10.5005/jp-journals-10063-0007

ORIGINAL ARTICLE

Evaluation of Shear Bond Strength of Fiber-reinforced Composite and Methacrylate-based Composite to Pure Tricalcium-based Cement

[1]Ravula A Reddy, [2]RS Basavanna

ABSTRACT

Aim: Fracture of restorative composite is reported as a common reason for replacement. Due to failures of this kind, it is still controversial whether restorative composites should be used in large, high-stress-bearing applications, such as in direct posterior restorations. The high brittleness of current composites hinders their use in large stress-bearing areas. Thus, recently short fiber-reinforced composite was introduced as dental restorative composite resin. The aim of the article is to evaluate shear bond strength of fiber-reinforced composite (everX Posterior) and methacrylate-based composite (FILTEK Z250) to pure tricalcium silicate-based cement (biodentine).

Materials and methods: Acrylic blocks (n = 30) with 2 mm high and 5 mm diameter central holes were prepared. The samples were taken and filled with biodentine and were divided into two groups containing 15 in each group. Group I: Fiber-reinforced composite. Group II: Methacrylate-based composite, which are layered over biodentine. The specimens are transferred to the universal testing machine and subjected to shear bond strength analysis at a cross-head speed of 1.0 mm/minute.

Results: The bond strength values were significantly higher in case of fiber-reinforced composite when compared with methacrylate-based composite.

Conclusion: Within the limitations of the study, it was concluded that the fiber-reinforced composite with biodentine had highest bond strength when compared with methacrylate-based composite.

Clinical significance: Fiber-reinforced composite has excellent fatigue resistance because the embedded fibers are bonded to the polymer matrix and allow the stresses to be distributed effectively throughout the restoration. They are most suitable for applications in which the direction of highest stress is predictable. They are used in cavities with three or more surfaces missing and also in large-sized cavities. They are extensively used in cavities where inlays and onlays are prescribed.

Keywords: Biodentine, Fiber-reinforced composite, Methacrylate-based composite, Shear bond strength.

How to cite this article: Reddy RA, Basavanna RS. Evaluation of Shear Bond Strength of Fiber-reinforced Composite and Methacrylate-based Composite to Pure Tricalcium-based Cement. CODS J Dent 2016;8(1):25-27.

[1]Postgraduate Student, [2]Professor

[1,2]Department of Conservative Dentistry and Endodontics College of Dental Sciences, Davangere, Karnataka, India

Corresponding Author: Ravula A Reddy, H. No: 5-11-476/1 Naim Nagar, Hanumakonda, Warangal 506001, Telangana, India Phone: +919945401397, e-mail: abhishek.ravula90@gmail.com

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Calcium silicate-based dental cement known as mineral trioxide aggregate (MTA) has gained popularity especially in endodontic dentistry because of its physical and regenerative characteristics.[1,2] Mineral trioxide aggregate is one of the most successfully used materials in clinical procedures, such as indirect pulp capping, apexification, and root-end filling material.[3-6] Despite its unique combination of favorable properties, MTA has some critical shortcomings, such as prolonged setting time, high solubility, and difficulty in handling.[7]

To overcome the disadvantages of MTA, biodentine, a new calcium silicate-based cement, is used as dentin substitute for resin composite restorations, pulp capping, and endodontic repair material. It has improved sealing ability, higher compressive strengths, and short setting time.[8,9]

Resin composites were very popular in restorative dentistry. They cannot be placed directly over MTA because it affects its setting and can dislodge the material. However, it has claimed that the setting time of biodentine is 12 minutes. So hypothesis is that resin composites can be layered overset biodentine which might enable single-visit procedures.[10] Therefore, the present study is to evaluate the bond strength of methacrylate-based composite and fiber-reinforced composite when used with biodentine.

MATERIALS AND METHODS

Specimen Preparation

Acrylic blocks (n = 30) with 2 mm high and 5 mm diameter central holes were prepared. In all 30 samples, the holes were fully filled with biodentine. The specimens were stored at 37°C in 100% humidity for respectively, 15 minutes and 96 hours for setting.

Placement of Restorative Material

After the setting, biodentine samples are randomly divided into two groups. Group I: Methacrylate-based

Table 1: Manufacturer and application details of the materials used in the study

Material	*Manufacturer*	*Steps for application*
Tricalcium silicate cement	Biodentine® (Septodont, Saint Maurdestosses, France)	Mixing premeasured unit dose capsules in a high-speed amalgamator for 30 sec
Methacrylate-based composite	FILTEK™ Z250 (3M ESPE USA)	Light polymerization 20 sec
Self-etch adhesive	SCOTCH BOND™ universal adhesive (3M ESPE)	Apply and scrub for 35 s then air dry for 5 sec followed by light cure for 10 sec
Fiber-reinforced composite	everX Posterior (GC, Europe)	Light polymerize for 20 sec

composite; group II: Fiber-reinforced composite. In both the groups, corresponding adhesive system was applied over biodentine according to manufacturer's instructions as displayed in Table 1. Each resin composite was placed at the center of biodentine by placing the packing material into cylindrically shaped plastic tubes with internal diameters of 2 mm and height of 2 mm. The composite resins were cured with light-emitting diode for 20 seconds as per manufacturer's instructions. After the polymerization, the plastic tubes were removed carefully and specimens were stored at 37°C in 100% humidity for respectively, 15 minutes and 96 hours for setting.

Shear Bond Strength Test

Each block was secured in a universal testing machine. A chisel-edge plunger was mounted on to the movable cross-head of testing machine and positioned so that the leading edge was aimed at the biodentine®. The force required to remove the restorative material was measured in Newtons.

Statistical Analysis

All calculations were processed using Statistical Package for the Social Sciences software. The mean bond strength of groups was compared using independent t-test.

