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Influence of Ascorbic Acid on Shear-Bond Strength at Tooth Restoration Interface After Immediate Bleaching Procedures

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ABSTRACT

Purpose: This study evaluated the effect of ascorbic acid on shear bond strength at tooth restoration interface after immediate bleaching procedures. **Materials and Methods:** Sixty freshly extracted human premolars were used. Teeth were divided into two main groups (A& B) according to the application mode of the adhesive system (n=30). Group A: self-etch mode, Group B: Etch-and-rinse mode. Each group was subdivided into three subgroups (1,2,3) according to ascorbic acid application (n=10). Data were collected, tabulated, and statistically evaluated. **Results:** The immediately bonded specimens after the bleaching procedure showed the statistically lowest mean shear bond strength values. These results were in comparison to the other unbleached specimens due to enamel surface energy. The antioxidant treatment exerted a significant effect on shear bond strength. **Conclusion:** Bleaching had a direct effect on enamel. Bond strength is adversely affected by bleaching. Ascorbic acid improves the bond of enamel after bleaching

KEYWORDS

Ascorbic acid,
shear bond strength,
immediate bleaching procedures.

INTRODUCTION

Tooth bleaching is one of the simplest and well-common aesthetic dental applications. There are several techniques to manage dental hard tissue discoloration [(1)]. Patients seek to get improvement of esthetics. Many bleaching agents have been used to remove intrinsic and extrinsic discoloration [(2)].

The effect of bleaching agent on the stain depends on its etiology, and the degree of saturation of chromogenic stain inside the tooth. Use of hydrogen peroxide to remove discoloration with nascent oxygen have a power effect on enamel [(3)]. The residual oxygen affects the

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polymerization of resin composite, also, softening of monomer may be due to chemicals of bleaching agents[4]. The response of bleaching agent differs from tooth to direct resin restoration. On the other hand, resin composite restoration with good color matching, changes after bleaching [5].

Lower bond strength after bleaching due to oxygen suppression of the resin infiltration, so the recommendation to wait from one to three weeks to guarantee the removal of oxygen from the tooth tissue [6]. Sodium ascorbate is a neutral, nontoxic, and biocompatible antioxidant that when used as a 10% solution and application time of 10 min can reverse the reduced bond strength of bleached enamel [7]. An antioxidant solution of 10% sodium ascorbate applied on the bleached enamel surface for 10 min effectively reversed the reduced bond strength this give the opportunity to place a restoration directly[8]. The aim of this in vitro study was to evaluate the effects of 10% sodium ascorbate on the bond strength of enamel following extra-coronal bleaching using 35% hydrogen peroxide. The null hypothesis is the immediate use of ascorbic acid ascorbic acid has no effect on the bond strength.

MATERIAL AND METHODS

Materials

The materials which were used in the present study were listed in (Table 1).

Table (1): *Resin composite and their adhesive.*

Product name	Category	Composition	Manufacturer and Batch number
Feltik Z250xt (A3)	Nano Hybrid Composite	Zirconia filler loading is 60%by vol, particle size range of 0.01-3.5microns and nanofillers. bisphenol-diglycidyl-ether-dimethacrylate TEGDMA:tri-ethylene-glycol-dimethacrylat.	3M, Minosota, USA www.3m.com.
Universal Scoth-bond Adhesive 3M	Selfetch Adhesive	10-MD, 2-hydroxyethyl-methacrylate Methacrylated phosphoric esters, nanosilica filler with 7 nm, Ethanol, Water, Initiators based on camphorquinon.	3M, Seefeld, Germany. www.3m.com
G-aenial (One step)	Selfetch adhesive	4-Methacryloxyethyltrimllitate anhydride, water, acetone, phosphoric acid ester monomer& photoinitiator	GC, Tokyo Japan Websitewww.gc-dental.com

Methods

Samples' grouping:

Sixty freshly extracted human premolars were used. The teeth were stored in normal saline till use. The teeth should be free from caries. Teeth were classified into two main groups according to application mode of adhesive system (n=30). Each group was divided in to three subgroups according to ascorbic acid application or not (n=10).

