

COMPARISON OF UNIVERSAL ADHESIVES WITH OTHER CONTEMPORARY ADHESIVES: A NARRATIVE REVIEW

COMPARAÇÃO ENTRE ADESIVOS UNIVERSAIS E OUTROS ADESIVOS
ATUAIS: UMA REVISÃO NARRATIVA

COMPARACIÓN DE LOS ADHESIVOS UNIVERSALES CON OTROS ADHESIVOS
ACTUALES: UNA REVISIÓN NARRATIVA

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ABSTRACT

The evolution of adhesive systems has brought great advances to dentistry, enabling a more conservative approach to carious tissue removal, as well as even more efficient adhesion. Conventional, self-etch, and universal adhesives are available on the market. Universal adhesives have offered the potential for reduced chair time, simplified techniques, and bonding to substrates beyond just enamel and dentin. This study aims to compare universal adhesives with other adhesive systems, based on a review of the literature published in English in the PubMed, Embase, Scopus, and Web of Science databases between 2020 and 2026, evaluating bond strength, marginal adaptation, secondary caries, and postoperative sensitivity. Following screening, 12 studies were included in the review. The results highlighted a predominance of bond strength assays as the most explored laboratory parameter to determine adhesive efficacy. Furthermore, the necessity of selective or total acid etching on enamel to avoid technical compromise of universal adhesives also became clear, alongside the high predictability of the self-etching mode in dentin, especially when associated with the chemical stability promoted by the 10-MDP monomer. Based on the analyzed articles, universal adhesives, in enamel and dentin,

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achieved satisfactory performance; although selective etching remains necessary on enamel, this material appears to be an advantageous alternative for the practitioner.

Keywords: Enamel. Dentin. Universal Adhesives.

RESUMO

A evolução dos sistemas adesivos trouxe grandes avanços à odontologia, permitindo uma abordagem mais conservadora na remoção de tecido carioso, bem como uma adesão ainda mais eficiente. No mercado, estão disponíveis adesivos convencionais, de autogravação e universais. Os adesivos universais oferecem o potencial de reduzir o tempo de atendimento, simplificar as técnicas e proporcionar adesão a substratos além do esmalte e da dentina. Este estudo tem como objetivo comparar os adesivos universais com outros sistemas adesivos, com base em uma revisão da literatura publicada em inglês nas bases de dados PubMed, Embase, Scopus e Web of Science entre 2020 e 2026, avaliando a resistência de adesão, a adaptação marginal, a cárie secundária e a sensibilidade pós-operatória. Após a triagem, 12 estudos foram incluídos na revisão. Os resultados destacaram a predominância dos ensaios de resistência de adesão como o parâmetro laboratorial mais explorado para determinar a eficácia do adesivo. Além disso, ficou clara a necessidade de condicionamento ácido seletivo ou total no esmalte para evitar comprometimento técnico dos adesivos universais, juntamente com a alta previsibilidade do modo de autocondicionamento na dentina, especialmente quando associado à estabilidade química promovida pelo monômero 10-MDP. Com base nos artigos analisados, os adesivos universais, tanto no esmalte quanto na dentina, alcançaram desempenho satisfatório; embora a condicionamento seletivo continue sendo necessário no esmalte, esse material parece ser uma alternativa vantajosa para o profissional.

Palavras-chave: Esmalte. Dentina. Adesivos Universais.

RESUMEN

La evolución de los sistemas adhesivos ha supuesto grandes avances para la odontología, lo que ha permitido un enfoque más conservador en la eliminación del tejido carioso, así como una adhesión aún más eficaz. En el mercado se encuentran disponibles adhesivos convencionales, de autograbado y universales. Los adhesivos universales han ofrecido la posibilidad de reducir el tiempo de tratamiento, simplificar las técnicas y lograr la adhesión a sustratos más allá del esmalte y la dentina. El objetivo de este estudio es comparar los adhesivos universales con otros sistemas adhesivos, basándose en una revisión de la literatura publicada en inglés en las bases de datos PubMed, Embase, Scopus y Web of Science entre 2020 y 2026, evaluando la resistencia de la unión, la adaptación marginal, la caries secundaria y la sensibilidad postoperatoria. Tras la selección, se incluyeron 12 estudios en la revisión. Los resultados pusieron de relieve el predominio de los ensayos de resistencia de la unión como el parámetro de laboratorio más explorado para determinar la eficacia adhesiva. Además, quedó clara la necesidad de un grabado ácido selectivo o total en el esmalte para evitar problemas técnicos con los adhesivos universales, junto con la alta previsibilidad del modo autograbante en la dentina, especialmente cuando se asocia a la estabilidad química que proporciona el monómero 10-MDP. Según los artículos analizados, los adhesivos universales, tanto en el esmalte como en la dentina, obtuvieron resultados satisfactorios; aunque el grabado selectivo sigue siendo necesario en el esmalte, este material parece ser una alternativa ventajosa para el odontólogo.

