Comparative Evaluation of Apical Extrusion of Debris Using K-Files, Protaper Next, Oneshape, Waveone and Revos: An In Vitro Study

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Abstract

Aim: To compare and evaluate the apical extrusion of debris using 2 rotary multiple file system (RevoS, ProTaper Next), one rotary single file system (OneShape) and one reciprocating single file system with hand K-file.

Material and Methods: seventy-five single rooted teeth with single root canal were selected and divided into five experimental groups (n =15) according to the rotary system used: Groupo 1- K-fill, Group 2 - Protaper Next, Group 3 - Revo S, group 4 - OneShape and group 5 - WaveOne. After instrumentation debris adhered to root surface was collected by washing root with 1ml distilled water in the glass vial and stored in MICROWAVE at 900 watts for 2 minutes and 3 consecutive cycles. The dry weight of extruded debris was weighed in an electronic balance.

Result: Protraper Next significantly show less debris extrusion compared with K-fill, Revo S, OneShape and WaveOne.

Keywords: Apical extrusion, debris, K-fill, ProTaper Next, Revo S, OneShape, WaveOne

INTRODUCTION

Complete preparation of root canal space is important stage in root canal preparation. The preparation of the root canal system is crucially important not only for the removal of the organic and inorganic irritants but also for allowing the correct placement of the obturating material. Even though instrumentation technique force intracanal content through periapical tissues[1], the amount of debris extrusion may differ according to the preparation techniques and the design of the file systems[2-7]. During root canal preparation, these materials and the irrigant may be extruded into the periapical tissues despite strict control of working length. This extrusion may cause an inflammatory reaction and postoperative pain, the so called flare-up (Seltzer & Naidor 1985)[8]. The main purpose of root canal treatment is to enlarge the root canal system in order to remove all residual pulp tissue, bacteria, necrotic tissue and dentine chips from the root canal system[8].

Forcing microorganisms and their products into the periradicular tissues can generate an acute inflammatory response, whose intensity will depend on the number and or virulence of the extruded microorganisms. At present, all preparation techniques and instruments are associated with extrusion of debris, even when the preparation is maintained short of the apical terminus and manual instrumentation happens to produce greater extrusion when compared to engine driven rotary preparation[9-12]. The studies so far have proven that none of the various techniques and instruments can clean and shape the root canal system without producing some apically extruded debris (AED)[13]. However, it has been proved that various instrumentation techniques have been associated with different amounts of AED[14]. As AED generates an acute inflammatory reaction in the periapical tissues, it is considered as an important parameter to assess the efficacy of an instrumentation technique or instrument design during root canal preparation.

The clinical endodontic breakthrough was progressing from utilizing a long series of stainless steel hand files and several rotary Gates Glidden drills to integrating Ni-Ti files for shaping canals. When properly performed; these mechanical objectives promote the biological objectives for shaping canals, 3-dimensional (3-D) disinfection, and filling root canal systems. [5]

WaveOne are characterized by a triangular or modified triangular cross-section resulting in a lower cutting efficiency and smaller chip space[15]. This design may enhance debris transportation toward the apex when used in combination with a reciprocal motion. Contrarily, incontinuous rotation may improve coronal transportation of dentine chips and debris by acting like a screw conveyor[9,16].

ProTaper Next instruments have an off-centered, rectangular design, generating traveling waves of motio along the active part of the file. The superior performance of the ProTaper Next system might be caused by the new swaggering motion, which serves to minimize the engagement between dentine and the file and enhances augering debris out of the canal[17].

RevoS (Micro-Mega, France) - Contains three basic file, SC1, SC2 and SU. The corresponding size is 25/. 06, 25/. 04 and 25/. 06 respectively. The asymmetrical cross section provides less stress on the instrument. The canal axis has 3 cutting edges located on 3 different radiuses: R1, R2 and R3. The 3 cutting edges are located to the canal axis on 3 different radiuses: R1, R2 and R3.

OneShape (Micro-Mega, France) - It contain single instrument for canal shaping and size 25/. 06. 3 different cross-section zones: The first zone presents a variable 3-cutting edge design. The second (transition zone) has a cross-section that progressively changes from 3 to 2 cutting edges. The last (coronal) is provided with 2 cutting edges.

