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Research Article

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Efficacy of low-level laser therapy on postoperative sequelae following extraction of impacted mandibular third molars

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Abstract

Background: In dentistry, extraction of the impacted mandibular third molar is a routine treatment. The most frequent consequences following this procedure are pain, trismus, and edema. To address these issues, systemic drugs have been employed; however, due to their side effects, non-medication therapies have evolved, such as cryotherapy, ice packs, low-level laser therapy, and ozone, which treat these consequences without side effects. Low-level laser therapy induces biostimulation, speeds up tissue regeneration, enhances wound healing, and reduces pain and swelling through an anti-inflammatory effect. This might be due to the effect of a low-energy laser that increases phagocytic activity and the number and diameter of lymphatic vessels, decreases the permeability of blood vessels, and restores microcapillary function.
Aim: Its purpose was to assess the effects of low-level laser therapy on sequelae following impacted third molar surgery.
Patients and methods: Thirty patients were enrolled in the current study and were randomly divided into two equal groups. Preoperative clinical examination included measurement of maximum mouth opening and facial swelling measurements. The position and configuration of the impacted lower third molar, the surrounding bone, the mandibular canal, and the neighboring tooth were all assessed radiographically using a panoramic radiograph. Low-level laser therapy was applied extra and intra-orally immediately after surgery. On the second and seventh days after surgery, the maximum mouth opening and facial swelling dimensions were again assessed in addition to the measurement of pain by a numerating rating scale. Statistics were used to asses each reading.
Conclusion: A therapeutic option utilizing a low-energy laser following the extraction of impacted mandibular third molars has clinically beneficial effects on reducing pain, edema, and trismus.

Keywords: Impacted third molar, improved postoperative sequelae, low-level laser therapy, pain, trismus, swelling.

1. Introduction

One of the most frequent surgical operations in oral surgery is the removal of third molar teeth (wisdom teeth) [Grossi et al., 2007]. Pain, trismus, and edema are the most frequent complications after surgical removal of impacted lower wisdom teeth [Barone et al., 2010]. Pain reaches maximum intensity between

three to five hours after local anesthesia has worn off, continues for two to three days, and gradually reduces until the seventh day [Markovic and Todorovic, 2006; Lago et al., 2007]. Swelling reaches peak intensity in 12–48 h, resolving between the fifth and seventh day [Ra'ed Mohammed et al., 2013; Ferrante et al., 2013]. Trismus subsides when pain and edema decrease [López-Ramírez et al., 2012].
Nonsteroidal anti-inflammatory Drugs (NSAIDs) and local or systemic corticosteroids are frequently advised. However, the majority of these may cause harmful effects, including susceptibility to systemic bleeding, gastrointestinal problems, and allergic reactions. [Thaer Abdul Lateef et al., 2010, Ferrante et al., 2013]. These findings support efforts to develop a novel strategy for postoperative pain management that does not result in adverse effects like the use of surgical closure techniques with or without incorporation of drains, ice packs, herbals, platelet-rich plasma, platelet-rich fibrin, and cryotherapy have been suggested [Gelesko et al, 2011, Ali S. Abdul-Kareem, 2019]. Ozone therapy and low-level laser therapy (LLLT) have been introduced as alternatives over the past 20 years.

Light Amplification by Stimulated Emission of Radiation, or LASER, is the abbreviation. The energy output determines the laser into a "hard" and "soft" laser. While soft lasers are low-level lasers that aid in tissue healing, hard lasers are high-energy output devices utilized for tissue cutting [Nagammai, 2022]. Studies on the biological effects of LLLT were conducted in 1967, and the development of the laser treatment paradigm started in 1971 [Hamblin, 2016]; since then, it has been utilized to treat a variety of disorders, including osteoarthritis, carpal tunnel syndrome, rheumatoid arthritis, and many other inflammatory conditions. When using a ruby laser to treat malignant cells, it was found that LLLT did not kill tumor cells; instead, it sped the healing process, which gave rise to the principle of photobiomodulation [Hamblin, 2016]. However, evidence suggests that the LLLT induces cellular biostimulation, speeds up tissue regeneration, enhances wound healing, and reduces pain and swelling through an anti-inflammatory effect. This is because the LLLT increases phagocytic activity and the number and diameter of lymphatic vessels, decreases the permeability of blood vessels and restores microcapillary function [He WL et al., 2015; Fabre et al., 2015]. The precise biological mechanism of the analgesic effect produced by the LLLT is still unknown [Ferrante et al., 2013]. To achieve its analgesic effects, LLLT stimulates the production of endogenous endorphins, lowers inflammatory cytokines and enzymes, modifies pain threshold, causes changes in the morphology of neurons, lowers mitochondrial membrane potential, and blocks fast axonal flow, which blocks neural conduction. [Domah et al., 2021; Ferrante et al., 2013; Oliveira Sierra et al., 2013]. Notably, LLLT has recently been used in research at wavelengths around 800 nm. In recent studies on LLLT, it has been shown that diode lasers with wavelengths of 940-980 nm are also effective in improving wound healing, reducing postoperative inflammation, and accelerating regeneration [Ferrante et al., 2013; Lobo and Pol, 2015; Kuboyama et al., 2014]. Accordingly, in this regard, the laser will stimulate the surrounding tissue regionally using a dual-wavelength (810,980nm) diode laser in addition to the areas primarily affected by the surgery, including the masseter muscle.

