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Evaluation Study

EFFECTIVENESS OF A DIODE LOW-LEVEL LASER THERAPY ON TOOTH SENSITIVITY RELATED TO IN-OFFICE BLEACHING: A CLINICAL STUDY

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ABSTRACT

The aim of this study was to investigate the effectiveness of low-level laser therapy (LLLT) on tooth sensitivity post-in-office bleaching. Sixty patients were selected for a randomised clinical trial. After the in-office bleaching procedures with 38 % hydrogen peroxide, the participants were randomly divided into two groups of 30 subjects each. In the LLLT group, patients received LLLT through an 810 nm diode laser with 0.5W for 30 sec at a density of 15 J/cm2, while participants in the placebo group were subjected to an LLLT with similar conditions but without any energy output. The intensity of tooth sensitivity was recorded at 1, 24, and 48 h after bleaching using a visual analogue scale (VAS). The intensity of tooth sensitivity was not significantly different between groups at 1h after bleaching (p=0.593). At 24 h and 48 h after the bleaching procedure, the pain level was significantly lower in the LLLT group compared to the placebo groups ($p < 0.0001$). The LLLT with a diode laser could be used as a suitable strategy to reduce the intensity of tooth sensitivity after in-office bleaching.

KEYWORDS: *bleaching, tooth, sensitivity, low-level laser therapy, pain*

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INTRODUCTION

Bleaching is one of the most frequently performed procedures in esthetic dentistry and can significantly impact the look of the teeth by removing extrinsic and intrinsic stains. Several techniques have been proposed to provide efficient tooth whitening, including in-office bleaching, night guard and home-applied bleaching. Although the use of home bleaching techniques has considerably increased during the last few years, in-office bleaching continues to have a great demand for patients requesting immediate results, intolerant to wearing trays or worried about ingesting bleaching products (1, 2). The reactive oxygen species released by bleaching materials oxidise dentin and enamel chromogens, producing the whitening effect. It has been demonstrated that hydrogen peroxide (HP) and its derivatives could easily reach the pulp tissue through enamel and dentine, causing structural damage and inflammatory reactions (3). Adverse effects of bleaching agents, including cytotoxicity and DNA modification, have been reported in several in vitro studies (4). Tooth sensitivity is the most usual clinical side effect of in-office treatment with 35 % HP. The frequency and degree of tooth sensitivity depend on the patient's pain threshold, the concentration of the bleaching agent and eventually, the heat used for accelerating the proceedings (5).

Several studies reported an incidence rate of 65–85 % for tooth sensitivity after the in-office bleaching treatment using high concentrations of HP alone or associated with heat. Usually, pain and discomfort are generally mild and transient. However, it may sometimes be severe and irritating as it requires the withdrawal of whitening treatment. In order to reduce teeth sensitivity from whitening, some researchers have proposed the application of agents containing potassium nitrate and fluoride or casein-phosphopeptide amorphous calcium phosphate before, during or after the ending of the whitening treatment. Several studies confirm the success of desensitising agents in reducing tooth sensitivity after bleaching (6-9).

Low-level laser therapy (LLLT) has become more significant in medicine and dentistry due to its anti-inflammatory, analgesic and biostimulating effects (10, 11). These excellent properties suggest that LLLT may decrease the damage and inflammation induced by in-office bleaching products in the pulp tissue, thus reducing the risk and intensity of tooth sensitivity caused by the bleaching (12, 13). Considering that the smile aesthetic is a hot topic today, as well as the use of low-level laser (14, 15), this study was conducted to evaluate the effectiveness of a diode laser to low power on tooth sensitivity arising from in-office bleaching.

