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A Study on Effectiveness of Mirror Therapy on Grip and Release Function of Hand in Sub acute Stroke Patients

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ABSTRACT

Background and Purpose: The impairment of hand function is one of the most significant hurdles to independence after a stroke, necessitating the use of novel procedures and tactics aimed at boosting the functional recovery of motor skills after a stroke. A newer technique known as "mirror therapy" is said to alter neuroplasticity and is simple to implement. As a result, the purpose of this study is to see how well mirror therapy improves hand function in persons who have had subacute stroke.

Methodology: Ethical clearance was obtained from institutional ethical committee. Subjects fulfilling the inclusion and exclusion criteria were included and informed consent form was taken from each prior to the treatment. A sample of 42 subjects within the age group of 40-60 years with sub-acute stroke were recruited in the study and were treated with Mirror therapy and conventional therapy. Pre and post intervention tests were assessed for Grip and release function of hand using Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) and Wolf Motor Function Test (WMFT) measures.

Results: The study of pre and post intervention data revealed that the Mirror group improved significantly in hand function. At the post-test, participants demonstrated considerable improvement in FMA-WH and WFMT-WH. FMA-UE rose from 38.57 to 48.14 (p=0.000), while WMFT from 2.38 to 4.8 (p=0.000).

Conclusion: The preliminary data indicate that Mirror therapy can be a valuable intervention to enhance patient rehabilitation; it provides a simple and cost-efficient therapy for wrist and hand motor recovery and improves grip and release function in subacute stroke patients.

Keywords: Stroke; FMA-UE; WMFT; Mirror therapy.

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INTRODUCTION

A stroke is stated as a sudden neurological incident driven on by diminished blood flow to the brain. Brain clots prevent blood from flowing properly, obstructing arteries and causing blood vessels to burst, which causes bleeding. The abrupt death of brain cells due to a lack of oxygen

occurs when the arteries leading to the brain are ruptured during a stroke.[1]

Prior to the publication of the International Classification of Diseases 11 (ICD-11) in 2018, stroke was categorized as a blood vessel illness. The actual nature and significance of stroke were finally acknowledged in the ICD-11 after persistent advocacy from a group of doctors; stroke was re-categorized within the neurological chapter.[2] Hemorrhagic (bleeding) stroke and thrombotic (ischemic) stroke are the two main classifications of stroke syndrome.[3] Hemorrhagic stroke is spurred on by bleeding or blood vessel leaks, whereas ischemic stroke is spurred on by insufficient blood and oxygen delivery to the brain.[1] Stroke clinical staging is generally regarded as follows (Cramer, 2008; Rehme *et al*., 2012; Zhao *et al*., 2014): The acute stage lasts two weeks; the subacute period lasts three to eleven weeks, during which most changes occur; the early chronic stage lasts 12 to 24 weeks, and the chronic stage lasts longer than 24 weeks.[4]

Given that the population is already surviving through the peak years (age 55–65) for the occurrence of stroke or cerebrovascular accident (CVA), India will soon have to shoulder a significant socioeconomic load due to the expenditures of the rehabilitation of stroke survivors. Crude prevalence rates for stroke (suspected to be of vascular origin) range from 90 to 222 per 100,000 people, according to community surveys from several locations.[5]

Since India's life expectancy has lately risen to nearly 60 years old, age-related, non-communicable diseases like stroke have become more prevalent, making them the country's fourth major cause of death and fifth leading cause of disability. According to previous studies, the annual crude incidence of stroke ranged from 108 to 172/100,000 people, the annual crude prevalence from 26 to 757/100,000 people, and the annual crude case fatality rates from 18% to 42%.[6]

The predicted number of incident stroke cases in India in 2019 was 129 million (95% UI 115-145), while the expected number of stroke related fatalities was 699 000 (95% UI 594 000-807 000). In 2019, there was a 55 times difference in the crude stroke DALY rate amongst the states, with West Bengal having the highest rate, followed by Chhattisgarh and Tripura.[7]

