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Progress in Mechanism of Acupuncture and Moxibustion for Irritable Bowel Syndrome

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Abstract: *Irritable bowel syndrome (IBS) is a prevalent functional gastrointestinal disorder characterized by abdominal pain, bloating, and alterations in bowel habits. Its pathogenesis is multifaceted, and effective therapeutic options remain limited. Acupuncture, as a key component of traditional medicine, has in recent years demonstrated distinct advantages in the management of IBS, with growing support from evidence-based medical research. This review systematically examines four proposed mechanisms through which acupuncture exerts its therapeutic effects: modulation of brain-gut axis(also encompassing the broader microbiota-gut-brain axis) function, alleviation of visceral hypersensitivity and pain, regulation of gastrointestinal motility and secretion, and restoration of intestinal flora and mucosal immune homeostasis. Furthermore, based on these mechanistic insights, the article explores the theoretical foundation of acupuncture treatment for IBS from the perspective of traditional Chinese medicine.*

Keywords: *Acupuncture; Irritable Bowel Syndrome; Brain-Gut Axis; Visceral Hypersensitivity; Mechanism*

1. Introduction

Irritable bowel syndrome (IBS) is a chronic functional gastrointestinal disorder with a global prevalence of 10%–20%, severely impairing patients' quality of life and imposing a substantial socio-economic burden [1]. According to the Rome IV diagnostic criteria for functional gastrointestinal disorders published in 2016, IBS is classified into four subtypes: diarrhea-predominant (IBS-D), constipation-predominant (IBS-C), mixed-type (IBS-M), and unclassified (IBS-U) [2]. The pathophysiology of IBS remains incompletely understood, though current evidence suggests a multifactorial etiology involving brain-gut axis dysregulation, visceral hypersensitivity, gastrointestinal dysmotility, intestinal microbiota imbalance, low-grade mucosal inflammation, and psychosocial factors [2].

Conventional pharmacological management is primarily symptom-oriented, including antispasmodics, probiotics, and antidepressants; however, limitations such as variable efficacy, adverse effects, and suboptimal patient satisfaction are often noted. In contrast, acupuncture, an external therapeutic modality rooted in traditional Chinese medicine theory of meridians and zang-fu organs, has a longstanding history in the treatment of functional gastrointestinal disorders. By stimulating specific acupoints, acupuncture is believed to regulate meridians, harmonize qi and blood, and restore the balance of yin and yang.

2. TCM etiology and pathogenesis of IBS

Irritable Bowel Syndrome (IBS) is a common functional gastrointestinal disorder characterized by recurrent abdominal pain associated with changes in stool form or frequency. Due to differences in theoretical frameworks, Traditional Chinese Medicine (TCM) does not have a disease name that fully corresponds to IBS; however, its understanding can be drawn from discussions on the etiology, pathogenesis, diagnosis, and treatment of conditions such as abdominal pain, bloating, constipation,

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and diarrhea.

Diarrhea-predominant IBS (IBS-D) is primarily attributed to emotional depression or excessive emotional activity leading to liver-qi stagnation, which then invades the spleen and stomach; improper diet may also injure the spleen and stomach, resulting in the spleen's failure to transform dampness and the internal accumulation of fluids [3]. Constipation-predominant IBS (IBS-C) is mostly caused by liver-qi stagnation, emotional imbalance, and impaired free flow of liver-qi, which affects the spleen. This leads to spleen dysfunction, inadequate transportation and transformation, and subsequent impairment of intestinal conveyance, resulting in stagnation of waste and constipation. This can be summarized as liver-qi stagnation with impaired spleen movement [4].

Multiple factors may lead to liver depression and spleen deficiency, disrupting transportation and transformation, and causing qi blockage in the middle energizer. This results in failure of clear yang to ascend, improper digestion of fluids and grains, combined with liver dysfunction and disordered qi movement, ultimately impairing large intestine conveyance and leading to symptoms such as abdominal pain and diarrhea.

