RESEARCH ARTICLE

Journal of Ecophysiology and Occupational Health, *Vol 24(1), DOI: 10.18311/jeoh/2024/34288, 21-29, March 2024*

ISSN (Online) : 0972-4397
ISSN (Online) : 0974-0805

The Effect of Task-Oriented Training and Progressive Resisted Exercise on Upper Limb Function and Quality of Life in Chronic Stroke Patients

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Abstract

Introduction: Stroke is defined as a neurological deficit subjected to acute focal injury of the Central Nervous System (CNS) due to vascular cause. The cause may be several embracing cerebral infarctions. Stroke is the third leading cause of death and the most common cause of disability among adults. Many studies have shown that motor impairment is a common factor leading to disability in stroke survivors. Improving the deficient motor power and strategies will reduce motor disability (Task-oriented training is given mainly for improving Functional performance). **Need for the Study:** Studies have shown a significant effect on motor function post-stroke with several techniques like conventional exercise, Proprioceptive Neuromuscular Facilitation (PNF), and Brunnstorm techniques. The effect of the treatment was significant because the weak muscles were strengthened, and the tight muscles were relaxed. However, there is a scarcity in the literature related to the effect of task-oriented training on motor performance in subjects with chronic stroke. Hence this study is undertaken. **Methods:** The study was carried out in the OPD of the College of Physiotherapy- Dayananda Sagar University-Bangalore on a sample size of 40 subjects for 6 months. It was a randomised clinical trial where subjects were split into two groups with task-oriented training and Progressive Resisted Exercises (PRE). The therapy was 30 minutes/session for 5 days /week for 4 weeks. **Results:** Task-oriented training showed significant changes within the group from pre- and post-trial and between the group effects, thus demonstrating it to be more significant in enhancing motor performance compared to mere strengthening exercises. **Conclusion:** The current study demonstrates that task-oriented training compared to Progressive Resisted Exercises (PRE) works efficiently in improving upper limb functions and quality of life. The improvement in motor performance varied but the Chedoke Arm and Hand Activity Inventory and Stroke Impairment Scale showed quite significant improvement post-rehabilitation with task-oriented training compared to Progressive Resisted Exercise.

Keywords: Quality of Life, Stroke, Task-Oriented Training, Upper Limb Function

1. Introduction

A stroke or brain attack is defined as the sudden loss of neurological function caused by an interruption of the blood flow to the brain[1]. The World Health Organization (WHO) defines stroke as: "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than of vascular origin"[2,3]. There are two types of strokes: ischemic stroke (≈85%) and hemorrhagic stroke (≈15%)[4-5].

Stroke is the third leading cause of death and the most common cause of disability among adults. The incidence of stroke is about 1.25 times greater for males than females and it increases with age, doubling in the decade after 65 years of age. The WHO collaborative study

Article Received on: 30.06.2023 Revised on: 23.11.2023 Accepted on: 24.11.2023

showed that both in developed and developing countries, nearly one-third of stroke patients died within 3 weeks 48 percent died within one year. Stroke represents 1.2% of the total mortality in India[6].

Upper limb neuromuscular weakness occurs frequently after stroke with loss of muscle strength and dexterity together considered to produce the largest impact on functional recovery. Muscle strength may be related to functional ability and may contribute more to loss of functional ability than impaired dexterity, muscle tone sensation or pain[7].

Problems with arm function (upper limb impairments) are very common after a stroke. These upper limb impairments commonly include difficulty moving and co-coordinating the arms, hands, and fingers, often resulting in difficulty carrying out daily activities such as eating, dressing, and washing. A study carried out by Chowan *et al*., demonstrated more than half of subjects with upper limb impairment after a stroke still had problems years after the attack. Thus, improving arm function becomes a core element of rehabilitation[8].

