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To evaluate the effect of antioxidants on the shear bond strength of composite resin to enamel following extra-coronal bleaching: An In-Vitro study

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Abstract

Aim: The aim of this study is to evaluate the influence of different antioxidants on the shear bond strength of composite resin to enamel following extra-coronal bleaching.

Methodology: Forty premolars were randomly assigned into 4 groups of 10 each. Group 1: composite built-up was done immediately after bleaching, Group 2,3, 4, : bleached specimens received an application of 10% grape seed extract, 10% green tea extract, 10% sodium ascorbate before composite build-up. Specimens were immersed in artificial saliva, stored in an incubator 37°C (24 hours), thermocycling, and tested using a universal testing machine. Data were analyzed by one-way ANOVA and Tukey's test with 95% level of significance.

Results: Bleaching significantly reduced shear bond strength of composite following extra coronal bleaching ($p<0.05$). However, application of 10% grape seed extract, 10% green tea and 10% Sodium ascorbate produced significantly greater shear bond strength compared to bleached group ($P<0.05$).

Conclusion: Application of antioxidants increased the shear bond strength of composite resin to enamel following extra-coronal bleaching using 38% hydrogen peroxide 10 % grape seed extract, 10% green tea,10%

sodium ascorbate and produced the same effect on the shear bond strength of composite resin to enamel following extra-coronal bleaching using 35% hydrogen peroxide.

Keywords: Antioxidants, Bleaching, Composite, Shear bond strength.

Introduction

Increasing interest and trends in esthetic dentistry has resulted in the widespread practice of extra-coronal bleaching or vital bleaching. Extra-coronal bleaching is known to be a safe, popular, conservative and well-accepted treatment modality for discolored teeth.[1]

Bleaching agents are available in varying concentration, namely carbamide peroxide (35% to 37%) or hydrogen peroxide (30% to 40%) which have been used to achieve rapid esthetic results. Furthermore, hydrogen peroxide and carbamide peroxide have been used successfully for many years to achieve lighter and more desirable tooth color. [2]

Hydrogen peroxide undergoes ionic dissociation resulting in the formation of free radicals such as nascent oxygen, hydroxyl radical, per-hydroxyl, and superoxide anions on the application to tooth [3]. These free radicals are highly reactive and hence reach out for electron-rich regions of pigment inside the tooth structure, breaking down the large pigmented molecules with double bonds involving atoms of carbon, nitrogen, and oxygen into the smaller, less pigmented ones [4].

There are numerous studies that emphasises on postoperative complications of bleaching such as sensitivity , irritation to pulp, tooth structure alterations or microleakage of existing restorations [5-7]. Another important post operative bleaching complication is decreased bond strength of composite resin to enamel when bonding is performed immediately after the bleaching process; this is due to the presence of residual peroxide that interferes with resin adhesion and inhibits resin polymerization [8].

Few recent techniques have been suggested to solve the clinical problems related to post bleaching compromised bond strength by treating the bleached enamel with alcohol before restoration, removing the superficial layer of enamel, and using adhesives containing organic solvents [7,9]. However, the general approach is to postpone any bonding procedure for a specific period after bleaching, as the reduction in bond strength has been shown to be temporary [10]. Thus, The waiting period for bonding procedures after bleaching has been reported to vary from 24 hours to 4 weeks [11]. Therefore, to overcome this delay in restorative treatment, numerous studies have proposed the use of antioxidants agents namely 10% Grape seeds extract, 10% green tea extract and 10% sodium ascorbate [12,13], after the bleaching procedure.

Grape seed extract contains oligomeric proanthocyanidin complexes (OPCs) that have free radical scavenging ability.[14]

The green tea is made from the plant Camellia sinensis. It is made up of flavanols or catechins, such as epicatechin (EC), gallocatechin (GC), epigallocatechin (EGC), epicatechin gallate (ECG), and epigallocatechin gallate (EGCG). Green tea catechins have more potent antioxidant activity. In recent years, the use of green tea has been studied in dentistry.[15]

Sodium ascorbate (Vitamin C) is a neutral, nontoxic, and biocompatible antioxidant, when used as a 10% solution with application time of 10 min has capability of reversing the reduced bond strength of bleached enamel [16]. The aim of this in vitro study was to evaluate and compare the effects of 10% grape seed extract, 10% green tea extract, 10% sodium ascorbate on the bond strength of composite resin to enamel following extra-coronal bleaching using 35% hydrogen peroxide. The following null hypothesis were tested in this study: There would be no effect of 10% grape seed, 10% green tea extract, 10% sodium ascorbate on the shear bond strength of composite resin to enamel following extra-coronal bleaching.