2. Hypothesis

H0: LLLT is not-significantly effective in reducing pain, trismus, and swelling after extraction of the impacted mandibular third molar. H1: LLLT is significantly effective in reducing pain, trismus, and swelling after extraction of the impacted mandibular third molar.

3. Aim

The current study aimed to examine the efficacy of LLLT using a dual-wavelength (810,980nm) diode laser on pain, swelling, and trismus that occurred after impacted third molar extraction.

4. Patients and method

This blind placebo-controlled randomized prospective clinical study involved 30 patients, 12 males and 18 females, aged between 18 and 34 years, with impacted mandibular third molars in similar positions (Class II-III and position B, according to Pell and Gregory's classification). They were randomly assigned to the study and control groups using the coin toss method and divided into two equal groups, with 15 patients in each. The study was conducted between March 2022 and the end of November 2022. Study group: LLLT was administered right away following extraction of an impacted lower third molar. Control group: subjected to routine extraction of impacted lower third molar without application of LLLT. Patients who needed surgical extraction of their mandibular third molars (Class II-III and position B, according to Pell and Gregory's categorization) and whose condition was assessed clinically and radiologically met the inclusion criteria. Patients should have good oral hygiene and be free of any acute illnesses, as well as be between the ages of 18 and 40 years, be willing to comply with the study and be available for follow-up. Contraindications to laser therapy, systemic illness, local infection, tobacco usage, oral contraceptive use, pregnancy, and lactation were among the exclusion criteria. All patients signed a written informed consent after being given information regarding the study's purpose, the specifics of the surgical procedures, any anticipated complications, and potential adverse effects of the medications being used. Following surgery, the patients were givenAugmentin® tab. 625mg (amoxicillin 500mg and clavulanate 125mg) and Panadol® tab. 500mg (acetaminophen) as needed.

5. Operative procedure

Mandibular third molar extractions were performed under local anesthesia, which was obtained by inferior alveolar, lingual, and long buccal nerve block injection using the (lidocaine hydrochloride 2% local anesthetic cartridge 1.8ml with adrenaline 1:80,000 (Septodent®, France)). Next, a three-sided (trapezoidal)mucoperiosteal flap was made, and bone was removed using a round bur in a surgical straight handpiece (Castellini ®, Germany) with copious saline irrigation to expose the tooth. Tooth delivery was followed by meticulous irrigation of the surgical site with physiologic saline (0.9%). The flap was repositioned then wound closure. The length of time required for the tooth extraction using lasers (from the first incision to the final suture) was recorded.

6. Laser therapy

With an 8mm handpiece, laser therapy was administered using a gallium-aluminum-arsenide (Ga-Al-As) diode laser device (Quicklase®, UK). This laser has a continuous dual wavelength of 810 and 980 nm. Both the patient and the operator were shielding their eyes with safety goggles. Patients in the LLLT group received low-level laser light at six points immediately following surgery: three extraoral at the masseter muscle, including the origin and insertion, and three intraoral, placed at 0.5 cm from the operation site and administered on the occlusal, buccal, and lingual sides. In continuous mode, laser energy was delivered to the study group at a power of 400 mW (0.4 w) for 180s (30 s per point). The biostimulation handpiece was intraorally placed at the surgery site and touched extra orally to the masseter muscle for a total of 180 seconds in the control group, but the laser was not turned on.

