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Evaluation of effect of calcium hydroxide as a root canal dressing material on dentin micro tensile fracture strength in primary teeth: An *in-vitro* study

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Abstract

Background: Root canal treatment in primary teeth is indicated when the radicular pulp exhibits clinical signs of irreversible pulpitis or pulp necrosis while the roots show minimal or no resorption. The present study was conducted to evaluate the effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth.

Materials and methods: 60 human maxillary primary incisor were divided into two experimental groups. The teeth were immersed in saline at room temperature for 7 (group I), 30 (group II) and 90 days (group III). The saline was changed with a fresh sterile solution once a week. In group IV, 15 teeth with root canals filled with sterile saline and the orifices sealed with IRM. Microtensile fracture strength was measured in Mechanical tester Lloyd testing machine.

Results: The mean microtensile fracture strength in group I was 30.5 MPa, in group II was 25.7 MPa, in group III was 92 MPa and in group IV was 34.9 MPa. The difference was significant ($P < 0.05$).

Conclusion: Calcium hydroxide placed in root canals for an extended time had a significantly negative effect on root strength.

Keywords: Calcium hydroxide, Root strength, microtensile

Introduction

Root canal treatment in primary teeth is indicated when the radicular pulp exhibits clinical signs of irreversible pulpitis or pulp necrosis while the roots show minimal or no resorption. The most commonly used root filling materials for primary teeth are zinc oxide-eugenol (ZOE), iodoform-based pastes and calcium hydroxide^[1].

The use of calcium hydroxide $\text{Ca}(\text{OH})_2$, in dentistry is well established and widespread and was introduced by Hermann in 1920. $\text{Ca}(\text{OH})_2$ has been used in various formulations as a liner beneath restorations and as a pulp capping agent in different pathological conditions. Calcium hydroxide is accepted as an interappointment intracanal medicament^[2]. The endodontic treatment of teeth with immature root formation has always been a challenge due to the wide open apices that make obturation difficult^[3]. The apexification technique was first described in 1966 by Frank. He described reduction of contaminants present within the root canal by precise instrumentation and canal irrigation and filling the endodontic space with resorbable paste such as calcium hydroxide. Rendering the canal aseptic, promotes apical closure. The canal can be then obturated with suitable obturating technique^[4].

Researchers have suggested that increased pH alters the strength of the bond between hydroxyapatite and collagen fibrils, induces conformational change in proteoglycan molecules and exerts a proteolytic effect via increased matrix metalloproteinase activity. The exact mechanism by which teeth become more susceptible to fracture is not known with certainty, but may be a combination of these^[5]. The present study was conducted to evaluate the effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth.

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Materials and Methods

The present study comprised of 60 human maxillary primary incisor. Teeth were divided into two experimental groups. 15 teeth with root canals packed with pure calcium hydroxide mixed with saline were divided into group I, II and group III. The paste was carried to the coronal part of the pulp cavity using a Lentulo spiral at slow speed. The calcium hydroxide was further condensed from the apical foramen and all the samples had a minimum of 2 mm intermediate restorative material placed in both orifices. The teeth were then immersed in saline at room temperature for 7 (group I), 30 (group II) and 90 days (group III). The saline was changed with a fresh sterile solution once a week. In group IV, 15 teeth with root canals filled with sterile saline and the orifices sealed with IRM. The teeth were stored in saline for a month at room temperature and the saline was exchanged with a fresh sterile solution once a week. Microtensile fracture strength was measured in Mechanical tester Lloyd testing machine. Results thus obtained were subjected to statistical analysis. P value less than 0.05 was considered significant.

Results

Table 1: Distribution of teeth

Groups	Group I	Group II	Group III	Group IV
Days in immersion	7	30	90	Control
Number of teeth	15	15	15	15

Table 1 shows distribution of teeth in experiment and control group. Each group had 15 teeth each.

Table 2: Comparison of Microtensile fracture strength

Groups	Mean (MPa)	P value
Group I	30.5	0.02
Group II	25.7	
Group III	19.2	
Group IV	34.9	

Table 2, Figure 1 shows that mean microtensile fracture strength in group I was 30.5 MPa, in group II was 25.7 MPa, in group III was 19.2 MPa and in group IV was 34.9 MPa. The difference was significant ($P < 0.05$).

