OPEN ACCESS

Saudi Journal of Oral and Dental Research

Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) |ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Quantitative Evaluation and Comparison of Apical Extrusion Using Reciprocating File Reciproc, WaveOne with Rotary OneShape, ProTaper Next Ni-Ti Systems

Dr. Thimmanagowda N Patil[1*], Dr. Sneha S Vanaki[2], Dr. Prahlad A Saraf[3], Dr. Anand Vallabhdas[4], Dr. Kusuma S C[5], Dr. Pradeep K[6]

[1]Reader, Subbaiah Institute of Dental Sciences, Purle, Shimoga, Karntaka, India
[2]Reader, P.M.N.M Dental College and Hospital, Bagalkot, Karnataka, India
[3]Professor and H O D, P.M.N.M Dental College and Hospital, Bagalkot, Karnataka, India
[4]Reader, Subbaiah Institute of Dental Sciences, Purle, Shimoga, Karntaka, India
[5]Reader, Subbaiah Institute of Dental Sciences, Purle, Shimoga, Karntaka, India
[6]Professor and H O D, Subbaiah Institute of Dental Sciences, Purle, Shimoga Karnataka, India

DOI: 10.36348/sjodr.2021.v06i10.007 | **Received:** 06.09.2021 | **Accepted:** 21.10.2021 | **Published:** 26.10.2021

***Corresponding author:** Dr. Thimmanagowda N Patil

Abstract

Aims and objectives of the study: The objective of this *in vitro* study aimed at evaluation with comparision of extrusion of the debris apically using Reciproc, WaveOne with OneShape, Protaper Next rotary file systems. ***Materials and Method:*** Sixty mandibular premolars with single root and singe canal were selected. The samples were distributed along four similar groups based on the length between cementoenamel junction and the apex. To collect the extruded debris glass vials with rubber stoppers were used. Pre weighed glass vials were used to collect the debris extruded and the irrigant. Preparation sequences were divided as follows: Group 1: A R25 Reciproc. Group 2: The WaveOne Primary file. Group 3: A classic OneShape file. Group 4: Multiple files ProTaper Next system. Once the instrumentation was completed with respective groups and files, tooth was remoed from the glass vial and root surface was rinsed with 1ml of bidistilled water into the receptor tube.within to make sure the debris accumulated is in the glass vial completely. Preweighed glass vials containing the debris was weighed in an electronic balance with an accuracy of +/- 0.00001g. ***Results:*** Readings, data collected, analyzed, computerized with the help of SPSS (STATISTICAL PACKAGE FOR SOCIAL SCIENCES software), 20.0 VERSION. One-way Analysis of Variance (ANOVA) and Tukey HSD test statistical analysis was done. All instruments resulted in extrusion of debris and irrigants, but highest average extrusion of debris was eident in Reciprocting file systems.***Conclusion****:* Among the four different file systems used, Reciproc file system showed the maximum apical extrusion.

Keywords: Apical extrusion, Reciproc, WaveOne, OneShape, ProTaper Next.

INTRODUCTION

To get rid of irreversibly inflamed pup tissue, pulp tissue remnants completely, to clean shape and fill all the root canals is the primary goal of endodontic therapy to preserve the tooth, save the healthy periodontium to serve as a single functional unit [1].

Removal of pulpal tissue, microorganisms, their by-products, organic and inorganic debris and intracanal irrigants are the vital part of chemomechanical preparation along with cleaning and shaping [2].

The resultant squeal chemical and mechanical canal preparation is extrusion of debris and irrigants into the periapical region leading to inflammation from the creation of wound or trauma [3].

More debris was produced and extruded in conventional hand filing technique. Crown down pressureless technique in both curved and straight canals was compared with conventional step back

instrumentation by Ruiz Hubard *et al*., The study concluded that the amount of debris extruded was less in crown down pressureless technique [4].

A common finding from the studies is that push pull instrumentation results in more production of debris than that incorporates reciprocation or rotational movements. This lead to the hypothesis that engine driven rotary instruments when compared to hand filing techniques [4].