Methodology

Forty extracted human premolars were collected, and stored in a distilled water following extraction for orthodontic purpose. All teeth used in this study were extracted in the course of 1 month. The roots were sectioned approximately 2 mm apically of cemento-enamel junction (CEJ) using microtome (Diamond saw, Maruto, Japan). Each crown of teeth then was cut in mesial-distal direction, and the buccal side of crown were used in this study. The buccal side of crowns were embedded in clear acrylic resin (Hillon S, Court Limited, England) block, keeping only the buccal portion exposed, and were flattened with 600 grit silicon carbide paper ((Moyco Precision Abrasives, Montgomeryville, PA, USA) to obtain flat and rough enamel surfaces.

All specimens were assigned randomly in to total 4 groups,

Group 1- Specimens were bleached using 35% hydrogen peroxide (Pola office 35%,SDI Ltd,Australia) as manufacturer's direction. After bleaching, composite resin restoration were performed immediately. Specimens were acid etched with 37% phosphoric acid (Prime dental products Pvt Ltd,Thane,Maharashtra) for 20 seconds, rinsed for 30 seconds and air dried for 10 seconds. A thin layer of adhesive material (Bond Plus, Medicept dental Pvt Ltd, Mumbai,Maharashrta) was applied on the etched enamel, gently spread with compressed air and light-cured for 10 seconds. The embedded specimens were mounted in an apparatus containing a split metal mold with a circular hole 3 mm in diameter and 4 mm in height. Two increments of a composite resin (Z350 XT,Filtek,3M ESPE,USA) were inserted into the hole of the split mould and each increment was light cured for 20 seconds. Therefore, composite resin restoration was attached to the buccal portion of crown. The specimens were stored in an artificial saliva for 24 hours in 37ºC incubator.

Group 2- Specimens were bleached and received application of 10% grape seed extract as an antioxidant before composite restoration.

Group 3 -specimens were bleached, then were applied 10% green tea extract before composite restoration. Green tea extract were prepared by maceration method with ethanol solvent and were diluted using distilled water to obtain 10% concentration.

Group 4- Specimens were bleached and received application of 10% sodium ascorbic acid as an antioxidant before composite restoration. To attain 10% sodium ascorbate, 10 g crystal of sodium ascorbate was dissolved in distilled water, was diluted in ethyl ethanol to make 10% solutions.

0.02 mL of antioxidants were applied on to enamel surface using sponge pellet once/minute for 10 minutes. All the enamel surfaces were then rinsed using distilled water for 30 seconds each.

Each specimen were loaded in universal testing machine for shear bond strength testing (Shanmukh laboratory, Nashik,Maharashtra). The long axis of the specimen was perpendicular to the direction of the applied forces. The knife edge was loaded at the interface between the composite and enamel surface (Fig.1). The shear bond strength was measured in shear mode at a crosshead speed of 1 mm/min until fracture occurred. The results were expressed in MPa, and were analysed using a one-way ANOVA, followed by Tukey's test at the 5% level of significance.

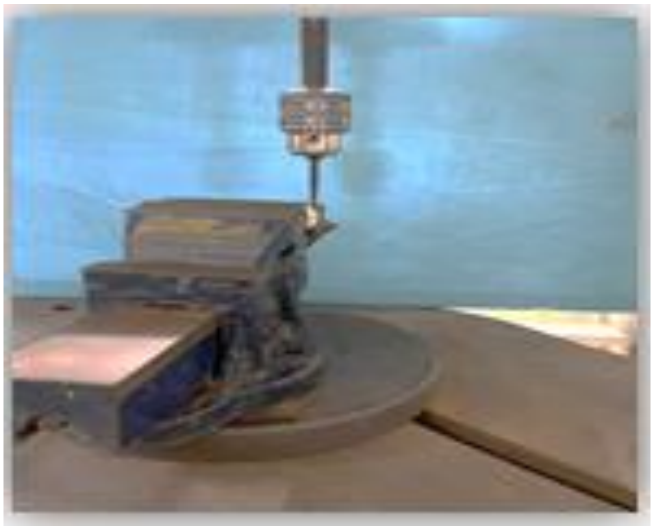

Figure 1

Results

One-way ANOVA showed significant differences in shear bond strength among the four groups ($p<0.05$). Results revealed (Table 1) that specimens that were restored using composite resin immediately following bleaching, had the lowest shear bond strength compared to other antioxidant groups ($p<0.05$).

