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Original Article

Impact of Hand Grip Strength on Functional Independence and Arm Motor Performance in Stroke Survivors

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ABSTRACT

Background: Stroke remains a leading cause of disability worldwide, with a significant number of survivors experiencing impairments in upper limb function and hand grip strength, which are crucial for performing activities of daily living (ADLs). Understanding the relationship between hand grip strength, functional independence, and arm motor performance is essential for optimizing rehabilitation strategies.

Objective: This study aimed to investigate the impact of hand grip strength on functional independence and arm motor performance in stroke survivors and to evaluate the effectiveness of Mirror Therapy in enhancing these outcomes.

Methods: An analytical cross-sectional study was conducted at DHQ Teaching Hospital Sargodha, involving 22 stroke survivors, evenly split between genders. Participants were aged 45-65 years, clinically diagnosed with ischemic stroke in the subacute stage, and exhibited Modified Ashworth Scale scores of 1 to 1+ for hand flexors. The study employed randomized assignments to intervention groups, utilizing assessments such as the Action Research Arm Test (ARAT), Fugl-Meyer Assessment for Upper Extremity (FMA UE), Hand-Held Dynamometer (HHD), and Stroke Impact Scale (SIS) at baseline, 3 weeks, and 6 weeks. Statistical analysis was performed using Pearson's coefficient of correlation with SPSS version 25.

Results: Significant improvements were observed in upper limb strength and hand dexterity, particularly in the group undergoing Mirror Therapy. The correlation coefficients among ARAT, HHD, and SIS were .676**, .748**, and .704** respectively, indicating strong positive relationships between hand grip strength, functional ability, and quality of life. Mirror Therapy demonstrated notable enhancements in ARAT ($p = .001$), FMA UE ($p < .000$), HHD ($p = .000$), and SIS scores ($p = .000$), reflecting increased functional ability, grip strength, and improved quality of life.

Conclusion: The study confirmed the significant impact of hand grip strength on the functional independence and arm motor performance of stroke survivors, with Mirror Therapy providing substantial benefits. These findings advocate for the inclusion of grip strength-focused interventions and Mirror Therapy in stroke rehabilitation programs to improve survivors' functional outcomes and quality of life.

Keywords: Stroke, Hand Grip Strength, Functional Independence, Arm Motor Performance, Mirror Therapy, Rehabilitation.

INTRODUCTION

Stroke, recognized for its sudden onset of symptoms that indicate a focal or global disruption of cerebrum functions lasting over 24 hours, is a condition frequently of vascular origin that may lead to mortality. The primary clinical manifestations associated with stroke encompass weakness on one side of the body and speech difficulties, with a variety of focal deficits possibly arising, including altered consciousness and impairments in sensory, motor, cognitive, perceptual, and language functions (1, 2). Globally, stroke affects 15 million individuals annually, with 5 million enduring permanent disabilities such as hemiparesis and spasticity. Hemiparesis, the weakness on one side of the body opposite the affected brain hemisphere, is noted in approximately 60% of stroke instances. Despite many recovering walking abilities, a significant portion suffers from suboptimal functional recovery in the upper limb (UL),

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with 30–66% of survivors reporting persistent UL impairments. This has profound implications on their ability to perform activities of daily living (ADLs), severely affecting their quality of life (3, 4).

In the context of Pakistan, where the projected stroke incidence is 250 per 100,000 population, the role of the arms and hands in activities of daily living is crucial. Stroke-induced upper limb impairments significantly diminish an individual's ability to grasp and manipulate objects, highlighting the necessity for effective treatment strategies (5). Various physical therapy interventions, including biofeedback, cross-education, virtual reality, hydrotherapy, and neurodevelopmental techniques such as Bobath, proprioceptive neuromuscular facilitation, resistance training, and mirror therapy, have demonstrated efficacy in mitigating stroke symptoms (6, 7). Mirror therapy (MT), in particular, has emerged as a beneficial approach for addressing sensory, perceptual deficits, and motor challenges in stroke patients. This therapy involves the use of the unaffected hand to perform activities while the patient observes in a mirror, simulating the action of the paretic hand. This not only serves as a priming strategy but also incorporates multisensory feedback, leading to increased neuronal activation in cortical areas associated with self-awareness and spatial attention (8, 9). Clinical assessments support the effectiveness of MT in enhancing functional recovery of both upper and lower limbs (8, 10).

