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Comparative Efficacy of Low-Level Laser Acupuncture and Cupping for Treatment of Patients with Myofascial Pain Dysfunction Syndrome: A Double-blinded, Randomized Clinical Trial

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Abstract

Background: Myofascial pain dysfunction syndrome (MPDS) is among the most common causes of facial pain. This study compared the efficacy of low-level laser (LLL) acupuncture and cupping for the treatment of MPDS. **Materials and Methods:** This double-blind, before-after, randomized clinical trial evaluated 60 MPDS patients that were divided into two groups for LLL acupuncture (808 nm, 0.5 W, 30 J, 4 J/cm^2 energy density, 60 seconds; group 1), and cupping (group 2) of masticatory muscle trigger points. Both treatments were performed for maximally eight sessions once every other day. The level of pain at the trigger points was measured upon admission, before and 5 minutes after treatment in each session, at ten days, and two months after treatment completion by a visual analog scale (VAS). The painless maximum mouth opening (MMO) and patient satisfaction with treatment were also assessed at the time as mentioned earlier points. **Results:** Averagely, 4.5 treatment sessions were required to achieve a 50% reduction in VAS pain score, with no significant difference between the two groups (P=0.9). Both treatments significantly decreased the number of trigger points and pain score, but this reduction occurred significantly sooner in the cupping group (P<0.01). MMO significantly improved in both groups after treatment with no significant difference between them (P=0.2). Patients were significantly more satisfied with LLL acupuncture (P<0.05). **Conclusion:** Both cupping and LLL acupuncture are equally effective for MPDS; thus, the patient can choose the type of treatment after receiving sufficient information regarding the two modalities. **[GMJ.2022;11:e2305]** **DOI:10.31661/gmj.v11i0.2305**

Keywords: Laser Therapy; Acupuncture Therapy; Cupping Therapy; Facial Neuralgia

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Introduction

Temporomandibular disorders (TMDs) refer to a group of temporomandibular joint (TMJ) problems that mainly cause non-odontogenic pain in the orofacial region and are a subgroup of skeletal muscle disorders [1,2]. TMD patients usually complain of pain at the muscles of mastication around the TMJ area or in the peri-auricular region. Also, TMD patients may suffer from headaches, facial pain, earache, dizziness, tinnitus, neck pain, and shoulder pain. Other reported complaints include jaw locking when opening or closing the jaw, and clicking, popping, and grating jaw sounds [1-3].

TMDs often affect women between 20 to 40 years of age [3,4]. Their etiology is still a matter of debate; however, occlusal interferences, parafunctional habits, positional changes of the teeth, oral and facial macro-trauma, and hormonal changes have been proposed to be implicated in the development of TMDs [2,3,5]. Around 75% of TMD patients have chronic symptoms [6], which are associated with adverse psychological outcomes such as depression and somatization [7,8]. The diagnosis of TMDs is made according to the Research Diagnostic Criteria for TMDs that is a globally accepted multi-dimensional diagnostic tool [8-10].

Myofascial pain dysfunction syndrome (MPDS) is among the most common causes of facial pain and the most common type of TMD [11]. MPDS patients experience pain, stiffness of movements, and tenderness of the muscles of mastication, which adversely affect their quality of life [12].

Since no consensus has been reached on a specific etiology for MPDS, several treatment modalities have been proposed for its management such as occlusal splints, occlusal adjustment, physiotherapy, laser therapy, pharmaceutical and non-pharmaceutical psychological treatments, and surgery. However, since approximately 85% to 90% of patients are treated by non-surgical interventions, it is imperative to find the most conservative approach that can decrease pain and improve muscle function in the majority of patients [13]. Sipilä *et al.* [14] discussed that MPDS is not a self-limiting condition and requires treatment. The primary treatment approach for TMDs aims to control pain and dysfunction with reversible treatments such as neuromyorelaxing occlusal splints [1,15].

Pharmaceutical therapy is the most commonly adopted treatment option for TMDs [16]. Non-steroidal anti-inflammatory drugs (NSAIDs) are probably the most commonly prescribed medications for pain control in TMDs. NSAIDs are prescribed for over 90% of patients with TMDs [17]. They inhibit the synthesis of prostaglandins and exert their analgesic and anti-inflammatory effects. However, NSAIDs have side effects such as gastric stimulation and platelet inhibition [18].

Some adjuvant modalities that are often used for pain control have also been suggested for TMDs, including a wide range of medications and alternative therapeutic modalities such as acupuncture [19,20]. The analgesic efficacy of acupuncture is related to the induction of production of endogenous opioids in the brain [21] and stimulation of monoaminergic and dopaminergic internal systems [22]. However, the stimulations caused by traditional needles are not completely acceptable since they can cause infection or unwanted trauma [23]. Thus, low-level laser (LLL) is used in modern acupuncture instead of needles but with the same traditional principles [24].

This modality is faster and can be performed for anatomical sites where needle insertion would be hazardous [25]. A clinical study confirmed that LLL acupuncture was comparable to needle acupuncture in terms of clinical efficacy [24]. Laser acupuncture is used for the treatment of hypersensitivity conditions such as allergic rhinitis, bronchial asthma, neurodermatitis, neural diseases (such as migraine, trigeminal neuralgia, post herpes zoster neuralgia, and phantom pain), orthopedic disorders, and some pediatric conditions (such as bronchial asthma, otitis media, and cystitis) [26].

