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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF THE SEALING ABILITY OF BIODENTINE AND MTA IN FURCATION REPAIR –AN IN VITRO STEREOMICROSCOPIC STUDY

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ABSTRACT

Aim: To evaluate and compare the sealing ability of a new material, biodentine with MTA when used as a furcation repair material.
Material and method: Thirty recently extracted mandibular molars with non-fused well developed roots were collected and intentional furcation perforations were made with a bur. The perforations were repaired with MTA andbiodentine. These specimens were then immersed in 2% methylene blue dye. After their removal, they were sectioned and examined under stereomicroscope to evaluate dye penetration.
Results: Demonstrated that furcation perforation repaired with MTA showed decrease in microleakage compared with that of biodentine, However there was no statistical significant difference between the two groups.
Conclusion: Both MTA and biodentine showed good sealing ability when used as furcation repair material.

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INTRODUCTION

The American Association of Endodontists (AAEs) Glossary of Endodontic Terms defines perforations as the mechanical or pathologic communication between the root canal system and the external tooth surface (Hatim *et al*., 2006). The etiology of perforations are caries, resorption, or iatrogenic factors. It can occur as a result of a misdirected bur during access preparation, while search of canal orifice in the chamber, during preparation of the post space or due to excessive flaring of the cervical portion of the curved roots in molars. Persistent bleeding into the pulp space may be the first evidence of an iatrogenic perforation, Blood in the middle of the chamber floor in a molar indicates the possible presence of a furcation perforation (DivyaShetty *et al*., 2012). Perforation is a procedural error that can have a profound effect on treatment prognosis.

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It has been reported that perforations are a common cause of endodontic failure. According to Washington study in determining the success and failure of endodontic treatment reported that 9.61% of failure was due to perforation which occurs when trying to find the orifice of the canal at the floor of pulp chamber (Zohrehahangari, 2006). Regardless of the cause, perforation allows bacterial invasion into the supporting structures that initially intiates inflammation and loss of attachment, which eventually may compromise the prognosis of the tooth (Hatim *et al*., 2006). Diagnosis of iatrogenic perforation requires a combination of symptomatic findings and clinical observations. Identification of root perforations is possible through diagnostic aids that include direct observation of bleeding, indirect bleeding assessment using a paper point, two or more radiographs taken at various angles for comparison and use of apex locators (DivyaShetty *et al*., 2012). However management of a perforation still remains a challenge in endodontics as there is no ideal means to repair a perforation defect. Perforation repair can be achieved intra coronally or by external surgical approach in which usually the former precedes the latter. The important factor in both approaches is however in achieving a good seal between the

tooth and the periodontium (DivyaShetty *et al*., 2012). The quick sealing of the perforation and the successful healing of the region are crucial for salvaging the tooth. The material should be essentially biocompatible, non – toxic, non – carcinogenic, completely resorbable and easily sterilizable. Above all, it should provide adequate seal, non penetrable to bacteria and induce osteogenesis and cementogenesis (Sanoopgeorge *et al*., 2010). Several materials have been used to repair furcation perforations, including zinc oxide-eugenol cements (IRM and Super-EBA), glass ionomer cement, composite resins, resin-glass ionomer hybrids, and mineral trioxide aggregate (MTA) (Seong-Tae Hong *et al*., 2008).

MTA was developed at Loma Linda University in the 1990s as a root-end–filling material. The chemical composition of MTA was determined by Torabinejad *et al*. They declared that calcium and phosphorus were the main ions in MTA (Ahmed Abdel RahmanHashem and Ehab E Hassanien, 2008). However MTA is reportedly difficult to use because of its long setting time, poor handling properties, high material cost and discolouration potential of dental tissue (Parirokh and Torabinejad, 2010; Damamaschke *et al*., 2005). A newly researched material with largely improved physical properties BioDentine has been introduced which can be used as a perforation repair material. BioDentine is a calcium silicate based cement, it has increased physico-chemical properties like short setting time, high mechanical strength which make it clinically easy to handle and compatible, not only with classical endodontic procedures, but also for restorative clinical cases of dentine replacement (Hui-min Zhou *et al*., 2013). The quality of seal achieved by furcation repair materials has been assessed by various means like the degree of dye penetration, radioisotope penetration, bacterial penetration, electrochemical means and fluid filtration techniques (Hatim *et al*., 2006). The dye penetration method used for measuring sealing ability is the most popular. According to the various studies conducted, methylene blue has been proved to be a useful aid in detecting microleakageendodontics (Janani Balachandran and Gurucharan, 2013). Therefore the purpose of this study was to compare and evaluate the sealing ability of two calcium silicate based materials biodentine and MTA as furcation repair materials.

