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SINGLE VS MULTIPLE FILE SYSTEMS IN RETRIEVAL OF TWO OBTURATION METHODS USING EITHER SINGLE OR MULTIPLE CONE TECHNIQUE

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ABSTRACT

Background: comparison of single file system using wave one gold file versus multiple file system using M Pro gold file system in removal of obturation material obturated by either single cone technique using bioceramic sealer or multiple cone technique with resin-based sealer and their impact on amount of extruded debris and percentage of remaining obturation material. ***Aim:*** To evaluate the cleanliness of the root canal walls after mechanical removal of the gutta percha obturated with different techniques; cold lateral condensation and single cone effect of different obturation techniques using single or multiple rotary Niti files.

***Materials and Methods*:** Forty-four (44) mandibular premolars will be evaluated for amount of remaining root canal filling material and amount of extruded debris after retreatment and will be divided into two groups each group of 22 premolars using either single file rotary system or multiple file rotary system. Each group will be subdivided into two subgroups each group of 11 premolars either using single cone obturation technique or lateral condensation technique. After access cavity preparation, working length will be set 1mm short of the length established visually using size 10K-file inserted into the root canal until its tip is visible at the apical foramen. Initial root canal preparation will be performed using the Protaper system according to manufacturer's instructions to size F3 and the other group will be prepared by single file technique WaveOne. The shaping will be stopped at size 35 K-files reaching the working length. Canals will be irrigated between instruments with 5.25% NaOCl and 17% EDTA alternatively. Canals will be dried after instrumentation with paper points and filled using two techniques single cone technique obturated using bioceramic sealer and the other technique using lateral condensation technique using AH sealer. The teeth then will be assessed by using stereomicroscope to detect remaining amount of gutta percha. Eppendorf tubes should be weighed to assess amount of apically extruded debris during retreatment.

Results: None of the tested methods were capable of totally removing remaining obturation material. Highest percentage of remaining obturation material was found in teeth retreated by single file system using wave one file which was obturated by single cone technique using bioceramic sealer. The highest weight of amount of extruded debris was found in Multiple file system used in retreatment of teeth obturated by lateral condensation technique using resin based sealer.

KEYWORD: Wave One Gold Rotary File System, M-Pro Retreatment Rotary File System, Obturation Techniques, Retreatment Techniques.

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INTRODUCTION

Obturation of the root canal system is a crucial step during root canal treatment. Several techniques have been used during obturation either lateral condensation technique using resin-based sealer or single cone technique using bioceramic sealer. However, with the development of obturation materials used, still failure in root canal treatment may arise and lead to post-treatment complications [(1)].

To achieve a high sealing ability throughout the root canal system, endodontic sealers are utilized. An optimal root canal sealer should have the following qualities: biocompatibility, proper adhesion with canal walls, insolubility against tissue fluids, dimensional stability, and an excellent seal when set [(2)]. There are many types of resin-based sealers as Epoxy resin-based sealers and methacrylate resin-based sealers. Resin-based sealers have high sealing and good retreat ability in root canal systems. However, it cannot be completely removed during retreatment of the root canal system [(3)(4)]. Also, bioceramic sealers are used with single cone technique as ceraseal. It has high sealing ability and biocompatibility but more difficult to be removed during retreatment in root canal system [(5)(6)].

Retreatment of root canal system offers a second chance to save the tooth. Retreatment procedure starts with the removal of obturation material from inside root canal system followed by cleaning, shaping, and obturation of the root canal system.

Several methods are used for removing obturation material from inside root canal system either by manual files with solvents or rotary files system which can be single rotary file system or multiple rotary file system [(7)(8)(9)].

Evidence is still conflicting about efficiency of different file systems in totally removing obturation material as whatever file system used there still remaining obturation material observed in the retreated canal .Based on the above-mentioned information, the aim of this study was to evaluate efficacy of different file systems in removal of obturation material during retreatment whether obturated by single cone technique using bioceramic sealer or lateral condensation technique using resin-based root canal sealer and their effect on amount of extruded debris and remaining percentage of obturation material.

