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Jegan K S
Intern, Srinivas College of Physiotherapy and Research Centre, Pandeshwar, Mangalore, India.

Jeyaganesh V, MPT
Associate Professor, Srinivas College of Physiotherapy and Research Centre, Pandeshwar, Mangalore, India.

Correspondence:
Jegan K S
Intern, Srinivas College of Physiotherapy and Research Centre, Pandeshwar, Mangalore, India.

Transcranial Magnetic Stimulation to Increase the Voluntary Control and Functional Activities in Stroke Population

Jegan K S, Jeyaganesh V, MPT

Abstract
Background: TMS is used as a tool for studying the brain and also to treat neuropsychiatric disorders. Brain is a structure which has the ability to adapt to internal and external homeostatic changes, which is the basic idea for neuro rehabilitation.in patients with acquired brain injuries also have adaptive capacity called neuroplasticity. The extent of neuroplastic changes will influence the degree of recovery and functional prognosis in the patients.
Aim: To determine the effectiveness of transcranial magnetic stimulation to increase the voluntary control and functional activities in stroke population.
Methodology: The relevant papers from 2018 – 2022 were looked up in Cochrane, google scholar, PUBMED
Result: There was a significant improvement in stroke patients who underwent transcranial magnetic stimulation, it increased the voluntary control as well as functional activities.

Keywords: transcranial magnetic stimulation, stroke population, the voluntary control and functional activities.

Introduction

Main causes of prolonged motor impairment is stroke. Most stroke victims have sensorimotor abnormalities in their upper limbs that continue into long standing phase. Spasticity is a common sensory deficit after stroke. Increased muscle tone can appear in as many as 20–50% of individuals during the first year following the incident. Increased muscle tone and its consequences on self-regulated motion must be objectively and accurately quantified in order to i rehabilitate the affected limbs. Though there are a number of clinical markers of increased muscle tone, the best one is still up for debate. Additionally, the methods currently in use are insufficient to establish links between functional capacity, mobility deficiencies, and spasticity. It is a notable drawback that the MAS only assesses one aspect of the spasticity phenomena, namely the degree of hypertonia at rest. The scale is additionally small. Voluntary movement disruption may not simply be caused by altered muscular resistance at rest. A more precise explanation of the relationship between spasticity and movement deficiencies is provided by the TSRT, which pinpoints the location in the biomechanical joint range where abnormal muscle resistance starts to add up to the disrupted muscle activation patterns and kinematics. The Montreal Spasticity Measure gadget can be used to determine TSRT objectively. The threshold control theory put forward by Feldman serves as the foundation for the correlation between the TSRT angle and increased muscle tone. The threshold control theory states that voluntary movement is produced by controlling the spatial thresholds at which muscle activation starts. The TSRT, or the spatial threshold at zero velocity, is concluded using observations of dynamic spatial thresholds triggered at various stretch velocities.

The restoration of premorbid movement patterns is referred to as behavioural restitution, which is primarily fueled by spontaneous restitution in the case of upper limb recovery after brain loss. Additionally, behavioural compensation, in which the system performs functional tasks by changing movement patterns, can results in development in upper limb function.

To distinguish between restitution and compensation, standard clinical measurements of upper limb function are insufficient since they are unable to precisely capture movement quality. It was recommended that the optimum solution for this issue be movement kinematics and kinetics measurement. There is no agreement on how to distinguish the connection among spasticity and muscle dysfunction, despite the fact that some guidelines are available addressing the metrics used to evaluate motor recovery. Movement speed and several difficult-to-control elements, including exhaustion, other tasks, posture, mental anguish, and time of day, all have an impact on spasticity. The evaluation of the impact of spasticity on dynamics is complicated by the variability coming from these characteristics in addition to the intrinsic inconsistency of human motion, particularly during sluggish movement, which is prevalent in stroke patients. We therefore need a measure that can account for motion variability and include the temporal and spatial aspects of motion.

Methodology

A literature review type study was conducted in, Srinivas College of Physiotherapy and Research Centre, Pandeshwar, Mangalore. Literature used for analysis from: Google scholar, PubMed Sci-hub, Cochrane and research gate search engines were completed for studies published during the period of 2017 to 2022 and having key words like Transcranial Magnetic Stimulation and Volumetric Control & Functional Activities in Stroke were used.

