

NuSmile®

Smiles ahead.

MTA Plus®

Root and Pulp Treatment Material

**JOURNAL ABSTRACTS**

# Biocompatibility of New Pulp-capping Materials NeoMTA Plus, MTA Repair HP, and Biodentine on Human Dental Pulp Stem Cells.

Christopher J. Tomas-Catala, DDS, MSc, Mar Collado-Gonzalez, BSc, MBB, MSc, David Garcia-Bernal, BSc, PhD, Ricardo E. Oñate-Sanchez, MD, DDS, PhD, Leopoldo Forner, MD, DDS, PhD, Carmen Llana, MD, DDS, PhD, Adrian Lozano, MD, DDS, PhD, Jose M. Moraleda, MD, DDS, PhD, Francisco J. Rodriguez-Lozano, DDS, PhD

## ABSTRACT

The aim of the present study was to evaluate the in vitro cytotoxicity of MTA Repair HP, NeoMTA Plus, and Biodentine, new bioactive materials used for dental pulp capping, on human dental pulp stem cells (hDPSCs).

## METHODOLOGY:

Biological testing was carried out in vitro on hDPSCs. Cell viability and cell migration assays were performed using eluates of each capping material. To evaluate cell morphology and cell attachment to the different materials, hDPSCs were directly seeded onto the material surfaces and analyzed by scanning electron microscopy. The chemical composition of the pulp-capping materials was determined by energy-dispersive X-ray and eluates were analyzed by inductively coupled plasma-mass spectrometry. Statistical differences were assessed by analysis of variance and Tukey test ( $P < .05$ ).

## RESULTS:

Cell viability was moderate after 24 and 48 hours in the presence of MTA Repair HP and NeoMTA Plus, whereas at 48 and 72 hours, Biodentine showed higher rates of cell viability than MTA Repair HP and NeoMTA Plus ( $P < .001$ ). A cell migration assay revealed adequate cell migration rates for MTA Repair HP and NeoMTA Plus, both similar to the control group rates, meanwhile the highest cell migration rate was observed in the presence of Biodentine ( $P < .001$ ). Scanning electron microscope studies showed a high degree of cell proliferation and adhesion on Biodentine disks but moderate rates on MTA Repair HP and NeoMTA Plus disks. Energy-dispersive X-ray pointed to similar weight percentages of C, O, and Ca in all 3 materials, whereas other elements such as Al, Si, and S were also found.

## CONCLUSIONS:

The new pulp-capping materials MTA Repair HP, NeoMTA Plus, and Biodentine showed a suitable degree of cytocompatibility with hDPSCs, and good cell migration rates, although Biodentine showed higher rates of proliferation time-dependent.

# Cost Estimates for Bioactive Cement Pulpotomies and Crowns in Primary Molars.

Halima Abukabbos, BDS, MPH, CPH, Scott Tomar, DMD, MPH, DrPH, Marcio Guelmann, DDS

## ABSTRACT

Comparative analysis of the biological effects of the endodontic bioactive cements MTA-Angelus, MTA Repair HP and NeoMTA Plus on human dental pulp stem cells.

## METHODOLOGY:

Thirty extracted primary molars were divided into five groups, each having two sets of three teeth (one first molar and two second molars). Pulpotomy and restorative options were randomly assigned: Biodentine plus Ketac Molar; NuSmile NeoMTA plus Tempit LC; NeoMTA Plus plus Fuji IX; MTA Angelus plus IRM capsule; MTA Flow plus IRM powder and liquid. After mixing one dose, pulp chambers of the first molar and one second molar were filled with a two-millimeter layer of bioactive cement and filling material (protocol A). The other second molar's chamber was solo filled by a single mixed dose of bioactive cement (protocol B). The cost for each material was calculated independently, regardless of the group to which they belonged. A market assessment for primary molar crowns was performed, and a comparison table was produced.

## RESULTS:

For protocol A, the lowest mean cost per tooth (LMC) was obtained for NeoMTA cements and IRM powder and liquid; for solo bioactive cement pulp chamber filling, protocol (B), LMC was obtained for NeoMTA cements. Zirconia crowns were the costliest.

## CONCLUSIONS:

NeoMTA-type cements were the most cost-effective option for single-tooth pulpotomy. Zirconia crowns had the highest cost per tooth.

# Comparative analysis of the biological effects of the endodontic bioactive cements MTA-Angelus, MTA Repair HP and NeoMTA Plus on human dental pulp stem cells.

Tomas-Catala CJ, Collado-Gonzalez M, Garcia-Bernal D, O~nate-Sanchez RE, Forner L, Llana C, Lozano A, Castelo-Baz P, Moraleda JM, Rodriguez-Lozano FJ.

## ABSTRACT

Comparative analysis of the biological effects of the endodontic bioactive cements MTA-Angelus, MTA Repair HP and NeoMTA Plus on human dental pulp stem cells.

### AIM:

To evaluate the biological effects in vitro of MTA-Angelus (MTA-Ang; Angelus, Londrina, PR, Brazil), MTA Repair HP (MTA-HP; Angelus) and NeoMTA Plus (NeoMTA-P; Avalon Biomed Inc, Bradenton, FL, USA) on human dental pulp stem cells (hDPSCs).

### METHODOLOGY:

Cell viability and cell migration assays were performed using eluates of each material. To evaluate cell morphology and cell attachment to the different materials, hDPSCs were directly seeded onto the material surfaces and analysed by immunocytofluorescence and scanning electron microscopy, respectively. The chemical composition of the materials was determined by energy-dispersive X-ray (EDX), and eluates were analysed by inductively coupled plasma–mass spectrometry (ICP-MS). Statistical analysis was performed with the analysis of variance and Bonferroni or Tukey post-test ( $\alpha < 0.05$ ).

### RESULTS:

Undiluted MTA-Ang, MTA-HP and NeoMTA-P displayed a significant increase in cell viability greater than that obtained using complete medium alone (control) (\* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ ). Moreover, a cell migration assay revealed cell migration rates after incubation with extracts of MTA-Ang, MTA-HP and NeoMTA-P that were similar to levels obtained in the control group. In addition, stretched cytoskeletal F-actin fibres were detected in the cells treated with the three material extracts. SEM studies revealed a high degree of cell proliferation and attachment on all three materials. EDX analysis demonstrated similar weight percentages of C, O and Ca in all three materials, whilst other elements such as Al, Si and S were also found.

### CONCLUSIONS:

MTA-Ang, MTA-HP and NeoMTA-P were associated with biological effects on hDPSCs in terms of cell proliferation, morphology, migration and attachment.

# Biocompatibility and mineralized nodule formation of Neo MTA Plus and an experimental tricalcium silicate cement containing tantalum oxide.

Tanomaru-Filho M, Andrade AS, Rodrigues EM, Viola KS, Faria G, Camilleri J, Guerreiro-Tanomaru JM

## ABSTRACT

Biocompatibility and mineralized nodule formation of Neo MTA Plus and an experimental tricalcium silicate cement containing tantalum oxide. International Endodontic Journal.

### AIM:

To evaluate the biocompatibility and mineral-ized nodule formation of an experimental tricalcium silicate cement with tantalum oxide (TSC/T2aO5) as radiopacifier, Neo MTA Plus (Avalon Biomed Inc., Bradenton, FL, USA) and MTA (Angelus, Londrina, PR, Brazil) on human osteoblast-like cells (Saos-2).

### METHODOLOGY:

Biocompatibility was evaluated by 3-(4,5-dimethyl-thiazoyl)-2,5-diphenyl-tetrazolium bromide (MTT) and neutral red (NR) assays, after exposure of Saos-2 to cement extracts at 1 : 1, 1 : 2, 1 : 4 and 1 : 8 dilutions for 24 h. Bioactivity was evaluated by alkaline phosphatase (ALP) activity, and calcium deposits were detected with alizarin red stain-ing (ARS). Statistical analysis was performed with analysis of variance and Bonferroni or Tukey post-test ( $\alpha = 0.05$ ).

