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A Comparative Evaluation of Extruded Apical Debris and Irrigant by Three Rotary NI-TI Systems and Step Back Technique

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ABSTRACT

Background: The extruded debris and irrigant out of the apex during root canal treatment are one of the major causes of untoward events that can happen during root canal therapy. The aim of this in vitro study was to evaluate and compare the extruded debris and irrigant by using three rotary Ni-Ti systems and one hand instrumentation technique. Method: Forty single-rooted freshly extracted teeth were randomly and equally divided into the four groups. The teeth were fitted in the preweighed Eppendorf's tubes using analytic weight measuring machine. The teeth were instrumented with Protaper universal (Dentsply Maillefer, Ballaigues, Switzerland) in Group I, Protaper next (Dentsply Maillefer, Ballaigues, Switzerland) in Group II, Adaptive file system (TFA; SybronEndo, Orange, CA) in Group III and Step back technique in Group IV. The extruded irrigant was measured first calculating the equal amount in different but similar Eppendorf tube using the micropipette and comparing the level of irrigant. After drying the tubes in incubator, the final weights of the Eppendorf's tubes were measured, and differences of the mean weights were calculated. All the data was put to statistical analysis using SPSS 20.0 and p<0.05 was set as significant. Results: The extrusion of irrigant was statistically significantly higher in step back as compared to other techniques whereas results of debris extrusion were not statistically significant.

Key words: Debris, Extrusion, Irrigant, Rotary files, Step back technique

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INTRODUCTION

The main purpose of the endodontic therapy is to either prevent or cure the peri-radicular periodontitis. This goal is achieved by disinfection through cleaning and shaping of the root canals after gaining access followed by three-dimensional sealing of the root canals. Shaping of the root canals is done with the help of various instruments and techniques and cleaning of the root canals is done with the use of irrigants and other intra canal medicaments.

During the cleaning and shaping, there is always a possibility of extrusion of dentin chips, microorganisms, necrotic tissue, and irrigating agents out of the apex irrespective of the instrumentation technique used [1]. This extruded debris has capability to induce peri-radicular inflammation and cause flare ups during treatment or after treatment [2]. The incidence of flare ups is 1.6% to 14% during root canal treatments [3]. Similarly, extrusion of irrigant mainly sodium hypochlorite can cause severe complications like sodium hypochlorite accident [4,5].

Each technique of cleaning and shaping whether it is crown down or step back tends to extrude the debris and irrigating solution out of apex with

varying amount [1]. Crown down techniques has been reported to be extruding lesser debris as compared to the conventional step back technique [6]. Most of the nickel titanium rotary instrumentation techniques use crown down motion whether in rotation or reciprocation. Lately, there has been intense development in the rotary files for endodontic treatment with respect to design of the instrument, material of instruments, motion during shaping and number of the instruments to be used.

In our study we compared extrusion of the debris and irrigant in new system Adaptive file system (TFA; Sybron Endo, Orange, CA) with Protaper next (Dentsply Maillefer, Ballaigues, Switzerland), Protaper universal (Dentsply Maillefer, Ballaigues, Switzerland) and Step back hand technique. Adaptive file system is twisted file system with R phase heat treatment technology. It has an interrupted clockwise and counterclockwise motion which allows optimal brushing and circumferential filing for better debris removal in oval canals [7]. There is no method by which we can measure the extruded debris or irrigant in vivo conditions. The in vitro studies for this most common factor causing flare up in patients gives us an insight to decide about the instrumentation technique to be chosen for clinical use. There has been no study that has compared both the factors for the file systems chosen for our study.

MATERIALS AND METHODS

Inclusion criteria

Forty single canaled teeth (anterior and premolars) with similar lengths were selected with non-complicated root canal anatomy, no curvatures and mature root formation confirmed with the radiographs for all the teeth. The length of the tooth was standardized to 22 mm by flattening the crown part of the teeth.

Exclusion criteria

Any tooth with curvature, multiple canals, open apex, and any complex anatomies was excluded.

Tooth preparation

The soft-tissue remnants and calculi on the external root surface were removed mechanically with periodontal curette. Access cavities were prepared with high speed round bur #4 and Endo Z bur. The straight exit of the canal was checked with patency file K-file #10. The working length was established at 1 mm short of the file just visible at the apical foramen (tooth length) which was equal to 21 mm length and confirmed by taking working length radiograph.

