Efficacy of using 810-nm diode laser after impacted lower third molar extraction surgery at Hue University of Medicine and Pharmacy Hospital

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Backgroud: Third molar extraction surgery often has many postoperative complications and the most common of them are pain, swelling and trismus. Currently, researchers pay attention and apply 810-nm diode laser in treatment to help patients return to normal daily life quickly. **Objectives:** This study aimed to investigate the effectiveness of 810-nm diode laser after impacted lower third molar extraction surgery. **Materials and Methods:** 60 patients, who underwent impacted lower third molar extraction surgery at Dental Clinic, Hue University of Medicine and Pharmacy Hospital, were divided randomly into 2 groups. In Diode laser group, each patient is applied 810-nm diode laser, power 0,5W at 6 points (22 seconds per point) with total energy 66J and power density 27.5 J/cm^2 after surgery. In control group, the same procedures were set up at surgical site but diode laser was not activated. Patients were evaluated for the intensity of the pain by VAS score during 7 days and the number of painkiller during 2 days after surgery. All the patients were assessed for swelling and trismus at postoperative intervals of 1, 2 and 7 days. **Results:** The number of painkiller used in Diode laser group in first 2 days after lower third molar extraction surgery was 1.20 ± **0.**50 tablets, while the control group was 2.50 ± 0.57 tablets. The pain intensity of Diode laser group is lower than that of control group in first 6 days after surgery significantly ($p < 0.05$). The facial swelling and trismus of Diode laser group is lower than that of control group at day 1 and day 2 after surgery significantly ($p<0.05$). **Conclusion:** 810-nm diode laser therapy effectively reduces pain, swelling and trismus after impacted lower third molar extraction surgery.

Keywords: *810-nm diode laser; Impacted lower third molar; Hue University of Medicine and Pharmacy Hospital.*

1. INTRODUCTION

Lower third molar is the most frequently impacted tooth with an incidence of about 34.71% of all types of impacted teeth and often causes local complications [1]. Lower third molar extraction surgery is performed to treat or prevent complications. However, this is a relatively invasive intervention, with many risks and complications after surgery, the most common of which are pain, swelling and trismus [2]. In addition to minimally invasive intervention techniques, reducing pain, swelling and trimus after surgery mainly depends on internally medical treatment, but the prescription of medication should be cautious, especially with elderly patients and patients with systemic diseases such as ulcers, gastric perforation, kidney failures, allergic reactions, platelet function disorders because of unwanted side effects. Currently, one of the supportive and alternative methods that receive a lot of attention is diode laser therapy after lower third molar extraction surgery due to the bio-stimulation effect on the cell activity with low-intensity irradiation [3]. Although most recent studies have shown clinical significance in the reduction of postoperative complications using diode laser after impacted lower third molars extractions, there are still differences between treatment procedures in simultaneously controlling pain, swelling, and trimus. Accordingly, this study was conducted to investigate the effectiveness of applying an 810-nm diode laser as an adjunct treatment in reducing pain, swelling and trimus after lower third molar extraction surgery at Hue University of Medicine and Pharmacy Hospital.

2. MATERIALS AND METHODS

Ethical approval

This study was conducted from April 2021 to April 2023 in full accordance with the Helsinki Declaration of 1975, as revised in 2000. The protocol and the informed consent form were reviewed and approved by the Institutional Ethics Committee of Hue University of Medicine and Pharmacy, Hue University, Hue, Vietnam. Sixty participants were

Corresponding author: Dang Minh Huy; Email: dmhuy@huemed-univ.edu.vn
Received: 2/1/2024; Accepted: 18/6/2024; Published: 25/6/2024
DOI: 10.34071/jmp.2024.4.2

recruited from Hue University of Medicine and Pharmacy Hospital. The signed informed consent form provides documentary evidence that the patient has given informed consent to participate in the study and that the patient has been given the requisite information.

Study population

Participants were recruited from patients who came for dental examination and were diagnosed with impacted lower third molar extraction surgery.

The inclusion criteria were as follows:

- 18-35 years of age [4].

