Evaluation of sealing ability of Biodentine™ and mineral trioxide aggregate in primary molars using scanning electron microscope: A randomized controlled *in vitro* trial

Allwyn Samuel, Sharath Asokan, P. R. Geetha Priya, Seby Thomas

Abstract

Objective: The aim of this study was to compare the sealing ability of mineral trioxide aggregate (MTA) and Biodentine™ when used to repair the furcal perforations in primary molars using scanning electron microscope (SEM). **Study Design:** The study sample comprised forty recently extracted primary molars. These teeth were placed in a 5.25% sodium hypochlorite solution for 24 h and washed with tap water. Access cavities were made using a round bur in high-speed handpiece. Perforations were made in the center of the floor of the pulpal chamber using a 0.5 mm round bur. The teeth were randomly assigned into two experimental groups based on the material used to seal the perforation: Group A – MTA and Group B – Biodentine™. The packed materials were allowed to set for 24 h. The samples were sectioned longitudinally and the extent of marginal adaptation was measured by SEM. Wilcoxon-signed rank test was used for statistical analysis using SPSS software. **Results:** All teeth exhibited microleakage, but Biodentine™ showed significantly less leakage (0.149) compared to MTA (0.583). **Conclusion:** Based on the results of this study, Biodentine™ showed lesser microleakage compared to MTA and thus may be a good alternative to MTA.

Keywords: Biodentine™, furcation, mineral trioxide aggregate, scanning electron microscope

Introduction

Accidental perforations of pulpal floor during endodontic treatment affect the prognosis of the treatment. The prognosis is affected by various factors such as the size, location, and time of perforation as well as the ability of the material used to seal the defect. These perforations can be repaired nonsurgically with suitable biocompatible, nontoxic, radiopaque, nonabsorbent material, thus preventing bacterial contamination. In permanent teeth, several materials have been suggested for perforation repair such as amalgam, calcium hydroxide, reinforced zinc oxide-eugenol cements, mineral trioxide aggregate (MTA), calcium-enriched mixture (CEM) cement, and Biodentine™.[1]

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MTA was introduced by Lee *et al*. in 1993 for repair of lateral root perforations.[2] It consists of dicalcium silicate, tricalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite. Although MTA has certain drawbacks such as long setting time, poor handling, and relatively high price, it has a superior sealing ability compared to other restorative materials when used for repairing perforations.

Furcal repair in primary teeth Has become more essential than extraction, to prolong the longevity of the tooth. Oliveira *et al*.[3] showed that the tooth with furcal perforation treated with MTA was asymptomatic after 20 months and also concluded that bone formation was seen in the furcation area. Haghgoo *et al*.[1] concluded that CEM and MTA have similar sealing ability in furcal perforation repair of primary molar teeth.

Biodentine™ is relatively new calcium silicate-based material introduced as a dentine substitute by Septodont® in 2009. It is mainly composed of highly pure tricalcium silicate, which regulates the setting reaction, calcium carbonate (filler), zirconium dioxide (radiopacifier), calcium chloride (setting accelerator), water reducing agent (superplasticizer), and

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water.[4] It has been claimed that this material can be used for pulp capping, pulpotomy, apexification, root perforation, internal and external resorption and also as a root-end filling material in periapical surgery.

Literature search showed no studies in assessing the effect of Biodentine™ in primary tooth perforations. Hence, the present *in vitro* study was planned to compare the sealing ability of MTA and Biodentine™ when used to repair the furcal perforations in primary molars using scanning electron microscope (SEM).

Materials and Methods

A randomized controlled *in vitro* trial was planned, and the study protocol was approved by the Institutional Review Board.

Forty extracted human primary molars with complete roots were included in the study. The exclusion criteria included the samples with root resorption where the furcal area could not be involved. The samples were stored in 5.25% sodium hypochlorite for 24 h for the removal of tissue remnants. After 24 h, the samples were washed and stored in saline (0.9% w/v, Nirlife, Nirma Limited, Gujarat, India) until the preparation was done. All the forty samples were embedded in a modeling wax (Hindusthan No. 2, The Hindustan Dental Products, Hyderabad, India).

A 0.5 mm round diamond bur was initially used to prepare the access cavity. A standard access cavity was prepared in each tooth using a diamond bur and non-end cutting bur in high-speed handpiece with water spray. A 0.5 mm round bur was used to standardize the size of furcal perforation, and the furcal involvement was made on the center of the pulpal floor. After the furcal perforation, the blocks were randomly divided into two groups: Group A ($n = 20$) and Group B ($n = 20$).

Group A – MTA Group (Angelus, Angelus Industries, Brazil). The powder and liquid were dispensed in a glass slab and mixed in circular motion. The material was carried using MTA applicator and sealed in the furcation site.

Group B – Biodentine™ Group (Biodentine™, Septodont®, France). The powder and liquid in a capsule were manipulated using triturator for 30 s. The material was scooped and applied on the perforation site.

