EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 68, 3981:3988, OCTOBER, 2022
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
CONSERVATIVE DENTISTRY AND ENDODONTICS
Submit Date : 27-06-2022 • Accept Date : 23-07-2022 • Available online: 01-10-2022 • DOI : 10.21608/edj.2022.147100.2169

ASSESSMENT OF APICALLY EXTRUDED DEBRIS DURING ROOT CANAL RETREATMENT USING TWO DIFFERENT FILE KINEMATICS (AN IN-VITRO STUDY)

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ABSTRACT

Objective: The study intended to assess the amount of the apical-debris extruded using two different file kinematics during the retreatment procedure on mandibular premolars.

Methodology: A total number of 40 extracted mandibular premolars (single root -single canal) were disinfected by sodium hypochlorite, and decoronated to attain a length of 19 mm for each tooth to ensure standardization. Root canal treatment was done to all roots then, roots were kept for 1 week at 100% humidity and 37 °C to allow for proper setting of sealer. Teeth were coded and randomly assigned into two groups corresponding to the technique of retreatment; group I: Mtwo Retreatment files and group II: Reciproc 25 single file. Extruded debris was collected in Eppendorf tubes which were then weighed after incubation for 15 days at 37^{0}C. The time required for removal of gutta-percha was recorded.

Results: For assessment of the amount of debris extruded following retreatment, results showed insignificant difference between the tested groups at p=0.470. For time of preparation, group I (M Two) showed more time consuming compared to group II (Reciproc) at p=0.023.

Conclusion: Both Reciproc and Mtwo retreatment systems were efficient in retreatment procedure. Both systems resulted in extrusion of debris with no significant difference between them. While the Reciproc significantly shortened the time of preparation compared to the Mtwo system.

KEYWORDS: Apical extrusion, Mtwo, Reciproc, Retreatment

INTRODUCTION

Non-surgical retreatment is advised as the first treatment option, when preliminary root canal treatment fails [(1)]. It is usually more challenging and needs more time than the initial treatment itself [(2)]. Even though various techniques and improvements in instruments' design, kinematics, number, and innovation in irrigation systems had evolved,

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extrusion of debris past the apical foramen stays a challenge. Endodontic retreatment is associated with, the extrusion of debris, like dentin chips, irrigants, filling materials, pulp remnants, bacteria, and their by products [3,4]. The apical extrusion phenomenon is an unfavorable condition resulting from instrumentation procedures that may disturb the equilibrium between the microbial virulence and the host defense mechanism, initiating an inflammatory reaction causing postoperative pain and delaying the periapical healing [5-7]. Though apical extrusion of debris (AED) and irrigants have been noted with all root-canal preparation techniques, less AED has been allied with rotary instrumentation than with manual instrumentation techniques [8-10]. These undesirable consequences highlight the importance of reducing debris extrusion [11].

Several rotary systems have been introduced specially for retreatment practices. One of those systems is the Mtwo Retreatment system (Mtwo R) (VDW, Munich, Germany) which is operated with an engine driven motor in continuous rotation. The Mtwo system includes 2 files having cutting tips, and with constant helical angle [12].

By introducing reciprocation-based systems, new perceptions of root canal preparation have been set up. Several reports showed that reciprocation has performed better than conventional rotary preparation in some respects. The reciprocating motion lessens the stress to which the instrument is subjected by counterclockwise and clockwise motions. The reciprocating instruments have extended durability with improved resistance to cyclic fatigue when compared to continuous rotation motion [13, 14]. Although reciprocating systems were not designed originally for retreatment and removal of gutta-percha (GP), their use is effective due to the high capability of this special motion in proceeding towards the apex [15]. Moreover, the use of a single file is favored over the use of multiple file systems. Studies showed that, utilizing a single reciprocating file was as efficient as multiple rotary files for GP and sealer removal altogether in a faster way [16,17].

The Reciproc system (RC) (VDW, Munich, Germany) is a single NiTi file, which is developed for root canal preparation with reciprocating motion. Several studies evaluated the effectiveness of Reciproc instruments during retreatment [16, 18-19]. Since there is an elevated interest in this new model for root canal preparation, the impact of a single reciprocating file in respect of AED has also been evaluated [4, 20].

