



## Measurement of Residual Material Remained in the Root Canals that Retreated by Different Rotary System

*Running title: Residual material remained after endodontic retreatment.*

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### Abstract

**Aims:** This study was aimed to measure the quantity of residual material remained in root canals after root canal system being retreated by rotary instruments of three types: EdgefileXR, D-RaCe, and R-Endo in teeth that their canals filled by either single cone method or the continuous wave compaction method. **Methods:** human mandibular cuspid teeth (n=60) had only one non curve canal were instrumented with file (25/0.04). Then, the teeth classified into two main groups depending on the technique that they were obturated with (thirty teeth for each group): A: single cone method and B: continuous wave compaction method. After that, other subcategories for each of the groups subdivided into three subgroups depending on the retreatment system that used (n=10/group) as following: A1, B1: D-RaCe, A2, B2: R-Endo, and A3, B3: EdgefileXR. The teeth were analyzed by using cone beam computed tomography with aid of AutoCAD software to evaluate the percentage of residual obturating material. We used both tests one way ANOVA and post hoc Duncan to analyze the data statically. **Results:** the results were found there was significant difference between D-race and other two rotary systems, while no significant difference between EdgefileXR and R-Endo in both technique of obturation. Also, this study reported there was no difference statically in the same rotary system in both techniques of obturation. **Conclusions:** All rotary retreatment systems left residual obturating material. EdgeFileXR rotary system is more effective among systems.

### Introduction:

Root canal retreatment of previously unsuccessful endodontic treatment is first choice for treating root canal failures.

Removing as much obturating material as possible from a poorly instrumented and obturated root canal system is necessary to

remove any remnants of necrotic tissue or bacteria that may play a major role in root canal failure<sup>(1)</sup>. The major purpose of endodontic retreatment is to reach to apical constriction by total removal of the obturating filling material, thereby allowing enough chemomechanical cleaning root canal system and facilitate proper obturation<sup>(2)</sup>. Currently rotary retreatment instruments had been used because they effective and time saving when compared with other techniques<sup>(3)</sup>. Currently EdgefileXR rotary retreatment files has been utilized for retreatment procedure. It was made of an annealed heat treated NiTi alloy. When its material treated by heat, mechanical properties could be improved<sup>(4)</sup>. R-Endo rotary retreatment files was used to remove obturating material because it has special design for retreatment with triangular cross section<sup>(5)</sup>. Also, D-RaCe rotary retreatment system has been used for removing root filling material. It contains of 2 instruments (DR1 and DR2)<sup>(6)</sup>. There are some problems associated with removing the filling material from root canal system. One of these is the difficult to remove old filling material completely after endodontic retreatment<sup>(7)</sup>. So, it is necessary to identify the effective rotary retreatment instruments with least problem<sup>(8)</sup>.

## Materials and Methods:

### 1.Prepared Samples:

Freshly extracted mandibular cuspid human teeth (n=60) with only single non curve canal had been used, and they placed in distilled water until needed for using. The criteria for chosen teeth checked by radiograph which must include: apices completely formed, diameter of the canal apically confirming to size twenty K-file, no calcification, no internal resorption, no caries or old endodontic treatment. Then teeth cleaned from any of debris and the teeth sterilized by put them in 2.5% sodium hypochloride<sup>(11)</sup>. Then, we used diamond disc bur to cut all crown of teeth to the length 16mm from the apex to give standardization aid. By the use high speed handpiece bur and with water spray for cooling access

preparation was done. After that, a K-file size 10 which was 1 mm passed below the apex of all canals to ensure the patency of them. Also, a K-file size 10 enter into the root canal system until it was appearing at the apex of the tooth. Then the working length (WL) is recorded 1 mm short from apex<sup>(12)</sup>. The teeth after that fixed in silicone impression material blocks and in order to give more standardization during preparation and filling the root canal the blocks were stabilized by bench vice. Preparation the canals of teeth with two Shape system by using file size 25 with taper 0.04 and the contra-angled rotary hand piece which was adjusted at 250 (rpm) speed and 2(N/cm) torque. Then we irrigate each canal with NaOCL 2% (5 ml) for two minutes during preparation phase, 5 mL of 17% EDTA for one minute after finishing preparatory phase and 5 ml distilled water for two minutes as final; irrigating solution to remove any remnant<sup>(13)</sup>. Then a paper points used to dry the canals.

### 2.Samples Grouping

The whole teeth divided into two main groups depending on the technique of obturation with thirty teeth for each group as follow:

- Group A: Single cone technique.
- Group B: Continuous wave compaction technique.

