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Topical application of sodium ascorbate after in-office dental bleaching: a randomized controlled trial

Aplicação tópica de ascorbato de sódio após clareamento dental em consultório: um ensaio clínico randomizado

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ABSTRACT

Objective: To evaluate the intensity and risk of tooth sensitivity (TS), and the bleaching efficacy, after the application of 10% sodium ascorbate (SA) following in-office bleaching, in a randomized, parallel, triple-blind, controlled trial. **Material and Methods:** Forty participants underwent two in-office bleaching sessions with 35% hydrogen peroxide (3x15-min applications) and they were randomized into two groups (n = 20): 1) placebo (application of placebo gel during 10 min) and 2) 10% SA group (application of 10% SA for 10 min). The intensity and risk of TS were assessed using the scales: Visual Analog Scale (VAS, 0-10) and Numerical Scale (NRS, 0-4). Bleaching efficacy was evaluated using the shade guide units Vita Classical and Vita Bleachedguide scales. The VAS scale, and bleaching efficacy were compared between groups using independent t-tests. The NRS scale was analyzed using Mann–Whitney. The risk of TS was analyzed using Fisher's exact test. **Results:** No difference in the intensity of TS was detected for both pain scales ($p > 0.07$). The risk of TS was 95% (95% CI 76 to 99%) for the SA group and 100% (95% CI 83 to 100%) for the placebo group (RR = 0.95; 95% CI 0.86 to 1.05; $p = 1.0$). Color change was observed in both groups without significant differences ($p > 0.20$). **Conclusion:** Topical application of 10% SA for 10 min after in-office bleaching did not reduce the intensity or risk of TS and did not jeopardize the bleaching efficacy.

KEYWORDS

Antioxidants; Controlled Clinical Trial; Dentin Sensitivity; Hydrogen Peroxide; Tooth Bleaching.

RESUMO

Objetivo: Avaliar a intensidade e o risco de sensibilidade dental (SD) e a eficácia do clareamento após a aplicação de ascorbato de sódio (AS) a 10% após clareamento em consultório, em um ensaio clínico randomizado, paralelo, triplo-cego e controlado. **Material e Métodos:** Quarenta participantes foram submetidos a duas sessões de clareamento em consultório com peróxido de hidrogênio a 35% (3 aplicações de 15 minutos) e foram randomizados em dois grupos (n = 20): 1) placebo (aplicação de gel placebo durante 10 minutos) e 2) grupo AS a 10% (aplicação de AS a 10% por 10 minutos). A intensidade e o risco de SD foram avaliados usando as escalas: Escala Visual Analógica (EVA, 0-10) e Escala de Avaliação Numérica (NRS, 0-4). A eficácia do clareamento foi avaliada usando as escalas de escalas Vita Classical e Vita Bleachedguide. A escala EVA e a eficácia do clareamento foram comparadas entre os grupos usando testes t independentes. A escala NRS foi analisada usando Mann-Whitney. O risco de SD foi analisado usando o teste exato de Fisher. **Resultados:** Nenhuma diferença na intensidade de SD foi detectada para ambas as escalas de dor ($p > 0,07$). O risco de SD foi de 95% (IC 95% 76 a 99%) para o grupo AS e 100% (IC 95% 83 a 100%) para o grupo placebo (RR = 0,95; IC 95% 0,86 a 1,05; $p = 1,0$). O clareamento dental foi observado em ambos os grupos sem diferenças significativas ($p > 0,20$). **Conclusão:** A aplicação tópica de 10% AS por 10 minutos após o clareamento no consultório não reduziu a intensidade ou o risco de SD e não comprometeu a eficácia do clareamento.

PALAVRAS-CHAVE

Antioxidantes; Clareamento Dental; Ensaio Clínico Controlado; Peróxido de Hidrogênio; Sensibilidade Dental.

INTRODUCTION

Dental bleaching, whether done at-home or in-office, has become one of the most requested dental treatments by patients. In-office systems are typically used in cases where the patient prefers not to use bleaching trays and desires faster results [1]. Clinically noticeable color change can be observed even after a single in-office bleaching session. However, despite its advantages, in-office bleaching requires the application of higher concentrations of hydrogen peroxide, which can lead to bleaching-induced tooth sensitivity (TS), a common adverse effect of dental bleaching [2-8].

Hydrogen peroxide can penetrate the enamel and dentin tubules to reach the pulp, leading to increase in intracellular reactive oxygen species, calcium influx and ATP levels, while decreasing cell viability. In addition, the expression of pro-inflammatory cytokines (IL-6, TNFα) and pain-related channels (TRPA1, PANX1) increase [9]. This process reduces cellularity and cellular metabolism, alters vascular permeability, and even results in tissue necrosis [10-12].

These free radicals generated can persist in the dental substrate even after the bleaching gel is removed [13,14]. In an attempt to reduce the damage produced by hydrogen peroxide on the pulp, some authors have investigated the role of antioxidants [4,10,15-18]. The sodium ascorbate (SA) is a powerful water-soluble antioxidant found in biological fluids, capable of donating electrons to neutralize reactive oxygen and nitrogen species (ROS), preventing oxidative damage to biological macromolecules such as DNA, proteins, and lipids [4,10]. It can be a strategy to minimize TS by removing excess oxygen in the dental structure post-bleaching [18].

Clinical studies have attempted to assess the potential of antioxidants in preventing TS. de Paula et al. [4] conducted a randomized triple-blind clinical trial to evaluate the systemic administration of acid ascorbic before bleaching. More recently, Nabil et al. [17] investigated the topical use of 10% SA after bleaching.

