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DOI:

10.4103/jos.jos_164_21

“Effect of grape seed and green tea on shear bond strength of brackets bonded to bleached enamel with and without Lase Peroxide Lite” – An *in vitro* study

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Abstract

OBJECTIVE: To investigate the effect of antioxidants on shear bond strength of brackets bonded to bleached enamel with and without titanium dioxide nanoparticles (Lase Peroxide Lite).

MATERIALS AND METHODS: One hundred and five human maxillary premolars were randomly divided into seven groups ($n = 15$). Group I served as control, in group II-A bleaching was performed with Opalescent Boost. In group II-B and C, bleaching was performed with Opalescent Boost followed by application of 5% grape seed and 10% green tea extracts, respectively. Group III-A bleaching was performed with Lase Peroxide Lite. Group III-B and III-C bleaching was performed with Lase Peroxide Lite followed by application of 5% grape seed and 10% green tea extracts, respectively. Brackets were bonded with composite resin and cured with light emitting diode (LED) light. Shear bond strength of brackets was tested with a Universal testing machine.

RESULTS: There was statistically significant difference in the shear bond strength among the seven groups included in the study. There is a statistically significant decrease in shear bond strength in group II-A (8.2 ± 1.6 Mpa), group III-A (8.6 ± 2.1 Mpa) when compared with group I-A (15.9 ± 1.4 Mpa). Among all experimental groups, group II-A showed the lowest mean shear bond-strength values (8.2 ± 1.6 Mpa) ($P < 0.005$). Group III-C (14.9 ± 2.2 Mpa) has significantly higher shear bond strength.

CONCLUSION: Bleaching reduced the shear bond strength of brackets below acceptable level while application of grape seed and green tea extracts has recovered the shear bond strength.

Keywords:

Antioxidant, bleaching, bonding, shear bond strength

Introduction

Discoloration of teeth is one of the major esthetic concern among dental patients.^[1] Etiologic factors are varied and complex but are classified as intrinsic and extrinsic.^[2] With increase in the demand for adult orthodontics, we often encounter

patients unsatisfied with the alignment and also the color of their teeth.^[3] Since the introduction of vital bleaching by Haywood and Heymann in 1989, this method has been the most performed esthetic treatments.^[4]

Today, most commonly used bleaching agents contain hydrogen peroxide as powerful active ingredient. Although bleaching has esthetic benefits, major side

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How to cite this article: Mallepally JP, Aileni KR, Sugavasi GD, Kumar KS, Pittala N, Nukala SS. “Effect of grape seed and green tea on shear bond strength of brackets bonded to bleached enamel with and without lase peroxide lite” - An *in vitro* study. J Orthodont Sci 2022;11:23.

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Submitted: 24-Jul-2021

Revised: 17-Oct-2021

Accepted: 21-Jan-2021

Published: 04-May-2022

effect is tooth sensitivity during and after the treatment.^[5] To overcome the disadvantages of conventional bleaching methods, new generation bleaching agents have been developed, that is, nanofilled hydrogen peroxide commercially available as Lase Peroxide Lite which contains titanium oxide nanoparticle as photocatalyst. These bleaching agents with low hydrogen peroxide concentration have been introduced recently for in-office tooth bleaching, with claim of increased safety and efficacy over conventional formulations.^[5] The agent's activity is catalyzed and potentiated by a semiconductor agent – normally, titanium dioxide.

Following bleaching, they undergo ionic dissociation to form residual-free oxygen radicals that interfere with resin polymerization during bonding resulting in a significant decrease in shear bond strength of brackets.^[6]

To reverse this effect, antioxidants such as grape seed and green tea extracts are applied to the bleached enamel.^[7] Utilization of natural antioxidants such as plant extracts, for example, grape seed and green tea act as a viable alternative to chemical and synthetic antioxidants.

Grape seed extract and green tea extract are naturally occurring antioxidants to possess free radical scavenging activity.

There were insufficient studies to evaluate the effect of grape seed and green tea antioxidants on shear bond strength of brackets bonded to bleached enamel with 40% hydrogen peroxide (Opalascence Xtra boost/Ultradent) and Lase Peroxide Lite (hydrogen peroxide with nanoparticles).

Therefore, the aim of this study is to investigate the effect of antioxidants on shear bond strength of brackets bonded to bleached enamel with Opalescent Boost and Lase Peroxide Lite and to compare neutralization effect of natural antioxidants grape seed and green tea extracts on shear bond strength of brackets.

Materials and Methodology

Preparation of teeth

About 105 freshly extracted human premolar teeth were cleaned with an ultrasonic scaler to remove any blood and debris, and stored in 0.1% thymol solution until use. Teeth were mounted vertically on acrylic resin blocks with only crown portion exposed for the study. Acrylic blocks were color coded for identification and differentiation of the groups.

