

Is Low-Level Laser Therapy Effective in the Management of Pain and Swelling After Mandibular Third Molar Surgery?



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Purpose: This study evaluated the effect of low-level laser therapy (LLLT) on decreasing pain and swelling after removal of impacted third molars.

Patients and Methods: This randomized, double-blinded, split-mouth study included patients presenting 2 symmetrically impacted mandibular third molars. In each participant, one side was randomly assigned to laser treatment and the other side received placebo. LLLT was performed by intraoral application of a 660-nm laser (200 mW, 6 J per point at 4 points) followed by extraoral application of an 810-nm laser (200 mW, 6 J per point at 3 points). Irradiation at the 810-nm wavelength was repeated on days 2 and 4 after surgery. On the control side, the treatment protocol was similar to the experimental side, but with laser simulation. The main outcomes were the degree of pain during the next 7 days and the edema coefficients on days 2, 4, and 7 after surgery. Data were analyzed using generalized linear models to determine the effect of group and time on pain level and edema coefficients.

Results: The final sample consisted of 40 patients. Pain level was significantly lower in the laser than in the placebo side at all time points during the experiment ($P < .05$). Swelling was significantly lower in the laser than in the placebo group on days 2, 4, and 7 after surgery ($P < .05$).

Conclusion: LLLT proved effective in decreasing the intensity of pain and swelling after removal of impacted third molars and can be recommended to alleviate patients' symptoms after surgery.

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Removal of impacted third molars is one of the most common surgical procedures in the dentofacial area and is usually associated with detrimental side effects, such as pain, swelling, and trismus during the first few days after surgery. These complications can affect the routine activities of patients, such as sleeping, eating, and chewing and might even deter some patients from undergoing further surgical procedures.

Pain usually reaches its peak 3 to 5 hours after surgery, when local anesthesia has waned, whereas swelling is maximized 12 to 48 hours later,¹⁻³ influencing facial esthetics and social interactions.

The trauma occurring during surgery has been considered the etiologic factor for the inflammatory process, which is accompanied by postoperative complications.¹ Although pain and swelling gradually disappear within the first week after surgery, decreasing these sequelae is an important aim for the surgeon and for the patients. Most surgeons have tried to decrease complications after third molar surgery by the prescription of analgesics, nonsteroidal anti-inflammatory drugs, or corticosteroids, but the side effects of these drugs remain a concern. Therefore, alternative approaches, such as platelet-rich fibrin or low-

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level laser therapy (LLLT), which are free of adverse effects, have been suggested for patients undergoing oral surgical procedures.⁴

LLLT has been found to have strong effects on promoting the rate of wound healing, relieving pain, and accelerating the inflammatory process.⁵⁻¹² Because of these benefits, LLLT has been used for different purposes in dentistry, such as controlling the complications of tooth extraction or periodontal surgery, attenuating orthodontic pain, decreasing dentin hypersensitivity, alleviating the signs and symptoms of temporomandibular joint disorders, and increasing the rate of repair of sensory deficits. However, previous studies on the effect of LLLT after third molar surgery have indicated controversial outcomes.^{13,14} Some studies found substantial improvement in pain, trismus, and facial swelling,¹⁵⁻²² whereas others reported no beneficial effect of using low-power lasers after third molar surgery compared with a placebo application.^{1,3,13,23}

The purpose of this clinical trial was to evaluate the combined effect of low-power red and infrared lasers applied intra- and extraorally on decreasing pain and facial swelling after surgical removal of mandibular third molars. The authors hypothesized that LLLT would have no effect on decreasing pain and swelling after mandibular third molar surgery. The specific aims of the study were 1) to compare pain levels in the laser and placebo sides over 7 days after surgery and 2) to calculate and compare edema coefficients for the distances from the tragus to the commissure and from the gonion to the external canthus on days 2, 4, and 7 after surgery.

Patients and Methods

STUDY DESIGN AND PARTICIPANTS

To address the research purpose, the authors designed and implemented a prospective, randomized, double-blinded, split-mouth study.

