



A Comparative Study of Low-Level Laser Therapy and Transcutaneous Electrical Nerve Stimulation as an Adjunct to Pharmaceutical Therapy for Myofascial Pain Dysfunction Syndrome: A Randomized Clinical Trial

Arash Mansourian^{1,2}, Sara Pourshahidi¹, Maryam-Sadat Sadrzadeh-Afshar^{3*}, Hooman Ebrahimi⁴

1. Department of Oral and Maxillofacial Medicine, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
2. Dental Research Center, Dentistry Research Institute, Tehran University of Medical Sciences, Tehran, Iran
3. Oral and Maxillofacial Medicine Department, Faculty of Dentistry, AJA University of Medical Sciences, Tehran, Iran
4. Oral and Maxillofacial Medicine Department, Faculty of Dentistry, Islamic Azad University of Medical Sciences, Tehran, Iran

Article Info

Article type:
Original Article

Article History:

Received: 6 July 2018
Accepted: 29 September 2018
Published: 30 August 2019

* Corresponding author:

Oral and Maxillofacial Medicine Department, Faculty of Dentistry, AJA University of Medical Sciences, Tehran, Iran

Email: m_sadrzade@alumnus.tums.ac.ir

ABSTRACT

Objectives: Myofascial pain dysfunction syndrome (MPDS) is the most common form of temporomandibular disorders. Because of the multifactorial nature of the problem, its management usually involves several treatment modalities to maximize their synergistic effects. This randomized clinical trial aimed to assess the efficacy of low-level laser therapy (LLLT) and transcutaneous electrical nerve stimulation (TENS) as an adjunct to pharmaceutical therapy for treatment of MPDS.

Materials and Methods: This clinical trial evaluated 108 MPDS patients. First, the initial pain intensity of patients was determined using a visual analogue scale (VAS). The first phase of the study included education, awareness, self-care, behavior and relaxation therapy. After 1 month, the pain score was measured again using VAS. Patients who acquired a pain score >1 were divided into three groups of LLLT with diode (GAAlAr) laser with 0.2 W power, TENS, and control, using block randomization. All groups received 10 mg fluoxetine once daily, 0.25 mg clonazepam once daily and 10 mg baclofen three times a day. ANOVA was used to compare the recovery rate of the three groups.

Results: Pain in the trapezius muscle and pain on mouth opening resolved faster in the laser + medication group. The recovery rate was faster in the mean muscle pain, general pain reported by patients, pain in the masseter and pterygoid muscles and pain and limitation in lateral movements in both laser + medication and TENS groups.

Conclusion: Combination of LLLT and TENS with medication accelerated pain relief and resolved movement restrictions in MPDS patients. (IRCT registration number: IRCT20141113144N4)

Keywords: Temporomandibular Joint Dysfunction Syndrome; Low-Level Light Therapy; Transcutaneous Electric Nerve Stimulation

- **Cite this article as:** Mansourian A, Pourshahidi S, Sadrzadeh-Afshar MS, Ebrahimi H. A Comparative Study of Low-Level Laser Therapy and Transcutaneous Electrical Nerve Stimulation as an Adjunct to Pharmaceutical Therapy for Myofascial Pain Dysfunction Syndrome: A Randomized Clinical Trial. *Front Dent.* 2019;16(4):256-264. doi:

INTRODUCTION

Myofascial pain dysfunction syndrome (MPDS) is the most common form of temporomandibular disorders (TMDs), and masticatory muscle pain is the second most common pain in the orofacial area. MPDS refers to the pain that starts from points on muscles and fascia and is associated with spasm, tenderness, motion restriction, muscle fatigue, and dysfunction in some cases [1,2]. Although the exact cause is unknown, occlusal interferences, bruxism, systemic factors and psychological stress are considered as the possible underlying factors for MPDS [3]. Because of the multifactorial nature of this problem, its treatment usually consists of a number of methods such as training, self-care and quitting the harmful habits, physiotherapy such as ultrasound and transcutaneous electrical nerve stimulation (TENS), laser therapy, intra-oral appliances, medication, behavioral therapy, relaxation techniques, Botox injection, acupuncture, and massage therapy [1,2,4,5].

