Effect of grape seed extract and sodium ascorbate solution on the shear bond strength of ceramic brackets bonded to bleached enamel

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Abstract

Introduction: To evaluate the effect of application of two anti-oxidants, sodium ascorbate and grape seed extract after bleaching on the shear bond strength (SBS) of ceramic brackets.

Materials and Method: Fifty freshly extracted human first premolars for orthodontic purposes were collected and randomly divided into five groups (n=10 per group), an unbleached control group (Group I) and four experimental groups bleached with 35% hydrogen peroxide as follows: Group II (immediate bonding post-bleaching), Group III (delayed bonding), Group IV (bleaching followed by application of 10% sodium ascorbate solution, then bonding) and Group V (bleaching followed by application of grape seed extract, then bonding). Polycrystalline ceramic brackets were bonded to all the teeth. Bond strength was tested with a Universal testing machine following debonding.

Results: Analysis of variance indicated a significant difference between SBS of the groups ($p<0.001$). The highest values for bond strength were measured in Group V (12.68±0.2) and the lowest in Group II (6.92±0.85). Group II (immediate bonding) had significantly lower bond strength than all the other groups. There was no significant difference between the SBS of Groups I, III, IV and V. Adhesive Remnant Index (ARI) scores indicated bond failure at the bracket/adhesive interface and within the adhesive.

Conclusion: Bleaching with 35% hydrogen peroxide significantly reduced the bond strength of ceramic brackets. Treating the bleached enamel surface with 10% sodium ascorbate solution or grape seed extract (5% proanthocyanidin solution) before bonding, reverses the reduction in bond strength and can be used as an alternative to delayed bonding.

Keywords: Bleaching, Bond Strength, Ceramic Brackets, Anti-Oxidants

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Introduction

Discoloration of teeth is a major aesthetic concern for dental patients. Bleaching is often used as a conservative method for whitening of teeth in adult patients. As a result, orthodontists are often required to treat patients who have had their teeth bleached. Tooth bleaching agents commonly contain hydrogen peroxide as the active ingredient, either applied directly or indirectly produced from sodium perborate or carbamide peroxide. Hydrogen peroxide acts as a strong oxidizing agent through the formation of reactive oxygen molecules which attack long-chained, dark coloured chromophore molecules and split them into smaller, diffused and less coloured molecules.[1]

Changes in the structure and composition of enamel induced by these bleaching agents may affect the shear bond strength of bleached enamel. Several studies have evaluated the effects of bleaching on the shear bond strength (SBS) of orthodontic brackets.[2-7] Some authors found no adverse effect of bleaching on SBS of orthodontic brackets [2,3,5,7], however, many others have reported a significant reduction in bond strength after bleaching.[4,6,8] This reduction in bond strength has been attributed to a delayed release of oxygen from the bleaching agent that could either interfere with the infiltration of resin into etched enamel or inhibit polymerization of adhesive resin.[7,9,10]

To overcome the problem of reduced bond strength after bleaching, several methods have been proposed such as removal of a superficial layer of enamel, pre-treatment with alcohol and use of adhesives containing organic solvents.[9] The most commonly recommended method is to delay the bonding procedure because the reduction in bond strength has been shown to be transient.[8,9] Studies have shown that the reduction in bond strength can also be reversed with the application of an anti-oxidant agent, such as 10% sodium ascorbate used either in the gel or solution form.[9-14] Grape seed extract is a natural anti-oxidant containing oligomeric proanthocyanidin complexes that have free radical scavenging ability which is reportedly fifty times more potent than sodium ascorbate.[15,16] However, to our knowledge, this agent has not been previously investigated for its ability to reverse reduction in bond strength of orthodontic brackets to bleached enamel.

Most of the studies evaluating bond strength of orthodontic brackets to bleached enamel have employed metal brackets, while only a few have evaluated the bond strength of ceramic brackets to bleached enamel.[8,17-19] It is quite likely that adult patients who have had their teeth bleached would also be concerned with the visibility of their orthodontic appliances and opt for ceramic brackets. The aim of the present study was to determine the effect of bleaching on the shear bond strength of ceramic brackets and to evaluate the effect of application of two anti-oxidants, namely sodium ascorbate and grape seed extract after bleaching on the shear bond strength of ceramic brackets.

