

Article

Impact of Salivary Contamination at Various Application Stages of an Acetone-Based Universal Adhesive on Dentin Bond Strength

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Abstract

This study evaluated the effect of saliva contamination at different stages of application of an acetone-based universal adhesive on dentin bond strength. Seventy-two caries-free third molars were assigned to six groups ($n = 12$) according to contamination step. Specimens underwent shear bond strength testing. To determine the SBS, each bonded specimen was subjected to an SBS test in a universal testing machine (Shimadzu Autograph AGS-X; Shimadzu Corp., Kyoto, Japan) equipped for operating at a crosshead speed of 1 mm/min. Data were analyzed using one-way analysis of variance (ANOVA) followed by Tamhane's T2 test for post hoc multiple comparisons with $p < 0.05$ as the significance level. Saliva contamination significantly affected dentin bond strength ($p < 0.001$). The highest bond strength was observed in the post-polymerization contamination group with adhesive reapplication (12.32 MPa), whereas the lowest values were recorded when contamination occurred after the initial adhesive application (6.37 MPa). Overall, contamination prior to polymerization resulted in reduced bond strength, while reapplication of adhesive after polymerization improved bonding performance. Within the limitations of this in vitro study, salivary contamination adversely influences the dentin bonding effectiveness of acetone-based universal adhesives, particularly when it occurs before curing. However, adhesive reapplication following post-polymerization contamination may partially compensate for this effect.

Keywords: adhesives; saliva contamination; bond strength; dentin



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1. Introduction

In dental practice, the proper preparation of the tooth surface and effective application of adhesives are critically important for the success of restorative procedures. During this process, saliva, blood, excessive moisture, hemostatic agents, gingival fluid, and other contaminants pose common sources of contamination that can impact the adhesive strength of dentin bonding agents [1–3]. Particularly, the contamination of the prepared tooth surface can jeopardize the bonding strength of dentin adhesive agents. Preventing such liquid contamination can pose a significant clinical challenge [4].

Traditionally, isolation methods like rubber dam application are preferred to provide a suitable working area during composite restorations. However, a survey of U.S. general dentists reported that for anterior direct resin composites, 45% never used a rubber dam and only 17% always used it; for posterior composites, 39% never used a rubber dam and

18% always used it, indicating that contamination in the operative field remains a serious clinical issue [5].

Effective isolation is essential for predictable adhesive bonding as moisture contamination can adversely affect interfacial integrity and bond strength. Rubber dam isolation is widely considered the gold standard for achieving optimal moisture control because it provides effective protection against saliva, blood, and crevicular fluid contamination while improving visibility and access. However, in clinical practice, alternative techniques such as cotton roll isolation are frequently used due to time constraints, patient comfort considerations, or clinical limitations. Although cotton roll isolation may be adequate for certain procedures, it is generally less reliable in maintaining a consistently dry field, potentially increasing the risk of contamination during adhesive application. Therefore, understanding how contamination affects bonding performance remains clinically relevant, particularly in situations where ideal isolation cannot be achieved [6].

Saliva is primarily made up of water, accounting for 99% of its composition, while the remaining 1% contains a variety of organic and inorganic substances. It is known that saliva can contribute to increased microleakage and diminished bond strength in composite resin applications [7]. Tooth surface contamination often occurs after the etching process, as factors such as the force of water irrigation, the abrasive nature of acid etching, and inflammation in nearby soft tissues make the surface more susceptible to saliva contamination [8]. Previous research offers diverse and conflicting recommendations for the effective decontamination of saliva-contaminated dentin surfaces [9,10].

Saliva contamination generally reduces the bond strength and effectiveness of universal adhesives; however, the effect of contamination depends on the timing, type of adhesive used, and decontamination protocols [11,12]. The type of solvent used in universal adhesives directly affects resistance to salivary contamination and decontamination effectiveness. Universal and self-etch adhesives often use water or water/ethanol mixtures as solvents to facilitate monomer penetration into moist dentin. However, the use of these hydrophilic solvents can make adhesives more susceptible to salivary contamination because excess water from saliva can dilute the adhesive concentration, inhibit polymerization, and increase phase separation, leading to decreased bond strength [13,14].

