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ORIGINAL ARTICLE

Effectiveness of sodium fluoride varnish and/or diode laser in decreasing post-bleaching hypersensitivity: A comparative study

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Abstract *Background:* Professional tooth whitening has gained popularity in the past several years. The most commonly active chemical agent used in bleaching is hydrogen peroxide (HP). HP is a low molecular weight unstable material that easily diffuses into the tooth structure, causing oxidative reactions with a consequent whitening effect. After bleaching, tooth sensitivity and gingival irritation are anticipated.

Aim: This study aimed to compare the effectiveness of remineralization and/or diode laser therapies in reducing tooth sensitivity after bleaching.

Methodology: Thirty-nine participants from Umm Al-Qura University, dental clinics, Makkah, SA. They were divided into three equal groups according to the desensitizing technique used. All participants were subjected to bleaching by 40% opalescence boost HP. Subsequently, 13 participants received 5% sodium fluoride varnish (5% NaF), 13 participants received low-level laser therapy (LLLT), and 13 participants received a combination of both desensitizing techniques. Each participant represented self-control, where tooth sensitivity was measured before and after bleach-

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ing. The cold test was used to measure tooth sensitivity before bleaching, immediately after bleaching and after application of the proposed desensitizing technique. Then, a visual analogue scale (VAS) was used for re-assessment.

Results: The desensitizing methods exhibited a notable reduction in tooth sensitivity post-bleaching with no significant difference among the following therapies ($p = 0.544$).

Conclusion: All the employed desensitizing methods reduced post-bleaching sensitivity, with no significant differences among them. Thus, using one technique individually is enough for effort, time and cost savings.

1. Introduction

In the last decade, professional tooth bleaching has played an important role in cosmetic dentistry, which involves the application of chemically active agents and allows them to diffuse into the tooth structure and trigger a series of oxidation reactions that promote the whitening effect of the tooth. Nevertheless, several adverse effects occur after the bleaching process, mainly tooth sensitivity and gingival irritation (Carey, 2014).

To overcome the adverse effect of bleaching, desensitizing agents are currently used in an attempt to decrease tooth sensitivity after bleaching through dentinal tubule occlusions, as these agents are believed to reduce intradental nerve excitability (Markowitz and Pashley, 2008; Torres et al., 2014). Sodium fluoride, nanohydroxyapatite, amorphous calcium phosphate, calcium and/or sodium monofluorophosphate are common components of different desensitizing agents.

Low-level laser therapy (LLLT) was recently introduced as a desensitizing protocol that acts by changing the nerve transmission network inside the pulp (Ladalardo et al., 2004; Silveira et al., 2011). This action depends on the interaction of the laser with biological tissues under certain wavelengths, intensities, active media and optical properties of the irradiated tissue (Ladalardo et al., 2004).

Laser treatment of dentin hypersensitivity includes the following two types of low-power output laser treatment: He-Ne laser and GaAIAs laser. Their mechanism to decrease dentin sensitivity by depression of nerve transmission and acts as an analgesic effect by blocking the depolarization of C-fibre afferents (Wakabayashi et al., 1993). The other type is middle power output laser which had different types Nd:YAG, CO2 and Er:YAG laser, The mechanism of Nd:YAG and CO2 lasers effect on dentin hypersensitivity by occlusion or narrowing of dentinal tubules, as well as direct nerve analgesia (Funato et al., 1991).

Several previous studies discussed numerous methods to overcome post-bleaching tooth sensitivity. However, a limited number of studies have been conducted to clinically assess the effectiveness of LLLT in reducing discomfort and sensitivity after in-office bleaching. Hence, the aim of the present study was to compare the effectiveness of remineralization therapy and/or diode laser application in reducing tooth sensitivity arising after bleaching. The null hypothesis was that a combination of both LLLT and 5% NaF would have an efficient therapeutic effect in diminishing post-bleaching sensitivity more than LLLT or 5% NaF alone.

2. Materials and methods

Ethical approval was obtained from the institutional review board (IRB No. 140-19) of Umm al-Qura University, Faculty of Dentistry, Makkah.