According to TCM theory, the pathogenesis of IBS mainly involves spleen-stomach weakness, liver-spleen disharmony, and impaired conveyance in the large intestine. The spleen and stomach are considered the acquired foundation and the source of qi and blood production. Weakness of the spleen and stomach leads to failure in transportation and transformation, causing undigested food and fluids to accumulate in the intestines and impair intestinal function. The liver governs the free flow of qi, while the spleen governs its movement. Disharmony between the liver and spleen disrupts the normal flow of qi, further affecting intestinal conveyance. Impairment of the large intestine's conveyance function results in symptoms such as difficult defecation, abdominal pain, and diarrhea.

Acupuncture can regulate the balance of qi, blood, yin, and yang in the human body by stimulating specific acupoints, thereby achieving therapeutic effects for IBS. From a modern medical perspective, acupuncture is believed to modulate intestinal motility, alleviate intestinal inflammation, reduce visceral hypersensitivity, and regulate patients' psychological state, contributing to the management of IBS.

3. Study on modern mechanism of acupuncture in treating IBS

3.1 Regulation of brain-gut axis function

The "brain-gut axis" is a concept in modern Western medicine, referring to a bidirectional neuroendocrine communication network between the gastrointestinal tract and the central nervous system. Current research indicates that a key pathogenic mechanism in digestive system diseases involves dysregulation of brain-gut interactions. Substantial evidence supports the existence of two-way communication between the gut-along with its microbiota-and the brain through neural, endocrine, and other pathways, collectively described as the microbiota-gut-brain axis [5]. The brain-gut axis comprises a neuroendocrine pathway coordinated by the central nervous system and the enteric autonomic nervous system, maintaining dynamic balance between central regulation and gastrointestinal function via gut-brain peptides [6].

Zhao et al. [7] observed increased connectivity between the default mode network and the dorsal attention network, as well as between the default mode network and the ventral attention network, following acupuncture in patients with diarrhea-predominant irritable bowel syndrome (IBS-D). These changes may reflect a potential regulatory mechanism underlying acupuncture treatment for IBS-D. Geng Hao et al. [8] proposed that acupuncture techniques aimed at regulating mental state and strengthening the spleen can alter functional connectivity in brain regions such as the hippocampus in IBS patients. Tang Heyong [9] reported significantly enhanced functional connectivity between the amygdala and hippocampus in anxious IBS-D patients after acupuncture, indicating that acupuncture reinforces interactions within the limbic system.

Collectively, these studies demonstrate that acupuncture-particularly at acupoints such as Zusanli (ST36), Tianshu (ST25), and Shangjuxu (ST37)-can markedly modulate activity in brain functional areas associated with IBS, including the default mode network, anterior cingulate cortex, prefrontal cortex, and amygdala. These regions are critically involved in pain perception, emotional regulation, and visceral sensory integration [10]. The findings suggest that acupuncture may alleviate abnormal visceral perception by regulating central nervous system processing of gut-derived signals.

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3.2 Alleviation of visceral hypersensitivity and pain

Visceral hypersensitivity refers to an abnormally lowered sensory threshold of visceral tissues to physiological or pathological stimuli, characterized by enhanced sensitivity to pain (amplified responses to noxious stimuli) and visceral allodynia [11]. It is a hallmark feature of irritable bowel syndrome and a key contributor to abdominal pain and discomfort in affected patients. Studies indicate that visceral hypersensitivity is significantly positively correlated with disease severity in diarrhea-predominant IBS (IBS-D) and represents a core pathological mechanism underlying progressive abdominal pain, frequent diarrhea, and reduced pain tolerance thresholds [12].

Modern medical research suggests that visceral hypersensitivity arises primarily from functional alterations in both the central and peripheral nervous systems, which amplify the transmission and processing of sensory signals from the gastrointestinal tract [13]. Functional magnetic resonance imaging (fMRI) studies have demonstrated that, following colorectal distension stimuli, brain activity related to pain modulation is significantly enhanced in patients with visceral hypersensitivity [14].

