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Meta-Analysis

Effectiveness of Mirror Therapy on Post Stroke Functional Ability: A Meta-Analysis

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ABSTRACT

Background: Stroke is the third leading cause of death after heart disease and cancer. One of the impacts of stroke is it causes a decrease in the functional ability to carry out daily activities, therefore mirror therapy is carried out to restore the functional ability. The study aims to determine the effect of mirror therapy on the functional ability of post-stroke patients based on previous primary studies.
Subjects and Method: It was a systematic review and meta-analysis study with PICO as follows: P= post-stroke patients, I= mirror therapy, C= conventional therapy, and O= functional ability. Data collection was conducted from databases, namely: Google Scholar and PubMed. The inclusion criteria used were full-text articles in English, with randomized control trial design, published in 2006-2021. The keywords used were "stroke" AND "mirror therapy" AND "functional independence measure" OR "FIM" AND "randomized control trial". The inclusion criteria of the study were articles using a randomized control trial study design, the effect size used was the Mean SD, the subjects of the study were patients with poststroke conditions, the intervention given was mirror therapy, the comparison was conventional therapy, with the outcome was increased functional ability. The articles were analyzed using Review Manager 5.3. application.
Results: The meta-analysis was conducted on 9 primary studies from several countries such as Turkey, South Korea, India, and Italy. The results of the study showed that there was an effect of mirror therapy on the functional ability of post-stroke patients. Patients who obtained mirror therapy had a functional ability of 0.92 units higher than conventional therapy. The results were statistically significant (SMD= 0.92; 95% CI= 0.67 to 1.17; p<0.001).
Conclusion: mirror therapy can improve the functional ability of post-stroke patients.

Keywords: mirror therapy, functional ability, post-stroke

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BACKGROUND

Stroke is the third leading cause of death after heart disease and cancer. Stroke is a condition that occurs when the blood supply to the brain is cut off due to blockage or rupture of blood vessels, resulting in the death of cells in some areas of the brain (Agusman and Kusgiarti, 2017). Stroke is the leading cause of long-term adult disability and the fifth leading cause of death with 795,000 incidents each year in the United States. The prevalence of stroke is estimated to increase by 3.4 million people between 2012 and 2030 (Boehme et al. 2017). The highest prevalence of stroke in the world is in Asia, that is China with a prevalence of stroke at

69.6%, intracerebral hemorrhage at 23.8% and 15.8%, subarachnoid hemorrhage at 4.4%, with hypertension at 88%, smoking at 48%, and alcohol use 44% (Wang et al., 2017).

Indonesia is the country with the highest number of strokes in Southeast Asia with the number of deaths caused by stroke is the second highest above the age of 60 years. East Kalimantan is the highest area with stroke (14.7%), followed by Yogyakarta (14.3%) Bangka Belitung, and DKI Jakarta respectively (11.4%) and Bali in 17th place (10.8%) (RISKESDAS 2018).

The last Riskesdas (Basic Health Research) conducted in 2018 in Indonesia discovers the result that stroke prevalence has increased compared to 2013, from (7%) to (10.9%). Nationally, the prevalence of stroke in Indonesia in 2018 in the population of ≥ 15 years of age was 10.9% or an estimated 2,120,362 people. Based on the age group, the incidence of stroke occurs more in the age group of 55-64 years (33.3%) and the least number of stroke sufferers is in the age group of 15-24 years. Men and women have almost the same number of stroke incidences. The prevalence of stroke in urban areas is greater (63.9%) compared to rural areas (36.1%) (Kemenkes RI, 2018).

One of the impacts of a stroke is a decrease in the functional ability to walk which causes the walking speed of post-stroke sufferers to be slower than the time before getting the stroke (Fatati et al., 2020). Limited functional ability is a common impact of stroke which affects about 85% of sufferers. Decreased functional ability can cause difficulties in carrying out daily activities therefore the recovery of motor functions becomes an important goal of stroke rehabilitation Hence, the goal of stroke rehabilitation is that the patient can be functionally independent again and improve the quality of life of the patient as an individual. The impaired motor function causes functional limitations and disabilities in stroke patients (Hyunjin, 2013).