However, the topical application of antioxidants immediately after bleaching may also interfere with the oxidative reactions responsible for tooth bleaching. By neutralizing residual hydrogen peroxide and free radicals, antioxidants [15,16] could reduce bleaching efficacy, potentially resulting in smaller color changes. This effect has been primarily observed in an in vitro study using objective evaluation through a spectrophotometer [18].

Importantly, the translation of in vitro findings to clinical practice has some limitations. Tooth color change in vivo is influenced by multiple biological factors, including baseline tooth color, enamel and dentin thickness, patient age, and pulp vitality. Therefore, a comprehensive evaluation of post-bleaching antioxidant application must weigh the potential trade-off between TS and any influence on color change outcomes.

The aim of this randomized controlled study was to evaluate the effect of 10% SA application after in-office bleaching with 35% hydrogen peroxide on the risk and intensity of TS and color change. We hypothesized that the post-treatment application of 10% SA would reduce the incidence and intensity of TS, impairing bleaching efficacy.

MATERIAL AND METHODS

Ethics committee approval and registration protocol

This randomized controlled trial was approved by the Ethics Committee of the local university (5.975.580) and was prospectively registered in the Brazilian Clinical Trials Registry (RBR-10g2hcrj, registration date: May 30, 2023 [19]. The reporting of this study adheres to the Consolidated Standards of Reporting Trials (CONSORT) guidelines for parallel-group randomized trials [20,21].

Trial design, Settings, and Locations of data collection

This study was a parallel, triple-blind, randomized controlled trial. It was performed from June 2023 to July 2023 in the clinics of the School of Dentistry at the Universidad de Las Américas, Quito, Ecuador.

Recruitment

Participants were recruited through social media announcements. Those interested in dental bleaching underwent an initial clinical examination at the Dental Clinic from the local university and were selected based on the eligibility criteria study. All participants enrolled in the study received an information sheet and informed consent was obtained.

Eligibility criteria

Participants aged 18 to 49, with good general and oral health, having healthy maxillary anterior teeth without exposed dentin, visible cracks, restorations, prosthetics, or endodontics, and possessing an upper right canine (tooth 13) color of A2 or darker as per the Vita Classical color scale (Vita Zahnfabrik, BadSäckingen, Germany), were eligible for the study.

Participants who had undergone prior dental bleaching, pregnant or breastfeeding women, those with a history of dentin hypersensitivity, periodontal disease, gingival recession, with tetracycline stains (grades I, II, III, or IV) or severe discoloration, individuals undergoing orthodontic treatment or suffering from bruxism, those with fixed orthodontics, and those using medications with anti-inflammatory or antioxidant properties were excluded from participation.

Sample size

The primary outcome of this study was the intensity of TS. The sample size was based on the results of the TS reported by a previous study [22], which used the same bleaching gel that was used in the present study. In this earlier study, the participants from the control group experienced a TS intensity of 6.0 ± 2.9 units (VAS scale). To be able to detect a reduction of TS intensity of 50% in a superiority test (power = 80% and alpha = 5%), fifteen participants per group were needed. To avoid possible losses, 20 participants per group were included. The sample size was calculated on the website [23].

Randomization

A blocked randomization (with block sizes of 2 and 4) was conducted on the website [23], with an equal allocation rate between the groups. This process was carried out by an investigator who was not involved in the current clinical trial. Forty participants were randomly assigned to two groups (n = 20) using opaque, sealed envelopes numbered from 1 to 40, each containing the group assignment. The envelopes were opened only before implementing the protocol.

Blinding

This study was a triple-blinded clinical trial, meaning that the participant, operator, and evaluator were unaware of the group assignments. A third researcher, not involved in the evaluation process, handled the randomization, delivery, and guidance on gel administration. The desensitizing gels were transparent and had identical consistency, placed in syringes that looked the same. Each syringe was labeled with numbered codes, ensuring that neither the evaluators, operators, participants could identify them.

Study intervention

Before starting the bleaching procedure, a prophylaxis was conducted to remove the biofilm from the patient's dental surfaces. Volunteers underwent two in-office bleaching sessions, with a one-week interval between them. During the procedure, cheeks, lips, and tongue were retracted using a labial retractor (ArcFlex, FGM, Joinville, Santa Catarina, Brazil). The gums and teeth were dried with an air syringe, and a light-cured gingival barrier (Top Dam, FGM, Joinville, Santa Catarina, Brazil) was applied to the gingiva and papillae, creating a barrier 3 to 5 mm wide and 1 mm thick. The gingival barrier was light-cured for 20 s after every tooth, using a curing light (RadiiCall, SDI, Bayswater, Victoria, Australia) [24].

The in-office bleaching gel (Whiteness HP, FGM, Joinville, SC, Brazil) was applied to the buccal surface from the second right premolar to the second left premolar. The gel was applied in three 15-min applications. After the 45 min, the bleaching gel was aspirated with a disposable endodontic cannula, the gingival barrier was removed with the aid of an explorer probe and the teeth were rinsed with air-water syringe [3].

All participants were instructed to maintain their usual oral hygiene routines and avoid the use of any desensitizing agents, whitening agents or other dental treatments throughout the study period. If participants experienced exaggerated TS or gingival irritation, the treatment would be discontinued and appropriate medications or interventions would be administered [24].

Application of 10% SA

We based our choice of SA concentration on the work of Mena-Serrano et al. [18], who demonstrated that the application of 10% SA after in-office bleaching reduced the penetration of hydrogen peroxide into the pulp chamber.

