**Methodology** Twenty four human single-rooted mandibular teeth were instrumented with System GT rotary files (Dentsply Maillefer, Switzerland) using a crowndown technique. Following removal of smear layer, teeth were randomly divided into two groups: Group 1: teeth were filled with the soft resin root filling system and Group 2 (control) with a cold lateral compaction technique using standard gutta-percha points. Epiphany root canal sealer was used in both groups. Horizontal sections were obtained from 1 mm up to 5 mm from the apex, using a low-speed saw. Digital colour images of sections were obtained at 40× under a stereomicroscope and transferred to an IBM compatible PC. Calculation of the canal area (in per cent) filled by material or sealer was performed by use of an image processor software (AutoCAD). The data were analyzed using unpaired Friedman Test and Mann Whitney-*U* tests.
**Results** There was no significant difference in apical filling adaptation between the groups.
**Conclusions** The new soft resin canal filling system was similar in terms of the apical adaptation of root filling in comparison with the conventional cold lateral compaction technique.

## R43

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### Microleakage of root filled teeth after cyclic loading when restored with Glassix posts and metal crowns

**Aim** To evaluate *in vitro* the microleakage of root filled teeth after cyclic loading when restored with Glassix posts and metal crowns.
**Methodology** In 30 filled root canals of central maxillary incisors Glassix posts (Harald Nordin sa, Chailly/Montreux, Switzerland) were cemented with either Harvard (Richter & Hoffmann, Harvard Dental GmbH, Berlin, Germany), Fuji PLUS (GC Corporation, Tokyo, Japan) or Variolink II cements (Vivadent, Schaan, Lichtenstein) in three groups of ten canals each. The coronal restoration consisted of composite cores (Clearfil core, Kuraray, Osaka, Japan) and metal cast crowns. Specimens were embedded in acrylic resin and loaded on a special testing machine. A load was applied at an angle of 135° to the long axis of the tooth, with forces oscilating from 0 to 35 N. Each specimen was exposed to 700 000 cycles through a period of 148 h. After performing cyclic loading, specimens were prepared for testing of microleakage. The acrylic bases were removed and the crowns were sectioned along with the composite cores and the coronal aspect of the Glassix posts to leave 15 mm long roots. Coronal microleakage was evaluated using a fluid transport system. The movement of an air bubble in a capillary glass tube connected to the apex of the experimental root section was measured over 5-min periods. Measurements were performed four times for each specimen and the mean values recorded. Analyses of variance were performed.
**Results** The highest values of microleakage (μL) occurred in the group cemented with Harvard cement (0.67), followed by Fuji PLUS (0.55) and Variolink II (0.22) cements. Results among the groups were significantly different ($P < 0.05$).
**Conclusions** Canals with Glassix posts cemented with Variolink II cement had the least leakage after cyclic loading.

## R44

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### A comparison of the penetration of three sealers into dentinal tubules: a SEM study

**Aim** To compare the penetration of Roeko Seal, AH Plus and Gutta Flow into dentinal tubules.
**Methodology** Fifteen single rooted extracted human teeth were used. The crowns of all teeth were sectioned and removed at the cemento-enamel junction. All canals were prepared chemo-mechanically up to a size 60 K-file and irrigated with 5.25 NaOCl, 30% citric acid and isopropyl alcohol. All teeth were randomly divided into 3 groups and filled with a single gutta-percha cone and sealer. In group 1 AH Plus (Dentsply DeTrey, Germany) was used as a sealer in groups 2 and 3 Roeko Seal (Coltene Whaledent, Germany) and Gutta Flow (Coltene Whaledent) were used respectively. The sealers were introduced into the root canals with a lentulo spiral. After setting the roots were grooved, longitudinally split and examined under a scanning electron microscope. The penetration of the sealers into the dentinal tubules was examined 3 mm, 6 mm and 9 mm from the root apex at 1500 and 3000 magnification. The focus of observation was the interface between the dentine and the sealing material. The numbers of examinations with positive sealer penetration were noted for each sealer and compared using Kruskal-Wallis and Mann-Whitney tests.
**Results** Statistical analyses revealed that in comparison with AH plus, the other two sealers had significantly more sealer penetration ($P < 0.05$). There was no significant difference in sealer penetration between Roeko Seal and Gutta Flow.
**Conclusions** AH plus sealer had better penetration into dentinal tubules than Roeko Seal and Gutta Flow.

# Research Posters – Materials Science

## R45

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### Physical characteristics and surface analysis of grey and white MTA and Portland Cement

**Aim** To analyze and compare the pH value, the conductivity, the particle size distribution and the surface characteristics of grey and white Mineral Trioxide Aggregate (ProRoot MTA, Dentsply, USA) and Portland Cement (PC).

