Are bleaching and desensitizing agents contraindication for patients seeking orthodontic treatment?

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Aim: To compare in vitro the effects on shear bond strength of the application of a dental bleaching and desensitizer agent prior to bonding metallic orthodontic brackets to extracted human teeth. Method: Sixty therapeutically extracted human premolars without any visible defects were collected and stored in 0.1% thymol solution at room temperature. All teeth were randomly assigned to one of four groups (each n = 15): group I, teeth were treated with bleaching gel containing 10% carbamide peroxide; group II, teeth were treated with a desensitizer containing 26% potassium oxalate; group III, teeth were treated as in group I followed by application of the desensitizer agent as in group II; and group IV, control group. The teeth from all the four groups were then bonded with 0.018-inch Roth premolar brackets. The shear bond strength was tested in a Hounsfield material testing machine. Results: In group I, 10% carbamide peroxide gel alone did not affect the shear bond strength significantly compared with the unbleached specimens in the control group. The use of the desensitizer agent alone in group II significantly reduced the shear bond strength. In group III, further significant reduction of the mean shear bond strength occurred compared with all the three groups. Conclusion: The use of 10% carbamide peroxide prior to bonding orthodontic metallic brackets does not significantly alter shear bond strength. Application of desensitizer agent alone or in combination with bleaching agent significantly lowers the shear bond strength of orthodontic brackets. Application of desensitizer agent alone or in combination with bleaching agent does not lower the shear bond strength below the recommended value for orthodontic bonding procedure. As a result, their use is not a contraindication before orthodontic fixed mechanotherapy. ORTHODONTICS (CHIC) 2012;13:e181–e187.

Key words: bleaching, carbamide peroxide, desensitizer, shear bond strength

Orthodontic bond failure is a common complication in the orthodontic clinic and rebonding a loose bracket is time consuming. However, most bond failures occur because of improper execution, not because of the orthodontic bonding resins. Hence, one should be careful with the protocols for basic bonding procedures despite the introduction of newer orthodontic bonding resins. One of the factors that may affect the bond strength...
Bleaching and desensitizing agents as treatment contraindications

of the orthodontic brackets is tooth-whitening or bleaching agents. Tooth discoloration creates a wide range of cosmetic problems in the dental profession, and people expend considerable amounts of time and money in an attempt to improve the appearance of discolored teeth. The methods available to manage discolored teeth range from removal of surface stains, bleaching or tooth-whitening techniques, and operative techniques (veneers and crowns) to camouflage the underlying discoloration.

One of the most common adverse effects of vital tooth bleaching is tooth hypersensitivity, which is a result of heat and high concentrations of hydrogen peroxide. Various desensitizer agents have been introduced to counteract the problem of dentin hypersensitivity. These are fluorides (sodium fluoride, stannous fluoride, hydrogen fluoride, etc.), potassium oxalate, potassium nitrate, and calcium phosphate, which are available in the form of toothpastes, mouthwashes, and chewing gums and in office application methods by topical applications.

Lehmann and Degrange had shown the effects of various desensitizers in combinations with various dentin bonding systems on the shear bond strength of these dentin bonding systems. They found that the shear bond strength may or may not be significantly affected depending on the type of combination being used.

Studies by Turkkahraman and Adanir have shown that orthodontic brackets bonded to enamel treated with potassium nitrate and oxalate desensitizers showed significantly lower bond strengths than brackets bonded to untreated enamel. Hence, the authors did not recommend the desensitizer procedures with potassium nitrate and oxalate immediately prior to bonding.

In light of these facts, the present study focuses on the effects of a commonly used home bleaching method (10% carbamide peroxide gel), potassium oxalate–based desensitizer agent, and their combined in vitro effects on the shear bond strength of the metallic orthodontic brackets bonded to the teeth treated with these agents.

The purpose of this in vitro study was to compare the effects of the application of dental bleaching and desensitizer agents before bonding on the shear bond strength of the orthodontic metallic brackets bonded to human teeth.

