International Journal of Health Sciences and Research
Vol.11; Issue: 2; February 2021
Website: www.ijhsr.org
ISSN: 2249-9571

Original Research Article

Comparative Evaluation of Push out Bond Strength of Two Commercially Available MTA and Biodentine - an in Vitro Study

Vijetha Badami[1], Anusha Nadipineni[2], Sujathagopal Sooraparaju[3], Pavan Kumar Kanumuru[4], Mohd Kashif uddin Ahmed[5], Swetha Kommavarapu[6], Mounika Pulijala[7]

[1] Professor, Department of Conservative Dentistry and Endodontics, MNR Dental College and Hospital, MNR Nagar, Narsapur Road, Fasalwadi, Sangareddy, Telangana 502294, India
[2,3,4,5,6,7] Department of Conservative Dentistry and Endodontics, MNR Dental College and Hospital, Sangareddy, India

Corresponding Author: Vijetha Badami

ABSTRACT

Introduction: Root perforation complicates the endodontic treatment and compromises the prognosis if not properly managed. With the advent of newer materials for sealing, the clinical management and prognosis have improved. The aim of this study was to evaluate the push-out bond strength of two commercially available MTA and Biodentine.
Materials and Methods: 45 freshly extracted maxillary incisors were selected for the study. Teeth were cleaned and immersed in 5.25%NaOCl solution to remove hard and soft tissues. The coronal and apical segments were sectioned and removed. The root canal space of the horizontal root slices obtained was enlarged to 1.3mm using Peeso reamer size:4. The samples were divided into 3 groups (15 samples each). The root canal spaces of the sectioned samples were restored with three different repair materials-Group-1: MTA (Angelus), Group-2:Biodentine, Group-3: Pro Root MTA (Dentsply). All the samples were stored in contact with the moistened gauze for 7 days and subjected to push-out assay. The maximum load applied to dislodge the material was recorded in Newton. The obtained results were then subjected to statistical analysis using one way ANOVA and Tukey's post- hoc test($P<0.05$).
Results: The results of the present study showed that Biodentine exhibited better push-out bond strength than MTA and ProRoot MTA. There is no statistical significant difference between the push-out bond strength of MTA and Pro root MTA.
Conclusion: Within the limitations of this study, it can be concluded that Biodentine showed better push-out bond strength than MTA.

Keywords: Mineral trioxide aggregate, Biodentine, Push-out bond strength.

INTRODUCTION

In endodontic practice, procedural accidents are commonly encountered which affect the prognosis of root canal treatment. According to Seltzer, perforations were the second greatest cause of failure in endodontics. [1]

Root perforation is a mechanical, iatrogenic or pathologic communication between the root canal system and the external tooth surface. [2] Biologic events such as caries, pathologic resorption, iatrogenic perforation during restorative or endodontic procedures are most often reasons causing perforations. The cause of iatrogenic perforation is often due to misalignment of burs or engine driven instruments during endodontic access preparation, canal negotiation or root canal preparation. [3]

The prognosis of endodontic root perforation depends on factors like location, time delay to perforation sealing, and the sealing ability of the material used to seal the defect. [4] An ideal root repair material should be biocompatible, dimensionally stable, adhere to the root end cavity walls, resist dislodging forces, prevent microleakage and remain unaffected in the presence of tissue fluids that might be acidic in an infected area. [5]

Biomaterial science aims to develop materials that are ideal mechanically, physically & biologically. Some of the bioactive dental materials include calcium hydroxide cement, glass ionomer cement, MTA and other newer tricalcium silicate based cements such as Biodentine. [6]

MTA is widely used as a promising biomaterial to repair root perforations because of its excellent biocompatibility, superior sealing ability and its ability to set even in the presence of moisture. Two commercial forms of MTA are available; ProRoot MTA in either the gray or white form. Recently, MTA-Angelus (Angelus, Londrina, PR, Brazil) has also become available as an alternative to ProRoot MTA where the former is similar to latter except that it does not contain calcium sulfate in an attempt to reduce setting time. [7]

Calcium-silicate based products have gained popularity in recent times due to their resemblance to MTA and their applicability in all the cases where MTA is indicated. So, Biodentine was introduced by Septodont, as a calcium silicate based product which became commercially available in 2009. [8]

Camilleri et al have reported that in mechanical properties and biocompatibility, Biodentine showed superior results when compared to MTA, because greater opposition of hydroxyapatite crystals was observed on Biodentine surface when exposed to the tissue fluids. [9] These biological properties with good colour stability and lack of genoxicity make it an ideal material of choice for endodontic practice. [10] The present study aimed to evaluate and compare the push-out bond strength MTA (Angelus), Biodentine (Septodont) and Pro root MTA (Dentsply).

