

Effects of Mirror Therapy (MT) and Modified Constraint Induced Movement Therapy on Improvement of Hand in Stroke Survivors: A Comparative Study

Miss. Prangya Paramita Paitial¹, Mr. Ramakumar Sahu²

¹Occupational Therapist, Department of Occupational Therapy, Swami Vivekanand National Institute of Rehabilitation Training & Research Olatpur, Bairoi, Cuttack, Odisha, India

²Lecturer, Department of Occupational Therapy, Swami Vivekanand National Institute of Rehabilitation Training & Research Olatpur, Bairoi, Cuttack, Odisha, India

ABSTRACT

INTRODUCTION: CVA is a complex dysfunction caused by a lesion in the brain. The WHO defines stroke as an “acute neurologic dysfunction of vascular origin with symptoms and sign corresponding to the involvement of focal areas of the brain.” In India the cumulative incidence of stroke ranged from 105-152/100000 persons per year, and the crude prevalence of stroke ranged from 44.29-559/100000 persons in different parts of the country during the past decade.

DESIGN: Convenient sampling method.

SETTING: Inpatient and outpatient of Department of Occupational Therapy, SV.NIRTAR, Olatpur.

PARTICIPANTS: A total of 30 stroke survivors with 15 in each group, A group (Mirror Therapy and Conventional OT), B group (modified constraint induced therapy with Conventional OT).

INTERVENTIONS: Treatment duration for both the groups is same. Each group receives occupational therapy intervention for 4 weeks, 5 sessions (each session will be 50 minutes) in a week. In group A subjects received 20 minutes of mirror therapy and group B subjects received 20 minutes of modified CIMT for 20 minutes respectively in addition to 30-minutes of conventional occupational therapy.

OUTCOME MEASURES: Action Research Arm Test

RESULT: The current study has shown that there is no significant difference improvement of hand function in mirror therapy with conventional occupational therapy and mCIMT with conventional occupational therapy.

CONCLUSION: The applications of Mirror therapy with conventional occupational therapy as well as mCIMT with conventional occupational therapy are equally effective on functional recovery of hand in stroke survivors.

KEYWORDS: mCIMT, Mirror Therapy, Stroke survivors

INTRODUCTION

CVA is a complex dysfunction caused by a lesion in the brain. The WHO defines stroke as an “acute neurologic dysfunction of vascular origin with symptoms and sign corresponding to the involvement of focal areas of the brain.” In India the cumulative incidence of stroke ranged from 105-152/100000 persons per year, and the crude prevalence of stroke ranged from 44.29-559/100000 persons in different parts of the country during the past decade. Stroke is the third leading cause of mortality in United States after cardiovascular disease and cancer, accounting for 10% to 12% of all deaths. An estimated 550,000 strokes occur each year, resulting in 150,000 death and more than 300,000 individuals with significant disabilities.

Sequel of stroke are often disabilities and global involvement interferes significantly with Activities of Daily Living (ADLs). Over 85% of stroke patients undergo hemiplegia and more than 69% among them experience functional motor disability of the upper extremities. Functional motor disability noticeably appears in the upper extremities rather than in the lower extremities. The most common stroke related disorders are manifested as hemiplegia, imbalance, in-coordination and spasticity which are especially seen in upper extremities. The upper limbs (UL) are very important to motor functionality and the effective handling, gripping and reaching capability required in most ADLs. Arm functions are impaired in 73-88% of CVA survivors, and 55-

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75% of them present hemiplegia, resulting in disabilities and restrictions to function.

Middle cerebral artery, supplies much blood to the brain part which are responsible for the motor functions of the upper extremities and the hands. So, damage to middle cerebral artery may affect the function of the upper extremity and hand. Slight recovery of the lower extremities enables functional gait, whereas in the recovery of upper extremity functions, recovery of minute functions (e.g., grasp and manipulation) and that of the distal parts is needed. As a result, the upper extremities look like they have recovered less than the lower extremities. Lang et al. noted that upper extremity motor disability significantly affects stroke patient's performance of activities of daily living, such as having a meal, wearing clothes, or washing one's face. Purposeful movements of the upper extremities require adjustment of the arms and hands, and stroke patients may extend the upper extremities after a stroke but have difficulty in grabbing objects, with considerably reduced manipulation ability and decreased ability to perform purposeful movements. The upper extremity functions of stroke patients play an important role in performing activities of daily living and in coming back to society; as a result, upper extremity functions have been emphasized as an important element in humans.