Low-level laser therapy (LLLT) has been successfully used for treatment of muscle pain due to its analgesic and anti-inflammatory properties, muscle relaxation and enhanced tissue healing [1,6]. Its mechanism of action includes increasing the mitochondrial activity, affecting the sodium-potassium pump, and increasing vascularization [6,7]. LLLT can also cause hyperpolarization of neuronal membrane and increase the stimulation threshold. Another possible cause is increasing the secretion of enkephalin and endorphin, which have anti-inflammatory and analgesic effects [7]. Among the physiotherapeutic modalities, TENS is a commonly used technique. It has been shown that TENS decreases muscle pain and causes muscle relaxation [1,4]. Both of the aforementioned methods have been proposed to control MPDS symptoms but are not generally accepted as a single treatment modality. Treatment of such pains also improves the patient's quality of life [4]. The present study aimed to compare the efficacy of TENS and LLLT, as an adjunct to medication in patients with MPDS.

MATERIALS AND METHODS

This clinical trial evaluated 108 MPDS patients referred to the Oral Medicine Department of Tehran University of Medical Sciences who met the inclusion criteria. The inclusion criteria were age between 18 to 60 years, pain on palpation in masticatory muscles, normal posterior occlusion, and suffering from orofacial pain for a minimum of 6 months [6,8]. The exclusion criteria were presence of TMD with joint origin according to the Research Diagnostic Criteria for TMDs, systemic diseases such as cardiovascular disorders, infectious diseases, inflammatory diseases, epilepsy, tumors, or mental illnesses which could affect the clinical picture of patients, osteoarthritis or cervical disc herniation, history of trauma, removable denture, missing of more than one tooth in each quadrant, and major malocclusion (anterior open bite, maxillary unilateral lingual cross-bite, and overjet greater than 6 mm) [1,6,8]. Informed consent was obtained from all patients prior to their enrollment. The study was registered in the Iranian Registry of Clinical Trials (IRCT201411113144N4) and approved by the ethics committee of our university (142107). After determining the initial pain intensity using a visual analog scale (VAS), the first phase of treatment was started, which included training, communication, self-care and habit quitting, behavioral therapy, and relaxation. Self-care instructions included avoiding foods that require lots of chewing and quitting the activities that lead to overuse of muscles such as long yawning, and gnashing of teeth [9]. After 1 month, we measured the pain intensity again. The patients whose VAS score was ≤ 1 were excluded from the study. The remaining patients were divided into three groups (LLLT, TENS, and control) using block randomization. All groups received 10 mg fluoxetine (Tehran Daroo, Tehran, Iran) once daily, 0.25 mg clonazepam (Sobhan Daroo, Tehran, Iran) once daily and 10 mg baclofen (Zahravi, Tehran, Iran) three times a day. Adjunct therapy was immediately started for LLLT and TENS groups.

LLLT was performed in 10 sessions (2 sessions per week) with GAAlAr diode laser in continuous

wave mode with 810 nm wavelength, 0.2 W power, 10 s time and 2 J/cm² energy density with a bio-stimulation hand-piece. TENS was performed in 10 sessions (3 sessions per week) using Newtens 900F device (Novin Medical Engineering, Iran) with 20 W power, 220 v voltage, and 50 Hz frequency for 10 minutes. Pain intensity and maximum mouth opening were measured and recorded before and after each session of LLLT and TENS and also every week for 2 months. All factors were measured and recorded in patients in the control group weekly for up to 2 months. Treatment was performed by one researcher and data were collected by another researcher. The study had a single-blind design (the examiner was blinded to the group allocation of patients).

Statistical analysis:

The pain recovery rates among the three groups were compared using ANOVA. To analyze the recovery of sore muscles and lateral left and right movements to assess the internal consistency of data, the generalized estimating equation (GEE) analysis with the linear model was used. Recovery rate values of limited jaw movement were analyzed using the Chi-square test. In addition, the recovery of lateral movements to the left and right was analyzed using the exchangeable form of GEE. P<0.05 was considered statistically significant.

