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ORIGINAL RESEARCH

Clinical and radiographic assessments of potassium nitrate in polycarboxylate versus mineral trioxide aggregate as pulpotomy biomaterials in immature mandibular first permanent molars- An original research

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ABSTRACT

Aim: The purpose of this study was to compare clinically and radiographically the effects of potassium nitrate in polycarboxylate cement and mineral trioxide aggregate (MTA) as pulpotomy agents in vital immature mandibular first molars.

Methodology: The trial design was a parallel randomized, 1:1 allocation ratio, with both the participants and the data assessor blinded. A total of 50 molars of 48 eligible children aged 6–9 years were studied. The children had mandibular immature first molars with extensive caries that revealed pulp exposure during caries excavation. Patients were randomly allocated equally into 2 groups in which potassium nitrate in polycarboxylate cement (the intervention group) and MTA (the control group) were used as pulpotomy biomaterials. The treated teeth were restored permanently. The primary outcome was clinical/radiographic assessment after 1 week, 6 months, and 12 months. The secondary outcomes were radiometric analysis at 6 and 12 months to determine dimensional changes during maturogenesis. The digital radiographs were imported to image processing software to perform radiometric measurements. Data were tabulated and statistically analyzed with significance set at P < .05.

Results: Only a single tooth failed at the 6-month recall, and another one was lost during recall in each group. Thus, the overall success rate for cases/group who finally attended the 12-month follow-up time point was 92% (23/25) with no statistically significant difference between the 2 groups. At the 12-month recall, successful cases showed root development with an increase in root length and a decrease in apical foramen width. Complete apical closure was observed in 65.2% of the roots in the intervention group and 52.1% in the control group.

Conclusion: The clinical and radiographic success reported in the present study reveals that potassium nitrate in polycarboxylate cement could be used as a biological and economic alternative to MTA as a pulpotomy agent in vital immature mandibular first molars.

Keywords: Mineral trioxide aggregate; potassium nitrate in polycarboxylate; vital pulp therapy.

INTRODUCTION

Dental caries and its sequelae are the greatest challenges to the integrity of the developing teeth. Although vital pulp therapy in carious-exposed pulps is controversial[1], it is universally accepted that it should be performed on immature teeth. [2] Carious exposures in immature teeth cause irreversible damage to the pulp tissue and arrest root development, which can negatively influence the long-term prognosis of tooth retention. Therefore, the chief purpose of treating

carious-exposed dental pulps in immature teeth is to maintain pulp vitality and hence allow continuation of root development and apical closure. This approach is called apexogenesis[4]. Vital pulp therapies establish a biologically acceptable environment for the pulp tissue and prevent future bacterial contamination by using an appropriate pulp-capping agent. [3] The material should be biocompatible, bactericidal, provide a biologic seal, and induce hard tissue formation. [3,5] Calcium hydroxide (CH) has been the material of choice for vital pulp therapy for many decades.[6] Despite its common use, CH has several disadvantages including the presence of tunnel defects in induced dentinal bridges, poor adherence to dentine, and lack of long-term seal.[7] Mineral trioxide aggregate (MTA), the new gold standard for vital pulp therapies, provides long-term seal, acceptable biocompatibility[8], and dentinal bridge formation in animal[9] or human teeth.[10] A clinical trial showed 100% clinical ⁄ radiographic success rates for apexogenesis treatment with MTA.[11]Different pulpotomy materials have been used in practice, with the most popular being mineral trioxide aggregate (MTA). Clinical studies evaluated the use of MTA as a direct pulp capping material and as a pulpotomy material after partial and complete pulpotomy. Despite its clinical effectiveness, MTA has some drawbacks such as difficult handling characteristics, a long setting time, tooth discoloration, and high cost. These urged the search for an alternative pulpotomy material to MTA. Potassium nitrate (KNO3) is a known desensitizer for hypersensitive teeth.[12] Histopathologic animal studies reported a satisfactory response for the use of polycarboxylate as a direct pulp capping material. The combination of 5% KNO3 in polycarboxylate cement is reported for direct capping of traumatically exposed pulp in animal models. Clinical studies evaluated KNO3 in polycarboxylate in vital pulp therapy as a pulp cappingor pulpotomy material. Clinical and radiographic evaluation of teeth treated with KNO3 in polycarboxylate cement as a direct pulp capping material for deep nonexposed carious lesions showed a success rate of 98% over a 4-year period.[13] Direct capping of KNO3/dimethyl isosorbide/polycarboxylate cement in carious exposure vital pulp showed all patients to be clinically and radiographically normal over 2 years. Indirect capping by 5% KNO3 in polycarboxylate cement was compared with calcium hydroxide liner in the treatment of reversible pulpitis in permanent teeth.[14] The results suggested that 5% KNO3 in

