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COMPARATIVE EVALUATION OF APICAL EXTRUSION OF DEBRIS USING DIFFERENT ROTARY FILE SYSTEMS FOR SHAPING ROOT CANALS – AN INVITRO STUDY

Dental Science

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ABSTRACT

The aim of the study was to evaluate whether there was any significant difference in the amount of apically extruded debris using Protaper next, Twisted files and one shape file. Forty five single-rooted, human mandibular premolar teeth were selected. Access cavity preparation was done in each. Each individual tooth was then held in a Preweighed eppendorf tube which was fixed inside a glass vial. After working length determination, the vials were divided into 3 groups of 15 each. Group 1: ProTaper Next, Group 2: Twisted file, Group3: One shape file. Each group were prepared with an endodontic hand piece. The extruded debris and irrigant during preparation are collected in eppendorf tube. After canal preparation, the eppendorf tube was removed from the glass vial and incubated at 37°C for 15 days to allow the evaporation of moisture. The weight of extruded debris in each tube was calculated. Results- Protaper Next presented with least debris extrusion followed by One shape file and Twisted file.

KEYWORDS

Debris extrusion, Working length, Eppendorf tube, Electronic microbalance

INTRODUCTION

The most important stages in endodontic treatment is the complete preparation of pulp space. The procedure encompasses not only canal shaping but also the usage of intracanal irrigants to provide optimal cleanliness and disinfection within the root canal system. Despite precise estimation of working length and various advanced pulp space preparation techniques there is an inadvertent apical extrusion of debris consisting of dentinal chips, pulp tissue fragments and microorganisms. The extruded material referred to as the 'worm of necrotic debris'(Seltzer & Naidorf 1985) has been related to periapical inflammation and postoperative flare-ups characterized by intense pain and swelling[1].

The immunological aspects of postoperative flare-ups demonstrated that antigens originating from root canals resulted in the formation of an antigen-antibody complex when forced beyond the apical foramen, which could lead to a severe inflammatory response[1] Studies have reported that bacteria also extruded along with debris through the apical foramen[4,5,]. The number of bacteria extruded apically has a direct correlation with the weight of the debris (quantitative factor); and the type and virulence of the bacteria is related to the severity of the periapical inflammation (qualitative factor) and this has a direct effect on the systemic diseases such as endocarditis, brain abscess which can further compromise the primary disease.

Studies examining an apical extrusion of debris have stated that procedures using the push-pull motion tend to produce more debris than those involving some sort of rotational movement. This has led to the hypothesis that engine-driven instruments produce less debris than hand filing techniques, as they have a tendency to pull debris in the flutes of the instrument[2].

The present study uses three different rotary systems- Twisted file, Protaper next and One shape file. The purpose of selecting these files was to compare between the recently introduced rotary systems for the quantitative evaluation of the apical extrusion of debris.

MATERIALS AND METHODS

Forty five single-rooted, non carious human mandibular premolar teeth with similar sizes and completed apices will be selected. The teeth will be verified radiographically as having a single root canal. The teeth will be then stored in 4 °C distilled water until used. The selected teeth are randomly assigned into 3 experimental groups (Groups 1-3) with 15 teeth in each group.

To maintain similar tooth lengths, all teeth are measured and the crowns are sectioned with a high-speed bur. Access cavity preparation is done in each tooth and all external tooth surfaces are covered with 2 layers of nail polish except for 1 mm around the apical foramen. A 15 K-file was used to determine the working length until it is visible at the apical foramen. Final estimation will be done by subtracting 1 mm from this measurement.

Test Apparatus

Eppendorf tubes will be taken and weighed by electronic microbalance with an accuracy of 10^{-4} g to give the initial weight. Three consecutive weights were obtained for each tube, and the mean value calculated. Each individual tooth will be held in a preweighed eppendorf tube which is fixed inside a glass vial through rubber plug. It will be ensured that no possible contact will be made between the tube and the glass vial. The tube is vented with a 25 gauge needle to equalize the pressure inside and outside.