The present study planned to assess the amount of AED using two different file kinematics; rotation and reciprocation during retreatment procedure on mandibular premolars, as well as to compare the retreatment time elapsed for each technique. The null hypothesis investigated was that there were no significant differences in the amount of AED between the two assessed systems.

MATERIALS AND METHODS

Calculation of the sample size:

PS software was used to calculate the sample size. Considering the primary outcome (AED), we found that 20 teeth in each group were an appropriate sample size for the study with a total sample size of 40 teeth (n=20). The power is 80% and α error probability =0.05. The magnitude of the effect to be detected was estimated as the mean and standard deviation of the variable of interest and obtained from the scientific literature *provided by Dincer et al, 2015* [21].

Sample selection:

A total number of 40 extracted mandibular premolars having single root and single oval-shaped canal with completely formed apices were selected. Initial radiographs were taken in two dimensions; buccolingually and mesiodistally to ensure the presence of a single oval canal with no calcification,

root fracture, cracks, and/or internal resorption. External root surfaces were thoroughly cleaned from adherent tissues and hard deposits using ultrasonic scaling. Afterward, samples were disinfected with sodium hypochlorite (NaOCl) for 30 minutes and stored in saline solution until further use.

Root canal preparation

The selected teeth were decoronated partially to reach a uniform length of 19 mm for each tooth to ensure standardization. Access to the orifice endodontic access cavities was done using a high-speed carbide bur (Dentsply Sirona, Ballaigues, Switzerland) under coolant. Checking root canal patency was done using K-file size #10, then the working length (WL) was detected by passing K-file size #10 through the apical foramen and then withdrawing it for 1 mm. The root canals were prepared using ProTaper Next rotary system; X1, X2, and X3 were used sequentially to full WL (according to manufacturing instructions) with an X-smart endodontic motor (Dentsply Sirona, Ballaigues, Switzerland). The root canals were copiously irrigated with 15 mL of 5.25% NaOCl during preparation. While after preparation, the root canals were irrigated with 3 mL of 17% EDTA solution for 1 minute to remove smear layer followed by 5 mL of distilled water and dried with paper points then filled with X3 gutta percha points and resin-based sealer (AD Seal; Meta-Biomed, Cheongwon, Korea) by lateral compaction technique. Then, the access cavities were sealed with Cavit (3M ESPE, Seefeld, Germany). Radiographs were taken to ensure adequate filling of the root canal. Afterward, the filled teeth were stored at 37 °C and 100% humidity for 7 days to ensure the proper setting of the sealer..

Grouping of samples

Teeth were coded and randomly assigned into two groups according to the retreatment technique; group I (n=20): Mtwo Retreatment files and group II (n=20): Reciproc 25 single file.

Group I (MTwo retreatment files): Mtwo R (#15 .05 and #25 .05) were operated according to the manufacturer's instructions with a gentle in and out motion till reaching the full working length.

Group II (Reciproc 25 file): R25 file (#25 .08) was used till reaching the full working length.

For each tooth, 20 mL of distilled water was used for irrigation between files during the retreatment procedures. Retreatment was considered complete when there was no gutta percha or root canal sealer visible on the surfaces of the instrument and the walls of the root canal were smooth. A dental operating microscope (Zeiss OPMI; Carl Zeiss, Jena, Germany) was used during the procedure for inspection of the canal walls. All steps of the procedure were done by the same operator to avoid inter-operator variability.

Collection of debris

The experimental model which was used to evaluate apical extrusion of debris was taken from a previous study by *Myers and Montgomery*[22] (Figure 1). An Eppendorf tube (Eppendorf AG,

