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Mechanism Analysis of Acupuncture Intervention in Stroke Rehabilitation Guided by the Concept of "Promoting Healthy Qi"

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Abstract: ***Stroke is characterized by high incidence and high disability rates, and its core pathogenesis can be summarized as "root deficiency and branch excess, with impaired movement of healthy qi." The concept of "promoting healthy qi" originates from the Huangdi Neijing, which emphasizes that, in addition to reinforcing healthy qi, one should also unblock locally stagnant healthy qi and revive dormant healthy qi, thereby restoring the normal movement of healthy qi. Acupuncture, as an important rehabilitation intervention for stroke, exerts multi-level regulatory effects through stimulating acupoints: during the acute and subacute stages, it improves cerebral hemodynamics, promotes collateral circulation, and reduces inflammatory injury in the ischemic penumbra; during the recovery stage, it upregulates the expression of neurotrophic factors and synapse-associated proteins, facilitating neural repair and remodeling; during long-term rehabilitation, it regulates monoamine neurotransmitters such as serotonin (5-HT) and dopamine (DA), alleviating post-stroke depression. These effects correspond respectively to the conditions of "insufficient healthy qi that cannot move," "obstructed healthy qi that fails to move," and "dormant healthy qi that is unable to move," reflecting the regulatory characteristics of acupuncture in reinforcing healthy qi, removing stagnation, and awakening healthy qi. Elucidating the mechanisms of acupuncture in treating stroke based on the concept of "activating healthy qi" helps enrich the theoretical framework of traditional Chinese medicine rehabilitation and provides new perspectives for acupuncture intervention in stroke rehabilitation.***

Keywords: Promoting healthy qi, Stroke, Rehabilitation, Acupuncture, Neural remodeling, Ischemic penumbra.

1. Introduction

Stroke is an acute cerebrovascular disease caused by sudden rupture or occlusion of cerebral blood vessels, with typical clinical manifestations of sudden disturbance of consciousness and focal neurological deficits [1]. It is characterized by high incidence, high disability, and high recurrence rates [2]. Epidemiological data show that the mortality rate of stroke is second only to ischemic heart disease, ranking second in the world, and the disability rate ranks first [3]. In China, the lifetime risk of developing stroke is as high as 39.9%, the highest in the world [4]. In recent years, due to accelerated population aging and sustained exposure to risk factors, the epidemic situation of stroke in China has continued to worsen, with more than 2 million new cases annually [5]. Clinical studies indicate that 70%–80% of stroke survivors have varying degrees of functional impairments, such as motor, swallowing, and language deficits. These not only affect patients' ability to perform activities of daily living but also lead to substantially increased family caregiving costs and high consumption of medical resources, imposing a huge socioeconomic burden [6].

The concept of "promoting healthy qi" originates from the *Huangdi Neijing* statement: "When healthy qi exists internally, pathogenic factors cannot interfere." Its core connotations are, firstly, to dredge the locally obstructed "stagnated healthy qi," and secondly, to awaken the "dormant healthy qi" that has not been mobilized in the body [7]. Different from traditional "reinforcing healthy qi", which focuses only on the *quantity* of healthy qi, this concept places greater emphasis on the *movement state* of healthy qi, and it highly aligns with the pathogenesis of stroke, i.e., "root deficiency and branch excess, with impaired movement of healthy qi." The core pathogenesis of stroke is "root deficiency and branch excess": deficiency of healthy qi leads to impaired flow of qi and blood, and the mutual binding of phlegm and stasis blocks the cerebral collaterals. Thus, there exists both "obstructed healthy qi that fails to move" due to local meridian blockage and "dormant healthy qi that is unable to move" due to overall functional debilitation. Acupuncture has shown significant clinical efficacy in post-stroke recovery. Studies have confirmed that acupuncture can regulate neurological function, improve blood circulation, and offer advantages such as high safety, convenient operation, and few adverse reactions. It is therefore widely used in stroke rehabilitation [8]. By stimulating acupoints to unblock meridians, harmonize qi and blood, and promote the movement of healthy qi, acupuncture guides the patient toward a rehabilitative "state." This paper, based on the concept of "promoting healthy qi," explores the mechanisms of acupuncture in stroke rehabilitation, Such exploration holds important theoretical and practical significance for unlocking the potential of acupuncture in treating stroke, enriching the theoretical framework of traditional Chinese medicine rehabilitation, and improving clinical treatment outcomes.

