Published online: 2019-10-15

The effect of tooth bleaching on the shear bond strength of orthodontic brackets using self-etching primer systems

Mehmet Akin[1]
Sertac Aksakalli[1]
Faruk Ayhan Basciftci[1]
Abdullah Demir[1]

ABSTRACT

Objective: The purpose of this study was to determine the effect of 10% carbamide peroxide and 38% hydrogen peroxide bleaching agents on the shear bond strength of orthodontic brackets using self-etching primer systems.

Methods: Forty five freshly extracted human premolar teeth were randomly divided into 3 groups of 15 teeth each: control (group 1), 10% carbamide peroxide at-home bleached (group 2), and 38% hydrogen peroxide in-office bleached (group 3). Three weeks later, all brackets were bonded using a self-etching primer system. The shear bond strength of these brackets was measured and recorded in MPa. Adhesive remnant index (ARI) scores were determined after the brackets failed. Data were analyzed using Kruskal- Wallis test, pairwise comparisons were made using the Mann-Whitney U test and ARI scores were analyzed using a chi-square test at a significance level of $P<.05$.

Results: The shear bond strengths of group 1 (mean: 17.7 ± 9.7 MPa) were significantly higher ($P<.05$) than those of group 3 (mean: 9.9 ± 5.4 MPa). No significant differences were found between group 2 (mean: 12.3 ± 4.7) and either group 1 or group 3 ($P>.05$). ARI scores did not differ significantly among the 3 groups.

Conclusions: The use of 10% carbamide peroxide bleaching does not significantly reduce shear bond strength values. In contrast, use of 38% hydrogen peroxide bleaching significantly reduces these values. (Eur J Dent 2013;7:55-60)

Key words: Bleaching; self-etching primer; bond strength; orthodontic; bracket

[1] Department of Orthodontics, Faculty of Dentistry, University of Selcuk, Konya, TURKIYE

Corresponding author: Dr. Mehmet Akin
Selcuk Universitesi, Dishekimliği Fakultesi, Ortodonti Anabilim Dali, Selçuklu 42079, Kampus / Konya, TURKIYE
Tel: + 90 332 2231174
Fax: + 90 332 2410062
Email: mehmetakin07@hotmail.com

INTRODUCTION

One of the great esthetic problems in dentistry is tooth discoloration. It has many complex etiologic factors that are usually classified as being intrinsic, extrinsic, or internalized in nature.[1,2] Today, patients can have tooth bleaching done in 2 ways: either in-office or at home bleaching. In-office vital tooth bleaching has been used for many years in dentistry. Most tooth bleaching procedures are safe and well-accepted for the treatment of this esthetic problem, as they do not require any reduction in tooth structure.[3-7]

The first condition of orthodontic treatment is bonding the orthodontic brackets to tooth surfaces. However, this step is temporary, because the brackets are removed after active treatment,[8] and maintaining a sound, unblemished enamel surface after debonding is the clinician's primary goal.[9] Tooth-conserving and time-saving adhesive methods for retaining orthodontic attachments are replacing traditional methods. Thus, self-etching primers (SEPs) were introduced to improve the bonding procedures. In late 2000, a new SEP was developed particularly for orthodontic bonding.[10,11]

Reports are controversial about the shear bond strengths of brackets after bleaching. Authors have generally reported that mean shear bond strength of orthodontic brackets with bleached enamel is significantly lower than that with unbleached enamel corresponding to the bleaching type or waiting period after the bleaching procedure.[3,12,13] However, others have reported no significant differences in mean shear bond strength between bleached and unbleached teeth.[14-16] To our knowledge, there have been no reports to date about SEP bond strengths for bleached enamel between bleaching types. Therefore, the aim of this present study was to determine the effect of in-office and at-home bleaching of the enamel on shear bond strength of orthodontic brackets bonded using a Self-etching Primer system and orthodontic composite.