METHODS

Sixty therapeutically extracted human premolars without any caries or visible defects were collected from the patients who had undergone extractions in the course of orthodontic treatment. These teeth were stored in 0.1% thymol solution at room temperature. Each tooth was individually embedded in autopolymerizing acrylic resin block measuring 10 × 10 × 25 mm, with the crowns of the teeth exposed. These blocks were color-coded to distinguish each group. The specimens were kept in distilled water except during the bleaching, bonding, and testing procedures. All the teeth were randomly assigned to four groups (each n = 15). The color code used for each group is mentioned below:

In group I (bleaching agent), the buccal surfaces of the teeth were cleaned using a pumice-and-water paste with a rubber cup on a slow-speed handpiece for 5 seconds. They were then washed for 10 seconds and dried for 10 seconds with a gentle oil- and moisture-free air spray. Thereafter, a 1-mm layer of bleaching gel (Opalescence Tooth Whitening Systems, Ultradent Products) containing 10% carbamide peroxide was applied to the buccal surface of the teeth and gently spread over the entire buccal surface of the teeth with a clean microbrush. Thereafter, the teeth were kept at room temperature for 6 hours.
After each daily bleaching session, the gel was washed away using an air-water syringe for 5 seconds. The specimens were stored in distilled water in a sealed container at room temperature (25°C during the period of study). The above-mentioned procedure was repeated every day for 14 days. This replicates the instructions usually provided with home-bleaching kits. Changes in the color were recorded at day 7 and 14 after bleaching. After 14 days of bleaching, the teeth were stored in distilled water at room temperature before bonding.

In group II (desensitizer agent), the buccal surfaces of the teeth were cleaned using a pumice-and-water paste with a rubber cup on a slow-speed handpiece for 5 seconds. The teeth were cleaned with distilled water and wiped with a clean cotton swab so that buccal surfaces of the teeth remained moist, not completely dry. Just prior to application, the teeth were dried with a gentle oil- and moisture-free air spray. Desensitizer (Prime Dental Products) containing 26% potassium oxalate was applied with applicator needle (provided with the package) directly to the exposed buccal surface of the teeth. After 90 seconds, as instructed by the manufacturer, excess gel was wiped off the teeth with a clean cotton swab and all the teeth were rinsed thoroughly with distilled water. Thereafter the teeth were stored in distilled water for 7 days before bonding.

In group III (bleaching and desensitizer agent), the buccal surfaces of the teeth were cleaned using a pumice-and-water paste with a rubber cup on a slow-speed handpiece for 5 seconds. Teeth were bleached with 10% carbamide peroxide in the same way as in group I and stored in distilled water for 24 hrs. Thereafter the desensitizer agent was applied to the teeth in the same way as in group II. Thereafter, the teeth were stored again in distilled water at room temperature for 6 days before bonding.

In group IV (control group), the buccal surfaces of the teeth were cleaned using a pumice-and-water paste with a rubber cup on a slow-speed handpiece for 5 seconds. Neither bleaching nor desensitizer agent were applied. After cleaning, the teeth were stored in distilled water for 7 days.

Prior to bonding, the buccal surfaces of the teeth were cleaned with a mixture of water and pumice. The teeth were rinsed thoroughly with water and dried with oil- and moisture-free compressed air. The teeth were etched with 37% phosphoric acid gel (Scotchbond Multipurpose, 3M ESPE) for 30 seconds. The teeth were then rinsed with an air/water spray combination for 30 seconds and dried until a characteristic frosty white etched area was observed. With a microbrush, a thin uniform layer of primer (Transbond XT, 3M Unitek) was applied to the etched enamel surface. Using a syringe tip, the adhesive paste (Transbond XT) was applied to the bracket base (0.018-inch Roth premolar brackets, Ortho Organizers). The bracket was then positioned on the tooth and pressed lightly in the desired position. Excess adhesive was removed with a sharp scaler, and the adhesive was cured with halogen light with the intensity of 900 mW/cm² for 40 seconds (20 seconds on the mesial surface and 20 seconds on the distal surface of the brackets) with the light tip kept at a distance of 2 mm from the bracket.

After all the teeth were bonded, the specimens were kept in distilled water for 24 hours at room temperature. Each specimen was then loaded into universal testing machine (model H25KS Hounsfield material testing machine, Hounsfield) for testing, with the long axis of the specimen parallel to the direction of the applied force. The custom-made knife-edge metallic jig was positioned in the upper jaw of the machine in such a way the edge of the jig makes contact with the bonded specimen between the bracket base and the buccal surface of the teeth. The specimens from all four groups were loaded in the lower jaw of the machine one by one. Bond strength was determined in the shear mode at a crosshead speed of 0.5 mm/min until debonding took place. The values of failure loads were recorded in KgF/cm² and converted into megapascals (MPa).
RESULTS

The statistical analysis of the data was calculated using Minitab16 (Minitab). Table 1 gives the values of shear bond strength of brackets of all four groups. The trends of the shear bond strength values are shown in Fig 1. The graph shows that groups I and IV are quite close, whereas groups II and III are also close together.