MATERIALS AND METHODS

Samples Size Calculation:

A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found between different groups. By adopting an alpha level of (0.05) a beta of (0.2) i.e. power=80% and an effect size (f) of (0.527) calculated based on the results of a previous study; the predicted sample size (n) was found to be a total of (44) samples (i.e. 22 samples per group and 11 samples per subgroup). Sample size calculation was performed using G*Power version 3.1.9.71

Samples Selection:

Forty-four single rooted human mandibular first premolars were collected from Misr International University "MIU" teeth bank. Teeth will be assessed both clinically and radiographically to exclude the presence of calcifications, pulp stones, and internal or external root resorption and to confirm the existence of a single straight canal and full root development.

Samples preparation:

Immersion in 5.25% NaOCl for five minutes was used to disinfect all samples. After that, any surface deposits and/or calculus were removed from the teeth by cleaning and scaling them using an ultrasonic scaler. After that, the samples were kept for further use in regular saline.

Access cavity preparation:

Access cavities were prepared in all samples using a contra-angle high-speed handpiece, round bur #3, and tapered stone with a round end under continuous water cooling.

The round bur was used for accessing and deroofing the pulp chamber. The canal orifices were located using DG16 Explorer. Then the tapered stone was used for flaring and smoothening of the axial walls, to ensure a straight-line access [10][11].

Root canal Instrumentation:

The root canal orifice was located using an endodontic explorer. Passing the #15 flex file to the apical foramen allowed for the determination of patency and working length. This length was noted, and it was determined that the ultimate working length was 1 mm less than the recorded length. Following the manufacturer's instructions, root canals were instrumented using the M-Pro rotary (Ni-Ti) files system at the working length utilizing a crown-down approach with M3PG rotary files until the size and taper #25/.06 were achieved. The NSK Endo Mate AT Endo motor's speed and torque were set to 350 RPM and 2.5 Ncm, respectively, in accordance with the manufacturer's instructions. The manual flex-file sizes #30 and #35 were used to further extend the master apical file to size #35. To guarantee straight-line access from the coronal orifice to the apical foramen and that no iatrogenic errors, such as canal blockage or ledges, irrigation and patency were performed using a manual k-file size #10 in between each rotary or manual file use. After being used in four canals, each hand or rotary file was thrown away. To prevent file separation, files that showed signs of unwinding were replaced with new ones [12].

Irrigation protocol

5.25% sodium hypochlorite (NaOCl) in a 25 ml volume was employed as the irrigation during instrumentation, along with a 30-gauge needle with a side vent. Three milliliters of a 17% EDTA solution were used to irrigate the canals for one minute. This was followed by a final flush with 5.25% NaOCL. Paper points in the size #35 were used to dry the canals.

Samples grouping:

All samples were randomly divided into two main groups according to file system used:

Group 1: Single File rotary system technique using wave one gold file.

Group 2: Multiple file rotary system technique using M-Pro retreatment files.

Each group was further sub-divided into two sub-groups according to the obturation technique used:

Sub-group A: single cone obturation technique using bioceramic sealer.

Sub-group B: cold lateral condensation technique using resin-based sealer.

Coded samples were used throughout the study to avoid possible bias:

Samples of group 1 coded S1 to S22 to be subdivided into:

Sub-group 1: SB1 to SB11.

Sub-group 2: SC11 to SC11.

Samples of group 2 coded M1 to M22 to be subdivided into

Sub-group 1: MB1 to MB11

Sub-group 2: MC1 to MC11

Root canal obturation:

Paper points were used to dry the instrumented canals. Using gutta-percha size 40 taper 0.04, which corresponds to the master apical file size, the master cone was adjusted, inserted to its full working length, and examined both visually and radiographically.

Sealer was distributed circumferentially and vertically by in and out motion of the master cone, touching the dentinal walls. The First group of 22 premolars was retreated by single file technique using wave one gold file which were further divided into two subgroups, subgroup one obturated by single cone technique using bioceramic sealer and subgroup two obturated utilizing a resin-based endodontic sealant and the cold lateral condensation procedure. The second group of 22 premolars was retreated by multiple files technique using M Pro retreatment files which are further divided into two subgroups, subgroup one obturated by single cone technique using bioceramic sealer and subgroup two obturated utilizing a resin-based endodontic sealant and the cold lateral condensation procedure. Obturation was done until the spreader could no longer penetrate the canal. Then Excess Gutta-percha was removed using hot instrument till the canal orifice. To confirm that the obturation was adequate, radiographs of every obturated tooth were taken from two distinct angles. If a radiograph shows any defects or voids, the sample was disposed and replaced [13][14]. To achieve full setting, specimens were then placed in an incubator set at 37˚C with 100% humidity.