**Methodology** pH value and conductivity were measured in suspensions produced after mixing material specimens that were allowed to set for 4 h with 50 mL of distilled water. Initial measurements were taken and subsequently repeated after 24 h, 48 h and 7 days. Particle size distribution of white MTA powder was measured using a CILAS device (Companie Industrielle de Lasers, France). This equipment counts the percentage of particles of different size in the material. Surface characteristics of material specimens, stored at 100% humidity and 37°C, were analyzed by profilometry (Diavite DH-5, Switzerland) at time intervals of 72 h, 7, 15 and 30 days. The values of Ra, Rz, Rmax, R3z, Rt and Rq were calculated and Abbott-Firestone curves were plotted for each specimen.

**Results** Grey MTA and PC had very similar pH and conductivity values at all time intervals. These values were slightly higher than those of white MTA and PC, which were themselves very similar. Particle size distribution analysis showed that 100% of the particles of white MTA had a diameter smaller than 24 μm. Profilometric analysis did not show any difference between the materials at any time interval. All of the specimens had a considerable surface roughness and the mean value of Ra (in μm) ranged between 1.71–2.13 for white MTA, 1.87–2.24 for white PC, 1.63–2.06 for grey MTA and 1.56–2.13 for grey PC.
**Conclusions** MTA has similar physical and surface characteristics to Portland Cement. This is especially true for materials of the same colour. However, particle size distribution analysis revealed an important difference between the materials: the mean particle size of MTA was half of the mean particle size of Portland Cement.

## R46

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### The effect of condensation pressure on selected physical properties of mineral trioxide aggregate (MTA)

**Aim** To examine the effect of condensation pressure after mixing on the surface hardness, micro-structure and compressive strength of MTA.
**Methodology** Tooth-coloured mineral trioxide aggregate (ProRoot, Dentsply, USA) was mixed according to the manufacturer's instructions, divided equally by weight and packed into cylindrical polycarbonate tubes. Six groups each of 10 specimens were prepared using pressures of 0.06 MPa, 0.44 MPa, 1.68 MPa, 3.22 MPa, 4.46 MPa and 8.88 MPa respectively. Pressure on each specimen was applied for 1 minute using a custom-made device. Condensed samples were retained in the polycarbonate tubes and kept in 100% humidity at room temperature for 4 days. The surface hardness of each specimen was measured using Vickers hardness. Data were subjected to one-way ANOVA. The micro-structure was analysed using a SEM after sectioning specimens with a scalpel.
**Results** A trend was observed for higher condensation pressures to produce lower surface hardness values. A condensation pressure of 8.88 MPa produced specimens with statistically significantly lower values in terms of surface hardness than other groups ($P < 0.001$). A condensation pressure of 1.68 MPa conferred the maximum compressive strength; however, it was not statistically different from the other groups. Higher condensation pressure resulted in fewer voids within the specimens, when sectioned and analysed with SEM, however, un-reacted MTA particles scattered in a non-uniform matrix were present. In specimens prepared with lower condensation pressure distinctive crystalline structures embedded within a more uniform matrix were seen.
**Conclusions** Variable factors may affect the strength and hardness of MTA and optimal hydration of the material crystals during setting may improve its physical properties.
**Acknowledgements** Mrs. Sadighe Salariye, Mrs. Wendy Rowe, Mr. Brian Western, Mr. D C Stone, Mr. P J Milward.

## R47

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### The effect of pH on the surface hardness and micro-structure of mineral trioxide aggregate

**Aim** To evaluate the effect of pH on the surface hardness and micro-structure of MTA.
**Methodology** Tooth-coloured mineral trioxide aggregate (ProRoot, Dentsply, USA) was mixed according to the manufacturer's instructions, divided equally by weight and packed into identical cylindrical polycarbonate tubes. Four groups each of 10 specimens were prepared using a pressure of 3.22 MPa applied for 1 minute in a custom-made device. Condensed samples were retained in the polycarbonate tubes and each group was exposed for 4 days to butyric acid that had been buffered at either pH 4.4, 5.4, 6.4 and 7.4 respectively. The surface hardness of each specimen was measured using Vickers hardness. Data were subjected to one-way ANOVA. The micro-structure was analysed using a SEM after sectioning specimens with a scalpel.
**Results** The highest surface hardness values were observed with pH 7.4 and the values decreased through to pH 4.4. The difference between the Vickers hardness values were statistically significant ($P < 0.001$). Specimens kept in contact with pH 4.4 butyric acid had un-reacted MTA particles scattered in a non-uniform matrix whereas those kept in contact with pH 7.4 had distinctive crystalline structures embedded within a more uniform matrix.
**Conclusions** Surface hardness and setting reaction of MTA is impaired in an acidic environment.
**Acknowledgements** Mohammad Saeed Sheykh Rezaeer, Dr Gabriel Adusei, Ms. Wendy Rowe, Mr. Brian Western, Mr. Christopher Fenton.

