EFFECT OF 16% CARBAMIDE PEROXIDE BLEACHING AGENT ON THE SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS

Objective: To determine the effect of 16% carbamide peroxide on the shear bond strength of metal brackets bonded to premolars either immediately or 30 days after bleaching and to evaluate the bond-failure sites. Material and Method: Sixty freshly extracted human premolars were randomly divided into three groups, each containing 20 teeth. Specimens in group A (control) were not bleached (etched only with 37% phosphoric acid) before bonding. The teeth in the other two groups were first bleached with 16% carbamide peroxide according to the manufacturer’s recommendation. The teeth in group B were bonded immediately, while the teeth in group C were stored in artificial saliva for 30 days prior to bonding. Shear bond strength was measured and recorded in MPa. Adhesive remnant index (ARI) scores were determined after the brackets failed. Data were analyzed with analysis of variance (ANOVA) and the chi-square test. Results: Group A showed higher shear bond strength values than groups B and C, but the differences among the three groups were not significant (P = .053). Moreover, no significant differences in ARI were found. Conclusion: After bleaching with 16% carbamide peroxide, there is a slight, insignificant decrease in shear bond strength. The site of bond failure is not significantly affected by bleaching. World J Orthod 2009; 10:211–215.

Key words: bleaching, bonding, carbamide peroxide, shear bond strength
instructions. Various bleaching systems use 10%, 15% to 16%, or 20% to 22% carbamide peroxide. Some studies have shown that the bonding strength of enamel decreases after bleaching with carbamide peroxide. Turkun and Kaya found not only a significant decrease in the shear bond strength but also a reduction in tensile bond strength postbleaching.

Recent studies in which 35% hydrogen peroxide were used showed that bleaching does not adversely affect the bond strength of brackets bonded immediately or 30 days after bleaching, even though bleaching affected the failure site. Thus, it seems that bonding does not have to be postponed after bleaching.

Because bleaching solutions with 16% carbamide peroxide were found to be safe for clinical use, many practitioners use them. The purpose of this in vitro study was to determine the effect of bleaching with 16% carbamide peroxide on the shear bond strength of brackets bonded immediately or 30 days after bleaching and to evaluate the bond failure site.

**MATERIAL AND METHODS**

The sample consisted of 60 noncarious mandibular premolars that were extracted for orthodontic reasons. Hypoplastic teeth, teeth with cracks, or those with other macroscopic enamel irregularities were excluded. None of the teeth were previously exposed to chemical agents such as alcohol, formalin, or hydrogen peroxide. Immediately after extraction, all teeth were scraped of any residual tissue, pumiced, and washed under running tap water. Subsequently, they were stored in distilled water that was changed weekly to avoid bacterial growth. The sample was randomly divided into three groups of 20 teeth each. All teeth were mounted vertically in self-cure acrylic so that only their crowns were exposed.

Specimens were prepared according to their assigned group.

**Group A (control):** Teeth were etched with a 37% phosphoric acid gel (Fine Etch 37, Spident Lab) for 30 seconds. They were then rinsed with water for 30 seconds and dried with oil-free air for 20 seconds.

**Group B:** Teeth were covered with an approximately 1-mm layer of a commercially available 16% carbamide peroxide bleaching gel (Whiteness Perfect, FGM Dental Products) for 4 hours (manufacturer’s instruction). The specimens were then thoroughly rinsed for 30 seconds, air-dried, and stored in 250 mL artificial saliva at 37°C for 1 day. This procedure was repeated for 10 consecutive days. Before bonding, the teeth were etched with 37% phosphoric acid gel for 30 seconds.

**Group C:** Teeth in this group were treated similarly to those in group B, except that they were stored in artificial saliva for 30 days at room temperature after bleaching. The artificial saliva was changed every day after the bleaching cycle was completed.

Stainless-steel edgewise premolar brackets with a base surface area of 10 mm² were bonded to all teeth according to manufacturer’s instructions (G&H Wire). After surface preparation, Transbond XT primer (3M Unitek) was applied and the brackets were bonded with Transbond XT light-cure adhesive. Excess resin was removed with an explorer before polymerization. Curing was accomplished with a light-emitting diode (Blue Swan Digital, Dentanet) within 20 seconds.

**Debonding procedure**

For debonding, the embedded specimens were secured on a jig attached to the base plate of a universal testing machine (Model-500, Testometric). A chisel-edge plunger was mounted onto the crosshead of the testing machine and positioned so that the leading edge was aimed at the enamel-adhesive interface. At a crosshead speed of 0.5 mm/min, the maximum load (in N) necessary for debonding was recorded and the shear bond strength was calculated (in MPa = N/mm²).
Residual adhesive

After debonding, all teeth and brackets were examined under 10× magnification, and the adhesive remnant index (ARI) was assessed.\(^{19,20}\) The ARI scale ranges from 5 (no composite remnants on the enamel) to 1 (composite completely on the enamel, as well as an impression of the bracket base).

