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## COMPARISON OF SHEAR BOND STRENGTH OF DIFFERENT LIGHT CURE ORTHODONTICS ADHESIVES

### IŞIKLA SERTLEŞEN FARKLI ORTODONTİK YAPIŞTIRICILARIN BAĞLANMA DİRENÇLERİNİN KARŞILAŞTIRILMASI

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#### ABSTRACT

The aims of the current study were to evaluate and compare bond strength of two conventional light - cure adhesives and one reinforced glass ionomer cement. Thirty extracted human premolars were randomly divided into 3 groups. Premolar brackets were bonded to the tooth specimens in each group with their respective adhesive according to the manufacturer's instructions. All specimens were stored in distilled water in sealed containers and placed in an incubator at 37° C for 24 hours before shear bond strengths were tested. Analysis of variance was used to compare the three adhesives. A One-way analysis of variance and Tukey multiple comparison test were used to determine statistical significance differences between groups. The present findings indicated that the mean bond strength of two light cure adhesives ranged between 15.21 and 16.39 MPa while mean bond strength of reinforced glass ionomer cement was 7.16 MPa.

The results of variance analysis showed that there were statistical significant differences in the bond strength among the 3 groups. Tukey multiple comparison test indicated that these differences took root from reinforced glass ionomer cement which has the weakest bond strength in our study. It was concluded that adhesives tested in this study would be adequate for routine clinical use.

**Key Words:** light-cure adhesive, glass ionomer, bond strength:

#### ÖZET

Bu çalışmanın amacı, iki adet ışıkla sertleşen adeziv ve bir adet güçlendirilmiş cam iyonomer simanın bağlanma dirençlerinin belirlenmesi ve birbirleriyle karşılaştırılmasıdır. 30 adet çekilmiş insan küçük azı dişi rastgele 3 gruba ayrılmış ve küçük azı braketleri üretici firmaların kullanma talimatlarına göre çekilen dişlere yapıştırılmıştır. Tüm örnekler sıyırılma dirençleri test edilmeden 24 saat önce 37 derecelik distile suda bekletilmiştir. İstatistiksel değerlendirme için One-way ANOVA varyans analizi ve Tukey çoklu karşılaştırma testi kullanılmıştır. Işıkla sertleşen iki adet adezivin ortalama bağlanma dirençleri 15.21 ile 16.39 MPa iken güçlendirilmiş cam iyonomer simanın bağlanma direnci 7.16 MPa olarak bulunmuştur.

Varyans analizi sonuçları 3 grup adezivin bağlanma dirençleri arasında istatistiksel olarak önemli farklılık olduğunu göstermiştir. Tukey çoklu karşılaştırma testi farklılıkların en zayıf bağlanma direncine sahip olan güçlendirilmiş cam iyonomer simandan kaynaklandığını göstermiştir. Bu çalışmada kullanılan adezivlerin rutin klinik kullanım için yeterli olduğu sonucuna varılmıştır.

**Anahtar kelimeler:** Işıkla sertleşen adeziv, cam iyonomer, bağlanma direnci

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## INTRODUCTION

Since Buonocore<sup>1</sup> introduced the acid etch bonding technique in 1955, the concept of bonding various resins to enamel has developed applications in all fields of dentistry, including the bonding of orthodontic brackets<sup>2,3</sup>. This approach resulted in improvements in orthodontic treatment such as greater comfort for patient, elimination of pretreatment separation, decreased gingival irritation, easier oral hygiene, improved esthetics, and reduced chair side time<sup>4-7</sup>. Although the direct bonding technique has introduced potential disadvantages, such as enamel loss during acid-etching and enamel decalcification around the brackets<sup>8-12</sup>, this technique has been widely accepted by orthodontists throughout the world. One problem clinician's face during treatment is bonding failure. Bonding failures are inconvenient and delay treatment; therefore, they are costly to the orthodontic practices and might compromise the outcome of treatment<sup>13</sup>.

Numerous modifications have been made both to the type of resin and the acid-etching technique. Light curing adhesives and Fluoride-releasing resins are examples of such modifications. Tavas and Watts<sup>14</sup> first described the use of visible light cure composites used in orthodontic bonding. The advantages of increased time available to remove excess adhesive material from around the brackets base and to position the bracket outweigh the disadvantage of increased light curing time.

