ORIGINAL RESEARCH PAPER

Volume - 13 | Issue - 09 | September - 2024 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

COMPARATIVE EVALUATION OF PUSH OUT BOND STRENGTH OF FLOWABLE BULK FILL COMPOSITE AND CALCIUM SILICATE CEMENT AS INVITRA ORIFICE BARRIER: AN INTRO STUDY

Dentistry

Jishnu Ap Post Graduate Department Of Conservative Dentistry And Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India.

Mohit Kumar Associate Professor Department Of Dentistry, Kalyan Singh Government Medical College, Bulandshahr, Uttar Pradesh, India.

Nikita Sharma Senior Lecturer, Department Of Conservative Dentistry And Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India.

Pulkit Arora Senior Lecturer, Department Of Conservative Dentistry And Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India.

Sravyanjali Akkanapally Post Graduate, Department Of Conservative Dentistry And Endodontics, Shree Bankey Bihari Dental College & Research Centre, Ghaziabad, Utter Pradesh, India.

Anjitha R Bachelor In Dental Surgery, PSM College Of Dental Science & Research, Thrissur, Kerala, India.

ABSTRACT

Introduction: Coronal microleakage is one of the major causes of the failure of endodontic treatment. Loss of coronal seal can be due to leakage of temporary filling material or fracture of the permanent restoration. Thus, the use of an intraorifice barrier material can be very effective in reducing leakage and improving the treatment outcome. **Aim:** To compare the push-out bond strength of Flowable bulk fill composite and Bio MTA+ as an intra-orifice barrier. **Methodology:** In this invitro study, thirty freshly extracted single-rooted maxillary incisors were obtained from the Department of Oral and Maxillofacial Surgery, ITS Centre for dental studies and Research and instrumented using rotary files and obturated. Specimens were decoronated and coronally 3mm of gutta-percha from the root canals of all specimens were removed with a heated plugger. All samples were randomly divided into three groups each containing 10 specimens. The specimens were randomly assigned to the following groups with respect to the intra-orifice barrier used: Bio MTA+ (Cerkamed) (n=10), Flowable bulk fill composite (n=10) and light cure GIC (Kavitan LC) (n=10). After 1 week, 2mm thick transverse slices were taken coronally from each specimen and subjected to a push-out bond test using a universal testing machine. The statistical difference between the groups was calculated using post hoc Tukey tests and the statistical significance was set at 5%. **Results:** The bulk fill composite's push-out bond strength was significantly higher than Bio- MTA+ and Light cure GIC ($p<0.05$). Bio MTA + showed higher push-out bond strength (5.12 ± 0.54) than Light cured GIC (4.92 ± 0.71) but the difference was not statistically significant. **Conclusion:** The push-out bond strength of beautiful bulk flowable composite was significantly higher than BIO MTA+ light cure GIC.

KEYWORDS

Coronal leakage, Coronal seal, Endodontic failure, sealing ability

INTRODUCTION

The major causative factor implicated in the failure of root canal therapy is coronal leakage. [1] Ray H and Trope M reported that the quality of coronal restoration might be a more important factor than the quality of obturation in maintaining the periradicular health of the tooth. [2] Placing an intra-orifice barrier immediately after removing the coronal portion of gutta-percha is an efficient method to decrease coronal leakage in endodontically treated teeth. [3]

Several materials such as temporary filling materials, glass-ionomer cement, composite resin, Mineral trioxide aggregate (MTA) and intermediate restorative material (IRM) have been advocated as intra-orifice barriers.[4, 5]

Several materials have been used in an attempt to provide an intra-coronal seal to prevent microleakage, such as Cavit, amalgam, intermediate restorative material (IRM), Super-EBA, composite resin, glass-ionomer cement and mineral trioxide aggregate (MTA) [6-7]

Since the previous materials used didn't show good coronal reinforcement, the quest for the search of newer materials led to the development of materials with better bonding characteristics and good sealing ability.

