the mechanical properties of Ticp such as tensile strength and hardness, which can reflect Ticp dental implants dimensional accuracy and performance. The objective of this study is to evaluate the dimensional accuracy by scanning electron microscopy and maximum principal stress and strain distributions of the external hexagon implants (EH) by finite element analysis of a conventional and a modified grade 4 Ticp implant.

Methods and materials: HE Ticp dental implants were selected based the purity grade: (1) C – Grade 4 (n = 5), 3.75 diameter × 13 mm length (Conexão Sistema de Próteses – Brazil); and (2) H – 'modified' Grade 4 (n = 5), advertised as superior in hardness, with the same dimensions as C (Conexão Sistema de Próteses – Brazil). The dimensional accuracy of these implants was evaluated by scanning electron microscopy (SEM) of all implants before and after the 70 N/cm digital torque. These images were then analyzed in Image J software (1.44o-NIH, USA) for measuring the dimensional variations caused by the strain after torqueing. Results were statistically analyzed. The experimental set-up 3D-model represented by the implant/mounting system/torquemeter was designed using a CAD software package (Rhinoceros 4.0, USA) and the generated file was then exported to a FEA software package (ANSYS 13.0, USA), consisted with a total of 106.976 tetrahedral elements and 188.254 nodes for a structural and static analysis. All materials were considered linear, elastic, homogeneous and isotropic. A 'no separation' contact was used for the interfaces. A torque was then applied and the movement of the implant was avoided by the thread nodes constrain. Maximum principal and maximum shear stresses were then reported in MPa.

Results: The dimensional accuracy of H (0.22 mm^2) was significantly ($p < 0.05$) greater than C (0.40 mm^2). Maximum principal stress and maximum shear of H (19.95 MPa, 19.94 MPa), was lower than C (55.83 MPa, 55.96 MPa), respectively.

Conclusion: H-implants seem to be a promising choice to avoid plastic deformation of the external hexagon, suggesting a better clinical performance and longevity with much greater dimensional accuracy and significantly lower maximum stresses than C-implants.

Keywords: Titanim; Implants; Deformation

http://dx.doi.org/10.1016/j.dental.2014.08.242

242

Nanomechanical properties of TiF4 varnish protective layer after erosive challenge

F.G. Carvalho [1,*], M.I.D. Medeiros [1], H.L. Carlo [1], R.L. Santos [2], B.A.S.G. Lima [1]

[1] *Federal University of Paraíba, School of Dentistry, João Pessoa, Brazil*
[2] *Federal University of Campina Grande, School of Dentistry, Patos, Brazil*

Purpose: This in vitro study assessed nanohardness (N), elastic modulus (E), topography and thickness of protective layer formed by TiF4 and NaF varnishes on enamel surface after erosive challenge.

Methods and materials: Thirty human enamel specimens (4 × 4 mm) were divided into 3 groups (n = 10): control, NaF varnish (2.26%F) and experimental TiF4 varnish (2.45%F). The initial N and E values (GPa) were obtained by nanoindentation testing. Specimens remained in artificial saliva for 24 h, and the varnishes were applied only once and removed after 6 h. Specimens were submitted to erosive challenge (10 cycles: 5 s in cola drink/5 s in artificial saliva). The depth of indentation, N and E values after erosion were measured. The surface topography and thickness of protective layer formed were evaluated by optical microscope and atomic force microscopy (AFM). The data were subjected to Two-Way ANOVA and Tukey tests (a = 0.05).

Results: The thickness of protective layer value of TiF4 group (953 ± 55.7 nm) was significantly higher compared to NaF group (53.1 ± 3.7 nm). The depth of indentation for TiF4 group (296.9 ± 49.2 nm) was lower than thickness of protective layer, thus values of N (2.4 ± 0.8) and E (82.2 ± 14.3) were considered from TiF4 protective layer. However, these N and E values were lower than the control group (N: 3.4 ± 0.4/E: 104.0 ± 8.5). The N and E values of NaF layer was not able to be measured. AFM images showed homogeneous globular deposits completely hiding the enamel surface for TiF4 group.

Conclusion: In conclusion, TiF4 varnish showed a thick and homogeneous protective layer formation with significant nanomechanical properties after short erosive challenge.

http://dx.doi.org/10.1016/j.dental.2014.08.243

243

Effect of a synthetic nanocrystalline-fluorohydroxyapatite on the eroded enamel lesions

M. Behroozibakhsh [1,*], F. Shafiei [1], T. Hooshmand [1], F. Moztarzadeh [2], M. Tahriri [2], H. Bagheri Gorgani [1]

[1] *Department of Dental Biomaterials, School of Dentistry/Research Center for Science and Technology in Medicine, Tehran University of Medical Sciences, Tehran, Iran*
[2] *Biomaterials Group, Faculty of Biomedical Engineering, Amirkabir University of Technology, Tehran, Iran*

Purpose: The application of hydroxyapatite based materials in the repair of early enamel lesions has received considerable attention, but the repair and protective mechanism are still open for debate. The purpose of this research was to determine the effect of nano-fluorohydroxyapatite on defected enamel and remineralization process.

Methods and materials: In this research, first a fluorine-substituted hydroxyapatite ceramic $[Ca_5(PO_4)_3(OH)_{0.59}F_{0.41}]$ was synthesized via pH-cycling method. The powder was characterized using scanning electron microscope (SEM), transmission electron microscopy (TEM), Fourier transform infra-red (FTIR), X-ray diffraction (XRD) and F-selective electrode. For remineralization of demineralized areas the specimens were immersed into the remineralization solution

for 5 min three times a day for 7 days. The remineralized surfaces were examined using SEM, ATR-FTIR and AFM.

