Effect of post space preparation on apical seal: Influence of time interval and sealer

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ABSTRACT

Objective: To assess the efficacy of two sealants to preserve the apical seal after root canal preparation and cementation of posts at 24 h or 72 h after endodontic treatment.

Study design: Sixty human single-root teeth were instrumented and obturated using lateral compaction technique with EndoFill® [30] or AH-Plus® [30] and were prepared in one of three ways, leaving a 3 mm gutta percha remnant in all cases: without cast post preparation, with preparation after 24 h or after 72 h. After cementing the posts, the specimens were thermal cycled at 5 and 55˚C in water baths, submerged in 2% methylene blue dye for 72 h, embedded in acrylic resin and cut transversally into three 1-mm apical sections. Dye leakage was quantitatively assessed as the percentage leaked area.

Results and conclusion: Comparison of the apical sections showed significant differences in leakage with both sealers among the three preparation groups ($p<0.001$). No significant differences between sealers were found in any preparation group or in the same sections.

Key words: *Apical leakage, post space, apical seal, post preparation.*

INTRODUCTION

Restoration of endodontically treated teeth commonly requires the partial removal of obturating material in the canal in order to prepare the post space, and this procedure can affect the apical seal (1). Metzger et al. (2) showed that the sealing is proportional to the length of the remaining filling.

Five millimetres of obturating material is considered a safe margin (3). In many clinical situations, however, a smaller remnant must be left in order to increase the post retention, thereby compromising the apical seal. Some authors (3,4) considered 3 mm to be the minimum remnant to preserve the seal. On the other hand, Abramovitz et al. (3) reported that a reduction of fillings to 3 mm produced an unpredictable seal. In these situations, the sealer is crucial for preserving the apical seal. Some experiments (5-8) found lower leakage with the use of epoxy resin sealants compared with zinc oxide-eugenol sealers, whereas Karapanou et al. (9) reported that zinc oxide-eugenol and epoxy resin sealers (AH26) had similar behaviours. Also it had found equal efficacious in the apical sealing with lateral condensation and low-temperature thermoplasticized gutta-percha (10).

There is no consensus on the time interval between the endodontic treatment and the post preparation, with some authors proposing an immediate preparation (9,11,12) and others recommending different time intervals (9,13).

With respect to the gutta percha removal method, Hiltner et al. (14), who left 4 mm of remnant, found no differences among gutta percha removal procedures. Other authors (4) recommended the use of a mechanical method rather than organic solvents for removing the obturating material.

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The objective of the present study was to assess the efficacy of two sealants to preserve the apical seal after root canal preparation and cementation of posts at 24 h or 72 h after endodontic treatment.

MATERIALS AND METHODS

Sixty single-root human teeth with a straight root canal were stored in 10% buffered formalin immediately after their extraction and kept at 37 ºC until use.

Preparation of root canal:

The crowns were amputated at the cemento-enamel junction line using a low-speed carborundum disk under abundant water refrigeration. The full working length was established by deducting 1 mm from the actual tooth length, determined by introducing a nº 10 K-file (Maillefer-Dentsply, Ballaigues, Switzerland) until it was visible through the apical foramen.

The root canals were prepared using the step-back technique with K-files. The apical portion was enlarged to a nº 55 master file. The mid- and coronal thirds were prepared with drills (Gates-Glidden drills, sizes 1 and 2; Maillefer-Dentsply, Ballaigues, Switzerland). The canals were irrigated with 3 ml of 0.5% NaOCl. When the preparation was completed, each canal was finally irrigated with 10 ml of 0.5% NaOCl and 3 ml 17% trisodium ethylenediaminetetraacetic acid (EDTA) (Biodinámica Inc., Paraná, Brazil).

Obturation of root canals

The root canals were dried with sterile absorbent paper points (Dentsply DeTrey, Konstanz, Germany) and obturated by lateral compaction technique using Nº 55 standardized gutta-percha (Dentsply DeTrey, Konstanz, Germany) as master cone and nº 25 gutta percha (Dentsply DeTrey, Konstanz, Germany) as accessory cones. The canals were then randomly divided into two groups [n=30]; EndoFill® sealer (Dentsply DeTrey, Konstanz, Germany) was used in one group (Group A), and AH-Plus® sealer (Dentsply DeTrey, Konstanz, Germany) in the other (Group B). X-rays were made of all teeth to confirm adequacy of fill. Excessive obturating material was then removed using a flame-heated instrument and cold vertical compaction was performed (Pluggers 2, 3, 4, Maillefer, Ballaigues, Switzerland). Access cavities to the canal were sealed with a provisional sealer (Cavit®, 3M Espe, St. Paul, MN, USA). The teeth were again submerged in 10% buffered formalin solution until use.

