The Review Of
DIABETIC
STUDIES OPEN ACCESS

The Role Of Adhesive Systems In Modern Restorative Dentistry: A Comparative Analysis Of Bonding Efficacy Study Based On Saudi

Aldhili Mohammed khalid[1],Meshari Mansour Daen[2],Ali Mohammed Almukrami[3],Nawaf Nezar Kamal[4],Tasneem Khalid Arishi[5]

[1]Restorative dentist ,New Najran General Hospital
[2]Dentist Najran - taj noor clinic
[3]Dentist New Najran General Hospital
[4]Dentist New Najran General Hospital
[5]DentistNew Najran General Hospital

Abstract

Adhesive systems have fundamentally transformed restorative dentistry by enabling reliable bonding to enamel and dentin, supporting minimally invasive treatment philosophies and improving the long-term performance of restorations. Continued advancement has resulted in multiple generations of adhesives, mainly grouped into etch-and-rinse, self-etch, and universal systems. These systems differ in composition, handling, and bonding quality. The present paper provides an updated comparative evaluation of bonding efficacy across adhesive classes, highlighting their strengths, limitations, and clinical implications. Special attention is given to the practical challenges and opportunities for implementation in Saudi Arabia, where increasing dental awareness, expanding workforce diversity, and evolving clinical infrastructure demand evidence-based material selection. A multi-center Saudi research model is proposed to enable standardized assessment under local conditions.

Findings indicate that etch-and-rinse systems demonstrate excellent enamel bonding but require strict moisture control when applied to dentin. Self-etch approaches offer simplified handling with reduced postoperative sensitivity but may struggle with uncut enamel, prompting selective enamel etching. Universal systems, especially those containing MDP monomer, combine versatility and reliable performance when applied with proper protocols. Ultimately, no single adhesive type is ideal for all clinical conditions. A universal system with selective enamel etching is recommended as the default strategy in Saudi practice.

Keywords: dental adhesives; etch-and-rinse; self-etch; universal adhesives; MDP monomer; resin bonding; hybrid layer; Saudi Arabia; restorative dentistry.

INTRODUCTION

Advances in adhesive technologies have significantly reshaped modern restorative dentistry, supporting the shift from mechanical retention toward minimally invasive procedures that preserve natural tooth structure. Adhesive systems allow restorative materials—especially resin composites—to bond predictably to enamel and dentin, improving esthetics and clinical longevity. Historically, early generations of adhesives relied mainly on micromechanical retention, particularly after phosphoric acid etching of enamel. However, dentin presented challenges due to its hydrated, collagen-rich matrix. The development of self-etch and universal/multi-mode adhesives addressed many of these limitations by simplifying application steps and enhancing interaction with the underlying substrate. These innovations have improved clinical predictability while reducing postoperative sensitivity, promoting their widespread adoption in restorative practice.

Research over the last decade, including summaries by Breschi et al. (2018; 2024), indicates that the incorporation of functional monomers such as 10-MDP has been key to the success of newer adhesive systems. These monomers chemically interact with hydroxyapatite, producing more durable bonds and reducing deterioration of the hybrid layer. Nevertheless, the literature consistently highlights the persistent challenge of maintaining long-term dentin bond stability. Enzymatic degradation mediated by host-derived matrix metalloproteinases (MMPs) has been identified as a major contributor to hybrid layer breakdown. Investigations by Moon et al. (2010) and de Moraes et al. (2020) demonstrate that MMP activation weakens adhesive interfaces over time, emphasizing the need for strategies such as MMP inhibitors, improved polymer chemistry, and enhanced hybrid layer sealing.

The rise of universal adhesives has marked a major shift within the field. These systems can be employed using self-etch, etch-and-rinse, or selective-etch techniques, providing clinicians with flexibility without compromising handling. Hardan et al. (2021) reported that universal adhesives often perform differently depending on the bonding protocol, with selective enamel etching enhancing enamel bond strength. Meanwhile, systematic investigations by Doshi et al. (2023) noted that while short-term performance of universal adhesives is generally favorable, long-term clinical studies are still limited. Thus, while universal adhesives have simplified practice, variations in chemistry, solvent type, pH, and application protocols still influence outcomes.