During the last decade, Rotary Nickel Titanium instruments have become popular. More recently, instruments with non-cutting tips, radial lands, different cross-sections and varying tapers are available to improve working safety, reduce working time and create a greater flare within preparations [5].

The recently introduced nickel-titanium (Ni-Ti) files such as, self-adjusting file (SAF; ReDent-Nova, Raanana, Israel), Twisted File (TF) (SybronEndo, Orange, CA, USA), Reciproc Reciprocating file system (VDW, Munich, Germany), WaveOne Reciprocating file system (Dentsply Maillefer, Ballaigues, Switzerland) and F2 ProTaper universal Ni-Ti rotary instrument (Tulsa Dentsply, Tulsa, OK, USA) as per the study only one instrument can completely clean and prepare the canals. The concept of single file endodontics needs no glide path or minimum preparation and only a single file system for complete instrumentation for majority of root canals. Use of single file system has an extra advantage of reducing stress on instrument and also the fatigue. Now it seems that in the quest for an endodontic system that is faster and uses fewer files, the technique is supposed to decrease the working time and lower cross contamination between patients [6].

Reciproc Reciprocating file system made of a special Ni-Ti-alloy called M-Wire that is created by an innovative thermal-treatment process to increase flexibility and resistance to cyclic fatigue. These files are also used in a reciprocal motion that requires special automated devices. Reciproc files are of different sizes 25, taper 08; 40, taper 06; 50, taper 05 [6].

The new WaveOne NiTi file system from DENTSPLY Maillefer is a SINGLE-use, SINGLE file system to clean and shape the radicular pulp chamber completely from start to finish. WaveOne single-file reciprocating system consists of three files and are available in lengths of 21, 25 and 31mm:

Sizes Available are:

1. The Wave One Small file with tip size of 21 with a continuous taper of 6% is used in fine canals.
2. The WaveOne Primary file with tip size of 25 with an apical taper of 8% that reduces towards the coronal end is used in majority of the canals.
3. The WaveOne Large file with tip size of 40 with an apical taper of 8% that reduces towards the coronal end is used in large canals [6].

OneShape rotary file system has a changing triangular or modified triangular cross section with three sharp cutting edges at the tip, apical and the middle part and an S-shaped design with two cutting edges near the shaft [7].

Oneshape instrument are produced from Ni-Ti alloy and has a tip size of 25mm with constant taper of 0.06mm such that it has different cross sectional design over. This file is not symmetrical in design and asymmetry is to inhibit threading, locking and binding of the instrument when in continuous rotation inside the canal. To overcome the failures of Ni-Ti rotary files; three main changes which have been included are use of improved alloys, different movements used and new concepts of use [8].

Previous studies comparing multiple file rotary systems reported that Protaper Universal rotary file system resulted in large quantity of debris production which was due to their aggressive cutting capacity. Recently, newer improved file the Protaper Next system has been introduced. The quantity of debris extrusion when compared is significantly lower in newer Protaper Next files than the Protaper Universal system. This could be related to the shape and design of the apical portion of the Protaper Next files as they have rectangular cross section which is off-centered, helping in the nonuniform and reduced contact points between the cutting edge of the instrument and the root canal walls. This plus the lower taper could lead to decreased cutting in coronal part and result decreased debris extrusion [9].

A thorough comparison between new rotary file systems and older cleaning and shaping techniques for the quantity of debris they extrude with other parameters may be beneficial so that the best technique with the lowest chances of post-operative pain, flare up and extrusion may be selected [5].

As there is scarce information and need for the thorough comparison between recent reciprocating file systems, new multiple rotary instruments and new single file rotary system may be beneficial, which might help choose best technique with lowest postoperative flare-up and extrusion may be selected.

So, this study aims to compare, evaluate the quantity of apically extruded debris with Reciproc, WaveOne with single file rotary system OneShape and Protaper Next.

MATERIALS AND METHODS

Mandibular first Premolars with closed apex were selected and sample size for the study was fixed to

be sixty. Verification of single root, single canal, single apical foramen was verified by viewing their radiographs in different angulations. Teeth extracted with root fillings, resorption, calcification, fracture or caries were excluded from the study.

