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EFFICACY OF REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION (r-TMS) THERAPY ON IMPROVING MOTOR STRENGTH IN STORKE PATIENTS AT DR. MOEWARDI SURAKARTA

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ABSTRACT

Background: Stroke, an acute neurological dysfunction, poses a health challenge with potential fatality, emerging as a leading cause of long-term disability. This study explores the efficacy of repetitive Transcranial Magnetic Stimulation (r-TMS) with medical rehabilitation in enhancing stroke patients' motor strength, comparing it with standard therapy, focusing on the Medical Research Council score.
Objective: Stroke is an acute manifestation resulting from neurological dysfunction, persisting for ≥24 hours or leading to death due to blood vessel disorders. The study aims to determine the effectiveness of r-TMS therapy in improving stroke patients' motor strength, comparing it with standard therapy based on the Medical Research Council score.
Methods: A quasi-experimental study with a pre-post control group design involved 30 respondents selected through consecutive sampling in stroke units and outpatient clinics. Upper extremity muscle strength, measured with the Medical Research Council score, was analyzed using the Mann-Whitney U test, with a significance level set at $p < 0.05$.
Results: The post-test ranking value of the r-TMS group (20.56) exceeded that of the Non r-TMS group (10.46). The Mann-Whitney U test indicated a significant difference in the average ranking of the Medical Research Council scores between the two groups ($p < 0.05$, 0.001), highlighting the efficacy of r-TMS therapy in enhancing motor strength.
Conclusion: This study shows that stroke patients receiving standard therapy and transcranial magnetic stimulation exhibit improvements in extremity motor strength compared to those undergoing medical rehabilitation alone. The r-TMS group notably showed a significant increase in extremity motor strength.

Keywords : improvement of motor strength, r-TMS, stroke

Introduction

Stroke is the main cause of long-term disability in adulthood. At Dr. Moewardi Regional Hospital, Surakarta, stroke ranks first among all patients treated in the department of Neurology. Ischemic strokes and hemorrhagic strokes can cause long-term disability. Long-term disability is the most common cause of complications from stroke. The most disability caused by stroke is a decrease in motor ability, namely hemiparesis, 88%. Motor abilities are highly correlated with their impact on daily activities after stroke. Upper extremity hemiparesis usually affects the hands causing weakness and decreased precision of movement, muscle fatigue, lack of coordination, and impaired ability to grasp objects, which has a major impact on activities of daily living.[1-4] The latest neuroscience discoveries reveal the fact that the process of neuroregeneration and neuroplasticity of the human central nervous system continues throughout life. Brain injury, such as stroke, will be responded to by forming new neurons (neurogenesis), new vascularization (angiogenesis), and the formation of new connections between neurons (synaptogenesis).[5]

Repetitive Transcranial Magnetic Stimulation (r-TMS) is an effective method used to diagnose and treat many neurological disorders. Although r-TMS has been used to treat a variety of serious pathological conditions including stroke, the pathophysiological mechanisms underlying the long-term effects of r-TMS remain unclear. In this review, the effects of r-TMS on neurotransmitters and synaptic

plasticity are described, including the classic interpretation of the effects of r-TMS on synaptic plasticity through long-term potentiation and long-term depression. The neurotrophic effects of r-TMS on dendritic growth and sprouting and neurotrophic factors were described, including changes in brain-derived neurotrophic factor concentrations under the influence of r-TMS.[6]

There was an improvement in motor function in patients who received standard therapy plus a combination of r-TMS compared to those who received standard therapy alone, so new ways to reduce disability are needed. Recently, one way to restore motor repair has been developed using r-TMS.[6,7]

Methods

This research is a clinical trial conducted at RSUD Dr. Moewardi, Surakarta, from December 2021 to March 2023. Inclusion criteria included stroke patients who experienced hemiparesis/hemiplegia, aged 30–70 years, and signed a statement of consent. This research has passed ethical review from the Health Research Ethics Committee of Dr. Moewardi Surakarta via letter number 1.367/VII/HREC/2023.

Stroke is confirmed based on clinical symptoms, physical examination and supporting examinations. Patients were excluded from the study if there was impaired consciousness, hearing impairment, peripheral neuropathy, impaired kidney, liver and heart function that could interfere with attention or concentration; as well as mental/mental disorders, depression, and aphasia. Anamnesis and physical examination were carried out to determine the location of the side of the paresis using the results of a CT scan of the head, as well as an assessment of the Medical Research Council score. Standard therapy consisted of oral antiplatelets and medical rehabilitation for both groups. Therapeutic outcomes were determined based on the Medical Research Council score.

The tool used is a Magstim brand TMS. During therapy, the subject sits with both arms placed on his thighs, arms facing upwards. The coil is placed in a tangential position in the precentral area on the side of the lesion, given 1200 pulses of 10Hz impulses to the primary motor cortex and the contralesional area is given 1200 pulses of 1Hz impulses.

