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Evaluation of Apical Extrusion of Debris by Reciprocating and Rotary Single File Systems versus Twisted File System

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Abstract **Original Research Article**

Introduction: The purpose of this in vitro study was to assess the amount of apically extruded debris using rotary and reciprocating nickel-titanium instrumentation systems. ***Method:*** Forty five human mandibular single rooted premolars were randomly assigned to 3 groups (n = 15). The root canals were instrumented according to the manufacturers' instructions using the reciprocating single-file systems WaveOne Gold (Dentsply Maillefer), rotary single file system OneShape (Micro Mega, France) and a full-sequence Twisted File system (Sybron Endo, CA). The apically extruded debris was collected in preweighted glass vials using the Myers and Montgomery method. The amount of extruded debris was assessed with an electronic balance. The significance level was set at P = .05. ***Results:*** All the specimens were associated with apical extrusion of debris. The reciprocating single-file WaveOne Gold system produced significantly more debris compared with single file OneShape rotary system (P < .05). No statistically significant difference was obtained between OneShape and Twisted file system. ***Conclusions:*** Single file rotary instrumentation was associated with less debris extrusion compared with the use of reciprocating single-file system.

Keywords: Nickel titanium instrumentation, WaveOne Gold, OneShape, Twisted File.

INTRODUCTION

Root canal preparation is one of the most important stages in endodontic treatment. For successful treatment, vital and necrotic tissue, microorganisms, and dentinal debris should be removed from the root canal system [1, 2].

Cleaning and shaping are done with the aid of instruments and irrigants. During this procedure, dentin chips, pulp tissue, microorganisms, and irrigants are intended to be moved coronally but may be transported apically and extruded into the periradicular tissues [3]. The extrusion of debris, bacteria, and irrigants beyond the apex may have undesired consequences, such as inflammation, postoperative pain, and delay of periapical healing [4]. Studies on apical extrusion of debris all instruments are associated with extrusion of debris [5-9].

However, the amount of debris extrusion may differ according to the preparation techniques and the design of the file systems [10, 11, 7, 12, 13].

WaveOne Gold (Dentsply, Maillefer) instruments are manufactured utilising a new proprietary thermal process, producing a super-elastic NiTi file. The gold process is a post manufacturing procedure in which the ground NiTi files are heat-treated and slowly cooled. WaveOne Gold files are designed with a reverse cutting helix, engage and cut dentine in a 150^0 counterclockwise (CCW) direction and then, before the instrument has a chance to taper lock, disengages 30^0 in a clockwise (CW) direction. The net file movement is a cutting cycle of 120^0 and therefore after three cycles the file will have made a reverse rotation of 360^0 [14].

OneShape files (Micro-Mega, France) are used in a traditional continuous rotation motion. They have a triangle cutting edge in the apical part, 2 cutting edges in the coronal part, and a cross-section that progressively changes from 3 to 2 cutting edges between the apical and coronal parts; this design offers an optimal cutting action.

The Twisted File System (Sybron Endo) is another novel file that uses a combination of continuous rotation and reciprocating motion. The file uses continuous rotation when it is exposed to minimal or no applied load and uses reciprocal motion when it

engages dentin and a load is applied. Manufacturers have claimed that this adaptive technology and twisted file design using R-phase treatment increase debris removal and flexibility and allow the file to adjust to intracanal torsional forces depending on the amount of pressure placed on the file [15]. Therefore the purpose of this in vitro study was to assess the amount of apically extruded debris using rotary and reciprocating nickel-titanium instrumentation systems.

MATERIALS AND METHODS

Forty five human-extracted single-rooted intact mandibular premolars with mature apices were selected. The coronal access cavity was prepared using #2 access opening bur (Dentsply Maillefer) and all of the canals were confirmed for apical patency with a size 10 K-file (Dentsply Maillefer). The file was inserted into the canal until its tip was visible at the apical foramen. The working lengths (WLs) were set by subtracting 1 mm from the initial length. All the teeth were randomly assigned to three groups for instrumentation.

The experimental model described by Myers and Montgomery [16] was used in this study. In preparation for weighing, a hole was created on the stopper of an Eppendorf tube, and a tooth was inserted until the cementoenamel junction stayed 1–2 mm above the stopper. A 27-G needle was placed alongside the stopper to balance the air pressure inside and outside the tube. Then, each stopper with the tooth and the needle were attached to its Eppendorf tube, and the tubes were fitted into vials covered by aluminum foil to shield the operator from seeing the root apex during instrumentation. A precision analytical microbalance (Model HT 224, Hindustan Analytical Testing Lab, and India) was used to measure the weights of the tubes. Three consecutive weights were obtained for each tube, and the mean was calculated.

