

Restorative Dentistry Bonding Strategies: A Narrative Analysis

Anjali Gupta¹, Sachin Gupta², Vineeta Nikhil³

¹Junior Resident, Department of Conservative Dentistry and Endodontics, Subharti Dental College and Hospital, Swami Vivekanand Subharti University, Meerut, India.

²Professor, Department of Conservative Dentistry and Endodontics, Subharti Dental College and Hospital, Swami Vivekanand Subharti University, Meerut, India.

³Professor and Head, Department of Conservative Dentistry and Endodontics, Subharti Dental College and Hospital, Swami Vivekanand Subharti University, Meerut, India.

Corresponding Author: Anjali Gupta

DOI: <https://doi.org/10.52403/ijrr.20250669>

ABSTRACT

In restorative dentistry, effective bonding techniques are fundamental to achieving long-lasting, functional, and aesthetically pleasing dental restorations. As adhesive materials and technologies have advanced, clinical practices have shifted away from traditional mechanical retention methods toward minimally invasive procedures that rely on strong adhesion to enamel and dentin. This article outlines the primary bonding methods currently in use, such as etch-and-rinse, self-etch, and universal adhesives. Each method offers distinct advantages and challenges concerning bond durability, ease of application, and material compatibility. Key factors influencing clinical outcomes include the type of tooth surface being treated, moisture control during the procedure, and the chemical formulation of the adhesive agent. Innovations such as bioactive materials have contributed to improved adhesive properties, enhancing both the longevity of restorations and resistance to recurrent decay. A thorough understanding of these bonding strategies and their clinical applications is essential for delivering reliable and high-quality restorative dental care.

Keywords: Adhesion, Bonding strategies, Bond strength, Etching, Universal adhesives

INTRODUCTION

Teeth endure structural challenges like caries, trauma, and restorative procedures, especially in endodontically treated teeth that become brittle and fracture prone.^[1] Deep cavity preparations exacerbate structural weakening.^[1] Various materials like amalgam, glass ionomer cements (GIC), composites, and ceramics are used based on aesthetics, strength, and biocompatibility.^[2] Bonding these to tooth surfaces enhances longevity, function, and aesthetics, while reducing caries and hypersensitivity.^[2-3] Failures often occur at the dentin-adhesive interface due to degradation.^[4] Bond success depends on enamel v/s dentin bonding, moisture control, adhesive type, and clinical skill.^[3] Modern techniques and biomimetic adhesives that promote remineralization and resist degradation offer promise for more durable and functional restorations.^[5]

DISCUSSION

Innovations in stem cells, imaging, robotics, and 3D printing have transformed dental reconstruction. Tooth loss from decay or injury is common, demanding restorative

materials that endure the oral cavity's variable temperature, moisture, and bacterial load.^[6] Materials must be durable, biocompatible, and adaptable. Clinicians need a solid grasp of biomechanics to select suitable options for optimal function. Restoration longevity depends on bonding strength, patient habits, and material properties.^[3,7] Over 60% of restorations fail, emphasizing durability. Adhesive dentistry—initiated by Buonocore and advanced by Bowen, Smith, and Wilson—has enhanced outcomes.^[8] Modern adhesives allow conservative tooth

preparation and reduce the need for extensive mechanical retention. While metals are being phased out in favour of more aesthetic materials, the demand for strong and reliable adhesive systems in both direct and indirect restorations continues to grow. Adhesive approaches in restorative dentistry primarily involve the use of bonding agents and luting cements.

The classification of bonding agents is outlined in **Table 1**:

Generation	Pre-treatment of the surface	Components	Number of steps	Shear bond strength (MPa)	Examples
1 st	Enamel etch	2	2	2	Cervident
2 nd	Enamel etch	2	2	5	Clearfil bond system
3 rd	Dentine conditioning	2-3	3	12-15	ScotchBond 2
4 th	Total etch	3	3	25	ScotchBond multipurpose
5 th	Total etch	2	2	25	OptiBond Solo
6 th	Self-etch adhesive	2 2	1 2	20	Clearfil SE bond Optibond XTR
7 th	Self-etch adhesive	1	1	25	iBOND
8 th	Self-etch adhesive	1	1	Over 30	Futurabond DC

