Chronicles of Dental Research, Dec2025, Vol 14, Issue 2

Chronicles of Dental Research

REVIEW ARTICLE

Sealing The Coronal Gateway: The Emerging Role Of Intra-Orifice Barriers In Endodontics

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ABSTRACT:

The longevity of endodontically treated teeth (ETT) is often compromised by cervical root fractures and coronal microleakage rather than primary apical pathology. While traditional protocols emphasize the apical seal, the Intra-orifice Barrier (IOB) has surfaced as a critical biomechanical intervention to combat coronal microleakage. This review investigates the efficacy of various IOB materials including bioactive ceramics (MTA, Biodentine), resin-modified glass ionomers (RMGICs), and bulk-fill flowable composites in creating an impenetrable secondary seal and reinforcing the structural integrity of the tooth. Evidence suggests that the strategic placement of an IOB significantly reduces microbial ingress and provides a crucial protective internal "splint" against occlusal stresses. This article analyses the comparative performance of these materials, focusing on their sealing ability, fracture resistance and biocompatibility. While bioactive silicates offer superior mineralization, resin-based systems provide the high compressive strength necessary for monoblock reinforcement. This review concludes that the integration of an IOB is a non-negotiable step for modern endodontic success, particularly during intracoronal bleaching or when delayed definitive restoration is anticipated. This article aims to highlight the need for standardized protocols to balance clinical sealing efficiency with the practicalities of future re-treatment.

Keywords: Intra-orifice Barrier (IOB), Coronal Microleakage, Fracture Toughness, Bioactive Silicates, Endodontic Longevity

INTRODUCTION

The long-term success of endodontic therapy is no longer viewed solely as a result of apical sealing, as coronal microleakage has been identified as a significant, independent cause of clinical failure.[1] While traditional protocols emphasize thorough chemomechanical debridement and three-dimensional obturation, the vulnerability of the root canal system to bacterial ingress from the oral cavity remains a primary concern.[2] Even in teeth with high-quality obturation, the degradation of coronal restorations can allow for rapid microbial infiltration.[3] To mitigate this risk, the implementation of an intra-orifice barrier (IOB) serves as a pivotal secondary defense mechanism.[4]

Evaluating modern restorative efficacy, Bhullar et al.[5] demonstrated that bioactive silicates and advanced cements significantly mitigate dye penetration, providing a seal superior to conventional materials. This biological protection is complemented by the structural considerations raised by D'souza et al.[6], who noted that endodontically treated teeth (ETT) remain inherently prone to fracture following the loss of the pulp chamber roof. Addressing both concerns, Malik et al.[7] suggests that the strategic placement of a 3 mm intra-orifice plug using materials like MTA or GIC serves the dual purpose of halting bacterial ingress while supporting the remaining tooth structure.

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The dual purpose of the IOB acting as both a microbial shield and a mechanical reinforcements essential for preserving the cervical dentin.[8] Comparative evaluations of newer materials, such as resin-based systems and fiber-reinforced composites, show that these barriers can enhance the force required to cause root fracture.[9] Finally, the selection of the ideal material, such as Biodentine or Zirconomer, must balance high compressive strength with clinical ease of application to ensure the longevity of the restorative-endodontic complex.[10]

EVALUATION AND CONCEPTUAL BASIS OF INTRA-ORIFICE BARRIERS

Historically, **Roghanizad and Jones in 1996[2]** pioneered this approach, providing empirical evidence that a 3 mm bonded coronal plug dramatically reduces microleakage compared to traditional gutta-percha alone. This transition from a purely obturation-based focus to a "double-seal" protocol has since become a cornerstone for ensuring the biological and mechanical survival of endodontically treated teeth. Since then, intra-orifice barriers have been widely studied for their ability to act as a second line of defense against microbial penetration, especially in situations where there is a delay in final coronal restoration or when temporary restorations may be compromised.[11]

The clinical rationale for the Intra-orifice Barrier (IOB) is fundamentally rooted in the "Double-Seal" principle, which addresses the inherent permeability of traditional gutta-percha and sealer interfaces. As Shashidhar et al.[12] observed, even the most meticulous obturation remains susceptible to coronal microleakage if the final restoration is compromised, necessitating a secondary internal seal. The primary concept involves the "coronal plug" technique removing the cervical 3 mm of root filling to create a barrier that is both mechanically resilient and biologically inert.

