Original Article

Effect of Saliva Contamination on Shear Bond Strength of Transbond XT and Assure Universal Bonding Resin to Enamel

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Abstract

Background and Aim: Assure universal bonding resin is a modified cement with fluoride releasing property. It is claimed to provide adequate bond strength between the bracket and enamel in wet conditions; although more studies are required in this regard. This study compared the shear bond strength of Transbond XT and Assure universal bonding resin to dry and saliva-contaminated enamel in vitro.

Materials and Methods: In this in vitro study, 60 extracted human premolars were selected and stainless steel brackets were bonded to enamel surfaces. Bonding of brackets to enamel surfaces was done using Assure universal bonding resin (dry condition), Transbond XT (dry condition) and Assure (saliva-contaminated condition). The shear bond strength of brackets to the enamel was determined by Zwick/Roell machine in three groups. Data were analyzed using one-way analysis of variance (ANOVA), and the Kruskal Wallis test.

Results: The mean shear bond strength of brackets to enamel surfaces bonded with Assure (dry condition), Transbond XT and Assure (saliva-contaminated condition) was 14.18± 4.78 MPa, 16.13±5.49 MPa and 13.32±4.74 MPa, respectively (with no significant differ ences). Non-parametric Kruskal-Wallis test found no significant differences regarding the adhesive remnant index (ARI). (p=0.053).

Conclusion: Bonding of stainless steel brackets to enamel surfaces with Assure universal bonding resin provided adequate bond strength in dry and saliva-contaminated conditions. Thus, it may be used for bonding of orthodontic brackets to the enamel surfaces in the clinical setting.

Key Words: Shear strength, Orthodontic adhesive, Dental enamel

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Introduction

By the introduction of acid-etch bonding systems by Buonocore in 1995 [1], direct bonding of orthodontic brackets to teeth was made possible; orthodontic treatmentwasthen simplified, gingival irritation decreased, oral hygiene habits became easier, esthetic needs of the patients were better achieved and orthodontic visits decreased [2]. Acid etchingcreates rough surfaces that enable micromechanical retention; enamelcrystalsbecome prismaticand adherent. However, there is still a need to improve resinsand theirresistance to saliva contamination during bonding to reduce the incidence of failure. [2]

Manufacturers have tried to increase fluoride release levels from the adhesives to prevent the incidence of white spot lesionswhile maintaining high-bond strength values. Glass ionomer cements have been found to release fluoride in the long-term, and the amountof fluoride released from them ismore

than that of fluoride-releasing composites [3-5]. Although adequate fluorideis released from these cements, their bond strengthsare poor (2.37-5.5 MPa) [6-7]. Different combinations of glass ionomer cements and composite resins were tried for bonding brackets to the enamel surfaces. Resin modified glass ionomer cements are similar to glass ionomer cements regarding fluoride release; however, their bond strength values havebeen reported to be in the range of 5.39-18.9 MPa [8-11]. Bond strength values reported for the polyacid-modified composite resins were in the range of 7.3-11.97 MPa [12-13].

Conventional composite resins need completely dry surfaces to achieve clinically acceptablebond strength values; however, complete isolation of the bonding site against moisture is not possible during bracket bonding [14] and salivacontamination is always probable during the process of etching the enamel surface or after using primers. [15] In the case of contaminated enamel surfaces prior to primer application, the developed porosities following acid etching areclosed off and the enamel surface energy will be decreased.Due to impaired resin penetration anddecreased micromechanical retention, substantial reductions occur in the bond strength of resin to etched enamel [16]. To solve this problem, some moisture-resistant primers have been developed.

According to astudy byFaltermeier and colleagues in 2007, Transbond XT showed no significant difference in shear bond strength underdry conditions. However, the bond strength was clinically unacceptable using Transbond XT after saliva and blood contamination. [17]

Saliva contamination control anduse of materials that form proper bondsin the presence of saliva are needed. Also, with the introduction of lingual brackets, we need products that release fluoride to reduce white spot lesions.

Assure Universal Bonding Resin is a new system with fluoride releasing properties. Assure hydrophilic resin system (Reliance, Itasca, III) was examined under saliva-contaminated conditions and bond strength values were found to be clinically acceptable. [14, 15]

The currentstudy compared the bond strength of Transbond XT (3M Unitek), and Assure Universal Bonding Resin (Reliance orthodontic products, Itasca, IL) to dry and saliva-contaminated enamel.

