

Original Article

Evaluation of the Apically Extruded Debris During Canal Preparation by WaveOne Gold, Hyflex EDM and XP-endo Shaper, An in Vitro Study

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Abstract

Objective: The main cause of this in vitro study was to measure and compare the amount of debris extruded apically using three NiTi single rotary files (primary WaveOne Gold file, Hyflex EDM file, and the XP-endo Shaper).

Methods: Palatal root of sixty freshly extracted human maxillary molar teeth were sectioned at 12 mm, and inserted through the center of a rubber stopper of a pre-weighed collecting vial except for the coronal quarter of the root. Then separated three groups in accordance with their (n =20) system. G I: primary WaveOne Gold single file system (Dentsply-Maillefer, Ballaigues, Switzerland), G II: Hyflex EDM single file system (Colten/Whaledent, Germany). and G III: Xp-endo Shaper single file system (FKG, Switzerland) used, the 1mm irrigation with distilled water applied for washing the instruments, apical debris was collected and dried at 100° C. Sequential weights were obtained for each vial, and the distinction between the weights of the vial (pre- instrumentation and post-instrumentation), considered debris weight. Data were analyzed statistically using the One-way ANOVA test and LSD test, $p \leq 0.05$ was considered for data analysis value.

Results: All rotary systems applied in this study showed apical extrusion of debris. GIII showed the significantly highest amount of debris ($p < 0.001$) compared to GI and GII, whereas, mean value differences of Hyflex and WaveOne Gold were statistically non-significant ($p > 0.05$).

Conclusions: The Hyflex EDM showed the lowest mean value of debris extruded apically compared to WaveOne Gold and Xp-endo Shaper. XP-endo Shaper had the highest mean value of debris extruded apically.

Keywords: Apical extruded, Debris, WaveOne gold, Hyflex EDM, XP-endo shaper.

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Introduction

Root canal instrumentation has been one of the most critical stages in endodontic treatment; the success of endodontics is based on thorough debridement, Disinfection, and three-dimensional for maintenance of health in the periapical tissues. Therefore, complete cleaning of the root canal by instrumentation and irrigation solutions has been critical in endodontic treatment⁽¹⁾.

The inter-appointment flare-up is considered a real complication led to the development of pain, swelling, or both, which has been proven during a few hours or days after root canal procedures and requires an unscheduled visit for emergency treatment⁽²⁾.

This severe symptom's main cause was mechanical, chemical, and microbial damage to the pulp or periradicular tissues; the infected debris has been extruded apically to the periradicular tissues⁽²⁾.

The protocol of cleansing and shaping the root canal system has been carried out probably by step-back or crown-down techniques; hand and rotary instruments are used with either of these techniques⁽³⁾. Recently advanced instrument designs such as variable tapers, radial lands, different flute depths, cross-sections, and noncutting tips also the use of different operating techniques have been developed for the improvement and shorten the working time, and to provide a smoother and cleaner preparation to receive the final obturation⁽⁴⁾. The output quantity of debris extruded may vary depending upon the instrumentation method, file size. The instrumentation process is performed in a way that minimizes the output quantity of debris extruded into periapical tissues⁽⁵⁾.

Many previous studies had established that chemomechanical debridement of the root canal led to extrusion of dentinal filings, pulp tissue fragments, necrotic tissue, microorganisms, and irrigation additionally extruded via the apical foramen⁽⁶⁾. Furthermore, despite maintaining working length strictly short of the apical terminus, all preparation techniques and instruments have been reported to be associated with extrusion of infected debris, whilst some extrude much less materials and others extrude a greater amount of debris^(7,8). Extrusion of debris can result in irritation at the periapical area. Therefore, the instrumentation method can result in less extrusion of particles at the apical area, which is considered more desirable.

Consequently, finding a suitable method and application number that minimizes the extrusion of debris that assist

in decreasing the incidence of a flare-up in endodontics^(9,10).

This study aims to measure and compare the amount of debris extruded apically using three NiTi rotary instruments during canal preparation by WaveOne Gold file, Hyflex EDM file, and XP-endo Shaper file.