Hemiplegic upper extremities can be a significant factor in stroke patients' inability to perform daily life tasks (ADL). Promoting motor recovery of the arm and hand functions rather than the lower extremities for the patient after a stroke is the main goal for rehabilitation doctors.[8]

It is commonly accepted that arm movement recovery is less than leg movement recovery. However, rather than using tests to identify specific motor deficits of the upper and lower extremities, this clinical paradigm frequently relies on measures of disability. Even with severe motor impairment in the lower extremity (severe impairment but minimal disability), a person may still be able to walk normally. It would be predicted that there would be less of a difference between impairment and disability because the upper extremity's function calls for finer motor control.[9]

Skillfull control of prehensile finger forces is required for grasping and object handling activities to be completed successfully. Grip forces in healthy individuals are controlled to be just a little bit higher than what is necessary to keep the object from slipping. According to the object's shape, surface friction, and weight distribution, this safety margin is calculated. The grip force is continuously adjusted when the hand moves through space (lifting, transporting, placing objects), proportionate to the load forces associated with the mass and acceleration of that object. It is thought that anticipatory sensorimotor control is characterised by this temporal connection between grip and load forces. A failure in the timing and amplitude of grip force modifications may result from disruptions to motor planning, volitional motor control, or somatosensory feedback.[8]

Muscle weakness, stiffness, contractures, and a decreased ability to independently regulate the joints are the main deficits noted in the hemiparetic upper extremities. The ability to execute activities of daily living (ADL) is hampered by these disabilities. Making judgements on the type, length, and objectives of an effective rehabilitation requires evaluating early indicators for hand dexterity. The main approaches for restoring the best hand function in stroke patients are early, individualized rehabilitation therapies.[10]

Hemiparesis sufferers often show spasticity, muscle weakness, and a continual deficit in movement coordination. The neuronal circuitry that mediates an action intention and a performed action that perfectly reflects that purpose is no longer intact either as a result of brain injury or owing to acute disuse, which contributes at least in part to this lack of coordination.[11]

Repetition of actions is how traditional stroke rehabilitation methods deal with this incompatibility. It is hoped that regular physical

exercise will enhance motor function, enabling fluid and regulated movements to happen and serving as models for the brain to use in re-establishing the neural pathways that control voluntary movement. This method's dependence on a damaged limb's performance is one of its drawbacks.[12]

Mirror treatment was developed by Vilayanur S. Ramachandran to assist alleviate Phantom limb pain, which occurs when patients believe they still have pain in a limb after having it amputated.[13]

Mirror therapy has been proposed as a straightforward, low-cost, and most crucially, patient-directed treatment that enhances upper-extremity function.[14]

The Fugl-Meyer evaluation - Upper Extremity (FMA-UE) is a stroke-specific evaluation that examines performance in the domain of body function/impairment.[15] It scores 33 items on an ordinal scale for the upper limb, for a total possible score of 66. The FMA-UE is a popular quantitative measure of motor disability following a stroke. Excellent inter- and intra-rater reliability, as well as concept validity, have been proven, and data suggests that the FMA-UE is change responsive.[16] A greater than 6 score change for improvement of overall upper limb function in chronic stroke has been found as the lowest clinically relevant difference for the FMAUE.[17] The FMA manual (version 7) developed by Dr. Steven Cramer's group at the University of California, Irvine is used at each site.[18]

The Wolf Motor Function Test (WFMT) is a popular evaluation tool in subacute and chronic stroke rehabilitation research. It assesses upper limb function in the context of activity.[16] The WMFT consists of 15 timed activities and two strength tasks. A 6-point functional ability measure is used to assess movement quality, with scores ranging from zero (does not attempt) to five (normal movement).[19] The highest possible score is 75. The performance time for 15 activities is recorded, and the maximum time permitted to finish each job is 120 seconds. A dynamometer is used to measure strength. The WMFT has strong inter-rater reliability, great test-retest reliability, moderate construct validity, and responsiveness evidence.[20]