Figure 1-Test Apparatus

Root Canal Preparation

After working length determination, the vials are divided into 3 groups of 15 each. Then the rotary instrument groups are prepared with an X Smart Endomotor endodontic hand piece. For each file, the individual torque limit and rotational speed programmed in the file library of the motor were used. All the preparations are made by a single operator. The shaping sequences are as follows:

1. Group 1: ProTaper Next: Instruments are used with gentle in- and

out- motion. The instrument sequences are X1(17/04), X2(25/06).
2. Group 2: Twisted file: The file is advanced to the canal with a single controlled motion. The instrument sequences are 25/08 (orifice shaper), 25/06
3. Group3: One Shape file: The one shape file are used with the sequence 25/0.6

Time taken from the calculation of working length to the culmination of cleaning and shaping will be monitored using a stopwatch for each of the rotary filing system. The extruded debris and irrigant during preparation are collected in eppendorf tube. A total volume of 7 mL of distilled water should be used in each root canal for irrigation. The irrigation needle is placed short of working length or slightly coronal to the point where resistance is encountered.

After canal preparation, the eppendorf tube is removed from the glass vial. Then the tooth is separated from the tube and the root apex is washed off with 1 ml of distilled water that is collected in the same tube. All the eppendorf tubes is then incubated at 37°C for 15 days to allow the evaporation of moisture before weighing the dry debris.

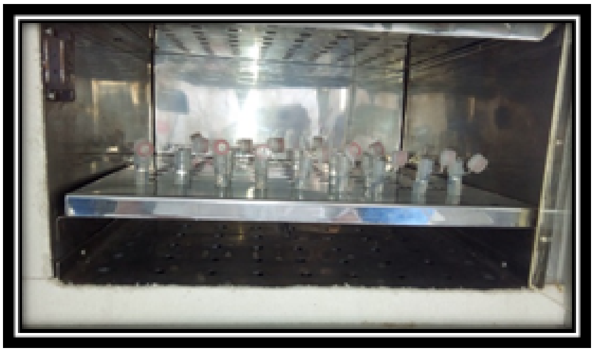


Figure 2- Incubated At 37 Degree Celcius

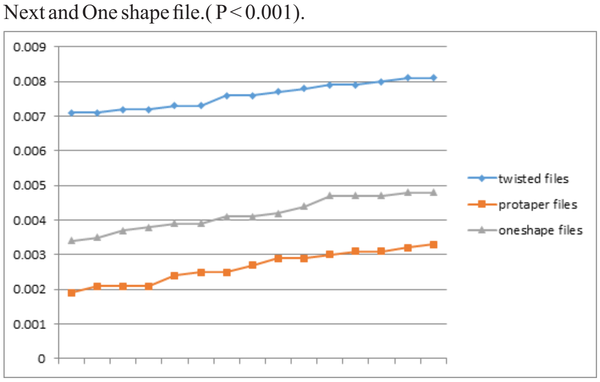
For each eppendorf tube three consecutive measurements are taken on an electronic microbalance and the mean measurement for each tube is considered to be its weight. The weight of extruded debris in each tube is calculated by subtracting pre experiment weight of the tube from the weight of tube with dried debris. The mean weight of extruded debris is then calculated for each group.

Results And Statistical Analysis

The mean apically extruded weight of debris in Twisted file (0.0075 g) was more when compared to Protaper Next (0.0026 g) and One shape file (0.0041g). Protaper Next resulted in least debris extrusion.

One way Anova was used to find out the statistical difference between the groups.

There was a statistical difference in the mean apical extruded debris between Protaper Next and Twisted file and also between Protaper Next and One shape file.($P < 0.001$).



Line diagram showing distribution of exrtuded debris in each files

Table- 10 Showing Mean And Standard Deviation

Debris extrusion (g)	Protaper Next	Twisted File	One Shape File
Mean	0.0026	0.0075	0.0041
Standard Deviation	0.00045	0.00036	0.00048
Minimum	0.0019	0.0071	0.0034
Maximum	0.0033	0.0081	0.0048

DISCUSSION

The objective of the present study was to determine the apical extrusion of debris as a result of canal shaping using three different rotary systems. According to the results, debris extrusion occurred independent of the type of instrument used. The obtained differences may be caused by the preparation technique or the cross-sectional designs of the instruments.

To our knowledge only two studies has evaluated the apically extruded debris during root canal treatment with Twisted file. Results of both the studies were contradicting the present study.

One study [3] showed that there was no significant difference between the Twisted file group and the ProTaper Next and WaveOne groups. Another study by Demet et al[4] showed that it was asssociated with less debris extrusion compared to hand files, although no significant difference did exist between Twisted file and reciproc.