Among antioxidants groups, 10% Sodium ascorbate revealed the highest shear bond strength compare to other antioxidants groups, whereas 10% Green tea extract produced the lowest shear bond strength. However, the difference between antioxidants did not vary significantly.($P>0.05$).

Group	Sample size	Mean (Standard Deviation)
1	10	2.15±0.7
2	10	3.16±0.96
3	10	3.0±0.52
4	10	4.15±0.29

Table 1: Descriptive statistics for shear bond strength of composite following extra coronal bleaching with and without antioxidant application.

Group 1, after bleaching, composite resin restorations were performed immediately. Group 2,3,4 Bleaching followed by 10% Grape seed extract, 10% Green tea extract application, 10% Sodium ascorbate application, before composite restoration

Discussion

Extra-coronal bleaching procedures are the most conservative and efficient treatment options available today to treat discoloration of teeth[3]. In this present study, it was noted that the extra-coronal bleaching procedure using 35% hydrogen peroxide resulted in a significant decrease of shear bond strength values. The compromised bond strength following bleaching is due to the fact that the bleaching agent leaves behind a residual oxygen layer which interferes with the resin infiltration into etched enamel and inhibits the polymerization of resin. During bleaching with hydrogen peroxide, peroxide apatite is formed as a result of the substitution of hydrogen radicals by peroxide ions. The structural changes caused by the incorporation of peroxide ions are eliminated upon storage for 2-3 weeks as the peroxide ions decomposes and the substituted hydroxyl radicals reenter the apatite lattice. Free radical is the any molecule that has one unpaired electron, providing it high reactivity. These molecules react with the electron-rich regions of dental structure, breaking down large pigmented molecules into smaller, less pigmented ones [1,2]. One theory proposed that the influence of bleaching agents on bonding suggests that peroxides and their by-products present inside the dental structure are capable to interfere with the polymerization process of the adhesive material. [16]

The bleached specimens in the group 1, which were immediately restored using composite resin without any antioxidant treatment showed the lowest bond strength values. This was probably due to residual oxygen produced by bleaching agent on the tooth surface hampering the polymerization of bonding agent. As a result, the oxygen-rich layer on tooth structure did not provide a good surface for bonding [17].

The antioxidant agents may facilitate free radical polymerization of the adhesive resin without the early termination [18]. Neutralizing process from antioxidant agents to free radicals has been categorized into 3 types, i.e., the prevention of continuous (full-time prevention), active detoxification of oxidative stress, and passive detoxification. Sodium ascorbate, green tea extract are included in passive detoxification that can neutralize free radicals and belong to non-enzyme antioxidants [19].

Proanthocyanidins are high molecular weight polymers that comprise the monomeric flavan-3-ol (þ) catechin and (-) epicatechin. Proanthocyanidins are naturally found in high concentrations such as grape seed extract, pine bark extract, cranberries, lemon tree bark, and hazelnut tree leaves. As a naturally occurring plant metabolite, it has been proven to be safe as an antioxidant in various clinical applications and dietary supplements. [17,18]

The green tea catechins, such as EGCG and EGC, have potent antioxidant activities caused by the three adjacent OH groups on the B-ring that scavenge free radicals more effectively than the adjacent OH groups in ECG and EC [8,11]. Thus, green tea catechins are more potent antioxidants. In this way, it was speculated that EGCG are mainly responsible for the capture of free radicals from the bleaching [15]. It was speculated that higher concentrations of green tea results in a greater reversal of bond strength in bleached enamel. Sodium ascorbate is a sodium salt of ascorbic acid and a very well-known antioxidant. This agent reduces a variety of oxidative compounds, particularly free radicals.

Sodium ascorbate has a pH of 7.4, but its antioxidant activity is similar to that of ascorbic acid [20]. The antioxidizing ability of sodium ascorbate helps in neutralizing and reversing the oxidizing effects of the bleaching agent. Thus, the altered redox potential of the oxidized bonding substrate is restored and polymerization of the adhesive continues without permanent termination [21].

The results of the present study altogether supports these findings. The antioxidant concentration of 10% was employed in this study because the effective concentration used for antioxidant to neutralize the free oxygen present in a higher amount in dentin than in enamel as reported by previous studies. [12]

Conclusion

Within the limitation of this study, it can be concluded that application of antioxidants increases the shear bond strength of composite resin to enamel following extra-coronal bleaching using 38% hydrogen peroxide.

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