Quality of Life (QoL) for stroke survivors causes a significant deterioration of the patient's functioning and worsening of her/his QoL and long–term disability is a common problem in all countries. Several studies have publicized that many stroke survivors experience a decline in their QoL in terms of physical, functional, psychological, and social health. QoL assessment has been an important part of the evaluation of stroke patients and their treatment for more than 30 years. Several questionnaires exist to assess QoL based on a patient's subjective self–report or self–evaluation. Some of these tools provide information about perceived health status: physical and mental functions, ability to perform everyday activities/roles or the limitation in performing these activities/roles[9].

One of the most common impairments in stroke survivors is loss of strength. The most widely employed Conventional Therapy (CT) is commonly used to improve strength in subjects without disability. This kind of therapy is delivered by physiotherapists using established methods which generally include active, active-assisted, and passive movements, stretching, strengthening, and coordination exercises to improve the range of motion, muscle strength and coordination of the affected extremities, soft tissue mobilization and facilitation of muscle activity/movement, positioning, and patient education. The therapist here generally provides sensory inputs either by cueing the subject performing the exercise or by the hands placed on the subject's extremities (hands-on techniques)[10].

A study by Harris and Janice J. Eng demonstrated that; stroke survivors had a predominant reduction in maximal voluntary force in the arm and hand muscles, and upper-limb strength in post-stroke individuals which proposed improvement after training with rehabilitation. This review study included a total of 517 individuals. A positive outcome for strength training was found for grip strength (p=0.04) and upper-limb function (p=0.03). No significant effect was found for strength training on measures of activities of daily living[11]. Another study by Sousa D *et al.,* demonstrated a significant effect concerning strength training for the upper limb which included subjects with moderate (p=0.03) and mild (p=0.01) upper-limb motor impairment post-stroke respectively[12].

The Progressive Resistance Exercise (PRE) is a method of increasing the ability of a muscle/group of muscles to generate force. Patients with stroke demonstrate a decreased level of physical conditioning following prolonged periods of immobility causing a reduction in activity. A study performed by Tricia *et al.,* demonstrated that resistance training programs for stroke survivors exemplified optimistic results by escalating electromyographic activity during the first 4-8 weeks of training. The reason behind this suggestion was that neural adaptations are credited to motor learning and improved coordination which embraces a hiked number of motor units recruited as well as an increased rate of and synchronization of firing[13].

Task-oriented Training (ToT) is a behavioural approach in which the main goal is the act ofthe task that needs to be performed to meet certain goals. It is ideally aimed to improve control strategy through various measures. Stroke survivors often have trick movements due to the present synergy pattern. The treatment for such subjects consists not only of the release of tight muscles but also of training the weak muscles or uncoordinated movements. As stated above the goal of the task-oriented program is to coordinate movement and to achieve functional strengthening, thus, task-oriented training may deliver better results if added with conventional physiotherapy of strengthening as it facilitates the improvements of neuromuscular and

musculoskeletal system leading to improvement in task performance[14]. The tasks given involve things such as answering a telephone, reaching something from an overhead shelf etc[15].

There are several outcome measures used to assess upper limb and hand motor function. Upper limb function will be assessed by the Chedoke Arm and Hand Activity Inventory (CAHAI). The convergent cross-sectional validity is 0.87, 0.96. The scale is used to assess the functional ability of the paretic arm and hand. Quality of life will be assessed by a specific Quality of Life (SS-QOL) Questionnaire which has good criterion validity, predicting 88-95 % of the variance of the original SS-QOL. Dexterity- The nine-hole Peg Test (9HPT) measures finger dexterity in patients with various neurological diagnoses and has high inter-rater reliability and good test-retest reliability[16].

Need for the study: Upper limb weakness is common in stroke survivors. Physiotherapy techniques available for upper limb strengthening in stroke survivors can be listed as; Proprioceptive neuromuscular training, Progressive resistive exercises, functional training, constraint-induced movement therapy, modified constraint-induced movement therapy, Bobath approach etc. Various studies have been conducted to check the effects of Progressive resistive exercises by Wang Q *et al.,*[17] and Donaldson *et al.,*[18] which concluded that strengthening exercises were found to be effective in reducing weakness of the upper extremity in the stroke population. The reason established behind the results was the change in the neural response that increased the threat of muscle fibre recruitment, thus leading to the strengthening of the weak muscle.

