

OCCURRENCE OF SENSITIVITY DURING AT-HOME AND IN-OFFICE TOOTH BLEACHING THERAPIES WITH OR WITHOUT USE OF LIGHT SOURCES

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ABSTRACT

The aim of this study was to evaluate the effect of tooth bleaching with 10% carbamide peroxide (CP) or 35% hydrogen peroxide (HP), with or without quartz-tungsten-halogen light or hybrid source LED/infrared laser exposition on the occurrence, duration, intensity and location of tooth sensitivity. Forty patients were selected and randomly divided into four groups: GI – home bleaching with CP for 4 hours a day, over the course of 3 weeks; GII – three sessions of HP, with three 10-minute applications at each session and no light source; GIII – the same procedure as GII with quartz-tungsten-halogen light irradiation; GIV – the same procedure as GII with LED/laser light irradiation. The evaluation included an

appointment with each patient before and after each HP bleaching session or each weekly CP bleaching and 7, 30 and 180 days after the end of treatment. The Kruskal-Wallis test revealed that the duration and intensity of post-treatment sensitivity were significantly higher for HP than for CP ($p < 0.05$), and symptoms were located predominantly in anterior teeth. All bleaching methods generated sensitivity, which was more frequent in anterior teeth. However, treatment with CP generated lower sensitivity than treatment with HP, independently of the light sources.

Key words: tooth bleaching, carbamide peroxide, hydrogen peroxide, adverse effects.

OCORRÊNCIA DE SENSIBILIDADE DURANTE O CLAREAMENTO DENTAL CASEIRO E DE CONSULTÓRIO COM OU SEM USO DE FONTES DE LUZ

RESUMO

O objetivo deste estudo foi avaliar o efeito do clareamento dental com peróxido de carbamida a 10% (PC) ou peróxido de hidrogênio 35% (PH), com ou sem a exposição a luz halógena ou fonte de luz híbrida LED/laser infravermelho, sobre a ocorrência, duração, intensidade e localização da sensibilidade dentária. Para tanto, quarenta pacientes foram selecionados e divididos aleatoriamente em quatro grupos: GI- clareamento caseiro com PC 4 horas por dia, ao longo de três semanas; GII- três sessões de PH, com três aplicações de 10 minutos durante cada sessão e sem uso de fonte de luz; GIII- o mesmo procedimento do GII com irradiação de luz halógena; GIV- o mesmo procedimento do GII com irradiação de luz LED/laser. A avaliação incluiu uma entre-

vista com cada paciente antes e após cada sessão de clareamento com PH ou cada semana de clareamento com PC e 7, 30 e 180 dias após o término do tratamento. O teste de Kruskal-Wallis revelou que a duração e intensidade da sensibilidade pós-tratamento foram significativamente maiores para o PH em relação ao PC ($p < 0,05$), e a localização dos sintomas foi predominantemente em dentes anteriores. Todos os métodos de clareamento geraram sensibilidade, que foi mais freqüente em dentes anteriores. No entanto, o tratamento com CP gerou menor sensibilidade do que o tratamento com PH, independente das fontes de luz.

Palavras-chave: Clareamento dental, peróxido de carbamida, peróxido de hidrogênio, efeitos adversos.

INTRODUCTION

Peroxides have been applied to bleach teeth for more than a century¹. However, peroxide use became more popular after the development of at-home bleaching techniques². The demand for esthetics has

increased the frequency of requests for tooth bleaching among dental patients.

Home bleaching is considered a safe and effective treatment³⁻⁵. This technique is performed with low-concentration hydrogen peroxide or carbamide

peroxide (CP) formulations, which are inserted into trays. These trays are placed in the mouth for 2-8 hours per day, over the course of 2 to 6 weeks. The in-office bleaching technique applies highly concentrated peroxides to the tooth surface for up to one hour. This procedure can be repeated weekly to achieve the intended esthetic result. This method is usually indicated for patients that desire faster results or do not wish to perform the at-home technique. In-office tooth bleaching is usually associated with heat or light sources, to improve the effect of the bleach product. However, this association is still in question and some clinical studies do not confirm these benefits⁶⁻⁹.

