

Clinical Research Advances in Acupuncture Treatment for Temporomandibular Joint Disorders

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Abstract: Temporomandibular disorders (TMD) are common and intractable conditions affecting the oral and maxillofacial region. Given the limitations of conservative Western medical treatments in terms of long-term efficacy and side effects, acupuncture—a distinctive non-pharmacological intervention in traditional Chinese medicine—is increasingly recognized for its clinical value in the treatment of TMD. This article systematically reviews recent advances in clinical research on acupuncture for TMD. It focuses on the differences in efficacy and mechanisms of action among various acupuncture modalities—including traditional manual acupuncture, electroacupuncture, warm acupuncture, laser acupuncture, and scalp acupuncture—analyzes existing limitations in current research, such as insufficient standardization of procedures and difficulties in implementing blinded studies, and outlines future research directions. The aim is to provide a more robust evidence-based foundation for the standardized integrated Traditional Chinese and Western medicine diagnosis and treatment of TMD.

Keywords: Temporomandibular Joint Disorder, Acupuncture, Clinical Efficacy, Mechanism of Action, Research Progress.

1. Introduction

Temporomandibular disorders (TMD) refer to a group of conditions involving abnormalities in the structure and function of the temporomandibular joint, masticatory muscles, and surrounding tissues. Clinically, they primarily manifest as maxillofacial pain, joint clicking or crepitus, and limited mouth opening—all of which constitute disorders of mandibular movement [1,2]. Epidemiological data indicate that the prevalence of TMD in the global adult population is approximately 31%, with the highest incidence among young and middle-aged adults aged 20–40; women are approximately twice as likely to develop the condition as men [3]. The exact etiology of this condition remains unclear, but common precipitating factors include malocclusion, psychological anxiety, trauma and overuse, and exposure to cold and wind. The condition is prone to recurrent episodes, significantly impacting patients' ability to eat, speak, and their overall quality of life. Modern medicine follows the principle of stepwise treatment. Mild cases are often managed with conservative interventions such as occlusal splints, nonsteroidal anti-inflammatory drugs (NSAIDs), and physical therapy, while severe cases may require intra-articular injections or even surgical intervention. However, long-term medication use can easily lead to gastrointestinal adverse reactions, invasive procedures carry a risk of infection, and symptomatic treatment alone cannot fundamentally correct muscle hypertonicity, resulting in persistently high long-term recurrence rates [4].

Traditional Chinese Medicine (TCM) classifies TMD under the categories of “cheek pain,” “jaw bi syndrome,” and “lockjaw,” and views its core pathogenesis as obstruction in the facial meridians, deficiency of nourishment in the tendino-muscular channels, and impaired circulation of qi and blood. Treatment is based on the fundamental principles of unblocking the meridians, relieving spasms and alleviating pain, and harmonizing qi and blood. Acupuncture, as a core method of external treatment in TCM, can directly target the affected area, offering both local relaxation and systemic regulation. In recent years, with the continuous advancement

of evidence-based medical research, the efficacy of acupuncture in treating TMD has been confirmed by numerous clinical studies. Various modified acupuncture techniques and combination therapies have emerged, and research into the mechanisms of action has gradually deepened [5,6]. This article systematically compiles recent clinical and basic research findings from both domestic and international sources, comprehensively elucidating the current status and future directions of acupuncture treatment for TMD, thereby providing a reference for clinical practice and future research.

2. Evidence on the Overall Clinical Efficacy of Acupuncture for TMD

Multiple systematic reviews and meta-analyses have confirmed that acupuncture is significantly effective in alleviating TMD-related pain and improving mandibular function, with the level of evidence steadily increasing. A systematic review and meta-analysis conducted by Di Francesco et al. indicated that acupuncture and laser acupuncture can significantly reduce pain intensity in patients with TMD, with efficacy superior to sham acupuncture or standard care. By integrating data from multiple randomized controlled trials, this study [7] found that both the Visual Analog Scale (VAS) and Numerical Rating Scale (NRS) scores decreased significantly following acupuncture intervention, suggesting that acupuncture has a definite analgesic effect. Similarly, a review by Serritella et al. found that acupuncture not only helps alleviate pain but also effectively relieves muscle tension and improves mandibular motor function [8]. These findings suggest that acupuncture is not merely a single analgesic modality but rather achieves overall functional recovery through multi-target regulation.

