

# ESE Wladimir Adlivankine Research Prize, Education Prize and Original Research Abstracts

20TH ESE BIENNIAL CONGRESS



### Education Prize Thursday, 8th September

### **EP01 - DIGITAL ENDODONTICS: ENDODONTIC EDUCATION IN THE THIRD DIMENSION**

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Cone beam CT was first introduced to dentistry in Europe in 1998. Over the years, CBCT has proved to be a valuable tool in diagnosis and treatment planning. The impact of CBCT is that we can visualize the radiographic image of the tooth in 3 dimensions.

The Intraoral scanner has been introduced for digital impressions but its use has evolved and is already being used for clinical assessment of the dentition during regular check-ups.

CAD CAM technology can be employed for "root to crown" approaches in endodontics, where the post endodontic restoration can be designed, milled and fitted at the same appointment. The digital workflow appears to be very useful during student education in assessing occlusion, tooth preparation and also discussing treatment with the patient.

Education in a classroom has evolved from blackboards to LCD projector or the overhead projector to visualizers, document camera, video projectors and interactive whiteboards. The endodontic treatments have evolved similarly with the usage of CBCT, digital radiographs, Operating microscopes, electronic apex locators and thermoplastic obturation systems. These resources are important for the training of future endodontists. However, the general infrastructure of many institutions does not allow the use of these technologies.

The aim of this presentation is to highlight the growing importance of digital technology in the delivery of endodontic education to compliment the technological developments taking place in endodontics. The objective is to use CBCT and its associated software, intraoral scanner and CAD CAM systems to highlight improved method of endodontic care that can be be applied in an educational setting, by early career dentists and by the experienced dentists to evolve and utilize the benefits of digital dentistry

### EP02 - INFLUENCE OF THE INCORPORATION OF SMALL-GROUP PRACTICAL SEMINARS TO A TRADITIONAL LECTURE FOR THE UNDERSTANDING OF ROOT CANAL MORPHOLOGY CLASSIFICATION SYSTEMS.

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**Aim**: To analyse whether the incorporation of small-group practical seminars to a traditional lecture format improves the understanding and learning of the root canal classification systems in undergraduate students.

**Materials and Methods:** A small-group practical seminar was designed for 3rd year undergraduate students. The seminar consisted of the analysis of a guide-summary of three classifications systems for root canal morphology (Weine, Vertucci and Ahmed) followed by the discussion of practical cases and a practical exercise that included a template showing the external anatomy of the different dental groups in which the student was requested to draw several internal anatomies based on the different classifications. The students' opinion about the classification systems and the educational method used to learn them was registered through an anonymous questionnaire. The knowledge acquired was assessed in a final exam. The scores obtained were compared using the Mann-Whitney U test with those obtained in the cohort of the previous year in which only the traditional lecture was delivered.

**Results:** Students in the cohort that included the seminar obtained a significantly higher score (p = 0.006) in the final exam questions related to the classification of root canals (mean = 7.7; SD = 2.5) than those from the previous year (mean = 6.9; SD = 2.3). Most students agreed that Ahmed's classification system was the most complete (84%) and intuitive (89.2%), but also the most difficult to understand (67%). All the students believed that the small-group practical seminar helped them understand the new classification system.

**Conclusions:** The incorporation of small-group practical seminars to traditional lecture formats improved the understanding and learning of root canal configurations in undergraduate students. Students rated the classification system suggested by Ahmed et al. as the most complete and intuitive out of the three systems, but also the most difficult to learn.

### ESE Wladimir Adlivankine Research Prize Thursday, 8th September

# **RP01 - CHARACTERISATION OF A NOVEL BIOACTIVE STRONTIUM-BASED ENDODONTIC SEALANT**

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**Aims**: To design and synthesise a novel bioactive endodontic sealant that contains a bioactive glass (BAG) with strontium and fluoride embedded in a polydimethylsiloxane (PDMS) matrix. The physical and chemical properties of this sealant were compared with a commercially available, bioactive sealant, Guttaflow Bioseal (GFBS).

**Method**: Physical properties were tested for both sealants against ISO standard 6876 and included: radiopacity, solubility, setting time and flow rate. Chemical properties were also assessed after immersion of both sealants in simulated body fluid (SBF) and Tris buffer solution. The following were analysed: pH rise, ion release (via inductively coupled plasma optical emission spectrometry (ICP-OES)) and apatite formation via X-Ray Diffraction (XRD).

**Results**: Both sealants demonstrated physical properties that met ISO 6876. The novel sealant illustrated improved physical properties (higher radio-opacity, lower solubility, and increased setting time). The rate of the Na+ ion release from GFBS was greater than 50 times that of the novel sealant. This explains why the solubility was higher from the GFBS than from the novel sealant. The flow rates for both sealants appeared similar. Both sealants showed an increase in pH over three months, after immersion in solution. A higher pH rise was seen in GuttaFlow Bioseal. Both sealants showed ion release (Ca, Na, P and Si), with additional Sr release from the novel sealant. Strontium has been associated with upregulation of osteoblast and downregulation of osteoclast. GFBS had evidence of apatite formation after a 3-month immersion period in simulated body fluid, as seen from XRD analysis.

**Conclusion**: Both the novel sealant and GFBS demonstrated bioactive properties with ion release from both sealants and the ultimate formation of apatite from GFBS. The novel sealant showed improved physical properties with the addition of strontium increasing radiopacity and the reduction of sodium in the bioactive glass minimising solubility.

### **RP02 - THE ROLE OF THE KYNURENINE PATHWAY (KP) IN IRREVERSIBLE PULPITIS**

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**Aim**: The kynurenine pathway (KP) is associated with pain hypersensitivity and Indoleamine 2,3 Dioxygenase (IDO) is its first and rate limiting enzymatic step. IDO's connection to irreversible pulpitis and post-operative pain has not been explored. This study aims to investigate the role of the KP in irreversible pulpitis.

**Methodology**: The IDO activity of healthy and irreversibly pulpitic human teeth was examined using: HPLC; mRNA expression of enzymes of the KP using RT-qPCR; and immunofluorescence of cells involved in the KP. In separate experiments 'Odontoblast like cells' (OLCs) were generated from human dental pulp stem cells and stimulated using LPS and ODN2006 for 4 and 24 hrs. HPLC and RT-qPCR was then used to assess for changes in the KP in the OLCs.

**Results**: IDO activity was significantly raised in irreversible pulpitis compared to healthy teeth (Mann–Whitney U = 180.5,  $p \le 0.001$ ) but unrelated to the duration or intensity of pain. RT-qPCR indicated increased IDO activity drove the KP away from the neuroprotective agent kynurenic acid (Mann–Whitney U = 15.0, p < 0.001) and towards N-methyl-D-aspartate receptor activation, neuroinflammation and potentially persistent pain. Immunofluorescence demonstrated strong colocalization of signal for IDO and its product kynurenine with pulpal sensory afferents. Stimulation of the differentiated OLCs demonstrated that LPS and ODN2006 can both stimulate the KP in a manner which mimics irreversible pulpitis indicating these changes may take place in response to the bacterial invasion in irreversible pulpitis.

**Conclusion**: The KP is associated with a neuroinflammatory and neurotoxic role in irreversible pulpitis. It is intimately colocalised with sensory afferents and potentially driven by bacterial toxins. It is therefore likely that KP may play a role in the pain experienced during irreversible pulpitis. The nature of its activation in irreversible pulpitis may also increase the risk of persistent pain post-operatively.

### RP03 - ARTIFICIAL INTELLIGENCE BASED AUTOMATIC DENTAL ROOT CANAL SEGMENTATION FROM CONE-BEAM CT IMAGES

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**Aim**: Dental root canals have highly different morphology. 3D shape of dental root canals is a great help in planning endodontic interventions. This study aims to develop and evaluate an artificial intelligence (AI) based automatic root canal segmentation method able to support root canal treatment in dentistry.

**Methodology**: A UNet architecture based neural network model was defined for the root canal segmentation. The network parameters were adopted to the problem, where cone-beam computer tomography slices (501X501 pixel matrix, 100µm voxel size) were processed. The data set consists of mainly wisdom molars except for 5 upper premolars. 44 images were used to train the neural network model. 5 images were used to assess the method's accuracy by calculating the Jaccard index. In addition to quantitative evaluation of the segmentation accuracy, visual inspection by two medical experts was also applied to measure segmentation quality and visual appearance. Observers compared the visualized results from a high-efficiency semi-automatic segmentation procedure previously developed by the research team with the results from AI-based automatic segmentation method. Logistic regression model was used to determine the agreement among the observers.

**Results**: The UNet based neural network model has been successfully trained for the segmentation problem, the validation using the data set of 5 teeth showed no sign of over-fitting in training. The proposed model reached high segmentation accuracy, a high level of overlapping between the segmented volumes and the ground truth masks (0.85 Jaccard index). The result of the visual evaluation of the teeth showed that the experts appreciated the Albased segmentation better (81,6% and 93,9%) than the semi-automatic method. No significant difference among the observers (p>0.05) has been found.

**Conclusions**: New automatic root canal segmentation method was created. The results showed that the method could produce accurate root canal segmentation with similar accuracy to the semi-automatic method.

### **Original Scientific Research Posters**

# R001- CALCIUM HYDROXIDE RELEASES MORE ACTIVE DENTINE-DERIVED TGF-B1 THAN MTA AFTER IRRIGATION

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**Aim**: To analyse the influence of clinical irrigation protocol (IP) on the release of two TGF- $\beta$ 1 forms: active and latent (inactive pool for active form), both important for the dental tissue repair process dynamics, by calcium hydroxide Ca(OH)2 and mineral trioxide aggregate (MTA) from human radicular dentine.

**Methodology**: In present in vitro study we used matching root pairs model of 20 contralateral permanent lower incisors (40 teeth in total). Root canals were endodontically instrumented and randomly assigned to groups and each tooth subsequently to subgroup. Group I: subgroup1-control (mechanical instrumentation-MI+distilled water irrigation); subgroup2 (MI+IP-1% NaOCI, 17% EDTA). Group II: subgroup1 (MI+IP+Ca(OH)2); subgroup2 (MI+IP). Group III: subgroup1 (MI+IP+MTA); subgroup2 (MI+IP). Group IV: subgroup1 (MI+IP+Ca(OH)2); subgroup2 (MI+IP). Roots were incubated at 37°C/100% humidity/14 days. Then materials were removed, roots homogenized and stored at 4°C for 24h in PBS. TGF- $\beta$ 1 forms were quantified by ELISA method (with and without sample preprocessing). Paired t-test was used for statistical analyses.

**Results**: IP caused active TGF- $\beta$ 1 release similarly to control, but released significantly lower latent TGF- $\beta$ 1 levels than control (P<0.05). Ca(OH)2 and MTA applied after IP released significantly higher levels of both TGF- $\beta$ 1 forms than IP alone (P<0.05). Compared to MTA, Ca(OH)2 released significantly higher levels of active TGF- $\beta$ 1 after IP (P<0.05), while latent TGF- $\beta$ 1 levels did not differ (P=0.112).

**Conclusions**: After irrigation, Ca(OH)2 and MTA were able to provide significant increase in both, active and latent, TGF- $\beta$ 1 forms release and counteract negative effect of irrigation on latent TGF- $\beta$ 1 release. Ca(OH)2 showed superiority to MTA in releasing the active TGF- $\beta$ 1 after irrigation, while both materials showed similar ability to provide pool for the active TGF- $\beta$ 1 form, important for tissue repair process.

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# R002 - COMPARISON OF THE CYTOTOXIC ACTIVITY OF ALEXIDINE AND CHLORHEXIDINE ON CULTURED L929 FIBROBLAST: AN IN VITRO STUDY

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**Aim**: To examine the cytotoxic effect of chlorhexidine gluconate(CHX) and alexidine dihydrochloride(ALX) on cultured L929 fibroblasts.

**Methodology**: The cultured L929 fibroblasts were exposed to CHX or ALX solutions at concentrations of 0.0005%, 0.001%, 0.002%, 0.005%, and 0.01%. Cell metabolism was evaluated by MTT assay and cell morphology was assessed under scanning electron microscopy(SEM). Also analysis of reactive oxygen species(ROS) generation and detection of apoptosis and necrosis was done by flow cytometry at concentrations of 0.0005%, 0.001%, and 0.002%. Comparisons between the different groups were performed by One-way ANOVA followed by Tukey test or Dunnett T3 post hoc test at a significance level of 95%.

**Results**: In the MTT assay, higher cytotoxicity to the L929 fibroblasts was observed as the concentration of ALX or CHX increased, characterizing a dose-dependent cytotoxic effect of these chemical agents. ALX was more cytotoxic to L929 fibroblasts than CHX at the same concentration. Under SEM, marked alterations of cell morphology were observed in the groups subjected to ALX at all concentrations and CHX at concentrations of 0.005% and 0.01%. At all concentrations, CHX induced no significant apoptosis and necrosis of L929 fibroblasts. On the other hand, ALX induced a significant increase in the percentage of necrotic cell populations at all concentrations(p<0.05). Also 0.001% ALX induced significant apoptosis of L929 fibroblasts(p<0.05). Compared with control, ROS generation was increased with ALX at all concentrations and 0.001% ALX induced significantly increased ROS generation(p<0.05). However, CHX groups showed significantly decreased ROS generation compared with control(p<0.05).

**Conclusion**: Both ALX and CHX were found to impair cell function of the target cells in a dose-dependent manner. ALX had more cytotoxic effect than CHX. Its clinical significance, however, needs to be evaluated further because concentration used, exposure time to the agent, and exposure surface area are important factors affecting the resulting effect.

### R003 - LOCAL MIGRATION OF BISMUTH FROM PROROOT MTA AFTER CONTACT WITH CONNECTIVE TISSUE

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**Aim**: Mineral trioxide aggregate (MTA) consists of tricalcium silicate, dicalcium silicate, tricalcium aluminate and the radiopacifier bismuth oxide (BiO). BiO toxicity is a concern due to the possible migration to adjacent tissues. The aim of this study is to evaluate the tissue response, migration and local accumulation of bismuth after contact with subcutaneous tissue.

**Methodology**: Thirty-four animals were divided into 3 experimental groups, according to the cement implanted: tricalcium silicate (TCS) (n=10), ProRoot MTA (MTA) (n=10), hydroxyapatite with 20% BiO (HAp-BiO) (n=10), and negative control, without implantation (n=4). The animals were sacrificed after 30 and 180 days, and the cement was removed along with adjacent tissue after euthanasia. Histological analysis and local elemental migration were evaluated using microscopy techniques and inductively coupled plasma mass spectrometry (ICP-MS). Data was statistically compared using Anova or Kruskal-Wallis according to their parametric distribution (p < 0.05).

**Results**: The histological analysis from the samples showed a moderate inflammatory infiltrate after 30 days and subsided after 180 days to a chronic infiltrate. Bismuth was detected surrounding the MTA and Hap-Bi in both evaluated periods. A higher mean mass fraction was observed for Hap-Bi after 30 days in the connective tissue in comparison with the 180-day period. No statistical differences were found between MTA and Hap-Bi (p > 0.05).

**Conclusion**: It was concluded that the bismuth oxide used as radiopacifier in the ProRoot MTA has potential to migrate and to accumulate in connective tissue around implantation site.

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# R004 - PERIAPICAL TISSUE REACTION TO EXTRUDED BIOCERAMIC SEALERS AND EPOXY RESIN-BASED SEALER ON A RABBIT MODEL

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**Aim:** To evaluate the response of periapical tissues to the overfilling root canals with bioceramic sealers and epoxy resin-based sealer on a rabbit model.

**Methodology**: Maxillary and mandibular incisors from eighteen male rabbits were used in the study. The research protocol was approved by the Ethics Committee and conducted in accordance with DIRECTIVE 2010/63/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2010 on the protection of animals used for scientific purposes. After coronal access and pulp extirpation, the root canals were instrumented up to a size 25.04 with rotary files. The root canals were obturated with sealer and gutta percha by single cone technique, originating 3 experimental groups: G1- AH Plus (Dentsply DeTrey, Germany); G2 - TotalFill BC Sealer (FKG Dentaire SA, Switzerland); G3 - Bioseal (OGNA, Italy). The animals were killed by anesthetic overdose 7 and 30 days after endodontic treatment. The bone fragments with the treated incisor were obtained and serial histological sections were prepared for histomorphological study. Data were statistically analyzed by Wilcoxon nonparametric test at 5% significance level.

**Results**: The biocompatibility of sealers had a statistically significant difference between groups in 7-day period (p<0.01). At the 7-day observation, group 2 and 3 showed an initial mild to moderate iniammatory periapical reaction. Epoxy resin-based sealer showed a severe periapical tissue reaction for all observation periods. The only group to show a statistically significant reduction in iniammation during the 30-day period was the TotalFill BC Sealer (p>0.05).

**Conclusions**: After 30-day observation period, TotalFill BC Sealer was less toxic than AH Plus and Bioseal. Bioceramic sealer TotalFill BC Sealer proved to have ideal characteristics for biocompatibility with periapical tissues. AH Plus sealer remained toxic for the duration of the study.

#### R005 - REAL-TIME CYTOTOXICITY AND PHYSICOCHEMICAL PROPERTIES OF A NEW-POTENTIAL COPPER AND SILVER INTRACANAL DISINFECTANTS NANOMATERIALS ON HUMAN PERIODONTAL LIGAMENT (HPDL) CELLS

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**Aim**: To evaluate cytotoxicity and physicochemical properties of Ag and Cu-nanosols plus Ag and Cu-nanogels, stabilized with polyvinylpilorridone-PVP and polyvinylalcohol-PVA, as a new-potential intracanal disinfection materials.

**Methodology**: HPDL cell proliferation, viability, and morphology were quantified using real-time live cell microscopy with the IncuCyte S3 system, exposed for 3 days to Ag/Cu-nanosols and Ag/Cu-nanogels at different concentrations, generated by chemical reduction method assisted by microwave. Data were analysed using the one-way repeated measures analysis of variance (ANOVA p<0.05). Then, nanomaterials were characterized by UV-Visible spectroscopy, to analyze the effect of PVA on the stabilization of sols; Fourier Transform Infrared Spectroscopy (FTIR) in order to confirm the functional groups of both polymers; X-ray diffraction Analysis (DRX) to analyze crystallinity changes; Transmission Electron Microscopy (TEM), Scanning Electron Microscopy(SEM) and Atomic Force Microscopy(AFM) to observe the morphology. Ethics Committee approval (CEC-SSC 20-10-55).

**Results**: Cell proliferation in presence of all nanosols was significantly affected at 24 h. Ag-nanogel [low PVA-concentration] and Cu-nanogel [high PVA-concentration] lead to an increase in cell proliferation with no significant differences with the control group at 72 h. hPDL cells co-cultured whit them showed a spindle-shaped morphology. All nanosols and others nanogels inhibited cell growth in real time and significantly increased cell death and the hPDL cells morphology where smaller and rounder(p<0.05).

FTIR-spectra shows a characteristic pick at 3284 cm-1 of OH stretching vibration, corresponding to hydroxyl group from PVA was observed. Also, the bands at 2876 cm-1 of symmetric stretching correspond to the CH deformation modes from PVP ring, confirming the formation of gels. DRX, SEM, TEM and AFM micrograph shows porous surfaces with an increase in porosity in nanostructured gels, to the higher concentration of PVA.

**Conclusions**: The biocompatibility of the novel nanogels performed better than the nanosols, highlighting the cell proliferation of the high PVA-concentration Cu-nanogels in real time. Funding:FONDECYT- IN:11201236.

### R006 - CYTOCOMPATIBILITY OF THE NEW SILICATE-BASED ENDODONTIC SEALER AH PLUS BIOCERAMIC SEALER ON HPDLSCS: AN IN VITRO STUDY.

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**Aim**: To assess the cytocompatibility of the new calcium silicate-based sealer AH Plus Bioceramic Sealer (AHPbcs) on hPDLSCs compared to the classic epoxy resin-based sealer AH Plus (AHP) and the calcium silicate-based sealer Endosequence BC Sealer (ESbcs).

**Methodology**: Standardized set material discs and 1:1, 1:2, and 1:4 eluates of AHPbcs, AHP, and ESbcs were prepared. hPDLSCs were isolated from extracted third molars and characterized to confirm their mesenchymal phenotype. The hPDLSC extraction protocol was previously approved by the Human Research Ethics Committee from Universidad de Murcia (ID: 2199/2018). The following cytocompatibility assays were performed: hPDLSC viability via MTT assay (24, 48, and 72h), hPDLSC proliferation/migration via a wound healing assay (24, 48, and 72h), and hPDLSC attachment and morphology via scanning electron microscopy. Test groups consisted in hPDLSCs cultured with material eluates or sample discs. Negative control groups consisted of hPDLSCs cultured in unconditioned culture medium. Statistical significance was considered at p<0.05.

**Results**: Both ESbcs and AHPbcs-treated hPSLCSs exhibited a higher attachment than AHP-treated cells. hPDLSCs cultured with 1:1, 1:2 and 1:4 eluates of ESbcs, and 1:2 and 1:4 eluates of AHPbcs exhibited a significantly higher viability and migration/proliferation than AHP (p<0.05). AHP-treated cells exhibited a significantly lower viability and migration/proliferation than the negative control group (p<0.01).

**Conclusions**: The new AH Plus Bioceramic Sealer exhibits a significantly higher cytocompatibility than AH Plus on human periodontal ligament stem cells, comparable to that of Endosequence BC Sealer. The present study is the first to elucidate the cytocompatibility of the new AH Plus Bioceramic Sealer on human periodontal ligament stem cells (hPDLSCs).

Acknowledgements: The authors declare no conflicts of interest related to this study.

### R007 - RADIOGRAPHIC EVALUATION OF THE TECHNICAL QUALITY OF ROOT CANAL TREATMENTS PERFORMED BY POSTGRADUATE STUDENTS

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**Aim**: To evaluate the technical quality of root canal treatments performed by postgraduate students endodontology at Ghent University and to evaluate which clinical and diagnostic factors influence the outcome.

**Materials & Methods:** All final radiographs of endodontic treatments performed by postgraduate students during the academic year 2018-2019 were collected. Each canal was scored for density, length, taper and preparation errors as these factors are decisive for the technical quality of the treatment. If density, length and taper were scored adequate and if no preparation errors were present, the treatment was considered adequate. Treatments were scored at canal and tooth level. In order to obtain an adequate score at tooth level, each canal needed to be scored adequate. The clinical and diagnostic factors were extracted from the patient file and comprised: tooth type, quadrant, apical and pulpal diagnosis, level of experience of the postgraduate student, number of canals and appointments, location of rubberdam clamp, type of sealer and type of opening cavity. The curvature of each canal was determined as described by Luijten et al. (0-30° or >30°).

All data were introduced in SPSS software and statistically analysed using GEE.

**Results:** 1154 canals were included in the study. All canals showed a positive taper. At canal and tooth level density was scored adequate in respectively 96,1% and 93,8% of all cases, length in 94,7% and 90% and preparation errors in 1.2% and 3,1%. In general, in 90,3% of the canals and in 81,9% of the teeth the root canal treatment was found to be adequate.

Except for type of sealer, type of opening cavity and curvature, all clinical and diagnostic factors influenced the quality on one or more occasions.

**Conclusion:** The technical quality of root canal treatments performed by postgraduate students was high and was influenced by clinical and diagnostic factors.

# R008 - A MICRO-CT ANALYSIS OF FILLING ABILITY OF TWO ORTHOGRADE OBTURATION TECHNIQUES WITH OR WITHOUT RETROGRADE OBTURATION: A PILOT STUDY

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**Aim:** To assess the filling ability of two orthograde obturation techniques (single cone technique (SCT) and MTA placement) followed by the apical resection with or without retrograde obturation through micro-CT.

**Methodology:** A total of twenty single-rooted permanent teeth were prepared and randomized into four groups (n=5) according to the orthograde obturation technique (single cone with the bioceramic sealer BioRoot RCS (Septodont, Saint-Maur-des-Fossés, France) and MTA placement with the cement ProRoot MTA (Dentsply Maillefer)) combined or not with retrograde obturation (MTA cement placement). The root canal instrumentation was performed using Hyflex EDM rotary nickel–titanium instruments (Coltene, Coltene/ Whaledent AG, Altstatten, Switzerland) up to size 40,.04 taper in a closed root canal system. A single operator performed all the specimen preparation procedures. The volume of voids (VoV) within the entire endodontic space, the apical 3-mm and 1-mm after root resection was determined by micro-CT (SkyScan 1072; Bruker microCT, Kontich, Belgium). Data were analyzed statistically using the Kruskal-Wallis test to evaluate differences among groups in terms of total VoV and the Mann-Whitney test with Bonferroni correction for the pairwise comparisons. The significance level was set at 5% (SPSS Inc., Chicago, IL, USA).

**Results:** No significant differences emerged among the groups regarding the total VoV in all root canal as well as within the apical 1-mm after root resection. The SCT and apical resection without retrograde filling had significant better results in terms of VoV at the apical 3-mm after root resection.

