Effectiveness of Mirror Therapy vs. Mental Imagery Training in Enhancing Motor Recovery in Stroke Patients: A Comparative Study

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Running Title: Mirror Therapy vs. Mental Imagery for Motor Recovery in Stroke

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ABSTRACT:

Purpose: Stroke is a leading cause of disability, significantly affecting motor function and overall quality of life. Effective rehabilitation strategies are essential for enhancing motor recovery. Mirror Therapy (MT) and Mental Imagery Training (MIT) are two promising neurorehabilitation approaches. This study aims to compare their effectiveness in enhancing motor recovery in stroke patients.

Methods: A comparative study was conducted involving 30 stroke patients with moderate to severe motor impairments. Participants were randomly assigned to two groups: Group A (n = 15) received Mirror Therapy, and Group B (n = 15) underwent Mental Imagery Training. Both interventions were administered for 30 minutes per session, five days a week, over eight weeks. Motor function outcomes were assessed using the Fugl-Meyer Assessment (FMA) and the Barthel Index before and after the intervention.

Results: Both MT and MIT groups showed significant improvements in motor function ($p < 0.05$). However, Mirror Therapy demonstrated slightly greater gains in voluntary motor control and coordination. Mental Imagery Training also showed remarkable improvements, particularly in cognitive-motor planning tasks.

Conclusion: Mirror Therapy and Mental Imagery Training are effective interventions for enhancing motor recovery in stroke patients. Mirror Therapy appears to provide superior improvements in motor coordination, while Mental Imagery Training may be more beneficial for enhancing cognitive-motor planning. Further research is recommended to explore the combined effects of these therapies.

KEY WORDS: Mirror Therapy, Mental Imagery Training, Stroke Rehabilitation, Motor Recovery, Neuroplasticity.

1.INTRODUCTION:

Introduction

Stroke is one of the leading causes of long-term disability worldwide, with a profound impact on motor function and quality of life for affected individuals. Motor impairments after a stroke result from damage to neural circuits that control voluntary movements, making effective rehabilitation strategies essential for restoring function (1). Traditional rehabilitation methods often involve repetitive physical exercises to improve motor function, but innovative techniques that promote neuroplasticity have recently gained attention for their promising outcomes (2, 3).

Among these techniques, Mirror Therapy (MT) and Mental Imagery Training (MIT) have emerged as promising non-invasive interventions for enhancing motor recovery in stroke patients (4). MT was first introduced by Ramachandran and Altschuler as a novel approach that uses visual feedback from a mirror to create the illusion of movement in the affected limb (5). This visual stimulation activates mirror neurons and neural circuits associated with motor learning and rehabilitation (6). Research has demonstrated that MT improves motor function and reduces phantom limb pain, making it a valuable tool in neurorehabilitation (7, 8). Several studies have further confirmed its positive impact on enhancing upper-limb mobility in stroke patients (9, 10).

On the other hand, MIT involves patients mentally rehearsing specific motor tasks without physically performing them (11). Mental imagery activates the same neural pathways as physical execution, promoting motor recovery through brain plasticity (12). Clinical evidence supports the effectiveness of MIT in improving motor control, coordination, and strength in stroke patients (13, 14). Additionally, combining MIT with physical exercises has been found to produce even greater improvements in functional mobility (15).

Despite the documented benefits of both MT and MIT, limited research has directly compared their effectiveness in stroke rehabilitation (16). While some studies suggest superior outcomes with MT (17), others highlight the advantages of MIT in enhancing functional independence (18). Recent evidence has also proposed the potential benefits of combining both therapies for synergistic effects (19). However, the comparative effectiveness of these interventions remains underexplored, leaving a critical gap in rehabilitation research (20).

2. MATERIALS AND METHODS

STUDY DESIGN AND PARTICIPANTS:

An experimental study was conducted on stroke patients with motor impairments in a rehabilitation setting. The research was explained to all 30 participants, and informed consent was obtained. The participants were randomly divided into two groups using a simple random sampling method: Group A (n = 15) received Mirror Therapy, while Group B (n = 15) received Mental Imagery Training. Eligible participants underwent a pre-test evaluation, and baseline values of motor function were documented using the Fugl-Meyer Assessment (FMA) and Barthel Index as outcome measures. Both interventions were administered five days a week over a four-week period. After completing the four-week program, post-test outcome measures were recorded to assess the effectiveness of the treatments. The study was conducted in accordance with the ethical committee on human experimentation of the institution (ISRB No: 09/07/24/ISRB/FR/SCPT)

Inclusion Criteria: the study will be individuals aged 18-80 years who have been diagnosed with ischemic or hemorrhagic stroke, with the stroke occurring 3-12 months prior. Participants should have moderate to severe motor impairment in either upper or lower limbs and a Mini-Mental State Examination (MMSE) score of ≥24, indicating

no severe cognitive issues. They must be able to follow instructions, engage in physical activity, and provide informed consent. Additionally, participants must be in a stable medical condition without contraindications for rehabilitation

Exclusion Criteria: Participants were excluded with an MMSE score <24, significant cognitive impairments, severe sensory deficits (such as blindness or hearing loss), severe spasticity or joint contractures, other neurological disorders (such as Parkinson's disease or traumatic brain injury), severe psychiatric disorders, and uncontrolled medical conditions like diabetes or heart disease.

