Original Article

Evaluating the efficiency of DRaCe re-treatment rotation technique in gutta excision from the two perspectives of operating time and the amount of gutta-percha remaining in the canal

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ABSTRACT

Background and objective: MTA sealers have just been developed, and because of their excellent biological characteristics, they may be employed as fillers in endo treatments. Accordingly, this study aims to investigate the efficiency of the rotary DRaCe retreatment approach in gutta excision from the two viewpoints of operating time and the quantity of gutta-percha still present in the canal.
Materials and methods: In this experimental-laboratory work, 64 single-root mandibular premolar removed teeth were produced using the DRaCe technique up to size F3 [30.9%] and were then randomly separated into two groups of 32 teeth depending on the kind of sealer applied. Also, they were filled under the manufacturer's instructions, with the first group's canals being sealed with resin (AH-26) and gutta-percha using a lateral compression technique and the second group's being sealed with gutta-percha and MTA sealer (Endoseal MTA) using a single cone technique for all samples. Using the DRaCe rotating retreatment system, the canals were drained, and the time needed to remove the canal infill material was noted. The samples were then divided longitudinally by a diamond disc, and each half was used to create a computerized periapical radiograph. Using AutoCAD software, the remaining amount of filling material in the radiography image was determined. The Mann-Whitney non-parametric test was utilized to calculate the data. The significance threshold ($P<0.05$) was taken into account.
Findings: When compared to the group filled with AH-26 sealer, the group filled with MTA-based sealer had considerably more residual sealer ($p<0.05$). The group filled with MTA sealer took substantially longer to remove the canal-filling material than the control group ($p<0.05$).
Conclusion: The findings of this investigation show that following retreatment, MTA sealer leaves substantially more residue in the canal walls than resin sealer.

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

Introduction

Despite the high success rate of endodontic therapy, treatment failure and secondary illnesses are always possible. Root canal failure rates range from 16 to 14 percent. If therapy is unsuccessful, there are non-surgical re-treatment alternatives, surgical procedures, or tooth extraction, with non-surgical re-treatment being the primary option (1). The most crucial step in the procedure is the thorough removal of the old filling material from the root canal, followed by a new determination of the proper working length, re-infection, and uniform filling of the root canal (2, 3). Although there are several materials utilized for root canal filling, gutta-percha and sealer are the most often used materials (4). Because gutta-percha cones cannot bond with one another or the dentine walls of the root canal, they are unable to adequately fill the channel (5). For this reason, sealers are used to cover imperfections in canals and the crevices between the canal-filling material (gutta percha) and the ivory walls to establish a full and integrated seal. In dentistry nowadays, a variety of sealants are utilized. Among them, we may highlight those based on glass ionomer, calcium silicate, and silicon ZOE (1). The most popular primary filling material for dental canals is gutta-percha (4), which is flexible, radioactive, semi-solid, and thermoplastic. Since it was first used as a root canal filler more than 160 years ago, gutta-percha has served as the benchmark by which other fillers are measured. Its primary ingredients are gutta-percha (20%), zinc oxide (65%), opacifiers (10%), plasticizers or softeners (5%), and gutta-percha (6, 7). This substance is an isomer of trans-polyisoprene that comes in two different crystal forms, alpha, and beta. It is unheated and solid in the beta phase and malleable and sticky in the heated alpha phase (8). Sealer 26 AH is often employed. This epoxy resin-based sealant, which is the gold standard when compared to all other modern sealants, offers exceptional sealing qualities (5). For pulp capping, apexification, perforation repair, root-end filling, and pulpotomy, MTA is typically utilized as a material. A revolution in pediatric and preventive dentistry was recently brought about by the introduction of MTA-based sealers, including bioaggregate, Micro Mega MTA, and MTA Fillapex Endoseal (9).

