Effect of dental bleaching on the microleakage of class V composite restorations

Efeito do clareamento dental na microinfiltração em restaurações classe V de resina composta

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Abstract

Purpose: The purpose of this study was to evaluate the effect of bleaching agents on the microleakage of Class V composite restorations.

Methods: Class V cavities were prepared on the buccal surface of 30 bovine incisors with the incisal margin located in enamel and the gingival margin located in dentin. The cavities were restored using the adhesive system Adper SingleBond2 and the composite Filtek Z250. After 24 h, the samples were finished, polished, thermocycled (500 cycles), and randomly divided into three groups (n=10): (G1) bleached with 35% Hydrogen Peroxide, (G2) bleached with 10% Carbamide Peroxide, and (G3) control group. After bleaching, the samples were coated with wax and nail polish varnish, immersed in 0.5% basic fuchsin for 24 h, and cut parallel to the long axis of the tooth at three reference points on the restoration. The slices were photographed to evaluate the dye penetration and scored for microleakage. Data were analyzed by Kruskal-Wallis test.

Results: Microleakage was absent in more than 90% and 53% of the margins located in enamel and dentin, respectively. No significant difference in microleakage was found between control and experimental groups.

Conclusion: The bleaching agents tested had no effect on microleakage at the adhesive interface in enamel or dentin.

Key words:Dentin-bonding agents; tooth bleaching; microleakage

Resumo

Objetivo: Avaliar os efeitos dos agentes clareadores na microinfiltração em restaurações Classe V de resina composta.

Metodologia: Foram preparadas 30 cavidades classe V na face vestibular de incisivos bovinos com a margem incisal localizada em esmalte e a gengival em dentina. As cavidades foram restauradas com o sistema adesivo Adper Single-Bond e resina composta Filtek Z250. Após 24 horas realizou-se o acabamento, polimento e 500 ciclos de termociclagem. Os dentes foram divididos aleatoriamente em 3 grupos (n=10). (G1) clareados com Peróxido de Hidrogênio 35%; (G2) clareados com Peróxido de Carbamida 10%; e (G3) controle. Os espécimes foram recobertos com cera e esmalte de unha e imersos em fucsina básica 0,5% por 24 horas. Transcorrido esse período, as amostras foram seccionados no longo eixo do dente em três pontos da restauração e as fatias fotografadas para analisar a microinfiltração do corante. Os dados (escore) foram analisados por teste de Kruskal-Wallis.

Resultados: Mais de 90% e 53% das margens localizadas em esmalte e dentina, respectivamente, não apresentaram microinfiltração. Não houve diferença estatística na microinfiltração dos grupos testados em comparação com o grupo controle.

Conclusão: Os agentes clareadores testados não afetaram a microinfiltração na interface adesiva em esmalte e dentina.

Palavras-chave: Adesivos dentinários; clareamento dental; microinfiltração

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Introduction

Dental bleaching agents must have close contact to the tooth surface and penetrate the dental substrate, where the hydrogen peroxide is decomposed into oxygen (O^+) and peroxyl (HO_2^- radicals (1). These free radicals react with the dark pigments, organic macromolecules composed of aromatic rings that provide molecular stability (2), breaking them into smaller molecules, which are less complex or visible than the original macromolecule (3). However, this reaction is nonspecific and may cause undesirable effects on teeth and restorative materials (4).

Scientific evidence shows that bleaching can reduce the concentration of calcium and phosphorus, microhardness and fracture resistance of dental structures (5), but the roughness of enamel surface increases (6,7). When the bleaching agent contacts the resin composite, dental surface roughness and porosity may increase (8,9). Moreover, the literature showed that the bleaching agent can contain products that are able to promote degradation of the adhesive interface, which may reduce the longevity of the restoration (10).

Among previous studies about the affects of bleaching agents on dental structure and restorations, only four studies have analyzed the effect of peroxide on the adhesive interface, and their results were controversial (11-14). Thus, the objective of this laboratory study was to determine the effects of bleaching agents on the tooth-restoration interface using a microleakage test. The null hypothesis was that different bleaching agents do not promote increased microleakage of the adhesive interface of composite restorations.

Methods

Thirty bovine lower incisors were selected, cleaned, disinfected with 0.5% chloramine T, and stored in tap water at room temperature (15 to 25 ºC). A standardized "U"-shaped Class V cavity (dimensions: 3.0 mm of mesiodistal width, 2.0 mm of incisor-gingival width, and 1.5 mm of depth) was prepared on the vestibular surface of each tooth, located 1.0 mm below and 1.0 mm above the cement-enamel junction. The cavities were prepared with diamond burs (3131, KG Sorensen, Rio de Janeiro, RJ, Brazil) using a high speed turbine under constant water cooling.