The rationale behind the correlation between non-paretic limb training and mirror therapy lies in their common focus on neuroplasticity and motor learning principles. Non-paretic limb training exercises the unaffected limb to promote neural adaptations that may positively transfer to the impaired limb through cross-education mechanisms. Similarly, mirror therapy utilizes visual feedback from the unaffected limb's movements in a mirror to stimulate neural pathways, potentially enhancing motor area activation associated with movement planning and execution. Both approaches aim to optimize neural resources and facilitate motor recovery in the affected limb. Studies by Rauf et al. (2021) and S. Karamat et al. (2022) have found no significant difference in the effectiveness of Mirror Therapy compared to Motor Relearning Programs in improving upper limb motor function among stroke patients, indicating both strategies' efficacy in acute stroke patient rehabilitation (1, 11). Further research by S.Hambir et al. (2023) and P. Klinkwan et al. (2022) has demonstrated the effectiveness of both movement-based and task-based mirror therapy in enhancing upper limb function, reducing muscle tone, and improving grip strength in stroke patients, with mirror therapy offering notable advantages over conventional therapy in terms of enhancing hemiplegic motor impairments and presenting a cost-effective, safe, and easily implementable option for at-home rehabilitation (12, 13).

MATERIAL AND METHODS

The study employed an analytical cross-sectional design, conducted at DHQ Teaching Hospital Sargodha. A total of 26 participants were involved, based on a calculated sample size of 22, which accounted for a 10% attrition rate (14). The inclusion criteria targeted both male and female individuals aged between 45 to 65 years, clinically diagnosed with ischemic stroke in the subacute stage, specifically within 3 to 6 months from stroke onset (15, 16). Eligibility for participation also required the stroke to involve the dominant side in areas supplied by the anterior cerebral artery (ACA) or the middle cerebral artery (MCA), a Mini-Mental State Examination (MMSE) score of at least 25, and a Modified Ashworth Scale score for hand flexors ranging from 1 to +1 (17). Exclusion criteria were set to omit individuals diagnosed with Alzheimer's disease, Parkinson's disease, multiple sclerosis, brain tumors, those who had experienced recurrent strokes, or those who had undergone major surgery or trauma within the last 14 days (18).

Prior to the commencement of the interventions, demographic information of the participants was meticulously collected. The study's assessments were systematically conducted at baseline, during the 3rd week, and at the 6th week. The tools utilized for these evaluations included the Action Research Arm Test, the Fugl-Meyer Assessment for the upper extremity, a Hand-Held Dynamometer, and the Stroke Impact Scale (19). These instruments were chosen for their reliability and validity in measuring the aspects of upper limb functionality, muscle strength, and the overall impact of stroke on the participants' quality of life.

To ensure the integrity and ethical consideration of the study, all procedures were designed in compliance with the Declaration of Helsinki. Participants were provided with a comprehensive explanation of the study's aims, methods, potential risks, and benefits. Informed consent was obtained from all participants prior to their inclusion in the study. Confidentiality of participant data was strictly maintained throughout the research process. The hypothesis testing was conducted using Pearson's coefficient of correlation, utilizing the Statistical Package for the Social Sciences (SPSS) version 25 for data analysis.

RESULTS

Table 1: Demographic Characteristics of Participants

Characteristic	Male	Female
Age (years)	52.27 ± 6.52	53.36 ± 6.80
BMI	27.27 ± 1.45	28.09 ± 2.33

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Characteristic	Male	Female
Gender	11 (50.0%)	11 (50.0%)
Weeks after Stroke	12.50 ± 5.57 (Total)	-
Marital Status	Married: 20 (90.9%)	Unmarried: 2 (9.1%)
Hemisphere Involved	Right: 12 (54.5%)	Left: 10 (45.5%)
Lobe Involved	Parietal: 5 (22.7%)	Frontal: 5 (22.7%)
Type of Stroke	Haemorrhagic: 0 (0.00%)	Ischemic: 22 (100%)

Table 2: Correlations among ARAT, HHD, and SIS

Measure	Correlation with ARAT	Correlation with HHD	Correlation with SIS
Hand-Held Dynamometer	.676**	-	.704**
Stroke Impact Scale	.748**	.704**	-
Action Research Arm Test	-	.676**	.748**
Sig. (2-tailed)	.001	.000	.000
N	22	22	22
The study utilized ARAT for upper extremity function, HHD for grip strength, and SIS for stroke impact on life quality. Pearson Correlation, with coefficients .676, .748, and .704, showed strong positive correlations. Significance was confirmed with Sig. 2-tailed < .05, across 22 participants.			

