regeneration treatment. In the first appointment, a mini-invasive opening of the pulp chamber was achieved and the clearance of necrotic pulp and disinfection was obtained with NaClO (2,5%). 3-MIXC was positioned following the previously published protocol of the University of Turin. Three weeks later, the second appointment consisted in removing the antibiotic paste using EDTA (17%). Bleeding stimulation was promoted and MTA sealing at the cement enamel junction (CEJ) with composite restoration was fulfilled. Follow-ups were scheduled at 1 month, 3 months, 6 months, 1 year and a following annual recall.

Results: The efficacy of the novel 3-MIXC was previously tested ex-vivo through confocal laser scanner microscopy (CLSM) viability staining to quantitatively analyze the mean depth of the antibacterial effect and the proportions of dead and live bacteria inside the dentinal tubules. The clinical and radiographic treatment outcomes were observed with a minimum follow-up of 6 months and a maximum of 3 years. This in-vivo study evidenced no symptoms or clinical and radiographic signs of pathology for each case. Moreover, no tooth discoloration was observed for all the patients.

Conclusions: Alternative antibiotic mixtures are already applied in pulp regeneration protocols, although tooth discoloration can occur in more than 40% of the cases as a side effect. 3-MIXC demonstrated an ex- vivo efficacy depth of action similar to the Trimix antibiotic paste but without dentinal discoloration as side effect in both ex vivo and in vivo studies. Neither post-operative pain and tooth discoloration were observed for all the cases treated with 3-MIXC. This antibiotic paste may be an effective alternative for the disinfection during the endodontic regenerative procedures and the management of necrotic immature permanent teeth.

Influence of sealer placement technique and powder/liquid mixing ratio on the quality of single-cone root canal filling: a micro-CT analysis

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Aim: To assess the influence of two different placement techniques and powder/liquid mixing ratio of a bioceramic sealer on the quality of root canal filling by single-cone using a micro-CT analysis.

Methods: Thirty-two single-rooted elements with a mesio-distal diameter of 5,00±0,50 mm, a buccal-lingual diameter of 6,50 ±0,50 mm and a root length of 14,50±0,50 mm measured at CEJ level were selected to be included in the study. After creating the coronal access cavity, root canals were scouted with manual files and the working length was acquired. Root canals were shaped with R40 Reciproc Blue and irrigated with NaOCl 5% and EDTA 17% solutions. Prepared samples were randomly assigned into four experimental groups (n=8), according to the sealer placement technique and the powder/liquid mixing ratio: G1, the sealer (BioRoot RCS, Septodont) was mixed in a 1:5 ratio, as suggested by the manufacturer, and carried into the root canal by a dedicated gutta-percha cone up to the working length; G2, sealer placement as group G1, but using 1:6 mixing ratio; G3, the sealer was mixed in a 1:5 ratio and carried into the root canal by a syringe with a cannula (Apexcal, Ivoclar) up to its complete filling, then a dedicated gutta-percha cone was inserted into the canal; G4, sealer placement as group G3, but using 1:6 mixing ratio. All the samples were submitted to micro-CT analysis. Micro-CT scans were acquired after shaping procedures (t0) and after canals obturation (t1) and then compared to evaluate the presence of voids in the gutta-percha, sealer and dentin interfaces. The normality of the distribution and the equality of variance of the microtomographic datasets were tested with a Shapiro-Wilk and Levene test, respectively; the significance of the differences between groups in terms of the formation of voids was ascertained with the Kruskal-Wallis test. The results were considered statistically significant for a $p\text{-value} < 0.05$.

Results: Minimal void volumes were observed among groups. G1 performed the best result: total void volumes were 0,253±0,175% of the entire canal space. The other experimental groups follow in order of increasing volume: G3 (0,260±0,254%), G2 (0,532±0,528%), G4 (0,840±0,705%), but no statistically significant difference was observed. All groups showed a similar distribution of voids: in the apical and middle third of the root canal the presence of voids was minimal while the greatest void volumes were detected in the coronal third, due to the canal anatomy and the larger amount of sealer. In this canal portion voids were mainly distributed within the sealer. Concerning the sealer viscosity, the more fluid formulation (1:6) showed an increase of void volumes, although without statistical significance. Likewise, no statistically relevant influence was registered regarding the sealer placement technique.

