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Original Research Article

Whitening gel and light source influence on pulp chamber temperature

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Abstract

Introduction: The chemical injury caused to the pulp by the penetration of the whitening gel is already known, but another possible cause may be the heat generated by the irradiation of the whitening gel with light sources to accelerate the whitening reaction. **Objective:** To evaluate *in vitro* the temperature increasing in the pulp chamber during in-office bleaching with different gel concentrations and light sources. **Material and methods:** A maxillary human central incisor was used in the 6 groups evaluated. The specimen was sectioned 3 mm apical to the cementoenamel junction. The root canal and pulp chamber were cleaned and widened with a diamond bur to receive the sensor of a thermocouple thermometer. The following hydrogen peroxide gel concentrations were evaluated: 35%, 25%, 15%, and 10%; and the following light sources were applied: blue hybrid LED/laser and violet hybrid LED/laser. The specimen bleaching was repeated 6 times per group. As a control, the temperature was measured with the application of light, without applying any gel. Results were evaluated with one-way ANOVA and Tukey's test ($\alpha = 5\%$). **Results:** Significant differences between groups were observed ($p < 0.05$). The blue LED without the gel induced the smallest heat (37.5 ± 0.2) and the blue LED with 15% gel caused the highest heat (38.2 ± 0.3). The combination of violet LED with the 10% gel caused no significant increase in temperature compared to the control in which light was used without gel ($p > 0.05$). **Conclusion:** No increase in pulp chamber temperature was higher than 2°C.

Introduction

The search for the rehabilitation of smile beauty has increased more each day, since in the society the anterior teeth are considered essential for good physical appearance of the individual [19]. The esthetics plays an important role in dentistry and aim to return the beauty of today's standards. In the case of teeth, beauty is given by contour, shape, symmetry, and color [21]. To solve the color changes of the teeth starting with less invasive procedures, the whitening techniques are increasingly being used in Cosmetic Dentistry [17].

Among the different techniques available to perform tooth whitening, one can opt for in-office bleaching, with the possibility of using higher concentration gels, and also associate the gel with light source and/or heat in order of accelerating the peroxide excitement reaction and the release of reactive oxygen [5, 22]. Thus, the use of light in the bleaching could reduce the time of gel contact with the tooth surface decrease the sensitivity and promote satisfactory results. The devices currently available in the market employ incandescent, halogen, lasers and high-power LED light sources. These have been shown to be effective in promoting the breakdown of hydrogen peroxide [7, 20, 27]; however, its use has been widely discussed in the literature [14, 16]. And yet exists a concern of the professionals and manufacturers about the possible deleterious effects to the pulp by the action of bleaching agents associated with such sources, since the light, by accelerating the peroxide degradation process can raise the temperature of the bleaching agent and the dental pulp [19].

In function of this increase in temperature, tooth sensitivity may be a side effect [4]. Furthermore, so that irreversible pulp damage do not occur, this increase in temperature may not exceed 5.5°C above normal body temperature [27]. This study was designed to assess the increase in pulp chamber temperature after activating the bleaching gels at various concentrations associated with two different hybrid light sources. We tested the hypothesis that the use of hybrid LED/laser light source could cause temperature increases in the pulp chamber exceeding 5.5°C in relation to the body temperature of 37°C.

Material and methods

The study was submitted and approved by the local Ethics Committee with protocol number 139/2011. A human maxillary central incisor was selected after extraction due to periodontal reasons, free of decay and restoration. The tooth was cleaned by prophylaxis with Robson brush, pumice and distilled water and kept submerged into a vial containing saline. After cleaning, the tooth was sectioned at the root portion about 3 mm below the cementoenamel junction with diamond disc. The removal of the remnants inside the pulp chamber and root canals was performed by irrigation with 0.5% sodium hypochlorite and saline. The root canal was enlarged with a diamond tip number 2235 (KG Sorensen, Barueri, SP, Brazil) to allow insertion of the sensor of a thermometer along with a thermal paste.

The thermometer sensor was inserted into pulp chamber and the sensor position was determined by means of a radiograph. Inside the pulp chamber, a thermal paste was applied. This paste was changed after every five applications of the gel. The root portion of the tooth was immersed in water at 37°C, therefore raising the pulp chamber to this temperature (figure 1).

