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Assessment of Tooth Sensitivity Using a Desensitizer Before Light-activated Bleaching

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Clinical Relevance

The use of a desensitizing gel before light-activated in-office bleaching does not eliminate, but may reduce, the duration of this side effect.

ABSTRACT

Clinical Objective: This clinical study evaluated whether the use of a desensitizing agent (5% potassium nitrate/2% sodium fluoride) before in-office light-activated bleaching decreased this sensitivity.

Methods: Before in-office bleaching with 35% hydrogen peroxide gel (three applications, 15 minutes each) associated with an LED/laser unit, clinicians applied a placebo gel or the desensitizing agent on the buccal surfaces of all participants. They repeated this protocol one week later. Patients recorded their tooth sensitivity on a 0-to-4 scale. The authors used one-way repeated measures ANOVA to compare the tooth color changes and non-parametric statistics to compare the different percentages of patients with tooth sensitivity and the levels of tooth sensitivity in the different periods of time between groups (α=0.05).

Results: The use of a desensitizing gel did not affect the bleaching efficacy. Eighty percent and 100% of the participants from the experimental and placebo groups, respectively, experienced tooth sensitivity (p>0.05). The intensity of sensitivity was similar immediately after bleaching for both groups (p>0.05). After 24 hours, lower

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sensitivity was reported in the experimental group, while most of the participants from the placebo group experienced tooth sensitivity ($p<0.05$).

INTRODUCTION

Tooth discoloration is becoming a greater concern, as more emphasis is placed on esthetics. With the growing awareness of esthetic options, there is a greater demand for cosmetic solutions. Within this context, vital tooth bleaching is one of the most requested cosmetic dental procedures requested by patients who want a more pleasing smile. Vital tooth bleaching can be accomplished by a variety of methods or systems, which can be generally categorized as in-office (professionally administered), at-home (professionally dispensed) or over-the-counter (self-administered).

Owing to an increased demand for whiter teeth in a short period of time, in-office bleaching is a popular option available to patients desiring a whiter, more attractive smile, as outcomes can already be seen in a single clinical appointment with a dental professional.[1-2]

Since the introduction of in-office bleaching treatments, the use of curing lights (including halogen curing lights, plasma arch, LED, LED plus lasers and lasers) has been recommended to accelerate the action of the bleaching gel. The theoretical advantage of a light source is its ability to heat the hydrogen peroxide, thereby increasing the rate of decomposition of oxygen to form oxygen-free radicals and enhancing the release of stain-containing molecules.[3-4]

Clinical studies investigating the use of supplementary light on the effectiveness of vital bleaching have been controversial.[1-2,5-10] Even though evidence is not definitive on the use of light-enhanced bleaching, patients often demand its use due to media coverage. Many clinicians look upon light-activated bleaching as important for patient satisfaction and because many current systems use light activation in conjunction with hydrogen peroxide.[11]

An important issue that needs to be addressed when performing light-activated bleaching is the adverse effect of tooth sensitivity. Most of the clinical trials that compared light-activated versus non-activated in-office bleaching have reported that the levels of tooth sensitivity are usually higher for the former.[2,8-9,12] With the aim of reducing the tooth sensitivity associated with in-office tooth bleaching, a recent study demonstrated that the use of a desensitizing gel (5% nitrate potassium/2% sodium fluoride) before in-office bleaching did not affect the bleaching efficacy, but did reduce the prevalence of tooth sensitivity and its intensity level.[13] To the authors' knowledge, no study to date has addressed the effects of a preventive desensitizer on the bleaching efficacy and tooth sensitivity of light-enhanced in-office bleaching, which was the aim of the current investigation.

METHODS AND MATERIALS

This clinical investigation was approved (protocol number 05531/09) by the scientific review committee and the committee for the protection of human subjects at the local Institutional University Review Board. The authors of the current study enrolled 30 undergraduate students with anterior teeth shade C2 or darker as judged by comparison with a value-oriented shade guide (Vita Lumin, Vita Zahnfabrik, Bad Säckingen, Germany) in a double-blind controlled clinical trial. All the subjects received a dental screening and dental prophylaxis two weeks before the start of bleaching and signed an informed consent form before the study began.

