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Original Article

Dentistry Section

Effect of 10% Sodium Ascorbate on Shear Bond Strength of Bleached Teeth - An *in-vitro* Study

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ABSTRACT

Background: Patient often requires some additional interventions such as replacement of old restorations, laminates and veneers after bleaching, for aesthetic purposes. The residual oxygen inhibits polymerization of resin based materials which results in reduced bond strength of the restorations. Some techniques are available to solve the clinical problems related to the post bleach compromised bond strength.

Objectives: The purpose of this study is to evaluate, the role of 10% sodium ascorbate on reversing the compromised bond strength and compare enamel shear bond strength of 5th and 6th generation dentine bonding agents on bleached and unbleached teeth.

Materials and Methods: Eighty freshly extracted human anterior teeth were assigned in to Group A and Group B of 40 teeth each. Samples in both groups were subdivided in to 4 subgroups of 10 teeth each. In Group A composite resins was bonded using 5th generation dentine bonding agent (3M Single Bond) and Group B was bonded using 6th generation (3M ESPE Adper SE Plus). Subgroups were subjected to the procedure as, A1;B1 etching and bonding (control), A2; B2 bleaching, etching and immediate bonding, A3; B3 bleaching,10% ascorbic acid treatment for 10 minutes after that etching and bonding immediately, A4; B4 bleaching, storage in artificial saliva for 4 days and then etching and bonding. Pola office, in office bleach (SDI (082216) was used for bleaching. The specimens were subjected to shear load in a Universal testing machine to evaluate bond strength.

Results: A decrease in bond strength was seen with 6th generation adhesive system compared to 5th generation bonding system, which is statistically significant, $p<0.001$.

Conclusion: Treating the bleached enamel surfaces when treated with 10% sodium ascorbate, which reverses the compromised bond strength and is a good alternative to delayed bonding.

Keywords: Dentin adhesive agents, Dentin Conditioner, Tooth Bleaching, Vitamin C

INTRODUCTION

In the pursuit of looking good, mankind has always tried to improve the facial features. Since the appearance and alignment of teeth influence the personality, they have received considerable attention. With increasing awareness of aesthetic dentistry, bleaching has become a common procedure. In 1799 Macintosh reported the use of chloride of lime as a bleaching agent and in 1895 Garretson reported the use of chloride as a bleaching agent, he said “it is a decomposer of organic substances that contains the discoloured elements” [1,2]. The use of bleaching for improving the aesthetics of natural dentition has widened only after the introduction of home bleaching systems in the 1990’s [3,4].

As vital and non vital bleaching has become increasingly popular, dentist should be aware of the outcome of the bleaching treatment and their interactions with further dental procedures, especially in terms of adhesive restorations [5]. It is believed that residual oxygen remains on the tooth surface or inside the tooth, after the bleaching procedure is completed [6,7]. Various suggested treatment modalities for that include the removal of superficial layer of enamel or treating the bleached enamel with alcohol before restoration or the use of adhesive containing organic solvents [8]. However, with the passage of time; the residual oxygen dissipates slowly leading to reduce oxidation.

Lai et al., showed that, the hydrogen peroxide induced reduction in bond strength of composite resin to enamel and dentin was reversed with the use of antioxidants [6]. If antioxidant treatment of bleached enamel before bonding could reverse the reduced bond strength of composite resin, it might be an alternative to the delayed bonding procedure after bleaching [6,9]. The waiting period for bonding procedure after bleaching varies from 24hours to 4 weeks and such a long waiting period may be an inconvenience to a patient seeking immediate aesthetics [10-12]. So the need to conduct the present study was to reverse the compromised bond strength in patients seeking immediate aesthetics after bleaching procedures.

AIM OF THE STUDY

(1) To evaluate and compare enamel shear bond strength of newer i.e., 5th and 6th generation bonding agents on bleached and unbleached teeth.
(2) Evaluate the role of 10% sodium ascorbate on reversing the compromised bond strength.

