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Assessment of effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth: An *in vitro* study

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Abstract

Background: CH materials have also been used for retrograde root fillings and as root canal sealers. However, since most CH hydroxide materials are soluble and can dissolve in the presence of tissue fluids, they have not been a permanent solution for some of these clinical applications.

Aim of the study: To study the effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth.

Materials and Methods: The present study was conducted in the Department of pedodontics of the dental institution. The present study comprised of 80 human maxillary primary incisor. Teeth were divided into two experimental groups. 20 teeth with root canals packed with pure calcium hydroxide mixed with saline were divided into group I, II and group III. The teeth were then immersed in saline at room temperature for 7 (group I), 30 (group II) and 90 days (group III).

Results: Each group had 20 teeth each. The mean microtensile fracture strength in group 1 was 29.9 MPa, in group 2 was 24.9 MPa, in group 3 was 18.6 MPa and in group 4 was 35.3 MPa. The difference was statistically significant.

Conclusion: Within the limitations of the present study, it can be concluded that calcium hydroxide placed in root canals for a long period of time has a negative effect on the dentin microtensile fracture strength in primary teeth.

Keywords: Primary teeth, dentin fracture, fracture strength, calcium hydroxide

Introduction

Calcium hydroxide (CH) has a highly alkaline nature due to release of hydroxyl ions. Released ions are responsible for antimicrobial actions [1, 2, 3] and for promoting mineralized tissue formation [4]. CH has been used as an intra-canal medicament between appointments [5], as well as for apexification [6, 7], apexogenesis [7], arrest of root resorption defects [8], and direct and indirect pulp-capping procedures [9]. CH materials have also been used for retrograde root fillings and as root canal sealers. However, since most CH hydroxide materials are soluble and can dissolve in the presence of tissue fluids, they have not been a permanent solution for some of these clinical applications. When used for apexification, CH pastes require frequent replacement over a 6–18 month period to achieve dentinal bridge formation [4]. The high alkalinity of CH has led to investigations of the effects of CH on root dentine over the long term. Several *in vitro* studies have found an association between deteriorations in strength and other physical properties [10]. Hence, the present study was conducted to study the effect of calcium hydroxide as a root canal dressing material on dentin microtensile fracture strength in primary teeth.

Materials and Methods

The present study was conducted in the Department of pedodontics of the dental institution. The ethical clearance for the study was approved from the ethical committee of the hospital. The present study comprised of 80 human maxillary primary incisor.

Teeth were divided into two experimental groups. 20 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, 20 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.

The statistical analysis of the data was done using SPSS version 11.0 for windows. Chi-square and Student's t-test were used for checking the significance of the data. A p-value of 0.05 and lesser was defined to be statistically significant.

Results

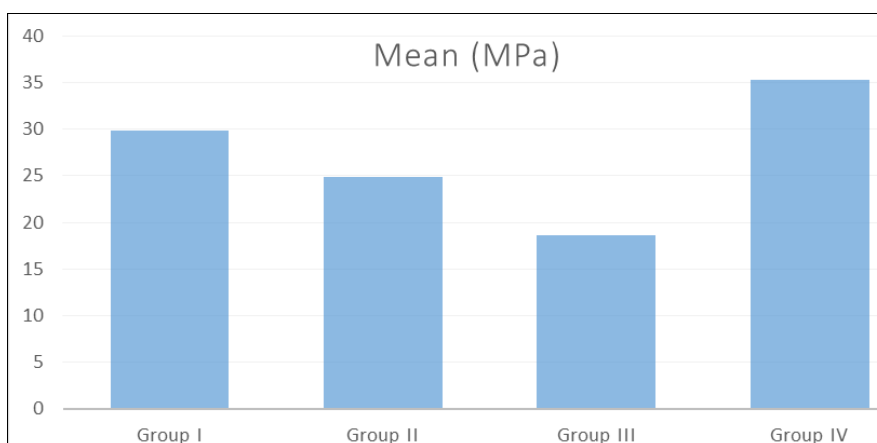
Table 1 shows distribution of teeth in experiment and control group. Each group had 20 teeth each. Table 2, graph I shows that mean microtensile fracture strength. The mean microtensile fracture strength in group 1 was 29.9 MPa, in group 2 was 24.9 MPA, in group 3 was 18.6 MPA and in group 4 was 35.3 MPa. The difference was statistically significant ($P < 0.05$).

