Advanced Medical Research

Global Science Publishing

Number 4 (2025), pp. 01–12

Article

Physical Therapy in Patients with Temporomandibular Joint Disorders

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Received: April 6, 2025; Revised: April 16, 2025;; Accepted: April 21, 2025; Published: April 30, 2025

Abstract: Temporomandibular joint disorder (TMD) is a chronic disease caused by multiple factors working together. Although it does not affect the patient's lifespan, it significantly interferes with their psychology and daily life. The treatment for TMD is mainly divided into two categories: conservative treatment and surgical treatment. The vast majority of TMD patients have mild symptoms, so conservative treatment is often their primary choice. As an important component of conservative treatment, physical therapy is highly favored by patients due to its simple operation, minimal side effects, and significant effectiveness. Therefore, this article elaborates on the clinical value of various physical therapies for TMD patients, with the hope of expanding the application of physical therapy in TMD.

Keywords: TMD; physical therapy; pain; manual therapy; therapeutic exercise

1. Introduction

Temporomandibular disorders (TMD), also known as temporomandibular joint disorder, mainly refers to a type of disease caused by anatomical and functional abnormalities between structures related to the temporomandibular joint [1]. These structures include the condyle, joint fossa, joint disc, etc. TMD mainly affects middle-aged and young women aged 20 to 40, but it has also been found in the adolescent population [2,3]. Another study also showed that the prevalence of TMD among the world population ranges from 5% to 12%, but only about 2% of people have received corresponding interventions or treatments [4]. The main symptoms of temporomandibular joint disorders include pain when opening and closing the mouth, grinding or biting teeth, frequent headaches, neck pain, joint locking, and facial muscle pain and tenderness [5,6]. Although TMD does not shorten the patient's lifespan, its prolonged treatment often leads to insomnia, anxiety, and decreased appetite, all of which can interfere with the patient's quality of life [7].

The etiology of temporomandibular joint disorder is not yet fully understood, but it is related to multiple factors. Factors such as intra-articular and extra-articular trauma, depression, anxiety, poor occlusion, autoimmune disorders, and abnormal joint anatomy can all increase the risk of developing TMD [8–10]. When various factors related to the temporomandibular joint coordinate and coexist, the joint can function normally. On the contrary, when these factors are abnormal, or stress or trauma occurs, temporomandibular joint disorder will occur.

Temporomandibular joint disorders can be classified into masticatory muscle disorders, joint structural disorders, inflammatory diseases, and osteoarthritis based on different pathogenic factors [11]. The treatment methods for this disease mainly include drug therapy, physical therapy, surgical treatment, and traditional medical treatment. Among these treatment methods, physical therapy is often the first choice for conservative treatment

due to its significant efficacy and low side effects. Based on this viewpoint, this article systematically reviews all possible beneficial physical therapy methods for TMD.

2. Classification of Physical Therapy

Physical therapy is the main body of rehabilitation therapy, which uses non-invasive and non-pharmacological treatments to restore the original physiological functions of the body for local or systemic functional disorders or lesions [12]. In soft tissue injury diseases, it often plays a role in anti-inflammatory, analgesic, bactericidal, and relieving spasms [13].

Physical therapy can be divided into two categories. One is mainly based on functional training and manual therapy, also known as exercise therapy; Another type is to use various physical factors (sound, light, cold, heat, electricity, magnetism, water, etc.) as the main means, also known as physical factor therapy.

3. Exercise Therapy

3.1. Manual Therapy

Manual therapy mainly includes physical therapists pressing, releasing, and peeling specific muscle trigger points, as well as loosening joints with limited mobility [14]. In the treatment process of TMD, manual therapy is widely used (Table 1). There are two main methods of manual therapy: mobilization and muscle energy techniques (MET).

Mobilization techniques are most commonly used for intervertebral disc disorders and joint stiffness [15]; It mainly involves multiple traction or smooth movements at low speed and with increased amplitude, entering a position that promotes joint recovery [16]. Its ultimate goal is to increase the limited range of motion within the joint and alleviate pain [17]. These movements are usually performed perpendicular or parallel to the plane of the treated joint, and are typically repeated 8 to 10 times per treatment [18].