Materials and Method

Fifty human first premolars that had been freshly extracted for orthodontic purposes were collected, debrided, washed with water and stored in a solution of 0.1 % (weight/ volume) thymol till use. The criteria for selection of the teeth were intact buccal enamel, no pre-treatment with chemical agents and no cracks, caries or restorations. Each tooth was embedded in autopolymerising acrylic resin so that the long axis of the tooth was perpendicular to the base of the mould. The teeth were randomly assigned to 5 groups of 10 teeth each. Group I (control), in which teeth were not bleached before bonding; Group II, in which teeth were bleached and bonded immediately after bleaching; Group III, teeth were bleached and bonded after being stored for one week in artificial saliva; Group IV, teeth were bleached followed by application of 10% sodium ascorbate and then bonded and Group V, teeth were bleached followed by application of grape seed extract (5% proanthocyanidin) and then bonded.

In the four bleaching groups, a commercial bleaching material containing 35% hydrogen peroxide (Pola Office Bleach, SDI, Bayswater, Victoria) was applied according to the manufacturer's recommendations. The enamel surfaces were cleaned with pumice and water with a brush in a slow speed handpiece and dried with an air syringe before bleaching. The bleaching gel was applied and spread evenly over the enamel surface with a microbrush for 8 minutes. The bleaching gel was removed and reapplied three times. After the bleaching procedure, the teeth were thoroughly rinsed with water and the bleaching material removed with a soft toothbrush.

Bleaching was followed by application of antioxidant agents for the specimens of Group IV and V. In Group IV, after bleaching and rinsing, 10 ml of 10% sodium ascorbate solution was dripped on the enamel surface and agitated with a sterile brush for 10 minutes. The enamel surfaces were thoroughly rinsed with water for 30 seconds followed by bonding. In Group V, after bleaching and rinsing, the enamel surfaces were treated with 5% proanthocyanidin solution, which was prepared by dissolving grape seed extract powder in distilled water. The solution was applied for 10 minutes and then rinsed off, followed by bonding.

The same bonding procedure was used to bond polycrystalline ceramic premolar brackets (Ortho Organizers, CA, USA) to the teeth of all the groups. The teeth were cleaned with water and fluoride-free pumice before being etched with 37% phosphoric acid gel for 30 seconds followed by rinsing with a water spray for 15 seconds and dried until a characteristic frosty white appearance was observed. A thin uniform layer of Transbond XT primer (3M Unitek) was applied with a microbrush on the etched enamel surface and light cured for 10 seconds. Transbond XT plus adhesive paste (3M Unitek, Monrovia, Calif) was applied on the bracket base. The bracket was positioned on the tooth, pressed firmly to express the excess adhesive which was removed with a sharp scaler and the adhesive was cured with a LED light curing unit (Satelec, Acetone, France) for 20 seconds.

Each specimen was loaded onto a Universal testing machine (Banbros, WDB-5) with the long axis of the specimen kept perpendicular to the direction of the applied force. The knife edge was positioned in the occlusogingival direction and the shearing force was applied at a cross-head speed of 1 mm/minute to determine bond strength. After debonding, all the teeth and brackets were viewed under 10X magnification to assess the remaining adhesive and scoring was done according to the modified ARI.[20] The scoring criteria was as follows:

1. The entire adhesive, with an impression of the bracket base, remained on the tooth.
2. More than 90% of the adhesive remained on the tooth.
3. More than 10% but less than 90% of the adhesive remained on the tooth.
4. Less than 10% of the adhesive remained on the tooth.
5. No adhesive remained on the tooth

Statistical Analysis: Statistical analysis was done with SPSS version 16. Descriptive statistics including mean, standard deviation and minimum and maximum values were calculated for each test group. The Levene test indicated that the data was normally distributed. Hence parametric tests were used. One-way analysis of variance (ANOVA) was used to compare SBS among the groups. Multiple comparisons were made with the Tukey HSD test. The chi square test was used to determine differences in ARI scores. Significance for all the tests was kept at $p<0.05$.

Results

Descriptive statistics for the SBS (MPa) of all the test groups are presented in (Table 1) and as box plots (Graph 1). ANOVA indicated a significant difference between the groups ($p<0.001$) as shown in (Table 1). The highest values for bond strength were measured in Group V (12.68±0.2) and the lowest in Group II (6.92±0.85). There was a significant difference ($p<0.05$) in the SBS values of the groups. Group II (immediate bonding) had significantly lower bond strength than all the other groups.

There was no significant difference between Groups I, III, IV and V. The frequency distribution of ARI scores is presented in (Table 2). Chi-square analysis showed a significant difference between the groups. Most of the samples in Groups I, III, IV and V showed ARI scores of 2 and 3, whereas, Group II showed a greater number of ARI score of 4.