After that, another subdivision for both of the main two group into three groups (10 teeth for each subgroup) depending to the system used for retreatment as follow:

- Group A1 and B1: D-RaCe (FKG Dentaire, La Chaux-de-Fonds, Switzerland).
- Group A2 and B2: R-Endo (Micro-Mega, Besancon, France).
- Group A3 and B3: EdgefileXR (EdgeEndo, USA).

After obturating the root canals, all the teeth were filled coronally with composite (Ivoclar Vivadent, Liechtenstein), then the samples were separated from the blocks of silicon impression and then placed in incubator for 28 days at 37°C in 100% humidity<sup>(14)</sup>.

### 3. Assessment of Obturated Teeth by Cone Beam Computed Tomography before Endodontic Retreatment

The composite filling removed from each sample using high speed round bur. Then, all obturated teeth are implanted in box of wax of 2 cm length, 2 cm width and 2 cm height in order to be evaluated by CBCT images which had been taken with CS8100 equipment in the high-resolution dental mode at 90 kilo volt (KV), 3.2 millie amber (mA). A one photo (lateral view obtained in accordance with the teeth position), and a 360° scan will acquire afterward. The whole scans time will 15 sec. Images for each sample was obtained from three view (coronal with axial, and sagittal). The volume of the obturating material in the root canals analyzed by using the CS 3D Imaging software with aid of AutoCAD software (Sketchup, Startup company, USA) Fig. (1)<sup>(15)</sup>.

### 4. Retreatment Techniques

- Group (A1 and B1): D-RaCe rotary instruments had been employed: D-RaCe system has two files, the first one called DR1 which it's tip size 30 and it's taper 0.10 and the second files called DR2 which it' tip size 25 and it's taper 0.04. the first file used for desobturing the canal in coronal two thirds. The second files used for desobturing the canal in apical part. Retreatment procedure had been done for first file at a speed of 1000 rpm and torque of 1.5 N/cm according to manufacturer's instruction and second file DR2 at 600 rpm speed and a torque of 0.7 N/cm.
- Group (A2 and B2): R-Endo retreatment system had been employed. It has three instrument: The first one is R1 which it's tip size 25 and it's taper 0.08 used for desobturing the canal coronally, the second instrument is R2 which it's tip size 25 and it's taper 0.06 used for desobturing the canal in the middle third, the final instrument R3 which it's tip size 25 and it's taper 0.08 used for desobturing the canal in apical third. Retreatment procedure was conducted

at a speed of 300 rpm and a torque of 1.2 N/cm.

- Group (A3 and B3): EdgefileXR system had been employed. Retreatment procedure had been done as by using four files as follow the first one is R1 which it's tip size 25 and it's taper 0.12, the second file is R2 which it's tip size 25 and it's taper 0.08, the third file is R3 which it's tip size 25 and it's taper 0.06, and the final file is R4 which it's tip size 25 and it's taper 0.04 that must reach the full working length of the canal. Retreatment technique done at speed 400 rpm and a torque of 3 N/cm.

### 5. Assessment of Obturated Teeth by Cone Beam Computed Tomography after Endodontic Retreatment:

After the removal of obturation material from teeth. The CBCT images was taken as mentioned in previously and was recorded. The volume of the remained obturating material was assessed. The volume percentage of remained obturating material on canal walls after endodontic retreatment was measured by using following equation <sup>(15)</sup>. Volume % of residual obturation material = volume of residual obturation material after endodontic retreatment/ volume of obturation material in canal before endodontic retreatment ×100 Fig. (2).

### Results:

To see if there is any difference exist in the mean percentage of remaining obturating material. ANOVA and post hoc Duncan tests were performed. Results showed a significant difference ( $P$ -value  $\leq 0.05$ ) among groups that retreated by different rotary retreatment systems and between two groups obturated by different techniques. It was determined from ANOVA test that there is significant difference among retreatment files that used in teeth obturated by single cone technique. But, in order to know where the differences are were existed the post hoc Duncan test was done Table (1). Post hoc Duncan test showed that there was no difference statically between EdgefileXR and R-Endo rotary retreatment files. Moreover, it showed that there was

difference statically between both of D-RaCe and the other two rotary retreatment system Table (2). It was cleared from ANOVA test that there is significant difference among retreatment files that used in teeth obturated by continuous wave technique. But, in order to know where that the difference was presented the post hoc Duncan test was performed Table (3). Post hoc Duncan test revealed that there was difference statically between EdgefileXR and R-Endo rotary retreatment system. Beside this, results found that there is significant difference between both of (EdgefileXR and R-Endo) and D-RaCe group Table (4). Moreover, Independent t-test was used to compare the percentage of remnant filling material for each retreatment system in two obturation techniques. Results showed that there was no difference statically for the same system in both obturation techniques Table (5).