Statistical methods

All statistical analyses were performed using the Statistical Package for Social Sciences software (SPSS for Windows 10.0.1, SPSS). Descriptive statistics, including means, standard deviations, and minimum and maximum values, were calculated for all three groups. Means of shear bond strength values were compared with analysis of variance (ANOVA); the chi-square test was used to determine differences among ARI scores.

RESULTS

The descriptive statistics for the shear bond strengths of all three groups are presented in Table 1. ANOVA revealed no significant differences among the three groups (\(P > .05\)).

### Table 1 Shear bond strength statistics of the three test groups (\(n = 20\) for each group)

<table>
<thead>
<tr>
<th>Group</th>
<th>Bond strength (MPa)</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>A</td>
<td>20.25</td>
<td>7.00</td>
</tr>
<tr>
<td>B</td>
<td>16.10</td>
<td>4.10</td>
</tr>
<tr>
<td>C</td>
<td>15.55</td>
<td>7.80</td>
</tr>
</tbody>
</table>

\(n = \) number of specimens, SD = standard deviation, NS = not significant, A = control, no bleaching, B = bonding immediately after bleaching, C = bonding 30 days after bleaching.

### Table 2 ARI scores of the three test groups

<table>
<thead>
<tr>
<th>ARI scores</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>A</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>B</td>
<td>1 (5%)</td>
</tr>
<tr>
<td>C</td>
<td>1 (5%)</td>
</tr>
</tbody>
</table>

A = control, no bleaching, B = bonding immediately after bleaching, C = bonding 30 days after bleaching.

The results of the chi-square test indicated that there were no significant differences among the ARI scores of the three groups (Table 2). An ARI score of 2 was most frequent because failures occurred mostly at the adhesive-bracket interface.

DISCUSSION

Different agents, concentrations, frequencies of application, and application modes are currently used for tooth bleaching.\(^{21-23}\) In some in-office vital tooth bleaching techniques, high concentrations of hydrogen and carbamide peroxide are used,\(^{24,25}\) which, according to some authors,\(^{24}\) lead to enamel surface alterations, whereas other authors\(^{6,26-29}\) observed no change or only a different etching pattern. Enamel alterations are attributed to a loss of the prismatic structure,\(^{6}\) a loss of calcium, and an alteration in the organic substances.\(^{30}\) The decreased bond strength was also explained by diffusion of residual oxygen from the bleaching agent out of enamel, which inhibits polymerization of the resin.\(^{1,5,6,14}\) The insignificant decrease in bond strength in the bleaching group could be explained by the aforementioned inhibition of the polymerization of the resin and a modification of the tooth enamel surface.
sequence to the debonding procedure.

Turkun and Kaya\(^6\) showed a significant decrease in shear bond strength after enamel bleaching with 10%, 16%, and 20% carbamide peroxide. Here, a 16% concentration of carbamide peroxide was used, which is between the highest and lowest concentrations reported.

Although there are remarkable variations among the recommended post-bleaching time periods in different studies (24 hours to 4 weeks), most researchers advised delaying bonding a minimum of 1 week.\(^1,2,8,9\)

Cacciafesta et al\(^7\) evaluated the effect of bleaching on the shear bond strength of brackets bonded with resin-modified glass ionomer. They found the shear bond strength in the group with bleached teeth using 10% carbamide peroxide significantly lower than in the unbleached control group. However, no significant difference between bonding immediately after bleaching and bonding 1 week later was observed.

One study\(^31\) showed that a prolonged exposure to bleaching agents results in the formation of a precipitate on the enamel surface that might adversely affect the bonding procedure.

Previous investigations have demonstrated that immersion of in vitro specimens in distilled water, artificial saliva, or even saline solution reverses a reduced enamel bond strength.\(^1,3,5,8,9,24\) The results of the present study do not agree with these findings because the worst results were found in group C, in which bonding took place 1 month after bleaching.

As in the present study, Miles et al\(^1\) reported that debonding occurs mostly at the bracket-adhesive interface.

**CONCLUSION**

The results of this study suggest that bleaching with 16% carbamide peroxide does not significantly reduce the shear bond strength of brackets. This was regardless of whether bonding took place immediately or 1 month after bleaching. Bleaching altered the failure site during debonding, which was generally at the adhesive-bracket interface. This might be of consequence to the debonding procedure.

**REFERENCES**


