Advances in Bioscience and Clinical Medicine
ISSN: 2203-1413
www.abcmed.aiac.org.au

Original Article

The Effectivity of Mirror Therapy on Arm Motoric Improvement in Acute Ischemic Stroke Patients

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ARTICLE INFO

Article history
Received: September 14, 2018
Accepted: December 19, 2018
Published: January 31, 2019
Volume: 7 Issue: 1

Conflicts of interest: None
Funding: None

Key words:
Ischemic Stroke,
Action Research Arm Test (ARAT),
Mirror therapy

ABSTRACT

Cerebrovascular diseases (stroke) ranked the second cause of death worldwide. This research aimed at investigating the effectiveness of mirror therapy on artery therapy by ARAT (ARAT) score. The research was carried out by the clinical trials study towards 32 acute ischemic stroke patients who were divided into an experimental group got the combination of mirror therapy and standard therapy, and the control group only got the standard therapy. The level of the motor action was tested by Action Research Arm Test (ARAT) score. The research then compared the ARAT score difference between the two groups. The result of the research reveals that the ARAT score differences on the group who gets the combination of mirror therapy and standard therapy (15.56±4.38) higher than the group who only gets the standard therapy (7.69±1, 66). By using T-test, it is obtained the significant difference of P <0.05 (0.001).

INTRODUCTION

Cerebrovascular disease (stroke) ranks the second leading cause of death worldwide. The mortality rate after the first year of the first stroke ranged from 20% (Endres et al., 2009). *World Health Organization* (WHO) estimated that each year worldwide 15 million people suffer a stroke. Stroke is as the leading cause of long-term disability in North America, Europe and Asia and the second leading cause of dementia. Data from the *National Health and Nutrition Examination Survey* (NHANES) from 2007 to 2010, estimates that as many as 6.8 million Americans with age ≥ 20 years has had a stroke. The incidence of stroke each year around 795,000 people; 610,000 of them is as the first attacks and 185,000 suffer from recurrent attacks (Go et al., 2013).

In general, there are two types of stroke. The first is ischemic stroke (SI) covers about 80-85% and the rest is in the form of hemorrhagic stroke (SH). Ischemic stroke results from reduced blood flow and oxygen to the brain. The reduced blood flow causes decreased perfusion in a part of the brain. The decreased of perfusion brain damage is due to ischemia of neurons accompanied by vascular leakage, inflammation of small blood vessels and endothelial apoptosis (Hansen *et al.,* 2008).

Stroke causes many disabilities in a person's life even though recent acute stroke therapy has been able to increase the life expectancy. Paralysis of the upper extremities, which often occur after a stroke is one of the problems that most hamper to the patient (Langhorne et al., 2009). Loss of arm functionality makes it difficult to perform daily activities, and causes the patient to become dependent. The targets for stroke rehabilitation are to be able to functionally independently as individuals and improve the patient quality of life. Nevertheless, the conventional therapeutic methods used for such purposes are still not enough to repair the functionality of the motor arm (Gurbuz et al., 2016).

Mirror therapy (MT) is a therapeutic intervention focused on the movement of the hand or leg paresis. This technique is relatively new, simple, cheap, and proven to improve the function of upper limbs. This procedure is done by placing a mirror on the field midsagital patients, so that the patients can see the shadow of a healthy hand, and give a visual feedback that can improve the weak side arms (Toh & Fong, 2012).

There are two general hypotheses underlying the MT mechanism, namely primary motor cortex mechanism and mirror neuron. In the first hypothesis, MT is believed to

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.abcmed.v.7n.1p.6

trigger the normalization of the hemisphere balance after a stroke, which is important in motor repair. There is the evidence that perceptual and motor activity in MT modulates the excitation of the primary motor cortex (M1). At the time of MT, the excitability of M1 is modulated by the ipsilateral arm movement and passive observation of the contralateral arm movement as seen in the mirror image. In other words, the real movement of the ipsilateral arm activates the ipsilateral M1 and the observation of the movement of the mirror activates the contralateral M1. Simultaneous changes in M1 could be expected to facilitate the reorganization of cortical suitable for functional improvement (Ezendam et al., 2009).

