The influence of desensitizing dentifrices on pain induced by in-office bleaching

Abstract: The purpose of this study was to evaluate whether the use of desensitizing dentifrices used 15 days prior to and after in-office tooth bleaching could eliminate or reduce tooth sensitivity. After institutional review board approval and informed consent, 45 subjects were selected and divided into 3 groups according to the dentifrice selected: Colgate Total (CT), Colgate Sensitive Pro-Relief (CS) or Sensodyne ProNamel (SP). The subjects used toothpaste and a toothbrush provided to them for 15 days prior to bleaching. They were then submitted to two in-office bleaching sessions (Whiteness HP Blue Calcium). Their tooth sensitivity was assessed using the Visual Analog Scale (VAS) for a week after each session. Their tooth shade alteration was measured with a Vitapan Classical shade guide to determine if the dentifrices could influence the effectiveness of the bleaching agent. The data were submitted to Wilcoxon, Kruskal-Wallis and Mann-Whitney tests ($\alpha = 0.05$). The use of desensitizing dentifrices did not affect the bleaching efficacy. In regard to tooth sensitivity, there was a statistically significant difference between the results of the Control Group and Group T2 after the first session ($p = 0.048$). There was no statistically significant difference in the results for the other groups after the first session. In regard to the second session, there was no statistically significant difference in the results for all the groups. The use of a desensitizing dentifrice containing nitrate potassium reduced tooth sensitivity during the bleaching regimen. Dentifrices containing arginine and calcium carbonate did not reduce tooth sensitivity. Color change was not influenced by the dentifrices used.

Descriptors: Tooth Bleaching; Dentin Sensitivity; Toothpastes.

Introduction

Tooth color is defined as a combination of intrinsic and extrinsic staining. The main intrinsic causes of discoloration are aging and pulp necrosis, whereas the most common extrinsic causes are coffee, tea, red wine, and tobacco.\textsuperscript{1-3} Vital teeth whitening is a solution for discolored teeth, because of its conservative approach and high success rate.\textsuperscript{1,4-6}

It has been theorized that the tooth bleaching mechanism is based on hydrogen peroxide ($\text{H}_2\text{O}_2$) penetration through the tooth structure due to its low molecular weight. Free radicals, such as perhydroxyl ($\text{HO}_2^-$), are able to oxidize chromophores and break them down into less complex molecules that reflect more light.\textsuperscript{5,7-9}
Whitening products of high hydrogen-peroxide concentration usually offer the best results in a short period of time, associated with mild and transient collateral effects, such as tooth sensitivity and gingival irritation. Brännström’s hydrodynamic theory is the most accepted explanation for tooth sensitivity and posits that it is caused by fluid movement inside the dentinal tubules. Recently, it has been hypothesized that sensitivity after bleaching differs from tooth sensitivity to cold and tactile stimuli, which are usually associated with root dentin exposure. Sensitivity after whitening probably occurs as a consequence of the functional properties of a chemosensitive ion channel called TRPA1 (transient receptor potential cation channel with ankyrin domain-type 1). This ion channel is associated with the pain caused by oxidants, including hydrogen peroxide. Since the afferent fibers of primary dental pulp contain TRPA1, it is possible that direct TRPA1 activation of nerve fibers is involved in the pain caused by tooth bleaching.

The mechanisms responsible for tooth sensitivity after bleaching have not been fully elucidated; however, some inflammatory mediators may play an important role. These effects have commonly been reported in association with bleaching techniques and different peroxide concentrations, although in-office whitening products cause greater sensitivity than at-home bleaching gels.

Several approaches to reducing sensitivity after dental bleaching have been suggested. The use of fluoride and treatment with nonsteroidal anti-inflammatory drugs (NSAIDs) lead to a significant reduction in post-operative sensitivity.

Anti-sensitivity dentifrices are another option for reducing the adverse effects of bleaching agents. These products act by:

1. reduction in the excitability of nerve fibers present in the pulp, and
2. obliteration of dentinal tubules.

A reduction in the excitability of nerve fibers could occur due to the diffusion of potassium salt through the enamel and dentine. These salts can reach the nerve terminations, affect nerve impulse transmission and result in a reduction or deletion of pain. The obliteration of dentinal tubules after using strontium chloride results in a reduction in dentin permeability and blocks the hydrodynamic mechanism.

