Effect of Immediate and Delayed Post Preparation on Apical Microleakage by Using Methacrylate-based EndoREZ Sealer with or without Accelerator

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Abstract

The purpose of this study was to evaluate the effect of immediate and delayed post space preparation on the apical sealing ability of EndoREZ, a methacrylate-based dual-cured resin sealer, with or without accelerator. Fifty extracted human teeth were endodontically prepared and randomly divided into 6 groups. Teeth in experimental groups 1, 2, 3, and 4 (n = 10) were filled with resin-coated gutta-percha and either EndoREZ with accelerator (A+) or EndoREZ without accelerator (A−) by the lateral compaction technique. In group1 (A+) and group2 (A−), the post space was prepared immediately at the time of obturation. In groups 3 (A+) and 4 (A−), the post space was prepared after storage in 100% humidity at 37°C for 1 week. Groups 5 and 6 (n = 5) represented positive and negative control groups, respectively. Leakage was determined by computerized fluid filtration device. Complete leakage was observed in group 5, and no leakage was evident in group 6 ($P = 1.000$). In experimental groups, mean apical microleakage values ($\mu L/cmH_2O/min^{-1}$) were as follows: group 1, 2.77 ± 0.79^a; group 2, 2.88 ± 1.38^a; group 3, 19.95 ± 7.85^c; group 4, 6.20 ± 2.09^b (different letters indicate significantly different groups, $P < .005$). Immediate post space preparation achieved better sealing than delayed post preparation at the apical end, regardless of whether the EndoREZ accelerator was used. There was no significant difference between the (A+) and (A−) in immediate post space preparation. However, more leakage was found when using (A+) than (A−) in delayed post preparation. Under the conditions of this study, it was concluded that EndoREZ accelerator seems not to provide clinicians with any advantage for rapid transition from endodontic treatment to post-endodontic restorative procedures immediately after completion of root canal therapy. *(J Endod 2008;34:1504–1507)*

Key Words

Accelerator, methacrylate-based sealer, microleakage, post preparation

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Endodontically treated teeth with insufficient coronal tooth structure generally require radicular posts to assist in restoring the tooth to function. The required post space might be prepared immediately after completion of the endodontic treatment or at a later stage after full setting of the sealer. But during the preparation of the post space, it is important not to disrupt the integrity of the apical seal.

In terms of post space preparation, gutta-percha removal techniques, immediate or delayed preparation, the amount of root canal filling remaining, the type of sealer, and obturation techniques used have been the subject of investigation (1–6). In light of these studies, it would be wise to seal the apical portion of the root canal as well as the available materials allow. Gutta-percha has remained the material of choice to obturate the apical portion of the root canal with different types of sealers in post-restored teeth. Endodontic sealers are materials that work as luting and sealing agents in root fillings and should therefore have properties that prevent the contact of oral cavity irritant with periapical tissues (7). Consequently, the kind of sealer used seems to be a possible factor affecting potential microleakage (2). Various studies have been performed to evaluate the effect of different root canal sealers and/or immediate-delayed post preparation on apical sealing (2, 6–17). But it seems that no clear consensus has been reached in the endodontic community on the suitable post preparation time related to used root canal sealer.

EndoREZ (Ultradent Products, Inc, South Jordan, UT) is a dual-cured resin sealer that is based on the urethane dimethacrylate (UDMA) molecule, similar to many restorative resins. The clinical and radiographic evaluation by Zmener and Pameijer (18) indicated that the use of EndoREZ as a sealer constituted a potential promising alternative to conventional sealers.

