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Original Research Article

Effectiveness of Movement Based Mirror Therapy Versus Task Based Mirror Therapy on Upper Limb Function, Muscle Tone and Grip Strength in Patients with Stroke: A Comparative Study

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ABSTRACT

BACKGROUND: Stroke is one of the major leading causes of death and disability in India. Motor impairment at the hand is very common and major after stroke. Large numbers of people are left with permanent impairments of arm and hand function, even after completion of conventional rehabilitation programs. Mirror therapy is based on neuroplasticity which explains that the brain tends to recognize visual feedback before proprioceptive or somatic feedback. Studies suggest that mirror therapy leads to better functional recovery of the upper extremities. One major category of MT is movement-based MT (MMT), and another one is task-based MT (TMT). Till now, less literature is done to find out difference between the effects of movement based mirror therapy and task based mirror therapy.
METHOD: 60 individuals were selected and allocated into 2 groups using chit method. Individuals in group A received Movement based Mirror therapy and group B received Task based Mirror therapy. The intervention period was given for 4 weeks, 5 days per week.
RESULTS: On comparing the performance of MMT and TMT, it is observed that it did not show statistically significant difference for upperlimb function, muscle tone and grip strength. However, both the MMT and TMT training individually showed significant difference on upperlimb function, muscle tone and grip strength in stroke patients.
CONCLUSION: Both movement based mirror therapy and task based movement therapy was effective in improving upperlimb function, reducing muscle tone and improving grip strength in stroke patients.

Keywords: stroke, mirror therapy, task based mirror therapy

INTRODUCTION

Stroke is one of the major and leading causes of death and disability in India. The estimated adjusted prevalence rate of stroke ranges from 84-262/100,000 in rural and 334-424/100,000 in urban areas. The incidence rate is 119-145/100,000 based on recent population-based studies.[1] Stroke (cerebrovascular accident (CVA)) is defined as sudden loss of neurological function caused by an interruption of blood flow to the brain. Ischemic stroke is the most common type, affecting about 80% of people with stroke. Clinically, variety of focal deficits is possible, including changes in the level of consciousness, impairment of sensory, motor, cognitive, perceptual, and language functions. To be classified as stroke, neurological deficits must persist for at least 24 hours.[2] The term cerebrovascular accident (CVA) is used interchangeably with stroke to refer to vascular conditions of the brain. Stroke causes tissue damage due to ruptured blood vessels or blood clots that may block oxygen and nutrient supply, which results in symptoms such as facial muscle weakness, one-sided extremity muscle weakness, gait difficulty, dizziness, and loss of balance and control.[3] Diminished motor skills leads to use of non-paretic extremities for extended periods of time, which will further lead to muscle weakening on the paretic side relative to the non-paretic side.

Motor impairment at the hand is very common and major after stroke. At 6 months after severe stroke, one third of people develop wrist and hand contracture (loss of passive joint range of motion) and more than 50% of people with hand impairments do not regain function. The loss of functional hand movement is disabling and can persist for many years. The neurophysiological mechanisms underlying the recovery of hand function are complex, interdependent, and occur at different periods of time after onset of stroke.[3,4]

Understanding upper limb impairments after stroke is much essential to plan therapeutic efforts to restore function. The most useful way to understand how impairments contribute to upper limb dysfunction may be to examine them from the perspective of their functional consequences. There are three main functional consequences of impairments on upper limb function are: (1) learned nonuse, (2) learned bad-use, and (3) forgetting as determined by behavioral analysis of tasks. The impairments that contribute to each of these functional limitations are described.

