

Original Article

Comparative analysis of extrusion of debris and irrigants from the apical foramen using hand and rotary systems

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Abstract

Background: The purpose of combining instrumentation and irrigation is to disinfect the root canal by removing microorganisms, pulp remnants and dentin chips, but debris may extrude through the apex into the peri-radicular tissues. The aim of present study was to compare the extrusion of debris and irrigants through apical foramen using hand and rotary systems. **Materials and methods:** For the study, we selected a total of 60 freshly extracted human maxillary canines with complete root formation. For the study, we grouped the sample equally into 4 groups for instrumentation with different techniques; Group 1- Instrumentation of the teeth sample was carried out with step-back technique; Group 2- The teeth in this group were instrumented with a Hand Protaper; Group 3- The teeth were instrumented with K-3 Rotary Ni-Ti Technique; Group 4- the instrumentation of teeth in this group was carried out with a Rotary Protaper. **Results:** More debris and irrigant was extruded from the apex with hand instrumentation techniques (Step-back and Hand Protaper techniques) as compared to engine driven K-3 and Rotary Protaper systems. The extrusion of debris and irrigant was observed to be highest with step-back technique. The authors observed statistically significant difference between the step-back technique and other hand and rotary Ni-Ti instrumentation techniques. **Conclusion:** The extrusion of debris and irrigants from apical area is present in all the techniques but is greatest in hand K-files instrumentation with step-back technique.

Keywords: Apical, Irrigant, Protaper, Root canal

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INTRODUCTION

A successful endodontic treatment depends on the effective cleaning and shaping of root canal completely. The aim of combining instrumentation and irrigation is to disinfect the root canal by removing microorganisms, pulp remnants and dentin chips, but debris may extrude through the apex into the periradicular tissues.¹ Extruded debris consists of irrigation solutions, necrotic tissue, microorganisms, pulpal fragments and dentin powder. This is responsible for postoperative inflammation and failure.² Vande Visse and Brilliant were the first to quantify the amount of debris extruded apically.³ In spite of adequate chemomechanical preparation and obturation, endodontic flare up may be caused by extruded material referred as the “worm” of necrotic debris. Alper Kustarci et al reported that mechanical instrumentation with rotary movements significantly reduced the amount of debris extrusion because these techniques tend to pack

dentin chips within the grooves of the file and expelled them in a coronal direction from the root canal.⁴ Various studies have shown that crown down technique leads to minimum apical extrusion of debris but various instrument designs may affect the extrusion.⁵ The aim of present study is to compare the extrusion of debris and irrigants through apical foramen using hand and rotary systems.

MATERIALS AND METHODS

The present study was conducted in the Department of Conservative Dentistry and Endodontics in the institution. Ethical approval for the study was obtained from the ethical committee of the institute. For the study, authors selected a total of 60 freshly extracted human maxillary canines with complete root formation.

Inclusion criteria for selection of extracted teeth:

1. Single canal and apical foramen

2. Curvature of canal between 0 and 10 degrees
3. Apical diameter corresponding to #20 K file

Preparation of the standard access cavity was done and working length was determined. The apparatus for collection of irrigant and debris was prepared similar to that described by Meyers and Montgomery.⁶ For the study, we grouped the sample equally into 4 groups for instrumentation with different techniques. Group 1- Instrumentation of the teeth sample was carried out with step-back technique. Group 2- The teeth in this group were instrumented with a Hand Protaper Group 3- The teeth were instrumented with K-3 Rotary Ni-Ti Technique.^{and} Group 4- the instrumentation of teeth in this group was carried out with a Rotary Protaper. For irrigation of the canal, 1ml of distilled water was used after every change of instrument. For all instrumentation techniques, the apex was prepared with #40 file. After completion of canal instrumentation, the volume of irrigant extruded from apex was measured following the method given by Meyers and Montgomery.⁶ For the measurement of dry debris, the debris adhering to root surface after canal preparation was collected by washing off the apical area of tooth with 1 ml of distilled water and stored in an incubator at 68°C for 5 days for moisture to evaporate and dry weight of debris was measured. Statistical analysis of the data was done using SPSS software for windows. Student's t-test and Chi-square test was done to check the statistical significance of the data. Statistical significance was predetermined to be at $P < 0.005$.

