VOLUME-9, ISSUE-3, MARCH-2020 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Endodontic

COMPARATIVE EVALUATION OF APICAL EXTRUSION OF DEBRIS DURING ROOT CANAL PREPARATION USING FOUR DIFFERENT FILE SYSTEMS

Dr Dattaprasad S	Professor & HOD, Department Of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India.
Dr Kumari H	Post Graduate Student, Department Of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India.
Dr. N.Vamsee Krishna *	Associate Professor, Department Of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India. *Corresponding Author
Dr Sunil Kumar C	Professor, Department Of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India.
Dr Sunil Kumar S	Reader, Department Of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India.
Dr R Bharathi Suma	Senior Lecturer, Department of Conservative Dentistry & Endodontics, CKS Teja Institute of Dental Sciences & Research, Tirupati, Andhra Pradesh, India.

ABSTRACT The success of root canal therapy is determined by proper access cavity preparation, biomechanical preparation and three dimensional obturation. Microorganisms that are apically extruded during chemo-mechanical preparation causes the host to be compromised by a more number of irritants than before. The aim of this invitro study is to quantitatively evaluate the apically extruded debris during the root canal instrumentation using Protaper Hand, Protaper Next, Protaper Gold, Wave one single file systems. 60 freshly extracted human mandibular incisors were selected and divided into four groups according to the file system used for biomechanical preparation. Apical extrusion of Debris was seen in all groups during the root canal preparation procedure regardless of the instrument or the preparation technique used. Protaper hand file extruded greatest amount of debris whereas Protaper next extrude less amount of debris when compared to that of other file systems ($P < 0.05$).

KEYWORDS : Protaper Next, Protaper Gold, Wave One Single File System

INTRODUCTION

During biomechanical preparation, pulp tissue fragments, dentinal fillings, necrotic tissue, microorganisms, and intracanal irrigants may extruded from the apical foramen into the periradicular region. The extruded material causes periapical inflammation and post operative flare–ups[1]. All preparation techniques are associated with apical extrusion of some amount of debris, which depends on various factors, including anatomy of the apical area, instrument design and the instrumentation technique[2,3]. Vandevisse and Brilliant[4] found that instrumentation with irrigant produced extrusion, whereas instrumentation without irrigant produced no collectible debris. Martin & Cunningham[5] reported that less debris was extruded when the intracanal preparation was performed with and ultrasonic instruments. Al-Omari & Dummer[6] verified that involving a linear filing motion techniques, such as the step back techniques, create a greater portion of debris than those involving some sort of rotational motion. The rotary instruments use crown down or cervical flaring type preparation that results in less apical extrusion of debris by creating a space large enough for debris to be rinsed away in a coronal direction[7]. Single file system have benefits such as reduced canal shaping time allowing the clinician to consume more time on cleaning the canal with more advanced irrigation techniques. The aim of this invitro study was to compare the apically extruded debris during the root canal instrumentation using Hand Protaper, Protaper Next & Protaper Gold rotary systems with Wave one single file reciprocating system.

METHODOLOGY:

Sixty freshly extracted, single rooted mandibular incisors without caries or visible cracks were selected for the study. External surfaces of all the teeth were debrided with a hand scaler and were analyzed using the Vista Scan digital radiographic system in the labial and proximal directions to confirm the presence of single, straight root canals and non-complicated root canal anatomy. A standard access cavity was prepared for all the samples & canal patency was verified with a ISO size #15k file. The working length of each canal was determined by visible method i.e., size #15k file was placed at the major diameter of apical foramen and reduced by 1mm.

Myers and Montgomery model was used in this study for the collection of apically extruded debris. An electronic balance with an accuracy of 10−5g was used to measure the pre-weight of the Eppendorf tubes that are going to be used in the study. A hole was created on each Eppendorf tube lid & each tooth was cemented upto the CEJ using cyanoacrylate gel. A 25-G needle was placed parallel to the tooth which helps as a drainage canula to maintain the air pressure inside and outside the Eppendorf tube. Then each lid with the tooth and the needle was attached to its Eppendorf tube, and the Eppendorf tubes were fitted into stopper of the vials. These samples were then randomly divided into four groups (n=15) for instrumentation with different file systems.

GROUP1:

Protaper Handfiles (Dentsply Maillefer, Ballaigues, Switzerland) were used for instrumentation according to the

manufacturers instructions. Shaping files (Sx, S1 & S2) were used for crown down preparation and finishing files (F1 &F2) were used for apical-third preparation of the root canals.