MTA is a hydrophilic powder that becomes harder when there is moisture present. The colloidal gel that is produced when this material is combined with water solidifies in 4 hours. After 3 hours of mixing, the mixture's pH rises from 2.10 to 12.5 (game) (10). After setting, MTA has a compressive strength of 40 MPa, which rises to 70 MPa after 21 days (11). The most significant substance that MTA releases in water are calcium hydroxide. Its high pH is also justified by the production of calcium hydroxide, coagulation necrosis, and dystrophic calcification (which take place following the installation of MTA). (12) Due to its alkaline pH and calcium ion release, MTA is an active and biological material for bone cells and increases the generation of interleukin. (13) This substance is a member of the Portland cement family in terms of its chemical composition and contains 5% gypsum, 20% bismuth oxide, and 75% Portland cement by weight. Additionally, it has been demonstrated that MTA offers improved flooding compared to IRM and Super EBA. 14) Edge matching for MTA with and without payment is also superior to Super EBA and IRM. (15)

High biocompatibility, stimulation of mineralization in the dentinal tubules, excellent sealing, very good bond strength compared to ZOE-based sealers, and the formation of hydroxyapatite crystals along the length of the apical third and middle wall have all been highlighted as benefits of these sealers (16). The filling material of the canal can be removed using a variety of methods, including manual files, rotary devices, ultrasonic devices, laser, and thermal devices, etc. (9) After treatment, the canal's filling materials are completely compacted, which makes the equipment less effective. It is required to completely remove the gutta-percha and sealer to regain access to the apical foramen, clean the area, and reshape the canal. This problem claims that one of the advantages of the sealer is its capacity to be eliminated through retreatment. (2)

The thorough removal of old filling materials from the canal is one of the endodontists' major challenges. These substances produce a mechanical barrier that keeps the root canal's cleaning solution and internal medications from coming into touch with the canal's walls. This technique is more challenging due to the complex architecture of the dental canal. (17) Gutta-percha removal from root-treated teeth can be accomplished using a variety of methods, such as manual files (with or without heat and chemical solvents), rotary systems (with rotary files), ultrasonic devices, heat-carrying instruments, and lasers. (18) Use of Gates Glidden burs or rotary files is the quickest method for removing gutta-percha. (19, 20) Gutta-percha has been softened and helped removed from the root canal using a variety of solvents. The exposed gutta-percha is given a drop of the chosen solvent, and as soon as the material starts to soften, a rotary or manual file is applied. Chloroform appears to be the quickest and most efficient solvent for softening gutta-percha out of all the options. (21). We chose to look at the feasibility of removing MTA sealer from the canal walls in retreatment because of the paucity of research covering the removal of this material from the walls of single-canal teeth.

Materials and methods

Randomized controlled intervention is the type of study used in the current experimental laboratory investigation. The group of human mandibular single-canal direct premolar teeth that were removed because they couldn't be saved for different reasons, including periodontal disorders, irreparability, or orthodontic procedures, etc. Using the G*Power program, the data input as type 1 error rate (α=0.05) and type 2 error rate (β=0.2), and taking into account (power=80%), the quantity of sample size for each group was determined to be the equivalent of 32 teeth in each group (64 teeth in total). The best sampling technique was utilized. These characteristics of the elongated mandibular premolar's single-rooted and single-canal teeth were investigated in this study:

- After reviewing the PA radiograph, no calcification, pulp stone, or evident root blockage should be visible.
- The roots of the teeth should be straight.
- Visual examination and radiographs should reveal no analysis, fracture, or root abnormalities.
- The apical foramen should have the same size in all teeth, and the teeth have a closed apex.
- The teeth have never received root canal therapy.

To create the final sample size of 64 teeth, periapical proximal and buccal radiographs were collected from 100 single-root mandibular premolar teeth. Exclusion criteria for the study were teeth with curvature, canal blockage (calcification), pulp stone, analysis, fracture, crack, or prior root treatment. Before the experiment began, hand instruments were used to remove any remaining soft tissue or bulk from the crown and root surfaces of the teeth. The chosen samples were maintained in a 1% thymol solution and disinfected for five minutes with 5.25% sodium hypochlorite.

Samples preparation

To generate a consistent root length of 15 mm and a flat surface as a benchmark, the crowns of all samples were cut using a sharp round handpiece, and a carbide fissure bur from Tizkavan, Iran (teeth with a shorter length was excluded from the study). K-file [Dentsply Maillefer Switzerland] No. 10 was inserted into the canal once it was inside to test its length and patency. Once its end was visible in the apical foramen, one millimeter of its length was shortened to the working length (14mm). The sample was eliminated from the study if file 15 did not have adequate grip for the desired 14mm working length. To directly detect the placement of the tooth in the acrylic, the specimens were mounted in the acrylic 5 mm below the reference point, with 10 mm of each specimen covered by acrylic and 5 mm remaining visible outside the acrylic. The tooth also has sufficient stability and strength in the mount, and at the time of cutting, it does not separate from the mount under the force and vibrations of the disc.

