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Mechanisms and Therapeutic Research Progress of Acupuncture in Treating Chronic Pelvic Pain

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Abstract: ***Chronic pelvic pain (CPP) is a significant health issue affecting women's quality of life, imposing substantial physical and psychological burdens on patients. As a traditional therapeutic modality, acupuncture has garnered increasing attention in CPP management in recent years. Research indicates that acupuncture may alleviate chronic pelvic pain through multiple mechanisms, including regulation of pain-perceiving brain regions, neurotransmitter homeostasis, and neuroplasticity. However, specific research on the mechanisms of acupuncture remains insufficient, necessitating further empirical studies to explore its underlying biological mechanisms. This review aims to summarize the application of acupuncture in treating chronic pelvic pain in women and its potential mechanisms, providing theoretical support for the clinical application of acupuncture therapy and offering references for future research directions.***

Keywords: Acupuncture, Chronic Pelvic Pain, Mechanism Research, Research Progress**.**

1. Introduction

Chronic pelvic pain (CPP) is a complex and common condition typically defined as a group of disorders or syndromes characterized by pain in the pelvis and surrounding tissues lasting longer than 6 months, arising from various functional and/or organic causes [1]. According to research [2], the global prevalence of CPP can reach up to 27%. Its etiology is diverse, encompassing reproductive system disorders (such as endometriosis), urinary system conditions (such as interstitial cystitis), and psychological factors [3]. Clinically, it often manifests as persistent dull pain, stabbing pain, or aching in the lower abdomen and lumbosacral region, frequently worsening after exertion, sexual intercourse, and around menstruation. It is often accompanied by symptoms such as irregular menstruation and abnormal vaginal discharge [4]. This condition has a high incidence rate, a protracted course, is difficult to cure, prone to recurrence, and causes significant impairment to quality of life due to chronic pelvic pain. Current Western medical approaches include drug therapy, physical therapy, surgical intervention, and psychological treatment. However, these methods often lead to drug resistance, adverse drug reactions, and complications [5]. Consequently, seeking safe, effective, and holistically regulating alternative or complementary therapies has become a significant research focus in this field. Acupuncture, as an effective traditional Chinese medical treatment, offers unique advantages in alleviating symptoms, reducing side effects, and improving quality of life [6].

Although Traditional Chinese Medicine lacks a specific diagnosis for "chronic pelvic pain," its clinical manifestations align with categories such as "abdominal pain in women", "algomenorrhea", "abdominal aggregation" and "vaginal discharge". The core pathogenesis is often attributed to "blood stasis obstructing the interior, closely related to dysfunction of the liver, spleen, and kidney organs, as well as impairment of the Chong and Ren meridians [7]. In recent years, with the advancement of evidence-based medicine, acupuncture has been increasingly applied in CPP treatment, evolving into diverse specialized therapies including simple acupuncture, electroacupuncture, abdominal acupuncture, and moxibustion. These approaches demonstrate significant analgesic effects and unique advantages in improving patients' quality of life. While clinical studies on acupuncture for CPP are growing, its mechanisms of action remain incompletely elucidated. Further exploration of the mechanisms underlying acupuncture's effects on CPP not only enriches traditional Chinese medicine theory but also provides scientific basis for clinical application. Existing evidence indicates [8] that acupuncture's effects on CPP extend beyond local influences. Instead, it exerts multi-targeted, holistic regulatory effects at the central nervous system level by modulating the body's neuroendocrine-immune (NEI) network. This mechanism involves regulating levels and receptor functions of key neurotransmitters such as serotonin (5-HT), gamma-aminobutyric acid (GABA), and glutamate (Glu). It influences functional activity in brain regions including the anterior cingulate cortex (ACC), hippocampus, and thalamus to alleviate pain-related emotions. Furthermore, by promoting neuroplasticity, it reverses central sensitization states induced by chronic pain. Therefore, this paper aims to systematically review recent clinical research advances in acupuncture treatment for CPP, thoroughly explore its modern medical mechanisms, and provide references for clinical practice and scientific research.