Palabras clave: Esmalte. Dentina. Adhesivos Universales.



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INTRODUCTION

The development of adhesive dentistry and the evolution in the ways of performing restorations have their initial landmark in the establishment of the principle of acid etching of enamel to promote micromechanical bonding. This altered the clinical practice of macro-retentive preparations to a minimally invasive approach based on adhesion. Since then, research has focused on the complex task of extending this reliable bond from what is obtained in enamel to that of dentin, resulting in the diversity and evolution of adhesive systems (Van Meerbeek, 2020).

The types of adhesives currently available on the market can be classified as conventional, self-etching, and universal. Conventional adhesives can be divided into 3 steps (acid, primer, and adhesive) or 2 steps, where the acid and primer combine, followed by the adhesive (de Freitas Matos; de Lavor; Fontes, 2021). One- or two-step self-etching adhesives aimed to optimize etching and rinsing (Kitahara *et al*, 2024), as they eliminate the need for dentin etching, although selective enamel etching is still required. Universal adhesives combine all the elements of adhesive systems in one bottle, making the procedure faster compared to previous adhesives and allowing the professional to choose which technique to use, either self-etching or selective enamel etching (Peumans *et al*, 2023).

Universal adhesives were developed with the aim of optimizing procedures without compromising bond strength, in addition to adapting to the needs of each dental substrate (Ren; Wang; Zhu, 2024). These factors have led to this type of adhesive gaining the attention of dental surgeons. Their composition generally contains the monomer 10-metacryloyloxydecyl-dihydrogen phosphate (10-MDP), which allows for a strong chemical interaction with hydroxyapatite, consequently resulting in increased bond strength. This is a characteristic that sets universal adhesives containing this monomer apart (Fehrenbach; Isolan; Münchow, 2021).

There is no consensus in the literature regarding the actual equivalence in performance among conventional, self-etch, and universal adhesives; however, according to Matijević *et al.* (2026), a comparison of the bond strength to sound dentin between a two-step self-etch adhesive

and a universal adhesive, both applied in self-etch mode, revealed that the two-step system outperformed the universal one. This finding underscores the need for a critical, comparative analysis of these adhesive categories, given that each adhesive possesses unique characteristics and specific clinical applications.

This study is a narrative literature review that aims to present, analyze, and critically discuss the available scientific production on the comparison between universal adhesives with the other adhesives systems, focusing on analyzing the performance of both in characteristics such as the occurrence of secondary caries, postoperative sensitivity, marginal adaptation, and bond strength. A narrative review approach was adopted to allow for a broader, more interpretive approach to the topic, making it possible to integrate different types of studies, with an emphasis on theoretical contextualization and the construction of a critical analysis.

METHODOLOGY

The literature search was conducted by two reviewers (A.C.L. and M.T.) in the following databases: Scopus, PubMed, Embase, and Web of Science. The search period was restricted to publications between 2020 and 2026. The search was performed using the following descriptors: enamel, dentin, and universal adhesives. Regarding the inclusion criteria, the following were considered: full-length original scientific articles published in English; a publication period restricted to the years 2020–2026; studies conducted on sound permanent teeth (*in vitro* or *in vivo*); studies comparing universal, self-etch, and/or conventional adhesive systems on sound enamel and dentin; and articles evaluating at least one of the outcomes of interest, namely: bond strength, marginal adaptation, secondary caries, or postoperative sensitivity.

