International Journal of Applied Dental Sciences 2020; 6(1): 179-182


**ISSN Print:** 2394-7489
**ISSN Online:** 2394-7497
IJADS 2020; 6(1): 179-182

www.oraljournal.com
Received: 25-11-2019
Accepted: 27-12-2019

**Sreeshna P**
Post Graduate Student, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Anjali Narayan**
Reader, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Nazima Jamal**
Post Graduate Student, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Sindhu**
Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Suresh S Nair**
Senior Lecturer, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Sandhya P**
Post Graduate Student, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

**Corresponding Author:**
**Sreeshna P**
Post Graduate Student, Department of Orthodontics and Dentofacial Orthopedics, M.R Ambedkar Dental College and Hospital, Bangalore, Karnataka, India

# Evaluation of shear bond strength of two light cure adhesives with three different primers: A comparative *in vitro* study

**Sreeshna P, Anjali Narayan, Nazima Jamal, Sindhu, Suresh S Nair and Sandhya P**

**Abstract**
The bond strength of the orthodontic brackets should be able to withstand the forces applied during the orthodontic treatment and also permit easy removal of the brackets without damage to enamel surface. In the study a significant statistical difference existed with three different primers along with two different adhesives bonded on 60 upper premolar teeth with Gemini metal brackets by ANOVA test. Tran's bond XT primer showed significantly greater SBS than the Assure primer and Ortho Solo Universal Sealant. Higher ARI scores noted with Trans bond XT along with Trans bond XT primer. Shear bond strength of Assure primer is comparable with the conventional Trans bond XT primer.

**Keywords:** Shearbond strength, universal testing machine, adhesive, primer, adhesive remanant index

## 1. Introduction
Trends in Orthodontics, as in any other sphere of human activity, are to simplify technical procedures so that the objective can be achieved with minimum effort. As the orthodontic specialty advances with time, several new concepts are emerging some of which become the state of the art now, while others may become in the near future. Rest of the ideas require further refinements and developments. Material science, related to Orthodontics, has seen a sea change in the last decade. While listing the important landmarks, bonding would figure high in the list. The introduction of the acid etch technique by Buonocore[1] in 1955, and the development of orthodontic resins by Newman in 1965, has replaced banding with bonding, marking a new era in Orthodontic therapy.

Shear bond strength (SBS) is the main factor, which has to be concerned in the evolution of bonding materials. The bond strength of the orthodontic bracket must be able to withstand the forces applied during the orthodontic treatment. Reynolds [2] stated that 5.9-7.8 MPa resistances are sufficient to withstand masticatory forces. On further investigation a shear bond strength of 10.4±4.4 MPa was considered clinically acceptable [5]. An ideal orthodontic adhesive should have adequate bond strength while maintaining unblemished enamel after debonding.

Conventional adhesive systems use 3 different agents (an enamel conditioner, a primer solution, and an adhesive resin) during the bonding of orthodontic brackets to enamel. The use of acid etchants followed by a primer has been an essential part of the bonding procedure of composite adhesives to allow good wetting and penetration of the sealant into the enamel surface [3, 4]

The viscosity of orthodontic primer and penetration of the resin into the bracket base interface could influence orthodontic attachment to the enamel surface. The strength and physical properties of the resin tags are determined by the degree of penetration. The greater the ability to flow, the higher the degree of penetration and the higher the bonding strength. Low viscosity cement could, therefore, penetrate into pores effectively compared to high viscosity cements. However, adhesive resin materials with very low viscosity and high flow rate are not ideal for bracket bonding [5].

Transbond XT primer contains 45-55% of Bisphenol A diglycidyl methacrylate (Bis-GMA) and 45% 55% of Triethylene glycol dimethacrylate (TEGDMA).

Bis-GMA is a large molecule and has a high viscosity value at room temperature.

New materials and items of equipment regularly appear, with the purpose of simplifying the procedure and making it faster, however, without losing the quality necessary for attaching the accessory to the tooth, and enabling it to resist the masticatory forces as well as those of orthodontic mechanics.

