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Original Research

Comparison of the amount of Debris Extrusion using two rotary files and reciprocating file system

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ABSTRACT

Background and Aim
Almost all endodontic treatment instruments used for cleaning and shaping are known to cause some amount of apically extruded debris (AED), which can cause post-operative complications known as flare-ups. Therefore the aim of this in- vitro study was to assess the AED during root canal preparation using rotary and reciprocating instrumentation systems.

Material and Methodology
In this study, 15 human mandibular first premolars were randomly assigned into 3 groups (n=5). The root canals were instrumented using full sequence rotary K3 XF files and Hyflex CM files and reciprocating single file system WaveOne Gold reciprocating files. Distilled water was used as an irrigant. The extruded debris was collected in preweighed Eppendorf tubes and assessed with an electronic balance and compared. The debris extrusion was compared and statistically analyzed using one-way ANOVA and post hoc test.

Results
Wave One Gold reciprocating files showed significantly more debris extrusion compared to Hyflex CM and K3 XF rotary file system.

Conclusions
Under the condition of the present study, it was shown that all the instrumentation techniques resulted in apically extruded debris. However, reciprocating WaveOne Gold file system showed more apically extruded debris compared to full sequence rotary Hyflex CM and K3 XF.

INTRODUCTION

One of the unintended events that occurs during cleaning and shaping of root canals is apical extrusion of debris (AED) (1,2). Dentin chips, necrotic tissue, pulpal tissue fragments, irrigants and microorganisms may be extruded from the apical foramen which may cause pain or flare up (2). In chronic periradicular lesions, a delicate balance exists between infected canal microbiota and the host defenses. Apical extrusion of bacteria causes a change in this balance and causes an acute inflammatory response (3). This leads to post-operative complications characterized by pain, swelling, or both, starting within a few hours or days after the procedures (3). Studies have proven that all the instrumentation techniques and instruments will produce some AED even when kept short of the apical foramen (4).

K3 XF files (Kerr Dental Products, CA, USA) were introduced in 2009. It uses R-phase technology to

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improve on their original K3 system. The result is increased flexibility and ductility giving K3 XF better cyclic fatigue resistance when compared to K3. The manufacturer claims the positive rake angle of K3 XF increases the cutting efficiency and its variable helical flute angles aid in debris removal from the root canal. It utilizes a non-cutting tip and has a self-centring feature for added safety (5).

Hyflex CM files (Coltene-Whaledent, Allstetten, Switzerland) is a new revolution in rotary endodontics introduced in 2012. They are machined from a wire (termed CM wire) with double fluting, symmetrical cross-section, variable pitch, non-cutting tip and negative rake angle. They are produced by an innovative methodology called Controlled Memory (CM) that controls the material's memory by a complex heating and cooling treatment (6,7).

A major concern with the use of Ni-Ti engine driven rotary instruments are unexpected separation of instruments during clinical procedures without warning. Therefore a recent advancement was the use of a single file system for instrumentation of the root canal from the start to finish. This helped the elimination of procedural errors that occurred during the use of multiple files (8). WaveOne Gold file (Dentsply Maillefer, Ballaigues, Switzerland), system is a single use, single file system to shape the root canal completely from start to finish in reciprocating motion. These files are manufactured from M-wire technology, improving strength and resistance to cyclic fatigue nearly 4 times in comparison with other brands of rotary Ni-Ti files. The instruments are designed to work with a reverse cutting action (9,10).

The aim of this study was to compare the amount of AED during preparation of straight root canals in extracted human teeth using WaveOne GOLD compared with the rotary full-sequence HyFlex™ CM and K3 XF files.

MATERIALS AND METHODOLOGY

In this study, 15 freshly extracted human mandibular premolar teeth were used. The inclusion criteria included single rooted mandibular premolar teeth with single root canal and apical foramen. Radiographs were taken both mesiodistally and buccolingually to assess root canal morphology. The degree of root curvature was calculated by using the method of Schneider (11). Teeth with cracks, internal or external resorption, root caries, canal calcifications and open apices were excluded. The selected teeth were then sectioned to a standardized length of 16±0.20 mm using high speed carbide disc.

Access cavity preparation was done in each tooth and canal patency was checked using a no. 10 K file (Mani, Japan). Working length determination was done using no. 15 K file. Length was estimated by measuring the length of the file till the tip just emerges from the apical foramen. The working length was estimated by reducing 0.5mm from that measured length. Each of the samples were then apically prepared upto 20 K file to maintain standardization. The teeth were then randomly assigned into 3 experimental groups.