- The depth of impacted third molar in relation to occlusal plane (Class B, Class C) was recorded along with the distance or width between the vertical ascending mandibular ramus and the distal surface of the second molar (Class II, Class III) according to the classification of Pell- Gregory and Winter. Corrected oblique radiographs of each patient side were obtained to evaluate right and left retromolar available space and third molar angulation [5].

Exclusion criteria included:

- Patients with contraindications to laser therapy: retinal degeneration, radioactive iodine therapy for thyroid and gonads cancer, premalignant and malignant tumors, significant mental and psychological disorders, photosensitivity or drug-induced photosensitivity [6].

- Patients with systemic diseases: cardiovascular disease, diabetes, blood disorders, neurological disorders.

- Patients with fever, local infections or using anti-inflammatory drugs.

- Patients allergic to local anesthetics or to the medication prescribed in the study

- Curent smoking, alcoholism, and pregnant or nursing women [4].

After obtaining informed consent, 60 patients having lower third molars with same declination were randomly divided into two equal groups: Diode laser group involved subjects on whom were treated with 810-nm diode laser therapy after impacted lower third molars extraction whereas control group included subjects on whom were not treated with 810-nm diode laser therapy after impacted lower third molars extraction. Randomization was done by drawing paper from a box containing numbers from 1 to 100; odd numbers were assigned to diode laser group and even numbers were placed in control group. All the patients were operated by the same surgeon.

Pre-operative Assessments

Pain Intensity

The pain level was evaluated using a visual analogue scale (VAS) of 100 mm, whose extreme scores were from 0 (no pain) to 100 (the worst pain imaginable

Facial Swelling

Facial swelling was assessed by using a modification of the method described by Schultze-Mosgau et al. [7]. Measurements are made of the distances from the lateral comer of the eye to the angle of the mandible (horizontal measure), from the tragus to the outer comer of the mouth (vertical measure)

Trimus

Distance between the incisal edge of the upper central incisors and the incisal edge of the lower central incisors in the maximum mouth opening by a boley gauge caliper was measured preoperatively.

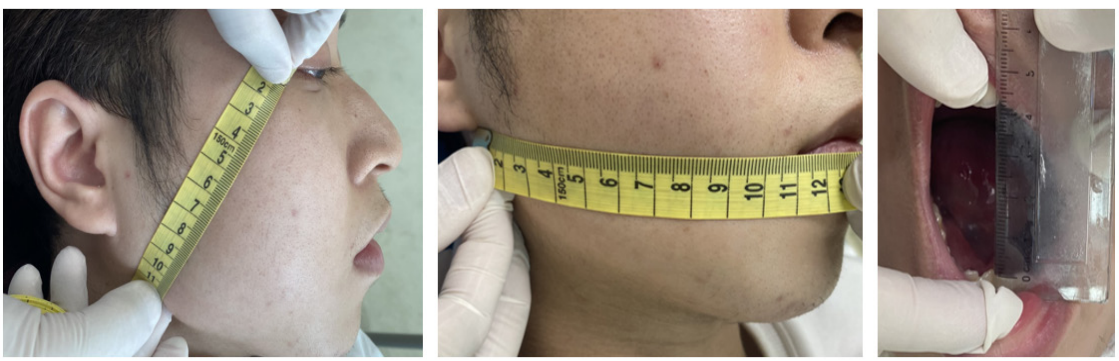

Figure 1. Measurement method for facial swelling and trismus parameter.

Surgical Technique

Oblique radiographs were taken to assess the third molar positions and to check the presence of any pathological lesion. Surgical extraction was performed by the same surgeon using a standardized technique with the following steps: Standard anesthesia of inferior alveolar nerve block and the long buccal nerve block using a solution of 2% lidocaine with epinephrine 1:100.000; a triangular full-thickness mucoperiosteal flap with releasing incision on the disto-buccal aspect of the second molar; bone removal around the tooth with straight hand-piece under continuous irrigation with normal saline; tooth sectioning when necessary and gently elevated; sockets inspected and irrigated copiously with normal saline; the flap suture back with interrpted 4 - 0 silk sutures; small gauze packs applied to the site and usual post-operative instructions were given to the patients [8]. All patients required the same surgical procedure on impacted lower third molars extractions.

