Sealing ability of Biodentine as a root Perforation Treatment Material (An in Vitro Study)

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Key words
Biodentine , dye leakage, furcation perforation

Abstract

Perforation of the root canal system is the second large cause of root canal failure. Failure to seal the perforation defect permits rapid break-down of the periodontium and tooth loss. Hence sealing the defect is paramount. **Aims**: This study was conducted to evaluate the sealing ability of a new material, self-setting dentine substitute (Biodentine) in furcation perforations and compare it with Mineral trioxide aggregate and glass ionomer cement. **Materials and Methods**: Fifty five (55) recently extracted permanent lower molars with non-fused well developed roots were collected and intentional perforations were made in the furcation area with a bur. The perforations were repaired with Biodentine for group(A) ,mineral trioxide aggregate (MTA) for group (B) and glass ionomer cement(GIC) for group (C). The specimens were then immersed in 2% methylene blue dye for 48 hour. After their removal, they were sectioned and examined under stereo microscope to evaluate dye penetration. **Results**: demonstrated that furcation perforation repaired with Biodentine showed least microleakage. **Conclusion** Biodentine demonstrated better results than MTA and GIC.

Introduction

In endodontic practice procedural accidents are encountered that will affect the prognosis of root canal space therapy. [1]One of these accidents is endodontic perforation; which can often result in the loss of periodontal tissue. [2] The root perforation can be repaired surgically, but a furcation perforation is surgically in accessible.[3]Therefore, furcal perforations have a more unfavorable prognosis than the perforations occurring in the middle and apical root thirds.[4] However the material employed for sealing is one of the important factors for prognosis that directly interfere with the repair of these defects.[5] Several materials have been proposed for sealing of perforations. Different outcomes have demonstrated that so far no ideal sealing material has been achieved to provide optimal sealing, easy manipulation, biocompatibility and ability of induction of osteogenesis and cementogenesis.[6, 7] Mineral trioxide aggregate (MTA) has been recommended as a repair for root perforation.[8,9] The main drawbacks of this material has been slow setting time and complicated handling, which rendered these technique – sensitive procedures even more difficult and restricted their use. [10,11] Biodentine™cement is a part of a new approach seeking to simplify clinical

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procedures. A modified powder composition, the addition of setting accelerators and softeners, and a new predosed capsule formulation for use in mixing device, largely improved the physical properties of this material making it much more easy to use .[12,13] Biodentine™ (Septodont, Saint Maur des Foss'es, France) is a high-purity calcium silicate–based dental material composed of tricalcium silicate, calcium carbonate, zirconium oxide, and a water-based liquid containing calcium chloride as the setting accelerator and water-reducing agent. Biodentine is recommended for use as a dentin substitute under resin composite restorations and an endodontic repair material because of its good sealing ability, high compressive strengths, short setting time, [14] biocompatibility,[15] bioactivity,[16] and biomineralization properties.[17] The purpose of this study was to evaluate the sealing ability of Biodentine cement in furcation perforation repair and compare it with mineral trioxide aggregate and glass ionomer cement.

Material and Methods

Fifty- five recently extracted permanent lower molars with non-fused well developed roots were collected from a private clinic in Mosul city , and randomly divided into five groups: Group **A**:(15 teeth), perforations were repaired with Biodentine™(Septodent – Saint Maur, desFoss's, France). Group **B**: (15 teeth) , perforations were repaired with MTA (Pro Root, Tulsa, Dentsply).Group **C**: (15 teeth) , perforations were repaired with GIC glass ionomer cement (Medifil, ProMedica, Germany).Group **D**: (5 teeth), Positive control: perforations were not repaired with any material. Group **E**: (5 teeth), Negative control: unrepaired intact teeth.

