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Comparative Efficacy of Mental Practice and Mirror Therapy on Upper Limb Motor Function in Acute Stroke Rehabilitation: A Randomized Controlled Trial

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ABSTRACT

Background: Stroke rehabilitation help restore lost function and re integrates the stroke survivors in to the society. Based on mirror neuron system, mental practice (MP) does cognitive rehearsal of activities that involves same cortical changes as physical practice in stroke survivors.
Objective: To determine the comparative efficacy of a mental practice (MP) intervention versus a mirror therapy (MT) intervention on upper limb motor function after stroke.
Methodology: A thirty acute stroke subjects were assigned to the mental practice (MP; n-15) or to the mirror therapy (MT; n-15) group. Subjects were assessed before and after 7 weeks of intervention using Action Research Arm Test (ARAT). MP group was administered functional activity based visual motor imagery training and MT group was administered functional activity based mirror therapy training. Both groups had five tasks of real life rehearsal strategies and each session consisted of60minutes, 3 days in a week.
Results: After the intervention, means of ARAT using an 'independent t-test' showed subjects in the mental practice (MP) group were significantly higher than those of subjects in the mirror therapy (MT) group. There is a statistically significant difference in grasp, gross, pinch, grip and total score between the groups.
Conclusion: Mental practice is a promising adjuvant therapy to physiotherapy practice with minimal direct supervision and minimal expense. It's feasible to self-administer in virtually any environment with no specialized equipment.

Keywords: Mental practice, Motor imagery, Mirror therapy, Stroke rehabilitation, Plasticity.

INTRODUCTION

In India, stroke incidence is elevating than western countries. Stroke causes life time disability among adults and it is the important burden parameter. In India there were 795.57 per100,000 person-years disability-adjusted life years (DALYs) lost because of (1). The prevalence rate is 84-262/100,000 in rural and 334-424/100,000 in urban India (2).

Stroke Rehabilitation is the long term and it is a costly area of care in developing countries like India where it requires a team effort including a patient and caregivers. Novel self-management interventions in stroke rehabilitation like mirror therapy and mental practice have shown to be useful adjunct exercise therapies.

The basis of human social organization is action understanding. We can call this as imitation learning. The observation of physical actions done by others activates the motor cortex, without any overt motor activity is called as mirror-neuron system. Based on mirror-neuron system the conception of novel intervention mirror therapy (MT) and motor imagery (MI) get evolved. Several studies confirmed the mirror neurons physiological functions in human brain which has action perception and action execution mechanism.

Motor imagery (MI) or Mental practice (MP) is a technique where the movement is imagined and mentally rehearsed without voluntary movement. This practice induces neural plasticity which is the key to restore movements especially the upper limb function.

Many studies have proved the benefits of MI and MP with sub-acute stroke patients. Studies using a mirror therapy aimed to get mirror reflection facilitates paretic upper limb functions in real world scenarios. Mental practice or Motor imagery is found to enhance the cortical level re organization similar to that of physical exercise.

METHODOLOGY

This study is an experimental, comparative design involving two groups: Group A (Functional Activity Based Motor Imagery with Mental Practice) and Group B (Functional Activity Based Mirror Therapy). The study includes a total of 30 subjects, with 15 subjects in each group. Participants were selected using a simple random sampling method and allocated to the groups accordingly. The setting for the study is home care-based rehabilitation, conducted over a duration of seven weeks, with sessions held three days a week, each lasting 60 minutes. Materials used in the study include a mirror, a video displayed on a laptop screen, a tea cup with a handle, a book, a mobile phone, and a pen.

Subjects were selected based on the following inclusion criteria: first-time unilateral hemiplegic stroke (either right or left), hemiplegia occurring between 2 to 6 months post-stroke, ischemic stroke, age between 40 and 80 years, both male and female, and a Brunnstrom stage of motor recovery between 3 to 5, with a Modified Ashworth Scale score of less than 2. Exclusion criteria included subjects with wrist and finger contractures, significant visual and auditory impairments, chronic stroke, behavioral and attention impairments, global aphasia with cognitive impairments, and those undergoing physical therapy.