To find whether differences in mean shear bond strength were significantly different among the groups, a one-way analysis of variance (ANOVA) was carried out. The F value (87.84) shows significant differences ($P = .0001$) among the different groups. Pairwise comparisons for different pairs of groups was also carried out. Table 2 gives the means, standard deviations (SDs), and 95% confidence intervals for the mean based on the pooled variance from the ANOVA. The mean shear bond strength of the four groups is shown in Fig 2.

Table 1  The shear bond strength of all groups

<table>
<thead>
<tr>
<th>Sample</th>
<th>Group I: Bleaching (MPa)</th>
<th>Group II: Densensitizer (MPa)</th>
<th>Group III: Bleaching and desensitizer (MPa)</th>
<th>Group IV: Control (MPa)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>22.145</td>
<td>17.416</td>
<td>13.562</td>
<td>23.192</td>
</tr>
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<td>3</td>
<td>23.879</td>
<td>12.326</td>
<td>11.513</td>
<td>22.467</td>
</tr>
<tr>
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<td>12.326</td>
<td>18.691</td>
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<tr>
<td>5</td>
<td>22.506</td>
<td>13.288</td>
<td>13.739</td>
<td>19.191</td>
</tr>
<tr>
<td>6</td>
<td>24.595</td>
<td>16.082</td>
<td>13.513</td>
<td>24.418</td>
</tr>
<tr>
<td>7</td>
<td>24.389</td>
<td>15.180</td>
<td>12.748</td>
<td>21.947</td>
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<tr>
<td>8</td>
<td>20.446</td>
<td>13.601</td>
<td>13.268</td>
<td>23.310</td>
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<tr>
<td>9</td>
<td>24.281</td>
<td>17.347</td>
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<td>24.134</td>
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<tr>
<td>10</td>
<td>24.997</td>
<td>11.513</td>
<td>10.159</td>
<td>19.897</td>
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<td>19.554</td>
<td>15.523</td>
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<td>23.634</td>
</tr>
<tr>
<td>15</td>
<td>20.652</td>
<td>13.964</td>
<td>9.7674</td>
<td>22.516</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>22.095 ± 2.013</td>
<td>14.577 ± 1.747</td>
<td>12.592 ± 2.207</td>
<td>22.450 ± 2.391</td>
</tr>
</tbody>
</table>

SD, standard deviation; MPa, megapascals.

Fig 1  Comparison of shear bond strengths of all groups.
Controversy

Ray et al. The Tukey test was done for making pairwise comparisons for the mean shear bond strength for all possible pairs of four treatment groups. The difference between groups I and II (7.567 MPa) was statistically significant ($P = .0001$). The mean shear bond strength of the bleaching group was much higher than that of desensitizer group. The mean shear bond strength of the bleaching group was also significantly higher than the mean shear bond strength of the bleaching and desensitizer group. Although the difference between the mean shear bond strength of the bleaching and control group is not statistically significant, the mean shear bond strength of control group stands marginally higher (0.305 MPa) than the mean shear bond strength of the bleaching group ($P = .709$).

The difference between the mean shear bond strength of groups II and III (1.986 MPa) was also significant statistically ($P = .011$).

The difference between the mean shear bond strength of groups III and IV (~11.73 MPa) is statistically significant ($P = .0001$). This shows a high reduction in the shear bond strength due to a combination of bleaching and desensitizer.

### DISCUSSION

The increasing demands of an esthetic smile and increase in the number of adult patients in orthodontic clinics makes an orthodontist think beyond leveling and alignment of teeth. This includes achievement of a bright white smile with various tooth-whitening systems. Numerous products are currently used to bleach teeth, both internally on a nonvital tooth and externally on a vital tooth.

In the present study, 10% carbamide peroxide was used as the bleaching agent for groups I and III, since the product is commonly available on the Indian market and used primarily as a home-bleaching method.

**Table 2  Means, SDs, and 95% CIs for studied groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Mean ± SD</th>
<th>CIs (based on pooled SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>22.145 ± 2.024</td>
<td>(–*–)</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
<td>14.578 ± 1.747</td>
<td>(–*–)</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
<td>12.592 ± 2.208</td>
<td>(–*–)</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>22.451 ± 2.392</td>
<td>(–*–)</td>
</tr>
</tbody>
</table>

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Pooled SD, 1.106
SD, standard deviation; CI, confidence intervals.

