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CLEANING EFFICIENCY OF NITI SINGLE FILE ROTARY SYSTEM WITH A NOVEL DESIGN IN OVAL SHAPED ROOT CANALS: A COMPARATIVE IN VITRO STUDY

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ABSTRACT

Objective: The purpose of the current study was to compare the cleaning efficiency of single file system with a novel design (AF F ONE) to a multiple file system (ProTaper Next; PTN) in oval-shaped root canals. .

Material and methods: Eighteen extracted human mandibular premolar teeth with single oval canal were collected. Decoronation of teeth was performed to achieve a standardized root length of 14 mm. Then, random allocation of teeth into two groups was done according to NiTi rotary system used as follows; group I (PTN), group II (AF F ONE). After root canal preparation, roots were longitudinally sectioned into 2 halves. The most visible half was selected and the amount of debris in coronal, middle and apical thirds was assessed by using a stereomicroscope (Ziess technival 2, Germany) at 25X magnification. The percentage of the remaining debris in each third was then calculated by dividing the areas covered by the remaining debris by the total area of each third multiplied by 100.

Results: There was no statistically significant difference between debris percentage following the use of both files at coronal and middle thirds respectively. However, at the apical third, ProTaper Next showed statistically significant lower debris percentage than AF F ONE.

Conclusion: It could be concluded that ProTaper Next rotary file system had better cleaning efficiency than AF F ONE single file rotary system in oval canals.

KEYWORDS: AF F ONE; ProTaper Next; Stereomicroscope

INTRODUCTION

Disinfection of root canal system is the primary goal of root-canal mechanical instrumentation to hinder or treat apical periodontitis [(1)]. This can be achieved by complete elimination of remaining pulp tissues, infected dentin, debris and smear layer[(2)]. The degree of root-canal cleanliness may vary according to many factors such as root canal

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anatomy and instruments used for root-canal preparation. It was previously reported that it was difficult to debride oval shaped canal where large area of the canal remained untouched which negatively affected root-canal treatment outcome [3].

Rotary nickel titanium (NiTi) instruments were developed to overcome problems associated with hand instruments and to increase root-canal cleaning efficiency [4], however, there is still no instrument that is capable of cleaning the entire root-canal predictably [5,6]. Recently, several advancements in NiTi rotary systems have been made involving design, metallurgy and motions to increase their efficacy [7].

ProTaper Next (PTN; Dentsply Maillefer, Ballaigues, Switzerland) has progressive taper design, rectangular cross section and unique mechanical wave of motion as a result of its unique off-centered design [8], it is also manufactured from M-Wire, heat treated alloy which has higher flexibility and better mechanical properties than conventional NiTi alloy [9]. It is a commonly used and well established NiTi rotary system that was extensively studied in literature for its cleaning ability [10,11]. AF F ONE (Shanghai Fanta Dental Materials Inc., Shanghai, China) is a one-file instrumentation system with special heat treatment and a novel flat sided design in which flutes present only in one side [12]. It has been studied for the quantity of apical extruded debris produced during root-canal instrumentation [13]. To the best of our knowledge, it hasn't been studied yet for its cleaning efficiency. So, the purpose of the present study was to assess the cleaning efficiency of AF F ONE single file system compared to ProTaper Next multiple file system in oval shaped root canals.

MATERIALS AND METHODS

The proposal for this study was approved by the Ethics committee, Faculty of Dentistry, Cairo University. (Approval number: REC reference: 27/2/23).

Sample size calculation

This power analysis used percentage of debris at the apical third as the primary outcome. Based on the findings of Ghobashy A et al (2016) [14], the mean and standard deviation (SD) values of debris percentage were 20.56 (5.73) and 27.49 (3.23) % for ProTaper Next and OneShape files, respectively. Using alpha (α) level of (5%) and Power of 80%; the least predicted sample size was 9 specimens in each group.

Sample selection

Eighteen recently extracted intact human mandibular premolar teeth with mature apices that were extracted due to causes not related to the study were selected for the present study. Teeth with single oval canal with a canal curvature (≤10) determined using Schneider's technique [15], were included in the study.

Radiographs were taken both buccolingually and mesiodistally to verify the single, oval root-canal anatomy. If the ratio of the bucco-lingual to mesio-distal diameters was at least 1.3-1, the canals were classified as oval [16].

The teeth were thoroughly cleaned of debris, remnants of soft tissues as well as deposits of calculus and kept in distilled water until needed. Decoronation of all the teeth was performed at cemento-enamel junction (CEJ) by a water-cooled low speed diamond disc to achieve a standard root length of 14 mm.