For manual environmental exploration and manipulation, functional hands are essential. One of the biggest barriers to independence after a stroke is the impairment of hand function, which makes it necessary to use fresh methods and strategies aimed at enhancing the functional recovery of motor skills after a stroke. Simple, quick, affordable, patient directed, and efficient treatment methods are required to speed up recovery after a stroke. A more recent method known as "mirror therapy" is supposed to influence neuroplasticity and is easy to use. Therefore, the goal of this study is to assess how well mirror treatment improves hand function in people who had subacute strokes.

Research Question

Is there any effect of Mirror therapy on improving grip and release function of hand in patients with sub-acute stroke?

Hypothesis

Null hypothesis (H_0)

There will be no significant effect of Mirror therapy on grip and release function of hand in sub-acute stroke patients.

Alternate hypothesis (H_1)

There will be significant effect of Mirror therapy on grip and release function of hand in sub-acute stroke patients.

OBJECTIVES OF THE STUDY

To summarise the effectiveness of mirror therapy for improving hand function in sub-acute stroke patients.

To summarise the effectiveness of mirror therapy for improving grip and release function of hand in sub-acute stroke patients.

Institutional Ethical clearance was obtained. This interventional study was carried out in a period of 12 months. The subjects were screened for inclusion and exclusion criteria and those who met the given criteria were recruited for studywere given patient information sheet containing the study details and informed consent. The sample size 42 was estimated. The purposive sampling method was used to include participants in Study. Total 42 subjects were included in this study and they were randomly assigned into two groups, 21 in experimental group (Group A) and 21 in control group (Group B). Experimental group subjects received mirror therapy whereas control group received normal conventional therapy. Subjects in both the experimental and control groups received the standard-of-care, multidisciplinary rehabilitation intervention based on their requirements and tolerability, with the experimental group receiving MT for an additional

30 minutes.

Group A Mirror Therpy

For 40 minutes, the experimental group received mirror therapy with functional tasks with both hands. All subjects in group were evaluated using outcome measures and had a pretest before the intervention, i.e., on the 0 day, as well as a post-test after 6 weeks of intervention. The subjects were trained or instructed how to perform MT, and they were shown the specified exercises with demonstration and were asked to do three days a week for six weeks. The subjects will have access to the exercise aid. A mirror will be set at a perpendicular angle on the table, with its reflecting surface facing the non-paretic limb.

