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Effect of sodium ascorbate on composite resin bond strength to bleached teeth

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Abstract

Objective: The objective of this study was to evaluate the effect of sodium ascorbate on resin composite bond strength.

Methods: Forty human premolars were used, which were divided into 4 groups: C – (control) unbleached teeth submitted to a restorative procedure; S – teeth bleached with 35% hydrogen peroxide and stored in artificial saliva for 48 hours; AS – teeth bleached with 35% hydrogen peroxide and irrigated with a 10% sodium ascorbate solution for 10 minutes; AG – teeth bleached with 35% hydrogen peroxide and immersed in 10% sodium ascorbate for 3 hours. After restoration, the samples were section and microtensile bond strength tests were performed in a universal test machine (Emic) at a speed of 1mm/min. The data were evaluated and submitted to the ANOVA and Tukey statistical tests (5% significance level).

Results: Group C presented the highest bond strength value, differing statistically from Groups S and AG, however, without statistical difference in comparison with Group AS.

Conclusion: Keeping teeth that have been bleached with 35% hydrogen peroxide in saliva for 48 hours is insufficient to recover bond strength. However, the use of 10% sodium ascorbate for 10 minutes may promote adequate bond strength, allowing immediate restoration of the teeth.

Key words: Tooth Bleaching; Hydrogen peroxide; Bond strength.

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Efeito do ascorbato de sódio na adesividade da resina composta em dentes clareados

Resumo

Objetivo: Avaliar o efeito do ascorbato de sódio na adesão de resina composta em dentes submetidos a tratamento clareador.

Métodos: Foram utilizados 40 pré-molares humanos, divididos em 4 grupos: C – (controle) dentes não clareados; S – dentes clareados com peróxido de hidrogênio 35% e armazenados por 48 horas em saliva artificial; AS – dentes clareados com peróxido de hidrogênio 35% e irrigados com solução de ascorbato de sódio 10% por 10 minutos; AG – dentes submetidos a tratamento clareador com peróxido de hidrogênio 35% e imersos em gel de ascorbato de sódio 10% por 3 horas. Após a restauração, as amostras foram seccionadas e submetidas ao teste de microtração em máquina de ensaios universais (Emic) sob velocidade de 1 mm/min. Os dados foram avaliados e submetidos aos testes estatísticos ANOVA e Tukey, com nível de significância 5%.

Resultados: O grupo C apresentou o maior valor de adesividade, diferindo estatisticamente dos grupos S e AG.

Conclusão: A manutenção dos dentes clareados em saliva por 48 horas não é suficiente para a recuperação da resistência adesiva. No entanto, a utilização da solução de ascorbato de sódio 10% por 10 minutos pode promover uma resistência adesiva adequada, permitindo a imediata restauração dos dentes.

Palavras-chave: Clareamento dental; Peróxido de hidrogênio; Resistência de união.

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Introduction

As the contemporary pattern of beauty, widely disseminated by the media, extols the attractiveness of "white teeth", dental bleaching has become a routine treatment in dental offices, as is the case with several other esthetic procedures. Therefore dental bleaching has assumed an important role in esthetics, and is a less invasive and onerous treatment option for discolored teeth than prosthetic treatment, with the fabrication of facets and resin composite or porcelain crowns that require considerable wear of healthy dental structure, in addition to having a much higher cost.

In spite of its advantages, bleaching continues to promote several adverse effects, such as: Cytotoxic effects on pulp tissue cells [1], increase in intra-pulp temperature [2] dentin sensitivity, release of oxygen during the first 24 hours [3], reduction in microhardness [4], reduction in shear strength [5], greater microleakage in resin composite restorations [3], and lower resin composite bond strength to the tooth structure [3,6].

This reduction in bond strength is of significant clinical importance due to the fact that many restorations have to be replaced after bleaching. Thus, weakened bond strength results in failure and reduced clinical longevity of adhesive restorations.

The reduction in bond strength has been attributed to the presence of residual oxygen within the tooth structure [5,7] preventing polymerization of the adhesive monomers, alteration in mineral and protein content [8,9] and the capacity of the bleaching agent to influence the formation of resin tags, structures responsible for micromechanical bond of resin composites to tooth structure. When the bond technique is performed immediately after conclusion of the dental bleaching session, the absence of tags or formation of shorter tags has been observed [10,11].

With the purpose of eliminating the clinical problem generated by the compromised bond after bleaching, several techniques have been suggested. Cvitko et al. [12] proposed removal of the superficial layer of enamel, Barghi & Godwin [13] pre-treated the bleached enamel with alcohol, whereas Kalili et al. [14] and Sung et al. [15] recommended the use of adhesive containing organic solvents. However, The most common recommendation is to wait some time after bleaching [10] before performing the adhesive restorations as the reduction in bond strength of resin composite to recently bleached teeth appears to be temporary [5]. There is still no scientific consensus about the time to wait, although it has been suggested waiting for 24 hours to 4 weeks [5,7,10,16]. Thus, the trapped oxygen would be completely released and the bond efficiency would return to normal levels.

