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Temporomandibular joint disorder therapy: A review

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ABSTRACT

Aims: Temporomandibular disorders (TMD) are one of the most prevalent disorders in maxillofacial area. Due to lack of understanding of the etiology or pathogenesis of TMD and a definitive diagnostic or therapeutic approach, patients have to tolerate symptoms such as pain. This study was aimed to perform a review of non-surgical treatment methods for TMD.

Materials and Methods: In this review, Google, Google Scholar, PubMed, SID, ISI Web of Science, SID and IranMedex databases were searched using key terms: temporomandibular disorders, temporomandibular joint, temporomandibular pain, non-surgical treatment. Articles meeting the inclusion criteria were recruited in the study. Finally, a total of 63 prospective clinical trials were evaluated from 2015 to 2020.

Results: From the 61 studies evaluated, 27 studies were on low-level laser therapy (LLLT), 13 studies on transcutaneous electrical nerve stimulation (TENS), 5 studies on acupuncture and dry needling, 1 study on laser acupuncture, 9 studies on platelet-rich plasma (PRP) and 6 studies on Botox injection.

Conclusion: Laser acupuncture had similar treatment effects in reducing pain to TENS, low-level laser, acupuncture and dry needling. It seems that the use of laser acupuncture is safer than other methods in decreasing pain of patients with TMD.

Keywords: Temporomandibular disorders; Low-level laser; Acupuncture; Transcutaneous electrical nerve stimulation; Botox.

Introduction

Temporomandibular disorders (TMD) are one of the most common disorders at maxillofacial area that induce the involvement of masticatory muscles and temporomandibular joints. The symptoms of this disorder are pain, jaw dysfunction, malocclusion, deviation of the jaw in opening or closing, limited movement, noisy joints and locking, headache, and sleep disorders. TMD is more prevalent in patients aged 20-40 years. Approximately 33% of population have at least one symptom of TMD [1,2]. The american academy of orofacial pain (AAOP) has classified TMD into four categories: TMJ disorders, masticatory muscle disorders, headache, and associated structures [3].

These disorders can be caused by trauma, systemic diseases, occlusal disorders, and mental or iatrogenic disorders [4,5]. However, these varies in different societies with due attention to the age, ethnicity, geographical location, and time of the study and have been reported to be higher in women than men [6,7]. TMD treatment is divided into two main groups. The first group is non-surgical treatment, which includes the use of counseling, physiotherapy, medication, occlusal splint and low-level laser therapy [8-10]. The second group is surgical treatment, which involves TMJ arthrocentesis and arthroscopy using open surgery methods (arthrotomy), arthroplasty and TMJ displacement [3,9]. Dry needling, Botox injection and TENS are the other methods for pain relief in TMD patients [11,12]. The purposes of these treatments are pain reduction, performance addition and improvement of quality of life of the patients [3]. Injection of corticosteroids in TMJ is another surgical and non-surgical treatment method affecting the pain of patients with mouth opening limitation [13,14]. Injection of hyaluronic acid, sodium hyaluronate and ozone therapy are other treatment modalities [15,16].

Most of the time, surgical treatments are associated with complications, such as damage to adjacent anatomic structures, infections, hypersensitivity reactions, intracranial hematoma, malocclusion and damage to the maxillary artery, external auditory canal, tympanic membrane and the middle ear [17]. Due attention to the above complications, reversible treatment, minimally invasive and non-surgical treatment is generally preferred. Since, the conservative treatment is more admissible than surgery by patients, it can be used as the definitive treatment in some TMD patients. The purpose of this review is to collect various conservative methods and their post-operative results in treatment of TMD patients.

Materials and Methods

Numbers of 61 articles were retrieved from PubMed, ISI Web of Science, and Google Scholar databases from January 2015 to August 2020. The Persian databases, including SID and IranMedex were separately searched from March 2015 to August 2020. The key terms: temporomandibular disorders, temporomandibular joint, temporomandibular pain and non-surgical treatment were used to search all Persian and English language studies published in the past five years. Recruitment of studies was done based on a series of inclusion and exclusion criteria. First, the title and abstract of studies retrieved were analyzed by two experts. The selected articles were evaluated in terms of practical principles and inclusion criteria as well as accuracy of the methodology. The references of these articles were also evaluated manually to assess the relevant studies and included them in the study if they met the inclusion criteria.