A few studies carried out by Timmermans *et al.,*[19], Thant AA *et al.,*[20], and Ahmad A *et al.,*[21] demonstrated the positive effect of Task-Oriented training in stroke patients for upper limb functions. In these studies, the authors concluded that task-oriented training is synonymous with functional training of the subject. Mere strengthening of certain groups of muscles wouldn't reflect on the quality of daily activities performed by the subject. Thus, training stroke survivors repeatedly concerning their daily activity would improve their quality of life thus reducing the burden on society and increasing their dependency. Thus, the present study was undertaken to find out the combined effect of conventional therapy and task-oriented training against task-oriented training alone on both strength and movement time.

2. Procedure

- Institutional ethical clearance was obtained. Before the commencement of the study Participants were asked to give informed consent. **Ethical Number: IEC/IRB/DSU/FACULTY/2022/004**. Based on inclusion and exclusion criteria the subjects were recruited in the study. 66 stroke patients were randomly distributed into two groups by envelope method. A brief explanation of the process was given to the subjects regarding the procedure before the intervention.
- 1st-day demographic details were collected, and baseline outcome measures were noted down, after which the assessment of 1RM was carried out of every individual.
- Pre-treatment outcome measure assessments were taken by Chedoke Arm and Hand Activity Inventory (CAHAI)[22] and Stroke Specific Quality of Life (SS-QOL)[23] Questionnaire.
- The variables used in the study were the independent variable: Task-oriented training (ToT) and Conventional therapy; the Dependent variable: Strength and Upper limb function and quality of life.

Sample Size and Formula

$$n = \frac{2(SD1+SD2)^2\,(1.96+1.682)^2}{d^2}$$

$$n = \frac{2(3+4.9)^2\,(13.264)}{49}$$

$$n = 2(62.4)\,(13.264)/49$$

$$n = 33 \text{ per group}^{13}$$

Hence the total sample size for the study is 66.

Inclusion Criteria: Chronic stroke (>3 months), Brunnstrom stage IV-V, Age group 40-70 years having MMSE score ≥ 24, Both male and female, Unilateral (right hand), Moderate pain (VAS: 4 -6) and Able to follow instructions.

Exclusion Criteria: Severe aphasia (with any medical disorders, Parkinson's, Alzheimer's), Apraxia or visuospatial disorders, severe spasticity (grade: 4 and 5), Musculoskeletal disorder to the lower limb, Unstable medical conditions such as uncontrolled hypertension, convulsion, Unconscious patient, Uncooperative patients, Severe cognitive impairment, and Pain persisting in more than 3 joints/ severe pain (VAS: 7-10).

3. Outcome Measures

- Upper limb function will be assessed by the Chedoke Arm and Hand Activity Inventory (CAHAI)[22].
- Quality of life will be assessed by Stroke Specific Quality of Life (SS-QOL) Questionnaire[23].
- Dexterity- Nine Hole Peg Test (9HPT). The time limit was set at 50 seconds and 1 trial was conducted[24].

3.1 Assessment of 1RM

Subjects were required to visit the laboratory for 4 weeks including one orientation session and the rest at the same time of day. The first visit consisted of preliminary screening (demographic data, the baseline outcome measure, and the value of 1RM). 1RM was tested with the testing equipment (different weighing cuffs) and the lifting techniques, which consisted of three sets of 10-15 repetitions, with a light load on the specific exercises used in this study and two-minute rest intervals given between sets and exercises. In the subsequent visits, the subjects were trained for strength depending on their group of recruitment. Maximal dynamic strength was evaluated using the 1RM test assessed with free-weight arm curl (Patient was made to sit on a chair, with feet firmly positioned on the floor, erect trunk positioned against the chair back and 1RM for each subject was determined). Between each session, 48–72 hours of recovery were given[25].

