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Original Article

Effect of Green Tea Extract as Antioxidant on Shear Bond Strength of Resin Composite to in-Office and Home-Bleached Enamel

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Abstract

Statement of Problem: Shear bond strength (SBS) of home and office bleached enamel will be compromised by immediate application of composite restoration. Antioxidant agent may overcome this problem.

Objectives: This in vitro study assessed the effect of green tea extract on shear bond strength of resin composite to in-office and home-bleached enamel.

***Materials and Methods*:** In this experimental study, 40 extracted intact human incisors were embedded in cylindrical acrylic resin blocks (2.5 ×1.5 cm), with the coronal portion above the cemento enamel junction out of the block. Then, after bleaching labial enamel surfaces of 20 teeth with 15% carbamide peroxide 6 hours a day for 5 days, they were randomly divided into two groups: A1 and A2 (n = 10), depending upon whether or not they are treated with antioxidant. Labial enamel surfaces of the remaining 20 teeth were bleached with 38% hydrogen peroxide before being randomly divided into groups B1 and B2 (n = 10), again depending on whether or not the antioxidant was used in their treatment .

The experimental groups (A2,B2) were treated with 5% solution of green tea extract before resin composite restoration was done by a cylindrical Teflon mould (5×2 mm). Shear bond strength of the specimens was tested under a universal testing machine (Zwick/Roell Z020). The SBS data were analyzed by using One-way ANOVA and Tukey HSD tests ($p < 0.05$).

Results: There were no statistically significant differences between shear bond strength of the control group (A1) and treated group (A2), but there were statistically significant differences between the groups B1 and B2 ($p < 0.05$).

Conclusions: Application of antioxidant did not increase the shear bond strength of home-bleached enamel to resin composite but its application increased the shear bond strength of in-office bleached enamel to resin composite.

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Introduction

Vital tooth bleaching generally involves the application of hydrogen peroxide on the tooth surface in an office technique or the application of carbamide peroxide in home technique [1,2].

Carbamide peroxide and hydrogen peroxide function as oxidative agents by forming free radicals, oxygen reactive molecules and hydrogen ions. These active molecules attack the pigments existing in the teeth and remove them; that is why, they are effective in whitening of the teeth [3-5]. In the home bleaching technique, carbamide peroxide is used based on its concentration 0.5-8 hours a day under a dentist's supervision [6]. Hydrogen peroxide or its derivatives are used in different concentrations in most in-office bleaching technique [7].

Bleaching treatment has some negative effects on the teeth which include decreasing the bonding ability, changing morphology of the enamel and dentin surface, decreasing the enamel wear resistance, causing surface roughness, increasing enamel porosity and changing the enamel and dentin mechanical features, such as fracture toughness which may reduce the tooth crack resistance and strength [8,9,10].

It has been shown that the shear bond strength (SBS) of resin composite to the tooth structure decreases immediately after using bleaching agent [7]. Residual peroxides which interfere with resin tag formation and the resin bond to the tooth is responsible for the reduction of shear bond strength. Oxygen is released after an appropriate time interval, i.e. from 24 hours to 2-4 weeks; the resin composite restores its shear bond strength again [7]. There are some techniques to improve the bond strength of resin composites after bleaching process, such as the removal of the superficial tooth surface and the application of adhesives containing organic solutions, alcohol or antioxidant agents on the bleached enamel surface [2,11-13].

It was reported that application of antioxidants had beneficial effects on SBS of resin composite restoration to the bleached enamel by its positive role against free radical reactions [14]. One type of antioxidant is green tea extract whose antioxidant activity is related to flanavols [15,16]. While it was reported that different concentration of green tea solution for especial time did not increase the SBS of resin composite restoration to enamel bleached with 30% hydrogen peroxide [17], Sharafeddin *et al.* showed that the application of green tea solution on the bleached enamel by hydrogen peroxide increased the SBS of resin composite [18]. Sasaki *et al.* showed that 10% sodium ascorbate as an antioxidant neither reversed the oxidizing effect of 10% carbamide peroxide on enamel nor increased the SBS [14]. However, in one study, after the carbamide peroxide bleaching process, sodium ascorbate hydrogel application increased the SBS of bleached enamel surface. But this depended on the duration of the application of sodium ascorbate hydrogel [19].

To the best of our knowledge, there are few published studies comparing the effectiveness of green tea extract on SBS of in-office and home-bleached enamel. Hence, this in vitro study has been performed to evaluate the effects of green tea as an antioxidant on the SBS of in-office and home-bleached enamel.

