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Advances in Clinical Research on Acupuncture Treatment for Pain Conditions

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Abstract: Pain is one of the most prevalent clinical symptoms and exerts a profound impact on patients' quality of life. Acupuncture, a cornerstone of Traditional Chinese Medicine with a history spanning millennia, has accumulated extensive clinical experience in pain management. In recent years, the integration of evidence-based medicine and modern medical technologies has propelled significant advancements in clinical research on acupuncture for pain treatment. This paper presents a comprehensive systematic review, summarizing the underlying mechanisms of action, current clinical evidence, and therapeutic advantages of acupuncture across diverse types of pain. Furthermore, it critically examines existing challenges in research and practice, and discusses emerging trends, thereby providing a valuable reference for optimizing clinical applications and guiding future investigations in acupuncture-based pain management.

Keywords: acupuncture; pain; clinical research; evidence-based medicine

1. Introduction.

Pain represents a complex physiological and psychological response to harmful stimuli and is generally classified as acute or chronic based on its duration. Chronic pain not only inflicts physical discomfort but can also lead to psychological complications, including anxiety and depression, profoundly affecting patients' quality of life and social functioning. According to data from the U.S. Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH), pain is one of the most common reasons adults seek medical care in the United States [1]. Approximately one in five U.S. adults had chronic pain in 2019 and approximately one in 14 adults experienced "high-impact" chronic pain, defined as having pain on most days or every day during the past 3 months that limited life or work activities [2]. While conventional analgesic medications can provide significant relief, long-term use may lead to dependence, tolerance, and various adverse effects.

Acupuncture, a cornerstone of Traditional Chinese Medicine, has a long-standing history in pain management. Its theoretical foundation is derived from the ancient text Huangdi Neijing (The Yellow Emperor's Classic of Internal Medicine), which posits: "Where there is pain, there is obstruction; where there is free flow, there is no pain." Among complimentary health approaches specifically for managing pain, acupuncture has been one of the most commonly used nonpharmacological modalities for effective pain care [3]. Contemporary research has revealed that acupuncture produces analgesic effects through multiple mechanisms, including modulation of the nervous, endocrine, and immune systems. With advantages such as high safety, minimal adverse effects, and cost-effectiveness, acupuncture is increasingly recognized as a valuable therapeutic option in both clinical and integrative pain management settings.

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2. Mechanisms of Acupuncture Analgesia

2.1. Principles of Acupuncture Analgesia in Traditional Chinese Medicine

According to *Suwen: On Raising Pain*, "The meridians flow ceaselessly, circulating without rest. When cold qi enters the meridians, it lingers and stagnates, obstructing their flow. If it lodges outside the vessels, blood becomes deficient. If it lodges within the vessels, qi fails to circulate. Thus, pain arises suddenly." This passage elucidates the pathogenesis of pain in Traditional Chinese Medicine (TCM), attributing it primarily to the invasion of cold pathogens, which obstruct meridian flow, stagnate ying and wei qi, induce qi stagnation and blood stasis, and lead to blood deficiency, ultimately resulting in pain. This concept was later distilled into the well-known dictum: "Where there is free flow, there is no pain; where there is pain, there is no free flow," providing a foundational principle for acupuncture-based pain therapy.

Acupuncture treatment follows the meridian system, wherein meridians internally connect to the zang-fu organs and externally link to the limbs and joints. By stimulating specific acupoints with needles, acupuncture activates meridian energy, promotes the circulation of qi and blood, and regulates the functions of zang-fu organs, thereby achieving analgesic and therapeutic effects.

2.2. Western Medical Principles of Acupuncture Analgesia

From a modern biomedical perspective, chronic pain is frequently associated with neuroinflammatory processes. Studies have shown that acupuncture modulates microglial activation, suppresses the release of pro-inflammatory cytokines (e.g., IL-1 β , TNF- α , IL-6), and enhances the production of anti-inflammatory cytokines (e.g., IL-10, IL-4), thereby regulating inflammatory responses and contributing to analgesia.

