Sealing ability of three different root repair materials for furcation perforation repair: An in vitro study

Abhijeet K. Kakani, Chandrasekhar Veeramachaneni

Departments of Conservative Dentistry and Endodontics, Nanded Rural Dental College and Research Center, Nanded, Maharashtra, 1Malla Reddy Dental College for Women, Hyderabad, Telangana, India

Abstract

Aim: The present study aimed to evaluate and compare the sealing ability of mineral trioxide aggregate (MTA)-Angelus, Biodentine™, and EndoSequence cement in furcation perforations using protein leakage assessment.

Materials and Methods: The present study was conducted using seventy extracted human maxillary and mandibular molars with intact furcation. The samples were randomly allocated into three groups (n = 20) based on repair material used: Group 1 – MTA-Angelus, Group 2 – Biowisnte™, and Group 3 – EndoSequence. Two additional groups served as positive and negative controls (n = 5). Using the leakage assessment apparatus, the presence of protein was detected with a reagent (Coomassie Brilliant Blue) every day for 60 days. One-way ANOVA and post hoc Tukey’s test were used for statistical analysis using SPSS software.

Results: All the groups exhibited protein leakage from day 1. Biodentine showed minimum (0.1201 mg/ml), MTA showed maximum (0.3738 mg/ml), and EndoSequence had intermediate (0.2465 mg/ml) leakage. None in the negative control and all of the positive control specimens leaked during the experimental period of 60 days.

Conclusion: The newer biomaterials, Biodentine and EndoSequence with better handling properties, could be used as alternatives to MTA-Angelus while repairing furcation perforations.

Keywords: Biodentine; furcation perforation; protein leakage

INTRODUCTION

Perforations can be defined as mechanical or pathologic communications between the root canal system and the external tooth surface. Perforations can result from caries, resorption, or iatrogenic factors. Furcation perforations are significant iatrogenic complications of endodontic treatment and could lead to endodontic failure. Ideally, a material with good sealing ability might be used to prevent continued exposure to a contaminating environment. The use of biocompatible materials to repair perforations might be advocated to reduce the incidence of inflammatory reactions in the surrounding tissues. In recent decades, a new material known as mineral trioxide aggregate (MTA) has been introduced by Torabinejad, which is capable of creating a thorough seal between root canals and external dental surfaces. In vitro and in vivo studies have shown that MTA has a considerable sealing ability and marginal adaptation. Biodentine is a calcium silicate-based bioactive cement that is recently developed to overcome some of the shortcomings of white MTA, which is difficult handling and has long setting time. Recently, EndoSequence root repair material has been developed as ready-to-use, premixed bioceramic material recommended for perforation repair, apical surgery, apical plug, and pulp capping. The present study was conducted to evaluate and compare the sealing ability of MTA-Angelus, Biodentine™, and EndoSequence cement in case of large furcal perforations.

Address for correspondence:
Dr. Abhijeet K. Kakani, Department of Conservative Dentistry and Endodontics Nanded Rural Dental College and Research Center, Pangri Village, Behind SKTM University, Nanded - 431 606, Maharashtra, India.
E-mail: abhijeetkakani@yahoo.com

Date of submission: 18.08.2019
Review completed: 27.06.2020
Date of acceptance: 14.07.2020
Published: 10.10.2020

For reprints contact: reprints@medknow.com

How to cite this article: Kakani AK, Veeramachaneni C. Sealing ability of three different root repair materials for furcation perforation repair: An in vitro study. J Conserv Dent 2020;23:62-5.
MATERIALS AND METHODS

The present study was conducted at the department of endodontics with seventy extracted human maxillary and mandibular molars with intact furcation, well-developed nonfused roots. The teeth were cleaned, and access cavities were prepared. The roots were horizontally sectioned in the apical third to facilitate their attachment into the glass vial apparatus. The exposed root tips were sealed with a cyanoacrylate resin (FeviKwik, Pidilite, India), and the whole tooth was covered by two coats of nail varnish (Nail Trend, Fiabila India Ltd.) except at the furcation. All the orifices of the root canal were sealed. An artificial defect measuring 2 mm in diameter was made from the external surface. The chamber and perforation were flushed with water and dried. The teeth were randomly allocated into three groups of twenty teeth each – Group 1 repaired with MTA-Angelus, Group 2 repaired with Biodentine™, and Group 3 repaired with EndoSequence. Group 4 comprised five teeth that were not perforated served as the negative control. Group 5 comprised five teeth that were perforated and not sealed, which served as the positive control.