Dental adhesives are broadly classified into etch-and-rinse (ER) and self-etch (SE) systems.^[9]

Etch-and-Rinse Adhesives: These systems utilize phosphoric acid to condition both enamel and dentin. Acid etching increases enamel surface energy by removing hydroxyapatite and creating microporosities, enabling micromechanical retention through resin tag formation. On dentin, etching eliminates the smear layer, opens tubules, and exposes a hydrated collagen matrix within the top 1–5 µm of demineralized dentin. Examples include Scotchbond Multipurpose and All-Bond 3 (3-step), and OptiBond Solo Plus (2-step).

Self-Etch Adhesives: SE systems combine etching and priming in a single step using acidic functional monomers (e.g., carboxyl or phosphate groups). These monomers penetrate and modify the smear layer,

incorporating it along with demineralized tooth components into the hybrid layer without rinsing. Examples include Clearfil SE Bond 2 (2-step) and iBOND, G-Bond (1-step).

Universal (Multi-Mode) Adhesives

Universal adhesives represent the latest generation of bonding systems, designed for use with multiple techniques—ER, SE, or selective etch—earning them the "multi-mode" label. These adhesives can also bond to a range of restorative substrates such as ceramics, composites, and metals. With pH levels between 1.5 and 3.2, they are categorized as ultra-mild, mild, or intermediately strong. Unlike traditional 1-step SE systems, universal adhesives contain specific functional monomers like 10-MDP, as well as others such as GPDM, 4-MET, 4-META, and PENTA.^[10] Common examples include All-Bond Universal, Clearfil Universal Bond, Scotchbond

Universal, Prime & Bond Universal, and OptiBond Universal.

Luting agents are materials used to securely bond indirect restorations (e.g., crowns, inlays) to tooth structure. They are classified by setting mechanism into acid-base (e.g.,

zinc phosphate, zinc polycarboxylate, GIC), polymerization (resin-based), or a combination of both.

The classification of resin-based luting cements is discussed in the **Table 2**.

Based on		Example
Polymerization mechanism	Light cured	RelyX™ Veneer
	Self cured	Panavia™
	Dual cured	Variolink® II
Application mode	Etch & rinse	Rely X ARC
	Self-etch	BisCem
	Self-adhesive	RelyX U200/3M ESPE-U200

Bonding to enamel

Enamel, the hardest tissue in the body, is primarily composed of hydroxyapatite, making it the principal substrate for bonding.^[1] Buonocore's acid etching technique using phosphoric acid significantly enhanced enamel adhesion.^[11] Modern gels with polymeric thickeners offer better control during etching, and studies show that etching mode such as agitation improves enamel bonding. While 37% phosphoric acid remains standard, reduced etch times (15–20 seconds) are now preferred to prevent over-etching. Selective etching has emerged as an effective enhancement to self-etch systems.^[12] Bond strength is influenced by several substrate-related factors: *hypomineralized enamel*, with lower mineral content, shows decreased bond strength (8–15 MPa), but pre-treatment with 5% NaOCl can improve outcomes.^[13] *Fluorosed enamel*, particularly in moderate to severe cases, requires longer etching or the use of two-step self-etch systems for optimal results.^[14] Additionally, *prepared enamel* provides significantly higher tensile bond strength compared to *intact enamel* (25.44 ± 5.23 MPa vs. 8.51 ± 2.45 MPa),^[15] and *permanent teeth*, due to their higher mineralization, allow stronger bonding than *primary teeth*, which have thinner enamel and greater moisture sensitivity.^[16]

Post-bleaching, residual oxygen interferes with resin polymerization, reducing bond strength. Bond strength to *bleached enamel*

drops notably (e.g., 13.6 ± 5.9 MPa v/s 23.0 ± 3.9 MPa in unbleached enamel).^[17] A delay of 7–21 days is generally advised before proceeding with adhesive procedures.^[17] However, immediate bonding can be restored using antioxidants like 10% sodium ascorbate, 5% proanthocyanidin, and 10% alpha-tocopherol, all applied for 10 minutes.^[18] Natural agents such as green tea and yerba mate are also effective within similar time frames. These antioxidants counteract the inhibitory effects of oxygen on polymerization, thereby reestablishing the bonding potential to levels comparable to untreated enamel.