Materials and Methods

In this experimental study, 40 recently extracted intact human maxillary incisors, without any defects, were collected and randomly divided into 4 groups (n = 10). The tooth roots were embedded in cylindrical shape of acrylic resin blocks (1.5 × 2.5 cm), the coronal part, above the cemento enamel junction, out of the block. The labial enamel surface of each tooth was polished (6 × 6 mm) with 600-grit silicon carbide paper (Moyco Precision Abrasives, Montgomeryville, PA, USA). The twenty sub- groups of prepared labial surfaces of the teeth surface were bleached with 15% carbamide peroxide gel (Opalescence, 15% PF, Ultradent Product Inc, South Jordan, UT, USA) 6 hours a day for 5 consecutive days. After completing the daily bleaching procedures, teeth were rinsed with water spray for 60 seconds and then kept them in distilled water at room temperature for one day. The remaining twenty prepared labial surfaces of the teeth were bleached with 38% hydrogen peroxide gel (Opalescence, Ultradent Product Inc., UT, USA) for 20 min according to the manufacturer instruction. The gel rinsed off thoroughly with water spray for 60 seconds and the process was repeated one more time.

The 5% green tea solution was prepared by dissolving a 5-mg green tea extract pill (Camgreen,

Giah Essence, Iran) into 100 mL of distilled water at room temperature [6]. The study groups were: A1, A2, B1, B2. In group A1 (control group), immediately after bleaching with 15% carbamide peroxide gel, composite restorative procedure was done after the application of adhesive. In group A2, immediately after bleaching, a 5% solution of green tea was applied on the carbamide peroxide bleached enamel surface for 10 minutes. Then, the samples were rinsed in water for 30 seconds and dried and resin composite buildup procedure was carried out.

In group B1 (control group), immediately after bleaching with 38% hydrogen peroxide gel, resin composite restorative procedure was carried out. In group B2, immediately after bleaching, a 5% solution of green tea was applied on the hydrogen peroxide bleached enamel for 10 minutes.

Then, the specimens were rinsed in water for 30 seconds and dried. Finally, resin composite restoration procedure was performed. Bleached enamel surfaces of specimens were etched by 37% phosphoric acid gel for 15 seconds (Total Etching Gel, IvoclarVivadent, Schaan, Liechtenstein). Then, they were rinsed with water spray for 15 seconds. Application of Adper Single Bond (3M ESPE, Dental Products, St Paul, MN, USA) was done and light-curing was performed by an LED unit (Demi Plus, Kerr, Switzerland) for 20 seconds at a light intensity of 1200 mW/cm^2. Finally, resin composite (Filtek Z350, 3M Dental Products) restoration procedure was carried out by using a Teflon mould measuring 5mm × 2mm in cured for 20 seconds.

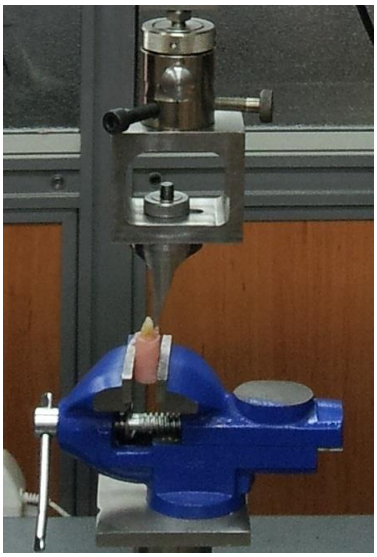

Figure 1: The specimen under the shear bond strength test using the Universal Testing Machine.

All the specimens were immersed in distilled water at room temperature for 24 hours. Then, the shear bond strength of the samples was measured by using a universal testing machine (Zwickroell Testing Mechine Z020, Germany) with a blade-shaped tip and the force was applied to the resin composite– enamel interface at a crosshead speed of 0.5 mm/min (Figure 1). Data was analyzed by SPSS version 18 (SPSS Inc, Chicago, IL., USA) using One-way ANOVA and *post-hoc* Tukey HSD tests ($p < 0.05$).

Results

The mean shear bond strength values and standard deviations in all of the 4 groups are presented in Table 1& Figure 2.

The results showed that there was no significant differences between the group A1 (carbamide peroxide) and group A2 (carbamide peroxide + green tea) treated with antioxidants, but there was a statistically significant difference between the group B1 (hydrogen peroxide) and B2 (hydrogen peroxide + green tea) ($p < 0.05$). Moreover, no statistical significant difference was found between groups A1 and B1 but reported significant differences between groups A2 and B2.

