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**Original Research/Systematic Review**

# The Application of Mirror Therapy in Ischemic Stroke Patients with Hemiparesis to Improve Upper Extremity Muscle Strengt

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**ABSTRACT**

***Background:*** *Ischemic stroke is one of the leading causes of disability worldwide, with hemiparesis being the most common clinical manifestation after stroke. Hemiparesis may reduce muscle strength and increase the risk of complications such as joint contractures*

***Methods:*** *This study aimed to evaluate the effectiveness of mirror therapy in improving upper extremity muscle strength in a 45-year-old male patient with ischemic stroke and left-sided hemiparesis. A case study design was used, with the intervention carried out over five consecutive days. The therapy consisted of adaptation exercises, basic movements, variations, and combination exercises, each repeated eight times.*

***Results:*** *The evaluation showed an improvement in upper extremity muscle strength from a score of 5555 \| 4432 to 5555 \| 4443. Additionally, there were no observed decreases in physical tolerance or therapy-related injuries.*

***Conclusion:*** *These findings suggest that mirror therapy is an effective, safe, and feasible rehabilitation intervention that can be implemented by nursing professionals in clinical settings for stroke patients with hemiparesis.*

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## INTRODUCTION

Cerebrovascular accident (CVA), or stroke, is a general term for functional disturbances of the central nervous system (CNS) caused by an interruption of blood supply to the brain (Hinkle & Cheever, 2018). According to Hinkle and Cheever (2018), stroke can be divided into two main categories: ischemic stroke (occurring in approximately 87% of cases) and hemorrhagic stroke (occurring in approximately 13% of cases). These two types differ in terms of etiology, pathophysiology, management, and nursing care provided.

In 2020, there were approximately 89.1 million cases of stroke worldwide, including 68.2 million ischemic strokes, 18.9 million intracerebral hemorrhages, and 8.1 million subarachnoid hemorrhages. Stroke-related deaths globally reached 7.1 million (American Heart Association, 2022). In Indonesia, the prevalence of stroke was reported to be 2,120,362 cases in 2018 based on data from the Ministry of Health (Kemenkes RI, 2022). Besides being one of the leading causes of mortality, stroke is also a major cause of disability worldwide (Carvalho-Pinto & Faria, 2016). Stroke-related disabilities include impairments in motor and

sensory function, cranial nerve dysfunction, altered levels of consciousness, and changes in mental status (El Tallawy et al., 2015; Hinkle & Cheever, 2018; Winstein et al., 2016).

The most commonly observed condition in stroke patients is hemiparesis (El Tallawy et al., 2015; Carvalho-Pinto & Faria, 2016; Meena et al., 2022). Hinkle and Cheever (2018) define hemiparesis as a condition where one side of the body experiences weakness due to injury in the brain's motor area. Stroke rehabilitation efforts focus on physical, psychological, and social aspects (Stewart et al., 2018). The success of stroke rehabilitation is influenced by several factors, including stroke severity, type and location of the stroke, and the patient's general condition before and after the event. One of the rehabilitation strategies to prevent joint contractures in stroke patients with hemiparesis is mirror therapy (Hardiyanti, 2013; Samuelkamaleshkumar et al., 2014; Shih et al., 2017). Mirror therapy is performed by placing a mirror along the patient's midsagittal plane.

**Figure 1. Mirror Therapy**
(Corbetta et al., 2018)

After the mirror is placed between the weakened extremities, the patient is instructed to perform range of motion (ROM) exercises (Shih et al., 2017). The ROM exercises implemented during mirror therapy consist of adaptation exercises, basic movement exercises, variation exercises, and combination exercises. These exercises follow the Bonner protocol as outlined in Table 1.

**Table 1.** Bonner Protocol

| Exercise Phase | Movement description |
|---|---|
| **Adaptation exercise** | Performed when the patient is not yet accustomed to the mirror reflection. |
| a. Counting | Both hands are placed on the table; extend each finger one by one or lift several fingers simultaneously. |
| b. Finger Abduction-Adduction | Both hands are placed on the table; perform abduction starting from the thumb followed by the index finger, and so on. For adduction, start from the little finger followed by the ring finger, and so on. |
| **Basic Movement Exercises** | Performed when the patient can focus on the mirror image and has completed the adaptation phase. |
| a. Elbow flexion | Position 1: Both forearms are placed on the table; Position 2: Forearms are raised 45° with elbows resting on the table; Position 3: Both forearms form a 90° angle with the table. |
| b. Elbow extension | Straighten the arms from the flexion position. |
| c. Shoulder internal/ external rotation | Posisi 1: Geser lengan bawah mendekati badan; posisi 2: Kembali ke tengah; posisi 3: Menjauhi badan. |
| **Variation Exercises** | Dilakukan setelah pasien mampu melakukan gerak dasar terus-menerus. |
| a. Pronation–Supination | Posisi 1: telapak ke bawah. Posisi 2: telapak setengah terbuka. Posisi 3: telapak ke atas. |
| b. Grip and Prehension | Place both hands on the table and perform the following: grip both hands; grip with thumb inside (thumb-in-palm); hook grip (half-flexed fingers); finger extension (straight and close together); finger abduction (straight and spread out). |
| c. Finger counting | Count by lifting fingers one at a time in sequence. |
| d. Finger opposition | Touch the thumb to each finger alternately. |
| **Combination Exercises** | A combination of two movements performed simultaneously. Example: elbow flexion while gripping. |