Inclusion and Exclusion Criteria

Patients included in this clinical trial were at least 18-years old and had good general and oral health. The participants were required to have six caries-free maxillary anterior teeth without restorations on the labial surfaces, be willing to sign a consent form and have central incisors determined to be shade C2 or darker. Patients were excluded from the study if they had undergone tooth-whitening procedures, had labial anterior restorations, were pregnant or lactating women, had severe internal tooth discoloration (tetracycline stains, fluorosis, pulpless teeth), had bruxism habits or had any gross pathology in the mouth. Patients were also excluded if they had non-carious cervical lesions or anterior teeth with exposed incisal dentin or spontaneous tooth pain. Subjects were asked to record whether they experienced sensitivity the week before starting the bleaching therapy, using the following criteria: 0 = none, 1 = mild, 2 = moderate, 3 = considerable and 4 = severe.[13-14] Patients with sensitivity equal to or greater than mild were also excluded from the study.

Study Design

The authors randomly divided subjects into the experimental and placebo groups by tossing a coin. Neither the patient nor the evaluator knew to which group the patient was assigned.

The two clinicians applied a 5% potassium nitrate and 2% sodium fluoride desensitizing gel (Desensibilize KF 2%, FGM Dental Products, Joinville, SC, Brazil) to the buccal tooth surfaces of participants in the experimental group, which was left undisturbed for 10 minutes. They then used a rubber cup mounted in a slow-speed handpiece to scrub the desensitizing gel on the teeth for 20 seconds, as specified by the manufacturer.

The clinicians applied a placebo gel to the buccal tooth surfaces of participants in the control group in the same manner as described for the experimental group. The placebo gel had the same composition as that of the desensitizing agent, except that it did not contain the active ingredients (potassium nitrate and sodium fluoride). The authors gave the desensitizing and placebo gels to the clinicians in unmarked syringes. The syringes were marked only with numbered codes that neither the clinicians nor the patients could identify.

The clinicians then isolated the gingival tissue of the teeth to be bleached by using a light-cured resin dam (Top Dam, FGM Dental Products). They applied a 35% hydrogen peroxide gel (Whiteness HP, FGM Dental Products) in three 15-minute applications. Full-mouth LED/Laser energy (Whitening Lase Light Plus, DMC São Carlos, SP, Brazil) was used following the manufacturer's directions. This light source is made of a matrix of LEDs with a wavelength of 470 nm and three infrared laser diodes with 830 nm and a light intensity of 200 mW. The tooth surfaces were illuminated for one minute, then the device was turned off for two minutes. This procedure was repeated three times in each 15-minute application. Participants repeated the in-office bleaching treatment one week later. The authors instructed all participants to brush their teeth regularly, using fluoridated toothpaste (Sorriso Fresh, Colgate-Palmolive, São Paulo, SP, Brazil).

Shade Evaluation

The shade guide's 16 tabs were arranged from highest (B1) to lowest (C4) value. Although this scale is not linear in the truest sense, the changes were treated as representing a continuous and approximately linear ranking for the purpose of analysis. Shade changes were calculated from the start of the active phase to the individual recall times by calculating the change in the number of shade guide units (ΔSGU) that occurred toward the lighter end of the value-oriented list of shade tabs.

Two different and calibrated evaluators recorded the shade of each subject's teeth at baseline and weekly. The measurement area of interest for shade matching was the middle third of the facial surface of the anterior teeth (central incisors), according to American Dental Association[15] guidelines. There were five patients whom the authors did not include in the sample, because they were used in the pilot study and participated in the training phase of the study. The two examiners scheduled these patients for bleaching and evaluated their teeth against the shade guide weekly. The two examiners were required, prior to starting the study evaluation, to agree on shade at a level of at least 85% (kappa statistic).

