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The Effect of Three Different Calcium Hydroxide Combinations on Root Dentine Microhardness

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Abstract: The aim of this study, was to evaluate the effect of a calcium hydroxide-glycerin mix, calcium hydroxide-saline mix and calcium hydroxide-distilled water mix on the microhardness of root dentine after 7 and 14 days of treatment. In this *in vitro* study, 15 freshly extracted maxillary canine and central incisor teeth were used. The crowns of the teeth were removed and the canals were prepared. The teeth were sectioned transversally to produce a total of 30 dentine discs from the middle-third of the root. The specimens were then divided into 3 groups of 10 discs each. Dentine samples were proximate with calcium hydroxide-glycerin mix, calcium hydroxide-saline mix or calcium hydroxide-distilled water mix for 7 and 14 days. Dentine microhardness was measured with a Vicker's indenter with a load of 200 g for 15 second before and after treatment. Data were statistically analyzed using repeated measure analysis, paired t-test and LSD. Statistical analysis showed that all 3 combinations decreased dentine microhardness. After 7 days, the reduction in dentin microhardness following the use of a calcium hydroxide glycerin combination was significantly greater than that of a calcium hydroxide-saline and calcium hydroxide-distilled water combination. After 14 days, the reduction in dentine microhardness following the use of calcium hydroxide-distilled water combination was considerably greater than that of the other 2 groups. According to the results of this study, the use of calcium hydroxide combinations as an intra canal dressing softens dentine. At 7 days period, calcium hydroxide-glycerin combination decreased the microhardness of dentine more than two others, but at 14 days period calcium hydroxide-distilled water combination was most reductive.

Key words: Calcium hydroxide, microhardness, root dentine

INTRODUCTION

During root canal treatment, it is necessary to remove as many bacteria as possible from the root canal. The use of a root canal medicament has been considered one of the necessary steps to reduce the microbial population prior to root filling. Calcium hydroxide paste has been used widely because of its antibacterial action and tissue dissolution ability (Wadachi *et al*., 1998; Sjogren *et al*., 1991).

Calcium hydroxide is a short- or long-term intracanal dressing material and may be included in some root sealers (Holland and de Souza, 1985). Although, a number of other root canal medicaments have been advocated (Steinberg *et al*., 1990), calcium hydroxide remains the compound of choice because of its superior activity and reduced cytotoxicity to the periradicular tissues. The routine application of calcium hydroxide products in dentistry has resulted in considerable degrees of success in the treatment of various pathological conditions of the tooth. These include: assisting in the production of reparative dentin to bridge a pulp exposure, induction of apical closure in incompletely developed pulpless teeth (Fava 1994), healing of large periradicular lesions (Crabb, 1965; Kennedy and Simpson, 1969) to prevent or arrest root resorption (Andreasen, 1971) and to repair perforations resulting from internal root resorption (Frank and Weine, 1973). Today, calcium hydroxide is the drug of choice in teeth that are not completed in one-visit (Bystrom *et al*., 1985). In addition, in teeth with lesion, the use of calcium hydroxide following complete canal instrumentation, for one week period is suggested (Card *et al*., 2002). A major factor in the therapeutic success of calcium hydroxide is its antibacterial activity. The efficiency of this antibacterial action is directly proportional to the ability of hydroxide ions to diffuse from the calcium hydroxide compound (Fisher and McCabe, 1978; Brannstrom *et al*., 1979).

Calcium hydroxide powder has been mixed with various vehicles for canal medication, such as distilled

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water, saline, local anaesthetic solution, Ringer's solution, glycerin, etc. (Rivera and Williams, 1994; Oztan *et al*., 2002). These mixtures make an applicable paste which can be used in root canal treatment. Calcium hydroxide combinations are usually preferred by dentists due to their easy handling.

When mixed with glycerin, Calcium hydroxide has better handling characteristic and provides more complete canal filling. But mixing Calcium hydroxide with glycerin is not ideal, because even though glycerin is a strong solvent for calcium hydroxide, but it can't dissociate it completely. This is also true when Calcium hydroxide is mixed with other vehicles such as propylene glycol and Iodoform (Rivera and Williams, 1994; Oztan *et al*., 2002). Safavi and Nakayama (2000) concluded that the use of high concentrations of glycerin as a vehicle might decrease the effectiveness of calcium hydroxide as a root canal dressing.

Calcium hydroxide dissolves slightly in water and dissociates into hydroxyl ions and calcium ions. Accordingly, Calcium hydroxide-water mixture has a high alkalinity and high antibacterial effect (Safavi and Nakayama, 2000).

When a medicament is placed, it may cause surface alterations on the root dentine. As microhardness depends on composition and surface structure, attention has been focused on the relationship between dentinal microhardness and the structural changes associated with application of medicaments (Moon and Davenport, 1976; Panighi and G'Sell, 1992).