### RESULTS:

The MTT assay revealed lower cytotoxicity for NEO and MTA ( $P < 0.05$ ), and higher for TSC/Ta2O5 at 1 : 1 and 1 : 2 dilutions when compared to serum-free medium – control ( $P > 0.05$ ). At 1 : 4 dilution, the TSC/Ta2O5 cytotoxicity was similar to the control ( $P > 0.05$ ). At 1 : 8 dilution, cell viability was significantly greater than the control ( $P < 0.05$ ). Saos-2 cell viability performed using the NR assay at all dilutions revealed no cytotoxic effect of MTA, NEO and TSC/Ta2O5. ALP activity at 1 and 3 days was similar to the control ( $P > 0.05$ ). TSC/Ta2O5 had significantly greater ALP activity at 7 days when compared with the control ( $P < 0.05$ ). All materials induced the production of mineralized nodules, and NEO produced significantly more mineralized nodules than MTA and TSC/Ta2O5 ( $P < 0.05$ ).

### CONCLUSIONS:

Neo MTA Plus and TSC/Ta2O5 were biocompatible and induced ALP activity in Saos-2 cells. Both materials induced mineralized nodule formation by Saos-2 with Neo MTA Plus producing significantly more.

# Osteoinductive potential and bone-bonding ability of ProRoot MTA, MTA Plus and Biodentine in rabbit intramedullary model: Microchemical characterization and histological analysis.

Gandolfi MG, Iezzi G, Piattelli A, Prati C, Scarano A.

## ABSTRACT

### OBJECTIVE:

To study the *in vivo* osteoinductive potential, bone-bonding ability (bioactivity) and bone biomineralization of current hydraulic calcium silicate cements used as graft materials and placed in contact with medullary bone.

### METHODS:

ProRoot MTA, MTA Plus and Biodentine were used to fill surgical bone defects (2-mm diameter through the entire cortical thickness to reach the medullary bone) in the tibia of mature male rabbits. Tibiae were retrieved after 30 days and submitted to histological analysis and microchemical characterization using Optical Microscopy (OM) and Environmental Scanning Electron Microscopy with Energy Dispersive X-ray analysis (ESEM-EDX). Bone neoformation and histomorphometric evaluations, degree of mineralization (by Ca/P, Ca/N and P/N ratios) and the diffusion of material elements were studied.

### RESULTS:

Bone neoformation was observed in response to all materials. No sign of necrosis were found on the walls of the preexisting cortical bone. No osteoclasts and no formation of fibrous tissue were evident. Sign of angiogenesis were present. EDX (element content, line profile and element mapping) showed the increase in Ca and P and decrease in C, S and N from the mature bone towards the mineralizing interface. Ca/P, Ca/N and P/N ratios showed differences in the degree of mineralization/maturation stage of bone. MTA Plus and ProRoot MTA exhibited close contact with the pre-existing bone and good bone-bonding with neoformed bone juxtaposed on the medullary side of the materials without interposed connective tissue or resorption lacunae or gaps. The materials showed a dense appearance with 100% of residual materials and no colonization by fluids and cells. No migration of Bi or Al material elements to the newly formed bone was found. Biodentine showed newly formed trabecular bone with marrow spaces and sparse traces of residual material (~9%).

### SIGNIFICANCE:

The *in vivo* osteoinductive properties with dynamic biomineralization processes around these calcium silicate materials extruded in medullary bone in appropriate animal model have been demonstrated by ESEM-EDX in association with OM. Good biocompatibility was evident as only slight inflammatory infiltrate and no sign of necrosis at the interface with the pre-existing bone were found. MTA Plus and ProRoot MTA exhibited bioactive potential as they can bond to bone directly without interposed connective tissue. Biodentine was replaced by newly formed bone.

### CLINICAL SIGNIFICANCE:

The results of the study demonstrate the capacity of calcium silicate cements to allow osteoid matrix deposition by activated osteoblasts and favour its biomineralization, and to achieve a direct bond between the (bioactive) materials surface and the mineralized bone matrix.

---

# Comparative evaluation of push-out bond strength of Neo MTA Plus with Biodentine and white ProRoot MTA.

Sevinç Aktemur Türker, Uzunoğlu, Emel and Bilgin, Burcu

## ABSTRACT

### OBJECTIVE:

The aim of this in vitro study was to evaluate the bond strength of a new calcium silicate cement, Neo MTA Plus (Avalon Biomed Inc. Bradenton, FL, U.S.A) by comparing ProRoot MTA and Biodentine.

### MATERIAL AND METHODS:

Sixty dentin slices were instrumented to achieve a diameter of 1.3 mm. Group 1: white ProRoot MTA, group 2: Biodentine, group 3: Neo MTA Plus – G (powder mixed with gel), group 4: Neo MTA Plus – W (powder mixed with distilled water) were loaded into cavities. The push-out bond strength values were measured. Data were analyzed using Welch ANOVA with Bonferroni correction  $p = 0.05$ . Failure modes (adhesive, cohesive, and mixture) were analyzed.

### RESULTS:

The highest bond strength value was recorded in Neo MTA Plus mixed with gel ( $5.23 \pm 1.78$  MPa), whereas white ProRoot MTA ( $2.57 \pm 0.66$  MPa) had the lowest. Bond strength values of Neo MTA Plus mixed either with gel or with distilled water were statistically different from both white ProRoot MTA and Biodentine ( $2.61 \pm 0.70$  MPa) ( $p < 0.05$ ). Adhesive failure was predominantly observed in all groups.

### CONCLUSION:

Neo MTA Plus could be considered as alternatives to the ProRoot MTA and Biodentine due to its better performance in bonding to root dentin.

# Human dental pulp cells response to mineral trioxide aggregate (MTA) and MTA Plus: cytotoxicity and gene expression analysis.

Rodrigues EM, Cornélio AL, Mestieri LB, Fuentes AS, Salles LP, Rossa-Junior C, Faria G, Guerreiro-Tanomaru JM, Tanomaru-Filho M

## ABSTRACT

### AIM:

To investigate the cytotoxicity, osteogenic bioactivity and mRNA expression of osteogenic markers of bone morphogenetic protein 2 (BMP-2), osteocalcin (OC) and alkaline phosphatase (ALP) induced by the extracts of set MTA Plus (MTA P) (Avalon Biomed Inc. Bradenton, FL, USA) in comparison with MTA (Angelus, Londrina, PR, Brazil) on human dental pulp cells (hDPCs).

### METHODOLOGY:

Cell viability was assessed by mitochondrial dehydrogenase enzymatic (MTT) assay, and the mechanism of cell death was evaluated by flow cytometry. Bioactivity was evaluated by alkaline phosphatase (ALP) assay and detection of calcium deposits with alizarin red staining (ARS). The gene expression of BMP-2, OC and ALP was quantified with real-time PCR. Statistical analysis was performed with analysis of variance and Bonferroni or Tukey post-test ( $\alpha = 0.05$ ).

### RESULTS:

MTA and MTA P were not cytotoxic and did not induce apoptosis. MTA P had significant higher ALP activity in relation to MTA and the control ( $P < 0.05$ ). MTA had a significantly higher percentage of mineralized area than MTA P ( $P < 0.05$ ). The expression of BMP2 and OC mRNA was significantly higher in cells exposed to MTA than MTA P after 1 day ( $P < 0.05$ ). At day 3, the mRNA expression of ALP was significantly higher in MTA P compared with MTA ( $P < 0.05$ ).

### CONCLUSION:

MTA and MTA Plus were noncytotoxic, increased mineralization processes in vitro and induced the expression of osteogenic markers.

