EFFECT OF EDTA IN THE CALCIUM HYDROXIDE PASTE DIFFUSION THROUGH ROOT DENTIN

Efeito do EDTA na difusão da pasta de hidróxido de cálcio através da dentina radicular

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Abstract

OBJECTIVES: The aim of the present study was to evaluate *in vitro* the influence of EDTA on calcium hydroxide paste diffusion through root dentin. **MATERIAL AND METHODS**: Twenty extracted molars were chosen and had their root canals instrumented and irrigated with sodium hypochlorite 1%. The teeth were randomly divided into two groups. In Group I final irrigation was performed with 17% EDTA in order to remove the smear layer. In Group II the smear layer was not removed. After preparation, calcium hydroxide paste was placed inside the root canals and sealed. After that, each tooth was fixed to an endodontic file and placed inside a flask containing distilled water. The pH value was measured with a manual pH measure for 1, 7, 14, 21, and 28 days. **RESULTS**: The study has not detected any significant statistical difference between the test groups as to pH values. However, both groups presented an increase in pH values during the observation period. **CONCLUSION**: The use of 17% EDTA was not relevant to the alkalinized aspect of the external dentine.

Keywords: Calcium hydroxide; EDTA; Endodontics.

Resumo

OBJETIVOS*: Os objetivos do presente estudo foram avaliar in vitro a influência do EDTA na difusão da pasta de hidróxido de cálcio através da dentina radicular.* ***MATERIAL E MÉTODO****: Vinte molares extraídos foram escolhidos, seus condutos radiculares foram instrumentados e irrigados com hipoclorito de Na a 1%. Os dentes foram separados aleatoriamente em dois grupos. No Grupo I, a irrigação final foi executada com EDTA a 17% com a finalidade de remover a smear layer. No Grupo II, a smear layer não foi removida. Após preparo, pasta de hidróxido de Ca foi colocada no interior dos condutos, que foram selados. Em seguida, cada dente foi fixado a uma lima endodôntica e colocado dentro de um frasco contendo água destilada. O pH foi mensurado com um instrumento de medição manual aos 1, 7, 14, 21 e 28 dias.* ***RESULTADOS****: O estudo não detectou quaisquer diferenças estatísticas entre os grupos de testes, com relação aos valores de pH. Entretanto, ambos os grupos apresentaram um aumento de pH durante o período de observação.* ***CONCLUSÃO****: O uso de EDTA a 17% não foi fator relevante na alcalinização da dentina externa.*

Palavras-chave*: Hidróxido de cálcio; Endodontia; EDTA.*

INTRODUCTION

The use of calcium hydroxide pastes as an intracanal medication is now well established in Endodontics, due to their acknowledged antimicrobial and biological properties. Given that they facilitate the repair process of periapical tissues, calcium hydroxide pastes may well account for successful endodontic treatments (1, 2, 3, 4).

The successful use of calcium hydroxide as medication can be traced to its ionic effect, caused by its chemical dissociation into calcium and hydroxile ions, both of which will act on tissues and bacteria. Hydroxile ions tend to diffuse across dentin, increasing the medium pH to values that could turn out to be as high as 12.6. On the one hand, the biological property of the medication is the result of alkaline phosphatase being activated by this pH increase. This enzyme is inductive of a reaction (between phosphate ions and calcium ions) which forms precipitates of calcium phosphate (hydroxiapatite), characteristic of the mineralization process. On the other hand, the antimicrobial property of calcium hydroxide pastes is related to a loss of integrity of the cytoplasmatic membrane of the bacteria, given that the bacterial enzymes are made inactive and the DNA of the microorganisms is damaged. This is caused by the dissociation of the hydroxile ions – allowing for an ideal pH to be reached which causes bacteria and endotoxins to be neutralized (5, 6, 7).

Dentinal permeability is of paramount importance for the effectiveness of calcium hydroxide pastes. Permeability will grant the diffusion of the intracanal medication through the dentinal tubules, therefore granting the alkalinization of the root canal system, of the root dentin, and of the parendodontic tissues. Accordingly, authors such as Galvan, et al. (8) have asserted that procedures aiming at increasing dentin permeability could increase the diffusion of substances in the deeper portions of the dentinal mass.