Evidence shows that traditional needle acupuncture is effective for the alleviation of pain and other symptoms of chronic TMDs [19,27]. Numerous studies are available regarding the advantages of needle

acupuncture; however, reports regarding the efficacy of LLL acupuncture for the treatment of TMDs are limited.

Cupping is a type of alternative therapy that originated in China and involved placing cups on the skin of the painful area to create suction [28]. Cupping requires several cups (6 or more) of different sizes made of plastic, glass, bamboo, ceramic, metal, or silicone, a manual suctioning pump, a #15-#21 surgical scalpel, a needle, antiseptic agent, pad, and dressing [29]. Each cupping therapy session would take 5 to 20 minutes, depending on the patient's condition, and a treatment course includes 4 to 6 sessions within 3 to 10 days [30].

Considering all the above, this study aimed to assess the efficacy of LLL acupuncture and cupping for the treatment of MPDS. The null hypothesis was that no difference would be found between LLL acupuncture and cupping for treatment of MPDS in terms of pain relief, painless maximum mouth opening (MMO), and patient satisfaction with the treatment.

Materials and Methods

This study was conducted at the Oral Medicine Department of School of Dentistry, Shahed University of Medical Sciences, between May 2020 and May 2021. The study was approved by the ethics committee of this university (IR.SHAHED.REC.1399.026) and registered in the Iranian Registry of Clinical Trials (IRCT20111121008146N38).

Trial Design

A double-blind, before-after, randomized clinical trial was conducted in which one group underwent LLL acupuncture, and the other group underwent cupping. The results were reported according to the Consolidated Standards of Reporting Trials (CONSORT).

Participants, Eligibility Criteria, and Settings

The inclusion criteria were as follows: MPDS patients complaining of pain of the muscles of mastication lasting for 3 months or more, age older than 18 years [31], presence of a trigger point in the temporalis, masseter, or external pterygoid muscle identified by clinical examination and palpation [31], having idiopathic pain, willingness for participation in the study, and signed informed consent forms.

The exclusion criteria were as follows: intake of analgesics, muscle relaxants, anti-inflammatory medications such as NSAIDs, and benzodiazepines [31], fear of cupping or laser therapy [32], hemorrhagic and vascular conditions [32], presence of underlying metabolic diseases such as diabetes mellitus, or hypertension [32], neurological disorders such as trigeminal neuralgia [32], pregnancy [31], and history of previous treatments for TMDs [31].

The sample consisted of 60 matched MPDS patients who required treatment.

Sample Size Calculation

The sample size was calculated to be 60 according to a study by Costa *et al*. [44], assuming alpha 0.05, beta 0.2, and study power of 0.8.

Randomization

Eligible MPDS patients (n=60) were randomly divided into two groups (n=30) for treatment with LLL acupuncture and cupping by using a table of random numbers.

Blinding

To blind the patients to the type of allocated intervention, placebo cupping was performed for the LLL acupuncture group, and sham laser was used for the patients in the cupping group. The examiner who assessed the pain score, MMO, and patient satisfaction, and the statistician who analyzed the data were blinded to the group allocation of patients.

Interventions

The patients were clinically examined by a post-graduate student of oral medicine under the direct supervision of an oral medicine specialist. The diagnosis of MPDS was made according to the Research Diagnostic Criteria for TMD [8-10]. For this purpose, a complete history was taken from patients, and a physical examination of the involved muscles was also performed. The presence of myofascial trigger points in the involved muscles is a

characteristic symptom for MPDS, which is often associated with pain, jaw movement limitation, and difficulty in jaw functions such as speech and mastication [33].

The diagnostic criteria for detection of trigger points included: (I) presence of a tender point in the stiffed muscle [34], (II) a sudden local pain response elicited by palpation of the trigger point [34], (III) the same sudden local response is elicited every time the trigger point is palpated [34], and (IV) movement limitation and painful muscle movements [33]. To assess the pain and tenderness of the masseter muscle, fingers of both hands were placed at the two sides of the zygomatic arch in front of the TMJ and were then slowly moved towards the inferior border of the mandibular ramus with a circular motion [35]. The level of pain was subjectively reported by patients. For this purpose, the patients were instructed on how to use a 0-10 visual analog scale (VAS), and accordingly reported their preoperative level of pain (VAS1 pain score). A 10-cm VAS was used for this purpose; 0 indicated no pain while 10 indicated maximum excruciating pain [36].

To assess the pain and tenderness of the temporalis muscle, the fingers were placed over the anatomical location of this muscle in a clenching manner and this muscle was clinically palpated with a circular motion and gentle pressure. The patient was asked about any pain or discomfort felt using the VAS [35].

Since direct palpation of pterygoid muscles does not provide accurate information regarding their painfulness, the medial and lateral pterygoid muscles were examined in function. For examination of the right medial pterygoid muscle, the patients were asked to shift their jaw to the left while this movement was resisted by the examiner's hand.

The same in opposite direction was performed for examination of the medial pterygoid muscle of the contralateral side [35,37]. The patients were requested to report any pain or discomfort in this process using the VAS.

