

# Effectiveness of Low-level Laser Therapy in the Management of the Temporomandibular Joint Disorders: A Placebo-controlled Trial

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## ABSTRACT

**Objective:** The purpose of this clinical study is to assess the capability of low-level laser therapy (LLLT) in the treatment of temporomandibular joint disorders (TMJDs).

**Materials and methods:** Twenty-four temporomandibular disorder (TMD) patients were selected based on TMD pain screening, Wong and Baker pain scale, and clinical evaluation for signs of TMJDs. Sixteen patients were randomly selected and placed in an experimental group, and a placebo group comprised of eight patients. Painful muscular areas were identified by digital pressure, and laser was applied to these areas for an average of 300 seconds for each patient. The laser device was directed to painful areas without emission in the placebo group. Patients were evaluated before and immediately after each session and after 1 month.

**Results:** Before and after treatment, the changes in pain levels in group I were statistically significant ( $p < 0.0001$ ). The changes in pain levels before and after treatment in group II did not show any statistical significance ( $p = 1.000$ ). The results were statistically significant ( $p = 0.000$ ), on comparing the pain levels after 1 month in groups I and II.

**Conclusion:** The results revealed a significant amount of pain reduction after LLLT on a short-term basis, the majority of patients reported a decrease in clicking frequency, and a softer mandibular movement compared with the placebo group.

**Clinical significance:** The LLLT can be advocated as an adjunct in reducing pain levels in most TMJDs on a short-term basis. Observations from this study second this view.

**Keywords:** Laser, Low-level laser therapy, Pain, Temporomandibular joint, Temporomandibular joint disorders.

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**Conflict of interest:** None

## INTRODUCTION

The temporomandibular joint (TMJ) is a joint that regulates mandibular movement and connects the mandibular bone to the skull; the articulation is compound and developed from articular surfaces of the temporal bone and the condyle of the mandible. Dense articular fibro cartilage covers both these surfaces. The hallmark functions of the TMJ are jaw movements during mastication and speech.<sup>1</sup>

Disorders involving the masticatory muscles, the TMJ, and the associated structures are collectively termed TMD. These disorders are the most common cause of nondental pain in the orofacial region.<sup>2</sup> The TMD can occur due to any injury to the jaw, TMJ, or corresponding muscles of the head and neck. Other attributable causes include grinding, clenching the teeth, bruxism which puts load on the TMJ, disk dislocation, presence of osteoarthritis or rheumatoid arthritis, and stress.<sup>1</sup>

Self-management, behavioral modification, physical therapy, medications, and orthopedic appliances are conservative treatment protocols for the management of TMD. Complex occlusal therapy or surgery which is aggressive should be limited to select cases.<sup>2</sup> Among therapeutic procedures, LLLT has recently been advocated to reduce symptoms and improve function in TMD patients.<sup>2</sup>

A low-power laser or light-emitting diode is used in LLLT. There is increased pain threshold due to changes in cell membrane structure, vasodilatation, decrease in edema, increase in metabolism of cellular activities, and wound-healing time is reduced.<sup>3,4</sup> The LLLT has recently been advocated to alleviate symptoms and improve function in patients with TMD. A number of clinical trials and analyses have shown that LLLT effectively reduces the pain level, clicking and improving range of mandibular motions.<sup>5</sup>

