Comparison of the shear bond strength of no-mix and two-paste adhesives on rebonded brackets

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ABSTRACT

Purpose: Bond failure is not an unusual happening. It may occur well before the end of the treatment, in which rebonding becomes a necessity. This study investigates the shear bond strength of two different resin systems on rebonded brackets.

Materials & Methods: Thirty non-carious human adolescent upper premolar teeth were bonded and rebonded. No mix and two paste Composit resin systems and Edgewise premolar brackets (American Orthodontics) with a slot size of 22 were used in the present study. Testings were performed with an instron machine at a cross-head speed of 1 mm/min. The debonding force was exerted through a full dimension rectangular $17 \times 25$ stainless steel looped wire, engaging the entire bracket slot, so that the point of force application was at the same distance from the bracket – resin interface in all cases. The shear bond strength of each tooth was recorded. Following the initial test, the resin remnants of the enamel surface was removed with a tungsten carbide bur; then, the enamel surface, polished and retreated with 37% H$_3$PO$_4$ for 15 seconds. The residual resin at each bracket base was reduced to a minimum thickness with a green stone. The whole procedure of bonding and debonding was repeated again and data was recorded. Means and standard deviations for each group was completed and analyzed by t-test and paired t-test.

Results: The results of the paired t-test for the no-mix and two paste resin systems indicate that the difference between the shear bond and rebond strength is not statistically significant. The t-test showed that the bond and rebond strengths of the no-mix systems is not statistically different from that of two paste systems. The analysis of the bond failure showed that the great majority of the bond failures occurred at the bracket-resin interface.

Conclusion: The strength of the bond determined in vitro seems to be sufficient to withstand bond failure, but because of the aggressive environment of the oral cavity caution must be exercised, when attempting to extrapolate results to the clinical setting.

Keywords: Shear bond strength, Rebonded brackets, No-mix resin, Two pasteresin.

INTRODUCTION

Repeated bond failure for a single tooth is of particular clinical concern. It has been shown that 10% of the second and third time bonds fail in 4 to 5 weeks, whereas only 2% of the first time bonds, fail during the same time.\(^{(1)}\)

The percentage of bond failure, increases with the number of time that the same attachment required to be rebonded.\(^{(1)}\) The cause of the repeated failures could be alteration of enamel that follows previous bonding procedures.\(^{(2)}\)

Alternatively, these failures may be due to any of the primary causes of failure such as occlusal forces.\(^{(2)}\)

Relatively few studies have looked at the
strength of rebonded attachments. Faust et al\(^3\) found that rebonded strength were generally lower than for first bonds; however, differences in bond strength among various kinds of composite resins or between metal and plastic brackets were more dramatic that bond/rebond differences.\(^3\)

Rosenstein et al\(^4\) rebonded the same bracket to teeth with and without preparing them. With either a no-mix or two paste resin system, rebonding with no preparation of the tooth or bracket yielded peel strengths greater than initial bonding or any other rebonding protocol.\(^4\)

On the contrary, Wright and Power\(^5\) bonded and rebonded brackets to plastic cylinder with roughening the residual resin on the bracket base. Rebond tensile strengths were less than initial bond strengths for self-cure adhesives.\(^5\)

Likewise, many other rebonding protocols were experimented and conflicting results and conclusions were published.

This experiment is aimed at defining and comparing the shear bond strength of two resin systems (no-mix) and (two paste) on initially bonded and rebonded brackets after repreparing the enamel surface.

**MATERIALS & METHODS**

This invitro experimental study was done on extracted teeth under well defined experimental conditions. For this study, thirty non-carious human adolescent upper premolar teeth were stored in distilled water. Teeth were polished with pumice and rubber prophy cup and embedded in resin blocks. All the samples were divided into two groups of 15, based on the 2 undertaken adhesive systems: no-mix (N) (3M Unitek) and two paste (P) (Degufill-Degussa). The bonded samples were stored in 37\(^\circ\)C water for 24 hours before testing.

The teeth surfaces were etched for 15 seconds with 37% phosphoric acid and bonded according to the manufacturer’s direction. They were labeled as BN = initial bond with no-mix and BP=initial bond with two paste, whereas initials such as RN and RP were used for the rebonding agents. Edgewise premolars brackets (American Orthodontics) with a slot size of 22 were used on all the teeth, and testing were performed with an instron machine at a cross-head speed of 1mm/min (1195, Instron Corporation, Canton Mass).

The recommendations of Nigel and John were followed as much as possible.\(^6\) The debonding force were exerted through a rectangular 17\(\times\)25” stainless steel looped wire, engaging the entire bracket slot, so that the point of force application was at the same distance from the bracket-resin interface in all cases. The specimens were mounted on a universal joint to eliminate variation in the direction of the debonding force. These precautions made the method of testing more reproducible.

The shear bond strength was recorded for each tooth.

Mpa was the used bond strength unit. Following the initial test, the resin remnants of the enamel surface was removed with a tungsten carbide bur, then the enamel surface was polished and retreated with 37% H\(_3\)PO\(_4\) for 15 seconds. The residual resin at each bracket base was reduced to a minimum thickness with a green stone.