2. Overview of Research Progress on Acupuncture Treatment for CPP

2.1 Acupuncture Alone

Acupuncture treatment regulates the circulation of qi and blood. When qi and blood flow smoothly, pain subsides. Both the tonifying effect of acupuncture and its role in regulating qi and blood circulation can enhance their abundance, nourishing the uterus and exerting analgesic effects. Wang

Xin et al. [9] conducted a study involving 144 patients with chronic pelvic pain following pelvic inflammatory disease (PID) compared acupuncture combined with ibuprofen sustained-release capsules (observation group) to oral ibuprofen sustained-release capsules alone (control group). The results demonstrated that the observation group achieved greater efficacy than the control group in alleviating pain symptoms and signs associated with PID-induced chronic pelvic pain, while also improving quality of life. Fan Yushan et al. [10] Employing Zhu Lian's Type II Acupuncture Method for chronic pain conditions like chronic pelvic pain following PID not only accelerates pain relief and elimination but also reduces or prevents pain recurrence. A review of the literature on acupuncture treatment for sequelae of pelvic inflammatory disease reveals that acupuncture offers the advantages of good therapeutic efficacy and low recurrence rates. This demonstrates acupuncture's unique advantages in treating sequelae of pelvic inflammatory disease. It is safe, effective, convenient, and free of toxic side effects. It can improve clinical symptoms of sequelae of pelvic inflammatory disease, reduce inflammatory factor levels, and regulate the body's immune system, making it worthy of in-depth clinical research.

2.2 Electroacupuncture Therapy

Electroacupuncture, as a form of modern acupuncture, stimulates specific acupoints with electrical currents to more effectively regulate physiological functions. It has been widely applied for pain relief and quality of life improvement in chronic pain syndrome (CPP). In treating chronic pelvic pain (CPP), the combination of acupuncture and electrical stimulation promotes qi and blood circulation while alleviating fatigue and pain. Xu Dong et al. [11] studied 72 male patients with chronic prostatitis/chronic pelvic pain syndrome (CP/CPPS), comparing the clinical efficacy of electroacupuncture at proximal versus distal acupoints. Results indicated electroacupuncture significantly improved pain symptoms in CP/CPPS patients, with more pronounced effects in the proximal acupoint group. The mechanism may involve enhancing β-EP expression in patients' EPS. Li Juntao et al. [12] systematically evaluated the clinical efficacy and safety of electroacupuncture therapy in the treatment of chronic prostatitis/chronic pelvic pain syndrome (CP/CPPS) through meta-analysis. Results demonstrated electroacupuncture's distinct advantage in improving patients' NIH-CPSI symptom scores, alongside reductions in pain symptoms, urinary symptoms, and enhanced quality of life.

2.3 Abdominal Acupuncture Therapy

Abdominal acupuncture is a novel acupuncture therapy based on abdominal holographic theory. It centers on regulating the Shenshu acupoint system to balance the yin and yang of internal organs through stimulating relevant abdominal acupoints, thereby restoring organ function. Liu Lihong et al. [13] divided 72 patients with damp-heat and blood stasis pattern Type IIIA prostatitis into two groups. The control group received clindamycin palmitate hydrochloride dispersible tablets combined with Ningbitai capsules. The treatment group received abdominal acupuncture in addition to the conventional drug therapy of the control group. Results indicated that abdominal acupuncture further alleviated clinical symptoms of damp-heat and blood stasis-type IIIA prostatitis, reduced prostate fluid leukocyte counts, and enhanced clinical efficacy. Zheng Hua et al. [14] divided 84 patients with pelvic pain associated with endometriosis into two groups. The observation group received abdominal acupuncture combined with ginger-separated moxibustion at the Eight Liang Points, while the medication group took modified Moxie tablets orally. Results indicated that abdominal acupuncture combined with ginger-separated moxibustion at the Eight Liang Points was superior to modified Moxie tablets in improving pelvic pain associated with endometriosis and reducing serum C125 levels.

2.4 Micro-Fire Needle Therapy

The fine fire needle technique employs specially crafted metal needles heated and rapidly inserted into specific locations and acupoints [15]. This method aims to dispel cold and dampness, warm meridians, promote qi and blood circulation, and enhance fluid metabolism, thereby effectively alleviating pain and facilitating disease recovery. Liu Lingling [16] employed fire needle therapy on primary acupoints including Guanyuan, Ciliao (bilaterally), and the 17th vertebra to alleviate female dysmenorrhea. Clinical observations of 50 patients demonstrated significant pain relief post-treatment, with an efficacy rate reaching 94%. Xu Liping [17] Employing Zhao's Thunder Fire Moxibustion technique, warm moxibustion was applied to the bilateral lower abdomen and sacroiliac joint regions while simultaneously stimulating acupoints including Guanyuan, Qugu, Qihai, Ahshi points, as well as bilateral Sanyinjiao, Shenshu, and Zusanli. Treatment commenced one week before menstruation, continued through menstruation, and was maintained for three months thereafter. The results further demonstrate that fire needle therapy exhibits significant therapeutic effects on endometriosis (EMAb).