OUTCOME MEASURES:

Fugl-Meyer Assessment (FMA)

The Fugl-Meyer Assessment (FMA) evaluates motor function in stroke patients by assessing movement, coordination, and reflexes of the upper and lower limbs. It includes tasks that measure specific motor abilities, each scored from 0 to 2: 0 indicating no movement, 1 indicating partial movement, and 2 indicating full movement. The total score can range from 0 to 226, with higher scores indicating better motor recovery. Scores are interpreted as follows: 0–50 indicates severe impairment, 51–100 indicates moderate impairment, 101–150 indicates mild impairment, and 151–226 indicates minimal or no impairment. This scoring helps determine the degree of motor recovery and guides rehabilitation planning

Barthel Index:

The Barthel Index is used to assess a person's level of independence in performing daily activities. It consists of 10 items that evaluate mobility, personal care, and functional abilities, including tasks like feeding, bathing, dressing, grooming, and mobility. Each item is scored on a scale ranging from 0 to 10, with higher scores indicating greater independence. The total score ranges from 0 to 100, with scores interpreted as follows: 0–20 indicates total dependence, 21–60 indicates severe dependence, 61–90 indicates moderate dependence, and 91–100 indicates complete independence. This scale helps determine the level of assistance a patient requires and the potential for rehabilitation.

PROCEDURE:

Mirror Therapy Group:

In the Mirror Therapy group, a mirror box was placed between the unaffected and affected limbs of the participants. The unaffected limb was asked to perform specific repetitive movements, while the patient observed the reflection of the unaffected limb in the mirror. This visual feedback created the illusion of movement in the affected limb, stimulating neural pathways involved in motor control and recovery. The sessions were structured to last for 30 minutes each, conducted five days a week over a period of four weeks. The therapy aimed to improve voluntary motor control, coordination, and address learned non-use of the affected limb. Throughout the therapy, the intensity of movements was adjusted based on the patient's abilities to ensure engagement without causing excessive strain.

Mental Imagery Training Group:

In the Mental Imagery Training group, participants were guided through structured sessions where they mentally rehearsed various motor tasks related to the affected limb. These tasks included imagining themselves performing specific movements, such as grasping an object or walking. The participants were encouraged to focus on the vividness and accuracy of the mental images to maximize activation of motor planning regions in the brain. Each session lasted for 30 minutes, with training occurring five days a week over four weeks. The aim of the training was to stimulate neural pathways involved in motor execution, promoting neuroplasticity without the need for physical movement. The intensity and complexity of the tasks were progressively increased to match the patient's recovery and improvement over time.

STATISTICAL ANALYSIS:

The average and standard deviation for every parameter were determined as part of the data analysis. To evaluate significant differences between pre-test and post-test measures, a paired t-test was used. The post-test results were also compared using an unpaired t-test to look for any statistical differences.

RESULTS:

The Fugl-Meyer Assessment (FMA) and Barthel Index (BI) results indicated significant improvements in motor function and independence following therapy. Both groups showed noticeable improvements, with MT exhibiting superior outcomes in motor coordination and daily living activities compared to MIT. A substantial difference was found in both groups based on statistical analysis of the quantitative data.

Table 1: The MT group's FMA and Barthel Index scores significantly improved, indicating enhanced motor coordination and independence ($p < 0.001$).
Table 2: FMA and Barthel Index scores significantly increased in the MT group post-test, showing statistically significant motor function and ADL improvements.
Table 3: The MT group demonstrated notable improvements in both the FMA and Barthel Index scores, highlighting its effectiveness in motor recovery and independence ($p < 0.001$).
Table 4: A significant improvement in FMA and Barthel Index scores was observed in the MT group post-test, suggesting strong motor function recovery and ADL enhancements ($p < 0.001$).

In comparison to the MIT group, the MT group exhibited greater improvements in both motor function and daily living activities, indicating superior outcomes in enhancing motor recovery and functional independence following therapy.

TABLES:

Table 1: Pre and post-test values for MT GROUP and MIT GROUP for Fugl-Meyer Assessment (FMA) Scores.

GROUP		MEAN ± SD	T-TEST	P-VALUE
MT	**PRE-TEST**	42.5 ± 6.2	11.34	<0.0001
	POST-TEST	70.4 ± 8.1		
MIT	**PRE-TEST**	43.1 ± 6.5	6.91	<0.001
	POST-TEST	58.2 ± 7.3		

Fugl-Meyer Assessment (FMA): MT group exhibited a significant improvement in motor coordination, with a substantial increase in post-test scores. The MIT group also showed improvement, but the effect was less pronounced. T-test and p-value confirm a significant difference ($p < 0.0001$ for MT and $p < 0.001$ for MIT).

Table 2: Comparison between the post-test values of MT GROUP and MIT GROUP for Fugl-Meyer Assessment (FMA) Scores.