In 1998, several hydrophilic primers were introduced. Ortho Solo (Ormco), Assure (Reliance Orthodontic Products), and MIP (3MUnitek) were hydrophilic bonding resins that bonded well to wet or dry enamel making the bonding procedure more forgiving. In addition, Assure would bond to atypical enamel such as fluorosed enamel, aprismatic enamel, and primary enamel and to dentin [6].

Ortho Solo is a fluoride-releasing universal sealant and bond enhancer. It is composed of dimethacrylate resins, barium glass, fumed silica, sodium hexafluorosilicate, and ethanol. According to the manufacturers, Ortho Solo incorporates a bond-enhancing property that improves adhesion to the tooth at the adhesive interface, hence reducing bond failures. The glass filler, unique to Ortho Solo, acts as a stress and shock absorber, preventing cracks that can lead to bond failure [7].

Assure Universal Bonding Resin is a relatively new product with fluoride-releasing potential and has been reinforced with resin cement. It is composed of Biphenyl Dimethacrylate, Hydroxyethyl methacrylate and Acetone.Assure hydrophilic resin (by Reliance) has been reported to have adequate bond strength under humid conditions. It can bond to roughened surface (amalgam, gold and stainless steel) and composite with no need for an extra primer [8]. However, further studies are still required in this regard since documented evidence is lacking regarding the accuracy of the manufacturers' claims.

As this study aims to investigate the usability of Assure primer ® (Reliance orthodontics), A hydrophilic primer with two different light cure adhesives for orthodontic bracket bonding where Transbond XT primer and Ortho Solo sealant could possibly function as a comparison.

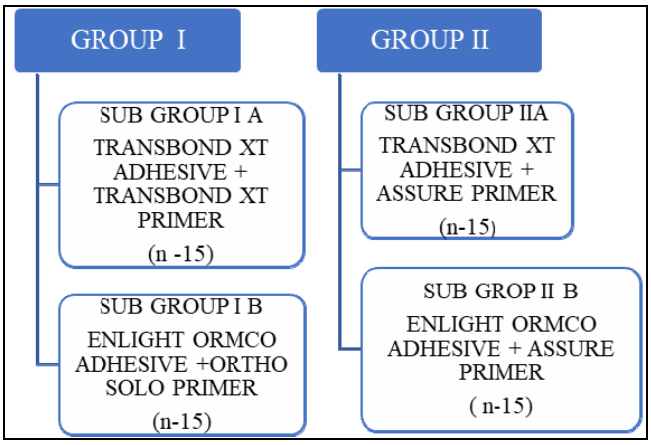
The current need of testing the numerous materials used to bond orthodontic brackets justifies this present study, whose aim was to analyse and compare *in vitro* the shear bond strength of Assure primer with two different light cure adhesive for bonding of orthodontic brackets as well as to evaluate the enamel conditions after the debonding, through Adhesive Remnant Index determination.

## 2. Materials and Methods

### 2.1: Materials

- In this study, 60 human maxillary premolar teeth, extracted from patients undergoing routine extractions after taking their consent, at the Department of Oral and Maxillofacial Surgery, M. R. Ambedkar Dental College and Hospital, Bangalore were obtained. Decayed teeth, Fluorosed teeth, Attrited teeth, Restored teeth. Hypoplastic teeth and fractured teeth were excluded.
- MBT, 0.022 inches slot, premolar bondable metal brackets (Gemini series, 3M Unitek, USA).
- Etchant: 37% orthophosphoric acid.(Scotch bond,3M)
- Primers:
- Transbond™ XT Primer (3M Unitek, USA)
- Ortho Solo Universal Sealant and Bond Enhancer.(Ormco)
- Assure primer(Reliance USA)
- Adhesives:
- Transbond™ XT Adhesive.
- Enlight Ormco light cure adhesive.
- Light curing unit (3M ESPE Elipar ™ S10)
- Universal testing Machine

