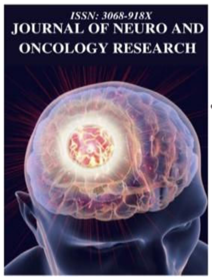

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Case Report

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Additional Effect of Task-Oriented Training Algorithm on Learn Non-Use in Upper Extremity Function of Stroke Patients: A Clinical Study

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Abstract

Background and Need of Research: Stroke is a leading cause of long-term disability, with up to 80% of survivors experiencing upper extremity impairment. Despite various interventions, Task-Oriented Training (TOT) remains one of the most functionally relevant and cost-effective methods. However, studies lack clear evidence on optimal dosimetry and clinical decision-making for progression in TOT. Hence, this study aimed to test a structured algorithm integrating motor learning and neuroplasticity principles to address learned non-use in stroke patients.

Aims and Objectives: To determine the additional effect of a task-oriented training algorithm on upper extremity function and learned non-use in subacute and chronic stroke patients using Motor Activity Log (MAL), Goal Attainment Scale (GAS) and Fugl-Meyer Assessment (FMA).

Methodology: An experimental study with 24 participants divided into two groups (Algorithm-based TOT vs Conventional TOT). Interventions were given 5 days/week for 6 weeks. Pre- and post-intervention outcomes were assessed using MAL, GAS and FMA. Data were analyzed using paired and unpaired t-tests.

Result: Both groups showed significant improvement ($p<0.05$) within groups. Between groups, the algorithm group showed greater gains in MAL (AOU and QOU) and GAS, indicating enhanced goal attainment and arm use.

Conclusion: Task-oriented training using an algorithm showed superior improvement in functional goal attainment and arm use compared to conventional TOT. Further large-scale studies are recommended to validate the algorithm's clinical utility.

Keywords: Stroke (CVA); Task-Oriented Training (TOT); Learned Non-Use (LNU); Upper Extremity Function (UEF); Motor Activity Log (MAL); Goal Attainment Scale (GAS); Fugl-Meyer Assessment (FMA-UE)

Introduction

Stroke is a leading cause of long-term disability, with up to 80% of survivors experiencing upper extremity impairment. Despite various interventions, Task-Oriented Training (TOT) remains one of the most functionally relevant and cost-effective methods. However, studies lack clear evidence on optimal dosimetry and clinical decision-making for progression in TOT. Hence, this study aimed to test a structured algorithm integrating motor learning and neuroplasticity principles to address learned non-use in stroke patients.

The number of stroke sufferers is gradually increasing worldwide. A stroke leaves suffering with long term disabilities [1]. The prevalence and cost of stroke care have increased and innovative techniques are becoming widespread. Such cost is producing social and economic burden for stroke patients [2].

Developing countries like India are facing a double burden of communicable and non-communicable diseases. Stroke remains a significant public health concern, with estimated adjusted prevalence rates ranging from 84 to 262 per 100,000 population in rural areas and 334 to 424 per 100,000 in urban settings [1]. Recent population-based studies report an incidence rate of approximately 119 to 145 per 100,000 population. Among the various post-stroke impairments, upper extremity dysfunction is a major contributor to long-term disability. Evidence suggests that only about 5% of individuals achieve complete functional recovery of the paretic upper limb, which substantially impacts overall functional independence and quality of life [2]. The prevalence of upper limb impairment is approximately 50-80% in the acute phase and 40-50% in the chronic phase [3,4].

Research has focused on lower limb motor impairment more than upper limb partly because lower extremity is more easily described, outcomes are more easily quantified and mobility is considered a key consideration after stroke. However, among that upper limb recovery is considered important because it is integral to independence in many activities of daily living. Therefore, interventions designed and tested for upper extremity motor recovery are required [3].

The recent treatments available for upper limb function are robotic assisted training, action observation therapy, transcranial current stimulation, virtual reality, functional electrical stimulation, electromyography, task-oriented training and goal directed training. These treatments lead to the functional recovery on the basis of neural plasticity that is the capacity of the injured brain for recovery and repair. Among these treatments task-oriented training is highly based on motor control and motor learning theories and neural plasticity principle with moderate level of evidence and also it is cost effective in comparison to other treatment approaches [2,4,5].