The function of the upper limbs results from sensory and motor skills. Motor skills are divided into coarse and fine movements. Dexterity is a form of fine motor skill that allows one to manipulate objects through voluntary movements. Manipulation of objects means checking out and transferring the object between the fingers. Yancosek KE et al.[5] showed that dexterity skills are one of the predictors of independence in one's daily activities. Subordinate skills allow one to control objects using the fingers[6], which is important because it affects the ability to use fine motor skills in daily activities, such as unscrewing toothpaste cap, knitting, writing, and many other home and work activities. Disability in these activities causes dependence, emotional changes, and depression and leads to reduced quality of life.[7]

It has been reported that up to 85% of stroke survivors experience hemiparesis and 55%–75% continue to have limitations in upper extremity function.[8] Hence, functional recovery of the upper extremity is one of the main purposes of the rehabilitation of stroke survivors.[8] The brain tends to recognize visual feedback before proprioceptive or somatic feedback. Mirror therapy is based on the neuroplasticity suggested by this theory. The normal upper limb movement as seen in the mirror serves as the visual feedback necessary to stimulate the primary somatosensory cortex to induce movement of the paralyzed side. Altschuler et al.[9] demonstrated improvement of movements in terms of range of motion, speed and accuracy through Fugl-Meyer Assessment (FMA) in post-stroke patients who underwent mirror therapy. Yavuzer et al.[10] reported that mirror therapy in addition to a conventional rehabilitation program was beneficial in terms of motor recovery and upper limb functioning. These studies suggest that mirror therapy leads to better functional recovery of the upper extremities than does conventional therapy.

During mirror therapy, a mirror is placed in the person's midsagittal plane, thus reflecting the non-paretic side as if it were the affected side (Ramachandran 1995). By this setup, movements of the non-paretic limb create the illusion of normal movements of the paretic limb (Deconinck 2015). One of the advantages of mirror therapy is the relatively easy administration and the possibility of self-administered home therapy, even for people with severe motor deficits.[11] The heterogeneity of conducting MT was obvious across studies. One major category of MT is movement-based MT (MMT), in which participants practice simple movements such as wrist flexion and extension, or finger flexion and extension, with their unaffected hands when viewing the MVF generated by a physical mirror placed at their mid-sagittal plane. Another category of MT is task-based MT (TMT), in which participants perform specific motor tasks with their unaffected hands, such as squeezing sponges, placing pegs in holes, and flipping a card, while they are viewing the MVF.[12]

Stroke can cause severe and long-lasting disability, and therefore there is a need to explicate various interventions for physiotherapy rehabilitation. Till now, less literature is done to find out the difference between the effects of movement based mirror therapy and task based mirror therapy. Therefore, the aim of the study is to find the effectiveness of movement-based mirror therapy along with hand dexterity training versus task-based mirror therapy along with hand dexterity training on upper limb function, muscle tone and grip strength in patients with stroke.

MATERIALS & METHODS

60 individuals were selected and allocated into two groups using chit method. Individuals in the group A received Movement based Mirror therapy with hand dexterity training and conventional therapy and individuals in the group B received Task based Mirror therapy with hand dexterity training and conventional therapy. The intervention period was given for 4 weeks, 5 days per week.

INCLUSIVE CRITERIA:[1,18,13,14]

1. Gender: Both male and female
2. 1st Episode of stroke at least 6 months prior proven by computed tomography or magnetic resonance imaging
3. Sufficient cognitive ability to follow instructions (Mini-mental State Examination score >24).
4. Brunnstrom recovery stage in the affected upper extremity from 4 to 6.
5. Modified Ashworth scale score ≤2.
6. Upper Limb motor function by MESUPES

- MESUPES-arm score ›24/40
- MESUPES-hand score ›9/18

EXCLUSIVE CRITERIA:[20]

1. Individuals having participation in any other experimental projects.
2. Unilateral neglect.
3. Patients with severe sensory distribution, pain and contracture in upper limb.
4. Any other comorbid neurological diseases except for stroke.
5. Diagnosis of any other neuromuscular or orthopedic disease in the upper extremities.

