Turk J Phys Med Rehab 2020;66(1):24-30
DOI: 10.5606/tftrd.2020.3355

Original Article

Evaluation the effects of low-level laser therapy on disc displacement with reduction

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Received: July 10, 2018 **Accepted:** October 04, 2018 **Published online:** March 03, 2020

ABSTRACT

Objectives: This study aims to evaluate the effects of additional low-level laser therapy (940 nm GaAlAs) to the routine occlusal splint therapy on maximal mouth opening (MMO), visual analog scale (VAS) scores, and passive mouth opening (PMO).

Patients and methods: Between January 2016 and March 2018, a total of 40 patients (10 males, 30 females; mean age 22.35 years; range, 18 to 60 years) with disc displacement with reduction of the temporomandibular joint were included. The patients were divided into two groups. Group 1 (control group, n=20) received routine non-steroidal anti-inflammatory drug (NSAID) therapy and occlusal splint therapy for eight hours per day for a total of three months. Group 2 (laser group, n=20) received NSAID, occlusal splint therapy and 940 nm wavelength diode laser therapy for two sessions per week for a total of four weeks. The MMO, PMO, and VAS scores were recorded before and at one, two, three, four, and 12 weeks after treatment. The joint and muscle examinations were performed.

Results: A constant decrease was found in the VAS scores in both groups. At four (p=0.008) and 12 weeks (p=0.003), a statistically significant difference in the VAS scores was observed. At all time points, PMO and MMO scores increased in both groups. The MMO scores were statistically higher in the laser group at all time points (p<0.005).

Conclusion: Our study results suggest that short-term low-level laser therapy additional to conventional treatment may yield satisfactory outcomes.

Keywords: Low-level laser therapy, occlusal splint, temporomandibular disorders.

Temporomandibular disorders (TMDs) are a group of conditions characterized by pain or dysfunction in the temporomandibular joint (TMJ) and related muscles.[1] Symptoms of TMD are muscle and joint pain, limited mandibular movements, mouth opening, and joint sounds during these movements.[2] Although the majority of patients have at least one of these symptoms, only one quarter is aware of these symptoms and 10 to 20% require treatment.[3]

Temporomandibular disorders are mainly classified into three main groups: myofascial pain, joint disc displacement with or without reduction, and degenerative joint disorders.[4] Disc displacement is commonly a non-inflammatory TMJ pathology which may present asymptomatically.[5] Disc displacement with reduction (DDR) is a frequent TMJ disorder. It is typically characterized by a clicking sound during opening and closing of the mouth.[6] Some of the researchers have pointed out that DDR may result from the masticatory muscle contracture.[7] Limitations in mouth opening is also seen in some patients, and the next phases of pain may occur due to secondary muscle spasms, which are related to the soft tissues around the TMJ.[6]

Pharmacological treatment of TMD includes analgesics, non-steroid anti-inflammatory drugs (NSAIDs), sedatives, antidepressants, muscle relaxants, vitamins, and antibiotics. In addition, occlusal splints, physical therapy methods such as ultrasound, acupuncture, and laser, and parafunctional habit therapy can be used.[8,9]

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Cite this article as:
Keskin Tunç S, Ünalan Değirmenci B, Alpaslan Yaylı N, Aslan Ş, Akdeniz MŞ. Evaluation the effects of low-level laser therapy on disc displacement with reduction. Turk J Phys Med Rehab 2020;66(1):24-30.

Laser application is the most preferred treatment modality in physiotherapy of TMDs. Low-level laser therapy (LLLT) is a form of phototherapy with its biostimulation and analgesic effects without thermal changes.[10] It is a successful, easy applicable, and short-term treatment option and has become widely used as an alternative treatment for musculoskeletal disorders due to its analgesic, anti-inflammatory, and regenerative effects.[9] Öz et al.,[10] and Douglas De Oliveira et al.,[11] showed that diode lasers and occlusal splints could be used in the treatment of TMDs.