Materials and methods

Sixty freshly extracted human maxillary molar teeth were used in this study. The palatal roots of each tooth were sectioned to a length of 12 mm. Each root was inserted through the center of a rubber stopper of a pre-weighed collecting vial except for the coronal quarter of the root. Then the vial with the root was inserted inside a glass container; after that, the vial with the container was covered with rubber dam material except for the exposed coronal part of the root, shown in Figure 1. Then a vented 25-gauge needle was inserted through the rubber stopper. According to the rotary system used, the roots were divided randomly into 3 groups of 20 roots for each. Group I: primary WaveOne Gold single file system was used. Group II: Hyflex EDM single File system was used, and Group III: Xp-endo Shaper single file system. After instrumentation of each root, 1 ml of distilled water was used to wash the external surface of the instrumented root.

Canal patency was ensured using K-file size 15. Then, the collecting glass vial containing debris extruded from the apical foramen was dried using an oven at 100° C and was checked every ten minutes until the vial appeared dry. Three sequential weights were obtained for each vial, and the mean value was calculated by using a Sensitive electronic balance (0.00001g) (Kern-ABT 100-5M, Germany) (Figure 2). The difference between the weights of the vial (pre- instrumentation and post- instrumentation weights) represented the weight of debris extruded from apical foramen during canal preparation.

Statistical analysis

The obtained data were analyzed statistically using One way ANOVA test and LSD test.

Results

The descriptive statistics results, including Min., Max., mean values (in mg), and SD of apically extruded debris for all groups, are shown in Table 1 and Figure 3.

From Table 1 and Figure 3, Hyflex EDM Group showed the lowest mean value of debris apically extruded compared to the other two groups WaveOne Gold and the XP-endo Shaper groups, respectively. While XP-endo Shaper has been showing the highest mean value. Analysis of variance (ANOVA) test was performed to identify the presence of any statistically significant difference among groups, Table 2. The test was showed a highly significant difference among groups.

The least significant difference test (LSD) was performed for multiple comparisons between groups (Table 3).



Figure 1: Coating the flask with rubber dam material, and insertion the needle through the rubber stopper.



Figure 2: Sensitive electronic balance (0.00001g) (Kern-ABT 100-5M, German).

The results showed that all rotary systems applied in this study extruded debris apically; the XP-endo Shaper group showed the highest mean value of debris extruded apically with significant difference ($p < 0.001$) compared to Hyflex EDM and WaveOne Gold groups. While the variation between the mean value of Hyflex and WaveOne Gold was a statistically non-significant difference ($p > 0.05$).

Table 1: The mean values of apically extruded debris (in mg) and SD for all groups.

Statistics	Files		
	WaveOne Gold	Hyflex EDM	XP-endo Shaper
N	20	20	20
Minimum	0.27518	0.26237	0.27120
Maximum	0.27520	0.28344	0.29199
Mean	0.27519	0.27499	0.28154
±Std. Deviation	0.00001	0.00607	0.00671
±SE	0.00000	0.00136	0.00150

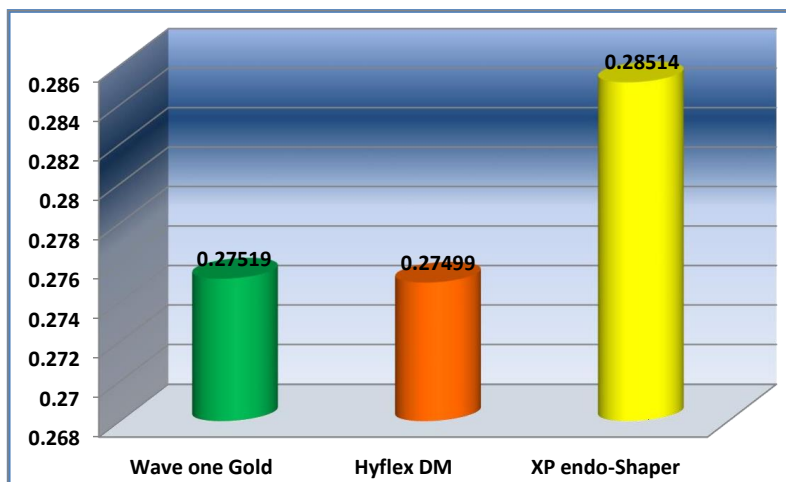


Figure 3: Bar chart graph for mean of apically extruded debris among three groups.

Table 2: Analysis of Variance (ANOVA) of AED between files.

	Sum of Squares	Df	Mean Square	F	Sig.
Between groups	0.00055	2	0.00028	10.16384	0.00017 (HS)
Within groups	0.00155	57	0.00003		
Total	0.00211	59			

Table 3: Multiple Comparisons of AED between groups using LSD.

