IJL, Issue 2, Vol. 23, 2024
https://doi.org/10.31900/ijl.v23i2.488

Research Article

IRAQI JOURNAL OF LASER

Impact of Low Level Laser Therapy on Mandibular Range Motion in Temporomandibular Joint Disorder in Iraqi Patients

Haidar Flayyih Hasan[1,*], Layla M. H. Al-ameri[1], Ammar Saleh Alalawi[2]

[1]*Institute of Laser for Postgraduate Studies, University of Baghdad, Baghdad, Iraq*
[2]*Department of Maxillofacial Surgery, Al-Imamain Al-Kadhimain Medical City, Baghdad, Iraq*
* *Email address of the Corresponding Author:Haidar.hasan2102m@ilps.uobaghdad.edu.iq*

Article history: Received 13 Jul. 2024; Revised 21 Aug. 2024; Accepted 27 Aug. 2024; Published online15 Dec. 2024

Abstract

Background: Temporomandibular disorder (TMD) is a painful condition that specifically affects the muscles, bones, and temporomandibular joint (TMJ). Pain can vary in intensity, ranging from mild to moderate or severe. It is often accompanied by limited movement of the jaw, resulting in a restriction of mouth opening.
Aim of the study: The purpose of this study was to determine the effect of low-level laser therapy on mandibular range of motion in patients with temporomandibular joint disorders.
Patients and methods: fifteen patients were randomly selected. The mandibular range of motion was evaluated for each patient before treatment and after 3 months, a dual-wavelength (810-980nm) diode laser was used in this study. Three main criteria were utilized in the statistical calculation, they are relaxed mouth opening, full mouth opening, and lateral mandibular movement. Paired t-test and one-way analysis of variance (ANOVA) tests were used for statistical analysis.
Results: The study revealed a significant enhancement in mandibular range of motion in TMD patients during a short period of laser sessions.
Conclusion: Low-level laser therapy is an efficient way to improve the mandibular range of motion in patients with temporomandibular joint disorder.

Keywords: Dual wavelength (810-980nm) diode laser, Low-level laser therapy, Mandibular range of motion, Temporomandibular joint disorder.

1. Introduction

Temporomandibular disorders (TMD) encompass a wide range of conditions that impact the temporomandibular joint (TMJ) and the associated musculoskeletal systems. Temporomandibular disorder (TMD) impairs the regular operation of the temporomandibular joint (TMJ) and results in pain, limited jaw movements, and impaired chewing[1]. An audible clicking or popping noise occurs while the mouth is being opened or closed[2, 3].

The main goals of treatment for individuals with temporomandibular disorders (TMD) are to alleviate discomfort, restore normal chewing ability, increase the range of motion of the jaw, and improve the overall quality of life for patients[4, 5]. The available treatments vary from non-invasive procedures to invasive procedures. While surgical techniques can provide assistance in certain instances[6], it is advisable to prioritize conservative therapy as the initial therapeutic choice. Conservative treatments encompass behavioral therapy, pharmaceutical interventions, and low-level laser therapy (LLLT)[7].

Behavioral therapy is a treatment approach that is rooted in psychology and is recommended for patients who experience chronic temporomandibular disorder pain. This therapy is safe and does not require any invasive procedures. It includes various techniques such as cognitive behavioral therapy, biofeedback, re-education, and relaxation techniques. The goal of this therapy is to reduce pain-related disabilities and improve coping skills by enhancing cognitive and adaptive behaviors[8].

Low-level laser therapy (LLLT) has lately been employed as a conservative treatment modality for persons suffering from temporomandibular disorder (TMD) and myofascial pain[9, 10]. Low-level laser treatment (LLLT) is a type of phototherapy that stimulates biological processes and relieves pain without inducing changes in temperature[11, 12]. The therapy technique is regarded as successful, straightforward, and short-term[13]. It has become popular as an alternative treatment for TMD because of its pain-relieving, anti-inflammatory, and regenerative capabilities[14, 15].

