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Effects of Task-Oriented and Strength Training on Upper Limb Recovery in Hemiplegic Stroke Patients

Tehseen Akhtar[1], Anam Amjad[2], Anum Zafar[2], Esha Khan[3], Hanan Azfar[4], Nimrah Humayoon[1]

Riphah International University, Islamabad[1], Ibadat International University, Islamabad[2], Al-Shifa Tameer-e-Millat University, Islamabad[3], Bhatti Hospital, Gujranwala[4]

Corresponding Email: anum.zafar@uipt.uol.edu.pk

Abstract

Background: Ischemic stroke leads to the development of hemiplegia in the affected arm in more than 80% of the first-ever stroke cases, which impedes upper limb skills in performing daily living activities. Thus, this study aimed to determine the efficacies of two therapeutic exercise regimes in improving hand function in hemiplegic stroke patients after 12 weeks of intervention.

Methods: A total of 80 hemiplegic stroke patients were recruited and randomized into Group-A (n=40) and B (n=40), respectively. Group A received Task-Oriented Training (TOT), while B received resistance training.

Results: The findings revealed that both exercises were significantly useful ($p<0.05$) in improving the upper limb function of hemiplegic stroke patients on FMA-UE, ARAT, and DASH outcome measures.

Conclusion: It was concluded that both strength training and TOT were effective in improving upper limb function for patients with hemiplegic stroke across all outcome measures and thus showed improved recovery.

Keywords

Exercises, Hemiparesis, Stroke, Upper Limb.

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Introduction

Stroke is the leading neurological disorder that causes substantial deficits in upper limb motor function and impedes skills to perform daily life activities[1]. More than 80% of stroke cases having the first stroke, with ischemic infarctions, result in immediate hemiplegia of the afflicted arm[2]. This impairment not only limits the functional capability of the afflicted limb but also impedes Daily Living Activities (ADLs)[3]. Early post-stroke recovery is crucial since studies have indicated that individuals who improve within the first month have better long-term results. Patients having no discernible movement or recordable finger grasp by day 28 are unlikely to regain considerable meaningful function[4-5]. This information emphasizes the significance of making early decisions on additional treatment approaches. Stroke is the leading cause of the increase in the population with motor or sensory impairments, accounting for up to 85% of stroke patients' loss of upper limb function. Unfortunately, for most of these people, regaining upper limb function remains difficult[6]. Early and repeated exercise-based therapies, on the other hand, have shown the ability to provide long-term, clinically meaningful improvements in upper limb function following stroke. Task-Oriented Training (TOT) is vital in improving functional recovery after a stroke, principally using the potential of neuroplasticity inside the injured brain. TOT is an evidence-based intervention rehabilitating the paretic upper extremity by emphasizing active engagement in functional tasks rather than essential, repetitive exercises[7]. This technique, developed by Carr and Shepherd in 1987, prioritizes movement relearning through task-specific exercises, transferring training benefits from the therapeutic context to everyday life. Although much research has focused on the chronic stage of stroke rehabilitation, the subacute stage, in which treatments might maximize neuroplasticity, has received less attention[7]. TOT emphasizes the necessity of starting therapy as soon as possible after an injury, stimulating the brain to reorganize and adapt, and eventually enabling reintegration of upper limb function into daily life for those recovering from hemiplegic stroke. Progressive Resistance Training (PRE) is another strategy often employed in rehabilitating stroke patients, particularly to improve upper limb function[8-9]. This strategy entails gradually increasing muscular resistance, promoting higher power generation and endurance development. The core principles of PRE include providing enough resistance with just a limited number of consecutive repetitions (usually fewer than 12) before fatigue sets in. Resistance is gradually increased as strength increases[10-12]. The training regimen should be followed for a minimum of four weeks. These essential features highlight the importance of resistance training in stroke rehabilitation, as it focuses on restoring and developing upper limb function by building muscle strength and endurance, resulting in enhanced functional skills in stroke patients. Numerous studies have provided evidence that both TOT and strength training play a vital role in improving the upper limb function of stroke patients, yet comparative studies between the two techniques are less and have not provided any robust evidence on the efficacy of exercise regimes. Hence, the present study aims to determine the comparative analyses between the efficacies of two therapeutic exercise regimes in improving hand function in hemiplegic stroke patients after 12 weeks of intervention.

