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A Novel Transcranial Interfering Electric Field Stimulation Device for Neuro-Rehabilitation: A Pilot Test in a Stroke Animal Model

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Brain stimulation can effectively regulate neural activity and modulate neuroplasticity, which is a new possible therapeutic approach for neuro-rehabilitation in central nervous system impairments, such as stroke, spinal cord injury, Parkinson's diseases, and etc. Currently, various brain stimulation approaches have been applied in brain neuromodulatory therapy. Compared to traditional brain stimulation approaches, the transcranial interfering electric field stimulation (tIEFS) is a recently new emerging brain stimulation technology, in which the major breakthrough of tIEFS is that the clinical purpose of "deep brain electrical stimulation" can be achieved in a "non-invasive" way. This technology can improve the problem of poor stimulation focalization in deep brain targets by using traditional non-invasive stimulation approaches. However, the therapeutic effects and neuromodulatory mechanisms of tIEFS in rehabilitation application is not fully investigated yet. Therefore, in this study, we aimed to develop a novel tIEFS technology and explore its underlying mechanism in an animal model of stroke. In our study, we first established a dual-channel high frequency electrostimulator and then used brain electrode to validate the electric field distribution generated by tIEFS. Furthermore, we utilized 2-pole mode of tIEFS to test the effect of neuroplastic modulation. Finally, we in vivo evaluated the neuro-rehabilitation effects in a stroke rat model. Our results demonstrated that our developed novel tIEFS device showed the error of the accuracy of electrical current outputs was <±3%. The device was well applied in in vivo animal study, which demonstrated an excellent brain neuromodulatory performance. The therapeutic effects of tIEFS evaluated in stroke rats also demonstrated a good rehabilitative outcome. In the future, a long-term tIEFS experiment will be conducted in the animal model under awake state, and prove the chronic therapeutic effects of tIEFS.