

# Effect of Acidic Environment on the Push-out Bond Strength of Biodentine™

Gaurav Poplai, Sameer Jadhav, Vivek Hegde

## ABSTRACT

**Introduction:** An apical sealing material may be exposed to an inflamed environment with low pH levels. The change in physical and chemical properties of mineral trioxide aggregate has been well-documented in the presence of low pH. However, on literature search there is no documentation of the effect of low pH on Biodentine™.

**Aim:** To compare the effects of various levels of acidic pH on the push-out bond strength of Biodentine™.

**Materials and methods:** Forty root dentin slices from single rooted human teeth were sectioned horizontally. The canal lumens were instrumented to obtain a standardized diameter of 1.3 mm and filled with Biodentine™. The specimens were then randomly divided into four groups (n = 10) and wrapped in pieces of gauze soaked in phosphate buffer saline solution (pH = 7.4) and butyric acid buffered at pH values of 4.4, 5.4 and 6.4 respectively. They were incubated at 37°C for 4 days. Push-out test were then carried out using universal testing machine. The data was analyzed using one-way analysis of variance (ANOVA) technique with Tukey's correction for multiple group comparisons.

**Results:** Data was subjected to one-way ANOVA using Tukey's post hoc test. Group I (control, pH = 7.4) showed greatest bond strength of  $19.5 \pm 0.9$  MPa. The least push-out bond strength of  $11.7 \pm 0.5$  MPa was observed in Group IV where the specimens were soaked at pH 4.4. A p-value less than 0.05 were considered to be statistically significant.

**Conclusion:** The force needed to displace Biodentine was significantly lower in samples stored at lower pH values.

**Keywords:** Biodentine, Mineral trioxide aggregate, Pulp and periapical lesion.

**How to cite this article:** Poplai G, Jadhav S, Hegde V. Effect of Acidic Environment on the Push-out Bond Strength of Biodentine™. *World J Dent* 2012;3(4):313-315.

**Source of support:** Nil

**Conflict of interest:** None declared

## INTRODUCTION

Overtime, there has been a continuous search for dental materials that present an ideal combination of good mechanical, physicochemical and biological properties. This search is even more incessant where treatment of periapical lesions is concerned. An ideal root-end filling material has to be biocompatible, dimensionally stable, adhere to the dentinal walls with excellent marginal adaptation preventing the passage of bacteria, and be unaffected in the presence of tissue fluids that may be acidic in an infected area.<sup>1-4</sup>

Mineral trioxide aggregate (MTA) has most of these essential properties and is highly popular as a root-end filling material.<sup>5</sup> Recently a new tricalcium silicate-based material has been introduced, known as Biodentine, the applications of which are similar to those of MTA.<sup>6</sup>

Variations in pH of periapical tissues may affect the physical and chemical properties of the material. The push-out test can be used to measure the interfacial shear strength developed between different surfaces, providing additional information on the evaluation of adhesion properties.<sup>7,8</sup> The effect of acidic pH on the push-out bond strength has been well-documented for MTA but there is lack of information about Biodentine in a similar environment.<sup>9</sup>

## AIM

To evaluate the push-out bond strength between Biodentine and intraradicular dentin after exposure to a range of acidic pH.

## MATERIALS AND METHODS

Forty freshly extracted single rooted human anterior teeth which were intact and noncarious were used for the study. The teeth were stored in chloramine-T at 4°C for up to 1 month before use. Mid-root dentin was sectioned horizontally, perpendicular to the long axis of the teeth into  $1.00 \pm 0.05$  mm thick slices using a microtome. The lumen of each slice was instrumented with Gates-Glidden drills (Dentsply-Maillefer, Ballaigues, Switzerland) size #1 through #5 to obtain 1.3 mm standardized cavities. Biodentine was mixed according to manufacturer's instructions in an amalgamator and placed in the cavities using a carrier (Premier Dental, PA, USA) and condensed thoroughly with a plugger (Dentsply-Maillefer, Ballaigues, Switzerland) followed by additional material until a surplus was seen above the cavity margins. The material in each sample was then burnished with a burnisher (Analylic, SybronEndo, Orange, CA, USA). The specimens were then randomly divided into four groups (n = 10). In Group I, the specimens were wrapped in phosphate buffered saline solution (pH = 7.4). In Groups II, III and IV the specimens were wrapped in pieces of gauze soaked in butyric acid buffered at pH values of 6.4, 5.4 and 4.4 respectively. Each group was placed in a separate vial. Acid soaked pieces of gauze were replaced everyday with fresh ones to ensure

sufficient acidic environment within the vials. The specimens were then incubated for 4 days at 37°C.