Methodology

Study Design

A randomized controlled trial was performed to identify the effects of TOT and Strength training on hand motor function among hemiplegic stroke patients.

Study Setting

The study setting was the physical therapy department of Benazir Bhutto Hospital (BBH) Rawalpindi in collaboration with MMC Hospital from March 2022 to October 2022.

Target Population

A total of n=80 patients were enrolled and diagnosed with first unilateral hemiparesis following a stroke from 2-12 months.

Participants Recruitment Criteria

Male and female patients between the age of 40-70 years diagnosed with unilateral post-stroke hemiparesis that was verified by Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) were enrolled. The patient can comprehend simple instructions based on the Mini-Mental State Examination with a score of 20 or above. Based on the Modified Ashworth Scale, elbow flexor spasticity equals to or less than three.

Individuals with a history of recent upper extremity injury, illness, or contracture and those with poor sitting balance were excluded. Participants with any concomitant neurological comorbidities, such as multiple sclerosis, Parkinson's disease, spinal cord injury, traumatic brain lesions, brain tumours, epilepsy, or dementia, were also barred from participating. Further hemineglect patients were also ruled out as per exclusion criteria.

Intervention Strategies

Based on the envelope technique of randomization, a total of n=80 individuals were divided into two groups. Each Group comprises of 40 participants. In Group A, participants were given intervention based on the TOT protocol, whereas, in Group B, resistance training was provided as an interventional protocol.

- ***Group A (TOT protocol)***
  Patients are seated in a chair with their feet securely grounded on the floor and their trunks held upright on the chair's back. Every participant completed a TOT program designed specifically for their afflicted Upper Extremity (UE). The TOT session began with a 10-minute warm-up and ended with 30 minutes of practicing patient-chosen functional tasks.

During warm-up, a gentle range of exercises at the levels of shoulder and elbow were performed, along with pendulum swings and hand squeezing exercises. A 2-minute rest interval was included after every 10 minutes of continuous practice throughout this 30-minute TOT session. Each participant in the TOT program might pick and practice three of six functional activities. Among the tasks were drinking water from a glass, lifting a glass to a 90° shoulder flexion with an extended elbow, stacking paper cups, cleaning with an extended elbow, holding and releasing a 6 cm diameter tennis ball, and eating with a spoon. The TOT program was created using the ideas of 'use it and enhance it, "specificity, "repetition, "salience", and "intensity". Training was performed three times a week for 12 weeks.

- ***Group B (Strength Training)***
  Four strengthening exercises, each targeting a different upper limb muscle group, were included in this Group's routine. These workouts focused on improving the afflicted Upper extremities (UE), Shoulder Flexion (SF), Elbow Flexion (EF), Elbow Extension (EE), And Wrist Extension (WE). The weight cuffs ranged from 1/2 kg to 1 kg, depending on the individual one-repetition maximum (1-RM) capabilities. The participants' Progressive Resistance Training (PRE) program began with a steady increase in intensity. They began at a modest intensity level in the first week, equaling 50% of their one-repetition maximum (1-RM). They then moved to a moderate intensity level for the following weeks, set at 70% of their 1-RM. The PRE sessions lasted 30 minutes per session and were held three days a week for 12 weeks. A concentric muscular contraction pattern was used throughout these sessions, primarily targeting the shoulder, elbow, and wrist muscles.

Outcome Measures

- ***Fugyl-Meyer Assessment for Upper Extremity (FMA-UE)***
  The FMA-UE value was tested twice, once at baseline and another after 12 weeks of intervention. The FMA-UE comprised 66 scores divided into two parts: 36 for the upper arm and 30 for the hands and wrist. Each activity was marked out of 3, with 0 representing an inability to perform, 1 representing partial completion of movement, and 2 representing complete movement within synergies[13].

