Low level Laser Therapy Versus Cryotherapy on Relieving Pain and Trismus After Third Molar Surgery

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Original Article

ABSTRACT

Purpose: Aim of the study was to compare the effect of Photobiomodulation therapy and Cryotherapy on relieving pain and trismus after third molar surgery.

Methods: Forty patients - who underwent surgical removal of their lower third molar - participated in this study. They were randomly assigned into two groups of twenty patients. A diode laser device - with a continuous wavelength of 808 nm and a maximal output power of 100 mW - was used. Patients in the photobiomodulation group received 12 J (fluence of 4 J/cm2) over four points on masseter muscle for 10 days, extraorally. Patients in the Cryotherapy group received postoperative ice bags on the painful area of the cheek for 30 minutes for 10 days. Visual analogue scale (VAS) and Inter-Incisal Mouth Opening were used: before starting the treatment, after five days, and after ten days.

Results: Photobiomodulation therapy was more effective than cryotherapy on pain and trismus relief after third molar surgery in terms of decreasing visual analogue scale and increasing vernier caliper gauge.

Conclusion: The study demonstrated that Photobiomodulation therapy was more effective than Cryotherapy for reduction of postoperative pain and trismus after ten days of third molar surgery.

Key Words: Photobiomodulation Therapy, Low Level Laser Therapy (LLLT), Cryotherapy, Pain, Trismus, Third molar surgery.

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INTRODUCTION

Removal of impacted teeth is one of the most performed procedures in the oral surgery field, especially the third molars. Tooth Impaction is defined as, a pathological failure of teeth to erupt into its functioning position in the dental arch within an expected time [1].

Extraction of an impacted third molar is usually accompanied with pain, which can be characterized as moderate to severe. Limited mouth opening can cause inflammation, which, in turn, leads to pain. Over the last two decades, pain - following third molar surgical extraction - was considered a gold standard model to test the efficacy of analgesics in clinical trials. Postoperative pain is a well-documented and validated method to study pain in general [2] . Post-operative pain is considered the most common complication after tooth extraction. It reaches its highest intensity 68- hours after surgery [3].

There are many factors that influence postoperative pain's intensity and duration: the more complicated the procedure to extract the third molar (excessive bone cutting and tissue manipulation), and the more the procedure's time, the more increased chances of necrosis with subsequent increase in pain's intensity and duration. Technique of surgery is a modifying factor for pain following the third molar extraction [4].

Trismus is a common complication of dental treatment. In many ways, it is mostly harmless, but it could give rise to many constraints for the patient, including social restrictions, which can cause anxiety and decrease life quality. In a few instances, lawsuits have been instigated against the clinicians. Hence, it is imperative to be able to recognize trismus, to understand its causes, and to have the capacity to treat it [5].

Postoperative trismus frequently associates with the oral surgeries performed in the region of the mandible ramus and angle. In addition, the severity of the intervention, and the massiveness of tissue and bone destruction are in direct proportion to trismus presence. It seems that the complicated position of the impacted third molars, as well as the circulation features in its region make the post-operative trismus presence more frequent than other oral surgical interventions [6].

Photobiomodulation is a form of lighttherapy

Photobiomodulation therapy utilizing Low-Level Laser Therapy (LLLT) is a simple and inexpensive

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method that can be used easily in the dental practice for different purposes; such as pain reduction, enhancement of wound healing, and alleviating inflammation [7].

Cryotherapy involves the use of cold locally in order to reduce tissue inflammation, swelling, and to alleviate the resultant pain [8]. It is well-established that acute inflammatory response does happen right after soft tissue injury and trauma. Localized cryotherapy treatment has been found to remove dead cells, tissue debris and irritants from the inflammation site [9].

The aim of the study was to compare the effect of photobiomodulation Therapy and Cryotherapy on relieving pain and trismus after third molar surgery. Was there any difference between low level laser and cryotherapy on relieving pain and trismus after third molar surgery?

MATERIALS AND METHODS

The study was approved by the ethical committee at Benha university. All subjects were made aware of the experiment details, and they signed consent forms.

Patients:

Forty patients of both genders were selected: their ages ranged from 20 to 40 years, and they suffered from pain and trismus immediately following third molar surgery. The patients were free from any other health problems - like pregnancy, lactation, kidney or hepatic disease, diabetes mellitus and thyroid disease - that may affect the study results.

Patients were chosen under the inclusive and exclusive criteria. Inclusive criteria were: The patients ages were ranged from (2040-) years, all patients in both groups of the study were received the same medication, they all were suffering from pain and trismus right after the third molar surgery, all patients hadn't any history of previous trismus, they hadn't taken any medication that might influence the treatment procedure and were all conscious and co-operative.

The patients - examined by a physician before the study - excluded for the following criteria: Pregnant and lactating patients, patients with diabetes mellitus and hypertension, history of vascular or circulatory disorders, clinical evidence of pre-existing pulmonary diseases, patients who had marked hypotension, life threatening disorders as renal failure and myocardial infarction. Additionally, we excluded patients with hemorrhage diseases specially hemorrhage of digestive system and those with bleeding per rectum, severe fungal diseases and acute viral diseases, active tuberculosis, and tumors, those with peacemakers, patients with limitation of mouth opening due to intra-articular causes of the tempromandibular joint (TMJ), peritonsillar abscess, tetanus, microstomia, and osteochondroma of the mandibular coronoid process.

