The efficacy of low-level diode laser versus laser acupuncture for the treatment of myofascial pain dysfunction syndrome (MPDS)

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Background: Myofascial pain dysfunction syndrome (MPDS) is the most common type of temporomandibular disorder. This study compared the efficacies of low-level diode laser therapy (LLLT) and laser acupuncture therapy (LAT) in the treatment of MPDS.

Methods: This double-blind randomized controlled clinical trial included 24 patients with MPDS who were randomly divided into two equally sized groups. Patients in the LLLT group received 12 sessions of low-level diode laser irradiation applied to the trigger points of the masticatory muscles during 1 month. The same protocol was also used in the LAT group according to the specific trigger points. We measured pain intensity and maximum mouth opening in both groups at baseline, during treatment, and 2 months after treatment completion.

Results: The pain intensities decreased from 6.58±1.31 to 0.33±0.65 and from 7.08±1.37 to 0 in the LLLT and LAT groups, respectively. The maximum mouth openings increased from 32.25±8.78 mm to 42.58±4.75 mm and from 33±6.57 mm to 45.67±3.86 mm in the LLLT and LAT groups, respectively. Pain intensity (P = 0.839) and level of maximum mouth opening (P = 0.790) did not differ significantly between the groups.

Conclusion: Our results showed similar efficacy between LLLT and LAT in the treatment of MPDS signs and symptoms.

Keywords: Acupuncture, Low-Level Light Therapy, Temporomandibular Joint Disorders.

INTRODUCTION

Temporomandibular disorders (TMD) are a diverse group of pathologies involving the temporomandibular joint (TMJ), the muscles of mastication, and the supporting structures [1,2]. Epidemiologic studies have reported that 75% of the adult population has a minimum of one sign of TMJ dysfunction, with approximately 30% of individuals showing more than one symptom [3]. TMDs are common in adults aged 20–50 years, with a higher frequency in females than in males [4]. The signs and symptoms of TMDs include pain in the TMJ and muscles of mastication [1,3]; articular sounds and crepitus [3]; joint locking [3]; headache; earache [3]; and mouth opening deviation, deflection, or restriction [1].
TMD-associated pain is an important cause of disability, which imposes high socioeconomic burdens on patients [5]. Myofascial pain disorder syndrome (MPDS) is the most common form of TMDs affecting the muscles of mastication [6,7] and accounts for 90% of TMDs [8].

The various treatments for MPDS include soft diet, rest, moist heat, pharmacotherapy, ultrasound, massage therapy, transcutaneous electrical nerve stimulation (TENS), acupuncture, dry needling, and low-level laser therapy (LLLT) [9,10,11].

Among different physiotherapeutic methods for the treatment of MPDS, LLLT has gained popularity due to its conservativeness. LLLT has shown analgesic, healing, and anti-inflammatory effects on irradiated tissues. The mechanisms of action behind the therapeutic and analgesic effects are variable and include the release of endogenous opioids, enhancement of cellular respiration and tissue healing, vasodilation, increased pain threshold by changing the action potential of cell membranes, and decreasing inflammation by reducing prostaglandin E2 and cyclooxygenase 2 level [5].

Laser acupuncture therapy (LAT) is a therapeutic modality that uses laser light instead of a needle to stimulate acupuncture points [3]. This method has been used in the clinical setting since 1970 by using LLLT targeting the acupuncture points and some researchers have reported its optimal efficacy [12]. LAT is superior to conventional acupuncture since it is painless, atraumatic, non-invasive, and has a shorter duration. Moreover, LAT does not have any risk of infection and is ideal for patients with a fear of needles [13]. LAT has been suggested as an effective treatment modality to alleviate chronic pain associated with MPDS [14]. The mechanism of analgesic action of LAT has not been well elucidated; however, it may affect the synovia and stimulate cellular energy processes [14].

While Ahrari et al [15] and Maia et al [16] showed that LLLT improved MPDS, Huang et al [3] and Ferreira et al. [17] supported the therapeutic efficacy of LAT. However, no previous study compared the therapeutic and analgesic efficacy of LLLT and LAT for MPDS. As acupuncture points are easier to find and access than trigger points and LAT requires fewer trigger points than those required for LLLT, this study aimed to compare the efficacy of LLLT and LAT for the treatment of MPDS.

