Original Article

Evaluating the Ability to Re-Treat the MTA-Based Obturated Sealer Canals Compared to Ah-26 Resin Sealer in Mandibular Premolar Teeth Using the Protaper Re-Treatment System

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ABSTRACT

Background and Objective: MTA sealers have been recently introduced, which could be used as filling materials in endo treatments given their good biological properties. The purpose of the study was to evaluate the ability to re-treat the MTA-based obturated sealer canals compared to Ah-26 resin sealer in mandibular premolar teeth using the ProTaper re-treatment system.

Materials and Methods: In this experimental-laboratory study, 64 extracted single-root mandibular premolar teeth were prepared using the ProTaper system up to size F3 [30.9%] and randomly divided into two groups of 32 according to the type of sealer used and filled according to the instructions of the manufacturer. The canals of the first group were filled using resin sealer (AH-26) and gutta-percha with lateral compression method and the second group using gutta-percha and mineral trioxide aggregate (MTA) sealer (Endoseal MTA) with single cone method. The filling of all the samples was emptied using the ProTaper rotary retreatment system and the time needed to remove the canal filling material was recorded. Later on, the samples were cut longitudinally using a diamond disc and digital periapical radiographs were prepared from each half. The value of the remaining filling material in the radiographic image was calculated in AutoCAD software. The data was calculated using the Mann-Whitney non-parametric test. $P<0.05$ was considered as the level of significance.

Results: The residual sealer was significantly higher in the group filled with MTA-based sealer compared to AH-26 sealer ($p<0.05$). The time needed to remove the canal filling material in the group filled with MTA sealer was significantly higher than the first group ($p<0.05$).

Conclusion: The findings indicated that MTA sealer leaves significantly more residue in the canal walls after retreatment than resin sealer does and the ProTaper retreatment system cannot completely remove this sealer from the root canal.

Keywords: MTA sealer, AH-26 sealer, retreatment, ProTaper

Introduction

Although endodontic treatment has a high success rate, treatment failure and subsequent diseases might take place. The failure rate of root canal treatment is 16-14% (1), whose process includes the complete removal of filling materials from the root canal, determining the length of the correct function again, re-disinfection and uniform re-filling of the root canal, the most important part of which is the removal of the previous filling material (2, 3). Although different materials are used to fill the root canal, gutta percha along with sealer is the most common root canal filling material (4). Gutta percha cones cannot to connect to each other and also adhere to

the dentine walls of the root canal, so they are not able to flood the canal properly (5).

MTA is a material usually used for pulp caps, apexification, and perforation repair and for root end filling and pulpotomy (6). It is claimed that these sealers have many advantages, such as high biocompatibility, stimulation mineralization in dentinal tubules, excellent sealing, very good bond strength compared to ZOE-based sealers and the formation of hydroxyapatite crystals along the apical third and middle wall (7). Different techniques are available to remove the canal filling material, including hand files, rotary tools, ultrasonic tools, laser and thermal tools, and so on.

Many studies have stated that after the retreatment process is completed, some amount of filling material and debris remains on the canal walls regardless of the type of device used, the type of filling material, and the use or non-use of solvents (2). It is very important to investigate the possibility of retreatment of this sealer given the undeniable benefits of MTA sealer at least in certain cases. Hence, the purpose of the study is to examine the retreatment efficiency of MTA sealer compared to AH26 sealer in single-canal extracted teeth using the ProTaper rotary system.

Materials and Methods

The study was a randomized controlled interventional study and experimental-laboratory in terms of method. The population was the direct single-canal premolar teeth of the human mandible. The sample size of each group, using G*Power software and the entered data as: type 1 error rate ($\alpha = 0.05$) and type 2 error rate ($\beta = 0.2$) and considering (power=80%) equal to 32 teeth in each group (64 teeth in total) was calculated. Convenient sampling method was used.

One hundred single-root mandibular premolar teeth were selected and periapical proximal and buccal radiographs were taken from the samples to reach the final sample size of 64 teeth. Teeth with curvature, canal obstruction (calcification), pulp stone, analysis, fracture, crack, or previous root treatment were excluded from the study. The selected samples were disinfected for 5 minutes in 5.25% sodium hypochlorite and kept in 1% thymol solution.

1. Preparing the samples

The crowns of all specimens were cut by a round sharp handpiece [Bien Air, Switzerland] and a carbide fissure bur [Tizkavan, Iran] to create a standard root length of 15 mm, and to create a smooth surface as a reference point (Teeth with shorter length were excluded from the study). After evaluating the inside of the canal, K-file [Dentsply Maillefer Switzerland] number 10 was placed inside the canal to confirm the length and patency until its end was seen in the apical foramen. Then one millimeter of its length was reduced as the working length (14mm).

