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Research Article

Quantitative Evaluation of Apically Extruded Debris during Root Canal Instrumentation with Reciproc, Wave One, Protaper Universal and One Shape File System - An *Invitro* Study

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Abstract

Aim: The aim of this in *invitro* study is to quantitatively evaluate the apically extruded debris during the root canal instrumentation using reciproc, wave one, protaper universal and one shape Ni-Ti systems.

Materials and Methods: Sixty Single (60) rooted extracted human mandibular first premolar teeth were collected. Post inclusion criteria check, teeth were decoronated using separating disc at the level of 15 ± 1 mm from the apex. Next Apical gauging was carried out using 10, 15 and 20 K files. Sample teeth were divided into 4 groups each and Bio Mechanical Preparation was carried out. The debris obtained was collected in Eppendorf tubes and dry weight of debris was calculated by subtracting the weight of empty tube from the weight of tubes containing debris.

Statistical Analysis: Date obtained was analysed using One-Way ANOVA followed by post-HOC Tukey's test with a P = 0.05 as the level for statistical significance.

Results: Results suggested a significant difference in the debris extrusion between four experimental rotary Nickel Titanium Instrumentation groups (P < 0.001).

Conclusion: Although, all instruments showed debris extrusion, but protaper universal file system showed highest mean debris extrusion then other rotary file systems.

Keywords: *Apical Extrusion; Reciproc; Wave One; One Shape; Protaper Universal*

Introduction

When the root canal preparation is performed mechanically, chemically the irritants in the form of necrotic tissues, microorganisms, dentin chips or irrigants might be introduced into the periapical tissues. The apically extruded debris or the material is held responsible for postoperative inflammation and flare-ups, even in teeth instrumented short of the foramen. Hence forth it is important to remove the apically extruded debris and its re-entry [1].

The apical extrusion of debris is common to all the preparation techniques, but the amount of extruded material varies accordingly with the file systems and the instrumentation techniques [1,2]. Also, apically extruded debris or irritants may lead to flareups and post-operative pain [2,3].

Various factors, viz, instrument design, irrigants used, speed, etc. play an important role in apical extrusion [4,5].

The motions, viz, reciprocation or continuous rotation, push and pull or crown down equally determine apical extrusion, thereby maintaining the relationship between microbiota and the host defence. Any disturbance may lead to post-operative pain and inflam-

matory reactions [6,7]. Hence the aim of this *in vitro* study was to quantitatively evaluate the apically extruded debris during root canal instrumentation with single file [8,9] and multiple file systems [10,11].

Materials and Methods

A total of sixty (60) extracted mandibular first premolars with mature apices and straight root canals were selected for this investigation. Coronal access was achieved by decoronating the crowns with a diamond disc attached and the canals were controlled for apical patency with a size 15 K-file. The teeth were allocated into 4 identical groups based on the measured distances from the cementoenamel junction to the apex. The working length was obtained by subtracting 1mm from the length where size 15 K file was visible at the apical foramen.

The glass vials with rubber stoppers were adjusted for use by using heated instruments to create a hole through the center. The tooth was inserted under pressure into the rubber stopper which was fixed at the cementoenamel junction.

The extruded debris and the irrigant collected in pre-weighed glass vial were used as a receptor tube.

The preparation sequences were as follows:

- **Group 1 (n = 15 teeth):** Root canal preparation will be done with a One Shape file in a full sequence motion.
- **Group 2 (n = 15 teeth):** Root canal preparation will be done with a Primary wave one file in a reciprocating motion.
- **Group 3 (n = 15 teeth):** Root canal preparation will be done with a Reciproc file (R 25) in a reciprocating motion.
- **Group 4 (n = 15 teeth):** Root canal preparation will be done with a Protaper Universal (Sx, S1, S2, F1 and F2) file in a full sequence motion.

Instruments were used according to the manufacturer's instructions, 2 ml of bidistilled water was used as irrigant and apical patency was checked using a 15K-file.

Once the instrument negotiates the canal and rotates freely, it was removed. At this point, the instrumentation was judged to be completed for single file systems and the next sequence of instrument was used for ProTaper Universal.

An electronic balance with an accuracy of +/- 0.00001g was used to weigh the tubes containing the debris. The dry weight of extruded debris was calculated by subtracting the weight of the empty tube from the weight of the glass vial containing debris.