3.1.1 Group A (Task-Oriented Training)

- In the TOT program, each participant was asked to practice 3 out of 6 selected functional tasks. Tasks were drinking water from a glass, lifting a glass of water to a level of 90-degree shoulder flexion with an extended elbow, stacking paper cups one over another, wiping the table with a towel with the elbow extended, grasping, and releasing a tennis ball and eating with a spoon. All the conventional exercises were repeated in group A as well.
- Patients were asked to practice the selected tasks for at least one time before the actual exercise and then the subject was asked to complete the TOT exercise for 30 min. During the 30-minute TOT session, a 2-minute rest time for every 10 minutes of continuous practice is given.
- Duration of Task-oriented training was 30 minutes/session for 5 days/week for 4 weeks[26].
- Total duration of individual candidates per session will be 30-40 minutes.

The outcome measures were noted at the beginning of the therapy and the end of every week during the therapy and post-therapy.

3.1.2 Group B (PRE)

- The musculatures for which 1RM was assessed were strengthened. All subjects initially started with intensity being 40% of 1RM.
- The exercises were given for Four activities: Shoulder Flexion (SF), Elbow Flexion (EF), Elbow Extension (EE) and Wrist Extension (WE) for affected UE with weight cuffs.
- The exercise started with 3 sets of exercises in each session starting with 10 repetitions till aim of 18 repetitions in the final sessions.
- If the grip is weak, Weight cuffs will be secured to the wrists.
- The therapist will document the repetitions and intensity of each exercise session.
- Gradually in 4 weeks the intensity will be increased from 40% of 1RM to 70% of 1RM.
- Intensity of 70% of 1 RM is selected and is performed for 3 sets with 10 repetitions in 1 set[27].
- Duration of PRE was 30-40 minutes/session thrice per week frequency for 4 weeks[27]. The total duration of Conventional therapy was 30-50 minutes per session per day.

At the end of the therapy, again the upper limb function will be assessed by Chedoke Arm and Hand Activity Inventory (CAHAI)[22], and Quality of life will be assessed by Stroke Impact Scale (SIS)[23].

4. Results

Data normality Assessment: The normality of data was assessed by Skewness which was demonstrated to be right skewed distribution. The Data is not normally distributed; thus, non-parametric tests were chosen which are the Wilcoxon Test for within-sample assessment and the Mann-Whitney U Test for between-sample assessment. Table 1 demonstrated the age and gender distribution among groups A and B respectively. The table shows no significant difference between and within groups. Table 2 demonstrated lesion area of wise distribution of subjects

Table 1. Demographic data

Group	Age	Males	Females
Group A	59±2.8	15	16
Group B	60±2.1	16	17
p-value	0.127	0.214	0.231

Table 2. Group versus lesion area

Group	Right lesion	Left Lesion	*p-value*
Group A	15	16	0.224
Group B	16	17	0.262
p-value	0.214	0.231	

among the groups. The table showed no significant distribution of between and within sample with respect to area of the lesion.

The Table 3 demonstrated the existing scores of ARAT and 9HPT before the therapy and after completion of the therapy. Within group analysis of Group A showed significant improvement of ARAT and 9HPT where as that of group B showed significant improvement only with respect to 9HPT. Between group analysis by Mann Whitney U test demonstrated only significant value to be of ARAT after the therapy.

Table 4 represents the within and between group analysis of Group A and B with respect to Wolf Motor

Table 3. Within and between analysis of ARAT and 9HPT pre- and post-values by WilcoxonTest for within-sample assessment and Mann Whitney U Test

Group	ARAT		*p-value*	9HPT		*p-value*
	Pre Therapy	Post Therapy		Pre Therapy	Post Therapy	
Group A	33.70±9.80	43.60±15.52	0.01*	0.55±0.01	0.16±0.15	0.05*
Group B	30.81±10.12	32.14±9.31	0.121	0.53±0.05	0.15±0.13	0.05*
p-value	0.139	0.05*		0.812	0.417	

Table 4. Wolf motor function test (time) by Wilcoxon Test for within sampleassessment and Mann Whitney U Test