There are various methods of rehabilitation with therapeutic services for stroke patients, one of them is mirror therapy which is relatively new and has not been widely applied in Indonesia. This mirror therapy is conducted to restore muscle strength in stroke patients to improve or help restore motor function. Mirror therapy is a form of rehabilitation that uses motor shading to provide visual stimulation to the disturbed part of the body with the help of the healthy part of the body using the medium of mirrors. Based on a study conducted by Sengkey in 2014 regarding mirror therapy in stroke rehabilitation, effective results are obtained for stroke patients (Sengkey, 2014).

Based on the description above, researchers are interested in conducting a study through a systematic review and a meta-analysis approach to determine the effect of mirror therapy on the functional ability of post-stroke patients. The study aims to analyze the effect of mirror therapy on post-stroke functional ability with meta-analysis based on primary studies conducted in previous studies.

SUBJECTS AND METHOD

1. Study Design

It was a systematic review and meta-analysis study. Data collection was obtained from databases, namely: Google Scholar and PubMed. Analysis of this study used RevMan 5.3 software. The articles used were full-text articles in English with a randomized control trial design, published from 2006 to 2021. Study subjects were post-stroke patients who obtained mirror therapy interventions. The articles search was conducted using the keywords "stroke" AND "mirror therapy" AND "functional independence measure" OR "FIM" AND "randomized control trial".

2. Steps of Meta-Analysis

Meta analysis was carried out in 5 steps as follows:

1) Formulate research questions in PICO format (Population, Intervention, Comparison, Outcome).
2) Look for primary study articles from various electronic and non-electronic databases such as PubMed, ScienceDirect, Google Scholar, Scopus.
3) Perform screening to determine inclusion and exclusion criteria and carry out a critical assessment
4) Extract primary study data and synthesize effect estimates using the RevMan 5.3 application.
5) Interpret the results and draw conclusions.

3. Inclusion Criteria

The inclusion criteria of the study were articles using a randomized control trial study design, the effect size used was the Mean SD, the subjects of the study were patients with post-stroke conditions, the intervention given was mirror therapy, the comparison was conventional therapy, with the outcome was increased functional ability.

4. Exclusion Criteria

The exclusion criteria of the study were articles published in non-English and Indonesian languages, published before 2006.

5. Operational Definition of Variables

The articles included in the study were in accordance with PICO. The article search was carried out by considering the eligibility criteria using PICO as the following the population used was patients with post-stroke conditions, the intervention was the administration of mirror therapy and the comparison was the administration of conventional therapy, whereas the outcome was increased functional ability.

Mirror therapy is a rehabilitation that relies on motor imagery, where the mirror will provide visual stimulation that tends to be imitated by the mirror image of the disturbed part of the body.

Functional ability is a process to discover the patient's ability to perform specific activities related to the daily life routines integrated with his activity environment.

6. Study Instruments

The instrument used in this study was the Critical Appraisal Checklist for Randomized Controlled Study in the studies related to mirror therapy.

7. Data Analysis

Articles were collected based on PRISMA flow and Critical Appraisal diagrams. The study used the Review Manager 5.3 application for the data analysis. The study was subsequently analyzed based on the calculation of the results of effect size and heterogeneity, based on several relevant studies with a variety of different methodologies and characteristics and according to the inclusion criteria. The final result of data analysis and processing was to calculate the value of effect size and heterogeneity to determine the mixed methods and establish the final result of meta-analysis in the form of forest plots and funnel plots.

RESULTS

The results of searching for relevant study articles from both databases are as follows: Figure 1 of the preliminary search results obtained 777 identified articles. The advanced article screening discovered 4 duplicated articles which were subsequently deduplicated and obtained 773 articles. The selection process was continued by excluding 717 articles and leaving only 56 articles. Subsequently, 9 identified articles met the predetermined criteria and were considered eligible for full-text review.