This research has received approval from the Ethics Committee of RSUD Dr. Moewardi Surakarta with ethical approval recommendation number 1.367/VII/HREC/2023. Data analysis used the SPSS version 21 program. The Mann-Whitney test was used to assess differences in motor function between each pretest and posttest score for the two groups.

Results

A total of 30 research subjects were divided into control and treatment groups, 15 people each. It was found that most of the subjects were male (60%) and aged >45 years (90%).The following is demographic data between the two groups (Table 1).

Table 1. Demographic characteristics of both groups

Characteristics	r-TMS group (n=15)	Non-r-TMS group (n=15)
Gender		
Man	11	7
Woman	4	8
Age		
<45 years	2	1
>45 years	13	14
Number of Hz	10	
Number of pulses		
1000 pulses	3	
1200 pulses	9	
1500 pulses	2	
Number of sessions		
5 sessions	11	
10 sessions	4	

Both groups had the same Medical Research Council score before therapy, namely 0-2. The normality test is carried out to test whether the data in the study is normally distributed or not. If the p value is > 0.05 then the data is said to be normally distributed. Conversely, if the p-value <0.05 then the data is not normally distributed. The following is a table of normal distribution results from the two groups (Table 1).

Table 2. Normal Distribution Test for Both r-TMS and Non-r-TMS Groups

Variable		Mean (SD)	p
TMS group (n=15)	Pre test	0,71 (0,686)	0,003
	Post test	2,29 (0,772)	0,000
Non-TMS Group	Pre test	1,21 (0,579)	0,000
(n=15)	Post test	1,36 (0,497)	0,000

Based on the results of the normality test in the table, it was found that all data was not normally distributed, so a non-parametric test would be carried out, namely using the Mann-Whitney U test to determine the differences between two independent groups.

The average ranking value of the pre-test results of the Non-r-TMS group was greater than the post-test results of the r-TMS group (19.39 vs 13.21). The Mann-Whitney U test will measure whether the difference in the average ranking of the Medical Research Council scores is significantly different or not (Table 2).

Table 3. Mann-Whitney U test on post test results for both r-TMS and non-r-TMS groups

Variable	N	Average Rating	Median (min-max)	p
Pre test r-TMS Group	15	13,21	1,00 (0-2)	
Pre test Non r-TMS Group	15	19,39	1,00 (0-2)	0,059

From the results of the Mann-Whitney U test, the p-value was > 0.05 (0.059). So, it can be said that there is no significant difference between the average ranking results of the pre-test for the r-TMS group and the pre-test for the non-r-TMS group (Table 3).

The average ranking value of the post test results of the r-TMS group was greater than the post test results of the Non r-TMS group (20.56 vs 10.46). The Mann-Whitney U test will measure whether the difference in the average ranking of the Medical Research Council scores is significantly different or not.

Table 4. Mann-Whitney U test on post test results for both r-TMS and non-r-TMS groups

Variable	N	Average Rating	Median (min-max)	p
Pre test r-TMS Group	15	20,56	2,00 (1-4)	
Pre test Non r-TMS Group	15	10,46	1,00 (1-2)	**0,001**

From the results of the Mann-Whitney U test, the p-value was <0.05 (0.001). So, it can be said that there is a significant difference between the average post test results of the r-TMS group and the post test of the non-r-TMS group (Table 4).

Discussion

This study gathered 30 subjects with a diagnosis of stroke, each consisting of 15 subjects in the control group who were only given standard therapy and the treatment group which was supplemented with r-TMS therapy.[9] Both the control and treatment groups had greater increases in Medical Research Council scores based on therapy given. However, the increase in Medical Research Council scores in the treatment group was greater than in the control group ($p<0.05$), which was thought to be caused by r-TMS therapy.[12]

In this study, 1200 pulses were given with a frequency of 10Hz. The frequency used in this research is a frequency >5Hz, which will cause an increase in neuronal excitability. r-TMS stimulation can increase cortical excitability which will change maladaptive patterns with phenomena such as LTP. r-TMS stimulation can strengthen synapse activity to repair damaged brain function.[8,11] In the area around the lesion or in homologous contralateral cortical areas (which have similar anatomical structures), r-TMS is able to balance the compensatory network to restore lost function because these areas may have the same anatomical structure so that they are able to carry out the function that has been lost.[10,15] The functional balance between the two hemispheres of the brain is controlled by interhemispheric inhibition. The hemisphere affected by a stroke can experience twice as much damage as the side not affected by the lesion, due to the stroke and the imbalance of inhibition and excitation.[5,6]

The results of this study are in accordance with previous research which found significant differences in motor improvement between the control and treatment groups.[13,14] In patients with stroke, administering medical rehabilitation therapy and r-TMS significantly increased motor strength compared to medical rehabilitation therapy alone. The limitation of this study is that follow-up was not carried out over a longer period of time to evaluate long-term effects.[5,6]

Conclusion

This research shows that providing medical rehabilitation therapy plus additional therapy in the form of r-TMS to stroke sufferers significantly increases motor strength compared to the group that only received standard therapy.

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