Transient receptor potential vanilloid 1 (TRPV1) is a heat-sensitive ion channel involved in pain signal transmission. Protease-activated receptor 2 (PAR2) can potentiate TRPV1 activity and mediate pain generation in IBS patients [15]. Animal studies have confirmed that acupuncture reduces the abdominal withdrawal reflex threshold induced by colorectal distension in IBS model rats. This effect involves inhibition of neuronal activation in the spinal dorsal horn, down-regulation of P2X3 receptor expression, and modulation of various neurotransmitters-such as serotonin, noradrenaline, and endogenous opioid peptides-thereby exerting analgesic effects at both peripheral and central levels [16].

Furthermore, related animal experiments indicate that acupuncture treatment can desensitize pain-sensitive neurons by regulating the PAR2-TRPV1 pathway, increase pain thresholds, reduce visceral hypersensitivity in IBS, and alleviate abdominal pain symptoms [17].

Mast cells, important immune cells widely distributed in the intestinal mucosa, also play a role in visceral hypersensitivity. Studies have shown that increased mast cell density in colon biopsies from IBS patients correlates with the severity of visceral hypersensitivity symptoms [18]. Inflammatory mediators released by mast cells can directly and rapidly activate or sensitize intestinal sensory nerve endings, lowering their activation threshold and inducing visceral hypersensitivity [19]. Moreover, mast cell number and activity in IBS patients are positively correlated with intestinal permeability and abdominal pain [20].

Electroacupuncture has been shown to significantly down-regulate mast cell activation-related substances, thereby alleviating visceral hypersensitivity and diarrhea in IBS rat models [21].

3.3 Regulation of gastrointestinal motility and secretion

Abnormal gastrointestinal motility is a key pathophysiological feature of irritable bowel syndrome (IBS) and can be influenced by multiple factors such as diet, genetics, and others. Studies have indicated that motility disturbances in IBS patients are most prominent in the colon, although abnormalities can also be observed to varying degrees in the esophagus, stomach, small intestine, and rectum [22-23]. Moreover, motility patterns differ among IBS subtypes. Research has shown that these abnormalities are characterized by accelerated basal electrical rhythm frequency, delayed or reduced action potential peaks, an increased colonic motility index, and markedly enhanced segmental propulsive peristalsis-particularly in the descending and sigmoid colon, which is often associated with abdominal pain.

Evidence suggests that acupuncture at Zusanli (ST36) can enhance gastric emptying and intestinal transit, whereas in diarrhea-predominant IBS (IBS-D), acupuncture may slow intestinal motility and reduce bowel frequency. These effects are likely mediated through modulation of the autonomic nervous system-such as increased parasympathetic activity-and influence on the release of gastrointestinal hormones, including motilin, substance P, and vasoactive intestinal peptide (VIP) [24].

The experimental study by Liu Tingting et al. [25] demonstrated that electroacupuncture can downregulate colonic slow-wave frequency in constipation-predominant IBS (IBS-C) model rats, enhance colonic propulsion, activate vagal nerve endings to release acetylcholine, stimulate the enteric nervous system, and thereby accelerate gastrointestinal motility. Conversely, high-frequency electroacupuncture has been shown to inhibit the expression of vasoactive intestinal peptide in IBS-D rats [26], contributing to slowed gastrointestinal motility.

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3.4 Regulation of intestinal flora and mucosal immunity

The human microbiota comprises trillions of microorganisms, the majority of which reside in the gastrointestinal tract. As the body's "second brain," the gastrointestinal system possesses autonomous regulatory mechanisms and plays a crucial role in maintaining digestive homeostasis. The intestinal microbiota represents a core element in preserving intestinal equilibrium, and its dynamic balance is essential for normal gastrointestinal function. Dysbiosis of the gut microbiota and its metabolic activities is a significant factor in the pathogenesis and progression of irritable bowel syndrome (IBS).

Patients with IBS exhibit varying degrees of elevated inflammatory factors in peripheral blood, contributing to a state of chronic low-grade intestinal inflammation [27]. This condition can lead to intestinal barrier impairment and heightened visceral sensitivity, which may be further exacerbated under stress. Clinical studies indicate that up to 30% of patients report onset or worsening of IBS symptoms following gastrointestinal infection or inflammation. Such individuals often present with low-grade mucosal inflammation and immune activation. Acupuncture has demonstrated advantages in ameliorating this chronic low-grade inflammatory state in IBS patients.