MEASUREMENT TOOLS:

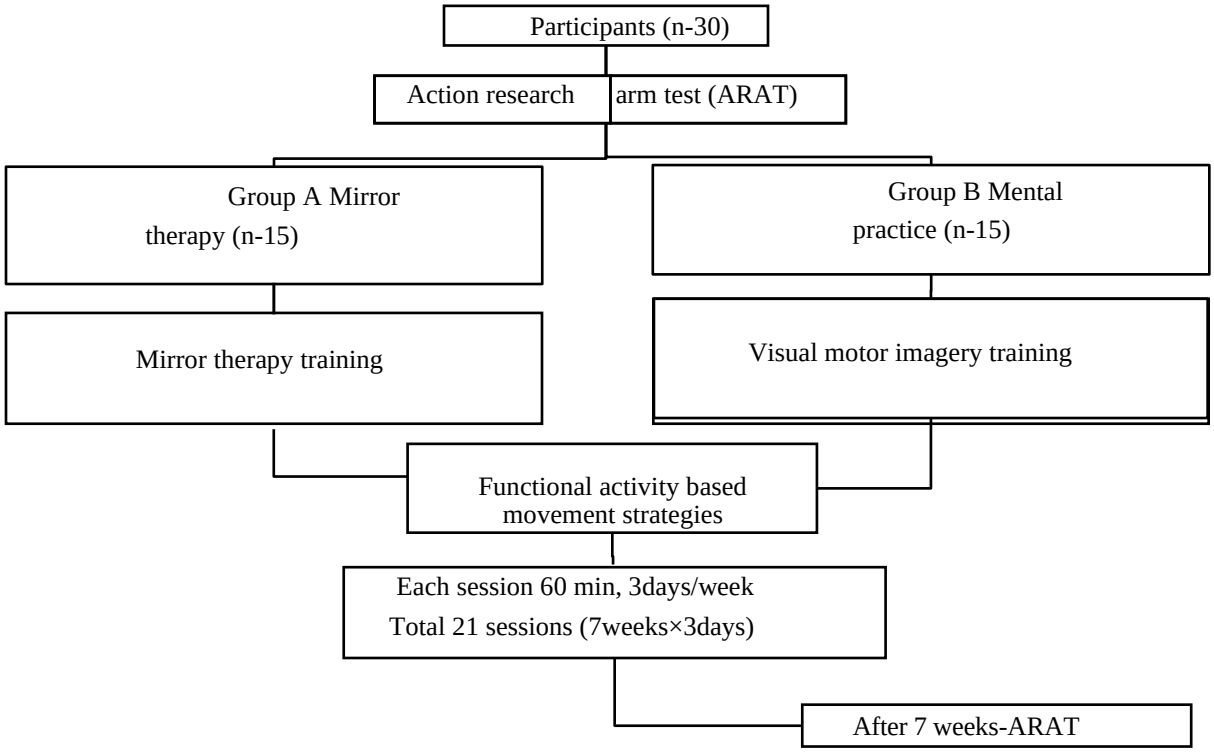
Pre and post intervention measurement was done by ARAT scale which evaluates the upper extremity function. Action research arm test (ARAT) was done before and after 7 weeks.

ARAT is used to evaluate upper extremity motor function using 19 tests across 4 subsets: grasp, grip, pinch and gross movement of the hand both proximally and distally. Test took approximately10 min to administer. Base line to complete the task was 1 min. Total score is

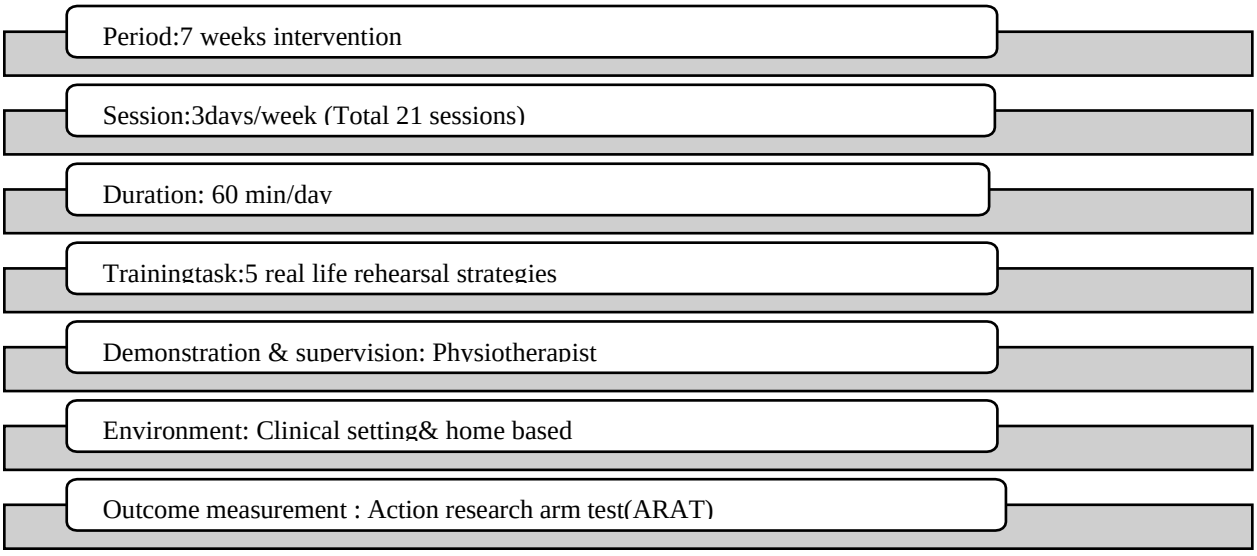
57.

