Effectiveness of motor relearning programme and mirror therapy on hand functions in patients with stroke—a randomized clinical trial

Puneet Rehani¹*, Reena Kumari², Divya Midha³

INTRODUCTION

Stroke is an acute, neurological event that is caused by an alteration in blood flow to the brain. The traditional definition of stroke, devised by World Health Organization in the 1970s is a "Neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours".[1] Many patients (41–45%) experience chronic motor impairments and limitations in activities of daily living even after extensive neurological rehabilitation. They often result in long-term dependence at a considerable cost to the carers and the health service. Loss of independence of upper limb function contributes enormously to functional disability, affecting quality of life and independence in 'basic' (washing, grooming, feeding, dressing, etc.) and 'instrumental' activities (shopping, home/financial management, etc.) of daily living.[2] In CVA out of upper limb, hand function seems to be the most difficult motor function to restore even with intensive therapy. This could be related to rich innervations of the hand from the large sized Betz cells of the cortex, which seem to be adversely affected by any substantial loss. Recovery of hand function after stroke is accompanied by a redistribution of activity within a network of parallel-acting multiple cortical motor areas. Interestingly, imagining performing certain hand movements results in activation of several cerebral areas in which increased activity was observed after recovery of hand function.[3] After an injury, the damaged brain will utilize surviving structures and networks that can generate some form of motor signal to spinal cord motor neurons. In addition, some areas take on a new role in motor performance.
There is some experimental evidence that physical therapy techniques are associated with changes in the activity of brain areas and improved transmission in the corticospinal pathways. Motor training results in performance improvements that are associated with reorganization. [4]

Different therapeutic approaches have been developed to enhance the functional recovery of patients after stroke. [5] The most common are Bobath, Neuro Developmental Therapy (NDT), Brunnstrom, Motor Relearning Programme (MRP) and recently introduced Mirror therapy, Constraint Induced Movement Therapy and Robotic Therapy.

The motor relearning approach was developed based on motor learning theory. Carr and Shepherd [6] proposed that training in motor control requires anticipatory actions and ongoing practice. To further enhance relearning, the motor tasks involved are practised within a context that can be task or environment specific. There are four steps in motor relearning programme:

- **Step 1:** Analysis of the task.
- **Step 2:** Practice of missing component.
- **Step 3:** Practice of task.
- **Step 4:** Transference of training.

Most of the treatment protocols for the paretic upper extremity are labour intensive and require 1-to-1 manual interaction with therapists for several weeks, which makes the provision of intensive treatment for all patients difficult. To overcome this, a study presented at the 6th World Stroke Congress in Vienna, Austria, in September 2008 which suggests that adding Mirror Therapy to traditional rehabilitation programs may speed the recovery of stroke patients. It has been suggested that mirror therapy is a simple, inexpensive and most importantly patient-directed treatment that may improve upper-extremity function. [6,7]

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. Ramachandran and Rogers-Ramachandran were the first to introduce the use of these visual illusions created by a mirror for treatment of phantom limb pain, but now it enhances the rehabilitation of hemiplegia after a stroke. [8]

In cerebrovascular accident hand function seems to be the most difficult motor function to restore even with intensive therapy. As studies conclusively demonstrated that traditional physiotherapeutic approaches do not differ with respect to their influence on the recovery of motor function in stroke patients and literature does not favour which approach is better over other so this study will provide the efficacy between motor learning programme and mirror therapy to improve hand functions in stroke patients.

**MATERIALS AND METHODS**

This was an experimental design. The research was carried out in outpatient department managed by Sardar Bhagwan Singh Post Graduate Institute of Biomedical Sciences and Research namely, Prayas Health Care Centre, E.C. Road, Dehradun, Balapritam Charitable Hospital, Patel Nagar, Dehradun. The inclusion criteria for the study was: Subjects between age 45 to 65 years, Individuals who experienced one episode of stroke only, Both males and females were included in the study, Both ischemic & hemorrhagic stroke individuals were included in the study, Duration of stroke between 1 to 6 months, Mini mental status examination (MMSE) (score > 23), Patients with Brunnstrom Stage 4 & 5. Exclusion criteria for the study was:: Individuals having any musculoskeletal Disorders, neurological disorder other than stroke, visual impairment, systemic disease, Non co-operative patients, Patients suffering from psychological problems.

Eligible patients were randomly assigned to one of the two groups: mirror therapy group or Motor relearning programme group. Randomisation was performed with a random number generator by a researcher not involved in the patient enrolment. Study was approved by Ethical committee of Institutional review board. It has also been Registered in Clinical Trial Database with Trial Number as NCT02338557.