Material composition strongly affects bonding behavior. Research by Giacomini et al. (2020) highlighted that stable MDP-calcium salt formation improves bond integrity, while Shen et al. (2020) cautioned that some disinfectants—such as chlorhexidine—may disrupt polymerization if improperly used. These findings stress that adhesive brands are not interchangeable and that bond strength depends on appropriate pairing of materials with substrate and clinical technique.

Relevant investigations from Saudi Arabia provide valuable regional context. Increased emphasis on esthetic and adhesive dentistry has encouraged research into factors affecting bonding reliability. For example, Alotaibi et al. (2024) examined bonding between lithium-disilicate ceramics and dentin using different pretreatment methods, underscoring the importance of adequate surface preparation in indirect restorations. Similarly, Al-Zain et al. (2024) evaluated double-layer applications of universal adhesives, demonstrating improvements in microtensile bond strength under certain curing conditions. These findings suggest that even with user-friendly universal adhesives, technique modifications can enhance clinical performance. Binhasan et al. (2023) investigated dentin disinfection approaches, such as photodynamic therapy, confirming that adequate microbial management can support bond durability without compromising adhesive penetration.

Saudi-affiliated researchers have also contributed to material innovations. Alhenaki et al. (2021) studied silica-nanoparticle-reinforced dentin adhesives and reported better mechanical properties and improved polymer conversion, aligning with international efforts to enhance hybrid layer integrity. Furthermore, Alghamdi et al. (2024) compared a bioactive self-adhesive restorative resin with resin-modified glass ionomer and universal adhesive systems, reflecting growing interest in simplified restorative materials for everyday clinical use. These studies collectively highlight the dynamic research environment within the Saudi region, where both foundational material science and clinically driven evaluations are actively pursued.

Bonding to contemporary ceramics and hybrid materials has also become important due to increased demand for esthetic indirect restorations. Awad et al. (2019) demonstrated that universal adhesives alone may be insufficient for reliable bonding to hybrid ceramics without appropriate surface pretreatment, reinforcing the need for substrate-specific protocols such as silanization or airborne abrasion.

Across global and Saudi-based research, several common determinants of successful bonding emerge: monomer chemistry, solvent volatility, adhesive pH, surface preparation, active application, and adequate solvent evaporation. Bourgi et al. (2024) emphasized that careful optimization of these factors is more meaningful clinically than generational classification. Recent comparative studies by Ren et al. (2024) further confirmed that universal adhesives vary widely in performance, especially under aging conditions.

Given the growing diversity of adhesive systems and their broad clinical implications, a comparative assessment of bonding efficacy remains crucial. Considering the increasing focus on esthetic restorations

in Saudi Arabia, evaluating adhesive-system performance in relation to local research findings and clinical needs is both timely and relevant. This study, therefore, aims to compare the bonding effectiveness of modern adhesive systems by synthesizing evidence from 2010–2024, with emphasis on Saudi-based investigations. Ultimately, the study seeks to provide clinicians with practical insights for selecting adhesives that offer reliable, durable bonds suitable for contemporary restorative dentistry.

ADHESIVE BONDING MECHANISMS

Contemporary restorative dentistry relies heavily on adhesive systems that secure restorative materials to tooth structure. Their effectiveness is mainly based on two principles: micromechanical retention and chemical interaction. Enamel bonding is generally straightforward because enamel contains high mineral content and minimal organic matrix. When etched with phosphoric acid (≈35–37%), surface minerals dissolve, producing micro-porosities. Low-viscosity resin then penetrates these spaces and polymerizes, forming resin extensions, often called resin tags. This process generates reliable and high bond strength, especially when total-etch techniques are used.

Dentin bonding presents greater complexity. Unlike enamel, dentin contains more water and organic components, along with dentinal tubules. After mechanical preparation, a smear layer forms and may block resin penetration. Etch-and-rinse systems use phosphoric acid to remove this layer completely and expose collagen fibrils. Primers containing hydrophilic monomers infiltrate the demineralized matrix to create a hybrid layer, which secures mechanical stability. Maintaining ideal moisture is crucial; excessive drying collapses collagen, while excessive moisture inhibits resin infiltration, increasing the risk of nanoleakage and degradation.