Patients were randomly assigned into two groups of equal numbers: each group consisted of twenty patients. The first group (group A) received photobiomodulation therapy (2 minutes over four points on masseter muscle daily for 10 days) after third molar extraction surgery. The second group (group B) received cryotherapy (ice packs 30 minutes on the painful area of check daily for 10 days) after third molar surgery.

Measurements were conducted after surgery. Readings were recorded before starting the treatment (first record), at the fifth day of treatment as a second record, and at the ten days of treatment as a third (final) record.

Equipment and tools:

The study equipment and tools were divided into measuring and therapeutic equipment.

Measuring tools:

They were divided into tools for measuring pain intensity, and tools for measuring inter-incisal mouth opening. One tool used for measuring pain intensity was the Visual analogue scale (VAS). Pain intensity was assessed using a 10-level visual analog scale (VAS) with the patient placing a mark on the scale to indicate an intensity range from no pain (0) to severe/unbearable pain (10), as demonstrated in Figure (1) [10].

Figure 1 Visual analogue scale

Patients were oriented to mark a trace on the horizontal line to reflect pain intensity, considering zero as no pain and 10 as maximum possible pain [11]. Vernier caliper gauge (Figure (2)) was utilized to measure interincisal mouth opening. It measured the maximum inter-incisal mouth opening ability of the patient at the commencement of the procedure. Incisal edge of the maxillary central incisor and incisal edge of mandibular central incisor, at maximum opening available, would be the reference point [12].

Figure 2 Vernier caliper gauge.

Therapeutic equipment and tools:
Low- Level Laser device (Photon Scientific, Industrial Area, Egypt) was used in the photobiomodulation treatment protocol. It is a Laser diode system 808 nm-500 mw. The laser source is GaAIAs, its wavelength is 808 nm, output Power: up to 500 mW, energy of 12 J, and the total exposure time was 120 sec. The spot size was 1 cm circle so, the energy density was 4J/cm2. It weights two kilograms its electrical input is AC220V, and the mode of Operation is CW. Figure (3).

Figure 3 Photobiomodulation apparatus.

Additionally, it is digitally controlled with a digital display, it has two control modes, test mode and a time control mode. The test mode is a continuous operation with key switch control, and the time control mode is digitally controlled with a digital display. The readings on the time control are: 0-100 Sec. Res. 0.01 Sec, 0-100 Min. Res. 0.01 Min, and 0-100 Hour Res. 0.01 Hour. For cryotherapy treatment, Ice pack (block of ice enveloped by a band to protect the skin) of appropriate size was applied directly on the painful area of the cheek for 30 minutes for 10 sessions daily [13].

Procedure
The experimental protocol was explained in detail for every patient before starting the initial assessment, and a written consent form was signed by each patient before starting the treatment. The treated patients were instructed to report any side effects during the treatment sessions.

Measurement procedures:
In this phase, the assessment procedure was performed after third molar surgery. Measurements were recorded three times: before starting the treatment in both groups, on the fifth day by the end of the treatment, and at the end of all sessions after ten days.

Measurement of pain intensity by using visual analogue scale (VAS)
Visual analogue scale (VAS) is a ten cm line anchored at each end with words indicating no pain and the worst pain possible. VAS was performed three times; before starting the study in both groups, then at the treatment end of the fifth day, and at the end of all sessions after ten days. The patient was asked to place a mark a point on the line which best represent their experience of pain between two areas; (no pain) to (worst pain), then the operator would measure the distance from the zero (no pain) in millimeters. The visual analogue scale (VAS) can be considered to have a ration scale property, quick scoring system for the clinician, sensitivity to the treatment effects, and good evidence for the reliability and repeatability for both affective and intensity scales. The reliability of visual analogue scale (VAS) was the highest and its validity was the highest among other pain scales [14].

Measurement of inter-incisal mouth opening by using vernier caliper gauge (VCG)
Vernier caliper gauges can measure any dimension using the standard, measuring range is from 0- 150 mm. It was used to measure patients' maximum inter-incisal mouth-opening ability at the start of the procedure. The incisal edge of the maxillary central incisor and incisal edge of mandibular central incisor at maximum opening available were the reference point. Before using of the vernier caliper gauge measuring surface were checked to see if there are any scratches that may impede calibration [15]

The scale is checked for any marking lines or numbers, which may be missing or worn. The marking lines should be of the same width and have sharp edges. The specified starting distance is checked: for the zero value (for micrometers of 0- 25mm) by tightening the micrometer (using the ratchet) until it tightens no more, and then reading off the value or for values other than zero in the same way, but with the use of a gauge block of appropriate dimension (e.g. for micrometer 50-75mm starting point is checked using a gauge block 50 mm) [15–18] Figure 4.

Figure 4 Vernier caliper Gauge measurement.

Therapeutic procedures:
Group A

Group A, the group treated with Laser, underwent two phases. Phase one is the preparatory treatment application phase, in which, patients' history was taken in relation to the study, they were informed of the treatment and its purpose, absolute and relative contraindications (mentioned in exclusion criteria) were excluded, and patients were placed in the most proper position.

Phase two involved placing the patients in a comfortable position with their heads placed in a suitable position. Then, they were instructed to wear protective glasses. The laser beam is adjusted to be perpendicular to the masseter muscle extra orally in contact with the skin on four points: 1- lower region (near the mandibular insertion), 2- lower middle region, 3- upper middle region, and 4- upper region (near the insertion of the zygomatic arch). Laser was applied for 30 seconds for each point. Surface of the skin was cleaned with alcohol to remove any material that might absorb or scatter the radiation [19–21]. Figure (5 & 6).

