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EFFICACY OF MULTIPLE VERSUS SINGLE NITI ROTARY SYSTEMS FOR REMOVAL OF ROOT CANAL FILLING MATERIAL DURING ROOT CANAL RETREATMENT (A COMPARATIVE IN-VITRO STUDY)

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ABSTRACT

Aim: To assess the effectiveness of the Rogin multiple NiTi rotary file system compared to the Hyflex EDM single rotary file system in removing root canal filling material during root canal retreatment.

Materials and methods: Thirty human permanent mandibular premolars with single root canals were mechanically prepared with ProTaper Next files up to X2 (25/06) till full working length. Then root canals were obturated using the continuous wave of compaction technique with gutta percha and AH Plus sealer. After one week of incubation, samples were randomly allocated into two groups according to retreatment file systems as follows; Group I: retreatment was performed by Rogin multiple retreatment file system, Group II: retreatment was performed by HyFlex EDM single file system. After retreatment samples were vertically split into two halves and digital images were captured by a digital camera mounted on a stereomicroscope at 10 x to be analyzed by image analysis software to calculate the percentage of residual filling material.

Results: There was no statistically significant difference between the two groups in coronal (p=0.280) and middle thirds (p=0.180) but in the apical third; group I showed a higher statistically significant percentage of residual filling material than group II (p=0.001).

Conclusion: Neither of the systems used was able to completely remove root canal-filling material and the Hyflex EDM single file system performed better in the apical third.

KEYWORDS: Rogin retreatment files; Hyflex EDM; Stereomicroscope

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INTRODUCTION

Non-surgical root canal retreatment is the initial choice following root canal treatment failure to save natural dentition [1]. The main step in nonsurgical endodontic retreatment is root canal filling material removal [2].

Many methods have been suggested for the removal of root canal filling material including manual files, Gates Glidden, ultrasonics, laser, and NiTi different systems[3-5]. However, the entire removal of root filling material still has been unpredictable [6,7].

Many NiTi systems were developed especially for retreatment to facilitate faster root canal filling material removal with fewer procedural errors. Still, they didn't show superiority over conventional NiTi systems [8].

NiTi single file systems showed efficacy in mechanical preparation in comparison to multiple file systems[9], their improved mechanical properties made them effective for root canal filling removal [10].

HyFlex EDM (HEDM [Coltène- Whaledent] is a controlled memory single file rotary system with a variable taper that is manufactured by electrical discharge machining (EDM) which resulted in an extremely flexible file with high cutting efficiency and improved resistance to cyclic fatigue [11].

Rogin retreatment files (Rogin Dental, China) are a recent multiple-file system that was recently brought into the market and developed for root canal filling removal. The system consists of 3 files; D 1(30/09; 16 mm), D 2 (25/08; 18 mm) and D 3 (20/07; 22mm) [12]. Their efficacy hasn't been evaluated in the literature yet.

There is still a debate regarding the efficacy of a single file system versus a multiple file system in root canal filling removal procedures [13,14].

So, the current study goal was to assess the effectiveness of the Rogin multiple NiTi rotary file system in comparison to the Hyflex EDM single rotary file system in removing root canal filling material during root canal retreatment.

MATERIALS AND METHODS

The research was granted approval by the ethical committee, faculty of dentistry, Minia University;(Committee 90, Decision No 641)

Sample size calculation

According to previous research done by Ozkan et al. (2019) [15], detecting an effect size of 0.40, a power (1-β) of 80%, and a significance level of 5% (p<0.05) required a total sample size of 24 samples, Sample size was increased to a total of 30 samples to compensate any loss during the experiment. G*Power software 3.1.9.4 was used for calculating the sample size.

Samples selection

Thirty human permanent mandibular premolars with single root canals that were extracted for orthodontic or periodontal reasons were collected. The presence of a single root canal was ensured by radiographs. Exclusion criteria were root carious, resorption, root fracture, previously treated teeth, calcifications, and immature teeth. Teeth were disinfected in 2.6% sodium hypochlorite for 30 minutes and tissue remnants were eliminated using a periodontal curette (Roydent, USA) then teeth were stored and kept in distilled water till use.

Root canal preparation

After access cavity preparation, a k file #10 was inserted until it was visible through the apical foramen then subtracted 1mm to determine working length. A glide path was secured by k file #15 and root canal instrumentation was performed by ProTaper Next (PTN; Dentsply Maillefer, Ballaigues,

Switzerland) up to X2 (25/06) till full working length. During preparation, root canal irrigation was done using 2.6% NaOCl by a # 30-gauge side vented needle (Cerkamed, Poland) followed by 17% EDTA and distilled water as final flush. After that, sterile Protaper next X2 paper points (Dentsply Maillefer, Ballaigues, Switzerland) were used to dry the root canals.