METHODS

According to the results of a pilot study, we considered the expected average difference in pain intensity based on a visual analogue scale (VAS) between the two groups to be equal to 3 and the standard deviation of VAS to be equal to 2.5. To test and detect this difference with a type I error level of $\alpha = 0.05$ and type II error level of $\beta = 0.2$ (power = 80%), at least 11 samples were required in each of the treatment groups. The required sample size was calculated using PASS software. Thus, each treatment group in the current study included patients. The patients were assigned to each group using a table of randomized numbers in Excel software.

$$n = \frac{2(z_{1-\alpha} + z_{1-\beta})^2 s^2}{(\mu_1 - \mu_2)^2}$$

This double-blind, single-center, randomized controlled clinical trial included 24 patients with MPDS presenting to the Oral Medicine Department of School of Dentistry at Shahid Beheshti University of Medical Sciences. The inclusion criteria were patients with: 1) MPDS who consented to participate in the study, 2) a minimum VAS pain score of 4 in their muscles of mastication, and 3) pain lasting for more than 3 months [17]. The exclusion criteria were patients 1) who were uncooperative, 2) with systemic diseases contraindicating laser therapy, and 3) under pharmaceutical therapy or other treatments for MPDS.

The study protocol was approved by the ethics committee of Shahid Beheshti University (code: IR.SBMU.IRDS.REC.1394.100) and registered in http://www.irct.ir/ (code: IRCT2015102124631N1). The
patients were briefed about the study and signed written informed consent forms before the beginning of the study. The patients were randomly divided into the LLLT and LAT groups (n = 12 each). The trained examiner and the patients were blinded to the group allocation (double-blind design).

The person who applied the laser irradiation was different from the person who evaluated the patients and completed the forms; thus, they were also blinded to the treatment modality. The patients were also unaware of which method of irradiation they had received.

The laser handpiece was calibrated before use at each radiation session and the laser probe was disinfected with alcohol before use for each patient. Both patients and operator wore protective glasses and laser irradiation was performed in a quiet room with adequate protective measures while the patient was seated on a dental chair in a comfortable position in such a way that the Frankfort plane (superior border of the external auditory meatus to the infraorbital rim) was parallel to the ground. The facial skin was cleaned with 70% alcohol before irradiation using a Ga-Al-As diode laser (Doctor Smile, Italy).

**Table 1. Laser irradiation protocol for the treatment of patients in the low-level diode laser therapy (LLLT) group**

|        | 1st week | 2nd week | 3rd week | 4th week |
|--------|----------|----------|----------|----------|
| Saturday | 0.5 W    | 0.2 W    | 0.3 W    | 0.1 W    |
| Sunday  | 0.4 W    |          |          |          |
| Monday  | 0.3 W    | 0.3 W    |          |          |
| Tuesday | 0.2 W    |          |          |          |
| Wednesday | 0.1 W | 0.4 W | 0.2 W | 0.2 W |

**Laser irradiation**

**LLLT group:** Patients in this group received 12 sessions of laser irradiation at 810 nm with the output powers indicated in Table 1 (irradiation protocol) in continuous mode using a probe with a diameter of 9 mm. The probe was positioned perpendicular to the irradiation site with slight pressure on the target muscle. Each masticatory muscle was examined by applying firm pressure bilaterally to find painful areas. The laser probe was then placed over the tender points identified in the first treatment session with mild pressure and irradiation was applied (Fig. 1) for 60 seconds [5]. In this protocol, the number of irradiated points was equal to the number of involved muscles in each patient. As the power in each session differed, the power densities varied in each session but ranged between 6 and 24 J/cm².

