World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

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Effect of motor relearning programme on neurological functions and level of disability on upper limb activity in post-stroke patients

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World Journal of Advanced Research and Reviews, 2023, 18(03), 007–015

Publication history: Received on 09 April 2023; revised on 26 May 2023; accepted on 28 May 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.18.3.0961

Abstract

Objective: To compare the effects of Motor Relearning Programme and Mirror Therapy on upper extremity functions in Post-Stroke patients.

Design: Parallel group, randomized controlled trial

Settings: The present study was conducted at OPD of University College of Physiotherapy, Faridkot, IPD and OPD of Department of Neurology and Neurosurgery of Guru Gobind Singh Medical College and Hospital, Faridkot,Punjab.

Participants: A total of 45 post-stroke patients with upper limb impairent were randomly allocated into three equal groups comprises 15 patients each.Group A received Motor Relearning Programme (MRP) along with Conventional Physiotherapy (CPT), whereas Group B received Mirror Therapy (MT) along with CPT and Group C receivedCPT only. The total duration of intervention was 1 hour per session and frequency of 8 weeks, with 5 sessions per week.

Main Outcome Measures: The outcome measures included were National Institutes of Health Stroke Scale (NIHSS) and Modified Rankin Scale (MRS).

Results: The present study revealed that both parameters within the groups had significantly improved in the pre-intervention analysis. However, post-intervention scores of all the parameters of Group A revealed considerable high improvement at a significant level of ($p<0.0001$) when compared to the other two groups i.e. Group B and Group C**.**

Conclusion: In light of the study's findings, it is concluded that the MRP along with CPT is more effective than MT along with CPT and CPT alone.

Keywords: Conventional Physiotherapy; Mirror Therapy; Motor Relearning Programme; Stroke

1. Introduction

Stroke is defined by the World Health Organization (WHO) in the 1989, as "Neurological impairment of cerebrovascular origin that persists for more than 24 hours or is interrupted by death within 24 hours". According to estimates, India has 203 incidences of stroke per 100,000 people over the age of 20, approximately 1 million cases overall[1]. Around 85% of stroke population suffers from initial arm weakness which exists in 55-75% of patients even after 3 to 6 months. However, the complete restoration of hemiparetic upper extremity happens in just 5-20% of stroke patients[2]. Loss of upper limb function independence contributes enormously to functional disability, affecting the quality of life and independence in 'basic' (washing, grooming, feeding, dressing, 'instrumental' home/financial management, etc.) of daily

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living[3]. Relearning motor skills is a necessary part of recovering motor function after a stroke and neuroplasticity plays a role in this. In order to maximize upper extremity functions after a stroke, recent studies have focused on designing rehabilitation procedures that encourage such neuroplasticity[4].

Task-specific exercises are generally thought to have the greatest advantage for stroke patients because they are thought to promote neural plasticity. This method is excellently demonstrated by the MRP for stroke created by Janet Carr and Roberta Shephard. This process includes many aspects of the theory of motor learning and provides valuable instructions for re - training functional skills[5].

Mirror therapy is a type of rehabilitation approach where the reflection (visual input) of a moving non-affected limb gives the illusion of movement in the affected limb[6]. Ramachandran and Rogers-Ramachandran were the first to introduce the use of these mirror image visual illusions for the relief of phantom limb pain[7]. Mirror theory is based on evidence that action observation activates the same motor areas of the brain as action execution. Observed actions lead to the generation of intended actions, engaging motor planning and execution. Further, evidence suggests that damaged areas of the brain's motor cortex may improve by viewing movements of intact, functioning limbs[3].

Conventional Physiotherapy, often known as "mobilisation and tactile stimulation," and is designed to provide therapists with hands-on sensory stimulation for stroke survivors who have paralysis or severe paresis. The focus of the conventional physical therapy treatment plan is on therapist-assisted movements that facilitates and guide sensory information to improve joint alignment and set up voluntary movement[8].Several studies have examined the effects of MRP and MT on stroke patients, but very little has been established regarding the best ways to implement the various exercise techniques.According to our knowledge, this is the first randomized control trial which properly defined the exercise programme and evaluate the impact of MRP and MT on upper extremity functions in post-stroke patients.

2. Materials and Methods

2.1. Participants

A total of 45 patients, aged 40-65 years, both males and females diagnosed with ischemic and hemorrhagic stroke, with unilateral stroke, duration between 1 to 6 months, MMSE score >23 and Brunnstrom stage 4 and 5, were included in the study. Exclusion criteria was patients with visual and auditory deficits , patients with mental disability, patients with any musculoskeletal disorder, patients with more than one stroke incident, patients with any systematic disease (neoplasms, uncontrolled hypertension, high blood sugar level), patients who have already undergone any neurosurgical interventions (craniotomy, epilepsy surgery, brain aneurysm surgery).