Inclusion criteria

The prospective studies and clinical trials with a full description of treatment procedures and details of treatment results on TMD, studies with a control group, studies on low-level laser therapy, TENS, laser acupuncture, acupuncture, dry needling and PRP injection were included in the analysis. The studies in English and Persian language with full text were retrieved.

Exclusion criteria

Systemic studies, reviews, case reports and poor-quality studies in the hierarchy of evidence were excluded from the study. Animal and experimental studies and those on patients with systemic diseases were also excluded from the study.

Results

A total of 61 articles were found in the literature search, among which 27 (44%) articles were found about low-level laser therapy, 13 (21%) were about TENS, 5 (0.08%) articles were about acupuncture and dry needling, 1 (0.01%) was about laser acupuncture, 9 (0.14%) were about PRP and 6 (0.09%) were found to be related to Botox injection. In low-level laser therapy, from 27 articles, 23 (85%) showed significant improvement in VAS (Visual Analogue Scale) and 10 (37%) showed improvement in MMO (Maximum Mouth Opening) scores. Four (14%) articles demonstrated unsuccessful reasons in VAS or MMO and 8 (29%) showed no significant differences between LLLT and other therapies in study.

In TENS therapy, from a total of 13 articles, 8 (61%) articles showed improved results for VAS and 4 (30%) showed improvements in MMO. Six (46%) articles showed unsuccessful reasons in VAS or MMO compared with other groups and one (0.07%) of the studies demonstrated a better result in combination with laser and medication for pain relief. Two (15%) articles described no significant differences between groups of the study. In dry needling therapy, from 5 articles, 4 (80%) showed similar reduction in pain and 3 (60%) showed same improvement in MMO with the other study group. One (20%) of the articles showed signif-

icant reduction in pain and 2 (40%) articles showed great improvements in MMO. There was just one article compared laser acupuncture therapy with LLLT and showed similar improvement in pain and MMO in both groups, but it was suggested to use LAT (Laser Acupuncture Therapy) because of its less chair time and ease of use.

In PRP therapy, from total of 9 articles, 7 (0,77%) articles showed significant reduction of pain and 4 (0.44%) showed significant improvement of MMO in PRP group. Three (0.33%) articles showed no significant differences between study groups for VAS and 3 (0.33%) described it for MMO. In Botox injection therapy, there were 6 articles totally, that 4 (0.66%) of them showed significant pain reduction and 2 (0.33%) of them showed great MMO improvement. Just 1 (0.16%) article demonstrated similar result for VAS and 1 (0.16%) for MMO in study groups.

Discussion

Totally, the methods of low-level laser therapy, TENS, acupuncture and dry needling therapy, laser acupuncture therapy, PRP and Botox injection therapy had been done for TMD pain relief and treatment. In the following, details of every procedures numbers of articles and their results are demonstrated.

Low-level laser therapy

low-level lasers (LLLT) was introduced in early 1960s and become a popular application due to its analgesic, anti-inflammatory, biostimulative and regenerative effects [11,18]. LLLT causes vasodilation and increased local blood flow which reliefs the inflammation [19]. Its special character which is no interaction with healthy hard tissue, make it as a suitable tool for soft tissue procedures and treatments of musculoskeletal disorders [11,20]. In this treatment modality, 27 articles reported a comparison of pain reduction following by low-level laser therapy (LLLT), 24 of which showed a significant pain reduction after LLLT and 11 showed significant improvement in MMO in patients with TMD (Table 1).

TENS therapy

In TENS technique, pulse stimulation is applied at different frequencies, intensities, and periods. The advantages of this method are non-invasiveness and safeness. Another advantage is that it is used for conducting anesthesia in patients with fear of needle [20]. In this treatment modality, 13 articles investigated the effect of TENS on pain reduction compared with other treatments. Seven articles showed a significant decrease in pain and 4 articles indicated a significant increase in MMO.

Acupuncture and dry needling therapy

Acupuncture is another non-invasive treatment modality that is considered from 1970 and used as an alternative therapy for pain relief [18]. It disrupts mechanically contractile elements that are atypically functioning and exerts its analgesic mechanism by inducing the production of endogenous opioids, hence, it relives pain of trigger point and discomfort associated with that condition [18,117,119]. In this treatment modality, 5 articles were found on the effect of acupuncture and dry needling in management of TMD patients, 5 of which reported a significant reduction in pain and 4 articles reported a significant rise in maximum mouth opening (MMO).