## R48

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### Chemical analyses of different gutta-percha products used for cold and warm filling techniques

**Aim** To determine the chemical composition of eleven commercially available gutta-percha materials for root canal filling and evaluate the differences between cold and warm gutta-percha products.
**Methodology** Eleven gutta-percha formulations were chosen for chemical analyses: Gutta-percha points (Dentsply Maillefer, USA), Thermafil (Dentsply Maillefer), Autofit for warm techniques (Analytic Endodontics, USA), Autofit for greater taper (Analytic Endodontics), Obtura (Obtura, USA), Ultrafil white-green-blue (Coltene/Whaledent, USA), Hygenic points (Coltene/Whaledent), Successfil (Coltene/Whaledent) and Softcore (Septodont, UK). The organic fraction (gutta-percha polymer and wax/resin) was separated from the inorganic fraction (zinc oxide, barium sulphate) by dissolution in chloroform. Gutta-percha polymer was precipitated with acetone and the remaining soluble material in acetone (wax/resin) was determined after evaporation. For the determination of the inorganic fraction new samples of the same materials were used. The samples were calcinated in an electrothermal oven at 550°C to eliminate organic compounds. The ashes were washed with

 

nitric acid to dissolve zinc oxide. Zinc oxide was determined by atomic absorption spectroscopy.

**Results** The minimum and maximum percentage of each component was as follows: for gutta-percha the lowest percentage (16%) was found in Ultrafil white, while Autofit for warm technique had the highest percentage (22%). The wax/resin percentage was 1% for Dentsply points and 4% for Obtura. The minimum percentage of zinc oxide (50%) was found in Softcore and the maximum (78%) in Dentsply points. Dentsply points also had the minimum percentage (3%) of barium sulphate, while Softcore had the maximum (27%).

**Conclusions** New gutta-percha formulations showed great chemical heterogeneity among different manufacturers and among different products of the same manufacturer used for cold and warm techniques.

## R49

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### Contact angles of various endodontic sealers

**Aim** To measure the contact angles of two conventional endodontic sealers, Roth (Roth International, USA) and AH26 (Dentsply De Trey, Germany), and two silicone based sealers, Roekoseal (Roeko, Germany) and Gutta-Flow (Coltene/Whaledent, Germany) on dentine and gutta-percha surfaces.

**Methodology** Controlled volume droplets of each sealer were placed onto 10 dentine disks and onto 10 gutta-percha slabs. A photo was taken of each specimen under standard conditions after 5 min and after 60 mins. The contact angle was measured mathematically with a goniometer attached to a computerized system. The contact angle was calculated from the base width and height of the droplet.

**Results** The mean values of contact angle onto dentine disks for the first observation period (5 mins) were for AH26 = 14.5, Roth = 11.1, Roekoseal = 44.6, Gutta-Flow = 45.1. The mean values of contact angle onto gutta-percha slabs for the first observation period were for AH26 = 18.2, Roth = 16.0, Roekoseal = 45.5, Gutta-Flow = 41.4. Lower mean values of contact angle for all sealers were obtained after 60 mins. Statistical differences were not found between the two conventional sealers and between the two silicone based sealers for the two observation periods. However, statistical differences were found between the conventional and silicone based sealers for the two observation periods (*t*-test, $P < 0.001$).

**Conclusions** Conventional sealers (AH26, Roth) had lower contact angles than the silicone based sealers (Roekoseal, Gutta-Flow).

## R50

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### Physical properties of newly developed root canal sealers

**Aim** To investigate selected physical properties of eight root canal sealers.

**Methodology** The radiopacity, film thickness, flow and compressive strength of AH Plus (DeTrey Dentsply, Germany), Epiphany (Pentron, USA), EndoREZ (Ultradent, USA), RC Sealer (Sun Medical, Japan), Acroseal (Septodont, France), Apexit (Vivadent, Leichtenstein), RoekoSeal (Roeko, Germany) and GuttaFlow (Coltene/Whaledent, Germany) were evaluated. Radiopacity and film thickness measurements were performed in accordance with the International Organization for Standardization (ISO) standard 6876-2001. Flow measurements were performed in accordance with ISO/DIS 6876-1984. For compressive strength measurements, cylindrical test specimens, 6 mm high and 4 mm in diameter were produced in stainless-steel moulds and tested in a universal testing machine after 1, 4, 18, 24 and 48 h of incubation.

**Results** The radiopacity ranged from 9.9 to 4.5 mm of aluminium and decreased in the following order: AH Plus > Epiphany > EndoREZ > RC Sealer > RoekoSeal > GuttaFlow > Apexit > Acroseal. The film thickness ranged from 3 μm to 43 μm and increased in the following: EndoREZ < RoekoSeal < Apexit < Epiphany < AH Plus < GuttaFlow < Acroseal < RC Sealer. The flow of the sealers ranged from 44.67 to 22.1 mm and decreased in the following order: RoekoSeal > Epiphany > Apexit > Acroseal > GuttaFlow > AH Plus > EndoREZ > RC Sealer. A wide variation in compressive strength was noticed ranging for fully set test pieces from 6.59 MPa (Apexit) to 336.39 MPa (EndoREZ). Except Epiphany, which reached maximum strength almost as soon as the material was hard enough to be removed from the mould, other sealers showed increasing compressive strength values for periods up to 2 days. GuttaFlow, RoekoSeal and RC sealer were unsuitable for testing compressive strength.

