ACTA SCIENTIFIC NEUROLOGY (ISSN: 2582-1121)

Volume 7 Issue 11 November 2024

Research Article

Combined Effect of Action Observation Therapy and Motor Relearning Program on Upper Extremity Recovery and Activities of Daily Living in Patients with Hemiparesis

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DOI: 10.31080/ASNE.2024.07.0782

Received: September 20, 2024

Published: October 30, 2024

Abstract

Upper extremity hemiparesis following a stroke significantly impacts a person's independence, affecting Activities of Daily Living (ADL) and functional mobility. Traditional compensatory approaches often emphasize using the unaffected arm and hand to compensate for deficits in the affected limb, rather than seeking to restore function to the impaired side. However, research supports the idea that involving the affected arm and hand in functional activities can lead to greater functional improvements and increased independence. Combining Action Observation Therapy (AOT) and the Motor Relearning Program (MRP) is designed to encourage the use of the impaired limb in functional tasks, emphasizing task-oriented training and active patient participation.

The objective of this study was to evaluate the combined effect of AOT and MRP on upper extremity (UE) function and ADL in patients with hemiparesis. A quasi-experimental design was employed, with 34 participants aged 35 to 65 years, all of whom had experienced a hemiparetic stroke. These participants were randomly assigned to two groups: 17 in the experimental group, which received a combination of AOT and MRP, and 17 in the control group, which received conventional therapy (including the Biomechanical Frame of Reference and Proprioceptive Neuromuscular Facilitation). Pre- and post-test scores were assessed using the Motor Assessment Scale (MAS), the Motor Activity Log (MAL), and the Modified Barthel Index (MBI) to measure UE function and ADL in both groups. Statistical analysis of the data was conducted using the Wilcoxon signed-rank test and the Mann-Whitney U test.

Post-test p-values for MAS, MAL, and MBI between the experimental and control groups were 0.016, 0.048, and 0.001, respectively, suggesting that the combination of AOT and MRP significantly improved UE function and ADL. These findings support the hypothesis that integrating AOT and MRP enhances UE function and ADL in hemiparetic stroke patients. Occupational therapists play a vital role in developing comprehensive, effective interventions for stroke rehabilitation, ultimately helping patients regain independence and improve their quality of life.

Keywords: Stroke; Hemiparesis; Action Observation Therapy; Motor Relearning Program; Upper Extremity Function; Activities of Daily Living

Abbreviations

AOT: Action Observation Therapy; MRP: Motor Relearning Program; ADL: Activities of Daily Living; MAS: Motor Assessment Scale; MAL: Motor Activity Log; MBI: Modified Barthel Index; UE: Upper Extremity

Introduction

Stroke is a major global health challenge and ranks among the leading causes of mortality and disability worldwide, affecting both high-income and low- and middle-income countries (LMICs). In fact, the majority of stroke cases occur in LMICs, resulting in a disproportionately higher disease burden compared to affluent nations. In India, stroke has emerged as the fourth leading cause of death and the fifth leading cause of disability, a trend driven by increasing life expectancy and the growing prevalence of non-communicable diseases [1]. Globally, stroke ranks as the third most common cause of death and the fourth largest contributor to the disease burden [2]. The World Health Organization (WHO, 2023) defines stroke as a sudden loss of brain function caused by a vascular event, with symptoms persisting for more than 24 hours or leading to death [2,3].

One of the most debilitating consequences of stroke is impaired mobility, which often results in dependence on others for daily activities and increases the risk of falls. According to the International Classification of Functioning, Disability and Health (ICF) model, stroke-related neurological impairments can lead to deficits in body function, activity limitations, and participation restrictions. Mobility is a crucial factor in maintaining independence and quality of life, and when compromised, it can lead to functional disability, decreased selfconfidence, and diminished self-esteem [4]. To foster brain plasticity and promote motor recovery after a stroke, rehabilitation programs must prioritize intensive, task-specific, repetitive, and purposeful movement training. However, this approach is not always adequately prioritized in clinical practice [2].

