

Effect of Mirror Therapy Combined with Conventional Physiotherapy on Upper Limb Motor Recovery in Individuals with Stroke

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ABSTRACT

Background:

Stroke is the main cause of long-term disability, which affects mainly the upper limb and results in motor impairment and limits independence in daily activities. Mirror therapy uses visual feedback to facilitate motor recovery through neuroplastic changes. Which is a simple and cost-effective rehabilitation approach; because of this, it has gained attention in treatment therapy.

Objective:

To determine the effectiveness of mirror therapy in improving upper limb motor function in individuals with stroke when used along with conventional physiotherapy.

Methods:

A pre- and post-interventional study was conducted on 30 individuals with subacute and chronic stroke presenting with upper limb motor impairment. Mirror therapy in addition to conventional physiotherapy was given to participants for 12 weeks (30 minutes per session, five sessions per week). Motor recovery and functional performance both before and after the intervention were assessed using the Fugl-Meyer Assessment for Upper Extremity (FMA-UE) and the Action Research Arm Test (ARAT). The paired t-test was used for statistical analysis, and the significance level was set at $p < 0.05$.

Results:

Both outcome measures showed statistically significant improvements following the treatment. The mean FMA-UE score increased from 28.6 ± 5.4 to 42.1 ± 4.9 ($p < 0.001$), which indicates enhanced motor recovery. Similarly, Action Research Arm scores improved from 19.8 ± 4.3 to 33.5 ± 5.1 ($p < 0.001$), resulting in better functional use of the affected upper limb.

Conclusion:

It was observed that mirror therapy, along with conventional physiotherapy when given in upper limb motor impairment after stroke is effective and a good practical intervention for improvement. It is suitable for both clinical and home-based rehabilitation because of simplicity and low cost. Further studies with larger samples and controlled designs are needed to strengthen the evidence.

Keywords: Stroke, Mirror Therapy, Upper Limb Rehabilitation, Motor Recovery, Neuroplasticity, Physiotherapy

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INTRODUCTION:

Stroke is a sudden neurological condition that occurs when the blood supply to the brain is interrupted or reduced. Medical treatment for stroke has improved in recent years but it still remains one of the main causes of death and long-term disability worldwide. According to the Global Burden of Disease Study 2019, stroke is the second leading cause of death and

the third leading cause of disability across the world (1).

Even though more people survive after a stroke today, many survivors continue to live with serious physical problems that affect their ability to perform daily activities (1).

Among the various problems caused by stroke motor dysfunction is the most common and disabling impairment. In about 70–80% of patient upper limb motor weakness occurs during the acute stage of stroke, and many of these patients do not regain full functional recovery (12).

Persistent weakness of the arm greatly affects a person's ability to perform daily activities such as reaching, grasping objects, dressing, eating, and other tasks needed for independent living (14). Restoring upper limb motor control is one of the main goal of stroke rehabilitation because upper limb is mostly involved in performing daily activities.

Stroke rehabilitation is based on the principles of neuroplasticity and motor relearning, which means the brain can adapt and relearn itself after injury. Repetitive and task oriented and intense practice is advised by Evidence-based guidelines to help the brain reorganize and improve functional recovery (7).

Over the years, several treatment methods have been introduced to improve upper limb recovery after stroke, such as constraint-induced movement therapy, robotic training, and task-specific training. Recently mirror therapy has also gained attention as a simple and low-cost treatment method that shows neurophysiological benefits in stroke rehabilitation.

Mirror therapy is based on the visual feedback mechanism and on the concept of activating the mirror neuron system. In this technique, a mirror is placed in the middle of the patient's body so that the movement of the unaffected limb is reflected in the mirror while the affected limb is hidden behind it.

The reflected movement creates a visual illusion that makes it appear as if the weak or paralyzed limb is moving normally. It is believed that visual feedback stimulates motor areas of the brain and helps in the functional reorganization of the brain (13).

Mirror therapy is a non-invasive, low-cost, and easy-to-use treatment method, which can be applied in both clinical settings and at home.

Over the past decade, scientific evidence supporting mirror therapy has increased. A Cochrane review reported that mirror therapy can improve motor function and activities of daily living when it is used along with conventional rehabilitation compared to conventional rehabilitation alone (3).

Similar to this, a number of systematic reviews and meta-analyses have revealed modest evidence in favor of mirror therapy's ability to improve upper limb motor function in stroke patients (4). According to recent research we can use Mirror therapy as an extra treatment in structured rehabilitation programs to gain better results in stroke recovery (2).