The 60 canals were prepared as follows: Group A1,EndoFill®, no post space preparation [N]; Group A2, EndoFill®, post space preparation after 24-h interval [P24]; Group A3, EndoFill®, post space preparation after 72-h interval [P72]; Group B1, AH-Plus®, no post space preparation [NP]: Group B2, AH-Plus®, post space preparation after 24-h interval [P24]; Group B3, AH-Plus®, post space preparation after 72-h interval [P72].

For the post space preparation, the gutta percha was removed from the canal using hot instruments. The space was prepared with a drill (Largo Nº 2 drill, Maillefer, Ballaigues, Switzerland) to the depth required to leave a 3-mm gutta percha remnant. When the preparation was completed, it was again irrigated with 10 ml of 0.5% NaOCl. After drying the bed, a metal post (Reforpost I, Angelus. Paraná, Brazil) was cemented in each canal using glass ionomer cement according to manufacturer's instructions (Ketac Cem 3M-Espe, St. Paul, MN, USA).

Apical dye penetration:

All posts were cut at the cervical level of the roots using high-velocity diamond drill under abundant water refrigeration, and the coronal portion of the root was sealed with temporary filling material (Cimpat N Spécialités Septodont, Saint Maur, France). The roots were coated with a layer of fast-acting cyanoacrylate ester adhesive (Super Bonder-Loctite, Kentucky, USA), covering the whole specimen including the access restoration but not the apical 2 mm of the root. Finally, the entire root except this apical 2 mm was coated with two layers of nail polish. The specimens were stored in 100% humidity at 37ºC for 72 h.

Subsequently, all specimens were thermal cycled at 5 and 55˚C in water baths, with an immersion time in each bath of 1 min for a total of 500 cycles. They were then submerged in 2% methylene blue dye for 72 h. Finally, specimens were washed in running water to remove excess dye.

Results assessment:

Specimens were embedded in self-curing colourless acrylic resin (Ortocryl EQ, Dentautum, Germany). Three 1-mm thick transversal sections were cut from each specimen from the apex to the post [S1 – at 1 mm from the apex-, S2 – at 2 mm - and S3 – at 3 mm] using a refrigerated microcutter and 0.27 mm-thick diamond disk (Dinser LTDA, São Paulo - SP - Brasil).

Sections were studied at 20x magnification with a MZ APO model LECCA stereomicroscope (Meyer Instruments, Houston, TX) and photographed using an HPS60 LECCA automatic camera fitted to the microscope.

The leakage of the dye was quantified as the percentage of the area stained. Millimetre-ruled transparent paper was placed on the photograph of each root section, marking the whole area and leaked area with using fibre-tip pens of different colours and counting the squares corresponding to the whole area and to the stained area. After the count was made by an experienced observer, the percentage of leaked area was calculated.

Statistical analysis:

The percentage leakage was considered the variable dependent in the analyses. A full-factorial ANOVA was used to assess the influence of the apical section, sealer type (AH Plus or Endofill®) and post space preparation on the leakage, including the main factors and second-order interactions (apical section x sealer, apical section x post space preparation and sealer x post space preparation), and third-order interaction (apical section x sealer x post space preparation). The influence of each factor on the leakage was then examined.

Because the results for each group did not follow a normal distribution, the variables were analysed using a non-parametric test. Global comparisons were made by using the Kruskal-Wallis test and the Mann-Whitney U test for paired comparisons. A p-value of 0.05 was regarded as significant.

Table 1. Influence of sealer type, technique and section on leakage (%).