The Mirror Neuron System (MNS) reinforces Action Observation Therapy (AOT), which influences mirror neurons that activate both when an individual performs an action and when they observe someone else performing the same action. This system plays a crucial role in acquiring new motor skills, particularly in the observation of hand movements such as gripping, tearing, grasping, and manipulating [5].

The Motor Relearning Program (MRP) emphasizes task-specific learning through feedback and practice to improve motor control and the relearning of daily activities [2]. According to motor learning theory, motor patterns can be developed and refined through experience, including repeated practice and observation. Individuals with brain damage may experience deficits in motor programs, motor memory, and associated feedback and feed-forward mechanisms, which can impair functional performance. During rehabilitation, MRP facilitates the relearning of motor control and movement patterns for specific tasks. This approach promotes recovery of normal motor functions through task-oriented practice with appropriate feedback and active patient engagement [4].

The MRP consists of four steps: task analysis, practice of missing components, task practice, and training transfer [2]. It involves analyzing abnormal movement patterns during tasks, focusing on relearning daily activities, correcting these abnormal patterns, and practicing tasks repetitively. The goal is to develop new motor programs or refine existing ones to improve task performance in daily life and varied environments. Through extensive functional exercise practice, MRP supports the functional use of weaker limbs [5].

While numerous studies have shown the effectiveness of both Action Observation Therapy and Motor Relearning Programs in improving upper extremity motor function and activities of daily living in stroke survivors, no research has combined these two therapies to evaluate their impact on upper extremity function and daily living activities in stroke patients.

Aim

The study aims to evaluate the combined effect of Action Observation Therapy and the Motor Relearning Program in improving upper extremity function and activities of daily living in patients with hemiparesis.

Materials and Methods

This quasi-experimental study design involved 34 hemiparetic patients, divided into an experimental group (n = 17) and a control group (n = 17) using a convenient sampling method. The study was conducted in and around Coimbatore, with interventions administered for six weeks, five sessions per week, each lasting 45 minutes to one hour.

Participants met the following inclusion criteria: first-onset stroke patients, diagnosed with hemiparetic stroke, duration of stroke within six months, medically stable, aged 35–65 years, both male and female, with MiniMental Status Examination (MMSE) scores > 24, and upper extremity muscle strength greater than 2+. Patients with sensory involvement, cognitive or perceptual disorders, other neurological deficits (e.g., Parkinsonism, dementia), musculoskeletal disorders, cardiorespiratory diseases, and mental health disorders (e.g., anxiety, depression) were excluded.

The screening tools included the Mini-Mental Status Examination (MMSE), Manual Muscle Testing (MMT), and the Modified Ashworth Scale (MAS). Outcome measures were assessed using the Motor Assessment Scale (MAS), Motor Activity Log (MAL), and the Modified Barthel Index (MBI).

Ethical clearance for the study was obtained from the KMCH Ethical Committee (Scientific Clearance No: RC/264/2022 and Ethical Clearance No: Ref: EC/AP/974/11/2022). The study's purpose was explained to participants and their caregivers, and informed consent was obtained to ensure confidentiality. Patients meeting the selection criteria were assigned to the experimental and control groups. Pre-tests were conducted using the Motor Assessment Scale, Motor Activity Log, and Modified Barthel Index for both groups. The experimental group received Action Observation Therapy combined with the Motor Relearning Program in addition to their regular therapy, while the control group received conventional therapy, which included multi-contextual sensory-motor treatment techniques to facilitate upper extremity function and activities of daily living. Posttests were conducted after six weeks using the same assessment tools. The obtained scores were statistically analyzed using SPSS Version 26.

(MAS- Motor Assessment Scale: MAL- Motor Activity Log: MBI- Modified Barthel Index) Intervention procedure

In this study, patients who had experienced a hemiparetic stroke and met the inclusion criteria were assigned to either the experimental or control group. Throughout therapy sessions, patients were carefully monitored, with adjustments made as needed.

Figure 1: Activities for Experimental group patients with Hemiparesis.