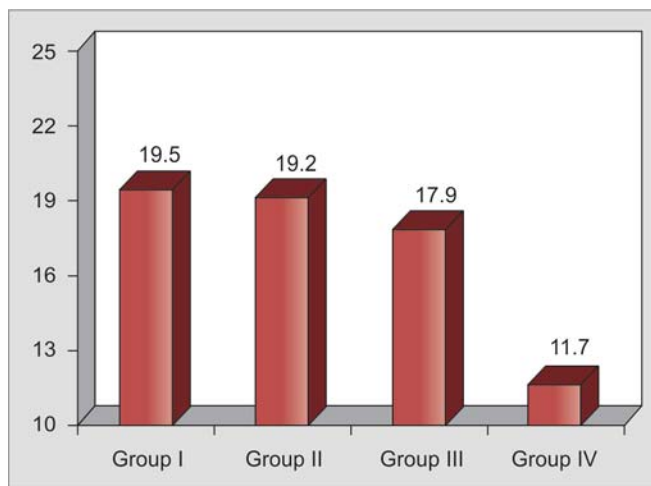
The push-out bond strengths were measured using a universal testing machine with a crosshead speed of 5 mm/min. The samples were placed on a metal slab with a central hole to allow the free motion of the plunger. The compressive load was applied by exerting a downward pressure on the surface of the material using a 1 mm diameter cylindrical plunger. The plunger had a clearance of approximately 0.2 mm from the margin of the dentinal wall to insure contact with the material only. The maximum load applied to the material in the sample at the time of dislodgment was recorded in Newtons. In order to express the bond strength in megapascals (MPa) the recorded value was divided by the adhesion area of the root canal filling. The adhesion area was calculated by the following formula:  $2\pi r \times h$  where 'r' is the root canal radius and 'h' is the thickness of the root dentin slice in millimeters.

### RESULTS

The data obtained after the push-out test was performed is tabulated in Table 1. The mean retentive strength of the test groups are shown in Graph 1 and the statistical comparison of groups are shown in Table 2. One-way analysis of variance (ANOVA) using Tukey's post hoc correction for multiple group comparisons showed significant difference between bond strengths of all the groups except for between Group I (control, pH = 7.4) which showed bond strength of  $19.5 \pm 0.9$  MPa and Group II (pH = 6.4) which showed bond strength of  $19.2 \pm 0.8$  MPa where the p-value was 0.846. A p-value less than 0.05 was considered to be statistically significant. Group III (pH = 5.4) showed bond strength of  $17.9 \pm 1.1$  MPa. The least push-out bond strength was observed in Group IV ( $11.7 \pm 0.5$  MPa) where the specimens were soaked at pH = 4.4.

### DISCUSSION

There are various methods for evaluating the adhesion of a dental material to dentin including tensile, shear and push-



Graph 1: Mean retentive strength

Group comparison	Bond strength
Group I vs group II	0.846
Group I vs group III	0.001 (significant)
Group I vs group IV	0.001 (significant)
Group II vs group III	0.010 (significant)
Group II vs group IV	0.001 (significant)
Group III vs group IV	0.001 (significant)

out strength tests. In our study, the push-out test method was used to test the bond strength between Biodentine and dentin while exposed to acidic solutions with several pH values since inflamed and/or infected tissues have a low pH.<sup>10,11</sup> Biodentine being a root end filling material will be exposed to this sort of an acidic environment. Butyric acid has been used in the present study since its presence has been reported in inflamed tissue by gas chromatography and is an indicator of anaerobic infection.<sup>12</sup>

Shokouhinejad et al studied the effect of acidic environment on MTA where the force needed for displacement of MTA was significantly lower as the pH values decreased. In that study the greatest mean push-out strength of  $7.28 \pm 2.28$  MPa was observed at pH 7.4 and the value decreased to  $2.47 \pm 0.61$  MPa at pH 4.4.<sup>9</sup>

The mean push-out bond strength at pH 7.4 was  $19.5 \pm 0.9$  MPa and even at pH 4.4 the bond strength obtained was  $11.7 \pm 0.5$  MPa. Higher bond strength of Biodentine can be explained on the basis of calcium chloride (CaCl<sub>2</sub>) present in the liquid provided by the manufacturer. The addition of CaCl<sub>2</sub> is intended to reduce the setting time of the Portland cement and to improve its physicochemical properties in civil construction.<sup>13,14</sup>

