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Does Laser-LED Photobiomodulation Therapy Alleviate Swlling, Pain, and Trismus Following Impacted Third Molar Extraction?

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Research Article

History

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ABSTRACT

Objectives: The purpose of the study determine effectiveness of a single-session laser-LED photobiomodulation therapy (PBMT) using 904 nm GaAlAs infrared laser, and 650 nm InGaAlP LED in alleviating parameters related to postoperative survival following the surgery of impacted mandibular third molars (IM3M). **Materials and Methods:** In this study, patients undergoing prophylactic extraction of IM3M were enrolled. Participants were randomly assigned into two groups: the intervention group received dual-wavelength PBMT immediately post-surgery, while the placebo group received sham treatment without therapeutic irradiation. Postoperative evaluations included pain intensity using a VAS, facial swelling through landmark measurements, maximum mouth opening (MMO), and quality of life metrics based on a modified postoperative symptom severity scale (PoSSe). Measurements were conducted preoperatively and daily for seven days post-surgery. **Results:** A total of 36 volunteers participated, with 15 assigned to the placebo and 21 to the laser group. Statistically significant changes in pain, MMO, and swelling were observed postoperatively (P<.05). Additionally, while there was no variation between the groups regarding isolation, eating-drinking, sleep, or physical appearance, the placebo group showed significantly less impact on speech changes compared to the laser group (P = .019). **Conclusions:** Further clinical studies are necessary to identify the optimal parameters for PBMT, including wavelength and dose, to effectively reduce morbidity after IM3M.

Keywords: Photobiomodulation; Impacted third molar; Pain; Edema; Extraction

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Introduction

Impacted teeth are a procedure that ranks high in the fields of oral and maxillofacial surgeons.[1] When deciding on treatment, the potential benefits that can be obtained after the procedure are taken into account, along with the indications for extraction and possible risks.[2] Problems such as cysts, tumors, and other pathological formations around impacted wisdom teeth, as well as caries and periodontal problems in neighboring teeth, pain and infection in the jaws, and pathological fractures may occur.[2–4] To prevent such problems, extraction is typically recommended.

Photobiomodulation therapy (PBMT) is a free of invasion treatment method that utilizes free of ionizing light sources.[5] Thanks to the photobiomodulation effect, laser/LED beams can affect tissue metabolism in an inhibitory or stimulating way.[6] This working procedure begins with the absorption of light by photoreceptors and continues by altering ATP synthesis in mitochondria through acceleration of electron transport chains.[7] Thus, cellular reactions are modulated. PBMT is utilized to increase tissue repair, reduce inflammation, or provide analgesia.[8,9] Unlike other laser treatments, PBMT is not a heat or ablation-based treatment.[10] Instead, light is directly used to relieve pain, reduce inflammation, or stimulate wound healing.[8,11]

After tooth extraction, problems such as edema, pain, and restriction of mouth opening are commonly encountered, which may lead to a decrease in patients' quality of life (QoL).[1] PBMT is widely employed as a supplementary approach to alleviate these issues.[12] However, the literature lacks a consensus on the optimal laser type, power settings, session duration, and application frequency for this therapy.

The purpose of the study determine effectiveness of a single-session laser-LED PBMT using 904 nm GaAlAs infrared laser, and 650 nm InGaAlP LED in alleviating parameters related to postoperative survival following the surgery of impacted mandibular third molars (IM3M).

Material and Methods

This prospective study was approved by the TOGU Ethics Committee with registration number 21-KAEK-078. Participants were recruited from TOGU Faculty of Dentistry. Both written and verbal informed consent were obtained from the participants, following the guidelines of the Helsinki

Declaration. The study's ClinicalTrials.gov registration number is NCT05992233.

The study included ASA I volunteers aged 18-40 years, with IM3M in class-III position-B. Individuals with pathological conditions affecting the impacted tooth or neighboring teeth, pregnant or breastfeeding women, patients undergoing anticoagulant or antiplatelet therapy, those with a history of radiotherapy to the head or facial region, and individuals with allergies to local anesthetics or prescribed medications were excluded from the study.

Creation and Randomization of Groups

Participants were randomly assigned into two groups: the intervention group received dual-wavelength PBMT immediately post-surgery, while the placebo group received sham treatment without therapeutic irradiation. The closed-envelope method was used for randomization. After tooth extraction, the independent person opened the envelope to assign the patient to a group.

The surgeon performing the procedure and the researcher conducting the measurements were both blinded to the patient's group allocation. Additionally, as all patients received laser (with the placebo control group receiving light without therapeutic effect as a placebo), the patients were also unaware of their group assignment. Only the person who administered the laser knew which group the patient was in. The assigned groups were recorded in closed and opaque envelopes.