(I) Files	(J) Files	Mean Difference	SE	Sig.
WaveOne Gold	Hyflex EDM	0.0002	0.0017	0.9058 (NS)
	XP-endo Shaper	0.0063	0.0017	0.0003(HS)
Hyflex EDM	XP-endo Shaper	0.00065	0.0017	0.0002(HS)

Discussions

The present study showed that The Hyflex EDM files had the lowest amount of debris extruded apically compared to the XP-endo Shaper file system and WaveOne Gold. This may be related to the file design with variable cross-section; the modern file has three different cross-sectional zones through the entire length of the working part (rectangular in the apical part and two different trapezoidal cross-sections in the middle and in the coronal part of the instrument working portion almost triangular), also it may be related to the size of the tip 25 with a 0.08 taper. The taper in the apical portion is constant 0.08 in about 4 mm of the instruments but reduced progressively up to 0.04 in the coronal portion of the instrument.

The result of this study agreed with Ana Gomes in 2016; her study compared the debris extruded apically in the root using One Shape, Protaper NEXT, Hyflex EDM, and WaveOne Gold. It was shown that the Hyflex EDM file produced the fewest amount of debris extruded apically than the WaveOne Gold file.

This study showed that the WaveOne Gold file showed less extruded debris than the XP-endo Shaper but more than the Hyflex EDM files. WaveOne Gold files have several properties which may lead to reduced extrusion of debris apically. First of all, it may be related to the file design and cross-section, which is a parallelogram with two 85 degree cutting edges, only one cutting edge has been in contact with the canal wall thus will work on reducing the contact area between the file and the canal wall and limit the binding (taper lock) and in conjunction with a constant helical angle of 24 degrees along the active length of the instrument ensures little or no screwing in. The extra space around the instrument also the presence of adequate area for enhance the elimination of debris coronally and make certain the debris will be pushed apically⁽¹¹⁾.

The result of this study agreed with several studies evaluating the debris that extruded apically in the root using different file systems with different movement rotation or reciprocation. They reported that the WaveOne Gold showed the lowest amount of the debris which extruded apically compared to another file system^(12,13). The result of this study showed that the XP-endo Shaper file system had the maximum amount of apical debris extruded when compared to other file systems; this might be related to the adaptive rotation of the file at the body temperature inside the root canal, which leads to transforming the file to a virtual bottle brush and this leads to increase the capacity of touching

the walls of the root canal in all directions. The instrument has the ability to be fitted inside the oval canal and touch all surfaces, cutting or shaving dentin which makes the Shaper function like a tapered metal brush. Therefore, the Shaper defiantly cuts dentin and creates a tapered shape while using the same motion^(14,15).

The XP-endo Shaper represents a new generation of rotary files that can expand beyond its nominal size. Other rotary files, classified as “nonadaptive core” instruments due to the instrumentation of the canals to a rounded uniform shape without adaption to the individual variations of each canal when their shaping abilities compared to the XP-endo Shaper (Adaptive Core Rotary Instrument). As a result, the rotary instruments sometimes left untouched walls⁽¹⁵⁾. According to the new technology in fabricating the wire of the file (Max wire) (Martensite-Austenite electropolish-fleX), it brings two fundamental properties, which is superelasticity and shape memory; these two properties are able to react in variations temperature and to take on a predetermined shape inside the root canal, at body temperature. Furthermore, their special design and extreme flexibility enable these instruments to contract and expand within the canal and reach areas that conventional instruments cannot access⁽¹⁶⁾.

The Booster Tip (BT), which provides benefits from the unique geometry, the six cutting edges at the tip of the file respect the curve of the canal, while more material had been eliminated with each pass. This allows the instrument to start after glide paths of at least ISO 15, gradually increasing the working field to achieve an ISO 30⁽¹⁶⁾.

Despite that, the manufacturer's recommendation, which mentions the micro- debris that results during the file's work, is removed easily and efficiently. Still, the file, according to this study, has the highest mean value of debris extruded apically.

Conclusions

Under the limitations of the present study, the following can be concluded: All systems extruded debris beyond the apical foramen; the Hyflex EDM showed the lowest mean value of apically extruded debris compared to WaveOne Gold and Xp-endo Shaper, Xp-endo Shaper showed the highest value of apically extruded debris.

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