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Effect of light-emitting diode phototherapy on pain and trismus following surgical extraction of impacted mandibular third molars

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ABSTRACT

Purpose: This study aimed to assess the effect of light-emitting diode (LED) phototherapy on pain and trismus following surgical extraction of impacted mandibular third molars.

Materials and Methods: This double-blind randomized controlled clinical trial evaluated 50 patients between 20 to 35 years requiring extraction of their impacted mandibular third molars. The patients were randomized into two groups of LED phototherapy and control by flipping a coin. Patients in the LED group underwent LED phototherapy immediately after surgery with red light at 618nm wavelength, 20 mW/cm^2 power density and 4 J/cm^2 energy density in continuous-wave mode (irradiated area: 3.15cm×1.5cm=4.725cm^2). The LED device was used in off mode in the control group (as placebo). The level of postoperative pain was measured by the numerical rating scale, and trismus of patients was evaluated by measuring the maximum mouth opening (MMO). The two groups were compared by the Mann-Whitney and NPar tests.

Results: The mean difference in MMO postoperatively, compared with baseline, was lower in the LED group than the placebo group but not significantly (P=0.465). The two groups were not significantly different regarding the level of pain.

Conclusion: LED phototherapy with the parameters applied in this study failed to significantly decrease the level of pain and trismus following surgical extraction of impacted mandibular third molars.

Keywords: Impacted mandibular third molars; LED; Phototherapy; Trismus; Pain.

Introduction

Surgical extraction of impacted third molars is among the most common dentoalveolar surgical procedures performed in the maxillofacial region. An inflammatory process associated with pain, trismus, and edema occurs following surgical trauma. Low-level light therapy is a treatment modality to enhance wound healing, which is performed by using lasers or light-emitting diodes (LEDs). Since their introduction, lasers are commonly used in different medical and dental fields. Low-energy laser systems, which are relatively novel, induce cellular activity and exert wound healing, analgesic, anti-infective, and anti-inflammatory properties [1-4]. As a general rule, all impacted teeth need to be extracted unless contraindicated. Surgical extraction of impacted teeth becomes more difficult with age. The most common complications of surgical extraction of impacted third molars include pain, edema,

inflammation, and trismus; these complications can adversely affect the quality of life, daily activities, speech, and deglutition of patients [5]. Analgesics, non-steroidal anti-inflammatory drugs, local and systemic corticosteroids, and long-lasting anesthetics are often administered to decrease postoperative pain and discomfort. The maximum level of pain is often reported at 3-5 h after surgery. Maximum edema is often reported at 24-48 h postoperatively, and is often resolved within 5-7 days. Trismus is also resolved following the reduction of pain and edema [5-13]. Surgical extraction of impacted teeth can prevent periodontal disease, dental caries, pericoronitis, and development of odontogenic cysts and tumors [5]. However, this procedure is contraindicated in old age, presence of systemic diseases, and if there is risk of damaging the adjacent structures [5].

Pain is an unpleasant sense that occurs following tissue injury. It is a protective mechanism that informs the individual about the injury. Surgical extraction of impacted teeth can cause mouth opening limitation, also known as trismus, which can be due to inflammation of the muscles of mastication or repeated anesthetic injections particularly into the muscle. Trismus of the internal pterygoid muscle is the most common, which occurs following the inferior alveolar nerve block injection. Surgical extraction of impacted mandibular third molars often results in trismus due to inflammation and edema of the surgical site, affecting the adjacent muscles of mastication [5,14]. LEDs are generally similar to lasers; however, they are different in generation and formation of waves. LEDs are polarized. A resonance cavity promotes the amplification and radiation of photons to form a coherent and collimated beam in lasers. However, LEDs do not have this optical cavity; therefore, LEDs have non-coherent and non-collimated light, but the electromagnetic spectrum produced by LEDs is similar to that of lasers. It has been claimed that since the beam coherence is quickly lost when the light penetrates into the tissues, LEDs exert therapeutic effects even with non-coherent beams. The mechanism of action of light at the cellular level is responsible for its biological effects, which are based on photobiological reactions. A photobiological reaction includes absorption of a specific wavelength of light by the light receptor molecules [15,16]. Controversy exists regarding the benefits of LED phototherapy, and there are some unanswered questions regarding the quality of therapeutic and biological effects of LEDs and lasers, and their ideal parameters [3]. The advantages of LEDs over lasers include: (I) LEDs are the first light source that enables controlling the composition of actual spectra; as a result, their wavelength can be optimized for therapeutic purposes; (II) LEDs have a small size and can be used in hard-to-reach areas; (III) LEDs are safer than the currently available lasers because they do not require a high voltage; (IV) LEDs are more durable and therefore are more cost-effective in long-term. Currently, LED phototherapy is used for treatment of rhinitis, jaundice, arthritis, skin abnormalities, actinic keratosis, mucositis, rheumatoid arthritis, edema following facial bone fractures, and seasonal depressions, as well as enhancement of wound healing [17].