Figure 5 Low Level Laser application for the group (A) on the lower region (near the mandibular insertion)

Figure 6 Low Level Laser application for the group (A) on the upper region (near the insertion of zygomatic arch)

Group B

The group treated with cryotherapy (group B) underwent two phases: Phase one, which was the preparatory treatment application, and phase two, which involved cryotherapy. In preparatory treatment application, Patient's history was taken in relation to the study. They were informed of the treatment and its purpose; absolute and relative contraindications (mentioned in exclusion criteria) were excluded. Patients were sitting in a comfortable position on the chair, and all ice pouches had similar amount and size.

In phase two, patients were treated with cold pack (blocks of ice enveloped by a band to protect the skin). The cold packs were applied on the painful area of the cheek [13,22]. The Duration and frequency were 30 minutes daily for ten days. Figure (7).

Figure 7 Application of Cryotherapy for the group (B)

Statistical analysis

In this study, Descriptive statistical analysis was used by calculating the mean, the standard deviation, range, variance, and the standard error were calculated for each group in the study. The mean, the standard deviation and range were used to measure central tendency by connecting the facts about each parameter.

Paired t-test was used to make comparisons within each group, and to detect the level of significance. Unpaired t-test was used to compare the variable and detect the significance level between two groups by comparison. To compare the mean between both groups, Repeated Measures MANOVA test was employed. The statistical package for social science (SPPSS) was utilized for data analysis and the level of significance was set at 0.05 levels [23].

RESULTS

The mean value for age variable in group (A) was 29.70 ± 6.00, and for group (B) was 29.00 ± 6.47. Variance values were 36.01 and 41.89 for the first and second groups respectively. The range values were 20 for both groups. Maximum values were 40 for group A, and 40 for group B. Whilst the minimum values were 20 for groups A, and B respectively as shown in table 1 and appendix (II).

Table 1 Descriptive statistics for variable age

Age (year) (n = 20)						
Group	Mean	Std. Deviation	Range	Minimum	Maximum	Variance
Group (A) photobiomodulation	29.70	6.00	20	20	40	36.01
Group (B) Cryotherapy	29.00	6.47	20	20	40	41.89

* N=20

General characteristics comparison of both groups was analyzed by independent sample t-test and showed that, there was no significance difference between both groups in the mean age, ($p > 0.05$) as a value (t) equal (0.355), abstract P-value level more than (0.05) as shown in (Table 2, figure 8).

Table 2 Comparing the mean age of both groups A, and B by using Independent Samples t-test.

Variables	Group (A) Photobio-modulation	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
Age (year)	29.70 ± 6.01	29.0 ± 6.47	0.70	0.355	0.72	NS

* N=20
SD: Standard Deviation MD: mean difference T value: unpaired t value
P-value: probability value NS= non-significant

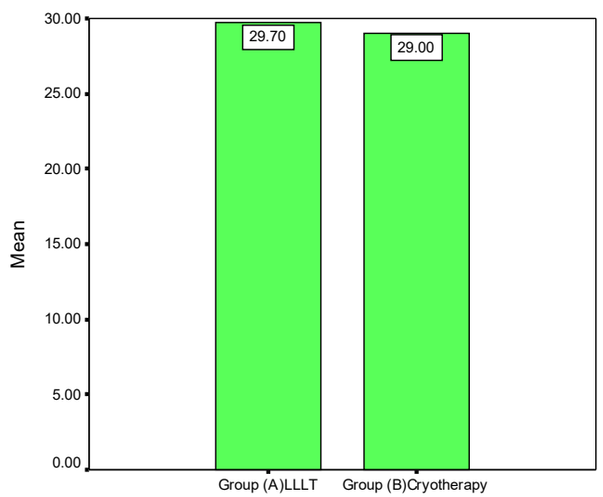

Figure 8 Mean age (years) for group A and group B.

Descriptive statistical analysis results of VAS in Group A, before photobiomodulation application (VAS1) are: The mean value ± SD was (8.65 ± 1.04), Variance was (1.082) and Co-efficient was (12.02) as shown in table (5) and appendix (III). After fifth day of treatment, VAS 2 mean value ± SD was (4.20 ± .95), Variance was (0.905), and Co-efficient was (22.65) as shown in table (3) and appendix (III). VAS 3 mean value ± SD after ten days of treatment was (0.50 ± .60), Variance was (0.368) and Co-efficient was (121.40) as shown in table (3).

Table 3 Comparison between treatment mean values and standard deviation of VAS of group (A) Photobiomodulation

Variables	Mean	(SD)	Variance	Co-efficient
VAS 1	8.65	1.04	1.082	12.02
VAS 2	4.20	.95	0.905	22.65
VAS 3	0.50	.60	0.368	120.23

Comparison of mean values of the visual analog scale (VAS) within Group A, using Repeated measures MANOVA, indicated a significant difference between VAS1 before starting the treatment, VAS 2 on the fifth day of treatment, and VAS 3 after 10 days of treatment. Wilks lambda = (1204.263) level of significance less than (0.01). Values are shown in table (4), and figure (9).