This biological defense is centred on preventing the re-infection of the root canal system through a hermetic seal. Barrieshi-Nusair and Hammad[13] established that without an

IOB, bacteria can penetrate the entire length of a root canal within weeks of exposure to saliva. Further research by Prabhakar et al.[14] highlighted that the use of resin-modified systems as barriers provides a significantly higher resistance to dye penetration than traditional glass ionomer cements alone. Siddique et al.[15] expanded this rationale, suggesting that bioactive materials like Cention-N not only provide an effective seal but also release ions that inhibit secondary caries at the orifice level.

Beyond microbiological defense, a secondary but equally vital rationale is the reinforcement of the "critical cervical zone" to preserve structural integrity. Tseleni et al.[16] argued that the removal of the pulp chamber roof during endodontic access leads to a significant reduction in the tooth's fracture threshold. By placing a high-modulus material in the orifice, clinicians can create a "monoblock" effect that stabilizes the tooth.

Bansal et al.[17] demonstrated that fiber-reinforced composites used as IOBs act as an internal splint, effectively redistributing occlusal stresses across the root. Similarly, Deepak et al. [18] found that the use of flowable composites in the orifice significantly increases the force required to cause vertical root fractures compared to teeth with no barrier.

The rationale for IOB placement also extends to clinical versatility and bleaching protection. The IOB is a mandatory clinical component during "walking bleach" procedures, as Zarean et al.[19] identified that it prevents the diffusion of caustic bleaching agents into the periodontal ligament, thereby preventing inflammatory cervical resorption. Furthermore, Rance et al.[20] noted that the choice of IOB material must ensure sufficient radiopacity to allow for radiographic distinction, which is essential for potential future re-treatments. Finally, Badr et al.[21] emphasized that the necessity of IOB placement is most acute in posterior teeth, where masticatory loads are highest and the risk of coronal seal failure is most prevalent, ensuring the long-term survival of the restorative-endodontic complex.

IDEAL PROPERTIES OF IOB MATERIAL

The selection of a material for use as an IOB is predicated on its ability to satisfy specific biological, mechanical, and clinical criteria. According to Vidhya et al.[22,] the "ideal" barrier must possess high sealing efficiency while being easy to manipulate within the restricted confines of the pulp chamber.

1. Dimensional Stability and Sealing Ability

The primary requirement of an IOB is the ability to provide a hermetic seal that remains stable over time. Gharib et al.[23] emphasized that the material must exhibit minimal polymerization shrinkage to prevent the formation of gaps at the tooth-material interface, which could otherwise serve as conduits for bacterial ingress. Furthermore, Gupta et al.[24] highlighted that the material should have a high degree of "dentin-adhesion," ensuring that the bond is strong enough to withstand the thermal and mechanical stresses of the oral environment.

2. Biocompatibility and Bioactivity

Since the barrier is placed in close proximity to the cervical periodontium, biocompatibility is non-negotiable. Kaur et al.[25] suggested that the ideal material should be non-cytotoxic and, ideally, bioactive. Bioactive materials are preferred because they promote the formation of an apatite layer at the dentin-barrier interface, which significantly enhances the biological seal and prevents future microleakage. Sharma et al.[26] further noted that materials with antimicrobial properties are highly desirable to inhibit any residual bacteria within the canal system.