1.2 Objective:

This study aimed to assess the effect of LED phototherapy on pain and trismus following surgical extraction of impacted mandibular third molars.

Materials and Methods

This study was conducted at the Oral and Maxillofacial Surgery Department of School of Dentistry, Tehran University of Medical Sciences from March 2016 to August 2017, and the study has been independently reviewed and approved by the ethics committee of this university (IR.TUMS.REC.1394.1018).

2.1 Trial design:

In this double-blind randomized controlled clinical trial, the surgical site underwent LED phototherapy (Biolux Ltd, Vancouver, Canada) extraorally for 200 s in the intervention (LED) group. In the control group, LED was used in off mode under similar conditions (placebo).

2.2 Participants, eligibility criteria, and settings:

The inclusion criteria were patients between 20 to 35 years with level B, class II impacted mandibular third molars according to the Pell and Gregory classification [5].

The exclusion criteria were presence of systemic diseases, acute pericoronitis, severe periodontal disease of the adjacent teeth, allergy to local anesthetic agents or the prescribed medications, pregnancy or lactation, intake of analgesics or anti-inflammatory drugs, and prolonged duration of surgery.

2.3 Interventions:

All surgical procedures were performed by the same

surgeon in all patients after obtaining their written informed consent. An inferior alveolar nerve block was first administered, and then the long buccal and lingual nerves were anesthetized by infiltration anesthesia at the surgical site using 1.8mL of 2.0% lidocaine with 1:100,000 epinephrine tartrate (Darou Pakhsh, Tehran, Iran). A maximum of 3 cartridges could be used. A full-thickness mucoperiosteal flap was elevated, and osteotomy was performed. After removal of the impacted tooth, the surgical site was rinsed with 30 cc sterile saline, and the area was sutured with 3-0 silk interrupted sutures (Supa, Tehran, Iran). The duration of surgical procedure from flap elevation to suturing was 25 to 30 min. In the LED group, the surgical site underwent LED phototherapy (Biolux Ltd, Vancouver, Canada) extraorally for 200 s. The irradiated area measured 3.15cm×1.5cm=4.725 cm^2 (Figure 1). The LED device used for this purpose had 20mW/cm^2 power density, and irradiated red light with 618nm wavelength in continuous-wave mode for 200 s (equal to an energy density of 4J/cm^2).

The same procedure was performed for the control group with the difference that the LED device was used as placebo in off mode. One operator provided the patients with postoperative instructions (eating soft foods only, and refraining from eating hot foods, and toothbrushing and dental flossing of the surgical site in the first 24 h, postoperatively). All patients received 400mg ibuprofen (Gelofen; Daana, Tehran, Iran) every 6 h for 2 days, postoperatively. Long-lasting anesthesia was not administered for any patient. Also, all patients received 500 mg amoxicillin every 8 h for 7 days, postoperatively for infection control. Moreover, 0.2% chlorhexidine mouthwash was prescribed for 7 days for oral hygiene.

2.4 Outcomes:

The main objective of this study was to assess the effect of LED phototherapy on pain and trismus following surgical extraction of impacted mandibular third molars. For assessment of trismus, the maximum mouth opening (MMO) was measured by a millimeter-scale ruler by one operator (Figure 2). For this purpose, the distance between the incisal edge of the maxillary and mandibular right central incisors was measured in all patients in both groups preoperatively and at 7 days postoperatively. The patients were requested to open their mouth as wide as they can. Also, each measurement at each session was repeated 3 times, and the maximum value was recorded in millimeters to increase the accuracy of the results.

Figure 1. Extraoral LED phototherapy after surgical removal of an impacted mandibular third molar.

Figure 2. Measuring the maximum mouth opening (distance between the incisal edge of the maxillary and mandibular right central incisors) by a millimeter-scale ruler.

For assessment of pain using the numerical rating scale, the patients were requested to express their level of pain by choosing a score from 0 (no pain) to 10 (worst pain imaginable). The severity of pain was assessed at 6 h, and 2 and 7 days, postoperatively. Selection of these time points was due to the fact that pain after third molar extraction surgery reaches its maximum level after 3 to 5 h, continues for 2-3 days, and then gradually subsides by day 7 [13].

2.5 Sample size calculation:

The minimum sample size was calculated to be 25 in each group (a total of 50) according to a study by Marta Lopez-Ramirez et al, [2] assuming α=0.5, β=0.2, mean standard deviation of 5, and significant difference of 4 units.

