



A Study on the Efficacy of Mirror Therapy in the Prognosis of Upper Extremity Motor functions in Stroke Patients

Sriram Nelakurthy*, Sampath Baireddy, Raja Mahendra, Vahini Devi Ch, Sandya Nelakurthy, Hima Varshini, Ragamai B

Department of Physiotherapy, Vaagdevi College, Ramnagar, Warangal, Telangana

ABSTRACT

Objective of the study: To evaluate the effect of Mirror therapy on upper extremity motor functions in stroke patients

Methodology: 22 subjects were selected who fulfilled the inclusion and exclusion criteria. The purpose and procedure of the study were explained to all subjects for maximum cooperation and written consent was taken from them. Detailed assessment was taken for each patient.

Inclusion criteria: Age 40-60 years, Brunnstrom stage of motor recovery for upper extremity 1-3, Time since stroke 2 months 1 year, Gender Both male and female

Exclusion criteria: Severe cognitive disorders that would interfere with study purpose (MMSE<23/30), bilateral hemiplegia, medically unstable patients, Patients with visual impairments.

Outcome measure: Action research arm test: (ARAT), Upper extremity subscale of Fugl-Meyer motor assessment scale: (FGMR)

Conclusion: Study concluded that Mirror therapy is proved to improve upper extremity motor functions in stroke patients.

ARTICLE HISTORY

Received: February 18, 2021

Accepted: March 04, 2021

Published: March 11, 2021

KEYWORDS

Action Research Arm Test: (ARAT);
Upper extremity subscale of Fugl-Meyer motor assessment scale: (FGMR)

Introduction

Stroke is the common neurological disease that leads to mortality, morbidity and disability in the adult population [1]. It is the leading cause of disability in most of adult population [2]. WHO defined stroke as "Rapidly developing clinical signs of focal (or global) disturbance of cerebral function; lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin"[3].

Persons with low socioeconomic status have high mortality and morbidity from ischemic stroke [4]. The major risk factors considered for stroke in young Indian population are hypertension, hypercholesterolemia, and smoking etc. Most common cause of ischemic stroke is atherosclerotic occlusive disorders [5].

After the 6 months of stroke attack, only few percent of people that is about 25% of the people remain partially dependent or independent in performing ADLs, whereas 65% of the people lands up in severe

disability where they feel difficulty in performing ADLs with affected hand [6,7] individuals with moderate to mild disabilities measured with functional outcome scales shows the speed recovery compared to severe disabilities [8].

One of the new alternative therapeutic interventions for stroke in recent times is Mirror therapy which is inexpensive simple and most importantly, patient-directed treatment which improves upper extremity functioning. Which involves patient performing movements with unaffected limb thereby creates the visual illusion of the unaffected limb as affected thereby helps in motor recovery [9].

Treatment with visual illusions created by mirror therapy for phantom limb pain was first introduced by Ramachandran and Rogers-Ramachandran [10]. Relaxation and sensations of cramped phantom limb were experienced by the patients by superimposing the intact arm on the phantom limb using a mirror reflection. 11 successful use of mirror therapy has

been reported in patients with other pain syndromes also such as complex regional pain syndrome, and also in sensory re-education of severe hyperesthesia after hand injuries.

There are various Studies conducted to know the effect of mirror imagination on brain activation. MI Gary et al [11] suggested that mirror viewing of phasic, unilateral hand movement enhances facilitation of ipsilateral primary motor cortex (M1). This effect did not differ between the dominant and non-dominant hand. Buccino et al [12] reported that motor imitation incorporates several stages, which includes motor imagery, observation and execution. Motor imitation increases the excitability of corticospinal pathway. Observation of actions done by other humans activates a complex network formed by rostral part of inferior parietal lobule which form the core of the human mirror neuron system [13].

Thus, there are various studies conducted to know the effect of mirror therapy to rule out its effectiveness on functional recovery of upper extremity after stroke but they are undersized and are not sufficiently controlled. Keeping all above in view, purpose of this study is to find out the effect of mirror therapy on upper extremity motor functions in stroke patients [14].

Aim of the study

To evaluate the effect of Mirror therapy on upper extremity motor functions in stroke patients

Study design

Experimental Study Design

Sample selection

Simple Random Sampling

Methodology

22 subjects were selected who fulfilled the inclusion and exclusion criteria. The purpose and procedure of the study were explained to all subjects for maximum cooperation and written consent was taken from them. Detailed assessment was taken for each patient [15].

Study conducted

Study was conducted at Vaagdevi College of Physiotherapy, attached Rehabilitation Clinic Ramnagar, Hanamkonda.