The features of the Twisted file system includes its twisted design, not ground, triangular cross-section, variable pitch. The instrument is made of R- phase Ni-Ti alloy.

The files tested have different alloy properties and cross-sectional designs. The Protaper Next possess a unique design, an offset center of mass and rotation. This design provides more cross-sectional space for enhanced cutting, auguring and allowing the debris to be pushed coronally. This can be the main advantage of the file hence, it was used for the present study. The M-wire NiTi material improves the flexibility while still retaining the cutting efficiency.

The samples in the group instrumented by Protaper Next resulted in less extrusion of the debris when compared to Twisted file and One shape file group. Mean value of the extruded debris in the group instrumented by Protaper Next (0.0026g) was much less when compared to One shape file group (0.0041g) and Twisted file group (0.0075g). Difference in the mean value was statistically and significantly different with $p < 0.001$.

One shape rotary NiTi files work with continuous rotation and and possess inherent flexibility and reduces screwing effects by a variable cross section along the instrument blade. They have three different cross section zones: apical (with a variable 3-cutting edge design), transitional (progressively changing from 3 to 2 cutting edges and coronal (with two cutting edges). The dual cutting-edge zone in the coronal portion of One Shape file provides increased chip space, may be speculated to offer extricating action for upward debris removal. The variable helix angle in One Shape is also designed to provide upward debris removal.

A study by Elham et al[5] concluded that short pitch design extruded less debris than the medium and long ones. They have more grooves between the cutting edges, to entrap more debris during preparation, which in turn might reduce the quantity of debris extruded.

In contrast, Diemer and Calas[6] reported that the long pitch design helps to prevent screw-in phenomenon and gives the instrument more ability to cut. However, it may leave larger apical canals than the short pitch design, resulting in more risk of irrigant extrusion.

The longer pitch of the One shape system could have attributed to more debris extrusion when compared to Protaper Next. However in a study by Sevinc et al[7] concluded that One shape system extruded less bacteria compared with the Twisted file and Protaper Next systems.

The selection of irrigation solution could effect the quantitative values of the extruded debris. The use of irrigants selected during routine endodontic procedures, such as sodium hypochlorite seems more logical and reflects clinical conditions more precisely. However, sodium crystals cannot be separated from debris and might adversely affect the reliability of the experimental methodology. Therefore, distilled water was used as an irrigant in the present study .

In the present study, the canal working length was 1 mm short of the apical foramen. Myers and Montgomery [8] clearly showed that a working length 1 mm short of the canal length contributed to significantly less debris extrusion. A certain degree of caution must be taken when these results are transferred to the clinical situation because of the zero back pressure used in this study design, gravity may have carried the irrigant out of the canal. This is a known drawback of *in vitro* designs with no periapical resistance. It has been suggested that using floral foam may simulate resistance of periapical tissues[9]. However, foam may absorb some irrigant and debris when used as a barrier and therefore, no attempt has been made in this present study to simulate periapical resistance.

A clinical study may give different results, as periradicular tissues may serve as a natural barrier, inhibiting apical extrusion. Results may also differ because of the persistence of residual pulp tissue, the pulp condition, canal curvature, and normal/ pathological periapical tissues[10]. The current 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.

The results obtained on the present study are contradictory to those in the previous studies. Twisted files resulted in more debris extrusion compared to other groups. The Protaper Next system resulted in more debris extrusion which is in agreement with the previous studies.

CONCLUSION

Plethora of factors exit associated with the extrusion of debris, use of a suitable rotary instruments with particular cross sectional designs can help prevent debris extrusion to a greater extent.

- The Protaper Next possess a unique design, an offset center of mass and rotation. This design accounted for least debris extrusion and hence, it was one of the rotary system selected for the present study.
- The dual cutting-edge zone in the coronal portion of One Shape file provides increased chip space, and variable helical angle accounted for reduced debris extrusion. However the longer pitch in the file led to some amount of debris extrusion in comparison with Protaper Next system.
- The twisted design and the R phase of NiTi alloy in the Twisted file makes it a more flexible system though it led to more debris extrusion when compared other systems used in the study

In the present study it has been concluded that Protaper Next presented with least debris extrusion followed by One shape file and Twisted file

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