Table 1: Descriptive Statistics of Shear Bond Strength (MPa) of the tested groups

Groups	Mean(±SD)
A1 (carbamide peroxide)	12.10 (2.30)^{AB}
A2 (carbamideperoxide + green tea)	13.86(0.81)^{A}
B1 (hydrogen peroxide)	10.52(1.23)^{A}
B2 (hydrogen peroxide + green tea)	16.76(1.15)^{B}

Mean values with at least a common letter in Superscript were not statistically different.

Discussion

The decrease in the shear bond strength of bleached tooth is related to residual peroxides which interfere with the process of resin tags formation and resin adhesion to the tooth structure, inhibiting the polymerization of resin monomers [5,20].

One study reported that the application of green tea solution for limited time did not increase the SBS of resin composite restoration to bleached enamel surface with 30% hydrogen peroxide [17]. In the

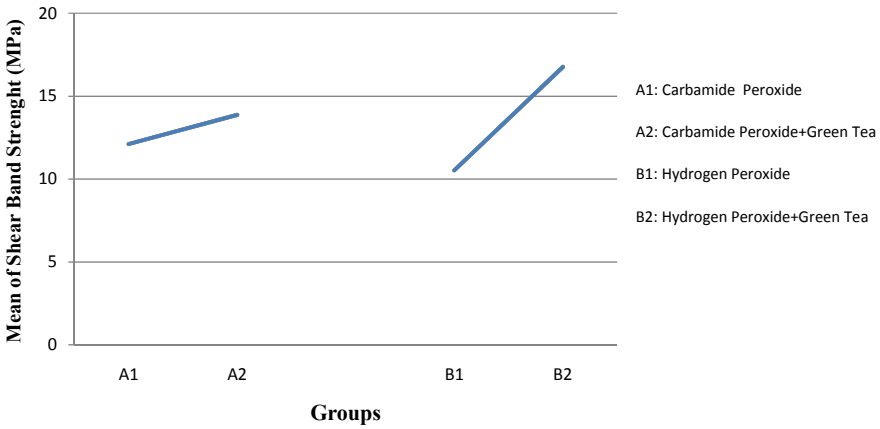

Figure 2: Comparison of shear bond strength (MPa) of all groups

present study, 15% carbamide peroxide bleaching gel was used in groups A1 (carbamide peroxide) and A2 (carbamide peroxide + green tea) and 38% hydrogen peroxide bleaching gel was used in groups B1(hydrogen peroxide) and B2 (hydrogen peroxide + green tea) and 5% green tea solution was applied for 10 minutes in groups A2 and B2. No significant increase in SBS of resin composite to home-bleached enamel was achieved in group A2 but significant increase in SBS was observed in group B2. This can be related to different concentration, composition and time of application of bleaching agents as well as different antioxidant and application time used.

Another study showed that the application of grape seed extract, pomegranate peel extract, sodium ascorbate, and green tea on enamel surface bleached with 38% hydrogen peroxide neutralized the effect of residual oxygen on the bleached enamel and increased the SBS of resin composite [18]. The concentration of green tea solution was the same as that used in this study but we used 15% carbamide peroxide for groups A1 and A2 as a bleaching agent that was weaker than (38% hydrogen peroxide) office bleaching agent, producing less residual oxygen molecules. We noticed that the effect of the antioxidant on SBS would decrease as the bleaching agent concentration decreased.

One study reported the effects of sodium ascorbate concentration as an antioxidant and the duration of application time on SBS of resin composite restoration to bleached enamel surface. The results revealed that the use of different concentration (10% and 20%) of sodium ascorbate hydrogel for 30, 60 and 120 minutes and bleaching with 17% carbamide peroxide gel increased the resin-enamel bond strength. The increased SBS of bleached enamel to resin composite had a direct relation with the application time but there was no relation between these effects and different concentrations of sodium ascorbate [5].

In the present study, green tea solution was used as an antioxidant at 5% concentrations for 10 minutes. Significant increase was observed in SBS of resin composite to 38% hydrogen peroxide bleached enamel in group B2 (hydrogen peroxide + green tea), but there were no significant increase in SBS of resin composite to 15% carbamide peroxide bleached enamel in group A2 (carbamide peroxide + green tea). In the study mentioned above, the different types, concentrations and application times of antioxidant used might explain the differences noticed in the results. In the present study, 15% carbamide peroxide and 38% hydrogen peroxide were used as a bleaching agents but in the above mentioned study, 17% carbamide peroxide was used. This difference, i.e., 17% carbamide peroxide with 38% hydrogen peroxide, might be the underlying reason for producing more peroxide molecules and hence this could be the reason for greater effectiveness of antioxidants on the SBS of resin composite to the bleached enamel.

