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Original Research

Application Of Mirror Therapy On Upper Extremity Motor Recovery In Post-Stroke Patients

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ABSTRACT

Background: *Stroke is a health problem for both developed and developing countries, including Indonesia. Paralysis in stroke is mainly due to damage to the internal capsule. This damage requires neuroplasticity involving a number of parts of the brain to restore. One therapy that is beneficial for neuroplasticity is Mirror Therapy (MT). MT is a rehabilitation tool that aims to restore some of the pathological conditions in which the body representation is affected, including post-stroke motor impairment.*

Methods: *This research is a quantitative pre-experimental design with the type one group pretest-postest. The research subjects were 15 post-stroke patients in residency of Semarang. Research data were collected in August-September 2020. Sample selection with purposive sampling technique who conform inclusion criteria. The Fulg-Meyer Upper Extremity Assessment (FMA-UE) as an aoutcame measure that be avowed valid and reliabel. Data analysis using Paired Sample T-Test because of normally distributed.*

Results: *Statistically the results represent a significant difference in the UE motor ability of post-stroke patients between baseline and after mirror therapy intervention, with a mean difference (5,14) and p value = 0.000 (ρ < 0,05). Application of MT effect on upper extremity motor recovery in post-stroke patients.*

Conclusions: *MT program is an effective intervention for UE motor recovery and motor function improvement in post- stroke patients. MT program can be used as a standardized of hand rehabilitation intervention in hospital, clinics and homes.*

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INTRODUCTION

Along with modernization, stroke has increased every year throughout the world. Stroke is a health problem for both developed and developing countries, including Indonesia. Stroke is a neurological deficit that occurs suddenly and is caused by cerebrovascular injury (Morton, et al., 2012). Upper Extremity (UE) paralysis is the most common symptom in stroke patients (Lee, et al., 2012). Paralysis in stroke mainly occurs due to damage to the internal capsule. This damage requires neuroplasticity

involving a number of parts of the brain to recover (Sengkey, 2014).

Indonesia's national statistic indicate that stroke is the most cause of death, which is 15.4%. There are about 750,000 stroke incidents annually in Indonesia, and 200,000 of them are recurrent strokes (Irdelia, et al, 2014). Stroke incidence in Central Java at the age above 15 years reaches 12.3% (Riskesdas, 2018). Post-stroke motor impairment affects the ability to move body parts and interact with objects (Tosi, et al., 2017). In stroke patients, 70-80% have hemiparesis and 20% be through into muscle weakness in the limbs if they do not get good intervention options in post-stroke rehabilitation (Halim, et al., 2016).

Motor recovery to the control of voluntary movement after a stroke is something that is quite difficult. Restoration of upper extremity motor skills is very important to do activities of daily living. Six months after stroke, only 38% of patients experienced recovery of hand ability, and only 12% showed functional recovery, despite undergoing rehabilitation (Hardiyanti, 2013). UE motor recovery importance should be emphasized during rehabilitation programs (Lee, et al., 2012).

One of rehabilitation that is beneficial for neuroplasticity is Mirror Therapy (MT). This therapy is used to improve motor function after stroke. MT is a rehabilitation tool intend to rehabilitate several pathological conditions in which body representations are affected, including post-stroke motor impairment (Tosi, et al., 2017). MT is a therapeutic intervention that focuses on paresis of limbs movements. This procedure is performed by placing a mirror in the patient's midsagittal plane, so as the patient can visualization the image of the normal hand, and providing visual feedback that can correct the paralyzed side of the hand.

Mirror Therapy's mechanism of action is to observe the reflection of a healthy limb in a mirror, while a paralyzed one is hidden behind a mirror, so that it can have a positive impact on various clinical conditions from chronic pain to motor deficits. The result is the process of realizing mirror reflection, which will be integrated into the representation of paralyzed limbs (Sengkey, 2014). Wu, et al (2013) suggested, by seeing a healthy extremity perform functional motor movements in front of a mirror as if it were a paresis, it would maintain sensory feedback through visuals to the brain.

The functions of the hand improved more after MT (Karnati, et al., 2015). Kuys, et al., (2012) reported that MT increased UE motor recovery and function in post-stroke patients. MT proves to be an effective and feasible approach to rehabilitate post-stroke survivors in the acute, sub-acute, and chronic phases of stroke (Gandhi, et al., 2020). MT is a simple intervention, inexpensive, and effective therapy in improving motor function in both limbs and activities of daily living. In this study, MT was performed on patients post-stroke during 8 weeks, 3 times a week to evaluate the effects on UE motor recovery. Intervention was performed by the subjects themselves under supervision of occupational therapists and the families who have been trained then performance was confirmed by occupational therapists.

MT is easy to do and only a very short exercise time without burdening the patient as rehabilitation is carried out in post-stroke patients. MT is currently a rehabilitation option given to post-stroke patients in several hospitals in Central Java. During pandemic the patient arrival schedule was very limited. In this study, apart from doing therapy at the hospital, a home program was also applied as an additional intervention where the families who have been trained as supervisors. Patients adherence in carrying out is documented by supervisors. Based on the facts above, the research entitled "Application of Mirror Therapy on Upper Extremity Motor Ability of Post-Stroke

Patients" is important to do.