MATERIALS AND METHODS

Freshly extracted 30 intact, non-carious, non fusedhuman mandibular first molarscollected during a period of 3 month from department of oral and maxillofacial surgery were used in this study. All teeth were disinfected using sodium hypochlorite (3 % vensone, India) for 30min. All soft tissue and debris was removed using ultrasonic tips and stored in normal saline at room temperature. A standard endodontic access cavity was prepared using high speed Endo Access Bur (Dentsply). The content of the pulp chamber was removed and the cavities were irrigated using normal saline. In the next step perforations were made between the mesial and distal orifices in pulp chamber floor using high speed long shank round carbide bur (no 2).

The width of the perforation will be equal to the diameter of the perforating bur but the length depends on the dentin and cementum thickness. All preparations were rinsed with distilled water and dried with compressed air. Moist cotton was placed in between the roots at the perforation area during the repair of perforation in order to simulate the oral environment. Prepared teeth were randomly divided into 2 control groups (n=5) and 2experimental groups.(n=10).

Control Groups

Positive controls - Five teeth in which the perforations were made and access cavity filled with composite resin
Negative controls - Five teeth in which perforation were made and access cavity were not filled with composite resin

Experimental group

Group 1 - Consist of 10 molars in which perforations were repaired with Biodentine (Septodont).
Group 2- Consist of 10 molars in which perforations were repaired with Mineral Trioxide Aggregate. (MTA, Angelus).

After 24 hrs the access cavity were filled with composite resin. All teeth were placed in a themocycling device for 2days surfaces of the molars including access filling were covered completely with two successive layers of nail varnish except around the perforation area such that dye would penetrate only through the perforation area fig (1 a) . The specimen were placed in 2% methylene blue dye solution for 7 days and then rinsed under tap water for 30 minutes teeth were splitbuccolingually with a diamond disc in a high speed lathe fig (1 b) .The depth of dye penetration were examined under a stereomicroscope (2X) to evaluate the furcation area for the extent of microleakage and scored.

Criteria for microleakage evaluation of dye penetration along the repair material

Score	Details
0	No leakage could be detected
1	Leakage extending to 1⁄4 of the repair material
2	Leakage extending to 1⁄2 of the repair material
3	Leakage extending to 3⁄4 of the repair material
4	Leakage extending beyond 3⁄4 of the repair material

The sample were subjected tochi square test

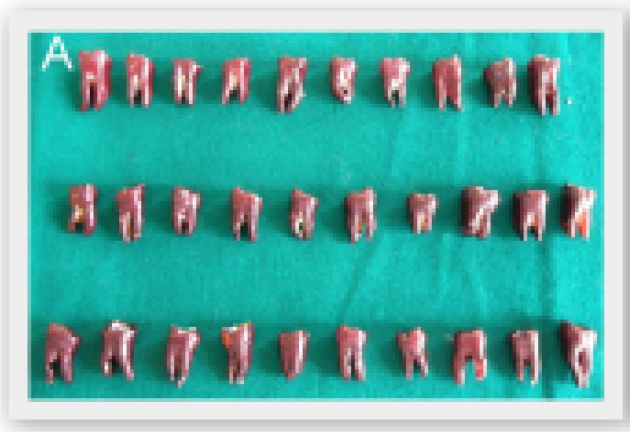
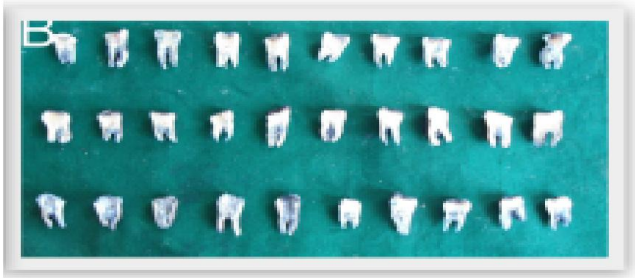