Fig. (1): Assembly for apical extrusion of debris

Hamburg, Germany) was assigned for each tooth according to the instrument used. First, the Eppendorf tube was individually weighed using an analytical balance with accuracy of 10^{-5} gm (AUW-220D; Shimadzu, Tokyo, Japan). Three successive weighings were done for each tube, and the means of the three weights obtained were considered as the initial weight of the Eppendorf tube. A hole was done on a separated Eppendorf tube cap, and the roots were inserted through the hole under pressure and stabilized at the cementoenamel junction using cyanoacrylate (Quickstar; Furkan, Istanbul, Turkey) to prevent the unintentional leakage of the irrigating solution. Then, the separated caps with the teeth were fitted over the pre-weighed Eppendorf's. The Eppendorf tubes were fitted into vials covered by black tape to blind the operator concerning the production of debris apically during root-canal preparation. A 27 Gauge needle was inserted into the Eppendorf cap to equalize the internal as well as the external pressure. After the root canal filling removal procedure, the separated cap with the tooth was removed from the tube, and the root was rinsed with 1 mL of distilled water to collect the debris that had stuck to the external surface of the root. Then, all tubes were plugged and incubated for 15 days at 37°C to allow complete evaporation of the remaining irrigation solution from the tubes. After the 15 days of incubation, a final weighing was done in the same way as the initial weighing. The weight of the extruded debris was determined by deducting the initial weight of the empty Eppendorf's from the final weight. The time spent for gutta-percha removal was recorded accurately for each tooth. Time measurements were done by the same operator.

Statistical analysis:

The available Data were checked for normality by the Shapiro-Wilk test. For time and debris extrusion, Mann Whitney U-test was used to compare between tested groups. The significant level was set at 0.05 (IBM SPSS, Ver 23, Armonk, NY, USA).

RESULTS

Weight of AED (in gm)

For the evaluation of the amount of AED following retreatment, the statistical results showed insignificant difference between both Mtwo R and RC at p=0.470 (Table1, figure 2).

Time of preparation (in minutes)

For time of preparation, group I (M Two) showed higher time compared to group II (Reciproc) at p=0.023 (Table1, figure 3).

TABLE (1): The results of Mann Whitney U test of the weight of AED and the time of preparation.

	Debris extrusion		Time (Min)
Groups	**Mean**	**Std Dev**	**Mean (SD)**
Group I (M Two)	0.00084	0.00113	5.72 ±2.96
Group II (Reciproc)	0.00075	0.000414	3.24±1.02
p-value	0.470 NS		0.023*

**=significant, NS=non-significant*

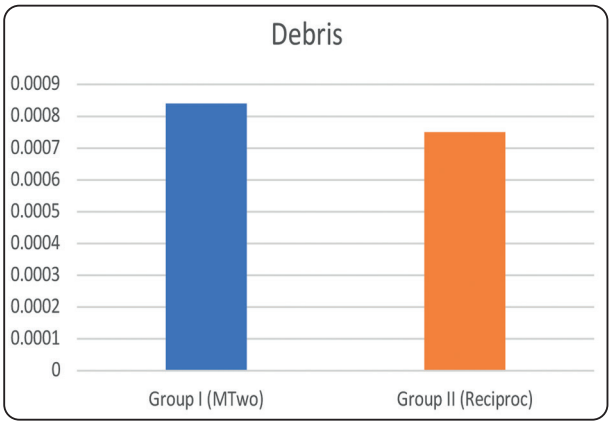

Fig. (2): Bar Chart showing the debris extrusion in gm.

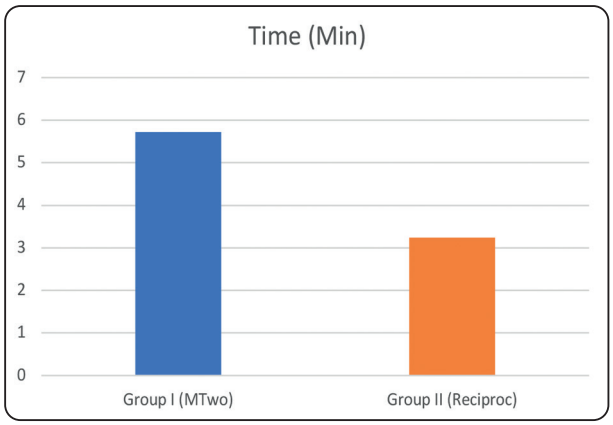

Fig. (3): Bar Chart showing the time of preparation.

DISCUSSION

One of the key matters while performing the retreatment of failed endodontic cases is the apical debris extrusion which is clinically connected to postoperative pain. During the retreatment, the attempts made to remove the failed obturating material and sealer results in extrusion of debris despite the technological innovations. Preceding studies support the concept that it is invincible to avoid extruded debris irrespective of the technique used for canal instrumentation [23, 24].