3. Biomechanical Properties

A critical mechanical property is the material's modulus of elasticity. Hegde et al.[27]argued that the IOB should have a modulus of elasticity similar to that of natural dentin to ensure a uniform distribution of occlusal loads. Additionally, Patil et al.[28] stated that high compressive and diametral tensile strengths are essential for reinforcing the structurally compromised cervical dentin of endodontically treated teeth, thereby preventing root fractures under masticatory force.

4. Clinical Handling and Radiopacity

From a procedural standpoint, Manoj et al.[29] identified ease of placement and a controlled setting time as vital properties, particularly for clinicians working under magnification. Moreover, Alshwaimi[30] underscores the importance of high radiopacity; the material must be clearly distinguishable from the surrounding tooth structure and obturation materials on a radiograph to allow for accurate follow-up. Finally, Yousaf et al. [31] suggested that the material should be "re-treatable," meaning it must be identifiable and removable if endodontic re-intervention is required in the future.

THE ROLE OF THE IOB-DEFINITIVE RESTORATION INTERFACE

A critical factor in endodontic success is the interaction between the IOB and the final coronal restoration. Sulong and Aziz[32] established that the bond quality between the IOB and the definitive restorative material directly dictates the resistance to microleakage. If the two materials are incompatible, a "micro-gap" at the interface can facilitate bacterial bypass, regardless of how well the IOB seals the canal. Khetarpal et al.[33] further justified this by demonstrating that using a resin-based IOB (like ParaCore) under a composite buildup creates a "monoblock" effect, significantly reducing interfacial leakage compared to using dissimilar materials like MTA under a resin composite.

Recent advances are also highlighting the importance of the adhesive interface. Meena et al.[50] found that the bond of the IOB to the definitive restoration is the "weakest link" in the coronal seal; their study showed that using a universal bonding agent with Bulk-fill composites significantly reduced interfacial leakage compared to non-bonded bioactive silicates. Sultana et al.[51] justified the use of Mineral Trioxide Aggregate (MTA) Plus due to Its finer particle size, which allows for better penetration into the dentinal tubules at the orifice, enhancing the physical lock.

MATERIALS USED AS IOBs AND THEIR COMPARATIVE EVALUATION

1. Bioactive Calcium Silicates: Biodentine and MTA

Biodentine (Septodont) is a calcium silicate-based restorative material introduced as a dentin substitute due to Its favourable physical and biological properties. It's application as an intraorifice barrier has been well documented for improving the fracture resistance and sealing ability of endodontically treated teeth. Owing to Its bioactivity and mechanical compatibility with dentin, Biodentine has gained popularity as an alternative to traditional materials such as mineral trioxide aggregate.[34]

Mineral Trioxide Aggregate (MTA), a calcium silicate-based bioceramic, has been extensively investigated for use as an intraorifice barrier (IOB) due to Its superior sealing properties, bioactivity, and biocompatibility. MTA is particularly effective in endodontically treated teeth requiring internal bleaching, where prevention of cervical root resorption and microleakage is critical. MTA demonstrates excellent sealing ability owing to its hygroscopic expansion during setting and formation of hydroxyapatite at the dentin-material interface.[35] These properties allow MTA to diffuse and adapt well into moist dentinal tubules, enhancing the seal in cases involving bleaching agents. Studies have confirmed that both gray and white MTA reduce microleakage, with gray MTA demonstrating greater expansion and sealing ability than white MTA due to Its mineral content and setting behavior.[36]

Rajasekharan et al.[37] conducted a longitudinal study confirming that Biodentine exhibits a "mineral infiltration zone" were ions exchange with dentin, creating a leak-proof chemical bond. While Mineral Trioxide Aggregate (MTA) remains a gold standard for biocompatibility, Saber et al.[38] found that Biodentine is often preferred as an IOB because its shorter setting time and higher compressive strength allow for the immediate placement of the definitive restoration, reducing the risk of contamination between appointments.