Task oriented training, a top-down training approach targeting functional activities has a measurable effect not only on paretic upper extremity functional performance but also on motor recovery and quality of life of hand function for stroke survivors [6]. Within the task-oriented approach, movement is organized around a behavioral goal is constrained by the environment. Hence therapist has to determine expectations about the likelihood of neurological and functional recovery from assessment scores which will facilitate: 1) setting realistic treatment goals and 2) selecting a restorative or compensatory approach to achieve those goals [7]. To determine functional goal, functional assessment by task analysis of upper extremity is required considering fundamental domains of reach, grasp, manipulation and release. However, explanation on clinical decision-making strategies for progression of complexity of treatment task to accomplish the goal are lacking among the literature's depicting beneficial effect of Task- Oriented Training (TOT).

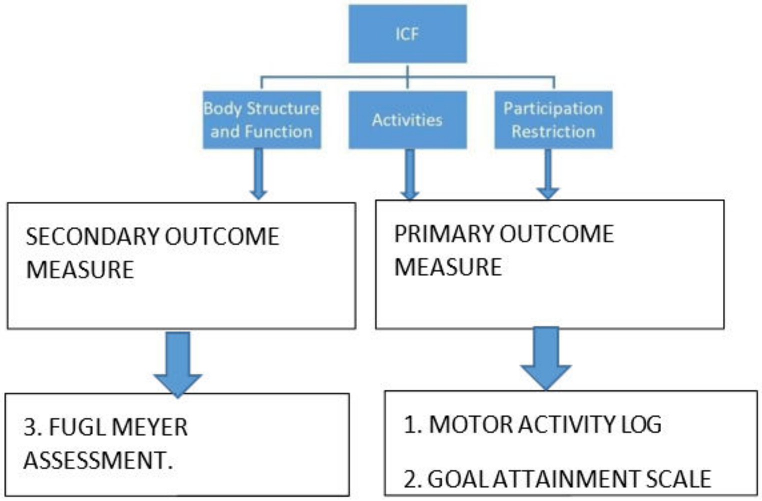
Further, implementing these recommendations in developing countries is even more challenging [8]. Thus, we are testing an algorithm which is made on the basis of current evidence for dosimetry and how to clinically decide the application and progression of task specific training specifically in urban and rural Indian stroke survivors. The Primary outcome measure selected for this study are Motor Activity Log (MAL) which is a reliable measure for stroke population and intended to examine how much and how well the subject uses their more- affected arm in real world which is matching with the intervention and Goal Attainment Scale (GAS) it is a therapist measured method of scoring the extent to which patient’s individual goals are achieved in the course of intervention. The secondary outcome measure selected is Fugl Meyer Assessment which is a highly reliable scale to assess sensorimotor impairment in stroke population (Table 1).

Materials and Methods

Component	Description
Study Design	An experimental study design was adopted
Study Setting	Conducted at Shree B. G. Patel College of Physiotherapy, Anand
Study Population	Participants with subacute and chronic stroke
Sampling Method	Purposive sampling technique was utilized
Sample Size	A total of 24 participants were recruited and allocated into two groups
Outcome Measures	Primary outcomes included upper extremity function and learned non-use

Table 1: Study description.

Outcome Measures



Selection Criteria

Inclusion Criteria

1. 40-70 years' age
2. Unilateral subacute (1-6 months) and chronic stroke (≥6 months)
3. Fugl Meyer score 19-58
4. Minimal Active extension of wrist and fingers
5. Stable medical condition
6. MMSE Score >24
7. c/c for upper limb function

Exclusion Criteria

1. Other significant neurological disorders visual problems, aphasia and perception disorders (unilateral neglect) which can affect the intervention
2. Major musculoskeletal, cardiopulmonary or psychological disorders (major depression, anxiety and emotional disturbances according to DSM-5 criteria) which can affect intervention
3. Pain score >1 on FMA