Results: TEM micrographs of powders showed that the microstructure of the FHA particles had perfectly rod-like shape that their lengths and diameters were about 10–40 nm and 20–50 nm, respectively. FT-IR and F-selective electrode analysis approved fluorine substitution in apatite structure. Evaluation of remineralized samples by AFM and SEM images showed the demineralized enamel surfaces were covered with synthetic powders after 7 days. AFM observation revealed changes on surface topography to a layered pattern after remineralization by nano-FHA crystallites. A similarity between covered layer and enamel surface was found with ATR-FTIR analysis.

Conclusion: Our findings suggest that fluorohydroxyapatite nano particles may contribute to the repair of demineralized enamel with overlaying on defective areas and can be used as an enamel remineralizing agent.

Keywords: Nano-fluorohydroxyapatite; Enamel; Remineralization

http://dx.doi.org/10.1016/j.dental.2014.08.244

244

Varnish containing biomaterial in subsurface carious lesions of primary teeth

T. Varanda, F. Naufel*, L.F. Pacheco, K.R. Kantovitz, R.M. Puppin-Rontani, F.M. Pascon

University of Campinas, Piracicaba Dental School, Pediatric Dentistry Department, Piracicaba, Brazil

Purpose: To evaluate quantitatively and qualitatively the effect of three fluoride varnishes, one containing biomaterial: Duraphat®, MI Varnish™, Vanish™ in subsurface carious lesions (SCL) of primary teeth (PT).

Methods and materials: Thirty-six PT ($n = 9$) were selected. SCL were produced in enamel blocks for 16 h. The materials were applied and after 7 days the specimens were sectioned and analyzed for the depth of the SCL (PLM), mineral loss (Knoop hardness) and calcium (Ca) and phosphorus (P) (energy dispersive spectroscopy – EDS). For depth lesion determination 3 measurements were performed in each SCL (μm) and the average was calculated. For microhardness, three rows with 12 impressions each were performed (10, 20, 30, 40, 50, 60, 80, 100, 120, 140, 160 and 180 μm) (25 g/5 s). Knoop microhardness (KHN) was obtained and it was calculated the KHN variation. For EDS, specimens were observed in a scanning electron microscope and the amount of calcium (Ca) and phosphorus (P) was calculated in surface and sub-surface regions. The images obtained in PLM were subjected to descriptive analysis. Quantitative data were subjected to Shapiro–Wilk test, ANOVA and Tukey's as post hoc test ($a = 5\%$).

Results: No significant differences were observed between groups in relation to the average depths of the SCL analyzed in PLM. The treated groups had similar mean values (39.73 ± 14.20 μm; 32.77 ± 11.86 μm; 38.13 ± 9.17 μm to Duraphat®, MI Varnish™ and Vanish™, respectively), numerically different from the control group (54.10 ± 34.56 μm). For the hardness, it was observed that Duraphat® (2022 ± 1071) had the lowest mineral loss compared to control (5239 ± 2299), MI Varnish™ (4505 ± 1098) and Vanish™ (4431 ± 1512) ($p < 0.001$, $p = 0.0022$ and $p = 0.0036$, respectively). For EDS, both Ca and P, there was no interaction between materials and regions studied, but there was a significant difference to the amount of Ca between regions ($p < 0.05$). The surface region showed a lower amount of Ca compared to sub-surface region.

Conclusion: It can be concluded that modified fluoride varnishes were not effective in reducing mineral loss of SCL in primary teeth and Duraphat® showed effectiveness to reduce mineral loss SCL in primary teeth.

Keywords: Remineralization; Fluoride varnishes; White spots lesion

http://dx.doi.org/10.1016/j.dental.2014.08.245

245

Effect of QMix with ultrasonic irrigation in smear layer removal

M.C. Prado[1,*], F. Leal[2], R.A. Simão[3], H. Gusman[1], M. Prado[1,3]

[1] *Federal University of Rio De Janeiro, Department of Dental Clinic, RJ, Brazil*
[2] *State University of Rio De Janeiro, Department of Dental Clinic, RJ, Brazil*
[3] *Federal University of Rio De Janeiro, Metallurgical and Materials Engineering, RJ, Brazil*

Purpose: The root canal preparation produces a smear layer (SL) that covers the instrumented walls and may have adverse effects on endodontic treatment. The QMix 2-1 is a new endodontic irrigant, which proposes SL removal simultaneous to the microbial elimination. The aim of this study was to compare the effectiveness of QMix on SL removal when used with passive ultrasonic irrigation (PUI) or not.

Methods and materials: Sixty single-rooted teeth were used in the present study. A 6% NaOCl solution or 2% chlorhexidine gel (CHX) was used during preparation. For SL removal, QMix was used for 1 min, with or without passive ultrasonic irrigation. Distilled water was used as control (DW). The groups evaluated were: NaOCl + DW; CHX + DW; NaOCl + QMix; CHX + QMix; NaOCl + QMix + PUI and CHX + QMix + PUI. After irrigation protocols, the teeth were prepared and analyzed by Scanning Electron Microscopy. Three photomicrographies (×1000) were performed on each root third. A score system was used to evaluate the images, where 1 represented complete absence of SL while score 4 indicated walls completely covered. The images were evaluated by three calibrated endodontists and the data were statistically analyzed by Kruskal–Wallis and Mann–Whitney tests ($p < 0.05$).

Results: When QMix was used without PUI significant lower scores were found (NaOCl + QMix: 2.99 ± 0.79; CHX + QMix: 2.86 ± 0.73) compared with the control groups (NaOCl + DW: 3.54 ± 0.56; CHX + DW: 3.66 ± 0.48). The groups that used QMix + PUI demonstrated the best results with the lower scores (NaOCl + QMix + PUI: 2.07 ± 0.88; CHX + QMix + PUI: 1.82 ± 0.73). There was no significant difference on scores