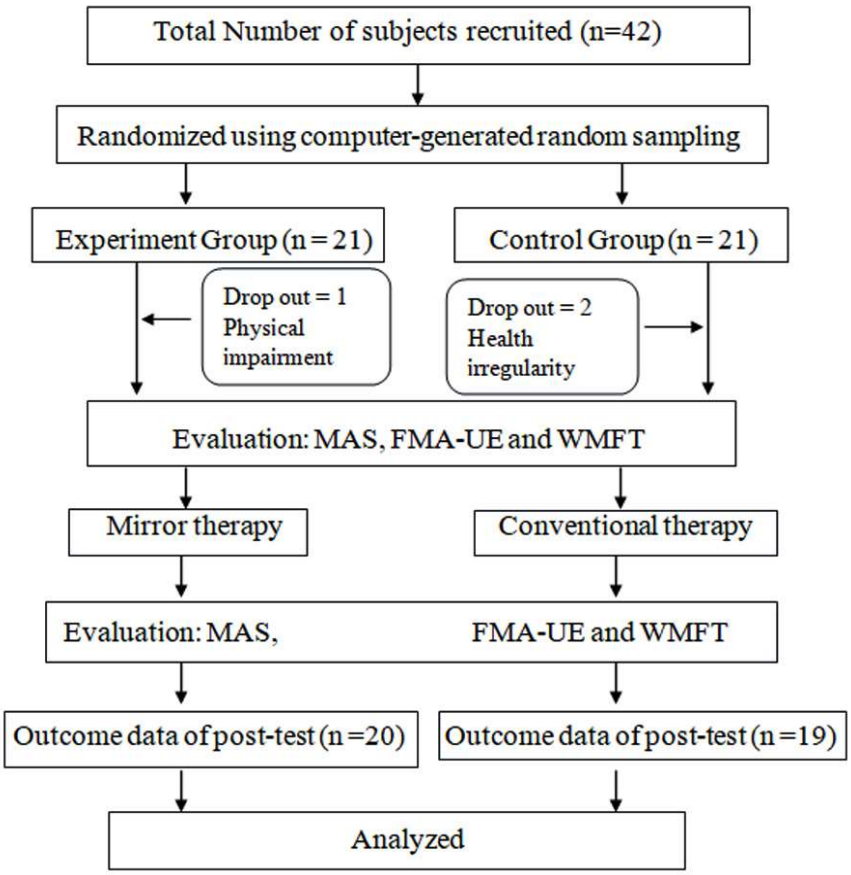
The participants in the MT group were taught to do the actions while looking in the mirror on the non-paretic side. Each action will be performed for ten repetitions with 2-3 sets (depending on patient tolerance) with a 2-minute break between sets. For a total of 40 minutes every session, 3 days a week for 6 weeks.[21]

Group B Conventional Therapy

For 40 minutes, the control group received conventional therapy with functional tasks with both hands without a mirror. All subjects in group were evaluated using outcome measures and had a pretest before the intervention, i.e., on the 0 day, as well as a post-test after 6 weeks of intervention. The subjects were asked to perform the exercises specified with demonstration and should continue three days a week for six weeks.

The participants in the CT group were taught to do the actions. Each action will be performed for ten repetitions with 2-3 sets (depending on patient tolerance) with a 2-minute break between sets. For a total of 40 minutes every session, 3 days a week for 6 weeks.

The level of upper limb motor impairment and functional performance are the major outcome measures of interest. The Fugl-Meyer Assessment-Upper Extremity (FMA-UE) and the Wolf Motor Function Test (WMFT) will be used to assess these factors. Both the FMA-UE and the WMFT are



Flow diagram of the progress through the phases of the study

reliable and accurate outcome measures that are widely utilised in MT research.

RESULTS AND DATA ANALYSIS

Statistical Analysis

IBM SPSS statistics 29.0.0.0 version was used to analyse the data in this study. The categorical variables are presented as frequency and percentage.

Table 1 & Fig. 1: Mean, Standard Deviation and Standard Error of Mean for Pre-test and Post-test scores of the subject i.e., Mirror Therapy Group-A and the Conventional Therapy Group-B

Paired Samples Statistics					
			Mean	SD	Standard Error Mean
Group - A	FMA-UE	Pre-Test	38.57	4.11	0.8986
		Post-Test	48.14	2.95	0.6447
	WMFT	Pre-Test	2.38	0.92	0.2009
		Post-Test	4.80	0.92	0.2025
Group - B	FMA-UE	Pre-Test	39.04	6.60	1.4416
		Post-Test	38.33	4.45	0.9718
	WMFT	Pre-Test	2.47	0.92	0.2025
		Post-Test	2.80	0.81	0.1775

The FMA-UE, the post mean value of group – A is 48.1428 increased, and in case of WMFT the post mean value is 4.8095 is increased after MIRROR THERAPY.

FMA-UE of Group-B, the post-test value 38.3333 is decreased slightly followed by the WMFT the post mean value 2.8095 is increased slightly compare to corresponding pre-test score after giving CONVENTIONAL therapy.