Tooth Sensitivity Evaluation

The authors asked subjects to record whether they experienced sensitivity immediately after bleaching or in the days that followed, using the following criteria: 0 = none, 1 = mild, 2 = moderate, 3 = considerable and 4 = severe.[13-14] The worst score given by each patient after the first bleaching session was used for the statistical analysis. The scores were arranged into two categories: overall percentage of patients with tooth sensitivity and overall tooth sensitivity intensity for each group.

Statistical Analysis

The authors checked the agreement between the examiners by using the kappa statistic. The means and standard deviations were calculated for changes in ΔSGU after each of the two bleaching sessions for each group. In order to evaluate whether the bleaching therapies were effective, the authors submitted the ΔSGU of each group to a one-way repeated measures ANOVA. A post-hoc analysis (Tukey test, α=0.05) was used to make pairwise comparisons. The different percentages of patients with sensitivity in the different periods of time for each group were compared using the Friedman repeated measures analysis of variance by rank. The percentage of patients with tooth sensitivity in each period of time between groups was compared using the Wilcoxon sign-ranked test (α=0.05). The levels of tooth sensitivity in the different periods of time for each group were compared using the Friedman repeated measures analysis of variance by rank. The intensity of tooth sensitivity in each period of time among groups was compared using the Wilcoxon sign-ranked test (α=0.05).

RESULTS

All participants completed the study. The kappa statistic agreement between the two evaluators was 92%. The means and standard deviations of ΔSGU are depicted in Table 1.

No significant difference between the treatment groups regarding bleaching efficacy was observed (p=0.75). Both bleaching therapies were effective in terms of bleaching, as statistically similar changes in

Table 1: *Tooth Shade Value at Assessment Points for the Two Treatment Groups*

	Treatment	
	Without Desensitizer	**With Desensitizer**
Baseline	7.7 ± 0.5 aA	7.5 ± 0.9 dA
After one week	2.7 ± 1.2 bB	2.9 ± 1.3 eB
After two weeks	1.0 ± 0.9 cC	1.1 ± 0.3 fC

Similar lower case letters indicate statistically similar means within columns. Similar upper case letter indicate statistically similar means within rows (p<0.05).

the total number of SGU were observed after one and two weeks of bleaching (p>0.05). The mean bleaching scores at baseline, after one and two weeks were significantly different (p=0.001). After two weeks of bleaching, the participants from the desensitizing group showed a change of 6.4 SGUs, while participants from the placebo group showed a change of 6.7 SGUs.

Table 2: *Comparison of the Number (%) of Patients Who Experienced Tooth Sensitivity During the Bleaching Regimen*

	Without Desensitizer		With Desensitizer	
	Number (%)	Statistical Analysis	Number (%)	Statistical Analysis
Immediate	15 (100.0)	aA	12 (80.0)	cA
24 hours	9 (60.0)	bB	5 (33.3)	dB
48 hours	5 (33.3)	bC	0 (0.0)	eD

Similar lower case letters indicate groups with similar frequencies (Friedman repeated analysis of variance) within columns. Similar upper case letters indicate groups with similar frequencies within rows (Wilcoxon sign-rank test) (p<0.05).

Table 3: *Median (minimum and maximum) of Intensity of Tooth Sensitivity Immediately, 24 Hours and 48 Hours After the Bleaching Regimen*

	Without Desensitizer		With Desensitizer	
	Median (min/max)	Statistical Analysis	Median (min/max)	Statistical Analysis
Immediate	2 (1/4)	aA	2 (0/3)	dA
24 hours	1 (0/3)	bB	0 (0/2)	eC
48 hours	0 (0/2)	cC	0 (0/0)	eC

Similar lower case letters indicate groups with similar medians (Friedman repeated analysis of variance) within columns. Similar upper case letters indicate groups with similar medians within rows (Wilcoxon sign-rank test) (p<0.05).

