

# The Effectiveness Of Mirror Therapy And Repetitive Transcranial Magnetic Stimulation For The Improvement Of The Arm Motoric Function Of Acute Ischemic Stroke Patients

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## Research article

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# THE EFFECTIVENESS OF MIRROR THERAPY AND REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION FOR THE IMPROVEMENT OF THE ARM MOTORIC FUNCTION OF ACUTE ISCHEMIC STROKE PATIENTS

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## Abstract

### Background

Both ischemic and hemorrhagic stroke can cause long-term disability that requires therapy. Motor repair after stroke is associated with plasticity, including the development of new neuronal interconnections, obtaining new functions, and compensation for existing damage. Transcranial magnetic stimulation (TMS) is an effective method used to diagnose and treat many neurological disorders. Another way that is proven to also improve upper arm motor function is mirror therapy which is proven to improve post motorized motor function.

### Method

The research design used in this study was an experimental method with a randomized pretest-posttest-control group design at Wahidin Sudirohusodo Hospital and the network.

### Results

Based on the results of the study found that the difference in ARAT score 1-2. The difference in ARAT scores was higher in the group receiving standard therapy with mirror therapy and repetitive transcranial magnetic stimulation ( $21.70 \pm 7.81$ ) compared to the group receiving standard therapy alone ( $2.80 \pm 1.20$ ). Using the unpaired T test, a significant difference  $p < 0.005$  ( $p < 0.00004$ ) was obtained.

### Conclusion

There was a significant difference between samples that received mirror therapy and rTMS compared to patients who only received standard therapy.

**Keywords:** Stroke, Transcranial Magnetic Stimulation, Mirror Therapy, ARAT Score

## BACKGROUND

Stroke is the leading cause of long-term disability and third death after heart disease and malignancy in the United States. The number of deaths due to stroke is expected to continue to reach 7.8 million in 2030. In Indonesia, stroke is the main cause of death. The prevalence of stroke in Indonesia based on diagnosis by health professionals is 7.0 per 1000. The highest prevalence of stroke based on symptoms is found in South Sulawesi (17.9%), D.I. Yogyakarta (16.9%), Central Sulawesi (16.6%), followed by East Java at 16 per 1000 (Ministry of Health, 2013). National stroke data shows the highest mortality rate is 15.4%. Other stroke data are based on a cross-sectional cross-sectional study in 28 hospitals with a total of 2065 patients from October 1996 to March 1997, the average age of stroke was 56.8 years  $\pm$  13.3 years with a range of 18-95 years and 65.8% have disabilities. At the general hospital Dr. Wahidin Sudirohusodo Makassar, the highest number of inpatients in the neurology treatment room was occupied by a stroke. [1,2,3,6,7,8]

In general, there are two types of stroke, namely ischemic stroke (IS), covering around 80-85% and the rest are hemorrhagic stroke. Ischemic stroke occur due to reduced blood flow (ischemia) and oxygen to the brain. Reduced blood flow causes decreased perfusion in a part of the brain. Decreased perfusion in the brain causes damage due to neuronal ischemia accompanied by vascular leakage, inflammation of small blood vessels, and endothelial apoptosis. [3,4]

Post ischemic neuron restoration includes speech therapy, occupational therapy, and psychotherapy. Most recovery occurs between 1 week and 6 months after a stroke. Various attempts were made to develop effective therapies to prevent disability so that other therapeutic approaches are needed to prevent disability due to stroke.[3] Motor repair after stroke is associated with plasticity, including the development of new neuronal interconnections, obtaining new functions, and compensation for existing damage. [14]

Mirror therapy or also called mirror therapy (MT) can be an alternative rehabilitation therapy to improve motor function in patients with hemiparesis due to stroke. Besides being efficient, easy and economical, MT is proven to improve motor function after stroke.[9]. MT increases the mobility of hemiparesis limbs through visual stimulation caused by seeing healthy body movements in the mirror and overlapping with limbs the paralyzed side. MT can be considered as an adjunct therapy to improve arm motor repair in acute ischemic stroke patients. [8]

Repetitive transcranial magnetic stimulation (rTMS) is an effective method used to treat a variety of neurological disorders. Although the mechanism of its long-term effects is unclear, rTMS has been used as a therapy for various serious diseases including stroke. rTMS can influence dendritic growth, sprouting, and changes in the concentration of neurotrophic factor.[10,11] Researchers want to combine these two therapies in patients with acute ischemic stroke. It is expected that high motor improvement will be better than without the therapy (conventional therapy only).