RESULTS

In the present study, we observed that more debris and irrigant was extruded from the apex with hand

instrumentation techniques (Step-back and Hand Protaper techniques) as compared to engine driven K-3 and Rotary Protaper systems. In all the techniques, same amount and type of irrigant was used and the preparation was done by same operator on all patients. The extrusion of debris and irrigant was observed to be highest with step-back technique. It was observed that significantly smaller amounts of irrigant and debris were extruded from the apex in the engine driven K-3 system. The authors observed statistically significant difference ($P < 0.005$) between the step-back technique and other hand and rotary Ni-Ti instrumentation techniques (**Table 1 & 2; Figures 1 & 2**).

DISCUSSION

In the present study, we assessed the apical extrusion of the irrigating solutions and dentin debris resulting due to canal shaping by different preparation techniques and instruments. The extrusion of great amount of debris and irrigant apically by step-back technique is due to the watch winding and in-and-out filing motion, which acted as a piston, extruding a greater amount of debris and irrigant compared to other instrumentation techniques, which prepared the coronal area first followed by the apical area, extruding less amount of material.⁷ The contact time between the file and root canal wall is responsible for the difference in the preparation of root canal using hand and rotary Protaper files. The contact of apical area to the engine driven Protaper file is for lesser duration and also rotational speed and torque is fixed. In contrast to this, the contact of Hand Protaper file to the apical area is for extended period of time and the rotational movement of the file is an "operator controlled variable factor", extruding more amount of debris. Results of the present

Table 1: Mean weight of dry debris extruded by different instrumentation techniques

Groups	N	Mean (mg)	Standard deviation
Group 1	15	0.56	0.0019
Group 2	15	0.14	0.0008
Group 3	15	0.04	0.0014
Group 4	15	0.08	0.0007

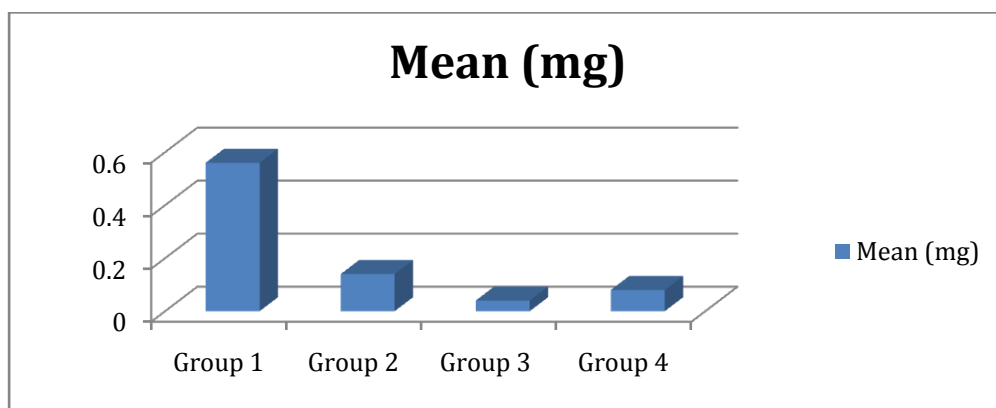


Figure 1: Mean weight of dry debris extruded by different instrumentation techniques

Table 2: Mean volume of irrigant extrusion by different instrumentation techniques

Groups	N	Mean (ml)	Standard deviation
Group 1	15	0.48	0.0018
Group 2	15	0.16	0.009
Group 3	15	0.11	0.015
Group 4	15	0.18	0.008

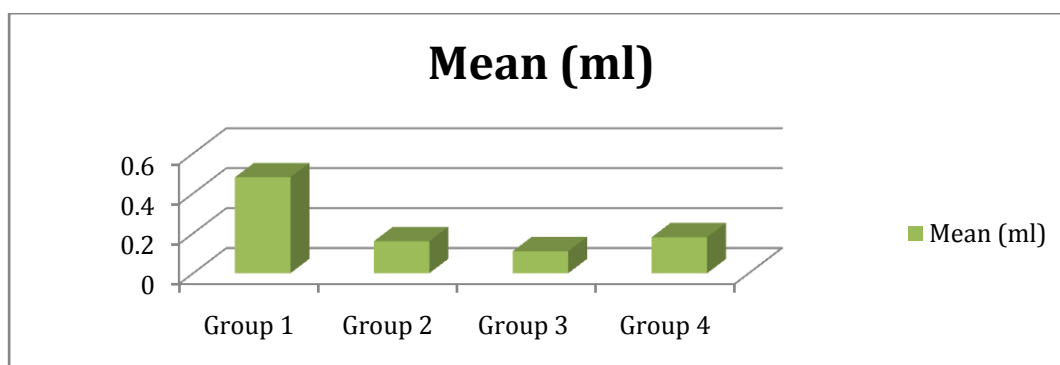


Figure 2: Mean volume of irrigant extrusion by different instrumentation techniques

