Original Article

Comparison of Calcium Hydroxide and Bioactive Glass after Direct Pulp Capping in Primary Teeth

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Abstract:

Objective: Bioactive glass is often used as a filler material for repair of dental bone defects. In different studies osteogenic potential of this material was proved, but its dentinogenesis property is in doubt. The purpose of this study was to evaluate the histological pulp responses of Calcium hydroxide and Bioactive glass placed directly on exposed pulp tissues.

Materials and Methods: Twenty teeth to be extracted due to orthodontic reasons were selected. These teeth were divided into two groups and treated with direct pulp capping. Calcium hydroxide was used for 10 teeth and Bioactive glass for 10 teeth. After 60 days the teeth were extracted and prepared for histological evaluation. Finally the data was analyzed with exact Fisher test.

Results: All teeth treated with Calcium hydroxide showed inflammation. Internal resorption was seen in six teeth, abscess in five teeth and dentinal bridge in two teeth. Inflammation was seen in three Bioactive glass samples and dentinal bridge in seven teeth, but internal resorption and abscess were not seen.

Conclusion: Bioactive glass appears to be superior to Calcium hydroxide as a pulp capping agent in primary teeth.

Key Words: Biogran; Calcium Hydroxide; Dental Pulp Capping

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INTRODUCTION

Children and young adults who have not received early and adequate dental care and optimal systemic fluoride and don't have adequate oral hygiene often develop deep carious lesion in the primary and permanent teeth. Approximately 75% of the teeth with deep caries have been found from clinical observation to have pulpal exposure [1]. Direct pulp capping is a procedure that is carried out when a healthy pulp has been exposed and means covering the exposed pulp with a medicament [2,3]. The standard material for pulp capping of normal vital pulp tissue is calcium hydroxide [1] which have an anti-bacterial effect because of its high pH. Calcium hydroxide can induce profilaration, healing and repair of fibroblasts and therefore soft or hard tissue replacement can occur [4]. Nevertheless, it has been shown that calcium hydroxide seriously impeded the healing process [5]. Calcium hydroxide forms microscopic dentinal bridge that does not provide a continuous seal and bacterial leakage may happen [6], and its antimicrobial properties are lost [7].

Bioactive glasses (BAGs) are relatively new materials in the field of dentistry [8]. They have been studied for more than 30 years as bone substitutes. They react with aqueous solutions and produce a carbonated apatite layer.

BAG is biocompatible and can bind to the bone. But based on present documents BAG is able to stimulate hard tissue formation and mineralization [8]. BAG can be the material of choice for pulp capping and peri apical bone healing because it is biocompatible and has antibacterial property [9]. Results of studies have shown that BAG can repair bone lesions through osteoblastic potential [10] so it is logical that odontoblastic activity of BAG is survived.

The purpose of this study was to compare the dental pulp response in human primary teeth when BAG and $Ca(OH)_2$ were used as direct pulp capping agent.

MATERIALS AND METHODS

This study was done as an experimental one. This histological evaluation was performed in 20 healthy primary canines to be extracted for orthodontic reasons. All of the teeth were sound and did not have any root resorption more than one third. The children were seven to 8.3 years old with the mean age of 7.2. Written informed consent was obtained from the parents of the patients. Twenty teeth which met the inclusion criteria were randomly allocated into two groups: calcium hydroxide or BAG. Cavity preparation included 20 class five cavities that were prepared 1 mm coronal to the gingival margin on the facial surfaces of these teeth. These cavities were prepared with a carbide bur at high speed with water spray. Preparation continued until shade of unexposed pulp was seen under dentin as a pink spot. After rinsing with physiologic saline and drying with cotton pellets, an exposure 0.5 mm to 0.7 mm in diameter at mesio-distal center of the preparation was made in to the coronal pulp chamber with a sterile, sharp probe. Hemorrhage was controlled by placing a cotton pellet moistened in sterile with slight pressure. The materials were then placed gently over the exposure: $Ca(OH)_2$ (Bosworth Hyd rox TM, USA) in 10 teeth (control group) and BAG Biogran® (3i Implant Innovations, USA) in 10 teeth (experimental group) and all of the teeth were restored with glass ionomer.

