

Original Article

EFFECTIVENESS OF MIRROR THERAPY AS A HOME PROGRAM IN REHABILITATION OF HAND FUNCTION IN SUB-ACUTE STROKE

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ABSTRACT

Background and introduction: Purpose is to study the effectiveness of Mirror Therapy as a home program in rehabilitation of hand function in sub-acute stroke

Method: An experimental study design, 30 subjects with sub-acute stroke with impaired hand function randomly allocated 15 subjects into each Mirror therapy and Sham mirror therapy group. Sham mirror therapy group received sham mirror therapy with conventional exercises while Mirror therapy group received home based Mirror therapy with conventional exercises. Subjects were asked to review once in a week and follow the treatment at home for 4 weeks. Hand functions were measured using Chedoke Arm and Hand Activities Inventory-9 (CAHAI-9) Scale before and after 4 weeks of intervention.

Results: When means of post intervention compared using Independent 't' test between the groups found there is a statistically significant difference ($p < 0.05$) in means of CAHAI-9 score for hand functions. When analyzed within groups using Paired 't' test and Wilcoxon signed rank test there is a statistically significant improvement in means of CAHAI-9 score in both the groups.

Conclusion: It is concluded that the Mirror therapy as a home program with conventional exercises significantly found effective than Sham mirror therapy in improving hand functions in sub-acute stroke.

KEYWORDS: Sub-acute stroke; Mirror therapy; Sham mirror therapy; Conventional exercise; Hand Function; Motor imagery; Hemiplegia.

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INTRODUCTION

Stroke is defined as a rapidly developing clinical sign 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.¹ Stroke patient's incidence rate ranges from 0.2 to 2.5 per 1000 populations per year in India. Prevalence rate in south India was reported to be 56.9 per 100000.¹ Up to 85% stroke survivors experience hemiparesis resulting in impairment of an upper extremity immediately after stroke.²

Mirror therapy is a relatively new approach in

rehabilitation used in different neurological disorders including stroke.³ In mirror therapy, patients being in front of a mirror that is oriented parallel to person's mid line blocking the view of the affected limb positioned behind the mirror. When looking into the mirror the person sees the reflection of the unaffected limb. This creates a visual illusion by movement or touch to the intact limb may be perceived as affecting the paretic or painful limb.⁴ Research has focused on the mechanisms that underlie the effects of mirror therapy.

Ramachandran originally hypothesized that paralysis following might have a 'learnt' component, which could possibly be 'unlearned' by means of the mirror illusion.⁵ Others suggested that mirror therapy might be a form of visually guided motor imagery.^{4,6,7} Mirror illusion increases activity in precuneus and posterior cingulate cortex areas associated with awareness of self and spatial attention.⁸ It is suggested that mirror therapy stimulates the mirror neuron. Mirror neuron provides visual input to review motor neurons⁹ again might trigger the mirror neuron system⁴. Studies have been found effectiveness of intense mirror therapy in stroke patients resulted in significant recovery of grip strength, hand movement of paretic arm, steady and accuracy of arm movements⁴, increase in Fugl Meyer assessments score, improvement in speed and hand dexterity,¹⁰ improvements in hand functions in sub-acute stroke patients with sensory and attention deficits, improvements in motor recovery in distal plegic,¹¹ improvement in Ashworth scale, self-care items of the FIM instrument⁴ and mirror therapy combined with conventional stroke rehabilitation program enhanced lower-extremity motor recovery and motor functioning in sub-acute stroke patients.¹² Studies have shown that during inpatient rehabilitation mirror therapy program with conventional rehabilitation improved hand functions compared with a control treatment immediately after 4 weeks of treatment and at the 6 months follow-up.⁴ Conventionally treating subjects for long term as inpatients or outpatients rehabilitation is cost effective and time consuming. The previous studies were limited to study the effectiveness of supervised mirror therapy as a home program with outpatient conventional rehabilitation exercises in hemiplegics. In post stroke who are hemiplegic loss of hand function is a major source of impairment, frequently preventing effective occupational performance and an independent participation in daily life.² Therefore this study was with research question whether the mirror therapy as a home program does have an effect on functional hand recovery in rehabilitation of hand function in subjects with sub-acute stroke. Hence the purpose is to find the effect of mirror therapy as

a home program with outpatient conventional rehabilitation program on functional recovery of hand in subjects with sub-acute stroke. It was hypothesized that there will be a significant effect of mirror therapy as a home program on functional hand recovery in rehabilitation of hand function in sub-acute stroke.