The provocation test was used to examine the lateral pterygoid muscle. For this purpose, the patients were asked to move their jaw forward against the pressure applied by the thumb finger of the examiner over the mandibular symphysis [35]. The level of pain experienced by the patient in this process adjacent to the TMJ was recorded using the VAS.

The level of pain was recorded upon patient admission (VAS1), before treatment, and at 5 minutes after treatment in each session, and at the two follow-up sessions scheduled at 10 days and 2 months after completion of treatment (after the final treatment session).

Painless MMO was evaluated using the Helkimo index. Accordingly, painless MMO by 30 to 39 mm was considered as mild limitation and MMO<30 mm indicated severe limitation [38]. MMO was quantified by measuring the distance between the incisal edges of the upper and lower central incisors by a ruler and reported in millimeters (mm).

MMO was recorded upon patient admission (MMO1) and before and 5 minutes after treatment in each treatment session, and also at 10-day and 2-month follow-up time points. Trigger point therapy is commonly performed for the temporalis, masseter, and lateral pterygoid muscles. After finding the painful trigger points of the abovementioned muscles, number of trigger points was determined in each session and recorded in patient records (marked on the schematic image of the respective muscles) [39].

Treatment in the two groups was performed after obtaining written informed consent from the patients and their random allocation to the two groups. Patients in the two groups were matched in terms of the mean age, gender, and subjective VAS1 (pain score upon patient admission).

Group 1 (LLL acupuncture): Patients in this group underwent LLL therapy (LLLT) with Ga-Al-As diode laser (Klas-DX6182; Konftec; Konf, Taiwan) with 808 nm wavelength with 0.5 W power, 30 J energy, and 4 J/cm^2 energy density for 60 seconds per each trigger point in continuous-wave mode. The laser was irradiated in contact mode with the gentle pressure of the hand-piece tip over the previously identified muscle trigger points. Laser therapy was performed three sessions/week once every other day, for a total of 8 sessions. The treatment would be discontinued at any time in case of full recovery before the 8th session (Figure-1) [40].

Figure 1. LLL acupuncture

Figure 2. Cupping

Both the operator and the patient wore protective glasses during laser irradiation, and tip #5 of the laser device was used as instructed by the manufacturer. Also, this tip had the closest diameter to that of the cups used for cupping.

Laser therapy was performed by a post-graduate student of oral medicine under the direct supervision of an oral medicine specialist. Group 2 (cupping): The trigger points were first identified and then cupping was performed by a post-graduate student of oral medicine under direct supervision of an acupuncturist by using 10 cc disposable transparent plastic cups with pressure valves (Iran). The cups were placed over the trigger points and vacuumed by using automatic dental saliva ejector (4U, Iran).

The level of vacuum was visually controlled such that the vacuum caused 1 cm of soft tissue and skin bump at the center of the cup (Figure-2). This amount corresponded to p ¼ 254 mbar negative pressure [41]. Duration of placement of cup over the skin was 5 minutes while maintaining the negative pressure. This procedure was repeated for 8 sessions once every other day [42].

Measurement of VAS pain score and MMO was performed at the designated time points equally in both groups. Recovery was defined as a 50% reduction in VAS pain score as reported subjectively by the patients [43]. Patient satisfaction with the treatment was also asked and accordingly, the patients were categorized into two groups of satisfied and dissatisfied.

Primary and Secondary Outcomes

The main objective of this study was to assess the analgesic efficacy of LLL acupuncture and cupping for the treatment of MPDS. Assessment of painless MMO and patient satisfaction with the treatment were the secondary outcomes of this study.

Interim Analyses and Stopping Guidelines

No interim analyses were performed, and no stopping guidelines were established.

Statistical Analysis

The Wilcoxon test was used to assess the change in pain score after the intervention within each group. The two groups were compared regarding the pain score by the Mann-Whitney U test. T-test was applied to analyze the change in painless MMO after the intervention within each group, and also between the two groups. The Chi-square test was used to compare the satisfaction of patients with the treatment between the two groups. Repeated measures ANOVA was applied to analyze the effect of time and type of treatment on the outcomes. All statistical analyses were carried out using SPSS (SPSS Inc., Chicago, Illinois, USA) version 24 at a 0.05 level of significance.

Results

Participant Flow

Sixty patients were evaluated in this study including 26 males (44%) and 34 females (56%). There were 14 males and 16 females in the laser group and 12 males and 18 females in the cupping group. The two groups were not significantly different regarding gender distribution (P=0.3)

The mean age was 33.88±6.03 years (range 19 to 48 years). The mean age was 34.33±6.01 years in the laser and 33.43±6.06 years in the cupping group. The two groups were not significantly different regarding the mean age (P=0.3).

Harms

No patients were harmed during the study.

Group Analyses

A number of treatment sessions required until recovery: The number of treatment sessions required until recovery (50% reduction in VAS1) was 4.86±0.8 sessions in the LLL acupuncture and 4.23±1.05 sessions in the cupping group. The two groups were not significantly different in this respect (P=0.9).

The number of trigger points: The number of trigger points was the same in the two groups before the intervention (P>0.05).

Table-1 presents the mean number of trigger points in the two groups of patients in each session. As shown, the difference between the two groups in this respect was not significant in the first three sessions; however, this difference was significant in the fourth to eighth sessions (P<0.01), and the number of trigger points was significantly lower in the cupping group. The difference was not significant at 10 days and 2 months between the two groups in this regard (P>0.05).