MATERIALS AND METHODS

Eighty freshly extracted human anterior teeth were collected from the Department of Oral and Maxillofacial Surgery, which were free of caries and fracture. This study was an invitro study and teeth extracted for periodontal reasons were taken. Institutional ethical committee clearance was taken. The total time duration required for the study was about 18 months. The study was conducted in year 2012-2013. Teeth were assigned into the groups A and B of 40 teeth each. The enamel surfaces of every tooth were ground with wet silicon carbide paper (no.80 & 400grit) to make a flat enamel surface. The teeth were embedded in self-curing acrylic resin block, up to the cervical level, with the labial surface positioned for surface treatment and composite bonding. Two bonding agents, 5th generation (3M Single Bond 2) and 6th generation (3M ESPE Adper SE Plus) respectively were used to evaluate the enamel bond strength on unbleached and bleached tooth surface, using Pola office, in office bleach (SDI (082216). The treatment regimen is given in [Table/Fig-1].

Bleaching treatment (excluding control subgroups A1&B1)

The teeth were cleaned with flour based pumice. The powder pot was opened and the content of one Pola office syringe was extruded into the pot. It was then mixed immediately using a brush applicator until the gel was homogeneous. This mix was applied in a thick layer to the entire labial surface. The gel was left on the tooth surface for 8 minutes. This cycle was repeated three times. After the last application, all the gel was removed using high vacuum suction, and the teeth surfaces were cleaned.

GROUP A - 5th Generation Dentin bonding agent		GROUP B - 6th Generation Dentin bonding agent	
A1	Etching and bonding (control)	B1	Bonding (control)
A2	Bleaching, etching and bonding immediately	B2	Bleaching and bonding immediately
A3	Bleaching, 10% ascorbic acid treatment, etching and bonding immediately	B3	Bleaching, 10% ascorbic acid treatment and bonding immediately
A4	Bleaching, storage in artificial saliva for 7 days ,etching and bonding	B4	Bleaching, storage in artificial saliva for 7 days and bonding

[Table/Fig-1]: Treatment regimen table

Bonding

Fifth Generation dentin bonding agent (Adper Single Bond 2) for subgroups A1, A2, A3 & A4.

1. Etching; the etchant {De Trey (conditioner 36)} was applied to the prepared labial enamel surfaces of the specimens. It was left for 15 seconds and then rinsed with water for 10 seconds. Excess water was blotted off using absorbent pads. The surfaces appeared glistening without pooling of water.
2. Adhesion; 2-3 consecutive coats of adhesive were applied immediately after blotting, to the etched enamel for 15 seconds with gentle agitation using a fully saturated applicator. The surface was gently air thinned for 5 seconds to evaporate the solvents and then it was light cured for 10 seconds.

Sixth generation dentin bonding agent (Adper SE Plus) for subgroups B1, B2, B3 & B4.

1. Teeth were air dried lightly.
2. One drop of liquid A was dispensed in to first mixing wells, and one drop of liquid B in to the second mixing well.
3. The entire bonding area was applied with liquid A using a microbrush, so that a continuous red coloured layer was obtained on the surface.
4. Liquid B was scrubbed onto the entire wetted surface of the bonding area using a new microbrush. The disappearance of the red colour indicated that the etching components had been activated. Scrubbing was continued with moderate finger pressure for 20 seconds to ensure a properly etched surface. Surface was gently air thinned for 10 seconds to evaporate solvents.
5. Liquid B was reapplied as a second coat to the entire bonding surface. It was lightly air thinned to adjust film thickness/ consistency.
6. The surface was light cured for 10 seconds.

Sodium ascorbate treatment

After the teeth were bleached and rinsed with distilled water, the samples in subgroups A3 and B3 were immersed in 10% Sodium ascorbate for 10 minutes to neutralize the oxidizing effect of hydrogen peroxide [6].

