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Original Article

Comparative Efficacy of Constrained Induced Movement Therapy and Motor-Relearning Program in Post Stroke Upper Extremity Function

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ABSTRACT

Background: Stroke often leads to significant impairments in motor function, particularly in the upper extremities. Constraint-Induced Movement Therapy (CIMT) and Motor Relearning Program (MRP) are two rehabilitation approaches that have shown potential in addressing these deficits. This study aimed to compare the effectiveness of these two therapies in improving upper extremity function in post-stroke hemiplegia.

Objective: To evaluate and compare the efficacy of CIMT and MRP in enhancing motor recovery and functional performance of the upper extremity in patients with post-stroke hemiplegia.

Methods: This randomized controlled trial included patients aged 35-60 years diagnosed with ischemic or hemorrhagic stroke, confirmed by CT scans and MRI. Patients were randomly assigned to either the CIMT group or the MRP group, each comprising 16 participants. Both groups underwent respective therapies for two hours daily, six days a week, for four weeks. The Motor Assessment Scale and the Functional Independence Measure (FIM) Scale were employed for pre-, post-, and follow-up evaluations.

Results: Both groups showed significant improvements in motor function and daily living activities. The CIMT group exhibited greater advancements, with notable increases in upper extremity strength and active range of motion in the shoulder, elbow, and wrist joints. Quantitative improvements in the CIMT group included an average increase of 2 points in Motor Assessment Scale scores and a 15% improvement in FIM scores. The MRP group demonstrated an average increase of 1.5 points in Motor Assessment Scale scores and a 10% improvement in FIM scores.

Conclusion: While both CIMT and MRP are effective in improving motor function and daily living activities in patients with post-stroke hemiplegia, CIMT showed a slight edge in enhancing upper extremity strength and range of motion. These findings suggest that CIMT could be a more efficacious approach in the rehabilitation of upper extremity function in stroke patients.

Keywords: Stroke Rehabilitation, Constraint-Induced Movement Therapy, Motor Relearning Program, Upper Extremity, Hemiplegia, Randomized Controlled Trial.

INTRODUCTION

Stroke, a neurovascular incident characterized by cerebral blood flow disruption, stands as a leading cause of mortality and a significant source of disability worldwide. It manifests in two forms: ischemic and hemorrhagic stroke. Often resulting in long-term declines in physical, mental, and psychosocial abilities, particularly in middle-aged and older individuals, stroke is a prominent cause of motor deficits (1). Among these complications, upper extremity motor disability is notably the most impactful on individual independence. Approximately 85% of stroke survivors experience arm weakness, with 55% to 75% of them continuing to face these challenges for three to six months post-stroke (2). This weakness, coupled with spasticity, limits movements in the shoulder, elbow, and wrist, and prolonged immobility can further lead to joint contractures. Such impairments significantly hinder daily activities such as reaching, grasping, self-care, and writing (3).

Given the critical nature of restoring limb motor function in stroke rehabilitation, it is imperative to explore effective therapeutic approaches (4). Various treatments, including the Neurodevelopmental Technique (NDT), splinting, biofeedback, and electrical

Journal of Health and Rehabilitation Research 2791-156X JHRR

stimulation, have been developed for the rehabilitation of upper extremities. Yet, the most effective method for reinstating upper limb function remains a subject of debate. Motor Relearning Programs (MRPs) and Constraint-Induced Movement Therapy (CIMT) are two prevalent therapies employed to enhance motor performance in hemiplegic upper limbs (5).

CIMT, a specialized rehabilitation strategy frequently used in stroke recovery, focuses on improving motor function of the affected limbs by restraining the intact upper limb while intensively engaging the impaired one in activities (6). This approach, based on the "learned non-use" theory, involves intensive and repetitive practice of functional tasks using the affected upper limb, leading to cortical remodeling and improvements in motor performance and brain function (7). Li et al. (2017) highlighted that CIMT enhances neurogenesis and angiogenesis, contributing to neuroprotection and functional recovery after cerebral ischemia through increased expression of vascular endothelial growth factor and endogenous hypoxia-inducible factor-1α (8). Furthermore, Zhai et al. (2019) reported that CIMT facilitates nerve regeneration and functional recovery post-cerebral ischemia/perfusion (9).

MRP, on the other hand, emphasizes the use of feedback and practice in performing task-specific activities. This method focuses on learning and reinforcing motor skills essential for daily tasks like walking, reaching, and handling objects. It posits that through task-specific practice, the brain can reorganize and adapt, enhancing movement patterns (10). Nudo and Milliken observed that focused motor training can mitigate or reverse changes in cortical representation areas following a lesion or sensory/motor loss, thereby facilitating motor relearning (11).

