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EFFECTS OF BRUNNSTROM MOVEMENT THERAPY VERSUS MIRROR THERAPY ON UPPER LIMB FUNCTION AND GRIP STRENGTH AMONG STROKE SURVIVORS

Original Research

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ABSTRACT

Background: Stroke is a leading cause of disability worldwide, often resulting in upper limb motor impairment and reduced grip strength. Effective rehabilitation strategies are essential to restore functional independence in stroke survivors. Brunnstrom Movement Therapy (BMT) and Mirror Therapy (MT) are widely used neurorehabilitation techniques, each leveraging distinct mechanisms to enhance motor recovery. However, the comparative efficacy of these interventions in improving upper limb function and grip strength remains an area of investigation.

Objective: To compare the effects of Brunnstrom Movement Therapy and Mirror Therapy on upper limb function and grip strength in stroke survivors.

Methods: This experimental study included 32 stroke survivors, equally divided into two groups: the BMT group (n=16) and the MT group (n=16). Participants aged 40–65 years with ischemic or hemorrhagic stroke and upper limb motor impairment (Brunnstrom stages 2–5) were recruited. Both groups underwent 45-minute therapy sessions, five times per week, for six weeks. Upper limb function was assessed using the Fugl-Meyer Assessment for Upper Extremity (FMA-UE), while grip strength was measured using a handheld dynamometer. Within-group and between-group analyses were conducted using SPSS version 22, with statistical significance set at $p < 0.05$.

Results: Both therapies significantly improved upper limb function and grip strength ($p < 0.001$). The BMT group exhibited a greater improvement in FMA-UE scores (45.8 ± 4.9 vs. 42.3 ± 5.0, $p = 0.04$) and grip strength (24.6 ± 3.5 kg vs. 22.1 ± 3.3 kg, $p = 0.03$) compared to the MT group. The percentage increase in FMA-UE was 29.01% for BMT and 17.50% for MT, while grip strength improved by 33.70% in the BMT group and 18.18% in the MT group.

Conclusion: Both interventions contributed to upper limb motor recovery, but Brunnstrom Movement Therapy demonstrated superior effectiveness in improving motor function and grip strength. These findings suggest that task-specific training may yield better functional outcomes in stroke rehabilitation.

Keywords: Grip strength, Ischemic stroke, Mirror therapy, Motor recovery, Stroke rehabilitation, Upper limb function, Upper extremity.

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INTRODUCTION

Stroke remains a leading cause of disability worldwide, significantly impacting millions of individuals annually on physical, emotional, and economic levels (1). Among the most debilitating consequences of stroke is upper limb impairment, which restricts the ability to perform activities of daily living (ADLs) and diminishes overall quality of life (2). Pakistan ranks among the top Asian nations with the highest stroke mortality rates, with an estimated annual incidence of 250 per 100,000 individuals. Alarmingly, nearly 30% of strokes in the country occur in individuals younger than 45 years, highlighting a concerning prevalence of stroke among the young population (3). Upper limb dysfunction following stroke is primarily attributed to muscle weakness, spasticity, disrupted motor control, and impaired grip strength, all of which severely affect functional independence. Despite advances in neurorehabilitation, restoring upper limb function remains a considerable challenge (4). Various rehabilitation strategies have been introduced to enhance motor recovery, among which Brunnstrom Movement Therapy and Mirror Therapy have demonstrated significant potential. However, a direct comparison of their efficacy in improving upper limb function and grip strength is an area that warrants further investigation (5). Brunnstrom Movement Therapy is a neurophysiological approach developed by Signe Brunnstrom, structured around the hierarchical stages of motor recovery following stroke. This technique systematically progresses patients from reflexive movement patterns to voluntary motor control by leveraging synergies—coordinated muscle activation patterns that facilitate movement (6). The therapy utilizes sensory-motor stimulation, repetitive movement practice, and task-specific exercises to optimize the functional restoration of the affected limb. By aligning with the brain's natural recovery processes, this method aims to reorganize neural pathways and restore purposeful movement (7).