MATERIALS AND METHOD

This research is a quantitative pre-experimental design with the type one group pretest-postest. The population in this study was post-stroke patients in residency Semarang. Research data were collected in August-September 2020. The research subjects were 15 post-stroke patients who have provided informed consent. Sample selection using purposive sampling technique.

The sample inclusion criteria used in this study were post-stroke patients who did not have visual problems, were able to understand instructions and had a maximum degree of spasticity is two. While the exclusion criteria is the subject experiencing negleck. The intervention was given for approximately 8 weeks with a frequency of therapy 3 times a week (one time in hospital and twice performed at home) and the duration was 15-25 minutes. A home program was also applied as an additional intervention where the families who have been trained as supervisors.

The instrument used was Fulg-Meyer Upper Extremity Assessment (FMA-UE). Validity and reliability carried out on stroke patient in South Korea. Reliability coefficient at least 0,70 and a correlation coefficient r > 0,8 indicates a high correlation (Kim, et., al, 2012). Data analysis used paired sample T-test with saphiro wilk *p value* = 0,053 (baseline) and *p value* = 0,054 (post intervention), that indicates normally distribution ($\rho > 0,05$).

RESULTS

The results show that the age category of the sample is dominated by age < 60 (66.7%) and the average age of the sample is 57 years and 3 months. The sex of the sample is more male (73.3%) than female (26.7%). The left side of the sample was more affected (60%) than the right side (40%). All samples had a stroke infarction (100%).

The onset of most of the samples occurred in the range of 6-12 months (46.7), at onset < 6 and > 12 not much different respectively (20%) and (33.3%). This can be seen on the Table 1.

Table 1. Characteristic Distribution of Sample Based on Age, Gender, Type of Stroke, Affected Side and Onset.

Variable	n	%	Mean	Min-Max	Std. Dev
Age (years)					
< 60	10	66,7	57 years 3 months	49-65	4,832
≥ 60	5	33,3			
Total	**15**	**100**			
Gender					
Male	11	73,3			
Female	4	26,7			
Total	**15**	**100**			
Type					
Ischemik	15	100			
Hemorrhagic	0	0			
Total	**15**	**100**			
Affected Side					
Right	6	40			

Variable	n	%	Mean	Min-Max	Std. Dev
Left	9	60			
Total	**15**	**100**			
Onset (months)					
< 6	3	20			
6 -12	7	46,7			
>12	5	33,3			
Total	**15**	**100**			

Table 2. Differences in the Mean Score of Baseline and Post Intervention FMA -UE

Sub Test FMA-UE	Mean		Delta
	Baseline	Post Intervention	
Upper Extremity	24,73	27	2,27
Wrist	5,6	6,93	1,33
Hand	7,13	8,4	1,27
Coordination/Speed	5,47	5,73	0,26
Total (*Motor Function*)	**42,93**	**48,06**	**5,13**

Based on Table 2. represent there is a difference in the mean of the FMA-UE which is 5.13. The most significant difference is found in the Upper Extremity sub-test, which is 2.27, while the coordination/speed sub-test has the smallest difference, which is 0.26.

Different test this research was conducted using a Paired Sample T-Test because the normality test of the data with the Shapiro Wilk was indicated normally distributed ($\rho > 0.05$). Different between baseline and post intervention were conducted to determine differences in UE motor function before and after receiving the intervention.

Based on the results analysis of the Paired Sample T-Test, it was found that *p value* = 0.000 ($\rho < 0.05$) with a difference of 5.13 meaning that there was a difference in the mean value of *FMA-UE* before and after the MT intervention was given. This shows that there is an effect of giving MT to the UE motor function of post-stroke patients.The results of the analysis can be seen in Table 3.

Table 3. Paired Sample T-Test Result

Sample	Mean (Std.Dev)	Delta (Std.Dev)	IK 95%	Sig (*p*)
Motorik UE Baseline (n=15)	48,07 (13,05)	5, 13 (2,90)	3,53- 6,74	
Motorik UE Post Intervention (n=15)	42,93 (12,21)			0,000

DISCUSSION

The results of hypothesis testing was *p value* = 0.000 indicate that there is an impact of giving MT on the UE motor ability of post-stroke patients. The mean score of FMA-EU also got a significant increase of 5.13 after the intervention was given. Lee, et al., (2012), who conducted a study on subjects with onset less than 6 months. The intervention group was given additional mirror therapy program for 25 minutes 2 times a day, 5 times a week, for 4 weeks. Outcome parameters were assessed by FMA-UE and

there was a significant difference in score increase between the groups.

The theory describe that neurological and functional recovery occurs especially in the first 6 months after stroke, where most of improvement occurs in the first 6 weeks (Lang, et al., 2021). The motor recovery course in 95% of stroke patients will improve the best neurological level within 12.5 weeks after onset. Individuals with lighter strokes recover more quickly. The motor recovery journey will achieve a plateau after the initial progressive recovery phase, and only a small incremental improvement occursed at 6 months post-onset (Hardiyanti, 2013).

