Evaluation of Apically Extruded Debris in Conventional and Rotary Instrumentation Techniques

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Abstract

Objective: The purpose of this in vitro study was to compare two common techniques, conventional and rotary instrumentation, in debris extrusion.

Methods and materials: Two hundred mature human teeth with mature apices and less than 15 degrees of root curvature as determined by Schneider's method were selected for use. Teeth were randomly divided into four groups of 50 teeth each and prepared using step-back instrumentation and profile 4 percent Taper Series 29 rotary system at three different speeds: 1,000 rpm, 8,000 rpm and 24,000 rpm. All of the speeds were reduced by contra angle to 1/6 rpm. Extruded debris were collected on pre-weighed vials containing distilled water through the apical foramen during instrumentation. The vials were then dried in a microwave oven at 150 degrees Celsius and weighed again. The difference was recorded as "the weight of the extruded debris."

Eight control vials, two for each group, were weighed and filled with distilled water, dried, and reweighed. The mean weight of extruded debris for each group was statistically analyzed. T-student, unilateral variance analysis and Pearson tests were used in this study.

Results: Step-back instrumentation (Group 1) produced significantly more debris than other groups. The difference in the amount of debris produced among rotary groups was not significant.

Conclusion: Rotary technique could reduce the amount of debris extrusion.

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Acknowledgment / This study was supported by a grant from the Research Council of Mashhad University of Medical Science, Iran.

Flare-up, which occurs as pain and swelling during or after treatment, is a considerable problem in endodontics. One of the causes of flare-up is extrusion of debris (necrotic tissue, remaining pulp tissues, infected dentinal shavings and bacteria, or irrigation solution) to the periapical area.[1-3] It is mandatory to look for a proper way to decrease extrusion of debris via the periapical area to reduce post-treatment problems.

Studies have shown that almost all techniques of instrumentation can cause extrusion of debris to the periapical area.[4-11]

Martin and Cuningham (1982) showed that the technique of endosonic instrumentation, compared to the hand technique, would pass less debris to the periapical area.[12] The 1987 study of Ruiz-Hubard and Gutman showed that crown-down pressure-less technique in straight and curved canals noticeably caused less debris extrusion to the periapical area when compared to the step-back technique.[13]

Myers and Montgomery (1991) showed that in the step-back technique, more debris would extrude to the apical foramen compared to the Canal Master rotary system.[14]

Beeson and Hartwell (1998) observed that the passing of debris in the step-back technique was significantly more than Profile System (Series 29).[4] Hinrichs and Hartwell (1998) observed that the difference between rotary technique with Light Speed, Profile 4 percent Taper Series 29, and hand instrument technique (Balanced Force) in extrusion of debris via apical foramen was not significant.[5] The presence of pros and cons in different studies is noticeable. The main goal of this study is to compare the quantity of extruded debris from the apical foramen with the use of the step-back technique and Profile GT rotary instrumentation at different speeds (1,000 rpm, 8,000 rpm, and 24,000 rpm). It also is to determine if there is any relationship between the length of root and the amount of debris passed in each technique and to compare them. The reason for using the various speeds is that debris extrusion varies at different speeds.

Methods and Materials

Case selection: Two human extracted single-root anterior maxillary teeth with mature apices and less than 15 degrees of root curvature as determined by Schneider's method were selected for use.[15] A radiograph was taken to make sure all the teeth had single root canal and one apical foramen. Teeth with calcification and open apices were excluded, and teeth with minimum curvature were selected. Soft tissues on root surfaces were removed by 5.25 percent NaOCl and roots were stored in 100 percent humidity until the time of experiment.

With the help of an airmotor handpiece and diamond bur, crowns of teeth were cut at the CEJ level and pulp tissue was removed with the help of broach. Then, one size 15 k-file was placed in the canal until the tip of the file became visible from apical foramen. The working length was selected 1 mm shorter than that.

Instrumentation of the Canals

The prepared teeth were divided randomly into four groups of 50 teeth. All of the teeth were instrumented by a single practitioner. In each group, after use of each instrument, the canals were irrigated by the standard amount of distilled water with a 28-gauge needle without bounding the needle to the canal's wall.