# Effect of root canal irrigating solutions on the compressive strength of tricalcium silicate cements.

Govindaraju L, Neelakantan P, Gutmann JL.

## ABSTRACT

### OBJECTIVE:

The aim of this study was to evaluate the effect of root canal irrigants on the compressive strength of hydraulic tricalcium silicate cements.

### MATERIAL AND METHODS:

Specimens (n = 60) of tricalcium silicate materials-Group 1: White ProRoot mineral trioxide aggregate (MTA), Group 2: NeoMTA Plus, Group 3: White MTA Angelus, and Group 4: Biodentine were exposed to one of the solutions (n = 20): Phosphate buffered saline (PBS; control), 3 % NaOCl, or 17 % EDTA for 5 min while being suspended in PBS. Compressive strength values were evaluated after 7 days of storage. The data were statistically analyzed by two-way ANOVA and Tukey's multiple comparison test (P = 0.05).

### RESULTS:

Biodentine (BD) showed significantly higher compressive strength than the other materials (P < 0.05) in the control group. When exposed to NaOCl, compressive strength of WMTA and WMTA-A decreased significantly (P < 0.05), while EDTA decreased the compressive strength of all the cements compared to the control (P < 0.05). There was no significant difference in the compressive strength of BD and NMTA-P when exposed to NaOCl or EDTA.

### CONCLUSION:

Biodentine and NeoMTA Plus did not show a significant reduction in compressive strength when exposed to NaOCl. EDTA reduced the compressive strength of the cements tested.

### CLINICAL SIGNIFICANCE:

Tricalcium silicates were differentially influenced by root canal irrigants. It is essential to understand the composition of these materials prior to clinical use. Traces of irrigants from the root canal wall must be thoroughly removed.

# Evaluation of cytotoxicity and gelatinases activity in 3T3 fibroblasts cell by root repair materials.

Varol Basaka, Tuna Elif Baharb, Karsli Eminec, Kasimoglu Yeldab, Koruyucu Mineb, Seymen Figenb & Nurten Rustem

## ABSTRACT

The aim of this study was to investigate the effects of calcium silicate-based products on cytotoxicity in the 3T3 fibroblast and gelatinolytic activity of matrix metalloproteinases (MMPs). 3T3 fibroblasts were incubated directly with Ortho Mineral trioxide aggregate (MTA), BioAggregate, Biodentine, MTA Plus, MTA Angelus and MTA CerKamed for 24 hours and seven days. The cytotoxicity was determined using an MTT assay. Supernatants were collected to determine MMP-2 and MMP-9. Data were analysed using IBM SPSS 22. Seventh day extracts of Ortho MTA and Biodentine showed reduced cell viability. Specific characterization of MMPs in cell culture demonstrated that MMP-2 (62 kPa) in the cell culture supernatants by gelatin zymography showed induced expression in four out of seven groups by 3T3 cells. No MMP-9 expression was observed. The cytotoxicity of materials revealed a significant difference in cell viability between the groups on the first and seventh days. The results of this study revealed minor cytotoxic effects for Ortho MTA and Biodentine. This study suggests that endodontic sealers induced production of MMP-2. MMP-9 might be expressed in small amounts when compared with MMP-2.

# Dentinal Tubule Penetration of Tricalcium Silicate Sealers.

McMichael GE, Primus CM, Opperman LA.

## ABSTRACT

### INTRODUCTION:

The treatments for which mineral trioxide aggregate (MTA)-based materials can be used in dentistry are expanding. Smaller particle size and easier handling properties have allowed the advent of tricalcium silicate sealers including EndoSequence BC Sealer (Brasseler USA, Savannah, GA), QuickSet2 (Avalon Biomed, Bradenton, FL), NeoMTA Plus (Avalon Biomed), and MTA Fillapex (Angelus, Londrina, Brazil). The objective of this study was to measure the tubule penetration with these sealers using continuous wave (CW) and single-cone (SC) obturation techniques.

### METHODS:

Eighty single-rooted teeth were randomly divided into 8 groups of 10 and obturated with 1 of the previously mentioned sealers mixed with trace amounts of rhodamine using either the CW or SC technique. Teeth were sectioned at 1 mm and 5 mm from the apex and examined under a confocal laser microscope. The percentage of sealer penetration and the maximum sealer penetration were measured.

### RESULTS:

The tricalcium silicate sealers penetrated tubules as deep as 2000  $\mu\text{m}$  (2 mm). The percentage of sealer penetration was much higher 5 mm from the apex, with many specimens having 100% penetration for both SC and warm vertical techniques. MTA Fillapex, a resin-based sealer with less than 20% MTA particles, had significantly greater tubule penetration with a warm vertical technique versus the SC technique at the 1-mm level.

### CONCLUSION:

Within the limitations of this study, the CW and SC techniques produced similar tubule penetration at both the 1-mm and the 5-mm level with the tricalcium silicate sealers BC Sealer, QuickSet2, and NeoMTA Plus.

# Comparative Analysis of Calcium Silicate-based Root Filling Materials Using an Open Apex Model.

Tran D, He J, Glickman GN, Woodmansey KF.

## ABSTRACT

### INTRODUCTION:

Many new calcium silicate-based root filling materials have emerged in the market; however, their performance in the orthograde obturation of an open apex has not been evaluated. The purpose of this study was to compare the marginal adaptation of ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK), NeoMTA Plus (Avalon Biomed Inc, Bradenton, FL), and Endosequence BC RRM-Fast Set Putty (BC RRM-FS; Brasseler USA, Savannah, GA) after orthograde placement in roots with open apices.

### METHODS:

Palatal roots of maxillary molars were instrumented to create divergent open apices and divided into 4 groups for orthograde obturation: ProRoot MTA, NeoMTA Plus, BC RRM-FS, and BC RRM-FS + BC Sealer. Using a scanning electron microscope, the quality of material adaptation at the anatomic apex was evaluated by 5 blinded examiners; 3 mm of the root end was sectioned, and gap distance was measured at the material-dentin interface. Statistical analyses were performed using the Kruskal-Wallis test.

### RESULTS:

There were no significant differences in marginal adaptation among the 4 groups at the level of the anatomic apex ( $P = .175$ ). BC RRM-FS + BC Sealer had a significantly smaller gap size after 3-mm root end resection compared with the other 3 groups ( $P < .01$ ). No differences were observed among the other 3 materials.

### CONCLUSION:

All materials showed comparable marginal adaptation at the anatomic apex when used for orthograde obturation of open apices. Application of BC Sealer before the delivery of BC RRM-FS Putty enhanced the quality of adaptation coronal to the apex.

# Osteogenic and Angiogenic Response to Calcium Silicate-based Endodontic Sealers.

Costa F, Sousa Gomes P, Fernandes MH.

## ABSTRACT

### INTRODUCTION:

Calcium silicate-based endodontic sealers are reported to favor the regeneration of periradicular tissues, a process requiring concerted osteogenic and angiogenic events. This study compared 4 calcium silicate-based sealers for the effects of their extracts on osteogenic and angiogenic cell behavior.

### METHODS:

Extracts from ProRoot MTA (Dentsply Tulsa Dental, Tulsa, OK), MTA Plus (Prevest Denpro Limited, Jammu City, India), MTA Fillapex (Angelus, Londrina, PR, Brazil), and Biodentine (Septodont, Saint-Maur-des-Fosses, France) were prepared from freshly mixed sealers (0.1 g/cm<sup>2</sup>/mL extraction medium) and diluted (1:2-1:20). The sealers were compared for the dose- and time-dependent effects on the proliferation and differentiation of human mesenchymal stem cells (hMSCs) and human umbilical vein endothelial cells (HUVECs). An ex vivo osteogenic assay (regeneration of neonatal mice parietal bone defects) and an in vivo angiogenesis assay (chorioallantoic membrane assay) were performed.