MATERIALS AND METHODS

This study was approved by the Institutional ethical committee (ECR/269/Indt/2016)

Sample Collection & Preparation:

45 extracted human maxillary central incisors were used for the study.

Inclusion and Exclusion criteria:

Visual inspection was done and teeth with caries, cracks and fractures were excluded. Preoperative mesiodistal and buccolingual radiographs of each root were taken to confirm the canal anatomy. Teeth presenting more than single root canal and apical foramen, previous root canal treatment, internal or external resorption, immature root apices, or caries / cracks / fractures on root surface were excluded.

Teeth were cleaned and immersed in 5.25% sodium hydrochloride solution for 10 mins to remove the hard and soft tissues respectively and stored in distilled water till use. The coronal and apical segments of all samples were sectioned, resulting in middle third with 10 mm of length. From this segment, horizontal slices (1.5 ± 0.1mm thick) were created using a low-speed diamond disc.

Preparation of the canal:

Root canal space of the sectioned slices was enlarged to 1.3mm using Peeso reamer No: 4 as shown in Fig 1. These root slices were immersed in 10ml of 2.5% sodium hypochlorite solution (NaOCl) for 15 mins followed by 10 ml distilled water for 1 min. To remove the smear layer, samples were immersed in 17% EDTA for 3 minutes followed by 10ml distilled water for 1 min. Prepared root canal spaces were dried with paper points. The samples were randomly divided in to 3 groups: Group-1: MTA (Angelus), Group-2: Biodentine (Septodont) and Group-3: Pro Root MTA

(Dentsply) as shown in Fig 2. All the test materials were manipulated according to the manufacturer's instructions and inserted into the root canal spaces. Later, the samples were stored in contact with gauze moistened in phosphate buffered saline solution for 7 days before the push-out assay.