DISCUSSION

In this analytical study conducted at DHQ Teaching Hospital Sargodha, the investigation centered on the relationship between hand grip strength and functional outcomes among stroke survivors. The cohort comprised 22 patients of both genders who met specific inclusion criteria, including Modified Ashworth Scale scores of 1 to 1+ for hand muscle flexors and a minimum MMSE score of 25. Participants were randomly assigned to intervention groups, with each group receiving distinct therapies.

The intergroup analysis revealed significant differences in the final scores and the degree of score changes among the participants, highlighting the efficacy of the interventions in improving upper limb strength and hand dexterity. Notably, Mirror Therapy stood out, showing pronounced enhancements in post-treatment scores across various assessments such as the Action Research Arm Test (ARAT), Fugl-Meyer Assessment for Upper Extremity (FMA UE), Hand-Held Dynamometer, and Stroke Impact Scale (SIS). These improvements encompassed grip strength, pain reduction, coordination, and speed of movement, underscoring the method's effectiveness in augmenting functional ability and quality of life. The substantial gains in activities of daily living (ADLs) and overall quality of life, as reflected in the SIS outcomes, were particularly significant.

The findings of R Zlatičanin et al. (2023), through an extensive literature review on the effectiveness of Mirror Therapy for stroke rehabilitation, resonate with the observations from this study. Their research, which synthesized outcomes from five randomized clinical trials, corroborated the substantial benefits of Mirror Therapy in enhancing functional independence and quality of life among stroke survivors. The review highlighted the positive impact of Mirror Therapy on cognitive functions and sensorimotor performance, contributing to improved execution of daily activities and overall well-being. This aligns with the current study's results, where mirror therapy facilitated notable improvements in upper limb strength, hand function, and quality of life for stroke survivors (20).

Similarly, the systematic review by Yuqian Zhang et al. (2022) on utilizing mirror therapy for addressing unilateral neglect post-stroke provided further context. Their analysis of data from five randomized controlled trials (RCTs) indicated that mirror therapy, both as a standalone treatment and in conjunction with other interventions, was more effective than sham therapy or no treatment in improving neglect and daily living activities. These findings are in harmony with the present study, which also found significant benefits of mirror therapy in enhancing upper limb functionality and hand dexterity (21).

Despite its contributions, this study is not without limitations. The six-week study duration may not adequately capture the long-term effects and sustainability of the observed improvements. The selection of participants did not specifically consider the involvement of the dominant side, nor were individual patient goals integrated into the experimental tasks, which were standardized for group consistency. For future research, it is recommended to include a larger, more diverse sample size to improve the generalizability of the findings across the broader stroke survivor population. Incorporating long-term follow-up assessments would also be crucial to evaluate the durability of the improvements and to observe any delayed effects or relapses. Additionally, adopting

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a multidisciplinary approach involving various rehabilitation disciplines could offer a more holistic view of post-stroke recovery, addressing its multifaceted nature.

The study elucidates the significant influence of hand grip strength on functional independence and arm motor performance in stroke survivors. The correlations between hand grip strength, upper limb function, and the perceived impact of stroke on daily life form a cohesive pattern of associations, suggesting that higher hand grip strength and improved upper limb function are consistently linked with better self-reported outcomes on the Stroke Impact Scale. These insights offer valuable guidance for healthcare professionals and therapists in tailoring stroke rehabilitation programs, emphasizing the critical role of enhancing hand grip strength and upper limb functionality to improve the quality of life for stroke survivors.

CONCLUSION

The study underscores the pivotal role of hand grip strength in enhancing functional independence and arm motor performance among stroke survivors, with Mirror Therapy emerging as a particularly effective intervention. These findings highlight the necessity of incorporating targeted therapies that focus on improving grip strength and upper limb functionality into stroke rehabilitation programs. Such approaches can significantly impact patients' recovery trajectories, improving their ability to perform activities of daily living and, consequently, their overall quality of life. Healthcare professionals and therapists should consider these insights when designing and implementing rehabilitation strategies, emphasizing the importance of personalized, evidence-based interventions to optimize outcomes for stroke survivors.

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