### 2.2 Grouping




Grouping

### 2.3 Shear bond strength testing

The buccal surface of the crowns of the teeth was polished with non-fluoridated pumice and water. The roots of these teeth was mounted in a cubic mold which was made of chemically cured acrylic resin such that the labial surface of the crown was perpendicular to the base of the mold. These were divided into three groups of fifteen each. The enamel was etched with 37% phosphoric acid for 30 seconds and the teeth rinsed with water and dried with oil free air for 10 seconds. The enamel should exhibit a frosty, white appearancce. For each experimental group, respective adhesive primer was applied on the etched surface. Transbond XT Primer. A thin layer of the primer coat was applied and gently thinned with air. The primer was then light cured for 10 seconds. Assure Primer. Each tooth received 2 coats of Assure primer. After a 10-second wait, the primer was gently dried with contaminant-free air and then light cured for 10 seconds. Ortho Solo Sealant, Ormco: The Primer was applied on the etched surfaces and light cured for 10 seconds. The metal brackets were placed on the tooth and bonded with the respective adhesives for the respective subgroups and were cured with a LED curing light for 10 seconds. (3M Elipar S 10). An occluso-gingival load was applied to produce a shear force at the bracket-tooth interface. This was accomplished with the flattened end of a steel rod attached to the crosshead of a Universal Testing Machine. The bond strengths were measured at a crosshead speed of 1 mm/min, and the load applied at the time of fracture was recorded in Newton and then calculated by dividing the debonding force by the bracket base surface area yielding Mega pascals (MPa) as a unit.

### 2.4 Adhesive remnant index

The sheared surfaces and base of the bracket was further investigated with a stereomicroscope (LYNX) at 5x magnification to assess the adhesive remnants on the specimen surface. The adhesive remnant index (ARI) as described by Artun and Bergland (1984) [11] was used for this assessment. ARI scores were used as a means of defining the sites of bond failure between the composite surface, resin (adhesive), and the bracket base. The scoring of which is as follows:

- **Score 0:** No adhesive remained on the surface.
- **Score 1:** Less than 50% of the adhesive remained on the surface.
- **Score 2:** More than 50% of the adhesive remained on the surface.
- **Score 3:** All adhesive remained on the surface.

## 3. Results and Discussion

**Table 1:** Multiple comparison of mean difference in shear bond strength between different adhesives for metallic brackets using Tukey's Post hoc Analysis

| (I) Groups | (J) Groups | Mean Diff. (I-J) | 95% CI for the Diff. | | P-Value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Transbond XT + XT Primer | Enlight Ormco + Solo Primer | 4.047 | 2.410 | 5.683 | <0.001* |
| | Transbond XT + Assure Primer | 0.375 | -1.262 | 2.012 | 0.93 |
| | Enlight Ormco + Assure Primer | 2.062 | 0.426 | 3.699 | 0.008* |
| Enlight Ormco + Solo Primer | Transbond XT + Assure Primer | -3.672 | -5.308 | -2.035 | <0.001* |
| | Enlight Ormco + Assure Primer | -1.985 | -3.621 | -0.348 | 0.01* |
| Transbond XT + Assure Primer | Enlight Ormco + Assure Primer | 1.687 | 0.051 | 3.324 | 0.04* |

*-Statistically Significant

**Table 2:** Comparison of mean Shear Bond Strength (in Mpa) between different adhesives for Metallic Brackets using One-way ANOVA Test

| Adhesives | N | Mean | SD | Min | Max | P-Value |
|---|---|---|---|---|---|---|
| Transbond XT + XT Primer | 15 | 13.067 | 1.232 | 11.01 | 14.88 | <0.001* |
| Enlight Ormco + Solo Primer | 15 | 9.020 | 0.598 | 7.99 | 9.90 | |
| Transbond XT + Assure Primer | 15 | 12.692 | 2.479 | 9.57 | 17.40 | |
| Enlight Ormco + Assure Primer | 15 | 11.005 | 1.854 | 8.36 | 14.12 | |