Bonding to dentin

Bonding to dentin poses greater challenges than to enamel due to its heterogeneous composition and structural complexity. While enamel is about 95% hydroxyapatite, dentin contains roughly 50%, with higher organic content and water, and a less organized arrangement of hydroxyapatite. The presence of a smear layer, dentinal fluid, and vital pulp processes within tubules further complicates adhesive penetration. Bond strength is influenced by depth—*superficial dentin* offers better adhesion due to more intertubular dentin, while *deeper layers* with larger, more numerous tubules yield lower values. Aging alters dentin structure, increasing mineral content and reducing tubule density, which diminishes adhesive performance. Etch-and-

rinse adhesives typically achieve 20–30 MPa, self-etch systems range from 15–25 MPa, and universal adhesives vary from 20–35 MPa, depending on the mode of application.^[19] Fourth-generation adhesives have shown superior results in all dentin depths compared to self-etching systems, with All Bond 2 demonstrating the highest bond strengths in superficial dentin.^[20]

Moisture control also plays a crucial role in bonding. Acid etching exposes dentinal collagen, which must remain hydrated to allow resin infiltration and hybrid layer formation. Over-drying causes collagen collapse, impairing adhesion, while acetone-based primers improve monomer diffusion. *Caries-affected dentin*, due to demineralization and poor structural integrity, compromises bonding, and has shown reduced resin penetration and long-term stability.^[21] Contamination with saliva or blood can reduce bond strength by 20–100%, although re-etching can effectively restore adhesion without mechanical re-preparation.^[22] In the case of sclerotic dentin, which is less receptive to acids due to occluded tubules, using 37% phosphoric acid improves tubular access and bond strength more effectively than multiple etch-prime approaches.^[23]

Bonding strategies for various restorations

1. Porcelain fused to metal restorations (PFM)

Extracoronary restorations provide better retention than intracoronary ones due to full coverage and increased bonding area. Vinaya *et al* found higher retention in complete cast crowns on teeth with adequate height, with proximal grooves outperforming boxes.^[24] PFM crowns, composed of metal coping and porcelain layers, are typically luted with resin-modified glass ionomer cement.^[25] Surface treatment includes sandblasting (30–50 µm aluminium oxide at 2 bar), alcohol cleaning, and cautious tooth preparation. Bonding is enhanced by acid etching, sandblasting, and primers

with 10-MDP. Chlorhexidine maintains bond strength.^[26] Immediate dentinal sealing strengthens bonds, protects the pulp, and reduces sensitivity, especially with resin cements.^[27] Proper curing remains vital.

2. All-metal restorations

Metal crowns, inlays, and onlays made from gold, Co-Cr, or Ni-Cr alloys are valued for strength and durability. Their luting follows PFM protocols, often using resin-based or glass ionomer cements.^[28] Mann *et al* reported resin cements provide highest bond strength, with Co-Cr showing the strongest shear bond (8.06 MPa), and noble alloys the weakest (5.36 MPa).^[29] Reddy *et al* found zinc phosphate (21.28 kg/cm²) and GIC (20.69 kg/cm²) outperformed polycarboxylate cement (16.79 kg/cm²), favouring GIC for ease and performance.^[30] Surface conditioning, especially 110 µm alumina sandblasting and RMGIC, showed best results,^[31] with Sharma *et al* supporting dual-cure resin cement as most effective.^[32]

3. Zirconia restorations

Bonding zirconia is difficult due to its chemical inertness. Success depends on mechanical roughening and 10-MDP monomers, which bond to metal oxides.^[33] Post-try-in decontamination is vital, using zirconia-specific cleaners, 50 µm alumina sandblasting, or 5% sodium hypochlorite—phosphoric acid is avoided.^[34] GIC may be used for retentive preparations; resin cement is preferred otherwise. Sandblasting tailored to zirconia type optimizes bond strength.^[35] Tribochemical silica-coating and silanization enhance bonding,^[36-37] though thermocycling may weaken results.^[38] 10-MDP primers like Z-Prime™ Plus are applied before cementation. Enamel is etched, and self-adhesive resin cements like Panavia F2.0 ensure strong bonds, especially when used with alumina abrasion.^[39,40]