**Conclusions:** Within the pilot study limitations, single cone technique combined with the apical resection without retrograde preparation reported similar or less amount of voids than the other groups. Thus, after validation in larger samples, single cone technique with a bioceramic sealer could represent a suitable alternative technique compared to the current gold standard for apicectomy in terms of clinical convenience.

### R009 - SYSTEMIC BISMUTH ACCUMULATION FOLLOWING SUBCUTANEOUS IMPLANTATION OF PROROOT MTA – IN VIVO ANALYSIS

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**Aim**: Migration of bismuth along the tooth from the material interface leads to dentine discolouration. The bismuth mobility raises a concern on its systemic uptake pattern. The aim of this study was to evaluate the systemic migration of bismuth using an animal model.

**Methodology**: ProRoot MTA, tricalcium silicate, hydroxyapatite with 20 and 80% replacement of bismuth oxide were implanted subcutaneously in 12-week-old Wistar rats (n = 40). Negative controls were used for comparisons (n = 6). After 30 and 180 days the animals were euthanized and the blood, brain, liver, and kidney samples extracted, and acid digested. The levels of bismuth, calcium, phosphorus and silicon in the digested blood and organs was assessed by inductively coupled plasma mass spectrometry (ICP-MS). Data was statistically compared using Anova or Kruskal-Wallis according to their parametric distribution (p < 0.05).

**Results**: All bismuth-containing materials exhibited an accumulation in the kidneys which increased with time. The blood levels were initially high but significantly subsided by 180 days (p < 0.05). The liver, and brain bismuth levels were lower and also subsided with time (p < 0.05).

**Conclusions**: The deposition of bismuth leached from ProRoot MTA in the kidney was high and cumulative. Besides, it was not possible to trace this ion in the blood after 180 days, making the long-term quantification of this potentially nephrotoxic ion harder. Therefore, the use of bismuth oxide in this material should be carefully reconsidered since this compound serves only as its radiopacifier and has been used clinically without any bismuth systemic levels monitoring.

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### R010 - FRACTURE RESISTANCE OF IMMATURE TEETH RESTORED WITH DIRECT AND INDIRECT RESTORATIONS

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**Aim**: To compare the fracture resistance of endocrowns builded by CAD/CAM with lithium disilicate ceramic and resin nanoceramic and, direct composite resin with fiber post in immature teeth treated with apical plug by a bioceramic cement.

**Methodology**: Eleven mm immaturized root were prepared from 60 maxillary incisors, divided into two groups (n=30). Biodentine was inserted as an apical plug and post spaces in 3- and 6-mm depth were obtained. According to the restoration type, each ten of samples were restored with direct composite crown and fiber post (Gr1), indirect lithium disilicate ceramic endocrowns (IPS e.max CAD, Ivoclar Vivadent, Ellwangen, Germany) (Gr2) and indirect resin nanoceramic endocrowns (CeraSmart, GC Coorp. Tokyo; Japan) (Gr3). Immature teeth with intact coronal portion were used as negative control (n = 10). In all of the groups, self-adhesive resin cement (Nova Resin; R&D Series, Imicryl, Konya, Turkey) was used to cement the endocrowns. Samples was subjected to oblique (45°) compressive loads for fracture resistance by using a universal testing machine (INSTRON). Maximum load of fracture (N) and failure modes were recorded. The data was statistically analyzed with two-way ANOVA and pairwise comparisons were performed with Bonferroni test (p<0.05).

**Results**: Fracture resistance of IPS e.max with 6 mm post in depth was higher than the ones with 3 mm (p<.05), however similar to the control group (p>.05). Fracture resistance of Cerasmart and composite with fiber post were higher than the ones with 3 mm (p<.05), however lower than the control group (p<.05).

**Conclusion**: Lithium disilicate ceramic endocrowns exhibited higher fracture resistance than resin nanoceramic and composite groups. Restorations with deeper posts showed better fracture resistance.

### **R011 - APICAL EXTRUSION OF THREE NEWLY DEVELOPED ROOT CANAL SEALERS**

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**Aim**: The aim of the present study was to measure apical extrusion of three newly developed sealers inserted with two different methods of sealer placement.

**Methodology**: 128 straight single-rooted teeth were divided into four groups according to the use of different sealers (AH Plus (AHP, as comparison group), Oxford Root FILL (Oxford), BioCal Root Sealer (BioCal) and Harvard MTA – RootSeal (MTA)). Each group was divided into two subgroups (n = 16 each) regarding sealer placement (Lentulo versus Eddy). Root canals were prepared to size 40, .04 taper using Hyflex instruments. The length of root canal preparation was kept in the range of 1 to 1.5 mm short of the anatomical apex. Patency was maintained by size 10, .02 taper C-Files 2 mm beyond the apex. Final irrigation was carried out with Citric acid 40%, NaOCI 3% and ethanol 70%. Root canals were filled with the respective sealer and an adjusted master point size 40, .04 taper. Extruded sealer was measured with a precision balance. Data was analysed using SPSS 21.0.

**Results**: Sealer placement had no significant influence on sealer extrusion (Mann-Whitney tests, P>0.05). Sealer extrusion varied significantly among sealers (Kruskal-Wallis test P<0.001). MTA showed significantly less extrusion than all other sealers (Mann-Whitney tests, P<0.01). The new sealers tended to show less or equal extrusion than the established material AHP.

**Conclusions**: Within the limits of the study, sealer placement showed no influence on sealer extrusion. The new sealers under investigation exhibited acceptable properties regarding sealer extrusion.

## R012 - COMPARISON OF PHYSICOCHEMICAL PROPERTIES AND CELL VIABILITY OF THE RECENTLY INTRODUCED BIOCERAMIC SEALERS

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Aim: This study aimed to evaluate the physicochemical properties and cell viability of recently introduced bioceramicbased sealers.

**Methodology:** In this study, AH-plus Bioceramic sealer (AH-bio), Bio-C sealer (Bio-C), EndoSequence BC Sealer (BC-sealer), and Total Fill (Total-Fill) were compared to evaluate flow, setting time, radiopacity, and pH change according to the international standards such as ISO 6876/2012 and ANSI/ADA's specifications No. 57 (n = 10 per each test). Cytotoxicity on human periodontal ligament fibroblast cells was compared for biological properties using MTT assay (n = 6). MTT assays were performed after exposure of cell culture media to sealer samples for 72 hours. All sealers were mixed and manipulated depending on the manufacturers' instructions.

For data analysis, SPSS software was used. Shapiro-Wilk test was used for the normality test and Levene's test was used for homogeneity of variance test. One-way analysis of variance (ANOVA) and Tukey's post hoc test was used for flow, setting time, radiopacity and pH changes. The Kruskal-Wallis test was used for the analysis of MTT assay. The significance level was set at P<0.05.

**Results:** AH-bio (mean; 33.80 mm) and Bio-C (mean; 31.00 mm) presented significantly higher flow then the other groups (P<0.05). AH-bio had the longest (mean; 475 min) setting time and Bio-C (mean: 83 min) showed significantly shorter setting time than others (P<0.05). AH-bio showed significantly higher values of radiopacity (mean; 10.15 mmAl) than others (P<0.05). All sealers showed high alkaline pH from set materials in all evaluation periods from 12h to 4 weeks and there were no significant differences between groups(P>0.05). They showed maximum pH of 12 at 7-day evaluation and the pH was gradually decreased but still higher than 10. MTT assay showed that all sealers have similar cell viability.

**Conclusions:** In conclusion, the bioceramic sealer showed clinical acceptable physicochemical properties and favorable cell viability.

#### R013 - ARTIFICIAL INTELLIGENCE IDENTIFICATION OF MATERIAL AND PORES IN ROOT CANAL FILLINGS IMAGED IN 3 DIMENSIONS BY HIGH-RESOLUTION PHASE CONTRAST-ENHANCED MICRO-CT

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**Aim**: To examine the reliability of artificial intelligence (AI) as a tool for identification of pores and sealer in high-resolution 3D phase contrast-enhanced  $\mu$ CT (PCE-CT) data, as compared with manual segmentation (MS).

**Methodology**: Fifteen human, single-root mandibular premolars were prepared to ISO/conicity 40/04 (Hyflex EDM&CM, Coltène) 1 mm short of the apex and filled by Gutta-percha (GP) and one of three sealer materials: AH-Plus (AHP) (Dentsply Sirona), Bioroot-RCS (BRCS) (Septodont) and TotalFill-BC Sealer HiFlow (TFHF) (FKG Dentaire).

The samples were scanned with PCE-CT at 2.2 µm resolution, reconstructed and the apical 1 mm region containing ~0.3 mm sealer and ~0.7 mm GP was analyzed with Dragonfly (ORS, Montreal, Canada) by segmentation either manually (MS) or by trained U-net AI. Each method was used to quantify sealer pores. Pearson correlation and 1-way ANOVA (Tukey post-hoc test) were used for method and material analyses, respectively.

**Results**: For AHP, MS revealed 22.2 (13.8) % voids versus 20.1 (17.5) % by AI [mean (SD)]. BRCS showed 43.1 (9.2) % voids for MS and 39.9 (9.4) % for AI; TFHF found 8.5 (2.8) % by MS versus 7.8 (1.3) % voids by AI. The mean difference between MS and AI was 2% (Confidence interval: -2.17 - 6.2), both methods were highly correlated (0.94; p < 0.0005; Pearson). Irrespective of the analysis method BRCS has significantly more voids compared to AHP and TFHF (p < 0.05; Tukey).

**Conclusions**: Based on the trained classifications for GP and sealer, AI may slightly underestimate the extent of the pores adjacent to the root treatment material. MS is more human-time consuming compared to AI but can better classify artefacts and similar grey values. Future work should compare additional root treatment materials and may be used to also assess larger numbers of samples and additional materials such as dentine.

### R014 - ROOT CANAL INSTRUMENTATION WITH ROTARY FILES PROMOTES IRRIGANT PRESENCE AT WORKING LENGTH

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Aim: To determine irrigant presence at working length after root canal instrumentation

**Methodology**: Twelve transparent 3D models of maxillary first premolar with 2 canals were used. After working length (WL) determination, the models were randomly distributed into 3 groups to be instrumented with Mtwo (#15/.05, #20/.06, #25/.06, #35/.04), Aurum Blue (#17/.025, #20/.04, #25/.06, #35/.04), TruNatomy (#17/.02, #20/.04, #26/.04, #36/.03) files. Irrigation between files was performed with 1 ml of contrast solution deposited in the pulp chamber between each file with a side-vented needle. The instrumentation procedures were recorded in digital video format. A baseline image and a still image each time a file was removed from the canal after reaching working length were saved. If WL was reached by the irrigant the number of the file last used within the specified sequence was noted. The independent variable was group (Mtwo, Aurum Blue or TruNatomy) and the dependent variables were whether WL was reached and after which file. The data were analyzed using the Kruskall-Wallis test using the statistical package R 3.3.1. (R Core Team 2016) with a significance level of 5%.

**Results**: WL was not reached in two specimens each in the Mtwo and Trunatomy groups. In most cases, the irrigant reached WL after the 3rd or 4th file within all groups (median was 3.5, 3 and 3.5 for Mtwo, Aurum Blue and Trunatomy, respectively). No statistically significant differences were found between the groups (p = 0.339).

**Conclusion**: The irrigant reached the WL during instrumentation with rotary files in most cases and the observed trend was that WL was reached after the use of the larger files.

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### R015 - EFFECT OF DIFFERENT ROTATIONAL SPEED AND LUBRICANTS ON THE SHAPING ABILITY OF TRUNATOMY NITI FILES

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**Aim**: To evaluate the effect of two rotational speeds and lubricates on the shaping ability of TruNatomy NiTi (TN) files including canal geometry, centering ability, and preparation time.

**Methodology**: Seventy-two simulated resin blocks with a J-shaped canal were divided into four combinations (n=18) according to speed and type of lubricants (500/EDTA, 500/NaOCI, 700/EDTA and 700/NaOCI). A total of 12 new TN25 files were used (n=3 files per group). Therefore, each file was used to shape 6 blocks. All preparation were carried out using crown-down technique. Pre- and post-instrumentation images of each canal were superimposed to calculate the change in canal diameter and centering ratio at five measuring points: straight part of the canal (SP), beginning of curvature (BC), middle of curvature (MC), end of curvature (EC) and apical foramen (AF). The mean preparation time was also recorded. Finally, deformation of files was checked after each use under stereomicroscope. The effect of speed, lubrication and their combination were analyzed utilizing Two-way ANOVA under significant level 5%.

**Results**: Higher speed led to significantly larger canal diameter at SP and MC points (P = 0.015) while EDTA led to larger canal diameter along all measured points (P<0.05) except EC. The interaction between speed and type of lubricants showed larger diameter with 700 RPM and EDTA at MD (P = 0.017). No significant effect of speed and/or lubricant type was observed on the centering ability at all points in all groups (P> 0.05). Higher speed resulted in a significantly shorter preparation time (P = 0.001). Deformation signs with no fracture were detected in 1 file of 700/NaOCI group and 2 files of 700/EDTA group.

**Conclusions**: High-speed revealed faster preparation time and maintained the canal centering ability but showed higher deformation rate. Using EDTA lubricant seems to increase the cutting ability of NiTi files.

#### R016 - ABSENCE OF DENTINAL MICROCRACKS AFTER CANAL PREPARATION WITH ROTARY AND RECIPROCATING SYSTEMS USING AN IN SITU CADAVER MODEL AND MICRO-CT

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**Aim**: To assess the impact of root canal preparation with XP-endo Shaper and Reciproc Blue systems on the development of dentinal microcracks using an association of an in situ cadaver model and micro-computed tomography technology.

**Methodology**: At autopsy, 10 maxillary bone blocks with the first and second molars were excised, scanned at a resolution of 13.18  $\mu$ m and distributed into 2 groups (n = 10 teeth) according to the canal preparation protocol used: XP-endo Shaper and Reciproc Blue systems. In the XP-endo Shaper group, all root canals were prepared according to the manufacuter's recommendations, but the palatal canal was subjected to an extra 45 s of active instrumentation at the working length. In the Reciproc Blue group, mesiobuccal and distobuccal canals were prepared up to the Reciproc Blue R25 instrument, while the palatal canal was prepared up to the Reciproc Blue R40 instrument. After the preparation procedures, the bone blocks were scanned again, and the registered preoperative and postoperative cross-section images of the roots (n = 22,840) were screened to identify the presence of dentinal defects.

**Results**: After the analyses of 22,840 slices (11,520 and 11,320 in the XP-endo Shaper and Reciproc Blue groups, respectively), no dentinal microcracks was observed in both pre- and postoperative cross-section images.

**Conclusion**: No dentinal microcrack was observed in situ neither in the baseline images nor after root canal preparation with XP-endo Shaper and Reciproc Blue systems in fresh cadaveric bone blocks.

### R017 - SHAPING ABILITY OF NEW REVOS + AND PROTAPER GOLD: A CONE-BEAM COMPUTED TOMOGRAPHY STUDY

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Aim: To explore root canal transportation (RCT) performed by RevoS +® (RS+) and ProTaper Gold® (PTG) instruments in endodontic training blocs by using a new cone-beam computed tomography (CBCT) automated method.

**Methodology**: Thirty-two endodontic training blocs (ETB) with J-shaped canals were scanned with a CS 8100 3D® CBCT (75µm). Two acquisitions of each ETB were performed in quick succession in order to improve image quality by averaging acquisitions. ETB were divided in two groups and each Nickel-Titanium instrument was used to prepare dedicated group, half at 250 rpm and half at 400 rpm (Ai-Motor, DTE – WoodPecker). Instruments are changed after each canal. ETB were then scanned again as before. Volumes, amount of transportation and centring ability were automatically evaluated using a specific developed image processing tool for CBCT acquisitions. ANOVA and PLSD Fischer's test were performed with an alpha risk fixed at 5%.

**Results**: Significant differences were found between RS+ and PTG concerning canal transportation (p<0.001), and speed (p<0.001). Both increase the endodontic volume with reduced canal transportation even if the RS+ deviate it slightly more than the PTG. The difference is less than 50 $\mu$ . A better centring ability is generally observed at 400 rpm and particularly in the apical third. RS+ procedure appears significantly faster than with PTG files (p < 0.05).

**Conclusions**: Even if the design, the number of files and the protocol were different, RS+ and PTG with post machining heat treatment were able to produce centred preparations with no significant procedural errors.

**Key learning points:** High speed (400rpm) gets a better centred shape of the canal in endodontic training blocs with J-shaped canals.

#### R018 - ROOT CANAL VOLUME, CANAL TRANSPORTATION AND CENTERING ABILITY OF PROTAPER NEXT, PROTAPER GOLD, WAVEONE GOLD, AND RECIPROC BLUE USING MICRO-COMPUTED TOMOGRAPHY 3D MODELLING ANALYSIS

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**Aim**: This study determined the volume changes in the root canal space, the apical canal transportation, and the filecentering ability of four thermomechanically heat-treated new generations of engine-driven NiTi instruments with different kinematic motions and sequences in mandibular premolar teeth.

**Methodology**: Forty freshly extracted human mandibular premolars with a single-canal and straight root were assigned to four experimental groups (n = 10), in each of which one of the following instrumentation systems was used: ProTaper Next (PTN), ProTaper Gold (PTG), WaveOne Gold (WOG) and Reciproc Blue (RCB). The samples were scanned using high-resolution (9µm) micro-computed tomographic (micro-CT) imaging before and after the root canal preparation. The samples were prepared to file size #25. The micro-CT analysis of the samples was performed to measure the volumetric changes and the mesial and distal dentin thicknesses at 1mm, 3mm and 5mm locations from the root apex to determine the apical transportation and the centering ability. The results were analysed using parametric and non-parametric tests.

**Result**: There was a significant difference in the root canal volume before and after the preparation (P=0.00). However, there was no significant difference in the canal volume gain among all the tested files regardless of the systems and the kinematic motion. All the files had some degree of apical transportation but it was not statistically significant between all the files at 1mm (P=0.891), 3mm (P=0.632), and 5mm (P=0.845). All files had similar centric ratios at 1mm (P=0.678), 3mm (P=0.450), and 5mm (P=0.413).

**Conclusion**: Over-instrumentation may lead to a procedural error. The study showed that all tested files increased the root canal volume. The files could not stay at the centre of the canal, which created apical transportation during canal preparation.

# R019 - TREATMENT OUTCOME OF SURGICAL AND NON-SURGICAL ENDODONTIC RETREATMENT OF TEETH WITH APICAL PERIODONTITIS

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**Aim**: To evaluate and compare the treatment outcome of root-filled teeth with apical periodontitis treated either nonsurgically or by endodontic surgery, and to assess the influence of an intra-radicular post, clinical and demographic factors.

**Methodology**: Clinical and radiological data from 458 patients with apical periodontitis in previously root-filled teeth at the Department of Endodontics, University of Oslo, between September 2010 and January 2020 were studied. Surgical cases were scored using the Rud/Molven criteria and grouped into success, uncertain or failure at control. Nonsurgical cases were scored with the periapical index (PAI) and similarly grouped into success, uncertain or failure. Chi-square and regression analyses were used in comparisons of subgroups of teeth treated.

**Results**: Non-surgical retreatment was performed on 351 teeth and 107 teeth were treated with microsurgery, with overall success rates of 65.5 % and 77.6 %, respectively. The difference was statistically significant. Teeth with intra-radicular post treated non-surgically (n=30) were successful in 73.3 % of cases, whereas teeth with intra-radicular post treated with apicoectomy and retrograde root filling (n=30) had a significantly lower, 66.7 % success rate. When surgical cases were tested separately against other recorded parameters, no factor showed a significant association with treatment outcome. Non-surgical retreatment cases was significantly influenced by patients' age (older patients had poorer outcome) and preoperative PAI score (negatively correlated with outcome).

**Conclusions**: The tooth type differed significantly for teeth treated by surgical versus non-surgical methods. Microsurgical treatment with apicoectomy and retrograde filling showed significantly better treatment results than non-surgical retreatment of teeth with apical periodontitis, whereas treatment outcome in teeth with posts after non-surgical treatment tended to be better than after surgical treatment. Outcome of non-surgical retreatment was negatively influenced by older age and higher preoperative PAI score.

#### R020 - EARLY PHASE CLINICAL TRIAL OF NON-SURGICAL ROOT CANAL TREATMENT WITH RECIPROCATING ONERECI VERSUS CONTINUOUS ROTATION ONECURVE INSTRUMENTS

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**Aim**: To evaluate 6-month clinical outcome and post-operative pain of teeth treated with reciprocating OneReci or continuous rotation OneCurve instrumets.

**Methodology**: For this study 41 teeth (35 subjects, mean age 42.2  $\pm$  15.3 years), shaped with OneReci (n=21) vs OneCurve (n=20) instruments were involved in a recall programme. Teeth were irrigated with 5% NaOCI and 10% EDTA and filled with Thermafil and AH Plus sealer or single cone with Neosealer bioceramic. Patients were prospectivly re-examined after 3 and 6 months in a controlled environment. Clinical and radiographic data were obtained and the following parameters were evaluated: preoperative Periapical Index (PAI) score and signs/symptoms, post-operative pain using visual analogue scale (VAS) for a week after the instrumentation and follow-up PAI score. Teeth were considered 'healthy' (PAI  $\leq$  2, no signs/symptoms) or 'diseased' (PAI  $\geq$  3, signs/symptoms present, retreated, extracted for endodontic reasons). Two PAI-calibrated examiners assessed outcomes blinded to preoperative status. Chi-square test evaluated the outcome between these two instrumentation techniques.

**Results**: No drop-out were registered. At 6-month evaluation, survival rate was 100% and 92% percent of the teeth were classified as healed. No statistically difference was observed on clinical outcome between the two different types of instrumentation. Post-operative pain was higher in patients treated with OneCurve in continuous rotation than OneReci reciprocating instruments ( $p\leq.05$ ).

**Conclusions**: Clinical outcome shows a high rate of survived and healed teeth with both type of instrumentations. Post-operative pain was higher in teeth treated with OneCurve continuous rotation than OneReci Reciprocating instruments.

### R021 - OUTCOME OF ROOT CANAL TREATMENT OF TEETH WITH APICAL PERIODONTITIS IN PATIENTS WITH TYPE 2 DIABETES

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**Introduction**: To investigate outcome of root canal treatment of teeth with apical periodontitis in patients with type 2 diabetes.

**Material and methods:** Seventy-five patients with apical periodontitis were divided into three groups: type 2 diabetic with well-controlled disease (HbA1c<7%; n=25), type 2 diabetic with poor-controlled disease (HbA1c≥7%; n=25), and healthy subjects (control group; n=25). Twelve months after completion of endodontic treatment, 69 patients were evaluated. Treatment outcome was assessed by clinical and radiographic criteria. The periapical index (PAI) was used for the radiographic evaluation of treatment and dichotomized as healed (PAI ≤2) or not healed (PAI≥3). Data were analyzed using chi-square test ( $\alpha$ =0.05).

**Results:** Clinical success of root canal treatment was observed in all subjects 12 months after treatment. Treatment success (PAI≤2) was observed in 79.2% of control subjects and was higher compared to type 2 diabetic patients with good-controlled disease (65.2%, p>0.05) and type 2 diabetic patients with poor-controlled disease (40.9%, p=0.008).

**Conclusion:** The obtained results show that poor-controlled type 2 diabetes may reduce the success of endodontic therapy of teeth with apical periodontits.

**Key words:** apical periodontitis, diabetes mellitus, endodontic therapy, glycosylated hemoglobin, periapical index, treatment success.

### R022 - EFFECT OF MTAD ON OUTCOME OF PRIMARY ROOT CANAL TREATMENT: A RANDOMIZED CONTROLLED TRIAL

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**Aim:** To compare the radiographic outcome of a root canal treatment with and without additional use MTAD solution after 24 months recall.

**Methodology:** One hundred single-rooted teeth with periapical radiolucency of 100 patients were randomized into two groups using a randomized block design with block sizes of 10 patients each. Root canals were prepared with Reciproc Blue and irrigation was performed with 5 ml 2.5% NaOCI during instrumentation. Final irrigation protocol was performed using 5 ml 2.5% NaOCI (n= 50) or 5 ml MTAD (n=50). Then the root canals were irrigated with 5 ml of saline and obturated with gutta-percha and AH Plus sealer. Three patients were excluded due to pregnancy, systemic disease and use of medicament. The 97 patients were recalled and evaluated radiographically at 24 month according to PAI scores. Twenty five patients were lost during follow-up period. Pre and posttreatment PAI scores were compared and teeth were considered 'healthy' (PAI  $\leq$  2) or 'diseased' (PAI  $\geq$ 3). Mann-Whitney U test was used to compare the differences between the post-operative and follow-up images. Wilcoxon signed rank test was conducted to examine the changes in PAI score from base line to the follow-up evaluation.

**Results:** Seventy two patients were reexamined 2 years after treatment. Overall, a statistically significant decrease in PAI score from the base line to the follow-up evaluation was seen in 65 of 72 teeth. Absence and reduction of the radiolucency together were observed in the MTAD group in 33 of 37 teeth (89.2%) and 32 of 35 teeth (91.4%) in the NaOCI group. There was no significant difference between the results of decrease in PAI score was seen in both groups (P = 0.551).