Removal of obturation material:

Samples of group 1 using single file technique (wave one gold rotary file system) were sub-divided into two sub-groups according to type of sealer used. Sub-group A single cone technique using bioceramic sealer and sub-group B multiple cone technique using resin-based sealer. A pilot hole by manual file was performed in a gentle inward rotary motion with gentle apical pressure with a lateral brushing movement along the canal walls. Mechanical removal of gutta percha and sealer by wave one gold rotary file system #25 was performed according to manufacturer's instructions. Using gauze, adhering debris was removed from the file's flutes and reinserted into the canal after the file was examined for deformation and flute unwinding during the procedure. The torque and speed were changed in accordance with the manufacturer's instructions (2.5 N/cm and 500–700 RPM). When the rotary file had reached its maximum working length and there were no more fillings or debris visible to the naked eye, the step was considered finished. After being used in 6 canals, each file was discarded in accordance with the manufacturer's instructions. To prevent file separation, a file that showed signs of unwinding was replaced with a new file [15][16][17].

Samples of group 2 using multiple file technique (M-Pro retreatment files system) were sub-divided into two sub-groups according to type of sealer used. Sub-group A single cone technique using bioceramic sealer and sub-group B multiple cone technique using resin-based sealer. Mechanical removal of gutta percha and sealer by M -Pro retreatment files A pilot hole by file Opener size 22#, taper .11, Length 19m in a gentle inward rotary motion with gentle apical pressure with a lateral brushing movement along the canal walls for making straight access of root canal, Then inserting file R1 Size 25#, taper .08, Length 15 m for cleaning first third of the root, then R2 Size 25#,taper, 06, Length 19m to clean middle third of root canal, then R3 Size 25#, taper .04, Length 23m to clean apical third of root canal and preparation of the canal till apex then R4 Size 30#, taper .04 Length 25m to be used for final root preparation. Throughout the procedure file was checked for any distortion or flutes unwinding and adherent debris were cleaned from the flutes of the file using gauze then reinserted in the canal. The torque and speed were changed in accordance with the manufacturer's recommendations (2.5 N/cm and 500–700 RPM). Using a side-vented 30-gauge needle and two milliliters of 2.25% NaOCL, the canals were irrigated. Irrigation with 5.25%NaOCL was reapplied several times during the procedure to allow softening of the gutta-percha and allow removal of debris, cleaning of the canals

and sliding of the file into the canal with minimal possible errors or complications. When the rotary file reached its maximum working length and there was no more filler or debris visible to the human eye on the rotating file, the retreatment process was considered finished. After being used in 6 canals, each file was discarded in accordance with the manufacturer's instructions. A file that appeared to be unwinding was changed off with a new one in order to avoid file separation. Gutta percha will be removed till reaching working length of tooth. Retreatment procedure is considered completed when no gutta percha is observed on instrument and irrigation flush out [18][19][20].

Inclusion criteria: Mandibular premolars with single roots, Mandibular premolars with single canals and Teeth with mature apex.

Exclusion criteria: Presence of multiple canals, Cracked or fractured teeth, Carious teeth, Restored teeth, Teeth with calcifications or pulp stones, Teeth with internal or external resorption and Teeth with a curvature of more than 9 degrees.

Method of Evaluation:

A. 0.0001 electronic weighing machine:

In many scientific applications, such as density determination and differential weighing, where precise measurement of small quantities or substances is crucial, an analytical balance with a precision of 0.0001 g reading is a necessary tool. Additionally, all METTLER TOLEDO 0.0001 g analytical balances have a windshield to protect valuable samples and data from air currents and outside influences. Eppendorf tubes were used in collecting extruded debris to be measured during removal of obturation material. Eppendorf tubes must be pre-weighed before usage and each weight should be recorded. Before weighing the dry debris, Eppendorf tubes were kept in an incubator set at 68°C for five days to remove any remaining moisture. Weighing tubes containing dried extruded debris was done in the same way as the first measurement. By deducting the weight of the tubes containing dried debris from the weight of the pre-weighed empty tubes, the weight of the extruded debris was calculated.

