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Assessment of Apically Extruded Debris after Using Different Endodontic Instrumentation systems.

Saif Nadhim Hassoon *

Department of Conservative Dentistry, College of Dentistry, University of Mosul., Iraq

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***Correspondence:**
Saif Nadhim Hassoon

E-mail:
saifnadhimdent@uomosul.edu.iq

Abstract

Aims: Assess the quantity of apical extruded debris after instrumentation with ProTaper universal files, K3 files, and Wave One reciprocating file. **Materials and Methods**: Thirty lower premolars were used in this study. Teeth were randomly divided into 3 groups each one contained 10 samples as follow: Group1- Teeth were prepared with ProTaper universal files. Group2- Teeth were prepared with K3 files. Group3- Teeth were prepared with Wave One file. Debris that was apically extruded during canals preparation was collected in the centrifuge tubes, which previously were weighed. Centrifuge tubes were put for 5 days in the incubator with temperature of 70 °C to allow evaporation of moisture. After that centrifuge tubes that contained debris were weighed, and quantity of extruded debris was determined via subtraction the initial weight of centrifuge tube from the final weight of same tube, then collected data was analyzed statistically. **Results**: Statistical analysis revealed that, ProTaper group showed highest amount of apical extruded debris followed by Wave One group and, K3 group showed least amount of apical extruded debris. The difference between ProTaper group and Wave One group was not significant, but both of them had significant difference with K3 group. **Conclusions**: Within the limits of the current study, preparation of root canals with K3 files is better than other groups in terms of less extrusion of apical debris.

الخلاصة

الأهداف: تهدف الدراسة الى تقييم كمية البقايا المنبثقة من القمة الجذرية بعد تحضير القنوات بواسطة مبارد البروتيبر ومبارد الكي ثري ومبرد الويف ون. **المواد وطرائق العمل**: ثلاثون ضاحك سفلي استخدم في هذه الدراسة. الأسنان قسمت عشوائيا إلى ٣ مجاميع كل مجموعة تحتوي عشرة أسنان وكما يلي: المجموعة الأولى- الأسنان حضرت بواسطة مبارد البروتيبر. المجموعة الثانية- الأسنان حضرت بواسطة مبارد الكي ثري. المجموعة الثالثة- الأسنان حضرت بواسطة مبرد الويف ون. البقايا المنبثقة من القمة الجذرية خلال تحضير القنوات جمعت في أنابيب جهاز الطرد المركزي والموزونة مسبقا. الأنابيب وضعت في الحاضنة لمدة خمسة أيام بدرجة حرارة ٧٠ مئوية للسماح بتبخر الرطوبة. بعد ذلك الأنابيب التي تحتوي على البقايا المنبثقة من القمة الجذرية وزنت وكمية البقايا المنبثقة من قمة الجذر حددت بواسطة طرح الوزن الابتدائي لأنبوبة جهاز الطرد المركزي من الوزن النهائي لنفس الأنبوبة ثم البيانات التي جمعت حللت احصائياً. **النتائج**: التحليل الإحصائي اظهر أن مجموعة البروتيبر بينت أعلى كمية من البقايا المنبثقة من القمة الجذرية متبوعة بمجموعة الويف ون وأخيرا مجموعة الكي ثري بينت أقل كمية من البقايا المنبثقة من القمة الجذرية. الاختلاف بين مجموعتي البروتيبر و الويف ون لم يكن معنويا لكن كلا المجموعتين اختلفت معنويا مع مجموعة الكي ثري. **الاستنتاجات**: ضمن حدود هذه الدراسة, تحضير قنوات الجذور بواسطة مبارد الكي ثري افضل من المجاميع الاخرى فيما يخص الكمية الأقل من البقايا المنبثقة من القمة الجذرية.

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INTRODUCTION

Cleaning and shaping of root canals system are the essential steps in any root canals therapy [1-2]. The principal aim of canals preparation is to enlarge the root canals, furthermore eliminate microorganisms, dentine chips, remaining pulpal tissue, and necrotic tissue [3].

One of problems that may occur during root canal preparation is the emersion of intra canal debris into the peri-apical tissues [4-5], and this can result undesirable complication, such as postoperative pain [6-7]. So, quantity of apical extruded debris must be minimized to diminish postoperative complication [5, 8]. All endodontic files and instrumentation techniques cause apical extrusion of debris [9–12], and quantity of debris differs according to methods of instrumentation, and design of files that are used [9, 13–16].