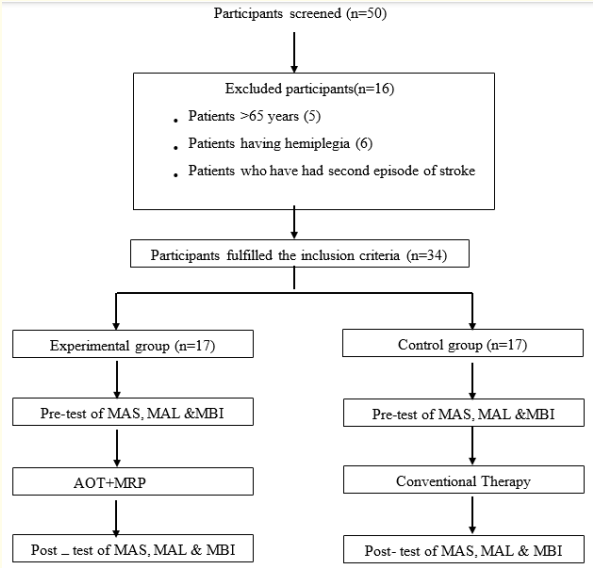

Figure 2: Flow Chart of Intervention Plan for Patients with Hemiparetic Stroke.

The experimental group underwent a combination of Action Observation Therapy and the Motor Relearning Program, which was administered five days a week, with each session lasting 45

minutes. This intervention involved 15 minutes of observing action videos, followed by 30 minutes of task-based exercises. Activities practiced in the experimental group included eating (such as drinking water and consuming solid food), grooming (combing hair and washing the face), dressing (putting on a t-shirt or top), and bathing or toileting (pouring water).

The control group in the study received a combination of intervention techniques, including the Neurodevelopmental approach, Biomechanical Frame of Reference, and Proprioceptive Neuromuscular Facilitation approach for the same 45-minute session duration. These methods were utilized to enhance both upper and lower extremity strength, promote independence in performing functional tasks with the affected upper limb, improve lower limb function such as ambulation, and facilitate the integration of regained movements into daily activities. The overall goal of these approaches is to aid stroke patients in recovering physical abilities and promoting functional independence [6].

Results and Discussion

Data analysis and Results

The Motor Assessment Scale (MAS), Motor Activity Log (MAL), and Modified Barthel Index (MBI) were used for pre- and post-intervention data from 34 stroke patients. Statistical analysis was conducted using SPSS version 26 (IBM Corporation), with the Wilcoxon signed-rank test and Mann-Whitney U test applied at a 95% confidence level. Descriptive statistics were utilized to outline the demographic characteristics of patients with hemiparetic stroke (Table 1) and to compare the pre-test and post-test mean scores for MAS, MAL, and MBI in both the experimental and control groups. The Wilcoxon signed-rank test assessed the treatment effectiveness within each group (Table 2), while the Mann-Whitney U test compared the effectiveness of the interventions between the experimental and control groups before and after the intervention (Table 3).

Baseline Characteristics		Experimental Group	Control Group
Gender	Male - N (%)	10 (59%)	11 (65%)
	Female - N (%)	7 (41%)	6 (35%)
	Total sample	17	17
Age (years)	Mean ± SD	55 ±10.77	58.35 ±6.031
	Minimum	35	47
	Maximum	65	65
Hemi-sphere affected	Right	10	6
	Left	7	11
Diagnosis	MCA infarction	16	11
	PCA infarction	1	1
	Pontine infarction	-	2
	Thalamic bleed	-	2
	CG bleed	-	1

Table 1: Descriptive statistics for Demographic characteristics of Hemiparetic patients in Experimental and Control groups.

