The Saudi Dental Journal (2010) **22**, 119–124

King Saud University

The Saudi Dental Journal

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ORIGINAL ARTICLE

The comparison of MTA, Geristore® and Amalgam with or without Bioglass as a matrix in sealing the furcal perforations (*in vitro study*)

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Received 31 August 2009; revised 9 November 2009; accepted 26 December 2009
Available online 18 April 2010

KEYWORDS

Geristore®;
Mineral trioxide aggregate;

Abstract *Aim:* The objective of this in vitro was to assess the sealing ability of MTA, Geristore®, and amalgam with and without Bioglass as a matrix used to repair furcation perforations in mandibular molars by using dye penetration.

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doi:10.1016/j.sdentj.2010.04.004

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Bioglass;
Amalgam;
Perforation;
Dye leakage

Materials and methods: One hundred mandibular molars were randomly divided into six experimental groups. Five teeth with perforation were used as positive control while five teeth without perforation were used as negative control group. Furcal perforations were made in the teeth. Perforations were repaired with amalgam in group 1, amalgam and Bioglass in group 2, MTA in group 3, MTA and Bioglass in group 4, Geristore® in group 5, and Geristore® and Bioglass in group 6. All repairing materials were allowed to set for 72 h. Leakage at the repaired sites was then evaluated using dye penetration and clearing technique under stereomicroscope.
Results: The perforations repaired with MTA and Geristore® leaked significantly less than amalgam ($p = 0.000$). Bioglass reduced sealing ability of MTA and Geristore® significantly ($p = 0.000$, $p = 0.019$), while reduced the sealing ability of amalgam insignificantly ($p = 0.78$).
Conclusion: MTA and Geristore® have shown acceptable sealing ability in furcal perforation in comparison to amalgam while Bioglass as a matrix beneath them has reduced their sealing ability.

1. Introduction

An important factor in conservative repair of furcation perforation is the type of the repairing material. Materials such as amalgam, Gutta-percha, calcium hydroxide, calcium-sulphate based materials and various cements were used previously in this regard (Alhadainy, 1994). Amalgam had been used widely for furcation perforation repair; however, it has been seriously criticized for increased leakage and the potential risk of contamination by mercury (Gartner and Dorn, 1992). Another major drawback of amalgam, and also of other materials, is its massive extrusion into periodontal tissues, since there is no resistance during compaction which will definitely lead to severe periodontal destruction (Lantz and Persson, 1967; Stromberg et al., 1972). Another challenge during perforation repair is bleeding. To overcome extrusion and bleeding problems, some clinicians recommended placing a material between the main repair material and the alveolar bone in order to act as matrix barrier; however, there are few studies about the influence of these materials on the sealing effectiveness of the main repairing material. Bioactive glass is a kind of bioactive ceramic consisting of SiO_2, CaO_5, Na_2O, P_2O_5 (Demir et al., 2007). It has been suggested that the bioactive glasses (BG) bond to bone without an intervening fibrous connective tissue (Demir et al., 2007). BG has shown an osteostimulatory and osteo-conductive properties. It was demonstrated that BG had an anti-bacterial effect against sub gingival and supragingival bacteria (Demir et al., 2007). This material has good clinical manageability, and certain haemostatic properties (Sculean et al., 2007). It was assumed that Bioglass might be an ideal matrix in furcal perforations by considering its barrier-like properties. Mineral trioxide aggregate (MTA) was suggested as a repairing material in furcal perforation (De-Deus et al., 2006). The suitable properties of MTA including biocompatibility, high sealing ability, and the ability to promote dental pulp and periradicular tissues regeneration are the main reason for this selection (De-Deus et al., 2006). Main et al. (2004) have shown that MTA provided an effective seal for root perforations.

Geristore® has been recommended both as a root-end filling material, and in restoring sub gingival surface defects such as root-surface caries and iatrogenic perforations.