Graph 1: Box plots showing Shear Bond Strengths (MPa) of all the Groups

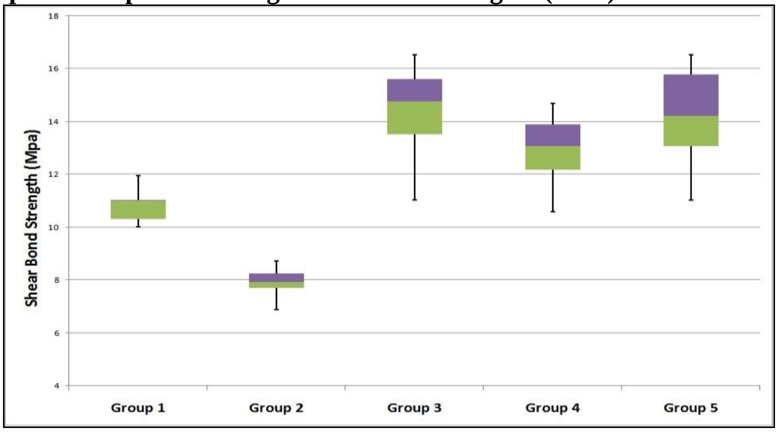

Table 1: Descriptive Statistics and ANOVA to compare SBS of test groups

Test Groups	n	Mean	SD	Std. Error	Minimum	Maximum	p-value
Group I	10	11.7	0.26	0.08	11.24	12.09	0.000***
Group II	10	6.92	0.85	0.27	5.92	8.09	
Group III	10	11.95	1.03	0.32	10.51	13.16	
Group IV	10	12.23	0.97	0.3	10.59	13.39	
Group V	10	12.68	0.2	0.06	12.35	12.96	
The same small letters indicate homogenous subsets							

Table 2: Frequency distribution of the Adhesive Remnant Index scores

Test Groups	n	ARI scores				
		1	2	3	4	5
Group I	10	1	3	5	1	0
Group II	10	0	1	1	6	2
Group III	10	0	7	3	0	0
Group IV	10	1	5	3	1	0
Group V	10	1	4	4	1	0

Discussion

The effect of bleaching agents on the bond strength of composite resin to enamel has been investigated in many previous studies. Several authors have reported a significant decrease in bond strength of orthodontic brackets to bleached enamel.[1,8,9,21,22] The results of the present study demonstrated a significant reduction in the bond strength of ceramic brackets bonded immediately after bleaching. Miles et al[8] also reported a significant reduction in bond strength of ceramic brackets after 72 hours of bleaching with 10% carbamide peroxide (CP) and suggested discontinuing of bleaching at least 1 week before bonding of orthodontic attachments. In contrast, Oztas et al.[17] reported that bleaching agents that contain 20 % CP did not affect SBS of metal and ceramic brackets when bonding is performed 24 hours or 14 days after bleaching.

Bishara et al[3], Mishima et al[7] and Uysal et al[5] contradicted the effect of bleaching on bond strength and reported no significant difference in bond strength of bleached and unbleached enamel when 10% CP or 35% hydrogen peroxide was used. This may have been due to the difference in the post-bleaching period, before the samples were tested for bond strength. Studies that reported no adverse effect of bleaching on bond strength evaluated bond strength after 24 hrs to 14 days post- bleaching which may have reversed any changes due to bleaching.

Delaying the bonding procedure after bleaching has been recommended to avoid the reduction in bond strength after bleaching, although investigators differ in the amount of time that should be allowed to lapse before bond strength values return to the levels of unbleached enamel. A delay of 24 hours to 4 weeks has been suggested by various authors.[1] In this study, a delay of 1 week after bleaching reversed the decrease in bond strength, which confirms previous investigations by Miles et al[8], Bulut et al[9] and Mishima et al.[7] In contrast, Firoozamand et al.[18] reported a reduction in bond strength of polycrystalline ceramic brackets even after 14 days of bleaching.

Several reasons have been proposed to explain the reduction in bond strength to bleached enamel such as alterations in the morphology of the enamel surface like increase in the porosity of the enamel, loss of prismatic structure with a mild etching effect, loss of calcium, decrease in micro-hardness and alterations in the organic substance.[2,3,7,9] Presence of residual oxygen which interferes with resin infiltration into the etched enamel and inhibits polymerization of resin, has also been cited as a reason for the reduction in bond strength.[9-11,22]