Additionally multiple transmitters and modulators, including endogenous opioids, cholecystokinin octapeptide, 5-hydroxytryptamine, glutamate, noradrenalin, dopamine, γ -aminobutyric acid, acetylcholine, and orexin A, are involved in acupuncture analgesia [4]. Acupuncture also influences the release and metabolism of various neurotransmitters in the central nervous system, such as opioids, serotonin, norepinephrine, orexin and endocannabinoid, forming a complex neuromodulatory network that underlies its analgesic mechanisms [5]. Collectively, these multi-pathway interactions integrate peripheral and central mechanisms, providing a scientific basis for acupuncture's efficacy in pain management.

3. Current Status of Clinical Research on Acupuncture Treatment for Different Types of Pain Syndromes

3.1. Headache

Headaches are among the most common pain syndromes encountered in clinical practice, with diverse underlying causes and complex pathophysiology. Acupuncture has demonstrated notable analgesic effects for prevalent headache conditions such as migraines and tension-type headaches.

Yanxia Sun et al. evaluated the efficacy of acupuncture for treatment of chronic headache. They searched the databases of Medline (1966–2007), CINAHL, The Cochrane Central Register of Controlled Trials (2006), and Scopus for randomized controlled trials investigating the use of acupuncture for chronic headache [6]. Studies were included in which adults with chronic headache, including migraine, tension-type headache or both, were randomized to receive needling acupuncture treatment or control consisting of sham acupuncture, medication therapy, and other nonpharmacological treatments. They extracted the data on headache intensity, headache frequency, and response rate assessed at early and late follow-up periods. Results indicated that needling acupuncture is superior to sham acupuncture and medication therapy in improving headache intensity, frequency,

and response rate. These findings suggest that acupuncture can enhance overall clinical outcomes for chronic headache patients.

Further research focused specifically on migraine management demonstrated that adding acupuncture to standard treatment regimens effectively alleviated clinical symptoms and improved physiological indicators. Patients receiving acupuncture showed lower pain scores, improved blood rheology markers, and increased intracranial arterial blood flow velocity. These improvements were associated with enhanced quality of life compared to patients treated with medication alone.

Acupuncture has also been evaluated in the treatment of chronic tension-type headaches [7]. In a controlled study, patients receiving true acupuncture (TA) over 8 weeks. The acupuncture treatments were standardized across participants, and each acupuncture site was needled to achieve deqi sensation, demonstrated superior outcomes to those receiving superficial acupuncture (SA) group—defined as a type of sham control by avoiding deqi sensation at each acupuncture site. The true acupuncture group achieved higher short-term cure rates and overall efficacy, highlighting the therapeutic advantage of acupuncture in managing prophylaxis of chronic tension-type headaches (CTTH).

In summary, acupuncture has proven to be an effective modality for treating various types of headaches. It not only alleviates pain more rapidly than conventional treatments alone but also improves overall patient well-being, making it a valuable complementary therapy in clinical practice.

3.2. Neck, Shoulder, Waist, and Leg Pain

This category primarily includes cervical spondylosis, frozen shoulder, lumbar disc herniation, and lumbar muscle strain. These conditions represent a common type of chronic musculoskeletal pain, with increasing prevalence due to accelerating lifestyles, evolving work patterns, and an aging population. Such pain significantly affects patients' quality of life, work capacity, and psychological well-being due to the characteristics of recurrent attacks and long course of disease [8].

Clinical studies have demonstrated the effectiveness of integrated traditional Chinese medicine (TCM) acupuncture therapy for these conditions. Yunping Shan et al. found that patients receiving comprehensive acupuncture treatment consistently showed superior outcomes in pain relief, functional improvement and inflammatory factor levels to those receiving conventional therapies [8].

Specifically, Tingting Zhu et al. reported the clinical efficacy of moving qi acupuncture in the treatment of neck, shoulder, low back, knee and ankle pain [9]. The results show that the use of moving qi acupuncture for the treatment has good therapeutic effects, rapid effectiveness, significant and immediate analgesic effects. In some other research patients with shoulder impingement syndrome undergoing acupuncture treatment exhibited lower pain scores on the Visual Analog Scale (VAS) and improved scores on functional assessments such as UCLA questionnaire [10]. It also proved that acupuncture treatment to be a safe and reliable technique to achieve clinically significant results and could be implemented in the therapy options offered by the health services.

Overall, comprehensive TCM acupuncture therapy not only effectively reduces pain but also promotes functional recovery, improves patient safety, and accelerates rehabilitation. These consistent clinical benefits suggest that acupuncture should be widely adopted as a complementary or primary therapy for patients suffering from neck, shoulder, waist, and leg pain.