Group 1: K3 XF files, n=5

Group 2: Hyflex CM files, n=5

Group 3: WaveOne Gold reciprocating files, n=5

The debris collection apparatus designed by Myers and Montgomery was used in this study (12). Eppendorf tubes (Eppendorf India Ltd., Chennai, India) were used, having a capacity of 1.5ml, each pre weighed for three consecutive measurements using an electronic weighing machine (Single Pan K-Roy analytical balance, K Roy

and Co, Kolkata, India). The 15 sample teeth were then placed in the pre weighed Eppendorf tubes and were fixed to the glass vial using its rubber caps. To equalise the pressure inside and outside, the tubes were vented using a 25 guage needle (Dispovan, Faridabad, India). The apical part of the root was suspended within the Eppendorf tube, which acted as a collector for extruded debris.

Group 1 and 2 rotary files were used with Endomate DT endomotor (NSK, Japan). In Group 3, Wave-One files were used in a reciprocating working motion (R Smart Plus, RebornEndo, Guangzhou, China).

Group 1: K3 xf files were used in the following sequence – 10/25, 08/25, 04/25, 06/25. Speed 400rpm, torque 1N /cm.

Group 2: Hyflex CM files were used in the following sequence - 06/20, 06/25. Speed 500rpm, torque 2.5N /cm.

Group 3: Reciprocating WaveOne Gold file with a 07/25 master apical file used at a torque of 2.5 N /cm.

The canals were irrigated with 1ml of distilled water for one minute after each file. The irrigating needle (Navitip 30 gauge, Dentsply Sirona, USA) was kept 2mm short of the working length. A total of 7ml of irrigant was used in each of the sample teeth. After instrumentation, the Eppendorf tubes were removed from the glass vial and external surface of the sample teeth were irrigated with 1ml of distilled water. The extruded debris was collected in the Eppendorf tube and all the tubes were incubated at 37^0C for 15 days. This was to facilitate evaporation of moisture before weighing the dry debris. The debris was weighed on an electronic balance. The weight of the extruded debris was calculated by subtracting the pre weight of the Eppendorf tube from the post weight.

The mean weight of extruded debris was calculated for each group. The data was analysed

using Statistical Package for Social Science® 16 (SPSS, version 16; SPSS Inc., Chicago, IL, USA). Analysis was performed using one-way ANOVA and post hoc test at a significance level of $P < 0.05$.

RESULTS

The mean and standard deviation of the three groups are given in Table 1. Comparison of apical debris extrusion of the three groups by one way Anova revealed that there was statistically significant difference ($p<0.001$).

STATISTICAL RESULTS

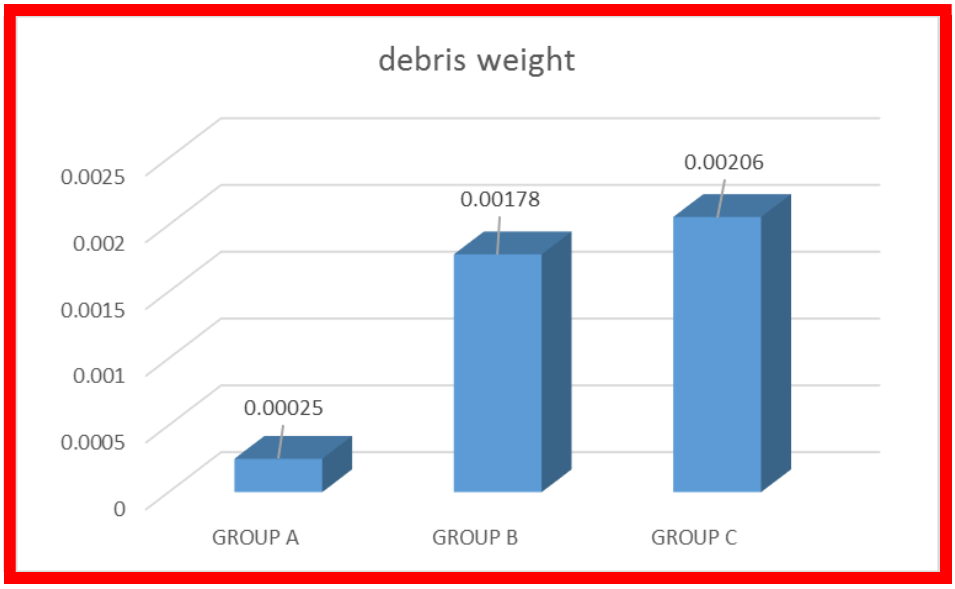
	N	Mean	Std. Deviation	Std. Error	95% Confidenc Me
					Lower Bound
1.K3XF	5	0.0002520	0.00025243	0.00011289	-0.0000614
2.HYFLEX CM	5	0.0017800	0.00067602	0.00030232	0.0009406

Table 2: The intergroup comparison between the groups showed a statistically significant mean difference between group 2 i.e Hyflex CM and group 3 i.e WaveOne gold ($p<0.05$).