Neuroscience and brain science have developed dramatically over the last century, and methods of rehabilitation have been influenced by changes in scientific paradigm. Various new types of rehabilitation therapies have been introduced in the field of neuroplasticity and brain mechanisms. One of the popular rehabilitation intervention for the upper body function following stroke is mirror therapy, which is based on the concept of Ramachandran's synesthesia phenomenon in phantom limbs.

In mirror therapy, a hemi-paretic patient is asked to move the unaffected limb while watching the moving limb being reflected in the mirror. In this therapy, though paralyzed limb does not move behind the mirror, the congruent visual feedback through the mirror affects brain lesion and motor related areas on the affected side. Mirror therapy has been applied to many stroke populations and been found to facilitate motor recovery in randomized clinical trials. Many studies have also reported biomechanical recovery and functional recovery in ADLs following mirror therapy.

CIMT, another type of traditional rehabilitation therapy, was first developed by Taub et al. in 1993. This technique prompts the use of the affected arm by limiting the use of unaffected side with a sling or splint. Although there are time and resource limitation associated with CIMT, it has been adopted as the best clinical practice. Recently various types of modified version of CIMT have been introduced to minimize the limitation of traditional CIMT. The intention to move the paralyzed extremities on rehearsal of planning to execute the movement were activated during therapy session.

Many studies have reported that mCIMT improves upper extremity function and ADL performance. In this study, we applied mCIMT to stroke patients. A resting hand splint was applied during the session in order to minimally constrain

the use of the unaffected arm. The procedure was based on Smania's protocol.

The main difference between mirror therapy and mCIMT is the part of extremity engaged in the rehabilitation exercise. In mirror therapy the unaffected arm is moved and the patient receives only visual feedback from the mirror. However in mCIMT, the unaffected arm is restrained and the affected arm is voluntarily engaged even though the arm itself is not effectively moved. At most, the intention to move the paralyzed arm is activated. There is no doubt that the two types of rehabilitation facilitate motor function recovery. Both mCIMT and mirror therapy have been shown to experience improvement in upper extremity function and performance of ADL respectively.

To further the level of understanding in the field of stroke rehabilitation in this study an attempt has been taken for investigating whether changes in upper extremity function directly impact improvement in ADL performance by comparing mCIMT and mirror therapy group.

AIMS AND OBJECTIVES

AIM:-

- To evaluate and compare the effect of Mirror therapy and mCIMT on improvement of UE function in post stroke survivor.

OBJECTIVES:-

- To find out the effectiveness of mirror therapy on improvement in sub-optimally functioning UE in post stroke survivor.
- To find out the effectiveness of mCIMT on improvement in sub optimally functioning UE function in post stroke survivor.

HYPOTHESIS

EXPERIMENTAL HYPOTHESIS:-

- The Mirror therapy is more effective than mCIMT in improvement of UE function in post stroke survivors.

NULL-HYPOTHESIS:-

- Mirror therapy and mCIMT are equally effective in improvement of UE function in post stroke survivors.

METHODOLOGY:-

Study Location: Occupational Therapy Department, SV.NIRTAR.

Study Population: Stroke Survivor

Study Duration: 4weeks

Sample Size: 30 stroke survivor

Sample Design: Convenient sampling method with randomly allocation of stroke survivor recruited from DOT. Subjects are randomly allocated into 2 groups having 15 each. Sample design (AA-AB)

AA-1st group: Conventional with mirror therapy.

AB- 2nd group: Conventional with mCIMT.

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

INCLUSION CRITERIA:-

1. Medically diagnosed cases of stroke
2. Post stroke duration of at least 6 months
3. Both male and female subjects are selected
4. Age group 40 yrs to 60 yrs
5. Able to grip objects with paralyzed arm.
6. Wrist extension >20, MCP joints >10 (Taub et al., 1993)
7. Interested in participating in the study.