Although acetone-based adhesives are highly volatile and provide excellent water repellency, their rapid evaporation may result in inadequate surface wetting or weakening if contamination persists [15]. Furthermore, the impact of saliva contamination on acetone-based multipurpose adhesives has not yet been adequately documented in the literature. Given acetone's volatility and water repellency, these adhesives may respond differently to moisture contamination than ethanol- or water-based systems, making further research in this area crucial.

This study aims to investigate the effects of different decontamination protocols on saliva-contaminated dentin surfaces after acid etching, and their effects on the shear bond strength achieved using an acetone-based universal adhesive resin. The findings obtained by examining the interactions between dentin and adhesive under acid etching and rinsing conditions can provide valuable guidance to dentists in optimizing dental adhesive procedures. In this study, the null hypothesis was that saliva contamination timing and the type of decontamination protocol applied would have no significant effect on the shear bond strength (SBS) of an acetone-based universal adhesive.

2. Materials and Methods

This *in vitro* study was conducted following approval from the Ethics Committee of Batman University Faculty of Dentistry (2024/01-23). Informed consent was obtained from all patients prior to tooth extraction.

2.1. Sample Selection and Storage

Seventy-two extracted human third molars were collected, all removed for orthodontic or periodontal reasons. Teeth exhibiting cracks, hypoplasia, extensive caries, or previous restorations were excluded. Immediately after extraction, all soft tissues and calculus were removed using a hand scaler, and the teeth were stored in 0.1% thymol solution at 4 °C for no longer than one month until use. Prior to preparation, teeth were rinsed thoroughly with distilled water.

2.2. Power Analysis

The required sample size was determined via power analysis using G*Power software (Version 3.1.9.2; Heinrich-Heine University, Düsseldorf, Germany). Based on a 95% confidence interval, 80% power, and effect size estimated from previous studies, a minimum of 12 specimens per group was calculated.

2.3. Saliva Collection

A member of the research team volunteered as a donor for the collection of saliva. To simulate the natural composition of saliva as accurately as possible, fresh, unstimulated saliva was collected from this researcher in a plastic container. The donor had no medical conditions and did not use any medication throughout the study.

All procedures were performed in the morning. Oral hygiene measures (brushing with 1450 ppm fluoride toothpaste) were applied twice daily (once in the morning and once before bedtime). To minimize variations in pH, electrolyte levels, and enzymatic and protein activity, all procedures were conducted one hour after the cessation of any salivary stimulation (no eating, drinking, smoking, gum chewing, or toothbrushing). The saliva was collected in a sterile polypropylene container, kept at room temperature, and used within 10 min of collection to avoid enzymatic degradation.

2.4. Tooth Preparation

Teeth were mounted in acrylic resin blocks with their occlusal surfaces exposed. A standard Class I dentin surface was prepared using a new diamond fissure bur (FG 016) in a high-speed handpiece under continuous water cooling. The enamel was removed until a flat mid-coronal dentin surface was exposed, confirmed visually. Burs were replaced after every five preparations to maintain cutting efficiency.

The enamel crown was sectioned using a high-speed diamond bur under water cooling to obtain sound dentin. Teeth were embedded in cylindrical acrylic resin blocks starting 1 mm apical to the cemento-enamel junction. In order to obtain a standardized smear layer and flat dentin surface, the specimens were gently ground under slow water flow for 30 s using 600-, 1000-, and 1200-grit aluminum oxide abrasive papers without applying pressure (Exakt 400 cs Apparatebau, Norderstedt, Germany). Residual debris was removed by rinsing with distilled water for 10 s. All dentin surfaces were etched with 37% phosphoric acid gel (Optidisc, Kerr, Orange, CA, USA) for 15 s, rinsed with distilled water (flow rate: 50 mL/min) for 15 s, and dried with oil-free compressed air with controlled air pressure for 3 s to achieve a visibly moist surface.