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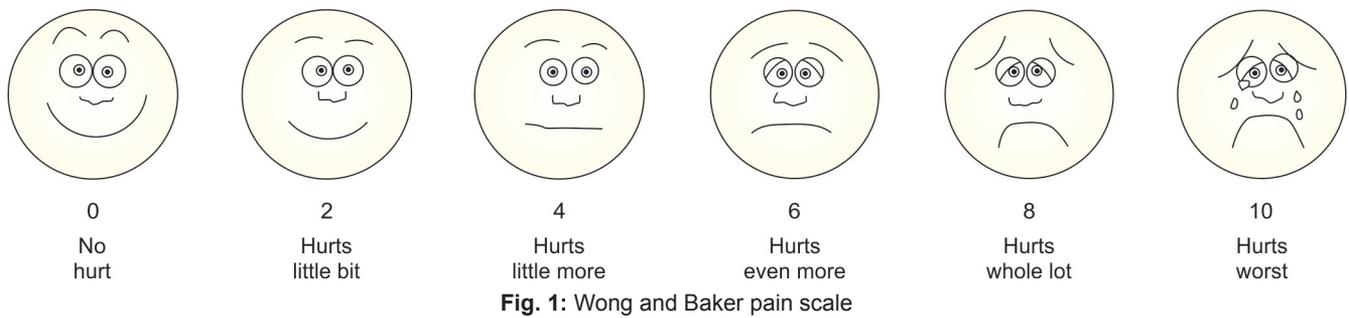
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## MATERIALS AND METHODS

The study is a randomized single-blind controlled trial of patients who were diagnosed with TMD. It was conducted in Ajman University of Science and Technology dental college specialized clinics. The ethical review committee approved the study; 24 patients (2 males and 22 females) diagnosed with TMDs were included in the study.

### Inclusion Criteria

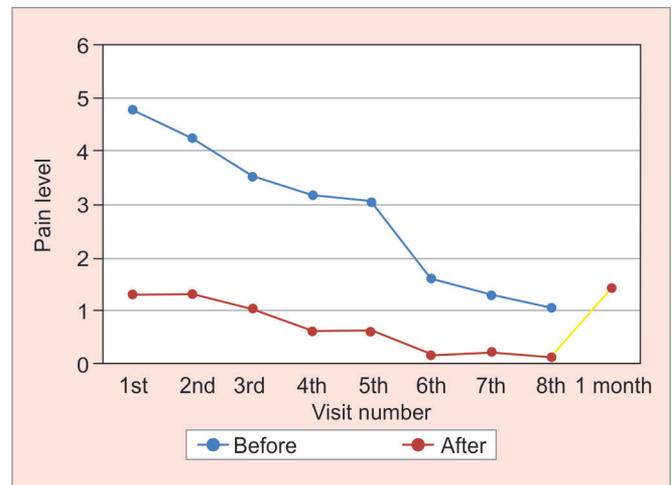
Middle age (18–50 years), patients with TMD like pain clicking, limitation of mandibular movements, etc., and medically fit patients.

### Exclusion Criteria

Tumors involving TMJ, pain attributed to other causes like dental caries, neuralgia, etc., patient under treatment for headache or bruxism in the last 6 months, and patients taking analgesics during the therapy period.

The patients were segregated into two groups randomly: Group I—LLLT group (16), group II—placebo group (8). Painful muscular areas were identified by digital pressure over TMJ, masseter muscle, temporalis muscle, and trapezius muscle. Subjects in group I received exposure of the painful areas to laser for 100 seconds. A diode laser (Denmat, USA), wavelength 940 nm and a power of 6 W in a continuous mode, was used during the trials; the laser tip was kept at a distance of 1 cm up to 3 cm for darker skin types. Diode laser was selected for this study, as it has a property of high tissue penetration when compared with erbium and carbon dioxide laser devices; 940 nm wavelength gives optimal effect for most procedures and its effects were positively seen in most surgical procedures. In subjects in group II, the laser device was directed to painful areas without emission for 100 seconds. Patients were asked to wear goggles with compatible optical density during the treatment duration as a safety measure.

Pain levels were measured using Wong and Baker pain scale. The scale consisted of pictorial faces with ratings in multiples of two from 0 to 10 (Fig. 1). A total of eight sessions were carried out and pain levels were measured before and after each session and after 1 month from the last session.