2. Hypothesis

H0: LLLT is not-significantly effective in improving relaxed mouth opening, full mouth opening, and lateral mandibular movement in patients with temporomandibular disorder. H1: LLLT is significantly effective in improving relaxed mouth opening, full mouth opening, and lateral mandibular movement in patients with temporomandibular disorder.

3. Patients and methods

3.1 Study design

This study employed a randomized clinical trial design, with a total of 15 participants. The sample consisted of 11 female and 4 male individuals, with an average age of 31.4 years. The participants in this study were selected from the Department of Oral and Maxillofacial Surgery at Al-Hussein Teaching Hospital in Al-Samawa City. The study received ethical approval from the Research Scientific Committee of Laser Institute, with reference number 1377 on 17/10/2023. Prior to their inclusion in the study, all patients signed a consent agreement before laser sessions.

3.2 Laser system

The apparatus utilized was a Quicklase laser device as in Figure 1. The laser emits light with a dual wavelength of 810-980nm in a continuous mode. A specific handpiece or prism is utilized to deliver the laser radiation in a contact manner, applying the low-power laser to the affected site for 30 seconds for each trigger point. The output power was set to 400 milliwatts. According to the diameter of the prism tip, the spot size was 4 cm. Laser therapy was delivered at many sites on the affected muscle during each session.

3.3 Laser components

The following are the laser device accessories as shown in Figure 1.

a) Laser device
b) Electrical cable
c) Prism
d) Pain therapy

e) Foot switch
f) Fiber optic
g) Goggles

Fig.1. laser apparatus and components.

3.4 Patient selection

3.4.1 Criteria for inclusion and exclusion:

In order to be eligible for participation in the study, patients are required to have a diagnosis based on the Research Diagnostic Criteria for Temporomandibular Disorders (RDC of TMD) as shown in Figure 2 briefly.The study did not include patients who had previously performed TMJ surgical intervention, had a history of radiation therapy or chemotherapy, had an inflammatory or pathological joint disease, had facial trauma, or had congenital dyscrasia such as hyperplasia or hypoplastic changes of the joint.

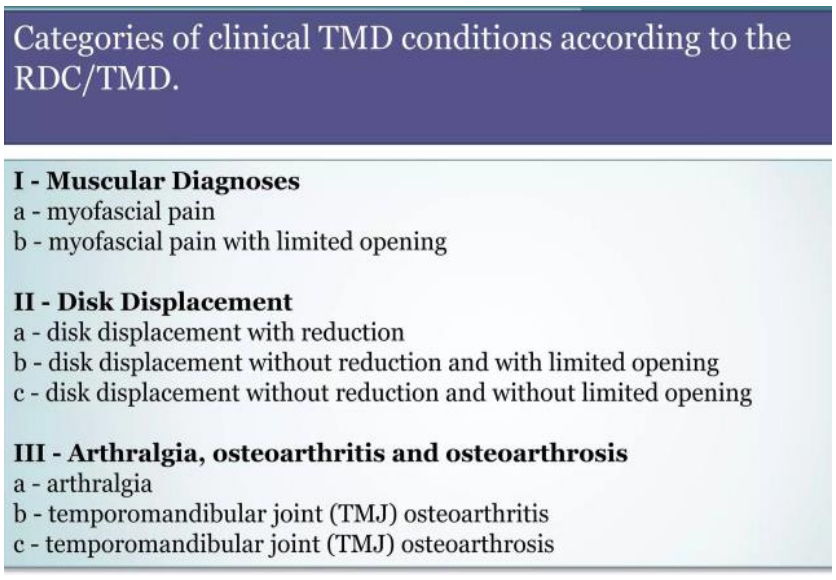

Fig. 2. RDC/TMD (The research diagnostic criteria for temporomandibular disorders is an informative tool used by Schiffman in 1992 to facilitate the diagnosis of the disorder).

3.5 Laser application

The patients underwent low-level laser therapy (LLLT) treatment following a specific protocol. The laser was administered to the tender muscle area twice a week for a total of two weeks, resulting in a total of four treatment sessions as in Figure 3.

