Original Research Paper

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The evaluation of apically dxtruded debris during root canal preparation using protaper universal, protaper gold and reciproc blue system: An in-vitro comparative study

ABSTRACT

Aims & Objectives: The purpose of this study was to compare the amount of apically extruded debris with four nickel-titanium instruments i.e ProTaper Universal, ProTaper Gold, and Reciproc Blue system, Hand K file System. Methods: Eighty extracted single-rooted mandibular premolar human teeth were randomly assigned to 4 groups (n = 20). The canals were instrumented using 1 of the following instruments: ProTaper Universal, ProTaper Gold, and Reciproc Blue system, Hand K file System. Apically extruded debris during instrumentation was collected into preweighed Eppendorf tubes. The weight of the extruded debris was calculated by subtracting the weight of the empty tubes from that of the tubes containing the debris. The data were analyzed statistically using the analysis of variance (ANOVA) and Post-hoc bonferroni test at a significance level of P < .05. Results: All the instrumentation systems resulted in production of extruded debris. The amount of extruded debris was significantly more in Hand K file than PTU, PTG and Reciproc Blue (P<0.05). The PTU system was associated with significantly more extruded debris than the PTG(P=0.041), Reciproc Blue systems (P=`0.011), whereas no significant difference was found in the amount of the debris extruded between PTG and Reciproc Blue (P=0.271). The amount of extruded debris was least in Reciproc Blue in comparison to all used system. Conclusions: Within the limitations of this in vitro study, the amount of apically extruded debris registered for the different files tested was highest for hand file, Protaper Universal, followed by the ProTaper Gold and least in Reciproc Blue.

Keywords: Apical Extrusion, ProTaper Gold, ProTaper Universal, Reciproc Blue

Introduction :

The success rate of root canal treatment ranges from 31%–96%.[1] Proper debridement of root canal space is indispensable for the success of root canal treatment. During the chemomechanical preparation of root canals even small amounts of apical extrusion can promote flare-ups, postoperative inflammation, pain and delay healing.[2] The incidence of these complications is reported to range between 1.4% and 16.3 Many studies[4,5] compared the amount of debris extruded after canal shaping with different file systems and techniques. It was found that all preparation techniques produce some degree of apically extruded debris, the use of motor-driven tools has been shown to extrude less debris as compared to hand file techniques.[6] Technological advancements in nickel-titanium (NiTi) instruments have led to new design ideas and simpler and quicker procedures that have revolutionized root canal treatment with less iatrogenic error.

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Recently, a more flexible NiTi instrument, ProTaper Gold (Dentsply Tulsa Dental, Tulsa, OK, USA) has been introduced. According to the manufacturer, ProTaper Gold instruments have the same geometry as that of ProTaper Universal with proprietary advanced metallurgy. It exhibits a convex triangular cross-section and progressively tapered

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design that claimed to improve the cutting efficiency and safety resistance to cyclic fatigue.[7,8] ProTaper Gold systems consist of 3 shaping files (SX, S1, and S2) and 5 finishing files (F1, F2, F3, F4, and F5), uses the same rotary action and works with the same motors and settings as Pro Taper Universal.

Reciproc Blue (VDW GmbH, Munich, Germany) is a thermally treated nickel-titanium single file system which is the improved version of the original Reciproc. It has S-shaped cross-sectional design having 2 cutting edges, an increased resistance to cyclic fatigue and greater flexibility.[9]

Aim: The aim of this study was to compare the amount of apically extruded debris with four nickel-titanium instruments i.e ProTaper Universal, ProTaper Gold, and Reciproc Blue system, Hand K file System.

Method:

A total of 80 freshly extracted human mandibular premolars with complete root formation were selected Fig.1. A digital radiograph in a buccolingual and mesiodistal direction of each tooth sample was taken. The teeth were screened under the following criteria: Inclusion criteria: Teeth with single canal and apical foramen, canal curvature between 0 and 20 degrees (Calculated using the Schneider technique), an apical diameter corresponding to a #10 file. The exclusion criteria: Teeth having more than a single root canal and apical foramen, root canal treated teeth, internal/external resorption, immature root apices, caries/cracks/fractures on the root surface, calcified canal. After screening, 80 specimens were then randomly assigned to four experimental groups (n = 20) according to the instrument system to be used: The Hand K file, Protaper Universal system, the ProTaper Gold system, the Reciproc Blue reciprocating system. New instruments were used in each tooth. The experimental model described by Myers and Montgomery in 1991 was used in this study.