polycarboxylate cement had a very good analgesic action with normal electrical excitability being restored faster than cases treated with calcium hydroxide. A 2-step technique of pulpotomy in permanent teeth used ferric sulfate followed by a mixture of either iodoform or KNO3. After a 2-year observation period, the author concluded that both formulations had a very promising value with the production of a dentin bridge.[15]

AIM OF THE PRESENT STUDY

The purpose of this study was to compare clinically and radiographically the effects of potassium nitrate in polycarboxylate cement and mineral trioxide aggregate (MTA) as pulpotomy agents in vital immature mandibular first molars.

METHODOLOGY

The study design was a parallel, randomized with the protocol being approved by institutional ethical committee. Participants were recruited from the outpatient clinic of the Department of Pedodontics. The eligibility criteria were children ranging from 6–9 years who had an asymptomatic vital immature mandibular first molar with extensive and deep caries that revealed pulp exposure during caries excavation. Cases had no preoperative acute pulp or periapical involvement symptoms. The exclusion criteria were medically compromised children and cases diagnosed to have necrotic pulp or acute inflammation of the pulp or the periapical tissue. Consent was obtained from the guardians before the treatment. A detailed history of participants was taken followed by a thorough clinical and radiographic examination. Visual pulp status examination revealed the involved tooth to have extensive caries. Preoperative radiographic assessments checked the extent and location of caries as well as the periapical status. A total of 50 molars from 48 children were randomly allocated into 2 groups, each composed of 25 molars. Access cavity preparation was performed with a sterile highspeedcarbide round bur and an Endo-Z bur. The materials were as follows: in the intervention group, teeth were treated with 5% KNO3 and polycarboxylate cement pulpotomy, and in the control group, teeth were treated with MTA pulpotomy. In the intervention group, the cavity was covered with 5% KNO3 in polycarboxylate. In the control group, the cavity was covered with white MTA. A resin-modified glass ionomer (Prime Dental Manufacturing, Chicago, IL) was placed as a base to seal the pulp chamber. For both groups, the cavity was restored with resincomposite (Filtek Z350 XT Universal Restorative; 3M ESPE, St Paul, MN) as a permanent restoration. The primary outcomes were clinical and radiographic outcomes assessed by a direct answer of yes or no with no subjective influence. Radiographic evaluations checked for root maturogenesis progress denoting success as well as checked signs of failure (including the formation of a periradicular/interradicular lesion and internal/ external root resorption) by binary answers yes or no at 2 follow-up periods (ie, 6 and 12 months). For the secondary outcome, radiometric analysis was performed by the operator for preoperative, 6-month, and 12-month radiographs. At 12 months, roots showing complete apical closure were counted and compared with roots showing root development yet to be achieved. Numerical data were described as the mean, standard deviation, and range. Data were explored for normality using the Kolmogorov-Smirnov test and the Shapiro- Wilk test and revealed normal distribution ofthe data. Comparisons between the 2 groups were performed using the independent t test. Categoric data were summarized as percentages. Differences were analyzed with the Fisher exact test. A P value $<.05$ was considered statistically significant.

RESULTS

Sixty-seven patients were allocated for eligibility, of which 48 patients with inclusion criteria were included. Two patients had 2 teeth to reach the sample of 50 teeth (N = 50). The

children were between 6 and 9 years old, with a mean age of 7.760.4 years in the intervention group and 7.7 6 0.5 years in the control group. The overall success rate for cases/ group who finally attended the follow-up periods was 92% (23/25). Successful cases in either group did not experience pain, swelling, abscess formation/fistulation, or pathologic mobility at any of the follow-up appointments. In addition, there was no radiologic evidence of periodontal ligamentwidening, internal or external root resorption, interradicular bone destruction, or periradicularbone destruction. Radiographic evaluation showed complete apical closure in 65.2% of the roots in group 1, whereas in group 2, it was 52.1% of the roots at the 12-month time point. Statisticalcomparisons of percent changes betweenboth groups at 12 months revealedthat the mean percent increase in root height inthe distal and mesial roots of the interventiongroup was slightly lower than in the controlgroup; however, this was not statisticallysignificant (P = .399). The mean percentreduction in apical foramen width in the distalroot of the intervention group was slightly lowerthan the control group with no statisticallysignificant difference (P < .581). On the other hand, the mesial root was almost equal the mean percent decrease in apical foramen width in both groups, with no statistically significant difference (P = .967). (Table 1)