EXCLUSION CRITERIA:-

1. Modified Ashworth Scale – 2 and 3
2. MMSE < 21
3. Presence of accompanying disorders such as seizure, psychological disorders, hearing or visual problem, or orthopedic disorders in upper extremities
4. Reflex Sympathetic Dystrophy
5. Severe Shoulder Subluxation

OUTCOME MEASURE: Action Research Arm Test

PROCEDURE:-

1. Informed consent (Annexure - I) was obtained from all participants.
2. Based on the inclusion criteria, 30 medically diagnosed stroke survivors was selected for the study and subjects was excluded based on the presence of other pathologies as found from the medical report and exclusion criteria.
3. A general evaluation (Annexure - II) was done including demographic data, history and functional outcome measures of stroke survivors.
4. As per baseline assessment by outcome measures the stroke survivors were allocated into 2 groups, having 15 in each, randomly using random number table for the study.
5. Each group receives intervention for 4 weeks, 5 sessions (each session will be 60 minutes) in a week.
6. After 4week of intervention, a posttest was done using both outcome measures to know whether any improvement is there or not.

INTERVENTION

Treatment duration for all three groups is same. Each group receives occupational therapy intervention for 5 times a week, 60 min a session and for 4 weeks. Subjects will receive 20-minutes of Mirror therapy and mCIMT respectively in addition to 20-minutes of ADL training and 20-minutes conventional occupational therapy.

1st group: Conventional OT with Mirror Therapy

➤ **Conventional occupational therapy includes:-**

- Muscle stretching
- Positioning
- Facilitating normal patterns of movement
- Facilitator and inhibitory techniques
- Reflex inhibitory patterns
- Facilitating higher level reflexes
- Muscle tone normalization
- ADL training

Mirror Therapy

- The intervention was conducted within the regularly scheduled occupational therapy sessions.
- During the MT training, patient will sit close to a table on which a mirror is placed vertically.
- Affected upper limb will place behind the mirror and the unaffected upper limb will place in front of the mirror.
- Patients will orient to watch the reflection of their normal hand on the mirror as it is the affected one, and to perform activities bilaterally.
- Then participants will instruct to look at the reflection of the unaffected hand in the mirror as if it were the affected hand and perform bilateral symmetrical movements as much as possible.
- The activities consisted of
 - Transitive movements, such as fine motor tasks of squeezing sponges, placing pegs in holes, or flipping a card,
 - Gross motor tasks of reaching out to touch a switch or keyboard, and
 - Intransitive movements, including the distal part movement of wrist repetitive extension-flexion or finger opponent and the proximal part movement of forearm pronation, supination.

2nd group: Conventional OT with mCIMT

➤ **Conventional occupational therapy includes:**

- Muscle stretching
- Positioning
- Facilitating normal patterns of movement
- Facilitator and inhibitory techniques
- Reflex inhibitory patterns
- Facilitating higher level reflexes
- Muscle tone normalization
- ADL training

➤ **mCIMT include:-**

Movements on shoulder, elbow, forearm, fingers joint on the affected side guided by the therapist were performed. Repetitive training was focused on muscle strengthening, gross motor exercise, and fine motor exercise. To discourage the use of unaffected hand outside of the therapy sessions, subject wore a padded mit.

➤ **Activities Include:**

For muscle strengthening:

- Theraband pulling
- Grip power
- Therapeutic putty

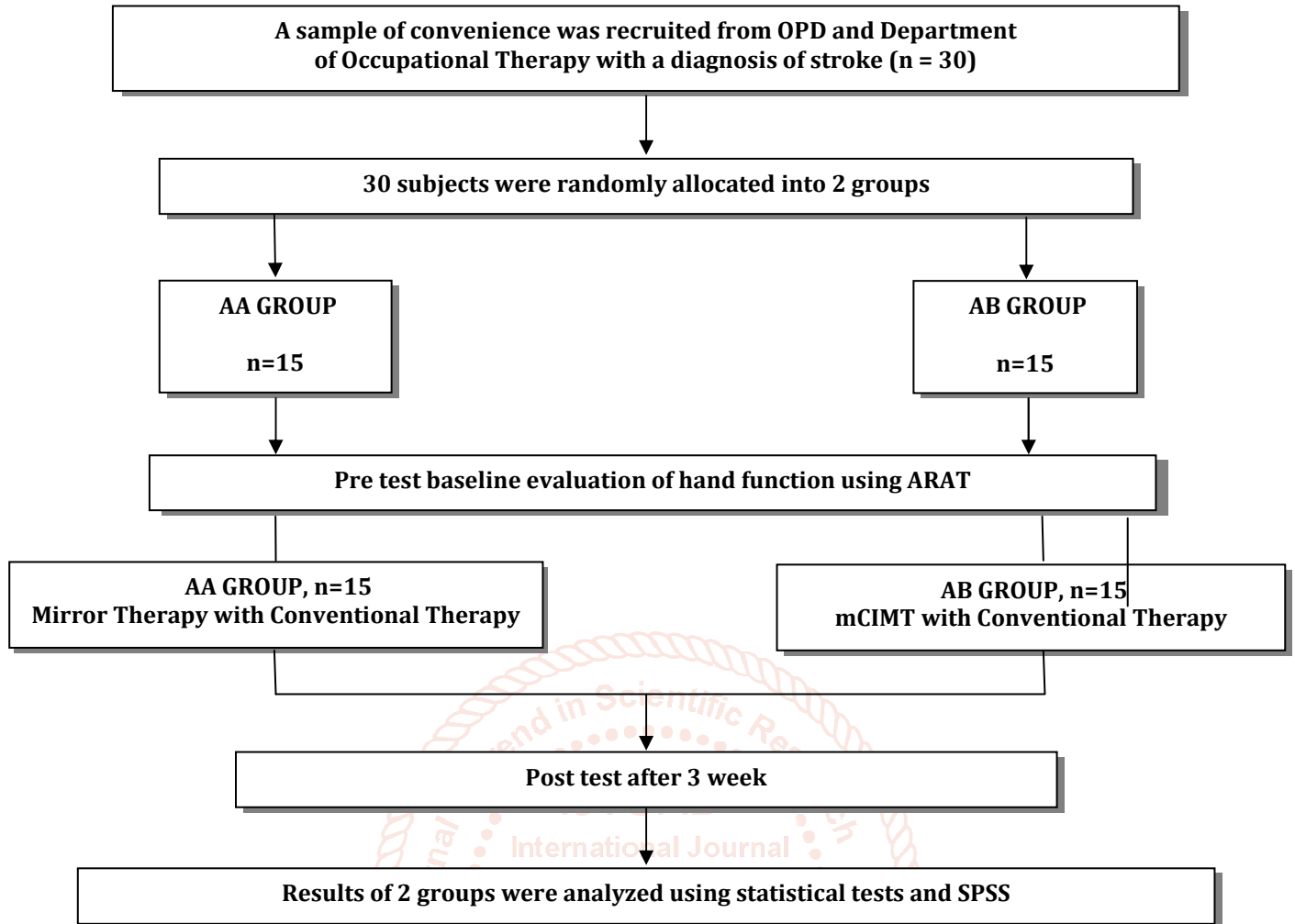
For gross motor exercise:

- Shoulder Wheel
- Throwing and catching the ball
- Peg-board lifting and shifting

For fine motor exercise:

- Chess board activity
- Not bolt

FLOW CHART



STATISTICAL ANALYSIS

- SPSS version-25 was used for statistical analysis.
- **Wilcoxon Signed rank test** was used for within group analysis for non parametric data.
- **Mann Whitney ‘U’ test** was used for the between group analysis for non parametric data.
- Level of significance was set at $p < 0.05$ with 95% confidence interval.