The access cavity was filled with IRM and left for 72 h at 37°C in an incubator, to allow the setting of repair material. Before leakage assessment, the temporary filling material was removed from the access cavities of the samples, and the setting of the MTA, Biodentine, and EndoSequence was checked with an explorer.

Leakage assessment apparatus was made for each sample. Figure 1a and b illustrates the apparatus and its schematic representation. To prepare the leakage assessment apparatus, a hole was created in the rubber stopper of a 10 ml glass vial, and the teeth were inserted through it and sealed with cyanoacrylate paste through the rubber. Another glass vial was attached around the crown of the rubber stopper. The glass vial was filled with 9.5 ml of redistilled water, and the other vial was filled with 1 ml of 22% bovine serum albumin (BSA) solution. The apparatus was prepared for all the experimental and control groups and placed in an incubator (Yorco sales Pvt. Ltd.) at 37°C for 7 days. The water in the glass vial was changed, and BSA in the reservoir was replenished daily during the experiment. The presence of protein was detected with a reagent (Coomassive Brilliant Blue) every day for 60 days. Color conversion of the protein reagent was considered to indicate leakage. Protein concentration was quantified with an ultraviolet spectrophotometer (Genesis USA). All the data thus obtained were arranged in a tabulated form and analyzed using IBM spss software [Spss - Statistical package for company IBM, chicago: USA]. Statistical analysis was done using one-way ANOVA and post hoc Tukey’s test.

RESULTS

The mean protein leakage in all the groups is shown in Table 1. There was a statistically significant difference in mean protein leakage in all groups, with least in the negative control group and highest in the positive control group. Figure 2 illustrates the bar diagram comparing the groups. In the experimental group, Biodentine had the least leakage followed by Endosequence, and MTA had the highest leakage.

DISCUSSION

Many authors have reported that the prognosis of a tooth with a root perforation depends on the size and location of the defect, the time period the opening is exposed to contamination, the material used to repair it, the possibility of sealing the perforation, and the accessibility to the main canal. Biodentine has a wide

![Figure 1: (a) Leakage assessment apparatus. (b) Schematic representation of the apparatus](image1)

![Figure 2: Bar diagram showing the comparison between the groups](image2)
range of applications including endodontic repair (root perforations, apexification, resorptive lesions, and retrograde filling material in endodontic surgery) and pulp capping and can be used as a dentin replacement material in restorative dentistry.[6] In this era driven by innovative biomaterials, the prognosis of a furcal perforation repair could be far better than that accounted for 9.6% of all endodontic failures by Ingle.[6] There is a body of evidence emphasizing the biocompatibility and sealing ability of MTA.[10] The cementogenic activity of MTA is because of its release of an abundance of calcium ions, which interact with phosphate groups in the surrounding tissue fluid to form hydroxyapatite on its surface.[11] Laurent et al. found Biodentine to be biocompatible after evaluating its genotoxicity, cytotoxicity, and effects on the target cell-specific functions (Septodont, Biodentine™ Scientific File, 2010). Compared to other materials such as MTA, Biodentine™ is easily handled owing to its ease of manipulation and needs much less time for setting. [12,13] EndoSequence is a bioceramic material composed of calcium silicates, zirconium oxide, tantalum oxide, calcium phosphate monobasic thickening agents, and proprietary fillers.[14] Torabinejad et al. and various other researchers have stated that the relatively low protein leakage observed when MTA was used as repair material was a result of its sealing ability rather than any antimicrobial properties of the material.[12] Gunser et al. commented that a smaller particle size and uniform components might have a role in the better interlocking of Biodentine with the dentin as compared to that of MTA.[15] The adhesion of Biodentine to dentinal tubules may also result from the tag-like structures within the dentinal tubules leading to a micromechanical anchor.[16] According to Han and Okiji showed that calcium and silicon ion uptake into dentin leading to the formation of tag-like structures in Biodentine was higher than MTA. [17] All these factors might have contributed to the least leakage observed in the Biodentine group. Shokouhinejad et al. tested the bioactivity of EndoSequence by exposing the set material on phosphate-buffered saline. There was precipitation of apatite crystalline structures, which is indicative of its bioactivity.[18] This precipitation of apatite crystals could be considered a factor responsible for reduced leakage in the EndoSequence group.