Mineral Trioxide Aggregate has proved to be a bioactive material inducing the formation of hard tissues; it is well-tolerated by the tissues it contacts because of its biocompatibility. [8, 9] According to the manufacturer, BioMTA+ (cerkamed) is characterized by a high plasticity, enabling precise and controlled application wherever necessary. MTA ensures perfect tightness and hard tissue formation by supporting the process of dentine remineralization. [10]

With the advancement in composite resin technology a new class of composite, flowable bulkfill has been developed. Beautifill flowable bulk fill (shofu) composite exhibits self leveling property and better bonding to cavity walls. It allows 4 mm depth of cure without incorporating air bubbles or voids. It can easily be extruded through the large gauge tips due to its high viscosity. [11]

The adaptation and interface between root dentine and filling materials have been determined by push out tests. It is a mechanical test to measure the resistance of the tested material to dislodgement and its adhesive property. [12]

No previous study has compared the push out bond strength of BioMTA+, beautifil flowable bulk fill and light-cured glass ionomer when used as an intra orifice barrier. Thus, the aim of present study was to evaluate the push out bond strength of these materials.

The null hypothesis tested was that there is no difference between push out bond strength of all the material tested when used as intra orifice barrier.

MATERIALS & METHOD

The present in vitro study was carried out in the department of conservative dentistry and endodontics, ITS Dental College, Murad Nagar, Ghaziabad, Uttar Pradesh, India in November 2018 for a period of one month

1. Selection of specimens

After Ethics Committee approval (ITSCDSR/IIEC/RP/2018/024), freshly extract single-rooted maxillary incisors were collected from the department of Oral & Maxillofacial Surgery, ITS Dental College, Murad Nagar, Ghaziabad, Uttar Pradesh, India

Inclusion Criteria: Thirty periodontally compromised freshly extracted maxillary central incisors were selected on the basis of their macroscopically similar size and straight roots.

Exclusion Criteria: Teeth with fracture craze lines, signs of calcification and curved roots were excluded

2. Specimen Preparation

Soft tissue & calculus were mechanically removed from the root surface of 30 selected specimens [Table/Fig-1]. The teeth were decoronated (by ensuring 16 mm of root length) with a fine diamond disc at the cementoenamel junction perpendicularly to the long axis of the teeth under copious irrigation. After that, all specimens were examined under a stereomicroscope to ensure the absence of cracks. A size 10 K-type file was placed into the canal until it was visible at the apical foramen. The working length was established as 1 mm short of this length.

3. Canal Preparation

Initial access into root canals was gained using #10 K-file (Dentsply Maillefer, Ballaigues, Switzerland); and kept 0.5mm short of radiographic apex. For cleaning and shaping, ProTaper gold (PTN; Dentsply Maillefer) rotary file systems S1, S2, F1, F2, F3, and F4 were used according to the manufacturer's instructions in Dentsply endodontic motor. Only four canals were prepared using each file and discarded. The root canals were irrigated with 2 mL of 5.25% NaOCl solution after each file. Final irrigation of the root canals was done using 2 mL of 17% EDTA (Vista Dental Products, USA) for 2 minutes and then 2 mL of 5% NaOCl for 2 minutes and 5 mL of distilled water.

4. Canal Obturation

The root canal of each tooth was dried with paper points. AH plus sealer was mixed according to the manufacturer's instructions. The root canal was coated with sealer and obturated with F3 gutta-percha cones and lateral compaction. Subsequently, obturated teeth specimens were placed in 100% humidity in a humidor for 48 hrs to allow the sealer to set completely.

With the help of a suitable size heated plugger 2mm depth of gutta percha was sheared off and vertically compacted. The coronal 2 mm of the canal was scrubbed with an alcohol-moistened pellet, rinsed with sterile saline, and dried with an air stream to clean the pulp chamber. The samples were randomly divided with respect to the intra-orifice barrier material placed over the root canal fillings into the following groups

Group I: Bio MTA+ (cerkamed) powder was dispensed on the glass slab along with 1-2 drops of liquid and mixed until the compound reaches a soft putty-like consistency. The mix is then carried with the help of an MTA carrier and placed into the cavity and compacted with the help of a plugger. A moist cotton pellet is placed over it and the material is allowed to set.