Preparation of the Specimens: The buccal cusp edges was flattened by using high speed bur and considered as reference point. Canal patency and glide path determination were achieved using size k-file. The length of the 1 canal was determined by introducing a size 15 K-file into the canal till the tip of the file was visible from the apex. The working length (WL) was determined by subtraction of 1 mm from the canal length. For all groups, the apical foreman of each tooth was only enlarged to size 15 prior to shaping with the respective single-file system.

Pre weighing of the tubes: An analytical balance (Mettler Toledo) Fig.2 with an accuracy of 10^{-4} g was used to measure the weights of the empty tube with their caps. Three consecutive weights were obtained for each tube, and the average was calculated. The Eppendorf tubes were placed in the glass vial and the opening was sealed with chemically activated acrylic resin (Pyrax, Roorkee, India). Cap of the tube was removed, a stopper with a hole was fitted on the tube, and tooth was inserted until the cementoenamel junction stayed 1–2mm above the stopper. Each tooth was fixed through the stopper with manual pressure. A 27-G needle was placed alongside the stopper as a drainage cannula and to balance the air pressure inside and outside the tube. Each roots and needle were fixed to the stopper by means of chemically activated acrylic resin (Pyrax, Roorkee, India) to prevent irrigant extrusion through the holes. Paper was used to cover the glass vials to prevent any operator bias during the instrumentation procedure. An aspirator was used to suction excess irrigating solution overflowing from the tooth crown.

Experimental Groups:

All rotary NiTi instruments were used with a torque and speed controlled X-Smart plus, Dentsply Maillefer at the torque and speed recommended by the manufacturer for each specific system used. Further, root canal instrumentation was performed with the Hand K file, Protaper Universal, the ProTaper Gold rotary system, the Reciproc Blue reciprocating system according to the group. A single operator performed all the root canal preparations. Fig. 3.

Group A: Root Canal Instrumentation with the Hand K-file. In the hand file group, the canals were prepared with K-file instruments ((MA, Dentsply Maillefer, Ballaigues, Switzerland) using a step-back technique. Apical preparation was continued up to size 25 and the step-back was done with a reduction of 1 mm for each file until size 35k-files.

Group B: Root Canal Instrumentation with Protaper Universal file system (Dentsply Maillefer, Ballaigues, Switzerland). Protaper Universal file system was used with X-SMART™ (Dentsply, mallifer 16:1 contrangle endomotor).Following sequence was used till the working length-SX-S1-S2-F1-F2(Size 25, 0.08 Taper).

Group C: Root Canal Instrumentation with The ProTaper Gold rotary system (Dentsply Maillefer, Ballaigues, Switzerland).Root canals were instrumented according to the manufacturers' instructions. The files were operated using an electric motor with a 16:1 reduction handpiece. The root canals were instrumented to the working length using the

following sequence: Sx file(1/2 of the WL), S1 and S2 files (2/3 of the WL), F1 file (20/.07), and F2 file (25/.08) (full WL).

Group D: Root Canal Instrumentation with Reciproc Blue (VDW Dental, Munich, Germany) R25 (25/.08) instruments were used with "Reciproc" mode of the endodontic motor (X-Smart Plus).

In these above group, irrigation was performed with a 30-G needle at a flow rate of 2 ml/min. Distilled water was used as an irrigant between each instrument change to irrigate canal with a total volume of 5 ml irrigant.

Post weighing of the Eppendorf Tubes:

After the instrumentation was complete, the stopper, the needle and the tooth were separated from the tubes, and the debris adhered to the root surface was collected by washing the root with 1 ml distilled water inside the tubes. The tubes were then stored in an incubator at 65°C for 10 days for evaporation of the distilled water before weighing the dry debris. The tubes were then weighed using the same analytical balance to obtain the final weight of the tubes including the extruded debris. Three consecutive weights were obtained for each tube. The dry weight of the extruded debris was calculated by subtracting the weight of the empty tubes from that of the tubes containing the debris.