The study population was composed of patients referred to the Department of Oral and Maxillofacial Surgery of the School of Dentistry, Mashhad University of Medical Sciences (Mashhad, Iran) for surgical removal of mandibular third molars from October 2013 through June 2014. To be included in the study, the subjects had to have impacted mandibular third molars with similar position (Class I according to the classification of Pell and Gregory²⁴) and inclination (mesioangular) on the right and left sides. Patients were excluded as study subjects if they had systemic diseases, severe periodontal disease, or acute pericoronitis. Also excluded were patients who smoked or had poor oral hygiene, and pregnant and nursing women in whom laser therapy might be contraindicated. The study protocol was reviewed and approved by the ethics committee of Mashhad University of Medical Sci-

ences, and an informed consent document was taken from each participant after a brief explanation of the treatment process.

INTERVENTIONS

A split-mouth design was used in this study so that one side of each patient was assigned to the laser group (experimental) and the other side was assigned to the placebo group (control). The surgery was accomplished under local anesthesia by an experienced surgeon who was blinded to the patients' assignment. The second operation was accomplished after complete resolution of the signs and symptoms of the first operation, with an interval of at least 2 weeks between sessions. The duration of surgery was recorded, and if it was more than 50% longer in one side than the other side, the subject was excluded from the sample. The patients were advised to take medication after surgery, including 500-mg amoxicillin capsules every 8 hours for 7 days and 400-mg ibuprofen tablets every 8 hours if they experienced pain. A 0.12% chlorhexidine mouthwash twice a day for 10 days was also prescribed. Furthermore, the patients were instructed not to apply ice over the face to allow the authors to measure the effect of laser therapy on postoperative edema.

At completion of the surgery, the experimental side was exposed to intraoral and extraoral irradiation from visible (red) and infrared lasers, respectively. Initially, a low-power diode laser (indium, gallium, aluminum, phosphide; Thor DD2 Control Unit, Thor, London, UK) was used to irradiate 4 areas in the surgical site (buccal, lingual, mesial, and distal aspects of the socket) for 30 seconds each. The laser apparatus emitted a wavelength of 660 nm and operated at the power of 200 mW and continuous wave mode at approximately 1 cm from the target area. The laser energy was 6 J per area with an energy density of 85.7 J/cm² at the surface of the probe (spot size, 0.07 cm²). The intraoral irradiation was not repeated during the postoperative period.

Afterward, an infrared diode laser (gallium, aluminum, arsenide; Thor) was used in contact with the skin surface at the angle of the mandible, the lower border of the mandible along the surgical site, and a point 1.5 cm higher than the lower border of the mandible along the surgical site. The infrared laser device emitted a wavelength of 810 nm and operated at the power of 200 mW and continuous wave mode. Each area was irradiated for 30 seconds, and the laser energy was 6 J with an energy density of 21.4 J/cm² at the surface of the probe (spot size, 0.28 cm²). The irradiation from the infrared laser was repeated on days 2 and 4 after surgery. The patient and the laser therapist wore safety goggles during irradiation.