Section	Preparation technique	No post preparation [NP]		With post preparation [P24]		With post preparation [P72]		Comparison NP-P24-P72[c]
		x[a]	sd[b]	x[a]	sd[b]	x[a]	sd[b]	
S1	EndoFill® [E]	32.99	12.67	30.83	4.84	34.82	6.68	0.389
	AH Plus® [A]	27.58	4.84	30.09	9.68	30.81	9.60	0.825
	Comparison E-A[d]	0.473		1.000		0.257		
S2	EndoFill® [E]	4.38♥	5.72	4.91♠	5.35	6.21☺	7.96	0.936
	AH Plus® [A]	2.42♣	3.62	2.12♦	4.54	1.57☻	4.97	0.244
	Comparison E-A[d]	0.741		0.214		0.085		
S3	EndoFill® [E]	0.40♥	1.26	0.86♠	1.84	0.77☺	2.03	0.595
	AH Plus® [A]	0.47♣	1.47	0.00♦	0.00	0.00☻	0.00	0.368
	Comparison E-A[d]	0.942		0.068		0.147		
Comparison EndoFill® S1-S2-S3[c]		<0.001		<0.001		<0.001		
Comparison AH Plus® S1-S2-S3[c]		<0.001		<0.001		<0.001		

a: arithmetical mean.
b: standard deviation.
c: Kruskal-Wallis test.
d: Mann-Whitney U test.
Values linked by ♥♣♠♦☺☻ did not significantly differ.

RESULTS

ANOVA analysis of the influence of the apical section, sealer type (AH-Plus® or EndoFill®) and post space preparation on the leakage revealed that the interaction among the three factors was not statistically significant (p=0.578). After excluding this interaction, the three second-order interactions were significant in the final model.

The independent effect of each factor on the leakage is shown in the Table 1. In all groups, leakage was higher in the S1 section and considerably lower in S2, whereas there was virtually no leakage in S3, at 3 mm from the apex. The overall comparison of the leakage among the different apical sections showed significant differences (p<0.001) with both sealers in the three preparation groups (NP/P24/P72). However, paired comparisons showed no significant differences between S2 and S3 in any group.

There were lower leakage levels with AH-Plus® versus EndoFill®, although no significant differences between them were found when each section type (1, 2 or 3) or post space preparation group was studied.

DISCUSSION

In restorations of endodontically treated teeth, spaces for any posts required are usually made with a rotary instrument at a subsequent visit after the complete curing of the sealer (15,16). These procedures can compromise the apical seal, producing bacterial leakage and failure of the restoration (17). In the present study, post space preparation did not affect the apical seal quality, which did not differ from that in groups without this space preparation. These results are in agreement with findings by other authors using various methodologies (13,18,19) and leaving different lengths of apical remnant ranging from 3 to 7 mm. In the clinical setting, it is frequently necessary to leave a minimal remnant of gutta-percha to increase post retention, and a remnant of 3 mm was selected for this study, since a remnant of shorter length has been reported to produce an unpredictable seal (3). The sealing capacity of the endodontic sealers used appears to have influenced the preservation of the apical seal. Although statistical significance was not reached, a lower percentage of leakage was found using AH-Plus® versus EndoFill® sealer in almost all of the groups, consistent with the results of some authors (5-8,20-22) who found lower leakage with epoxy resin-based versus zinc oxide-eugenol sealers.

The most widely used methodology to assess dye leakage is the longitudinal sectioning of samples, expressing the measurement in linear millimetres, the disadvantage of this techniques is that only the visible dye is measured (11) and the total leakage of the sample cannot be assessed from a single section. The use of cross-sections (21,23-25) yields a more accurate quantification of leakage.

Section 1 showed a significantly higher (p<0.001) percentage leakage compared with S2 and S3. There were no differences between sections S2 and S3, indicating that the post space preparation had no effect on the apical seal under these experimental conditions.

Solano et al. (11) found significantly less leakage when the post space was prepared at the time of obturation than when it was prepared at one week after obturation, since the sealer is still within its working time when the gutta-percha is removed and defects can be remedied. In the present study, post space preparation was performed after complete setting of the cement, in accordance with usual clinical practice.

Post space preparation has been reported to reduce the sealing capacity of apical endodontic obturating material, increasing the possibility of leakage in a corono-radicular direction (1). According to the present findings, apico-coronal leakage is not affected, since significant leakage was only found in the most apical slices (S1) and not in the sections that would theoretically be more affected by post space preparation, i.e., S2 and S3. However, it must be taken into account that only 3 mm of gutta-percha was left, implying a high risk of corono-apical leakage. It is important to minimize the risk of bacterial contamination of the post space, and the post should therefore be cemented immediately after preparation of the space and the definitive restoration should follow as rapidly as possible (26).

Comparison of the present results with other analyses of sealing capacity is hindered by the absence of a standardized methodology, which has led to contradictory findings. Finally, the demonstration of a good seal in vitro must be confirmed by a corresponding in vivo study.

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