Table 4 Comparison Mean VAS (Visual analogue scale) between pre and post treatment (within group photobiomodulation) by using Repeated Measures MANOVA

Treatment	Pre (VAS 1)	Post 1 (VAS 2)	Post 2 (VAS 3)	Wilk's lambda		
Group	Mean ±SD	Mean ±SD	Mean ±SD	F-value	P-value	S
(A)LLLT	8.65± 1.04	4.20 ± 0.95	.50 ± 0.60	1204.263	0.001*	Sig.

**Significant at the (.01) level
*Significant at the (.05) level

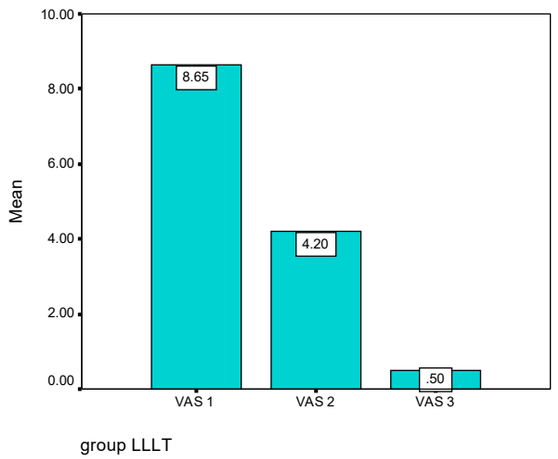

Figure 9 Comparison between treatment mean values of VAS (Visual analogue scale) of group (A) LLLT.

The Least Significant Difference Test (LSD), for VAS values within Group A, revealed a statistically different significant between VAS 1, before starting treatment, and after fifth days of treatment (VAS 2) since a mean difference equal (4.45) abstract p-value level less (0.01), table (5). There was statistically different significant between reading value on the fifth day of treatment (VAS 2) and after ten days of treatment (VAS 3), as the mean difference equal (3.70) abstract p-value level less (0.01).

Table 5 Comparison Mean VAS (Visual analogue scale) between pre and post treatment (within group photobiomodulation) by using LSD test.

	Pre (VAS 1) MD	Post 1(VAS 2) MD	Post 2 (VAS 3) MD
Pre (VAS 1)	-	4.45**	8.15**
Post 1(VAS 2)		-	3.700**
Post 2(VAS 3)			-

**Significant at the (.01) level *Significant at the (.05) level
MD, mean difference

Descriptive statistical analysis results of VAS values within Group B before starting the treatment (VAS 1) were: The mean value ± SD was (8.70 ± 1.03), Variance was (1.063) and Co-efficient was (11.85). After fifth day of cryotherapy application, VAS 2 mean value ± SD was (4.95 ± .99), Variance was (0.997) and Co-efficient was (20.18). After tenth day of cryotherapy treatment for group B (VAS 3), The mean value ± SD was (2.15 ± .74), Variance was (0.555) and Co-efficient was (34.659) as shown in table (6).

Table 6 Comparison between treatment mean values and standard deviation of VAS of group (B) Cryotherapy

Variables	Mean	(SD)	Variance	Co-efficient
VAS 1	8.70	1.03	1.063	11.85
VAS 2	4.95	.99	0.997	20.175
VAS 3	2.15	.74	0.555	34.659

The comparison of mean values of the visual analog scale (VAS) within Group B, using Repeated Measures MANOVA test, indicated a significant difference between VAS1 before starting the treatment, VAS 2 on the fifth day of treatment, and VAS 3 after 10 days of treatment. Wilks lambda = (865.423) level of significance less than (0.01). Table (7), and figure (10).

Table 7 Comparison Mean VAS (Visual analogue scale) between pre and post treatment (within group Cryotherapy) by using Repeated Measures MANOVA

Treatment	Pre (VAS 1)	Post 1 (VAS 2)	Post 2 (VAS 3)	Wilk's lambda		
Group	Mean ±SD	Mean ±SD	Mean ±SD	F-value	P-value	S
Cryotherapy	8.70± 1.03	4.95 ± .99	2.15 ± .74	865.423	0.001*	Sig.

**Significant at the (.01) level *Significant at the (.05) level

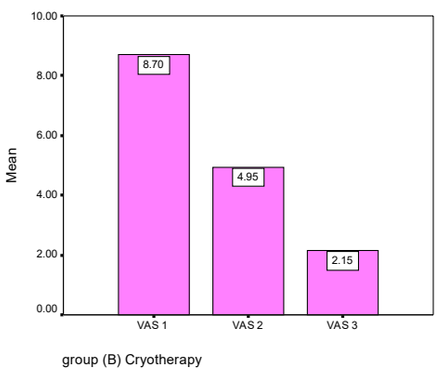

Figure 10 Comparison between treatment mean values of VAS (Visual analogue scale) of group B Cryotherapy.

The Least Significant Difference Test (LSD), for VAS values within Group B, revealed a statistically different significant between treatment groups VAS 1, and VAS 2 as a mean difference equal (3.75) abstract p-value level less (0.01). LSD also indicated a statistically different significant between VAS 1, and VAS 3 as a mean difference equal (6.55) abstract p-value level less (0.01). Additionally, there was statistically different significant between VAS 2, and VAS 3 as a mean difference equal (2.80) abstract p-value level less (0.01), Table (8).

Table 8 Comparison Mean VAS (Visual analogue scale) between pre and post treatment (within group (B) Cryotherapy) by using LSD test.