The 10% SA gel was prepared by mixing 0.5 mg of SA (98% purity, Sigma–Aldrich Co., St. Louis, MO, USA) with 5 mL of glycerol. After removing the bleaching gel and the gingival barrier, either the SA or placebo gel was applied directly onto each tooth using a microbrush (Cavibrush, FGM, Joinville, SC, Brazil) for 10 s and left undisturbed for an additional 10 min. The placebo gel consisted solely of glycerol.

TS assessment

The absolute risk and intensity of TS were assessed using two scales: the Visual Analog Scale (VAS) and the 5-Point Numerical Scale (NRS). The VAS scale ranges from 0 to 10 [25], where zero indicates no pain and ten severe pain, and the NRS scale ranges from 0 to 4, where zero indicates no pain and four indicates severe pain. Participants reported the intensity of their TS immediately after the bleaching session, at 1h, 24h, and 48h post-bleaching. For statistical analysis, the highest TS value reported across both bleaching sessions was used, as this represents the clinically most relevant discomfort experienced by the patient [6,26].

Color evaluation

The color evaluation of the middle third of the buccal surface of the maxillary canines and maxillary incisors was performed by subjective methods using shade guides (Vita classical A1-C4, Vita Zahnfabrik, Bad Säckingen, Germany, and Vita Bleachedguide 3D-MASTER, (Vita Zahnfabrik, Bad Säckingen, Germany), by two blind, independent, and calibrated examiners, and it was recorded at baseline, one week after the first bleaching session before the second session, one week after the second bleaching session, and one month after the second session. The color evaluation was performed in the same room with the same lighting conditions. In case of discrepancies between examiners, a consensus had to be reached.

Although the Vita Classical shade guide is traditionally organized into four hue groups (A1–D4), in this study the shades were rearranged by value from highest (B1) to lowest (C4) value, following established protocols for color evaluation in bleaching studies. This approach allows for a more accurate assessment of color changes [6,7,26]. Vita Bleachedguide 3D-MASTER scale is a tooth bleaching scale, which contains lighter colored tabs, being arranged from the highest value (0M1) to the lowest (5M3) value. The color change of shade guide units (ΔSGU), in the middle third of the buccal surface of the maxillary canines and maxillary incisors was calculated by subtracting the baseline color number to the final color number [5,6,24,26].

Only trained examiners, who have followed and helped in previous clinical trials on bleaching at our research center, were assigned to be evaluators. A formal analysis of the calibration is done using five volunteers who do not belong to the clinical trial and are submitted to dental bleaching. The evaluators measure the dental color using all color measurement tools described in this article in the different time assessments. They are considered calibrated when an agreement of at least 85% (kappa statistic) in all sets of evaluations was obtained. During the study, if disagreements arise, the examiners have to reach a consensus before dismissing the patient [24].

Statistical analysis

The statistician remained blinded to the study groups. Data analysis followed an intention-to-treat protocol, including all randomized patients in their original assignment group. We employed the SigmaPlot version 11.0 software (Systat Software) with a significance level set at 5%.

Data were initially evaluated for normality using the Shapiro–Wilk test. Color change (ΔSGU) between groups was analyzed using independent sample t-tests for both shade guide scales. The intensity of TS measured by the VAS scale was analyzed using independent sample t-tests. The NRS scale was analyzed using the Mann–Whitney test. The risk of TS was analyzed using Fisher's exact test. Effect sizes (mean difference and relative risk) along with 95% confidence intervals (CIs) were also calculated.

TS and color change were assessed at different time points across the bleaching sessions. However, the most clinically relevant outcomes for this study were the highest TS score reported during treatment and the final tooth color observed after completion of both sessions [6,26]. The individual de-identified participant data, statistical code, and data dictionary will be made available upon reasonable request to the corresponding author.

RESULTS

Characteristics of the eligible participants

Sixty-five participants were examined, and 40 were included in this clinical study (Figure 1). The baseline features of the participants for both groups were very similar, showing they were balanced at baseline for the variables collected (Table I). No harms or unintended adverse events other than TS were reported by the participants throughout the study.

Tooth sensitivity evaluation

No significant difference in the intensity of TS was observed for both pain scales ($p > 0.05$). The mean difference of TS intensity in VAS units was -1.2 (95% CI, (-2.9 to 0.4; Table II). The absolute risk of TS was 95% (95% CI 76 to 99) for the SA group and 100% (95% CI 83 to 100) for the placebo group. In comparative terms, the relative risk for TS was 0.95 (95% CI 0.86 to 1.05; Table III) with no statistical difference ($p= 1.0$).

Color evaluation

A significant bleaching effect was observed after bleaching in both groups. The color change was approximately 5 units on the Vita Classical scale and 9 units on the Vita Bleachedguide (Table IV) when measured on the incisors. A greater degree was noted when measuring the canines. However, no significant difference in color change was observed between the SA and placebo groups (Table IV; $p> 0.20$) in either the incisors or canines.

Table I. Baseline characteristics of the participants included in this controlled trial

Groups (number of patients)	Sodium ascorbate (n = 20)	Placebo (n = 20)
Baseline color (SGU; mean ± SD)	11.8 ± 2.6	11.3 ± 2.8
Gender (female; %)	8 (40%)	12 (60%)
Average age (years; female/male)	21.6 / 23.6	21.1 / 22.8

SGU, shade guide unit measured by Vita Classical scale; SD, standard deviations.