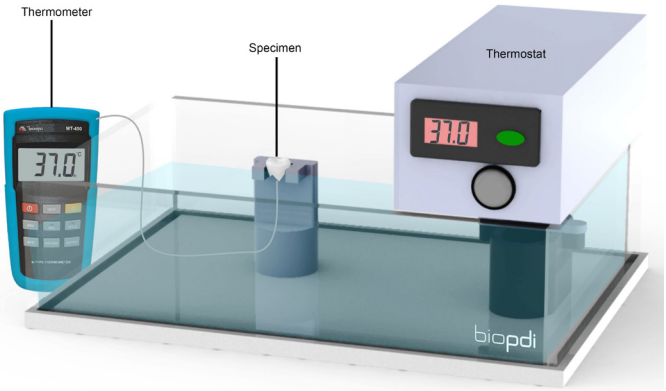

Figure 1 – Schematic drawing of the study design

The bleaching of the same specimen was repeated 6 times in each group, wherein applying the gel lasted for 8 consecutive minutes, and activation with light performed 2 times for 3 min with an interval of 1 min between activations. The temperature measurements were performed every 30 seconds, totalizing 17 measurements. Hydrogen peroxide gels were used at concentrations of 10, 15, 25 and 35% activated by two light sources: Whitening Lase II System (blue hybrid LED/diode laser light) and experimental violet light (violet hybrid diode laser), ambos da DMC Devices Ltd., São Carlos, SP, Brazil.

The control of the gel thickness was performed with the aid of a periodontal probe at 1 mm and the distance from the light source to the tooth surface was standardized at 10 mm with the aid of a millimeter ruler. Six groups were evaluated according to the combinations of the bleaching gel and the light source (table I).

Table I – Groups evaluated

Groups	Treatment
Group 1	Tooth without gel, activated with Whitening Lase II (Violet LED)
Group 2	Tooth without gel, activated with Whitening Lase II (Blue LED)
Group 3	Tooth bleached with 10% hydrogen peroxide (Lase Peroxide Lite, São Carlos, SP, Brazil) activated with hybrid light (violet LED and diode laser) Whitening System Lase II (DMC Devices Ltd.)
Group 4	Tooth bleached with 15% hydrogen peroxide (Lase Peroxide Lite) activated with hybrid light (blue LED and diode laser) Whitening Lase II system (DMC Devices Ltd.)
Group 5	Tooth bleached with 25% hydrogen peroxide (Lase Peroxide Sensy II) activated with hybrid light (blue LED and diode laser) Whitening Lase II System (DMC Devices Ltd.)
Group 6	Tooth bleached with 35% hydrogen peroxide (Lase Peroxide Sensy) activated with hybrid light (blue LED and diode laser) Whitening Lase System

To measure the temperature, a digital thermometer we used with type K thermocouple (Minipa Ind. Com. Ltda., São Paulo, SP, Brazil), measuring the initial temperature starting from the gel application, following by readings every 30 seconds, totalizing 17 measurements in 8 minutes. Data were analyzed by ANOVA and Tukey test. It was adopted a global significance level of 5%.

Results

The means and standard deviations of temperature in different bleaching protocols are presented in table II. For statistical analysis, it was considered the measurement periods in the presence of light in the six whitening sessions per experimental group and a mean of these sessions. Statistical significant differences were observed between groups ($p < 0.05$). The blue LED without gel provided the lowest temperature increase (37.5 ± 0.2). The blue LED with 15% exhibited the highest temperature increase (38.2 ± 0.3). The violet LED without gel, violet LED with 10% gel, the blue LED with 35% gel, and the blue LED with 25% gel presented no significant differences. The violet LED associated with a 10% gel caused no significant increase in temperature compared to control, in which light was used without gel ($p > 0.05$).

Table II – Mean temperature (in °C) and standard deviations at measurement periods with light, per group in 6 whitening sessions followed by the session mean*

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Mean
G1 (no gel / violet LED)	38 ± 0	38 ± 0	38 ± 0	38 ± 0	38 ± 0	38 ± 0	38 ± 0BC
G2 (no gel / blue LED)	37.6 ± 0.5	37.1 ± 0.3	37.7 ± 0.4	37.8 ± 0.4	37.2 ± 0.4	37.7 ± 0.4	37.5 ± 0.2A
G3 (10% / violet LED)	37.8 ± 0.4	38 ± 0	38 ± 0	38 ± 0	38 ± 0	38.8 ± 0.4	38.1 ± 0.1BC
G4 (15% / blue LED)	38.6 ± 0.5	37.9 ± 0.3	38.3 ± 0.6	37.7 ± 0.4	38.7 ± 0.4	37.8 ± 0.4	38.2 ± 0.3C
G5 (25% / blue LED)	37.2 ± 0.4	37.6 ± 0.5	38.1 ± 0.3	37.9 ± 0.3	37.9 ± 0.3	38.7 ± 0.5	37.9 ± 0.3B
G6 (35% / blue LED)	38.3 ± 0.5	38.4 ± 0.5	38 ± 0	37.5 ± 0.5	38 ± 0	38.3 ± 0.8	38.1 ± 0.2BC