Ethical clearance

Institutional Human Based Ethical Clearance was Obtained (IHEC) for conducting the study.

Inclusion criteria

Age: 40-60 years, Brunnstrom stage of motor recovery

for upper extremity: 1-3, Time since stroke: 2 months 1 year, Gender: Both male and female.

Exclusion criteria

Severe cognitive disorders that would interfere with study purpose (MMSE<23/30), bilateral hemiplegia, medically unstable patients, Patients with visual impairments.

Outcome measure

Action Research Arm Test: (ARAT), Upper Extremity Subscale of Fugl-Meyer motor assessment scale: (FGMR)

Consent form

Consent forms were obtained after explaining the procedure in their regional Language, ethical issues and Confidentiality was maintained, No financial perks only personal transport allowances were provided for subjects at the study conducting time.

The subjects were randomly allocated to either Mirror therapy group (Group A) or control group (Group B) by using sealed envelopes. ARAT and Fugl-Meyer assessment for upper extremity (FGMR) were performed before and after intervention of 4 weeks in both groups.

Group A

Mirror therapy group (11 subjects): Patients in this group underwent Mirror therapy programme along with conventional therapy.

Mirror therapy: Patients in this group were made to sit on chair in front of a table, on which mirror was placed. Patients were asked to place both affected and unaffected hands on either sides of the mirror. Where unaffected arm is placed in front the mirror and patient was asked to perform exercises like active wrist extension for 5 minutes, supination pronation for 5 minutes, fingers flexion extension for 5 minutes and moving different objects (pen, wooden blocks etc.) from one place to another for 5 minutes with unaffected hand. While doing above exercises, patient were asked to observe the reflection of unaffected extremity in mirror (which looks like the affected extremity) and to imagine that his/her affected extremity is moving normally (motor imagery). The Mirror therapy session was conducted for 20 min/day, 5 days/week for 4 weeks.

Conventional therapy: Conventional therapy given was patient specific. It included NDT approach, Roods approach, Brunnstrom approach, Splinting, task oriented approach, strengthening, etc.

Group B

Control group (11 Subjects): Patients in this group

were asked to perform same exercises as in Mirror therapy group but the mirror was placed in opposite direction so that the patient observed the reflection of the affected extremity (placebo Mirror therapy). Conventional therapy was given as in the Mirror therapy group to all patients.

Result and Discussion

Stroke is the leading cause of disability in many of the adult population. 2 only few percent of patients return to the normal level of everyday participation where most of patients remain dependent in all terms of physical functioning of the body. Many studies stated that Mirror therapy plays a promising role which can promote motor recovery. Mirror therapy provides visual input that replaces decreased or absent proprioceptive input. Mirror therapy is a motor imagery process that modulates central mechanisms of motor recovery and neural plasticity [16] (Figures 1-3).



Figure 1. Images showing patients performing simple movements of hand in front of mirror



Figure 2. Images showing patients performing simple movements of hand in front of mirror



Figure 2. Images showing patients performing simple movements of hand in front of mirror



Figure 3. Images showing patients performing simple movements of hand in front of mirror

So, the main objective of this study was to evaluate the effect of Mirror therapy on upper extremity motor functions and motor recovery in sub-acute

stroke patients. 22 patients with stroke who fulfilled inclusion and exclusion criteria were selected for the study; they were randomly allocated into 2 groups: Mirror therapy group and control group. Mirror therapy group underwent Mirror therapy along with conventional therapy, while control group treatment consists of same movements like Mirror therapy where mirror was placed in opposite direction [17]. 4 exercises: wrist dorsiflexion, fingers flexion-extension, supination pronation and moving different objects were selected for the exercise protocol. Motor functioning of the selected subjects were measured by using ARAT and motor recovery with FGMR, Which has (ARAT and FGMR) good validity and reliability [18,19] (Figures 4-6).

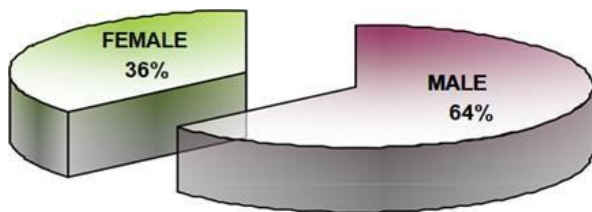


Figure 4. Images showing patients performing simple movements of hand in front of mirror Graph showing Gender distribution in Mirror therapy and Control group