Fig. 3: Laser administration.

4. Statistical analysis

Continuous variables were expressed as means and standard deviations or medians with range, depending on whether the distribution was normal or skewed. The categorical variables were represented using frequency and percentages. The One-way repeated measure ANOVA was employed to examine the variations in mean values during the follow-up periods for parametric variables, while the Friedman Rank sum test was utilized for non-parametric variables to assess differences in medians. Furthermore, Cochran's Q test was employed to analyze dichotomous variables. A P-value below 0.05 was deemed to be statistically significant. The data processing, visualization, and statistical analysis were performed using R software packages, specifically dplyr, gt_summary, and ggplot.

5. Results

The study had a cohort of 15 participants, with a mean age of 31.4 years and a standard deviation of 8.3 years. The participants were distributed depending on sex, with 73.3% (n=11) being female and 26.7% (n=4) being male. The sex ratio was calculated to be 0.36, which is known as the female-to-male ratio as shown in Table 1.

Table 1. Description of patient's demographics.

Characteristic	value
Sample size	15
Age	31 ± 8
Gender	11 (73.3%) Female 4 (26.7%) Male
Sex ratio	0.36

[1]Mean ± SD; n (%)

5.1 Statistical criteria

a) Relaxed mouth opening.
Refer to the interincisal distance between the upper and lower central incisor tips in an unassessed vertical mouth open without any force.
b) Full mouth opening.
Refer to the interincisal distance between the upper and lower central incisor tips in a maximum and stressful vertical mouth open.
c) Lateral mandibular movement.
Refer to the horizontal distance between the midlines of upper and lower central incisors.
All these findings were measured by digital vernier.
Functional outcomes were assessed by measuring the first relaxed mouth opening (30.1 ± 8.4 mm), full mouth opening (39.6 ± 9.4 mm), and lateral mandibular movement (7.7 ± 2.8 mm). Further assessments conducted at different time intervals showed that there were insignificant changes in full mouth opening ($p = 0.23$) and relaxed mouth opening ($p = 0.5$). However, there were significant differences observed in lateral mandibular movement ($p < 0.001$) as the following Table 2.

Table 2. Description of clinical parameters stratified by the follow-up time (N=15).

	Baseline[1]	1-week[1]	2-weeks[1]	1-month[1]	3-months[1]	P-value[2]
Relaxed mouth opening (mm)	30.1 ± 8.4	31.0 ± 9.1	30.9 ± 6.5	32.1 ± 6.2	32.0 ± 6.7	0.5
Full mouth opening (mm)	39.6 ± 9.4	40.0 ± 8.5	40.6 ± 7.7	40.1 ± 6.4	42.7 ± 6.3	0.23
Lateral mandibular movement (mm)	7.7 ± 2.8	9.3 ± 3.2	8.6 ± 3.0	10.1 ± 2.4	10.7 ± 2.7	**<0.001**

[1]Mean ± SD; n (%); Median (Range)
[2]One-Way Repeated Measure ANOVA; Friedman Rank Sum Test; Cochran's Q test.

6. Discussion

Individuals diagnosed with temporomandibular disorder (TMD) frequently encounter limited jaw motions and discomfort in the temporomandibular joint (TMJ) region, as well as the muscles involved in chewing and other maxillofacial musculature[15, 16].
The primary aim of this study was to treat the disorder of mandibular motion through a few sessions of laser, hence improving the mandibular range of motion by utilizing a dual-wavelength diode laser(810-980nm), resulting in fewer visits and more significant outcomes.
In this study, a significant p-value <0.001 has been achieved in lateral mandibular movement, with a baseline of 7.7 mm and 10.7 mm after three months of follow-up, since the affected muscle was lateral pterygoid, the lateral movement was enhanced by the accused muscle. this contradicts the findings of Venancio et al. with 0.1762 (right lateral movement) and 0.4143 (left lateral movement) p-values, where the baseline readings 7.69 mm (right lateral movement) and 6.66 mm (left lateral movement) become 8.78 mm and 7.54 mm, respectively[17]. However, it is similar to the findings of Máximo et al.[18]