2.2. Study Procedures

Selected patients were randomly divided into three groups by using random number table, Group A (n=15), Group B (n=15) and Group C (n=15). Group A was the experimental group where motor relearning programme along with conventional physiotherapy was given to all the patients for 8 weeks with 5 sessions per week for 1 hr/day. Group B was also the experimental group in which mirror therapy along with conventional physiotherapy was given to all the patients for 8 weeks with 5 sessions per week for 1 hr/day. Group C constituted control group in which only conventional physiotherapy was given to all the patients for 8 weeks with 5 sessions per week for 1 hr/day. Patients in all the three groups were assessed at three intervals. Baseline assessment before the administration of physiotherapy intervention, 2nd assessment after4 weeks of baseline assessment and final 3rd assessment after 8 weeks of baseline assessment.

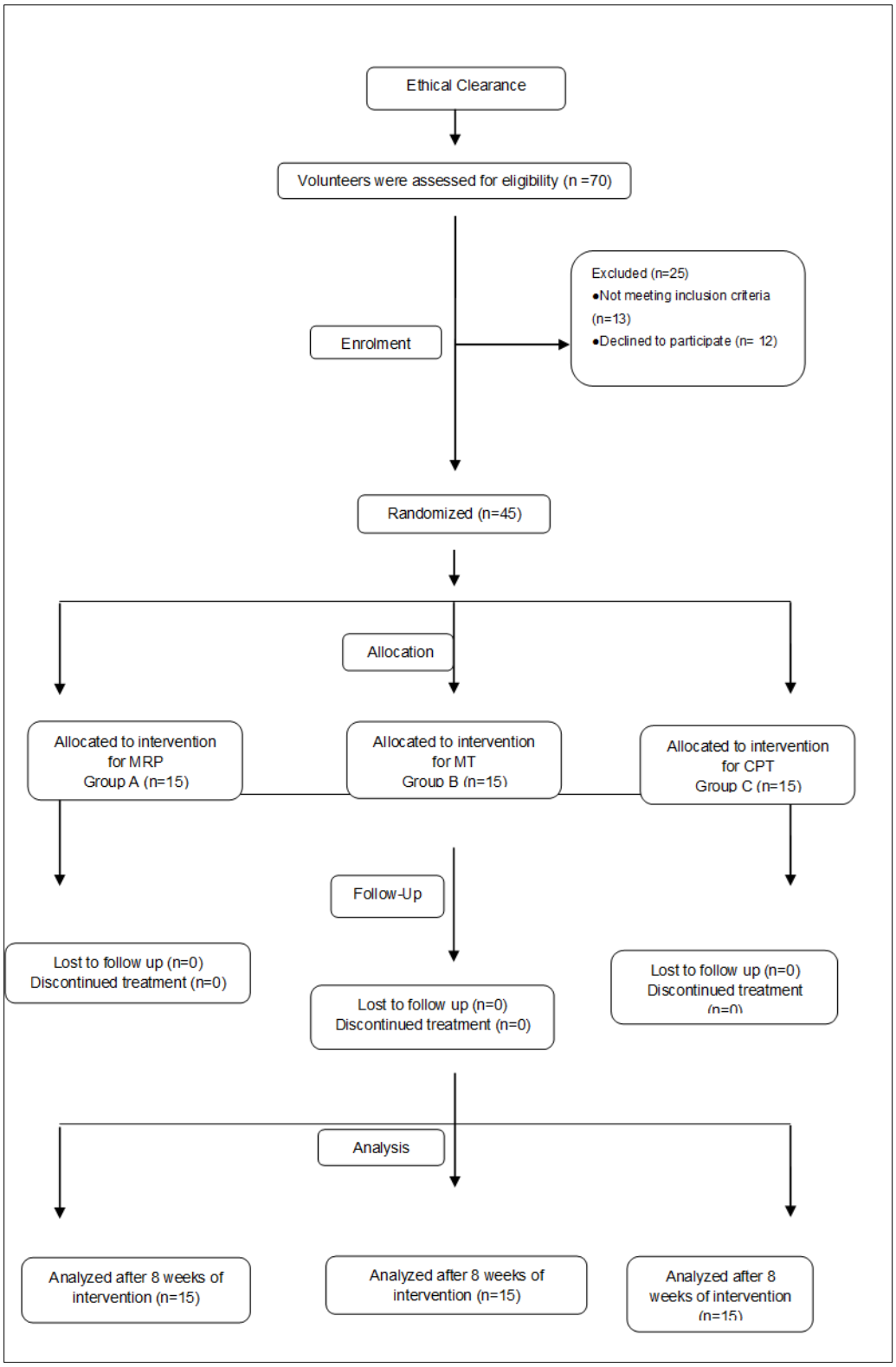

Figure 1 Consort flow diagram

3. Intervention

3.1. Group A -Experimental group

Motor relearning programme[9]