**Conclusion:** Root canal treatments with and without MTAD irrigation contributed equally to periapical healing.

### R023 - CLINICAL SIGNS AND SYMPTOMS OF APICAL PERIODONTITIS: A PROSPECTIVE COHORT STUDY

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**Aim:** Assessment of effect of endodontic treatment on prevalence of clinical signs and symptoms of apical periodontitis (AP) among patients of private endodontic practice.

**Methodology:** Primary or secondary endodontic treatments were performed by single endodontist according to ESE guidelines (2006) in 1143 teeth of 654 patients. Before and 1-4 years post treatment (mean follow-up time 24 months), several clinical parameters were registered on every tooth (presence and nature of pain, swelling, sinus tract; periodontal parameters: gingival pocket depth, furcation involvement, and mobility of tooth; periapical involvement using palpation and percussion) and radiographic parameters (periapical index (PAI), lesion diameter) on every one of 2217 roots by single calibrated examiner. Pre- and post-treatment data were statistically analysed with paired-samples t-test, Wilcoxon signed-rank test, sign test, and McNemar's test, p was set at 0.05.

**Results:** A significant decrease was noted in proportion of painful teeth over the follow-up period from 51.3% to 5.0%. Prevalence of swelling and sinus tract decreased from 8.4% to 1.4% and 6.4% to 1.9%, respectively (p=0.0005). Significant decrease was observed in periapical involvement for both percussion (51.5% to 4.4%) and palpation (22.3% to 3.1%). Radiographic parameter PAI decreased in 44.7%, increased in only 3.7%, and remained unaltered in 51.6% of examined roots (p=0.0005). Majority of unchanged PAI was  $\leq 2$  and in only 12.9% of roots the PAI remained  $\geq 3$  after the treatment. There was 1.92 mm (95%CI 1.79 – 2.05) mean decrease in lesion diameter from 2.38 to 0.46 mm (p=0.0005). Periodontal parameters pocket depth, furcation involvement and mobility did not change significantly over the follow-up period.

**Conclusion:** The endodontic treatment significantly reduces prevalence of AP signs and symptoms - pain, swelling, sinus tract, periapical involvement, reduces the PAI score and lesion diameter, but does not affect the periodontal parameters of pocket depth, mobility, and furcation involvement.

#### R024 - POSTOPERATIVE PAIN AFTER ROOT CANAL FILLING WITH BIOCERAMIC AND EPOXY RESIN BASED SEALER – PRELIMINARY RESULTS OF A RANDOMIZED CLINICAL STUDY

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**Aim:** To evaluate the occurrence and intensity of postoperative pain in patients with periapical lesion after root canal filling with the bioceramic or epoxy resin based sealer.

**Methodology:** This randomized clinical study (ClinicalTrials.gov ID:NCT04072926) included 40 patients with chronic apical periodontitis and previous root canal treatment. The patients were selected based on inclusion (asymptomatic previously treated teeth with periapical lesion larger than 5mm, sensitive to percussion and palpation) and exclusion criteria (immunocompromised patients, pregnancy, periodontally compromised teeth, signes of vertical root fracture, antibiotics usage in the last month). All selected patients received single-visit root canal retreatment by the same endodontist. After chemo-mechanical root canal instrumentation and 3% sodium hypochlorite irrigation, passive ultrasonic irrigation was used for final irrigation protocol. Then, the patients were randomly (using wheeldecide.com) divided into two groups based on the sealar used for single-cone filling: Group 1. Bioceramic sealer (BioRoot RCS) and epoxy resin based sealer (AH Plus). Every patient received a visual analog scale (VAS) to record occurence and pain intensity immediately after the retreatment and every next day during seven days and analgesic consumption. The results were analysed using Chisquare, Mann Whitney and Wicoxon tests with the level of significance 5%.

**Results:** There was no significant difference in the occurence and intensity of postoperative pain, nor consumption of analgesics, between the bioceramic and epoxy resin based sealer (P < 0.05). Average duration of postoperative pain was 3 days, pain mostly started after 12h, and more then half of the patients felt no pain.

**Conclusion:** Bioceramic and epoxy resin based sealer caused similar and low occurence and intensity of postoperative pain after single-visit root canal retreatment in patients with chronic periapical lesion.

## R025 - THE IMPACT OF UNINTENTIONAL ROOT CANAL OVERFILLING ON LONG-TERM RADIOGRAPHIC OUTCOME OF ROOT CANAL TREATMENTS AND RETREATMENTS

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**Aim:** to determine the impact of unintentional root canal overfilling on long-term radiographic outcome of root canal treatments and retreatments.

**Methodology**: seventy nine teeth with periapical radiolucency treated by two endodontists and regularly monitored during 9 years were selected. Teeth underwent rotary treatments (24 primary / 55 retreatments) and were filled using warm vertically compacted gutta-percha and AH Plus (Dentsply-Sirona, Germany), recording the overfilling on postoperative radiograph. Two observers assessed the radiographs and determined the outcome according to PAI score pooled in a 3-category scale (1 health, 2 or 3 uncertain, 4 or 5 diseased). The persistence or resorption of the extruded material were registered. The Kappa coefficient (K) was calculated. Wilcoxon, Friedman, Mann -Whitney U and chi-square tests were used for group comparisons. Statistical significance was set at p<0.05.

**Results:** average recall time was 2.96 years, K= 0.591. At 1 year recall, mean PAI score decreased (from 3.32 to 1.45; p<0.001), a favourable outcome was observed in 74.68% teeth and persistence of extruded material was observed in 88.14% teeth. Initial PAI score was statistically significant lower in favourable than in uncertain/unfavourable outcomes (p<0.001). Mean PAI score decreased (from 3.5 to 1.58) in the first two years, to 1.17 in the following years (p<0.001). A more favorable outcome was observed in the maxillary teeth (93.1%), when overfilling was only with sealer (77.6%) and restoration was performed without post (81.3%), but differences were not statistically significant. The type of extruded material, its persistence or resorption did not affect the outcomes.

**Conclusions:** the outcome of root canal treatment with unintentional canal overfilling registered the best results in the first two years. The persistence of extruded materials did not associate with a favourable or unfavourable outcome.

#### R026 - RADIOGRAPHIC OUTCOME OF ENDODONTIC TREATMENT OF TEETH WITH CHRONIC APICAL PERIODONTITIS, USING TWO DIFFERENT ROOT CANAL IRRIGANTS. A PROSPECTIVE COHORT STUDY.

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**Aim**: To compare the radiographic outcome of root canal treatment using either 1% sodium hypochlorite (NaOCI) or 2% chlorhexidine digluconate (CHX) as root canal irrigant in teeth with chronic apical periodontitis.

**Methodology**: Five hundred thirty-seven patients with one tooth diagnosed as chronic apical periodontitis treated between 2013 and 2015 at the Faculty of Dentistry, University of Oslo were included. 1% NaOCI and 2% CHX alternated by semesters as mandatory irrigation for all endodontic treatments. Demographic, clinical and radiographic data from a random sample of 100 patients in each group were retrieved. Periapical conditions were scored by the PAI scoring system at start and in control radiographs. Outcome was registered either as healed for end scores 1 or 2 and diseased for end scores 3, 4 or 5 (strict criteria), or as healed or healing for end scores 1 or 2 and for start scores 4 or 5 moving to 3 at control, and diseased for persisting scores 3 and all scores 4 or 5 at control (lenient criteria). Chi-square test and t-tests and logistic regression analyses were performed to detect associations of outcome with irrigant used and other relevant parameters.

**Results**: Healing rates were approximately 70 percent by strict and 80 percent by lenient criteria for both groups. PAI score and lesion size at start were correlated with outcome (p<0.01), whereas apical width and taper of the root filling were not. Ordinal regression analysis showed that women had better outcome than men; mandibular teeth healed better than maxillary; and treatment of primary apical periodontitis was more successful than retreatments for both groups.

**Conclusions**: The present study showed similar radiographic outcomes for irrigation with 1% NaOCI and 2% CHX for both primary apical periodontitis and retreatments.

### R027 - THE USE OF A BIOCERAMIC SEALER IN ASSOCIATION WITH PLASTIC CARRIER WARM GUTTAPERCHA TECHNIQUE: A 2-YEAR PROSPECTIVE RANDOMIZED STUDY

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**Aim**: To evaluate the use of flowable bioceramic sealer (Ceraseal, Meta-Biomed, South Korea) in association with warm gutta-percha of carrier-based system.

**Methodology**: One-hundred-seven healthy consecutive patients requiring 136 root canal treatments were enrolled in this randomized clinical trial. Patients were randomly divided in 3 groups on the basis of root canal filling technique and materials. Group 1: Ceraseal + single cone cold technique n=47. Group 2: Ceraseal + Thermafil n=45. Group 3: AH Plus + Thermafil n=44.

Periapical X rays were taken preoperatively, after root canal filling and after 6, 12 and 24 months. Two evaluators blindly assessed the Periapical Index (PAI) and sealer extrusion in the 3 groups (k =0.90). Healing rate and survival rate were also analysed.

Chi square tests was used to analyse statistically significant differences among the groups. Multilevel analysis was performed to analyse the factors associated to healing status and survival status.

**Results**: A total of 135 root canal treatment in 106 patients was analysed at the end-line (24 months) (1 drop out due to medical complications). Three teeth were lost, 1 in the Ceraseal + single cone group, 1 in the Ceraseal + Thermafil group and 1 in the AH Plus carrier-based group. A total of 85.1% of healthy teeth was observed in Group 1, 90.9% in group 2 and 88.6% in group 3. No significant difference on healing outcome and survival among the 3 groups (p>0.05). Interestingly, sealer extruded over the periapical space was reduced in 7 cases out of 92 (Groups 1 and 2). Of these, 6 were not radiographically detectable. AH Plus sealer extrusions (Group 3) did not change during the evaluation time.

**Conclusions**: Ceraseal can be used with both cold and warm obturation techniques with comparable outcomes when compared to the gold standard carrier-based technique.

### R028 - HISTOPATHOLOGICAL AND IMMUNOHISTOCHEMICAL EVALUATION OF THE EFFECT OF INJECTABLE-PLATELET RICH FIBRIN ON BIOACTIVE MATERIALS USED AS DIRECT PULP CAPPING: AN EXPERIMENTAL ANIMAL STUDY

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Vital pulp therapy has been known as one of the treatment options to preserve pulp vitality after being exposed by trauma or caries.

**Aim:** This study was conducted to investigate the effect of injectable-platelet rich fibrin (i-PRF) on biocompatibility, bioactivity and bio mineralization of pulp capping agents (Mineral Trioxide Aggregate (MTA) and Bioactive Bone Graft (BBG)).

**Materials and methods:** A total number of 92 teeth of 8 healthy male beagle dogs were used. The teeth were exposed and randomly assigned into four groups, according to the capping agents. Group A; capped with MTA, Group B; capped with MTA+ i-PRF, Group C; capped with BBG, Group D; capped with BBG+ i-PRF. The access cavity was restored with Intermediate Restorative Material (IRM). The dogs were sacrificed at each pre-determined intervals (1 month, and 3 months). Specimens were prepared for standard histopathological and immunohistochemical examination using dentine sialoprotein (DSP) marker. Regarding the histopathological part, Chi square test was used to compare different groups. For immunohistochemistry, ANOVA and Tukey's post hoc tests were used for intergroup comparisons, while paired t test was used for intragroup comparisons. Kruskal-Wallis and Mann Whitney U tests were used for percent change of sialoprotein marker in each group. Statistical significance was considered at P < .05.

**Results:** For the histopathological part, the results of dentine continuity and thickness after one month showed that there was a significant difference between all groups. Immunohistochemical part, revealed that after one and three months the best values of immunoexpression of DSP marker, were recorded in groups B and D, followed by group C, with the least value recorded in group A.

**Conclusion**: i-PRF promoted a greater and a supportive regenerative ability for the stimulation of odontoblastic differentiation and reparative dentine formation for pulp healing. Furthermore, i-PRF also attenuated the inflammatory condition.

### R029 - CLINICAL EXPERIENCE LEADS TO CERTAINTY – A QUALITATIVE ANALYSIS OF DENTAL STUDENTS' REFLECTIONS ABOUT UNCERTAINTY DURING RISK ASSESSMENT

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**Aim**: To study how final year dental students acknowledge uncertainty when assessing the risk of exacerbation of apical periodontitis in root filled teeth.

**Methodology**: A qualitative study design was used to analyze written reflections from final year dental students at Malmö University, Sweden. The students were presented with a patient case with a brief description of the patient's lack of symptoms and a radiograph showing a root filled tooth with diffuse widening of the periodontal ligament space. The reflection exercise comprised seven questions related to the case adapted from prompts of the 4R Reflection Scale by Ryan and Ryan (2012) constructed to stimulate increasing levels of reflection.

**Results**: Fifty-two students completed the reflection exercise. Five preliminary themes were identified concerning the participants in relation to how they acknowledged the uncertainty: lack of experience, lack of knowledge, lack of information about the case, lack of scientific knowledge and inability to interpret the radiograph. The students' acknowledgements of different sources of uncertainty varied between individuals, but with few exceptions, they agreed that an expert would be more certain and better at assessing the risk for exacerbation due to clinical experience. They suggested that for themselves, more clinical experience would lead to a better risk assessment and that they would feel more certain about the right thing to do for their patients.

**Conclusion**: The findings indicate that students acknowledge several sources of uncertainty when assessing the risk of exacerbation. The preliminary data indicate that students perceive their own lack of experience as a source of uncertainty. Teachers should be aware of this perception, especially as teachers act as role models for students, as uncertainty in assessment of risk of exacerbation cannot be addressed solely by increased experience.

The Foresight Research Consortium is funded by grants received from Malmö University.

### R030 - A SURVEY ON THE INFLUENCE OF DENTAL EDUCATION ON THE ADOPTION AND INTEGRATION OF TECHNOLOGY BY DENTAL PRACTITIONERS

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**Aim**: To investigate integration and adoption of technology when performing root canal treatment(RCT) by dental practitioners(DPs) and where they learned to use this technology.

**Methodology**: An electronic questionnaire was distributed to 459 dentists who graduated from University of Bergen, Bergen, Norway between 2008-2018. The respondents were divided into two cohorts, DPs who graduated between 2008 to 2013(older graduates) and from 2014 to 2018(newer graduates). Data was analyzed using Chi-squared test. The level of significance was set at 5%.

**Results**: A total of 314(68.4%) DPs answered the questionnaire. More than half of the respondents (n=180, 59.6%) used some form of magnification. Dental operating microscope(DOM) was used by 35 DPs while dental loupes were used by 145 DPs. Of the dentists who used DOM, the most frequent response on where they learned to use it was during dental education (42.5%) followed by self-taught(25.7%) and colleagues(20.0%). Electronic apex locator(EAL) was used by 271(89.7%) DPs. Out of these, 78.6% respondents stated that they learned to use it during dental education. Significantly more newer graduates used EAL when determining working length(p=0.002). Motor-driven files were used by 281(93.4%) of DPs. Significantly more newer graduates stated that they learned to use motor-driven instrumentation during dental education(p<0.001). Significantly more newer graduates (90.7%) based instrumentation method learned during dental education(p<0.001). Older graduates based their instrumentation method equally on what they learned during dental education(51.9%) and continuing dental education(42.6%). Rubber dam was used for all RCT procedures by 93% of the DPs. The remaining DPs placed rubber dam sometimes 16(5.3%) or never 5(1.7%).

**Conclusions**: Dental education serves as the most important communication channel for adoption and integration of technology by DPs. Exposure to innovations(awareness) during dental education is adequate for adoption and integration of technology. Continuing dental education is as valuable as dental education for adoption of technology for older graduates.
### R031 - USE OF FORMAL DEBATE AS A TEACHING STRATEGY TO PROMOTE CRITICAL THINKING: IS IT A VALID TOOL FOR UNDERGRADUATE AND POSTGRADUATE DENTAL STUDENTS?

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To evaluate student satisfaction with the use of formal debate as a tool to promote learning and critical thinking at different academic levels (undergraduate and graduate students) for different roles (active debaters and passive attendees).

**Methodology**: Virtual learning strategies were designed during COVID-2019 pandemic. Both undergraduate students in the last course and first-year postgraduate students in the program in Endodontology were separately invited to participate in a series of formal debates. Although in different sessions, debates had the same organization for both under and graduate students. A series of clinical cases with two plausible therapeutic options were selected. Debaters were randomly elected for both the undergraduate and graduate sessions. Each clinical case was debated among 4 students at undergraduate levels and 2 in the Graduate program. Half of the debaters defended one of the two plausible treatment options with a power-point presentation that the students prepared using arguments based on scientific evidence. The rest of the students attended the session and subsequently participated in an open debate (passive attendees). Student satisfaction was measured with a survey in which students rated on a 1-10 scale the satisfaction, quality, usefulness, and organization of the activity, and on 5-point Likert scale aspects related to the knowledge acquired, the content and the use of the debate as a method of instruction. Responses from both the active debaters and passive attendees, as well as between undergraduate and graduate students, were compared with Mann-Withey U and the linear trend statistical tests.

**Results**: Both undergraduate and graduate students, as well as active debaters and passive attendees rated positively the use of debate as an instructional method to foster critical thinking, with no significant differences among them.

**Conclusions**: Formal debate demonstrated to be a satisfactory learning tool to promote critical thinking for both undergraduate and postgraduate students

### R032 - INVESTIGATING THE EFFECT OF AN ENDODONTIC COMPLEXITY ASSESSMENT TOOL (E-CAT) ON THE USER EXPERIENCE FOR UNDERGRADUATE DENTAL STUDENTS IN ASSESSING ENDODONTIC CASE COMPLEXITY

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**Aim**: To establish whether the introduction of the Endodontic Complexity Assessment Tool (E-CAT) improves the user experience for undergraduate dental students in assessing endodontic case complexity

**Methodology**: A group of fourth year undergraduate dental students (n=70) were invited to participate in the study. A total of 40 students completed the study. Participants were given traditional lecture-based teaching on endodontic complexity assessment at the beginning of the academic year. They were then asked to complete two 45-minute formative assessments. Each involved identification of the complexity classification and complexity factors for 15 test cases. The first assessment was completed independently. The second was completed with the addition of utilising E-CAT (www.e-cat.uk). On completion of both assessments, a Likert scale questionnaire was used to evaluate the user experience with each method.

**Results**: Following the first assessment (without E-CAT), students reported on average (mean) a 'Neutral' response to statements related to the ease of determining a complexity grade and identifying complexity factors, as well as their confidence in deciding when to refer and in assessing case complexity in general. In the second assessment (using E-CAT), the mean response for these statements increased to 'Agree'. Also, students generally agreed that E-CAT was easy to use, however, 30% of students either agreed or strongly agreed with the potential benefit of further training on how to use E-CAT.

Participant comments also highlighted a lack of confidence in independently assessing case complexity, as well as in deciding when it is appropriate to refer a case. The comments also reinforced the comparable ease and positive user experience with completing the task using E-CAT.

**Conclusions**: Students feel more confident in assessing complexity using E-CAT and the tool is beneficial to undergraduate training on the subject of endodontic complexity assessment. Additional training on how to use E-CAT may provide further benefit.

## R033- LONG-TERM CRYOPRESERVATION EFFECT ON THE STEMNESS OF STEM CELLS OF APICAL PAPILLA

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**Aim**: Stem cells of apical papilla (SCAPs) are a subpopulation of dental stem cells with unique properties. Banking of these stem cells can offer a source of dental stem cells for future regenerative therapies. The aim of this study was the evaluation of the long-term (19 months) effect of cryopreservation on SCAPs.

**Methodology**: SCAPs' were isolated from the apical papillae of human healthy immature fleshly extracted third molars and cultured. The cells were cryopreserved for different time periods, 3, 8 and 19 months to test their characteristics upon thawing.

The stem cells of the primary cultures, before cryopreservation, and the established cultures after thawing, were examined by means of estimation of their induced differentiation capacity (osteogenic, adipogenic and chondrogenic), flow cytometry, immunophenotypical characterization for CD24, CD146, CD105, CD90, CD34, CD44, CD29 and CD45 by using monoclonal antibodies and molecular characterization of the main transcriptional factors (NANOG, OCT4, CMYC, SOX2, KLF4, SALL4, ESRRB, ZNF217 and ZNF878 genes) that coincide with pluripotency.

**Results**: After 3, 8 and 19 months of SCAPs' cryopreservation, no significant difference was observed on their typical fibroblast-like morphology in comparison to those before cryopreservation. Stem cells after cryopreservation in all cases retained their differentiation capacity and no discrepancies were found either on immunophenotypical or molecular level.

**Conclusion**: Long-term (19 months) cryopreservation of SCAPs did not affect negatively their stemness.

Keywords: Stem cells of apical papilla, cryopreservation, banking, pluripotency, transcriptional factors.

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## R034 - QUALITY AND READABILITY ASSESSMENT OF WEB-BASED INFORMATION ON REGENERATIVE ENDODONTICS

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**Aim:** Regenerative endodontics (RE) is a novel treatment approach that has attracted the interest of both researchers and clinicians engaged in Endodontics. Its increasing application is likely to drive more patients to resort to online searches for information, including for better understanding and as part of the treatment decision-making procedure. This study aims to assess the content, quality and readability of those information on RE.

**Methodology:** An online search for the term 'regenerative endodontics' was performed by using Google search engine. Exclusion criteria were applied to only the first 100 results identified. The retrieved webpages were assessed for their content, quality and readability. Quality assessment was completed using the DISCERN tool, Journal of the American Medical Association (JAMA) benchmarks analysis and Health on the Net (HON) code seal. Readability evaluation was facilitated by the Flesch Reading Ease Score (FRES), Flesch-Kincaid Grade Level (FKGL), Simplified Measure of Gobbledygook (SMOG) Index and Coleman-Liau Index (CLI) formulas. Descriptive statistics were used for data analysis.

**Results:** A total of 30 webpages met the inclusion criteria. The majority of them were commercial webpages containing information of low quality, with an overall DISCERN rating of 2.0 ( $\pm$ 1.145) out of 5. JAMA benchmarks evaluation confirmed low quality of the available information with no webpage found to fulfil all four criteria simultaneously. Readability was found to be difficult or very difficult, requiring a minimum average of 12th-13th grade level (SMOG: 12.397) of education in order to understand the information provided.

**Conclusion:** The overall quality of the content available online regarding RE is low. Higher level of education is required to be able to fully understand information relevant to RE. Efforts need to be made for the development of assessment tools specifically for dental topics. There is also the need for more reliable and accurate online information on RE.

## R035 - REGENERATIVE ENDODONTIC PROCEDURE OUTCOMES: A CLINICAL AND RADIOGRAPHIC RETROSPECTIVE STUDY

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**Aim**: Treating immature necrotic teeth with open apex is a clinical challenge. Regenerative endodontic procedures (REP's) may provide periapical lesion healing, root lengthening, increased canal wall thickness, and apical closure. This retrospective study investigates the outcome of revascularization, a REP, in necrotic immature traumatized teeth with open apex.

**Methodology**: A retrospective study of 44 necrotic immature traumatized teeth with open apex was treated with REP In three appointments. (1) Access cavity was performed. The canal was irrigated with 3% sodium, EDTA 17%, and saline. Intracanal medication of calcium hydroxide or triple antibiotic paste (ciprofloxacin, Cefaclor, Metronidazole). was placed as interappointment dressing. (2) The dressing material was flushed out with copious irrigation of 20 ml of 3% sodium hypochlorite and 20 ml of 17% EDTA. A blood clot was formed; MTA or Biodentin was placed below the cementoenamel junction, and the access cavity was sealed by Fuji IX. (3) A permanent composite restoration was performed. The average follow-up period was 22 months. The evaluation included a qualitative comparison between radiographic images and quantitative calculation of root growth using the software Image J. The outcome criteria were increased thickening of the dentin walls and narrowing of root canal space, apical closure., root lengthening, severe obliteration, dentin bridge formed in the canal below coronal MTA plug.

**Results**: Radiographic healing was observed in all cases with periapical lesion (19/19) teeth. Increased thickening of the canal walls and continued root maturation was observed in 29 (66%) cases, closure of the root apex in 30 (68%) cases, and 27(61%) cases showed continued root development. Canal obliteration was observed in 13 (29.5%) cases

**Conclusions**: REP is a predictable and effective treatment for immature necrotic permanent dentition. The study found that REP has successfully healed all periapical lesions with root lengthening and apical closure.

## R037 - THE EFFICACY OF JE TIP VERSUS DIAMOND-COATED TIPS FOR ROOT-END PREPARATION – A MICRO-COMPUTED TOMOGRAPHY STUDY

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**Introduction**: Retrograde endodontic surgery may be indicated in failing Root Canal Treatments (RCT) when orthograde root canal retreatment is impractical. Many measurement methods have been used to assess the efficacy of endodontic procedures, though Micro-computed tomography (micro-CT) scans have been found the most accurate in evaluating root-end preparation and sealing.

