A cone-beam computed tomography assessment of the efficacy of different irrigation devices for removal of silicone oil-based calcium hydroxide from root canal system

Pradeep Kumar, Ida de Noronha de Ataide, Marina Fernandes, Rajan Lambor
Department of Conservative Dentistry and Endodontics, Goa Dental College and Hospital, Bambolim, Goa, India

Abstract
Background: Most often used intracanal medicament is calcium hydroxide (Ca(OH)\textsubscript{2}). Removal of Ca(OH)\textsubscript{2} before obturation is mandatory. Different irrigation solutions and devices were tested in the previous study for this purpose.

Aim: The aim of this study was to evaluate the comparative efficacy of different irrigation techniques in removing intracanal medicament using cone-beam computed tomography (CBCT).

Materials and Methods: Cleaning and shaping was carried out in 42 freshly extracted single-rooted mandibular first premolars using Protaper Rotary Files. Intracanal medicament (silicone oil-based Ca(OH)\textsubscript{2} paste) was placed and left for 2 weeks in the root canal. Medicament was then removed by five different irrigation techniques: EndoActivator, EndoVac, ultrasonic irrigation with Endo-U-File, F-file, and Max-i-Probe needle. Changes in volume percentage were measured using CBCT and results were statistically analyzed using Levene’s statistics and ANOVA.

Results: Remnants of Ca(OH)\textsubscript{2} were found in all experimental groups. No significant difference was detected among the groups. F-file showed maximum removal efficacy of approximately 48%.

Conclusion: (1) There is no statistically significant difference between any irrigation technique for removal of oil-based Ca(OH)\textsubscript{2}. (2) F-file demonstrated better results among all the other systems.

Keywords: EndoActivator; EndoVac; F-file; cone-beam computed tomography; passive ultrasonic irrigation; silicon-based calcium hydroxide

INTRODUCTION

Calcium hydroxide (Ca(OH)\textsubscript{2}) has been shown to be an effective intracanal medicament during endodontic therapy. Various biological properties have been attributed to this substance, such as antimicrobial activity, high alkalinity, inhibition of tooth resorption, and tissue-dissolving ability\cite{1}. Before root filling, the Ca(OH)\textsubscript{2} medicament that has been applied to the root canal should be removed.

Any Ca(OH)\textsubscript{2} residue on the canal walls negatively affects the quality of the root filling. In vitro studies have shown that remnant Ca(OH)\textsubscript{2} can hinder the penetration of sealers into the dentinal tubules, hinder the bonding of resin sealer adhesion to the dentin, markedly increase the apical leakage of root canal treated teeth, and potentially interact with zinc oxide-eugenol sealers and make them brittle and granular. Thus, complete removal of Ca(OH)\textsubscript{2} from the root canal before obturation becomes mandatory\cite{2,3}.

The removal of Ca(OH)\textsubscript{2} has been investigated using a wide range of products and techniques. The most frequently


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used methods for removal of Ca(OH)$_2$ is master apical file along with copious irrigation, EndoVac system, passive ultrasonic irrigation (PUI), EndoActivator, and F-file. Few studies have mentioned the use of cone-beam computed tomography (CBCT) for measuring the volume of remaining intracanal medicaments after final irrigation.

The purpose of this study was to evaluate the efficacy of different root canal irrigation techniques on the removal of silicone oil-based Ca(OH)$_2$ intracanal medicament using CBCT with a novel method of mounting the samples in a wax rim.

**MATERIALS AND METHODS**

The study was approved by the Ethical Committee of the institution. Fifty single-rooted mandibular premolars extracted for orthodontic treatment were selected. All the teeth with fracture, cracks, or any other defect were excluded. Teeth were stored in a normal saline solution that was changed daily as previously described by Nandini et al.

Samples were radiographically examined for the presence of single canal. The crowns were decoronated at 16 mm from the apex to standardize the length of the roots. The working length was determined by subtracting 1 mm from the length at which a #15 K-file tip extruded apically. The root canals were instrumented using the crown-down technique with Protaper Rotary Files (Dentsply Maillefer, Ballaigues, Switzerland) up to size #40 (F4). During the preparation, the root canal was irrigated with 2 ml of 5.25% NaOCl solution after instrumentation. Final rinse was carried out using 5 ml 17% ethylenediaminetetraacetic acid (EDTA) for 1 min and 5 ml 5.25% NaOCl for 1 min. Canals were dried with paper points (Dentsply Maillefer, Ballaigues, Switzerland). Metapex (Meta Dental Corp. Ltd., Elmburst, NY, USA) was injected into the root canal until the material extruded through the apex. Access cavities were sealed temporarily with cotton pellets and IRM (Dentsply Int., Millford DE, USA). All the samples were coated with nail varnish. The teeth were stored at 37°C and 100% relative humidity for 7 days.