Post-operative treatment

Patients were not informed which group they would be placed in. Upon completion of the suture in the experimental side was applied laser AsGaAl with a wavelength of 810-nm diode laser (Picasso Lite+, AMD Lasers, USA). The power applied was 0.5 W on the display in continuous mode for 22 s. The total energy released was 66J and the energy density applied was 27,5 J/cm^2. The laser was placed intraorally, at a distance of 1 cm in six position of the location of the surgical area: 1/4 of the sutures in the mesial-distal direction; 3/4 of the sutures in the mesial-distal direction; 1/3 of the cervical on the lingual side; 1/3 of the apical on the lingual side; 1/3 of the cervical on the buccal side; 1/3 of the tip on the buccal side [4]. On the control group, the laser handpiece was applied intraorally with same positions and same time after surgery, but laser was not activated.

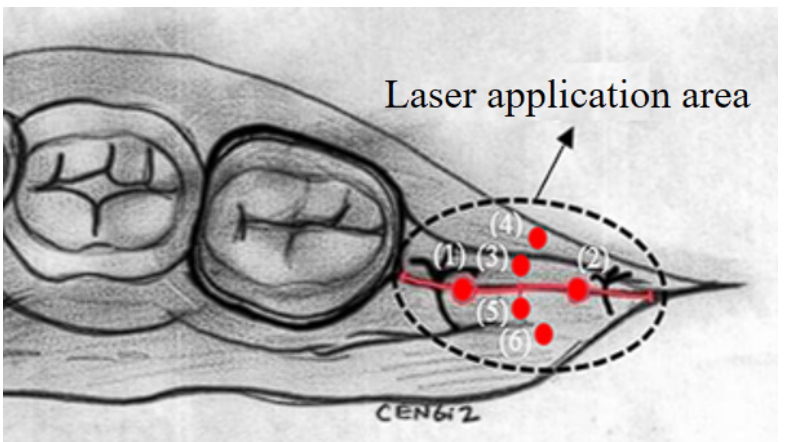

Figure 2. Six point of laser application used in the study.

Postoperative Assessment

Pain Intensity

Instructions for filling out the assessment forms were also given to the patients after surgery. The medication prescribed after surgery was: 500 mg of Amoxicillin, applied orally every 8 h for 7 days. A blister pack of four 500 mg-tablets of Paracetamol (painkiller) was given to each patient after surgery. They were advised to take the painkiller only when necessary, at six-hour intervals if the pain persisted and to take down, in the assessment form, the time each tablet was taken. The pain scale was recorded daily during the seven days after the completion of the surgery, and for the next 3 days, always at the same time.

Facial Swelling

Landmarks marked before surgery were kept and measured repeatedly on the 1st, 2nd and 7th postoperative days. Measure 3 times and take the average value.

The postoperative facial swelling was calculated according to the formula of Amin and Laskin (1983) [9]:

$$\text{Facial measure (FM)} = \frac{\text{Horizontal measure} + \text{Vertical measure}}{2}$$

$$\text{Facial swelling coefficient (\%)} = \frac{FM_{postoperative} - FM_{preoperative}}{FM} \times 100\%$$

Trimus

Trimus was measured on the 1st, 2nd and 7th postoperative days with similar landmarks as before surgery. Patients are instructed to open their mouth (not forcibly), to stop when reaching the maximum or not be able to continue opening due to pain. Measure 3 times and take the average value.

The postoperative trismus coefficient was calculated according to the formula of Amin and Laskin (1983) [9]:

$$\text{Trismus coefficient (\%)} = \frac{\text{preoperative distance} - \text{postoperative distance}}{\text{preoperative distance}} \times 100\%$$

Statistical Analyses

Data were collected and analyzed with SPSS statistical software package, ver. 22.0 (SPSS Inc., Chicago, IL, USA). Pain, trismus, and facial edema were analyzed by ANOVA for a repeated-measures test. Pain medication was assessed by Student's t test for paired samples. The significance level was set at $p < 0.05$ with a confidence interval of 95%.