Group2: Protaper Next (Dentsply Maillefer, Ballaigues, Switzerland) rotary files were used for instrumentation according to the manufacturers instructions. X1(17/0.04) & X2(25/0.06) rotary files were used in an Endodontic motor sequentially at 300 rpm speed and torque of 4-5.2N/cm. A brushing out stroke motion was used until working length was reached.

GROUP 3: Protaper Gold (Dentsply Maillefer, Ballaigues, Switzerland) rotary files were used for instrumentation according to the manufacturers instructions. Shaping files (Sx, S1 & S2) and finishing files (F1 &F2) were sequentially used with a slightly in-and-out movement at the speed of 300 rpm & torque of 3-5N/cm until working length was reached.

Group 4: Wave One (Dentsply Maillefer, Ballaigues, Switzerland) reciprocating file at a speed of 300 rpm and torque of 2N/cm was used for instrumentation according to the manufacturers instructions. Canal preparation was done with Wave one primary file of tip size ISO 25 in a reciprocating slow in and out pecking motion to the full working length.

During instrumentation each sample was irrigated with 9ml of distilled water using side vent endodontic needle. Immediately after instrumentation, the Eppendorf tubes were removed from the vial and then stored in an incubator at 70°C for 2 days to evaporate the distilled water. After that the Eppendorf tubes were post weighed using the same electronic balance. Three consecutive measurements were taken and the average values was recorded for each sample in each group to obtain the final weight of tubes including the extruded debris. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tube from that of the tube containing debris.

RESULTS:

The mean dry weights of extruded debris were analysed statistically using SPSS version 20.0 soft ware. Multiple group comparisons were analysed by using One-way ANOVA followed by Student's t-test for pair wise comparisons at a significant level of $P<0.05$. The Protaper hand showed maximum amount of apical extrusion of debris among all the groups & the least amount of debris was observed in Protaper next system.

Table 1: The mean values of amount of apically extruded debris (in mcg) SD, for all groups

Groups	n	Mean	Std. deviation	Std. error	F value	P value
Protaper Hand	15	0.011	0.006	0.0016	4.887	0.004
Protaper Next	15	0.005	0.002	0.0006		
Protaper Gold	15	0.006	0.002	0.0006		
Wave one	15	0.008	0.006	0.002		

Table2: Paired Samples Statistics

		Mean	n	Std. deviation	Std. Error mean
Pair 1	Protaper hand preweight	1.0871647	15	0.00496893	0.00128297
	Protaper hand post weight	1.09803500	15	0.005635932	0.001455191
Pair 2	Protaper next pre weight	1.0840640	15	0.00350247	0.00090433
	Protaper next postweight	1.0891793	15	0.00383242	0.00098953
Pair 3	Protaper goldpreweight	1.0875993	15	0.00327918	0.00084668
	Protaper gold postweight	1.0933847	15	0.00477626	0.00123322
Pair 4	Wave one preweight	1.0865360	15	0.00381726	0.00098561
	Wave one postweight	1.0944673	15	0.00420370	0.00108539

Table3: Paired Samples Correlations

		n	Correlation	Sig.
Pair 1	Protaper hand preweight & Protaper hand post weight	15	0.336	0.220
Pair 2	Protaper next pre weight & Protaper next post weight	15	0.813	0.000
Pair 3	Protaper gold preweight & Protaper gold post weight	15	0.921	0.000
Pair 4	Wave one preweight & Wave one post weight	15	-0.085	0.764

Table 4: ANOVA values of within group and between groups

	Sum of Squares	Df	Mean Square	F	P Value
Between Group	0.000	3	0.000	4.888	0.004
Within Groups	0.001	56	0.000		
Total	0.001	59			

Table 5: Post Hoc tests Multiple group Comparisons
Dependent Variable: Values - Tukey HSD

(I) GRP	(J) GRP	Mean Differenc e (I-J)	Std. Error	P Value	95% Confidence Interval	
					Lower Bound	Upper Bound
Protaper hand	Protaper next	0.0057667*	0.0016571	0.005	0.001379	0.010155
	Protaper gold	0.0050600*	0.0016571	0.018	0.00672	0.009448
	Wave one	0.0029267	0.0016571	0.300	-0.001461	0.007315
Protaper next	Protaper hand	-0.0057667*	0.0016571	0.005	-0.010155	-0.001379
	Protaper gold	-0.0007067	0.0016571	0974	-0.005095	0.003681
	Wave one	-0.0028400	0.0016571	0.326	-0.007228	0.001548
Protaper gold	Protaper hand	-0.0050600*	0.0016571	0.018	-0.009448	-0.000672
	Protaper next	0.0007067	0.0016571	0.974	-0.003681	0.005095
	Wave one	-0.0021333	0.0016571	0.575	-0.006521	0.002255
Wave one	Protaper hand	-0.0029267	0.0016571	0.300	-0.007315	0.001461
	Protaper next	0.0028400	0.0016571	0.326	-0.001548	0.007228
	Protaper gold	0.0021333	0.0016571	0.575	-0.002255	0.006521