Surgical Procedure

The surgery was performed using local anaesthesia with 4% articaine and 1:100,000 epinephrine. After local anesthesia was achieved, an incision was made in the mucosa, the flap was lifted, osteomy and tooth separation were performed with a bur, and the tooth extraction was completed.

The surgical area was washed with 0.9% saline and sutured. Patients were prescribed antibiotics (amoxicillin 750 mg; clindamycin 300 mg for patients with a history of penicillin allergy), NSAIDs (preferably ibuprofen, at least 12 hours apart if needed), and mouthwash (0.12% chlorhexidine). Ice was not applied to the patients after the operation.

Laser Procedure

Immediately after suturing, patients in the laser group received extraoral dual-wavelength, PBMT for 5 minutes using the probe of the laser device (GRR Laser Medical Company, Ankara/Turkey). This probe contains 4 light emitting diodes (LEDs) and 5 red lasers and has an area of 30mm x 30mm (Figure 1). The device features are summarized in Table 1. Radiation was delivered simultaneously at energy density of ~9 J/cm^2.

In placebo control group, a laser probe was used as well, but the device emitted only red light without delivering any actual irradiation.

Variables

The swelling that occurs was evaluated on the 2nd - 7th postoperative days by measuring specific facial landmarks, including the distances between the gonion, pogonion, tragus, and cheilion, using a flexible ruler (refer to Figure 2). Additionally, the patient's MMO was measured in millimeters. This measurement represented the distance between teeth numbered 11 and 41. Measurements of MMO were taken prior to surgery and repeated on the second and seventh postoperative days using a caliper.

Pain levels were assessed via a VAS, consisting of a line segmented into 10 equal parts. Patients marked their pain intensity on this scale. The patient was asked to mark the VAS scale at the 6th hour to 7th days after the operation and to note how often they used anti-inflammatory drugs.

On the 2nd-7th days, the patients completed a questionnaire prepared by Majid *et al.*[13], which was a modification of the postoperative symptom severity scale (PoSSe) used to assess the severity of postoperative complications. The questionnaire consisted of 5 parts and a total of 14 questions.

Statistical Analysis

The Mann-Whitney U test was utilized to evaluate differences between the placebo and laser groups for continuous variables, while the Chi-Square test was applied for categorical data. To assess changes in continuous variables over time within each group, the Dependent Samples T-Test was employed. Between-group differences in means for independent samples were analyzed using the Independent Samples T-Test. For repeated measures of outcomes (e.g., swelling, pain, maximum mouth opening), a Repeated Measures ANOVA was performed to determine interactions between time and group factors. The p statistical significance value of the study is 0.05.

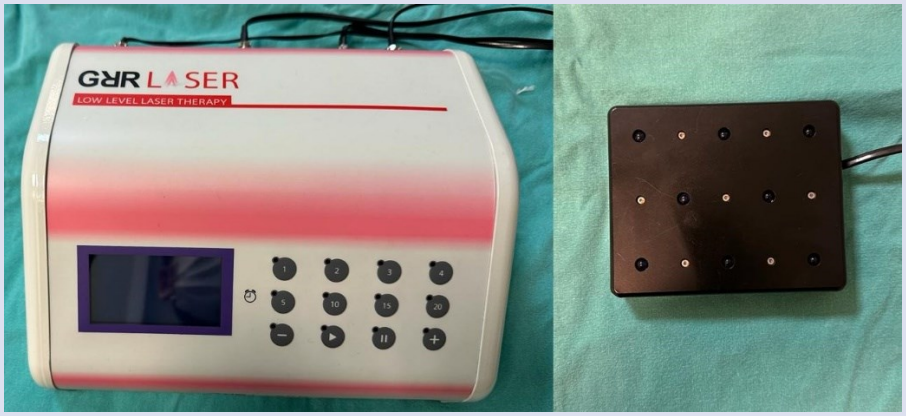

Figure 1. Laser device and probe used

Table 1. Features of the Laser Device Used

	Laser- LED-based PBMT	
Parameters	**Laser-Led Device**	
Manufacturer	GRR Laser Medical Company, Ankara/Turkey	
Type	Ga-Al-As Infrared Laser	InGaAIP LED
Peak wavelength (nm)	904	650
Peak power (mW)	5mW-200mW	
Prob diameter (mm)	10 mm	
Frequency	Continuous output	Continuous output
Radiation time (min)	1	1
Energy (J)	9 J	

Note: Energy density=power density·radiation time.LED, light-emitting diode.