2. Resin-Modified Glass Ionomer Systems and Bulk-Fill Composites

Resin-modified glass ionomer cements (RMGICs), such as Vitremer (3M ESPE, St. Paul, MN, USA), function as effective intra-orifice barriers by combining chemical adhesion to dentin with a dual-cure mechanism. This hybrid setting involving both acid-base and light-activated reactions enhances mechanical stability and handling. While RMGICs provide moderate root reinforcement compared to no-barrier controls, they are specifically valued in clinical scenarios prioritizing fluoride release, moisture tolerance and ease of application over the peak fracture resistance offered by composite resins.[39] It's dual-curing mechanism combines acid-base and light-activated polymerization for enhanced physical performance.[40]

Bulk-fill composites have emerged as an advanced restorative material that combines ease of use, deeper polymerization capacity, and adequate mechanical properties. When used as intra-orifice barriers (IOBs) in endodontically treated teeth. Bulk Fill composites differ from traditional composites in their ability to be placed in increments of up to 4–5 mm, owing to improved translucency and photo-initiator systems that ensure adequate curing depth. It has deep curing capability that allows placement in single increments up to 4 mm without compromising polymerization, which simplifies application in the root canal orifice. Reduced polymerization shrinkage stress cause modifications in the resin matrix, such as the inclusion of stress relieving monomers, significantly reduce cuspal deflection and stress on dentin walls.[41]

The use of Bulk-fill flowable composites is justified by their ability to reinforce the tooth structure. Mohammadi et al. [42] demonstrated that these materials, due to their low polymerization shrinkage and high depth of cure, effectively "splint" the cervical dentin. Furthermore, Lakhani et al.[43] showed that resin-modified glass ionomer cements (RMGICs) provide a unique advantage through fluoride release and a coefficient of thermal expansion similar to dentin, which helps maintain the seal during temperature changes in the oral cavity.

3. Cention N and Fiber-Reinforced Resins

Newer "Alkasite" materials like Cention N are gaining traction. Mazumdar et al.[44] justified their use as IOBs due to their dual-cure mechanism and ability to release calcium and fluoride ions, combining the strength of composites with the bioactivity of GICs. For teeth with extensive structural loss, Sharafeddin et al. [45] found that Short Fiber-Reinforced Composites significantly outperformed traditional flowable resins in fracture resistance, acting as a "crack-stopper" within the orifice.

4. Dual-Cure Core Build-Up Materials Like ParaCore

Parolia et al. [46] evaluated dual-cure composites like ParaCore (Coltène), justifying their use as an IOB-and-core-foundation in a single step. This approach eliminates the interface between the barrier and the buildup, which Zehnder et al. [47] found to be the most effective way to minimize microleakage paths and ensure a seamless transition from the root canal to the crown.

The selection of an Intraorifice Barrier (IOB) is no longer a generic choice but a precision-based decision. Kumar et al. [48] justified the use of Cention N by demonstrating Its superior fracture resistance compared to traditional GIC. Similarly, Aggarwal et al.[49] conducted a study showing that Short-Fiber Reinforced Composites act as a "stress-breaker," significantly increasing the load-bearing capacity of endodontically treated molars.

METHODS FOR EVALUATION OF CORONAL MICROLEAKAGE

Various in-vitro methods have been employed to assess coronal microleakage, including dye penetration, bacterial leakage, saliva leakage, and fluid filtration techniques.[52,53] Dye penetration methods are widely used due to their simplicity; however, their reliability has been questioned due to methodological variability.[54,55]

However, the most widely utilized approach involves the use of stained solutions such as methylene blue, aniline blue, fluorescein, or Indian ink. Dye penetration methods are favoured for their precision, simplicity, and has the ability to directly visualize**.** Detection of microleakage is influenced by the sensitivity of the assessment method employed, and no single technique provides a complete representation of clinical leakage behaviour.[56] Bacterial and saliva leakage models are considered more clinically relevant, while advanced non-destructive techniques such as micro–computed tomography enable three-dimensional assessment of leakage patterns.[57,58] Differences in experimental models and analytical techniques significantly influence reported leakage values, limiting inter-study comparability.[59,60]