## RESEARCH METHODS

This research is an experimental study with a randomized pretest-post test control group design. The research subjects consisted of 20 samples divided into two groups; the treatment group (n = 10) and the control group (n = 10). Subjects were patients who were diagnosed with acute ischemic stroke based on history taking, physical examination, and CT scan of the head who were treated in the neurology treatment at RSUP Dr. Wahidin Sudirohusodo Makassar and Hasanuddin University hospital.

Subjects included in the study were taken from affordable populations that met the inclusion and exclusion criteria by consecutive sampling method during the period July 2019 to December 2019. Inclusion criteria included: (1) patients with ischemic stroke onset <3 months, (2) motor power  $\geq 3$ , (2) 3) aged 35 - 70 years, (4) the first attack on one side or the second attack on the opposite side, and (5) willing to follow the research by signing the consent sheet by the sufferer / guardian of the sufferer. Exclusion criteria include: (1) impaired consciousness, (2) hearing loss, (3) visual impairment, (4) severe depression, (5) brain stem stroke, (6) embolic stroke, (7) aphasia.

All research protocols and procedures are explained to the subject. Every patient who has signed the consent form follows the study and meets the inclusion criteria, the complete identity of the subject is recorded. Motor functional assessment is measured using an action research arm test (ARAT) which consists of grasp, grip, pinch, and gross movement assessments.

In the treatment subject, a combination therapy was carried out in the form of MT and rTMS. MT is carried out for 10 days where every day consists of two sessions, each 15 minutes interspersed with rest for 5 minutes. The rTMS procedure is carried out for 5 days every week for 2 weeks. The method is a single pulse TMS in the area of the lesion hemisphere and non-lesion to measure the motor threshold. Then as an excitation effect performed rTMS with a frequency of 5Hz, 20 bursts, pause 40, duration 1 minute 50 seconds, poser 100% with a number of pulses 600 on the side of the lesion presentral girus. rTMS with a frequency of 1Hz, 20 bursts, pause 5, duration 40 seconds, power 100% with a number of pulses 600 performed on the non-lesion presentral girus as inhibition. After therapeutic interventions are completed, motor functional outcomes are measured again using ARAT.

The research data were processed using the SPSS version 25 program. Comparison of therapy results between the two groups was used using an unpaired T test with a significance limit of  $\alpha$  5% ( $p < 0.05$ ).

## RESULT

Research has been conducted on 20 people with acute ischemic stroke, consisting of 10 people both in the trial group and the control group.

**TABLE 1. Characteristics and Homogeneity Tests of Research Subjects14.**

Variable	N (20)	Group		P
		Trial (n=10)	Control (n=10)	
<b>Sex, n(%)</b>				
Men	9	4	5	0,88
Women	11	6	5	
<b>Ages (Mean±SD)</b>		52.50±8.59	57.70±9.21	
<45, n (%)	2	2	0	
46-54, n(%)	9	5	4	0,43
55-64, n(%)	5	2	3	
≥ 65, n(%)	4	1	3	
<b>Paresis, (%)</b>				
Right	8	4	4	0, 69
Left	12	6	6	
<b>Onset (Mean±SD)</b>		1.35±0.85	1.65±1.35	
0.5	6	3	3	0,64
1	6	3	3	
2	5	3	2	
<b>ARAT Score-Grasp (Mean±SD)</b>		6.20±6.69	1.40±1.50	0.0001
<b>ARAT Score-Grip (Mean±SD)</b>		3.90±5.66	0.50±0.52	0.003
<b>ARAT Score-Pinch (Mean±SD)</b>		4.00±5.41	0.40±0.84	0.001
<b>ARAT Score-Grossmt (Mean±SD)</b>		3.80±2.48	0.90±1.44	0.001
<b>Total ARAT Score (Mean±SD)</b>		18.00±19.45	3.00±3.01	0.00004

Source: Primary Data

For the sex variable in the trial group consisted of 4 men and 6 women, while in the control group consisted of 5 men and 5 women. Most age groups are in the 69-year group of 4 people. All patients who were sampled were right-handed people. Overall the motor abnormalities are not much different between the right side and the left side (8 right sides, 12 left sides). In the study group found 4 people experiencing motor abnormalities on the right side and 6 people on the left side, in the control group who experienced motor abnormalities on the right side 4 people and 6 people on the left side. To find out whether the data distribution is normal or not, then the normality test is in the form of Kolmogorv-Smirnov (sample over 50) and Shapiro-Wilk (sample less than 50).

