Quantitative assessment of the presence of calcium hydroxide remnants associated with different vehicles after removal of intracanal medication

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ABSTRACT

Objective: The aim of this study was to assess, after removal, the presence of calcium hydroxide (CH) remnants associated with different vehicles in the cervical, medial and apical thirds. **Methods:** Forty-five bovine incisors were transversely sectioned at 18 mm from the apex. The canals were biomechanically prepared and received CH. The samples were divided into groups (n = 10): G1, saline solution; G2, CH(bp); G3, polyethylene glycol; G4, polyethylene glycol + CMPC; Negative control, no CH (n = 5). After 7 days, the medication was removed by means of mechanical action of files associated with saline solution irrigation, until the irrigating solution became transparent. The roots were longitudinally sectioned in half. Afterwards, they were photographed and the images were digitalized, allowing the calcium hydroxide remnants to be macroscopically quantified by the Image Tool® software. **Results:** The statistic results reveal that all roots presented remnants from the medication within the canals. Saline solution presented a lower amount of remnants, however, it showed a higher concentration in the apical third.

Keywords: Endodontics. Calcium hydroxide. Residue removal.

How to cite this article: Alves-Balvedi RP, Manna FF, Biffi JCG. Quantitative assessment of the presence of calcium hydroxide remnants associated with different vehicles after removal of intracanal medication. Dental Press Endod. 2013 May-Aug;3(2):30-4.

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» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

Received: May 3, 2013. Accepted: August 23, 2013.

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Introduction

Cleaning and disinfection of the root canal system are among the principles that guide endodontic therapy. These requirements are essential to achieve the desired sanitization and provide conditions for the damaged tissues to return to normality.[1] Most endodontic infections show a predominance of restricted anaerobic bacteria. In these cases, there is a long-term pulp infection that promotes bacterial spread to the entire root canal system, including isthmus, branches, holes and tubules. In these regions, bacteria are protected from the effects of biomechanical preparation. Thus, the use of intracanal medication during preparation of the root canal is necessary to control endodontic infections and for periapical repair in case of *E. faecalis* infection.[2] Intracanal calcium hydroxide (CH) has been the most widely used medication.[3,4] CH is known for its antimicrobial action and ability to stimulate mineralization.[5] For these reasons, this material is commonly used in pulpotomies[6] and as an intracanal medication.[7]

The CH mixed with an appropriate vehicle and left in the root canal for several days or weeks has been widely accepted in endodontic therapy.[8,9] It can be associated with different vehicles, with different characteristics: I) Soluble-aqueous (distilled water, saline solution and chlorhexidine); II) Soluble nonaqueous (propylene glycol and polyethylene glycol) and III) Insoluble in water (camphorated paramonochlorophenol).[10] CH can be combined with other medications, such as camphor paramonochlorophenol (CMPC),[11] in order to supplement or enhance its antibacterial properties. Saline vehicles,[12] polyethylene glycol and olive oil[13] are also used to influence the CH action as well as its ionic dissociation and diffusion. On the other hand, according to Estrela and Holland,[14] associating aqueous vehicles with CH provides the best biological and antimicrobial action, allowing higher rates of dissociation and diffusion.

Nevertheless, the use of CH is questioned when its residues are taken into account. Evaluation of apical infiltration after root canal obturation are focused by other studies. Some authors claim that the residue of $Ca(OH)_2$ hinders the penetration of cement in the tubules[15] and changes the characteristics of zinc oxide-eugenol cements, causing their consistency to become brittler and more granular.[16] These residues may also increase apical leakage after obturation.[17]

Methylene blue stain tests have evaluated the sealing ability of CH. However, with the recent discovery that the CH discolored methylene blue, which results in a misinterpretation of results, it was concluded that this technique could not be used alone.[18]

Researches investigating the effects of two formulations of CH on its sealing ability by means of adding other references such as India ink or radionuclide to it, revealed that CH does not increase its sealing ability in root apex with filling.

Other researches evaluated whether intracanal medication would act to prevent penetration of bacteria inside the canal. They concluded that these medications do not provide adequate protection against bacterial infiltration by interfering in the sealing ability of cements.[16-19]

Thus, the aim of this study was to analyze the calcium hydroxide removal capacity when associated with different vehicles, by means of the filing technique and irrigation.

Material and Methods

Forty five single-rooted lower bovine incisors of adult animals, with anatomic diameter compatible with K-files #35/40 (anatomical diameter) and stored in 10% formalin were used. The crown portion was perpendicularly removed (along the axis of the tooth) with steel disc (KG Sorensen, São Paulo, Brazil) under constant cooling in water, resulting in a backlog of 18 mm from the apical portion of each root.

The step back instrumentation technique was performed, starting with K-files #35/40 (Dentsply Maillefer, Tulsa, Oklahoma, USA) in the real working length (RWL) of 17 mm, with 1 mm being respected in the apical foramen, and finishing with K-files #50/55 (Dentsply Maillefer, Tulsa, Oklahoma, USA) at the same length, which determined the diameter of the canal surgery. 5 ml of 1% sodium hypochlorite (Biodynamic Ibiporã, PR, Brazil) was applied at each change of file. A disposable syringe and a 0.55 x 20 mm needle (BD, Curitiba, PR, Brazil)were used and final irrigation was done with saline solution (ADV, Nova Odessa, SP, Brazil).