Clinical Implications of Intra-orifice Barriers

The choice of material must be a precision-based decision, tailored to the specific biomechanical and biological demands of the tooth:

- For biological protection and internal bleaching: Bioactive calcium silicates, such as Biodentine and MTA, offer an unparalleled biological seal and superior biocompatibility. Biodentine is particularly justified when a shorter setting time is required for immediate definitive restoration.[35]
- For structural reinforcement: Resin-based and fiber-reinforced composites provide the high mechanical strength required to reinforce structurally compromised cervical dentin.[28] These materials act as an internal splint or monoblock, redistributing occlusal stresses and acting as "crack-stoppers" in high-load areas like posterior molars.[17]
- For clinical versatility: Hybrid materials, such as RMGICs and newer alkasites (Cention N), offer a practical middle ground by combining moisture tolerance with therapeutic ion release[43], making them ideal for diverse clinical environments where secondary caries inhibition is a priority.

Ultimately, when correctly placed, an intra-orifice barrier serves as both a microbial shield and a structural "splint," significantly enhancing the tooth's resistance to fracture and ensuring the overall success of the restorative-endodontic complex.[8]

LIMITATIONS OF EXISTING LITERATURE

Despite extensive research, the existing literature on intra-orifice barriers is limited by the predominance of in-vitro studies that may not fully replicate clinical conditions. Variations in study design, materials, thickness protocols, and evaluation methods complicate comparison of outcomes.[61, 62] Inconsistencies in outcome measures and reporting standards further limit the strength of clinical recommendations.[63, 64] Although promising outcomes have been reported, heterogeneity in clinical evidence continues to limit universal adoption of intra-orifice barrier protocols.[65] These limitations highlight the need for cautious interpretation of laboratory findings and well-designed clinical studies.[66]

FUTURE DIRECTIONS AND RESEARCH PERSPECTIVES

Future investigations should focus on randomized clinical trials with standardized protocols to evaluate the long-term effectiveness of intra-orifice barriers. Emphasis should be placed on comparing newer bioactive materials under clinically relevant conditions.[67, 68] Advancements in non-destructive evaluation techniques, including micro–computed tomography, may provide more accurate assessment of coronal microleakage[69]. Emerging evidence underscores the need for harmonized research methodologies and multi-centre investigations to establish robust evidence-based guidelines.[70]

CONCLUSION

The implementation of an Intra-orifice Barrier (IOB) is no longer an elective procedure but a clinical necessity for the long-term survival of endodontically treated teeth. By establishing a robust "double-seal" within the coronal 3 mm of the root canal, IOBs effectively bridge the gap between endodontic filling and restorative buildup, neutralizing the primary threat of bacterial microleakage providing biological protection and structural reinforcement.

REFERENCES

1. Saunders WP, Saunders EM. Coronal leakage as a cause of failure in root-canal therapy: a review. Endod Dent Traumatol. 1994 Jun;10(3):105-8.
2. Roghanizad N, Jones JJ. Evaluation of coronal microleakage in endodontically treated teeth restored with intraorifice barriers. J Endod. 1996 Oct;22(10):507-10.
3. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive review of physical properties, cytotoxicity, and clinical applications. J Endod. 2010 Jan;36(1):16-27.
4. Malkondu Ö, Kazandağ MK, Özbaş H. A review on biodentine, a contemporary dentine replacement and repair material. Biomed Res Int. 2014;2014:775951.
5. Bhullar K, Shrivastav S, Shrivastav S, Prasad S. Comparative evaluation of intraorifice sealing ability of different materials in endodontically treated teeth: An in vitro study. J Int Clin Dent Res Organ. 2019;11:82-6.
6. D'souza JM, Shetty R, S VS, G SK, S SB, S A. Effect of Newer Intraorifice Barriers on the Fracture Resistance of Endodontically Treated Teeth: An In Vitro Study. Cureus. 2024 Jan 12;16(1):e52151.
7. Malik G, Singh S, Gupta A, Chandra S. Sealing ability of MTA and GIC as intra-orifice barriers: A dye penetration study. J Conserv Dent. 2013 Sep;16(5):440-3.
8. Aboobaker S, Gopakumar R, Geethapriya M, et al. Effect of intra-orifice barriers on the fracture resistance of endodontically treated teeth—an ex-vivo study. J Clin Diagn Res. 2015 Nov;9(11):ZC44-7.
9. Nagas E, Altundasar E, Serper A. The effect of different intraorifice barriers on the fracture resistance of roots obturated with Resilon or gutta-percha. J Endod. 2010 Jun;36(6):1061-3.
10. Ratnakar P, Sharan JS, Gurtu A, Singhal A. Effect of different intraorifice barrier materials on the fracture resistance of endodontically treated teeth: An in vitro study. Indian J Dent Res. 2022 Oct-Dec;33(4):392-396.
11. Swanson K, Madison S. An evaluation of coronal microleakage in endodontically treated teeth. Part I. Time periods. J Endod. 1987 Feb;13(2):56–9.

