P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (RJIF): 5.38
IJPESH 2023; 10(2): 107-112

www.kheljournal.com
Received: 23-01-2023
Accepted: 25-02-2023

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To compare the effect of motor relearning programme and progressive resisted exercise for upper-extremity functions in subacute MCA stroke survivors

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Abstract
Background: The patients affected by stroke have been found to experience variety of difficulties. These disabilities produce physical, psychological and functional limitations in their day-to-day life. The major disruptive factor impending rehabilitation is the functional limitations of affected extremities. This study aims to compare two different concepts in clinical rehabilitation - First the Motor relearning programme and second the Progressive resisted exercise on the upper limb functions in stroke patients.
Objectives: To compare the effect of Motor relearning programme and Progressive resisted exercise is improving physical performance following stroke.
Methodology: A total of 30 patients suffering from MCA stroke aged 40-55 years were selected and randomly allocated to two experimental groups (Group I and Group II) till the number of 15 subjects were reached in each group. Assessments were done to measure level of upper extremity function using FMA (Fugl-Meyer Assessment scale) and MESUPES (Motor Evaluation Scale for Upper Extremity in Stroke). One group received Motor relearning programme and other group received progressive resistance exercise.
Result and Discussion: Both Groups show significant improvement in upper limb physical performance; comparison of both groups show significant improvement in Motor relearning programme group.
Conclusion: Motor relearning programme is more significant than progressive resistance exercise in improving upper limb physical performance following stroke.

Keywords: MRP, PRE, FMA, MESUPES, stroke

Introduction

A stroke is a clinical syndrome characterized by rapidly developing clinical signs of focal and a time global loss of cerebral function, with symptoms lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin (WHO) [1]. Quite recently, a new definition of stroke that incorporates clinical and tissue criteria has been proposed by the American Stroke Association for the century. This definition is much broader and includes any objective evidence of permanent brain, spinal cord, or retinal cell death attributed to a vascular etiology based on pathological or imaging evidence with or without the presence of clinical symptoms [2].

The prevalence of stroke in India was estimated as 203 per 100,000 populations above 20 years, amounting to a total of about 1 million cases. The male to female ratio was 1.7. Around 12% of all stroke occurred in population below 40 years. The estimation of stroke mortality was limited by the method of classification of cause of death in the country [3].

The effect of a stroke depends on the site and severity of brain injury. The three quarters of stroke occur in the region supplied by middle cerebral artery, as a consequence the upper limb is affected in large number of subjects. It has been reported that up to 85% of stroke survivors experience hemiparesis and that 55% to 75% of stroke survivors have continued to have limitations in upper-extremity functioning. Only about 40% of such patients achieve full recovery. The remaining 60% of stroke survivors have persistent motor and non-motor impairments that significantly disrupt their ability to participate in home and community life [4]. Although many stroke patients are able to recover some walking function during initial rehabilitation, the majority of stroke patients are unable to use their upper extremity in their activities of daily living after months of standard physiotherapy. Upper limb neuromuscular weakness occurs frequently after stroke with loss of muscle strength and dexterity together considered producing the largest impact on functional recovery [5].

The Motor Relearning approach was developed by Australian physiotherapists Janet H. Carr and Roberta B. Shepherd based on motor learning theory. Carr and Shepherd proposed that training in motor control requires anticipatory actions and ongoing practice. Motor Relearning programme focuses on task specific learning through effective use of feedback and practice. The studies have shown that it is effective in enhancing motor function recovery of post stroke paretic limb [8].

Progressive resisted exercises were developed by Delorme and Watkins. PRE training is a well-established form of exercise for increasing muscle strength. The principles of progressive resistance training are that muscles are exercised against the maximum amount of external resistance they can sustain (in isometric training) or move (in dynamic training) for a small number of repetitions, in order to overload the muscle. Additionally, the exercise is systematically progressed, for example by increasing the amount of resistance [9].

The Fugl-Meyer Assessment (FMA) is a stroke specific, performance-based impairment index. It is designed to assess motor functioning, balance, sensation and joint functioning in patients with post-stroke hemiplegia [10].

The Motor Evaluation Scale for Upper Extremity in Stroke Patients (MESUPES) assesses quality and quantity of upper limb daily life functional movements in stroke. Because tone, muscle contractions, and active movements are scored by a therapist, the scale is useful for people with no active arm or hand function to minimal motor impairments [11].

The aim of this study is to compare the effectiveness of Motor Relearning Programme and Progressive Resisted Exercise to improve upper extremity functions in stroke survivors

Methodology

Inclusion criteria:

- Age limit between 40-55 years.
- Both males and females.
- First onset of stroke.
- Medically stable patients.
- Motor assessment scale score 2-3
- Subjects able to sit for 30 secs without using upper extremities for support.

