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Original Article

Removal efficiency of calcium hydroxide intracanal medicament with RinsEndo system in comparison with passive ultrasonic irrigation, an *in vitro* study

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ABSTRACT

Background: Different techniques have been introduced to improve removing the calcium hydroxide intra-canal dressing. The purpose of this study was to compare the efficiency of passive ultrasonic irrigation (PUI) and RinsEndo system in the removal of calcium hydroxide from root canal system.
Materials and Methods: Access cavities were prepared in 50 single-rooted anterior teeth. Cleaning and shaping were done using the Flexmaster rotary system up to size no. 30, 6%. The canals were filled with injectable calcium hydroxide (calcipex). After 7 days, the calcium hydroxide were retrieved using RinsEndo system in Group 1 (n = 20), with PUI system in Group 2 (n = 20). In positive control group (n = 5), no irrigation was performed. In negative control group (n = 5), root canals were not filled with any medicament. Following the removal of the calcium hydroxide with these two systems, teeth were split buccolingually into two sections and every third of the root canals was evaluated under stereomicroscope (×30) to analyze the residual medicament in each segment. Data were analyzed using the Kruskal-Wallis and Mann-Whitney tests ($P < 0.05$).
Results: There was no significant difference in the removal of calcium hydroxide between RinsEndo and PUI at cervical ($P = 0.67$), middle ($P = 0.51$) and apical ($P = 0.75$) part of the root canals.
Conclusion: None of the irrigation techniques was able to completely remove calcium hydroxide from the root canal system.

Key Words: Calcium hydroxide, irrigation system, passive ultrasonic irrigation, RinsEndo

INTRODUCTION

Calcium hydroxide has been widely accepted as the most frequently used intra-canal medicament owning to its antimicrobial properties,[1] inhibition of osteoclast activities and favorable tissue repair response.[2] All interappointment dressing placed inside the root canal have to be removed before obturating the canals.[3] *In vitro* studies have shown that remnant calcium hydroxide hinder the penetration of sealers into dentinal tubules,[4] hinder the bonding of resin sealer adhesion to the dentin,[5] interact with zinc oxide eugenol sealers,[6] increase the apical leakage of root canal treated teeth.[4] Hence, calcium hydroxide should be removed completely from the root canal system.

The elimination may be obtained by the mechanical action of instruments in reaming motion[7] and the chemical and physical action of irrigants.[6] Several studies have been done to assess the efficacy of various devices or techniques in removal of intra-canal dressing.[5-8] However, conflicting results exist regarding the effectiveness of these techniques in removing the calcium hydroxide.

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Recently, a new technology for root canal irrigation, which produces hydrodynamic activation based on the pressure-suction technology, has been presented to the market, which is called RinsEndo system.[9,10] One study reported an enhanced penetration depth of a dye marked irrigant with RinsEndo into the dentinal tubules of the root canal and a superior efficacy in terms of tissue removal compared with manual irrigation.[11] Vivan *et al*.[9] evaluated the debris removal efficacy of the RinsEndo system and the conventional irrigating method. They determined that the RinsEndo system was more effective than conventional irrigating method.

Methods of measuring residual material have included direct visualization, digital microscopy and scanning electron microscopy (SEM) with or without staining.[12-14]

The purpose of the present study was to compare the amount of calcium hydroxide remaining with the RinsEndo device and passive ultrasonic irrigation (PUI) in the every third of the root canal by stereomicroscope.