ARAT is a highly reliable observational rating scale after stroke (3). This is a standardized format test used to evaluate upper extremity motor function. On the table, test materials were placed and the subjects were seated on a chair comfortably so the subjects could reach and grasp the materials has demonstrated. The failure of doing first and second task by the subject scored has zero, no other subtests needed to be tested. If the subject does the test, he or she needed to complete all tasks within the subtest. When the first task was done by the subject, then no more tasks were needed to be administered and scored top marks. The ARAT scale indicating very high inter-rater reliability and validity (4).

PROCEDURE



TRAININGPROTOCOL



TRAINING PROGRAM:

Interventional procedure for Group A:

In Group A, subjects were treated with functional activity based motor imagery with mental practice inducting physical practice with video previewed consisting of 5 tasks for duration of 60 minutes for 3 days a week for 7 weeks.

The subject was made to sit on a chair in front of the table containing task related materials like video displayed on the laptop screen, tea cup with handle, book, mobile phone and pen. The unaffected limb and affected limb was placed on the table. The subject was first asked to observe the video previewed of motor tasks. Then the subject was asked to mentally practice each activity ten times. Then the instruction to physically practice each activity for ten times was given to the subject. The total duration of motor imagery tasks was for 60 minutes per session.

The motor tasks given were, picking up tea cup with handle and taking it to the mouth, and then returning the cup to its initial position, turning pages of a book, reaching the top of the head to comb, picking up a mobile phone to receive the call and holding of a pen to write.

Interventional procedure for Group B:

In Group B, subjects were treated with functional activity based mirror therapy consisting of 5 tasks for duration of 60 minutes for 3 days a week for 7 weeks.

The subject was made to sit on a table with the mirror stationed between the affected and unaffected limbs. The limb which is affected was placed behind the mirror and the unaffected limb is placed in front of the mirror. The mirror was positioned in front of the subject's midline. The reflection of the unaffected limb was fully visible on the mirror as well the affected limb was fully covered by the mirror. Subject was demonstrated to observe the mirror reflection of the unaffected limb for one to two minutes, trying to visualize and perceive the mirror image as the affected limb. Once the subject perception with the mirrored limb got engaged they were asked to perform motor activities slowly, easy to achieve mentally perceived bilateral movements by looking at the reflected image. The functional activity based motor tasks were, picking up tea cup with handle and taking it to the mouth, and then returning the cup to its initial position, turning pages of a book, reaching the top of the head to comb, picking up a mobile phone to receive a call and holding of a pen to write.

Subjects were instructed to do home exercise program for the rest of the days in a week and were demonstrated about the functional activity exercises and were practiced at home. Twice a day home program was done and recorded in a log note. All exercises were real life functional activity for both the upper extremity and lower extremity.

STATISTICAL METHODS:

Descriptive statistical analysis method was presented in this study. The subsets of ARAT and the total value of ARAT is presented and analyzed as mean ± SD. The significant level of the study was set at p value 0.05, less than this is considered as statistically significant difference. Intergroup analysis is carried out to compare the values of variables between two groups using Independent 't' test as a parametric. The Statistics were done using MS Excel 2013 Data analysis. The Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS AND DISCUSSION

Total 30 subjects participated in the study. Group A there were 15 subjects with 10 males and 5 females were participated in the study. In Group B there were 15 subjects with 9 males and 6 females were participated in the study. No significant difference was found in mean age, duration and Brunnstrom stage between the two groups.

When means of Action Research Arm Test were analyzed there was a significant change between Group A and Group B. The means of total score of ARAT were showing a significant changes from pre intervention to post intervention analysis. This shows there is a clinically significant improvement between the two groups.

There was no statistically significant difference when pre intervention means of grasp, grip, pinch, gross movement of ARAT were analyzed between group A and group B. This shows no clinical significant difference among the groups who had Action Research Arm Test as a base line measurement before 7 weeks of intervention.