Materials and Methods

Sixty human premolar teeth without carious lesions, fracture, crack or attrition were collected and stored in distilled water untilthe experimentation. They were randomly allocated tothree equal groups and their buccal crown surfaces were polished with pumice paste for 15 seconds, rinsed and dried. Stainless steel metal premolar brackets were bonded to the teeth with different adhesives.

Stainless steel brackets (AO, American Orthodontics) (12.68 mm^2) were used in this study. They were bonded to the enamel surfaces of the teeth with light-cured Transbond XT (3M) composite in the control specimens. In this group, the buccal enamel surfaces wereetched with 37% phosphoric acid for 30 seconds, rinsed for 20 seconds, and dried with oil-free air until the enamel became white. Transbond XT primer was applied to the etched surface in a thin film and Transbond XT composite was applied to the bracket base. The bracket was then positioned exactly on the tooth and compressed to expel the excess adhesive. The specimens were cured for onesecond to obtain adequate appearance. Then, additional adhesives were removed from around the brackets' base followed by another round of light curing for 10 seconds. All these were done according to the manufacturer's directions.

In the first experimental group, Assure Universal Bonding Resin (Reliance orthodontic products, Itasca, IL) was used. All etching, rinsing and drying procedures were done according to Transbond XT protocol. Assure sealant was appliedin two-coats tothe buccal crown surface, left for 10 seconds, and dried slowly. Assure adhesive and Transbond XT composite wereapplied to the bracket base, and the bracket was positioned exactly on the tooth and compressed to expel the excess adhesive. The specimens were cured for onesecond to obtain adequate appearance. Then, excess adhesives were removed from around the brackets' base followed by another round of light curing for 10 seconds.

In the secondexperimental group, all etching, rinsing and drying procedures were done according to Transbond XT protocol; however, before sealant

application, a thin layer of natural saliva was applied to the enamel surface. The saliva was collected by the operator after teeth washing and not eating any food for onehour. The brackets were bonded similar to the previous group.

After bonding, all specimens were immersed in chloramine T solution for 24 hours at 37°C followed by storage in an incubator for oneweek at 37°C temperature. The specimens were thermocycled at 5°C-50°C for 1000 cycles (each cycle for 30 seconds). Each specimen was then mounted in a custom device by means of 17×25 wire. Shear loads wereapplied to the specimens at a crosshead speed of 1mm/min and 0.5 N preload force by means of Zwick machine (Zwick Roell, Germany) until bracket debonding occurred. The debonding force was recorded. Shear bond strength forces were calculated by testXpert V11.0 (Zwick Roell, Germany) software inMegapascals by dividing force (N) to bracket base area (mm^2).

The debonded enamel surfaces were examined by a stereomicroscope at10× magnification and the residual adhesive remaining on the teeth was scored from 0 to 5using the adhesive remnant index (ARI):

Scale 5: Adhesive and resin remained on 100% of the bracket surface

Scale 4: Adhesive and resin remained on 75%-100% of the bracket surface

Scale 3: Adhesive and resin remained on 50%-75% of the bracket surface

Scale 2: Adhesive and resin remained on 25%-50% of the bracket surface

Scale 1: Adhesive and resin remained on less than 25% ofthe bracket surface

Scale 0: No adhesive and resin remained on the bracket surface [14].

The shear bond strength values were analyzedby one-way ANOVA and the Kruskal Wallis test was used to assess significant differences in ARI.

Results

The shear bond strength of brackets to the enamel surfaces was16.13±5.49 MPa (range 7.66-27.32 MPa) when bonded with Transbond XT; these values were 14.18±4.78 MPa (range 7.54-25.82 MPa) for the specimens bonded with Assure Universal Bonding Resin and 13.32±4.74 MPa (range 5.6-26.9 MPa) for those bonded with Assure Universal Bonding Resin in the saliva-contaminated enamel surfaces. One-way ANOVA showed no significant differences regarding the shear bond strength of the brackets to the teeth using Transbond XT light-cured composite, Assure and Assure in the saliva-contaminated enamel (p=0.2) (Table 1).

