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ORIGINAL ARTICLE

Comparison of Apical Sealing of Two Canal Sealers between Immediate versus Delayed Post Space Preparation

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Abstract

The effect of post space preparation on the sealing ability of a root canal filling is important because the sealer is crucial for preserving the apical seal. The question of how, when, and how much of the gutta-percha should be removed is a debate when preparing a post space. This study is aimed to compare the effect of immediate versus delayed post space preparation on the apical seal using AH Plus and EndoREZ sealers. Forty four single rooted teeth were prepared using the step-back technique and were obturated with combinations of gutta-percha/AH Plus and gutta-percha/EndoREZ using the lateral compaction technique. Four teeth were used as positive/negative controls. After the teeth were divided randomly into six groups, post spaces were prepared either immediately after filling or after storage of the obturated teeth in saline at 37°C for one week. The post space preparation procedure was performed using hot pluggers or Gates Glidden drills leaving a 5 mm of root canal filling in the apical part. Leakage was determined by a computerized fluid-filtration device. Immediate and delayed post space preparation of the gutta-percha/AH Plus groups had mean leakage values of 4.97 µl.cmH2O.min-1.10-4 and 4.94 µl.cmH2O.min-1.10-4, respectively. The respective mean leakage values of immediate and delayed post space preparation of the gutta-percha/EndoREZ groups were 4.97 µl.cmH2O.min-1.10-4 and 5.57 µl.cmH2O.min-1.10-4. The mean leakage value obtained in the positive control group was 398.16 µl.cmH2O.min-1.10-4, whereas there was no fluid filtration in the negative control group. Better sealing was achieved in the gutta-percha/AH Plus delayed group in comparison to the other groups. Delayed post space preparation in the gutta-percha/EndoREZ group showed the highest percentage of leakage.

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Introduction

The objectives of modern endodontic therapy are to clean and shape the root canal system by removing all organic material and to seal the system three-dimensionally in order not to allow any leakage (1, 2). Due to the caries and access cavity preparation, endodontically treated teeth sometimes need to be restored with post-core and crown restorations. The effect of post space preparation on the sealing ability of a root canal filling has been evaluated and discussed widely in the dental literature. Gutta-percha removal techniques, immediate or delayed preparation, amount of remaining root canal filling, type of sealer, and obturation techniques used have been the subject of these investigations concerning post space preparation (3, 4 ,5, 6). During the preparation of the post space, it is important not to disrupt the integrity of the apical seal. There has been much debate as to how, when, and how much of the gutta-percha should be removed when preparing a post space. Different methods, including heated instruments, Gates Glidden drills, piezo reamers, hand instruments, and solvents in combination with these instruments, have been used to remove the gutta-percha in preparation of a post space (7). The required post space may be prepared either immediately after the completion of the endodontic procedure using hot pluggers or alternatively at a later session after a full setting of the sealer using rotary instruments (8, 9, 10). Immediate removal of the coronal part of a root canal filling by hot pluggers often requires a modification in the canal preparation allowing the insertion of the desired plugger to the predetermined length. This procedure can be performed by the same operator under rubber dam just following the obturation of the root canal using the same aseptic conditions. An additional advantage of this protocol is that the condensation of the remaining gutta-percha filling can be assessed and improved if necessary. Additionally, the familiarity of the operator with the root canal system minimizes the risk of perforation or stripping.

Yet the common procedure is late removal of the coronal part of the root canal filling performed at a subsequent visit (9,10). The procedure is usually performed using rotary instruments such as Gates Glidden drills, with or without a gutta-percha solvent. This procedure is usually performed in conditions similar to those used

in general restorative dentistry, rubber dam isolation is rather uncommon.

Metzger et al. demonstrated the sealing to be proportional to the length of the remaining root canal filling (11). Five millimetres of obturation material is considered as a safe margin (12). In many clinical situations, however, a smaller remnant has to be left in order to increase the post retention, thereby compromising the apical seal. Although some authors considered 3 mm as the minimum acceptable remnant to preserve the seal, Abramovitz et al. reported that a reduction of filling to 3 mm produced an unpredictable seal (12, 13). In these situations, the sealer becomes crucial for preserving the apical seal.