The bleaching process occurs because the low molecular weight of hydrogen peroxide (HP) allows it and its derivatives (reactive oxygen species – ROS) to diffuse easily through enamel and dentin^{1, 10}. The mechanics of bleaching action are not fully understood, although it is known that HP reacts with the pigmented molecules in hard tooth tissues, fragmenting them into shorter, lighter-colored molecules¹¹. However, some *in vitro* studies have demonstrated that HP may also penetrate the pulp chamber^{10, 12-15} and generate pulp inflammation and tooth sensitivity, which are the most common side effects of bleaching treatment¹⁶. Although post-bleaching tooth sensitivity can be mild and transient, it may cause patient discomfort³. The sensitivity may be exacerbated when a whitener with high HP concentration is applied with heat^{3, 17}.

Various authors have demonstrated that application time¹⁵, heat-activation^{7, 13}, and the concentration of peroxide and other chemical components can influence the diffusion of ROS through hard tooth tissues and the extent of pulp penetration. Variations in enamel and dentin thickness may also determine the diffusion of products released from bleaching gels through enamel and dentin. These differences can result in varying degrees of pulp damage. Therefore, the association of these factors may generate sensitivity after tooth bleaching^{3, 10, 13, 14, 18}.

The recent popularity of bleaching has given rise to many papers being published in major dental journals. However, most of the research has evaluated and compared the bleaching efficacy of commercial products used on hard tooth tissues, rather than the biological safety of this clinical procedure¹.

According to the FDA (Food and Drug Administration), a drug can be considered safe when its components generate a low incidence of adverse

reactions or side effects when applied according to the manufacturer's instructions¹. Clinical reports reveal that most patients exhibit post-bleaching tooth sensitivity^{3, 6, 19}, so the aim of this *in vivo* study was to compare the effect of CP (at-home bleaching) and HP (in-office bleaching) bleaching gels, with or without quartz-tungsten-halogen light or LED/laser irradiation on the occurrence, duration, intensity and location of tooth sensitivity.

Three null hypotheses were established: 1. there is no difference in tooth sensitivity when using various tooth bleaching techniques; 2. the exposition of HP bleaching gel by different light sources does not alter tooth sensitivity during and after bleaching; and 3. there is no difference between anterior and posterior teeth with regard to the occurrence of sensitivity during and after bleaching.

MATERIALS AND METHODS

The study was analyzed and approved by the Research Ethics Committee of Araçatuba Dental School – UNESP (Protocol 2007-01120).

Patient selection

Forty volunteers that desired tooth bleaching were selected after anamnesis and detailed clinical and radiographic exams.

The inclusion criteria selected patients with no caries, good general and periodontal health, between 18-28 years of age, with good oral hygiene, who were nonsmokers and available for follow-up examinations.

Patients who were pregnant or lactating; patients who had undergone orthodontic treatment or previous bleaching treatment; individuals presenting deficient restorations, any symptom of spontaneous pain or tooth sensitivity triggered by air spray, and patients who continuously used analgesics or anti-inflammatory drugs were excluded.

Materials and bleaching treatments

Each volunteer was informed about the objectives, benefits and potential risks (including tooth sensitivity) involved in the experiment. The subjects also received, read and signed an informed consent form. The volunteers were randomly divided into four groups (n=10), according to the tooth bleaching techniques used.

The volunteers in group I (GI) were submitted to at-home bleaching with a 10% CP (Whiteness Per-

fect, FGM, Joinville, Brazil). Alginate impressions of the superior and inferior arches were performed to obtain dental casts. Silicone trays (1 mm in thickness) were made in a vacuum-forming machine (Plastivac P5, Bio-Art Dental Equipments Ltda, 13568-000, São Carlos, SP, Brazil). The trays were cut at the cervical region of teeth, and additional repairs were performed after clinical evaluations. The volunteers were instructed to insert the bleaching gel on the area corresponding to the buccal surface of each tooth in the tray. The trays with bleaching gel were placed on the upper and lower arches for 4 hours each day. This at-home bleaching procedure was carried out for 21 days, with a weekly follow-up to clinically evaluate patients and provide additional whitener.