While vertical mouth opening revealed p-values for both relaxed mouth opening 0.5, and full mouth opening 0.23, with a baseline of 30.1 mm and 39.6 mm, respectively, to become 32.0 mm and 42.7 mm, respectively, after three months of follow-up, also this enhancement in the vertical mouth opening is related to the laser effect on the responsible muscles which were the temporalis and masseter.
This resembles De Godoy et al. with p-values 0.1816 and 0.1727 for maximum active opening and maximum passive opening respectively[19].
It also mimics Catao et al., who got a mouth opening average of 46.34 mm, and after that, the mouth opening increased to 50.05 mm[20].

Low-level laser therapy may not generate thermotherapy[21]. Instead, it may initiate photochemical reactions that may stimulate mitochondrial metabolism[22], boost ATP production, enhance tissue oxygenation through the induction of vascularization, and elevate serotonin and endorphin levels[23, 24]. The laser light used in this field is mostly limited to the range of the red or near-infrared region of the electromagnetic spectrum, specifically between 600 and 1000 nm[25] so in this research, the "Quicklase" 810-980 nm diode laser device was used. The primary chromophore for this wavelength is cytochrome c oxidase [26], which are substances that selectively absorb laser energy. However, in comparison to shorter wavelengths (below 600nm), this chromophore (cytochrome c oxidase) demonstrates the minimum absorption rate for the shorter wavelengths and maximum absorption for the higher (810-980 for example). This is advantageous because laser light in these wavelengths has more penetration inside the tissues so that stimulation of the underlying muscles would occur [25, 27].
Multiple researchers have discovered that mitochondria, particularly the enzyme known as cytochrome c oxidase of the respiratory chain, selectively absorb laser light at these wavelengths [28, 29]. Cytochrome c oxidase plays a role in the production of ATP and also regulates reactive oxygen species[30]. This leads to increased production of growth factors, cell proliferation, and higher amounts of inflammatory mediators and oxygen in the tissue[31].

Our investigation revealed a noteworthy enhancement in mandibular movement among 12 out of 15 individuals, along with improved lateral mandibular movement.
Based on the clinical parameters, the p-values for relaxed mouth opening and full mouth opening were found to be insignificant (0.5 and 0.23, respectively). This means that we cannot rely on these measurements as clinical criteria or diagnostic features in the treatment of temporomandibular joint disorder.

7. Conclusions

It is concluded that low-level laser therapy of diode dual wavelength (810-980 nm) is an important therapeutic modality in case of restricted mandibular movement that is accompanied by temporomandibular joint disorder.

References

[1] Al-Kufi, H.M. and A.M. Al-Bayati, Efficacy of photobiomodulation therapy (PBMT) in management of temporomandibular disorder (TMD). Lasers in Dental Science, 2023. **7**(2): p. 77-83.
[2] Emam, A.-N.M., et al., Efficacy of occlusal splints and low-level laser therapy on the mandibular range of motion in subjects with temporomandibular joint disc displacement with reduction. Journal of International Society of Preventive and Community Dentistry, 2023. **13**(3): p. 229-236.
[3] Ismael, W.K., T. AbdulLateef, and M.K. Shumran, An analysis of the efficacy of platelet-rich plasma injections on the treatment of internal derangement of a temporomandibular joint. Journal of Baghdad College of Dentistry, 2017. **29**(3): p. 39-44.
[4] Gil-Martínez, A., A. Paris-Alemany, I. López-de-Uralde-Villanueva, and R. La Touche, Management of pain in patients with temporomandibular disorder (TMD): challenges and solutions. Journal of pain research, 2018: p. 571-587.
[5] Al-Nakib, L.H., A.O. Abdullah, S.A. Abd Al-Kareem, and S.H. Ali, An Assessment of Sagittal Condylar Position of TMJ Dysfunction in Centric Occlusion by Using Cone Beam Computed Tomography. Journal of Baghdad College of Dentistry, 2016. **28**(2): p. 58-62.