B. Stereomicroscope:

Stereomicroscope examination of remaining obturation material. One half of each sample was examined under the stereomicroscope. The percentage of remaining obturation material was identified and measured using ImageJ software, an image analysis software, the percent of root canal debris in relation to root canal surface area was calculated. The photos were uploaded to a computer system for examination. Each root length was measured automatically, and the canal was separated into three sections: coronal, middle, and apical. Image analysis software (Image J, 149-jre6-32- USA) was used to determine the proportion of leftover infill material in each root third.

Initially, images were automatically adjusted for brightness and contrast. The root canal area was identified and removed from the picture, which was then converted to an 8-bit monochrome image. Color code thresholding was used twice: once to show the whole area of the root canal third and once to highlight the remaining filling material within the canal third.

Adobe Photoshop 7.0, Adobe Systems Inc., San Jose, California, USA, was used to process the stereo photos. ImageJ software (version 1.53a National Institutes of Health, USA) was then used to determine the stained area as a percentage of the total tooth area.

Scheem1 provides a summary of the image analysis procedures and measuring method. Step 1: Each tooth was segmented based on its contour using the semiautomatic outline selection tool in Photoshop software. The root canal was therefore separated from the remainder of the picture and separated into the cervical, middle, and apical thirds.

The remanent spots (those stained white or orange) were then automatically identified, highlighted in blue, and segregated from the remainder of the image. - Step 2: The full visible third area (apical, middle, or cervical) was automatically measured in millimeters (mm2) using image j software. The stained area in each third was automatically measured in mm2 from the images of isolated remanent that separated in step 1 and applied a threshold. The stained area in each third was then computed as a percentage of the total third area using equation (1): *% = Smm. of blue sraired area (mm2) [100] Total third area (mm2).*

Data collection and Statistical analysis:

- The independent T-test was applied to compare the two file systems (single file and multiple files) as well as the two obturation techniques (single cone and lateral compaction) in terms of image analysis results and the weight of extruded debris.
- The One-way ANOVA followed by a post hoc test was conducted for intra-group comparisons among the three thirds (coronal, middle, and apical) in the image analysis results.
- Pearson's correlation test was used to study the correlation between total remnant percentage results and the weight of extruded debris across the four subgroups. Pearson's correlation measures the strength and direction of a linear relationship between two variables, with values ranging from -1 (strong negative relationship) to +1 (strong positive relationship). The test criteria can be classified according to the Likert scale as follows:
- r = 0: No correlation
- $0.00 < r \leq 0.25$: Weak correlation
- $0.25 < r \leq 0.75$: Moderate correlation
- $0.75 < r < 1.00$: Strong correlation
- r = 1: Complete correlation
- p-value $\leq$ 0.05 was considered statistically significant (95% significance level), while p-value $\leq$0.001 was deemed highly statistically significant (99% significance level).
- The Shapiro-Wilk test was used to assess the normality of the data.
- Statistical analysis was performed using the SPSS statistical package (version 25, IBM Co., USA).

RESULTS

Results showed that Regarding highest percentage of remaining gutta percha was found in teeth retreated by single file system using wave one file which were obturated by single cone technique using bioceramic sealer followed by single file system using wave one file used in retreatment of teeth obturated by lateral condensation technique using resin based sealer then multiple file system used in retreatment of teeth obturated by single cone technique using bioceramic sealer and least amount of remaining gutta percha was found in Multiple file system used in retreatment of teeth obturated utilizing a resin-based sealant and the lateral condensation technique. Regarding amount of apically extruded debris, Multiple file system used in retreatment of teeth obturated by utilizing a resin-based sealant and the lateral condensation technique was found to have the highest weight of extruded debris followed by multiple file system used in retreatment of teeth obturated by single cone technique using bioceramic sealer then single file system using wave one file used in retreatment of teeth obturated utilizing a resin-based sealant and the lateral condensation technique and least amount of extruded debris was found in teeth retreated by single file system using wave one file which were obturated by single cone technique using bioceramic sealer.