### **Discussion:**

Removing as much obturating material as possible from root canal systems necessary to uncover bacteria and debris that may be cause flare up and failure of the treatment<sup>(5)</sup>. There are many technique have been used to remove old obturating material from canals which include hand files, ultrasonic instruments and lasers<sup>(3,16,17)</sup>. Recently in the endodontology, the trend toward the use of Ni-Ti rotary files<sup>(18)</sup>. There are many benefits of using Ni-Ti of rotary instrument which includes reduced working time, efficient, and reduced dentist fatigue whereas disadvantages include lack of tactile sensation during using that led to higher incidence of file fracture<sup>(19,20)</sup>. D-RaCe, R-Endo and EdgefileXR rotary retreatment were selected in this study because they are safer, faster, and especially design for more removing of obturating material as it is claimed by their manufacturers and all of this rotary system, the final instrument of it had (25/0.04) which gives more standardization. In the current study, there is no instrumentation was used after removal of obturating material because this may lead to increase in the diameter of the canal and made all canal similar which

can give unreliable comparison between files and give inaccurate result. Methodology of present study is nearly similar to studies that had been performed by<sup>(21,22)</sup>. There are many methods used to evaluate residual obturating material after endodontic retreatment such: radiograph, splitting root longitudinally, and evaluating residual obturating material with evaluation scales, and the recent method micro-CT scanner<sup>(1,23,24,25,26)</sup>. Among them CBCT images may give important knowledge in the volumetric assessment of the amount of obturating material left in root canals after endodontic retreatment procedures<sup>(27)</sup>. To get more standardization during these procedures, only one observer conducted the experiment in the our study. From the results of the current experiment, all rotary retreatment instrument left obturating material inside the canal after the procedure, especially at apical third of the canals that was noticed in most of the samples used, this is similar to studies by<sup>(19,28)</sup>. This result may be related to the fact, that the morphology of root canal system made difficulty of removing obturating material in some regions of the root especially in the apical third due to the presence of deep grooves, lateral canal and depressions. While this result disagrees with an experiment that had been done by other authors<sup>(29,30)</sup>. Which may be due to the use of radiographic method for evaluation of filling remnants which is not very accurate. The result of this study revealed that mean percentage of remaining obturating material after endodontic retreatment with single cone obturation groups were less than continuous wave obturation group. This mean that EdgeFileXR instrumentation was more effective than R-Endo and D-Race groups in removing of obturating material. Whereas no significant difference was exited between the R-Endo and EdgeFileXR system, but EdgeFileXR was statistically different from D-Race. Moreover, the more residual material remained in the root canals found in D-Race groups. The better performance of EdgefileXR instruments in the current study, may be because they are made of an annealed heat treated Ni-Ti alloy brand

named Fire Wire™. The heat treated which may lead to improve strength and mechanical properties of the files. Also, R-Endo system claimed that the file has special designed for retreatment procedure as they have three equally spaced cutting edges, no radial land and active tip. Also, this result may be attributed to the number of files, that mean when increase the number of files in the system, the effectiveness of the system was increased. Furthermore, the results of the current study confirm the finding that had been performed by Tomer et al. (2017)<sup>(4)</sup> who compared between three rotary retreatment systems (EdgefileXR, Mtwo R, and R-Endo) to measure amount of residual filling material after retreatment in vitro study. They found that teeth retreated with the EdgeFileXR files has less obturating material remained in the root canal among testing groups. Also, R-Endo left almost nearly same quantity of obturating in the canal walls compared with EdgefileXR. But there were no enough studies comparing the effectiveness of the EdgefileXR files to other retreatment files used for retreatment in root canals. The previous study is the only study found for EdgefileXR. Consistent with result of present study Tasdemir et al. (2008)<sup>(29)</sup> compared three rotary Ni-Ti instruments (ProTaper, R-Endo, and Mtwo R) in term of remained obturating material after retreatment. Results showed that ProTaper files left less obturating material inside the root canals than the other groups, but significantly not different from R-Endo, and statically different was exit between ProTaper and Mtwo groups. This study was also in agreement with study that had been conducted by Raj et al. (2018)<sup>(6)</sup> which found that ProTaper instruments were the more effective than D-RaCe files in term of removing obturating material from middle third of root canal. While the findings of current study were inconsistency with study that was achieved by Gokturk et al. (2013)<sup>(5)</sup> who compared different rotary retreatment systems during root canal retreatment (Hedstom file, R-Endo, Mtwo R, ProTaper universal retreatment, and D-RaCe system), and found no significant difference between the different rotary systems in the removal