2.1. Study design

Participants were randomly allocated and divided into three groups according to the treatment method (13 participants in each group). A random allocation sequence was generated using a table of random numbers. Based on previous literature, the estimated mean sensitivity VAS score for teeth bleached with 5% NaF varnish was 3.53 ($\pm$2.36) (Genovesi et al., 2010). We calculated the sample size based on the assumption of a continuous outcome superiority trial using a sealed envelope TM calculator. The 5% NaF were the control group. Using the previous parameters, a sample size of 60 teeth (20 in each group) was sufficient to detect a clinically significant difference with 80% power and a 5% level of significance.

2.2. Sample selection

The study enrolled 39 dental student participants from Umm Al-Qura University, dental clinics, Makkah, SA. With a total of 136 teeth were tested. All participants were between 20 and 25 years old with good oral hygiene and were free from medical conditions. The study excluded participants with multiple active caries, enamel hypoplasia, periodontal disease and root canal treatment.

2.3. Study procedure

A consent form was given before starting the procedure. Tooth sensitivity was measured by the selection of four teeth before dental bleaching using a cold test. A small cotton pallet was sprayed with endo ice and kept near the cervical one-third of the upper and lower central incisors until the participant felt pain. VAS was used to record tooth sensitivity. All participants underwent professional in-office tooth bleaching procedures using an opalescence boost (40 %HP gel). First, a light-polymerized resin dam (OpalDam) was applied for gingival protection. Then, bleaching gel was applied from premolar to premolar of the other quadrant. Two bleaching cycles were performed, twenty minutes per cycle. Finally, bleaching gel was removed, rinsed and dried. After bleaching, tooth sensitivity was evaluated by endo ice. Then, participants were randomly divided into 3 groups, with thirteen participants in each group according to the therapy method:

Group 1 received 5% NaF varnish treatment postbleaching.
Group 2 received LLLT treatment postbleaching.
Group 3 received the combination of 5% NaF varnish and LLLT treatments postbleaching.

Tooth sensitivity and VAS were measured immediately after each desensitizing therapy.

2.3.1. 5% NaF varnish application

In groups 1 and 3, the treatments with 5% NaF varnish (Clinpro® 5% NaF White Varnish with TCP, 3 M ESPE, MN) (Fig. 1) followed the manufacturing instructions. Teeth were isolated with cotton rolls and suction. Varnish was applied with an appropriate brush in sweeping horizontal strokes. Then, participants were instructed to close their mouth to set the varnish for a minimum of 4 hr to 24 hr to obtain the maximum benefit of continuous release of fluoride, calcium and phosphate. In addition, they were instructed to avoid food and liquid intake for two hours.

2.3.2. Laser application

Groups 2 and 3 were treated with LLLT (Hager & Werken LaserHF® "comfort", diode laser). (Fig. 2), teeth were isolated. There was no need for pre-drug application according to the type of laser used. An LLLT laser tip was applied at a distance of 1 mm and perpendicular to the tooth surface (Fig. 3), operating in continuous mode, with a power of 90 mW at 660-900 nm wavelength with no cooling. The application duration was approximately 60 sec for each cervical and incisal area.

2.3.3. Combination group

Group 3 was treated with combination therapy. LLLT was applied first followed by 5% NaF varnish, as the varnish needed to be set for 3–4 hr.

2.4. Statistical analysis

Data were analysed using SPSS ver.23. One-way ANOVA for repeated measures and post hoc Tukey tests were used to determine the difference in VAS scores between different treatment stages. For the comparison of posttreatment sensitivity between the three treatment groups, one-way ANOVA and a post hoc Tukey's test were used. The significance level was set at $P = 0.05$.

3. Results

The results of the one-way ANOVA test for repeated measures showed that the VAS score before bleaching was 4.801 ± 2.41, after bleaching was 6 ± 2.23, and after therapy application was 3.72 ± 2.31. The differences were found to be statistically significant ($P < 0.05$). Post hoc tests revealed that the sensitivity scores significantly increased from before bleaching to after

Fig. 1 5% NaF varnish (Clinpro® 5% NaF White Varnish with TCP, 3 M ESPE, MN).

bleaching and significantly decreased after applying the treatment.