The samples were then numbered and each sample was assigned a unique number. After determining the glide path with file 20, the canals were filled with brushing movement and crown down technique by ProTaper rotary system [Dentsply Maillefer Switzerland] and ENDO MATEDT rotary motor [NSK, Japan] according to the manufacturer's instructions, respectively from Sx to F3 [#30 ,0.09] were prepared with a speed of 300 RPM and a torque of 2.2

2. Filling the canals

The samples were divided into two groups of 32 according to the type of sealer used and the filling technique, according to the instructions of the manufacturer (the type of sealer used for the obturation of each sample was determined randomly in WinPepi software):

Group 1: Gutta-percha and AH26 sealer with lateral compression technique

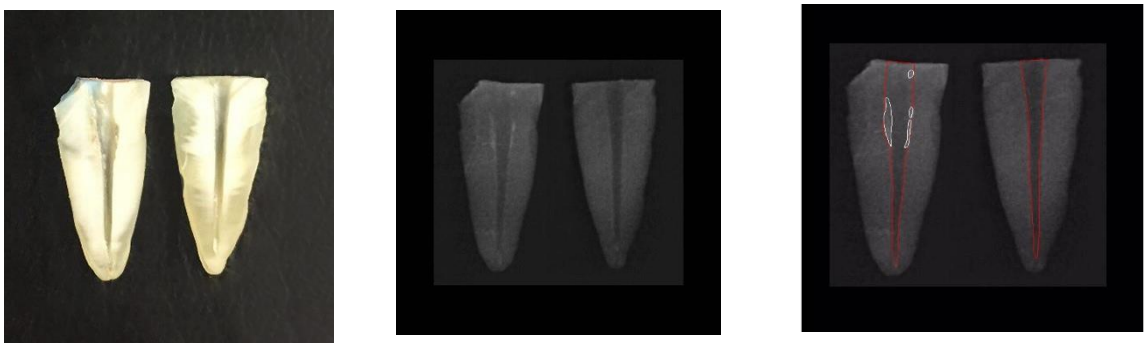
Group 2: Gutta-percha and MTA sealer with single cone technique

3. Retreatment

In the next stage of temporary restoration on the removed root, 2 mm gutta was removed from the entrance of the canal by heat carrier. The path was created to the working length using 0.2ml chloroform [Sinabartar, Iran] and K-File [#15, Dentsply, Maillefer, Switzerland]. Then the rotary retreatment system [Dentsply Maillefer Switzerland] ProTaper (with ENDO MATE DT engine [NSK, Japan]) at a speed of 500 rpm and a torque of 2.2 with minimum apical pressure and brushing movement and crown down technique was used to remove the filling materials inside the canal.

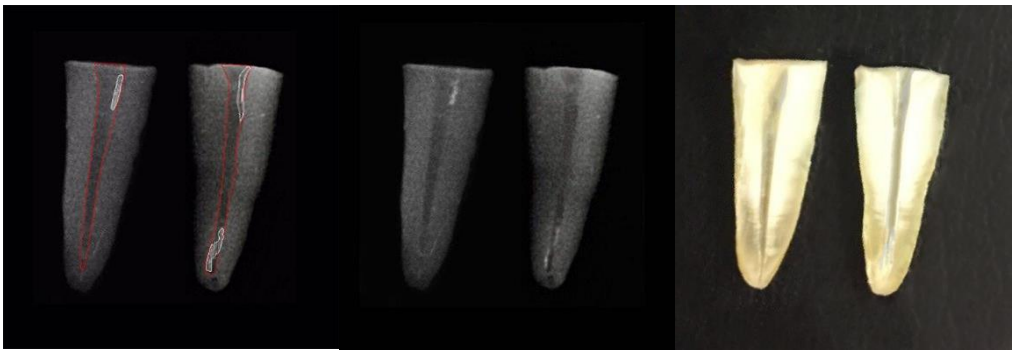
4. The analysis of the remaining filling material

The samples were cut using the diamond disk of the [Nemo Fannavarane Pars Iran] CNC machine available in the equipment center in Tehran University of Science and Technology in the bucolingual direction of the longitudinal section (pictures 1 and 2, a) and from each half a digital periapical radiograph (with the same conditions for all samples) was prepared. (Figures 2 and 2, b) and the obtained images were transferred to AutoCAD2013 software [Mechanical Desktop Power Pack Desktop; Microsoft Redmond WA].



(c) (b) (a)

Figure 1. Longitudinal section of halves filled with AH-26 sealer after retreatment; a: photography, b: digital periapical radiograph, c: AutoCAD analysis



(c)) b) (a (

Figure 2. Longitudinal section of the halves filled with Endoseal MTA sealer after retreatment; a: photograph, b: digital periapical radiograph, c: AutoCAD analysis

Non-parametric test (Mann-Whitney U) was used to compare quantitative variables. Chi squared or Fisher's exact test was used to analyze the qualitative variables. The permissible error value was considered 0.05 and p values less than that were considered statistically significant.

Results

The samples studied were in two groups of 32 mandibular premolar teeth with straight root and single canal, the first group was filled with gutta-percha and AH-26 sealer and the second group with MTA and gutta-percha sealer (Table 1).

Table 1. Relative frequency distribution of sealers used in root canal retreatment

Sealer	Frequency	Percentage
AH-26	32	50
MTA	32	50

Among the samples filled with resin sealer, 7 samples (21.9%) indicated no detectable residue in the radiographic image, and 100% of the samples showed filling in the canal walls in the samples filled with MTA sealer. There is a significant difference ($p<0.005$) between the two groups in terms of the presence or absence of filling material in the canal walls.

