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ORIGINAL ARTICLE

Effect of timing of post space preparation on the apical seal when using different sealers and obturation techniques



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Abstract *Background/purpose:* To prepare the post space, some of the root-canal filling material has to be removed, which can affect the apical seal. The aim of this study was to compare the effect of immediate post space preparation to that of delayed post space preparation on apical sealing using three different endodontic sealers and obturation techniques. *Materials and methods:* In total, 90 decrowned single-rooted human teeth were studied. After root canals were prepared with 0.06 tapered nickel–titanium rotary files to size 30, the roots were categorized randomly into three experimental groups according to the obturation material: (1) AH plus/gutta-percha; (2) Sealite Ultra/gutta-percha; and (3) Epiphany/Resilon. Furthermore in all groups, specimens were categorized randomly into three subgroups according to the obturation technique ($n = 10$): (1) single cone; (2) cold lateral compaction; and (3) System B + Obtura. After root-canal filling, post space preparation was immediately performed in Group 1, after 24 hours in Group 2, and after 7 days in Group 3. Apical leakage was measured using the fluid-filtration method. Statistical analysis was performed using the Kruskal–Wallis test and Wilcoxon signed ranks test at $P < 0.001$.

Results: Regardless of the obturation technique and sealers used, significantly better ($P < 0.001$) sealing was achieved at the apical ends using delayed post space preparation than with immediate post preparation. The obturation techniques tested did not significantly affect leakage values. The following statistical ranking of fluid filtration values was obtained for the obturation materials: Epiphany/Resilon > Sealite Ultra/gutta-percha > AH plus/gutta-percha ($P < 0.001$).

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Conclusion: To reduce apical leakage, clinicians should use AH plus together with any of the obturation techniques after 7 days of obturation.

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Introduction

The use of posts to retain cores in teeth that have undergone extensive loss of coronal structure is generally necessary after root-canal treatment.¹ To prepare the post space, some of the root-canal filling material has to be removed, which can affect the apical seal.² During post space preparation, it is important not to disrupt the integrity of the remaining filling material, because it provides an apical seal, which is of primary importance for successful endodontic therapy.³ The techniques used for removing the filling material vary, but it is recommended that an apical seal of at least 5 mm of gutta-percha be retained.^{4–6} Further, the use of a mechanical method is recommended over organic solvents for removing the obturating material.⁷

The outcome of endodontic therapy is affected by the technique used for removing the root-canal filling material and by the amount of root-canal filling material retained; in addition, it is affected by the timing (immediate or delayed) of post space preparation, the type of sealer, and the obturation technique used.^{8–11} Results of studies published on the time interval between endodontic treatment and post space preparation are controversial.^{8,12,13} Post space preparation may be performed either immediately after completing endodontic treatment or at a later stage after the sealer has completely set. Regardless of whether post space preparation is immediate or delayed, the type of sealer and obturation technique is also crucial during post space preparation. Although in previous studies the type of sealer and obturation technique have been tested separately, there are no published data on the effect of immediate and delayed post preparation and the obturation technique on apical leakage of zinc oxide–eugenol, resin, and methacrylate-based sealers. Therefore, the objective of the present study was to evaluate the effects of immediate and delayed post space preparation on apical leakage using different filling materials and obturation techniques. The null hypothesis tested was that the timing of post space preparation and the obturation technique do not affect the apical sealing ability of different types of root-canal sealers.

Materials and methods

Specimen preparation

In total, 90 decrowned single-rooted human teeth were studied. The lengths of the roots were standardized to 16 mm. The root canals were enlarged using ProFile rotary instruments (Maillefer, Dentsply, Tulsa, OK, USA) with RC-Prep lubrication (Premier Dental Products, Tulsa, OK, USA), until the file 30/0.6 taper reached the working length (1 mm from

the apical foramen). The root canals were irrigated with 2 mL of a 5.25% sodium hypochlorite (NaOCl) solution between each file size. To remove the smear layer, the root canals were rinsed with 10 mL of 17% ethylenediaminetetraacetic acid (EDTA) followed by 10 mL of 5.25% NaOCl. The roots were then irrigated with 10 mL of distilled water to avoid prolonged exposure to the EDTA and NaOCl solutions. The canals were subsequently dried with paper points. Thereafter, the roots were categorized randomly into three experimental groups according to the obturation material used: (1) gutta-percha + AH Plus sealer (Dentsply Caulk, Milford, DE, USA) (epoxy resin-based sealers); (2) Resilon + Epiphany sealer (Resilon group) (Pentron Clinical Technologies, Wallingford, CT, USA) (a methacrylate-based resin sealer); and (3) gutta-percha + Sealite Ultra (Pierre Rolland, Merignac, France) (a zinc oxide–eugenol-based sealer). Furthermore, in all groups, specimens were categorized randomly into three subgroups ($n = 10$) according to the obturation technique used: (1) single cone; (2) cold lateral compaction; and (3) System B + Obtura. Post space preparation was performed immediately after root-canal filling in Group 1, after 24 hours in Group 2, and after 7 days in Group 3. For post space preparation, the root-canal filling material was removed using a Gates-Glidden drills (Dentsply-Maillefer, Ballaigues, Switzerland). To preserve the apical seal, 5 mm of the root filling material was retained at the apical level. The same experienced operator prepared all specimens.