The second hypothesis deals with mirror neurons, which are thought to be present in the frontotemporal and superior temporal regions. Mirror neurons are known to be activated bimodal neurons when a person performs or observes motor activity. Buccino reported bilateral activation of the cortex at the time of observation premotorik object associated with the action of your hand or arm function (Still & Fong, 2012). *Mirror neurons* may accelerate the improvement of motor skills. Mirror neurons are activated when observing, imagining, or perform a movement (Lim et al., 2016).

Previous research by Sutbeyaz et al. (2007) and Yavuzer et al. (2008), reported that MT can help to restore motor function in the hand of paresis. MT in stroke patients involves the movement of the healthy hand while looking at its reflection in the mirror is positioned in front of the affected hand (not shown), so it causes the illusion as if the hands of the sick moves.

Functional imaging studies in healthy individual brains, suggesting the excitability of the ipsilateral primary motor cortex against unilateral hand movements, are facilitated by looking at the reflection of hand movements in the mirror. When the right hand is used, but perceived as the left hand, it will increase activation in the right brain (and vice versa). The activation when subject movement also occurred in bilateral inferior parietal area, supplementary motor area and the premotor cortex (Michelsen et al., 2011).

Dohle et al. (2008), examined the effects of MT in 36 post-stroke ischemic hemiparesis patients. Patients underwent standard therapy plus MT for 6 weeks. Clinically, Fugl Meyer score increased higher in the mirror group than in the control group (95% CI = -0.6-6.3.6).

Based on the description above, this study aims to determine the effect of *mirror therapy* (MT) against the arm motor improvement in patients with acute ischemic stroke by using a score *Action Research Arm Test* (ARAT).

MATERIALS AND METHODS

Locationand Time Research

The study was conducted at the hospital, Dr. Wahidin Sudirohusodo Makassar, implemented from June until the number of samples met.

Design and Research Variables

The study design is a *randomized* clinical trial with a *pretest-posttest design-control group.* The research variables consist of independent variable (standard therapy of stroke ischemic + mirror therapy, standard therapy of stroke ischemic without mirror therapy), the dependent variable (the motor function arm), between variable (the mechanism of change in motor function of patients with acute ischemic stroke accompanied by *mirror therapy* and were not accompanied by *mirror therapy),* and confounding variable (size of the lesion and the lesion).

Population and Sample

Acute ischemic stroke patients who experienced first hemiparesis attacks were admitted to the neurological treatment room at Wahidin Hospital in June 2017 to July 2017. Samples were drawn from affordable populations fulfilled the inclusion and exclusion criteria.

Method of Collecting Data

The study was conducted on samples that fulfill the inclusion criteria, the data were obtained by primary means. The data obtained was processed by using statistical analysis.

Data Analysis Technique

The collected data was processed through statistical analysis using SPSS program. For a comparison of the results between the two groups of therapy, it used unpaired T test with significance limit $\alpha = 5\%$ ($P < 0.05$).

RESULTS

This study is a clinical trial design with *randomized pretest-posttest-control group* to determine the effect of *mirror therapy* (MT) against the arm motor improvement in patients with acute ischemic stroke by using use the score *Action Research Arm Test* (ARAT). The study was conducted at the hospital. Dr.Wahidin Sudirohusodo Makassar, implemented from June until the number of samples met. It carried out on 32 patients with acute ischemic stroke, consisting of 16 people in both of the study group and the control group.

The result of this study showed that there was a difference in mean difference between ARAT scores by sex between the study group and the control group. In the study group, the difference in average score ARAT of men and women amounted to 16.50 at 14.00, while the average difference ARAT score in the control group was 8.33 for men and 6.86 for women. The average difference between the sexes ARAT score was not statistically significant ($P \geq 0.05$), both in the study group or the control group Table 1.