Resin based root canal sealers have been used for many years with clinical success (14). AH Plus (Dentsply De Trey, Konstanz, Germany) is an epoxy-amine resin sealer that has recently gained popularity among clinicians. EndoREZ (Ultradent, South Jordan, UT, USA) is a dual-cured methacrylate resin-based root canal sealer designed to bond to resin-coated gutta-percha for creating adhesion between intraradicular dentin and the root canal filling (15). The increased hydrophilicity of EndoREZ significantly enhanced its penetration into dentinal tubules that are rendered patent via the recommended use of ethylenediaminetetraacetic acid (EDTA) as the final rinse (16). However, creation of long, unbonded resin tags alone is unlikely to provide sufficient adhesive strength to resist the polymerization shrinkage of a comparatively thick sealer layer that is associated with the use of a single resin-coated master cone, or with the passive placement of additional accessory cones (17). Pulling of resin sealer tags out of the tubules during polymerization shrinkage of the sealer may create gaps along the sealer-dentin interface that could account for the reported suboptimal seal of the EndoREZ system (18).

The apical leakage of the endodontic sealers has been measured by degree of dye/radioisotope/bacterial penetration, by electrochemical means, or by scanning electron microscopy (19, 20, 21, 22, 23, 24).

The purpose of this study was to compare the effect of immediate versus delayed post space preparation on the apical seal using AH Plus and EndoREZ sealers by a fluid filtration model first described by Derkson et al. in 1986 and revised by Wu et al. in 1993 (25, 26).

Materials and Methods

A total of 44 mandibular premolars with single straight root canals were used in this study. Roots with open apices, cracks, and resorptive defects were excluded. Teeth had been cleaned carefully with curettes to remove any remnant of soft tissue and stored in saline solution. The coronal portions were removed using highspeed diamond burs with air-water spray coolant to obtain a uniform remaining root length of 15 mm. The working length was established as 1 mm short of the apex by placing a size 15 K-file (Kerr, Romulus, MI, USA) into each root canal until the tip of the file was visible at the tip of the apical foramen. The canal systems were filed up to master apical file size 40 by using the step-back technique. The root canals were irrigated with 10 ml of 5.25% NaOCl after the use of each file throughout the preparation. The coronal one-third of the roots was flared up to a size 3-4 Gates Glidden drills (Dentsply, Maillefer, Switzerland) with a low-speed handpiece. The root canals were then irrigated with 10 ml of 17% aqueous solution of EDTA (Canal+, Septodont, France) for 5 minutes followed by irrigation with 10 ml of 5.25% NaOCl. Finally, the root canals were flushed with 3 ml of saline solution and dried with paper points. The teeth (n=44) were divided randomly into 6 groups; 10 teeth in groups A1, A2, E1, E2 and 4 teeth in positive/negative control groups. In groups A1 and A2, root canals of 10 teeth were obturated by lateral compaction using gutta-percha and AH Plus sealer. In groups E1 and E2, the root canals were obturated by lateral compaction using gutta-percha and EndoREZ. In group A1 and E1, the post spaces were prepared using a heated instrument and Gates Glidden drills at 9000 rpm to a depth that left 4 mm of gutta-percha apically immediately following obturation. In groups A2 and E2, following the storage of the teeth in saline solution at 37°C for 1 week after obturation, the post spaces were prepared in the same manner as mentioned for groups A1 and E1. Two groups each consisting of 2 teeth were used as positive and negative controls. The control groups were instrumented with no obturation material in the canals. However, the teeth in negative control group were coated with 2 layers of nail varnish.

The apical portions of the roots were inserted into a plastic tube and connected to 18-gauge stainless steel tube. The cyanoacrylate adhesive (Zapit, Dental Venture of America Inc., Anaheim Hills, CA, USA) was applied circumferentially between the root and the plastic tube. The computerized fluid filtration meter with a laser system, which had a 25-µl micropipette (Microcaps, Fisher Scientific, Pittsburgh, PA, USA) mounted horizontally, was used in this study. O2 from a pressure tank of 120 kPa (1.2 atm) was applied to the apical side. The pressure was kept constant throughout the experiment by means of a digital air pressure regulator connected to the pressure tank. The 25-µl micropipette was connected to the pressure reservoir by polyethylene tubing (Microcaps, Fisher Scientific, Pittsburgh, PA, USA). All pipettes, syringes and the plastic tubes at the apical side of the sample were filled with distilled water. The water was sucked back approximately 2 mm with the microsyringe. In this way, an air bubble created in the micropipette was adjusted to a suitable position in the syringe. A 5-min pressurization preload of the system was completed before taking readings. The fluid movement was measured automatically for 2 min during the 8 min for each sample using the PC-compatible software (Fluid Filtration'03, Konya, Turkey). The leakage quantity was expressed as µl.cmH2O.min-1 at 1.2 atm and the means were calculated.

