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Histopathological Evaluation of Primary Teeth after Pulp Capping with Calcium-Enriched Mixture and Bioactive Glass

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ABSTRACT

Introduction: Direct pulp capping (DPC) is a conservative vital pulp therapy, which has some limitations in primary dentition. The aim of this study was to evaluate pulpal response of primary teeth after DPC with two biocompatible materials naming calcium-enriched mixture (CEM) and bioactive glass (BAG). **Methods and Materials:** This study was designed as a randomized clinical trial. After obtaining informed consent, 20 sound primary canines scheduled for orthodontic extraction, were selected. Following mechanical pulp exposure, the exposed site was capped with either CEM cement or BAG and then restored with amalgam. Teeth were extracted after two months and examined histopathologically. Parameters of hard tissue bridge (HTB) formation, its type and pulpal inflammation scores, were compared between the two groups. Data were analysed using the Fisher's exact test. **Results:** All CEM specimens showed inflammation scores of 0 (less than 10%). In the BAG group, inflammation scores of 0, 1 and 2 were observed in 7, 2 and 1 specimens, respectively. Fisher's exact test showed no significant differences ($P>0.05$). All CEM specimens (100%) formed HTB, which was irregular in all cases. In 7 of 10 teeth in BAG, HTB formed and was irregular. Fisher's exact test revealed no significant differences between the two groups in this regard ($P<0.001$). **Conclusion:** Both CEM and BAG are suitable DPC agents in terms of HTB formation and pulp inflammation scores.

Keywords: Bioactive Glass; Calcium-Enriched Mixture; Direct Pulp Capping; Primary Teeth

Introduction

Direct pulp capping (DPC) of primary teeth is not a routine treatment because of the high pulp cellularity [1, 2] that leads to internal resorption, acute alveolar abscess, risk of pulpal calcification, necrosis and trauma to the adjacent bone [3, 4].

Based on the literature, calcium hydroxide has been considered the gold standard for DPC but dissolves over time and leads to bacterial microleakage, pulp inflammation and necrosis. In addition, calcium hydroxide interferes with the healing process, and the formed dentinal bridge does not provide a suitable seal. Also, the antimicrobial effect of calcium hydroxide is not permanent [5-7]. Thus, it seems rational to use other biomaterials *i.e.* mineral trioxide aggregate for DPC [8].

Calcium-enriched mixture (CEM) cement contains calcium compounds, has antimicrobial properties, is biocompatible and can induce the formation of hard tissue bridge [1, 9]. Therefore, CEM can be effectively used not only for vital pulp therapy [10, 11] but also for sealing furcal perforation in primary teeth [12-14].

The use of bioactive glass (BAG) is relatively new in dentistry [15]. Similarly, it is composed of calcium and phosphate. Also, BAG has antibacterial properties, is biocompatible and stimulates hard tissue formation [16-19].

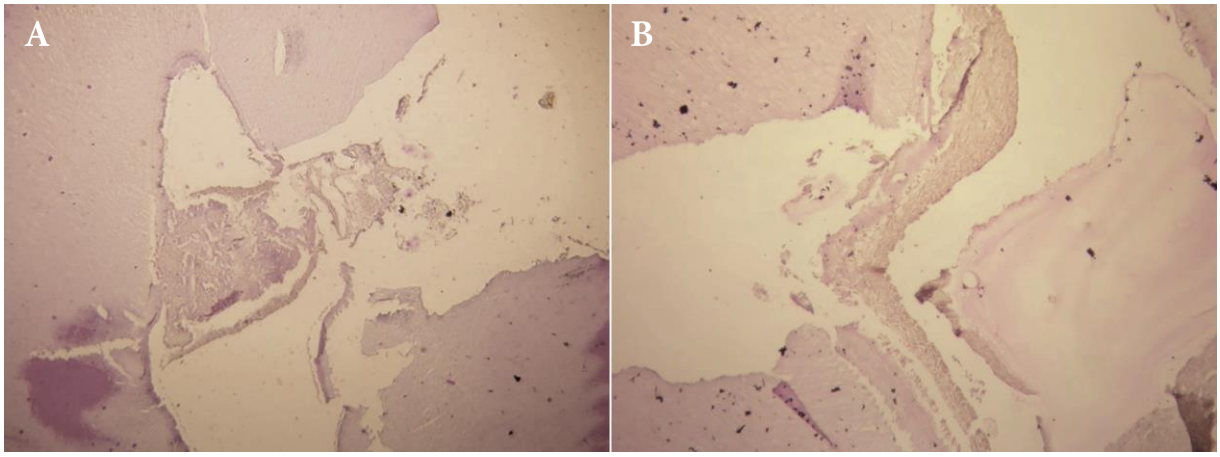

Figure1. *A)* HTB in CEM samples; *B)* HTB in BAG samples

Considering that DPC with calcium hydroxide in primary teeth has a low success rate when compared with the favourable properties of both BAG and CEM, these two latter agents have the potential to show valuable results in this regard.