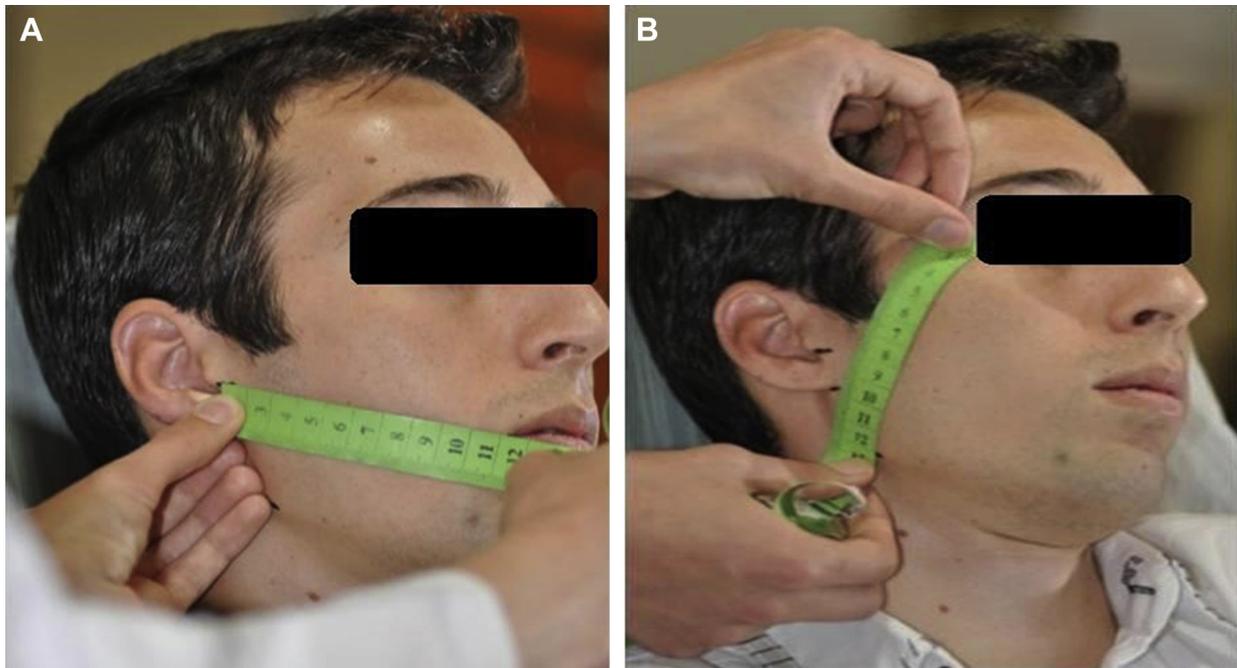


FIGURE 1. Measuring the distance between the A, tragus and commissure and B, gonion and external canthus.

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On the control (placebo) side, the treatment protocol was similar to that described for the laser side, but with the device turned off. Therefore, the patient was not aware which side received laser treatment. Half the patients received laser irradiation first and then placebo and the other half received placebo and then laser irradiation. The order of assignment to laser or placebo treatment was determined randomly using a random-numbers table.

VARIABLES

The predictor variable was the use of laser versus placebo after third molar surgery. The primary outcome variables were the amount of pain perceived during the first 7 days and the edema coefficients on days 2, 4, and 7 after surgery in the laser and placebo sides. Because of the split-mouth design of the study, the baseline characteristics (age, gender, pain threshold, etc) were similar between groups.

DATA COLLECTION METHODS

For assessment of postoperative pain, a visual analog scale (VAS) was used. The patients were asked to mark the degree of perceived pain on a 10-cm horizontal line, with 0 (left side) indicating no pain and 10 (right side) indicating the most terrible pain. The intensity of pain was recorded at bedtime for 7 days after surgery. The number of analgesics consumed per day was also recorded by the patients.

To determine the amount of facial swelling, the distance between the tragus and lip commissure and the distance between the gonion and external canthus of the eye (Fig 1) were measured before surgery (baseline) and 2, 4, and 7 days after surgery. The measurements were performed by an experienced operator who was blinded to the type of treatment delivered to the patient. The edema coefficient was calculated using the following formula¹⁸:

$$\text{Edema coefficient} = \left(\frac{[\text{distance after surgery} - \text{distance before surgery}]}{\text{distance before surgery}} \right) \times 100$$

STATISTICAL ANALYSES

The Kolmogorov-Smirnov test confirmed the normal distribution of variables in the 2 groups ($P > .05$). Statistical analysis was performed using generalized linear models to determine the effect of group and time on pain level and edema coefficients (for distances between the tragus and lip commissure and between the gonion and external canthus). Between-group differences in the frequency of analgesic consumption were assessed by the χ^2 test. Statistical analysis was performed using SPSS 11.5 (SPSS, Inc, Chicago, IL), and the significance level was determined at a P value less than .05.

Results

The right and left sides of 44 patients (24 women, 20 men; age range, 18 to 35 yr; mean age, 22 yr 2 months) were randomized to the laser or placebo treatment after third molar surgery. Four patients had incomplete records during the experiment and were excluded from the sample. Therefore, data from the laser and placebo sides of the remaining 40 patients were used in the statistical analysis. Table 1 presents a summary of the study variables.

Table 2 and Figure 2 present the intensity of perceived pain (outcome variable) in the laser versus placebo group (predictor variable) during the study period. The generalized linear models indicated that pain level was significantly lower in the laser than in the placebo side at all time points during the experiment ($P < .001$; Table 3). Furthermore, the intensity of pain decreased significantly in the laser and placebo sides during the experiment ($P < .001$; Table 3).