The studies related to the effect of mirror therapy on the functional ability of post-stroke patients consisted of 4 articles from Turkey, 3 articles from South Korea, 1 article from India, and 1 article from Italy. The quality and design of the studies analy-

zed in the meta-analysis are very important because it affects the results. Assessment of the quality of the studies was carried out quantitatively and qualitatively. This study used the Critical Appraisal Checklist for Randomized Controlled Study in the studies related to mirror therapy.

Figure 2 is a distribution map of the study article locations. The articles included in the review process were articles from 2 continents. The search results obtained 9 articles with search locations all over the world. The articles were then assessed to determine their quality using a draft examination from a cohort study (survey).

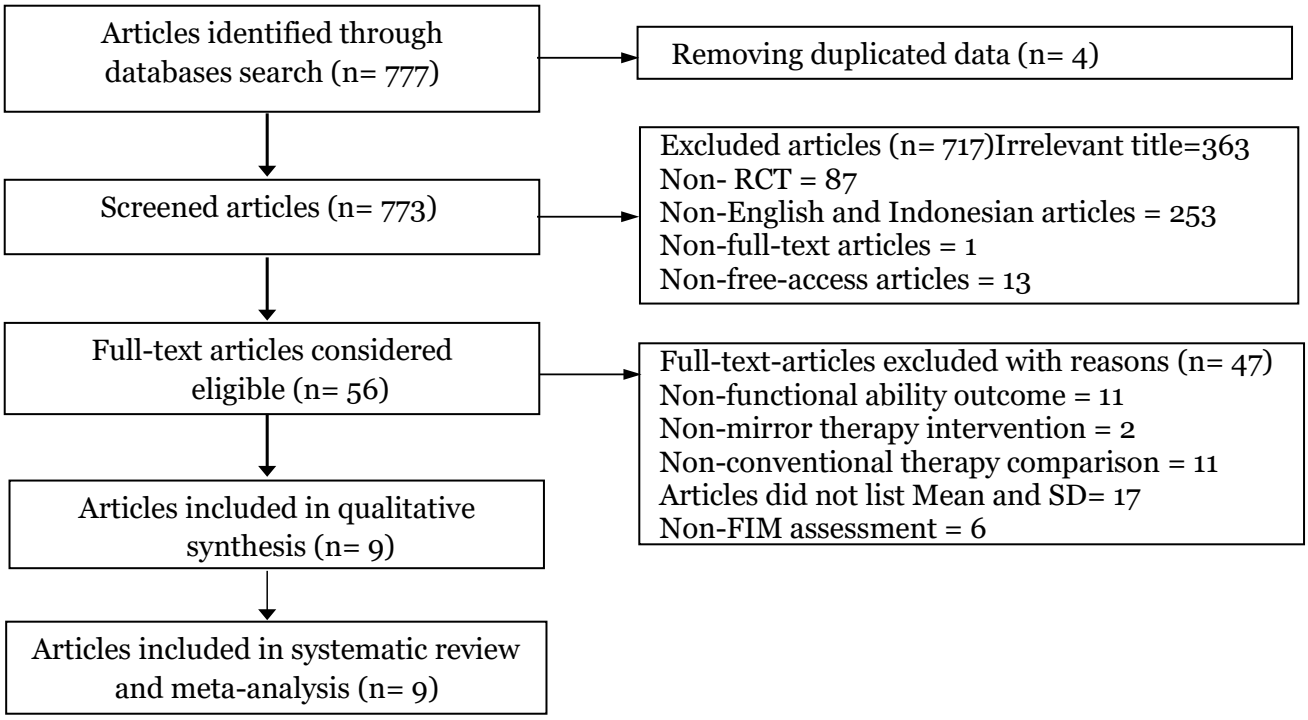

Figure 1. Results of Prisma Flow Diagrams

Figure 2. Resarch Distribution Map

Table 1 Quality assessment of randomized controlled trial study the effect of mirror therapy on post-stroke functional ability