**Table 3:** Comparison of Adhesive Remnant Index (ARI) scores between different combinations of adhesive and primers using Chi Square Test

| ARI | Transbond XT + XT Primer | | Enlight Ormco + Solo Primer | | Transbond XT + Assure Primer | | Enlight Ormco + Assure Primer | | P-Value |
|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | n | % | N | % | |
| Score 0 | 0 | 0.0% | 5 | 33.3% | 1 | 6.7% | 8 | 53.3% | <0.001* |
| Score 1 | 8 | 53.3% | 10 | 66.7% | 9 | 60.0% | 7 | 46.7% | |
| Score 2 | 7 | 46.7% | 0 | 0.0% | 5 | 33.3% | 0 | 0.0% | |
| Score 3 | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | |

*-Statistically Significant

**Table 4:** Multiple group comparison for difference in ARI Scores using Chi Square Test

| (I) Groups | (J) Groups | P-Value |
|---|---|---|
| Transbond XT + XT Primer | Enlight Ormco + Solo Primer | 0.002* |
| | Transbond XT + Assure Primer | 0.50 |
| | Enlight Ormco + Assure Primer | 0.001* |
| Enlight Ormco + Solo Primer | Transbond XT + Assure Primer | 0.02* |
| | Enlight Ormco + Assure Primer | 0.27 |
| Transbond XT + Assure Primer | Enlight Ormco + Assure Primer | 0.005* |

*-Statistically Significant

### 3.1 Discussion

In orthodontic bonding, tooth surface conditions and type of bonding material greatly affect bond strength. Clinically acceptable bond strengths have been reported to range from 6 to 8 MPa [2]. These bond strengths are considered to be able to withstand masticatory and orthodontic forces. In this experiment, mean bond strengths were well above this minimal requirement, and all combinations of bonding adhesives, with or without saliva contamination, resulted in sufficient bond strengths. However, there were variations in bond strengths with different combinations of adhesive and primers used in this study. Groups were bonded with two conventional adhesives (Transbond XT and Enlight) in combination with three different primers (Ortho Solo sealant, Transbond XT and Assure) with Transbond XT light primer, being a material used as control in several studies available in the literature. The bond strength for the control composite Transbond XT with XT primer, at 13.067 MPa, was significantly greater than the bond strengths of the other adhesive and primer combinations in this study.

One way ANOVA test revealed that the different groups exhibited different bond strengths which were statistically significant. There was statistically significant difference in the shear bond strength between the groups tested in the study.

In the present study on comparing the shear bond strength of the different groups with each other using post hoc Tukey test statistically significant ($P$<0.001) difference in the shear bond strength was found among the groups.

Shearbond strength of Transond XT primer and Assure primer showed no statistically significant difference on application along with Transbond XT adhesive. Transbond XT primer and Assure primer showed a stastically significant difference with Ortho Solo sealent.

In contrast, another study [9] showed no statistically significant difference in the mean SBS among the primers Trans bond XT and Ortho Solo primer.

Supporting the present study, a study [10] was done to compare the shear bond strengths of Assure and Transbond XT with XT primer. The enamel surface was etched, primed, and moistened with artificial saliva; there existed no significant

differences between Assure and Transbond XT. Bonding Transbond XT to a surface that was contaminated after the primer had been placed yielded an adequate bond strength, indicating that the adhesive was able to bond adequately to a primed surface that was contaminated. This may be due in part to the fact that the resin was light cured before the contamination contamination occurred, and that its hydrophobic capabilities were possibly able to prevent the saliva from diluting or penetrating its surface.

Another study [8] compared the shear bond strength of Transbond XT and Assure Universal Bonding Resin to stainless steel brackets, amalgam and porcelain. The results of two-way ANOVA showed that the effect of type of material (stainless steel bracket, amalgam and porcelain) on microshear bond strength values was significant but the effects of type of bonding agent (Assure and Transbond XT) on bond strength values were not statistically significant. It indicates that despite the manufacturers' claims, Assure does not chemically bond to stainless steel and the existing bond is only mechanical. Such higher bond strength may be attributed to the size of porosities on the bracket surface and optimal consistency of Transbond XT.

