THE EFFECT OF MATRIX METALLOPROTEINASE INHIBITOR ON BOND DURABILITY OF RESIN COMPOSITE AND GIOMER RESTORATIONS TO DENTIN (IN-VIVO STUDY)

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**ABSTRACT**

**Objective:** This in vivo study was carried out to evaluate the effect of chlorhexidine pretreatment on the durability of bonded resin composite restoration and giomer restorations as assessed by microtensile bond strength testing. **Materials and methods:** The study protocol involving dogs was performed at the faculty of veterinary medicine, Cairo University. A total number of eight young healthy dogs, aged between one & two years old with an average weight of 10 Kg were used in this study. The study was divided into four phases at different time intervals; after 24 hours, three months, six months and nine months. One experimental dog was enrolled within each phase. A two step etch-and- rinse adhesive system (Adper Single Bond 2) was used with nanofilled resin composite and giomer restorative materials with and without chlorhexidine pretreatment. All premolars and molars dogs’ teeth of the experimental dogs of each phase of the study were subjected to the different predetermined treatment modalities. This experimental study design was performed to obtain a total of 80 premolars and molars dogs’ teeth (sample size n = 5 teeth per each subdivision). Dogs were sacrificed after the specified testing period. The teeth were separated from the jaws by the use of saw. Teeth were mounted on the cutting machine, and sectioned into slabs and then into beams of cross sectional area of 1 mm². For microtensile testing; each beam was fixed to a specially designed attachment and stressed in tension using universal Lloyd testing machine at a cross-head speed of 0.5 mm/minute until failure. Microtensile bond strength values were tabulated and statistically analyzed. **Results:** The analysis of variance ANOVA test revealed that with both Giomer and nanofilled resin composite when used with Adper Single Bond 2 without Consepsis, there was no statistically significant difference between means microtensile bond strengths after 24 hours, 3 months, 6 months and 9 months. On the other hand, when Giomer was used with Adper Single Bond 2 with Consepsis, the mean microtensile bond strength after 24 hours showed the statistically significantly highest value. This was followed by mean microtensile bond strength after 3 months. There was no statistically significant difference between means microtensile bond strengths after 6 months and 9 months which showed the statistically significantly lowest values. While, with Nanofilled resin composite and Adper Single Bond 2 with Consepsis, there was no statistically significant difference between means microtensile bond strengths after 24 hours, 3 months, 6 months and 9 months. **Conclusions:** The bond performance of Adper Single Bond 2 deteriorates by time. The use of 2% chlorhexidine gluconate (Consepsis) diminishes the loss of bond strength of Adper single Bond 2 over time up to certain limit. The use of 2% chlorhexidine gluconate (Consepsis) was not able to completely prevent the loss of bond strengths over time.
INTRODUCTION

The major shortcoming of contemporary adhesive restoratives is their limited durability in vivo, where the most cited reasons of failure of adhesive restorations are loss of retention and marginal adaptation (De Munck et al., 2005). Although in vivo studies on the degradation of resin-dentin bonds are scanty, they generally support the in vitro reports that claimed that progressive decreases in microtensile bond strengths occurred after aging (Burrow et al., 2002), (Burrow et al., 2005), (Chitnis et al., 2006). Degradation of these bonds occurs via the interaction of the components above the adhesive interface manifested by occlusal loading, thermo-cycling, moisture and PH-fluctuation (Bedran de Castro et al., 2004). These extrinsic degradation mechanisms of the resin–dentine interface that originate in the adhesive above the hybrid layers are accompanied by intrinsic degradation mechanisms that originate from beneath dentine hybrid layers represented by dentinal fluid and intrapulpal pressure (Donmez et al., 2005). Several authors have shown the hydrolytic degradation of collagen matrices in aged dentin–resin bonds, even in the absence of bacterial enzymes (Tjäderhane et al., 1998). The recent reports of collagenolytic and gelatinolytic activities in partially demineralised dentine collagen matrices are indirect proofs of the existence of matrix metalloproteinases (MMPs) in human dentine (Mazzeni et al., 2006). The release and activation of these endogenous enzymes during dentine bonding are thought to be responsible for the in vitro manifestation of thinning and disappearance of collagen fibrils from incompletely infiltrated hybrid layers in aged, bonded dentine (Mazzoni et al., 2006), resulting in hydrolytic degradation and reduction of bond strengths. Chlorohexidine is an antibacterial and antiseptic agent widely used in dentistry (Ribeiro et al., 2007), (Zhang et al., 2007). It has been stated that the currently accepted disinfection technique applying Chlorohexidine to acid-etch dentin prior to the use of etch-and-rinse adhesives may prevent the degradation of collagen fibrils, besides its antimicrobial property (Hebling et al. 2005). Therefore, it was found beneficial to evaluate the effect of chlorohexidine before bonding agent application on the bond durability of resin composite and giomer restorations in vivo.