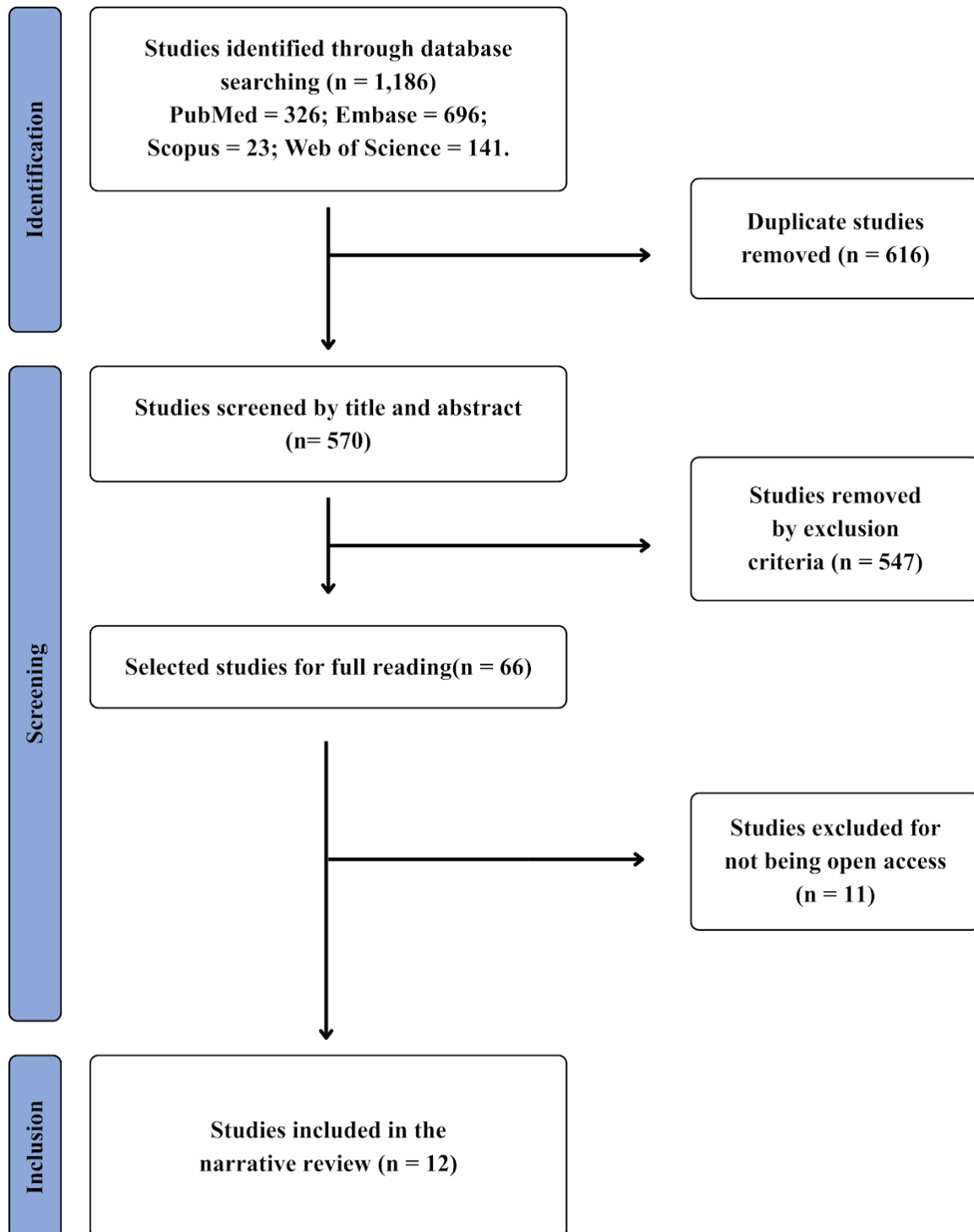
Exclusion criteria included: studies limited only to comparing application modes and techniques of the same adhesive; studies focused on orthodontic bracket bonding; cemented indirect restorations or other procedures not directly related to composite resin bonding; and works classified as case reports, letters to the editor, opinion articles, conference abstracts, or other types of literature reviews.

The process of study identification, screening, and inclusion was conducted in stages, as detailed in the flowchart (Figure 1), with the assistance of the Rayyan reference management software. After compiling the results found in the four databases and removing duplicates, articles were screened by reading titles and abstracts. Subsequently, the pre-selected texts were evaluated

in their entirety.

RESULTS

Figure 1 - Study flowchart



Source: Own work.

Table 1 - Articles included in the narrative review.

Author and Year	Study Type and Objective	Studied Groups	Sample	Evaluated Parameters	Methodology	Results	Conclusion
Niculescu <i>et al</i> 2025	<i>In vitro</i> Evaluate and compare the effectiveness of marginal sealing in the hybrid layer in Class I enamel restorations. OptiBond Solo Plus, total etching. Adhese Universal VivaPen, self-etching.	Group A: OptiBond Solo Plus Group B: Adhese Universal VivaPen	N = 20 Extracted human teeth.	Microleakage	Preparation of Class I cavities. Restoration with Herculite XRV resin. Immersion in 2% methylene blue for 10 days. Longitudinal section and microscopic measurement (500x) of dye penetration.	Group A: 0.2503mm Group B: 0.2484mm	Both adhesive systems demonstrated comparable performance and effectiveness in marginal sealing.
Ren <i>et al</i> 2024	<i>In vitro</i> To evaluate the adhesion performance of universal and self-etching adhesives using the same acid etching method.	Group 1: Single Bond Universal (SBU) for short-term testing; Group 2: Single Bond Universal for thermocycling; Group 3: Adper Easy One for short-term testing; Group 4: Adper Easy One for thermocycling; Group 5: Clearfil Tri-S Bond (S3) for short-term testing.	N = 80 Extracted human teeth.	Bond strength	The microtensile bond strength and microleakage of all adhesives were tested and compared after 24 hours and 5000 thermal cycles, respectively. The morphology of the adhesive interfaces was observed by scanning electron microscopy and fluorescent staining.	The results were not presented numerically, but rather in graph form. Analyzing it, it is possible to conclude that the bond strength and microleakage of (SBU) are comparable to those of the self-etching adhesives, although (S3) showed significantly lower bond strength compared to the other two groups of self-etching adhesives evaluated. No significant differences were found in microleakage resistance, although SBU demonstrated the highest resistance.	The self-etching adhesives evaluated showed similar performance to universal adhesives in selective acid etching mode with respect to bond strength and microleakage resistance.
Brkanovic <i>et</i>	<i>In vitro</i>	Clearfil SE Bond (self-	N = 40	Shear bond strength	After a storage period, half of the samples were	Group 1: 32 MPa;	The universal adhesive, G2-Bond