In a large-scale systematic review of orofacial pain, Mohamad et al. reported that there is moderate- to high-quality evidence supporting acupuncture's efficacy in reducing pain, increasing maximum mouth opening (MMO), and improving mandibular function [9]. Maximum mouth opening is a key indicator for assessing the degree of joint dysfunction in

patients with TMD; the significant increase in MMO following acupuncture treatment directly reflects improved joint range of motion and relief from muscle spasm. It is worth noting that the efficacy of acupuncture does not occur in isolation but often acts by modulating local muscle tone and central pain perception pathways [10]. The conclusions of Medrano et al.'s systematic review indicate that acupuncture can significantly expand the range of joint motion and improve muscle function, thereby enhancing patients' quality of life. These findings establish acupuncture as an effective and safe intervention in the conservative treatment of TMD.

Furthermore, from a health economics perspective, acupuncture treatment offers a high cost-effectiveness ratio. Although some advanced acupuncture techniques (such as laser acupuncture) involve higher equipment costs, traditional manual and electroacupuncture treatments are relatively inexpensive and do not require long-term medication, thereby reducing additional healthcare expenditures resulting from drug side effects. For patients with chronic TMD, acupuncture provides a sustainable long-term management strategy that helps reduce disease recurrence rates and the consumption of healthcare resources. In summary, existing clinical evidence fully supports the core value of acupuncture in controlling TMD symptoms and restoring function, laying a solid foundation for its widespread clinical adoption.

3. Comparison and Optimization of Different Acupuncture Modalities

As research has progressed, traditional manual acupuncture has given rise to a variety of modified techniques, including electroacupuncture (EA), warm needle acupuncture (WNA), laser acupuncture (LA), and scalp acupuncture. These different acupuncture modalities differ in terms of stimulation parameters, depth of action, and physiological effects; therefore, they each exhibit distinct advantages and indications in clinical practice.

3.1 Electroacupuncture (EA)

Electroacupuncture enhances neuromodulatory effects by applying low-frequency electrical current to traditional acupuncture points and is currently one of the most extensively studied acupuncture modalities for treating TMD. A systematic review [10] by Sung et al., which included 11 RCTs involving a total of 667 patients, found that electroacupuncture has significant analgesic effects in the management of TMD; commonly used acupoints include Jiache, Xiaguan, and Hegu. The choice of frequency in electroacupuncture significantly influences therapeutic efficacy. Low-frequency electroacupuncture (2–10 Hz) primarily stimulates the release of endogenous opioid peptides, producing long-lasting analgesic effects; whereas high-frequency electroacupuncture (100 Hz or higher) primarily inhibits pain signal transmission through the spinal cord gating mechanism. A narrative review [11] by Zhu et al. further noted that electroacupuncture, by regulating the activity of trigeminal nerve nuclei and inhibiting the release of inflammatory mediators, serves as an important non-pharmacological approach for managing TMD-related pain. Compared to manual acupuncture, electroacupuncture provides a continuous and stable level of stimulation,

reducing fluctuations in therapeutic efficacy caused by operator variability, and is thus more conducive to standardized research and clinical implementation.

3.2 Warm Needle Acupuncture (WNA)

Warm needle acupuncture combines the thermal effects of needle insertion and moxibustion, aiming to warm and unblock the meridians, dispel cold, and relieve pain. It is particularly suitable for TMD patients diagnosed according to Traditional Chinese Medicine (TCM) patterns as “cold-damp obstruction” or “qi and blood stasis.” A systematic review and meta-analysis conducted [12] by Liu et al. showed that warm needle acupuncture is superior to acupuncture alone or conventional physical therapy in improving pain and mandibular movement disorders in TMD patients, with particularly significant effects in patients presenting with symptoms such as pain exacerbated by cold exposure and morning stiffness. Thermal stimulation may enhance therapeutic effects by improving local blood circulation, accelerating the clearance of metabolic byproducts, and relieving muscle spasms. From a modern medical perspective, the thermal effect can dilate local blood vessels, increase tissue oxygen supply, and reduce muscle viscosity, thereby improving the elasticity of the soft tissues surrounding the joint [13]. However, care must be taken during warm acupuncture to prevent burns, and the technique requires a high level of skill from the practitioner, which limits its widespread adoption in some primary care facilities.

