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REVIEW

Acupuncture for Post-Stroke Lower Limb Dysfunction: Clinical Efficacy and Neurophysiological Mechanisms

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Purpose: Lower limb dysfunction is a common and debilitating consequence of stroke, significantly compromising patients' quality of life. This mini-review synthesizes clinical research on acupuncture for post-stroke lower limb dysfunction over the past five years, integrating traditional Chinese medicine (TCM) theories and modern evidence.

Methods: The review analyzed clinical studies and TCM theoretical perspectives. TCM attributes stroke pathogenesis to Yin-Yang disharmony, Qi-blood imbalance, and complex interactions of wind, phlegm, fire, stasis, and toxin.

Results: Acupuncture therapies, including body acupuncture, electroacupuncture, abdominal acupuncture, scalp-body acupuncture, specific acupoint stimulation, moxibustion, and combined techniques, demonstrate significant efficacy in improving motor coordination, reducing muscle tone, and enhancing voluntary movement. Mechanistically, acupuncture regulates cerebral blood flow, reduces ischemic-reperfusion injury, modulates neuroinflammation, and promotes neural regeneration. Clinical studies show that these approaches effectively alleviate symptoms, with total effective rates ranging from 70% to 95.5%.

Conclusion: Acupuncture shows considerable potential for post-stroke lower limb dysfunction, likely exerting effects through modulation of cerebral blood flow, neuroinflammation, oxidative stress, and neural plasticity. However, challenges remain, including the lack of standardized acupoint selection protocols, stimulation parameters, large multicenter trials, and in-depth mechanistic research.

Keywords: stroke, lower limb dysfunction, acupuncture, traditional Chinese medicine, neurorehabilitation

Introduction

Stroke was recorded as "Piangu" (hemiplegia) and "Pianfeng" (unilateral wind) in *Huangdi Neijing* (Inner Canon of the Yellow Emperor). *Ling Spiritual Pivot: Needling Nodes and True Evil* states:

> When pathogenic factors invade one side of the body deeply, they reside in the Nutritive Qi and Defensive Qi. As the Nutritive and Defensive Qi decline, the True Qi departs, leaving the pathogenic factors alone, leading to Piangu.

In Traditional Chinese Medicine (TCM), stroke is also understood in terms of "Yin–Yang disharmony", which refers to imbalance between the body's passive (Yin) and active (Yang) forces, and "Qi–blood imbalance", indicating insufficient or obstructed flow of vital energy (Qi) and blood.[1] These imbalances are believed to impair organ function, block meridians, and contribute to motor and sensory deficits.[2] Western medicine refers to it as "stroke" or "cerebrovascular accident (CVA)", primarily caused by sudden rupture or spasm of cerebral arterial vessels, or acute local cerebral tissue circulatory disorders and hemiplegia dominated by limb function impairment due to stenosis or obstruction.[3] Lower limb dysfunction is particularly common among limb impairments, clinically characterized by disorders of motor coordination

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in major muscle groups and joints of the affected side, accompanied by increased muscle tone, decreased muscle strength, and impaired voluntary motor function.[4] It is also a key factor contributing to reduced quality of life and aggravated family and social economic burdens after stroke.[5] Numerous clinical studies have shown that body acupuncture, electro-acupuncture, abdominal acupuncture, scalp-body acupuncture, specific acupoint acupuncture, acupuncture with different manipulation techniques, moxibustion, and combined acupuncture-moxibustion demonstrate significant efficacy in treating post-stroke lower limb dysfunction, playing a crucial role in improving patients' quality of life and reducing mortality and disability rates.[6] This article summarizes the clinical research achievements of acupuncture in treating post-stroke lower limb dysfunction over the past five years.

Methods

This narrative review aimed to synthesize recent clinical research on acupuncture for post-stroke lower limb dysfunction and integrate it with TCM theories. We conducted a structured literature search in PubMed, Web of Science, CNKI, and Wanfang databases for articles published between January 2018 and December 2024. Search terms included "stroke", "hemiplegia", "lower limb dysfunction", "motor impairment", "gait disturbance", and "acupuncture" (including electro-acupuncture, scalp acupuncture, abdominal acupuncture, and moxibustion).

Inclusion Criteria

To ensure a structured and transparent selection of studies, we applied the PICOS framework to formulate the inclusion criteria as follows:

1. Population: Adult patients with post-stroke lower limb dysfunction.
2. Intervention: Acupuncture or acupuncture-based interventions, either as monotherapy or combined with conventional rehabilitation.
3. Comparator: Conventional rehabilitation, standard care, or control groups.
4. Outcomes Motor function (Fugl-Meyer Assessment), activities of daily living (Barthel Index), gait, muscle strength, or spasticity.
5. Study design: Randomized controlled trials, non-randomized trials, and observational studies.

Exclusion Criteria

Studies were excluded if they met any of the following:

1. Animal or in vitro studies.
2. Review articles, case reports, or conference abstracts without primary clinical data.
3. Studies lacking clear outcome measures related to lower limb function.
4. Duplicate publications or studies with incomplete data.

