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Article

Comparison of Mirror Therapy and Task-Specific Training on Upper Limb Function in Post-Stroke Patients With Shoulder Pain

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ABSTRACT

Background: Stroke is a leading cause of adult disability worldwide, often resulting in upper limb motor deficits and shoulder pain that significantly impair daily function and quality of life. Despite various rehabilitation strategies, comparative evidence on the standalone effectiveness of mirror therapy (MT) versus task-specific training (TST) in this population remains limited. **Objective**: This study aimed to compare the effects of mirror therapy and task-specific training on upper limb motor function, shoulder pain, and muscle strength in post-stroke patients with shoulder pain, hypothesizing that TST would yield superior outcomes. **Methods**: A single-center, randomized controlled trial was conducted involving 36 post-stroke patients (n = 36) aged 39–67 years, with stroke onset between 3–12 months, Fugl-Meyer Assessment (FMA) scores of 20–50, and shoulder pain rated ≥4 on the Visual Analog Scale (VAS). Participants were randomly allocated to receive either MT or TST for 30-minute sessions, three times weekly for 8 weeks. Outcome measures included FMA (primary), VAS, and Manual Muscle Testing (MMT) for shoulder abduction, elbow flexion, and wrist extension. Ethical approval was obtained from the Research and Ethics Committee at Government College University, Faisalabad (Ref: GCUF/ERC/24/2465), and informed consent was secured in compliance with the Declaration of Helsinki. Data were analyzed using SPSS v25 with paired t-tests, independent t-tests, and Mann-Whitney U tests where appropriate ($p < 0.05$). **Results**: Both groups showed significant pre-post improvements in FMA, VAS, and MMT ($p < 0.001$). Post-intervention analysis revealed significantly higher FMA scores (43.89 ± 2.70 vs. 38.00 ± 3.03), lower VAS scores (2.56 ± 0.51 vs. 3.78 ± 0.81), and better shoulder abduction strength ($p = 0.047$) in the TST group compared to the MT group. No significant differences were noted for elbow flexion ($p = 0.279$) or wrist extension ($p = 0.406$), though both improved clinically. **Conclusion**: Both mirror therapy and task-specific training significantly improved upper limb function and reduced shoulder pain in post-stroke patients; however, task-specific training demonstrated superior functional and pain-related outcomes. These findings support the integration of TST as a primary rehabilitation strategy and highlight its practical utility in neurorehabilitation settings.

Keywords: Stroke Rehabilitation, Upper Extremity Function, Mirror Therapy, Task-Oriented Training, Shoulder Pain, Motor Recovery, Physical Therapy Modalities

INTRODUCTION

Stroke is a leading cause of adult disability worldwide, often resulting in persistent motor deficits that substantially impair functional independence. Among these, upper limb (UL) motor impairment is particularly debilitating, affecting up to 80% of stroke survivors (7). This limitation significantly restricts activities of daily living such as eating, dressing, and personal hygiene, ultimately impacting the quality of life and social reintegration of individuals post-stroke (8). The incidence of UL dysfunction is further complicated when accompanied by shoulder pain, a common sequela that exacerbates disability and hinders rehabilitation engagement (9). Post-stroke shoulder pain is frequently associated with motor dysfunctions like spasticity, contracture, and impaired proprioception, which can delay or regress motor recovery if not managed effectively (10). Despite various rehabilitation approaches, optimizing motor recovery in the affected UL remains a clinical challenge. Conventional therapy methods often fail to provide sufficient intensity, task specificity, or engagement to elicit significant neuroplastic changes (11).

Among emerging techniques, mirror therapy (MT) and task-specific training (TST) have shown promise in promoting motor recovery through distinct mechanisms. Mirror therapy capitalizes on visual feedback and activation of the mirror neuron system, thereby facilitating cortical reorganization in motor regions via the visual illusion of movement in the paretic limb (16). Conversely, TST is grounded in principles of motor learning and neuroplasticity, involving repetitive, context-relevant activities that reinforce use-dependent motor skills and functional integration (14). Both interventions have demonstrated effectiveness independently; however, the evidence is mixed regarding their comparative efficacy when used in isolation.