Primary Study	Criteria												
	1	2	3	4	5	6	7	8	9	10	11	12	Total
(Sütbeyaz et al. 2007)	1	1	1	1	1	1	1	1	0	1	1	1	11
(Yavuzer et al. 2008)	1	1	1	1	1	0	1	1	1	1	1	1	11
(Invernizzi et al. 2013)	1	1	1	1	1	0	1	1	0	1	1	1	10
(Young et al. 2015)	1	1	1	1	1	1	1	1	0	1	1	1	11
(Park et al. 2015)	1	1	1	1	1	1	0	1	1	1	1	1	11
(Gurbuz et al. 2016)	1	1	1	1	1	1	1	0	1	1	1	1	11
(Kim et al. 2016)	1	1	1	1	1	0	1	1	1	1	1	1	11
(May et al. 2020)	1	1	1	1	1	1	1	1	1	1	1	1	12
(Saha et al. 2021)	1	1	1	1	1	1	1	0	0	1	1	1	10

Description of the question criteria:

1 = Does this study clearly address the focus of the study?
2 = Is the Randomized Controlled Trial study method appropriate to answer research questions?
3 = Are there enough subjects in the study to establish that the findings were made not by chance?
4 = Were the subjects randomly divided into experimental and control groups? If not, can this lead to bias?
5 = Does the study use inclusion/exclusion criteria?
6 = Were the two groups comparable at the beginning of the study?
7 = Are the outcome criteria objective and unbiased to use?
8 = Is the measurement method used objective and valid for measuring the results? If not, is there blinding applied to the study?
9 = Is effect size practically relevant?
10 = Is the approximate effect, correct? Is there a confidence interval?
11 = Are there any unmeasured confounding factors?
12 = Can the results be applied to your research?

Answer score description:

0 = No
1 = Can't tell
2 = Yes

Tabel 2. Summary of primary RCT study with PICO (N=290)

Authors (Years)	Countries	Total sample	P	I	C	O
Gurbuz et al., 2016	Turki	31	31 Stroke hemiparesis less than 6 months	MT for 4 weeks (60-120 minutes, 5 days/week)	CT for 4 weeks (60-120 minutes, 5 days/week)	*ADL Functional Ability*
Invernizzi et al. 2013	Italy	26	26 Stroke hemiparesis under 4 weeks	MT + CT (30 minutes)	CT (30 minutes)	Recovery of the upper extremities
Kim et al. 2016	Korea Selatan	25	25 Stroke (6 months after stroke)	MT for 4 weeks (30min/day, 5days/week)	CT for 4 weeks (30min/day, 5days/week)	Effect of MT with *ADL Functional Ability*
May et al. 2020	Turki	42	42 Stroke hemiparesis (suffering from stroke for at least 1 year)	MT for 4 weeks (60-120mins, 5days/week)	CT 4 weeks (60-120mins, 5days/week)	Effect of MT

Authors (Years)	Countries	Total sample	P	I	C	O
Park et al. 2015	Korea Selatan	30	30 Stroke hemiparesis (3 months after stroke)	MT 5x/week for 6 weeks	CT 5x/week for 6 weeks	Functional ability of upper extremities & Self-care
Saha et al. 2021	India	30	30 Stroke hemiparesis (1 year after having a stroke)	MT for 4weeks (30mins/day, 5x/week)	CT for 4weeks (30min/day, 5x/week)	Functional ability, edema, upper extremity pain (shoulder)
Sütbeyaz et al. 2007	Turki	40	40 Stroke hemi-paresis (1 year after having a stroke)	MT for 4weeks (30mins/day, 5x/week)	CT for 4weeks (30min/day, 5x/week)	Functional ability of the lower extre-mities, mobility ability
Yavuzer et al. 2008	Turki	36	36 Stroke hemi-paresis (1 year after having a stroke)	MT for 4weeks (30mins/day, 5x/week)	CT 4weeks (30min/day, 5x/week)	Functional ability of hand extre-mities & flexibility
Young et al. 2015	Korea Selatan	30	30 Stroke hemiparesis	MT for 4weeks (30mins/day, 5x/week)	CT 4weeks (30min/day, 5x/week)	Effect of Upper Extremity MT + ADL