<i>al</i> 2024	To compare the longevity of dentin adhesion of different universal adhesives after different storage and acid etching conditions.	etching) Group 1: 2 months incubation; Group 2: thermal cycle; Scotchbond Universal Plus Adhesive (self-etching) Group 3: 2 months incubation; Group 4: thermal cycle; G2 Bond Universal (total conditioning) Group 5: 2 months incubation; Group 6: thermal cycle; G2 Bond Universal (self-etching) Group 7: 2 months incubation; Group 8: thermal cycle.	Extracted human teeth.		placed in an Ultra Tester bond strength testing machine and tested in macroscopic shear mode. The second subgroup of samples was tested after the thermal cycling process.	Group 2: 28 MPa; Group 3: 27 MPa; Group 4: 25 MPa; Group 5: 31 MPa; Group 6: 30 MPa; Group 7: 34 MPa; Group 8: 33 MPa.	Universal, proved to be the most effective for clinical practice, especially when applied in self-etching mode.
Valsan <i>et al</i> 2023	<i>In vitro</i> Evaluate the shear bond strength of different adhesive systems to dentin.	Group A: Single Bond Universal (self-etch); Group B: Single Bond Universal (total etch); Group C: Clearfil SE Bond;	N = 60 Extracted human teeth.	Shear bond strength	Using a two-part Teflon mold, composite resin cylinders were fabricated on the prepared dentin surfaces. The shear bond strength was then evaluated with a universal testing machine.	Group A: 20.7059 MPa; Group B: 18.7913 MPa; Group C: 22.0167 MPa;	The acid etching/self-adhesive primer system showed greater adhesion to the pulp floor dentin than the multimode adhesive and the total acid etching system.

Group D: Adper Single Bond 2.				Group D: 20.2315 MPa;			
Hosseini <i>et al</i> 2023	<i>In vitro</i> To evaluate and compare the micro-shear bond strength of two universal adhesives with different pH levels when applied to superficial dentin in self-etching and total-etch modes. All-Bond Universal and G-Premio Bond. Clearfil SE Bond as a control (self-etching).	Group 1: Clearfil SE Bond; Group 2: G-Premio Bond, total etch; Group 3: G-Premio Bond, self-etch; Group 4: All-Bond Universal, total etch; Group 5: All-Bond Universal, self-etch.	N = 75 Extracted human teeth.	Bond Strength	Exposure of superficial dentin with silicon carbide sandpaper. Application of adhesives in self-etching and total etch modes and control. Fabrication of resin cylinders to be bonded to the prepared dentin. The micro-shear bond strength test was performed and the failure mode was determined.	Group 1: Showed the lowest performance in the study, with significantly lower bond strength than all other groups. Groups 2 and 3: Showed no statistical difference between themselves, registering averages of 15.26 MPa in total conditioning and 15.14 MPa in self-conditioning, both higher than the control group. Group 4: Recorded a significant reduction in bond strength when applied in total conditioning mode, compared to self-conditioning. Group 5: Obtained the highest bond strength value of the entire experiment, reaching an average of 16.70 MPa in self-conditioning mode.	The type of universal adhesive and its application method influence the bond strength to superficial dentin. For G-Premio Bond, the application method does not make a significant difference in bond strength. For All-Bond Universal, however, the self-etching method resulted in higher bond strength.
Chistyakova 2023	<i>In vitro</i> The study aims to analyze how the chemical composition of	Group 1 (n=10): Single Bond 2, total etch. Group 2 (n=10): Prime Bond Universal, self-	N = 20 Extracted human teeth.	Marginal adaptation	Extracted teeth with Black Class I cavities were restored according to the groups.	Group 1: Accumulation of calcium and phosphorus in the hybrid layer. Group 2: Absence of	The accumulation of calcium and phosphorus demonstrates the deep decalcification