Table 2. The distribution of the relative frequency of the presence or absence of the remaining filling material in the canal walls

AH 26		MTA		
Frequency	**Percentage**	**Frequency**	**Percentage**	
25	78.1%	32	100%	**With residue**
7	21.9%	0	0	**Without residue**

The Kolmogorov-Smirnov normality test was performed to analyze the data, where the p value was less than 0.05, and we concluded that the data were not normal, and non-parametric tests were used to analyze the data. Using the Mann-Whitney test and the p value that was obtained less than 0.05, we concluded a significant difference between the values of sealer remaining in the canal wall in two types of sealer. This value for MTA sealer was greater than AH-26Based on the median and mean values.

Table 3. Determining and comparing the values of sealer remaining in the canal wall in two types of sealer

Sealer	Mean (percentage)	Median	SD	p-value
AH-26	8.38	5.32	9.9	<0.001
MTA	32.48	26.5	20	

Using the Mann-Whitney test and the p value that was less than 0.05, one can conclude a significant difference between the times needed to remove the canal filling material in two types of sealer. One can be seen that this value for MTA sealer is higher than AH-26according to the median and mean values (Table 4). Moreover, the initial function length was obtained again in all samples (100%).

Table 4. Determining and comparing the time needed to remove canal filling materials in min

Sealer	Mean (percentage)	Median	SD	p-value
AH-26	2.5	2.38	0.38	<0.001
MTA	3.47	3.35	0.39	

Discussion

None of the canals filled with MTA sealer was completely removed from the filling material and at least one segment showed residual material based on the study carried out. In the AH26 group, 21.9% of the samples indicated no sealer in the radiograph, which is probably due to the lack of power of radiography in detecting the very small values of remaining material. Hence, MTA is a good candidate and the proper selected material for filling the root canal. Nonetheless, MTA cannot be recommended as a common orthograde filling material given its sandy nature and non-recyclability of the filled path, which has made its use in complex root canal systems challenging (7).

Favorable mechanical properties like fast setting time (about twelve minutes), high washout resistance relative to other commercial MTAs in the market, and biological effects include good tissue compatibility, mineralization potential, and odontogenic effects of Pz-MTA cement. Studies conducted related to MTA sealer have used MTA Fillapex, which has lower bond strength and greater solubility than Endoseal MTA (9, 8).

Based on our findings, it seems that the removal of this sealer (Endoseal MTA) during retreatment is more difficult compared to other MTA sealers and AH26 sealer, and more time is required to remove the canal filling materials.

The ProTaper retreatment system was used to remove the filling material in the present study. Different studies have confirmed the effectiveness, cleaning power, and safety of Protaper (10). ProTaper rotary files include three flexible files designed to remove filling material from the coronal, middle, and apical 1/3 of the canal. The better performance of the ProTaper system could be because of its design. D1, D2, D3 files have a convex triangular cross-section with 3 progressive convergences and progressive length, enabling them to remove not only gutta-percha, but also the surface layer of dentin during the removal of canal filling materials. Furthermore, the special design of the flutes (greater distance from each other and negative cutting angle) and the rotational movements of the ProTaper retreatment files cause the filling material inside the canal to be drawn into the flutes of the file and towards the canal openings. Furthermore, the rotary movements of the files create a percentage of frictional heat that can plasticize the consistency of gutta-percha. Softened gutta-percha shows less resistance to removal and is easier to remove (11).

It has been used to evaluate the remaining amount of filling material inside the canal too. It is inevitable to lose a part of the sample and the remaining filling material inside it if the tooth is bifurcated using a diamond disc (longitudinal cutting technique). Hence, there is a possibility that in retreatment of the root, the small amount of its residues (sealer AH-26) in the canal walls will not be detected in the radiographic images. This technique is not an accurate method for evaluating the amount of remaining sealer inside the canal due to the artifact by the material inside the canal in the images, as well as the low density of the material inside the canal and because of the impossibility of accurate observation in CBCT (12).

The study was carried out on single-canal and straight teeth to eliminate as much as possible the effect of root anatomical complications in material removal. Overall, the time needed to reach the removal of canal filling material, with a significant difference in The MTA group was more than AH26 in this study. Given the hardness of Endosel MTA and the penetration of this sealer into the dentinal tubules and its resistance to the usual retreatment techniques, more time is required for its removal.

The initial functional length was obtained again in all the samples of both groups in the present study. According to Anastasi, the initial functional length is obtained in 100% of the samples if the main cone is used during the functional length. Besides chloroform, rotary devices and hand files, ultrasonic was also used in in her study as the present study.

It is recommended that if micro-CT technology becomes available in IRAN, this method should be used to evaluate the remaining material of the canal. The present study was in vitro and is not directly adapted to clinical conditions.

Conclusion

The findings of this experimental-laboratory study revealed that the ProTaper retreatment system cannot completely remove Endoseal MTA from the canal walls and the remaining values of filling material in the obturated teeth filled with it is significantly higher than the obturated samples filled with resin sealer.

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Ethics Statement: None

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