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REVERSAL OF COMPROMISED BOND STRENGTH FOLLOWING BLEACHING USING THREE DIFFERENT ANTIOXIDANTS AS REVERSAL AGENTS: AN IN VITRO STUDY.

Endodontic

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ABSTRACT

Aim: To assess the effect of 10% sodium ascorbate, 10% ß carotene and 10% green tea extract on the shear bond strength of composite resin to bleached enamel

Settings and Design: Original research, In vitro study

Methods and Material: Ninety recently extracted human premolars were divided into six groups of 15 teeth each. Except Group I, the labial enamel surface of all specimens in the other groups were bleached with 30% hydrogen peroxide. After bleaching, Group II specimens were stored in artificial saliva for 3weeks before composite bonding. Immediately following bleaching; Groups III, IV, and V specimens were treated with antioxidants 10% sodium ascorbate, 10% ß carotene extract, and 10% green tea extract, respectively, for 10 min and bonded with composite resin. In Group VI , the composite bonding was done immediately after bleaching.

Statistical analysis: One way ANOVA test followed by Duncan's multiple range test at $P<0.05$ with SPSS 16 software.

Results: Group I showed highest mean shear bond strength value which was statistically significant and Group VI showed the least mean shear bond strength value which was not statistically significant. Group V (Green tea extract) showed highest mean shear bond strength value among the antioxidants and was statistically significant.

Conclusion: 10% green tea extract was superior in reversing the reduced bond strength of composite resin to bleached enamel.

KEYWORDS

Bleaching, hydrogen peroxide, antioxidants, composite.

INTRODUCTION

Increased awareness and concern about esthetics has resulted in the popularity of the more conservative technique of tooth whitening with bleaching.[1] Vital bleaching is a safe and well-accepted procedure for the treatment of both surface and intrinsic staining of teeth.[2] Bleaching agents used contain high concentrations of carbamide peroxide (35% to 37%) or hydrogen peroxide (30% to 38%).[3]

Studies have shown that the shear bond strength of composite resin bonded to the tooth surface immediately after bleaching was significantly lower than that on unbleached tooth surface due to the presence of residual oxygen layer. The general approach of overcoming this post bleaching compromised bond strength was to delay the bonding procedure by a period varying from 24 h to 3 weeks.[4,5] Several other methods have been proposed to reverse the compromised bond strength after bleaching, such as removal of superficial layer of enamel[6], treatment of the bleached enamel with alcohol before the restoration[7], use of adhesives containing organic solvents[8,9], and application of antioxidant agents[10,11,12,13].

Sodium ascorbate is water soluble and can eliminate free radicals in biological systems and prevent the acidic effect.[14,15] Green tea extract used as an antioxidant can also reverse the compromised bond strength following bleaching.[16] ß carotene extract has also been used effectively as an antioxidant and a herbal endodontic irrigant.[17] The aim of this in vitro study was to evaluate and compare the effects of 10% sodium ascorbate, 10% ß carotene and 10% green tea extract on the bond strength of composite resins to bleached enamel. The hypothesis of this study was that the use of an antioxidant reversed the reduced bond strength of composite resins to bleached enamel.

SUBJECTS AND METHOD

Preparation of solutions:

Ten grams of sodium ascorbate powder, ß carotene powder and green tea powder were dissolved in 100ml of distilled water to make 10% sodium ascorbate solution, 10% ß carotene solution and 10% green tea solution respectively.

Specimen preparation:

Ninety recently extracted human premolars were used in this study. The teeth which were free of caries, cracks, wear lesions, or developmental enamel defects were included in the study. The teeth were stored in a disinfectant solution of 0.1% thymol prior to the study. All teeth were decoronated at the cementoenamel junction using a diamond disc and the decoronated surface was sealed with self-cure acrylic resin. All the specimens were then embedded in self-cure acrylic resin molds such that the labial surfaces faced upwards. The samples were kept in deionized water until the resin was completely cured. The labial surfaces of teeth were polished with silicon carbide paper for 60 s to create smooth, flat surfaces for treatment and bonding. The specimens were randomly assigned into six groups of 15 teeth each (Table 1). All specimens except Group I (negative control) were bleached with 30% hydrogen peroxide, with three applications of eight min each. Following bleaching, the specimens were thoroughly rinsed with deionized water for 1 min.