**Conclusions** The endodontic sealers had satisfactory physical properties according to the ISO standards 6876-1984 and 2001.

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## R51

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### Influence of occlusal contacts on stress distribution in two-rooted teeth restored with aesthetic endodontic posts

**Aim** To investigate the stress distribution of a new composite post and to compare the changes in the stresses in normal occlusion and in malocclusion.

**Methodology** The 3D finite element method (FEM) was used to perform the stress analysis of the two rooted first maxillary premolar restored with glass fibre posts. Composite resin was used as the core material and a full porcelain crown covered the preparation. Four noded tetrahedral elements were applied in the description of the tooth morphology, resulting in 1 684 512 elements and 246 510 nodes with 739 530 degrees of freedom. A total force of 200 N was applied.

**Results** In the case with normal occlusion, stress distribution was mainly compression in its nature (from −4.7 to −230 MPa), except in the fissure where stress was tensile (+2.9 MPa). In the case with malocclusion, tensile stress was generated on the cervical areas of both the sound tooth (+74 MPa) and restored tooth (+6.5 MPa). At the root furcation, tensile stress appeared only on the restored tooth (+4.7 MPa).

**Conclusions** In the case of malocclusion, the post and core modified the stress distribution at the root furcation, therefore increasing the possibility of root fracture.

## R52

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### The effect of polyethylene fibre on fracture resistance of immature maxillary central incisors

**Aim** To evaluate *in vitro* the reinforcement effect of a resin cement with or without leno woven ultra high modulus polyethylene fibre on fracture resistance of immature maxillary central incisors.
**Methodology** Forty sound extracted human maxillary central incisors were used in this study. In Group 1 (negative control, $n = 5$), access cavities were prepared and restored with composite resin. Teeth in Groups 2 to 5 were prepared with burs to simulate the thin dentinal wall of immature teeth throughout their length. The groups were restored as follows: Group 2 (Positive control, $n = 5$): access cavities were restored with composite to the level of the CEJ, Group 3 ($n = 10$): the canals were obturated with AH-Plus root canal sealer (Dentsply DeTrey, Germany) and thermoplasticized gutta-percha (Obtura, Unitek Corp., USA), Group 4 ($n = 10$) and 5 ($n = 10$): Apical 3 mm of the canals were obturated with AH-Plus root canal sealer and thermoplasticized gutta-percha. The rest of the canal system was filled with Panavia-F (Kuraray Co. Japan) in Group 4 and Panavia-F resin was reinforced with a polyethylene fibre (Ribbond, USA) in Group 5. After restoring the access cavities with composite. The specimens were stored in 100% humidity at 37°C for 24 h and then subjected to compressive force using an Instron testing machine at a crosshead speed of 0.5 mm/min until fracture. The data was recorded as Newton (N) and subjected to analysis of variance (ANOVA) and Tukey post-hoc test.
**Results** The mean load necessary to fracture the samples in each group were (in N): Group 1: 1019.22 ± 64.00a, Group 2: 391.86 ± 23.76b, Group 3: 398.99 ± 35.75b, Group 4: 781.54 ± 50.99c, Group 5: 925.71 ± 54.96d. Different letters show significantly different groups ($P < 0.05$).
**Conclusions** Use of resin cement in root canals of immature teeth increased fracture strength, however, the highest fracture strength values were obtained with reinforcement of resin cement using a polyethylene fibre.

## R53

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### Evaluation of the fracture resistance of root filled teeth restored with different restorative materials and post systems