For patients from groups II, III and IV, the gingival tissue was isolated with a barrier of light-polymerized resin (Top Dam-FGM, Joinville, SC, Brazil). This procedure was performed before the application of bleaching gel on the teeth to avoid contact of the product with the soft tissues. These patients were submitted to the in-office bleaching technique with a bleaching gel containing 35% HP (Whiteness HP, FGM, Joinville, SC, Brazil), with or without quartz-tungsten-halogen light or LED/laser irradiation. The product was handled according to the manufacturer's instructions. We used enough of the product to cover the buccal surface of teeth.

The gel remained on the enamel for 10 minutes. It was then removed with plastic suction cup and cotton. After washing the region, we applied the whitener two more times, according to the previously described protocol. Each bleaching session lasted 30 minutes altogether. A total 3 sessions were performed at 7-day intervals.

Considering that the bleaching gel was not irradiated in group II, free radicals were generated exclusively by chemical reaction. This reaction was accelerated by the increased pH that resulted from mixing the peroxide and thickener at a ratio of 3:1.

In group III, the bleaching gel was irradiated by halogen light for 20 s (Ultralux-Dabi Atlante, Ribeirao Preto, SP, Brazil – light intensity of 400 mW/cm² and wavelength between 450-500 nm) immediately after application to the tooth. Therefore, in this group, the product was irradiated for 60 s during the 30-minute bleaching session each week. For group IV, a LED/laser light source (Whitening Lase II, DMC Equipamentos Ltda, Sao Carlos, SP,

Brazil) was applied. This light source is composed of 6 LEDs that generate blue light with an intensity of 120 mW/cm² and wavelength of 470 nm. The device also includes 3 diodes for infrared laser emission, at a wavelength of 808 nm and potency of 0.2 W. The bleaching gel was irradiated during the first 3 minutes after application to the buccal surface of teeth. The total irradiation time was 9 minutes, since the bleaching gel was applied for 30 minutes (3 applications of 10 minutes) during each session.

Analysis of sensitivity

Sensitivity was evaluated through volunteer reports before, during and after in-office bleaching sessions, or at the weekly follow-ups for the at-home bleaching treatment. Additional evaluations were carried out after 7, 30 and 180 days of treatment. The evaluated criteria included duration (Table 1), intensity and location of tooth sensitivity.

The intensity of sensitivity was recorded using an analog scale with values from 0 to 10. Zero values were established for patients with no sensitivity, values of 10 represented patients that reported unbearable pain sensitivity⁵.

The patients were also asked about symptom location: 1. sensitivity in anterior teeth (central and lateral incisors, and canines); 2. sensitivity in posterior teeth (premolars and molars); or general sensitivity (both regions).

Data analysis

The duration and intensity of sensitivity were analyzed by the Kruskal-Wallis and Dunn's multiple comparison tests, at the 5% level. Sensitivity analysis of the region is in the form of a percentage.

RESULTS

Forty volunteers completed the study. Only 5 patients (12.5%) reported no pain throughout the entire treatment. There was no report of sensitivity 7, 30 or 180 days after the end of treatment.

Table 1: Scores for the evaluation of duration of sensitivity.

| Scores | Duration of tooth sensitivity |
|--------|---|
| 0 | No sensitivity |
| 1 | Only during bleaching session or tray use |
| 2 | Up to 12 hours after bleaching |
| 3 | More than 12 hours after bleaching |

Duration of sensitivity

Considering the initial comparison among the groups (7 days with bleaching tray or first in-office bleaching session), the pain lasted longer in the patients treated with HP associated with LED /laser. This difference was statistically significant ($p < 0.05$) in comparison to the patients submitted to tooth bleaching with CP (Table 2). There was no statistical difference ($p > 0.05$) among the groups treated with HP, either with or without light (G-II, G-III and G-IV).

