



Comparative Evaluation of Three Rotary Retreatment Systems for Apical Extrusion of Root Canals Obturated with Different Techniques

Running title: Apical extruded debris after endodontic retreatment.

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Abstract

The aim of this study was to evaluate the quantitative amount of apically extruded debris after endodontic retreatment using three retreatment rotary systems D-RaCe, R-Endo, and EdgefileXR in the teeth obturated by two techniques (single cone and continuous wave compaction). Sixty human mandibular premolars with single straight root canals were prepared by 2Shape endodontic rotary system with file size (25/0.04). After that, samples were divided into two groups according to the technique of obturation used (n=30/group): A: single cone and B: continuous wave compaction. Then, further random subdivision for each group into three sub groups according to the system used for retreatment (n=10/group) as follow: A1,B1:D-RaCe, A2,B2:R-Endo, and A3,B3: EdgefileXR. Prewieghed Eppendorf tubes were used to collect the apical extruded material during endodontic retreatment. Then, Eppendorf tubes were stored in an incubator at 68C for 5 days. The weight of extruded debris was calculated by subtracting the weight of the empty tube from the weight of the tube containing the extruded debris. Data were analyzed statistically using one way ANOVA analysis of variance and post hoc Duncan test. EdgeFileXR and R-Endo were significantly not different, but significantly different from D-race in two obturation technique. Also, result showed that the same system exhibited no difference in both obturation techniques. All retreatment techniques resulted in apical extrusion debris. Also, it was concluded that the techniques of obturation had no significant effect in the amount of apical extruded debris by different retreatment systems used in this study.

Introduction:

Even with the newest materials and techniques that were used in endodontic

treatment, failures in root canal therapy are sometimes unavoidable and in this

case it is essential to retreat the tooth ⁽¹⁾. The failures of root canal treatment might occur due to many causes such: presence of microorganisms in the root canal system as a result of improper chemo mechanical cleaning, improper obturation, or in cases of lack of coronal or apical seal ⁽²⁾. When the failures of endodontically treated tooth occur, treatment options involve: non-surgical retreatment, surgical retreatment, or extraction. Despite good results of surgical retreatment, now the preferred treatment is a conservative nonsurgical treatment ⁽³⁾. Recently new technique has been introduced which include nickel-titanium (NiTi) retreatment rotary files that have the advantages of more effective and save the time when compared with manual techniques ⁽⁴⁾. EdgefileXR rotary system has been recently introduced into the market to be used for retreatment. It was manufactured of an annealed heat treated NiTi alloy brand named fire wire. Its mechanical properties could be improved with heat treatment ⁽⁵⁾. R-Endo rotary retreatment was another system that has been introduced with special design to remove root filling material. It has triangular cross section. This system was used in a gentle in and out motion on the canal walls ⁽⁶⁾. Also, D-RaCe rotary retreatment system has been used for retreatment procedures. It consists of 2 files (DR1 and DR2), with triangular cross sections ⁽⁷⁾. The apical extrusion of debris is a main problem that occur during retreatment procedure which may lead to post treatment pain ⁽⁸⁾. During instrumentation and irrigation of root canals, dentin chips, residue of pulp tissue, and bacteria can be transported to the apical foramina of the canal and forced out into the periapical tissues ⁽⁹⁾. Apically extruded debris may cause for postoperative discomfort, pain, and flare-up and even failure of the therapy ⁽¹⁰⁾. Moreover, when quantity of extruded debris increase, which may result in a greater inflammatory reaction ⁽⁸⁾. The apically extrusion material popular to all chemo-mechanical preparation techniques, but the quantitative of apical extruded debris differs accordingly with the types of file and instrumentation technique. Many factors, such design of the instrument, type

of irrigants used, speed of instrumentation, etc. play an essential role in apical extrusion ⁽¹¹⁾. So that, it is essential to know the good rotary system that will permit to remove the root filling material effectively with less postoperative problems ⁽¹²⁾. Therefore, this study was aimed to evaluate and compare the amount of apically extruded debris the root canal after using three rotary retreatment systems (D-Race, Re-Endo, and Edge file XR) in the teeth obturated by two techniques (single cone and continuous wave compaction). The null hypothesis of this study, that there were no significant differences between tested systems for the amount of apical extruded debris in the root canals obturated by two techniques after endodontic retreatment. Also, there was no significant difference for each system among different obturation techniques used.