Geristore® is used for surgical repair of root perforations and as an adjunct to guided-tissue regeneration (Abitbol et al., 1995, 1996; Behnia et al., 2000; Resillez-Urioste et al., 1998). Geristore® is less sensitive to moisture rather than conventional Glass-Ionomer cement. Dry environment will improve the results of Geristore® usage (Cho et al., 1995). Due to lack of information about the influence of Bioactive glass as a matrix in furcal perforation, this study was conducted to compare the sealing ability of MTA, Geristore® and amalgam and show the influence of Bioglass as a barrier on their sealing ability.

2. Materials and methods

One hundred recently extracted, multi-rooted permanent human molars, with well-developed and non-fused roots were used. All the teeth were cleaned of soft tissues with periodontal curette immediately after extraction and disinfected with NaOCl 2.5% for 10 min and stored in normal saline for further usage. Access cavity was prepared with a #4 round bur using a high-speed handpiece with copious water coolant spray. The canals were chemo mechanically prepared according to the step-back method using K-files (Dentsply-Maillefer, Ballaigues, Switzerland). NaOCl 2.5% was used as an irrigant during cleaning and shaping of the root canals. After drying the root canals by using multiple paper points, they were filled by means of lateral condensation technique using Gutta-percha points and AH 26 sealer (Dentsply-Trey, Konstanz, Germany). All teeth stored in an incubator at 37 °C with 100% humidity for 48 h for complete setting of sealer. The external surface of the root was covered with two layers of nail polish in order to prevent dye penetration into dentinal tubules, or lateral canals, especially in the furcation area. Perforations were made in the centre of the pulpal floor using a #4 round bur with a high-speed handpiece under water spray. The width of the perforation corresponded to the diameter of the bur, and the depth depended on the pulp chamber floor thickness. All preparations were then rinsed with distilled water and dried with compressed air. Prepared teeth were randomly divided into two control groups (positive: without a filling material and negative: without a perforation) and six experimental groups consisting of 15 teeth in each group. To simulate clinical situation all teeth were inserted approximately to the level of the cementoenamel junction, into the distilled water-moistened sponge. Following materials were used for furcation perforation repair: grey MTA (Pro Root, Dentsply, Ballaigues, Switzerland), Geristore® (Den-Mat, Santa Maria, CA), zinc-free amalgam with or without a barrier of Bioglass (Nova Bone, US Biomaterials Corporation Alachva, Florida, US) as a matrix. All repair materials were mixed according to the manufacturer's instructions and were placed into the perforation sites as follows:

2.1. Group 1 (Amalgam)

The material was mixed according to the manufacturer's instruction (Vibrated for 8 s), transferred to the site with an amalgam carrier and condensed with micro condensers wider in diameter than cavities, as gently as possible.

2.2. Group 2 (Amalgam and Bioglass)

The Bioglass powder was mixed with sterile saline according to the manufacturer's instructions on a slab with a metallic spatula, then carried to the perforation site and pushed completely over the perforation sites. Then amalgam was mixed according to the manufacturer's instructions (vibrated for 8 s), and transferred to the site with amalgam carrier and condensed over Bioglass matrix with micro condenser, as gently as possible.

2.3. Group 3 (MTA)

MTA was mixed according to the manufacturer's instruction, powder was mixed with sterile water on a glass slab with a metallic spatula and carried to the perforation site by an MTA gun and gently condensed using endodontic micro pluggers and micro condensers. MTA remnants was carefully removed with a moisten cotton-pellet. A moisten cotton was left in pulp chamber for 72 h for final setting of MTA.

2.4. Group 4 (MTA and Bioglass)

The Bioglass was mixed and placed in the perforation site exactly the same as group 1. MTA was placed above the Bioglass and mixed and used in a similar way to group 3.