Brackets used in the study

Stainless steel first premolar brackets of American orthodontics MBT 0.022 slot were used in the study. The

surface area of the bracket base was 9.806 mm² as per the information given by the manufacturers.

Bonding procedure

The samples were randomly divided into a control group (*n*-15) and six experimental groups (*n*-90) to assess the shear bond strength

Group I (*n*-15): This group served as the control group. No bleaching agent or antioxidant was applied in this group. Enamel surface was etched with 37% phosphoric acid for 15 sec, rinsed with water for 10 sec, and dried followed by application of primer and bonding of brackets.

Group II (*n*-45): This group was sub-divided into three groups.

Group II-A (*n*-15) – No antioxidant was applied in this group. Specimens were bleached with 40% hydrogen peroxide for 40 min and rinsed with water immediately after bleaching, teeth were etched and brackets were bonded.

Group II-B (*n*-15) – Teeth were treated same as group II-A except that after bleaching and before etching, buccal surface was treated with 5% grape seed extract.

Group II-C (*n*-15) – Teeth were treated same as group II-A except that after bleaching and before etching bleached surface was treated with 10% green tea extract.

Group III (*n*-45): This group was sub divided into three groups.

Group III-A (*n*-15) – Specimens were bleached with Lase Peroxide Lite and photocatalyzed with light emitting diode (LED) curing light.

Group III-B (*n*-15) – Teeth were treated same as group III-A except that after bleaching and before etching buccal surfaces were treated with 10% grape seed extract.

Group III-C (*n*-15) – Teeth were treated same as group III-A except that after bleaching and before etching buccal surfaces were treated with 10% green tea extract.

Bleaching procedure

Forty percent hydrogen peroxide bleaching gel (Opalascence Xtra boost/Ultradent) of 0.5–1.0 mm thick layer was applied on buccal surfaces for 20 min according to the manufacturer's instructions. For the groups II-A, B, and C to simulate the in-office bleaching procedure, samples were then rinsed for 30 sec and air-dried. This procedure was repeated two times.

Lase Peroxide Lite was applied for groups III-A, B, and C to simulate the in-office bleaching procedure.

A 0.5–1.0 mm thick layer of bleaching gel was applied on buccal enamel surfaces and light cured with LEDition for 20 min according to the manufacturer's instructions. Samples were then rinsed for 30 sec and air-dried.

Preparation of antioxidant solution

A 10% grape seed antioxidant solution was prepared by dissolving 10 gm of grape seed powder (99% grape seed powder, Nusci, Herb store, USA) in 100 ml of distilled water.

A 10% green tea antioxidant solution was prepared by dissolving 10 gm of green tea powder (98% green tea extract, Life extension care, Florid, USA) in 100 ml of distilled water.

Application of antioxidant solution

Freshly prepared antioxidant solution was applied to the buccal surfaces of teeth in groups II-B, C and groups III-B, C with the help of an applicator brush and was left for 15 min. The samples were then rinsed with water for 10 sec.

Etching procedure

The buccal surfaces of teeth in all the seven groups were washed with water and dried using oil-free air from a three-way syringe. About 37% of orthophosphoric acid was applied to the labial surface and left for 15 sec and washed with water. The tooth surface was then dried with a three-way syringe until a dull frosty appearance was seen on the surface.

Bonding procedure

Following etching in all the groups, primer was applied to the etched enamel surface with the help of an applicator brush and cured with LED (LEDition Ivoclar vivadent) for 15 sec. Stainless steel brackets (0.022 MBT premolar brackets) were positioned on the labial surface in the center of the clinical crown along the long axis of the teeth. The brackets were pressed on the tooth surface using reverse end of the bracket holder with uniform pressure and flash around the brackets was removed. The brackets were cured using LED. Following bonding, the teeth were stored in sealed containers for 24 h.

Evaluation of shear bond strength

Each specimen was loaded into a Universal testing machine (DAK SERIES 9000 Universal testing machine) with the long axis of the specimen kept perpendicular to the direction of applied force. The standard knife edge was positioned in the occlusogingival direction and in contact with the bonded specimen. Bond strength was determined in the shear mode at a crosshead speed of 0.5 mm/min until the bracket debonded.

Statistical analysis

Data were analyzed by Microsoft XL and graph pad prism software. Data were summarized by mean \pm SD for continuous data. The comparison between control and other groups was done by one-way analysis of variance (ANOVA)/Kruskal–Wallis test, and followed by Tukey's multiple post hoc test for continuous data. The comparison between the two groups was done by unpaired *t*-test for continuous data. All *P* values $<$ 0.005 were considered as statistically significant.