In contrast, Mirror Therapy is a more contemporary intervention that capitalizes on neuroplasticity through visual feedback mechanisms. Initially introduced for phantom limb pain management, this approach has since demonstrated efficacy in post-stroke rehabilitation (8). Mirror Therapy involves placing a mirror along the mid-sagittal plane, enabling patients to visualize the reflection of their unaffected limb as if it were their impaired limb. This illusion provides sensorimotor stimulation that engages motor recovery circuits and activates the mirror neuron system, a specialized neural network implicated in both movement execution and observation (9). Through this process, Mirror Therapy is believed to enhance motor learning, reduce spasticity, and strengthen grip force, making it a valuable adjunct in stroke rehabilitation (10). Given the distinct underlying mechanisms of Brunnstrom Movement Therapy and Mirror Therapy, it is imperative to evaluate their comparative efficacy in upper limb motor recovery and grip strength enhancement in stroke survivors (11). While Brunnstrom Movement Therapy emphasizes structured motor progression and voluntary control, Mirror Therapy relies on visual-motor feedback and neuroplastic adaptation to stimulate movement (12). Both interventions have individually demonstrated positive outcomes in stroke rehabilitation, yet their relative effectiveness remains an area of limited empirical clarity. A comparative analysis of these rehabilitation strategies is essential to refine evidence-based clinical practices and optimize functional outcomes for stroke survivors (13).

Upper limb functionality, including grip strength, is a critical determinant of independence, affecting essential activities such as lifting, grasping, dressing, and writing (14). Grip weakness significantly impairs functional capacity and social reintegration, underscoring the importance of rehabilitation interventions that target grip strength improvement (15). Furthermore, understanding the neural mechanisms driving motor recovery following these interventions can facilitate the development of more effective rehabilitation protocols. Neuroplasticity, the brain's ability to reorganize itself through new neural connections, is central to post-stroke recovery (16). While Brunnstrom Movement Therapy promotes neuroplasticity through progressive motor training, Mirror Therapy achieves it via visual-motor interactions and mirror neuron activation. Investigating the differential contributions of these mechanisms can provide deeper insights into optimizing stroke rehabilitation strategies. This study aims to compare the effectiveness of Brunnstrom Movement Therapy and Mirror Therapy in enhancing upper limb function and grip strength in stroke patients. By assessing their relative impact, this research seeks to provide clinicians with evidence-based guidance on selecting the most effective rehabilitation approach for improving motor recovery and functional independence in stroke survivors.

METHODS

An experimental study was conducted to compare the efficacy of Brunnstrom Movement Therapy (BMT) and Mirror Therapy (MT) in improving upper limb function and grip strength among stroke survivors. A total of 32 participants were recruited using a simple convenience sampling technique and were equally assigned to two groups: the BMT group (n=16) and the MT group (n=16) (4,5). The study was carried out at Ganga Ram Hospital and Jinnah Hospital from March 2024 to September 2024. Participants included male and female stroke survivors aged 40 to 65 years diagnosed with ischemic or hemorrhagic stroke, presenting with upper limb motor impairment classified as Brunnstrom stages 2–5. Individuals with extreme spasticity (Modified Ashworth Scale ≥3), contractures in the

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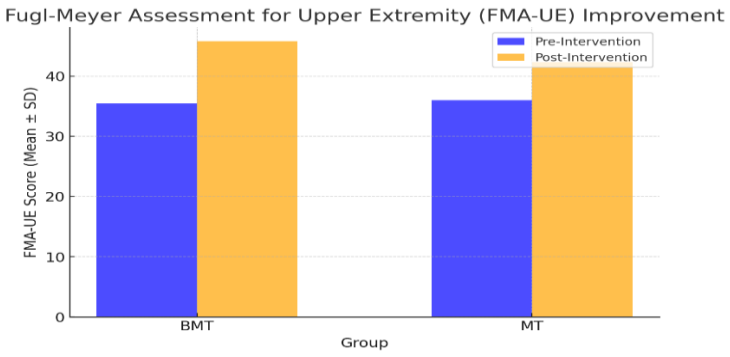
affected limb, coexisting neurological disorders such as Parkinson's disease or multiple sclerosis, significant cognitive impairment (Mini-Mental State Examination score <24), or severe visual deficits interfering with therapy participation were excluded from the study. The intervention was conducted under the supervision of trained rehabilitation therapists, following standardized rehabilitation protocols for both therapies. Participants in both groups underwent 45-minute therapy sessions, five days per week, for a total duration of six weeks. The BMT group received therapy focused on structured motor progression, including reflexive movement initiation, synergy-based movement facilitation, and voluntary motor control training. The MT group engaged in therapy utilizing a mirror placed in the mid-sagittal plane, allowing them to visualize the reflection of their non-affected limb to stimulate movement in the affected limb. Both therapies incorporated repetitive task-oriented exercises tailored to individual needs.

