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Apical extrusion of debris during instrumentation using three different rotary file systems in permanent teeth- in vitro study

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ABSTRACT

Aim: Invitro study aimed to compare the amount of debris that is extruded during instrumentation using three different rotary endodontic files system.

Methodology: Thirty Human single rooted teeth were categorized into 3 groups (n=30). Group 1- Protaper Gold (n=10); Group 2- Neo Endo (n=10) and Group 3-Profit S3 (n=10). According to the Myers and Montgomery protocol, the apically extruded material was collected in pre-weighed Eppendorf tubes. The mean weight of debris was measured with a microbalance after drying and statistically evaluated using one-way ANOVA and post hoc test.

Results: Profit S3 showed lesser debris extrusion than PTG and Neo Endo. There was statistically significant results obtained between the three groups ($p<0.05$).

Conclusion: Although all three rotary files caused apical debris extrusion, the Profit S3 showed significantly less debris extrusion than other two rotary files.

discourteous behaviors, followed by verbal discourteous ranging between abusive to very abusive as the second level, and physical discourteous stand for the third one.

Keywords: *Debris extrusion, Neo Endo, Protaper Gold, ProFit S3, single canal*

INTRODUCTION

Biomechanical preparation in endodontic treatment is the most significant part of the treatment. Instrumentation and irrigation are equally important in removing dentinal debris, necrotic tissues, and microbes from the canal for a successful outcome of endodontic treatment (1) (2). Extrusion of debris apically into periradicular tissues during instrumentation causes severe pain or edema(3). Researches have been trying to find the factors determining the incidence and severity of this phenomenon (4). The debris extruded apically could vary according to the techniques and file design(5). Manual instrumentation produces extrusion of debris more when compared to engine-driven rotary instruments (6) at the same time reciprocating single file system extrudes more compared to the rotary instrument (7).When the cervical preflaring was performed before the mechanical preparation of the root canal utilizing engine-driven Ni-Ti files, less debris extrusion beyond the apical foramen was seen (8). The linear file movements performed in preparation methods have the tendency to pump the debris upward. In contrast, the grooves of manual or mechanical rotational devices accumulate debris, making its disposal easier(9). Less debris was extruded when an ultrasonic device was used for intracanal preparation, according to Martin and Cunningham(10)

The ProTaper Gold (PTG) system has a constantly tapered form for more efficient, flexible, and safer cutting action, as well as a convex triangular cross-section, variable progressive taper, and rotational action, according to the manufacturer. (11). The PTG system comprises shaping (Sx, S1, and S2) and finishing (F1, F2, F3, F4, and F5) files.

Neo Endo files are gold-treated NiTi rotary files with controlled memory, a triangular cross-section, sharp cutting edges, and exceptional flexibility for navigating canals.(2). The Neo Endo file system comprises shaping (Sx, S1, and S2) and finishing (F1, F2, F3) files (12). Profit S3 (PS3) was introduced in 2019 and is based on Blue Technology and a new heat-treated rotary mechanism with titanium oxide coating. It has a rectangular cross-section with a variable taper design. This cross-section features two points of contact, which reduces debris extrusion at the apex. One orifice opener and three finishing files make up PS3. Finishing files are P0-orifice opener, PF1 (yellow), PF2 (red), and PF3 (blue). PS3 has excellent shape memory, flexibility, and fracture resistance. The taper is vary, ranging from 4% to 8% (13).With several improvements to endodontic innovation, such as preparation methods, the number of files utilised, kinematics, tip design, type, cross-section, cutting blade, design, flexibility, and cutting efficiency of the instrument, the amount of apically extruded debris has been strived to be limited(14). Our team has extensive knowledge and research experience that has translate into high quality publications (Sathish and Karthick 2020; Krishna, Nivesh Krishna, and Yuvaraj Babu 2016; Sriram, Thenmozhi, and Yuvaraj 2015; Subashri and Thenmozhi 2016; Mootha et al. 2016; Marofi et al. 2021; Mohanavel et al. 2020; Vigneshwaran et al. 2020; Suresh et al. 2014; Robert et al. 2010)

The aim of the study is to compare the amount of dried debris that is extruded during instrumentation using three different rotary endodontic files systems. The null hypothesis considered all the files extrude an equal amount of debris and there will be no significant difference between the three files.