Exclusion criteria

- Sensory involvement
- Cognitive disorders and perceptual disorders
- Shoulder hand syndrome
- Shoulder pain or subluxation
- Musculoskeletal disorders
- Severe cardiac diseases

Sampling procedure

Sample Design: Simple random sampling technique

Study Procedure: 30 subjects were screened based on the inclusion & exclusion criteria. A written consent was taken from patients who fulfil the inclusion criteria. Subjects was randomly allocated in to 2 groups.

Group 1: Motor Relearning Programme and Conventional therapy.

Group 2: Progressive Resisted Exercise and Conventional therapy.

Group 1

Initially, we took Fugl- Meyer Assessment Upper Extremity motor score (FMA) and Motor Evaluation Scale for Upper Extremity in Stroke (MESUPES). Motor relearning programme includes following steps as the treatment plan.

Step 1: analysis of task.

Step 2: practice of missing components.

Step 3: practice of task.

Step 4: transference of training.

Training programme (specific motor task) to improve upper limb function,

- To elicit muscle activity and train motor control for reaching and pointing.
- To elicit muscle activity and train motor control for manipulation to train wrist extension.
- To train palmar abduction and rotation of the thumb (opposition).
- To train opposition of radial and ulnar sides of hand.
- To train manipulations of objects.
- To improve the use of holding objects for daily.

Later, following exercises will be given.

Upper limb stretches:

- Long finger flexors
- Wrist flexors
- Thumb adductors
- Forearm pronators
- Adductors and Internal rotators of GH joint.

Active and self-active assisted ROM exercises

Treatment will be given for 1hour /day for 5 days in a week for 6 weeks. After 6 weeks, Fugl- Meyer Assessment Scale Score on Upper component and Motor Evaluation Scale for Upper Extremity in Stroke was taken again.

Group 2

Same as Group 1, we took Fugl- Meyer Assessment Upper Extremity Motor score (FMA) and Motor Evaluation Scale for Upper Extremity in Stroke (MESUPES) from Group 2. Subject should sit on the edge of the bed or a chair without backrest.

Treatment protocol includes-

Brief period of warm up and cool down (5 minutes).

Same as Group 1, Group 2 also get Upper limb stretch and active exercises. Regime used for progressive resisted exercises is De Lorme & Watkins which is as follows:

10 lifts with ½ 10 R.M. 10 lifts with ¾ 10 R.M.10 lifts with 10 R.M

Strengthening exercises consisted of

- Shoulder flexion and extension
- Shoulder abduction and adduction
- Shoulder external and internal rotation
- Elbow flexion and extension
- Wrist flexion and extension

Exercises was given as 3 sets of 8-12 repetitions, 1 hour / day for 5 days in a week for 6 weeks.

After 6 weeks, Fugl- Meyer Assessment Scale Score on Upper component and Motor Evaluation Scale for Upper Extremity in Stroke (MESUPES) was taken again.

Outcome measurement

- Fugl- Meyer Assessment Scale (FMA)
- Motor Evaluation Scale for Upper Extremity in Stroke (MESUPES)

Results

Statistical tool and formula

For the analysis of statistical data, I first consider the exploratory data analysis. It mainly consists of statistical techniques such as mean, standard deviation, minimum value, maximum value.

The mean value is defined as

$$\bar{X}=\frac{1}{n}\sum_{i=1}^{n} X_i$$

Where $\bar{X}$= Arithmetic mean of the data

$\sum_{i=1}^{n} X_i$ = sum of all observation in the data set

n = number of observations

In this study pre and post interventional differences within the two groups analyzed using paired t- test and between the two groups were analyzed using unpaired t test for each of the outcome measures.

$$\sqrt{\frac{\Sigma d_i^2 - n(\bar{d})^2}{n-1}}$$

Paired t-test (comparison of pre & post observations)

Mean difference (paired differences) = d

Standard deviation of differences, S.D. =

Standard Error (S.E.) = SD/√n

Test statistic, t = d / SE

Unpaired/independent t-test (compare between groups)

$$\sqrt{\frac{\Sigma (x_{1_i} - \bar{x}_1)^2 + \Sigma (x_{2_i} - \bar{x}_2)^2}{n_1 + n_2 - 2}}$$

$$\frac{S}{\sqrt{\frac{n_1 n_2}{n_1 + n_2}}}$$

Pooled S.D. of both groups, S =

Standard Error (S.E.) =

Test statistic, t = Mean difference between two groups/S.E.

Analysis of descriptive data

Mean age distribution of MCA stroke survivors.

