



ORIGINAL ARTICLE

Effects of arm ability training versus task-oriented training on dexterity, functional ability, and quality of life in subacute stroke survivors: a single-blinded randomized controlled trial

Mythili D¹ , Kotteeswaran K² , and Balchandar V.³ 

¹Saveetha College of Physiotherapy, Saveetha Institute of Medical & Technical Sciences, Chennai, Tamil Nadu, 602105, India

²Saveetha College of Physiotherapy, Saveetha Institute of Medical & Technical Sciences, Thandalam, Tamil Nadu, 602105, India

³Jaya College of Paramedical Sciences, College of Physiotherapy “The Tamil Nadu Dr. MGR Medical University,” Guindy, Chennai, Tamil Nadu, 600062, India

* Correspondence Author:

✉ kotteeswaran.scpt@saveetha.com

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ABSTRACT

BACKGROUND

Stroke is a worldwide health issue, with the loss of upper limb function along with diminished cognitive function. Post stroke, more than 2/3 of the patients have impairment in the motor function of the upper limb. As a result, there will be difficulty in performing activities of daily living. Hence, this study focused on comparing the effects of arm ability training (AAT) and task oriented training (TOT) on improving dexterity, functional ability, and quality of life in subacute stroke survivors.

METHODS

This was a randomized clinical study involving 210 sub-acute stroke patients. They were randomized into group A (n=105) receiving arm-ability training, and group B (n=105) receiving task-orientated training. Both groups received treatment 5 days a week, for 3 weeks. The outcome measures included the modified standardized nine-hole peg test (mS-NHPT), Graded Wolf Motor Function Test (gWMFT) and 12-item Stroke-Specific Quality of Life Scale Questionnaire (SS-QoL-12). The independent t - test and the Chi Square test of independence for gender variance were used for statistical analysis. A p-value <0.05 was considered statistically significant.

RESULTS

Baseline assessment observed no statistically significant difference between groups for AAT and TOT (p>0.05). AAT exhibited significant improvements over TOT in terms of mS-NHPT, gWMFT (FAS, PT), and SS-QOL-12 (p<0.0001) among sub acute stroke survivors.

CONCLUSION

This study provides support for the superior efficacy of AAT than TOT in dexterity, functional ability and quality of life among subacute stroke survivors. These beneficial effects were observed after 3 weeks of training.

Keywords: Dexterity, functional performance, quality of life, sub-acute stroke patients.

INTRODUCTION

Stroke is a worldwide health problem and accounts for 70% of cases. In 2021, the World Stroke Organization reported that there were approximately 93.8 million prevalent strokes and about 11.9 million incident strokes.⁽¹⁾ The major risk factors are diabetes mellitus, hypertension, smoking, and lifestyle modification.⁽²⁾ After a stroke, the survivors have marked motor deficits in their arms. The degree of impairment is determined by day-to-day functioning, functional performance of the upper extremity, and loss of precision and prehension activities.⁽³⁾ Loss of dexterity and strength of muscles combined with upper limb neuromuscular weakness had the largest effect on stroke patients' functional recovery.^(4,5) The burden of stroke relates to Sustainable Development Goal 3, which focuses on Good Health and Well-being. The exercise training protocols in this study, the arm ability training and task-oriented training, directly addressed SDG 3 by improving motor control, facilitating hand function, and increasing satisfaction with daily living dexterity among the stroke subjects.

Stroke is the primary cause of acquired disabilities, and approximately 50% of stroke subjects present with chronic impairments in functions of the upper limb, which significantly affect their independence and activities of daily living.⁽⁶⁾ Many studies on stroke patients have examined the components of dexterity with regard to force control upper limb weakness, decreased accuracy in power grip and precision grip grasp-and-lift activities; finger movement independence is common, impairing the ability to execute sequential finger movements.⁽⁷⁾ The capability to execute precise, coordinated hand and finger movements, such as fine control when grasping and handling small items, is known as manual dexterity.⁽⁸⁾ Therefore, reduced force control, decreased finger movement independence, slower timing, or inadequate finger sequencing could all affect manual dexterity in stroke patients that adversely affects the quality of life.^(9,10)

Mirror therapy, repetitive transcranial magnetic stimulation (rTMS), repetitive task practice, musical therapy, Bobath therapy, modified constraint-induced movement therapy and electrical stimulation were all beneficial, but the available data were insufficient to determine the relative efficacy of various therapies in

enhancing stroke patients' quality of life and upper limb function.⁽¹¹⁾

The unique rehabilitation demand of the subgroup of stroke survivors is the arm ability training (AAT), developed to improve these sensorimotor skills.⁽¹²⁾ With an emphasis on attention and enhanced feedback, the eight training tasks improve highly repetitive structure, provide variability in practice, with different training tasks having varying task difficulty, and are explicitly designed to improve performance through motor learning.⁽¹³⁾ The structured, individualised programmes that focus on enhancing dexterity empower the skill development and self-confidence of stroke survivors that directly support SDG 4 (Quality Education), which promoted equitable learning opportunities in health contexts.