Procedure

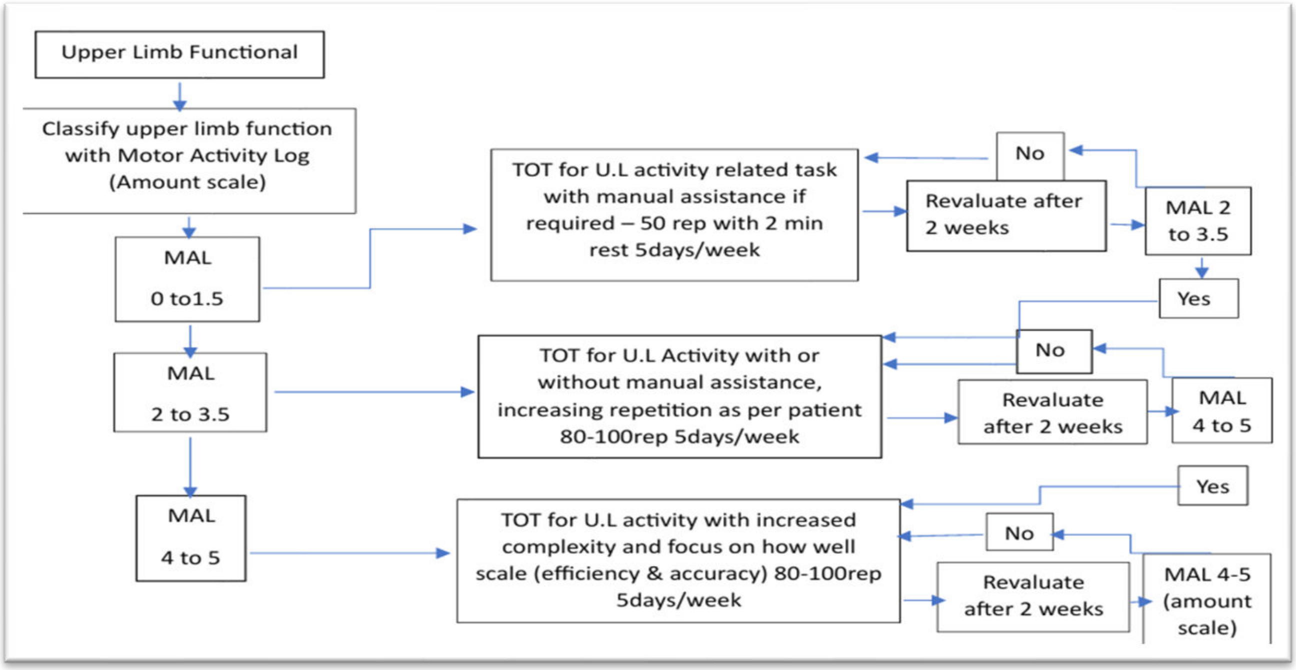
After screening for baseline data, patients were allocated to 2 groups by purposive sampling and initially were asked about chief complaints, functional difficulties and participation restriction.

Intervention

1. *Experimental Group*

Patients were asked to major 3 activity related chief complains and assessed with the help of task analysis utilizing all the domains of upper extremity function (reaching, grasping, manipulating/moving and releasing) and trained each 3 in all the sessions. Goals were set for each task using Goal Attainment Scale (tailor made specificity principle) and were re-assessed every 15 sessions. After assessing 15 sessions if the patients reached the goal i.e. expected outcome set 0 or more, then Progression were made with increasing complexity of the task in order to reach actual goal i.e. increasing the weight of object to original context, modifying the consistency of food for eating, reaching at different heights, moving different objects of original context ("intensity", "salience" and "repetitions" principle). If the patient did not reach at least 0, then patients were reassessed, environmental modifications were made (compensatory approach used wherever required) and ask to practice further. In order to engage patients in the activity variable practice were given for e.g. same diameter of different objects, different distance set for reaching (use it and improve it). Along with that patient were educated related to their arm use in the clinical and other environmental context e.g. Home and occupation. After 6 weeks of intervention (5 days/week), MAL and FM were analyzed.