2. Theoretical Foundations of Stroke in Traditional Chinese Medicine and Modern Medical Research

2.1 Etiology and Pathogenesis in Traditional Chinese Medicine

In traditional Chinese medicine (TCM) theory, stroke is classified under terms such as "*zhong feng*", "cu zhong", "*pu ji*", and related terms. The name "zhong feng" first appeared in the *Essentials from the Golden Cabinet*, in the chapter

"Pattern Differentiation and Treatment of Wind-Strike and Arthralgia Disorders," which recorded for the first time: "When wind-strike disease manifests, it presents with hemiplegia, or possibly numbness of one arm … all caused by wind-strike." This clarifies that the primary clinical feature of stroke is motor dysfunction of the limbs. Physicians throughout history have pointed out that insufficiency of healthy qi, invasion by external pathogens, or imbalances in diet and emotions can all cause the disease, with qi deficiency and blood stasis being the key pathogenic factors [9]. Another chapter in the *Essentials from the Golden Cabinet*, "Patterns of Pulses in Viscera, Bowels, Channels, and Collaterals, Their Sequential Development and Diseases" states: "When the original qi of the five viscera flows freely, the person is peaceful and healthy," indicating that unimpeded flow of healthy qi is the core of maintaining health [10]. Factors such as deficiency of qi and blood, overstrain and depletion, extreme emotional states, or improper dietary habits can lead to imbalances of qi, blood, yin, and yang in the viscera and bowels, thereby causing either deficiency or obstruction of healthy qi. The core pathogenesis during the recovery phase of stroke is healthy qi deficiency with lingering pathogen, collateral stasis and obstruction, and impaired movement of healthy qi. Deficiency of qi and blood, along with phlegm-stasis binding, causes blockage of the cerebral collaterals and limb meridians, resulting in abnormal movement of healthy qi. This manifests clinically as loss of limb function, slurred speech, and impaired mental agility. The *Su Wen* in the chapter "Discussion on Heat Diseases" states: "The weakest site is exactly where pathogenic factors lodge," suggesting that deficiency of healthy qi is the basis for disease onset. Zhang Zhongjing proposed "healthy qi deficiency leads to attack by pathogenic factors," emphasizing that internal deficiency is the fundamental cause during the recovery phase. Therefore, treatment must simultaneously reinforce healthy qi and unblock the collaterals.

2.2 Modern Medical Research

According to pathological mechanisms, stroke can be classified into ischemic stroke and hemorrhagic stroke [11]. Among these, ischemic stroke accounts for 72.9% of stroke cases in China [12], and its pathological feature is cerebral hypoperfusion caused by transient or persistent blockage of cerebral blood vessels. Hemorrhagic stroke, on the other hand, is an acute cerebrovascular disease in which rupture of cerebral blood vessels leads to blood extravasation into the brain parenchyma or subarachnoid space [13], resulting in acute neurological injury. Pathological studies have shown that the stroke lesion consists of a central necrotic core and a surrounding ischemic penumbra. The surviving nerve cells and neurons in the ischemic penumbra depend on collateral circulation for blood supply. The neurovascular unit is the basic structural and functional unit of the central nervous system and plays an important role in maintaining normal brain function and modulating pathological processes. Therefore, rescuing the ischemic penumbra is key to the treatment of ischemic stroke [14]. The inflammatory response following ischemic stroke is a crucial component of cerebral ischemic injury and is associated with patient rehabilitation outcomes. Interleukin-1β (IL-1β) is activated early in cerebral ischemia, promoting the release of other inflammatory factors such as IL-6 and triggering an inflammatory cascade. Levels of IL-1β and IL-6 rise rapidly after stroke and are positively correlated with cerebral infarct volume and neurological deficit scores. The post-ischemic inflammatory cascade, characterized by elevations of IL-1β, IL-6, and TNF-α, exacerbates blood-brain barrier disruption and neuronal apoptosis via the NF-κB/NLRP3 inflammatory pathway, which is a key mechanism underlying aggravated neurological damage. Additionally, excitotoxicity, mitochondrial dysfunction, blood-brain barrier damage, and cell death processes play important roles in the pathophysiology of stroke.