An activity-centered method known as a task-orientated approach entails repeatedly training a task with an emphasis on functional performance to successfully complete it.⁽¹⁴⁾ Repeated training, task analysis, feedback, and the environment work together to enhance the exercise training effects. Functional activities aid in the organization of motor activity by reintegrating reflex circuits with central nervous system (CNS) neuronal networks.⁽¹⁵⁾ Task-orientated training (TOT) emphasize the principle of motor learning along with neuromuscular mechanisms to enable the stroke survivors with better functional outcomes, demonstrate a restored hand function.⁽¹⁶⁾

Many research studies highlighted that both AAT and TOT are individually effective in upper limb rehabilitation, but the focus towards dexterity, functional ability and quality of life is limited. However, AAT with biofeedback techniques also yielded consistent improvements in dexterity and functional ability,⁽¹³⁾ and TOT had positive effects when compared to conventional therapy.^(14,15) Despite these findings, the relative comparative efficacy of AAT versus TOT remained inconclusive, where AAT focuses on fine motor dexterity and TOT focuses on activities of daily living. This divergence underscores the inconclusive nature of direct comparisons, and the different trials use distinct outcome measures. This heterogeneity makes it difficult to establish a unified conclusion. Hence, the novelty of the current study is a comparison between the effects of AAT and TOT among subacute stroke survivors, thereby addressing this gap that focuses on fine motor dexterity, functional ability and

quality of life among subacute stroke survivors. This study also addresses the comparative effects of AAT and TOT on neuroplasticity by employing enhanced evaluation measures, namely modified standardised nine-hole peg test with autotimer, the Graded Wolf motor function test and Stroke-Specific Quality of Life-12. This study focused on the effectiveness of AAT versus TOT among subacute stroke subjects in terms of manual dexterity, functional upper limb performance, and personal, emotional, and social well-being in subacute stroke survivors.

METHODS

Research design

A single blinded randomized controlled trial was conducted among subacute stroke patients in the Outpatient Department of the College of Physiotherapy, Chennai, Tamil Nadu, India. The participants were recruited from November 2025 to January 2026. Follow up assessments were concluded by March 2026.

Study subjects

Two hundred and ten patients participated in the current investigation; the clinically diagnosed patients were enrolled for the study after receiving a thorough explanation of the study and giving informed consent. The participants were randomized into two groups, namely Group A—AAT (n=105) and Group B—TOT (n=105) using block randomization with block size of 6. Randomization was administered independently by a faculty member not involved in treatment or assessment to ensure allocation concealment.

The participants enrolled in the study were aged 30 to 60 years with a history of stroke; both genders with a body mass index (BMI) ranging from 24 to 35 kg/m² had unilateral middle cerebral artery (MCA) sub-acute stroke lasting longer than three months (both ischemic and haemorrhagic), diabetes mellitus, hypertension, Brunnstrom approach for upper extremity (UE) (II and III stages),⁽¹⁷⁾ and Mini-Mental State Examination ≥ 24 (21 for illiterate).⁽¹⁸⁾ Subjects demonstrating independent sitting ability for half an hour were included. Excluded were those with recent fracture, deformities, Alzheimer's disease (AD) and Parkinson's disease (PD), any systemic disease, severe somatosensory deficit, pain in 1 or 2 joints, sensory deficits (visual or auditory), significant shoulder pain, any coexisting illness

that hindered upper extremity ability, and psychiatric comorbidities.

Sample size determination

Sample size estimation was conducted using GPower software (version 3.1.9.7), with a significance level of $\alpha=0.05$ and type II error probability $\beta=0.20$ (power = 80%). Assuming a medium effect size ($d=0.5$), the required sample size was calculated to be 105 participants per group (210 total).⁽¹⁹⁾ To account for potential attrition, additional participants of 220 in total were recruited, ensuring that the final analyzed sample met the calculated requirement.