Another study investigated the effect of 10% sodium ascorbate and the effect of delaying the bonding procedure on the SBS of resin-modified glass-ionomer (RMGI) and SBS of resin composite. The enamel surface was bleached with 9.5% hydrogen peroxide for 6 hours a day for 7 days consecutively. They reported that the SBS decreased when the tested groups were restored with resin composite immediately after bleaching; also, RMGI did not bond to bleached enamel surface immediately after bleaching procedure. Therefore, application of 10% sodium ascorbate resulted in increasing the SBS of

the restorations to enamel surface after bleaching with 9.5% hydrogen peroxide [20].

In the current study, in groups A1 and A2, carbamide peroxide 15% was used 6 hours a day for 5 consecutive days, and in groups B1 and B2, hydrogen peroxide 35% was used as a bleaching agent. In the study mentioned above and in our study, in groups B1 and B2, hydrogen peroxide was used as the bleaching agent which was stronger than carbamide peroxide in producing residual oxygen molecules and hence could significantly decrease SBS of resin composite. This was probably because of the significant effect of antioxidant material treatment in the groups that were bleached with hydrogen peroxide.

One study reported the positive effects of 10% sodium ascorbate gel as an antioxidant on the bonding capacity to enamel surface bleached with 10% carbamide peroxide;10% sodium ascorbate was applied for 10, 60, 120, 240, and 480 minutes on bleached enamel surface. This study reported that as the application time of the antioxidant increased, SBS of resin composite to enamel increased, too. For greater effectiveness, antioxidant gel should be applied to enamel surface for at least 60 minutes. Consistent with the results of the present study, no significant increase in shear bond strength was observed in the group that received the antioxidant for 10 minutes [12]. In the present study, in group A2, 15% carbamide peroxide was used, producing more oxygen reactive molecules than when 10% carbamide peroxide was used; the antioxidant was applied for 10 minutes. Therefore, based on the results of the current study, it seems that with increasing the concentration of bleaching agent, the application time of antioxidant should be increased.

Another study investigated the effects of 10% sodium ascorbate for 1 minute as an antioxidant on SBS of resin composite to enamel surface bleached with 35% hydrogen peroxide or with 16% carbamide peroxide gel and reported an increase of the SBS [21,22]. In the present study, 15% carbamide peroxide and 5% green tea were used for 10 minutes in group A2 but it did not show significant effects on SBS of resin composite to bleached enamel. Therefore, an increase of the concentration of antioxidant might be required.

It was reported that application of only 10% sodium ascorbate as an antioxidant resulted in an increase in shear bond strength of dual-cured resin cement to enamel surface bleached with carbamide peroxide gel but delaying the bonding procedure had no effects on increasing SBS of that of bleached enamel surface [23]. On the other hand, another study reported that application of 10% sodium ascorbate as an antioxidant and delaying the bonding process increased the bond strength [13,24].

One study assessed the neutralizing effect of 5% grape seed solution on the bond strength of enamel bleached with 38% hydrogen peroxide gel. They concluded that the use of 5% grape seed solution for 10 minutes completely neutralizes the effect of bleaching agents [8]. This study, in which 38% carbamide peroxide and 5% green tea solutions were used for 10 minutes, led to a similar result.

Another study showed that 6.5% grape seed solution as an antioxidant increased the shear bond strength of enamel bleached with 35% carbamide peroxide gel [25]. In the current study, using 15% carbamide peroxide and 5% green tea solution as an antioxidant; no significant increase was observed in SBS of resin composite to home-bleached enamel. But 35% carbamide peroxide gel produced more residual oxygen than 15% carbamid peroxide and this difference might be the underlying cause of the neutralizing effect of grape seed extract.

Further studies should be conducted to evaluate the effect of different application time, different concentrations and different types of antioxidants on shear bond strength of bleached enamel surface with different concentrations of bleaching agents.

Conclusions

Under the limitation of this in vitro study, it can be concluded that, surface treatment using green tea extract had no significant effects on the SBS of resin composite to enamel bleached with 15% carbamide peroxide gel but it had significant increasing effect on the shear bond strength of resin composite to enamel bleached with38% hydrogen peroxide gel.

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