Evaluation of apical leakage

A modified fluid transport test was used to measure apical leakage by studying the movement of a tiny air bubble traveling within the constant bore of a 100- μ L micropipette. All pipettes, syringes, and plastic tubes used in the system were filled with deionized water. The micropipette was connected to a plastic tube, and this tube was connected to the root by epoxy resin (Pattex; Henkel, Düsseldorf, Germany) (Fig. 1).

Water was drawn back by approximately 2 mm with a microsyringe to introduce a tiny air bubble in the micropipette. The air bubble was adjusted to a suitable position within the micropipette using the microsyringe. Finally, regulated air from a pressure tank at 121.6 KPa (1240 cmH₂O) was applied from the apical ends of the specimens, thereby forcing water through the voids, if any, along the root-canal filling. Displacement of the air bubble caused by water movement in the capillary tube was measured per unit time. The linear displacement of this air bubble was converted to a volume displacement, and was recorded as the amount of fluid transported. Values are expressed in terms of μ L/minute/cmH₂O. The procedures for selection and instrumentation of the specimens used as the positive controls were similar to those used for the

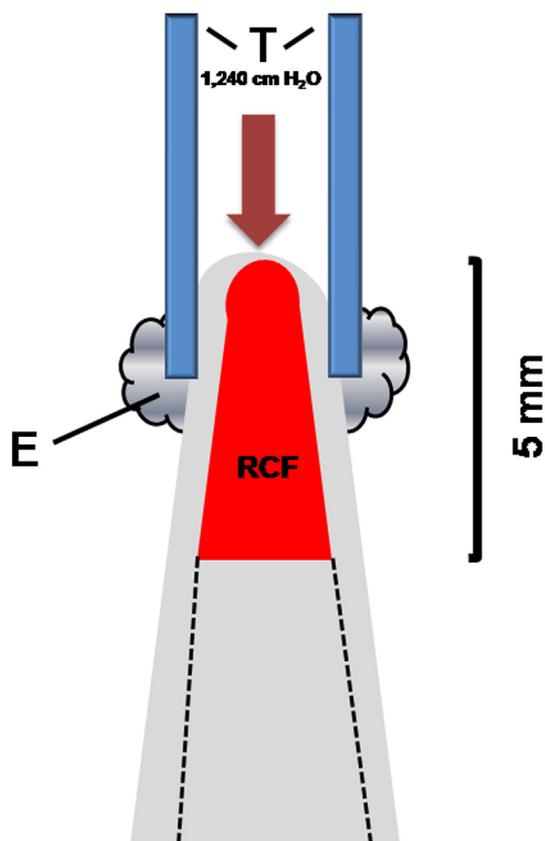


Figure 1 Schematic view of a specimen attached to the fluid filtration setup. An arrow indicates the direction of water movement. E = epoxy resin; RCF = root-canal filling; T = tube.

experimental groups, except that the prepared root-canal spaces were not obturated. The fluid flow rate through the unfilled root canal was measured by recording the movement of the air bubble that could pass through the root canal in 1 minute ($1428 \mu\text{L}/\text{minute}/\text{cmH}_2\text{O}$). This value served as both a positive control and the 100% leakage value, to which sealed values could be compared. The fluid transport results were analyzed using SPSS statistical software (version 11.5; SPSS, Chicago, IL, USA). The statistical analysis was performed using the Kruskal–Wallis test and Wilcoxon signed ranks test at $P < 0.001$.

Results

Fluid conductance values are presented in Fig. 2. Irrespective of the obturation technique and sealers used, delayed post space preparation showed significantly better sealing at the apical end than did immediate post preparation ($P < 0.001$). The obturation techniques tested had no significant effects on leakage values. The following statistical ranking of fluid filtration values was obtained for the obturation materials used: Epiphany/Resilon > Sealite Ultra/gutta-percha > AH plus/gutta-percha ($P < 0.001$).