Group II: Prior to the restoration with composite, the root canal orifices were etched with 37% phosphoric acid (scotch bond etchant) for 15-20 sec. Then the surface was rinsed with water and the excess water was removed with an air syringe. Then the Single bond 2 (3M) adhesive was applied to enamel and dentine and was light cured for 10 sec. Finally placed Beautifil flowable bulk fill composite was placed and cured for 20 sec.

Group III: The powder and liquid was dispensed on a paper pad according to manufacturer's instruction and mixed with the help of agate spatula. Mixed GIC was placed into the canal orifices and it was cured for 20 seconds

6. Preparation of the Samples for the Push-out Bond Strength Test

Specimens were then sliced perpendicular to the longitudinal axis of the root using a low-speed diamond-coated saw under water cooling. 2mm thick sections were constructed from the coronal part of each root. The thickness of each section was estimated with a digital calliper.

7. Push-out bond strength evaluation

Each specimen was subjected to morphometric analysis for calculation of area and load employing a universal testing machine (Instron, Canton, MA, USA) that brought a 1 mm diameter cylindrical plunger for the coronal specimens, was guided in apico-coronal direction at 1 mm/min crosshead speed until dislodgement. (Table/Figure 2) The time of dislodgement values were noted in Newton for each specimen. The Newton (N) values were transmuted into MPa values using the formula below: Bond strength (MPa) = Force for dislodgement (N)/ Bonded surface area (mm^2).

Bonded surface area = $2\pi r x h$

Where π is the constant 3.14, r is the root canal space radius, and h is the thickness of the slice in mm. Then, the bond strength (δ), expressed in MPa, was calculated using the equation: $\delta = E/A$ [13]

Statistical Analysis

The statistical difference between groups was calculated using the post hoc Tukey test. The analysis was performed using SPSS 21 software, and the statistical significance was set at 5%.

Table/ Figure 3: Push-out bond strength values of tested intra-orifice barrier materials (Mpa)

	Mean	Standard Deviation	Standard Error	95% Confidence Interval For Mean	
				Lower Bound	Upper Bound
BIO MTA+	5.12	0.54	1.92	2.15	6.15
FLOWABLE BULK FILL COMPOSITE	6.61	0.25	0.88	3.22	7.45
LC GIC	4.92	0.71	0.25	2.11	5.75

Table/ Figure 4: The comparison of bond strength of various restorative materials using ANOVA Post-Hoc Tukey Test

		STANDARD ERROR	P VALUE
BIO MTA+	BULK FILL COMPOSITE	.19	.003 (significant)
BIO MTA+	LIGHT CURED GIC	.25	.852 (not significant)
BULK FILL COMPOSITE	LIGHT CURED GIC	.26	.005 (significant)

Post hoc tukey test

Table/ Fig 5: The importance of a good coronal seal (GE = good endodontics, GR = good restoration)

Study	Measure of coronal seal	No. of teeth	Outcome
Ray & Trope, USA 1995 [2]	Radiographs	1,010 (no post + cores)	GR more important than GE
Tronstad et al, Norway 2000 [14]	Radiographs	1,000(post+cores included)	GE more important than GR
Kirkevang et al, 2000 Denmark [15]	Radiographs	773	Better periapical status with GR
GR Hommez et al, Belgium 2002 [16]	Exam & Radiographs	745	Better periapical status with GR
Boucher et al, France 2002[17]	Radiographs	5,373	No coronal restoration more periapical areas
Segura-Egea et al, Spain 2004[18]	Radiographs	93	Better periapical status with GR
GR Tavares et al., France 2009 [19]	Radiographs	1,035	Better periapical status with GR
Ng et al., UK 2011 [20]	Exam & Radiographs	1,452	Better periapical status with GR

RESULTS

The mean and standard deviation values of the tested materials obtained from the push-out bond strength test are presented in Table/Fig 3. The push-out bond strength of beautiful flowable bulk fill is significantly higher than Bio- MTA+ and Light cure GIC (p= 0.003 and 0.005 respectively). However, there is no significant difference between Bio MTA+ and Kavitan LC GIC. (p =0 .852) Table/ Fig 4

DISCUSSION

An effective coronal seal is important for the success of endodontic therapy. [2, 14-20] (Table/Fig 5) Growing attention has been given to procedures administered after completion of endodontic treatment and also their impact on the prognosis of endodontically treated teeth.