In many TMD clinical trials, joint mobilization techniques are also widely used [19–25]. The patient is placed in a lying or sitting position, with their head fixed in front of the therapist's chest. The therapist uses both hands to move the mandibular and cervical joints. Although these experimental methods differ in duration, frequency, and specific techniques, they fundamentally improve joint mobility and pain levels compared to the control group. Interestingly, some studies not only focus on manual manipulation of the temporomandibular joint, but also on cervical spine [20,22,25]. The reason may be that (1) the chewing muscle group and the head, neck, and shoulder muscle group interact with each other in terms of function; (2) The trigeminal spinal tract nucleus is closely related to the cervical spinal cord. (3) Head and facial pain can be caused by the involvement pain generated by the trigger point of the upper cervical trapezius muscle. Therefore, improving cervical joint range of motion can help alleviate symptoms of TMD [26,27].

Other studies have mostly used muscle energy technique to treat TMD, which is mainly based on the theories of spontaneous inhibition and interactive inhibition. Through gentle isometric contractions, muscles are relaxed and stretched, ultimately reducing the sensitivity of trigger points [28]. Compared to passive static muscle stretching relying solely on therapists, MET is an active treatment technique that requires active patient participation [29]. However, there has been no study comparing the efficacy differences between joint mobilization technology and MET in the treatment of TMD. The reason for this may be that both are operated by therapists on joints and muscles separately, so the duration, frequency, and intensity of treatment can all affect the results. In other words, there are many uncontrollable factors that affect the accuracy of the results.

Table 1. Overview of included studies.

Intervention	Study Period (Weeks)	Frequency	Outcome Measure	Ref.
4-step slow jogging technique for mandibular operation	18	once a week	Mouth-opening limitation, orofacial pain, and temporomandibular joint (TMJ) sounds	[19]
Manual treatment of intraoral and extraoral muscle groups	4	Three times a week, 21 min per time	pain relief, mandibular function, levels of anxiety	[30]
Facial myofascial release therapy	2	10 treatment sessions for 10 consecutive days except Sundays.	a surface electromyography (sEMG), the intensity of spontaneous masticatory muscle pain	[31]
Manual mobilization therapy for facial muscles, temporomandibular joint, and cervical spine	4	three times a week	Pain intensity, Pain-free maximum mouth opening	[20]
Mascatory muscle trigger point relaxation technique	6	once a week	cervical range of movement, Maximal Mouth Opening	[32]
Coordination training of chewing muscles	3	once a week	Pain Intensity, Functional status of the mandibular and craniofacial regions	[33]
Mandibular and cervical soft tissue mobilization	4	six treatment sessions	Tinnitus and TMD-Related Disability, Pain level, quality of life	[21]
Right supine C0–1 traction thrust joint technique. Right side supine C2–3 uphill thrust joint technique	4	six treatment sessions	Maximal Mouth Opening, Pain, Jaw Function	[22]
Mobilize the temporomandibular joint	12	twice a week	Pain intensity, Pain-free maximum mouth opening	[23]
Atlantooccipital joint manipulation and suboccipital muscle suppression technique	Single session	Single session	Pressure sensitivity of potential myofascial trigger points in chewing muscles	[34]
Mandibular joint mobility techniques	32	1 session every two weeks	Maximal mouth opening	[24]
Intraoral temporal muscle release and intraoral wing medial and lateral (origin) techniques	5	Twice a week	Pain, Maximal mouth opening	[35]
Facial myofascial trigger point release technique through ischemic compression	1	Once every other day	Pain	[36]
Using upper chest technique to promote thoracic spine curvature	Single session	Single session	Vertical Mouth Opening	[25]
Post-isometric relaxation technique	2	six treatment sessions	pain and maximal mouth opening	[37]

3.2. Massage Therapy

Massage therapy is different from manual therapy, as it mainly relies on the therapist's passive stretching of muscles to enhance their flexibility and length [38]. At present, in many studies, this method is mainly used as an auxiliary therapy to alleviate muscle and fascia pain and tension before manual therapy [19,21,30,33,35–37]. During the massage process, the therapist slowly increases finger pressure to gradually stretch and extend the muscles. The massage therapy of TMD can be divided into effleurage, kneading, friction, stretching, and petrissage

(Table 2). In addition to local effects, massage can also relax the whole body and improve the patient's mood, making it easier for patients to accept subsequent manual treatments. It can also reduce tension headaches and neck discomfort, restore balance between masseter muscle tension, improve chewing, and to some extent enhance the effectiveness of manual therapy [39].

Table 2. The forms of movement during massage.