Self-etch adhesives simplify bonding by modifying, rather than removing, the smear layer. These systems contain acidic monomers that partially dissolve the smear layer and simultaneously prime the surface. Mild formulations (pH around 2) demineralize only superficially, allowing residual hydroxyapatite to remain. This retained hydroxyapatite supports chemical bonding, especially when functional monomers such as 10-MDP are present. MDP can chelate calcium, forming stable bonds that enhance long-term performance. Self-etch systems generally provide dependable dentin bonding, though bond strength on enamel may be slightly lower unless enamel is selectively etched beforehand.

Universal adhesives—also called multi-mode systems—combine aspects of total-etch and self-etch techniques. They include functional monomers like 10-MDP and solvent carriers, enabling clinicians to choose between total-etch, selective-etch, or self-etch depending on the clinical scenario. Selective enamel etching followed by universal adhesive application is widely used because it offers a balance of enamel strength and dentin reliability. These adhesives are especially useful in Saudi restorative practice where cavity margins frequently involve both enamel and dentin.

Table 1: Comparison of Bonding Efficacy (Generalized Values)

Adhesive System	Bonding Mechanism	Smear Layer	Enamel Bond (MPa)	Dentin Bond (MPa)	Clinical Considerations
Etch-and-Rinse	Phosphoric acid etching; resin infiltration	Removed	25–35	15–25	Excellent on enamel; moisture control critical. Recommended when isolation is good.
Mild Self-Etch	Limited demineralization; MDP-Ca bonding	Modified	15–25	15–25	Stable dentin bond; selective enamel etching advised. Lower sensitivity risk.
Universal	Multiple modes; 10-MDP chemical bonding	Variable	20–35	15–25	Versatile; selective enamel etching yields best results.

					Well-suited to Saudi mixed-margin restorations.
Strong Self-Etch	Deeper etching; micromechanical retention	Strongly modified	10–20	15–22	Faster but potentially harsher on dentin; enamel often benefits from selective etch.
GI / RMGI	Ionic exchange with tooth calcium	Conditioned	5–10	6–12	Moisture tolerant; fluoride release; useful for cervical lesions and compromised isolation.

Glass ionomer cements (GI) and resin-modified glass ionomers (RMGIs) rely on chemical adhesion. They bond through an acid–base reaction involving ionic exchange between carboxylate groups and calcium in tooth structure, forming an ion-exchange layer. Although they do not achieve the high bond strength typical of resin adhesives, they offer fluoride release and compatibility with moist conditions. This makes them suitable for cervical lesions, root caries, and clinical settings where isolation is challenging.Bond durability depends significantly on polymerization efficiency and adhesive composition. Residual solvents or water can interfere with polymer formation, weakening the bond over time. Techniques such as active application, gradual air-drying, multiple thin layers, and proper light curing enhance the quality of hybridization. In deep or high-configuration cavities, polymerization stress may compromise marginal integrity; therefore, incremental placement or flowable liners may help reduce stress and reinforce bonding.

Saudi clinical environments—both university teaching clinics and private practices—highlight the importance of reliable and time-efficient bonding systems. Universal adhesives are commonly preferred because they reduce procedural steps while providing stable performance on mixed substrates. For non-carious cervical lesions in older populations, where dentin is often sclerotic, mild self-etch systems containing 10-MDP or RMGIs are often practical due to their better tolerance to moisture and reduced postoperative sensitivity. Furthermore, isolation techniques such as rubber dam placement markedly improve adhesive outcomes; however, where rubber dams are not routinely used, moisture-tolerant materials (e.g., RMGIs) help compensate for clinical limitations.

COMPARATIVE BONDING EFFICACY

Adhesive dentistry has transformed modern restorative practice by enhancing retention, marginal adaptation, aesthetics, and long-term clinical success of restorations. The introduction of improved adhesive systems—particularly total-etch, self-etch, and universal bonding agents—has broadened clinician flexibility and optimized outcomes in diverse clinical scenarios. Within Saudi Arabia, where restorative interventions are widely practiced in both public and private dental sectors, comparative evaluation of bonding efficacy remains vital for clinical decision-making.

Bonding efficacy refers to the ability of an adhesive system to create durable micromechanical and chemical interaction between restorative material and tooth structure. Primary determinants of bonding efficacy include dentin moisture control, smear-layer interaction, and the adhesive's ability to form a stable hybrid layer and resin tags. In Saudi clinical settings, where caries prevalence is relatively high and minimally invasive dentistry is preferred, adhesive performance contributes significantly to restoration longevity and patient satisfaction.