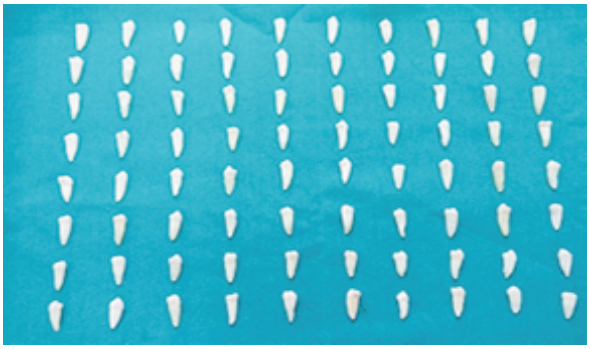

Fig.1.Selected Samples: 80 Freshly extracted human single rooted.

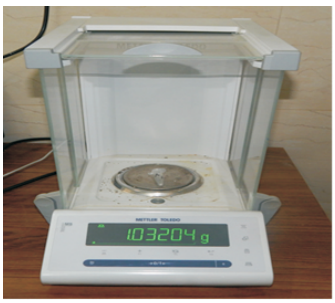

Fig.2. Analytical balance (Mettler Toledo)

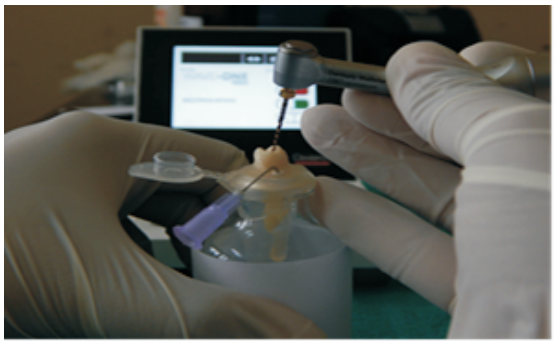

Fig.3. Root Canal Instrumentation using X-Smart plus Endomotor

Statistical Analysis:

All statistical analyses were performed using SPSS 20.0 software (SPSS Inc, Chicago, IL). The amount of extruded debris and preparation times were analyzed statistically using the analysis of variance (ANOVA) and Post-hoc bonferroni test at a significance level of $P < .05$.

Results:

All the instrumentation systems resulted in production of extruded debris. The mean values and the standard deviation of each experimental group are shown in Table I. The amount of extruded debris was significantly more in Hand K file than Protaper Universal, Protaper Gold and Reciproc Blue ($P<0.05$). The Protaper Universal system was associated with significantly more extruded debris than the Protaper Gold ($P=0.041$) and Reciproc Blue systems ($P=`0.011$), whereas no significant difference was found between Protaper Gold and Reciproc Blue ($P=0.271$). The amount of extruded debris was least in Reciproc Blue in comparison to all used system.

Table:1 showing mean apical extrusion of debris and Std. Deviation among Group A (Hand K file), Group B (Protaper Universal), Group C (Protaper Gold) and Group D (Reciproc Blue)

Groups	Mean	Std. Deviation	Std. Error	Minimum	Maximum	95% Confidence Interval	
						Lower Bound	Upper Bound
Group A	0.00212	0.00010	0.00003	0.00200	0.00230	0.00204	0.00220
Group B	0.00160	0.00035	0.00012	0.00110	0.00200	0.00134	0.00187
Group C	0.00135	0.00035	0.00012	0.00100	0.00190	0.00108	0.00163
Group D	0.00125	0.00008	0.00003	0.00100	0.00130	0.00119	0.00131

Discussion :

For the endodontic success complete debridement of the root canal space is mandatory. During chemomechanical preparation, extrusion of infected debris into the periradicular region may cause postoperative inflammation, pain, swelling and delay of periapical healing.2 According to the results of

this study, all files resulted in some degree of extrusion of debris from the apex, which is similar to the findings of previous studies, which reported that all file systems used for root canal treatment, working both in continuous rotation and reciprocation, and even including hand instrumentation, could trigger different degrees of apically extruded debris.[10,11,12] The amount of debris extrusion may varies based on instrumentation technique, instrument type, instrument size, taper, and number of files, the final apical diameter of the apical foramen and irrigant solution.(Reddy & Hicks 1998,6 Mangalam et al. 2002,14 De-Deus et al. 2010 10).

The present in vitro study investigated for the first time the amount of apically extruded debris using NiTi files (The Hand K file, Protaper Universal, the ProTaper Gold system, the Reciproc Blue reciprocating system) during root canal preparation. The generally accepted methodology of Myers and Montgomery[15] was employed in this study to collect apically extruded debris.

