ISSN: 2321-5690
IJOPT
INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL

INDIAN JOURNAL OF PHYSICAL THERAPY
AN INTERNATIONAL JOURNAL
editor.ijopt@gmail.com

COMPARISON BETWEEN MOVEMENT- BASED MIRROR THERAPY AND ACTIVITY-BASED MIRROR THERAPY ON THE OUTCOMES OF LOWER EXTREMITY MOTOR FUNCTION AND AMBULATION AMONG SUBACUTE STROKE PATIENTS

[1]Dr Anjali Sharma (PT), [2]Dr Amandeep Singh (PT), [3]Dr Umangpreet Kaur (PT), [4]Dr Reetika Soni (PT)

*[1]PG student in Neurophysiotherapy Department, anjali.sharma.27699@gmail.com
[2]Professor in Neurophysiotherapy Department, adsingh88@gmail.com
[3]PG student in Neurophysiotherapy Department, tarvinderkaur0104@gmail.com
[4]PG student in Neurophysiotherapy Department, sonireetika23@gmail.com
ASIMSR College, Baba Farid University, Ludhiana, Punjab.

***Corresponding Author:** anjali.shaarma.27699@gmail.com

DOI: https://doi.org/10.63299/ijopt.060330

ABSTRACT

Background: Stroke is characterized as a neurological deficit attributed to an acute focal injury of the central nervous system by a vascular cause. Mirror Therapy, introduced by Altschuler et al., improves upper and lower extremity motor recovery among post stroke patients.

Objective: The purpose of the study was to compare the effect of Movement- based and Activity-based Mirror Therapy on the outcomes of lower extremity motor function and ambulation among subacute stroke patients.

Methods: This was a quasi-experimental study, which is comparative in nature. Based on inclusion and exclusion criteria, 45 stroke patients of age 45-65 years were taken. The participants were divided into 3 groups as Group-A, B and C of 15 each. Group-A (Experimental 1) was administered Movement-based Mirror Therapy. Group-B (Experimental 2) was administered Activity-based Mirror Therapy and Group-C (Control) underwent Conventional Treatment. Participants received training 5 days/week for 4 weeks. Pre and Post scores were taken for motor function and ambulation using Motricity Index, Fugl Meyer Assessment, 10-meter Walk Test and Functional Ambulation Category.

Results: Data was meaningfully assorted through calculation of Mean and Standard Deviation. Thereafter, Paired 't' test were applied for intragroup Comparison at 0.05 level of significance and ANOVA was applied for intergroup comparison. All the groups showed improvement in intragroup analysis whereas, there was no significant difference between Movement-based Mirror Therapy group, Activity-based Mirror Therapy Group and Control group on the outcomes of lower extremity motor function and ambulation, except for Fugl Meyer Assessment which showed significant improvement in group which received Activity-based Mirror Therapy

Conclusion: Both Movement-based and Activity-based Mirror therapies are effective in improving the lower extremity motor function and ambulation among subacute stroke patients. However, Activity-based Mirror therapy appears to be superior to Movement-based Mirror Therapy in improving lower extremity motor function

Keywords: Activity-based mirror therapy; ambulation; lower extremity motor function; movement-based mirror therapy; subacute stroke.

INTRODUCTION

Stroke is a major neurological condition characterized by an acute focal injury to the central nervous system due to vascular causes such as cerebral infarction or hemorrhage1. It remains a leading cause of long-term disability globally, frequently resulting in motor impairments that severely affect the lower extremities. Although approximately 85% of post-stroke patients regain the ability to walk independently but they still are not able to achieve the speed and strength necessary for safe and functional ambulation in daily life. Thus, improving lower extremity motor function and ambulation is a critical goal in stroke rehabilitation.2

Mirror therapy (MT), initially was introduced in 1995 to treat phantom limb pain3, was later adapted for stroke rehabilitation in 1999.4 MT involves placing a mirror in the midsagittal plane, allowing patients to perform movements with the unaffected limb while watching its reflection, creating a visual illusion that stimulates motor recovery in the affected limb5. The effectiveness of MT is attributed to several neural mechanisms, including activation of the mirror neuron system during action observation and execution6, facilitation of the ipsilesional corticospinal pathways7, and compensation for reduced proprioceptive input from the affected side.8

Studies have demonstrated that MT improves motor function, balance, walking speed, and quality of life in post-stroke patients, especially during the subacute phase9. However, MT is more effective when the affected limb has limited mobility, and its benefits are maximized when combined with other rehabilitation techniques.