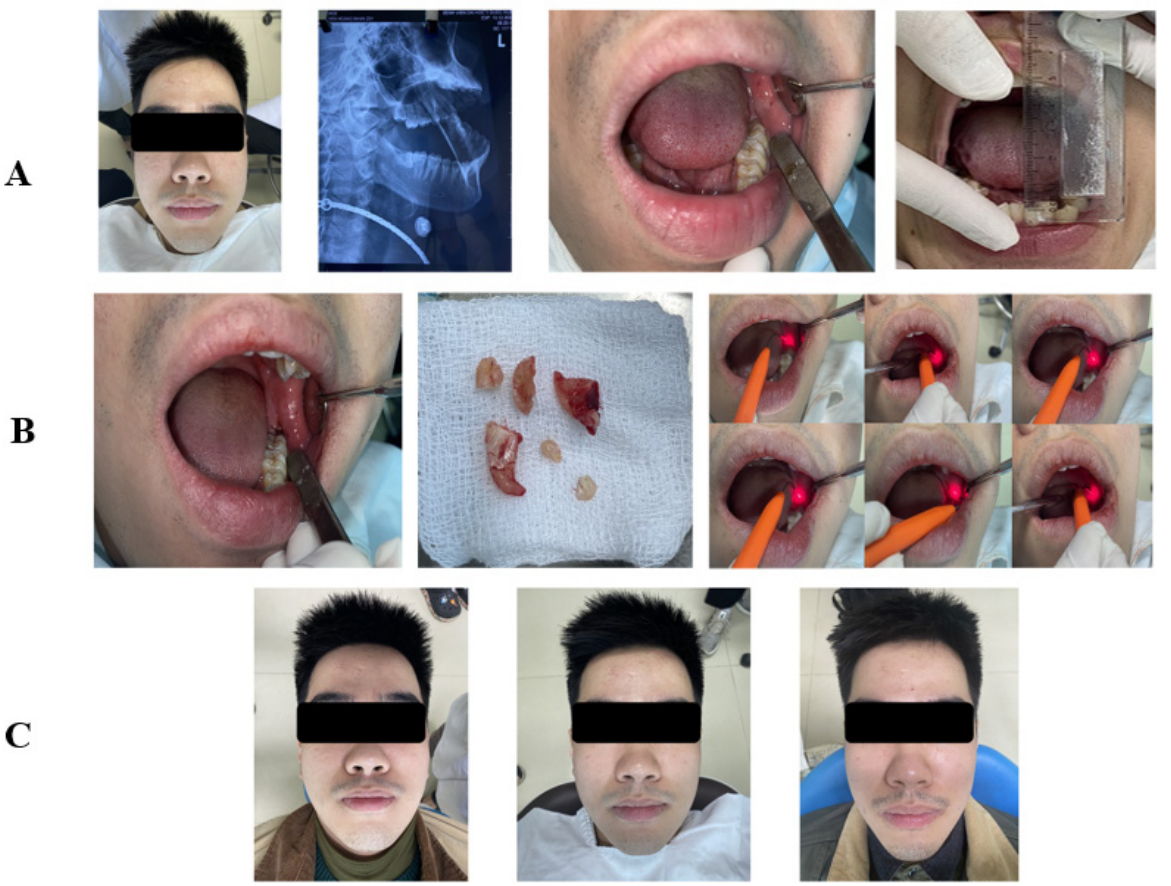

Figure 3. Preoperative intraoral and radiographic examination (A); Surgical Suture, Application of Diode Laser in the surgical area (B); Follow-up on the 1st, 2nd and 7th postoperative days (C).

3. RESULTS

A total of 60 patients underwent impacted lower third molar surgery and were included in the current study. All of the subjects accepted the medicines appropriately with no untoward side effects. All surgical sites were healed uneventfully.

