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Comprehensive Assessment and Evaluation of Apical Extrusion of Debris with Different Files System: An (In-Vitro) Original Study

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ABSTRACT

Background: As we all know that apical extrusion of debris also referred to as a "worm of necrotic debris," is an unfavorable incident that occurs during the instrumentation of the root canal system. Also, one of the main reasons for the failure of root canal treatment is the apical extrusion of pulp tissue, microorganisms, and irrigants beyond the apical foramen. Apical debris extrusion may be associated with pain and/or swelling in the presence of a severe inflammatory response in clinical practice. The present study was conducted to assess apical extrusion of debris with different files system.

Materials & Methods: This study was performed on thirty freshly extracted maxillary central incisors. In all the selected samples, 30 roots were further segregated into three groups based on the NiTi system. Accordingly, in group I PTN files were used in the sequence ProTaper Universal SX, ProTaper Next system X1, ProTaper Next system X2, ProTaper Next system X3, ProTaper Next system X4 and ProTaper Next system X5. In group II, TF (Twisted File Adaptive) adaptive instruments were used in the sequence ML1, ML2, and ML3. In group III, Reciproc R25 instrument was used.

Results: Statistical analysis was done using statistical software 'Statistical Package for the Social Sciences (SPSS)'. The recorded data was subjected to suitable statistical tests to obtain p values and mean. $P \leq 0.05$ was considered as statistically significant. Debris extrusion in group I was 0.00047 grams, in group II was 0.00058 grams and in group III was 0.00050 grams. The difference was non- significant (P> 0.05).

Conclusion: Within the limitations of the study the authors have concluded that maximum amount of debris were extruded by TF adaptive instruments followed by Reciproc R25 and PTN files system. However, we expect other studies to be conducted those include larger samples and wider testing parameters.

Keywords: Extrusion, Debris, ProTaper Next files.

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INTRODUCTION

Apical debris extrusion has been shown to vary based on kinematics, number of files used, taper, cross section, and cutting efficiency, and these findings justify the necessitate for an analysis of the widely used systems. Complete root canal cleaning and shaping are necessary for successful endodontic treatment and periradicular healing. Shaping and cleaning of the root canal system can be accomplished mainly by step-back and crown-down techniques. Both hand and rotary files are used with either of the two methods. More recently advanced instrument designs such as radial lands, non-cutting tips, different flute depth, variable tapers and cross-sections and the use of different operational principles have been developed to improve working safety, to shorten the working time and to create a greater flare within the preparations. The newer systems also provide a cleaner and smoother preparation to receive the final obturation. Cleaning and shaping of the root canal is one of the most important steps in any root canal treatment.[1] Complete debridement of the root canal system is complicated by the presence of a complex system of isthmuses, accessory canals, fins, and deltas that can provide ideal locations for harboring bacteria, debris and necrotic tissue. Therefore, chemical debridement via use of irrigants is a necessary adjunct to mechanical instrumentation to achieve the goals of canal preparation.[2] A common finding of the studies examining the amount of apically extruded debris and irrigant was that the instrumentation techniques using a push-pull motion tend to produce a more apical extrusion of debris than instrumentation techniques using a rotational motion. Various instrumentation techniques have been used in the past for evaluating the apical extrusion of debris. Apical debris extrusion may be associated with pain and/or swelling in the presence of a severe inflammatory response in clinical practice.[3] However, debris extrusion is an undesired result of mechanical instrumentation of the root canal, and none of the available instrumentation systems can completely prevent extrusion. Hence, techniques to minimize the phenomenon have been investigated. Apical debris extrusion reportedly varies based on kinematics, taper, cross-section, file number, and cutting efficacy.[4] The ProTaper Next (PTN) system consists of three instruments made of M-wire nickel titanium (NiTi) alloy. The M-wire alloy is manufactured via a thermal process. The Reciproc single-file system features a specialized motor that performs alternating clockwise (CW) and counterclockwise (CCW) motions collectively known as reciprocating motion, and it is recommended for single use. The Twisted File Adaptive system uses a combination of rotational and reciprocating motions.[5] The present study was conducted to evaluate apical extrusion of debris with studied files system.