MT has two main branches, Movement-Based Mirror Therapy (MBMT), where patients perform simple functional movements10, and Activity-Based Mirror Therapy (ABMT), where patients engage in task-oriented activities using objects.11 While both approaches have shown benefits, there is a paucity of research directly comparing their effects on lower extremity motor function and ambulation. Thus, this study aimed to compare MBMT and ABMT to determine which method better improves lower limb motor recovery and walking ability among subacute stroke patients, thereby guiding more effective rehabilitation protocol.

Although MT has been widely studied for upper limb rehabilitation, its comparative application in lower limb recovery remains underexplored, and few studies available suggested that task-based therapies may activate the mirror neuron system more robustly than simple movement imitation, but still this assumption has yet to be validated in the context of lower limb rehabilitation during the critical subacute phase. Also, with the given prevalence of gait impairments post-stroke and the lack of clarity regarding which form of MT yields better functional outcomes, there is a need to investigate these two approaches. Thus this study therefore aims to compare MBMT and ABMT in improving lower extremity motor function and ambulation among subacute stroke patients, with the goal of informing evidence-based rehabilitation strategies.

METHODOLOGY

Study Design: A quasi-experimental, comparative study design was employed to evaluate and compare the effects of Movement-Based Mirror Therapy (MBMT) and Activity-Based Mirror Therapy (ABMT) on lower extremity motor function and ambulation in subacute stroke patients.

Study Setting: The study was conducted at All Saints Institute of Medical Sciences and Research (ASIMSR), Ludhiana, and affiliated hospitals/clinics in and around Ludhiana.

Sample Size: A total of 45 participants were included. Sample size was determined using OpenEpi Version 3 software, based on an effect size of 0.8, alpha level of 0.05, and power of 80%.

Ethical Considerations: The study was conducted after obtaining ethical clearance from the Institutional Ethics Committee of ASIMSR (Approval No.: 244/23) and institutional permission from Baba Farid University of Health Sciences

(BFUHS) (Consent letter reference: BFUHS/2K23p-TH/11702). Written informed consent was obtained from all participants prior to the initiation of study procedures.

Sampling Method and Sample Size

A purposive sampling technique was employed. Potential participants were identified and referred from affiliated neurology OPDs and inpatient rehabilitation units. After an initial screening against inclusion and exclusion criteria, eligible participants were provided with study information and enrolled upon consent. Random allocation into three equal groups (n=15 each) was performed using sealed envelopes.

Group A: Movement-Based Mirror Therapy (MBMT)

Group B: Activity-Based Mirror Therapy (ABMT)

Group C: Conventional Treatment (Control)

Inclusion criteria:

- Subjects between the age group of 45 to 65 years
- Subjects whose lower limb was involved
- Males and females
- First ever unilateral ischemic stroke
- Duration of stroke – subacute phase (1- 6 months)
- MMSE > or = 24 (sufficient cognitive ability to follow instructions)
- Brunnstrom stages 1- 4
- Modified Ashworth Scale score ≤ 2 for lower limb spasticity
- Patient must have been ambulatory before stroke
- Subjects who were willing to participate

Exclusion criteria:

- Person with visual defects, hearing defects and perceptual defects
- Person with hemianopsia, apraxia
- Spasticity > Grade 2 on Modified Ashworth Scale in lower extremity
- Musculo-skeletal disorders affecting mobility and operation of lower limbs
- Any other comorbid neurological diseases except stroke which may affect treatment protocol

Outcome Measures:

Motricity Index (MI): Assesses muscle strength by evaluating key movements in lower extremity including ankle dorsiflexion, knee extension, and hip flexion. Demonstrates excellent inter-rater and test-retest reliability in chronic stroke patients (ICC = 0.93)12.

Fugl-Meyer Assessment – Lower Extremity (FMA-LE): Assesses motor function post-stroke. Shows excellent reliability in subacute stroke populations (ICC = 0.96)13.

10-Meter Walk Test (10mWT): Evaluates gait speed over a 10-meter distance. Has strong test-retest reliability (ICC = 0.76)14 and is validated for stroke patients15.