In the present study, for the purpose of standardization, the amount and type of irrigant were fixed and common to all techniques. Distilled water was used as an irrigation solution in this study to prevent misleading weight measurements as a result of possible crystallization of sodium hypochlorite solution. The working length for all samples was kept 1mm short of the apical foramen. Myers and Montgomery[15] demonstrated that a working length 1mm short of canal length exhibited significantly less debris extrusion. Martin and Cunningham[16] proved that when the instrumentation was performed at a length where the file was observed to just protrude through the apical foramen contributed significantly more debris extrusion than 1mm short of the apical foramen. Instruments with a no. 25 apical diameter at D0 were selected in all the groups to avoid any variations in the amount of extruded debris because of the size of apical enlargement.

In our study, it was found that hand K file extruded more debris as compared to engine-driven instruments rotary ProTaper universal, ProTaper Gold file and reciprocating Reciproc Blue file system. It may be due to the fact that the linear motion of Hand K file in step back technique extrudes more debris because in and out motion (filling motion) acts as a piston and pushes the debris out through the apical foramen. Also there is less space available to flush the debris out coronally. The discrepancy in the root canal instrumentation using manual, rotary and reciprocating system is that due to the time of contact between the file and the root canal wall.[17] The engine-driven file contacts the apical area for a lesser period of time and also the rotational speed and torque is fixed, whereas, the Hand file prepares the apical area for an extended period of time and the rotational movement of the file is an operator controlled variable factor, extruding more amount of debris.[17] In case of engine-driven instruments, early flaring of the coronal part of the preparation may improve instrument control during preparation of the apical third of the canal. The rotary motion tends to direct debris towards the orifice, avoiding its compaction in the root canal.[17]

ProTaper Gold rotary files have the same exact geometry as ProTaper Universal and share the same motion kinematics, number of files, and instrument design. ProTaper Universal was more resistant to torsional stress and micro-hardness. The ProTaper Gold system has been metallurgically enhanced by heat treatment technology and has increased resistance to cyclic fatigue, increased flexibility and canal maintenance than ProTaper Universal. These properties of ProTaper Gold instruments might explain the reduced amount of debris extrusion than ProTaper Universal.[7,8]

Burklein and Schafer11conclude that the full sequence of the rotary instrumentation was associated with less debris extrusion than Reciproc blue reciprocation single-file systems. In contrast, this study showed that the reciprocating single file system associated with less apical extrusion than the rotary instrumentation file systems (ProTaper Gold and ProTaper Universal) and this agreed with other study.[19]

The Reciproc blue reciprocating single file system also showed highly significant difference with the PTU and hand k file ($p \leq 0.01$). This may be due to the reciprocation movement as it is a type of automated, balanced, pressureless technique. The technique of balanced force is known to have stronger control of debris extruded apically.[20] The Reciproc blue has file design with specific s-shaped cross-section and a larger space to accommodate dentine debris, no radial lands, thermally improved raw material and non-cutting tip for a gentle treatment near the apex.[9] The concept can be used to endorse the enhanced performance of single-file systems found in this report.

A certain degree of caution should be taken when transferring the present results to the clinical situation, because this experimental design is limited by its inability to mimic the periapical tissues that act as natural barrier or provide physical back-pressure, so the gravity may have extruded the irrigant and debris out of the canal.[21] This shortcoming of this study

design has already been discussed by Myers & Montgomery.[15] It has been suggested to simulate resistance of periapical tissues by using floral foam as proposed by Altundasar et al.[22], Hachmeister et al.[23] however, this study design had several disadvantage like foam may absorb some irrigant and debris when used as a barrier, therefore, no attempt has been made in the present study to simulate periapical resistance using foam.[22,23] Results may also differ because of positive and negative pressure at the apex and with normal or pathological periapical tissues. Moreover, this study was limited to teeth with mature root morphology. The observed results should not be generalized to teeth with immature root development and open apices.

Based on the results of this study, independently of the systems used, all instrumentation techniques produced debris extrusion. Nonetheless, the present results may provide guidance to clinicians in their selection of an instrument to use in root canal preparation.

Conclusion:

Within the limitations of present in vitro study, following conclusions can be drawn:All the instrumentation systems resulted in production of extruded debris. The amount of extruded debris was highest in Hand K file in comparison to rotary and reciprocating file system. Among the rotary and reciprocating file, the amount of extruded debris was highest for ProTaper universe, followed by ProTaper Gold and least in Reciproc Blue. The amount of extruded debris was least in Reciproc Blue in comparison to all used system.

