

Neuroplastic Effects of Acupuncture in Stroke and Parkinson's Disease: A Narrative Review

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Abstract: Neuroplasticity is a key mechanism underlying recovery in neurological disorders, allowing the brain to reorganize and adapt after injury or degeneration. Recent research suggests that acupuncture may influence neuroplastic processes through modulation of cortical activity, synaptic remodelling, neurogenesis, and neurotrophic signalling. This narrative review examines contemporary evidence on the neuroplastic effects of acupuncture, with particular focus on stroke and Parkinson's disease. Recent neuroimaging and mechanistic studies indicate that acupuncture may affect sensorimotor networks, dopaminergic pathways, and inflammatory regulation associated with functional recovery. In stroke, acupuncture has been linked to improved motor-network activation and neurorepair-related signalling, while in Parkinson's disease it may support dopaminergic preservation and circuit-level plasticity. Current evidence supports the view that acupuncture may function as a neuromodulatory adjunct in neurorehabilitation, particularly when combined with conventional rehabilitation strategies. However, further standardized and large-scale studies are required to strengthen clinical translation.

Keywords: Acupuncture; Neuroplasticity; Stroke; Parkinson's Disease; Neuromodulation; Neurorehabilitation.

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I. INTRODUCTION

The nervous system's capacity to recruit compensatory networks, restructure surviving circuits, and modify synaptic and anatomical connections all play a role in recovery from neurological illnesses. Neuroplasticity, which encompasses both short-term alterations in cortical excitability and long-term alterations such as synaptogenesis, axonal sprouting, and network remodelling, is typically used to categorize these processes. Modern neurorehabilitation research has placed a strong emphasis on therapies that can engage adaptive plasticity since many neurological illnesses leave residual but adjustable brain function.(1)(2)

Acupuncture has moved from being studied solely as a traditional symptom-based therapy to being investigated as a neuromodulatory intervention with measurable central nervous system effects. In order to investigate how needling affects sensorimotor networks, default mode network dynamics, dopaminergic circuits, and neurotrophic signalling, modern acupuncture publications increasingly employ fMRI, fNIRS, electrophysiological, and molecular assays. This change is significant because it makes it possible to explain acupuncture in terms of mechanistic

neuroscience instead of only clinical or conventional frameworks.(3–5)

The present paper is written entirely around acupuncture-focused evidence and recent acupuncture literature. The discussion focuses on new papers on acupuncture and original research on the brain underpinnings of functional recovery, particularly in stroke and Parkinson's disease, where the most pertinent data was found.

II. NARRATIVE REVIEW APPROACH

This is a narrative review based on main mechanistic investigations reported in recent acupuncture-specific publications that were gathered from current sources. Instead of unrelated biological literature, emphasis is given on contemporary human neuroimaging investigations, acupuncture mechanistic studies, and innovative experimental work directly related to neuroplasticity and recovery. The review is organized according to fundamental neuroplastic pathways and then applied to particular neurological conditions. Parkinson's disease is utilized to demonstrate circuit-specific and dopaminergic mechanisms supported by more current acupuncture neuroscience research, while stroke is explored first since recent

acupuncture imaging studies directly address motor-network plasticity in patients.

➤ *Neuroplasticity as the Mechanistic Framework*

Neuroplasticity is the most rational framework to understand how acupuncture might impact neurological recovery. The recent literature on acupuncture discusses neuroplasticity in terms of neural stem-cell activity, axonal regeneration, synapse repair, glial control, and whole-brain functional reconstruction. This is especially crucial after a stroke, since natural recovery is not always full and external interventions may have an impact on cortical reconfiguration.(1,2)

According to research on acupuncture, stimulation at particular acupoints triggers peripheral afferents that relay to supraspinal and spinal structures, impacting central neuronal circuits. These impacts may involve sensorimotor networks, elements of the default mode network, insular processing, cerebellar circuitry, and, in Parkinson's disease, hypothalamic projections related to substantia nigra and hippocampus plasticity, according to recent imaging and mechanistic research.(4,6,7)