The aim of this study is to compare and evaluate the apical extrusion of debris using 2 rotary multiple file system (Revo S, Protaper Next), one rotary single file system (One shape) and one reciprocating single file system with hand K-file.

MATERIALS AND METHOD

Methodology

In this study 75 freshly extracted human mandibular premolar teeth that were sacrificed for orthodontic and periodontal purpose were used. Teeth with Single rooted premolar, root curvature between 0-10 degree, working length approximating 21mm. Teeth with Sign of crack, Internal resoption, External resorption, Root caries, Canal calcifications, Open apices were extruded from study. Radiograph taken both mesiodistally and buccolingually to assess internal resorption, calcification and curvature of canals. Degree of root curvature was calculated from buccolingual radiograph using Schneider method.

External root surface of experimental teeth were cleaned of tissue tags and debris with periodontal scalars. Teeth were stored in 2. 5% Sodium hypochlorite for 2 hours before experimentation. To create an ease of refence point for the working length of teeth cuspal reduction was done using taper fissure bur and air rotor handpiece.

Following this procedure endodontic asses cavity was prepared using endoasses bur (DENTSPLY Maillefer, Switzerland). No. 10 K-file was introduced uptil visible at apical foramen and working length was established by subtracting 1mm from this measurement. The size of minor foramen was controlled moving No. 15 K-file to working length. If it extruded beyond apical foramen, the tooth was extruded from study.

75 glass vials with rubber stopper were selected for the study. Holes were created in center of rubber stopper by heated instruments. After this individual teeth were inserted with pressure into rubber stopper. Now teeth with rubber stopper were placed onto the glass vials and vented with 27 gauge needle alongside rubber stopper. Following this procedure, empty vials without stopper were weighed on electronic balance and values were recorded in terms of grams. Rubber stopper with attached teeth were reposition on the preweight vials.

75 glass vials were randomly assigned to 5 groups, 15 teeth in each.

Group A: K-file

Group B: ProTaper Next

Group C: RevoS

Group D: OneShape

Group E: WaveOne

Each instrument was used in 3 canals.

Group A: K-File

K-file was used in step back manner. Apical preparation was continued till size 40. After this stage, step back technique was applied uptil size 55 file reducing 1mm length for every next file used.

Group B: ProTaper Next

In sequence of X_1 followed by X_2 (both uptil working length) with speed of 300 rpm and torque of 2 Ncm. File was used in brushing motion.

Group C: RevoS

Used according to manufacturer's instructions. Speed with 300rpm.

Instrument Sequence

SC1 – uptil 2/3 rd of working length, with slow and unique downward movement in a free progression and without pressure.

SC2 – uptil working length, with a progressive 3 wave movement(up and down movement).

SU – uptil working length, with a slow and unique downward movement in a free progression and without pressure.

Group D: OneShape

Size 25 at tip and taper. 006 was used at a speed of rotation of 350-450rpm and maxi torque of 2. 5 Ncm. Used with in and out movement without pressure.

Group E: WaveOne

According to manufacturer's instructions. Primary file with tip size ISO 25 and apical taperwith 8% was used in progressive up and down movement no more than three to four times.

For IRRIGATION PROTOCOL 4ml distilled water was used between files group 1-3 and between pecking sequences- group 4 &5. Irrigation needle was placed slightly coronal to the point where resistance was offered. For single file systems, irrigation was done at every 3 pecks of instrumentation.

After instrumentation was complete, stopper was partially removed and debris adhered to root surface was collected by washing root with 1ml distilled water in the glass vial. Vials were then stored in INCUBATOR at 70^0C for 7 days to evaporate distilled water before weight extruded debris. Weight of extruded debris was calculated by subtracting the weight of empty vials from weight of vials containing debris using electronic balance.

RESULT

The weight of the extruded debris was determined by subtracting the weight of the preweighed empty vials from the weight of the vials plus the dried debris. The mean weight of extruded debris was calculated for each group and statistical analysis performed using SPSS programme.

In group-I, instrumentation was done with K-file showed the mean extrusion value of 0. 0009920.

In group-II, instrumentation was done with ProTaper Next showed the mean extrusion value of 0. 0004133.

In group-III, instrumentation was done with RevoS showed the mean extrusion value of 0. 0007713.

In group-IV, OneShape showed the mean extrusion value of 0. 0007140.