An intra-orifice barrier material should be firmly attached to the root canal walls and combat tooth movements or mechanic stresses occurring during treatment procedures.[12] Due to this, the push-out bond strengths of bio MTA+, Beautifil bulk flow and resin modified GIC were compared in the present study.

The present study employed 2mm thick material to seal the coronal orifice as literature reports that it appeared more reasonable and suitable for the contemporary barrier materials. [21]

Different methods can be employed to test the bond of an endodontic material to root dentin such as traditional shear and push-out tests. [12] The push out test is a rational method for evaluating the adherence of a material to root dentin and simulates the clinical stresses. [22] This test represents true shear bond strength of the material as fracture occurs parallel to cement dentin interface. [23] For this reason, the push-out test was employed in the present study. The motive for taking 2-mm-thick dentin slices in the present study was that frictions which could misconstrue the results and that it would be safer to utilize 2-mm-thick slices in order to minimize friction to eradicate this risk. [12]

According to the results of this study, the push-out bond strength values of beautifil bulk flowable composite was found to be higher than Bio MTA+ and light cured GIC.This could be due to the fact that beautifil bulk flow offer higher flow and self-leveling allows easy adhering of the material to the root canal dentin. Besides, it has been claimed to have lower shrinkage stress. [11]

Findings similar to our study has been reported by Caixeta et al, who reported Filtek Z350 XT flow resin composite has higher push out bond strength than bulk fill xtra fil resin composite. This can probably be explained by difference in the composition of materials in terms of filler content.[24]

Bio MTA+ showed better push out bond strength as compared light cured GIC and this could be attributed to the fact that Bio MTA+ enriched with hydoxyappatite and its nanoparticles ensures perfect tightness and hard tissue formation providing ultimate plasticity (as claimed by the manufacturer).

Singla et al reported higher push-out bond strength of MTA-Angelus than Glass Ionomer Type II Cement in their study. [25] According to several studies, this could be due to the formation of passivating trisulfate layer over hydrating crystals of MTA during the prolonged maturation process. [26-28]

Light-cured GIC displayed the lowest push-out bond strength values amongst the material tested; adhesion of LCGIC is by the development of an ion-exchange layer adjacent to dentin. [29] The lower strength of glass ionomers was due to their brittleness, initial sensitivity to moisture contamination, and sensitivity to dehydration. Moisture leads the material to be chalky and porous, resulting in a loss of surface hardness while MTA has a prolonged maturation process, with increased compressive strength, push-out strength, and retention strength of the material with time in the presence of moisture. [30]

Many studies (3, 12, 29,31-38) Table/ Figure 6 in the literature have assessed the sealing ability of intra orifice barrier but there are limited studies [12] examining the push-out bond strength of the coronal barrier to corroborate or contradict the findings of the present study.

Limitations

The limitations of the present study are that the results of the study cannot apply to clinical conditions. The influence of sealer on the bonding of restorations to the root canal walls was not taken into consideration. Further studies are necessary to precisely correlate the results of this study to clinical success.

CONCLUSION

Within the limitation of this in vitro study, the following conclusion can be drawn:
Beautifil bulk fill composite showed the highest bond strength among the material tested. Bio MTA+ showed better push-out bond strength than light-cured GIC But the difference was not statistically significant.

Beautifill bulk flow is a good material to be used as intra orifice barrier material.