These 20 teeth were extracted after 60 days. Serial sections were cut for H&E staining. Then a pathologist who was not informed about study design studied these sections. The evaluation was performed according to the criteria by Fuks et al [11]: 0, none or mild inflammation; 1, moderate inflammation; 2, severe inflammation; 3, necrosis; 4, abscess; 5, resorption.

In addition, the presence or absence of a dentin bridge was also evaluated. Finally the data was analyzed by exact Fisher test.

Table 1. Tissue changes in both groups.

Pulpal response	Calcium hydroxide	BAG
Mild inflammation	2	0
Moderate inflammation	5	2
Severe inflammation	3	1
Internal resorption	6	0
Abscess	5	0
Necrosis	0	0
Dentinal bridge	7	2

BAG = Bioactive Glass

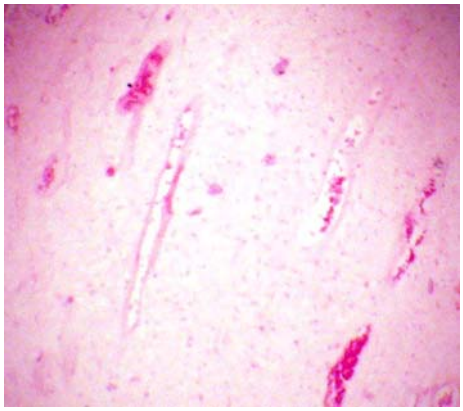

Fig 1. Calcium hydroxide at 60 days showing areas of inflammation (H&E× 40).

RESULTS

The histopathologic tissue changes in both calcium hydroxide and BAG groups are shown in Table 1. All of the pulps capped with $Ca(OH)_2$ showed inflammation and inflammation were

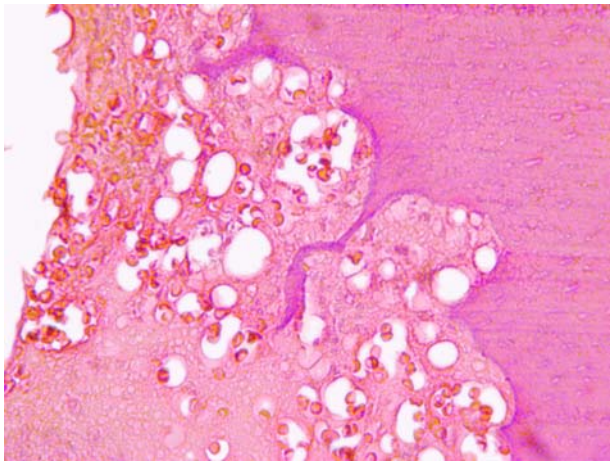

Fig 2. Calcium hydroxide at 60 days showing internal resorption (H&E× 40).

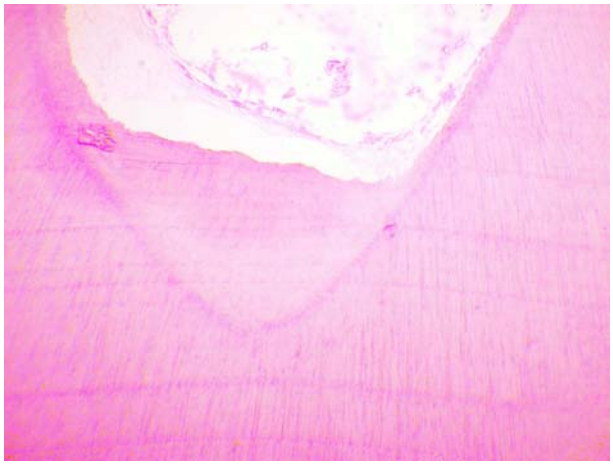

Fig 3. Bioactive glass at 60 days showing dentinal bridge (H&E× 40).

seen in three teeth in BAG group (Fig 1). Exact Fisher test showed significant difference ($P<0.05$). Internal resorption was seen in 6 teeth in $Ca(OH)_2$ group and all of the teeth in BAG samples were free of internal resorption (Fig 2).