2.5. Experimental Groups

In this study, the samples were randomly allocated into six groups using a computer-generated randomization sequence (n = 12 each):

1—Group Control: No contamination. Adhesive applied according to manufacturer's instructions (G-Premio Bond, GC Corp., Tokyo, Japan), followed by placement of a transparent silicone mold (4 mm diameter, 2 mm height, corresponding to a bonded area of

approximately 12.56 mm²), and filling with composite resin (G-aenial Posterior, GC Corp., Tokyo, Japan).

Excess composite was removed, a transparent Mylar strip placed, and light curing performed for 20 s (Bluephase N, Ivoclar Vivadent, Bürs, Austria; 1200 mW/cm², 430–490 nm, tip positioned 1 mm from surface).

2—Group CDA (Contamination/Drying/Adhesive): Saliva applied for 60 s (50 µL using a disposable microbrush) to etched dentin, air dried for 10 s, then adhesive and composite applied as in Control.

3—Group CWDA (Contamination/Washing/Drying/Adhesive): Saliva contamination as in CDA, rinsed with distilled water for 10 s, dried for 10 s, adhesive and composite applied as in Control.

4—Group ACWDR (Adhesive/Contamination/Washing/Drying/Reapplication): Adhesive applied, saliva contamination as in CDA, rinsed 10 s, dried 10 s, adhesive reapplied, then composite placed as in Control.

5—Group ACD (Adhesive/Contamination/Drying): Adhesive applied, saliva contamination as in CDA, dried 10 s, adhesive polymerized, then composite applied as in Control.

6—Group APCWDR (Adhesive/Polymerization/Contamination/Washing/Drying/Reapplication): Adhesive applied, polymerized, saliva contamination as in CDA, rinsed 10 s, dried 10 s, adhesive reapplied, then composite applied as in Control.

In this study, the amount of saliva applied was standardized by fully saturating the disposable microbrush before each application, ensuring a consistent volume delivery. Although the exact volume in microliters was not directly measured, the same operator performed all applications using an identical protocol to minimize variability.

A single layer of saliva was applied to the flat dentin surface using a microbrush and left undisturbed for 10 s. Saliva contamination was performed either before or after the polymerization of the adhesive, depending on the bonding stage. Each of these groups was subsequently subjected to one of the investigated decontamination protocols. All bonding and composite polymerization procedures were conducted under standardized laboratory conditions, with an ambient temperature of 23 ± 1 °C and a relative humidity of 50 ± 5%. All specimens were stored in distilled water at 37 °C for 24 h prior to testing.

2.6. SBS Testing

Shear bond strength testing was performed using a universal testing machine (Shimadzu AG-IC, Shimadzu Corp., Kyoto, Japan) equipped with a 5 kN load cell, operating within a measurement range of 0–5000 N and with an accuracy of ±0.5% of the indicated load. The bonded interface was standardized using a cylindrical silicone mold with a diameter of 4 mm, resulting in a cross-sectional bonding area of approximately 12.56 mm², calculated according to the formula $A = \pi r^2$. The specimens were mounted in a custom fixture, and a knife-edge loading blade was aligned parallel to the adhesive interface to ensure shear force application as close as possible to the bonded interface. Load was applied at a crosshead speed of 1 mm/min until failure occurred, in accordance with the general recommendations for bond strength testing described in ISO/TS 11405:2015 (Dental materials—Testing of adhesion to tooth structure) [16]. The maximum load at failure (N) was recorded, and shear bond strength values were calculated in megapascals (MPa) by dividing the failure load by the bonded cross-sectional area.

2.7. Statistical Method

The data were analyzed using IBM SPSS software (Version 23). The Shapiro–Wilk test was applied to evaluate whether the data followed a normal distribution. For group

comparisons where the data were normally distributed, one-way ANOVA was utilized, and Tamhane's T2 test was employed for post hoc multiple comparisons. The findings are presented as mean $\pm$ standard deviation and median (minimum–maximum). Individual p -values were reported. Statistical significance was set at $p < 0.05$.

3. Results

The statistical analysis showed that saliva contamination significantly affected the bond strength of composite resins to dentin ($p < 0.001$) (Table 1). Different bond strength values (MPa) were obtained depending on the stage at which contamination occurred (Figure 1).