Subjects consisted of 9 men and 11 women with an age range <45 years, there were 2 people, 46-54 years 9 people, 55-64 years as many as 5 people, over 65 years as many as 4 people. The most age range is between 46-54 years. Most onset in the first week. Weaknesses motor strength there are more left than right.

There is a comparison of ARAT 1 control and treatment score distribution where ARAT 1 on control  $3 \pm 3.01$  median value 3, minimum 0, maximum 8, while pointgrasp  $1.4 \pm 1.5$ , median 1, drink 0, maximum 4, while point grip  $0.5 \pm 0.52$ , median 0.5, minimum 0, maximum 1, while pinch  $0.4 \pm 0.84$ , median 0, minimum 0, maximum 2, grossmovement  $0.9 \pm 1.1$ , median 0.5, minimum 0, maximum 3, while for the treatment group ARAT scores  $218 \pm 19.45$  median value of 10.5, minimum 0, maximum 50, while pointgrasp  $6.2 \pm 6.69$ , median 6, minimum 0, maximum 18, while point grip  $3.9 \pm 5.66$ , median 0, minimum 0, maximum 12, while pinch  $4 \pm 5.41$ , median 0, minimum 0, maximum 12.

**TABLE 2: Distribution of ARAT 1 Scores Pre and Post in Both Groups of Study Subjects**

Score	Trial (n=10)				Control (n=10)			
	Mean±SD	Median	Min	Max	Mean±SD	Median	Min	Max
Sub Item								
ARAT 1	18.00±19.45	10.50	0	50	3.00±3.01	3.00	0	8
Grasp1	6.20±6.69	6.00	0	18	1.40±1.50	1.00	0	4
Grip1	3.99±5.66	0.00	0	12	0.50±0.52	0.50	0	1
Pinch1	4.00±5.41	0.00	0	12	0.40±0.84	0.00	0	2
Gross Movement1	3.80±2.48	4.50	0	3	0.90±1.10	0.50	0	3

Source: Primary Data

**TABLE 3: Distribution of ARAT 2 Score 2 Pre and Post in Both Groups of Study Subjects**

Score	Trial (n=10)				Control (n=10)			
	Mean±SD	Median	Min	Max	Mean±SD	Median	Min	Max
Sub Item								
ARAT 2	39.7±16.4	40.5	18	57	5.8±4.21	4.5	2	12
Grasp2	13.3±4.94	14	18	57	2.6±1.34	2.5	1	4
Grip2	7.9±3.6	7	2	12	7.9±3.6	1	0	2
Pinch2	11.5±6.9	14	1	18	0.9±1.44	0	0	3

Source : Primary Data

There is a comparison of the ARAT 2 score control and trial distribution where ARAT 2 is  $5.8 \pm 4.21$  median control value 4.5, minimum 2, maximum 12, while pointgrasp  $2.6 \pm 1.34$ , median 2.5, minimum 1, maximum 4, while point grip  $0.9 \pm 0.87$ , median 1, minimum 0, maximum 2, while pinch  $0.9 \pm 1.44$ , median 0, minimum 0, maximum 3, while for the treatment group ARAT score 2 was  $39.7 \pm 16.4$  median value of 40.5, minimum 18, maximum 57, while point grade

13.3 ± 4.94, median 14, drink 6, maximum 18, while point grip 7.9 ± 3.6, median 7.5, minimum 2, maximum 2, while pinch 11.5 ± 6.9, median 14, minimum 1, maximum 18.

**TABLE 4: Analysis of Functional Motor Skills in The Treatment and Control Groups After a Combination of Mirror Therapy and rTMS Interventions**

<b>Group</b>	<b>ARAT Score pre</b>	<b>ARAT Score post</b>	<b>ΔScore (mean±SD)</b>	<b>P</b>
<b>Trial</b>	18.00±8.59	39.70±16.40	21.70±7.81	0.00004
<b>Control</b>	3.00±3.01	5.80±4.21	2.80±1.20	

P value by Wilcoxon test

Source: Primary data

Table 4 shows the increase in ARAT scores in the two groups with a difference in score increase of 21.70±7.81 points in the trial group and 2.80±1.20 in the control group. After testing the significance of ARAT score changes in both groups of subjects using the Wilcoxon test, found significant differences in the increase in functional motor ability scores between the trial and control groups (p = 0.00004).

