Comparison of Shear Bond Strength of Orthodontic Color Change Adhesive with Traditional Adhesive

Abstract

Introduction: The purpose of this study was to compare the shear bond strength of color-change adhesive with a conventional light-cure adhesive at different debonding times. Materials and Methods: Seventy-two intact extracted human permanent premolar teeth were used in this research. The brackets were bonded with Transbond XT (Group I) and Transbond Plus color change adhesive (Group II). Each of the two adhesive groups were then further divided into three subgroups of 12 specimens each, for a total of six subgroups. The subgroups represented the three different time points to be tested, 15 min, 24 h, and 1 week. Then, the shear bond strength (SBS) of the brackets was tested with a Universal Testing Machine. Adhesive remnant index (ARI) scores were calculated for each debonded teeth. Results: Although Transbond XT yielded the lowest SBS values at 1 week, there was no significant difference between samples regarding shear bond at different times and ARI. Conclusion: The application of these adhesives did not affect bond strength. Both adhesives demonstrated acceptable bond strength to withstand orthodontic forces throughout the experiment.

Keywords: Adhesive remnant index, color change adhesive, shear bond strength

Introduction

Bracket bonding is one of the most important procedures in orthodontic treatment. The adhesive force should be high enough to keep the bracket in position, but not too strong to cause damage on debonding.

Reynolds suggests that shear strength should be 6–8 MPa. This adhesive force would be clinically effective and minimize the risk of enamel fracture. Amongst the latest products in this field are color change adhesives (CCAs). Bonding brackets can increase the accumulation of dental plaque that can cause carious lesions and gingival inflammation. Most of the bonding adhesives are similar to enamel color, one of the most advantage of these CCAs is visibility of any adhesive remnant at bracket seating as well as identifiable cleanup of adhesive remnants after debonding.

The aim of this study was to compare shear bond strength (SBS) of Transbond Plus CCA (3M Unitek, Monrovia, California, USA) with traditional light cure adhesive Transbond XT (3M Unitek, Monrovia, California, USA). The condition was tested at 15 min, 24 h, and 1 week to investigate longevity.

Materials and Methods

Seventy-two intact extracted human permanent premolar teeth were used. Each tooth was embedded in autopolymerizing acrylic resin (Meliodent; Heraeus Kulzer, Hanau, Germany). The specimens were kept in distilled water at room temperature except during the bonding and testing procedures. Before bonding, the facial surfaces of the teeth were cleaned with water and pumice. Each tooth was etched with 37% phosphoric acid (Gel etch®, 3M Unitek) for 30 s, rinsed for 30 s, and dried until a frosty white etched area was observed. Premolar metal brackets (3M Unitek Victory Series) were used. The minimum sample size for 0.75 power of the study was statistically calculated as 12; therefore, teeth were divided into two equal groups.

Group 1: Transbond XT Primer (3M Unitek) was applied to each tooth surface. A small amount of Transbond XT adhesive paste was applied to the bracket base.

Group 2: The brackets were bonded with Transbond XT Primer and Transbond Plus CCA.

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After application of the adhesive, the brackets were placed onto the tooth surface and pressed firmly. Excess adhesive was removed and cured with an Ortholux LED (3M Unitek) for 20 s. Each group were then divided into three subgroups of 12 specimens each, for a total of six subgroups. The subgroups represented the three different time points to be tested at 15 min, 24 h, and 1 week.

Each specimen was loaded into a Universal Testing Machine (Testometric, M350-10CT, UK). Bond strength was determined in shear mode at a crosshead speed of 1 mm/min until fracture occurred. Failure load values (N) were recorded and converted into megapascals (MPa) by dividing the failure load (N) by the surface area of the bracket base (9.63 mm²). The subgroups that were to be debonded at 24 h and at 1 week were placed in containers with distilled water and stored at 37°C to simulate the oral environment before testing.

The data were analyzed using two-way analysis of variance and with Fisher’s protected least significant difference multiple comparisons test at the 0.05 level of significance. After debonding, all teeth and brackets in the test groups were viewed using a light stereomicroscope at ×10 magnification to determine the bracket failure interface. Any adhesive remaining after debonding was assessed and scored according to the modified adhesive remnant index (ARI). The ARI was developed by Artun as a four-point scale to assess the amount of adhesive remaining on the tooth surface after debonding [Table 1].

### Results

Transbond Plus at 1 week had the highest mean SBS at 15 MPa, and Transbond XT tested at 1 week had the lowest mean SBS of 13.8 MPa [Table 2].

There were no significant differences in SBS for the main effects of different debonding times (P = 0.43).

There were not significantly different effects in SBS among the adhesive types (P = 0.18).

Both Transbond groups had >50% of samples with ARI scores of 3. Twenty-five percent of the Transbond XT samples had an ARI of score of 0 only at 24 h [Table 3].

