Original Article

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Dentistry Section

Effect of Different Anti-Oxidants on Shear Bond Strength of Composite Resins to Bleached Human Enamel

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ABSTRACT

Introduction: The bond strength of the composite to the bleached enamel plays a very important role in the success and longevity of an aesthetic restoration.

Aim: The aim of this study was to compare and evaluate the effect of Aloe Vera with 10% Sodium Ascorbate on the Shear bond strength of composite resin to bleached human enamel.

Materials and Methods: Fifty freshly extracted human maxillary central incisors were selected and divided into 5 groups. Group I and V are unbleached and bleached controls groups respectively. Group II, III, IV served as experimental groups. The labial surfaces of groups II, III, IV, V were treated with 35% Carbamide Peroxide for 30mins. Group II specimens were subjected to delayed composite bonding. Group III and IV specimens were subjected to application of 10% Sodium Ascorbate and leaf extract of Aloe Vera following the Carbamide Peroxide bleaching respectively. Specimens were subjected to shear bond strength using universal testing machine and the results were statistically analysed using ANOVA test. Tukey (HSD) Honest Significant Difference test was used to comparatively analyse statistical differences between the groups. A p-value <0.05 is taken as statistically significant.

Results: The mean shear bond strength values of Group V showed significantly lower bond strengths than Groups I, II, III, IV (p-value <0.05). There was no statistically significant difference between the shear bond strength values of groups I, II, III, IV.

Conclusion: Treatment of the bleached enamel surface with Aloe Vera and 10% Sodium Ascorbate provided consistently better bond strength. Aloe Vera may be used as an alternative to 10% Sodium Ascorbate.

Keywords: Aloe vera, Bleaching, Carbamide peroxide, Shear bond strength, 10% sodium ascorbate

INTRODUCTION

In the current era of aesthetic dentistry, bleaching is readily considered for the treatment of discoloured teeth. Tooth discolouration can occur either intrinsically or extrinsically, the origin and nature of the stain will determine whether external or internal bleaching will be most effective [1].

The most commonly used modern day bleaching systems include H_2O_2 and Carbamide Peroxide or a combination of these with heat or light as activating agents [2]. Previous studies have shown that 10-35% of Carbamide Peroxide bleaching agents adversely affect the bond strength of resin composite when bonding is performed immediately after bleaching [3].

The presence of oxygen, which is a break down product of hydrogen peroxide, has been related to a reduction in bond strength after bleaching because the residual oxygen might interfere with resin infiltration into the dentinal tubules [4] and inhibit resin polymerization [5].

Delaying the composite restorations for 1-3 weeks was recommended to overcome this problem. To avoid the delay after bleaching, application of an antioxidant is recommended prior to bonding which allows the clinician to immediately carry out the bonding procedure [6].

In a study conducted by Lai et al., the hydrogen peroxide or sodium hypochlorite induced reduction of bond strength of resin composite to dentin is reversed with the use of antioxidant, Sodium Ascorbate [7]. So, the surface treatment of bleached enamel with an antioxidant prior to bonding is used as an alternative to the delayed restorative procedure.

Aloe barbadensis Mill, is a short succulent herb resembling a cactus which is filled with a clear viscous gel and proved to have antibacterial, antifungal, antiviral and antioxidant properties [8].

The purpose of this study was to investigate the effect of Aloe Vera, a natural antioxidant on shear bond strength of composite resin to bleached enamel.

MATERIALS AND METHODS

Fifty human maxillary central incisors which were extracted due to periodontal reasons were collected. This study was conducted in duration of 6-8 weeks. Inclusion criteria consisted of sound teeth, no history of bleaching, no restorations on the tooth. Exclusion criteria consisted of teeth with caries, cracks and non carious lesions. Residual surface debris from the teeth was removed with pumice and stored in saline for 3 weeks. The roots were separated from the teeth at the level of cemento-enamel junction using a water cooled diamond disc. The coronal pulps were removed and light body elastomeric impression material was used to fill the coronal pulp chamber, this inhibits the penetration of self-cure resin into the pulp chamber. The self-cure resin was loaded in aluminium holders and the specimens were mounted in the resin with their buccal surfaces upward at the level of acrylic resin. Until the resin was completely cured the samples were placed in cold water. The buccal surfaces of the teeth were sand blasted with 50µ alumina to remove the aprismatic enamel at the bonding surface [9]. A 35% carbamide peroxide (Opalescence, Ultradent Products. Inc. USA) bleaching gel was applied on the buccal surfaces of the specimens for 30 minutes and rinsed with distilled water for 30 seconds. The samples were randomly divided into 5 groups (n=10)–

Group I: Unbleached control group, consisting of composite bonding to unbleached enamel.

Group II: 35% Carbamide Peroxide bleaching followed by delayed composite bonding, after 1 week.

Group III: 35% Carbamide Peroxide bleaching followed by the application of 10% Sodium Ascorbate and composite bonding immediately.

