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Effect of natural antioxidants on composite shear bond strength of bleached enamel – An in vitro study

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Abstract

Background: Increased esthetic concern has made bleaching and composite very popular option. But bleaching hampers immediate composite bonding.

Aim - hence the aim of this in vitro study was to evaluate the effect of natural antioxidants on composite shear bond strength of bleached enamel.

Materials And Method: 60 recently extracted permanent maxillary intact incisors were chosen for the experiment. All the teeth were divided into 5 groups: A-control group, B- bleaching + grape seed extract, C- bleaching + pomegranate extract, D- bleaching + green tea extract, E- bleaching+ Aloe vera extract. Composite molds were bonded and universal testing machine was used to measure the bond strength.

Statistical Analysis: statistical analysis was done using anova test.

Results: statistically significant difference were found between all groups. No statistically significant difference was found between group C, D and E. highest mean shear bond strength value was of group B which was 28.93.

Conclusion: henceforth it concludes that antioxidants has greater effect on reversal of shear bond strength of composite and among this study grape seed extract proved to be best.

Keywords: Antioxidant, bleaching, bond strength.

Introduction

Popularity of many esthetic enhancement procedures is due to increased awareness and concern about esthetics these days. One of the more conservative techniques is tooth whitening by bleaching, as an alternative to invasive

therapies such as complete veneer crowns or placement of veneers[12].

Due to increased awareness about esthetic enhancement procedures and minimal invasion, bleaching is popular these days. Vital bleaching involves hydrogen peroxide for in office and carbamide peroxide for at home bleaching methods.

Bleaching agents are oxidizing in nature; as they diffuse into the tooth, they break down to produce unstable free radicals. In the spaces between the inorganic salts in tooth enamel, these unstable free radicals strike organic pigmented molecules, resulting in smaller, less highly pigmented constituents. These smaller molecules reflect less light, thus creating a ‘‘whitening effect’’[13].

In certain cases of severe staining, e.g. intrinsic staining such as tetracycline staining; For better performance, enamel bleaching has been recommended as a preparatory step prior to restoration by acid etching or veneer bonding. Also, certain teeth that have been previously treated with bonded restorations may need their replacement after bleaching for better esthetic results[14].

Although, it has been found that the adhesion between the bonding agent and tooth surface is hampered after bleaching. Some of the reasons are alterations in enamel surface morphology, changes in fracture toughness, hardness and abrasion characteristics of human enamel, changes in salivary pH, changes in ultrastructural morphological resin tooth interfaces and alteration of composite resin. The oxygen free radicals affect the penetration of the bonding agent into the tubules; as well as prevent the complete polymerization of the agent.[14]

Clinically, a significant decrease in bond strength of composite to bleached enamel was noticed for up to a period of three weeks. [14]

Traditionally 35% hydrogen peroxide was used for majority of bleaching procedures, but due to its higher concentration, it has more adverse effects. With the advent of ‘home bleach’ techniques, the use of a lower concentration i.e. 10% carbamide peroxide based systems for slow and long-time release of peroxide radicals at low risk have been used successfully in lightening of teeth. [15]

Several systems are used to bond aesthetic restorations. The total etch system is a two-step system, where the surface is first treated with phosphoric acid which opens the dentinal tubules, allowing for better penetration of the applied adhesive. Since the self-etch adhesive method is a one-step process, chair time is reduced. They remove the risk of collagen fibre failure, but the use of weak acids can prevent the bonding agent from penetrating completely[16].

Studies have shown that the decrease in bond strength could be affectively reversed with various antioxidants. These are available in various forms and sources e.g. sodium ascorbate (citrus substances), proanthocyanidin (grape seed extract), pine bark extract, lycopene (tomato extract), epigallactin (green tea extract), etc. They are free oxygen radical scavengers, thus, reducing the presence of oxygen radicals from the tooth surface and thus regaining the bond strength of adhesives to tooth surface. Also, since they are obtained from natural sources, they are highly biocompatible. Sodium ascorbate has been shown to be consistently successful in reversing the impact of bleaching agents on composite bond strength to the tooth surface among the various antioxidants accessible[18].

The aim of this in-vitro study was to evaluate and contrast the effects of different antioxidants, including grape seed extract, aloe vera, pomegranate extract, green tea powder on the 35% carbamide peroxide bleached

enamel as the effect of some of these antioxidants are not known in literature. The shear bond strength of composite bonded to enamel will be analysed in this study.