In regard to the prevalence of tooth sensitivity, 80% and 100% of the participants from the experimental and placebo groups, respectively, experienced tooth sensitivity immediately after tooth bleaching (p=0.28; Table 2). The percentage of patients with tooth sensitivity decreased significantly after 48 hours for both groups (p<0.05). Approximately 33.3% and 60% of the participants from the experimental and placebo groups, respectively, showed tooth sensitivity after 24 hours. None and 33.3% of the participants from the experimental and placebo groups, respectively, reported tooth sensitivity after 48 hours (Table 2). The percentage of patients with sensitivity was similar for both groups, either immediately or after 24 hours (p>0.05). However, after 48 hours, a significant difference was detected between groups (p=0.04) (Table 2).

Figure 1 depicts the percentage of participants according to the level of reported tooth sensitivity for both groups immediately after bleaching. One can observe that severe sensitivity was only reported by two participants (one from each group). Forty percent of participants from the experimental group reported moderate sensitivity, while this figure was 66.6% for the placebo group. The sensitivity levels of both groups were similar, either immediately or after 48 hours (median 2 and 0, respectively) (p>0.05). However, a significant difference was detected after 24 hours between groups. The intensity of sensitivity was significantly higher in the placebo group (median 1) than the experimental group (median 0) after 24 hours (p=0.03) (Table 3).

DISCUSSION

As previously reported by Tay and others,[13] the results of the current study indicate that the application of a 5% potassium nitrate and 2% sodium fluoride desensitizing agent does not interfere with the bleaching efficacy of 35% hydrogen peroxide, as it seems to not affect the trans-enamel and trans-dentinal diffusion of hydrogen peroxide due to the low molecular weight of this oxidizing molecule.[13,16] Although the desensitizing agent contains 2% sodium fluoride, which occludes dentinal tubules[17-18] and increases enamel hardness,[19] this was shown to not interfere with the whitening effect of in-office or at-home bleaching.[13,16]

The results of the current study showed that around 90% of patients submitted to the light-activated in-

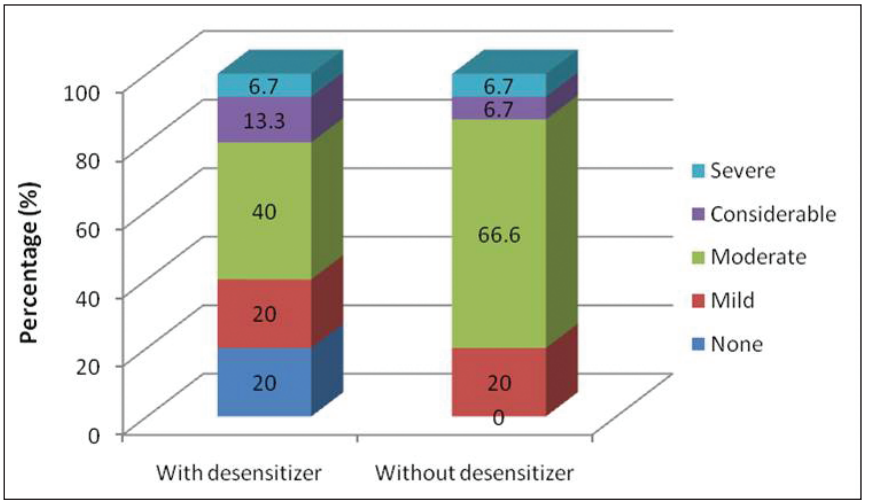

Figure 1. *Levels of sensitivity (%) perceived by the participants for both groups immediately after the bleaching protocol.*

office bleaching presented tooth sensitivity. A number of studies utilizing animal models and human teeth scheduled for extraction have attempted to ascertain if various bleaching treatments caused structural damage and histological signs of inflammation in the dental pulp.[20-23] The repeated application of 35%-38% H_2O_2 solution to newly erupted dog canine teeth[20] and human lower incisors[23] caused structural damage to the pulp, such as disruption of the odontoblast layer, inflammatory infiltrates, hemorrhage and also coagulation necrosis.