Outcome measures included the Fugl-Meyer Assessment for Upper Extremity (FMA-UE) and grip strength assessment using a calibrated handheld dynamometer. Assessments were conducted at baseline and after the six-week intervention period. Data were analyzed using SPSS version 22. Within-group and between-group comparisons were performed using appropriate statistical tests. A p-value of <0.05 was considered statistically significant. Ethical approval was obtained from the Institutional Review Board (IRB). Written informed consent was obtained from all participants before enrollment, ensuring voluntary participation and confidentiality. Participants were also informed of their right to withdraw from the study at any stage without consequences.

RESULTS

A total of 32 stroke survivors were enrolled, with 16 participants allocated to each intervention group. The mean age was 58.30 ± 7.53 years in the Brunnstrom Movement Therapy (BMT) group and 57.46 ± 8.40 years in the Mirror Therapy (MT) group, with no statistically significant difference between the groups ($p = 0.78$). Gender distribution was comparable, with a male-to-female ratio of 9:7 in the BMT group and 8:8 in the MT group ($p = 0.73$). The affected limb distribution was also similar, with 10 participants having right-sided involvement and 6 having left-sided involvement in the BMT group, compared to 9 and 7 in the MT group, respectively ($p = 0.75$). The time since stroke onset averaged 5.2 ± 1.3 months in the BMT group and 5.4 ± 1.5 months in the MT group, with no significant difference between them ($p = 0.68$). Within-group analysis revealed significant improvements in both interventions. The BMT group showed an increase in Fugl-Meyer Assessment for Upper Extremity (FMA-UE) scores from 35.5 ± 5.2 at baseline to 45.8 ± 4.9 post-intervention, with a mean difference of 10.3 ± 2.1 ($p < 0.001$). Similarly, the MT group demonstrated an improvement in FMA-UE scores from 36.0 ± 5.5 to 42.3 ± 5.0, with a mean difference of 6.3 ± 1.8 ($p < 0.001$). Grip strength also significantly improved in both groups, with the BMT group increasing from 18.4 ± 3.2 kg to 24.6 ± 3.5 kg (mean difference = 6.2 ± 1.5, $p < 0.001$) and the MT group increasing from 18.7 ± 3.1 kg to 22.1 ± 3.3 kg (mean difference = 3.4 ± 1.2, $p < 0.001$).

Between-group comparisons indicated significantly greater post-intervention improvements in the BMT group compared to the MT group. The final FMA-UE scores were significantly higher in the BMT group (45.8 ± 4.9) than in the MT group (42.3 ± 5.0), with a p-value of 0.04. Similarly, grip strength was significantly greater in the BMT group (24.6 ± 3.5 kg) compared to the MT group (22.1 ± 3.3 kg), with a p-value of 0.03. These findings suggest that while both interventions contributed to upper limb functional recovery, BMT demonstrated superior efficacy in improving motor function and grip strength. The percentage improvement analysis further highlights the superior efficacy of Brunnstrom Movement Therapy (BMT) over Mirror Therapy (MT) in enhancing upper limb function and grip strength. The Fugl-Meyer Assessment for Upper Extremity (FMA-UE) scores increased by 29.01% in the BMT group, compared to a 17.50% improvement in the MT group. Similarly, grip strength showed a greater percentage increase in the BMT group (33.70%) compared to the MT group (18.18%). These findings reinforce the effectiveness of BMT in promoting motor recovery and functional independence, suggesting its greater potential for enhancing neurorehabilitation outcomes in stroke survivors.



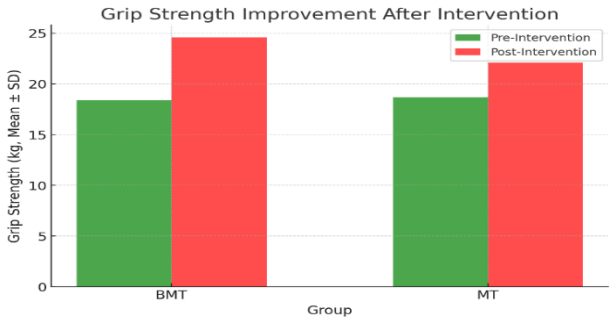


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Table 1 Demographic Characteristics of Participants

Variable	BMT Group (n=16)	MT Group (n=16)	p-value
Age (years)	58.30 ± 7.53	57.46 ± 8.40	0.78
Gender (M/F)	9/7	8/8	0.73
Affected Side (R/L)	10/6	9/7	0.75
Time Since Stroke (months)	5.2 ± 1.3	5.4 ± 1.5	0.68