Results

Results showed that there was statistically significant difference in the mean shear bond strength among the seven groups included in the study [Table 1 and Figure 1]. There is a statistically significant decrease in shear bond strength in group II-A (8.2 ± 1.6 Mpa), group III-A (8.6 ± 2.1 Mpa), when compared with group I (15.9 ± 1.4 Mpa). Among all the experimental groups, group II-A (Bleaching with Opalescent Boost) showed the lowest mean shear bond-strength values (8.2 ± 1.6 Mpa) compared to all other experimental groups ($P < 0.005$). Group III-C (Bleaching with Lase Peroxide Lite followed by application of 10% green tea extract; 14.9 ± 2.2 Mpa) has significantly higher shear bond strength.

Discussion

In current practice, tooth discoloration has always been a factor of utmost concern as more stress is being placed on esthetics. With the developing awareness of esthetic options, there is a great demand for various treatment modalities for discolored teeth. Vital tooth bleaching procedures are the most commonly used conservative and effective treatment options to treat discolored teeth.^[8] While conserving the tooth structure it also permits a successful esthetic outcome at minimal expense.^[9]

In the present study, it was observed that the bleaching procedure resulted in a significant decrease of

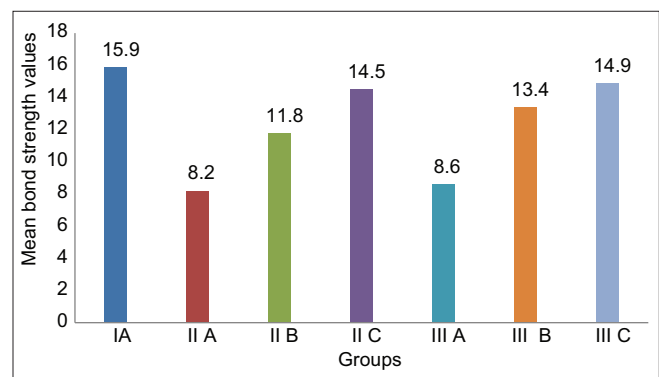


Figure 1: Comparison between groups I-A, II-A, II-B, II-C, III-A, III-B, and III-C (mean and shear bond-strength values in Mega pascal [Mpa])

Table 1: Comparison of mean shear bond strength between control group and experimental groups

Group	Sample	Minimum (MPA)	Maximum (MPA)	Mean (MPA)	SD	P
Group I-A	15	13.4	18.0	15.9	1.4	<0.0001
Group II-A	15	4.1	10.2	8.2	1.6	
Group II-B	15	5.3	15.4	11.8	2.6	
Group II-C	15	10.7	18.3	14.5	2.3	
Group III-A	15	5.0	12.8	8.6	2.1	
Group III-B	15	7.6	16.8	13.4	2.5	
Group III-C	15	10.2	19.0	14.9	2.2	

Unpaired *t*-test; $P < 0.001$. Group I-A: no bleaching; group II-A: bleaching with 40% hydrogen peroxide; group II-B: bleaching with 40% hydrogen peroxide followed by application of 5% grape seed extract; group II-C: bleaching with 40% hydrogen peroxide followed by application of 10% green tea extract; group III-A: bleaching with Lase Peroxide Lite; group III-B: bleaching with Lase Peroxide Lite followed by application of 5% grape seed extract; group III-C: bleaching with Lase Peroxide Lite followed by application of 10% green tea extract. SD: standard deviation

bond-strength values compared to the unbleached group. The present study compared two types of bleaching agents – Opalescent Boost and Lase Peroxide Lite. Bleaching with either Opalescent Boost or Lase Peroxide Lite resulted in decreased mean shear bond when compared to control. Among Opalescent Boost and Lase Peroxide Lite, there was no significant difference in bond strength. In-office bleaching is generally performed by 40% Opalescent Boost. However, it is accompanied by an increase in tooth sensitivity. This drawback has compelled investigators to search for an effective method of in-office bleaching agent with improved safety for both teeth and soft tissue.^[10] So hydrogen peroxide solution containing titanium dioxide nanoparticle acting as a photocatalyst is used as a safe office bleaching agent.^[11]

Bortolatto *et al.*^[12] in 2004 has reported that hydrogen peroxide gel containing titanium oxide nanoparticles is greater in its efficacy compared with traditional treatment while providing a low occurrence of tooth sensitivity. According to Sakai *et al.*^[13] in 2007 incorporation of the titanium oxide nanoparticles in hydrogen peroxide allows a reduction in the concentration required of the latter, improving the biocompatibility of the final product and thereby preventing postoperative sensitivity and increasing the safety of the bleaching processes. The gel used in this study is composed of this new formulation that improves its reactivity when exposed to LED light.