Several years ago, products containing fluoride and potassium nitrate were launched on the market as desensitizers for professional use, dentifrices, or even associated with bleaching gels. More recently, products containing calcium carbonate and arginine have been marketed with the intent of providing a barrier and preventing fluid movement inside the dentinal tubules, aiming at reducing tooth sensitivity.

Considering that sensitivity is the main adverse effect of tooth whitening and that information on the effects of dentifrices as desensitizing agents is scarce, the aim of this study was to evaluate the efficiency of different desensitizing agents (potassium nitrate and arginine/calcium carbonate), contained in two dentifrices, in reducing tooth sensitivity in patients submitted to an in-office bleaching protocol. In addition, the influence on tooth color was evaluated.

**Methodology**

This research was approved by the Ethics Committee on Human Research of the Universidade Federal de Santa Catarina - UFSC (process number 1171 FR: 390769). All patients were selected according to inclusion and exclusion criteria (Table 1). Day 1

Tooth sensitivity was verified using a syringe with air spray positioned 2 millimeters from the buccal surfaces of the upper anterior teeth for 2 seconds. Patients who reported tooth sensitivity were excluded from the research. The patients who fulfilled all the prerequisites were given details of the bleaching procedure and were included in the research.

Selected patients were randomly divided into three groups (n = 15), each of which was assigned a dentifrice (Table 2).

Each patient received a soft toothbrush (Top Plus, Condor S/A, São Bento do Sul, Brazil) and a
supply of the toothpaste type assigned to the group. There were no labels or other types of identification on the toothpaste tubes, only a code for later analysis; both the patient and the operator were blinded. The toothbrush and toothpaste were used by the patients for 15 days before the first bleaching session.2

**Day 15**

Fifteen days after the patients began using the assigned toothpaste, each patient received a prophylaxis in a prophylactic paste without oil (Prophylactic paste Villevie, Dentalville of Brazil Ltda., Joinville, Brazil) for the removal of extrinsic stains. The tooth color of the upper right canine was evaluated by two operators, and, in the case of disagreement, a third individual was called. The Vitapan Classical guide (Vita Zahnfabrik RauterGmbH H. & Co, Bädsackingen, Germany) was organized according to a scale of values numbered 1–16.3,4,24,25 The first in-office bleaching session was performed in the maxillary arch.3,24 A resin barrier (Top Dam, FGM, Joinville, Brazil) and a lingual/lip retractor (Arcflex, FGM, Joinville, Brazil) were used. The whitening gel (35% HP Whiteness HP Blue Calcium, FGM, Joinville, Brazil) was applied on the buccal surfaces of the right second premolar through to the left second premolar, and left for 40 minutes. Each patient received a “sensitivity diary” to keep daily notes on tooth sensitivity for a period of one week, using an analogue visual scale that ranged from 0 to 10 (0 = no sensitivity/10 = maximum sensitivity). This scale is well-known and used as an instrument to measure a characteristic or an attitude, and is based on continuous values that cannot be measured objectively. During this period the patients continued to use the toothpaste assigned to their group.

**Day 22**

Seven days after the first bleaching session, the patients returned for a second session, which involved the same procedures. The sensitivity continued to be noted by the patients.

**Day 29**

One week after the second bleaching session, the “sensitivity diary” was returned by the patients and a new color evaluation was performed. The whitening procedure may lead to dehydration of the teeth, and consequently induce a false, lighter aspect immediately after the end of the session.26 For this reason, an interval of one week was considered neces-

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**Table 1 - Inclusion and exclusion criteria.**

<table>
<thead>
<tr>
<th>Inclusion</th>
<th>Exclusion</th>
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</thead>
<tbody>
<tr>
<td>* Presence of all six maxillary teeth equal or darker than shade D2 in the Vita Classical Guide in the value order</td>
<td>* Presence of restoration in the six anterior teeth, involving the labial surface or labially passing the contact area from the lingual surface</td>
</tr>
<tr>
<td>* Candidates must be willing to sign a consent form</td>
<td>* Candidates with gross pathology within the oral cavity</td>
</tr>
<tr>
<td>* Candidates must be at least 18 and less than 30 years of age</td>
<td>* Pregnant or lactating women</td>
</tr>
<tr>
<td>* Absence of any kind of dental pain</td>
<td>* Presence of calculus or heavy stain on the study sites</td>
</tr>
<tr>
<td>* Candidates must be able to return</td>
<td>* Candidates who recently used or currently use drugs, alcohol or over-the-counter pain relievers</td>
</tr>
<tr>
<td>* Candidates must be non-smokers</td>
<td>* Candidates who recently used or currently use desensitizing toothpaste or over-the-counter desensitizers</td>
</tr>
<tr>
<td>* Absence of cervical lesion and root exposure</td>
<td></td>
</tr>
<tr>
<td>* Candidates with good oral health</td>
<td></td>
</tr>
<tr>
<td>* Absence of dental hypersensitivity to cold and/or heat</td>
<td></td>
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</tbody>
</table>

