

Comparison of the Effect of Various Irrigants on Apically Extruded Debris after Root Canal Preparation

Masoud Parirokh, DMD, MS,* Shahrzad Jalali, DMD, MS,[†] Ali Akbar Haghdoost, MD, PhD,[‡] and Paul Vincent Abbott, BDS (WA), MDS (Adel), FRACDS(Endo), FPFA, FADI, FICD[§]

Abstract

Introduction: Several factors can influence the amount of apically extruded debris. The aim was to quantitatively compare the amount of debris extruded apically from root canals when 3 different irrigants were used during canal preparation with rotary instruments.

Methods: Ninety-one extracted single-rooted human mandibular premolar teeth with straight root canals were used. The teeth were randomly divided into 1 control group (group 1, n = 4) and 3 experimental groups of 29 teeth each. Hero 642 instruments were used for root canal preparation in all teeth, and 3 different irrigants were used (group 2, 2% chlorhexidine; group 3, 5.25% sodium hypochlorite; group 4, 2.5% sodium hypochlorite). Seven Eppendorf tubes served as a second control group. Debris extruded from the apical foramen during root canal preparation was collected into preweighed Eppendorf tubes. The weight of the dry extruded debris was established by subtracting the preinstrumentation and postinstrumentation weight of the Eppendorf tubes for each group. The data obtained were analyzed by using one-way analysis of variance and Tukey honestly significant difference. **Results:** Group 3 (sodium hypochlorite 5.25%) had the highest amount of extruded debris, which was significantly different from the other groups ($P < .05$). **Conclusions:** The type of irrigant used can affect the amount of apically extruded debris. The 5.25% solution of sodium hypochlorite had the greatest amount of debris. (*J Endod* 2011; ■:1–4)

Key Words

Apical extrusion, chlorhexidine, debris, irrigation, sodium hypochlorite

From the *Oral and Dental Diseases Research Center, Kerman, Iran; [†]Department of Endodontics, Kerman Dental School, Kerman, Iran; [‡]Research Center for Modeling in Health, Kerman Medical Science University, Kerman, Iran; and [§]School of Dentistry, University of Western Australia, Perth, Australia.

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Address requests for reprints to Dr Masoud Parirokh, Oral and Dental Diseases Research Center, Kerman 76186, Iran. E-mail address: masoudparirokh@yahoo.com
0099-2399/\$ - see front matter

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The main purpose of root canal instrumentation is to enlarge the root canal system to remove all residual pulp tissue and bacteria as well as provide a space for delivery of root canal irrigants, medicaments, and finally root-filling materials (1). Numerous techniques and antibacterial agents have been used for preparing root canals and particularly to render them free of microorganisms (2–24). Most of these investigations have focused on the antibacterial activity of the root canal irrigants, the shaping properties of various hand and rotary instruments, or the amount of apically extruded debris (AED) (2–24). The AED mostly contains pulp tissue remnants, dentin chips, microorganisms, necrotic tissue, and root canal irrigants (25). It is generally accepted that none of the various techniques and instruments can clean and shape the root canal system without producing some AED (10–24). However, it has been shown that various instrumentation techniques have been associated with different amounts of AED. The importance of AED is that it can potentially generate an acute inflammatory reaction in the periapical tissues after root canal preparation (25). Therefore, one of the parameters to assess the efficacy of an instrumentation technique or instrument is the amount of AED produced during root canal preparation.

Sodium hypochlorite (NaOCl) is the most popular irrigant, and it is used at different concentrations ranging from 0.5%–6%. It is used because of its good tissue-dissolving ability and good antibacterial action (9, 26). Chlorhexidine (CHX) is another irrigant that has the ability to kill various microorganisms, but it has no ability to dissolve pulp tissue (26, 27).

Previous investigations have evaluated the amount of AED by various instruments or techniques (10–24). However, none of them have investigated the effect of various types or concentrations of irrigants on AED. Therefore, the purpose of the present study was to compare the effect of 2 different concentrations of NaOCl (2.5% and 5.25%) and CHX on the amount of AED.

Materials and Methods

In this study 91 freshly extracted human mandibular premolar teeth were used. The inclusion criteria were single-rooted mandibular premolar teeth with 1 root canal and 1 apical foramen, root curvature between 0°–10°, no signs of cracks, internal resorption, external resorption, root caries, root canal calcification, and open apices. To assess internal resorption, root canal calcification, and curvature of the root canals, radiographs (Dentus E-speed, Agfa, Germany) were taken from both buccolingual and mesiodistal directions. The degree of root curvature was calculated from the buccolingual radiographs by using the method of Schneider (28). The teeth were randomly divided into 1 control group (group 1, n = 4) and 3 experimental groups (groups 2–4) with 29 teeth each.