Clinically, the ideal time needed for the sealers to set should be neither too fast nor too slow (19). Depending on the type of sealer and the experimental technique, a wide range of setting times has been recorded (20, 21). Recently, EndoREZ accelerator has become available, which facilitates rapid cure of EndoREZ in the canal in 4–6 minutes, as compared with 20–30 minutes. Because an extended setting time might facilitate the leakage and material dislodgement during the post space preparation, it might be a useful procedure to accelerate the setting of EndoREZ when it is used as a root canal filling material together with gutta-percha before post space preparation. Also, it can enable a clinician and patient to avoid a second recall appointment to finish restorative work. EndoREZ accelerator might only be used with EndoREZ. In other words, EndoREZ accelerator is only compatible with EndoREZ. According to the manufacturer, the release of EndoREZ accelerator makes EndoREZ the only self-priming, hydrophilic, and biocompatible endodontic sealer system available with a fast-polymerizing accelerator component. Delivery is accomplished by dipping either accessory gutta-percha or resin-coated gutta-percha cones into the accelerator followed by harpooning these cones into the as yet unpolymerized EndoREZ, thus accelerating polymerization. Furthermore, a reduced volume of EndoREZ is subjected to less polymerization shrinkage, which will benefit the seal. However, there is no research related to this subject yet. For this reason, the purpose of this study was to evaluate the effect of immediate and delayed post space preparation on the apical sealing ability of EndoREZ with or without accelerator.

Materials and Methods

A total of 50 maxillary anterior human teeth with single straight root canals were used for the study. Teeth were cleaned carefully with curettes to remove any remnant of soft tissue and were stored in saline solution. In an attempt to standardize the length of

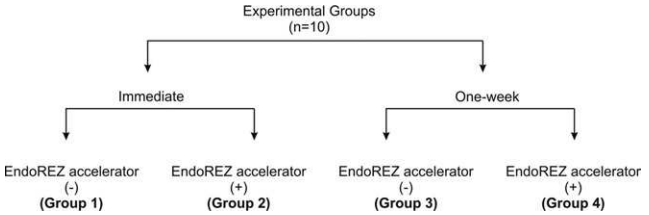

Figure 1. Experimental design.

canal involved in the experiment, similar root segments were used, with a length of approximately 17 mm. Canal patency was determined by passing a size 10 K-file (Kerr, Romulus, MI) through the apical foramen. Working lengths were established 1.0 mm short of the apical foramen, and the roots were instrumented by using ProFile .06 taper Series 29 rotary instruments (Tulsa Dental Products, Tulsa, OK). The same operator instrumented all the teeth to the same size. The canals were enlarged to a diameter of 0.465 mm (#7) at the apical stop, with patency assured by periodic recapitulation with a size 10 K-file. During instrumentation, canals were irrigated with 1 mL of 5.25% NaOCl after each file. On completion of instrumentation, to remove the smear layer, the root canals were irrigated with 10 mL of 17% ethylenediaminetetraacetic acid followed by 10 mL of 5.25% NaOCl. Each solution was applied for approximately 3 minutes. All irrigating solutions were delivered via a 23-gauge needle inserted as far as possible into the canal without binding. The samples were then randomly divided into 6 groups, 2 of which were control groups; the treatment allocations are shown in Fig. 1.

Groups 1 and 3

EndoREZ with laterally compacted gutta-percha technique was used for obturation. The canal was dried with only 1 paper point for 2–3 seconds only for maximum tubule penetration of EndoREZ. A 0.02 taper EndoREZ point master cone was fitted to desired length with tug-back. Then the cone was removed. The sealer was loaded into a plastic syringe equipped with a 30-gauge NaviTip needle (Ultradent). The tip of the needle was inserted into the canal to within 2–3 mm from the working length and was slowly back-filled with the sealer until it reached the coronal third. The prefitted EndoREZ point master cone was inserted and seated to working length. A finger spreader was then inserted into the canal to a level that was approximately 1–2 mm short of the working length. Lateral compaction with accessory 0.02 taper resin-coated gutta-percha cones was performed until the entire canal was obturated.

Groups 2 and 4

In these groups, the filling technique was the same as that in groups 1 and 3, but EndoREZ was used together with accelerator. Mixed EndoREZ was introduced into the root canal via a 30-gauge NaviTip needle. The master cone was inserted and seated to working length. Then with a size 25 accessory cone, the cone was fully dipped in the EndoREZ accelerator vial. This cone was inserted into canal as far as it would go, and then usual lateral condensation procedures were continued.

