Can previously bleached teeth be bonded safely?

Tancan Uysal, DDS,a Faruk Ayhan Basciftci, DDS, MS, b Serdar Üşümez, DDS, PhD, b Zafer Sari, DDS, PhD, b and Ahmet Buyukerkmen, DDS a

Konya, Turkey

The purpose of our study was to determine the effect of a 35% hydrogen peroxide bleaching agent on the shear bond strength of metallic orthodontic brackets. Sixty premolars were randomly divided into 3 groups of 20 each. Teeth in group A were etched with 37% phosphoric acid before bonding metallic premolar brackets. Teeth in the other two groups were bleached with a 35% hydrogen peroxide in-office bleaching agent according to the manufacturer’s recommendations. Twenty bleached teeth (group B) were bonded immediately, and the other 20 (group C) were stored in artificial saliva for 30 days before bonding. Shear bond strength of these brackets was measured on a universal testing machine and recorded in MPa. Adhesive remnant index (ARI) scores were determined after the brackets failed. Data were analyzed with analysis of variance (ANOVA) and chi-square tests. The shear bond strength values of groups A, B, and C were 12.9 ± 3.4, 12.0 ± 4.6, and 14.8 ± 4.0 MPa, respectively. Results of ANOVA showed no statistically significant differences in shear bond strengths between groups (P > .05). ARI scores were significantly different in all groups. The unbleached group’s failures were primarily at the bracket/adhesive interface, whereas the bleached groups either showed cohesive failures within the adhesive or failed at the adhesive/enamel interface. The results of this study suggest that office bleaching with hydrogen peroxide does not adversely affect the bond strengths of brackets bonded immediately after bleaching or 30 days after bleaching, even though bleaching can result in differences in the failure site. (Am J Orthod Dentofacial Orthop 2003;123: 628-32)

Various whitening systems are currently being used to bleach enamel.1,2 Some of the external bleaching systems are applied by the clinician as an office procedure, using a strong solution of hydrogen peroxide subjected to either heat or light to speed up the reaction.2 Concentrated solutions of hydrogen peroxide are the most common agents used to bleach discolored teeth. The use of peroxide-based tooth-whitening materials has increased substantially in the past few years, despite many unanswered questions about their use.3,4 Thus, little is known of their biological and physical effects, particularly their effects on dental restorative materials and on the shear bond strength of orthodontic adhesives to human tooth enamel.4

Previous studies5-7 have shown changes in enamel structure, composition, and bond strength when exposed to 35% hydrogen peroxide for in-office vital bleaching. Some authors8-11 identified a substantial reduction in bond strengths to enamel shortly after exposure to concentrated aqueous solutions of hydrogen peroxide. Demarco et al9 reported reduced bond strength to human dentin and suggested a 1-week delay of the bonding procedure after bleaching. Sung et al10 suggested using an alcohol-based bonding agent to achieve less compromised bond strength when restorative work is planned immediately after bleaching.

Because some adults who are interested in orthodontic treatment might have also had their teeth bleached or might be interested in bleaching, it seems important to determine whether bleaching would significantly influence the bond strength of orthodontic bracket adhesives to the enamel surface.

The purpose of this study was to determine the effect of a 35% hydrogen peroxide bleaching agent on the shear bond strength of metallic orthodontic brackets immediately bonded to premolars or brackets bonded to premolars 30 days after bleaching.

MATERIAL AND METHODS

Sixty noncarious premolars extracted with orthodontic indication were used in this study. Teeth with hypoplastic areas, cracks, or gross irregularities of the enamel structure were excluded. The criteria for tooth
selection dictated no pretreatment with a chemical agent such as alcohol, formalin, or hydrogen peroxide, or any other form of bleaching. The teeth were stored in distilled water after extraction. The water was changed weekly to avoid bacterial growth. The sample was randomly divided into 3 groups of 20 teeth. Each tooth was mounted vertically in a self-cure acrylic so that the crown was exposed. The buccal enamel surfaces of the teeth were polished with nonfluoridated pumice and rubber prophylactic cups, and then washed and dried before the procedure.

Brackets were bonded according to one of the following procedures.