Tabel 3. Effect estimates (Mean SD) of all primary studies performed in the meta-analysis (N=290)

Authors (year)	Mirror therapy		Conventional therapy	
	Mean	SD	Mean	SD
(Casilda-López et al., 2017)	19.8	8.10	16.9	6.40
(Yennan et al., 2010)	93.18	22.07	22.07	13.19
(Dias et al., 2017)	77.3	6.30	6.30	4.30
(Fransen et al., 2007)	74.1	11.7	11.70	20.0
(Hale et al., 2012)	24.5	5.70	5.70	5.00
(Silva et al., 2008)	88.33	18.72	18.72	15.33
(Khruakhorn et al.,2021)	65.9	4.80	61.7	14.6
(Lim et al., 2010)	28.9	10.0	22.2	6.30
(Taglietti et al., 2018)	8.80	4.12	4.06	4.92

1. Forest Plot

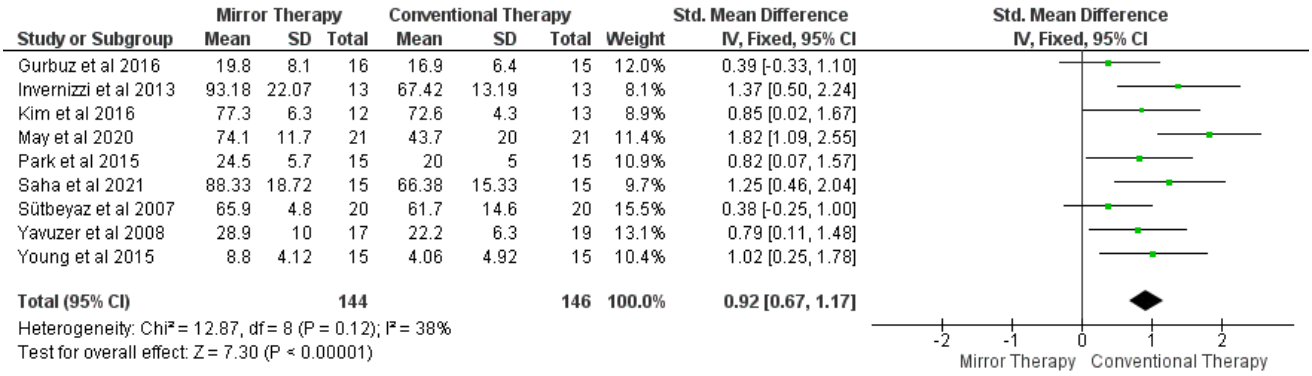

Figure 3 Forest plot of meta-analysis of the effect of mirror therapy on post-stroke functional ability

Figure 3 shows the effect of mirror therapy on the functional ability of post-stroke patients. Patients who obtained mirror therapy had a functional ability of 0.92 units higher

than conventional therapy, and the effect was statistically significant (SMD= 0.92; 95% CI= 0.67 to 1.17; p<0.001). The forest plot shows that the estimates of effect across studies had low variation(homogeneous), with I^2= 38% (P=0.12). Thus, the calculation of the average effect estimates was carried out with a fixed effect model approach.

