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An In Vitro Evaluation of Effect of Chelating Agents on the Push Out Bond Strength of New Perforation Repair Materials Bio Dentine, Bio Aggregate and Retro MTA

Vandana Gade[1*], Aparajita Gangrade[2], Nitin Jogad[1], Leena Bhede[3], Deepa Thakur[1], Kalyani Umale[1]

[1]*Department of Conservative Dentistry and Endodontics Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur, India*

[2]*Private Practitioner and Consultant Endodontist, Apollo Hospital, Hyderabad, India*

[3]*VSPM Dental College and Hospital Nagpur, India*

ABSTRACT

Perforation repair should be done prior to completion of endodontic therapy which leads to contact of irrigants and cheating agents with repair material.

Aim: To evaluate the effect of 17% EDTA and 10% Citric Acid on the bond strength of Biodentine, BioAggregate and Retro MTA.

Materials and Methods: 120 dentine slices of 2-mm thickness were prepared with lumen 1.3mm. divided into 3 groups, Biodentine, BioAggregate and Retro MTA were placed in the respective samples Each group divided into 4 subgroups (n=10) Control, saline,17% EDTA, 10% Citric Acid. Immersion was done for 30 minutes, followed by incubation for 48 hours. The samples were then tested for compressive strength through a push out test. Data were analyzed statistically using ANNOVA and Tukey's post-hoc test. The significant level was present to P=0.05.

Results: EDTA and Citric Acid negatively influenced the pushout bond strength of all repair materials. The bond strength of BioAggregate is much less as compared to Biodentine, and RetroMTA.

Conclusion: decalcifying agents have a negative impact on the bond strength of all root repair materials.

Key words: perforation repair material, Citric acid, Retro MTA, Bio dentine, Bio Aggregate ,17%EDTA,10%citric acid

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Corresponding author: Vandana Gade
e-mail✉: gade.vandana@gmail.com
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INTRODUCTION

"Endodontics" has reached a stage where more and more people are realizing that saving a single natural tooth is worthwhile and advantageous as there is no substitute for a healthy natural tooth; to preserve the aesthetics and function of the masticatory framework and integrity of the arch [1].

Perforation is an artificial communication between root canal system and the supporting tissues of teeth or the oral Cavity [2]. Perforations are complication that can occur due to caries, resorption or iatrogenically during endodontic treatment or post space preparation of teeth [3, 4]

The prognosis of perforation repair depends on several factors including the location of the perforation, size of the perforation, time of occurrence of perforation and the material used for the repair of perforation. Successful management of furcation perforations poses a challenge for a clinician [5]. Ideally, perforations should immediately be repaired with a biocompatible material to halt the passage of fluids from within to outside the tooth and vice versa, so that favourable prognosis can be achieved [6, 7].

Biodentine (Septodont, Saint Maur des Fossés, 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 also recommended to be used as a dentine substitute under resin composite restorations and an endodontic repair material because of its good sealing ability, high compressive strength, short setting time and biocompatibility, bioactivity and bio-mineralization properties [3].

Bioaggregate (Verio Dental Co. Ltd., Vancouver, Canada) is a new material that has recently been introduced to the market as an alternative to MTA for use in perforation repair and vital pulp therapy and as a root-end filling material. BioAggregate has shown antibacterial effects and sealing ability comparable to that of MTA, and the absence of aluminium and bismuth in BioAggregate has resulted in a reported biocompatibility greater than that of MTA [8].

RetroMTA® (BioMTA, Seoul, Korea) has recently been introduced in the market as a new hydraulic bioceramic material proposed for use in similar endodontic applications as MTA (pulp capping, and apical surgery). However, unlike MTA, this material does not contain Portland cement, and hydraulic calcium zirconia is included as a radiopacifying agent. According to the manufacturer, RetroMTA® is ideal for aesthetic repair, since it has no discoloration and has a fast setting (initial setting considering the moist environment of the oral cavity [9].

Following the repair of perforation, nonsurgical endodontic treatment is performed with various endodontic irrigants and chelating agents. This leads to inadvertent contact of repair material with irrigants.

So, the present study was conducted with an aim of evaluating and comparing the effect of 17% ETDA, 10% Citric acid and normal saline on the push out bond strength of Biodentine, BioAggregate and RetroMTA.

Null hypothesis tested for this study was that there were no effects of chelating agents on Biodentine, BioAggregate and RetroMTA.

MATERIALS AND METHODS

120 freshly extracted single-rooted permanent human teeth with straight root canal were procured according to protocols approved by the state health University and Institutional Ethical Review Board.