Glass ionomer cement (GIC), introduced to dentistry by Wilson and Kent<sup>15</sup>, was popularized in orthodontics by White<sup>16</sup>. Glass ionomer cements do not require acid-etching of the tooth surface to create micromechanical retention. Researches dealing with GICs demonstrated the advantage of releasing fluoride known to be an important factor in preventing decalcification and white spot lesions around bonded orthodontic appliances; however, these cements have generally shown poor bond strengths compared with composite resins<sup>17-21</sup>. In order to increase the bond strengths of GICs, these adhesives are reinforced with resin particles.

The objectives of this study are to evaluate and compare shear bond strengths of resin-reinforced

glass ionomer cement (RRGIC) and two light cure adhesives.

## MATERIAL AND METHODS

Thirty freshly extracted human premolars were collected and stored in a solution of 0.1% thymol. The criteria for tooth selection were intact buccal enamel, absence of cracks caused by the extraction forceps, and absence of dental caries. The teeth were cleaned and polished with nonfluoridated pumice and rubber prophylactic cups for 10 seconds, and were embedded in self curing acrylic leaving the crowns exposed. Each tooth was oriented so that its labial surface would be parallel to the force during the shear strength test. Premolar brackets (Ormco edgewise wide twin slot, Ormco Corporation, Glendora, California USA) were used to bond all teeth.

The teeth were randomly divided into 3 groups, each containing 10 teeth. The teeth were etched with 37 % liquid phosphoric acid for 30 seconds, rinsed with water for 5 seconds, and dried with an oil-free air source. The following light cure adhesives were applied according to manufacturer's instructions:

Group 1: GAC ideal (GAC International, Central Islip, NY)

Group 2: Transbond XT (3M Unitek, Monrovia, Calif)

Group 3: Fuji Ortho LC (GC Corporation, Tokyo, Japan)

After the bracket was properly positioned on the tooth, each bracket was subjected to 300 grams of force using a force gauge (Correx Co, Bern, Switzerland) for 10 seconds and excess bonding resin was removed using a small scaler. The brackets were light-cured with a halogen light source (Astralis 10, Ivoclar-Vivadent, Schaan, Liechtenstein) for 20 seconds (10 seconds from the mesial side and 10 seconds from the distal side of the bracket). The bracketed teeth were stored in of distilled deionised water in sealed containers and placed in a water bath at 37° C for 24 hours. After that, the teeth were thermo cycled 500 times in 2 thermally controlled streams of water maintained at 5° C and 55° C.

A shearing force was applied with Hounsfield test equipment (37 Fullerton Roaol, Raydon, England) with a 50-kilonewton<sup>22</sup>. Each acrylic block was placed

in the lower jaw of the machine with bracket base parallel to the direction of the shear force (Figure 1). The upper member of testing machine was fitted with a chisel-shaped blade for shearing the brackets. Then the tooth was stressed in an incisal-to-apical direction at a crosshead speed of 1mm/min. The shear force required to debond each bracket was recorded in Newton and converted into megapascal as a ratio of Newton to surface area of the bracket base. Shear bond strengths of the different groups were compared by one-way ANOVA, with post hoc Tukey tests.



**Figure 1:** Specimen placed in the testing machine.

## RESULTS

The mean shear bond strengths, standard deviations, minimum and maximum values, and results of one-way ANOVA are presented in Table 1. Mean shear bond strength values were  $15.21 \pm 2.67$  MPa for GAC ideal light cure group,  $7.16 \pm 1.76$  MPa for Fuji Ortho LC RRGIC group,  $16.39 \pm 4.03$  MPa for 3M Transbond XT group-which was the highest value among the all test groups. There was not statistically significant difference between group I and II regarding shear bond strength values because these values were similar. But there were statistically significant differences ( $P < 0.001$ ) between group III and other groups because Fuji Ortho LC RRGIC has lower shear bond strength value than the other groups (Table 2).

**Table 1:** Means, Standard Deviations (SD), minimum and maximum values (MPa) of shear bond strengths for each group and results of one-way ANOVA.