Item	Group A		*p*-value	Group B		*p-value*
	Pre	Post		Pre	Post	
Forearm to table	2.42	1.56	*0.0001**	2.56	2.19	*0.05**
Forearm to box	2.91	1.94	*0.0005**	2.81	2.14	*0.1378*
Extend elbow (side)	126	122	*0.05**	126	122	*0.05**
Extend elbow (weight)	65.27	5.52	*0.0001**	65.27	45.17	*0.05**
Hand to table	2.23	1.61	*0.0001**	2.23	1.78	*0.05**
Hand to box	2.98	1.47	*0.0001**	2.61	2.45	*0.187*
Weight to box						
Reach and retrieve	2.87	2.31	*0.05*	2.87	2.27	*0.417*
Lift can	126	116	*0.0001**	126	120	*0.05**
Lift pencil	115	99	*0.0001**	120	117	*0.05**
Lift paper clip	115	109	*0.005**	118	112	*0.05**
Stack chequers	126	126	*0.011**	122	122	*0.891*
Flip card	126	120	*0.031**	124	123	*0.781*
Grip Strength						
Turnkey in	126	119	*0.0006**	127	115	*0.05**
Fold towel	126	126	*0.0009**	126	125	*0.524*
Lift basket	126	40.69	*0.015**	127	80.41	*0.05**
Average total time/score	79.378	66.14	*0.0001**	79.623	62.527	*0.05**

Function Test against time. Within group analysis of Group A showed significant difference with respect to all the variables whereas within group analysis of Group B demonstrated nonsignificant difference with respect to Stack chequers and Flip card. P value for Between group analysis of Wolf Motor function Test (time) was 0.1782 and post test showed nonsignificant difference with p value of 0.1101.

Table 5 represents the within and between group analysis of Group A and B with respect to Wolf Motor Function Test. Within group analysis of Group A also showed significant difference with respect to all the variables whereas within group analysis of Group B demonstrated nonsignificant difference with respect to Weight to box, Lift can, Lift paper clip, Stack chequers and Flip card. P value for Between group analysis of Wolf Motor function was 0.1071 and post test showed nonsignificant difference with p value of 0.1921.

Table 6 concluded the significant difference on within group analysis of Group A with respect to CAHAI-7 and SIS whereas there was no significant difference seen in group B. Between group analysis showed the significant difference in CAHAI-7 and SIS of post-tests scores.

Table 5. Wolf Motor function test by Wilcoxon Test for within sample assessment and MannWhitney U Test

Item	Group A		*p-value*	Group B		*p-value*
	Pre	Post		Pre	Post	
Forearm to table	3.00	5.00	*0.01**	3.00	4.5	*0.01**
Forearm to box	3.00	4.50	*0.01**	3.00	4.5	*0.01**
Extend elbow (side)	1.00	5.00	*0.01**	1.50	3.0	*0.01**
Extend elbow (weight)	1.00	5.00	*0.01**	1.00	3.0	*0.01**
Hand to table	1.50	3.00	*0.05*	1.00	3.0	*0.01**
Hand to box	1.50	3.00	*0.05**	1.00	3.0	*0.01**
Weight to box	1.00	3.00	*0.05**	1.50	3.0	*0.874*
Reach and retrieve	3.00	4.50	*0.121*	3.00	4.0	*0.01**
Lift can	1.00	3.00	*0.05**	1.50	2.5	*0.542*
Lift pencil	1.00	3.00	*0.05**	1.00	3.0	*0.01**
Lift paper clip	1.00	2.50	*0.05**	1.00	2.5	*0.421*
Stack chequers	1.00	3.00	*0.05**	1.00	2.5	*0.412*
Flip card	1.00	3.00	*0.05**	1.00	2.5	*0.412*
Grip Strength	18.6 (±2.1)	24.6 (±3.5)	*0.001**	17.9 (±1.9)	25.0 (±2.9)	*0.0001**
Turnkey in	1.00	4.50	*0.05**	1.50	3.0	*0.05**
Fold towel	2.00	4.50	*0.05**	1.50	3.0	*0.05**
Lift basket	2.00	4.50	*0.05**	2.00	3.0	*0.01**
Average total time/score	24.00	59	*0.001**	25.5	50	*0.05**