3.1.1. Analysis of motor performance

Weakness of glenohumeral joint abductors, flexors, external rotators and supinators has a significant effect on reaching actions, while weakness of wrist extensors, finger and thumb flexors and extensors, abductors and adductors affect the manipulation of objects.

3.1.2. Observational analysis

As part of day-to-day motor training, therapists must rely on their own visual observation of motor performance for ongoing analysis and as a guide to intervention.

3.1.3. Focusing attention

It is important to decide what the patient should pay attention to during practice.Two methods of directing the focus of attention are demonstration (both live and recorded) and verbal instruction.

3.1.4. Soft tissue stretching

Brief passive stretches are carried out immediately before an exercise session to decrease muscle stiffness and throughout exercises as needed. Active stretching occurs throughout active exercise.

3.1.5. Training

- Active exercises

Sitting Position: with arm on table, lifting and lowering a glass which held by the palm and the fingers. Lifting glass from table by radial deviation at wrist, forearm in mid rotation, placing it to left and right by wrist flexion and extension. Tapping table top with all fingers. Holding a ruler, supinating and touching the end of ruler to table. Holding a cup filled with water, transfer to other hand and place it on target. Slide glass forward in different direction to touch targets keeping forearm in mid rotation. Slide glass backward and forward to touch the target by extending & flexing the elbow. Shoulder placed at 90º flexion, reaching and pointing within controllable range above 90º, gradually increasing range in forward and sideways direction.With forearm supported on the lap- shoulder shrugging. Lifting hands to comb the hair.

- Reaching and balancing practice

Exercises on sitting on stool includes reaching forward, sideways or backwards to pick up an object, transport it to another place (e.g. the floor), pick it up again, reach as far in one direction as possible then put it down.

- Manipulation and dexterity practice

Pegboard exercises, hand-cupping exercises to train opposition of radial and ulnar sides of the hand, scooping coins from the table top into the palm of the other hand, picking up a glass of water and drinking it as well as doing tapping activities to quickly touch the tips of each finger to the thumb.

- Bimanual practice

As soon as the patient has the ability to control simple movements with the affected limb, bimanual training should begin it includes actions like hold paper between ring and little fingers and palm - try to pull paper out from grasp with other hand .Drinking from spoon includes action like hold spoon and carry fluid to mouth. Practice moving hand while keeping fluid from spilling.

- Strength training

Strength training can increase muscle strength without an increase in spasticity. Elastic band exercises are progressed by changing to a different coloured band. Some examples includes gripping exercises using spring resisted gripping device, elastic band exercises, exercises with hand weights, use progressively heavier objects in reaching, lifting and manipulating tasks.

- Feedback

An essential aspect of skill acquisition is the feedback that learners receive about their performance of an action. There are two principal forms of feedback: intrinsic, which is the naturally available sensory feedback (visual, proprioceptive, tactile) occurring as part of the action and augmented feedback providing knowledge of the results of the actionand knowledge of the performance itself.

- Transfer of learning

A major goal of the therapist as facilitator and teacher is to assist the patient to transfer training (learning) from the practice environment (the rehabilitation setting) to other environments.

3.2. Group B- Experimental group

3.2.1. Mirror Therapy[10]

Positioning of arm: In mirror box therapy, patient was seated close to a table on which a square box mirror which was 35 cm in length and 35 cm in breadth was positioned vertically. The involved hand was placed behind mirror that is, the non reflective side and the non - paretic hand in front of the reflective side of the mirror. During the session patient was asked to try to do the same movements with paretic hand while he was moving the non-paretic hand. Mirror neurons are bimodal visuomotor neurons that are active during action observation, mental stimulation (imagery) and action execution.

Practice of movements The practice consisted wrist flexion and extension movements, finger flexion and extension, reaching, grasping ,lifting, placing the objects, counting with fingers, hand opening, hand sliding, forearm supination and pronation, writing or drawing circles, squeezing ball, opponens of all fingers.