WITHDRAWAL CRITERIA:

- Subjects' participation in this project is completely voluntary.
- Subject may withdraw from the project for any reason (or no reason at all), at any time, without penalty of any sort, or loss of benefit to which he/she would otherwise be entitled.
- The individuals which miss more than 4 sessions will be included as dropouts.
- Subjects will be informed and explained about the right to 'Withdrawal of Participation' while obtaining consent. The data collected on the participant to the point of withdrawal remains a part of the study database.

OUTCOME MEASUREMENTS

1. Motor Evaluation Scale of Upper Extremity in Stroke Patients (MESUPES):

MESUPES is used measures quality of movement of the hemiparetic upper extremity The MESUPES was divided into two sub scales: the MESUPES-arm test and the MESUPES-hand test.

- Arm items total – 40
- Hand items total -18 Total score -58

A higher score indicates the greater the quality of movement. Reliability – 0.99 For MESUPES Arm 0.97 for MESUPES Hand Validity – 0.87

2. Modified Ashworth Scale

The Modified Ashworth Scale is the most widely clinical scale used to measure the increase of muscle tone which is manifested by an increased resistance of joints to passive movement.

3. Hand-held Dynamometer

Handheld dynamometer is used to measure the grip strength. Patient is in comfortable sitting position with arm and forearm supported. Patient is asked to grip the handles of the dynamometer try to squeeze it. Three readings were taken and the maximum score was noted.

METHOD OF DATA COLLECTION

Individuals were assessed for eligibility

⇩

Allocation by chit method

Group A

⇩

Pre-assessment by MESUPES, Modified Ashworth Scale and dynamometer was done

⇩

Movement based Mirror therapy, dexterity training and conventional therapy was given 5 times a week for 4 weeks

⇩

Post-assessment by MESUPES, Modified Ashworth Scale and dynamometer was done

Group B

⇩

Pre-assessment by MESUPES, Modified Ashworth Scale and dynamometer was done

⇩

Task based Mirror therapy, dexterity training and conventional therapy was given 5 times a week for 4 weeks

⇩

Post-assessment by MESUPES, Modified Ashworth Scale and dynamometer was done

⇩

Data analysis was done using paired t test within the groups and unpaired t test between 2 groups.

INTERVENTION

Movement Based Mirror Therapy

- The participants were instructed to sit on a chair in front of a table. A mirror on the table was positioned perpendicular to the participants.
- All jewellery were asked to remove from the unaffected arm, and the affected hand was positioned behind the mirror, whereas the unaffected hand was placed in the front of the reflective surface.
- Thereby, the participants were asked to view the reflected upper limbs in the mirror instead of their real upper limb.
- Once the training started, the participants were asked to perform some simple movements with the unaffected upper limb, such as finger flexion and extension, griping and releasing, wrist ulnar and radial deviation, wrist extension and flexion, forearm pronation and supination, elbow extension and flexion, moving the affected arm from middle position to the lateral side, lifting the hand up, returning it to the table.
- During the practices with the unaffected arm, the participants were instructed to move their affected arm synchronically while viewing the mirror.
- Each movement was repetitively performed for 3–4min, with 30-s break was allowed intermittently when changing the movements.
- The treatment period was of 5 days per week for 4 weeks between pre and post assessment.

Task Based Mirror Therapy

- The procedure and setup were the same as movement based mirror therapy.
- Tasks were performed with unaffected arm: finger tapping, gripping ball, sliding cards from left to right side with forearm supported, picking up seeds from bowl and placing them on table with forearm supported, turning pages from book, stacking blocks, transferring small objects from middle position to lateral side, putting objects on shelf.
- During the practices with the unaffected arm, the participants were instructed to move their affected arm synchronically while viewing the mirror.
- Each movement was repetitively performed for 3–4min, with 30-s break was allowed intermittently when changing the movements.
- The treatment period was of 5days per week for 4 weeks between pre and post assessment

STATISTICAL ANALYSIS AND RESULT

The data was collected by primary investigator to find out the effect of movement based mirror therapy and task based mirror therapy along with hand dexterity training and conventional therapy on upper limb function, muscle tone and grip strength in stroke patients and was entered into excel spread sheet, tabulated and subjected to statistical analysis. The data was analysed using GraphPad InStat (version 3.10) and data was analysed using appropriate statistical tests. Various statistical measures such as mean, standard deviation (SD) and test of significance were utilized to analyse the data. The results were concluded to be statistically significant if, $p < 0.05$ with 95% confidence interval taken into consideration.