Based on the above, the concept of "Promoting healthy qi" can provide a new theoretical perspective for acupuncture intervention in stroke. This concept differs from traditional "reinforcing healthy qi" in that it focuses not only on the *quantity* of healthy qi but also on its *state of movement*. After stroke, local stagnation and blockage of the cerebral collaterals with qi and blood flow obstruction resemble the microcirculatory disturbances in the ischemic penumbra; while the overall dormancy of healthy qi corresponds to the state in which neuronal function is suppressed but not yet completely necrotic. By dredging local obstructions and awakening dormant healthy qi, acupuncture, through its action of "Promoting healthy qi," mechanistically echoes modern medical treatment strategies such as improving collateral circulation and awakening hibernating neurons.

3. Stroke Rehabilitation Based on the Concept of "promoting healthy qi"

3.1 Connotation of the Concept of "promoting healthy qi"

The term "healthy qi" first appeared in the *Huangdi Neijing*, referring primarily to the role of the body's qi in maintaining health, preventing pathogen invasion, expelling pathogens, and promoting rehabilitation and self-recovery during illness. In the process of disease evolution, healthy qi participates in the preventive mechanism of "preventing disease before its onset," the therapeutic process of "preventing disease progression once it has occurred," and the rehabilitation stage of "preventing recurrence after recovery." *The Plain Questions* chapter "Discourse on Acupuncture (Fǎ Lùn)" states: "When healthy qi exists internally, pathogenic factors cannot interfere," emphasizing that healthy qi is fundamental to maintaining physiological balance in the human body [15]. Modern research has revealed that individuals with abundant healthy qi have strong immune function and metabolic regulatory capacity, whereas those with deficient healthy qi are prone to imbalances in the neuro-endocrine-immune network, leading to the formation of pathological products such as phlegm and blood stasis. The article "A new explanation of "healthy qi was preserved inside, pathogenic factorcan not intrude" proposed the concept of "promoting healthy qi", which contains two implications: first, to move the locally obstructed and stagnated healthy qi; second, to awaken and mobilize the healthy qi that remains dormant in other parts of the body [16]. This concept aligns with the idea from the *Essentials from the Golden Cabinet* that "when the original qi of the five viscera flows freely, the person is peaceful and healthy." It emphasizes the use of acupuncture, herbal medicine, exercise therapies and other means to

support healthy qi, dredge local stagnation, and awaken healthy qi. By harmonizing the state of qi and blood, these approaches guide the patient toward rehabilitation, promote the recovery of impaired bodily functions, and improve prognosis.

3.2 Mechanism of Acupuncture in "promoting healthy qi"

The occurrence of stroke is closely related to "healthy qi". There may be healthy qi deficiency due to qi deficiency and blood stasis, obstruction of the cerebral collaterals due to phlegm-stasis binding leading to impeded healthy qi, or "dormant healthy qi" due to overall functional debilitation. Acupuncture, by stimulating acupoints, activates and mobilizes the meridian qi along the body's channels and collaterals, supplements healthy qi to re-establish internal homeostasis, unblocks the channels and collaterals to restore the distribution of qi and blood, and awakens resting healthy qi to initiate the body's self-healing potential, ultimately promoting the restoration of the patient's bodily functions.

First, acupuncture acts on insufficient healthy qi-that is, it supports and supplements healthy qi to rebalance qi, blood, yin, and yang. When healthy qi is sufficient, the disease tends to resolve easily and external pathogens are difficult to invade; when healthy qi is deficient, the disease is difficult to heal and pathogens invade easily. The recovery phase of stroke is fundamentally characterized by healthy qi deficiency. Acupuncture can cultivate and supplement healthy qi, regulate qi, blood, yin, and yang. At the micro level, this manifests as enhancing immune function, upregulating neurotrophic factors, and improving the post-stroke state of overall functional debilitation.