The current body of research presents gaps in directly contrasting the standalone effects of MT and TST in populations with post-stroke shoulder pain. Although prior studies like those by Lim et al. and Arya et al. underscore the benefits of functional task incorporation into MT protocols (14,15), others, such as Abbas and Jabeen, suggest superior results when both MT and TST are integrated (19). Still, there remains a paucity of research isolating and comparing these two strategies to determine which yields better motor and pain-related outcomes when applied independently. This is particularly important in clinical scenarios where resource constraints or patient conditions necessitate the prioritization of one modality over another.

Therefore, this study aimed to address the comparative effectiveness of MT versus TST on upper limb function in post-stroke individuals experiencing shoulder pain. By focusing on changes in motor performance, pain levels, and muscle strength over an 8-week intervention, the study intended to clarify whether either intervention alone confers superior therapeutic benefits. The central hypothesis was that while both therapies would produce significant functional improvements, task-specific training would result in greater gains in motor recovery and pain reduction compared to mirror therapy.

MATERIALS AND METHODS

This randomized controlled trial was conducted over a six-month period, from July to December 2024, at Ahmad Poly Clinic Faisalabad. The study enrolled 36 participants diagnosed with ischemic or hemorrhagic stroke confirmed via neuroimaging (CT or MRI), with stroke onset between 3 and 12 months prior to enrollment. Eligible participants presented with upper limb motor impairment, as defined by a Fugl-Meyer Assessment (FMA) score between 20 and 50, and reported shoulder pain rated ≥4 on the Visual Analog Scale (VAS). All participants were required to demonstrate sufficient cognitive ability to follow simple verbal commands. Individuals with severe cognitive impairment (Mini-Mental State Examination score <24), severe aphasia, neurological or musculoskeletal disorders affecting the upper limb, shoulder subluxation, or contracture were excluded from the study. Informed written consent was obtained from all participants, and the study protocol received ethical clearance from the Research and Ethics Committee of the College of Physical Therapy at Government College University, Faisalabad (Reference: GCUF/ERC/24/2465). The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Participants were randomly assigned to either the mirror therapy (MT) group or the task-specific training (TST) group using a computer-generated randomization algorithm. Allocation concealment was maintained using opaque, sealed envelopes, while outcome assessors were blinded to group assignments. The MT intervention involved 30-minute sessions conducted three times per week over eight weeks. During these sessions, participants positioned their unaffected limb in front of a mirror and performed targeted upper limb movements—such as shoulder abduction, elbow flexion, wrist extension, and finger movements—while the affected limb remained concealed behind the mirror. Movement sequences progressed in complexity, incorporating proprioceptive neuromuscular facilitation patterns when appropriate. The TST group also received 30-minute sessions three times weekly for eight weeks. These sessions included warm-up activities followed by functional tasks such as overhead reaching, side reaching, wall slides, and object manipulation. Exercises were progressively adapted in complexity, resistance, and range according to individual tolerance and were performed within a pain-free or tolerable pain threshold.