MATERIALS AND METHODS

The study protocol involving dogs was performed at the faculty of veterinary medicine, Cairo University. A total number of eight young healthy dogs, aged between one & two years old with an average weight of 10 Kg were used in this study. The study was divided into four phases at different time intervals; after 24 hours, three months, six months and nine months. One experimental dogs were enrolled within each phase. A two step etch-and-rinse adhesive system (Adper Single Bond 2) was used with nanofilled resin composite (filtek Supreme XT, 3MESPE, USA) and giomer restorative materials (Beautufil, Shofu, Japan) with and without chlorhexidine pretreatment (Consepsis, Ultradent, USA). All premolars and molars dogs’ teeth of the experimental dogs of each phase of the study were subjected to the different predetermined treatment modalities. This experimental study design was performed to obtain a total of 80 premolars and molars dogs’ teeth (sample size n = 5 teeth per each subdivision). Dogs were sacrificed after the specified testing period. The teeth were separated from the jaws by the use of saw. Teeth were mounted on the cutting machine (Bronwill), and sectioned into slabs and then into beams of cross sectional area of 1 mm². For microtensile testing; each beam was fixed to a specially designed attachment and stressed in tension using universal Lloyd testing machine at a cross-head speed of 0.5 mm/minute until failure. Microtensile bond strength values were tabulated and statistically analyzed.

RESULTS

Microtensile bond strength

With both Giomer and nanofilled resin composite when used with Adper Single Bond 2 without Consepsis, there was no statistically significant difference between means microtensile bond strengths after 24 hours, 3
months, 6 months and 9 months. On the other hand, when Giomer was used with Adper Single Bond 2 with Consepsis, the mean microtensile bond strength after 24 hours showed the statistically significantly highest value. This was followed by mean microtensile bond strength after 3 months. There was no statistically significant difference between means microtensile bond strengths after 6 months and 9 months which showed the statistically significantly lowest values. While, with Nanofilled resin composite and Adper Single Bond 2 with Consepsis, there was no statistically significant difference between means microtensile bond strengths after 24 hours, 3 months, 6 months and 9 months (Table 1).

### TABLE (1) The means, standard deviation (SD) values and results of comparison between microtensile bond strength after the four aging periods.

<table>
<thead>
<tr>
<th>Material</th>
<th>Aging Bonding</th>
<th>24 hours</th>
<th>3 months</th>
<th>6 months</th>
<th>9 months</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Giomer</td>
<td>No Consepsis</td>
<td>Single Bond</td>
<td>26.3</td>
<td>6</td>
<td>27.6</td>
<td>2</td>
</tr>
<tr>
<td>Giomer</td>
<td>Nanofilled</td>
<td>Single Bond</td>
<td>25.3</td>
<td>7.4</td>
<td>22.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Nanofilled</td>
<td>Consepsis</td>
<td>Single Bond</td>
<td>31.3 a</td>
<td>7.8</td>
<td>22.2 b</td>
<td>1.3</td>
</tr>
<tr>
<td>Nanofilled</td>
<td>Single Bond</td>
<td>21.7</td>
<td>5.2</td>
<td>30.8</td>
<td>8.8</td>
<td>23.2</td>
</tr>
</tbody>
</table>

*: Significant at P ≤ 0.05, Means with different letters are statistically significantly different according to Tukey’s test

**DISCUSSION**

The results of the microtensile bond strength values of the tested groups revealed that there was no statistically significant difference between mean microtensile bond strength after the four aging periods regardless of other variables. This analysis revealed that, despite the fact that adhesives are sensitive to mechanical fatigue phenomena; the major factor affecting durability in vivo is hydrolysis of interface components, such as collagen and resin, and subsequent elution of the breakdown products (De Munck et al, 2005). In the current study, it seems that bonding effectiveness of the materials used was more stable over the testing periods. This may be due to some factors regarding the type of adhesive system used (Reis et al., 2008, Delipri et al.2006, and Tay et al., 2002 a,b), restorative material type (Matis et al., 2004, Dias et al., 2004, Gordan 2005, Asaka et al., 2006, Chiba et al., 2006, Wilson et al., 2006), and the use of chlorhexidine which seemed to be able to diminish the loss in bond strength and maintain durability of the bond (Carrilho et al., 2007, Erdhart et al., 2008 and Campos et al., 2009). In the current study, although when Single bond was used in conjunction with giomer restorative material with the use of chlorhexidine, the mean microtensile bond strength was drop dramatically after nine months. This may be attributed to the degradation of giomer-adhesive interface that might be caused due to the
relative incompatibility between the adhesive used and the restorative material (Ilie et al., 2006) as well as degradation of the adhesive itself over time (Tay and Pashley 2003). Under the limitation of this study the following conclusions could be derived: Restorative material type and aging had no statistically significant effect on mean microtensile bond strength but rather the adhesive system. The bond performance of Adper Single Bond 2 deteriorates by time. The use of 2% chlorhexidine gluconate (Consepsis) diminishes the loss of bond strength of Adper single Bond 2 over time up to certain limit. The use of 2% chlorhexidine gluconate (Consepsis) was not able to completely prevent the loss of bond strengths over time.

**RECOMMENDATIONS**

Further *in vivo* studies are needed to clarify the causes behind the remaining loss of bond strength, to optimize the MMP inhibitory effect (e.g., concentration of chlorhexidine, time of application), and to find the optimal MMP inhibitor that would result in the best time-related preservation of the dentin-adhesive interface.

**REFERENCES**

5. Campos E A, Correr G M, Leonardi D P, Barato-Filho F, Gonzaga CC, Zielak J. Chlorhexidine diminishes the loss of bond strength over time under simulated pulpal pressure and ther-


