Comparative Evaluation of Bond Strength of Self-Etching and Total Etch Dental Adhesive Systems to Dentin of Deciduous and Permanent Teeth

Evaluación Comparativa de la Fuerza de Unión de los Sistemas de Adhesivo Dental Autograbado y Grabado Total para la Dentina de Dientes Deciduos y Permanentes

C. A. Martínez-Carrasco¹; A. Nevárez-Rascón² & U. Soto-Barreras²


ABSTRACT: The aim of this study was to analyze the bond strength of total-etch and self-etch adhesive systems to dentin of primary and permanent teeth. Methods: Thirty sound naturally exfoliated primary molars deciduous teeth (DT) and thirty sound permanent bicuspids permanent teeth (PT) were randomly divided into six groups (n=10 per group) according to two commercial adhesive systems: Adper Single Bond 2; 3M ESPE (Total-etch) and Adper Easy Bond; 3M ESPE (self-etch and total-etch). Specimens submitted to cyclic loading in a universal Instron testing machine. Bond strength values (MPa) were analyzed by ANOVA test and Duncan post hoc test (a=0.05). Results: Mean values were higher in PT compared to DT. In deciduous teeth, no significantly differences observed. Total etch AdperTM Single Bond 2 showed significantly higher bond strength than self-etch AdperTM with additional acid etching in PT (p=0.031). Conclusion: Our findings suggest that the highest bond strength was found in dentin tissue of PT with total etch AdperTM employing the adhesive the Single Bond 2 of one step self-etch.

KEY WORDS: adhesive systems, bond strength, permanent and deciduous teeth.

INTRODUCTION

The dentin tissue is a heterogeneous structure consisting of dentinal tubule surrounded by a highly mineralized tubular wall called peritubular dentin, which in turn imbedded within a partially mineralized collagen matrix called intertubular dentin (Mai et al., 2010).

Number and diameter of dentinal tubules increases as they approach to dental pulp, but some characteristics like structural heterogeneity, presence of dentinal fluid (relative humidity) and low surface energy, make of this tissue, a unique adhesive substrate for different adhesive systems (Chowdahary & Subba Reddy, 2010). Successful adhesion to dentine is accomplish with an appropriate surface treatment (Mazzeo et al., 1995). Current adhesive systems employ two different ways to achieve the micromechanical properties of the dentin/adhesive interface. The first mechanism consists in the complete removal of the smear layer and the demineralization of the undamaged surface of the dentin by etching the dental substrate with phosphoric acid followed by the application of a primer and a bond resin (Mortazavi et al., 2004). The second method simplifies steps through the application of a self-etching system, which leaves the smear layer of the dentin as a bonding substrate. Nevertheless, chemical, physiological and micro-morphological differences among permanent teeth (PT) and deciduous teeth (DT) are not fully understood (Schmitt & Lee, 2002).

Previous studies have shown lower bonding strength in DT compared to PT (Agostini et al., 2001). In addition, DT present a minor concentration and diameter of dentinal tubules (Hegde & Bhandary, 2008).

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Furthermore, peritubular dentin has been reported up to five times thinner in DT which leads to lower moisture (Mazzeo et al.; Prabhakar et al., 2003; Stanlin et al., 2005; Cavalcanti et al., 2008; Chowdahary & Subba Reddy), as well as greater reactivity to acid conditioning (Nör et al., 1996). The stable adhesion between resin and dentin represents a fundamental requirement for clinical success and it depends on the proper interaction between the dental substrate, the adhesive system and the restoration (Castro et al., 2007). In agreement with García-Godoy & Donly (2002), a minimum bonding force of 17-20 MPa is necessary to withstand the contraction force of the composite resin in the enamel and dentin. Therefore, the purpose of this research was to compare the bonding strength of total etch and self-etch adhesive systems on primary deciduous teeth as well as on permanent teeth.