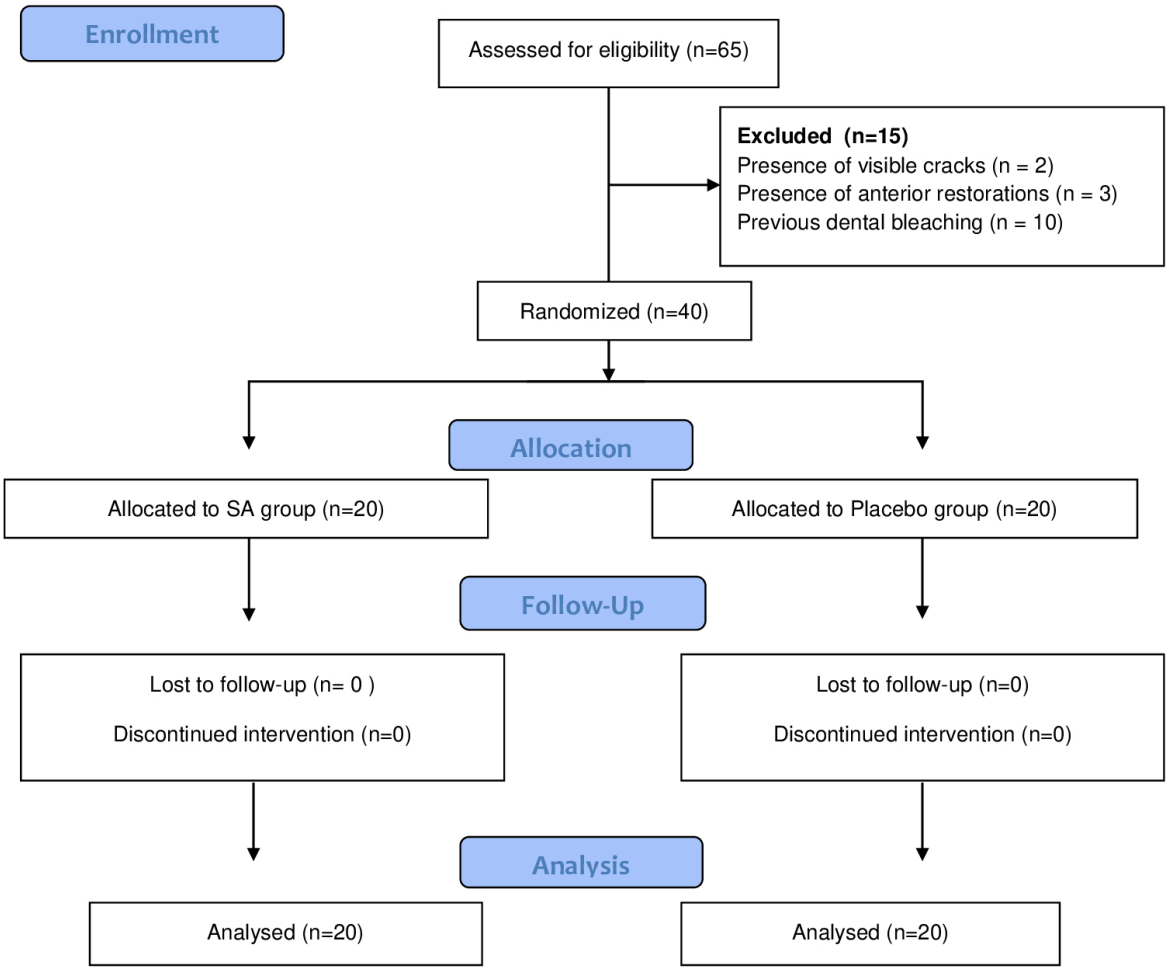

Figure 1 - CONSORT Flow Diagram.

Table II. Intensity of TS in VAS scale (means and standard deviations) and NRS scale (medians and interquartile ranges)

Scales		Sodium ascorbate (n = 20)	Placebo (n = 20)	Mean difference (95% CI)	*p*-value
VAS (0-10)	First week	4.7 ± 2.7	6.2 ± 2.4	-1.5 (-3.1 to 0.1)	0.07‡
	Second week	4.7 ± 3.7	6.5 ± 2.8	-1.8 (-3.9 to 0.3)	0.09‡
	Worst scenario	5.9 ± 3.0	7.1 ± 2.1	-1.2 (-2.9 to 0.4)	0.14‡
NRS (0-4)	First week	3.0 (2.0–3.0)	3.0 (2.0–3.0)	--	0.50†
	Second week	3.0 (1.0–2.0)	3.0 (3.0–3.0)	--	0.21†
	Worst scenario	3.0 (2.0–3.0)	3.0 (3.0–3.0)	--	0.36†

CI: confidence interval; ‡Student's t-test for independent samples; †Mann–Whitney test.

Table III. Absolute and relative risk of TS

Group	Tooth Sensitivity (Number of participants)		Absolute risk (95% CI)	Risk ratio (95% CI) *
	Yes	No		
Sodium ascorbate	19	1	95% (76 to 99%)	0.95 (0.86 to 1.05)
Placebo	20	0	100% (83% to 100%)	

CI: confidence interval; *Fisher's exact test (p = 1.00).