**LAT group:** Patients in the LAT group received 12 sessions of laser irradiation once every other day for 4 weeks. The modified laser irradiation protocol was adopted as described by Hu et al (14). The ST6 and ST7 standard acupuncture points on the same side as the involved muscle and the LI4 point on the opposite side were irradiated with a laser wavelength of 810 nm, 150mW maximum power output, 5 W/cm² power density, and 7.5 and 26.25 J/cm² energy density for 5 seconds. The local Ashi point was irradiated for 40 seconds with the aforementioned parameters (Fig. 2). The acupuncture points were irradiated by a trained operator expert in identifying acupuncture points [14]. The LAT procedure used a tip 1 mm in diameter in contact mode.

At the beginning of each treatment session, the patient pain level was determined by a blinded examiner, who palpated the muscles of mastication, during which the patients expressed their level of pain using a 0–10 cm VAS (0: no pain, 10: maximum imaginable pain) [18]. To measure the pain-free maximum mandibular opening (MMO), the patients were requested to open their mouths as wide as possible until they felt pain. The vertical distance between edges of the upper and lower central
incisors was then measured in millimeters using a ruler.

According to Helkimo’s index, MMO is the pain-free maximum opening assessed by measuring the vertical distance between the edges of the upper and lower central incisors. This distance is normally 40 mm; values of 30–39 mm and < 30 mm indicated mild and indicate severe limitation, respectively [8].

Subjective pain severity, tenderness of muscle points, and pain-free MMO were measured at each session before laser irradiation and at 2 months after treatment completion. A minimum of 50% reduction in pain was defined as the recovery criterion [19].

The data were analyzed using IBM SPSS Statistics for Windows, version 21.0. Qualitative data were reported as absolute values and relative frequencies. Qualitative data were analyzed using chi-square and Fisher’s exact tests. Quantitative data were reported as means and standard deviation. Repeated-measures analysis of variance (ANOVA) was used to analyze quantitative data. P < 0.05 was considered statistically significant.

RESULTS

Among the 24 patients, 20 (83.3%) were women and 4 (16.7%) were men. The sex distributions were the same in the LLLT and LAT groups.

The mean patient age was 41 years (range, 24–59 years). The highest involvement was the masseter, with a mean VAS pain score of 7.57, followed by lateral pterygoid (mean pain score 6.85), temporalis (mean pain score: 6.66), and medial pterygoid (mean pain score: 6.25) muscles.

Table 2 shows the sex distribution, class of occlusion,
parafuncional habits, and muscle involvement of the patients.

**Quantitative variables in LLLT and LAT groups**

**Subjective total pain score:** The mean subjective total pain scores were 6.58 ± 1.31 in the first treatment session and 0.33 ± 0.65 at 2 months after the last session (P < 0.0001) in the LLLT group and 7.08 ± 1.37 in the first treatment session and 0 at 2 months after the last irradiation session is the LAT group (P < 0.0001).

Table 3 shows the pain scores of the patients at the baseline, the final treatment session, the follow-up, the trend of reduction in total subjective pain and time of recovery (defined as a minimum of 50% reduction in baseline pain score) in the LLLT and LAT groups.

The reduction in subjective total pain score did not differ significantly between the two groups (P = 0.839).

**Pain-free MMO:** The mean pain-free MMO was 32.62 mm (range 43-15 mm) in all patients (n = 24). The mean pain-free MMO was 32.25 ± 8.76 mm at baseline and 42.58 ± 4.75 mm at 2 months (P = 0.001) in the LLLT group and 33 ± 6.57 mm at baseline and 45.67 ± 3.86 mm at 2 months in the LAT group (P < 0.0001). The mean MMO values at baseline, the final treatment session, and the follow-up session; increase in pain-free MMO; and complete recovery (no limitation in MMO) in the LLLT and LAT groups are shown in Table 3. The time of significant increase in MMO did not differ significantly between the two groups (P = 0.79).

**Changes in pain severity for each muscle of mastication:** The changes in pain severity for each of the muscles of mastication were assessed as the mean pain score at baseline, the mean pain score at the final session, the mean pain score at 2 months, the time required for a significant reduction in pain, and the time required for recovery (defined as a minimum of 50% reduction in baseline pain score) separately for the masseter, temporalis, medial pterygoid, and lateral pterygoid muscles in the LLLT and LAT groups (Table 4). Comparisons of the efficacies of LLLT and LAT separately for each muscle of mastication showed no significant differences (P = 0.258, 0.444, 0.253, and 0.630 for the masseter, temporalis, medial pterygoid, and lateral pterygoid muscles, respectively).