**Aim** To compare the fracture resistance of teeth restored with new generation composite resins and two post systems following root canal treatment.
**Methodology** Seventy maxillary premolar teeth were used. The root canals were enlarged with K-files to size 50. A standard flare was produced using sizes 2–5 Gates Glidden drills. Irrigation was performed using a 2.5% NaOCl solution. The root canals were filled with gutta-percha and AH26 using the lateral condensation technique. MOD cavities were prepared in each tooth so that the thickness of the buccal wall measured 2 mm at the occlusal surface and 3 mm at the CEJ. The teeth were randomly allocated into 7 groups each comprising 10 teeth. Each group were restored with the following materials: Group 1: Control-intact teeth, Group 2: Prepared and filled, unrestored, Group 3: Packable composite resin (Solitaire2 + I Bond), Group 4: Packable + flowable composite resin (Solitaire2 + Flowline composite + I Bond), Group 5: Ormocer (Admira + Admira Bond), Group 6: Glass fibre post system (Everstick Post + Renew + One Step Bond), Group 7: Zirconia post system (Cosmo Post + Renew + One Step Bond). Using an universal test device a force of 1 mm/min at an angle of 150 degrees between tooth and material was applied to each specimen until failure. The Results were evaluated statistically using Kruskall Wallis.
**Results** Intact teeth were the most resistant; teeth prepared and unrestored had the poorest resistance values. Ormocer and the post groups were significantly more resistant ($P < 0.05$) than Solitaire2. No significant difference was found between Solitaire2 with or without flowable resin. Also no significant difference was found between the two post groups ($P > 0.05$).
**Conclusions** In this laboratory study flowable resin did not increase resistance to fracture whereas the glass fibre zirconia post systems combined with composite resin enhanced resistance. The fracture values of Solitaire2 and Solitaire2 with flowable composite may be a reflection of the one-bottle dentine bonding system I Bond.

## R54

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### A temporary filling material may cause cusp deflection, infractions and fractures in endodontically treated teeth

**Aim** To test the hypothesis that Coltosol F (Coltène/Whaledent Inc., Switzerland) might cause infraction and cusp fracture due to material expansion.
**Methodology** Thirty two extracted human molars were root filled and prepared with MOD cavities with or without undercuts. The specimens were filled proximally with glass ionomer cement and then occlusally with either Coltosol F or zinc oxide eugenol cement. The tooth specimens were kept in water at 37°C for a period of 20 days, and every second day, the inter cusp distance (ICD) of each specimen was measured in a travelling microscope, and the number of infraction lines as well as fractures were noted.
**Results** The number of infraction lines increased in teeth filled with Coltosol F. Between day 8 and 16, seven out of 16 teeth filled with Coltosol F had fractures and exhibited a mean increase in ICD of 316 ± 156 µm. Teeth filled with ZOE did not show an increase in number of infraction lines or in ICD, and none had fractures.
**Conclusions** The hygroscopic expansion of Coltosol F in a cavity may lead to cusp deflection, infraction development and fracture. The material is not recommended for temporary filling except for a few days.

## R55

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### Flexural properties of human dentine: an *in vitro* study

**Aim** To evaluate the mechanical properties of human root dentine under flexural stresses.
**Methodology** Standardized dentine bars ($n = 20$) with 1.5 mm × 1.5 mm sides and at least 10 mm in length were obtained from intact,

 

single rooted, completely formed human premolars, freshly extracted for orthodontic reasons. The specimens were selected from a pool of dentine bars evaluated for cracks and defects under stereomicroscope at 30× and with μCT analysis (Skyscan 1072, Assing s.p.a.; Belgium). The specimens were stored in normal saline until testing and then loaded to failure in a three-point bending test with an electronic dinamometer (Lloyd Instruments Ltd, UK). The three-point bending test according to the ISO 10477 standard (span 10.0 mm, crosshead speed 1.0 mm/min, cross-sectional diameter of loading tip 2 mm) was used to measure the flexural modulus and flexural strengh of the dentine bars. The load-deflection curves were recorded with PC-software (Nexygen Mt v4.5, Lloyd Instruments Ltd, UK).

**Results** The flexural modulus registered for human root dentine was 18.58 ± 3.7 GPa and the flexural strength was 216.38 ± 45.84 MPa.

**Conclusions** Mechanical properties of human root dentine under flexural stresses obtained in this study are similar to those obtained in other studies with different techniques (Young's Modulus), commonly considered the reference parameter in the evaluation of the mechanical properties of materials as posts. The values are similar to those reported for the most commonly used fibre reinforced root canal posts.

## R56

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### Effect of heat on the physical properties of dentine treated with saline or 2.5% NaOCl

**Aim** To evaluate the effect of heat on physical properties [flexural strength (FS), maximum strain (MS), storage modulus (SM) and tan delta (TD)] of dentine bars treated with either saline or 2.5% sodium hypochlorite.

**Methodology** Eighty-six dentine bars fabricated from different teeth were randomly distributed to 8 test groups and stored in 0.9% saline. Groups 2, 4, 6 and 8 were treated with 2.5% NaOCl for a period of 20 minutes. Groups 1, 3, 5 and 7 were untreated. Groups 1 & 2 ($n = 30$) and groups 3 & 4 (which were heat treated to 200°C for 10 min and re-hydrated in 0.9% saline; $n = 30$) were assessed for FS and MS using an Instron loading machine. Groups 5 & 6 ($n = 20$) were subjected to Dynamic Mechanical Analysis (DMA) to assess SM and TD, at room temperature. DMA was repeated after heating groups 5 & 6 to 200°C and repeated for a second time following re-hydration of groups 5 & 6 in 0.9% saline. Groups 7 & 8 ($n = 6$) were subjected to DMA continuously between 25°C–185°C. Raman spectroscopy was performed on a single dentine bar from each of the groups 1–4.