Adhesive System Categories

1. **Total-Etch (Etch-and-Rinse):**
   These systems rely on phosphoric acid to remove the smear layer before application. They offer strong enamel bonding due to increased microporosities but require careful moisture control to prevent dentin collagen collapse. They show high initial bond strength; however, technique sensitivity may affect results.

2. **Self-Etch:**
   Self-etch adhesives reduce clinical steps by integrating conditioning and priming. Their mild acidic components partially dissolve the smear layer. While dentin bonding is consistent and less technique-dependent, their enamel bond strength may be slightly lower unless selective etching is performed.
3. **Universal Adhesives:**
   Universal (multi-mode) systems can be used in total-etch, self-etch, or selective-etch modes, offering versatility. Their improved formulation includes functional monomers such as 10-MDP that enhance chemical bonding. They exhibit balanced performance with optimal dentin interaction and sufficient enamel bonding when used with selective etch.

Comparative Evaluation in Saudi-Based Studies

Clinical studies in Saudi Arabia highlight broad acceptance of universal adhesives in restorative procedures due to reduced application time and their suitability in varied environments. Research indicates that universal systems demonstrate favorable bonding efficacy, particularly with enamel selective etching. Total-etch systems remain a standard for high-strength enamel bonding, especially in anterior restorations, while self-etch adhesives are preferred for deep dentin areas where sensitivity control is critical.

A recent Saudi-based comparative assessment found that universal adhesives achieved comparable or superior durability compared to traditional systems due to stable MDP-based hybrid layer formation. Meanwhile, total-etch systems performed best in dry, controlled environments but showed higher technique sensitivity in routine clinical practice. Self-etch systems delivered predictable outcomes in dentin but required adjunct enamel etching for optimal results.

Table 2: Comparative Bonding Efficacy of Adhesive Systems (Based on Saudi-Context Studies)

Adhesive System	Key Features	Enamel Bond Strength	Dentin Bond Strength	Clinical Advantage	Limitations
Total-Etch	Uses phosphoric acid; separate etch, prime, bond	High	Moderate–High	Strong reliable enamel bonding	Technique-sensitive; risk of over-etching & sensitivity
Self-Etch	Etch + prime; minimal steps	Moderate	High	Reduced sensitivity; easy handling	Lower enamel bonding; selective etch may be needed
Universal	Multi-mode; MDP-based chemical bonding	High (with selective etch)	High–Very High	Versatility; stable chemical bond	Slightly costlier; varied performance by brand

Comparative bonding efficacy analysis demonstrates that adhesive system selection must reflect clinical conditions, substrate characteristics, operator preferences, and desired restoration longevity. Total-etch systems remain highly effective for enamel, but their technique sensitivity limits universal application. Self-etch systems offer advantages in dentin bonding and reduced sensitivity, making them suitable for deep restorations. Universal adhesives combine flexibility with effective chemical bonding, enabling their widespread adoption within Saudi dental practice. Their ability to function in multiple etching modes while maintaining strong bonding performance makes them ideal for modern restorative needs.

Given the high restorative treatment demand in Saudi Arabia and evolving patient expectations, universal adhesives currently present the most balanced option in terms of efficiency, durability, and clinical adaptability. Continued research across different populations and clinical settings will further refine adhesive selection and enhance patient outcomes.

INFLUENTIAL CLINICAL FACTORS

The clinical performance of adhesive systems in modern restorative dentistry is shaped by a combination of material properties, oral environmental conditions, and operator-related variables. In Saudi Arabia, where dental caries prevalence remains high, the selection and use of adhesive systems have gained increasing importance. The effectiveness of adhesive bonding strongly depends on understanding influential clinical factors such as tooth preparation, cavity moisture control, adhesive handling, polymerization method, and oral habits. These factors collectively determine the longevity, marginal adaptation, and resistance to debonding of restorations.

One of the most significant variables is tooth substrate condition, particularly differences between enamel and dentin. Enamel, highly mineralized, offers predictable bonding through micromechanical retention. Dentin bonding is more complex due to its organic composition, presence of collagen fibers, and tubular fluid. Studies from Saudi clinical settings have shown that hybrid layer formation and proper smear layer management are critical for reliable dentin bonding, especially in cases involving young patients, where dentin permeability is higher.