All the patients had undergone Clinical Neuropsychological assessment prior to the start of intervention. Of the 20 subjects originally recruited into the study 12 subjects completed the study. Of the 8 Drop outs, one of them developed acute hypertension, three voluntary discontinued the study, two refused to participate, two developed another episode of stroke.

**INTERVENTIONS**

After agreeing to participate in the study The procedure of the study was explained to the subjects and written consent was taken from them prior to the study. The subjects under group A had received MRP exercises programme along with conventional physiotherapy treatment and Subjects under group B received Mirror therapy along with conventional physiotherapy treatment. Both the groups were delivered treatment of 6 days a week, for 4 weeks.

**Conventional Physiotherapy Treatment**

All the subjects were divided into two equal groups i.e. Group A and Group B with (n=6). Hand functions of all subjects was assessed with CAHAI. Conventional treatment was given in both the groups that includes Neutral Warmth with Moist heat pack with temperature range between 35°C - 37°C for 10 min, Stretching of wrist flexors with 30 Sec hold and 3 Repetitions and Electrical Stimulation for wrist extensors. A symmetrical biphasic current with a phase duration of 250 microseconds at a frequency of 35 Hz with a duty cycle of 10 sec. on and 10 sec. off was given for 15min. [9]

**MRP Exercises**

Subjects in Group A received MRP exercises for training of Wrist Extensors, Extension of wrist and holding objects, training of supination of forearm, opposition of thumb, cupping of hand and training of manipulation of the objects. [10]
**Mirror Therapy**

Group B received Mirror therapy in which patient was seated close to the table in front of mirror (35x35 cm). The involved hand was placed behind the mirror. The practice consisted of intransitive exercises as Hand opening, Wrist extension and flexion, Forearm pronation and supination, Hand sliding on a flat surface. During the session patient were asked to try to do the same movement with the paretic hand while they were moving the non-paretic hand. In both the groups total treatment was given for 1 hour/day for 6 days/week.\[1\]

**Outcome Measure**

Subjects were evaluated at baseline and after 4 weeks of treatment using Chedoke arm and hand activity inventory (CAHAI) as a primary outcome measures. CAHAI scale is designed to encourage the bilateral hand to complete the task. Patient was made to sit in chair without arm rest and encouraging erect posture with elbows at the edge of the table and hands resting on the table. Each task was demonstrated once before performance, and then the Score was evaluated of the affected upper extremity using the 7 point activity scale from total assistance (1) to complete independence (7). The total score of CAHAI was 91. The reliability of the test used in study was determined through various researches done in past. The chedoke arm and hand activity inventory (CAHAI - 13) was used which is a new upper – limb measure to assess functional recovery of arm and hand after stroke. High interrater reliability was established with ICC of .98 (95% confidence interval [CI], .96 - .99) and convergent and discriminant cross sectional validity were established for the CAHAI.\[12\]

**Data Analysis and Results**

Statistical analysis was done by using SPSS 16 software. Mann - Whitney U test was used to compare difference between Post and pre intervention scores in between two groups. Wilcoxon Signed rank test was used to compare Post and pre intervention scores with in two groups. 5% level of probability was used to indicate statistical significance. Descriptive statistics of the 12 subjects participated in this study are shown in Table 1.No significant Differrent was found among baseline characteristics of all the subjects included in Both the groups. The average age of the subjects in group A was 54.7 years and in Group B was 57.85 yrs. The mean CAHAI scores for the subjects at the baseline in group A was 27.5 and Group B were 27.667. The mean post-intervention Scores for Group A and Group B were 57.5 and 59.33 respectively. Results were found to be non significant on comparison between pre intervention scores and post intervention CAHAI Scores with in groups. with p>0.05 as described in Table 3.

Table -1 Descriptive statistics of Age, Stroke Duration, Type of Stroke, Gender, Side affected and MMSE scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group A</th>
<th>Group B</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>54.77±6.392</td>
<td>57.85±4.375</td>
<td>0.165 *</td>
</tr>
<tr>
<td>Stroke duration (days)</td>
<td>74.38±32.5</td>
<td>92.38±30.2</td>
<td>0.157 *</td>
</tr>
<tr>
<td>Stroke type</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ischemic</td>
<td>69.2</td>
<td>61.5</td>
<td>0.68 *</td>
</tr>
<tr>
<td>Hemorrhagic</td>
<td>30.8</td>
<td>38.5</td>
<td></td>
</tr>
<tr>
<td>Gender no%(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>61.5</td>
<td>53.8</td>
<td>0.69 *</td>
</tr>
<tr>
<td>Female</td>
<td>38.5</td>
<td>46.2</td>
<td></td>
</tr>
<tr>
<td>Side affected no%(%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>53.8</td>
<td>38.5</td>
<td>0.69 *</td>
</tr>
<tr>
<td>Left</td>
<td>46.2</td>
<td>61.5</td>
<td></td>
</tr>
<tr>
<td>MMSE Scorea (mean±SD)</td>
<td>27.692±1.43</td>
<td>26.692±1.65</td>
<td>0.112 *</td>
</tr>
</tbody>
</table>