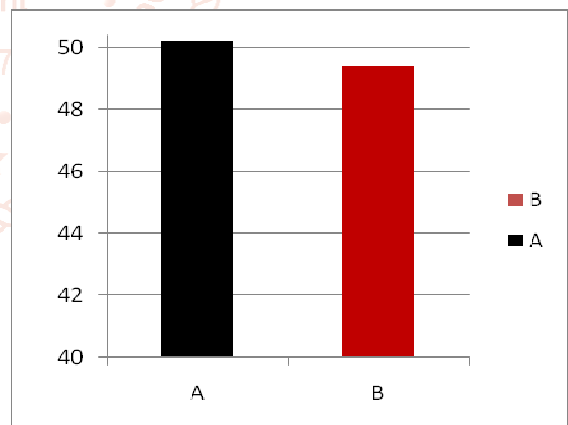
RESULTS

DEMOGRAPHIC STATISTICS

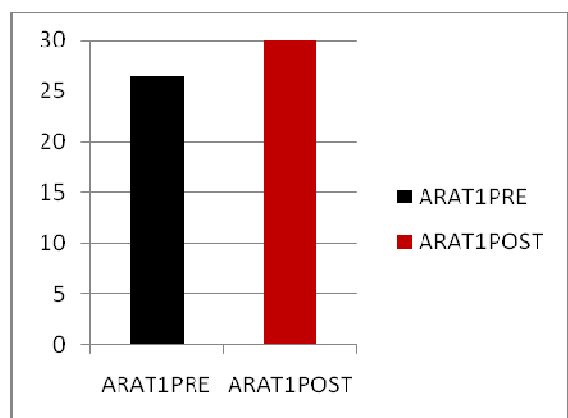
A total number of 30 subjects with stroke were enrolled in the study and all completed the study with 15 subjects each in 2 groups, ‘A group’ and ‘B group’. The mean age of the subjects in group A was 50.20 years (SD ± 5.88) and in group B was 49.40 years (SD ± 6.73). Total participant characteristics are shown in table No.1. Mean age and ARAT score of both the groups are shown in Graph 1 & 2.

SL. NO.	BASELINE CHARACTERISTICS	A GROUP	B GROUP
1	No. of subjects	15	15
2	Age range	40-60	40-60
3	Mean age (SD)	50.20 (±5.88)	49.40 (±6.73)
4	Sex ratio (M : F)	7:8	8:7

Table 1 Demographic characteristics of stroke survivors in Group A and B



Graph1. Mean of Age in Group ‘A’ and ‘B’



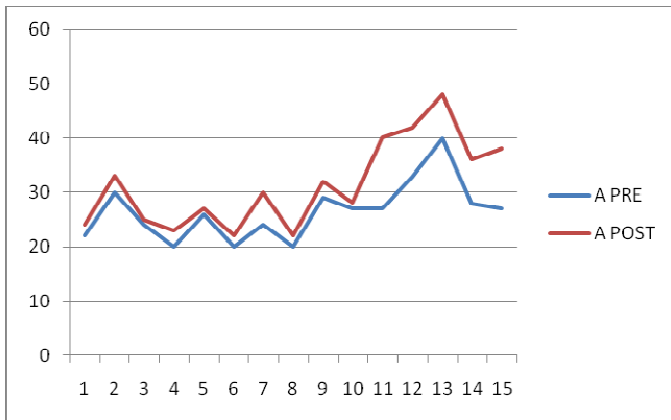
Graph2. Mean of ARAT (Pre-test) Score in Group ‘A’ and ‘B’

DESCRIPTIVE ANALYSIS:-

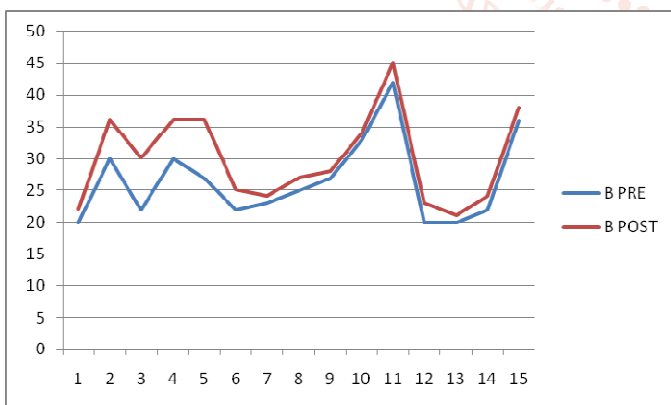
ARAT scale shows significant improvement in hand function in stroke survivor in both the groups (A and B) having $p < 0.05$ within the group analysis by using Wilcoxon on Sign Rank Test. Pre test and Post test were done by using the ARAT scale. **Table - 2** below shows significant improvement in hand functions within ARAT pretest (26.46 ± 5.38) and ARAT posttest (31.33 ± 5.04) in group A. The group B shows significant improvement in hand function ARAT pretest (26.6 ± 6.54) and ARAT posttest (29.93 ± 7.15). This result shows that the improvement in hand function at posttest in both the groups as compared to pretest. This is graphically represented in **Graph - 3 & 4**.