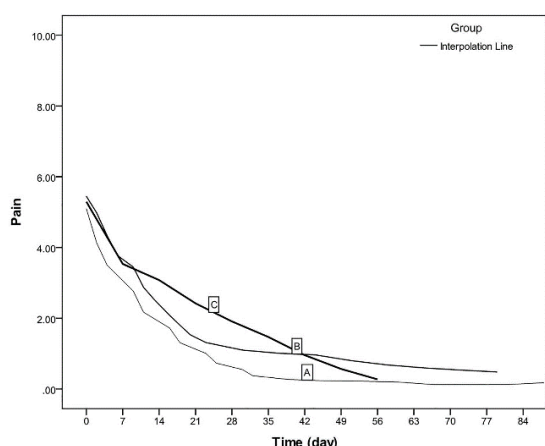


Fig. 1: Changes in the mean pain score of painful muscles over time in the study groups. A: LLLT + pharmaceutical therapy, B: TENS + pharmaceutical therapy, C: Pharmaceutical therapy

RESULTS

After 1 month of relaxation training, the patients whose VAS score was more than 1 remained in the study. During the study period, 2 patients were excluded because of reaching a VAS score of one or lower. Finally, 108 patients were selected and randomly divided into three groups of LLLT, TENS, and control (only medication) using the balanced block randomization method. One patient in the LLLT group was excluded from the study because of getting pregnant. In addition, 3 patients in the TENS group and 4 patients in the control group were excluded from the study since they did not regularly show-up for the follow-up sessions. The mean age of patients was 29 years (range 21 to 60 years). Of all, 81.46% were female and 18.54% were male. In terms of occupation, 44.64%, 39.8%, and 15.7% of patients were housewives, employees and students, respectively. In addition, 24.06%, 39.83%, 28.7% and 6.5% of patients had elementary school education, high-school diploma, bachelor's degree, and higher educational levels, respectively. Only 0.93% of patients were illiterate. Also, 80.56% of patients were married and 19.44% were single. The pain intensity for each muscle in static and functional modes and overall pain score were recorded in each session. We also assessed the opening and lateral movement restrictions (Figs. 1 and 2). Table 1 shows the recovery values of the study groups.

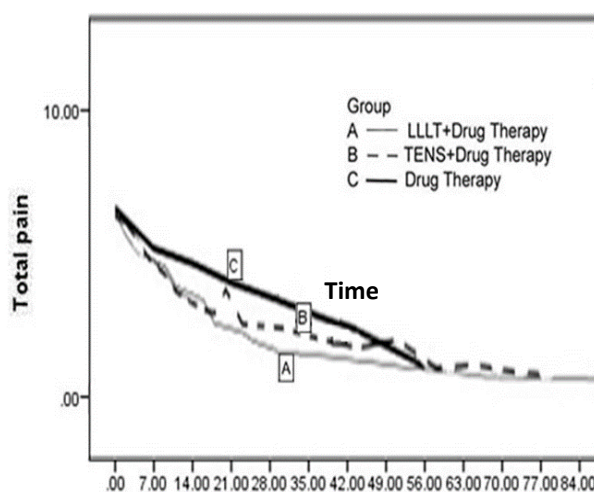


Fig. 2: Changes in the overall pain score reported by patients over time in the study groups

Table 1: VAS recovery values (week) of the assessed variables in the study groups