Material And Methods

Armamentarium:

- Slow-speed Micromotor handpiece
- Diamond disk with mandril
- Airotor handpiece (BEING FOSHAN)
- Polyacrylic molds
- Light curing unit (WOODPECKER)
- Teflon coated condenser
- Universal testing machine (INSTRON)
- 600 grit carbide paper
- No. 12 Wheel bur

Materials

- 60 permanent maxillary anterior teeth
- Thymol
- Saline
- Self-curing acrylic resin
- 35% carbamide peroxide (Ammdent ultra white)
- 7^{th} generation bonding agent (3M)
- Light cure packable composite (3M)
- aloe vera extract(mothertree nutra, delhi; india)
- grape seed extract(emmbros overseas lifestyle pvt.,panchkula,india)
- pomegranate extract(Healthy Hey, mumbai; India)
- green tea extract (Healthy Hey, mumbai; India)

Inclusion Criteria

- Intact permanent upper incisor teeth extracted due to periodontal purpose.

Exclusion Criteria

- Discoloured tooth with intrinsic stain due to any etiology
- Any physiologic or anatomic malformative teeth
- Tooth which are damaged and not intact
- Restored teeth
- Teeth subjected to bleaching previously

Methodology

- Collection of 60 recently extracted intact maxillary anterior teeth was done for the study.
- The teeth were rinsed under tap water. Soft tissue tags, bone or calculus was removed with the help of an ultrasonic scaler, cleaned with thymol, until use stored at room temperature.
- The roots of all teeth were separated 2mm below the cemento- enamel junction using diamond coated disc in a slow-speed micromotor handpiece, under continuous water spray. The teeth were placed on standardised acrylic blocks that revealed the buccal surfaces. These buccal surfaces were then flattened using a 600 grit carbide paper to gain approx flat area of 3*3 mm^2.

The samples were divided into 5 groups containing 12 samples each

A- Control group

B- Bleaching followed by grape seed extract treated group

C- Bleaching followed by pomegranate extract treated group

D- Bleaching followed by green tea extract treated group

E- Bleaching followed by Aloe vera extract treated group

Group A

The samples of this group were subjected to a bleaching regimen with 22% carbamide peroxide home bleach (WhitenessPerfect, FGM, Brazil). Using a syringe, about 1-mm thick layer of gel was applied to the buccal surface and kept for 2 hours. The gel was then removed, rinsing with water and air drying of teeth was done. This procedure was repeated for 7 consecutive days.

Group B, C, D, E

The samples of these groups were subjected to the same bleaching regimen like Group A.

After that teeth were divided into 4 groups

Group B: 10 mg of grape seed extract pill powder (emmbros overseas lifestyle pvt.,panchkula,india) ,

Group C: 10 mg pomegranate extract powder (Healthy Hey, mumbai; India),

Group D: 10 mg green tea extract pill powder(Healthy Hey, mumbai; India),

Group E: 10 mg aloe vera extract pill powder(mothertree nutra, delhi; india) were collected and dissolved in 100 ml of distilled water to prepare 4 antioxidant solutions.

- Immersion of samples in this solution for 10 mins and then rinsing was done.
- The samples were rinsed; 2-3 generous coats of 7th generation bonding agent (Scotchbond Universal, 3M) were applied onto the enamel surface for 20 seconds, dried for 5 seconds, light cured for 15 seconds.
- Standardized polyacrylic molds (3x3 mm internal diameter) were used for composite build-up. The composite (Filtek Z250 XT, 3M) was placed in 1mm increments and light cured for 20 seconds. To make composite cylinders measuring 3mm*3mm, the moulds were removed.
- All the 60 samples were mounted on metal test blocks and subjected to shear bond strength analysis in a universal testing machine (Instron 3382, Germany). A knife edge shearing rod was used at a cross-head speed of 0.5 mm/ minute. The force was applied at the tooth composite interface and the load at failure was recorded by the software (Instron Bluehill 2). Calculation of shear bond strength was done.

Results

Table 1: Distribution of study subjects based on descriptive statistics measurements by 5 methods.