Table 1. Comparison of Average Values by Groups.

	Mean $\pm$ SD	(Min.–Maks.)	Test Statistic	<i>p</i>
Control	10.31 $\pm$ 1.75 b	9.98 (7.45–13.34)	27.501	<0.001
CDA	8.74 $\pm$ 1.70 b	9.01 (6.12–11.70)		
CWDA	9.28 $\pm$ 1.12 b	9.30 (7.41–11.73)		
ACWDR	6.37 $\pm$ 1.09 a	6.33 (4.96–8.72)		
ACD	6.83 $\pm$ 1.16 a	7.08 (5.07–8.29)		
APCWDR	12.05 $\pm$ 1.47 c	12.32 (9.85–14.90)		
Comparison	Mean Difference	<i>p</i> -Value		
Control vs. ACWDR	3.94	<0.001	<i>p</i> < 0.05	
Control vs. ACD	3.48	<0.001		
ACWDR vs. APCWDR	5.68	<0.001		
Control vs. APCWDR	−1.74	0.039 *		

* One-way ANOVA, a, b, c There is no difference between groups with the same letter.

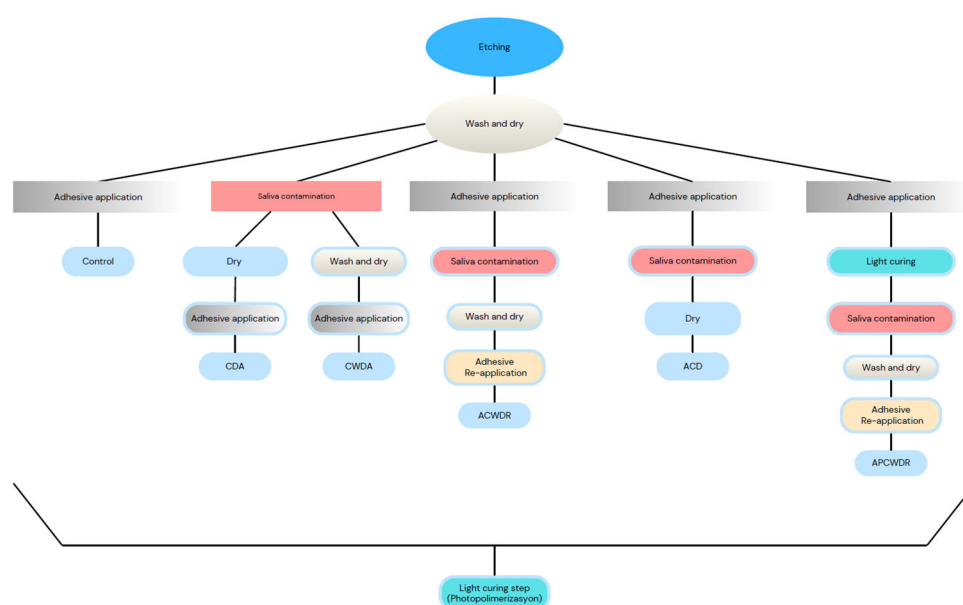


Figure 1. Experimental Workflow.

The highest mean bond strength was found in APCWDR (12.05 MPa), where contamination occurred after adhesive light-curing, followed by rinsing and drying with air-water spray, and reapplication of the adhesive. The lowest mean value was observed in ACWDR

(6.37 MPa), where contamination occurred after polymerization and only rinsing and drying were performed (Figure 2). The other groups, from lowest to highest, were ACD (6.83), CDA (8.74), CWDA (9.28), and Control (10.31). One-way ANOVA revealed a statistically significant difference among the groups ($F = 27.501, p < 0.001$). Pairwise comparisons using Tamhane's T2 test demonstrated significant differences between Control and ACWDR, Control and ACD, and ACWDR and APCWDR groups ($p < 0.001$).