RESULTS

Table 2 shows the descriptive statistics of shear bond strength for each group. The highest and lowest bond strength values were recorded for the fiber-reinforced composite with biodentine and methacrylate-based composite with biodentine respectively.

DISCUSSION

Dental restorative filling composite resins have been introduced to the dental community in the 1960s. Since then after many significant material improvements, restorative composite still suffers lack of mechanical properties and problems related to polymerization shrinkage. Clinical studies have shown that direct fillings fail predominantly because of occlusal wear (or) secondary caries.[11]

However, the fracture of restorative composite is also a common reason for replacement. Due to failures of this kind, it is still controversial whether restorative composites should be used in large, high-stress-bearing applications, such as in direct posterior restorations. The relatively high brittleness and low fracture toughness of current composites still hinder their use in large stress-bearing areas.

Recently, short fiber-reinforced composite was introduced as dental restorative composite resin. The composite resin is intended to be used in high-stress-bearing areas, especially in molars. The results of the laboratory mechanical tests revealed substantial improvements in the load-bearing capacity, the flexural strength, and fracture toughness of dental composite resin reinforced with short E-glass fiber fillers in comparison with conventional particulate filler restorative resin.[11]

In this study, fiber-reinforced composite showed highest bond strength when compared with methacrylate-based composite. The result of our present study is in accordance with previous studies conducted by Abouelleil et al[12] which stated that everX Posterior performed relatively better. The study concluded that the fibers have played a role in increasing the material stiffness and resistance to bending force during testing and probably during function. The enhancement of material properties was explained due to the stress transfer from matrix to the fibers and also due to the action of fibers in stopping crack propagation through the material.[12]

In this study, fiber-reinforced composite showed highest bond strength with biodentine. It is unknown whether a chemical union exists between Biodentine™ and the overlying resin composite restoration; however, previous research found that the functional monomer 10-methacryloyloxydecyl dihydrogen phosphate (10-MDP), present in the adhesive used in this study binds to calcium in tooth structure. Theoretically, it could be assumed that the 10-MDP monomer may bind chemically to the calcium in Biodentine™, hence, promoting chemical adhesion in addition to micromechanical attachment.[13]

Table 2: Descriptive statistics of shear bond strength for each group

Group	*Number*	*Mean ± SD*	*p-value*
Fiber-reinforced composite	15	3.19 ± 0.37	<0.0001[a]
Methacrylate-based composite	15	1.48 ± 0.21	

[a]Highly significant; SD: Standard deviation

In the present study, methacrylate-based composite showed lower bond strength when compared with fiber-reinforced composite; it might be because of less filler volume percentage and also because of absence of fibers which inhibit crack propagation.

CONCLUSION

Within the limitations of the study, the new pure tricalcium-based pulp capping and endodontic repair material showed clinically acceptable and higher bond strength with fiber-reinforced composite. However, the bond strength with methacrylate-based composite was low.

REFERENCES

1. Lee SJ, Monsef M, Torabinejad M. Sealing ability of a mineral trioxide aggregate for repair of lateral root perforations. J Endod 1993 Nov;19(11):541-544.
2. Alhadainy HA. Root perforations: a review of literature. Oral Surg Oral Med Oral Pathol 1994 Sep;78(3):368-374.
3. Hargreaves KM, Diognes A, Teixeira FB. Treatment options: biological basis of regenerative endodontic procedures. J Endod 2013 Mar;39(3 Suppl):S30-S43.
4. Hargreaves KM, Diogenes A, Teixeria FB. Treatment options: biological basis of regenerative endodontic procedures. Pediatr Dent 2013 Mar;35(2):129-140.
5. Paryani K, Kim SG. Regenerative endodontic treatment of permanent teeth after completion of root development: a report of 2 cases. J Endod 2013 Jul;39(7):929-934.
6. Torabinejad M, Chivian N. Clinical application of mineral trioxide aggregate. J Endod 1999 Mar;25(3):197-205.
7. Antunes Bortoluzzi E, Juárez Broon N, Antonio Hungaro Duarte M, de Oliveria Demarchi AC, Monterio Bramante C. The use of a setting accelerator and its effect on pH and calcium ion release of mineral trioxide aggregate and white Portland cement. J Endod 2006 Dec;32(12):1194-1197.
8. Koubi G, Colon P, Franquin JC, Hartmann A, Richard G, Faure MO, Lambert G. Clinical evaluation of the performance and safety of a new dentine substitute, Biodentine, in the restoration of posterior teeth – a prospective study. Clin Oral Invest 2013 Jan;17(1):243-249.
9. Laurent P, Camp J, About I. Biodentine(TM) induces TGF-β1 release from human pulp cells and early dental pulp mineralization. Int Endod J 2012 May;45(5):439-448.
10. Cantkin K, Avci S. Evaluation of shear bond strength of two resin based composites and glass ionomer cement to pure ticalcium silicate-based cement (Biodentine®). J Appl Oral Sci 2014 Jul-Aug;22(4):302-306.
11. Garoushi S, Tanner J, Valittu P and Lassila L. Preliminary Clinical Evaluation of short Fiber-Reinforced Composite Resin in Posterior Teeth: 12 months Report. Open Dent J. 2012;6: 41-45.
12. Hazem Abouelleil, Nelly Pradelle, Cyril Villat, Nina Attik, Pierre colon and Brigitte grosgogeat. Comparison of mechanical properties of a new fiber reinforced composite and bulk filling composites. Restor. Dent Endod 2015;40(4):262-270.
13. Hasham DF, Foxton R, Manoharm A, Watson TF, Banerjee A. The Physical characteristics of resin composite-calcium silicate interface as part of a layered/laminate adhesive restoration Dent Mater. 2014;30(3):373-379.