Statistical analysis was performed using NCSS (Number Cruncher Statistical System) 2007&PASS 2008 Statistical Software (Utah, USA) using Kruskal Wallis test, at the 5% significance level.

Results

On the basis of the results of this study; for group A1 and group A2, mean leakage values of 4.97 µl.cmH2O.min-1.10-4 and 4.94 µl.cmH2O.min-1.10-4 were calculated, respectively (Table 1). Group E1 had a mean leakage value of 4.97 µl.cmH2O. min-1.10-4; whereas group E2 showed a mean leakage value of 5.57 µl.cmH2O.min-1.10-4 (Table 1). The mean leakage value obtained in the positive control group was 398.16 µl.cmH2O.min-1.10-4 and there was no fluid filtration in the negative control group.

Better sealing was achieved in group A2 in comparison to the other groups. Group E2 showed the highest percentage of leakage.

Table 1. Mean leakage values ($\mu l.cmH_2O^{-1}.min^{-1}x\ 10^{-4}$) and standard deviations (SD) of groups

Groups	Leakage Mean ± SD	*p*
A1	4.97 ± 0.15	
A2	4.94 ± 0.14	
E1	4.97 ± 0.22	
E2	5.57 ± 0.12	*0.867*

Discussion

In this in vitro study, the effect of immediate versus delayed post space preparation on the apical seal using AH Plus and EndoREZ sealers was tested by a fluid filtration model.

Leakage can be measured with greater sensitivity with this method compared to dye penetration along the root canal (26). Fluid filtration method suggests pathways between the coronal and the apical ends of a root filling and indicates the diameter and length of the void, rather than only the length (27). The fluid transport model is an example of an active pressure leakage assay that does not require the sacrifice of the tested specimen. Furthermore, it allows repeated measurements of the same specimen, before as well as after procedural manipulation, diminishing the effect of variables such as anatomical variations that may otherwise influence the results (28). In this respect, the roots were in the same length in all teeth to minimize anatomic variations and to obtain standardized leakage measurements.

For restorative procedures of endodontically treated teeth, post spaces are usually prepared with rotary instruments at a subsequent visit after the complete curing of the sealer (9,10). These protocols may compromise the apical seal, producing bacterial leakage and failure of the restoration (29). In the clinical setting, it is frequently necessary to leave a minimal remnant of gutta-percha to increase post retention. In this study, 4 mm of gutta-percha was left in the apical parts of the root canals as Abramovitz et al. (12) reported leaving 3 to 6 mm of gutta-percha was sufficient to maintain an apical seal. However, in a study by Metzger et al. (11), leaving less than 7 mm of gutta-percha apically was demonstrated to diminish the quality of the apical seal and it was concluded that the sealing was proportional to the length of the remaining filling.

The results of the present study indicated that both of the tested root canal sealers resulted in some degree of leakage. Although not statistically significant, a lower percentage of leakage was found using AH Plus versus EndoREZ sealers.

On the other hand, the mean values obtained in the immediate preparation groups of both sealers were similar. This similarity may be due to the result of the setting times of the sealers.

The results of this study were in agreement with those of Madison and Zakariasen, and Abromovitz et al. (3,30) suggesting that there were no statistically significant differences between immediate versus delayed post space preparations.

The scope of this study does not respond to the question as to why there is more leakage when preparation of the post space is delayed by using EndoREZ. One possible hypothesis is that when the post space is prepared at the time of obturation, the sealer does not form a lasting bond to the gutta-percha or root canal wall (31). When the heated instrument or rotary instrument is introduced into the canal to remove the gutta-percha, the sealer is still within its working time and allows the sealer to set without introducing micro-fractures where the sealer is in contact with the gutta-percha and root canal wall. When the sealer is set during delayed post space preparation, it is possible that the rotational forces of the Gates Glidden drill cause movement of the gutta-percha and thus break the bond at the sealer interface.

As a conclusion of this study, AH Plus sealer results in less apical leakage compared to EndoREZ both in immediate and delayed post space preparations.

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