Algorithm along with dosimetry has been decided according to the current available evidence for upper extremity recovery.



2. *Control Group*

Task oriented training was given without using algorithm according to patient's chief complain and task analysis. Along with that patient were educated related to their arm use in the clinical and other environmental context e.g. Home and occupation. After 6 weeks of intervention (5 days/week), MAL and FM were analyzed. There were no analysis and modification in treatment protocol had been made in between

Statistical Analysis

1. Baseline characteristics and results are presented as mean ± SD and statistical difference show homogeneity of groups
2. IBM SPSS statistics 26 is used for data analysis
3. Paired t-test is performed to determined differences within groups
4. Unpaired t-test is performed to determined differences between groups
5. T score calculation was used for analysis of GAS

Result

(Table 2,3, Fig. 1).

Variable	Experimental	Control
Age	51.58±13.54	55.17±11.72
Gender: Male Female	8 4	7 5
Hand Dominance	RT: 10 LT:02	RT: 08 LT: 04
Subacute Chronic	08 04	07 05
MAL(QOU)	1.453±0.788	1.35±0.54
MAL(AOU)	1.411±0.7320	1.343±0.747
FM (UE)	43.17±4.239	44.00±5.831

Table 2: Baseline data.

Outcome		Mean	SD	DF	P value	T value
FMA	Pre	43.17	4.239	11	<0.0001	12.16
	Post	48.83	4.260			
Mal (AOU)	Pre	1.41	0.732	11	0.0021	3.990
	Post	2.30	0.688			
Mal (QOU)	Pre	1.45	0.788	11	0.0034	3.717
	Post	2.39	0.690			
Gas	Pre	45.09	5.123	11	<0.0001	10.28
	Post	65.20	8.248			

Table 3: Within group analysis experimental group paired T test (P value< 0.05 shows clinical significance).

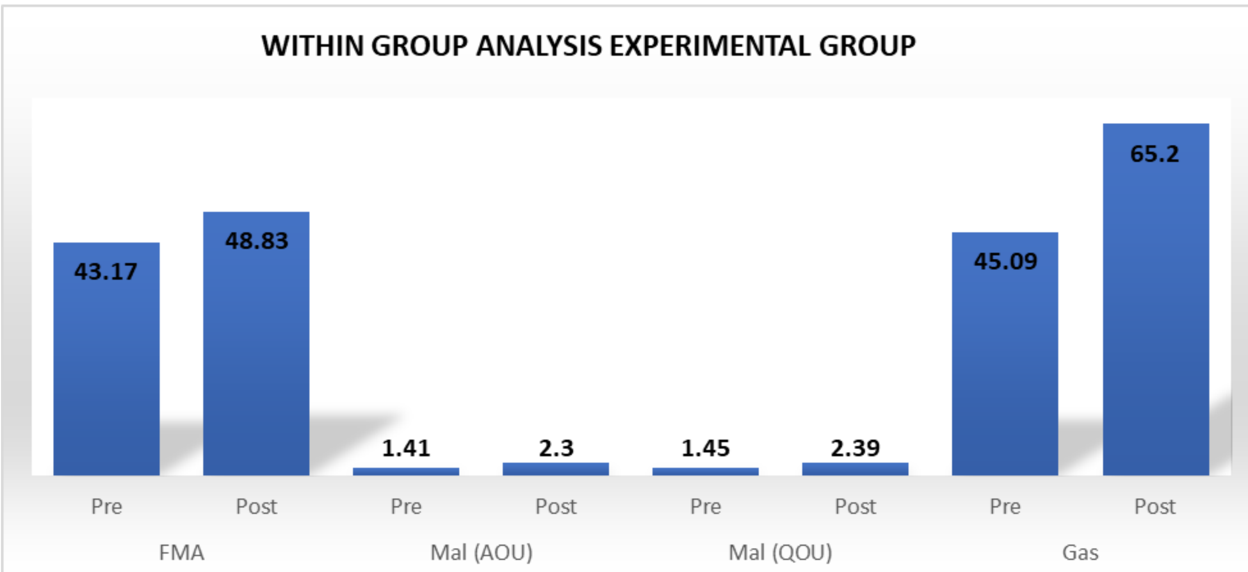


Figure 1: Analysis within experimental group.

