

# Endodontics

## Comparative analysis of two experimental root-end filling cements about apical sealing, bioactivity and biocompatibility

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**Aim:** The aim of this study was to compare two innovative root end filling materials: an experimental penta-aggregate calcium silicate cement and a light-curing penta-aggregate calcium silicate cement doped with di-calcium-phosphate; the apical sealing ability, bioactivity and biocompatibility were the parameters analyzed for this study.

**Methods:** A penta-aggregate calcium silicate cement doped with di-calcium-phosphate (ENDOPASS LC), an experimental penta-aggregate calcium silicate (Exp. ENDOPASS) and a calcium silicate Portland-based (Control, PC) were assessed for their biocompatibility and alkalinizing activity (pH). Single-root canal teeth were endodontically treated, filled with gutta-percha and finally submitted to apicoectomy. Root end fillings were performed using all tested cements, and their apical sealing ability was evaluated up to 4 weeks of immersion in simulated body fluid (SBF). The mineral precipitation ability at the apical region and the cement adaptation to root dentine were also evaluated through non-destructive optical microscopy both at 24h and prolonged water storage (4 week).

**Results:** ENDOPASS LC had neutral pH, and it showed the greatest sealing ability after 24h. ENDOPASS also showed excellent fibroblasts proliferation. ENDOPASS presented excellent sealing ability after two and four weeks, as well as biocompatibility after 4 and 7 days similar to ENDOPASS LC. The control PC cement showed

the lowest sealing ability, the greatest alkalinization properties and greatest cytotoxicity compared to the tested experimental cements. Mineral precipitation, as well as optimal adaptation to the root dentine were observed with the use of the two experimental materials.

**Conclusions:** ENDOPASS LC and ENDOPASS may be promising materials for root end obturation as they present appropriate (in vitro) biocompatibility, sealing ability and aptitude to induce mineral precipitation.

## Efficacy of photon-initiated photoacoustic streaming technique on root canal disinfection deep into dentinal tubules

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**Aim:** Photon-induced photoacoustic streaming (PIPS) technique is a root canal disinfection system that induces a profound photoacoustic shock wave, facilitating a three-dimensional movement of the irrigants. It is based on the use of a Er:YAG laser with both a radial and stripped tip at subablative power settings (0.3 W), placed only into the coronal portion of the root canal. Using low-energy levels and short microsecond pulse rates (50 µsec) peak power spikes are generated. The primary objective of the study was to compare antimicrobial efficacy deep into dentinal tubules of PIPS irrigation system compared with a traditional irrigation protocol with endodontic needles.

**Methods:** Thirty human single-root teeth were selected. Specimens were instrumented with ProGlider and ProTaper Next X1, X2 and X3 (Dentsply, Maillefer) at working length (WL) used at 300 rpm and torque 4.0 Ncm, alternating irrigation with NaOCl and EDTA after

been reworked with ImageJ (NIH, Bethesda, MD). Differences between groups were analysed with the Kruskal-Wallis test and Dunn's post-hoc ( $P < 0.05$ ). The level of significance was set at  $P < 0.05$ .

**Results:** Dead Ratio: NaOCl vs Diode (KW=17,28,  $P < 0.01$ ) - NaOCl vs PIPS (KW=17,28,  $P < 0.001$ ) - Diode vs PIPS (KW=17,28,  $P > 0.05$ ).

**Conclusions:** The results show a significant reduction of the counts of CFU for all the techniques, compared to the positive control group. Both methods based on laser technology (PIPS and diode lasers) shown increased antibacterial efficacy than conventional endodontic irrigation. The PIPS method proved more performing cleaning than the one performed with diode laser, difference was not statistically significant. CLSM analysis of the penetration within the dentinal tubules showed that all systems have a high efficiency in terms of deep cleaning of dentin structure, with no differences between groups.

### Influence of continuous rotation or reciprocation of optimum torque reverse motion on cyclic fatigue resistance of five nickel-titanium rotary instruments

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**Aim:** To evaluate the resistance to cyclic fatigue of ProTaper Next (PTN), Revo-S, Mtwo, Twisted Files (TF) and EndoWave used in continuous rotation or in reciprocation of Optimum Torque Reverse motion (OTR).

**Methods:** Files from five NiTi rotary brands (PTN X2 size 25, .06 taper, Revo-S SU size 25, .06 taper, M-two size 25, .06 taper, TF size 25, .06 taper and EndoWave size 25, .06 taper) were used. A total of one-hundred and twenty instruments (25-mm long), twenty-four for each brand, were divided into 2 groups ( $n=12$ ) on the basis of the motion tested: Group 1 in continuous rotation and Group 2 in reciprocation of OTR motion. Resistance to cyclic fatigue was determined by recording time to fracture (TtF) in a stainless steel artificial canal with a 60° angle of curvature and 5 mm radius of curvature. The length of the fractured file tip was measured by using a digital microcaliper. The TtF data were analysed by using the two-way analysis of variance (ANOVA) and Bonferroni post-hoc tests at 0.05.

**Results:** Reciprocating OTR motion improved TtF of

all of the tested instruments ( $P < 0.0001$ ). Mtwo and TF had significantly higher TtF when compared with all other instruments, both in continuous rotation and reciprocation of OTR motions ( $P < 0.0001$  and  $P < 0.05$ , respectively). No difference was observed between Mtwo and TF ( $P > 0.05$ ), in both motions. PTN was associated with higher cyclic fatigue resistance than Revo-S and EndoWave, both in continuous rotation and reciprocation of OTR motions ( $P < 0.0001$ ). No difference was observed between Revo-S and EndoWave, in both motions ( $P > 0.05$ ). The mean length of the fractured fragment (5.0 mm) was not significantly different for all of the tested instruments ( $P > 0.05$ ). SEM images of the fracture surface revealed mechanical damage due to cyclic fatigue failure in all of the groups tested both in OTR reciprocating motion and continuous rotation with dimpling and cone formations from the ductile rupturing.