A randomised controlled trial was used in the investigation. Regardless of when or what sort of stroke the patients had, computed tomography or magnetic resonance imaging was used to make the diagnosis. Recruitment of participants with limb motor dysfunction. The intention of the study was to find out how rTMS affected stroke survivors' ability to restore motor function. According to the PEDro scale, the included studies were of moderate or high methodological quality whereas the control group got a sham treatment. The outcome measurements were reported using continuous scales that assessed limb motor function

Role of transcranial magnetic stimulation in stroke patients

TMS is a non-invasive cortical stimulation technique that presents a wide range of opportunities for both the investigation of neurology and the treatment of different neuropsychiatric disorders. TMS is a practical and comfortable neurophysiological technology that is frequently used for prognostication, research, and when administered repeatedly. Role of rTMS in enhancing motor function. They work well in vascular depression as well. Another frequent stroke-related consequence is spasticity, which is characterised by a velocity-dependent rise in muscle tone. rTMS has been suggested as a treatment for spasticity. Neglect is the inability to react to contralateral touch or visual inputs when there is no sensory-motor impairment present. rTMS has been suggested as a method for neglect recovery while being challenging to use.

Stroke is a frequent acute neurovascular condition that results in long-term limits to activities of daily life that are incapacitating. Motor impairment of varying degrees is the most frequent result of a stroke. TMS is a widely used neurological tool for therapeutic, diagnostic, research, and, when performed repeatedly, painless and feasible. improvement of motor function via rTMS. Another frequent stroke-related consequence is spasticity, which is characterised by a velocity-dependent rise in muscle tone. rTMS has been suggested as a treatment for spasticity. They work well for vascular depression as well. Neglect is the inability to react to contralateral touch or visual inputs when there is no sensory-motor impairment present. rTMS has been suggested as a method for neglect recovery while being challenging to use.

TMS is built on the electromagnetic induction hypothesis, which Michael Faraday first proposed in 1831. According to this theory, a magnetic field generates an electric field that is perpendicular to it, and vice versa. In TMS, a circuit discharges an electrical impulse that passes through a copper-wire coil wrapped in a plastic container. When the coil is placed on the patient's head, it generates a magnetic field that is perpendicular to the patient's head. This varying magnetic field induces an electric current via any nearby conductive substance. When such an electric pulse is sent through the coil, it passes through the patient's head and skull without weakening.

Effects on sensory motor integration

The cerebral cortex's (association regions') processing of sensory stimuli and conversion of those stimuli into motor activity is known as sensory-motor integration. Peripheral cortical regions can remodel after brain injury to improve motor function and learning. Controlling interactions between the primary motor cortex in the temporoparietal and ipsilesional hemispheres can lead to neural remodelling. It's an intriguing circumstance because interhemispheric communication is necessary for sophisticated motor activities. Based on the stimulation frequency, rTMS can excite both the contralesional and ipsilesional areas, which can result in a variety of motor patterns.

Applications and current use of transcranial magnetic stimulation

1. Neurophysiology

The neurobiological modes of TMS are based on the fact that a single stimulus of a specific amplitude and orientation causes neuronal depolarization, followed by an action potential that causes an excitatory postsynaptic response lasting one millisecond, preceded by an inhibitory postsynaptic potential lasting one hundred milliseconds. TMS subsequently interferes with normal brain function, extends the refractory period, and regulates discharge pattern. In order to study motor cortical areas and corticospinal tract conduction, TMS is largely used in neurophysiology.

2. Neural networks.

Studies on cognitive function and behaviour in animals and people using neuropsychological, neurophysiological, and neuroimaging methods have demonstrated that these processes are mediated by functional neural networks that connect distal brain areas. The effects of TMS on one area have an influence on nearby cortical and subcortical regions in both hemispheres, and because of brain activity, the effects will extend to deep brain regions, based on the principle of diastasis. Distant areas are impacted by the activation or inhibition of a particular region; the consequences vary based on whether the stimulus is excitatory or inhibitory.