➤ *Stroke*

The neurological disorder with the strongest current evidence connecting acupuncture to quantifiable neuroplastic effects is still stroke. Acupuncture can affect motor dysfunction following a stroke by altering activation and synchronization patterns in cortical and subcortical areas involved in sensorimotor rehabilitation, according to recent studies on the subject. This is significant because the brain's ability to restructure dispersed motor networks—rather than just the size of the infarct—strongly influences post-stroke impairment.(1,4,6)

➤ *Recent Imaging Evidence*

Different acupuncture manipulation times caused different brain responses, including alterations in the inferior frontal gyrus, insula, inferior temporal gyrus, precentral gyrus, cerebellum, posterior cingulate gyrus, and anterior cingulate gyrus, according to a 2024 fMRI pilot study in stroke patients with motor dysfunction. Longer stimulation may more powerfully engage brain systems important for stroke recovery, according to the study, which found a significant correlation between manipulation time and the volume of engaged voxel clusters. These results provide credence to the notion that acupuncture dosage is more than just a procedural element and may significantly influence individuals with motor impairments' immediate brain reactions.(6)

Significantly higher peak motor-evoked potentials, higher oxyhemoglobin content in the M1 region, and improved Fugl-Meyer Assessment scores were observed in a 2023 study on auricular acupuncture in stroke patients with upper-limb motor impairment. The scientists came to the conclusion that auricular acupuncture improved motor deficiencies in the upper limbs and that stimulation of the M1 region might be a crucial neural node that underlies its

effects. This is useful because it links direct evidence of brain activity to a clinical recovery measure.(4)

When taken as a whole, these recent studies demonstrate that the effects of acupuncture on stroke vary depending on manipulation time, modality, and protocol design. This lends credence to the idea that acupuncture is not a single, fixed intervention but rather an adjustable neuromodulatory input.

➤ *Neurogenesis and Repair Pathways After Stroke*

A significant amount of original preclinical research in which electroacupuncture enhanced neurogenesis-related responses following ischemia is described in recent acupuncture-focused stroke literature. Following acupuncture or electroacupuncture, these investigations found increases in BrdU-positive cells, nestin-related markers, doublecortin-associated neuroblasts, and NeuN-linked maturation markers in the subventricular zone, hippocampus, brain, and peri-infarct areas. These results imply that rather than acting solely through temporary symptom regulation, acupuncture may help create a pro-repair milieu in the damaged brain.(1)

According to the same study, acupuncture activates pathways related to BDNF, VEGF, Notch1, Hes1, Wnt1, β -catenin, PI3K, and CREB following ischemia injury. These signalling systems are extremely important for functional recovery following stroke because they are essential for neural precursor survival, migration, differentiation, and integration. The convergence of behavioural gains and molecular indicators of restoration described across stroke models is what makes these studies significant.(2)

➤ *Axonal Sprouting and Synaptic Remodeling After Stroke*

Recent studies on acupuncture also highlight synapse repair and axonal development as important pathways of healing. Increased GAP-43, synaptophysin, PSD-95, dendritic spine density, and long-term potentiation-related alterations following acupuncture are reported in the stroke neuroplasticity literature, coupled with inhibition of growth-inhibitory molecules such NogoA, NgR, RhoA, and PirB in ischemia models. These results provide credence to the theory that, rather than just changing subjective perception, acupuncture may aid in the restoration of communication across damaged motor circuits.(1)

This method makes sense from the standpoint of rehabilitation since surviving neurons must establish new synaptic connections and extend new projections in order to recover from a stroke. Acupuncture appears to affect both microscopic repair mechanisms and network-level organization when compared to this experimental literature and current human imaging studies that demonstrate changed sensorimotor and motor-cortex activity.(1,3,4)

➤ *Network-Level Reorganization in Stroke*

Network rearrangement is the most clinically significant recent stroke data. Longer acupuncture manipulation intervals may recruit larger brain responses in stroke patients with motor impairment, according to the

2024 fMRI pilot study, which also showed that varied acupuncture manipulation times caused different regional homogeneity patterns. In addition to enhanced upper-limb motor performance, the 2023 auricular acupuncture study also discovered signs of M1 activation.(3,4)

These findings fit the broader idea that stroke recovery is a systems neuroscience problem. If acupuncture can shift activity within sensorimotor, cingulate, cerebellar, and associated cortical systems, it may serve best as a priming intervention that enhances the effects of structured rehabilitation rather than as a standalone therapy.