of filling material along root thirds. This can be attributed to the use of radiographic technique for evaluation, which is not accurate, because it provides only 2D information on a 3D object. Also, the result of this study disagrees with result that had been performed by Unal et al. (2009)<sup>(30)</sup> which reported that manual and ProFile instruments more effective than ProTaper and R-Endo retreatment files in term of the removal filling material from canal walls and this may be due to the using of selected teeth with curved canals which could be affected the results and to the using of retreatment systems differ from present study. Another study that had been done by Bhagavaldas et al. (2017)<sup>(31)</sup> concluded that the D-Race is more effective than Mtwo R in removing obturating material. They said that these differences because the higher rpm of D-Race system when compared to the rpm used for Mtwo R rotary retreatment instrument, and removing of obturating material requires higher rpms than that for cleaning and shaping. In current study the percentage of residual material is higher after removing obturating material from teeth filled by continuous wave compaction method compared to the quantity of residual material after the removal of obturating material from teeth obturated by single cone method using different retreatment files (D-Race, R-Endo, and EdgefileXR), but without any significant difference. There are many previous studies estimated and compared (sealing ability and volume of obturation) between two obturation methods (single cone and continuous wave) and concluded that there were no differences between them<sup>(32,33)</sup>. Therefore, the previous results can be a cause for explanation of no significant differences for the same retreatment system in both obturation techniques used in current study for the percentage of remnants left inside the canals. Beside this, Prasad et al. (2018)<sup>(5)</sup> reported that the types of obturation materials affect the difficulty of retreatment when compared retrievability of different obturation materials (Resilon and C-points) by different rotary systems. However, in our study similar material was used for two obturation techniques.

So, this may explain that the retrievability effected by the types of obturation materials used, but not by the techniques of obturation that were used.

retreatment systems used (D-RaCk , R-Endo, and EdgefileXR). Also,EdgefileXR rotary retreatment system proved to be more effective in removing root obturation material than other systems (D-RaCe and R-Endo).

**Conclusion:**

Residual obturation material was remained in the root canals after endodontic treatment with any of the rotary

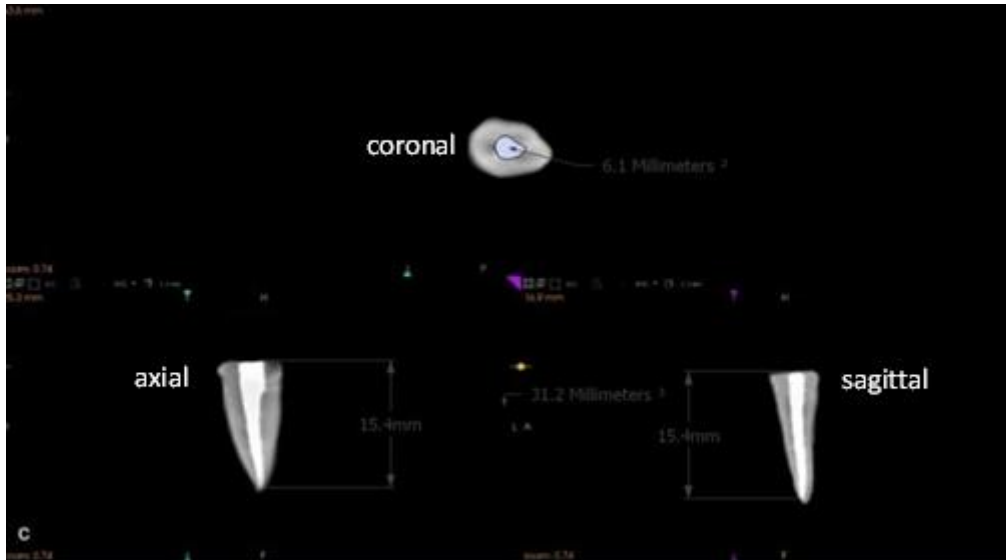


Fig. (1): Volumetric measurement of root canal filling before retreatment.