DISCUSSION

Endodontic treatment occasionally fails due to persistent microbial invasion, extra-radicular infection, and iatrogenic factors that include poor access cavity, untreated canals, canals that are poorly cleaned and obturated, and complications of instrumentation. Endodontic retreatment is required for these teeth to re-establish healthy periapical tissue after endodontic treatment failure. During retreatment there are many problems including removing obturation material without leaving any remnants and avoidance of apical extrusion of obturation material or any other debris.

Obturation technique whether by single cone using bioceramic sealer or by lateral condensation technique using resin-based sealer or type of files used during retreatment whether single file or multiple files. These factors will lead to efficient removal of obturation material with minimum avoidance of extrusion of debris.

Single root premolars were chosen for this study due to lack of canal curvature and root variations found in mandibular or maxillary molars. Maxillary molars are well-known for their complex anatomy and may cause significant challenges to the instruments used in the removal of root canal filling. Zahra Ghoncheh et al [21] revealed that the MB root configuration was the most frequent anatomical variation in maxillary first molars; greater anatomical differences were seen in the root canal system of maxillary second molars. Francisco Gomez et al [22] showed that mandibular second molars that have two apical foramina, three root canals, and two roots. Radix Paramolaris and C-shaped root canals were two of their variations.

The obturation techniques chosen for this study was the lateral condensation technique and single cone obturation technique. Lateral obturation technique was used in first group because it is a standard obturation method, easy to be applied, and does not require complex devices. It has a significant disadvantage which is the possibility of voids formation [23] Single cone technique using bioceramic sealer was used in second group. Bioceramic root canal sealer was chosen for this study because it forms hydroxyapatite tags inside the dentinal tubules and it has better physical, chemical, and sealing properties when used in single cone obturation technique [24]. The two groups were prepared as follows, the round bur was used for accessing and deroofing the pulp chamber. The canal orifices were located using DG16 Explorer. Then the tapered stone was used for flaring and smoothening of the axial walls, to ensure a straight-line access. An endodontic explorer was used to locate the orifice of the root canal. Bypassing the #15 K file to the apical foramen, the working length and patency were established. The final working length was determined to be 1 mm less than this recoded length after this length was recorded. Throughout the procedure, a 27-gauge needle was utilized to provide 2 milliliters of NaOCL 5.25% irrigating solution between each file size. At this working length, the M-Pro rotary (NiTi) files system cleaned and shaped the canals. First establish straight access till 3mm to apex using M-Pro file #18 taper 0.04 using speed of 450 rpm and torque of 3N.cm according to manufacturer instructions. Afterward, continuing preparation till full of working length by M-Pro file #20 taper 0.04 and #25 taper 0.06 using speed 450 rpm, and torque of 1.5N.cm. K files up to master apical file size #40 were used to manually prepare the canals. Then two groups were divided into first group retreated by single file rotary system technique using wave one gold file which was divided into subgroup A which was obturated by single cone obturation technique using bioceramic sealer and subgroup B which was obturated by lateral condensation obturation technique using resin-based sealer obturated by lateral condensation technique in which using Resin-based sealer. Second group retreated by multiple file rotary system technique using m pro retreatment files which was divided into subgroup A which was obturated by single cone obturation technique using bioceramic

sealer and subgroup B which was obturated by lateral condensation obturation technique using resin-based sealer obturated by lateral condensation technique in which using Resin-based sealer. A finger spreader size 30 was used for obturation, and an extra accessory cone #25 taper 0.02 was filled.

Obturation was done until the spreader can no longer penetrate the canal. Then Excess Gutta-percha was removed using hot instrument till the canal orifice.

Every instrument used in this investigation was utilized in accordance with the guidelines provided by the manufacturer. To prevent file breakage, all files were disposed of after being used in four canals. Therefore, no fracture was recorded during instrumentation. Any adherent debris on the surface of the file was cleaned with sterile gauze before advancing the instrument again inside the canal.