MATERIAL AND METHOD

In the present in vitro study, 30 sound primary molars next to exfoliate and 30 sound permanent bicuspids with complete rizogenesis and removed for orthodontic reasons, were distributed in six groups of 10 specimens each (Table I). All specimens with solid physiological faces and without any associated pathologies, were autoclaved for 20 minutes at a 120°C temperature employing a M7 Speed Clave Sterilizer (Midmark Corporation, OH. U.S.A), according to the methodology employed by Jaques & Hebling (2006), and randomly distributed through Research Randomizer V 3.0 into six groups.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean-SD(MPa)</th>
<th>Duncan*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10</td>
<td>16.87±9.5</td>
<td>1,2</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>12.97±8.0</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>17.43±9.9</td>
<td>1,2</td>
</tr>
<tr>
<td>D</td>
<td>10</td>
<td>38.86±20.4</td>
<td>3</td>
</tr>
<tr>
<td>E</td>
<td>10</td>
<td>28.67±13.2</td>
<td>2,3</td>
</tr>
<tr>
<td>F</td>
<td>10</td>
<td>26.54±9.2</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 1. Group’s distribution.

Specimen’s storages. All specimen’s was maintained in an aseptic glass with distilled water at room temperature once they were recollected and after the composites adaptations procedures, in order to avoid dehydration and alteration of collagen structure.

Bonding and failure analysis. Specimens were placed in a loading loop in a universal testing machine (Instron 4469 machine) and programmed to a compression charge of 0.5 mm/min. Bond strength values were recorded in Mega Pascal’s (MPa). Finally, the amount of adhesive left on the tooth after the test evaluation under stereomicroscope (Leica EZ4HD) at 35 fold magnifications. The Adhesive Remnant Index (ARI) system was used to explore the microscopic debonding mechanism of the dentin/hybrid layer/resin adhesive interface. All the results expressed as the mean and ±standard deviation. Q test at 95 % reliability carried out for identification and rejection of outliers. Shapiro–Wilk and Brown Forsythe tests employed to assess the normality of the data distribution. One-way ANOVA test and Duncan post hoc procedures used to compare differences between groups. Data were analyzed using the IBM SPSS statistics 23 program (IBM, SPSS Statistics 23 Chicago. USA). Statistical significance was set at a=0.05.
RESULTS

On Table II, distributions of shear bond strengths values in the various adhesives systems described by groups were A, B, C correspond deciduous teeth (DT) strengths values and D, E, F corresponded permanent teeth (PT) strengths values. Respect to the comparison of bonding strength values between PT and DT, specimens of PT showed the greater bonding strength values (p<0.05).

*Duncan post hoc: Groups with the same numbers denote that there was no statistical difference.

Comparing the bond strengths values on PT and DT by groups and according to the adhesive system, it was found a significant higher values (p<0.05) in PT when a total etch Adper Single Bond 2 and self-etch were used in group D.

<table>
<thead>
<tr>
<th>Group</th>
<th>Adhesive System</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Adper Single Bond 2 (3M)</td>
<td>Total-etch Deciduous Teeth</td>
</tr>
<tr>
<td>B</td>
<td>Adper Easy Bond (3M ESPE)</td>
<td>Self-etch Deciduous Teeth</td>
</tr>
<tr>
<td>C</td>
<td>Adper Easy Bond (3M ESPE)</td>
<td>Total-etch Deciduous Teeth</td>
</tr>
<tr>
<td>D</td>
<td>Adper Single Bond 2 (3M)</td>
<td>Total-etch Permanent Teeth</td>
</tr>
<tr>
<td>E</td>
<td>Adper Easy Bond (3M ESPE)</td>
<td>Self-etch Permanent Teeth</td>
</tr>
<tr>
<td>F</td>
<td>Adper Easy Bond (3M ESPE)</td>
<td>Total-etch Permanent Teeth</td>
</tr>
</tbody>
</table>

No significant differences also were found applying additional acid etching to specimens with Adper Easy Bond compared to self-etched technique. However, a decrease in bond strength values of PT and an increment in DT, observed when dentin was further etched (groups C and D).