7. Evaluation

Using a numeric rating scale (NRS), by which the intensity of the pain was estimated. Whose high ratings range from zero (no pain) to ten (the worst pain imaginable). By measuring the maximum distance between the cutting edges of the right maxillary and right mandibular central incisors, mouth openings were assessed before and after surgery. The mouth opening was measured three times using the same technique: before surgery, on the second and seventh postoperative days. Measurements were taken with a digital Vernier [Ra'ed Mohammed et al., 2013]. Using a measuring tape in centimeters, facial measurements were taken between the lateral corner of the eye and the angle of the mandible (Line A), the tragus and the outer corner of the mouth (Line B), and the tragus and soft tissue pogonion (Line C) [LATT et al., 2016]. As a baseline record, preoperative maximum mouth opening and facial measurements were taken. To calculate the rate of cheek swelling, the same measurement was repeated in the second and seventh days after surgery.

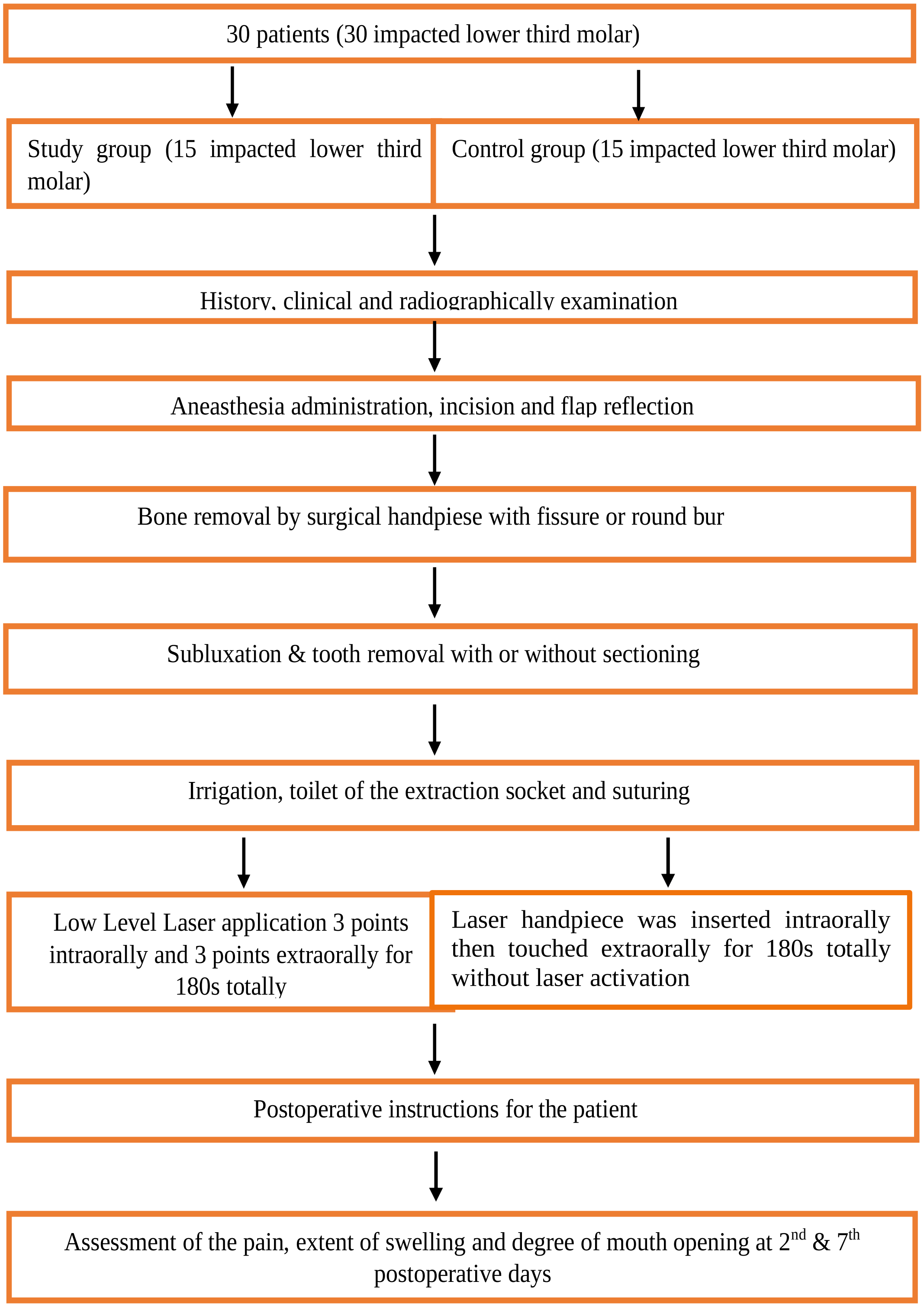

Fig.1: Study flow chart illustrating the basic steps of the study.