In this study, total 60 subjects, both male (78%) and female (21%) with mean age of 52.43 ±11.98 (Group A- Movement based mirror therapy) and 54.03 ± 10.21 (Group b- Task based mirror therapy) were selected using random sampling method and were allocated into two groups (30 subjects in each group) using chit method.

The pre and post intervention data in group A (Movement based mirror therapy) and group B (Task based mirror therapy) was analyzed using Paired t-test and Wilcoxon Signed Rank test. There was significant difference in the pre (39.93 ± 3.0) and post (48.23 ± 3.7) mean MESUPES scale score, Thus, movement based mirror therapy is effective in improving the upper limb function in stroke patients.

There was significant difference in pre (1.16 ± 0.37) and post (1.03 ± 0.18) mean shoulder flexor muscles score, pre (1.33 ± 0.80) and post (1.13 ± 0.50) mean shoulder extensor muscles score, pre (2.86 ± 1.22) and post (2.20 ± 0.84) mean shoulder abductor score, pre (1.73 ± 1.25) and post (1.53 ± 0.93) mean shoulder adductor muscles score, pre (2.7 ± 1.08) and post (2.1 ± 0.88) mean elbow flexor score, pre (1.63 ± 1.09) and post (2.1 ± 0.88) mean elbow extensor score, pre (3.1 ± 0.43) and post (2.4 ± 0.57) mean wrist flexor score, pre (1.1 ± 0.30) and post (1 ± 0) mean wrist extensor score in group A. Thus, movement based mirror therapy is effective in improving the upper limb muscle tone in stroke patients.

There was statistically significant difference for pre (3.76 ± 1.6) and post (5.33 ± 1.5) mean score of grip strength in group A. Thus, movement based mirror therapy with hand dexterity training is effective in improving the grip strength in stroke patients.

There was significant difference in the pre (40.6 ± 2.4) and post (48.8 ± 2.5) mean MESUPES scale score. Thus, task based mirror therapy is effective in improving the upper limb function in stroke patients.

There was no statistically significant difference in pre (1 ± 0) and post (1 ± 0) mean shoulder flexor muscles score, pre (1.06 ± 0.25) and post (1 ± 0) mean shoulder extensor muscles score, pre (2.96 ± 1.35) and post (2.3 ± 0.96) mean shoulder abductor score, pre (1.86 ± 1.35) and post (1.6 ± 0.93) mean shoulder adductor muscles score, pre (2.4 ± 1.16) and post (2.2 ± 0.92) mean elbow flexor score, pre (1.8 ± 1.12) and post (1.5 ± 0.81) mean elbow extensor score, pre (2.86 ± 0.50) and post (2.5 ± 0.57) mean wrist flexor score, pre (1.03 ± 0.18) and post (1 ± 0) mean wrist extensor score in group B. Thus, task based mirror therapy is effective in improving the shoulder abductor-adductor, elbow and wrist muscle tone in stroke patients.

There was statistically significant difference for pre (4.43 ± 1.7) and post (6.4 ± 1.6) mean score of grip strength in group B. Thus, task based mirror therapy with hand dexterity training is effective in improving the grip strength in stroke patients.

The comparison of the two group scores was done using unpaired t test and Mann-Whitney test. There was no significant difference found in the pre (8.3 ± 2.2) and post (8.23 ± 1.8) MESUPES scale score between group A and B.