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Table 3. Overall subjective pain and maximum mouth opening changes in patients

| Changes in group | Changes in group | Last session | 2 month follow up | Sig change in pain reduction | Pain relief session | Initial MMO | Last session MMO | 2 month follow up MMO | Sig change in MMO increase | Time of deletion of MMO limitation |
|------------------|------------------|--------------|------------------|-----------------------------|-------------------|------------|----------------|---------------------|---------------------------|-------------------------------|
| LLLT             | Initial OSP      | 6.58 ± 1.31  | 0.33 ± 0.65      | 2nd session                 | 4th session       | 32.25 ± 8.76 | 42.17 ± 4.58     | 42.58 ± 4.75          | 2nd session                | 10th session                  |
|                  | Final OSP        | 0.33 ± 0.65  |                  |                             |                   |            |                |                     |                          |                               |
| LAT              | Initial OSP      | 7.08 ± 1.37  | 0.33 ± 0.77      | 2nd session                 | 4th session       | 33 ± 6.57   | 43.25 ± 3.95    | 45.67 ± 3.86          | 3rd session                | 11th session                  |
|                  | Final OSP        | 0.33 ± 0.77  |                  |                             |                   |            |                |                     |                          |                               |

LAT, laser acupuncture therapy; LLLT, low-level diode laser therapy; MMO, maximum mouth opening; MO, mouth opening; OSP, overall subjective pain; Sig, significant.

Table 4. Changes in pain intensity in the involved muscles in the low-level diode laser therapy (LLLT) and laser acupuncture therapy (LAT) groups

| Involved muscle | Group | Initial pain | Last session pain | 2 month follow up pain | Significant change in pain reduction | Pain relief session |
|-----------------|-------|--------------|-------------------|------------------------|--------------------------------------|---------------------|
| Masseter        | LLLT  | 7.57 ± 1.27  | 0.35 ± 0.62       | 0.35 ± 0.62            | 2nd session                          | 5th session         |
|                 | LAT   | 6.35 ± 2.42  | 0.10 ± 0.31       | 0                      | 2nd session                          | 5th session         |
| Temporalis      | LLLT  | 6.66 ± 0.57  | 0                 | 0                      | 2nd session                          | 3rd session         |
|                 | LAT   | 5.25 ± 1.17  | 0.33 ± 0.81       | 0                      | 3rd session                          | 5th session         |
| Medial pterygoid| LLLT  | 6.25 ± 1.66  | 0.50 ± 0.54       | 0.5 ± 0.54             | 3rd session                          | 6th session         |
|                 | LAT   | 5.35 ± 2.58  | 0                 | 0                      | 2nd session                          | 4th session         |
| Lateral pterygoid| LLLT | 6.85 ± 2.73  | 0.28 ± 0.48       | 0.28 ± 0.48            | 3rd session                          | 5th session         |
|                 | LAT   | 6.20 ± 2.61  | 0.20 ± 0.63       | 0.20 ± 0.63            | 3rd session                          | 4th session         |

LAT, laser acupuncture therapy; LLLT, low-level diode laser therapy.
DISCUSSION

MPDS is one of the most common causes of orofacial pain. Patients often seek a dentist for problems other than toothache [8,20]. We observed a female predominance of MPDS, with a female to male ratio of 5:1, consistent with the findings of previous studies reporting a three to five-fold higher female than male patients [3,7,14,21]. This higher prevalence may be related to lower pain tolerance, more stressful lives, and higher rate of psychological disorders in this group of patients [14]. More than 60% of patients with MPDS in this study were aged 25–50 years, with a mean age at onset of 41 years. Similar findings were also reported in two different countries by Hue et al. and Manferedin et al. [14,22].