Irrigation with sodium hypochlorite was used during the preparation of the samples before and after the retreatment. Sodium hypochlorite irrigation is used because of its advantages as an effective antibacterial, tissue-dissolving agent, has an adequate shelf life and is readily accessible and affordable [25]. Final irrigation with EDTA has been excluded from the final irrigation after retreatment since it removes the smear layer completely from the canal walls, resulting in no difference between the different groups.

To confirm that the obturation was adequate, radiographs of every obturated tooth were taken from two distinct angles. The samples were replaced and disposed of a radiograph revealed any flaws or voids. Specimens were then allowed to set in 100% humidity at 37˚C in an incubator to ensure its complete setting.

Both groups underwent retreatment using either a multiple-file retreatment kit or a single-file approach. By keeping the file more centered in the canal and taper of the Wave One files, the single file retreatment technique using the Wave One rotary file system produces a broader motion in the counterclockwise direction but a shorter motion in the clockwise direction. This increases the contact area between the instrument and the obturation material, enabling removal of the material with an effectiveness comparable to that produced with continuous rotation [26]. Multiple file technique using protaper file system proved to be an efficient method of removing obturation material and resulted in a smaller percentage of canal area covered by residual obturation material [27].

In this investigation, the roots were longitudinally sectioned and examined under a stereomicroscope to determine the percentage of filling material that remained. Because radiographic imaging only provides a two-dimensional image and is susceptible to distortion and magnification, this method was preferred over radiography methods. The sectioning of the root should be carried out safely so as not to cause damage to the root or cause displacement of the gutta-percha. None of the tools that were tested were able to entirely remove the root canal filling from the root canal wall in terms of the proportion of filler material that remained. In terms of the percentage of filler material that remained after testing, none of the studies that were comparable to this one were able to completely eliminate obturation material from the root canal wall [28]. However, compared to Wave One instruments, ProTaper instruments removed more obturation material; both instruments took less time to remove obturation material. It was discovered that a single file system employing wave one had more remaining gutta percha than a multiple file system using the M-Pro retreatment kit. Regardless of the sealer used, residual material debris was found in all samples of premolars that were obturated using either the single cone technique with bioceramic sealer or the lateral condensation approach with resin-based sealer. Every sealer was eliminated to a comparable degree [29][30].

For all studied regions (coronal, middle, apical thirds, and the total remanent percentage), the single cone obturation technique achieved the highest mean remanent percentage, while the lateral compaction obturation technique recorded the lowest.

Regarding highest percentage of remaining gutta percha was found in teeth retreated by single file system using wave one file which were obturated by single cone technique using bioceramic sealer followed by single file system using wave one file used in retreatment of teeth sealed with a resin-based sealant and obturated by the lateral condensation technique then multiple file system used in retreatment of teeth obturated by single cone technique using bioceramic sealer and least amount of remaining gutta percha was found in Multiple file system used in retreatment of teeth sealed with a resin-based sealant and obturated by the lateral condensation technique.

Regarding amount of apically extruded debris, Multiple file system was used in retreatment of teeth sealed with a resin-based sealant and obturated by the lateral condensation technique

was found to have highest weight of extruded debris followed by multiple file system used in retreatment of teeth obturated by single cone technique using bioceramic sealer then single file system using wave one file used in retreatment of teeth sealed with a resin-based sealant and obturated by the lateral condensation technique and least amount of extruded debris was found in teeth retreated by single file system using wave one file which was obturated by single cone technique using bioceramic sealer.

Apically extruded debris was collected using Eppendorf tubes. For five days, tubes were kept at 70°C in an incubator. The weight of the dry extruded debris for each group was determined by subtracting the initial weight from the final weight of the Eppendorf tubes. Every file used in retreatment causes debris to extrude apically.

CONCLUSION

None of the tested methods were capable of totally removing remaining obturation material. The highest percentage of remaining obturation material was found in teeth retreated by single file system using wave one file which was obturated by single cone technique using bioceramic sealer. The highest weight of amount of extruded debris was found in multiple file system used in retreatment of teeth obturated by lateral condensation technique using resin based sealer.

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Interest conflicts

The authors declare no conflict of interest.