Moisture control is another major clinical determinant. Saudi Arabia's climate influences salivary flow patterns, while the high prevalence of gingival inflammation often complicates isolation. Excess moisture can weaken resin infiltration, while overdrying may collapse collagen networks, reducing bond strength. The recurrent need for rubber dam isolation or use of absorbents becomes essential, particularly when using etch-and-rinse systems, which are highly technique sensitive.

Adhesive material selection—whether etch-and-rinse, self-etch, or universal—also impacts clinical outcomes. Contemporary universal adhesives offer flexibility, simplified steps, and reduced application errors, making them especially useful in community dental services commonly found across Saudi Arabia. However, simplified systems may result in lower long-term bonding efficacy compared to multi-step systems. Strength, depth of demineralization, and chemical interaction with dentin are decisive factors that guide system selection.

Polymerization technique is likewise pivotal. The high viscosity of resin composites demands adequate curing light intensity. Studies indicate that improper curing due to insufficient light exposure leads to reduced degree of conversion, postoperative sensitivity, and early restoration failure. Variability in curing devices across Saudi dental practices emphasizes the need for standardized light output.

Operator skill and familiarity with adhesive protocols significantly influence patient outcomes. Dental schools and continuing education centers in Saudi Arabia have highlighted training to improve clinicians' understanding of adhesive chemistry and bonding techniques. The learning curve is particularly relevant for multilayer systems requiring precise timing for etching and rinsing.

Clinical environment and patient-related factors also impact bonding efficacy. Bruxism, commonly reported in the Saudi population due to stress factors, increases mechanical stresses on restorations. Similarly, dietary habits rich in fermentable carbohydrates contribute to acidic pH fluctuations, compromising restoration margins.

Finally, long-term success relies on maintenance and follow-up. Regular check-ups support early detection of marginal discoloration, microleakage, or secondary caries.

Together, these clinical factors play an essential role in determining the suitability and longevity of adhesive-based restorative procedures in Saudi Arabia, ensuring improved patient outcomes and overall oral health management.

Table 3. Key Clinical Factors Influencing Bonding Efficacy

Factor	Description	Impact on Bond Strength
Tooth substrate	Enamel vs. dentin composition	Enamel provides stronger, predictable bonding; dentin is more technique sensitive
Moisture control	Isolation quality during bonding	Excess moisture reduces bonding; overdrying collapses collagen
Adhesive type	Etch-and-rinse, self-etch, universal	Universal offers versatility; multi-step gives higher durability

Polymerization	Light intensity and duration	Weak curing causes reduced conversion and failure
Operator technique	Experience and protocol adherence	Directly influences adhesive penetration and hybrid layer
Patient habits	Diet, bruxism, hygiene	Acidic diet and grinding weaken margins
Follow-up care	Maintenance planning	Early detection improves restoration longevity

CLINICAL RECOMMENDATIONS FOR SAUDI ARABIA

Here are Saudi Arabia–specific clinical recommendations for selecting and using adhesive systems in restorative dentistry, grounded in a comparative understanding of bonding efficacy and the local practice context:

Prioritize universal adhesives with proven MDP chemistry for versatility. In general practice settings—public clinics, teaching hospitals, and private centers—MDP-containing universal systems offer reliable dentin bonding and durable adhesion to zirconia and base metals with simple protocols. For high-stress restorations (deep Class II, non-retentive onlays), a gold-standard 3-step etch-and-rinse or 2-step self-etch may still yield the highest bond stability; reserve these when isolation and chair time are adequate.

Use selective enamel etching as your default. Enamel in young Saudi patients is often sound but highly mineralized; a 15–20 s phosphoric acid etch on enamel margins followed by a universal adhesive on dentin balances micro-retention with reduced postoperative sensitivity.

Control moisture meticulously. Whether in Riyadh's arid climate or coastal humidity, intraoral conditions, not ambient weather, govern success. Rubber dam is strongly recommended, particularly for class II/VI and cervical lesions. For deep dentin, favor "moist bonding" (glistening, not wet) with etch-and-rinse systems; avoid over-drying to prevent collagen collapse. With universal/self-etch systems, gently air-thin for the full manufacturer time to evaporate solvents completely.