Mirror therapy can be applied to post-stroke patients with hemiparesis who are in generally stable condition (Shih et al., 2017; Thieme et al., 2018). Gandhi et al. (2020) stated that mirror therapy may be used in patients with a range of motion (ROM) from active to passive. However, contraindications for mirror therapy include patients with cognitive impairments, visual disturbances, severe cardiopulmonary disorders, or other medical conditions that may interfere with functional activities or the ability to perform exercises (Hardiyanti et al., 2013; Shih et al., 2017). According to a study by Thieme et al. (2018), mirror therapy has been proven effective as a rehabilitative intervention for post-stroke patients in the acute, subacute, and chronic phases.

Based on previous research, mirror therapy is a feasible procedure that can be implemented for stroke patients with hemiparesis. The researchers believe that mirror therapy can be performed by nurses as part of nursing care for patients in the acute phase of stroke, such as the case of Mr. R. Therefore, further evaluation is necessary to determine whether the procedure can effectively improve muscle strength, particularly in the upper extremities.

## MATERIALS AND METHOD

This study employed a case study design using an evidence-based intervention approach. The subject was Mr. R, a patient diagnosed with ischemic stroke accompanied by left-sided hemiparesis. The intervention applied was mirror therapy, which consisted of four phases: adaptation exercises, basic movement exercises, variation exercises, and combination exercises. Each exercise in every phase was performed in eight repetitions. Mirror therapy was carried out in front of a flat mirror measuring 30 x 20 cm, placed along the patient's midsagittal plane. Each session lasted approximately 30 minutes and was conducted once daily for five consecutive days.

Nursing evaluations were conducted over the five-day intervention period and focused on two main aspects: (1) changes in upper extremity muscle strength, and (2) assessment of the patient's physical tolerance before and after each mirror therapy session. Physical tolerance parameters included monitoring of systolic and diastolic blood pressure, mean arterial pressure (MAP), pulse rate, respiratory rate, and oxygen saturation.

## RESULTS

On the fourth day of hospitalization, initial assessment of Mr. R revealed blood pressure of 131/81 mmHg, pulse rate of 83 beats per minute, capillary refill time (CRT) under 2 seconds, warm extremities, no edema, strong and regular peripheral pulses, and absence of paresthesia. Notably, the patient experienced muscle weakness on the left side, particularly in the left arm, with an inability to grip using the left hand. Muscle strength assessment showed scores of 5555 | 4432 (upper extremities) and 5555 | 4444 (lower extremities). Passive range of motion (ROM) examination indicated limitations in the thenar and hypothenar muscles of the left hand. Facial asymmetry was observed, and the patient reported a throbbing headache on the right side.

The patient had a history of ischemic stroke in 2020 and admitted to noncompliance with antihypertensive medications. Laboratory results showed elevated LDL cholesterol at 133 mg/dL. MRI and MRA imaging revealed chronic lacunar infarcts in the periventricular white matter of the bilateral posterior horns, bilateral thalamus, suspected thrombus in the internal carotid artery, and severe stenosis of the left middle cerebral artery (M1 segment).

Based on this assessment, the primary nursing diagnosis was impaired physical mobility related to decreased muscle strength. Mirror therapy intervention was performed daily for five consecutive days, with monitoring of physical tolerance before and after each session. This included measuring systolic and diastolic blood pressure, MAP, pulse rate, respiratory rate, and oxygen saturation.

Pre-intervention measurements from November 7–11, 2023, showed systolic blood pressure ranging from 122–132 mmHg, diastolic pressure from 72–85 mmHg, MAP from 89–101 mmHg, and pulse rate from 73–88 bpm. Post-intervention measurements showed systolic pressure of 124–

134 mmHg, diastolic pressure of 76–87 mmHg, MAP of 93–102 mmHg, and pulse rate of 76–87 bpm. Respiratory rate ranged from 18–21 breaths/min before the intervention and 18–22 breaths/min after. Oxygen saturation ranged from 97%–100% before therapy and 98%–100% afterward.