The external tooth surfaces were cleaned to remove debris and soft tissue remnants, and then they were stored in phosphate-buffered saline solution. To have similar tooth lengths, all teeth were measured, and the crowns were ground with a high-speed bur under copious water spray until equal lengths were achieved. Then an access cavity was prepared in each tooth, and all external tooth surfaces were covered with 2 layers of nail polish except for 1 mm around the apical foramen and around the access cavity. The working length of each tooth was determined by inserting a size 15 K-file (Mani, Tochigi, Japan) into the access cavity and observing it under a microscope (Carl Zeiss Surgical GmbH, Oberkochen, Germany) at ×25 magnification to determine when the apical foramen was reached. The working length was then

Basic Research—Technology

set as 1 mm less than the length observed. One Eppendorf tube (Behdad, Tehran, Iran) for each tooth was weighed with a 0.0001 electronic weighing machine (Mettler Instruments, Greifensee-Zurich, Switzerland), 3 consecutive measurements were done, and the mean measurement for each tube was considered to be its weight. If these 3 consecutive measurements showed very different numbers, the process of weighing was continued until 3 similar measurements were obtained that only differed in the last digit by 1–2. The electronic weighing machine was placed in a room without any windows, and the door of the room was carefully closed during weighing of the tubes. Only 2 persons who were seated and had no movement during the process were present in the room.

As controls, 7 empty Eppendorf tubes (group 5) were also weighed at this stage. The teeth were then fixed inside the Eppendorf tubes with self-curing acrylic resin.

A 27-gauge needle was inserted into each Eppendorf tube cover to balance the air pressure between the inside and outside of the tube. The whole apparatus was then placed in a stable stand. The coronal thirds of the root canals were prepared with Gates Glidden no. 2 and 3 burs (Mani), whereas Hero 642 (Micro-Mega, Besançon, France) rotary instruments with Endo IT engine driven motor (VDW, Munich, Germany) were used for the rest of root canal preparation. The apical preparation was finalized with size 30 6% Hero rotary instruments. The sequence of instrumentation was #30 6%, #30 4%, #25 6%, #25 4%, #20 6%, #20 4% in a crown-down manner. The torque and speed of the motor were based on the manufacturer's instructions; these settings automatically appeared on the monitor of the electric motor. Preparation of the teeth in group 1 was performed without using irrigants. In the other experimental groups (groups 2–4), 1 mL of one of the irrigants (group 2: CHX [Chlorhexidina S; FGM, Joinville, SC, Brazil], group 3: 5.25% NaOCl, group 4: 2.5% NaOCl) was used between each file with a one side-port round-end 28-gauge needle (ProRinse Probes R; Dentsply, Tulsa Dental, Tulsa, OK) placed 2 mm shorter than the working length and used with a 2-mm vertical movement range.

On completion of the root canal preparation, the canals were dried with paper points (Ariadent, Tehran, Iran), and the teeth were removed from the Eppendorf tubes. The apical part of each tooth was washed with distilled water to collect any AED that had adhered to the root. All of the tubes were incubated at 37°C for 15 days before being weighed 3 times again. The mean of these measurements was considered to be the new weight of the tubes. The unit of measure was microgram. The differences between the first and the second mean weights were calculated and analyzed by one-way analysis of variance and Tukey honestly significant difference. The level of significance was set at .05.

Results

There were no significant differences between the 3 measurements of the teeth and the empty tubes at each step of the study ($P > .05$). The minimum and maximum amounts of AED in group 1 were 0.1 and 2.5 μg , in group 2 they were 8.2 and 14.2 μg , in group 3 they were 74.1 and 113 μg , and in group 4 they were 9.9 and 34 μg , respectively. The average of AED in each group is shown in Table 1.

TABLE 1. Average of AED in Different Groups

Groups	n	AED (μg)
1 (negative control)		1.2
2		11.2
3		93.6
4		21.9

The teeth in group 1 (first control group) showed no significant change before and after root canal preparation. There was no significant difference between the first and second mean weights of group 1 (canal preparation without irrigant) and group 5 (empty tubes).

The mean weights of the samples in groups 2–4 were significantly greater ($P < .05$) when their before and after root canal preparation measurements were compared. Among these 3 experimental groups, group 3 (5.25% NaOCl) showed significantly greater mean weight ($P < .05$) compared with the other groups, whereas there was no significant difference between the mean weights of groups 2 and 4 (Fig. 1).

Discussion

The present study showed that different root canal irrigants and concentrations of irrigants can produce different amounts of AED with the same root canal preparation technique and instruments.

Laboratory research on the optimal concentration of NaOCl during root canal preparation has shown that a concentration of 5.25% significantly decreased the elastic modulus and the flexural strength of human dentin (29). On the other hand, a survey has shown that many U.S. endodontists use 6% NaOCl (30). In the present study, 2 different concentrations of NaOCl were used because they have different tissue-dissolving ability, and this might influence the amount of AED produced during root canal preparation.

No significant differences were found between weight of the empty Eppendorf tubes before and after the study. This demonstrated that precise measurement was possible with the weighing machine used in the study.