Tables 4 and 5 present the edema coefficients for the distances between the tragus and commissure and between the gonion and external canthus (outcome variables) in the laser versus placebo group (predictor variable) during the study period. The total (collective) postoperative edema coefficients were 6.65% in the laser side and 9.87% in the placebo side for the distance between the tragus and commissure and 7.61% in the laser side and 11.84% in the placebo side for the distance between the gonion and external canthus. Statistical analysis showed that the 2 edema coefficients were significantly lower in the laser than in the placebo group at 2, 4, and 7 days after surgery (Tables 6,7). Furthermore, the edema coefficients decreased significantly in the laser and placebo sides during the experiment ($P < .001$; Tables 6,7).

The χ^2 test showed that the frequency of analgesic consumption was not significantly different between the 2 groups ($P > .05$) except on day 6, when the laser-treated side required a lower consumption of medication compared with the placebo side.

Table 1. SUMMARY OF STUDY VARIABLES

Variable	Sample
Sample size, n	40
Men, n (%)	17 (42.5)
Age, mean \pm SD	23 \pm 1.8

Abbreviation: SD, standard deviation.

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Discussion

The present study investigated the combined effect of 2 wavelengths of low-power lasers on decreasing pain and swelling after third molar surgery. The null hypotheses of the study were that laser therapy would have no effect on pain and swelling after removal of impacted third molars. The specific aims of the study were 1) to compare pain levels in the laser and placebo sides for 7 days after surgery and 2) to calculate and compare edema coefficients for the distances between the tragus and commissure and between the gonion and external canthus on days 2, 4, and 7 after surgery. The laser application was performed 3 times during the experiment, because it is believed that optimum therapeutic results are achieved by repeating laser therapy 2 or 3 times per week. The outcomes of this study proved the analgesic effect of LLLT, because the level of pain perceived in the laser side was significantly lower compared with the placebo side throughout the experiment. On day 1, the mean VAS score in the laser and placebo sides were 4.7 and 6.3 cm, respectively. Pain level was markedly lower in the laser side on day 1, because the patients received LLLT immediately after the surgical procedure. On day 2, the mean VAS score in the laser side was 3.6 cm versus 5.4 cm on the placebo side. The percentage of pain decrease was larger in the laser than in the placebo group on day 2 (24% vs 14%). Although pain level was considerably lower in the laser than in the placebo side on days 3 to 6, the percentage of pain decrease per day was similar between the 2 groups. In other words, the initial difference in VAS scores obtained on days 1 and 2 was maintained for the rest of the experiment. As expected, a marked decrease in pain symptoms occurred in the 2 groups during the experiment. The frequency of analgesic consumption was comparable between the 2 groups at most time points.

In the present study, the severity of swelling, as measured by the edema coefficient for the distances between the tragus and commissure and between the gonion and external canthus, was markedly lower in the laser than in the placebo side on days 2, 4, and 7 after the surgical procedure. The differences in the collective amount of postoperative edema coefficients were considerable (~1.5 times greater in the placebo vs laser group). The smaller amount of facial swelling in the laser than placebo group on day 2 could be attributed to the radiation of red and infrared lasers immediately after the surgical procedure, which has proved anti-inflammatory and antiedematous effects. The repeated application of low-power infrared laser on days 2 and 4 after surgery might have an important role in decreasing the amount of swelling in the laser side throughout the experiment. Similar to VAS scores,

Table 2. DESCRIPTIVE STATISTICS OF PAIN LEVEL (CENTIMETERS) FOR 7 DAYS AFTER SURGERY IN LASER AND PLACEBO GROUPS

Treatment	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
	Mean	SD												
Laser	4.75	2.17	3.6	1.35	2.77	1.45	1.77	1.45	1.2	1.18	0.7	0.86	0.23	0.57
Placebo	6.3	1.87	5.4	1.57	4.1	1.41	2.85	1.59	2.01	1.36	1.22	1.24	0.47	0.84

Abbreviation: SD, standard deviation.

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edema coefficients decreased considerably over time in the laser and placebo groups. This is due to the spontaneous improvement in pain and swelling, which is usually observed within a few days after the surgical procedure.