4. Lithium disilicate restorations

Lithium disilicate crowns are valued for strength, aesthetics, and versatility in CAD/CAM or press techniques. They can be conventionally cemented with GICs like Fuji Plus or Ketac when adequate retention exists^[41] or bonded for enhanced strength and aesthetics. After try-in, clean the tooth with pumice and the intaglio with Ivoclean or glass bead blasting. Bonding involves 60-second hydrofluoric acid etching, silanization,^[42] and phosphoric acid etching (30 s enamel, 15 s dentin), followed by adhesive and resin cement. Dual-cure is ideal for thick crowns; light-cure for veneers. Total-etch cements offer highest durability,^[43] and increased cement thickness improves bond strength.^[44]

5. Post

A post supports the core in endodontically treated teeth and aids crown retention. Post shape and size influence bond strength—parallel-sided, oval, and longer posts offer better retention, but must preserve 5–6 mm of gutta-percha apically.^[45-46] Fiber posts are preferred over metal due to lower fracture risk.^[46] Dual-cure resin cements with phosphate monomers provide superior bonding,^[47] with self-adhesive cements showing the highest strength.^[48] Surface treatments like sandblasting and etching enhance adhesion.^[49] Bond strength varies by root level, highest in the apical third.^[50] Cleaning with NaOCl, EDTA, CHX, or mechanical methods improves retention,^[49-54] with EDTA being most effective for smear layer removal.^[54]

6. Amalgam

Amalgam, made of ~50% mercury with metals like silver and tin, is favored for posterior restorations due to its strength and longevity. Its natural bond to enamel (1.2-1.6 MPa) and dentin (2-20 MPa) is low but improves with adhesives like resin-modified glass ionomers.^[55] Bonded amalgam techniques using agents like 4-

META/MMA-TBB enhance sealing and reduce leakage. Composite-amalgam combinations improve aesthetics and strength, with dual-cure resin cements showing bond strengths up to 8.86 MPa.^[56]

Repairing amalgam restorations involves a systematic approach. Proper isolation with a rubber dam, followed by surface cleaning and roughening—using burs or air abrasion with alumina particles is crucial for achieving mechanical retention. When using composite for repair, etching enamel and dentin, applying silane to the amalgam, and using adhesive agents enhances bond strength.^[57] Though repairs restore only ~40% strength, proper bonding systems like Panavia 21 enhance composite repair outcomes. Final steps include contouring and polishing the restoration to ensure proper function, aesthetics, and hygiene maintenance.^[58]

7. Conventional glass ionomer restorations

GIC, introduced in 1972, self-adheres to enamel and dentin, showing bond strengths of 3–12 MPa depending on type and treatment.^[59] Light-cured and Type IX GICs bond better than conventional ones. Repair involves evaluating the restoration and preparing the surface with mechanical tools or acids like polyacrylic or phosphoric; silane is used if composite is applied.^[60] Same-material GIC repairs ensure compatibility, while RMGIC or composite enhances strength and aesthetics. Varnish protects post-finishing. Repaired GICs retain ~44% of original strength,^[60] with same-material repairs outperforming composites.^[59] Phosphoric acid improves bonding, though retreatment rates (7%) slightly exceed replacements (5%).^[61]

8. Resin modified glass ionomer restorations (RMGIC)

RMGIC, a resin-reinforced GIC, offers enhanced strength and aesthetics, bonding to enamel (5–10 MPa) and

dentin (7–13 MPa) based on surface conditioning. Poggio *et al* found bond strengths of 15.88 MPa with Clearfil SE Bond, 10.24 MPa with cavity conditioner, and lower with phosphoric acid or no treatment.^[62] Repairs require mechanical (e.g., air abrasion) and chemical conditioning.^[62] For composite repairs, silane and bonding agents are crucial.^[63] Fuji II LC bonded better (~10 MPa) to aged surfaces than Ketac N100.^[63] Composite–RMGIC bonds ranged from 9–16 MPa. With a 62.9% five-year survival rate, repairs are a conservative alternative to full replacement.^[64]