***. The mean difference is significant at 0.05 level.**

DISCUSSION:

The Endodontic Triad consisting of biochemical preparation, microbial control and complete obturation of the root canal space. An acute inflammatory response may develop in the periradicular tissues as a result of insults from the root canal system, which can be mechanical, chemical, or microbial in origin[5]. Mechanical and chemical injuries are usually associated with iatrogenic factors, such as over-instrumentation, apical extrusion of debris or irrigant, perforations, etc.,Apical extrusion of contaminated debris into the periradicular tissues is one of the principal cause of mid treatment flare-up and postoperative pain. Passive insertion of the needle & passive irrigation with side vent needles have been shown to provide safer treatment procedure, decreasing the likelihood of considerable amounts of liquid being pushed periapically[8]. Furthermore, the proximity of the irrigating needle to the apex plays an important role in removing the canal debris[9,10]. Instrument design plays a role in apical extrusion of debris. Tınaz et al.,[11] concluded that more debris was extruded with an increase in apical diameter. Elmsallati[12] showed that the short pitch design extruded less debris than the medium and long ones.Diemer et al.,[13] compared the effect of pitch length and stated that the increasing variable pitch decreases the tendency to screw in and also reduces the helical angle which in turn reduces the apical extrusion.

Apart from instrument design, instrumentation technique also play a role in the apical extrusion of debris. Full-sequence rotary instrumentation was associated with less debris extrusion compared to reciprocating single-file systems[14]. A common finding is that push-pull instrumentation produces more apical debris than instrumentation techniques that incorporate a rotational force. This leads to the hypothesis that engine driven rotary instruments will produce less debris than hand filing techniques[12]. Canal preparation in a step back manner led to increased debris extrusion, in comparison to a canal instrumentation with balanced force or rotary technique. It seems that push-pull motions of files during root canal preparation cause more debris extrusion than techniques that are based on a reaming or rotational action[7,15]. Al Omari and Dummer[6] instrumented 208 canals using eight different hand instrumentation techniques and found that balanced and crown down pressure less technique extruded the least amount of debris. Ferraz and Gomes[16] observed that engine driven nickel-titanium systems were associated with less apical extrusion. Apical extrusion of debris tends to be greater with hand instruments than with techniques that use rotary forces because the files may act as pistons that push irrigating solutions and debris towards the apex conversely rotary instruments may move debris along the files, which results in debris being expelled cervically[7].

In the present study, extrusion of debris apically occurred independent of the type of instrument used. First protaper hand shows significantly more debris compared to that of the reciprocating single-file followed by the full sequence rotary NiTi instruments ($P < 0.05$). Protaper hand extrude more debris compared to that of rotary file. Protaper hand and Protaper gold rotary systems has same convex triangular cross-section and a variable progressive taper[17]. Engine driven rotary files contacts the apical area for lesser period of time and also rotational speed and torque is fixed for rotary files. Protaper hand file prepares the apical area for an extended period of time and rotational movement of the file is an operator controlled variable factor. Longer pitch design and extended period of working time at the apex, extrude greater amount of debris by Protaper hand system in comparison to the Engine driven file systems. This long pitch design of Protaper hand has been changed to variable pitch in case of Protaper rotary files[18].

ProTaper next System, which uses an offset mass of rotation are made from M-wire technology and have an off-centered rectangular cross-section. This off-centered rectangular design gives the files a snake like swaggering movement and reduces the screw effect by minimizing the contact between the file and dentin[19]. WaveOne is the single-file NiTi system that work on the reciprocating action and simulate the Balanced Force Technique, as theorized by Roane and Sabala[20]. These files are made of M-Wire under specific tensions and heat treatments at various temperatures.

The WaveOne primary file used in this study has tip size 25 & continuously decreasing taper from its tip to its shaft (0.8, 0.65, 0.6, 0.55). In the tip region, the cross-section presents radial lands, while the middle part of the working length and near the shaft, the cross sectional design changes from a modified triangular convex cross-section with radial lands to a neutral rake angle triangular convex cross-section. This design may enhance debris transportation towards apex when used in combination with a reciprocal motion. The variable pitch flutes along the length of the instrument considerably improve safety. The counterclockwise (CCW) movement of WaveOne file is greater than the clockwise (CW) movement. CCW movement advances the instrument, engaging and cutting the dentine. CW movement disengages the instrument from the dentine before it can lock into the canal. Three reciprocating cycles complete one complete reverse rotation and the instrument gradually advances into the canal with little apical pressure required. The reciprocation movement is formed by a wider cutting edge angle and smaller release angle. While rotating in the release angle the flutes will not remove debris but push them apically[21]. 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[22].