**Table 2 - Groups.**

<table>
<thead>
<tr>
<th>CT</th>
<th>CS</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colgate Total</td>
<td>Colgate Sensitive Pro-Relief</td>
<td>Sensodyne ProNamel</td>
</tr>
<tr>
<td>(Colgate-Palmolive, São Paulo, Brazil)</td>
<td>(Colgate-Palmolive, Sao Paulo, Brazil)</td>
<td>(GlaxoSmithKline, Rio de Janeiro, Brazil)</td>
</tr>
<tr>
<td>1450 ppm of fluoride</td>
<td>containing arginine and calcium carbonate (1450 ppm of fluoride)</td>
<td>containing 5% potassium nitrate (1450 ppm of fluoride)</td>
</tr>
</tbody>
</table>
sary before performing the new evaluation, since most of the color variation due to the rebound effect occurs in the first week after bleaching.24

Values ranging from 1 (B1) to 16 (C4) were determined for each Vitapan Classical Guide shade, and the color change was assessed based on the difference between the initial and final colors.25

A statistical analysis was performed to determine the sensitivity reported by the patients, and the color changes were analyzed subjectively based on the Vitapan scale. The results were analyzed applying the Shapiro-Wilk, Wilcoxon, Kruskal-Wallis and Mann-Whitney tests at a significance level of \( \alpha = 0.05 \). The analysis was performed on Microsoft Excel 2008 (Microsoft Office system 2008, Redmond, USA) and SPSS 19 (SPSS Inc., Chicago, USA).

**Results**

**Tooth sensitivity**

The results showed a statistically significant difference between groups CT and SP only in the first week of evaluation. When comparing the two evaluations (first and second) for any same group, no statistically significant difference was observed (Table 3 and Figure 1).

**Color**

Tooth Color changes were observed through visual analysis based on a scale. Table 4 and Figure 2 present the initial and final values for the three experimental groups. There was no statistically significant difference between one group and the other. However, there was a statistically significant difference in color change for all groups before and after the bleaching session.

**Discussion**

The results of this study show that in-office bleaching is an effective procedure. Considering that no significant difference was observed in color change between the groups evaluated, it can be assumed that the dentifrices did not influence the

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**Table 3 -** Mean, standard deviation and statistical results for comparison of dental pain sensitivity between the groups in the two periods evaluated.

<table>
<thead>
<tr>
<th>Group</th>
<th>After first session</th>
<th>After second session</th>
<th>( p )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colgate Total (CT)</td>
<td>1.97 ± 1.6( \alpha )</td>
<td>1.67 ± 1.3( \alpha )</td>
<td>0.440</td>
</tr>
<tr>
<td>Colgate Sensitive Pro-Relief (CS)</td>
<td>1.63 ± 1.7( \beta )</td>
<td>1.17 ± 1.3( \alpha )</td>
<td>0.292</td>
</tr>
<tr>
<td>Sensodyne ProNamel (SP)</td>
<td>0.83 ± 0.9( \beta )</td>
<td>0.83 ± 0.9( \alpha )</td>
<td>0.765</td>
</tr>
<tr>
<td>( p )-value</td>
<td>0.048</td>
<td>0.145</td>
<td></td>
</tr>
</tbody>
</table>

Means with same lower-case letters, in the same column (for each criteria), are not statistically different.
bleaching results. It was expected that the dentifrice containing calcium carbonate and arginine would influence bleaching gel diffusion because of its mechanism of action, which is similar to that of fluoride. Fluoride action involves dentinal tubule obliteration and modification of enamel permeability. However, the peroxide molecule is very small and can penetrate the interstitial spaces between enamel pores. This probably explains the similar bleaching results obtained for the different groups. A study using bleaching with 35% hydrogen peroxide and color evaluation using the Vita Classical shade guide showed a color change (6.15 units) similar to that of our research results (6.3 units). In another study a variation of 2.1 to 3.7 units was noted after each in-office whitening session.