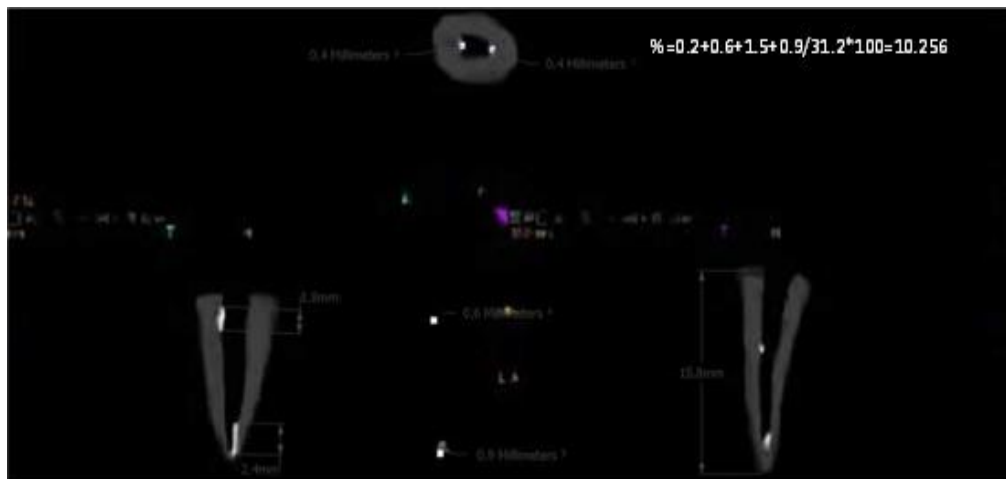


Fig. (2): Volumetric and percentage measurement of residual root canal filling after retreatment.

Table (1): ANOVA test for percentage of remaining obturating material using single cone technique.

|                       | Sum of Squares | df* | Mean Squares | F-value | P-value** |
|-----------------------|----------------|-----|--------------|---------|-----------|
| <b>Between Groups</b> | 23.072         | 2   | 11.536       | 15.131  | 0.000     |
| <b>Within Groups</b>  | 20.585         | 27  | 0.762        |         |           |
| <b>Total</b>          | 43.656         | 29  |              |         |           |

\*df= degree of freedom.

\*\* $P \leq 0.05$  mean significant variation exist.Table (2): Duncan<sup>a</sup> test for percentage of remaining obturating material using single cone technique.

| Retreatment systems | Mean(%)±SD | Duncan Grouping |
|---------------------|------------|-----------------|
| <b>D-RaCe</b>       | 13.36±0.47 | B*              |
| <b>R-Endo</b>       | 11.91±1.39 | A               |
| <b>EdgefileXR</b>   | 11.29±0.59 | A               |

\*The variable letters mean significant difference exist.

Table (3): ANOVA test for percentage of remaining obturating material using continuous wave obturation technique.

|                       | Sum of Squares | df* | Mean Squares | F-value | P-value** |
|-----------------------|----------------|-----|--------------|---------|-----------|
| <b>Between Groups</b> | 23.934         | 2   | 11.967       | 20.488  | 0.000     |
| <b>Within Groups</b>  | 15.771         | 27  | 0.584        |         |           |
| <b>Total</b>          | 39.704         | 29  |              |         |           |

\*df= degree of freedom

\*\* $P \leq 0.05$  mean significant variation exist.Table (4): Duncan<sup>a</sup> test for percentage of remaining obturating material using continuous wave technique.

| Retreatment systems | Mean(%)±SD | Duncan Grouping |
|---------------------|------------|-----------------|
| <b>D-RaCe</b>       | 13.67±0.77 | B*              |
| <b>R-Endo</b>       | 11.95±0.96 | A               |
| <b>EdgefileXR</b>   | 11.64±0.48 | A               |

\*The variable letters mean significant difference exist.

Table (5): Independent t-test for percentage of remaining obturating material for each retreatment system in two obturating techniques.

| Retreatment systems | Techniques of Obturation | Mean(%)±SD* | P-value* |
|---------------------|--------------------------|-------------|----------|
| <b>D-RaCe</b>       | Single cone              | 13.36±0.47  | 0.135    |
|                     | Continuous Wave          | 13.67±0.77  |          |
| <b>R-Endo</b>       | Single cone              | 11.91±1.39  | 0.165    |
|                     | Continuous Wave          | 11.95±0.96  |          |
| <b>EdgefileXR</b>   | Single cone              | 11.29±0.59  | 0.859    |
|                     | Continuous Wave          | 11.64±0.48  |          |

\* $P \leq 0.05$  mean significant variation exist.

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