3.3 Laser Acupuncture (LA)

As a non-invasive alternative, laser acupuncture uses low-intensity laser light to stimulate acupoints, thereby avoiding the fear associated with needle insertion and the risk of infection. A study [7] by Di Francesco et al. confirmed the efficacy of laser acupuncture in alleviating TMD pain. A network meta-analysis conducted [14] by Mota et al. further demonstrated that laser acupuncture performs exceptionally well in increasing maximum mouth opening and reducing pain scores; due to its non-invasive nature, it is particularly suitable for children, the elderly, and patients with coagulation disorders who have a fear of needles. A systematic review [15] by Peixoto et al. also supports the notion that laser acupuncture is as effective as traditional acupuncture in improving the signs and symptoms of TMD. The parameters of laser acupuncture (such as wavelength, power, and exposure time) significantly influence therapeutic efficacy; however, a standardized protocol is currently lacking, which is a key issue that future research needs to address.

3.4 Other Acupuncture Techniques

Scalp acupuncture exerts a systemic regulatory effect by stimulating specific reflex zones on the scalp and is particularly suitable for TMD patients with psychological factors such as anxiety and depression. A randomized controlled trial (RCT) by Peixoto et al. found [16] that scalp acupuncture was superior to conventional manual therapy in improving pain, sleep disturbances, and quality of life in TMD patients, suggesting the importance of its central regulatory mechanisms. In addition, Thread Embedding

Acupuncture (TEA), as a long-acting stimulation method, is currently being evaluated in clinical trials to assess its long-term efficacy and cost-effectiveness in chronic TMD. By using absorbable threads to generate sustained mechanical and chemical stimulation at acupoints, TEA prolongs the duration of the therapeutic effect and improves patient compliance [17].

3.5 Combination and Comparison of Acupuncture with Other Therapies

In clinical practice, a single therapy often fails to comprehensively address the complex pathophysiological changes associated with TMD; therefore, acupuncture is frequently combined with other conservative therapies to enhance therapeutic efficacy. A network meta-analysis conducted by Yan et al. [18] compared the relative efficacy of different acupuncture methods and other interventions. The results showed that comprehensive treatment regimens incorporating acupuncture were often superior to monotherapies in terms of pain relief and functional improvement.

For example, a study by Sant'Anna et al. [19] examined the efficacy of combined acupuncture and occlusal splint therapy for temporomandibular joint (TMJ) myofascial pain and found that the combined treatment was more effective in reducing muscle tension and pain levels. Occlusal splints alleviate joint load by adjusting the occlusal relationship, while acupuncture relieves spasm through neuromuscular regulation; the synergistic effect of both approaches achieves "treatment of both the symptoms and the root cause." Furthermore, the combined use of acupuncture and physical therapy (such as ultrasound and transcutaneous electrical nerve stimulation, TENS) has also shown promising results. Physical therapy focuses on the repair of local tissues and functional training, while acupuncture focuses on the regulation of the body's overall qi and blood circulation as well as the nervous system; the combination of the two can accelerate the rehabilitation process. However, controversy regarding the specific effects of acupuncture persists. A double-blind RCT by Şen et al. [20] compared the effects of acupuncture at specific versus nonspecific acupoints on non-chronic painful TMD; the results found no significant differences between the two groups, suggesting that the placebo effect or nonspecific neural modulation may play an important role in the efficacy of acupuncture. Nevertheless, the majority of high-quality evidence still supports the superiority of acupuncture over sham acupuncture or wait-list control groups [21]. This suggests that, even in the presence of nonspecific effects, the clinical benefits of acupuncture as a holistic intervention are well-established.