In terms of Angle’s classification of malocclusion, Class I malocclusion was the most common type of occlusion in our patients with MPDS, followed by classes II and III. These findings were also in line with those reported by Mortazavi et al [8], Madani et al [23] Darbandi et al [24] Williamson et al [25], and Lauriti et al [26]. However, while some studies identified malocclusion as one of the most important etiologic factors in MPDS [27,28] other studies showed no or only mild relationships between TMD and malocclusion [29]. Parafunctional habits may play an etiologic role in MPDS, which can be explained as follows: long-term muscle contraction during bruxism prevents adequate blood supply to muscle tissue, resulting in the accumulation of CO2 and pain-inducing products in the muscles. These processes eventually lead to pain, fatigue, and muscle spasm [8,27-31]. Hu et al reported bruxism, clenching, and gum chewing as the most important pain-causing factors in the masseter and temporalis muscles [14]. In this study, clenching was the most common parafunctional habit in MPDS patients, followed by bruxism, and gum chewing. The same findings were also reported by Mortazavi et al [8]. Lauriti et al reported that about 30% of patients with MPDS had some type of parafunctional habit [26].

The frequency of muscle involvement and pain intensity in patients with MPDS differs among individuals. We observed the highest involvement in the masseter and lateral pterygoid muscles and the lowest involvement in the temporalis muscle. The same results were reported by Sancakli et al and Khalighi et al [5,32]. Mortazavi et al observed the highest and the lowest frequencies of involvement in the medial pterygoid and temporalis muscles, respectively [8], while the lateral pterygoid was the most affected muscle in the study by Darbandi et al [24].

In this study, we observed notable reductions in pain for both treatment modalities (LAT and LLLT), with no statistically significant difference in pain management between groups. However, compared to LLLT, LAT had more stability in pain control in patients with MPDS (Table 3). Positive changes in MMO level and achievement of a normal level of pain-free MMO (40 mm) occurred earlier in the LLLT group compared to the LAT group. While MMO did not differ significantly between the LAT and LLLT groups, patients in the LAT had a greater MMO level than those in the LLLT group at 2 months after treatment (Table 3). No other studies have compared LLLT and LAT efficacy in the treatment of MPDS. However, Ahrari et al [15], Maia et al [16], Rohling et al [33], Mazzetto et al [34], and Kulekcioglu et al [35] reported the optimal efficacy of LLLT for pain management in TMDs. In contrast Cuhna et al [36], Emshoff et al [37], and Carrasco et al [38] reported that LLLT did not have a therapeutic effect in MPDS-related pain and dysfunction. While Huang et al [3], Ferreira et al [17], Ayyildiz et al [2], Hu et al [14], and Hotta et al. [12] demonstrated optimal efficacy of LAT in pain management of TMDs, Kannan et al [39] and Dundar et al [40] did not. These contrary findings may be related to differences in case selection methods, sample size, laser types, and irradiation protocols.

The results of the present study showed significant pain reduction in the masseter and lateral pterygoid muscles from the second and third sessions, respectively, in both groups. Recovery (> 50% reduction in pain score) in the masseter muscle started from the fifth session in both
groups, while that in the lateral pterygoid muscle started from the fifth and fourth sessions of LLLT and LAT, respectively.

Significant pain reduction in the temporalis muscle was achieved starting in the second and third sessions of LLLT and LAT, with recovery starting from the third and fifth sessions, respectively. Complete analgesia was achieved from the eighth session in the LLLT group and at 2 months following treatment completion in the LAT group. In the medial pterygoid muscle, the reduction in pain score reached statistical significance later in the LLLT group than in the LAT group. The same finding was also observed for the timing of recovery. Moreover, patients in the LAT group achieved complete analgesia at the final treatment session and pain had not recurred at the 2-month follow-up. However, our study was limited by the lack of a long-term follow-up.

In conclusion, the results of this study showed no significant differences in pain control and increased MMO between LLLT and LAT. However, the time required for the treatment of MPDS with LAT was shorter than that with LLLT and the trigger points in LAT are more accessible than those for LLLT.