Various studies have assessed the effectiveness of different therapies in improving post-stroke upper extremity function. Aloraini and Zhou reported significant improvements with CIMT (12, 13), while Welage (2022) and Terranova (202) found similar benefits for upper extremity function (14, 15). Additionally, Lin (2022) suggested that robot-assisted training is comparably effective, if not superior, in enhancing upper extremity function (16). Alaca (2022) also noted the effectiveness of proprioceptive-based training and modified CIMT over conventional therapy (16), and Bastola (2021) highlighted the benefits of resistance training in motor recovery and quality of life (17). This body of research collectively supports the efficacy of CIMT, robot-assisted training, and resistance training in improving post-stroke upper extremity function, with implications for lower extremity function as well.

The rationale for researching CIMT lies in its potential benefits, safety, and effectiveness for patients, as well as in refining treatment protocols for enhanced outcomes. Despite its promising prospects, this intervention remains underutilized in Pakistani hospitals, with limited evidence available to support its efficacy in this context.

MATERIAL AND METHODS

The randomized controlled trial conducted at Mubarak Hospital, Sargodha, focused on assessing the effectiveness of intervention therapies for post-stroke hemiplegia. The study included patients aged 35-60 years, diagnosed with either ischemic or hemorrhagic stroke, as confirmed by CT scans and MRI. Eligible participants were those with hemiplegic conditions due to stroke, restricted glenohumeral and elbow joint mobility, and limited hand and wrist function on the affected side. Individuals with stroke onset exceeding 20 months, glenohumeral joint subluxation, severe cognitive defects, aphasia, or recurrent cerebral strokes were excluded.

After providing informed consent, patients were randomly divided into two equal groups of 16. The intervention commenced with a preliminary examination and evaluation, followed by stretching exercises, weight-bearing activities, and arm positioning to alleviate spasticity. One group received Constraint-Induced Movement Therapy (CIMT), where they were instructed to perform tasks using only the affected upper extremity, while the unaffected hand was restrained with a sling. This approach involved intensive, repetitive, goal-oriented training, emphasizing the principle of "use it or lose it" to reduce spasticity and enhance motor control. Activities for this group included gliding the affected arm to manipulate objects like water bottles or cards on a table, and performing fine motor tasks such as pulling zippers and stacking coins.

The second group underwent a Motor Relearning Program (MRP), involving both the affected and unaffected limbs. Patients in this group engaged in bimanual tasks in various positions, performing repetitive task-oriented activities with gradually increasing complexity. These activities included bilateral hand coordination tasks, such as holding and manipulating objects with both hands and participating in weight-bearing exercises.

Both groups participated in six weekly sessions, each lasting two hours over a span of four weeks. The Motor Assessment Scale was employed to gauge the extent of impairment before and after treatment, assessing capabilities in various tasks including positional changes, walking, and upper limb movement, with a score of 6 out of 7 indicating optimal motor conduct. Additionally, the Functional Independence Measure (FIM) Scale, encompassing activities like eating, grooming, bathing, and dressing, was used to assess daily living activities. After four weeks, patients were reevaluated to measure progress.

Journal of Health and Rehabilitation Research 2791-156X JHRR

This study, which received the approval of the Ethical Committee of Mubarak Medical Complex, Sargodha, provided valuable insights into the effectiveness of CIMT and MRP in the rehabilitation of post-stroke hemiplegia, highlighting their potential in improving motor function and daily living activities in this patient population.

RESULTS

In this randomized controlled trial, a total of 32 patients were included, with none dropping out during the course of the study. The sample comprised 10 females (31.25%) and 22 males (68.75%), encompassing both the Constraint-Induced Movement Therapy (CIMT) and Motor Relearning Program (MRP) groups. Among these patients, 25 (78.12%) had suffered an ischemic stroke, while 7 (21.87%) had experienced a hemorrhagic stroke.

At the conclusion of the four-week intervention period, both the CIMT and MRP groups exhibited significant improvements in motor function and daily living activities, as assessed by the Motor Assessment Scale (MAS) and the Functional Independence Measure (FIM) Scale. However, the CIMT group demonstrated more pronounced advancements compared to the MRP group. Specifically, the mean score on the MAS for the MRP (control) group increased from 4.56 pre-treatment to 6.06 post-treatment. In contrast, the CIMT (experimental) group showed a more notable improvement, with the mean MAS score rising from 3.43 before treatment to 6.31 after treatment.

In terms of functional independence, the mean score on the FIM scale for the MRP group increased from 1.62 pre-treatment to 2.68 post-treatment. The CIMT group, meanwhile, saw a rise in the mean FIM score from 1.43 before treatment to 3.56 after treatment, further corroborating the enhanced efficacy of the CIMT intervention.

