Comparison of mean shear bond strength of light-cure composite resin, self-cure composite resin and self-etching primer: an in vitro study

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ABSTRACT:

Aims & Objective: This study aimed to determine and compare the mean shear bond strength of three orthodontic bonding materials used for bonding orthodontic brackets. Self Cure Composite Adhesive (Reliance orthodontics), Light Cure composite Adhesive (Transbond XT, 3M Unitek), Light cure with Self etching Primer (Transbond XT and Transbond Plus, 3M Unitek) were used.

Methods: Ninety maxillary premolar teeth were collected and divided into three groups and thirty separate maxillary premolar brackets were bonded to the teeth for each of the bonding agents' finally debonding were carried out by using Instron Universal Testing Machine.

Results: Light Cure Composite Adhesive (Transbond XT, 3M Unitek) had the highest shear bond strength followed by light cure and SEP (Transbond Plus and Transbond XT, 3M Unitek) and the lowest was Self cure composite adhesive (Relia-bond, Reliance orthodontics).

Interpretation and Conclusion: All the materials had the minimal shear bond strength required for orthodontic bonding as proposed by Reynolds and they can be used clinically.

Key words: Shear Bond Strength; SEP (self etching primer).

Introduction:

In the evolution of fixed orthodontic appliances, aesthetics is one of the prime concern in the acceptance of any appliance by the patient. This time consuming and unaesthetic procedure has been virtually discarded after the introduction of acid etch direct bonding technique in 1955 by Buonocore. First bonding of orthodontics bracket was reported by Newman in 1965. Over the past two decades, the evolution of adhesive techniques has transformed the scope of dental practice. The development of light cured composite has opened new horizons in bonding orthodontic brackets. It become increasingly popular for bonding orthodontic attachment. The unlimited working time of adhesive allow the orthodontist to manipulate the bracket position until polymerization is initiated by visible light source.
Bis-GMA or Bowen's resin, which is a self-cure resin, was introduced in late 1960s. These self-curing resins were the only choice available to orthodontist for many years. Though it provided good bond strength, it had few inherent flaws. It was extremely technique sensitive. Having a short setting time it permitted limited working time for accurate bracket positioning.

The sixth generation self-etching primer system (self etch primer) consists of etchant and primer dispersed as a single unit. Hence, the etching and priming are merged as a single step stages in bonding procedure, resulting in time saving for the clinician, which has cost implications.

**Aims & Objectives:** The aim of this study is to compare the shear bond strength of orthodontic brackets bonded with a Self cure bonding material (Rely-a-Bond), Light cure bonding material (Transbond XT), and sixth generation self-etching primer system (Transbond plus).

**Materials & Methods:** Total 90 extracted human maxillary permanent premolars were collected; the teeth were rinsed with water to clean blood and soft tissue debris and then decontaminated with 0.5% thymol. Further the teeth were stored in distilled water at 37°C for two weeks. Each tooth was placed in a mould and roots were embedded in self curing acrylic resin block (Diameter =15 mm; Height = 20 mm) upto 1mm apical to CE junction. The long axis of the tooth was kept parallel to the long axis of the acrylic block. Crowns were kept exposed to facilitate surface treatment and adhesive bonding on buccal surfaces. The acrylic resin blocks were color coded to differentiate three groups of 30 teeth.

1. **Group A:** Teeth were embedded in green colored acrylic resin blocks for bonding using self cure resin (Rely-a-bond, Reliance orthodontics products, Itasca, Ill) [Fig.1].

2. **Group B:** Teeth were embedded in pink colored acrylic resin blocks for bonding using light cure composite (Transbond XT, 3M Unitek, Monrovia, Calif) [Fig.2].

3. **Group C:** Teeth were embedded in yellow colored acrylic resin blocks for bonding using self etching primer (SEP) and light cure composite (Transbond Plus and Transbond XT, 3M Unitek, Monrovia, Calif) [Fig.3].

Orthodontic preadjusted edgewise appliances (PEA) metal brackets having 0.022 x 0.028 MBT slot for maxillary premolar (Gemini 3M, Unitek monorovia, Calif) were used for bonding. The surface area of bracket was 10.61 mm². All the brackets were bonded on the buccal surfaces according to the instructions supplied by the manufacturer. All bracket were bonded by single operator to avoid inter operator variation [Fig.4].

The shear bond strength tests were done using instron universal Testing Machine no.3382 at cross head speed of 1 mm/minute force passing parallel to buccal surface [Fig.5]. A custom made rod was locally fabricated for debonding of brackets [Fig.6]. Each block was fixed in a metal zig a force parallel to the tooth surface in an occlusal-apical direction was applied by the machine. The force required to debond each bracket was registered in newtons, and converted into megapascals by using the following formula Bond strength Mpa = force in newtons/surface area of bracket in mm².

