

Effect of sodium ascorbate and ascorbic acid hydrogels on microleakage of composite restorations after an office bleaching protocol

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ABSTRACT | *Aim:* This study evaluated the influence of 20% sodium ascorbate (SA) and 10% ascorbic acid (AA) hydrogels on the microleakage of class V composite restorations after an office bleaching protocol (B). *Methods:* Sixty bovine incisors were sectioned at one point extending 8 mm from the amelodentinal junction toward the incisal edge, and at a second point extending 2 mm from the amelodentinal junction toward the root apex. Root canals were sealed with a composite and the teeth were divided into 5 groups. In Group C (control group), the teeth were prepared (P; 4 × 3 mm depth × diameter; diamond bur 3131, KG Sorensen), etched, rinsed (ER), submitted to an adhesive system protocol (Ambar, FGM), and restored (R) with a microhybrid composite (Opallis, FGM); In Group IR, the teeth were bleached (B; 2 sessions, 1 week interval, 35% hydrogen peroxide, Whitess HP Blue, FGM) + P + ER + R; In Group SA, teeth were B + P + SA (20%/15 minutes) + ER + R; In Group AA, teeth were B + P + AA (10%/15 minutes) + ER + R; and in Group MR, the teeth were B + stored in water (37°C/14 days) + P + ER + R. Specimens were submitted to an aging process by thermocycling (5 × 10⁴ cycles of 5°C and 55°C with a dwelling time of 30 s), varnish-sealed, immersed in basic fuchsin (3 h), washed and sectioned with a diamond disc. Microleakage was measured with the aid of ImageTool[®] software. ANOVA and Tukey's *post hoc* test ($p < 0.05$) were applied. *Results:* Microleakage (mm) and standard deviations per group were as follows: C, 0.29 (0.06)^A; IR, 1.86 (0.15)^C; SA, 1.08 (0.09)^B; AA, 1.07 (0.10)^B; MR, 1.02 (0.12)^B. *Conclusions:* Bleached teeth submitted to superficial treatment with 20% SA and 10% AA applied for 15 minutes prior to restoration presented reduced microleakage, as compared to immediately restored bleached teeth. Use of these antioxidants led to a microleakage comparable to that observed after a waiting period of 14 days prior to restoration.

DESCRIPTORS | Dental Materials; Dental Leakage; Tooth Bleaching.

RESUMO | **Efeito de hidrogéis de ascorbato de sódio e ácido ascórbico na microinfiltração de restaurações de resina composta realizadas após aplicação de um protocolo de clareamento em consultório** • *Objetivo:* Este estudo avaliou a influência da utilização de hidrogéis de ascorbato de sódio (SA) e ácido ascórbico (AA) na microinfiltração de restaurações classe V de resina composta realizadas após a aplicação de um protocolo de clareamento em consultório (B). *Métodos:* Sessenta incisivos bovinos foram seccionados a 8 mm da junção amelodentínaria em direção incisal e a 2 mm em direção ao ápice radicular. Os canais radiculares foram selados com um compósito e os dentes foram divididos em 5 grupos: no grupo C (controle), os dentes foram preparados (P; 4 × 3 mm profundidade × diâmetro; ponta diamantada 3131, KG Sorensen), condicionados, lavados (ER), submetidos a um protocolo adesivo (Ambar, FGM) e restaurados (R) com uma resina composta microhíbrida (Opallis, FGM); no grupo IR, os dentes foram clareados (B; 2 sessões, 1 semana de intervalo, peróxido de hidrogênio a 35%, Whitess HP Blue, FGM) + P + ER + R; no grupo SA, os dentes foram submetidos à sequência B + P + SA (20%/15 minutos) + ER + R; no grupo AA, os dentes receberam B + P + AA (10%/15 minutos) + ER + R; e, no grupo MR, após B, os dentes foram armazenados em água (37°C/14 dias) + P + ER + R. Todos os espécimes foram submetidos a um processo de envelhecimento por termociclagem (5 × 10⁴ ciclos, 5°C/55°C, 30 s de intervalo), selados com verniz, imersos em fucsina básica por 3 h, lavados e seccionados. A microinfiltração foi medida com o auxílio do programa ImageTool[®]. ANOVA e o teste Tukey ($p < 0,05$) foram aplicados para as médias. *Resultados:* A microinfiltração medida em mm e os desvios-padrão foram: C, 0,29 (0,06)^A; IR, 1,86 (0,15)^C; SA, 1,08 (0,09)^B; AA 1,07 (0,10)^B; MR, 1,02 (0,12)^B. *Conclusões:* Dentes clareados submetidos a um tratamento superficial com SA a 20% e AA a 10% aplicados por 15 minutos previamente à restauração apresentaram menor grau de microinfiltração quando comparados aos dentes imediatamente restaurados. A microinfiltração observada após o uso desses antioxidantes foi comparável àquela obtida após um período de espera de 14 dias previamente ao procedimento restaurador.

