Original Article

Retreatability of Root Canals Obturated using Mineral Trioxide Aggregate-based and Two Resin-based Sealers

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Abstract

Background: The aim of this study was to compare the retreatment time and the removal efficiency of different root canal sealers using WaveOne Gold reciproc file system by measuring required time. **Materials and Methods:** Forty-five mandibular premolars were prepared and randomly divided into three groups (n = 15). In Groups 1–3, the canals were filled with gutta-percha and mineral trioxide aggregate (MTA) Fillapex, EndoREZ, and AH26, respectively. After 7 days, root canal filling materials (RCFM) were removed with WaveOne Gold reciproc files by measuring time. Teeth were grooved and sectioned longitudinally, then remaining RCFM was evaluated using digital camera. The images were transferred to image analysis software to measure the areas of remaining RCFM. Data were analyzed using one-way analysis of variance and Tukey's test (α = 0.05). **Results:** There was a statistically significant difference between groups according to time required for removing RCFM ($P < 0.05$). The time required for removing RCFM was significantly shorter in Group 1 and longer in Group 3 than the other groups ($P < 0.05$). In Group 1, the remaining RCFM was more than other groups at middle third ($P < 0.05$), but there was no statistically significant difference between groups at coronal and apical thirds ($P > 0.05$). **Conclusions:** None of the sealers evaluated in this study could completely be removed from the root canals. MTA-based sealer was removed faster than resin-based sealers.

Keywords: *Mineral trioxide aggregate, reciproc file, retreatment, root canal filling, sealers*

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Introduction

The primary reason for an endodontic failure is the persistence or regrowth of bacteria within the root canal system.[1] The endodontic failure cases can be treated in three ways: nonsurgical retreatment, surgical retreatment, or extraction. Among all these treatment alternatives, nonsurgical retreatment should be considered as the first choice of treatment.[2] Nonsurgical retreatment procedures require complete removal of the root canal filling materials (RCFM), followed by further shaping, cleaning, disinfection, and reobturation to reestablish healthy periapical tissues.[3] Different techniques have been proposed for the removal of RCFM from the root canal system, including the use of hand files, Gates Glidden burs, nickel-titanium (Ni-Ti) rotary and reciprocating instruments,[4] heat pluggers,[5] ultrasonic instruments,[6] and lasers,[7] with or without the use of adjunctive solvents.[8] Instruments with reciprocating motion were initially developed for root canal preparation. However, due to their flexibility and high resistance to cyclic fatigue, these files are new alternatives for filling material removal during endodontic retreatment.[9] Recently, WaveOne Gold reciproc file system has become available in the market and there is limited data about it.

One of the properties of ideal root canal sealer is easy removability from root canals when it is

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necessary. AH26 is one of the most common epoxy resin-based sealer, which is claimed to provide good sealing properties.[10] EndoREZ is a new hydrophilic, urethane-dimethacrylate (UDMA) resin-based sealer. The UDMA resin-based sealer is purportedly bondable to both dentin and the gutta-percha for the establishment of a tight seal.[11] One of its prime characteristic properties is high hydrophilicity, allowing the penetration of the material into the dentinal tubules.[12] Due to good biological and sealing properties of mineral trioxide aggregate (MTA), MTA-based root canal sealers have been introduced. MTA Fillapex is a radiopaque, insoluble sealer that apart from MTA, is composed of resins, radiopaque bismuth, nanoparticulated silica, and pigments. The required setting hydration is taken from surrounding dentin.[13]

The aim of this study was to compare the removal efficiency of three different root canal sealers (AH26, EndoREZ, MTA Fillapex) from root canals using WaveOne Gold reciproc file system by measuring required time. The null hypotheses tested are that no statistically significant differences between retreatability of groups and required time during removing RCFM.