Data Extraction and Synthesis

Two authors independently screened titles and abstracts, evaluated full-text articles for eligibility, and extracted relevant information, including study design, sample size, patient characteristics, intervention protocols, acupoints used, treatment duration, and primary outcomes. Discrepancies were resolved through discussion. The included studies were qualitatively synthesized according to acupuncture modality and primary outcome measures. Given the heterogeneity in study designs and interventions, quantitative meta-analysis was not performed; instead, findings were summarized narratively to highlight overall trends and clinical efficacy.

Epidemiological Context

Stroke is a leading cause of long-term disability worldwide, with over 12 million new cases and 6 million deaths annually.[7] Post-stroke lower limb dysfunction—including motor impairment, spasticity, and gait disturbances—affects a substantial proportion of survivors, significantly limiting mobility and quality of life. Patients exhibit considerable

Table 1 Epidemiological Characteristics and Heterogeneity of Post-Stroke Lower Limb Dysfunction

Characteristic	Data/Description	Clinical Relevance	Reference
Global incidence of stroke	~12 million new cases/year	Indicates high prevalence of potential lower limb dysfunction	World Stroke Organization[7]
Global stroke-related mortality	~6 million deaths/year	Highlights clinical burden	World Stroke Organization[7]
Prevalence of post-stroke lower limb dysfunction	50–70% of stroke survivors	Common target for rehabilitation	Zhang et al, 2024[9]
Age distribution	Most cases >60 years, but increasing in younger adults	Age influences recovery potential and comorbidities	Feigin et al, 2023[10]
Stroke subtype	Ischemic: 70–85%; Hemorrhagic: 15–30%	Recovery patterns differ by subtype	Campbell et al, 2022[11]
Time since stroke onset	Acute (<1 month), Subacute (1–6 month), Chronic (>6 month)	Treatment response varies with stage	Bernhardt et al, 2017[12]
Comorbidities	Hypertension, diabetes, cardiovascular disease	Affects prognosis and rehabilitation outcomes	Ovbiagele et al, 2019[13]
Conventional rehabilitation approaches	Physiotherapy, task-specific training, robotic-assisted therapy	Standard care, but often limited by residual deficits and patient adherence	Winstein et al, 2016[14]

heterogeneity in age, stroke subtype, severity, comorbidities, and time since onset, all of which influence recovery and treatment outcomes.[8] Conventional rehabilitation, such as physiotherapy and task-specific training, remains standard but is often constrained by residual deficits and variable adherence. This epidemiological and clinical landscape highlights the need to explore complementary interventions, such as acupuncture, to optimize functional recovery (Table 1).

Etiology and Pathogenesis of Stroke

Traditional Chinese Medicine Perspective on Stroke

The earliest record of "stroke" appears in *Plain Questions: Treatise on Wind* of *Huangdi Neijing*, but it had a different meaning from the current concept.[15] The term "stroke" was first used in *Synopsis of the Golden Chamber: Syndrome and Pulse Differentiation of Stroke and Arthralgia*, and its association with symptoms like hemiplegia was first documented. Analysis of etiology and pathogenesis: External causes include not only the six exogenous pathogens but also various infectious factors in Western medicine.[16] Internal causes vary among individuals and are complex, with their role in pathogenesis widely acknowledged by physicians.[1]

Phlegm-blood stasis obstruction: Phlegm-dampness blocks the Qi movement of Zang-Fu organs, disrupts the distribution of body fluids and blood, generates blood stasis, forms phlegm-blood stasis, blocks meridians, and clouds the clear orifices.[1]

Phlegm-heat in the fu organs: Excessive consumption of fatty, sweet, and thick foods or alcohol impairs the spleen and stomach, leading to phlegm-heat; or emotional depression transforms into fire, consuming Qi and Yin, condensing body fluids into phlegm, with phlegm-heat clouding the clear orifices.

Blood stasis obstruction: Prolonged illness, Zheng deficiency (healthy Qi deficiency), or emotional disorders cause Qi stagnation and blood stasis; fire-heat scorching blood or Yin fluid deficiency can also lead to stasis, blocking cerebral collaterals.

Exuberant fire-toxin: Fire-toxin can be triggered by internal or external factors, generating wind, moving blood, and disturbing the mind and orifices.

Qi deficiency and blood stasis: Internal injury from overwork, prolonged illness, or congenital deficiency weakens Zheng Qi, causing poor Qi-blood circulation, blocking tendons and cerebral collaterals, and impairing mental function.

Toxin damaging brain collaterals: Long-term accumulation of exogenous six pathogens, improper diet, or emotional disorders generates toxins, which harm the brain marrow and damage brain vessels.