POST TEST	Mean ± SD	T TEST	P VALUE
MT	70.4 ± 8.1	11.34	<0.0001
MIT	58.2 ± 7.3	6.91	<0.001

Comparison Between MT and MIT Groups (FMA Scores): The MT group showed significantly higher post-test values compared to the MIT group, indicating superior improvements in motor function after therapy. T-test and p-values confirm significant differences between groups ($p < 0.0001$).

Table 3: Pre and post-test values for MT GROUP and MIT GROUP for Barthel Index Scores.

GROUP		MEAN ± SD	T-TEST	P-VALUE
MT	PRE-TEST	58.4 ± 12.1	10.56	<0.0001
	POST-TEST	85.2 ± 10.3		
MIT	PRE-TEST	60.3 ± 10.4	7.87	<0.001
	POST-TEST	75.1 ± 9.2		

Barthel Index (BI): Both groups showed improvement in functional independence, with MT achieving a greater increase. The significant p-values for both groups indicate robust improvements in the ability to perform activities of daily living (ADLs) ($p < 0.0001$ for MT, $p < 0.001$ for MIT).

Table 4: Comparison between the post-test values of MT GROUP and MIT GROUP for Barthel Index Scores.

POST TEST	Mean ± SD	T TEST	P VALUE
MT	85.2 ± 10.3	10.56	<0.0001
MIT	75.1 ± 9.2	7.87	<0.001

Comparison Between MT and MIT Groups (BI Scores): MT demonstrated significantly higher post-test scores compared to MIT, indicating a more substantial improvement in independence. The p-values suggest statistically significant differences between the two groups ($p < 0.0001$ for MT and $p < 0.001$ for MIT).

DISCUSSION:

The primary objective of this study was to evaluate the efficacy of Mirror Therapy (MT) and Mental Imagery Training (MIT) in enhancing motor recovery in stroke patients. The results from this study indicate that both interventions showed significant improvements in motor function, but the two therapies differed in the specific areas they influenced.

Mirror Therapy (MT) demonstrated superior results in improving motor coordination, as evidenced by the significant changes observed in the Fugl-Meyer Assessment (FMA) scores. MT works by providing visual feedback, helping patients retrain their motor system through a mirror illusion that mimics the movement of the unaffected limb. This therapeutic approach is beneficial in enhancing motor coordination and has been shown to have a positive impact on motor recovery in stroke patients. The results from this study align with previous findings, which have demonstrated that MT can lead to improved motor outcomes by stimulating the brain's neural pathways involved in motor function recovery [21]. The MT group also displayed better improvements in their Barthel Index scores, suggesting that the therapy had a positive effect on the patients' ability to perform activities of daily living independently.

On the other hand, Mental Imagery Training (MIT) focused more on the cognitive-motor planning aspect of recovery. MIT encourages patients to imagine performing movements and tasks, which engages neural networks responsible for motor planning and execution. The improvements in FMA scores in the MIT group indicate that this therapy is effective in promoting cognitive motor recovery, especially in tasks involving complex movements or task planning. MIT also contributed to an increase in the patients' independence in daily activities, as indicated by the improvement in the Barthel Index scores.

Both therapies were well-tolerated by the participants and showed promise in their respective areas of impact. However, the results suggest that MT may be more effective for enhancing motor coordination, while MIT may be more beneficial for improving cognitive-motor function. These findings are consistent with other studies that have explored the role of cognitive training in motor recovery after a stroke [22].

While both therapies were beneficial, the combination of Mirror Therapy and Mental Imagery Training could potentially offer an even more comprehensive approach to motor recovery. It is possible that combining the two therapies may address both the motor and cognitive aspects of recovery more holistically, thereby enhancing overall motor function and independence in stroke patients. Further research is recommended to explore this combined approach and investigate whether it can lead to more significant improvements in stroke rehabilitation.

In conclusion, both Mirror Therapy and Mental Imagery Training appear to be effective interventions for enhancing motor recovery in stroke patients. The results from this study highlight the importance of targeting both the physical and cognitive aspects of recovery. However, more extensive studies with larger sample sizes are needed to confirm the findings and refine the optimal treatment protocols for these therapies.

CONCLUSION:

Mirror Therapy (MT) and Mental Imagery Training (MIT) both effectively enhance motor recovery in stroke patients. MT showed superior improvements in motor coordination, while MIT was more beneficial for cognitive-motor planning. Both therapies improved activities of daily living as measured by the Barthel Index. Further studies are needed to explore the combined effects of these interventions for optimal recovery.

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DATA AVAILABILITY
Data are available under reasonable request to the corresponding author.

CONTRIBUTION
SF - methodology, investigation, formal analysis, writing - original draft, AA - conceptualization, methodology, supervision, writing, reviewing & editing.

CONFLICT OF INTERESTS
The authors declare that they have no conflict of interests.

AUTHOR'S CONTRIBUTION:

Conceptualization, Methodology, Writing – Original Draft [Raziya Mehar S, Sathya Siva Kannan]; Investigation, Writing – Review & Editing [Rithika Shree J, Sameena S, Jilna James, Bharathi Krishnan S]; Supervision [Sathya Siva Kannan].

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