Access opening was done using small diamond burs and the apical patency was checked with 15 number file. The teeth were allocated into 4 identical groups based on the measured distances from the cervical line that is cementoenamel junction to the apex of the tooth. The working length was determined by decreasing 1mm from the length where number 15 K file was visible at the apex or apical foramen of the tooth.

The Samples were inserted into the rubber stoppers through a hole created and adjusted with heated instruments and fixed at Cementoenamel junction.

Irrigant and the debris extruded were collected in pre-weighed glass vials, which were used as a receptor tube for the extruded materials. A second bottle to hold the device during instrumentation so that no contact to the collecting vial was possible. The receptor tube was vented with 25-gauge needle alongside to equalize the pressure.

All instruments slow motion and strictly with accordance of manufacturer's instructions. The preparation sequences were as follows:
Group 1: A R25 Reciproc file having a size 25 at the tip and a taper of 0.08 was used.
Group 2: The WaveOne Primary file tip size of 25 with an apical taper of 0.08 was used.
Group 3: A classic OneShape file having a size 25 at the tip and a taper of 0.06 was used.
Group 4: Multiple files ProTaper Next system
X1 with tip size 17 and a taper of 0.05
X2 with tip size 25 and a taper of 0.06 was used

After the instrumentation, apical patency was checked with K File, irrigation was done with 2 ml of bidistilled water.

Cleaning and shaping was done until the rotary files rotates freely inside the canal, and concluded that instrumentation completed for single file systems. Next sequential instrument was used in Protaper Next system.

Once the instrumentation was competed, tooth was removed from the receptor tube; root surface was rinsed with 1 ml of bidistilled water to collect the debris adhering to the root surface. Then the receptor tubes containing the irrigant and the debris were incubated at 70 degree Celsius for 5 days to get rid of the moisture before weighing the dry debris.

Receptor tubes containing the dry debris were weighed in an electronic balance with an accuracy of +/- 0.00001g, three consecutive weights were taken for each tube and the mean was calculated. Weight of dry debris was determined by subtracting the weight of the empty receptor tube.

All the weights of the dry debris was computed, analysed using statistical software, statistical analysis was done using One-way Analysis of Variance (ANOVA) and Tukey HSD Test.

The weight of extruded debris was determined by subtracting the weight of the pre weighed empty glass vials from the weight of the glass vials containing the dried debris.

The data were then analyzed by One Way ANOVA for the comparison of extruded debris between all the groups. Post Hoc Tukeys HSD was done to evaluate the mean difference between all the groups.

Table 1: Mean weights of apically extruded debris

SAMPLES	GROUP I RECIPROC	GROUP II WAVEONE	GROUP III ONESHAPE	GROUP IV PROTAPER NEXT
1	0.0044	0.0031	0.00317	0.00253
2	0.003	0.0033	0.0025	0.0024
3	0.00317	0.00397	0.003	0.0023
4	0.0041	0.0027	0.0031	0.00313
5	0.00463	0.00277	0.00207	0.0028
6	0.003	0.00337	0.00357	0.0027
7	0.0039	0.00247	0.0026	0.0027
8	0.0039	0.0035	0.00293	0.00267
9	0.00363	0.00297	0.0039	0.0026
10	0.0031	0.00353	0.0021	0.00277
11	0.00577	0.0037	0.0028	0.0026
12	0.0031	0.00277	0.00313	0.00253
13	0.0037	0.00207	0.00257	0.003
14	0.00333	0.00257	0.0022	0.0028
15	0.00287	0.0032	0.0035	0.00267

Table 1: shows the mean weights of apically extruded debris.

Table 2:- Mean values and standard deviation of apically extruded debris using different file systems and One-way ANOVA analysis

Group	N	Mean	SD	Minimum	Maximum	ANOVA	
						F-value	p-value
Reciproc	15	0.0037	0.0008	0.0029	0.0058	9.69	<0.001*
WaveOne	15	0.0031	0.0005	0.0021	0.0040		
OneShape	15	0.0029	0.0005	0.0021	0.0039		
ProTaper Next	15	0.0027	0.0002	0.0023	0.0031		

*p<0.05 statistically significant
p>0.05 non-significant, NS

Table 2: shows mean values and standard deviation of apically extruded debris using different file systems and One-way ANOVA analysis showed statistically significant difference between the groups and Reciproc extruded the maximum debris.