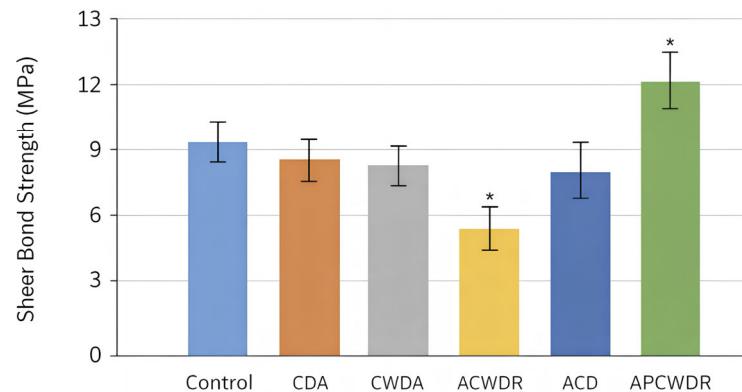


Figure 2. Column Chart of Mean and Standard Deviation Values by Groups (The highest and lowest shear bond strength values are indicated with a *).

Interestingly, the mean value in Group 6 APCWDR was significantly higher than the control group (Control) ($p = 0.039$). This suggests that contamination after polymerization did not reduce bond strength; instead, a second application of the adhesive increased it. Significant differences were observed between several groups, such as Control–ACWDR ($p < 0.001$), Control–ACD ($p < 0.001$), and Control–APCWDR ($p = 0.039$). However, no significant difference was found between Control and CDA–CWDA, where contamination occurred before adhesive application.

Saliva contamination negatively affected bond strength, although the magnitude of this effect varied depending on the decontamination protocol. While group CDA (air drying only) demonstrated bond strength values that were numerically lower than the control group, the difference was not statistically significant. Similarly, no significant difference was observed between groups CDA and CWDA. However, the mean bond strength values of group CWDA (rinsing followed by air drying) were consistently higher than those of group CDA, suggesting that rinsing may contribute to a more effective removal of saliva residues.

4. Discussion

In this study, we evaluated the impact of saliva contamination and potential strategies to mitigate its effects on the dentin bond strength of an acetone-based universal adhesive systems at various application stages. The null hypothesis that saliva contamination has no effect on bond strength was rejected. There was no significant difference between the group exposed to contamination post-adhesive application followed by air drying and the group subjected to rinsing and subsequent air drying ($p > 0.05$). However, both groups exhibited significantly lower mean bond strength values compared to the control group. Notably, after polymerization of the adhesive resin, removal of the contaminant and reapplication of the adhesive yielded higher bond strength values.

Saliva contamination represents an undesirable challenge frequently encountered by dentists. Despite its benefits, the use of rubber dams for isolation remains unpopular among many general practitioners and specialist dentists. Challenges such as placement difficulty, inadequate training, and the cost of equipment and materials contribute to this reluctance [17]. Moreover, not all cases allow for the placement of a rubber dam, thereby

increasing the risk of contamination [18]. A survey study indicated that 6.8% of patients who experienced rubber dam use during dental treatment were unwilling to continue with its use in subsequent treatments. Additional research reports that 93% or more of patients would agree to reapplication of the rubber dam in future procedures [17]. Consequently, even when a patient's tooth is suitable for a rubber dam, achieving complete isolation may not be feasible, thereby heightening the risk of saliva contamination.

It has been documented that water present in saliva during contamination hinders the polymerization of monomers, thereby reducing their binding capacity. This effect is particularly pronounced with the HEMA monomer in adhesives, which exhibits high hydrophilicity, preventing its incorporation into polymer chains by retaining water molecules and disrupting the polymerization cascade [19]. Consequently, this leads to the formation of an uneven hybrid layer, resulting in diminished bond strengths [18]. Furthermore, the precipitation of glycoproteins from saliva forms a protein layer on the adhesive interface, hindering the adhesion of future composite materials and leading to inadequate copolymerization [20].

Several studies have indicated that saliva moisture prevents the collapse of collagen networks by maintaining a moist dentin surface, thereby mitigating the adverse impact of saliva contamination on adhesive-dentin bonding strength [18]. However, acetone-based adhesives may behave differently under saliva contamination due to acetone's strong water-chasing effect, which can sometimes help maintain bond strength if contamination occurs before curing and is followed by proper cleaning [21]. However, most studies do not specifically examine acetone-based universal adhesives, and there is a clear gap in the literature on this topic [21,22]. More targeted research is needed to clarify their unique response to saliva contamination.