Functional Ambulation Category (FAC): A 6-point ordinal scale assessing the level of human assistance required for ambulation. Exhibits high reliability in subacute stroke patients (ICC = 0.90)16.

Procedure:

Participants were screened based on the inclusion and exclusion criteria. Upon consent, 45 subjects were enrolled and randomly assigned to one of the three groups (n=15 per group). Baseline assessments were carried out on Day 0, and post-intervention assessments were conducted after 4 weeks of treatment by a blinded assessor.

Group A: Movement-Based Mirror Therapy (MBMT)

Participants received 30 minutes of MBMT along with 30 minutes of conventional therapy (total 1 hour/day), 5 days/week for 4 weeks. A mirror was positioned vertically between the lower limbs, with the affected limb placed behind and the unaffected limb in front of the mirror. Participants performed the following movements using the unaffected limb while viewing its reflection:

Long sitting: Hip-knee-ankle flexion; Hip and knee flexion with internal/external knee movement; Hip abduction with external rotation and adduction with internal rotation

Short sitting: Hip-knee-ankle flexion; Knee extension with ankle dorsiflexion; Knee flexion beyond 90°

Each movement was repeated for 2–4 sets of 10 repetitions. Participants were instructed not to move the paretic limb during sessions.14

Figure 1

Figure 2

Figure 1: Participant performing Hip abduction with external rotation followed by hip adduction with internal rotation

Figure 2: Participant performing Knee flexion beyond 90°

Group B: Activity-Based Mirror Therapy (ABMT)

Participants received 30 minutes of ABMT along with 30 minutes of conventional therapy (total 1 hour/day), 5 days/week for 4 weeks. The mirror setup was similar to that in MBMT.13 Activities included:

Activity	Target movement	Dosage
Ball rolling	Knee flexion-extension	10 reps X 2-4 sets
Ball rolling	Hip internal-external rotation	10 reps X 2-4 sets
Rocker board	Ankle dorsi-plantar flexion	10 reps X 2-4 sets
Rocker board	Ankle inversion-eversion	10 reps X 2-4 sets
Pedaling bin	Alternate ankle dorsi plantar flexion	10 reps X 2-4 sets
Ball kicking	Knee extension	10 reps X 2-4 sets
Wiping floor	Hip internal-external rotation	10 reps X 2-4 sets
Picking-releasing pen, pencil, pegs or marbles	Toe movements	10 reps X 2-4 sets
Pushing pillow side – ward	Hip abduction	10 reps X 2-4 sets
Pushing pillow forward	Knee flexion-extension, Ankle dorsi-plantar flexion	10 reps X 2-4 sets

Figure 3

Figure 3: Ball Kicking (Knee extension)

Group C: Control (Conventional Therapy Only)

Participants in this group received 30 minutes of conventional neurophysiological therapy (Brunnstrom and Bobath approaches)11 for the affected lower limb. Exercises included:

Techniques	Dosage
Weight bearing in standing on flat surface	2-3 mins
Weight bearing in standing on inclined wedge	2-3 mins
Movements using associated reactions	10 reps
Knee flexion control in prone position	10 reps
Active-assistive movements using activities (Ball, rocker board, pedo-cycle) for hip, knee and ankle in sitting position	10 reps for each

Figure 4

Figure 5

Figure 4: Pedo-cycling

Figure 5: Weight bearing in standing on flat surface.

Statistical Analysis

Analysis of raw data was done using SPSS software 20 version (IBM SPSS Statistics Inc Chicago, Illinois USA). The p value for statistical analysis was set at $p < 0.05$ with a confidence interval of 95%. Within the group comparison demonstrated that data is normally distributed checked by Shapiro wilk test, so parametric test were applied for the descriptive statistical analysis using Mean and Standard Deviation (SD) to summarize the central tendency and variability of outcome measures. For intragroup comparisons (pre- vs. post-intervention) within each group (Group-A: MBMT, Group-B: ABMT, Group-C: Control), paired t-tests were applied to determine the significance of changes in Motricity Index (MI), Fugl-Meyer Assessment of Lower Extremity (FMA-LE), 10-Meter Walk Test (10mWT), and Functional Ambulation Category (FAC).

For intergroup comparisons between Group-A, Group-B, and Group-C, One way ANOVA analysis was conducted on both pre-intervention and post-intervention scores to assess the effectiveness of each intervention, along with Tukey Kramer analysis.