Interventions

Group A: Arm ability training: 3 weeks, 5 days/wk, 50 min/session⁽²⁰⁾

1. Subjects were aimed with a stylus at a distance of 18–23 cm and a breadth of 3–50 mm displayed on the monitor, both on and above the table surface.
2. Tapping: quick, repetitive, alternating, targeted forefinger, middle finger, and thumb were placed on the sensor pad.
3. Cancellation: using a pen, different-sized circles are drawn.
4. Coins turning: 18 and 23 mm.
5. Tracking on the sensor of maze.
6. Screwing and unscrewing—nuts and bolts (12 mm, 5 mm, 3 mm).
7. Placing objects of small and large sizes.

Group - B task-oriented training: 3 weeks, 5 days/wk, 50 min/session⁽²¹⁾

The subject was made to sit on a chair so that the trunk was erect and feet were firmly positioned on the floor. After 10 minutes of warm-ups and exercise, the subjects practiced the selected functional tasks for 30 minutes. Every 10 minutes of continuous practice during these 30 minutes of TOT was followed by a 2-minute rest interval.

1. Drinking a glass of water.
2. Raising a glass of water at a 90-degree angle while extending the elbow and flexing the shoulders.
3. Stacking paper cups on top of one another.
4. Transferring five crystals from a table to a box
5. Using an elbow-extended table to wipe the table.
6. Holding and releasing a tennis ball with a diameter of 6 cm.
7. Using a spoon to eat

Depending on the person's ability, variables including resistance, speed, and distance gradually increased in difficulty. The subjects received manual assistance, verbal, visual, or proprioceptive feedback to ensure that they completed the activities accurately.

Study outcomes

Finger dexterity:

The modified standardized Nine-Hole Peg Test (mS-NHPT) ⁽²²⁻²⁴⁾ with auto-timer was quick and easy to administer and was an advanced method of recording the duration taken to complete the task as a measure of finger dexterity. The setup consisted of two pegboards in that were analogous with each other in a virtual setting. The pegs were placed from the primary pegboard into the target pegboard's holes. A precise sequence for choosing the pegs in a virtual setting was added. The double pegboard was placed on the table between their arms, with pegs filled in the lateral pegboard towards the hand to be assessed and at the midline, an empty medial pegboard. The lateral pegboard's pegs (No. 1 to No. 9) were picked uni-manually one at a time, the pegs were moved and placed into the medial pegboard holes and then returned to the lateral pegboard (from No. 9 to No. 1) one by one. When Peg No. 1 was put in the lateral pegboard and the timer stopped, the monitor indicated the duration in seconds. The time taken to complete the test was noted. (Figure 1)



Figure 1. Modified standardized nine hole peg test

Functional ability:

The graded Wolf Motor Function Test (gWMFT) ^(25, 26) is a modified version designed for the assessment of moderate to severe upper limb impairment in stroke patients. It includes 13 standardized tasks that simulate everyday arm and hand movements, evaluating performance time and functional ability and graded across tasks. The tasks include raise forearm to table (side), raise

forearm from table to box (side), extend elbow (side), extend elbow against 1lb weight (side), raise hand to table (front), raise hand to box (front), reach and retrieve 1 lb weight on table, move foam stick through supination and pronation, grasp and lift wash cloth, flip light switch, grasp and lift pen, grasp and lift cotton balls, lift weighted basket of 3lb and place onto the raised table (standing). The scoring of the gWMFT functional ability scale (FAS) was an eight-point ordinal scale, ranging from zero (not attempted) to seven (normal movement). Items were completed on two levels (A and B), where level A items were of a higher level of difficulty and were scored between four and seven. Level B items were of a lower level of difficulty and were scored between zero and three. Any items not completed were scored zero. For the assessment of performance time (PT), which is the time taken to complete the tasks, the participants had 30 seconds to complete level A items, and if unable to do so, had a second opportunity to complete the task at level B. Sixty seconds were added onto performance time for level B items, with a maximum time of 120 seconds.

Quality of life:

An efficient and valid outcome in research for assessment of quality of life, a shortened version was the 12-item Stroke-Specific Quality of Life Scale (SSQOL) ^(27,28) which developed an efficient and valid outcome in research. It is a multifaceted analysis of the functioning of stroke survivors across family roles, language, energy, thinking, upper extremity, mobility, mood, personality, self-care, social roles, vision, and work. It records the patient's own perception of their physical, emotional, and social functioning on points from 0 to 5 on a Likert scale. The greater the score, the better the quality of life; the average scores ranges from 12 to 60, and in the case of stroke, the score may vary from 30 to 45 based on duration, severity, and status of rehabilitation; hence, it is a valuable complement to clinical assessments.