Primary outcome. VAS pain score: Table-2 presents the mean VAS pain score in the two groups at different time points. The difference between the two groups was not significant in the VAS pain score before treatment or at 5 minutes after treatment in the first and second sessions (P>0.05).

In the third session, this difference was not significant before treatment; however, the pain score after treatment was 19% lower in the cupping group, and this difference was significant (P<0.01). In the fourth session, the pain score in the cupping group was 1.1 units or 29% lower than that in the LLL acupuncture group, and this difference was significant (P<0.01). At 5 minutes after

Table 1. Number of Trigger Points in The Two Groups Over Time (n=30 in Each Group).

Session	Time	LLL acupuncture	Cupping	P-value
1	Before treatment	0.71±1.96	0.82±1.93	0.7>
	5 minutes after treatment	0.71±1.96	0.82±1.93	0.7>
2	Before treatment	0.71±1.96	0.69±1.83	0.4>
	5 minutes after treatment	0.71±1.96	0.69±1.83	0.4>
3	Before treatment	0.71±1.96	0.61±1.63	0.06>
	5 minutes after treatment	0.73±1.93	0.62±1.6	0.07>
4	Before treatment	0.64±1.83	0.56±1.43	0.01>
	5 minutes after treatment	0.61±1.8	0.56±1.43	0.01>
5	Before treatment	0.49±1.6	0.44±1.26	0.01>
	5 minutes after treatment	0.49±1.6	0.44±1.26	0.01>
6	Before treatment	0.6±1.66	0.6±0.9	0.01>
	5 minutes after treatment	0.49±1.63	0.66±0.8	0.01>
7	Before treatment	0.88±1.33	0.62±0.43	0.01>
	5 minutes after treatment	0.88±1.33	0.62±0.43	0.01>
8	Before treatment	0.99±0.9	0.43±0.23	0.01>
	5 minutes after treatment	0.98±0.73	0.44±0.2	0.03>
10 days	------	0.86±0.5	0.46±0.3	0.6>
2 months	------	0.89±0.56	0.44±0.26	0.3>

Table 2. Mean VAS Pain Score in The Two Groups at Different Time Points.

Session	Time	LLL acupuncture	Cupping	P-value
1	Before treatment	5.8±2.02	1.95±5.36	0.4>
	5 minutes after treatment	5.53±1.75	1.89±5.33	0.7>
2	Before treatment	5.03±1.75	1.7±5	1>
	5 minutes after treatment	4.86±1.59	1.44±4.63	0.6>
3	Before treatment	4.43±1.45	1.4±4.03	0.2>
	5 minutes after treatment	4.26±1.46	1.16±3.43	0.01>
4	Before treatment	1.17±3.73	1.09±2.63	0.01>
	5 minutes after treatment	1.16±3.56	0.91±2.3	0.01>
5	Before treatment	1.09±2.33	0.73±2.06	0.3>
	5 minutes after treatment	1.06±2.1	0.73±1.93	0.7>
6	Before treatment	0.99±2.33	0.9±1.26	0.01>
	5 minutes after treatment	0.88±1.96	0.82±0.93	0.01>
7	Before treatment	1.06±1.36	0.77±0.53	0.01>
	5 minutes after treatment	0.92±1.2	0.56±0.4	0.01>
8	Before treatment	0.96±0.8	0.43±0.23	0.01>
	5 minutes after treatment	0.77±0.56	0.4±0.2	0.03>
10 days	-------	0.67±0.4	0.46±0.3	0.8>
2 months	-------	0.67±0.43	0.44±0.23	0.4>

treatment, the pain score was significantly lower in the cupping group (P<0.01).

In the fifth session, the difference between the two groups was not significant neither before nor after the intervention (P>0.05).

In the sixth, seventh, and eighth sessions, the difference between the two groups in VAS pain score was significant both before and after the treatment (P<0.01). The difference in this regard was not significant between the two groups at 10 days and 2 months.

Assessment of within-group changes in VAS pain score revealed a non-significant reduction in pain score in both groups in the second session prior to treatment onset compared with baseline pain score. At 5 minutes after treatment, 16% reduction was noted in LLL acupuncture and 14% reduction was noted in the cupping group compared to VAS1; both reductions were significant (P<0.05).

In the third session, prior to treatment, pain reduction compared to VAS1 was significant in both groups (P<0.05). The reduction in pain score was also significant after treatment in both groups compared with VAS1 (P<0.01). In the fourth session, the pain score was significantly lower in both groups compared with VAS1 both before and 5 minutes after treatment (P<0.01). The same result was obtained in the sixth to eighth sessions (P<0.01).

Secondary outcome. MMO: Table-3 presents the MMO in the two groups at different time points. The difference in MMO was not significant between the two groups prior to treatment onset in the first session (P=0.2) or at any of the next treatment sessions (P>0.05). In this study, 48.3% of patients had MMO limitations prior to treatment; out of which, 45% had mild and 3.3% had severe limitations.

Patient satisfaction: In the LLL acupuncture group, 25 out of 30 patients were satisfied with the treatment (85%) while in the cupping group, 20 out of 30 patients were satisfied with the treatment (66.7%). Treatment satisfaction was significantly higher in the LLL acupuncture group (P<0.05).

