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Comparative Evaluation of Push Out Bond Strength of Beautiful Flowable Bulk Fill and Bio MTA+ as Intra Orifice Barrier: An in-Vitro Study

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ABSTRACT:

Background: 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. The aim of the study was to compare the push-out bond strength of Flowable bulk fill composite and Bio MTA+ as an intra-orifice barrier. Materials and Methods: In this in-vitro study, thirty freshly extracted single-rooted maxillary incisors were obtained from the Department of Oral and Maxillofacial Surgery, Shree Bankey Bihari Dental college and instrumented using rotary files and obturated. All specimens were decoronated, and a hot plugger was used to remove 3mm of gutta-percha from their root canals. All samples were randomly divided into three groups each containing 10 specimens. With regard to the intra-orifice barrier employed, the specimens were randomly assigned to the following groups: 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. Post hoc Tukey tests were used to determine the statistical difference between the groups, and a significance level of 5% was chosen. 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+.

Keywords: Coronal Leakage, Coronal Seal, Endodontic Failure, Sealing Ability

1. Introduction

Coronal leakage is the main cause implicated in the root canal treatment's failure. [1] According to Ray H. and Trope M., sustaining the periradicular health of the tooth may depend more on the quality of the coronal restoration than the obturation. [2] An effective way to reduce coronal leakage in teeth that have had endodontic treatment is to place an intra-orifice barrier as soon as the coronal section of gutta-percha is removed. [3] In an effort to develop an intra-coronal seal that would prevent microleakage, a number of materials,

including Cavit, amalgam, intermediate restorative material (IRM), Super-EBA, composite resin, glass-ionomer cement, and mineral trioxide aggregate (MTA), have been used. [4-7]
The hunt for newer materials led to the creation of materials with improved bonding properties and good sealing capacity because the previously employed materials didn't demonstrate good coronal reinforcement. Mineral Trioxide Aggregate has shown to be a bioactive substance that promotes the development of hard tissues; due to its biocompatibility, it is well-tolerated by the tissues it encounters. [8, 9] The manufacturers claims that BioMTA+ (cerkamed) has a high plasticity that allows for precise and controlled application wherever it is required. MTA promotes the process of dentine remineralization, which results in flawless tightness and the creation of hard tissue. [10] An entirely new category of composite, flowable bulkfill has been created due to advancements in composite resin technology. 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]

Push out tests have been used to analyze the adaptability and interface between root dentine and filling materials. It is a mechanical test to evaluate the tested material's adhesion and resistance to dislodgment. [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 assumption that all materials examined have the same push out bond strength when utilized as an intra orifice barrier was the null hypothesis that was put to the test..

2. Materials and Method

Study Design:
Freshly extracted single-rooted maxillary incisors were acquired from the Oral & Maxillofacial Surgery division at the Shree Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh, India.

Selection Criteria:
Thirty periodontally compromised freshly extracted maxillary central incisors were chosen due of their straight roots and macroscopically similar size. Teeth with fracture craze lines, signs of calcification and curved roots were excluded

Specimen Preparation
Soft tissue & calculus were mechanically removed from the root surface of 30 selected specimens**.** A fine diamond disc was used to decoronate the teeth under heavy irrigation at the cementoenamel junction perpendicular to the long axis of the teeth (by assuring 16 mm of root length). Then, to confirm that there were no cracks, all specimens were checked with a stereomicroscope. A size 10 K-type file was inserted into the canal until it was evident at the apical foramen. It was decided that 1 mm less than this length would be the working length.

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. The final irrigation of the root canals was carried out using 2 mL of 17% EDTA (Vista Dental Products, USA) for 2 minutes, followed by 2 mL of 5% NaOCl for 2 minutes, and 5 mL of distilled water.

Canal Obturation

Paper points were used to dry out each tooth's root canal. Following the manufacturer's instructions, AH plus sealer was mixed. Using F3 gutta-percha cones and lateral compaction, the root canal was sealed with sealer. To allow the sealer to fully set, obturated tooth specimens were then placed in a humidor with 100% humidity for 48 hours.