	Mean	SD.	Min.	Max	F value
GAC ideal	15.21	2.67	9.93	18.63	28.54***
3M Transbond XT	16.39	4.03	10.55	21.73	
Fuji Ortho LC	7.16	1.76	5.04	10.40	

\*\*\* $p < 0.001$

**Table 2:** Results of Tukey multiple comparisons.

	I	II	III	Differences mean		
				I-II	I-III	II-III
Shear bond strength	15.21	16.39	7.16	1.18	8.06***	9.24***

\*\*\* $p < 0.001$

**I.** GAC ideal **II.** 3M Transbond XT **III.** Fuji Ortho LC

## DISCUSSION

Bond failure during orthodontic treatment is relatively frequent and undesirable process. The time it takes to clean, prepare and bond a new bracket can be disruptive in a busy practice: it might also lengthen the overall treatment time. Therefore, it is important to determine to use bonding the attachment to teeth during treatment. One important criterion in the choice of adhesive is its bond strength. Precise determination of these is possible in vivo or in vitro circumstances. But the most ideal is in vitro study done under standard circumstance. Although a lot of in vitro methods are suggested to determine the adhesive bond strength, in this study, in vitro shear bond strength testing method described by Fox et al<sup>23</sup> was used.

Arici et al<sup>24</sup> reported that thermal changes have influence on bond strength because orthodontic adhesives are routinely subjected to thermal changes in the oral cavity. In vitro situations coherent to oral cavity circumstance for adhesive hold a place in the oral cavity. Hence, in our study all specimens were prepared, at  $23 \pm 2^\circ\text{C}$  and stored at  $37 \pm 2^\circ\text{C}$  in water for 24 hours, in standard environment recommended by International Organization for Standardization. Then mounted teeth were thermocycled between  $5^\circ\text{C}$  and  $55^\circ\text{C}$  for 500 cycles.

In the present study, the shear bond strengths of 3 different light cured adhesive materials were evaluated. The findings of this study indicated that

groups 1, 2 and 3 had mean shear bond strengths of  $15.21 \pm 2.67$  MPa,  $16.39 \pm 4.03$  MPa and  $7.16 \pm 1.76$  MPa, respectively. However, there are statistically differences among the groups, results of I and II groups were similar. The shear bond strength of Fuji Ortho LC was the lowest but this result was supported by the results of Silverman et al<sup>25</sup> and Movahhed et al<sup>26</sup>.

In their in vitro study, Büyükyılmaz et al<sup>27</sup> found the shear bond strength value;  $16 \pm 4.5$  MPa for the group conditioned with Transbond Plus self etching primer before bonding orthodontic brackets with 3M Transbond XT, and for the group conditioned with acid and primer  $9.9 \pm 4.0$  MPa. Our results for 3M Transbond XT is higher than the results for the group conditioned with acid and primer in Büyükyılmaz et al<sup>27</sup> study, is similar with the results of Chung et al. Bishara et al<sup>28</sup> found the bond strength value of 3M Transbond XT  $2.8 \pm 1.9$  MPa. The difference between their results and the other studies can be explained by the use of different acid primer (Acid primer; Clearfil Liner Bond 2). In their study with 3M Transbond XT, Mohavved et al<sup>26</sup> found within 5 and 15 minutes of initial bonding shear bond strength values  $8.8 \pm 2.0$  MPa and  $11.0 \pm 1.6$  MPa respectively.

According to Newman<sup>29</sup>, Wheeler and Ackerman<sup>30</sup>, in the oral cavity bonded brackets are subject to either shear, tensile or torsion forces, or a combination of these. They have reported that these forces are difficult to measure and orthodontic forces do not surpass 4.45 N per tooth. Reynolds and von Fraunhofer<sup>31</sup> stated that for most clinical orthodontic needs a minimum bond strength of 5.9 to 7.8 MPa was sufficient enough. For successful clinical bonding was estimated to be 7 MPa by Lopez<sup>32</sup>, 35.6 N by Keizer et al<sup>33</sup>, 97.88 N by Maijer and Smith<sup>34</sup>. Movahhed et al<sup>26</sup> explained this wide range of results may occurred due to variations of test methods or devices and stated that there are no specific in vitro or in vivo tests that can be valid for all of the various clinical applications.

In the present study, although bond strength of resin-reinforced glass ionomer cement was found to be significant lower than the other two groups, it can be used for clinical purposes. Bond strengths of light cured adhesives reached adequate bond strength for

clinical applications according to Reynolds and von Fraunhofer<sup>31</sup> and Lopez<sup>32</sup>.

## CONCLUSIONS

The present findings indicated that:

- The mean shear bond strengths of the three light cured adhesives ranged 15.21, 16.39 and 7.16MPa respectively.
- While bond strength of RRGIC approximates clinical application standards, those of light cured adhesives are exactly adequate.

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