Liver-Kidney Yin deficiency: Aging, internal injury, or accumulated damage lead to Liver-Kidney insufficiency, Yin-blood deficiency, and wind disturbing the brain orifices.[17]

In summary, the pathogenesis of stroke roots in Yin-Yang disharmony of Zang-Fu organs and Qi-blood disorder, characterized by fundamental deficiency and superficial excess, with the disease location in the Liver, Spleen, and Kidney.[18] It involves pathological factors such as wind (internal and external), phlegm (damp-phlegm, wind-phlegm), fire (phlegm-fire, Liver-fire), blood stasis, Qi disorder (Qi reversal, Qi sinking), deficiency (Yin deficiency, Qi-blood deficiency), and toxin (infection). The current trend of stroke occurrence and progression is the combination of multiple

Table 2 Traditional Chinese Medicine (TCM) Perspectives on Stroke Pathogenesis

Etiological Pattern	Clinical Characteristics	Pathogenetic Mechanism	Reference
Phlegm-blood stasis obstruction	Qi movement blocked, blood stasis forms	Collaterals obstructed, clear orifices clouded	Zhong et al, 2020[1]
Phlegm-heat in the fu organs	Overeating greasy/sweet foods, alcohol, or emotional fire	Phlegm-heat obstructs orifices	Wu et al, 2019[16]
Blood stasis obstruction	Long illness, Qi deficiency, emotional stagnation	Blood stasis blocks cerebral collaterals	Zhang et al, 2023[17]
Exuberant fire-toxin	Fire-toxin flares up due to internal or external factors	Moves blood, generates wind, disturbs spirit and orifices	Wang et al, 2022[19]
Qi deficiency with blood stasis	Overwork, congenital weakness, chronic disease	Qi-blood circulation impaired, tendons and brain collaterals blocked	Liu et al, 2017[20]
Toxin damaging brain collaterals	Pathogen accumulation, improper diet, or emotional disorders	Toxins injure brain marrow and cerebral vessels	Sun et al, 2016[21]
Liver-Kidney Yin deficiency	Aging, chronic damage, or prolonged illness	Yin-blood deficiency, wind disturbs brain orifices	Gao et al, 2019[22]

factors, which mutually transform and influence each other (Table 2). As summarized in Figure 1, the pathogenesis of stroke in TCM involves a complex interplay of multiple factors, including wind, phlegm, fire, blood stasis, and deficiency.