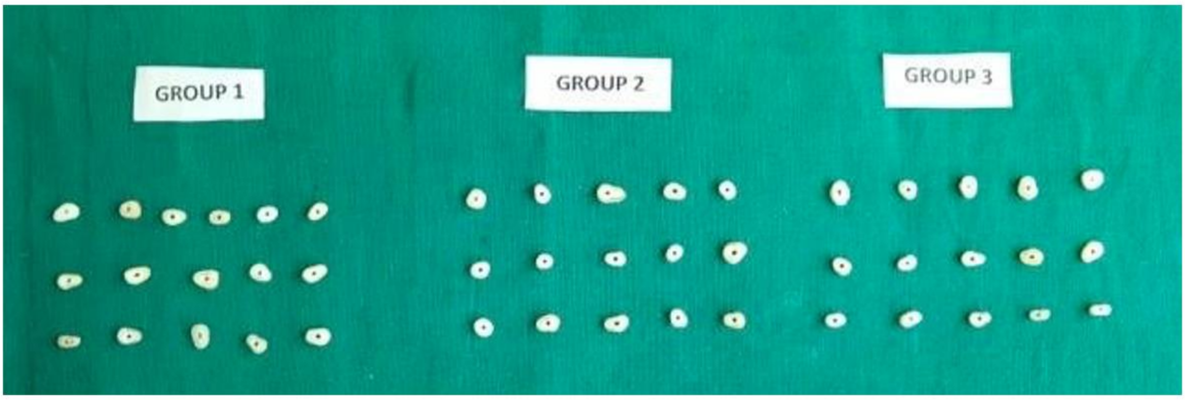


Fig 1: Prepared Samples Divided In Groups

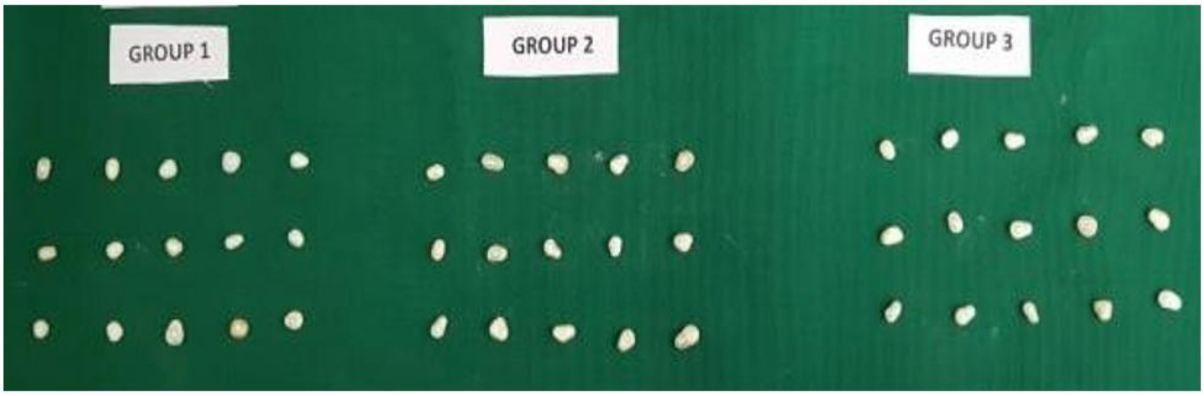


Fig 2: Restored Samples

Push-out Assay

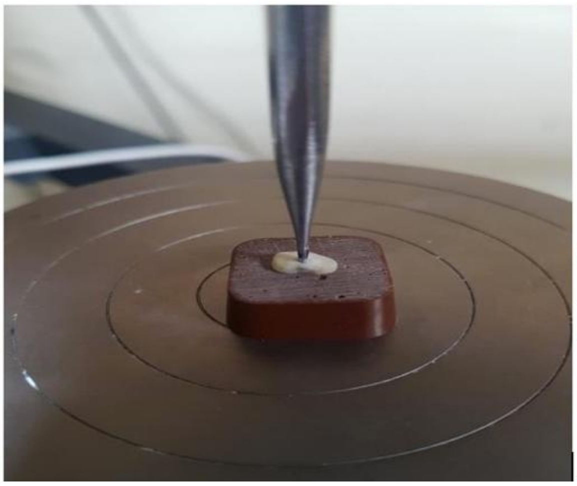


Fig 3: Push Out Assay Performed

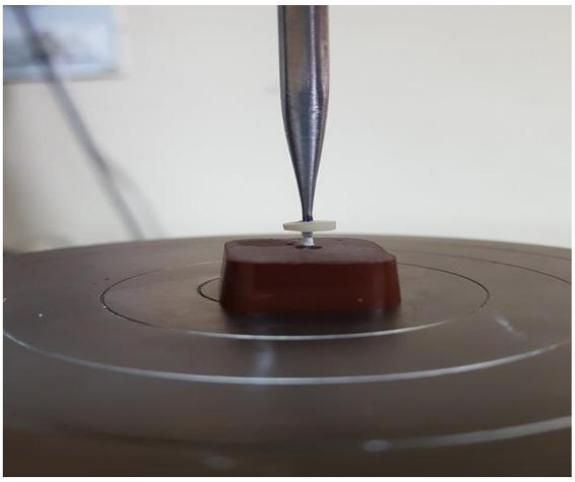


Fig 4: Material Dislodged

The test material was loaded by the plunger tip 1.1 mm diameter, which was positioned in a corono-apical direction as shown in Fig 3. Loading was performed on a Universal Testing Machine (Dak series7200) at a head speed of 1mm/min until material dislocation occurred as shown in Fig 4. The plunger had a clearance of approximately 0.2 mm from the margin of the dentin to ensure contact with material only. The maximum load applied to the cement plug at the time of dislodgement was recorded in Newton (N). The bond strength in MPa was obtained after dividing the load at failure (Newton) by the area of the bonded interface.

STATISTICAL ANALYSIS

The descriptive data shows mean and standard deviation (SD) were used for comparison between the groups. One-way Anova analysis was carried out to compare the equality of bond strength means followed by Tukey post hoc analysis for pair wise comparisons. Confidence intervals were set at 95% and values of $P < 0.05$ were interpreted as statistically significant (Software-SPSS 23.0, Tulsa,UK).