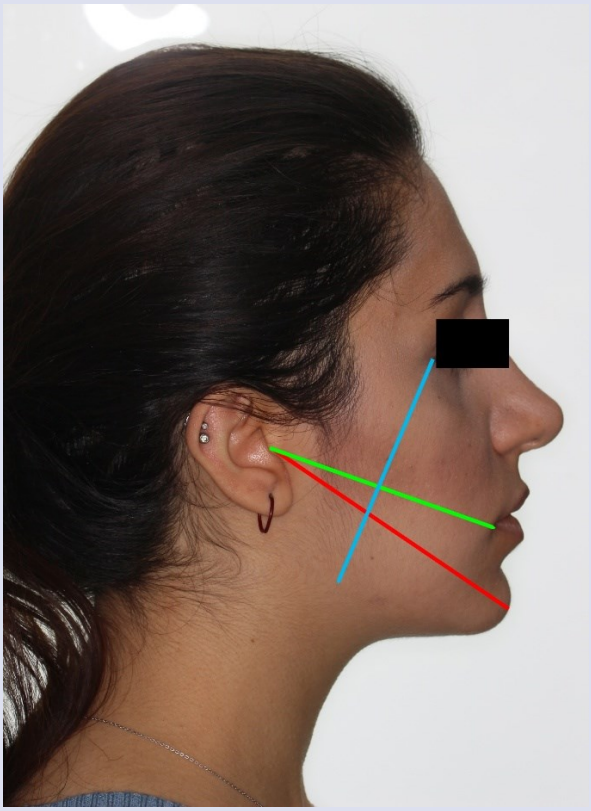

Figure 2. Measurements for the evaluation of edema. Blue line: Lateral canthus-Gonion, Green Line: Tragus-Chelion, Red Line: Tragus-Pogonion

Results

The study included a total of 36 volunteers, with 15 (Female: 9, Male: 6, Mean Age: 25.53) in the placebo control group and 21 (Female: 11, Male: 10, Mean Age: 24.38) in the laser group. Demographic characteristics of the patients and operation time, with no difference found between the groups in these parameters shows in Table 2.

Mean MMO in the placebo control was 41±8.4 (before surgery), 26.00±11.98 (postsurgery 2nd day), and 34.67±10.88 (postsurgery 7th day) preoperatively. In laser group, these values were 44.86±86.92, 31.38±10.55, and 38.48±9.29, respectively. A change was observed in three parameters used to evaluate postoperative edema ($P < .05$), but no difference was found in the amount of edema between the laser and placebo control groups ($P > .05$). Figure 3 shows the changes in maximal mouth opening and edema amounts, while Table 3 shows the corresponding statistical calculations.

Pain scores were highest at 6 hours postoperatively, with the greatest amount of painkiller use on the third day post-surgery (Figure 4). Although there was a change in pain scores and amount of painkiller use, no difference was found between the groups (Table 4).

Table 5 shows evaluation of QoL after surgery by assessing the duration of impact on social and physical activities. The groups were similar in terms of isolation, eating and drinking, sleep, and physical appearance. The placebo control was significantly less affected in terms of speech changes compared to the laser ($P = .019$).

Table 2. Participant Demographic Characteristics

		Groups		*P*
		Placebo Control	**Laser**	
Gender	Female	9	11	.650†
	Male	6	10	
Job	Not working	4	4	.526†
	Student	5	11	
	Worker	6	6	
Smoking	None	13	18	.663†
	Yes	2	3	
Operation Time		650.33±244.245	713.19 ±244.245	.377*
Age		25.53±5.194	24.38±4.489	.529*

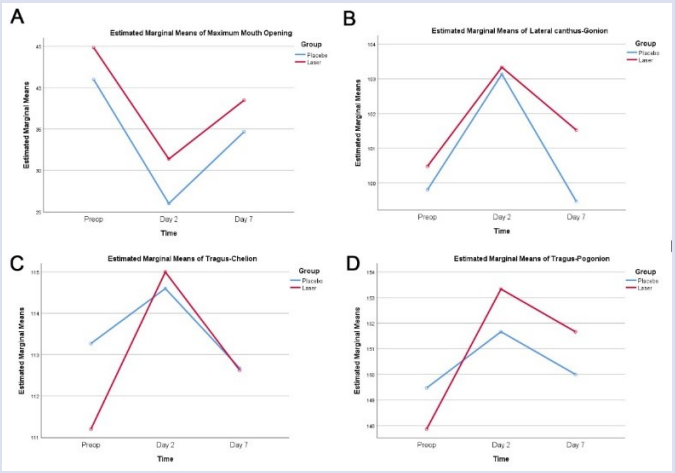

Figure 3. Graph examining changes in maximum mouth opening and edema.