GROUP	TEST	MEAN (SD)	z VALUE	p VALUE
A	PRE	26.46 (± 5.38)	-3.417	.001
	POST	31.33 (± 8.04)		
B	PRE	26.6 (± 6.54)	-3.425	.001
	POST	29.93 (± 7.15)		

Table2: Within group analysis of both the Groups "A" and "B"



Graph 3: Graph showing comparison of pre and post test of group 'A' using ARAT scale

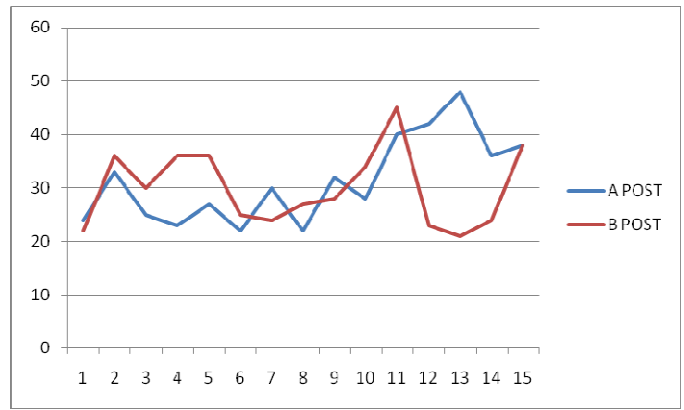


Graph 4: Graphical presentation of mean value of pre and post reading of group 'B' using ARAT scale

In **Table - 3** between group analysis of ARAT scale showed no statistically significant difference between A and B on post test ($p = .653$). The graphical interpretation was shown in **Graph - 5**.

GROUP	MEAN (SD)	z VALUE	p VALUE
A	31.33 (± 8.04)	-.457	.653
B	29.93 (± 7.15)		

TABLE 3: In between group analysis of post ARAT study of group 'A' and 'B'



Graph 5: Graph showing comparison post test of both group 'A' and 'B' using ARAT scale.

DISCUSSION

The purpose of the present study was to determine the effects of 4 week of Mirror Therapy with conventional occupational therapy and Modified Constraint Induced Movement therapy with conventional occupational therapy on improvement of hand function in post stroke survivors and to compare whether any of these interventions is more effective over the other.

The findings of the present study revealed that both mirror therapy group and modified constraint induced movement therapy group improved the ARAT score, improved the functional outcome, which says that both the treatment programmes were effective in improving the hand function in post stroke survivors.

Comparison of pre and post-test ARAT score in group A (Mirror Therapy with Conventional Occupational Therapy)

The result of within group analysis shows that there is statistically significant improvement in upper extremity and hand function after the therapy. ARAT scores after 4 weeks $p = .001$ having mean value pre-test (26.46 ± 5.38) and post-test (31.33 ± 8.04) suggesting that there is satisfactory improvement in hand function after the implementation of MT with the conventional therapy.

Similar findings are also reported by **M. Invernizzi (2013)** on adding the mirror therapy for upper limb motor recovery of sub acute stroke patient which was a randomized controlled trial and he found significant improvement of upper extremity function by adding the mirror therapy to the conventional therapy. He suggested that it was a promising and easy method to improve motor recovery of upper limb in post stroke survivor.

In 2015, **Snehal Narsinha Waghavkar** studied on effectiveness of mirror therapy on improvement of hand function on post stroke survivor and he reported that mirror therapy provides a simple and cost effective therapy for wrist and hand motor recovery in acute and sub-acute stroke patient.

Gunes Yavuzer et al. did a study on 36 patients with sub acute stroke which showed improvement in hand functions in the form of functional independence measure (FIM) score after Mirror therapy in addition to a conventional rehabilitation program compared with a control treatment directly after 4 weeks of treatment ($p = 0.01$) and at the 6-

month follow-up ($p=0.01$), whereas Mirror therapy did not affect spasticity ($p=0.904$).