In group A, a 37% phosphoric acid gel (3M Dental Products, St Paul, Minn) was used to etch 20 premolars for 30 seconds. The teeth were then rinsed with water from a 3-in-1 syringe for 30 seconds and dried with an oil-free air source for 20 seconds. In all teeth, the frosty white appearance of etched enamel was noticed.

In Group B, before bleaching, the surface of each tooth was polished for 1 minute with a polishing agent and a brush at a low speed (3000 rpm). The buccal surface of the tooth was then etched with 37% phosphoric acid gel for 60 seconds and washed and dried. Then a 35% hydrogen peroxide solution and a bleaching agent (Quasar Brite, Spectrum Dental, Culver City, Calif) were mixed according to the manufacturer’s instructions and applied with a brush to the tooth surface, in a layer approximately 1 mm thick. The mixture on the tooth surface was then exposed to a fast halogen curing light (VCL 501, Kerr, Danbury, Conn). The distance between the emitting tip of the light source and the tooth surface was set at 15 mm. Teeth were exposed to the light source for 3 seconds, left standing for 5 min, and then exposed to the light source again for another 3 seconds. After they were left standing for another 2 min, each tooth was exposed to the light source for another 3 seconds. Then the mixture that had been applied to the teeth was washed away. The bonding area was again etched with 37% phosphoric acid gel for 30 seconds (Figure).

Group C was treated the same as Group B, except that, after bleaching and before bonding, the teeth were stored in artificial saliva for 30 days at room temperature. The artificial saliva was changed daily.

Sixty stainless steel premolar standard edgewise brackets (790-010, Dentaurum, Phorzeim, Germany), with a base surface area of 10 mm², were used for this study. After surface preparation, the liquid primer Transbond XT (3M Unitek, Monrovia, Calif) was applied to the etched surface, and the brackets were bonded on premolars with Transbond XT. Excess resin was removed with an explorer before it was polymerized. A fast halogen light source was used for curing for 20 seconds.

Debonding procedure

The embedded specimens were secured in a jig attached to the base plate of a universal testing machine (Model 500, Testometric, Rochdale, United Kingdom). A chisel-edge plunger was mounted in the movable crosshead of the testing machine and positioned so that the leading edge was aimed at the enamel/adhesive interface. A crosshead speed of 0.5 mm/min was used, and the maximum load necessary to debond the bracket was recorded. The force required to remove the brackets was measured in newtons (N), and the shear bond strength (1 MPa = 1 N/mm²) was then calculated by dividing the force values by the bracket base area (10 mm²).

Residual adhesive

After debonding, all teeth and brackets were examined under 10× magnification. Any adhesive remaining after bracket removal was assessed with the adhesive remnant index (ARI)¹²,¹³ and scored with respect to the amount of resin adhering to the enamel surface. The ARI scale has a range between 5 and 1: 5 indicates that no composite remained on the enamel; 4, less than 10% of the composite remained on the tooth; 3, more than 10% but less than 90% remained on the tooth; 2, more than 90% of the composite remained; and 1, all the composite remained on the tooth, along with the impression of the bracket base. The ARI scores were used as a more comprehensive means of defining the sites of bond failure between the enamel, the adhesive, and the bracket base.

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1. Flowchart for bleaching procedure. HP, hydrogen peroxide.
Statistical methods

Descriptive statistics, including the mean, SD, and minimum and maximum values, were calculated for the 3 groups of teeth tested. Comparisons of means were made with analysis of variance (ANOVA) and Tukey tests. The chi-square test was used to determine significant differences in the ARI scores between the different groups. All statistical analyses were performed with the SPSS software package (SPSS for Windows 10.0.1, SPSS, Chicago, Ill).

RESULTS

The descriptive statistics for the shear bond strengths of the various groups tested are presented in Table I. ANOVA revealed no statistically significant differences between the 3 groups tested (P > .05).

The results of the chi-square comparisons indicated that there were significant differences between the 3 groups tested (Table II) (P ≤ .001). There was a greater frequency of ARI scores of 1 in the acid-etched groups; this indicated that failures were mainly at the adhesive/bracket interface. Differences in ARI scores were statistically significant between all groups (Table II). In Group B, the failures were mostly adhesive at the resin/enamel interface, and some cohesive failures within the resin were also observed. In Group C, there was a higher frequency of ARI scores of 2 and 4, indicating cohesive failures within the resin.