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.

Grouping and Allocation:

On the basis of intra-orifice barrier material used to cover the root canal filling, the samples were randomly divided 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: The root canal orifices were etched for 15-20 seconds with 37% phosphoric acid (Scotch Bond Etchant) prior to composite placement. Following a water rinse, an air syringe was used to remove any extra water from the surface. After applying the Single Bond 2 (3M) adhesive to the enamel and dentine, it was light-cured for 10 seconds. Subsequently, Beautifil flowable bulk fill composite was placed and cured for 20 seconds.

Group III: The powder and liquid were 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

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

Then, under water cooling, specimens were cut using a low-speed diamond-coated saw perpendicular to the longitudinal axis of the root. The coronal portion of each root was cut into portions that were 2mm thick. [Fig. 1] A computerized calliper was used to estimate the thickness of each slice.

Push-out bond strength evaluation

Each specimen was put through morphometric analysis for the calculation of area and load using a universal testing machine (Instron, Canton, MA, USA) that brought a 1 mm diameter cylindrical plunger for the coronal specimens, which was guided in apico-coronal direction at 1 mm/min crosshead speed until dislodgement. **[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 = $2\pi r \times h$

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: δ=F /A [13]
E= Force for displacement
A= Bonded surface area

Statistical Analysis
With the aid of Statistical Package for the Social Sciences (SPSS) software program, version 23.0 (IBM, Chicago, Illinois), statistical analysis was carried out. A pilot study was initially done following which sample size calculation was done using G*Power software with a 95% confidence level. A value of $P<0.05$ was considered statistically significant. The mean and standard deviation for each group were determined, post hock tukey test was used to compare the outcomes of the various groups.

3. Results

The result showed that beautiful flowable bulk fill had higher mean push out bond strength followed by Bio- MTA+ and Light cure GIC. [**Table 1** and **Figure 3]** Beautiful flowable bulk fill had a push-out bond strength that was much higher than Bio- MTA+ and Light cure GIC (p=0.003 and 0.005, respectively). However, Bio MTA+ and Kavitan LC GIC do not significantly differ from one another. (p =0 .852) [**Table 2]**

4. Discussionn

An effective coronal seal is important for the success of endodontic therapy. [2,14-20] [**Table 3**] Growing attention has been given to procedures administered after completion of endodontic treatment and also their impact on the prognosis of endodontically treated teeth. In order to prevent tooth movements or mechanical stresses during treatment, an intra-orifice barrier material should be firmly adhered to the root canal walls.[12] Because of this, the present study examined the push-out bond strengths of bio MTA+, Beautifil bulk flow, and resin modified GIC.
As reported in the literature, 2mm thick material seemed more acceptable and appropriate for the current barrier materials, thus it was used in the current study to seal the coronal orifice. [21] Traditional shear and push-out tests, as well as other techniques, can be used to determine how well an endodontic material adheres to the root dentin. [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] The push-out test was used in the current investigation for this reason. In the current investigation, 2-mm-thick dentin slices were used since it would be safer to do so in order to reduce friction and eliminate the chance of results being misinterpreted by friction. [12]
The push-out bond strength values of beautifil bulk flowable composite were found to be greater than Bio MTA+ and light cured GIC, according to the findings of this investigation. (Table 4,6). 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). In their work, Singla et al. found that MTA-Angelus had a stronger push-out bond strength than Glass Ionomer Type II Cement. [25] Numerous studies suggest that this may be because of the creation of a passivating trisulfate layer over MTA crystals that are hydrated during the lengthy maturation period.. [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 investigations [3, 12, 29,31–38] [Table 4] in the literature have evaluated the sealing ability of the intra orifice barrier, however there are few studies [12] assessing the push-out bond strength of the coronal barrier to support or refute the conclusions of the current study. The null hypothesis was rejected since the push-out bond strength values of the beautiful bulk flowable composite were higher than those of the Bio MTA+ and the light-cured GIC.