The pre and post intervention mean difference scores of MAS for shoulder muscles between group A and group B was analyzed using Mann-Whitney test. Statistically there was not significant difference found in the pre (0.13 ± 0.34) and post (0) shoulder flexor score, pre (0.2 ± 0.4) and post (0.06 ± 0.2) shoulder extensor score, pre (0.66 ± 0.47) and post (0.6 ± 0.1) shoulder abductor score, pre (0.20 ± 0.40) and post (0.26 ± 0.44.) shoulder adductor score.

The pre (0.60 ± 0.5) and post (0.26 ± 0.4) elbow flexor score, pre (1.73 ± 0.73) and post (0.26 ± 0.44) elbow extensor score showed that both groups showed significant differences for elbow muscle score. The pre (0.66 ± 0.47) and post (0.36 ± 0.49) wrist flexor score, and pre (0.10 ± 0.30) and post (0.03 ± 0.18) wrist extensor score showed that there were significant differences for wrist flexor muscle score.

The pre and post intervention mean difference score of grip strength between the data in group A and group B was analyzed using unpaired t test. The upper limb function mean difference score of Group A was 1.56 ± 1.19 and Group B was 1.96 ± 1.54. There was no significant difference between the groups.

Hence the results showed that both movement based mirror therapy and task based mirror therapy with conjunction with hand dexterity training are equally effective in improving the upper limb function, muscle tone and grip strength in stroke patients.

Table 1: Comparison of the mean and SD values of demographic distribution of age and MMSE in group A and group B.

Parameter	Mean (SD)		p value	t value	Result
	Group A	Group B			
Age	52.43 ± 11.98	54.03 ± 10.21	>0.05	0.55	Not Significant
MMSE	26.33 ± 1.37	26.53 ± 1.57	>0.05	0.52	Not significant

Table 2: Comparison of the gender distribution in group A and group B.

	Males	Females	Total
Group A	22 (73%)	8 (27%)	30
Group B	25 (83%)	5 (17%)	30

Table 3: Comparison of the demographic distribution of participants in Brunnstorm Recovery Stage in group A and group B.

	Stage 4	Stage 5
Group A	15 (50%)	15 (50%)
Group B	12 (40%)	18 (60%)

Table 4: Comparison of the pre and post mean values, SD and p values of MESUPES for group A

Parameter	Mean (SD)		p value	t value	Result
	Pre MESUPES score	Post MESUPES score			
Group A	39.93 ± 3.0	48.23 ± 3.7	< 0.05	20.52	Significant

Table 5: Comparison of the pre and post mean values, SD and Z values of MAS in shoulder muscles for group A

	Flexors		Extensors		Abductors		Adductors	
Group A	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean (SD)	1.16 ± 0.37	1.03 ± 0.18	1.33 ± 0.80	1.13 ± 0.50	2.86 ± 1.22	2.20 ± 0.84	1.73 ± 1.25	1.53 ± 0.93
p value	< 0.05		< 0.05		< 0.05		< 0.05	
Z value	-2.0		-2.45		-4.47		-2.44	
Result	Significant		Significant		Significant		Significant	

Table 6: Comparison of the pre and post mean values, SD, and Z values of MAS in elbow muscles for group A

Parameter Group A	Mean (SD)		p value	Z value	Result
	Pre score	Post score			
Elbow Flexors	2.7 ± 1.08	2.1 ± 0.88	< 0.05	-4.025	Significant
Elbow Extensors	1.63 ± 1.09	2.1 ± 0.88	> 0.05	-0.995	Not Significant

Table 7: Comparison of the pre and post mean values, SD and Z values of MAS in wrist muscles for group A

Parameter Group A	Mean (SD)		p value	Z value	Result
	Pre score	Post score			
Wrist Flexors	3.1 ± 0.43	2.4 ± 0.57	< 0.05	-4.472	Significant
Wrist Extensors	1.1 ± 0.30	1 ± 0	> 0.05	-1.732	Not Significant

Table 8: Comparison of the pre and post mean values, SD, and p values of grip strength for group A

Parameter	Pre-Grip Strength	Post- Grip Strength	p value	t value	Result
Group A	3.76 ± 1.6	5.33 ± 1.5	< 0.05	7.18	Extremely Significant