MATERIALS AND METHODS

Pre to Post test Experimental study design. As the study included human subjects ethical clearance was obtained from ethical committee of K.T.G. College of Physiotherapy and K.T.G. Hospital, Bangalore. The study was registered with University no.09_T031_39084. Subjects were recruited from various Rehabilitation centers in Bangalore and study conducted in K.T.G. Hospital, Bangalore. Subjects included with sub-acute stroke who were diagnosed by Neurologist after confirmed by CT/MRI and referred to Physiotherapy treatment, age group between 40 to 65 years, both male and female, history of first episode of right hemiplegia within the duration of 4 weeks who were in the stage III to IV on Brunnstrom stage¹⁶ of motor recovery of upper extremity with Modified Ashworth scale¹⁷ score between 1 to 3 and with no severe cognitive disorders (MMSE score >24). Subjects excluded who were associated with psychological and perceptual disorders, significant visual and auditory impairment. 30 subjects who fulfilled the inclusion criteria were informed about the study and a written consent was taken. Subjects were randomly allocated 15 into Mirror Therapy Group and 15 into Sham Mirror Therapy Group using pieces of paper tightly folded and placed in a box. After shaking the box each piece of paper was withdrawn individually and the group name was written on a paper that corresponds with the patient numbers from 1 to 30. Both group trained once a week under supervision at Hospital and advised to practiced mirror therapy at home for 30 minutes daily, 5 times a week for 4 weeks and record was maintained to monitor the exercises performed at home.

Procedure of Intervention for Mirror Therapy group:

In this group subjects performed 30 minutes of Home based Mirror Therapy with conventional therapy.

Mirror Therapy: During mirror practices subject seated on a chair close to the table on which a mirror was placed vertically and advised to place both the hands on the table. The involved hand was placed behind the mirror and the noninvolved hand in front of the mirror. The subjects were advised not to look on the affected hand and focus on the mirror. Keep the unaffected hand flat on the table. The practice consisted of Non Paretic side wrist flexion and extension finger flexion and extension fanning out the hand, finger and thumb abduction, makes a fist and release, Lateral prehension, pad to pad, pad to side, pad to pad grip, grasping objects, single finger movement, thumb opposition while subject looked into the mirror, watching the image of their noninvolved hand.⁴ During the session, subjects were asked to try to do the same movements in the paretic hand while they were moving the non-paretic hand. Subjects were advised to practice mirror therapy at home for 30 minutes daily, 5 times a week for 4 weeks.

Conventional therapy: Conventional exercises involved were range of motion exercises and stretching to shoulder, elbow, wrist, fingers, hip and ankle. Bed mobility tasks such as rolling, moving from supine to sitting by coming over the involved Side and using the involved arm for support, and bridging. Weight shifting was performed in sitting and standing with controlled shifting over the involved leg. Sit to stand and transfers toward the involved side without pushing up with the uninvolved Leg. Control of the hemiplegic arm performed in weight bearing and functional non-weight bearing patterns. Gait training and balance activities to increase control of the involved leg. Activities of daily living, vocational and recreational activities performed with the use of involved arm and avoiding patterns that increase spasticity. Weight bearing through hand performed to help & stabilize objects. Fanning out the hand on the table, manual dexterity exercises and after conventional therapy patient is asked to take rest for some time.^{18,19} All exercises were performed for 1 hour and 30 minutes.