Table 2 Within-Group Analysis of Upper Limb Function and Grip Strength

Assessment	Group	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)	Mean Difference ± SD	p-value
FMA-UE	BMT	35.5 ± 5.2	45.8 ± 4.9	10.3 ± 2.1	<0.001
	MT	36.0 ± 5.5	42.3 ± 5.0	6.3 ± 1.8	<0.001
Grip Strength	BMT	18.4 ± 3.2	24.6 ± 3.5	6.2 ± 1.5	<0.001
	MT	18.7 ± 3.1	22.1 ± 3.3	3.4 ± 1.2	<0.001

Table 3 Between-Group Comparison of Upper Limb Function and Grip Strength

Assessment	BMT Group (Mean ± SD)	MT Group (Mean ± SD)	p-value
FMA-UE	45.8 ± 4.9	42.3 ± 5.0	0.04
Grip Strength	24.6 ± 3.5	22.1 ± 3.3	0.03

DISCUSSION

The findings of the study demonstrated that both Brunnstrom Movement Therapy (BMT) and Mirror Therapy (MT) significantly improved upper limb function and grip strength in stroke survivors. However, the greater improvements observed in the BMT group suggest that it exerted a more pronounced effect on neuromuscular recovery (17). The higher post-intervention Fugl-Meyer Assessment for Upper Extremity (FMA-UE) scores in the BMT group (45.8 ± 4.9) compared to the MT group (42.3 ± 5.0, p = 0.04) indicate superior neuromuscular reorganization following BMT. These results align with previous research suggesting that task-specific training methods facilitate cortical reorganization and improve motor recovery in stroke rehabilitation. Grip strength, a key determinant of functional independence, also exhibited a greater post-intervention increase in the BMT group (24.6 ± 3.5 kg) compared to the MT group (22.1 ± 3.3 kg, p = 0.03), reinforcing the potential of BMT in promoting better strength adaptations (18). While both interventions demonstrated efficacy in stroke rehabilitation, the underlying mechanisms likely contributed to the observed differences in outcomes. BMT, which emphasizes structured movement progression and repetitive voluntary movement, may have facilitated greater motor engagement and prevented learned non-use of the affected limb (19). This movement-oriented approach, focusing on synergy-based recovery, might have contributed to more robust neuromuscular adaptations, as opposed to the visual-motor stimulation provided by MT. Mirror Therapy, although well-established for its role in neuroplasticity through mirror neuron activation and visual feedback, may have been less effective in eliciting real motor execution and strength development in comparison to BMT (20). Nonetheless, within-group

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improvements indicate that both techniques have valuable roles in stroke rehabilitation by contributing to neuroplasticity and motor recovery.

Despite the strengths of the study, including a structured intervention protocol and validated outcome measures, certain limitations should be acknowledged. The relatively small sample size may have affected the generalizability of findings, necessitating further large-scale studies to confirm these results. Additionally, the study duration of six weeks may not have been sufficient to capture long-term recovery patterns, particularly in assessing the sustained impact of both interventions on motor function and strength retention. Future research should explore extended follow-up periods to determine the durability of these rehabilitation effects. The study contributes to the growing body of evidence supporting the effectiveness of rehabilitation techniques in stroke recovery and highlights the comparative advantages of BMT over MT in improving functional motor outcomes. The findings emphasize the need for rehabilitation programs to incorporate task-specific movement training to maximize recovery potential. Future research should focus on integrating multimodal rehabilitation strategies, potentially combining elements of both therapies to optimize motor and functional recovery. Further investigations into the neural mechanisms underlying these interventions could provide deeper insights into personalized rehabilitation approaches for stroke survivors.

CONCLUSION

The findings of this study confirm that both Brunnstrom Movement Therapy and Mirror Therapy effectively enhance upper limb function and grip strength in stroke survivors. However, Brunnstrom Movement Therapy demonstrated greater improvements, suggesting its superior efficacy in facilitating motor recovery. These results highlight its potential as a more effective rehabilitation approach for individuals seeking to regain upper limb function and independence following a stroke. The study underscores the importance of structured movement-based interventions in stroke rehabilitation and provides valuable insights for clinicians in optimizing treatment strategies to maximize functional recovery.

AUTHOR CONTRIBUTIONS

Author	Contribution
Muhammad Danial Baig Chughtai	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Usama Ishfaq	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Faiza Khan*	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Esha Malik	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Wajeeha Iqbal	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Zarish Younas	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Jahanzeb Ahmed	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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