**Aim**: this study aims to evaluate and compare the retrograde preparation efficacy of the new Je Tip (B&L Biotech, Bala Cynwyd, PA) compared to a diamond-coated tip, AS3D (Satelec, Paris, France) using micro-CT.

**Methods**: 60 extracted human single-rooted premolars have been used in this study. Root canal preparation and filling were made, and submitted to the first micro-CT scan. Then, root-end resection and preparation to a 3mm and 6mm depth were made by the two different retrograde tips. The teeth then went through a second micro-CT scan and were evaluated for the preparation time, area of removed dentin (RDT), residual root canal filling, and complications.

**Results**: The time required for root end preparation using the Je-Tip were significantly longer. In the AS3D group, The RDT was significantly smaller comparing the Je-Tip, both in 3mm and 6mm groups. Residual root end filling material were significantly smaller in the AS3D group, comparing to the Je-Tip in 6mm depth. The Je-Tip has the tendency to break more than the AS3D tip.

Conclusion: according to this ex-vivo study, Root end preparation efficacy may be effect by the tip type.

## R038 - ROOT-FILLED TEETH IN TWO PARALLEL DANISH COHORTS. A REPEATED COHORT STUDY.

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Aim: To compare the frequency and quality of root fillings (RFs) in two parallel, Danish cohorts each examined during a 10-year period and to evaluate factors associated with the loss of RF-teeth over 10 years.

**Methodology:** Two randomly selected cohorts (C1, C2) from Aarhus County (age: 20-64 years) were each followed over approximately 10 years, with a full-mouth radiographic survey at 5-year intervals (C1: 1997–2003–2008; C2: 2009–2014–2019). Frequency and quality of RFs and coronal restorations were assessed. Multivariable multinomial logistic regression models were used to assess the effect of cohort, age, tooth group, and restoration quality on the frequency and quality of RFs at baseline, new RFs, and loss of RF-teeth during the observation period.

**Results:** In total, 330 individuals from C1 (mean-age: 42 years) and 170 from C2 (47 years) attended all three radiographic examinations. RF frequency was significantly lower in C2 than C1 at baseline (C1: 4.7%, C2: 3.6%; OR=0.51, p<0.001, 95%CI: 0.39-0.68) and after 10 years (C1: 5.7%, C2: 4.2%; OR=0.54, p<0.001, 95%CI: 0.42-0.69) despite age-correction. Frequency of new RFs decreased from 25.6% (C1:2003) to 16.9% (C2:2019). C2 had significantly lower risk of too short/too long RFs at baseline than C1; however, no significant difference between the cohorts was observed in the quality of new RFs performed during follow-up. The proportion of RF-teeth lost after 10 years was similar in the two cohorts (C1: 8.6%, C2: 10.7%; OR=1.34, p=0.39, 95%CI: 0.69-2.6). Risk of loss of RF-teeth was significantly higher for molars (p=0.04) and teeth with inadequate coronal restorations in both cohorts (p=0.01).

**Conclusion:** The frequency of RFs and new RFs decreased over time (1997–2019) with no significant increase in the quality of new RFs or decrease in the proportion of lost RF-teeth. Root-filled molars and RF-teeth with inadequate restorations had an increased risk of being lost.

## R039 - PREVALENCE OF APICAL PERIODONTITIS IN PATIENTS WITH AUTOIMMUNE DISEASES: A CASE CONTROL STUDY.

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**Aim**: The purpose of this case-control study was to compare the prevalence of Apical Periodontitis (AP) in patients affected by Autoimmune Disorders (AI) [Inflammatory Bowel Disease (IBD), Rheumatoid Arthritis (RA), and Psoriasis (Ps)] with the prevalence of AP in subjects without AI.

**Methodology**: 89 patients (2,145 teeth) with AI were investigated and the control group included 89 patients (2,329 teeth) with no systemic diseases. Full dental panoramic tomograms were used to determine the periapical status of the teeth. Additional variables investigated included patient's socio-demographic characteristics, medications taken by AI patients, the Decayed, Missing, and Filled Teeth (DMFT) index and the Periapical Index (PAI). The chi-square test and logistic regression analysis were used to evaluate the correlation between AI and AP. P-values lower than 0.05 were considered to be statistically significant.

**Results**: The prevalence of AP was 89.9% in AI patients and 74.2% in control subjects (odds ratio [OR]=4.40, p=0.004). The DMFT score was found to be significantly higher in the AI group (p=0.004). Patients with RA had the highest risk of developing AP, whereas those with IBD had the lowest risk. Multiple binary logistic regression analysis indicated that the teeth of AI patients who were not taking any medication or were being treated with biologic Disease Modifying Anti-Rheumatic Drugs (bDMARDs) had a higher risk of developing AP than did the teeth of the control subjects (OR=1.76 and OR=2.76 respectively; p=0.001). The teeth of patients taking conventional DMARDs (cDMARDs) were less affected by AP compared to those of patients taking bDMARDs.

**Conclusions**: Patients with AI, whether treated or not with biologic medications, showed a higher prevalence of AP than did those in the control group. The DMFT index score, which was higher in AI patients compared to controls, as well as socio-demographic characteristics were identified as significant predictors of AP prevalence.

## **R040 - DEEP CARIOUS LESIONS AND THEIR MANAGEMENT AMONG FINNISH ADOLESCENTS: A RETROSPECTIVE RADIOGRAPHIC STUDY.**

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**Aim**: To find out the prevalence of deep carious lesions (both untreated and previously treated) and how deep carious lesions were managed in a Finnish public health care setting.

**Methodology**: From all the 14–15-year olds examined at the oral health care of the City of Helsinki in 2017–2018 (N=3990), a random sample of 278 patients was selected. Radiographic subsample consisted of patients with bitewing and periapical radiographs (n=128, 46% of the total sample). Deep carious lesions (extending to at least the inner half of dentine), deep restorations, direct pulp cappings, root canal treatments and extractions in permanent premolars and molars were recorded from radiographs. In addition, patients with previously untreated deep carious lesions were followed up for 24 months.

**Results**: In the total sample 12% had at least one untreated deep carious lesion, 10% had at least one deep restoration and 19% had at least one untreated or previously treated deep carious lesion. The risk of having at least one untreated or previously treated deep carious lesion to the inner quarter of dentine was significantly higher among female patients (OR=4.6, Cl 1.5–14.0) and patients in high caries risk category (OR=4.4, Cl 1.3–14.4). The follow up cohort included 48 deep carious lesions in 26 patients. Complete excavation was the most frequently chosen method for both the lesions reaching the inner half of dentine (81%) and inner third of dentine or deeper (56%), followed by stepwise excavation (19% and 37%, respectively).

**Conclusion**: Nearly one fifth of 14–15-year-olds had at least one untreated or previously treated deep carious lesion to the inner half of dentine or deeper. The choice for the carious tissue removal did not follow the current recommendations for less invasive methods.

Acknowledgements: The study was funded by a research grant from the Finnish Association of Women Dentists.

## **R041 - BLEEDING RELATED TO CONSERVATIVE AND ENDODONTIC TREATMENT IN PATIENTS RECEIVING VITAMIN K ANTAGONISTS. A RETROSPECTIVE CLINICAL STUDY.**

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**Aim**: To investigate the occurrence and severity of postoperative bleeding events after conservative and endodontic treatments administered to a cohort of patients receiving vitamin K antagonists (VKAs).

**Methodology**: This retrospective study included 123 patients who were prescribed VKAs drugs and received conservative and endodontic treatments associated with a high bleeding risk from January 2015 to January 2021. The variables recorded for each patient were demographic data, medical history, indication for anticoagulants, perioperative management of VKAs therapy, and International Normalized Ratio (INR) values before dental treatment. All treatments were performed in patients with INR values  $\leq$  2. Postoperative bleeding events were assessed on the day of surgery and at 3-5-7 days follow-up visits. The extent of bleeding was categorized as slight, moderate, and severe. The data were analyzed using IBM SPSS package version 21.0 for Mac.

**Results**: The patients age ranged from 26 to 83, and the male to female ratio was 0,89:1. A total of 148 dental treatments were performed in patients receiving VKAs therapy and, out of them, 129 were related to conservative procedures, including crown lengthening and gingival recontouring, performed in 84,6% of individuals, and 19 were periradicular surgeries (12,3%). One hundred forty-three (96,6%) bleeding events were described as slight and controlled by local hemostasis procedures on the day of surgery. During the first three days, postoperative bleeding occurred in only 5 of the 148 cases and was managed with a revision of the wound and resuturing. No bleeding was recorded at 5 and 7 postoperative days.

**Conclusions**: According to our preliminary outcome data, conservative and endodontic procedures associated with a high risk of bleeding can be safely performed in patients receiving VKAs with INR values  $\leq 2$ , assessed at least 4-6 hours before surgical treatment. All bleeding episodes were easily controllable using local hemostatic measures.

### R042 - PAINFUL ROOT-FILLED TEETH WITH AND WITHOUT SIGNS OF DENTAL DISEASE: COMPARISON OF PATIENT CHARACTERISTICS, CONSEQUENCES OF PAIN AND BACKGROUND FACTORS. A CASE-CONTROL STUDY

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#### Aim: To compare

(i) Painful root-filled teeth with/without signs of dental disease concerning pain characteristics, consequences of pain and patient characteristics

(ii) Patients with and without pain from their root-filled teeth concerning patient characteristics.

Methodology: In a cross-sectional study in public dental care, 550 individuals with 1256 root-filled teeth were screened for pain from their root-filled teeth. 49 participants who had 53 painful root-filled teeth (cases) were included and matched with 50 participants with 53 pain-free root-filled teeth (controls). Cases either had signs of dental disease (DD+), defined as having ≥1 sign of apical radiolucency, swelling, sinus tract or pocket-depth ≥6mm, or no such signs (DD-), defined as absence of all of those findings. Controls were matched on sex, age-group, jaw, and tooth type. Examination included clinical (swelling, sinus tract, probing depth) and radiographical assessment and questionnaires covering pain intensity (0–10 NRS), duration; pain-related disability (GCPS) and TMD screening (3Q/TMD). Statistical analyses: descriptive statistics, Mann-Whitney U-tests and Chi-square tests.

**Results**: DD+ group included 27 patients with 31 root-filled teeth and DD- group included 22 patients/ 23 teeth. Average pain intensity for DD+; NRS 1.5, for DD- NRS 3.1 (p=0.030); pain duration 24.7 vs. 38.2 months (p=0.476); pain days past month was 8.6 vs. 11.8 (p=0.380); no group reported affected activities. 3Q/TMD responses were similar between groups (p=0.978) but cases more often indicated TMD pain compared to controls (p=0.029).

**Conclusions**: Both case groups reported mild recurrent and enduring pain, which did not limit their daily life. Patients with painful root-filled teeth without signs of dental disease experienced higher pain intensity, which could indicate a different, non-odontogenic pain origin in this group. Patients with painful root-filled tooth were more likely to report TMD pain than their pain-free peers.

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## R043 - LONG-TERM SURVIVAL OF TEETH UNDERGOING ENDODONTIC SURGERY IN THE SWEDISH ADULT POPULATION. A LONGITUDINAL REGISTRY STUDY.

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Aim: The aim of this study was to evaluate the long-term survival of teeth within 11–12 years of a registration of performed endodontic surgery.

**Methodology**: The Swedish Social Insurance Agency (SSIA) register was searched for all individuals who were registered with endodontic surgery during the year 2009. The registry allows following a specific tooth in a specific individual over time. No clinical data on for instance presence of symptoms or quality of root filling or coronal restoration was available. The included teeth were followed until the terminal event of extraction was reported in the database, and if not, until the end of 2020. Deaths before terminal events were censored. In case an individual was registered with more than one treated tooth, the first registered tooth was included in the study; only one tooth per individual was included. Distribution of age, sex, dental service provider (private or public) and tooth group was assessed. Kaplan-Meier analyses were performed.

**Results**: After data cleaning 5 622 teeth/individuals were identified, of which 34% (n=1 915) were reported extracted during the 11–12 year follow-up. The calculated cumulated survival ten years after the registration of endodontic surgery was 73%. The incidence of tooth extraction was non-linear being somewhat steeper in the first year, and markedly steeper in the 11th year. Maxillary front teeth had the highest tooth survival and mandibular molar teeth the lowest. Teeth treated in the public sector had a higher survival than teeth treated in the private sector.

**Conclusions**: Tooth survival after endodontic surgery after 10 years was 73%. The proportion of extractions was not constant over time and the reason for the higher incidence of extractions during the 11th year remains unanswered.

### **R044 - MANAGEMENT OF ROOT-FILLED TEETH IN A SWEDISH PUBLIC DENTAL SERVICE**

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**Aim**: To investigate the management of root-filled teeth over a six year-period in general dental practice in Örebro County, Sweden.

**Methodology**: In 2015, a total of 550 patients with 1256 root-filled teeth attended a clinical examination including intraoral radiographs with the Public Dental Service of Örebro County, Sweden. At baseline, 62 (4.9%) of the root-filled teeth had symptoms and 265 teeth (21.6%) exhibited periapical bone lesions. After six years, the patient records were searched for information on any further treatment of the teeth by two independent reviewers.

**Results**: 1025 (81.6%) of the 1256 root-filled teeth were available for follow-up. Among all teeth 176 (17.2%) were extracted or had undergone surgical or non-surgical retreatment. Among teeth with neither symptoms nor lesions, 90 (11.8%) were extracted or had undergone surgical or non-surgical retreatment. Among the teeth associated with symptoms at baseline, 17 teeth (32.7%) had been extracted and four teeth (7.7%) had either surgical or nonsurgical retreatment registered. Teeth with symptoms had undergone additional treatment more often than symptom-free teeth (P<0.001). Among teeth with periapical bone lesions 55 teeth (25.8%) had been extracted and 16 teeth (7.5%) had surgical or non-surgical retreatment recorded. Teeth displaying a bone lesion had more often undergone additional treatment than teeth without a lesion (P<0.001).

**Conclusions**: A majority of the root-filled teeth were not subjected to extraction or further endodontic intervention even if there were signs of apical periodontitis or symptoms at baseline. However, interventions of some kind was significantly more frequent among teeth with signs of disease.

Acknowledgements: Grants from European Society of Endodontology and the Public Dental Service in Region Örebro County.

## R046 - ENDODONTIC INFLAMMATORY DISEASE INDEX: A COMPOSITE INDICATOR OF A FIRST MYOCARDIAL INFARCTION

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**Aim**: To explore different sets of weights to the categories of an index of endodontic inflammatory disease and its association with a first myocardial infarction.

**Methodology**: Panoramic radiographs from a nationwide Swedish population of 797 patients with recent experience of a first myocardial infarction and 796 healthy controls matched for age, sex and geographical area were assessed by three calibrated observers. All teeth, excluding third molars, were assigned one of the following eight categories suggested to represent different stages of endodontic inflammatory disease: 1.) healthy tooth, 2.) tooth with filling, 3.) tooth with decay, 4.) tooth with filling and decay, 5.) root filled tooth, 6.) tooth with apical periodontitis, 7.) root filled tooth with apical periodontitis and 8.) missing tooth. By taking a suggested graded order into account, where a healthy tooth was scored 0 (minimum possible weight) and a missing tooth was scored 1 (maximum possible weight), all patients and controls were assigned a composite index of endodontic inflammatory disease. A total of 33 different sets of weights for the in-between categories were tested for their association with a first heart attack. Statistical analysis was performed with univariable logistic regression standardized weighted index-sum for each individual.

**Results**: Index-score based on 27 of the 33 sets of weights associated significantly with a first myocardial infarction (p < 0.05). The set that achieved the strongest association (OR 1.24; 95% CI 1.11–1.37) put greater weights to decay (weight 0.9) and untreated apical periodontitis (weight 1) and lesser weights to filled teeth with caries (weight 0.1) and root filled teeth with apical periodontitis (weight 0.2).

**Conclusions**: A weighted composite index-score of endodontic categories was associated with higher odds of a first myocardial infarction. Future research that investigates composite measures of endodontic inflammatory disease when studying associations with systemic diseases are warranted.

# R047 - PREVALENCE OF APICAL PERIODONTITIS IN PATIENTS TAKING STATINS, A PILOT STUDY.

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**Aim:** Given the pleiotropic effect of statins on the inflammatory processes, the aim of this pilot clinical study was to evaluate the oral condition and the prevalence of apical periodontitis (AP), in patients in treatment with statins (S).

**Methods**: Seventy patients, 40 men, 30 women (average age  $67\pm11$  yrs), (1520 teeth) taking statins for hypercholesterolemia, with no other systemic disease, referred to the university clinic, were investigated. The controls included 70 patients, 39 men and 31 women (average age  $62\pm9$  yrs), (1720 teeth), with no systemic pathologies and under no medications. Patients underwent a complete oral, dental, and radiographic examination and, more specifically, the periapical index (PAI) and the status of endodontic and restorative treatments were assessed. Statistics were based on descriptive analysis and continuous variables for the total sample. Adjusted odds ratios and 95% confidence intervals were calculated.

**Results:** The prevalence of AP was 23%, in the study group (S), and 50% in the controls ( $P \le .05$ ) considering both patients and teeth, even though the DMFT score was higher in S than in control (C) (1145 *vs* 739). The average PAI score was similar in both groups (2,6 *vs* 2,8). In S, 25% of AP lesions were observed in treated teeth, and 75% in teeth never treated before ( $P \le .05$ ), while in C, the prevalence of AP was similar in treated and not treated teeth (50% *vs* 44%).

**Conclusions:** In this preliminary study patients taking statins exhibited a lower prevalence of AP, these results suggest a possible beneficial influence of statins on the prevalence of AP, further investigations are needed.

Acknowledgements: The authors deny any conflicts of interest related to this study.

### **R048 - PREVALENCE OF APICAL PERIODONTITIS IN PATIENTS AFFECTED BY RHEUMATOID ARTHRITIS**

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**Aim**: To evaluate the oral health status and the prevalence of apical periodontitis (AP) in patients affected by Rheumatoid Arthritis (RA) and under Biologic Medication (BMs) or Immuno-supressors (ISs).

**Methodology**: The study group (RA) consisted of 52 patients (7 men and 45 women, age  $57 \pm 11,6$  years) of whom 36 treated with BMs and 16 under ISs (Methotrexate, Leflunomide and Corticosteroids), referred from the Rheumatology Units of the University Hospital. 52 controls (C) (7 men and 45 women, age  $55 \pm 14,3$ ) registered for a check-up at the Dental Clinic, matched for age, sex and physical characteristics, without any systemic disease and under no pharmacological treatment were selected. Each patient underwent a complete dental clinical and radiographic examination. The Periapical Index Score (PAI) and the Decayed- Missing-Filled Teeth score (DMFT) were calculated. Statistics were based on descriptive analysis and continuous variables for the total sample. Adjusted odds ratios and 95% confidence intervals were calculated.

**Results:** The prevalence of AP was statistically significantly higher in RA than in C, considering the number of the patients (67% vs 46%; p-value <.05) and the number of the teeth affected by AP (5% vs 3.5 %; p-value <.05), even though DMFT scores were comparable between the two groups (AR 10 - C 10). Average PAI score was very similar in the two groups (2.85 vs 2.84). In this pilot study, the association between smoking and AP was very significant (p-value <.05).

**Conclusions** : These preliminary data suggest that patients with RA had a high rate of AP, regardless of the therapy adopted. These results may indicate that the status of the patients' immune system may have an effect on the prevalence of AP.

Acknowledgements: The authors deny any conflicts of interest related to this study.

### R049 - PERFORMANCE AND SATISFACTION OF POSTGRADUATE STUDENTS WITH DIFFERENT CONTEMPORARY RECIPROCATING INSTRUMENTS AFTER ROOT CANAL PREPARATION OF SIMULATED ROOT CANALS

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**Aim**: To compare the performance and satisfaction of postgraduate students with WaveOne Gold (WOG) and EdgeOne Fire (EOF) after root canal preparation of simulated root canals and plastic deformation of instruments after use.

**Methodology**: Thirteen postgraduate students who had never used reciprocating instruments before participated in the study. Thirteen new WOG and EOF Primary instruments and twenty-six plastic blocks simulating curved root canals were used. A package containing a blinded sample of each instrument and two blocks were delivered to each student. Instruments and blocks were paired and numbered in an assigned random order. Every student prepared one root canal with each instrument in the random order assigned, returned it to the package after shaping was completed and blindly filled out a satisfaction survey to detect overall satisfaction with reciprocation and the reciprocating systems used. Pre- and postoperative digital photographs of plastic blocks and instruments were obtained. Pre- and post-instrumentation images of blocks were superimposed and compared for performance evaluation. Images of instruments were mounted in random order in a Keynote presentation and colour-masked for two calibrated examiners' blind evaluation of plastic deformation. Kappa coefficient was calculated to determine their level of agreement. Consensus data on plastic deformation were compared using the Chi-square test and quantitative data related to students' performance with the Student T-test.

**Results**: Inter-rater level of agreement was very high (K=0.88). No instrument fracture was observed, although 100% of EOF instruments deformed after preparation (p<.05). Overall satisfaction with reciprocating motions was high. There were no significant differences in students' performance, although 61% preferred WOG over EOF. Conclusions: Students performed equally with both systems, but EOF instruments suffered evident plastic deformation after shaping a single simulated root canal.

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### R050 - COMPARATIVE BACTERIAL LEAKAGE OF FURCAL PERFORATIONS RESTORED WITH MINERAL TRIOXIDE AGGREGATE, CALCIUM ENRICHED MIXTURE AND BIODENTINE IN PRIMARY MOLARS

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**Aim**: to evaluate the sealing ability of Mineral Trioxide Aggregate (MTA), Calcium Enriched Mixture (CEM) and Biodentine in furcal perforation repair of primary molar teeth using a dual chamber bacterial leakage model.

**Methodology**: In total, 61 freshly extracted primary mandibular second molars were randomly divided into three experimental groups of 17 in each and 5 teeth as negative control group (without furcal perforation) and 5 teeth as positive control group (perforated without repair). Dual chamber leakage model was used with the turbidity as the criteria of leakage. Chi-Square test and Kaplan-Meier survival analysis was used for data analysis in SPSS at the significant level of 0.05.

**Results**: All control samples behaved as their name implies (positive with turbidity and negatives without turbidity). As found by statistical test, there was no significant difference between number of turbidity samples in MTA group (n=2), those repaired with CEM (n=6) and Biodentine (n=7) (P=0.138). There was no significant difference in mean survival time (P> 0.05).

**Conclusions**: Based on the results, CEM and Biodentine can be recommended as suitable alternative of MTA for repair of furcal perforation.

### R051 - THE EFFICIENCY OF THE BTR-PEN SYSTEM IN REMOVING DIFFERENT TYPES OF BROKEN INSTRUMENTS FROM ROOT CANALS AND ITS EFFECT ON THE FRACTURE RESISTANCE OF ROOTS

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**Aim:** The study aimed to evaluate the efficiency of the BTR-Pen system in removing different types of instrument fragments from root canals and to assess its effect on fracture resistance of the roots after the removal of the instruments.

**Material and Methods:** One hundred thirty human teeth were divided into 10 groups (2 control groups and 8 study groups) according to the localization and type of the fractured fragment as well as the retrieval techniques. Broken instruments were extracted either with BTR-Pen system loops or removed using solely ultrasonic tips. The success rate of instrument removal and consumed time were recorded. All the teeth were subjected to a load at a 1 mm/min rate in a universal testing machine for mechanical testing.

**Results:** The success of removing broken instruments using the BTR-Pen and ultrasonic was 86.7% and 83.3%, respectively (p> 0.05). When the time is compared, the BTR-Pen system (23.97 ± 8.35 min) showed similar results to that of the ultrasonic technique (24.1 ± 8.28 min) (p > 0.05). The BTR-Pen group required less force to fracture than the ultrasonic group (p = 0.024).

**Conclusion:** The BTR-Pen and ultrasonic groups showed no significant difference in terms of the success rate and removal time. The roots that underwent instrument removal using the BTR-Pen system had less fracture resistance.

### R052 - DEEP LEARNING FOR TEETH SEGMENTATION AND NUMBERING ON ORTHOPANTOMOGRAMS

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**Aims**: To compare the accuracy of teeth identification on Orthopantomograms (OPGs) using a Deep Learning (DL) Artificial Intelligence (AI) model with human annotators for instance segmentation and teeth numbering.

**Methodology**: OPGs were manually annotated by human annotators to lay down the ground truth for training two Convolutional Neural Network (CNN) algorithms, namely U-net and Faster RCNN. These algorithms were concurrently trained and validated on a dataset of 40 labelled OPGs. The U-net algorithm was trained on OPGs specifically annotated with fluid margins to label all 32 teeth via instance segmentation allowing each tooth to be denoted as a separate entity. Simultaneously, the teeth were also numbered as per the FDI (Fédération Dentaire Internationale) system, using bounding boxes to train the Faster RCNN algorithm. Consequently, both trained algorithms were combined to develop an AI model capable of segmenting and numbering all teeth on an OPG.