The results of the current study cannot be applied to clinical conditions, which is one of its drawbacks. The effect of sealer on the adhesion of restorations to the root canal walls was not taken into account. To clinically comprehend the benefits of this method, additional comprehensive and lengthy clinical trials involving the placement of intraorifice barriers are required.

5. Conclusion

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.

6. 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.
39. Halkai RS, Begum R, Halkai KR, Zakaullah S, Indi S, Thimwala AM, et at. Evaluation of the effect of diode laser activation on push-out bond strength of different intraorifice barriers in endodontically treated teeth. An in-vitro study. Saudi Endod J 2023;13:155-9.

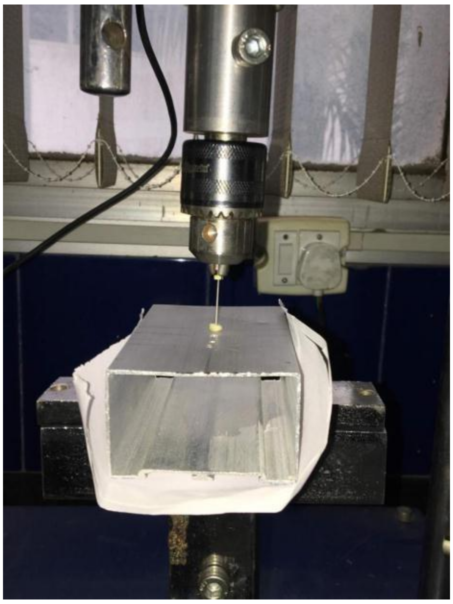

Figure 2: Instron Machine

Figure 1: Dentine slices with Intra orifice barrier

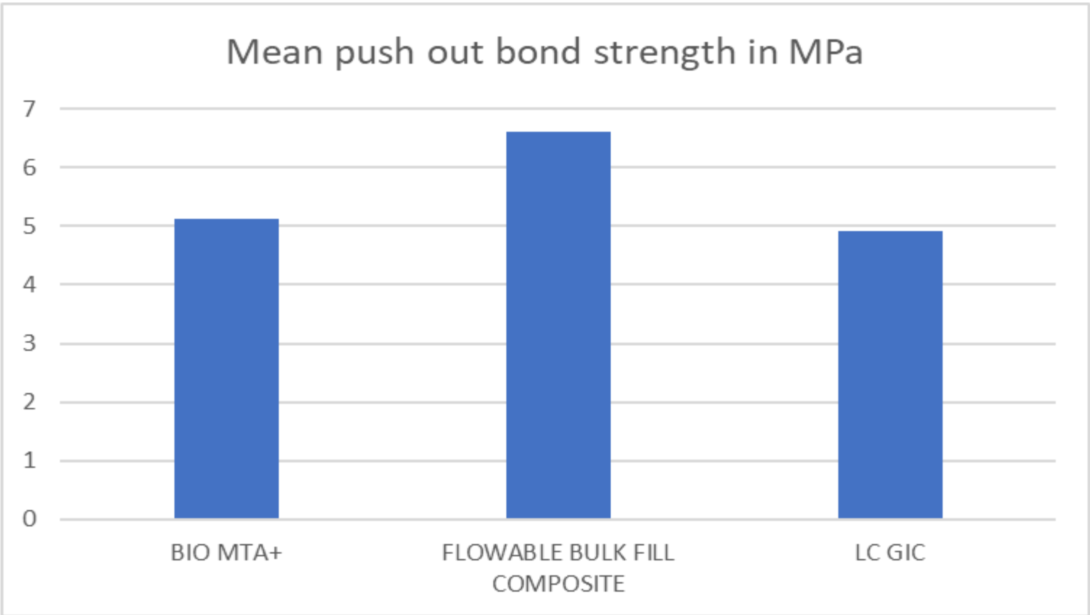

Figure 3: Push-out bond strength values of tested intra-orifice barrier materials (MPa)