Many researchers have suggested that occlusal splints are insufficient, although it is the preferred treatment option.[12-15] Some authors[12,16] have proposed that LLLT is a successful treatment modality, while some others have failed to achieve promising results, reporting that LLLT has a placebo effect.[17-19] In the light of literature data, it may be important to combine TMD treatments.[12,14,15] In the present study, we aimed to evaluate the effects of combined occlusal splint and LLLT (940 nm GaAlAs) on maximal mouth opening (MMO), visual analog scale (VAS), and passive mouth opening (PMO).

PATIENTS AND METHODS

A total of 286 patients with TMD who were referred to Van Yüzüncü Yıl University, Faculty of Dentistry, Department of Prosthodontics and Maxillofacial Surgery were examined between January 2016 and March 2018. The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) were applied with questionnaires to all patients. *Inclusion criteria were as follows:* having DDR within the past six months; bilaterally TMJ retention; age 18 to 60 years; presence of natural posterior occlusion; and no previous TMD treatment. *Exclusion criteria were as follows:* having TMD due to psychological reasons; orofacial pain unrelated to TMD; unilaterally TMJ retention; posterior tooth loss; partial removable prostheses; serious orthognathic deformities; systemic diseases; pregnancy or lactation; face or joint infection; and a history of trauma related to TMJ. In total, 40 patients (10 males, 30 females; mean age 22.35 years; range, 18 to 60 years) with DDR of the TMJ were included into the study. The patients were randomly divided into two groups using a randomization procedure (GraphPad Prism version 6; GraphPad Inc., CA, USA). The study flowchart is shown in Figure 1. Inclusion and exclusion criteria are shown in Table 1.

A written informed consent was obtained from each patient. The study protocol was approved by the Van Yüzüncü Yıl University Faculty of Medicine Clinical Research Ethical Committee for this study (YYÜ-06-19072016). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Treatment procedures

Group 1 (control group, n=20) received routine NSAIDs and occlusal splint therapy for eight hours per

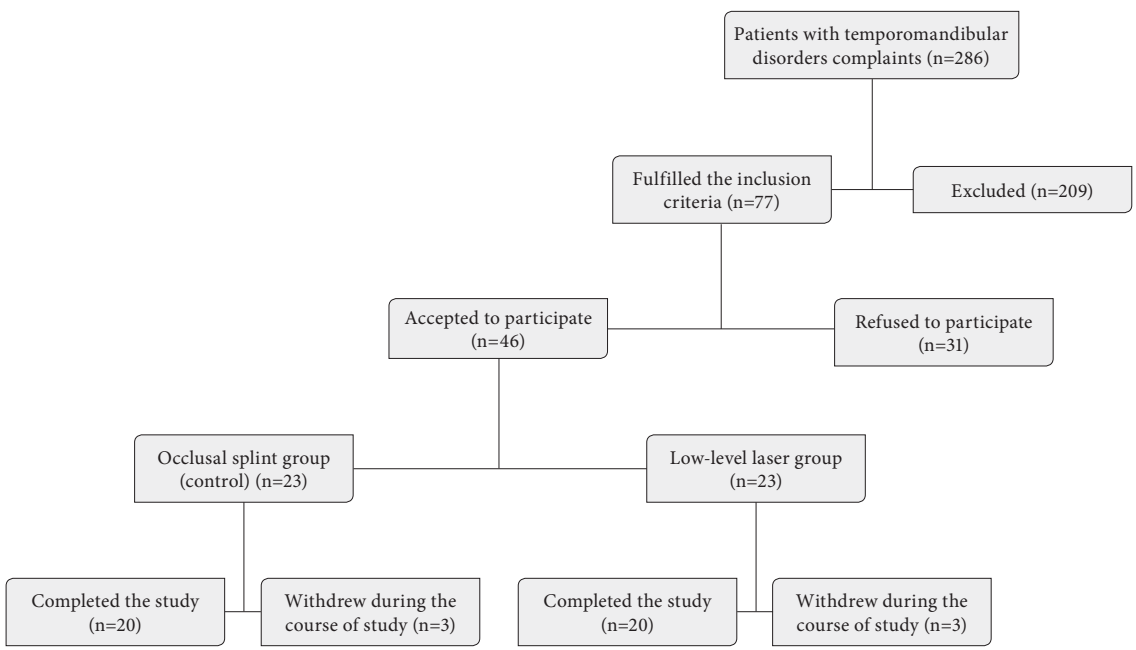

Figure 1. Study flowchart.