In the study group with impaired motor right side margin ARAT average score was 16.80, and on the left side was 13.50. While in the control group, the difference in average scores ARAT motor impaired the right side was 7.78, and on the left side was 7.57. The difference in average score ARAT by motor disorders right side and the left side was not statistically significant ($P \geq 0.05$), both in study group or the control group Table 2.

The average difference of ARAT score according to level of education, in non-school research group was 12.00 and the school according to level of elementary, junior high school, and college education respectively were 12.00; 12.40; 19,67; 16.50, and 17.75. While in the control group who did not go to school was at 7.00 and the school according to the level of elementary, junior high school, high school, and S1 education respectively were 9.33; 10.00; 7.00; and 7.12. ARAT score average differences by education level was not statistically significant *(P ≥ 0.05),* both in the study group or the control group Table 3.

In this study, the examination score ARAT done 2 times, those are resentful and after therapy. The average score ARAT before treatment and after treatment, as well as the percentage of motor recovery rate in the standard therapy group *therapy* plus *mirror* each was at 27.69 and 43.25, an increase of 56.2% while in the standard therapy group without *mirror therapy* respectively 27.25 and 34.94, an increase of 28.2% Table 4.

Further, in the study group, the average difference ARAT score was 15.56 and in the control group amounted to 7.69. The average difference between the two groups ARAT score was considered statistically significant *(P*<0.05) Table 5.

DISCUSSION

This study showed that the difference ARAT score in the group with standard therapy plus mirror therapy (15.56 ± 4.38) was higher than the group with only receiving the standard therapy (7.69 ± 1.66). By using unpaired T test, there was significant difference, shown by P <0,05 (0,001).

Various epidemiological studies illustrate that the incidence of stroke increases with age. After the of age 55, the incidence of stroke doubles for each additional decade, both in men and women (Ov g he b ele et al., 2011). The theory states that the age including stroke risk factors can not be modified *(non-modifiable risk factor)*. As the ages increase, the incidence of stroke increases. This is due to an increasing in the process of atherosclerosis as age increases are associated with other stroke risk factors, such as atrial fibrillation and hypertension. Pathophysiology of hypertension leads to changes in blood vessels, changes starting from the thickening of the intima tunica and increased endothelial permeability by old hypertension, especially in small arteries (perforated branches). The process will continue with the formation of lipid deposits, especially cholesterol and oleic cholesterol in the muscular tunic that causes the

Table 1. Difference in average scores ARAT according to gender

Variable	Standard therapy+Mirror therapy (n=16)				Standard therapy without mirror therapy (n=16)			
	Mean (SD)	Median	Min.	Max.	Mean (SD)	Median	Min.	Max.
Gender								
Man	16,50 (4,387)	18	9	21	8.33 (1,936)	9	6	11
Women	14.00 (4,290)	12.5	9	21	6.86 (0.690)	7	6	8
The value of P		0.284				0.077		

Primary data, unpaired T test

Table 2. Difference-rata average scoreARAT according side motor disorders

Variable	Standard therapy+Mirror therapy (n=16)				Standard therapy without mirror therapy (n=16)			
	Mean (SD)	Median	Min.	Max.	Mean (SD)	Median	Min.	Max.
Side of motor damage								
Right side	16,80 (4,417)	18	9	21	7,78 (1,787)	8	6	10
Left side	13,50 (3,782)	12.5	9	19	7,57 (1,618)	7	6	11
The value of P		0.150				0.815		

Primary data, unpaired T test

Table 3. ARAT-rata average difference scoreby level of education

Variable	Standard therapy+Mirror therapy (n=16)				Standard therapy without mirror therapy (n=16)			
	Mean (SD)	Median	Min.	Max.	Mean (SD)	Median	Min.	Max.
Level of education								
Not in school	12.00 (0,000)	11	12	12	7,00 (0,000)	7	7	7
SD	12,40 (4,561)	21	9	20	9,33 (2,082)	10	7	11
SMP	19,67 (2,309)	16.5	17	21	10,00 (0,000)	10	10	10
SMA	16.50 (0.707)	16.5	16	17	7.00 (1,000)	7	6	8
S1	17,75 (3,948)	19	12	21	7,12 (1,356)	6.5	6	9
The value of P		0.075				0.151		