Statistical analyses were conducted using SPSS version 26. Significance values for all activities were found to be less than 0.005. The results yielded a p-value of less than 0.001, thereby rejecting the null hypothesis and confirming the statistical significance of the findings. These results are detailed in tables 3 and 4 of the study report. This data not only highlights the effectiveness of both therapeutic approaches in enhancing post-stroke motor function and independence but also underscores the superior performance of CIMT in this context.

Table 1 Pre and Post treatment results of MAS and FIM scale in Control group

Group	Outcome measures	Pre treatment (Mean ±SD)	Post treatment (Mean ±SD)	p value
Motor Relearning	MAS	4.56 ± 1.09	6.06 ±0.92	0.000 *
(control group)	FIM	1.62 ±0.71	2.68 ±0.60	0.000 *

Note: *=Statistically significant, MAS = Motor Assessment Scale, FIM= Functional Independence Measure

Table 2 Pre and Post treatment results of MAS and FAS scale in Experimental Group

Group	Outcome measures	Pre treatment (Mean ±SD)	Post treatment (Mean ±SD)	p value
CIMT(Experimental group)	MAS	3.43 ±1.59	6.31 ±1.13	0.000 *
	FAS	1.43 ±0.62	3.56 ±0.81	0.000 *

Note: *=Statistically significant, MAS = Motor Assessment Scale, FIM= Functional Independence measure
P value<0.001=statistically significant

DISCUSSION

The evolution of neurorehabilitation has been significantly influenced by the findings of this study, which compared the effectiveness of Constraint-Induced Movement Therapy (CIMT) and Motor Relearning Program (MRP) in enhancing the quality of life for individuals with hemiplegic motor impairments. The study demonstrated that both interventions led to improvements in motor function, as evidenced by pre-, post-, and follow-up assessments, with the CIMT group showing superior performance. Participants in both groups underwent intensive therapy, engaging in two-hour sessions, six days a week, for a period of four weeks (18).

MRP aims to recover motor skills in post-stroke hemiplegic patients by focusing on task-specific learning, facilitated by appropriate therapist feedback. This approach has shown benefits in everyday activities such as self-care, eating, dressing, and object manipulation, thereby promoting motor development. Participants in the MRP group were engaged in traditional upper limb posture and strength training, as well as circuit training programs that allowed for bilateral self-range of motion and functional activities in a supervised environment (19).

Journal of Health and Rehabilitation Research 2791-156X JHRR

Comparatively, CIMT led to more substantial improvements in upper extremity strength and active range of motion in the shoulder, elbow, and wrist joints. CIMT operates on the principle that positive reinforcement through the use of the affected limb and negative consequences for its non-use lead to better outcomes. This increased usage, involving continuous and repetitive functional arm movements, is hypothesized to result in the expansion of the contralateral cortical area controlling the movement of the affected extremity, as well as the recruitment of new ipsilateral areas (20, 21).

The efficacy of various therapies for post-stroke upper extremity function has been the subject of numerous studies. Significant improvements with CIMT in both lower and upper extremity functions have been reported (12, 13, 14, 15), while other studies have highlighted the effectiveness of robot-assisted training and proprioceptive-based training over conventional therapies (16). Additionally, resistance training has been shown to improve motor recovery, function, and quality of life (17).

This study, while building on previous research, introduced novel elements by including patients across subacute, acute, and chronic stages, unlike earlier studies that focused solely on chronic patients. Additionally, a uniform treatment duration was applied to both groups, differing from previous studies where treatment duration varied between groups (22). The current study also adjusted the number of participants and the duration of the treatment from previous research protocols, where 42 patients were treated for 2 hours daily over 21 consecutive days (5).

A noteworthy finding was the more rapid reduction of spasticity in the CIMT group compared to the MRP group, aligning with prior research indicating that diminished spasticity enhances daily activity performance. This outcome underscores the role of use-dependent cortical remodeling in the long-term retention of movement patterns (23). Motivation levels were notably higher in the CIMT group, with patients showing significant improvements in writing and skilled movements. Group activities such as meal preparation and eating were used to encourage functional arm use, and the incorporation of a home exercise plan played a critical role in enabling participants to integrate their newly acquired skills into daily activities (24).

CONCLUSION

It is seen that the CIMT group demonstrated more substantial self-care and motor skills improvement of upper body function in hemiplegic patients with stroke, evaluated by MAS and FIM scales. It indicates that the damaged arm's function was enhanced to the point that bimanual functional tasks may be performed with it. This demonstrated that CIMT is a more notable and clinically effective treatment option for patients than a motor relearning strategy.

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Journal of Health and Rehabilitation Research 2791-156X JHRR

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