In the last years root canals instrumentation by Engine motivated NiTi files was being dominant, and widely using [17-18] as the instrumentation with rotary NiTi systems is more comfortable for patients, and operators. In addition to that, preparation with NiTi rotary files remains more centrally in the root canal subsequently, this yields less passage of debris apically as a compare with the hand files [8]. Newly tool designs such as non-cutting tip, radial lands, differing cross section, and variable taper were introduced to advance functioning safety, decrease working time, and produce large flare of the root canals [19].

More recently introduction of reciprocation technology leads to a novel generation of instruments for canals preparation that uses only one file such as Wave One and Reciproc instruments [20]. These systems are utilized to prepare the canals of roots wholly from start to end. Their main advantages include diminishing the cost and reducing preparation time [12].

With these new developments in designs, and technologies of endodontic files, there is an importance to evaluate and compare the effect of different endodontic instrumentation systems on the apical extrusion of debris, which can be responsible of postoperative flare-up. So, the aim of the current study is to evaluate the quantity of apical extruded debris after canals Instrumentation with ProTaper universal files (multi files use continuous rotation), K3 files (multi files use continuous rotation), and Wave One file (single reciprocating file). The research hypothesis supposed no difference in the quantity of apical extruded debris among ProTaper universal files, K3 files, and Wave One file.

MATERIALS AND METHODS

This study was approved by Research Ethics Committee at the College of dentistry, University of Mosul (Approval number UoM.Dent/H.L.6/20). Thirty newly extracted single canal lower

premolars were collected, and stored in distilled water. Scaling and polishing of the teeth were done, and hand curette (Lascod, Italy) was used to remove soft periodontal tissue, that was attached to teeth. Then, teeth were checked by Stereomicroscope (Motic,China) with ×20 magnification to eliminate teeth with flare apices and crack. Radiographs in buccolingual and mesiodistal directions were taken for each tooth to eliminate teeth with twisted canal, obstructive canal, and teeth with more than one canal.

Conventional straight line coronal access opening for all teeth was achieved by using a diamond round bur (Technical and General LTD, United Kingdom), which was mounted to the high-speed turbine (W&H, Austria), and pulp extirpation was done by Barbed broach (Densply Maillefer, Switzerland). K-file (Densply Maillefer, Switzerland) size 8 was entered into canal, till its tip could be seen at the foramen apically. 1 mm was subtracted from this length for working length determination.

Crowns of teeth were cut with diamond disk (GEBR.BRASSELER GmbH & Co. KG, Germany) to adjust the working length to 15 mm of all samples. For more standardization, the apical width of root canals was controlled with K-file size 10, which was introduced in the canal to full working length. When K-file size 10 was loose and easily crossed through the apical foramen of teeth, these teeth were excluded from the study. But when K-file size 10 was scarcely crossed through the apical foramen of teeth, these teeth were included in the study [1].

The model that was utilized for debris collection was shown in figure 1. Before the installation of whole apparatus, stoppers of centrifuge tubes that were used for debris collection were separated, and then centrifuge tubes were weighed by an electronic weighting machine (Shimadzu Corporation, Tokyo, Japan) with an accuracy of +/-0.0001 gram. Three measures were done of each tube, and the mean of 3 measurements was regarded the weight of this tube.

Figure 1: Experimental model for debris collection.

Punctures were made in the stoppers of tubes next teeth were pushed throughout punctures of stoppers and fixed to stoppers at the level of cementoenamel

junction by using of super glue that also would prevent leakage of the irrigating solution during instrumentation.

Bent gauge 27 needles also were inserted into the stoppers of centrifuge tubes along the teeth to equalize the pressure of air between the inside and outside of centrifuge tubes [5, 12].

Tooth, needle and stopper units were fixed into the centrifuge tubes after that centrifuge tubes were positioned in the vials of glass for preventing contact with the centrifuge tubes during canals preparation. Some wax was used to seal the boundaries of openings of the glass vials with the stoppers of centrifuge tubes to prevent leakage of irrigating solution during instrumentation.

The whole number of samples was 30, which were divided arbitrarily into 3 groups; every group included 10 samples as follow:

Group 1 – In this group samples were prepared with ProTaper universal files (Densply Maillefer, Ballaigues, Switzerland) to size F2 that has tip width of ISO 25 and 8% tapering.