Experimental model preparation

In this study, the experimental model described by Myers and Montgomery was used as described in following steps and shown in Figure 1 [8]. Eppendorf tubes were used to collect debris and irrigant; premeasured after separating the stoppers. The initial weights were recorded three times using precision electronic analytical balance with an accuracy of 10-4 grams by blind observer. Each tooth was inserted up to the cement-enamel junction in the hole created in the stoppers and a 27-G needle was placed alongside the stopper for use as a drainage cannula and to balance the air pressure inside and outside the tubes. Then, each stopper with the tooth and the needle was replaced to its Eppendorf tube, and

Figure 1: Experimental model showing its components 1-needle; 2- tooth; 3-eppendorf's tube and 4-glass vial.

the tubes were fitted into glass vials for better handling.

Instrumentation proceure

The teeth were randomly and equally divided into four groups and the root canal preparation was done by second blind observer. The group I was instrumented with Protaper universal (Dentsply Maillefer, Ballaigues, Switzerland; group II with Protaper next (Dentsply Maillefer, Ballaigues, Switzerland); group III with Adaptive file system (TFA; SybronEndo, Orange, CA) group IV with traditional Step back technique using hand K files. A rubber dam sheet was used around the neck of the tooth to avoid any irrigant to seep inside the tube from coronal extrusion (Figure 2). The controlled preparations were done up to same working length, same apical width of size #25 and by the same operator to eliminate the bias, using NSK endomate DT torque-controlled motor according to the manufacturer's recommendations. The total volume of 7ml of the irrigant (distilled water) was used for each tooth during preparation equally divided between each instrument used in different instrumentation techniques using 30-gauge side vent irrigation needle with up down motion without binding to the root canal walls.

Measurement of irrigant extrusion

After instrumentation of the teeth, the solid debris extruded settled down at the base of the tube and extruded liquid irrigant suspended above the debris (Figure 3). Similar Eppendorf's tubes were taken and same irrigant was added in that alternate tube in 0.01ml increment using micropipette and insulin syringe up to the same mark as in original Eppendorf's tube. The amount of the calculated irrigant added in alternate tube was noted for each tooth in ml by two different blind observers and average was taken.

Measurement of debris extrusion

After measuring the irrigant volume, the tubes were stored in incubator (Sanyo electronics, Japan) at 70˚C for three days to dry all the irrigant. The final weights of the tubes containing the remaining extruded debris were done using analytic balance up to 10-4 grams three times by another blind observer. The average of the final weights of the tubes was taken. The net weight of the extruded debris was calculated by subtracting mean final weight and mean initial weight of the Eppendorf's tubes.

Analysis

The mean extruded irrigant volume for each group was compared using one-way ANOVA

Figure 2: Rubber dam application.

Figure 3: Eppendorf's tube showing 1-irrigant extruded & 2- extruded debris.

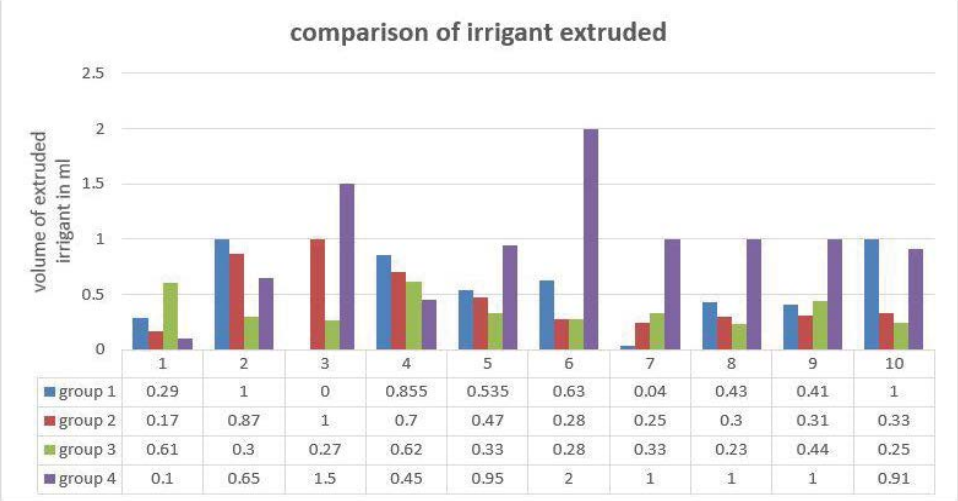
test and Tukey HSD test. The P values <.05 were considered to indicate statistical significance for all tests.