After 7 weeks of post intervention, means of Action Research Arm Test – grasp, grip, pinch, Gross Movement, and total Score were compared and analyzed for the statistical difference. There found to have no statistical significant differences in grasp, grip and pinch score between group A and group B, but there was a statistical difference in gross movement score between group A and group B. This shows a marked difference clinically in moderate effect size.

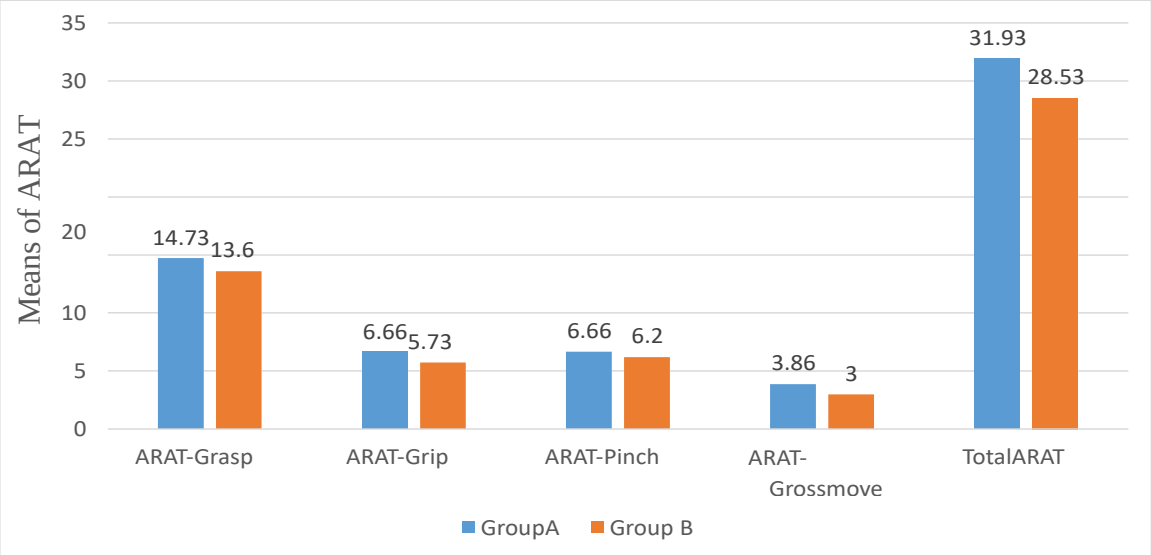
Table1: Comparison of means of Action Research Arm Test between Group A and Group B (Preintervention Comparison)

Pre-intervention	Group A (Mean ±SD)	Group B (Mean ±SD)	t value (Parametric)	Significance P value
ARAT-grasp	13 ± 2	12.6 ± 1.76	0.580	P=0.566
ARAT-Grip	5.13 ± 2.09	4.6 ± 1.68	0.767	P=0.449
ARAT-Pinch	5.2 ± 1.78	5.06 ± 1.22	0.239	P=0.813
ARAT-Gross Movement	2.26 ± 0.88	2.2 ± 0.77	0.219	P=0.827
ARAT-Total	25.6 ± 3.77	24.46 ± 2.23	1.000	P=0.327

Table2: Comparison of means of Action Research Arm Test between Group A and Group B (Postintervention comparison)

Post-intervention	Group A (Mean ±SD)	Group B (Mean ±SD)	t value (Parametric)	Significance P value
ARAT-grasp	14.73 ± 1.90	13.6 ± 1.72	1.707	P=0.098
ARAT-Grip	6.66 ± 1.91	5.73 ± 1.75	1.393	P=0.174
ARAT-Pinch	6.66 ± 1.98	6.2 ± 0.65	0.787	P=0.439
ARAT-Gross Movement	3.86 ± 1.06	3 ± 0.65	2.694	P=0.012
ARAT-Total	31.93 ± 3.97	28.53 ± 2.41	2.832	P=0.009

Graph 1: Post intervention comparative analysis of means of ARAT between Group A and Group B



The graph which is above shows a compared analyzes of post intervention mean values of Action Research Arm Test scores of grasp, grip, pinch, Gross Movement individually depicted. The total score of ARAT and gross movement score shows a significant difference and there is no significant difference in grasp, grip and pinch scores.

The findings from the present study revealed that there is statistically as well as clinically significant improvement in hand motor functions in subjects who received 7 weeks of functional activity based motor imagery training with mental practice than the subjects who underwent functional activity based mirror therapy training.

