

# The Evaluation of Photobiomodulation by 980 nm Diode Laser on Postoperative Complications after Third Molar Surgery

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**Introduction:** The aim of this study is to figure out how effective 980 nm diode laser is to reduce post surgical complications of impacted mandibular third molar tooth. **Materials and Methods:** This randomized, double-blind clinical trial is performed on 30 patients who were randomly divided into two groups. In the case group, the diode laser was irradiated in two regions extraorally and four regions intraorally. Each region received a thirty-second irradiation with a wavelength of 980 nm and power of 500 mW, immediately after operation while the control group was exposed to the inactive irradiation of the same laser. The severity of pain, swellings, mouth opening, and patients' quality of life were evaluated. Data is analyzed by Independent two-sample t test, Fisher's exact test and Two-way repeated measures analysis of variance. **Results:** On the seventh day of study, the case group received both a significantly lower mean score of functional limitation, physical discomfort domains and a lower total score of Oral Health Impact Profile 14-questionnaire rather than the control group (Respectively  $P=0.011$ ,  $P=0.027$ ,  $P=0.032$ ). However, the mean score related to pain, swellings, trismus and other domains of OHIP-14 wasn't much varied between the two groups throughout the study period ( $P>0.05$ ). **Conclusion:** Although irradiating PBM after impacted mandibular third molar surgery isn't effective to reduce side effects such as pain, swellings and trismus it seems to improve the quality of life related to functional limitation and physical discomfort.

**Keywords:** Complications; Photobiomodulation; Third Molar Surgery

## Introduction

Impacted third molar is considered an oral hygiene issue and its extraction is the most common procedure in oral and maxillofacial surgery units worldwide (1). This intervention can be a challenging operation and its difficulty can be predicted based on variables such as tooth position, root number and morphology, periodontal space, and second molar relation (2, 3).

This minor surgery is usually associated with complications that impact the patient's quality of life and recovery (4). Factors found to indicate the occurrence of third molar removal sequelae are anatomical, technical, or patient-related (5). The inflammatory response induced by the trauma of the surgery as well as the duration of the operation proportionate to its difficulty are among these factors (6, 7). Pain, swelling and restriction on mouth opening (trismus) are the most common complications one develops in a few days' post-surgery (8). Postoperative bleeding, dry socket (alveolar osteitis), wound healing retardation and trauma to inferior alveolar nerve are also prevalent (9).

Pain peaks three to five hours after surgery, endures for two to three days and gradually diminishes until the seventh day. Swelling elevates to its maximum in 12 to 48 hours which disturbs facial appearance and social interactions and resolves within five to seven days (6, 9-11). Trismus is defined as the tonic contraction of masticatory muscles and can result in chewing problems and subsequent lack of nutrition, dysarthria and inefficient oral hygiene (12). What occurs during a third molar removal such as inflammation of masticatory muscles, trauma to temporomandibular joint (TMJ), local anesthesia injection, and infection can cause trismus (13).

Although these complications are expected to resolve gradually, their management is a concern to surgeons as it can influence treatment outcome and patient satisfaction (10). Currently, corticosteroids and non-steroidal anti-inflammatory medication are prescribed pre and post-operatively (14). Given their known side effects, photobiomodulation (PBM) have been proposed as a safe alternative (15).

Previous literature has demonstrated that low level laser energy may stimulate serotonin and acetylcholine central secretion and regulate peripheral histamine and prostaglandin production (10). PBM has reported analgesic effect due to increasing endorphin (B-endorphin) and reduction of C-fiber action and bradykinin release (16, 17). PBM is also capable of induction of morphological changes in neurons, reduction of mitochondrial membrane potential and occluding axon fast current which ultimately results in blockade of nervous transmission (18). The indication of PBM in minimizing third molar extraction complications has been studied and the results have not been coherent (19, 20). Some studies have reported considerable improvement in pain, swelling, and trismus after application of PBM (7, 11, 21, 22), while others have failed to show any significant difference between PBM and placebo (10, 23-25). These contradicting results could be attributed to differences in measurement of complications, application of different surgical hand pieces, different surgical methods and particular lasers with varying parameters (wavelength, power, exposure time, probe diameter, etc.). In this study, we aimed to investigate the effect of 980 nm Diode laser on postoperative complications of the mandibular impacted third molar surgery in order to identify and introduce it as a minimally invasive postoperative method.