All the sealed perforations were compacted using a moist cotton pellet, and the samples were stored in a closed container for 24 h to allow the repair materials completely set. After 24 h, the samples were sectioned using a hard tissue microtome and the perforated portion of the teeth was taken for examination. The samples were gold sputtered and viewed under SEM in different magnifications (50×, 500×, 750×, 1000×, 3000×) for evaluating the sealing ability and the intra-molecular space between the materials as shown in [Figures 1-4]. The microleakage was evaluated by measuring the gap (in μm) between the pulpal floor and the material used for the furcal repair.

Results

Wilcoxon-signed ranks test was used for statistical analysis using SPSS Statistical Package (SPSS Statistics for Windows, Version 17.0, SPSS Inc., Chicago, IL, USA). The overall results showed that the microleakage was lesser in Biodentine™ (0.149 ± 0.097) when compared to that of MTA (0.583 ± 0.24). Table 1 shows that Biodentine™ had more sealing ability than MTA in 18 samples whereas MTA had only 1 sample which showed better sealing ability than Biodentine™. One sample in both the groups revealed equal ability. There was a statistically significant difference in the sealing ability between the two groups ($P < 0.01$). Graph 1 shows the mean value of the microleakage in both the groups. MTA had higher microleakage (0.583) than Biodentine™ (0.149).

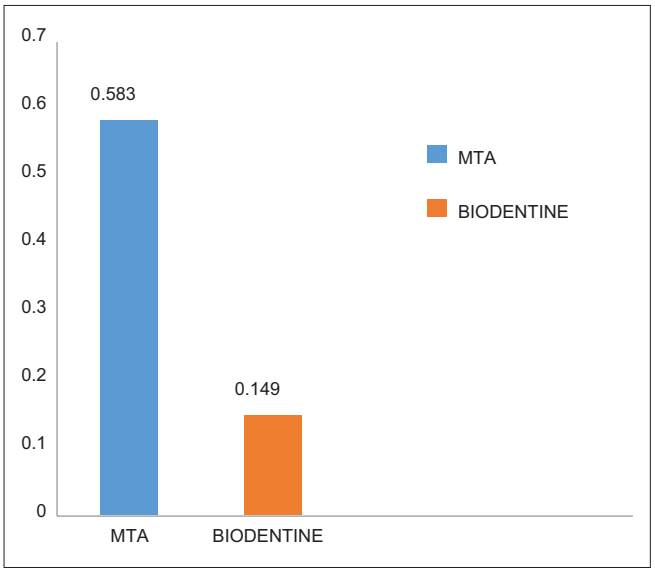
Discussion

The success of the furcation repair is always dependent on the effective seal between the root canal and the periodontal

Table 1: Statistical ranks for microleakage in two groups

	n	Mean rank	*P*
Biodentine - MTA			
Negative ranks	18[a]	10.50	<0.01
Positive ranks	1[b]	1.00	
Ties	1[c]		
Total	20		

[a]Biodentine < MTA; [b]Biodentine > MTA; [c]Biodentine=MTA. MTA: Mineral trioxide aggregate



Graph 1: Comparison of the mean microleakage values in µm of Biodentine and mineral trioxide aggregate