2. Funnel Plot

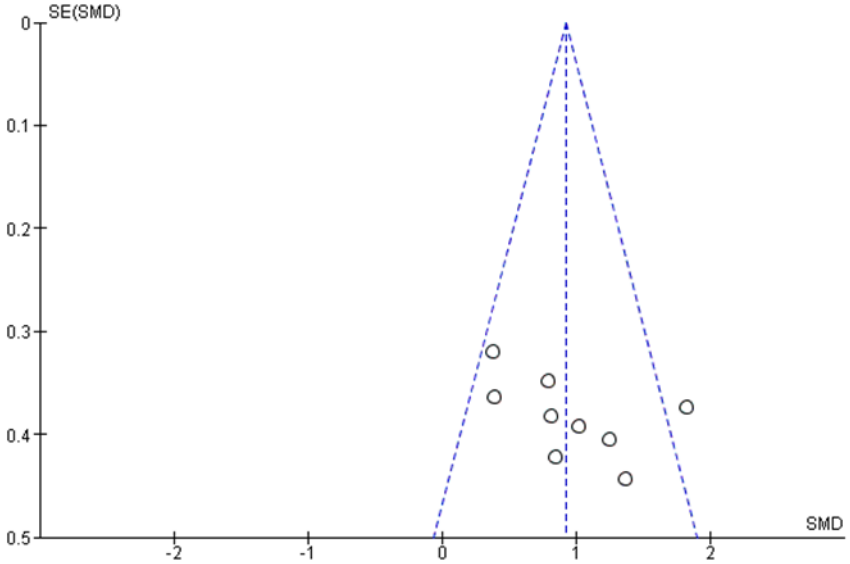

Figure 4 Funnel plot of meta-analysis of the effect of mirror therapy on the functional ability of post-stroke patients.

Figure 4 shows approximately equal distributions of effect estimates across studies on the right and left of the vertical line of average estimates. Thus, the funnel plot did not show publication bias in the meta-analysis.

DISCUSSION

Stroke is the third leading cause of death after heart disease and cancer, stroke occurs due to blockages and rupture of blood vessels which results in an interrupted supply of oxygen and nutrients leading to brain damage that causes disorders (Widyaswara et al., 2019). Stroke disorders are generally in the form of hemiparesis and hemiplegia in the area of the middle or anterior cerebral arteries that cause infarction in the motor nerves or movement control nerves of the front cortex. A person who has a stroke, experiences sudden numbness or weakness on one side of the body on the face, arms, or legs, impaired walking, dizziness, loss of balance or coordination and confusion, difficulty in speaking or understanding speech, visual impairment in one or both eyes (ASA, 2016). These impacts cause a loss or decrease in arm function which causes difficulty in carrying out daily activities and causes the patient to become dependent on others. Therefore, the target of stroke rehabilitation is to be functionally independent as an individual and improve the quality of life of the patient. Conventional therapy is still not enough to improve functional abilities, therefore, mirror therapy is one of the interventional therapies focused on hand and foot movements that are paresis due to stroke.

The studies related to the effect of mirror therapy on functional ability after stroke consisted of several primary studies spread across 2 continents, namely Asia and Europe. A total of 9 primary study articles were

included in this meta-analysis synthesis originating from Turkey, South Korea, India, and Italy.

The results of the analysis of 9 primary studies included in the systematic review and meta-analysis showed a low heterogeneity across experiments (I^2=38%; p<0.001) therefore the analysis used a Fixed Effect Model (FEM). The low heterogeneity was based on the nearly similar number of samples between the experimental group and the control group.

The result of the meta-analysis of 9 articles related to the effect of mirror therapy on post-stroke functional ability was able to improve functional ability compared to Conventional therapy (SMD= 0.92; 95% CI= 0.67 to 1.17; p<0.001). The 9 primary study articles indicated the significant value of mirror therapy study toward the functionnal ability of post-stroke characterized by the untouched horizontal line of each study on the forest plot. This significance value was influenced by several factors among which was all articles had a nearly similar number of samples between the control group and the intervention group so that the proportion of the two is almost equal.