Table 3:- Tukey Post Hoc test analysis for comparison within the groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Reciproc	WaveOne	0.0006	0.0002	0.01*	0.0001	0.0012
	OneShape	0.0008	0.0002	0.001*	0.0003	0.0014
	ProTaper Next	0.0010	0.0002	<0.001	0.0005	0.0016
WaveOne	OneShape	0.0002	0.0002	0.78(NS)	-0.0003	0.0007
	ProTaper Next	0.0004	0.0002	0.24(NS)	-0.0002	0.0009
OneShape	ProTaper Next	0.0002	0.0002	0.77(NS)	-0.0003	0.0007

*p<0.05 statistically significant
p>0.05 non-significant, NS

Table 3: Tukey Post Hoc test analysis for comparison within the groups showed statistically significant difference between Reciproc, WaveOne and OneShape.

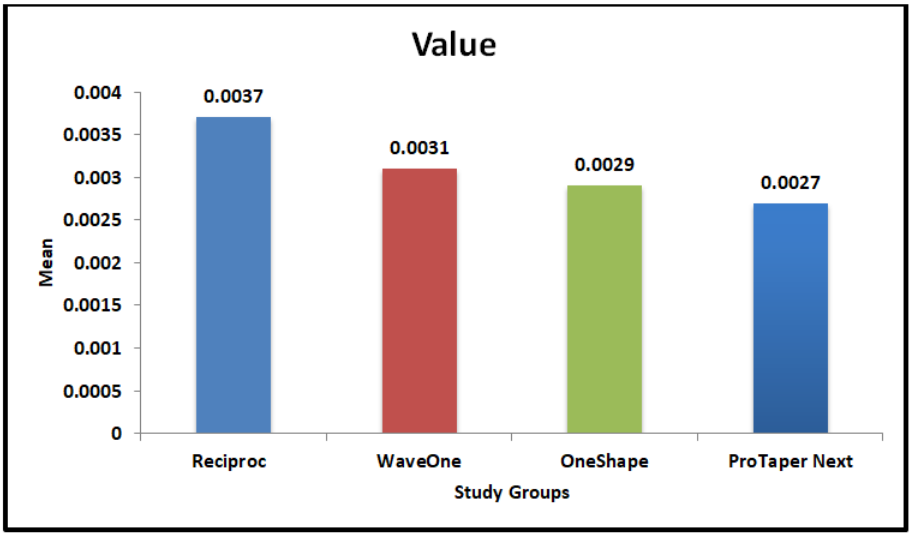

Figure-1: Mean values (y-axis) comparison between four study groups (x-axis)

Graph 1: Mean values (y-axis) comparison between four study groups (x-axis)

RESULTS

- Regardless of the instruments and the instrumentation techniques used, debris and irrigation extrusion was observed in all the groups, rotary file systems extruded less debris in comparison to reciprocating file systems.
- Debris extrusion was significant in WaveOne reciprocating file systemand also with the Reciproc reciprocating file system.
- Reciproc extruded more debris than ProTaper Next rotary file system

- Reciproc extruded significantly more debris than WaveOne and OneShape. No significant difference was recorded in comparison between WaveOne, OneShape and ProTaper Next Group

DISCUSSION

The prevention of post-operative pain after an root canal treatment is a prime consideration to both dentist and patient. During the root canal procedure adequate local anaesthesia avoids the pain, due to the instrumentation mild to moderate discomfort is experienced occasionally after the procedure. Studies have reported chances of post-operative after the procedure in 21% by Ingle and Zeldow, 40% by Seltzer and others and 25% by Clem [10].