2.5. Group 5 (Geristore®)

In this group, each perforation site was etched with 37% phosphoric acid gel, and then rinsed with 5 ml of water and gently dried with air spray. Tenure bonding system was sequentially applied and light cured for 20 s. Then Geristore® was mixed, and carefully applied into the perforation site and light cured for 40 s.

The quality of the repair was assessed by taking a periapical X-ray. The repair was assessed by two endodontists blindly as being clinically acceptable when the perforation was filled within 0.5 mm of the furcal side or a slight overfilling was present. Unacceptable repair was recorded when the repairing material was not extended to within 0.5 mm of the furcal side of the perforation or a gross overfilling was evident.

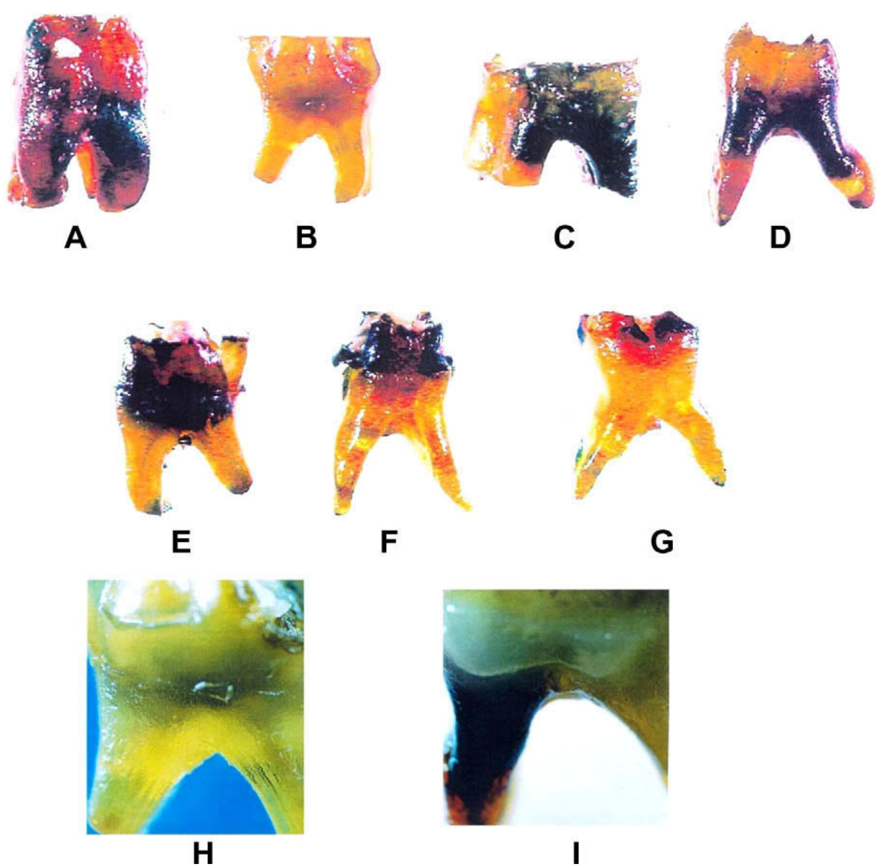

Figure 1 The pattern of dye leakage in perforated samples repaired with; (A) MTA and Bioglass, (B) MTA, (C) Amalgam and Bioglass, (D) Amalgam, (E) Geristore® and Bioglass, (F) MTA, (G) Geristore®, (H) Geristore® (20× magnification), (I) Geristore® and Bioglass (20× magnification).

2.6. Group 6 (Geristore® and Bioglass)

The Bioglass was mixed and placed similar to group 1. Then Geristore® was placed above the Bioglass similar to group 5.