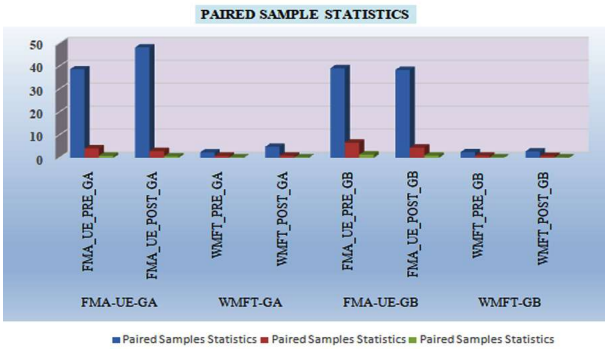


Table 2: Paired t-test between Pre-test and Post-test scores of the subject i.e., Mirror Therapy Group-A and the Conventional Therapy Group-B

Paired Samples Test							
		Paired Differences			t	P-Value	Significance
		Mean	Std. Deviation	Std. Error Mean			
Group - A	FMA-UE	Pre-Test	-9.5714	5.5006	1.2003	-7.9739	0
	WMFT-GA	Post-Test	-2.4285	1.4342	0.3129	-7.7594	0
Group - B	WMFT	Pre-Test	0.7142	4.1126	0.8974	0.7958	0.4354
	WMFT-GB	Post-Test	-0.3333	0.5773	0.1259	-2.6457	0.0155

There is a significant difference between Pre and the Post test scores of Mirror Therapy i.e., in Group-A, but in case of Conventional Therapy in Group-B, there is no significant difference between pre and the post test scores i.e., FMA/WMFT

The post mean value of FMA-UE-GA (MIRROR THERAPY) is 48.1428 increased and also in WMFT-GA the post mean value 4.8095 is increased when compare to CONVENTIONAL THERAPY.

Table 3 & Fig 2: Mean, Standard Deviation and Standard Error of Mean of Post-test scores for between the Groups A &B of the subject i.e., Mirror Therapy Group-A and the Conventional Therapy Group-B

Paired Samples Statistics				
Post-test Analysis		Mean	SD	Std. Error Mean
FMA-UE-A vs. B	Group A	48.1428	2.9544	0.6447
	Group B	38.3333	4.4534	0.9718
WMFT-A vs. B	Group A	4.8095	0.9283	0.2026
	Group B	2.8095	0.8135	0.1775

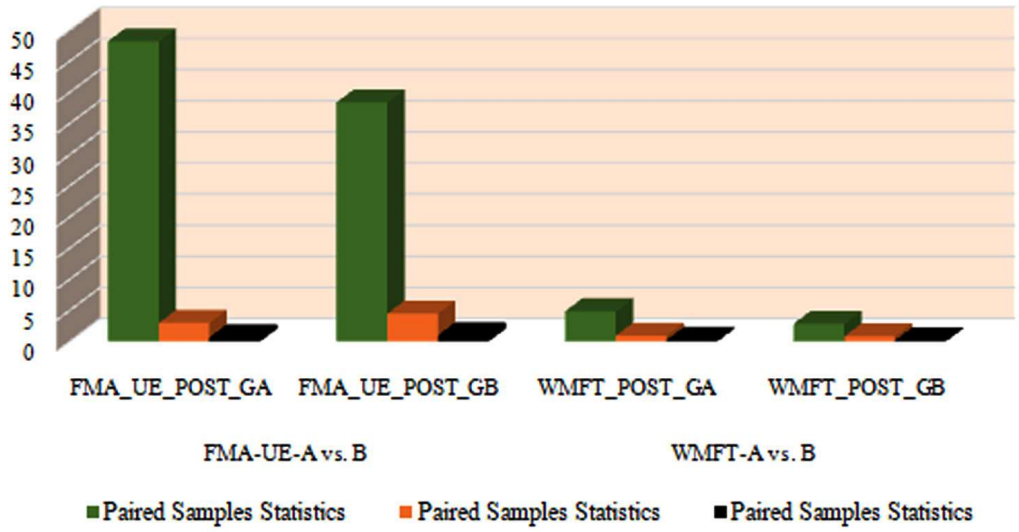


Table 4: Paired differences of Mean, Standard Deviation and Standard Error of Mean and corresponding t-value with p-value for the Post analysis of the subject i.e., Mirror Therapy Group-A and the Conventional Therapy Group-B (Post-Analysis)

