Original Article

Comparison of the Effects of Transcutaneous Electrical Nerve Stimulation and Low-Level Laser Therapy on Drug-Resistant Temporomandibular Disorders

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KEY WORDS
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ABSTRACT

Statement of the Problem: Temporomandibular disorder (TMD) is a clinical term used for clinical signs and symptoms that affect the temporomandibular joints, masticatory muscles, and associated structures. Surgical and non-surgical treatments can be used for management of TMD. Non-surgical route is the main part of the treatment, since clinicians prefer non-aggressive treatment for TMD such as pharmacological and physical therapy. Low-level laser therapy (LLLT) and transcutaneous electrical nerve stimulation (TENS) are the main procedures in physical therapy.

Purpose: The aim of this study was to evaluate the effectiveness of TENS and LLLT in treatment of TMD patients who did not respond to pharmacological therapy.

Materials and Method: This clinical trial was performed on 45 patients who randomly received either TENS or LLLT for 8 sessions. LLLT was applied with diode laser (Ga-Al-As, 980nm, dose 5j/cm^2) and TENS by using two carbon electrodes with 75 Hz frequency (0.75 msec pulse width). Helkimo index and visual analogue scale (VAS) were measured during the treatment period and throughout the follow-up sessions.

Results: Significant reduction in the VAS and Helkimo index was observed in both TENS and LLLT group. There was no significant difference between the two methods during the treatment; however, TENS was more effective in pain reduction in follow-ups.

Conclusion: This study justified the use of TENS therapy as well as LLLT in drug-resistant TMD. Both were useful in relieving the pain and muscles tenderness, although, TENS was more effective than LLLT.

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Introduction

The clinical term of temporomandibular disorder (TMD) refers to signs and symptoms that influence the temporomandibular joint (TMJ), masticatory muscles, and related structures. [1] Etiologic factors include parafunctional habits, as well as psychological and occlusal factors. [2-3] Patients with TMD suffer from orofacial pain, muscle tenderness, joint noises, limited mandibular movements, pain in TMJ, headache, and tinnitus. [4-5]

Diagnosis of TMD is based on clinical examination, history, and other methods such as questionnaires (research diagnostic criteria for TMD). Yet, clinical examination is the main part of TMD diagnosis. It consists of measurement of mandibular movements with digital caliper, palpation of masticatory muscles and TMJ and the use of the stethoscope to assess the joint noises. [6]

Although both surgical and non-surgical treatments are employed to manage TMD, the non-surgical route is the first and main part. It consists of pharmacological therapy such as non-steroidal anti-inflammatory drugs (NSAIDs), antidepressants, and muscle relaxants. The second part includes occlusal and physical therapy such as low-level laser therapy (LLLT), transcutaneous electrical nerve stimulation (TENS) and ultrasound. [7-9]

TENS is one of the safest and most inexpensive modalities that are used to control both chronic and acute pain. [10-11] According to the gate control theory, the modulation of pain perception induced by TENS is attributed to the recruitment of A_β afferent fibers in the posterior horn of the spinal cord which would prevent the activation of the pain conducted in thin fiber. Electrical stimulation inhibits the transmission of painful impulses through the spinal cord and stimulates the release of endogenous opioid by the brain. [12]

LLLT is used in different fields of medicine like dermatology and physical therapy. [13] It reduces histamine, PGE2 and substance P in the posterior horn of the spinal cord. It also elevates the level of acetylcholinesterase, lymphatic drainage, adenosine triphosphate, and beta-endorphin. That is the reason why this modality is suggested for chronic and acute pain reduction. [14]

Different studies used LLLT for TMD management. Cetiner *et al*. [15] Shirani *et al.* [16] and Carvalho *et al.* [9] used LLLT in TMD patients and reported positive effects especially in pain reduction. In contrast, some studies did not show any significant result. [7, 17] Having compared the TENS and pharmacological therapy, Shanavas *et al*. justified the use of TENS therapy as an adjuvant modality in controlling the pain associated with TMD. [18]

A number of studies compared the effects of LLLT and TENS on patient with TMD. Nunez *et al*. [19] concluded that LLLT was more effective than TENS in improving the maximum vertical jaw opening. However, Keto *et al*. [20] showed both therapies to be effective in decreasing the symptoms of patients with TMD. Regarding the limited number of studies on the issue and absence of any similar study on drug-resistant patients, the current study aimed to compare the effects of TENS and LLLT on treatment of drug-resistant TMD patients.