The power of instrument kinematics, design, and the number of files used on the apically extruded debris had been formerly studied [2, 4, 24-25]. However, their impact is debatable. *DeDeus et al, 2010* [10], compared ProTaper (#F2) file in both reciprocation and rotation and noticed no difference. While others observed that Reciproc resulted in a significantly higher amount of AED when compared to rotary files [4, 20]. Conflicting results were found by others [26, 27], who noticed that reciprocating files resulted in a significantly lesser amount of debris extrusion.

Thus, this study aimed to assess and compare the Mtwo retreatment system and Reciproc file regarding the amount of AED during the retreatment of previously filled single rooted premolar teeth.

For standardization objectives, all teeth were flattened to standardize length of 19 mm [28,29]. Preparation of samples was accomplished by same operator. Specimens were then randomly divided; after obturation and storage; into one of the two groups where; Group I: Mtwo (#15. 05 and #25.05); and in Group 2; a single Reciproc file (#25.08) was used for removal of the old filling. The solvent was avoided in our study to elude the chemical meltdown of GP and adherence of the material to the walls of root canals [30]. Also, to sidestep the risk that softened GP may be forced into irregularities, impeding the cleaning procedure [31].

The irrigant used during the whole procedure was distilled water; as it lacks solvent effect. NaOCl irrigation was precluded to prevent the sodium (Na) crystallization phenomenon; as it may affect the result of the experiment [28,29]. The use of NaOCl may lead to weight increase due to crystal formation thus influencing the actual amount resulting from only the instrumentation procedure [28,29].

The Myers and Montgomery method for the evaluation of AED was applied in this study for its competency, precise measurements, and simplicity [22]. One of the main concerns when adopting this method is the influence of touching the assembly with moist fingers or even being contaminated by the environment which may affect tremendously the final weight [11]. In this study, the assembly was fitted into a larger dark glass vial to avoid touching the tube directly and to make sure that the operator won't go to see the apex and eliminate bias.

An incubator was used to store the Eppendorf tubes at 37ºC for 15 days; to make certain that the temperature will not affect the weight of the tubes which may impact the results. As was proven by *Elsadat and Refai, 2017* [32], when the incubation temperature is ≥ 50°C for 5 days the tube weight decreases when compared to the pre-incubation weight. While *Kuştarci et al, 2008*[33], found no change in the weight of the tubes when

incubated for 15 days at 37°C, and this resulted in effective evaporation of the distilled water from the specimens. In contrary to *Roshdy and Hassan 2022*[34], who stored the specimens at 70ºC for 5 days.

Results of this study showed that there was no significant difference between the AED of the two groups despite the difference in the number of files, the design, and the kinematics. Both resulted in a significantly low amount of extrusion.

Bucheli et al., 2016 [35], noted that the design of an instrument is the most prominent factor in the AED, irrespective of the kinematics used. Both Mtwo and Reciproc have similarities in designs; the S-shape cross-section and both should reach the working length; which may support our findings. As these two factors may influence the amount of AED[36].

Former studies stated that, the difference in the number of used instruments might be a factor that reasons for the greater amount of AED [8]. While others [37, 38], found that the number of instruments used did not seem to influence the results which are by our findings.

The impact of kinematics is controversial. In our study, the impact of kinematics also seems of low significance which agrees with other studies [10, 38]. Dissimilar to our findings, *Lu et al, 2013*[36], noted that Reciproc resulted in more AED than Mtwo retreatment. This difference may be interpreted by the fact that they used different sizes and tapers; Reciproc #40. 06, Mtwo files up to # 40, .04 instruments for final canal preparation [36]. In addition, they weighed both the debris and NaOCl irrigant extruded.

Reciproc resulted in significantly faster preparation than the Mtwo. These findings are in accordance with other studies [16, 21, 36]. This may be inferred as the time needed to change files is eliminated in the Reciproc group and may be supported by the differences in kinematics.

CONCLUSIONS

Within the constraints of this study, it may be determined that,

1- Both the Reciproc file and Mtwo retreatment system are efficient in retreatment procedures.

2- Both systems resulted in the extrusion of debris with no significant difference between them.

3- The Reciproc significantly shortened the time of preparation compared to the Mtwo system.

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