Group 2 – In this group samples were prepared with K3 files (Sybron Endo, West Collins, California, USA) to size 25 K3 File that has tip width of ISO 25 and 6% tapering.

Group 3 – In this group samples were prepared with Wave One primary single reciprocating file (Dentsply Maillefer, Ballaigues, Switzerland), which has tip diameters of ISO 25 and 8% apical tapering.

In this study the files of all groups were used with X. smart® plus endodontic motor (Dentsply Maillefer, Ballaigues, Switzerland) see figure 2. The files of all groups were used according to manufacturer instructions of each file. During the instrumentation 8 ml of distilled water was used for irrigation of each sample in all groups. Also, irrigation was achieved by needle gauge 23 that was placed 3 mm inside the canals passively, and prevented from wedging into the canals to avoid pushing of debris with the irrigant through the apical foramen.

Figure 2: X. smart® plus endodontic motor.

Once the instrumentation was completed needle, tooth and stopper units were detached from tubes. Debris that was adhered to apical area of root was congregated by rinsing the apical area with 1 ml of distilled water inside the centrifuge tube [21]. After that, centrifuge tubes were put for 5 days in the incubator with temperature of 70 °C so as to allow evaporation of distilled water [20-22]. Lastly centrifuge tubes that contained debris were weighed by the same electronic weighting machine that was firstly used. Also, 3 measures were taken for each tube and the mean of 3 measurements was considered weight of this tube. Initial tube weight was subtracted from final weight of same tube for calculation quantity of debris. Finally, data was statistically analyzed by SPSS Program version 21 for windows software (IBM, USA). Descriptive statistics, one way ANOVA and post hoc Duncan's multiple rang test were statistical methods that were used to analyze data.

RESULTS

Number of samples, weight mean of apical extruded debris in milligram (mg), standard deviation, minimum and maximum values for whole groups are tabulated in the table 1. These results demonstrate that, ProTaper group revealed highest mean of apical extruded debris, followed by Wave One group while K3 group showed the least mean of apical extruded debris. One Way ANOVA showed significant difference among groups because p-value < 0.05 see table 2. Duncan's Multiple Rang Test illustrated that, non-significant difference was existed between ProTaper group and Wave One group, but both of these groups had significant difference with K3 group see table 3.

Table 1: Descriptive statistics for experimental groups

Instrumentation system	N	Mean (mg)	± SD	Min. (mg)	Max. (mg)
Protaper	10	0.86	0.1264911	0.7	1.1
K3	10	0.5	0.1632993	0.3	0.7
Wave One	10	0.8	0.1054093	0.7	1

N= Number of samples, SD= Standard Deviation, Min. = Minimum values, Max. = Maximum values.

Table 2: One way analysis of variance

Source of Variation	Sum of square	df	Mean Square	F	*p*
Between Groups	0.744	2	0.372	20.752	0.000**
Within Groups	0.484	27	0.018		
Total	1.228	29			

** P≤0.05 means significant difference among experimental groups.

Table 3: Duncan's multiple rang test

Instrumentation	N	Mean (mg)	Duncan [+]
K3	10	0.5	A
Wave One	10	0.8	B
ProTaper	10	0.86	B

[+] Groups that have different letters indicate significant difference between them while groups that have same letter indicate non-significant difference between them.

DISCUSSION

Proper endodontic treatment depends on efficient preparation (shaping and cleaning) of root canals [23]. During canal instrumentation debris such pulpal tissue, dentine chips, microorganisms, and irrigation solutions can be emerged into the peri-apical area and this may cause flare-up postoperatively [24-25]. Therefore, the amount of apical extruded debris should be investigated, especially with the introduction of new root canal instrumentation systems. In the present study, apical extruded debris, after canals preparation by ProTaper universal files, K3 files, and Wave One single reciprocating file was evaluated.

There are numerous factors that have an effect on the quantity of apical extruded debris, such type of tooth, curvature of root canal, size of root canal, type of instrument, size of instrument, canal preparation method, end point, type of irrigant, and delivery method of irrigation [26].