- ***Action Research Arm Test (ARAT)***
  ARAT was used to evaluate coordination, dexterity and overall function of UE. A 19-item observational assessment tool had a total score of 57 in which a score of less than 19 revealed a low ability, a score between 20-38 revealed a moderate ability and a score greater than 39 suggested a high ability to perform a task as provided in ARAT. The test was performed twice at baseline and after 12 weeks of intervention[14].

- ***Disability of Arm Shoulder and Hand (DASH)***
  The questionnaire was used to assess the functional disorder of the upper extremity. It comprises 30 questions with a total of 100 points. The points near 0 represent a complete,

unrestricted function of the upper extremities, whereas a higher score represents the most significant possible functional impairment. The assessments were carried out twice, once at the start and second after 12 weeks of intervention[15].

Ethical Considerations

The Institutional Review Board Ref # IRB/093/2022 approved the study. The study strictly adhered to the guidelines as laid down in the Belmont report for human subjects. All data obtained from the participants were kept confidential, and complete autonomy was granted to the participants to leave the study at any point without giving any reason. The purpose of the study was narrated at full length, and informed consent was obtained before induction.

Results

A total of n=80 patients were recruited and divided into two groups, each with n=40 patients. Demographic characteristics revealed that n=53 patients were male, and n=27 were female. The average age of the participants in Group-A was 58.35±3.14, and in Group-B was 58.11±3.24. Detailed descriptions regarding the demographic characteristics of the participants are illustrated in Table-1.

Table-1 Demographic description of participants

Variables	Age in Years (Mean±S.D)	T-test	Level of significance
Group A	58.35±3.14	1.95	0.07
Group B	58.11±3.24		

Further demographic analyses had revealed that the number of male participants in group A were n=28 and females were n=12 whereas in Group-B the number of males were n=25 and females were n=15. The effects of exercises based intervention was determined on the outcome measure and paired t-test was applied to identify with in the group effects. Analysis of the findings had revealed that both exercises were found to be significantly effective $p<0.05$ in improving upper limb function of hemiplegic stroke patients where the values after intervention was found to be 45.6±2.45 for patient in Group-A and 44.99±3.01 for patients in group B on FMA-UE scale. The values on ARAT scale were also improved for patients in both the group with a post mean of 37.72±3.25 and 38.12±2.56 respectively. On DASH parameter a significant reduction in the mean value were observed and the obtained values were 14.56±1.89 for Group-A and 15.02±2.01 for Group-B (Table-2).

Table-2: Within-the group analysis using paired t-test					
Variables	**Pre Mean±S.D**	**Post Mean±S.D**	**MD**	**T-test**	**Level of Significance**
Group-A (TOT)					
FMA-UE	28.53±2.78	45.6±2.45	17.07	9.26	<0.001
ARAT	32.56±1.85	37.72±3.25	5.16	4.71	<0.05
DASH	28.66±1.64	14.56±1.89	14.1	8.52	<0.001
Group-B (Strength Training)					
FMA-UE	29.45±3.21	44.99±3.01	15.54	9.11	<0.001
ARAT	33.41±1.97	38.12±2.56	4.71	4.54	<0.05
DASH	27.63±1.47	15.02±2.01	12.61	6.13	<0.05

Further comparisons between the groups were performed using an independent t-test, and the analyses of the findings revealed that the mean difference between the two groups was non-significant p>0.05 (Table-3).