Second, acupuncture acts on moves obstructed healthy qi. When pathogenic factors cause blockages, healthy qi cannot perform its normal functions, and the body becomes diseased. Therefore, dredging the pathways for healthy qi movement helps healthy qi exert its pathogen-resisting effects. As recorded in the *Miraculous Pivot (Ling Shu)* chapter "Channels and Vessels": "The channels and collaterals are what determine life and death, manage all diseases, and regulate deficiency and excess; they must not be obstructed." Hence, unblocking the channels and collaterals is the principle of treatment. For the blocked cerebral collaterals and impeded limb meridians after stroke, acupuncture dredges local stagnation, which can improve cerebral blood flow, relieve vasospasm, clear blood stasis, and restore the pathways of healthy qi.

Third, acupuncture acts on moves dormant healthy qi-that is, it mobilizes, awakens, and activates the "sluggish" healthy qi, allowing healthy qi to reach the entire body, regulate bodily functions, and fully exert its abilities to resist pathogens, treat disease, regulate balance, and repair damage [17]. In the penumbra neurons that are not completely necrotic after stroke and in dormant neural stem cells, the healthy qi in those regions or functional units may be in a "resting" or "non-activated" state. Acupuncture, through acupoint stimulation, can awaken this dormant healthy qi, mobilizing systemic functions to cooperatively combat pathogenic factors.

4. Exploration of the Mechanism of Acupuncture in "promoting healthy qi" for Stroke Rehabilitation

Acupuncture has a long history in the treatment of stroke. Through the clinical practice of generations of physicians, a relatively complete diagnostic and therapeutic system has been developed. *The A–B Classic of Acupuncture and Moxibustion (Zhen Jiu Jia Yi Jing)* records: "Hemiplegia, with one side of the body unusable and painful … treat with contralateral needling (ju ci)," which is the earliest documentation of contralateral needling for post-stroke hemiplegia [18]. *The Great Compendium of Acupuncture and Moxibustion (Zhen Jiu Da Cheng)* records point prescriptions for post-stroke sequelae, such as: "For facial deviation due to wind-stroke, select Tinghui (GB 2), Jiache (ST 6), and Dicang (ST 4); for hand weakness, numbness, and contracture with inability to extend, select Shousanli (LI 10)." Based on the experience of previous generations and combined with modern diagnostic and therapeutic techniques, contemporary physicians have developed various distinctive acupuncture methods, such as xing nao kai qiao, tong du tiao shen, and tong guan li qiao [19]. These have formed new acupuncture intervention protocols with reliable efficacy and high safety, which have gained international recognition.

4.1 Restoration of Blood Flow

In the acute phase of stroke, rapid restoration of blood flow perfusion in the ischemic penumbra is key to reducing irreversible neuronal damage. After the onset of ischemic stroke, severe hypoperfusion leads to ischemic and hypoxic changes in the brain, triggering neurological deficits [20]. In stroke patients, healthy qi is damaged, rendering qi insufficient to move blood, resulting in obstruction of the channels and blood vessels. Concurrently, reduced limb movement further aggravates blood stasis and vessel blockage. Acupuncture therapy regulates cerebral blood flow and promotes blood circulation in stroke patients, which is beneficial for the recovery of motor function [21]. Studies have shown that acupuncture therapy exhibits good therapeutic effects in regulating cerebrovascular function, promoting cerebral blood flow recovery, and improving collateral circulation in stroke patients [22]. Acupuncture at Baihui (GV 20) and Shenting (GV 24) can stimulate relevant nerve endings, generate nerve impulses, thereby regulating neuroelectrophysiological function. It improves cerebral hemodynamics in stroke patients, increases the content of vasoactive substances, and bidirectionally regulates the cerebral cortex. Moreover, it promotes synapse regeneration, enhances energy metabolism in damaged neurons, and nourishes neurons, ultimately improving neurological function [23].