Root Canal Instrumentation with the OneShape

A 'classic' OneShape file having a size 25 at the tip and a taper of 0.06 was used with a rotational speed of 400 rpm in an electric motor (X Smart Plus, Dentsply) and the torque was adjusted to 4 Ncm. The canal was rinsed with distilled water, and#10 K-file (Dentsply Maillefer) was used to confirm patency before the file was reused. A total amount of 5 mL distilled water was used.

Root Canal Instrumentation with the WaveOne Gold

The Primary (25/.07, Dentsply Tulsa) was used in an electric motor (X smart Plus, Dentsply) with an in-and-out motion until the WL was reached. After 3 pecking motions, the file was withdrawn and then cleaned and inspected before being reused. The canal was rinsed with distilled water, and#10 K-file (Dentsply Maillefer) was used to confirm patency before the file was reused. This procedure was repeated until the file reached the WL. The canal was then rinsed with distilled water.

Root Canal Instrumentation with the Twisted File

The files were used in an electric motor (X Smart Plus, Dentsply). The SM1 file (20/.04, SybronEndo) advanced in the canal with a single controlled motion until the file engaged dentin. The file was then withdrawn, cleaned, and inspected before being reused. The canal was rinsed with distilled water, and#10 K-file (Dentsply Tulsa Dental) was used to confirm patency. These procedures were repeated until the SM1 file reached the WL. The canal was rinsed with distilled water. The same procedures were performed with the SM2 file (25/.06, SybronEndo). A total amount of 5 mL distilled water was used.

After the instrumentation was complete, the stopper, the needle, and the tooth were separated from the Eppendorf tube, and the debris adhered to the root surface were collected by washing the root with 1 mL distilled water inside the tube. The tubes were then stored in an incubator at 55^0 C for 5 days for evaporation of the distilled water before weighing the dry debris. The Eppendorf tubes were 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 tube from that of the tube containing the debris. The data were statistically analyzed using the one-way analysis of variance and the least significant difference tests at a significance level of $P < 0.05$.

RESULTS

All the specimens were associated with apical extrusion of debris. The reciprocating single-file WaveOne system produced significantly more debris compared with single file OneShape rotary system ($P < .05$). Although no statistically significant difference was obtained between OneShape and Twisted file system ($P > .05$), the reciprocating single-file system produced more debris compared with all other instruments.

Table-1: Debris extrusion in grams

Instrument	Mean	SD
WaveOne Gold	0.00034^b	0.00010
OneShape	0.00019^a	0.00009
Twisted File	0.00023^a	0.00014

SD, standard deviation

Different superscript letters indicate a significant difference between groups.

DISCUSSION

Shaping and irrigating the root canal may trigger an inflammatory reaction by forcing intracanal contents, such as dentine particles, necrotic pulp tissue,

or microorganisms, through the periapical region [17] and also the inflammatory response is likely to be more severe with the increase of the amount of apically extruded debris [18].

The WL must be ideally set at the minor constriction, which is closely associated with the major foramen. The minor constriction connects the root canal system to the apical tissues, and instruments and irrigants work very close to this anatomic structure, making it difficult to control the extrusion of debris and irrigants to the periodontium [19]. It has been shown that the instrumentation technique [10] and pitch design of specific instruments [20] influence the amount of extruded debris. The kinematics, number of files, and instrument design are also important factors in determining the shaping characteristics of rotary systems [15].

The results of the present study showed that all the instrumentation systems tested produced apically extruded debris in vitro. WaveOne Gold was associated with more apical extrusion of debris followed by Twisted file and them OneShape instrumented groups.

It is important to quote that the current results can be regarded as a consequence of the interplay between two known variables: (i) the number of files of each system and (ii) movement kinematics. For that reason, it is not possible to segregate the influence of each of these variables per se from overall results [21].

WaveOne Gold was associated with more apical extrusion of debris followed by twisted file and them OneShape instrumented groups which are in association with previous studies which found that reciprocating systems cause statistically significant more apical extrusion of debris than rotary systems. The reasons include file design such as flute depth and cross-section, the pecking motion applied to the files, fast dentin removal, and packing of debris into the irregularities of the root canal space [3, 22]. Additionally, these studies used teeth with uncomplicated anatomy, which may have influenced their final results.