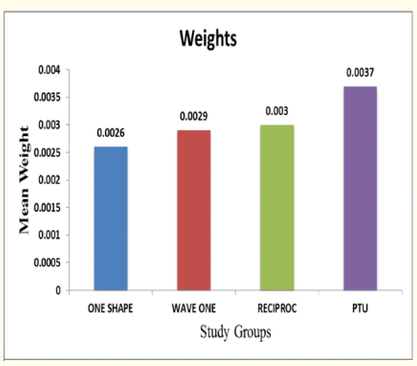
Results

This present, an *in vitro* study was to quantitatively evaluate the amount apically extruded debris during root canal instrumentation with Reciproc, wave one, One shape and Protaper Universal Ni-Ti file systems. From this *invitro* study the following results were obtained.

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. i.e. Group I (One Shape), Group II (Primary wave One), Group III (Reciproc R25) and Group IV (Protaper Universal) respectively.

Post Hoc Tukey's HSD test was done to evaluate the mean difference between all the groups.



Discussion

The Endodontic Triad consisting of biochemical preparation, microbial control and complete obturation of the root canal space, remains the basis of endodontic therapy. According to Baumgartner, Ingle, Bakland: 60% endodontic failures occur due to incomplete obturation of root canals, whereas 40% failures occur due to various factors, like root perforations, external root resorption, constant trauma, broken instruments, unfilled root canals, grossly overfilled or over extended root canals and other minor causes including inadvertent removal of silver points.

The goals of endodontic instrumentation include thorough debridement and disinfection of the root canal system, in addition to creating a suitable shape to achieve a complete 3D obturation [31] with reciprocating and rotary instrumentation [24,25].

Apical Extrusion is defined as an imbalance between the infected canal microbiota and the host defences. A disturbance caused between the infected canal microbiota and the host defences, leads to an acute inflammatory response, thereby ensuring the re-establishment of the equilibrium. Therefore, minimizing the apical extrusion of debris can minimize the postoperative reactions with reciprocating and continuous rotating instruments [6,20].

Pain after the endodontic instrumentation is usually due to periapical inflammation. During the biomechanical instrumentation of the root canal, necrotic debris, dentin, pulp fragments, microorganisms or irrigants may be forced into the periapical tissue. This extruded material into the periapical tissues may then provoke an inflammatory reaction [32]. Apical extrusion of the infected debris to the peri-radicular tissues is possibly one of the principal causes of the post-operative pain [32] post using various nickel-titanium instruments [26].

Seltzer and Naidroff discussed several factors that possibly trigger this process, including a quiescent chronic inflammatory periapical lesion which reacts violently when root canal therapy is initiated and introduces infective debris into the lesion and immunological phenomena, either cell mediated or humoral, that respond to foreign material or antigens in the area [31].

In 1975, Vande Visse and Brilliant demonstrated that instrumentation with irrigation produced significantly more debris than did instrumentation without irrigation. However, other inherent problems with dry instrumentation and irrigation was deemed essential [32].

The extruded material has been referred to as a "worm'' of necrotic debris by some authors and has been related to post instrumentation pain and flare-up. The apical extrusion of infected debris may have the potential of disrupting the balance between microbial aggression and host defenses, resulting in episodes of acute exacerbations and flare-ups [33].

It has been well documented in the literature that non contaminated as well as contaminated dentin and pulp tissue can trigger an inflammatory reaction when forced peri-apically during instrumentation including the canal master techniques [30]. The immunological aspects of postoperative flare-ups have been assessed by a number of researchers who concluded that antigens originating from the root canal result in the formation of an antigen-antibody complex leading to a severe inflammatory response [33].

Despite strict length control of endodontic instruments during root canal preparation, Dentin filings, pulp tissue fragments, necrotic tissue, microorganisms and intracanal irrigant [2] may be extruded from the apical foramen. Martin and Cunningham have shown that more debris is extruded apically if instrumentation is performed beyond the confines of the root canal compared with instrumentation 1mm short of the apical foramen [35,36].

Various factors influence this extrusion. Nearly all studies on the subject agree on the predominant role of the apical area, the size and type of the needle tip, the distance of the needle tip from the foramen, the flow rate of irrigant delivery and the use of suction during irrigation [37].

Al Omari and Dummer instrumented 208 canals using eight different hand instrumentation techniques and found that balanced and crown down pressureless technique extruded the least amount of debris. Ferraz and Gomes observed that engine driven nickel-titanium systems were associated with less apical extrusion.

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 [7].

Fairbourn., *et al.* demonstrated that sonic, ultrasonic and cervical flaring techniques produced less apically-extruded debris than a conventional filing method. Canal preparation in a step back manner led to increased debris extrusion [34], 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 [17].