**Graph 1:** Average pain levels before and after each session and after 1 month from the last session for group I

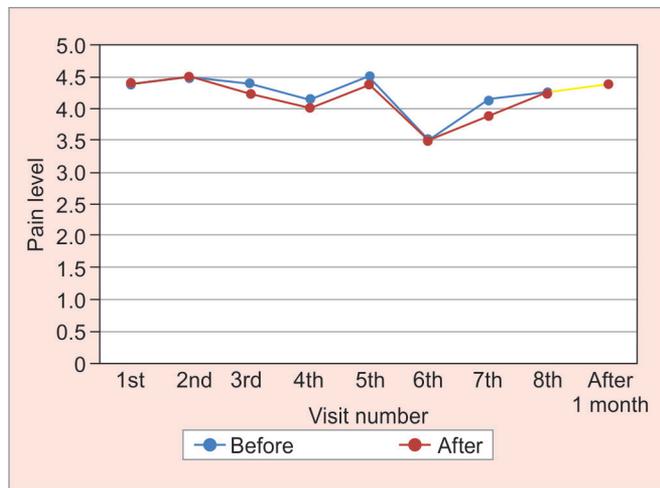
## RESULTS

The pain levels in group I before first visit was 4.81 and this has significantly reduced to 1.06 before the 8th visit. Similarly, pain levels after exposure in the first visit was 1.31 and reduced to 0.13 after exposure in the 8th visit. But the pain levels after the 8th visit was 0.13 and increased to 1.44 during the 1-month follow-up (Graph 1).

The pain level in group II before the first visit was 4.38 and had reduced to mere 4.25 before the 8th visit. Similarly, pain level after exposure in the first visit was 4.38 and reduced to 4.25 after exposure in the 8th visit. But the pain level after the 8th visit was 4.25 and increased to 4.38 during the 1-month follow-up (Graph 2).

The comparative difference in levels of pain before and after treatment in group I was statistically significant ( $p < 0.0001$ ). The difference in levels of pain before and after treatment in group II did not show any statistical significance ( $p = 1.000$ ). On comparing the pain levels after 10 month in groups I and II, the results were statistically significant ( $p = 0.000$ ). The comparative pain levels before and after therapy in both the groups are presented in Table 1.

After 1 month of therapy in group I, the TMJ clicking decreased in 68.8% of the cases, where as 18.8% reported no change, and 12.4% reported increase in clicking (Table 2). After 1 month of therapy in group II, the TMJ clicking



**Graph 2:** Average pain levels before and after each session and after 1 month from the last session for group II

**Table 1:** Comparative data for pain scale: baseline to 1-month follow-up

	Baseline	After 1 month	t-test significance (p-value)
Group I (n = 16)	4.81 ± 1.24	1.44 ± 0.58	<0.0001
Group II (n = 8)	4.38 ± 0.93	4.38 ± 0.61	1.000
ANOVA test significance (p-value)		0.000	–

**Table 2:** Changes in TMJ clicking

	After 8th week		After 1 month	
	Group I, %	Group II, %	Group I, %	Group II, %
No change	6.3	0	18.8	0
Decreased	81.3	62.5	68.8	100
Increased	12.5	37.5	12.4	0

**Table 3:** Changes in mandibular movements

	After 8th week		After 1 month	
	Group I, %	Group II, %	Group I, %	Group II, %
No change	0	75	12.5	100
Softer	100	0	81.3	0
Harder	0	25	6.2	0

decreased in 0% of the cases, whereas 100% reported no change, and 0% reported increase in clicking (Table 3).

The pain level and the TMJ clicking have been followed up within the 6 months after the exposure to the low-level laser where it was noticed that both the TMJ pain and clicking had increased gradually within this period in the laser group.

**DISCUSSION**

In this clinical study, 24 patients diagnosed with TMJDs were recruited and segregated into two groups. Group I received LLLT and group II received placebo. The clinical

trial was randomized and single-blinded and aimed to reduce bias when testing the therapeutic effect of the LLLT. Laser application was done twice per week for a total of eight sessions. Patients were evaluated before and immediately after each session and after 1 month. Pain scale was administered and recorded at before and after each appointment and after 1 month. Their feedback about clicking frequency and ease of mandibular movement were also recorded. The results revealed a significant amount of pain reduction after LLLT as compared with placebo and majority of patients who underwent LLLT reported a decrease in clicking frequency and a softer mandibular movement compared with the placebo group.