Table IV. Color change (mean and standard deviations) for the different shade guide units on different periods of evaluation, mean difference and 95% confidence interval

Color change instrument	Tooth evaluated	Periods	Groups		Mean difference (95% CI)	p-value*
			Sodium ascorbate (n = 20)	Placebo (n = 20)		
ΔSGU Vita Classical	Canine	Baseline vs. 1 week	4.9 ± 1.8	5.7 ± 2.0	-0.8 (-2.0 to 0.4)	0.20
		Baseline vs. 2 weeks	9.0 ± 2.7	9.4 ± 2.6	-0.4 (-2.1 to 1.2)	0.59
		Baseline vs. 30 days	9.3 ± 2.4	9.8 ± 2.3	-0.5 (-2.0 to 1.0)	0.50
	Incisors	Baseline vs. 1 week	3.3 ± 1.4	3.3 ± 1.5	0.0 (-0.9 to 1.0)	0.91
		Baseline vs. 2 weeks	5.2 ± 1.8	5.1 ± 2.7	0.1 (-1.4 to 1.6)	0.89
		Baseline vs. 30 days	5.3 ± 2.0	5.5 ± 2.6	-0.2 (-1.7 to 1.3)	0.79
ΔSGU Vita Bleached guide	Canine	Baseline vs. 1 week	5.1 ± 1.6	5.0 ± 1.9	0.1 (-1.0 to 1.3)	0.79
		Baseline vs. 2 weeks	11.9 ± 3.2	12.1 ± 3.4	-0.2 (-2.3 to 1.9)	0.85
		Baseline vs. 30 days	12.1 ± 3.4	12.4 ± 3.5	-0.3 (-2.5 to 1.8)	0.75
	Incisors	Baseline vs. 1 week	5.6 ± 2.4	5.5 ± 2.3	0.1 (-1.4 to 1.6)	0.89
		Baseline vs. 2 weeks	8.1 ± 2.0	8.4 ± 2.4	-0.3 (-1.7 to 1.1)	0.67
		Baseline vs. 30 days	8.0 ± 2.0	8.6 ± 2.7	-0.6 (-2.1 to 0.9)	0.43

CI: confidence interval; *Student's t-test for independent samples.

DISCUSSION

The null hypothesis of this randomized clinical trial was that there would be no significant differences between the SA and placebo groups in terms of TS and color change. The findings supported this hypothesis: no statistically significant difference was observed between the groups in TS intensity measured by both the VAS and NRS scales, and both groups experienced similar bleaching efficacy, as assessed by the Vita Classical and Vita Bleachedguide shade guides.

Many previous studies have investigated topical products to reduce this common side effect. The application of fluorides [27], potassium nitrate [28], calcium-containing products [29], analgesics and anti-inflammatory agents [30,31] have been investigated. The most promising desensitizer so far has been potassium nitrate, which exerts a neural action to block the transmission of pain. Potassium nitrate can reduce the intensity of TS in 0.8 VAS units on average and reduce the occurrence of bleaching-induced TS by 12% [28].

We also found in the literature another study that investigated the potential of ascorbate benefit with oral rather than topical administration. de Paula et al. [4] showed that acid arcorbic, when taken by patients before in-office bleaching, was not capable of reducing TS either. Had the authors applied the product topically, different results might have been observed. Topical application allows for targeted delivery to the treatment area, potentially yielding a higher medication concentration of the product where it is needed.

Given hydrogen peroxide's low molecular weight and its high availability when used in the in-office protocol with high concentrated products, hydrogen peroxide can readily travel through enamel and dentin and reach the pulp chamber in a very short period, around 15 min [29]. Within the pulp tissue, hydrogen peroxide triggers an inflammatory response, oxidative stress, and cellular damage, leading to the release of adenosine triphosphate, prostaglandins, and other inflammatory mediators [12,32,33] that activate nociceptors and cause TS [9,11].

We hypothesized that SA could serve as a potential desensitizing agent after the findings of some in vitro studies. Mena-Serrano et al. [18] demonstrated that applying 10% SA after in-office bleaching could reduce hydrogen peroxide penetration into the pulp chamber. Lima et al. [15] showed that SA could mitigate the toxic effects of carbamide peroxide on MDPC-23 odontoblastic cells. As SA has low molecular weight of 198.11 g/mol and minimal toxicity, it could diffuse through the dental substrates, neutralize excess hydrogen peroxide and free radicals [15], prevent damage to pulp cells and avoid reduction of bond strength of polymer-based materials [10,16,34].

Although laboratory studies showed promising results, controlled trials are needed to determine whether the product offers any real benefits in a complex clinical scenario where multiple variables interact. It is possible that the concentration of the agent used was insufficient to neutralize enough free radicals that could damage the pulp tissue.

Contrary to our findings, Nabil et al. [17] recently reported that 10% SA can reduce bleaching induced TS, although they did not provide precise effect-size estimates for sample-size planning. Therefore, we calculated our sample size to detect a large effect to ensure feasibility in this randomized trial. Smaller effects may have gone undetected due to this design.

Although the findings were not statistically significant, a modest potential benefit of SA in reducing the intensity of TS cannot be entirely excluded. On average, the SA group exhibited a 1.2-unit lower TS intensity on the VAS scale compared to the control group. These findings underscore the need for future randomized controlled trials with larger sample sizes to further investigate the topical application of SA.

It is important to clarify that, unlike the study by Nabil et al. [17]; our protocol did not include or compare light-activated bleaching. A systematic review has shown that light-activated protocols achieve the same shade changes but are also associated with increased TS [35]. The rise in temperature and generation of reactive oxygen species during light activation are likely to intensify pulpal inflammation, suggesting a potential trade-off between improved bleaching efficacy and TS [36].

The concentration of the bleaching gel is another factor that may influence the clinical outcomes of bleaching protocols. High-concentration gels tend to produce faster and more noticeable bleaching results; however, they are also associated with a higher risk and intensity of TS. In contrast, lower-concentration gels are less likely to irritate pulpal tissues but achieve similar color changes [25,37]. All these factors together probably explain why high rates of patients are affected by bleaching-induced TS.