Specific Forms of Massage Therapy	Operating Mode	Outcome
Effleurage, Kneading	Relaxation, caressing, and cyclic movement of the skin and adjacent tissues	Warm up muscles, promote blood circulation, and benefit tissue metabolism
Stretching ("petrissage")	Muscle rolling	Increase range of motion and reduce muscle tension
Friction	Fingertip pressure is concentrated at the trigger point; The pressure gradually increases and then slowly releases	Local remodeling of tissue; Relieve temporary pain

3.3. Therapeutic Exercises

Therapeutic exercise, as an active muscle training, is also one of the ways to achieve muscle recovery, especially after soft tissue injury [40]. This treatment only requires language guidance from the therapist, and the specific procedures are completed independently by the patient, making it considered the simplest and most non-invasive method in TMD treatment [41]. Therapeutic exercise must be carried out in moderation according to the specific condition of the patient to avoid resistance caused by pain.

Many studies have used therapeutic exercise to intervene in TMD and have made significant progress in indicators such as mouth opening range and pain level [42–49] (Table 3). The treatment process roughly involves (1) the therapist providing health education and specific training guidance on TMD to the patient; (2) The patient undergoes isometric and isotonic training for the jaw, chewing muscles, and tongue muscles as required; (3) The patient undergoes head and neck posture adjustment. Although the specific plans included in each study vary in terms of the form, frequency, and duration of exercise, they generally follow the above process. It is worth noting that in recent years, there has been less research on therapeutic exercise in TMD compared to manual therapy. The reason for this may be that the clinical effects of therapeutic exercise are closely related to the patient's cognitive ability, compliance, and individual pain threshold. However, the above factors lack objective standards, which hinders further research on this treatment.

Table 3. Overview of included studies.

Intervention	Study period (weeks)	Frequency	Outcome Measure	Ref.
Posture training	4	once a week	Maximum pain-free opening and pressure algometer threshold measurements	[42]
Controlled chewing exercise	8	three times a day	Pain levels, mouth opening range	[43]
Individualized Therapeutic jaw exercises	24	two times a day	Mouth opening range	[44]
6 × 6 Exercises	4	6 times a day	Intensity of jaw pain,	[45]
Therapeutic exercises for temporomandibular joint dislocation	12	once a day	Reducing the clicking	[46]
Mandibular condylar movement exercise	Single session	Single session	Mouth-opening, Lateral movement	[47]
Therapeutic jaw exercises	4	three times a day	Pain drawing, jaw symptoms	[48]
Relaxation exercises for the masticator muscles	4	three times a day	Limited range of motion, pain	[49]

4. Physical Factor Therapy

4.1. Ultrasound

Ultrasound therapy is an effective method for relieving pain, relieving muscle tension, and improving muscle function. This method has become one of the main physical factor therapies for treating TMD due to its simple operation and non-invasiveness.

The current research mainly utilizes low-intensity ultrasound to treat TMD [50–57] (Table 4). The general process involves applying a coupling agent to the ultrasound probe and temporomandibular joint area, and setting the frequency to no more than 2 MHz with an intensity of around 2 W/cm^2. Gently roll the probe over the affected area and remember not to stay in one area for too long. And the results of these studies indicate that ultrasound can significantly alleviate tissue edema near the temporomandibular region, reduce pain, and effectively promote soft tissue repair.

Table 4. Overview of included studies.

Study Period (Weeks)	Frequency	Ultrasonic Parameters (Frequency (MHz); Intensity(W/cm^2))	Outcome Measure	Ref.
2	Five times a week	1 MHz; 4 W/cm^2	Headache-type symptoms and muscle spasm symptoms	[50]
4	once a week	1 MHz; unknown	Pain level, mouth opening range	[51]
3	once a day	1 MHz; 30 mW/cm^2	Sagittal skeletal change, Vertical skeletal change	[52]
2	three times a week	1 MHz; 1.5 W/cm^2	inflammation levels, pain levels	[53]
4	five times a week	Unknown; 1 W/cm^2	pain-free maximum mouth opening, pain level	[54]
4	three times a week	1.5 MHz; 30 mW/cm^2	Measurement of Joint Spaces, the Condylar Head and Remodeling	[55]
4	eight sessions	1 MHz; 1 W/cm^2	Psychological discomfort, physical pain, and psychological limitation	[56]
4	Five times a week	1 MHz; 1.5 W/cm^2	pain and functional jaw movements	[57]

4.2. Electrical Stimulation

Electrical stimulation is a non-invasive analgesic therapy based on the “gate control theory” that uses current pulses to activate peripheral nerve fibers [58]. Due to its high safety, good analgesic effect, reduced use of opioid drugs, and avoidance of the risk of acupuncture induced infectious diseases, it is highly favored in clinical and scientific research. At present, Transcutaneous electrical stimulation (TENS) and high-voltage electrical stimulation (HVES) have been recommended as a treatment method for TMD, as they have been proven to have analgesic effects on patients and can relieve chewing muscle tension [59].