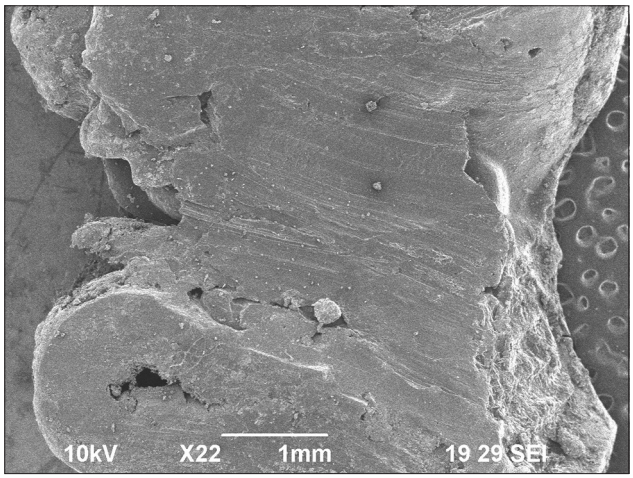


Figure 1: Sealing ability of Biodentine with pulpal floor

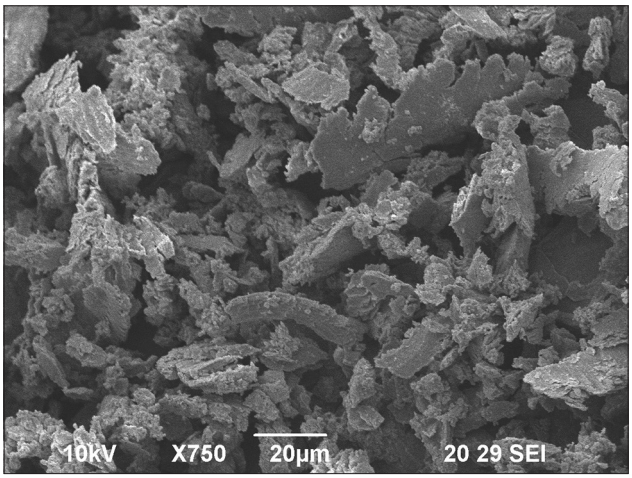


Figure 2: Intramolecular space in Biodentine material

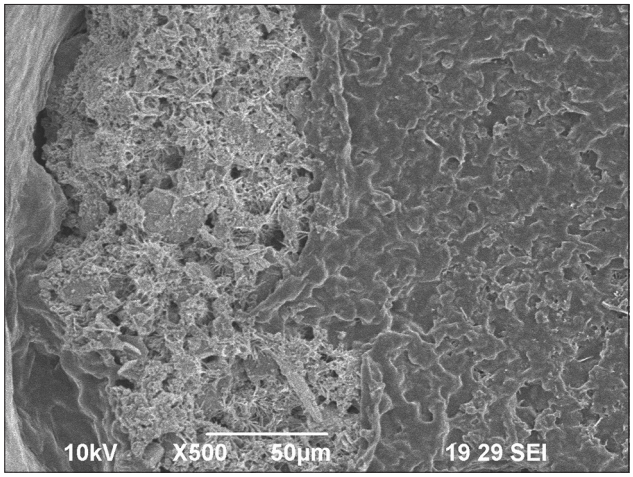


Figure 3: Sealing ability of mineral trioxide aggregate with pulpal floor

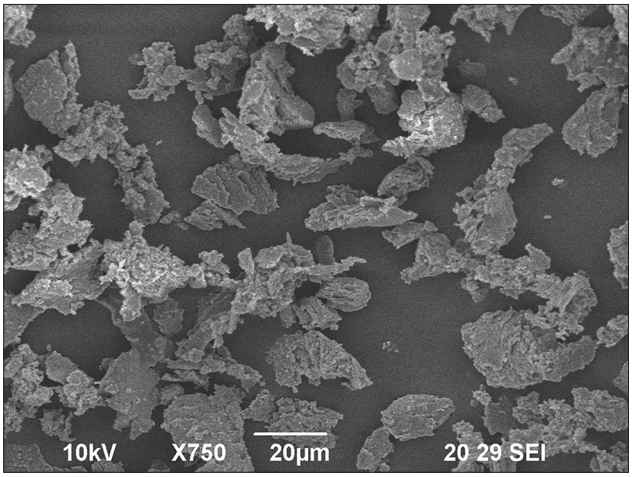


Figure 4: Intramolecular space in mineral trioxide aggregate material

ligament. This can be achieved by a suitable material which should stop the microleakage and communication between the tooth and periodontal ligament. To obtain success, the perforation repair material should ideally result in formation of new bone, periodontal ligament and cementum. Previous studies have shown that cementogenesis is a vital process in dentoalveolar formation and the newly formed cementum acts a biological barrier against the spread of microbial irritants within the root canal system.[5] MTA and Biodentine™ are capable of causing complete regeneration of the adjacent dentoalveolar tissue in permanent teeth and are hence used in furcal perforation repairs.[6]

Various techniques such as bacterial leakage, fluid filtration method radioisotopes, and dye penetration were used to measure the sealing ability of repairing materials.[7] Orosco *et al*.[6] stated that for evaluation of marginal adaptation, the samples can be directly viewed under SEM after gold sputtering and there is no need for creation of resin replicas as direct SEM evaluation of the samples did not result in artificial gap formation; hence, we sectioned the samples and examined its interface directly under SEM.

The search for alternative materials has been aimed to overcome the drawbacks of previously used materials to reduce the cost and to increase the feasibility to both professionals and patients. This present study is the first of its kind to compare the sealing ability of Biodentine™ and MTA in repairing the furcal perforation in primary molars using SEM.

Biodentine™ is very similar to MTA in basic composition. The manufacturers claim that the addition of setting accelerators and softeners, a new predosed capsule formulation for use in a mixing device predominantly improves the physical properties of the material, making it more user-friendly. Biodentine™ does not require two-step obturation as the setting is faster and thus is lower risk of bacterial contamination making it superior to MTA.

Soundappan *et al*.[8] evaluated the marginal adaptation of Biodentine™ in comparison with MTA and intermediate restorative material (IRM) using SEM. They conducted the study using thirty permanent central incisors and stated that in overall comparison, MTA and IRM were significantly

superior when compared to Biodentine™ in terms of marginal adaptation when used as retrograde filling material.

Kaup *et al*.[9] compared the solubility, microhardness, radiopacity, and setting time of Biodentine™ and ProRoot MTA. They stated that the ProRoot MTA showed lower solubility with higher setting time and the radiopacity of Biodentine™ which did not fulfill the requirements as per the ISO 6876:200.

Kokate and Pawar[10] evaluated the microleakage of three root-end filling materials: MTA, glass ionomer cement, and Biodentine™ using dye penetration method in thirty permanent central incisors and concluded that microleakage was found to be significantly less in Biodentine™. The results of the present study also showed less microleakage in the Biodentine™ group compared to MTA group.

Conclusion

From this *in vitro* study, it can be concluded that Biodentine™ showed lesser microleakage compared to MTA and may be a good alternative to MTA in sealing the furcal perforations in primary molars, thereby increasing the life of the tooth.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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