3.3. Pain in Limb Joints and Sports Injuries

Limb joint pain and sports-related injuries, such as knee osteoarthritis (KOA), gouty arthritis and acute lateral ankle sprains are common musculoskeletal conditions that significantly impair mobility and quality of life. Recent clinical studies have explored the

therapeutic effects of acupuncture, often in combination with complementary interventions, for these conditions.

Acupuncture and heat therapy in conjunction with standard care has been shown to improve joint function and alleviate pain in patients with knee osteoarthritis (KOA) [11]. In comparative studies, heat and acupuncture restore mobility in knee osteoarthritis (HARMOKnee) group exhibited significantly lower pain, stiffness, and functional assessment scores than those receiving standard care. Improvements were observed across considerable pain reduction and knee flexion and extension. Notably, knee flexion range of motion (ROM) were significantly greater in the HARMOKnee group with Kidney yang deficiency with phlegm and blood stasis syndrome indicating that heat and acupuncture treatment were especially more effective to the function of this syndrome knee patients.

Acupuncture has also demonstrated efficacy and safety in the management of gouty arthritis [12]. Patients receiving acupuncture showed higher overall effectiveness, lower level of uric acid, and improved total symptom scores compared to those receiving standard pharmacological treatment. Furthermore, the incidence of adverse reactions was markedly lower in the acupuncture group, indicating that this approach is not only effective but also safe.

Additionally, in a randomized controlled trial, Wen Wen et al. found the evidence that acupuncture may provide rapid pain relief and restoration of motor function in Acute Lateral Ankle Sprains [13].

Overall, acupuncture-whether used alone or alongside complementary therapies such as heat therapy provides significant analgesic benefits, improves joint function, and reduces the risk of adverse effects in patients with limb joint pain and sports injuries. These findings support its broader clinical application as a safe and effective treatment modality for musculoskeletal disorders.

3.4. Gastric Pain

One case has been reported by Jihe Zhu et al. of fire-needle acupuncture treating in patient presented with gastric pain. The 39 years old woman patient presented with pain and cramps in the stomach and esophagus after sudden weight loss (16 kg in 1 month) after coronavirus infection. Liver, bile, spleen, pancreas are normal after physical examination. Both the kidney and the bladder are neat without pathological findings. The patient received medicament therapy Reglan 10 mg for 10 days, but without any effect and changes. After receiving only one fire-needle acupuncture treatment, the pain was gone and didn't come back. The treated points are located on the vertebrae Th5 and Th6. This case indicated acupuncture is very effective and gives fast and satisfying results in conditions presented with abdominal pain and discomfort in the stomach and esophagus [14].

3.5. Dysmenorrhea

Dysmenorrhea (period pain) is common and affects around three quarters of all young women under the age of 25 [15]. Acupuncture has proven effective and safe in treating primary dysmenorrhea (PD).

Weiting Liu et al. did a research of Efficacy and Safety of Acupuncture and or Moxibustion for Managing Primary Dysmenorrhea. Their findings demonstrated significant reductions in Visual Analog Scale (VAS) scores in the acupuncture and moxibustion group with more participants in the acupuncture and moxibustion group experiencing complete relief or marked improvement. These findings indicate that acupuncture and moxibustion is effective in alleviating symptoms of primary dysmenorrhea (PD) and represents a safe therapeutic approach [16].

Another clinical study has been conducted by Yanan Wang et al. regarding fMRI study of immediate analgesic effect of acupuncture in patients with primary dysmenorrhea. And these findings support the importance of rACC-left precentral gyrus resting-state FC in the modulation of the intensity of PD pain through acupuncture, which may support the central mechanism of acupuncture in the treatment of PD [17].

3.6. Coronary Heart Disease and Angina Pectoris

Acupuncture has been shown to be effective and safe in the treatment of coronary heart disease and stable angina pectoris. A literature research was performed in nine databases, including PubMed and the Cochrane Library, from their inception to 30 August 2018 [18]. Randomized controlled trials were compared between acupuncture therapy and sham acupuncture or no treatment. Pooled analysis of 17 eligible trials with 1516 participants showed that acupuncture may safely and effectively improve physical restrictions, emotional distress, and attack frequency in patients with stable angina pectoris. However, angina intensity and medication use were not reduced. Adequate studies and a valid sham control group are expected due to the low quality of evidence.