Primary data, ANOVA test

Table 4. ARAT score both preand post therapy group

Variable	Standard therapy+Mirror therapy (n=16)				Standard therapy without mirror therapy (n=16)			
	Mean (SD)	Median	Min.	Max.	Mean (SD)	Median	Min.	Max.
Time								
Pre	27,69 (4,438)	27.5	20	34	27,25 (4,374)	27	20	34
Post	43.25 (6,527)	44	33	53	34.94 (4,697)	35.5	27	43
The value of P		0,000				0,000		

Primary data, T paired test

Table 5. Comparison average score ARAT-rata difference between study group and control group

Variable	ARAT difference value				The value of P
	Mean (SD)	Median	Min.	Max.	
Group					
Standard therapy+Mirror therapy (n=16)	15.56 (4,381)	16.5	9	21	0,000
Standard therapy without mirror therapy (n=16)	7.69 (1,662)	7	6	1	

Primary data, unpaired T Test

lumen of blood vessels to narrow and winding. Hardening of blood vessel walls may lead to autoregulatory disturbances, in the form of difficulty to contract or dilate with changes in systemic blood pressure. If there is a sudden drop in blood pressure, the brain perfusion pressure is inadequate, causing ischemic brain tissue. The data showed that the risk of thrombotic stroke in hypertensive patients increased 4.5 times higher than normotensive (Rashid et al., 2017).

The number of male subjects was more (59.4%) than women (40.6%) also found in this study. This is in accordance with Zube's research results (2017), which found the subject was more men (66.7%). The role of gender on motor recovery by using mirror therapy on the study showed that no significant (P≥0.05), although there is a shopping passage and the average gap between the ARAT score of men (16.50 ± 4.38) and women (14.00 ± 4.2 9) in the plus MT standard therapy group and the MT standard therapy group without men (8.33 ± 1.93) and women (6.86 ± 0.69).

Furthermore, the size and location of lesions and genetic factors included confounding variables in this study. A total of 13 subjects in this study were patients with right hemisphere stroke. The theory suggests that there is a significant difference in cognitive ability between left hemisphere strokes and right hemispheres, which will have an effect on the understanding and learning process of the patient. Right hemisphere strains often show perceptual visio-motor disorders, visual memory disturbances, and "left sided neglect". Superficial and deeper sensibility disorders are also more common in right hemisphere strokes. On the other hand, verbal skills remain favorable. While for left hemisphere strokes the main problem is communication/language. Vocabulary and listening is declining, so the activity/practice should be given through visual demonstrations, and limit orders with words.

This study also shown the relationship between the motor disorders with unknown levels of motor improvement was not significant (P ≥ 0.05). In the group chances, t mirror therapy plus standard therapy, the difference score nearly as well ARAT motor disorders on the right side of (16.80 ± 4.41) and on the left side (13.50 ± 3.782). The motor recovery process on right and left side motor disruptions is the same. Similarly, the role of education level to motor recovery mirror therapy. These results are in contrast to studies conducted by Husni (2011), who invented the process of motor recovery in motor disorders better right side from the left side, although some studies have found an association between the lesion with clinical output.

The average day of the study was conducted on day 3 of onset, both in the study group and control group. In the group receiving mirror therapy, the average ARAT score increase was greater than the control group. According to Hatem et al. (2016), the largest motor improvement occurred in week 1, and after 6 months of plateau on motor repairs. If there is no good motor repair process in the first 1 month showing a poor motor prognosis.