➤ *Parkinson’s Disease*

The second major disorder for which a useful neuroplasticity framework is provided by contemporary acupuncture material is Parkinson's disease. Research on acupuncture in Parkinson's disease has progressed from merely reporting symptoms to identifying particular brain circuits and molecular pathways that may mediate both motor and non-motor effects. Because Parkinson's disease progressively disrupts dopaminergic neurons, basal ganglia circuitry, hippocampal plasticity, and reactive glial signaling, this is particularly crucial.(5)

This circuit-level model is important because it connects peripheral acupuncture input to defined central pathways rather than relying on general claims of neuromodulation. It also expands the mechanistic scope of acupuncture beyond motor control by including hippocampal pathways relevant to memory and other non-motor symptoms.

➤ *Dopaminergic Preservation and Synaptic Plasticity*

The broader Parkinson’s disease acupuncture literature shows repeated evidence of dopaminergic neuron preservation and circuit modulation. Experimental studies summarized in the retrieved Parkinson’s disease source reported increased tyrosine hydroxylase-positive neurons and fibers, improved dopamine-related measures, reduced α -synuclein burden, and improved motor behavior after acupuncture or electroacupuncture at commonly used points such as GB34, LR3, ST36, GV20, and GV14. These findings support the idea that acupuncture may preserve the structural substrate required for compensatory plasticity within nigrostriatal networks.(8)

This perspective is further supported by the recent circuit analysis from 2024, which specifically connects

acupuncture to both motor circuitry and poor hippocampal synaptic plasticity. This is significant because dispersed circuit malfunction, as opposed to a single lesion site, is the origin of Parkinson's disease symptoms. The multifaceted clinical picture of Parkinson's disease is better explained by a therapy that affects both substantia nigra-related and hippocampal plasticity than by a purely motor explanation.(5)

➤ *Glial and Inflammatory Modulation*

Reactive gliosis and inflammatory regulation are crucial in Parkinson's disease, according to both recent and previous acupuncture research. Recovery linked to reactive gliosis following acupuncture was specifically reported in the 2024 circuit investigation. Acupuncture has been shown to reduce GFAP, Iba-1, NF- κ B, TNF- α , COX-2, and iNOS while preserving dopaminergic neurons and improving behaviour in toxin-based models of Parkinson's disease.(5)

Because excessive glial activation can disrupt trophic signalling, destabilize synapses, and exacerbate progressive degeneration, this pattern is particularly significant to neuroplasticity. Acupuncture may improve the residual circuits' capacity for adaptive remodelling and functional adjustment by changing the neuronal environment away from chronic inflammatory stress.

➤ *Other Neurological Disorders*

Additionally, recent research on acupuncture suggests that it may be used more widely to treat post-stroke aphasia, upper-limb dysfunction, stiffness, and other consequences where cortical remodeling is essential to healing. However, the most robust recent original mechanistic data for stroke and Parkinson's disease are directly accessible within the returned evidence set, whereas information for other illnesses is more dispersed or primarily available through more specialized modality-specific studies.(9,10)

