

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

lateral incisor, that became necrotic before the complete formation of the apex.

**Methods:** A 35-year old male patient referred a history of recurring abscesses with a vestibular fistula corresponding to the left maxillary lateral incisor. The intraoral periapical radiograph showed the presence of a periapical radiolucency of the 2.2 which had an open apex, and dentine tissue similar to a tooth within the pulp chamber. Cone Beam Computed Tomography (CBCT) confirmed the diagnosis of "dens invaginatus class II Ohler". The concerned tooth did not respond to both electric and heat test. Provisional diagnosis was concluded as non-vital tooth with periapical lesion in relation to 2.2. After proper isolation with rubber dam an appropriate access cavity was prepared to allow the debridement of the necrotic pulp. A barbed broach was used for debridement. The glide path was performed with a manual K-file n. 10, which crossing the invaginated canal reached the immature apex at a working length of 22 mm measured by Root ZX apex locator. Thanks to the operating microscope it was possible to find access to the "real" endodontic space and to clean it circumferentially to the invaginated hard tissues. Gentle circumferential filing had been performed with minimal dentin removal using #80 H file. The canal was then irrigated with 5.25% NaOCl. Paper point had been introduced inside canal to dry it. Trying to follow and respect the C-shaped, already highlighted by CBCT. At first the whole endodontic space, both the real and the invaginated one, was filled with calcium hydroxide for 3 months. After 3 months the calcium hydroxide was removed by irrigation with 5.25% NaOCl, and the endodontic space was dried. The intraoral radiograph and CBCT showed that the internal hard structure was almost completely detached from the "real" canal walls; so, it was mobilized and removed with ultrasonic tip (StartX #3) through the access cavity, and the wide endodontic space was filled with MTA, condensed for approximately 3 mm by using a Schilder's plugger and an ultrasonic tip for 10 seconds; it was covered with a moist cotton pellet, and the access was sealed with Cavit. One week later, a dual composite sealer (Relyx Unicem 2) was placed over the MTA cement, and the tooth was restored with an universal nano-hybrid composite (Tetric Evoceram).

**Results:** After the first sessions of root canal shaping and medication with calcium hydroxide, the clinical symptoms and the fistula, which to date (two years) have not presented, disappeared. The radiographs, 12 months after the end of endodontic treatment, showed that the periapical lesion was gradually reduced both in size and intensity of gray.

**Conclusion:** The cases of dens invaginatus may differ and consequently different is the treatment approach. In the case described, through the use of CBCT and the operating microscope, it was possible to locate

and remove the hard tissue invaginated and then to proceed as a classic endodontic treatment of a tooth with open apex. The patient was included in a follow-up program to check and verify the complete periapical bone healing of the affected tooth.

### Activation of two irrigating solutions with the XP-Endo finisher: canal cleanliness analysis

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**Aim:** To evaluate the formation of smear layer and debris on canal walls of prepared root canals after activating the irrigating solution by using the XP-endo Finisher either with sodium hypochlorite or ethylenediaminetetraacetic acid (EDTA).

**Methods:** The crowns of 24 single-rooted similarly-sized extracted teeth were removed with a cutting disc. After working length determination and glide path creation, root canals were shaped with BT Race files up to size 40/04. During the enlargement phase, the canals were rinsed with 2 ml of 5% sodium hypochlorite solution after each instrument. The prepared canals were rinsed with 3 ml of distilled water and dried with sterile paper points. At this stage, the roots were randomly allocated to a control and two test groups (n=8). The control group received three minutes-long rinses with 17% EDTA followed by 5% sodium hypochlorite. The canals of the remaining roots were rinsed with the same irrigants, activating for one minute with the XP-endo Finisher (800 rpm, 1 Ncm) the EDTA solution in the first test group and the sodium hypochlorite solution in the second. Two longitudinal grooves were created on the external surface of the roots, which were split, sputter coated with gold and observed at the scanning electron microscope. Five microphotographs per canal third were acquired at 2000 magnifications and scored according to the Hülsmann scale for smear layer and debris formation. The median value of the scores attributed to each third was regarded as statistical unit. Non-parametric statistical analysis was performed to assess the differences among groups and canal thirds ( $p < 0.05$ ).

**Results:** The coronal third was found to be satisfactorily cleaned irrespective of the experimental group; on the contrary, all the considered irrigation protocols were unable to avoid smear layer and debris accumulation in the apical third. In the group where the sodium hypochlorite was activated, significantly worse scores were attributed to the middle third in terms of both smear layer and debris, in comparison to the other two