Laser acupuncture therapy

Laser acupuncture therapy (LAT) is an alternative to conventional acupuncture therapy, because in this method, laser is used instead of needle insertion and make this method more conservative than the conventional of that [120,121]. Also, this method is simple, painless and safer than traditional acupuncture therapy and has the ability to apply for chronic pain associated with TMD treatment [120,122]. In this therapy, one article was conducted on the effect of laser acupuncture on pain level in TMD patients, it has been indicated a significant decrease in pain level and significant increase in MMO.

PRP injection

Platelet-rich plasma (PRP) is one of the minimally invasive therapies that is based on the effects of growth factors (GFs). It has biological properties and promote cellular proliferation and regulation. It has a major role in promoting in regeneration of degenerative bone, cartilage and synovial tissue [123,124]. In this treatment modality, 9 articles were found on the effect of this method on pain reduction in patients with TMD, 6 of which indicated a significant reduction in pain and 4 articles showed a significant increase in MMO.

Botox injection therapy

Botulinum toxin type (BTX) is the exotoxin of a gram-positive anaerobic bacterium called Clostridium botulinum. It can be used as a single therapeutic agent or in combination with other methods for treatment of hemifacial spasm, headache, myofascial pain, tem-

poromandibular joint disorders and it needs to pass periods of two or four months to achieve regenerative results [125,126]. In this therapy, 6 articles were found on the efficacy of this technique in patients with TMD, all of them indicated a significant pain reduction and 3 of them indicated and improvement in MMO in TMD patients.

Table 1. Characteristics of studies on low-level laser therapy.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Chellapa et al. (21)	2020	Comparative efficacy of LLLT and TENS in the symptomatic relief of temporomandibular joint disorders: A randomized clinical trial	Patients with history of persistent, recurrent or chronic TMJ pain for more than 3 months not relieved by analgesics	60	LLLT was significantly more effective in the measure of mouth opening and pain than TENS.
2	Yamaner et al. (22)	2020	Comparison of the efficiency of two alternative therapies for the management of TMDs	Patients with disc displacement with reduction (DDR)	80	Significant improvement in pain and maximum-mouth opening after ozone therapy when compared with LLLT group.
3	Hassanien et al. (19)	2020	Dextrose prolotherapy versus LLLT for management of TMD: clinical randomized controlled study	Patients with TMJ pain, sounds during mandibular movements, functional disability, between 16-40 years old	20	No significant difference between the means of dextrose and laser groups regarding VAS. MMO was greater in dextrose group in comparison with LLLT
4	Oliveira chami et al. (23)	2020	Rapid LLLT protocol for myofascial pain and mouth opening limitation treatment in the clinical practice: An RCT	Patients with myofascial pain with mouth opening limitation between 18-60 years old	20	Significant improvements in pain and maximum mouth opening were observed in laser group after 30 days.
5	Maracci et al. (24)	2020	Treatment of myofascial pain with a rapid laser therapy protocol compared to occlusal splint: A double-blind, RCT	Patients with myofascial pain with or without limitation of mouth opening between 18-60 years old of both genders	30	Splint therapy was more effective in reducing pain than laser group.
6	Mansourian et al. (25)	2019	A Comparative Study of LLLT and TENS as an Adjunct to Pharmaceutical Therapy for Myofascial Pain Dysfunction Syndrome: An RCT	Patients with orofacial pain for a minimum of 6 months, pain on palpation, normal posterior occlusion, between 18-60 years old	108	Combination of both LLLT and TENS with medication accelerated pain relief and improvement in mouth opening limitation.
7	Nadershah et al. (26)	2019	Photobiomodulation Therapy for Myofascial Pain in TMJ Dysfunction: A Double Blinded RCT	Patients with unilateral TMJ and masticatory muscles pain during function of a magnitude of at least 3 on the VAS	202	There was a significant reduction in VAS scores in test group compared with control group.