DESCRITORES | Materiais Dentários; Infiltração Dentária; Clareamento Dental.

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INTRODUCTION

Vital teeth bleaching is one of the most popular procedures performed in dentistry due to its simplicity and to the patients' high demand for cosmetic interventions.¹ There are three approaches for bleaching, commonly adopted by clinicians:

- home bleaching, which consists of topical application of carbamide peroxide or hydrogen peroxide in low concentrations;
- office bleaching, which is a faster procedure, with higher concentrations of peroxide under clinician control,² and
- the combination of these two techniques.³

Even though the bleaching procedure presents predictable results and a high success rate,^{4,5} it may have some setbacks.⁶ Composite restoration shades, for instance, remain unaltered after treatment. Replacement of these restorations is needed to adjust them to the new esthetic condition achieved. The process of reducing pigment molecules by peroxide action releases a high amount of oxygen that remains trapped in the dental structure.⁷ When an urgent treatment is required, the residual oxygen present in dentin or enamel tissues negatively affects the adhesion, increasing the risk of restoration failure.⁸ This implies having to wait one or two weeks so that any residual oxygen is released before the restoration is placed.⁹⁻¹¹

Recently, some attempts to reduce the immediate inability of adhesion have been made with antioxidant solutions applied to the tooth structure after bleaching procedures. Many antioxidant agents have been tested, such as sodium ascorbate,¹²⁻¹⁷ ascorbic acid,^{17,18} α -tocopherol^{12,17} and even a solution of grape seed extract.¹⁹ Their presentation varies from solutions to gels, and application time varies from ten minutes¹⁹ to one hour.^{14,16}

These studies used shear bond strength to evaluate how antioxidants enhance adhesion, with favorable results. Nevertheless, few studies have eval-

uated microleakage as an indicator of the bleaching effect on adhesion,²⁰⁻²² and there is only one study that considered using antioxidants after an office bleaching protocol,²³ but it did not evaluate the ensuing restoration placement. Since office bleaching proposes a faster treatment, the use of antioxidants after office bleaching protocols could allow immediate composite restorations, thus avoiding a waste of time.

The objective of this study was to evaluate the effect of sodium ascorbate and ascorbic acid hydrogels on the microleakage of composite class V restorations after an office bleaching protocol. The null hypothesis tested was that the use of antioxidant hydrogels prior to the restoration procedure does not significantly change microleakage, as assessed by the penetration depth of fuchsin dye, in millimeters.

MATERIALS AND METHODS

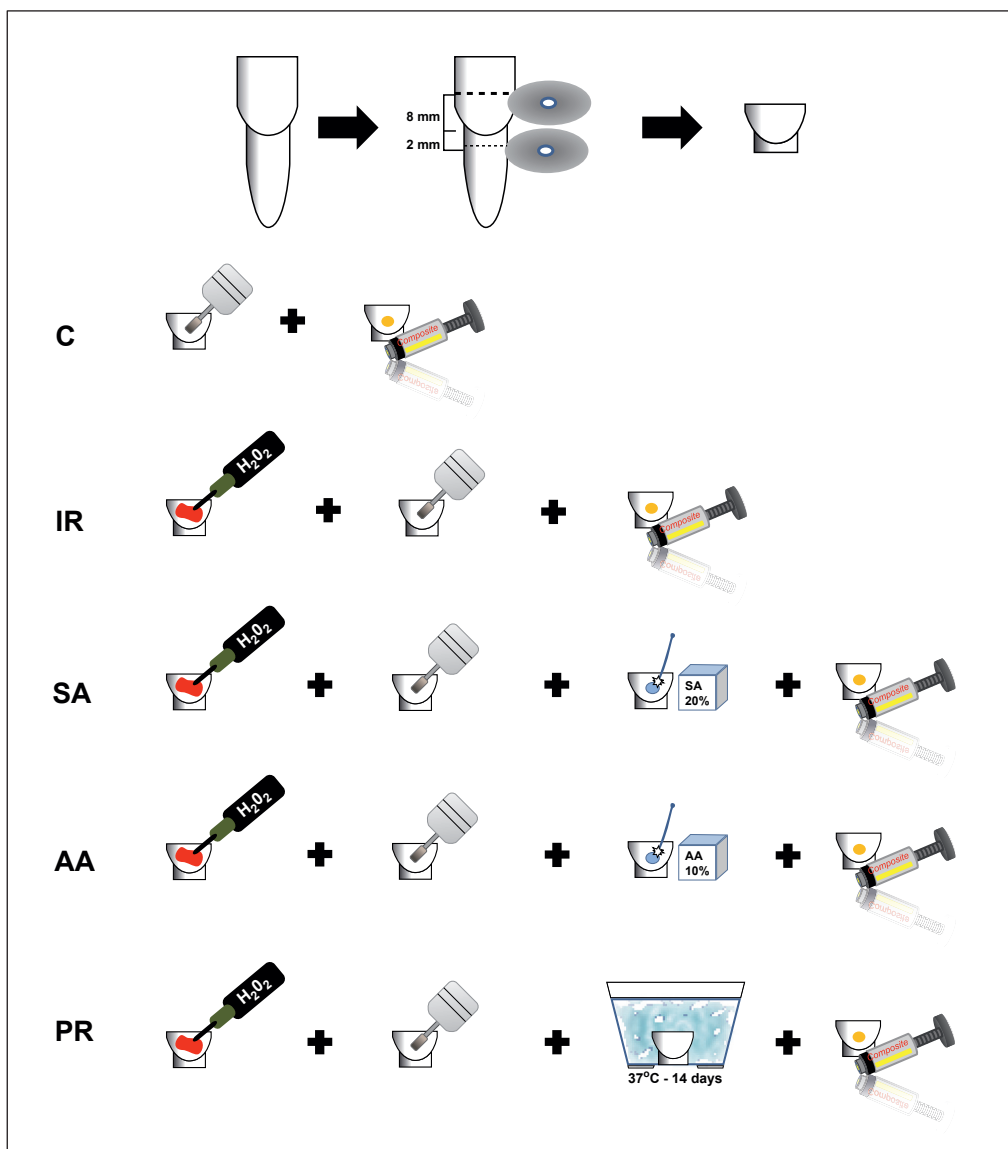
Sixty bovine incisors were selected for the experiment. The teeth were cleaned and stored at 4°C in saline solution until use. Combined crown-root specimens were created by sectioning each tooth 8 mm above and 2 mm below the dentinoenamel junction, using a double-sided diamond disk at low speed.