study are consistent with various studies conducted by different researchers.^{7, 8} Madhusudhana K et al. conducted a study to compare apical extrusion of debris and irrigants using hand and three rotary instrumentation systems. Forty caries free single rooted human mandibular premolar teeth were divided in four groups of ten teeth each. Teeth in each group were instrumented until the working length with rotary ProTaper, K3, Mtwo systems, and hand K-type stainless steel files. Debris and irrigant extruded from the apical foramen were collected into vials and the amounts were quantitatively determined. The data obtained were

analyzed using Kruskal-Wallis one-way analysis of variance and Mann-Whitney U tests. The results show that all instrumentation techniques produced significant amount of extruded debris and irrigant. The engine-driven nickel-titanium systems showed less apical extrusion of debris and irrigant than manual technique. No statistically significant difference was found between the groups at [P > 0.05]. Maximum apical debris and irrigant extrusion was seen with K-file group and least in the Mtwo group. It was concluded by the authors that the use of rotary files and techniques to perform instrumentation does show less extrusion

of the debris and irrigant from the apex. This can contribute to more successful endodontic therapy.⁸ Adi Aet al. conducted an in vitro study to evaluate the quantity of debris extruded from the apical foramen during root canal preparation by using one hand, and two rotary instrumentation techniques. Three different groups each with 12 mesiobuccal roots of human maxillary first molar were instrumented using either step-back technique with hand instruments, FlexMaster or Mtwo rotary system. Debris extruded from the apical foramen during canal preparation was collected. The mean dry weights of debris were compared using one-way ANOVA. Step-back group had a significantly greater mean weight of debris compared to the other two groups ($P < 0.05$). Mtwo group had the lowest mean weight of debris, though it was not significantly different from FlexMaster group. According to this study, the engine driven techniques were associated with less apical debris extrusion.⁹ Jindal R et al. performed a study to evaluate and compare the apical extrusion of debris and irrigant using various rotary instruments with crown down technique in the instrumentation of root canals. Thirty freshly extracted human permanent straight rooted mandibular premolars with minimum root curvature of $0-10^\circ$ were divided in three groups with 10 teeth in each group. Each group was instrumented using one of the three rotary instrumentation systems: Rotary Hero shapers, Rotary ProTaper and Rotary Mtwo. One ml of sterile water was used as an irrigant after using each instrument. Debris extruded was collected in pre weighed glass vials and the extruded irrigant was measured quantitatively by Myers and Montgomery method and was later evaporated. The weight of the dry extruded debris was calculated by comparing the pre and post instrumentation weight of glass vials for each group. Statistical analysis showed that all the rotary instruments used in this study caused apical extrusion of debris and irrigant. A Statistically significant difference was observed with Rotary ProTaper and Rotary Mtwo groups when compared with Rotary Hero shapers. But no significant difference was observed between Rotary ProTaper and Rotary Mtwo groups.¹⁰ Vivekanandhan P et al. performed research to evaluate the amount of apically extruded debris after preparation of straight root canals in extracted human teeth using three rotary systems. Sixty single-rooted human teeth with single root canal and apical foramen were selected and randomly divided into three experimental groups ($n = 20$) according to the rotary system used: Group 1 - ProTaper, Group 2 -

Revo-S, Group 3 - WaveOne. Apical enlargement was done up to size 40/0.06 for Groups 1 and 2 and 40/0.08 for Group 3. For debris collection, each tooth was held in a preweighed Eppendorf tube fixed inside a glass vial through rubber plug. After instrumentation, each tooth was separated from the Eppendorf tube and the debris adhering to the root surface was collected by washing the root with 1 mL of bi-distilled water and incubated at 70°C for 5 days. The dry weight of extruded debris was weighed in an electronic balance. There was a statistically significant difference in the mean debris score among all the three groups - ProTaper (0.00065 g), Revo-S (0.00045 g) and WaveOne (0.00089 g). It was concluded that Revo-S system was associated with significantly less debris extrusion compared with ProTaper or WaveOne.¹¹

CONCLUSION

The authors concluded that the extrusion of debris and irrigants from apical area is present in all the techniques but is greatest in hand K-files instrumentation with step-back technique.

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