Discussion

A modified fluid transport test, which was proven to be more sensitive than bacterial penetration and conventional

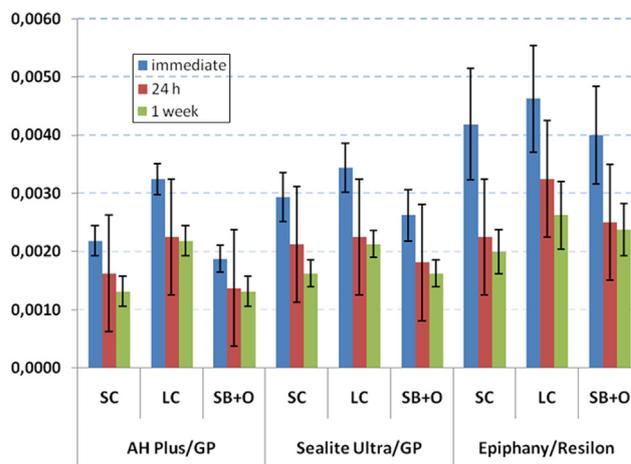


Figure 2 Fluid conductance values (L/minute/cmH₂O) of test specimens with respect to the post space preparation time (immediately, at 24 hours, and at 1 week) and filling technique. GP = gutta-percha; LC = lateral compaction; SB = system B/Obtura; SC = single cone.

dye-penetration methods, was used to measure apical leakage around root-canal fillings.^{14,15}

Results of this study indicated that irrespective of the root-canal sealers and obturation techniques used, the most severe leakage was caused by immediate post space preparation, followed by post space preparation at 24 hours, and finally by post space preparation at 7 days. The null hypothesis that the timing of post space preparation (immediately, at 24 hours, or at 7 days after completing root-canal filling) and the obturation technique do not affect the apical sealing ability of different types of root-canal sealers had to be rejected. Salona et al¹ reported that immediate post space preparation had a positive influence on apical leakage of s. This result contradicts the findings of the present study which showed that leakage resulting from immediate post preparation was significantly higher than that resulting from delayed post preparation. Although results obtained using different methodologies should be compared carefully, a possible explanation for the difference between the present results and those obtained by Salona et al could be that the method used for removing the root-canal filling materials for post space preparation could have affected the quality of the apical seal. In the present study, a Gates–Glidden drill was used to remove the root-canal filling material; use of the Gates–Glidden drill for post space preparation enables breaking of the bond sealer interface without obturation.¹ In contrast, adequately condensed root-canal filling can be obtained using a hot plugger, as described in a previous study.¹⁶ In addition, it was speculated that fluid conductance decreased with time because of sufficient polymerization of the root-canal sealers. According to the manufacturer's instructions, setting times for Epiphany, Sealite Ultra, and AH plus are 45 minutes, 15–50 minutes, and 8 hours, respectively. Therefore, polymerization of root-canal sealers may also be a factor in the better sealing of delayed post preparations.

In the present study, 0.6 tapered points were used for Groups 1 and 3, because these cones have the same taper

and dimensions of a ProFile final file. Although the extents of leakage in both groups were less than that in the group that used lateral condensation for root-canal filling, the differences between the leakages were not significant, and are probably not clinically meaningful. This result is in agreement with those of previous apical leakage studies,^{17,18} which showed that root fillings obturated using cold lateral compaction can give rise to voids that can disrupt the integrity of the sealer, or possibly be filled with sealer that can eventually be resorbed. In addition, root-canal filling performed using a matching master cone can minimize the amount of sealer used, which improves the sealing ability. Sealer thickness is strongly dependent on the obturation technique,¹⁹ and it was shown that the single-cone technique provides void-free obturation along with a minimal sealer thickness. Remember that the use of matched gutta-percha or Resilon points in canals prepared with tapered rotary instruments can improve the apical sealing ability of root-canal fillings.

Apart from the timing of post space preparation and the obturation technique, apical leakage was also affected significantly by the type of sealer used. In particular, the amount of apical leakage observed for the three groups was in the order of AH plus/gutta-percha group < Sealite Ultra/gutta-percha group < and Epiphany/Resilon group, and the differences were statistically significant. This result is in agreement with those of previous studies,^{20,21} which showed that the apical sealing ability of resin-based sealers is better than those of Sealite Ultra and Epiphany sealers. Moreover, when AH plus sealer was used, the leakage that occurred when the post space was prepared 7 days after obturation was significantly less than that which occurred when the post spaces were prepared at the time of obturation and when they were prepared 24 hours after obturation. The results obtained in the present study suggest that the type of sealer can play a significant role in fluid conductance, because the extents of apical leakage in teeth obturated with AH plus sealer were significantly lower than those in teeth obturated with Epiphany and Sealite Ultra. Therefore, the type of sealer used seems to be a possible factor affecting potential microleakage. Extrapolation of the present data to *in vivo* conditions should be done cautiously, because in the case of post space preparations, sealing quality is just one of the factors that might affect the outcome of endodontic treatment.

Clinicians should be extremely cautious with regard to preparing and maintaining the apical seal during post space preparation. The obturation technique does not seem to affect the amount of apical leakage, and therefore, to reduce apical leakage, clinicians can use AH plus sealer with any of the obturation techniques 7 days after obturation. However, additional studies using different root-canal sealers and leakage models are required.

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