Access cavity preparations were done on the three experimental groups and the positive controls. The pulp tissue remnants and debris were cleaned. Using a hand piece fitted to drill press (to standardize perforation diameter and parallelism to the long axis of tooth), perforations were made on the center of the floor of the pulp chamber using size # 2 carbide round bur. A moist cotton pellet(which did not act as a matrix for repair material) was placed in the furcation area to simulate wet clinical field. The perforations were repaired with the concerned repair material. The pulp chamber and access preparations of all these 4 groups were filled with visible light activated composite. Now all the teeth in groups (A, B, C, D and E) were coated with two layers of nail polish except for 1-2 mms around the furcation perforation. The five teeth in the positive control group were accessed and perforated in the same manner without any further treatment. The main objective was to demonstrate that the dye used in this study could penetrate through the perforation. All these teeth were kept in the incubator at(37^0C) for 24 hours to allow the experimental materials to completely set, all the teeth were then immersed in 2% methylene blue dye for 48 hours. After removal from dye, the teeth were rinsed in water and dried at room temperature for 24 hours.[6] Every sample was placed separately in a transparent acryl impression. The teeth were sectioned buccolingually parallel to long axis of the teeth exactly in the middle of perforation area. The sections were evaluated with the use of a stereomicroscope (25 X) and a scale graded in hundreds of 9 millimeter. Leakage was measured on each wall, as the amount of linear dye penetration from the apical end of the perforation to the pulp chamber floor. Random data were recorded and analyzed for statistical significance using analysis of variance (ANOVA), statistical analysis to be described at a level of significance of P= 0.05 according to mean, average and standard deviation.

Results

In the present study, the positive control teeth showed complete dye penetration through both the perforation area and access preparation. The negative controls did not demonstrate any dye penetration. Descriptive statistical analysis was carried out on the collected data to establish the

values of standard deviation (SD), minimum (Min), maximum (Max) and mean in millimeters for each experimental group used in the study, as shown in table (1). Student t-test was used to evaluate the significance of difference between each two groups. The results of student t-test are in table (2). The least amount of leakage was seen in the teeth restored with Biodentine, but it was the highest in the group repaired with GIC(as shown in figure 1 and 2). While the difference was significant between group A and group B ($P<0.05$), and between group A and group C. But it was highly significant difference between group A and group C ($P<0.001$).

Discussion

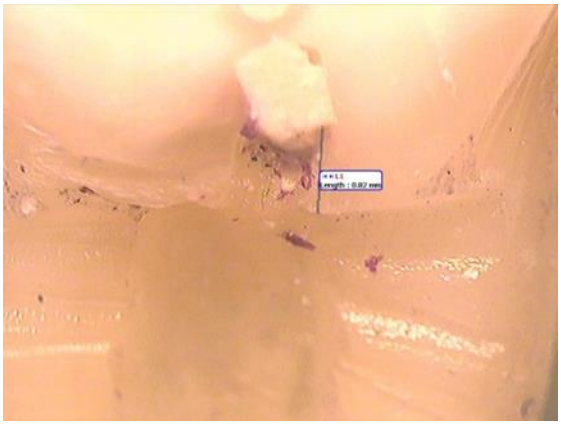
The literature mentions several methods for the evaluation of the sealing ability of the root canal filling materials. However, methylene blue is not the best choice for the measurement of the quality of sealing of root perforation materials. In our study, we evaluated the microleakage between the root perforation repair materials and dentine. We used the Dye because of its common use in several articles for the evaluation of microleakage of dental fillings.[18] Torabinejad et al, [19] stated that a material that is able to prevent the penetration of small molecules (dye) should be able to prevent the larger substances like bacteria and their byproducts. Based on this, the dye penetration method seems to be a reliable technique. It takes into account all absorbed dye by the samples. Camps and Pashley[20] reported that the dye – extraction method gave the same results as the fluid-filtration method and also saved much laboratory time.