Paired T Test
(Table 4,5, Fig. 2,3).

Outcome		Mean	SD	DF	P value	T value
FMA	Pre	44.00	5.831	11	<0.0001	11.87
	Post	46.67	5.959			
Mal (AOU)	Pre	1.34	0.747	11	0.0053	3.463
	Post	1.66	0.573			
Mal (QOU)	Pre	1.35	0.541	11	<0.0001	9.884
	Post	1.80	0.541			
Gas	Pre	43.63	4.645	11	<0.0001	31.73
	Post	54.25	4.801			

Table 4: Within group analysis control group (P value< 0.05 shows clinical significance).

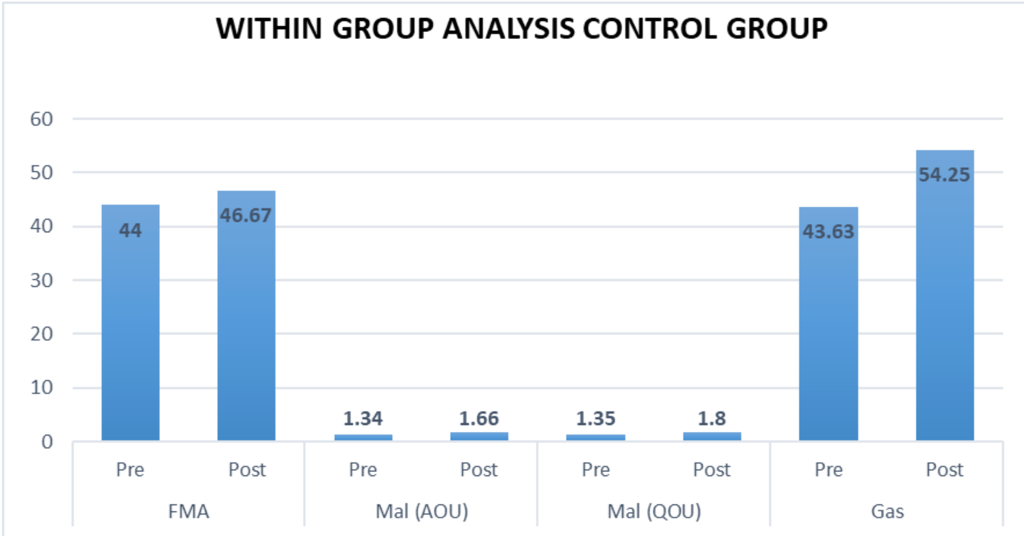


Figure 2: Analysis within experimental group.

Outcome		Mean	SD	DF	P value	T value
FMA	EX POST	48.83	4.26	22	0.3167	1.025
	CONT.	46.67	5.959			
	Post					
Mal (AOU)	EX POST	2.3	0.688	22	0.022	2.465
	CONT.	1.66	0.573			
	Post					
Mal (QOU)	EX POST	2.39	0.69	22	0.0258	2.391
	CONT.	1.8	0.541			
	Post					
Gas	EX POST	65.2	8.248	22	0.0006	3.975
	CONT.	54.25	4.801			
	Post					

Table 5: Between group analysis: Unpaired T test.

Within group analysis both the group showed statistically significant difference. However, experimental group showed high significant difference in MAL(AOU) and GAS compared to control group.