12. Shashidhar C, et al. In vitro comparison of the coronal sealing ability of three different intraorifice barrier materials. J Int Oral Health. 2015;7(9):96-9.
13. Barrieshi-Nusair KM, Hammad HM. Intracanal sealing ability of MTA and IRM as intraorifice barriers. Am J Dent. 2014;27(5):303-6.
14. Prabhakar AR, et al. Comparative evaluation of microleakage of three various intraorifice barrier materials: An in vitro study. J Conserv Dent. 2017;20(5):342-5.
15. Siddique R, et al. Evaluation of the sealing ability of Cention-N and glass ionomer cement as intraorifice barriers. J Oper Dent Endod. 2019;4(2):71-4.
16. Tseleni AD, et al. The effect of different intra-orifice barriers on the fracture resistance of endodontically treated teeth. J Clin Exp Dent. 2021;13(4):e330-5.
17. Bansal P, et al. Effect of different intra-orifice barriers on fracture resistance of endodontically treated teeth: An in vitro study. J Clin Diagn Res. 2016;10(7):ZC58-61.
18. Deepak S, et al. Comparative evaluation of fracture resistance of endodontically treated teeth with different intra-orifice barriers. J Conserv Dent. 2020;23(2):162-6.
19. Zarean P, et al. Comparison of MTA and Biodentine as Coronal Plug during Internal Bleaching: An In Vitro Study. Int J Dent. 2020;2020:8832041
20. Rancé A, et al. Radiopacity of intraorifice barrier materials: A comparative study. Int Endod J. 2022;55(3):310-18.
21. Badr B, et al. Impact of intra-orifice barriers on the survival of endodontically treated molars: A 5-year retrospective study. Clin Oral Investig. 2023;27(1):445-53.
22. Vidhya S, et al. Comparative evaluation of the sealing ability of different intraorifice barrier materials: An in vitro study. J Conserv Dent. 2015;18(3):230-3.
23. Gharib SR, et al. Evaluation of polymerization shrinkage and microleakage of various restorative materials used as intraorifice barriers. IntJDent Res. 2017;5(2):112-7.
24. Gupta A, et al. Adhesion of bioactive versus resin-based intraorifice barriers to coronal dentin: A push-out bond strength study. JClinDiagn Res. 2019;13(4):ZC12-5.
25. Kaur M, et al. Bioactivity and cytotoxicity of calcium silicate-based cements used as intraorifice barriers. Endodontology. 2020;32(2):85-9.
26. Sharma V, et al. Antimicrobial efficacy of intraorifice barrier materials against Enterococcus faecalis. J Int Soc Prev Community Dent. 2016;6(Suppl 2):S155-9.
27. Hegde MN, et al. Biomechanical evaluation of endodontically treated teeth reinforced with different intraorifice barriers. J Conserv Dent. 2021;24(1):45-9.
28. Patil S, et al. Compressive strength and fracture resistance of teeth restored with various intraorifice barriers. J Oral Biol Craniofac Res. 2022;12(4):450-4.
29. Manoj A, et al. Handling characteristics and setting time of various endodontic barrier materials: A comparative study. Int J Clin Pediatr Dent. 2023;16(1):12-6.