RESULTS

Table 1 : Comparison of push out bond strength among the study groups

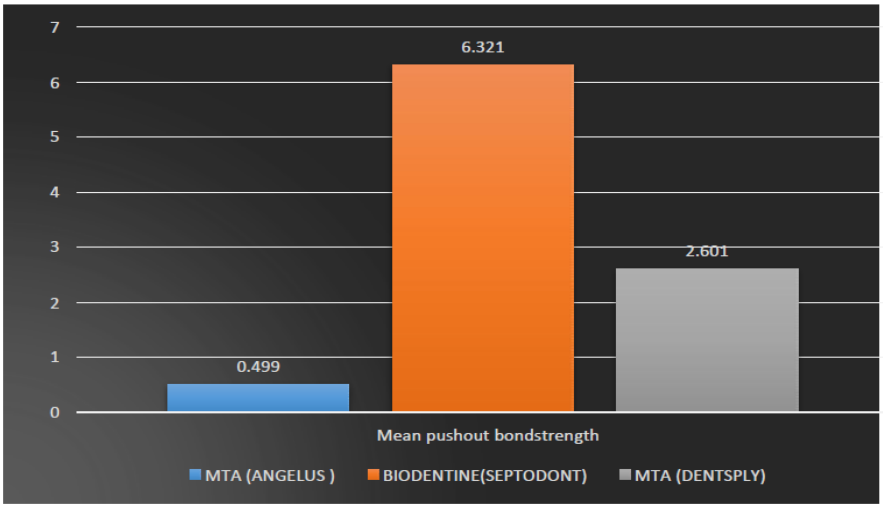
GROUPS	N	Mean	Std. Deviation	Std. Error	F,df	*p* value
MTA (ANGELUS)	15	.49	.65	.16	22.13	.0001(S)
BIODENTINE (SEPTODONT)	15	6.32	3.73	.96		
MTA (DENTSPLY)	15	2.60	1.82	.47		
Total	45	3.14	3.39	.50		

F – Anova test statistic; df- degree of freedom; S- significant; p value – probability value

Table 2: Pair wise comparison of push out bond strength among study groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p value	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
MTA (ANGELUS)	BIODENTINE (SEPTODONT)	-5.82*	.88	.00	-7.97	-3.66
MTA (ANGELUS)	MTA (DENTSPLY)	-2.10	.88	.05	-4.25	.05
BIODENTINE (SEPTODONT)	MTA (DENTSPLY)	3.72*	.88	.00	1.56	5.87

**The mean difference is significant at 0.05 level.; Tukey HSD post hoc test*



Graph 1: Comparison of pushout bond strength among study groups

Table 1 shows statistical result of push-out bond strength of the test groups. Pairwise comparisons with Tukey HSD post hoc test showed that Biodentine was significantly different from the other groups (p <0.05), while no statistically significantly difference was observed amongst the others (Table 2). Graph 1 shows the comparison of pushout bond strength among the study groups.

DISCUSSION

The repair of the root perforations must be done immediately to reduce the possibility of infection at the perforation site that necessitates extraction of the involved tooth. The main aim of repairing a root perforation is to maintain a healthy periodontium that is in juxtaposition with the perforation site so that it is free from persistent inflammation and loss of attachment could be prevented. In case of established periodontal breakdown, the repair serves to establish some form of tissue re attachment. Success of perforation repair depends on good seal at the perforated site with a biocompatible material that contributes to the well-being of PDL. [11]

The ideal repair material should induce osteogenesis, cementogenesis, should be biocompatible, nontoxic, easily obtainable, convenient to use and economical. It should also be completely degraded during the repair process in order to allow for its replacement by new, healthy bone and act as a barrier against which the root canal obturating material can be placed. It should also be biocompatible, adhere to cavity walls an adequate seal, resistant to dislodgement, and have antimicrobial effect and the ability to set in the presence of blood. [12]

The present study was done to evaluate the push-out bond strength of two different commercially brands of MTA and Biodentine as root repair materials. The push-out test aimed to assess the bond strength of a restorative material to dentin.