And at the end, the whole procedure of bonding and debonding was repeated and the data was recorded. Means and standard deviations for each group was computed and the data was analyzed by t-test.

**RESULTS**

The P values and shear bond and rebond strength for both resin systems are given in tables 1 and 2.

The results of the t-test for the both no-mix and two – paste resin systems indicate that the difference between the shear bond and rebond strength is not statistically significant.

The t-test showed that the bond and rebond strengths of the no – mix system are not statistically different from that of the two paste system.

The study showed that the great majority
of the bond failures occurred at the bracketeresin interface (10 in two-paste and 8 in no-mix system) while 2 bond failures occurred at the bracket/tooth interface in no-mix system.

Table 1. Bond and rebond strength of no-mix and two-paste composite systems.

<table>
<thead>
<tr>
<th></th>
<th>Bond strenght</th>
<th>Rebond strenght</th>
<th>P-value</th>
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<tbody>
<tr>
<td>No-mix</td>
<td>7.28±2.7</td>
<td>7.21±3.06</td>
<td>0.9</td>
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<tr>
<td>(Not significant)</td>
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<td></td>
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<tr>
<td>Two-paste</td>
<td>6.86±3.05</td>
<td>6.44±2.31</td>
<td>0.7</td>
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<tr>
<td>(Not significant)</td>
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Table 2. Bond and rebond strength of no-mix and two-paste composite systems.

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**DISCUSSION**

In the present study no significant difference was found between the bond and rebond strengths with either resin systems. In addition, the bond strengths between the 2 resin systems was not significantly different. This finding agrees with other investigations which found no significant loss of bond strength in rebonding enamel to enamel or a new bracket to enamel.\(^{(3,7,8)}\)

In the present study failure predominantly occurred at the bracket/resin interface. The bracket/resin interface is the site of usual failure with stainless brackets.\(^{(9,10)}\) Other investigations have reported similar findings.\(^{(9,10)}\) It has been claimed that the bracket/resin bond is the weakest point in orthodontic bonding.\(^{(3,9,11)}\) Failure at this site does not reflect enamel-resin bond strength.

Associations have been made between teeth and major interfaces of bond failure. Clinically, anterior bonds separate often at the bracket/resin interface, whereas posterior teeth are more likely to demonstrate an enamel/resin break.\(^{(8,12)}\) In vitro, the opposite pattern is evident with bracket/resin failure predominating for posterior teeth.\(^{(13)}\) This pattern of failure agrees with the present invitro study.

Failure of bracket/resin interface is desirable in clinical practice; since failure at the resin/enamel interface could result in fractures occurring in the enamel.\(^{(14)}\)

The results of the experiments on the bond and rebond strength conducted by Egan and Alexander\(^{(14)}\) are different from the present study. These authors used supermesh bracket bases and a different resin system (Rely a Bond and Phase II) during the experiment. More over the tooth preparation was also different. According to the investigations of Jassem\(^{(7)}\), Faust\(^{(3)}\) and Farquhar\(^{(8)}\) who found no significant loss of bond strength in rebonding enamel to enamel and a new bracket to enamel, Frank et al\(^{(14)}\) believed that treating the enamel twice would not have affected the outcome. So, they did not etch the teeth in the rebonded groups and found a significant difference in bond strength between bonded and rebonded groups with no-mix system, though the same difference with two paste system was statistically indistinguishable. The less rebond strength in their study can also be explained by the fact that their experimental design has produced an increase in the total resin thickness. As resin thickness increases, bond strength decreases because of greater thermal expansion, polymerization shrinkage, trapped volatiles, voids and cracks.\(^{(15)}\) This might be the cause of the trend toward decreased bond strength in their rebond samples. In the case of no-mix resin systems, increased resin thickness is also associated with incomplete polymerization.\(^{(15)}\)

On the other hand, in their study, the two paste system (Phase II) provides a greater rebond strength than the no-mix system, while in the present study the rebond strength provided by two systems were statistically indistinguishable.

In the present study a restorative type of resin (Degufill) available in the department of orthodontics was used instead of the conventional two paste system found in the market. This restorative resin usually contains larger filler particles (2 to 30µm).
which comprise 50 to 85% by weight of the composite.

Although very controversial, the higher viscosity result in the smaller bond strength in the Degufill system.

In the study of Frank et al\(^{(14)}\) bond separation occurred in the majority (more than 80%) of the samples at enamel/resin interface. This finding is contrary to the other investigations with regard to stainless steel brackets and invitro testing of posterior teeth.\(^{(9,10,13)}\) In their study, the predominance of enamel/resin fractures is most likely attributed to characteristics of the supermesh base, the adhesive systems\(^{(16)}\) and the lack of acid etching procedure.

**CONCLUSION**

The strength of the bond determined in vitro, seems to be sufficient to withstand bond failure, but because of the aggressive environment of the oral cavity, caution must be exercised when attempting to extrapolate results to the clinical setting.

**REFERENCES**