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Effectiveness of low-level laser therapy in temporomandibular disorder

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Objective: To investigate the effectiveness of low-level laser therapy in the treatment of temporomandibular disorder and to compare treatment effects in myogenic and arthrogenic cases.
Methods: Thirty-five patients were evaluated by magnetic resonance imaging and randomly allocated to active treatment (n = 20) and placebo treatment (n = 15) groups. In addition to a daily exercise program, all patients were treated with fifteen sessions of low-level laser therapy. Pain, joint motion, number of joint sounds and tender points were assessed.
Results: Significant reduction in pain was observed in both active and placebo treatment groups. Active and passive maximum mouth opening, lateral motion, number of tender points were significantly improved only in the active treatment group. Treatment effects in myogenic and arthrogenic cases were similar.
Conclusion: Low-level laser therapy can be considered as an alternative physical modality in the management of temporomandibular disorder.

Key words: low-level laser therapy, infrared laser, temporomandibular disorder, magnetic resonance imaging, treatment, exercise

Temporomandibular joint (TMJ) pain can be a significant problem in a selected number of patients referred to rheumatology units. Destructive arthritis of this synovial joint might be seen in various rheumatic conditions such as rheumatoid arthritis, psoriatic arthritis, juvenile rheumatoid arthritis and mixed connective tissue disease (1–6). Significant overlap also exists between fibromyalgia and it is frequently classified as a myofascial pain syndrome (1,2). However, most of the cases are associated with dysfunction of the masticatory or the stomatognatic system.

Temporomandibular disorder (TMD) is a collective term, characterized by symptoms involving muscles of mastication, TMJ and orofacial structures resulting from a dysfunction of the stomatognatic system. This is basically defined as a functional unit consisting of structures associated with chewing, speaking and swallowing (7). Failure of one component of this system can impair the function of the system as a whole. Epidemiological studies reveal that up to 75% of the adult populations have at least one sign of TMJ dysfunction, approximately 30% have more than one symptom, while only 3–7% of the population admitted for advice or care (1–3).

Several imaging methods have been suggested to demonstrate the bony structures and the disc making up the TMJ. Magnetic Resonance Imaging (MRI) is considered the most accurate diagnostic method for evaluation of soft tissues of the TMJ, especially in cases suspected of internal derangement and disc disorder (2, 8–10). Disc displacement and degenerative changes are the most frequently observed findings on MRI studies (11).

Current treatment of TMD is mostly conservative (12). Although different studies have reported improvement of symptoms with early initiated physiotherapy, controlled comparative studies are scarce and there are problems in terms of standardization of treatment (13–22). Exercise management is frequently suggested in the treatment of TMD especially of muscular origin (23,24). Tetelberg (25) and Au (26) have reported significant symptom reduction after exercise management in TMD.

Light amplification by stimulated emission of radiation (laser) is one of the most recent treatment modalities in the field of physiotherapy. Low-level laser therapy (LLLT) is suggested to have biostimulating and analgesic effects through direct irradiation without causing thermal response (27). It has been studied in several musculoskeletal pain syndromes and contradictory results were reported in two major meta-analyses (28–29). Few studies have investigated the efficacy of laser therapy in TMD (16–22). Due to utilization of different types, frequencies and duration of laser radiation in various patient groups, the results could not have been standardized.

According to our knowledge, treatment effects

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in arthrogenic and myogenic TMD have not been studied. This study was designed in order to evaluate the efficacy of LLLT and exercise treatment combination in TMD and to compare treatment effects in patients with arthrogenic and myogenic TMD.

Materials and methods

A total of 35 patients (28 female, 7 male) 20–59 years of age (mean: 37.0 ± 12.3 years), admitted to the Uludag University Medical Faculty Department of Physical Medicine & Rehabilitation outpatient clinic with orofacial pain, TMJ sounds, limited mouth opening, or TMJ locking, were included in the study. Cases with congenital abnormality, concomitant inflammatory or neoplastic conditions, and those with a recent history of acute trauma or any form of treatment within the last month were excluded.

After informed consent was obtained, all patients were evaluated by the first investigator. Pain intensity, number of tender points and joint sounds, maximal active and passive mouth opening, right and left lateral jaw motion were assessed before, after and 1 month after treatment.

