**Title:** Chemical-physical properties and apatite-forming ability of MTA-Flow

**Author:** Guimaraes  B et al

**Journal:** JOE Vol 43 No (10):1692

**Reviewer:** Sodam Lee DMD

**Purpose:** MTA Flow is a new MTA-like cement composed of a gray powder of di- and tri-calcium silicate that sets with a water-based gel. According to the manufacturer, the new gel-based vehicle makes the cement more washout resistant and improves versatility for use in a variety of procedures. This study investigated the chemico-physical properties (pH, volumetric change, radiopacity, and apatite-forming ability) in simulated body fluid (SBF) of MTA Flow in comparison with MTA Angelus.

**Materials and Methods:** MTA Flow and MTA Angelus were used. The samples were prepared according to the manufacturer’s instructions. To look for alkalizing activity (pH) the samples were immersed in 10mL distilled water at 37°C. The soaking water was collected and replaced after time intervals of 3, 24, 72, and 168 hours. The pH of the soaking water was measured. To assess volumetric change 20 acrylic teeth with a standardized root-end cavity with a 3-mm depth were used. The cavities were filled with cements, and the samples were scanned with a CT scanner. After the scanning procedure, and elapse of the final setting time, the samples were immersed in glass flasks containing 15mL ultrapure water, and stored for 168 hours. Then, the samples were removed from the flasks, dried, and scanner again. The volume change was determined in percentage by calculating the volume of cement that was lost during immersion. Radiopacity was assessed by preparing and radiographing three cylindrical samples of each MTA type on occlusal films. The radiographic density values were evaluated in comparison with an aluminum step wedge reference. Apatite-forming ability was analyzed with molds filled with freshly prepared cement which were vertically immersed in 20mL HBSS and stored at 37°C for 28 days. Fresh samples and 28-day samples were examined using elemental analyses by energy-dispersive X-ray spectroscopy.

**Results:** Both MTA Flow and MTA Angelus induced alkalinization of the soaking water that reduced with time but was still present in the final periods analyzed. No statistically significant difference was found between the cements. No statistically significant difference was seen for volumetric change. MTA Flow had a significantly lower radiopacity value than MTA Angelus. Both MTA Flow and MTA Angelus showed the ability to nucleate calcium phosphate on their surface after 28 days in HBSS.

**Conclusion:** This study revealed that the new MTA Flow cement showed alkalinizing capability, low solubility, good radiopacity, and the ability to form calcium phosphate deposits after being soaked in simulated body fluid, with values similar to those of MTA Angelus. MTA Flow is a new bioactive calcium silicate material, and although it represents a good alternative to the “gold standard” MTA Angelus, further research is necessary.

**LOE:** 5
Title: Effect of mineral trioxide aggregate apical plug thickness on fracture resistance of immature teeth

Author: Cicek E et al.

Journal: JOE 43 (10): 1697

Reviewed by: Laura Kim, DDS

Purpose: This study compared the fracture resistance of simulated immature teeth after using different thickness of an MTA apical plug.

Materials & Methods: Fifty-two extracted human maxillary anterior teeth with a single root canals were used. Teeth were prepared from apical to the coronal direction of the canal using Peeso reamers up to size 5 to simulate immature teeth without any access cavity. Of the fifty-two, five of these teeth were considered positive controls. For the experimental groups/ negative controls:

- 4 round bur used to access, and pulps were removed with barbed broach, and canals were instrumented with Peeso reamers until size 5 can easily pass 1mm beyond the apex
- Peeso reamer size 3 was used to reduce the canal wall thickness to replicate Cvek’s stage 3 of root development
- When white MTA was used, it was mixed powder to liquid ratio of 3:1

Experimental groups:

- Gr 1: MTA apical plug of 3mm and warm gutta percha filled to CEJ
- Gr 2: MTA apical plug of 6mm and warm gutta percha filled to CEJ
- Gr 3: MTA used to completely obturate the root canal

Negative controls canals were filled with calcium hydroxide. The canals were sealed with composite. The root surfaces were covered with polyether impression material to mimic periodontal membrane and embedded in self-curing resin blocks to 2mm from CEJ. On the fracture-testing machine, the force was applied on the facial surface in bucco-lingual direction at a 135° angle at a point 3mm above the CEJ. The teeth were stored in distilled water for 24 hours at 37°Celsius before being subjected to fracture testing. Fracture strength testing was performed using a universal testing machine. Force required to fracture each tooth was recorded in Newtons. Each sample were examined under a light microscope to determine the level of fractures.