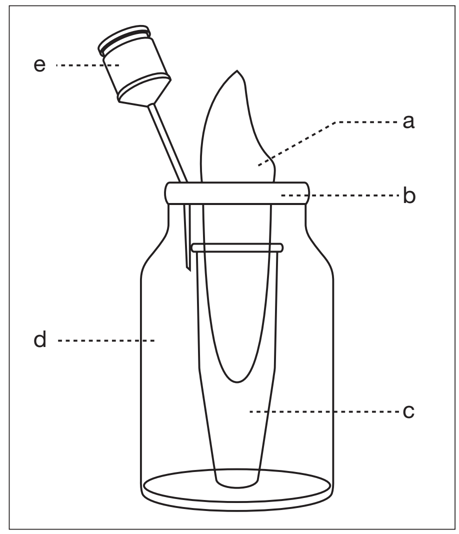

Figure 1. Diagram of apparatus collecting debris and irrigant during endodontic preparation.

Group 1 — Hand step-back technique of instrumentation.

In this group, stainless-steel (k-files) were used. Preparing the canal was started with the first file, which bounded to the working length. Each file was used with push and pull movements until easy and loose movements of the same file in the canal was achieved. The next file was then used.

The apical area was prepared until size 35 file, then larger files were used with the step-back technique and two-thirds of the canal (coronal portion) was prepared with circumferential technique of filing until the size 60 file.

Group 2 — Rotary instrumentation technique (profile 0.04 Taper Series 29 with speed of 1,000 rpm).

After determination of the working

length, all the teeth were prepared according to the company's instruction. In the first stage of preparation, crown-down technique, (the size 20 file, 0.12 taper without any force) until the length with no blockage over it, was used. The size 20 file with reduction in tapering degree (0.10 taper, 0.08 taper, and the last 0.06 taper) was used.

The next stage was preparation of the apical portion with step-back technique that profile 0.04 taper with size 20 was used until ¼ mm shorter than the canal's length. Then, profile size 25 with 0.04 taper until ½ mm shorter than canal's length, the size 30 file with 0.4 taper until ¾ mm shorter, and file 35 with 0.04 taper until 1 mm shorter than canal's length, were used respectively.

In Groups 3 and 4, the preparation was done the same as Group 2, and the speeds used were 8,000 rpm and 24,000 rpm. All of the speeds were reduced by contra angle to ⅙ rpm.

Debris Collection

The data collection process was double-blinded. During the instrumentation, all debris and irrigant solutions extruded through the apical foramen of each tooth were collected in one separate vial. Each vial contained distilled water, which was inside a larger glass flask (according to the Myers and Montgomery techniques).[14] The vial had a plastic cover on top, which had one hole in the center, according to the size of each root. The root was fixed in that, and the root apex was inside the distilled water. All vials from 1 to 200 were numbered. Each one without distilled water was weighed with the use of a sensitive scale that could weigh an amount as

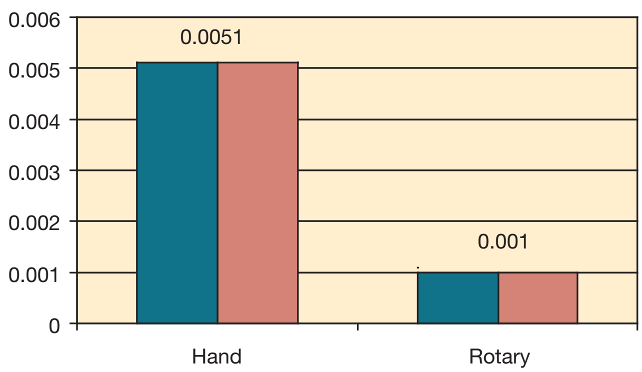

Figure 2. Comparison of average extruded debris in hand and rotary techniques with speed of 1,000 rpm.