### CONCLUSION

It can be concluded that Biodentine and EndoSequence have significantly better sealing ability compared to MTA-Angelus when used to repair large furcal perforations, assessed using a protein leakage model. Hence, the newer biomaterials, Biodentine and EndoSequence with better handling properties, could be used as alternatives to MTA-Angelus while repairing furcal perforations.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### REFERENCES

1. American Association of Endodontists. Glossary of Endodontic Terms. 7th ed. Chicago, IL: American Association of Endodontists; 2003.
2. Jew RC, Weine FS. A histologic evaluation of periodontal tissue adjacent to root perforation filled with cavit. Oral surg Oral Med Oral Pathol 1982;54:124-35.
3. Sinai IH. Endodontic perforations: Their prognosis and treatment. J Am Dent Assoc 1977;95:90-5.
4. Gutmann JL, Harrison JW. Posterior endodontic surgery: Anatomical considerations and clinical techniques. Int Endod J 1985;18:8-34.
5. Fuss Z, Tsesis I, Lin S. Root resorption—diagnosis, classification and treatment choices based on stimulation factors. Dent Traumatol 2003;19:175-82.
6. Ingle JI. A standardized endodontic technique utilizing newly designed instruments and filling materials. Oral Surg Oral Med Oral Pathol 1961;14:83-91.
7. Kerekles K, Tronstad L. Long-term results of endodontic treatment performed with a standardized technique. J Endod 1979;5:83-90.
8. Malkondu O, Kazandag M K, Kazazoglu E. A review on Biodentine, a contemporary dentine replacement and repair material. Biomed Res Int 2014;2014:1-10.
9. Farzaneh M, Abitbol S, Friedman S. Treatment outcome in endodontics: The Toronto study. Phases I and II: Orthograde retreatment. J Endod 2004;30:627-33.
10. Lee SJ, Monsef M, Torabinejad M. Sealing ability of a mineral trioxide aggregate for repair of lateral root perforations. J Endod 1993;19:541-4.
11. Nakata TT, Bae KS, Baumgartner JC. Perforation repair comparing mineral trioxide aggregate and amalgam using an anaerobic bacterial leakage model. J Endod 1998;24:194-6.
12. Torabinejad M, Rastegar AF, Kettering JD, Pitt Ford TR. Bacterial leakage of mineral trioxide aggregate as a root-end filling material. J Endod 1995;21:109-12.
13. Imura N, Otani SM, Hata G, Toda T, Zuolo ML. Sealing ability of composite resin placed over calcium hydroxide and calcium sulphate plugs in the repair of furcation perforations in mandibular molars: A study in vitro. Int
Endod J 1998;31:79-84.

14. Jantarat J, Dashper SG, Messer HH. Effect of matrix placement on furcation perforation repair. J Endod 1999;25:192-6.

15. 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. J Endod 2013;39:380-4.

16. Atmeh AR, Chong EZ, Richard G, Festy F, Watson TF. Dentin-cement interfacial interaction: Calcium silicates and polyalkenoates. J Dent Res 2012;91:454-9.

17. Han L, Okiji T. Uptake of calcium and silicon released from calcium silicate-based endodontic materials into root canal dentine. Int Endod J 2011;44:1081-7.

18. Shokouhinejad N, Nekoofar MH, Razmi H, Sajadi S, Davies TE, Saghiri MA, et al. Bioactivity of endosequence root repair material and bioaggregate. Int Endod J 2012;45:1127-34.