**Results**: The performance metrics of the algorithms were assessed relative to the ground truth laid down by human annotators in the training and validating datasets of OPGs. The performance of the U-net algorithm was determined using performance metrics including: precision=88.8%, accuracy=88.2%, re-call=87.3%, F-1 score=88%, dice index=92.3% and IoU=86.3%. The performance metrics of the Faster RCNN algorithm were determined using performance metrics including: overlap accuracy=30.2 bounding boxes (out of a possible of 32 boxes) and classifier accuracy of labels=93.8%.

**Conclusion**: The ability of an AI model to automatically identify teeth on OPGs will aid dentists with diagnosis and treatment planning. This will lead to the reduction of workload and diagnosis time of dental professionals, eventually increasing the efficiency as well as accuracy of dental treatment. The instance segmentation and teeth numbering results of our trained AI model were exceptionally close to the ground truth; holding a promising future for its incorporation into clinical dental practice

## R053 - EVALUATION OF THE CLINICAL EFFICACY OF QUANTITATIVE LIGHT-INDUCED FLUORESCENT TECHNOLOGY IN DIAGNOSING CRACKED TEETH

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**Aim**: This retrospective study was aimed to confirm the clinical efficacy of Quantitative Light-induced Fluorescent(QLF) technology for crack detection and the diagnosis of cracked teeth and to assess the possibility of a quantitative evaluation of cracks using QLF technology.

**Methodology**: Patients clinically diagnosed with cracked teeth for one year were included. The QLF image of corresponding symptomatic cracked teeth and the asymptomatic contralateral teeth with crack were taken with Qraypen C(All-in-one bio, Seoul, Korea). Fluorescence loss( $\Delta$ F), maximum fluorescence loss( $\Delta$ Fmax), red fluorescence( $\Delta$ R), and maximum red fluorescence( $\Delta$ Rmax) of the crack line were analyzed. The correlation between these parameters and gender, age, tooth position(1st premolar, 2nd premolar, 1st molar, 2nd molar), spontaneous pain(+/-), percussion test(+/-), cold test(++/+/-), bite test(+/-) results was statistically analyzed.

**Result**: A total of 66 patients and, accordingly, 66 symptomatic cracked teeth were included. Twenty-four patients had asymptomatic contralateral teeth whose crack was observed, so 90 teeth were analyzed. Among them, the crack line of 84 teeth showed  $\Delta R$  value higher than the cut-off value set by the analysis program used, and the crack line was observed as a red fluorescent line on the QLF image. Cracked teeth with pain on the percussion and bite test had significantly higher  $|\Delta F|$ ,  $|\Delta Fmax|$ ,  $\Delta R$ , and higher  $|\Delta F|$ ,  $|\Delta Fmax|$  values, respectively. Also, there was a positive correlation between the patient's age and the  $|\Delta F|$  and  $\Delta R$  values. There was no statistically significant difference in QLF parameters between the same patient's symptomatic tooth and the contralateral tooth.

**Conclusion**: QLF technology is a useful assistive diagnostic device for diagnosing cracked teeth. There was a correlation between some QLF parameters and clinical signs and symptoms. The possibility of quantitative evaluation of the progression of the crack was partially confirmed.

This study was supported by a research fund from Yonsei Innovative Medical Device Evaluation and Development Center.

## **R054 - ASSOCIATION BETWEEN MAXILLARY SINUS PATHOLOGY AND PERIAPICAL LESIONS: A RETROSPECTIVE CONE-BEAM COMPUTED TOMOGRAPHY STUDY.**

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**Aim**: To analyse sinus membrane thickening in association with odontogenic infection of endodontic origin in maxillary premolars and molars using cone-beam computed tomography (CBCT) imaging.

**Methods**: Study design – retrospective radiological study. A sample of 524 CBCT images was collected, analysed and divided into two groups according to the presence (n=161) or absence (n=157) of periapical lesions in order to assess the association with sinus membrane thickening. Clinical features such as sex and age of the patients and pathologic findings in maxillary sinuses and adjacent teeth were recorded, graded, and analysed. Descriptive statistics and inferential statistics were used to analyse the data, specifically logistic regression, Fisher's exact test, Pearson's chi-squared test, Fisher's exact test for count data with simulated p-value based on 2000 replicates. The level of significance was set at p = 0.05.

**Results**: Maxillary sinus abnormalities were strongly associated with the presence of at least 1 tooth with a periapical lesion (p < .001). In 114 (70.4%) patients with periapical lesion, mucosal thickness of 3 mm or more was found, whereas in patients with absence of the lesions this was seen only in 43 (27.6%) cases. In patients with periapical pathology, age (p = .031) and destruction of periapical cortical bone (p < .001) had a statistically significant impact on the prevalence and severity of maxillary sinus mucosal thickneing. No correlation was found between sex, tooth group, spatial relationship between the maxillary sinus floor and the infected root tips, CBCT periapical index, foreign body and mucosal thickening.

**Conclusions**: Sinus membrane thickening is strongly correlated with the infection of posterior maxillary teeth. The risk of getting mucosal thickening over 3mm is 6.2 times higher for patients with an untreated endodontic pathology (95% TI 3.84, 10.16). Age and destruction of periapical cortical bone were statistically significant factors affecting mucosal thickening.

## R055 - SURFACE WEAR AND CYCLIC FATIGUE OF NOVEL ROTARY NITI INSTRUMENTS: 3D NONCONTACT OPTICAL PROFILOMETRY ANALYSIS

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**Aim:** To compare surface wear and cyclic fatigue of reciprocating (Reciproc Blue, WaveOne Gold) and novel rotary (XP-endo Shaper, TruNatomy) instrumentation systems, after two uses in curved root canals at body temperature.

**Methodology:** Forty round root canals of extracted human third molars with curvature of 25-40° measured on cone beam computed tomography (CBCT) scanns, were randomly assigned to four experimental groups (n=10) according to the instrumentation system used: Reciproc Blue, WaveOne Gold, XP-endo Shaper (XPS) and TruNatomy Prime (TRN). Each instrument was used twice in two different root canals. The instrumentation was performed according to manufacturer's instructions for each system, at body temperature, using 5 mL of 2.5% NaOCI for each canal. The instruments were evaluated before instrumentation, after the first and second use, with a noncontact 3D optical profilometer (Zygo NewView<sup>TM</sup> 7100) to quantify the surface roughness. Three roughness parameters were measured (Ra, Rq, Rz). After two uses, the tested instruments were submitted to cyclic fatigue (CF) test to evaluate the time to failure. The obtained data were analyzed with one-way analysis of variance ANOVA, post-hoc tests ( $\alpha = 0.05$ ), and Mann-Whitney U test was used for cyclic fatigue data ( $\alpha = 0.01$ ).

**Results:** The novel rotary instruments showed no significant difference in roughness compared to the reciprocating instruments, irrespective of the evaluation stage (p = 1.0). Contrary, the reciprocating instruments had significantly higher CF resistance compared to the rotary instruments (p < .01). Reciproc Blue showed the highest CF resistance, with 318 s time to failure. XPS had the lowest CF resistance (57,2 s), with no significant difference compared to TruNatomy (91,2 s).

**Conclusions:** The novel rotary and reciprocating systems showed similar surface wear, after two uses in curved root canals. Reciprocating instruments exhibited superior cyclic fatigue resistance compared to novel rotary instruments.

## **R056 - CYCLIC FATIGUE EVALUATION OF TWO HEAT-TREATED FILES USING A NEW TESTING DEVICE**

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**Aim**: To evaluate cyclic fatigue behavior of Hyflex EDM (HEDM) and CM (HCM) (Coltene/Whaledent AG, Altstatten, Switzerland) heat-treated instruments using a novel testing machine.

**Methodology**: Eighty new 40.04 Hyflex EDM and Hyflex CM, 25-mm long, were classified into 2 groups for each system according to the angle of curvature tested (n = 20): groups 1, 2 consisted of HEDM tested at 30° and 60° angles, respectively; groups 3 and 4 included HCM tested at 30° and 60° angles, respectively. The novel apparatus permitted the file rotated freely, not being forced within a suitable shaped housing. Cyclic fatigue was expressed as times to fracture (TtF). Dynamic bending force and thermal behavior of the file at the breakage were also recorded. Data were statistically analyzed using 2-way analyses of variance (ANOVA) and the Tukey multiple comparison posthoc test with the significance level established at 5% (P < 0.05).

**Results**: Both files exhibited significant lower TtF at 60° compared to 30°. Moreover, HEDM exhibited higher fatigue resistance than HCM when tested at 60°. For dynamic bending force at breakage, it was significantly higher at 60° compared to 30° for both files. Furthermore, HEDM exhibited less bending force than HCM at 60°. With regard to temperature in the middle of curvature at breakage, HCM reported a higher temperature at breakage at 60° than 30°. Moreover, HCM showed significantly higher values than HEDM at 60°.

**Conclusions**: Within the limitations of this study, both tested files exhibited reduced cyclic fatigue resistance when the angle of canal curvature increased from 30° to 60°. In addition, HEDM reported significantly better cyclic fatigue parameters at 60° angle of curvature in comparison with HCM. The novel apparatus permitted to minimize the effects of the friction phenomena and ensure unchanged geometric parameters.

## R057 - TORSIONAL RESISTANCE UNDER DIFFERENT BENDING CONDITION OF TWO DIFFERENT GLIDE PATH ROTARY FILE

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**Aim**: Of this study was to determinate the torsional resistance of two different Nickel Titanium (NiTi) rotary glide path files under different bending conditions, such as different degrees and angles of curvature.

**Methodology**: 100 Hyflex EDM Glide Path file 15.03 instruments (Coltene/Whaledent, Altstätten, Switzerland) and 100 One G glide path file 14.03 (Micro-Mega SA, Besancon, France). For each brand, 5 groups were created according to the different bending conditions (straight canal, 90° of curvature with 3 mm of radius, 90° and 5 mm, 60° and 3 mm, 60° and 5 mm). The static torsional test was performed by using a custom-made device, already validated in previous published studies, composed of an electric torque recording motor (N·cm); a vice used to secure the instruments at 3 mm and 5 from the tip; and artificial canals, which allow instruments to remain flexed during test. Each instrument was rotated at 500 rpm with a torque limit set to 5.5 Ncm until its fracture. Torque at Fracture (TtF) was registered. A scanning electron microscopy (SEM) observation was conducted to determinate and certificate the fractographic pattern.

**Results**: The results shows that an increase in the angle of curvature and a decrease in the radius of curvature of the artificial canals lead to an increase of TtF values with a statistically significant difference (p < 0.05), both in the One G and Hyflex EDM Glide Path file groups. Regarding the comparison between the two groups in the same bending condition, a statistically significant difference was found only when the torsional test was performed in the canals with the degrees of curvature of 90° with any radius of curvature.

**Conclusions**: In conclusion, it can be stated that an increased martensitic percentage positively influences the maximum torque at fracture when the instruments are subjected to bending conditions.

## R058 - A MULTIMETHOD ASSESSMENT OF A NEW CUSTOMIZED HEAT-TREATED NICKEL-TITANIUM ROTARY SYSTEM

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Aim: To compare 3 rotary systems regarding design, metallurgy, mechanical properties and shaping ability.

**Methodology**: New Genius Proflex (25/.04), TruNatomy (26/.04v) and Vortex Blue (25/.04) instruments (n=41 per group) were analyzed regarding design, metallurgy and mechanical performance, while shaping ability (untouched canal walls, volume of removed dentin and hard tissue debris) was tested in 36 anatomic matched root canals of mandibular molars. Results were compared using One-way ANOVA post hoc Tukey and Kruskal-Wallis tests with a significant level set at 5%.

**Results**: All instruments showed symmetrical cross sections with asymmetrical blades, no radial lands, no major defects, and almost equiatomic nickel and titanium ratios. Differences were observed in their number of blades, helical angles, cross-sectional design and tip geometry. Genius Proflex and TruNatomy instruments had the highest and lowest R-phase start and finish temperatures, as well as time and cycles to fracture (P < .05), respectively. TruNatomy had the highest flexibility (P < .05), while no differences were observed between Genius Proflex and Vortex Blue (P > .05). No differences among tested systems were observed regarding the maximum torque, angle of rotation prior to fracture, and shaping ability (P > .05).

**Conclusions**: Instruments showed similarities and differences on their design, metallurgy and mechanical properties. However, their shaping ability was similar without clinically significant errors.

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## **R059 - WEAR ANALYSIS OF FIVE DIFFERENT SINGLE-FILE RECIPROCATING INSTRUMENTS BEFORE AND AFTER FOUR USES IN ROOT CANALS: AN EX VIVO STUDY.**

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Aim: to assess the surface alterations of five reciprocating instruments before and after shaping of four root canals.

**Methodology:** Five reciprocating instruments were selected: Reciproc Blue, Reciproc, WaveOne Gold, EdgeOne Fire and a recently introduced instrument OneRECI, for a total of 50 new instruments. Before root canals shaping each instrument was mounted on a stub in a standardized position and observed using a scanning electron microscope to detect any surface alteration such as microfractures, metal defects, deformations, blunt and disruption of cutting edges, debris, pitting and tip flattening. Micrographs were acquired at the tip, 4mm, 8mm and 12mm from it. After that, each instrument was used in 4 root canals of 4 different lower incisors, selected based on a comparable anatomy, assessed trough CBCT. SEM observation was repeated after the simulated clinical uses to assess the wear resistance of the instruments. Surface alterations were registered before and after instrumentation and a statistical analysis was performed using Chi-Square test to verify homogeneity of defects distribution and GLM to evaluate the differences of RMS at baseline and after use for groups ( $\alpha$  level 0.05).

**Results:** Before simulated clinical uses no alteration were found except for three cases of EdgeOne Fire with metal strips on the tip, disruption of cutting edge of WaveOne Gold and an oily spotting on four different OneRECI. After simulated clinical use, EdgeOne Fire showed a statistically significant difference in terms of spiral distortion and flattening of the cutting edges. OneRECI showed the highest presence of debris despite the ultrasonic cleaning procedures. No instrument fractures were observed.

**Conclusion:** EdgeOne Fire should be discarded after 4 clinical uses and carefully inspected after each insertion in root canals. Moreover, tough attention should be paid during cleaning procedures after instrumentation, considering the copious debris detected in each instrument, particularly in OneRECI.

### **R060 - EFFECTS OF PASSIVE ULTRASONIC IRRIGATION ON BACTERIAL PRESENCE AND ACTIVITY IN ROOT CANALS ASSOCIATED WITH APICAL PERIODONTITIS**

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**Aim**: To evaluate the effect of passive ultrasonic irrigation (PUI) on bacterial presence and activity when used as a complementary approach after chemomechanical preparation (CMP).

**Methodology**: Root canal samples were obtained from 35 patients with asymptomatic apical periodontitis after the access cavity (S1), CMP (S2) and PUI (S3). The DNA and rRNA (cDNA) of the samples were subjected to qPCR with universal primers for bacteria. Bacterial levels were estimated by DNA-targeted qPCR, while bacterial activity was estimated by rRNA-targeted qPCR. The data were analyzed using the nonparametric Wilcoxon signed rank test (p < 0.05).

**Results**: CMP promoted a drastic reduction in bacterial levels (p < 0.0001). In addition, a significant decrease in bacterial counts was found when comparing S2 with S3 (p < 0.05). The concentration of rRNA copies was significantly higher than rDNA copies in S1, S2 and S3 samples (p < 0.05), indicating bacterial activity.

**Conclusions**: This study using a combined rRNA and rDNA approach showed that PUI was effective in reducing bacterial levels after CMP. However, bacteria persisted active in the root canals after CMP and PUI procedures (FAPESP 2016/15473-0).

## R061 - EVALUATION OF ANTIMICROBIAL ACTIVITY OF NEW ALL-IN-ONE DUAL-ACTION IRRIGATING SOLUTIONS FOR CONTINUOUS CHELATION.

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**Introduction**: The aim of this study was to compare the antimicrobial activity of two all-in-one dual-action irrigating solutions for continuous chelation (Triton and Dual Rinse HEDP) with the traditional dual-step NaOCI and EDTA sequential chelation irrigation.

**Methods**: A total of 90 straight single-rooted single-canal teeth with similar root canal length and shape were included in the study. After root canal instrumentation and irrigation procedures, teeth were sliced to obtain 180 dentine discs (3-mm thickness). Eighty discs were contaminated with Candida albicans and 80 with Enterococcus faecalis and irrigated with Triton (Brasseler; Savannah, US), Dual Rinse HEDP (Medcem GmbH; Weinfelden, Switzerland) mixed with 6% NaOCI and 6% NaOCI/17% EDTA (Vista Apex, Racine, WI) or were not treated (positive controls). Fifteen discs from each group were used to evaluate colony forming units (CFU) and 5 discs from each group were analyzed by SEM. Twenty discs were not contaminated (negative controls): 15 discs were used for CFU study and 5 were used for SEM analysis. The statistical analysis was performed using One-Way Anova test with a statistical significance level set at 0.05.

**Results**: All the irrigation protocols significantly reduced the number of E. faecalis (CFU 0) compared with the untreated group (P < 0.05), without any significant difference among them. Triton group showed the lowest number of remaining C. Albicans compared to other groups (P < 0.05) and Dual Rinse group reduced C. Albicans more than NaOCI/EDTA group (P < 0.05). SEM analysis have shown the presence of C. albicans and E. faecalis biofilm in the positive controls, while confirming the absence of microorganism in the negative controls.

**Conclusions**: All the irrigation protocols were effective against E. faecalis, while Triton showed the highest antimicrobial efficacy against C. Albicans.

### R062 - ANTIBACTERIAL EFFICACY OF DIFFERENT IRRIGANT ACTIVATION PROTOCOLS ON A POLYBACTERIAL BIOFILM: AN EX-VIVO STUDY

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Aim: To investigate the antibacterial efficacy of a variable pressure irrigation device on a polybacterial biofilm.

**Methodology**: Sixty previously sterilized monoradicular teeth were divided into two groups and colonized by either a E.f, P.g, F.n, P.i, polybacterial biofilm, or a E.f monostrain biofilm. After fifteen days of colonization, they were randomly allocated into six groups corresponding to six disinfection procedures: a conventional irrigation with a side vent needle, a special variable pressure device tested at 1, 2 or 3 bars, an ultrasonic device, and a diode laser. On each tooth, a first sample was taken to reflect the initial bacterial load (t0). A conventional chemo-mechanical preparation was then performed to allow a final irrigation procedure according the six methods. To assess the efficacy of each method, a second sample (t1) was taken to reflect of the post disinfection bacterial load. A Fisher test was performed on the obtained measures with an alpha risk set at 5%.

**Results:** In the polybacterial biofilm group, the whole of t0 samples came out positive. Only 20% of the samples remained positive after conventional side vent needle disinfection, ultrasonic activation, 3 bars pressure irrigation and with the use of laser. Samples came back negative after the irrigation at 1 or 2 bars. In the E.f monostrain group, the whole t0 samples came out positive. Some samples remained positive after the conventional needle disinfection, 2 bars and 1 bar pressurized irrigation respectively with 60%, 40% and 20%. All the samples came back negative for the laser assisted, ultrasonic activated and 3 bars pressurized irrigations. No statistically significant difference was found between the methods (p > 0.05).

**Conclusion:** Despite emerging tendencies, none of the investigated method works significantly better than the others. All the investigated methods seem to be valid to disinfect the root canal system.

## **R063 - THE INFLUENCE OF ROOT CANAL TAPER ON THE DEBRIDEMENT EFFICACY OF DIFFERENT IRRIGANT ACTIVATION METHODS - AN IN-VITRO QUANTITATIVE ANALYSIS.**

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Aim: To investigate the influence of root canal taper on the debridement efficacy of different irrigant activation methods.

**Material and Methods:** Transparent polymethylmethacrylate root canal models containing two standardized root canals (apical diameter: 0.3 mm, length: 16 mm, taper: 2%, 4% or 6%, with a coronal reservoir) connected by an isthmus (width: 0.15 mm, height: 2 mm) were used as the test models. The isthmus was filled with a biofilm mimicking hydrogel (BMH), containing dentine debris. These models were randomly assigned to 4 irrigant activation groups (n=20): conventional needle irrigation (NI), sonic activation with Eddy (EDDY), ultrasonically activated irrigation (UAI) with an Irrisafe file and laseractivated irrigation (LAI) (Auto-SWEEPS) with an Er:YAG laser (20 mJ, 20 Hz) with a flat-ending fibre tip (Varian 400/14). Standardized images of the isthmus were taken before and after irrigation and the amount of removed BMH was determined using image analysis. A two-way ANOVA was conducted to explore the interaction between activation method and taper on BMH removal.

**Results:** A statistically significant interaction was observed between the effects of taper and activation method on BMH removal from the isthmus (p<.05). Greatest biofilm removal was seen in 6% taper (NI:43.5%, Eddy:86.4%, UAI:91.1%, LAI:92.6%). The biofilm removal in 4% taper was NI:50%, Eddy:60.5%, UAI:81.2.1%, LAI:79.6%. Least biofilm removal was seen in 2% taper (NI: 10.9%, Eddy: 6.2%, UAI:65.7 %, LAI: 28.7 %).

**Conclusion:** Root canal taper impacts the debridement efficacy of the tested irrigant activation methods. Greater tapers resulted in greater BMH removal from the isthmus for the 4 tested activation groups. The efficacy of UAI was least affected by decreasing taper, while EDDY was most affected by smaller taper.

Keywords: Biofilm removal, Eddy, Isthmus, LAI (SWEEPS), Root canal irrigation, Root canal taper, UAI.

### R064 - NEGATIVE AIR PRESSURE ROOM EFFECT ON AEROSOL AND SPLATTER DISTRIBUTION PATTERNS DURING ENDODONTIC PROCEDURES USING PASSIVE ULTRASONIC IRRIGATION(PUI) DEVICE

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**Aim:** To evaluate aerosol and splatter distribution patterns during endodontic procedures using passive ultrasonic irrigation(PUI) devices on the effect of negative air pressure room and normal pressure room at Dental Hospital(RSKGMP) Universitas Airlangga.

**Methodology:** The design of this study was a posttest-only control group design. 1g fuorescein and 1L distilled water were mixed as irrigation solution for PUI devices. Root canals of tooth 11 on a mannequin were irrigated using a PUI device with the operator positioned at 9 o'clock zone. Filter paper was placed on a platform around the working area forming a radius of 30 cm at 12, 2, 4, 6, 8, and 10 o'clock zones. This research was carried out at the Dental Hospital Universitas Airlangga with negative air pressure room (-2.5 Pa) and normal air pressure room. The surface area of the aerosol and splatter attached to the filter paper was calculated using Image-J Software and then analysed using the Kruskal-Wallis test, Mann Whitney, and Independent T test.

**Results:** The pattern of the negative air pressure room group has the highest average contamination in the 10 o'clock zone with a total of 3,667,271.8 m<sup>2</sup>. While in the normal air pressure group at 8 o'clock zone with a total of 10,444,576.6 m<sup>2</sup>. In the Kruskal Wallis test to determine the significance of the difference in contamination in the two rooms, no significant difference was found (P = .652 and .347). In the Mann Whitney test and the Independent T test to find out the significant difference between each clockwise direction zone in the negative and the normal air pressure room, no significant difference was found in each clockwise direction (P = > 0.05).

**Conclusions:** Negative air pressure room has a different effect on the pattern and amount of aerosol distribution compared to normal air pressure room.

### R065 - EFFECT OF SONIC ACTIVATION AND ACTIVATION TIP SIZE IN REMOVAL OF CALCIUM HYDROXIDE PASTE

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Aim: The aim of this study was to evaluate the effect of sonic activation and activation tip size in removal of calcium hydroxide paste on oval shaped root canal.

**Methodology:** Fifty oval shaped mandibular premolars were divided into five groups (n=10). All teeth were prepared with Ni-Ti file and filled with calcium hydroxide paste. The calcium hydroxide paste was removed with irrigation without activation or with activation using either EndoActivator or EQ-S. All canals were irrigated with 3% NaOCI at 2 mm short of the working length. Sonic activation was delivered for 20s. The samples were scanned using micro-computed tomography (Quantum GX). The volume of calcium hydroxide pastes were measured before and after removal, and the percentages of volume of residual paste in the root canal were calculated.

**Results:** Supplementary sonic irrigation resulted in significantly higher percentage of removal volume (p<0.05). The percentage of removal volume of calcium hydroxide paste at the apical part was higher than in the coronal and middle part in all groups (p < 0.05). In the apical third, 11.97% and 10.98% of calcium hydroxide epaste were removed when conventional needle irrigation (group 1) and EndoActivator (group 3, size 35, .04 taper) agitation were used each. It showed significantly lower removal rate than other groups (p<0.05). There was no statistically significant difference in the removal rate according to the tip size of the activation device. The removal rate of calcium hydroxide paste showed a tendency to decrease at the tip size of EndoActivator used for removal increased.

**Conclusion:** Supplementary sonic irrigation using the EndoActivator and EQ-S system was more effective than conventional needle irrigation alone. EQ-S groups were more effective than EndoActivator group. However, there was no statistically significant difference in the removal rate according to the tip size of the activation device.