Figure 1A. Total no of sample



1B. Samples after sectioning

RESULTS

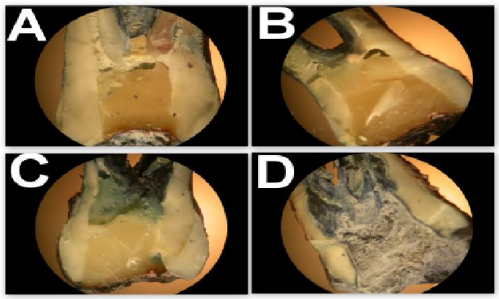


Figure 2. A-Dye penetration biodentine,
B-dye penetration MTA,
C - Positive Control,
D– Negative Control

Table 1. Reveals the classification of subjects on Response Scores with Biodentin and MTA

Scores	Biodentin		MTA	
	N	%	N	%
Zero	1	10.0	4	40.0
One	7	70.0	2	20.0
Two	2	20.0	4	40.0
Total	10	100.0	10	100.0
$\chi 2$ Value		5.244 NS		

NS : Non-Significant, $\chi 2(0.05,2df) = 5.991$

The findings indicate that 10 percent of the sample under Biodentin had score zero
70 percent of sample had score 1
20 percent with score 2.
MTA 40 percent of sample had zero score
20 percent had score 1
40 percent had score 2.

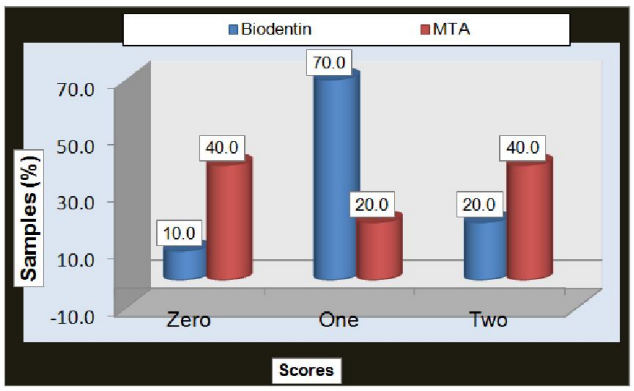


Figure 3. Response Scores of Subjects on Biodentin and MTA

However, the classification of subjects with respect to scores between Biodentin and MTA found to be non-significant ($\chi 2$= 5.244, p>0.05)

DISCUSSION

Today in the era of regenerative endodontics, continual research into the field of bio-materials, has made restoring back original form and function of even the most complicated cases a reality. A furcation perforation is one such complication that refers to mid-curvature opening in to the periodontal ligament space and leads to worst possible treatment outcome[10]. Accidental perforation complicates the treatment and compromises the prognosis if it is not managed properly. It is crucial that the perforation site does not become infected, and the immediate repair of the perforation should be undertaken if possible (Manoj Komath and HarikrishnaVarma, 2002). Sinai found that the prognosis of a tooth with a perforation depends on the location of the perforation, the amount of time the perforation is open to contamination, the possibility of sealing the perforation and accessibility of the main canal (DivyaShetty *et al*., 2012).

Bryan *et al* reviewed the etiology, diagnosis, prognosis and material selection of nonsurgical repair of furcation perforation and stated that the furcal perforations as such had a poor prognosis and thus should be sealed immediately with a biocompatible and sealable material (DivyaShetty *et al*., 2012).

The quick sealing of the perforation and the successful healing of the region are crucial for salvaging the tooth. This poses stringent requirements on the properties of the sealing materials. It should be essentially biocompatible, non – toxic, non – carcinogenic, completely resorbable faster setting and easily sterilizable (Manoj Komath and HarikrishnaVarma, 2002).