REFERENCES

1. Saunders W, Saunders E. Coronal leakage as a cause of failure in root canal therapy: a review. Dent Traumatol1994; 10:105-8.
2. Ray H, Trope M. Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. Int Endod J 1995; 28:12-8.
3. Yavari HR, Samiei M, Shahi S, Aghazadeh M, Jafari M, Abdolrahimi M, et al. Microleakage comparison of four dental materials as intra-orifice barriers in endodontically treated teeth. Iran Endod J. 2012; 7(1):25-30.
4. Canoglu E, Gulsahi K, Sahin C, Altundasar E, Cehreli ZC. Effect of bleaching agents on sealing properties of different intraorifice barriers and root filling materials. Med Oral Patol Oral Cir Bucal 2012; 17: e710.
5. Galvan RR, West LA, Liewehr FR, Pashley DH. Coronal microleakage of five materials used to create an intracoronal seal in endodontically treated teeth. J Endod2002; 28:59-61.
6. Chailertvanitkul P, Saunders W, Saunders E, MacKenzie D. An evaluation of microbial coronal leakage in the restored pulp chamber of root canal treated multirooted teeth. Int Endod J. 1997; 30(5):318-22.
7. Beckham BM, Anderson RW, Morris CF. An evaluation of three materials as barriers to coronal microleakage in endodontically treated teeth. J Endod. 1993;19(8):388-91
8. Menezes R, Bramante CM, Letra A, Carvalho VGG, Garcia RB. Histologic evaluation of pulpotomies in dog using two types of mineral trioxide aggregate and regular and white Portland cements as wound dressings. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2004; 98:376-9.
9. Moretton TR, Brown CE, Legan JJ, Kafrawy A. Tissue reactions after subcutaneous and intraosseous implantation of mineral trioxide aggregate and ethoxybenzoic acid cement. J Biomedic Mater Res 2000; 52:528-33.
10. Thompson JI, Gregson PJ, Revell PA. Analysis of push-out test data based on interfacial fracture energy. J Mater Sci Mater Med 1999; 10:863-8.
11. Glazer H S. Beautifil-Bulk flowable; AGD Impact Available from: https://www.shofu.com
12. Ozyurek T, Uslu G, Yilmaz K.Push-out bond strength of intra-orifice barrier materials: Bulk-fill composite versus calcium silicate cement. J Dent Res Dent Clin Dent Prospects2018; 12(1): 6–11.
13. Barbizam JV, Trope M, Tanomaru-Filho M, Teixeira EC, Teixeira FB. Bond strength of different endodontic sealers to dentin: push-out test. J Appl Oral Sci. 2011;19(6):644-647
14. Tronstad L, Asbjørnsen K, Døving L, Paedersen I, Eriksen H M. Influence of coronal restorations on the periapical health of endodontically treated teeth. Endod Dent Traumatol 2000; 16: 218–221.
15. Kirkevang L L, Ørstavik D, Horsted-Bindslev P, Wenzel A. Periapical status and quality of root fillings and coronal restorations in a Danish population. Int Endod J 2000; 33: 509–515.
16. Hommez G M, Coppens C R, De Moor R J. Periapical health related to the quality of coronal restorations and root Fillings. Int Endod J 2002; 35: 680–689.
17. Boucher Y, Matossian L, Rilliard F, Machtou P. Radiographic evaluation of the prevalence and technical quality of root canal treatment in a French subpopulation. Int Endod J 2002; 35: 229–238.
18. Segura-Egea J J, Jimenez-Pinzon A, Poyato-Ferrera M, Velasco-Ortega E, Rios-Santos J V. Periapical status and quality of root fillings and coronal restorations in an adult Spanish population. Int Endod J 2004; 37: 525–530.
19. Tavares P B L, Bonte E, Boukpessi T, Siqueira J F, Lasfargues J. Prevalence of apical periodontitis in root canal–treated teeth from an urban French population: influence of the quality of root canal fillings and coronal restorations. J Endod 2009; 35: 810–813.
20. Ng YL, Mann V, Gulabivala K. A prospective study of the factors affecting outcomes of non-surgical root canal treatment: part 1: periapical health. Int Endod J 2011; 44: 583–609.