	Pre (VAS 1) MD	Post 1(VAS 2) MD	Post 2 (VAS 3) MD
Pre (VAS 1)	-	3.75**	6.55**
Post 1(VAS 2)		-	2.80**
Post 2(VAS 3)			-

**Significant at the (.01) level *Significant at the (.05) level
MD: mean difference

Comparison between the means of the first record (before starting of the treatment) of visual analogue scale (VAS 1) in the two groups A, and B was observed in table (9) and figure (11): the mean value ± SD of VAS before treatment for Group A was (8.65± 1.04) and that for Group B was (8.70± 1.03), the mean difference between both groups was (0.70). There was no significant difference between group (A) photobiomodulation and group (B) Cryotherapy before treatment (VAS 1) as a value (t) equal (0.153) abstract p-value level more than (0.05).

Table 9 Comparison between treatment mean values of (VAS 1) of group (A) and group (B) by using independent t-test.

Variables	Group (A) Photobio-modulation	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
VAS 1	8.65± 1.04	8.70 ± 1.03	0.05	0.153	0.87	NS

**Significant at the (.01) level *Significant at the (.05) level

Comparison between the means of the first record (after the fifth day of treatment) of visual analogue scale (VAS 2) in the two groups A, and B demonstrated that the mean value ± SD of VAS after fifth days of treatment for group A was (4.20± .95) and that for group B was (4.95± 99), the mean difference between both groups was (0.75). There was a significant difference between group A, and B after the fifth day of treatment (VAS 2) as a value (t) equal (2.432) abstract p-value level less than (0.05). Shown in table (10).

Table 10 Comparison between treatment mean values of (VAS 2) of group (A) and group (B) by using independent t-test.

Variables	Group (A) LLLT	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
VAS 2	4.20± .95	4.95 ± .99	.75	2.432	0.02*	Sig.

**Significant at the (.01) level *Significant at the (.05) level

Comparison between the means of the first record (after tenth day of the treatment) of visual analogue scale (VAS 3) in the two groups A, and B was observed in table (11) and figure (11): the mean value ± SD of VAS after ten days of treatment for group A was (0.05± .60) and that for group B was (2.15± .74), the mean difference between both groups was (1.65). There was significant difference between group (A) LLLT and group (B) Cryotherapy after ten days of treatment (VAS 3) as a value (t) equal (7.678) abstract p-value level less than (0.01).

Table 11 Comparison between treatment mean values of (VAS 3) of group (A) and group (B) by using independent t-test.

Variables	Group (A) Photobio-modulation	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
VAS 3	0.50± .60	2.15 ± .74	1.65	7.678	0.001**	H.Sig.

**Significant at the (.01) level *Significant at the (.05) level

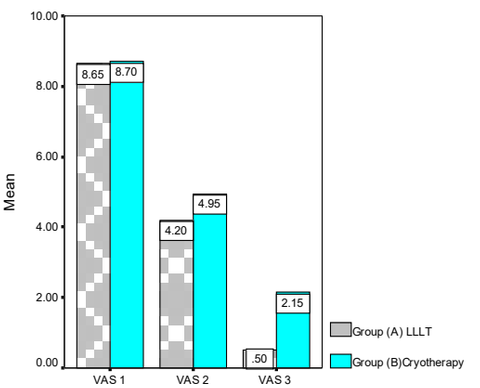

Figure 11 Comparison between treatment mean values of VAS (Visual analogue scale) of groups A and B.

Vernier caliper gauge (VCG) readings of group A and B were taken at three points; before treatment commencement (VCG 1), after five days of treatment (VCG 2), and after the tenth day of treatment (VCG 3). Descriptive statistical analysis of group A's VCG 1 result was: The mean value ± SD was (26.15 ± 4.05), Variance was (16.45) and Co-efficient was (15.509). Group A's VCG 2 mean value ± SD was (35.8 ± 4.93), Variance was (24.38) and Co-efficient was (13.79) as shown in table (12) and appendix (V). VCG 3's mean value ± SD was (46.85 ± 4.88), Variance was (23.82) and Co-efficient was (10.417) as shown in table (12).

Table 12 Comparison between treatment mean values and standard deviation of VCG of group (A) photobiomodulation:

Variables	Mean	(SD)	Variance	Co-efficient
VAS 1	26.15	4.05	16.45	15.509
VAS 2	35.80	4.93	24.379	13.79
VAS 3	46.85	4.88	23.82	10.42

Repeated measure MANOVA of Group A indicated that there was a significant difference between (VCG 1) before starting of treatment, (VCG 2) after fifth days of treatment and (VAS 3) after ten days of treatment, (table 13, and figure 12), Wilks lambda = (1326.608) level of significance less than (0.01).

Table 13 Comparison Mean VCG (Vernier Caliper Gauge) between pre and post treatment (within group (A) photobiomodulation) by using Repeated Measures MANOVA.

Treatment	Pre (VCG 1)	Post 1(VCG 2)	Post 2(VCG 3)	Wilk's lambda		
Group	Mean ±SD	Mean ±SD	Mean ±SD	F-value	P-value	S
(A)LLLT	26.15± 4.05	35.80 ± 4.93	46.85 ± 4.88	1326.608	0.001*	Sig.

