ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 8, Issue – 4, July – 2025, Page No. : 230 - 235

A Comparative Assessment of Three Intraorifice Materials in Enhancing the Durability of Endodontically Treated Roots

[1]Dr. Abhik Ray, Third Year Post Graduate Student, Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research, Banbishnupur, P.O- Balughata, Haldia, Purba Medinipur, West Bengal: 721645

[2]Dr. Anirban Bhattacharyya, Professor and HOD, Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research, Banbishnupur, P.O- Balughata, Haldia, Purba Medinipur, West Bengal: 721645

[3]Dr. Asim Bikash Maity, Professor, Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research, Banbishnupur, P.O- Balughata, Haldia, Purba Medinipur, West Bengal: 721645

[4]Dr. Gayatri Majumder, Assistant Professor, Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research, Banbishnupur, P.O- Balughata, Haldia, Purba Medinipur, West Bengal: 721645

Corresponding Author: Dr. Abhik Ray, Third Year Post Graduate Student, Department of Conservative Dentistry & Endodontics, Haldia Institute of Dental Sciences & Research, Banbishnupur, P.O- Balughata, Haldia, Purba Medinipur, West Bengal: 721645

Citation of this Article: Dr. Abhik Ray, Dr. Anirban Bhattacharyya, Dr. Asim Bikash Maity, Dr. Gayatri Majumder, "A Comparative Assessment of Three Intraorifice Materials in Enhancing the Durability of Endodontically Treated Roots", IJDSIR- July – 2025, Volume – 8, Issue – 4, P. No. 230 – 235.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: This study aimed to compare the fracture resistance of endodontically treated teeth restored with three intraorifice barrier materials: bulk-fill flowable composite, Resin Modified Glass Ionomer Cement, and Mineral Trioxide Aggregate.

Material and methods: A total of 45 freshly extracted, single-rooted mandibular premolars with similar canal morphology were selected. After cleaning, shaping, and obturation using the Protaper Universal rotary system and F3 gutta-percha, the coronal 3 mm of root filling material was removed and replaced with one of the test materials. Teeth were embedded in acrylic resin with elastomeric material to simulate the periodontal ligament, and crowns were sectioned at the cementoenamel junction.

The samples were then divided into three groups (n = 15 each):

1. Resin Modified Glass Ionomer Cement group: Light-cured after placement.
2. Bulk-fill flowable composite group: Bonded with self-etch adhesive and light-cured.
3. Mineral Trioxide Aggregate group: Hand-condensed into the space and allowed to set.

All specimens were stored at 37°C in 100% humidity for complete setting for seven days. Fracture resistance was tested using a universal testing machine, with compressive force applied vertically at 1 mm/min until fracture occurred. Data were recorded in Newtons (N). Statistical analysis was conducted using one- way ANOVA with Tukey's post-hoc test.

Results: The results showed statistically significant differences between the groups ($p < 0.05$). The Resin Modified Glass Ionomer Cement group had the highest fracture resistance, followed by bulk-fill composite, while Mineral Trioxide Aggregate exhibited the lowest values.

Keywords: Intraorifice barrier, fracture resistance, bulk-fill flowable composite resin, Mineral Trioxide Aggregate, Resin Modified Glass Ionomer Cement

Introduction

Teeth that have undergone endodontic treatment are generally more susceptible to fracture compared to healthy, vital teeth. Several contributing factors both iatrogenic (treatment-related) and non-iatrogenic can compromise the structural integrity of these teeth.[1] These include over- instrumentation, dehydration of dentin after treatment, and excessive force during the obturation process. Additionally, occlusal forces and the chemical effects of intracanal irrigants and medicaments may alter the physical and mechanical properties of root dentin, further increasing the risk of fracture. Since several factors contribute to the structural compromise of teeth after root canal treatment, it's important to reinforce both the coronal and root portions of the tooth.[2] One effective approach is using materials with a modulus of elasticity similar to that of dentin, which helps reduce stress at the junction between the dentin and restorative material. The use of intraorifice barriers-originally proposed by Roghanizad and Jones to prevent coronal leakage has gained attention not only for sealing purposes but also for enhancing root strength.[3] Supporting this, a study by Nagas et al. demonstrated that placing a barrier material at the canal orifice can significantly boost the tooth's resistance to fracture. Using materials that bond effectively to root dentin and have mechanical properties similar to dentin may not only ensure a better coronal seal but also reinforce the root structure.[4] While materials like resin-modified glass ionomer (RMGIC), glass ionomer cement (GIC), and composites have been commonly studied for use as intraorifice barriers, limited research has evaluated mineral trioxide aggregate (MTA) for the same purpose. This study was designed to compare the fracture resistance of endodontically treated teeth using three different intraorifice barrier materials: bulk-fill flowable composite (BFFC), RMGIC, and MTA. This study aimed to compare the fracture resistance of endodontically treated teeth restored with three intraorifice barrier materials: bulk-fill flowable composite (BFFC), Resin Modified Glass Ionomer Cement, and Mineral Trioxide Aggregate.