Pain intensity was recorded in mm on a 100 mm Visual Analogue Scale (VAS). Number of tender points (Minimum: 0, Maximum: 36) were assessed by palpation of the following 18 points in both sides: joint capsule (lateral-posterior-superior), masseter (anterior-inferior-deep), temporal (anterior-deep-middle-origin), medial and lateral pterygoid, sternocleidomastoid (upper-middle-lower), trapezius (origin-upper), splenius capitis muscles. On examination the four most tender points in each patient were selected for therapy.

Number of joint sounds were assessed by oscultation of TMJ during mouth opening and closing, listening for the presence of opening and closing clicks as well as fine and coarse crepitation (30). The total number of sounds on both sides were recorded.

The patient was asked to open his/her mouth as much as possible for the measurement of maximal active mouth opening. Maximal passive mouth opening was measured after the application of downward pressure on the mandible by the second and third fingers of the patient. The vertical distance between upper and lower teeth was measured by a ruler and recorded in mm for these parameters (23, 30–31). Lateral jaw motion was assessed by measurement of the horizontal distance between the midpoints of upper and lower incisors in mm (23, 30,31).

All patients were evaluated by TMJ MRI (1.5 Tesla Siemens® Magnetom Vision) using a 7.5×7.5 cm surface coil for the presence of internal disc derangements or degenerative changes. The patients were then grouped according to the diagnosis on MRI summarized below:

1. **Normal:** Disc is in normal position during closed mouth position,
2. **Reductable disc displacement:** Disc is displaced during closed mouth position, but can be reduced to normal position during open mouth position,
3. **Irreductable disc displacement:** Disc is displaced in both closed and open mouth positions,
4. **Degenerative changes:** Osseous changes of the condyle such as flattening and erosion of the articular surfaces as well as presence of osteophytes.

While those patients with normal findings on MRI were considered as TMD of mainly myogenic origin, those with internal disc derangement and degenerative changes on MRI were considered as TMD of mainly arthrogenic origin.

Patients were then randomly assigned to active (Group 1, $n = 20$) and placebo (Group 2, $n = 15$) treatment groups. In addition to a standard daily exercise program consisting of range of motion exercises, stretching exercises and postural training, all patients were treated with fifteen sessions of LLLT. Elettronica Pagani® Roland Serie CE Infrared-27 Laser Unit producing semi-conductive (diodic) gallium arsenide (GaAs) laser (wavelength: 904 nanometers, mean output power: 17 mW) was utilized in the study. LLLT (frequency: 1000 Hz, duration: 180 seconds, dosage: 3 J/cm^2) was applied to the four most tender points selected during examination. The laser unit was not turned on in the placebo group. All patients were evaluated by the first investigator who was blinded to treatment groups.

Statistical analysis of the results in both treatment groups before, after and 1 month after treatment were conducted by SPSS for Windows, Version 7.5 (SPSS Inc., Chicago, IL). Between-group and within-group differences were analyzed by Mann-Whitney U and Wilcoxon tests. Any P value less than 0.05 was considered significant.

Results

The active treatment group ($n = 20$) consisted of 18 female and 2 male patients (mean age 38.3 ± 8.3 years), while the placebo treatment group ($n = 15$) consisted of 10 female and 5 male patients (mean age: 37.9 ± 12.3 years). TMJ MRI findings are summarized in Table I, revealing 18 mainly arthrogenic (51.4%) and 17 mainly myogenic (48.6%) cases. There was no significant difference between the two groups according to etiology.

Comparison of the study groups after initial assessment revealed no significant difference in any

Table I. Radiological (TMJ MRI) findings of the patients.

	Group 1 (n=20)	Group 2 (n=15)	Total (n=35)	%
Myogenic TMD:	**10**	**7**	**17**	**48.6**
1- Normal				
Arthrogenic TMD:	**10**	**8**	**18**	**51.4**
2- Reductable disc displacement	2	3	5	14.3
3- Irreductable disc displacement	6	1	7	20.0
4- Degenerative changes	2	4	6	17.1

of the study parameters. Myogenic and arthrogenic cases were also similar according to initial assessment results.

Significant reduction in pain was observed in both treatment groups and was maintained 1 month after treatment (Table II). However, the number of tender points, maximal active and passive mouth opening, right and left lateral jaw motion were significantly improved only in the active treatment group. No significant change was observed in joint sounds in any group.