Table 3. Results of Measurements For The Evaluation of Trismus And Edema

		Group	**Mean**	**SD**	**Between Groups**	**Within-subjects variable (Time)**	**Between-subjects factor (Group)**
Maximum Mouth Opening	Preop	Placebo	41.00	8.40	.141	.000	.825
		Laser	44.86	6.92			
	Day-2	Placebo	26.00	11.98	.163		
		Laser	31.38	10.55			
	Day-7	Placebo	34.67	10.88	.267		
		Laser	38.48	9.29			
Lateral canthus-Gonion	Preop	Placebo	99.80	5.84	.322	.000	.388
		Laser	100.48	6.50			
	Day-2	Placebo	103.13	6.97	.933		
		Laser	103.33	6.95			
	Day-7	Placebo	99.47	6.86	.335		
		Laser	101.52	5.72			
Tragus-Chelion	Preop	Placebo	113.27	8.86	.503	.000	.150
		Laser	111.19	9.20			
	Day-2	Placebo	114.60	7.52	.612		
		Laser	115.00	8.06			
	Day-7	Placebo	112.67	8.48	.987		
		Laser	112.62	8.15			
Tragus-Pogonion	Preop	Placebo	149.47	9.85	.695	.026	.311
		Laser	147.86	13.37			
	Day-2	Placebo	151.67	9.38	.612		
		Laser	153.33	9.78			
	Day-7	Placebo	150.00	9.25	.581		
		Laser	151.67	8.56			

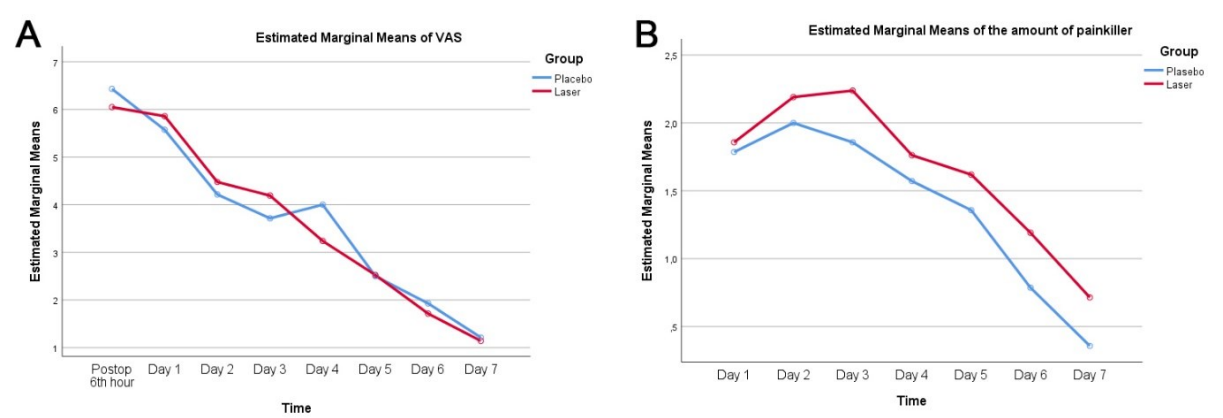

Figure 4. Graph examining the changes in the pain score and the amount of painkillers taken.

Table 4. Pain Score and the Amount of Painkiller Taken Values

	Time	Group	Mean	SD	Between Groups	Within-subjects variable (Time)	Between-subjects factor (Group)
Pain (VAS)	Postop 6h	Placebo	6.43	1.86	.608	.000	.699
		Laser	6.05	2.29			
	Day-1	Placebo	5.57	2.20	.737		
		Laser	5.86	2.59			
	Day-2	Placebo	4.21	2.19	.714		
		Laser	4.48	1.96			
	Day-3	Placebo	3.71	2.67	.605		
		Laser	4.19	2.62			
	Day-4	Placebo	4.00	2.96	.417		
		Laser	3.24	2.48			
	Day-5	Placebo	2.50	2.41	.976		
		Laser	2.52	2.11			
	Day-6	Placebo	1.93	1.68	.728		
		Laser	1.71	1.82			
	Day-7	Placebo	1.21	1.47	.878		
		Laser	1.14	1.23			
The amount of painkiller taken	Day-1	Placebo	1.79	.802	.774	.000	.918
		Laser	1.86	.655			
	Day-2	Placebo	2.00	1.301	.597		
		Laser	2.19	.814			
	Day-3	Placebo	1.86	1.099	.343		
		Laser	2.24	1.179			
	Day-4	Placebo	1.57	1.342	.724		
		Laser	1.76	1.670			
	Day-5	Placebo	1.36	1.216	.558		
		Laser	1.62	1.322			
	Day-6	Placebo	.79	.893	.253		
		Laser	1.19	1.078			
	Day-7	Placebo	.36	.745	.229		
		Laser	.71	.902			

Table 5. Posse Scale Scores Examining the Change in Quality of Life.