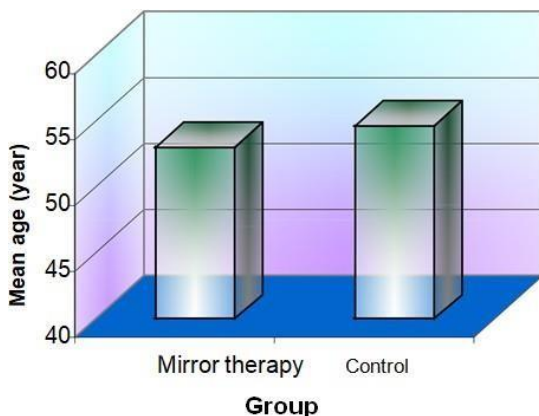


Figure 5. Images showing patients performing simple movements of hand in front of mirror Graph showing Gender distribution in Mirror therapy and Control group

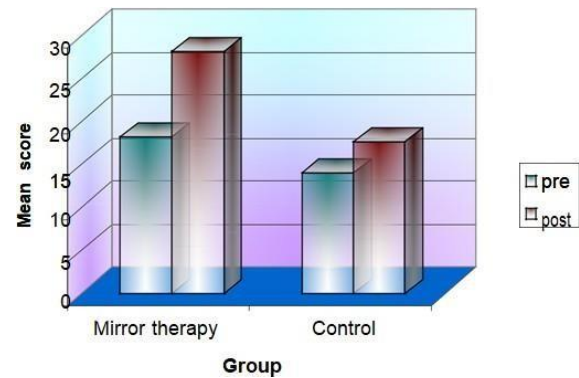


Figure 6. Graph showing changes in pre to post intervention mean scores of ARAT in mirror therapy and Control group

Paired t-test was done to know the effects of Mirror therapy and placebo Mirror therapy along with conventional therapy in experimental and control group respectively. Results shown that there was highly significant improvement in the score of ARAT in Mirror therapy group ($p=0.00$) and in control group ($p=0.00$). The results for FGMR score were highly significant for Mirror therapy group ($p=0.00$) as well as in control group ($p=0.00$). So it is easily understood that interventions in both groups are effective (Figures 7 and 8).

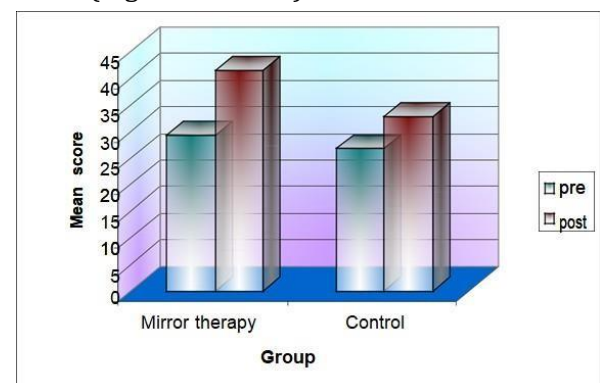


Figure 7. Graph showing changes in pre to post intervention mean scores of ARAT in mirror therapy and Control group

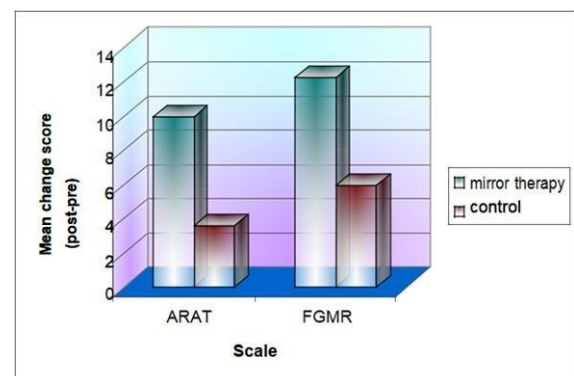


Figure 8. Graph showing changes in mean change score (post - pre) of ARAT and FGMR between Mirror

therapy and Control group

We have also compared the Mirror therapy group and control group using unpaired t-test to investigate whether Mirror therapy group changed more compared to control group. There was highly significant difference in ARAT ($p=0.00$) and FGMR ($p=0.00$) scores between Mirror therapy group and control group after 4 week of intervention. This suggests that Mirror therapy is more effective than placebo treatment given in control group (Tables 1-5).

Table 1. Table showing Descriptive statistics of Age of subjects in Mirror therapy and Control group

GROUP	N	Mean	Std. Deviation
Mirror therapy	11	53	4.517
control	11	54.64	7.42
Total	22	53.82	6.052

Mean age of 11 subjects in Mirror therapy group is 53 ± 4.517 and the mean age of 11 subjects in control group is 54.64 ± 7.420 . Mean age of total 22 subjects is 53.82 ± 6.053 .