### RESULTS:

Diluted extracts from MTA ProRoot and MTA Plus had evident stimulatory effects on the proliferation of hMSCs, alkaline phosphatase activity, and ex vivo regeneration of bone defects. They also increased HUVEC growth; allowed normal tubularlike network organization; and, in vivo, did not affect angiogenesis. Comparatively, Biodentine also elicited a favorable response on hMSCs and HUVECs, but the overall osteogenic and angiogenic outcome was slightly lower. MTA Fillapex exhibited the highest toxicity in hMSCs and HUVECs and, unlike the other sealers, only allowed a partial regeneration of bone defects.

### CONCLUSION:

The sealers caused dose- and time-dependent effects on the osteoblastic and endothelial response, eliciting similar cytocompatibility profiles. Results suggest that the induction of both osteogenic and angiogenic events may contribute to the sealers' regenerative outcome.

# Biocompatibility and bioactivity of calcium silicatebased endodontic sealers in human dental pulp cells.

Mestieri LB, Gomes-Cornélio AL, Rodrigues EM, Salles LP, Bosso-Martelo R, Guerreiro-Tanomaru JM, Tanomaru-Filho M.

## ABSTRACT

Mineral Trioxide Aggregate (MTA) is a calcium silicate-based material. New sealers have been developed based on calcium silicate as MTA Fillapex and MTA Plus.

### OBJECTIVE:

The aim of this study was to evaluate biocompatibility and bioactivity of these two calcium silicate-based sealers in culture of humandental pulp cells (hDPCs).

### MATERIAL AND METHODS:

The cells were isolated from third molars extracted from a 16-year-old patient. Pulp tissue was sectioned into fragments with approximately 1 mm<sup>3</sup> and kept in supplemented medium to obtain hDPCs adherent cultures. Cell characterization assays were performed to prove the osteogenic potential. The evaluated materials were: MTA Plus (MTAP); MTA Fillapex (MTAF) and FillCanal (FC). Biocompatibility was evaluated with MTT and Neutral Red (NR) assays, after hDPCs exposure for 24 h to different dilutions of each sealer extract (1:2, 1:3 and 1:4). Unexposed cells were the positive control (CT). Bioactivity was assessed by alkaline phosphatase (ALP) enzymatic assay incells exposed for one and three days to sealer extracts (1:4 dilution). All data were analyzed by ANOVA and Tukey post-test ( $p \leq 0.05\%$ ).

### RESULTS:

MTT and NR results showed suitable cell viability rates for MTAP at all dilutions (90-135%). Cells exposed to MTAF and FC (1:2 and 1:4 dilutions) showed significant low viability rate when compared to CT in MTT. The NR results demonstrated cell viability for all materials tested. In MTAP group, the cells ALP activity was similar to CT in one and three days of exposure to the material. MTAF and FC groups demonstrated a decrease in ALP activity when compared to CT at both periods of cell exposure.

### CONCLUSION:

The hDPCs were suitable for the evaluation of new endodontic materialsin vitro. MTAP may be considered a promising material for endodontic treatments.

# The effect of root dentin conditioning protocols on the push-out bond strength of three calcium silicate sealers.

Prasanna Neelakantan , Mugunth Nandagopal, Hagay Shemesh

## ABSTRACT

### OBJECTIVE:

To compare the effects of irrigation protocols on the push-out bond strength of calcium silicate materials at two different time periods (7-days and 3-months).

### MATERIALS AND METHODS:

Root canals (n=300) were irrigated with one of the following (n=60): group 1 (3% NaOCl–17% EDTA); group 2 (17% EDTA–3% NaOCl); group 3 (1:1 mixture of 6% NaOCl and 18% etidronic acid); group 4 (3% NaOCl–QMix 2in1); group 5 (3% NaOCl–2% chlorhexidine). Specimens were subdivided into three subgroups (n=20): A, Endosequence BC sealer [EBC]; B, MTA Plus [MTA-P]; C, Tech Biosealer Endo [TECH]. Specimens were suspended in phosphate buffered saline [PBS] for 7 days or 3 months (n=10 per sealer). Push-out bond strength was measured and data were analyzed (P=0.05).

### RESULTS:

MTA-P: showed the highest bond strength at both time periods, when NaOCl+EA was used as an irrigant. This was not significantly different from the strength produced when NaOCl–QMix was used for 7 days (P>0.05). There was no significant difference between the bond strengths of the three materials when irrigated with group 1, 2 or 5 (P>0.05), but these groups showed significantly lower bond strengths than groups 3 and 4 (P<0.05). While the bond strength of EBC and MTA-P in specimens irrigated with groups 3 and 4 improved significantly with time [P<0.05], this was not true for TECH.

### CONCLUSION:

Push-out bond strength of calcium silicate cements was differentially influenced by irrigation protocol and time. MTA Plus showed the highest bond strength at both time periods, when root canals were irrigated with NaOCl+EA. The bond strength of Tech Biosealer Endo did not improve with time immaterial of the irrigation protocols.

# Staining Potential of Neo MTA Plus, MTA Plus, and Biodentine Used for Pulpotomy Procedures.

Camilleri J.

## ABSTRACT

### INTRODUCTION:

Mineral trioxide aggregate (MTA) used for pulpotomy procedures in immature permanent teeth can reduce treatment to 1 session as opposed to classic calcium hydroxide therapy, which necessitates multiple appointments. The main disadvantage of MTA use is crown discoloration after treatment. The aim of this study was to characterize 3 materials that are used for pulpotomy procedures in immature permanent teeth and assess their color stability in the presence of sodium hypochlorite solution.

### METHODS:

Hydrated Neo MTA Plus (Avalon Biomed Inc, Bradenton, FL), MTA Plus (Avalon Biomed Inc), and Biodentine (Septodont, Saint-Maur-des-Fossés, France) were characterized after immersion in Hank's balanced salt solution for 1 day and 28 days using a combination of scanning electron microscopy, energy-dispersive spectroscopy, and X-ray diffraction analysis. The color stability of the 3 materials in contact with water or sodium hypochlorite was evaluated by photography, spectrophotometry, and X-ray diffraction analysis.

### RESULTS:

All the materials hydrated and produced calcium hydroxide as a by-product of hydration at early age. All materials interacted with synthetic tissue fluid, forming a calcium phosphate phase. MTA Plus exhibited discoloration in contact with sodium hypochlorite.

### CONCLUSION:

All the materials tested are suitable to be used in the treatment of immature teeth because they all produced calcium hydroxide, which is necessary to induce dentin bridge formation and continued root formation. Neo MTA Plus and Biodentine are suitable alternatives to MTA, and they do not exhibit discoloration.

# Marginal Adaptation Evaluation of Biodentine and MTA Plus in “Open Sandwich” Class II Restorations.

Aggarwal V, Singla M, Yadav S, Yadav H, Ragini.

## ABSTRACT

### PURPOSE:

This study aimed at evaluation of two different commercially available calcium silicate materials (Biodentine and mineral trioxide aggregate [MTA] Plus) used as dentin substitute.

### MATERIAL AND METHODS:

Sixty Class II cavities were prepared in extracted mandibular third molars, with margins extending 1 mm below the cementum-enamel junction. The samples were divided into three groups on the basis of dentin substitute used: resin modified glass ionomer cement, Biodentine, and MTA Plus. Cavities were restored with composite resins in an “open sandwich” technique. The samples were subjected to alternate aging in phosphate buffered saline and cyclic loading. Marginal adaptation was evaluated in terms of “continuous margin” at the gingival margin, using a low vacuum scanning electron microscope. Statistical analysis was done with two-way analysis of variance with Holm-Sidak’s correction for multiple comparisons.

### RESULTS:

The glass ionomer group and Biodentine group presented an overall 83% and 91% of continuous margins, with no difference between them. MTA Plus showed least values of continuous margins. Granular deposits were seen over the surface of Biodentine and MTA Plus.