The canal width at the apex of each tooth was standardized to be compatible with a K-file size #10 (Mani, Inc., Utsunomiya, Japan). Canals that were wider or had a smaller diameter were discarded. By deducting 1 mm from the length of a K-file size #10 put inside the root-canal till the file's tip was seen at the apical foramen, the working length was determined. To replicate clinical situations, the apex was coated with sticky wax to prevent irrigant solution from escaping through the apex. [17].

Root canal preparation:

Random allocation of the selected teeth was performed according to the NiTi system used for root-canal instrumentation into two groups as follows; group I (PTN), group II (AF F ONE). One endodontist carried out all root-canal preparation. Each file was only used in 5 root-canals and operated by an electric cordless torque control endodontic handpiece (Rooter S, FKG Dentaire, Switzerland). A manual stainless steel K-file size #10 (Mani, Inc., Utsunomiya, Japan) was used to secure a gliding path. Apical preparation was performed till size #25 in each group, after each canal had been prepared till working length in a crown-down manner. Each NiTi rotary file system was used in accordance with the manufacturers' instructions [8,12] as follows;

Group I (PTN): At 300 rpm and 2 Ncm torque, PathFile (16/02), PTN X1 (17/04), and PTN X2 (25/06) were used to prepare the canals to their full working length.

Group II (AF F-One): orifice opener, followed by 25/6 to the full working length at 500 rpm speed and 2.5 Ncm torque.

A 30-gauge needle (Cerkamed, Poland) was used to perform irrigation with 3 ml of 2.5% sodium hypochlorite (NaOCl) following each file. As a final flush, irrigation with 5 ml of 2.5% NaOCL was delivered for 60 seconds; the irrigation needle was positioned 1 mm less than the WL and pulsed continuously for 1-2 mm in the apical to coronal direction. After that, 5ml of distilled water was used as a final rinse in each root canal.

Cleaning efficacy assessment

Drying the canals with paper points was followed by creating two longitudinal grooves with a diamond disc on the buccal and lingual sides of each root, gutta-percha cones were placed into the root-canals to indicate maximum groove depth and to preserve the innermost layer of dentin around the root-canal, and then a chisel was used to split the roots. A total of nine roots per group were sectioned into 2 halves. For each specimen, the half enclosing the most visible part of the apex was chosen and the other half was discarded. As a result, each group received 9 samples. Each half was divided into coronal, middle and apical thirds.

For evaluating the cleaning efficiency of various files, amount of remaining debris has been used as criteria.

Stereomicroscopic evaluation

The evaluation was carried out by another blinded operator to all the samples. Digital images were obtained to evaluate the amount of debris in coronal, middle and apical thirds by using a stereomicroscope with digital camera mounted on it (Ziess technival 2, Germany) at 25x magnification, as shown in figure (1) after which they were transferred to the computer. Image analysis software

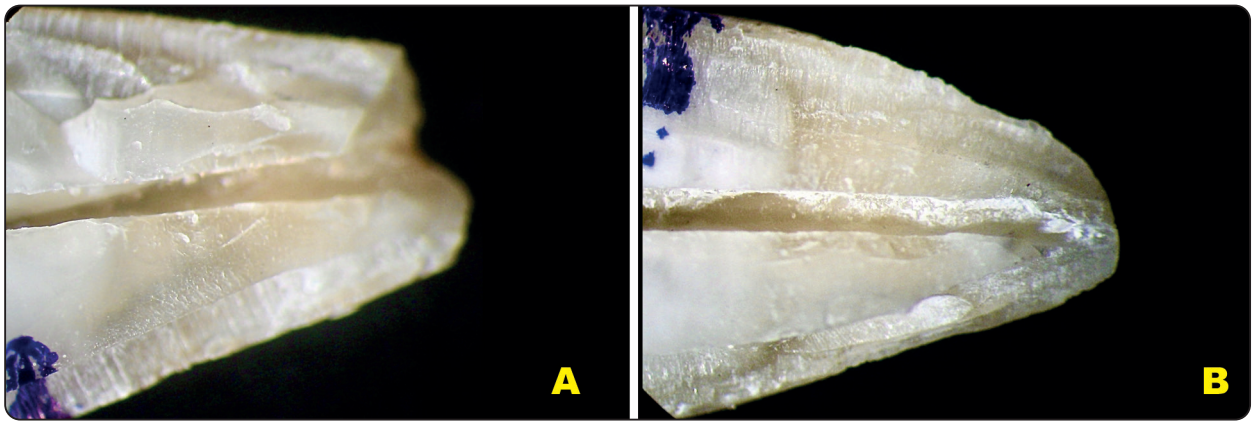

Fig. (1) Digital image (magnification X25) showing longitudinal section at the apical third; A: for a sample in PTN group, B: for a sample in AF F-One group.