Sham Mirror Therapy Group: In this group, the subject performed same exercises for the same duration but they were instructed to observe the

movement through nonreflecting side of the mirror⁴. Subjects were advised to practice mirror therapy at home for 30 minutes daily, 5 times a week for 4 weeks. Conventional therapy was given for one hour and thirty minutes same as Mirror Therapy Group.

Outcome Measure:

Chedoke Arm and Hand Activities Inventory Scale.^{13,14,15} Version – 9 (CAHAI-9) was used to measure the functional hand recovery before and after 4 weeks of intervention in both the groups. CAHAI-9 is an activity- based assessment developed to include relevant functional tasks and to be sensitive to clinically important changes in upper limb function.¹³ CAHAI – has a high inter rater reliability, more sensitive and high construct validation. The performance of each task of the affected upper limb is rated using the 7 point activity scale. The scores on individual items are added yielding an overall sum score, the maximum obtainable sum score is 63 points.



Fig. 1: Mirror therapy



Fig. 2: Sham Mirror Therapy

Statistical Methods:

Descriptive statistical analysis has been used and presented as mean \pm SD. Significance is assessed at 5 % level of significance with p value 0.05 less than this is considered as statistically significant difference. Paired 't' test as a parametric and Wilcoxon signed rank test as a

non-parametric test have been used to analysis the variables pre-intervention to post-intervention with calculation of percentage of change. Independent 't' test as a parametric and Mann Whitney U test as a non-parametric test have been used to compare the means of variables between groups with calculation of percentage of difference between the means. The Statistical software namely SPSS 16.0 , Stata 8.0, MedCalc 9.0.1 and Systat 11.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc.

RESULTS

In study group there were 15 subjects with mean age of 49.87 years and there were 9 males and 6 females were included in the study.

In Sham Mirror Therapy Group there were 15 subjects with mean age 50.80 years and were 9 males 6 females were included in the study. There is no significant difference in mean ages between the groups. When means of CAHAI-9 scores analyzed from pre to post intervention with in Mirror Therapy Group and Sham Mirror Therapy Group there is a statistically significant improvement in Post means with p<0.000. When pre-intervention means were compared between the groups found that there is no statistically significant difference in means of CAHAI-9 scores. Means of post intervention compared there is a statistically significant difference in means of CAHAI-9 scores between the groups.

Table 1: Basic Characteristics of the subjects studied.

Basic Characteristics of the subjects d studied		Mirror Therapy Group	Sham Mirror Therapy Group	Between the groups Significance ^a
Number of subjects studied (n)		15	15	--
Age in years (Mean± SD)		49.87± 7.01 (40-63)	50.80± 6.83 (41-61)	P= 0.861 (NS)
Gender	Males	9	9	P=0.100*
	Females	6	6	
Total number of subjects		15	15	30

a- Pearson Chi-Square

Table 2: Analysis of CAHAI-9 score means within Mirror Therapy Group and Sham Mirror Therapy Group.

CAHAI Score	Pre intervention (Mean±SD) min-max	Post intervention (Mean±SD) min-max	Percentage of change	Z value ^b (Non parametric)	95%Confidence interval of the difference		Effect Size r	t value ^a (Parametric)	Significance (2-tailed) P value
					Lower	Upper			
Mirror Therapy Group	35.12 ± 4.97 (28.57 - 49.20)	62.97 ± 5.66 (57.14 - 77.77)	79.29%	-3.415 P=0.001**	-29.57	-26.12	0.93 (Large)	-34.545	P <0.000**
Sham Mirror Therapy Group	33.85 ± 4.09 (28.57 - 39.68)	46.10 ± 2.76 (42.85 - 50.79)	36.18%	-3.411 P=0.001**	-14.56	-9.92	0.86 (Large)	-11.328	P <0.000**

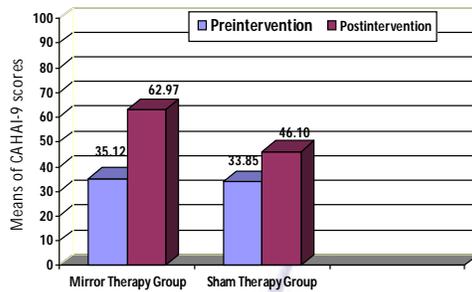
** Statistically Significant difference p<0.05 a. Pared t test. b. Wilcoxon Signed Ranks Test ; NS- Not significant

Table 3: Comparison of means of CAHAI-9 scoremeans between Mirror Therapy Group and Sham Mirror Therapy Group.