In the present study, we used a high-concentration gel and evaluated whether post-bleaching application of SA could mitigate the TS. While most existing protocols apply desensitizing agents before bleaching [6,26] we based our approach on in vitro evidence suggesting that antioxidant application after bleaching may offer additional benefits [18]. Future randomized clinical trials comparing different gel concentrations and various timings of SA application (before and after bleaching) are essential to optimize the balance between bleaching efficacy and patient comfort.

Regarding color change, observations from an early in vitro study suggest that SA may interfere with the bleaching efficacy of 35% hydrogen peroxide. The reduction reaction involving the transfer of electrons from SA to hydrogen peroxide molecules can convert hydrogen peroxide into water and oxygen and reduce the availability of hydrogen peroxide to oxidize the organic compound of the dental substrates [18].

In the present clinical trial, the application of SA did not compromise color change. The bleaching protocol resulted in very good effectiveness of the upper central incisors and excellent effectiveness of the canines [38]. This difference can be attributed to the greater saturation and darker shade of the canines, as teeth with a deeper initial color generally show a higher degree of color change [39].

The Vita Classical shade guide is the most frequently used visual tool for evaluation of color changes in bleaching studies, but it presents a nonlinear arrangement of colors, as it was not designed for evaluation of color changes from the bleaching protocol. For this reason, we also employed the Bleachedguide VITA 3DMASTER shade guide, which offers a more comprehensive and accurate approach to evaluating color change after tooth bleaching. A similar trend was observed when VITA 3DMASTER was used.

Instrumental color change evaluation is also employed in bleaching studies [5,6,8,24,26,37]. We have not employed any in the current one due to the non-availability of a spectrophotomer in the university where the study was conducted. Due to the high costs of the device in the country where the study was performed, we opted to only use visual examination of color change. However, although instrumental evaluation has a higher sensitivity to detect subtle differences, the results of ΔE values gathered from color parameters measured with the spectrophotometer are consistently in agreement with ΔSGU values in studies that employed both methods of color change evaluation [5,6,24,26].

Finally, we should mention the limitations of the current clinical trial. We have just evaluated one bleaching gel which is known to have an acid pH [40,41]. Acid bleaching gels are usually associated with higher risk and intensity of TS [8]. Therefore, other clinical trials evaluating gels with neutral or alkaline pH gels should be performed. Another limitation is the small sample size of 40 participants. This sample size can only allow us to state that a difference of 50% was not observed in the TS intensity between groups, however we cannot rule out that smaller effect sizes may exist and therefore we encourage more studies on this subject.

CONCLUSION

In this clinical trial, the application of 10% SA after bleaching did not significantly reduce the intensity or risk of TS. Additionally, no significant effect was observed on tooth color change.

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Author's Contributions

AMS: Conceptualization; Data curation; Funding Acquisition; Investigation; Methodology; Project Administration; Resources; Software; Supervision; Validation; Visualization; Writing – Original Draft Preparation. EAF, CQL, DA, FNG, LC: Conceptualization; Data Curation; Investigation; Methodology; Validation; Visualization; Writing – Original Draft Preparation. MWF: Data Curation; Formal Analysis; Investigation; Methodology; Project Administration; Software; Validation; Visualization; Writing – Original Draft Preparation. ADL, AR: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – Original Draft Preparation; Writing – Review & Editing.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of CEP/UEPG. This study protocol was reviewed and approved by Comitê de Ética em Pesquisa envolvendo Seres Humanos da Universidade Estadual de Ponta Grossa, approval number 5.975.580. And it was prospectively registered in the Brazilian Clinical Trials Registry (RBR-10g2hcrj).

REFERENCES

1. Silva FBD, Chisini LA, Demarco FF, Horta BL, Correa MB. Desire for tooth bleaching and treatment performed in Brazilian adults: findings from a birth cohort. Braz Oral Res. 2018;32:e12. http://doi.org/10.1590/1807-3107bor-2018.vol32.0012. PMid:29538477.

2. Mounika A, Mandava J, Roopesh B, Karri G. Clinical evaluation of color change and tooth sensitivity with in-office and home bleaching treatments. Indian J Dent Res. 2018;29(4):423-7. http://doi.org/10.4103/ijdr.IJDR_688_16. PMid:30127190.

3. Kose C, Calixto A, Bauer J, Reis A, Loguercio A. Comparison of the effects of in-office bleaching times on whitening and tooth sensitivity: a single blind, randomized clinical trial. Oper Dent. 2016;41(2):138-45. http://doi.org/10.2341/15-085-C. PMid:26509229.

4. de Paula EA, Kossatz S, Fernandes D, Loguercio A, Reis A. Administration of ascorbic acid to prevent bleaching-induced tooth sensitivity: a randomized triple-blind clinical Trial. Oper Dent. 2014;39(2):128-35. http://doi.org/10.2341/12-483-C. PMid:23802640.

5. Centenaro GG, Favoreto MW, Cordeiro DCF, Gumy FN, Machado AG, Cochinski GD, et al. Effect of the type of application tip for 35% hydrogen peroxide on bleaching efficacy and tooth sensitivity: a randomized clinical trial. J Esthet Restor Dent. 2024;36(7):1029-37. http://doi.org/10.1111/jerd.13219. PMid:38475979.

6. Favoreto MW, Vochikovski L, Terra RMO, Campos VS, Santos ME, Meireles SS, et al. Topical application of Otosporin® before in-office bleaching: a split mouth, triple-blind, multicenter randomized clinical trial. Clin Oral Investig. 2022;26(3):2555-64. http://doi.org/10.1007/s00784-021-04224-9. PMid:34668065.