Table 2. Table showing Gender distribution in Mirror therapy and Control group

	Mirror therapy group		Control group		Total
	Count	%	Count	%	
Male	5	45.50%	9	81.80%	14
Female	6	54.50%	2	18.20%	8
Total	11	100.00%	11	100.00%	22

Out of 11 patients Mirror therapy group consists of 45.5%) male and 6 female (54.5%). In control group, there are 9 (81.8%) male and 2 (18.2%) female. Out of total 22 subjects, there are 14 male (64%) and 8 (36%) female.

Table 3. Table showing Intra group comparison of scores of ARAT between pre and post intervention in both groups.

Group		Mean	Std. Deviation	Std. Error Mean	t	p
Mirror therapy	Pre Intervention	18.1818	13.26513	3.99959	-7.906	0
	Post Intervention	28.1818	14.75004	4.4473		
Control	Pre Intervention	14	10.89036	3.28357	-10	0
	Post intervention	17.6364	11.48279	3.46219		

Pre and post intervention mean ARAT scores in Mirror therapy group are 18.18 ± 13.26 and 28.18 ± 14.75 respectively; whereas in control group are 14.00 ± 10.89 and 17.63 ± 11.48 respectively. There is highly significant difference between pre intervention and post intervention ARAT total scores in Mirror therapy group ($t=-7.96$; $p=0.000$) and in control group ($t=-10.00$; $p=0.000$).

Table 4. Table showing Intra group comparison of scores of FGMR between pre and post intervention in both groups

Group		Mean	Std. Deviation	Std. Error Mean	t	p
Mirror therapy	Pre intervention	29.272	12.5625	3.7877	-10	0
	Post intervention	41.545	9.9635	3.0041		
Control	Pre intervention	26.727	11.3056	3.4087		
	Post intervention	32.727	9.7271	2.9328	-8	0

Pre and post intervention mean FGMR scores in Mirror therapy group are 29.27 ± 12.56 and 41.54 ± 9.96 respectively; whereas in control group are 26.72 ± 11.30 and 32.72 ± 9.72 respectively. There is highly significant difference between pre and post intervention FGMR total scores in Mirror therapy group ($t=-9.69$; $p=0.000$) and in Control group ($t=-7.63$; $p=0.000$).

Table 5. Table showing Inter group comparison of mean change scores (Post-Pre) of ARAT and FGMR between Mirror therapy and Control group

Scale	Group	Mean	Std.	Std. Error	t	p
ARAT	Mirror therapy	10	4.1952	1.2649	4.83	0
	Control	3.636	1.206	0.3636		
FGMR	Mirror therapy	12.272	4.1974	1.2655	4.21	0
	Control	6	2.6076	0.7862		

Mean change score of ARAT (post-pre) in Mirror therapy group is 10.00 ± 4.19 and in control group is 3.63 ± 1.20 . Mean change score of FGMR in Mirror therapy group is 12.27 ± 4.19 and in control group 6.00 ± 2.60 . There is highly significant difference of mean change scores (post - pre) of ARAT ($t=4.83$; $p=0.00$) and FGMR ($t=4.21$; $p=0.00$) between Mirror therapy group and control group.

Eric Lewin Altschuler et al conducted a study on 9 patients with stroke and evaluated that, with 8 weeks of mirror therapy programme there was improvement observed in terms of movement ability, range of motion, speed, and accuracy [20].

Many mechanisms were proposed to find of the effect of Mirror therapy on stroke patients. Altschuler et al [20] proposed that Mirror therapy through the proper visual input improves the decreased or absent proprioceptive input and helps in regaining functional strength. K Sathian et al. suggested that Mirror therapy through visual biofeedback influences kinesthesia during active movement. Which there by facilitates use of more established strategies such as motor copy and forced use?

Kozo Funase et al [21] found that the somatosensory afferents which helps in kinesthetic sensations are not enhanced with mirror box observation and that mirror box therapy lacks the potential to increase M1 excitability in healthy subjects.

So it can be known from previous studies that, although neurophysiology of Mirror therapy for motor recovery is not clear, it can be used as an alternative rehabilitation program for stroke affected individuals. (Table 4 and 5)

Limitations of the Study

Sample size taken in the study was small, study conducted was of short duration i.e. 4 weeks, type of stroke i.e. ischemic/hemorrhagic and area of the brain involved was not specific.

Recommendations for further Study

Underlying mechanisms of motor recovery after Mirror therapy in stroke patients can be studied in depth. Randomized controlled trials of Mirror therapy in stroke rehabilitation are required more to

make protocol of Mirror therapy in stroke patients.