	Group	Mean (Day)	SD	t	*P*
Isolation	Placebo	2.21	1.122	-.744	.462
	Laser	2.57	1.720		
Eating-Drinking	Placebo	4.00	.877	.306	.762
	Laser	3.86	1.852		
Speech	Placebo	1.29	.825	.009	***.019***
	Laser	2.33	1.653		
Sleep	Placebo	2.07	1.385	-.417	.679
	Laser	2.29	1.554		
Physical Appearance	Placebo	3.79	1.847	-.125	.902
	Laser	3.86	1.526		

Discussion

After IM3M, pain, edema, and trismus are common conditions that patients and surgeons aim to reduce. The literature on impacted wisdom teeth focuses on reducing these postoperative conditions.[14-16] This study aimed to assess the effectiveness of a single session of PBMT, utilizing dual-wavelength combined lasers, following IM3M extraction. The results indicated that a single session of PBMT had almost the same effect as the placebo group.

Although it is not clear through which mechanisms PBMT reduces pain, several possible mechanisms are thought to provide this effect, including increased endogenous opioid production[17], increased production of anti-inflammatory cytokines[18], increased local blood circulation[19], and increased thermal pain threshold.[20] Asutay *et al.*[21], Hamid *et al.*[22], Eshghpour *et al.*[23], and Saber *et al.*[24] have reported that PBMT significantly reduces postoperative pain in their studies evaluating effect of PBMT on pain after IM3M surgery. On other hand, Sierra *et al.*[25], Sampaio-Filho *et al.*[26], and Fikackova *et al.*[27] have reported that PBMT has no effect on postoperative pain. According to the results, a single session of PBMT treatment was not effective enough to reduce pain. The PBMT mentioned above is estimated to require multiple sessions to activate the analgesic mechanisms.

Edema that occurs after the IM3M surgery is caused by exudate and transudation and leads to tissue damage characterized by vasodilation, hyperemia, fluid accumulation in the interstitial space, increased capillary permeability, and migration of monocytes and granulocytes due to increased osmotic pressure in capillaries.[28–30] Aras *et al.*[31] and López-Ramírez *et al.*[32] reported in their studies that PBMT reduces swelling after IM3M extraction. Both studies used a total radiation of 4 J/cm^2, with the first study using wavelength of 808 nm-device and the second study using a wavelength of 810 nm-device. However, Asutay *et al.*[21], Eroglu *et al.*[33], and Eshghpour *et al.*[23] reported that PBMT had no effect on swelling after IM3M extraction. The first two of these studies[21,33] used an irradiation of 4 J/cm^2, and the third[23] used an irradiation of 85.7 J/cm^2, with devices using wavelengths of 810, 940, and 600 nm respectively. In this study, we used a dual-wavelength laser with the GaAlAs laser at 904-nm and the red laser at 650-nm, and according to our findings, it was not effective in reducing postosurgical swelling.

The extraction of IM3M can have a short-term impact on a person's QoL due to various factors, such as pain, swelling, bleeding, gum sensitivity, and even lip numbness[34,35]. Therefore, traditional methods such as pain medication and ice applications[36], as well as innovative methods such as PBMT, seem promising in the first few days after extraction. The findings of our study, PBMT had no effect on the duration of isolation, eating and drinking, sleep, and physical appearance. However, speech was less affected in the PBMT group.

This study has several limitations. Firstly, using 3D imaging systems to measure edema could have provided more accurate results. Secondly, the hormonal status of the patients could have affected the level of pain and edema, but no hormone level measurements were taken, which is another limitation of the study.

Conclusions

This studies results support the conclusion that a single session dual wavelength photobiomodulation therapy combining 650 nm red laser and 904 nm GaAlAs infrared laser does not reduce pain, trismus, or swelling after IM3M surgery. Further randomized controlled studies are required to determine the best wavelength and dose for PBMT with multiple sessions applied in reducing morbidity after impacted wisdom tooth surgery.

Acknowledgments

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