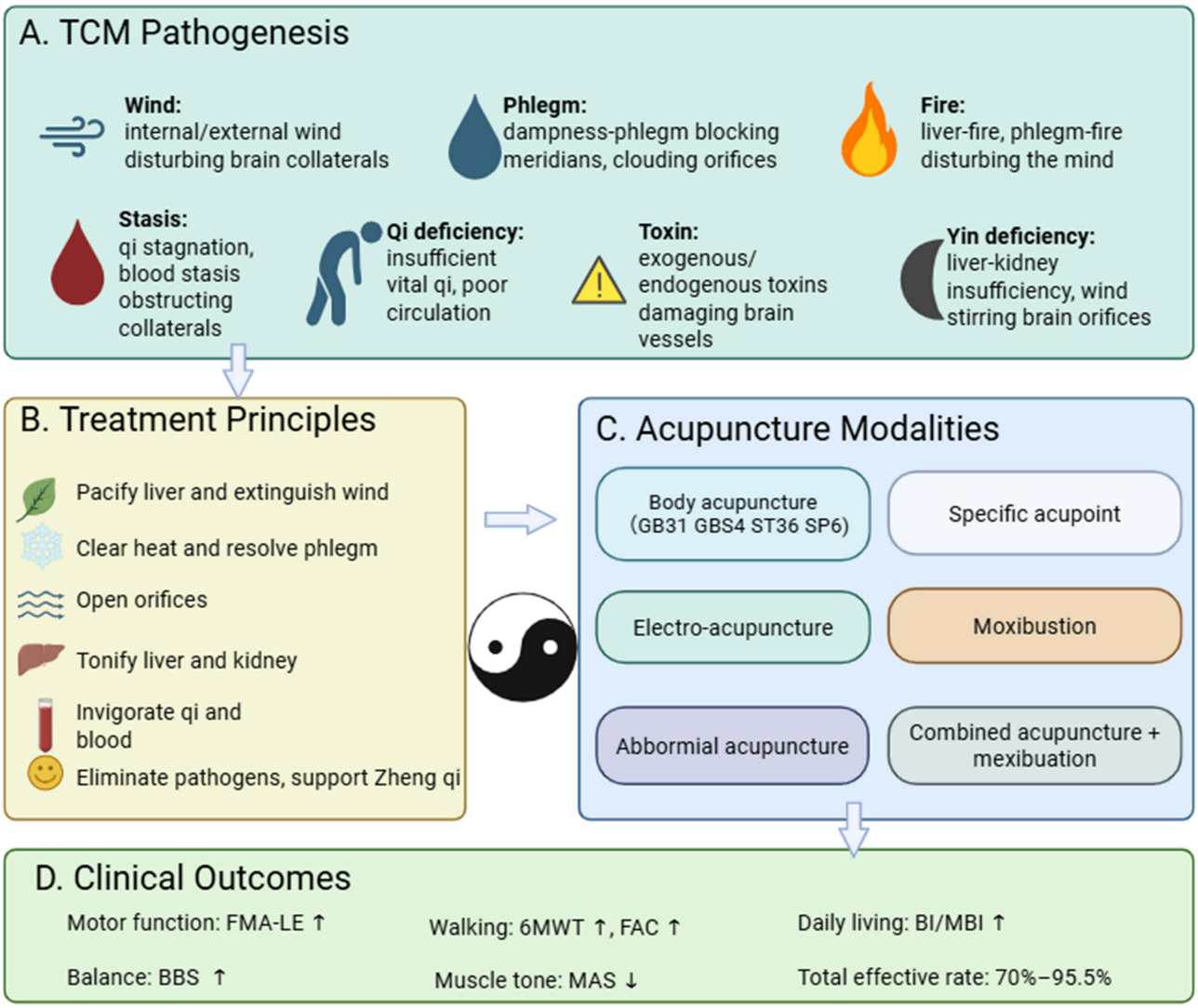

Figure 1 Conceptual framework illustrating TCM pathogenesis, treatment principles, acupuncture modalities, and associated clinical outcomes. (**A**) TCM Pathogenesis (**B**) Treatment Principles (**C**) Acupuncture Modalities (**D**) Clinical Outcomes.

Guiding Principles of TCM Treatment for Post-Stroke Limb Dysfunction

The treatment principles of stroke follow "treating the branch in emergency and the root in remission". The main therapies focus on eliminating pathogens, commonly using methods such as calming the Liver to extinguish wind, clearing heat and resolving phlegm, removing phlegm to open orifices, tonifying the Liver and Kidney, and activating blood to unblock collaterals.[1] For the closed syndrome and collapse syndrome, treat them with eliminating pathogens to open orifices and resuscitate, and supporting Zheng Qi to solidify collapse, restoring Yin and Yang, respectively.[23] In the recovery and sequelae stages, syndrome differentiation mainly identifies mixed deficiency-excess and pathogen excess with Zheng deficiency, requiring combined pathogen elimination and Zheng support, such as nourishing Yin to extinguish wind and invigorating Qi to activate blood. Post-stroke limb dysfunction results from tendons and vessels losing Qi-blood nourishment, requiring combined acupuncture and medication to invigorate Yuan Qi, tonify Qi-blood, activate blood, and unblock meridians for joint flexibility.[24] The following reviews acupuncture therapies alone.

Acupuncture Methods

Body Acupuncture

Traditional acupuncture follows the principle of "treating flaccidity by exclusively selecting Yangming", mainly selecting acupoints from the Hand and Foot Yangming meridians to promote Qi-blood circulation in meridians, nourish tendons, and activate blood to unblock collaterals. Li et al (2022) treated 60 patients with post-stroke lower limb dysfunction by selecting acupoints such as Weizhong (BL40), Ququan (LR8), Fengshi (GB31), Yanglingquan (GB34), Xuanzhong (GB39), Zusanli (ST36), Geshu (BL17), Sanyinjiao (SP6), Fengchi (GB20), and Xuehai (SP10) (Figure 2). The results showed 25 cures, 12 improvements, 16 marked effects, and 7 cases with no effect, with a total marked effective rate of 88.33%, indicating significant acupuncture efficacy. Scholars have proposed that effective stimulation of body acupuncture is a necessary means to treat limb dysfunction in post-stroke hemiplegic patients, often using pain sensation and limb twitching as standards to excite neural pathways, induce brain tissue excitation, and promote local brain function recovery.[25] Mechanistically, body acupuncture may modulate peripheral sensory input to the central nervous system, enhancing cortical excitability and promoting neuroplasticity in motor-related regions.[26] Additionally, it can influence local microcirculation, reduce oxidative stress, and facilitate neuromuscular junction recovery.[27]

Wei et al[28] randomly divided 60 patients with post-stroke lower limb dysfunction into two groups (30 cases each) to study the effect of Taiyin-Yangming balanced acupuncture on post-stroke lower limb hemiplegia. Both groups selected acupoints based on syndrome differentiation. The treatment group used Taiyin-Yangming meridian balanced acupuncture, while the control group received conventional acupuncture. The results showed the total effective rate of the treatment group was significantly higher than that of the control group (93.3% > 86.1%), and the marked effective rate was also higher (76.7% > 56.7%), with a significant difference between the two groups ($P<0.05$). Tian et al[29] divided 100 eligible patients into two groups randomly to explore the effect of Yin-Yang opposite needling combined with respiratory reinforcing-reducing method on post-stroke lower limb balance dysfunction. The control group received basic therapy without relevant rehabilitation treatment, while the acupuncture group received Yin-Yang opposite needling combined with respiratory reinforcing-reducing method in addition to basic treatment. Before and after treatment, the balance trajectory parameters, stability coefficient, and weight distribution coefficient were significantly improved in both groups ($P<0.05$). After treatment, the rectangular area, peripheral area, trajectory length, trajectory length per unit area, left-right offset stability, and weight distribution coefficient showed significant differences between the acupuncture group and the control group ($P<0.05$). Yu et al[30] divided 50 eligible patients into two groups (25 cases each) to explore the efficacy of double-needle concurrent needling for increased lower limb muscle tone after stroke. The treatment group performed double-needle concurrent needling on antagonistic acupoints of the affected limb, while the control group received conventional acupuncture on the affected limb. The results showed the total effective rate of the treatment group was significantly higher than that of the control group (72% > 56%, $P<0.05$). These protocols likely enhance synaptic plasticity and modulate inhibitory-excitatory balance in motor circuits, promoting recovery of motor coordination and reducing spasticity.[25,31,32]