**Significant at the (.01) level *Significant at the (.05) level

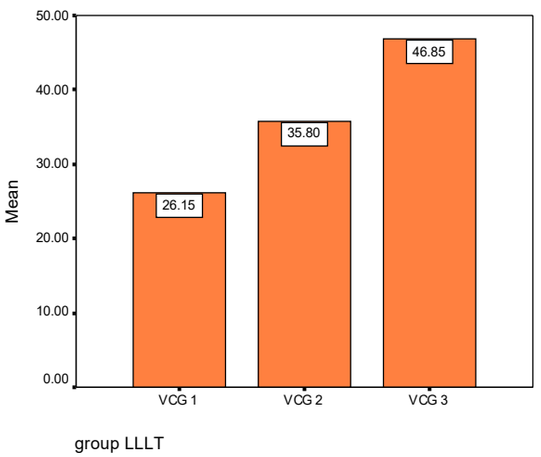

Figure 12 Comparison between treatment mean values of VCG (Vernier Caliper Gauge) of group A LLLT

LSD test demonstrated statistically different significant between VCG 1 and VCG 2 as the mean difference equal (9.65) abstract p-value level less (0.01) within group A. There were statistically different significant between VCG 1 and VCG 3 as the mean difference equal (20.70) abstract p-value level less (0.01). Statistically different significant between VCG 2 and after ten days of VCG 3 since the mean difference equal (11.05) abstract p-value level less (0.01). As shown in table (14).

Table 14 Comparison Mean VCG (Vernier Caliper Gauge) between pre and post treatment (within group A (LLLT) by using LSD.

Treatment	Pre (VAS 1) MD	Post 1(VAS 2) MD	Post 2 (VAS 3) MD
Pre (VAS 1)	-	9.65**	20.70**
Post 1(VAS 2)		-	11.05**
Post 2(VAS 3)			-

**Significant at the (.01) level *Significant at the (.05) level
MD, mean difference

Regarding cryotherapy group (Group B), vernier caliper gauge (VCG) reading was taken before starting the treatment (VCG 1), after five days of treatment (VCG 2), and after ten days of treatment (VCG 3). The mean value ± SD of VCG 1 was (26.35 ± 3.87), variance was (14.98) and Co-efficient was (14.69). VCG 2's mean value ± SD was (30.60 ± 4.17), variance was (17.41) and Co-efficient was (13.636). VCG 3's mean value ± SD was (35.95 ± 3.77), Variance was (14.26) and Co-efficient was (10.404) as shown in table (15).

Table 15 Comparison between treatment mean values and standard deviation of VCG of group (B) Cryotherapy:

Variables	Mean	(SD)	Variance	Co-efficient
VAS 1	26.35	3.87	14.98	14069
VAS 2	30.60	4.17	17.41	13.64
VAS 3	35.95	3.77	14.26	10.504

Repeated measures MANOVA test results are shown in table 16 and figure 13. There was a significant difference between VCG 1, VCG 2, and VCG 3 after ten days of treatment, Wilks lambda = (336.327) level of significance less than (0.01).

Table 16 Comparison Mean VCG (Vernier Caliper Gauge) between pre and post treatment (within group (B) Cryotherapy) by using Repeated Measures MANOVA

Treatment	Pre (VCG 1)	Post 1(VCG 2)	Post 2(VCG 3)	Wilk's lambda		
Group	Mean ±SD	Mean ±SD	Mean ±SD	F-value	P-value	S
(B) Cryotherapy	26.35± 3.87	30.60 ± 4.17	35.95 ± 3.77	336.327	0.001*	Sig.

**Significant at the (.01) level *Significant at the (.05)

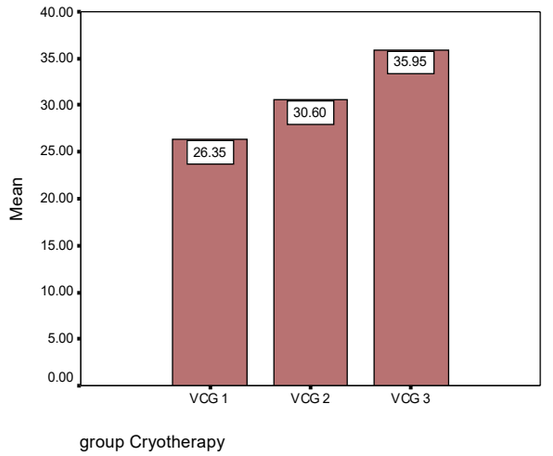

Figure 13 Comparison between treatment mean values of VCG (Vernier Caliper Gauge) of group B Cryotherapy

LSD test for VCG within Group B revealed a statistically different significant between VCG 1, and VCG 2, since the mean difference equal (4.25) abstract p-value level less (0.01). Additionally, there were statistically different significant between treatment groups VCG 1 and, VCG 3, as the mean difference equal (9.60) abstract p-value level less (0.01). Statistically different significant between VCG 2, and VCG 3 was found since the mean difference equal (5.35) abstract p-value level less (0.01), Table (17).

Table 17 Comparison Mean VCG (Vernier Caliper Gauge) between pre and post treatment (within group (B) Cryotherapy) by using LSD.

Treatment	Pre (VAS 1) MD	Post 1(VAS 2) MD	Post 2 (VAS 3) MD
Pre (VAS 1)	-	4.25**	9.60**
Post 1(VAS 2)		-	5.35**
Post 2(VAS 3)			-

**Significant at the (.01) level *Significant at the (.05) level MD, mean difference

When we compared the means of Group A, and B at the first record (VCG1), There was no significant difference between group (A) photobiomodulation and group (B) Cryotherapy since the value (t) equal (0.160) abstract p-value level more than (0.05). As observed in table (18) and figure (14): the mean value ± SD of VCG before treatment for group A was (26.15± 4.05) and that for group B was (26.3± 3.87), the mean difference between both groups was (0.20).

