the operations was comparable with conventional spine surgeries, and the need for blood replacement was relatively low. The one year follow up with Neck Disability Index (NDI) and Oswestry Disability Index Scores (ODI) were comparable with conventional studies. We had 5 cases of dural tears (1.6%) in patients with lumbar spinal disease.

Conclusion: MUBS does not produce excessive heat and is a useful instrument for procedures performed in narrow epidural spaces near the dura mater. According to our experience; it is also a safe tool with very low complications rates after the learning curve is reached. We recommend this device as an assistant tool in various spine surgeries, and as a primary tool in foraminatomies.

GP123. Surgical Management of the Spinal Cord Vascular Lesions Supplied by the Anterior Spinal Artery

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Introduction: Surgical management of the spinal cord (SC) vascular malformations supplied by the anterior spinal artery (ASA) is still disputable and technically demanding. Treatment options include endovascular, open surgical, or a combination of the two methods. All options have a risk of SC ischemia resulting from retraction or dissection through the SC, coagulation or embolization of the SC supplying artery. The authors consider surgery to be an ultimate solution for this pathology. We present four patients with symptomatic anteriorly placed vascular malformations in which total excision of the lesions was performed by a posterolateral approach with unilateral arthropediculectomy.

Materials and Methods: The case series included 4 patients (2 male, 2 female), ages 23–56 (mean 32). All patients initially presented with weakness in the lower limbs and (or) pelvic organ dysfunction. The preoperative evaluation consisted of a neurologic/urodynamic evaluation, and imaging studies. In all patients the neuroimaging included magnetic resonance imaging (MRI) and selective spinal angiography (SSA), confirming the diagnosis of arteriovenous malformation in two patients, spinal hemangioma in one, and cavernous angioma in another. Vascular malformations were supplied by the ASA in 2 cases and by both the anterior and posterior spinal arteries in the other two cases. Neurologic status was based on duration of symptoms, the presence of motor, sensory or sphincter dysfunction and grading by the Frankel scale. Two patients with malformations supplied by anterior and posterior spinal arteries underwent endovascular intervention to reduce the intensity of blood flow by means of embolization. In all patients the surgery was three stage procedure made in one operative session: 1. Posterolateral approach with unilateral arthropediculectomy; 2. Microsurgical resection of the malformation; 3. Posterior instrumented fusion (to avoid postlaminectomy kyphosis). The patients were positioned prone on the Jackson table with 3-point Mayfield clamp affixed to the head placed in a neutral position, to allow adequate posterior fusion. Posterolateral approach with unilateral arthropediculectomy allowed to obtain adequate visualization of the anterior and lateral aspects of the SC for direct manipulations on the malformation and its feeding vessels, while avoiding direct manipulations on the SC or its dissection. Cervical/thoracic posterior screw fixation and fusion was performed using freehand technique considering unique osteoligamentous and vascular anatomy. None of the screws were malpositioned or interfered with post-op SSA.

Results: Postoperative SSA demonstrated complete disappearance of the malformation in all cases. Neurological outcome improved in all patients. Follow-up Frankel grades showed improvement to grade E in 2 patients (50%), and reached grade D in 2 (50%).

Conclusion: Despite the increasing use of endovascular techniques there is a significant role for operative management of spinal cord (SC) vascular malformations having complicated/combined arterial feeding. Treatment should be individualized and integrated by endovascular and surgical procedures, considering lesional angioarchitecture and clinical status of the patient. Surgical approach should provide the exposure of the anterior and lateral aspects of the SC for direct manipulations on the malformation and its feeding vessels, and exclude manipulations and dissection of the SC.

GP124. The Apifix Automatic Self-Correction Technique for Adolescent Idiopathic Scoliosis at 1 ½ Years Follow-Up: A Preliminary Report

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Introduction: To present a new system for the treatment of adolescent idiopathic scoliosis and the first outcomes.

Material-Methods: The new system (Apifix) is an automatic self-correction system, which is fixed by two transpendicular screws on the convex side of the apex of the curve. This system has been used in 4 adolescents with progressive scoliosis of 32°-42°. No blood transfusion was needed. The surgical time was ~1 hour, and the hospital stay was one day. After three weeks, a special program of physiotherapy was started to expand further the system. The Cobb angle, the parameters of sagittal balance and the vertebra rotation (using Nash-Moe technique), has been evaluated during a follow-up of 1 ½ years.

Results: The Cobb angle average improved from 37° to 18,2°. Immediately postoperatively a scoliosis improvement of 13,7° (range: 17°-12°) was noted, and after the physiotherapy other 5° (range: 1°-8°) of improvement was achieved. The sagittal balance parameters remained unchanged. A spontaneous vertebra derotation average from 39,1% to 28,6% was noted using Nash-Moe evaluation.

Conclusions: The first outcomes of the use of this system are encouraging but further research in more patients, and in longer follow-up is needed. This system offers an option between conservative treatment and spinal posterior fusion to be used as an internal brace.