9. Composite restorations

Composite resins, composed of a resin matrix (e.g., bis-GMA or UDMA) and inorganic fillers (e.g., silica, zirconia), exhibit bond strengths of 15–40 MPa to enamel, 10–30 MPa to dentin, and 3–10 MPa to cementum, influenced by substrate composition and bonding protocols.^[65] However, challenges such as polymerization shrinkage, incomplete conversion, marginal gaps, and moisture contamination can compromise restoration success.^[66] Techniques like sandwich restorations (open or closed), snowplow, successive cusp build-up, and incremental layering are used to mitigate these issues by improving depth of cure, reducing stress, and enhancing marginal adaptation.^[67-68]

10. Fiber-reinforced composites (e.g., Ribbond) increase fracture resistance and stress distribution, especially in structurally compromised teeth.^[67] Biomimetic restorations further promote preservation and mimicry of natural tooth structures by applying minimally invasive techniques and using advanced adhesive materials that maintain biomechanical integrity.^[69] Together, these modern approaches offer more durable and biologically respectful alternatives in restorative dentistry.

CONCLUSION

Advances in restorative dentistry have refined bonding techniques vital for long-lasting, aesthetic outcomes. Etch-and-rinse, self-etch, and universal adhesives offer distinct benefits based on clinical and substrate needs. Bonding success depends on substrate condition, moisture control, smear layer management, and clinician skill. Though interface degradation persists, innovations like nanofillers, MMP inhibitors, and enhanced polymerization improve bond strength. Direct restorations vary as amalgam requires post-etch bonding, GICs bond chemically, and composites need etching and adhesives. Indirect restorations follow material-specific steps for e.g., silane for ceramics, MDP primers for zirconia. Proper surface preparation, isolation, and precise techniques are essential for durable, functional restorations.

Declaration by Authors

Acknowledgement: None

Source of Funding: None

Conflict of Interest: No conflicts of interest declared.

REFERENCES

1. Goel VK, Khera SC, Singh K. Clinical implications of the response of enamel and dentin to masticatory loads. *J Prosthet Dent* 1990;64(4):446-54.
2. Anusavice KJ. Overview of dental materials. In: Shenoy A, editor. *Phillips' science of dental materials*. St. Louis: WB Saunders Co. Ltd; 2021. p 3-14.
3. Fernandes NA, Vally ZI, Sykes LM. The longevity of restorations - A literature review. *S Afr Dent J* 2015;70(9):410-3.
4. Davis MJ, McGregor A. Assessing adhesive bond failures - Mixed-mode bond failures explained. *Adhes Assoc* 2010;4(2):1-13.
5. Zafar MS, Amin F, Fareed MA *et al*. Biomimetic aspects of restorative dentistry biomaterials. *Biomimetics* 2020;5(3):34-45.
6. Sakaguchi RL. Role and significance of restorative dental materials. In : Powers JM, editor. *Craig's restorative dental materials*. Philadelphia: Elsevier Health Sciences, 2011. p 1-3.