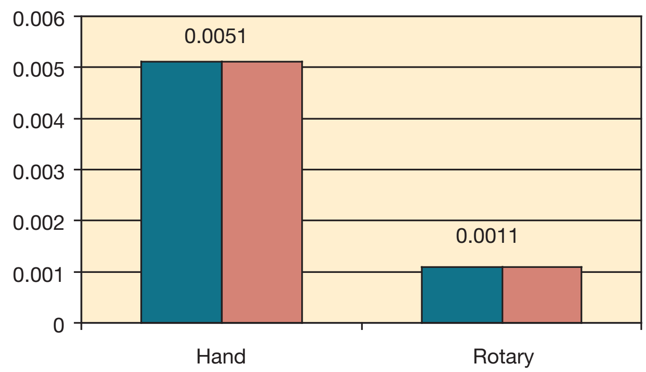

Figure 3. Comparison of average extruded debris in hand and rotary techniques with speed of 8,000 rpm

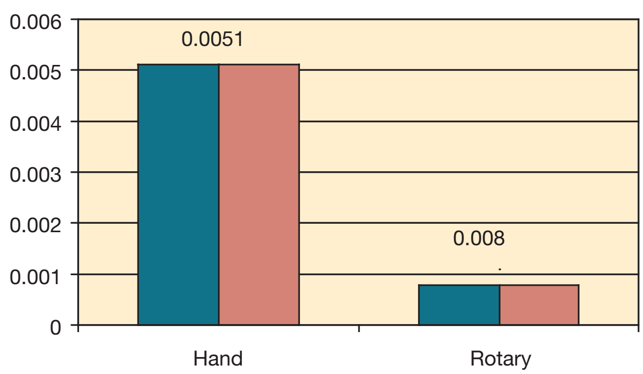

Figure 4. Comparison of average extruded debris in hand and rotary techniques with speed of 24,000 rpm.

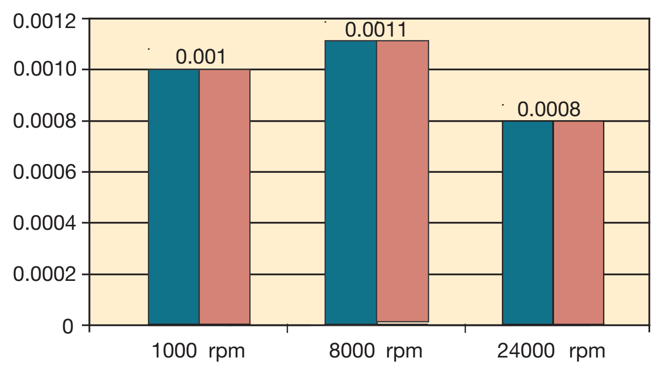

Figure 5. Comparison of average extruded debris mean in rotary technique with different speeds (1,000 rpm, 8,000 rpm, and 24,000 rpm).

little as 0.0001 g. For equality of the air pressure inside and outside of the flask, a needle with a 23-gauge was put inside of the plastic cover of the vial.

Weighing Debris

After accomplishing all stages of instrumentation in each group, vials were removed from the flask and placed inside a microwave oven at 1,500 degrees Celsius for 12 hours until all liquids evaporated. All the vials then were placed in a desicator containing $CaCl_2$ to prevent moisture absorption, and then weighed. Weight of dry debris in comparison to the primary weight was obtained. For each group, two vials of distilled water were used as a control, which were dried at the same condition and weighed. Considering a 95 percent confidence interval, the data was analyzed with PSS statistical software using a student test, unilateral variance analysis and the Pearson test. The results were compared.

Results

The data revealed there was a significant difference between the average of extruded debris in hand and rotary techniques, P=0.000 (**Figure 2**)

In each of the hand or rotary techniques, the difference in debris extrusion between the speed of 8,000 and 24,000 rpm was significant. P=0.000 (**Figures 3 and 4**).

The mean of extruded debris in the rotary technique between 1,000 rpm, 8,000 rpm and 24,000 rpm was not significant P=0.00(0.04) (**Figure 5**).

Linear correlation between length of the root and extruded debris showed that the increase in length of the root, increased the amount of debris extrusion significantly P=0.015 (**Figure 6**).

Discussion

In endodontics, the pain after instrumentation is usually because of periapical inflammation. During biomechanical instrumentation of the root canal, necrotic debris, remnants of pulp tissue, microorganisms or irrigation solution can enter the periapical tissue and induce an inflammatory reaction and finally liquification necrosis.

Presence of infected dentinal shaves in periapical area can delay the healing procedure. It has also been revealed that inflammatory reaction can be the cause of edema, pain and bone resorption.[5,6]

During irrigation of the canals, there is also a risk of passing the debris to the periapical area. Irrigation should be done passively.[4]

The coronal removing of debris is characteristic, which is present in profile 0.04 taper.