Following that, each sample was given a distinct number and numbered. The ProTaper rotary system [Dentsply Maillefer Switzerland] and ENDO MATEDT rotary motor [NSK, Japan] are used to fill the canals with brushing movement and crown down technique after determining the glide path with file 20. According to the manufacturer's instructions, the canals from Sx to F3 [#30, 0.09] were prepared with a speed of 300 RPM and a torque of 2.2. After setting up five channels, each file was replaced and not used again. The sample was removed from the research in the event of file breakage or over-instrumentation. Patency was achieved with file number 10 after each file had been washed with 2 ml of 5.25% hypochlorite. Following preparation, each sample was rinsed twice with normal saline (2 ml each time). The smear layer was then removed using 1 ml of 17% EDTA [SinaTeb Iran] for a minute and 5 ml of 5.25% hypochlorite afterward. With a needle [1/2 inch, Vecto], 25-G, and 1 mm shorter than the working length, all washing solutions were employed.

The canal had one last cleansing using regular saline. According to the manufacturer's instructions, the samples were split into two groups of 32 based on the filling method and the kind of sealer used (the WinPepi program generated a random sealer type for each sample):

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

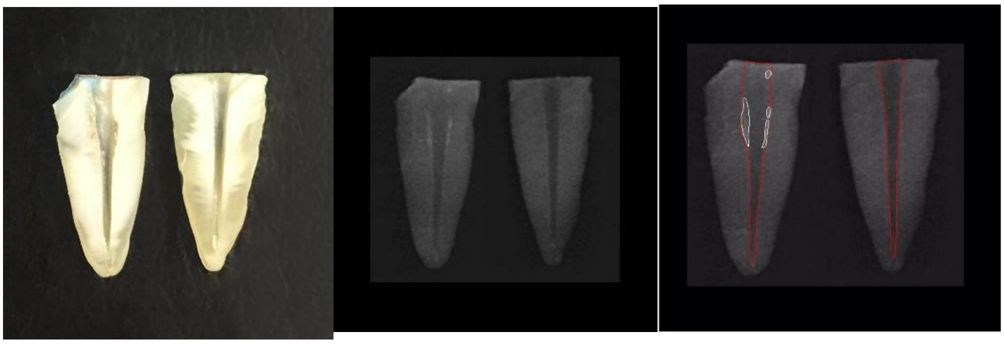
Group 2: Gutta-percha and MTA sealer with single cone technique

Paper towels were used to dry the samples. The primary gutta-percha cannula [MAC#35/4% Ariadent, Iran] was extended to operate in the first group. If the length is appropriate, the main can's radiograph is then sealed with AH26 sealer [Dentsply De Trey Germany], and the canal is then filled using the lateral compaction technique with several secondary guttas [#15/2% Ariadent, Iran] and spreaders [#25 Dentsply, Maillefer, Switzerland]. A customized needle up to 1.3 coronal within the included syringe was used to inject Endoseal MTA sealer (Maruchi, Wonju, Korea) into the canal in the second group. The working length of the chosen gutta-percha [#35/0.04 Dentsply Maillefer Switzerland] was then increased.

The second stage of interim repair on the severed root was the removal of 2 mm of gutta by heat carrier from the canal's opening. The route was built up 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 method was used to remove the filling materials inside the canal. Files D1[0.09/30], D2[0.08/25], and D3[0.07/20] were utilized in the coronal, middle, and apical sections, respectively, up till the WL, in accordance with the manufacturer's recommendations as long as gutta-percha and debris are not visible on the flutes of the D3 file and are not flushed out of the canal during saline washing. The final apical preparation was completed by using a ProTaper rotary file [F4#40/0.06, Dentsply Maillefer Switzerland] and attempting to achieve the working length after 2 ml of 5.25% sodium hypochlorite was put into the canal. The canal was cleaned with a 5.25% hypochlorite solution between each file, and the files were changed after five applications. The targeted sample was eliminated in the event of a retreatment error. The canals were cleaned with 5 cc of the regular saline solution once the treatment was completed, and they were then dried with a paper towel. A timer was used to time and keep track of the length of the retreatment procedure. One operator completed all phases of initial cleaning, root canal filling, and re-treatment of the canals.