Pain Recovery	Week	LLLT + Medication (A)	TENS + Medication (B)	Medication (C)	Overall P-value between groups			Results
					A-B	A-C	B-C	
Mean pain recovery of painful muscles	3 rd	4.09±1.76	4.13±1.75	2.87±0.98	0.99	0.003	0.002	A≈B>C
	6 th	4.83±0.26	4.48±0.26	4.33±0.26	0.62	0.38	0.92	A≈B≈C
	8 th	4.90±0.27	4.77±0.27	5.01±0.27	0.94	0.95	0.79	A≈B≈C
Overall pain recovery reported by patients	3 rd	4.47±2.22	4.06±2.18	2.80±1.30	0.64	0.001	0.02	A≈B>C
	6 th	5.39±0.35	4.94±0.35	4.42±0.35	0.64	0.12	0.53	A≈B≈C
	8 th	5.94±0.29	5.69±0.29	5.94±0.29	0.81	1.00	0.81	A≈B≈C
Masseter muscle pain recovery	3 rd	4.82±0.35	4.36±0.73	2.38±0.27	0.59	<0.001	0.01	A≈B>C
	6 th	5.35±0.43	4.90±0.57	3.86±0.40	0.53	0.01	0.14	A>C
	8 th	5.38±0.41	5.01±0.62	4.83±0.49	0.61	0.38	0.82	A≈B≈C
Temporalis muscle pain recovery	3 rd	3.60±0.39	4.74±0.57	4.17±0.43	0.10	0.33	0.43	A≈B≈C
	6 th	4.56±0.41	5.35±0.55	5.12±0.43	0.25	0.35	0.74	A≈B≈C
	8 th	4.87±0.45	5.62±0.55	5.82±0.47	0.28	0.14	0.76	A≈B≈C
SCM muscle pain recovery	3 rd	4.57±0.64	4.05±0.48	4.03±0.50	0.44	0.44	0.98	A≈B≈C
	6 th	5.19±0.47	4.23±0.48	5.06±0.51	0.16	0.85	0.24	A≈B≈C
	8 th	5.31±0.46	4.32±0.44	5.53±0.46	0.12	0.74	0.06	A≈B≈C
Medial pterygoid muscle pain recovery	3 rd	4.18±0.44	3.89±0.48	1.89±0.17	0.65	<0.001	<0.001	A≈B>C
	6 th	4.66±0.40	4.74±0.59	3.78±0.27	0.20	0.07	0.95	A≈B≈C
	8 th	4.66±0.48	4.37±0.47	4.25±0.28	0.70	0.46	0.82	A≈B≈C
Lateral pterygoid muscle pain recovery	3 rd	4.92±0.81	3.72±0.64	2.29±0.17	0.24	0.001	0.03	A≈B>C
	6 th	6.10±0.81	4.54±0.58	3.71±0.24	0.12	0.14	0.18	A≈B≈C
	8 th	6.10±0.85	4.59±0.59	4.46±0.41	0.14	0.08	0.86	A≈B≈C
Mylohyoid muscle pain recovery	3 rd	2.67±0.54	2.67±0.54	2.80±0.33	1.00	0.84	0.84	A≈B≈C
	6 th	2.67±0.54	2.67±0.54	4.30±0.33	1.00	0.06	0.06	A≈B≈C
	8 th	0.54±2.67	2.67±0.54	4.60±0.46	0.06	0.6	0.60	A≈B≈C
Trapezius muscle pain recovery	3 rd	4.54±0.58	3.33±0.41	2.28±0.18	0.09	0.04	0.03	A≈B>C
	6 th	5.21±0.52	3.67±0.49	3.76±0.28	0.03	0.01	0.87	A>B≈C
	8 th	5.38±0.49	3.97±0.46	4.73±0.32	0.04	0.27	0.17	A>B≈C
Protrusive movement pain recovery	3 rd	4.00±0.64	4.00±0.70	2.20±0.70	1.00	0.16	0.18	A≈B≈C
	6 th	5.33±0.57	4.40±0.63	3.90±0.63	0.52	0.23	0.84	A≈B≈C
	8 th	5.41±0.63	5.00±0.69	4.20±0.63	0.90	0.41	0.70	A≈B≈C
Lateral movement pain recovery	3 rd	4.26±0.42	3.42±0.45	2.07±0.23	0.17	<0.001	0.04	A≈B>C
	6 th	4.57±0.50	3.67±0.51	3.81±0.41	0.20	0.24	0.82	A≈B≈C
	8 th	4.56±0.49	3.76±0.51	4.31±0.51	0.26	0.54	0.45	A≈B≈C
Opening movement pain recovery	3 rd	4.86±0.49	3.90±0.51	2.35±0.55	0.37	0.004	0.10	A>C
	6 th	5.38±0.54	4.50±0.55	4.35±0.60	0.49	0.41	0.98	A≈B≈C
	8 th	5.43±0.59	5.10±0.60	5.12±0.65	0.92	0.93	1.03	A≈B≈C
Closing movement pain recovery	3 rd	4.40±0.97	4.50±0.88	2.00±0.97	1.00	0.22	0.16	A≈B≈C
	6 th	5.20±1.10	4.83±1.00	3.20±1.10	0.97	0.43	0.53	A≈B≈C
	8 th	5.20±1.10	4.83±1.01	3.40±1.10	0.97	0.50	0.61	A≈B≈C

Table 2: Motion values (%) of the study groups in lateral movements

	Time (week)	LLLT + Medication (A)	TENS + Medication (B)	Medication (C)	Overall P-value between groups			Results
					A-B	A-C	B-C	
Limitation in lateral movements	Before	38.9	27.8	16.7	-	-	-	-
	3 rd	36.1	23.6	13.9	0.16	0.01	0.22	A>C
	6 th	37.5	25.0	18.1	0.16	0.04	0.41	A≈B≈C
	8 th	38.9	27.8	16.7	0.27	0.04	0.002	A≈B>C

Table 3: Values of opening movement and protrusive range (%) for the study groups