Specimens' preparation:

(A) Group A: Self-etch mode adhesive application

Subgroup A1: G-bond adhesive was applied on the buccal surface, with a micro brush, followed by light curing system 20s, then Composite Z250 built up on the buccal surface was applied according to manufacture instructions using Teflon mold in one increment 2mm.

Subgroup A2: The specimens were bleached with 35% hydrogen peroxide Opalescent gel (Ultradent. Products Inc., USA) with two applications of 15min each. Following bleaching, then the specimens were thoroughly rinsed with water for 1 min. The composite built up was done and the specimen was attached to the mold using self-cure acryl.

Subgroup A3: The specimens were bleached, then 10% sodium ascorbate hydrogel was applied on tooth surfaces for 10 minutes and rinsed with distilled water for 30 seconds. After that the adhesive system and resin composite were applied on the tooth surface.

(B) Group B: Etch-and-rinse mode adhesive application

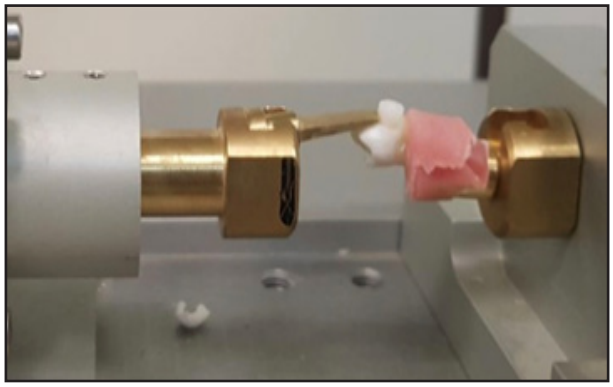
Subgroup B1: Etching with 37% phosphoric acid was done on the buccal surface then rinsed with water for 5s, followed by application of Scotch-bond universal with a micro brush, followed by light curing system 20s, then Composite Z250 built up on the buccal surface using Teflon mold in one increment 2mm.

Subgroup B2: The bleaching procedure was done and then composite built up were done as mentioned previously and then the specimen was attached to the mold using self-cure acryl.

Subgroup B3: The specimens were bleached, then 10% sodium ascorbate hydrogel was applied on tooth surfaces for 10 minutes and rinsed with distilled water for 30 seconds. After that the adhesive system and resin composite were applied on the tooth surface.

Testing procedure:

The specimens were subjected to shear bond strength testing in a Universal Testing Machine (Model5565, Instron Co., Canton, MA, USA). Shear loading was applied on the buccal surface of the tooth using a sharp chisel point on composite / tooth interface using a cell load of 21 MPa at a crosshead speed of 2 mm/min till failure (Fig. 1). Data were tabulated and checked for normality distribution then analyzed using student t-test at significance P-value ($P \leq 0.05$). Software IBM® SPSS® Statistics version 20 was used.



Figure(1) A photograph showing a sample was subjected to shear bond strength testing in a universal machine.

RESULTS

Total effect of application mode: (Table 2, Fig. 2)

Table (2): *Mean values and standard deviation of shear bond strength measured in Newton (N) with ascorbic acid and bleaching agent regarding application mode of adhesive.*

Group / Subgroups	Group A (Self-etch)	Group B (Etch-and-rinse)	T- test (*P-value*)
Subgroup1 (Without bleaching)	180 ±3.02 [a]	210±2.1 [b]	0.001 *
Subgroup2 (Bleaching without ascorbic acid)	130 ±1.10 [b]	150±2.5 [b]	0.003 *
Subgroup 3 (With ascorbic acid)	176 ±3.3 [b]	207±2.4 [a]	0.04 *
ANOVA test (P- value)	0.046*	0.018*	

**; significant P-value (P < 0.05)*

ns; non-significant p-value (P >0.05)