Mirror therapy is a promising tool which can promote motor recovery, mobility, muscle strength, dexterity and functionality after stroke. It provides proper visual input that substitute for the often decreased or absent proprioceptive input.

Mirror therapy is a motor imagery which may modulate central mechanisms of motor recovery and neural plasticity. The motor cortex can be modified with repeated muscle activity, supporting the neural plasticity concept. Mirror therapy is one of the new approaches. The movements in front of a mirror are thought to trigger neuronal connections in the relevant motor cortex and functional magnetic resonance images (fMRI) have supported this hypothesis.

Altschuler et al. suggested that mirror therapy provides a visual input regarding the normal movement of the affected arm and this may compensate for decreased or lost proprioceptive input. **Stevens** and **Stoykov** have defined mirror therapy as some type of visually managed motor illusion where the movement is performed mentally without a clear application.

In case of stroke the paralyzed side is neglected by the patient. Unilateral neglect is caused by the lesion of the inferior parietal lobe is an important occurrence. The behavioral impact of observed in stroke cases is that there is a progressive disuse of neglected side. Subsequent to this motor praxis and neural anagrams are deleted by the brain. Mirror therapy keeps the paralytic neglected arm in active consciousness so that strategy to use that side constantly undergoes revision. So, Mirror therapy improves active regard towards the limb. Although the session fixed for Mirror therapy is short duration comparing to the number of hours the patient remains alert, it may be proposed that beyond the session of therapy the patient flashes the active use of paralytic site as impressed during therapy.

Hence the therapy of active involvement may be pulled to reason out the result.

Comparison of pre and post-test ARAT score in group B (mCIMT with Conventional Occupational Therapy)

The result of within group analysis shows that there is statistically significant improvement in upper extremity and hand function after the therapy. ARAT scores after 4 weeks $p=.001$ having mean value pre-test (26.6 ± 6.54) and post-test (29.93 ± 7.15) suggesting that there is satisfactory improvement in hand function after the implementation of mCIMT with the conventional therapy.

Similar findings are also reported by **Changshen Yu** (2017) to know the effect of mCIMT on post stroke survivor. It was a randomized controlled trial, the application of mCIMT after stroke result in beneficial effects on motor function of upper extremity in stroke survivor.

Wei-ming ZHANG on 2015 took 60 participants from which 30 took in control group and other 30 receives mCIMT. Modified CIMT has positive therapeutic effects on motor function of limbs in hemiplegic patients with stroke which improves the ability of daily life so as to raise the quality of

life. The efficacy of mCIMT is superior to general routine rehabilitation treatment.

Patients in the mCIMT group tried to move their affected arm with constraint of the unaffected arm. The attempt to execute movement leads to reorganization of motor areas in the brain, resulting in motor skill improvement and higher performance on ADLs.

The execution of motor processes, from merely attempting to move the affected arm to actually moving the affected arm, is helpful in the performance of daily tasks. These findings imply that it is the performance of whole motor actions, rather than increased mechanical muscle function, that is of clinical importance.

Comparison of post-test ARAT score in group A and B (Mirror Therapy Vs mCIMT)

The result of between group analysis shows that there is no statistical significant difference in improvement of hand function in both the group post-test $p=.653$. Although individually they are showing significant improvement but while comparing to know which one is better it is not showing significant difference.

mCIMT is a modified version of CIMT in which duration of implementation of constraint reduced and this therapy protocol is already established through many studies. Mirror therapy is completely based of the brain mechanism in which the unaffected arm is working instead of affected one. From my study i concluded that mirror therapy also can used with conventional therapy instead of modified CIMT as both of them are showing equal effectiveness in improvement of hand function in post stroke survivor.

CONCLUSION

In this clinical trial, our findings suggest no significant difference in improvement of functional recovery of hand in stroke survivors when mirror therapy with conventional occupational therapy and mCIMT with conventional occupational therapy are given.

On the basis of the current results, it was also concluded that, individually the mirror therapy with conventional occupational therapy as well as mCIMT with conventional occupational therapy showing a noticeable better effects on paretic hand function.

Though the present study has a few limitations which could be further suggests for future study programmes however, it clarifies the equality of importance of modified CIMT and Mirror therapy.

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