MTA has been investigated and used as a perforation repair material since its introduction . MTA has a high Ph of 12.5 and seems to seal the furcation area effectively. The main constituents of this material are calcium silicate, bismuth oxide, calcium carbonate, calcium sulphate, and calcium aluminate. Hydration of the powder produces a colloidal gel that solidifies into a hard structure consisting of discrete crystals in an amorphous matrix (DivyaShetty *et al*., 2012).

The reason for MTA to provide the best sealing ability in this study when compared to the other materials used may be due to the excellent adaptation of the material to the external margins of the perforation cavities. MTA also has a paste like consistency which allows the material to flow into the irregularities of the external margins (DivyaShetty *et al*., 2012).

The improved sealing ability of MTA is due to its hydrophilic nature and slight setting expansion. In the presence of water MTA partially dissolves producing hydroxyapatite crystals, which provides a mechanical seal by filling the microscopic spaces between MTA and the dentinal wall. With time, a diffusion controlled reaction between the apatite layer and dentin leads to their chemical bonding. The favorable

interaction of MTA with osteoblasts and its ability to induce cytokine production make it a biologically active substrate for bone cells (KrantiKumariBellam *et al*., 2009).

BioDentine is similar to MTA in basic composition .Tricalcium Silicate forming the main Core Material, Dicalcium Silicate Second Core Material, Calcium Carbonate as Filler Iron Oxide –Shade, Zirconium Oxide- Radiopacifier, Calcium Chloride –Accelerator Hydrosoluble Polymer -Water Reducing Agent (Manoj Komath and Harikrishna Varma, 2002). The modified powder composition i.e the addition of setting accelerators and softeners, a new pre dosed capsule formulation for use in a mixing device largely improve the physical properties of the material making it more user-friendly. Increasing the setting time was achieved by a combination of different effects. First, particle size greatly influences the setting time, since the higher the specific surface, the shorter the setting. Also, adding calcium chloride to the liquid component accelerates the system. Finally, the decrease of the liquid content in the system decreases the setting time to harden within 9 to 12 minutes (Sharad R. Kokate and Ajinkya M. Pawar, 2012).

The uptake of Ca and Si by the dentine in contact with both Biodentine and MTA occurred following Phosphate Buffered immersion. This may represent the biomineralisation ability of these calcium silicate materials promoted by the interaction with dentine in the presence of phosphate-containing solutions (Sarkar *et al*., 2005, Reyes-Carmona *et al*. 2009, 2010). Ca and Si uptake most probably causes chemical and structural modification of dentine, which may result in higher acid resistance and physical strength. The apatite-forming ability of an artificial material in the presence of phosphate solutions ex vivo is regarded as a prerequisite for achieving bonds between the material and living bone (Kokubo and Takadama 2006). It is known that calcium silicate–based ceramic materials commonly exhibit bioactivity to induce bone-like apatite formation (Liu *et al*. 2008); various calcium silicate–based ceramic materials are reported to show such activity, including ortland cement (Tay *et al*., 2007; Reyes-Carmona *et al*., 2009), dicalcium silicate (Gou *et al*. 2005) and tricalcium silicate (Zhao *et al*., 2005) (FirasDaoudi *et al*., 2002).

The dye-penetration technique has long been used in endodontics because of its ease of performance and difficulty of other available techniques. Camps and Pashley reported that the dye-extraction method gave the same results as the fluid-filtration method and also saved much laboratory time Ahmed (Abdel RahmanHashem and Ehab E Hassanien, 2008. In this present study MTA showed a decrease in the microleakage than biodentine but there was no statistical significant difference between the two groups as shown in Table 1. The formation of the interfacial layer and tag-like structures between the tooth and material may be responsible for the good marginal seal of MTA. The biomineralisation ability confers the material with greater resistance to dislodgement, most likely through the formation of tags, which constitutes micromechanical anchorage (Han and Okiji, 2011). Biodentine is believed to have the potential to exhibit similar characteristics.

Conclusion

Within the limitation of this study it can be concluded that both biodentine and MTA showed good sealing ability when used as furcation repair material. Biodentine can thus be a promising material for furcation repair as it overcomes some of the disadvantage of MTA like long setting time, poor handling characteristic and high cost.

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