2.6 Interim analyses and stopping guidelines:

No interim analyses were performed, and no stopping

guidelines were established.

2.7 Randomization:

The patients were randomly divided into 2 groups of LED and control by flipping a coin.

2.8 Blinding:

All surgical procedures were performed by the same surgeon. LED phototherapy was performed by another operator. The operator who measured the MMO and level of pain was blinded to the group allocation of patients. The patients were also blinded to the intervention since LED was used in off mode in the control group (placebo).

2.9 Statistical analysis:

The MMO and pain score were compared between the two groups using the Mann-Whitney and NPar tests.

Results

3.1 Participant flow:

A total of 50 patients were evaluated in two groups (n=25). There were 13 males and 12 females in each group. There were no dropouts. The mean age of patients was 28 years (range 20 to 35 years). All patients had level B class II impacted mandibular third molars requiring surgical extraction. Figure 3 presents the process of patient selection and allocation to the groups.

3.2 Harms:

No patients were harmed during the study.

3.3 Subgroup analysis:

The mean difference in MMO after the procedure compared with baseline was -5.52mm in the LED and -7.68 mm in the control group (Table 1). Although the level of trismus was lower in the LED group, the difference in this respect between the LED and control groups was not significant (P=0.465). At 6 h postoperatively, the mean pain score was 6.00 in the LED and 7.08 in the control group; this difference was not significant (P=0.265). At 2 days postoperatively, the mean pain score was 3.52 in the LED and 3.48 in the control group; this difference was not significant (P=0.845). At 7 days postoperatively, the mean pain score was 1.08 in the LED and 1.04 in the control group; this difference was not significant either (P=0.942; Table 2).

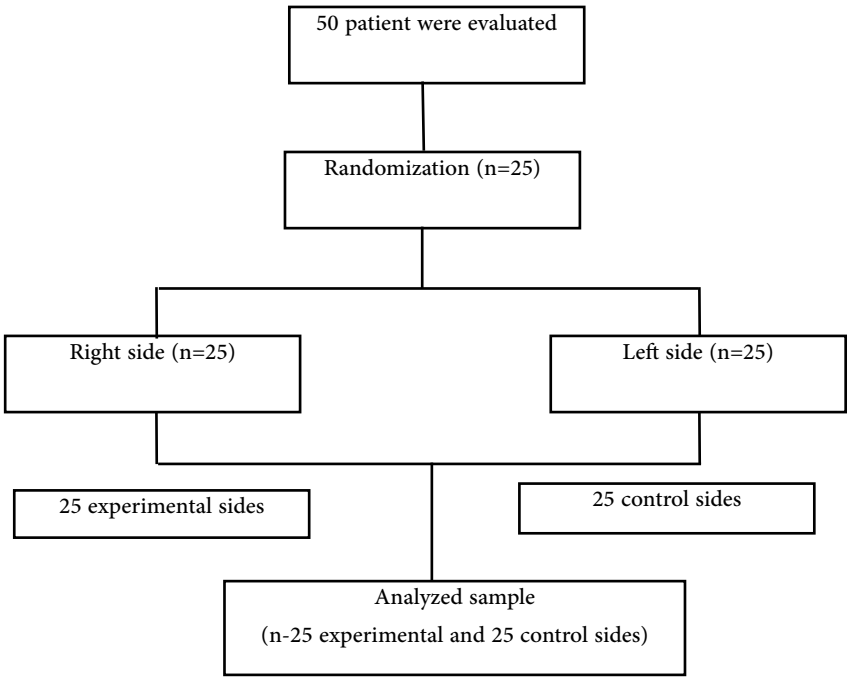

Figure 3. Consort diagram of patient selection and allocation.

Table 1. Measures of central dispersion for maximum mouth opening in the two groups (n=25).

Variable	Minimum (mm)	Maximum (mm)	Mean	Standard deviation
Mouth opening range before surgery in the LED group	27	49	38	5.627
Mouth opening range before surgery in the control group	30	59	41.60	7.427
Mouth opening range after surgery in the LED group	20	48	32.48	2.790
Mouth opening range after surgery in the control group	16	56	33.92	9.768
Difference of MMO1 and MMO2 in the LED group	-24	4	-5.52	7.02448
Difference of MMO1 and MMO2 in the control group	-27	0	-7.68	7.11056

Table 2. Mean pain score at different time points in the two groups (n=25).