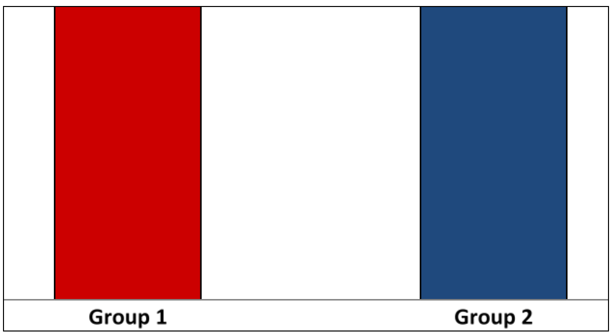

Fig 1: Age distribution

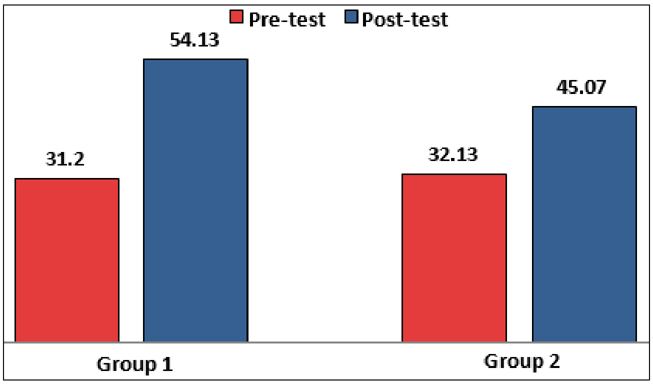

Fig 2: Comparison of pre-test and post-test FMA in group 1 and group 2

Table 1: Comparison of pre-test and post-test FMA in group 1

Test	Mean	SD	Mean change	n	t	df	p-value
Pre-test	31.2	5.61	22.93	15	11.53	14	$p < 0.001$
Post-test	54.13	6.84					

Table 2: Comparison of pre-test and post-test FMA in group 2

Test	Mean	SD	Mean change	n	t	df	p-value
Pre-test	32.13	3.39	12.94	15	19.65	14	$p < 0.001$
Post-test	45.07	3.65					

Table 3: Comparison of pre-test FMA between group 1 and group 2 using t- test.

Group	Pre-test Mean	S.D.	Difference in mean	n	t	df	p-value
Group 1	31.2	5.61	0.93	30	0.551	28	p = 0.586
Group 2	32.13	3.39					

Table 4: Comparison of post-test FMA between group1 and group 2 using t- test.

Group	Post-test Mean	S.D.	Difference in mean	n	t	df	p-value
Group 1	54.13	6.84	9.06	30	4.53	28	$p<0.001$
Group 2	45.07	3.65					

Table 5: Comparison of pre-test and post-test mesupes in group 1 and group 2 using t-test

Group	Pre-test mean	SD	Post-test mean	SD
Group 1	27.53	3.64	45.87	4.65
Group 2	28.13	2.09	38.6	1.29

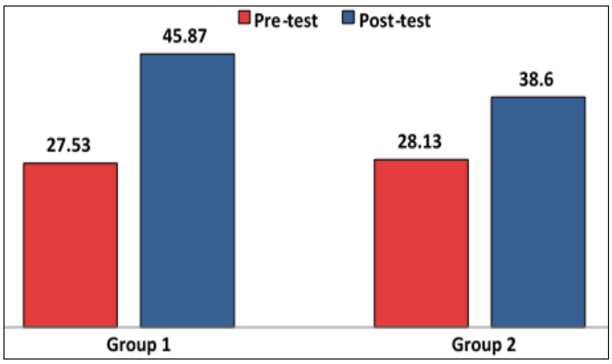

Fig 3: Comparison of pre & post MESUPES in groups 1 and groups 2

Table 6: Comparison of pre-test and post-test mesupes in group 1.

Test	Mean	SD	Mean change	n	t	df	p-value
Pre-test	27.53	3.64	18.34	15	13.13	14	$p < 0.001$
Post-test	45.87	4.65					

Table 7: Comparison of pre-test and post-test mesupes in group 2

Test	Mean	SD	Mean change	n	t	df	p-value
Pre-test	28.13	2.09	10.47	15	25.37	14	*p*< 0.001
Post-test	38.6	1.29					

Table 8: Comparison of pre-test mesupes between group 1 and group 2 using t- test.

Group	Pre-test Mean	S.D.	Difference in mean	n	t	df	p-value
Group 1	27.53	3.64	0.6	30	0.553	28	p = 0.585
Group 2	28.13	2.09					

Table 9: Comparison of post-test mesupes between group1 and group 2 using t- test

Group	Post-test Mean	S.D.	Difference in mean	n	t	df	p-value
Group 1	45.87	4.65	7.27	30	5.82	28	p < 0.001
Group 2	38.6	1.29					

Discussion

The present study demonstrated that 6 weeks of MRP and PRE can safely improve the motor recovery, hand and finger dexterity, functional status and quality of life in subacute MCA stroke subjects. The result has shown more significant improvement FMA and MESUPES in MRP group compared to PRE group.