**Results** The mean FS or MS for groups 1 & 2 (no heat treatment) was not significantly different from groups 3 & 4 (subjected to heat). DMA of group 6 (subjected to 2.5% NaOCl) revealed a significant decrease in TD ($P < 0.05$) after heat treatment but no change in SM. Group 5 (untreated) showed a significant ($P < 0.05$) increase in SM and concurrent decrease in TD following heat treatment.

**Conclusions** Heating dentine up to 200°C is unlikely to affect its flexural strength or maximum strain irrespective of prior treatment with 2.5% NaOCl. The storage modulus is also unlikely to be affected by heat provided that re-hydration occurs.

## R57

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### Effect of irrigant solutions on the microhardness of root dentine

**Aim** To evaluate the effects of NaOCl, EDTA, EGTA, EDTAC, and Tetracycline-HCl solutions on the microhardness of root dentine.

**Methodology** Thirty single-rooted teeth were sectioned longitudinally into 2 equal halves. Each half was embedded in acrylic blocks and metallographic grinding and polishing completed. The 60 specimens were randomly divided into 6 equal groups. Vickers hardness of root dentine in the middle third was measured using a microhardness tester with a 200-g load with a 20 second contact time. The specimens were then irrigated for 1 minute using 2.5% NaOCl, 17% EDTA, 17% EGTA, 15% EDTAC, Tetracycline-HCl or distilled water. The microhardness procedure was repeated. The percentage differences before and after irrigation were analyzed statistically with ANOVA and Kruskal-Wallis tests.

**Results** All the irrigant solutions decreased significantly the microhardness of root dentine ($P < 0.05$). The difference in microhardness when EDTA was applied was significantly more than the other groups ($P < 0.05$). Although irrigation with Tetracycline-HCl, EDTAC and EGTA reduced dentine hardness compared to NaOCl irrigation, there was no statistically significant difference between them. EGTA application reduced microhardness significantly more than the distilled water ($P < 0.05$).

**Conclusions** EDTA irrigating solution reduced significantly the microhardness of root canal dentine compared to the other solutions.

## R58

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### *In vitro* examination of the effect of bleaching agents on dentine microhardness and atomic structure

**Aim** To evaluate the effects of non-vital bleaching agents on dentine microhardness and to investigate the changes created by these agents on dentine surfaces using Quartz Crystal Non-Contact Atomic Force Microscopy (NC-AFM).

**Methodology** The roots of twenty extracted mandibuler molar teeth were removed at the cementoenamel junction, and the crowns sectioned buccolingually and mesiodistally into 4 sections to measure microhardness of the dentine in such a manner that control and test sections were located on the same tooth. In each tooth one section was used as the control. On the remaining dentine sections either 10% hydrogen peroxide (HP), 30% HP and a paste of sodium perborate (SP) mixed with distilled water were applied. Dentine microhardness of all specimens were measured before and after application of bleaching agents. NC-AFM evaluation: Dentine sections were prepared in the same manner. Initially, all the surfaces covered with smear layer were examined by NC-AFM. After the removal of smear layer 10% HP, 30% HP and SP were applied on the same smear free surfaces for 15 min. NC-AFM examinations were made before and after application of the test materials.

**Results** Statistical analysis showed that HP solutions significantly reduced dentine microhardness when compared with SP ($P < 0.01$); but the most significant difference was produced after application of 30% HP. NC-AFM images and depth profiles demonstrated that both HP solutions deepened the grooves; their deepening effect increased with increasing concentration, SP caused minimal

microstructural changes in dentine that made the dentine surfaces relatively smooth.

**Conclusions** High concentrations of HP caused a significant decrease in dentine microhardness and caused microstructural changes. SP paste created less damage.

## R59

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### SEM investigation of the MTA/Composite interface in simulated immature teeth

**Aim** To evaluate the quality of the interface of MTA (Dentsply Tulsa, USA) and various types of composites in simulated immature teeth.

**Methodology** Seventy single rooted extracted teeth were selected, radiographed and their canals enlarged using a crowndown technique with Gates Glidden burs and K-type files. The apical 2 mm of each root were then removed and the apical portion of the canals were enlarged using K3 (SybronEndo, USA) in a retrograde approach to simulate an open apex. Teeth were randomly divided into 5 experimental groups and 2 controls. The experimental groups were filled using MTA to a depth of 4 mm at the apex followed by 5 different composite systems each used according to the manufacturer's instructions. Group 1 had a self cured composite; group 2 a base-increment self cured composite; group 3 a dual cured luting composite; group 4 and 5 had two different light cured composites. Teeth in group 6 had gutta-percha and sealer placed on the MTA and in group 7 the canals were filled completely with MTA (controls). Teeth were embedded in resin, longitudinally sectioned and processed for SEM to evaluate the interface between the dentinal wall, the MTA and the composite restorations. A scoring system was used and the Kruskall Wallis one-way ANOVA and the Mann-Whitney tests were applied.