Statistical analysis

SPSS Software Version 23.0 was utilized for advanced statistical analysis, namely inferential statistics. An independent sample "t"-test was used to evaluate group mean comparisons between groups, and the Chi Square test of independence for gender variance. Statistical significance was reached when the "p"-value was <0.05.

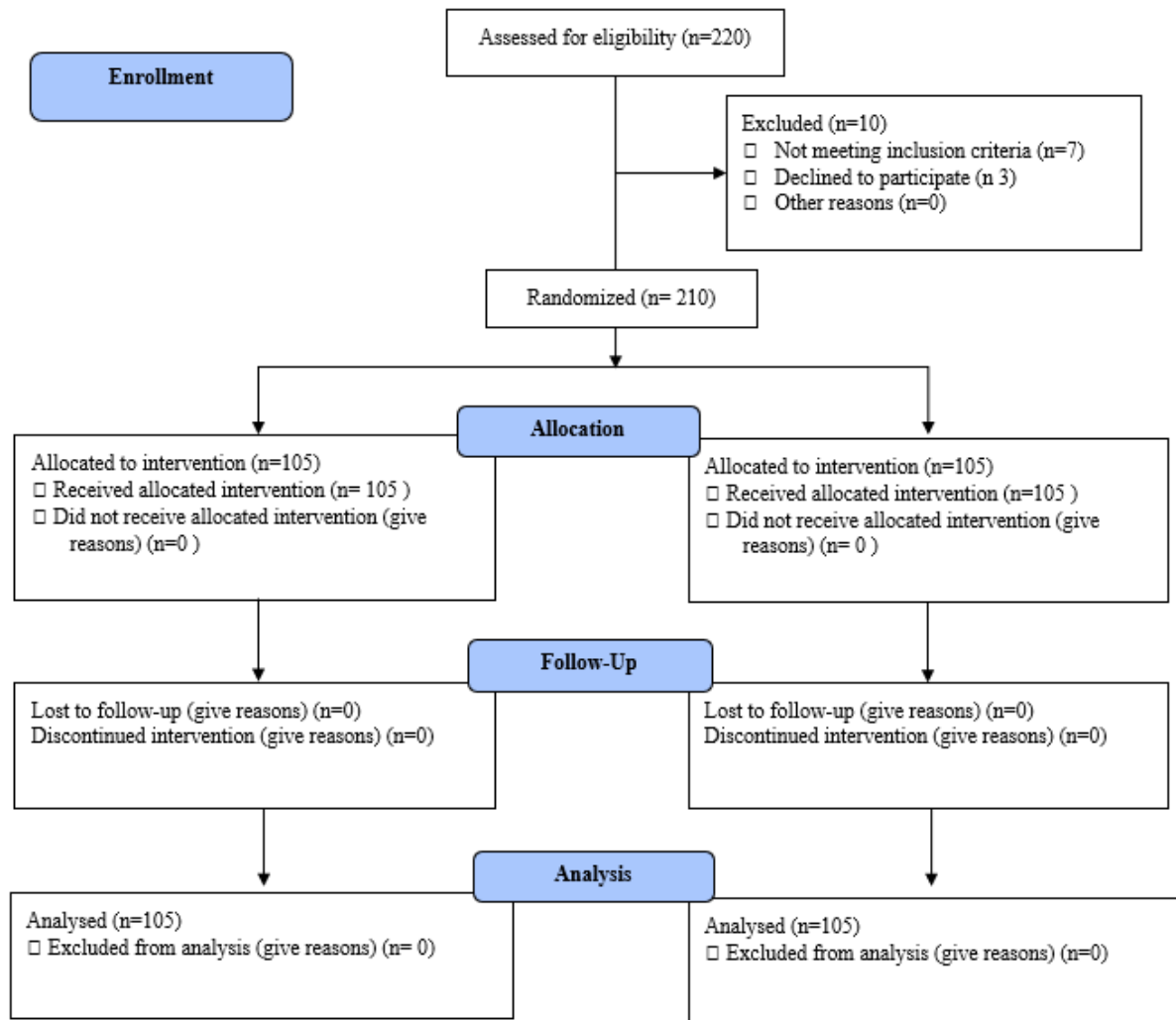


Figure 2. Consort flowchart of participants

Ethical clearance

The Institution's Ethical Committee (EC/JCP/11/2023) approved the study, Clinical Trials Registry of India, CTRI No: CTRI/2024/07/069788, and knowledge-based consent from the participants was obtained.