The analgesic and anti-inflammatory effects of LLLT have been explained through different mechanisms.^{1,25-31} It is believed that LLLT stimulates the synthesis of endogenous endorphins, increases pain threshold, and blocks neuronal conduction. The anti-inflammatory effect of LLLT has been attributed to the increase in the number and diameter of lymph vessels, decrease in the permeability of blood vessels, and inhibitory effects on inflammatory mediators, such as prostaglandin E₂, interleukin-6, interleukin-10, and tumor necrosis factor- α . The results of this study suggest that laser therapy should be considered an effective modality to decrease the adverse effects of surgical intervention in patients with impacted mandibular third molars. This is a simple and noninvasive modality that can be performed in a relatively short time (<5 minutes) in the dental office, leading to decreased pain and swelling after surgery. Furthermore, this approach eliminates the possible lack of cooperation in using an ice pack to decrease swelling and does not produce the side effects of nonsteroidal anti-inflammatory drugs and corticosteroids for attenu-

ating postoperative pain. The authors believe that LLLT would be especially useful in patients affected by systemic diseases, such as diabetes mellitus, or immunocompromised patients in whom postoperative sequelae may be exaggerated. Although LLLT was applied 3 times in 1 week, the outcomes of 1-time laser application immediately after the surgical procedure was also promising, because it relieved pain symptoms at least on days 1 and 2 and facial swelling on day 2 in this investigation.

The results of this study are in agreement with the findings of other investigators who reported a meaningful decrease in postoperative pain and swelling levels in patients who underwent LLLT after third molar surgery.¹⁵⁻²² Aras and Gungormus¹⁵ used LLLT (12 J, 4 J/cm²) on the operative site intraorally and on the masseter muscle extraorally immediately after third molar surgery and found markedly lower trismus and swelling on postoperative days 2 and 7 in the LLLT versus placebo group. Markovic and Todorovic¹⁸ compared the effectiveness of low-power laser therapy (637 nm, 50 mW, 4 J/cm²) and dexamethasone after surgical removal of lower third molars and reported that the least amount of swelling was achieved with the combination of laser therapy and local intramuscular injection of dexamethasone. In contrast to the findings of this clinical trial, several studies reported no evidence of a difference in pain and swelling between the laser and placebo sides after

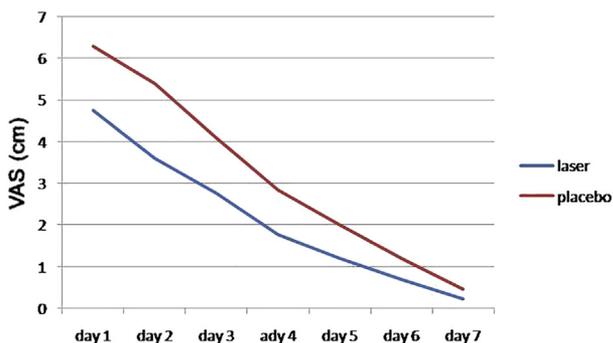


FIGURE 2. Line chart indicating visual analog scale values in the laser and placebo sides during the postoperative period.

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Table 3. RESULTS OF GENERALIZED LINEAR MODELS TO DETECT THE EFFECT OF GROUP AND TIME ON PAIN LEVEL

Parameter	B	Std. Error	Significance
Intercept	6.547	0.168	.000
Laser group	-1.046	0.133	.000
Placebo group	0*		
Time	-0.733	0.030	.000

* Set to 0 because this parameter is redundant.

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Table 4. DESCRIPTIVE STATISTICS REGARDING EDEMA COEFFICIENT (PERCENTAGE) FOR DISTANCE BETWEEN THE TRAGUS AND COMMISSURE ON DAYS 2, 4, AND 7 AFTER SURGERY IN THE LASER AND PLACEBO GROUPS

Treatment	Day 2		Day 4		Day 7	
	Mean	SD	Mean	SD	Mean	SD
Laser	4.22	1.27	2.39	1.17	0.04	0.21
Placebo	5.69	2.06	3.76	1.87	0.42	0.77

Abbreviation: SD, standard deviation.

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third molar surgery.^{1,3,13,23} Lopez-Ramirez et al¹ found that the intraoral application of a low-level laser (810 nm, 0.5 W, 5 J/cm²) did not show beneficial effects of decreasing pain, swelling, and trismus after removal of impacted lower third molars. Amarillas-Escobar et al³ found no statistically meaningful effect on postoperative pain, swelling, and trismus after using a therapeutic laser (810 nm, 100 mW, 4 J/cm² applied intraorally and extraorally) for the management of patients after surgical removal of third molars. A recent systematic review and meta-analysis found that LLLT provides no benefit on pain and swelling and a moderate benefit on trismus after mandibular third molar surgery.¹³ The controversies observed among the results of previous studies could be attributed to the application of different laser parameters, such as wavelength, power, energy, and energy density, the frequency and duration of laser radiation, intraoral versus extraoral application, and area of irradiation.