At present, TENS and HVES treatments for TMD are mainly achieved by improving the degree of facial pain in patients [60–65] (Table 5). This is mainly due to the fact that regardless of the type of electrical stimulation, it can essentially stimulate sensory fibers and increase the pain threshold to achieve the effect of reducing pain. Although these studies have obtained positive results, due to the different parameters of electrical stimulation applied in each research institute, it is necessary to explore the effects of different parameters on TMD under the same type of electrical stimulation in the future.

Table 5. Overview of included studies.

Type of Electrical Stimulation	Study Period (Weeks)	Frequency	TENS Parameters (Frequency (Hz); Intensity(mA))	Outcome Measure	Ref.
TENS	10	once a day	50 Hz; 0–80 mA	Pain intensity	[60]
TENS	Single session	Single session	100 or 50 Hz; unknown	Pain intensity	[61]
High-Voltage	5	three times a week	10 Hz; unknown	Pain intensity	[62]
TENS	Single session	Single session	0.5 Hz; Comfortably tolerated with muscle contraction	Pain intensity, mouth opening range	[63]
TENS	Single session	Single session	0.66 Hz; 0–24 mA	Surface electromyography activity	[64]
High-Voltage	4	3 days a week	10 Hz;50 mA	maximum mouth opening, pain intensity, pressure pain thresholds	[65]

4.3. Laser Therapy

Laser therapy is a type of phototherapy that can induce additional photochemical reactions at the mitochondrial level, altering cellular metabolism and protein synthesis [66]. In addition, it has been proposed that low-intensity phototherapy induces neovascularization, produces collagen, and increases fbroblast cell activity. Laser therapy can increase tissue temperature and improve microcirculation in irradiated tissues, clearing most inflammatory mediators [67].

Many existing studies have shown that laser therapy can significantly alleviate the pain symptoms of TMD and improve the range of motion of the temporomandibular joint [68–76] (Table 6). This fully demonstrates that laser therapy can promote facial blood circulation, reduce tissue edema and inflammatory reactions. However, the specific mechanism of laser therapy on TMD still needs to be improved, and more extensive research should be conducted at the animal and cellular levels.

Table 6. Overview of included studies.

Laser Type	Study Period (Weeks)	Frequency	Laser Parameters (Power (mW); Dosage (J/cm^2))	Outcome Measure	Ref.
GaAs 820 nm	4	Three times a week	300 mW; 3 J/cm^2	lateral excursion, mouth opening and pain intensity	[68]
GaAIAs 780 nm	5	Two times a week	70 mW; 52.5 J/cm^2	lateral excursion, mouth opening and pain intensity	[69]
GaAIAs 650 nm/830 nm	1	Six sessions	300 mW; unknown	lateral excursion, protrusion excursion, mouth opening and pain intensity	[70]
GaAIAs 810 nm	4	Three times a week	50 mW; 3.4 J/cm^2	mouth opening and pain intensity	[71]
GaAIAs 780 nm	4	Two times a week	70 mW; 89.7 J/cm^2	Pain level	[72]
GaAlAs 808 nm	2	once a day	250 mW; unknown	Pain level	[73]
GaAlAs 808 nm	4	Two times a week	100 mW; 70 J/cm^2	pressure pain threshold, pain intensity	[74]
GaAlAs780 nm	4	Three times a week	70 mW; 35 J/cm^2	Muscle tenderness palpation and the questionnaire of fonseca	[75]
Diode laser (810 nm)	2	Five times a week	250 mW; 8 J/cm^2	Pain level	[76]

4.4. Other Physical Therapy Techniques

In addition to the aforementioned treatment methods, there are many emerging treatment strategies that are also effective for TMD. Among them, biofeedback therapy, Kinesio Taping and occlusal splint therapy are also widely used.