Anti-oxidation has been suggested as one of the most recent ways used to eliminate this residual oxygen [17], promoting a reversal of the reduction in bond strength after bleaching; an *in vitro* study [11] showed that when 10% sodium ascorbic is applied to bleached teeth there are a larger number of tags formed and of a better quality than those formed in bleached teeth and those without the use of Ascorbic in bleached teeth and without the use of sodium Ascorbate. In 2004, Turkun & Kaya [18] demonstrated that when an adhesive restoration is made right after dental bleaching with carbamide peroxide, the shear resistance is significantly lower than that of non bleached teeth, and that the use of an anti-oxidant agent or immersion in saliva could provide normal values in shear tests.

In 2006, Kimyai and Valizadeh [19] evaluated to use of hydrogel and sodium ascorbate solution and found no significant difference between the formulations. To understand the process of anti-oxidation, it is necessary to know the action mechanism of bleaching agents. For both hydrogen peroxide and carbamide peroxide, the mechanisms are similar, as in both cases the active agent is hydrogen peroxide. The basic process of the action of hydrogen peroxide involves an oxidation reaction in which the compounds of highly pigmented carbon rings are opened and converted into chains that have a lighter coloring.

If the bond strength diminishes in bleached enamel as a result of the oxidant action of the bleaching agent, it could theoretically be reverted by the application of a neutral and biocompatible antioxidant, such as sodium ascorbate, before the application of adhesive procedures.

Thus, the aim of this study was to evaluate the effect of antioxidant treatment with 10% sodium ascorbate in comparison with waiting for 7 days before performing resin composite restorations in human teeth bleached with 35% hydrogen peroxide.

Methods

This study was approved by the Research Ethics Comittee by number 10/2007 – PH/CEP. Tooth selection Forty healthy premolars were selected, cleaned with periodontal curettes and section at the amelocement line, using carborundum discs coupled to a cutter mounted on a table. After sectioning the teeth were embedded in acrylic resin, using a matrix measuring 2×1×1cm. Embedment was performed to allow future sectioning of the teeth to prepare test specimens. After embedment the specimens were stored in saline solution and frozen at -20 ^{o}C.

Dental bleaching

The teeth were randomly divided into 4 groups, and those corresponding to Group C remained stored in saline solution, as they would not be submitted to bleaching. The teeth corresponding to Groups S, AS and AG, were submitted to the first bleaching session with 35% hydrogen peroxide (Whiteness HP Maxx–FGM, Joinvile, Santa Catarina, Brazil) and then stored in artificial saliva.

In the first bleaching session, the bleaching agent was applied on the entire external surface of the tooth for 10 minutes, and the tooth was irradiated with LED (Biolux, BioArt®) twice, for 20 seconds each time. After this the bleaching agent was removed with gauze and the application and irradiation were repeated another two times.

The specimens were kept in artificial saliva for 7 days, when the second bleaching session was initiated.

Afterwards, the teeth were submitted to the second stage of the bleaching procedure: Application of the bleaching agent on the entire external surface of the tooth for 10 minutes, and the tooth was irradiated with LED (Biolux, BioArt) twice, for 20 seconds each time. After this the bleaching agent was removed with gauze and the application and irradiation were repeated another two times.

Group S: After bleaching the specimens were kept in artificial saliva for 48 hours before the restorative procedure.

Group AS: After bleaching, 10 ml of 10% sodium ascorbate solution (Sigma Chemical) were applied for 10 minutes on the external surface of the teeth, and afterwards they were washed with distilled water and dried with a jet of air . Immediately after drying the teeth, the restorative procedure was performed.

Group AG: After bleaching the teeth were immersed in 10% sodium ascorbate gel for 3 hours. The surfaces were abundantly washed with distilled water for 30 seconds, and dried with jets of air. Immediately afterwards the teeth were submitted to the restorative procedure.

Dental restoration

The occlusal surfaces of the specimens were cut with a carborundum disc mounted in a low speed turbine, to expose dentin. After this the exposed surfaces were worn with silicone carbide water abrasive papers with increasing grits of 240, 320, 400 and 600, in a Polishing machine under constant irrigation.

The teeth were etched with phosphoric acid for 15 seconds, washed and dried. Afterwards two layers of adhesive Single Bond (3M Espe) were applied and polymerized with a Halogen polymerizing light appliance (XL 3000, 3M Espe) for 20 seconds each. The restorations were performed with Esthet X (Dentsply) resin composite in Shade A3, covering the entire exposed surface. Two increments were applied and light polymerized for 40 seconds each. The test specimens were stored in distilled water for later sectioning of the teeth.