### R066 - EFFECT OF FINAL IRRIGANTS ON THE RELEASE OF TRANSFORMING GROWTH FACTOR BETA 1 AND VASCULAR ENDOTHELIAL GROWTH FACTOR FROM HUMAN ROOT DENTINE

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**Aim**: To evaluate the effect of different final irrigants on the release of transforming growth factor beta 1 (TGF- $\beta$ 1) and vascular endothelial growth factor-A (VEGF-A) from human root dentine.

**Methodology**: Thirty two extracted teeth were used. The standardized root segments were prepared and distributed into four main groups according to the used final irrigation after NaOCI irrigation: 17% EDTA, 10% citric acid, MTAD, and saline (control group). After treatment procedures, the root segments were placed into eppendorf tubes containing phosphate-buffered saline solution for 24h. The release of TGF-β1 and VEGF-A from dentin was measured using the enzyme-linked immunosorbent assay (ELISA). The data were tested for normality and statistical analysis were performed using the one-way analysis of variance at a significance level of .05. A post hoc LSD test was used for multiple comparisons between groups.

**Results**: Ten percent citric acid released the greatest amount of TGF- $\beta$ 1 in comparison to all other groups, which was statistically different to 17% EDTA (p<0.01) and saline (p<0.01). The 17% EDTA and MTAD released more TGF- $\beta$ 1 than saline, but difference was significant only for MTAD (p<0.01). No VEGF release was detected for any group.

**Conclusions**: Ten percent citric acid seems to be more effective as final irrigant for releasing TGF-b1 then 17% EDTA and MTAD, which showed similar TGF-b1 releasing capability. Investigated irrigants did not released amount of VEGF detectable by ELISA.

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## R067 - EVALUATION OF APICAL IRRIGANT EXTRUSION AFTER TWO ER:YAG LASER ACTIVATED IRRIGATION MODES USING THREE TYPES OF LASER TIPS

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**Aim**: To evaluate the amount of apically extruded 3% sodium hypochlorite (NaOCI) using two modes of Er:YAG laser activated irrigation (LAI) i.e. Super Short Pulse (SSP) and Shock Wave Enhanced Emission Photo-acoustic Streaming (SWEEPS®) combining three types of laser tips (LT), and conventional needle irrigation (NI).

**Methodology**: Twenty extracted human maxillary central incisors, which had been previously prepared with Reciproc® instruments (size 40, taper 0.06) with standardized working length were selected. Irrigant volumetric flow rate (VFR) was accurately standardized using a precision syringe pump (PSP) with constant irrigant delivery through the 27gauge (G) needle. The tested irrigation protocols (duration 60s) were: Group 1. SSP (Er:YAG laser, LightWalker AT, Fotona):10 mJ, 15 Hz, pulse duration 50  $\mu$ s; Group 2. AutoSWEEPS (ASWEEPS, Er:YAG laser, LightWalker, AT, Fotona): 20 mJ, 15 Hz, pulse duration 25  $\mu$ s; Group 3. 27 G NI constant VFR 0.05 ml/s. In the SSP and ASWEEPS groups, three LT-s were used: X-Pulse 600/14 cylindrical; SWEEPS 600 saphire; PIPS 600/9 quartz tapered. Each protocol with three types of LT-s was evaluated in 20 teeth (10 repetitions on each). Apically extruded irrigant was collected and net weighed for each protocol. Data were analyzed by Friedman's Two-Way Analysis of Variance and Dunn's Pairwise test with the significance level was set at p ≤ .05.

**Results:** Significantly lower amounts of extruded irrigant during NI and SSP mode using X-Pulse and PIPS LT-s compared to other tested LAI protocols (p<0.05) were found. In the ASWEEPS group, all three LT-s resulted in similar amounts of extruded irrigant (p>0.05).

**Conclusion:** In straight root canals, the amount of irrigant extrusion with X-Pulse and PIPS LT-s used with SSP mode of Er:YAG LAI was at the same level of needle-syringe irrigation and can be considered a safe technique.

Keywords: Er:YAG, Extrusion, Laser, PIPS, Root canal, Sodium hypoclorite, SWEEPS

### R068 - COMPARATIVE EFFECT OF TWO METHODS OF NEEDLE INSERTION SITE DEFINITION ON INFERIOR ALVEOLAR NERVE BLOCK IN MIXED DENTITION: A RANDOMIZED CLINICAL TRIAL

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**Aim**: to assess the objective and subjective pain reactions using tactile versus visual method to determine needle insertion point of IANB in children of mixed year dentition.

**Methodology**: Forty 7 to 9-year old children who required bilateral permanent mandibular first molars vital pulp therapy or bilateral primary mandibular second molars pulpotomy were recruited in this randomized double-Blind, cross-over trial. Subjects were randomly divided into two groups (A and B). Groups of A and B received IANB using tactile and visual methods respectively for the right side in the first session. In the second session, groups were received not previously applied method for the left side. Outcomes of objective and subjective pains during injection (using SEM and FIS respectively) and anesthesia failure (any reaction during cavity preparation by using SEM) were recorded. Mann-Whitney U, Wilcoxon Singed Rank and Fisher's Exact Tests were used to analyze data in SPSS 20 at the significance level of 0.05.

**Results**: Comparing groups, there were no significant differences in all outcomes in tactile method (P> 0.05). However, analysis showed a statistical significant difference in subjective pain reaction in groups regarding visual method (P= 0.013).

In group A, visual method demonstrated significant differences in both pain reactions compared to tactile method (P< 0.05). In group B, there was no differences between the two methods in all studied outcomes. Briefly, in all outcomes, visual method showed statistically superior results than tactile method (P<0.05).

**Conclusion**: The visual method provokes less pain reactions during anesthesia injection and shows simultaneously higher anesthesia success rate.
## R069 - THE ROLE OF TNFA AND CASPASE3 PATHWAY ON THE UP-REGULATION OF VOLTAGE-GATED SODIUM CHANNEL NAV1.7 IN EXPERIMENTAL FLARE-UP POST DENTAL PULP TISSUE EXTIRPATION

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**Aim:** To analyze the immunohistochemical picture of flare-up in vital dental pulp tissue after pulp tissue extirpation or intervention with lipopolysaccharide (LPS) administration followed by pulp tissue extirpation.

**Methodology:** The experimental laboratory research with post-test only control group design. Twenty Sprague Dawley rats were divided into four groups, each group consists of five rats which were control group (G1), pulp tissue extirpation group (G2), LPS group (using Ultrapure lippopolysaccaride from Porphyromonas gingivalis – TLR4 ligand) (G3), and LPS group followed by pulp tissue extirpation (G4). Samples were collected from dental apical field of the mandibular incisor. Examination was done by immunohistochemically method. The data was statistically analyzed using ANOVA ( $\alpha < 0.05$ ).

**Results:** There were significant differences in TNF $\alpha$  expression between all treatment groups with p value < 0.05, except between G3 and G4 with p value = 0.278 (p > 0.05). There were significant differences in Caspase3 expression between all treatment groups with p value < 0.05, except between G2 and G3 with p value = 0.548 (p > 0.05) and between G3 and G4 with p value = 0.098 (p > 0.05). NaV1.7 expressions between all treatment groups have p value < 0.05, showed that there were significant differences in expression of NaV1.7 between all treatment groups.

**Conclusions:** Pulp tissue extirpation causes the increasing of TNF $\alpha$  expression in the pulp tissue. An increase in TNF $\alpha$  causes an increase in Caspase3 through TNF $\alpha$  Receptor pathway, which leads to apoptosis and an increase in NaV1.7 through TNF $\alpha$  Receptor pathway, which induces flare-up. Flare-up response induced by pulp tissue extirpation tends to be greater in vital tooth than those in inflamed vital pulp tissue.

# R071 - MICROBIOME IN ROOT CANAL APICES AND THE ASSOCIATED PERIAPICAL LESIONS IN CASES WITH FAILED ROOT CANAL TREATMENT

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**Aim**: To assess and compare the microbiome of root apices and the associated periapical lesions retrieved surgically from cases with failed root canal treatments using next-generation sequencing.

**Methodology**: The apex and the associated periapical lesion of 21 teeth with failed root canal treatments of adult patients were extracted during surgical retreatment. All teeth presented radiographic evidence of post-treatment apical periodontitis. Each specimen was cryo-pulverized, the DNA was extracted, and the V3–V4 hypervariable regions of the 16S rRNA gene were amplified and subjected to high-throughput sequencing using the Illumina Miseq platform. Bioinformatic analysis was carried out using the Mothur software and diversity indices were obtained using operational taxonomic units (OTUs). The taxonomic classification was performed using SILVA v.132 as the reference database. The diversity indices of the apices and lesions were compared with the Wilcoxon Signed Rank test and community composition differences were explored with Permutational Multivariate Analysis of Variance (PERMANOVA) and LefSe analysis ( $\alpha = 0.05$ ).

**Results**: A higher alpha diversity was observed in the periapical lesions as compared to the apices with an increase in the number of OTUs. Firmicutes and Bacteroidetes were the most abundant phyla identified, both accounting for 57% of the total reads, and Fusobacterium, Porphyromonas and Streptococcus were the most prevalent genera in both sites. Principal coordinate analysis and PERMANOVA did not reveal any statistical differences in the community composition in either site (P = 0.72), although LefSe analysis showed that the genera Clostridium\_sensu\_stricto\_1, Blautia and Veillonella were enriched in the lesions.

**Conclusions**: The periapical lesions showed a higher diversity than the apices although the bacterial community in both sites was similar.

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# R072 - EFFICACY OF MICROBIAL SAMPLING WITH PAPER POINTS OR ENDODONTIC INSTRUMENTS FROM THE ROOT CANAL

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**Aim**: To evaluate the suitability of sampling microorganisms from the root canal with either paper points or endodontic instruments for investigations of the endodontic microbiome by 16S sequencing.

**Methodology**: Fifteen patients presenting clinical and radiologic sings of asymptomatic apical periodontitis were recruited for sampling, giving their written informed consent. After the application of rubber dam and disinfection of the crown, pulp chambers were opened and root canals were identified. Glide paths were assessed using C-Pilot Files (size 10, VDW, Munich, Germany) and K-Files (size 15, Dentsply Sirona, Bensheim, Germany) under electronic root canal length control. Microbial samples were taken from 30 root canals in duplicates, the first sample with a sterile paper point (size 15, VDW) and the second with a sterile endodontic instrument (F6 SkyTaper size 20/.06, Komet, Lemgo, Germany). DNA was extracted and the hypervariable region V4 of the bacterial 16S rRNA gene was amplified and sequenced using the Illumina MiSeq Instrument. Sequencing data was processed with Cutadapt and exact ribosomal sequence variants (RSVs) were inferred with DADA2. Diversity parameters were calculated using Phyloseq. Statistical analysis comprised PERMANOVA and Wilcoxon signed-rank tests.

**Results**: Endodontic microbial samples taken with sterile paper points or sterile instruments presented similar microbial community compositions (P=1.000, PERMANOVA). Similar richness (P=0.863; number of observed RSVs per sample) and slightly higher, although statistically noticeable diversity (P=0.002; Shannon's diversity index) and evenness (P=0.043; Pielou's evenness index) and slightly lower dissimilarity (P=0.025; Bray-Curtis dissimilarity) were found in instrument samples compared to paper point samples.

**Conclusions**: Both paper point and endodontic instrument sampling are suitable to generate valid specimens for 16S rDNA community profiling. Endodontic instrument sampling is easier to execute and therefore, could be the preferred technique.

Acknowledgements: The local ethics committee accredited this research (2020-180-f-S).

## R073 - QUANTITATIVE STUDY OF THE MICROBIOMES OF TEETH WITH VITAL PULP AND ASSOCIATED PERIODONTAL DISEASE

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To investigate the microbial communities of teeth with vital pulp and associated periodontal disease, as well as the interrelationship between the microorganisms from root canals (RCs) and periodontal pockets (PPs).

Ten patients with vital pulp and associated periodontal disease were selected. Samples from RCs (n=10) and PPs (n=10) had their DNA extracted. The microbiome was examined by focusing on the V3-V4 hypervariable region of the 16S rRNA gene, using Illumina MiSeq platform. The identified OTUs showed 3 phyla in RCs and 5 phyla in PPs. RCs had the highest proportion of OTUs identified for Firmicutes 94.78% and Proteobacteria 1.16%. The most predominant phyla in PPs were Firmicutes72.44%, Proteobacteria 26.62%, and Bacteroidetes 0.21%. The microbiota at the genera level showed a total of 17 (RCs) and 28 (PPs) identified genera, the most abundant being Enterococcus 67,17%. Streptococcus 10,11% and Gemella 9,01% and Staphylococcus 3,06% in RCs samples; and Streptococcus 35.43%, Aggregatibacter 16.54%, Enterococcus 10.31% and Desulfobulbus 9.63%, in PPs. Thirty species were identified in RCs and 47 in PPs. RCs presented a representative number of OTUs annotated for: E. faecalis 67.11% and G. morbillorum 6.71%; PPs for A. actinomycetemcomitans 16.54%, Streptococcus sp. 10.53%, E. faecalis 10.29% and Desulfobulbus sp. 9.63% were the most abundant. Comparative studies for annotated OTUs revealed a sharing of 17 genera among the study conditions. RCs and PPs shared 29 species. It was concluded that microorganisms were present in all samples of CRs and PPs, with Streptococcus and Enterococcus being the most predominant genera; and E. faecalis one of the most abundant species in both sites. There was sharing between some species of RCs and PPs, suggesting an intercommunication between these sites. (Supported by FAPESP 15/23479-5; 17/25242-8, 19/14448-0, 19/19300-0; CNPg 303852/2019-4, 164905/2020-0, CAPES 001 & FAEPEX).

## R074 - ANTIBACTERIAL ACTIVITY OF NOVEL ROOT CANAL DESINFECTANT NANOMATERIALS AGAINST ANTIBIOTIC-RESISTANT *ENTEROCOCCUS FAECALIS* STRAIN ISOLATED FROM PERSISTENT ENDODONTIC INFECTION.

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**Aim**: To evaluate antibacterial activity against a antibiotic resistant *Enterococcus faecalis* of silver and coppernanosols and nanogels, stabilized with polyvinylpilorridone-PVP and polyvinylalcohol-PVA by chemical method, as a new potential root canal desinfectants.

**Methodology**: A microbial sample obtained from the root canal with persistent endodontic infection, was inoculated in a selective *Enterococcus* medium. The isolated strain were identified by biochemical tests and 16S rDNA sequencing. Minimum inhibitory concentration (MIC) values and breackpoints for the antibiotics that are commonly used in dentistry were determinated by the E-test technique according to the Clinical and Laboratory Standard Institute (CLSI/M100-S27-2017). To evaluate the antibacterial activity against clinical endodontic isolated, six silver and copper nanosols and twelve silver and copper nanogels were used at different concentrations of PVP/PVA (1:0.3, 1:0.5 and 1:1) in ethyleneglycol. MIC for nanosol were determinated by broth microdilution. Diffusion test in agar were performed for nanogels. Finally, time-kill kinetics assays was performed in triplicate for all nanomaterials. To compare the antibacterial activity of the different nanomaterials, a multifactorial ANOVA test (P < 0.05) followed by tukey's multiple comparison test was performed. Ethics Committee approval (C.I.Y.B.04/15).

**Results**: Endodontic clinical strain isolated were confirmed as *E. faecalis* with 98% identification according NCBI accession number KJ803877.1. MIC values and breackpoints confirmed as an antibiotic resistant strain. Antibacterial activity over time was present in both Ag/Cu-nanosols and Ag/Cu-nanogels. Ag and Cu-nanosol [high PVA-concentration] behaved similarly at 2h of application, presenting bacteriostatic activity (*P*>0.05). On the contrary, Ag-nanogel [medium PVA concentration] and Cu-nanogel [high PVA concentration] presented bactericidal activity over time, where the latter showed a significant activity in relation to other gels (*P*<0.05).

**Conclusions**: Polymeric gels nanostructured with smaller size and low concentration of metallic nanoparticles, allows to obtain an effective antibacterial activity, generating a possible alternative intracanal dressing to persistent endodontic diseases.

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### R075 - FETAL BOVINE SERUM REDUCES THE ANTIBACTERIAL POTENTIAL OF THREE ROOT-END FILLING MATERIALS: AN IN VITRO STUDY

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**Aim**: To evaluate the antibacterial activity of three root-end filling materials after exposure to water or fetal bovine serum (FBS) in vitro.

**Methodology**: MTA Angelus (MTA; Angelus, Londrina, Brazil), TotalFill BC RRM putty (TotalFill; FKG Dentaire SA, La Chaux-de-Fonds, Switzerland) and Intermediate Restorative Material (IRM; Dentsply Sirona, Charlotte, NC, USA) were tested (n=9 per group). Materials were placed upon a standard part of the side walls of 96-well microtiter plates. Fifty µl of purified water or FBS (F7524, Merck, Darmstadt, Germany) were applied upon each material. Samples were incubated for 2 h ('fresh'), 1 and 7 days at 37 °C in >95% humidity. Consequently, a 10 µl Enterococcus faecalis inoculum was placed upon the material surfaces or uncoated wells (positive control). Following incubation at 37 °C for 1 h, 300 µl phosphate buffered saline were added to each well and mixed. Viable bacteria were counted after culturing aliquots on agar plates. Data were processed with analysis of variance and Bonferroni post-hoc tests for multiple comparisons in addition to t-tests for the same materials under the same aging period and different exposure medium (water/FBS) (P=0.05).

**Results**: Upon water-exposure, all materials reduced the E. faecalis colonies in all aging periods (P<0.05). Fresh MTA eliminated all bacteria but its effect was decreased after 1 day (P<0.05). Fresh IRM was the least antibacterial (P<0.05), but with a stable effect throughout time. TotalFill had its highest antibacterial efficacy after 1 day (P<0.05). Exposure to FBS reduced the antibacterial activity of MTA after 7 days, while in TotalFill a decrease was observed after 1 day (P<0.05). FBS-exposed IRM was not antibacterial in any studied period (P<0.05).

**Conclusions**: Exposure of root-end filling materials to a serum-containing environment can deteriorate their antibacterial potential. IRM was affected the most, while MTA was the least affected material.

## R076 - COMPARISON OF MICROBIOME IN RETREATMENT OF TEETH WITH CHRONIC PERIAPICAL LESIONS BEFORE AND AFTER IRRIGATION. ON-GOING RANDOMIZED CLINICAL TRIAL. PRELIMINARY REPORT.

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**Aims**: Our aim is to determine the microbiome of root canal space during retreatment before and after sodium hypochlorite (NaOCI) or hyper-pure chlorine dioxide (CIO2) irrigation.

**Methodology**: So far, we have included 21 patients needing revision due to chronic periapical lesion. After surface sterilization the root canal obturations were removed mechanically. After taking the first sample (M1) from the infected root canal, the canals were rinsed with 2mL per canal 2.5% NaOCI (n=8) or 0.12% CIO2 (n=13) activated for 1 minute. The teeth were temporarily sealed without intracanal dressing. Patients were recalled one week later. Surface sterilization was repeated and the second samples (M2) were taken from the root canals. Following a final disinfection the root canal obturation was completed. The presence of bacteria was confirmed by culturing and species dedicated PCR strip test (Micro Ident Plus11, HAIN).

**Results**: All samples in M1 and M2 showed bacterial presence. Before irrigation 19 genera, dominantly Streptococcus, Staphylococcus, Fusobacterium, Enterococcus, and after irrigation 15 genera were found, mainly Streptococcus, Enterococcus, Lactobacillus when irrigated with NaOCI and Streptococcus, Fusobacterium and Enterococcus in case of CIO2. In all patients irrigated by NaOCI some bacteria found in M2 were also present in M1; however, in case of CIO2 this was only true in half (54%) the cases. In both groups after irrigation species have appeared, that have not been shown in M1.

**Conclusions**: Endodontic disinfection was not able to totally eliminate microbes from the root canals. New species appearing after disinfection could have been suppressed by other microbes before irrigation and were able to dominate due to disinfection. Species persisting despite disinfection and new species appearing after disinfection must fundamentally influence endodontic irrigation protocol to solve the complication of persistent/secondary infections.

Funding: No funding

## R077 - MICROBIOLOGICAL ASPECT OF REGENERATIVE ENDODONTIC TREATMENT: FROM CULTURE BASED TO HIGH-THROUGHPUT MOLECULAR SEQUENCING TECHNIQUES

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**Aim:** Regenerative endodontic treatment (RET) allows the resolution of periapical lesions and promote continuous root development. However, critical to RET is the disinfection of the pulpal space without affecting stem cells properties. In this study, we analysed the microbial composition of immature traumatized teeth. Further, we studied differences in microbiome profiles based on treatment outcomes.

**Methodology:** RET was performed in 75 traumatized necrotic immature incisors from 71 patients. In 45 of 75 teeth (60%), RET was successful with resolution of clinical and radiographic signs and continued root development. RET failed due to absence of bleeding (n=19; 25.4%) and persistent infection (n=11; 14.7%). Bacterial sampling was collected at five time points and samples were analyzed combining culture and a high-throughput molecular sequencing technique to investigate the microbial profiles. Colonies with different phenotypic patterns were selected and identified with PCR (16S rRNA). Illumina Miseq sequencing was applied and the V3-V4 hypervariable regions of the 16S rDNA were PCR amplified.

**Results:** Viable bacteria were detected in 66% of the root canal samples at baseline. No statistical correlation was observed between bacterial loads and clinical/radiographical features or type of trauma. Fusobacterium nucleatum, Dialister invisus, Peptostreptococcaceae yurii, and Slackia exigua were the most prevalent species isolated. Actinomyces gerencseriae was highly prevalent and exclusively identified in failed cases. Bacterial growth after instrumentation and intracanal dressing was detected only in failed cases. The root canal microflora of traumatized teeth was highly diverse as analysed by Illumina. The microbiome clustered distinctly at the different time points. However, there was no significant difference between the microbiome profile of root canals that succeed and failure RET.

**Conclusion:** Failed RET is associated with bacterial growth and high prevalence of Actinomyces gerencseriae. The microbiome composition of immature traumatized teeth is very diverse but seems not to be correlated to the treatment outcome.

# R078 - THE NOVEL VB\_EFA29212\_2E AND VB\_EFA29212\_3E E. FAECALIS BACTERIOPHAGE THERAPY IN ROOT CANAL BIOFILM ERADICATION

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E. Faecalis is the most often found microorganism in a consistent mono- and multispecies biofilm within root canal space causing persistent infections of endodontic origin.

Aim: was to isolate, characterize and evaluate the lytic activity of bacteriophages against E. Faecalis in a formed biofilm model.

**Methodology:** E. faecalis ATCC 29212 strain was used for the study. Two vB\_Efa29212\_2e and vB\_Efa29212\_3e phages were isolated from urban wastewater and characterized with a transmission electron microscope (TEM). The phage 3e was inoculated in E. Faecalis biofilm established in the dentinal tubules of bovine teeth (n=16) during 21 days. Teeth were randomly divided into the test group (n=8), positive control (n=5), negative control (n=3). Confocal and scanning electron microscope (SEM) were used for the assessment of the biofilm eradication in the investigated groups of teeth before and after inoculation with the phages. Colony-forming unit (CFU) counting from biofilms bacteriophage-treated biofilms and their untreated counterparts was determined.

**Results**: Based on International Committee on the Taxonomy of Viruses (ICTVs) guidelines taksonomy of vB\_Efa29212\_2e and vB\_Efa29212\_3e phages was confirmed as Siphoviridae and Brockvirinae, respectively. Confocal microscope assessment has shown less amount of bacteria in the field of view and SEM visual analysis revealed distortion of bacteria cells after phage inoculation. Reduction of 54.6% of E. faecalis forming biofilm after treatment with phage 3e for 48 h was observed.

**Conclusions**: Complete loss of structure of bacterial cells confirm lytic activity of the phages.Together with conventional disinfection protocol this novel bacteriophage therapy is a promising strategy against E.faecalis biofilm. Further research is required.

## **R079 - PROCEDURAL ERRORS USING TWO INSTRUMENTATION TECHNIQUES**

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**Aim:** the purpose of this study was to compare the arithmetic crown-down dynamic tactile (ACDT) technique with the single length technique (SLT) when shaping severely curved root canals in terms of procedural errors.

**Methodology:** The participants were 339 dental interns over 9 months. A presentation of the describing SLT and ACDT was shown to the interns. Each intern was required to shape 4 root canals, 2 for each technique. The root canals included in the study had degrees of curvature of more than 30 degrees. They were mandibular mesial canals and maxillary buccal canals. The SLT was performed using a 10 K file followed by sequential enlargement by sizes 17/.04, 20/.04, 25/.04 and finishing with a 30/.04, each to the full working length (WL). For ACDT, a formula was used to calculate the maximum insertion depths of higher tapered instruments to prevent overflaring of the canal and preserve the pericervical dentine. Based upon the formula, the following sequence was used: the 25/.12 inserted to 10.25 mm short of the WL, 20/.06 inserted to 3.67 mm short of the WL, or to the beginning of the curve, whichever came first. Then, the 17/.04, 25/.04 and 30/.04 were inserted to the full WL. The martensitic nickel-titanium rotary files were activated upon dentinal engagement followed by 3 apical strokes. Procedural errors were recorded and statistically analysed. Post hoc pairwise comparisons were used to compare the 2 techniques with the significance level set at p<0.05.