Table 1- Mean Percentage Difference 6 Standard Deviation (SD) of the Root Length Change Percentage (R) and the Foramen Width Change Percentage Reduction (F) in the Intervention Group (Potassium Nitrate in Polycarboxylate Cement) and the Control Group (Mineral Trioxide Aggregate) at 12 Months

		Intervention group			Control group			
			95.0% CI			95.0% CI		
Follow-up	Root	Mean % ± SD	Lower	Upper	Mean % ± SD	Lower	Upper	P value
12 months	Distal R	17.87 ± 4.54	15.90	19.83	19.26±6.37	16.50	22.01	.399
	Mesial R	17.48 ± 4.59	15.49	19.47	18.53 ± 6.03	15.92	21.14	.510
	Distal F	-255.81 ± 9.29	-259.83	-251.79	-257.37 ± 9.68	-261.55	-253.18	.581
	Mesial F	-257.23 ± 8.32	-260.83	-253.63	-257.35 ± 10.18	-261.75	-252.94	.967

CI, confidence interval; D, distal; M, mesial. P < .05 is significant. A negative sign means a reduction in value

DISCUSSION

Young permanent molars are more prone to dental caries. Pulpal exposures due to dental caries require prompt and suitable treatment to ensure the viability of pulp and periradicular cells. When encountering a cariously exposed pulp, it is difficult to assess the condition of the pulp, which plays a critical role in the outcome of the pulp therapy. Thus, complete pulpotomy was chosen in this study because of its reported higher success rate (99.3%) compared with direct pulp capping therapy (72.9%). After amputation of the coronal pulp, various options are available for the achievement of pulp hemostasis, such as mechanical pressure using a sterile cotton pellet, which may be soaked in sterile water, sodium hypochlorite, or saline. In the present investigation, ferric sulfate was used to provide hemostasis before application of the pulpotomy material. Ferric sulfate has been reported as a hemostatic agent for pulpotomy in permanent molarsand as a pulpotomy agent in primary

molars.[16] In the present investigation, MTA was selected to be the baseline standard in the control group for comparison because of its accepted reported benefits; MTA is a bioactive, biocompatible, and self-setting hydrophilic calcium silicate cement. It is considered an optimal material for use in vital pulp therapy of young permanent teeth. In the current investigation, 5% KNO3 in polycarboxylate cement was investigated as an alternative material to MTA as a pulpotomy agent. KNO3 in polycarboxylate cement was used in a 5% concentration as previously recommended for preserving pulp vitality in direct pulp capping. Clinically, KNO3 in polycarboxylate cement was reported to eliminate or decrease postoperative pain significantly. This mix is considered to be effective because it releases potassium nitrate. KNO3 depolarizes the nerve fibers. The dentinal-pulpal circulation and natural defense system remain functionally intact and are even improved. They may be helped by the nitrate ion because nitrate salts tend to increase circulation by being converted to nitric oxide.[17] Glass ionomer filling material was used as intermediate restorative material, which provided further temporary sealing over the pulpotomy agent to prevent leakage. A prospective clinical study on MTA partial pulpotomy of immature and mature asymptomatic carious-exposed molars and a case series study on MTA pulpotomy of carious-exposed symptomatic permanent teeth showed 100% clinical and radiographic success rates. The small sample size in these two studies is, however, a serious limitation. A randomized clinical trial on apexogenesis treatment with MTA on immature asymptomatic teeth has demonstrated 100% clinical and radiographic success rates. However, they encountered calcification in four of 15 cases in the MTA group after 12-month follow-up.[18] In the present investigation, complete apical closure was observed in 65.2% and 52.1% of the roots in the intervention group (KNO3 in polycarboxylate cement) and the control group (MTA), respectively, at 12 months. Thus, approximately only two thirds to one half of the cases have completed apical closure. This may be due to the age range selected because only those patients with 8 years at the start of the investigation had complete closure at the end of the 1-year follow-up.

CONCLUSION

The clinical and radiographic success reported in the present study reveals that KNO3 in polycarboxylate cement can be used as a biological and economic alternative to MTA as a pulpotomy agent in immature caries exposed permanent molars.

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