SD: Standard Deviation; MCA: Middle Cerebral Artery; PCA: Posterior Cerebral Artery; CG: Capsular Ganglia

Wilcoxon signed rank test			Experimental group			Control group	
Outcomes		MAS	MAL	MBI	MAS	MAL	MBI
Mean ± SD	Pre	28.18 ± 8.589	2.30 ± 1.10	48.24 ± 28.84	23.24 ± 4.982	1.89 ± 0.664	32.53 ± 19.46
	Post	44.71 ± 5.022	5.55 ± 0.864	78.88 ± 12.66	23.24 ± 4.982	5.04 ± 0.804	62.71 ± 13.270
Z value		-3.625	-3.622	-3.623	-3.625	-3.621	-3.624
p value		.000*	.000*	.000*	.000*	.000*	.000*

Table 2: Comparative Descriptive analysis of Pre and Post test scores for MAS, MAL and MBI within the experimental and control groups using Wilcoxon.

Signed-Rank Test patients with Hemiparesis

SD: Standard Deviation; MAS: Motor Assessment Scale; MAL: Motor Activity Log; MBI: Modified Barthel Index

Level of significance is at $p < 0.05$.

The above table displays the means and standard deviations of the pre- and post-test scores for MAS, MAL, and MBI variables in the experimental and control groups of hemiparetic patients. And indicates a statistically significant difference ($p < 0.05$) between the pre-test and post-test scores of the MAS, MAL, and MBI scales in both the experimental and control groups. This implies a significant improvement in the motor performance of the upper extremity and ADL performance within the groups.

The chart presented above demonstrates an increase in mean scores for the experimental and Control group of hemiparetic patients between the pre- and post-test assessments of MAS, MAL, and MBI. The Experimental group mean scores for MAS increased from 28.18 to 44.71, for MAL from 2.3 to 5.55, and for MBI from 48.24 to 78.88. The Control group mean scores for MAS increased from 23.24 to 40.47, for MAL from 1.89 to 5.04, and for MBI from 32.53 to 62.7.

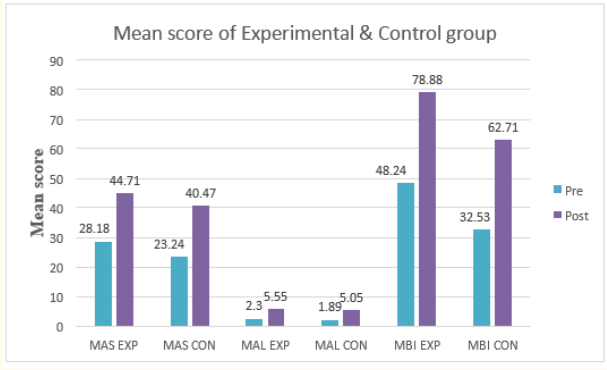

Chart 1: Comparative analysis of Pre and Post Test Mean Scores of MAS, MAL, and MBI for Experimental and Control group Hemiparetic patients.

EXP: Experimental Group; CON: Control Group

Variables	Group		Mean ± SD	Z-Value	95% CI		P Value
					Lower	Upper	
MAS	Pre-test	Experimental	25.7 ± 7.355	-1.654	0.000	0.084	0.098
		Control					
	Post-test	Experimental	42.59 ± 4.363	-2.406	0.000	0.084	0.016
		Control					
MAL	Pre-test	Experimental	2.10 ±0.918	-0.985	0.141	0.447	0.335
		Control					
	Post-test	Experimental	5.29 ±0.862	-1.974	0.000	0.184	0.048
		Control					
MBI	Pre-test	Experimental	40.38 ±25.507	-1.457	0.028	0.266	0.145
		Control					
	Post-test	Experimental	70.79 ±15.185	-3.298	0.000	0.084	0.001
		Control					

Table 3: Comparative analysis of Pre and Post Test Scores for MAS, MAL and MBI between Experimental and Control groups using Mann-Whitney U Test for patients with Hemiparesis.

SD: Standard Deviation; Level of Significance is at $p < 0.05$.

The above table indicates a statistically significant difference ($p < 0.05$) in the post-test scores of MAS, MAL, and MBI between the experimental and control groups and the differences were $p < 0.016$, 0.048, and 0.001, respectively. This demonstrates that both groups of patients have shown improvement after the intervention.