## Materials and Methods

In this double-blinded randomized controlled clinical trial, 30 patients (7 males and 23 females) aged between 18 and 25 years who attended oral and maxillofacial department in dental school of Rafsanjan University for impacted mandibular third molar extraction in 2017 were enrolled. This study was approved by ethic committee of Rafsanjan University of Medical sciences (IR.Rums.REC.1396.64). Eligible subjects were recruited after consideration of exclusion criteria including: presence of preoperative pain, any systemic condition (such as cardiovascular diseases, high blood pressure, diabetes, psychotic disorders, etc.), substance abuse, chronic intake of medication, analgesic consumption 12 hour before the surgery, pregnancy, lactation, history of allergy to laser and duration of surgery (from incision to final suture) longer than 30 minutes. Written consent with the approval of ethics committee of the university was obtained from the patients and panoramic radiography was taken from all patients to help locate the tooth. Position of the tooth was recorded for every patient.

All patients were given a 500 mgr. dose of acetaminophen tablet (rampharmin, Tehran, Iran) immediately before the surgery and were asked to rinse with chlorhexidine 0.2% (behsa, Arak, Iran) for 30 seconds. After scrubbing and disinfecting the peri-oral skin,

local anesthesia of surgical area was achieved by lingual, buccal, and inferior alveolar nerve block injection of at least one 1.8 mL capsules of 2% lidocaine with 1:100000 epinephrine (darupakhsh, Tehran, Iran). Next, extraction of impacted third molar of mandible was carried out by a surgeon according to standard surgical protocol. In sterile condition, a triangular flap was created by an incision from the mesial of second molar to distobuccal of the impacted tooth. After access to tooth, bone was removed up to cemento-enamel junction (CEJ) using a round carbide hand piece bur (Tizkavan, Tehran, Iran) with low speed and normal saline flow. Tooth was segmented and removed where it was indicated. After removal of residual sharpness and debris, tooth socket was thoroughly rinsed with normal saline. Flap edges were then held together and sutured non-continuously with 3-0 silk (Hoordeb, Qazvin, Iran) and duration of the surgery (from incision to final suture) was recorded.

Patients were randomly divided into case (n=15) and control (n=15) groups using table of random numbers. Study group received laser therapy and routine care while the control group received the routine care solely. Participants were not aware of the group they were assigned to. In the study group, low level diode laser (Simpler, Doctor smile, Italy) with wavelength of 980 nm, tip diameter of 7 mm, power output of 500 mW, and 15 J energy and 39.06 J/cm<sup>2</sup> energy density was applied right after surgery extra-orally 1.5 cm below inferior border of mandible in contact with skin of surgical area and intra-orally in buccal, lingual, mesial, and distal of the socket (picture 1-2) for 30 seconds in each area (180 seconds overall). The control group were sham-treated for the same time by an inoperative system meaning that laser probe was maintained at the area similar to exposure conditions without activating the laser (7). After fixing the therapeutic laser at the right position, it was held until energy density reached sufficient level for bio stimulation and then laser was instituted to the target area.

After the surgical procedure, a 500 mg. dose of acetaminophen every 6 hour (the first dose to be taken 6 hours after the preoperative dose) for three days (26), 500 mg amoxicillin (Dana, Tabriz, Iran) every 8 hour for seven days (23, 27) and chlorhexidine 0.2% mouthwash 2 times a day for seven days (22) were prescribed for both groups and patients taking other analgesics were excluded from the study. Patients were instructed to record acetaminophen intake time and hour during the three post-operative days. They were also asked to mark the daily pain intensity as a vertical line in VAS (visual analogue scale) scale starting from zero (no pain) to 10 (worst pain ever experienced) at the time of taking acetaminophen tablet in the first three days and at least once a day at a particular hour until the 7<sup>th</sup> day (24, 25). The OHIP-14 questionnaire of oral health related quality of life (28) was explained to patients

**Table 1.** Comparison of demographic data, tooth position, operation duration and pre-operative measurements in PBM and control group

	Control (n=15)	PBM (n=15)	P-value
Age	26.3 (33.98)	28.8(40.90)	0.422
Sex (male/female)	6/9	1/14	0.08
Tooth position	Horizontal	8	6
	Vertical	5	3
	Mesioangular	2	6
Operation duration(mins)	18.5(20.23)	20.4(73.96)	0.184
Outer eye corner to angle of mandible (cm)	10.0(50.72)	10.0(56.73)	0.823
Tragus to outer lip corner (cm)	11.0(51.61)	11.0(53.83)	0.960
Tragus to Pogonion (cm)	14.0(89.85)	15.0(13.90)	0.458
Mean facial measures (cm)	12.0(30.60)	12.0(41.74)	0.673
Upper and lower right incisor distance in maximum opening (cm)	4.0(21.82)	4.0(12.52)	0.731