RESULT

Baseline demographic variables, including age and gender distribution, along with pre intervention scores of all the outcome measures are tabulated in Table No. 1. No statistically significant differences were found in all the variables, indicating the homogeneity of the data across all the three groups.

Variables	Group A	Group B	Group C
Gender Female Male	5 (33%) 10 (67%)	7 (47%) 8 (53%)	6 (40%) 9 (60%)
Age	56.47±6.424	55.93±6.112	56.87±5.33
Motricity	30.47±6.3	31.47±5.805	32.73±6.352

Index (%)			
FMA-LE	14.20±2.513	15.13±2.416	15.0±2.33
Functional Ambulation Category	2.60±0.828	2.67±0.724	2.73±0.594
10 m walk test	70.07±24.763	67.07±22.24	67.80±15.594

Table No.1 Baseline Data across the groups

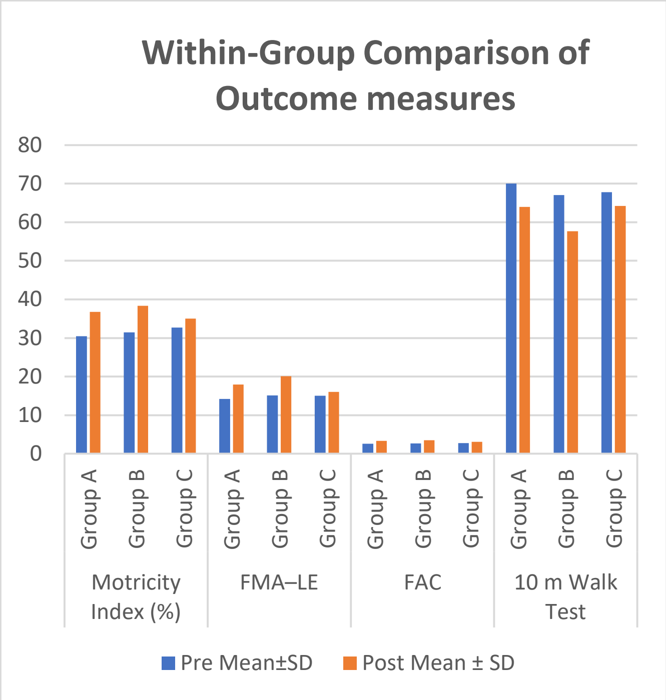
Within-Group Comparisons

Following the 4-week intervention, all three groups demonstrated statistically significant improvements from pre- to post-intervention across all outcome measures, including Motricity Index (MI), Fugl-Meyer Assessment for Lower Extremity (FMA-LE), Functional Ambulation Category (FAC), and 10-Meter Walk Test (10mWT) as shown in Table No. 2 and Figure No.1.

Group B (ABMT) showed the largest gains, particularly in FMA-LE ($t = 19.880$, $p < 0.05$), followed by Group A (MBMT) and Group C (CT). Similar trends were observed for MI, FAC, and 10mWT outcome measures as well.

Table No.2 Within-Group Comparison of Outcome Measures (Pre vs Post Intervention)

Outcome Measure	Group	Pre Mean± SD	Post Mean ± SD	t-value	p-value	Significance
Motricity Index (%)	Group A	30.47±6.30	36.73 ± 4.28	9.224	<0.05	Significant
	Group B	31.47±5.81	38.33 ± 4.42	12.875	<0.05	Significant
	Group C	32.73±6.35	35.00 ± 6.33	2.893	0.012	Significant
FMA–Lower Extremity	Group A	14.20±2.51	17.93 ± 2.52	13.148	<0.05	Significant
	Group B	15.13±2.42	20.07 ± 2.43	19.880	<0.05	Significant
	Group C	15.00 ± 2.33	16.00 ± 2.54	3.873	0.002	Significant
Functional Ambulation Category (FAC)	Group A	2.60 ± 0.83	3.33 ± 0.98	6.205	<0.05	Significant
	Group B	2.67 ± 0.72	3.53 ± 0.74	9.540	<0.05	Significant
	Group C	2.73 ± 0.59	3.07 ± 0.88	2.646	0.019	Significant
10-Meter Walk Test (sec)	Group A	70.07 ± 24.76	64.00 ± 23.86	15.092	<0.05	Significant
	Group B	67.07 ± 22.24	57.67 ± 21.11	17.356	<0.05	Significant
	Group C	67.80 ± 15.59	64.20 ± 16.24	11.225	<0.05	Significant