Apical and coronal canal accesses were then sealed with a composite (Opallis A3, FGM, Joinville, Brazil). The depth of composite placement was limited to 2.0 mm with the support of a sticky wax.

The teeth were distributed into 5 groups (Figure 1; n = 12):

- Group C: positive control. This consisted of unbleached specimens. A class V cavity preparation (3 mm in depth and 4 mm in diameter) was made (diamond bur 3131, KG Sorensen, São Paulo, Brazil) on the labial surface. Cavities were etched with 37% phosphoric acid (Cond Ac 37, FGM; 30 s for enamel and 15 s for dentin), rinsed with distilled water for 30 s, and

Figure 1 | Specimen configuration and treatment applied per group.



air-dried. An adhesive (Ambar, FGM) was then applied to the cavity walls with a microbrush (Cavibrush, FGM), following the manufacturer’s instructions, and light-cured for 20 s (Blue-phase, Ivoclar Vivadent, Schaan, Liechtenstein; 1200 mW/cm²). The composite (Opallis A3, FGM) was placed using the incremental technique (six increments), and each increment was light-cured for 20 s. An additional 40 s exposure was conducted after the last increment was irradiated.

- Group IR: immediate restoration. An office bleaching protocol was performed as follows: a 35% hydrogen peroxide solution mixed with a thickening agent (Whitness HP Blue, FGM) was applied to the labial surface in two 45-minute sessions, with a 7-day interval between sessions. The teeth were kept in distilled water at 37°C between sessions. Class V cavities were prepared and restored as described for Group C after the second bleaching session.
- Group SA: sodium ascorbate. Specimens were

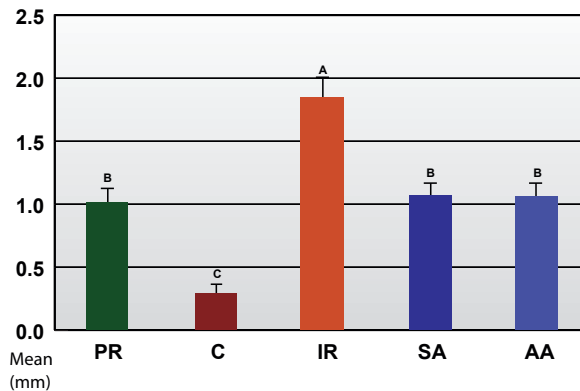


Figure 2 | Microleakage (mm) per group. Same letters correspond to similar results ($p > 0.05$).

submitted to the same bleaching treatment conducted in Group IR. After cavity preparation, a sodium ascorbate hydrogel (20%) was placed on the labial surfaces for 15 minutes. Hydrogel preparation followed the technique described by Kimyai and Valizadeh.¹³ Specimens were rinsed and immersed in distilled water for 10 minutes previously to the adhesive/restoration procedure.