Table 1: 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 2: 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)

Table 3: 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

Table 4: Studies evaluating intra-orifice barrier materials

S.No	Author's name and year	Place of study	Number of samples	Materials compared	Parameters evaluated	Conclussion
1	Yavari et al, 2012 [3]	Iran	188	Light-cured glass-ionomer (GI), mineral trioxide aggregate (MTA), and composite resin	Sealing Ability, dye leakage	MTA exhibited less leakage than composite and GI
2	Özyurek et al, 2018 [12]	Turkey	24	ProRoot MTA; Biodentine; SureFil SDR; EverX Posterior	Push out Bond Strength	Calcium silicate-based ProRoot MTA cement's push-out bond strength was lower than those of Biodentine, SureFil SDR and EverX Posterior materials
3	Parekh et al,2014 [29]	Pune, Maharastra, India	40	LCGIC, Tetric N-Flow, and LCGIC+ Flowable Composite in Sandwich Technique, positive control	Sealing Ability, dye leakage	LCGIC+Tetric N-Flow was found to be superior over other experimental materials
4	Bhullar KK et al, 2019 [31]	Amritsar, Punjab, India	50	Cention N, GIC, Biodentine, Positive and negative control	Sealing ability	Biodentine proved to be the best followed by GIC, Cention N, and control groups.
5	Bailon-Sanchez ME, 2011 [32]	Spain	42	Cavit™ G, ProRoot™ MTA and Tetric® EvoFlow	Sealing ability Glucose Filtration	sealing ability of the Cavit™ G, ProRoot™ MTA and Tetric® EvoFlow used as intraorifice materials tends to be similar over time

6	Ghulman et al, 2012 [33]	Saudi Arabia	92	Fusio, Fuji II, Fuji IX, and MTA“G”	Sealing Ability, dye leakage	MTA “G” had the least leakage when placed at 2 or 3 mm depths
7	Zarenejad et al, 2015 [34]	Iran	70	glass-ionomer (GI), mineral trioxide aggregate (MTA), and calcium-enriched mixture (CEM)	Sealing Ability, bovine serum albumin marker	GI, MTA, and CEM cements are considered as suitable intra-orifice barrier to provide coronal seal during walking bleaching.
8	Sadeghi et al, 2017 [35]	Iran	40	CEM	Sealing Ability, dye leakage	coronal microleakage in 2mm thickness of CEM cement had no statistically significant difference with 3 mm thickness of the material
9	Ramezanali et al, 2017 [36]	Iran	76	mineral trioxide aggregate (MTA), calcium-enriched mixture (CEM) cement 9and Biodentine	Sealing Ability, dye leakage	CEM cement exhibited the least microleakage
10	Divya et al, 2014 [37]	Karnataka, India	70	glass ionomer cement (GIC), composite resin, gray mineral trioxide aggregate (GMTA) and white mineral trioxide aggregate (WMTA)	Sealing Ability, dye leakage	GMTA and WMTA provided significantly better coronal seal when compared to other two restorations

11	Navya et al, 2017 [38]	Karnataka, India	90	GIC, MTA, Biodentine	Sealing Ability, dye leakage	Biodentine or MTA may be preferred over GIC as an intracanal barrier
12	Halkai et al, 2023 [39]	Saudi Arabia	60	GIC, Tetric-N-Flow and Biodentine.	Pushout Bond strength	Biodentine with laser activation before placement of the coronal barrier of endodontic treated tooth increases the quality of bond strength
13	Kumar et al, 2023	Uttar Pradesh, India	30	Flowable Bulk fill, Bio MTA+, LCGIC	Pushout Bond strength	Beautifill Flowable bulk fill showed better push out bond strength than Bio MTA+ and LCGIC