### Discussion

Plaque accumulation around the brackets is important in orthodontic treatments since the orthodontic brackets may be responsible for caries and gingival inflammation.

Many adhesives completely polymerize in 24 h. Thus, these three time periods were specifically included to evaluate the immediate, 24 h, and slightly longer follow-up stages. Time had no statistically significant effect on the bond strengths of the adhesives. Ekhlassi et al. yielded similar findings. Bayani et al. measured the mean SBSs of 3 adhesives in the range of 14.0–27.5 in 20 s curing time. Unlike the present study, the SBS of Transbond Plus was significantly lower than Resilience adhesive.

The bond strengths of all the adhesives ranged from 13.8 mPa to 15 mPa. These were higher than the 6–8 MPa formerly reported as a sufficient bond strength for the orthodontic treatment. Higher bond strengths can cause a greater risk of enamel fracture on debonding. As all the groups had a SBS well above minimally acceptable level, we recommended the use of self-etching primers instead of etch and rinse.

In orthodontics, maintaining an intact enamel surface is important. To reduce the risk of enamel damage, bond failure at the bracket–adhesive interface or within the adhesive is more desirable than at the adhesive–enamel junction. The ideal bonding system would leave a healthy enamel surface without large amounts of adhesive to remove.

ARI index 3 is the safest one and the chance of dental damage is less likely. We found that for all groups the

### Table 1: Adhesive remnant index

| Score | Quantity of adhesive bonded to enamel |
|-------|--------------------------------------|
| 0     | No adhesive left on the tooth         |
| 1     | Less than half of the adhesive left on the tooth |
| 2     | More than half of the adhesive left on the tooth |
| 3     | All adhesive left on the tooth with a distinct impression of the bracket mesh |

### Table 2: Mean bond strengths (mPA) of two adhesives with respect to time

| Adhesive     | 15 min | 24 h | 1 week |
|--------------|--------|------|--------|
| Transbond™ XT| 14.7   | 14   | 13.8   |
| Transbond Plus| 14.6 | 14.8 | 15     |

### Table 3: Adhesive remnant index scores for adhesives for all time points

| Storage interval | Bonding agent  | ARI | Total (n) |
|------------------|----------------|-----|-----------|
|                  | Score 0 | Score 1 | Score 2 | Score 3 |
| 15 min           | Transbond™ XT | 0    | 3       | 2       | 7       | 12   |
|                  | Transbond Plus | 1    | 0       | 3       | 8       | 12   |
| 24 h             | Transbond™ XT | 3    | 7       | 1       | 1       | 12   |
|                  | Transbond Plus | 0    | 1       | 2       | 9       | 12   |
| 1 week           | Transbond™ XT | 1    | 3       | 2       | 6       | 12   |
|                  | Transbond Plus | 0    | 1       | 2       | 9       | 12   |

ARI=Adhesive remnant index
most common result was the score 3. Therefore, the SBS obtained with both resins is safe. CCAs are a remarkable step toward faster and facilitated adhesive removal.

**Conclusion**

An *in vitro* bonding environment is very different from an *in vivo* bonding. Factors such as saliva contamination, the patient’s enamel composition, the difference between the universal testing machine forces and intra-oral forces may affect the results.[2,6,8] Thus, it is important to pursue with more clinical studies.

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**Conflicts of interest**

There are no conflicts of interest.

**References**

1. Reynolds IR. A review of direct orthodontic bonding. Br J Orthod 1975;2:171-8.

2. Türkkahraman H, Adanir N, Gungor AY, Alkis H. *In vitro* evaluation of shear bond strengths of colour change adhesives. Eur J Orthod 2010;32:571-4.

3. Lowder PD, Foley T, Banting DW. Bond strength of 4 orthodontic adhesives used with a caries-protective resin sealant. Am J Orthod Dentofacial Orthop 2008;134:291-5.

4. 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.

5. Abu Alhaija ES, Al-Wahadni AM. Evaluation of shear bond strength with different enamel pre-treatments. Eur J Orthod 2004;26:179-84.

6. Ekhlassi S, English JD, Ontiveros JC, Powers JM, Bussa HI, Frey GN, *et al*. Bond strength comparison of color-change adhesives for orthodontic bonding using a self-etching primer. Clin Cosmet Investig Dent 2011;3:39-44.

7. Bayani S, Ghassemi A, Manafi S, Delavarian M. Shear bond strength of orthodontic color-change adhesives with different light-curing times. Dent Res J (Isfahan) 2015;12:265-70.

8. Guzman UA, Jerrold L, Vig PS, Abdelkarim A. Comparison of shear bond strength and adhesive remnant index between precoated and conventionally bonded orthodontic brackets. Prog Orthod 2013;14:39.