MATERIALS AND METHODS

Fifty extracted single-canal anterior teeth with completely formed roots that had been stored in 10% formalin solution were used in the study. After immersion for 48 h in 5.25% sodium hypochlorite (NaOCl), access cavity was prepared in a standardized manner, using diamond burs 114 HL (Dentsply/maillefer, Ballaiguss, Switzerland). Working length was established 1 mm short of the length where the k file (Dentsply/maillefer, Ballaigues, Switzerland) exited the apical foramen. Canals were prepared by preflaring using Gates Glidden burs no. 2-3 (Maillefer, Ballaigues, Switzerland) followed by a crown-down technique with 0.06 rotary file FlexMaster (Tulsa Dentsply, Tulsa, OK, USA) system to a master apical file (MAF) size of no. 30. Between each file, canals were irrigated with 2 ml NaOCl (3%) delivered by a syringe and a 30-gauge needle (NaviTip: Ultra-dent, South Jordan, UT, USA). After preparation, root canals were irrigated with a sequence of 5 ml ethylenediaminetetraacetic acid (17%) and 5 ml NaOCl (3%) and then dried with paper points. Calcipex II (Nippon Shika Yakuhin Co., Ltd., Yamaguchi, Japan) water-based paste calcium hydroxide was injected into the canals and radiographs were taken to ensure that canals were completely filled with calcium hydroxide. For positive control group, five teeth received calcium hydroxide placement but no subsequent removal, to assure that calcium hydroxide was uniformly present throughout the length of the canals and that the amount initially placed was significantly different from any amount remaining after irrigation. For negative control, five teeth did not receive any calcium hydroxide placement to ensure that analysis of clean canals did not yield false positive of remaining debris. Access cavities were sealed temporarily with a cotton pellet and Cavit (ESPE Dental, Seefeld, Germany). The specimens were stored in incubator at 37°C and 100% humidity. After 7 days, the crowns of teeth were separated from roots at cementoenamel junction level using a diamond disc (Bego, Berman, Germany). The remaining samples were randomly divided into two experimental groups of 20 teeth each, according to the irrigation method employed. In 1st group (n = 20), the root canals were irrigated with RinsEndo system (Dürr Dental GmbH and Co KG, Bietig heim-Bissingen, Germany) connected to a 30G needle (Dürr Dental GmbH and Co., KG) supplied with the system. This needle presents a 7-mm opening on the lateral aspect. The technology of this system is based on pressure-suction with hydrodynamic activation. The system presents an opening for insertion of the suction needle during irrigation and suction procedures. In 2nd group (n = 20) PUI was performed with a stainless steel k-type file size 15 (Deutsply/maillefer, Ballaigues, Switzerland) driven by an ultrasonic device (Piezen Master 400) with its power set at the ¼ of the scale.

After irrigation was completed, two slots were prepared in buccal and lingual parts of the roots using diamond disk (Bego, Berman, Germany). The roots were sectioned longitudinally. Segments were divided into 3 thirds: Apical, middle and coronal and each third were individually evaluated under stereomicroscope (MJC IO, Moscow, Russia) (×30 magnification). Remaining calcium hydroxide was measured in apical, middle and coronal part of the root according to calibrated stereomicroscope. The remaining calcium hydroxide was calculated for each 20 experimental group in three segments of the each root (coronal, middle, and apical) by using a four grade scoring system:

0 = the surface was not covered with calcium hydroxide.
1 = 1/3 of the surface was covered with calcium hydroxide.

2 = 2/3 of the surface was covered with calcium hydroxide.
3 = the surface was covered with calcium hydroxide completely.

Data were analyzed using the Kruskal-Wallis and Mann-Whitney tests ($P < 0.05$).

RESULTS

Table 1 show the means values of residual calcium hydroxide remaining after two removal techniques. Positive and negative controls were found to be statistically different from all other remaining debris scores. There was no significant difference between RinsEndo and PUI in the removal of calcium hydroxide from the root canal in cervical ($P = 0.67$), middle ($P = 0.51$), and apical ($P = 0.75$) part of the canal. Calcium hydroxide was not completely removed from any third of canal in both techniques.