Discussion

Stroke is a major cause of disability worldwide, leading to muscle weakness, fatigue, reduced postural control, and mobility challenges for many patients. These impairments severely affect upper extremity (UE) function, limiting the ability to perform

activities of daily living (ADLs) and diminishing quality of life. Since more than 50% of ADLs involve reaching and grasping, restoring UE function is crucial for regaining independence. Unfortunately, many stroke survivors are unable to use their affected limbs in everyday tasks and eventually discontinue these activities. This study aims to evaluate the combined effects of Action Observation Therapy (AOT) and the Motor Relearning Program (MRP) in improving UE function and ADL in hemiparetic stroke patients.

Fifty stroke patients were initially screened for the study, with 34 meeting the inclusion criteria. Sixteen were excluded: five due to age, six due to hemiplegia, and five due to a second stroke episode. The 34 eligible patients were randomly divided into two groups 17 in the experimental group and 17 in the control group. The study used the Motor Assessment Scale (MAS), Motor Activity Log (MAL), and Modified Barthel Index (MBI) to evaluate participants' UE function and ADL performance before and after intervention. Participants in the experimental group received a combination of AOT and MRP interventions, while the control group received conventional therapy for six weeks, with five sessions per week, each lasting 45 minutes to an hour.

In the experimental group, 10 patients had a right hemisphere lesion, while 7 had a left hemisphere lesion. In the control group, 6 patients had right hemisphere lesions and 11 had left hemisphere lesions. Most experimental patients 16 had Middle Cerebral Artery (MCA) infarctions, with only 1 patient diagnosed with a Posterior Cerebral Artery (PCA) infarction. In the control group, 11 had MCA infarctions, 1 had a PCA infarction, 2 had pontine infarctions, 2 had thalamic infarctions, and 1 had a capsuloganglionic (CG) bleed. Participants' ages ranged from 35 to 65 years, with a mean age of 55 in the experimental group and 58.35 in the control group.

Weekly progress was recorded for all participants, and post-intervention assessments showed marked improvement across the experimental group. In this group, the MAS improved from 28.18 to 44.71, MAL from 2.30 to 5.55, and MBI from 48.24 to 78.88. Further statistical analysis revealed a significant improvement in MAS, MAL, and MBI scores within each group, as indicated by a p-value of 0.000 (Table 2). Additionally, comparisons between the experimental and control groups showed statistically significant differences in post-test scores, with p-values of 0.016 for MAS, 0.048 for MAL, and 0.001 for MBI (Table 3). These results highlight the effectiveness of the intervention in enhancing motor function and daily living activities in stroke patients.

Previous research has compared the effectiveness of Action Observation Therapy (AOT) and Motor Relearning Program (MRP) in enhancing upper extremity function in stroke patients [2]. In one study, thirty MCA stroke patients were divided into two groups: one received AOT and the other received MRP for 8 weeks, with sessions lasting one hour per day, six days a week. The outcome measures included the Fugl Meyer score for upper extremity function, Upper Extremity Function Test, and Modified Sphygmomanometer Test. The results indicated that the MRP group showed a statistically significant improvement in motor function compared to the AOT group, although both interventions were effective for handgrip rehabilitation. The current study, which investigated the combined effect of AOT and MRP on upper extremity function and Activities of Daily Living (ADL) in hemiparetic stroke patients, aligns with previous findings. It also emphasizes the potential advantages of integrating AOT and MRP in stroke rehabilitation. The combination of active patient engagement and task-oriented training in MRP likely facilitated the application of motor skills learned through AOT to everyday activities. By customizing interventions to the specific needs and goals of stroke patients, occupational therapists can enhance motor learning and functional recovery. Regular, repetitive training, along with targeted visual stimuli and feedback, can further improve the therapeutic outcomes. Overall, these findings suggest that combining AOT and MRP may offer a promising strategy for enhancing motor function and ADL in stroke patients.