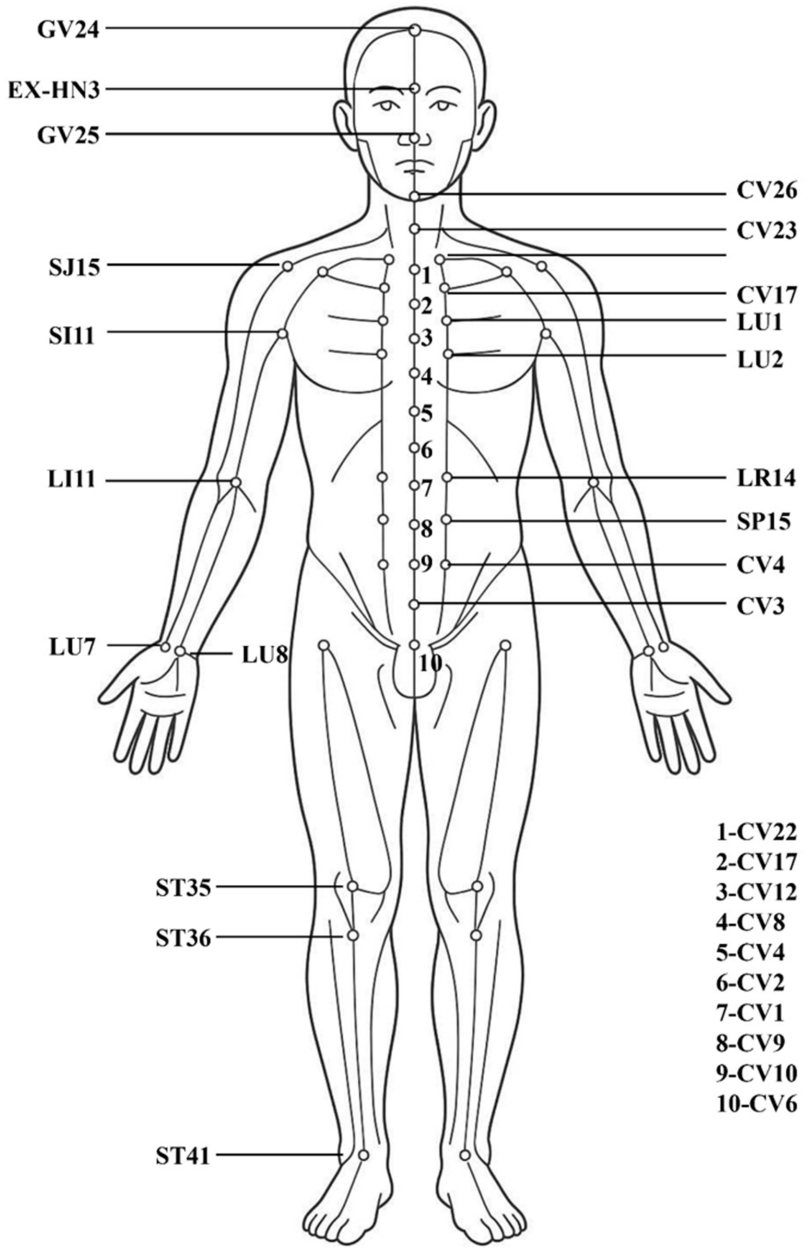

Figure 2 Anatomical localization of the primary acupuncture points used in post-stroke lower limb rehabilitation.

Electro-Acupuncture

Electro-acupuncture increases oxygen supply to the ischemic area, indirectly improves oxygen and energy metabolism in the ischemic area, thereby reducing the infarction focus, inhibiting cell apoptosis, alleviating neuronal damage, and promoting functional recovery of neurons in the ischemic penumbra.[33] Mechanistically, electrical stimulation can activate Aβ and Aδ fibers, inducing long-term potentiation in motor cortex neurons and facilitating corticospinal tract reorganization.[34] It also modulates neurotransmitter release (eg, glutamate, GABA) and neurotrophic factors such as BDNF to enhance neuroplasticity.[35] Li et al[36] randomly divided 40 eligible patients into two groups. The treatment group received conventional rehabilitation therapy and electro-acupuncture at BIguan (ST31), Liangqiu (ST34), Fengshi (GB31), Chengfu (BL36), Yinmen (BL37), etc. The control group selected Huantiao (GB30), BIguan (ST31), Futu (ST32), Fengshi (GB31), etc, using the Qi ci method (triple needling). The control group used discontinuous waves,