Groups 5 and 6

These groups represented positive and negative control groups, respectively. Five unfilled root segments were used as positive controls to test the maximum fluid flow of the fluid filtration system through the root canals. Five filled root segments were used as negative controls to test the intrinsic leakage of the fluid filtration system. They were filled as in groups 1 and 3 and dipped in molten sticky wax and further covered with nail varnish.

In groups 1 and 2, the post space preparation was performed 7–8 minutes after the obturation by using a hot plugger of a predetermined size. The root canal filling removal was carried to the working length minus 5 mm. The quality of the remaining filling was checked by a finger spreader. The remaining root canal filling was then vertically condensed by using a cold plugger. The teeth were radiographed to confirm that the procedure resulted in a 5-mm root canal filling in the apical part of the canal. In groups 3 and 4, the canal orifices were filled with Cavit-G (ESPE, Seefeld, Germany). In this way, the sealer was allowed to fully set for 1 week at 37°C at 100% humidity followed by root canal filling removal to the same length as in groups 1 and 2 by using a hot plugger.

Leakage was determined by computerized fluid filtration device.

Measurement of Sealing Properties

Apical sealing ability of EndoREZ with or without accelerator in both immediate and delayed post space preparations was measured by using the computerized fluid filtration method described by Cobankara et al. (22). Measurements of fluid movement were automatically made at 2-minute intervals for 8 minutes for each sample by means of PC-compatible software. Leakage quantity was expressed as hydraulic conductance (Lp) ($\mu l/cmH_2O/min^{-1}$). Between the readings, the samples were stored in isotonic saline solution with 0.2% sodium azide to inhibit bacterial growth.

Statistical Analysis

A two-way analysis of variance (ANOVA) was used (accelerator and time as the 2 factors) to analyze the data for significant differences. Kruskal-Wallis one-way ANOVA and Mann-Whitney *U* tests were used to analyze the differences among the Lp values of EndoREZ with or without accelerator for each time period. For both EndoREZ with accelerator and EndoREZ without accelerator, the difference among the Lp values of 2 of them according to 2 time periods was analyzed with the Wilcoxon signed rank test. The confidence level used was 95% ($P < .005$).

Results

A summary of apical microleakage data in all experimental groups is depicted in Table 1.

The samples in group1 exhibited a mean leakage ($\mu L/cmH_2O/min^{-1}$) of 2.77 ± 0.79. The samples in group 2 showed a mean leakage of 2.88 ± 1.38. In group 3, samples showed a mean leakage of 19.95 ± 7.85, and in group 4, samples exhibited a mean leakage of 6.20 ± 2.09.

Statistical analysis revealed that immediate post space preparation (groups 1 and 2) achieved better sealing than delayed post preparation (groups 3 and 4) at the apical end, regardless of use of the EndoREZ accelerator ($P < .005$). There was no significant difference between the EndoREZ with and without accelerator (groups 1 and 2) in immediate post space preparation ($P > .005$). However, more leakage was found when using EndoREZ with accelerator than EndoREZ without accelerator (groups 3 and 4) in delayed post preparation ($P < .005$).

Complete leakage was observed in group5 (positive control), and no leakage was evident in group 6 (negative control) ($P = 1.000$).

TABLE 1. Apical Microleakage Values of EndoREZ Sealer with and without Accelerator in Both Immediate and after 1-week Post Space Preparations

Groups (n = 10)	Mean ± Standard Deviation, Lp ($\mu L/cmH_2O/min^{-1}$
1: EndoREZ A(−) immediate	2.77 ± 0.79[a]
2: EndoREZ A(+) immediate	2.88 ± 1.38[a]
3: EndoREZ A(−) 1-week	19.95 ± 7.85[c]
4: EndoREZ A(+) 1-week	6.20 ± 2.09[b]

The means with same superscripts in the same column are not statistically different at $P < .005$.
A(+) = with accelerator; A(−) = without accelerator.