After biomechanical preparation, the canals were dried with absorbent paper cones (Tanari, Brazil) of

which diameter was compatible with the last instrument, and divided into four groups:

- » Group 1 (n = 10): CH + saline solution (ADV, Nova Odessa, SP, Brazil).
- » Group 2 (n = 10): CH + BP (Biodinâmica, PR, Brazil).
- » Group 3 (n = 10): CH + polyethylene glycol (Calen, SS White, RJ, Brazil).
- » Group 4 (n = 10): CH + polyethylene glycol + camphor paramonoclorofenol (Calen + CMPC, SS White, RJ, Brazil).
- » Negative control (n = 5) without CH.

In group 1, the medication was conditioned with a Centrix syringe, apically to the cervical direction, assuring that it was placed all over the length of the canal. In group 2, a curettage instrument was used and the material was condensed with paper cones. In groups 3 and 4, the canals were filled with medication by means of a ML endodontic syringe (SS White, RJ, Brazil). The canals were sealed in the cervical portion with intermediate restorative material (IRM) (Dentsply, Catanduva, SP, Brazil) and stored at 37°C in 100% relative humidity for seven days. A spoon excavator was used to remove the IRM from the canal entrance. Calcium hydroxide removal began with saline solution irrigation and movement of the K-file #45 (Dentsply Maillefer) in the CRT, without touching the walls, until CH was absent in the irrigating solution.

Then, longitudinal grooves limited to the dentin were made with double-sided steel disks (KG Sorensen), using a chisel and a hammer to prevent dentine pieces from being thrown into the canal, promoting total cleavage, which was followed by photographic documentation (Fig 1A).

Assessment of medication residues in different types of vehicles was carried out by digitized photographic images. To match the working length, the tooth canal guides were divided into three parts: apical, medial and cervical (Fig 1B). The software Image Tool 3.00 (The University of Texas Health Science Center at San Antonio, USA) was used to quantify the CH present in each third of the canal (Fig 1C).

Results

To verify whether or not statistically significant differences were identified among the proportions (quantification/perimeter) found in the cervical, medial and apical thirds, the Kruskal-Wallis relative values were applied to the four subgroups tested. Differences were statistically significant between the CH + saline solution proportion, when the values obtained in the three groups were compared (Table 1).