### CONCLUSION:

Biodentine and resin-modified glass ionomer cement, when used as a dentin substitute under composite restorations in open sandwich technique, gave satisfactory marginal adaptation values.

### CLINICAL SIGNIFICANCE:

Contemporary calcium silicate materials can be used as dentin substitute materials in “open sandwich” Class II restorations. This study evaluates the marginal adaptation of Biodentine, MTA Plus, and resin modified glass ionomer cement used as dentin substitutes and reports better adaptation obtained with Biodentine and glass ionomer cement.

# Ion release, porosity, solubility, and bioactivity of MTA Plus tricalcium silicate.

Gandolfi MG, Siboni F, Primus CM, Prati C.

## ABSTRACT

### INTRODUCTION:

The aim of this study was to evaluate MTA Plus (Prevest Denpro Limited, Jammu, India, for Avalon Biomed Inc) material's properties, namely calcium release, the pH change, solubility, water sorption, porosity, surface morphology, and apatiteforming ability after immersion in simulated body fluid.

### METHODS:

Two tricalcium silicate powders (MTA Plus and ProRoot MTA; Dentsply Tulsa Specialties, Tulsa, OK) and Dycal (Dentsply Caulk, Milford, DE) were tested. After incubation at 37°C and 99% relative humidity, calcium and hydroxyl ion release were tested up to 28 days in deionized water at 37°C. Water absorption, interconnected pores, apparent porosity, and solubility were measured after 24 hours of immersion in deionized water at 37°C. The morphologic and elemental analysis of the materials' surfaces were examined using an environmental scanning electron microscope/energy dispersive x-ray analysis after storage at 37°C for 1-28 days in simulated body fluid using the ISO 23317 method.

### RESULTS:

All 3 materials created an alkaline pH within 3 hours, which continued for 28 days. MTA Plus had a higher ion release than ProRoot MTA and Dycal; the use of the MTA Plus gel enhanced the initial calcium release and the increase of the pH. Both MTA materials were more porous, water soluble, and water sorptive than Dycal and more bioactive. After aging in simulated body fluid, MTA Plus material caused precipitation of an apparent calcium phosphate layer..

### CONCLUSION:

MTA Plus showed improved reactivity and prolonged capability to release calcium and increase the local pH to alkaline values in comparison with ProRoot MTA. These pronounced ion-releasing properties are interlinked with its noticeable porosity, water sorption, and solubility and with the formation of calcium phosphorus minerals. The finer calcium silicate powder may explain the higher ion release, water sorption, porosity, and solubility of MTA Plus compared with ProRoot MTA. For clinicians, MTA Plus represents a lower-cost bioactive tricalcium silicate material with interesting chemicalphysical properties that could be a convenient alternative to the conventional calcium silicate mineral trioxide aggregate-like cements.

# Capping a pulpotomy with calcium aluminosilicate cement: comparison to mineral trioxide aggregates.

Kramer PR, Woodmansey KF, White R, Primus CM, Opperman LA.

## ABSTRACT

### INTRODUCTION:

Calcium aluminate cements have shown little affinity for bacterial growth, low toxicity, and immunogenicity when used as a restoration material, but calcium aluminosilicate cements have not been tested in vivo in pulpotomy procedures.

### METHODS:

To address this question, a calcium aluminosilicate cement (Quick-Set) was tested along with 2 mineral trioxide aggregates, ProRoot MTA and MTA Plus. These cements were used as a capping agent after pulpotomy. Control rats had no pulpotomy, or the pulpotomy was not capped. Proinflammatory cytokines interleukin (IL)-1 $\beta$  and IL-1 $\alpha$  were measured, and histology was performed at 30 and 60 days after capping. The nociceptive response was determined by measuring the lengthening of the rat's meal duration.

### CONCLUSION:

IL-1 $\beta$  and IL-1 $\alpha$  concentrations were reduced in the capped teeth, but no differences were observed among the 3 cements. Dentinal bridging could be detected at both 30 and 60 days with each of the 3 cements, and the pulps were still vital 60 days after capping. Meal duration significantly shortened after placement of the 3 different cements, indicating a nociceptive response, but there were no differences among the materials. Calcium aluminosilicate cement had similar properties to mineral trioxide aggregates and is a viable option for pulpotomy procedures.

# Evaluation of compressive strength of hydraulic silicate-based root-end filling materials.

Walsh RM, Woodmansey KF, Glickman GN, He J.

## ABSTRACT

### INTRODUCTION:

Hydraulic silicate cements such as mineral trioxide aggregate (MTA) have many clinical advantages. Newer hydraulic silicate materials have been developed that improve on the limitations of mineral trioxide aggregate such as the long setting time and difficult handling characteristics. The purpose of this study was to examine the effect of saline and fetal bovine serum (FBS) on the setting and compressive strength of the following hydraulic silicate cements: ProRoot MTA (white WMTA; Dentsply International, Tulsa Dental Specialties, Johnson City, TN), EndoSequence Root Repair Material (Brasseler USA, Savannah, GA), MTA Plus (MTAP; Avalon Biomed Inc, Bradenton, FL), and QuickSet (QS; Avalon Biomed Inc, Bradenton, FL).

### METHODS:

Samples of root-end filling materials were compacted into polyethylene molds. Samples were exposed to FBS or saline for 7 days. A universal testing machine was used to determine the compressive strengths.

### RESULTS:

QS had significantly lower compressive strength than all other materials ( $P < .001$ ). White MTA and MTAP mixed with liquid had lower compressive strengths after exposure to FBS compared with saline ( $P = .003$ ). ERRM, MTAP mixed with gel, and QS were not affected by the exposure to FBS.

### CONCLUSION:

New silicate-based root-end filling materials, other than QS, have compressive strength similar to MTA. Within the limits of this study, premixed materials and those mixed with antiwashout gel maintain their compressive strength when exposed to biological fluids.

# Push-out bond strength of MTA with antiwashout gel or resins.

Formosa LM, Mallia B, Camilleri J.

## ABSTRACT

### AIM:

Assessment of the push-out bond strength of four MTA-based formulations for use as root-end filling materials.

### METHODOLOGY:

MTA Plus mixed with (i) water ('MTA-W'); (ii) a proprietary water-based antiwashout gel ('MTA-AW'); (iii) Superbond C&B chemically curing resin ('MTA-Chem'); and (iv) Heliobond light-curing resin ('MTA-Light') was tested. Root slices 3 mm thick human had a 1.5 mm diameter hole drilled centrally and were treated with 17% EDTA for 60s. Forty specimens divided into groups 1-4 were prepared and filled with MTA-W, MTA-AW, MTA-Chem and MTA-Light, respectively. Groups 3 and 4 were etched with 37% phosphoric acid for 60s, and bonding agent was applied to the dentine surface. Specimens were stored for 28 days in Hanks' Balanced Salt Solution at 37 °C. Push-out strength was tested with a punch and die (punch diameter 1.3 mm, die diameter 2.0 mm, punch speed 1 mm min<sup>-1</sup>). Stereomicroscopy was used to classify failure mode (adhesive, cohesive or mixed type).

### RESULTS:

The resulting push-out strengths were 5.1 MPa (MTA-W), 4.3 MPa (MTA-AW), 4.7 MPa (MTA-Chem) and 11.0 MPa (MTA-Light). MTA-W had higher push-out strength than MTA-AW ( $P = 0.022$ ). The same was noted for MTA-Light relative to the other materials ( $P < 0.05$ ). All materials exhibited adequate push-out strengths compared with MTA-W. Failure was predominantly mixed, except for MTA-Chem (predominantly adhesive).

### CONCLUSION:

All materials exhibited adequate push-out strength. Previous studies have shown the new formulations have additional advantages including increased washout resistance and faster setting time, making them promising for future dental applications.