Although clinical investigations correlating pulpal histological alterations with tooth sensitivity arising from bleaching are still lacking in the literature, one may hypothesize that inflammation and dental pain are intimately linked.[25-26] Pulp tissue damage caused by dental bleaching likely causes the release of cell-derived factors, such as ATP and prostaglandins, that excite or sensitize pulpal nociceptors.[27-28] The observation that certain bleaching procedures increase pulpal expression of substance-P (a nerve-released vasoactive peptide) indicates that neurogenic inflammation plays a role in tooth sensitivity caused by bleaching.[29]

This is probably the reason why the application of a 5% potassium nitrate and 2% sodium fluoride desensitizing agent prior to the in-office bleaching protocol, not activated by light, was efficient to reduce the prevalence and intensity of tooth sensitivity in a previous study.[13] It is the depolarization followed by repolarization in activity of dentinal sensory nerves that causes tooth pain. Potassium nitrate acts by preventing nerve repolarization after initial depolarization, reducing nerve excitability and the ability of the nerve to transmit pain.[30]

However, the current study showed that this approach (preventive use of a desensitizing agent) was not effective in reducing tooth sensitivity when in-office bleaching was performed with laser/LED activation immediately after bleaching. Although the effects of light-activated bleaching on pulp reaction has not been clinically evaluated, *in vitro* studies have indicated that application of the bleaching gel associated with halogen light exposure produced more severe cytotoxic effects to cultured odontoblast-like cells than application of hydrogen peroxide alone.[31] The light source heats the hydrogen peroxide, thereby increasing the rate of decomposition of oxygen to form oxygen-free radicals. If the availability of free radicals is enhanced, more oxidizing agents are expected to reach the pulp tissue and initiate an intense inflammatory response. Also, light can elevate the pulp temperature, contributing to pulp inflammation.[32] Irreversible pulp damage was observed in 15% of rhesus monkeys for temperature elevations of only 5.6°C.[33]

Thus, based on the aforementioned discussion, one may hypothesize that the degree of inflammation initiated by light-activated bleaching is likely higher than in-office bleaching performed only with hydrogen peroxide gel. This hypothesis is corroborated by clinical findings showing that the prevalence and intensity of tooth sensitivity is higher when light is associated with in-office bleaching.[1-2,8-9,12] Under such high inflammation levels, desensitizing agents based on 2% potassium nitrate are likely less effective in reducing the transmission of tooth pain immediately after bleaching.

However, the pain seemed to be less persistent for the experimental group. While the placebo group showed significant levels of tooth pain even 24 hours after the bleaching protocol, the experimental group experienced tooth sensitivity only immediately after bleaching. Owing to the oxidative stress generated by the presence of free radicals, the defense system of the pulp cells is activated soon after hydrogen peroxide reaches the pulp. This action probably releases several endogenous antioxidant agents, such as peroxidases and catalases, which promote an enzymatic degradation of H_2O_2 to avoid excessive tissue damage.[34] As time goes by, the amount of these oxidants and inflammatory mediators are likely reduced and fewer nerve fibers are therefore excited. Under these circumstances, 2% potassium nitrate may be effective in reducing tooth pain. This hypothesis needs to be further investigated.

The effectiveness of desensitizing agents with increased concentration of potassium nitrate to reduce bleaching-induced pain should be a matter of future investigations along with other clinical approaches for reducing the level of inflammation of teeth submitted to light-activated in-office bleaching.

CONCLUSIONS

Within the limitations of this investigation, the authors conclude that the use of a desensitizing gel based on 5% potassium nitrate and 2% sodium fluoride prior to the light-activated in-office tooth bleaching procedure does not jeopardize the whitening effect. Its use does reduce the prevalence and intensity of bleaching-induced tooth sensitivity.

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