During canal preparation mechanically and chemically the dentine chips, pulp tissue, microorganisms and even the irrigants move out of the apex and these extruded materials into the periradicular region can cause irritation. In general, debris and irrigation extrusion may lead to postoperative pain; swelling complications and the incidence of these complications are reported to range between 1.4 and 16% [7].

Pain after endodontic instrumentation is usually due to periapical inflammation. Root canal preparation and instrumentation also force necrotic debris, pulp tissue fragments, dentinal debris and chips or even the irrigants. This extruded material may then provoke an inflammatory reaction [10].

Infected debris moving into the periradicular region is possibly the principal causes of postoperative discomfort and pain [11].

Seltzer and Naidroff discussed several factors that can be the major cause for this process, which includes a quiescent chronic inflammatory periapical lesion which can react violently when root canal treatment is started with infective debris unkwowingly moving into the lesion and stimulating immunological phenomena, either cell mediated or humoral, that respond to foreign material or antigens in the area [12].

The extruded material has been called as a “worm’’ of necrotic debris by some authors and has been related to post instrumentation pain and flare-up. The infected debris extruding out of the apex have the ability to disturb the balance between the host defense mechanism and the microbial activity, resulting in frequent episodes of acute exacerbations and flare-ups [13].

It has been well documented in the literature that noncontaminated and the contaminated dentinal debris with pulp tissue can lead to an inflammatory reaction when extruded forcefully periapically during instrumentation. Post-operative flareups have been researched by many reaeachers with the conclusion that antigens originating from the radicular pulp chamber play an role in the sequence of antigen antibody complex leading to moderate to severe inflammatory reactions [13].

Several factors influence the outcome of the root canal therapy and the extrusion of debris and irrigants. Allmost all the research studies on this subject come to an conclusion that role of the apical area is important and predominant, the size and type of the needle tip used, the distance of the needle tip from the apical foramen, irrigant delivery with the flow rate and the use of high evacuation suction during irrigation [14].

Hand instrumentation was associated with higher amounts of debris extrusion than with rotary instruments, as hand instrumentation functions like a piston that pushes irrigating solutions and dentinal debris more towards the apex as when compared to rotary instruments which move the debris along the flutes of the files towards the coronal end [15].

Generally rotary instruments have a tendency to pull the debris into their flutes, thus lifting them away from the apex and towards coronal direction. As nickel-titanium rotary instrument vary in their designs, cross sectional shapes and methods of use, the extrusion of debris periapically also vary among the different file systems [16].

All the instruments and their mechanical preparation techniques are associated with extrusion of debris. Few researchers have concluded that manual or hand instrumentation technique extruded more debris than compared to rotary instrumentation. It has also been researched and reported that single reciprocating file systems extrude more debris than multiple rotary file system [7].

All the biomechanical preparation techniques and instruments extrude debris to some extent, the amount of debris extrusion peri-apically vary accordingly with techniques and the methods used [13].

This research study observed debris extrusion with all the instruments, which is in accordance with other research and confirms that all the instruments and instrumentation techniques to some extent extrude debris [7].

In the present research study Reciprocting file system were associated with greater mean extrusion of debris than compared with the rotary file systems and there was a significant difference between WaveOne, Reciproc reciprocating file systems and OneShape single file rotary systems. This research showed that all the instruments used in the canal preparation resulted in extrusion of debris apically, which is in accordance

with the previous research and studies which concluded that no instrumentation technique completely inhibits debris extrusion. The WaveOne and Reciproc reciprocating file systems extruded significantly more amount of debris in comparison to multiple file rotary system ProTaper Next and the OneShape single file rotary system. This observation and results are in agreement with previous research studies that concludes multiple file rotary instrumentation techniques were associated with less debris extrusion [7].

No Major and statistically significant differences were noticed with rotary file systems used OneShape and ProTaper Next. Differences in the preparation technique, cross sectional design of the instruments with varitations in the taper may have led to minor discrepancies'.

OneShape single file rotary system extruded significantly lesser amounts of debris than Reciproc and WaveOne with no significant differences with the amount of extrusion by multiple file ProTaper Next rotary system. It can be also be concluded that the greater taper of Reciprocating file system at the tip as compared with other instruments and the reciprocal working motion might be possible reasons for the greater amount of debris extrusion determined.