7. Rezende M, Chemin K, Vaez SC, Peixoto AC, Rabelo JDF, Braga SSL, et al. Effect of topical application of dipyrone on dental sensitivity reduction after in-office dental bleaching. J Am Dent Assoc. 2018;149(5):363-71. http://doi.org/10.1016/j.adaj.2017.11.003. PMid:29550020.

8. Loguercio AD, Servat F, Stanislawczuk R, Mena-Serrano A, Rezende M, Prieto MV, et al. Effect of acidity of in-office bleaching gels on tooth sensitivity and whitening: a two-center double-blind randomized clinical trial. Clin Oral Investig. 2017;21(9):2811-8. http://doi.org/10.1007/s00784-017-2083-5. PMid:28303471.

9. Chen C, Huang X, Zhu W, Ding C, Huang P, Li R. H2O2 gel bleaching induces cytotoxicity and pain conduction in dental pulp stem cells via intracellular reactive oxygen species on enamel/dentin disc. PLoS One. 2021;16(9):e0257221. PMid:34506603.

10. Lima AF, Lessa FCR, Gasparoto Mancini MN, Hebling J, De Souza Costa CA, Marchi GM. Transdentinal protective role of sodium ascorbate against the cytopathic effects of H2O2 released from bleaching agents. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(4):e70-6. http://doi.org/10.1016/j.tripleo.2009.12.020. PMid:20303050.

11. De Souza Costa CA, Riehl H, Kina JF, Sacono NT, Hebling J. Human pulp responses to in-office tooth bleaching. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(4):e59-64. http://doi.org/10.1016/j.tripleo.2009.12.002. PMid:20303048.

12. Vaz MM, Lopes LG, Cardoso PC, Souza JBD, Batista AC, Costa NL, et al. Inflammatory response of human dental pulp to at-home and in-office tooth bleaching. J Appl Oral Sci. 2016;24(5):509-17. http://doi.org/10.1590/1678-775720160137. PMid:27812622.

13. Cavalli V, Shinohara MS, Ambrose W, Malafaia FM, Pereira PNR, Giannini M. Influence of intracoronal bleaching agents on the ultimate strength and ultrastructure morphology of dentine. Int Endod J. 2009;42(7):568-75. http://doi.org/10.1111/j.1365-2591.2009.01543.x. PMid:19467056.

14. Piemjai M, Surakompontorn J. Effect of tooth-bleaching on the tensile strength and staining by caries detector solution on bovine enamel and dentin. Am J Dent. 2006;19(6):387-92. PMid:17212083.

15. Lima AF, Marques MR, Soares DG, Hebling J, Marchi GM, De Souza Costa CA. Antioxidant therapy enhances pulpal healing in bleached teeth. Restor Dent Endod. 2016;41(1):44-54. http://doi.org/10.5395/rde.2016.41.1.44. PMid:26877990.

16. Roela AVT, Rossi NR, Paradella TC, Paes TJA Jr, Ribeiro CSC, Carvalho RF. Influence of different hydrogen peroxide neutralizer solutions on the dental root morphology. Braz Dent Sci. 2025;28(1):e4457. http://doi.org/10.4322/bds.2025.e4457.

17. Nabil M, Hasan MM, Shebl EAE. Effect of antioxidant on tooth sensitivity after bleaching. J Esthet Restor Dent. 2024;36(3):429-36. http://doi.org/10.1111/jerd.13190. PMid:38130089.

18. Mena-Serrano A, Granda-Albuja MG, Naranjo J, Fierro EA, Favoreto MW, Loguercio AD, et al. Effects of the application of sodium ascorbate after in-office bleaching on the penetration of hydrogen peroxide, color change, and microtensile bond strength. Braz Dent J. 2023;34(5):87-94. http://doi.org/10.1590/0103-6440202305214. PMid:38133477.

19. ReBEC: Registro Brasileiro de Ensaios Clínicos. RBR-10g2hcrj Topical application of sodium ascorbate after in-office tooth whitening [Internet]. 2023 [cited 2025 Jun 5]. Available from: https://ensaiosclinicos.gov.br/rg/RBR-10g2hcrj

20. Pandis N, Chung B, Scherer RW, Elbourne D, Altman DG. CONSORT 2010 statement: extension checklist for reporting within person randomised trials. BMJ. 2017;357:j2835. http://doi.org/10.1136/bmj.j2835. PMid:28667088.

21. Hopewell S, Chan AW, Collins GS, Hróbjartsson A, Moher D, Schulz KF, et al. CONSORT 2025 statement: updated guideline for reporting randomised trials. BMJ. 2025;389:e081123. http://doi.org/10.1136/bmj-2024-081123. PMid:40228833.

22. de Lima TM, França FMG, do Amaral FLB, Turssi CP, Basting RT. The use of desensitizing agents during in-office bleaching might not decrease tooth bleaching sensitivity: a randomized clinical trial. Int J Esthet Dent. 2022;17(1):100-14. PMid:35175011.

23. Sealed Envelope. [Internet]. 2025 [cited 2025 Jun 5]. Available from: www.sealedenvelope.com

24. Gumy FN, Da Silva KL, Gumy MN, Forville H, Cordeiro DCF, Favoreto MW, et al. The decomposition rate and bleaching efficacy of in-office bleaching gels with different pHs: a randomized controlled trial. Clin Oral Investig. 2024;28(8):440. http://doi.org/10.1007/s00784-024-05821-0. PMid:39042288.

25. Cavalcante LM, Bomgiovanni C, Antunes K, Loureiro E, Tannure P, Schneider LF. Color change, tooth sensitivity, aesthetic self-perceptions and quality of life after at-home dental bleaching. Braz Dent Sci. 2022;25(1):e2739. http://doi.org/10.4322/bds.2022.e2739.