It is current knowledge today that using ethylenediaminetetraacetic acid (EDTA) to remove the smear layer has proved effective in increasing dentinal permeability (9, 10, 11). On the other hand, some aspects have been recently disputed that were usually taken for granted to be advantageous in using this substance in the endodontic treatment, such as a better obturation of the lateral canals and a decrease in bacterial infiltration (12, 13). The present study aims at assessing *in vitro* to what degree using EDTA at 17% will influence the diffusion of calcium hydroxide through the root dentin.

MATERIALS AND METHOD

Twenty human inferior molars were selected for the present study, which had been extracted for various reasons. Teeth available for the experiment were radiographed so that those presenting calcifications, internal reabsorptions, or previous endodontic treatment would not comprise the sample. The selected teeth were conditioned in distilled water in flasks numbered 1 through 20.

The crown portion of each tooth was removed by means of a carborundum disc adapted to the straight piece of a micromotor, thus preventing any relevant variations among the sample teeth during the stages of access to the root canals, instrumentation, and application of intracanal medication.

During the chemical-mechanical preparation, the roots were fixed to support and facilitate instrumentation. The teeth were instrumented using step back technique, when use was made of endodontic files K-Flex (Moyco Union Broach, New York), and the teeth were irrigated with 1.8 ml of sodium hypochlorite at 1% (Farmácia Fitonfarma, Porto Alegre, Brazil) at each change of instruments. The length of the root canal work was achieved by introducing an endodontic file inside the canal down to the apical foramen exit, then retrieving 1 mm from this limit.

The sample was randomly divided into two groups of 10 teeth each. In Group I, after instrumentation of the canals, a trisodic EDTA solution at 17% (Farmácia Fitonfarma, Porto Alegre, Brazil) was used for 3 minutes, during which time the irrigating liquid was agitated by means of an endodontic instrument. This solution was used in order to remove the smear layer. In Group II, the other ten teeth were instrumented in the same way, but no EDTA was used.

In Groups I and II, the canals were dryed up with absorbent paper points (Dentsply Indústria e Comércio Ltda., Petrópolis, RJ, Brazil) and filled with calcium hydroxide paste. The paste was prepared with calcium hydroxide pro analysis (Farmácia Fitonfarma, Porto Alegre, Brazil) and distilled water. Once the canals were filled, a procedure done with endodontic files and Lentulo bur, the teeth were sealed on their cervical portion with temporary restorative material IRM (Dentsplay Indústria e Comércio Ltda., Petrópolis, RJ, Brazil), and on their apical portion (exit area through the apical foramen) with Super Bond Cyanocrylate (Loctite Química Ltda., São Paulo, Brazil) and nail enamel.

The sample teeth were conditioned in distilled water in glass flasks sealed with plastic caps. A small hole was opened in the center of each cap, so that an endodontic file could be inserted in the flask. The sample teeth could then be fixated on the files with cyanocrylate, leaving the more apical portion of the roots immersed in 10 ml of distilled water, while their more cervical portion could be kept completely out of the water.

The pH value of the liquid was measured after periods of 1, 7, 14, 21, and 28 days. The pH measuring device was a microprocessor MB10 Model. The changes in the liquid's alkalinity proved the diffusion of hydroxile ions from the calcium hydroxide through the dentin.

The results were statistically evaluated with the application of the variance analysis (ANOVA) test, with a significance level of 5%.

RESULTS

The results of the present study showed an increase in pH values for both Groups I and II during the experimental periods. No statistically significant differences were found between Groups I and II (Table 1).

