Quality of Different Gutta Percha Techniques when Filling Experimental Internal Resorptive Cavities, A Micro–Computed Tomography Study

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Aims

Besides proper cleaning and shaping of the root canal, the complete and hermetic obturation of the root canal system is a major objective in root canal treatment (1). Root canal anatomy may display complex irregularities in shape as a result of pathological processes such as internal resorption (2). By their very nature, internal root resorption defects can be difficult to obturate adequately (3, 4).

Many putative techniques have been studied ex vivo to address this deficit in quality when filling internal defects (2, 5-7). These studies have evaluated voids, obturation mass, and the amount of gutta percha (GP) or sealer in the defects, and have shown that significant differences exist between obturation techniques with respect to their ability to fill defects (2, 5, 6).

The objective of this study was to evaluate and compare the proportions of experimental internal resorption defects occupied by voids, sealer and GP with different obturation techniques. Using micro-CT, we compared cold lateral condensation, warm vertical condensation and Thermafil techniques.

Method

Forty-five extracted maxillary canine teeth were selected. The coronal part of each tooth was removed and the 45 roots were then randomly assigned to three groups (n=15 per group).

Artificial internal resorptive cavities were created as previously described (2, 8). Briefly, roots were sectioned perpendicular to the root axis with a fine diamond disc 7 mm from the apex. Semi-circular cavities were created using a low-speed No. 6 round diamond bur around the periphery of the root canal opening of each section. The sections were then reapproximated using luting cement on the dentin surface around the cavities. Group 1: The experimentally defective roots were obturated by cold lateral condensation (CLC) using AH Plus (Dentsply De Trey GmbH, Germany) and GP (Aceone-Endo, Aconeondent Co. Geonggi-Do, Korea). Group 2: The experimentally defective roots were filled using the vertical condensation technique (BeeFill, VDW, Munich, Germany). Group 3: The experimentally defective roots were obturated using the Thermafil technique with a plastic carrier.

Filled roots in this group were stored for 2 weeks at 37 °C and 100% relative humidity to allow the sealer to set completely before scanning. A single operator performed the whole root canal preparation and obturation.

Micro-CT Analysis

A commercially available high-resolution µ-CT system (Skyscan 1172, Kontich, Belgium) was used to scan the roots. The X-ray tube was operated at 85 kV and 118 µA using a 0.5 mm Al+Cu filter with a resolution of 13.68 µm pixels. Each specimen was scanned for a total of 60 min. The resulting two dimensional images (8-bit TIFF) were used to reconstruct axial cross-sections. Each raw data set was then reconstructed into images using NRecon software (Skyscan). The root filling and any voids within the resorption cavity were segmented and reconstructed using NRecon, CT An and CT Vol software (Skyscan).

Statistical Analysis
MedCalc statistical software (www.medcalc.org) was used for data analysis. All data are shown as mean±standard deviation (SD). Normality of distribution for continuous variables in the groups was determined by the Shapiro-Wilk test. The variables did not show normal distribution (p<0.05). Therefore, the Kruskal-Wallis and Conover’s *post hoc* tests were used to compare variables among the studied groups. A value of p<0.05 was considered significant.

**Results**

From visual analysis of the 3D µCT reconstruction, the best quality filling was formed using vertical condensation, which achieves compression of the filling material towards the cavity walls. This quality could not be matched by Thermafil and CLC techniques. In CLC, the sealer diffused towards the cavity and some twisting of the GP cones within the cavity was observed, resulting in the formation of a filling mass. Similarly, because of the overflow of GP on the carrier that was shed from the apical canal orifice, a filling mass was formed on the bottom edge of the cavity when using the Thermafil technique (Figure 1).

![Figure 1. 3D models of sample fillings using A) vertical condensation technique; B) lateral condensation technique; and C) Thermafil technique.](image)

Separate analyses were made of the total, apical and coronal sections of the resorption cavity. The percentages of total volume occupied by sealer, GP and voids were calculated and are shown in Table 1. The Thermafil carrier was considered as gutta-percha.

**Conclusion**

This study results suggest that the vertical condensation technique is optimal for filling artificial resorptive cavities and is significantly superior to lateral condensation and Thermafil techniques. We also conclude that using micro-CT to analyze obturation of these canal resorption cavities is a significant improvement on previous 2D techniques and predict that this will become the predominant methodology for similar future endodontic studies.