Many studies on mirror therapy continue to show differences in treatment protocols, dosage, and patient selection. So more research is needed to better understand its effectiveness. Subacute and chronic stroke patients whose natural recovery has slowed or plateaued require treatments that can speed up motor recovery even further. The goal of this study is to evaluate the efficacy of mirror therapy on upper limb motor recovery in stroke patients, as well as to define its usefulness as an addition to traditional physiotherapy during the subacute and chronic stages of rehabilitation.

METHODOLOGY:

Study Design

This study was conducted as a pre–post interventional study to evaluate the effectiveness of mirror therapy on upper limb motor recovery in individuals with stroke.

Study Setting and Duration

The study was carried out at the Department of Physiotherapy, Pacific Medical College and Hospital Udaipur, for 12 weeks.

Participants

A total of 30 participants diagnosed with stroke were enrolled for the study based on inclusion and exclusion criteria.

Inclusion Criteria

- Adults aged 30–70 years with first-ever unilateral stroke
- Patients in subacute or chronic stage (> 4 weeks post-stroke)
- Presence of upper limb motor impairment
- Ability to follow simple verbal instructions

Exclusion Criteria

- Severe cognitive impairment or aphasia
- Visual deficits affecting participation in mirror therapy
- Severe spasticity (Modified Ashworth Scale > 3)
- Other neurological or musculoskeletal conditions affecting upper limb function

Outcome Measures

The following standardized outcome measures were used:

- Fugl-Meyer Assessment for Upper Extremity (FMA-UE)
- Action Research Arm Test (ARAT)

Assessments were conducted at baseline (pre-intervention) and after 12 weeks (post-intervention).

Intervention Protocol

All participants received mirror therapy in addition to conventional physiotherapy.

Conventional Physiotherapy

Conventional rehabilitation aimed to improve motor control and functional use of the affected upper limb. The program included:

- Perform active and assisted range of motion exercises.
- Perform task-oriented upper limb tasks.
- Perform reaching and gripping tasks.
- Providing functional training for daily living activities.
- Strengthening exercises for shoulders, elbows, and wrists.

Each session was conducted for approximately 30 minutes.

Mirror Therapy

Mirror therapy was performed with a mirror located in the mid-sagittal plane of the patient. The injured upper limb was placed behind the mirror while the unaffected limb was visible in front of it.

The participants were told to perform simple tasks such as looking at the reflection of the unaffected limb while

- Flexion and extension of wrist.
- Opening and closing of fingers.
- Forearm supination and pronation.
- Ability to pick up and drop off tasks

This visual feedback gave the impression that the affected limb was moving correctly and this could help cortical remodelling and motor recovery.

Mirror therapy was administered for 30 minutes per session 5 days a week for 12 weeks.

Outcome Measures

Upper limb motor recovery was assessed using standardized clinical outcome measures.

The Fugl-Meyer Assessment was used to assess motor impairment and recovery of the upper limb.

The Action Research Arm Test was used to assess functional performance of the upper limb in tasks involving grasp, grip, pinch, and gross movement.

Assessments were conducted at baseline (pre-intervention) and after 12 weeks (post-intervention).

Statistical Analysis

Data were analysed using a paired t-test to compare pre- and post-intervention scores. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Written informed consent was obtained from all participants before enrolling in the study. Throughout the study, patient confidentiality was maintained, and the intervention procedures were conducted according to ethical guidelines for clinical research.

RESULT

Participant Characteristics

A total of 30 patients with stroke completed the study. All participants followed the intervention protocol, and during the study period, no adverse events were reported.

Changes in Upper Limb Motor Function

Upper Limb Motor Function

After receiving 12 weeks of intervention, a significant improvement was observed in upper limb motor function.

The mean Fugl-Meyer Assessment for Upper Extremity (FMA-UE) score increased from 28.6 ± 5.4 at baseline to 42.1 ± 4.9 post-intervention. This improvement was statistically significant ($p < 0.001$).

Action Research Arm Test (ARAT) scores improved from 19.8 ± 4.3 to 33.5 ± 5.1 , showing better functional ability in the affected upper limb. This change was also statistically significant ($p < 0.001$).

Table 1: Comparison of Pre- and Post-Intervention Scores

Outcome Measure	Pre-Intervention (Mean $\pm$ SD)	Post-Intervention (Mean $\pm$ SD)	Mean Change	t-value	p-value
FMA-UE	28.6 $\pm$ 5.4	42.1 $\pm$ 4.9	13.5	10.12	< 0.001
ARAT	19.8 $\pm$ 4.3	33.5 $\pm$ 5.1	13.7	9.45	< 0.001

Appendix: Individual Patient Data.