# X-ray diffraction analysis of MTA-Plus, MTA-Angelus and DiaRoot BioAggregate.

Guven Y, Tuna EB, Dincol ME, Aktoren O.

## ABSTRACT

### OBJECTIVE:

The purpose of this study was to investigate and compare the crystalline structures of recently released MTA Plus (MTAP), MTA Angelus (MTA-A), DiaRoot BioAggregate (BA) by X-ray diffraction (XRD) analysis.

### MATERIALS AND METHODS:

Phase analysis was carried out on powder and set forms of tested materials. The powder specimens placed into sample holders that were packed with a glass slide and the set samples prepared according to the manufacturer's instructions were placed into molds. The samples after being set for three days at 37°C and 100% humidity in an incubator were mounted onto the XRD machine and phase identification was accomplished using a search-match software program.

### RESULTS:

XRD findings indicated that major constituents of MTA-P were bismuth oxide, portlandite, dicalcium silicate and tricalcium silicate. The crystal structure of MTA-A were similar to those of MTA-P except for the absence of portlandite. Additionally, MTA-A had tricalcium aluminate differing from MTA-P. BA mainly differed from MTA-P and MTA-A by the radiopacifier (tantalum oxide-TO) in its composition.

### CONCLUSION:

The majority of constituents of the tested materials have shown similarity except for the presence of tricalcium aluminate in MTA-A and the inclusion of TO in BA. In addition, set MTA-P showed a strong peak of portlandite.

# In vitro biocompatibility and oxidative stress profiles of different hydraulic calcium silicate cements.

Eid AA, Gosier JL, Primus CM, Hammond BD, Susin LF, Pashley DH, Tay FR.

## ABSTRACT

### INTRODUCTION:

MTA Plus is a new calcium silicate cement with unknown cytotoxicity characteristics. The objectives of this study were to examine the effect of MTA Plus on the viability, apoptosis/necrosis profile, and oxidative stress levels of rat odontoblastlike cells.

### METHODS:

MDPC-23 cells were exposed to gray and white MTA Plus (GMTAP, WMTAP), gray and white ProRoot MTA (GMTA, WMTA) cements, or their eluents. The cells were evaluated for (1) cell viability by using XTT assay, (2) apoptosis/necrosis by using flow cytometry and confocal laser scanning microscopy, and (3) oxidative stress by measuring reactive oxygen species.

### RESULTS:

XTT assay showed that all test cements exhibited marked initial cytotoxicity that decreased with time. By the end of the third week, GMTAP and GMTA were comparable to untreated cells (negative control) in terms of cell viability, whereas WMTAP and WMTA were significantly lower than the untreated cells. Apoptosis/necrosis profiles of cells exposed to WMTAP and GMTAP were not significantly different from untreated cells, whereas cells exposed to WMTA and GMTA showed significantly less viable cells. All experimental groups exhibited reduction of intracellular reactive oxygen species formation compared with untreated cells, although cells exposed to WMTA were not significantly different from untreated cells.

### CONCLUSION:

Both the gray and white versions of MTA Plus possess negligible in vitro cytotoxic risks that are time and dilution dependent. They enrich the spectrum of hydraulic calcium silicate cements currently available to clinicians for endodontic applications.

# In vitro osteogenic/dentinogenic potential of an experimental calcium aluminosilicate cement.

Eid AA, Niu LN, Primus CM, Opperman LA, Pashley DH, Watanabe I, Tay FR.

## ABSTRACT

### INTRODUCTION:

Calcium aluminosilicate cements are fast-setting, acid-resistant, bioactive cements that may be used as root-repair materials. This study examined the osteogenic/dentinogenic potential of an experimental calcium aluminosilicate cement (Quick-Set) by using a murine odontoblast-like cell model.

### METHODS:

Quick-Set and white ProRoot MTA (WMTA) were mixed with the proprietary gel or deionized water, allowed to set completely in 100% relative humidity, and aged in complete growth medium for 2 weeks until rendered non-cytotoxic. Similarly aged Teflon disks were used as negative control. The MDPC-23 cell line was used for evaluating changes in mRNA expressions of genes associated with osteogenic/dentinogenic differentiation and mineralization (quantitative reverse transcription polymerase chain reaction), alkaline phosphatase enzyme production, and extracellular matrix mineralization (alizarin red S staining).

### RESULTS:

After MDPC-23 cells were incubated with the materials in osteogenic differentiation medium for 1 week, both cements showed up-regulation in ALP and DSPP expression. Fold increases in these 2 genes were not significantly different between Quick-Set and WMTA. Both cements showed no statistically significant up-regulation/down-regulation in RUNX2, OCN, BSP, and DMP1 gene expression compared with Teflon. Alkaline phosphatase activity of cells cultured on Quick-Set and WMTA were not significantly different at 1 week or 2 weeks but were significantly higher ( $P < .05$ ) than Teflon in both weeks. Both cements showed significantly higher calcium deposition compared with Teflon after 3 weeks of incubation in mineralizing medium ( $P < .001$ ). Differences between Quick-Set and WMTA were not statistically significant.

### CONCLUSION:

The experimental calcium aluminosilicate cement exhibits similar osteogenic/dentinogenic properties to WMTA and may be a potential substitute for commercially available tricalcium silicate cements.

# The setting characteristics of MTA Plus in different environmental conditions.

Camilleri J, Formosa L, Damidot D.

## ABSTRACT

### AIM:

Characterization and assessment of the hydration reaction of mineral trioxide aggregate (MTA) Plus exposed to different environmental conditions.

### METHODOLOGY:

The specific surface area, surface morphology and characterization of un-hydrated MTA Plus (Avalon Biomed Inc. Bradenton, FL, USA) were investigated. The specific surface area was compared with that of ProRoot MTA (Dentsply International, Tulsa Dental Specialties, Johnson City, TN, USA). The reaction rate was determined using calorimetry, and the hydrated cement was assessed for setting time (determined using an indentation technique), and the set material was characterized using X-ray diffraction analysis, scanning electron microscopy and X-ray energy-dispersive analysis. Atomic ratio plots were drawn to establish the relationship of the hydration products. Three different environmental conditions namely dry or immersed in either water or Hank's balanced salt solution (HBSS) were used.

### RESULTS:

Mineral trioxide aggregate Plus had a higher specific surface area than ProRoot MTA. The hydration reaction was exothermic. The setting time of MTA Plus was retarded when in contact with fluids ( $P < 0.001$ ). The setting time was longer when MTA Plus was in contact with HBSS than when in contact with water ( $P < 0.001$ ). Hydration of MTA Plus resulted in the formation of calcium silicate hydrate, calcium hydroxide, ettringite and monosulfate phases. Bismuth was incorporated in the calcium silicate hydrate structure. The hydration of the core material was not affected by contact with the different solutions but the periphery exhibited microcracking, leaching of calcium hydroxide, partial decalcification of calcium silicate hydrate, inhibition of hydration in contact with the physiological solution.

### CONCLUSION:

The novel MTA Plus was finer than ProRoot MTA but had a similar chemical composition. MTA Plus in direct contact with fluids exhibited partial decalcification of calcium silicate hydrate in contact with the solution, microcracking and leaching of calcium hydroxide. Interaction with a physiological solution resulted in inhibition of hydration.

# Retreatability of 2 mineral trioxide aggregate-based root canal sealers: a conebeam computed tomography analysis.

Neelakantan P, Grotra D, Sharma S.

## ABSTRACT

### INTRODUCTION:

The retreatability of recent calcium silicate or mineral trioxide aggregate (MTA) sealers has not yet been assessed. The aim of this study was to evaluate the removal of 2 MTA-based sealers (MTA Fillapex [Angelus Soluções Odontológicas, Londrina, PR, Brazil] and MTA Plus [Prevest-Denpro, Jammu City, India]) using a rotary retreatment system, considering an epoxy resin sealer (AH Plus [Dentsply Maillefer, Ballaigues, Switzerland]) as the standard for comparison.