	Time (week)	LLLT + Medication (A)	TENS + Medication (B)	Medication (C)	Overall P-value between groups	Results
Limitation in mouth opening	Before	58.3	47.2	47.2	-	-
	3 rd	27.8	11.1	27.8	0.15	A≈B≈C
	6 th	36.1	30.6	41.7	0.62	A≈B≈C
	8 th	58.3	47.2	47.2	0.62	A≈B≈C
Limitation in protrusive movements	Before	36.1	25.0	25.0	-	-
	3 rd	25.0	13.9	16.7	0.45	A≈B≈C
	6 th	33.3	22.2	25.0	0.54	A≈B≈C
	8 th	36.1	25.0	25.0	0.40	A≈B≈C

In the third week after the onset of treatment, the improvement in the mean pain score of each painful muscle in LLLT (P=0.003) and TENS (P=0.002) groups showed a significant increase compared with the control group. However, after 6 weeks (P=0.38 and P=0.92, respectively) and 2 months (P=0.38 and P=0.92, respectively), no significant difference was found between the experimental groups. In terms of overall pain intensity which was expressed by patients before treatment, after each session, and in each follow-up session, the highest recovery was seen in LLLT (P=0.001) and TENS (P=0.02) groups in the third week after the start of treatment, with a significant difference with the control group. The common point between the two variables of the improvement in the mean pain score of each muscle of mastication and overall pain was that both LLLT and TENS resulted in the highest recovery. In addition, they caused significantly greater improvement in pain score than the control group. At the end of the 2-month follow-up, combination of LLLT and pharmaceutical therapy was significantly more effective than other methods in relieving

trapezius muscle pain. In terms of pain during mouth opening, LLLT decreased the pain significantly more than other methods. In relieving the pain of the masseter muscle, pterygoids, pain in lateral movement, resolving the lateral movement restriction, average muscle pain, and overall pain reported by patients, both LLLT and TENS combined with pharmaceutical therapy were more effective than pharmaceutical therapy alone (Tables 1-3).

DISCUSSION

In the present study, the prevalence of MPDS was higher in women (81.46%), which is consistent with the findings of other studies [1,8,10,11]. This can probably be due to the effect of hormonal and bio-behavioral factors and higher demand of women for treatment [11].

The pain of muscles on palpation, pain in function, and range of jaw movements were recorded in the initial examination. Then, we started the first treatment phase. After 1 month, we repeated the examinations. Pain of two patients significantly decreased after the

initial phase and their VAS score decreased to 1 or lower; thus, they were excluded from the study. Recovery of two patients out of 110 showed that this treatment method is not sufficient for most cases. In a previous study, self-care training was compared with addition of a physical therapy program at home to self-care training. After 3 months, the success rate was 57% and 77% in the two groups, respectively [12]. This is inconsistent with the findings of our study and may be due to the fact that different factors were studied in these two studies.

In this study, pain in all masticatory muscles was measured before treatment, in each session of treatment, and in each session of follow-up after treatment. The most and the least painful muscles were temporalis (70.4%) and mylohyoid (10.2%), respectively. In the studies by Kato et al, [4] Oz et al, [3] and Michelotti et al, [12] involvement of the masseter and temporalis muscles was evaluated. In a study by Fouda [13], it was found that the masseter and temporalis muscles were the most commonly involved muscles. In studies by Mortazavi et al, [14] and Darbandi and Jajouei [15], the medial pterygoid muscle was reported to be the most commonly involved muscle.

Kato et al. [4] compared LLLT and TENS in treatment of TMDs and found no significant difference between these two treatment methods in terms of overall pain reduction and pain intensity in the masseter and temporalis muscles on palpation. This is consistent with the findings of our study. However, they had no control group. On the other hand, they did not use LLLT and TENS as an adjunct to pharmaceutical therapy.

In the study of masseter muscle pain recovery in the third week after treatment, LLLT ($P<0.001$) and TENS ($P=0.01$) groups showed higher levels of recovery than the control group. In the assessment at 6 weeks, LLLT ($P=0.01$) still showed a significantly higher recovery rate than pharmaceutical therapy alone, but the difference between TENS ($P=0.14$) and the control group was not significant. In the second month after the treatment, there was no significant difference

between the experimental groups. Medial and lateral pterygoid muscles also showed similar results. LLLT ($P<0.001$ and $P=0.001$, respectively) and TENS ($P<0.001$ and $P=0.03$, respectively) groups had higher level of recovery than the control group in the third week of treatment. However, no significant difference was found between the experimental groups at 6 weeks in the medial ($P=0.07$ and $P=0.95$, respectively) and lateral pterygoid ($P=0.14$ and $P=0.18$, respectively) muscles and at 2 months after the beginning of treatment in the medial ($P=0.07$ and $P=0.95$, respectively) and lateral pterygoid ($P=0.46$ and $P=0.82$, respectively) muscles.