while the treatment group used a flexor-extensor alternating stimulator with discontinuous waves. The results showed that the neurological deficit scores of both groups were significantly different from those before treatment (P<0.01), and the treatment group was also significantly different from the control group (P<0.01). The total effective rate of the treatment group was significantly better than that of the control group (90% > 55%), indicating that electro-acupuncture was more effective than flexor-extensor alternating stimulation therapy. In addition, Li et al highlighted that combining electro-acupuncture with traditional rehabilitation enhances proprioceptive function,[37] improving balance and gait stability. Proprioceptive training facilitates sensorimotor integration and motor relearning,[38] suggesting a synergistic effect with electro-acupuncture in restoring lower limb function. This synergistic effect likely arises from enhanced sensorimotor integration and cortical remapping induced by patterned electrical stimulation.[39]

Abdominal Acupuncture

Abdominal acupuncture activates the Nogo-A-mediated central nerve regeneration function, not only significantly improving the clinical efficacy of patients with cerebral ischemia-reperfusion but also playing an important role in promoting motor function recovery, reducing ischemia-reperfusion injury, and alleviating mental disorders. Zhan et al[40] analyzed the efficacy of Sun's abdominal acupuncture in treating 120 patients with post-stroke lower limb dysfunction. The patients were randomly divided into two groups: the observation group received body acupuncture combined with Sun's abdominal acupuncture, while the control group received only body acupuncture with the same acupoints. The clinical symptoms of lower limb dysfunction, FMA scale, and the lower limb motor function component of the BI index were significantly improved in the observation group compared to the control group ($P<0.05$). Abdominal acupuncture may act through modulation of central nervous system plasticity, influencing motor cortex excitability and activating descending motor pathways, while also affecting autonomic regulation to improve circulation and metabolic support to ischemic tissues.[41]

Scalp-Body Acupuncture

The combination of scalp and body acupuncture embodies the near-far acupoint selection method, jointly maintaining the integrity of the blood-brain barrier, reducing brain edema, inflammatory response, and brain cell apoptosis, and promoting cell proliferation and DNA repair, thus improving neurological function.[42,43] Researchers have pointed out that the earlier the combined use of scalp and body acupuncture in stroke treatment, the better the efficacy.[44] Stimulation of scalp motor areas is believed to enhance cortical excitability, promote synaptogenesis, and facilitate reorganization of motor networks, while body acupuncture provides complementary peripheral neuromodulation.[45,46] By improving local blood circulation and regulating biochemical metabolism, it not only shows significant effects in neurological deficit scale scores but also significantly improves patients' daily living ability and quality of life when combined with functional exercise during treatment.[47] To explore the efficacy of staged scalp-body acupuncture combined therapy in promoting lower limb function recovery in post-stroke patients, Song et al[48] conducted an exploratory randomized controlled trial in patients with acute ischemic stroke, comparing scalp cluster acupuncture combined with constraint-induced movement therapy (CIMT) against body acupuncture with conventional rehabilitation. Both groups improved on the Fugl-Meyer scale and functional MRI outcomes, but the combined therapy group achieved greater functional recovery, highlighting the enhanced efficacy of integrating scalp acupuncture with body acupuncture and rehabilitation in lower limb function restoration. To explore the efficacy of acupuncture at the upper one-fifth of the scalp motor area in treating post-stroke lower limb dysfunction, a meta-analysis by Huang et al[6] systematically evaluated randomized controlled trials investigating scalp acupuncture for post-stroke hemiplegia. The pooled results demonstrated that scalp acupuncture significantly improved motor function, as measured by the Fugl-Meyer Assessment, after both 1-month and 3-month treatment courses. Moreover, scalp acupuncture was associated with better recovery of activities of daily living compared to control interventions, indicating that conventional acupuncture combined with scalp acupuncture can significantly accelerate muscle strength recovery of the affected side.

Specific Acupoint Acupuncture

Evidence from recent systematic reviews highlights the therapeutic potential of specific scalp acupoint stimulation in post-stroke motor rehabilitation. Huang et al[6] conducted a meta-analysis of randomized controlled trials and reported that scalp acupuncture significantly improved motor recovery, as reflected in Fugl-Meyer scores, and enhanced activities of daily living compared with control interventions, despite methodological limitations among the included studies. Complementing these findings, Wang et al (2023) applied Apriori algorithm-based data mining to analyze clinical literature and identified the motor area of the scalp as a core acupoint frequently used in combination therapies. Targeting specific scalp regions may optimize neuroplasticity and synaptic remodeling, improving lower limb motor function and coordination.[49]