MATERIALS AND METHODS

The samples used for this study came from 60 subjects treated at the Dental Clinic of the University of Campania "Luigi Vanvitelli". The study was conducted in agreement with a randomised double-blind and placebo-controlled clinical trial and in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013. All patients were in good general health with maxillary and mandibular anterior teeth without caries, visible defects or any restoration. Teeth with negative responses to the vitality test were excluded from the study. Patients were at least 18 years old with central incisors of a shade darker than C2 using the shade guide of Vita Classical A1-D4® (Germany). Subjects who used analgesics, anti-inflammatory or antioxidant medicine and those with smoking habits were excluded from the study. Patients during orthodontic treatment with temporomandibular disorders, bruxism habits or any medical and pathologic defect such as gingival recession or dentin exposure that could cause tooth involvement were also excluded from the study (16-19). None of the patients recruited reported symptoms attributable to tooth sensitivity. Two weeks before the bleaching treatment, the participants underwent professional oral hygiene and received oral hygiene instructions to brush their teeth twice per day with a similar toothbrush and toothpaste during the experiment. All patients were informed about the treatment procedures and asked to sign an informed consent document before the beginning of the study.

The in-office bleaching procedure

Before the bleaching, patients were randomly divided into two groups (n=30) using software for casual distribution by a not-clinician researcher. Then, bleaching was carried out by a single clinician operator. Initially, the gingival tissues of the teeth to be bleached were isolated from the bleaching gel using a light-cured resin dam (OpalDam Kit, Ultradent;

Corsico- MI, Italy). Next, a 38% ready-to-use HP-containing gel (The Smile® Strong, Italy) was applied from the canine to the canine tooth of both jaws for a total period of 20 minutes for a 1 single whitening session, according to the manufacturer's instructions. After the bleaching treatment, the gel was rinsed off, and the participants underwent two different treatments for each of the 2 study groups:

LLLT group (n=30): the whitened teeth received an irradiation treatment utilising a diode laser (Soft Touch; 810 nm, 5 W, Creation). The laser probe (a fibre of 400 μm diameter) was positioned in contact mode with the cervical enamel of the tooth with irradiation for 30 sec in continuous-wave using 0.5 W, with horizontal and vertical moving to cover the whole area. As a result, each tooth received an energy density of 15 J/cm2.

Placebo group (n=30): the teeth whitened underwent the same procedure but with the device switched off.

Subsequently, the participants were asked to record the degree of tooth sensitivity perceived at 1 h, from 1 to 24 h, and from 24 to 48 h at the end of the bleaching treatment. A visual analogue scale (VAS) was employed to objectify the degree of pain intensity, consisting of a 100-mm horizontal line with 0-10 points where the ends were represented from 0 (the left side), indicating no pain and 10 (the right side) representing the worst possible pain never warned. The participant and the clinician operator who collected the VAS data were blinded to the assignment groups. During this research, all operators wore surgical masks to prevent the spread of respiratory system viruses and maintain office hygiene (20, 21).

Statistical analysis

The total VAS scores obtained at each measurement point for each study group were considered for the statistical analysis. The VAS values were compared between the different evaluation times in each group and between the single values of each study group. The statistical analysis was performed with GraphPad Prism version 9 (by Dotmatics, San Diego, CA, USA). The significance level for all tests was predetermined at $p < 0.05$.

RESULTS

All 60 participants completed the study. The mean age of the patients was similar in the study groups (LLLT group 26.4 ± 6.8 and placebo group 27.8 ± 9.2), and there were no significant gender differences among the groups (LLLT 18 females and placebo 16 females) ($p = 0.854$). Table I shows the value VAS (total, mean and standard deviation, SD) for each study group at different time points during the clinical trial. The comparison of the VAS scores at different time points for each participant belonging to the same group revealed statistically significant differences with $p < 0.0001$ using the Wilcoxon signed-rank test comparing A *vs* C and B *vs* C for the LLLT group and A *vs* B and B *vs* C for the placebo group, while it was reported no statistically significant differences after comparing A *vs* B of LLLT group and A *vs* C of the placebo group, with $p= 0.2885$ and $p= 0.1009$, respectively. Fig. 1 shows the changes in dental sensitivity reported