**TABLE 5: Analysis of Grasp Motor Skills in The Treatment and Control Groups After a Combination of Mirror Therapy and rTMS interventions**

<b>Group</b>	<b>ARAT Score Grasp pre</b>	<b>ARAT Score Grasp post</b>	<b>ΔScore (mean±SD)</b>	<b>P</b>
<b>Trial</b>	6.20±6.69	13.30±4.94	7.1±1.75	0.0001
<b>Control</b>	1.40±1.50	2.60±1.34	1.20±0.16	

P value by Wilcoxon test

Source: Primary data

Table 5 shows an increase in ARAT-motor Grasp scores in the two groups with an increase in the score of 7.1±1.75 points in the trial group and 1.20±0.16 in the control group. After testing the significance of ARAT score changes in both groups of subjects using the Wilcoxon test, found significant differences in the increase in functional motor ability scores between the trial and control groups (p = 0.0001).

**TABLE 6: Analysis of Gripp's Motor Ability in The Treatment and Control Groups After a Combination of Mirror Therapy and rTMS Interventions**

Group	ARAT Score- Grip pre	ARAT Score- Grip post	ΔScore (mean±SD)	P
<b>Trial</b>	3.90±5.66	7.90±3.60	4.00±2.66	0.003
<b>Control</b>	0.50±0.52	0.90±0.87	0.40±0.35	

P value by Wilcoxon test

Source: Primary data

Table 6 shows an increase in ARAT-motor Grip scores in the two groups with a difference in score increase of 4.00±2.66 points in the trial group and 0.40±0.35 in the control group. After testing the significance of ARAT score changes in both groups of subjects using the Wilcoxon test, found significant differences in the increase in functional motor ability scores between the treatment and control groups (p = 0.003).

**TABLE 7: Analysis of Pinch Motor Skills in The Treatment and Control Groups After a Combination of Mirror Therapy and rTMS Interventions**

Group	ARAT Score- Pinch pre	ARAT Score- Pinch post	ΔScore (mean±SD)	P
<b>Trial</b>	4.00±5.41	11.50±6.90	7.50±1.49	0.001
<b>Control</b>	0.40±0.84	0.90±1.44	0.50±0.60	

P value by Wilcoxon test

Source: Primary data

Table 7 shows an increase in the ARAT-motor Pinch score in both groups with a difference in the increase in score of 7.50±1.49 points in the trial group and 0.50±0.60 in the control group. After testing the significance of ARAT score changes in the two groups of subjects using the Wilcoxon test, found significant differences in the increase in functional motor ability scores between the treatment and control groups (p = 0.001).

**TABLE 8: Analysis of Gross Movement Motor Skills in The Treatment and Control Groups After a Combination of Mirror Therapy and rTMS Interventions**

Group	ARAT Score- Grossmt pre	ARAT Score- Grossmt post	ΔScore (mean±SD)	P
<b>Trial</b>	3.80±2.48	7.40±1.71	3.60±0.77	0.00001
<b>Control</b>	0.90±1.10	1.50±1.17	0.60±0.07	

P value by Wilcoxon test

Source: Primary data

There is a comparison of the ARAT 2 control and trial score distribution where ARAT 2 is  $5.8 \pm 4.21$  median control value 4.5, minimum 2, maximum 12, while pointgrasp  $2.6 \pm 1.34$ , median 2.5, drink 1, maximum 4, while the grip point  $0.9 \pm 0.87$ , median 1, minimum 0, maximum 2, while pinch  $0.9 \pm 1.44$ , median 0, minimum 0, maximum 3, while for the treatment group ARAT scores  $23.9, 7 \pm 16.4$  median value of 40.5, minimum 18, maximum 57, while point grade  $13.3 \pm 4.94$ , median 14, drink 6, maximum 18, while point grip  $7.9 \pm 3.6$ , median 7, 5, minimum 2, maximum 2, while pinch  $11.5 \pm 6.9$ , median 14, minimum 1, maximum 18.

## DISCUSSION

This study is an experimental study with interventions in the form of mirror therapy and repetitive TMS/ rTMS in patients with acute ischemic stroke by assessing how the effects of mirror therapy and repetitive transcranial magnetic stimulation on the improvement of arm motor function are assessed using ARAT score. The number of samples as many as 20 people were divided into 2 groups: the group receiving standard therapy plus the effect of mirror therapy and repetitive transcranial magnetic stimulation (trial group) and the group receiving only standard therapy (control group). Each group consists of 10 subjects.