**Conclusion:** Reciprocation of OTR motion improved significantly cyclic fatigue resistance of all instruments tested compared with continuous rotation. Moreover, Mtwo and TF showed significantly higher cyclic fatigue resistance than the other tested instruments, both in continuous rotation and reciprocation of OTR motion. Because reciprocation of OTR motion increases cyclic fatigue resistance of rotary instruments, clinicians should consider the possibility to use OTR motion and its reciprocating motion (with instruments designed for CW continuous rotation) in the clinical situations that produce high cyclic fatigue as in shaping of curved canals.

### Two fibre post systems luted with or without post space preparation: cement thickness analysis

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**Aim:** To appraise the cement thickness around two adhesively luted fibre posts in straight single-rooted teeth: a double-tapered post placed after traditional post space preparation and a single-tapered post adapted to the canal without further removal of root dentine.

**Methods:** Twenty straight single-rooted permanent teeth were cross-sectioned to obtain 14 mm-long roots, whose canal was shaped with Mtwo rotary files up to size 40/.04 and then filled with the continuous wave of condensation technique. The coronal portion of the canal was left empty for 9 mm. The roots were randomly allocated to two experimental groups of 10

elements each. In group 1 (G1), the post space was drilled by means of dedicated burs corresponding to the relative double tapered DT light post. In group 2 (G2), the canal was not further enlarged prior to receiving a single taper TechES post, which underwent standardised trimming to fit into the prepared canal. In both groups, posts were luted with self-adhesive cement (RelyX Unicem). The specimens were longitudinally cut with a microtome in mesiodistal direction, sputter-coated with gold and observed at the scanning electron microscope. For each side of the post, a technician acquired three microphotographs at 250× for every third of the post length (coronal, middle and apical third). An independent calibrated examiner measured the cement thickness 20 times per image (120 readings per post third, 360 readings per specimen). The mean cement thickness was compared with parametric statistical tests between the two post systems and among different post thirds ( $p < 0.05$ ).

**Results:** The fit of the post at the coronal level was excellent irrespective of the experimental group. In G1, the cement thickness did not significantly vary among the post thirds; the impression left on canal walls by the tip of the bur was observed at the apical third of the post. In G2, the post fit decreased in the apical third ( $p < 0.05$ ), reaching maximum thickness at the post tip (200–250  $\mu\text{m}$ ).

**Conclusion:** In straight single-rooted teeth, the post fit at the apical third of the post was superior when the post space was prepared by drilling, at the cost of removing sound dentine. Single taper posts allowed for good fit, which slightly decreased along with the canal depth, but required no further removal of tooth structure. The relatively greater cement thickness detected at this level was ascribable to the methodological standardization required in the research setting.

### Torsional and cyclic fatigue resistance of a new nickel-titanium instrument manufactured by electrical discharge machining

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**Aim:** The purpose of this study was to evaluate the torsional and cyclic fatigue resistance of the new Hyflex EDM OneFile manufactured by electrical discharge machining and compare the findings with

the ones of Reciproc R25 and WaveOne Primary.

**Methods:** One hundred-twenty new Hyflex EDM One-File (#25/0.08), Reciproc R25, and WaveOne Primary files were used. Torque and angle of rotation at failure of new instruments ( $n = 20$ ) were measured according to ISO 3630-1 for each brand. Every instrument was inspected for defects or deformities before the experiment under a stereomicroscope; none were discarded. Cyclic fatigue resistance was tested measuring the number of cycles to failure in an artificial stainless steel canal with a 60° angle and a 3-mm radius of curvature. The length of the fractured file tip was measured by using a digital microcaliper. The fracture surfaces of all fragments were examined under a scanning electron microscope to look for topographic features of the fractured instruments. Data were analyzed using the analysis of variance test and the Student-Newman-Keuls test for multiple comparisons.

**Results:** The cyclic fatigue of Hyflex EDM was significantly higher than the one of Reciproc R25 and WaveOne Primary ( $P < .05$  and  $P < .001$ , respectively). Hyflex EDM showed a lower maximum torque load ( $P < .05$ ) but a significantly higher angular rotation ( $P < .0001$ ) to fracture than Reciproc R25 and WaveOne Primary. No significant difference was found comparing the maximum torque load, angular rotation, and cyclic fatigue of Reciproc R25 and WaveOne Primary ( $P > .05$ ). The mean length of the fractured fragment (3.0 mm) was not significantly different for all of the instruments tested ( $P > .05$ ). Scanning electron microscopy of the fracture surface showed similar and typical features of cyclic fatigue and torsional failure for the 3 brands.

**Conclusions:** Within the limitations of this study, our results showed higher flexibility and angular rotation to fracture but a lower maximum torque load to failure of HEDM (CM-wire) compared with reciprocating instruments (M-wire for both files), and they highlight the potential of EDM for use in the manufacturing of endodontic mechanical instruments.

### Diagnosis and treatment of dens invaginatus with open apex in adult patient, by using cone-beam computed tomography and operative microscope

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**Aim:** To present a clinical case of dens invaginatus, where the invagination gave rise to a structure radiologically similar to a tooth inside of a maxillary