8	Khairnar et al. (27)	2019	Comparative evaluation of LLLT and ultrasound heat therapy in reducing TMD pain	Patients with TMJ pain, between 25-45 years old	42	There were significant differences in VAS score and MMO between test groups and favoring the LLLT.
9	Madani et al. (28)	2019	A RCT comparing the efficacy of LLLT and laser LAT in patients with TMD	Patients with limited mouth opening or function, presence of pain in masticatory muscles and/or TMJs	45	Both LLLT and LAT were significantly effective in decreasing pain and mouth opening improvement. LAT is suggested because of less chair time
10	Del Vecchio et al. (18)	2019	Evaluation of the efficacy of a new LLLT home protocol in the treatment of TMD-related pain: A randomized, double-blind, placebo-controlled	Patients with mono or bilateral TMJDs	90	Home LLLT was effective in management of TMJD related pain.
11	Abbasgholizadeh et al. (29)	2019	Evaluation of the efficacy of different treatment modalities for painful TMDs	Patients with unilateral disc displacement reduction in mouth opening, TMJ pain during palpation and/or	45	Both LLLT and LAT were effective in pain reduction and improvement of excursive and protrusive mandibular motion in TMD patients.
12	Magri et al. (30)	2019	Follow-up results of a RCT for LLLT in painful TMD of muscular origins	Women with myofascial pain between 18-40 years old	41	Both of active and placebo LLLT were effective in reducing pain only in short term period after treatment (6 months).
13	Budakoti et al. (11)	2019	A comparative evaluation of the effectiveness of LLLT, ultrasound therapy, and TENS in the treatment of patients with TMDs: a prospective study	Patients with TMJ pain, joint sounds, limited mouth opening and TMJ locking, between 20-50 years old	45	There was statistically significant greater reduction in pain and increase in mouth opening in LLLT group compared with ultrasound and TENS.
14	Rodrigues et al. (31)	2018	Effects of low-power laser auriculotherapy on the physical and emotional aspects in patients with TMDs: A blind, RCT	Patients with equal or higher score of 3 in orofacial pain, TMD with myofascial pain in age of 18 or older than that	2018	Both LLLT and occlusal splint therapy similarly improved physical (pain score) and emotional symptoms.
15	Richa et al. (32)	2018	TENS and laser therapy in the management of TMDs	Patients with signs and symptoms of pain on the masticatory muscles	18	Both groups of LLLT and TENS showed decrease in pain and increase in active range of motion.
16	Magri et al. (33)	2018	Non-specific effects and clusters of women with painful TMD responders and non-responders to LLLT: double-blind RCT	Women with myofascial pain between 18-40 years old	64	Both active and placebo group were effective similarly in pain reduction during treatment period, but active LLLT was more effective in maintaining

17	Magri et al. (34)	2017	Effect of LLLT on pain intensity, pain threshold and SF-MPQ index in women with myofascial pain	Women with myofascial pain between 18-60 years old	61	LLLT active or placebo are effective in reducing the overall subjective perception of myofascial pain, but they do not affect on orofacial and corporal points.
18	Rezazadeh et al. (35)	2017	Comparison of the Effects of TENS and LLLT on Drug Resistant TMDs	Patients with drug-resistant TMD	45	Significant improvement in mouth opening and pain reduction in both LLLT and TENS groups. No significant difference was observed. TENS was more effective than LLLT in follow-ups.
19	Demirkol et al. (36)	2017	Efficacy of LLLT in Subjective Tinnitus Patients with TMDs	Patients with bilateral subjective tinnitus with TMDs	46	Significant reduction of pain in both Nd; YAG and diode groups but the group of LLLT with Nd; YAG was more effective than the others.
20	Seifi et al. (37)	2017	Comparative effectiveness of LLLT and TENS on TMDs	Patients with complained of head and neck pain, tenderness on palpation, especially around the ears and during function, showed limited mouth-opening	40	Significant greater reduction in pain and increase in mouth opening in both groups of LLLT and TENS than placebo after treatment. No significant difference for maximum-mouth opening between three groups at the end of the study.
21	Machado et al. (38)	2016	Effects of oral motor exercises and laser therapy on chronic TMDs: a randomized study with follow-up	Patients with chronic pain and diagnosis of TMD	102	LLLT combined with oral motor exercises was more effective than LLLT alone in pain reduction.
22	Khalighi et al. (39)	2016	LLLT vs. Pharmacotherapy in Improving Myofascial Pain Disorder Syndrome	Patients with myofascial pain with/without limited mouth opening	40	LLLT was more effective in pain reduction and MMO improvement than naproxen.
23	Cavalcanti et al. (40)	2016	Comparative Study of the Physiotherapeutic and Drug Protocol (PDP) and LLLT in the Treatment of Pain Associated With TMD	Women with TMD triggering agents between 20-50 years old	60	LLLT was more effective to control pain than PDP.