7. Shen C. Overview of dental materials. In : Shenoy A, editor. Phillips' science of dental materials. St. Louis: Elsevier Health Sciences, 2021. p 3-14.
8. Suresh M, Abraham TA, Venkatachalam P *et al.* Bonding system for restorative materials - A review. *Ind J Pub Health Res Dev* 2019;10(8):1557-61.
9. Sofan E, Sofan A, Palaia G *et al.* Classification review of dental adhesive systems - From the IV generation to the universal type. *Ann Stomatol* 2017;8(1):1-17.
10. Arandi NZ. The classification and selection of adhesive agents - An overview for the general dentist. *Clin Cosmet Investig Dent* 2023;15(2):165-80.
11. Garg N. Bonding to enamel and dentin. In : Garg A, editor. Textbook of operative dentistry. New Delhi: Jaypee Publishers; 2010. p 237-54.
12. Erickson RL, Barkmeier WW, Kimmes NS. Bond strength of self-etch adhesives to pre-etched enamel. *Dent Mater* 2009;25(10):1187-94.
13. Ekambaram M, Yiu CK. Bonding to hypomineralized enamel - A systematic review. *Int J Adhes Adhes* 2016;69(2):27-32.
14. Aram A, Faris A, Khalid A *et al.* Bonding to fluorosed teeth - A review of the literature. *Cureus* 2024;16(3):1-5.
15. Patil D, Singbal KP, Kamat S. Comparative evaluation of the enamel bond strength of 'etch-and-rinse' and 'all-in-one' bonding agents on cut and uncut enamel surfaces. *J Conserv Dent* 2011;14(2):147-50.
16. Pires CW, Soldera EB, Bonzanini LL *et al.* Is adhesive bond strength similar in primary and permanent teeth? A systematic review and meta-analysis. *J Adhes Dent* 2018;20(2):87-97.
17. Brock T, Soveral AB, Junior JR *et al.* Effect of antioxidants on adhesive bond strength to bleached enamel. *J Dent* 2024;143(4):1-6.
18. Sung EC, Chan SM, Mito R *et al.* Effect of carbamide peroxide bleaching on the shear bond strength of composite to dental bonding agent enhanced enamel. *J Prosthet Dent* 1999;82(5):595-9.
19. Sharifian A, Esmaceli B, Gholinia H *et al.* Microtensile bond strength of different bonding agents to superficial and deep dentin in etch-and-rinse and self-etch modes. *Front Dent* 2023;20(9):1-7.
20. Singh K, Naik R, Hegde S *et al.* Shear bond strength of superficial, intermediate and deep dentin *in vitro* with recent generation self-etching primers and single nano composite resin. *J Int Oral Health* 2015;7(1):28-32.
21. Costa AR, Garcia-Godoy F, Correr-Sobrinho L *et al.* Influence of different dentin substrate (caries-affected, caries-infected, sound) on long-term μ TBS. *Braz Dent J* 2017;28(4):16-23.
22. Powers JM, Finger WJ, Xie J. Bonding of composite resin to contaminated human enamel and dentin. *J Prosthodont* 1995;4(1):28-32.
23. Kwansirikul A, Sae-Lee D, Angwaravong O *et al.* Effect of different surface treatments of human occlusal sclerotic dentin on micro-tensile bond strength to resin composite core material. *Eur J Oral Sci* 2020;128(3):263-73.
24. Vinaya K, Rakshith H, Prasad DK *et al.* To evaluate and compare retention of complete cast crown in natural teeth using different auxiliary retentive features with two different crown heights - An *in vitro* study. *Int J Biomed Sci* 2015;11(2):99-106.
25. Junior LR, Baroudi K, Barroso LS *et al.* Bond strength of self-adhesive resin cement to dentin using different adhesion protocols. *J Clin Exp Dent* 2022;14(1):35-9.
26. De Munck J, Van den Steen PE, Mine A *et al.* Inhibition of enzymatic degradation of adhesive-dentin interfaces. *J Dent Res* 2009;88(12):1101-6.
27. Kumar V, Vasunni G, Krishnan C. Effect of immediate dentin sealing in prevention of post-cementation hypersensitivity in full coverage restorations. *J Dent Med Sci* 2015;14(5):3-14.
28. Strassler HE, Morgan RJ. Cements for PFM and all-metal restorations. *Ins Dent* 2013;9(11):1-4.
29. Mann NK, Chahal GK, Singh GJ *et al.* Evaluation of bond strength of resin and non-resin cements to different alloys. *Cureus* 2023;15(3):1-9.
30. Reddy MR, Reddy VS, Basappa N. A comparative study of retentive strengths of zinc phosphate, polycarboxylate and glass ionomer cements with stainless steel crowns - An *in vitro* study. *J Indian Soc Pedod Prev Dent* 2010;28(4):245-50.
31. Tomar SS, Bhattacharyya J, Ghosh S *et al.* Comparative evaluation of bond strength of