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REFERENCES

1. Manfredin D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temporomandibular disorders: a systematic review of axis I epidemiologic findings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2011; 112: 453-62.
2. Ayyildiz S, Emir F, Sahin C . Evaluation of low-level-laser therapy inTMD patients. Case Rep Dent 2015; 424213.
3. Huang YF, Lin JC, Yang HW, Lee YH, Yu CH. Clinical effectiveness of laser acupuncture in the treatment of temporomandibular joint disorder. J Formos Med Assoc 2014; 113: 535-9.
4. Jung A, Shin BC, Lee MS, Sim H, Ernst E. Acupuncture for treating temporomandibular joint disorders: a systematic review and meta-analysis of randomized, sham-controlled trial. J dent 2011; 39: 341-50.
5. Khalighi HR, Mortazavi H, Mojahedi SM, Azari-Marhabi S, Moradi Abbasaabadi F. Low level laser therapy versus pharmacotherapy in improving myofacial pain disorder syndrome. J Laser Med Sci 2016; 7: 45-50.
6. Cardelli P, Lattari M, Massaro P, Pollicita M, Barlattani A. Pharmacologic treatment of the dysfunctional patients. Minerva Stomatol 2005; 54: 265-79.
7. Javadzadeh Bolouri A, Delavarian Z, Mortazavi H, Toufani Asl H, Falaki A, Falaki F. The effect of combination therapy with fluoxetine and clonazepam in myofacial pain dysfunction syndrome. Aust J Basic Appl Sci 2011; 5: 520-5.
8. Mortazavi H, Javadzadeh A, Delavarian Z, Zare-Mahmoodabadi R. Myofascial pain dysfunction syndrome (MPDS). Iranian J Otorhinolaryngol 2010; 22: 131-6.
9. Okeson JP, De Leeuw R. Differential diagnosis of...
temporomandibular disorders and other orofacial pain disorders. Dent Clin North Am 2011; 55: 105-20.

10. Herranz-Aparicio J, Vázquez-Delgado E, Arribat-Dominguez J, España-Tost A, Gay-Escoda C. The use of low level laser therapy in the treatment of temporomandibular joint disorders. Review of the literature. Med Oral Patol Oral Cir Bucal 2013; 18: e603-12

11. Uemoto I, Garcia MA, Gouvêa CV, Vilella OV, Alfaya TA. Laser therapy and needling in myofascial trigger point deactivation. J Oral Sci 2013; 55: 175-81.

12. Hotta PT, Hotta TH, Bataglion C, Bataglion SA, de Souza Coronatto EA, Siéssere S, et al. Emg analysis after laser acupuncture in patients with temporomandibular dysfunction (TMD). Implication for practice. Complement Ther Clin Prac 2010; 16: 158-60.

13. de Oliveira RF, da Silva CV, Cersosimo MC, Borsatto MC, de Freitas PM. Laser therapy on points of acupuncture are there benefits in dentistry?. J Photochem Photobiol B 2015; 151: 76-82

14. Hu WL, Chang CH, Hung YC, Tseng YJ, Hung IL, Hsu SF. Laser acupuncture therapy in patients with treatment-resistant temporomandibular disorders. PLoS One 2014; 9: e110528.

15. Ahrafi F, Madani AS, Ghafouri ZS, Tunér J. The efficacy of low-level laser therapy for the treatment of myogenous temporomandibular joint disorder. Laser Med Sci 2014; 29: 551-7.

16. Maia ML, Bonjardim LR, Quintans Jde S, Ribeiro MA, Maia LG, Conti PC. Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review. J Appl Oral Sci 2012; 20: 594-602.

17. 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: 1549-58.

18. Herpich CM, Leal-Junior EC, Amaral AP, Tosato Jde P, Glória IP, Garcia MB, et al. Effects of phototherapy on muscle activity and pain in individuals with temporomandibular disorder: a study protocol for a randomized controlled trial. Trials 2014 Dec; 15: 491.

19. Seres JL. The fallacy of using 50% pain relief as the standard for satisfactory pain treatment outcome. J Pain 1999; 8: 183-8.

20. Smith P, Mosscrop D, Davies S, Sloan P, Al-Ani Z. The efficacy of acupuncture in the treatment of temporomandibular joint myofascial pain: a randomised controlled trial. J Dent 2007; 35: 259-67.

21. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. N Engl J Med 2008; 359: 2693-705.

22. Manfredin D, Arveda N, Guarda-Nardini L, Segù M, Collesano V. Distribution of diagnosis in a population of patients with temporomandibular disorders. Oral Surg Oral Med Oral Pathol Oral Radiol 2012; 114: e35-41.

23. Madani A, Mehdizade F. Prevalence of temporomandibular joint disorders in patients referred to Mashhad Dental School. J Dent Sch 2002; 20: 242-51.

24. Darbandi A, Jajoei A. Etiology of TMJ disorder in patients referred to Shahed Dental School Tehran-2000. J Dent Sch 2003; 21: 36-43.

25. Williamson EH, Lundquist DO. Anterior guidance: its effect on anterior temporals and masseter muscles. J Prosthet Dent 1983; 49: 816-23.

26. Lauriti L, Motta IJ, Silva PF, Leal de Godoy CH, Alfaya TA, Fernandes KP, et al. Are occlusal characteristics, headache, parafunctional habits and clicking sounds associated with the signs and symptoms of temporomandibular disorder in adolescents? J Phys Ther Sci 2013; 25: 1331-4.

27. Kalanjiam V, Manoharan GVMG. A study of the relationship between stress, adaptability and temporomandibular disorders. Int J Cur Res Rev 2016; 8: 1-5.

28. De Godoy CH, Silva PF, De Araujo DS, Motta IJ, Biasotto-Gonzalez DA, Politti F, et al. Evaluation of effect of low-level laser therapy on adolescents with temporomandibular disorder: study protocol for a randomized controlled trial. Trials 2013 Dec; 14: 229.

29. Govindaraj A, Dinesh SP, Srirengalakshmi M. Relationship between temporomandibular joint problem and malocclusion-An awareness survey among dental students and dentists. Drug Invention Today 2019; 11: 404-8.

30. Okeson JP. Management of temporomandibular disorders and occlusion-E-book. Elsevier Health Sciences; 2019.
31. Reddy SV, Kumar MP, Sevanthi D, Mohsin AH, Anuhya V. Bruxism: a literature review. J Int Oral Health 2014; 6: 105-9.

32. Sancakli E, Gökçe-Röhlig B, Balk A, Öngül D, Kipirdi S, Keskin H. Early results of low-level laser application for masticatory muscle pain: a double-blind randomized clinical study. BMC Oral Health 2015; 15: 131.

33. Gökçe-Röhlig B, Kipirdi S, Meriç U, Çapan N Keskin H. Masticatory muscle pain and low-level laser therapy: a double-blind and placebo-controlled study. Turk J Phys Med Rehabil 2011; 57: 31-7.

34. Mazzetto MO, Hotta TH, Pizzo RC. Measurement of jaw movements and TMJ pain intensity in patients treated with GaAlAs laser. Braz Dent 2010; 21: 356-60.

35. Kulekçıoğlu S, Sivrioglu K, Özcan O, Parlak M. Effectiveness of low-level laser therapy in temporomandibular disorder. Scand J Rheumatol 2003; 32: 114-8.

36. da Cunha LA, Firoozmand LM, da Silva AP, Camargo SE, Oliveira W. Efficacy of low-level laser therapy in the treatment of temporomandibular disorder. Int Dent J 2008; 58: 213-7.

37. Emshoff R, Bösch R, Pümpel E, Schöning H, Strobl H. Low-level laser therapy for treatment of temporomandibular joint pain: a double blind and placebo-controlled trial. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008; 105: 452-6.

38. Carrasco TG, Guerisoli LD, Guerisoli DM, Mazzetto MO. Evaluation of low intensity laser therapy in myofascial pain syndrome. Cranio 2009; 27: 243-7.

39. Kannan P. Management of myofascial pain of upper trapezias: a three group comparison study. Glob J Health Sci 2012; 4: 46-52.

40. Dundar U, Evcik D, Samli F, Pusak H, Kavuncu V. The effect of gallium arsenide aluminum laser therapy in the management of cervical myofascial pain syndrome: a double blind placebo-controlled study. Clin Rheumatol 2007; 26: 930-4.