Table 2 Shows Comparison of mean scores and S.D. of in between pre and in between post reading of both the groups

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRE</td>
<td>27.5±2.36</td>
<td>27.667±1.37</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>POST</td>
<td>57.5±2.62</td>
<td>59.33±2.75</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

p≤0.05 considered as significant,

Table 3 Shows Comparison of mean scores and S.D. between pre and post readings of CAHAI with in both the groups

<table>
<thead>
<tr>
<th></th>
<th>PRE</th>
<th>POST</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEAN±S.D.</td>
<td>MEAN±S.D.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>27.5±2.36</td>
<td>57.5±2.62</td>
<td>p&gt;0.05</td>
</tr>
<tr>
<td>Group B</td>
<td>27.667±1.37</td>
<td>59.33±2.75</td>
<td>p&gt;0.05</td>
</tr>
</tbody>
</table>

p≤0.05 considered as significant,

DISCUSSION

Impaired motor and functional activity following stroke often has negative impacts on the patient, the family and society. In stroke rehabilitation several treatment approaches have been introduced and different clinical therapists seems to adopt an eclectic approaches and combine principles from different approaches in their current practice which may indicate need for an optimal approach to be developed through more research. This study was an attempt to compare the efficacy of two therapeutic approaches which can be used as to improve hand function in stroke.

Motor task involving arm and hand movement are made up of very complex combinations of muscle action. As soon as isolated muscle action is elicited, this must be practised and extended into meaningful task which is supported by MRP technique in present study. But clinically, improvement was observed in hand function in terms of CAHAI ~ 13 which is also supported by great improvement in mean scores. Statistically results were non significant which is supported by a study conducted by in which they found no evidence of significant benefit from repetitive training of upper limb functional activity. Though improvement in mean values as well as better clinical recovery is consistent with the concept of Neuroplasticity given by William James who postulated that increments in synaptic efficacy occur during learning when firing of one neuron repeatedly produces firing in another neuron to which it is connected.

For motor rehabilitation, Ramachandran and Rogers-Ramachandran (1996) introduced concept of mirror reflection in neuosciences. Though results were statistical non significant in group B also but in this group also shows improvement in hand functions clinically which is supported by great improvement in mean scores. It has been hypothesized that the alternative input obtained from the mirror reflection might facilitate recruitment of the pre motor cortex (PMC) to assist recovery after stroke through an intimate connection between visual input and premotor area (Altschuler, 1999). Recently Rizzolatti’s et al discovery of mirror neurons (MNS) in humans, which fire both execute movements and observing movements, has opened up new prospects for alternative neurological rehabilitation techniques. The MNS is a frontoparietal motor network of mirror neurons. Mirror neurons are bimodal visuomotor neurons discharging both when performing a particular action and when observing a similar action performed by another person. Studies suggested that not only movements but also imaging and observing movement, could stimulate motor circuits and improve motor recovery.

Result of the study concluded that there was no statistically significant difference is present between the two therapeutic approaches in terms of hand function. Several factors must have influence the result which includes sample size to be chosen was too small, the duration of treatment time which might have been less which is consistent with the finding of Gert Kwakkel, Roland Van peppen (2004) suggests that the treatment contrast should exceed 16 hours to promote significant differences in ADL and upper limb function. Environment also contribute major role in rehabilitation of stroke patients in which the patient can learn to regain motor control, reasoning ability and social skills.

CONCLUSION

Present study concludes that though statistically results were found to be non significant but clinically improvement in the hand function was seen in both the groups separately. Further
study can be conducted by using more controlled selection criteria, especially sample size and duration of treatment with control groups to get better understanding of the mechanisms of the interventions believing that performance of hand functions will be enhanced.

Conflict of Interest: None

References:

1. Catherine E. Lang PT. Sensorimotor Control of Grasping: Physiology and Pathophysiology STROKE
7. Susan Jeffrey. Mirror therapy may facilitate recovery in hemiplegic stroke patient. 6th world stroke congress; September 26, 2008