According to Motor learning theory, the ways in which motor patterns can be acquired and modified is through experiential learning, such as through observations and repeated practice. The people with a damaged brain have deficits in motor programmes, motor memory, and associated feedback and feed forward mechanisms, which largely impede their functional performance. Hence, the Motor Relearning Approach promotes the regaining of normal motor skills through task oriented practice with appropriate feedback and the active participation of the patients [43].

In this present study, all the patients whose duration of stroke was at most 2 months and subjects in Group a received MRP (along with the routine conventional exercises) for improving upper extremity function for five days in a week for total six weeks. The analysis of the results of before and after intervention were statistically highly significant (p<0.0001) which showed that the need-based approach, that is MRP, is effective for improving upper limb functions in MCA stroke survivors.

Similarly, the study done in 2013 by Bhalerao *et al*. also suggest that MRP is more effective in early enhancement of activities of daily living and ambulation starting at 2 weeks of treatment. Hence, improvement is because MRP in initial phase of rehabilitation helped in learning of the motor control and pattern of movement for specific activity and not just learning the non-task specific movement and motor control of movement. This active participation and self-reliance helped in motor learning of the pattern of movement, in a given context and task [44].

As the nervous system is dynamic, according to the theory of Neuroplasticity, the nervous system is adaptable and changing when there are demands from the environment, from new learning, developmental processes and from a variety of experiences. The following influence the changes in the structure and neurophysiology of a developing nervous system or damaged nervous systems in children, adolescents and adults (Kidd *et al*. 1992): Practice and repetition, Task related voluntary actions for learning, Movements in the context or under conditions in which they are to be used, Active and purposeful sensorimotor experiences which are part of a person's daily life, Early treatment takes more advantage of neuroplasticity after brain damage in children, adolescents and adults [46, 47].

Recovery of upper limb function involves three phases: firstly; activation of cell repairs, secondly; functional cell plasticity and finally; neuro anatomical plasticity. An effective rehabilitation allows most subjects to regain enough movement and control of their limbs to perform their activities of daily living [48]. It might be possible to influence this process with therapies directed towards increasing muscle strength and thus motor function [49]. One objective of rehabilitation after stroke is to maximize the subject's independence in gross motor skills and walking and thus improve his/her ADLs [50]. Previous literature was found for stroke rehabilitation on upper extremity functions which was based on research on muscle weakness, the correlation of muscle strength with function, and the studies on the effects of strength training suggest that strengthening exercises may improve functional outcomes [51].

In this study, Group B received PRE (along with the routine conventional exercises) for improving upper extremity function for five days in a week for total six weeks. The improvement was also observed in PRE group which can be explained by the following mechanism. The strength gain are likely to be mediated by both improvement in neural activation and muscular structure and function [52]. Gabriel DA has found that an increase in neural drive is due to increase in the magnitude of efferent neural output from the CNS to activate muscle fibers [53]. Muscle structure and functions has been explained by the training that can result in improvement in the ability to generate force in individual with stroke by increase in the recruitment of motor unit [52]. Motor unit are also capable of increasing their discharge rate with strength training. Strength training has potential to alter passive viscoelastic properties of muscle and tendon [54]. So, in Progressive Resisted Training, more improvement was seen in strengthening of the muscles. Whereas, in case of Motor Relearning Programme, greater improvement was in the functional activities.

The major limitation of the study is that, it was conducted in a small size. Based on the results of statistical analysis, it is suggested that in future study should be modified to accommodate the following changes to establish the efficacy of the result a large sample is required for more valid results and also this study was done only on MCA ischemic stroke patients. The study can also be done in subjects with other types of strokes. Another limitation was the results of males and females cannot be compared because of fewer female patients as compared to male patients. Another potential limitation of this study is the generalizability of the results that these findings may not be applicable to chronic stroke subjects with severe cognitive deficits.

This study found impressive positive effects of MRP compared with PRE on motor recovery, especially manual dexterity, grasping performance, functional transfer ability as well as gross motor recoveries; motor functioning and quality of life in stroke subjects.

Conclusion

The study was conducted in an effort to compare the effect of Motor Relearning Programme and Progressive Resisted Exercise are improving upper limb function of stroke patients. 30 stroke patients were selected and assigned into two groups, one group receiving Motor Relearning Programme and the other group receiving Progressive Resisted Exercise.

The study was pre-test and post-test experimental design. The results were analyzed using t" test. The results show significant improvement in group received Motor Relearning Programme treatment than Progressive Resisted Exercise. The study can be compared with other neurophysiological approaches like Roods Brunnstroms Bobath and Johnstons approaches.

From this study, it may be concluded that Motor Relearning Programme is more significant than Progressive Resisted Exercise in improving upper limb functional performance in subacute MCA stroke survivors.

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