Future studies should be aimed at the careful evaluation of new file systems in clinical condition for determination of the exact relationship between debris extrusion and flare up by a particular file system.

References:

1. Ng YL, Mann V, Rahbaran S, et al. Outcome of primary root canal treatment: systematic review of the literature—part 1. Effects of study characteristics on probability of success. Int Endod J 2007;40:921–39.
2. Siqueira JF Jr. Microbial causes of endodontic flare-ups. Int Endod J 2003;36:453-63.
3. Siqueira JF, Rocas IN, Favieri A, Machado AG, Gahyva SM, Oliveira JCM. Incidence of post operative pain after intracanal procedures based on an antimicrobial strategy. J Endod 2002;28:457–60.
4. Torabinejad M, Eby WC, Naidorf IJ. Inflammatory and immunological aspects of the pathogenesis of human periapical lesions. J Endod 1985;11:479-88.
5. VandeVisse JE, Brilliant JD. Effect of irrigation on the production of extruded material at the root apex during instrumentation. J Endod 1975;1:243-6.
6. Reddy SA, Hicks ML. Apical extrusion of debris using two hand and two rotary instrumentation technique. J Endod 1998;24:180-3.
7. Gao Y, Gutmann JL, Wilkinson K, Maxwell R, Ammon D. Evaluation of the impact of raw materials on the fatigue and mechanical properties of ProFile Vortex rotary instruments. J Endod 2012;38:398-401.
8. Ye J, Gao Y. Metallurgical characterization of M-Wire nickel-titanium shape memory alloy used for endodontic rotary instruments during low-cycle fatigue. J Endod 2012;38:105-7.
9. Cangül Keskin, Evren Sariyilmaz . Apically extruded debris and irrigants during root canal filling material removal using Reciproc Blue, WaveOne Gold, R-Endo and ProTaper Next systems. J Dent Res Dent Clin Dent Prospect 2018;12(4):272-276|
10. De-Deus G, Silva EJNL, Vieira VTL, Belladonna FG, Elias CN, Plotino G, Grande NM. Blue thermomechanical treatment optimizes fatigue resistance and flexibility of the Reciproc files. J Endod 2017;43: 462-426.
11. B€urklein S, Sch€afer E. Apically extruded debris with reciprocating single-file and full-sequence rotary instrumentation systems. J Endod 2012;38:850–2.
12. €Ust€un Y, C¸ anakc¸ ı BC, Dinc¸er AN, et al. Evaluation of apically extruded debris associated with several Ni–Ti systems. Int Endod J 2015;48:701–4.
13. Borges AH, Pereira TM, Porto AN, et al. The influence of cervical preflaring on the amount of apically extruded debris after root canal preparation using different instrumentation systems. J Endod 2016;42:465–9.
14. Mangalam S, Rao CV, Lakshminarayanan L. Evaluation of apically extruded debris and irrigant using three instrumentation techniques. Endodontology 2002;14:19–23.
15. Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and canal master techniques. J Endod 1991;17:275-9.23.
16. Martin H, Cunningham WT. The effect of endosonic and hand manuplation on the amount of root canal material extruded. Oral Surg Oral Med Oral Pathol 1982;53:611-3.
17. Goering AC, Michelich RJ, Schultz HH. Instrumentation of root canals in molars using the step-down technique. J Endod 1982;8:550–4.
18. Bidar M, Rastegar AF, Ghaziani P, Namazikhah MS. Evaluation of apically extruded debris in conventional and rotary instrumentation techniques. J Calif Dent Assoc 2004;32(9):665-71.
19. Koçak, M. M., et al. Apical extrusion of debris using ProTaper Universal and ProTaper Next rotary systems. International Endodontic Journal 2015; 48(3)283-86.
20. McKendry DJ. Comparison of balanced forces, endosonic, and step-back filing instrumentation techniques: quantification of extruded apical debris. J Endod 1990;16(1)24- 27.
21. Salzgeber RM, Brilliant JD. An in vivo evaluation of the penetration of an irrigating solution in root canals. J Endod 1977;3:394–8.
22. Emre Altundasar, Emre Nagas, Ozgur Uyanik, and Ahmet Serper, Ankara. Debris and irrigant extrusion potential of 2 rotary systems and irrigation needles. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011;112: e31-e35.
23. Hachmeister DR, Schindler WG, Walker WA, Thomas DD. The sealing ability and retention characteristics of mineral trioxide aggregate in a model of apexification. J Endod 2002 ;28: 386–90.