### METHODS:

Root canals in 45 single-rooted teeth were instrumented using a rotary nickel-titanium system (MTwo; VDW GmbH, Munich, Germany) and obturated with gutta-percha using one of the following sealers (n = 15): group 1, MTA Fillapex; group 2, MTA Plus; and group 3, AH Plus. The teeth were scanned using a cone-beam computed tomography scanner. After 2 months, the root canals were retreated with a rotary retreatment system (ProTaper Universal Retreatment; Dentsply Maillefer, Ballaigues, Switzerland) and a second cone-beam computed tomography scan was performed to assess the amount of remaining root filling material (in percentage) and dentin removal (in cubic millimeters). The time taken to reach the working length was calculated in minutes. Group comparisons were performed using 1-way analysis of variance and the Student-Newman-Keuls post hoc test (P = .05).

### RESULTS:

There was a significant difference in the amount of remaining root filling material between the 3 groups (P < .05), with group 1 showing the least amount of root filling material (1.8% ± 0.22%) and group 3 showing the highest (10.4% ± 0.71%). The amount of dentin removal and the time taken to reach the working length was significantly higher in group 3 than in groups 1 and 2 (P < .05). There was no significant difference between groups 1 and 2 in these outcome variables (P > .05).

### CONCLUSION:

The rotary retreatment system evaluated was not able to completely remove any of the sealers. MTA Fillapex showed less remaining root filling material than MTA Plus.

# Mineral trioxide aggregate with anti-washout gel - properties and microstructure.

Formosa LM, Mallia B, Camilleri J.

## ABSTRACT

### OBJECTIVE:

One of the problems encountered clinically when using mineral trioxide aggregate (MTA) as a root-end filling material is washout immediately after placement. A novel MTA is supplied with an anti-washout gel that replaces the mixing water. The aim of this research was to characterize and assess the properties of a novel MTA mixed with an anti-washout liquid.

### METHODS:

MTA Plus mixed with either water (MTA-W) or an anti-washout gel (MTA-AW) was investigated. Un-hydrated and set materials were characterized by scanning electron microscopy (SEM), energy X-ray dispersive analysis (EDX), X-ray diffraction analysis (XRD) and Fourier transform infrared spectroscopy (FT-IR) after being stored dry or immersed in Hank's balanced salt solution (HBSS). The chemical and physical properties of the set materials were then investigated.

### RESULTS:

The MTA Plus was composed of tricalcium silicate, dicalcium silicate and bismuth oxide. The anti-washout gel used was water-based and FT-IR plots showed the presence of an organic additive. Both materials immersed in HBSS displayed the presence of reaction by-product with MTA-W exhibiting a high-intensity calcium hydroxide peak on X-ray diffraction. The X-ray diffractograms of all materials following hydration demonstrated the reduction in peak intensity of the tri- and dicalcium silicate. Hydroxyapatite deposits were evident on the surfaces of both materials in contact with HBSS. The pH of the leachate was similar for both materials. MTA-AW exhibited lower levels of calcium ions in solution and reduced fluid uptake in the early stages of reaction. The anti-washout gel reduced the setting time of the cement and enhanced the compressive strength. The radiopacity of both materials was approximately 8mm aluminum.

### SIGNIFICANCE:

The use of the water-based anti-washout material instead of the standard water with MTA affects the hydration and properties of the set material.

# **A quantitative method for determining the antiwashout characteristics of cement-based dental materials including mineral trioxide aggregate.**

Formosa LM, Mallia B, Camilleri J.

## **ABSTRACT**

### **AIM:**

To introduce and assess a novel method for measuring washout resistance of cement-based dental materials, including mineral trioxide aggregate (MTA), to qualitatively verify the results with a clinical simulation and to evaluate the washout resistance of a new root-end filling material.

### **METHODOLOGY:**

A method for assessment of washout resistance of root-end filling materials was developed by adapting the CRD-C 661-06 (a method for evaluating the resistance of freshly mixed concrete to washout in water), to permit testing of dental cements. White Portland cement (PC), MTA-Plus mixed with either water or a polymer-based antiwashout gel (MTA-AW), MTA-Angelus, IRM and amalgam were tested with either distilled water or HBSS as washout media. Additionally, the washout resistance was tested qualitatively by spraying the test materials at the terminus of simulated canals with a metered jet of water.

### **RESULTS:**

A mass loss of 2-7% for PC, 0.4-4% for MTA-Plus, -0.9% for MTA-AW, 5-10% for MTA-Angelus and 0% for IRM and amalgam was recorded with the modified CRD-C 661-06 method. No significant difference was found between using water and HBSS as washout media for the same material. The results of the modified CRD-C 661-06 method were similar to those obtained on the simulated canals.

### **CONCLUSION:**

The modified CRD-C 661-06 method provided repeatable results that were comparable to the simulated clinical method. The antiwashout gel used with MTA-Plus reduced the material washout and was similar to IRM and amalgam.

# Effects of an experimental calcium aluminosilicate cement on the viability of murine odontoblast-like cells.

Wei W, Qi YP, Nikonov SY, Niu LN, Messer RL, Mao J, Primus CM, Pashley DH, Tay FR.

## ABSTRACT

### INTRODUCTION:

Quick-setting calcium aluminosilicate cement with improved washout resistance is a potential substitute for calcium silicate cements in endodontics. This study examined the effect of an experimental calcium aluminosilicate cement (Quick-Set; Primus Consulting, Bradenton, FL) on the viability of odontoblast-like cells.

### METHODS:

The biocompatibility of Quick-Set and white ProRoot MTA (WMTA; Dentsply Tulsa Dental Specialties, Tulsa, OK) cements and their eluents was evaluated using a murine dental papilla-derived odontoblast-like cell line (MDPC-23); 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay was used to examine the effects of the 2 hydraulic cements on mitochondrial metabolic activity. Flow cytometry and confocal laser scanning microscopy were used to identify the effects of the 2 cements on cell death-induced plasma membrane permeability to fluorescent dyes and DNA stains.

### RESULTS:

After the first week of immersion in culture medium, Quick-Set and WMTA were more cytotoxic than the Teflonnegative control ( $P < .05$ ), and the cells exhibited more apoptosis/necrosis than Teflon ( $P < .05$ ). After the second week of immersion, the 2 cements were as biocompatible as Teflon ( $P > .05$ ), with cells exhibiting minimal apoptosis/necrosis. Eluents from the set cements at 1:1 dilution were significantly more cytotoxic than eluents at 1:10 or 1:100 dilution ( $P < .05$ ).

### CONCLUSION:

Quick-Set and WMTA exhibited similar cytotoxicity profiles. They possess negligible in vitro toxicologic risks after time-dependent elution of toxic components.

# Effects of calcium silicate-based materials on collagen matrix integrity of mineralized dentin.

Leiendecker AP, Qi YP, Sawyer AN, Niu LN, Agee KA, Loushine RJ, Weller RN, Pashley DH, Tay FR.

## ABSTRACT

### INTRODUCTION:

Calcium silicate-based materials (CSMs) are used in various endodontic procedures. The present study examined whether prolonged contact of mineralized dentin with recently commercialized versions of these materials adversely affects dentin collagen matrix integrity.

### METHODS:

Dentin slabs prepared from extracted human third molars ( $7 \times 3 \times 0.3$  mm) were divided into 3 groups on the basis of the material to which dentin was exposed (MTA Plus, Biodentine, untreated control dentin slabs) and the time period of exposure (24 hours, 1, 2, and 3 months;  $n = 6$ ). Hydroxyproline assay was performed on each group's supernatant to quantify the collagen extraction amounts of each group per time period. Data were analyzed with two-factor repeatedmeasures analysis of variance and Holm-Sidak pairwise comparisons ( $\alpha = 0.05$ ) to determine the effects of material and aging time on collagen extraction. Dentin slabs from the 3 months of aging group were demineralized for transmission electron microscopy examination of collagen matrix ultrastructural changes.