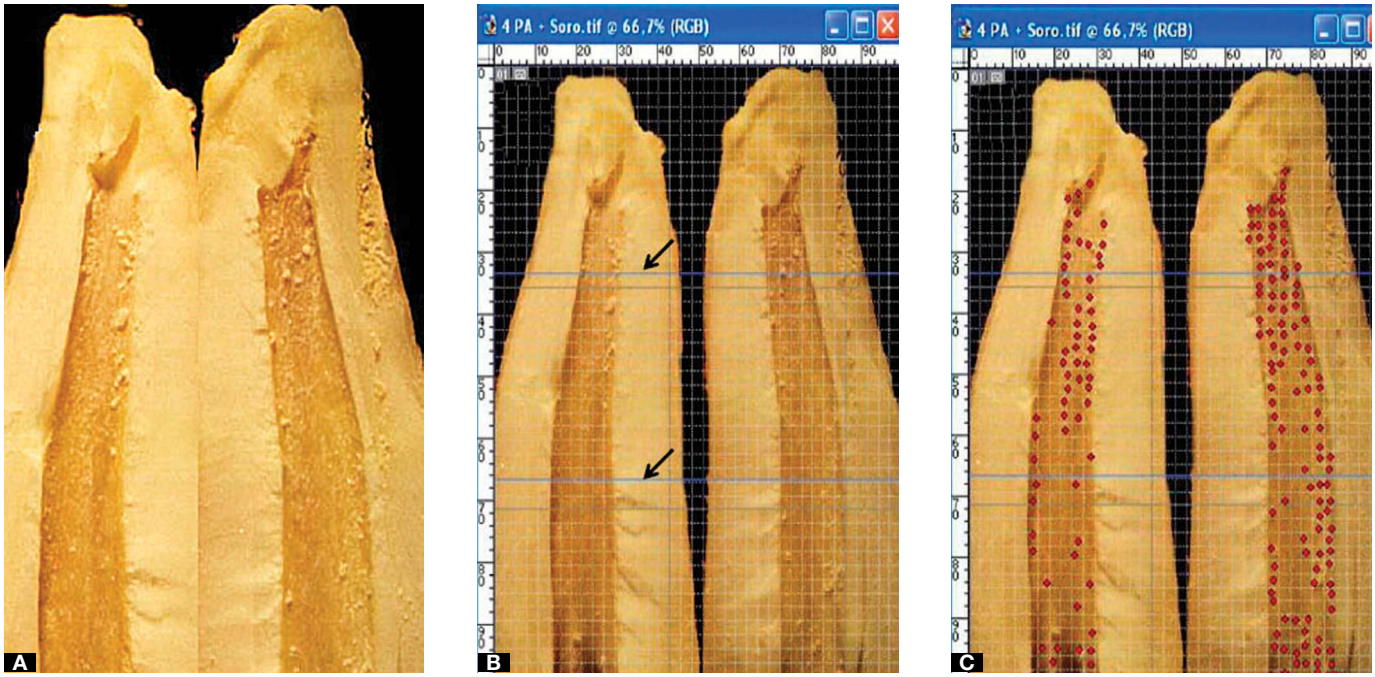

Figure 1. A) Longitudinal root section. **B**) Apical, medial and cervical thirds definition. **C**) Quantification of CH residues.

Afterwards, the Mann-Whitney U test was applied to the series of values of which pairs were compared considering the results obtained with each one of the four subgroups. The results showed that differences were statistically significant among the three comparisons made with CH+saline solution. The highest values were obtained from the apical third while the lowest values were obtained from the cervical third. As for the polyethylene glycol + camphorated paramonochlorophenol, the differences were statistically significant in the comparison between the cervical and the apical third, with the highest values obtained from the apical third (Table 2).

Table 1. Probability obtained among the proportions (quantification / perimeter) found in the cervical, medial and apical thirds.

Variables	Results
Calcium hydroxide (Saline solution)	0.001*
Calcium hydroxide (BP)	0.486
Calcium hydroxide (Calen)	0.238
Calcium hydroxide (Calen + CMPC)	0.112

* $p < 0.05$.

Table 2. Probability obtained from comparison between pairs, considering the results obtained from each one of the four subgroups.

Variables	Results
Calcium hydroxide (Saline solution)	
Medial third x cervical third	0.008 *
Cervical third x apical third	0.003 *
Medial third x apical third	0.034 *
Calcium hydroxide (BP)	
Medial third x cervical third	0.151
Cervical third x apical third	0.650
Medial third x apical third	0.821
Calcium hydroxide (Calen)	
Medial x cervical third	0.940
Cervical third x apical third	0.131
Medial third x apical third	0.162
Calcium hydroxide (Calen + CMPC)	
Medial third x cervical third	0.364
Cervical third x apical third	0.045 *
Medial third x apical third	0.199

* $p < 0.05$.

Discussion

Calcium hydroxide can be combined with other vehicles such as canfor paramonochlorophenol,[7] saline solution,[8] polyethylene glycol and olive oil,[9] when it aims at complementing or potentizing its action. However, it is known that the vehicle used can influence the CH ability to act as well as its ionic dissociation and diffusion. In addition, it is known that its association with aqueous vehicles provides better biological and antimicrobial action, allowing higher rates of dissociation and diffusion.[14]

Thus, in this research, undissolved pure calcium hydroxide powder (BP) was used in association with the following vehicles: saline solution (soluble in water), polyethylene glycol (soluble in water) and CMPC (oily, insoluble in water). All canals were adequately instrumented and filled by a single operator who is a specialist in Endodontics with technical expertise. Therefore, the present work does not refer to the efficiency of properties, but it aims at raising questions about which vehicle is the best when associated with calcium hydroxide, presenting the best and most efficient technique for removal of intracanal medication.

Studies assessing the cleaning capability for the removal of the medication reported differences in the techniques of evaluation and quantification. Demineralization techniques (clearing) or scanning electron microscopy (SEM) are common in this type of assessment. Based on a literature review, Maníglia et al.[20] considered the possibility of this type of assessment only on the macroscopic aspect, since it is less expensive and more easily accessible. These aspects were assessed and proved to be essential for the development of our work.

In this research, after an attempt to remove the calcium hydroxide associated with different vehicles in different test groups, we found that its effectiveness is not complete, as it still leaves a considerable amount of residue to the fullest extent of the canal after removal was carried out. Irrigation is an important factor for any endodontic procedure. Its participation is essential because cleanness happens only when the CH is associated with an irrigating solution. Thus, irrigation with saline solution was constant and controlled.

When looking at the roots immediately after the section (with the naked eye), the medication was not visible, however, after 5 minutes, the residues could be seen

due to dehydration of the canal walls in contact with air. The scanned photographs were used to standardize the quantification of these residues in each area represented by the cervical, middle and apical root.

Therefore, once calcium hydroxide, when used as intracanal medication, remains even after multiple removal techniques, new studies should suggest that other techniques for removal of calcium hydroxide and vehicles that facilitate removal of residues remaining in the canal be developed. It remains questionable whether the relevant literature corroborates the claim that these remnants have consequences for the quality of the canal in the event of leakage.[21-24]

Conclusion

All teeth presented residues of calcium hydroxide in the canal walls after medication was removed. According to statistical analysis, significant differences were found in relation to root thirds when the vehicle used was saline solution and Calen + CMPC. The highest values were obtained from the apical third while the lowest values were obtained from the cervical third. Thus, new removal techniques should be studied to improve the removal of these materials without compromising the biomechanical preparation.

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