Discussion

In the literature, controversial results exist on the manifestation of leakage after post placement. Whereas some authors demonstrated there was no difference in leakage between immediate and delayed post space preparation (3, 10, 13), others reported that immediate removal of gutta-percha resulted in less leakage when compared with delayed removal (2, 8, 9, 12, 15). In the present study, immediate post space preparation provided better sealing than delayed post preparation at the apical end, regardless of using the EndoREZ accelerator.

In the current study, there was no significant difference between the EndoREZ with and without accelerator in immediate post space preparation. In these groups (groups 1 and 2), the post space preparation was performed 7–8 minutes after the obturation. Because accelerated EndoREZ has a 4- to 6-minute setting time, one possible hypothesis is that when the post space is made at the time of obturation, the sealer might not still have formed a lasting bond to the EndoREZ point or canal wall. When the heated instrument was introduced into the canal to remove the gutta-percha, the sealer was still within its working time and allowed the sealer to set without introducing microfractures where the sealer was in contact with the EndoREZ point and canal wall. Therefore, there might not be differences between EndoREZ with or without accelerator in immediate post space preparation.

The scope of this study did not answer the question of why there is more leakage when preparation of the post space is delayed. But it was an interesting result that more leakage was found when using EndoREZ with accelerator than when using EndoREZ without accelerator in delayed post preparation. When the sealer is set during delayed post space preparation, it is possible that the compressive forces of the hot plugger causes movement of the gutta-percha, thus breaking the bond at only the accelerated EndoREZ interface and not that of EndoREZ. In addition, accelerant might be adversely affecting the sealing property of EndoREZ, because it is not known whether altering its makeup would change the physical properties of EndoREZ. A change in that property, possibly leading to more shrinkage, would likely have a negative impact on EndoREZ's sealing ability because polymerization shrinkage stresses developed along the root dentin-sealer interface might result in debonding of the sealer (23). Furthermore, these stresses are exacerbated inside the root canal because the bonding area is high relative to the volume of canal filling materials; canal walls cannot compensate for shrinkage stresses by elastic deformation (24). Hammad et al. (25) also stated that shrinkage strain associated with setting might jeopardize the seal of the root canal, leading to root canal failure.

The manufacturer recommended that the root canal walls be kept moist, not dehydrated, to take maximum advantage of the hydrophilic properties of the EndoREZ, thus allowing for resin sealer tag penetration. Zmener et al. (26) also found that the moisture condition of root canals at the time of obturation had a significant effect on microleakage of root canals filled with resin-coated gutta-percha/EndoREZ. Therefore, in the present study, the canals were dried with only 1 paper point for 2–3 seconds only for maximum tubule penetration of EndoREZ. But pulling of resin sealer tags out of the tubules during polymerization shrinkage of the sealer might create gaps along the sealer-dentin interface that could have accounted for the reported suboptimal seal of the EndoREZ system (27–29). In EndoREZ with accelerator, this gap formation might be too much because of fast polymerization. In addition, the accelerator addition to EndoREZ might have altered the chemical composition of the EndoREZ in negative manner. Also, because the material is delivered passively by using a dipped accessory cone as a carrier, another possible explanation is that the EndoREZ accelerator might not be conducive to the lateral compaction obturation method.

EndoREZ can be used with gutta-percha or with resin-coated EndoREZ point. However, the resin-coated gutta-percha cone is recommended for use with EndoREZ (30). According to the manufacturer, EndoREZ points are specifically designed to bond chemically to EndoREZ, resulting in a tight seal in the canal between gutta-percha, EndoREZ, and dentin. In addition, EndoREZ points form a 3-fold interface between the dentin, resin, and gutta-percha core. Therefore, we used the resin-coated EndoREZ point instead of the classic gutta-percha point in the presented study.

Within the limits of this study, EndoREZ accelerator seems not to provide the clinician with any advantage for rapidly transitioning from endodontic treatment to post-endodontic restorative procedures immediately after completion of root canal therapy. Future studies are indicated to investigate the influence of the accelerator on the long-term sealing ability of EndoREZ.

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