Artificial saliva treatment:

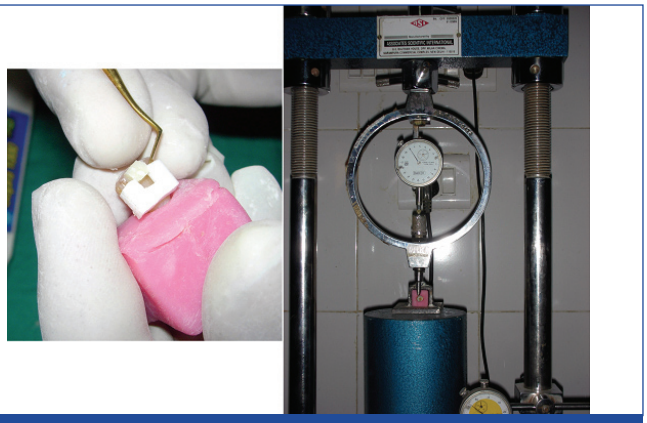
After the teeth were bleached and rinsed with distil water, the sub groups A4 and B4 were immersed in artificial saliva for 7 days at 37°C to neutralize the oxidizing effect of hydrogen peroxide.

After the above mentioned surface treatment, all the specimens were bonded with composite resin (Ceram X Nanoceramic restorative, Densply), using the Teflon moulds having dimension of 2x3x2 mm and then subjected to shear bond strength testing, using the Universal testing machine at a cross headed speed of 1.25 mm/min [Table/Fig-2]. After which the data was collected and statistically analysed.

RESULTS

The results were analysed by calculating the mean shear bond strength. Data for 5th and 6th generation bonding were tested using ANOVA (Two-way analysis of variance) followed by the t-test.

A decrease in bond strength was observed with 6th generation adhesive system when compared to 5th generation adhesive system; similar results were noted with their subgroups (A1, A2, A3, A4, B1, B2, B3, & B4) also.



[Table/Fig-2]: Sample preparation for shear bond strength testing, using the Universal testing machine

Comparison between 5th & 6th Gen DBA is summarized in [Table/Fig-3] while comparison within the subgroups is summarized in [Table/Fig-4]. The enamel bond strength of A1 & B1 (Control groups) which was 22.992Mpa and 19.782Mpa respectively when compared with the shear bond strength of A2 (9.982 Mpa) & B2 (8.968 Mpa) were found to be significantly higher. While the enamel bond strength of A3 (22.998Mpa), B3 (19.794Mpa), A4 (21.862Mpa) and B4 (18.592Mpa) showed no significant difference than their control groups respectively. Also A3, B3 when compared with A4, B4 respectively, showed no statistical significant difference but showed significant difference when compared with A2, B2 respectively.

DISCUSSION

The results of the present study indicated that the self-etching 6th generation dentin bonding agents showed decreased bond strength as compared to 5th generation dentin bonding agents. This may be attributed to the fact that, etching and rinsing with 5th generation dentin bonding agent is still the most effective approach to achieve efficient and stable bonding to enamel and basically requires only two steps. Selective dissolution of hydroxyl apatite crystals through etching (commonly with a 30-40% phosphoric-acid gel) is followed by in situ polymerization of resin that is readily absorbed by capillary attraction within the created etch pits, thereby, the exposed hydroxyl apatite crystals are enveloped individually. Two types of resin tags interlock within the etch-pits. “Macro”-tags fill the space

S N.	SOURCE OF VARIATION	Degree of Freedom (DF)	Sum of Squares (SS)	Mean Square (MS)	F-ratio = MS between MS within
1	Between groups (treatment)	9	2467.3	352.47	337.38**
2	Within groups (individual)	7	6.866	0.7629	
3	Residual (random)	63	65.818	1.045	
4	Total	79	2539.984		

[Table/Fig-3]: Comparison between 5th & 6th Gen DBA and its subgroups by two-way ANOVA test
(** Highly significant)

Characters		Samples		Mean		Standard deviation [SD]		F ratio	Standard Error of difference [SEd]	Test statistic [t]
A	B	A	B	A	B	A	B	A	B	
A1	B1	10	10	22.992	19.782	1.201	1.342	1.623	0.767	6.641**
A2	B2	10	10	9.982	8.968	1.365	0.929	2.982	0.489	3.923**
A3	B3	10	10	22.998	19.794	2.263	0.651	11.072	0.692	4.329**
A4	B4	10	10	21.862	18.592	1.984	0.982	2.314	0.702	4.670**

[Table/Fig-4]: Comparison of 5th generation and 6th generation bonding system with their respective sub- groups by t-test values for shear bond strength
(**:-Significant changes seen in bond strength of the subgroups compared)

surrounding the enamel prism, while numerous "micro" tags result from the resin infiltration/polymerization within the tiny etch-pits at the cores of the etched enamel prisms. The latter are especially thought to contribute the most for retention to the enamel [13].