**Results:** The percentage of canals instrumented using ACDT that had errors (19.6%) was significantly lower than those instrumented using SLT (53.2%) (p<0.001). SLT showed a significantly higher percentage of transportation, broken and deformed instruments (p<0.001).

Conclusion: The ACDT is a safe and predictable technique for severely curved canals

# R080 - THE REPEATABILITY OF THREE-DIMENSIONAL PRINTED REPLICAS OF A MAXILLARY PREMOLAR WITH A TYPE II CANAL: A MICRO-CT STUDY

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Aim: To evaluate the repeatability of three-dimensional (3D) printed maxillary premolar replicas.

**Methodology**: An extracted maxillary first premolar with a type II canal (Vertucci classification) was enlarged using Ni-Ti rotary files. Cone-beam computed tomography was used to scan the tooth and collect data for 3D printing. In particular, the part connecting the main canals (the isthmus), was designed with three parts (coronal, middle, and apical), and the lateral canal was designed on both sides of the apical area. Thirty-four 3D-printed tooth replicas were scanned with micro-computed tomography (micro-CT). Repeatability was evaluated in terms of the total volume and three area measurements by the ratio of the difference between the measured value and average reference value. The data were statistically analyzed using the Kruskal-Wallis test with the Bonferroni correction.

**Results**: The ratio of the difference between the measured and reference values was significantly lower in the main area than in the lateral canal or isthmus (p<0.001). Upon a further subdivision, the differences for the entire canal and main canals were significantly lower than those for all other parts: coronal, middle, apical, subleft, and subright (p<0.001). Significant differences were found for the middle and subleft areas (p=0.005).

**Conclusions**: Although repeatability was relatively low in narrow areas, 3D-printed replicas can be usefully applied in further experiments on teeth with various root canal systems.

**Funding source:** This work was supported by a National Research Foundation of Korea grant funded by the Korean government (No. NRF-2019R1A2C1005247) and Research Fund of Seoul St.Mary's Hospital, The Catholic University of Korea.

# R081 - CLINICAL INVESTIGATION OF INFECTIOUS AND INFLAMMATORY CONTENT IN TEETH WITH VITAL PULP AND ASSOCIATED PERIODONTAL DISEASE

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**Aim:** The objective of this in vivo study was to investigate the microbial profile as well as the levels of lipopolysaccharide (LPS), lipoteichoic acid (LTA) and inflammatory biomarkers at different phases of endodontic treatment in teeth with vital pulp and associated periodontal disease. Clinical parameters including mobility, probing depth and clinical attachment were also evaluated.

**Methodology:** Ten patients were selected for this clinical study. Samples were taken from periodontal pockets (PPs) and root canals (RCs) using sterile paper points before and after chemomechanical preparation (CMP) and after intracanal medication (ICM). The levels of bacteria (checkerboard DNA-DNA hybridization), LPS (LAL Pyrogent 5000), LTA, PGE2, TNF- $\alpha$ , IL-1 $\alpha$  and IL-1 $\beta$ 

(ELISA) were assessed. Data were statistically analyzed with a significance level of 5%.

**Results:** In the initial samples, 38 of 40 probes were detected in PPs, whereas 12 of 40 probes were detected in RCs using checkerboard DNA-DNA hybridization. Overall, endodontic procedures were

efficient in modifying the microbiota of PPs and RCs. Levels of LPS, LTA, TNF- $\alpha$ , IL-1 $\alpha$  and IL1 $\beta$  were reduced after the endodontic procedures, although higher concentrations of both had been

found in PPs compared with RCs. After a 1-year follow-up, tooth mobility was reduced.

**Conclusions:** The microbiota of PPs and RCs is polymicrobial. CMP and ICM allowed the reduction of infectious and inflammatory content in both sites. Endodontic treatment showed positive effects for the prognosis of periodontal treatment, favoring the clinical aspects.

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## R082 - NON-CLINICAL VARIABLES AFFECTING DECISION TO REFER A PATIENT TO A SPECIALIST ENDODONTIST

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**Aim**: To explore if a decision to refer a patient to a specialist endodontist varies regarding demographic variables of general practitioners (GP) and features of their dental practices.

**Methodology**: A questionnaire that focused on data regarding demographics, dental practice and referral patterns was mailed to all GPs with a work address in Rijeka, Croatia. Chi-square tests were used at level of significance p<0.05 to analyze the differences in the GP's referral decision regarding age, gender, years in practice, postgraduate education, employment position, number of dentists employed in practice and number of patients registered in practice.

**Results**: Of the 255 questionnaires mailed, 123 were returned. The response rate was 48%. Majority of the respondents (39.8%) were between 40 and 49 years old and female (52.0%). Significant differences in referral frequency were found regarding age ( $\chi$ 2=10.330; p=0.035) and gender ( $\chi$ 2=4.912; p=0.027) of the participant. GPs in age group 50-59 referred the patients significantly more often than all other age groups (all p<0.001). Female practitioners referred patients more often than their male counterparts (73.4% vs 52.5%; p=0.027). Regarding the variable number of dentists employed in practice, significant differences were noted between the groups ( $\chi$ 2=13.095; p=0.001). Referral frequency was significantly less in the group of respondents who work in practices where three or more dentists are employed than in cases where one (11.1% vs 70.2%; p<0.001) or two (11.1% vs 55.0%; p=0.026) dentists are employed.

**Conclusion**: Understanding of non-clinical factors associated with referral process may improve patient dental management. The present survey demonstrated that age, gender and the number of dentists employed in practice are non-clinical variables that have considerable influence on GP's decision to refer a patient to a specialist endodontist.

# R083 - THE IMPACT OF AGE AND GENDER ON THE DEVELOPMENT OF PRIMARY APICAL PERIODONTITIS: A RETROSPECTIVE STUDY

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Aim: The aim of our study was to examine the impact of age, gender and systemic disease on the development of primary apical periodontitis.

**Summary**: Primary endodontic disease results most often in asymptomatic apical periodontitis. Few studies examined the factors that may influence the dynamics of its development.

**Methodology**: Out of 2000 dental medical records of patients who attended the Faculty of Dentistry of the Hebrew University of Jerusalem and the Hadassah Medical Centre Jerusalem, Israel due to primary asymptomatic AP between the years 2015-2022, we identified 333 records of patients in which the interval between initial diagnosis and treatment on set was at least three months (Avg  $6.2 \pm 0.6$ ). Patients were between ages 8-98 (Avg $36 \pm 0.4$ ) years old. All the selected medical records included demographic data, general and dental anamnesis and at least two X-rays prior to endodontic intervention with a minimal 3 months interval .All X-rays were taken from the Mediadent ® software (The Dental Imaging Company, Ltd Shoreham by Sea, UK). The area of AP around the root apices was outlined using the software's polygon tool and measured (mm3). The delta between the two measurements was calculated and plotted as percentage of growth of the lesion per month.

**Results**: lesion development was age and gender depended (P< 0.0001, P<0.05 respectively). No correlation to systemic medical background was found in this study.

#### Conclusions:

- Age and gender may affect the development of apical periodontitis
- Younger ages tend to develop apical periodontitis relatively faster than older ages
- Females up to age of 40 tend to develop apical periodontitis slower than females above this age

# R084 - A CRITICAL LOOK AT OUTCOME MEASURES: COMPARISON BETWEEN THREE DENTAL RESEARCH JOURNALS BY USE OF A HIERARCHICAL MODEL

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**Aim:** The aims were to (i) categorize and systematically assess the outcome measures used in Endodontic studies, using a modied conceptual model and (ii) compare these with corresponding measures used in studies in Cariology and Craniomandibular disorders.

**Methodology:** The official journals of the European societies of Endodontology (International Endodontic Journal; IEJ), Cariology (Caries Research; CR), and Craniomandibular disorders (Journal of Oral & Facial Pain and Headache; JOFPH) were selected for screening. Titles and abstracts were screened independently by three of the authors. Original scientic studies and systematic reviews were eligible, and in each journal, the 50 most recent consecutive publications fullling inclusion criteria were included. The hierarchy model for diagnostic imaging studies by Fryback and Thornbury (1991) was modified to assess studies related to treatment. The model comprised six levels of outcome measures, with Technical as the lowest and Societal as the highest. Extracted data also included study origin and type of study, but not study quality.

**Results:** 598 publications were screened to identify the 150 most recent studies matching the inclusion criteria. Almost half (46%) of the 150 studies assessed the 'Clinical', 'Patient', or 'Societal' aspects of treatment. In the respective journals the proportion of studies assessing these higher levels was 16% in IEJ, 38% in CR and 82% in JOFPH. In IEJ, 84% of studies thus assessed outcomes on 'Technical' or 'Biological levels'.

**Conclusions:** This study indicates that within the endodontic field, research on treatment is mainly focusing on 'Technical' and 'Biological' levels. The benefit of patient and society appears less frequently examined than in published research in adjacent dental disciplines. Awareness of this is important and should be considered when designing studies in order to address potential benets for patients and society.

## R085 - CHARACTERIZATION OF EXTRACELLULAR VESICLES DERIVED FROM STEM CELL FROM THE APICAL PAPILLA IN A SIMULATED INFLAMMATORY CONTEXT

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**Objective:** The reciprocal interaction between dental mesenchymal stem cells such as stem cell from the apical papilla (SCAPs) and immune cells such as macrophages represent an elegant mechanism that may contribute to tissue homeostasis and healing of inflammatory dental pulp or bone periapical disease. SCAP-derived extracellular vesicles have been shown to mediate a significant part of the observed therapeutic effect. Our objective was to characterize and decipher the role of SCAP-derived small extracellular vesicles (sEVs) in a simulated inflammatory context.

**Methodology**: SCAPs, collected from third molars from healthy patients were treated with bacterial lipopolysaccharide (LPS) for 24h. sEVs were isolated from SCAPs culture supernatant by differential centrifugations and characterized by the presence of specific protein markers (CD9, CD81 and HSP70). sEVs concentration and size distribution were analyzed by tunable resistive pulse sensing (TRPS). Imaging of sEVs were performed by Transmission Electron Microscopy (TEM). THP-1 monocytic cell line was used to assess the effect of sEVs derived from primed SCAPs versus unprimed SCAPs on macrophages polarization. Gene expression of key inflammatory targets in differentiated macrophages were assessed using quantitative reverse transcriptase-polymerase chain (RT-qPCR). Measurement of cytokines released by polarized macrophages was also assessed by BioPlex assay.

**Results**: sEVs obviously expressed the extracellular vesicles markers CD9, CD81 and HSP70 based on western blot analyses. Moreover, TRPS quantification indicated that the EVs population has a mean diameter of 100 nm. Lastly, polarized macrophages, cultured in the presence of sEVs derived from primed SCAPs, exhibited an increase in mRNA expression of pro-inflammatory gene (IL-6, TNF- $\alpha$ , IL-1 $\beta$ ) and a decrease in the mRNA expression of anti-inflammatory gene (IL-10, CD206). These results were confirmed by cytokines measurement in culture media.

**Conclusion**: These preliminary results suggest a new role for SCAP-derived sEVs in the initiation, maintenance or resolution of dental pulp inflammation.

### R086 - INVOLVEMENT OF MATRIX METALLOPROTEINASES, THEIR TISSUE INHIBITORS AND BONE RESORPTION MODULATORS IN THE PATHOGENESIS OF APICAL PERIODONTITIS

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**Aim**: An excessive alveolar bone resorption is a hallmark of apical periodontitis (AP). Although numerous inflammatory mediators are involved in the pathogenesis of AP, the relationship between matrix metalloproteinases (MMPs), their tissue inhibitors (TIMPs), and bone resorption modulators (nuclear factor kappa B (RANK), its ligand (RANKL), and osteoprotegerin (OPG)) has not been fully elucidated in alveolar bone resorption. Thus, we aimed to investigate the expression of MMPs -2, -7 and -9, and TIMPs -1 and -2 in human AP lesions with different RANKL/OPG ratios and determine their potential correlation.

**Methodology**: The study group consisted of 50 AP lesions harvested from 50 adult voluntary participants (28 females, 22 males, and average age 36.5±13.4 years) in conjunction with apicoectomy. Twenty pulp tissues of intact teeth, collected following extraction due to orthodontic reasons from 20 voluntaries (10 females, 10 males, and average age 25.4±3.5 years), served as healthy control group. The relative gene expression of the investigated molecules (MMP-2, MMP-7, MMP-9, TIMP-1, TIMP-2, RANKL, and OPG) in all tissue samples was analyzed using reverse transcriptase real-time polymerase chain reaction. The Student t test, Mann-Whitney U test, and Spearman correlation were used for statistical analysis.

**Results**: A highly significant increase in relative gene expression was observed in apical periodontitis samples for RANKL, OPG and all analyzed MMPs and TIMPs compared to the healthy control group (P=0.001, P=0.001, P

**Conclusions**: Observed correlations between investigated molecules corroborate their joint involvement in excessive alveolar bone resorption in AP, and future studies should strengthen the evidence of their combined roles.

# **R087 - ANTI-INFLAMMATORY EFFECT OF THAI PROPOLIS IN HUMAN DENTAL PULP CELLS**

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**Aim**: To examine the anti-inflammatory effect of Thai propolis extract on the arachidonic acid pathway, activated by IL-1 beta, in cultured human dental pulp cells as well as to elucidate the signaling molecule(s) mediating this effect.

**Methodology**: Human dental pulp cells were harvested from freshly-extracted third molars (N=3) and cultured in IL-1 $\beta$  – containing growth medium. Non-toxic concentrations of Thai propolis extract (0.08-1.25 mg/ml) were co-cultured with IL-1 $\beta$  – stimulated human dental pulp cells for 24 hours. Total RNA was harvested and analyzed for the mRNA levels of 5-lipoxygenase (5-LOX) and cyclooxygenase-2 (COX-2). Western blot analysis was performed to investigate the level of COX-2 expression. Differences in the mean percentages of cell viability, in the mean degrees of mRNA and protein expressions, and in the mean prostaglandin E2 (PGE2) levels were assessed by one-way ANOVA and Bonferroni's post hoc comparison test, and were considered statistically significant at p<0.05.

**Results**: Stimulation of cultured human dental pulp cells with IL-1 $\beta$  resulted in the activation of arachidonic acid metabolism via COX-2, but not 5-LOX signaling pathway. Co-cultured of human dental pulp cells with 10 ng/ml IL-1 $\beta$  and Thai propolis extract at various concentrations exhibited the inhibited COX-2 expression profiles at both mRNA and protein levels, corresponding to the group treated with a specific COX-2 inhibitor indomethacin. The synthesis of PGE2, a downstream product of COX-2 induction, was reduced when IL-1 $\beta$  – stimulated human dental pulp cells were cultured with Thai propolis extract in a similar fashion.

**Conclusions**: Thai propolis extract exerts an anti-inflammatory activity against COX-2 induction, required for increased PGE2 synthesis, upon IL-1 beta treatment in human dental pulp cells. Thai propolis extract might be a potential agent as pulp capping due to its anti-inflammatory property.

# R088 - EVALUATION OF OXIDATIVE STRESS IN HEALTHY AND INFLAMED DENTAL PULP TISSUE

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**Aim**: During inflammation, besides the release of inflammatory mediators, reactive oxygen molecules (ROS) that can cause oxidative stress increase, followed by cell damage and thus tissue destruction. Glutathione (GSH) and antioxidant enzymes creates an antioxidant response to oxidative stress by removing ROS. Therefore, in this study, it was aimed to evaluate the oxidative stress cycle that occurs in healthy and inflamed pulp tissue.

**Methodology**: For this purpose, pulp tissue samples with reversible pulp inflammation (n=18), irreversible pulp inflammation (n=18) and healthy (n=18) were collected. Six samples from each group were embedded in paraffine and used for the histopathological and immunohistochemical evaluation of Glutathione (GSH), Glutathione S-Transferase pi 1 (GSTP), ROS immunolabeling and TUNEL marking. After homogenization of the remaining 12 dental pulp samples from each group, total protein, GSH, Glutathione S-Transferase (GST) and ROS values were determined by spectrophotometry. Data were statistically analyzed by One-Way-Anova followed by Bonferroni correction test at  $\alpha$  =0.05.

**Results**: Depending on the severity of inflammation, total protein and GST enzyme levels decreased, while ROS and GSH levels increased compared to healthy pulp samples (p<0.05). In addition, the number of tunnel (+) cells was found to be high in inflamed pulp samples (p<0.05). GSTP1 and GSH immunoreactivity was also observed in the area of inflammation.

**Conclusions**: It was concluded that oxidative stress cycle altered during pulp inflammation. GSH, which plays an active role in the removal of reactive species, may increase depending on ROS increase in inflamed pulp.

Funding source: This study was supported by Hacettepe University Scientific Research Project Coordination Unit.

# R089 - PULPAL TEMPERATURE CHANGE DURING THE CEMENTATION OF INTRACORONAL CERAMIC RESTORATIONS

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**Aim**: To determine the thermal changes of the pulp chamber ( $\Delta PT$ ) during the cementation of indirect restorations with different ceramic thicknesses in case of various adhesive cements (AC).

**Methodology**: The occlusal surface of a mandibular molar was reduced to obtain 2mm dentin thickness. A silicon mold (10mm x 2.0/2.5/3.0/3.5mm) with 6mm inner diameter placed to the occlusal dentin. Lithium disilicate ceramic blocks with the same dimensions that could be inserted into the inner opening were pressed. The ceramic was luted with light-polymerizing and dual-polymerizing AC, as well as microhybrid (55\_MC) and sub-micron composite (55\_SC) preheated to 55 °C.  $\Delta$ PT was recorded with a K-type thermocouple in the pulp chamber during the 40s polymerization. One-way ANOVA, Turkey's test, multivariate analysis and partial eta-squared statistics were used to analyse the data (p<0.05).

**Results**:  $\Delta PTs$  ranged between 3.5-5.9 °C. The highest  $\Delta PTs$  were obtained for the light-polymerizing AC, while the lowest for 55\_MC. In case of 2mm ceramic thickness, significantly higher  $\Delta PT$  was observed, however there was no significant difference between 2.5/3.0/3.5mm ceramics, except for 55\_MC, where significantly lower  $\Delta PT$  was achieved only for the 3.5 mm sample. Regarding the obtained  $\Delta PT$  values, significant effect was showed for both ceramic thickness( $\eta 2$ =0.75) and type of AC ( $\eta 2$ =0.65) factors, while the interaction had weaker effect ( $\eta 2$ =0,42).

**Conclusions**: The considered pathological threshold (5.5°C) was reached only for 2 mm thick ceramic sample luting with light-polymerizing AC and 55\_SC. Depending on the ceramic thickness, the cementation can be performed safely for the pulp with proper choice of material.

## R090 - IDENTIFYING POTENTIAL BIOMARKERS IN DENTINAL FLUID IN TEETH WITH REVERSIBLE AND IRREVERSIBLE PULPITIS

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**Aim**: To identify potential biomarkers in dentinal fluid in teeth with reversible and irreversible pulpitis using mass spectrometry-based proteomics technology.

**Methodology**: Dentinal fluid samples were collected from fifty vital third maxillary and mandibular molars, originating 1 control and 2 experimental groups: G1 (control) – clinically healthy pulp; G2 – reversible pulpitis; G3 - irreversible pulpitis. Dentinal fluid was collected during a period of 5 minutes from dentin cavities with cellulose membrane Sartorius 1288 (Sartorius Stedium Biotech GmbH, Germany) and fluid flow stimulation method. As soon as samples were obtained, the teeth were extracted and serial histological sections were prepared for histomorphological study in order to confirm clinical diagnosis. Histologically approved dentinal fluid samples were analysed by mass spectrometry. Identified proteins were rank-ordered in accordance to Normalized Spectrum Abundacy Factor value prominence in the groups. Protein levels between groups were compared by using non-parametric methods at 5% significance level.

**Results**: Five specimens from teeth with irreversible pulpitis were not included because clinical diagnosis was not proved. Two hundred and six proteins were detected in dentinal fluid samples from all groups; 71 proteins were contained only in dentinal fluid from healthy specimens, increased number of proteins up to 75 were observed in dentinal fluid from teeth with reversible pulpitis. The most enriched proteome was represented by 173 proteins in the group 3. Only 39 proteins were common for all groups and showed significant differences in abundance in Wilcoxon test (p>0.05). Dentinal fluid samples from teeth with reversible pulpitis had significantly higher Alpha-1-antichymotrypsin (SERPINA3) levels than those from clinically healthy counterparts and irreversible pulpitis teeth (p>0.05).

**Conclusions**: There was a high correlation between Alpha-1-antichymotrypsin in dentinal fluid from teeth with reversible and irreversible pulpitis. Biomarker of pulp inflammation Alpha-1-antichymotrypsin was identified to be a candidate for non-invasive molecular diagnostics of the pulp diseases.

# R091- DENTINAL FLUID AND GINGIVAL CREVICULAR FLUID: A DIAGNOSTIC TOOL FOR THE DETECTION OF PULP INFLAMMATION

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**Aim:** To evaluate the concentration of alpha-1-antichymotrypsin in dentinal fluid and lactate dehydrogenase (LDH) and alkaline phosphatase (ALKP) in gingival crevicular fluid (GCF) in teeth with reversible and irreversible pulpitis.

**Methodology:** Dentinal fluid samples (n=117) and gingival crevicular fluid samples (n=117) were collected from 117 maxillary and mandibular molars, originating 4 groups: G1 (control) – clinically healthy pulp; G2 – initial pulpitis; G3 - acute pulpitis; G4 – chronic pulpitis. Dentinal fluid was collected using cellulose membrane; GCF samples were collected using absorbent paper points size 20. As soon as the samples were obtained, the teeth were extracted and serial histological sections were prepared for histomorphological study in order to confirm clinical diagnosis. Alpha-1-antichymotrypsin (AACT) in dentinal fluid was analysed by enzyme-linked immunosorbent assay, LDH and ALKP in GCF were evaluated by spectrophotometric analysis. The protein concentration between groups was statistically compared using non-parametric methods at 5% significance level.

**Results**: The results of Kruskal-Wallis test defined that there was a significant difference in AACT concentration between groups (p<0.001). Data of Tukey post hoc test showed that the concentration of AACT in the control group does not statistically differ from the group 4. In the group 2 was identified the highest AACT-concentration more than 5.35 ng/ml (p<0.001), with decreasing inflammation extension (2.06 – 5.34 ng/ml). However, in case of chronic pulpitis, AACT was absent in 70% of the dentinal fluid samples. There was a significant difference in LDH and ALKP concentration between groups (p<0.05). In teeth with initial and acute pulpitis the increase in ALKP was defined compared to chronic pulpitis. The LDH concentration was higher in teeth with chronic pulpitis.

**Conclusions**: Using of biomarkers of dentinal fluid and GCF as indicators of pulp inflammation appears to be a promising approach in decision making during treatment of carious deep lesions.

## **R092 – STATINS AND ENDODONTIC DISEASE: A SYSTEMATIC REVIEW**

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**Aim**: Statins are the most effective drugs in reducing plasma LDL cholesterol levels. Some studies suggest that they exhibit a larger spectrum of actions, defined as the *pleiotropic effect* of statins, including the alteration of the expression of endothelial nitric oxide synthase and the production of proinflammatory cytokines and reactive oxygen species. The purpose of this systematic review of all eligible studies is to explore a possible influence of a systemic therapy with *statins in* the development and treatment of Apical Periodontitis (AP).

**Methods:** Three electronic databases (PubMed, Web of Science, and Scopus) were searched from their inception until February 2022 (PROSPERO CRD42021246231). Supplemental research was performed by screening the references of the relevant studies eligible for inclusion. A quality assessment of animal studies was performed using the Animal Research: Reporting of In Vivo Experiments guidelines, whereas the only cohort study included was evaluated using the "Newcastle-Ottawa Quality Assessment Form For Cohort Studies" guidelines. The Systematic Review Centre for Laboratory animal Experimentation Risk of Bias tool was used to assess the risk of bias for animal studies, and the "Tool to assess risk of bias in cohort studies of CLARITY Group" was used to grade the risk of bias for the only cohort study included. **Results:** A total of 623 records were screened, and 6 articles meeting the criteria were included for this qualitative review. The eligible studies showed a moderate overall quality, and a moderate risk of bias.

**Conclusions:** Our findings suggest that Statins may influence the inception and the development of periapical diseases, and they should be considered for future research for developing new therapeutics as an adjunct to endodontic treatment.

Acknowledgements: The authors deny any conflicts of interest related to this study.