In group- V, WaveOne showed the mean extrusion value of 0. 0008407.

These data were then, analyzed using **ONE WAY ANOVA** test and difference between the groups were found using **TUKEY HSD** test.

The mean extrusion, median values, and range of extrusion (minimum and maximum values) were calculated. The P values obtained after the comparison of groups.

Table 1: One Way ANOVA Demonstrating Statistical Difference for Weight of Empty Vials of Different Groups
ANOVA

		Sum of Squares	Df	Mean Square	F	P-Value
Preweighed	Between Groups	0. 00439	4	0. 00110	1. 75903	0. 14691
	Within Groups	0. 04366	70	0. 00062		
	Total	0. 04805	74			

Table 2: One Way ANOVA Demonstrating Statistical Difference for Weight of Vials Containing Debris of Different Groups
ANOVA

		Sum of Squares	Df	Mean Square	F	P-Value
Preweighed	Between Groups	0. 00450	4	0. 00113	1. 80199	0. 13818
	Within Groups	0. 04371	70	0. 00062		
	Total	0. 04822	74			

Table 3: One Way ANOVA Demonstrating Statistical Difference for Weight of Extruded Debris Different Groups
ANOVA

		Sum of Squares	Df	Mean Square	F	P-Value
Preweighed	Between Groups	0. 00000	4	0. 00000	28. 34712	0. 00000
	Within Groups	0. 00000	70	0. 00000		
	Total	0. 00000	74			

Table 4 - Tukey HSD Test
Post Hoc Test
Multiple Comparisons: Dependent Variable: Diff (Preweighed)
Multiple Comparisons - Tukey HSD

Dependent Variable	(I) Group Name	(J) Group Name	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Preweighed	**K- File**	Protaper next	0. 01729	0. 00912	-0. 00824	0. 04283
		Revo S	0. 01974	0. 00912	-0. 00579	0. 04528
		One shape	0. 01168	0. 00912	-0. 01385	0. 03722
		Wave One	0. 02088	0. 00912	-0. 00465	0. 04642
	Protaper next	K- File	-0. 01729	0. 00912	-0. 04283	0. 00824
		Revo S	0. 00245	0. 00912	-0. 02309	0. 02799

		One shape	-0. 00561	0. 00912	-0. 03115	0. 01992
		Wave One	0. 00359	0. 00912	-0. 02194	0. 02913
	Revo S	K- File	-0. 01974	0. 00912	-0. 04528	0. 00579
		Protaper next	-0. 00245	0. 00912	-0. 02799	0. 02309
		One shape	-0. 00806	0. 00912	-0. 03360	0. 01747
		Wave One	0. 00114	0. 00912	-0. 02439	0. 02668
	One shape	K- File	-0. 01168	0. 00912	-0. 03722	0. 01385
		Protaper next	0. 00561	0. 00912	-0. 01992	0. 03115
		Revo S	0. 00806	0. 00912	-0. 01747	0. 03360
		Wave One	0. 00920	0. 00912	-0. 01633	0. 03474
	Wave One	K- File	-0. 02088	0. 00912	-0. 04642	0. 00465
		Protaper next	-0. 00359	0. 00912	-0. 02913	0. 02194
		Revo S	-0. 00114	0. 00912	-0. 02668	0. 02439
		One shape	-0. 00920	0. 00912	-0. 03474	0. 01633
* The mean difference is significant at the 0. 05 level.						

Table 5 - Tukey HSD Test

Post Hoc Test

Multiple Comparisons: Dependent Variable: Diff (Postweighed)