Researchers controlled for gender variables, age groups in the study group (standard therapy plus mirror therapy and added rTMS) and control groups (standard therapy only). The demographic data obtained  $p > 0.05$  which concluded that these variables were not significantly different in the two groups. ARAT score data is evenly distributed with the normality test  $p > 0.005$ , so that the mean value and the comparative test of the two groups of pairs and unpaired are used. In this study, the average age of the subjects was 52.5 years with the most age groups being 46 -54 years. Yavuzer et al's research in 2008 on the effect of mirror therapy on improving hand function in 40 stroke patients, found that the average age of the sample was 63 years, while the results of the study of Dohle et al (2011) obtained an average age of 54.9 years.

Various epidemiological studies illustrate that the incidence of stroke increases with age. After the age of 55 years, the incidence of stroke has doubled for each additional decade in both men and women. The theory states that age is a risk factor for stroke that cannot be modified (non modifiable risk factor). As we age, the incidence of stroke increases, this is due to an increase in the process of atherosclerosis with increasing age which is also associated with other stroke risk factors, such as atrial fibrillation and hypertension. The pathophysiology of hypertension causes changes in blood vessels, changes starting from thickening of the tunica of intima and increasing endothelial permeability by long-standing hypertension, especially in small arteries (perforated branches). The process will continue with the formation of lipid deposits, especially cholesterol and oleic cholesterol in the muscularis tunika which causes the lumen of blood vessels to narrow and winding. Hardening of blood vessel walls can result in autoregulation disorders, in the form of difficulty contracting or dilating to changes in systemic blood pressure. If there is a sudden drop in blood pressure, the brain's perfusion pressure is inadequate, causing brain tissue ischemia. Data shows that the risk of thrombotic stroke in hypertensive patients is 4.5 times higher than normotension.:[7]

The effect of age on stroke outcomes has been extensively studied, older age is associated with poor clinical outcomes, more disability in the three months after stroke, and is associated with longer lengths of stay than young age. Age has a small but significant effect on

the speed and degree of motor repair, in old age, patients experience improvement but at a slower rate, and overall age has a relatively small impact on motor repair of stroke patients.[5,6] In this study, there were 9 male subjects (45%) and 11 female subjects (55%). Kwakkel G (2006) states that age and sex do not affect the level of motor improvement.

The relationship between handedness and the level of motor recovery was not done in this study due to the lack of samples with left handed, so it is difficult to do a comparative analysis between left handed and right handed. The relationship between handedness and motor recovery rates using mirror therapy and rTMS is still being debated. What has been discovered at this time is that there are differences between right handed and left handed groups in processing an action language such as listening to the word eat and then imagining the eating process, apparently there are differences in the parts of the brain that are activated. In people with left handed, the precentral motor area, post centralis right hemisphere is more activated than left hemisphere, and vice versa in people with right handed.[4,5]

In this study, the relationship between the motor impairment side and the level of motor improvement was found to be insignificant ( $p < 0.05$ ). The process of motor recovery in motor disorders right and left sides is the same. These results differ from studies conducted by Husni H (2011) who found that motor recovery in right-sided motor impairment was better than left-sided, although some of these studies did not find an association between the location of lesions and clinical outcomes.[9,10]

In the study group, the rTMS intervention was carried out in 2 cycles. Each cycle is carried out for 5 consecutive days with a gap of 2 days then followed by a second cycle for 5 consecutive days. The rTMS stimulation targets stimuli in the primary motor area (M1) which provide a facilitation effect on the extremity area without triggering a serious adverse reaction. In the area of ipsilesional cerebral hemisphere, rTMS stimulation is performed with a high frequency of 5Hz to 50% threshold of motor stimulation (motor threshold) while in contralesional hemisphere a low frequency stimulus of 1 Hz to 48% of motor threshold refers to the interhemispheric balance theory. Stimulation is given 3 pulses (pulses) per 1 second burst (stimulus) stimulus. Each hemisphere receives 20 stimulus sequences for 10 seconds followed by a rest interval of 2 seconds between stimuli so that each hemisphere cortex receives 600 stimuli. The stimulation of rTMS can affect excitability of the brain cortex and change synaptic plasticity.[5,6]

Jorgensen et al's (1995) study of 1197 stroke patients treated in a stroke unit in Copenhagen, Denmark, found that the course of motor recovery in 95% of stroke patients would reach the best neurological level within 12.5 weeks after onset. Individuals with lighter strokes recover faster. The course of motor recovery will reach the plateau after the progressive recovery phase that occurs at the beginning, and only a few additional improvements occur at 6 months post onset. However, in some stroke patients there is still significant recovery from voluntary movements after 6 months, and recovery continues for a longer period of time.