The selection criteria were the presence of a single root canal, no evidence of cracks, fractures, root caries or restoration, mature apices and straight canals without calcification. Remaining periodontal tissues and calculus was removed. The teeth were radiographed and the teeth possessing internal and external resorption were not used in the study. After extraction, teeth were kept in 10% buffered formalin prior to further use [9,10].

The crowns were removed, and the middle thirds of the roots were sectioned transversally by using a low-speed diamond disc in continuous water irrigation to obtain 2-mm-thick sections. A periodontal probe was used to measure the thickness (2 mm). Dentine slices less than 2 mm in depth were excluded, while those with greater depth were ground. All the dentine slices were rinsed with distilled water to remove debris produced during the procedure. In each sample, the canal space was enlarged using Gates-Glidden burs #1 through #5, to obtain 1.3-mm-diameter standardized cavity [11].

120 dentine slices were immersed in 3% NaOCl for 5 minutes and washed with distilled water. These samples were subdivided into 3 groups consisting of 40 samples each, according to the root repair material being used. The repair materials were mixed according to manufacturer's instructions and inserted in the lumen of respective samples with the help of plugger. Afterwards, the dentine slices were wrapped in wet gauze, set aside in an incubator, for 24 hours at 37°C with 100% humidity to mimic oral conditions [11].

After 24 hours of housing in the incubator, the specimens of each material were divided into 4 groups (n=10) according to final irrigation solution:

In group 1, (control), a wet cotton pellet dipped in distilled water was placed over the specimen without any irrigation and allowed to set for 48 hours.

In group 2, specimens were immersed in saline solution.

In group 3, specimens were immersed in 17% EDTA.

In group 4, specimens were immersed in 10% Citric Acid.

The dentine slices were immersed in their respective irrigants for 30 minutes. After 30 min, the specimens were removed from the irrigation solutions, rinsed with distilled water, and allowed to set for 48 hours at 37°C with 100% humidity in an incubator. The procedure was done according to Guneser, et al. and Elnaghy, et al. [3,12].

After incubation of 48 hours, dentine slices were removed from the incubator and mounted in self-cured acrylic blocks and sent for push out testing using Universal Testing Machine.

A cylinder-shaped plunger of diameter 1 mm was used for this study. The plunger had a clearance of approximately 0.15 mm from the margin of the dentinal wall to ensure contact only with the test materials and not the dentine. A load from the plunger was applied in a downward direction and parallel to the long axis of the tooth on the surface of the test material in each sample was applied until dislodgement occurred. The plunger had a crosshead speed of 1 mm/min.

The maximum force applied to materials at the time of dislodgement was recorded in Newton (N). The pushout bond strength in megapascals (MPa) was calculated by dividing this force by the surface area of test material ($N/2\pi rh$).

Statistical analysis

The analysis of data was done using the SPSS software version 2.0 (IBM, New York, NY, USA). One-way analysis of variance (ANOVA) was used to determine the statistical significance of difference in the mean push out strengths of each material across decalcifying agents. Paired analysis of push out strength between decalcifying agents for each material was performed using Tukey's post-hoc test. The significant level was present to P=0.05.

RESULTS

Results indicate that the push out bond strength of Biodentine is highest followed by Retro MTA. Pair wise test shows statistically insignificant difference between RetroMTA and Biodentine in control groups as compared to significant difference with BioAggregate (Table1).

The difference in the means across irrigants was mainly contributed by control group, while difference across materials was contributed by Bio aggregate. Among chelating agents EDTA and Citric acid show negative influence on the bond strength which is statistically significant (Table 2).

Table 1: Descriptive statistics for push out bond strength of Biodentine, BioAggregate and retro mta across different chelating agents.

Material	Irrigant	Mean	SD	Median	Min	Max
Biodentine	EDTA (n=10)	5.13	1.3	5.21	3.38	6.94
	Citric Acid (n=10)	5.25	2.3	4.52	1.8	8.39
	Saline (n=10)	6.25	1.94	6.27	4.03	8.97
	Control (n=10)	9.94	2.16	9.48	7.65	13.89
Bio Aggregate	EDTA (n=10)	3.05	0.98	2.97	1.8	4.48
	Citric Acid (n=10)	1.46	1.07	1.42	0.14	3.4
	Saline (n=10)	1.49	0.89	1.37	0.24	2.98
	Control (n=10)	3.03	1.76	3.09	0.57	5.76
Retro MTA	EDTA (n=10)	4.87	1.05	4.97	2.81	6.07
	Citric Acid (n=10)	3	1.53	3.66	0.58	4.77
	Saline (n=10)	8.41	3.77	6.66	4.26	13.56
	Control (n=10)	8.22	2.11	8.77	4.05	10.87

Table 2: Comparison of mean push out bond strength for each material used across chelating agents.