Another study demonstrated that Action Observation Training (AOT) effectively improves upper limb motor function in acute stroke patients, whereas conventional therapy did not yield significant improvements [7]. In this study, acute stroke patients were instructed to observe everyday actions they previously knew but needed to relearn due to the stroke. While some participants initially struggled with watching the same video throughout the AOT session, they were able to complete it with repeated explanations. Similarly, in the present study, which explored the combined effects of AOT and Motor Relearning Program (MRP) on hemiparetic stroke patients, participants experienced some initial challenges with

AOT but found the activity easier to grasp in subsequent sessions. The results indicated a significant improvement in upper extremity function and Activities of Daily Living (ADL), with a p-value less than 0.00. Therefore, this study concludes that combining AOT with MRP is effective in enhancing both upper extremity function and ADL in patients with hemiparetic stroke.

Research on task-based versus movement-based Action Observation Training (AOT) found that task-based AOT is more effective due to its greater impact on mirror neuron activation, which is more responsive to object-related actions [8]. Building on these findings, the current study examined the effectiveness of combining task-based AOT with the Motor Relearning Program (MRP) to enhance mirror neuron activation and improve upper extremity function and Activities of Daily Living (ADL) in hemiparetic stroke patients. The results revealed a significant improvement, with a p-value less than 0.00, indicating that the integrated approach of MRP and task-based AOT holds promise as an effective intervention for boosting upper extremity function and daily living activities in stroke patients.

Previous research into the effectiveness of the Motor Relearning Program (MRP) and the current study examining the combined impact of Action Observation Therapy (AOT) and MRP both reveal promising results for enhancing functional abilities in stroke patients [4,9]. In the earlier study, 34 stroke patients with balance dysfunction and functional deficits were randomly assigned to either the MRP group or a conventional therapy group. Evaluations using the Motor Assessment Scale and the Barthel Index (MBI) showed significant improvements in functional balance, mobility, and quality of life for those in the MRP group compared to the conventional therapy group. Similarly, the current study found that combining AOT and MRP resulted in more substantial improvements in upper extremity function and activities of daily living for hemiparetic stroke patients than either intervention alone.

Thus, the combined use of AOT and MRP offers a promising approach for improving upper extremity function, mobility, and quality of life in stroke patients. This integrative therapeutic strategy could serve as an effective method in stroke rehabilitation, emphasizing the need for regular, repetitive training and feedback. The Motor Relearning Program (MRP) offers a thorough approach to stroke rehabilitation, focusing on motor learning principles such as repetition, task-specific training, and feedback. Action Observation Training (AOT) can serve as an effective adjunct for occupational therapists working with stroke patients who have motor deficits. AOT involves having patients watch videos demonstrating various movements or actions, which stimulates the mirror neuron network in the brain and aids in motor system recovery. By integrating AOT with MRP, occupational therapists can design tailored interventions that address the specific needs and goals of stroke patients, thereby enhancing motor learning and facilitating functional recovery.

The study faced several limitations that may impact its findings. Firstly, the relatively small sample size used in the research could limit the generalizability of the results. Future investigations with larger sample sizes and extended follow-up periods would help to provide a more comprehensive evaluation of the treatment program's effectiveness. Additionally, the study was conducted with a limited number of treatment sessions; increasing both the frequency and duration of these sessions might lead to more significant and valuable outcomes. The absence of blinding techniques in the study design could affect the reliability of outcome measures. Moreover, the research did not account for variations in hemisphere involvement or the location and type of lesions, which could affect the results. Future studies should address these factors to further explore the treatment program's efficacy across different stroke types and locations.

Conclusion

The findings of this study support the hypothesis that combining Action Observation Therapy with the Motor Relearning Program has a positive impact on upper extremity function and activities of daily living in patients with hemiparesis. Occupational therapists play a vital role in helping individuals develop essential skills for daily living through well-rounded, effective interventions. Therefore, integrating these two therapeutic approaches can be viewed as an effective clinical strategy for enhancing motor recovery and promoting functional independence in stroke patients.

Funding

There was no funding for this publication.

Conflict of Interest

We declare that there is no conflict of interest exists.

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