Analyzing the remaining filling material

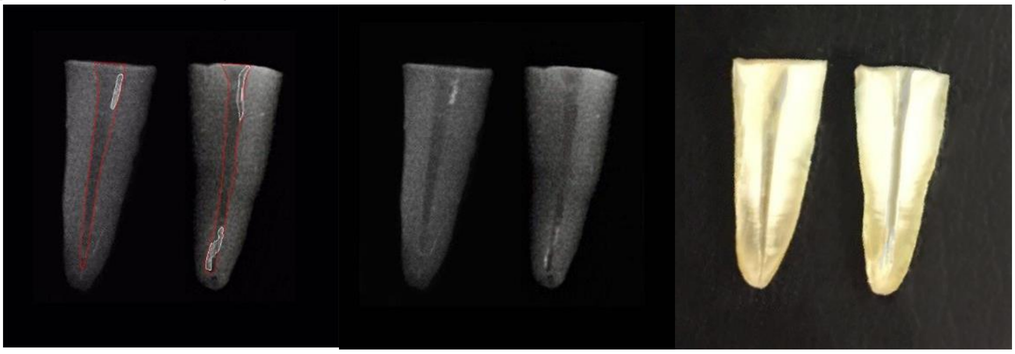
Using the diamond disc of the [Nemo Fannavarane Pars Iran] CNC machine accessible in the equipment center at Tehran University of Science and Technology, the samples were cut in the buccolingual direction (pictures 1 and 2, a). From each side, a digital periapical radiograph was created (with the same conditions for all samples). Images were transferred to the AutoCAD2013 program (Mechanical Desktop Power Pack Desktop; Microsoft Redmond WA) and labeled (Images 1 and 2, b). Based on the difference in radiopacity between the canal wall and the remaining infill material, the difference between the two is calculated. After sketching the boundaries of the channel space and the boundaries of the remaining filling material, the AutoCAD operator also computed the areas of each and showed the ratio of the areas to one another, which resulted in the percentage of filling material still present in the channel walls. (See images 1 and 2, c.) According to the coding of the samples, the endodontist and radiologist, who weren't there during the procedure, analyzed the AutoCAD findings based on how much filler material was still in the canal wall.



(c)

(b) (a)

Figure 1. Longitudinal section of halves filled with AH-26 sealer after retreatment; a: photograph, 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

According to the coding of the samples, the endodontist and radiologist, who weren't there during the procedure, analyzed the AutoCAD findings based on how much filler material was still in the canal wall. Less than 0.05 is regarded as the acceptable error value, and p-values below that threshold are seen to be statistically significant.

Findings

Thirty-two mandibular premolar teeth with straight roots and a single canal make up the studied samples; the first group was filled with gutta-percha and AH-26 sealer, while the second group was filled with MTA and gutta-percha sealer (Table 1). Data was gathered and input into the computer using the statistical program SPSS 21 to compare the effectiveness of retreating the filled canals. Following is a report of the findings:

Table 1. Distribution of the relative frequency of sealers used in canal retreatment

sealer	Number	Percentage
AH-26	32	50
MTA	32	50

Seven samples (21.9%) of the samples filled with resin sealer did not exhibit any discernible residue in the radiographic picture, whereas 100% of the samples filled with MTA sealer revealed filling in the canal walls. Regarding the presence or lack of filler in the canal walls between the two groups, there is a statistically significant difference ($p<0.005$) (Table 2).

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

	MTA		AH 26	
	Percentage	number	Percentage	number
With residual	100%	32	78.1%	25
Without residual	0	0	21.9%	7

The data were analyzed using non-parametric testing after the Kolmogorov-Smirnov normality test, which revealed that the data were not normal since the p-value was less than 0.05. It was determined that there is a significant difference in the amount of sealer left in the canal wall in two types of sealer using the Mann-Whitney test and the p-value that was less than 0.05. This number is more than -26AH for MTA sealer, as can be seen from the median and average figures (Table 3).