The aim of this randomized controlled clinical trial was to evaluate both BAG and CEM for pulp capping of primary teeth.

Materials and Methods

This randomised clinical trial was conducted on primary canines which had been scheduled for extraction as part of their orthodontic treatment plan. The sample size was determined to be 20, based on a previous study [20]. The study protocol was approved by the Ethics Committee of Shahed University, Tehran, Iran, and conducted in compliance with the ethical principles of the Helsinki Declaration. The trial has been registered at IRCT (Number: 2017102033162N3) and children's parents signed the informed consent.

Inclusion criteria were sound primary teeth with root resorption no more than the apical third and exclusion criteria were systemic diseases, concomitant medications, spontaneous toothache and uncooperative behaviour.

Teeth were randomly divided into two groups: 10 teeth in CEM cement group and 10 teeth in the BAG group. Randomization was done using a coin by an individual blinded to the experimental groups. A total of 20 class V cavities with a diameter of 0.5 mm were prepared with a carbide bur (D and Z Co., Germany) in the middle third of the buccal surfaces of the teeth and the preparation was continued until the shadow of the pulp was visible. The cavities were rinsed with saline and dried with cotton pellets and dental pulps were exposed with a sterile probe. Haemorrhage was controlled by cotton pellet moistened with sterile saline. Then, in 10 teeth, CEM (BioniqueDent, Tehran, Iran) was placed on the exposure site, and in 10 teeth, BAG Biogran (3i Implant Innovations,Palm Beach Gardens, FL, USA) was placed on the exposure site. All teeth were restored with amalgam [4]. All materials were prepared according to the manufacturers' instructions.

After 2 months, all teeth were extracted and prepared for haematoxylin and eosin (H and E) staining. The sections were studied by a pathologist blinded to the study design. The presence or absence of inflammation, degree of inflammation, presence of an odontoblastic layer and the external appearance of HTB (not formed, complete HTB, partial HTB) were recorded for each specimen. The degree of inflammation was scored as follows: *score 0*, less than 10%; *score 1*, 10%-30%; *score 2*, 30%-50% and *score 3*, more than 50%. The formation of HTB and degree of inflammation were compared between the two groups using the Fisher's exact tests. The level of significance was set at 0.001.

Results

The histological tissue changes in the BAG and CEM groups are as follows: All CEM specimens showed inflammation score of 0 (less than 10%). In the BAG group, inflammation scores of 0, 1 and 2 were observed in 7, 2 and 1 specimens, respectively. Fisher's exact test showed no significant differences ($P>0.05$).

All CEM specimens (100%) formed HTB (Figure 1A), which was irregular in all cases. In BAG, HTB was formed in 7 of 10 teeth and was irregular (Figure 1B). The Fisher's exact test revealed no significant differences between the two groups in this regard ($P<0.001$).

Discussion

Researchers demonstrated that prognosis of DPC in primary teeth is weak due to high chance of internal resorption, calcification and pulp necrosis. Fuks *et al.* [21] reported that undifferentiated mesenchymal cells change into odontoclasts which cause internal resorption. However, as DPC is a conservative method of vital pulp treatment, that eliminates the need for aggressive treatment, it seems logical to find a suitable alternative agent for DPC of primary teeth.

In this study, the success rate of DPC with both CEM and BAG was investigated. The results showed that there was no significant difference in inflammation between the two groups.

A number of efforts has been made to find the appropriate material for DPC. Evidence shows that exposed pulp has the ability of intrinsic repair when it is well sealed to prevent microleakage and it can lead to both reorganisation of the cells and the formation of a dentinal bridge [22].

Both CEM cement and BAG are biocompatible materials and have antibacterial properties that inhibit inflammation in these two groups after DPC.

This study is consistent with the findings reported in previous studies [4, 7, 23]. The results of this research showed that there is no significant difference in hard tissue formation between the two groups.

The combination of components in BAG is calcium and phosphorus in the same ratio as that of hydroxyapatite. This material is biocompatible and stimulates both hard tissue formation and mineralisation [19]. Also, CEM cement contains calcium, is biocompatible, can produce hydroxyapatite crystals and induces mineralisation [23].

These results are consistent with those reported by Mehrdad *et al.* [9], Haghgoo *et al.* [7] and Asgary *et al.* [1, 24]. The formation of hard tissue between the capping material and pulp is a challenging topic because the formation of hard tissue does not necessarily mean healthy pulp. This tissue cannot protect the pulp from bacterial microleakage, but may still be a sign of pulp recovery or inflammation [24, 25].

In this research, the pulp reaction to the two agents studied in canines that were scheduled to be removed because of orthodontic reasons and the limitation of this study was to identify these teeth.

In this study, we investigated pulp changes after two months. We suggest investigating these changes in another study that has a longer duration.

Conclusion

Both CEM and BAG are suitable agents for using as DPC agents in terms of HTB formation and pulp inflammation scores.

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Conflict of Interest: Dr. S. Asgary is the inventor of Endodontic Filling Material; USA, 7,942,961, 2011 May 17. Other authors declare that they have no conflict of interest.

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