[6] Alshamaa, A. and T. Aldelaimi, Treatment of myogenic temporomandibular joint disorders with diode laser and pharmacotherapy (comparative study). Int Med J, 2020. **25**: p. 461.
[7] Ali, O.A., Z.F. Mahdi, and B.S. Abdulhameed, Efficacy of low-level laser therapy on postoperative sequelae following extraction of impacted mandibular third molars. Iraqi Journal of Laser, 2024. **23**(1): p. 1-11.
[8] Liu, H., et al., The effectiveness of cognitive-behavioural therapy for temporomandibular disorders: a systematic review. Journal of oral rehabilitation, 2012. **39**(1): p. 55-62.
[9] Al-Khassaki, A.I., et al., Evaluation of Anti-nociceptive Activity of 940 Nanometer Low Level Laser Therapy on Temporomandibular Joint in Rats. Prof. RK Sharma, 2019. **13**(1): p. 259.
[10] Al-saadi, M.A., Chronic Orofacial Pain Management: A Narrative Review of Pharmacological and Promising Therapy. Medical Journal of Babylon, 2023. **20**(1): p. 24-27.
[11] Al-ameri, L.M. and R.A. Faris, Biochemical immune effects of low power laser irradiation on leukemia and breast cancer: A review. EurAsian Journal of Biosciences, 2020. **14**(2).
[12] Al-Ameri, L.M., et al., Cell Cycle Response to Low Power Laser Irradiation in Jurkat E6. 1 T-lymphocyte Cell Line. Cell Cycle, 2014. **4**(11).
[13] Abbas, Q.K. and L.M. Al-ameri, Photodynamic effect of Rose Bengal activated by low-level laser light on S. aureus. Iraqi Journal of Laser, 2022. **21**(2): p. 48-57.
[14] Madani, A., F. Ahrari, A. Fallahrastegar, and N. Daghestani, A randomized clinical trial comparing the efficacy of low-level laser therapy (LLLT) and laser acupuncture therapy (LAT) in patients with temporomandibular disorders. Lasers in medical science, 2020. **35**: p. 181-192.
[15] Ahmad, S.A., et al., Low-level laser therapy in temporomandibular joint disorders: a systematic review. Journal of Medicine and Life, 2021. **14**(2): p. 148.
[16] Medhat, A.H. and A.H. Al Haidar, Maximum bite force in relation to maximum mouth opening among primary school children. Journal of Baghdad College of Dentistry, 2019. **31**(4).
[17] De Abreu Venancio, R., C.M. Camparis, and R. De Fátima Zanirato Lizarelli, Low intensity laser therapy in the treatment of temporomandibular disorders: a double-blind study. Journal of oral rehabilitation, 2005. **32**(11): p. 800-807.
[18] Máximo, C.F.G.P., J.F. Coêlho, S.D. Benevides, and G.Â.d.S. Alves. Effects of low-level laser photobiomodulation on the masticatory function and mandibular movements in adults with temporomandibular disorder: a systematic review with meta-analysis. in CoDAS. 2022. SciELO Brasil.
[19] de Godoy, C.H.L., et al., Effect of low-level laser therapy on adolescents with temporomandibular disorder: a blind randomized controlled pilot study. Journal of oral and maxillofacial surgery, 2015. **73**(4): p. 622-629.
[20] Catão, M.H.C.d.V., P.S.d. Oliveira, R.d.O. Costa, and V.S.M. Carneiro, Evaluation of the efficacy of low-level laser therapy (LLLT) in the treatment of temporomandibular disorders: a randomized clinical trial. Revista CEFAC, 2013. **15**: p. 1601-1608.
[21] Ren, H., et al., Comparative effectiveness of low-level laser therapy with different wavelengths and transcutaneous electric nerve stimulation in the treatment of pain caused by temporomandibular disorders: A systematic review and network meta-analysis. Journal of oral rehabilitation, 2022. **49**(2): p. 138-149.
[22] Pruitt, T., et al., Photobiomodulation at different wavelengths boosts mitochondrial redox metabolism and hemoglobin oxygenation: lasers vs. light-emitting diodes in vivo. Metabolites, 2022. **12**(2): p. 103.
[23] Ergün, G., E. Atalar, and G. Aydın, Assessment of the efficiency of low level laser therapy in women with primary fibromyalgia syndrome: a randomized, placebo-controlled, double-blind study. Acta Oncologica Turcica. **53**(2): p. 288-293.
[24] Tam, G., Low power laser therapy and analgesic action. Journal of clinical laser medicine & surgery, 1999. **17**(1): p. 29-33.
[25] Freitas, P.M. and A. Simoes, Lasers in dentistry: guide for clinical practice. 2015: John Wiley & Sons.
[26] Tseng, S.-H., P. Bargo, A. Durkin, and N. Kollias, Chromophore concentrations, absorption and scattering properties of human skin in-vivo. Optics express, 2009. **17**(17): p. 14599-14617.
[27] Al-Tamemi, E.I., Analysis of inflammatory cells in osseointegration of CpTi implant radiated by low level laser therapy. J Baghdad Coll Dent, 2015. **27**(1): p. 105-110.
[28]2022, Mary Ann Liebert, Inc., publishers 140 Huguenot Street, 3rd Floor New …. p. 75-77.
[29] Al-ameri, L.M., Laser Biostimulation Effect on Human Sperm Motility. Iraqi Journal of Laser, 2021. **20**(1): p. 39-42.
[30] Watson, S.A. and G.P. McStay, Functions of cytochrome c oxidase assembly factors. International Journal of Molecular Sciences, 2020. **21**(19): p. 7254.
[31] Assi, A.A., R.A. Faris, B.S. Abdulhameed, and S.S. Almalki, The Effect of Dual Diode Laser:(810,980) nm in Acceleration of Orthodontic Tooth Movement: A Case Report. Iraqi Journal of Laser, 2023. **22**(2): p. 19-26.