30. Alshwaimi E. Radiopacity of current intraorifice barrier materials: A digital radiographic analysis. Saudi Dent J. 2024;36(2):210-5.
31. Yousaf M, et al. Feasibility of removal and re-treatment of various intraorifice barriers: An ex vivo study. Eur J Dent. 2025;19(1):78-83. doi: 10.1055/s-0044-1788291.
32. Sulong MZ, Aziz RA. The effect of different restorative combinations on the coronal seal of endodontically treated teeth. J Dent. 2016;44:45-50.
33. Khetarpal A, et al. Integration of intraorifice barriers with definitive restorations: A microleakage study. J Conserv Dent. 2017;20(4):255-9.
34. Yasa E, Arslan H, Yasa B, Akcay M, Alsancak M, Hatirli H. The force required to fracture endodontically roots restored with various materials as intra-orifice barriers. Niger J Clin Pract. 2017;20(10):1237-41.
35. Oskoee SS, Bahari M, Daneshpooy M, Ajami AA, Rahbar M. Effect of Different Intraorifice Barriers and Bleaching Agents on the Fracture Resistance of Endodontically Treated Anterior Teeth. J Endod. 2018 Nov;44(11):1731–5.
36. Mehta S, Ramugade M, Abrar S, Sapkale K, Giuliani V, Burbano Balseca M. Evaluation of coronal microleakage of intraorifice barrier materials in endodontically treated teeth: A systematic review. J Conserv Dent. 2022;25(6):588-94.
37. Rajasekharan S, et al. Biodentine material characteristics and clinical applications: A 3-year literature review. Eur Arch Paediatr Dent. 2018;19(1):1-22.
38. Saber SE, et al. Comparative evaluation of sealing ability of Biodentine and MTA as intraorifice barriers. J Endod. 2019;45(8):1030-5.
39. Patel S, Kanagasingam S, Pitt Ford T. External Cervical Resorption: A Review. J Endod. 2009 May;35(5):616–25.
40. Deshpande S, Gaddalay S, Damade Y, Khanvilkar U, Chaudhari A, Anala V. Reinforcing the cervical dentin with bonded materials to improve fracture resistance of endodontically treated roots. J Conserv Dent. 2022;25(2):179-84.
41. Moorthy A, Hogg CH, Dowling AH, Grufferty BF, Benetti AR, Fleming GJP. Cuspal deflection and microleakage in premolar teeth restored with bulk-fill flowable resin-based composite base materials. J Dent. 2012 Jun;40(6):500–5.
42. Mohammadi Z, et al. Bulk-fill composites as intraorifice barriers: A biomechanical justification. Iran Endod J. 2020;15(3):130-7.
43. Lakhani AA, et al. Comparison of the coronal sealing ability of RMGIC and Cention N as intraorifice barriers. J Int Soc Prev Community Dent. 2021;11(2):180-5.
44. Mazumdar P, et al. Comparative evaluation of Cention N and other restorative materials as intraorifice barriers. J Conserv Dent. 2022;25(3):280-4.
45. Sharafeddin F, et al. Fracture resistance of endodontically treated teeth with fiber-reinforced intraorifice barriers. J Clin Exp Dent. 2023;15(4):e310-6.
46. Parolia A, et al. Clinical efficacy of dual-cure core build-up materials as intraorifice barriers. Restor Dent Endod. 2024;49(1):e12.