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 [12].

Generally rotary instruments have a tendency to pull the debris into their flutes, thus lifting them out of the root canal in the coronal direction [14]. As nickel-titanium rotary instrument [22] vary in their designs, cross sectional shapes and methods of use, the amount of apically extruded debris may also differ among them [16,19].

In our present *in vitro* study, we have used four Nickle Titanium instruments, namely:

1. Protaper Universal multiple rotary file system (Sx-F2).
2. Reciproc R25, reciprocating single file system.
3. Wave one, rotary, single file system.
4. Primary One Shape, rotary, single file system.

The above-mentioned instruments were used to quantitatively evaluate the amount of debris extruded apically during the root canal treatment.

Damla Ozsu., *et al.* [18] conducted an *in vitro* study in which they compared Protaper Universal, Protaper Next, Wave One and Self adjusting file systems [23] respectively. It was concluded that Protaper Universal system extruded the maximum amount of debris apically [17]. This may be attributed to the fact that more apical forces are generated with more number of instruments used. Also, the aggressive cutting ability and less flute space present in the structural design of the file, leads to more amount of debris extrusion apically than in the upward direction towards the crown, that is apically.

F Xavier., *et al.* [28], conducted an *in vitro* study in which they compared the apical extrusion of debris from root canals using reciprocating files (Wave One and Reciproc) associated with two irrigation systems. It was concluded that Wave One system extruded lesser debris as compared to Reciproc system. This may be attributed to the fact that Wave One has a triangular cross section due to which it has a lesser space to come in contact with the root canal walls. Moreover, higher clockwise and anticlockwise angles, higher speed and modified triangular cross section further reduce the apical extrusion of debris [13].

Inderpreet Singh., *et al.* [15], conducted an *in vitro* study in which they compared the apical extrusion of debris using One Shape, Primary Wave One and Reciproc Nickle Titanium instruments. It was concluded that One Shape system extruded the least amount of debris into the peri-radicular tissues. This may be attributed to the fact Wave One system works in continuous rotation, thereby acting like a screw conveyor which aids in the transportation of dentin chips and debris coronally. Also, the triangular cross section of the files, three cutting edges and more space for better elimination of the debris, further prevent apical extrusion.

Emel Uzunoglu., *et al.* [27,29], conducted an *in vitro* study in which they compared the apical extrusion of debris using Protaper Next and One Shape apical file system using two different irrigation needles. It was concluded that It was concluded that One Shape system extruded the least amount of debris into the peri-radicular tissues. This may be attributed to the fact Wave One system has a continuous rotation motion, thereby acting like a screw conveyor which aids in the transportation of dentin chips and debris coronally. Moreover, the S-shaped cross section provides the better collection of debris into the flutes and hence further reduce the extrusion of debris into the peri-radicular tissues.

Within the limitations of the present study, rotary instrumentation with ProTaper Universal (a multiple file systems) was associated with more debris extrusion compared with the use of reciprocating single file system Reciproc and Wave One rotary One Shape file system. Taking into considerations the excellent shaping ability of the reciprocating single file systems, clinical studies are required to assess

whether these findings have an impact on the clinical outcome, particularly as the clinical relevance of debris extrusion still remains undetermined and challenged for the operator.