The degree of limb paralysis at the time of onset and the time at which the movements in the hands begin to appear are predictors of motor recovery in the upper limb. The prognosis for returning to the useful hand function is poor if there is complete paralysis of the upper limb at the time of the attack, and there is no ability to grasp after 4 weeks post attack. In patients with severe upper limb weakness at onset, around 40% achieve recovery of hand function. Whereas in patients who have shown partial motor hand recovery at 4 weeks onset, as much as 40% will

achieve complete recovery. Complete functional recovery (complete functional recovery), if it occurs, usually ends within 3 months after onset. [10]

In this study the study group that received standard therapy experienced significant improvement before ( $18.00 \pm 8.59$ ) and after therapy ( $39.70 \pm 16.40$ ) with a p value  $<0.005$  ( $p <0.00004$ ). Johansson BB (2011) states the combination of standard therapy, good care in terms of exercise and the presence of good motivation is significant in ischemic stroke outcomes. In most patients stroke clinical degrees generally improve in the first week or even months after stroke onset. Animal studies have shown that brain infarction is associated with plastic-growth-related-evacuation, including changes in axon structure, dendrites, synapses, increased activation and migration of neural stem cells and changes in extracellular matrix, glia cells, and vessels blood. In humans the area around the infarction will do remapping, the contralesional hemisphere and other areas will connect with the lesion area. In damaged areas axon sprout new connections will occur, novel projection patterns, and newly-born immature migration.

A meta-analysis conducted by Richards et al (2008) concluded that an increase in brain activation in the disrupted hemisphere after undergoing a rehabilitation program in the upper limb. Brain plasticity including reorganization and compensation processes are the basis of neurological improvement, however the exact pathophysiological mechanisms underlying rehabilitation efficacy are unclear.

The difference in ARAT scores was higher in the group receiving standard therapy with mirror therapy and repetitive transcranial magnetic stimulation ( $21.70 \pm 7.81$ ) compared to the group receiving standard therapy alone ( $2.80 \pm 1.20$ ). Using the unpaired T test, a significant difference  $p <0.005$  ( $p <0.00004$ ) was obtained. The same thing was also found in a randomized controlled assessor-blinded trial study by Yavuzer et al (2008) who reported the effect of mirror therapy on improving motor recovery and hand function of stroke patients in the recovery phase of the first attack (maximum 12 months after stroke) after 4 weeks (20 therapy session), and an increase in Brunnström scores in both groups.

The mechanism underlying mirror therapy for motor repair in stroke patients is still speculative. Mirror therapies are believed to trigger the normalization of the hemisphere balance after stroke, which is important in motor repair. Motor activity and perception in MT modulate the excitability of the primary motor cortex (M1), simultaneous changes in the primary motor cortex can facilitate cortical reorganization appropriate for functional improvement (Ezendam et al, 2009). Repeated MT sessions can reorganize the bilateral premotor area to establish functional communication with the contralateral primary motor cortex. Increased callosal communication from the lesion side to the healthy side balances interhemisfer inhibition. Bilateral cerebellum is also actively improving motor control and motor learning. Mirror neurons located in the fronto temporal region and superior temporal gyrus that are activated when MT can accelerate motor ability improvement. By seeing healthy limbs performing functional motor movements in front of the mirror as if they were paresis, will maintain sensory feedback through the visuals to the brain, so as not to facilitate learned nonuse. [12,13]

A randomized crossover study in 9 patients with chronic stroke (more than 6 months after stroke) by Altschuler et al (1999) reported joint area, speed, and accuracy of arm movement improved after mirror therapy 15 minutes, 2 times per day, 6 days a week, during 4 weeks. A study by Stevens and Stoykov (pre and post design) in 2 patients with chronic stroke

(14 months post stroke) showed improved Fugl Meyer scores, active joint area, speed, and hand dexterity after 1 hour mirror therapy, 3 times a week, for 4 weeks. Intensive mirror therapy for 2 weeks by Sathian et al (2003) in chronic stroke patients showed recovery of hand movements and gripping strength.