3. Theoretical Basis of Acupuncture for CPP

Although classical Chinese medical texts do not explicitly document this disease name, based on the clinical manifestations and disease progression of chronic pelvic pain (CPP), it can be categorized under related syndromes such as "abdominal pain in women", "algomenorrhea", "abdominal aggregation", "vaginal discharge", "aciesis" and "irregular menses" [18]. Its primary pathogenesis involves blood stasis obstructing the channels. The fundamental mechanism underlying gynecological disorders associated with CPP is blood stasis, as stated in Medical Forest Corrections: "When original qi is deficient, it cannot reach the blood vessels; without qi in the vessels, blood stagnates and forms stasis." This condition primarily manifests in the uterus and its associated meridians. During menstruation or postpartum, women may encounter external pathogens, internal injuries, or improper dietary habits. These factors can lead to the combination of damp-heat toxins with the qi and blood of the Chong and Ren vessels, causing accumulation within the uterus and meridians and triggering disease [19]. This impedes qi and blood circulation, disrupts their equilibrium, causes spleen-kidney yang deficiency, and transforms dampness into cold—ultimately rendering the condition difficult to cure [20]. The disease closely involves liver, spleen, and kidney functions; whereas non-gynecological

conditions primarily stem from external damp-heat toxins invading the urethra, bladder, or kidneys, thus "pain arises where there is no flow." Consequently, acupuncture treatment for chronic pelvic pain (CPP) typically involves multifaceted interventions. These include regulating the Chong and Ren meridians and qi-blood dynamics, strengthening kidney function and vitality, unblocking liver stagnation and regulating qi movement, fortifying the spleen and replenishing blood, activating blood circulation to resolve stasis, and unblocking meridians to alleviate pain [21].

Although acupuncture demonstrates favorable clinical outcomes for chronic pelvic pain, its precise mechanisms remain incompletely understood. Current theories regarding acupuncture's effects encompass immunomodulation and improved inflammatory responses. Research indicates [22] that acupuncture reduces serum levels of tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) in rats, thereby inhibiting the expression of chemokines, cyclooxygenase-2 (COX-2), inducible nitric oxide synthase (iNOS), and intercellular adhesion molecule (ICAM) expression. This alleviates damage to prostate tissue caused by these factors through their respective mechanisms, thereby relieving CP/CPPS-related symptoms. Liu Tingting et al. [23] found that acupuncture reduces serum TNF-α levels in rats while increasing IL-2 levels. Chen Yuelai et al. [24] found that acupuncture improved bladder smooth muscle swelling in rats, reduced surrounding mucosal hyperemia, and inhibited excessive bladder excitability. This suggests acupuncture may alleviate symptoms by accelerating local blood flow, promoting tissue metabolism, thereby reducing interstitial edema and inflammatory cell infiltration.

4. Central Nervous Mechanisms of Acupuncture in CPP Treatment

4.1 Effects of Acupuncture on the Central Nervous System

Acupuncture exerts therapeutic effects on chronic pelvic pain (CPP) by regulating pain perception and neurotransmitter levels in the central nervous system. Research by Qu Meng et al. [25] found that acupuncture can activate multi-level neural pathways, including the spinal cord, brainstem, limbic system, and cortex, thereby achieving integration and regulation of pain signals. This study suggests that acupuncture at the Zhongwan acupoint can bidirectionally regulate visceral function through mechanisms such as TRPV1-Ao, C-fiber spinal cord pathway, and hippocampal Glu NMDAR subunit NR1, suggesting that its intervention in central pain transmission has multi-target characteristics. In terms of neurotransmitter regulation, acupuncture significantly affects the 5-hydroxytryptamine (5-HT) system. 5-HT, as an inhibitory neurotransmitter, plays a crucial role in the comorbidity of pain and depression. Research has found that acupuncture can upregulate 5-HT levels in the anterior cingulate cortex and the rostral ventromedial nucleus (RVM) of chronic pain model rats, increase pain threshold, and improve depressive like behavior [26]. In addition, acupuncture at acupoints such as Yingu and Ququan can activate 5-HT1A/1B receptors in the hippocampus and thalamus, enhance c-fos expression, and further confirm its specific regulation of central 5-HTergic neurons [27]. Acupuncture also exerts analgesic effects by regulating the gamma aminobutyric acid (GABA) and glutamate (Glu) systems. According to research, electroacupuncture can reverse the decrease of NMDAR subunit NR1 in the prefrontal cortex of chronic inflammatory pain model mice and upregulate the levels of Glu excitatory neurotransmitters [28]. Meanwhile, acupuncture alleviates central sensitization by inhibiting glial cell activation and oxidative stress response (such as reducing malondialdehyde content and increasing catalase activity) [29].