DISCUSSION

All intra-canal interappointment dressing should be removed from the root canal walls prior to obturation. It has been reported that residual medicaments interact with the penetration of sealers into dentinal tubules, compromising the microleakage of the obturation. [15] However, calcium hydroxide pastes are not easily removed from the root canal walls. This aim requires new devices with high effectiveness and easy handling for clinical application. Some factors that can influence removing the medicaments from root canal include final apical instrumentation size,[16] the size of the needle used for irrigant delivery,[17] the length of time devoted to irrigation,[18] and the system that is used for canal irrigation.[19] Different irrigation methods have been introduced to improve the irrigation efficacy of calcium hydroxide removal or remaining debris from root canal such as canal brush, ultrasonic, manual technique, rotary instrument, EndoActivator, Endovac, and RinsEndo.[3,8,9,15-19]

Table 1: Mean values±SD of residual calcium hydroxide remaining after two removal techniques

Groups	Root canal parts		
	1/3 apical	1/3 middle	1/3 cervical
Positive control	3±0.02	3±0.6	2.8±0.04
RinsEndo	2.30±0.2	1.4±0.08	0.9±0.08
PUI	2.01±0.32	1.7±0.1	0.5±1.4
Negative control	0.6±0.09	0.2±0.01	0

PUI: Passive ultrasonic irrigation; SD: Standard deviation

Studies showed that the recapitulation of MAF in combination with irrigants removed more calcium hydroxide than irrigants flush alone.[12,15] Another study showed that MAF in combination with irrigants removed more calcium hydroxide than the canal brush system.[18]

Several studies have evaluated the effectiveness of RinsEndo in comparison with ultrasonic and manual irrigation for canal irrigation, smear layer removal, and debris removal.[9,10,13-15] Hauser *et al*.[10] showed that irrigation with RinsEndo resulted in a significantly higher penetration depth of a dye marker into the root canal dentine in comparison with syringe irrigation demonstrating the efficacy of the oscillation in distribution of the irrigant. In addition, McGill *et al*.[14] found that automated-dynamic irrigation with the RinsEndo was significantly more effective in removing a bio-molecular collagen film than static syringe irrigation. Caron *et al*.[13] examined the effect of different irrigant activation protocols on smear layer removal in curved root canals. They compared manual-static and manual-dynamic techniques, a sonic device (EndoActivator; Advanced Endodontics, Santa Barbara, CA, USA) and RinsEndo. For the middle and apical third, smear layer removal was significantly more effective in the activation groups in comparison with manual irrigation without activation. In the apical third, manual-dynamic activation and the EndoActivator showed significantly better smear layer removal than static manual irrigation and RinsEndo.

Rödig *et al*.[15] showed that irrigation with RinsEndo was significantly more effective than manual irrigation. Vivan *et al*.[9] in a SEM analysis compared the efficacy of RinsEndo system and conventional irrigation for debris removal and they found there was no difference in the cleaning ability of the RinsEndo system and conventional irrigation.

In present study, we tried to equalize type, volume and temperature of irrigant solution in all groups (NaOCl 3%, 14°C) to omit any interfering factors. Furthermore, all of the teeth were single rooted without any apical curve and were prepared with a rotary system (Flexmaster to size 30, 0.06 taper) in all groups to unify the effect of size and shape of canal on effectiveness of technique.

Rödig *et al*.[3] compared the effectiveness of RinsEndo and ultrasonic irrigation for removal of calcium hydroxide and Ledermix paste from root canal. They split the teeth longitudinally and prepared a groove

in the apical part of one segment and then all root halves were reassembled. There was no significant differences between RinsEndo and ultrasonic in the removal of calcium hydroxide and Ledermix from root canal. Maalouf *et al*.[16] compared the removal efficiency of calcium hydroxide dressing from the root canal with RinsEndo, ultrasonic and syringe. They found no statistically significant difference among the irrigation techniques in the whole canal, which are in agreement with those of the present study. In Maalouf *et al*. study, when mixed powder was used, RinsEndo and ultrasonics were the most effective in cleaning the apical third of the canal. This difference may be because of the different size of apical preparation and the type of calcium hydroxide used in their study.

CONCLUSION

This study showed no significant difference between RinsEndo and PUI in the removal of calcium hydroxide at any third of the canal. Within the limitation of the study, neither ultrasonic nor RinsEndo system was able to remove calcium hydroxide from the root canal effectively.

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