TABLE 1 - Means and pH as verified during the experiments (1, 7, 14, 21 and 28 days for Groups I e II, respectively)

	Group I			Group II		
	pH	SD	N	pH	SD	N
	Mean			Mean		
Day 1	9.55	0.35	10	9.38	0.69	10
Day 7	9.93	0.57	10	10.33	0.55	10
Day 14	10.22	0.84	10	10.75	0.71	10
Day 21	11.27	0.65	10	11.51	0.56	10
Day 28	10.78	0.80	10	11.01	0.52	10

DISCUSSION

The results of the present study corroborate the properties of the calcium hydroxide as a substance that increases pH external to the dentinal mass, and is in accordance with studies by authors such as Esberard, Carnes and Del Rio (14). This kind of data explains the success of experimental endodontic works *in vivo* that emphasize the importance of repair work carried out after endodontic treatment in cases where calcium hydroxide paste was used as an intracanal medication – when compared to the results one gets from one-session-only treatments (3, 4).

The data which refer to the diffusing property of the calcium hydroxide paste corroborate that the biological and antimicrobial characteristics of this medication can act on areas that are out of reach from the disinfection procedure as carried out during the chemical-mechanical preparation – such as more external portions of the dentinal mass, ramifications of the principal canal, and areas of external reabsorption – thus contributing to the success of the treatment. This is in accordance with Tronstad et al. (15), when they suggest the application of calcium hydroxide inside the root canal facilitates the success of endodontic treatments in cases of external reabsorption because it not only inhibits osteoclastic activity but also stimulates the self-repairing process of tissues.

As for calcium hidroxide pastes as alkalinizing agents, one has the choice of vehicle as a determining factor. In the present study, an aqueous vehicle was chosen, which proved capable of promoting a quick ionic dissociation, which means that pH increase could be observed at all experimental times (since day 1, and then every week for four weeks). This is in accordance with the study by Pérez, Franchi and Péli (16), who consider distilled water to be an adequate vehicle, allowing for the liberation of hydroxile ions in the root canal. On the other hand, it could be seen that, after 28 days, both Groups I and II presented reduced pH levels, thus corroborating the idea that a viscous vehicle is needed in cases when the medication will remain in the root canal for longer periods of time.

In order to bring about results that could be more favorable yet, it is desirable that permeability be increased along the whole extension of the dentinal tubules, thus helping the medications introduced in the root canal to have a better access to the parendodontic tissues. This is particularly recommended in cases of contamination by bacteria resistant to endodontic treatment, for they do survive in higher pH levels (17). In this sense, the removal of the smear layer aims at increasing the dentin permeability.

However, the use of EDTA did not provide us with statistically significant differences in the alkalinization of the medium external to the roots, though its power to remove the smear layer is well documented in the literature (10, 11). Similar results were observed by Foster, Kulild and Weller (18): removing the smear layer did not show statistically significant difference in the diffusion of calcium and hydroxile ions to the external dentin. Accordingly, Galvan et al. (8) did not observe any increase in dentinal permeability that could be related to the use of EDTA.

The results listed above may be due to the depth up into which EDTA is acting on the dentin. According to Pashley, Stewart and Galloway (19), EDTA can act up to a depth of 5 to 10 μm. Authors such as Hottel, El-Refai and Jones (20) have observed that EDTA at 17% has shown a total removal of the dentinal mud and an opening of the dentinal tubules from 2,2 to 3,2 ?m. In the present study, removing the smear layer superficially did not facilitate the action of calcium hydroxide throughout the extension of the dentinal tubules, a fact which evidence lies in the absence of statistically significant difference between the two experimental groups.

However, this fact could be related to the greater difficulty EDTA has in removing the smear layer of the apical third of the root canals (21, 22), thus diminishing the differences between the two experimental groups regarding dentinal permeability. This aspect may be taken into account when considering the results of other studies that did not present statistically significant differences in bacterial infiltration (12) and obturation of the lateral canals (13) after the application of EDTA.

CONCLUSIONS

Calcium hydroxide paste, when inserted in the light of root canals, penetrates the dentinal tubules along the whole of their extension,

increasing the pH of the medium external to the roots. This was experimentally verified in both groups of teeth.

The use of trisodic EDTA at 17% did not change dentinal permeability, meaning it did not interfere with the diffusion of the calcium hydroxide paste.

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