**Table 2.** Comparison of OHIP-14 scores in PBM and control group

	Control (n=15)	PBM (n=15)	P-value
Functional limitation	0.0(40.74)	0.0(27.70)	0.616
Physical pain	3.2(27.92)	2.2(33.61)	0.363
Psychological discomfort	3.2(53.50)	3.2(07.43)	0.609
physical disability	1.2(40.20)	1.2(20.04)	0.798
psychological disability	2.1(20.94)	1.1(73.98)	0.519
social disability	1.1(60.88)	1.2(47.53)	0.871
handicap	0.1(80.21)	1.2(27.43)	0.511
Total score	14.11(53.41)	11.11(33.96)	0.460

and filled out before the surgery and 7 days post-surgery. The day of surgery was designated as the day zero. OHIP-14 consists of seven sections: functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap and its validity and reliability has been analyzed in cross-cultural studies (29, 30). Swelling and mouth opening was evaluated before the surgery and on the second and seventh day (21, 22). To evaluate the swelling, distance between eye corner and angle of mandible, tragus and lip corner, tragus and pogonion at the site of surgery was measured in millimeters with ribbon ruler and to evaluate the mouth opening distance between upper and lower incisor of the right side was measured before the surgery and on the seventh day by an operator blinded to study groups. The same measurements were recorded by the patient or a previously instructed accompany on the second day. The suture was removed on the seventh day. To measure the amount of pain, a vertical line was drawn to the collision point of the line drawn by patient and the VAS straight scale and the point was measured with a ruler in millimeters. The responses to questions of oral health related quality of life questionnaire were coded by likert scale as 0=never, 1=rarely, 2=sometimes, 3=often, 4=most of the time. Thus the range of answers to the 14 questions varied between 0 and 56 (31).

#### Statistical Analysis:

Data was analyzed using SPSS software version 21. Independent two sample t test was used to compare mean value of quantitative variables (age, duration of surgery, facial measurements, mouth opening measurements, OHIP-14 questionnaire sectional and overall scores) in the study groups (PBM and control). Fisher's exact test was applied to compare distribution of sex and tooth position variables in the two groups. Two-way repeated ANOVA measures were used to compare mean values of swelling, trismus, pain, number of analgesics in PBM and control group during the study. A p value less than 0.05 was considered statistically significant.

## Results

In this randomized double-blinded controlled clinical trial, a total of 30 subjects (7 males and 23 females) aged between 18 and 45 years underwent impacted mandibular third molar removal surgery.

Demographic data are compared between test and control in Table 1. Mean age and duration of surgery did not show a significant difference between the two groups in Independent two-sample t-test ( $P>0.05$ ). Fisher's exact test also demonstrated that sex and position of the tooth were not significantly different between laser and control group ( $P>0.05$ ).



Pre-operative measurements were assessed and the results are summarized in Table 1. As shown in the table, no significant difference was observed between the study groups in mean facial measures and amount of mouth opening by independent two-sample t-test ( $P>0.05$ ). Subsequently, OHIP-14 quality of life questionnaire total score and mean scores of each section were assessed pre-operatively in the groups with independent two-sample t-test showing no significant statistical difference ( $P>0.05$ ) as shown in Table 2.

As displayed by two-way repeated measures ANOVA analysis, in facial measures and amount of mouth opening, the interaction between time and groups were not statistically significant ( $p>0.05$ ) meaning that the slope of shifts in variables during the study were similar in both study groups. In other words, laser group were not significantly different from control. On the other hand, the mentioned analysis proved that in all studied variables, the effect of time was significant ( $P<0.05$ ) that is to say, in each of the control and laser groups, swelling increased after operation until the second day and diminished from the second to seventh day and conversely, mouth opening decreased up to second day and then increased up to seventh day.

Results of two-way repeated measures ANOVA test on pain also found time-group interaction to be statistically insignificant ( $P=0.365$ ,  $F=1.098$ ) which means that slope of pain reduction from the first to the seventh day were comparable between control and laser group. However, the analysis found time's effect to be statistically significant ( $P<0.001$ ,  $F=46.124$ ). Thus, pain severity significantly decreased from the first day to the seventh day in both groups.

Same results were obtained with analgesic doses. ANOVA analysis failed to find any significant interaction of time and group ( $P=0.247$ ,  $F=1.424$ ) but time's effect was still significant ( $P<0.001$ ,  $F=8.548$ ). In a sense, analgesic intake significantly decreased between first and third day and the reduction was similar in the two groups. Regarding OHIP-14 questionnaire, total score, and mean scores of functional limitation and physical pain was significantly better after one week in laser group than control based on results from independent two-sample t-test ( $P<0.05$ ) but no statistical difference was found in other scopes ( $P>0.05$ ).

## Discussion

After removal of impacted mandibular third molar, pain, trismus and swelling are inevitable. Nevertheless, assessing these factors is relatively difficult (25). One of the recently developed methods to control complications of impacted tooth extraction is low level laser therapy.

In this study, low level diode laser with power output of 500 milliwatts, was applied immediately after surgery both intraorally and extra-orally. The obtained results demonstrated no significant difference in pain reduction, analgesic intake, swelling and trismus. Briefly, mean swelling and trismus increased after surgery up to the second day and diminished until the seventh day and the mean intake of acetaminophen decreased in three days while pain was reduced during the seven post-operative days.