The cavities were conditioned with 35% phosphoric acid (Scotchbond Etchant, 3M ESPE, St. Paul, MN, USA) for 30 s on the enamel and 15 s on the dentin, and then rinsed with a spray of water and air for 60 s. Excess water was removed from the dentin using a cotton ball, which remained in position during the drying of the enamel to keep the dentin moisture. The adhesive system (Adper Single Bond 2, 3M ESPE, St. Paul, MN, USA) was applied according to the manufacturer's instructions using a disposable applicator (Cavibrush, FGM Produtos Odontológicos, Joinville, SC, Brazil). The solvent was evaporated with a gentle air-blast, and the adhesive was light-cured using a halogen light (Curing Ligth 2500, 3M ESPE, St. Paul, MN, USA) at 500 mW/cm² of intensity for 10 s.

The resin composite (Filtek Z250, 3M ESPE, St. Paul, MN, USA) was inserted into the cavity using the incremental technique. The first layer was placed on the gingival wall, up to the half of the axial wall. The second layer was placed on the incisal wall, contacting the first layer. The last layer restored the anatomical dental shape. Each layer was light-cured for 20 s according to the manufacturer's instructions. The restored teeth were stored in tap water at 37 ºC for 24 h. After storage, the restorations were finished and polished using sequential flexible discs (Sof-Lex Pop-On™, 3M ESPE, St. Paul, MN, USA) without water cooling. Subsequently, the specimens were subjected to 500 cycles of thermal baths at temperatures of 5 ºC and 55 ºC (LTC: LAM Technologies, Sesto Fiorentino, FI, ITA), with a 30-s dwell time and a 3-s transfer. After thermocycling, the specimens were divided into 3 groups (n=10) as described in Table 1. The specimens of Groups 1 and 2 were subjected to the two bleaching agents; specimens of Group 3 were not treated with any bleaching agent (control) (Table 2).

Table 1. Description of the bleaching treatment protocol used for each group.

Groups	Gel and Concentration	Number of applications	Duration of each application	Total time of bleaching
1	Hydrogen peroxide (35%)	9 applications divided into 3 sessions	15 minutes	2 hours and 15 minutes
2	Carbamide peroxide (10%)	14 applications	8 hours	112 hours
3	Control (water)	–	–	–

Table 2. Technical information of the dental bleaching agents tested.

Bleaching agent	Concentration	Manufacturer	Batch	Composition	Protocol of application
Whiteness HP Maxx	35%	FGM, Joinville, SC, BRA	250707	Hydrogen peroxide, thickeners, dyes, glycol, deionized water and inorganic load.	Mix the hydrogen peroxide with the thickener in a proportion of 3/1 and stir. Apply on the tooth surface and wait for 15 minutes.
Whiteness Perfect	10%	FGM, Joinville, SC, BRA	310507	Carbamide peroxide, carbopol, potassium nitrate, sodium fluoride, moist (Glycol) and deionized water.	Apply the gel in the trays, the trays were fit to the teeth and kept the gel in contact with the tooth surface for 8 hours.

During the bleaching protocol, the teeth were immersed in tap water at 37 ºC, except for the period of application of the bleaching gel. For Group 1, the bleaching gel was applied on the tooth structure and restoration. For Group 2, individual plates of silicone were made to keep the gel in contact with the teeth. After the bleaching was completed, all specimens were coated with a layer of wax and two layers of nail polish, except for 1.0 mm around the restoration. The teeth were immersed in a solution of 0.5% basic fuchsin for 24 h at room temperature, washed in running water for 1 h, and dried for 24 h to fix the fuchsin. The specimens were cut lengthwise at three points of the restoration using a diamond saw at low speed (Wafering Diamond Blades, Buehler LTD, Lake Bluff, IL, USA) in an electric cutting machine (Isomat, Buchler Ltd, Lake Bluff, IL, USA). The first cut was made at the center of the restoration with the other two cuts 1 mm mesial and 1 mm distal to the first cut, resulting in 2 slices of approximately 0.7 mm per tooth.

All of the specimen faces, both the mesial and distal (20 slices per group) were photographed using a digital SLR camera (Nikon D50, Nikon, Japan) coupled to a 105 mm objective lens (Micro-Nikkor 105 mm, Nikon, Japan) and Close Up lens of 4X zoom (Hoya filter, THK Photo Products, Long Beach, CA, USA). To standardize the lighting, a ring flash (EM 140 DG, Sigma for Nikon, Sigma-Aldrich, St. Louis, USA) was used. The images were saved in JPEG format and displayed on a screen (Windows Picture and Fax Viewer, Microsoft Corporation, Chicago, IL, USA) to verify the presence of dye microleakage in the adhesive interface.

The extent of the dye infiltration into the tooth/restoration interface was measured separately for the incisal and gingival margins, in accordance with the ISO/TS 11405 criteria for measuring the adhesion to tooth structure (15). The score system used to evaluate the microleakage at the adhesive interface was: 0 = absence of microleakage, 1 = infiltration of the dye to less than half of the gingival or incisal wall, 2 = infiltration of the dye more than half the gingival or incisal wall, and 3 = infiltration of the dye along the entire axial or incisal wall.