The mean of net weights of all the groups were taken and compared statistically using SPSS 20.0 software by 1-way analysis of variance tests. The P values <0.05 were considered to indicate statistical significance for all tests.

RESULTS

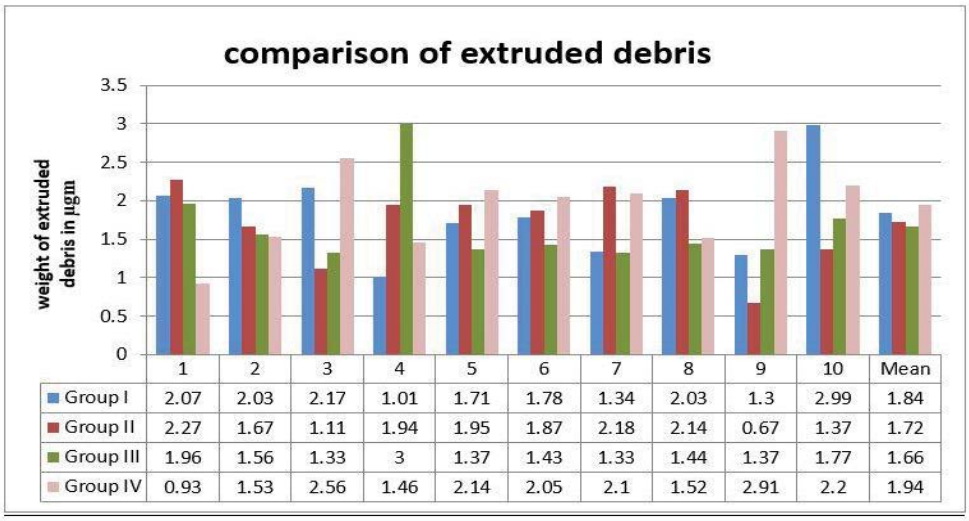
The irrigant extruded by the Group IV (step back technique) was highest with average of 0.96 ml followed by the Group I (Protaper universal) with average of 0.52 ml, Group II (Protaper next) with average of 0.47 ml and Group III (Adaptive file system) with average of 0.37 ml. Figure 4 demonstrates all the results obtained in ten samples of each group. The p- value corresponding to F-statistics of one-way ANOVA test was less than 0.05, therefore tukey HSD test was carried done to find significance between the groups. Statistically, there was significant difference between Group I and Group IV ($p<0.049$), Group II and Group IV ($p<0.018$) & Group III and Group IV ($p<0.0032$). The difference between Group I, Group II and Group III was not statistically significant.

Regarding the extrusion of the debris, the p- value corresponding to Q-statistics of one-way ANOVA test was more than 0.05. Figure 5 demonstrates all the results obtained in ten samples of each group. Therefore, no statistically significant difference was found between the groups. But the Group IV (step back technique) extruded highest quantity of debris with mean of (1.94 ± 0.58 µgm) outside the apex followed by Group I



	1	2	3	4	5	6	7	8	9	10
group 1	0.29	1	0	0.855	0.535	0.63	0.04	0.43	0.41	1
group 2	0.17	0.87	1	0.7	0.47	0.28	0.25	0.3	0.31	0.33
group 3	0.61	0.3	0.27	0.62	0.33	0.28	0.33	0.23	0.44	0.25
group 4	0.1	0.65	1.5	0.45	0.95	2	1	1	1	0.91

Figure 4: Result of extrusion of the irrigant in each sample.



	1	2	3	4	5	6	7	8	9	10	Mean
Group I	2.07	2.03	2.17	1.01	1.71	1.78	1.34	2.03	1.3	2.99	1.84
Group II	2.27	1.67	1.11	1.94	1.95	1.87	2.18	2.14	0.67	1.37	1.72
Group III	1.96	1.56	1.33	3	1.37	1.43	1.33	1.44	1.37	1.77	1.66
Group IV	0.93	1.53	2.56	1.46	2.14	2.05	2.1	1.52	2.91	2.2	1.94

Figure 5: Results of debris extrusion in each sample.