The negative controls did not demonstrate any dye penetration, whereas the positive control samples showed the highest dye absorbance of all groups denoting the accuracy of the technique.[21,22] It has been suggested that the most important factors determining the success of a perforation repair procedure on the location of the perforation, time elapsed between the occurrences of the perforation and repair and the ability of the material to seal the perforation site.[23] The present study was aimed at evaluating the sealing ability through dye penetration of Biodentine, MTA, and GIC when used as furcation repair materials. Biodentine showed a better sealing ability than MTA and GIC. There was a statistically significant difference found in between the groups. GIC is a material with universal properties. Its ability to exhibit chemical bound to tooth structure provides an excellent marginal seal. Studies have shown that the marginal seal of glass ionomer cement compromised because of its dissolution in tissue fluid and its being technique sensitivite. [24] MTA has been used as a root perforation repair material since its introduction. [9] Despite its good physical, biological properties and its being hydrophilic in nature, MTA has some disadvantages such as long setting time and high cost. [25] Biodentine is similar to MTA in basic composition. However it showed better sealing ability than MTA in this study. The manufactures claim that it's modified powder composition i.e. the addition of setting accelerators and softeners, a new predosed capsule formulation for use in mixing device largely improve the physical properties of the material making it more user-friendly. Biodentine proves superior to MTA as it does not require a two steps obturation and as the setting is faster there is a lower risk of bacterial contamination.[22] The results of this study showed that all materials exhibited some degree of microleakage, but there was significantly less leakage in Biodentine(0.0100 mm) when compared to MTA (0.4260 mm) and GIC (1.4253mm). These results were in agreement with previously done studies on root perforation repair materials.[26,27,28,29]

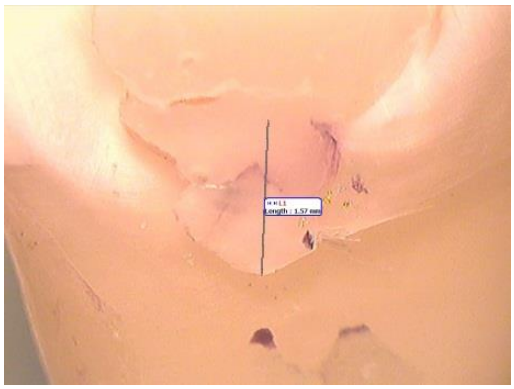
Conclusion

Under the conditions of this in-vitro study, it was concluded that all investigated materials (Biodentine, MTA and GIC)showed some degree of microleakage with BiodentineTM showing the least microleakage of all.

(a)Biodentine



(B)MTA



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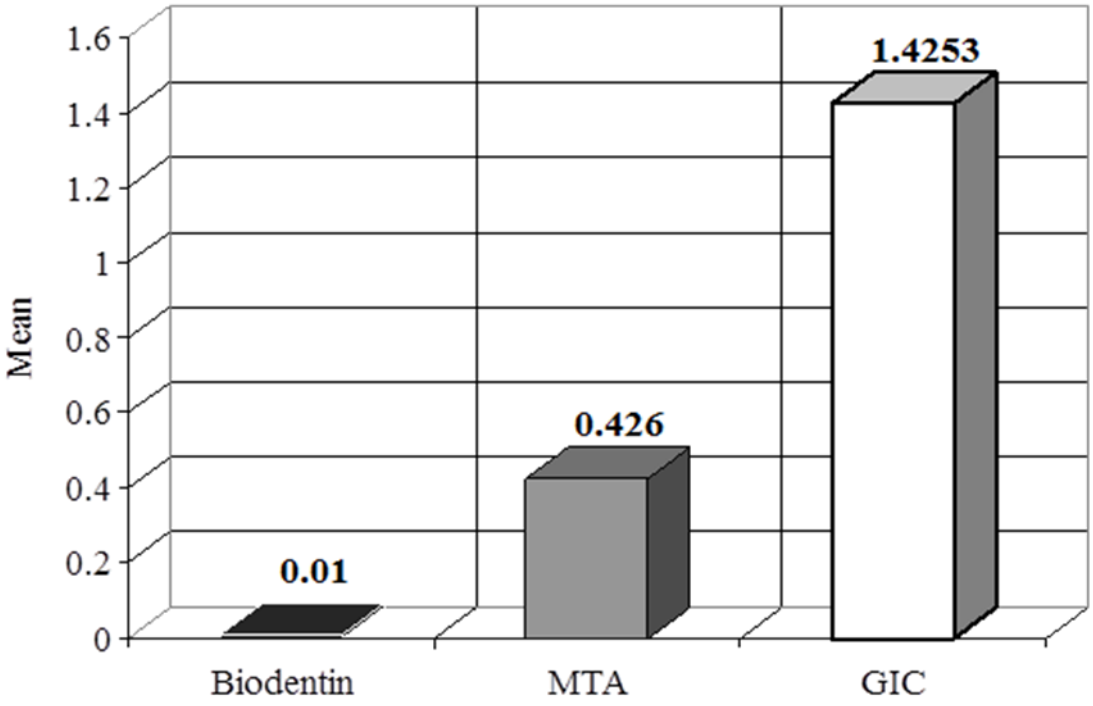