Table 3. MMO in The Two Groups at Different Time Points.

Session	Time	LLL acupuncture	Cupping	P-value
1	Before treatment	6.83±40.96	4.78±39.03	0.2>
	5 minutes after treatment	6.8±41.26	4.62±39.2	0.1>
2	Before treatment	6.58±42.03	4.13±39.96	0.1>
	5 minutes after treatment	6.61±42.43	40.9±4.2	0.2>
3	Before treatment	6.17±43.13	3.65±41.23	0.1>
	5 minutes after treatment	6.24±43.4	3.46±41.86	0.1>
4	Before treatment	5.79±43.73	2.63±42.43	0.2>
	5 minutes after treatment	5.66±44.6	2.8±43.3	0.1>
5	Before treatment	5.56±44.96	2.93±43.7	0.2>
	5 minutes after treatment	5.37±45.83	2.09±44.3	0.2>
6	Before treatment	5.21±45.56	1.91±45.33	0.6>
	5 minutes after treatment	5.13±46.36	1.86±45.36	0.3>
7	Before treatment	5.36±46.43	1.62±45.3	0.2>
	5 minutes after treatment	5.24±46.8	1.47±45.5	0.1>
8	Before treatment	5.33±47.03	1.61±45.4	0.06>
	5 minutes after treatment	5.36±47.16	1.52±45.56	0.07>
10 days	-----	4.9±46.96	1.67±45.23	0.07>
2 months	-----	5.35±47	1.84±45.4	0.1>

Discussion

This study assessed the efficacy of LLL acupuncture and cupping for treatment of MPDS. To the best of the authors' knowledge, this study is the first to compare the efficacy of these two modalities for the treatment of MPDS. The present results showed a higher prevalence of MPDS in females (56%) than males (44%), which was in agreement with previous findings [13,45]. The mean age of patients in this study (33.88±6.03 years) was in line with the findings of Ahrari *et al*, [32] and Fernández-Carnero *et al.* [34]. The number of treatment sessions until recovery was not significantly different between the two groups in this study. The number of identified trigger points decreased with treatment in both groups; however, this reduction was significantly greater in the fourth to eighth sessions in the cupping group compared with the LLL acupuncture group, indicating higher efficacy of cupping at the designated time points.

After completion of treatment, the trigger points were not significantly different between the two groups during the follow-up sessions, which indicates equal efficacy of the two groups. Regarding the VAS pain score, the current results showed that the pain reduction at the end of the third treatment session in the cupping group was significantly greater than the laser group. This finding may be due to the fact that response to LLLT requires time, while cupping has an immediate effect. After completion of treatment, 17 patients (56.6%) in the LLL acupuncture group and 24 patients (80%) in the cupping group reached complete painlessness (VAS=0). Recurrence of pain did not occur during the follow-up period in any patient. Thus, both modalities were equally effective for pain relief. Therefore, the null hypothesis of the study in this regard was accepted.

Regarding MMO, limited MMO (<40 mm) was recorded in 48.3% of patients prior to treatment. This rate was 26% in the study by Madani and Mahdizadeh [45] and 40.36% in

the study by Darbandi and Jajouei [46]. MMO increased with treatment in both groups with no significant difference between them, and both treatments were equally effective in this regard. Thus, the null hypothesis in this respect was accepted. Patient satisfaction was significantly higher with LLL acupuncture, probably due to fewer complications since cupping has some temporary side effects such as redness or uncomfortable sense of suction [40]. Thus, the null hypothesis was rejected in this regard. Three theories explain the effectiveness of cupping for pain relief, inactivation of trigger points, and improvement of painless MMO namely the pain gate theory, the diffuse noxious inhibitory theory, and the relax zone theory. The pain gate theory is the most probable theory which states that cupping affects the pain receptors in the spinal cord and brain, and alleviates chronic pain as such. Also, the impulses sent by larger nerve fibers partially inhibit the presynaptic receptors. Cupping stimulates the pain receptors, increases the frequency of impulses, and alleviates pain by decreasing the input [42]. The diffuse noxious inhibitory theory appears to be the prerequisite to prevent stimulation for pain reduction. According to this theory, a type of pain can inhibit another type of pain. Thus, stimulation of skin and capillaries by cupping can serve as a stimulus to activate the diffuse noxious inhibitory system [42]. According to the relax zone theory, external manifestations of an internal process can often be detected at an area distal to the affected organ. This can be explained by the interactions of neural, muscular, and chemical pathways [42]. Also, cupping can cause systemic relaxation and lead to pain relief by increasing the production of endogenous opioids in the brain [42]. Several explanations have also been provided for analgesic effects of LLL, inactivation of trigger points, and improvement of MMO. The suggested mechanisms include inhibition of release of pain mediators, inhibition of accumulation of acetylcholine by increasing the activity of acetylcholine esterase, vasodilation and enhancement of blood supply to the tissue, desensitization of receptors and transfer of pain signals, decreased permeability of cell membrane to Na^+ and K^+ and hypo-polarization of neurons and consequently increased pain threshold, increased ATP production and repolarization of cell membrane following increased tissue metabolism, increased descending analgesic impulses in the posterior spinal horn and inhibition of pain sensation at the cortical level, balancing the activity of autonomic system (adrenaline-noradrenaline), and increased production of endorphins [35].