In the present study, the SBS of all groups exhibited higher values than the minimum orthodontic bracket bond strength as suggested by Reynolds and therefore, could be considered sufficient for clinical application. In this study Ortho Solo sealent showed lesser ability to resist bond failure and shear bond strength when compared to Assure primer and Transbond XT primer.

The ARI scores were also used to assess the sites of bond failure on the enamel□adhesive interface and the adhesive□bracket interface [11]. On multiple comparision, Transbond XT primer and Assure primer showed no stastically significant difference in combination with Transbond XT adhesive. Similarly, Assure primer and Ortho Solo sealant showed no stastically significant difference in combination with Enlight adhesive. Enlight adhesive with Ortho Solo sealant displayed a high frequency of enamel fracture on debonding and indicating that the bond strength at the enamel adhesive interface is higher than that of at the bracket adhesive interface with no adhesive left on the tooth. Transbonxd XT primer showed bond failure at the adhesive bracket interface resulting in reduced enamel fracture. Assure primer displayed a balance between failure at the enamel-adhesive interface and the enamel-bracket interface, indicating more cohesive failure.

## 4. Conclusion

Hydrophillic primers (Assure and Ortho Solo sealant) were compared with a hydrophobic primer (Transbond XT primer) for *in vitro* shear bond strength and location of adhesive failure. The extent of enamel cracking upon debonding of orthodontic brackets was also investigated. The findings were as follows:

1. Acceptable shear bond strength was achieved by all three primers for clinical application; Transbond XT primer, Ortho Solo sealant and Assure primer
2. Transbond XT primer has a significantly higher shearbond strength. Assure primer had a comparable shearbond strength with Transbond XT primer.
3. Assure universal primer had a higher shearbond strength than the conventional hydrophilic Ortho Solo sealant.
4. Transbonxd XT primer showed bond failure at the adhesive bracket interface resulting in reduced enamel fracture and Ortho Solo sealant showed bond failure at the enamel adhesive interface increasing the risk of enamel fracture.
5. Assure primer displayed a balance between failure at the enamel-adhesive interface and the enamel-bracket interface in combination with different bonding adhesives.

Results of this study can only be used as a guideline in choosing the right bonding system for clinical practice and a sound base for further investigation.

## 5. References


1. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surface. J Dent Res. 1955; 34:849-853.
2. Reynolds I. A review of direct orthodontic bonding. Br J. Orthod. 1975; 2:171-178.
3. Barkmeier WW, Erickson RL. Shear bond strength of composite to enamel and dentin using Scotch bond multi-purpose. Am J Dent. 1994; 7(3):175-9.
4. Triolo PT JR, Swift EJ JR, Mudgil A, Levine A. Effects of etching time on enamel bond strengths. Am J Dent. 1993; 6(6):302-4.
5. Frankenberger R, Lopes M, Perdigao J *et al*. The use of flowable composites as filled adhesives. Dent Mater. 2002; 18:227-238.
6. Gange P. The evolution of bonding in orthodontics Am J Orthod Dentofacial Orthop. 2015; 147(4):S56-63.
7. Türkkahraman H *et al*. *In vitro* evaluation of shear bond strengths of colour change adhesives. Eur J Orthod. 2010; 32:571-574.
8. Eslami Amirabadi *et al* Microshear Bond Strength of Transbond XT and Assure Universal Bonding Resin to Stainless Steel Brackets, Amalgam and Porcelain ;Journal of Islamic Dental Association of IRAN (JIDAI) Spring. 2015; 27:(1).
9. Hadrous R, Bouserhal J, Osman E. Evaluation of shear bond strength of orthodontic molar tubes bonded using hydrophilic primers: An *in vitro* study. Int. Orthod. 2019; 17(3):461-468
10. Schaneveldt S, Foley TF. Bond strength comparison of moisture-insensitive primers.Am J Orthod Dentofacial Orthop2002; 122(3), 267–273.
11. Artun J, Bergland S. Clinical trials with crystal growth conditioning as an alternative to acid-etch enamel pretreatment, Am J Orthod. 1984; 85:333-40.