Analysis of the effectiveness of calcium hydroxide removal with variation of technique and solvent vehicles

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ABSTRACT

Context: Calcium hydroxide (Ca(OH)₂) paste filling is largely used as intra-canal medication and can be combined with different vehicles. Removal of that paste should be preceded by obturation, to avoid the occurrence of apical microleakage.

Aims: To evaluate the efficiency of removal of pulp Ca(OH)₂, from using different vehicles (water, propylene glycol) and removal techniques (mechanical and ultrasonic).

Study Design: Twenty-four premolars and four human incisors were prepared with step-back technique and divided into six groups according to the removal techniques and vehicles used: Group distilled water/mechanical removal, Group distilled water/ultrasonic removal, Group propylene/mechanical removal, Group propylene/ultrasonic removal, negative control group, and positive control group. The differences between groups were analyzed.

Materials and Methods: The teeth were prepared by step-back technique. The samples were evaluated by stereomicroscopy, using a scoring system for the evaluation of residues in the canal.

Statistical Analysis: Mann–Whitney test was used to a comparison between groups with the same vehicle. For comparison between groups, regardless of the vehicle, we used the Kruskal–Wallis test, considering P < 0.05 for both tests.

Results: Groups using distilled water or propylene glycol did not show statistically significant results. When the groups were compared, differences were detected between groups distilled water/propylene and mechanical removal/removal ultrasonic, with the first featuring superior performance.

Conclusion: None of the removal techniques employed in this study was able to completely remove Ca(OH)₂ from the root canal. However, the use of distilled water as a vehicle and ultrasonic removal presented the best performance.

Key words: Calcium hydroxide, endodontics, root canal therapy
MATERIALS AND METHODS

This study was submitted and approved by Ethics Committee on Human Research of the Institute of Health Sciences, Federal University of Pará by number 344 253.

Twenty-eight human permanent tooth were used 24 lower premolars and 4 upper incisors. The teeth were obtained of patients with extraction indication due to orthodontic indications or periodontal disease attended at School of Dentistry of Federal University of Pará, Belem, Brazil. The patients have been clarified about research objectives and signed a Free Informed Term of Consent and Biological Material Donation Term. The criteria of teeth selection were: One root, one canal, no pulpal calcifications, no internal and external resorption, as well as no root caries. The incisors were used as a control group: Two for negative and two for the positive control group.

The crowns of the teeth were sectioned transversely with carborundum disc in the cement-enamel junction. The canals were prepared by step-back technique. The memory instrument was a size 40 K-file (Maillefer Instruments SA, Dentsply Ind. Com. Ltda., Petrópolis, Brazil). After each instrument, irrigation was performed with 5 ml of 1% NaOCl (Fortsan of Brazil Ind. Chemicals and Pharmaceuticals Ltd., Eusebius, Brazil). At the end, the canal was flushed with 17% ethylenediaminetetraacetic acid (EDTA) (Pharmapele, Pharmacy Manipulation Ltda., Belém, Brazil).

Subsequently, we performed a longitudinal beading with a carborundum disc in the buccal. Lingual teeth in all were made to cleave, and an analysis of the results was conducted after the removal of medication.

The teeth were divided into six different groups depending on the type of removal technique and vehicle used. The paste was inserted with a lentulo until the medication was seen at the apex of the extruded tooth. The roots were then sealed with a cotton ball and stored in a greenhouse for seven days with an average temperature of 37°C and relative humidity of 100%.

Group distilled water/mechanical removal (G1) (n = 6) - The canals were filled with Ca(OH)₂ paste associated (PA) (Biodynamic Chemicals and Pharmaceuticals Ltd., Ibitorã, PR, Brazil) and distilled water (1 g/1.5 ml), and were removed by irrigation using 5 ml of 1% NaOCl; sharpening device with memory and irrigation for 1 min by using 5 ml of 1% NaOCl with cannula. The canals were filled with Ca(OH)₂ paste and distilled water. The stereomicroscope representing negative and positive control is shown in Figure 1.

