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# Effect of Imagery Therapy (IT) and Mirror Therapy (MT) on Hand Function with Stroke Survivors: A Comparative Study

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A B S T R A C T

A stroke can be seen as a massive distortion of the capacity of the brain to process neural information, with heterogeneous consequences. Not only the motor system is affected after a stroke, but also the cognitive and emotional systems may be seriously impaired. Imagery, and mirror box therapy are simple, inexpensive and patient led treatments that can be used to aid in the improvement of motor function in both the upper- and lower-extremities post-stroke. The Objective of this work examined the effect of arm movement through application of both imagery and mirror box therapy in stroke survivors. Pre test/post test experimental designed in this work at Occupational Therapy department, Swami Vivekananda National Institute of rehabilitation Training and Research, Olatpur, Odisha. 30 participates with stroke survivors.(17 right handed and 13 left handed) Group A-15, was taken in Imagery group and Group –B, 15 in mirror group. Subjects of both the group were provided therapy sessions for 45 minutes per day, 5 days in a week for 6 weeks. Outcome of this study measure Jebsen taylor hand function test.{JTHFT} and Action research arm test (ARAT). The results revealed that imagery produced a moderate mean treatment effect (p= 0.00; d= 0.48; 95% confidence interval: 0.05 to 0.91). Both the group shows the significant value where as mirror therapy group showed better result than the imagery group. However, the effectiveness of imagery during stroke rehabilitation is still uncertain, as indicated by the large confidence interval.The literature reviewed in this study showed that imagery and/or observation-based training may be valuable new methods for post-stroke motor rehabilitation. Although the underlying mechanisms are not yet clear. During mirror box therapy, patients observe their non-affected limb in a mirror. It could be questioned however, whether it was actually action observation that aided movement improvement or the physical practice that occurred during mirror box therapy

Keywords: Mirror Therapy, Stroke, Mirror neuron, Upper extremity. Jebsen taylor hand function test.{JTHFT} , Cognitive therapies ,Action research arm test (ARAT), motor imagery, rehabilitation,

## 1. Introduction

Stroke is a disease that occurs due to hypoxic damage, ischemia, infarction, or hemorrhage and is a major disease that causes diverse squeal such as movement disorders [Brodie, Holm, & Tomlin, 1994]. The motor paralysis that appears after a stroke onset generally occurs more frequently on the distal part of the upper extremity than on the lower extremity and out of functions related to the motor paralysis, finger extension is one of the functions of which the recovery is delayed the most [Trombly & Quintana, 1983].

Given that most of the activities of daily living are conducted through the movements of the hands including the upper extremity, patients who cannot use their hands after the stroke onset become to experience physical and mental pain. Therefore, the degree of functional recovery of the upper extremity can

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be said to have critical effects on the level of assistance necessary for the activities of daily living and whether independent activities are possible after the stroke onset [Chae, et al., 1998].

Cognitive therapies such as imagery (Page et al., 2005), mirror box therapy (Yavuzer et al., 2008) and action observation (Ertelt et al., 2007) are structured therapy methods that attempt to change positively the patients thoughts, emotions and behaviours, resulting in possible associated changes in physical function and behaviour (Beck, Rush, Shaw, & Emery, 1979).

Mirror therapy is known to be effective on the phantom sense and phantom pain due to the amputation of the extremity, postoperative rehabilitation, and pain due to CRPS [Ramachandran & Rogers-Ramachandran, 1996; Yıldırım & Kanan, 2016; Barbin, et al., 2016], and is also known to be effective for paretic side motor recovery after a stroke [Arya & Pandian, 2013; Amasyali & Yaliman, 2016; Kim & Lee, 2015]. However, because previous studies of mirror therapy presented diverse kinds of mirror therapy programs and used different intervention periods such as the time of therapy applied [Dohle, et al., 2009; Yun, Chun, Park, & Kim, 2011], lead to confusion for applies to standard format.

Mirror therapy is one of cognitive induced interventions based on mirror neurons as neurologic grounds proposed first by Ramachandran [Ramachandran & Rogers-Ramachandran, 1996]. Mirror therapy is a cognitive induced intervention that makes the patient see his/ her motions of the non-paretic side through a mirror after covering the paretic arm with the mirror to provide the patient with illusory motor sensation of the normal movements of the paretic arm and induce visual illusion thereby activating the damaged brain region [Ramachandran & Rogers-Ramachandran, 1996; Caligiore, et al., 2016]

Motor imagery can be defined as the covert cognitive process of imagining a movement of your own body(-part) without actually moving that body(-part) . Kosslyn et al. showed that visual and motor imagery depend on distinct neural processes. In their experiment, motor areas of the brain were found to be activated during the mental rotation of pictures of hands, but not during the mental rotation of three-dimensional (3-D) cubes. The mental rotation of 3-D cubes was associated primarily with activity of visual cortical areas.