Methodology

A total of 45 freshly extracted, permanent single-rooted mandibular premolars were selected for the study. Radiographs confirmed that all selected teeth had a single canal. Teeth with visible cracks, resorption, curved root, or multiple canals were excluded. The teeth were cleaned with 5.25% sodium hypochlorite and stored in 10% formalin solution in distilled water until further use.

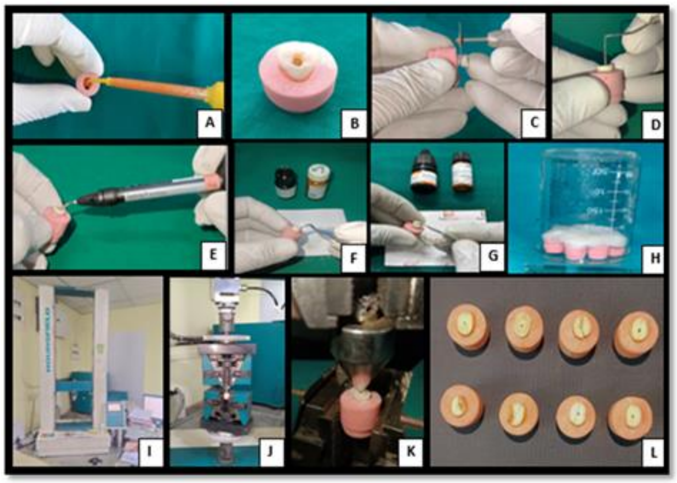
Conventional endodontic access cavities were prepared, and working lengths were established using a #10 K-file inserted until visible at the apical foramen, then adjusted to 1 mm short of that length. The canals were instrumented using hand files up to size 20, followed by rotary-preparation using the Protaper Universal system [Dentsply Sirona] (up to F3) with an endo motor (Coltene

CanalPro CL2i Endomotor), following the crown-down technique as per the manufacturer's guidelines. Irrigation was performed with 10 ml of 5.25% sodium hypochlorite [Prime Dental Products Pvt Ltd.] after each instrument, followed by a final rinse with 10ml of 17% EDTA [SafeEndo Smart Prep Liquid] and 10 ml of distilled water. The canals were dried and obturated with corresponding F3 gutta-percha points [Dia-ProT Gutta Percha] and epoxy resin- based sealer [SafeEndo Dental India Pvt Ltd]. Excess gutta-percha was removed and compacted at the orifice level. The samples were then incubated at 37°C for 8 hours to allow the sealer to set.

Each tooth was embedded vertically in self-cure acrylic using a light-body elastomeric impression material to simulate the periodontal ligament. Crowns were removed at the level of the cementoenamel junction using a high-speed handpiece under water coolant. The coronal 3 mm of the gutta percha was removed using a heated plugger, and the area was cleaned with ethanol to remove remnants.

The samples were randomly assigned to three groups of 15, based on the intraorifice barrier material used. In the RMGIC group [GC International], the canal space was conditioned, and the resin-modified glass ionomer cement was mixed and placed according to the manufacturer's instructions, then light- cured for 20 seconds. For the bulk-fill flowable composite[Tetric N-Flow, Ivoclar Vivadent] group, two coats of self-etch adhesive (Tetric N-Bond Universal, Ivoclar Vivadent) were applied for 20 seconds, gently air-dried for 5 seconds, and light- cured for 20 seconds before placing and curing the composite. In the MTA [SafeEndo Dental India Pvt Ltd] group, the material was prepared following the manufacturer's guidelines, placed into the canal using a plastic instrument, and compacted with a plugger.

All specimens were stored at 37°C in 100% humidity for complete setting for seven days. Fracture testing was carried out using a universal testing machine, with compressive force applied directly over the canal orifice at a speed of 1 mm/min until fracture occurred. The force required to fracture each tooth was recorded in newtons (N).



A and B- Light body silicone inserted into the acrylic mould to simulate periodontal ligament.

C – Decoronation done at the level of cement enamel junction.