3.7. Neuralgia

Acupuncture, especially when combined with complementary therapies, has shown clinical efficacy in managing neuralgia. In patients with postherpetic neuralgia, a study compared a combined therapy group receiving traditional Chinese acupuncture with high-energy red light therapy to a control group receiving red light therapy alone. Post-treatment assessments revealed that the combined therapy group had significantly lower pain intensity (VAS scores), reduced pain areas, and shorter pain duration than the control group ($P < 0.05$). Also, the combined therapy group exhibited higher interleukin-2 (IL-2) levels and lower interleukin-17 (IL-17) and tumor necrosis factor- α (TNF- α) levels. Levels of interferon-induced protein 10 (IP-10) and monocyte chemoattractant protein-1 (MCP-1) were higher, while CXC chemokine ligand 10 (CXCL10) was lower in the combined therapy group, demonstrating improved inflammatory and chemokine profiles (all $P < 0.05$).

Acupuncture guided by the principles that "the head is the convergence point of all yang meridians" and "wind is the origin of all diseases" has also been effective in treating trigeminal neuralgia caused by wind pathogens, showing favorable outcomes. A recent meta-analysis of 30 clinical trials involving 2295 patients showed that acupuncture was effective in managing trigeminal neuralgia. In this review, compared with carbamazepine, which was the most common used medication in treating trigeminal neuralgia, acupuncture led to improvements in pain scores. Additionally, acupuncture therapy demonstrated favorable effects on enhancing the response rate and positive effects on reducing the frequency of pain attacks. These findings indicate that acupuncture can significantly reduce pain intensity and improve inflammatory and immune responses in neuralgia patients [19].

3.8. Cancer Pain

Acupuncture has been widely applied as an adjunctive therapy for cancer pain, improving analgesic efficacy and quality of life. In one meta-analysis of Sixteen RCTs with a total of 1124 participants showed that acupuncture may be an effective intervention to reduce pain associated with cancer. Although some limitations due to the low quality and small sample size of some included studies, as well as the different types and stages of cancer, acupuncture might provide an effective and safe treatment to reduce cancer pain [20].

In other reports, acupuncture targeting Dong's extraordinary points (Sima Zhong) and primary points, such as Chongzi and Chongxian, provided effective pain relief for advanced lung cancer cases unresponsive to conventional analgesic strategies. Additionally, researches by Wenli Yan et al. on the efficacy and safety of transcutaneous electrical acupoint stimulation (TEAS) as an analgesic intervention for labor pain and Hsing Fang Ko et al. on the effects of acupuncture on postoperative pain after total knee replacement have also demonstrated promising outcome [21,22]. These findings support the broader application of acupuncture as a safe and effective adjunctive treatment for various types of severe pain.

4. Advantages and Characteristics of Acupuncture in Pain Management

4.1. Holistic Regulation

Acupuncture not only targets specific pain symptoms but also modulates the body's overall physiological and functional state. By stimulating key acupoints, acupuncture can enhance neuroendocrine balance, improve circulation, and promote homeostasis. Clinical observations indicate that acupuncture improves sleep quality, reduces fatigue, and alleviates anxiety and depressive symptoms often associated with chronic pain, highlighting its role in comprehensive patient care beyond mere analgesia.

4.2. Individualized Treatment

A central principle of Traditional Chinese Medicine (TCM) is pattern differentiation, which allows practitioners to tailor acupuncture protocols to each patient's unique physiological and pathological condition. This individualized approach considers factors such as the patient's constitution, type of pain, disease stage, and associated systemic symptoms. Consequently, acupuncture provides personalized therapeutic strategies that optimize efficacy, ensuring that treatment addresses both the underlying causes and the manifestations of pain.

4.3. High Safety Profile

Acupuncture is generally well-tolerated and associated with a low incidence of adverse effects [23]. Unlike long-term analgesic or opioid use, acupuncture does not induce drug dependence, tolerance, or significant organ toxicity. Minor side effects, such as transient soreness or slight bruising at the needle site, are usually self-limiting and clinically manageable. This high safety profile makes acupuncture suitable for long-term pain management and for patients with contraindications to conventional drug therapies .