MATERIALS AND METHODS

Forty five non-carious premolars extracted with orthodontic indication were used in this study. The criteria for tooth selection included intact buccal enamel; no pretreatment with chemical agents such as derivatives of peroxide, acid, alcohol, or any other form of bleaching; no cracks from forceps; no caries; and no restorations. 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 15 teeth. Each tooth was mounted vertically in a self-cure acrylic so that the crown was exposed and the labial surfaces would be parallel to the applied force during the shear test. The teeth were cleansed and polished with a pumice and water mixture for 10 seconds and rinsed with water.

Two protocols were used to imitate the bleaching methods used by clinicians. At-home bleaching was performed on 15 teeth using an Opalescence bleaching system (Ultradent, South Jordan, UT, and USA), containing 10% carbamide peroxide. The bleaching material was applied to the buccal surfaces using custom trays fabricated for each tooth specimen and left for 8 hours. The procedure was repeated on 10 consecutive days, as recommended by the manufacturer. The teeth were stored in artificial saliva at 37°C between bleaching cycles. The bleaching agent was changed every day after the bleaching cycle was completed.

In-office bleaching was performed on 15 teeth using the Boost bleaching system (Ultradent, South Jordan, UT, USA), containing 38% hydrogen peroxide gel. The 15 teeth were air dried, and the Boost whitening gel was applied to their buccal surfaces directly from the syringe. This regimen is consistent with the manufacturer's recommendations. The bleaching agent was then rubbed off the buccal surface. Second and third cycles were repeated for another 15 minutes. After bleaching, the bleaching and control group teeth were stored for 3 weeks in artificial saliva at 37°C.[14]

The control group consisted of 15 unbleached teeth.

Forty five stainless steel premolar standard edgewise brackets (790-010, Dentaurum, Pforzheim, Germany) with an average base surface area of 10 mm^2, were used in this study. Transbond Plus Self-etching Primer (TSEP) (3M Unitek, Monrovia, USA) was used for teeth surface preparation according to the manufacturer's instructions. After TSEP application, the brackets were bonded with Transbond XT light-cure adhesive paste (3M Unitek, Monrovia, USA). First, the bracket was properly positioned on the sample. Second each bracket was subjected to 300 g of force, and the excess bonding resin was removed using a sharp scaler. The adhesive was then light-cured for 20 seconds with a light-emitting diode

(Elipar Freelight 2, 3M ESPE, USA). This procedure was repeated for all samples.

Debonding procedure

The embedded samples were secured in a jig attached to the base plate of a universal testing machine (Elista TSTM 02500, Elista Corp, Istanbul, Turkey). A chisel-edge plunger was mounted in the movable crosshead of the testing machine to position the leading edge at the enamel/adhesive interface. A crosshead speed of 0.5 mm/min was used, and the maximum load required to debond the bracket was recorded. The force required to remove the brackets was measured in newtons (N), and the following formula was used to obtain the MPa value of the shear bond strength '1 MPa=1 N/mm^2'.

Residual adhesive

All samples and brackets were examined under 10 x magnification for the determination of the adhesive remnant index (ARI) scores after debonding. Any adhesive remaining after the debonding procedure was assessed using the ARI[4,14] and scored according to the ARI criteria. The ARI scale cosist of a 1-5 range; 5 indicated 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, adhesive, and bracket base.

Statistical methods

The shear bond strength data of the groups were subjected to normality testing. A non-parametric test (Kruskal–Wallis) was used to determine the significance between groups. The ARI scores were evaluated using chi-square analysis. The level of significance was established at P<.05 for all of the statistical tests. A Mann-Whitney U test was performed to determine the differences between groups. All statistics were performed using SPSS version 13.0 (SPSS Inc, Chicago, Illinois, USA).

RESULTS

The descriptive statistics for the shear bond strengths of the various groups are presented in Table 1. The Kruskal-Wallis test showed that there were statistically significant differences in shear bond strength among the 3 groups. The shear bond strength of the brackets in group 1 (control unbleached; mean, 17.7 ± 9.7 MPa) was significantly higher (P<.05) than that in group 3 (office bleaching; mean, 9.9 ± 5.4 MPa). We found no statistically significant differences between groups 1 and 2 or groups 2 and 3 (P>.05).