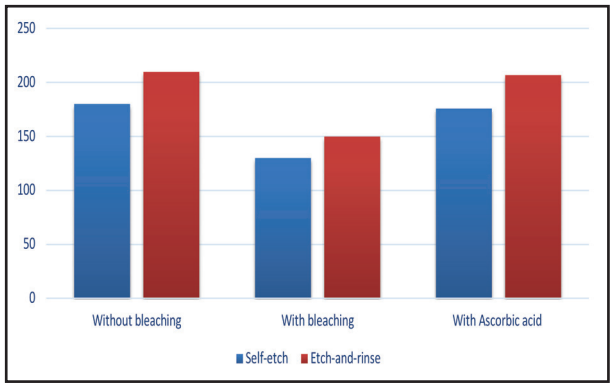


Figure (2) Bar chart representing the total effect of application mode of bleached and non-bleached specimens.

Effect of bleaching agent on enamel bond strength to resin composite (Table 2, Fig.3)

Within group A, subgroup 2 (immediate bonded specimens after bleaching procedure) showed statistically lower mean shear bond strength values in comparison to subgroup 1 (unbleached specimens). While, within group B, there was no statistical difference between subgroups 1 and 2.

Effect of ascorbic acid on the bond strength value to bleached enamel (Fig.3)

Within group B, subgroup 3 (with ascorbic acid) showed statistically higher mean shear bond strength values in comparison to subgroup 2 (immediate bonded specimens after bleaching procedure). However, the difference was not statistically significant.

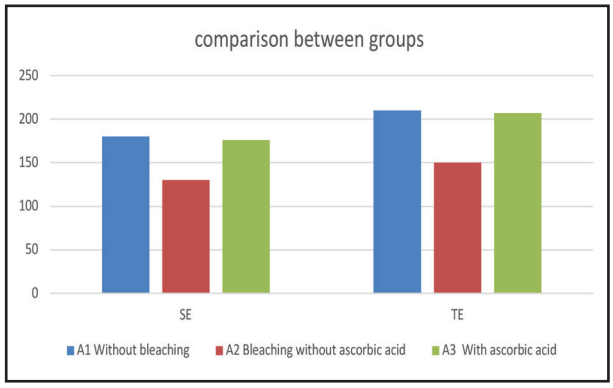


Figure (3) Bar chart comparing between subgroups representing the effect of Ascorbic acid.

DISCUSSION

Bleaching agents, as carbamide peroxide, hydrogen peroxide, and sodium perborate give a successful aesthetic outcome. Hydrogen peroxide is decomposed into nascent oxygen, which decrease resin penetration and retard the polymerization process[9]. Antioxidant treatment was used immediately instead of waiting from 10 to 30 days after enamel bleaching [10]. Bond strength test is widely test used for assessing the utilization of composite resin immediately [11].

In our study, ascorbic acid was used to neutralize the effect of bleaching on enamel immediately after bleaching. Bonded specimens after bleaching procedure showed significantly lower mean shear bond strength values (130 Mp in sub group 2 SE mode and 150 Mp in sub group 2 ER mode) compared to the other unbleached specimens. This may be attributed to the high surface energy of bleached enamel. The bleaching agent make oxidation to enamel surface which decrease the substrate wettability by the hydrophobic adhesives[6].

These results in agreement with previous study that revealed immediately using 10 % Sodium Ascorbate preserve bond strength [12]. Moreover our results was in agreement with a previous study that results found that, treatment of the bleached enamel surface with 10% SA reverses the reduced bond strength and might be an alternative to delayed bonding, especially when restoration is to be completed immediately after bleaching [13].

Our results in contrary with previous study[14], they have shown that the reduced bond strength of composite resin to bleached enamel was not effectively reversed by 10% SA treatment for 5 or 10 min.

The increased porosities of enamel by bleaching agents cause morphologic changes on the surface. It also proposed that the residual oxygen inhibit polymerization of resin. Furthermore, due to hydrogen peroxide low molecular weight may enter

the pulp through the coronal walls of teeth [12]. The residual oxygen in bleached enamel compromised the bond strengths after hydrogen peroxide bleaching [13].