Conclusion: All the examined techniques should be considered effective for the clinician. Under the conditions of the present study, the 1:5 powder/liquid mixing ratio should be preferred when associated with both the sealer placement techniques, according to the clinical situation and the operator preferences.

When using the low viscosity formulation, the clinician should insert the sealer slowly and in a controlled way, in order to minimize the formation of voids.

A micro-computed tomographic analysis of obturation and retreatability quality of an epoxy resin based sealer

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Aim: To evaluate the voids percentage of a matched-taper single cone and epoxy resin-based sealer (MM-Seal, Micromega, Besançon, France) root fillings and its retreatability using rotary instrumentation and supplementary irrigation techniques.
Methods: Single-rooted mandibular premolars (n=72) were prepared using Hyflex EDM nickel-titanium rotary instruments (Coltene, Coltene/Whaledent AG, Altstatten, Switzerland) up to 40.04. Each canal was trial fitted with a 40.04 gutta-percha point with tug-back at the working length. The MM-Seal was used as root canal sealer and prepared according to the manufacturer's instructions. All canals were filled with a matched-taper single-cone technique to maintain experimental consistency among the groups. The specimens were scanned with micro-CT scanner (Skyscan1172, Brunker microCT, Antwerp. Belgium) at 80 kV and 100 µA with an isotropic resolution of 11 µm, before and after root canal obturation. Volumetric measurements were performed using the software Amira 5.3 (Mercury Computer System Chelmsford, MA, USA) to calculate the percentage of voids in the whole root canal, root canal thirds and the last millimeter from the apex. The voids volume was calculated for each section by subtracting the filling material volume from the post-instrumentation root canal volume. In addition, root fillings were removed using rotary instruments and the teeth were randomly allocated to one of the groups for supplementary irrigation techniques (n=24): group A, syringe irrigation; group B, Tornado Brush (Tornado France, M.I.B, Suresnes, France) and group C, ultrasonically activated irrigation (P5Newtron; Satelec Acteon, Mérignac, France). Specimens were re-scanned with micro-CT to evaluate the volume of remnant root filling material. The data relative to voids and retreatment techniques were not normally distributed, consequently they were analyzed by Kruskal-Wallis test (P<0.05). Differences in retreatment time were analyzed using one-way ANOVA with the Tukey's test (P<0.05).
Results: No significant difference was observed between the baseline (after instrumentation) and final (gutta-percha+sealer) root canal volumes (mm3) for whole canal and each anatomical third (total baseline volume) (P>0.05). There was no significant difference in the percentage of voids between the different root-thirds (P>0.05). Regarding the retreatment techniques, there was no significant difference between the supplementary irrigation groups in the remnants of MM-Seal for the whole root canal and each anatomical part (P>0.05). In all the groups, the coronal region exhibited more remaining material than other anatomical thirds (P<0.05). For retreatment time, no significant difference was reported among the three different retreatment techniques (P>0.05).
Conclusion: Within the limitations of this in vitro study, root canals filled with a matched-taper single cone and MM-Seal showed a low percentage of voids. All root canals obturated with tapered single cone and MM-Seal sealer had residual filling material, with no significant differences among the anatomical parts examined. Regarding MM-Seal retreatability, additional retreatment techniques used did not improve MM-Seal removal in comparison with syringe irrigation.

Micro-CT evaluation of two rotary systems for canal shaping in mandibular first molar mesial canals

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Aim: To evaluate the shaping ability and the maintenance of the original root canal anatomy of a modified ProTaper Next technique (PTNm) and the TruNatomy (TN) rotary system using micro-computed tomography (Micro-CT).
Methods: twenty mesiobuccal and mesiolingual canals of permanent first mandibular molars extracted for periodontal reasons were randomly assigned into 2 groups (n = 10): (A) modified ProTaper Next technique and (B) TruNatomy system. The specimens were randomly selected, and the inclusion criteria were the following: a primary root canal curvature comprised between 20° and 40°, a mean radius between 4 and 8 degrees and the absence of root canal calcifications. The modified ProTaper Next technique, encoded by Professor Elio Berutti in 2014, consists in the following instrumentation sequence: ProGlider and ProTaper Next X1 at the working length (WL) and apical finishing with a K-file NiTiFlex #25. The TruNatomy system is constituted by: Orifice Modifier, Glider and Prime at WL. The shaping instruments were changed every canal. The irrigation was achieved with 5% NaOCl and 10% EDTA