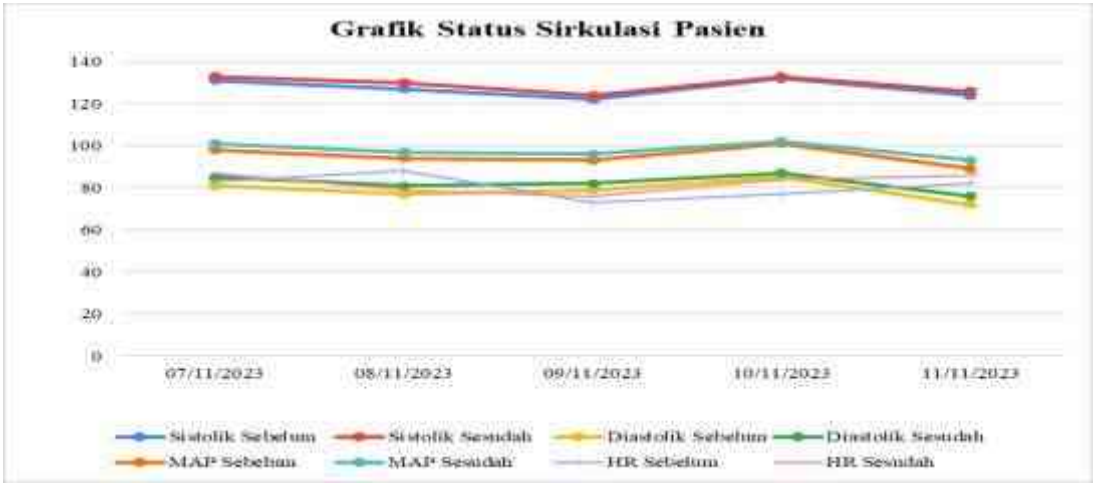


**Figure 2a**. Trend of the Patient's Circulatory Status

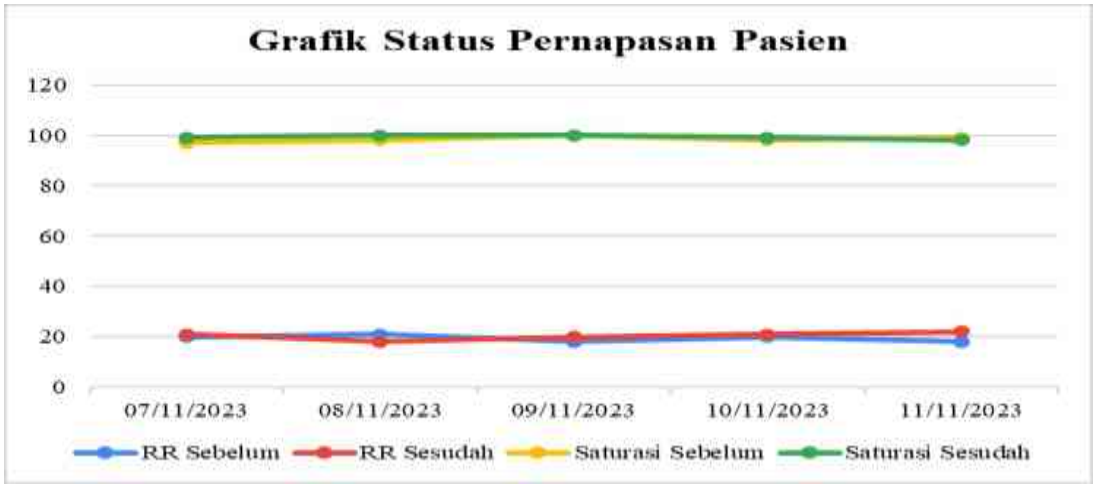


**Figure 2b**. Trend of the Patient's Respiratory Status

Muscle strength in the left upper limb was evaluated daily and showed progressive improvement over the five days. Initial strength was 5555 | 4432 and improved to 5555 | 4443 by the fifth day, as presented in the table below:

**Table 2.** Upper and Lower Extremity Muscle Strength Progression

| Date | Right Arm | Left Arm | Right Leg | Left Leg |
|---|---|---|---|---|
| 07/11/2023 | 5555 | 4432 | 5555 | 4444 |
| 08/11/2023 | 5555 | 4432 | 5555 | 5544 |
| 09/11/2023 | 5555 | 4433 | 5555 | 5544 |
| 10/11/2023 | 5555 | 4433 | 5555 | 5554 |
| 11/11/2023 | 5555 | 4443 | 5555 | 5554 |

These findings suggest that mirror therapy contributed to the gradual improvement of muscle strength in the patient's affected upper extremity without any adverse effects or decrease in physical tolerance.