After the second bleaching session, the duration of sensitivity generated by home bleaching (G-I) was statistically similar to that observed in the group treated with 35% hydrogen peroxide bleaching gel (G-II). The duration of sensitivity in G-I was shorter than that exhibited in G-III and G-IV, who were treated with irradiation by quartz-tungsten-halogen

light or LED/laser, respectively. After the third and final bleaching session, there was no significant difference among groups with regard to the duration of sensitivity.

Intensity of sensitivity

In general, teeth were less sensitive after home bleaching (G-I) than in-office bleaching with the application of a 35% HP gel, either with or without light irradiation (G-II, G-III and G-IV). For home bleaching with CP, 5 patients reported no symptoms or discomfort. However, there was one report of maximum pain (score 10) during the first bleaching session with HP irradiated by quartz-tungsten-halogen light (G-III).

The evaluation of pain intensity after the first bleaching session differed significantly between the groups submitted to bleaching with CP (G-I) and that submitted to treatment with bleaching gel irradiated by LED/laser light (G-IV) ($p < 0.05$). After the third bleaching session, there was a significant decrease in sensitivity, with no statistical difference among the groups ($p > 0.05$) (Table 3).

Location of sensitivity

Among the 35 patients that presented sensitivity, no patient reported that the symptom occurred exclusively in the posterior region; 26 (74.29%) exhibited sensitivity in the anterior region; and 9 patients (25.71%) reported general sensitivity. The location of sensitivity is presented as a percentage in Table 4 for each group.

Table 2: Mean (standard deviation) of scores obtained for evaluation of duration of sensitivity.

| Group | 1st session | 2nd session | 3rd session |
|-------|---------------|--------------|--------------|
| I | 0.7 (1.16) A | 0.3(0.94) A | 0.6 (1.26) A |
| II | 1.3 (0.94) AB | 1.0(0.94) AB | 0.9(0.99) A |
| III | 1.4 (0.69) AB | 2.0(0.81) C | 1.2 (0.91) A |
| IV | 1.7 (0.48) B | 1.3(0.82) BC | 0.6 (0.84) A |

Same letters in a row represent statistical similarity

Table 3: Mean (standard deviation) of scores obtained for evaluation of intensity of sensitivity.

| Group | 1st session | 2nd session | 3rd session |
|-------|---------------|--------------|--------------|
| I | 1.0 (1.76) A | 0.6(1.89) A | 0.7 (1.88) A |
| II | 3.3 (2.58) AB | 3.4(3.56) AB | 2.8 (3.01) A |
| III | 4.3 (2.90) AB | 3.8(2.78) B | 2.8 (2.97) A |
| IV | 5.4 (2.01)B | 4.7(3.36) B | 2.2 (3.22) A |

Same letters in a row represent similar results

Table 4: Percentage of occurrence and location of sensitivity.

| Group | No pain | Anterior | Posterior | General |
|-------|---------|----------|-----------|---------|
| I | 50 % | 50 % | 0 | 0 |
| II | 0 | 80 % | 0 | 20 % |
| III | 0 | 70 % | 0 | 30 % |
| IV | 0 | 60 % | 0 | 40 % |

DISCUSSION

The first null hypothesis was rejected because different techniques resulted in various levels of sensitivity. However, the second hypothesis may be partially accepted since the patients submitted to quartz-tungsten-halogen light irradiation presented sensitivity of longer duration than those treated with HP without a light source – but only during the second session. The third hypothesis was rejected due to a strong tendency for sensitivity in the anterior region.

This *in vivo* study demonstrates that tooth sensitivity, even if transitory, is a frequent side effect in patients submitted to various techniques tested. The results showed that only 5 patients reported no sensitivity, while 35 presented pain, although no symptoms remained after 7, 30 or 180 days of the end of treatment.

The great demand for bleaching treatment and the need for faster results led to the development of commercial products with high concentrations of hydrogen peroxide for in-office application. However, these products can be applied for long periods, since the appropriate parameters have not been outlined in the literature. It is important to highlight that the effects on pulp are proportional to whitener concentration and application time^{1, 14, 20, 21}.

