

solutions. The samples were scanned using micro-CT (SkyScan 1172®: ©Bruker microCT, Kontich, Belgium) at 100 kV and 100 μ A with isotropic voxel size of 14.99 μ m. Matched volumes, before and after shaping, were evaluated and the following bidimensional and three-dimensional parameters were analysed: the volume of the removed dentin, the difference of canal surface, the centroid shift, the minimum and maximum diameters, the cross-sectional areas and the canal geometry variations through the geometrical parameters ratio of diameter ratios (RDR) and ratio of cross-sectional areas (RA). The measurements were assessed at 2 mm from the working length and in centre of the root canal coronal and medium third. During the study, a secondary aim was obtained: it would be possible to get a standardized and feasible digital workflow to process the shaping outcomes from micro-CT analysis. The data were analysed statistically using one-way analysis of variance (ANOVA) with the level of significance set at $\alpha = 0.05$.

Results: the PTNm group showed a higher volume of removed dentin (1.40 ± 0.80 vs 0.91 ± 0.44 mm³; $p = 0.102$) and a less centroid shift at apical level (0.083 ± 0.045 vs 0.146 ± 0.27 mm; $p = 0.471$) while the TN sequence demonstrated a better centring ability at coronal level (0.070 ± 0.046 vs 0.155 ± 0.14 mm; $p = 0.085$). The only significant difference between the two groups is represented by the RA at coronal level (1.82 ± 0.71 vs 1.30 ± 0.21 ; $p = 0.037$).

Conclusion: despite the RA parameter at coronal level, there were no significant differences among the tested groups. Therefore, both shaping techniques demonstrated their ability to maintain the original root canal anatomy.

Root-end resection without retrograde preparation: a micro-CT study

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Aim: the gold standard in endodontic surgery is characterized by meticulous retrograde procedures that could be not performable in all teeth due to multiple clinical difficulties. The possibility to perform the only apical resection, when feasible, without further retrograde steps might represent a substantial clinical advantage. The present study analyzes the filling quality achieved with standard retrograde technique in comparison with alternative techniques with or without retrograde procedures.

Methods: the sample size was determined using with the

following parameters: $\alpha=0.05$; $\beta=0.20$; $\delta=3.0$; $\sigma=1.5$. Twenty-four single-rooted teeth were selected from a pool of freshly extracted teeth, discarding those with aberrant anatomy. Selected teeth of comparable size were decoronated to obtain 12 mm long roots. The canals were scouted with manual files and the working length acquired. After mechanical glide path establishment, canal shaping was performed with HyFlex EDM rotary files up to size 40.04 taper (500 rpm; 2.5 Ncm). The roots were analyzed with a computed microtomography scanner to identify the possible presence of dentine microcracks. Afterwards, the roots were randomly assigned to two groups: twelve canals were filled with the single cone technique (SCT) with dedicated cones and BioRoot RCS bioceramic sealer; twelve canals were filled with MTA cement (ProRoot MTA) for 6mm in the apical portion with the aid of the MAP System; the empty canal portion was backfilled with thermoplasticized gutta-percha (Obtura III Max System). After 24 h, the roots were apically resected with a carbide bur 3 mm from the apex. At this point, the two groups were randomly subdivided into two further groups of six elements each: G1, SCT and bioceramic sealer without retrograde procedures ($n=6$); G2, SCT and bioceramic sealer with standard retrograde ultrasonic preparation and MTA filling ($n=6$); G3, orthograde MTA placement without retrograde filling ($n=6$); G4, orthograde MTA placement and standard retrograde ultrasonic preparation and MTA filling ($n=6$). Lastly, the formation of internal and external voids was quantified by means of a second computed microtomographic analysis. The normality of the distribution and the equality of variance of the microtomographic datasets were tested with a Shapiro-Wilk and a Levene test, respectively; then, the volumes measured in the groups were statistically compared with the Kruskal-Wallis test and with the Mann-Whitney test with Bonferroni's correction couple comparison.

Results: All groups showed minimal voids volumes formation. In the groups characterized by standard retrograde procedures, the mean voids volumes were 1.16 ± 0.40 % (G4) and 1.87 ± 1.49 % (G2) of the entire canal space, in the groups with the only root-end resection 0.82 ± 0.58 % (G1) and 1.08 ± 0.50 % (G3). The difference between the groups was not statistically significant. Analyzing the volume within the apical 3 mm of the canal after root resection ($G1=0.06 \pm 0.10$ %; $G2=0.76 \pm 0.81$ %; $G3=2.06 \pm 1.92$ %; $G4=1.53 \pm 1.79$ %) the difference between G1 and the other groups was statistically significant ($p < 0.05$).

Conclusion: When suitable, filling the canal with the single cone technique and bioceramic sealer or orthograde MTA placement combined with simple root-end resection appears to provide an efficient seal of the endodontic space. These technique could represent a good alternative to the retrograde preparation and filling.