Table 9: Comparison of the pre and post mean values, SD and p values of MESUPES score for group B

Parameter	Mean (SD)		p value	t value	Result
	Pre MESUPES score	Post MESUPES score			
Group B	40.6 ± 2.4	48.8 ± 2.5	< 0.05	24.86	Significant

Table 10: Comparison of the pre and post mean values, SD and p values of MAS in shoulder muscles for group B

	Flexors		Extensors		Abductors		Adductors	
Group B	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mean (SD)	1 ± 0	1 ± 0	1.06 ± 0.25	1 ± 0	2.96 ± 1.35	2.3 ± 0.96	1.86 ± 1.35	1.6 ± 0.93
p value	> 0.05		> 0.05		< 0.05		< 0.05	
Z value	0		-1.414		-4.02		-2.828	
Result	Not Significant		Not Significant		Significant		Significant	

Table 11: Comparison of the pre and post mean values, SD, and p values of MAS in elbow muscles for group B

Parameter Group B	Mean (SD)		p value	Z value	Result
	Pre score	Post score			
Elbow Flexors	2.4 ± 1.16	2.2 ± 0.92	< 0.05	-2.121	Significant
Elbow Extensors	1.8 ± 1.12	1.5 ± 0.81	< 0.05	-2.828	Significant

Table 12: Comparison of the pre and post mean values, SD and p values of MAS in wrist muscles for group B

Parameter Group B	Mean (SD)		p value	Z value	Result
	Pre score	Post score			
Wrist Flexors	2.86 ± 0.50	2.5 ± 0.57	< 0.05	-3.317	Significant
Wrist Extensors	1.03 ± 0.18	1 ± 0	> 0.05	-0.317	Not Significant

Table 13: Comparison of the pre and post mean values, SD, and p values of grip strength for group B

Parameter	Pre-Grip Strength	Post- Grip Strength	p value	t value	Result
Group B	4.43 ± 1.7	6.4 ± 1.6	< 0.05	6.88	Significant

Table 14: Comparison of the pre and post mean, SD, P values of MESUPES for group A and group B

Parameters	Mean (SD)		p value	t value	Result
	Group A	Group B			
Pre-Post Diff Total MESUPES Score	8.3 ± 2.2	8.23 ± 1.8	> 0.05	0.127	Not Significant

Table 15: Comparison of the pre and post mean, SD, and p values of Modified Ashworth Scale for shoulder muscles for group A and group B

	Pre-Post Diff Score for Shoulder Flexors	Pre-Post Diff Score for Shoulder Extensors	Pre-Post Diff Score for Shoulder Abductors	Pre-Post Diff Score Shoulder Adductors
Group A	0.13 ± 0.34	0.2 ± 0.4	0.66 ± 0.47	0.20 ± 0.40
Group B	0	0.06 ± 0.2	0.6 ± 0.1	0.26 ± 0.44
p value		> 0.05	> 0.05	> 0.05
Mann-Whitney U-statistic		390	415	420
Result	It was not possible To analyze data Because one group's SD is zero.	Not Significant	Not Significant	Not Significant

Table 16: Comparison of the pre and post mean values of Modified Ashworth Scale for elbow muscles for group A and group B

Parameters	Mean (SD)		p value	Mann-Whitney U-statistic	Result
	Group A	Group B			
Pre-Post Diff Score for Elbow Flexors	0.60 ± 0.5	0.26 ± 0.4	< 0.05	311	Significant
Pre-Post Diff Score for Elbow Extensors	1.73 ± 0.73	0.26 ± 0.44	< 0.05	59	Significant

Table 17: Comparison of the pre and post mean values of Modified Ashworth Scale for wrist muscles for group A and group B