TABLE 1
Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
☐ Diagnosed with disc displacement with reduction at least 6 months ago	☐ TMD related to psychological reasons
☐ Age between 18 and 60	☐ Orofacial paints except TMD
☐ Had natural posterior occlusion	☐ Had posterior teeth loss
☐ Did not have any TMD treatment	☐ Partial removable prosthesis
☐ Bilateral TMJ retention	☐ Serious orthognathic deformities
	☐ Systemic diseases
	☐ Pregnancy
	☐ Nursing history
	☐ Infection at face or joint regions
	☐ Trauma history related to TMJ
	☐ Unilateral TMJ retention

TMD: Temporomandibular disorders; TMJ: Temporomandibular joint.

day for a total of three months. All occlusal splints were created for the maxillary arch and provided an occlusal relationship considered optimal for the patients. When the splints were in place, prosthodontists checked for musculoskeletal stabilization and tooth contact. Using the splints, canine disocclusion of the posterior teeth during eccentric movement was provided.[21]

Group 2 (laser group, n=20) received NSAIDs, occlusal splint, and diode laser treatment (Ezlase; Biolase Technology, Inc., Irvine, CA, USA). Laser applications were performed in two sessions per week for a total of four weeks. The treatment was performed using a laser at 940 nm and 0.3 W and applied with a bleaching hand piece (Figure 2). The laser contacted the skin and energy was transmitted to the TMJ. In each application site, energy was transmitted with a density of 2.14 J/cm^2 for 20 sec in accordance with the manufacturer's recommendations. The MMO (Figure 3), PMO, VAS scores, muscle, and joint examination data with the RDC/TMD were recorded before and at one, two, three, four, and 12 weeks after treatment.

Statistical analysis

Power analysis was performed using the G*Power version 3.1.9.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). The effect size was calculated as >0.80 for the VAS scores for 20 patients per group with a study power of 90 and 95%. For active mouth opening, the effect size was calculated as >0.80 with a study power of 87 to 96%. Statistical analysis was performed using the IBM SPSS version 21.0 software

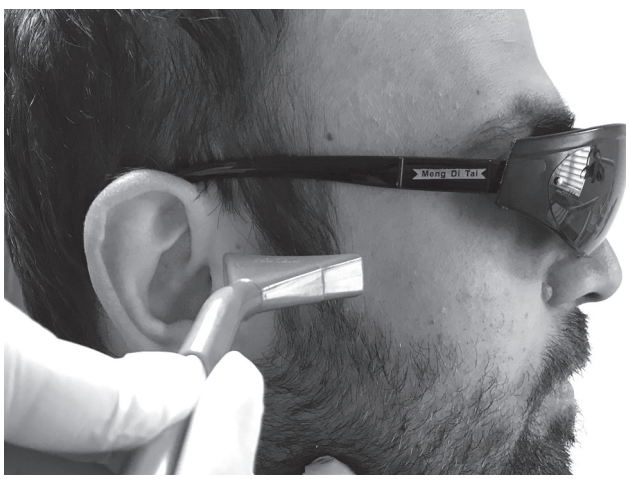

Figure 2. Application of laser to temporomandibular joint.

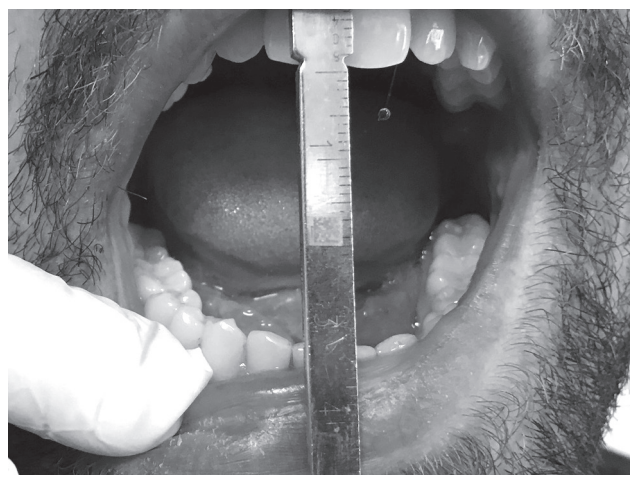

Figure 3. Measurement of maximal mouth opening via a ruler.