GP125. Report of One Year Follow Up of Patients after TLIF using a 3-Dimensional Expandable Cage for Lumbar Fusion with Lordotic Correction

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Introduction: The use of a new 3 dimensional (3D) expandable cage for TLIF was extensively studied in biomechanical tests, cadaver specimens and preliminary clinical series. A wide footprint is achieved through a one side portal due to the articulated implant positioned in the anterior third of the disc space. The lordotic correction is accomplished due to the expansion of the device in place assisting on the overall sagittal alignment. Previous reports presented showed initial promising clinical results. One year follow up of the first 10 patients is now reported.

Material and Methods: Ten patients were included in a 12 months prospective review after a TLIF using a 3D Titanium alloy FLXFit expandable cage. The procedure was done for a

single or two level fusion with positioning of the cage under fluoroscopy and expansion for disc space height and lordotic correction. All patients were supplemented with posterior instrumentation. Primary clinical outcomes were evaluated by preoperative, 6 months, 12 months and last follow-up visual analog scale (VAS) and the Oswestry Disability Index (ODI) scores. Complications and neurological impairment were recorded. Radiographic assessment of pre and post-operative results was performed with measurement of correction achieved in the frontal and sagittal planes with EOS imaging technology avoiding any distortion on X-Rays. All patients underwent CT scan control at 12 months.

Results: All ten patients underwent a successful one or two levels instrumented TLIF without any permanent neurological, vascular or visceral complication. The 3D cage implantation provided lordosis augmentation of 8° (± 2.1°) allowing restoration of the sagittal alignment according to pre-op planning. On early post-op CT scans, good footprint and no endplate violation were shown with no cage subsidence. Clinical outcomes showed significant improvement for both VAS and Oswestry scores ($P < 0.05$), 3.7 (± 2.9) and 31% (±11) respectively. Similar outcomes were found at 12 months: no cage subsidence, VAS and Oswestry scores ($P < 0.05$), 3.5 (± 2.7) and 28,4% (±12) respectively.

Conclusion: Lumbar interbody fusion using this new 3D expandable cage provided correction of the lordosis in a shorter and effective surgical procedure. A wide footprint well positioned cage, with customized height and angular correction achievement assured an optimal load transmission and biomechanical environment for fusion. Initial clinical results were followed with successful clinical outcomes in all patients.

Surgical Complications

GP126. Final Fusion in Patients Treated with Rib Based Distraction: A Review of Peri-Operative Results

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Introduction: Rib based distraction for early onset scoliosis (EOS) and thoracic insufficiency is an accepted form of managing progressive spinal and chest wall deformities. Once growth has ceased, these patients generally undergo definitive fusion surgery to prevent further progression of deformity. Our objective was to review peri-operative outcomes in patients undergoing definitive fusion following rib-based distraction treatment for EOS.

Methods: 27 patients treated with rib-based distraction for EOS who subsequently underwent final fusion were evaluated with an IRB approved patient registry. All patients were treated by a single surgeon. Information from the registry, patient operative reports, and X-rays were reviewed. Surgical time, blood-loss, complications, overall correction, and need for osteotomies were documented. Radiographic measurements included pre and post-operative sagittal and coronal Cobb angles. All numerical measurements were evaluated for statistical mean, range, and standard deviation.

Results: The average age at implantation of the rib-based construct was 7.45 (1.78–11.78) years. The mean age at definitive fusion was 13.51 (9.21–18.51) years, following an average of 10.5 (0–18) lengthening procedures and 13.35 (3–21) total surgeries. The mean coronal Cobb angle measured 67.42 (40–107) degrees prior to fusion and 50.17 (32–82) degrees following fusion. Pre-operative mean kyphosis was 61.08 (8–113) degrees and post-operatively averaged 50.00 (20–85) degrees. Operative time averaged 256 (115–520) minutes with a mean 534 cc (180–1280) blood loss. Osteotomies were required in 11 patients (41%). Complications occurred in 12 patients (44%), 9 requiring a repeat procedure.

Conclusion: Definitive fusion in patients treated with rib-based distraction is both technically challenging and tends to be associated with longer operative times, higher blood loss, and a higher rate of complications. Although the amount of correction is limited by stiffness, scaring, and autofusion, definitive fusion surgery does improve pre-operative coronal Cobb angles and kyphosis. Longer term studies will be needed to establish whether correction is maintained over time.

GP127. The Impact of Obesity on the Orthopedic Spinal Surgical Operative Time and Hospital Stay at King Khalid University Hospital

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Introduction: There is a conflict in the literature regarding the impact of obesity on the duration of surgical operation and the length of hospital stay. Some studies revealed that obesity has no impact on the duration of surgical operation and the length of hospital stay[1] and other studies showed the opposite.[2] Due to this conflict, we conducted this study to determine whether the obesity has a major role on operation time and hospital stay.

Material and Method: The study design is quantitative, observational, and retrospective cohort study on 129 patients who underwent orthopedic spinal surgical operations in King Khalid University Hospital during the years 2013 to 2015. After the exclusion, we reviewed the charts of 106 patients to obtain the duration of the surgical operation, length of hospital stay, the amount of blood loss and the development of postoperative complications. Also, we reviewed the patients' X-ray and MRI images to measure the space from lamina to skin silhouette and the space from spinous process to skin silhouette.

Results: 52.4% of the patients who were included in our study were obese.The results revealed that obese patients had a larger space from the lamina to skin silhouette and a larger space from spinous process to skin silhouette on both X-ray and MRI images. There was no statistically significant difference between obese and non-obese patients regarding time of surgery, blood loss and length of hospital stay. There is no statistically significant difference between obese and non-obese patients regarding the development of postoperative complications, in particular DVT, surgical site infection, surgical revision.