There was a statistically significant difference ($P<0.05$). Abscess was seen in five teeth in $Ca(OH)_2$ samples and none of teeth in BAG group showed abscess and the difference was statistically significant ($P<0.05$). Dentin bridge was seen in two teeth in $Ca(OH)_2$ samples and seven teeth in BAG samples (Fig 3) and according to exact Fisher test there was no significant difference. Reparative dentin was seen in six teeth in BAG group and two teeth in $Ca(OH)_2$ group, showing a significant difference ($P<0.05$).

DISCUSSION

Bioactive glass has been used in orthopedic and plastic surgery since 1984 [9,10]. It is a biomaterial and due to its osteoconductivity can be applied for infrabony periodontal and furcation defects [12]. It has been shown that BAG improves osteointegration around implants [13,14]. BAG has been used in bridge augmenting procedures successfully. Fiber-reinforced BAG can be tested as implant [15]. BAG has antibacterial effect against supra-gingival and sub-gingival microorganisms [16].

Based on the various properties of BAG, the present study was designed to test BAG as a direct pulp capping agent in human teeth.The present study is the first one that uses BAG in the primary teeth as direct pulp capping material.

In a study, Salako et al [17] pulpotomized molar teeth of Spragu-Dawley rats with MTA, formocresol, ferric sulfate or BAG. Then pulps of these teeth were analyzed two and four weeks after pulpotomy. Inflammatory changes in the pulp were seen in 2-week-old BAG samples. Histologic evaluation of the 4-week-old samples was better than the 2-week ones. In the most of the samples pulp tissue was normal [17].

According to the findings obtained in the present study, most samples demonstrated normal pulp tissue, which was in accordance with the results of an investigation conducted by Salako et al [17]. It can be inferred that BAG can induce a healing/ recovery period during which restoration of pulpal morphology is attempted. Internal resorption was seen in six teeth in $Ca(OH)_2$ group and none in the BAG group. Calcium hydroxide seriously impeded the healing process [5] and some authors believe that undifferentiated mesenchymal cells may

differentiate in to odontoclasts, leading to internal resorption [18], whereas BAG is biocompatible [9] and can restore pulpal histology.

Abscess was seen in five teeth in $Ca(OH)_2$ and none in BAG group. $Ca(OH)_2$ destroys the underlying healthy pulp tissue leaving a necrotic layer because of its alkaline pH. Degenerative changes may occur in the remaining pulp tissue [19], however BAG has antibacterial property [9] and underlying pulp probably remains vital.

Dentinal bridge was seen in 6 teeth of calcium hydroxide group and seven teeth of BAG group and two teeth of $Ca(OH)_2$ group. The results of a study conducted by Salako et al [17] showed no dentinal bridge formation.

Histological evaluation of that study was done after 2-4 weeks. Probably if evaluation period were longer, signs of dentinal bridge formation would be seen.

Furthermore, Salako et al [17] pulpotomized rat teeth with BAG and compared the results with their MTA, formocresol and ferric sulfate samples. In the current investigation direct pulp capping was performed with BAG and $Ca(OH)_2$ in human teeth. The differences between animal and human pulp may have affected the results of these two studies.

BAG has the capacity to serve as inductive material for hard tissue formation and mineralization [8] but it has been shown that the microscopic calcified bridge formed by $Ca(OH)_2$ does not constitute a continuous seal and may allow bacterial leakage through numerous defects [6].

CONCLUSION

Based on the results of this study, BAG maybe better than $Ca(OH)_2$ as a pulp capping agent in primary teeth.

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