In the present study, the root canals in group 1 were prepared without using an irrigant to determine whether the canal preparation procedure itself resulted in AED. No significant difference was observed before and after root canal preparation in these samples, and this is consistent with the study by Vande Visse and Brilliant (10), who reported no AED when no irrigant was used during root canal preparation. It can be assumed that root canal preparation without using an irrigant might result in some debris accumulation at the apical end of the root canal, and this might form an apical plug. This might be a reason for not having significant AED after instrumentation.

NaOCl is the most frequently used irrigant for root canal preparation (9, 26, 31). There is no general agreement regarding the ideal concentration of NaOCl that should be used in endodontics. It has been reported that 0.5% NaOCl has the same antibacterial activity compared with 5.25%, but its tissue-dissolving ability is less (9, 26, 32). In contrast, one study has reported that only 5.25% NaOCl was able to render root canals free of *Enterococcus faecalis* when

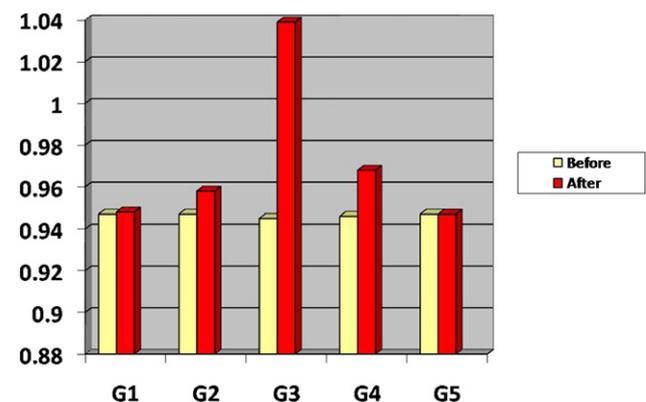


Figure 1. Mean weights of the Eppendorf tubes in each group before and after root canal instrumentation. Unit of measure is microgram.

compared with 1.3% and 2.5% of the same solution (33). Surveys of dentists and endodontists in different countries have shown that in the United States the most popular root canal irrigant was 6% NaOCl for teeth with closed apical foramina (30, 31), whereas in Lithuania 2%–3% NaOCl was the most popular irrigant (34). Hence, in the present study, 2 different concentrations of NaOCl (2.5% and 5.25%) were tested.

Different concentrations of CHX have been used in laboratory investigations (4, 27). A survey in the United States has shown that the most popular concentration of CHX used by endodontists was 2% (31). Therefore, this same concentration of CHX was used in the present study.

The depth of needle tip placement is an important factor in root canal irrigation. It has been recommended to place the needle tip to 2 mm short of the working length or slightly coronal to that point when resistance is encountered before the needle tip reaches the desirable distance (33, 34). Therefore, in the present study the same needle penetration depth was used.

In the present study, the one side-port needles with safe tips were used for 2 reasons. First, an investigation on needle tip design has shown that although open-end needles produced more apical pressure, the risk of NaOCl being injected through the apical foramen might be higher with this type of needle (35). Second, a study has shown that the safe-tip needle with one side-port was significantly more efficient at eliminating bacteria than the safe-tip needle with 2 side-ports and hypodermic needles (36).

It has been shown that the root canal curvature and length can influence the amount of AED (18). Therefore, in the present study only straight root canals (curve between 0°–10°) with similar lengths were used.

Camos et al (37) have reported that 5.25% NaOCl has the ability to penetrate through the root canal foramen when canals were prepared with both patency or without patency techniques. The results of the present study have confirmed that even with just “one time patency” at the time of working length determination, 5.25% NaOCl produced significantly more AED compared with either 2.5% NaOCl or CHX.

The present study was a laboratory investigation, and different results might be achieved with *in vivo* studies or in clinical use. In the present investigation, there was no pulp tissue inside the root canal as well as no periapical tissues that might act as a barrier against AED. However, it has been reported that periapical tissue might act to either reduce or increase the amount of AED (38). Therefore, comparing postoperative pain after the use of various concentrations of NaOCl might be useful to compare AED in the clinical setting. A clinical trial that compared postoperative pain after the use of 2% CHX and 5.25% NaOCl reported that the latter solution was significantly associated with more pain (39).

Clinicians should always decide whether to use a higher concentration of NaOCl with the chance of more AED or a lower concentration of the irrigant that might be less effective against certain types of microorganisms (33). Clinical studies comparing the effect of various concentrations of NaOCl on endodontic outcome, particularly in infected cases, would help clinicians to choose the optimal concentration of the irrigant for root canal preparation.

In conclusion, under the conditions of the present study, the type of irrigant used affects the amount of the AED, and 5.25% NaOCl had the greatest amount of debris.

Acknowledgments

The authors deny any conflicts of interest related to this study.

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Basic Research—Technology

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