The behavior of acetone-based and ethanol/water-based adhesive systems differs due to their distinct physicochemical properties. Acetone-based adhesives exhibit high vapor pressure and strong water-chasing ability, which allows them to effectively displace excess moisture from the substrate surface. However, their low hydrogen-bonding capacity limits their ability to re-expand collapsed collagen, making them more technique-sensitive and dependent on proper moisture conditions [23]. In contrast, ethanol-containing systems can form hydrogen bonds and help maintain interfibrillar spaces within the collagen network, thereby facilitating monomer infiltration. Nevertheless, ethanol evaporates more slowly than acetone and may remain within the adhesive layer for extended periods, which can negatively affect polymerization and mechanical properties if present in excessive amounts [24]. Under saliva contamination specifically, organic components such as glycoproteins can adsorb onto adhesive surfaces and reduce wettability, thereby interfering with polymerization and decreasing bond strength. Certain solvents—including ethanol and acetone—may partially denature salivary glycoproteins and aid in decontamination, although this effect appears concentration-dependent and may not fully restore bond strength [25].

Research has also demonstrated that bond strengths compromised by saliva-contaminated surfaces can be restored through straightforward procedures [26,27]. In our study, while the group (CDA) dried solely with air showed bond strengths close to the control group, superior bonding was observed in the group (CWDA) that underwent water rinsing followed by air drying. This finding is consistent with previous research findings [28]. The lower bond strengths observed in the air-drying group alone may be attributed to incomplete removal of saliva-derived structures adhered to the dentin surface [29]. Moreover, prolonged air-drying times (20 s) induce excessive dentin dehydration, leading to collagen precipitation [30].

The reduction in bond strength observed in contaminated groups may be explained by several physicochemical mechanisms. Saliva contamination has been shown to reduce dentin bond strength because salivary proteins and glycoproteins adsorb to the dentin surface and interfere with adhesive penetration and polymerization [31]. These proteinaceous deposits may decrease surface wettability and hinder formation of a uniform hybrid layer, thereby compromising bond strength [32]. Residual moisture associated with contamination can dilute adhesive monomers and negatively influence the degree of conversion and mechanical properties of the adhesive layer [33]. In addition, oxygen present at the adhesive surface may inhibit free-radical polymerization, resulting in a superficial layer with reduced mechanical integrity [34]. Incomplete solvent evaporation is another important factor, since residual solvent may lead to phase separation and reduced polymer cross-linking within the adhesive interface [33].

The hybrid layer is particularly sensitive to contamination, and disruption of resin infiltration or collagen encapsulation may result in a structurally weak adhesive interface [32]. Cleaning procedures such as rinsing or adhesive reapplication have been shown to partially restore bond strength by removing contaminants and allowing renewed adhesive infiltration [33]. Reapplication of adhesive may also increase adhesive layer thickness and improve stress distribution, which has been associated with improved bond durability in dentin bonding studies [35]. Air drying alone may be insufficient to eliminate salivary residues, which may explain the lower bond strength values observed in contaminated groups in several *in vitro* studies [31]. Taken together, these mechanisms provide a plausible explanation for the differences observed among decontamination protocols and emphasize the importance of contamination control and proper adhesive application in maintaining resin–dentin bond integrity [32].

In our investigation, although no statistically significant differences were found between groups CDA and CWDA, nor between these groups and the control group, group CDA exhibited lower bonding values. This outcome aligns with findings from previous studies, including those by Pashley et al. [26].

Shekhar et al. investigated the impact of saliva contamination on dentin adhesion and found that contamination occurring prior to adhesive polymerization significantly reduces adhesion [30]. The hydrophilic nature of adhesive monomers leads to water retention within the matrix, preventing resin monomers from participating in the polymerization chain in the presence of water. Moreover, air drying alone is insufficient to remove water from the adhesive, and saliva proteins can hinder the infiltration of hydrophilic monomers during the hybridization process [35–38].