Mineral trioxide aggregate (MTA), introduced by Torabinejad M in 1990 is a calcium silicate-based cement that is considered to be a predictable material for all dentinal defects. [13] Several studies have shown that B-type carbonated apatite formed by the cement-Phosphate buffered solution system deposited on collagen fibers promotes controlled mineral nucleation on dentin and triggers the formation of an interfacial layer with tag-like structures at cement-dentin interface. [14, 15] This biomineralization process could be responsible for the improvement in the marginal seal of MTA apical plugs after immersion in Phosphate Buffered Saline, which was previously observed by Martin et al. [16] MTA possesses an effective sealing ability, marginal adaptation and its retention characteristics increased from 24 to 72 hours, regardless of the presence of moisture.

Despite the favorable properties of MTA, it has several drawbacks such as prolonged setting time, difficult handling characteristics and potential for discoloration. [13] Hence, to overcome the shortcomings and properties of MTA, new calcium silicate-based materials have been formulated.

Biodentine was introduced by Gilles and Oliver (2010) [17] that was specifically designed as a “dentine replacement” material. It is a fast-setting calcium silicate based restorative material that can be used as a coronal restorative material for perforation repair. [18] Just after mixing, the calcium silicate particles of Biodentine react with water to form hydrated calcium silicate gel that later polymerizes to form a solid network and the alkalinity of the surrounding medium increases due to the release of calcium hydroxide ions. It has good adhesive performance and also improved resistance to dislodging forces such as mechanical stress due to tooth function or operative procedures. [19] According to clinical study by Kaubi et al (2012), the tolerance of Biodentine under posterior composite restorations showed that Biodentine was an efficient and well tolerated dentin substitute. [20]

Atmeh AR, Chong EZ, et al (2012) [21] investigated the dentin cement interfacial interaction of calcium silicates and polyalkenoates and found that alkaline Biodentine induced a caustic denaturation and permeability of organic collagen compound of the interfacial dentine and showed the formation of intra tubular tags in conjunction with an interfacial mineral interaction layer that is referred to as “mineral infiltration zone”. The interfacial layer formed between dentine and Biodentine might be comparable to interfacial layer formed between dentine and MTA.

Majeed A, AlShwaimi E et al (2017) [22] evaluated the Push-out bond strength and surface microhardness of calcium silicate-based biomaterials and reported that Biodentine and Pro root MTA demonstrated similar but significantly higher bond strength values compared to Bio aggregate material in root dentin samples.

Biodentine also has a better sealing ability compared to Pro root MTA; this can be attributed to its ability to construct biomimetic remineralization and deposition of calcium phosphate on the surface suggestive of a high rate of calcium release with constant formation of apatite making it a scaffold for clinical healing. [23]

In the current study, the push-out bond strength of Biodentine was significantly higher when compared with MTA (Angelus) and Pro root MTA (Dentsply). These results are in conjunction with the findings of Gunesar M et al (2013) [24] and showed that the good adhesion of Biodentine to root canal walls is because of the finer particle size that enhances the infiltration of the cement into the dentinal tubules. To support this evidence, Kim et al. have shown that Biodentine caused deposition of ACP interfacial layered with radicular dentin and that the Ca/P ratio of this layer is comparable to MTA. [25] Therefore, Biodentine can be concluded to be better in terms of its bond strength to root dentin.

CONCLUSION

The present in vitro study concluded that

1) Biodentine exhibited better push-out bond strength than MTA (Angelus) and Pro root MTA (Dentsply)
2) There is no statistical significance between the push-out bond strength of MTA (Angelus) and Pro root MTA (Dentsply)

ACKNOWLEDGMENTS

I affirm that I/We have no financial affiliation or involvement with any commercial organization with direct financial interest in the subject or materials discussed in this manuscript.