RESULTS

Two hundred and twenty patients were assessed, out of which 210 patients were included with 10 dropouts during the intervention (Figure 2). Baseline assessment was conducted before performing the intervention. There was no statistically significant difference between the two groups at baseline ($p > 0.05$), indicating that both groups were comparable prior to the intervention (Table 1). This randomized controlled trial was

completed after a three-week intervention period with two hundred and ten stroke participants. All the participants were analysed for outcome measures in the study.

Both groups demonstrated significant improvements in ms-NHPT, gWMFT (FAS and PT), and SSQoL-12 ($p < 0.0001$). When compared between the two groups, Group A (Arm Ability Training) experienced significantly greater improvements in mS-NHPT at 90.18 ± 3.04 ; gWMFT, FAS at 4.41 ± 0.68 ; PT at 41.59 ± 1.46 seconds; and SS-QoL-12 at 40.27 ± 1.75 ; compared to Group B (Task-Oriented Training) in terms of mS- NHPT 97.62 ± 1.55 ; gWMFT FAS 3.71 ± 0.47 ; PT 44.75 ± 1.18 seconds; and SS-QoL-12 36.78 ± 2.48 ; in improving dexterity, functional ability and quality of life among subacute stroke subjects (Table 2).

Table 1. General characteristics of the subjects by treatment groups at base-line

Characteristics	Group AAT (n=105)	Group TOT (n=105)	p value
Age (years)	47.40 ± 6.82	48.02 ± 6.21	0.491
BMI (kg/m ²)	28.39 ± 2.98	28.82 ± 2.42	0.252
Gender			
Male	41 (48.8)	43 (51.2)	0.780
Female	4 (66.7)	2 (33.3)	0.670
mS-NHPT (sec)	114.97 ± 2.69	115.52 ± 2.44	0.122
gWMFT-Functional ability scale	2.74 ± 0.24	2.66 ± 0.27	0.024
gWMFT-Performance Time (sec)	53.59 ± 1.48	54.22 ± 1.69	0.004
SSqoL-12	20.04 ± 1.02	20.20 ± 1.18	0.294

*Data presented as mean ± standard deviation, except for gender as n (%), ms-NHPT- Modified Standardized Nine Hole Peg test, gWMFT – Graded Wolf Motor Function test, SSQoL – 12: 12 item Stroke Specific Quality of Life; AAT : Arm Ability Training; TOT : Task Oriented Training

DISCUSSION

The present study demonstrated significant improvements in dexterity, functional ability, and quality of life following both AAT and TOT interventions. While AAT produced superior gains in fine motor dexterity, TOT was effective in enhancing activity of daily living (ADL) and gross motor function. These findings are consistent with previous reports that structured, repetitive training improves upper limb outcomes.⁽¹³⁻¹⁵⁾ However, unlike prior studies that examined AAT or TOT in isolation, our trial directly compared the two approaches, thereby resolving the inconclusive evidence regarding their relative efficacy. Mechanistically, AAT promotes neuroplasticity through sensorimotor learning and precision training, whereas TOT emphasizes functional task repetition to reinforce motor patterns. The novelty of this study lies in its

comparison, highlighting AAT's superiority for dexterity recovery while confirming TOT's role in functional rehabilitation.

According to research done by Karaganova and Mindova,⁽²⁹⁾ a multidisciplinary approach is essential in the early phase of stroke for better functional outcomes, as neuroplasticity of the brain is the key mechanism of stroke recovery. Personalized rehabilitation protocols and multimodal strategies have to be framed based on the needs of the patients for their enhanced recovery for therapeutic benefits and enhanced long-term outcomes. Stroke burden is an integral part of cities and communities both in urban and rural areas. The rehabilitation services contribute directly to SDG 11 (Sustainable cities and communities) by promoting sustainable therapy to the community and cities that uphold the dignity and resilience of all the residents of the community.