### RESULTS:

Material ( $P = .002$ ), aging time ( $P < .001$ ), and their interactions ( $P = .007$ ) significantly affected the amount of hydroxyproline (pg/mg of mineralized dentin) extracted from mineralized dentin and were significantly correlated by power regression models. Collagen degradation was identified from the surface of dentin slabs that were in direct contact with CSMs.

### CONCLUSION:

Prolonged contact of mineralized dentin with CSMs has an adverse effect on the integrity of the dentin collagen matrix. However, the amount of collagen extracted was limited to the contact surface. Clinicians can continue to apply CSMs in endodontic procedures; however, caution is advised when these materials are applied to thin dentinal walls.

# Effects of calcium silicate-based materials on the flexural properties of dentin.

Sawyer AN, Nikonov SY, Pancio AK, Niu LN, Agee KA, Loushine RJ, Weller RN, Pashley DH, Tay FR.

## ABSTRACT

### INTRODUCTION:

Prolonged exposure of root dentin to calcium hydroxide alters the fracture resistance of dentin. Calcium silicate-based materials (CSMs) used in endodontics release calcium hydroxide on setting. This study examined whether prolonged contact of dentin with CSMs adversely affects its mechanical properties.

### METHODS:

Dentin beams prepared from extracted human molars ( $7 \times 3 \times 0.3$  mm) were divided into 3 groups on the basis of the material to which dentin was exposed (Biodentine, MTA Plus, and untreated control beams). Three-point flexure to failure was performed for each beam at designated exposure times (24 hours, 1, 2, and 3 months;  $n = 10$ ). Data were analyzed with 2-factor repeated-measures analyses of variance to determine the effects of material and aging time on flexural modulus, flexural strength, and modulus of toughness ( $\alpha = 0.05$ ).

### RESULTS:

For flexural modulus, there was no significant difference for material ( $P = .947$ ) or aging time ( $P = .064$ ) when compared with baseline control. For flexural strength, significant differences were associated with aging time ( $P < .001$ ) but not with material ( $P = .349$ ). Flexural strength of dentin exposed to Biodentine decreased significantly after 2 and 3 months, whereas that exposed to MTA Plus decreased significantly after 3 months of aging ( $P < .05$ ). For modulus of toughness, significant declines were observed for both material ( $P < .004$ ) and aging time ( $P < .001$ ).

### CONCLUSION:

Both CSMs alter material toughness more than the strength and stiffness of dentin after aging in 100% relative humidity. Because dentin toughness is attributed to its collagen matrix, the amount of collagen extracted from mineralized dentin and changes in collagen ultrastructure should be further examined after exposure of dentin to CSMs.

# Remineralization of artificial dentinal caries lesions by biomimetically modified mineral trioxide aggregate.

Qi YP, Li N, Niu LN, Primus CM, Ling JQ, Pashley DH, Tay FR.

## ABSTRACT

Fluoride-releasing restorative materials are available for remineralization of enamel and root caries. However, remineralization of dentin is more difficult than remineralization of enamel due to the paucity of apatite seed crystallites along the lesion surface for heterogeneous crystal growth. Extracellular matrix proteins play critical roles in controlling apatite nucleation/growth in collagenous tissues. This study examined the remineralization efficacy of mineral trioxide aggregate (MTA) in phosphate-containing simulated body fluid (SBF) by incorporating polyacrylic acid and sodium tripolyphosphate as biomimetic analogs of matrix proteins for remineralizing caries-like dentin. Artificial caries-like dentin lesions incubated in SBF were remineralized over a 6 week period using MTA alone or MTA containing biomimetic analogs in the absence or presence of dentin adhesive application. Lesion depths and integrated mineral loss were monitored with microcomputed tomography. The ultrastructure of baseline and remineralized lesions was examined by transmission electron microscopy. Dentin remineralization was best achieved using MTA containing biomimetic analogs regardless of whether an adhesive was applied; dentinal tubules within the remineralized dentin were occluded by apatite. It is concluded that the version of MTA employed in this study may be doped with biomimetic analogs for remineralization of unbonded and bonded artificial caries-like lesions in the presence of SBF.

MTA Plus was used

# **Biocompatibility and osteogenic potential of new generation endodontic materials established by using primary osteoblasts.**

Washington JT, Schneiderman E, Spears R, Fernandez CR, He J, Opperman LA.

## **ABSTRACT**

### **INTRODUCTION:**

Generex A and Generex B (calcium silicate based), Capasio (calcium-phospho-alumino silicate based) along with Ceramicrete-D (magnesium phosphate based) are being introduced as a new generation of endodontic materials with the potential to facilitate bone healing. The aim of this study was to evaluate the biocompatibility and osteogenic potential of these new materials by using primary osteoblasts.

### **METHODS:**

Primary osteoblasts were prepared from rat calvaria and exposed to mineral trioxide aggregate (MTA), Generex A, Generex B, Capasio, and Ceramicrete-D prepared to standardized size and shape (n = 5). Trypan blue staining was used to evaluate cell viability from 1-6 days. Mineralization potential was evaluated by scanning electron microscopy for the presence of mineralized nodules. Data were analyzed by Kruskal-Wallis and Mann-Whitney U tests.

### **RESULTS:**

Only Generex A and MTA allowed cell growth and proliferation throughout the experiment. There were statistically significant differences between groups throughout the experiment beginning on day 1. The greatest amount of cell growth was consistently observed with Generex A and MTA. There was no difference in mineralized nodule formation between any test materials.

### **CONCLUSION:**

Generex A was the only new generation endodontic material that supported primary osteoblast growth; no material besides MTA facilitated nodule formation.

# Physical and chemical properties of new-generation endodontic materials.

Porter ML, Bertó A, Primus CM, Watanabe I.

## ABSTRACT

### INTRODUCTION:

Mineral trioxide aggregate (MTA), white and gray, has many uses in endodontic therapy but is limited by its difficult handling characteristics. This study compared the physical and chemical properties of white MTA (WMTA) with three experimental root-end filling materials: Capasio (Primus Consulting, Bradenton, FL), Ceramicrete-D (Tulsa Dental Specialties/Argonne National Laboratory, Argonne, IL), and Generex-A (Dentsply Tulsa Dental Specialties, Tulsa, OK).

### METHODS:

The setting time and radiopacity were tested using International Organization for Standardization (ISO) 6876 methods. Compressive strength was measured following the ISO 9917 method. The pH of the materials was measured after mixing. A novel test was developed for washout resistance of the materials immediately after placement. Data were compared by analysis of variance and Sidak post hoc analysis ( $p < 0.05$ ) for compressive strength and washout resistance.

### RESULTS:

The setting time of Generex-A was half that of WMTA. All materials met the ISO 6876 requirements for radiopacity. The compressive strengths after 7 days decreased in this order: Generex-A > Capasio > WMTA > Ceramicrete-D. The initial pH of Capasio and Generex-A were alkaline, similar to WMTA, whereas that of Ceramicrete-D was acidic. Significantly, alternative materials remained in situ after the washout test, whereas WMTA was displaced from the retropreparations.

### CONCLUSION:

The clinical handling and washout resistance of the alternative materials were far superior to WMTA. The radiopacity, compressive strength, and washout resistance make Generex-A and Capasio materials suitable for further study. Ceramicrete-D was weaker, less radiopaque, and initially acidic.





Smiles ahead.

3315 West 12th Street  
Houston, TX 77008

[nusmile.com](http://nusmile.com)

713.861.0033 | 800.346.5133