In another study Page et al. investigated this question. They trained 6 one-year post-stroke patients for 6 weeks with physical therapy combined with mental practice (motor imagery) and compared improvements in hand function with a control group that received physical therapy combined with relaxation exercises. They showed that arm function and daily arm use improved more for the group that received the combined physical therapy and motor imagery training than the group that received the combined physical therapy and relaxation training. This study shows that motor recovery might be possible even if the patients are one-year post-stroke and show stable motor deficits

Imagery is a mental technique in which physical skills are cognitively rehearsed in the absence of overt physical movement (Page, 2000; Page, Levine, Sisto, & Johnston, 2001a). Physical movement is also absent during action observation, but movements are observed with the intent to imitate (Pomeroy et al., 2005). However, mirror box therapy involves the performance of bilateral arm movements while the impaired limb is obscured from sight by the box. The patient watches the movement of the unimpaired limb in the mirror reflection, thus giving the illusion that the impaired limb is moving unaffected with enhanced movement capability.

The effect of mirror box therapy on motor recovery post-stroke. Even though it is unclear what the mechanisms are behind mirror box therapy, researchers have reported improvements in movement both in the upper and lower extremities. Yavuzer et al. (2008) found that a four week mirror box and conventional rehabilitation programme in sub-acute stroke patients produced significant improvements in Brunnstrom stages for the hand and upper-extremity and the Functional Independence Measure (FIM) self-care score.

Therefore, the studies described in this thesis investigated whether imagery and mirror therapy produced a positive effect on movement ability post stroke and whether cognitive therapies are currently being used by therapists during stroke rehabilitation.

**Aims and Objectives:**

- To evaluate the effect of arm movement through application of both imagery and mirror box therapy in stroke survivors.
- To enhance hand function through both imagery and mirror box therapy .

**Alternate Hypothesis:**

- Both the imagery and mirror therapy show significant result in recovery of hand function with stroke patients.

**Null Hypothesis:**

- There will be no effect of both therapies in recovery of hand function in stroke patients.

## 2. Methodology

**Place of study**

The study was conducted at Swami Vivekananda National Institute Of Rehabilitation training and Research, Cuttack Orissa.

**Study Design:** Pre test / Post test experimental design

**Sample size:** 30 stroke survivors.(17 right handed and 13 left handed)

**Group A-15,** was taken in Imagery group and **Group –B,** 15 in mirror group.

**Inclusion criteria:**

- Sub acute stage stroke with 1 month rehabilitation ward stay.
- Age –25- 45years
- Brunnstrom stages -2,3
- Able to follow simple command and follow instructions correctly.
- Have gross grasp

**Exclusion criteria:**

- No accessory neurological and orthopaedic condition associated.
- Any congenital deformity

**OUTCOME MEASURE**:

- Jebsen taylor hand function test.{JTHFT}
- Action research arm test (ARAT)

**PROCEDURE:**

Subjects were collected from department of Occupational Therapy, SVNIRTAR.Parents of subjects was explained about the study and informed consent were taken from them. Baseline data were collected for all subjects by using. Jebsen taylor hand function test, Action research arm test (ARAT)Before beginning the intervention each subjects were randomly divided into two groups as Group A and Group B .Subjects of both groups were provided therapy sessions for 45 minutes per day, 5days in a week for 6 weeks. The subjects of Group A had received imagery Occupational Therapy for 45 minutes. Whereas subjects in Group B had received mirror box Occupational Therapy for 15 minutes..At the end of 6 weeks , all the subjects were administered Jebsen taylor hand function test, Action research arm test (ARAT) and were collected as pre and post intervention data.Both pre and post data will be taken for statistical analysis.

**Group A (IT):** The treatment group A received IT training.. The IT training was implemented once a day for 45 minutes from Monday to Friday for four weeks. Each training consistent of three sessions with five minute breaks between two sessions. Each IT session was performed by an appropriate position, followed by explanation of rules and instructions by the therapist. The subject received the following instructions before each session: during this session there are some IT activities including flexion/extension of the thumb, abduction/adduction of all digits, making a fist/spreading the hand, moving extended fingers backwards and forwards, and moving the hand between the ulnar and radial deviation that you are going to imagine doing with your paretic hand. Each IT activity was performed as follows: firstly, the therapist explained the IT activity and watched the video of the IT activity twice with the subject. Secondly, the subject used the unaffected hand to physically perform the IT activity twice. Thirdly, the subject imagined the IT activity using the unaffected hand. The instructions of each IT activity were given as "Close your eyes. Concentrate on your hand, but do not move it. Concentrate on how it feels just resting there. Do not move your fingers, hand, or arm. Just imagine the required IT activity

**Group B (MT):** The treatment group B received MT training.

Comfortably sitting on the chair, the participant put the arms on the desk and put the paretic arm into the mirror box so that it was not visible. The mirror box was placed on the midline of the participant's body and the non-paretic arm was placed in front of the mirror surface so that the non-paretic arm would be naturally seen when the participant sees the mirror.