Root canal filling

The continuous wave of compaction technique was employed for obturating root canals. The manufacturer's recommendations were followed for mixing AH Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) and inserting it within the canal using Protaper next X2 gutta percha point till full working length. Then gutta percha was down-packed using Fast-Pack Pro (Changzhou Sifary Medical Technology Co., Ltd, China) and compacted using a suitable size hand plugger (Shanghai Fanta Dental Materials Inc., Shanghai, China). The Backfill procedure was performed using Fast-Fill (Shanghai Fanta Dental Materials Inc., Shanghai, China). Samples were radiographed to confirm the obturation's quality. After obturation, temporary filling was used to seal orifices, and samples were incubated at 37 C with 100% humidity for one week to allow for sealer setting.

Root canal retreatment

Samples were coded and divided at random into two groups (n=15 per group) by the Randomize List software program according to the retreatment system as follows:

Group I: root canal filling was removed by Rogin retreatment files in the sequence of D 1(30/09; 16 mm), D 2 (25/08; 18 mm), and D 3 (20/07; 22mm) in the coronal, middle and apical third respectively at 300 rpm speed and 2.5 Ncm torque.

Group II: root canal filling was removed by HyFlex EDM one file (25/~) for full working length at 500 rpm speed and 2.5 Ncm torque.

A single operator performed all retreatment procedures using torque control endodontic motor. Each file was used in 5 canals. Through instrumentation 2.6% NaOCl was used for irrigation during the retreatment procedure, followed by 17% EDTA and distilled water as a final rinse, then root canals were dried using sterile paper points. The retreatment process was deemed finished when file flutes were free from any gutta percha remnants or debris, also irrigation had no debris.

Evaluation of gutta perch removal

Another operator who was blinded to retreatment procedures had evaluated the removal of root canal filling material. All samples were split into two halves by a hammer and chisel after being grooved buccolingually with a diamond disc. Digital images of the intact half of each sample were acquired by a digital camera mounted on a stereomicroscope (Zeiss Technival 2, Germany) at 10 x magnification. Then images were uploaded to a computer in which the total root canal area of each third was outlined and the remaining filling material was traced by image analysis software (Image J version 1.49. NIH, USA) (Figure 1). The percentage of residual filling material was calculated by the following equation: A = (residual filling area * 100)/total root canal area [16].

Statistical analysis

The Kolmogorov-Smirnov and Shapiro-Wilk tests showed that the data had a parametric (normal) distribution. To compare data from more than two groups, an ANOVA test was utilized. In related samples, two groups were compared using a paired sample t-test. Two groups in unrelated samples were compared using an independent sample t-test. With a significance threshold of $P \leq 0.05$, the statistical analysis was conducted using IBM SPSS Statistics Version 20 for Windows.

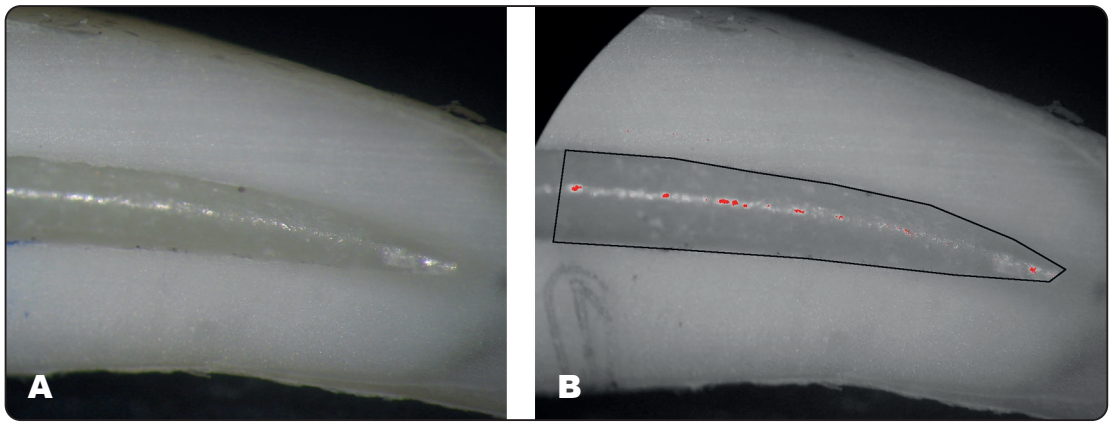

Fig. (1) Stereo micrograph at 10 x magnification of the apical third after retreatment by Hyflex EDM showing remaining filling material; A: before analysis, B: after analysis by Image J software

RESULTS

Table (1) shows the percentages of residual filling material for both groups. Both groups showed residual filling material. Regarding group I; the apical third revealed a statistically significantly larger proportion of residual filling material than in the coronal and middle thirds where there was no statistically significant difference between them. In group II there was no statistically significant difference in the percentage of residual filling material in the coronal, middle, and apical thirds.