Materials and Methods

This study was approved by Ethics Committee of Ankara University Faculty of Dentistry, Turkey, in accordance with the Declaration of Helsinki (Reference number: 36290600/33). Forty-five freshly extracted human mandibular premolars with straight and single root canals were stored in 1% thymol solution until used. Calculus and soft tissue remnants were removed with ultrasonic tips. The root surface and apical portion of each tooth were examined for the absence of fractures and the presence of a mature apex under a dental loupe (Carl Zeiss, Jena, Germany) at ×4 magnification. The teeth were evaluated by obtaining mesiodistal and buccolingual digital radiographs to determine that they had only one straight noncalcified root canal. The crowns of teeth were removed with a water-cooled, diamond disc to form standardized root samples with 15 mm lengths.

A #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was inserted in the canal until it was visible at the apical foramen and the working length (WL) was determined by subtracting 1 mm from this measurement. The root canals were prepared using WaveOne Gold reciproc file system (Dentsply Maillefer) to a size 35.06 according to the manufacturer's instructions. Syringe irrigation with 2 mL of 2% sodium hypochlorite (NaOCl) solution was performed during preparation. The prepared canals were dried with paper points and randomly divided into three groups (n = 15). In Groups 1–3, the canals were filled with single-cone gutta-percha and MTA-based sealer (MTA Fillapex, Angelus, Londrina, Brazil) and resin-based sealers ([EndoREZ, Ultradent Products Inc., South Jordan, USA], [AH26, Dentsply Maillefer, Tulsa, USA]), respectively. The access of canals was sealed with glass ionomer cement and the specimens were stored at 37°C in 100% humidity for 7 days. Then, the temporary filling material was removed and WaveOne Gold 25, 35, 45 were used to remove the RCFM. WaveOne Gold 45.06 was used to reach the WL until no debris could be seen on the file. During removing RCFM, the root canals were constantly irrigated with 2% NaOCl. The time required for removing RCFM with using the files was recorded with a chronometer in seconds excluding the time for file change and irrigation. To reduce interoperator variability, a single operator carried out all root canal instrumentation and the removing procedure. Teeth were grooved buccolingually with a diamond disc and root halves were gently removed with light pressure using chisel. Root halves were marked sectionally (coronal, middle, and apical thirds). All root halves were photographed with a digital camera (EOS 70D, Canon USA Inc., Lake success, NY, USA) and macro ring lite (MR-14EX II, Canon USA Inc.,). Assessment of the remaining RCFM was performed by transferring the images to specific imaging software (Adobe Photoshop CS 6, San Jose, California, USA) used to determine the mean percentage of remaining RCFM. The mean percentage of remaining RCFM was expressed as the ratio between filling materials and the total area of root canal third. Throughout the evaluation process, the blind observer evaluated the specimens.

Statistical analysis was performed with SPSS 16.0 software (SPSS Inc., Chicago, IL, USA). Data of the mean percentage of remaining RCFM for each group and each one-third segment and the time required for removing RCFM were analyzed using one-way analysis of variance and Tukey's test. Significance level was set at $P < 0.05$.

Results

Mean percentage of remaining RCFM and mean time required for removing RCFM were presented in Table 1. Regarding the mean time of removing RCFM, there was a statistically significant difference between the groups ($P < 0.05$). The time required for removing RCFM was significantly shorter in Group 1 and longer in Group 3 than the other groups ($P < 0.05$).

Regarding the percentage of remaining RCFM, all tested groups exhibited some remaining RCFM within the root canal halves [Figure 1]. Within the intergroup comparisons, there was no statistically significant

Table 1: Mean and standard deviations of the remaining root canal filling materials (%) and time required for root canal filling materials (s)

Groups	Remaining RCFM (%)			Time required for RCFM (s)[A]
	Coronal	Middle	Apical	
Group 1 (MTA Fillapex)	41.0±19.9[a]	48.0±23.5[a]	32.9±23.6[a]	45.6±36.7[B]
Group 2 (EndoREZ)	30.8±18.3[a]	26.4±17.3[b]	34.8±9.9[a]	71.8±29.2[C]
Group 3 (AH26)	25.3±18.1[a]	26.8±20.5[b]	28.1±24.1[a]	113.2±23.8