Exercise materials Besides objects that are needed for functional motor training (e.g. cups, towels) materials with more sensory input can be used, especially in patients with impairments in body perception like: • Plastic bowl or tubs filled with sand or peas • Hedgehog ball • Temperature stimuli (warm, cold) • Different brushes • Washing up gloves • Sand paper.

Position of affected limb: The affected limb should be positioned on a height adjustable table so that its position can be adjusted to the length of the patient's trunk and arm. The affected limb is situated in a safe and preferably comfortable position behind the mirror. In case of severe muscle spasticity, preliminary manual mobilization may be necessary and helpful before positioning the limb.

Position of non-affected limb; The patient should try to facilitate a vivid "mirror illusion" (mirror image perceived as the affected limb) by matching the position and image of the non-affected limb to the affected side. For example, the non-affected limb should be positioned in a similar position as the affected limb, as this facilitates the intensity of the mirror illusion.

**DATA ANALYSIS**

After collecting all the data, data analysis were done by using SPSS version 23.0 .

Mann Whitney U test were used to analyze the changes in scores Jebsen taylor hand function test, Action research arm test (ARAT) between group and Wilcoxon signed rank test was used to analyse the changes within the groups. Level of significance was set at $p \leq 0.05$.

## 3. Results

The analysis of data gives the following tables showing the demographic characteristic and test results .

**Table 1 Shows Demographic Characteristics Of Subjects**

| SR NO. | BASELINE CHARACTERISTICS | GR. A | GR B |
|---|---|---|---|
| 1 | No. of subjects (male and female) | 15 (M=8, F=7) | 15 (M=9 , F=6) |
| 2 | Age range (years) | 25-45 | 25-45 |
| 3 | Mean age | 24.9 years | 35.36 years |

**Table 2 Shows Descriptive Statistics of Outcome Measure**

| OUTCOME MEASURE | GROUP A | | | | GROUP B | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean test score | | Standard deviation | | Mean test score | | Standard deviation | |
| | Pre test | Post test | Pre test | Post test | Pre test | Post test | Pre test | Post test |
| ARAT | 91.83 | 58.64 | ±7.21 | ±7.81 | 87.87 | 43.37 | ±5.55 | ±5.21 |
| JTHFT | 33.86 | 28.53 | ±3.97 | ±6.18 | 32.94 | 23.53 | ±3.24 | ±3.73 |

Table 2 shows mean value of pre test and post test score and standard deviation of ARAT and JTHFT for both the groups ..

**Table 3 Shows The Result of Wilcoxon Signed Rank Test :Within The Groups**

| GROUPS | MEAN DIFFERENCE | z- VALUE | P(2 TAILED) |
|---|---|---|---|
| **ARAT SCORE** | | | |
| **IMAGERY GROUP** | 22.81 | -3.408 | .041 |
| **MIRROR GROUP** | 9.5 | -3.408 | .011 |
| JTHFT SCORE | | | |
| **IMAGERY GROUP** | 13.47 | -3.440 | .032 |
| **MIRROR GROUP** | 5.39 | -3.413 | .008 |

**Table 4 : Showing Results Of Mann-Whitney U Test Between The Groups.**

| GROUP | MEAN RANK | SUM OF RANK | U VALUE | P VALUE |
|---|---|---|---|---|
| **PRE ARAT SCORE** | | | | |
| **GROUP A** | 13.47 | 202.00 | 82.000 | .217[b] |
| **GROUP B** | 17.53 | 263.00 | | |
| **POST ARAT SCORE** | | | | |
| **GROUP A** | 22.17 | 332.50 | 12.500 | .000[b] |
| **GROUP B** | 8.83 | 132.50 | | |
| **PRE JTHFT SCORE** | | | | |
| **GROUP A** | 15.73 | 236.00 | 109.000 | .902[b] |
| **GROUP B** | 15.27 | 229.00 | | |
| **POST JTHFT SCORE** | | | | |
| **GROUP A** | 20.87 | 313.00 | 32.000 | .000[b] |
| **GROUP B** | 10.13 | 152.00 | | |

## 4. Discussion

Current study presents there was improvement in hand function in mirror therapy group than imagery group. In sub acute stage imagery therapy is not beneficial unless physical practice was not there.