4.4. Cost-Effectiveness

Acupuncture is a relatively low-cost intervention that demonstrates favorable health economic value. It can reduce the need for expensive medications, minimize hospitalization rates, and lower the overall burden of chronic pain management. When integrated into standard clinical care, acupuncture not only provides effective symptom relief but also contributes to more sustainable healthcare resource utilization.

5. Existing Issues and Challenges

5.1. The Core Challenge Lies in Balancing Theory and Practice

A central challenge in acupuncture research and clinical application lies in harmonizing traditional theory with modern practice. Traditional Chinese acupuncture emphasizes individualized diagnosis and treatment based on pattern differentiation, which inherently allows flexibility in acupoint selection, needle depth, manipulation techniques, and treatment frequency. While this flexibility enhances personalized care, it also leads to significant variability among practitioners. Such variability complicates the standardization of treatment protocols and can reduce the reproducibility and predictability of therapeutic outcomes, presenting a barrier to wider clinical and research adoption.

5.2. Insufficient Depth in Mechanism Research

Despite substantial progress in elucidating the analgesic mechanisms of acupuncture, the precise biological pathways through which it modulates pain remain incompletely understood. Existing studies suggest involvement of neurochemical regulation, anti-inflammatory effects, and central nervous system modulation, yet the complex interactions among these mechanisms require further investigation. A deeper mechanistic understanding is essential to optimize treatment strategies, enhance efficacy, and facilitate integration into modern biomedical frameworks.

5.3. The Scientific Evidence base Requires Refinement

Although acupuncture's clinical analgesic effects are widely acknowledged, the evidence base is often limited by small sample sizes, heterogeneity in study design, and methodological inconsistencies. High-quality randomized controlled trials (RCTs), systematic reviews, and meta-analyses that adhere to contemporary standards of evidence-based medicine are still insufficient [24]. This lack of rigorous evidence constrains the acceptance of acupuncture within the international medical community and limits its integration into mainstream clinical guidelines .

5.4. Finally, Patient Perception and Acceptance Cannot be Overlooked

Patient attitudes toward acupuncture play a critical role in its clinical application. Some individuals harbor fears of needle insertion, skepticism about efficacy, or misconceptions about safety, which can reduce compliance and limit widespread adoption. Enhancing patient education, providing clear communication about treatment rationale and expected outcomes, and integrating acupuncture into multidisciplinary pain management programs may help improve acceptance and promote broader utilization.

6. Development Trends and Outlook

Acupuncture for pain management is currently entering a pivotal phase characterized by the deep integration of traditional Chinese medicine principles with modern scientific and technological advances. There is a clear trend toward diversification, standardization, and modernization of acupuncture practices. As evidence-based medicine frameworks continue to mature, a growing number of high-quality randomized controlled trials (RCTs) and systematic reviews are providing robust, empirical support for the clinical efficacy of acupuncture in managing various pain syndromes.

At the same time, international promotion and recognition of acupuncture are expanding its application across more countries and healthcare systems. Collaborative research initiatives between institutions worldwide are accelerating the modernization of acupuncture, fostering the development of standardized protocols, optimized techniques, and intelligent treatment approaches. By combining the distinctive theoretical foundation of traditional Chinese medicine with modern technological innovations, acupuncture is increasingly positioned as a scientifically grounded, safe, and effective modality for pain relief. In the future, it is expected to offer accessible, cost-effective, and high-quality pain management options for patients globally.

7. Conclusion

Acupuncture possesses a long-standing clinical history and a well-documented capacity to alleviate various pain conditions. Modern scientific research has increasingly validated its physiological basis, efficacy, and safety. As research methodologies advance and therapeutic techniques continue to evolve, acupuncture's role in pain management is becoming more established and prominent within both traditional and modern medical frameworks.

Nevertheless, acupuncture research faces ongoing challenges, including the need for standardized treatment protocols, rigorous study designs, and deeper mechanistic understanding. Future efforts should prioritize multidisciplinary collaboration, integration with modern biomedical approaches, and the modernization of acupuncture techniques to further enhance clinical outcomes. By refining both theoretical frameworks and practical applications, acupuncture is poised to play an increasingly central role in contemporary pain medicine, contributing to safer, more effective, and more accessible treatments for patients worldwide.

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