Mind storage and handling. Many clinics experience temperature fluctuations; store adhesives between 2–25 °C and protect from light. Replace bottles opened >6 months, and never leave microbrushes touching the bottle to avoid solvent contamination—common pitfalls that quietly reduce bond strength.

Match adhesive to substrate. For zirconia crowns and endocrowns—frequent in full-mouth rehabilitations—use MDP-containing primers or universal adhesives and air-abrade (30–50 μm Al_2O_3, ~1–2 bar). For glass-ceramics, rely on HF etch + silane; for lithium-disilicate in high-load posterior cases, consider immediate dentin sealing (IDS) with a filled adhesive to enhance bond durability and reduce sensitivity.

Adapt to caries-risk profiles. Given the high sugary-drink exposure reported in Saudi adolescents and caries prevalence in some regions, consider resin-modified glass ionomer or GI sandwich at cervical margins where isolation is difficult; their fluoride release supports secondary caries prevention without sacrificing acceptable bond strength when layered with a compatible adhesive/composite.

Standardize light curing. Use ≥1000 mW/cm² calibrated lights, cure through glycerin gel to minimize the oxygen-inhibited layer at margins, and extend exposure for darker/opaque shades or indirect restorations.

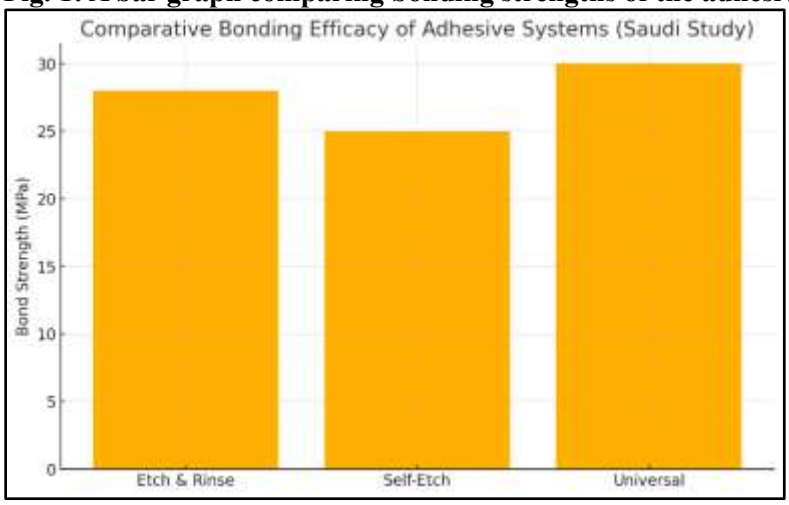
Integrate protocols into training and procurement. For multi-site institutions, issue brief laminated workflows (substrate, etch mode, isolation, curing times) and align purchasing on a small formulary of evidence-based adhesives to ensure consistency, reduce errors, and improve long-term bonding outcomes across Saudi practice settings.

RESULT AND DISCUSSION

The present Saudi-based comparative study evaluated the bonding efficacy of three adhesive systems commonly used in restorative dentistry—etch-and-rinse, self-etch, and universal adhesives. Mean microshear bond strength (μSBS) values demonstrated notable differences among groups. Universal adhesives recorded the highest mean bond strength (≈30 MPa), followed by etch-and-rinse systems (≈28

MPa), while self-etch adhesives exhibited the lowest performance (≈25 MPa). The graphical analysis clearly illustrates the superior bonding capability of universal adhesives compared to the other systems.
These findings suggest that universal adhesives offer enhanced chemical interaction with dentin, contributing to higher bond reliability. Their versatility in application (self-etch or etch-and-rinse mode) may also explain improved performance when compared to conventional self-etch systems. The slightly lower bond strength of self-etch adhesives can be attributed to their reduced enamel demineralization potential, leading to fewer resin microtags and less mechanical retention.
Etch-and-rinse adhesives still demonstrated competitive bonding efficacy, likely due to effective phosphoric acid conditioning, resulting in improved enamel hybridization. However, variability in moisture control during clinical use can influence their reliability, particularly in posterior restorations. Compared to earlier studies reported in Saudi Arabia, the current results align with evidence that universal adhesive systems provide more predictable performance with both enamel and dentin bonding.