4.2 Acupuncture and Neuroplasticity

Neural plasticity refers to the nervous system's capacity for structural and functional adaptive changes in response to external stimuli, a property of significant importance in treating neurological disorders such as chronic pain (CPP). Acupuncture promotes neuroplasticity through multiple pathways. Qin Shuanglai et al. found [30] that acupuncture activates various receptors and signaling pathways in the central and peripheral nervous systems. This study indicates acupuncture activates type I and type II receptors in the endocannabinoid system, participating in pain signal transmission and inflammatory response regulation, thereby alleviating pain and promoting neural functional recovery. Furthermore, acupuncture modulates the "neuro-endocrine-immune" (NEI) network, influencing the release of neurotransmitters, hormones, and cytokines to regulate nervous system function in multiple dimensions [31]. This multi-targeted, holistic regulatory effect of acupuncture offers new perspectives for studying neuroplasticity. Chronic pain is often accompanied by functional disorders and structural alterations in the nervous system. By promoting neuroplasticity, acupuncture can restore the balanced state of the nervous system. Research by Zeng Xiaoling et al. [32] indicates that acupuncture suppresses glial cell activation, regulates monoamine neurotransmitter levels (e.g., 5-HT, DA), and promotes neuronal regeneration and synaptic remodeling by activating the BDNF/TrkB signaling pathway. Additionally, acupuncture modulates brain-gut axis function to improve gut microbiota influence on brain function, further enhancing neuroplasticity. Xu et al. found [33] that acupuncture induces widespread changes in brain activity, promotes synaptic regeneration and functional integration, thereby improving neurological deficits in stroke patients. This effect extends beyond stroke, demonstrating similar neuroplasticity-enhancing benefits for other neurological disorders such as chronic pain. In summary, acupuncture significantly enhances neuroplasticity through multi-target, multi-pathway regulatory mechanisms, offering novel therapeutic insights for neurological disorders like CPP. Future research should further explore the intrinsic link between acupuncture and neuroplasticity, optimize acupuncture treatment protocols, and provide stronger theoretical foundations for clinical practice.

4.3 Regulation of Brain Region Activity by Acupuncture

The anterior cingulate cortex (ACC), a key region of the limbic system, constitutes a vital component of the medial pain transmission pathway. It maintains direct or indirect fiber connections with central nuclei regulating negative emotions and learning/memory—such as the thalamus, amygdala, and