Different lowercase superscript letters indicate a statistically significant differences for remaining RCFM ($P < 0.05$). Different uppercase superscript letters indicate a statistically significant differences for time required for removing RCFM ($P < 0.05$)

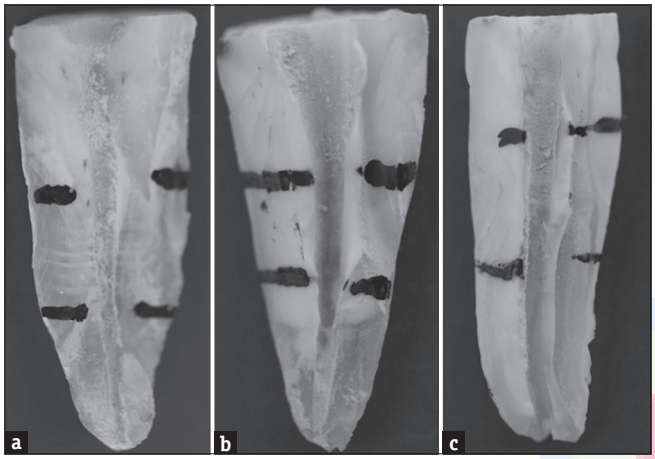

Figure 1: Remaining root canal filling materials (a: group 1, b: group 2, c: group 3)

difference between remaining RCFM at coronal and apical thirds ($P > 0.05$). The mean percentage of remaining RCFM in Group 1 (48.0%) at middle third was more than in Group 2 (26.4%) and Group 3 (26.8%) ($P < 0.05$). Within the intragroup comparisons, there was no statistically significant difference between root canal thirds for remaining RCFM ($P > 0.05$).

Discussion

The success of endodontic retreatment directly hinges on the maximum removal of RCFM in a reasonable time manner.[14] The aim of this study was to evaluate the removal efficiency of MTA Fillapex, EndoREZ, and AH26 with using WaveOne Gold reciproc file system.

In this study, mandibular premolar teeth with similar dimensions were used. According to minimize the variability, only teeth with straight canals were used and the roots were cut to a length of ± 15 mm to standardize the length of RCFM. Similar with previous studies,[2,15-17] the specimens were stored at 37°C in 100% humidity for 7 days to allow the full setting of the sealers. In several studies, storage time of specimens was varying from 5 days to 1 year.[18-21] Furthermore, in manufacturers' recommendations, the setting time of AH26, MTA Fillapex, and EndoREZ was 9-15 h, 130 min, and 30 min, respectively.

In this study, no effort was done to remove the smear layer. Researchers showed that the sealing ability of calcium silicate-based cements reduced after smear layer removal[22,23] which was aspect to the calcium silicate-based cement particles to penetrate into the dentin tubules due to larger particle size.[24] Several researchers found no statistically significant difference between sealing ability of AH26 and EndoREZ in the presence and absence of smear layer.[25-27] For these reasons, EDTA was not used as a final irrigant.

Endodontic engine drivers with Ni-Ti files have been using during endodontic retreatments.[28] Although reciproc systems were not originally designed for root canal retreatment, their specific design, flexibility, fatigue strength, and reciprocation motion can be potentially beneficial for effective RCFM removal.[9] In this study, WaveOne Gold was used to prepare the root canals and to remove the RCFM without using solvents. By the use of solvents during retreatment, a thin layer of RCFM, which is not easy to remove, might remain on the root canal walls.[29]

Retreatment might be considered complete when there is no observable filling material left on the instruments.[30,31] In this study, RCFM removal was continued until WaveOne Gold reciproc file reached the WL and the absence of visible RCFM on this file. However, in the present study, despite ensuring the absence of visible RCFM on the instruments, all canals revealed RCFM during visual observation. Thus, it is evident that a lack of RCFM on the instruments is not a valid criterion to demonstrate complete removal of RCFM from the root canal walls.[32]