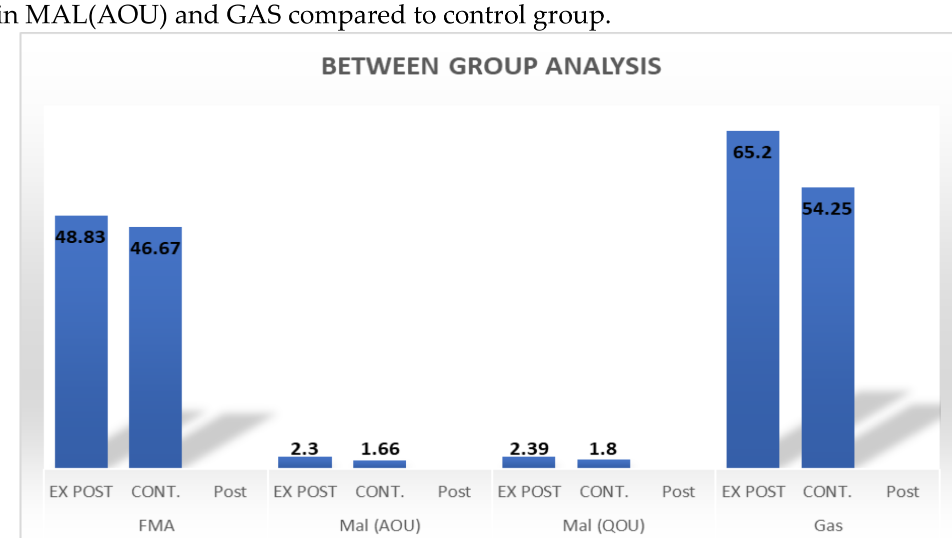


Figure 3: Analysis between group.

Discussion

This study aimed to evaluate the effectiveness of a task-oriented training algorithm in improving upper extremity function and reducing learned non-use in individuals with subacute and chronic stroke. Task-oriented training has been shown to induce cortical reorganization associated with functional recovery, characterized by decreased activity in the unaffected hemisphere and increased activation in the affected primary sensorimotor cortex [6]. Furthermore, it promotes neural plasticity and facilitates the transfer of learned motor skills to real-life functional activities. Task-specific training may enhance recovery by utilizing spared neural pathways adjacent to the lesion and by recruiting supplementary motor areas [1-3].

The experimental group received Task-Oriented Training (TOT) using a structured algorithm along with a prescribed home exercise program, whereas the control group received conventional TOT without the use of the algorithm. Patient education was provided equally to both groups. The results demonstrated statistically significant improvements within both groups across all outcome measures ($p < 0.05$). However, the experimental group showed greater improvements in Motor Activity Log (MAL) scores-Amount of Use (AOU) and Quality of Use (QOU), exceeding the minimal clinically important difference (MCID >1)-as well as in Goal Attainment Scale (GAS) scores, surpassing the minimal detectable change (MDC >10). These findings are consistent with previous literature suggesting that structured, task-specific training combined with appropriate progression strategies and increased practice intensity can enhance functional outcomes in stroke rehabilitation [2,6]. The observed differences may be attributed to variations in clinical decision-making for task analysis, progression and dosimetry, despite both groups receiving the same fundamental treatment approach (TOT). Additionally, the inclusion of a home exercise program in the experimental group may have further contributed to improved outcomes, as supported by existing evidence emphasizing the role of increased practice and carryover in functional recovery [5].