The reasons by which coronally removing of debris happens in profile 0.04 taper are as follows:

■ 1 — Ni-Ti files have external blades that are flat and can place the file in center of the canal.

■ 2 — 0.04 tapering can produce the funnel form in the crown-down technique.

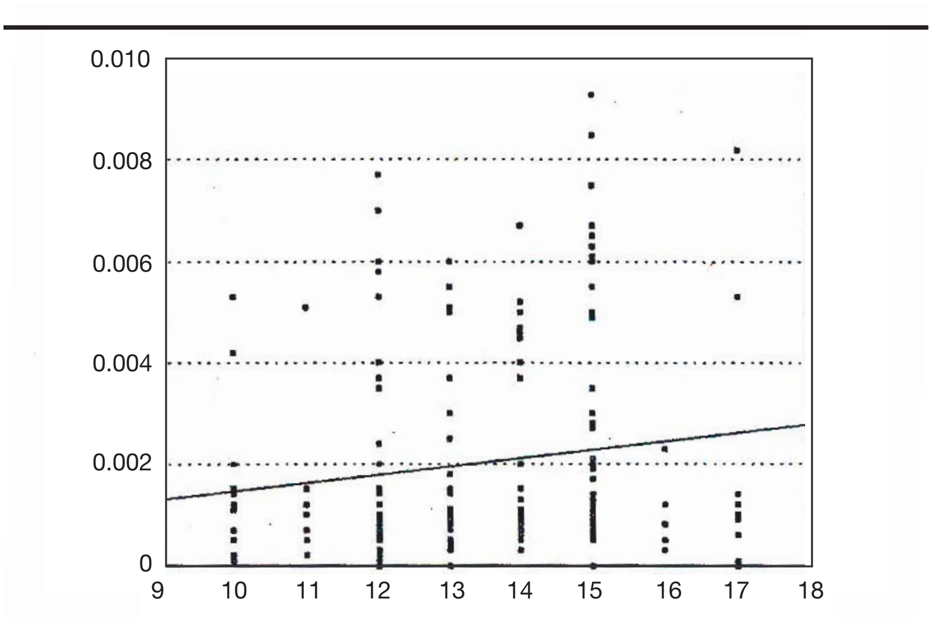

Figure 6. The amount of linear correlation between root length and extruded debris in all experimental samples.

■ 3 — U-shaped flutes and slow motion of rotary technique (150 to 350 rpm) can cause blockage of dentinal cuts inside of file flutes and move toward coronal portion.

According to these characteristics, this technique is better than hand instrumentation technique (step-back), can minimize the amount of debris removed, and decrease all the reactions after the treatment.

Results in our study showed that linear filing increased the amount of entering debris to the periapical area but the rotary system, profile 0.04 taper, with rotary movement along crown-down or cervical flaring, caused minimal removal of debris to the periapical area. This is because the amount of dentin for entering to the periapical area decreases and produces a large space for irrigation of debris toward the coronal portion. These results are in accordance with those of McKendry, Alomary, Beeson and Reddy.[4-8]

In this study, the average debris extrusion at different speeds of the machine was not different significantly, but debris extrusion in rotary groups was less significant than that of hand technique of instrumentation.

Our results showed that the increase in length of the root would increase the amount of debris extruded, and all the results are in accordance with those of Vandevisse.[9] The findings presented in this study confirm that using rotary technique is useful in decreasing the amount of debris extrusion to the periapical area since in the rotary technique, debris is blocked in file flutes and moves to the coronal portion. In the push and pull technique, debris goes to the periapical area.[8]

Since our study is an in vitro research, different results may be achieved using in vivo models, because periapical tissue may act as a natural bridge and prevent the passage of debris. Even the difference between negative and positive forces can produce different results.[3]

It should be determined how much this natural bridge resists the removed debris and debris present in an irrigation solution. In an in vivo condition, debris will be removed along with bacteria.[6]

The type and virulence of bacteria pushed during instrumentation and the host defense can influence the inflammatory reaction.

According to studies, instrumentation with the rotary profile system could reduce the amount of debris extrusion to the periapical area.[4-8] Therefore, inflammatory reaction and post-treatment problems could be reduced. Consequently, the use of the rotary technique to minimize the extrusion of debris is recommended. CDA

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