The comparison between the two groups revealed that there was no statistically significant difference between them in coronal (p=0.280) and middle thirds (p=0.180) but in the apical third; group I demonstrated a larger statistically significant percentage of residual filling material than group II (p=0.001)

TABLE (1) The mean, and standard deviation (SD) values of percentage of residual filling material of different groups.

Variables	Residual filling material						p-value
	Coronal		Middle		Apical		
	Mean	SD	Mean	SD	Mean	SD	
Group 1	52.15	8.27	49.75	9.53	69.46	5.68	**0.003***
Group 2	56.96	7.61	54.98	1.85	57.22	4.48	**0.606ns**
p-value	**0.280ns**		**0.180ns**		**0.001***		

; significant (p<0.05)** **ns; non-significant (p>0.05)

DISCUSSION

For endodontic retreatment to be successful, complete eradication of root canal filling material is essential to uncover microorganisms and allow effective disinfection of the entire root canal system to induce healing of apical periodontitis [17,18].

Complete crown removal wasn't performed to simulate the clinical situation. Single-rooted single-canaled teeth were selected for standardization and reducing other confounding factors and also for ease of sectioning procedure. Root canals were obturated by a continuous wave of compaction technique as it produced better adapted and condensed root filling with less incidence of voids [19].

No solvent was used in the current study as chemically softened gutta-percha is challenging to remove from the root canal system and the frictional heat of NiTi rotary instruments plasticizes gutta-percha and facilitates its penetration [5].

Different methods have been utilized to assess the residual filling material such as radiographic techniques and microscopic evaluation [20,21]. In the current study, roots were vertically split and the residual filling material was imaged and evaluated by stereomicroscope, then images were analyzed using image analysis software to estimate the percentage of residual filling material, as this method is well-established [22-24], and better than radiographic techniques as this method allows direct visualization of the remaining filling material [25].

Hyflex EDM single file system was selected for comparison as it had shown similar efficacy in retreatment to multiple file system that is specially designed for retreatment procedures plus the advantages of simplifying root canal treatment and decreasing its time [15].

In the current study, both systems were unable to remove entirely root-filling material which was in agreement with previous studies that used different NiTi rotary systems [26-29].

The results revealed that Rogin retreatment files removed more root canal-filling material in coronal and middle thirds than in apical thirds, this was similar to other retreatment file systems in previous studies in which more residual filling material was detected in the apical third [30-32]. This may be due to the tip size and taper of the Rogin retreatment file used in the apical third (20/07) that may not engage the root canal wall that was initially prepared to size (25/06), while in coronal and middle thirds instruments with larger sizes and taper were used in brushing motion against root canal wall which enables removal of more filling material.

In the Hyflex EDM group, there was no statistically significant difference between coronal, middle, and apical thirds which may be attributed to its variable taper and different cross sections at the same file, as it has a quadratic cross-section at the tip, trapezoidal cross section at the middle third and triangular cross-section at the coronal third, this variable design [11] enabled the file to remove root canal filling in the apical third similar to coronal and middle thirds.

Comparing the two groups showed that no statistically significant difference was observed in the coronal and middle thirds, but there was a statistically significant difference in the apical third in which the Hyflex EDM single file system performed better with the removal of more root canal filling material than Rogin retreatment system. It has been known that the cross-sectional design and taper affect instrument performance in retreatment procedures [18]. Hyflex EDM one file has a tip size of 25 with 8% taper and a rectangular cross-section in its apical 4 mm part [33], which enables the file to engage more root canal-filling material resulting in better performance in the apical third. Also, Hyflex EDM one file operated at a higher rotational speed than the Rogin retreatment system which generated more frictional heat that softened gutta percha and facilitated its removal.

CONCLUSION

Under the current study's limitations, it could be concluded that neither of the systems used could completely remove root canal-filling material and the Hyflex EDM single file system performed better in the apical third.

Conflict of interest:

Authors declare any conflict of interest.

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