Between group analysis doesn't show any significant difference in FM while there is significant change in GAS score. There is no significant change which was expected in algorithm group even in MAL. As MAL is a patient reported outcome measure there could be inability of patients to perceive small gains in their function or arm use which may influence on scoring of the scale, also few of them were not able to correctly score the outcome as they were illiterate and were finding difficult to understand and judge there activities according to their pre-stroke ability. Similarly, these reasons could also affect the control group. Other reasons where few contexts related chief complains of patient like difficulty calculating, roti making were not matching with the component of the scale. This is the reason where GAS got improved, as it is Patient specific measure and also at completion of every 15 sessions, the patients where reassessed for their activities and progression were made accordingly in the algorithm group and hence GAS improved better in algorithm group than in control. Observing the individual patients in algorithm group having mild to moderate impairment on FM and has less score in MAL (developed learned non-use) in subacute stage improved well (MCID score >1) as compared to those who were having mild to moderate impairment and developed learned non- use in chronic stage. This finding also gives an insight that the acute stroke patients having similar baseline might also improve using the algorithm. Those patients who were highly self-motivated for their arm use in real-world were improving better. Thus, similar results were gained by the study conducted by Vasanthan Rajgopalan, et al., stating immediate social environment, awareness on how to self-engage in their physical environment and to perceive small gains in arm function can affect their arm use [10]. The present findings suggest that the applied dosimetry appears to be more effective in subacute stroke patients compared to those in the chronic stage, indicating a potential dose-response relationship in earlier phases of recovery. This observation is partially consistent with the study by Lang, et al., which reported no significant dose-response relationship in individuals with chronic stroke (≥6 months). One possible explanation for this difference lies in the choice of outcome measures. While previous studies have utilized domain-specific tools such as the Action Research Arm Test, the present study employed the Goal Attainment Scale (GAS), which allows for individualized, patient-centered goal evaluation. This flexibility may have contributed to the observed improvements. Furthermore, the findings highlight that dosimetry alone may not be sufficient; psychosocial and contextual factors-such as the patient's environment, engagement level and nature of task practice-play a crucial role in promoting real-world arm use, particularly within the Indian population. A key strength of the present study lies in the development and application of a structured, evidence-based task-oriented training algorithm that integrates principles of motor learning with practical clinical decision-making for task selection and progression. Unlike conventional approaches, this algorithm emphasizes individualized goal setting, periodic reassessment and context-specific task modification. Additionally, the use of patient-centred outcome measures such as GAS enhances the clinical relevance of the findings by capturing meaningful functional improvements. The observed improvement in GAS scores further supports the utility of this approach in guiding baseline assessment and progression strategies in task-oriented training. When it comes to dosimetry for TOT research by

Catherine lang, et al., has manipulated different dosimetry for amount of task specific training and concluded that there is no dose-response effect of task specific training on functional capacity in people with long standing upper limb paresis post stroke [6]. Qualitative Research by Vasanthan Rajagopalan et al had studied influence of contextual factors such as immediate social environment, lack of awareness to self-engage and ability to perceive small changes influence the arm use in stroke survivors [8]. Hence, alone dosimetry is not enough! Thus, precise and adequate task and goal specific interventions i.e. individual's context practice may give favorable result in improvement of function along with adequate dosimetry. Thus, there is lack of evidence for accurate dosimetry or favorable quality of treatment approach to be used in order to improve upper extremity function [4]. Further, to regain functional ability of the paretic arm, stroke rehabilitation guidelines recommend optimal quality and quantity of functional task practice to be sustained for a few months. To gain substantial improvements, the patient must actively engage in the practice of salient tasks at a challenging intensity. For each task, practice has to be repeated numerous times per day, progressed gradually until a cumulative dose of 2000-3000 repetitions are achieved, i.e. A total of 50-100 repetitions of the specific task/day (Principle of intense practice). However, the amount of practice provided within and outside rehabilitation is far less than the requirement.

Conclusion

The findings of the present study indicate that the task-oriented training algorithm demonstrates potential effectiveness in enhancing functional goal attainment, as reflected by improvements in Goal Attainment Scale (GAS) scores. Although the algorithm showed favorable outcomes in terms of arm use and goal achievement, the overall magnitude of its effect remains modest when considered in a broader clinical context. Therefore, while the algorithm may serve as a useful adjunct to conventional rehabilitation, further large-scale studies with rigorous methodology are warranted to establish its clinical efficacy and generalizability.

Limitation of the Study

- No blinding was done because patient education was necessary.
- Chances of therapist bias is high due to tailor made protocol which can affect the result.

Future Scope

Large sample size study required for the validity of the algorithm in clinical setting.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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Acknowledgement

None.

Data Availability Statement

Not applicable.

Ethical Statement

The project did not meet the definition of human subject research under the purview of the IRB according to federal regulations and therefore, was exempt.

Informed Consent Statement

Informed consent was taken for this study.

Authors' Contributions

All authors contributed equally to this paper.

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