D- Measurement of the depth after removal of gutta percha from the coronal third of the root canal, E- Placement of Bulk fill flowable composite

F- Placement of RMGIC,

G- Placement of MTA,

H- All the samples of the MTA group are covered with moist cotton and placed in a beaker for 24 hours for final setting.

I-Universal testing machine,

J and K- samples placed under Universal testing machine to check fracture resistance.

L- Samples after the fracture resistance test.

Results

Statistical analysis was performed using SPSS version 21. A one-way ANOVA was used for overall group comparison, and Tukey's post-hoc test was employed for intergroup analysis. Significance was set at $p < 0.05$ (Table 1, Table 2).

Table 1:

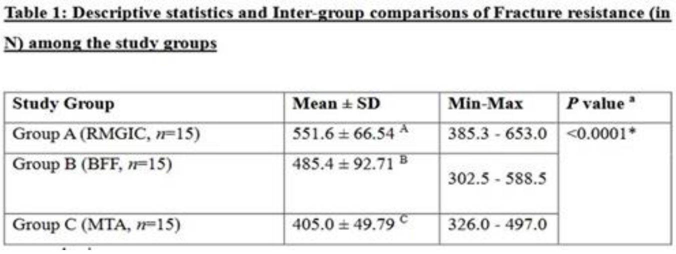


Table 1: Descriptive statistics and Inter-group comparisons of Fracture resistance (in N) among the study groups

Study Group	Mean ± SD	Min-Max	*P* value [a]
Group A (RMGIC, *n*=15)	551.6 ± 66.54 [A]	385.3 - 653.0	<0.0001*
Group B (BFF, *n*=15)	485.4 ± 92.71 [B]	302.5 - 588.5	
Group C (MTA, *n*=15)	405.0 ± 49.79 [C]	326.0 - 497.0	

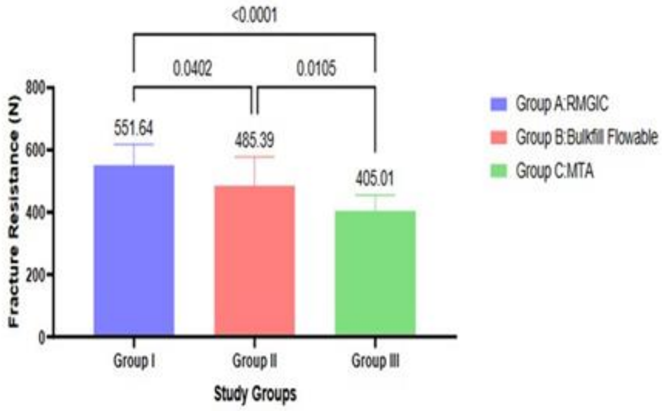
Table 2: Pairwise comparisons [optional]

Tukey's HSD comparison test	Mean Diff.	Adjusted P Value
Group I vs. Group II	66.25	0.0402
Group I vs. Group III	146.6	<0.0001
Group II vs. Group III	80.38	0.0105

Table 1: Intergroup comparison of fracture resistance.

Table 2: Pairwise comparison of fracture resistance.

The results showed statistically significant differences in fracture resistance among all three groups. RMGIC demonstrated the highest mean fracture resistance, followed by flowable bulk-fill composite and then MTA (Graph 1).



Graph 1: Showing the mean fracture resistance of individual groups and statistical significance between the groups.

Discussion

Root canal-treated teeth are inherently more fragile, making reinforcement critical. Intraorifice barriers have recently gained attention not only for their ability to reduce coronal microleakage but also for enhancing fracture resistance.[5] To reinforce endodontically treated tooth, stress concentrations at the dentin material interface should preferably be minimized by using materials with a modulus of elasticity similar to that of the dentin, which is about 14-16 GPa.[6] The present study found that the type of barrier material significantly influences the strength of treated roots.

Interestingly, MTA, despite its favorable sealing properties, did not perform as well in enhancing fracture resistance. This may be due to its limited ability to bond with root dentin. These findings align with a study by Nagas et al., who reported similar results.[4]

On the other hand, RMGIC displayed superior performance, most likely due to its elastic modulus (10–14 GPa) and flexural strength, which closely match those of natural dentin. Moreover, it chemically bonds with the dentinal surface, rendering more strength at the dentin cement interface.[7] All these properties might have resulted in RMGIC being the most fracture-resistant material tested in the present study. Its ease of use and ability to withstand high stress levels make it a strong candidate for intraorifice barrier placement. Aboobaker *et al*. (2015) also have reported RMGIC and flowable resin to be an effective intraorifice barrier with significantly high resistance.[8]