**Results** The best interface was observed between the MTA, the light cured traditional composites and dentine; the results were statistically relevant ($P < 0.05$).

**Conclusions** In this laboratory study the best combination of MTA and composite for the filling of immature roots was obtained with light cured traditional composite.

## R60

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### A new device for cyclic fatigue testing of NiTi rotary endodontic instruments

**Aim** To evaluate a new device for cyclic fatigue testing of NiTi rotary endodontic instruments that permits the use of precise parameters for canal angle and radius of curvature.

**Methodology** The device consisted of a frame that supports a handpiece and a stainless steel block with artificial canals. Each artificial canal is matched for each instrument size and taper, in such a way that provides a precise trajectory pathway for the instruments. The number of cycles to failure (NCF) was compared in the new device (artificial canals calibrated and with tapered shape – Group A) and in 18-gauge stainless steel needles with an internal diameter of 0.83 mm (artificial canals not calibrated and with no tapered shape – Group B). The geometrical parameters were radius of curvature = 2 mm, angle of curvature = 60°; the point of maximum curvature was 6 mm from the tip of the instruments. Ten instruments ProFile (Dentsply Maillefer, Switzerland) taper .06 size 25 were tested for each Group. An electric handpiece was configured to rotate at 300 rpm. The NCF was calculated from the rpm data by multiplying the rpm by the time of failure. Data were analyzed by one way analysis of variance (ANOVA) and *t*-test using a 95% confidence level.

**Results** The mean NCF was significantly lower ($P < 0.005$) for Group A (NCF = 79.5 ± 8.5) than for Group B (NCF = 346.5 ± 24.7), despite the same geometrical parameters being used.

**Conclusions** If the artificial canal is not identical in shape and size to the instruments, their movement is less predictable and could influence the results of the cyclic fatigue test. The new device improves the reliability of cycling fatigue tests.

## R61

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### Root canal morphology of mandibular central and lateral incisors after root-end resection

**Aim** To evaluate macroscopically the root canals of mandibular incisors after root-end resection in horizontal cross-sections in the apical region, and on longitudinal sections.

**Methodology** The study included 120 extracted mandibular central and lateral incisors. After determination of the working length, the canals of all teeth were chemomechanically prepared 0.5 mm short of the apex foramen to size 40 K-file with a stepback technique and then filled with laterally condensed gutta-percha (Roeko, Germany) and AH Plus sealer (Dentsply DeTrey, Germany). After resecting horizontally 3 mm of each root apex, the canal shapes on the remaining root-end were evaluated. Longitudinal sections of the teeth were made in the labio-lingual direction and the morphology of the entire canal length assessed.

**Results** The following shapes of the canals in the apical region were observed on the horizontal cross-sections: I – a single round canal in 59% of the cases; II – two separate round canals with possible isthmus occurrence – 12%; III – a single canal with isthmus running in the labial and lingual directions – 29%. Five types of canals were found on the longitudinal sections: I – a single canal – 59%; II – two separate canals – 9%; III – two canals, main buccal and the second one lingual located 1–2 mm beneath the CEJ, fusing into one in the apical region or terminating with two separate orifices – 16%; IV – one canal dividing into two separate ones and fusing again into one – 13%; V – one canal dividing into two separate ones – 3%.

**Conclusions** In the apical region after root resection a round single canal was observed on horizontal cross-sections in the majority of mandibular incisors (59%). On longitudinal sections a single root canal was detected in 59% of the cases.

## R62

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### Solubility of AH 26 at different consistencies using Endosolv E and R root filling removers

**Aim** To compare the weight loss of AH 26 (Dentsply De Trey, Germany) at two consistencies in two different solvents: Endosolv R (Septodont, France) and Endosolv E (Septodont).

**Methodology** Forty standardized stainless steel ring moulds were filled with epoxy resin based root canal sealer AH 26 in either the normal ($n = 20$) or a viscous consistency ($n = 20$) after which the samples were allowed to set for 24 h at 37°C and 95% relative humidity. For the normal viscosity AH 26 was mixed at a one to one ratio as prescribed by the manufacturer, for the viscous consistency extra powder was added (1.25 : 1). The groups were each divided in

 

four groups ($n = 5$), and each group submitted to immersion in a solvent according to one of the following procedures: (i) Endosolv R for 1 minute, (ii) Endosolv R for 5 minutes, (iii) Endosolv E for 1 minute, (iv) Endosolv E for 5 minutes. The samples were dried for 24 h at 37°C. Before and after immersion and drying, the samples were weighed three times and the difference of the mean weights was calculated. The mean percentage loss of weight was calculated for each sample. The results were evaluated statistically using Kruskal-Wallis and Mann-Whitney tests. Level of significance was set at 0.05.