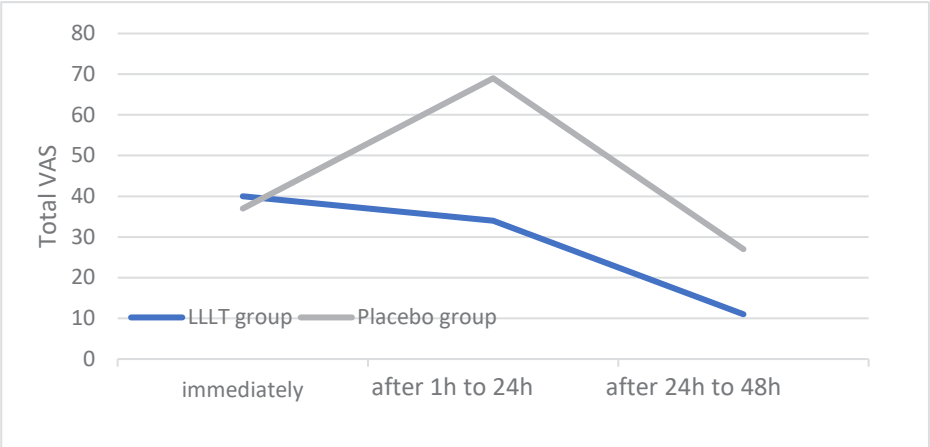

Fig. 1. *Comparison of total VAS from total VAS during the observation period.*

by patients of both groups during the entire observation period. The unpaired t-test was used to compare pain intensity reported by each subject at different time points for each study group. The results showed no statistical differences in the intensity of tooth sensitivity among groups within the first 1 h after bleaching (p = 0.593). In contrast, significance was highlighted between both group differences at 24 h (p< 0.0001) and 48 h (p <0.0001) after whitening treatment (Table I).

DISCUSSION

This study determined the effects of LLLT on the decrease of tooth sensitivity related to in-office bleaching. Most sensitivity complaints were reported within the first 24 h after bleaching, in agreement with the results from other authors (22-26). Both groups recorded tooth sensitivity within 1 hour immediately after whitening with overlapping values (total VAS score 40 and 37 for LLLT and placebo group, respectively, with p= 0.593). These results indicate that LLLT cannot reduce the incidence of pain and discomfort for tooth sensitivity after in-office bleaching from immediately to 1 h post-bleaching. No significant differences were found among the groups, implying that LLLT had no immediate effects on reducing pain and discomfort perceived by the patients. Within 24 h after bleaching, pain level increased in the placebo group (total VAS of 69) while it decreased in the individuals from the LLLT group (total VAS of 34); this means that the laser treatment can reduce the painful experiences of dental sensitivity that are statistically reported in patients within the 24 hours post whitening 8 (p <0.0001). The intensity of referred tooth sensitivity at 48 h after in-office bleaching was slight for both groups but especially for participants of the LLLT group (total VAS of 11 and 27, respectively, for LLLT and placebo groups, p<0.0001). Finally, the intensity of the dental sensitivity returns to the baseline values for the LLLT group, while it remains above the initial values in the placebo group from 24 h to 48 h after whitening. Thus, we can confirm that the use of LLLT can limit tooth sensitivity, reported as pain/discomfort, using a VAS score, in patients from 1 hour up to 48 hours post-in-office whitening, while it does not have any effect on the symptoms reported by patients within 1 hour after the item procedure. These findings indicate that LLLT should be considered an effective strategy for alleviating pain and discomfort after in-office bleaching procedures. Since the maximal pain level generally occurs within 24 h after bleaching, irradiation with LLLT can be included in the current strategies. When pain degree at different measurement points was compared within each group, the intensity of tooth sensitivity in the placebo group reached the peak value at 24 h after bleaching (total VAS of 69) and reduced after that (p <0.0001). In the placebo group, the total VAS score at 48 h was comparable to that recorded at 1 h after bleaching (total VAS score 27 vs 37 with p= 0.1009), while the laser therapy in the LLLT group was effective, reducing the pain level at 48 h in comparison with that of the 1 h interval (total VAS score 11 *vs* 40 with p <0.0001). On the contrary, patients in the laser group perceived higher tooth sensitivity immediately after treatment, although they experienced a progressive reduction of tooth sensitivity throughout the treatment protocol.