Conclusion: The BMI of the patients who underwent spinal orthopedic surgical operations in King Khalid University Hospital from 2013 to 2015 did not impact the time of surgery, blood loss and length of hospital stay.

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GP128. Iliac-Cava Complication after L4–L5 Discectomy

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Introduction: Lumbar discectomy is one of the most often performed surgical technique at spinal level. The appearance of post discectomy complications is uncommon, being even rarer the vascular ones.

Materials and Methods: In this paper we present the case of a woman who underwent L4-L5 discectomy, left L5 foraminotomy and interspinous UniWallis implant at this level through posterior longitudinal approach. Four weeks after surgery, the patient presented symptoms of right heart failure and systolic-diastolic murmur on aortic area with abdominal and lumbar clear dominance. The CT scan revealed the presence of a right iliac-cava fistula that was treated by endovascular surgery with success.

Results: Postdiscectomy vascular complications are very uncommon (from 0.04 to 0.14%). However, they are potentially fatal for patients. For this reason they should be suspected, identified and treated as soon as possible. In this case, the potential cause could had been a damage at baseline wall of the right iliac artery. This could produce a pseudoaneurysm that progressed overtime and eroded the wall of the vein cava adjacent leading to a right iliac-cava fistula formation due to the blood flow pressure. This justifies the start of the characteristic symptoms. However, one of the peculiarities and particularities of this case is that the clinic started 4 weeks after surgery, not having found in the literature publications with these characteristics until this moment. Even though, it has been described the formation of an aneurysm at 5 -6 weeks after trauma in Vascular Surgery. Moreover, postdiscectomy vascular complications have been reported more frequently in the L4-L5 space, being more frequent lesion in the right iliac artery. In this case, the disc level and laterality agree with the most frequent complication, although approaching has been done by left side. On the other hand, the anterior approaching has the highest rates of vascular complication in spine surgery, but in our case the approaching has been done by left posterior incision.

Conclusions: Postdiscectomy lumbar vascular complications represent a vital risk to the patient. For this reason they must be taken into account for prompt diagnosis and treatment. These complications can be asymptomatic during hospitalization and postoperative and be revealed several weeks later. Posterior approaches in lumbar spine surgery are not exempt from vascular complications, since they frequently occur by anterior approach. This case highlights the importance of taking into account these vascular complications despite the posterior approach as well as after initial satisfactory postoperative course.

GP129. A Case Report of Rod Migration into Cerebellum through Foramen Magnum after Lateral Mass Fixation

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Introduction: There are many methods of posterior cervical fixation for various indications and each with its own early & late known complications. Among the late complications, Screw or rod pullout, screw or plate breakage, and screw loosening are common. We are reporting here, connecting rod migration into posterior cranial fossa, a rare complication after lateral mass fixation.

Case Report: A 55 year old male patient was operated with lateral mass fixation after posterior cervical decompression for ossification of posterior longitudinal ligament (OPLL). Patient had symptomatic recovery without any complication postoperatively. One and half years later the patient started complaining of sudden onset giddiness followed by loss of consciousness a few hours later. Ct scan showed lateral mass screws construct with migration of left sided connecting rod into the right cerebellum through foramen magnum. Patient was operated for rod removal but he never regained consciousness and was lost on eighth postoperative day. Autopsy confirmed damage to right cerebellum due to rod migration.

Conclusion: Clinician should be aware that superior rod migration is a rare but potentially disastrous complication. Regular follow up with radiological evaluation should be done to look for implant loosening, migration and non-union even in asymptomatic patients. The implant should be subsequently removed after it has served its purpose.

Trauma Cervical

GP130. CT Analysis of Anatomical Variation and Injury Affecting Posterior Pedicle Screw Fixation for Unstable Hangman's Fractures

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Introduction: The aim of this study was to evaluate the anatomical variations and injuries in patients with unstable Hangman's fractures that affected the posterior pedicle screw (PS) placement of C2-C3 and retrospectively review our experience with management of these fractures.

Material and Methods: Clinical data were reviewed in 72 patients with unstable hangman's fractures, especially using three-dimensional computed tomography (3D-CT) scan to identify the presence of anatomical variations or injuries and analyzing the treatment strategies we used.

Results: Twenty-two patients(22/72,30.6%) with 39(C2 or C3) risk factors were not fit for safe C2–3 PS placement, due to factors such as small pedicle size of C2 or C3, high-riding vertebral arteries, fractured fragments encased into vertebral canal or transverse process foramen of C2, sclerotic pedicles and pedicle fractures of C3.One or more than one of these risk factors could pose more risks of arterial or neural structures damages in PS fixation for unstable Hangman's fractures. Individualized treatment plans were made to minimize the risks of surgery for the 22 patients.

Conclusion: There is a high incidence of anatomical variations and injuries in the C2- C3 region in patients with unstable Hangman's fractures that affect the PS placement. Preoperative evaluation of these conditions using 3D-CT scans is of paramount importance to avoid and decrease operative complications and to choose appropriate surgical techniques.