The average of the three different values of lines A, B, and C were calculated and reflected the swelling for that day [RAOUÂA et al., 2013, ZHANG et al, 2018]. The difference between measurements taken before surgery and each postoperative measurement done on the second and seventh days was recorded.

8. Statistical analysis

Data description, analysis, and presentation were performed using Statistical Package for Social Science (SPSS version 21, Chicago In press, Illionis, USA), Minimum, maximum, mean, standard deviation (SD), and standard error (SE) for quantitative variable while, median, mean rank frequency and percentage for qualitative variable, Fisher exact chi-square, Shapiro Wilk test of normality, Repeated Measure Analysis of variance, Wilcoxon Sign rank test and Mann- Whitney U test.

9. Result

Thirty patients with asymptomatic impacted mandibular third teeth were involved in the study. These had a mean age of 23.6 ± 4.75 years, with 12 males and 18 females (range, 18–34 years). Thirty molar extractions were carried out without complications. The time of surgery counting from the first incision to the last suture (p>0.05). 13 impacted molars were classified as cl II, and 17 impacted molars as cl III by Pell and Gregory (p>0.05). 17 mesioangulation, 7 vertical, 4 horizontal, and 2 distoangulation of impacted molars (p>0.05). All patients experienced primary healing and no abnormal bleeding throughout the procedures. There was no ecchymosis or hematoma-related alteration in skin color. None of the patients had any negative effects from the medication and laser therapy that were used.

Table 1. Descriptive and statistical test of Age among groups.

Groups	N	Mean	Std. Deviation	Std. Error	Minimum (year)	Maximum (year)	T-test	P value
Laser	15	23.867	4.868	1.257	18.000	34.000	0.230	0.820
Control	15	23.467	4.658	1.203	18.000	32.000		

Table 2. Demographic data among groups.

Vars.		groups					
		Laser		Control			
		N	%	N	%	test	P value
Gender[b]	M	5	26.67	7	46.67	2.778	0.427
	F	10	73.33	8	53.33		
Classification	M	8	53.33	5	33.33	1.667	0.644
	F	7	46.67	10	66.67		
Angulation	M	9	60.00	8	53.33	3.572	0.979
	V	3	20.00	4	26.67		
	H	2	13.33	2	13.33		
	D	1	6.67	1	6.67		
Side [b]	R	5	33.33	8	53.33	1.357	0.716
	L	10	66.67	7	46.67		

A=Fisher exact, b=chi square.

Table 3. Descriptive and statistical test of surgical Duration among groups.

Groups	Mean	Std. Deviation	Std. Error	Minimum (minutes)	Maximum (minutes)	T-test	P value
Laser	35.333	8.649	2.233	25.000	55.000	0.207	0.838
Control	35.933	7.176	1.853	27.000	56.000		

Recalled patients had their pain, edema, and trismus assessed. According to (Table 4), trismus was considerably lower in the study group than in the control group during the second postoperative day (p=0.01). However, on the seventh day, the values were comparable in both groups (p>0.05). In all evaluations, patients in the study group reported highly significantly less pain as compared to the control group (Table 5), as shown by NRS scores (p = 0.002 and p = 0.001 for the second and seventh postoperative days, respectively). in addition to three patients in the study group who did not require analgesics. For each group, postoperative edema developed. In comparison to the control group (Table 6), the study group exhibited highly significantly less postoperative edema on the second day (p=0.029); nevertheless, on the seventh day, the values were comparable between the two groups (p>0.05).

Table 4. Mean ± SD and P values of mouth opening (in mm) for all groups along the different observation periods.