24	Sancakli et al. (41)	2015	Primary results of LLLT for masticatory muscle pain: A randomized double-blind trial	Patients with myofascial pain and natural posterior occlusion between 18-60 years old	30	More efficient results were observed after treatment with LLLT at the point of greatest pain than other groups.
25	Fornaini et al. (42)	2015	The «at-home LLLT» in TMDs pain control: a pilot study	Patients with mono- or bi-lateral TMD, with acute pain restricted to the joint area, associated with the absence of any muscle tenderness during palpation	24	Home LLLT was effective in management of TMJD related pain.
26	Demirkol et al. (43)	2015	Effectiveness of occlusal splints (OS) and LLLT on myofascial pain	Patients with TMD and myofascial pain	30	Both methods were effective in pain relief similarly. No significant differences were observed between LLLT and OS groups after treatment.
27	Soheilipour et al. (44)	1393	Effect of LLLT on otalgia and tinnitus originating from TMJ	Patients with symptoms and signs of tinnitus and otalgia	33	VAS scores decrease significantly in laser group but there was not any improvement in control group.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Ramesh et al. (45)	2020	Comparative evaluation of the effect of therapeutic ultrasound and TENS in temporalis and masseter myofascial pain	Patients between 20 to 50 years with symptoms coinciding with myofascial pain	30	LLLT was significantly more effective in the measure of mouth opening and pain than TENS.
2	Saranya et al. (46)	2019	Comparison of TENS and Microcurrent Nerve Stimulation (MENS) in the Management of Masticatory Muscle Pain: A Comparative Study	Patients with myofascial pain with a duration of more than 3 weeks in both genders	60	TENS and MENS were both equally effective in improving the functional mouth opening. MENS showed better and immediate effect in reducing pain.
3	Nimavat et al. (47)	2019	TENS therapy as compared to placebo TENS therapy for the management of myofascial pain dysfunction syndrome patients: A clinical study	Patients with unilateral pain within one or more muscles of mastication	30	Significant improvement of muscle tenderness in active TENS therapy group in comparison with placebo TENS therapy.
4	Kirupa et al. (48)	2019	A comparative study of ultrasound therapy and TENS in reducing pain for TMD	Patients with clinical signs and symptoms of TMD in both genders between 20-40 years old	30	Ultrasound group showed greater VAS scores than TENS group related to pain relief.

5	Mansourian et al. (25)	2019	A Comparative Study of LLLT and TENS as an Adjunct to Pharmaceutical Therapy for Myofascial Pain Dysfunction Syndrome: An RCT	Patients with orofacial pain for a minimum of 6 months, pain on palpation, normal posterior occlusion, between 18-60 years old	108	Pain in the trapezius muscle and pain on mouth opening resolved faster in the laser + medication group. Using the combination of Laser and Tens with medication showed better result in pain relief and movement restrictions.
6	Shailaja et al. (49)	2019	TENS and cyclobenzaprine in TMDs- a comparative study	Patients of both genders with TMD	40	TENS had better result in reducing pain. Cyclobenzaprine showed significant improvement in mouth opening.
7	Zhang et al. (50)	2019	Effect of TENS on jaw movement-evoked pain in patients with TMJ disc displacement without reduction and healthy controls	Patients with chronic TMJ pain over 3 months with bilateral DDwoR without jaw opening limitation	20	TENS showed significant reduction movement evoked pain and improved jaw motor function during repeated jaw movements.
8	Budakoti et al. (11)	2019	A comparative evaluation of the effectiveness of LLLT, ultrasound therapy, and TENS in the treatment of patients with TMDs: a prospective study	Patients with TMJ pain, joint sounds, limited mouth opening and TMJ locking, between 20-50 years old	45	LLLT played as the most effective in relieving pain, improving mouth opening, and reducing the number of tender points compared with other groups.
9	Richa et al. (32)	2018	TENS and laser therapy for management of TMDs	Patients with signs and symptoms of pain on the masticatory muscles	18	Both groups showed decrease in pain and increase in active range of motion.
10	Rezazadeh et al. (35)	2017	Comparison of the Effects of TENS LLLT on Drug-Resistant TMDs	Patients with drug-resistant TMD	45	Significant reduction of pain in both groups. No significant differences between two groups during treatment. TENS was more effective in pain reduction in follow-ups.