In general, the design of rotary files along with the motion used tends to direct debris toward the canal orifice, packing the dentinal debris into the flutes of the instruments and forcing them outside toward the orifice, thus avoiding their compaction in the root canal [23]. Variability has been observed between different rotary systems in terms of debris extrusion [8]. This is thought to be caused by differences in cross-section and cutting blade design of a particular system as well as taper, tip, configuration, concepts of use, flexibility, alloy, and number of files, kinematics, and cutting efficacy [24]. Both the WO and TFA have a triangular cross-section. The WO uses a reciprocation movement only, whereas the TFA uses predominantly a rotary movement. In the TFA system, a reciprocating movement is only used when the file finds too much resistance against the dentin walls.

An increased cutting ability is usually associated with an increased cleaning efficacy [25, 26] but may enhance debris transportation toward the apex when used in combination with a reciprocal motion. Contrarily, continuous rotation may improve coronal transportation of dentin chips and debris by acting like a screw conveyor. This might be the reason of less extrusion of debris by OneShape group.

The generally accepted method of Myers & Montgomery [16] was used to collect apically extruded debris. The flaw of this methodology is the absence of a material (agar, foam etc.) simulating the apical pressure of the periodontal ligament against extrusion of debris. Although the vital periapical tissues are not mimicked, this technique allows a comparison of the file systems.

Both the extrusion of irrigation solutions and debris can irritate the periapical tissues and may cause interappointment emergencies [27]. This leads to the controversial discussion regarding the impact of the creation of an apical (dentin) plug or of the patency approach on the incidence of flare-ups and the treatment outcome.

Myers and Montgomery [16] suggested a reassessment of the apical dentinal plug because of the potential benefits of reducing the amount of apically extruded debris and irrigants and the prevention of over instrumentation in combination with extrusion of filling materials [16].

Previous studies showed that the amount of apical debris extrusion can be related to the root canal anatomy and/or the instrumentation technique, and currently no method completely avoids debris extrusion [28-34].

CONCLUSION

Within the limitations of the present study, single file rotary instrumentation (OneShape) was associated with less debris extrusion compared with the use of a reciprocating single-file system i.e WaveOne Gold.

REFERENCES

1. Koçak S, Koçak MM, Saglam BC, Türker SA, Sagsen B, Er Ö. Apical extrusion of debris using self-adjusting file, reciprocating single-file, and 2 rotary instrumentation systems. J Endod. 2013; 39:1278-80.
2. Tambe VH, Nagmode PS, Vishwas JR, P SK, Angadi P, Ali FM. Evaluation of the Amount of Debris extruded apically by using Conv-entional syringe, endovac and ultrasonic irrigation