تأثير الليزر منخفض المستوى على مدى حركات الفك السفلي في اضطراب المفصل الفكي الصدغي لدى المرضى العراقيين.

حيدر فليح حسن[1] , ليلى محمد حسن[1] , عمار صالح العلوي[2]

[1]معهد الليزر للدراسات العليا، جامعة بغداد، بغداد، العراق
[2]فرع جراحة الوجه والفكين, مدينة الامامين الكاظمين الطبية, بغداد, العراق.

*البريد الالكتروني للباحث: Haidar.hasan2102m@ilps.uobaghdad.edu.iq

الخلاصة

مقدمة: اضطراب المفصل الفكي الصدغي هو حالة من الألم تصيب العضلات, عظام الوجه و المفصل الفكي الصدغي. يتراوح الألم في الشدة من خفيف الى متوسط ثم شديد, الاضطراب عادةً يكون مصاحب لقلة حركة الفك مما ينتج عن تقييد حركة فتحة الفم.

الهدف من الدراسة: الهدف هو تحديد الى أي مدى يكون تأثير الليزر منخفض الشدة على مدى حركات الفك السفلي لدى مرضى اضطراب المفصل الفكي الصدغي.

المواد والطرق: تم اختيار خمسة عشر مريض عشوائياً, وتم قياس مدى الحركات للفك السفلي قبل وبعد العلاج بثلاثة اشهر. تم استخدام ليزر دايود ثنائي الطول الموجي (٨١٠-٩٨٠ نانومتر). اهم المعايير المستخدمة في الحسابات الإحصائية هي: فتحة الفم في حالة استرخاء, فتحة الفم في حالة الشدة و حركة الفك الجانبية. اختبار تي المزدوج, التحليل احادي الاتجاه و انوفا هي البرامج المستخدمة للإحصاء.

النتيجة: أظهرت الدراسة نتائج ملحوظة في تحسن مدى حركات الفك لدى مرضى اضطراب المفصل الفكي الصدغي خلال فترة قصيرة من استخدام الليزر منخفض الشدة.