METHODOLOGY

Specimen Preparation

With ethical consent from the Institution's Ethics Committee, thirty extracted human mandibular incisors were selected. Teeth with mature apices, curvature less than 10° calculated using Schneider methodology (3), single canal, and complete root formation verified viewing buccolingual and mesiodistal radiographs were included in the study (2) disinfected using 5.2% of sodium hypochlorite to remove the remnants from the tooth surface (5). The length of the tooth was standardized to 16mm using diamond disk by flattening the occlusal surface of the tooth. Teeth with two canals, calcification, dentinal cracks, pulp stones, and resorption were not included in the study. Access opening and working length were established using a 15 K file and working length was kept 1mm short of the radiographic apex. Thirty Human mandibular incisors were categorized into 3 groups (n=10) based on three different rotary file systems.

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Preweighing The Eppendorf Tubes

Thirty Eppendorf tubes were taken and pre-weighed using the electronic microbalance three times and the mean value of the weight was taken into consideration.

Experimental Setup

The experimental design was similar to how Myers and Montgomery described (Myers & Montgomery. 1991).A Pre-weighed Eppendorf tube was attached to the rubber stopper as seen in (figure 1) glass bottle was used to hold the device to avoid contacting the vial during instrumentation (6), 15 gauge needle was placed inside the rubber stopper to equalize the internal and external pressure within the tube. Each tooth was placed in the rubber stopper attached to the Eppendorf tube, where each tube were fitted in to the glass vial.

FIGURE 1: Extrusion of apical debris in an experimental setup

Root Canal Preparation

Root canal preparation was done using three different rotary files Protaper Gold, Neo Endo, Profit S3. Distilled water was used as an irrigant during cleaning and shaping. 15K file was used to maintain the apical patency. The irrigant's total volume was confined to 8 ml per tooth.(3)..

Group 1-Protaper Gold

Coronal enlargement is done using SX rotary file and apical enlargement was done with Protaper Gold rotary file till size F2 and 6% taper was used according to manufactures instruction till the working length with the coronal portion as a stable reference point. Distilled water was used as an irrigant during instrumentation.

Group 2-Neo Endo

Coronal enlargement is done using SX rotary file and apical enlargement was done with Neo Endo rotary file till size F2 and 6% taper was used according to manufactures instruction till the working length with the coronal portion as a stable reference point. Distilled water was used as an irrigant during instrumentation.

Group 3- ProFit S3

Coronal enlargement is done using SX rotary file and apical enlargement was done with Profit S3 rotary file till size PF2 and 6% taper was used according to manufactures instruction till the working length with the coronal portion as a stable reference point. Distilled water was used as an irrigant during instrumentation.

To eliminate bias, the same operator completed the cleaning and shaping of all the samples. The Eppendorf tube is detached from the glass vial once instrumentation is complete, and the outer surface of the root is cleaned with distilled water to eliminate material attached to the root surface. To evaporate the distilled water and collect the dry debris, all specimens were incubated in the incubator for fifteen days at 37°C.

Quantifying The Debris

The debris collected in the Eppendorf tube was weighed three times in the electronic microbalance, and the average mean value for the three groups was calculated. By subtracting the empty weight of the Eppendorf tube from the tube containing dry debris, the dry weight of the debris is computed.

Statistical Analysis

The IBM Statistics 23 version was used for Statistical analysis. For all variables. A one-way ANOVA was used, followed by post hoc Tukey for multiple comparisons between groups. Results with a level of significant value $p<0.005$ are found to be statistically significant (Table 1)

RESULTS

After obtaining the values, the mean and standard deviation was calculated in all three groups. There were statistically significant results obtained in all three groups. Group 1 has a mean value of 1.2066 g, group 2 has a mean value of 1.2004 g, and group 3 has a mean value of 1.1953 g of extruded debris (Table 2).

TABLE 1: Significant difference in multiple comparisons between groups on apically extruded debris

Groups	Comparison	Sig.
Protaper gold	Neo Endo	.030
	Profit S3	.000
Neo Endo	Protaper gold	.030
	Profit S3	.084
Profit S3	Protaper gold	.000
	Neo Endo	.084

TABLE 2: Amount of apically extruded debris in grams after the use of three rotary instruments

Groups	Debris Extrusion Mean(grams)	N	Std. Deviation
tProtaper gold	1.2066	10	.00508
Neo Endo	1.2004	10	.00659
Profit S3	1.1953	10	.00306
Total	1.2008	30	.00682