Parameters	Mean (SD)		p value	Mann-Whitney U-statistic	Result
	Group A	Group B			
Pre-Post Diff Score for Wrist Flexors	0.66 ± 0.47	0.36 ± 0.49	< 0.05	315	Significant
Pre-Post Diff Score for Wrist Extensors	0.10 ± 0.30	0.03 ± 0.18	> 0.05	420	Not Significant

Table 18: Comparison of the pre and post mean values of Grip Strength for group A and group B

Parameters	Mean (SD)		p value	t value	Result
	Group A	Group B			
Pre-Post Diff Score for Grip Strength	1.56 ± 1.19	1.96 ± 1.54	> 0.05	1.113	Not Significant

DISCUSSION

The present study was undertaken with the intention to see the effectiveness of movement based mirror therapy along with hand dexterity training versus task-based mirror therapy along with hand dexterity training on upper limb function, muscle tone and grip strength in patients with stroke using MESUPES, Modified Ashworth Scale and handheld dynamometer. Individuals were assessed for eligibility and total of 60 participants (MMT = 30, TMT = 30) according to the eligibility criteria were recruited for this study. No patient was dropped out from the study.

Upper limb paresis is one of the challenging manifestations in post stroke patients. Several underlying mechanisms for the effect of mirror therapy on motor recovery after stroke have been proposed. It was assumed that mirror therapy consists of three strategies. In one strategy, a subject watches the movements of his or her unaffected hand in a mirror and tries to imitate those movements with the affected hand. In another strategy, a subject mentally pictures the affected hand moving as desired (motor imagery). In the other strategy, a therapist assists in the movements of the affected hand so as to synchronize it with the movement of the unaffected hand in the mirror.[19]

Several mechanisms may explain the effects of mirror therapy on locomotion capacity. First, the mirror therapy facilitates recovery of locomotion ability by visually stimulating the hemiplegic upper limb using the reflection of the normal side.[8] Altschuler et al.[9] reported that the reflected image of the hemiplegic hand created the delusion that it was normal, which facilitated rehabilitation by replacing the lost proprioceptive sense to assist reconstruction of the total motor cortex and stimulation of whole-body activity. Funase et al.[20] demonstrated that passive observation and imitation of specific movements in mirror therapy stimulated activities of the spinal cord and cerebral cortex. Stevens and Stoykov[21] 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.[22] Garry et al[23] performed transcranial magnetic stimulation during mirror illusions 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. For example, it has been shown that passive observation of an action facilitates M1 excitability of the muscles used in that specific action.[24]

Second, the mirror neuron system accelerates the recovery of motor ability. The mirror neurons are visuomotor neurons activated when observing, imagining, or attempting to execute movements.[24] This is the theoretical framework of process of learning new exercise techniques through observation.[25] Stevens reported that mirror therapy was related to motor imagery and improved the motor activities of a hemiplegic extremity using the visual feedback brought on by imagined action.[21] Fadiga and Craighero46 demonstrated that the passive observation of motions through the mirror neuron system boosted activation of the primary motor area, which controlled the movements performed by the patient.

Thirdly, the simultaneous motion of both limbs induces additional stimulation of the paralyzed unilateral cerebral cortex through interactions with the stimulated normal cerebral cortex. Summers et al.[27] reported that exercising both the normal and hemiplegic sides was more effective in restoring upper limb functions and muscle strength than working the hemiplegic side alone. Cauraugh and Summers[28] hypothesized that concurrent exercise of both sides would control the excessive suppression of transmission due to balance between the hemiplegic and normal limbs. This hypothesis supports the conclusion that mirror therapy involving the exercise of both limbs is more effective than exercise of only the hemiplegic side.

In this study we found out that movement based mirror therapy with hand dexterity training is effective in improving upper limb function, muscle tone and grip strength in patients with stroke ($p < 0.01$). The results of the present study are in agreement with the study conducted by Christian Dohle, et al[16] (2009) studies “Mirror Therapy Promotes Recovery From Severe Hemiparesis: A Randomized Controlled Trial”. Regarding improvement of motor functions, it has been demonstrated that observation of mirrored distal movements enhances corticospinal excitability, similar to actual movement execution. It has been shown that movement observation modulates not only motor cortex excitability, but also cortical somatosensory representations.