	the dentin in the tooth crown is affected by the application of two different types of adhesives.	etch.			The microstructure and elemental composition were analyzed by Scanning Electron Microscopy and X-ray Spectral Analysis.	calcium and phosphorus accumulation.	promoted by the acid attack of the conventional system, being responsible for ensuring better marginal adaptation in the dentin.
	Single Bond 2, total etch (Conventional).						
	Prime Bond Universal, self-etching (Universal).						The absence of this accumulation in the universal system reflects an interaction that only modifies and incorporates the smear layer in self-etching mode, which resulted in lower marginal performance.
Tsujimoto <i>et al</i> 2022	<i>In vitro</i> Compare the fatigue resistance of the following adhesives: G2-Bond Universal; OptimoBond FL; Prime & Bond NT; Clearfil SE Bond 2; Scotchbond Universal Plus.	Group 1: G2-Bond Universal, total conditioning; Group 2: G2-Bond Universal, self-conditioning; Group 3: OptiBond FL, total conditioning; Group 4: Prime&Bond NT, total conditioning; Group 5: Clearfil SE Bond 2, self-conditioning; Group 6:	N = 140 (resin cylinders) In extracted human teeth.	Fatigue resistance.	The teeth were sectioned, exposing enamel and dentin so that the adhesives could be applied. Resin cylinders were bonded directly to the surfaces. 50,000 load cycles (20Hz) were performed. The adhesive interface analysis was performed by Scanning Electron Microscopy.	Group 1: enamel - 24.6 MPa dentin - 20.7 MPa; Group 2: enamel - 21.3 MPa dentin - 27.2 MPa; Group 3: enamel - 17.8 MPa dentin - 20.4 MPa; Group 4: enamel - 21.0 MPa dentin - 11.4 MPa; Group 5: enamel - 21.5 MPa dentin - 23.2 MPa;	The G2-Bond Universal two-step universal adhesive has demonstrated higher or equivalent bond strength to established adhesive systems on both substrates and application methods.

		Scotchbond Universal Plus, total conditioning;				Group 6: enamel - 19.7 MPa dentin - 17.5 MPa;	
		Group 7: Scotchbond Universal Plus, self-conditioning.				Group 7: enamel - 12.1 MPa dentin - 13.7 MPa	
Suzuki <i>et al</i> 2021	<i>In vitro</i> Evaluate the bond strength of universal adhesives on enamel, comparing the surface of intact enamel with that of worn enamel, in different application methods. Clearfil Universal Bond Quick ER; Scotchbond Universal; Clearfil SE Bond 2 (control).	Each adhesive (3) was tested in 2 enamel conditions (intact and worn) and in two forms of use (total conditioning and self-conditioning).	n = 660 (resin cylinders) In extracted human teeth.	Bond strength and fatigue	Preparation of specimens for 3 adhesives in 2 enamel conditions in 2 modes of use, totaling 12 groups in 2 evaluation times (24 groups). The first time point is the initial (baseline). The second time point is after the samples have been subjected to 30,000 cycles. The microshear bond strength test was performed. The same number of groups (12) was divided and 25 specimens were allocated to each group. A fatigue bond strength test was performed after 50,000 cycles. Analysis of failure modes and SEM.	All adhesives showed significantly higher values in both the shear and fatigue tests in the total conditioning mode than in the self-etching mode. In the self-etching mode, adhesion to the worn surface was significantly greater than to the intact surface. After the cycles, the universal adhesives with intact enamel showed lower values in the shear test.	For universal and self-etching adhesives, complete etching or wear of the enamel surface is essential to ensure reliable bond strength and durability in the enamel. Intact enamel in self-etching mode is the worst-performing scenario.
Fazelian	<i>In vitro</i>	Group 1: Flat wall;	N = 108	Bond strength	After applying the adhesives on the different	Average microtensile bond	Regardless of the adhesive type, the C

<i>et al</i> 2021	To evaluate the effects of the C-factor on the bond strength of universal adhesives to the dentin of the floor and wall of Class I restorations.	Group 2: Flat floor; Group 3: Cavity wall; Group 4: Cavity floor. Then, each group was divided into 3 subgroups according to the adhesive used: Single Bond Universal; G-Premio Bond; Adper Single Bond 2.	Extracted human teeth.		surfaces of the dentin, the teeth were sectioned and subjected to μ TBS tests in a universal test machine. Three failure modes were determined: 1. Adhesive (interfacial) failure: fracture at the adhesive-dentin interface; 2. Cohesive failure: fracture within the dentin or composite; 3. Mixed failure: a combination of adhesive and cohesive fractures	strength of adhesives: G-Premio Bond Group 1: 15.64 MPa; Group 2: 18.01 MPa; Group 3: 5.26 MPa; Group 4: 5.04 MPa. Single Bond Universal: Group 1: 15.25 MPa; Group 2: 12.83 MPa; Group 3: 3.63 MPa; Group 4: 4.65 MPa. Adper Single Bond 2: Group 1: 28.92 MPa; Group 2: 14.22 MPa; Group 3: 8.74 MPa; Group 4: 10.70 MPa.	factor reduced the microtensile bond strength of the composite resin to dentin. The Adper Single Bond 2 adhesive showed a higher μ TBS than the G-Premio Bond and Single Bond Universal adhesives.
Fathpour <i>et al</i> 2021	<i>In vitro</i> To compare microleakage in Class V restorations using the universal adhesive G-Premio Bond and the two-step self-etching adhesive Clearfil SE Bond, in different application methods.	Group 1: G-Premio Bond, self-conditioning; Group 2: G-Premio Bond, total conditioning; Group 3: G-Premio Bond, selective conditioning; Group 4: Clearfil SE Bond, self-conditioning; Group 5:	N = 70 Extracted human teeth.	Marginal microleakage	Preparation of 70 Class V cavities in extracted human premolars. Restoration with Gradia Direct resin. They underwent 1,000 cycles. Evaluation of microleakage by dye penetration (2% fuchsin) and scores from 0 to 4 under a stereomicroscope.	Group 1: 1.07 in enamel, 0.97 in dentin; Group 2: 0.57 in enamel, 0.85 in dentin; Group 3: 0.57 in enamel, 0.64 in dentin; Group 4: 1.28 in enamel, 1.35 in dentin; Group 5:	The use of enamel etching, selective or total-etch, significantly reduces marginal microleakage compared to the self-etch mode for both adhesives. G-Premio Bond demonstrated better results on dentin compared to Clearfil SE Bond in the self-etch mode.