Group IV: 35% Carbamide Peroxide bleaching followed by the application of leaf extract of Aloe Vera, an antioxidant, and composite bonding immediately.

Group V: 35% Carbamide Peroxide bleaching followed by immediate bonding without the antioxidant treatment.

The surfaces of the teeth were treated with 37% Phosphoric acid (D tech, Pune, India) for 15 seconds and rinsed with running water for 30 seconds and blot dried. A layer of adhesive (Single bond 2,3M ESPE, Dental products, USA) [Table/Fig-1] was applied and translucent polyvinyl moulds of 4mm height and 4mm internal diameter were positioned over the adhesive covered specimen. The adhesive was light cured with an intensity of 800mW\sq.cm (Elipar, 3M ESPE, USA) for 10 seconds. The nanofilled hybrid composite (Z 250XT, 3M ESPE, USA) [Table/Fig-1] was incrementally placed in the polyvinyl moulds, each increment was cured for 30seconds [Table/Fig-2]. Following complete curing polyvinyl moulds were cut and removed. All the specimens were immersed in water for 24 hours. Shear bond strengths were then measured using universal testing machine (INSTRON limited, Bucks, England) at a cross head speed of 1.0mm/min [Table/Fig-3]. The load at which failure occurred was recorded by software. The shear bond strength values of the samples were calculated and expressed in S.I. units (Mega Pascal).

RESULTS

The Statistical package, SPSS (Statistical Package for Social Science, Version 18.0) was used for statistical analysis. Mean and standard deviation were estimated from the sample for each study group. The mean composite bond strength values were compared by one-way Analysis of Variance (ANOVA) appropriately followed by Tukey HSD test. Tukey HSD test was employed to comparatively analyse the statistical significance between the groups. In the present study, the level of significance was set as p<0.05.

As shown in [Table/Fig-4], One-way Analysis of Variance (ANOVA) showed statistically significant difference among the study groups (p-value=0.001).

As depicted in [Table/Fig-5], group V (bleached control) showed significantly lower composite bond strength compared to Group

Adhesive	Contents	Manufacturer
Adper single bond2	BisGMA, HEMA, dimethacrylates, ethanol, water, photoinitiator system and a methacrylate functional copolymer of polyacrylic and polyitaconic acids	3M ESPE, Dental products, USA
Filtek Z250 XT	BIS-GMA, UDMA, BIS-EMA, PEGDMA and TEGDMA, surface modified silica particles, photoinitiator	3M ESPE, Dental products, USA

[Table/Fig-1]: Compositions of the Adhesives used in the Study
Abbreviations: BisGMA. Bisphenol A glycidylmethacrylate, HEMA. 2-hydroxyethyl methacrylate, UDMA. Urethane dimethacrylate; BIS-EMA. ethoxylated bisphenol A glycol dimethacrylate, PEGDMA. Polyethylene glycol dimethacrylate, TEGDMA. triethylene glycol dimethacrylate

[Table/Fig-2]: Resin composite placed on the sample

[Table/Fig-3]: Sample under universal testing machine

GROUPS	MEAN	SD	f VALUE	p VALUE
GROUP I	19.080	3.070	9.951	0.001*
GROUP II	18.150	3.430		
GROUP III	16.040	2.650		
GROUP IV	16.260	2.550		
GROUP V	11.600	2.630		

[Table/Fig-4]: Mean comparison among study groups using ANOVA one-way test
* p<0.05 Statistically significant

(I) GROUP	(J) GROUP	Mean Difference MPa (I-J)	p-value	95% Confidence Interval	
				Lower Bound	Upper Bound
GROUP V	GROUP I	-7.47	0.001*	-11.135	-3.797
	GROUP II	-6.54	0.001*	-10.211	-2.873
	GROUP III	-4.43	0.011*	-8.099	-0.761
	GROUP IV	-4.65	0.007*	-8.315	-0.977

[Table/Fig-5]: Multiple comparisons with Group V (bleached control) using Tukey HSD
.* p<0.05 Statistically significant

(I) GROUP	(J) GROUP	Mean Difference MPa (I-J)	p-value	95% Confidence Interval	
				Lower Bound	Upper Bound
GROUP IV	GROUP I	-2.82	0.204	-6.489	0.849
	GROUP II	-1.90	0.588	-5.565	1.773
	GROUP III	0.22	1.000	-3.453	3.885
	GROUP V	4.65	0.007*	0.977	8.315

[Table/Fig-6]: Multiple comparisons with Group IV (leaf extract of Aloe Vera) using Tukey HSD
.* p<0.05 Statistically significant

I (Unbleached Control), II (Delayed bonding), III (10% Sodium Ascorbate), IV (leaf extract of Aloe Vera).

As shown in [Table/Fig-6], comparison between Group IV (leaf extract of Aloe Vera) with Group I, II, III using Tukey HSD test showed no significant difference in composite shear bond strength values.