Materials and Method

This clinical trial was performed on 45 patients with drug-resistant TMD who referred to the Department of Oral Medicine, in Shiraz Dental School, Iran. The related research protocol was approved by the Human Research Ethics Committee of Shiraz University of Medical Sciences (process number#IR.SUMS.REC.1394.124). The informed consents were signed by all patients prior to beginning of the treatment. The exclusion criteria were having five or more missing posterior teeth (except for the third molars), parafunctional habits (bruxism, clenching, and so on), degenerative joint disorder, crepitus sound, and any kind of systemic disease. The enrolled patients were those with panoramic x-ray who used 1000 mg methocarbamol every 8 hours and 100 mg celecoxib every 12 hours for 10 days but did not feel better based on Visual Analog Scale (VAS) and clinical examination. Therefore, the patients discontinued the drugs 3 days before starting the new treatment and during the course of study. If any change was seen in condylar surface or joint space, the patients were referred to radiologist for better evaluation. The patients were examined based on Helkimo index, [21] in which the distance between the incisors was measured by a caliper (Insize, China) and considered as the maximum jaw opening. Ten muscles were palpated according to this index, including deep masseter, superficial masseter, posterior part of temporal, anterior part of temporal, insertion of temporal, lateral pterygoid, medial pterygoid, anterior digastric, posterior digastric and sternocleidomastoid muscles. [22] According to the block randomization, the patients were divided into two groups of TENS and LLLT. The TENS group received treatment for 8 sessions within two weeks (NEURDYN 710L; Iran). Carbone electrodes (6.5×4.5cm) were placed on the tender muscles with 75 HZ frequency and 0.75 millisecond pulse width for 20 minutes per session. The LLLT group received low-level laser therapy for 8 sessions within two weeks. For these patients, Gallium-Aluminum-Arsenide (Ga-Al-As) (Azor-2k-02, 980 nm) was applied on three regions of both sides including the posterior and anterior aspect of the joint, as well as the trigger points. Energy intensity was adjusted to 5 j/cm^2 using the output power of 200 mw for 2.5 minutes. The pain intensity was assessed according to VAS and recorded in each session. The clinical evaluation of TMD

was checked, using Helkimo index before and after the treatment (in the last session). The patients were followed up 4, 8, and 16 weeks after the treatment and VAS was recorded in these sessions. Data was analyzed by using SPSS software, version 18.0 (SPSS Inc.; IL, USA), and interpreted in form of mean, standard deviation (SD), and frequency (percentage). Paired t-test was used to compare Helkimo index before and after using each device. Student's t-test was employed to compare the mean differences in Helkimo index and pain intensity (VAS) between the two devices at each time-point. Repeated measures ANOVA was used to assess the changes in pain scores (VAS) over time. $p< 0.05$ was considered to be significant.

Results

Out of 45 patients, 19 in the TENS and 15 in LLLT group completed the course of treatment. Table 1 represents the demographic data of patients of the two groups. Both groups were similar concerning the mean age and gender ($p= 0.79$ and $p= 0.21$, respectively).

Table 1: Comparison of age and sex in LLLT and TENS group

Group	Number	Female	Male	Mean age	*p*.Value (age)	*p*.Value (sex)
LLLT	15	11	4	30.79	0.79	0.21
TENS	19	14	5	31.87		

The pre-treatment Helkimo index was 12.20 in LLLT and 11.2 in TENS group, indicating no significant difference between the two groups ($p= 0.39$). This index decreased significantly in both groups after the treatment ($p< 0.001$) (Table 2); However, the difference between the two methods was not significant ($p= 0.17$) (Table 3).

Table 2: Comparison of the pre- and post-treatment Helkimo Index in each group

Group	Pre-treatment Helkimo Index (H1)	Post-treatment Helkimo Index (H2)	Differences (H1-H2)	*p* Value
LLLT	12.20	9.07	3.13	<0.001
TENS	11.21	7.00	4.21	<0.001

Table 3: Comparison of post-treatment Helkimo Index between the two groups

Group	Mean differences (H2-H1)	*p* Value
LLLT	-3.13	0.17
TENS	-4.21	

The two groups were not significantly different in terms of pain reduction (VAS) during the treatment course (8 session); however their difference was significant in follow-up sessions (4, 8, 16 weeks after treatment) (Table 4). The VAS was significantly lower in TENS group than LLLT group throughout the follow-ups ($p= 0.04, 0.02, 0.025$, respectively).

Table 4: Comparison of VAS between the groups during the treatment

	Group	VAS Mean	*p* Value
1	LLLT	7.200	0.883
	TENS	7.105	
2	LLLT	6.553	0.457
	TENS	5.74	
3	LLLT	6.367	0.152
	TENS	5.184	
4	LLLT	6.033	0.135
	TENS	4.789	
5	LLLT	5.867	0.059
	TENS	4.263	
6	LLLT	5.533	0.056
	TENS	3.482	
7	LLLT	5.300	0.089
	TENS	3.842	
8	LLLT	5.520	0.0059
	TENS	3.632	
9	LLLT	5.467	0.044
	TENS	3.789	
10	LLLT	5.633	0.027
	TENS	3.816	
11	LLLT	5.967	0.025
	TENS	4.053	

Fallow-up period included 9, 10 and 11 session.

According to Figure 1, the TENS method decreased the pain more rapidly than LLLT. The pain decreased significantly in the TENS group from the second session on ($p= 0.016$); whereas, in the LLLT group, significant decreased was noticed from the third session on ($p= 0.007$).