MATERIALS & METHODS

This study was completed in the department of Conservative Dentistry and Endodontics. It consists of thirty freshly extracted maxillary central incisors for non traumatic etiologies. All soft-tissue remnants and calculi on the external root surface were removed using hand and ultrasonic devices. Teeth with more than one canal and apical foramen, an immature root apex, root canal treatment, and a root canal curvature of more than 10° were excluded from the study. The incisal surfaces of the teeth were flattened with high-speed bur. Access cavities was prepared and the working length was determined. The working length (WL) was determined to be 1-mm short of the length of a size 15 K-file that was visible at the major diameter of the apical foramen. Debris collection was achieved via a model described by Myers and Montgomery. The 30 roots were divided into three groups based on the NiTi system. In group I PTN files (ProTaper Next system (PTN; Dentsply Maillefer, Ballaigues, Switzerland) were used in the sequence ProTaper Universal SX, ProTaper Next system X1, ProTaper Next system X2, ProTaper Next system X3, ProTaper Next system X4 and ProTaper Next system X5. Once the instrument had negotiated

the full WL and rotated freely, it was removed. In group II, TF adaptive instruments (Twisted File Adaptive (TFA; SybronEndo, Orange, CA, USA) were used in the sequence ML1, ML2, and ML3. In the PTN and TFA groups, the instruments were withdrawn when resistance was felt, and before being reused, 2 ml irrigation was performed. In group III, Reciproc R25 instrument was used. Preweighed glass vials (10 ml) were used for debris collection. The teeth were removed from Eppendorf tubes, and the apical surfaces of the teeth were irrigated with distilled water to collect adhered debris. The dry weight of the extruded debris was measured after a 5-day storage period in 68°C incubator. The weight of the extruded debris was determined by subtracting the weight of the preweighed empty vials from the weight of the vials containing debris. Results thus obtained were subjected to statistical analysis. P value less than 0.05 was considered significant.

RESULTS

Resultant data were sent for statistical analysis using statistical software Statistical Package for the Social Sciences version 21 (IBM Inc., Armonk, New York, USA). The resulting data was subjected to suitable statistical tests to obtain p values, mean, standard deviation, chi- square test, standard error and 95% CI. Response evaluation and analysis exhibits some very intricate inferences. These inferences were shown to have clinical explicabilities too. Here, every attempt has been made to genuinely process the data so as to make it authentic. Table I shows type of files system used in all groups. Each group had 10 teeth each. Graph I shows that debris extrusion in group I was 0.00047 grams, in group II was 0.00058 grams and in group III was 0.00050 grams. Table II shows comparison of difference between groups and basic statistical description with level of significance evaluation using Pearson chi-square test. The difference was non- significant (P> 0.05). Pearson Chi-Square values were reported to be 2.567, 2.265, 2.899 respectively for group I, II and III. Standard Deviation values were reported to be 0.565, 1.345, 1.276 respectively for group I, II and III. 95% coefficient of interval values was reported to be 2.34, 1.23, 1.98 respectively for group I, II and III.

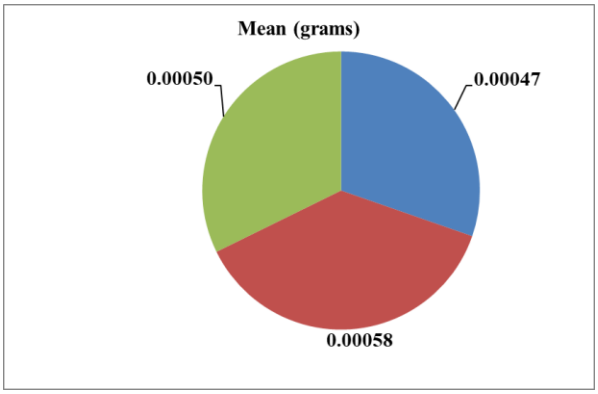
Table I: Allocation of sample teeth.

Groups	Group I	Group II	Group III
Materials	PTN files	TF adaptive	Reciproc R25
Number	10	10	10

Table II: Comparison of difference between groups and basic statistical description with level of significance evaluation using Pearson chi-square test.

Groups	Mean (grams)	Std. Deviation	Std. Error	95 % CI	Pearson Chi-Square Value	df	Level of Significance (p value)
I	0.00047	0.565	0.342	2.34	2.567	1.0	0.61
II	0.00058	1.345	0.786	1.23	2.265	1.0	
III	0.00050	1.276	0.520	1.98	2.899	1.0	