Groups		Baseline	2-day	7th	F	P value	ES
Laser	**Min.**	26.600	22.400	26.500	3.843	**0.034**	0.222
	Max.	52.400	52.200	51.700			
	Mean	39.800	36.100	38.973			
	±SD	7.452	8.360	7.371			
Control	**Min.**	26.000	13.100	21.400	29.834	**0.000**	0.688
	Max.	50.600	40.900	43.800			
	Mean	41.040	29.400	36.200			
	±SD	6.733	8.033	6.052			
F		0.229	5.010	1.268			
P value		0.636	**0.033**	0.270			

Table 5. Descriptive and statistical test of Pain among groups and time.

Groups	Median (2nd)	MR[1] (2nd)	MR[2] (2nd)	Median (7th)	MR[1] (7th)	MR[2] (7th)	Wilcoxon sign rank	P value
Laser	2	7	10.60	0	0	10.57	3.275	**0.001**
Control	4	8	20.40	3	0	20.43	3.471	**0.001**
Mann-Whitney U		3.091			3.170			
P value		**0.002**			**0.001**			

MR1=Intragroup, MR2=Intergroup

10. Discussion

Growing interest has been shown in studying the physiological effects of LLLT and its various clinical uses in treating orofacial pain and acute and chronic inflammation, either as a single therapy or complementary therapy [Sigaroodi et al., 2023]. However, the absence of quality publications on the analgesic and anti-inflammatory effects of LLLT after surgically extracting third molars, along with the controversial results found, raises concerns about its effectiveness. Due to the wide range of factors, including the type of laser wavelength, power, pulse rate, time, and application mode, the ideal radiation parameters for this purpose have not yet been established. [Pergolini et al, 2022]. Some researchers found a substantial correlation between the length of the operation and trismus, pain, and overall analgesic consumption [Lago-Méndez et al., 2007]. In our study, we observed no difference in operation time between the control and study groups ($p>0.05$). The use of nonsteroidal anti-inflammatory medications (NSAIDs) and local or systemic corticosteroids may cause a variety of adverse effects. As a result, a novel, comfortable therapeutic approach without drugs is required.

LLLT was obtained in this study in a single visit, directly after the surgery; studies that used LLLT in repetitive sessions generally did not find a significant difference between LLLT and placebo for pain [Ferrante et al., 2013; Amarillas-Escobar et al., 2010; Kazancioglu et al., 2014]. Instead of focusing on the success obtained through repeated LLLT sessions, it would be more appropriate for the research to concentrate on achieving the highest level of therapeutic success in a single session. This is because repeated treatments waste time and require more work from both patients and physicians. This seems to be more of a trivial disadvantage of frequent LLLT sessions than a benefit. Because of this, researchers ought to concentrate on single-session applications, the efficacy of which might be statistically confirmed by conducting research using various laser parameters and various medical combinations. [Anand et al., 2013].

In the current study, LLLT was applied intraorally and extra orally because the intraoral application allows for maximum penetration and absorption at the surgical site. Some authors only applied LLLT extra orally [Kazancioglu et al., 2014] or only intraorally [López-Ramrez et al., 2012], while others conducted clinical trials applying LLLT both extra orally and intraorally [Aras et al.,2010; Sigaroodi et al., 2023; Carroll et al.,2014; Aoki et al.,2015]. However, extraoral treatment was adopted in addition to intraoral application because extraoral laser therapy may directly affect the masseter muscle, where the trauma of surgery might cause a spasm of the masseter muscle, whereas intraoral laser application does not directly affect that muscle [Aras et al.,2010]. A comparison of the efficiency of intraoral and extraoral laser administration supports this. They reported that extraoral laser therapy has better effects on improving pain intensity and trismus after impacted third molar surgery. Even though LLLT is effective in reducing pain, edema, and trismus following the extraction of impacted third molars, some studies have found a good effect of laser therapy while others have not [Ferrante et al., 2013]. Because of this, the ideal parameters of LLLT for biostimulation have not yet been determined [López-Ramírez et al., 2012]. According to studies, the pain reaches maximum intensity at 3 to 5 hours after surgery, lasts for 2 to 3 days, and then steadily subsides till day 7. Within 12 to 48 hours after surgery, postoperative swelling reaches its maximal strength and subsides between the fifth and seventh postoperative days. Trismus subsides when pain and edema decrease [López-Ramírez et al., 2012].

