



Mirror Therapy Versus Bilateral Arm Training Combined with Task-Oriented Training on Upper Limb Recovery in Sub-Acute Stroke Patients

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Abstract

Background: Stroke is a leading cause of long-term disability, often resulting in impaired upper limb function. Rehabilitation strategies such as mirror therapy, bilateral arm training, and task-oriented training aim to enhance motor recovery through neuroplasticity.

Methodology: In this experimental comparative study, 30 sub-acute stroke patients were recruited using convenience sampling and randomly allocated into two groups. Group A received mirror therapy combined with task-oriented training, while Group B received bilateral arm training combined with task-oriented training. Interventions were administered for 30 minutes per session, 5 days per week for 4 weeks. Outcome measures included the Fugl-Meyer Assessment for Upper Extremity (FMA-UE) and the Wolf Motor Function Test (WMFT).

Results: Both groups demonstrated significant improvement in upper limb motor function. Group A showed significantly greater improvement than Group B, with a mean FMA-UE improvement of 10.33 ± 1.58 compared to 6.53 ± 1.24 ($p < 0.001$).

Conclusion: Both interventions are effective in improving upper limb function in sub-acute stroke patients, but mirror therapy combined with task-oriented training is more effective than bilateral arm training combined with task-oriented training.

Keywords: Stroke; Task-Oriented Training; Mirror Therapy; Bilateral Arm Training; Upper Limb Function; Fugl-Meyer Assessment; Wolf Motor Function Test

Introduction

Stroke is a major global health concern and one of the leading causes of long-term disability among adults. It is defined as a rapidly developing clinical sign of focal or global disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin. The incidence of stroke continues to rise, particularly in developing countries, resulting in a significant socioeconomic burden due to prolonged rehabilitation needs and reduced quality of life. Among the various impairments following stroke, upper limb dysfunction is one of the most common and disabling consequences. A large proportion of stroke survivors experience persistent deficits in motor control, coordination, and functional use of the affected upper extremity. These impairments severely limit the ability to perform activities of daily living (ADLs), thereby affecting independence and participation in social and occupational roles.

Recovery of upper limb function after stroke is complex and largely depends on the brain's ability to reorganize itself, known as neuroplasticity. In the sub-acute phase of stroke (typically within 3–6 months), the brain exhibits heightened plasticity, making it a critical period for rehabilitation interventions. During this phase, appropriate therapeutic strategies can significantly enhance motor recovery by promoting reorganization of neural pathways and improving motor relearning.

Task-oriented training is a widely accepted rehabilitation approach that emphasizes repetitive practice of functional, goal-directed activities. It is based on motor learning principles and aims to improve the performance of meaningful tasks by engaging patients actively in therapy. This approach has been shown to facilitate cortical reorganization and improve functional outcomes in stroke patients.

Mirror therapy is another innovative rehabilitation technique that utilizes visual feedback to stimulate motor recovery. By placing a mirror in the sagittal plane, the reflection of the non-affected limb creates an illusion that the affected limb is moving normally. This visual illusion is believed to activate mirror neurons and promote cortical reorganization, thereby enhancing motor function in the affected limb. Mirror therapy is simple, cost-effective, and can be easily incorporated into rehabilitation programs.

Bilateral arm training involves the simultaneous use of both upper limbs to perform symmetrical or coordinated movements. This technique is based on the concept of interlimb coupling, where movement of the unaffected limb facilitates activation of the affected limb through shared neural pathways. Bilateral training has been shown to improve motor control, coordination, and functional performance by enhancing neural connectivity between the hemispheres.

Although each of these interventions—task-oriented training, mirror therapy, and bilateral arm training—has demonstrated effectiveness individually, evidence comparing their combined effects with task-oriented training remains limited. Task-oriented training, when used as an adjunct to other therapies, may further enhance functional recovery by reinforcing learned motor patterns in real-life activities. However, there is limited evidence comparing the combined effects of mirror therapy and bilateral arm training when integrated with task-oriented training in sub-acute stroke patients. Understanding which combination yields better outcomes is essential for optimizing rehabilitation strategies and improving patient care. Therefore, the present study aims to compare the effectiveness of task-oriented training combined with mirror therapy versus bilateral arm training in improving upper limb function in sub-acute stroke patients.

Materials and Methods

Study design and study setting

- This study was designed as a randomized experimental comparative study.
- JDT Islam college of physiotherapy and Rehabilitation centre Vellimadukunnu, Calicut

Subjects

A total of 30 sub-acute stroke patients were recruited for the study using convenience sampling. Participants of both genders, aged between 50 and 70 years, with unilateral hemiplegia due to stroke were included. Only those in the sub-acute stage of stroke with a Brunnstrom stage of 3 or above for both proximal and distal upper limb and with the ability to initiate active wrist and finger extension were selected. Patients with severe aphasia, musculoskeletal deformities or recent fractures, severe cardiopulmonary conditions, visual or hearing impairments, and other neurological disorders such as Parkinson's disease or multiple

sclerosis were excluded from the study. The selected subjects were randomly allocated into two groups, with 15 participants in each group.