For the 5% NaF varnish treatment group, the mean VAS score post bleaching was 6.32 ± 2.21, and it significantly decreased after treatment to 3.89 ± 2.41. This difference was statistically significant ($p < 0.05$). For the LLLT treatment group, the mean VAS score post bleaching was 5.83 ± 2.33, and it significantly decreased after treatment to 3.9 ± 2.38. This difference was statistically significant ($p < 0.05$), and for the combination treatment group, the mean VAS score post bleaching was 5.83 ± 2.21, and it decreased after treatment to 3.44 ± 2.16. This difference was statistically significant ($p < 0.05$) Table 1 and Fig. 4.

The result of the one-way ANOVA test showed that the mean VAS index for the 5% NaF varnish treatment group was 3.89 ± 2.41, that for the LLLT treatment group was

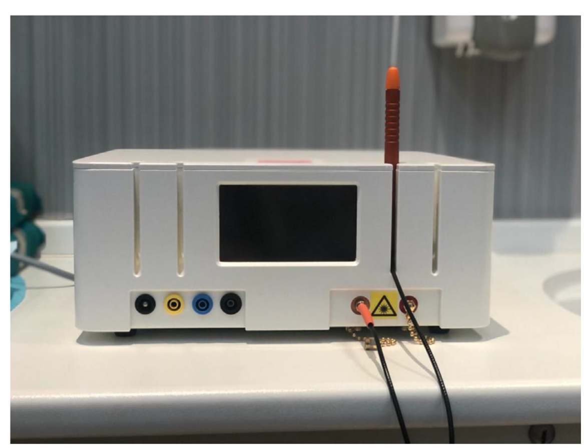

Fig. 2 Low-level laser therapy LLLT (Hager & Werken LaserHF® "comfort", Diode laser).

Fig. 3 LLLT laser tip was applied at distance 1 mm and perpendicular to the tooth surface.

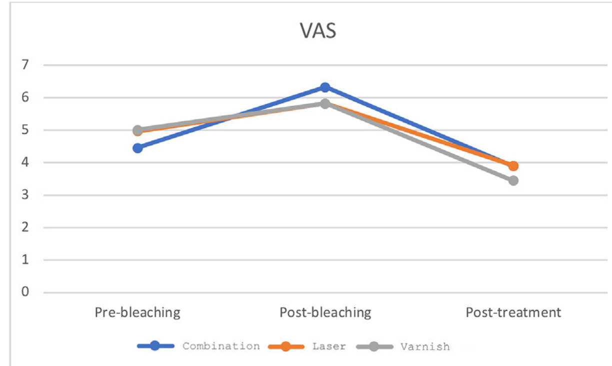

Fig 4 Changes of mean VAS scores in each treatment group.

3.9 ± 2.38, and that for the combination treatment group was 3.44 ± 2.16. The mean VAS score for the combination treatment group was lower than that for the other treatment groups. However, the difference among the three treatment groups was not statistically significant ($p = 0.544$) (Table 2).

4. Discussion

This study was conducted to compare the effectiveness of remineralization therapy and/or laser application in reducing post-bleaching tooth sensitivity. In the present investigation, all the participants experienced high sensitivity just after the bleaching procedure, attributed to the active ingredient in the bleaching gel used: HP.

Desensitizing agents act through the following two mechanisms: occlusion of dentinal tubules or nerve depolarization. Dentinal tubule occlusion works through precipitation of protein or formation of a superficial pellicle. Meanwhile, nerve depolarization involves the penetration and diffusion of ions into the dentinal structure and entry to the pulp (Torres et al., 2014).

Three desensitizing protocols were utilized in this study. The first was NaF varnish, which significantly reduced post-bleaching tooth sensitivity. This finding was in agreement with Gaffar, 1999; Kumar and Mehta, 2005. Moreover, in 2004, Leonard Jr et al. tried to apply an active 3% potassium nitrate and 0.11% fluoride desensitizing agent for 30 min before bleaching, which reduced tooth sensitivity. Additionally, Chen et al. in 2008, used fluoridated bleaching agents in their study, which lessened demineralization of enamel and consequently less tooth sensitivity. The reduction in post-bleaching tooth sensitivity of sodium fluoride varnish could be accredited to the formation of calcium, phosphorus and fluorapatite precipitates that block fluid movement within the dentinal tubules (Attin et al., 1997).