The current study's findings revealed that all groups experienced the most pain during the first two days following surgery. There was a significant difference between the days in each group after that, with the pain score tending to diminish over time until the seventh day. The study's findings also showed that the study group's pain scores were lower than those of the control group, with the difference being highly significant on the second and significant on the seventh day. The results of this study are in agreement with those of [Markovic and Todorovic2006; Aras et al.,2010; MarwahSafaa, 2019; Ferrante et al.,2013; Kazancioglu et al.,2014; Eshghpour et al.,2016], who observed that LLLT could minimize postoperative pain following surgical removal of the mandibular third molar. However, LLLT showed no beneficial effect on pain, according to [Amarillas-Escobar et al., 2010] and López-Ramrez et al., 2012] investigations findings. The results of this study showed that the difference in mouth opening between the study group and the control group was significant on the second postoperative day (p=0.01) and non-significant on the seventh postoperative day (p>0.05), which was consistent with the findings of [Eroglu & Keskin, 2016; Aras et al., 2010] who found that LLLT has a positive effect on trismus. On the other hand, researchers [Momeni et al., 2022; Marwah Safaa et al., 2019; López-Ramrez et al., 2012] reported that LLLT had no positive impact on trismus.

In the present study, a difference in swelling was highly significant in the study group on the second postoperative day but not on the seventh. According to [Aras et al., 2010 ; Ferrante et al., 2013 ; Eshghpour et al., 2016], low-level laser therapy can reduce facial swelling, which is compatible with the findings of this study. Contrary to the findings of this study, [Momeni et al., 2022] and [Farhadi et al., 2017] found no statistically significant difference in swelling between the study and control groups.

11. Conclusion

As a result, LLLT using a dual-wavelength (810,980nm) diode laser with a 0.4W power provides a therapeutic option with clinically beneficial effects on pain, edema, and trismus, which are likely to arise after extraction of an impacted molar. Directly following the removal of an impacted molar, physicians might use a single session of LLLT using a diode laser to enhance healing and anti-inflammatory processes.

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فعالية العلاج بالليزر منخفض المستوى لتقليل المضاعفات بعد خلع الضرس الثالث المطمور من الفك السفلي

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الخلاصة
مقدمة : يعتبر خلع الضرس الثالث من الفك السفلي علاجًا روتينيًا. المضاعفات الأكثر شيوعًا بعد هذا الإجراء هي الألم وتشنج عضلات الفكين وانتفاخ الوجه. لمعالجة هذه المضاعفات ، تم استخدام الأدوية العلاجية ؛ ومع ذلك ، نظرًا لآثارها الجانبية ، فقد تطورت العلاجات غير الدوائية ، مثل العلاج بالتبريد ، وحزم الثلج ، والعلاج بالليزر منخفض المستوى (LLLT) ، والأوزون ، والتي تعالج هذه المضاعفات دون آثار جانبية. يحث الليزر منخفض المستوى على التحفيز الحيوي ، ويسرع تجديد الأنسجة ،

ويعزز التئام الجروح ، ويقلل من الألم والتورم من خلال تأثير مضاد للالتهابات. وذلك لأن الليزر منخفض المستوى يزيد من نشاط البلعمة ، وعدد وقطر الأوعية اللمفاوية ، ويقلل من نفاذية الأوعية الدموية ويعيد وظيفة الشعيرات الدموية الدقيقة.
الهدف : كان الغرض منه هو تقييم آثار العلاج بالليزر منخفض المستوى على المضاعفات الناتجة عن جراحة الضرس الثالث المطمور.
المواد والطرق : تم تسجيل 30 مريضاً في الدراسة الحالية وتم تقسيمهم بشكل عشوائي إلى مجموعتين متساويتين. تضمن الفحص السريري قبل الجراحة قياس الحد الأقصى لفتح الفم وقياسات الخد. تم تقييم موضع وتكوين الضرس الثالث السفلي المطمور ، والعظم المحيط ، والقناة السفلية ، والأسنان المجاورة باستخدام الأشعة السينية البانورامية. بعد الجراحة ، تم تطبيق العلاج بالليزر منخفض المستوى بشكل إضافي وداخل الفم. في اليومين 2 و 7 ، بعد الجراحة ، تم تقييم الحد الأقصى لفتح الفم وفحص الأبعاد مرة أخرى. تم استخدام الإحصائيات لتقييم كل قراءة.
الاستنتاجات : تشير النتائج إلى دلالة إحصائية للألم ، وتشنج عضلات الفك ، والتورم.

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