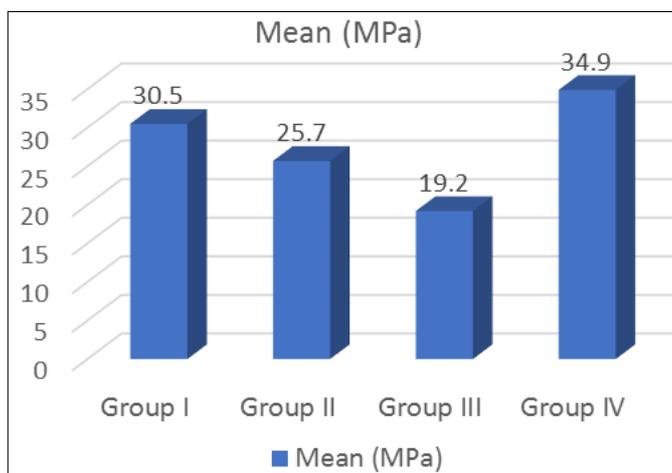


Fig 1: Comparison of microtensile fracture strength

Discussion

The antimicrobial action of calcium hydroxide is associated with its ionic dissociation into calcium and hydroxyl ions which diffuse through the dentinal tubules. The aqueous,

viscous, or oily vehicle used in the formulation of the root canal filling paste impacts the speed of ionic dissociation.⁶ As aqueous vehicles favor a high degree of solubility they will cause a depletion of the paste from the root canals before the time of physiological root resorption. Viscous vehicles promote a lower solubility of the paste and oily vehicles have the lowest solubility and diffusion of calcium hydroxide pastes showing better results¹⁷. The present study was conducted to evaluate the effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth.

In present study, mean microtensile fracture strength in group I was 30.5 MPa, in group II was 25.7 MPa, in group III was 19.2 MPa and in group IV was 34.9 MPa. Said *et al.*¹⁸ found that there was a significant difference ($P < 0.05$) between the fracture strength of the calcium hydroxide-filled teeth after 90 days (19.1 MPa) compared with the control (35.8 MPa). Dentin microtensile fracture strength of the calcium hydroxide-filled teeth decreased at an average of 0.142 MPa per day.

The high pH and antimicrobial properties¹⁷ combined with the permeability of dentin may account for its effectiveness as an intra-canal inter-appointment medicament, an inhibitor of inflammatory root resorption, and an inducer of apical closure in nonvital immature permanent teeth¹⁹. However, when used in root canal for apexification the treatment may last from months to years and immature permanent teeth treated with calcium hydroxide have been shown to have a high failure rate due to an unusual great number of root fractures¹¹⁰.

Pranav *et al.* in their study forty five freshly extracted single rooted human teeth divided into three groups of 15 teeth each. Number 4 round bur was used for Coronal access, endodontic instrumentation using stainless steel files were completed for each tooth. Root canal system of each tooth was filled with Ca (OH)₂ (group 1), Metapex (group 2) and saline solution (group 3). The apices and access openings were sealed with glass ionomer cement and the teeth were immersed in saline for 7, 15 and 30 days. At the end of this selected time period fracture strength test were performed. There was a decrease in the fracture strength of human teeth when exposed to Ca (OH)₂ and metapex in comparison to control group after 15 days. Ca (OH)₂ is not medicament of choice beyond 15 days and if treated for long duration then root reinforcement should be carried out.

Whitebeck *et al.* found that the edge toughness values (\pm one standard deviation) for groups 1-4, respectively, were 219 (\pm 21) N/mm, 308 (\pm 23) N/mm, 346 (\pm 32) N/mm, and 283 (\pm 20) N/mm. One-way ANOVA showed the calcium hydroxide treated groups' edge toughness values were significantly different than that for the control group using 95% confidence intervals. The forces necessary to create edge chips were greater, on average, for the treated specimens than for the untreated controls.

Conclusion

Authors found that calcium hydroxide placed in root canals for an extended time had a significantly negative effect on root strength.

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