The recovery process of the mylohyoid muscle in the third week, sixth week, and the second month of treatment had no significant difference between the experimental groups. This could be due to the anatomical location of this muscle in the floor of the mouth, which is not entirely in the area of the effect of laser and TENS.

Regarding the trapezius muscle in the third week after treatment, LLLT ($P=0.04$) and TENS ($P=0.03$) groups showed significantly higher levels of recovery than the pharmaceutical therapy group. At 6 weeks, the LLLT group showed significantly higher level of recovery than TENS ($P=0.03$) and pharmaceutical therapy ($P=0.01$) groups. In the second month, the recovery rate in LLLT group was significantly higher than that in TENS ($P=0.04$) group. Totally, it seems that LLLT was more effective in recovery of the trapezius muscle. Recovery of temporalis and sternocleidomastoid muscles had no significant difference in the experimental groups. The factors listed above were pain in the static mode. Functional pain, which includes pain in opening and closing of the mouth and lateral and protrusive movements of the jaw, was also measured before treatment, at each session of treatment, and at each session of follow-up after treatment.

Regarding the resolution of pain in protrusive motion and closing the mouth, no significant difference was found between the experimental groups. The masseter, lateral pterygoid, stylohyoid ligament, and

retrodiscal lower lamina are involved in protrusive motion. In addition, the masseter, lateral pterygoid, medial pterygoid, and temporalis muscles are involved in closing of the mouth. Since the jaw motions are the result of all these muscles and ligaments, it seems to be a satisfactory explanation for inconsistency of the results regarding pain in these movements and pain in each muscle.

Pain recovery during mouth opening in the third week of treatment in LLLT group ($P=0.004$) was higher than that in the pharmaceutical therapy group. This recovery in TENS group ($P=0.10$) was higher than that in the pharmaceutical therapy group, but it was not statistically significant. However, no significant difference was found between the experimental groups at 6 months and the second month of treatment. Since pain resolution was higher in lateral pterygoid muscle, which is responsible for mouth opening in LLLT group compared with the control group in the third week of treatment, it seems that LLLT alone is more effective in recovery of painful mouth opening and resolution of lateral pterygoid pain. However, no significant difference was found between the groups after 2 months. These results are consistent with the findings of Kato et al, [4] who observed no significant difference between LLLT and TENS in terms of the range of maximum mouth opening. However, due to the lack of a control group in their study, it is not possible to correctly compare the groups in the two studies.

Pain recovery of lateral movements in the third week of treatment in LLLT ($P<0.001$) and TENS ($P=0.04$) groups showed higher level than the pharmaceutical therapy group, which was statistically significant. However, no significant difference was found between the experimental groups in the sixth week and the second month of treatment. These findings are in full consistence with the results of pain scores in medial and lateral pterygoid muscles, which are involved in the lateral movements of the jaw. Decreased restriction of lateral movement in the sixth week in LLLT group ($P=0.01$) was significantly higher than the pharmaceutical therapy group. At 6 weeks,

there was no significant difference between the experimental groups. In the second month, LLLT ($P=0.04$) and TENS ($P=0.002$) groups showed significantly higher level of recovery than the control group. Considering the two factors of pain and range of lateral movements, it can be concluded that LLLT had a faster effect on pain reduction and resolving the restrictions. However, LLLT had the same effect as the other two modalities on pain reduction. In addition, at the end of the treatment, the effect of both LLLT and TENS on resolving the restrictions of lateral movements was higher than pharmaceutical therapy alone. It can be concluded that although pain recovery at the end of treatment in pharmaceutical therapy group was the same as that in LLLT and TENS groups, LLLT and TENS were faster in resolving the restrictions of lateral movements. This could be attributed to the synergistic effects of LLLT and TENS combined with pharmaceutical therapy. It seems that combination of LLLT and TENS with pharmaceutical therapy causes faster resolution of pain in medial and lateral pterygoid muscles and also functional pain in lateral movements. In addition, it causes the resolution of restrictions of lateral movements in long-term. According to our study results, the highest synergistic effect in combination of LLLT and TENS with pharmaceutical therapy was observed on pterygoid muscles for recovery of static and functional pain and resolving the restrictions of lateral movements. In assessment of restriction reduction of protrusive movements and mouth opening, no significant difference was found between the groups.