For microleakage assessment, the pulp chamber of each tooth was filled twice a day with Indian ink (Winsdor & Newton, London, UK). The teeth were stored at 37 °C in incubator for 7 days. After that, the teeth were washed thoroughly under running tap water, and then dried. Each tooth was transferred to a separate glass vial and dematerialized in 11% nitric acid until the texture was ruby and a pin could be passed through the decalcified unimportant part of the root. The teeth were washed thoroughly with water, accompanied by gentle scrubbing with toothbrush to remove all remaining traces of nitric acid before dehydration. They were then dehydrated by immersion in 70%, 95%, and 100% ethyl alcohol, respectively, for 24 h each and rendered transparent by storage in methyl salicylate. Dye penetration depth was examined in four walls of perforation sites by stereomicroscope (SMZ 100, Nikon, USA) under the magnification of 20×, the walls were evaluated for leakage. Two investigators reported the amount of leakage in a blind manner. In the case of the two investigators suggesting different value, a third investigator was asked to score the sample. At least two similar values were considered as the final. The number of walls with leakage was considered as leaked grade of the teeth when the leakage was observed in the whole coronoapical length of the perforation site (Fig. 1). The data were analyzed using analysis of variances and Mann–Whitney test.

3. Results

All negative control samples showed no dye leakage while, all positive control samples showed complete leakage. In the groups without Bioglass, there were statistically significant differences among the materials, in which amalgam has shown the highest leakage than others ($p < 0.05$).

There was no significant difference between MTA and Geristore® ($p > 0.05$).

In groups with Bioglass, the leakage was significantly higher with amalgam than MTA ($p < 0.05$), and MTA than Geristore® ($p < 0.05$). The effect of Bioglass was not significant in amalgam group ($p > 0.05$), However, the leakage values in MTA and Geristore® groups with Bioglass were significantly higher than MTA and Geristore® groups ($p < 0.05$). (Figs. 2 and 3).

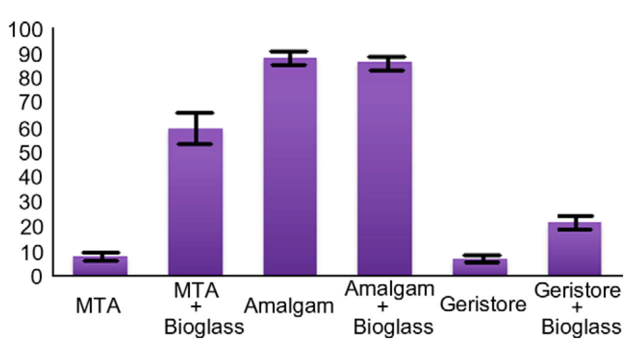

Figure 2 The percentage of walls with leakage in each of the experimental groups.

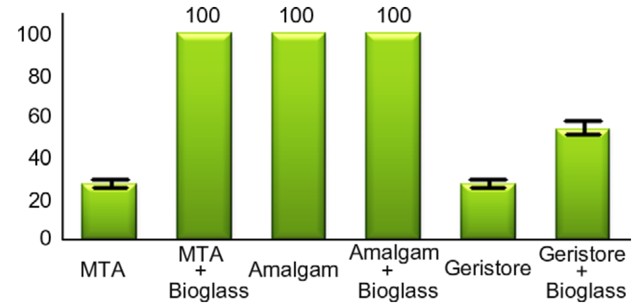

Figure 3 The percentage of teeth with leakage in each of the experimental groups.

4. Discussion

Accidental root perforations will complicate the treatment and compromise the prognosis if it is not managed properly. The sealing ability, biocompatibility and possible extrusion of repairing materials into the furcation area should be considered when selecting such materials.

Dye penetration techniques are the most frequently used method of evaluating the sealing ability of dental repairing materials (Camps and Pashley, 2003; Torabinejad et al., 1995; de Martins et al., 2009; Attam et al., 2009). Daoudi and Saunder (2002) showed some advantageous of clearing method for dye penetration assessment in furcal perforations areas. So, Indian ink used for dye penetration evaluation in this study due to its resistance against nitric acid and alcohol during clearing process while it is able to demonstrate the leakage depth due to its small particle's size. According to the clinical importance of leakage in the perforation area and the fact that leakage in site of perforation may be related to the dentinal tubules or accessory canals, we came in conclusion that only the walls showing leakage in their entire length should be considered as a true leaked wall. The sealing ability of MTA has been examined by dye leakage, bacterial penetration, and fluid filtration tests.