Multiple studies reported that LLLT was effective in reduction of pain levels and clicking frequency; they also reported an improvement in the range of mandibular movement. Lassemi et al<sup>6</sup> assessed the effectiveness of laser in 980 nm on 48 TMD patients, and each visit lasted for 60 seconds; their study showed a significant reduction in clicking frequency when compared with the placebo group.

Long-term effects of LLLT in TMDs have not been investigated. In most studies, relief is of short duration. Palano et al<sup>7</sup> assessed the effectiveness of laser in 670 nm on 32 TMD patients, and the duration of each session lasted for 10 minutes. Their study revealed that pain and clicking were significantly reduced. Mazzetto et al<sup>3</sup> conducted a study on 40 TMD patients using 830 nm laser for a duration of 10 seconds per session. Sayed et al<sup>8</sup> made a study on 20 TMD patients using 904 nm laser for a duration of 60 seconds per session. Both studies observed a marked reduction in pain levels and an improvement in mandibular movement, but effects were of short duration.

On the contrary, several studies reported no significant reduction in TMJ pain and no significant effect on clicking after LLLT. Emshoff et al<sup>9</sup> used 632 nm laser on 26 TMD patients; they received 2 to 3 treatments per week for 8 weeks. Venancio et al<sup>10</sup> used 780 nm laser on 30 TMD patients for 10 seconds per session. Both of their study did not show any significant effect in reducing TMJ pain during function. Saheb et al<sup>11</sup> made a study on 64 TMD patients using 830 nm laser for 2 minutes per session, and the results did not reveal any significant effects on clicking.

All the previous clinical trials used different settings; the first and the most important characteristic being the wavelength, it ranged from 632 to 980 nm. There is also large variation in the number of sessions, laser power and duration of each session, number of patients in each group, and sites of laser application. In most of these studies, duration of treatment did not last more than 3 months as follow-up, owing to the uncertainty of relief

from pain and side effects, which is one of the main reasons for disparity in results. Due to these observations, we decided to stick to a 1-month follow-up.

In the treatment of TMD, several therapies, such as acupuncture, transcutaneous electrical nerve stimulation, massage, ultrasound, pharmacotherapy, occlusal splints, and psychological treatments were used as alternative methods.<sup>12</sup> However, LLLT is an easily tolerated, noninvasive, and nonpharmaceutical treatment. It is a time-saving method for both clinician and patient and also has a rapid effect that can be felt by the patient after the application.<sup>9</sup>

The LLLT plays a major role in pain control by its analgesic effect. The LLLT increases the metabolism of certain neurotransmitters (endorphins, acetylcholine, serotonin, and cortisol), decreases c-fiber cavity, and changes transmission and stimulation of nerve impulse, thus reducing pain perception.<sup>13</sup> The LLLT enhances adenosine triphosphate synthesis in neurons causing hyperpolarization of the neuronal membrane and also needs higher impulse to stimulate the action potential of cellular activity. Moreover, the inhibition of prostaglandin E2 (which increases pain by sensitizing the receptors) and interleukin-1 $\beta$  will decrease pain induction. Also, improved peripheral blood flow plays a role in reducing pain.<sup>14</sup>

The LLLT causes vasodilation, alters blood flow, and induces proliferation of endothelial cells, macrophages, and lymphocytes. In addition, it increases lymph drainage and modulates temperature and thus decreases inflammation.<sup>14</sup>