For the self-etching primer system, simultaneous etching and priming facilitates the penetration of the adhesives' resin monomer into etched enamel. This process creates micromechanical retention between enamel and the restoration through resin tags. The SEM observation of enamel surfaces treated with whitening agent followed by treatment with the self-etching primer showed inferior etching of enamel prisms compared to that observed after phosphoric acid etching by Masashi et al., [14].

In the 5th generation system, the dissolved components are rinsed away and the surface is then covered with a resin film free of such contaminants. In case of 6th generation adhesives, the dissolved dentin components are retained within the adhesive resin. Furthermore, during the self-etching process, the monomer became anionic, something that should decrease the ability of the monomer to diffuse in to the tooth surface [15], the reason for reduction in shear bond strength value of subgroup A2 & B2 compared to their respective control groups.

When bleaching agents are applied to the dental structures there is release of free radicals like nascent oxygen and hydroxyl or per hydroxyl ions [16]. These free radicals react with the electron-rich regions of the pigments inside the dental structure and convert large pigmented molecules into smaller, less pigmented molecules [17]. According to a theory, the peroxides and their by-products are capable of interfering with the polymerization process of the adhesive material [6].

In the present study, samples of A3 group, which were treated with 10% sodium ascorbate for 10 minutes showed no significant difference ($p<0.001$) with its control group, and samples of B3 group treated with 10% sodium ascorbate for 10 minutes showed less significant difference ($p<0.005$) with its control group.

Ascorbic acid and its sodium salt are well-known antioxidants with the capacity of reducing oxidative compounds, especially free radicals. Immersion of the bleached specimens in 10% sodium ascorbate solution for 3 hours [6], or 10 minutes of antioxidant treatment was tested [15]. In all studies, sodium ascorbate treatment appeared to restore the reduced bond strength of composite to the bleached enamel samples. Sodium ascorbate allows free-radical polymerization of the adhesive resin to proceed without premature termination by restoring the altered redox potential of the oxidized bonding substrate thus reversing the compromised bonding [6,7].

In the present study there was no significant difference ($p<0.001$) between unbleached and delayed bonding group (7days storage in artificial saliva) (A1-A4) and less significant difference ($p<0.005$) with B1-B4.While teeth were stored in artificial saliva, the possible morphological or structural changes on enamel that were repaired during the 7 days waiting period between bleaching and bonding. Storing samples in artificial saliva might have contributed to the removal of the residual oxygen from the enamel surface during immersion process. Thus, delaying bonding process by immersing in a remineralizing solution for one week seems to restore enamel properties and contribute to an optimal adhesion after bleaching [6,10]. This might be due to the residual oxygen from the bleaching material being removed by the immersion process. It has been noted that, under clinical conditions, saliva might have a similar action after bleaching. However, the amount of time required to restore bond strength to the pre bleaching level is controversial. Although there is a considerable variation in the recommended post bleaching time, most researchers have advised a delay in bonding of one week. Vitamin C and its salts are nontoxic and are widely used in the food industry as antioxidants. It is unlikely that their intraoral use will create any adverse biological effect or clinical hazard [9].

LIMITATIONS OF THE STUDY

There are variations in calcification, morphology and fluoride content of extracted teeth. There are different responses of extracted teeth exposed to the two bleaching agents and to the antioxidant agent. There are limitations in simulating the oral environment invitro.

CONCLUSION

Within the limits of this invitro study, it may be concluded that, when restorations are to be completed immediately after bleaching procedure with 35% H_2O_2, where a significant reduction in shear bond strength of both 5th and 6th generation bonding systems is observed, the treatment of the bleached enamel surfaces with 10% sodium ascorbate which reverses the reduced bond strength is a good alternative to delayed bonding. Also, the enamel shear bond strength of 5th generation dentin bonding system is significantly higher as compared to 6th generation dentin bonding system.

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