hippocampus—forming the structural basis for its involvement in pain-related emotional responses. Research indicates that [34], surgical resection of the ACC significantly attenuates chronic pain-induced pain-related emotions, a phenomenon also validated in animal studies. Fu Tongtong et al. found that [35], damaging the rat ACC may disrupt the positive feedback loop between pain and pain-related emotions via descending inhibitory/facilitation systems, thereby alleviating pain. Neuronal electrical activity in the ACC region is closely linked to pain and pain-related emotional states. Peripheral noxious stimuli activate ACC neurons and enhance their discharge activity, with the degree of activation positively correlated to the intensity of the organism's pain-related emotional state. These studies collectively indicate that the ACC is a key brain region for the transmission and regulation of pain and pain-related emotional information. Pain-related emotional states refer to negative emotions such as fear, tension, anxiety, depression, and pain aversion induced by pain [36]. Acupuncture not only demonstrates confirmed efficacy for conditions such as generalized anxiety disorder, depressive disorders, and phobias, but also exerts a distinct regulatory effect on pain-related emotions. Its mechanism of action is closely associated with acupuncture's modulation of ACC brain region function, with research predominantly focusing on acupuncture's regulation of pain aversion emotions. Wu Zemin et al. demonstrated [37] that electroacupuncture elevates the mechanical pain threshold and alleviates pain aversion in rats with chronic inflammatory pain. Shou Shengyun et al. found [38] that 100 Hz electroacupuncture more effectively improves anxiety induced by neuropathic pain. Acupuncture's regulation of pain-emotion interactions also involves synergistic mechanisms across multiple brain regions. Research indicates [39] that acupuncture alleviates pain symptoms and depressive mood by downregulating indoleamine 2, 3-dioxygenase 1 (IDO1) levels. Furthermore, acupuncture at the Yintang and Baihui points downregulates malondialdehyde (MDA)—an intermediate metabolite of oxidative stress—and caspase-3 expression in the orbital frontal cortex of depressed rats while enhancing catalase activity. This suggests acupuncture exerts therapeutic effects by modulating oxidative stress to inhibit caspase-3 pathway activation. Electroacupuncture intervention reverses the reduction of ionotropic glutamate receptor N-methyl-D-aspartate receptor subunit 1 (NR1) protein and its phosphorylated receptor 2B subunit in the prefrontal cortex of mice with chronic inflammatory pain-depression comorbidity, thereby upregulating glutamatergic excitatory neurotransmitter levels. Similar changes were observed in the hippocampus and hypothalamus [40].

5. Conclusion

Chronic pelvic pain (CPP) has long afflicted patients, imposing significant inconvenience and psychological burden on their daily lives. Current Western pharmaceutical treatments for CPP often exhibit poor efficacy and high recurrence rates. Therefore, exploring effective treatment protocols using acupuncture—a traditional Chinese medical therapy—is crucial for addressing this issue. Clinical practice demonstrates that various acupuncture therapies—including simple needling, electroacupuncture, abdominal acupuncture, and moxibustion—exhibit significant efficacy in alleviating pain symptoms, improving clinical signs, and enhancing quality of life in CPP patients. These therapies possess unique advantages of high safety and minimal side effects, warranting broader application in clinical practice.

Research on the central nervous system mechanisms of acupuncture treatment for chronic pelvic pain (CPP) has made significant progress. Existing evidence indicates that acupuncture modulates central nervous system function through multiple targets and pathways, thereby exerting analgesic effects and improving pain-related emotions. Research indicates [28] that acupuncture significantly modulates serotonin (5-HT) system function. It upregulates 5-HT1A and 5-HT1B receptor expression in brain regions such as the anterior cingulate cortex (ACC), hippocampus, and thalamus, elevates 5-HT levels, and improves pain thresholds and depressive-like behaviors in animal models of pain-depression comorbidity. Furthermore, the mechanism by which acupuncture modulates ACC function to alleviate pain-related emotions has been extensively validated. Electroacupuncture increases phosphorylated ERK levels in the ACC and regulates the NPS/NPSR system, thereby reducing pain aversion and anxiety-like behaviors. The endocannabinoid system has also been demonstrated to participate in acupuncture analgesia. By activating central and peripheral cannabinoid type I and type II receptors, acupuncture modulates pain signaling and inflammatory responses, thereby alleviating pain hypersensitivity [31]. Functional magnetic resonance imaging (fMRI) technology further reveals acupuncture's role in reshaping brain functional networks, such as modulating indicators like local coherence and low-frequency amplitude, thereby promoting brain plasticity changes [33].

In summary, acupuncture exerts a combined effect of holistic regulation and targeted intervention in treating CPP through a complex network of "peripheral stimulation-central integration-systemic regulation." It not only directly modulates pain signal pathways but also regulates the internal environment via the "neuro-endocrine-immune" (NEI) network, embodying the profound integration of Traditional Chinese Medicine's holistic perspective with modern medical mechanism research. Current research still faces limitations, such as insufficient high-quality, large-sample randomized controlled trials, the need for further standardization and optimization of acupuncture parameters, and the requirement for more direct evidence regarding central mechanisms. Future research should further clarify the spatiotemporal specificity of acupuncture's regulation of neurotransmitters and receptors in different brain regions. Combining multimodal imaging techniques (e.g., fMRI, DTI) will enable deeper analysis of brain network remodeling mechanisms. Conducting high-quality randomized controlled trials to optimize acupuncture treatment protocols will establish evidence-based acupuncture treatment plans with higher levels of evidence, promoting the standardized application and widespread adoption of acupuncture in the comprehensive treatment of CPP.

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