Three U-shaped wax rims were prepared. Fifteen teeth were randomly embedded in each rim in such a way that there was 2 mm of modeling wax all around the teeth to simulate the soft tissue around teeth and increase image contrast. All the teeth were numbered from 1 to 42. In this way, the position of each sample remained constant during pre- and post-retrieval exposure of CBCT.

Preretrieval CBCT imaging [Figure 1a] was done for all the samples in the group, and volume of medicament inside the canal was estimated.

The teeth were grouped on the basis of agitation device used for retrieval of Metapex.

- **Group 1** ($n = 10$): Metapex retrieved with 5 ml of 5.25% NaOCl for 30 s with macrocannula of EndoVac and three cycles of irrigation with microcannula of EndoVac, of which the first cycle was with 5.25% NaOCl, the second cycle with 17% EDTA, and third cycle with 5.25% NaOCl for 30, 60, and 30 s, respectively
- **Group 2** ($n = 10$): Metapex retrieved with 5 ml of 5.25% NaOCl for 30 s with EndoActivator at 10,000 cpm with 30/0.04 tip placed 2 mm short of apex and then 5 ml of 17% EDTA for 60 s with EndoActivator at 10000 cpm with 30/0.04 tip placed 2 mm short of apex and finally 5 ml of 5.25% NaOCl for 30 s agitated with EndoActivator
- **Group 3** ($n = 10$): Metapex retrieved with F-file latched in slow speed handpiece at 700 rpm as in group 2
- **Group 4** ($n = 10$): Metapex retrieved with Ultrasonic Endo-U-File at 110 V F-file as in Group 2
- **Group 5** ($n = 10$): Metapex retrieved with Max-i-Probe needle irrigation as in Group 2.

Postretrieval CBCT imaging [Figure 1b-f] was done for all the samples in group, and volume of medicament inside the canal left was estimated.

**Outcome assessment**

The calculation of Ca(OH)$_2$ volume in each specimen was performed using Planmeca Romexis 3.2.0.8 software (Planmeca, India) by the Bucket tool. Each dataset

![Figure 1: (a) Preirrigation scan of sample. Postirrigation scan after using (b) F-file, (c) EndoActivator, (d) passive ultrasonic irrigation, (e) EndoVac, (f) Max-i-Probe needle](image-url)
was divided into small segments using a uniform grayscale threshold (Romexis software, Planmeca, India) to visualize and quantify the volume of residual Ca(OH)$_2$ material. Volumes of Ca(OH)$_2$ were expressed as cubic mm. The removal efficiency was calculated as:

$$\left(\frac{a - b}{a}\right) \times 100$$

where, $a =$ the volume of material packed in the root canal and $b =$ the volume remaining after retrieval. Statistical analysis was done with SPSS version 20 software (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). Descriptive analysis (mean, standard deviation, standard error) was done. Levene’s statistics were calculated for testing homogeneity of variance. ANOVA was applied to evaluate the statistical difference in all five groups.

RESULTS

There was no significant difference between the groups when tested using ANOVA ($p = 0.247$). The removal efficacy for various groups was 42.9% (Ultrasonic), 35.2% (EndoActivator), 48.2% (F-file), 38.3% (EndoVac), and 22.9% (Max-i-Probe) [Graph 1].

DISCUSSION

Intracanal medicaments have been recommended with the goal of eliminating bacteria from the root canal, prevent bacterial proliferation between appointments, and to act as physiochemical barriers preventing root canal reinfection. It is well established that the residual Ca(OH)$_2$ should be removed because of its influence on bonding and sealing of endodontic sealer. [10-12] Nandini et al. reported in their study that removal of silicone oil-based Ca(OH)$_2$ is difficult as compared to water-based Ca(OH)$_2$ because of lesser penetration of chelating and irrigating solution through the silicone oil layer. [8] Hence, in this study, removal of silicone oil-based Ca(OH)$_2$ efficacy was investigated using different irrigating system. Various studies conducted to analyze the removal of intracanal Ca(OH)$_2$ consisted of digital image analysis of two-dimensional images obtained after longitudinal sectioning to measure the surface area covered with the remaining medicament. [12] Spiral CT has also been used for volumetric analysis of Ca(OH)$_2$. In the current study, volume analysis was done with CBCT. Volume analysis provides accurate results than surface area measurement. Advantages of the CBCT technique are a lower radiation dose, a shorter acquisition time, and reduced costs as compared to spiral CT. [6] The main disadvantage of CBCT is scattered radiation. [7] For more accurate volumetric analysis, CBCT was used with the novel method of mounting the samples in wax rim. Modeling wax was used to simulate the soft tissue around teeth, which was essential for reducing scattered radiation. The thickness of the modeling wax was selected by testing of mounted samples with variable thickness: 1, 2, and 3 mm. It was found that 2 mm thickness was optimal for the elimination of scattered radiation. Samples were mounted in the wax rim in such a way that position and numbering of the sample remain constant during pre- and post-irrigation scan.