Moreover, the research group who received standard therapy experienced a significant improvement in the time before (27.25 ± 4.374) and after treatment 34.94 ± 4.697) with a value of P <0.005 (0.001). Johansson (2011), stated that combination of standard therapy, the treatments both in terms of exercise and a good motivation is significantly on ischemic stroke outcomes. In most stroke patients, clinical degrees generally occur in the first week or even after the onset of stroke. Animal studies showed that cerebral infarction is associated with *plastic-growth-related events* including, changes in the structure of axons, dendrites and synapses, increased activation and migration of neural stem cells and the extracellular matrix changes, glial cells and blood vessels. In humans, the area around the infarction will do the remapping, the hemispheres of the lesion and other areas will connect with the lesion area. At the damaged area will occur *axons sprout new conection, novel pattern projection* and *newly-born* neurons migrate immature.

The difference ARAT score to be higher in the group receiving standard therapy with mirror therapy (15.56 ± 4.38) compared to the group that only receiving standard

therapy (7.69 ± 1.62). By using unpaired T test, there was a significant difference P <0,005 (0,001). The same was found in *the study randomized controlled assessor-blinded trial* by Yavuzer et al. (2008), who reported the effect of mirror therapy to increased recovery of motor and function of patients' hands stroke recovery phase of the first attack (a maximum of 12 months post-stroke) after 4 weeks (20 therapy sessions), and an increase in Brunnstrom score in both groups.

Systematic review based on 12 randomized controlled trials and four systematic reviews indicate the presence of moderate quality of evidence with that *mirror therapy* is better *than sham therapy, control therapy,* or standard rehabilitation therapy for upper limb function improvement. Mirror therapy seems to be beneficial in acute, subacute and chronic phase strokes. Based on a number of sufficient evidence of the advantages of mirror therapy, this time MT is important, and can be integrated on stroke rehabilitation strategies for improving upper extremity motor function (Hatem et al*.,* 2016).

Ideally, the process of mirror therapy is done on a special place that is conducive and comfortable. In this study, however, the process of *mirror therapy* performed at the place where the patient is treated, so that it can affect the patient's attention and concentration when performing *mirror therapy.*

In this study, the Action Research Arm Test (ARAT) score was used to assess the rate of motor recovery in patients with acute ischemic stroke. There are several considerations that we use the ARAT score in this study, which is about 8-10 minutes and ARAT is specific to assess arm function which includes 4 subtest (grasp, grip, pinch, and gross movement) (McDonnell, 2008). In addition, ARAT reliability of stroke sufferers is high enough with intrarater values of r = 0.99 and retest r = 0.98. However, during the research process, we found difficulty in assigning values between 1 and 2. There was no clear boundary between the values of 1-2, especially in acute stroke patients who were less able to assess changes or motor development well. Other researchers who are looking to use ARAT scores may need to think about modifying an ARAT score. Almost the same thing also expressed by McDonnel (2008), that there is a difficulty in scoring for grades 2 and 3, so there is an element of subjectivity in the interpretation.

CONCLUSIONS

Researchers concluded that the average score ARAT before and after therapy with the combination of medical rehabilitation therapy mirror each was 27.69 ± 4.438 and 43.25 ± 6.527. The average difference ARAT scores before and after treatment with a combination of medical rehabilitation therapy mirror of 15.56 ± 4.381. ARAT average scores before and after standard therapy without each mirror therapy was 27.25 ± 4.374 and 34.94 ± 4.697. The average difference in score ARAT before and after standard therapy without mirror therapy amounted to 7.69 ± 1.662. There was a significant difference in mean difference between ARAT scores between standard-treated groups with mirror therapy and standard therapy groups alone without mirror therapy. Researchers suggest that mirror therapy may be considered as an adjunctive therapy to improve motor repair arm in patients with acute ischemic stroke. Further research is needed to determine the effect of mirror therapy on other stroke outcomes. Besides, it is needed on the factors that affect the motor recovery process in stroke patients, such as side factor of motor abnormality, motor dexterity, and gender.

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