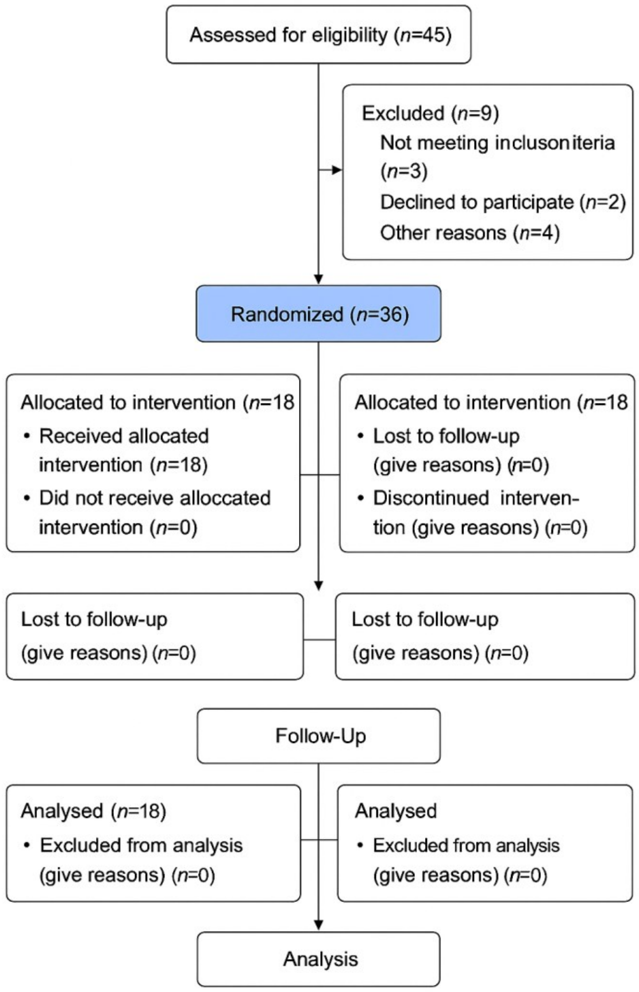

Figure 1 CONSORT Flow Chart

Primary outcome measurement focused on upper limb motor function, assessed using the Fugl-Meyer Assessment (FMA) specific to the upper extremity. Secondary outcomes included shoulder pain intensity measured by the Visual Analog Scale (VAS) and muscle strength assessed through Manual Muscle Testing (MMT) targeting shoulder abduction, elbow flexion, and wrist extension. Baseline and post-intervention assessments were conducted by trained physical therapists before and after the eight-week intervention period.

Data were analyzed using IBM SPSS Statistics software, version 25.0 (IBM Corp., Armonk, NY). Descriptive statistics were used to summarize demographic and clinical data, with continuous variables expressed as mean ± standard deviation and categorical variables as frequencies and percentages. The Shapiro-Wilk test was used to assess data normality. Within-group comparisons were conducted using paired samples t-tests for parametric data and Wilcoxon signed-rank tests for non-parametric data. Between-group differences were evaluated using independent samples t-tests and Mann-Whitney U tests. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 36 post-stroke participants (mean age: 53.06 ± 7.10 years) were included in the final analysis, with 18 individuals allocated to each intervention group. The average duration since stroke onset was 7.94 ± 2.91 months. Descriptive participant characteristics are presented in Table 1. No participants were lost to follow-up or excluded from analysis, and both groups were statistically comparable at baseline in terms of demographic and clinical variables.

Between-group analyses at baseline showed no statistically significant differences in upper limb motor function, pain levels, or muscle strength measures, confirming successful randomization. The Fugl-Meyer Assessment (FMA) scores were comparable between the Mirror Therapy (MT) group (26.83 ± 2.61) and Task-Specific Training (TST) group (27.27 ± 2.10; p = .579). Similarly, Visual Analog Scale (VAS) pain scores (mean rank: MT = 20.03, TST = 16.97; p = .349), as well as Manual Muscle Testing (MMT) scores for elbow flexion and wrist extension, were not significantly different. However, a significant difference was noted for shoulder abduction strength (mean rank: MT = 15.00, TST = 22.00; p = .021), suggesting slightly better baseline strength in the TST group (Table 2).

Both MT and TST exhibited statistically significant improvements across all primary and secondary outcomes following the 8-week intervention period. The FMA scores in the MT group increased from 26.83 ± 2.62 to 38.00 ± 3.03 (p < 0.001), while the TST group improved from 27.28 ± 2.11 to 43.89 ± 2.70 (p < 0.001). VAS scores significantly decreased in both groups (MT: 6.78 ± 0.81 to 3.78 ± 0.81; TST: 6.5 ± 0.92 to 2.56 ± 0.51; both p < 0.001). Notably, MMT scores improved for all assessed movements — shoulder abduction, elbow flexion, and wrist extension — in both intervention groups, with all p-values < 0.01 (Table 3).