Figure(2): Bar chart to compare the mean leakage among the experimental groups

Table (1): (The mean leakage among the experimental groups)

Group	No.	Minimum	Maximum	Mean	SD
A: Biodentin	**15**	**0.00**	**0.03**	**0.0100**	**0.00926**
B: MTA	**15**	**0.03**	**0.90**	**0.4260**	**0.35083**
C: GIC	**15**	**0.20**	**2.27**	**1.4253**	**0.58894**

SD: Standard deviation.

Table (2): Student's t–test between groups

Group	t–value	df	*p*–value
A: Biodentinvs B: MTA	–4.591	28	0.000*
A: Biodentinvs C: GIC	–9.306	58	0.000*
B: MTA vs C: GIC	–5.646	28	0.000*

*Significant difference existed at 0.01 level.

References

1.Roland R. Lemon: Non – surgical repair of perforation defects. Dental Clinics of North America, 1998; 36(2): 441-457.

2. Chng HK, Islam I, Yap AU, et al. Properties of a new root-end filling material. ***J Endod*** 2005;31:665–8.

3.Torabinejad M, Chivian N. Clinical applications of mineral trioxide aggregate. ***J Endod***. 1999; 25: 197-205.

4.Holland R, Filho JA, Souza V, Nery MJ, Junior ED. Mineral trioxide aggregate repair of lateral root perforation. ***J Endod***. 2001; 27: 281-4.

5.Balto HA. Attachment and morphological behavior of human periodontal ligament fibroblasts to mineral trioxide aggregate: a scanning electron microscope study. ***J Endod***. 2004 Jan;30(1):25-9.

6.Hardy I, Liewehr FR, Joyce AP, Agee K, Pashley DH. Sealing ability of One-Up Bond and MTA with and without a secondary seal as furcation perforation repair materials. ***J Endod*** 2004; 30 (9) :658–61.

7.Thomson TS, Berry JE, Somerman MJ, Kirkwood KL. Cementoblasts maintain expression of osteocalcin in the presence of mineral trioxide aggregate. ***J Endod***. 2003; 29(6):407–412.

8.Bogen G & Sergio Kuttlers. Mineral Trioxide Aggregate Obturation: A Review and case series. ***JOE***.2009; 35(6): 777-790.

9.Torabinejad M &Masoud Parirokh. Mineral trioxide aggregate: A comprehensive literature review—Part II: Leakage and biocompatibility investigations. ***J Endod***. 2010, 36:190–202.

10.Parirokh M & Torabinejad M. Mineral trioxide aggregate: A comprehensive literature review-Part I: Chemical, Physical, and antibacterial Properties**.** ***J Endod***. 2010; 36:16-27.