GP131. Open Fracture of the Cervical Spine Due to a Peculiar Injury Mechanism

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Introduction: Scarce literature is available regarding traumatic open injuries of the cervical spine. In the majority of the reported cases, the injury was caused by a penetrating trauma due to a gunshot. We present the case of a patient with

an open fracture of the cervical spine due to a peculiar injury mechanism.

Material and Methods: Case report of a healthy 29-year-old male who suffered an accident while riding a bicycle on his way to work. Characteristics of the injury mechanism, reported lesions, their treatment and follow-up are described.

Results: This 29-year-old male crushed his bicycle against the inside of the door of a parked car, which was suddenly opened while he was riding by it. As a result, he was expelled from the bicycle and hit the right side of the anterior aspect of his neck against the posterior superior corner of the car´s door, causing a small stab wound-like injury. The patient had no head injury, dysphagia or dysphonia and was neurologically intact, but presented subcutaneous emphysema of the neck. He was initially assessed with cervical spine X-rays and a neck computed tomography (CT) scan, which revealed a marginal fracture of the anterior inferior border of the C4 vertebral body with extension to the inferior platform of the same level, but with normal sagittal alignment of the cervical spine. A cervical spine magnetic resonance imaging study was also obtained, which demonstrated hyper intensity at the anterior longitudinal ligament, the C4-C5 disc and the C4 vertebral body on T2-weighted images. He also presented a traumatic dissection of the right common carotid artery, detected on a CT-angiogram, but no injury of both the airway and the esophagus was identified. Due to the lack of clinical guides for the treatment of open spine fractures, this patient received empiric IV antibiotic treatment with ceftriaxone and clindamycin for one week follow by another week of PO amoxicillin with clavulanic acid. The wound was cleaned and closed with 2 interrupted stitches. The C4 fracture was initially treated with a hard collar, but retro listhesis at the C4-C5 level was detected on follow-up X-Rays 6 days after the accident, probably due to anterior longitudinal ligament and/or disc disruption, so an anterior discectomy and instrumented fusion of the C4-C5 level was performed. The carotid artery dissection was treated non-surgically with anti-coagulants (initially subcutaneous followed by PO treatment). C4-C5 anterior fusion was confirmed with a CT scan performed 2 months after the surgery. The patient presented no complications due to his injuries or their treatment, returned to work 3 months after the accident and evolved with no neck pain during follow-up.

Conclusion: Open fractures of the cervical spine present particular characteristics that must be considered during their initial work-up and treatment, usually involving a multidisciplinary approach to assess and treat associated injuries. Injury of the anterior longitudinal ligament and/or intervertebral disc disruption due to penetrating trauma may cause segmental instability requiring surgical treatment.

Trauma: Other

GP132. Assessment of Whole Spine MRI for Multilevel Noncontaguous Spinal Fractures: Incidence, Patterns, and Missed Injuries

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Introduction: Multi-level non-contiguous spinal injuries are not uncommon and their incidence varies from 1.6 to 77% depending on the type of imaging modality used. Delayed diagnosis and missed spinal injuries in non-contiguous spine fractures have been frequently described which can result in significant pain, deformity and neurological deficit. Mulitlevel injuries patterns have been studied in the past using X-rays and occasionally CT scans. With the growing use of MRI in assessment of spinal trauma scenario the impact of whole spine MRI in evaluation of multilevel injuries have not been assessed in the past. We performed this study to evaluate the impact of using whole spine sagittal MRI in the multilevel spine injuries.

Methods: Consecutive spinal injury patients treated between 2011 and 2013 were retrospectively evaluated based on clinical and radiographic records. Patient demographics, mode of injury, presence of associated injuries, clinical symptoms and the presence of neurological deficit were studied. Radiographs of the fractured region and whole spine MRI were evaluated for the presence of multi-level injuries We evaluated 484 consecutive patients undergoing whole spine sagittal MRI for multilevel injuries, missed injuries and analyzed the images for specific injury patterns.

Results: Among 484 patients, ninety five (19.62%) patients had multilevel injuries including 86 (17.76%) with noncontiguous injuries. Five common patterns of non-contiguous spinal injuries between different regions were observed. Pattern I: Cervical and thoracic- 29.1%, Pattern II: Thoracolumbar and lumbosacral - 22.1%, Pattern III: Thoracic and thoracolumbar- 12.8%, Pattern IV: Cervical and thoracolumbar - 9.1% and Pattern V: Lumbosacral and associated injuries-9.0%. Whole spine MRI scan detected 24 (28.6%) missed secondary injuries of which 5 were unstable. Fall from height was the most common mechanism of injury I in 200 (51.6%), and road traffic accidents contributed to 145 case (37.1%). Neurological deficit was present in 251 patients (64.5%). Complete neurological deficit (ASIA A) was observed in 131 cases(53.3%) while incomplete deficit was present in 120 cases(47.8%). One twenty six patients (32.4%) had associated non-spinal injury including head injury ($n = 19$), chest injury ($n = 22$), abdomen injury ($n = 4$), pelvic injury ($n = 6$) and extremity injuries ($n = 75$).

Conclusion: The incidence of multilevel non-contiguous spine injury using whole spine MRI imaging is 17.76%. Five different patterns of multi-level non-contiguous injuries were found with the most common pattern being the cervical and thoracic level injuries. The incidence of missed injuries identified using whole spine MRI was as high as 28.6% and among them the incidence of unstable injuries can be as high as 21%.