(Protaper universal) (1.84 ± 0.56 µgm), Group II (Protaper next) (1.72 ± 0.52 µgm) and least by the Group IV (Adaptive file system) (1.66 ± 0.52 µgm).

DISCUSSION

The major objective of the root canal treatment is to disinfect the canal completely which is achieved by the cleaning and shaping. There is no technique of root canal instrumentation till the date that can completely avoid extrusion of the debris or irrigant out of the apex [9,10]. Similarly, in our study all the instrumentation techniques showed extrusion of the debris and irrigant with variable degrees.

In this study, the model apparatus described by Myers and Montgomery was used which is a well-accepted tool to measure extruded materials outside the apex but with its limitations as it cannot simulate presence of periodontal ligament which might differ the results from the actual in vivo situation [8]. We used distilled water as irrigant instead of sodium hypochlorite because crystal formation with sodium hypochlorite might result in wrong recordings [11]. The irrigation was done with the conventional technique using irrigation needle of 30 gauge with side vent using up down motion without binding the root canal surface. Though many advance irrigation delivery systems are available which have been proved to show less extrusion of irrigant but by far conventional irrigation method is the most used by dentists all over the world [12-14]. Both the extrusion of debris and irrigant can complicate the treatment, hence both the parameters were taken into consideration whereas most of the studies present in literature have reported comparisons of single parameter.

This study showed that the conventional step back technique with hand k files produced the maximum amount of the apically extruded debris although there was no difference statistically ($p > 0.05$) from other techniques. This technique involves back and forth filing motion that produces greater mass of debris and the hand files act as plunger which forcefully push the debris out. The direction of motion is apicocoronally, there is no free space coronally to flush the debris out effectively. Al-Omari and Dummer described that linear filing motion produced more amount of debris as compared to rotation motion [15].

On another hand, the use of coronoapical direction of the instrumentation and rotation motion with the use of engine driven Ni-Ti file systems, produces less debris when compared to hand instrumentation because there is space between the flutes for debris collection and removal with more coronal space for flushing the debris out.[16] In this study we compared three Ni-Ti file systems that are Protaper universal, Protaper next and recently introduced Adaptive file system.

In this study out of rotary instrumentation, Protaper universal extruded more debris followed by the Protaper next and Adaptive file system. This is attributed to the design of the file systems, Protaper Universal has triangular convex cross section with progressive taper hence more contact with the walls and positive rake angle with aggressive cutting produces more debris. On the other hand, Protaper next has offset mass of rotation and adaptive file system has interrupted rotation motion which result in better removal of the debris coronally [7]. Our study results showed that there was no statistically significant difference for extruded debris among all the rotary Ni-Ti file systems. Similarly, Cakici F et al. showed in their study that all the rotary Ni-Ti system which included Protaper universal, Protaper next and twisted files produced various degree of the apical debris extrusion but the difference was statistically insignificant [17].

The number of the instruments used to reach the desired apical width might be another important factor as in Protaper universal system five instruments were used as compared to Protaper next and adaptive file system in which only two files were required to reach the standardized apical width. Step back technique with hand files required highest number of the instruments to complete the radicular preparation. De-Deus G et al observed in their study that lesser the number of instruments used lesser was the extruded debris [18].

Similar results were shown regarding the extrusion of the irrigant as step back technique extruded highest volume of the irrigant followed by the Protaper universal, Protaper next and Adaptive file system but the difference between step back technique and rotary techniques were statistically significant. The reasons for the

results depend on the same factors as instrument design, direction of instrumentation and number of instruments required as explained in extruded debris results. The statistically significant result in extrusion of irrigant may be due to standardized amount of irrigant irrespective of the technique was used under positive pressure technique of irrigation.

CONCLUSION

Within the limitations of the study, it can be concluded that less extrusion of debris and irrigant was associated with coronoapical motion, lesser number of instruments used, and rotary instruments designed with more coronal clearance of debris. As there is no technique to test these parameters in clinical situation, further studies are warranted to compare these results in different simulated clinical conditions like curved canals, different kind of teeth or in presence of simulated supporting structures.

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