TABLE 2
Demographic data

	Control group		Laser group		
	n	Mean±SD	n	Mean±SD	*p*
Age (year)		23.1±4.9		21.3±4.8	0.248
Sex					1
Female	15		15		
Male	5		5		

SD: Standard deviation; * P values assessed by Student's t-test.

(IBM Corp., Armonk, NY, USA). Descriptive statistics were expressed in mean ± standard deviation (SD), median (min-max), or number and frequency. The Mann-Whitney U test was used to compare the groups, while the Friedman test was used to compare repeated measurements. The Wilcoxon test with the Bonferroni correction was used for multiple comparisons among the repeated data within the same group. A *p* value of <0.05 was considered statistically significant.

RESULTS

There was no statistically significant difference in sex and age between the groups. Demographic characteristics of the study groups are shown in Table 2.

The VAS scores were recorded at one, two, three, four and 12 weeks in both groups. The VAS scores decreased in both groups over time. However, lower VAS scores were recorded in the laser group at four

TABLE 3
Comparison of VAS scores between laser and control groups at study time points

	Control group			Laser group			Mann-Whitney U test
Times	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*
VAS1	5.5±1.4[a]	5	3-8	4.5±1.8[a]	4.5	1-7	0.076
VAS2	5.0±1.8[a]	5	2-8	3.8±2.1[a]	3.5	1-8	0.060
VAS3	4.6±1.7[a]	4.5	2-8	3.4±2.0[a,b]	3	0-7	0.056
VAS4	4.2±1.4[a,b]	4	2-8	2.5±2.0[bc]	2	0-6	0.0080*
VAS12	3.2±1.3[b]	3.5	1-6	1.7±1.8[c]	1	0-6	0.0030*
Friedman *p* value		<0.001			<0.001		

VAS: Visual analog scale; SD: Standard deviation; Min: Minimum; Max: Maximum; a, b, c: Lowercase superscript letters with mean values indicate differences VAS scores at study time points within the groups according to adjusted p value (* p<0.05).

TABLE 4
Comparison of maximal mouth opening between laser and control groups at study time points

	Control group (mm)			Laser group (mm)			Mann-Whitney U test
Times	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*
Week 1	41.9±9.5[b]	45	20-56	49.55±10.1[b]	51.5	28-65	0.020
Week 2	43.2±8.7[a,b]	46	23-57	49.25±10.7[b]	51	25-66	0.042
Week 3	43.2±9.7[a,b]	46	24-56	48.75±10.7[b]	50	24-65	0.031
Week 4	43.6±9.6[a,b]	47	26-56	50.75±10.2[a]	51.5	24-67	0.027
Week 12	43.9±9.4[a]	47.5	25-56	51.85±8.7[a]	51.5	30-67	0.010
Friedman *p* value		0.010			<0.001		

SD: Standard deviation; Min: Minimum; Max: Maximum; a, b: Lowercase superscript letters with mean values indicate differences visual analog scale scores at study time points within the groups according to adjusted p value (p<0.05).

TABLE 5
Comparison of passive mouth opening between laser and control groups at study time points

	Control (mm)			Laser (mm)			Mann-Whitney U test
Times	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*
Week 1	37.6±10.1	41	16-54	37.6±7.5[b]	40	25-50	0.807
Week 2	36.7±12.8	42	3-54	37.6±8.9[b]	39	22-52	0.828
Week 3	39.4±9.6	41.5	22-54	38.4±8.9[a,b]	40.5	18-48	0.735
Week 4	39.0±9.3	42	22-54	40.0±8.7[a]	42.5	18-50	0.704
Week 12	39.7±9.5	42	22-54	41.3±7.3[a]	43	25-50	0.724
Friedman *p* value		0.058			<0.001		

SD: Standard deviation; Min: Minimum; Max: Maximum; a, b: Lowercase superscript letters with mean values indicate differences visual analog scale scores at study time points within the groups according to adjusted p value (p<0.05).