Various studies have been conducted on the application of LLLT in patients with TMDs with conflicting results. The difference may result from various lengths of application, radiation dose, duration, or the parameters used to assess improvement. This gives variation in the sensitivity and specificity of the study. The main role is to assess whether LLLT can be used as an adjunct to alleviate pain in TMJDs. Using standard parameters to alleviate pain is impossible, as lot of factors come into play, such as thickness of tissue, presence of inflammation, use of particular laser, and settings. The use of LLLT has been clinically accepted because of its analgesic and anti-inflammatory actions. With different radiation doses at infrared wavelengths, it usually excites tissues during treatment of musculoskeletal disorders. In phototherapy, as wavelength is one of the important parameters, it is important to choose the effective wavelength with effects conducive in living tissue.<sup>14</sup> The diode laser is known to be a high tissue penetration laser because water has a low coefficient of absorption for it.<sup>10,15</sup>

One of the possible mechanisms whereby reduction in clicking can be attributed to is, the theory of microcirculation. Although its analgesic mechanism of action is not well known, several reports suggest that this may

occur due to improvement of area microcirculation, increased release of endogenous epinephrine, or an increase in lymphatic flow which reduces edema and reduces the permeability of nerve cells membrane.<sup>3,16</sup> The psychological aspects of TMJ problem treatment are important; the effect of placebos in treatment can be effective in over 40% of patients, and for this reason, the current study used a separate group with almost the same pretreatment conditions as placebo group to compare them with the treatment group.<sup>17</sup>

In the current study, patients who underwent LLLT reported a decrease in clicking frequency and a softer mandibular movement compared with the placebo group; this is in agreement with a study conducted by Mazzetto et al<sup>3</sup> who found that LLLT caused a significant decrease in pain symptoms and enhancement in mandibular lateral movements.<sup>18</sup>

A study by Marini et al<sup>19</sup> showed the reliability of LLLT in treating osteoarthritis and improving clinical signs and symptoms of TMJ disk displacement without reduction at the end of treatment.

Kulekcioglu et al<sup>20</sup> assessed the therapeutic role of LLLT in the management of the myogenic and arthrogenic cases of the TMD. They noticed significant reduction in maximal mouth opening, lateral jaw motion in the active group, and the number of tender points.

Bertolucci and Grey<sup>21</sup> reported improvement in TMJ noises, improvement of function of the masticatory apparatus and mouth opening through reduction of intra-articular inflammation and muscle contraction by LLLT.

Myalgia that can limit the range of the mandibular movements is associated with pain related to TMD and masticatory muscle fatigue and weakness. Decreased intramuscular and intra-articular blood flow due to compression of the vessels and inflammatory metabolite collection results in myalgia. Pathological conditions in TMJ and muscles is usually caused by circulatory and inflammatory reactions in the synovial membrane of the TMJ and connective tissues of muscles and bone which can increase the risk of the disk displacement and degenerative joint diseases.<sup>22</sup>

Biostimulation effects of the LLLT occur through metabolic activation,<sup>23</sup> activation of the respiratory chain in mitochondria, increasing vascular rate, fibroblast formation and oxygen supply to cells in hypoxic condition in stressed areas. Pain thresholds are increased, due to changes in the potency of cellular membrane, vasodilatation, decrease in edema and electrolytic nerve fiber blocking mechanism which is complex; it also causes a decrease in the release of inflammatory mediators which can explain the decrease in the rate of the clicking and in the range of the mandibular movement in the current study.<sup>23</sup>

Limitation in the current study is related to the pain perception that is considered subjective and also depends on the patients personal responses; in addition, pain threshold is variable. Limited number of the patients with TMDs that met the inclusion criteria is another factor that should be considered as one of the limitations in the current study.

## CONCLUSION

Within the limitations of this study, LLLT has been shown to be effective in reducing the signs and symptoms of TMJDs. Further research should include more patients and different laser wavelengths, such as 980, 810, 820, and 632 nm. Further clinical studies are still needed to settle standard protocol for laser-assisted TMD management. Longer time for follow-up and larger samples are needed to fully determine the real benefits of LLLT in the management of TMJDs.

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