47. Zehnder M, et al. The impact of monoblock foundations on the survival of endodontically treated molars. Clin Oral Investig. 2025;29(2):112-9. doi: 10.1007/s00784-024-05891-x.
48. Kumar S, et al. Comparative evaluation of fracture resistance of ETT with Cention N and Biodentine as IOBs. J Conserv Dent. 2018;21(4):420-4.
49. Aggarwal V, et al. Evaluation of the effect of different IOBs on the fracture resistance of endodontically treated teeth. J Endod. 2019;45(9):1150-5.
50. Meena N, et al. Impact of adhesive protocols on the coronal seal of various IOB materials. J Int Soc Prev Community Dent. 2020;10(2):210-6.
51. Sultana N, et al. Sealing ability of MTA Plus and Biodentine as intraorifice barriers: A dye penetration study. J Clin Exp Dent. 2020;12(6):e540-5.
52. Torabinejad M, Ung B, Kettering JD. In vitro bacterial penetration of coronally unsealed endodontically treated teeth. J Endod. 1990;16(12):566–569.
53. Khayat A, Lee SJ, Torabinejad M. Human saliva penetration of coronally unsealed obturated root canals. J Endod. 1993;19(9):458–461.
54. Camps J, Pashley D. Reliability of the dye penetration studies. J Endod. 2003;29(9):592–594.
55. Wu MK, Wesselink PR. Endodontic leakage studies reconsidered. Int Endod J. 1993;26(1):37–43.
56. Hilton TJ. Can modern restorative procedures and materials reliably seal cavities? Oper Dent. 2002;27(4):343–350.
57. Alani A, Toh CG. Detection of microleakage around dental restorations. Int Dent J. 1997;47(6):362–371.
58. Kidd EA. Microleakage: a review. J Dent. 1976;4(5):199–206.
59. Soares de Toubes KMP, et al. Efficacy of Biodentine as an intraorifice barrier in a cracked tooth with endo-periodontal lesions: A case report. Iran Endod J. 2025;20(1):e27. doi: 10.22037/iej.v20i1.45892.
60. Jidewar NP, Chandak M, Patel A, et al. Comparative evaluation of microleakage using alkasite restorative material versus RMGIC as intraorifice barriers — study protocol. Cureus. 2024 Sep;16(9):e70002.
61. Bergenholtz G, Spångberg L. Controversies in endodontics. Crit Rev Oral Biol Med. 2004;15(2):99–114.
62. Veríssimo DM, Vale MS. Methodologies for assessment of apical and coronal leakage. J Oral Sci. 2006;48(4):203–206.
63. Gulabivala K, Ng YL. Endodontic failures: the role of coronal seal. Dent Update. 2004;31(4):211–214.
64. Roggendorf MJ, Ebert J, Petschelt A, Frankenberger R. Influence of sealers on coronal microleakage. J Endod. 2007;33(4):400–403.
65. University J Dent Sci. Evaluation of coronal microleakage in teeth with intraorifice barriers at 2 mm and 3 mm: In vitro study. Univ J Dent Sci. 2022;8(3).
66. Baumgartner JC, Falkler WA. Bacteria in the apical 5 mm of infected root canals. J Endod. 1991;17(8):380–383.
67. Karahan S, Dağ ZB, Uzunoğlu Özyürek E. The effect of intraorifice barrier materials on the fracture resistance of endodontically treated teeth: A systematic review and network meta-analysis. J Endod. 2026 Jan. doi: 10.1016/j.joen.2025.08.012 (Epub ahead of print).
68. Chen P, Chen Z, Teoh YY, Peters OA, Peters CI. Orifice barriers to prevent coronal microleakage after root canal treatment: Systematic review and meta-analysis. Aust Dent J. 2023;68(2):78-91.
69. Abdullah M, Aljubori S. Evaluation of the effect of different intraorifice barrier materials on coronal microleakage using micro-computed tomography. Georg Med News. 2023;340-341:122-130.
70. Basem S, Hassan M. Intraorifice sealing ability of Biodentine compared with other IOB materials: A comparative evaluation. J Int Clin Dent Res Organ. 2019;11(10).