Table 3. Determination and comparison of the remaining amount of sealer in the canal wall in two types of sealer

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

There is a significant difference between the amount of time needed to remove the canal filling material between the two types of sealer, as determined by the Mann-Whitney test, where the p-value obtained was less than 0.05. This value is greater for MTA sealer than AH-26, as can be observed from the median and mean values (Table 4). Furthermore, the original working length was recovered in all samples (100%) tested.

Table 4. Determining and comparing the time required to remove canal filling materials in minutes

Sealer	Mean	median	SD	p-value
AH-26	2.5	2.38	0.38	<0.001
MTA	3.47	3.35	0.39	

Discussion

The study found that none of the canals sealed with MTA sealer had the filler material eliminated, and at least one section of the residual material was visible. Because radiography cannot identify the extremely small quantity of residual material, 21.9% of the samples in the AH26 group did not exhibit any sealant in the radiography. MTA sealer leaves greater residue on the canal walls upon retreatment than resin sealer when the entire canal surface is taken into account. Because calcium silicate-based sealers have a very hard consistency after setting, which resists the equipment and procedures used for retreatment, there is likely a considerable difference between the two sealers. Following the setting, the calcium ion is released, and the proximity of this ion to liquids containing phosphate promotes the growth of hydroxyapatite crystals in the middle and apical third of the canal. When this layer is formed, a powerful chemical bond is formed between the substance and the canal walls, which results in superior flooding ability than with resin sealers when the intensity is set. (22) MTA is a suitable contender and the material of choice for root canal filling because of this. However, due to the sand-like and non-recyclable character of the filled channel, MTA cannot be used as a typical orthograde filler material. This makes it difficult to employ problematic root canal systems. (23) There are MTA-based sealants, including Endoseal MTA, Micro Mega MTA, Fillapex MTA, and Micro Mega MTA. Recently released on the market is Endoseal MTA, a pozzolan-based MTA with small powder particles. This sealer's primary component is pozzolanic cement. Its prepared material (pre-mixed) offers a proper flow with enough consistency for injection through a thin plastic syringe tip that is readily put in the root canal after the pozzolanic reaction produces a cement that comprises calcium hydroxide and water. (24) Pz-MTA cement has advantageous biological effects, including good tissue compatibility, mineralization potential, and odontogenic effects, as well as favorable mechanical properties, including quick setting time (about twelve minutes), high washout resistance compared to other commercial MTAs on the market. MTA Fillapex, which has a weaker binding and more solubility than Endoseal MTA, has been employed in the majority of investigations related to MTA sealer. (25, 26).

Therefore, in this investigation, materials inside the canals in both groups were removed using the advantages of chloroform. The amount of remaining filling material inside the canal has been measured using a variety of techniques, including longitudinal sectioning of the tooth (27) and its evaluation using radiography (28) or direct observation with photography or a microscope (29), transparent evaluation, and use of cone beam computed tomography (CBCT) or micro-computed tomography technology (micro-CT) (30, 31). A portion of the sample and any residual filling material will inevitably be lost if the tooth is split in two using a diamond disc (longitudinal cutting technique). The major flaw in the radiographic assessment approach is that it produces a 2D image of a 3D structure, making it impossible to discern the small quantity of residual material in the canal. This is due to image distortion. (32) Although gutta-percha has a radiopacity that exceeds our criterion, the ISO standard states that the filler material inside the canal must have a radiopacity of less than 3 mm of aluminum. The radioactivity of PRoroot MTA (2.9081mm aluminum) and AH26 (2.2816mm aluminum) is less than the norm, according to Melahat's 2009 research. Finally, the radiopacity of the filling materials inside the canal can be improved by using gutta-percha (5.0448mm aluminum). This investigation showed that AH plus has the highest radiopacity. The radiopaque material used in these sealers is what causes the variation. (33) The radiopacity agents in these sealers are bismuth trioxide and calcium tungstate, which are both found in the structures of AH-26 and MTA, respectively. Therefore, it's possible that after root retreatment, the tiny amount of its remnants (sealer AH 26) in the canal walls won't show up on radiographic imaging.

Conclusion

The findings of this investigation show that following retreatment, MTA sealer leaves substantially more residue in the canal walls than resin sealer.

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Ethics Statement: None

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