Clearfil SE Bond, selective conditioning.				0.78 in enamel, 1.14 in dentin.			
Zecin-Deren <i>et al</i> 2020	<i>In vitro.</i> To evaluate whether increasing the number of applications and extending the application time of self-etching and universal adhesives influences shear bond strength and hybrid layer thickness.	The sample was divided into 20 subgroups based on the intersection of four adhesive systems with five application protocols: The times and number of layers were varied in five approaches: 1 application in 20 seconds; 2 applications in 20 seconds; 3 applications in 20 seconds; 2 applications in 40 seconds; 3 applications in 60 seconds	N = 140 Extracted human teeth.	Bond strength	The teeth were sectioned to expose dentin on the buccal and lingual surfaces. Each of the 4 adhesives was tested in 5 different application protocols, totaling 20 test subgroups. Each group received 14 specimens (resin cylinders), of which 11 participated in the shear bond strength test and 3 underwent SEM analysis.	The Single Bond Universal adhesive achieved the highest bond strength in the entire study, reaching a maximum value (31.40 MPa) in the 3-application protocol in 60 seconds. In addition, for Single Bond Universal, Adper Easy One, and Xeno V, extending the total procedure time, either through 2 applications in 40 seconds or 3 applications in 60 seconds, resulted in a statistically significant increase in bond strength to the substrate. In contrast, the Prime & Bond One Select system did not show a significant improvement in its performance, regardless of the changes applied to the times or the number of layers. Regarding the interface morphology, the thickness of the hybrid layer was generally thinner when the 2-application protocol in 20 seconds was used.	Modifying the application protocol for self-etch and universal adhesives may be recommended to significantly improve their bond strength to dentin, but this improvement is not directly related to an increase in hybrid layer thickness.
Mello Fabião <i>et al</i>	<i>In vitro.</i> To evaluate the	Group 1: Clearfil SE Bond; Group 2: Clearfil SE Bond	N = 66 Extracted	Bond strength	Half of the samples were tested after 24 h, while the other half was tested	Group 1 24 hours: 77.4 MPa;	Two-step self-etching adhesives showed a dentin bond strength

2020	microtensile bond strength to dentin and the morphology of the dental adhesive of four one-step adhesives and two two-step adhesives.	2; Group 3: G-Premio Bond; Group 4: Bond Force; Group 5: Adhese Universal; Group 6: Prime & Bond Active.	human teeth.	after 1 year of storage. The tests were performed in a universal testing machine at a crosshead speed of 1.0 mm/min until failure. The specimens were gold-coated by sputter coating and observed under a scanning electron microscope (SEM).	1 year: 71.3 MPa. Group 2 24 hours: 77.9 MPa; 1 year: 74.9 MPa. Group 3 24 hours: 28.2 MPa; 1 year: 27.0 MPa. Group 4 24 hours: 23.2 MPa; 1 year: 20.7 MPa. Group 5 24 hours: 66.5 MPa; 1 year: 65.3 MPa. Group 6 24 hours: 57.7 MPa; 1 year: 57.1 MPa.	immediately higher to all tested one-step adhesives. The one-step adhesive without 10-MDP (GPB) and the adhesive containing a combination of three different functional monomers (BOF) showed the lowest dentin bond strength.
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Source: Own work.