**Fig 2  Comparision of mean shear bond strengths of all groups (MPa).**
Patusco et al. conducted a comparative study between 10% carbamide peroxide and 35% hydrogen peroxide and found that 10% carbamide peroxide bleaching gel did not significantly alter the shear bond strength value when applied 24 hours before bonding in contrast to 35% hydrogen peroxide. Along with reduction of bond strength, 35% hydrogen peroxide diminishes the amount of resin remnant on the tooth surface after bracket debonding.

The mean shear bond strength value recorded in the present study for group I (bleaching agent only) was 22.095 ± 2.013 MPa (see Table 1). However, the mean shear bond strength of the control group stands marginally higher (0.355 MPa) than the mean shear bond strength of the bleaching group ($P = .709$); the difference is statistically insignificant. Hence, the results are similar to the results in the previous studies by Patusco et al. and Bishara et al. In this study, an oxalate-based desensitizer agent was used in both groups II and III. Although a single application of the desensitizer agent was done as per manufacturer’s instructions, the number of applications of the desensitizer agent in vivo depends on the patient’s symptoms. Hence, multiple applications may be required if the patient remains symptomatic after a single application.

Tay et al. claimed that when oxalates were used on acid-etched cavities that contain enamel margins, the enamel surfaces became covered by calcium oxalate crystals that could interfere with resin-enamel adhesion. A brief (10- to 15-second) acidic etch could dissolve apatite crystals beneath clinging acid-resistant oxalate crystals and leave etched enamel ready for resin infiltration after the oxalate crystals fall off.

The desensitizer used in the present study contained 26% potassium oxalate and a QSP vehicle including aqua, thickening agent, fragrance, and stabilizer. The mean shear bond strength value for group treated with only the desensitizer agent was 14.578 ± 1.747 (see Table 2). The reduction in the shear bond strength of group II was statistically significant compared with the control group ($P = 0.0001$) and group I ($P = .0001$). Although the results achieved in this study were similar to the study by Turkkahraman and Adanir, the mean shear bond strength of the teeth treated with desensitizer in the present study was much higher. They found significant reduction of the shear bond strength of the teeth treated with potassium nitrate (11.96 ± 2.07 MPa) and oxalate desensitizers (8.84 ± 2.37 MPa), which were significantly lower than the results achieved in the present study. This may be attributed to the differences in the composition of the desensitizer agents and methodologic differences.

However, significantly lower bond strengths observed in adhesives when applied to oxalate desensitizer–treated dentin may be attributed to the presence of spherical globules along the adhesive-dentin interface. These spherical globules closely resemble the loosely bound spherical calcium fluoride–like material formed on enamel.

In group III, the application of a bleaching agent followed by desensitizer further reduced the mean shear bond strength of the orthodontic brackets (12.592 ± 2.207 MPa). The difference in the mean shear bond strength value between groups II and III is 1.986 and is statistically significant ($P = .011$). The reduction of mean shear bond strength in group III is statistically significant ($P = .0001$) compared with groups I and IV.

The study by Turkkahraman et al. evaluated the effects of a bleaching agent containing 35% hydrogen peroxide followed by desensitizer (UltraEZ desensitizer) containing 3% potassium nitrate, but the results are in agreement with the present study, which shows significant reduction in the bond strengths of the orthodontic brackets after the application of both bleaching and desensitizer agents.

A comparison of shear bond strengths of all four groups of the present study (see Figs 1 and 2) revealed that the use of 10% carbamide peroxide gel
alone did not significantly affect the shear bond strength, although the mean shear bond strength of the unbleached specimens in the control group was marginally higher. The use of desensitizer containing 26% potassium oxalate alone in group II significantly reduced the shear bond strength of the adhesive used for orthodontic bonding. In comparison to group II, the application of 10% carbamide peroxide followed by desensitizer in group III further significantly reduced the mean shear bond strength of the adhesive.

Reynolds suggested that for an adhesive system to have acceptable clinical performance, in vitro bond strength of 5.9 to 7.8 MPa is required. There was significant lowering of the shear bond strength of the brackets in groups III and IV, but the values achieved were above the minimum recommended value required for bonding orthodontic brackets.

CONCLUSION

The following three conclusions can be drawn from the study:

1. The use of 10% carbamide peroxide bleaching 7 days prior to bonding orthodontic metallic brackets does not significantly alter shear bond strength.
2. Application of either desensitizer alone or after application of bleaching agent significantly lowers the shear bond strength of orthodontic brackets.
3. Application of desensitizer alone or in combination with a bleaching agent does not lower the shear bond strength below the recommended value for orthodontic bonding procedure. Therefore, their use is not a contraindication before orthodontic fixed mechanotherapy.

REFERENCES