11	Seifi et al. (37)	2017	Comparative effect of LLLT and PENS on TMD	Patients with TMD	40	Significant greater reduction in pain and increase in mouth opening in both groups of LLLT and TENS than placebo after treatment. No significant difference for maximum-mouth opening between three groups at the end of the study.
12	Patil et al. (51)	2017	Effect of TENS vs. Home Exercise Programme in Management of TMD	Patients of both genders with TMD between 18060 years old	36	Significant reduction in pain in TENS group compared to Home Exercise (HE) group. No significant differences between two groups with respect to maximum-mouth opening.
13	Ferreira et al. (52)	2017	Short-term TENS reduces pain and improves masticatory muscles activity in patients with TMD: An RCT	Patients with myofascial pain with/without limited mouth opening	40	The short-term effectiveness of TENS group was greater than placebo in pain scores.

Table 2. Characteristics of studies on TENS therapy.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Kutuk et al. (12)	2019	Comparison of the Efficacies of Dry Needling and Botox Methods in the Treatment of Myofascial Pain Syndrome Affecting the TMJ	Patients with myofascial pain syndrome between 18-60 years old, literacy, biochemical test results within normal limits	40	Both groups showed improvement in pain values and jaw functioning similarly.
2	Neto et al. (53)	2019	Effect of the dry needling vs manual myofascial therapy at the trigger points in TMD	Patients with TMD	15	Significant increase in pressure pain threshold (PPT) and decrease in VAS in both groups. No significant differences were observed between two groups.
3	Aksu et al. (54)	2019	Comparison of the efficacy of dry needling and trigger point injections with exercise in TMJ myofascial pain treatment	Patients with temporal, lateral pterygoid and/or masseter tenderness and existing trigger points and symptoms for at least three months	63	Significant improvement in pain and functional limitation status in all groups. No significant differences were observed between the groups at the end of the study.

4	Zotelli et al. (55)	2017	Acupuncture Effect on Pain, Mouth Opening Limitation and on the Energy Meridians in Patients with TMD: An RCT	Patients with pain due to TMD of muscular or mixed origin, with/ without mouth opening limitation	20	Both groups were equally effective in reducing pain. Treatment group showed increasing the unassisted mouth opening limitation without pain.
5	Gonzalez-Perez et al. (56)	2015	Deep dry needling of trigger points located in the lateral pterygoid muscle: Efficacy and safety of treatment for management of myofascial pain and TMD	Patients of both genders between 18-65 years old with temporo-mandibular myofascial pain located in the LPM	24	Significant greater reduction of pain and improvement of maximum-mouth opening were detected in dry needling group than control.

Table 3. Characteristics of studies on acupuncture and dry needling therapy.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Madani et al. (28)	2019	An RCT comparing the efficacy of LLLT and LAT in patients with TMDs	Patients with TMD referred to the center during the period from January 2017 to February 2018	45	Both LLLT and LAT were significant effective in decreasing pain and mouth opening improvement. LAT is suggested because of less chair time

Table 4. Characteristics of studies on laser acupuncture therapy.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Rajput et al. (57)	2020	A Comparative Analysis of Intra articular Injection of PRP and Arthrocentesis in TMJ Disorders	Patients with complaint of reduced mouth opening, joint noise, pain, jaw deviation, not responding to medicinal treatment and coming under group II/III of RDC/TMD	24	Both groups were effective in pain reduction significantly. Arthrocentesis group had significant improvement in MMO
2	Nabil et al. (٥٨)	2019	Comparative study of the use of arthrocentesis and arthrocentesis in addition with PRP in management of TMJ internal derangement	Patients with disc displacement without reduction with/without limitation	2019	Both groups showed improvement in VAS scores and MMO but there were not significant.
3	Singh et al. (59)	2019	Evaluation of Arthrocentesis with and Without PRP in the Management of Internal Derangement of TMJ: An RCT	Patients suffering from internal derangement of TMJ resistance to conservative treatment for up to 6 months	24	All the groups showed significant improvement about all the parameters but there were not any significant differences between groups.