The frequency distribution of the ARI scores is presented in Table 2. Chi-square comparison revealed no significant difference among groups

Table 1. The Result of the Kruskal–Wallis and Mann–Whitney U test comparing the shear bond strengths of the groups.

	Bond Strength (MPa)				Significance	Post-Hoc Test		
Groups Tested	n	Mean	SD	Range		I-II	I-III	II-III
Control (Unbleached)	15	17.7	9.7	12.3-23.1	P<.05*	NS	*	NS
Home Bleaching	15	12.3	4.7	9.7-15.0				
Office Bleaching	15	9.9	5.4	6.0-12.9				

NS indicates nonsignificant; *P<.05.

Table 2. Frequency of distribution of Adhesive Remnant Index (ARI) scores (%).

	ARI Scores					
Groups Tested	1	2	3	4	5	n
Control (Unbleached)	2	3	2	4	4	15
Home Bleaching	0	0	2	7	6	15
Office Bleaching	0	0	1	6	8	15

Chi-square comparison revealed no significant differences between Groups P>.05

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.

(P>.05). There was a greater frequency of ARI scores of 4 and 5 in all groups, which indicated that the failures occurred mainly in the adhesive-enamel interface.

DISCUSSION

Patients who visit an orthodontic clinic have esthetic concerns. Therefore, both tooth appearance and color is important to them. A number of bleaching products and techniques are now available to patients via the clinicians and over the counter for use by consumers without professional supervision. These products differ in terms of agent, concentration, application frequency, product format, application mode, and light activation.[17] Two types of bleaching are generally available to consumers: in office and at home. Some authors have investigated the effect of the 25-35% hydrogen peroxide used in the office bleaching agents[12,14] on the shear bond strength of brackets bonded on the bleached enamel while others have investigated the 10% carbamide peroxide that is used in home bleaching agents.[15,18,19]

A number of investigators have observed changes in enamel surface topography after bleaching, including loss of prismatic form, decreased numbers of resin tags, and decreased bond strength.[16,20] Although remarkable variations exist among the recommended post-bleaching time periods in different studies (24 hours to 4 weeks), some considered that a delay of at least 2 weeks is needed after bleaching for the tooth structure to regain its pre-bleaching adhesive properties.[21-23] Uysal et al14 stored their samples in artificial saliva for 30 days and suggested that a bonding delay of a minimum of 2-3 weeks might be beneficial. In the experimental set up of the present study, the bleaching groups were stored in artificial saliva for 3 weeks before bonding to mimic the conditions of the oral cavity.

TSEP generates a more conservative etching pattern and less aggressive enamel demineralization.[24] Previous studies have deduced that the SEP system can successfully bond orthodontic brackets as effectively as the total etching system.[25,26] However, the literature does not have sufficient information about the effect of bleaching treatments on the shear bond strength of orthodontic brackets bonded with TSEP and orthodontic composites.

Our study results indicated that there were no significant differences in shear bond strength between the control group (group 1) and the home bleaching group (group 2) or between the home bleaching group (group 2) and the office bleaching group (group 3). However, the office-bleaching group showed significantly lower shear bond strength values than those of the control group.

Many studies have reported controversial results concerning the effects of bleaching gels and bleaching types upon the bond strength of composite resins to enamel.[3,7,9] Some studies of bracket bond strengths to bleached enamel surfaces investigated how much time should pass after bleaching before bonding can occur.[3,14,15] Uysal et al[14] reported that the immediate bond strength values were not adversely affected by use of a 35% hydrogen peroxide in-office bleaching system. However, Miles et al[3] reported a significant reduction in bond strength of ceramic brackets after 72 hours of bleaching with the same agent. Both groups recommended that a 2-3 week delay before bonding might be beneficial.

Some authors studied the effect of different bleaching types on bracket bond strengths to bleached enamel surfaces.[21,27] Bishara et al[24] reported that the bond strength values were not adversely affected by bleaching types (10% carbamide peroxide or 35% hydrogen peroxide). However, similar to the present results, Patusco et al[25] reported a significant reduction in bond strength after the use of 35% hydrogen peroxide in-office bleaching and reported that 10% carbamide peroxide did not significantly alter shear bond strength values. It is known that the in-office bleaching method most often uses 35-50% hydrogen peroxide, which is considered 7-16 times stronger than the agent used in at-home bleaching formulations.[28] Consistent with these previous explanations, the results of our study demonstrated a statistically significant reduction in shear bond strength of brackets for teeth bonded after office bleaching compared with the control group. In office bleaching reduced shear bond strength values more than did at home bleaching. This result is probably due to the lower peroxide concentration (10%).