The present study results demonstrated a significant reduction in bond strength after bleaching, in agreement with the finding of Aksakalli *et al.*^[14]

Lai *et al.*,^[7] in 2002, in their study suggested that antioxidant needs to be applied for no less than one-third the bleaching time for it to completely reverse its effects which corresponds to a long treatment duration which is undesirable. Therefore, the application time of 10 min was chosen in this study, as this duration is considered to be adequate for clinical application of the antioxidant in solution form.^[14,15]

This study evaluated the ability of two antioxidants (10% green tea and 10% grape seed) to reverse the reduction in bond strength after bleaching with 10% carbamide peroxide.

Studies conducted by Turkun *et al.*^[16] in 2009 found that the concentration of 10% sodium ascorbate will be effective in reversing the bond strength of the bleached teeth to the normal. It has been proven that application of sodium ascorbate can result in accumulation of Streptococcus mutants on bleached surfaces.^[17] Also, pH of sodium ascorbate is 1.8, which has adverse effects on tooth structure in clinical application. Short shelf life of sodium ascorbate solution or gel is another disadvantage of using it.^[18,19] It has been demonstrated that use of herbal antioxidants such as green tea and grape seed is an effective alternative strategy for this purpose.^[20]

The current study evaluated green tea and grape seed extracts as an alternative antioxidant and found that bond-strength values in the green tea-treated group were similar to those in the control group. Also, bond-strength values of grape seed treated group are significantly higher than those in the bleached group but less than that of control group and green tea extract group.

In our study, when bond strengths were compared between experimental groups, the groups treated with green tea extract showed higher shear bond strengths compared to those of grape seed extract group post bleaching. Among the groups treated with green tea post bleaching, that is, groups II-C and III-C, bleaching with Lase Peroxide Lite (group III-C) showed highest mean shear bond strength compared to the other group treated with Opalescent boost (group II-C) though not statistically significant (P -value is 0.179). These findings were in accordance with the study conducted by Sharafeddin *et al.*^[21] where they used carbamide peroxide with similar concentration.

The cardinal antioxidative ingredient in the green tea extract is green tea catechins (GTC), which comprises four major epicatechin derivatives; namely,

epicatechin (EC – 6.4%), epigallocatechin (EGC – 19%), epicatechin gallate (ECG – 13.6%), and epigallocatechin gallate (EGCG – 59%).^[12] Studies have shown that green tea polyphenols exhibit some important properties like antioxidant, anticarcinogenic, anti-inflammatory, probiotic, and antimicrobial activity.^[22] In the literature for antioxidant activity the tea dose used is in the range 0.6–10 gm of tea per 100 ml of water. The present study used a concentration of 10%.

The use of green tea prior to bonding procedures on bleached enamel completely neutralized the deleterious effects of bleaching and was able to significantly increase the bond strength.^[23] Thus, the hypothesis tested in this study was confirmed.

Another antioxidant used in this study is 5% grape seed extract. The composition of grape seed extract consists of oligomeric proanthocyanidin (OPC) in the form of monomeric phenolic compounds such as catechin, epicatechin, and epicatechin-3-0-gallate and free flavanol monomer. They have free radical scavenging and antioxidant activity. They also have antibacterial, antiviral, anti-inflammatory, antiallergic, anticarcinogenic, and vasodilatory actions.^[14] The present study shows that treatment with 5% proanthocyanidin increases the bond strength significantly (13.4 MPa) when compared to other groups

Some naturally occurring antioxidants such as green tea and grape seed extracts have OPCs that have free radical scavenging activity, which is shown to be 50 times more potent than sodium ascorbate.^[14] So it can be concluded that, when preparing solutions, a lower concentration of grape seed or green tea extracts than sodium ascorbate can be considered.^[14]

The present study reported bleaching followed by application of antioxidant (i.e., groups II-B, II-C, III-B, and group III-C) showed an increased bond strength than solely bleaching (groups II-A and III A). However, the values were less compared to control group. Bleaching with Lase Peroxide Lite followed by 10% green tea extract (i.e., Group III C) showed the highest shear bond strength among antioxidant treated groups.

Ethics approval

The study protocol was approved by the Institutional ethics committee.

Authors contributions

Jaya P. Mallepally participated in study design, procurement of material, and manuscript preparation. Kaladhar R. Aileni participated in study design, and revising the manuscript. Gayathri D. Sugavasi participated in statistical analysis. Siva Kumar k

participated in manuscript corrections. Naveen Pittala participated in statistical analysis. Shree S. Nukala participated in manuscript correction. All the authors read and approved the final manuscript to be submitted.

Acknowledgments

We would like to thank Dr. Yannath Reddy, Biostatistician for his assistance with the statistical analysis.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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