Group	N	Mean	SD
Bleaching followed by composite	12	19.27	1.88
10 mg Grape seed extract	12	28.93	2.48
10 mg Pomegranate extract powder	12	24.42	1.94
10 mg Green tea powder	12	24.17	2.11
10 mg Aloe vera extract pill powder	12	26.16	2.83

SD: Standard Deviation

Table-1 shows distribution of study samples based on descriptive statistics. The above data showed that, the mean sheer bond strength of Group A, Group B, Group C, Group D and Group E were 19.27, 28.93, 24.43, 24.17 and 26.16 respectively.

Table 2: Distribution of study samples based on mean comparison of sheer bond strength between 5 methods.

Source	Sum of Squares	df	Mean Square	F value	P value
Between Groups	598.125	4	149.531	28.707	≤0.05*
Within Groups	286.485	55	5.209		
Total	884.609	59	-		

Level of significance ≤ 0.05, * significant result, ** Non-Significant result

Table-2 shows distribution of study subjects based on mean difference between all 5 methods. The above data showed that, statistically significant difference exists between Group A, Group B, Group C, Group D and Group E in sheer bond strength determination.

Table 3: Distribution of study samples based on intergroup comparison of sheer bond strength between all 5 methods.

Group	Other methods	Mean	Mean difference	P value
Bleaching followed by composite	10 mg Grape seed extract	28.93	-9.66	≤ 0.05*
	10 mg Pomegranate extract powder	24.42	-5.15	≤ 0.05*
	10 mg Green tea powder	24.17	-4.89	≤ 0.05*
	10 mg Aloe vera extract pill powder	26.16	-6.89	≤ 0.05*
10 mg Grape seed extract	Bleaching followed by composite	19.27	9.66	≤ 0.05*
	10 mg Pomegranate extract powder	24.42	4.50	≤ 0.05*
	10 mg Green tea powder	24.17	4.76	≤ 0.05*
	10 mg Aloe vera extract pill powder	26.16	2.77	≤ 0.05*
10 mg Pomegranate extract powder	Bleaching followed by composite	19.27	5.15	≤ 0.05*
	10 mg Grape seed extract	28.93	-4.50	≤ 0.05*
	10 mg Green tea powder	24.17	0.25	> 0.05**
	10 mg Aloe vera extract pill powder	26.16	-1.73	> 0.05**
10 mg Green tea powder	Bleaching followed by composite	19.27	4.89	≤ 0.05*
	10 mg Grape seed extract	28.93	-4.76	≤ 0.05*
	10 mg Pomegranate extract powder	24.42	-0.25	> 0.05**
	10 mg Aloe vera extract pill powder	26.16	-1.99	> 0.05**
10 mg Aloe vera extract pill powder	Bleaching followed by composite	19.27	4.26	≤ 0.05*
	10 mg Grape seed extract	28.93	-5.39	≤ 0.05*
	10 mg Pomegranate extract powder	24.42	-0.89	> 0.05**
	10 mg Green tea powder	24.17	-0.63	> 0.05**

Level of significance ≤ 0.05, * significant result, ** Non-Significant result

However, Statistically no significant difference exists in shear bond strength between group of 10 mg Pomegranate extract powder, 10 mg Green tea powder and 10 mg aloe vera extract pill powder.

Discussion

Haywood & Heymann formally introduced Carbamide Peroxide home bleaching, which has become widely accepted by the dental profession. Vital bleaching with a concentration of 10% Carbamide Peroxide became a standard technique also known as "night guard vital bleaching". This technique is performed at home by the patient with professional supervision & therefore also known as "home bleaching"[14]. Other products

dependent on higher concentrations of Hydrogen Peroxide are used for in-office power bleaching. Concentrations up to 44 percent are available for brief periods of bleaching with night guard while the patient sits in the waiting room.[14].

In a day-to-day clinical practice, bleaching and bonding are often used as therapeutic options for specific cases. In the instant life style of the world, the compromised bond strength of resin composites to teeth, after bleaching is of more clinical concern. The prolonged periods of postponing the bonding procedures would increase the patient's anxiety.[14]

Studies have examined the physical alteration after bleaching to find a possible explanation for decrease in enamel bond strength caused by carbamide peroxide.[15]

Studies comparing enamel surface morphologies have seen a decrease in content of calcium, phosphorus, sulfur and potassium of enamel after bleaching. [2, 4] Also, a decrease in fracture toughness, abrasion resistance [8] and microhardness [14] has been found. Since fracture toughness is an indication of ability of enamel to resists crack propagation, this would certainly lead to decreased bond strength. [1, 8]

The compromised bond strengths have previously been attributed to denaturation of protein in the enamel and causing alteration in organic and inorganic ratio with an increase in inorganic component. A loss of aprismatic enamel layer was seen[3, 5, 6].