The shade guide scale for color change evaluation is known as a quick, easy, reliable and valid method. It is noteworthy to mention that this research aimed at assessing the influence of dentifrices on bleaching results, and not to compare the total color variation with that of other studies.

Although the sensitivity after dental bleaching is usually mild, some patients report higher levels and abandon the treatment. Considering these difficulties and the lack of studies that have evaluated the effect of desensitizing dentifrices on in-office bleaching, the aim of this research work was to examine ways of reducing or preventing tooth sensitivity during and after bleaching procedures.

Two approaches are currently used for preventing tooth sensitivity. The first is based on the hydrodynamic theory and aims at reducing tooth permeability. The second strategy uses substances to diminish the excitability of nerve fibers in the dental pulp. Therefore, dentifrices with these two mechanisms of action were selected for the study, in addition to the control group.

Compared with the control group, the group of patients who used the dentifrice containing potassium nitrate showed a statistically significant reduction in tooth sensitivity during the first week after the first bleaching session. In the literature, two studies on dentifrices containing potassium nitrate to evaluate at-home bleaching have been reported. It

<table>
<thead>
<tr>
<th>Groups</th>
<th>Baseline</th>
<th>Final</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colgate Total (CT)</td>
<td>11.87 ± 2.4</td>
<td>4.33 ± 2.3</td>
<td>0.001</td>
</tr>
<tr>
<td>Colgate Sensitive Pro-Relief (CS)</td>
<td>11.07 ± 1.8</td>
<td>4.87 ± 2.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Sensodyne ProNamel (SP)</td>
<td>10.40 ± 2.3</td>
<td>4.13 ± 2.03</td>
<td>0.001</td>
</tr>
<tr>
<td>p-value</td>
<td>0.616</td>
<td>0.82</td>
<td></td>
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</tbody>
</table>

Figure 2 - Graphical representation of tooth shade, before and after the bleaching treatment, recorded using a VITA Classical shade guide arranged in decreasing order of value.
was observed that most of the patients (58%) did not report tooth sensitivity during the seven days after bleaching. Additionally, the groups of patients who used this dentifrice reported a longer period without experiencing sensitivity (10.1 days) than the control group (8.6 days). In the second similar study examined, although there was no significant difference in terms of color change, a greater percentage of patients who used the dentifrice were satisfied with the level of tooth sensitivity. In another study, a desensitizing gel containing potassium nitrate was applied on the teeth before the in-office bleaching session. The occurrence and/or intensity of sensitivity were significantly reduced for the experimental group compared with the control (46.7% versus 86.7%).

This effect may be explained by the following theory: The functional properties of the TRPA1 ion channel are associated with the pain caused by oxidants. This includes hydrogen peroxide through direct activation of dental innervation, and is not related to the hydrodynamic mechanism as reported by Markowitz. Furthermore, this theory could explain why the pain after bleaching differs from normal tooth sensitivity, as reported by patients who described this pain as sensations that resembled “needles” or were “shock-like,” and that were not triggered by thermal stimuli. It has been suggested that potassium salts are more effective than other treatments in reducing the sensitivity caused by tooth whitening. Another research study has demonstrated that the use of potassium nitrate might be more effective than fluoride in decreasing tooth sensitivity after at-home bleaching. These studies corroborate the results found in this research.

The use of dentifrice containing calcium carbonate and arginine did not lead to a significant reduction in tooth sensitivity, probably because patients with root exposure were not included in this research. The main mechanism of action of this dentifrice involves the obliteration of exposed root dentin tubules, but this condition was not observed in the patients.

The reduction of tooth sensitivity during a period of dental bleaching is beneficial because it improves the patient’s comfort and commitment to the treatment. The lack of statistically significant differences among the groups in the second week might be explained by the high standard deviation.

Conclusions
1. The use of dentifrice containing 5% potassium nitrate for 14 days (before and during dental bleaching treatment) reduced tooth sensitivity during the first week.
2. The dentifrices indicated for sensitive teeth, used in this study, did not affect the effectiveness of in-office bleaching with 35% hydrogen peroxide, when compared with the control group, which used traditional dentifrice.

References