The use of LLLT in treatment of a variety of syndromes of skeletal muscles and soft tissue pain such as MPDS has been taken into account because of its non-invasiveness, ease of use, speed, safety, anti-inflammatory effects, analgesic effects, muscle tension reduction, and regulation of cellular activities [7,11,16]. The low-level laser used in the present study was diode (GAAlAr) with a wavelength of 810 nm which was applied during 10 sessions twice weekly. In another study, the same laser was used in 12 sessions

which led to overall pain recovery and improvement of mouth opening range [17]. In another study, 8 sessions of LLLT were performed with a different wavelength (780 nm) on masseter and temporalis muscles [11]. The wavelength of laser used in the study by Hakguder et al. [10] was 780 nm applied on trapezius and shoulder lifting muscles in 10 sessions. In a study by Ilbuldu et al, [6] HE-Ne laser with a wavelength of 632 nm was applied on trapezius muscle three times a week for 4 weeks. In our study, all the masticatory muscles were examined. In the study by Oz et al, [3] diode laser with a wavelength of 820 nm was used in 10 sessions for treatment of MPDS. All the above-mentioned studies have reported favorable effects of LLLT. The wavelengths used in different studies vary between 780 and 980 nm. It seems that maximum efficiency of low-level laser is achieved when its wavelength is in the near infrared range [7]. For example, in the study conducted by Shirani et al, [18] patients were treated with 660 nm laser in 6 sessions and a good level of pain recovery was obtained. In the study by Azizi et al, [19] GaAlAs laser with a wavelength of 780 nm was used. This treatment method led to a significant reduction in severity and frequency of pain in the masseter, temporalis, and pterygoid muscles. However, it could not cause a significant difference in resolving the restrictions in opening and protrusive movements, neck muscle pain, headache, or joint pain. In a study by Oliveira Melchior et al, [11] the use of 780 nm laser led to pain relief immediately after treatment, but pain recurrence was observed 30 days after treatment. Three weeks after treatment, there was some degrees of recurrence. They used no medication in their study. This problem was not observed in our study, because the patients received medications during the treatment and for the next 2 months, with weekly examinations during the 2-month period. There was no pain recurrence. Patients who reached the “no pain” stage during the treatment also received the full course of treatment. In our study, fluoxetine, clonazepam, and baclofen were prescribed for

all patients. This prescription was based on the common pathophysiology of chronic pain and depression. Norepinephrine and serotonin are involved in the pathophysiology of mood disorders and play a role in the gate-control mechanism. Studies have also shown that individuals with TMDs have personality characteristics similar to patients with chronic pain [18,19]. Bolouri et al. [8] studied the effect of co-administration of fluoxetine and clonazepam on treatment of MPDS in a period of 6 months. Muscle pain gradually decreased after treatment. On-palpation pain of TMJ also decreased significantly. The use of this drug combination, regardless of mental disorders, caused recovery in 90% of patients and no adverse effect was observed after administration. In addition to the above-mentioned combination, baclofen which is a muscle relaxant was also added. This drug regimen showed high efficiency in treatment of patients with no side effects. It is noteworthy that based on our search on the available information resources, the effect of treatment on pain of all masticatory muscles, pain in all jaw movements, and range of all jaw movements has not been assessed in any previous study. In addition, the effect of combination of LLLT and TENS with pharmaceutical therapy on MPDS has not been compared in any previous study.

CONCLUSION

All three treatment methods used in this study caused recovery of pain in involved muscles and jaw movements and also resolved the restriction of jaw movements. However, combination of LLLT and TENS with pharmaceutical therapy caused accelerated recovery of pain and resolved movement restrictions.

CONFLICT OF INTEREST STATEMENT

None declared.