Material→	Biodentine				BioAggregate				Retro MTA			
Irrigant →	EDTA	Citric Acid	Saline	Control	EDTA	Citric Acid	Saline	Control	EDTA	Citric Acid	Saline	Control
Mean	5.13	5.25	6.25	9.94	3.05	1.46	1.49	3.03	4.87	3	8.41	8.22
SD	1.3	2.3	1.94	2.16	0.98	1.07	0.89	1.76	1.05	1.53	3.77	2.11
P - value*	<0.0001 (HS)				0.0035 (S)				<0.0001 (HS)			

DISCUSSION

The goal of an ideal endodontic therapy is to hermetically secure all pathways of communication between the pulp and periodontium [9]. One of the mishaps that may occur during endodontic therapy is furcation perforation. Such perforations have been reported to occur in 2-12% of cases [13].

Clinically, the operator should immediately mend the furcation perforations with an endodontic material to lessen the bacterial contamination and irritation and inflammation of periodontal tissues due to the use of endodontic irrigating solutions [14]. After repairing the furcal perforation, endodontic treatment should be performed. The furcal perforation sites are at a higher risk of dislodgement and hence bond strength is evaluated in the present study.

Guneser et al [3] reported that Biodentine had considerable performance as a repair material even after being exposed to various endodontic irrigation solutions including NaOCl and CHX [3]. RetroMTA and BioAggregate are recently introduced materials with limited knowledge about their bond strength.

In the present study the mean bond strength of Biodentine was 9.94 ± 2.16 MPa. It is similar to the finding of Cechella, et al who reported the mean bond strength of Biodentine after 24 hours was 8.06 ± 3.14 MPa. [15] The mean bond strength of BioAggregate is 3.03 ± 1.76 MPa. BioAggregate has got the least value which is like the findings of Hashem et al [16]. The mean bond strength of RetroMTA is 8.22 ± 2.11 MPa. No statistical difference in the bond strength of RetroMTA and Biodentine have been found. The probable reason for difference in the bond strength can be due to the presence and absence of aluminium in RetroMTA and BioAggregate respectively which provides strength to the material [8,17].

In the present study the bond strength of Biodentine after exposure to saline is 6.25 ± 1.94 MPa and that of BioAggregate is 1.49 ± 0.89 MPa. Saline has negatively affected the bond strength of Biodentine, however insignificantly. According to the manufacturers, Biodentine should be prevented from exposure to water and fluid during the initial setting. This excessive moisture may have adversely affected the setting reaction of Biodentine and resulted in separation from the dentin. This would explain the inferior bond strength values observed in the Biodentine group [11,18]. This can be the probable reason for reduced bond strength of BioAggregate after exposure to saline. The mean pushout bond strength of Retro MTA after being exposed to saline is 8.41 ± 3.77 MPa. Saline has positively affected the bond strength of both materials. The probable reason can be due to presence of excess moisture for increased hydration of calcium hydroxide and calcium silicate hydrate [3,12].

In the present study the mean bond strength of Biodentine after EDTA treatment is 5.13 ± 1.30 MPa that of BioAggregate and Retro MTA are 3.05 ± 0.98 and 4.87 ± 1.05 MPa respectively. EDTA has negatively influenced the bond strength of all the three materials. 17% EDTA has been reported to have a strong negative influence on the compressive strength of Biodentine [19]. EDTA has reported chelating action, which interferes with the formation of calcium silicate hydrate gel [19-21]. 17% EDTA has six potential sites (four carboxyl groups and two amino groups) available to bond with calcium to form highly stable bonds. The residual 17% EDTA in the root canal system may chelate with calcium ions released during hydration and disturb its precipitation [22].

In the present study the mean bond strength of Biodentine after treatment with Citric acid is 5.25 ± 2.30 MPa that of BioAggregate and Retro MTA are 1.47 ± 1.07 and 3.00 ± 1.53 MPa respectively. Citric acid has also significantly reduced the bond strength of all the repair materials. Acidic environment has been reported to reduce the bond strength of repair materials. Reduced pH affects the physical properties of repair materials. It affects the hydration mechanism adversely to reduce microhardness and bond strength of the repair materials. [23-25].

Biodentine and Retro MTA show promising results as furcation perforation repair materials as compared to BioAggregate. EDTA and Citric acid have significantly reduced the bond strength of all three repair materials used in the present study. Very few studies available on Bio aggregate and Retro MTA Material. So, further studies of such kind with large number of samples should be conducted.

CONCLUSION

With the limitation of study, it can be concluded as

- All the decalcifying agents have a negative impact on the bond strength of all root repair materials being used.
- Biodentine showed promising result as root repair material as compared to BioAggregate and Retro MTA.