In the current research for standardization, lower premolars with single straight canal, and mature apices were used only. Crowns of teeth were cut to standardize working length to 15 mm. Working length was established 1 mm shorter from apical foramen, because it had been revealed that the instrumentation to the apical foramen produces more amount of apical extruded debris as a compare to the instrumentation that is done 1 mm shorter from the foramen [4]. Apical width of root canals was standardized with K-file size 10, which was introduced to full working length. If K-file size 10 was loose and easily crossed through apical foramen of teeth, these teeth were excluded from the study. While if K-file size 10 was scarcely crossed through the apical foramen of teeth, these teeth were included in the study. Also, for more standardization the final instrumentation files that were used for all groups had the same tip diameters of ISO 25. Furthermore, during the irrigation of root canals for all groups, distilled water was used instead of NaOCl to avoid any possible weight increase due to formation of NaOCl crystals [20, 26]. Also, needle gauge 23 was used and placed 3 mm inside the root canals passively and prevented from wedging into the canals to avoid pushing

of debris with irrigant through apical foramen.

In the current study, experimental model for debris collection is commonly accepted and had been utilized previously by numerous authors, such as Nayak *et al.* [1], Mohamed *et al.* [2], Preethy *et al.* [5], Kustarci *et al.* [17], Verma *et al.* [20], Patel *et al.* [21], Kocak *et al.* [27], and Sharma *et al.* [28] . The disadvantage of this model is lack of physical back pressure supplied via tissues around apical foramen, which might be able to resist extrusion of debris [20]. Floral foam that had been suggested by Altundasar *et al.* [29], and Hachmeister *et al.* [30] could be used to simulate back pressure of the periapical tissues, but this approach suffers from disadvantage of absorption of debris [5, 20]. Thus, in the current study this approach for simulation back pressure of periapical tissues was not used.

The highest apical extrusion of debris with ProTaper group in current research can be explained by the following:

1- The ProTaper universal files have large apical taper and this causes more violent instrumentation of canal system consequently large quantity of debris is created [17].
2- Instruments of ProTaper universal system reach working length at the start of preparation. Thus, more debris may be extruded apically [31].
3- ProTaper universal system is quicker and violent system with its special features; it eliminates extensive quantity of dentin in short time. As a result, it is incapable of displacing debris coronally, and this causes more extrusion of debris apically [8].
4- Many files are needed for canal preparation accordingly; debris production is increased [20].
5- ProTaper universal system has strong cutting capacity with small flute space in its structural design, which may not be able to accommodate the debris that are produced so apical transportation of debris may happen [28].

Files of K3 system have a relatively positive rake angle with asymmetrical cross-sectional pattern [32-33]. This positive angle has a tendency to improve effectiveness of cutting [19]. Positive rake angle and a changeable helical flute angle make files have superior capacity to cut the dentine, and remove debris from the canal system [34]. Chips of dentine that are produced during instrumentation with K3 system are easily transferred coronally by its exclusive helical angle [35]. So, the less apical extrusion of debris during instrumentation with K3 system can be attributed to the presence of positive rake angle with variable helical flute design [8, 17], and this explains the result of least apical extrusion of debris with K3 group in the current study.

The result of high apical extrusion of debris with Wave One group in the existing study can be explicated by that the reciprocation movement of Wave One

system is produced via large angle of cutting and small angle of releasing. This smaller releasing angle results that, flutes have a tendency to push the debris apically [36]. Furthermore, Wave One primary file which was used in the existing study has large apical taper [37]and this causes intense instrumentation of canal system subsequently large amount of debris is formed.

Comparable results were documented by Nagaveni *et al.* [8], Kustarci *et al.* [17], and Jain [23] who concluded that instrumentation with K3 system produced significant less apical extruded debris as a compare with ProTaper universal system. Additional results look like results of existing study were concluded in 2017 by Western and Dicksit [7], and Verma *et al.* [20] where they concluded that ProTaper universal system formed higher apical extruded debris than Wave One system, but difference between them was non-significant.

Current study is an in vitro study, which may not exactly resemble the intraoral condition. Consequently, the limitation of the present study is absence of physical back pressure supplied by tissues around apical foramen, which may be able to resist apical extrusion of debris. Therefore, Additional clinical researches are necessary for confirming results of the current research.

CONCLUSIONS

Within the limits of the current study, it can be concluded that, root canals instrumentation by K3 system is better than other groups in terms of less extrusion of apical debris.

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