Mechanical Microtensile Test

After storage in distilled water the specimens were sectioned under constant irrigation, in the occlusal-pulp direction, using a circular diamond blade, coupled to a precision cutter, in order to obtain specimens approximately 0.8 mm thick. Each section was worn with cylindrical extra-fine diamond tips to obtain ampule-shaped specimens with a bond area of approximately 1 mm^2 in the narrowest region. The specimens were mounted in modified pachymeters with cyanoacrylate-based adhesive and submitted to microtensile force (load cell of 10 kg) in a Universal Test Machine EMIC, at a speed of 1 mm/min.

Results

The data obtained in the microtensile bond strength test were analyzed (Table 1), and the mean and standard deviation were calculated for each group (Table 2).

Table 1. Bond strength data (MPa) obtained in the microtensile tests

C	S	AS	AG
16.97	27.86	19.24	23.50
21.78	22.59	30.12	20.43
36.25	14.31	30.33	16.38
47.95	22.36	36.79	12.69
29.83	17.16	28.80	14.60
28.44	9.26	18.98	20.22
28.81	11.38	21.25	46.71
42.71	22.43	30.38	18.24
25.36	13.11	26.84	17.51
41.37	17.63	29.97	14.96

Table 2. Descriptive statistics of bond strength data (MPa)

Group	n	Mean	S.D.
C	10	31.95	9.87
S	10	17.81	5.92
AS	10	27.27	5.75
AG	10	20.52	9.74

According to the data presented, it may be observed that Group C presented the highest mean bond strength, and Group S, the lowest. The other groups presented intermediate means (Figure 1).

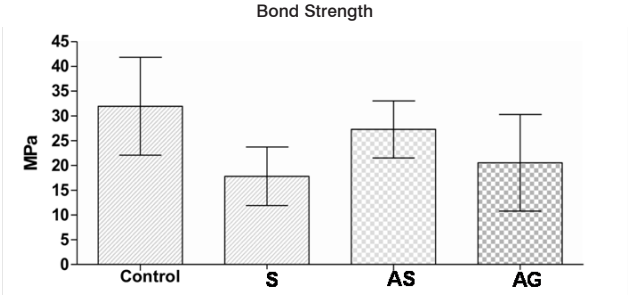

Figure 1. Column Graph (mean ± standard deviation) of the Bond Strength values (MPa).

After making the calculations, statistical analysis was performed by application of the ANOVA and Tukey test, in which statistical difference was found among the groups (Table 3). By means of the Tukey test (5%), it was verified that Group C presented the highest mean bond strength, which differed statistically from the conditions in S and AG, and did not differ from AS.

Table 3. Result of Tukey test (5%) for the four groups evaluated

Group	Mean	Homogeneous Groups*	
C	31.947	A	
S	17.809		B
AS	27.270	A	B
AG	20.524		B

*Means followed by different letters present statistical difference.

Discussion

Dental bleaching is a common procedure in the dental office and promotes the release of oxygen that is retained in the tooth structure. Authors have related that this oxygen is released for some days [7] and that after these days the restorative procedure may adequately be performed [5,7,10,16]. Nevertheless, apart from the great deal of discussion about the adequate waiting time, in dental practice, it is frequently not possible to wait for several days or weeks to perform restoration of the tooth, particularly for esthetic reasons.

With the purpose of eliminating this problem, the study of oxidant agents began with a view to eliminating the residual oxygen generated by bleaching, and re-establishing bond strength to the tooth structure. Studies verified that sodium ascorbate could normalize bond strength if it were used right after dental bleaching [11,18,20] and this substance is found both in solution and gel form. Studies have indicated that both form presented are capable of providing an increase in shear strength [19].

According to the present study, both the 10% sodium ascorbate solution and the gel provided an increase in microtensile bond strength, however, the bond strength values presented by the ascorbate solution were higher than those of ascorbate in gel form, being closer to those of the control group, however, without significant difference.

Although a previous studied reported that restorations could be performed with adequate bond strength immediately after dental bleaching [21], this was not verified in the present study, because the group in which the teeth were kept in saliva for 48 hours presented lower microtensile boned strength results, in agreement with other studies that related that adequate bond strength is only obtained in 7 or more days after bleaching [5,7,10].

The present study indicated that the application of sodium ascorbate could be clinically feasible, since it diminished the time necessary for performing adhesive restorations after dental bleaching.

Conclusion

Keeping teeth that have been bleached with 35% hydrogen peroxide in saliva for 48 hours is insufficient time for them to recover bond strength. However, the use of 10% sodium ascorbate for 10 minutes may promote adequate bond strength, allowing immediate restoration of the teeth.

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