26. Vochikovski L, Favoreto MW, Rezende M, Terra RMO, Da Silva KL, Farago PV, et al. Effect of an experimental desensitizing gel on bleaching-induced tooth sensitivity after in-office bleaching: a double-blind, randomized controlled trial. Clin Oral Investig. 2023;27(4):1567-76. http://doi.org/10.1007/s00784-022-04778-2. PMid:36418502.

27. Wang Y, Gao J, Jiang T, Liang S, Zhou Y, Matis BA. Evaluation of the efficacy of potassium nitrate and sodium fluoride as desensitizing agents during tooth bleaching treatment: a systematic review and meta-analysis. J Dent. 2015;43(8):913-23. http://doi.org/10.1016/j.jdent.2015.03.015. PMid:25913140.

28. Martini EC, Favoreto MW, Rezende M, De Geus JL, Loguercio AD, Reis A. Topical application of a desensitizing agent containing potassium nitrate before dental bleaching: a systematic review and meta-analysis. Clin Oral Investig. 2021;25(7):4311-27. http://doi.org/10.1007/s00784-021-03994-6. PMid:34075489.

29. Favoreto MW, De Souza Carneiro T, Forville H, Burey A, Simas Dreweck FD, Loguercio AD, et al. Use of calcium-containing bioactive desensitizers in dental bleaching. J Am Dent Assoc. 2023;154(3):245-259.e12. http://doi.org/10.1016/j.adaj.2022.11.012. PMid:36717350.

30. Rezende M, Bonafé E, Vochikovski L, Farago PV, Loguercio AD, Reis A, et al. Pre- and postoperative dexamethasone does not reduce bleaching-induced tooth sensitivity. J Am Dent Assoc. 2016;147(1):41-9. http://doi.org/10.1016/j.adaj.2015.07.003. PMid:26562735.

31. Charakorn P, Cabanilla LL, Wagner WC, Foong WC, Shaheen J, Pregitzer R, et al. The effect of preoperative ibuprofen on tooth sensitivity caused by in-office bleaching. Oper Dent. 2009;34(2):131-5. http://doi.org/10.2341/08-33. PMid:19363967.

32. Cintra LTA, Benetti F, Ferreira LL, Gomes-Filho JE, Ervolino E, Gallinari MDO, et al. Penetration capacity, color alteration and biological response of two in-office bleaching protocols. Braz Dent J. 2016;27(2):169-75. http://doi.org/10.1590/0103-6440201600329. PMid:27058379.

33. Soares DG, Sacono NT, Ribeiro APD, Leite ML, Duque CCDO, Gallinari MDO, et al. Pro-inflammatory mediators expression by pulp cells following tooth whitening on restored enamel surface. Braz Dent J. 2022;33(2):83-90. http://doi.org/10.1590/0103-6440202204688. PMid:35508040.

34. Mena-Serrano A, Aldás Fierro E, Estrada X, Boada A, Wendlinger M, Favoreto MW, et al. Effect of sodium ascorbate, grape seed extract, and aloe vera application after in-office bleaching on the bond strength of enamel: a 3-year evaluation. Int J Dent. 2023:4625818. PMid:37954498.

35. Abbasi M, Pordel E, Chiniforush N, Gorgani Firuzjaee S, Ranjbar Omrani L. Hydrogen peroxide penetration into the pulp chamber during conventional in-office bleaching and diode laser-assisted bleaching with three different wavelengths. Laser Ther. 2019;28(4):285-90. http://doi.org/10.5978/islsm.19-OR-20. PMid:32255920.

36. Maran BM, Ziegelmann PK, Burey A, De Paris Matos T, Loguercio AD, Reis A. Different light-activation systems associated with dental bleaching: a systematic review and a network meta-analysis. Clin Oral Investig. 2019;23(4):1499-512. http://doi.org/10.1007/s00784-019-02835-x. PMid:30767069.

37. Paula AM, Hanzen TA, De Oliveira M, Loguercio A, Reis A. Evaluation of different protocols with 4% hydrogen peroxide in bleaching efficacy and tooth sensitivity: a single-blind, randomized clinical trial. Oper Dent. 2023;48(3):268-76. http://doi.org/10.2341/22-051-C. PMid:36929775.

38. Paravina RD, Pérez MM, Ghinea RI. Acceptability and perceptibility thresholds in dentistry: a comprehensive review of clinical and research applications. J Esthet Restor Dent. 2019;31(2):103-12. http://doi.org/10.1111/jerd.12465. PMid:30891913.

39. Maran BM, Vochikovski L, Hortkoff DRA, Stanislawczuk R, Loguercio AD, Reis A. Tooth sensitivity with a desensitizing-containing at-home bleaching gel: a randomized triple-blind clinical trial. J Dent. 2018;72:64-70. http://doi.org/10.1016/j.jdent.2018.03.006. PMid:29551346.

40. de Mendonça RP, Baliza JR, Burey A, Cavalcante LM, Loguercio AD, Calazans FS, et al. In vitro analysis of the pH stability of dental bleaching gels during in-office procedures. J Clin Exp Dent. 2021;13(1):e22-9. http://doi.org/10.4317/jced.57367. PMid:33425227.

41. Trentino AC, Soares AF, Duarte MAH, Ishikiriama SK, Mondelli RFL. Evaluation of pH levels and surface roughness after bleaching and abrasion tests of eight commercial products. Photomed Laser Surg. 2015;33(7):372-7. http://doi.org/10.1089/pho.2014.3869. PMid:26154725.

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