3.3. Group C –Control group[10]

3.3.1. Upper Extremity

- Theraband exercises
- Weight bearing activities, elbow/wrist exercises passive or self assisted, exercises for range of motion for joints with no or minimal active movements, upper extremity weighing activities e.g. placing down on physio ball and pushing ups on the armrest of chair, dumbell/wrist cuff weight exercises, elbow/wrist flexion and extension. (progressed by increasing the weight and increasing repetitions from 2 sets of 10 to 3 sets of 15).

3.3.2. Hand activities exercises and functional training:

- Hand muscle strengthening:- exercises using putty, grippers (movements such as pinch, grip, finger extension) (progressed by increasing the resistance of the putty and grippers and increasing repetitions from 2 sets of 10 and 3 sets of 15.
- Functional activities:- playing cards, picking up objects of various sizes and shapes, reaching tasks, fine motor tasks

3.3.3. Lower Extremity

- Cardiorespiratory fitness and mobility, brisk walking.
- Sit to stand:- progressed by reducing the height of chair, alternate stepping onto low risers: progressed by increasing the height of the steppers and by reducing the arm support.
- Mobility and balance:- walking in different directions, tandem walking, walking through an obstacle course, sudden stops and turns during walking, walking on different surfaces (carpet, foam), standing on wobble board, standing with 1 foot in front of the other, kicking ball with either foot.
- Lower extremity muscle strength:- partial squats, progressed by increasing movement magnitude, toe rises, progressed from bilateral rise to unilateral rises on either leg and progressed by increasing no. of repetitions from 2 sets of 10 to 3 sets of 15.

Group C received the above conventional physiotherapy exercises along with 15 minutes of warm up and 15 minutes of cool-down phase.

Outcome Measures:- Cognition was assessed using Mini Mental State Examination (MMSE), recovery of upper extremity movement was assessed using brunnstrom recovery stage of upper extremity, neurological function was assessed using National Institutes of Health Stroke Scale (NIHSS) and degree of disability was evaluated using Modified Rankin Scale (MRS).

3.4. Data Analysis

Table 1 Demographic information of patients

Demographic details	**Comparison**		
	Age		
	Group A	**Group B**	**Group C**
Mean	54.13	54	53.93
S.D	7.79	6.75	6.65
Number	15	15	15
Male	10	9	11
Female	5	6	4

Table 2 Data analysis between the Group A, Group B and Group C

Data Analysis between the groups												
Outcome Measures	**Group A (MRP+CPT)**				**Group B (MT+CPT)**				**Group C (CPT)**			
	Mean ± SD 0th week	Mean ± SD 4th week	Mean ± SD 8th week	P-value	Mean ± SD 0th week	Mean ± SD 4th week	Mean ± SD 8th week	p-value	Mean ± SD 0th week	Mean± SD 4th week	Mean ± SD 8th week	p-value
NIHSS	10.07 ± 1.163	4.4 ± 0.527	1.67 ± 0.487	<0.0001	10.13 ± 1.457	6.73 ± 0.798	4.53 ± 0.516	<0.0001	9.93 ± 1.032	8.07 ± 0.704	7.0 ± 0.655	<0.0001
MRS	3.53 ± 0.516	2.33 ± 0.488	1.27 ± 0.457	<0.0001	3.47 ± 0.516	3.20± 0.414	3.47 ± 0.516	<0.0001	3.47 ± 0.516	3.47 ± 0.516	3.13 ± 0.352	<0.0001

Table 3 Data analysis within the Group A, Group B and Group C

Data Analysis within the groups												
Outcome Measures	**Group A (MRP+CPT)**				**Group B (MT+CPT)**				**Group C (CPT)**			
	Mean ± SD 0^{th} week	Mean ± SD 4^{th} week	Mean ± SD 8^{th} week	p-value	Mean ± SD 0^{th} week	Mean ± SD 4^{th} week	Mean ± SD 4^{th} week	p-value	Mean±SD 0^{th} week	Mean ± SD 4^{th} week	Mean ± SD 8^{th} week	p-value
NIHSS	10.07 ± 1.163	4.4 ± 0.507	1.67 ± 0.487	<0.0001	10.13 ± 1.457	6.73 ± 0.798	4.53 ± 0.516	<0.0001	9.93 ± 1.032	8.07 ± 0.704	7.0 ± 0.655	<0.0001
MRS	3.53 ± 0.516	2.33 ± 0.488	1.27 ± 0.457	<0.0001	3.47 ± 0.516	3.20 ± 0.414	2.33 ± 0.487	<0.0001	3.47 ± 0.516	3.47 ± 0.516	3.13 ± 0.352	<0.0001

Data was analysed by using SPSS Version 20. Dependent t- test and Repeated Anova test were used to determine the comparison of effects of motor relearning programme and mirror therapy on upper extremity functions in post-stroke patients.