Pain intensity	Minimum (mm)	Maximum (mm)	Mean	Standard deviation	P-value
6 h after surgery in the LED group	0	10	6.00	2.901	0.265
6 h after surgery in the control group	3	10	7.08	2.139	0.265
2 days after surgery in the LED group	0	8	3.52	2.275	0.845
2 days after surgery in the control group	0	8	3.48	2.002	0.845
7 days after surgery in the LED group	0	5	1.08	1.352	0.942
7 days after surgery in the control group	0	5	1.04	1.306	0.942

Discussion

Great advances made in LEDs have paved the way for their extensive use for phototherapy as an alternative to laser therapy [17]. The positive efficacy of LED phototherapy for enhancement of wound healing has been previously confirmed [18]. Also, it has been claimed that LED phototherapy may be effective for pain relief; however, clinical studies are required to confirm this claim [19]. The present study assessed the effect of LED phototherapy on pain and trismus following surgical extraction of impacted mandibular third molars, and showed that LED phototherapy with the aforementioned parameters had no significant effect on the level of pain or trismus following surgical extraction of impacted third molars; however, it slightly, but not significantly, decreased the level of pain at 6 h after surgery. Our results were in agreement with those of Marta Lopez-Ramirez et al. [2] who assessed the effect of low-level laser therapy (LLLT) on pain, edema, and trismus following surgical extraction of impacted third molars. Although the level of pain was lower in the first couple of hours after surgery in the laser group, the difference in this respect was not significant compared with the control group (P=0.258). Also, they reported higher level of trismus and edema at 2 and 7 days postoperatively in the control group but the difference was not significant with the laser group. Thus, they could not confirm the efficacy of LLLT for reduction of pain, edema or trismus following surgical extraction of impacted third molars. Markovic and Todorovic in their study on 30 patients irradiated AsGaAl laser with 637 nm wavelength and 50mW power for 10 min and re-

ported a significant reduction in the level of pain in the intervention group compared with the control group. Their results were different from our findings despite the fact that laser parameters in their study were similar to LED parameters in the present study. Difference between their results and ours may be due to the difference in duration of radiation since LED was irradiated for 200 s in our study while they irradiated laser for 10 min. Another possible explanation for this difference can be the lower power of LED device used in the present study [8]. Carillo et al. [20] assessed the effect of He-Ne low-level laser with 63nm wavelength and 10 J/cm^2 energy density on pain, edema and trismus following surgical extraction of impacted third molars. Of 100 patients, 50 were allocated to the laser and 50 to the control group. The results showed no significant difference in pain or facial edema between the two groups at 1 day postoperatively, which was in agreement with our findings. However, they reported significantly lower level of trismus in the laser group at 7 days, postoperatively, which was in contrast to our result. Difference between their results and ours in this respect may be due to the higher efficacy of He-Ne laser in reduction of trismus [20].

Roynesdal et al. [21] evaluated the efficacy of laser therapy for reduction of postoperative pain, edema, and trismus in 25 patients with bilaterally impacted third molars. They found no significant difference between the laser and control groups, which was in accordance with our findings. The laser used in their study had 40mW power and 830nm wavelength. Although the power of laser in their study was higher than the power of LED in the present study, similar results were obtained in the two studies, which may be due to the high wavelength of laser in their study and its subsequently lower penetration depth [21]. Leal-Junior et al. [22] evaluated the effect of LED combined with LLLT on knee pain. The patients in phototherapy group received 12 sessions of treatment with low-level laser with 905nm wavelength and LED with 875 and 640nm wavelengths. They evaluated 86 patients and showed that combination of LLLT and LED phototherapy in red and infrared wavelengths was effective for reduction of pain and improvement of the quality of life of patients with knee pain. Their results were different from our findings probably due to the use of different wavelengths of light, different energy sources, and multiple sessions of phototherapy [22]. Lima et al. [23] assessed the efficacy of LLLT and LED phototherapy for pain reduction in 120 patients who had undergone open heart surgery. The results revealed that phototherapy significantly decreased pain. The laser used in their study had 640nm wavelength and spatial average energy fluence of 1.06 J/cm^2. The LED used in their study had 660±20nm wavelength and spatial average energy fluence of 0.24 J/cm^2. Their results were in contrast to our findings, probably due to the difference in surgical site and type of tissues because bone is removed in surgical extraction of impacted teeth. Hodgson et al. [24] evaluated the effect of LED in near-infrared wavelength on mucositis pain in bone marrow transplantation patients. They showed that extraoral phototherapy in normal-risk patients significantly decreased pain according to the World Health Organization (WHO) criteria. In normal or low-risk patients, the level of pain decreased as measured with all scales except for the WHO criteria, but not significantly. Their results were in agreement with our findings although we did not use the WHO scale for pain.

4.1 Limitations:

Poor cooperation of patients was a limitation of this study.

Conclusion

The current results showed that LED phototherapy with the aforementioned settings did not significantly decrease the level of pain and trismus of patients following surgical extraction of impacted mandibular third molars.

Conflict of Interest

There is no conflict of interest to declare.

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