After stroke, the expression of basic fibroblast growth factor (bFGF) and vascular endothelial growth factor (VEGF) in patients is insufficient to effectively initiate angiogenesis [24]. Acupuncture can upregulate the expression of VEGF, bFGF, VEGFR2, CD34+, etc., promote the establishment of collateral circulation, improve perfusion in the ischemic penumbra, reduce neurological deficits in the ischemic area,

and facilitate the recovery of motor function in the affected limbs [25]. Studies have confirmed that electroacupuncture combined with rehabilitation training increases the levels of VEGF, VEGFR2, bFGF, and CD34+ in the ischemic penumbra of rats, reduces infarct size, promotes angiogenesis, and improves neurological function after cerebral ischemia [26]. Multiple studies have confirmed that acupuncture can promote VEGF expression; however, some studies have also found that while VEGF promotes angiogenesis, it may lead to blood-brain barrier leakage, suggesting that the timing and intensity of acupuncture intervention need to be precisely controlled in clinical application.

4.2 Anti-inflammatory Balance

As the disease progresses to the subacute phase, excessively activated inflammatory responses become an important factor exacerbating neurological damage. According to TCM theory, inflammatory responses are often attributed to insufficient healthy qi, invasion by external pathogens, or internal injury from prolonged illness leading to qi and blood stagnation. Acupuncture therapy can support healthy qi and eliminate pathogens to regulate the body's immune-inflammatory response and promote recovery [27]. Acupuncture exerts anti-inflammatory effects by regulating microglial polarization (i.e., the switching between the pro-inflammatory M1 phenotype and the anti-inflammatory M2 phenotype) and the release of inflammatory cytokines.

Activation of microglia (MG) is a key hallmark of the inflammatory response following ischemic stroke. Under physiological conditions, MG are in a resting state. When ischemic stroke occurs, a series of complex reactions in the brain trigger MG activation. Activated MG can switch between the M1 and M2 phenotypes under specific environmental or inducing conditions [28]. The M1 phenotype secretes pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), IL-6, and IL-1β, alters blood-brain barrier permeability, and exacerbates neurotoxic damage. The M2 phenotype secretes anti-inflammatory cytokines such as IL-10 and transforming growth factor-beta (TGF-β), as well as neurotrophic factors, suppressing inflammatory responses while promoting repair of damaged brain tissue [29].

Studies have confirmed that electroacupuncture at Yanglingquan (GB 34) and Quchi (LI 11) can regulate microglial polarization, limit the development of the pro-inflammatory M1 phenotype, and induce the polarization of MG from the M1 to the M2 phenotype, thereby reducing neuroinflammation, promoting recovery of limb motor function, and improving post-stroke status. Yang Xue et al. showed that the use of fire needling combined with a herbal formula for activating blood circulation and removing stasis can significantly inhibit the expression of the inflammatory cytokines TNF-α and IL-6, thereby improving cerebral blood flow and alleviating hypoperfusion in acute cerebral infarction [30]. Electroacupuncture can inhibit the activation of the NF-κB pathway, restrict the development of the M1 pro-inflammatory phenotype, and induce a shift toward the M2 phenotype, thus alleviating neuroinflammation. Fire needling combined with blood-activating and stasis-removing formulas exemplifies the acupuncture strategy of "dredging locally stagnated healthy qi."

4.3 Neural Remodeling

In the recovery phase of stroke, the repair and remodeling of neurological function become the core objectives for improving patient prognosis. From a modern medical perspective, "healthy qi" can be understood as the functional status of the body's cells, nerves, humoral factors, and immune system [31]. In the stroke recovery phase, "impaired movement of healthy qi" manifests as suppressed synaptic plasticity and delayed neural repair. The acupuncture method of tong du tiao shen upregulates the expression of molecules such as SNAP-25 and BDNF, promotes the structural repair of synapses, and embodies the mechanism of "awakening dormant healthy qi."