To the best of the authors' knowledge, no previous study has compared the efficacy of LLL acupuncture and cupping for treatment of MPDS to compare our results. Thus, the results are compared with relatively similar studies. Seifi *et al*. [47] compared the efficacy of LLLT (810 nm, 0.5 W, 60 seconds) and transcutaneous electrical nerve stimulation (TENS) for the treatment of TMDs. They used laser settings similar to those adopted in the present study and reported that both LLLT and TENS were significantly more effective than the placebo for pain reduction and improvement of MMO. Also, both LLLT and TENS were equally effective for pain reduction and enhancement of MMO, which was similar to the present findings. Khaleghi *et al*. [48] compared LLLT (810 nm laser, 0.5 W, 60 seconds) with pharmacotherapy with 500 mg naproxen twice daily for pain control in MPDS. They reported that LLLT resulted in significant pain reduction and improvement of MMO while such results were not recorded in the pharmaceutical therapy group. Their results regarding optimal efficacy of LLLT for pain reduction and improvement of MMO in MPDS patients were in line with the present findings. Ahrari *et al*. [32] assessed the efficacy of 810-nm LLL (average power 50 mW, peak power 80 W, 1,500 Hz, 120 seconds, 6 J, and 3.4 J/cm^2 per point) for pain reduction and improvement of function of the muscles of mastication in patients with TMDs and reported that LLLT significantly improved MMO and decreased pain compared with the placebo.

Azizi *et al*. [49] evaluated the efficacy of Ga-Al-As laser (780 mm) for treatment of MPDS and reported a significant improvement in

pain and tenderness of the masseter and medial and lateral pterygoid muscles, which continued for 3 months after completion of treatment, and were in agreement with the present results. Manfredini *et al.* [50] compared three modalities of LLLT, appliance therapy, and counseling for treatment of MPDS patients. They used VAS and electromyography to assess the outcome, and reported a significant reduction in pain and muscle index in all three groups.

Tanganeli and de Souza Zaroni [40] compared the efficacy of infrared LLL and dry needling for inactivation of bilateral masseter muscle trigger points in a case report and showed that both modalities were highly effective. Also, patients preferred LLLT; their results were similar to the present findings.

Basili *et al*. [51] evaluated the efficacy of LLLT (830 nm irradiated for 60 seconds, similar to present study) for treatment of pain in TMD patients. They concluded that LLLT decreased pain and resolved the dysfunction of TMJ in TMD patients, which was in accordance with the present results. Costa *et al.* [44] assessed the analgesic effects of photobiomodulation therapy with an 830 nm laser on the muscles of mastication. No significant difference was found between the laser and placebo groups in MMO but pain reduction was significantly greater in the laser group. Inefficacy of LLLT for improvement of MMO in their study (unlike the present findings) may be due to the lower power of laser used in their study (100 mW in their study versus 500 mW in our study). It appears that laser power >100 mW is required to cause significant improvement in MMO.

Wang *et al*. [52] assessed the effects of LLLT (830 nm) on TMDs and reported faster pain reduction and improvement of MMO in the laser group compared with the control group. Similar to the present study, they indicated the optimal efficacy of LLLT for the improvement of TMDs.

Rohlİg *et al*. [53] showed improvement of muscle tenderness, jaw movement, and pressure pain threshold by LLLT (820 nm, 0.3 W, 8 J/cm^2 energy density).

Fernández-Carnero *et al*. [34] evaluated the short-term effects of dry needling of active trigger points in the masseter muscle in TMD patients. They showed that dry needling significantly increased the pressure pain threshold and painless MMO compared with the placebo, which was in line with the current findings. Large sample size, long follow-up period, and assessment of patient satisfaction were among the main strengths of this study, which have been less commonly addressed in previous studies. This study had some limitations as well. Some patients were lost to follow-up which was replaced with eligible new cases. Future studies are required to compare the efficacy of these treatments over longer periods of time.

Conclusion

Both cupping and LLL acupuncture may be used for the treatment of MPDS with equal efficacy. However, considering the higher patient satisfaction with LLL acupuncture and lower cost of cupping, it would be best to brief the patients regarding the advantages and disadvantages of each modality and allow the patients to select their modality of choice.

Conflict of Interest

The authors declare that they have no competing interests.

References

1. Carrara SV, Conti PC, Barbosa JS. Termo do 1º consenso em disfunção temporomandibular e dor orofacial. Dental Press Journal of Orthodontics. 2010;15:114-20.
2. Greene CS. The etiology of temporomandibular disorders: implications for treatment. J Orofac Pain. 2001;15(2):93-105.
3. Glaros AG. Temporomandibular disorders