CONCLUSION:

Within the limitations of this present in vitro study, Apical extrusion of Debris was seen in all groups during the root canal preparation procedure regardless of the instrument or the preparation technique used. The amount of apically extruded debris was high in Protaper hand followed by Wave one, Protaper gold and Protaper Next file systems respectively.

REFERENCES:

1. Seltzer, S., & Naidorf, I. J. (1985). Flare-ups in endodontics: I. Etiological factors. Journal of Endodontics, 11(11), 472-478.
2. Patterson, S. M., Patterson, S. S., Newton, C. W., & Kafrawy, A. H. (1988). The effect of an apical dentin plug in root canal preparation. Journal of endodontics, 14(1), 1-6.
3. Radeva, E. N., & Vassileva, R. I. (2014). Comparative study of apically extruded debris and irrigant after using two rotary systems (K3, Race). Journal of IMAB–Annual Proceeding Scientific Papers, 20(1), 459-463.
4. 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.
5. 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.
6. Al-Omari, M. A. O., & Dummer, P. M. H. (1995). Canal blockage and debris extrusion with eight preparation techniques. Journal of endodontics, 21(3), 154-158.
7. Fairbourn, D. R., McWalter, G. M., & Montgomery, S. (1987). The effect of four preparation techniques on the amount of apically extruded debris. Journal of endodontics, 13(3), 102-108.
8. Brown, D. C., Moore, B. K., Brown Jr, C. E., & Newton, C. W. (1995). An in vitro study of apical extrusion of sodium hypochlorite during endodontic canal preparation. Journal of endodontics, 21(12), 587-591.
9. 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.
10. Hegde, M. N., & Thatte, S. (2011). Comparison of the amount of apical extrusion of bacteria following the use of different instrumentation techniques-An in vitro study. Nitte Univ J Health Sci, 1, 27-32.
11. Tinaz, A. C., Alacam, T., Uzun, O., Maden, M., & Kayaoglu, G. (2005). The effect of disruption of apical constriction on periapical extrusion. Journal of endodontics, 31(7), 533-535.
12. 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.
13. Diemer, F., & Calas, P. (2004). Effect of pitch length on the behavior of rotary triple helix root canal instruments. Journal of Endodontics, 30(10), 716-718.

14. De-Deus, G., Brandão, M. C., Barino, B., Di Giorgi, K., Fidel, R. A. S., & Luna, A. S. (2010). Assessment of apically extruded debris produced by the single-file ProTaper F2 technique under reciprocating movement. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology, 110(3), 390-394.
15. Ruiz-Hubard, E. E., Gutmann, J. L., & Wagner, M. J. (1987). A quantitative asses sment of canal debris forced periapically during root canal instrumentation using two different techniques. Journal of Endodontics, 13(12), 554-558.
16. Ferraz, C. C. R., Gomes, N. V., Gomes, B. P. F. A., Zaia, A. A., Teixeira, F. B., & Souza-Filho, F. J. (2001). Apical extrusion of debris and irrigants using two hand and three engine-driven instrumentation techniques. International Endodontic Journal, 34(5), 354-358.
17. Elnaghy, A. M., & Elsaka, S. E. (2016). Mechanical properties of ProTaper Gold nickel-titanium rotary instruments. International endodontic journal, 49(11), 1073-1078.
18. Ghivari, S. B., Kubasad, G. C., Chandak, M. G., & Akarte, N. R. (2011). Apical extrusion of debris and irrigant using hand and rotary systems: A comparative study. Journal of conservative dentistry: JCD, 14(2), 187.
19. Dincer, A. N., Guneser, M. B., & Arslan, D. (2017). Apical extrusion of debris during root canal preparation using a novel nickel-titanium file system: WaveOne gold. Journal of conservative dentistry: JCD, 20(5), 322.
20. Roane, J. B., Sabala, C. L., & Duncanson Jr, M. G. (1985). The "balanced force" concept for instrumentation of curved canals. Journal of endodontics, 11(5), 203-211.
21. Vallabhaneni, S., More, G. R., & Gogineni, R. (2012). Single file endodontics. Indian Journal of Dental Advancements, 4(2), 822-827.
22. Burklein, S., & Schafer, E. (2012). Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. Journal of endodontics, 38(6), 850-852.