Out of 45 patients, 30 were males and 15 were females. The overall mean age was 54.13 ± 7.79, 54 ± 6.75, 53.93 ± 6.65 (as shown in table 1).

4. Results

4.1. Flow of participants through the study

Among the 70 patients who were screened for the study, 12 participants withdrew from the study due to losing interest in participation, 45 met the eligibility criteria and were randomized into three groups: 15 in the experimental Group A, 15 in the experimental Group Band 15 in the control Group C (as shown in Figure 1).

4.2. Primary Outcomes

In all the three groups, there were significant differences between pre-treatment and post-treatment mean scores of both parameters ($p<0.0001$) (as shown in table 2). However the mean scores of Group A improved significantly more as compared to Group B and Group C (as shown in table 3).

5. Discussion

Patients with stroke have to deal not only with pain, neurological impairment, functional independence, disability, deprived motor function but also with psychological distress, anxiety and depression. As optimal functional recovery is the ultimate goal in stroke rehabilitation, so the main focus of the present study is to train and relearn the functional activities especially upper limb skills to improve their quality of life.

Literature search revealed few studies which compared MRP and MT. One such study of Puneet Rehani et al. (2015) analysed the effects of MRP and MT in stroke patients. The sample size of that study was 12, while in the current study the sample size was 45. The results of the earlier study did not support the results of the current study, because it did not reveal that one treatment was effective over the other and the results were not significant ($p>0.005$). This can be because of fact that the sample size of the trial was small, and also because the treatments were followed for a very short time[3].

Our findings have been supported by a study of Satwinder Singh et al. (2022) who examined MRP and Bobath therapy in rehabilitation of hemiplegic patients. The study was evaluated on 30 stroke patients.Both therapies were observed for 6 weeks, and it was concluded that MRP was considerably superior than Bobath therapy in reducing functional disability and improving functional mobility in hemiplegic patients[11].

The findings of the present study complement the study results of Preetinder Kaur et al (2015) whodid a randomized control trial on 30 patients with sub acute and chronic stroke with impaired hand functions. Mirror Therapy and Conventional Physiotherapy were administered to one group while only Conventional Physiotherapy was administered to other group. Both groups received treatment for five days a week for four weeks. This study revealed that mirror therapy combined with conventional physiotherapy has been proven to be much more effective than conventional physiotherapy alone in improving hand function in stroke patients[10].

The current study is based on Carr and Shepherd's motor relearning programme. According to this clinical trial's findings, "sequential" and "function-based" training are both crucial for accelerating patients' functional recovery following stroke. So based on the results obtained in the study we reject null hypothesis that, there will be no significant effect of MRP on functional impairment in upper extremity among post stroke patients and we accept the alternative hypothesis that, there will be significant effect of Motor Relearning Program on functional impairment in upper extremityamong post stroke patients. It is concluded that MRP along with conventional physiotherapy is effective in improvement of functions in upper extremity among post-stroke patients and can be effectively used in physiotherapy setups and community based rehabilitation as early intervention to improve functioning in activities of daily living.

6. Conclusion

According to the findings of this study, the Motor Relearning Programme is more effective in enhancing neurological function and reducing degree of disability inupper extremity in post-stroke patients. Improvement was highly significant after 8 weeks of treatment with Motor Relearning Programme along with Conventional Physiotherapy.

Limitation of the Study

- A gender discrepancy has been noted in the data collection in the present study, males were more dominant than females.
- The study considered age as limitation by selecting age group 45-60 years

Future Scope

- Studies including patients from both rural and urban background shouldincluded.
- Also there is need for a research which includes an equal percentage of males and females participants to compare gender based differences in patients with stroke.
- The age of stroke patients in inclusion criteria can be less than 40 years.

Compliance with ethical standards

Acknowledgments

The authors of present study would like to express their thanks to the dear patients who volunteered to help us by their participation in the study.

Disclosure of conflict of interest

There was no conflict of interest.

Statement of ethical approval

Ethical Clearance of the study was taken from institutionalethical committee of University College of Physiotherapy, Baba Farid University of Health Sciences, Faridkot Punjab.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

Funding/support

No funding involved.

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