Table 1: Distribution of teeth

Groups	Group I	Group II	Group III	Group IV
Days in immersion	7	30	90	Control
Number of teeth	20	20	20	20

Table 2: Comparison of Microtensile fracture strength

Groups	Mean (MPa)	P value
Group I	29.9	0.01
Group II	24.9	
Group III	18.6	
Group IV	35.3	



Graph 1: Comparison of microtensile fracture strength in Group 1, 2, 3 and 4

Discussion

Calcium hydroxide has been widely used to treat immature teeth to achieve periodontal healing and to promote the formation of an apical barrier. However, retrospective clinical studies have shown a high incidence of cervical root fractures with long-term calcium hydroxide dressing. The alkalinity of calcium hydroxide has been suggested to weaken the root. *In vitro* studies using ovine teeth show conflicting results on fracture strength of dentine, although different commercial products may have influenced the results. In the present study, the mean microtensile fracture strength in group 1 was 29.9 MPa, in group 2 was 24.9 MPA, in group 3 was 18.6 MPA and in group 4 was 35.3 MPa. The difference was statistically significant. The results were compared with previous studies from the literature and results were found to be consistent. Batur YB *et al.* [11] reported that the introduction of CH into the root canals seems to decrease the MTFs of teeth statistically significantly through the 180th, 270th, 360th, and 540th days, respectively, compared with the control group. The results indicated that long-term CH treatments can significantly reduce the strength of the teeth, causing an increase in fracture risk. Andreasen J *et al.* [12] tested the hypothesis that dentin in contact with calcium hydroxide would show a reduction in fracture strength after a certain period of time. Immature mandibular incisors from sheep were extracted and divided into two experimental groups. Group 1: the pulps were extirpated via the apical foramen.

The root canals were then filled with calcium hydroxide (Calasept) and sealed with IRM(R) cement, and the teeth were then stored in saline at room temperature for 0.5, 1, 2, 3, 6, 9, or 12 months. Group 2: the pulps were extirpated and the root canals were filled with saline and sealed with IRM(R) cement. The teeth were then stored in saline for 2 months. Intact teeth served as controls and were tested immediately after extraction. All teeth were tested for fracture strength in an Instron testing machine at the indicated observation periods. The results showed a markedly decrease in fracture strength with increasing storage time for group 1 (calcium hydroxide dressing). The results indicate that the fracture strength of calcium hydroxide-filled immature teeth will be halved in about a year due to the root filling. The finding may explain the frequent reported fractures of immature teeth filled with calcium hydroxide for extended periods. Kahler SL *et al.* [13] investigated the effects of 2 commercial products used in prior studies (Calasept Plus and UltraCal XS), as well as a new product (Calmix) that uses a nonaqueous vehicle that allows for a higher pH, on the fracture strength of dentine over time. No statistical differences were observed between the different calcium hydroxide products and the negative controls. They concluded that thin and fragile roots could be the cause of fracture rather than the calcium hydroxide dressing. Dalavai P *et al.* [14] evaluated and compared the compressive strength of root dentin exposed to CH, mixed with various vehicles after 30

days of placement. They concluded that CH when used as a root canal dressing material will reduce the compressive strength of the teeth irrespective of the form of CH and vehicle.

Conclusion

Within the limitations of the present study, it can be concluded that calcium hydroxide placed in root canals for a long period of time has a negative effect on the dentin microtensile fracture strength in primary teeth.

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