Materials and Methods:

Prepared Samples:

Sixty mandibular premolar human teeth with one straight canal recently extracted for orthodontic aim had been selected, and they kept in distilled water at room temperature till needed for employing. Radiographs were taken for these teeth to test the criteria for chosen teeth which must have: fully formed apices, apical diameter confirming to size 20 K-file (Dentsply Maillefer, Switzerland), canal not calcified, absence of internal resorption, and the teeth free from caries or old root canal treatment ^(13, 14). Then teeth cleaned from plaque, calculus and other remnant of debris and placed in 2.5% NaOCL (Chloraxid, Medical company, Poland) solution for 8 hours for sterilization ⁽¹⁵⁾. Then, all teeth decoronated to a length of 16mm from the apex as determined by digital vernier (China) using diamond disc bur (KG Sorensen SP, Brazil) for standardization purpose. Access preparation had been done by using high speed bur and cooling by water spray. Then, a size 10 K-file (Dentsply Maillefer, Switzerland) passed 1 mm under the apex of all canals to make sure of the apical patency of the canals. The same file reentered into the canals till

being seen at the apical foremen and the working length (WL) had been recorded shorter 1 mm from apical foramen ⁽¹⁶⁾. Then all teeth put in a blocks of silicone impression material of 2 cm length, 2 cm width and 2.5 cm height. Then a blocks of silicone impression material were fixed by bench vice in order to give more control and standardization during instrumentation and obturation technique. Instrumentation of root canals had been done with the 2Shape (TS; MicroMega, Besancon, France) endodontic rotary system by contra-angled rotary hand piece (X-smart plus, Dentsply Maillefer, Switzerland). The speed was maintained at 300 (rpm) and 1.2(N/cm) torque and all canal prepared by single files (25/.04). Sodium hypochlorite 2% (5 ml, 2 minutes) for each canal was employed as irrigating solution. After canal preparation completed, the canals rinsed with 5 mL of 17% EDTA (PD, Switzerland) for 1 minute. A final rinse of 5 ml distilled water for 2 minutes was used to remove any remnant of the irrigating solution ⁽¹⁷⁾. Then the canal was dried using a paper points size (25/.04).

Samples Grouping

All the samples assigned randomly into two groups according to the technique of obturation used with 30 samples for each as follow:

- ❖ **Group A:** Single cone.
- ❖ **Group B:** Continuous wave compaction.

Then, further random subdivision for each group into three sub groups according to the system used for retreatment with 10 samples for each 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).

Techniques of Obturation:

Obturation technique in each group was performed as follow:

Group A (Single cone): A size (25/.04) gutta-percha placed into the root canal to check working length and test

tug-back. AH plus sealer placed inside the canal by using paper point. The gutta percha cone also coated with sealer and placed into the canal and heated spoon excavator used to remove access gutta percha filling material ⁽¹⁸⁾.

Group B (Continuous wave compaction): The gutta-percha cone size (25/.04) introduced in the canal 1mm short of the working length and tug back tested. Then the AH plus sealer applied in the canal walls. The tip of the cone coated with sealer and placed in the canal. A system B heat source at 200°C was set. A medium- size tip plugger placed on the System B heat source with a rubber stop set at 3–5 mm short of the working length. After removing the coronal and middle portions of the gutta percha fillings material, followed by injecting gutta percha in 3-mm increments into the canal. A cordless gutta percha obturation gun with #23-gauge needle was set on 180°C and gutta-percha pellets and pluggers used for back filling ⁽¹⁹⁾.

After obturations, all the samples were sealed coronally with tetric N-ceram composite resin (Ivoclar Vivadent, Liechtenstein), and then the roots were removed from the blocks and were incubated for 4 weeks at 37°C in 100% humidity by placing them in gauze moisten with distilled water to simulate the clinical procedure as possible ⁽²⁰⁾.

Evaluation of Apical Extruded Debris:

Debris collection apparatus was set up according to the study by Myers and Montgomery ⁽²¹⁾. Apical 2/3 of each root put in pre weight Eppendorf tube (Eppendorf AG, Germany) for endodontic retreatment and debris collection. Digital microbalance (Adam Equipment, PW 124, UK) used for weighing the tube. The root fix in the tube. After that, specimen, and adjust Eppendorf tube, placed on the opening of 10 ml glass vial, in order to avoid contamination of the tube. Needle with 27 gauge placed in tube by passing it to equalize the internal and external pressures Fig. 1. After that, retreatment technique in each group was conducted according to the manufacture's instruction using Endomate micromotor (X-smart

plus, Dentsply Maillefer, Switzerland) as follow:

Group (A1 and B1): D-RaCe retreatment files used as follows: D-RaCe rotary retreatment system has 2 instrument, DR1 (30/0.10) and DR2 (25/0.04). DR1 used for removal obturation material in coronal two thirds of the canal. DR2 used for the removal obturation material in apical third until reach the full working length. Retreatment had been conducted for DR1 at a speed of 1000 rpm and torque of 1.5 N/cm, and for DR2 at 600 rpm speed and a torque of 0.7 N/cm:

Group (A2 and B2): R-Endo rotary retreatment instrument used. It contains three files: R1 (25/0.08) used for removal obturation material in cervical third, R2 (25/0.06) used for removal obturation material in middle third, R3 (25/0.04) used for removal obturation material in apical third and reaching to full working length. Retreatment had been done at a speed of 300 rpm and a torque of 1.2 N/cm.