21. John AD, Webb TD, Imamura G, Goodell GG. Fluid flow evaluation of Fuji Triage and gray and white ProRoot mineral trioxide aggregate intraorifice barriers. J Endod. 2008 Jul; 34(7):830-2.
22. 22. Hong ST, Bae KS, Baek SH, Kum KY, Shon WJ, Lee W, et al. Effects of root canal irrigants on the push-out strength and hydration behavior of accelerated mineral trioxide aggregate in its early setting phase. J Endod. 2010; 36:1995–9.
23. Nikhade P, Kela S, Chandak M, Chandwani N. Comparative evaluation of push-out bond strength of calcium silicate based materials:An ex-vivo study. IOSR-JDMS. 2016; 1:65–8.
24. Caixeta RV, Guiraldo RD, Kaneshima EN, Barbosa AS, Picolotto CP, Lima AE, Gonini Júnior A, Berger SB. Push-Out Bond Strength of Restorations with Bulk-Fill, Flow, and Conventional Resin Composites. ScientificWorldJournal. 2015;2015: 452976.
25. Singla M, Verma KG, Goyal V, Jusuja P, Kakkar A, Ahuja L. Comparison of Push-Out Bond Strength of Furcation Perforation Repair Materials - Glass Ionomer Cement Type II, Hydroxyapatite, Mineral Trioxide Aggregate, and Biodentine: An in vitro Study. Contemp Clin Dent. 2018; 9(3):410-414
26. Aggarwal V, Singla M, Miglani S, Kohli S. 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.
27. Vanderweele RA, Schwartz SA, Beeson TJ. Effect of blood contamination on retention characteristics of MTA when mixed with different liquids. J Endod. 2006; 32:421–4.
28. Salem Milani A, Rahimi S, Froughreyhani M, Vahid Pakdel M. Effect of blood contamination on marginal adaptation and surface microstructure of mineral trioxide aggregate: A SEM study. J Dent Res Dent Clin Dent Prospects. 2013; 7:157–63
29. Parekh B, Irani RS, Sathe S, Hegde V. Intraorifice sealing ability of different materials in endodontically treated teeth: An in vitro study. J Conserv Dent. 2014;17(3):234-237.
30. Malhotra N, Agarwal A, Mala K. Mineral trioxide aggregate: a review of physical properties. Compend Contin Educ Dent. 2013 Feb;34(2) : e25-32.
31. Bhullar KK, Malhotra S, Nain R, Bedi H, Bhullar RS, Walia AS. Comparative evaluation of intraorifice sealing ability of different materials in endodontically treated teeth: An in vitro study. J Int Clin Dent Res Organ 2019; 11:14-9
32. Bailón-Sánchez ME, González-Castillo S, González-Rodríguez MP, Poyatos-Martínez R, Ferrer-Luque CM. Intraorifice sealing ability of different materials in endodontically treated teeth. Med Oral Patol Oral Cir Bucal. 2011 Jan 1;16(1):e105-9.
33. Ghulman MA, Gomaa M. Effect of intra-orifice depth on sealing ability of four materials in the orifices of root-filled teeth: an ex-vivo study. Int J Dent. 2012;2012:318108.
34. Zarenejad N, Asgary S, Ramazani N, Haghshenas MR, Rafiei A, Ramazani M. Coronal microleakage of three different dental biomaterials as intra-orifice barrier during nonvital bleaching. Dent Res J (Isfahan). 2015 Nov-Dec;12(6):581-8.
35. Sadeghi, S., Tabari, R., Hosseini, S. The Effect of Thickness on Sealing Ability of Calcium Enriched Cement as a Coronal Seal Barrier. Journal of Dental Materials and Techniques, 2017; 6(4): 159-162.
36. Ramezanali F, Aryanezhad S, Mohammadian F, Dibaji F, Kharazifard MJ. In Vitro Microleakage of Mineral Trioxide Aggregate, Calcium-Enriched Mixture Cement and Biodentine Intra-Orifice Barriers. Iran Endod J. 2017;12(2):211-215.
37. Divya KT, Satish G, Srinivasa TS, Reddy V, Umashankar K, Rao BM. Comparative evaluation of sealing ability of four different restorative materials used as coronal sealants: an in vitro study. J Int Oral Health. 2014 Jul;6(4):12-7.
38. Navya RR, Kumar KR, Reddy LP, Pavan TV, Kiran GS, Sukumar R. Comparing the Sealing Ability of Different Intra Orifice Barriers using two Different Sealers. J Adv Med Dent Scie Res 2017;5(9):104-108.