Paired Samples Test						
Post Analysis (A Vs. B)		Paired Differences			t-value	P-value
		Mean	Std. Deviation	Std. Error Mean		
FMA-UE	FMA-UE-POST-GA –FMA-UE-POST-GB	9.8095	6.368823	1.389791	7.058272	0.000
WMFT	WMFT-POST-GA – WMFT-POST-GB	2	1.30384	0.284521	7.02935	0.000

There is a significant difference between FMA-UE & WMPT of Group-A (MIRROR THERAPY) and CONVENTIONAL THERAPY of Group-B.

DISCUSSION

The study findings showed that patients with subacute stroke who received mirror treatment and conventional therapy for 6 weeks improved more in terms of grip and release functions of hand, as well as performance of activities of daily living. The findings corroborated prior research indicating that mirror therapy in stroke patients improved grip and release capacity.

Several processes could explain mirror therapy's impact on locomotor capability. First, mirror treatment aids in the rehabilitation of locomotion capacity by visually stimulating the hemiplegic upper limb with the normal side's reflection. According to Altschuler *et al.*,[22] the reflected picture of the hemiplegic hand produced the illusion that it was normal, which aided rehabilitation by restoring the lost proprioceptive sense to aid restoration of the entire motor cortex and stimulation of whole-body activity. Funase *et al.*[23] found that passive observation and imitation of certain motions in mirror treatment enhanced spinal cord and cerebral cortex activities. Hence here in this present study it has been observed that rehabilitation via illusion of reflected image of the hemiplegic hand aids in restoration of proprioceptive sense, enhances activities of spinal cord and cerebral cortex and it stimulates whole-body activity.

Second, the mirror neuron system enhances motor ability recovery. Mirror neurons are bimodal visuomotor neurons that fire during action observation, mental stimulation (imagination), and action execution. Passive observation of an action, for example, has been demonstrated to improve M1 excitability in the muscles employed in that specific action. Mirror neurons are now well recognized as the system underlying the learning of new skills through visual inspection of the competence.[24] Neuroimaging revealed the existence of two major mirror networks: one in the parietal lobe and premotor cortex, as well as the caudal part of the inferior frontal gyrus (parietofrontal mirror

system), and the other in the insula and anterior mesial frontal cortex (limbic mirror system). The parietofrontal mirror system is responsible for recognizing voluntary behaviour, whereas the limbic mirror system is responsible for recognising emotional behaviour.[25]

The mirror gives subjects visual feedback. The mirror reflection of the moving good hand appears to be the affected hand moving correctly and may compensate for the often reduced or absent proprioceptive input. The use of a mirror may also aid in the recruitment of the premotor cortex to aid in motor recovery.[26] The premotor cortex has several characteristics that imply it could be a link between the visual picture in the mirror and motor rehabilitation following stroke. The premotor cortex contributes significantly to the descending corticospinal tracts, has more bilateral control of movement than the motor cortex, and has close links with visual information. Mirror therapy helped to reverse components of learned disuse of the damaged limb on a variety of neurological and psychological levels.[22] Stevens showed that mirror treatment was associated with motor imagery and improved the motor activity of a hemiplegic extremity by using visual feedback caused by imagined movement.[27] Fadiga and Craighero revealed that passive monitoring of motions via the mirror neuron system increased activation of the primary motor region, which regulated the subjects movements.[28] Hence the present study proved that through mirror therapy associated with motor imagery not only activates the cortex which in turn also improved the motor activity of the subjects by regulating the movements performed by the subjects.