Postoperative pain intensity

Postoperative VAS pain scores is shown in Figure 3. It can be observed that pain after surgery in patients treated with diode laser is less expressed than in those who did not undergo irradiation. VAS score of Diode laser group on day 1, day 2, day 3 and day 4 after surgery were 29.27 ± 0.81; 16.87 ± 0.63, 8.53 ± 0.31 and 1.67 ± 0.02, respectively. VAS scores of the Diode laser group at all periods were lower significantly than the control group ($p < 0.001$). VAS score of the Diode laser group was 0 at day 5 while the control group returned to 0 at day 7.

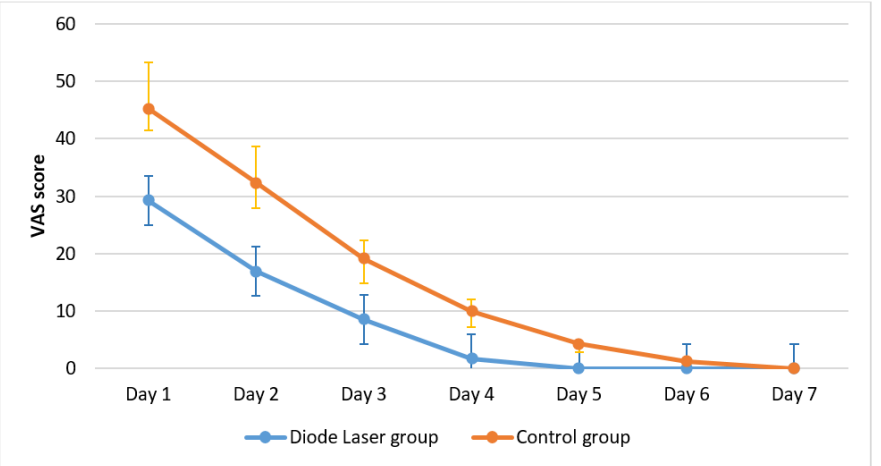

Figure 4. Postoperative VAS pain scores according to study groups in follow-up periods

Postoperative painkillers consumption

The number of postoperative painkillers consumption during first 2 days is shown in Table 1. After surgery, the number of painkillers intake in Diode laser group was 1.20 ± 0.50 tablets. The number in control group was 2.50 ± 0.57 tablets, which was higher significantly than the Diode laser group ($p < 0.05$).

Table 1. Number of postoperative painkillers consumption

	Diode laser group	Control group	p
Number of painkillers	1.20 ± 0.50	2.50 ± 0.57	0.001

Postoperative facial swelling

Postoperative coefficient of facial swelling of both group at day 1, day 2 and day 7 is presented in Table 2. The facial swelling at day 1 and day 2 in Diode laser group were 0.72 ± 0.08 and 3.27 ± 0.16, respectively, which were lower significantly than those in control group ($p < 0.05$). At day 7, there were no statistically significant differences between the two groups in facial swelling ($p > 0.05$).

Table 2. Difference in postoperative coefficient of facial swelling with periods of evaluation

Time	Diode laser group	Control group	p
Day 1	0.72 ± 0,08	1.08 ± 0,11	0.029
Day 2	3.27 ± 0.16	3.79 ± 0.14	0.022
Day 7	0.14 ± 0.04	0.27 ± 0.07	0.494

Postoperative trimus

Postoperative coefficient of trismus of both group at day 1, day 2 and day 7 is depicted in Table 3. The postoperative trismus at day 1 and day 2 in Diode laser group were 7.42 ± 0.58 and 1.35 ± 0.72, respectively, which were lower significantly than those in control group ($p < 0.05$). At day 7, there were no statistically significant differences between the two groups in trimus ($p > 0.05$).