## DISCUSSION

Ischemic stroke is caused by the blockage of cerebral blood vessels by a thrombus or embolus, leading to a reduction in cerebral blood flow, and subsequently, decreased oxygen and glucose supply. This results in cellular ischemia and ultimately cerebral infarction (Black & Hawks, 2014; Hammond & Zimmermann, 2013). According to Lewis et al. (2014) and LeMone (2017), stroke risk factors are classified into modifiable and non-modifiable factors. Non-modifiable factors include age and gender, with individuals over 55 years being twice as likely to experience a stroke, and males being more frequently affected. Modifiable factors are closely related to lifestyle and the quality of medical care received.

In this case, after being diagnosed with hypertension, the patient admitted to not regularly taking prescribed medication. Poorly controlled hypertension increases the risk of recurrent stroke. Therefore, blood pressure control is critical in stroke prevention. Cholesterol, although essential in bodily functions, can also pose a threat to cerebral vasculature when present in excessive amounts. Uzuner and Uzuner (2023) identified hyperlipidemia as one of the risk factors for recurrent stroke. While considered a minor risk factor for recurrent ischemic stroke, hyperlipidemia should be addressed to prevent recurrence. Excess LDL cholesterol may lead to the formation of plaques that can obstruct cerebral arteries (Ariani et al., 2023; Koosgiarto & Salim, 2015).

Collaborative administration of antiplatelet agents for Mr. R aimed to prevent recurrent stroke. Clopidogrel, the antiplatelet prescribed, binds specifically and irreversibly to the P2RY12 purinergic receptors on platelets, inhibiting ADP-mediated platelet activation and aggregation (Sangkuhl et al., 2010; Kamarova et al., 2022). The use of antihypertensive and statin medications was intended to control both blood pressure and LDL cholesterol levels. Statins have been shown to improve functional outcomes in ischemic stroke patients (Alexxander & Pinzon, 2017). MRI and MRA results for Mr. R revealed chronic lacunar infarcts in the periventricular area of the bilateral posterior horns and thalamus, suspected thrombus in the internal carotid artery, and severe stenosis of the left middle cerebral artery (M1 segment). According to Uzuner and Uzuner (2023), large artery occlusion and lacunar infarction are significant risk factors for stroke recurrence. Stenosis in the middle cerebral artery increases the likelihood of another stroke.

To address impaired physical mobility, mirror therapy was used in conjunction with monitoring of physical tolerance through vital sign checks before and after each session. The intervention showed positive outcomes, with an increase in upper extremity muscle strength from 5555 | 4432 to 5555 | 4443 after five days of therapy. Stevens and Stoykov (2003) demonstrated that muscle activation in the ipsilateral motor cortex can be stimulated by observing the mirrored movement of the unaffected hand. When the right hand is used and perceived visually as the left, increased activation in the right hemisphere occurs, and vice versa. The mirror image stimulates the contralateral hemisphere of the perceived limb, thus enhancing cortical muscle stimulation (Thieme et al., 2018).

The findings from this case are consistent with the results reported by Maisyaroh et al. (2021), who found that mirror therapy effectively increased muscle strength in stroke patients with hemiparesis. Setiyawan et al. (2019) also confirmed that mirror therapy significantly improved upper limb muscle strength in patients with non-hemorrhagic stroke. Additionally, monitoring of physical tolerance before and after therapy is crucial to assess fatigue levels and prevent complications such as injury (Doenges et al., 2019). In line with World Health Organization (WHO) recommendations for simple and safe rehabilitation methods for stroke patients with hemiparesis, mirror therapy is a cost-effective and safe intervention (Suaib & Kurniawan, 2022; Thieme et al., 2018). This was further supported by the stable vital signs observed in Mr. R before and after therapy, indicating no reduction in physical tolerance or occurrence of injuries. Brainin and Heiss (2019) also reported that mirror therapy, when administered over a six-month period, did not produce any adverse effects.

## CONCLUSION

Ischemic stroke is a condition in which a cerebral blood vessel becomes obstructed by a thrombus or embolus, resulting in reduced blood flow and, consequently, decreased oxygen and glucose supply. This leads to cellular ischemia and ultimately cerebral infarction. An obstruction in the frontal lobe, specifically in Brodmann area 4 along the pyramidal tract, can cause hemiparesis. Prolonged hemiparesis may lead to complications such as joint contractures. In this case study, the intervention applied by the researcher to improve muscle strength and prevent joint contractures was the implementation of mirror therapy. Evaluation of the five-day mirror therapy intervention in a patient with ischemic stroke and hemiparesis demonstrated a successful increase in upper extremity muscle strength. Moreover, the procedure was well tolerated, caused no adverse effects, and proved to be relatively simple to administer. Conclusion: These findings suggest that mirror therapy is an effective, safe, and feasible rehabilitation intervention that can be implemented by nursing professionals in clinical settings for stroke patients with hemiparesis.

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