Results: Negative control had lowest fracture resistance. The 3mm apical plug (gr 1) had highest fracture resistance. No significance difference between 3mm and 6mm apical plug groups.

Conclusions: MTA apical plug can be placed for thickness of up to 6mm, if required for one visit treatment of immature teeth without adversely affecting the resistance of tooth structures

LOE: 5
Purpose: This study evaluated the stress generation by screw-in forces (SFs) during the file rotation and pecking motion according to the different pecking depth.

Materials & Methods: “Screw-in tendency” of nickel titanium (NiTi) is the sensation of being “pulled” into the canal when the file rotates, which may cause unwanted penetration of the instrument beyond the apical foramen. A pecking motion (in-and-out motion) is a controlled movement against the screw-in forces (SFs), which distributes the flexural stress of the instrument.

- 20 resin blocks with a J-shaped curvature (canal length=16.5mm, apical size: 15)
- NiTi: OneG (MicroMega, France, size#14/taper03), all new files without any visible defect
- WL determined: 16mm
- The two experimental groups (different pecking depth) were 2mm (n=10): 6mm in then 4mm out and 4mm (n=10): 6mm in then 2mm out
- Controlled operating conditions: 300rpm, in-and-out speed (stroke velocity=1mm/s)
- Positive/negative apical loads at rate of 50Hz, Maximum negative apical load [SF], Cumulative screw-in force [CSF] (total energy during pecking motion until the file reached the WL) were recorded.
- Statistical analysis

Results: No significant difference in SF was found between the 2 groups of pecking depth, however, the longer pecking depth in the 4mm group showed a significantly larger cumulative screw-in force (CSF) than the shorter pecking depth group (P<.05). Longer pecking depths may need a shorter clinical time to reach WL, but there is a higher risk of file fracture. Using resin blocks can be good (anatomic standardization) and bad (different from real teeth).

Conclusion: Under the limited conditions of this study, a shorter pecking depth may generate lower overall stresses on the root dentin as well as the instrument.

LOE: 5
Title: Optimization of tube current in cone-beam computed tomography for the detection of vertical root fractures with different intracanal materials

Author: Gaêta-Araujo H et al.

Journal: JOE Vol 43(10): 1668-1673

Reviewer: Reza Akhavan , DMD

Purpose: This study evaluated the effect of different milliamperes on the detection of vertical root fractures (VRF) on CBCT scans in the absence of intracanal materials and in the presence of GP and metal (MP) or fiberglass (FP) intracanal posts.

Materials and Methods: The sample consisted of 320 CBCT scans of tooth roots with and without VRF divided into 8 groups: no fracture/no intracanal material; no fracture + GP; no fracture + MP; no fracture + FP; fracture/no intracanal material; fracture + GP; fracture + MP; fracture + FP. The scans were acquired with an OP300 unit using 4 different milliamperes (4 mA, 8 mA, 10 mA, 13 mA). Five oral radiologists analyzed the images. The area under the receiver operating characteristic curve (Az), sensitivity, specificity, positive and negative predictive values, and inter-observer agreement were calculated.

Results: Diagnostic performance for the different milliamperes tested was similar for teeth without root filling materials or with FP. Teeth with GP and MP showed the highest Az values for 8 mA and 10 mA, respectively. For teeth with MP, specificity was significantly higher when 10 mA was used.

Conclusion: For teeth without root filling materials or with FP, the use of a reduced milliampere does not seem to influence the detection of VRF in a significant manner. For teeth with GP and MP, an increased milliampere may lead to increased diagnostic performance.