GP133. Timing of Decompression in Patients with Acute Spinal Cord Injury: A Systematic Review

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Introduction: To perform an evidence synthesis of the literature assessing the comparative effectiveness, safety and cost effectiveness of early decompression ($\leq$ 24 hours) versus later decompression (>24 hours) in adults with acute traumatic spinal cord injury.

Material and Methods: A systematic search was conducted for literature published through November 6th, 2014. Included studies were critically appraised and GRADE methods were used to determine the overall strength of evidence. Based on clinical expert opinion, an improvement of two or more grades for Frankel or ASIA grades or 5 point improvement in ASIA Motor Score was considered a priori to represent clinically meaningful improvement.

Results: Six studies met inclusion criteria. All but one was considered to be a moderately high risk of bias. Single studies in cervical SCI, thoracolumbar SCI, cervical and thoracolumbar SCI, acute central cord injury without instability were identified, and two studies report across SCI levels. Due to the heterogeneity across studies (injury level, measures used, and clinical characteristics), pooling of data was not done. No studies of conservative management met inclusion criteria. No full economic studies or studies of patient preferences or values were identified. Across studies and injury levels, early surgical decompression, defined as surgery $\leq$ 24 hours of injury, was not consistently associated statistically with clinically important improvement in neurological status. (low to very low strength of evidence) Isolated studies reported statistically significant and clinically important improvement at 6 months for cervical injury and following discharge from inpatient rehabilitation but not at other time points in a population comprised of injury at any level; another study reported a statistically significant 6 point improvement in ASIA Improvement Score only among patients with AIS B, C, or D, but not for those with AIS A. (very low strength of evidence). In one study of acute traumatic cord injury without instability, a clinically and statistically meaningful improvement in total motor scores was seen at six months but not 12 months and there were no statistical differences in ASIA Impairment Scale up to 12 months. (very low strength of evidence) Only one of three studies found a shorter length of hospital stay associated with early surgical decompression. Safety and harms were reported in only three studies; although no statistical differences between early and late decompression were seen, including for mortality, neurologic deterioration, pneumonia or pressure ulcers, studies were underpowered to detect differences particularly for rare outcomes.

Conclusion: The overall strength (quality) of evidence across studies was low to very low that early decompression may lead to clinically important improvement in neurologic status in some instances. For studies considering cervical SCI alone and thoracolumbar SCI alone, the overall quality (strength) of evidence was low. For studies involving a combination of cervical, thoracic and lumbar SCI the strength of the same conclusion was very low. Although no statistical or clinically significant differences were noted between early and late groups, firm conclusions regarding the safety of early versus delayed surgical decompression are difficult given small sample sizes and rare events.

GP134. Sacral Fractures

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Introduction: Sacral fractures can result from a range of injury mechanisms. While sacral fractures typically result from high-energy injuries, there is increasing identification of low-energy insufficiency fractures of the sacrum and pelvis in elderly and osteoporotic patients. The pattern, location, and stability of the fracture also vary greatly. Stable nondisplaced fractures are usually treated nonoperatively, while significantly displaced fractures require reduction and internal fixation.

Materials and Methods: Observational, longitudinal, retrospective study of patients diagnosed sacrum fracture at the Leon hospital from 1 January 2010 until 31 December 2014. We collected sociodemographic variables, types of fractures, treatments and sequelae. We did a statistical analysis using SPSS software v22.0

Results: 55 patients, 56,1% men, 39.3 years. The pelvic fracture occur in ~50,9% of sacral fractures . Etiology: 40% precipitates, 27% traffic crash, 23% hit by car. 64% had associated fracture in the superior extremities, 56% in the lower extremities, 50% had vertebral fractures. There were 7% of deaths. Denis classification more frequent were 1 and 2. 14% had spinopelvic dissociation, 80% were men of 32,4 years, 70% were suicidal jumpers. The kind more frequent of Transverse Sacral Fractures was H and U.

Conclusion: Sacral fractures can be classified based on anatomical and morphological characteristics. This classification serves an important purpose in that it helps the surgeon identify fractures more commonly associated with neural compromise as well as those fractures requiring surgical fixation.

Trauma: Thoracolumbar

GP135. Evaluation of Functional and Radiographic Outcomes of Thoracolumbar Fractures

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Introduction: Thoracolumbar fractures are the most common fractures of the spinal column. There is no consensus about the preference of treatment method among the authors. The purpose of this study to compare the radiographic and functional outcomes of conservative management with that of surgical treatment in thoracolumbar spine fractures.

Material and Methods: Forty-nine patients with single level acute thoracolumbar fractures and without neurological complications were evaluated, of those 21 underwent surgery and 28 were treated with orthosis. Radiographic outcomes were evaluated by measuring sagittal kyphotic angle and anterior vertebral body collapse; and functional outcomes were assessed using SF36 health survey questionnaire and Denis work and pain scales

Results: Among the surgically treated patients, sagittal kyphotic angle was significantly lower immediately after operation and in the last follow-up compared with preoperative measurements ($p < 0.001$), and the functional results of SF36 score and pain scale were satisfactory. Among those receiving conservative management, sagittal kyphotic angle and anterior vertebral collapse were not significantly different before and after bracing ($p = 0.4$ and $p = 0.8$, respectively), functional outcome of SF36 scores were satisfactory, and functional and radiographic results had no correlation.