Mirror Therapy is an exercise therapy and relies on the imagination or motor projection of patients, mirrors are used as a means for providing visual stimulation to the brain for the movement of hemiparetic limbs. (Colomer et al., 2016) states that mirror therapy is effective in motor improvement in patients with mild to moderate hemiparesis. Chan et al. (2018) In addition to the upper extremities, mirror therapy also facilitates motor recovery in the lower limbs and can also reduce gait deviations. Mirror therapy combined with conventional motor therapy reduces gait deviations in chronic poststroke hemiparetic patients (Arya et al., 2017).

Several studies have shown the effect of mirror therapy on post-stroke functional ability, including Agusman and Kusgiarti's study (2017) " The effect of mirror therapy on muscle strength in non-hemorrhagic stroke patients at Semarang City Hospital" with 10 post-stroke patients as the study subjects. The study indicates the results that a good and appropriate therapy and exercise which meet the needs of stroke patients may properly overcome obstacles of Mobility limitations and improve independence and functional ability.

Another study by Champaiboon et al., (2017) entitled "Effect of mirror therapy in recovering strength and function of the upper limbs in chronic stroke patients: A randomized controlled trial" involving 44 stroke patients from the central rehabilitation center at King Chulalangkorn Memorial Hospital, obtained the results of the study that there is a significant improvement in the intervention group when compared to the initial examination using Brunnstrom, a significant recovery between the control groups is seen during the initial 2 weeks. In conclusion, mirror therapy with conventional rehabilitation programs can help improve the recovery stage and the use of mirror therapy is simple, easy, inexpensive, and can be conducted at home.

Another study by Chinnavan et al., (2020) entitled "Effectiveness of mirror therapy on upper limb motor functions among hemiplegic patients" with a total of 25 stroke patients conducted at the Malaysian Government Centre Special Hospital with the results of the study are changes in Fuglmeyer assessment and FIM size from the beginning to six weeks between the control and the experimental group, reveals that a significant improvement is in the experimental group (p<0.05) and the conclusion is the mirror therapy is an effective method of

recovering upper limb motor function in hemiplegic patients.

An article entitled "Effects of Mirror Therapy on Motor and Sensory Recovery in Chronic Stroke: A Randomized Controlled Trial" conducted by Wu et al., (2013) with a total sample of 33 stroke patients, and obtains better overall MT group results using an increased Fugl-Meyer score. It concludes that the application of MT after a stroke has an effect on movement and motor control that supports daily activities.

Another article entitled "Mirror Therapy Enhances Motor Performance in the Paretic Upper Limb After Stroke: A Pilot Randomized Controlled Trial" conducted by Samuelkamaleskumar et al., (2014) with a sample of 20 stroke patients, taken from a rehabilitation center in a teaching hospital, comes up with the results that after 3 weeks of MT there is a significantly greater average change score in the MT group than the controls group for Fugl-Meyer assessment (p=0.008), Brunstrom assessment for motor recovery of arms (p=0.003) and hands (p=0.003). It concludes that MT is effective in improving upper limb motor performance compared to conventional therapy without MT.

Another study conducted by Dohle et al., (2008) entitled “mirror therapy promotes recovery from severe hemiparesis: a controlled trial" with a sample of 36 stroke patients recruited from inpatient Godeshöhe rehabilitation center comes up with the results of 25 patients with plegia regaining function faster than other patients, MT improves sensory recovery. It concludes that MT performed on patients with early stroke or who have had a stroke recently, increases well the accomplishment rate.

Based on the study, it can be observed that mirror therapy has significant results in affecting the improvement of post-stroke functional ability. The final result was the administration of mirror therapy interventions was able to increase functional ability by 0.92 units higher than conventional therapy.

AUTHOR CONTRIBUTION

Galang Aji Samudera was the main researcher who chose topics, searched, and collected study data. Hanung Prasetya and Bhisma Murti analyzed and reviewed the study documents.

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CONFLICT OF INTEREST

There was no conflict of interest in the study.

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