Many studies have reported a promising effect of laser treatment in reducing tooth sensitivity (Pandis et al., 2013; García-Delaney et al., 2017). In the present study, LLLT resulted in significantly lower post-bleaching tooth sensitivity, consistent with Kumar and Mehta, 2005. Another clinical study proved that LLLT with an infrared diode laser can be used as a treatment to decrease tooth sensitivity after bleaching (Moosavi et al, 2016). The effect of laser irradiation could be explained by the capability of LLLT to stimulate photoreceptors. These photoreceptors absorb photons of certain wavelengths, leading to alteration of the functional and metabolic activity of cells. LLLT changes cell membrane permeability and temporarily modifies free nerve endings inside the dental pulp (Fávaro-Pípi et al., 2011), which results in less pulpal injury following tooth bleaching (Kimura et al., 2000; Tay et al., 2009). As an extreme biostimulant, LLLT also induces

Table 1 Comparison of mean VAS scores in each treatment group.

Treatment Group	Time	n	Mean ± SD	Greenhouse Geisser F-value p-value
Varnish	Pre-bleaching	48	4.45 ± 2.34	27.03 < 0.05
	Post-bleaching	48	6.32 ± 2.21	
	Post-treatment	48	3.89 ± 2.41	
Laser	Pre-bleaching	40	4.97 ± 2.71	22.52 < 0.05
	Post-bleaching	40	5.83 ± 2.33	
	Post-treatment	40	3.9 ± 2.38	
Combination	Pre-bleaching	48	5.01 ± 2.23	37.42 < 0.05
	Post-bleaching	48	5.83 ± 2.21	
	Post-treatment	48	3.44 ± 2.16	

n = Number of teeth.
SD = Standard deviation.

Table 2 Comparison of mean VAS scores post treatment.

Treatment Group	n	Mean ± SD	P-value
Varnish	48	3.89 ± 2.41	0.544
Laser	40	3.9 ± 2.38	
Combination	48	3.44 ± 2.16	

n = number of teeth.

the deposition of tertiary dentin (Ladalardo et al., 2004; Sgolastra et al., 2011). Moreover, LLLT has analgesic and anti-inflammatory effects (Pandis et al, 2013).

During the conduction of this study, a combination of LLLT and NaF varnish was utilized as a desensitizing regimen, and the treatment group exhibited significantly lower post-bleaching sensitivity. This was in agreement with Lan et al. in 2004, who presumed that the combination of NaF with a semiconductor laser would extremely improve the reduction in tooth sensitivity. More recently, Alencar et al. in 2018 studied the effect of LLLT combined with 5000 parts per million fluoride dentifrices. This combination therapy produced less tooth sensitivity than the application of NaF alone.

In the present investigation, there was no significant difference among the three therapies used in the reduction of post-bleaching tooth sensitivity. This finding was in disagreement with De Paula et al. in 2019, who proved that the use of a combination of LLLT and potassium nitrate significantly reduced post-bleaching sensitivity with 35% hydrogen peroxide. They referred their results to the double effect produced by that combination.

Similar to research by Mounika et al. in 2018, who evaluated tooth sensitivity by VAS, the authors used the same method of assessment in the current study. However, the VAS index depends on the participants, in which pain is a subjective feeling that cannot precisely determine stimulus intensity (Porto et al., 2009). Therefore, the recommendation for further clinical trials includes the use of an objective means rather than a subjective method to measure post-bleaching tooth sensitivity and long-term follow-up for the regimens used.

5. Conclusion

5% NaF, LLLT and the combination of both are similar effective methods for the treatment of postbl eaching hypersensitivity, with no significant difference among them. Therefore, the null hypothesis is rejected, as the combination of both techniques did not offer significant improvement of post-bleaching hypersensitivity. Consequently, the application of either 5% NaF or LLLT individually is effort, time and cost saving.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sdentj.2021.09.024.

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