Methods

Ethical approval was obtained from the Institutional Ethics Committee prior to commencement of the study. Written informed

consent was obtained from all participants before enrolment. Pre- and post-intervention assessments were conducted using:

- Fugl-Meyer Assessment (Upper Extremity)
- Wolf Motor Function Test

Description of interventions

Group	Intervention	Procedure	Duration and Frequency
Group A	Mirror Therapy +Task Oriented Training	Mirror therapy was performed by placing a mirror in the sagittal plane reflecting the non-affected limb, creating a visual illusion of movement in the affected limb. Patients performed movements such as wrist and finger flexion-extension, forearm pronation-supination, and reaching activities while observing the mirror image. This was followed by task-oriented training including functional activities like drinking from a glass, lifting objects, wiping a table, grasping and releasing objects, and combing hair.	30 minutes/session, 5 days/week for 4 weeks
Group B	Bilateral Arm Training + Task-Oriented Training	Bilateral arm training involved simultaneous symmetrical movements of both upper limbs. Exercises included bilateral shoulder flexion, arm elevation, reaching, and grasping tasks performed together. This was followed by task-oriented training consisting of functional activities such as drinking from a glass, lifting objects, wiping a table, grasping and releasing objects, and combing hair.	30 minutes/session, 5 days/week for 4 weeks

Table 1

Data analysis

The collected data were analysed using Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics such as mean and standard deviation were used to summarize pre- and post-intervention scores of outcome measures in both groups. The normality of data distribution was assessed using the Kolmogorov–Smirnov test. Based on the results of normality testing, both parametric and non-parametric tests were applied. For intra-group comparison, the paired t-test was used for normally distributed data, while the Wilcoxon signed-rank test was used for non-normally distributed data to determine the significance of differences between pre- and post-test scores. For inter-group

comparison, the independent sample t-test and Mann–Whitney U test were used accordingly to compare the level of improvement between Group A and Group B. The level of statistical significance was set at $p < 0.05$.

Results

Data are presented as Mean ± Standard Deviation (SD). Statistical significance was set at $p < 0.05$. Inter-group comparisons were performed using the Independent Samples t-test/Mann-Whitney U test, and intra-group comparisons were performed using the Paired t-test/Wilcoxon Signed Rank test as appropriate.

Outcome measure	Group A	Group B	P-value	Interpretation
FMA-UL(Pre)	33.86 ± 6.33	32.40 ± 4.28	>0.05	Group Comparable at Baseline
FMA-UL(Post)	44.20 ± 7.30	38.93 ± 4.06	-	Improvement observed in both groups
Mean Improvement	10.33 ± 1.58	6.53 ± 1.24	<0.001	Significantly greater improvement in Group A
Within Group Significance	Significant	Significant	A:=0.001 B:<0.001	Both groups improved significantly
Sensory Function	Greater Improvement	Less Improvement	-	Group A better
Passive Rom	Greater Improvement	Less Improvement	-	Group A better
WMFT Scores	Better Functional Improvement	Less Improvement	-	Group A better
Overall Outcomes	Superior	Effective but less than A	<0.001	Group A more effective

Table B

Discussion

The present study showed that both groups demonstrated significant improvement in upper limb motor function following the intervention. This improvement can be attributed to neuroplastic changes occurring during the sub-acute phase of stroke recovery. Mirror therapy combined with task-oriented training showed greater improvement, which may be due to the activation of the mirror neuron system through visual feedback. The illusion of movement of the affected limb helps stimulate the motor cortex and enhances cortical reorganization, thereby improving voluntary motor control. Similar findings were reported by Madhoun HY., *et al.* [1] and Lim KB., *et al.* [2] who observed significant improvement in upper limb function with mirror therapy. The present study has certain limitations. Convenience sampling may have introduced selection bias, and the relatively small sample size limits the generalizability of the findings. Furthermore, the short intervention duration may not reflect long-term outcomes. Future studies with larger sample sizes and longer follow-up periods are recommended.

Task-oriented training played a vital role in both groups by promoting repetitive, goal-directed functional activities. This enhances motor learning and improves functional performance in daily activities. Studies by Thant AA., *et al.* [3] and Singh P., *et al.* [4] also support the effectiveness of task-oriented training in improving

upper limb function. Bilateral arm training also contributed to motor recovery by facilitating interlimb coordination and activating both hemispheres simultaneously. This may enhance motor output in the affected limb through neural coupling. However, the improvement was comparatively less than mirror therapy, possibly due to the absence of strong visual feedback. Similar results were reported by Lee MJ., *et al.* [5] and Dhakate D., *et al.* [6].

Overall, the greater improvement observed in the mirror therapy group suggests that combining visual feedback with functional task practice produces better outcomes. These findings are consistent with previous studies, indicating that mirror therapy combined with task-oriented training is more effective in improving upper limb function in sub-acute stroke patients [7-10].

Conclusion

Both mirror therapy and bilateral arm training combined with task-oriented training are effective in improving upper limb function in sub-acute stroke patients.

However, mirror therapy combined with task-oriented training demonstrated greater improvement in upper limb motor recovery compared with bilateral arm training combined with task-oriented training. Further studies with larger sample sizes are recommended to confirm these findings.

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