Figure 1: *Samples collected, stored.*

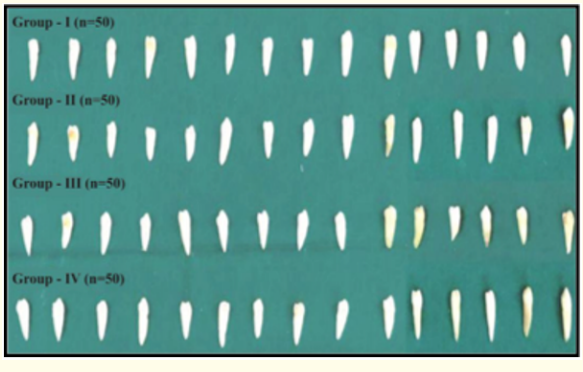


Figure 2: *Groups.*

Figure 3: *Armamentarium.*

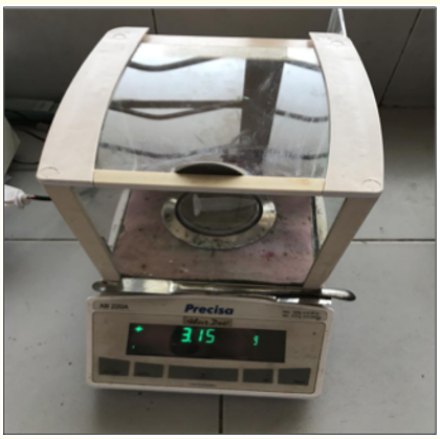


Figure 4: *Equipments (Microbalance).*

Figure 5: *Materials.*

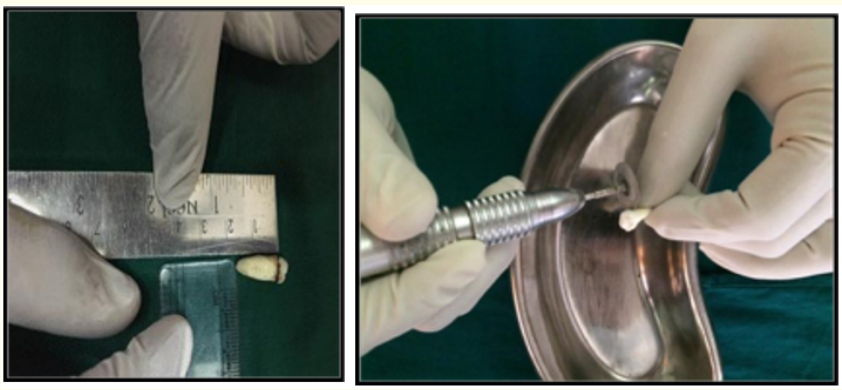


Figure 6: *Decoronation.*

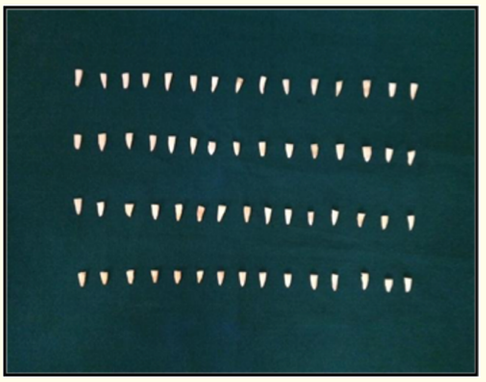


Figure 7: *Decoronated samples.*

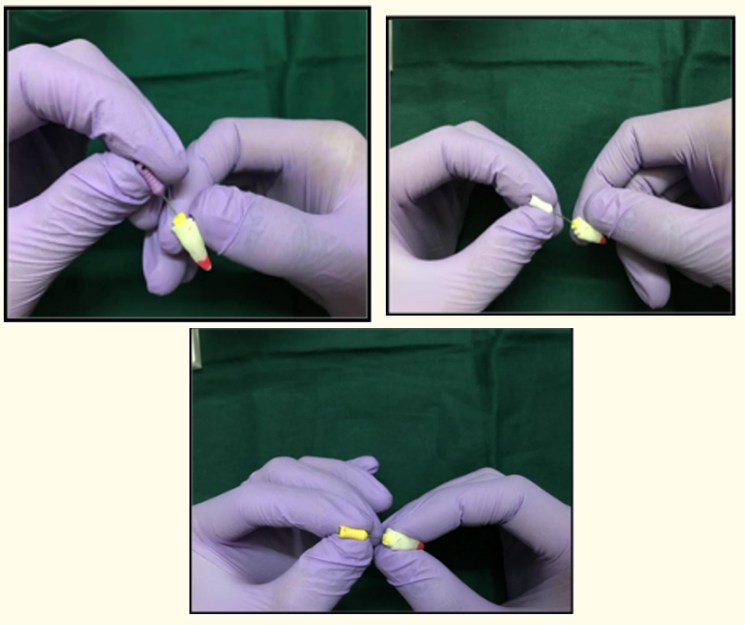


Figure 8: *Apical gauging with 10k,15kand 20k file.*

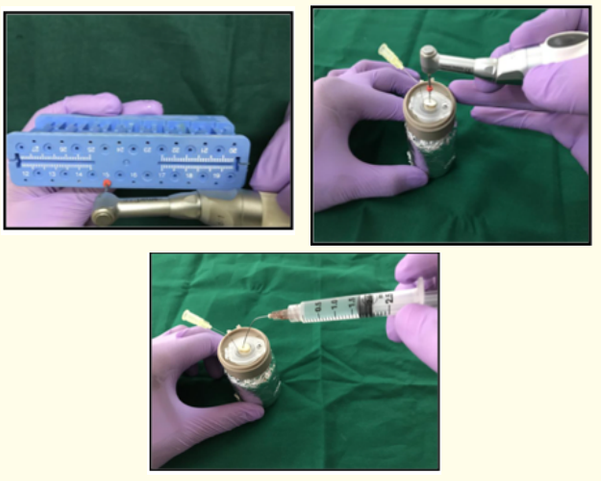


Figure 9: *Working length, cleaning and shaping and irrigation.*

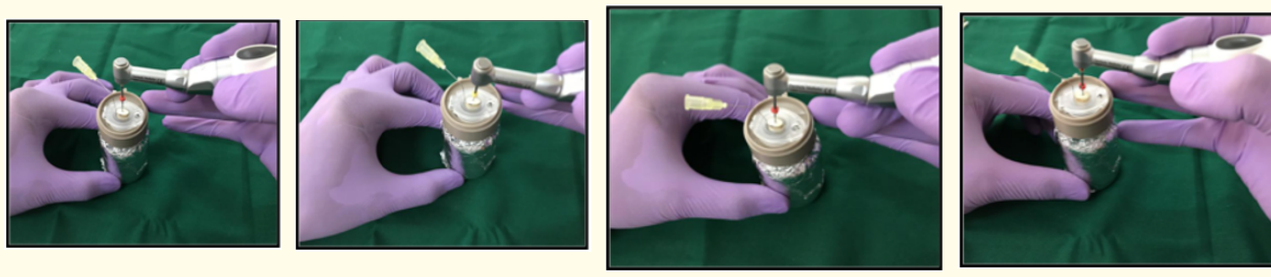


Figure 10: *Bmp with R25, One Shape, Wave One and F2.*

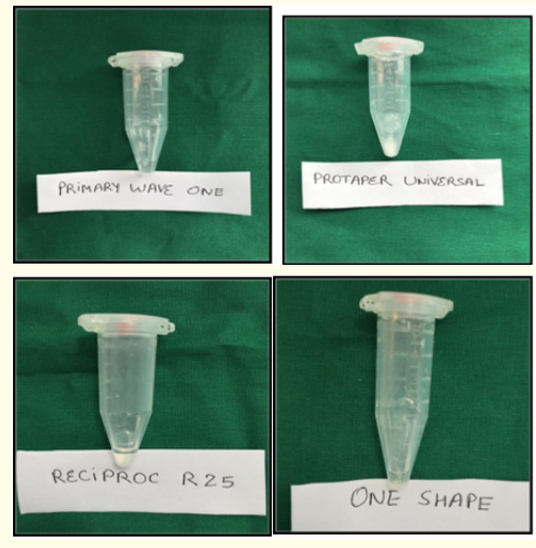


Figure 11: *Samples collected.*

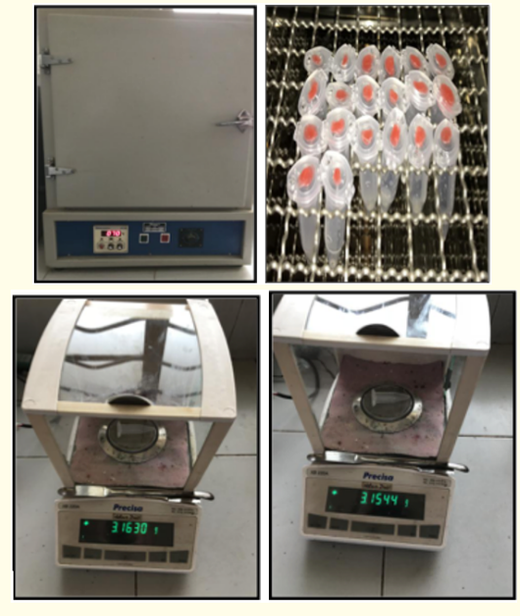


Figure 12: *Samples in incubator and weighing machine.*

Conclusion

Within the limitations of this present *in vitro* study the following conclusions can be drawn:

- Debris extrusion was seen in all groups during the root canal preparation procedure regardless of the instrument or the instrumentation technique used. Multiple rotary file system extruded more debris as compared to Reciprocating file system and rotary single file system.
- Multiple Rotary file system, Protaper Universal extruded maximum debris than Reciproc single file system, Reciproc which was significant.
- One Shape, Single rotary file system extruded less debris as compared to Protaper Universal.
- Reciproc and One Shape extruded significantly less debris than Protaper Universal but there was no significant difference between Reciproc, Wave One and One Shape groups respectively.

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