Table 3. Difference in postoperative coefficient of trismus with periods of evaluation

Time	Diode laser group	Control group	p
Day 1	7.42 ± 0.58	11.22 ± 1.03	0.002
Day 2	1.35 ± 0.72	4.81± 1.09	0.012
Day 7	0.39 ± 0.22	0.84 ± 0.56	0.088

4. DISCUSSION

In the present study, the pain intensity, the number of painkillers consumption, facial swelling and trismus of patients in Diode laser group were compared to those in control group at different periods in order to evaluate the effectiveness of 810-

nm diode laser therapy after impacted lower third molar surgery. As suggested by Avci et al. (2013), low-level laser therapy with 810-nm wavelength, belongs to dark red and near-infrared range laser group, which can penetrate 2 - 3 mm in depth and stimulate biological changes at the receiving area. Furthermore, 810-nm was shown to be the best wavelength for physical therapy treatments because it impacts to the dermis, which contains a rich vascular system [10].

Pain is a symptom commonly expected after surgery and may changes considerably according to surgical difficulty and individual pain thresholds. After third molar surgery, the pain peaks in the first day, continues on some next days, gradually goes down and usually ends at the seventh day [11]. The results showed that the pain intensity evaluated by VAS score of Diode laser group was lower significantly than those in control group during first 5 days after surgery ($p < 0.05$). This result is consistent with the study by Landucci et al. (2015) and the findings of Isolan et al. (2021), where 810-nm diode laser can effectively reduce complications after lower third molar surgery [4],[10]. However, the pain intensity was only evaluated at 2 hours, 4 hours, 6 hours, day 1, day 2 and day 7 after surgery. In this study, this parameter was assessed daily during the seven days after surgery to monitor patients closely and promptly handle complications. Diode laser helps to reduce pain immediately after impacted lower third molar surgery due to preventing nerve cell membrane depolarization and restoring the resting potential state. Besides, diode laser reduces bradykinin levels in application area, which is an important kinin of plasma and cause pain by stimulating pain receptors in the skin and internal organs [12]. At 7 days postoperative, patients in two groups were painless as a following normal progression after lower third molar surgery.

The number of painkillers intake is also a useful parameter to evaluate the pain intensity after lower third molar surgery. Our results showed that postoperative painkillers consumption in Diode laser group was 1.20 ± 0.50 tablets, which was lower significantly than control group ($p < 0.05$). A study by Kazancioglu et al. (2013) alsndicated that the number of painkillers intake by patients who were treated with Diode Laser was lower significantly than patients who did not [11]. Additionally, the number of painkillers was recorded in the first 2 days to match the progression of pain after lower third molar surgery.

Facial swelling is a consequence of surgery and usually relates to tissue injury level and surgery time. Trismus is influenced by local tissue destruction, the severity of the surgical procedure, the duration of pain and facial swelling. These symptoms generally disappear 5 - 7 days postoperatively [11]. In our study, the facial swelling and trismus coefficient in Diode laser group was statistically lower significantly than control group in day 1 and day 2 after surgery. This finding has been confirmed by Landucci et al. (2015) and Sierra et al. (2016) that using diode laser helps to reduce facial swelling and trismus intensity after impacted lower third molar surgery despite of different facial landmarks on patients [12],[13].

Using diode laser helps to improve facial swelling in the ealrly days after surgery because it reduces considerably the synthesis of inflammatory cytokines such as prostaglandin E2 and interleukin 1-β, tissue necrosis factor TNF-α as so as increasing vasodilation to rise blood flow and increasing lymphatic drainage [14]. When the pain and facial swelling intensity after surgery decreases, the level of trismus also goes down. Therefore, facial swelling and trismus of patients in two groups disappeared as a following normal progression after lower third molar surgery at 7 days postoperative.

5. CONCLUSION

The results of study show that diode laser presented a statistically significant reduction of pain intensity, facial swelling and trismus after impacted lower third molar extractions. This is a promising supportive treatment method, which is paid a lot of attention in recent days because of its simplicity, non-invasive and effective procedure. Compared with previous studies, our study showed clearly laser parameters to facilitate surgeons in setting up treatment procedures. However, it would be better if we could conduct futher split mouth randomized controlled study to eliminate the inter-individual variability in treatment outcome. Furthermore, it is needed to continue conducting further study in patients undergoing third molar surgeries with different degrees of difficulty and extension to evaluate comprehensive effectiveness of diode laser.

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