Table 6. Within and between analysis of the CAHAI and SIS by Wilcoxon Test for within sample assessment and Mann Whitney U Test

Group	CAHAI-7			SIS		
	Pre	Post	*p*-value	Pre	Post	*p*-value
Group A	72±0.113	77±0.84	0.0001*	60±0.52	69±0.50	0.001*
Group B	75±0.211	76±0.12	0.121	59±0.43	65±.50	0.759
p- value	0.274	0.001*		0.157	0.05*	

Values are considered significant if the value is less than 0.05*

5. Discussion

The current study showed significant differences between both groups. A study conducted by Donaldson C *et al.,* in the year 2009[17] conducted a 6-week study to assess the effects of conventional physical therapy and functional strength training on upper limb motor recovery after stroke. 279 subjects were randomly placed into 2 groups. The result showed that the group with Conventional Therapy (CT)+ Functional Strength Training (FST) had the largest increase in ARAT score. This demonstrates that functional strengthening adds to the benefits of improving the post-treatment effects of subjects with stroke. The ARAT score is very important for stroke survivors as it assesses their movement capability. The higher the score gives better movement performance and the lower the score gives inefficient movement.

The current study showed that adding task-oriented training yielded significant results compared to mere strengthening of the weak muscles may be because the subjective problem was resolved in the task-oriented training thus leading to an increase in the ARAT score.

The reason for the improvement of ARAT and 9HPT in the present study in both groups can be the conventional exercises provided commonly for the groups. In the present study, these exercises have also been seen to have a beneficial effect on the Wolf motor function scale and Wolf motor movement time assessment scale.

Another 4-week study was conducted by Aye Aye T *et al.*, in 2019[28]; to analyze the effect of task-oriented training on upper extremity functional performance in patients with sub-acute stroke. 28 patients with sub-acute stroke participated in the study and were randomly placed into 2 groups. Group A received ToT and Group B received a conventional exercise program with outcome measures Wolf Motor Function test, FMA. Results showed a statistically significant and clinically meaningful improvement of paretic U.E functional performance in group A. The present study showed similar results as it was shown in this study. Thus, stating the vital role of Task-oriented training. Another study by Ahamad A *et al*, in the year 2019[21] demonstrated that on comparison between the effects of a Task-oriented training program and balance training on improving balance in 30 stroke patients who were randomly divided into two groups with outcome measure Berg Balance Scale (BBS) and performance-oriented mobility assessment. Results showed that the ToT programme was more effective in improving balance in stroke patients.

In the present study, the task-oriented training group benefited more when compared to the other group by increasing the values of the Chedocke Arm and Hand Activity Inventory -7 scale and Stroke Impact Scale. These scales are the disability measures related to limited activities and performance that are restricted. The reason behind this can be that the task- oriented training exercise focuses on the goal to be reached smoothly. The goals of this training are the daily activities. Whereas in the conventional strengthening group strengthening of the muscle is the focus and not the target goal which in the present scenario is tasks related to daily activity.

6. Limitations

- A comparison of affected and unaffected hands was not studied.
- Comparison of individual muscle strength and length tests pre- and post-therapycould be performed.
- Long-duration studies are required to demonstrate the efficiency of the therapy.Future Scope:
- Focus on less conventional therapy and more on functional activities so thatquality of life improves.
- Long-duration studies by comparing the effects on radiological levels can beperformed.

7. Conclusion

The current study showed that adding task-oriented training yielded significant results compared to mere strengthening of the weak muscles may be because the subjective problem was resolved in the task-oriented training causing an increase in the ARAT score. Thus, in the present study, the task-oriented training group benefited more when compared to the other group by increasing the values of the Chedocke Arm and Hand Activity Inventory -7 scale and Stroke Impact Scale.

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