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Table 1 Major Mechanisms

Mechanism	Stroke	Parkinson’s disease	Evidence from recent acupuncture literature
Cortical/network reorganization	Strong recent human evidence	Emerging circuit evidence	fMRI and cortical physiology studies show modulation of insula, cingulate, cerebellum, precentral gyrus, and M1-related activity after acupuncture
Neurogenesis-related signaling	Strong preclinical emphasis	Less central than in stroke	Stroke acupuncture literature reports BDNF, VEGF, Notch1, Hes1, Wnt1, β -catenin, and PI3K-related changes
Axonal sprouting/regeneration	Strong preclinical	Indirect via	Increased GAP-43 and reduced inhibitory

	emphasis	dopaminergic fiber preservation	growth pathways in ischemic models
Synaptic plasticity	Strong experimental support	Strong recent relevance with hippocampal plasticity paper	Increased synaptophysin, PSD-95, dendritic spine-related changes in stroke; hippocampal synaptic plasticity implicated in recent PD acupuncture work
Dopaminergic circuit protection	Limited relevance	Strong relevance	Preservation of dopaminergic neurons, modulation of substantia nigra pathways, and motor recovery in PD models
Glial modulation	Present	Strong relevance	Reactive gliosis and inflammatory mediators are modulated in recent and prior PD acupuncture studies

III. CLINICAL IMPLICATIONS

These results have therapeutic significance because they suggest that acupuncture may serve as a biologically active supplement to neurorehabilitation rather than just a supporting one. While recent research on Parkinson's illness reveals that peripheral acupuncture can activate recognized central circuits relevant to both motor and non-motor recovery, recent stroke studies demonstrate that acupuncture can affect brain systems directly engaged in motor relearning.

Treatment design is affected in a useful way by this. Acupuncture may be most beneficial when combined with therapies that call for active learning, such as task-oriented motor training, balance rehabilitation, gait therapy, swallowing therapy, or cognitive rehabilitation, if it alters the brain's capacity for plastic change. According to that theory, rather than taking the place of behavioral rehabilitation, acupuncture serves as a priming intervention that may increase its efficacy.

IV. LIMITATIONS OF THE CURRENT LITERATURE

There are still a number of issues despite encouraging mechanistic discoveries. Comparing recent acupuncture studies is made more difficult by the wide variations in point selection, technique, manipulation time, number of sessions, frequency of stimulation, and combination with conventional rehabilitation. Even positive imaging results do not yet identify a single best course of action.

Large-scale clinical proof and preclinical mechanistic richness are likewise out of balance. Parkinson's disease has a compelling recent circuit study, but there aren't enough big human mechanistic studies to determine generalizability. In contrast, stroke research now has superior human mechanistic data. Furthermore, the neuroimaging results of several recent research should be viewed as encouraging rather than conclusive because they are pilot studies with limited sample sizes.

V. FUTURE DIRECTIONS

Future acupuncture research in neurological disorders should combine rigorous clinical outcomes with mechanistic endpoints such as fMRI, fNIRS, motor-evoked potentials,

diffusion imaging, and neurotrophic biomarkers. In stroke, dose-response research on manipulation time, session frequency, and task-coupled rehabilitation could clarify how to convert immediate neural effects into durable motor recovery. In Parkinson's disease, the next step is to test whether the recently described hypothalamic pathways translate into reproducible biomarkers or patient subtypes that predict response.

There is also a need for more recent disorder-specific original studies outside stroke and Parkinson's disease. As the field matures, acupuncture neuroplasticity research should move toward standardized protocols, pre-registered multicenter trials, and mechanistic stratification rather than broad efficacy claims.

VI. CONCLUSION

Recent acupuncture papers support the view that acupuncture can influence neuroplastic processes relevant to functional recovery in neurological disorders. Current mechanistic literature supports impacts on neurogenesis, axonal sprouting, and synaptic remodeling in stroke, while new human investigations demonstrate regulation of motor-related cortical activity and region-specific brain responses. Recent research on acupuncture neuroscience in Parkinson's disease has progressed from broad neuroprotection models to circuit-level mechanisms involving reactive gliosis, dopaminergic recovery, hypothalamic projections, and hippocampal synaptic plasticity.

The most evidence-based conclusion is that acupuncture is best understood as a neuromodulatory intervention with plausible capacity to support adaptive plasticity, particularly when integrated into broader neurological rehabilitation. Recent acupuncture literature does not justify exaggerated claims, but it does provide a stronger and more specifically neurological foundation than older symptom-only discussions, especially in stroke and Parkinson's disease.

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