- all-metal crowns with different luting agents after undergoing various modes of surface treatments - An *in vitro* study. J Indian Prosthodont Soc 2015;15(4):318-25.
32. Sharma A, Sharma M, Kumar S *et al.* *In vitro* comparative study of bond strength in all-metal crowns using different luting cements and surface treatments. Afr J Biomed Res 2024;27(3):11-8.
33. Powers JM, O'Keefe KL. "Guide to zirconia bonding essentials". Kuraraydental. 2018. https://kuraraydental.com/wpcontent/uploads/2018/05/zirconia_bond_guide-1.pdf.
34. Bender J. A systematic approach for cementing zirconia and lithium disilicate restorations. Chairside Magazine 2023;18(2):1-12.
35. Kim HK, Ahn B. Effect of Al₂O₃ sandblasting particle size on the surface topography and residual compressive stresses of three different dental zirconia grades. Materials 2021;14(3):1-18.
36. Lima RB, Leite JV, do Nascimento JV *et al.* Tribochemical silica-coating or alumina blasting for zirconia bonding? A systematic review of *in vitro* studies. Int J Adhes Adhes 2024;129(2):25-32.
37. Kumar R, Singh MD, Sharma V *et al.* Effect of surface treatment of zirconia on the shear bond strength of resin cement - A systematic review and meta-analysis. Cureus 2023;15(9):1-8.
38. Attia A. Bond strength of three luting agents to zirconia ceramic - Influence of surface treatment and thermocycling. J Appl Oral Sci 2011;19(4):388-95.
39. Gargari M, Gloria F, Napoli E *et al.* Zirconia cementation of prosthetic restorations. Literature review. Oral Implantol 2010;3(4):25-9.
40. Blatz MB, Phark JH, Ozer F *et al.* *In vitro* comparative bond strength of contemporary self-adhesive resin cements to zirconium oxide ceramic with and without air-particle abrasion. Clin Oral Investig 2010;14(2):187-92.
41. Shenoy A, Sivaswamy V, Maiti S. Bonding protocol for all ceramic restorations - A proposal for a clinical decision tree. J Res Med Dent Sci 2022;10(2):90-6.
42. Gre CP, de Re Silveira RC, Shibata S *et al.* Effect of silanization on microtensile bond strength of different resin cements to a lithium disilicate glass ceramic. J Contemp Dent Prac 2016;17(2):149-53.
43. Upadhyaya V, Arora A, Singhal J *et al.* Comparative analysis of shear bond strength of lithium disilicate samples cemented using different resin cement systems: An *in vitro* study. J Indian Prosthodont Soc 2019;19(3):240-7.
44. Alrabeah G, Binhasan F, Al Khaldi S *et al.* Effect of self-adhesive resin cement film thickness on the shear bond strength of lithium disilicate ceramic-cement-tooth triplex. Inorganics 2023;12(1):1-12.
45. Scotti N, Forniglia A, Bergantin E *et al.* Fibre post adaptation and bond strength in oval canals. Int Endod J 2014;47(4):366-72.
46. Peutzfeldt A, Sahafi A, Asmussen E. A survey of failed post-retained restorations. Clin Oral Investig 2008;12(1):37-44.
47. Ghodsi S, Aghamohseni MM, Arzani S *et al.* Cement selection criteria for different types of intracanal posts. Dent Res J 2022;19(1):51-63.
48. Singh N, Garg A, Mittal R. Comparative evaluation of pull-out bond strength of fiber post using different luting cements in endodontically treated teeth - An *in vitro* study. Endod 2021;33(3):165-9.
49. Alshahrani A, Albaqami M, Naji Z *et al.* Impact of different surface treatment methods on bond strength between fiber post and composite core material. Saudi Dent J 2021;33(6):334-41.
50. Jha P, Jha M. Retention of fiber posts in different dentin regions - An *in vitro* study. Ind J Dent Res 2012;23(3):337-40.
51. Mathew S, Raju IR, Sreedev CP *et al.* Evaluation of push out bond strength of fiber post after treating the intra radicular post space with different post space treatment techniques - A randomized controlled *in vitro* trial. J Pharm Bioallied Sci 2017;9(1):197-200.
52. Toman M, Toksavul S, Tamac E *et al.* Effect of chlorhexidine on bond strength between glass-fiber post and root canal dentine after six month of water storage. Eur J Prosthodont Restor Dent 2014;22(1):29-34.
53. Pena Bengoa F, Magasich Arze MC, Macchiavello Noguera C *et al.* Effect of ultrasonic cleaning on the bond strength of fiber posts in oval canals filled with a premixed bioceramic root canal sealer. Restor Dent Endod 2020;45(2):19-27.