DISCUSSION

For effective stain removal, hydrogen peroxide must be able to move through the tooth structure.\(^1^4\) This is possible because hydrogen peroxide is of low molecular weight and can denature proteins; this increases tissue permeability and allows ions to move through the tooth.\(^1^5\) Hydrogen peroxide releases free oxygen radicals,\(^1^6\) which are known to have the potential to cause cellular change.\(^1^7\)

Little is known about the effect of hydrogen peroxide over the long term. There is concern that vital bleaching could alter the surface topography of enamel and thus affect the bond strength of adhesives to enamel.\(^5^\,8\) Alterations in bond strength might be significant with regard to clinical operative procedures that involve composite resin bonding, such as bonding orthodontic brackets, porcelain veneers, composite veneers, or future composite restorations.\(^1^4\)

In the experimental setup of the study, the bleached teeth in Group C were stored in artificial saliva before bonding to imitate the conditions of the oral cavity. A study to investigate the effect of such solutions on the surface morphology of enamel\(^1^3\) showed that prolonged exposure results in the formation of a precipitate on the enamel surface that might adversely affect the bonding procedure. Thus, in accordance with the previous studies,\(^1^8,1^9\) this layer was removed by acid etching before bonding.
Two previous studies of bracket bond strengths to bleached enamel surfaces obtained controversial results. The results of this study agree with those of Bishara et al. who reported that the immediate bond strength values were not adversely affected by 10% carbamide peroxide bleaching for a week. However, Miles et al. reported a significant reduction in bond strength of ceramic brackets after 72 hours of bleaching with the same agent. Miles et al. reported that the debonding occurs in most cases at the bracket/resin interface, but they still related the reduced bond strength to the adverse effect of the residual bleaching agent. However, because most of the resin was left bonded to the enamel in most specimens, their suggestion does not seem valid. Adhesive remnant data were not given in the Bishara study, but they probably had more resin/enamel failures, considering the higher shear bond strengths they reported. In the present study, ARI scores were statistically different among all groups, and failures in the bleached groups were mostly located at the adhesive/enamel interface. Therefore, we conclude that the bleached-enamel/adhesive bond strength values in our study are more likely to be accurate.

In the immediately bonded bleaching group (B), the average bond strength values were lower, although not significantly so, than those of the acid-etched and saliva-stored bleaching groups. Josey et al. suggested that, under experimental conditions, hydrogen peroxide diffuses out of the teeth between 1 week and 6 weeks, thus allowing a composite resin-luting cement bond that was not influenced by a reaction with hydrogen peroxide. This would account for an increase in bond strength up to 6 weeks after bleaching and consistent bond strength thereafter. However, this process might occur more quickly in vivo. It is accepted that etching untreated enamel with 37% phosphoric acid can involve prism-core demineralization, prism-sheath demineralization, or both. Composite resin adheres to etched enamel by mechanical bonding, whereby unfilled resin penetrates and polymerizes in these surface irregularities. However, Josey et al. suggest that acid-etched bleached teeth lost these regular prism boundaries, and such changes might affect the retentive qualities of dental restorations or adhesives applied to the enamel surface. The insignificant decrease in bond strength of the immediately bonded bleaching group could be related to both factors (ie, surface modification and diffusion of residual hydrogen peroxide out of enamel). The highest bond strength values recorded were for the 30-day saliva-immersed group (C); this confirms that any possible adverse effect of residual hydrogen peroxide was neutralized during this period. However, some surface modification might still be present when the significantly different ARI scores are considered. Use of artificial saliva instead of distilled water, as in this study, might be more appropriate for imitating clinical conditions.

CONCLUSIONS

1. The use of a 35% hydrogen peroxide in-office bleaching system immediately before bonding does not significantly reduce shear bond strength values.
2. Immersing bleached teeth in artificial saliva does not have a significant effect on shear bond strength, but a delay of bonding for 2 to 3 weeks might be beneficial.
3. Bleaching significantly alters the site of failure during debonding. This might be beneficial in clinical use, because less residual adhesive remains on the tooth surface.

REFERENCES