technique: An in vitro study. J Int Oral Health. 2013; 5:63-6.
3. B€urklein S, Benten S, Sh€afer E. Quantitative evaluation of apically extruded debris with different single file systems: Reciproc, F360 and OneShape versus Mtwo. Int Endod J. 2013; 47:1–5.
4. H€ulsmann M, R€odig T, Nordmeyer S. Complications during root canal irrigation. Endod Topics. 2009;16:27–63
5. Fairbourn DR, McWalter GM, Montgomery S. The effect of four preparation techniques on the amount of apically extruded debris. J Endod. 1987; 13:102–8.
6. Er K, Sumer Z, Akpinar KE. Apical extrusion of intracanal bacteria following use of two engine-driven instrumentation techniques. Int Endod J. 2005; 38:871–6.
7. Tinaz AC, Alacam T, Uzun O. The effect of disruption of apical constriction on periapical extrusion. J Endod. 2005; 31:533–5.
8. Tanalp J, Kaptan F, Sert S. Quantitative evaluation of the amount of apically extruded debris using 3 different rotary instrumentation systems. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006; 101:250–7.
9. Kustarci A, Akpinar KE, Er K. Apical extrusion of intracanal debris and irrigant following use of various instrumentation techniques. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2008; 105:257–62.
10. Al-Omari M, Dummer P. Canal blockage and debris extrusion with eight preparation techniques. Journal of Endodontics.1995; 21, 154–8.
11. Ferraz C, Gomes N, Gomes B, Zaia A, Teixeira F, Souza-Filho F. Apical extrusion of debris and irrigants using two hand and three engine-driven instrumentation techniques. International Endodontic Journal.2001; 34, 354–8.
12. Kustarci A, Akdemir N, Siso SH, Altunbas D. Apical extrusion of intracanal debris using two engine driven and step-back instrumentation techniques: an in-vitro study. European Journal of Dentistry. 2008; 2, 233–9.
13. Kustarci A, Altunbas D, Akpinar KE. Comparative study of apically extruded debris using one manual and two rotary instrumentation techniques for endodontic retreatment. Journal of Dental Sciences.2012; 7, 1–6.
14. Shaping canals with confidence: Wave One GOLD single-file reciprocating system. Julian Weber. International Dentistry – African edition, (6).
15. Capar. An In Vitro Comparison of Apically Extruded Debris and Instrumentation Times with ProTaper Universal, ProTaper Next, Twisted File Adaptive, and HyFlex Instruments. Journal of Endodontics. 40, 1638-41
16. Myers GL, Montgomery S. A comparison of weights of debris extruded apically by conventional filing and Canal Master techniques. Journal of Endodontics.1991; 17, 275–9.
17. Ruiz-Hubard EE, Gutmann JL, Wagner MJ. A quantitative assessment of canal debris forced periapically during root canal instrumentation using two different techniques. Journal of Endodontics. 13, 554–8.
18. Sjögren U, Sundqvist G, Nair PN. Tissue reaction to gutta-percha particles of various sizes when implanted subcutaneously in guinea pigs. European Journal of Oral Sciences.1995; 103, 313–21
19. Tanalp J, G€ungor T. Apical extrusion of debris: a literature review of an inherent occurrence during root canal treatment. Int Endod J. 2013;47:211–21
20. Elmsallati EA, Wadachi R, Suda H. Extrusion of debris after use of rotary nickeltitanium files with different pitch: a pilot study. Aust Endod J. 2009;35:65–9
21. De-Deus. Apically extruded dentin debris by reciprocating single-file and multi-file rotary system. Clin Oral Invest.2015; 19:357–361
22. B€urklein S, Sch€afer E. Apically extruded debris with reciprocating ringle-file and full-sequence rotary instrumentation systems. J Endod. 2012; 38:850–2.
23. Beeson TJ, Hartwell GR, Thornton JD, Gunsolley JC. Comparison of debris extruded apically in straight canals: conventional filing versus Profile.04 Taper Series
24. Tinoco JM, De-Deus G, Tinoco EM. Apical extrusion of bacteria when using reciprocating single-file and rotary multifile instrumentation systems. Int Endod J. 2013; 47:1–7.
25. Sch€afer E, Vlassis M. Comparative investigation of two rotary nickel-titanium instruments: ProTaper versus RaCe. Part 2. Cleaning effectiveness and shaping ability in severely curved root canals of extracted teeth. Int Endod J. 2004; 37:239–48.
26. Bonaccorso A, Cantatore G, Condorelli GG, Sch€afer E, Tripi TR. Shaping ability of four nickel-titanium rotary instruments in simulated S-shaped canals. J Endod. 2009;35:883–6
27. H€ulsmann M, R€odig T, Nordmeyer S. Complications during root canal irrigation. Endod Topics. 2009;16:27–63
28. De-Deus G, Brand~ao MC, Barino B, Di Giorgi K, Fidel RA, Luna AS. Assessment of apically extruded debris produced by the single-file ProTaper F2 technique under reciprocating movement. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;110:390–4
29. Reddy S, Hicks L. Apical extrusion of debris using two hand and two rotary instrumentation techniques. J Endod. 1998; 24:180–3.
30. Mangalam S, Rao CV, Lakshminarayanan L. Evaluation of apically extruded debris and irrigant using three instrumentation techniques. Endodontology. 2002; 14:19–23.
31. Kustarci A, Akpinar KE, Sumer Z. Apical extrusion of intracanal bacteria following use of various instrumentation techniques. Int Endod J. 2008; 41:1066–71.

32. Logani A, Shah N. Apically extruded debris using three contemporary Ni-Ti instrumentation systems: an ex-vivo comparative study. J Dent Res. 2008; 19:182–5.
33. Elmsallati EA, Wadachi R, Suda H. Extrusion of debris after use of rotary nickeltitanium files with different pitch: A pilot study. Aust Endod J. 2009; 35:65–9.
34. Bidar M, Rastegar AF, Ghaziani P, Namazikhah MS. Evaluation of apically extruded debris in conventional and rotary instrumentation techniques. J Calif Dent Assoc. 2004; 32:665–71.