Table 1: Descriptive Statistics of Participants

Variable	Mean ± SD	Median (Min-Max)
Age (years)	53.06 ± 7.10	52.5 (39 – 67)
Time since stroke (months)	7.94 ± 2.91	8.5 (3 – 12)

Table 2: Between-Group Comparisons of Baseline Scores

Outcome Measure	Group	Mean ± SD / Mean Rank	p-value	Test Used
FMA Baseline	MT	26.83 ± 2.61	.579	Independent Samples t-test
	TST	27.27 ± 2.10		
VAS Baseline	MT	Mean Rank: 20.03	.349	Mann-Whitney U Test
	TST	Mean Rank: 16.97		
Shoulder Abduction (MMT)	MT	Mean Rank: 15.00	.021	Mann-Whitney U Test

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	TST	Mean Rank: 22.00		
Elbow Flexion (MMT)	MT	Mean Rank: 19.50	.511	Mann-Whitney U Test
	TST	Mean Rank: 17.50		
Wrist Extension (MMT)	MT	Mean Rank: 20.00	.323	Mann-Whitney U Test
	TST	Mean Rank: 17.00		

Table 3: Within-Group Pre- and Post-Intervention Comparisons

Variable	Mirror Therapy Group	Task-Specific Training Group
	Pre Mean ± SD	Post Mean ± SD
FMA	26.83 ± 2.62	38.00 ± 3.03
VAS	6.78 ± 0.81	3.78 ± 0.81
Shoulder Abduction	1.33 ± 0.49	2.33 ± 0.49
Elbow Flexion	2.56 ± 0.51	3.11 ± 0.47
Wrist Extension	1.56 ± 0.51	2.56 ± 0.51

Post-intervention comparisons revealed statistically superior outcomes in the TST group for several measures. Significant improvements favored TST over MT in post-treatment FMA scores (mean ranks: TST = 26.06, MT = 10.94; U = 26.0; Z = -4.317; p < 0.001) and VAS scores (mean ranks: TST = 11.67, MT = 25.33; U = 39.0; Z = -4.11; p < 0.001). Shoulder abduction strength also significantly favored the TST group (U = 99.0; p = 0.047). However, no statistically significant between-group differences were found in elbow flexion (p = 0.279) or wrist extension (p = 0.406), indicating these improvements may have been more influenced by general rehabilitation effects rather than the specificity of the intervention (Table 4).

Table 4: Post-Intervention Group Comparisons (MT vs. TST)

Variable	Mirror Therapy Mean Rank	TST Mean Rank	Mann-Whitney U	Z-value	p-value (2-tailed)
FMA_post	10.94	26.06	26.0	-4.317	<0.001
VAS_post	25.33	11.67	39.0	-4.11	<0.001
Shoulder Abduction	15.00	22.00	99.0	-2.304	0.047
Elbow Flexion	16.56	20.44	127.0	-1.284	0.279
Wrist Extension	20.00	17.00	135.0	-0.988	0.406

These results suggest that both interventions were clinically effective; however, Task-Specific Training offered statistically superior outcomes in motor recovery and pain reduction, particularly for shoulder function. Further studies with larger sample sizes and long-term follow-up are warranted to confirm these findings and assess sustained functional benefits.

DISCUSSION

The current study evaluated the comparative effectiveness of mirror therapy (MT) and task-specific training (TST) in improving upper limb function, reducing shoulder pain, and enhancing muscle strength among post-stroke patients with shoulder pain. Findings demonstrated that while both interventions significantly improved motor recovery and reduced pain, TST resulted in statistically superior outcomes in Fugl-Meyer Assessment (FMA) scores, Visual Analog Scale (VAS) pain levels, and shoulder abduction strength. These findings reinforce the role of task-oriented rehabilitation approaches as a central pillar in post-stroke upper limb recovery and align with contemporary neurorehabilitation frameworks emphasizing use-dependent plasticity and functional task integration.