Lee et al in Korea (2012), who conducted a study of 26 stroke patients with an onset of less than 3 months. The sample was divided into 2 groups, where both groups were given a standard rehabilitation program, then in the study group were given additional mirror therapy programs for 25 minutes 2 times a day, 5 times a week, for 4 weeks. In the outcome parameters assessed by Fugl Meyer Assessment, there was a significantly different increase in scores between the two groups, namely the shoulders (9.54: 4.61), wrists (2.76: 1.07) from the hands (4.43: 1.46). [14]

Based on the data of this research, it shows that the administration of repetitive transcranial magnetic stimulation interventions for 10 consecutive days with stimulation frequency of 1 Hz ipsilesion and 5 Hz contralesion with intensity <50% motor threshold affects the motor ability of ischemic stroke sufferers of the first attack with onset time of less than 3 month. Mirror therapy seems to be beneficial in acute, subacute, and chronic phase strokes. Based on sufficient evidence about the benefits of mirror therapy, and can be integrated into stroke rehabilitation strategies to improve motor function of the upper limb. So the merging of these two interventions accelerates upper motor recovery.

Weaknesses of this study include the variation of days when conducting research related to the onset and relatively short research time span. The range of days of onset of the study varied from the onset of the 2nd day to the onset of the 6th day, although the mean onset in the groups was almost the same. In this study, the mirror therapy process was carried out at the place where the patient was treated, so this could affect the attention and concentration of the patient when doing mirror therapy and rTMS. Ideally the mirror therapy process is carried out in a special place that is conducive and comfortable.

Interruption of intra and inter hemispheric interactions in the motor areas of the brain provide important pathophysiological aspects of motor disorders after stroke. The role of mirror therapy in the activation and connection of certain parts of the brain associated with motor repair in stroke patients can be seen using Functional MRI. One limitation in this study is that no fMRI examination was carried out due to device limitations.

Motivation, anxiety and depression have a role in functional recovery after stroke. Positive emotions have an influence in the process of motor recovery. High motivation in stroke patients to be more involved in treatment and rehabilitation activities results in an increase in the patient's functional status. In this study there was no examination of the emotional condition of the patient so that it is one of the shortcomings in this study. [15]

In this study, the Action Research Arm Test (ARAT) score was used to assess the level of motor recovery in patients with acute ischemic stroke. There are several considerations so we use the ARAT score in this study including the time required only about 8-10 minutes and this ARAT is specific to assess the function of the arm which includes 4 subtests (grasp, grip, pinch, and gross movement) (McDonnell M, 2008) besides ARAT reliability towards stroke patients is quite high with intrarater value  $r = 0.99$  and retest  $r = 0.98$ . However, during the research process, we found difficulties when giving a value between 1 and 2. There were no clear boundaries between grades 1-2, especially in patients with acute stroke so they could not

properly assess changes or motor development. Other researchers who want to use the ARAT Score, may need to think about modifying the ARAT score. Almost the same thing was also stated by Mc Donnel M (2008) that there were difficulties in scoring for grades 2 and 3, so there was an element of subjectivity in interpretation.

## **CONCLUSION**

There is improvement in clinical outcomes of patients with acute ischemic stroke with standard therapy and Repetitive Transcranial Magnetic Stimulation. There are improvements in clinical outcomes for patients with acute ischemic stroke with standard therapy accompanied by mirror therapy. Improved upper arm motor strength in the group of ischemic stroke sufferers is better by using Repetitive Transcranial Magnetic Stimulation with mirror therapy compared to ischemic stroke patients who only get standard therapy.

## **AVAILABILITY OF DATA AND MATERIALS**

The data sets used and/or analyzed during the current study available from the corresponding author on reasonable request.

## **ABBREVIATIONS**

**ARAT** : Action Research Arm Test  
**MT** : Mirror Therapy  
**rTMS** : repetitive Transcranial Magnetic Stimulation  
**IS** : Ischemic Stroke

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### **Author's Contributions**

AKB conceived and designed the study. FH and JCU wrote the manuscript. All authors have read and approved the final manuscript.

## **ETHICS DECLARATIONS**

The study was approved by the local ethics committee. Written informed consent was obtained from all subjects prior to study inclusion.

## **CONSENT FOR PUBLICATION**

Not applicable.

## **COMPETING INTERESTS**

We declared that we didn't have any competing interests.

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