In addition to the changes in wrist–hand, the present study exhibited significant motor recovery of the entire upper extremity. A number of studies that investigated the effect of mirror therapy on the upper limbs in chronic stroke patients have also reported improvements in the range, speed, and accuracy of movements as well as improvements in grip strength.[9,17,21]

Similarly, we found out that Task based Mirror therapy with hand dexterity is effective in improving upperlimb function, muscle tone and grip strength in patients with stroke ($p < 0.01$). The results of the present study are in agreement with the study conducted by Kamal Narayan Arya,et al "Task-Based Mirror Therapy Augmenting Motor Recovery in Poststroke Hemiparesis: A Randomized Controlled Trial".[15]

Mirror neuron system may be responsible for the effect of MT. The mirror neurons, present in the premotor cortex, get activated during observation of the goal-directed tasks such as reaching and picking up the food material. The activation is similar when the task is being performed. Furthermore, the mirror neuron activates separately for observation of object- and nonobject-related movements. The presence of object induces greater stimulation of the concerned cortical area. TMT allows integration of 2 therapeutic methods (mirror therapy and task-based training) in an undifferentiated way. It is assumed that such a method leads to a greater neural plasticity for the desired motor outcome. MT using tasks might have created illusion of bimanual task performance and functionally connected the 2 upper limbs to the ipsilateral brain.[3,27,29,30] Thus, task performance along with MT has potential benefit for improving motor impairment in stroke.

Clinically, quality of movement was found to be improved for many participants after TBMT; however, in the present study, no measure was used to assess such changes. Long-term intervention till the achievement of maximum independency in functional performance and subsequent follow-up were some of the other limitations of the study.[31]

When interpreting the differential effects of MMT and TMT in stroke rehabilitation, the nature of these two MT protocols needs to be considered. In our study, we found out that movement based mirror therapy was equally effective to task based mirror therapy in improving upper limb function in stroke patients. In task based mirror therapy group, participants were having difficulties doing the particular task while looking to its reflection in the mirror. This may be due to the reason that the tasks which were included in the protocol were not patient-based (client-chosen). During the training, the participants continuously exhibited the process of "fault and correction" owing to the increased complexity when performing the tasks in MT. The source of the increased complexity was mainly the mirrored spatial location. In the mirrored space, the spatial relationship among objects is opposite relative to real objects. Therefore, the increased complexity requires patients with stroke to manipulate their healthy hands carefully and may be the source of differential effects in motor impairment and functional performance.

When interpreting the effects of muscle tone and grip strength, both the groups i.e., movement based mirror therapy and task based mirror therapy showed improvement. Spasticity is defined as a motor disorder characterized by a velocity-dependent increase in the tonic stretch reflexes (muscle tone) with exaggerated tendon jerks.[1] Muscle stretching, a very popular exercise approach in athletic training programs, is primarily aimed at improving the viscoelastic properties of the muscle-tendon unit in order to reduce the risk of muscle tendon injury. It includes several types of muscle elongation procedures that can be applied by moving the joint through the range of motion (ROM) manually, or by means of different mechanical devices, to normalize muscle tone, maintain or increase soft-tissue extensibility, reduce contracture pain, and improve motor function.

The limitations of this present study were such as, only short-term effects were calculated, the age group was a wide range, and it was difficult to generalize the results to the entire population of hemiplegic patients. We were not able to conduct the follow-up assessment to observe the durability of the training effect. Further studies in the form of trial are needed to investigate the effects of MMT and TMT using different test measures. Also, the effects of MMT and TMT can be explored at various stages of stroke.

CONCLUSION

Both movement based mirror therapy and task based mirror therapy with conjunction with hand dexterity training are equally effective in improving the upper limb function, muscle tone and grip strength in stroke patients.

Declaration by Authors

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