The function of biofeedback is to force muscles to return to normal function and temporarily achieve maximum muscle relaxation [77]. This therapy uses electromyography to exercise the patient's neuromuscular tension and adjust the ability to alter physiological responses. The surface electrode is placed on both muscles (usually the masseter or anterior temporal muscles) in a transverse direction parallel to the underlying fibers of the muscle area. SEMG signals are amplified and filtered through specific software for muscle tone recognition. The treatment plan includes teaching patients how to move and relax facial muscles to cooperate with the computer to establish correct biofeedback. The results of these studies indicate that biofeedback therapy can not only reduce patients' pain levels, but also improve their depressive state to some extent [78,79].

Kinesio Taping (KT), as the auxiliary tape, has the functions of stabilizing muscles, adjusting body posture, and relieving pain [80]. At the same time, it has the advantages of non-invasiveness, low cost, and simple operation. Therefore, it is widely used as an auxiliary treatment for TMD. Usually, a "Y"-shaped driving ring strip is made based on the measurement results of each patient. The doctor requested the patient to move their chin to determine the temporomandibular joint. The base of the "Y" bar is placed slightly behind the temporomandibular joint without tension. Pull the skin from the temporomandibular joint to the nose and apply slight tension to the upper tail of the band. Subsequently, apply the same technique to the bottom of the "Y" bar. To improve the stability of the chin, tape is usually applied on both sides. This type of tape can normalize muscle tension and improve the level of self-healing. KT stimulates the endogenous analgesic system and changes the subjective experience of patients. By improving proprioception, restore the motor function of the chewing muscles [81,82].

In order to restore the corresponding relationship of the mandibular joint, occlusal splints are often used. Orthodontic appliances are detachable artificial bite aids used to treat abnormal positions of the mandible and maxilla [83]. Many TMD patients use occlusal splints to improve the stability of their oral and maxillofacial joints. Some clinical studies have also found that occlusal splints can not only relieve facial pain, but also improve symptoms such as anxiety and insomnia [84,85]. The most common is that they are used in cases of inter disc displacement. Splints are generally designed by a team of dentists and engineers based on principles of human mechanics, making them a product of the combination of medicine and engineering. The Michigan style occlusal splint made by Ramfjord and Ash Jr is currently the most widely used [86]. This type of splint is generally used for the maxilla, but if there is tooth loss in the posterior part of the maxilla, it can also be used for the mandible. The main function of this device is to reduce biting force, relax chewing muscles, improve joint mobility, and ultimately alleviate patient pain [87]. In clinical practice, two other types of occlusal splints are also used, as listed in Table 7.

Table 7. Types of occlusal splints.

Type of Occlusal Appliances	Activity	Function
Reflex appliances	Preventing long-term tooth contact can temporarily prevent gritting and biting, which has a positive impact on the resulting tension in teeth and muscles	Suitable for acute symptoms of mandibular joint overload (short-term application)
Stabilization appliances	Create a normal bite pattern in static bite, and synchronize tooth contact with the front teeth in the lateral tooth area in dynamic bite	Suitable for acute or chronic symptoms, and can also be used for psychological overreaction
Repositioning appliances	Fix the temporomandibular joint in the treatment position with a splint to shorten the healing time and maintain an asymptomatic joint posture	Suitable for temporomandibular joint diseases, such as anterior disc displacement with or without reduction, posterior condylar displacement, and osteoarthritis. It can be treated as a chronic or acute phase.

5. Conclusions

For newly diagnosed or mild TMD, physical therapy is the preferred treatment option. Physical therapy strategies such as manual therapy and physical factor therapy are not only minimally invasive but also easy to operate, which can significantly alleviate patients' pain and improve their temporomandibular joint mobility, thereby improving their quality of life. However, there are still several limitations in current research: (1) the lack of basic experiments makes it difficult to delve into the molecular biology mechanisms of physical therapy for treating TMD; (2) The sample size in clinical trials is small, resulting in low validity of the results; (3) The variety of equipment involved in the same intervention measure and the varying parameters used in the experiment also reduce the reproducibility of the study. Therefore, in future research, attention should also be paid to the combination of clinical trials and basic research, and large sample, multi center randomized controlled trials are also needed to consolidate the authenticity of the results.

Author Contributions

J.L. and F.Z. are responsible for writing the paper, while Y.C. and Y.L. are responsible for designing and reviewing it. All authors have read and agreed to the published version of the manuscript.

Funding

This research received no external funding.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

Not applicable.

Acknowledgments

We are grateful to all the scholars who have conducted studies on TMD.

Conflicts of Interest

The authors declare that they have no competing interests.

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