and facial pain: a psychophysiological perspective. Appl Psychophysiol Biofeedback. 2008 ;33(3):161-71.
4. Al-Jundi MA, John MT, Setz JM, Szentpétery A, Kuss O. Meta-analysis of treatment need for temporomandibular disorders in adult nonpatients. J Orofac Pain. 2008;22(2):97-107.
5. Thilander B, Bjerklin K. Posterior crossbite and temporomandibular disorders (TMDs): need for orthodontic treatment?. Eur J Orthod. 2012;34(6):667-73.
6. Manfredini D, Winocur E, Ahlberg J, Guarda-Nardini L, Lobbezoo F. Psychosocial impairment in temporomandibular disorders patients. RDC/TMD axis II findings from a multicentre study. J Dent. 2010;38(10):765-72.
7. de Oliveira SB, de Siqueira SR, Sanvovski AR, do Amaral LM, de Siqueira JT. Temporomandibular Disorder in Brazilian patients: a preliminary study. J Clin Psychol Med Settings. 2008;15(4):338-43.
8. Ohrbach R, Turner JA, Sherman JJ, Mancl LA, Truelove EL, Schiffman EL, Dworkin SF. The Research Diagnostic Criteria for Temporomandibular Disorders. IV: evaluation of psychometric properties of the Axis II measures. J Orofac Pain. 2010;24(1):48-62.
9. Dworkin SF, Sherman J, Mancl L, Ohrbach R, LeResche L, Truelove E. Reliability, validity, and clinical utility of the research diagnostic criteria for Temporomandibular Disorders Axis II Scales: depression, non-specific physical symptoms, and graded chronic pain. J Orofac Pain. 2002;16(3):207-20.
10. John MT, Dworkin SF, Mancl LA. Reliability of clinical temporomandibular disorder diagnoses. Pain. 2005;118(1-2):61-9.
11. Bolouri AJ, Delavarian Z, Mortazavi H, ASl HR, Falaki A, Falaki F. The effect of combination therapy with Fluoxetine and Clonazepam in My facial Pain Dysfunction Syndrome. Aust. J. Basic & Appl. Sci. 2011;5(12):520-5.
12. Barbosa TS, Leme MS, Castelo PM, Gavião MB. Evaluating oral health-related quality of life measure for children and preadolescents with temporomandibular disorder. Health Qual Life Outcomes. 2011;9(1):1-12.
13. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. N Engl J Med. 2008;359(25):2693-705.
14. Sipilä K, Zitting P, Siira P, Laukkanen P, Järvelin M-R, Oikarinen KS, et al. Temporomandibular disorders, occlusion, and neck pain in subjects with facial pain: a case-control study. Cranio. 2002;20(3):158-64.
15. Alencar Jr F, Becker A. Evaluation of different occlusal splints and counselling in the management of myofascial pain dysfunction.J Oral Rehabil. 2009;36(2):79-85.
16. Fleckenstein J, Zaps D, Rüger LJ, Lehmeyer L, Freiberg F, Lang PM, Irnich D. Discrepancy between prevalence and perceived effectiveness of treatment methods in myofascial pain syndrome: results of a cross-sectional, nationwide survey. BMC Musculoskelet Disord. 2010;11(1):1-9.
17. Cairns BE. Pathophysiology of TMD pain–basic mechanisms and their implications for pharmacotherapy. J Oral Rehabil. 2010;37(6):391-410.
18. Argoff CE, Kopecky EA. Patients with chronic pain and dysphagia (CPD): unmet medical needs and pharmacologic treatment options. Curr Med Res Opin. 2014;30(12):2543-59.
19. Rosted P, Bundgaard M, Pedersen AM. The use of acupuncture in the treatment of temporomandibular dysfunction–an audit. Acupunct Med. 2006;24(1):16-22.
20. La Touche R, Angulo-Díaz-Parreño S, de-la-Hoz JL, Fernández-Carnero J, Ge HY, Linares MT, Mesa J, Sánchez-Gutiérrez J. Effectiveness of acupuncture in the treatment of temporomandibular disorders of muscular origin: a systematic review of the last decade. J Altern Complement Med. 2010;16(1):107-12.
21. Cidral-Filho FJ, Da Silva MD, Moré AO, Córdova MM, Werner MF, Santos AR. Manual acupuncture inhibits mechanical hypersensitivity induced by spinal