The results corroborate existing literature that has consistently highlighted the benefits of TST in facilitating upper limb motor recovery through repetitive, context-specific training. Studies by Arya et al. and Lim et al. have demonstrated significant improvements in functional motor outcomes following TST protocols focused on real-life tasks that mirror activities of daily living (14,15). These findings support the premise that engagement in purposeful, goal-directed activities enhances motor relearning by promoting cortical reorganization and reinforcing motor patterns associated with daily functionality. The superiority of TST in this study may also reflect its stronger alignment with motor learning principles, such as variability, task specificity, and feedback-dependent adaptation, all of which are crucial for neuromuscular re-education.

Conversely, mirror therapy, while effective in promoting motor recovery and pain relief, yielded comparatively smaller gains in functional outcomes. This may be attributable to the passive nature of MT, particularly in cases where volitional motor activity is limited. Mirror therapy operates by harnessing visual feedback to activate the mirror neuron system and stimulate bilateral motor networks, fostering interhemispheric communication and compensatory activation of cortical areas (16). Although several trials have documented the utility of MT in subacute and chronic stroke populations, the degree of improvement may be constrained in isolation, especially when compared to more active, goal-directed interventions like TST. This is consistent with findings by Narang et al. and Michielsen et al., who observed that while MT facilitated improvements, it was less effective than more structured motor relearning programs (16,18).

Interestingly, previous studies such as those by Abbas and Jabeen reported enhanced motor recovery and functional independence when MT was combined with TST, suggesting a potential synergistic effect when visual feedback is coupled with task execution (19). While the present study did not explore the combined approach, its findings prompt consideration of such integrative strategies, particularly for patients with limited active movement who may benefit from the visual-motor priming offered by MT before engaging in TST. The lack of significant differences between groups in elbow flexion and wrist extension further highlights the need for individualized rehabilitation plans that address segmental motor deficits and incorporate multimodal strategies.

The clinical relevance of these findings lies in the practical utility of TST as a cost-effective, replicable, and scalable intervention that can be implemented in diverse clinical settings. As stroke rehabilitation programs strive to maximize functional gains within constrained timeframes, interventions that deliver superior outcomes—such as TST—may hold strategic value in standard care protocols. However, the broader applicability of these results is tempered by several limitations. The relatively small sample size and single-center design restrict the generalizability of findings. Although randomization was employed, the observed baseline difference in shoulder abduction strength may reflect unmeasured confounding or chance variation. Furthermore, the intervention period of eight weeks, while sufficient to demonstrate short-term efficacy, precludes any conclusions regarding the sustainability of these improvements.

Future research should focus on multicenter randomized controlled trials with larger sample sizes to validate these findings and explore long-term functional outcomes. Investigating the additive effects of combining MT and TST, particularly in patients with severe motor deficits, may offer novel insights into optimal rehabilitation sequencing. Additionally, incorporating neurophysiological assessments such as electromyography or functional MRI could help elucidate the underlying mechanisms of recovery and guide personalized therapy selection. Emphasis should also be placed on examining the impact of these interventions on quality of life, patient satisfaction, and independence in activities of daily living, ensuring that clinical gains translate into meaningful improvements for stroke survivors.

In summary, this study affirms the effectiveness of both mirror therapy and task-specific training in enhancing upper limb outcomes in post-stroke patients with shoulder pain. However, task-specific training demonstrated superior functional and pain-related outcomes, underscoring its primacy as a standalone intervention in stroke rehabilitation. These findings contribute to the growing body of evidence advocating for active, task-focused therapies and support the continued evolution of personalized neurorehabilitation strategies.

CONCLUSION

This randomized controlled trial compared the effects of mirror therapy and task-specific training on upper limb function in post-stroke patients with shoulder pain, revealing that while both interventions significantly improved motor function, reduced pain, and enhanced muscle strength, task-specific training produced superior outcomes across most domains. These findings underscore the clinical utility of incorporating functionally relevant, repetitive task-based exercises into rehabilitation protocols to maximize upper limb recovery and pain management in stroke survivors. The results advocate for prioritizing task-specific training as a primary intervention in clinical practice, while also highlighting the potential for future research to explore combined or sequential therapy models to optimize rehabilitation outcomes and extend the benefits to broader post-stroke populations.

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