# R093 - PCE-CT ANALYSIS OF THE INTERFACE BETWEEN GUTTA-PERCHA AND COMPOSITE AT THE CANAL ORIFICE BEFORE AND AFTER LOADING

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**Aim**: Tight sealing of the root canal filling is mandatory to prevent reinfection through leakage after root canal treatment. This study aims to qualitatively analyze the interface between root filling material and composite placed in the cervical part of the root canal of extracted human upper incisors before and after thermo-mechanical loading (TML) in vitro.

**Methodology**: 8 human incisors were endodontically treated and root filled using gutta-percha and epoxy resinbased sealer. The root canal orifice was enlarged using Gates Glidden burs size 6 up to 4 mm below the enameldentinal junction. Cavities were conditioned using an universal adhesive System (Futurabond U, VOCO) in etch-andrinse mode and subsequently filled with composites including SDR, Dentsply Sirona and VisCalor bulk, VOCO according to the manufacturers' instructions. Crowns were reconstructed with composite (GrandioSo, VOCO). The interface between gutta-percha and filling material was scanned using synchrotron phase contrast enhanced µcomputed-tomography (PCE-CT, Anatomix Soleil, France) at 40keV and a spatial resolution of 1.3 µm. Scans before and after TML were registered such that alterations could be detected and characterized.

**Results**: Voids were frequently observed inside the composite material and adhesive as well as delaminations between gutta-percha and composite materials. After TML at least 6 out of 8 samples showed an increase in gap size between gutta-percha and composite as well as inside the gutta-percha material. SDR revealed a mild increase: 10% volume increase and 50% mean thickness increase, whereas VisCalor bulk demonstrated rather a severe increase: 6-fold increase in volume and mean thickness.

**Conclusion**: PCE-CT was able to detect changes at the interface between root filling materials and adhesively placed composite fillings before and after TML. Changes occurred mainly at the interface to or inside the more flexible material gutta-percha and gap size increased after loading.

## R094 - ASSESSING THE RESTORABILITY OF ENDODONTICALLY TREATED MOLAR TEETH; A NATIONWIDE ELECTRONIC VIGNETTE SURVEY

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**Aim**: To assess and compare the decision making between UK clinicians when restoring endodontically treated molars (ETMs) and explore the tooth-related factors they consider.

**Methodology**: A vignette survey was designed and initially piloted amongst endodontology post-graduate students. It was then distributed to registered UK clinicians via an invitation letter and survey link through social media platforms and via email sent to practices from September to November 2021. Intraoral full upper and lower arch and bite scans, along with pre-endodontic and immediate post-endodontic periapical radiographs were included. Preliminary demographic questions were asked followed by three real clinical cases with follow up questions focusing on type of restoration, restorative material, and relevant tooth-related factors. Each case differed based on residual tooth structure and other tooth-related factors. Together, the cases encompassed the factors found during a prior review of literature.

**Results**: 394 participants completed the survey. 37.1% had between 0-5 years of experience and there was even divide between participants with 6-10, 11-20 or 20+ years of experience. Slightly more participants restored ETMs under the National Health System versus privately. For all three cases the type of restoration most selected was either a crown or an onlay. There was a greater variation of approach between clinicians regarding what type of restorative material they would use. Gold, zirconia, lithium disilicate and metal were generally most opted for. In cases 1 and 2 the three tooth-related factors considered to be most important by the participants was apparent, but this was less obvious in case 3, which had the least residual tooth structure.

**Conclusion**: Clinicians were generally in consensus regarding whether to place an indirect or direct restoration. Further evidence is required to help UK dentists decide more objectively what restorative material to select and what tooth-related factors require most consideration in any given case.

## R095 - PATIENT-SPECIFIC MODELLING COULD LEAD TO RECONSIDER RESTORATION OF THE PERFORATED TOOTH

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**Aim**: To evaluate the influence of the restorative choice on the stresses of the root and the strains of the bioceramic cement for a clinical situation of a perforated mandibular

**Methodology**: The patient was scanned before any intervention using an intraoral scanner Trios 3 and a cone beam computed tomography Planmeca ProMax 3D operating at 120 kV, 100 mAs, with a slice thickness of 0.75 mm. Patient-specific model was then constructed according to a previously published protocol. The different anatomical structures were segmented, aligned, and meshed using quadratic tetrahedral elements based on a previously validated procedure. Four restorative strategies were then simulated: a mesial fiber post with a zirconia crown, a distal fiber post with a zirconia crown, a composite core with a lithium disilicate overlay, and a lithium disilicate endowrown. All dental materials were supposed homogeneous and linearly elastic except for the periodontal ligament that was supposed hyper-elastic. An oblique load of 200 N was applied to the vestibular cuspid of the tooth to simulate masticatory forces. The FEA was conducted on the Abaqus software 6.14 to calculate the von Mises root stresses on the root and the strains of the bioceramic cement.

**Results**: For all models, high stresses were located on the perforated part of the root. However, the model of the endocrown presents significantly lower stresses of the root and lower strains of the bioceramic cement. A restoration with an endocrown was finally performed. The one-year control confirms bone healing and absence of vertical root fracture.

**Conclusions**: Restorative choice significantly influences transmission of stresses to the root and strains of the bioceramic cement, potentially leading to bacterial percolation. The current digital approach could offer a decision tool for restoration of the damaged tooth, yet raises technical and ethical questions regarding its integration in the current digital workflow.

## **R096 - EVALUATION OF BULK-FILL COMPOSITES AS INTRACANAL ANCHORAGE FOR RESTORING MAXILLARY INCISORS**

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**Aim**: Intracanal composite anchorage is a tissue saving option for restoring root canal treated teeth in contrast to postand-core restorations. For this purpose tight intracanal adhesion is mandatory, consequently, the present study aims to evaluate the bond strengths of composite materials for restoring root canal treated upper human incisors in vitro.

**Method**: Forty-eight extracted human teeth were root filled, distributed into four groups (G) and 2/3 of the crown was removed. A 4 mm deep cavity was prepared inside the root canal orifice and intracanal anchorage performed using SDR (Dentsply Sirona) in G1, Rebilda DC (VOCO) in G2, Admira Fusion x-tra (VOCO) in G3 and in G4 using VisCalor bulk (VOCO). The crown was restored using GrandioSO (VOCO) in all groups. All samples were subjected to thermomechanical loading (TML). Two samples of each group were scanned using phase-contrast enhanced microcomputer tomography (PCE-CT) before and after TML. The roots of the remaining samples (10 per group) cut into 1mm thick slices and push out tests of the intracanal composite fillings were performed.

**Results**: All samples except one survived TML. Intracanal bond strength was significantly affected by the composite material used (p=0.001) and location inside the root canal (p< 0.005; generalized estimating equations). VisCalor Bulk (13.5MPa±5.3MPa) resulted in significant lower bond strength compared to Rebilda DC (19.6MPa ±7.6MPa) and Admira Fusion-xtra (21.4MPa ±7.6MPa), but did not differ significantly from SDR (20MPa ±10.3MPa). All groups showed predominantly adhesive failures between composite and dentin (p< 0.05; Chi-square Test). PCE-CT of pre and post loading scans showed no degradation effects at the interfaces between composites, adhesive and dentin.

**Conclusion**: Intracanal composite fillings as anchorage for coronal fillings seem to be a suitable hard tissue saving option for restoring upper incisors in vitro. PCE-CT findings indicate tight bonding between composites, adhesive and dentin.

# R097 - INFLUENCE OF RHODAMINE GREEN ON THE PUSH-OUT BOND STRENGTH OF TWO COMPOSITES IN COMBINATION WITH A TWO-STEP SELF-ETCH ADHESIVE SYSTEM

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**Aim**: Rhodamines are a group of low toxic fluorochromes which are used in dental studies to add a visual dimension to dental materials, adhesive systems in particular. This pre-study will provide samples for a following study investigating Rhodamine through fluorescence microscopy. The aim is to determine if Rhodamine Green (RG) significantly decreases the strength of an adhesive system.

**Methodology**: Cavities of two by five millimeters, simulating a pulp chamber, were prepared in 32 endodontic treated monoradicular teeth. The root canals were obturated with gutta percha cones of VDW München and endodontic cement (EC) AH Plus from Dentsply. After removing the EC through several protocols, the prepared cavities were filled with a resin composite using the adhesive system Clearfil SE Bond from Kuraray.

Primer and adhesive containing 0,2 mg/ml RG were used in a test group of 16 of these teeth, the other 16 teeth served as a control group where primer and adhesive without RG were applied. An additional examination was performed by dividing each of these two groups into two subgroups. One group was filled with a classic composite (Majesty ES-2 from Kuraray), the other with a dual cure composite (DC Core Plus from Kuraray).

The teeth were fixed in resin and sliced at 1 mm thickness using a microtome. A push-out test (POT) was performed and the collected data were analyzed with a t-test for two unpaired samples.

**Results**: Statistical analysis revealed no significant difference (p=0,7914) in adhesive strength between the test group and control group.

No significant difference was measured between the subgroups "classic composite" and "dual cure composite".

**Conclusion**: Addition of 0,2 mg/ml RG in Clearfil SE Bond does not significantly decrease the adhesive strength, regardless of the type of composite. Further studies with a larger sample size and investigating other adhesive systems should be considered.

# R098 - THE EFFICIENCY OF ROOT CANAL FILLING REMOVAL IN AN OVAL SHAPED CANAL USING TWO STAGES RETREATMENT PROTOCOL: A MICRO-CT STUDY

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**Aim**: The aim of this study was to evaluate the efficacy of filling material removal from oval root canal after two stages of retreatment: filling removal using retreatment files and re-preparation with rotary files through Micro-Computed Tomography (Micro-CT) analysis.

**Methodology**: Thirty-six human extracted mandibular premolars with oval canals were prepared using WaveOne Gold rotary files up to medium size (0.35/0.06) and then filled utilising a matching single-cone (hydraulic condensation) with bioceramic sealer. The teeth were randomly divided into 3 groups (n=12) into 3 different retreatment rotary files system (stage one) and their suggested preparation files (stage two) as follows: ProTaper Universal Retreatment with ProTaper Next, D-Race with XP-Endo Shaper and Endo-ReStart with F6 SkyTaper. All samples were analyzed using Micro-CT imaging after removal of the filling material (stage one) and after re-preparation (stage two). The data, in mm3 of remaining filling material, were analyzed by the Kruskal-Wallis and Dunn post hoc tests.

**Results**: The total volume of the remaining filling material (median) in the root canal after using D-Race files (stage one) was 0.006 mm3 which is significantly less than ProTaper Retreatment files (0.555 mm3) and Endo-ReStart files (0.093 mm3) (p<0.0001). The total residual filling material (median) in the root canal after additional preparation with XP-endo Shaper (stage two) was 0.001 mm3 which is significantly less than ProTaper Next (0.191 mm3) and F6 SkyTaper (0.006 mm3) (p<0.0001).

**Conclusions**: None of the retreatment files were able to remove all the residual filling material from the whole root canal systems (stage one). Additional preparation enhanced the removal of filling materials from the entire root canals system. Overall, D-Race/XP-Endo retreatment protocol was highly effective in the removal of residual filling material from straight oval-shaped canal and was the best in cleaning the canal completely in both middle and apical thirds.

### R099 - A MICRO-COMPUTED TOMOGRAPHIC STUDY OF REMAINING BIOCERAMIC SEALER AFTER RETREATMENT PROCEDURES

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**Aim**: To determine the presence of residual root canal filling material TotalFill BC Sealer and the reestablishment of working length and apical patency after retreatment procedures with two rotary files systems.

**Methodology**: Thirty extracted human maxillary incisors were instrumented up to size 30.04 and obturated with TotalFill BC Sealer (FKG, Switzerland) and gutta percha by single cone technique. After 14-days, teeth were randomly assigned to 2 groups and 6 subgroups and canals were retreated with: Group 1A - D-Race/XP-endo Shaper/XP- Endo Finisher R; Group 1B - D-Race/XP-endo Shaper/XP-Endo Finisher R/ultrasonic agitation; Group 1C - D- Race/XP-endo Shaper/XP-Endo Finisher R/ultrasonic agitation; Group 2B - ProTaper Universal Retreatment files; Group 2B - ProTaper Universal Retreatment files/ultrasonic agitation; The samples were scanned using micro-CT before and after retreatment. The ability to reestablish working length and apical patency was recorded. Data were analyzed statistically using the Kruskal–Wallis tests and Mann-Whitney U test (p < 0.05).

**Results**: Residual material debris was observed in all samples. There was statistically significant difference in the percentage of the remaining filling material, reestablishment of working length and apical patency after retreatment with ultrasonic or sonic agitation compared to subgroups A (p<0.05). The percentage of remaining filling material was significantly lower at the apical third in group 2B (p<0.05), otherwise, no significant differences were observed among the coronal and middle thirds in groups 1B/1C/2B/2C. The working length and patency were regained in 89% of the specimens in subgroups A and in 100% of the specimens in subroups B and C.

**Conclusions** : The efficacy of filling material removal was more than 92% using D-Race rotary instruments, XP-ENDO files and ultrasonic agitation. The working length and apical patency were reestablished in 100% with rotary files and ultrasonic agitation.

## **R100 - IN VITRO EVALUATION OF WORKING TIME DURING ENDODONTIC RETREATMENT**

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**Aim**: The aim of this in vitro study was to evaluate the working time for gutta-percha and sealer removal using different instrumentation techniques.

**Methodology**: The root canals of seventy two extracted single-rooted straight premolars were prepared using BioRaCe rotary instruments and crown-down technique, before filling with laterally condensed gutta-percha and AH Plus® sealer. After 30-day storage at 37°C and 100% humidity, teeth were randomly allocated to 3 groups (n = 24) depending on retreatment instrumentation technique: ProTaper Universal Retreatment System (PTUS); D-RaCe System and Hedström hand files. Stopwatch was used for measuring the working time. Measuring included the time required to reach the working length, time to complete the filling material removal and total retreatment time. The criteria for complete filling material removal was absence of gutta-percha or sealer remnants during irrigation or attached to the files. Time required for desobturation, irrigation, working length measurement, instruments changing and cleaning was considered as a total retreatment time. Data were analyzed using one-way ANOVA and Scheffe's post-hoc test.

**Results**: No significant difference between groups was found when comparing the time required to reach the working length. Complete removal of filling material was the fastest in PTUS group and the slowest in Hedström group. Significant differences were found between each group (P<0.0001). After measuring the total retreatment time, significant differences were found when comparing both rotary systems to Hedström group (P<0.0001), but no significant difference was found when comparing PTUS to D-RaCe, although the procedure was the fastest in PTUS group.

**Conclusion**: Usage of rotary NiTi instruments for the removal of root filling material during retreatment procedure is less time-consuming comparing to hand files. No significant difference was recorded between two tested rotary systems.

## R101 - AGREEMENT BETWEEN CLINICAL TESTS FOR ASSESSMENT OF PULP VITALITY AND HISTOLOGICAL ANALYSIS OF PULP TISSUE

### Tenyi A<sup>1</sup>, Nemeth L<sup>2</sup>, Golež A<sup>3</sup>, Cankar K<sup>4</sup>, Milutinović - Živin A<sup>5</sup>

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In dental clinical practice, indirect diagnostic methods such as electrical sensibility testing and pulse oximetry are used to assess the status of the pulp.

The aim of the study was to determine the correlation between hemoglobin oxygen saturation and vascular volume density (Vvasc). In addition, a correlation between an electrical sensibility test and the volume density of myelinated nerve fibers (Vnerv) was performed as well.

Twenty-six permanent premolars were included in the study. For histological analysis, the pulp tissue was stained with hematoxylin-eosin and immunohistochemically for von Willebrand factor and S100 to detect blood vessels and myelinated nerve fibers, respectively. The stereological analysis was used to determine the Vvasc and Vnerv. Statistical analysis was done using the Pearson correlation test and Welch's ANOVA test.

Histological analysis presented the pulp as tissue as strongly vascularized and innervated tissue.

A significant positive correlation was found between Vvasc and hemoglobin oxygen saturation levels (p=0.030). A significant negative correlation was found between Vnerv and the lowest electrical voltage that patient felt (p=0.033). According to the maturity of the dental apex, teeth were divided into a group with open (N=6, OA group) and closed apex (N=20, CA group). The pulp tissue in the CA group was found to have a higher Vnerv in comparison to the OA group (p=0.037). In contrast, there were no significant differences in Vvasc of the pulp tissue (p=0.059), oxygen saturation (p=0.907), or electrical voltage (p=0.113) between both groups.

Results of our study indicate that the measurement of pulse oximetry and electrical sensibility test reflect the morphology of healthy pulp tissue independently of the maturity of the dental apex.

## R102 - DIAGNOSIS OF VRFS IN ENDODONTICALLY TREATED TEETH: A RETROSPECTIVE CLINICAL STUDY

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**Aim**: The purpose of this study was to evaluate different factors associated with the presence of vertical root fractures (VRFs) in endodontically treated teeth.

**Methodology**: The study was conducted from September 2009 to June 2021. All the patients were referred to the endodontic clinic for the diagnosis of the VRFs. We examined 240 teeth in which VRF was suspected. The diagnosis of the VRFs was made after clinical and radiographic examination and verified either diagnostic flap or after the extraction. The cases of the VRFs were compared to 50 cases without VRFs (Control group). The data about the patients' gender and age, tooth type and type of coronal restoration (filling, crown or abutment) were collected. Information about the presence of periodontal pocket and/or sinus tract was recorded and analyzed too. All radiographic images of VRFs were categorized based on the Tamse's classification (2006)

**Results**: The mean age of the patients with VRFs was  $53 \pm 14$  years with males 93 (38.8%) and 147 (61,3%) females. From the maxillary teeth premolars 80 (54,4%) and from mandibular teeth molars 80 (54,4%), were the most frequently affected. There was statistically significant difference between cases and controls with respect the periodontal pockets, sinus tracts and the radiographic appearances p<0.001. The type of the restoration was not strongly related with the diagnosis of the VRFs. (Fillings p=0.568, Crowns p=0.424, Abutments p=0.651)

**Conclusions**: According to this study, deep narrow pocket, sinus tract, and "Halo"-type radiolucency are characteristic features of VRFs in endodontically treated teeth.

## R103 - ARTIFICIAL INTELLIGENCE FOR DISCOVERING IMAGE BIOMARKERS IN ENDODONTICS: A SYSTEMATIC REVIEW

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Aim: to assess the role of Artificial Intelligence (AI) in discovering image biomarkers in Endodontic treatment considerations.

**Methodology**: The review was based on the PRISMA guidelines and the Quality assessment tool QUADAS 2. A systematic duplicate search (until February 2022) was performed of the literature on cases with endodontic and pulp close carious treatment considerations, comparing AI algorithms (test) versus conventional dental image assessments (control) for the detection image biomarkers (e.g. dental morphology, apical lesions, stages of carious lesions). The search was conducted in PubMed, Scopus, Google Scholar and the Cochrane library. Inclusion criteria were clinical, cadaveric and in-vitro studies on the use of AI and machine learning in endodontic treatments using either periapical radiographs (PA), Panoramic x-ray (PAN), or ConeBeam-CT (CBCT). Case reports, review papers, book chapters were excluded.

**Results**: The initial search retrieved 721 papers, from which 27 were included (Studies in English published between 2012 and 2022). High heterogeneity of the materials left out a meta-analysis. Quantitatively, 11 studies reported on PAs, 4 on PANs, and 12 on CBCTs. More than 65% of the studies had a low risk of bias and low concerns of applicability. Image biomarkers assessed were mostly periapical lesions. 24 of 27 papers compared the clinical efficacy of AI models with a human reference. The AI demonstrated comparable to human performance in 10 studies on detecting periapical lesions, three on detecting vertical root fracture, four on the classification of root morphology, four on pulp cavity segmentation, two on locating minor apical foramen and one on predicting the results of retreatment.

**Conclusions**: Detection of relevant image biomarkers shows effectiveness, mainly based on relatively crude marker grading being present or not.

Funding: This project has been selected for UCPH Data+ funding (Strategy 2023 funds).

**Registration**: The registration number is CRD42022320332

## R104 - TO REFRAIN FROM REMEDYING A ROOT-FILLED TOOTH WITH PERSISTENT ASYMPTOMATIC APICAL PERIODONTITIS – A MATTER OF UNCERTAINTY OR CONFIDENCE?

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Aim: To study general dental practitioners' decision in refraining from remedying a root-filled tooth with persistent asymptomatic apical periodontitis.

**Methodology**: Fifteen general dental practitioners (7 women) in Sweden were strategically selected for an in-depth interview. The informants were encouraged to tell in their own words and in as much detail as possible about the three latest patient cases presenting with a root-filled tooth with persistent asymptomatic apical periodontitis for which they were refraining from remedy. To provide for empirical variation of the informants several selection criteria were applied: sex, age, geographical domicile, working in private or public sector and occupational experience. The interviews were recorded digitally and transcribed verbatim. The collected material was analyzed according to Qualitative Content Analysis.

**Results**: The informants' patient cases were varied in regards to general and oral health status, age, sex, social context and ethnic origin.

A pattern comprising different degrees of uncertainty related to the decisions was identified and classified into the following theme and categories. The overall theme, covering the latent content, was 'A continuum of uncertainty with a certain measure of confidence'. The first main category covering the manifest content was 'The hesitance' with two subcategories (i) 'the experienced uncertainty' and (ii) 'support of acceptance'. The second category was 'The negligible risk' with two subcategories (i) 'the undisputed refrainment' and (ii) 'support of safety'.

**Conclusions**: The decision to refrain from remedying a root-filled tooth with persistent asymptomatic apical periodontitis was made with some measure of confidence, combined with compensatory strategies to support the decision.

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# R105 - PREOPERATIVE RISK ASSESSMENT AND OBTURATION LENGTH: A RETROSPECTIVE LONGITUDINAL AND MACHINE LEARNING STUDY

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**Aim**: We aimed 1) to identify significant associations between preoperative risk factors (based on the risk assessment form of the American Association of Endodontists (AAE)) and achieving optimal root filling length (RFL) during orthograde root canal treatments (RCT) and 2) to predict RFL using machine learning (ML).

**Methodology**: Teeth receiving RCT at a university clinic from 2016-2020 with complete documentation were included. Optimal RFL was defined to be 0-2mm of the apex, suboptimal RFL >2mm or beyond the apex. Logistic regression (logR) was used for association analyses on the overall dataset and operator subsets, logR and more advanced machine learning (random forest (RF), support vector machine (SVM), decision tree (DT), gradient boosting machine (GBM) and extreme gradient boosting (XGB)) were employed for predictive modeling (area-under-the-receiver operating characteristic-curve (ROCAUC)) and testing on a separate test dataset.

**Results**: 555 completed RCT (343 patients, female/male 32.1/67.9%) were included. On the overall dataset, single risk factors were more relevant for achieving optimal RFL than the determined overall risk level (operator undergraduate student (US): OR 2.74, 95% CI [1.61, 4.75], p<0.001; indistinct canal path: OR 11.04, [2.87, 44.88], p<0.001; root canal reduced in size: OR 2.56, [1.49, 4.46], p<0.01; retreatment: OR 3.13, [1.6, 6.41], p<0.001) on achieving optimal RFL. For US, different risk factors were more impactful than for dentists with endodontic training. Single risk factors outperformed the AAE risk level on the overall dataset. Prediction of RFL was limitedly possible (ROCAUC: logR 0.62, [53.8, 70.9]; GBM 0.58, [0.55, 0.61]; RF 0.56, [51.2, 60.4]; XGB 0.57, [0.57, 0.58]; SVM 0.58, [0.49, 0.67]; DT 0.54, [0.45, 0.63]).

**Conclusions**: Achieving RFL is depending on the operator and several risk factors. Predicting RFL via ML was only limitedly possible.
## R106 - PRE-MEDICAL ASSESSMENT OF ASYMPTOMATIC ROOT-CANAL TREATED TEETH WITH PERSISTING APICAL RADIOLUCENCY – AN INTERVIEW STUDY

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**Aim**: In Sweden, patients facing radiotherapy of the head-and-neck, chemotherapy, intravenous bisphosphonate treatment, solid organ transplantation or heart valve surgery are commonly sent to hospital-affiliated dental clinics for evaluation prior to the onset of medical treatment. The aim of the present interview study was to get a deeper understanding of the decision-making process and to describe factors influencing hospital-affiliated dentists' premedical management of root-canal treated teeth with persisting asymptomatic apical periodontitis.

**Methodology**: Fourteen hospital-affiliated dentists in Sweden were strategically selected for a semi-structured, indepth interview. The informants were asked to select and recount a minimum of two authentic patient cases where pre-medical dental assessment had resulted in either treatment or expectancy of an asymptomatic root-canal treated tooth with apical radiolucency. Open-ended questions and comments encouraging the informants to elaborate, explain and clarify their experience was offered. The interviews were digitally recorded, transcribed verbatim and the collected data was analyzed using Qualitative Content Analysis with an inductive approach.

**Results**: The preliminary results indicate that the decision process is an ambiguous balancing act characterized by a pooled risk assessment where an increased uncertainty entails an increased need of external support.

**Conclusions**: No conclusions can yet be drawn as the process of analysis is still ongoing.



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