Studies which compare motor imagery with and without mirror for stroke rehabilitation should be done.

Conclusion

Study concluded that Mirror therapy is proved to improve upper extremity motor functions in stroke patients.

References

- [1] Susan B. O'Sullivan. Physical rehabilitation. Assessment and treatment. Fourth edition. New Delhi: Jaypee Brothers; 2001
- [2] Jongbloed LY. Prediction of function after stroke: A critical review. Stroke. 1986;17(4):765-776.
- [3] Jakovljevic D, Sarti C, Sivenius J, Torppa J, Mähönen M, Immonen-Räihä P, et al. Socioeconomic status and ischemic stroke: The FINMONICA Stroke Register. Stroke. 2001;32(7):1492-1498.
- [4] Mehndiratta MM, Agarwal P, Sen K, Sharma B. Stroke in young adults: A study from a university hospital in north India. Med Sci Monit. 2004;10(9):535-541.
- [5] Kwakkel G, Kollen BJ, van der Grond J, Prevo AJ. Probability of regaining dexterity in the flaccid upper limb: Impact of severity of paresis and time since onset in acute stroke. Stroke. 2003;34(9):2181-2186.
- [6] Lai SM, Studenski S, Duncan PW, Perera S. Persisting consequences of stroke measured by the Stroke Impact Scale. Stroke.

- 2002;33(7):1840-1844.
- [7] Mirbagheri MM, Rymer WZ. Time-course of changes in arm impairment after stroke: Variables predicting motor recovery over 12 months. Arch Phys Med Rehabil. 2008;89(8):1507-1513.
- [8] Stevens JA, Stoykov ME. Using motor imagery in the rehabilitation of hemiparesis. Arch Phys Med Rehabil. 2003 ;84(7):1090-1092.
- [9] Ramachandran VS, Rogers-Ramachandran D. Synaesthesia in phantom limbs induced with mirrors. Proceedings of the Royal Society of London. Series B: Biological Sciences. 1996;263(1369):377-386.
- [10] Ramachandran VS, Hirstein W. The perception of phantom limbs. The DO Hebb lecture. Brain. J neurology. 1998 ;121(9):1603-1630.
- [11] Garry MI, Loftus A, Summers JJ. Mirror, mirror on the wall: Viewing a mirror reflection of unilateral hand movements facilitates ipsilateral M1 excitability. Exp Brain Res. 2005;163(1):118-122.
- [12] Buccino G, Solodkin A, Small SL. Functions of the mirror neuron system: Implications for neurorehabilitation. Cognitive and behavioral neurology. 2006;19(1):55-63.
- [13] McCabe CS, Haigh RC, Ring EF, Halligan PW, Wall PD, Blake DR. A controlled pilot study of the utility of mirror visual feedback in the treatment of complex regional pain syndrome (type 1). Rheumatology. 2003;42(1):97-101.
- [14] Moseley GL. Graded motor imagery is effective for long-standing complex regional pain syndrome: A randomised controlled trial. Pain. 2004;108(1-2):192-198.
- [15] Rosén B, Lundborg G. Training with a mirror in rehabilitation of the hand. Scandinavian journal of plastic and reconstructive surgery and hand surgery. 2005;39(2):104-108.
- [16] Rizzolatti G, Craighero L. The mirror- neuron system. Annu. Rev. Neurosci. 2004;27:169-192.
- [17] Van der Lee JH, De Groot V, Beckerman H, Wagenaar RC, Lankhorst GJ, Bouter LM. The intra- and interrater reliability of the action research arm test: A practical test of upper extremity function in patients with stroke. Arch Phys Med Rehabil. 2001;82(1):14-19.
- [18] Hsieh CL, Hsueh IP, Chiang FM, Lin PH. Interrater reliability and validity of the action research arm test in stroke patients. Age and ageing. 1998 ;27(2):107-113.
- [19] Sütbeyaz S, Yavuzer G, Sezer N, Koseoglu BF. Mirror therapy enhances lower-extremity motor recovery and motor functioning after stroke: A randomized controlled trial. Arch Phys Med Rehabil and rehabilitation. 2007;88(5):555-559.
- [20] Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Llewellyn DM, et al. Rehabilitation of hemiparesis after stroke with a mirror. The Lancet. 1999;353(9169):2035-2036.
- [21] Funase K, Tabira T, Higashi T, Liang N, Kasai T. Increased corticospinal excitability during direct observation of self-movement and indirect observation with a mirror box. Neuroscience letters. 2007;419(2):108-12.