Table 1: Minimum, maximum, mean and standard deviation of the adhesive bond strength tostainless steel brackets using Transbond XT and Assure (dry and wet enamel)

Group	N	Minimum	Maximum	Mean Std.Deviation
Transbond XT	20	7/66	27/32	16/13±5/49(a)
Assure	20	7/54	25/82	16/13±5/49(a)
Assure/Salvia	20	5/6	26/9	16/13±5/49(a)

A indicates lack of a significant difference (P>0.05)

Different valuesof ARI using Assure, Transbond XT and Assure in saliva contaminatedgroups are presented in Table 2. Non-parametric Kruskal-Wallis test showed no significant differences in ARI among groups (p=0.053). ARI was 2 in Assure dry enamel group, 4 in the wet enamel group and 3in the Transbond XT group. InAssureon dry enamel and Transbond XT groups, the failure rate between the bracket - adhesive and enamel - adhesive wasrelatively equal. In the group of Assure on wet enamel, higherfailure rate between the enamel - adhesive was noted.

SEM results

As seen in Figures 1 and 2, the enamel surface under the bracket in Assure dry enamel and Transbond XT was the same. But in Assure wet enamel group a rough surface with circular holes that are likely to be related to saliva trapped in the holes, can be seen.

Discussion

One of the main causes of bracket bond failure is contamination during the bonding process. It has been found that the presence of water [19, 20] or saliva [19, 21-22] can decrease the bond strength in orthodontic resin bonding systems. In the currentstudy, the shear bond strengths of stainless steel brackets to the enamel bonded with Transbond XT and Assure in dry conditions were

16.13±5.49 MPa and 14.18±4.78 MPa, respective- ly; while the bond strength decreased to

Table 2: Frequency of different values of ARI using Transbond XT and Assure (dry and wet enamel)

-			ARI						Total
			.00	1.00	2.00	3.00	4.00	5.00	
Group	**Assure**	Count	0	1	8	6	4	1	20
		%within group	0%	5/0%	40/0%	30/0%	20/0%	5.0%	100/0%
	Transbond	Count	1	1	6	7	5	0	20
		%within group	5/0%	5/0%	30/0%	35/0%	25/0%	0%	100/0%
	Saliva	Count	1	0	3	4	10	2	20
		%within group	5/0%	0%	15/0%	20/0%	50/0%	10.0%	100/0%
Total		Count	2	2	17	17	19	3	60
		%within group	3/3%	3/3%	28/3%	28/3%	31/7%	5.0%	100/0%

SEM results

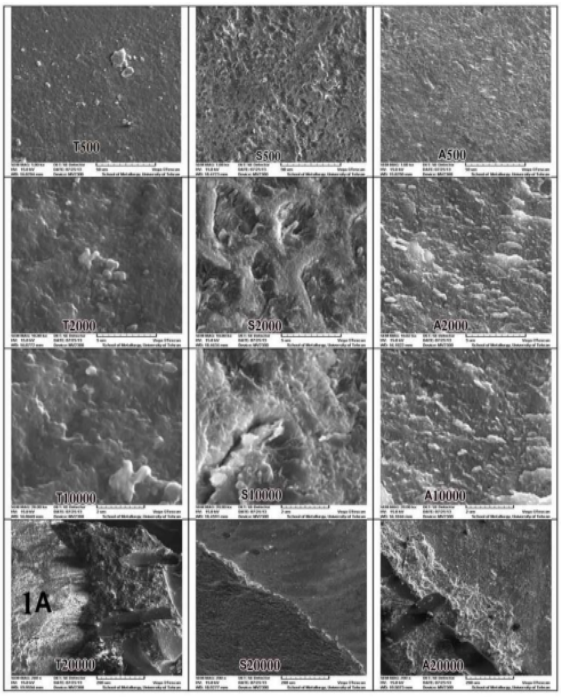

Figure 1: From left to right, enamel surface under orthodontic bracket respectively: Transbond XT, Assure on wet enamel, Assure on dry enamel. Magnification 500X (The first column),2000X(the second column),10,000X(the third column),20,000X(the fourth column). Trans bond XTgroup has a smooth surface;in Assure on wet enamelgroup, surface is uneven and many round holes can be seen.

13.32±4.74 MPa in the saliva-contaminated teethusing Assure system although with no significant difference. Therefore, saliva contamination did not cause significant decreases in the shear bond strength of brackets to enamel surfaces. In other