Table-3 Between the group analysis using independent t-test					
Variables	**Group A Post Mean±S.D**	**Group B Post Mean±S.D**	**MD**	**t-test**	**Level of Significance**
FMA-UE	45.6±2.45	44.99±3.01	0.61	1.36	>0.05
ARAT	37.72±3.25	38.12±2.56	0.4		
DASH	14.56±1.89	15.02±2.01	0.46		

Discussion

The study explored the effects of exercise-based therapies on the function of upper limbs in hemiplegic stroke patients. Following the intervention, substantial improvements in FMA-UE, ARAT, and DASH scores were seen in both Group-A (TOT) and Group-B (Strength Training), demonstrating the efficacy of both exercise regimens. It was revealed that both training groups (TOT and ST) were equally effective in improving upper limb function and yielded no significant differences between the group analysis. In another trial, the effects of loaded exercises in a TOT program for individuals with persistent hemiparesis after stroke were examined, which included two groups that received TOT without load (n=10) and TOT with individualized resistance (n=10)

for six weeks and twelve sessions16. Results of the study revealed that the TOT_ST group significantly (p=0.04) outperformed the other Group in unilateral tasks and bilateral movement quality. Furthermore, the Group scored considerably better in the Fugl-Meyer ratings (p=0.001), active range of motion (p=0.01), and shoulder flexor strength (p=0.001) than the TOT group, respectively.

Strength training can help upper-limb rehabilitation, especially in those who have modest disability following a stroke. It may also be an essential feature of a task-oriented rehabilitation program for patients with chronic stroke. Both groups showed gains after training[16]. In comparison to the TOT group, the TOT_ST group demonstrated significantly better results in shoulder flexor strength (p=0.001), active range of motion (p=0.01), and Fugl-Meyer scores (p=0.001), as well as superior outcomes in tasks performed unilaterally and the quality of task performed using bilaterally (p=0.04)[16]. Following Training, both groups showed gains, suggesting that strength training can help upper-limb rehabilitation, especially for those with mild disability following stroke. It may also be an important component of a task-oriented rehabilitation program for chronic stroke patients. In another study, researchers assessed the effect of TOT on the strength and dexterity of the hands in children with spastic hemiplegic cerebral palsy[17]. The intervention was provided for four weeks; twelve children were randomly divided into two groups and given occupational therapy twice a week: the TOT and the control groups. Furthermore, the TOT group received conventional care, while the control group received 20 minutes of TOT[17]. The box and block test showed that the TOT group significantly improved their hand dexterity. In contrast, the control group did not significantly increase their grip strength or hand dexterity after the intervention[17]. In a systematic review, the efficacy of task-oriented rehabilitation programs for enhancing upper extremity function in stroke survivors was determined by using evidence from previous studies between 2012 and August 2020 using certain search databases such as Cochrane, PubMed, PEDro, and MEDLINE. Task-oriented Training for the rehabilitation of upper extremity function following a stroke was the topic of randomized controlled trials chosen for assessment[18]. A total of 16 (57%) of the 28 papers that were first evaluated satisfied the requirements for inclusion. With PEDro ratings ranging from 6 to 10, these studies showed diverse quality in their methodology, with 75% classified as high-quality[18]. Task-oriented training rehabilitation led to statistically significant improvements in upper extremity function post-stroke in all included trials ($p<0.05$)[18]. The randomized controlled trial design of the study is favorable as it provides a strong basis for assessing the impact of strength training and TOT on upper limb function in stroke patients who are hemiplegic. In order to enhance the dependability and accuracy of the results, the research also employed recognized outcome indicators such as the DASH, ARAT, and FMA-UE. The study has attained a good sample of 80 patients, enhancing the generalizability of study findings in different settings. The study has a few limitations, i.e., it only occurs for a short period and thus fails to determine the treatment's efficacy in the long run. Also, it only involves stroke survivors who had experienced the event in the previous 2 to 12 months; thus, it may restrict the inclusion of patients with more chronicity and might not apply to persons who are at different stages of recovery. The study did not analyze the subgroups of hemiplegic stroke patients that may provide valuable information on tailored treatment regimens.

Conclusion

It was concluded that both strength training and TOT were effective in improving upper limb function for patients with hemiplegic stroke across all outcome measures and thus showed improved recovery. Thus, physical therapists must choose an intervention upon critically analyzing the patient's condition, needs and preferences during recovery.

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Conflict of Interest

None.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Akhtar T, Amjad A

Acquisition, Analysis or Interpretation of Data: Amjad A, Zafar A, Khan E

Manuscript Writing & Approval: Azfar H, Humayoon N

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.