CONCLUSION

The goal of this research study was to evaluate the quantity of debris extrusion, within the limitations OneShape and Protaper Next rotary file systems extruded lesser debris than compared with that of Reciproc and WaveOne. Clinical studies are needed to assess and evaluate the impact of reciprocating and rotary file system with specific relevance to debris extrusion and post-operative pain.

REFERCENCES

1. Camoes, I. C., Salles, M. R., Fernando, M. V. M., Freitas, L. F., & Gomes, C. C. (2009). Relationship between the size of patency file and apical extrusion of sodium hypochlorite. *Indian Journal of Dental Research*, *20*(4), 426-430.
2. Desai, P., & Himel, V. (2009). Comparative safety of various intracanal irrigation systems. *Journal of endodontics*, *35*(4), 545-549.
3. Martin, H., & Cunningham, W. T. (1982). The effect of endosonic and hand manipulation on the amount of root canal material extruded. *Oral Surgery, Oral Medicine, Oral Pathology*, *53*(6), 611-613.
4. Reddy, S. A., & Hicks, M. L. (1998). Apical extrusion of debris using two hand and two rotary instrumentation techniques. *Journal of endodontics*, *24*(3), 180-183.
5. Adl, A., Sahebi, S., Moazami, F., & Niknam, M. (2009). Comparison of apical debris extrusion using a conventional and two rotary techniques. *Iranian endodontic journal*, *4*(4), 135-138.
6. Vallabhaneni, S., More, G. R., & Gogineni, R. (2012). Single file endodontics. *Indian Journal of Dental Advancements*, *4*(2), 822-827.
7. Bürklein, S., Benten, S., & Schäfer, E. (2014). Quantitative evaluation of apically extruded debris with different single-file systems: R eciproc, F 360 and O ne S hape versus M two. *International endodontic journal*, *47*(5), 405-409.
8. Dhingra, A., Ruhal, N., & Miglani, A. (2015). Evaluation of single file systems Reciproc, Oneshape, and WaveOne using cone beam computed tomography–an in vitro study. *Journal of clinical and diagnostic research: JCDR*, *9*(4), ZC30.
9. Koçak, M. M., Çiçek, E., Koçak, S., Sağlam, B. C., & Yılmaz, N. (2015). Apical extrusion of debris using ProTaper Universal and ProTaper Next rotary systems. *International endodontic journal*, *48*(3), 283-286.
10. VandeVisse, J. E., & Brilliant, J. D. (1975). Effect of irrigation on the production of extruded material at the root apex during instrumentation. *Journal of Endodontics*, *1*(7), 243-246.
11. Kustarci, A., Akdemir, N., Siso, S. H., & Altunbas, D. (2008). Apical extrusion of intracanal debris using two engine driven and step-back instrumentation techniques: an in-vitro study. *European journal of dentistry*, *2*(04), 233-239.
12. Myers, G. L., & Montgomery, S. (1991). A comparison of weights of debris extruded apically by conventional filing and Canal Master techniques. *Journal of endodontics*, *17*(6), 275-279.
13. Tanalp, J., Kaptan, F., Sert, S., Kayahan, B., & Bayirl, G. (2006). Quantitative evaluation of the amount of apically extruded debris using 3 different rotary instrumentation systems. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*, *101*(2), 250-257.
14. Lambrianidis, T., Tosounidou, E., & Tzoanopoulou, M. (2001). The effect of maintaining apical patency on periapical extrusion. *Journal of Endodontics*, *27*(11), 696-698.
15. Luisi, S. B., Zottis, A. C., Piffer, C. S., Vanzin, A. C. D. M., & Ligabue, R. A. (2010). Apical extrusion of debris after hand, engine-driven reciprocating and continuous preparation. *Revista Odonto Ciência*, *25*, 288-291.
16. Elmsallati, E. A., Wadachi, R., & Suda, H. (2009). Extrusion of debris after use of rotary nickel-titanium files with different pitch: a pilot study. *Australian Endodontic Journal*, *35*(2), 65-69.