Graph I: Weight of apically extruded debris



DISCUSSION

Endodontic therapy enjoys a higher success rate in modern times with newer discoveries in cleaning and shaping systems. The key principle behind such systems is that Ni-Ti rotary instruments help in hassle free, rapid and

proficient cleaning and shaping. Nevertheless, a lot of instrumentation related factors might cause post-treatment complications, were not eliminated completely even in these rotary file systems and apical extrusion is one of them. Apical extrusion while preparing root canal space in any form such as debris, bacteria or irrigants has been found to be associated with many flare-up events and may even lead to treatment failure. As we all know that while performing bio mechanical preparation, dentin chips, remnants of pulpal tissue, irrigating solutions, and microorganisms and their by-products are frequently transported in the course of the apical foramen and introduced into the periapical tissues causing postoperative inflammation or infection, pain, flare-ups, and consequently, delay apical healing. Root canal preparation is an important step in endodontic treatment, and it plays a key role in treatment success. The extrusion of debris may be affected by natural physical factors associated with the anatomy of the tooth as well as mechanical factors such as the specific design of the instrument used and the use of rotary instruments. It is usually considered that instrumentation techniques that include rotational action produce less debris than push-pull instrumentation, and the crown-down method has been related with the least amount of debris extrusion, compared with techniques involving a linear filing motion. Therefore, motor-driven rotary systems have tendency to extrude less debris than hand techniques. Another factor that may affect debris extrusion is the design of the file, for example, the cross-section, rake and helicoidal angles, distance between flutes, taper, tip design, flexibility, alloy, and number of files. Apical extrusion of irrigation solution as well as intracanal debris can accidently extrude into the periapical area. These two components were responsible for post-operative flare-ups. Vande Visse and Brilliant[6] were the first to quantify the amount of debris extruded apically during instrumentation. They found that when instrumentation with irrigation was done, there was significant extrusion of debris. Whereas, when instrumentation was done alone there was no debris extrusion. Debris extruded from the apical foramen intra-operatively may result in postoperative pain. Thus, a reduction in debris extrusion during canal preparation is desirable in order to reduce postoperative pain following root canal treatment. The number of instruments used and the kinematics involved may contribute to debris extrusion during instrumentation.[7] The present study was conducted to assess apical extrusion of debris with different files system. In present study, 30 roots were divided into three groups based on the NiTi system. In group I PTN files were used in the sequence ProTaper Universal SX, PTN X1, PTN X2, PTN X3, PTN X4 and PTN X5. In group II, TF adaptive instruments were used in the sequence ML1, ML2, and ML3. In group III, Reciproc R25 instrument was used. Tinoco et al[8] conducted a study in which thirty extracted upper six molars were selected. In all teeth the distal roots were sectioned and shortened to a length of 15 mm. The specimens were randomly divided into two groups (n= 15) according to the instrumentation system used. Group A: One shape file (single file system), Group B: Revo-S (multiple-file rotary system). Bi-distilled water was used as the irrigant with traditional needle irrigation delivery system. The apically extruded debris and irrigant were collected into pre-weighed glass vials. The amount of extruded debris and irrigant were assessed with a precision electronic balance. The liquid inside the tubes was dried and the mean weight of debris was assessed. The One shape file system produced significantly less amount of debris and irrigant compared with Revo-S file system. We found that debris extrusion in group I was 0.00047 grams, in group II was 0.00058 grams and in group III was 0.00050 grams. Arslan et al[9] in their study found that the Reciproc file system produced significantly more debris compared with OneShape file system ($P<0.05$), but no statistically significant difference was obtained between the two reciprocating instruments ($P>0.05$). Extrusion of irrigant was statistically insignificant irrespective of the instrument or instrumentation technique used. Karatas et al[10] conducted a study to compare the amount of apically extruded debris during root canal instrumentation using ProTaper Next (PTN),

Twisted File (TF) Adaptive, and Reciproc instruments. Forty-five extracted human maxillary canines were selected and randomly assigned into 3 groups. The greatest amount of debris extruded by TF Adaptive and the least by PTN, but the difference was insignificant between groups (p=0.259). All instrumentation systems were associated with debris extrusion. Many studies have looked at various aspects of apically extruded debris and irrigants.[11-16] The results have shown that preparation up to the apex, the diameter of apical patency, the amount of irrigant used, formation of a dentin plug, the use of step-back versus crown-down technique, and the use of conventional hand filing versus rotary motion, all have a correlation to the amount of extruded debris.[17-21] A common finding of nearly all the studies in endodontic literature led to a generalized view that the crown-down technique extrudes less debris and irrigants apically as compared to the step-back technique and that a linear filing motion extrudes more debris when compared to instruments used in rotational motion.[22-24]

CONCLUSION

Even small amounts of apical extrusion can promote postoperative inflammation, pain and delay healing. Within the limitations of the study, authors found that maximum amount of debris were extruded by TF adaptive instruments followed by Reciproc R25 and PTN files system. Our study results must be considered as suggestive for presuming prognosis for similar clinical conditions. However, we expect some other large scale studies to be performed that might further establish certain standard and concrete guidelines in these perspectives.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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