After stroke, vascular occlusion leads to the formation of an ischemic penumbra, which expands as the disease progresses and eventually develops into an infarct core. However, the damage in the penumbra is reversible in the early stage. Actively repairing the ischemic penumbra can prevent further infarction and salvage residual neurological function [32]. Research data indicate that neurons within the ischemic penumbra are in a semi-dormant state, and effective intervention can activate the regulatory mechanisms of synaptic plasticity in this region, inducing neuronal proliferation and structural repair [33] [34]. Gu Shinong et al. found that the "unblocking the governor vessel and regulating the spirit" acupuncture method promotes synaptosome proliferation and structural repair of nerve cells by regulating the expression level of synaptosomal-associated protein 25 (SNAP-25) in the ischemic penumbra [35]. This method exerts a protective effect on nerve cells injured by ischemia-reperfusion and alleviates neurological impairment after cerebral ischemia. Additionally, electroacupuncture intervention has been shown to reduce the inhibition of synaptic plasticity and alleviate the pathological changes in the injured brain by activating neuronal activity.

Furthermore, acupuncture inhibits neuronal apoptosis in the ischemic penumbra by regulating neurotrophic factors, thereby protecting neural tissue surrounding the ischemic focus and promoting nervous system repair and remodeling [36]. In the mammalian central nervous system, neurotrophins, brain-derived neurotrophic factor (BDNF), and neurotrophin-3 (NT-3) together constitute the core members of the neurotrophic factor family. These three synergistically regulate neural cell differentiation and proliferation and have the ability to promote repair and regeneration of damaged neural tissue [37]. Xie Qing et al. found that scalp acupuncture combined with fire needling at back-shu points (Beishu) using fine fire needles increased the levels of neurotrophins, BDNF, and NT-3, thereby promoting the recovery of neurological function in patients with hemiplegia following cerebral infarction [38].

4.4 Integrated Physical and Mental Treatment

During the long-term rehabilitation process after stroke, psychological disorders often intertwine with physical dysfunction, forming a vicious cycle. Any excessive emotion can consume healthy qi. Stroke patients already suffer from

healthy qi deficiency, and prolonged depression will further damage healthy qi. Emotions can both cause and treat illness. As stated in *The Jing Yue Quan Shu*, chapter "Depression Disorders": "When emotions cause illness, only emotions can resolve it" [39]. Acupuncture can harmonize emotions and prevent emotional excess from damaging healthy qi. Stroke patients often experience anxiety, depression, and other psychological problems due to physical dysfunction and reduced ability to perform activities of daily living. These psychological problems, in turn, affect patients' motivation for rehabilitation and the outcomes of treatment.

After stroke, direct or indirect damage to brain tissue leads to decreased levels of 5-hydroxytryptamine (5-HT). The binding capacity of 5-HT to its downstream receptors is reduced, resulting in impaired 5-HT signaling and inducing depression [40]. 5-HT and dopamine (DA), as monoamine neurotransmitters, are closely related to emotional regulation. Dysregulation of the 5-HT system is not only a key factor in mood disorders but also indirectly increases susceptibility to depression through stress-mediated disruption of circadian rhythms [41]. Acupuncture therapy has unique advantages in regulating patients' psychological states. By modulating levels of neurotransmitters such as 5-HT and DA, it can improve patients' emotional state, enhance their confidence in rehabilitation, and improve rehabilitation outcomes. Qin Yanqiang et al. showed that scalp acupuncture combined with abdominal acupuncture at points such as Baihui (GV 20), Yintang (EX-HN 3), Zhongwan (CV 12), and Guanyuan (CV 4) significantly increased serum levels of 5-HT and DA in rats and improved post-stroke depression [42].

5. Conclusion

Based on the concept of "promoting healthy qi", this paper discusses the multiple mechanisms of acupuncture intervention in stroke rehabilitation. The concept extends beyond the traditional approach of "reinforcing healthy qi" by emphasizing the restoration of the "movement state" of healthy qi, which aligns closely with the pathogenesis of stroke: "root deficiency and branch excess, with impaired movement of healthy qi." Acupuncture exerts its therapeutic effects by acting on three distinct states of healthy qi: "insufficient healthy qi that cannot move," "obstructed healthy qi that fails to move," and "dormant healthy qi that is unable to move." These correspond respectively to improving cerebral blood flow and collateral circulation, regulating inflammatory balance, promoting neural remodeling, and modulating emotional states. Together, these mechanisms not only constitute the modern scientific connotation of acupuncture treatment for stroke but also provide a new interpretive framework for traditional Chinese medicine rehabilitation theory.

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