nerve ligation in rats. Neuroscience. 2011;193:370-6.
22. Zhao ZQ. Neural mechanism underlying acupuncture analgesia. Prog Neurobiol. 2008;85(4):355-75.
23. Ebneshahidi NS, Heshmatipour M, Moghaddami A, Eghtesadi-Araghi P. The effects of laser acupuncture on chronic tension headache–a randomised controlled trial. Acupunct Med. 2005;23(1):13-8.
24. Ferreira LA, de Oliveira RG, Guimarães JP, Carvalho AC, De Paula MV. Laser acupuncture in patients with temporomandibular dysfunction: a randomized controlled trial. Lasers Med Sci. 2013;28(6):1549-58.
25. Litscher G. High-tech laser acupuncture is Chinese medicine. Medical Acupuncture. 2008;20(4):245-54.
26. Schikora D. Laserneedle acupuncture: a critical review and recent results. Medical Acupuncture. 2008;20(1):37-42.
27. Litscher G, Wang L, Wiesner-Zechmeister M. Specific effects of laserpuncture on the cerebral circulation. Lasers Med Sci. science. 2000;15(1):57-62.
28. Chi LM, Lin LM, Chen CL, Wang SF, Lai HL, Peng TC. The Effectiveness of Cupping Therapy on Relieving Chronic Neck and Shoulder Pain: A Randomized Controlled Trial. Evid Based Complement Alternat Med. 2016;2016:7358918.
29. Aboushanab TS, AlSanad S. Cupping therapy: an overview from a modern medicine perspective. J Acupunct Meridian Stud. 2018;11(3):83-7.
30. Al-Bedah AM, Elsubai IS, Qureshi NA, Aboushanab TS, Ali GI, El-Olemy AT, Khalil AA, Khalil MK, Alqaed MS. The medical perspective of cupping therapy: Effects and mechanisms of action. J Tradit Complement Med. 2019;9(2):90-7.
31. Salmos-Brito JA, de Menezes RF, Teixeira CE, Gonzaga RK, Rodrigues BH, Braz R, Bessa-Nogueira RV, de Martínez Gerbi ME. Evaluation of low-level laser therapy in patients with acute and chronic temporomandibular disorders. Lasers Med Sci. 2013;28(1):57-64.
32. Ahrari F, Madani AS, Ghafouri ZS, Tunér J. The efficacy of low-level laser therapy for the treatment of myogenous temporomandibular joint disorder. Lasers Med Sci. 2014;29(2):551-7.
33. Uemoto L, de Azevedo RN, Alfaya TA, Reis RN, de Gouvêa CV, Garcia MA. Myofascial trigger point therapy: laser therapy and dry needling. Curr Pain Headache Rep. 2013;17(9):357.
34. Fernández-Carnero J, La Touche R, Ortega-Santiago R, Galan-del-Rio F, Pesquera J, Ge HY, Fernández-de-Las-Peñas C. Short-term effects of dry needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. J Orofac Pain. 2010;24(1):106-12.
35. Okeson JP. Management of Temporomandibular Disorders and Occlusion-E-Book. Elsevier Health Sciences. 2014:184-91.
36. Glick M. Burket's oral medicine. PMPH USA. 2015:281.
37. Carlsson GE, Magnussan T. Managment Of Temporomandibular Disorders In The General Dental Practice. Quintessence Publishing Company; 1999:183-8.
38. Mortazavi H, Javadzadeh A, Delavarian Z, Zare Mahmoodabadi R. Myofascial pain dysfunction syndrome (MPDS). Iranian Journal of Otorhinolaryngology. 2010;22(4):131-6.
39. Rajkannan P. Dry needling technique in myogenous temporomandibular disorders: A clinical commentary. Journal of Advanced Clinical and Research Insights. 2016;3(3):107-9.
40. Tanganeli JP, de Souza Zaroni WC. Trigger Point Inactivation by Infrared Low Level Laser Therapy Compared With Dry Needling. Advances in Dentistry & Oral Health. 2017.
41. Tham LM, Lee HP, Lu C. Cupping: from a biomechanical perspective. J Biomech . 2006;39(12):2183-93.
42. Khalique SKA, Ukhalkar V. Cupping therapy in pain management-A review. National Journal of Research in Ayurved Science. 2019;7(3).
43. Alkhutari AS, Alyahya A, PC RC, Christidis N, Al-Moraissi EA. Is the therapeutic effect of occlusal stabilization appliances more than just placebo effect in the management of painful

temporomandibular disorders? A network meta-analysis of randomized clinical trials. J Prosthet Dent. 2021;126(1):24-32.
44. Costa SAP, Florezi GP, Artes GE, Costa JRD, Gallo RT, Freitas PM, et al. The analgesic effect of photobiomodulation therapy (830 nm) on the masticatory muscles: a randomized, double- blind study. Braz Oral Res. 2017;31:e107.
45. Madani AA, Mahdizadeh F. Prevalence of temporo mandibular joint disorders in patients referred to mashhad dental school. 2002;20(2):242-51.
46. Darbandi A, Jajouei A. Etiology of TMJ Disorders in Patients Referred to Shahed Dental School Tehran-2000. 2003;21(1):36-43.
47. Seifi M, Ebadifar A, Kabiri S, Badiee MR, Abdolazimi Z, Amdjadi P. Comparative Effectiveness of Low Level Laser Therapy and Transcutaneous Electric Nerve Stimulation on Temporomandibular Joint Disorders. J Lasers Med Sci. 2017;8(1):27-31.
48. Khalighi HR, Mortazavi H, Mojahedi SM, Marhabi SA, Abbasabadi FM. Low level laser therapy versus pharmacotherapy in improving myofascial pain disorder syndrome. J Lasers Med Sci. 2016;7(1):45-50.
49. Azizi A, Sahebjamee 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;1(2):53-8.
50. Manfredini D, Favero L, Cocilovo F, Monici M, Guarda-Nardini L. A comparison trial between three treatment modalities for the management of myofascial pain of jaw muscles: A preliminary study. Cranio. 2018;36(5):327-31.
51. Basili M, Barlattani Jr A, Venditti A, Bollero P. Low-level laser therapy in the treatment of muscle-skelet pain in patients affected by temporo-mandibular disorders. Oral Implantol (Rome). 2017;10(4):406-11.
52. Wang X, Yang Z, Zhang W, Yi X, Liang C, Li X. Efficacy Evaluation of Low-Level Laser Therapy on Temporomandibular Disorder. Hua Xi Kou Qiang Yi Xue Za Zhi. 2011;29(4):393-9.
53. Rohlig BG, Kipirdi S, Meric U, Capan N, Keskin H. Detailed Search Results Masticatory muscle pain and low-level laser therapy: a double-blind and placebo-controlled study. Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi [Turkish Journal of Physical Medicine and Rehabilitation]. 2011;57(1):31-7