In Group I (negative control), the unbleached teeth were bonded with composite. In Group II, bleaching was followed by storage in 250 ml of artificial saliva solution at 37°C for 3 weeks. Bonding with composite was done 3weeks after bleaching.

In Groups III, IV, and V, bleaching was followed by treatment with antioxidants 10% sodium ascorbate solution, 10% ß carotene extract solution, and 10% green tea extract solution respectively for 10 min. This was followed by rinsing with deionized water for 30 s and then bonded with composite. In Group VI (positive control), bonding with composite was done immediately following bleaching.

For composite bonding, labial enamel surface of all specimens were etched with 37% phosphoric acid for 15 s, rinsed off with deionized water for 20 s, blot dried, and bonded with Tetric N Bond. A plastic mold of 5 mm height and 3 mm diameter was used for composite build up on the labial surface. Composite resin was build up in increments of 2 mm or less with each increment being light-cured for 40 s.

All the specimens were stored in deionized water for 24 h at 37°C prior to shear bond strength testing.

Shear bond strength testing:

Each specimen was placed in between the jigs of the universal testing machine and a pointed shearing rod was placed on the composite resin/tooth interface and was subjected to static loading at a rate of 0.5 mm/min until fracture occurred. The machine was interfaced with a computer through which the operation was controlled and shear bond strength was calculated.

Statistical analysis:
One-way analysis of variance (ANOVA) followed by Duncan's multiple range test was used to analyze the data. Significance was established at $P < 0.05$ level.

RESULTS

Highest mean shear bond strength value was observed in Group I, which was statistically significant compared to other groups with p values of 0.0001($P < 0.05$) - table 2.

The mean shear bond strength value of Group II was statistically significant with that of Group III with p value of .0002($P < 0.05$),Group V with p value of 0.022($P < 0.05$), and Group VI with p value of .0001($P<0.05$), but not with that of Group IV with p value of 0.107($P > 0.05$) - table 2.

The mean shear bond strength value of Group III was statistically significant compared to Group V ($P < 0.05$) and Group VI ($P < 0.05$) with p values of .0001, but not with that of Group IV with p value of 0.129($P > 0.05$) - table 2.

The mean shear bond strength value of Group IV was statistically significant when compared to that of Group V with p value of .0003($P <0.05$) and Group VI with p value of .0001($P<0.05$) - table 2.

The mean shear bond strength value of Group V was statistically significant when compared to that of Group VI with p value of .0001($P <0.05$) - table 2.

Group VI showed the least mean shear bond strength values compared to all other groups and was not statistically significant ($P > 0.05$) - table2.

Table 1: The distribution of specimens and study groups

Groups	Bleaching agent	Antioxidant used	Composite build up
Group I (n=15)	None	None	Done immediately
Group II (n=15)	30% Hydrogen peroxide	None	Done 3 weeks after bleaching
Group III (n=15)	30% Hydrogen peroxide	10% sodium ascorbate solution for 10 min	Done immediately
Group IV (n=15)	30% Hydrogen peroxide	10% ß carotene extract solution for 10 min	Done immediately
Group V (n=15)	30% Hydrogen peroxide	10% green tea extract solution for 10 min	Done immediately
Group VI (n=15)	30% Hydrogen peroxide	None	Done immediately

Table 2: Pair wise comparisons of six study groups (I, II, III, IV, V, VI) with respect to shear bond strength (Mpa) by Duncan's multiple range test

Groups	Group I	Group II	Group III	Group IV	Group V	Group VI
Mean	15.27	8.95	7.87	8.53	9.55	4.74
SD	1.10	0.46	0.54	0.53	0.63	0.79
Group I	-					
Group II	p=0.0001*	-				
Group III	p=0.0001*	p=0.0002*	-			
Group IV	p=0.0001*	p=0.1078	p=0.1296	-		
Group V	p=0.0001*	p=0.0223*	p=0.0001*	p=0.0003*	-	
Group VI	p=0.0001*	p=0.0001*	p=0.0001*	p=0.0001*	p=0.0001*	-

*p<0.05

Figure 1: Comparison of six study groups (I, II, III, IV, V, VI) with respect to shear bond strength (Mpa)