Sodium ascorbate group showed higher bond strengths values (176 Mp subgroup 3 SE mode and 207 Mp in subgroub 3 ER mode) than the immediate bleached group (130 and 150 Mp in SE and ER mode respectively). Moreover, there was no significant difference between sodium ascorbate group (176 Mp in SE mode and 207 Mp in ER mode) and the unbleached group (180 Mp in SE mode and 201Mp in ER mode). This may be related to the premature termination of the free radical polymerization mechanism of dental adhesives polymerize by light. Sodium ascorbates promote the adhesive resin to expel free radicals without altering redox potential of the polymerization to bonding [14].

Ascorbic acids could reduce the oxidative compounds treating the bleached enamel surface with antioxidant increase the bond strength [15]. Sodium ascorbate utilization was recommended with elimination of twice etching effect of etchant and ascorbic acid on the teeth [16]. Antioxidants with 30 minutes are limited in hindering the subsequent bonding that oxidize with time and thus become less reductive with clinical usefulness [17]. Mild hydrogen peroxide, plus low pH and prolonged bleaching time may increase the destruction of the morphology of enamel and effect enamel bonding [18].

Noteworthy bond strength values were lower when the restorative filling immediately loaded after bleaching. Moreover, this agrees with the peroxides produce an oxidation mechanism of action with the application of antioxidants, the organic pigments of the molecular chains of stain disintegrate the color [19]. On the other hand, another possible explanation of these divergent results may be due to the different antioxidant forms also with different methodology of bond evaluation. Antioxidants are substances that neutralizing the entrapped oxygen inside the hard tooth structure by oxidization reaction [20].

Moreover, the amount of sodium ascorbate required to reduce the effect of a 35% hydrogen peroxide gel is directly related to its concentration. The shear bond strength of enamel submitted to bleaching treated with antioxidant agents is enhanced, thus, sodium ascorbate solution is recommended[21]. In addition to premature interruption of antioxidant reaction allows the free radicals of the adhesive influence the efficacy of ascorbic acid with a brilliant effect of antioxidant[22].

Our results were in agreement with previous study that their results showed that the bleached specimens immediately restored using composite resin without any antioxidant treatment showed the lowest bond strength values with bond failure at the interface between the tooth substrate and the bonding agent [2]. This circumstances were probably due to residual oxygen produced by bleaching agent on the tooth surface inhibiting polymerization of the bonding agent. Consequently, the oxygen-rich tooth structure did not provide a good surface for bonding.

Moreover, this agreed with another research, who studied the effects of the two forms and concentrations of sodium ascorbate, hydrogel, and solution, in reversing the reduced bond strength [23].

Our result in contrary with previous study which stated that reduction in bond strength after bleaching specimens, which were restored by composite immediately revealed adhesive failure [24]. It has been attributed to residual oxygen reducing polymerization of monomers at the bonded interfaces. The oxygen released by the bleaching agent becomes trapped within the adhesive during light-activation, resulting in spherical bubble-like structures observed along the resin-enamel junction and close to the base of the adhesive layer [25]. Similar findings of composite resin application onto bleached enamel surfaces recommend waiting for twenty-four hours after hydrogen peroxide application, however, delay of one week to two weeks delay is enough effective for good bonding [26].

Since it was apparently that bonding application immediately after completion of bleaching treatment reduce bond strength, the null hypothesis was rejected, and the hypothesis was accepted.

CONCLUSION

Within the limitation of this study, it can be concluded that:

1. Bleaching had an adverse effect on the bond strength to enamel.
2. Application of 10% ascorbic acid for 10 min improved the bond strength of bleached enamel.
3. Sodium ascorbate reverses the negative effects of hydrogen peroxide bleaching.

RECOMMENDATION

Treatment of bleached enamel surface with sodium ascorbate antioxidizing agents could compete the residual oxygen in enamel and increase bond strength.

CONFLICT OF INTEREST

The authors deny any conflicts of interest related to this study.

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