Image J version 1.49. NIH, USA) was used to investigate the surface area of the root-canal third and the remaining amount of debris. The overall area of each third, and areas covered by remaining debris in each third were calculated. Then, areas covered by remaining debris were divided by the total area of each third multiplied by 100 to obtain the percentage of remaining debris for each third.

Statistical analysis

By examining the distribution of the data and using tests for normality (Kolmogorov-Smirnov and Shapiro-Wilk tests), the percentage of debris data were examined for normality. Debris data showed non-normal (non-parametric) distribution. Data were presented as median, range, mean and standard deviation values. Mann-Whitney U test was used to compare between the two systems. Friedman's test was used to compare between root levels. Dunn's test was used for pair-wise comparisons when Friedman's test is significant. The significance level was set at $P \leq 0.05$. With IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp., statistical analysis was carried out.

RESULTS

The percentage of debris in each third for each group was calculated and presented in table (1). There was no statistically significant difference between debris percentage after using the two files at coronal and middle root levels respectively. At the apical root level, ProTaper Next showed statistically significantly lower debris percentage than AF F ONE.

Pair-wise comparisons between root levels within each system revealed that, there was no statistically significant difference between debris percentages at different root levels after using ProTaper Next system. While after using AF F ONE system, there was a statistically significant difference between root levels; in which coronal and middle root levels showed statistically significantly lower debris percentage than apical root level.

TABLE (1) Descriptive statistics and results of Mann-Whitney U test for comparison between debris percentage (%) after using the two systems and Friedman's test for comparison between root levels

Level	ProTaper Next (n = 9)					AF F ONE (n = 9)					*P*-value	*Effect size (d)*
	Median	Min.	Max.	Mean	SD	Median	Min.	Max.	Mean	SD		
Coronal	3.29	1	5.13	3.19	1.4	4.45 ^{B}	1.66	13.51	5.53	3.79	0.223	0.586
Middle	4.2	0.15	5.97	4.26	1.8	6.66 ^{B}	2.78	10.9	6.81	2.55	0.566	0.273
Apical	6.32	0.66	10.38	5.96	2.91	10 ^{A}	5.56	22.5	12.79	6.04	0.001*	2.497
P-value			0.062					0.002*				
Effect size (w)			0.309					0.704				

: Significant at P ≤ 0.05, Different superscripts in the same column indicate statistically significant difference between root levels

DISCUSSION

One of the major objectives of root-canal preparation is complete elimination of infected tissues [18]. Oval shaped root canals were selected due to its high prevalence and its difficulty to be completely debrided [3,19] where remaining uncleaned areas may negatively affect treatment outcome [20]. Root-canal irrigation was performed only with sodium hypochlorite to avoid the effects of any confounding factors [21].

A criterion for evaluation was the assessment of any remaining debris, which is typically made up of dentin chips, pulp fragments, residual vital or necrotic pulp tissues, and loosely adherent root-canal wall particles. In most of the cases, these debris are infected hindering the effective disinfection of the root canals [22]. As well as the space occupied by debris prevents proper obturation of the root canal system [23]. Cleaning efficiency had been assessed by different methods including scanning electron microscopy and micro computed tomography radiology[16,24]. However, the advantage of assessment using stereomicroscope compared with other techniques was its ability to provide precise overall view of the root canal rather than a selected area, also quantitative method using digital software provided reliable non subjective results rather than traditional systems as the software depends on color difference between debris and background root canal wall [25].

The NiTi rotary system design affects its ability in root canal debridement [4]. The aim of the current study was to evaluate cleaning efficiency of a single file NiTi rotary system with a novel design (AF F ONE) compared to ProTaper Next system in oval shaped root canals.

Results of the study showed that neither of systems used rendered the root canals free of debris, in accordance with previous studies as no rotary file system touches all root canal wall surfaces [26,27]. Comparing both systems, results showed that there was no statistically significant difference in percentage of debris between them in coronal and middle thirds which could be explained by effect of irrigation rather than instrumentation technique due to wider diameter of canal in these thirds resulting in exposing dentin to large volume of irrigating solution facilitating debris removal [28-30]. However, in the apical third, ProTaper Next group showed statistically significant lower percentage of debris than AF F ONE group. This could be attributed to ProTaper Next design features in which the offset center of rotation resulted in bigger envelop of motion than other rotary systems of same size but with centralized mass of rotation [31]. Also, preparation of root canals with single file systems showed decreased cleaning ability than that of full sequence rotary systems [14].

Under limitations of the current study, it could be concluded that ProTaper Next rotary file system had better cleaning efficiency than AF F ONE single file rotary system in oval canals.

Conflict of interest

The study's authors rule out any potential conflicts of interest.

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