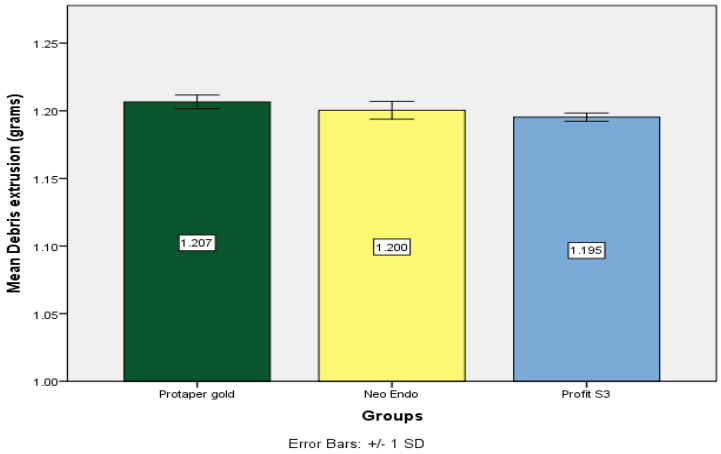

FIGURE 2: The amount of apically extruded debris using three different rotary endodontic files after canal preparation

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DISCUSSION

The most common complications occurring after instrumentation are flare-ups and post-operative pain due to the apical extrusion of debris(5). The approach described by Myers & Montgomery simulates a clinical setting where the operator is dependent on working length determination without being able to observe the root canal space and also eliminates practitioner bias(15). The amount of extruded debris may vary depending on the type of irrigant used. However, if sodium hypochlorite is utilised, the occurrence of sodium crystallisation may have an influence on the study's findings. Bidistilled water was therefore employed as a solution for irrigation(16). When teeth were compared for vitality, nonvital teeth were in more pain than vital teeth. An immediate inflammatory response has been found to be triggered by the extrusion of infected pulp tissue (17). According to the findings, apically extruded debris is less prevalent in ProFit S3 files, compared to Protaper gold and Neo Endo, the obtained difference in ProFit S3 compared to other file systems is, that it has variably variable taper design with rectangular cross-section and two-point contact (13) which pushes the debris coronally rather than pushing it apically by reducing the extrusion of debris. There were limited studies on neo Endo file system and on comparison between profit S3 and Protaper Gold, PTG extruded more debris comparatively to others as it is convex triangular in cross-section (11) then comes the neo endo files which is triangular in cross section (12).

The PTN system extruded more debris quantitatively than the PTG system (11). When compared to the step-back technique, the crown down technique extruded less debris (1). According to Bürklein and Schäfer, the rotary instrument produced less debris extrusion than the reciprocating single file system, and the amount of debris extruded reduced as rotational speed increased (18). According to movements rasping up-down motion of the file extrudes more debris when compared to instruments used in rotational motion (1). Due to their increased flexibility and superelasticity, heat treated rotary files minimise procedural error (19)

Factors contributing to debris extrusion are Irrigation of the root canal space, necrotic pulps, depth of file insertion into the canal, the technique of biomechanical preparation, amount of coronal and middle third flaring, and adjunctive irrigation (1). Techniques for instrumentation and instrument design have been demonstrated to be useful in decreasing apical debris extrusion. (20).

In this study, to eliminate the complications of precipitation of irrigant liquids, distilled water was used to reduce the chance of affecting the results, for all three groups 8 ml of distilled water was kept constant, and to overcome the WL loss we created a stable coronal reference point by decoronating the coronal surface of the tooth with the standard length of 16mm (1).

The limitation of the study is Myers and Montgomery's method is an in vitro procedure that does not account for periapical tissue resistance when forming the canal. The periapical tissues act as a natural barrier against debris ejection at the apex in clinical situations, in this study apical extrusion was not constrained because of their lack of physical backpressure(21) . The amount of apically ejected debris may be influenced by the diameter of the apical constriction (1). Avoiding debris extrusion can minimize the postoperative complications(11). To our knowledge there are no previous studies evaluating the debris extrusion with heat-treated, titanium oxide coated, variably variable taper design, rectangular cross-section, and two-point contact.

As a result of the study, we could conclude that all three rotary files extrude debris to some extent in which there are statistically significant results obtained by using profit S3 which has lesser debris extrusion in comparison to the two other file systems. Further clinical studies are required to evaluate the newly introduced NiTi instrument and confirm the findings.

CONCLUSION

Within the study's limits, it is possible to conclude that all three rotary endodontic files extruded debris in some amount and there were statistically significant results obtained. Among three different rotary files, ProFit S3 extruded less amount of debris compared to Protaper Gold and Neo Endo.

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