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

Dr. Bindal Shweta Pradeep Kumar, Dr. Ajay Pravin Pacharne, Dr. Aashima Anand, Dr. Nikita Mehta, Dr. Ratheesh MS and Dr. Sowmya Komanduri

DOI: https://doi.org/10.22271/oral.2022.v8.i2c.1499

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 apexitification [6, 7], apexogenesis [8], arrest of root resorption defects [9], 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 apexitification, CH pastes require frequent replacement over a 6–18 month period to achieve dental 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).

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

| 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        |

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.

**References**

1. Farhad A, Mohammadi Z. Calcium hydroxide: A review. Int. Dent. J. 2005;55:293-301. DOI: 10.1111/j.1875-595X.2005.tb00326.x.

2. Cwikla SJ, Belanger M, Giguere S, Progulske-Fox A, Vertucci FJ. Dental tubule disinfection using three calcium hydroxide formulations. J Endod. 2005;31:50-52. DOI: 10.1097/01.DON.0000134291.03828.D1.

3. Gangwar A. Antimicrobial effectiveness of different preparations of calcium hydroxide. Indian J Dent. Res. 2011;22:66-70. DOI: 10.4103/0970-9290.79986.

4. Enkel B, Dupas C, Armengol V, Akpe Adou J, Bosco J, Daculsi G, et al. Bioactive materials in endodontics. Expert Rev. Med. Devices. 2008;5:475-494. DOI: 10.1586/17434440.5.4.475.

5. Lima RK, Guerreiro-Tanomaru JM, Faria-Junior NB, Tanomaru-Filho M. Effectiveness of calcium hydroxide-based intracanal medicaments against Enterococcus faecalis. Int. Endod. J. 2012;45:311-316. DOI: 10.1111/j.1365-2591.2011.01976.x.

6. Vidal K, Martin G, Lozano O, Salas M, Trigueros J, Aguilar G. Apical Closure in Apexification: A Review and Case Report of Apexification Treatment of an Immature Permanent Tooth with Biodentine. J Endod. 2016;42:730-734. DOI: 10.1016/j.joen.2016.02.007.

7. Corbella S, Ferrara G, El Khabane Y, Taschieri S. Apexification, apexogenesis and regenerative endodontic procedures: A review of the literature. Minerva Stomatol. 2014;63:375-389.

8. Ebeleseder KA, Kqiku L. Arrest and Calcification Repair of internal root resorption with a novel treatment approach: Report of two cases. Dent. Traumatol. 2015;31:332-337. DOI: 10.1111/dtr.12171.

9. Graham L, Cooper PR, Cassidy N, Nor JE, Sloan AJ, Smith AJ. The effect of calcium hydroxide on solubilisation of bio-active dentine matrix components. Biomaterials. 2006;27:2865-2873. DOI: 10.1016/j.biomaterials.2005.12.020.

10. Grigoratos D, Knowles J, Ng YL, Gulabivala K. Effect of exposing dentine to sodium hypochlorite and calcium hydroxide on its flexural strength and elastic modulus. Int. Endod. J. 2001;34:113-119. DOI: 10.1046/j.1365-2591.2001.00356.x.

11. Batur YB, Erdemir U, Sancalik HS. The long-term effect of calcium hydroxide application on dentin fracture strength of endodontic ally treated teeth. Dent Traumatol. 2013;29:461-464.

12. Andreasen Jens, Farik Ban, Munksgaard Erik. Long-term calcium hydroxide as a root canal may increase risk of root fracture. Dental traumatology: official publication of International Association for Dental Traumatology. 2002;18:134-7. 10.1034/j.1600-9657.2002.00097.x.

13. Kahler SL, Shetty S, Andreasen FM, Kahler B. The Effect of Long-term Dressing with Calcium Hydroxide on the Fracture Susceptibility of Teeth. Journal of Endodontics. 2002;44(3):464-469. MARCH 01, 2018.

14. Dalavai P, Nasreen F, Srinivasan R, Pramod J, Bhandary S, Penmatsa C. To evaluate and compare the compressive strength of root dentin exposed to calcium hydroxide, mixed with various vehicles for a period of 30 days – An in vitro study. J Conserv Dent. 2021;24:563-7.