Brain science had under pinned the close functional similarities in neural connections for motor planning and motor execution (5). Is the actions done by other individuals provoke a same neural correlation in the brain was the subject of research for brain enthusiast. Our culture is based on learning which is called as imitation learning for the social being to survive. Research has explored the neuro physiological mechanism on the mirror-neuron mechanism which fascinates the science community on action perception and action understanding by humans (6).

Motor imagery or the mental practice is a dynamic state during which representation of given motor act are internally rehearsed in the mind without any physical motor output. There is connection between the basal ganglia and the prefrontal cortex to maintain a dynamic motor output. (7). The scientific reason behind the significant change in mental practice (MP) group is associated with the activation of this neural networks in planning and execution of movements. Though there is no muscular activity the mental practice (MP) can stimulate and process information in neurons which in turn induces neuroplasticity. Motor imagery can be divided into kinesthetic motor imagery and visual motor imagery. The kinesthetic is the first person perspective whereas the visual imagery is seeing others action (8).

In this study visual motor imagery was applied through a video which was previewed to the subject, then the subject has to simulate the same movement in a real-world scenario. Motor learning can be guided through proprioceptive techniques, tactile stimulation, and vestibular, visual and auditory information (9).

There is a solid evidence showing motor imagery activates similar cerebral neurons like those happening during actual physical movements (10). So it is a top down neuro technique where the neurons get activated just by observing others actions or movements where it enhances neuro plasticity and learning of complex motor tasks in a simple methodology. The role of primary motor areas in movement imagery is discovered in a research measuring electro cortical activity (11). Hence in this study, functional activity based motor imagery with mental practice is found to be an effective therapy to improve motor functions of upper limb in a home based environment itself i.e. self-administered.

In a recently published stroke journal, guidelines has been issued to deliver a evidence based neuro rehabilitation and recovery for the stroke patients. For the upper limb exercise therapy mental practice (MP) is an adjunct tool. Mental practice (MP) is recommended in a class 2 a with level of evidence A (12).

Functional activity based mirror therapy training, too is clinically beneficial to improve an upper limb motor function. It’s a very simple and promising neuro intervention where it illusion the brain to subtly activates a neurons which is not used due to weakness. The sensory motor activation due to the mirrored image of the unaffected limb favour to overcome the compromised hemisphere due to neglect of one side of the body. A recently published meta-analysis study has

given credit to mirror therapy in improving motor function of the upper limb in patients with stroke (13). Mirror therapy with functional activity or the task-oriented activity may augment and improve the muscle strength of the upper limb (14). The mirror therapy increases corticospinal excitability of the neurons that are stimulated during normal movements than directly visualizing a normal hand (15). The Cochrane review recommended mirror therapy (MT) to improve activities of daily living (ADL) and as an adjunct to conventional rehabilitation (16).

Lot more studies have been done on mental practice and mirror therapy in combination with task-oriented activities. In this study functional activity based training strategies had been given to find out the efficacy of the two techniques. The patients who underwent this study didn't get fatigue due to less physical activity during the intervention. Through this study, it has been found that mental practice regimen with functional activity based approach is significantly effective in upper limb motor training for the sub-acute hemiplegia. Therefore, null hypothesis is rejected.

CONCLUSION

The present experimental study concludes that the 7 weeks of functional activity based motor imagery with mental practice and functional activity based mirror therapy both shown significant effect on improvement of upper extremity function. However, functional activity based motor imagery with mental practice found to be effective in improving hand motor function when compared to functional activity based mirror therapy. To administer a comprehensive neurological rehabilitation program it is important to consider both the treatment techniques for the stroke patients in improving upper limb function to engage them in activities of daily living.

Limitations of the Study:

1. Ischemic stroke subjects alone were taken up for the present study.
2. Duration of the stroke subjects with 2 to 6 months only were selected.
3. Subjects were not included with the Brunnstrom stages of 1 and 2.
4. The number of real-life rehearsal strategies is taken only 5 for the study.
5. ARAT is the only Outcome measurement tool to measure the recovery.

Recommendation For Future Research:

As mentioned in the Cochrane review (16) evidence regarding the movement quality and motor recovery should be studied in in-depth scientific physiotherapeutic approach. The ideal dosage to administer mental practice (MP) intervention should be made clear by recruiting a large population. More functional activity based training should be embedded in research along with mental practice and mirror therapy. A tool to find out motor imagery activity should be used in research to confirm the cognitive rehearsal. How far the improvement is well able to be preserved in a aftermath of intervention is to be ascertained by doing a follow up or prospective kind of study.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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