A possible explanation behind CaCl<sub>2</sub> enhancing the physical properties are that CaCl<sub>2</sub> penetrates the pores of cements, strongly accelerating the hydration of silicates and leading to their faster crystallization and reducing the setting time.<sup>15,16</sup>

Sample ID	Group I (control pH = 7.4)	Group II (pH 6.4)	Group III (pH 5.4)	Group IV (pH 4.4)
1	20.63	18.98	17.98	11.37
2	18.87	19.42	16.42	11.97
3	19.68	19.20	18.54	11.82
4	19.55	20.38	19.44	12.32
5	18.42	19.75	16.98	11.49
6	20.02	19.54	16.67	12.22
7	18.92	18.49	18.33	10.98
8	18.04	19.88	16.78	12.09
9	20.23	18.13	18.43	10.84
10	20.41	17.89	19.32	11.75

It may also alter the chemical composition, surface area and characteristics of the pores of cements, providing the advantages of increased resistance to compression and reduced permeability.<sup>15</sup>

## CONCLUSION

Under the conditions of this study it could be concluded that the bond strength of Biodentine was impaired in conditions of low pH values.

## ACKNOWLEDGMENT

The authors wish to thank Mr Bhagat at Praj Metallurgical Laboratory, Pune, for his assistance with the universal testing machine.

## REFERENCES

1. Altonen M, Mattila K. Follow-up study of apicoectomized molars. *Int J Oral Surg* 1976;5:33-40.
2. Torabinejad M, Smith PW, Kettering JD, Pitt Ford TR. Comparative investigation of marginal adaptation of mineral trioxide aggregate and other commonly used root-end filling materials. *J Endod* 1995;21:295-99.
3. Shahriar S, Saeed R, Hamid RY, Mohammad S, Maryam J, Mahmoud B, et al. Effects of various mixing techniques on push-out bond strengths of white mineral trioxide aggregate. *J Endod* 2012;38:501-04.
4. Nekoofar MH, Namazikhah MS, Sheykhrezae MS, et al. pH of pus collected from periapical abscesses. *Int Endod J* 2009;42:534-38.
5. Parirokh M, Torabinejad M. Mineral trioxide aggregate: A comprehensive literature review – Part I: Chemical, physical and antibacterial properties. *J Endod* 2010;36:16-27.
6. Septodont R&D Department Biodentine™: Active Biosilicate Technology Scientific file 2009.
7. Thompson JI, Gregson PJ, Revell PA. Analysis of push-out test data based on interfacial fracture energy. *J Mater Sci Mater Med* 1999;10:863-68.
8. Chandra N, Ghonem H. Interfacial mechanics of push-out tests: Theory and experiments. *Composites Part A: Applied Science and Manufacturing* 2001;32:575-84.
9. Shokouhinejad N, Nekoofar MH, et al. Effect of acidic environment on the push-out bond strength of mineral trioxide aggregate. *J Endod* 2010;36:871-74.
10. Malmed SF. *Handbook of local anaesthesia* (5th edn). St Louis Mosby: Elsevier 2004:43-44.
11. Tsuchiya H, Mizogami M, et al. Interaction of local anaesthetics with lipid membranes under inflammatory acidic conditions. *Inflammopharmacology* 2007;15:164-70.
12. Tanaka JI, Takano N, et al. A rapid diagnosis of anaerobic infection in the oro-maxillary region by gas-liquid chromatography. *Bull Tokyo Dent Coll* 1990;31:155-62.
13. *Technical handbook: Additives for concrete and mortars* (39th ed). Salvador: Vedacit 2003 [In Portuguese].
14. Aquilina JW. *The physical properties of accelerated Portland cement* (Project report.). University of London 1999.
15. Ramachandran VS. *Concrete admixtures handbook*. New Jersey: Noyes Publications 1984:187-210.
16. Popovics S. *Concrete making*. Washington: McGraw-Hill Book Company, Washington 1979.

## ABOUT THE AUTHORS

### Gaurav Poplai

Student, Department of Conservative Dentistry and Endodontics, MA Rangoonwala College of Dental Sciences and Research Centre, Pune Maharashtra, India

**Correspondence Address:** B-44 Cozi Hom, 251 Pali Hill Mumbai-400050, Maharashtra, India, Phone: 9096666367, e-mail: gpoplai@hotmail.com gpoplai@gmail.com

### Sameer Jadhav

Professor, Department of Conservative Dentistry and Endodontics MA Rangoonwala College of Dental Sciences and Research Centre Pune, Maharashtra, India

### Vivek Hegde

Head, Department of Conservative Dentistry and Endodontics, MA Rangoonwala College of Dental Sciences and Research Centre, Pune Maharashtra, India