The degree of functional recovery of the upper extremity greatly affects the estimation and determination of the degree of assistance necessary to perform the activities of daily living and the level of independence after stroke. In particular, since many tasks in the activities of daily living required the use of the upper extremity, patients who cannot use their hands become to experience physical and mental pain. Stroke patients with serious upper extremity paralysis sometimes show repulsion against physical approaches focused on the recovery of paretic extremity functions [Blanton & Wolf, 1999], and this phenomenon sometimes becomes a secondary problem in achieving efficient recovery processes. One of the characteristics of stroke patients' movement disorders is the dysfunction of the sensorimotor feedback loop resulting fromtroubles in sensory functions. This problem affects task related task-intrinsic feedback loop activities to hinder the recovery of the motor functions of the invaded extremity [van Dijk, Jannink, & Hermens, 2005].

Given these facts, providing augmented sensory feedback using diverse sensory stimuli such as somatosensory stimuli and proprioception can be said to be indispensable for the recovery of stroke patients' upper extremity functions.

One of great advantages of mirror therapy is that mirror images of the non-paretic side are used for the improvement of the motor control of the paretic side. Since nervous excitement can be induced while mirror therapy is implemented so that the paretic side extremity can perform exercises in similar temporal and spatial patterns to those of the non-paretic side extremity and normal motion senses are provided through visual feedback, augmented sensory feedback will be provided while the motor system may be stimulated in the form of bilateral upper extremity training [Stevens & Stoykov, 2003].

One of important characteristics that must be considered during therapeutic Interventions for motor function recovery is the ipsilateral innervation of the upper motor neuron. Ninety percent of the corticospinal tract controls the contralateral side and the remaining 10% becomes to be involved in the control of the ipsilateral side [Chollet, et al., 1991]. Another characteristic is that when the upper extremity is to implement tasks that require the use of both hands, it prefers temoposatially identical implementation patterns [Fagard, 1987].

In the case of stroke patients, when the paretic side upper extremity moves, the movement is not appropriately controlled due to abnormal order of motor recruitment and deteriorated coordination to induce the excitement of peripheral muscles or muscle groups not directly related to the movements thereby restricting motor control with responses like the cocontraction of agonists and antagonists [Giuliani, 1991], If both upper extremities are continuously used simultaneously, the movements of both upper extremities will gradually show synchronized and stabilized temporal and spatial patterns [Kelso, Holt, Rubin, & Kugler, 1981].

To put the contents described above together, inducing simultaneous use of both upper extremities using mirror therapy can be very effective and it is thought that tasks to be implemented should be composed to have the patient repeatedly perform tasks related to daily living rather than simple tasks. In fact, a previous study indicated that images seen through the mirror could augment spatial coincidence to increase the trend to transfer space perception from one articulation to another articulation [Altschuler, 2005], and the results of this study showed that images seen through the mirror could bring about significant changes not only in muscle strength and the range of joint motion but also in upper extremity operating ability.

Both acute and chronic stroke-affected individuals have been used to investigate the use of imagery during stroke rehabilitation. Chronic stroke-affected individuals should never be excluded from rehabilitation even if it is expected that little improvement will occur (Hewett et al., 2007). Imagery has been reported to improve physical performance in acute (Liu et al., 2004a) and chronic (Page, Levine, & Leonard, 2007) stroke cases. Time post-stroke in these studies varied from seven days (Liu et al.,2004a) to 3.5 years (Page et al., 2007). A review by Malouin, Jackson, and Richards (2013), which assessed 27 imagery stroke rehabilitation studies, found that 74% of studies (20/27) included participants that experienced a stroke more than six months prior to participation in the study. A reason for researchers using participants more than six months post-stroke is that any motor improvements will unlikely be related to spontaneous neurological recovery.

The study by Liu et al. (63) showed that different imagery training strategies can potentially improve different aspects in post-stroke movement rehabilitation. It might be that a third person, visual strategy might be important to improve the relearning of new skills, whereas motor imagery could play a role in the recovery of actual motor co-ordination processes

Thus, any functional improvements can be attributed to the imagery intervention (Malouin et al., 2013). Braun, Beurskens, Borm,Schack, and Wade (2006) found that studies did not clearly state which stage of recovery participants were in and the average age of participants varied from 62.3 (Page et al., 2005) to 72.7 (Liu et al., 2004a) years old. Overall, most studies on the use of imagery during stroke rehabilitation have used chronic stroke patients but, as in the Liu et al. (2004a) study cited above, some research with acute stroke patients has started to emerge. Further research is needed to discover whether participant characteristics such as time post-stroke and age alter the effect of imagery on movement performance.

## 5. Conclusion

The literature reviewed in this study showed that imagery and/or observation-based training may be valuable new methods for post-stroke motor rehabilitation. Although the underlying mechanisms are not yet clear, it is evident that motor imagery, observation and execution rely on the same neural processes. Future research should pay particular attention to the role of the primary motor cortex in covert action representation processes and in motor recovery. Furthermore, it has been shown that neural reorganization may take place in a similar manner as would have occurred following physical practice.

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