In SEM observations, the interfaces between resin & bleached enamel were substantially different from those formed between resin & unbleached enamel. In bleached specimens large area of enamel surface were free of resin & when tags were present they were fragmented, poorly defined and penetrated to lesser depth than unbleached controls [3, 16]. It's been proposed that these are caused by gaseous bubbling caused by peroxide entrapment in the subsurface layer of enamel [16].

Recently, the most acceptable version of the explanation is that residual oxygen from the bleaching agent inhibits resin polymerization. Hydrogen peroxide is released from carbamide peroxide, and due to its low molecular weight it can penetrate enamel to reach the dentin, which could act as an oxygen reservoir. The hydrogen peroxide breaks down to release oxygen that is trapped within the adhesive during light activation. The effect of oxygen might be responsible for the formation of an inhibited zone on the surface of the bonding agent in contact with environmental air. [15]

The adverse effects related to the lower bond strengths following bleaching can be reversed with certain methods:

- Delayed bonding by immersion of bleached specimens in distilled water or artificial saliva resulted in complete reversal of reduced bond strengths. This may be due to residual oxygen from the bleaching material being removed by the immersion process. It has been expected that under a clinical condition saliva may have similar actions after bleaching. However, the amount of post-bleaching time needed to restore bond strength to pre-bleach levels is a contentious issue. A time period of 1-2 weeks is recommended to recover the normal bond strength values with use of hydrogen or carbamide peroxide agents [3, 6, 12].
- Dentin adhesives containing a water displacement solution are thought to be another form for reversal. It was discovered that using alcohol-based bonding agents with bleached enamel could reduce the bleaching process' inhibitory effect. This was attributed to the interaction of alcohol with residual

oxygen. Acetone in dentin adhesives displaces surface water containing oxygen. There by use of a bonding agent containing acetone can counter act decreased bond strength [9, 10].

- Recently it has been found that the compromised bonding to acid etched bleached enamel and dentin was reversed with sodium ascorbate, an antioxidant [11, 13, 16]. Vitamin C (ascorbic acid) and its salts are non-toxic and commonly used as anti-oxidants in the food industry.. Certain other biologically available anti-oxidants have also been studied for their reversal effect on enamel bond strength, which include catalases [16], anthocyanins like malvidin chloride and pelargonidin chloride [13], grape extract [1, 10], alpha-tocophero [2, 11], green tea [2, 3, 4, 5] and pine bark extracts. [5] The grape seed extract contains oligomeric proanthocyanidin complex which is more potent than sodium ascorbate. Antioxidant activity of dry green tea leaves is related to flavonoids. Pomegranate peel extract contains active compounds such as polyphenols, which outperform green tea in terms of antioxidant benefits. Aloe vera's antioxidant properties are due to polysaccharides present in the leaf gel.

Nair et al. investigated the bond strength of composite resin to bleached enamel using three different antioxidant treatments and concluded that immediate application of grape seed extract proved superior followed by *A. vera*.[1]

In the present study irrespective of the bonding agent used there was reversal of compromised bond strength using all the natural antioxidants. the mean sheer bond strength determined through Bleaching followed by composite(Group A), 10 mg Grape seed extract(Group B), 10 mg Pomegranate extract powder(Group C), 10 mg Green tea powder(Group D) and 10 mg Aloe vera extract pill powder(Group E) was 19.27, 28.93, 24.42, 24.17 and 26.16 respectively. There was statistically significant difference between group A and all the other groups. There was no significant difference between Group C (Pomegranate),Group D(green tea extract) and Group E(Aloe vera extract). These results are consistent with previous research. [1, 2, 10]

The results of our study indicate that there was significant difference between the antioxidant surface treatment group and direct composite group.

Conclusion

In this study irrespective of the bonding agent used there was reversal of compromised bond strength using all the natural antioxidants. From all grape seed extract was the most effective antioxidant group showed greatest shear bond strength. There was significant difference between the antioxidant surface treatment group and direct composite group.

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