REFERENCES

1. Nair, P.N.R. (2006), On the causes of persistent apical periodontitis: a review. International Endodontic Journal, 39: 249-281.
2. Lee, Ju Kyung, Kwak, Sang Won, Ha, Jung-Hong, Lee, WooCheol, Kim, Hyeon-Cheol, Physicochemical Properties of Epoxy Resin-Based and Bioceramic-Based Root Canal Sealers, Bioinorganic Chemistry and Applications, 2017, 2582849, 8 pages, 2017.
3. Adanir, N., Çobankara, F.K. and Belli, S. (2006), Sealing properties of different resin-based root canal sealers. J. Biomed. Mater. Res., 77B: 1-4.
4. ZMENER, O., SPIELBERG, C., LAMBERGHINI, F. and RUCCI, M. (1997), Sealing properties of a new epoxy resin-based root-canal sealer. International Endodontic Journal, 30: 332-334.
5. AL-Haddad, Afaf, Che Ab Aziz, Zeti A., Bioceramic-Based Root Canal Sealers: A Review, International Journal of Biomaterials, 2016, 9753210, 10 pages, 2016.
6. Zhekov KI, Stefanova VP. Retreatability of bioceramic endodontic sealers: a review. Folia Med (Plovdiv) 2020; 62(2):258-64.
7. Fatima, Kainath; Nair, Rohit; Khasnis, Sandhya; Vallabhaneni, Saritha; Patil, Jayaprakash D.. Efficacy of

rotary and reciprocating single-file systems on different access outlines for gutta-percha removal in retreatment: An in vitro study. Journal of Conservative Dentistry 21(4):p 354-358, Jul–Aug 2018.