Table 2 - Adhesive Systems, Classification, and Functional Monomers

Adhesive System and Manufacturer	Classification	Functional Acidic Monomers	Citation Frequency
Single Bond Universal / 3M	Universal	10-MDP	6
Clearfil SE Bond 2 / Kuraray	Self-etching	10-MDP	6
Clearfil SE Bond / Kuraray	Self-etching	10-MDP	6
G-Premio Bond / GC	Universal	10-MDP, 4-MET	5
OptiBond FL / Kerr	Conventional	GPDM	4
Adhese Universal VivaPen / Ivoclar	Universal	10-MDP	4

Prime-Bond Universal / Dentsply	Universal	PENTA	3
G2-Bond Universal / GC	Universal	10-MDP, 4-MET	3
Adper Single Bond 2 / 3M	Conventional	-	3
Scotchbond Universal Plus / 3M	Universal	10-MDP	2
Clearfil Universal Bond Quick ER / Kuraray	Universal	10-MDP	2
Adper Easy One / 3M	Self-etching	10-MDP	2
iBond Universal / Kulzer	Universal	4-MET	1
Scotchbond Universal / 3M	Universal	10-MDP	1
Peak Universal Bond / Ultradent	Universal	10-MDP	1
Clearfil™ S3 BOND / Kuraray	Universal	10-MDP	1
Optibond Universal / Kerr	Universal	GPDM	1
Optibond Solo Plus / Kerr	Conventional	GPDM	1
Single Bond 2 / 3M	Conventional	-	1
Prime&Bond NT / Dentsply	Conventional	PENTA	1
Xeno V / Dentsply	Self-etching	PENTA	1
Bond Force II / Shofu	Self-etching	3-DCP	1
Clearfil™ Tri-S Bond / Kuraray	Self-etching	10-MDP	1
BeautiBond / Shofu	Self-etching	6-MHAP, 4-MET	1
Optibond XTR / Kerr	Universal	GPDM	1

Source: Own work.

DISCUSSION

Universal adhesive systems showed laboratory performance comparable to the others adhesives regarding bond strength and marginal adaptation/microleakage. However, it is essential to understand the divergences in the selection between the types of adhesives, as both universal, self-etch and conventional systems presented similar results. As expected, 3M and Kuraray were the most frequent brands in the reviewed literature, with 3M being the most cited among universal adhesives and Kuraray among conventional adhesives.

The absence of Brazilian brands in the included studies can be understood considering the inclusion criteria, which restricted the search to English-language publications in the databases. This criterion may have selected research using globally recognized materials, such as those from 3M and Kuraray. Nevertheless, according to Dutra *et al.* (2022), Brazilian universal adhesives are subjects of scientific investigation, as evidenced in their study comparing the Brazilian adhesive Âmbor Universal (FGM) with the international gold standard Single Bond Universal (3M); the study concluded that the Brazilian brand presented satisfactory performance, although its effectiveness is highly dependent on the clinical protocol used. Therefore, the lack of included articles studying Brazilian products does not necessarily indicate lower clinical performance but highlights a representation gap in the international scientific literature. This reinforces the importance of expanding scientific production on Brazilian materials to validate their efficacy in the global dental scenario.

Although universal adhesives provide reduced chairside time, as pointed out by Niculescu *et al.* (2025), the precise evaluation of factors such as microleakage and marginal adaptation is feasible in a laboratory environment, which would be difficult to observe isolated in clinical studies. *In vitro* studies were more frequently found due to their lower costs, high reproducibility, and capacity for rigorous standardization. Furthermore, the fact that they do not involve human subjects simplifies research execution, allowing bond strength to be the most explored parameter to characterize the effectiveness of current adhesive systems.

Bond strength was the most evaluated methodology in this review, analyzed in nine of the twelve included articles. This predominance occurred because it is considered one of the fundamental properties to characterize the performance and clinical reliability of adhesive systems. As highlighted by Mello Fabião *et al.* (2020), bond strength is essential for characterizing the adhesion of adhesive systems, as it provides objective evidence of the bonding

effectiveness and the chemical interaction between the material and the dental substrate.

Regarding the methodologies applied for these evaluations, a diversity of mechanical assays to measure bond strength was observed. Shear and microshear tests were the most recurrent, adopted in five of the analyzed studies. Microtensile bond strength (μ TBS) was the method of choice in three articles, while fatigue resistance assays were used in two. For these measurements, the use of a universal testing machine was the most common for the application of fracture loads. In addition to strength assays, several methodologies included complementary analyses using Scanning Electron Microscopy (SEM), a technique used in six studies to observe the morphology of the adhesive interface and the quality of the formed hybrid layer.

Of the twelve articles analyzed, five evaluated the dentin substrate exclusively and only one focused solely on enamel, while another six studies investigated both substrates simultaneously. This predominance of dentin reflects the challenge of adhesion to this substrate which, unlike enamel, a highly mineralized structure with a homogeneous composition, presents high organic content and moisture, making hybrid layer formation fundamental for the longevity of the restoration. Furthermore, the difference between conditioning protocols, which differ between universal and other adhesives, justifies the higher volume of studies focused on this substrate; according to Brkanovic *et al.* (2024), it is in the dentin where technical choices between self-etching and total-etch modes produce significant differences for restorative longevity.