54. Alkhudhairy FI, Yaman P, Dennison J *et al.* The effects of different irrigation solutions on the bond strength of cemented fiber posts. *Clin Cosmet Investig Dent* 2018;10(1):221-30.
55. Setcos JC, Staninec M, Wilson NH. Bonding of amalgam restorations - Existing knowledge and future prospects. *Oper Dent* 2000;25(2):121-9.
56. Jasim HH, Gholam MK, Shukri BM. Assessment of the shear bond strength of composite resin to fresh amalgam using different adhesion protocols - An *in vitro* study. *Dent Hypotheses* 2022;13(3):94-8.
57. Ozcan M, Volpato CA. Repair protocol for amalgam fillings with and without cusp fracture - How and why? *J Adhes Dent* 2016;18(4):364-5.
58. Popoff DA, Goncalves FS, Magalhaes CS *et al.* Repair of amalgam restorations with composite resin and bonded amalgam - A microleakage study. *Indian J Dent Res* 2011;22(6):799-803.
59. Somani R, Jaidka S, Singh DJ *et al.* Comparative evaluation of shear bond strength of various glass ionomer cements to dentin of primary teeth - An *in vitro* study. *Int J Clin Pediatr Dent* 2016;9(3):192-6.
60. McCaghren RA, Retief DH, Bradley EL *et al.* Shear bond strength of light-cured glass ionomer to enamel and dentin. *J Dent Res* 1990;69(1):40-5.
61. Gordan VV, Riley JL, Rindal DB *et al.* Repair or replacement of restorations - A prospective cohort study by dentists in the national dental practice-based research network. *J Am Dent Assoc* 2015;146(12):895-903.
62. Poggio C, Beltrami R, Scribante A *et al.* Effects of dentin surface treatments on shear bond strength of glass-ionomer cements. *Ann Stomatol* 2014;5(1):15-22.
63. Maneenut C, Sakoolnamarka R, Tyas MJ. The repair potential of resin-modified glass-ionomer cements. *Dent Mater* 2010;26(7):659-65.
64. Garbim JR, Laux CM, Kim SJ *et al.* Can repair increase the survival of failed restorations when compared with replacement? A systematic review and meta analysis. *Res Sq* 2022;5(2):1-8.
65. Barkmeier WW, Erickson RL. Shear bond strength of composite to enamel and dentin using scotchbond multi-purpose. *Am J Dent* 1994;7(3):175-9.
66. Lehmann A, Nijakowski K, Jankowski J *et al.* Clinical difficulties related to direct composite restorations - A multinational survey. *Int Dent J* 2025;75(2):797-806.
67. Andersson IE, Van Dijken JW, Horstedt P. Modified class II open sandwich restorations - Evaluation of interfacial adaptation and influence of different restorative techniques. *Eur J Oral Sci* 2002;110(3):270-5.
68. Opdam NJ, VanBeek V, VanBeek W *et al.* Long term clinical performance of 'open sandwich' and 'total-etch' class II composite resin restorations showing proximal deterioration of glass-ionomer cement. *Dent Mater* 2023;39(9):800-6.
69. Dionysopoulos D, Gerasimidou O. Biomimetic dentistry - Basic principles and protocols. *J Dent Sci* 2020;5(3):1-3.

How to cite this article: Anjali Gupta, Sachin Gupta, Vineeta Nikhil. Restorative dentistry bonding strategies: a narrative analysis. *International Journal of Research and Review*. 2025; 12(6): 614-622. DOI: <https://doi.org/10.52403/ijrr.20250669>