**Results** Solubility of AH 26 – normal was significantly higher than that of AH 26 – viscous ($P < 0.001$). Endosolv E caused significantly greater dissolution than Endosolv R ($P < 0.005$). There was no significant difference between 1 and 5 minutes immersion time.

**Conclusions** Although Endosolv E is believed to remove zinc oxide eugenol types of sealers and Endosolv R to remove phenolic resin type of sealers, under the conditions of this study, Endosolv E was a more effective solvent of AH 26. Increasing the powder-liquid ratio made AH 26 more resistant to dissolution.

# Research Posters – Pathology

## R63

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### Presence of T cell subpopulations in apical granulomas and apical cysts

**Aim** To investigate immunohistochemically the presence of T helper/inducer (Thi) and T cytotoxic/supressor (Tcs) lymphocytes in apical granulomas and cysts.

**Methodology** Periapical lesions which were to be treated surgically were used in this study. Twelve histologically identified granulomas and nine apical cysts were immunohistochemically stained employing the immunoperoxidase technique. Positive cells were counted under the light microscopy and analysed statistically.

**Results** In both cysts and granulomas, the mean number of Thi cells was more numerous than Tcs cells, but with no statistically significant difference. The Thi/Tcs ratios for cysts and granulomas were 1.09 (±0.94) and 1.14 (±0.74) respectively, without significant difference between the lesions.

**Conclusions** There was no predominating presence of a certain type of T cell subpopulation associated with the periapical lesion type. The Thi/Tcs cell ratios found in both granulomas and cysts may indicate that both lesions were in chronic phase.

## R64

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### Pulpoperiapical osteosclerosis: prevalence in contemporary and archaeological populations

**Aim** To describe pulpoperiapical osteosclerosis in sample populations from the same geographical region (southern France) over a period of 4 millennia through an epidemiological study.

**Methodology** Sample populations were selected on the basis of jawbone condition in terms of clinical and/or anthropological data. The oldest sample included 50 individuals from the chalcolithic hypogea (–2000 BC) in Roaix (Vaucluse). The historic sample (IVth to XVIth century) included 250 individuals from the Notre-Dame-du-Bourg grave site (Alpes de Haute Provence). The contemporary sample included 223 individuals recruited from various dental practices in the Gard Department, France. Data for all individuals were obtained by digital radiographic imaging of the jawbones using an image processing software application (Sensor CCD Visualix, Gendex Dental Systems, Italy). Differences in lesion prevalence were analysed in terms of individual and dental features (Period, age, and gender; jawbone, dental group, and tooth type). Statistical analysis was performed using the Chi Square tests and Fisher exact test.

**Results** The prevalence of lesions showed an increase between archaeological samples and then decreased in the contemporary sample ($P < 0.001$). Regardless of the time period lesions were more likely to be found on the mandible ($P < 0.001$) and to involve the molar group ($P < 0.001$), especially the first molars ($P < 0.01$). Age and gender did not appear to be significant factors.

**Conclusions** Comparison with other archaeological samples is not possible since there are no previous reports on pulpoperiapical osteosclerosis. Most of the findings in the contemporary sample are in agreement with those reported elsewhere. The decrease in the prevalence of these lesions could be attributable to improvement in living conditions and to the development of dental care. This has not been the case for most other apical pathosis.

## R65

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### Influence of electronically controlled periapical instrumentation on periapical healing

**Aim** To study the influence of electronically controlled periapical instrumentation on the healing of chronic periapical lesions in the teeth of dogs.

**Methodology** After inducing periapical lesions in six mongrel dogs for 35 days, root canal treatment was performed using two different protocols. In group 1, 'intracanal instrumentation' (3 dogs – 17 canals), canals were instrumented to the apical delta with crown-down technique using ProFile (Maillefer Dentsply, Switzerland) instruments and then filled with Thermafil obturators (Maillefer Dentsply, Switzerland). In group 2, 'electronically controlled periapical instrumentation' (3 dogs – 18 canals), following the same procedure as in group 1, the apical delta was perforated and additional instrumentation was performed using a hand H–file to the length determined by a resistance type apex locator (EED–11, Struja, Croatia), on average 1.05 mm beyond the apex. Canals were filled as in the first group, 2 mm shorter then the apical foramen, where a new artificial apical constriction was created. Thirty-five days after filling, undemineralized sections 5–7 μm thick were stained with Toluidine blue and analyzed using light microscopy. Histomorphometric indices (lesion width, lesion length, osteoid surface and osteoclast index) were measured using a computer program (ISSA, VAMS, Croatia). Results were statistically analyzed using Mann-Whitney *U* test.

**Results** The difference between groups in terms of lesion width was not statistically significant (group 1: 2.76 mm; group 2: 2.67 mm;