Conclusion: This study showed that functional outcome in both groups with surgical and non surgical treatment was satisfactory. Radiographic indices were improved with surgical treatment, and no correlation was found between functional and radiographic outcome.

GP136. Neurological Recovery after Early Reposition, Decompression and Instrumented Fusion of C-Type L2 Fracture: A Case Report

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Introduction: The case report evaluates the clinical and radiological success of early reposition, posterior decompression, posterolateral fusion and stabilization by titanium pedicle screws and rods, performed within six hours after injury in young patient with C-type second lumbar vertebrae (L2) fracture.

Material and Methods: 22 years old male patient presented in our Clinic with C-type L2 fracture after accident on work site when a part of truck engine felt on his back. The severity of injury was determined using the ASIA (American Spinal Injury Association) scale. Preoperative ASIA impairment scale was evaluated as grade C, with L2 as the most caudal segment with normal motor function. ASIA muscle grading was grade ⅖ evaluated bilaterally on knee extensors, ankle dorsiflexors, long toe extensors and ankle plantar flexors. Patient had voluntary anal contraction and normal anal sensation. ASIA sensory pin prick and light touch scores were in the normal range. Concomitant injuries included transverse process fractures of first, third and fourth lumbar vertebrae (L1, L3, L4) with dislocation, bilateral pneumothorax, fracture of eighth rib on right side and right-sided pulmonary contusion. MSCT showed multifragmentary fracture of anterior and posterior elements of L2 with dislocation and luxation. Preoperative treatment included corticosteroid therapy according to NASCIS III protocol and was continued 3 days postoperatively. Surgery was performed within 6 hours after injury. Reposition of lumbar luxation, posterior decompression, stabilization by titanium pedicle screws and rods and posterolateral fusion with autologous bone graft was done. Postoperatively patient wore a thoracolumbar orthosis for 12 weeks. Physical therapy started second day after surgery and was continued for 12 weeks.

Results: Patient underwent neurological and radiological evaluation 3 days and 12 weeks postoperatively. MSCT and MR imaging were performed. 3 days postoperatively ASIA impairment scale was grade D, showing neurological recovery on lower limbs with muscle grading ⅘ on knee extensors, ankle dorsiflexors, long toe extensors and ankle plantar flexors. 12 weeks postoperatively ASIA impairment scale remained D but complete motor recovery was noticed on knee extensors and long toe extensors bilaterally. Radiological examinations showed residual dislocation in L1/L2 segment with faset joints subluxation and right-sided foraminal stenosis. 12 weeks postoperatively patient was walking independently with residual motor deficit seen on ankle dorsiflexors and ankle plantar flexors on both legs.

Conclusion: In young patient with C-type lumbar fracture and incomplete neurological deficit open reposition, posterior decompression, posterolateral fusion and instrumented stabilization is a safe and effective procedure. It is important to involve corticosteroid therapy and to perform a surgery in early phase after traumatic incident. Our results showed that there is a great possibility of neurological recovery if the surgery is performed within 6 hours after injury.

GP137. The Value of CT and MRI in the Evaluation and Management of Patients with Thoracolumbar Spinal Injuries

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Introduction: Although imaging has a major role in evaluation and management of thoracolumbar spinal trauma, the exact role of CT and MRI in addition to radiographs for fracture classification and management is unclear. We conducted an online survey base study to evaluate the added value of computed tomography (CT) and magnetic resonance imaging (MRI) in classification, evaluation of stability and management of thoracolumbar injuries.

Methods: Spine surgeons ($n = 41$) from around the world classified 30 thoracolumbar fractures. The cases were presented in a three step approach: first plain radiographs, followed by CT and MRI images. Surgeons were asked to classify according to the AO Spine Classification System, evaluate fracture stability and choose management.

Results: Surgeons correctly classified 43.4% of fractures with plain radiographs alone; after additionally evaluating CT and MRI images, this percentage increased by further 18.2% and 2.2% respectively. Instability was diagnosed in 68.5% cases with plain radiographs and this percentage increased to 79.3% after CT ($p < .0001$) but did not increase significantly after MRI. AO Type A fractures were identified in 51.7% of fractures with radiographs while the number of type B fractures increased after CT and MRI. The number of type C fractures diagnosed was constant across the three steps. Agreement between radiographs and CT was fair for A-type (k=0.31), poor for B-type (k=0.19), but it was excellent between CT and MRI ($k > 0.87$). CT and MRI had similar sensitivity in identifying fracture sub types except that MRI had a higher sensitivity (56.5%) for B2 fractures ($p < 0.001$).

Conclusion: For accurate classification, radiographs alone were insufficient except for C type injuries. CT is mandatory for accurately classifying thoracolumbar fractures. Though MRI did confer a modest gain in sensitivity in B2 injuries, the study does not support the need for routine MRI in patients without spinal cord injury for classification, assessing instability or need for surgery.