* Uppercase different letters in the same column (intergroup) indicate statistically significant difference ($p < 0.05$)

Discussion

This study was designed to test the hypothesis that the combination of hydrogen peroxide-based bleaching gels at different concentrations with two sources of light hybrid LED/laser would cause temperature increases in the pulp chamber greater than 5.5°C. Although the in-office tooth whitening is widely discussed in the literature, with studies reporting conflicting and controversial results, the hypothesis was rejected, since no association between whitening gel/light source provided temperature increase greater than 2°C. The use of heat sources was proposed by Abbot, in 1918 [1], and have been adopted in order to accelerate this reaction. However, with the improvement of bleaching technique combined with the variety of energy sources, the dentists' doubts on which type of treatment should be delivered increased. When combining the bleaching gel to a light source, one should take into account the intensity of the light used, the heat generated by this source and exposure time, to avoid irreversible pulp damage [2, 8, 24]. Previous studies have shown some advantages of using LED light sources such as low temperature increase in the pulp chamber [7, 17], which is consistent with the results of this study.

Currently there is a wide range of light devices for in-office bleaching. The hybrid devices that combine LED and diode laser therapy are relatively new on the market [18]. In this study, we employed: hybrid blue LED-based light and diode laser and an experimental source of violet LED-based and diode laser.

Some authors found different temperature increases in teeth by varying dentin thicknesses [23, 25]. For that reason, only one tooth was used for all groups, in order to standardize the size and thickness of the specimens. Furthermore, an upper central incisor was selected for this study, because this is the anterior tooth most bleached [6, 9, 11, 12]. Previous studies have also used maxillary central incisor [2, 3, 15, 23, 24, 26, 29]. It is interesting to note, however, that different results could be observed if other teeth as upper lateral incisors and lower incisors were used.

In the classic study of Zach and Cohen (1965) [27], it was demonstrated that the increasing in the pulp temperature at 5.5°C led to an irreversible pulpitis in 15% of the teeth tested [27]. In the present study, none of the light sources caused an increase in temperature greater than 2°C, as found in the study Zanin *et al.* (2003) [28], which also employed LEDs to speed up the reaction of the whitening gel. Thus, it can be said that the temperature rise was kept within the safe parameters already tested in other studies.

In the present study, the increase in temperature was studied in an *in vitro* condition, wherein the pulp chamber was filled with a thermal paste. Goodis *et al.* (1989) [10] highlighted the difficulty of reproducing the pulpal fluid in *in vitro* studies, as these are able to dissipate the heat applied. The whitening gel application can also help reducing the increase in temperature inside the pulp chamber initially, as studied by Kivanc *et al.* (2012) [13]. In this study, to measure the temperature, a digital thermometer with K-type thermocouple (MT-401) was used. This method has been employed in several studies [3, 15, 23, 24, 29] and is easy to perform and reproduce, and generate little variation between one reading and another. This small variation can be observed in this study by the analysis of Table II, in which a low standard deviation score between two bleaching sessions was noted. Moreover, the standardization of the results was favored by using only one tooth.

The interaction between the light source and heat can be explained by the chemical composition of the bleaching agent. When the light is projected onto the gel, a small fraction is absorbed and its energy is transformed into heat. To speed up the reaction, some specific commercial products to be associated with the use of light sources having mixed in its Formula specific dyes such as carotene [5], annatto and jua, among others, in an attempt to increase this absorption (photo-catalyzation). In this study, the gels at concentrations of 15%, 25%, and 35% containing annatto and jua in its formulation and the 10% gel contains only one nanoparticulate photocatalyst.

The hybrid violet LED light/laser used in this study with the 10% hydrogen peroxide gel (experimental) shoed similarity to the hybrid blue LED light/laser associated with other gel concentrations (15, 25 and 35%). %). Despite the shorter wavelength of this experimental light (410 nm), no significant increase in temperature inside the pulp chamber was observed. This new light source activates the particles of photo-activated nanocatalyst, promoting greater breakdown of hydrogen peroxide and consequently greater release of oxygen ions. Further studies are necessary to evaluate whether this feature would allow in-office whitening with low concentration gel and would decrease the sensitivity.

Conclusion

There was no significant increase in temperature compared to control, in which light was used without gel when the experimental materials violet LED /10% bleaching gel were employed. The whitening gels at different concentrations associated with hybrid light sources showed little change in the temperature increase of pulp chamber and the greatest increase in temperature did not exceed 2°C.

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