REFERENCES

1. Farina S, Casarotto M, Benelle M, Tinazzi M, Fiaschi A, Goldoni M, et al. A randomized controlled study on the effect of two different treatments (FREMS AND TENS)

- in myofascial pain syndrome. *Eura Medicophys*. 2004 Dec;40(4):293-301.
2. Zuim PR, Garcia AR, Turcio KH, Hamata MM. Evaluation of microcurrent electrical nerve stimulation (MENS) effectiveness on muscle pain in temporomandibular disorders patients. *J Appl Oral Sci*. 2006 Jan;14(1):61-6.
 3. Öz S, Gökçen-Röhlig B, Saruhanoglu A, Tuncer EB. Management of myofascial pain: low-level laser therapy versus occlusal splints. *J Craniofac Surg*. 2010 Nov;21(6):1722-8.
 4. Kato MT, Kogawa EM, Santos CN, Conti PC. TENS and low-level laser therapy in the management of temporomandibular disorders. *J Appl Oral Sci*. 2006 Apr;14(2):130-5.
 5. Glick M. *Burket's oral medicine*. 12th ed. Connecticut: PMPH USA; 2015.
 6. Ilbuldu E, Cakmak A, Disci R, Aydin R. Comparison of laser, dry needling, and placebo laser treatments in myofascial pain syndrome. *Photomed Laser Surg*. 2004 Aug;22(4):306-11.
 7. Maia ML, Bonjardim LR, Quintans Jde S, Ribeiro MA, Maia LG, Conti PC. Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review. *J Appl Oral Sci*. 2012 Nov-Dec;20(6):594-602.
 8. Bolouri AJ, Delavarian Z, Mortazavi H, ASI HR, Falaki A, Falaki F. The effect of combination therapy with Fluoxetine and Clonazepam in Myofascial Pain Dysfunction Syndrome. *Aust. J. Basic & Appl. Sci*. 2011;5(12):520-5.
 9. Graff-Radford SB. Facial pain, cervical pain, and headache. *Continuum (Minneapolis)*. 2012 Aug;18(4):869-82.
 10. Håkögüder A, Birtane M, Gürçan S, Kokino S, Turan FN. Efficacy of low level laser therapy in myofascial pain syndrome: an algometric and thermographic evaluation. *Lasers Surg Med*. 2003;33(5):339-43.
 11. Melchior Mde O, Venezian GC, Machado BC, Borges RF, Mazzetto MO. Does low intensity laser therapy reduce pain and change orofacial myofunctional conditions? *Cranio*. 2013 Apr;31(2):133-9
 12. Michelotti A, Steenks MH, Farella M, Parisini F, Cimino R, Martina R. The additional value of a home physical therapy regimen versus patient education only for the treatment of myofascial pain of the jaw muscles: short-term results of a randomized clinical trial. *J Orofac Pain*. 2004 Spring;18(2):114-25.
 13. Fouda A. Comparison between four treatment modalities for active myofascial triggers points. *Plast Aesthet Res* 2014;1:21-28
 14. Mortazavi H, Javadzadeh A, Delavarian Z, Zare Mahmoodabadi R. Myofascial pain dysfunction syndrome (MPDS). *Iran J Otorhinolaryngol*. 2010 Oct;22(4):131-6.
 15. Darbandi A, Jajouei A. Etiology of TMJ Disorders in Patients Referred to Shahed Dental School Tehran-2000. *J Dent Sch Shahid Beheshti Univ Med Sci*. 2003;21(1):36-43.
 16. Beckerman H, de Bie RA, Bouter LM, De Cuyper HJ, Oostendorp RA. The efficacy of laser therapy for musculoskeletal and skin disorders: a criteria-based meta-analysis of randomized clinical trials. *Phys Ther*. 1992 Jul;72(7):483-91.
 17. Khalighi HR, Mortazavi H, Mojahedi SM, Azari-Marhabi S, Moradi Abbasabadi F. Low Level Laser Therapy Versus Pharmacotherapy in Improving Myofascial Pain Disorder Syndrome. *J Lasers Med Sci*. 2016 Winter;7(1):45-50.
 18. Shirani AM, Gutknecht N, Taghizadeh M, Mir M. Low-level laser therapy and myofascial pain dysfunction syndrome: a randomized controlled clinical trial. *Lasers Med Sci*. 2009 Sep;24(5):715-20.
 19. Azizi A, Sahebamee M, Lawaf S, Jamalee F, Maroofi N. Effects of Low-level Laser in the Treatment of Myofascial Pain Dysfunction Syndrome. *J Dent Res Dent Clin Dent Prospects*. 2007 Summer;1(2):53-8.