Tumors

GP140. Craniovertebral Junction Meningiomas: Analysis of Clinical and Radiological Results

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Introduction: Craniovertebral junction (CVJ) meningiomas are lesions of complex surgical management for the delicate anatomical structures involved and for their tendency to encase/dislocate vital structures such as the vertebrobasilar system and the lower cranial nerves.

Matherials and Methods: We analized sex, age, clinical presentation, topography, surgical approach, Simpson Grade Resection, Lower Cranial Nerves postoperative deficit and radiological, histology and clinical follow up at 1, 12 and 24 months of 61 patients affected by CVJ meningiomas, operated on in the Neurosurgical Divisions of the University of Rome "Sapienza" from 1997 to 2013.

Results: 78.7% of patients were women (mean age 52.85 years); the onset symptom was pain in 65.5% of cases. The mean preoperative Nurick grade of the sample was 3,78; The most frequent histological type was endotheliomatous (42.8%). Twenty-two patients (5 with lateral and 17 posterolateral axial topography) were treated with posterior median approach; in 39 cases (30 anterolateral and 9 anterior) we performed a posterolateral approach. A Gross Total Removal was achieved in 85.2% of cases. We reported an average neurological improvement in this series (average preoperative Nurick 3.81 and at 12 months 2.13). In 29 patients there was a transient deficit of IX, X and XI cranial nerves. No statistically significant association between surgical approach and temporary or permanent postoperative complications has been found.

Conclusions: In conclusion posterior and posterolateral with/without condilectomy and transposition of VA approaches represents the gold standard for the surgical removal of these tumors and are safe and effective in terms of postoperative morbidity.

GP141. The Influence of Histological Subtype in Predicting Survival of Lung Cancer Patients with Spinal Metastases

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Introduction: Lung cancer is one of the most common primaries responsible for spinal metastases. Recent advancements in systemic therapies for lung cancer have significantly improved the survival of patients with certain histological subtypes. Existing prognostic scoring systems have little to no prognostic value in lung cancer spinal metastases, and this may be due to the lack of consideration of lung cancer histology in their algorithms. Since prognostication plays a key role in the decision for operative management of spinal metastases, this study aims to analyze survival of lung cancer patients with spinal metastases according to different histological subtypes, to provide some guidance in making more informed surgical management decisions, better complementing recent medical oncologic advancements.

Materials and Methods: All patients with histologically confirmed lung cancer treated for spinal metastases at our institution between May 2001 and April 2012 were retrospectively reviewed. The primary outcome measure was survival from the time of diagnosis. Survival data was obtained from the National Registry of Diseases Office. Patient demographic variables, lung cancer histology and various modalities of oncologic treatment were evaluated. Univariate and multivariate cox regression analyses of were performed using Stata v.12. Statistical significance was defined as $p < 0.05$.

Results: Out of a total of 180 patients, 51 were treated surgically. The overall median survival time was 4.8 months, (range: 0.1–111.1 months). When subdivided according to histology, patients with non-small cell lung cancer (NSCLC) had a median survival of 5.2 (range: 0.1–111.1) months while patients with small cell lung cancer had a median survival of 2.4 (range: 0.1–11.9) months. Female gender ($p = 0.049$), chinese ethnicity ($p = 0.040$), NSCLC ($p < 0.001$), treatment with epidermal growth factor receptor tyrosine kinase inhibitor (EGFR TKI) therapy ($p < 0.001$), treatment with platinum doublet chemotherapy ($p < 0.001$), and local radiotherapy ($p = 0.070$) for spinal metastases were all significant good prognostic factors upon both univariate and multivariate analysis. Surgery for spinal metastases itself did not significantly improve survival ($p = 0.147$).

Conclusions: Female gender, chinese ethnicity, NSCLC, treatment with EGFR TKI therapy, treatment with platinum doublet chemotherapy, and local radiotherapy for spinal metastases are all independent favorable prognostic factors for patients with lung cancers spinal metastases. Profiling patients according to these factors should help guide decisions for surgical management of spinal metastases given that prognostic scoring systems are currently not predictive in this patient group.

GP142. Is Salvaged Blood Ideal for Transfusion in Metastatic Oncological Surgeries?

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Introduction: Metastatic oncological surgery is associated with substantial blood loss. Allogeneic blood is the current method for blood replenishment but it has been associated with significant side effects such as: transmission of infections, immunosuppression and other transfusion reactions. Autologous salvaged blood can be a good alternative; yet, it has been contraindicated in oncological surgeries for theoretical concern of reinfusing tumor cells and thereby causing tumor dissemination. We aimed to investigate whether there is any supporting evidence that can logically address the concerns of autologous salvaged blood transfusion in metastatic oncological surgery.

Materials and Methods: We searched and reviewed the literature through the electronic database – Medline, Scopus, Web of Science and Google Scholar for relevant publications from the past 20 years (January 1 1993 to December 31 2014). We also supplemented the results by searching related key articles from before this period. Relevant articles were selected using search terms: "cancer surgery," "intraoperative cell salvage," "autologous salvaged blood" "leucocyte depletion filter," "circulating tumour cells," "leucocytes" and "white blood cells."