After the process of Ca(OH)₂ removal, cleavage was carried out with a scalpel blade. The sample images were obtained using a stereomicroscope (Medilux, MDL-DS4-BI, Biosystems, Curitiba, PR, Brazil). Samples were analyzed with a ×5 magnification, being evaluated throughout the root canal.

A scoring system adopted by Lambrianidis et al. was used to assess the amount of waste to the canal walls. Score 1: No visible remains of Ca(OH)₂, equal to the negative control group; Score 2: Remnants of Ca(OH)₂ dispersed in small quantities on the walls of the canal; Score 3: Masses of Ca(OH)₂ in different areas, moderate waste; Score 4: Dense masses across the canal, equal to the positive control group.

After tabulating the data and descriptive statistics of each group, they were submitted for the Kolmogorov–Smirnov normality test to confirm the nonparametric analysis.

Group propylene/mechanical removal (G3) (n = 6) - The canals were filled with Ca(OH)₂, PA and propylene glycol (Formula and Action, Pharmacy Manipulation Ltda., SP, Brazil) in the proportion of 1 g/2 ml. Removal was done using the same steps as in group distilled water/mechanical removal.

Group propylene/ultrasonic removal (G4) (n = 6) - The canals were filled with Ca(OH)₂, PA and propylene glycol in the proportion of 1 g/2 ml. Removal was done using the same steps as in group distilled water/ultrasonic removal.

Negative control (G5) (n = 2) - Two central incisors were used. Canals of this group were prepared similarly to other groups, but without being filled with the paste of Ca(OH)₂.

Positive control (G6) (n = 2) - Two central incisors were used. Canals of this group were prepared similarly to other groups by being filled with the paste of Ca(OH)₂; however, without removal. The teeth were filled with Ca(OH)₂ and distilled water. The stereomicroscope representing negative and positive control is shown in Figure 1.

Figure 1: Stereomicroscope is representing the negative and positive control. (a) G5, (b) G6
Mann–Whitney test was then used to compare between groups with the same vehicle, considering $P < 0.05$. To compare between groups, regardless of the vehicle used, the Kruskal–Wallis test was performed, considering $P < 0.05$. The results of the comparisons are represented by graphs. All analyses were performed in GraphPad Prism 5.0 software (San Diego, USA).

RESULTS

Analysis of the effectiveness of removing Ca(OH)$_2$ aird distilled water showed no statistical difference among the groups ($P = 0.2063$). Mechanical removal had a higher median (2.5, +3, −1) compared to the group with ultrasonic removal (2, +2, −1). However, we note a lower variability in the data obtained in the second group. The data are shown graphically in Figure 2.

The analysis of the effectiveness of removal of Ca(OH)$_2$ paste served to propylene glycol did not reveal significant differences between groups. Mechanical removal had a higher median (3, +3, −2) compared to the group with ultrasonic removal (2, +3, −2). The data are shown in Figure 3.

The analysis of the effectiveness of removal of Ca(OH)$_2$ paste independent of the vehicle showed the statistical difference ($P = 0.0459$) when compared with the G2 and G3. The other comparisons were not statistically significant. The data are shown in Figure 4 stereomicroscopy. The most representative of each group are shown in Figure 5.

DISCUSSION

The results of this study indicate that there were no statistically significant differences between groups, when same vehicle were compared, regardless of the removal technique. However, when done the inter-group analysis, distilled water/removal ultrasonic group (G2) showed greater efficiency in the removal of Ca(OH)$_2$ paste compared to propylene/removal mechanics group (G3).

To a satisfactory endodontic treatment, it is essential that there be a reduction or elimination of microorganisms in the root canal. Thus, the steps concerning the chemical and mechanical preparation of the canal consist of the most important steps which will lead to success or failure endodontic treatment. However, even after surgical treatment (instrumentation), the bacteria can persist within the root canal system, without the use of intra-canal medication between sessions.$^{[7,8]}$

As intra-canal medication in endodontic treatment, Ca(OH)$_2$ - an odorless, dry powder, when used alone, unwieldy - is associated, to improve its insertion into the canal, with different substances and vehicles, such as distilled water, physiological saline, propylene glycol, polietilenglicol, anesthetics, and glycerin.$^{[9]}$ New associations with chlorhexidine and antibiotics such as metronidazole and ciprofloxacin, potentiate the antimicrobial effect of the medication.$^{[8,10-12]}$