LOE: 5
Title: Canal transportation, unprepared areas, and dentin removal after preparation with BT-RaCe and ProTaper Next systems

Author: Brasil S et al.


Reviewer: Parth Karia DMD

Purpose: ProTaper Next instruments are manufactured from an NiTi alloy using special heat treatment (M-Wire) and present a rectangular cross section. • BT-RaCe has a triangular cross section made of a conventional NiTi alloy undergoing a surface electrochemical treatment that increases resistance to cyclic fatigue and has a blunt tip design termed a “booster tip,” which is claimed to reduce the occurrence of deviation and transportation This study compared the shaping ability of ProTaper Next and BT-RaCe instrument systems in the mesial canals of mandibular molars using micro-computed tomographic (micro-CT) imaging.

Materials and Methods:

• 17 Mand 1st Molars with Vertucci Type IV configuration with a root curvature from 20-40°
• Teeth were decoronated 2mm above the CEJ to establish similar root length
• Preop micro-CT and postop micro-CT was taken on all teeth
• Mesial canals were explored with size 10 K file → WL taken 1mm short of apex → instrumentation → irrigation with 2.5% NaOCl. ProTaper Next instruments were operated at 300 rpm and 2.0 Ncm using the following sequence: X1 (17/.04), X2 (25/.06), and X3 (30/.07). BT-RaCe instruments were driven at 600 rpm and 1.5 Ncm using the following sequence: BT1 (10/.06), BT2 (35/.00), and BT3 (35/.04).
• All following parameters were analyzed: root canal volume, surface area, unprepared surface areas, transportation, canal/root width ratio, and preparation time.

Results: No statistical difference between the two systems on all parameters. The unprepared surface areas for the full canal length and the apical 5 mm segment were 33% and 14% for BT-RaCe and 31% and 14% for ProTaper Next. After preparation, all root canals had a diameter that was not larger than 35% of the root diameter at the coronal and middle segments.

Conclusion: BT-RaCe and ProTaper Next instrumentation systems had similar shaping performance

LOE: 5
Title: Accuracy of 2 endodontic rotary motors with integrated apex locator

Author: Goes Cruz A, et.al.

Journal: JOE, Vol. 43(10):1716

Reviewer: Steve Rees, DMD

Purpose: This study evaluated in vitro the efficacy of both the electronic apex locator (EAL) and auto apical reverse (AAR) functions of the endodontic motor MM Control compared with Root ZX II.

Materials and Methods:

- 36 extracted human single-rooted teeth were selected.
- A size 15 k-file was used to confirm patency and the presence of a single canal. The root canals were preflared using SX rotary instruments.
- The apical foramen was standardized with a 25 k-file and the actual root canal length (AL) was measured with calipers.
- The EAL measurements at the marks “APEX” and “0.5” of both devices were obtained using an alginate model.
- The teeth were divided randomly into 2 groups (n = 18), and root canal preparation was performed with rotary instruments (ProTaper Universal up to F3) using the AAR function (0.5 mark) of each motor.
- The length provided by the AAR was compared with the visual length after preparation (AL2).
- The differences between the electronic lengths and the respective visual measurements were assigned as negative for lower or positive when higher. The means of the absolute values and the percentages of distribution of the electronic measurements between devices were compared.

Results: There was no difference between the devices in terms of the means of the EAL measurements or AAR length (analysis of variance, P > .05). However, the EAL function of MM Control presented a greater percentage of measurements >1.01 mm longer than AL (chi-square, P < .01). The AAR function set at the 0.5 mark provided an acceptable apical limit (range from 0mm to 1mm short of the AF) in 83.3% of the cases for Root ZX and 77.8% of the cases for MM Control.

Discussion: The AAR function of both MM Control and Root ZX II provided an adequate apical limit of preparation in vitro. However, the use of only the EAL function of MM Control resulted in significantly more cases of overextended readings.