4	Nitecka-Buchta et al. (60)	2019	PRPIntramuscular Injections – Antinociceptive Therapy in Myofascial Pain Within Masseter Muscles. In TMDs Patients: A Pilot Study.	Patients between 18 to 80 years old with myofascial pain within masseter muscles according to the RDC/TMD	58	Significant improvement in pain intensity in VAS scale was observed.
5	Gupta et al. (61)	2018	Comparison between intra articular PRP injection versus hydrocortisone with local anesthetic injections in TMDs: A double-blind study	Patients with history and clinical presentation of disc displacement with reduction, clicking, and pain on jaw movements	20	PRP group showed lower pain and lesser TMJ sound than the group of hydrocortisones with local anesthetic. Maximum mouth opening was similar in both groups.
6	Kilic et al. (62)	2016	Is arthrocentesis plus PRP superior to arthrocentesis plus hyaluronic acid for the treatment of TMJ osteoarthritis: An RCT	Patients with TMD osteoarthritis between May 2012 and September 2013.	49	Both treatments improved VAS and Maximum inter-incisal (MIO) parameters similarly and no significant differences observed between groups.
7	Hancı et al. (63)	2015	Intra-articular PRP injection for the treatment of TMDs and a comparison with arthrocentesis	Patients with anterior disc dislocation with reduction causing functional disability and pain and resistant to conservative treatment	20	Significant greater pain reduction and improvement of maximum-mouth opening in PRP group when compared with control.
8	Kilic et al. (62)	2015	Is ArthrocentesisPRP Superior to Arthrocentesis Alone in the Treatment of TMJ Osteoarthritis? A Randomized Clinical Trial	Patients with temporomandibular osteoarthritis (TMJ-OA)	30	Significant decreasing in pain values in both groups. Significant greater improvement of maximum mouth opening in PRP group than control.
9	Hegab et al. (64)	2015	PRP Injection as an Effective Treatment for TMJ Osteoarthritis	Patients with TMD osteoarthritis with mild to severe degenerative changes	50	PRP showed better results in pain scale and interincisal distance.

Table 5. Characteristics of studies on PRP injection.

No	Researchers	Year	Title	Statistical society	Sample size	Results
1	Kutuk et al. (12)	2019	Comparison of the Efficacies of Dry Needling and Botox Methods in the Treatment of Myofascial Pain Syndrome Affecting the TMJ	Patients with myofascial pain syndrome between 18-60 years old, literacy, biochemical test results within normal limits	40	Both groups showed improvement in pain values and jaw functioning similarly.
2	Sipahi Calis et al. (65)	2019	The use of botulinum toxin-a in the treatment of muscular TMDs	Patients with muscular TMDs and resistance to conservative treatments for 3 months, pregnancy test -, no systemic disease, no edentulous jaw	25	The groups of drug-physical therapy-occlusal splint and drug- physiotherapy-occlusal splint-Botox treatments were found to be successful regarding pain, force and mouth openness.
3	Al-Ibrahemy et al. (66)	2018	Treatment of Chronic Myofascial Syndrome associated with parafunctions by use of botulinum toxin type A	Patients with chronic myofascial pain dysfunction syndrome and masticatory muscles hyperactivity	18	Botox showed an improvement in pain symptoms in all the patients' resistance to traditional treatments and physical therapy.
4	Meral et al. (67)	2018	Evaluation of patient satisfaction after botulinum toxin A injection for the management of masticatory myofascial pain and dysfunction – A pilot study	patients with myofascial pain and dysfunction, pain on palpation of the masticatory muscles, resistance to conservative treatments	25	Significant improvements in both pain and MMO after Botox injection
5	Patel et al. (68)	2017	IncobotulinumtoxinA Injection for TMD: A Randomized Controlled Pilot Study	Patients with signs and symptoms of TMD and resistance to conventional therapy	10	Significant pain reduction after treatment with IncobotulinumtoxinA compared with placebo.
6	Gupta et al. (69)	2016	Effect of botulinum Toxin-A in myofascial pain in TMDs: A randomized, double-blinded, placebo-controlled stud	Patients with complaint of pain, restricted mouth opening, clicking and resistance to conservative management	12	Significant pain reduction and functional improvement after treatment with BTX-A

Table 6. Characteristics of studies on botox injection therapy.

Conclusions

Laser acupuncture has treatment effects in pain reduction similar to TENS (which is a common therapy for TMD), LLLT, acupuncture and dry needling. Use of laser acupuncture seems to be safer than other methods in pain reduction of patients with TMD.

Conflict of Interest

There is no conflict of interest to declare.

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