Comparison of improvement of the clinical parameters between the study groups at the end of treatment and 1 month after treatment is shown in Table III. Significantly more improvement was noted in the active treatment group in all parameters except pain intensity and joint sounds. Comparison of treatment effects in active and placebo treatment groups according to etiology revealed no significant difference between myogenic and arthrogenic cases.

Discussion

TMD is characterized by a composition of clinical problems involving TMJ, masticatory muscles or both. Similar to the results of various epidemiological and clinical studies, most of the patients in our study population were female (3,13,18,32).

Early diagnosis and treatment of physical and psychological complaints associated with TMD remains problematic. Reduction of muscular tension as well as correction of the postural imbalance by an appropriate exercise regimen might play an important role in the management of TMD. Tegelberg (25) has found significant improvement in the temporomandibular mobility after physical training, while Au (26) has observed that joint clicks in most of the patients have disappeared after an isokinetic exercise protocol. However, exercise therapy has not shown to be equally effective in improvement of symptoms such as pain and locking.

Table II. Results of study parameters in the treatment groups (Mean ± SD).

	Group 1			Group 2		
	Baseline	After treatment	1 month after treatment	Baseline	After treatment	1 month after treatment
Pain intensity (mm)	42.8 ± 27.0	10.5 ± 18.5^{b}	5.5 ± 17.9^{c}	35.3 ± 29.0	8.0 ± 9.4^{b}	5.3 ± 6.4^{b}
Number of tender points	10.5 ± 8.4	3.6 ± 5.8^{c}	2.8 ± 5.9^{c}	7.5 ± 7.3	5.7 ± 6.4	6.3 ± 7.4
Number of joint sounds	1.7 ± 2.0	1.4 ± 1.8	1.2 ± 1.6	1.7 ± 1.8	1.7 ± 1.8	1.7 ± 1.8
Active mouth opening (mm)	36.0 ± 8.0	42.3 ± 8.4^{c}	43.7 ± 7.4^{c}	37.4 ± 11.2	40.8 ± 8.9	40.8 ± 8.9
Passive mouth opening (mm)	38.8 ± 8.0	44.5 ± 8.5^{c}	45.6 ± 7.4^{c}	38.9 11.5	42.5 ± 8.9	42.3 ± 8.7
Right lateral motion (mm)	6.8 ± 3.9	10.9 ± 4.1^{c}	11.1 ± 3.9^{c}	8.1 ± 3.8	9.4 ± 4.3	9.8 ± 4.0^{a}
Left lateral motion (mm)	6.7 ± 3.3	11.5 ± 5.1^{c}	12.1 ± 5.1^{c}	9.3 ± 4.6	7.8 ± 4.1	9.7 ± 4.4^{a}

$^{a}P<0.05$, $^{b}P<0.01$, $^{c}P<0.001$

Table III. Comparison of mean change in clinical parameters between the study groups.

	After treatment			1 month after treatment		
	Group 1	Group 2	*P* Value	Group 1	Group 2	*P* Value
Pain intensity (mm)	−32.3 ± 25.1	−27.3 ± 27.6	0.708	−37.3 ± 27.1	−30.0 ± 28.5	0.438
Number of tender points	−6.9 ± 6.1	−1.8 ± 2.7	0.006	−7.7 ± 5.9	−1.1 ± 2.3	0.001
Number of joint sounds	−0.3 ± 0.6	0	0.127	−0.5 ± 1.4	0	0.104
Active mouth opening (mm)	6.3 ± 5.8	3.4 ± 11.1	0.006	7.7 ± 5.6	3.4 ± 11.1	0.001
Passive mouth opening (mm)	5.7 ± 5.6	3.6 ± 11.6	0.010	6.8 ± 5.6	3.5 ± 11.1	0.003
Right lateral motion (mm)	4.2 ± 3.9	1.3 ± 4.2	0.006	4.4 ± 3.8	1.7 ± 4.1	0.005
Left lateral motion (mm)	4.8 ± 3.9	1.5 ± 4.2	0.001	5.4 ± 3.8	1.9 ± 4.2	0.002

Based on the results of experimental studies and therapeutic evaluations, LLLT is suggested in the management of TMD through its analgesic, anti-inflammatory and biostimulating effects. Even though the mechanism of analgesic effect of low-level laser is not well understood, increased pain threshold through alteration of neuronal stimulation and firing pattern and inhibition of the medullary reflexes are thought to be involved (16). Few studies were published concerning clinical efficacy of laser treatment in TMD (16–22). The majority of the patients involved in these studies were TMD of arthrogenic origin, while a great variation was observed in terms of type, duration and frequency of laser employed. It has been proposed that infrared laser penetrates deeper than ultraviolet laser, and is most effective between the frequency ranges of 700–1000 Hz (33,34).