Table 18 Comparison between treatment mean values of (VCG 1) of group (A) and group (B) by using independent t-test.

Variables	Group (A) Photobio-modulation	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
VCG 1	26.15± 4.05	26.3 ± 3.87	0.2	0.160	0.87	NS

**Significant at the (.01) level *Significant at the (.05) level

When we compared the means of Group A, and B at the second record (VCG 2), it was found that the mean value ± SD of VCG 2 for group A was (35.8± 4.93) and that for group B was (30.6± 4.17), the mean difference between both groups was (5.20). There was a significant difference between Group A, and Group B at VCG 2, as the value (t) equal (3.597) abstract p-value level less than (0.05). Shown in table (19) and figure (14).

Table 19 Comparison between treatments mean values of (VCG 2) of group (A) and group (B) by using independent t-test.

Variables	Group (A) LLLT	Group (B) Cryotherapy	MD	T	p-value	Significance
	LLLT	Mean ± (SD)				
VCG 2	35.80± 4.93	30.60 ± 4.17	5.20	3.597	0.001**	H. Sig.

**Significant at the (.01) level *Significant at the (.05) level

When we compared the means of Group A, and B at the third record (VCG 3), there was significant difference between group (A) photobiomodulation and group (B) Cryotherapy after ten days of treatment (VCG 3) as a value (t) equal (7.899) abstract p-value level less than (0.01). As observed in table (20) and figure (14): the mean value ± SD of VCG after ten days of treatment for group A was (46.85± 4.88) and that for group B was (35.95± 3.77), the mean difference between both groups was (10.90).

Table 20 Comparison between treatment mean values of (VCG 3) of group (A) and group (B) by using independent t-test.

Variables	Group (A) Photobio-modulation	Group (B) Cryotherapy	MD	T	p-value	Significance
	Mean ± (SD)	Mean ± (SD)				
VCG 3	46.85± 4.88	35.95 ± 3.77	10.90	7.899	0.001**	H. Sig.

**Significant at the (.01) level *Significant at the (.05) level

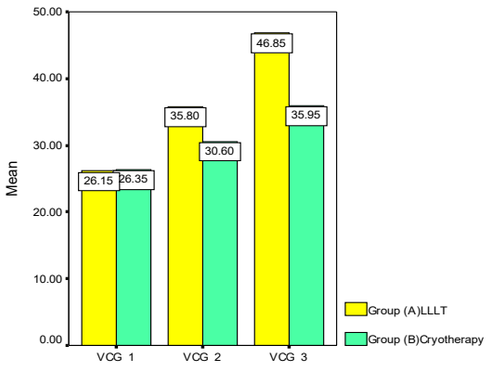

Figure 14 Comparison between treatment mean values of VCG (Vernier Caliper Gauge) of groups A and B

DISCUSSION

K carter et al. in 2015 stated that, globally, the prevalence of impaction of the third molar was 24.40%. Therefore, surgical removal of the third molar is one of the most common surgical procedure performed in the dental setting [5]. Surgeries are performed for a number of reasons: impacted third molars that are triggering pain, inflammation of the overlying gingiva (pericoronitis), putting pressure on the adjacent teeth, causing resorption and caries, bringing about teeth crowding, and associated cysts [24,25].

Postoperative pain correlates positively with surgical difficulty. Many factors come into play, such as prolonged surgery time, surgical technique used, excessive tissue handling, and bone cutting. These factors can cause alveolar osteitis (dry socket), infection of the surgical site, and possible tissue necrosis with subsequent pain [4,26].

Postoperative trismus usually occurs around mandibular angle and ramus. Many aspects may contribute in the postoperative trismus: medial pterygoid muscle repetitive stimulation after inferior nerve block, flap elevation beyond the external oblique ridge, low grade infection following local anesthesia, and excessive tissue manipulation and bone loss [6,27,28].

The most common Postoperative complications of surgical exodontia of third molars in this experiment are: pain, and trismus. Similar results were reported by Jaffar et al., and Khan et al [29]. Researchers have employed photobiomodulation treatment, also known as Low level laser therapy (LLLT), in treating musculoskeletal pain, acute inflammation, and wound healing. The exact biological mechanism of photobiomodulation is not known. Laser can influence synthesis and metabolism of histamine and prostaglandin in peripheral nerves, and acetylcholine in central nervous system. Photobiomodulation are found to increase endorphin production, decrease bradykinin and C fibers activity, thus changing the pain threshold [30].

On the other hand, the photobiomodulation anti-inflammatory effect was attributed to increase angiogenesis and number of phagocytes and edema reduction [31]. Cryotherapy analgesic and anti-inflammatory effects are well known. According to Van't Hoff's law, Cryotherapy can cause vasoconstriction deaccelerates biochemical reactions with subsequent preventing cellular metabolism [32]. The maximum intensity of vasoconstriction occurs at 15°C [33].

When the temperature drops below15°C, nerve conduction is deactivated and the vasoconstriction becomes vasodilatation [33,34]. Vasoconstriction counteracts inflammatory edema. Nerve blocking brought by cryotherapy reduces the postoperative pain by blocking neural endings [34].

