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TRANSCRANIAL LOW-FREQUENCY FOCUSED ULTRASOUND (TLFFU) FOR UPPER LIMB REHABILITATION ON PATIENTS WITH STROKE

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ABSTRACT

Upper limb dysfunction is a significant cause of disability after stroke. Previous studies have shown that the application of low frequency focused ultrasound as a brain stimulation technique modulates the function of the primary somatosensory motor cortex by enhancing sensory discriminative tasks, and application on the primary motor cortex provided cortical excitability. Ultrasound has only recently emerged as a non-invasive human neuromodulation technique for its distinct advantages over other electrotherapeutic techniques such as providing superior specificity and penetrability, eventually enhancing cortical plasticity stroke-affected hemisphere to provide post-stroke regains in upper limb functions.

Keywords: Upper limb rehabilitation, stroke, physical rehabilitation.

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BRIEF REPORT

Worldwide, stroke was the second major cause of death [1]; despite significant advancements in the prevention and treatment of acute cases, stroke is still a significant cause of disability. Approximately 1.1 million Europeans annually suffer from stroke; globally, stroke rates are decreasing, although stroke incidences in young adults are rising [2].

One of the major impairments after stroke is the inability or reduced ability to engage in upper limb functional activities [3], as stroke leads to changes in the brain structures responsible for sensory-motor control and coordination, directly restricting stroke patient's involvement in activities of daily living, specifically activities that require coordination and control of both upper limbs and fine finger movements [4].

Reduction in the activity of ipsilesional primary motor cortex after stroke is associated with the functional impairments found in the stroke-affected upper limb; ipsilesional primary motor cortex activity improves with ongoing rehabilitation and improvements in function, in addition to physical rehabilitation, there is strong reasoning supporting the use of modalities that are designed to increase activity in the ipsilesional primary motor area [5], such as Transcranial Magnetic Stimulation (TMS) which changes the excitability of the neurons, eventually enhancing cortical plasticity [6,7].

Ultrasound has surfaced as a promising new modality for influencing brain stimulation and subsequent remapping [8] using a low frequency; ultrasound can be applied to the intact scalp to reach brain tissue non-invasively and was found to be able to modulate brain potentials in different brain structures with exquisite specificity and depth of penetration not otherwise found in TMS or transcranial direct current stimulation (tDCS) [9].

Ultrasound has been used as an area-specific brain stimulation technique to stimulate the somatosensory cortex [10], thalamus [11], primary motor cortex [9]. Legon et al. focused on ultrasound-facilitated sensory brain activity when applied to humans' somatosensory motor cortex [10]. In another study, it was found that ultrasound could elicit tactile sensations in study volunteers' hands and generate cortical evoked potential when applied to the somatosensory motor cortex [12]. In the primary motor cortex, ultrasound was applied to the specific cortical representation of a muscle. It was found that it significantly reduced reaction time response to a simple task [9]. Ultrasound stimulation provides spatial specificity, penetrability, and transient plasticity using a highly focused and low-frequency technique to deliver acoustic energy to the brain tissue via the transducer's geometric shape [12].

Therefore, applying low intensity, focused ultrasound as a brain stimulation technique to the ipsilateral primary motor cortex and active physiotherapy rehabilitation will significantly enhance the cortical plasticity of the stroke-affected hemisphere leading to improved recovery of upper limb motor functions.

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