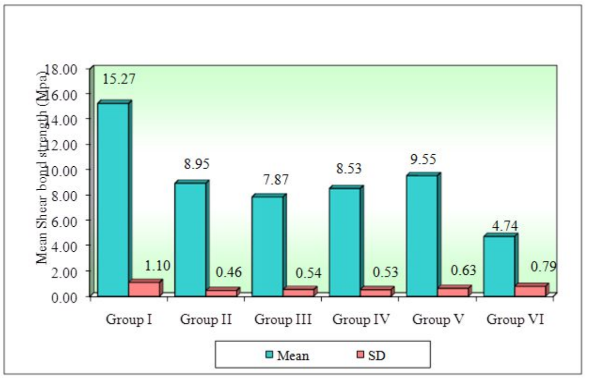

Figure 1 shows the mean shear bond strength and standard deviation of all six study groups. Group I shows the highest mean shear bond strength value while Group VI shows the least mean shear bond strength value among the six study groups.

DISCUSSION

Vital tooth bleaching procedures are the most commonly used conservative and effective treatment options to treat discolored teeth.[18] Given the objective of today's conservative dentistry to save tooth structure, it is preferable to combine tooth whitening procedures with direct composite restorations to achieve esthetically pleasing clinical results and also to limit the necessity for prosthodontic tooth preparation.

Human premolars recently extracted for orthodontic purposes were selected for this study. Following extraction they were stored in a disinfectant solution of 0.1% thymol solution until use to prevent cross infection.[19] The decoronated tooth surface was sealed with acrylic resin to avoid the penetration of the embedding medium or the bleaching solution into the pulp chamber[20]. Bonded specimens were stored in deionized water for 24 h at 37°C before shear bond strength testing to artificially age the composite resins. Artificial aging simulates the chemical and physical oral environments, producing in a relatively short period, degradation similar to that which a composite resin would undergo in its clinical life[21].

Commonly used bleaching agents include hydrogen peroxide, carbamide peroxide and sodium perborate. Hydrogen peroxide, a low molecular weight substance, decomposes into oxygen and perhydroxyl free radicals. The latter is associated with high permeability and high diffusibility in the tooth structure. Perhydroxyl radicals attack the long chained, dark colored macromolecules of pigments and spilt them into smaller, less colored and more diffusible molecules which are removed from the structure producing the bleaching effect. [22] The reduced bond strength of composite resin to bleached enamel may be caused by multifactorial events.[23,24,25] The bleaching reaction promotes the release of oxygen which decreases the bond strength. The residual oxygen layer interferes with the resin infiltration into etched enamel and inhibits the polymerization of resin.[26,27] The enamel acts as a reservoir for residual oxygen, which makes difficult its release immediately after bleaching. Therefore, morphological changes such as the increase of porosity and loss of prismatic form are observed in the bleached enamel.[28,29] The mineral content of enamel is reduced and resin tags observed are less defined and fragmented.[30] 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.[31]

The reduced bond strength in Group VI when compared to Group I may be due to the residual oxygen layer left behind following the bleaching process which could have interfered with the resin infiltration into etched enamel and inhibited the polymerization of resin.[26,27] Group II specimens showed significantly higher bond strength than that of Group VI which proves that delaying the bonding procedures following bleaching could reverse the compromised bond strength as a result of the removal of residual oxygen.[4,5] Group III specimens showed comparable values as that of Group II, which supports the fact that the use of antioxidants immediately following bleaching could neutralize the residual oxygen and reverse the reduced bond strength. [20] Group III specimens could not reverse the bond strength as much as that of Groups IV and V which could be attributed to the fact that green tea extract and ß carotene extract are powerful antioxidants, far more potent than the common antioxidants like vitamins C and E. Group V specimens showed a higher mean bond strength value than that of Group IV specimens and was not statistically significant.

Thus all the three antioxidants were capable of reversing the reduced bond strength following bleaching .So this could be used to avoid the waiting period before bonding to bleached enamel which makes it clinically significant. However, further clinical trials are needed to confirm these findings.

CONCLUSION

Within the limitations of this in vitro study, it was observed that among the different antioxidants used, 10% green tea extract was superior in reversing the reduced bond strength of composite resin to bleached enamel.

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