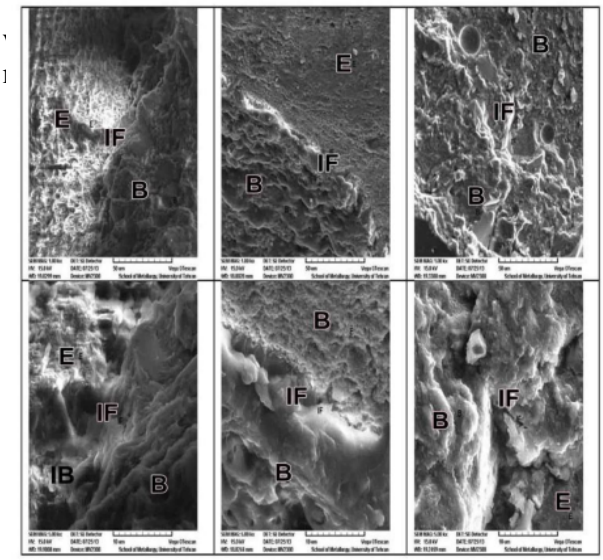

Figure 2: From left to right: Trans bond XT, Assure on wet enamel, Assure on dry enamel, enamel interface with orthodontic bracket, respectively. B=bracket, IF=interface, E=enamel.

underdry and saliva-contaminated conditions did not lead toobvious changes in the shear bond strength of brackets to the enamel surfaces of theteeth. It seems that Assure hydrophilic primer isable to tolerate saliva contamination of etched enamel. As suggested by the manufacturer, Assure universal bonding agent with the fluoride-releasing potential can bond to normal, atypical, dry, or slightly contaminated enamel. Furthermore, it can

be used with any light- or chemical-curing systems.

Other studies regarding the bond strength of bonding systems underthe saliva-contaminated conditions have reported controversial findings; some have noted an increase in bond strength values [23, 24], whileothers found no significant changes [25] or a significant decrease. [26] Differences in the experimental protocols, use of artificial or human saliva as well as the quantity of the applied saliva can explainsuchdifferent results. In addition, the composition of saliva can be different based onthe conditions under which it was produced.

The other possible reason can be the presence of water in the composition of hydrophilic primers. All these can affect bond strength of the brackets to the enamel.

Rix et al. (2001) reported higher bond strength values for Transbond XT specimens; although adequate bond strength of brackets to the enamel was noted in their study when bonding with Assure indry and wet conditions (10.74 MPa and 10.99 MPa); similar to our findings [27]. They showed that bond strength of the Assure adhesive was not significantly affected by dry orwet conditions. In contrast to our results, Oztoprak et al. (2007) showed that saliva (10.66 MPa versus 16.4 MPa) and blood contamination (6.83 MPa versus 16.4 MPa) significantly decreased bond strength values compared to dry conditions [23]. Furthermore, Webster et al. (2001) reported the Assure system to show more tolerance against saliva contamination similar to our study results [28]. Again, Schaneweldt et al. (2002) concluded that the bond strength of Assure and MIP primers are not affected by saliva contamination [15]. Similarly, Nemeth et al. (2006) reported that bond strength of Assure to enamel contaminated with saliva is better than other materials [21]. It seems that bonding to bothdry and wet enamel surfaces depends on the material itself and sufficientbond strengths to wet and saliva-contaminated enamel surfaces can be achieved using appropriate materials.

The reported bond strength in different studies maybe related to the factors such as thermocycling tests, bond strength testing machines, direction of the force applied to debond the brackets, the crosshead speed, bracket type, standardization of moisture application, quality and quantity of the products as well as thediversity in the used materials and methods [29].

In routine orthodontic practice, achievement of adequate bond strength for safe debonding is more favorable than obtaining the maximum possible bond strength [30]. Therefore, ARI scores are used in different studies to determine the site of bond failure between the enamel, the adhesive, and the bracket base via observation of the remaining composite on the enamel surfaces. In orthodontic bond strength examinations, cohesive failures in the composite (ARI score 3) indicate the internal strength of the composite rather than the adhesion to the surface under investigation [31]

In the currentstudy, the frequency of ARI scores of 2 (40%) and 3 (30%) washigher for Assure composite system; ARI scores of 3 (25%) and 2 (30%) were found frequently in Transbond XT and scores of 4 (50%) and 3 (20%) were higher for Assure in the saliva-contaminated conditions. When bonding to wet enamel, higher scores of ARI were recorded suggesting unfavorable bonding atthe bracket-adhesive interface. According to the SEM results, the mentioned finding is likely due to the accumulation of saliva in the area and creation ofbubbles under the brackets reducing the enamel - bracket bond strength and increasing failures in this area.

Conclusion

Bonding stainless steel brackets to the enamel surfaces with Assure Universal Bonding Resin produced adequate bond strength in bothdry and saliva-contaminated conditions. Thus, it can be used for bonding orthodontic brackets to the enamel surface in the clinical setting.

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