8. Abramovitz, I., Relles-Bonar, S., Baransi, B. and Kfir, A. (2012), The effectiveness of a self-adjusting file to remove residual gutta-percha after retreatment with rotary files. International Endodontic Journal, 45: 386-392.
9. Uzunoglu E, Turker SA. Impact of different file systems on the amount of apically extruded debris during endodontic retreatment. Eur J Dent 2016;10:210-4.
10. Adams, N., Tomson, P. Access cavity preparation. Br Dent J 216, 333–339 (2014).
11. Özyürek, T., Uslu, G., Arıcan, B. et al. Influence of endodontic access cavity design on mechanical properties of a first mandibular premolar tooth: a finite element analysis study. Clin Oral Invest 28, 433 (2024).
12. BRISEÑO, B.M. and SONNABEND, E. (1991), The influence of different root canal instruments on root canal preparation: an in vitro study. International Endodontic Journal, 24: 15-23.
13. Naseri M, Kangarlou A, Khavid A, Goodini M. Evaluation of the quality of four root canal obturation techniques using micro-computed tomography. Iran Endod J. 2013 Summer;8(3):89-93. Epub 2013 Aug 1. PMID: 23922567; PMCID: PMC3734521.
14. NAGY, C.D., BARTHA, K., BERNÁTH, M., VERDES, E. and SZABÓ, J. (1997), The effect of root canal morphology on canal shape following instrumentation using different techniques. International Endodontic Journal, 30: 133-140.
15. Canali, L.C.F., Duque, J.A., Vivan, R.R. et al. Comparison of efficiency of the retreatment procedure between Wave One Gold and Wave One systems by Micro-CT and confocal microscopy: an in vitro study. Clin Oral Invest 23, 337–343 (2019).
16. Costa PM, Leal RMS, Yamanari GH, Cavenago BC, Duarte MAH. Effectiveness of endodontic retreatment using WaveOne Primary files in reciprocating and rotary motions. Restor Dent Endod. 2023 Apr 25;48(2):e15.
17. Fatima, Kainath; Nair, Rohit; Khasnis, Sandhya; Vallabhaneni, Saritha; Patil, Jayaprakash D.. Efficacy of rotary and reciprocating single-file systems on different access outlines for gutta-percha removal in retreatment: An in vitro study. Journal of Conservative Dentistry 21(4):p 354-358, Jul–Aug 2018.
18. Francesco Somma, Giuseppe Cammarota, Gianluca Plotino, Nicola M. Grande, Cornelis H. Pameijer,The Effectiveness of Manual and Mechanical Instrumentation for the Retreatment of Three Different Root Canal Filling Materials,Journal of Endodontics,Volume 34, Issue 4,2008,Pages 466-469,ISSN 0099-2399.
19. Raj R A, Raju I, Varghese JG, Jeet Singh Birring O, Paul Yacob PJ, Chohan H. Comparative Evaluation of Debris Expulsion Beyond Apex During Re-root Canal Treatment by Utilizing Two Re-treatment Rotary Files and Two Reciprocating Files: An In-Vitro Study. Cureus. 2024 Mar 19;16(3):e56467.
20. Sharma N, Sharma M, Sethi HS, Kaur H. A study on three rotary retreatment systems in removing Gutta-percha and sealer. International Journal of Advanced Research in Medicine. 2023;5(1):46-48.
21. Ghoncheh Z, Zade BM, Kharazifard MJ. Root Morphology of the Maxillary First and Second Molars in an Iranian Population Using Cone Beam Computed Tomography. J Dent (Tehran). 2017 May;14(3):115-122. PMID: 29167682; PMCID: PMC5694843.
22. Gomez, F., Brea, G. & Gomez-Sosa, J.F. Root canal morphology and variations in mandibular second molars: an in vivo cone-beam computed tomography analysis. BMC Oral Health 21, 424 (2021).
23. Bhandi, S.; Mashyakhy, M.; Abumelha, A.S.; Alkahtany, M.F.; Jamal, M.; Chohan, H.; Raj, A.T.; Testarelli, L.; Reda, R.; Patil, S. Complete Obturation—Cold Lateral Condensation vs. Thermoplastic Techniques: A Systematic Review of Micro-CT Studies. Materials 2021, 14, 4013.
24. Ahmad Nouroloyouni, Vahid Samadi, Amin Salem Milani, Sara Noorolouny, Haleh Valizadeh-Haghi, "Single Cone Obturation versus Cold Lateral Compaction Techniques with Bioceramic and Resin Sealers: Quality of Obturation and Push-Out Bond Strength", International Journal of Dentistry, vol. 2023, Article ID 3427151, 8 pages, 2023.
25. Spencer, H., Ike, V. & Brennan, P. Review: the use of sodium hypochlorite in endodontics — potential complications and their management. Br Dent J 202, 555–559 (2007).
26. Fatima, Kainath; Nair, Rohit; Khasnis, Sandhya; Vallabhaneni, Saritha; Patil, Jayaprakash D.. Efficacy of rotary and reciprocating single-file systems on different access outlines for gutta-percha removal in retreatment: An in vitro study. Journal of Conservative Dentistry 21(4):p 354-358, Jul–Aug 2018.

27. Lalit, Pooja; Godara, Navneet; Varma, K Ravi. Evaluation of efficiency of three NiTi instruments in removing gutta-percha from root canal during retreatment - An in vitro study. Endodontology 24(1):p 80-88, Jan–Jun 2012.

28. Kanaparthy A, Kanaparthy R. The Comparative Efficacy of Different Files in The Removal of Different Sealers in Simulated Root Canal Retreatment- An In-vitro Study. J Clin Diagn Res. 2016 May;10(5):ZC130-3. doi: 10.7860/JCDR/2016/17731.7845. Epub 2016 May 1. PMID: 27437347; PMCID: PMC4948523.

29. Kakoura F, Pantelidou O. Retreatability of root canals filled with Gutta percha and a novel bioceramic sealer: A scanning electron microscopy study. J Conserv Dent. 2018 Nov-Dec;21(6):632-636. doi: 10.4103/JCD.JCD_228_18. PMID: 30546209; PMCID: PMC6249936.

30. Kishore, K. Nanda; Varma, Madhu K; Sajjan, Girija S.; Satish, Kalyan R; Mohammad, Raheem; Dutta, Gnana Sindhu. Comparative Evaluation of Efficacy of Three Single File Retreatment Systems for Removal of Gutta Percha and Assessment of Root Canal Transportation - An In Vitro Study. Indian Journal of Dental Research 33(4):p 435-439, Oct–Dec 2022.