Adequate bond strength is a factor that contributes to the clinical success of orthodontic treatment. Reynolds[29] suggested that minimum bond strength of 5.9 to 7.8 MPa is adequate for most clinical orthodontic needs and routine clinical use. However, clinical conditions may significantly differ from those in an in vitro setting. All bond strength values of the composites used in this study were greater than this minimum requirement and fell within the clinically acceptable ranges.

Cacciafesta et al[12] reported that failures occurred at the enamel-adhesive interface by using ARI score comparisons. However, comparisons of the ARI scores in the current study indicated that there were no significant differences among the 3 groups. There was a high frequency of ARI scores of 4 and 5 in groups 2 and 3, whereas there was a similar frequency among scores in group 1. The ARI scores from the bleached teeth showed that bond failure occurred at the resin-enamel interface. This finding is in agreement with those reported by Uysal et al[14] and Torneck et al[30]. Failures in the bleached groups were mostly showed adhesive characteristics.

Mouth conditions differ from in vitro conditions because the oral cavity has complex variations in temperature, stresses, humidity, acidity, and plaque.[31] As such, it is impossible to create a laboratory condition that fully represents the oral environment, but storage conditions and temperature variations can at least be emulated. Thermocycling of the specimens was recommended for quality testing of the adhesive materials. Further studies on this subject may better correlate with clinical conditions.

CONCLUSION

Within the limitations of this study, the following conclusions can be drawn:

Use of 10% carbamide peroxide at-home bleaching for 8 hours or use of 38% hydrogen peroxide in-office bleaching can effectively bleach teeth.

Use of 10% carbamide peroxide at-home bleaching does not significantly alter shear bond strength values, whereas use of 38% hydrogen peroxide in-office bleaching significantly reduces shear bond strength values.

REFERENCES

1. Sulieman M. An overview of tooth discoloration: extrinsic, intrinsic and internalized stains. *Dent Update* 2005;32:463-464, 466-468, 471.
2. Hafez R, Ahmed D, Yousry M, El-Badrawy W, El-Mowafy O. Effect of In-Office Bleaching on Color and Surface Roughness of Composite Restoratives. *Eur J Dent* 2010;4:118-127.
3. Miles PG, Pontier JP, Bahiraei D, Close J. The effect of carbamide peroxide bleach on the tensile bond strength of ceramic brackets: an in vitro study. *Am J Orthod Dentofacial Orthop* 1994;106:371-375.
4. Tancan Uysal, Ayca Sisman; Can Previously Bleached Teeth Be Bonded Safely Using Self-etching Primer Systems? *Angle Orthod* 2008;78:711-715.
5. Wang L, Francisconi LF, Atta MT, dos Santos JR, Del Padre NC, Gonini-Júnior A, Fernandes KBP. Effect of Bleaching Gels on Surface Roughness of Nanofilled Composite Resins. *Eur J Dent* 2011;5:173-179.
6. Oskoee PA, Kahnamoui MA, Oskoee SS, Zadfattah F, Pournaghi-Azar F. Effects of In-Office and Home Bleaching Gels on the Surface Mercury Levels of Dental Amalgam. *Eur J Dent* 2010;4:23-27.
7. Haywood VB, Heymann HO. Nightguard vital bleaching. *Quintessence Int* 1989;20:173-176.
8. Pandis N, Polychronopoulou A, Eliades T. Failure rate of selfligating and edgewise brackets bonded with conventional acid etching and a self-etching primer: a prospective in vivo study. *Angle Orthod* 2006;76:119-122.
9. Bishara SE, VonWald L, Laffoon JF, Warren JJ. Effect of a selfetch primer/adhesive on the shear bond strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop* 2001;119:621-624.
10. Uysal T, Ulker M, Ramoglu SI, Ertas H. Microleakage under metallic and ceramic brackets bonded with orthodontic self-etching primer systems. *Angle Orthod* 2008;78:1089-1094.
11. Bishara SE, Otsby AW, Ajlouni R, Laffoon J, Warren JJ. A new premixed self-etch adhesive for bonding orthodontic brackets. *Angle Orthod* 2008;78:1101-1104.
12. Cacciafesta V, Sfondrini MF, Stifanelli P, Scribante A, Klersy C. The effect of bleaching on shear bond strength of brackets bonded with a resin-modified glass ionomer. *Am J Orthod Dentofacial Orthop* 2006;130:83-87.
13. Bulut H, Kaya AD, Turkun M. Tensile bond strength of brackets after antioxidant treatment on bleached teeth. *Eur J Orthod* 2005;27:466-471.
14. Uysal T, Basciftci FA, Usumez S, Sari Z, Buyukerkmen A. Can previously bleached teeth be bonded safely? *Am J Orthod Dentofacial Orthop* 2003;123:628-632.