The result of the present study revealed that EndoVac, EndoActivator, PUI, and F-file showed a better result than a conventional side-vented needle. This is in accordance with the in vitro study done by Yücel et al., which showed that conventional needle irrigation was not sufficient to remove Ca(OH)$_2$ from the root canal system. [13]

Although in the present study, there was no significant difference found among the groups, F-file has shown superior result among all. One of the possible explanations for better efficacy of F-file is its active engagement of diamond-coated polymer tip with Ca(OH)$_2$ in root canal system. The finding of this study is consistent with the previous studies in relation to PUI, which have shown a better result than other group except F-file. Similar to these findings, several previous studies have shown that Ca(OH)$_2$ medicament removal was superior to PUI compared with conventional syringe irrigation and sonic irrigation. [4,14] The higher velocity of irrigant flow generated by PUI may explain its Ca(OH)$_2$ removal efficiency from root canals. [15] The poor performance shown by EndoVac group in the present study may be attributed to the blockage in microcannula by Ca(OH)$_2$ particles. [16] It could be hypothesized that the removal of the Ca(OH)$_2$ medicament may influence the sucking effect of the microcannula and result in insufficient Ca(OH)$_2$ removal. In the present study, EndoActivator showed a better result than conventional group but inferior to others, which could be because of its low frequency of vibration.

CONCLUSION

Within the limitations of this study, it can be concluded that:
- Ca(OH)$_2$ was not completely removed by any technique
- There is no statistically significant difference between
any irrigation technique for removal of oil-based Ca(OH)$_2$

- F-file demonstrated better results among the technique investigated.

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Conflicts of interest
There are no conflicts of interest.

REFERENCES

1. Calt S, Serper A. Dentinal tubule penetration of root canal sealers after root canal dressing with calcium hydroxide. J Endod 1999;25:431-3.
2. Kim SK, Kim YO. Influence of calcium hydroxide intracanal medication on apical seal. Int Endod J 2002;35:623-8.
3. Margelos J, Eliades G, Verdelis C, Palaghias G. Interaction of calcium hydroxide with zinc oxide-eugenol type sealers: A potential clinical problem. J Endod 1997;23:43-8.
4. Bahcall J, Oslein FK. Clinical introduction of a plastic rotary endodontic finishing file. Endod Prac 2007;10:17-20.
5. Schoeffel GJ. The EndoVac method of endodontic irrigation, part 2 – Efficacy. Dent Today 2008;27:32, 84, 86-7.
6. Mozzo P, Procacci C, Tacconi A, Martini PT, Andreis IA. A new volumetric CT machine for dental imaging based on the cone-beam technique: Preliminary results. Eur Radiol 1998;8:1558-64.
7. Endo M, Tsunoo T, Nakamori N, Yoshida K. Effect of scattered radiation on image noise in cone beam CT. Med Phys 2001;28:469-74.
8. Nandini S, Veimarugan N, Kandaswamy D. Removal efficiency of calcium hydroxide intracanal medicament with two calcium chelators: Volumetric analysis using spiral CT, an in vitro study. J Endod 2006;32:1097-101.
9. Wiseman A, Cox TC, Paranjpe A, Flake NM, Cohenca N, Johnson JD. Efficacy of sonic and ultrasonic activation for removal of calcium hydroxide from mesial canals of mandibular molars: A microtomographic study. J Endod 2011;37:235-8.
10. Tasdemir T, Celik D, Er K, Yildirim T, Ceyhanli KT, Yesilyurt C. Efficacy of several techniques for the removal of calcium hydroxide medicament from root canals. Int Endod J 2011;44:505-9.
11. Gu LS, Kim JR, Ling J, Choi KK, Pashley DH, Tay FR. Review of contemporary irrigant agitation techniques and devices. J Endod 2009;35:791-804.
12. Siqueira JF Jr., de Uzeda M. Influence of different vehicles on the antibacterial effects of calcium hydroxide. J Endod 1998;24:663-5.
13. Yücel AÇ, Gürel M, Güler E, Karabucak B. Comparison of final irrigation techniques in removal of calcium hydroxide. Aust Endod J 2013;39:116-21.
14. Kenne DM, Allemand JG, Johnson JD, Hellstein J, Nichol BK. A quantitative assessment of efficacy of various calcium hydroxide removal techniques. J Endod 2006;32:563-6.
15. Jiang LM, Verhaagen B, Versluis M, van der Sluis LW. Influence of the oscillation direction of an ultrasonic file on the cleaning efficacy of passive ultrasonic irrigation. J Endod 2010;36:1372-6.
16. Nielsen BA, Craig Baumgartner J. Comparison of the EndoVac system to needle irrigation of root canals. J Endod 2007;33:611-5.