Moxibustion

Moxibustion significantly improves the high-concentration, high-viscosity, coagulation, and aggregation state of blood, especially reducing high and low shear blood viscosity and whole blood viscosity.[50] It obviously improves red blood cells in the microenvironment of tissues in stroke patients, significantly increases tissue cell oxygen supply, and further exerts the physiological functions of body organs. Moxibustion reduces the recurrence rate and achieves secondary prevention by decreasing inflammatory cytokines IL-1β, IL-6, and hs-CRP.[51] Evidence supports the beneficial role of moxibustion in post-stroke rehabilitation. A meta-analysis by Chen et al[52] included nine randomized controlled trials with 723 participants, and found that grain-sized moxibustion was significantly more effective than conventional therapy in improving neurological deficit scores (standardized mean difference [SMD] = −1.20; 95% CI: −1.71 to −0.69; $P < 0.00001$). The analysis further indicated superior outcomes for motor function and activities of daily living in the moxibustion group compared with controls. Nakahara et al[53] conducted a controlled experimental study in 20 healthy volunteers, applying indirect moxibustion at ST36. The intervention significantly increased local skin temperature by approximately 2.5°C and decreased heart rate by about 4–5 beats per minute compared to baseline, suggesting that moxibustion can enhance peripheral blood circulation and modulate autonomic nervous activity. Mechanistically, moxibustion may promote motor recovery by modulating neuroinflammation, enhancing microvascular perfusion, reducing oxidative stress, and activating neurotrophic pathways (eg, BDNF/TrkB) to support neuroplasticity and neuronal repair, while also improving autonomic balance and tissue oxygenation.[54] Collectively, these results indicate that moxibustion may not only promote motor recovery but also improve hemodynamic regulation relevant to stroke rehabilitation.

Combined Acupuncture and Moxibustion

Combined acupuncture and moxibustion can increase blood perfusion and supply in the ischemic area, improving the microcirculation of local cerebral ischemic foci.[19,55] Gao et al[22] conducted a systematic review and meta-analysis evaluating the effects of acupuncture plus moxibustion combined with rehabilitation training for post-stroke shoulder-hand syndrome (SHS) The pooled results showed that the combined therapy significantly outperformed rehabilitation alone in improving upper limb motor function, relieving pain, and enhancing activities of daily living, thereby highlighting the synergistic effect of integrating acupuncture and moxibustion with conventional rehabilitation. Similarly, Zhao et al (2015) reported that acupuncture combined with moxibustion, based on the theory of meridians and myofascial pathways, was not only safe but also effective in reducing pain and improving motor recovery in post-stroke shoulder-hand syndrome patients. The synergistic effects of combined acupuncture and moxibustion may involve enhanced cortical excitability, upregulation of neurotrophic factors (BDNF, NGF), modulation of inflammation, improved synaptic plasticity, and better microcirculation, collectively supporting motor recovery and functional reorganization after stroke.[56] Together, these findings provide credible evidence that combined acupuncture and moxibustion interventions can enhance functional recovery and quality of life in stroke survivors (Table 3).

Table 3 Recent Clinical Studies on Acupuncture for Post-Stroke Lower-Limb Dysfunction

Method	Design & Population	Diagnosis	Acupuncture Points/Parameters	Statistical Results	Conclusions/Clinical Recommendations	Reference
Scalp acupuncture (interactive/dynamic)	Multicenter RCT; n=231; post-stroke motor impairment	Ischemic or hemorrhagic stroke; post-stroke hemiparesis	IDSA; motor-area lines; needle retention 30 min; 5 sessions/week	IDSA group showed significantly higher FMA-LE, 6MWT, and BBS improvements vs comparators after 8 weeks ($P<0.05$)	Enhanced lower-limb motor and gait; suitable for subacute stroke with motor deficits	Zhang et al, 2022[57]
Scalp acupuncture + intelligent feedback training	RCT; n=154; lower-limb dysfunction after stroke	Post-stroke hemiplegia	Scalp acupoints upper 1/5 anterior/posterior parietal-temporal lines; 25–30 min/session; 3 sessions/week	Combined therapy significantly reduced spasticity and improved balance, walking, ADL, and plantar pressure vs control ($P<0.05$)	Combined therapy more effective than training alone; consider for hemiplegic patients	Zhang et al, 2021[58]
Antagonistic needling (with EA on pairs)	RCT; n=100; post-stroke LL spasticity	Post-stroke lower limb spasticity	Head+body points; GB34, GB40, ST41, GB39; EA 2 Hz; 20–30 min/session; 5 sessions/week	Total effective rate: 91.8% vs 81.6% in control; MAS and FMA-LE significantly improved ($P<0.05$)	Reduces spasticity and improves ambulation; suitable for spastic hemiplegia	Yu et al, 2025[30]
Body acupuncture (meridian-based) + rehab	Large RCT; n=497; ischemic stroke	Ischemic stroke with lower limb motor deficits	GB31, GB34, GB39, ST36, BL40, SP6; 30 min/session; 5 sessions/week	Acupuncture + rehab showed significant improvements in neuro deficits, ADL, and muscle tone vs control ($P<0.05$)	Adding acupuncture improves overall motor function; suitable for ischemic stroke	Li et al, 2022[55]
Scalp vs body acupuncture (both + rehab)	Single-center RCT; n=90	Post-stroke hemiparesis	Zhu's scalp acupuncture + body acupuncture; 30 min/session; 5 sessions/week	Scalp+body showed significantly higher FMA-LL and ADL gains vs body acupuncture alone ($P<0.05$)	Combined scalp+body more effective; suitable for moderate hemiparesis	Xie et al, 2022[44]
Network meta-analysis (LL-focused)	Network meta-analysis of RCTs on LL motor dysfunction	Post-stroke lower-limb motor dysfunction	–	Body acupuncture + rehab ranked highest overall; warm-needling + rehab and EA + body + rehab showed outcome-specific advantages	Acupuncture generally effective; further high-quality RCTs needed	Liu et al, 2024[4]
Systematic review and meta-analysis (LLMD)	Meta-analysis of RCTs on lower-limb motor dysfunction	Post-stroke lower-limb dysfunction	–	Acupuncture—especially combined with rehab—improved balance and LL motor; effect sizes moderate (SMD ~0.45–0.78)	Acupuncture + rehab effective; consider patient-specific application	Chen et al, 2025[3]
Scalp acupuncture (general hemiparesis)	Meta-analysis of RCTs	Post-stroke hemiparesis	Scalp acupoints over motor projection areas; 20–30 min/session; 3–5 sessions/week	FMA scores improved significantly vs controls after 1–3 months ($P<0.05$)	Enhances motor recovery and ADL; suitable for hemiparetic patients	Huang et al, 2021[59]