In our study, contamination was induced in the 4th and 5th groups before polymerization, resulting in the lowest bond strengths in these groups. Particularly in the 5th group, additional water rinsing after saliva contamination increased water contact with monomers, resulting in lower bond strengths, although no significant difference was observed compared to the 4th group. However, contrary to our findings, some authors have reported that the hydrophilic nature of new adhesives and the application of multiple layers allow them to form a hybrid layer by migrating or penetrating through saliva [39].

When saliva contamination occurred after adhesive polymerization, washing with water and reapplying the adhesive resulted in a statistically significant increase in bond strength. This finding is consistent with Hitmi et al., who noted no saliva diffusion after adhesive hardening [36]. Conversely, studies have shown decreased bond strength when contamination occurred after adhesive polymerization and composite restorations were placed without reapplying adhesive [22]. In our study, APCWDR demonstrated the highest bond strengths, possibly due to incomplete coverage of the entire dentin surface during the

initial adhesive application, which was rectified by filling micro-cavities with the second adhesive application.

Clinical studies evaluating adhesive restorations have demonstrated that restoration longevity is influenced by multiple intraoral variables, including moisture control, operator technique, and functional stresses [40]. Future investigations incorporating artificial aging protocols and long-term clinical evaluation would be valuable to better correlate laboratory findings with clinical outcomes.

The present findings emphasize that immediate management of saliva contamination through rinsing, drying, and reapplication of the adhesive can effectively restore or even enhance dentin bond strength. Given that complete isolation is not always feasible in clinical settings, these results provide practical guidance for achieving reliable adhesion of acetone-based universal adhesives under suboptimal moisture control.

To enhance the clinical relevance of our findings, the present results suggest that contamination timing plays a critical role in determining the effectiveness of adhesive procedures. The findings indicate that contamination occurring after adhesive polymerization may be partially compensated by appropriate surface management and adhesive reapplication, which may restore or even improve bond performance. In contrast, contamination prior to adhesive curing may interfere with resin infiltration and polymerization, potentially compromising interfacial integrity. Based on these findings, the following chairside considerations may be proposed: (1) if contamination occurs before adhesive curing, the surface should be thoroughly rinsed and gently air-dried, and re-etching may be considered when enamel contamination is suspected; (2) if contamination occurs after polymerization, surface cleaning followed by reapplication of adhesive may be sufficient; and (3) strict moisture control remains essential throughout adhesive procedures. These recommendations should be interpreted with caution, as the present results derive from an *in vitro* model, and clinical conditions may introduce additional variables affecting adhesive performance.

Limitations of the study: Although this study was conducted with saliva, a biological fluid, it is not possible to imitate the exact same oral environment and physiology under laboratory conditions. Therefore, *in vitro* studies should be supported by clinical studies to increase the data obtained on the material. Another limitation of this study is that the failure mode has not been analyzed. Future studies, including failure mode analysis, will contribute to a more comprehensive interpretation of the effects of contamination on the adhesive interface. A key limitation of the present study is the absence of thermocycling or long-term water storage, which may influence adhesive interface stability and mechanical performance over time. Therefore, the results primarily reflect immediate bond strength rather than long-term durability. Aging procedures are known to affect resin–dentin interfaces through hydrolytic degradation, water sorption, and thermal stress, which may alter bonding effectiveness under clinical conditions. Consequently, caution is required when extrapolating these findings directly to long-term clinical performance.

5. Conclusions

1. The effect of contamination varied depending on the stage at which it occurred.
2. The presence of contamination prior to adhesive application had no statistically significant influence on bond strength.
3. Contamination of the adhesive before polymerization is the most undesirable situation. It causes the bond strength to decrease significantly.
4. Reapplication of the adhesive after rinsing and drying contaminated surfaces effectively restored and even improved bond strength compared to the uncontaminated control group.

5. Absolute isolation must be ensured so that the bond strength is not affected.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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Abbreviations

The following abbreviations are used in this manuscript:

MPa	Megapascal
SBS	Shear Bond Strength
HEMA	2-hydroxyethylmethacrylate
Mm/min	Millimeter/minute

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