REFERENCES

1. Seltzer S, Bender IB, smith, et al. Endodontic failures. An analysis based on clinical, roentgenographic, and histologic findings .II. Oral Surg Oral Path 1967;23: 517-30.
2. American Association of Endodontists. Glossary of Endodontic Terms. 7 th ed. Chicago: American Association of Endodontists; 2003
3. Kvinnsland I, Oswald RJ, Halse A, Gronningsaeter AG. A clinical and roentgenological study of 55 cases of root perforation. Int Endod J 1989;22:75– 84.
4. Seltzer S, Sinai I, August D. Periodontal effects of root perforations before and during endodontic procedures. J Dent Res 1970;49;332-9.
5. Nekoofar MH, Namazikhah MS, Sheykhrezae MS, et al. p^H of pus collected from periapical abscesses. Int Endod J 2009;42:534–8.
6. Hazel O. Simila, Natalia Karpukhina, Robert G. Hill et al. Bioactivity and fluoriderelease of strontium and fluoride modified Biodentine .J Dental . 2017.10.005.
7. Shahi S, Rahimi S, Lotfi M, et al. A comparative study of the biocompatibility of three root-end filling materials in rat connective tissue. J Endod 2006;32:776-80
8. Bhavya B, Mohammed Sadique, Elsy P. Simon, et al. Spectrophotometric analysis of coronal discoloration induced by white mineral trioxide aggregate and Biodentine. J Conserv Dent 2017;20:237-40.
9. Camilleri J, Sorrentino F, Damidot D. Investigation of the hydration and bioactivity of radiopacified tricalcium silicate cement, biodentine and MTA (Angelus). Dent Mater 2013;29:580-93
10. Opacie Galie V, Petrovic V, Zirkovic S, et al. New nanostructural biomaterials based on active silicate cements and hydroxyapetite: characterization and geniotoxicity in human peripheral blood lymphocytes . Int Endod J 2013;46;506-16.

11. Clauder T, Shin SJ .Repair of perforations with MTA: Clinical applications and mechanisms of action. Endod Toics 2006; 15:32-55.
12. Dazey S, Senia ES. An in vitro comparison of the sealing ability of materials placed in lateral root perforation. J Endo 1990 ;16:19-23 .
13. Unal GC, Maden M, Isidan T, et al. Repair of furcal iatrogenic perforation with mineral trioxide aggregate : 2 years follow- up of two cases . Eur J Dent 2010;4:475-81.
14. Tay FR, Pashley DH. Guided tissue remineralisation of partially demineralized human dentine. Biomaterials 2008;29:1127-37 .
15. Reyes Carmona JF, Felippe WT. Biomineralization ability and interaction of MTA and portland cement with dentin in a phosphate containing fluid. J Endod 2009; 35:731- 6.
16. Martin RI, Monticelli F, Brackett WW, et al. Sealing properties of MTA orthograde apical plugs and root fillings in an in vitro apexification model J Endod 2007;33:1272-5.
17. Gilles R, Oliver M. Dental composition. Patient 2011, WO, 2011/124841, US 2013/0025498. Applicant Septodont, Saint –Maur-des –Fosses, France.
18. Leiendecker AP, Qi Y, Sawyer AN, et al. Effects of calcium silicate based materials on collagen integrity of mineralized dentin J Endod 2012;38:829-33.
19. DammaschkeT, GerthHU, ZuchnerH, Schafer E, et al. Chemical and physical surface and bulk material characterization of white Pro root MTA and two Portland cements. Dent Mater 2005;21:731-8.
20. Koubi G, Colon P, Franquin JC, et al. Clinical evaluation of the performance and safety of a new dentine substitute. Biodentine, in the restoration of the posterior teeth – a prospective study. Clinical Oral. Investigations 2012
21. Atmeh AR, Chong EZ, Richard G, et al. Dentin cement interfacial interaction: calcium silicate sand polyalkenoates. J Dent Res 2012;91:453-9.
22. Majeed A, AlShwaimi E. Push-out bond strength and surface microhardness of calcium silicate-based biomaterials : An in vitro study. Med Princ Pract. 2017;26:139–45.
23. Akman M, Akbulut MB, Gunesar MB, et al. Effect of intracanal medicaments on the push out bond strength of Biodentine in comparison with bioaggregate apical plugs . J Adhes Sci Technol 2016;30:459-67 .
24. Gunesar M, Akhulat M, Eldeniz A. Effect of viruses endodontic irrigants on the push out bond strength of Biodentine and conventional root perforation repair materials. J Endod 2013;39:380-4.
25. Singh S, Podar R, Dasu S, et al. Solubility of a new calcium silicate based root end filling material. J Conserv Dent 2015;18: 149-53.

How to cite this article: Badami V, Nadipineni A, Sooraparaju S et.al. Comparative evaluation of push out bond strength of two commercially available MTA and biodentine - an in vitro study. *Int J Health Sci Res.* 2021; 11(2):12-18.

******