REFERENCES

1. Gupta PK, Mahajan UP, Gupta K, et al. Comparative evaluation of a new endodontic irrigant-mixture of a tetracycline isomer, an acid, and a detergent to remove the intracanal smear layer: A scanning electron microscopic study. J Int Oral Health 2015; 7:1-6.
2. Gutmann JL, Harrison JW. Surgical Endodontics: Quo vadis?? Endodontics Topics 2005; 11:1-3.
3. 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; 39:380-384.
4. Aggarwal V, Singla M, Miglani S, et al. Comparative evaluation of push-out bond strength of ProRoot MTA, Biodentine, and MTA Plus in furcation perforation repair. J Conserv Dent 2013; 16:462-5.
5. Nagas E, Cehreli ZC, Uyanik MO, et al. Bond strength of mineral trioxide aggregate to root dentin after exposure to different irrigation solutions. Dent Traumatol 2014; 30:246-9.
6. Fuss Z, Trope M. Root perforations: classification and treatment choices based on prognostic factors. Dent Traumatol 1996; 12:255-64.
7. Betul Memis Ozgul, Tugba Bezgin, Cem Sahin, et al. Resistance to leakage of various thicknesses of apical plugs of Bioaggregate using liquid filtration model. Dental Traumatol 2015; 31:250–254.
8. Souza LC, Yadlapati M, Dorn SO, et al. Analysis of radiopacity, pH and cytotoxicity of a new bioceramic material. J Appl Oral Sci 2015; 23:383.
9. Mathew LA, Kini S, Acharya SR, et al. A comparative evaluation of the microleakage of blood-contaminated mineral trioxide aggregate and Biodentine as root-end filling materials: An in vitro study. J Interdiscip Dent 2016; 6:19-24.
10. Srivastava AA, Srivastava H, Prasad AB, et al. Effect of calcium hydroxide, chlorhexidine digluconate and camphorated monochlorophenol on the sealing ability of biodentine apical plug. J Clin Diagn Res 2016; 10:43-46.
11. Üstün Y, Topçuoğlu H, Akpek F, et al. The effect of blood contamination on dislocation resistance of different endodontic reparative materials. J Oral Sci 2015; 57:185-90.
12. Elnaghy AM. Influence of QMix irrigant on the micropush-out bond strength of biodentine and white mineral trioxide aggregate. J Adhes Dent 2014; 16.
13. Ramazani N, Sadeghi P. Bacterial leakage of mineral trioxide aggregate, calciumenriched mixture and biodentine as furcation perforation repair materials in primary molars. Iran Endod J 2016; 11:214.

14. Loxley EC, Liewehr FR, Buxton TB, et al. 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.
15. Cechella BC, Almeida JD, Felippe MC, et al. Influence of phosphate buffered saline on the bond strength of endodontic cement to dentin. Braz J Oral Sci 2015; 14:126-129.
16. Hashem AA, Amin SA. The effect of acidity on dislodgment resistance of mineral trioxide aggregate and bioaggregate in furcation perforations: an in vitro comparative study. J endod 2012; 38:245-9.
17. Fakheran O, Birang R, Schmidlin PR, et al. Retro MTA and tricalcium phosphate/retro MTA for guided tissue regeneration of periodontal dehiscence defects in a dog model: A pilot study. Biomater Res 2019; 23:1-7.
18. Kim JR, Nosrat A, Fouad AF. Interfacial characteristics of Biodentine and MTA with dentine in simulated body fluid. J Dent 2015; 43:241-7.
19. Taha NA, Safadi RA, Alwedaie MS. Biocompatibility evaluation of endosequence root repair paste in the connective tissue of rats. J Endod 2016; 42:1523-8.
20. Govindaraju L, Neelakantan P, Gutmann JL. Effect of root canal irrigating solutions on the compressive strength of tricalcium silicate cements. Clin Oral Investig 2016; 1-5.
21. Lee YL, Lin FH, Wang WH, et al. Effects of EDTA on the hydration mechanism of mineral trioxide aggregate. J Dent Res 2007; 86:534-8.
22. Aggarwal V, Jain A, Kabi D. In vitro evaluation of effect of various endodontic solutions on selected physical properties of white mineral trioxide aggregate. Aust Endod J 2011; 37:61-4.
23. Namazikhah MS, Nekoofar MH, Sheykhrezae MS, et al. The effect of pH on surface hardness and microstructure of mineral trioxide aggregate. Int Endod J 2008; 41:108-16.
24. Buldur B, Öznurhan F, Kaptan A. The effect of different chelating agents on the push-out bond strength of proroot mta and endosequence root repair material. Eur Oral Res 2019; 53:88-93.
25. Ballal NV, Mishra P, Rao S, et al. Effect of chelating agents on the microhardness of Biodentine. Saudi Endod J 2019; 9:109-12.