	Mirror Therapy Group (Mean±SD) min-max	Sham Mirror Therapy Group (Mean±SD) min-max	Percentage of difference	Z value ^b (Non-parametric)	95%Confidence interval of the difference		Effect Size r	t value ^a (Parametric)	Significance (2-tailed) P value ^a
					Lower	Upper			
Pre intervention comparison	35.12 ± 4.97 (28.57 - 49.20)	33.85 ± 4.09 (28.57 - 39.68)	-3.68%	-0.46 P=0.646 (NS)	-2.14	4.67	0.14 (Small)	0.762	P=0.453 (NS)
Post intervention comparison	62.97 ± 5.66 (57.14 - 77.77)	46.10 ± 2.76 (42.85 - 50.79)	-24.80%	-4.686 P=0.000**	13.53	20.2	0.88 (Large)	10.371	P=0.000**

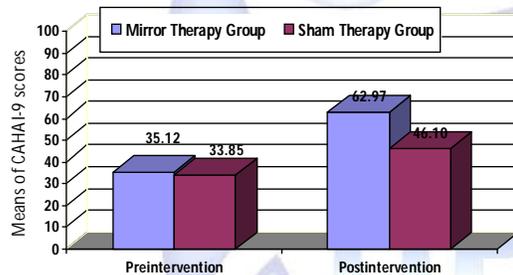
** Statistically Significant difference p<0.05; NS- Not significant; a. Independent t test. b. Mann Whitney U test Test

Chart 1: Analysis of CAHAI-9 score means within Groups.



The above graph shows that when means of CAHAI-9 scores analyzed from pre to post intervention in Mirror Therapy Group and Sham Mirror Therapy Group there is a statistically significant improvement in Post means with $p < 0.000$.

Chart 2: Comparison of means of CAHAI-9 score between the Groups.



The above graph shows that when pre-intervention means were compared between the groups found that there is no statistically significant difference in means of CAHAI-9 scores. When means of post intervention compared there is a statistically significant difference in means of CAHAI-9 scores between the groups.

DISCUSSION

The study found that there is statistically and clinically significant improvement in hand functions in subjects who received home based mirror therapy with conventional therapy than the subjects who received sham mirror therapy with conventional therapy for a period of 4 weeks.

In sham mirror therapy group, improvement in means of CAHAI-9 scores could be because of effects of home based placebo mirror therapy that involved bimanual activity of wrist and hand without mirror feedback, imagery hand movements with visual feedback while performing movement in unaffected limb and conventional exercises. Bimanual activity of wrist and hand without mirror feedback could be effective because when movements are performed in a bimanual context causes bilateral interactions in various brain regions giving rise to functional improvements in the control of the paretic limb.

Jill Whitall et al²⁰ suggested that repetitive bilateral arm training improves functional motor performance of the paretic upper extremity. Imagery hand movements could stimulate restitution and redistribution of brain activity which accompanies recovery of hand function thus resulting in a reduced motor deficit. Decety and colleagues have shown that imagery of movements activates largely the same brain areas that are activated when movements are actually executed. Furthermore, even passive observation of movement has been shown to activate cortical motor areas. Sjoerd et al suggested that the motor system can also be activated "offline" by imagining (motor imagery) or observing movements.²¹