To determine the effectiveness of LLLT on the potential onset of pain derived from tooth sensitivity was necessary to include a placebo group. The assignment of a placebo group is necessary when assessing the analgesic effects of LLLT; this is essential to consider the influence on pain relief of the psychological impact of a treatment that utilises a high-technology apparatus; for this reason, a control group without laser and placebo was not inserted (27, 28). The search shows a significant improvement in tooth sensitivity in subjects belonging to the placebo group over the study period. This trend represents a custom and should be considered since post-bleaching sensitivity has a limited duration and, in most cases,

Table I. *VAS scores (mm) with means and standard deviation (SD) for each study group at different time points.*

Groups	Immediately to 1h			After 1h to 24h			After 24h to 48 h		
VAS	Total	Mean	SD	Total	Mean	SD	Total	Mean	SD
LLLT	**40**(a)	1.3	0.76	**34**(b)	1.3	0.50	**11**(c)	0.37	0.49
Placebo	**37**(a)	1.23	0.68	**69**(b)	2.3	0.75	**27**(c)	0.9	0.66
	p= 0.5925			p< 0.0001			p< 0.0001		

P value for LLLT group: a vs b (p= 0.2885); a vs c (p < 0.0001); b vs c (p< 0.0001)
P value for placebo group: a vs b (p= < 0.0001); a vs c (p= 0,1009); b vs c (p< 0.0001)

it does not last more than 2 days after in-office bleaching. The efficacy of LLLT in reducing post-bleaching sensitivity could be assigned to the bio-stimulating effects, analgesic, and anti-inflammatory effects of low-power lasers (28). Laser therapy may recover the cell damage and modulate the inflammatory process induced by HP products in the pulp tissue, reducing the nerve transmission of pain for depolarisation of the membrane of the nerve endings and suppressing the passage of neurosensory impulses. These effects probably occur after several hours after laser treatment. The difference in pain scores (VAS) among the study groups was not significant within 1 h after bleaching. The effectiveness of the diode laser 810 nm in reducing post-bleaching sensitivity could be related to its ability to penetrate in depth, reaching the pulp chamber (29-32). The energy density employed in this study for a diode laser treatment was 15 J/cm2.

There are few studies regarding the influence of LLLT on the viability of cells exposed to bleaching agents, with controversial outcomes. Dantas et al. (33) indicated that irradiation by a low-power 780 nm laser at an energy density of 10 J/cm2 compensated for the cytotoxic effects of 35% HP on human pulp fibroblasts. Pereira et al. (34) showed that LLLT influenced the behaviour of odontoblast-like cells by irradiating with a diode laser 830 nm with an energy density of 85 mW/cm2 of for 10 sec 0.8 J/cm2, thus promoting the expression of the odontoblastic phenotype in a more significant way compared to longer time/highest laser energy density. On the contrary, Lima et al. (35) concluded that both HP and carbamide peroxide reduced the cell activity of odontoblasts and their injurious properties, whose effects could not be offset by LLLT at the defined parameters. Few studies have performed randomised clinical trials investigating the effects of LLLT on reducing post-bleaching sensitivity. However, several studies focused on the effectiveness of diode LLLT on dentine hypersensitivity by non-carious cervical lesions and on pain deep of cavity preparations post-dental restoration. Therefore, a direct comparison of our outcomes with previous results from other authors is impossible. There are conflicting reports regarding the effectiveness of LLLT in alleviating dentin hypersensitivity in patients with non-carious cervical lesions or deep from cavity preparations (36, 37), even if the mechanism of tooth sensitivity after in-office bleaching is assumed to be different from that of dentin hypersensitivity. The tooth sensitivity post-bleaching could be related to inflammatory mechanisms directed to the dental pulp and not to the exposure of the dentinal tubules. The limitation of this study was the subjective nature of VAS questionnaires, the difference in pain thresholds of the subjects and, above all, the impossibility to standardise a home technique to create a standard stimulus that could stimulate the tooth sensitivity symptoms (38-40).

The present study indicated that irradiation from a low-power diode laser could effectively reduce the intensity of tooth sensitivity after in-office bleaching; this makes it a viable alternative to conventional methods for controlling post-bleaching sensitivity. However, further studies with a larger patient group will be required to evaluate different parameters both for applied energy power and for the activity times to reduce dental sensitivity after in-office bleaching, which will allow comparing these results with those obtained with other agents used for counteracting dental sensitivity.

The use of diode LLLT cannot reduce the intensity of tooth sensitivity referred immediately to 1 h after in-office bleaching, while it is a valuable aid to decrease pain sensations reported by the patients from 1 to 48 h after application.

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