Group (A3 and B3): EdgefileXR rotary retreatment files used. It conducted with following sequences R1 (25/0.12), R2 (25/0.08), R3 (25/0.06), and R4 (25/0.04) until get full working length of the canal. Retreatment employed at speed 400 rpm and a torque of 3 N/cm.

The total volumes of irrigant are 12 mL of distilled water for each tooth. Retreatment was deemed complete when no debris of gutta percha/sealer was visible on the instrument surfaces, canal walls smooth, and the working length was reached. Each system will use for 5 canals and then discard.

After the retreatment procedure completed, teeth removed from the tube and apical part of each root surface washed with 0.1 mL of distilled water into the tube, in order to removing debris that remain adhere to the root. After the removal of the specimens, the collecting tubes placed in an incubator at 68°C for 5 days to evaporate the moisture before weighing the dry debris⁽²²⁾. A digital microbalance with an accuracy of 0.0001 mg was used for weighing the tubes. The weight of extruded debris will calculate by subtracting the weight of the empty tube

from the weight of the tube containing the extruded debris.

Results:

The minimum, maximum, mean values and the standard deviation for the weight of apical extruded material by various systems of retreatment techniques are seen in Table (1). It was shown that apical extruded material when EdgefileXR rotary retreatment files was used in single cone obturation technique had the lowest mean apical extruded material, followed by the group that was retreated with EdgefileXR retreatment files in continuous wave group. Moreover, results were shown that using any of the three rotary retreatment system (D-RaCe, R-Endo, and EdgefileXR) for removal of obturating material when single cone technique was used result in apical extruded material (0.0037, 0.0021, 0.001780) that are less than the groups that are retreated by the same retreatment systems when continuous wave compaction technique was employed (0.0038, 0.0022, 0.00189). To investigate if there is any difference exist in the mean apical extruded material. ANOVA and post hoc Duncan tests were performed. Result showed a significant difference (P-value < 0.05) among groups that retreated by different retreatment systems and between two groups filled by two techniques. It was found ANOVA showed that there was significant difference among retreatment files that used in canals obturated by single cone and continuous wave techniques. However, to know where is the difference exist Duncan test was used Table (2). Post hoc Duncan test revealed that there is no significant difference between EdgefileXR and R-Endo rotary retreatment system that used in teeth obturated by different techniques (single cone and continuous wave). Also, it was shown that there is significant difference between both (EdgefileXR and R-Endo) and D-RaCe group in the teeth obturated by the two techniques (single cone and continuous wave). However, there was no significant difference between the same files that were used in two obturation

techniques (single cone and continuous wave) Table (3).

Discussion:

During endodontic retreatment, debris extruded apically which contain organic and inorganic remnants, irrigants, and remnants of obturating material (gutta-percha and sealer) which can lead to an unfavorable result⁽²³⁾. The quantity of apical extruded material by different instrumentation techniques in root canal retreatment procedure has been studied thoroughly⁽²⁴⁾. The amount of apical extruded debris depends on many factors such as: the tooth, irrigation solution, instrumentation technique, files type, and size and preparation endpoint^(8, 24, 25, 26, 27). On the other way, there are numbers of studies compared amount of apically extruded debris when using Ni-Ti rotary instruments and conventional techniques and they reported favorable effects and better result of Ni-Ti rotary instruments (on each procedure's preparation or retreatment)^(28, 29). Irrigation is important and indispensable phase in instrumentation, although studies showed when used irrigation during instrumentation produced more debris than did instrumentation without irrigation⁽³⁰⁾. In the present study, we used distilled water instead of NaOCl as an irrigation solution to prevent any crystallization of NaOCl⁽⁸⁾. There several Methods used to measure the apical extruded debris such: qualitative method and visual evaluation^(31, 32, 33). The qualitative method is more accurate than visual method because one cannot have accurate insight in the amount debris extruded apically⁽²⁹⁾. In the current study, quantitative method to measure apical extruded material gave numerical results comparable to results of other studies by other authors^(34, 35). When compare various rotary instruments retreatment, higher amount of apically extruded debris was recorded. Which is consistent with results of other authors^(22, 36). Hence, the aim of current study was to evaluate the effect of three retreatment systems (D-RaCe, R-endo and EdgeFile XR rotary retreatment systems) on the amount of apically extruded debris.