11.Parirokh M & Torabinejad M. Mineral trioxide aggregate: A comprehensive literature review-Part III: Clinical application, draw backs, and mechanism of action. ***J Endod***. 2010;36: 400-413.

12. Laurent P, Camps J, I. Biodentine induces TGF-b1 release from human pulp cells and early dental pulp mineralization. ***Int Endod J*** 2012;45:439–48.

13. Loxley EC, Liewehr FR, Buxton TB. The effect of various intracanal oxidizing agents on the push-out strength of various perforation repair materials. ***Oral Surg Oral Med Oral Pathol Oral Radiol Endod*** 2003;95:490–4.

14. Yan P, Peng B, Fan B, et al. The effects of sodium hypochlorite (5.25%), chlorhexidine(2%), and Glyde File Prep on the bond strength of MTA-dentin. ***J Endod*** 2006; 32:58–60.

15.Chng HK, Islam I, Yap AU. Properties of a new root –end filling material. ***J Endod***. 2005;31:66-8.

16.Wonkornchaowalit N & LertchRakarn V, Setting time and flowability of accelerated Portland cement mixed with polycarboxylate super plasticizer. ***J Endod***. 2011; 26: 1-3.

17. Starkey DL, Anderson RW, and. Pashley DH, "An evaluation of the effect of methylene blue dye pH on apical leakage," ***JOE*** 1993;19(9): 435–439.

18. Gouw-Soares A. Stabholz JL, Lage-Marques DM, Zezell, EB and Eduardo CP, "Comparative study of dentine permeability after apicectomy and surface treatment with 9.6 microm TEA CO2 and Er:YAG laser irradiation", Journal of Clinical Laser Medicine and Surgery 2007;22(2) 129–139.

19.Torabinejad M**,** Watson TF, Pitt Ford TR: Sealing ability of Mineral Trioxide Aggregate when used as a root-end filling material. ***J Endod***. 1993**,** 19(12)**:**591-595**.**

20.Camps J, Pashley DH. Reliability of the dye penetration studies. ***J Endod*.** 2008; 29:592–594.

21.Bargholz C. Perforation repair with mineral trioxide aggregate: a modified matrix concept. ***Int Endod J***. 2005**;**38:59-69.

22.Guneser MB, Akbulut MB, Eldeniz AU . Effect of Various Endodontic Irrigants on the Push-out Bond Strength of Biodentine and Conventional Root Perforation Repair Materials. JOE. 2013; 39: 380-384.

23.Hamad HA, Tordik PA, McClanahan SB. Furcation perforation repair comparing gray and white MTA: a dye extraction study. ***J Endod***. 2006;32:337-340.

24.Inoue S, Yoshimura M**,** Tinkle JS, Marshall F, A 24-week study of the microleakage of four retrofilling materials using a fluid filtration method. ***J Endod***; 2009; 17(8):369-375.

25. Mangin C, Yesilsoy C, Nissan R, Stevens R. The comparative sealing ability of hydroxyapatite cement, mineral trioxide aggregate, and super ethoxybenzoic acid as root-end filling materials. J Endod; 2003; 29(4):261-264.

26.Perez AL, Spears R, Gutmann JL and Opperman LA . Osteoblasts and MG-63 osteosarcome cells behave differently when is contact with ProRoot MTA and white MTA. ***Int Endod J***.2003; 36(8): 564- 570.

27.Sousa CJ, Loyola AM, Versiani MA, Biffi JC, Oliveira RP and Pascon EA. A comparative histological evaluation of the biocompatibility of materials used in apical surgery. ***Int Endod J***. 2004; 37(11): 738-748.

28.Asgary S**,** Shahabi **S**, Jafarzadeh T, Amini **S**, Kheirieh **S.** The properties of a new endodontic material. ***J Endod*** . 2008; 34**:** 990-993**.**

29.Han L, Okiji T. Up take of Calcium and Silicon released from calcium silicate – based endodontic materials into root canal of dentine. ***Int Endod J***. 2011; 44: 1081-7.