The dye microleakage was recorded by two calibrated examiners (interexaminer kappa index was 0.893; intra-examiner kappa was above 0.9 for both examiners), who were blind to the procedures. In cases of disagreement between them, a third examiner (kappa index with inter and inter examiner up to 0.8) evaluated the specimen. The extension of the dye infiltration at the adhesive interface was measured using a software (1.4 g ImageJ, Wayne Rasband, National Institutes of Health, USA). Data were analyzed by Kruskal-Wallis test (α=0.05).

Results

Table 3 displays the comparison of dye infiltration at the enamel and dentin interfaces of the tested groups. Ten percent of the enamel margins in Groups 1 and 3 had an average infiltration of 50 µm. In Group 2, only 5% of the margins showed infiltration, with an average depth of 60 µm. For dentin margins, Groups 1 and 3 presented infiltration in 53% of the cases, with an average dye penetration of 150 and 220 µm, respectively. Group 2 had 60% of the dentin margins with infiltration (average depth of 230 µm).

There was no significant difference in microleakage at the tooth-restoration interface for both the enamel and dentin margins in the experimental tested groups, when compared with the control group. Dye infiltration was larger at enamel margins than at dentin margins (P<0.001).

Discussion

The null hypothesis of this present study was not rejected as the tested bleaching agents did not promote an increase of microleakage at the adhesive interface of resin composite restorations. However, all groups showed greater infiltration at the margins located in dentin than in enamel.

The microleakage test is a very useful method to measure the quality of adhesion in dental restorations (16,17). The location and size of the cavities prepared on the teeth were based on the ISO/TS 11405 (15) technical specification for adhesion tests in dental structure and published literature (16,17). According to Raskin et al. (16), the dental literature reported that 62.5% of the microleakage studies used Class V preparations, which allow evaluation of both enamel and dentin margins concurrently.

Some methodological issues were adopted in the present study to simulate a clinical condition more closely. Bovine teeth were used because they have very similar structure to human teeth and are easier to obtain (15-18). In order to artificially age the specimens, a thermocycling procedure was used as enamel, dentin, and composite restorations have

Table 3. Distribution of microleakage scores and mean depth by dental margin and group.

Group	Margins	Microleakage score				Mean depth
		0	1	2	3	
(1) Hydrogen Peroxide (35%)	Enamel	36	4	0	0	50 µm
	Dentin	19	21	0	0	150 µm
(2) Carbamide peroxide (10%)	Enamel	38	2	0	0	60 µm
	Dentin	16	23	1	0	230 µm
(3) Control (water)	Enamel	36	4	0	0	50 µm
	Dentin	19	21	0	0	220 µm

different behavior when subjected to temperature variations due to their different thermal expansion coefficients (15,16). Consequently, adhesive failure and dye infiltration at the tooth-restoration interface can occur after thermocycling. Also, a dye was used to simulate bacterial infiltration at the tooth-restoration interface, and basic fuchsin was chosen because its particles are similar in size to bacteria (17,19).

Recent studies showed that bleaching agents can cause the loss of calcium and phosphorus (5) from dental structure. Thus, microstructural changes occur in enamel (6,7) up to a depth of 50 μm (20). It is possible that these structural changes may cause degradation at the adhesive interface of pre-existing restorations.

In addition, when in contact with resin composite, bleaching agents may cause an increase in surface roughness and porosity (8,9) in addition to surface changes (21). According to Sarrett et al. (22), these changes occur because the organic matrix makes the resin more susceptible to chemical reactions. Although adhesive systems have a higher amount of matrix than resin composites, these changes would be greater and the interfaces more susceptible to adhesive failure (11,12). Crim (11) and Ulukapi et al. (12) found that bleaching agents (35% hydrogen and 10% or 16% carbamide peroxide) caused adverse effects to the tooth/restoration interface with increased microleakage. The results of the present study do not support these early findings as the tested bleaching agents (10% carbamide peroxide and 35% hydrogen peroxide) were applied in accordance with the manufacturer's recommendations, and there was no increase in microleakage when compared with the control group. Klukowsha (13) and White (14) also found that bleaching agents based of hydrogen, carbamide peroxide, and perborate did not cause an increase in microleakage at the interface adhesive.

In summary, the present study did not show an increase of microleakage at the adhesive interface of composite restorations subjected to bleaching treatment in both enamel and dentin margins. However, further studies are needed to assess the influence of other bleaching agents with different composition and concentration on different outcome measures using *in vitro* and *in vivo* experiments.

Conclusions

The results indicated that bleaching agents (10% carbamide peroxide and 35% hydrogen peroxide) did not cause adverse effects on the adhesive interface of the enamel and dentin margins of teeth restored with the Z250 resin composite and the Adper Single-Bond 2 adhesive system.

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