The vehicle plays an important function in the disinfection process, since it determines the speed of ionic dissociation, allowing the absorption of the paste of Ca(OH)$_2$ by the root canal and the periapical tissue.$^{[13]}$ Aqueous carriers, distilled water, are water-soluble and possess release of hydroxyl ions faster, being applied in cases of excessive exudate; while the viscous vehicle, propylene glycol, has a slower release of hydroxyl ions and is applied, for example in cases of apexification.$^{[9,13]}$

The bactericidal action of Ca(OH)$_2$ results from the effect of its hydroxyl ions. The effectiveness of this material is directly tied to the availability of such ions in the solution obtained between the carrier used and the Ca(OH)$_2$. In this

![Figure 2: Variation in scores of G1 group (left) and G2 group (right) groups expressed as median and interquartile range](image1)

![Figure 3: Variation in scores of G3 group (left) and G4 group (right) groups expressed as median and interquartile range](image2)
context, some publications suggest that remnants of Ca(OH)₂ after shutter promote sanitation channel long-term. In contrast, studies have shown that the retention of Ca(OH)₂ in the dentinal wall can impair the sealer penetration into dentinal tubules and change the characteristics of the cements based on zinc oxide and eugenol, becoming brittle and granular consistency.

The big challenge in evaluating the effectiveness of the removal of the Ca(OH)₂ paste from the root canal interior is the delineation of conclusive and reproducible experimental methodologies, especially for a proper analysis of the observed results. Methodologies has been employed for this assessment: Scanning electron microscopy - which, by requiring the metallization of the samples, may lead to the occurrence of cracks in the same - and digital photos.

Different techniques are used in intra-canal evaluations, as scanning electronic microscope (SEM) or analysis of color permeability in stereomicroscopy mensurations. Besides this, stereomicroscopy has been currently used and represents a valid method to evaluate the effectiveness of the removal or filling intra‐canal substances.

In turn, the stereomicroscopy methodology employed in this study presents some advantages, such as the analysis of the root canal in its entire length, without damaging the samples, ease to reproduce and analyze, and the currently use in similar studies.

The results of the groups using ultrasound for removal of Ca(OH)₂ had lower median than the groups in which mechanical removal were performed. Although the comparison between the groups was not statistically significant, the median and frequency indicate that the use of ultrasound leads to the occurrence of residues in the shortest amount of Ca(OH)₂ in the root canal pulp. Similar studies showed likewise more effective cleaning when using ultrasound.

The use of sodium hypochlorite with different mechanical means of removal, including the use of the K-type file, has already been reported, but without statistically significant differences between groups. Our results show that groups using mechanical removal, regardless of the vehicle associated with Ca(OH)₂, associated with vehicle did not differ each other, obtaining similar performance. However, G1 group showed greater variability in their results than the G3 group. Previous studies have reported the use of ultrasound provides the best results in the removal of calcium from inside the canal. Furthermore, Nandini et al. showed that use of oily substances, as propylene glycol, associated with Ca(OH)₂, have higher tensile strength when compared to aqueous vehicles, like distilled water. Thus, when analyzing the four groups, a statistically significant difference was detected in the group that the association of calcium with distilled water vehicle more fluid with ultrasonic removal, compared to (G3) group was performed with the first group exhibited lower scores on values established in this investigation.

The results showed that none of the techniques completely removed the folder from the root canal Ca(OH)₂. Among the comparisons, combining vehicle and technique, the paste of calcium with distilled water and ultrasonic removal hydroxide showed the best performance.

CONCLUSION

At the end, two practical considerations can be presented. None of the techniques used were able to completely
eliminate \(\text{Ca(OH)}_2\) paste. The use of a more fluid vehicle, distilled water, associated with \(\text{Ca(OH)}_2\) and a more aggressive technique for removing the paste, the ultrasound, showed better results compared with the group using propylene glycol as vehicle and mechanical removal, not differing from the other groups analyzed.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**REFERENCES**