Several techniques have been used to evaluate the remaining RCFM: radiography, micro-CT, and cleaving. Radiographic analysis only provides a 2-dimensional image and has proven less effective than the cleaving method.[4,33] Micro-CT represents the most precise method for this evaluation, but it is extremely expensive and time-consuming.[34] In cleaving method, the roots were first grooved with a diamond disc and then cleaved using a spatula in order not to dislodge the RCFM.[35] Some authors reported that the use of vertical split roots is an adequate technique and is more accurate than radiographic determination.[4,33] The amount of residual RCFM was evaluated by the cleaving method according the method of Rios *et al*.[33] in the present study and remaining RCFM was measured linearly instead of

scoring methods. Linear measurements were done on digital photographs taken with a digital camera and macro ring lite. It is not necessarily the best or the most precise method and can be supposed as the limitation of this study, but it minimizes subjectivity with respect to use of a scoring system.[36] Delineation of the remaining RCFM with aid of softwares is more precise than the utilization of scores.[28] This precision is related to image magnification on the computer, providing better quality of the images.[37]

In this study, time required for removing MTA Fillapex was significantly shorter than other groups. Therefore, the null hypothesis was rejected. Neelakantan *et al*.[38] found the time taken to reach WL for MTA Fillapex was shorter than AH Plus. Furthermore, Uzunoglu *et al*.[32] found that the time taken to reach WL for MTA Fillapex was shorter than AH26, which is similar to our results. The shorter removing time of MTA Fillapex might be correlate with its lower bond strength to root canal walls.[13,39] In this study, AH26 had longer required time for removing in comparison with other sealers. Barbizam *et al*.[40] reported no statistically significant difference between bond strengths of EndoREZ and AH26. On the other hand, Deniz Sungur *et al*.[41] compared the bond strengths of EndoREZ and AH26 and found higher bond strength for AH26. Besides, several studies have shown that AH26 had higher bond strength than different methacrylate resin-based sealers.[41,42] The higher bond strengths of AH26 might be related with the extended removing time.

In this study, RCFM was not completely removed from root canals in all experimental groups. According to comparison of coronal and apical thirds, there was no statistically significant difference between groups. On the other hand, the group filled with MTA Fillapex had significantly more remaining RCFM at middle thirds than other groups. Therefore, the null hypothesis was rejected. Vitti *et al*.[43] compared physical properties of MTA Fillapex with AH Plus and they reported that MTA Fillapex had lower solubility than AH Plus. However, it was shown that solubility of MTA Fillapex decreased after 28 days. In this study, removal efficiency of RCFM was evaluated after 1 week. The excess remaining RCFM in MTA Fillapex group at middle thirds might be explained by the low solubility of MTA Fillapex at short-time evaluation.

Within intragroup comparisons, there was no statistically difference between root canal thirds. Similar to our study, several studies have reported that no statistically significant difference between the remaining RCFM at coronal, middle, and apical third of root canals.[44,45] Furthermore, Bernardes *et al*.[45] evaluated the retreatment efficacy of three retreatment techniques (Reciproc technique, Protaper universal retreatment technique, and Hand files/Gates-Glidden technique) and showed that there was no statistically significant difference between the root canal thirds in intragroup comparisons.

This study was evaluated the retreatability of different root canal sealers but not to compare the removal efficiency of the RCFM using different file systems. Furthermore, reciproc file systems are not originally designed for retreatment procedures, they are frequently used for retreatment.[46-48] Further investigations are needed to compare the removal efficiency of these root canal sealers using WaveOne Gold and the other reciproc file systems and different retreatment techniques (hand files, rotary Ni-Ti retreatment files).

Conclusions

Within the limitations of this study, the root canal sealers could not be completely removed from root canals with using WaveOne Gold reciproc file system. On the other hand, the amount of remaining RCFM was not correlated with time. MTA-based sealer was removed faster than resin-based sealers.

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Conflicts of interest

There are no conflicts of interest.

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