Various studies have been conducted on the effect of low level laser therapy on the management of impacted third molar extraction complications but their results have been controversial (20, 32). In several studies considerable improvement in pain, trismus and swelling was observed after the application of low level laser (7, 11, 21, 22) while in others, no significant difference was found between low level laser and placebo (10, 23-25). These contradicting results could be attributed to differences in measurement of complication variables, application of different surgical hand pieces, various surgical methods, single vs multi session irradiation and particular lasers with varying parameters (wavelength, power, exposure time, probe diameter, etc.)

Lopez-Ramirez *et al.*, investigated the analgesic and anti-inflammatory effect of low level laser (wavelength of 810 nm, output power of 0.5 watts and energy density of 5 j/cm<sup>2</sup>) on pain, swelling and trismus in 20 patients with two symmetrical impacted mandibular third molars and reported that low level laser is not beneficial in reducing any of the assessed parameters (10). Roynesdal *et al.*, also studied 25 patients with symmetrical impacted third molar and concluded that low level laser (830 nm, 0.4 watt) has no positive effect on reduction of pain, swelling and trismus (33). Raouaa and amarillas-escobar also reached similar conclusion (24, 25). Our results were comparable to the mentioned studies.

Eshghpour *et al.* evaluated the effect of low level laser on pain and swelling after impacted mandibular third molar removal. 40 patients with symmetrical impacted mandibular third molar were enrolled. They concluded that amount of pain and swelling was significantly lower in laser group than control (7) which differed from our results. In that study similar to ours, laser was applied immediately after operation both intraorally and extra-orally but the laser exposure was repeated on the day two and day four which might explain the difference in obtained results.

The results of a study by Markovic and Todorovic was also inconsistent with ours. They inferred that intraoral low level laser exposure significantly reduced post-operative swelling. They evaluated post-operative pain in three groups: First group received Gallium-Aluminum-Arsenic Laser (637 nm, 50 mW, 4

j/cm<sup>2</sup> for 10 minutes in surgical area). Second group received 100 mgr. diclofenac one hour before the surgery and the third group was considered as control. Pain was reduced in Laser group compared to diclofenac and control groups. The fellow researchers then used four groups to compare laser's effect to dexamethasone. Group 1, laser (637 nm, 50 mW, 4 j/cm<sup>2</sup> in the surgical area), group 2, same laser dose and a 4 mgr. dose of dexamethasone in internal pterygoid muscle, group 3, same laser dose and IM injection of dexamethasone with added intraoral intake of 4 mgrs. of dexamethasone 6 hours post-operatively and the fourth group was considered as control. Significant reduction of swelling was observed in all groups involving laser therapy compared to control with better results obtained in the combined laser-local dexamethasone group(11, 34). The difference of their results could be attributable to the type of study, laser exposure duration and laser parameters.

Petrini *et al*, studied the effect of intraoral and extra-oral pre-operative application of low level laser on pain, swelling and trismus after third molar extraction. They concluded that laser therapy before the surgery improves the analgesic benefits of low level laser. Nonetheless, trismus and edema decreased in both laser therapy groups regardless of exposure time (35). Their results were irrelevant to ours and the reason may be the time of laser therapy.

In our study, OHIP-14 questionnaire scores which represent quality of life were significantly lower in laser group than control in two scopes of functional limitation and physical discomfort meaning that quality of life was better in laser group in those two scopes. Meanwhile, there was no significant difference between two study groups in other scopes of quality of life. No similar studies on low level laser's effect on quality of life and OHIP-14 questionnaire was found.

Batinjan *et al*, studied 40 patients who needed mandibular third molar extraction surgery with the aim of assessing low level laser therapy's effect on wound healing and oral health related quality of life (OHRQoL) questionnaire. Subjects were randomly divided into two treatment groups post-operatively. There was no significant difference between patient characteristics in the two groups. It was shown that swelling and wound temperature decreased and QHRQoL improved in a 7-day course after the surgery compared to placebo which resembles our results (36).

Further studies, especially randomized controlled clinical trials, are required to clarify effect of low level laser therapy on impacted mandibular third molar removal and to define ideal parameters of laser in order to introduce it as a complementary therapeutic method or as a substitute for other methods in reducing post-operative complication in case of proved beneficence.

## Conclusion

Results obtained in this study demonstrate that there was no significant difference between the Laser group (980 nm, 500 mw) and Control group for pain severity, analgesic dose, swelling and trismus. Meanwhile, low level laser has a possible positive effect on functional limitation and physical discomfort scopes of OHIP-14 quality of life questionnaire while it's ineffectual in other scopes.

Conflict of Interest: 'None declared'.

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