3. Treatment

Patients with a range of neuropsychiatric conditions may benefit, at least temporarily, from the neuroprotective benefits of rTMS, which we have a good impact on neuroplasticity. This has motivated researchers to consider rTMS's potential as an adjuvant therapy for a range of illnessesHowever, additional investigation is necessary before rTMS may be more firmly recommended for treating these conditions are a few of the conditions which may benefit from rTMS. Other conditions include psychiatric disorders like schizophrenia, anxiety disorders like anxious disorder and distress, autism, and autism spectrum disorders.

tDCS causes changes in the brain's excitability that are polarity-specific while activating a particular region of the brain non-invasively. As a remedy for visuospatial neglect, tDCS has recently attracted more and more attention. It has been proposed that the right posterior parietal cortex area is a good target for enhancing motor skills and reducing visuospatial neglect symptoms. In injured regions of the brain, tDCS induces neuroplasticity by raising cortical excitability and altering the neuronal architecture. Numerous studies have documented the positive effects of tDCS on patients with visuospatial neglect. To our information, no study has evaluated the effects of tDCS on visuo - spatial deficit in patients suffering from acute stroke utilising combined approaches (tDCS + FT) and randomised controlled trials. Therefore, the purpose of this study was to examine the effects of tDCS along with FT in moderate stroke patients who had unilateral visuospatial neglect.

Discussion

According to L A Lopez- Romero et al TMS is suggested as a non-invasive and safe therapeutic alternative that can be used to promote the recovery of people with post-stroke aphasia. Some studies suggest that stimulation with lower frequency of rTMS (1 Hz) in the anterior region of the non-dominant right hemisphere, in the area homologous to Broca (pars triangularis), improves activities related to the emission of language in patients with non-dominant aphasia. The study conducted by Eline CC van Lieshou shows that the rTMS treatment had improved their arm function. On the other hand, a few other patients claimed they were unable to pinpoint the reason for their recovery. They believed that progress was brought about by taking part in the experiment, receiving rehabilitative treatments, and having the will to get better on their own.

MEP, the pinch grasp, the hand grip, and the box and block test, Jinhong Kim et al. evaluated subjects prior to and after training. The MEP and hand function measurements both indicated a considerable improvement. High-Frequency rTMS in Combination with Task-Oriented Mirror Therapy can help acute stroke patients regain fine motor control over their hands.

According to Juan Du, the HFrTMS group showed noticeably increased cortical excitability and motor-evoked fMRI activity in ipsilesional motor areas, whereas the LF-rTMS group showed notably lower cortical responsiveness and motor-evoked fMRI activation. A significant relationship existed among ipsilesional motor cortex function and motor performance after the treatment and during the 3-month follow-up. Our research demonstrates that rTMS interventions that induce plasticity improve motor recovery in the acute and subacute periods following stroke. Through early modification of motor cortical plasticity, rTMS can aid in the recovery of motor function. Our research provides solid multimodal evidence in favour of the use of rTMS to enhance motor rehabilitation and gives insight on the neuroplastic process by which it affects motor recovery after stroke.

According to Brenton Hordacre et al., the estimated alpha band relation of the contralesional motor-premotor and ipsilesional sensorimotor networks in chronic stroke survivors is a trustworthy and accurate indicator of neuroplastic induction following anodal tDCS. Our understanding of the factors influencing neuroplasticity reactions to NIBS is improved by these findings, which also shed additional insight on the complex internal characteristics of interventional plasticity development in stroke patients.

According to Qingmei Chen et al., the facilitative rTMS and coupling inhibitory provided more satisfactory results in helping the motor's repair in the subacute and acute phase after stroke than did single-course modulation alone.In the current investigation, three distinct groups that underwent three distinct regimens were compared by Asrarul Fikri Hassan et el to determine which patient group could benefit from rTMS procedures, MEP reading pre and after stimulation was assessed. The inhibitory procedure was used to stimulate the brain's non lesion side while stimulating the lesioned side. Prior to and following the TMS intervention, the MEP reading was examined for any alterations. It was found that the group getting the TMS stimulatory treatment significantly outperformed the group getting the Sham procedure in terms of MEP score.

Conclusion

TMS is beneficial for stroke patients, according to the study's findings. A secure and non-invasive technique for stroke support management is rTMS potential. GABA level changes in reaction to the therapy largely governed the impact of rTMS on the outcome of motor function. However, other variables like age, sex, clot size, and the length of the intervention did not significantly differ amongst the various procedures. The role of rTMS in enhancing motor skills and aiding in the reduction of spasticity and neglect. In the near future, more people will get profit of the TMS therapy because it has the potential to be a helpful tool as an extra non-surgical stroke treatment.

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