In mirror therapy group, improvement in means of CAHAI-9 could be because of effects of home based mirror feedback therapy, bimanual activity for both hands, and conventional exercises. During mirror practices subjects practice consisted of non-paretic side movements while subject looked into the mirror watching the image of their noninvolved hand. Several underlying mechanisms for the effect of mirror therapy on motor recovery after stroke have been proposed. Altschuler et al²² suggested that the mirror illusion of a normal movement of the affected hand may substitute for decreased proprioceptive information, thereby helping to recruit the premotor cortex and assisting rehabilitation through an intimate connection between visual input and premotor areas. Stevens and Stoykov suggested that mirror therapy related to motor imagery and that the mirror creates visual feedback of successful performance of the imagined action with the impaired limb. Motor imagery itself, the mental performance of a movement without overt execution of this movement, has proven to be potentially beneficial in the rehabilitation of hemiparesis.⁶

In mirror therapy, the effect of mirror visual illusions on brain activity has been investigated in a number of studies. Garry et. al performed transcranial magnetic stimulation during mirror illusion in healthy subjects and showed increased excitability of primary motor cortex (M1) of the hand behind the mirror. Mirror neurons are bimodal visuomotor neurons that

are active during action observation, mental stimulation (imagery), and action execution. It has been shown that passive observation of an action facilitates M1 excitability of the muscles used in that specific action. Another possible mechanism for the effectiveness of mirror therapy might be bilateral arm training. In the present study the patients were informed to move the paretic hand as much as they could while moving the nonparetic hand and watching the image in the mirror in the bilateral training approach.¹⁰ Summers et al investigated the effectiveness of bilateral arm training and reported that compared with unilateral training, bilateral training intervention was more effective in facilitating upper limb motor function in chronic stroke patients.⁴ Carson suggested that when the nonparetic limb engaged during motor training, crossed facilitatory drive from the intact hemisphere give rise to increased excitability in the homologous motor pathways of the paretic limb, facilitating recovery of function.⁴ Both the group received home based conventional exercises as common treatment protocol that might have also influenced in improving hand functions. The effect of conventional exercises causes cortical reorganization, the mechanism probably reflects either an increase in the excitability of neurons already involved in the innervation of more affected hand movements or an increase in excitable neuronal tissue in the infarcted hemisphere.²³ Motor activity in the affected hand results in recruitment of the cortical areas along with the infarct rim, secondary motor areas in the contralateral hemisphere and ipsilateral hemisphere motor areas.

The post intervention comparison of means found no significant difference between the groups in improvement of functional activities, however the subjects in Mirror therapy found greater percentage of improvement in hand function by percentage of change 79.29% than the subjects in sham mirror therapy with 36.18%. There is clinical significant improvement in post intervention mean with large effect size in both groups with +0.88.

In this study the improvements in hand function was analyzed based on Chedoke Arm and Hand Activity Inventory Scale that has a high inter rater

reliability and more sensitive. Even if the study has found improvement in outcome, the study was carried for a period of 4 week wherein the hand function after 4 weeks was not studied with follow up.

Therefore, based on the findings the present study found that there is a statistically significant effect of mirror therapy as a home program on functional hand recovery in rehabilitation of hand function in sub-acute stroke than sham therapy. Hence, the present rejects null hypothesis.

The study is with several limitations: Improvements were found based on 4 weeks of intervention, follow-up was not done therefore long term effects were not found. Only hand functional recovery was measured. Study was carried only on subacute and right dominant side hemiplegia.

It is recommended for future research to find the long term effect of mirror therapy with conventional exercises as a home program with follow up, to find the effects of mirror therapy in stroke patients with apraxia or neglect with other perceptual disorders, to compare the home based mirror therapy with other motor imagery techniques, to find the variable duration and frequency of home based mirror therapy and exercise parameters to investigate the effect of different exercise regimes, to find the effectiveness of mirror therapy on specific activities of training during mirror therapy, and to find the effect of home based mirror therapy using other outcome measure such as sensory and motor recovery, and quality of life are needed.

CONCLUSION

The present study concluded that the 4 weeks of home based Mirror therapy combined with conventional exercises as a home program in rehabilitation of hand function found significantly effective on improvement of functional hand recovery in sub-acute stage of stroke. It is clinically important and recommended to consider home based mirror therapy with conventional exercises as an adjunct therapy to improve hand functions for subjects with sub-acute stroke.

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Conflicts of interest: None

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