LOE: 5
Presence of second mesiobuccal canals in maxillary first molars detected using cone-beam computed tomography, direct occlusal access, and coronal plane grinding

Hiebert B et al

JOE Vol 43(10): 1711-1715

Lauren Shin, DDS

The purpose of this study was to determine the prevalence of the MB2 canal in 100 maxillary first molars using CBCT, direct occlusal access, and coronal plane grinding.

Materials and Methods:

1. 100 extracted maxillary first molars were collected and analyzed, 1 tooth was excluded due to unusual root anatomy
2. Group 1: CBCT Imaging - Teeth were mounted in an embalmed human head and a CBCT scan was taken of each tooth. Two faculty from Loma Linda’s Department of Radiology independently viewed and evaluated the mesiobuccal root for the presence of an MB2 canal and the number of apical exit points
3. Group 2: Direct occlusal access under DOM - Pre-operative periapical images were taken of each tooth. The principal investigator accessed each tooth under a DOM using at least 10x magnification. A standard access was made to create an ideal straight-line access. If not immediately identified, the operator spent up to 15 minutes per tooth attempting to locate the MB2 canal using hand files, rotary files, and ultrasonic instruments. No more than 2 mm of tooth structure apical from the pulpal floor was removed when necessary.
4. Group 3: Direct access followed by CBCT volume evaluation and reaccess - After initial access, if MB2 was not found, the CBCT volume of that tooth was reviewed. The operator then spent 5-10 minutes attempting further canal negotiation
5. Group 4: Coronal Plane Root Grinding - After access of all samples, the mesiobuccal root of each tooth was carefully ground under DOM in the coronal plane until canal system was visualized. The root canal systems were classified according to Vertucci’s classification system
6. Chi-squared analysis was performed to compare the 4 methods of evaluation

Results: The differences between the groups were statistically significant. In terms of Vertucci’s canal classification, the following canal types were noted from root grinding: type I (8/99), type II (43/99), type III (1/99), type IV (37/99), type V (1/99), and type VI (9/99).

Conclusion: Although not always clinically negotiable, MB2 is present up to 92% of the time. Direct occlusal access of teeth found significantly more MB2 than viewing CBCT volumes alone. Therefore, exposing every patient to a preoperative CBCT scan may not be appropriate. However, taking a CBCT scan when an MB2 canal is not found clinically can significantly increase the chances of finding an MB2 canal.

LOE: 5
Purpose: This study compared different high-resolution CBCT imaging protocols in the diagnosis of incomplete root fractures of endodontically treated teeth.

Materials and Methods:

- 20 single rooted human teeth were evaluated clinically and radiographically to confirm that none had open apex, dilacerations, supernumerary root, pulp calcifications, or internal and/or external root resorption.
- Dental crowns were sectioned off to eliminate bias of coronary fractures at a later stage.
- Chemo-mechanical procedures using ProTaper universal manual files and 2.5% NaOCl, WL 1mm short of apex. Canals filled with GP and Sealer 26 sealer.
- Incomplete root fractures were produced in half of the sample and other half was used as control group.
- To induce fracture, teeth were embedded in polyvinyl chloride tubes fixed with cyanoacrylate and placed under a steel conical tip delivering compression at 30mm/min until fracture occurred.
- To confirm fractures, roots were scanned with a swept-source optical coherence tomographic system with a central WV of 1300nm at a 16 kHz sweep rate. A data set was obtained at optical resolution in air under 12 micrometers in a 3.0 mm depth and a 10 mm width.
- Fractured roots were then placed in two dry human mandibles and scanned with CBCT unit PreXion 3D operating at 90 kVp and 4mA with a voxel size of 0.1mm, a field of view of 51 x 51 mm. Two different protocols were used: high resolution/standard [HI-STD] 19 seconds, 512 basis images and CT dose index vol 8 mGy and high resolution/high density [HI/HI] 37 seconds, 1024 basis images and CT dose index vol 15mGy.
- Three oral radiologists examined images in axial, coronal, and sagittal reconstructions and rated each tooth using a 5-point scale for presence or absence of fractures.
- Statistical analysis was performed: weighted kappa, sensitivity, specificity, accuracy, positive predictive value, and negative predictive value.
- The receiver operating characteristic (ROC) curve was calculated to assess the relationship between the sensitivity and specificity of CBCT protocols.