In this study, the 35% hydrogen peroxide was applied and two times substituted by a new product totaling 30 minutes on the tooth surface at each session. This posology might result in higher sensitivity values compared to the carbamide peroxide group.

Consecutive applications of high concentrations of HP may result in post-operative pain and possible pulp damage on anterior teeth, which have thinner enamel and dentin than posterior teeth²².

Many studies have demonstrated that H₂O₂ and other free radicals released from bleaching gels diffuse through enamel and dentin^{10,23}, causing varying degrees of pulp response^{7, 17, 18, 24, 25}.

Increased synthesis of substance P (SP), a neuropeptide whose functions are linked to inflammation, is related to penetration of reactive oxygen species in the pulp tissue after in-office bleaching associated with light/heat¹⁸, while in the home bleaching, no increase in the release of SP²⁶ and only slight histological changes were reported²⁴.

Differences in the duration and intensity of sensitivity among groups probably resulted from the fact that a higher quantity of HP than CP penetrates the pulp chamber. After a 15-minute treatment, 35% HP delivers 12 times the amount of peroxide to the pulp chamber than 10% CP does²⁷. According to Patel, Louca and Millar⁸, treatment with CP may offer the best compromise between sensitivity and efficacy. They also question the efficacy of "power bleaching" techniques due to the increased risk of sensitivity as well as extended chair time and elevated cost. Haywood, in 1992, reported that high hydrogen peroxide concentrations cause alterations in tooth structure²⁸. These changes can be attenuated through treatment with CP, which applies a lower peroxide concentration and allows more contact with saliva^{28, 29}.

Despite such considerations, Zekonis et al.⁴, in 2003, reported similar sensitivity for HP and CP bleaching techniques. However, the materials and dosage used differed from those in the present study.

Some studies have established that the use of a light source increases temperature and H₂O₂ penetration in the pulp chamber^{13, 18}. This condition is related to the bleaching product²⁷, light source^{18, 30}, irradiation time³⁰, teeth group^{14, 22, 30} and presence of restorations¹². Elevated temperature and exacerbated diffusion of free radicals may cause increased sensitivity and pulp damage^{7, 18, 30, 31}. Other studies associate the light source and heat with post-operative problems such as inflammation^{3, 7, 10, 17}. However, in the present study, the technique with no light also generated sensitivity, as shown by Marson et al.⁶.

Therefore, a problem to be considered is the high H₂O₂ concentration that is often applied to enamel for long periods. Light seems to be a secondary determinant of bleaching effect^{4, 7-9} and pain⁶.

In the last bleaching session, all groups showed a decrease in tooth sensitivity (Tables 2 and 3). Although the literature presents a trend for reduced sensitivity over the course of treatment^{1, 3, 32, 7} patients that presented sensitivity during the first and second sessions (3 treated with HP without irradiation, 1 treated with HP and quartz-tungsten-halogen light, and 3 treated with HP and LED/laser) used analgesic before the third bleaching session, which may have attenuated the pain levels³³.

Regarding the location of sensitivity, differences between teeth in enamel and dentine thickness, as well as exposed area, must be considered. In the central incisors, a large area is exposed to the product, whereas the lateral incisors have thinner dentine, both of which increase temperature^{3, 14} and peroxide penetration into the pulp chamber^{10, 22}. This explains why all patients with pain reported discomfort in this region and why 74.29% of cases presented sensitivity only in the anterior teeth.

The results of this clinical research illustrate that in general sensitivity was mild to moderate and of short duration. In the group treated with CP, sensitivity was absent or lasted only during the treatment. In groups treated with HP, sensitivity was present no longer than 12 hours after treatment and the scores represent moderate pain. At-home bleaching techniques with 10% CP for 21 days generated lower sensitivity than the techniques with 3 sessions of 35% HP, independently of the light source used. Participants tolerated the sensitivity well and, as demonstrated by the fact that they completed the study, the benefits for these participants were greater than the discomfort.

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