- **Group AA: ascorbic acid.** Group AA specimens were soaked with ascorbic acid (10%) for 15 minutes after bleaching and preparation. As in group SA, they were rinsed and immersed in distilled water, and then restored.
- **Group PR: postponed restoration.** After performing the office bleaching protocol, samples were stored in water (37°C, 14 days), prepared and restored, as described for the other groups.

All the teeth were submitted to 5×10^4 cycles with temperatures between 5°C and 55°C and with a dwelling time of 30 s. Following thermocycling, specimens were coated with nail varnish, leaving a 1 mm window around the cavity margins. The teeth were then placed in a 0.5% basic fuchsin dye solution for 3 h at room temperature. After this, they were placed in a perforated metal basket and rinsed with distilled water for 1 hour, and then embedded in acrylic resin inside PVC cylinders.

Embedded specimens were sectioned longitudinally through their centers in the labial-palatal plane using a precision saw (Isomet 1000, Buehler, Lake Bluff, IL, USA). Images of the sectioned surfaces were obtained with a stereomicroscope (SZ61, Olympus, Center Valley, PA, USA) with 40× magnification. Digital images were improved by Photoshop software (Adobe Systems Inc, San Jose, CA, USA), and the dye penetration depth at the gingival wall of the restoration was obtained using UTHSC-SA Image Tool software (University of Texas). The data was submitted to one-way analysis of variance and Tukey's *post hoc* test ($p < 0.05$).

RESULTS

The means and the standard deviations for dye penetration (mm) at the gingival wall of the restorations are represented in Figure 2.

Groups treated with SA and AA prior to restoration presented microleakage values similar to those of the PR group. Teeth submitted to an office bleaching protocol and immediately restored (IR) presented the highest microleakage mean value.

DISCUSSION

This study evaluated the influence of antioxidants applied immediately after an office bleaching protocol on the microleakage of class V restorations. Results demonstrated that 20% sodium ascorbate or 10% ascorbic acid applied for 15 minutes over the tooth surface after office bleaching significantly reduced the microleakage in composite restorations placed subsequently, compared to the group where teeth were restored immediately after the bleaching procedure.

Dental bleaching gives rise to the release of oxygen that remains trapped in the tooth structure.⁷ Even when teeth are exposed to peroxide for short periods of time, as occurs in office bleaching, a large amount of oxygen is present.²⁴ This oxygen causes a reduction in bond strength. This is ob-

served when an adhesive procedure is performed right after the bleaching treatment, because oxygen inhibits the polymerization of resin monomers.²⁵

In this study, the use of two antioxidants (AA and SA) seemed to have partially neutralized the residual oxygen arising from bleaching. The microleakage means observed in the AA and SA groups were comparable to those obtained with restorations placed two weeks after the bleaching session (group PR).

The choice of these solutions was based on the positive effect of sodium ascorbate and ascorbic acid hydrogels reported in the literature.^{13,14,16-18} In a previous study, 10% ascorbic acid applied for only one minute was effective in increasing the bond strength of bleached teeth.¹⁸ The ionized form of ascorbic acid, namely, sodium ascorbate, was tested in different concentrations and for different time periods, but a recent study²⁶ suggests that 10% sodium ascorbate was not effective in increasing the bond strength of composites to bleached enamel and/or dentin.

Previous studies suggest that not all adhesives are affected by peroxides in respect to microleakage. When a three-step total-etch system was applied after bleaching (with water as the primer solvent) there was no change in microleakage.^{22,27} On the other hand, a two-step adhesive containing ethanol presented a higher leakage value when bleached preoperatively.²¹ Since Ambar employs ethanol as

a solvent, the increase in microleakage observed in the present study for teeth restored immediately after bleaching corroborates these findings.

Studies indicate that oxygen may remain in the tooth structure for several days. The recommended time for composite placement after bleaching varies from one¹¹ up to two weeks.^{10,21} Nevertheless, in the present study, specimens of group PR still presented higher microleakage than the control group, after two weeks of storage in water. Therefore, oxygen activity for a period longer than two weeks is a possibility that must be considered.

AA and SA application, as presented in this paper, may be a valid clinical approach when a restoration must be placed immediately after an office bleaching procedure. *In vivo* studies should be conducted to confirm these *in vitro* findings.

CONCLUSIONS

Sodium ascorbate and ascorbic acid applied after an office bleaching protocol were effective in reducing marginal microleakage, as compared to immediately restored bleached teeth. Microleakage results obtained from antioxidant groups were similar to those observed when the restoration was placed 14 days after bleaching, to eliminate residual oxygen from the dental substrate. Proposed treatment with sodium ascorbate or ascorbic acid may reduce the waiting time for restorative procedures after an office bleaching treatment.

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