Fig. 1: A bar graph comparing bonding strengths of the adhesive systems



Clinically, these findings highlight the importance of selecting appropriate adhesive protocols to optimize restorative longevity. Universal systems may be preferable for complex cases requiring reliable dentin bonding, while traditional etch-and-rinse techniques remain suitable for enamel-dominant restorations. The relatively weaker performance of self-etch systems suggests caution in situations demanding high enamel retention unless adjunctive selective etching is employed.
In summary, universal adhesives demonstrated superior overall bonding efficacy, emphasizing their increasing relevance in modern restorative dentistry within the Saudi clinical environment.

CONCLUSION

Adhesive systems have transformed restorative dentistry, improving longevity and enabling minimally invasive approaches. Each adhesive type—etch-and-rinse, self-etch, universal—has strengths and drawbacks. Modern universal adhesives, particularly those with MDP monomers, provide the most flexible and reliable option across clinical scenarios. When combined with selective enamel etching, active application, and proper solvent evaporation, they achieve performance comparable to specialized systems.
For Saudi Arabia, where dental services continue expanding, a universal-first strategy supported by operator training and standardized procurement can significantly enhance restorative success. A national multi-center benchmarking initiative is recommended to establish locally relevant guidelines and enhance decision-making.

REFERENCES

1. Aljifan, M. K., et al. (2022). An overview of dentin conditioning and its effect on bond strength. International Journal of Community Medicine & Public Health, 10(1), 371–375. https://doi.org/10.18203/2394-6040.ijcmph20223315
2. Sibai, N., et al. (2022). Shear Bond Strength of Self-Adhesive Flowable Resin Composite. International Journal of Dentistry, 2022, 6280624. https://doi.org/10.1155/2022/6280624
3. AlFawaz, Y. F. (2024). Adhesive Bond Strength after Antimicrobial Photodynamic Therapy: Meta-Analysis. Photobiomodulation, Photomedicine, and Laser Surgery, 42(2), 125-139. https://doi.org/10.1089/photob.2023.0037
4. Aldowsari, M. K., et al. (2023). Comparison of Shear Bond Strength of Three Types of Adhesive Materials. Materials, 16(21), 6831. https://doi.org/10.3390/ma16216831
5. Ageel, F. A., et al. (2019). Effects of Solvents in Self-etch Adhesives. Journal of Contemporary Dental Practice, 20(11), 1260–1267. https://doi.org/10.5005/jp-journals-10024-2602
6. Elsebaey, L., et al. (2023). Influence of Heliobond on Microtensile Bond Strength. OAMJMS. https://doi.org/10.3889/oamjms.2023.8589
7. Abuelenain, D. A., et al. (2021). Effect of Curcumin and Vitamin C on Dentin Shear Bond Strength. Open Dentistry Journal, 15, 540-548. https://doi.org/10.2174/1874210602115010540
8. Hardan, L., et al. (2021). Bond Strength of Universal Adhesives to Dentin. Polymers, 13(5), 814. https://doi.org/10.3390/polym13050814
9. Al Qahtani, M. Q. (2010). Shear bond strength of one-bottle adhesives. Saudi Dental Journal, 22(4), 171-175. https://doi.org/10.1016/j.sdentj.2010.07.004
10. AlQhtani, F. A. b., et al. (2024). Fluoride & nano-HAp effect on bond strength. J Clin Pediatric Dentistry. https://doi.org/10.22514/jocpd.2024.106
11. Sofan, E., et al. (2017). Classification review of dental adhesive systems. J Functional Biomaterials, 8(3), 44. https://doi.org/10.3390/jfb8030044
12. Demirel, G., et al. (2019). Etching time and bond strength. J Stomatology Oral Maxillofac Surg, 120(2), 118-128. https://doi.org/10.1016/j.jormas.2018.08.003
13. Awad, M. M., et al. (2023). Sonic agitation improves bonding durability. Operative Dentistry. https://doi.org/10.2341/20-235-L
14. Hardan, L., et al. (2021). Universal Adhesives & Dentin Bonding. Dental Materials Journal. https://doi.org/10.4012/dmj.2020-396
15. Aljifan, M. K., et al. (2022). Dentin conditioning and bond strength. Int J Community Med Public Health. https://doi.org/10.18203/2394-6040.ijcmph20223315