This study tested whether the reduction in bond strength could be reversed by neutralizing the effect of residual oxygen with application of anti-oxidizing agents as proposed by Lai et al.[11] and Bulut et al.[9] Two antioxidants were used for this purpose- sodium ascorbate and grape seed extract. Application of antioxidants before bonding restored the bond strength to levels similar to that of unbleached enamel. This finding is in accordance with previous studies by Lai et al[11], Bulut et al[9], Turkun et al[10], Freire et al[12] and Muraguchi et al[13], in which sodium ascorbate (salt of vitamin C) was used as an antioxidant. The mechanism by which sodium ascorbate reverses the reduction in bond strength has been previously explained by Zhao et al[23] and Lai et al.[11] According to Zhao et al[23], peroxide ions replace the hydroxyl radicals in the apatite lattice producing peroxide-apatite. When peroxide ions decompose, the substituted hydroxyl radicals re-enter the apatite lattice, thus, eliminating the structural changes caused by the peroxide ions. Lai et al[11] stipulated that the incorporation process of peroxide ions might also be reversed by an antioxidant. They suggested that sodium ascorbate allows free radical polymerization of the adhesive resin to proceed without premature termination by restoring the altered redox potential of the oxidized bonding substrate and hence reverses the compromised bonding.

In their study, Lai et al.[11] immersed the bleached specimens in 10% sodium ascorbate solution for 3 hours which can be difficult in a clinical setting especially while using the solution form. In the present study, application time of sodium ascorbate solution was kept at 10 minutes in accordance with the study of Bulut et al[9], during which, time the solution was continuously refreshed and agitated with a sterile brush. This application time was found to be adequate to reverse the reduction in bond strength, in accordance with the previous studies of Turkun and Kaya[10] and Thapa et al.[24] Turkun et al.[25] suggested that using the hydrogel form of 10% sodium ascorbate would make it easier to apply since the patients could apply the gel in a bleaching tray.

However, using the gel form requires longer application times as it has a lower diffusibility into the enamel compared to the solution form. Authors differ in the recommended time for the application of the gel form, ranging from 2 hours, 3 hours and 10 hours.[25-27] In the present study, sodium ascorbate was employed in the solution form as it requires a much shorter application time of only 10 minutes which can easily be used in a clinical setting.

In this study, the grape seed extract (proanthocyanidin) group demonstrated the highest bond strength which makes it a viable alternative to sodium ascorbate. Proanthocyanidins are high molecular weight polymers that comprise the monomeric flavan-3-ol catechin and epicatechin. They are found in natural sources such as grape seed extract, pine bark extract, cranberries, lemon tree bark and hazel nut tree leaves in high concentrations. It has been proven to be safe for use in dietary supplements since it is a naturally occurring plant metabolite. The reversal in reduction of bond strength by proanthocyanidins has been attributed to their specificity for hydroxyl free radicals, the presence of multiple donor sites that trap superoxide radicals and esterification of epicatechin by gallic acid which enhances the free radical scavenging ability.[15,16]

ARI scores indicated that the most common site of bond failure was at the bracket/adhesive interface or within the 9 adhesive in all the groups except the immediate bonding group, which showed bond failure closer to the enamel/ adhesive interface and the difference was statistically significant. This was consistent with the lower bond strength values found in this group. The bond failure at the bracket/adhesive interface and within the adhesive seen in the ceramic brackets was similar to that found by Oztas et al.[17] and indicated that risk of enamel damage was reduced.

Conclusion

Bleaching with 35% hydrogen peroxide immediately before bonding reduces the bond strength of ceramic brackets. A delay in the bonding procedure by one week reverses the reduction in bond strength. Treating the bleached enamel surface with 10% sodium ascorbate solution or grape seed extract (5% proanthocyanidin solution) also reverses the reduction in bond strength and can be used as an alternative to delayed bonding.

References

1. Gungnor AY, Ozcan E, Alkis H, Turkkahraman H. Effects of different intracoronal bleaching methods on shear bond strengths of orthodontic brackets. Angle Orthod 2012;82(5):942-6.