Results: The intra-observer reproducibility was excellent in the HI-STD protocol, and ranged from good to excellent in the HI-HI protocol. The HI-STD and HI-HI protocols presented an accuracy of 0.90 and 0.03, respectively. Both protocols had sensitivity of 0.97. The HI-HI protocol showed a higher positive predictive value and slightly higher areas under the ROC curve.

Conclusion: According to current guidelines, high-resolution protocols in CBCT imaging should only be indicated in cases of suspected root fracture when periapical radiography does not provide enough information to form an adequate treatment plan. The tested machine PreXion 3D has features that manufacturer associates with high-resolution protocol including a greater number of basis images, small voxel size, and FOV sizes. Authors Bechara et al, and Neves et al have shown that the number of basis images in different CBCT imaging protocols did no influence the diagnosis of root fractures in the presence of GP as intracanal filling. The results of present study were similar because the values of diagnosis tests were high and similar between the HI-STD and HI-HI protocols in the diagnosis of incomplete root fractures.

LOE: 5
Title: Experimental sealers containing metal methacrylates: physical and biological properties

Authors: Rossato T et al.


Reviewer: Ruoxue Feng DMD

Purpose: Calcium methacrylates release Ca⁺ ions that play an important role in repair. Dibutyltin methacrylates have been used for decades as a prophylactic agent in preventive dentistry, inhibiting bacterial biofilm formation, reducing the acid portion of this microbial polysaccharide matrix. Photoactivation of sealer may present good adhesion and adaptation to canal, decreasing the marginal leakage. This study evaluated the physical properties, the antimicrobial effect, and the biocompatibility of dual polymerization experimental sealers after the incorporation of dibutyltin (ET) or calcium (EC) methacrylate at concentrations of 0.5%, 1%, 2%, and 5%.

Materials and Methods: The sealers studied were RealSeal (SybronEndo), an experimental endodontic sealer + calcium methacrylate (EC) and an experimental endodontic sealer + dibutyltin methacrylate (ET). The sealers are photoactivated. Antimicrobial assays of sealers were incubated with *E. faecalis*. They were aerobically grown for 1, 24 and 48 hrs at 37°C in 95% humidity. Colony-forming units were counted and the colony-forming units/ml was calculated. Sealer elute was incubated with fibroblasts for the cell viability assay. Cytotoxicity was assessed with tetrazolidium. The byproduct of tetrazolidium (formazan) was computed as a percentage of the control group. Physical properties were assessed by:

- Degree of Conversion: the carbon double bond length was determined using Fourier transform infrared spectroscopy. The spectra of uncured and cured sealers were obtained after 20sec of photoactivation.
- Film thickness: the sealer film thickness was measured as the difference between plates with and without sealer.
- Radiopacity: the optical density or gray tones of images were measured and performed by ImageJ 1.4 software.

Statistical Analysis was done by 2-way analysis of variance followed by the Tukey test. The 1-way analysis of variance was followed by the Tukey test and the Stedent-Newman-Keuls test.

Results: The study showed that EC and ET showed antimicrobial activity against *E. faecalis*, similar to RS. ET showed cytotoxicity in all concentrations. The cytotoxicity might be contributed to ethoxylated bisphenol A dimethacrylate with 30 units of ethoxylation and triethylene glycol dimethacrylate. Five percent of EC showed a greater antimicrobial effect than other EC concentrations and showed cytotoxicity. 0.5 – 2% EC had lower cytotoxicity than RS. Varied Degree of Conversion among sealers and no correlation was observed with their toxicity and antimicrobial properties. EC and ET showed similar film thickness to RS. There was no difference in radiopacity between different concentrations of ET and EC, and RS showed the highest value of radiopacity compared to other. The radiopacifier agents in RS are barium sulfate and barium glass particles. EC and ET are ytterbium trifluoxide.

Conclusion: 0.5%- 2% EC sealers had better properties than other tested sealers.

LOE: 5