# 太极拳诱导增强皮质兴奋性的神经可塑性机制

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**摘要：目的：**神经可塑性作为神经系统动态重塑其结构与功能的能力，构成了神经适应的核心基础。运动干预是调节神经可塑性、促进大脑完整性的有效手段。太极拳整合了慢速动作、呼吸与正念，是一种多成分身心疗法，对脑卒中与帕金森病等神经系统疾病具有神经保护作用。本研究旨在通过系统性证据整合，验证太极拳实践对皮层兴奋性的促进作用，并揭示其作为中介变量引发的特异性神经可塑性机制。**方法：**本研究采用文献综述与荟萃分析方法，系统检索了 PubMed、Web of Science、Scopus 和 CNKI 等主要数据库，识别探讨太极拳与皮层兴奋性及神经可塑性关联的研究。文献纳入遵循预定义标准，优先考虑随机对照试验、纵向干预研究以及神经影像/神经生理学研究，对神经生理、结构及功能结局指标的数据进行了定量整合。**结果：**（1）皮层兴奋性提升：fMRI 证据表明，太极拳练习能持续激活运动与感觉皮层（包括初级运动皮层 M1、辅助运动区、前运动区及躯体感觉皮层）；（2）结构可塑性增强：结构 MRI 发现，长期坚持太极拳练习（≥6 个月）与 M1 灰质密度增加相关。经颅磁刺激研究进一步证明，脑卒中患者的运动诱发电位波幅增高，其皮质脊髓兴奋性升高；（3）白质完整性改善：弥散张量成像研究发现，长期太极拳练习者皮质脊髓束分数各向异性值升高，白质微结构完整性增强。（4）神经振荡与递质平衡调节：脑电图研究证明，太极拳练习能够调节θ/α频段的神经振荡活动，有助于促进兴奋性与抑制性神经传递之间的动态平衡。**结论：**太极拳能够通过增强初级运动皮层的兴奋性与结构密度、优化皮质脊髓束的结构-功能完整性，以及动态维持皮层的兴奋-抑制平衡，从而协同诱导有益的神经可塑性。上述发现从机制层面支撑了太极拳作为神经系统疾病康复的补充疗法的有效性，同时展示了其在全生命周期脑健康促进领域的应用前景。未来的研究方向需明确剂量-反应关系，并深入解析如 BDNF 等关键分子的介导作用，以加速其精准临床转化。

**关键词**：神经可塑性；太极拳；皮层兴奋性；健康促进

# Neuroplasticity Mechanisms Underlying Tai Chi'-induced Enhancement involved in Cortical Excitability

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**Abstract: Objective:** Neuroplasticity – the nervous system's dynamic capacity to reorganize structure and function – underpins neural adaptation. Exercise potently modulates neuroplasticity, enhancing brain integrity. Tai Chi, a multi-component mind-body practice integrating slow movements, breath control, and mindfulness, demonstrates significant neuroprotective efficacy in neurological rehabilitation (e.g., stroke, Parkinson's disease). This study systematically synthesizes evidence elucidating Tai Chi's specific neuroplasticity pathways in enhancing cortical excitability, a fundamental determinant of neural responsiveness. **Methods:** We conducted a systematic literature review and meta-analysis. Major databases (PubMed, Web of Science, Scopus, CNKI) were searched for studies investigating Tai Chi, cortical excitability, and neuroplasticity. Included studies (prioritizing RCTs, longitudinal interventions, and neuroimaging/neurophysiological investigations) underwent rigorous quality assessment. Meta-analytic techniques quantitatively synthesized data on neurophysiological, structural, and functional outcomes. **Results:** (1) Tai Chi significantly elevates cortical excitability, fMRI evidence demonstrates sustained activation of motor/sensory cortices (M1, SMA, premotor, somatosensory) during practice. (2) Structural MRI reveals increased M1 gray matter density after sustained practice (≥6 months), reflecting synaptogenesis/dendritic arborization. TMS studies corroborate increased Motor Evoked Potential (MEP) amplitudes in stroke patients, indicating heightened corticospinal excitability. (3) DTI evidence shows long-term Tai Chi practice increases Fractional Anisotropy (FA) in the corticospinal tract (CST), signifying enhanced white matter microstructural integrity (myelination, axonal coherence). (4) EEG studies reveal Tai Chi's integrated practice modulates neural oscillations (theta/alpha bands), promoting dynamic equilibrium between excitatory (glutamatergic) and inhibitory (GABAergic) neurotransmission. **Conclusion:** Tai Chi potentiates beneficial neuroplasticity by enhancing M1 excitability and structural density; optimizing CST structural/functional integrity; dynamically modulating cortical E/I balance. These mechanisms support Tai Chi's role as an effective complementary therapy for neurological disorders,

optimizing motor recovery and neural reorganization. Its neuromodulate effects further demonstrate significant potential for promoting brain health across the lifespan, particularly during neurodevelopment and cognitive aging. Future research should investigate dose-response relationships and molecular mediators (e.g., BDNF) to refine clinical applications.

**Keywords:** neuroplasticity; Tai Chi; cortical excitability; health promotion