15. Bishara SE, Sulieman AH, Olson M. Effect of enamel bleaching on the bonding strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop* 1993;104:444-447.
16. Josey AL, Meyers IA, Romaniuk K, Symons AL. The effect of a vital bleaching technique on enamel surface morphology and the bonding of composite resin enamel. *J Oral Rehabil* 1996;23:244-250.
17. Goldstein RE, Garber DA. Complete dental bleaching. Chicago: Quintessence; 1995.
18. Bulut H, Turkun M, Kaya AD. Effect of an antioxidizing agent on the shear bond strength of brackets bonded to bleached human enamel. *Am J Orthod Dentofacial Orthop* 2006;129:266-272.
19. Bulut H, Kaya AD, Turkun M. Tensile bond strength of brackets after antioxidant treatment on bleached teeth. *Eur J Orthod* 2005;27:466-471.
20. Lai SC, Tay FR, Cheung GS, Mak YF, Carvalho RM, Wei SH, Toledano M, Osorio R, Pashley DH. Reversal of compromised bonding in bleached enamel. *J Dent Res* 2002;81:477-481
21. Spyrides GM, Perdigao J, Pagani C, Araujo Ma, Spyrides SM. Effect of whitening agents on dentin bonding. *J Esthet Dent* 2000;12:264-270.
22. Van Der Vyver PJ, Lewis SB, Marais JT. The effect of bleaching agent on composite/enamel bonding. *J Dent Assoc S Afr* 1997;52:601-603.
23. Cavalli V, Reis AF, Giannini M, Ambrosano GM. The effect of elapsed time following bleaching on enamel bond strength of resin composite. *Oper Dent* 2001;26:597-602.
24. Bishara SE,Oonsombat C, Soliman MMA, Ajlouni R, Laffoone JF. The effect of tooth bleaching on the shear bond strength of orthodontic brackets. *Am J Orthod Dentofacial Orthop* 2005;128:755-760.
25. Patuscoa VC; Montenegrob G; Lenzac MA; Carvalhoa AA. Bond Strength of Metallic Brackets After Dental Bleaching. *Angle Orthod* 2009;79:122-126.
26. Sun G. The role of lasers in cosmetic dentistry. *Dent Clin North Am* 2000;44:831-850.
27. Seghi RR., Hewlett ER, Kim J. Visual and instrumental colorimetric assessments of small color differences on translucent dental porcelain. *J Dent Res* 1989;68:1760-1764.
28. Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. *Dent Mater* 1987;3:246-251.
29. Reynolds IR. A review of direct orthodontic bonding. *Br J Ortho.* 1975;2:171-178.
30. Torneck CD, Titley KC, Smith DC, Adibfar A. The influenc of time of hydrogen peroxide exposure on the adhesion of composite resin to bleached bovine enamel. *J Endod* 1990;16:123-128.
31. Zachrisson YO, Zachrisson BU, Buyukyilmaz T. Surface preparation for orthodontic bonding to porcelain. *Am J Orthod Dentofacial Orthop* 1996;109:420-430.