The results of our randomized placebo-controlled study which was designed to investigate the efficacy of LLLT in TMD are rather promising. Significant improvement was obtained in the active treatment group both in subjective parameters such as pain and number of tender points, as well as in objective functional parameters such as mouth opening and lateral motions. In contrast, only pain was significantly improved in the placebo group. This might be explained in two ways. First: the placebo effect which is frequently encountered when evaluating subjective symptoms in similar studies. Second: the indirect influence of exercise through the reduction of muscle spasm and recovery of proper muscular function. Improvement of TMJ functions in the active treatment group can be explained by both the analgesic and biostimulating effects of laser therapy.

TMJ sounds were not affected after treatment in any of the study groups. This was anticipated, since joint sounds commonly originate from mechanical disruption of the joint, and is not expected to be influenced by conservative measures.

The requirement of an etiological diagnosis prior to an effective treatment plan is still controversial. MRI has been proven to be of value in identifying articular disc pathologies; however, it has often failed to correlate with clinical findings (2). Although it is frequently stated that an etiological diagnosis is essential in order to plan management strategies in TMD, we have not observed significant difference between therapeutic responses in cases of arthrogenic and myogenic origin. This might also be due to the fact that MRI is not capable of completely distinguishing between arthrogenic and myogenic cases, since the problem is often a combination of both types.

LLLT (700 Hz) was previously demonstrated to improve pain, mouth opening and joint sounds in patients with refractory arthrogenic TMD (22). Similar type and frequency of low-level laser was investigated in arthrogenic TMD in another placebo-controlled trial, and significant improvement was observed in pain, maximal mouth opening and jaw lateral motion which are findings rather parallel to our study (16). The same investigators have compared laser and micro-current electrical stimulation (MENS) in another study where laser was found to be more effective in pain and mouth opening parameters (18). However, myogenic TMD were not included, and tender points were not evaluated in these studies.

There is only one study comparing efficacy of different physical modalities in TMD. Gray et al (17) have compared short-wave diathermy (SWD) (n = 27), pulsed SWD (n = 27), ultrasound (n = 30) and GaAs mid-laser (n = 29) in a double-blind placebo-controlled trial in 139 TMD patients. More patients were improved in all treatment groups compared to the placebo group (n = 26); however, statistical significance was reached only after 3 months. Unlike this study, significant improvement was observed much earlier in our short-term study with LLLT.

In a recent study, in which GaAs laser effects were investigated on myogenic and arthrogenic TMD, Conti (21) has found that pain was significantly improved in the myogenic group, while mouth opening and lateral motion were improved in the arthrogenic group. Our findings have not confirmed such a difference between the myogenic and arthrogenic groups in terms of therapeutic response. This might be explained by the different type of laser utilized and the combination effect of exercise in our study.

At present, TMD remains to be a complex disorder which is sometimes difficult to define and can be challenging in diagnosis and management. Girdler (35) has attempted to synthesize the cartilaginous meniscus in vitro, which may have a potential to repair or replace the damaged menisci in patients with internal derangement. At all times, physical therapy will continue to play an important role in conservative treatment and our results with a LLLT and exercise combination were reassuring. Few studies have addressed the effect of laser in TMD and improvement in pain has been shown in most of them; however, shortcomings such as small number of subjects, lack of a control group and diversity of the techniques employed have caused weakness in reliability.

We believe that our placebo-controlled study has supported the use of LLLT as an alternative to other conventional treatment modalities in TMD of myogenic and arthrogenic origin. Further research should focus on optimal treatment parameters such as frequency and duration with double-blind, randomized, placebo-controlled trials. Moreover, comparison of effectiveness of different modalities in myogenic and arthrogenic TMD deserves further investigation.

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