A reduction in hardness of treated tooth tissue indicates dissolution and degradation (Saleh and Ettman, 1999). It would be reasonable to assume that the dissolution effect of calcium hydroxide would affect dentine. As softened dentine is structurally nonsupportive, it is imperative that the microhardness of this tissue be retained or enhanced (Yoldas *et al*., 2004).

The aim of this study, was to evaluate the effect of a calcium hydroxide-glycerin mix, calcium hydroxide-saline mix and calcium hydroxide- distilled water mix on the microhardness of root dentine after 7 and 14 days.

MATERIALS AND METHODS

Fifteen freshly extracted human maxillary canine and incisor teeth were used in this experiment. Clinical and radiographic examinations were made to select teeth with no defects and canal obliteration. Debris, calculus and soft tissue remnants on the root surfaces were cleaned using a curette and all teeth were stored in distilled water until utilization.

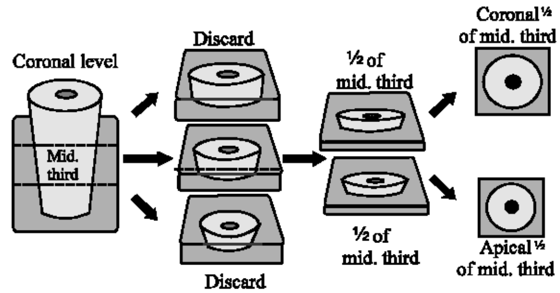

Fig. 1: Schematic representation of root sectioning in acrylic resin block for microhardness testing

The crowns were sectioned at the cementoenamel junction by using a high-speed bur under water cooling. The pulp tissue was extirpated and a step back technique was used to enlarge canals up to size 50 apically with K-file (Mani-Japan). Canals were irrigated with distilled water during instrumentation. Then, the roots were fixed in acrylic resin blocks and were cut transversally using a sectioning machine (Krupp Dental, Japan) to produce a total of 30 dentine discs from the middle-third of the root (Fig. 1).

The specimens were polished with abrasive paper (Matador Abrasive Paper, 240, Germany) to remove any surface scratches.

The root specimens were divided randomly into 3 groups of 10 discs each. Baseline microhardness was measured with the use of Vickers hardness tester (Leitz, Wetzler, Germany) with a Vicker's indenter. All indentation was made with 200 g loading for 15 sec. Each disc received a series of 3 indentations at points around the pulp space 1 mm from canal wall. Mean Vicker's Hardness Numbers (VHN) were calculated for each specimen.

Three calcium hydroxide combinations in three Petri dishes were prepared as follows:

First group: Calcium hydroxide powder (Merck- Germany) and Glycerin (Sadaf Company-Iran; 1:7 of glycerin-distilled water) mix.

Second group: Calcium hydroxide powder and saline (Daroupakhsh products) mix.

Third group: Calcium hydroxide powder and distilled water mix.

Each dish contained a 2 mm depth of Calcium hydroxide paste with one of the three combinations. To maintain the constant powder-liquid ratio over the experimental period, the powder-liquid ratio was 1.2 g mL^{-1} for all combinations and the Petri dishes were covered with Aluminum foil.

Calcium hydroxide pastes were not substituted over the experimental period. After each treatment period, the specimens were rinsed with distilled water and dried with soft absorbent paper before measuring microhardness. Microhardness test were repeated in the same manner at 7 and 14 days periods.

Statistical analysis was performed using the statistical package SPSS v 12.0. At first, time-dependent data within groups were analyzed by repeated measure analysis. Paired t-test was used to compare the results of 7 and 14 days in each group. One-way analysis variance and LSD were used to compare changes at 7 and 14 days between groups.

RESULTS AND DISCUSSION

Mean VHN values and standard deviations of root dentine before and after treating in each group are shown in Table 1 and Fig. 2. Significant reduction in dentine microhardness was observed in all experimental groups after periods of 7 and 14 days ($p<0.001$). Microhardness reduction in 3 groups at various time periods is shown in Fig. 3.

Microhardness changes at 7 days period: No significant statistical difference was observed in dentine microhardness reduction between groups 1 and 2 ($p = 0.189$). Dentine microhardness reduction in groups 1 and 2 was more than group 3 ($p<0.001$, $p = 0.008$).

Microhardness changes at 14 days period: No significant statistical difference in dentin microhardness reduction was observed between groups 1 and 2 ($p = 0.479$). Group 3 showed more statistically reduction in microhardness than group 1 and 2 ($p<0.001$, $p = 0.008$).

As microhardness of dentine may vary considerably within teeth, comparison of dentine hardness values before and after treatment with calcium hydroxide combinations was made within the same root dentine sample (Seaman and Shannon, 1979). This was performed to minimize the effect of structural variations of different teeth and to establish a reasonable baseline evaluation as suggested by Saleh and Ettman (1999). In addition, no other irrigant or disinfectant chemicals which may have affected hardness values were employed.