Multiple Comparisons - Tukey HSD

Dependent Variable	(I) Group Name	(J) Group Name	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Postweighed	**K- File**	Protaper next	0. 01787	0. 00912	-0. 00768	0. 04342
		Revo S	0. 01996	0. 00912	-0. 00559	0. 04552
		One shape	0. 01196	0. 00912	-0. 01359	0. 03751
		Wave One	0. 02104	0. 00912	-0. 00452	0. 04659
	Protaper next	K- File	-0. 01787	0. 00912	-0. 04342	0. 00768
		Revo S	0. 00209	0. 00912	-0. 02346	0. 02764
		One shape	-0. 00591	0. 00912	-0. 03146	0. 01964
		Wave One	0. 00316	0. 00912	-0. 02239	0. 02872
	Revo S	K- File	-0. 01996	0. 00912	-0. 04552	0. 00559
		Protaper next	-0. 00209	0. 00912	-0. 02764	0. 02346
		One shape	-0. 00800	0. 00912	-0. 03355	0. 01755
		Wave One	0. 00107	0. 00912	-0. 02448	0. 02662
	One shape	K- File	-0. 01196	0. 00912	-0. 03751	0. 01359
		Protaper next	0. 00591	0. 00912	-0. 01964	0. 03146
		Revo S	0. 00800	0. 00912	-0. 01755	0. 03355
		Wave One	0. 00908	0. 00912	-0. 01648	0. 03463
	Wave One	K- File	-0. 02104	0. 00912	-0. 04659	0. 00452
		Protaper next	-0. 00316	0. 00912	-0. 02872	0. 02239
		Revo S	-0. 00107	0. 00912	-0. 02662	0. 02448
		One shape	-0. 00908	0. 00912	-0. 03463	0. 01648
* The mean difference is significant at the 0. 05 level.						

Table 6 - Tukey HSD Test

Post Hoc Test

Multiple Comparisons: Dependent Variable: Diff (Postweighed – Preweighted)

Multiple Comparisons - Tukey HSD

Dependent Variable	(I) Group Name	(J) Group Name	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
					Lower Bound	Upper Bound
Difference	K- File	Protaper next	. 00057867*	0. 00006	0. 00042	0. 00074
		Revo S	. 00022067*	0. 00006	0. 00006	0. 00038
		One shape	. 00027800*	0. 00006	0. 00012	0. 00044
		Wave One	0. 00015	0. 00006	-0. 00001	0. 00031
	Protaper next	K- File	-. 00057867*	0. 00006	-0. 00074	-0. 00042
		Revo S	-. 00035800*	0. 00006	-0. 00052	-0. 00020
		One shape	-. 00030067*	0. 00006	-0. 00046	-0. 00014
		Wave One	-. 00042733*	0. 00006	-0. 00059	-0. 00027
	Revo S	K- File	-. 00022067*	0. 00006	-0. 00038	-0. 00006
		Protaper next	. 00035800*	0. 00006	0. 00020	0. 00052
		One shape	0. 00006	0. 00006	-0. 00010	0. 00022
		Wave One	-0. 00007	0. 00006	-0. 00023	0. 00009
	One shape	K- File	-. 00027800*	0. 00006	-0. 00044	-0. 00012
		Protaper next	. 00030067*	0. 00006	0. 00014	0. 00046
		Revo S	-0. 00006	0. 00006	-0. 00022	0. 00010
		Wave One	-0. 00013	0. 00006	-0. 00029	0. 00003
	Wave One	K- File	-0. 00015	0. 00006	-0. 00031	0. 00001
		Protaper next	. 00042733*	0. 00006	0. 00027	0. 00059
		Revo S	0. 00007	0. 00006	-0. 00009	0. 00023
		One shape	0. 00013	0. 00006	-0. 00003	0. 00029
* The mean difference is significant at the 0. 05 level.						

DISCUSSION

The endodontic procedures would be much simpler if all the root canals possess a smooth funnel shape from the orifice to the foramen, without curvatures or ramifications and the foramen is also located exactly at the radiographic apex. But in reality, the root canal anatomy is complex and manifest in different configurations. To clean and shape these canals requires appropriately designed instruments and thorough irrigation. Endodontic treatment is a triad of debridement, sterilization and obturation. The primary objectives in cleaning and shaping the root canal system are:

i) To remove infected soft and hard tissues,

ii) Give disinfecting irrigants access to apical canal space and

iii) To create space for the delivery of medicaments and subsequent obturation.

To obtain these objectives during root canal preparation, debris such as dentinal shavings, necrotic pulp tissue, bacteria and their products or irrigants may be extruded into the periradicular tissue, from the apical foramen. This may leads to periapical inflammation or post instrumentation pain or “flare-ups”[16]

Main objective of the present study was to evaluate the quantity of the debris extruded from the . apical foramen during canal preparation using three rotary system (ProTaper Next, RevoS, OneShape), one reciprocating system (WaveOne), and manual technique (K-file).