In the present study, comparing the effect between photobiomodulation using low level laser therapy versus Cryotherapy on relieving pain and trismus after third molar surgery was investigated, forty patients of both genders with ages ranging from 20 to 40 years and suffering from pain and trismus after third molar surgery, they were selected from the Surgery Department of the Oral and Maxillofacial surgery, Benha university Hospital. They were free from any other health problems that may affect results of the study such as pregnancy, lactation, active kidney or hepatic disease, diabetes mellitus and thyroid disease.

In relation to visual analogue scale (VAS), there was a highly significant decrease between the means of the second record (4.20 ± .95) and first record (8.65 ± 1.04), between the means of the third record (0.50 ± .60) and the first record as well as between the means of the third record and the second record after Low Level Laser Therapy application, and there was a low significant difference between the means of the second record (4.95 ± .99) and the first record (8.70 ± 1.03), between the means of the third record (2.15 ± .74) and the first record as well as between the means of the third record and the second record after Cryotherapy application.

In relation to vernier caliper gauge (VCG), there was a highly significant increase between the means of the second record (35.8 ± 4.93) and first record (26.1 ± 4.05), between the means of the third record (46.8 ± 4.88) and the first record as well as between the means of the third record and the second record after Low Level Laser Therapy application, and there was a low significant difference between the means of the second record (30.6 ± 4.17) and the first record (26.3± 3.87), between the means of the third record (35.9 ± 3.77) and the first record as well as between the means of the third record and the second record after Cryotherapy application.The result of this study supports the expectation that photobiomodulation was more significantly effective in decreasing pain and trismus after third molar surgery as manifested by the highly decreased visual analogue scale (VAS) and highly increased vernier caliper gauge (VCG) that may be attributed to the analgesic effect of LLLT, decreasing edema and inflammation.

These significant differences between the photobiomodulation group (A) and the Cryotherapy group (B), which were in the form of highly significant decrease in visual analogue scale (VAS) and highly significant increase in vernier caliper gauge (VCG), were consistent with those observed and recorded by many studies. Aras et al. .[19] concluded that LLLT is beneficial on reducing pain and trismus after third molar surgery. Aleksa et al.[35] established that LLLT was superior than non-steroidal anti-inflammatory drug, diclofenac, and long acting anaesthetic drugs, lidocaine and bupivacaine. In a study by Ozen et al.[36], it was concluded that LLLT reduces long-standing sensory nerve impairment (paraesthesia) following third molar surgery. After third molar surgery, LLLT treatment reduced edema and trismus significantly than placebo group in an experiment conducted by Aras et al.[19]. They also showed that laser radiation - when applied extraorally – better reduces postoperative problems than the intraoral application [37].

Ferrante et al.[38] applied LLLT at 1 cm from the involved surgical area and extraoral at the insertion point of the masseter muscle immediately after surgery and at 24 h. they also used the following parameters in LLLT: continuous mode, at 300 mW (0.3 W) for a total of 180 s (60 s × 3) (0.3 W × 180 s=54 J). The test group exhibited improved healing in the interincisal opening, and noteworthy reduction of trismus, swelling and intensity of pain. Moreover, Soliman el al. [39]'s study revealed that when diode laser was used in the third molar exodontia surgery, it significantly reduced pain and edema, postoperatively, since it achieves fast ,and gentle cutting with rapid hemostasis. Nonetheless, a study by Saber et al.[40] suggested that there was a significant difference in pain levels between laser and the placebo groups after surgery, but there was no significant difference in pain duration.

On the other hand, there were several studies that attested that low level laser had no effect on pain and trismus after third molar surgery. Kahraman et al.[41] determined that LLLT has no effect on pain and healing after third molar surgery, when compared to a placebo group. That study used the following laser parameters: Diode GaAlAs with 830nm wavelength and 2.25J energy which was applied for 15 seconds before and right after surgery on one side, while on the other side it was only applied as a placebo.

When Laser parameters – 5 J/cm2 of energy density, a wavelength of 810 nm, and an output power of 0.5 W – were used, randomly on one of the two sides after surgery, it showed no statistical significance when compared to control side with no laser activation, according to López-Ramírez et al. [42]. A study by Raouâa et al.[43] showed that Dexamethasone can reduce swelling postoperatively when compared to Laser treatment with following setting: . a diode laser device (Whitening laze II) with a continuous wavelength of 808 nm and a maximal output power of 100 mW was used.

Nevertheless, the experiment showed no significant difference between them in regards of reducing pain and trismus, postoperatively. In the future, a standard laser therapy should be determined, a therapy in which numerous proved positive effects of diode laser on soft tissue should be applied, while all other variations of the standard therapy that would include medicament usage or other variation regarding therapy application should be proven in future research. Despite our results showing that the Laser was superior to cryotherapy in pain and trismus relief, our study indicated that cryotherapy alleviated postoperative pain and trismus. That is concurrent with observations of several studies. Filho et al. [13] attested that Cryotherapy played no role in trismus reduction, but it was successful in relieving pain and swelling after third molar surgery. Cryotherapy was found that it can relieve trismus, significantly, more than Transcutaneous Electrical Nerve Stimulation and placebo group in a study by Olaogun et al.[22].

However, many studies suggested that cryotherapy plays no rule in postoperative pain and trismus reduction after third molar surgery, for an example, Forsgren et al. [44] found that ice pack application, postoperatively, has the same effect of the placebo group. We recommend that further longitudinal studies should be carried out to evaluate the long-term effects of Diode Laser on clinical as well as microbiological parameters.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

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