Abbreviations: LL, lower limb; FMA-LE, Fugl-Meyer Assessment for lower extremity; BBS, Berg Balance Scale; 6MWT, 6-Minute Walk Test; FAC, Functional Ambulation Category; MBI/BI, (Modified) Barthel Index; MAS, Modified Ashworth Scale.

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Discussion

Researchers have proposed that acupuncture can reduce brain cell damage after cerebralischemia and reperfusion by influencing the functional state of the cerebral cortex;[21] the warm-dredging and deficiency-tonifying effect of moxibustion can accelerate local blood circulation, improve local ischemic and hypoxic conditions, relieve muscle spasm, enhance muscle strength, and restore limb function;[60] electro - acupuncture produces peripheral regulatory mechanisms through effective stimulation, generating regulatory impulses that improve abnormal bodily conditions and promote limb function recovery.[61]

Recent studies suggest multiple underlying mechanisms for acupuncture's therapeutic effects on post-stroke lower limb dysfunction. Acupuncture has been shown to modulate cerebral blood flow, regulate neuroinflammation, reduce oxidative stress, and promote neurogenesis and synaptic plasticity in ischemic brain regions.[62,63] Electroacupuncture can enhance motor cortex excitability and facilitate corticospinal tract reorganization,[64] while scalp acupuncture targeting motor areas may optimize functional recovery through neuroplasticity.[46] Moxibustion further supports microcirculation and tissue oxygenation, contributing to neural and muscular repair.[65] Furthermore, although various studies demonstrate clinical efficacy, there is currently no universally accepted standardized protocol for acupoint selection, stimulation intensity, frequency, or treatment duration. Existing guidelines recommend selecting acupoints based on syndrome differentiation and targeting key meridians related to lower limb function (eg, Yangming, Taiyin), often combining local and distal points,[66] but considerable variability remains across clinical practice. Standardization is essential to improve reproducibility, comparability, and integration with multimodal rehabilitation strategies.

Various acupuncture treatment methods for post-stroke lower limb dysfunction have achieved satisfactory clinical efficacy.[9] They can effectively improve the ischemic and hypoxic state of the stroke - affected brain tissue,[67] reduce the damage of oxygen free radicals to brain neurons during cerebral ischemia-reperfusion, accelerate brain metabolism, promote the functional recovery of damaged nerve cells, inhibit the abnormal activity of spinal motor neurons, stimulate the excitation and antagonism of neural pathways, alleviate physical pain and muscle spasm, accelerate the recovery speed of patients' limb functions, and are of great significance for reducing disability rates and improving patients' quality of life. However, mechanistic studies exploring the underlying biological pathways of acupuncture remain limited, and long-term follow-up data are scarce, making it difficult to fully assess the stability and persistence of therapeutic benefits. Current research still lacks large-sample, multi-center, and in-depth clinical trials that could provide more robust evidence for its efficacy.[68] Future research should therefore focus on elucidating the biological mechanisms of acupuncture, establishing evidence-based standard protocols for acupoint selection and stimulation parameters, and integrating acupuncture into multimodal rehabilitation approaches to optimize functional recovery and quality of life in post-stroke patients.

Data Sharing Statement

The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

Because this study did not involve human trials or data, it was not subject to ethical approval.

Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work. Specifically, Wei Xie contributed to conceptualization, methodology, supervision, and drafting of the manuscript. Zhong Di, Wei Shao, Aijun Wang, and Lihua Guan contributed to data curation, formal analysis, and manuscript review and editing. Wei Xie and Zhong Di are the co-first authors.

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Disclosure

The authors declared that they have no conflicts of interest regarding this work.

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