Results: The benefits of transfusion of salvaged blood over allogeneic blood were clearly appreciated in various oncological surgeries. Salvaged blood was comparable or non-inferior to allogeneic blood in terms of safety. In view of the existing circulating tumor cells in the patients with metastatic cancer diseases, the theoretical concern of reinfusing malignant cells from the salvaged blood does not seem to be logical. The reinfusion of salvaged blood was not found to worsen outcomes - tumor dissemination or distant metastases in patients receiving it. It was also found that

preserving of white blood cells in the salvaged blood seemed to add benefits in promoting rapid immune recovery in the cancer patients.

Conclusions: There is evidence supporting the use of salvaged blood in various oncological surgeries. It was advocated that transfusion of salvaged blood is economically efficient, clinically effective and attractive alternative to other transfusion methods. Better understandings and evidence on the preserving white blood cells in the filtered salvaged blood would provide further advantages of salvaged blood in having rapid immune recovery in cancer patients.

GP143. Outcome of Kyphoplasty in Vertebral Compression Fractures for Multiple Myeloma

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Introduction: The principle symptoms in multiple myeloma result from bone destruction, especially the spine. Kyphoplasty is a new technique that involves the introduction of inflatable bone tamps (IBT) into the vertebral body. The purpose of the IBT is to restore the vertebral body back toward its original height, while creating a cavity that can be filled with highly viscous bone cement. The aim was to evaluate clinical and radiological outcome of kyphoplasty in the treatment of osteolytic vertebral compression fractures resulting from multiple myeloma.

Material and Methods: 10 (Ten) patients underwent consecutive kyphoplasty procedures in 13 vertebrae for osteolytic vertebral compression fractures resulting from multiple myeloma. Cement leakage and any complications were recorded. Early objective analysis was made by comparing preoperative and latest VAS and ODI scores. Height restoration was estimated by measuring vertebral height on lateral radiographs.

Results: The mean age of patients was 62years, mean duration of symptoms was 8 months, and mean follow-up was 7.4 (range 6–12) months. There were no major complications related directly to use of this technique. On average, 40% of height lost at the time of fracture was restored. Asymptomatic cement leakage occurred at one level in one patient. Significant improvement in VAS and ODI scores were observed.

Conclusion: Kyphoplasty was efficacious in the treatment of osteolytic vertebral compression fractures resulting from multiple myeloma. Kyphoplasty is associated with early clinical improvement of pain and function as well as some restoration of vertebral body height.

GP144. The Use of Secondary Prognostic Parameters when Malignancy of Undefined Primary Origin is Present in Spinal Metastases

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Introduction: Accurate prognostication is not feasible when the primary malignancy is unknown. Patients who harbor spinal metastases with malignancy of undefined primary origin are common in the clinical scenario of installed paraplegia within 24 hours or rapid progressive paraparesis. Acute spinal nervous tissue compression is an indication for urgent surgery and should be performed within 24 hours of hospitalization. In this urgent clinical situation, time-consuming neoplastic disease staging may not be feasible. An estimated 3-month post-operative survival period seems reasonable for the decision-making process regarding whether surgery should be performed. When the primary malignancy site is unknown, secondary parameters are used to estimate patient survival. Special patient care dependency, spinal cord tumor compression, walking impairment, urgent surgery, and malignancy of undefined primary origin can be used to estimate survival and can act as secondary prognostic parameters of survival. The objective of this study is to identify pre-operative prognostic parameters for survival in patients with spinal metastasis when malignancy of undefined primary origin is present.

Material and Methods: This study was a retrospective chart review of patients who underwent surgery for spinal epidural neoplastic metastases between February 1997 and January 2011. Inclusion criteria: Knowledge of the post-operative survival period. Five pre-operative prognostic parameters for patient survival where identified: Special care dependency (Karnofsky Performance Score 30 points); Spinal cord tumor compression (MRI/TAC spinal imaging); Walking impairment (*ASIA* Scale A & B); Urgent surgery; Malignancy of undefined primary origin. Statistical analysis compared patients with the selected five prognostic parameters for survival to those with one to four of these prognostic parameters. The Kaplan–Meier method was used to estimate the post-operative survival and the log-rank test was used for statistical inference.

Results: A total of 52 patients who underwent 52 surgical procedures were identified. The mean age at the time of spinal surgery was 53.92 years (standard deviation 19.09). Malignancy of undefined primary origin was present in 36 (69.23%) of the patients in the preoperative period. The overall median survival after surgery was 70 days (95% CI: 49.97–90.02) and post-operative mortality occurred within 6 months in 38 (73.07%) patients. The *median* post-operative survival for the 16 (30.77%) patients harboring the selected five prognostic parameters to estimate survival was 22 days (95% CI: 4.36–39.64) and for the other 36 (69.23%) patients with one to four of the prognostic parameters, 72 days (95% CI: 57.30–86.70). The *mean* post-operative survival for the same 16 (30.77%) patients harboring the selected five prognostic parameters to estimate survival was 109.75 days (95% CI: 107.49–251.27) and for the other same 36 (69.23%) patients with one to four of the prognostic parameters, 210.33 days (95% CI: 118.46–302.20). Statistical inference for the five analyzed prognostic parameters was p-value=0.123

Conclusion: Patient special care dependency, spinal cord tumor compression, walking impairment, urgent surgery and malignancy of undefined primary origin are useful as secondary prognostic parameters for patient survival. A 2- to 3-month post-operative survival period justified surgical treatment in this study.

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