2. Bishara SE, Sulieman AH, Olson M. Effect of enamel bleaching on the bonding strength of orthodontic brackets. Am J Orthod Dentofacial Orthop 1993;104(5):444-7.
3. Bishara SE, Oonsombat C, Soliman MM, Ajlouni R, Laffoon JF. The effect of tooth bleaching on the shear bond strength of orthodontics brackets. Am J Orthod Dentofacial Orthop 2005;128(6):755-60.
4. Turkkahraman H, Adanir N, Gungor AY. Bleaching and desensitizer application effects on shear bond strengths of orthodontic brackets. Angle Orthod 2007;77(3):489–93.
5. Uysal T, Basciftci FA, Usumez S, Sari Z, Buyukerkmen A. Can previously bleached teeth be bonded safely? Am J Orthod Dentofacial Orthop 2003;123:628-32.
6. Uysal T, Sisman A. Can previously bleached teeth be bonded safely using self-etching primer systems? Angle Orthod 2008;78(4):711–5.
7. Mishima FD, Valentim RGA, Araujo MTS, Ruellas ACO, Sant'Anna EF. The effect of tooth bleaching on the enamel surface and the tensile force to debond orthodontic brackets. J Orthod 2009;36:236-42.
8. Miles PG, Pontier JP, Bahiraei D, Close J. The effect of carbamide peroxide bleach on the tensile bond strength of ceramic brackets. Am J Orthod Dentofacial Orthop 1994;106(4):371-5.
9. 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;129:266-72.
10. Turkun M, Kaya AD. Effect of 10% sodium ascorbate on the shear bond strength of composite resin to bleached bovine enamel. J Oral Rehabil 2004;31:1184-91.
11. Lai SCN, Tay FR, Cheung GSP, Mak YF, Carvalho RM, Wei SHY, et al. Reversal of compromised bonding in bleached enamel. J Dent Res 2002;81:477-81.
12. Freier A, Durski MT, Ingberman M, Nakao LS, Souza EM, Vieira S,et al. Assessing the use of 35 percent sodium ascorbate for removal of residual hydrogen peroxide after in-office tooth bleaching. J Am Dent Assoc 2011;142(7):836-41.
13. Muraguchi K, Shigenobu S, Suzuki S, Tanaka T. Improvement of bonding to bleached bovine tooth surfaces by ascorbic acid treatment. Dent Mater J 2007;26(6):875-81.
14. Kunjappan S, Kumaar V, Prithviraj, Vasanthan, Khalid SA, Paul J. The effect of bleaching of teeth on the bond strength of brackets: An in vitro study. J Pharm Bioallied Sci 2013;5(Suppl 1):S17-S20.
15. Vidhya S, Srinivasulu S, Sujatha M, Mahalaxmi S. Effect of grape seed extract on the bond strength of bleached enamel. Oper Dent 2011;36(4):433-8.
16. Fine AM. Oligomeric Proanthocyanidin Complexes: History, Structure and Phytopharmaceutical applications. Altern Med Rev 2000;5:144-51.
17. Oztas E, Bagdelen G, Kilicoglu H, Ulukapi H, Aydin I. The effect of enamel bleaching on the shear bond strengths of metal and ceramic brackets. Eur J Orthod 2012;34:232-7.
18. Firoozamand LM, Brandao JVP, Fialho MPN. Influence of microhybrid resin and etching times on bleached enamel for the bonding of ceramic brackets. Braz Oral Res 2013;27(2):142-8.
19. Immerz I, Proff P, Roemer P, Reicheneder C, Faltermeier A. An investigation about the influence of bleaching on shear bond strength of orthodontic brackets and on enamel colour. ISRN Dentistry 2012:Article ID 375849.
20. Olsen ME, Bishara SE, Damon P, Jakobsen JR. Evaluation of Scotchbond Multipurpose and maleic acid as alternative methods of bonding orthodontic brackets. Am J Orthod Dentofacial Orthop 1997;111(5):493-501.
21. Stokes AN, Hood JAA, Dhariwal D, Patel K. Effect of peroxide bleaches on resin-enamel bonds. Quintessence Int 1992;23:769-71.
22. Titley KC, Torneck CD, Ruse ND. The effect of carbamide peroxide gel on the shear bond strength of a microfil resin to bovine enamel. J Dent Res 1992;71:20-4.
23. Zhao H, Li X, Wang J, Qu S, Weng J, Zhang X. Characteristics of peroxide ions in hydroxyapatite lattice. J Biomed Mater Res 2000;157-63.
24. Thapa A, Vivekanand PAR, Thomas MS. Evaluation and comparison of bond strength to 10% carbamide peroxide bleached enamel following the application of 10% and 25% sodium ascorbate and alpha-tocopherol solutions: An in vitro study. J Conserve Dent 2013;16(2):111-5.
25. Turkun M, Celik EU, Kaya AD, Arici M. Can the hydrogel form of sodium ascorbate be used to reverse compromised bond strength after bleaching. J Adhes Dent 2009;11:35-40.
26. Kimyai S, Oskoee SS, Rafighi A, Valizadeh H, Ajami AA, Helali ZNZ. Comparison of the effect of hydrogel and solution forms of sodium ascorbate on orthodontic bracket-enamel shear bond strength immediately after bleaching: An in vitro study. Indian J Dent Res 2010;21(1):54-8.
27. Mazaheri H, Khoroushi M, Shafiei E, Ghorbanipour R, Majdzade F. Bond strength of composite resin and resin – modified glass ionomer to bleached enamel: Delay bonding versus an antioxidant agent. Indian J Dent Res 2011;22(3):432-5.