Note: This detailed table is provided to substantiate the mean values reported above.

Patient no.	FMA-UE (Pre)	FMA-UE (Post)	ARAT (Pre)	ARAT (Post)
1.	24	38	16	28
2.	32	45	22	36
3.	28	41	19	32
4.	35	48	25	40
5.	22	37	15	29
6.	30	44	21	35
7.	26	40	18	31
8.	33	46	23	38
9.	29	43	20	34
10.	25	39	17	30
11.	31	45	22	36
12.	27	41	19	33
13.	34	47	24	39
14.	23	38	16	28
15.	30	43	21	35
16.	28	42	20	34
17.	36	49	26	41
18.	21	36	14	27
19.	29	43	20	34
20.	25	40	17	31
21.	32	45	23	37
22.	27	41	18	32
23.	34	46	24	39
24.	22	37	15	29
25.	31	44	22	35
26.	29	42	20	34
27.	26	40	18	32
28.	33	47	23	38
29.	24	39	17	30
30.	30	44	21	35

Overall, the result shows that mirror therapy combined with conventional physiotherapy led to statistically significant improvements in motor

recovery and functional performance of the upper limb in individuals with stroke.

DISCUSSION

This study showed that combining mirror therapy with conventional physiotherapy resulted in significant improvements in upper limb motor function in stroke patients. The observed changes in mean Fugl-Meyer Assessment FMA-UE and action research arm test scores indicate improved motor control and functional use of the affected limb after the intervention. Mirror therapy is thought to be beneficial in healing by providing visual feedback through the mirror of the unaffected limb, resulting in the illusion of movement in the affected limb. This visual input is believed to stimulate cortical motor regions and promote neuroplastic changes, which are essential for post-stroke motor recovery (10).

The result of this study is in contract with previous research. Arya et al. reported that task-based mirror therapy significantly improved motor recovery and functional performance in individuals with stroke when used with conventional rehabilitation (8). Similarly, Samuelkamaleshkumar et al. observed improvements in upper limb motor performance and functional independence following mirror therapy intervention (9).

Zeng et al. found that mirror therapy improves upper limb motor recovery when combined with normal physiotherapy (6). These findings are similar to the benefits seen in the current investigation. The intensity and repetition of rehabilitation affect motor recovery after a stroke. Structured and task-oriented training promote brain remodelling and improve functional results (11). By giving additional sensory feedback and encouraging active patient participation can enhance these treatments.

In addition, recovery of upper limb function depends on several factors, it includes the severity of impairment and mostly early initiation of rehabilitation. Evidence suggests that timely and consistent therapy contributes to better functional results (5). The improvements observed in this study may be due to both the structured rehabilitation programme and the combination of mirror therapy.

Overall, the findings suggest that mirror therapy is a simple, in-expensive, and clinically feasible intervention that can be included into routine stroke rehabilitation to improve upper limb recovery. However, more large-scale studies are required to confirm these findings.

LIMITATIONS

This study has certain limitations that should be considered while interpreting the findings:

The study had a relatively small sample size (n=30) which may limit the generalisability of the findings to the wider stroke population.

The study was carried out using single group pre-post interventional design without control group. Thus, there was no direct comparison with conventional physiotherapy alone or with other rehabilitation interventions.

The participants were recruited from one tertiary care centre and this may limit the external validity and applicability of the findings to other health care settings.

CONCLUSION:

This study shows that mirror therapy, along with standard physiotherapy and this can help in improving upper limb movement after stroke. It is simple, low-cost, and easy to use in clinical practice. However, more large-scale studies are needed to confirm these results.

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Conflict of Interest Statement

The authors declare that they have no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon

reasonable request.

Author Contribution Statement

Conceptualization: Dr. Deepak Lohar, Dr. Jafar Khan. Investigation: Bhumika Lohar. Methodology:

Bhumika Lohar, Dr. Deepak Lohar. Formal analysis: Bhumika Lohar, Dr. Deepak Lohar.

Supervision: Dr. Deepak Lohar, Dr. Jafar Khan. Writing – original draft: Bhumika Lohar. Writing –

review & editing: Bhumika Lohar, Dr. Deepak Lohar, Dr. Jafar Khan. All authors approved the final

version of the manuscript and agree to be accountable for all aspects of the work.

Ethics approval

This study was approved by the Institutional Ethics Committee of Pacific Medical University,

Udaipur, Rajasthan, India, and was conducted in accordance with the Declaration of Helsinki.

Informed consent

Written informed consent was obtained from all participants prior to their inclusion in the study.

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