Table 2. Primary outcome variables after three weeks interventions by treatment groups

Outcome	Treatment groups		p value
	Group AAT (n=105)	Group TOT (n=105)	
mS-NHPT(sec)	90.18 ± 3.04	97.62 ± 1.55	< 0.0001
gWMFT-functional ability scale	4.41 ± 0.68	3.71 ± 0.47	< 0.0001
gWMFT-performance time(sec)	41.59 ± 1.46	44.75 ± 1.18	< 0.0001
SSqoL-12	40.27 ± 1.75	36.78 ± 2.48	< 0.0001

*Data presented as mean ± standard deviation; ms-NHPT- Modified Standardized Nine Hole Peg test, gWMFT – Graded Wolf Motor Function test, SSQoL – 12: 12 item Stroke Specific Quality of Life; AAT : Arm Ability Training ; TOT : Task Oriented Training

Sensory stimuli from the somatosensory system interact with the motor control feedback to promote effective motor performance, enabling effective interaction with the environment. The somatosensory feedback arises from the receptors of cutaneous and proprioceptive centers that transmit the sensation to the parietal cortex of the brain. Cutaneous skin receptor feedback inputs (touch, pressure, vibration, temperature, and pain) play a critical role in honing dexterous movements that enable individuals to perform manual tasks.⁽³⁰⁾ According to the research of Platz and Lotze,⁽³¹⁾ AAT focuses on the specific requirements of subacute stroke survivors by augmenting sensory-motor performances through a neuro-motor and psycho-motor training protocol for subjects with arm paresis from mild to moderate disability of stroke. AAT facilitates maintenance and generalization of training effects by motor learning, promotes self-determined motivation, prioritizes neuroplasticity, and facilitates broad enhancement of hand and arm sensorimotor performances with lasting benefits. Additionally, training-induced plasticity and arm function recovery in hemiparetic subjects are facilitated by the functional reorganization of the brain with activation of the premotor cortex.

Using technological aids to help the patient participate actively is known as task-oriented training. Using a behavioural method known as TOT, the therapist focuses on the tasks that must be completed in order to reach specific performance standards or goals. Based on the research done by Desta,⁽³²⁾ stroke patients engage in a variety of motions during TOT, learning to decrease inappropriate movements and enhance their functional abilities. Task-oriented training causes brain remodelling; skill acquisition and active engagement are important aspects of the patient's recovery. TOT incorporates practiced, meaningful, and daily tasks; it enhances brain changes and guides in the transfer to real-life activities. Through the use of spared brain regions adjacent to the disrupted region and/or the activation of supplementary areas of the brain, improving functional activities is the main goal of a task-oriented approach or therapy.⁽³³⁾

Moreover, Arya et al.⁽³⁴⁾ concluded that task-specific interventions alone may have lacked the precision and grading needed for certain fine motor improvements, supporting the idea that targeted arm training, such as AAT, might have more potent effects on motor function recovery as it provided more precise sensorimotor feedback.

Improvement in SS-QoL reflected enhanced perceived independence, social participation, and emotional well-being. The superior results in AAT may have contributed more to functional independence, leading to improved quality of life.

The study was limited by its single center design, modest sample size, and short intervention period, which may have restricted generalizability and long-term conclusions. Arm ability training demonstrated superior improvements in dexterity and functional ability, while TOT effectively enhanced ADL performance. Both approaches were integrated to optimize rehabilitation outcomes among stroke survivors. Future research should focus on multicenter trials with extended follow-up, combined intervention strategies, and incorporation of advanced technologies to further strengthen evidence for upper limb rehabilitation in stroke survivors.

CONCLUSION

Both interventions yielded significant gains in improving dexterity, functional ability, and quality of life among subacute stroke survivors. Arm ability training produced superior improvements in fine motor dexterity and functional ability, whereas TOT was particularly beneficial for enhancing gross motor performance and activities of daily living. Arm ability training may be prioritized when dexterity recovery is the primary objective, while TOT remains valuable for functional independence in daily activities. This study contributes to the supporting structured, repetitive, and function focused interventions in stroke rehabilitation, and underscores the need for integrated approaches that combine dexterity focused and task oriented methods to optimize patient outcomes.

Conflict of Interest

The authors declare no conflicts of interest.

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Authors' Contribution

MD – Conceptualization, Methodology, Investigation, Data curation, Formal analysis, writing original draft. KK: Methodology,

Supervision, Validation, Writing– review & editing. BV: Clinical evaluation and diagnosis, supervision, Writing – review & editing. All authors have read and approved the final version of the manuscript.

Data Availability Statement

From the corresponding author upon reasonable request.

Declaration of AI Usage in Scientific Writing

AI was used only for minor grammatical corrections. All data presented in this study are original.

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