4. Discussion of Mechanisms of Action

The mechanisms by which acupuncture treats TMD involve multi-level regulation, encompassing peripheral local effects, spinal-level modulation, and central nervous system remodeling. First, local mechanical stimulation promotes the release of endogenous opioid peptides (such as endorphins and enkephalins), thereby producing analgesic effects [11]. Acupuncture stimulation activates local A δ and C fibers; signals are transmitted to the dorsal horn of the spinal cord,

triggering descending inhibitory pathways that release serotonin and norepinephrine, thereby inhibiting the transmission of pain signals [10]. Second, electroacupuncture and manual acupuncture can inhibit the transmission of pain signals by modulating the excitability of the trigeminal-cervical complex. Pain signals from TMD are primarily transmitted via the trigeminal spinal tract nucleus; acupuncture can inhibit the excessive excitation of neurons in this nucleus, thereby blocking the consolidation of pain memory.

Furthermore, acupuncture improves local microcirculation, accelerates the clearance of inflammatory mediators, and alleviates muscle spasms by regulating the balance of the autonomic nervous system. Studies have found that acupuncture reduces the levels of pro-inflammatory factors such as prostaglandin E2 (PGE2), interleukin-1 β (IL-1 β), and tumor necrosis factor- α (TNF- α) in local tissues, while simultaneously increasing the expression of the anti-inflammatory factor IL-10, thereby alleviating aseptic inflammation in joint and muscle tissues. From the perspective of Traditional Chinese Medicine (TCM) theory, acupuncture corrects the pathological state of "pain due to obstruction" by unblocking meridians and harmonizing qi and blood. Modern research further reveals that meridians may be highly correlated with the distribution of fascial networks and neurovascular bundles; acupuncture restores overall homeostasis by regulating fascial tension and neurovascular function.

5. Limitations of the Study and Future Prospects

Although existing evidence supports the efficacy of acupuncture in treating TMD, current research still has several limitations. First, some RCTs have small sample sizes and are at high risk of bias, such as difficulties in implementing blinding and non-standardized control group design. The unique nature of acupuncture makes double-blind designs particularly challenging, and the lack of standardized protocols for sham acupuncture has compromised the comparability of results. Second, the lack of standardization in acupuncture parameters—such as needle retention time, stimulation frequency, and acupoint selection—has led to significant heterogeneity across studies. The vast differences in acupoint combinations and stimulation intensities used in various studies make it difficult to establish uniform clinical guidelines.

Future research should focus on conducting large-sample, multicenter, strictly blinded RCTs and establishing uniform standards for acupuncture practice. It is recommended to report the details of acupuncture interventions in detail in accordance with the STRICTA criteria (Standards for Reporting Interventions in Clinical Trials of Acupuncture) to enhance research transparency and reproducibility. Furthermore, integrating neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) to elucidate the specific regulatory mechanisms of acupuncture on the central pain matrix in TMD (e.g., the anterior cingulate cortex, insula, and thalamus) will be a key direction for elevating the level of scientific evidence in this field. At the same time, research on

predictors of acupuncture efficacy should be strengthened to identify patient subgroups that respond well to acupuncture and achieve precision medicine.

6. Conclusion

In summary, acupuncture and its derivative techniques (electroacupuncture, moxibustion, laser acupuncture, etc.) provide safe and effective non-pharmacological treatment options for patients with TMD. Existing clinical evidence indicates that acupuncture can significantly alleviate pain, improve mandibular function, and enhance quality of life, and that combination therapies produce synergistic effects. Its mechanisms involve multiple pathways, including the activation of endogenous analgesic systems, anti-inflammatory effects, and central nervous system remodeling. Despite challenges related to standardization and methodology, the role of acupuncture in the comprehensive management of TMD is becoming increasingly established. By optimizing treatment protocols, standardizing operational procedures, and deepening research into its mechanisms, acupuncture is expected to play a more central role in the multidisciplinary comprehensive management of TMD, thereby contributing to the development of a diagnostic and treatment system for orofacial pain with Chinese characteristics.

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