In the present study, the energy used for each area was 6 J using the 2 wavelengths. However, the energy density at the surface of the probe was 85.7 J/cm² for the 660-nm laser and 21.4 J/cm² for the 810-nm laser, because the surface areas of the probes were different. Although the energy density of the 660-nm

Table 5. DESCRIPTIVE STATISTICS REGARDING EDEMA COEFFICIENT (PERCENTAGE) FOR THE DISTANCE BETWEEN THE GONION AND EXTERNAL CANTUS ON DAYS 2, 4, AND 7 AFTER SURGERY IN THE LASER AND PLACEBO GROUPS

Treatment	Day 2		Day 4		Day 7	
	Mean	SD	Mean	SD	Mean	SD
Laser	4.83	1.72	2.61	1.29	0.17	0.40
Placebo	6.39	2.06	4.43	1.68	1.02	1.03

Abbreviation: SD, standard deviation.

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Table 6. RESULTS OF GENERALIZED LINEAR MODELS TO DETECT THE EFFECT OF GROUP AND TIME ON THE EDEMA COEFFICIENT FOR THE DISTANCE BETWEEN THE TRAGUS AND COMMISSURE

Parameter	B	Std. Error	Sig
Intercept	7.39	.22	.000
Laser group	-1.07	.17	.000
Placebo group	0*		
Time	-.94	.04	.000

* Set to zero because this parameter is redundant.

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wavelength seems high, the beam was divergent and the laser handpiece was held 1 cm from the target area, which could cause a large area of irradiation and thus a substantial decrease in energy density. Intraoral and extraoral irradiations were used in this study to exploit the direct effect of the red wavelength on enhancing incisional wound healing and the great penetration depth of the infrared wavelength in facial muscles and deep tissues to decrease postoperative swelling. Using an 808-nm diode laser (100 mW, 12 J), Aras and Gungormus¹⁶ reported that extraoral LLLT at the insertion point of the masseter muscle was more effective than intraoral LLLT at the operation site for the decrease of trismus and swelling after removal of mandibular third molars. The combination of intraoral and extraoral laser therapy was also found beneficial for decreasing postoperative swelling and trismus after third molar surgery in another investigation.¹⁵

The strengths of this study can be summarized as follows. The study included patients with bilaterally symmetrical third molars, because the surgeon's accessibility to the impacted tooth is one of the most important factors in the difficulty of the surgical procedure and thus the occurrence of postoperative complications. The split-mouth design of the study allowed the clinician to measure the level of pain and swelling

Table 7. RESULTS OF GENERALIZED LINEAR MODELS TO DETECT THE EFFECT OF GROUP AND TIME ON THE EDEMA COEFFICIENT FOR THE DISTANCE BETWEEN THE GONION AND EXTERNAL CANTUS

Parameter	B	Std. Error	Sig
Intercept	8.28	0.24	.000
Laser group	-1.41	0.18	.000
Placebo group	0*		
Time	-1.00	0.04	.000

* Set to zero because this parameter is redundant.

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of the right and left sides in the same patients, thus preventing interindividual variations from affecting the outcomes of the study. All operations were performed by 1 experienced surgeon to avoid different surgical skills that could affect patients' symptoms. Unlike some previous studies that used intraoral or extraoral laser irradiation, the present study exploited the combined effect of low-power red and infrared lasers applied intra- and extraorally after third molar surgery. The assignment of a placebo group counteracted the psychological impact of treatment by a high technology apparatus, which can cause a decrease in patients' pain symptoms.^{32,33} The limitation of this study was that the therapeutic effects of 660- and 810-nm wavelengths were not evaluated individually.

Under the conditions used in this study, the combined intraoral and extraoral irradiation from red and infrared low-power lasers proved effective in decreasing the intensity of pain and swelling during the first week after surgical removal of mandibular third molars. Therefore, LLLT can be recommended as a safe and noninvasive modality for patients undergoing third molar surgery to decrease operative side effects.

Further clinical trials are suggested to compare the effect of 660- and 810-nm wavelengths using single versus multiple irradiations on decreasing surgical sequelae and increasing the rate of repair after extraction of impacted third molars.

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