(p<0.008) and 12 weeks (p<0.003), compared to the control group (Table 3).

The MMO and PMO measurements were compared between the groups at the study time points. The MMO scores increased in both groups over time. In addition, there was a statistically significant increase in the MMO scores of the laser group at all time points (p<0.005) (Table 4).

The PMO measurements were compared between the groups at the study time points. The PMO scores increased in both groups over time and there was no statistically significant difference between the groups (Table 5).

DISCUSSION

Temporomandibular disorders are characterized by pain and mobility dysfunction in the TMJ area, masticatory muscles, and associated musculoskeletal structures in the head and neck. Typically, TMDs affect females aged between 20 and 40 years.[22] Similarly, in our study, the majority of the patients were females with a mean age of 22.35 years, consistent with previous studies.[15,23-25]

The main goal of treatment for TMDs is to control or alleviate symptoms with reversible methods.[26] Clinicians should avoid complicated occlusal therapies and aggressive surgical procedures; therefore, soft diets, hot pack applications, NSAIDs, and occlusal splints are recommended.[27] Treatment with occlusal splints is a reliable option in TMDs to reduce the TMJ load and clinical symptoms.[28] Occlusal splints have no known effect on the clicking sound in patients with DDR,[29] although it is helpful to eliminate interference due to lateral and protrusive movements.[30] In the light of these data, we prescribed NSAIDs and created splints for the patients, as described by Okeson.[31] Canine-guided full arch maxillary occlusal splints were used for eight hours per day for three months.

Low-level laser therapy is an appealing treatment method with analgesic, anti-inflammatory, biostimulation, and muscle relaxant properties.[16,32,33] However, the mechanism of action has not been fully understood, yet. Some authors have demonstrated that LLLT enhances the pain threshold due to neurostimulation and firing pattern changes, inducing medullar inhibition.[34,35] The penetration and absorption of the laser in the biological tissue is dependent on some variables, the most important of which is the laser wavelength. Different wavelengths (632, 660, 810, 830 890, and 910 nm) can be used in the treatment of TMDs;[36] however, we were unable to find any study investigating the efficacy of using a laser at 940 nm in patients with TMDs. Therefore, we examined the effect of laser at 940 nm.

The output power of low-level laser is <250 mW. These lasers induce photochemical reactions without thermal action on tissue. To create these effects, the force density is a more important criterion than the laser force. If the density is <670 mW/cm^2, biostimulator effects are created without thermal reactions.[9] In our study, the LLLT at 940 nm with 6-W output power and 2.14 J/cm^2 was combined with the conventional occlusal splint therapy. We used these parameters to obtain the biostimulator effects, while avoiding thermal reactions.

In a study by Minakuchi et al.[37] which compared NSAIDs with occlusal splints, a significant healing was reported at four weeks in the splint group, as measured by VAS scores and MMO. In the

aforementioned study, the authors reported that there were no significant differences between the two groups at eight weeks. In our study, we found a statistically significant difference between the combined laser and occlusal splint groups at four and 12 weeks in terms of the VAS scores and MMO at all time points, consistent with previous studies.[38,39]

In their study, Doeuk et al.[39] reviewed the application of LLLT in maxillofacial surgeries and reported that LLLT was not a suitable option, particularly in the treatment of TMDs. Some authors reported satisfactory outcomes with LLLT,[12,16] while some others reported that the effect of LLLT was not different from a placebo.[17-19] Based on these data, we speculate that standard treatment options should be combined with LLLT in the treatment of TMDs.[6,14,23,35]

There are some limitations to our study. In LLLT studies, it is helpful to include a placebo group to obtain more objective results. One of the limitations of our study is the lack of a placebo group. Also, initial VAS scores and MMO scores were found to be different between the two groups possibly due to the randomization method of the study groups.

In conclusion, our study results suggest that occlusal splints can alleviate TMD and increase mouth opening to improve daily living activities of patients. Based on these results, we conclude that a combination of LLLT and conventional treatments may have a positive therapeutic effect in the short term. However, further large-scale studies using different laser wavelengths are needed to confirm our study findings.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

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