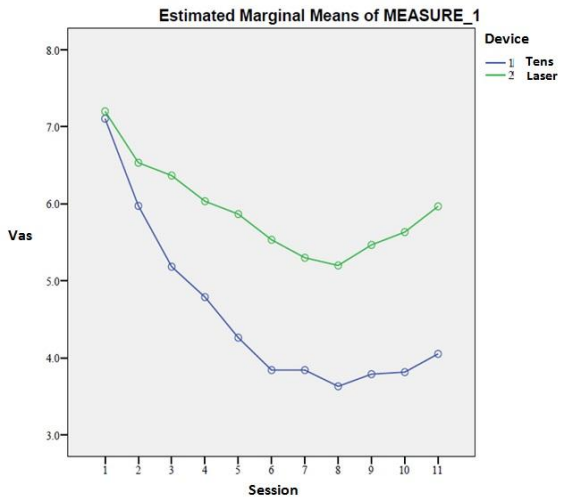

Figure 1: Comparison of VAS between LLLT and TENS group

Discussion

The present study compared the LLLT and TENS in TMD patients who did not respond to pharmacological treatments. Both methods significantly reduced the VAS and Helkimo index. Our result was similar to some previous studies [9, 15, 23-25] but different from those that reported no significant positive effect. [7, 17] Such difference may be due to the sample selection and treatment protocol.

This study found no significant differences between the effectiveness of TENS and LLLT on pain reduction and Helkimo index during the treatment course. Few studies have compared the effectiveness of LLLT and TENS on TMD. Generally, the main results of the current study were similar to what were detected by Kato *et al.* [20] and Nunez *et al.* [19] Meanwhile, our findings proved the TENS method to be more effective than LLLT in reducing the pain in follow-ups. It was inconsistent with Nunez *et al.*'s [19] findings, which reported the LLLT to be more effective than TENS. It may be due to the laser technical differences such as type of the device, power density, or length of the treatment. Furthermore, in Nunez's study, [19] the patients were evaluated only by their maximum opening score, while, we used a more precise clinical index (Helkimo index) and VAS for pain assessment.

The current study also found that the TENS reduced pain more rapidly than LLLT (after only two sessions). This effect might result from the delayed effect of laser therapy. The patient does not feel anything during LLLT, whereas, TENS creates a minor electrical shock. Therefore, the psychological effect of treatment may contribute to the better result of TENS on pain reduction.

In this study, we evaluated the effects of these two methods on patients who did not respond to pharmacological treatments. To the best of our knowledge, there existed no similar study on drug-resistant TMD patients. During the treatment course in this study, the patients did not use anti-inflammatory drugs; thus, the pain reduction effect of LLLT and TENS was evaluated per se. However, co-intervention by anti-inflammatory drugs was avoided only in some trials. [26] Moreover, selection of this group of patients eliminated the analgesic and muscle spasm effect of medicine, as well.

The equal number of sessions in both groups allowed comparing the effect of these methods in clinically similar situations, whereas, majority of trials continued the treatment for more sessions. [8-9, 27-28] It can be declared that the longer duration for LLLT may better control the pain. Nonetheless, it is rational that shorter treatment course with desirable effect increases the cooperation of patients and is clinically more applicable.

Concerning the age and gender of patients with TMD, our results were consistent with those of previous studies; i.e., TMD was more prevalent in females aged 20-40 years old. [29-30]

In the present study, Helkimo index and VAS were measured in both groups, while most other studies measured only VAS or jaw movements. [8, 16, 19, 31] Helkimo index evaluated the jaw movements, muscle tenderness and TMJ sounds, a comprehensive index involved many criteria. The results of Kulekcioglu's study [30] showed that the pain (subjective criteria) reduced in both placebo and laser group in TMD patients; however, mouth opening (objective criteria) improved only in laser group. Therefore, in the current study, both objective (Helkimo index) and subjective (VAS) parameters were evaluated to rule out the psychological effects of treatments.

VAS decreased in LLLT group during the treatment similar to other studies. [9, 15-16, 31] In follow-ups, the VAS decreased significantly until 8 weeks. A similar study with the same result followed up the patients for 3 weeks, [26] but in the present study, the patients were followed up longer.

Generally, some patients may need further modalities such as occlusal splint. Moreover, painful and tender muscles delay the beginning of treatment. Application of TENS and LLLT can increase the patient's cooperation and satisfaction.

Overall, this study found no significant difference between the two modalities, although TENS caused pain reduction to occur more rapid and persist longer, as well. Many of the current patients responded to pharmacological treatments; thus, the sample size was small. Results that are more reliable can be obtained through replication of these findings in a randomized placebo-control clinical trial with larger sam-

ple size. The patients did not cooperate for more follow-up sessions, although longer follow-up sessions could help in more precise evaluating the persistence of treatment.

Conclusion

With respect to the results of this study, it can be concluded that the use of TENS and LLLT is effective in TMD patients; so, they can be used as adjuvant therapy. In the present study, TENS caused a more rapid and long-lasting pain reduction. Longer administration of LLLT may be more effective in pain control, particularly during the follow-up period.

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Conflict of Interest

The authors of this manuscript certify no financial or other competing interest regarding this article.

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