Multiple Comparisons
Dependent Variable: value
Tukey HSD

(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.
K3XF	2	-0.00152800*	0.00028136	0.001
	3	-0.00180800*	0.00028136	0.001
HYFLEX CM	1	0.00152800*	0.00028136	0.001
	3	-0.00028000	0.0002813	0.594

Table 3



The mean apically extruded debris was more in Wave one Gold (0.00206g) compared to Hyflex (0.00178g) and K3 XF (0.00025g) files.

DISCUSSION

The primary aim of root canal treatment is to render the canal free of pulpal tissue, debris etc. This is achieved by

the process of cleaning and shaping. However, during this procedure, there are chances of periapical extrusion of small amounts of debris, leading to flareups which are responsible for postoperative pain and swelling. Studies have shown that flares up rates are between 1.4% and 16% (13). Extrusion of debris can be influenced by a number of factors like instrumentation technique, preparation end point, irrigating solution used, the instrument size and type.

Single canal teeth with closed apices were used in this present study. Standardization was maintained by decoronating the teeth to a length of 16mm. Distilled water was used as irrigant and a constant volume of 7ml was used in each of the samples. Pure distilled water was used since sodium hypochlorite crystallizes in the collection tube thereby affecting the weight of debris.

Clinically, periapical tissues maintain the apical patency by acting as a natural barrier. The width of the apical constriction may affect the amount of AED. Studies have shown that maintaining an apical patency showed less AED compared to those in which apical constriction is intact (14).

Crown down technique was used in this present study with all file systems. The rotary motion during instrumentation, design of the files along with crown down technique, pulls the debris towards the coronal aspect of the canal, thereby avoiding compaction in the root canal and reducing the amount of AED (15). A study by Ruiz-Hubard (16) et al showed that crown down technique showed less AED when compared to step back technique.

The result of the present study showed that, the reciprocating system showed significantly more debris extrusion compared to that of the rotary systems used ($P < 0.05$). The obtained difference may be due to the preparation technique and/or cross sectional design of instruments (9).

K3 XF showed less extruded debris when compared with Hyflex CM and WaveOne Gold system as these files have variable pitch. This provides more control and ensures that debris is channelled coronally. They also have better centring ability and more stability which is provided by third radial land. K3 XF has better cyclic fatigue resistance and the manufacturer claims the positive rake angle increases the cutting efficiency. Their increasing variable helical flute angle from tip to handle helps to dislodge the dentin chips from the working area, coronally to the orifice (17). These observations are in accordance with previous studies done by Ghogre P et al., and Zan R et al (18, 19).

Hyflex CM is a negative rake angled instrument which is machined from a wire termed CM wire or Controlled memory wire, which has negative rake angle, non-cutting tip and symmetric cross section variable pitch and double fluting. Cutting profiles of Hyflex CM facilitates penetration in canals and presents root canal shape corresponding to original anatomy which provides precise apical finishing (20, 21). A study by Capar ID et al proposed that the unwinding of the spirals of HyFlex instruments is known during root canal preparation which results in lengthening pitch and thereby causing more debris extrusion (22). This coupled with the absence of radial lands may be the cause of its increased AED.

WaveOne is a single file reciprocating system which is claimed to complete root canal preparation with only one instrument in reciprocating motion with adequate size and taper. These files are made of a special NiTi alloy called M-Wire that is created by an innovative thermal treatment process (9). However, WaveOne Gold files are at least 80% more flexible, 50% more resistant to cyclic

fatigue and 23% more efficient compared to the original Primary WaveOne M-wire files. (20, 23) The reciprocation movement in WaveOne system is formed by a wider cutting angle and smaller release angle, thereby pushing the debris apically in releasing motion. WaveOne Gold being bigger and rigid along with an increased taper (0.07/25) enhances debris transportation towards the apex during reciprocal motion (24,25).

CONCLUSION

Under the condition of the present study, it was shown that all the instrumentation techniques resulted in apically extruded debris. However, WaveOne GOLD showed more apically extruded debris, compared to Hyflex CM and K3 XF, suggesting that reciprocating motion showed more amount of apically extruded debris compared to rotary file system.

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