The present study showed that the use of calcium hydroxide combinations as an intracanal dressing softens dentine. Dentine hardness reduction was less when using calcium hydroxide-distilled water compared to using calcium hydroxide-glycerin and saline combinations in 7 days but was more in 14 days. This may be related to slight dissociation of calcium hydroxide ions in distilled water vehicle at longer time periods (Safavi and Nakayama, 2000). Low solubility of calcium hydroxide in water confines its effect to its placement site (Farhad and Mohammadi, 2005). Therefore, distilled water was added to glycerine in a ratio of 1:7 as suggested by Alacam *et al*. (1998).

Microhardness changes in 7 days: According to present study, mixing calcium hydroxide with glycerin for 1 week

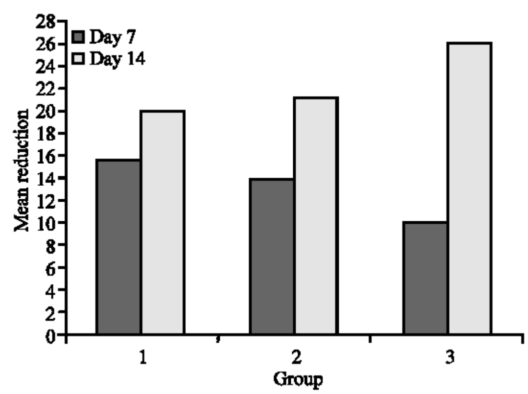

Fig. 2: The mean of dentin microhardness reduction of 3 groups after 7 and 14 days treatment

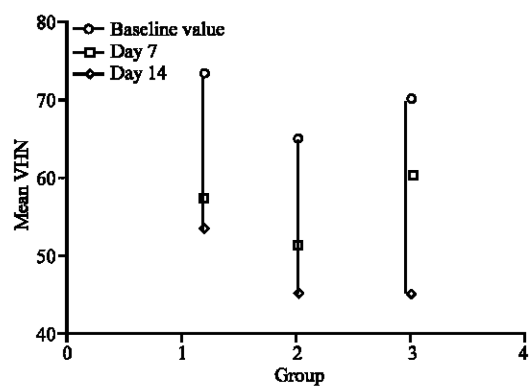

Fig. 3: The changes of dentin microhardness in 3 groups by time lapse

Table 1: Mean and Standard Deviation (SD) of VHN values before and after treatment in 3 groups

Group	Baseline	Days 7	Days 14	p-value (within groups)
Calcium hydroxide-glycerin	72.5 (3.668)	57.00 (4.26)	52.66 (3.42)	p<0.001
Calcium hydroxide-saline	66.01 (7.05)	52.23 (9.13)	44.86 (8.79)	p<0.001
Calcium hydroxide-distilled water	70.18 (4.36)	60.25 (5.84)	44.15 (4.71)	p<0.001
Total	69.59 (5.75)	60.25 (7.30)	47.22 (7.06)	p<0.001

Standard deviations are given in parentheses leads to more reduction in dentine microhardness. Yoldas *et al*. (2004) found that the reduction in dentine hardness after calcium hydroxide-glycerin combination treatment for 7 days period was significantly greater than that of the calcium hydroxide-distilled water combination (Yoldas *et al*., 2004). Metzler and Montgomery (1989) found that intracanal calcium hydroxide left for 7 days with subsequent instrumentation cleaned the canal and isthmuses. This could be due to decrease in dentine microhardness.

Alacam *et al*. (1998) explained that the glycerin penetrates better than distilled water in to the dentinal tubules. Therefore, the greater reduction in dentine hardness found after the calcium hydroxide-glycerin combination treatment, could be explained by the different penetration ability of the 2 combinations into dentinal tubules (Alacam *et al*., 1998). Osol and Hoover (1975) suggested that the reduction in dentin microhardness after the calcium hydroxide-glycerin combination treatment was significantly greater than calcium hydroxide-distilled water combination for a 7 day period, which is due to hygroscopic characteristic of glycerin Hasselgren *et al*. (1988) found that calcium hydroxide proximity to root dentine for 7 days leads to dentin microhardness reduction.

Microhardness changes in 14 days: This study showed that in 14 days distilled water has a greater dentine microhardness reduction than glycerin and saline. These results match the studies that evaluated calcium hydroxide for a long period. Doyon *et al*. (2005) found that after 180 days, the roots of the teeth exposed to calcium hydroxide showed a significant decrease in peak load at fracture when compared to the 30 day.

White *et al*. (2002) reported a 32% decrease in dentine strength after the use of calcium hydroxide for a 5 week period and proposed this was caused by breakdown of the protein structure as a result of the alkalinity of calcium hydroxide (White *et al*., 2002). Also, the present study supports Andreasen theory that the proteolytic action of calcium hydroxide in one year could weaken a tooth up to 50%. This can be explained by disruption in links between collagen fibers and hydroxyapatite crystals that is followed by a decrease in dentine microhardness (Andreasen *et al*., 2002).

CONCLUSION

The present observations suggest that all calcium hydroxide combinations tested leads to structural changes as evidenced by the reduction of dentine microhardness. This effect was milder in calcium hydroxide-distilled water combination at 7 days period, but this combination causes more reduction in microhardness at longer time period.

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