The degree of extremity paralysis at onset and the time at which hand movements begin are predictors of motor recovery in the upper extremities (Machyono, et al., 2018). The prognosis for return to useful hand function is poor if there is complete paralysis of the upper extremities at the time of the attack, and there is no grasping ability after 4 weeks after the attack. In patients with severe upper extremity weakness at onset, only 11% achieved recovery of hand function. Whereas in patients who have shown partial hand motor recovery at 4 weeks of onset, as many as 70% will achieve complete recovery (Stein & Brandstater, 2019).

Michielsen, et al., (2011) conducted a study of post-stroke hemiparesis patients with a mean onset of 3.9 years. MT is given once a week and 5 times a week to practice independently at home for 60 minutes. A significant difference was found in the Fugl Meyer score between the two groups. Stroke patients experience recovery of upper limb motor skills after rehabilitation interventions, in the chronic phase. Some stroke patients still get significant recovery from voluntary movements after 6 months, and recovery continues for a longer period of time (Hardiyanti, 2013).

The therapeutic approach provokes plasticity in the nervous system. Neuroscientists claim that the central nervous system is adaptable during development and throughout life. The nervous system can recover from serious illness and injury through spontaneous adaptation and healing processes (Pratiwi, 2017). Several brain areas such as the occipital lobe, dorsal frontal area and corpus callosum are involved during MT interventions.

Bilateral premotor cortex, primary motor cortex, primary somatosensory cortex, and cerebellum are also reorganized to improve function of the damaged brain. The motor areas of the affected hemisphere receive visuomotor processing information through the parieto-occipital lobe. Damaged motor cortex responds to mirror therapy in a variety of ways and can improve motor recovery (Arya, 2016).

Various clinical, neurophysiological, and imaging evidence suggests that imagining movement implicate the same neural pathways as movement execution. Another possible mechanism is the involvement of the mirror neuron system. Mirror neuron system is the nerve cells found in the premotor area to be active during observing movement, imagining movement (mental imagery) and execution of movement (Wang, et al., 2013). Mirror neurons are generally understood to be the basis in the process of learning new skills through visual observation of skills.

Imagining movement will activate the brain areas used to control movement, namely the premotor cortex, primary motor cortex, and parietal lobe (Arya, 2016). Imagining the movement causes activation in ±30% of the neurons that will execute the imagined movement. Functional activation studies prove that there are several nodes in the same motor system when producing movements, observing other people's movements, imagining movements, understanding other people's movements, and recognizing tools as objects of a movement (Hardiyanti, 2013).

Another study that is in line with previous research, that MT improves motor function in stroke patients (Cristina, et al., 2015). Subjects with mirror therapy exercise showed a significant increase in FMA-UE scores (Vural, et al., 2016). MT is effective in motor improvement in patients with mild to moderate hemiparesis (Chan & Au-Yeung, 2018). Also declare that was a significant difference in the mean pre-intervention and post-intervention scores of upper arm function and hand function.

MT in stroke patients involves moving the normal hand while viewing at reflection in a mirror positioned in front of the sick hand (invisible), giving the illusion as if the sick hand is moving (Sengkey, 2014). Functional imaging studies of the brains of healthy individuals, demonstrated an excitability of the ipsilateral primary motor cortex to unilateral hand movements, which was facilitated by viewing the reflection of hand movements in the mirror. When the right hand is used, it will be perceived as the left hand, so as increase activation in the right brain (and vice versa). Activation when the subject make movement also occurs in the bilateral inferior parietal area, supplementary motor area, and premotor cortex (Pratiwi, 2017).

The literature review of 20 articles by Maisyaroh, et al., (2021), declare that MT is effective in all stroke patients with hemiparesis. MT is effective for 15-60 minutes a day, with a frequency of 3-5 days per week for 2 to 12 weeks with minimum muscle strength requirements of 2 and ambulation between 3-5. MT has proven to be better than standard rehabilitation therapy. This therapy is also useful in acute, subacute, and chronic stroke phases, and can be integrated into stroke rehabilitation therapy to improve upper extremity motor function (Machyono, 2018). A number of studies that investigated the effect of mirror therapy on the upper limbs in chronic stroke patients have also reported improvements in the range, speed, and accuracy of movements as well as improvements in grip strength (Lee, et al., 2012).

This intervention requires a high level of concentration. It is thought to have had positive effect on triggering therapeutic motivation. Based on claims of most participants that experienced and even felt sensations in the paretic limbs moving in their imaginations as a result of the mirror illusion, nevertheless the fatigue factor can have an impact. More research is required on stage intervention, intensity, application time, duration and types of outcome measure.

CONCLUSION

The results showed that the MT program had an effect on the UE motor ability of post-stroke patients. Statistically showed a significant difference in UE motor ability of post-stroke patients between baseline and after MT intervention, with a mean difference (5,14) and *p value* = 0,000 ($\rho < 0,05$). MT program can be used as a standardized of hand rehabilitation intervention in hospital, clinics and homes. That a simple, inexpensive, and effective therapy in improving motor function in UE therefor critical for the performance of detailed tasks and activities of daily living.

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