Composites bond to the tooth structure micromechanically and thus, provide good marginal seal, reinforcement of remaining tooth structure, and conservation of tooth structure. Composite resins reportedly absorb and distribute forces in a uniform manner, thereby increasing resistance to fracture and providing an improved prognosis.[9] Bulk-fill composites also performed well, potentially due to their excellent polymerization depth and slower curing rate, which help minimize shrinkage stress and promote better mechanical interlocking.[10]

Efforts were made to standardize the study by selecting similar-sized premolars and using consistent preparation and obturation techniques. Periodontal ligament simulation and vertical loading were incorporated for realistic stress application. However, the study had limitations: the fracture test involved unidirectional force at a single point, which doesn't fully replicate the complex forces present in the oral environment. Further studies should explore a wider variety of restorative materials and more dynamic loading conditions.

Conclusion

Within the constraints of this study, it can be concluded that the use of intraorifice barriers significantly enhances the fracture resistance of endodontically treated teeth. Among the materials tested, RMGIC provided the highest reinforcement, followed by bulk-fill composite and MTA. These results suggest that the reinforcing effect is material-dependent. However, due to the limited number of studies on this topic, further research is warranted to investigate additional materials and validate these findings in more clinically relevant settings.

References

1. Patel S, Bhuva B, Bose R. Present status and future directions: vertical root fractures in root filled teeth. Int Endod J. 2022 May;55 Suppl 3(Suppl 3):804-826. doi: 10.1111/iej.13737. Epub 2022 Apr 15. PMID: 35338655; PMCID: PMC9324143.
2. Mohammed YT, Al-Zaka IM. Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers (A Comparative Study). J Contemp Dent Pract 2020;21(5): 490–493.
3. Chauhan, Parul & Garg, Ashima & Mittal, Rakesh & Kumar, Hemanshi. (2019). A comparative evaluation of fracture resistance of endodontically treated teeth using four different intraorifice barriers: An in vitro study. Journal of Conservative Dentistry. 22. 420. 10.4103/JCD.JCD_227_19.
4. Nagas E, Uyanik O, Altundasar E, Durmaz V, Cehreli ZC, Vallittu PK, et al. Effect of different intraorifice barrier on the fracture resistance of roots obturated with Resilon or gutta-percha. J Endod. 2010;36:1061–3
5. de Araújo LP, da Rosa WLO, de Araujo TS, Immich F, da Silva AF, Piva E. Effect of an Intraorifice Barrier on Endodontically Treated Teeth: A Systematic Review and Meta-Analysis of In Vitro Studies. Biomed Res Int. 2022 Jan 20;2022:2789073. doi: 10.1155/2022/2789073. PMID: 35097115; PMCID: PMC8794661.
6. Gupta A, Arora V, Jha P, Nikhil V, Bansal P. An in vitro comparative evaluation of different intraorifice barriers on the fracture resistance of endodontically treated roots obturated with gutta-percha. J Conserv Dent. 2016 Mar-Apr;19(2):111-5. doi: 10.4103/0972-0707.178682. PMID: 27099413; PMCID: PMC4815535.
7. Mandava J, Chang PC, Roopesh B, Faruddin MG, Anupreeta A, Uma Ch. Comparative evaluation of fracture resistance of root dentin to resin sealers and a MTA sealer: An in vitro study. J Conserv Dent. 2014 Jan;17(1):53-6. doi: 10.4103/0972-0707.124140. PMID: 24554862; PMCID: PMC3915387.
8. Mitchell CA, Douglas WH, Cheng YS. Fracture toughness of conventional, resin-modified glass-ionomer and composite luting cements. Dent Mater. 1999 Jan;15(1):7-13. doi: 10.1016/s0109-

5641(99)90024-6. PMID: 10483390.

9. Nezir, M., Dinçtürk, B.A., Sarı, C. et al. Effect of fiber-reinforced direct restorative materials on the fracture resistance of endodontically treated mandibular molars restored with a conservative endodontic cavity design. Clin Oral Invest 28, 316 (2024). https://doi.org/10.1007/s00784-024-05720-4
10. Abbasi M, Moradi Z, Mirzaei M, Kharazifard MJ, Rezaei S. Polymerization Shrinkage of Five Bulk-Fill Composite Resins in Comparison with a Conventional Composite Resin. J Dent (Tehran). 2018 Nov; 15(6):365-374. PMID: 30842797; PMCID: PMC6399456.