A characteristic of universal adhesive systems is that the clinician must choose between self-etching, total-etch, or selective-etch protocols according to the complexity of the case. However, the analyzed literature clarifies that this flexibility should not be confused with a lack of clinical criteria, as the choice of protocol directly interferes with the longevity and quality of the bond. While conventional systems depend on total acid etching to remove the smear layer and expose collagen, universal adhesives in self-etching mode offer a more conservative alternative by only modifying and incorporating these debris into the interface. According to Brkanovic *et al.* (2024), this approach is effective for clinical practice because it allows a stable interaction with the substrate without the need for prior demineralization, especially with the use of adhesives such as G2-Bond Universal (GC), which achieved a strength of 34 MPa in self-etching mode. This chemical stability is enhanced by the presence of the 10-MDP monomer, which enables a strong ionic bond with the remaining hydroxyapatite, resulting in an interface more resistant to degradation over time. However, the results of Mello Fabião *et al.* (2020) suggest that two-step

systems still outperform one-step systems in immediate performance, as observed with the G-Premio Bond adhesive (GC).

In enamel, the need for prior selective etching with phosphoric acid is a point of consensus among researchers to compensate for the lower acidity of these adhesives. Suzuki *et al.* (2021) demonstrated that the application of the self-etching mode on sound enamel results in the worst possible technical performance, concluding that acid etching or surface grinding are mandatory steps to ensure reliable bond strength. This vulnerability of the simplified technique in enamel corroborates the findings of Fathpour *et al.* (2021), which evidenced a drastic reduction in marginal microleakage when acid etching (selective or total) was performed, compared to the self-etching mode for the G-Premio Bond adhesive. Conversely, Niculescu *et al.* (2025) demonstrated that, under controlled laboratory conditions, both systems can show comparable performance, with microleakage means of 0.2503 mm for the conventional adhesive and 0.2484 mm for the universal. Thus, although universal and conventional adhesives have equivalent performance, the universal system enables a faster and more objective procedure; however, its maximum effectiveness in enamel remains dependent on the classic acid-etching technique to ensure better marginal adaptation of the restoration.

Beyond the etching technique, bonding effectiveness is also influenced by the application protocol; Zecin-Deren *et al.* (2020) suggest that extending the application time and performing active application of the adhesive can significantly improve dentin bond strength for specific brands, such as Single Bond Universal. This aligns with the study by Demirel Karaduman *et al.* (2026), which indicates that the dentin bond strength of universal adhesives depends primarily on the application strategy (self-etch or total-etch) and material composition, rather than solely on the presence of functional monomers like 10-MDP, thereby highlighting significant performance variability among different universal products. Thus, although universal adhesives simplify clinical practice, their application requires an approach carefully adapted to the substrate involved to achieve maximum performance.

The number of selected articles ($n = 12$) and the search strategy concentrated on the descriptors "enamel," "dentin," and "universal adhesives" represent factors that may have restricted the scope of the analysis. The predominantly *in vitro* nature of the included studies prevented the direct observation of biological variables, limiting the understanding of how these systems behave in the face of dentinal fluid dynamics and real thermal variations. The time frame established between 2020 and 2026, while ensuring the analysis of contemporary technologies,

may have omitted data from more extensive longitudinal follow-ups initiated in earlier periods. Therefore, it is fundamental that future studies prioritize the performance of controlled *in vivo* clinical trials with long-term follow-up to validate whether the efficacy observed in testing machines translates into real and predictable clinical durability for the dental surgeon.

The results found in the included studies indicate that universal adhesives presented laboratory performance comparable to conventional adhesives across the evaluated parameters, with no group proving significantly higher to the other. However, the performance of universal adhesives is dependent on the substrate and the application protocol: in enamel, acid etching (total or selective) is indispensable to ensure bond strength. In dentin, the self-etching mode proved to be an effective and more conservative alternative, especially when associated with the presence of the 10-MDP monomer, an acidic monomer found in the composition of most universal and self-etching adhesives in the selected studies. Conventional adhesives remained stable in dentin with total etching, reinforcing that the classic technique still constitutes a safe and well-founded option.

CONCLUSION

Based on the studies analyzed, universal adhesives demonstrated satisfactory performance on both substrates. Although selective enamel etching remains necessary, these materials represent a clinically advantageous alternative for the practitioner.

Self-etching and universal adhesive systems assist dentists in daily clinical practice by simplifying the technique and reducing the likelihood of errors. Furthermore, universal adhesives can be used on various substrates.

Regarding reported limitations, this review lacked studies on adhesive systems in clinical settings and did not include domestic brands; therefore, conducting searches in other languages could partially address this issue.

Future randomized clinical trials are recommended to evaluate the longevity of the bonding interface of conventional, self-etching, and universal adhesives, including Brazilian brands in the comparison groups.

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