Third, simultaneous motion of both limbs stimulates the paralyzed unilateral cerebral cortex via interactions with the stimulated normal cerebral cortex. Summers *et al*.[29] discovered that exercising both the normal and hemiplegic sides was more efficient than practicing only the hemiplegic side in improving upper limb functions and muscular strength. Cauraugh and Summers hypothesized that simultaneous training on both sides would moderate the excessive suppression of transmission caused by the hemiplegic and normal limb balance. This hypothesis supports the result that mirror therapy using both limbs is more successful than hemiplegic-only exercise.[30]

Based on these theories, rehabilitation programmes with mirror therapy when applied to groups, resulted in changes in their ability to undertake activities of daily living and upper limb function.

The present study included subjects with subacute stroke stage only as they showed better and faster improvements of hand functions. Subjects under sub-acute stage showed spontaneous recovery is usually at its limit, leading to a more or less stable. When intervened with mirror therapy the study showed that there are improvements in the function of grip and release of hand in subacute stroke patients.[31]

The results of the present study have shown thathave mirror therapy been significantly improved the grip and release function of hand by FMA-UE and WMFT in sub-acute stroke subjects compared with conventional therapy.

The study also predicted the benefits of mirror treatment in conjunction with functional tasks. The use of strategies emphasizing vigorous exercise and task-specific training maximized functional capacities and perhaps promoted brain reorganization, with the goal of increasing upper limb function and the ability to carry out everyday tasks.[32]

The null hypothesis of this study was that the mirror therapy may not have any effect on grip and release function of hand in sub-acute stroke patients; but the outcome has rejected null hypothesis and accepted the alternative hypothesis states that the mirror therapy can significantly improve grip and release function of hand in sub-acute stroke patients.

The study outcome proved that the frequency of wrist and hand recovery has been improved after mirror therapy, this has accepted the alternative hypothesis and rejected the null hypothesis stated that there would no significant effect of Mirror therapy on grip and release function of hand in sub-acute stroke patients.

Study Limitations

- The sample size taken for the study was small.
- The study included only short-term effects were evaluated as mirror therapy was of 6-week duration.
- The study involved subjects who were inpatients at the hospital and matched the inclusion criteria, and the effects of the patients' various types of rehabilitation could not be ruled out.
- The study included subjects only with

good cognitive function, as their cognitive processes were not impaired, the patients were able to communicate with others. As a result, generalizing the findings to the total population of hemiplegic patients proved problematic.

- The study duration was short and there was no follow up post treatment.
- Study conducted with limited age group of 40 – 60 years old.
- The study's inclusion criteria, findings, and conclusions are based on a cohort of subacute stroke patients (all within 12 months of the stroke) who survived without substantial cognitive deficits but with severe motor disability of the hand and upper extremity.

Future Scope of the Study

- Larger sample size so that multicenter study can be carried out.
- Can be done by considering wider age group.
- Study on recurrent stroke survivors.
- Mirror therapy's efficacy in stroke patients with apraxia or neglect.
- The efficacy of mirror therapy as a home treatment or conduct functional brain imaging investigations on the underlying mechanism of motor recovery following mirror therapy in stroke patients

CONCLUSION

The results from the present studies demonstrate the benefits of mirror therapy in improving the grip and release function of hand as compared to conventional therapy. Thus, mirror therapy can be integrated into the rehabilitation programme as an alternative method at an early stage, and using it for an extended length of time may be even more advantageous to improving hand function.

The mirror therapy should be preferably administered into the patients especially when the motor recovery and performance of the upper limb is to be improved and there is limited time as the limb may go to spasticity. A rehabilitation programme that would be more likely to adopt (do not take lot of time or effort) as a regime with the standard-of-care, multidisciplinary rehabilitation intervention based on their requirements and tolerability with low risk of muscle and connective tissue.

In conclusion, mirror treatment with functional tasks had a substantial effect on improving upper limb skills and the ability to do daily activities in patients with subacute stroke.

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