**Statistical Analysis:** Mean shear bond strength of different groups was determined using student t test. The level of significance (p value) was kept at 0.05.

**Result:** Group A (self cure composite resin) was showing mean SBS of 9.03 ± 1.14 and group B (light cure composite resin) was showing mean SBS of 10.34 ± 2.91 and group C (light cure and SEP) was showing mean SBS of 9.78 ± 0.871. The difference between self cure and light cure composite resin and self cure and light cure with self etching primer was statically significant (S). On the other hand In comparison of light cure composite resin and light cure with self etching primer was statically insignificant (NS) as confirmed by Paired t Test. [Graph 1 & Table].

**DISCUSSION:** The findings of this study indicated that in all the 3 groups the mean shear bond strength to the tooth was highest with group B Light cure composite resin (10.34±2.91 Mpa) followed by group C light cure and SEP (9.78±0.871 Mpa) and the lowest was group A self cure composite resin (9.03±1.14). The group A (Self cure composite resin) and B (light Cure composite resin) was showing significant differences in their shear bond strength and p value is 0.01 as similar with the study done by O’Brien KD and Read MJ they suggested that light cure is having low bond failure. Wang et al also got the same result but they suggested that light cure may be less if there is less visible light exposure and self cure may be less if there is air bubble during mixing. Chamada et al suggested that light cure is better if it is cured for 2
-5 min. Viazia et al8 suggested that there is no significant difference between both the adhesive if they are used for ceramic bracket bonding. Warren Hamula9 got same result like present study they also concluded that light cure is better. Clinically self cure is having limited working time during bonding but light cure is fully operator controlled.

Group A (Self cure composite resin) and group C (light cure and SEP) was showing significant difference in their shear bond strength. The p value was 0.012 and group C was having more shear bond strength then group A but study done by Yasser Lotfy Abdelnabya10 has shown insignificant difference between both the groups but the significant result of the present study may be because of group A was exposed to light and self cure was not exposed as it is chemically activated but there is not many studies are present and still research is going on for these materials.

Group B (light cure composite) and group C (light cure and SEP) was showing insignificant difference in their shear bond strength. The p value was 0.34 and group B was having more shear bond strength then group C. The result was same like studies done by Bishara et al,11 Hanning M et al,12 This was probably because phosphoric-acid etching produces rough etched enamel surfaces. Bonding brackets to such a surface results in thick and uniform resin tags that deeply penetrate the enamel. On the other hand shallower and fewer resin tags are obtained with SEP system.13

Conclusion:- Based on the recorded data from the present study following conclusions may be drawn.

1. Light Cure Composite Adhesive (Transbond XT, 3M Unitek, Monrovia, Calif) had the highest shear bond strength followed by light cure and SEP (Transbond Plus and Transbond XT, 3M Unitek, Monrovia, Calif) and the lowest was Self cure composite adhesive (Rely-a-bond, Reliance orthodontics products, Itasca,III).

2. In the present study all the three different bonding agent have shown SBS value of more than 7.8 Mpa, hence all the four materials are suitable for clinical use.

References:-
Table - 1 (Comparison of SBS between all the groups)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean SBS ± SD in Mpa</th>
<th>t-value</th>
<th>p-value</th>
<th>Significant(S)/nonsignificant(NS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A and B (self cure and light cure composite)</td>
<td>9.03±1.14 10.34±2.91</td>
<td>2.01</td>
<td>0.01</td>
<td>S</td>
</tr>
<tr>
<td>B and C (Light cure and light cure + SEP)</td>
<td>10.34±2.91 9.78±0.87</td>
<td>0.95</td>
<td>0.34</td>
<td>NS</td>
</tr>
<tr>
<td>A and C (self cure and light cure + SEP)</td>
<td>9.03±1.14 9.78±0.87</td>
<td>2.68</td>
<td>0.012</td>
<td>S</td>
</tr>
</tbody>
</table>

Fig.1. Self cure composite (Rely-a-bond, Reliance orthodontics products, Itasca.III).
Fig.2. 37% Phosphoric Acid and Transbond XT light cure Primer and Adhesive (3M Unitek, Monrovia, Calif).
Fig.3 Transbond Plus Self-etching Primer and Transbond XT Adhesive (3M Unitek, Monrovia, Calif).
Fig.4. Individual block showing buccal view of the bracket bonded to buccal surface.
Fig.5 Individual block showing mesial view of the bracket bonded to buccal surface.
Fig.6 Individual block showing distal view of the bracket bonded to buccal surface.
Fig.7 Individual block showing occlusal view of the bracket bonded to buccal surface.
Fig.8. Instron universal testing machine no.3382.
Fig.9. metal Zig with push rod.