In the present study 75 single rooted teeth were selected with mature apex. Experimental teeth were divided into five groups:

Group A: K-file

Group B: ProTaper Next

Group C: RevoS

Group D: OneShape

Group E: WaveOne

In this study al root canals were irrigated with distilled water using 27 gauge blunt needles. Distilled water was used as an irrigant solution to avoid any crystallization of Sodium hypochloride and also distilled water was used as a last irrigant to avoid any possible weight increase caused by NaOCl crystal formation[15,20,2122].

The results of present study showed that all the groups cause apical extrusion of debris. The study reveals that engine –driven nickel titanium instruments that were used for the crown down technique extruded less debris and irrigant than K-flex files for the step-back technique. The result of present study agree broadly with the previous findings – filing motion, that is step back technique with circumferential filing motion create a greater mass of debris than those involving some sort of rotational action.

The results of present study are correlating with the results of the study done by **Ruiz Hubard et al**[17] (1987) who determined the amount of debris forced through apical constriction during root canal instrumentation, comparing conventional step-back instrumentation technique with crowndown pressure less technique and reported that greater amount of debris was forced periapically in both straight and curved canals when stepback technique was performed.

This brief review of the literature suggests that apical extrusion is common to all preparation techniques, but that the amount of extruded material varies. As far as hand preparation techniques are concerned, stepback technique with circumferential filing motion extruded greater mass of debris as compared to engine driven groups. In the stepback technique, the reason for more apical extrusion of debris is that the file acting in the apical one third acts as a piston that tends to push the debris through the foramen and less space is available to flush it coronally. While crowndown technique by engine driven nickel titanium instruments produce early flaring of the coronal part of the preparation which improves the instrument control during preparation of the apical third of the canal, and allows deeper penetration of irrigating solution and easier removal of debris from the apical area. The rotatory motion of nickel titanium instruments direct debris towards the orifice, avoiding its compaction in the root canal[17,19]. So the results presented herein are consistent with other investigations and reinforce the fact that the conventional stepback technique extrudes more debris apically. (add reciproc system n one file system reason)

In this study, the rotary NiTi system extruded less debris than the K-files, although the difference was not significant. When the rotary system was used, early flaring of the coronal part of the canal with a crown-down technique may increase the guidance of debris towards the orifice of the canal through the rotational motion (Goerig et al. 1982, Beeson ET AL. 1999). When a step-back technique is used, increased apically extruded debris could be a result of the cation of the file acting as a piston in the apical one-third of the tooth. The difference between hand instrumentation and rotary files in the present study was comparable with the difference between theiruse in other studies (Zarrabi et al. 2006, De-Deus et al. 2010)[8].

The reciprocating single-file system showed significantly more debris extrusion compared with both the full-sequence rotary NiTi instruments. The obtained differences may be caused by the preparation technique and/or the cross-sectional designs of the instruments[23]. A study by Burklein et al. found that there was more debris in the apical part of the canals after canal preparation with WaveOne and PeoTaper instruments as they are characterized by three cutting edges with radial lands to support the blades and a relatively small chip space[26]. ProTaper and WaveOne are characterized by a triangular or modified triangular cross-section resulting in a lower cutting efficiency and smaller chip space. This design may enhance debris transportation toward the apex when used in combination with a reciprocal motion. Contrarily, incontinuous rotation may improve coronal transportation of dentine chips and debris by acting like a screw conveyor[9,16].

ProTaper Next instruments have an off-centered, rectangular design, generating traveling waves of motio along the active part of the file. The superior performance of the ProTaper Next system might be caused by the new swaggering motion, which serves to minimize the engagement between dentine and the file and enhances augering debris out of the canal[17].

Previous studies which demonstrated that no method completely avoids debris extrusion (Reddy & Hicks 1998, Mangalam et al. 2002, Tanalp et al. 2006, Kustarci et al. 2008, Logani & Shah 2008, Elmsallati et al. 2009, De-Deus et al. 2010). The reciprocating file extruded significantly more debris compared to the multiple-file rotary instrument and the single-file rotary system. This observation is in agreement with previous findings in as far as multiple-file rotary instrumentation was associated with less debris extrusion compared with the use of reciprocating single-file syatem[24](Burklein & Schafer 2012). OneShape extruded significant less debris than Reciproc. w/h file give Highest extrusion n min extrusion.

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