In the present study, MTA and Geristore® have shown a higher sealing ability than amalgam, but there was no significant difference between these two materials. However, sealing ability of MTA and Geristore® in association with Bioglass (Nova Bone) as matrix was significantly reduced and sealing ability of amalgam in association with this matrix was reduced insignificantly. Previous studies have shown similar results due to high sealing ability of MTA or Geristore® separately in sealing of perforation sites. It seems that MTA provides a better seal than other commonly used restorative materials, such as amalgam, IRM, and Super-EBA (Tsatsas et al., 2005). These findings are in agreement with our findings.

MTA was suggested as a repairing material in furcal perforation (Silveira et al., 2008; Oliveira et al., 2008). MTA has excellent marginal adaptation to the external borders of the perforation sites. The main disadvantage of MTA is the time required for initial setting which makes this material inappropriate for repairing transgingival defects. If the material is in contact with oral fluids, it will be washed out of defective site before setting. Therefore a more rapid-setting resin ionomer, such as Geristore® (Den-Mat, Santa Maria, CA) is recommend in such cases (Behnia et al., 2000; Dragoo, 1997; Scherer and Dragoo, 1995).

Geristore® has a leakage pattern similar to that of MTA (Scheeree et al., 2001) and this is in agreement with the results of the present study. Pichardo et al. (2006) investigated apical leakage of root-end placed super-EBA, MTA, and Geristore® restorations in human teeth and less dye leakage was noted in teeth stored with Geristore® as compared with MTA and super-EBA. It seems that the high sealing ability of Geristore® might be related to the chemical bonding of this material, acid-etching and bonding applying before the material placement which will definitely improve its sealing ability (Dragoo, 1997). Marginal adaptation of MTA could raise an issue after a period of time and under occlusal pressure which can be one of MTA disadvantages (Peters and Peters, 2002).

Sealing ability of MTA and Geristore® along with the Bioglass were significantly reduced. The reduction of sealing ability of MTA and Geristore® may be related to this fact that despite our efforts for applying Bioglass as deeply as possible into the perforation cavities, it is possible that some particles of this material may remain in the border of the cavities and interfere with adaptation or bonding of repairing materials, leading to reduction in sealing ability of MTA or Geristore®. Another major concern for using of Bioglass (Nova Bone) as matrix under Geristore® in furcal perforation repair is the effect of acid-etching and irrigation on the Bioglass which may lead to washing out of this matrix. Definitely in most cases, some material remained in the cavity borders and these remnants seemed to prevent effective chemical bonding of Geristore® to dentin and therefore reduce the sealing ability of Geristore®. Sealing ability of amalgam in association with this matrix was reduced but this reduction was not significant and this may be related to the barrier effect of Nova Bone from extrusion of amalgam. Also MTA can provide effective seal of perforated sites even without matrix placement which is confirmed by other studies (Pace et al., 2008).

In the present study amalgam was used as a common previously-used material. Similar to many other studies, amalgam has shown high level of microleakage. Amalgam is no longer an acceptable material for perforation repair.

MTA and Geristore® groups showed the least dye leakage. Also, there was no significant difference between these two materials. Amalgam was found to be the worst. Sealing ability of MTA and Geristore® in association with Bioglass matrix was reduced significantly. Also sealing ability of amalgam in association with this matrix was reduced insignificantly.

5. Conclusion

It can be concluded that amalgam much less sealing ability than MTA and Geristore® in perforation sites. Using Bioglass with amalgam did not significantly increase the sealing ability of amalgam. Geristore® has similar sealing abilities to MTA due to chemical adhesion to tooth structures.

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