The adhesion in the dentin of deciduous teeth showed no significant statistic difference in groups A, B and C (Adper Single Bond 2, Adper Easy Bond and Adper Easy Bond modified with acid etching respectively).

In permanent teeth there was a significant statistic difference (p=0.031) between groups D and F, which means that better bonding strength is obtained by using the Single Bond 2 Adper systems (fifth complete etching-generation) respect to Adper Easy Bond (seventh generation or self-etching), although there wasn’t significant statistic difference (p=0.704) between the groups E and F.

With Single Bond 2 PT (p<0.05), Adper (Group D) was used. Nevertheless, Single Bond 2 Adper (group A) and Adper Easy bond with acid etching prior to its collocation (group C) on the primary teeth resulted similar to the PT (groups E and F). The Easy Bond Adper adhesive in DT (group B) presented the lower bonding strength values (p<0.05), compared with use of any other system employed in this study regarding PT (groups D, E, F).

Composite release and crack. Respect to the release, two different types were found after compressive test, one in block mainly in temporal specimens and another like composite crack in permanent specimens. On Figures 1 and 2 is observed the difference between complete composite release in 1a), and partial composite release 2a) on permanent tooth.
DISCUSSION

Previous studies reported different bond strength values in DT employing the fifth generation adhesives such as Prime & Bond NT Dual Cure systems, with averages of 12.8±1.5 MPa (Agostini et al.). Stanlin et al. reported averages of 12.92±1.77 MPa for Single bond, while Bolaños-Carmona et al. (2006), reported 13.43±5.91 MPa for Excite and finally Gateva & Dikov (2012) mentioned averages of 11.72±1.54 MPa for the seventh generation of adhesives such as Adhese One.

In the present study, the bond strength of a total etch Adper Single Bond 2 (fifth generation) in primary teeth showed a mean of 16.87±9.5 MPa and 12.97±8.03 MPa for a self-etch Easy Bond Adper system (seventh generation). Moreover, an additional acid etching on dentin before Adper Easy Bond test showed a mean value of 17.43±9.91 MPa. Our results are in accordance with findings from studies addressing the same comparisons, stating that acid etching to dentin prior self-etch adhesives provide better bonding strength results.

Since bond strength adhesive systems are a major concern in PT, a previous study showed bond strength values of 25.6±5.7 MPa with Single Bond 2 (Barajas & Barceló, 2007). Furthermore, Hegde & Bhandary reported 26.09±0.55 MPa with total etch Prime & Bond NT Dual Cure bonding system, and 24.52±0.53 MPa with self-etch Clearfil S3, also values of 16.37±0.64 MPa with self-etch G Bond. Faria-E-Silva et al. (2009) described a bonding strength of 10.18±3.62 MPa with iBond; in the same way, Gateva & Dikov reported 6.88±1.28 MPa with the Adhese One system. On the present study results revealed high values of 38.86±20.46 MPa for Adper Single Bond 2, while averages of 26.54±9.21 MPa for Adper Easy Bond modified acid etching to dentin. Our finding suggests that the additional etching to dentin applied with Adper Easy Bond makes no difference in bond strength.

CONCLUSIONS

1. Shear bond strength of adapter composites observed superior on permanent teeth respect to temporal

2. Adper Easy Bond (3M) and total-etch manifest averages values of 17MPa in deciduous teeth while Adper Single Bond 2 (3M) and total-etch manifest values greater than 38MPa in permanent teeth

3. Not statistical differences observed between all deciduous teeth groups and between all permanent teeth groups.

4. Release observed different between permanent and deciduous teeth after the compressive test, while in deciduous was total release detachment, in permanent presented mainly in partial way with composite cracks.

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 commuters, fuerza de unión, dientes permanentes, dientes caducifolios.

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