We found in this study EdgefileXR files caused less apical extrusion of debris than any of the rotary NiTi retreatment systems. Also, we found there was no significant difference between EdgefileXR and R-Endo groups that used in canals filled by two techniques (single cone and continuous wave). Moreover, there was a significant difference between both of (EdgefileXR and R-Endo) and D-RaCe group in teeth filled by single cone and continuous wave techniques. Beside this, it was found that there was no significant difference between the same files that were used in single cone and continuous wave obturation techniques. This might arise because, although all final files have the same size tip and taper (25/0.04), EdgeFile XR made of an annealed heat treated Ni-Ti alloy which is new technology introduced to the market. Similarly, Uzunoglu et al.⁽³⁶⁾ reported EdgeFile XR was associated with less apical extruded material compared D-RaCe during retreatment and the previous study considers the only study found on EdgeFile XR regarding apical extruded material. Also, we found R-Endo files caused less apical extrusion than D-RaCe group this due R-Endo are designed especially for retreatment and their cross-section is characterized by three equally spaced cutting edges; the instrument has neither radial lands nor an active tip the same result by another compare of apically extruded debris between three group (Hedstrom, K3, and R-Endo)⁽³⁷⁾. Also, in our study The D-RaCe group revealed greater extruded debris than other two groups, this may due to the DR2 instrument was used at high speed of 600 rpm in the apical third which may lead the gutta-percha and sealer were extruded apically more than other groups which final files have less speed our study compliance with the results of other authors⁽⁶⁾. Contrary to our results, other authors found there was no significant difference between D-RaCe and R-Endo groups this may due to instruments have designed for retreatment (triangular cross sections and noncutting tips) and the same size tip and same taper (25/0.04)^(22, 28).

In present study the amount of apical extruded material is greater after removing gutta percha from teeth obturated by continuous wave compaction technique compared to the amount of apical extruded material after the removal of gutta-percha from teeth obturaed by single cone technique using three rotary retreatment system (D-Race, Re-Endo, and Edge file XR), but without any significant difference. This mean the type of obturation techniques not affect the amount of apical debris material. Although, no studies have been found to compare the amount of debris material during endodontic retreatment of teeth obturated by two techniques (single cone and continuous wave compaction technique). But our study compliance with

the results of other authors that compared amount of apical extruded material during different obturation techniques (15, 32, 38, 39).

Conclusions:

All retreatment techniques resulted in apical extrusion debris. Also, it was concluded that the techniques of obturation had no significant effect in the amount of apical extruded debris by different retreatment systems used in this study. Further study is required to verify this study specially on EdgeFile XR system, because it of an annealed heat treated Ni-Ti alloy which is new technology introduced to the market.



Fig.(1):- Modal system used for evaluation of apical extruded debris.

Table (1):- Descriptive statistics of apical extruded debris.

Techniques of Obturation	Retreatment Systems	No.	Mean (gm)	±SD	Minimum (gm)	Maximum (gm)
Single Cone	D-RaCe	10	0.0037	0.00054	0.0031	0.0048
	R-Endo	10	0.0021	0.00021	0.0018	0.0024
	EdgefileXR	10	0.0017	0.00024	0.0014	0.0021
Continuous Wave	D-RaCe	10	0.0038	0.00045	0.0032	0.0045
	R-Endo	10	0.0022	0.00041	0.0016	0.0028
	EdgefileXR	10	0.0019	0.00050	0.0011	0.0027

Table (2):- ANOVA test for percentage of remaining obturating material using single cone and continuous wave techniques.

	Sum of Squares	df ^{**}	Mean Squares	F-value	P-value ^{**}
Between Groups	47.877	5	9.575	14.223	0.000
Within Groups	36.355	54	0.673		

*df= degree of freedom

**P<0.05 mean significant variation exist.

Table (3):- Duncan^a test for percentage of remaining obturating material of different retreatment systems using single cone and continuous wave techniques.

Techniques of Obturation	Retreatment Systems	Mean(%)±SD	Duncan grouping
Single Cone	D-RaCe	13.36±0.47	B*
	R-Endo	11.91±1.39	A
	EdgefileXR	11.29±0.59	A
Continuous Wave	D-RaCe	13.67±0.77	B
	R-Endo	11.95±0.96	A
	EdgefileXR	11.64±0.48	A

*The variable letters mean significant difference exist

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