Modern research confirms that acupuncture can effectively improve chronic inflammation in IBS by activating the hypothalamic-pituitary-adrenal axis and reducing levels of pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α) [28-29]. Several studies have reported lower serum IL-10 levels in IBS patients compared to healthy controls [30]. Similarly, investigations using post-infectious IBS mouse models have shown decreased IL-10 expression in the jejunum, ileum, and colon [31], suggesting a role for IL-10-related immune mechanisms in IBS.

Furthermore, multiple studies indicate that acupuncture can reverse gut microbiota dysbiosis in both IBS animal models and patients. It has been shown to increase the abundance of beneficial bacteria-such as Lactobacillus and Bifidobacterium-reduce potentially pathogenic bacteria, and promote the production of short-chain fatty acids [32]. Duan Wan'e et al. [33] found that acupuncture, employing methods to strengthen the spleen and soothe the liver, effectively increased Lactobacillus and Bifidobacterium counts, reduced Escherichia coli levels, and improved overall microbial balance. Similarly, electroacupuncture at Shenque (CV8) increased the abundance of Lactobacillus and Clostridium in IBS-C model rats, helped maintain microbial equilibrium, and promoted the growth of potential probiotic species-a mechanism that may contribute to improved gastrointestinal motility and stool consistency [34].

Concurrently, acupuncture has been shown to attenuate low-grade intestinal inflammation by down-regulating pro-inflammatory factors (e.g., TNF-α, IL-6, IL-1β) and up-regulating anti-inflammatory mediators such as IL-10. These effects contribute to enhanced intestinal mucosal barrier function and restoration of a stable intestinal microenvironment [35].

3.5 Improve psychosocial factors

Depression, anxiety, and other psychosocial factors exert a dual pathogenic influence on the pathological process of irritable bowel syndrome (IBS), increasing disease susceptibility and exacerbating the burden of physical symptoms. Negative emotions can directly affect autonomic nervous system tone, induce functional reorganization of the enteric nervous system, and lead to intestinal dysmotility, hypersecretion, and visceral hypersensitivity, thereby triggering recurrent episodes of core symptoms such as abdominal pain and diarrhea [36].

Psychological stress associated with anxiety and depression can directly impair intestinal mucosal barrier function, promote the paracellular transport of macromolecular substances, activate immune cells in the lamina propria, and initiate a cascade of abnormal immune responses. A prospective cohort study with long-term follow-up revealed that patients with functional gastrointestinal disorders who exhibited only psychological symptoms-such as anxiety and depression-at baseline had a significantly increased risk of developing typical IBS symptoms during follow-up, suggesting that anxiety and depression serve as predictive indicators for IBS [37]. Conversely, individuals diagnosed with IBS at baseline but without initial psychological symptoms showed a significantly higher incidence of anxiety and depression during follow-up compared to controls, indicating a bidirectional association between IBS and these mental health conditions.

Acupuncture at Neiguan (PC6) has been shown to effectively improve heart rate variability in IBS-D model rats, restore autonomic nervous system balance by enhancing sympathetic excitation and reducing parasympathetic activity. This neural regulation may be associated with decreased substance P

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levels in the body [38]. In summary, acupuncture at Neiguan demonstrates potential therapeutic value and clinical prospects for modulating autonomic function and ameliorating the pathophysiology of IBS-D. Additionally, the impact of acupuncture on the quality of life of IBS patients, particularly concerning emotional well-being, merits further investigation.

4. Summary and outlook

In summary, substantial progress has been made in both the mechanistic understanding and clinical application of acupuncture for the treatment of Irritable Bowel Syndrome (IBS). Acupuncture exerts comprehensive therapeutic effects through multifaceted mechanisms, including modulation of the brain-gut axis, reduction of visceral hypersensitivity, and restoration of intestinal homeostasis, while maintaining a favorable safety profile and high patient acceptance

Looking ahead, further rigorous clinical trials and deeper mechanistic investigations will help to clarify the role of acupuncture within an integrated IBS management framework. Such advances are expected to enhance the application of acupuncture as a safe and effective complementary or alternative therapeutic strategy for IBS patients worldwide.

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