DISCUSSION

With the increasing demand for a white smile, conservative techniques such as bleaching for the treatment of discoloured teeth has gained importance [10]. Many authors have investigated and published the effects of bleaching on bond strengths of composite to enamel and dentin. These studies concluded that different concentrations of hydrogen peroxide and carbamide Peroxide based bleaching agents decreased the immediate bond strength to enamel [11,12] and dentin. On the other hand it has been reported in the literature that the effects of bleaching agent on bond strength to enamel were reversible [13] and delaying the bonding procedure for one week after bleaching decreased the adverse effects for bonding to human molar dentin [14] using phosphoric acid etchant.

The decreased bond strength of composite to enamel when bleached with carbamide peroxide is due to changes in its structure, resulting in erosive areas and increased porosity which is manifested by an over-etched appearance with loss of prismatic form [15,16]. Moreover the caustic nature of carbamide peroxide causes reduction in enamel micro hardness and alters the organic-inorganic ratio [17-19].

The hydrogen peroxide, due to its low molecular weight penetrates the enamel which is retained and continuously leached from bleached enamel [20], that eventually break down to oxygen and water. The liberated oxygen from hydrogen peroxide could directly inhibits the polymerization of the adhesive [4,11,13], or it may interfere with the infiltration of resin into enamel and dentin.

It has been reported that the resin enamel interface of the bleached enamel is different from that of unbleached enamel when viewed under Scanning Electron Microscope (SEM) [21]. In large areas of bleached enamel surface the resin tags are absent, when present they are sparse, penetrated to lesser depth and structurally incomplete resulting in increased density of voids along enamel resin interface. SEM examination also reveals the presence of spherical bubble like structures along the resin enamel interface, which could be due to the entrapped oxygen, released from the hydrogen peroxide, within the adhesive [22].

Some authors demonstrated that during bleaching with hydrogen peroxide, peroxide ions substituted the hydroxyl ions in the apatite lattice, resulting in the formation of peroxide apatite [23]. Since these lattice substitutions are thermodynamically unstable, the peroxide ions decomposed and the substituted hydroxyl ions re-enter the apatite lattice, after a storage period of two weeks [3,24,25]. It has been hypothesized that the process of incorporation of the peroxide ions could be reversed by an antioxidant [7].

Following the bleaching procedure, it is recommended to delay bonding for 1-3 weeks to allow the residual peroxide to leach away [6]. Compromised bonding to bleached enamel was reversed with 10% sodium ascorbate solution [3,9] which is a derivative of ascorbic acid, a potent antioxidant [21,26]. Previous studies were done using ascorbic acid in different formulations [6,27], it is said that sodium ascorbate reestablishes the altered redox potential of the oxidized bonding substrate and prevents the premature termination allowing free radical polymerization of monomers of adhesive resin.

Aloe Vera is one of the most versatile plants on the earth. The Egyptians called Aloe “the plant of immortality.” Today, the Aloe Vera plant is being used for various purposes. Pharmacologically it shows antibacterial, anti-inflammatory and antioxidant properties [28].

In this study leaf extract of aloe vera was used as an antioxidant, as it contain ascorbic acid along with tocopherol and vitamin A. It also contains vitamin B12, folic acid, and choline. Its antioxidant properties neutralize free radicals. Moreover anthraquinones present in the aloe vera reported to exert antioxidant property [28-30]. It contains calcium, chromium, copper, selenium, magnesium, manganese, potassium, sodium and zinc. These are essential for the proper functioning of various enzyme systems in different metabolic pathways and few are antioxidants [29].

In this study, Aloe Vera and 10% Sodium Ascorbate are applied for 10 minutes as this duration is considered to be adequate and clinically desirable [30]. In the study conducted by Lai et al., he concluded that the antioxidant should be used for at least one-third of the time of application of the oxidizing bleaching agent [7].

The results of the study shows that the shear bond strength was significantly increased for the groups of specimens where Aloe Vera and 10% Sodium Ascorbate were applied compared to the specimens where the resin composite was directly applied without treating with Aloe Vera gel.

LIMITATIONS

1. This study did not evaluate whether the bond failure is a cohesive or an adhesive.
2. As this is an invitro study, clinical evaluation is necessary to determine the efficacy of Aloe Vera as an antioxidant.

CONCLUSION

Within the limitations of this study, the leaf extract of Aloe Vera is as effective as 10% sodium ascorbate in reversing the reduced bond strengths due to oxidizing effect of in office bleaching with Carbamide Peroxide. Since Aloe Vera, and its derivatives are non-toxic are widely used in food, cosmetic, pharmaceutical industries, it is unlikely that their use on dentin will create any unfavorable biological effect or clinical hazard. Further studies are required to investigate the mechanism of this reversal process by chemical analytical method and clinical potential of the leaf extract of Aloe Vera as an antioxidant.

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