Graph No. 1: Graphical representation of Within-Group Comparison of Outcome measures

Between-Group Comparisons

The results of intergroup comparisons using one-way ANOVA are summarized in Tables No. 3 to 6 and Figures No. 2 to 5. At baseline, no significant differences were observed between the groups for any outcome measure, confirming statistical homogeneity ($p > 0.05$). Post-intervention, statistically significant differences were observed only for the FMA-LE scores ($F = 9.955$, $p < 0.001$). Post hoc analysis using the Tukey HSD method revealed that Group B showed significantly greater improvement compared to Group C (mean difference = 4.067, $p < 0.05$), while differences between Group A and Group B and between Group A and Group C were not significant.

Table No.3: ANOVA Comparison at Pre and after post score measurement of MI score between Group A, Group B and Group C.

	MOTORCITY INDEX (%)					
ANOVA	MOTORCITY INDEX PRE			MOTORCITY INDEX POST		
	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	GROUP C
MEAN	30.467	31.467	32.733	36.733	38.333	35.00
S.D.	6.300	5.805	6.352	4.284	4.419	6.325
NUMBER	15	15	15	15	15	15
MAX.	43	43	43	43	48	43
MIN.	24	24	24	29	33	24
Df	44			44		
F-TEST	0.511			1.606		
P-VALUE	0.604			0.213		
RESULT	Non-Significant			Non-Significant		
TUKEY HSD METHOD pairwise com.	v/s B v/s C v/s A			v/s B v/s C v/s A		
Result with mean diff.	1.00 N/Sig.	1.266 N/Sig.	2.266 N/Sig.	1.60 N/Sig.	3.333 N/Sig.	1.733 N/Sig.

Graph No.2: Graphical representation at Pre and after post score measurements of MOTORCITY INDEX (%) score between Group A, Group B and Group C.

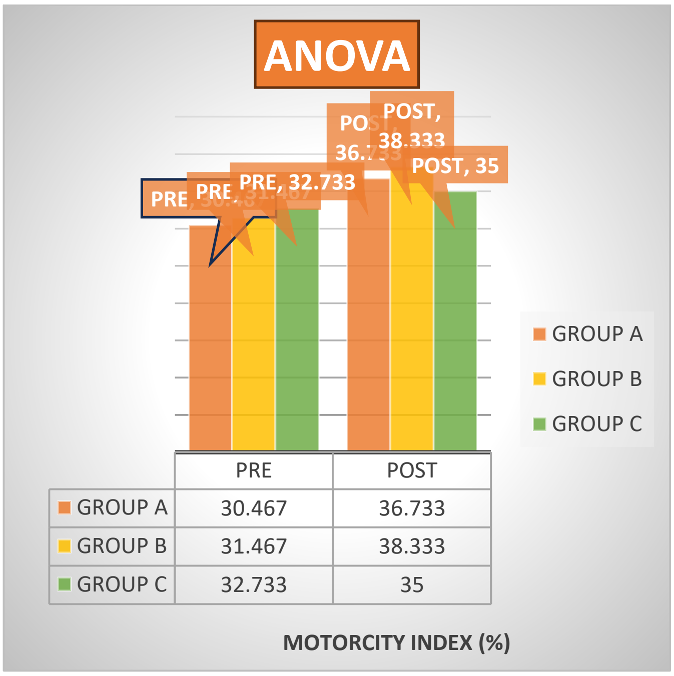


Table No. 4: ANOVA Comparison at Pre and after post score measurement of FMA-LE score between Group A, Group B and Group C.

ANOVA	FUGL MEYER ASSESSMENT-LE					
	FUGL MEYER ASSESSMENT PRE			FUGL MEYER ASSESSMENT POST		
	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	GROUP C
MEAN	14.20	15.133	15.00	17.933	20.067	16.00
S.D.	2.513	2.416	2.329	2.520	2.434	2.535
NUMBER	15	15	15	15	15	15
MAX.	18	18	18	21	23	20
MIN.	10	10	10	13	15	10
Df	44			44		
F-TEST	0.652			9.955		
P-VALUE	0.526			<0.001*		
RESULT	Not-Significant			Significant		
TURKEY'S METHOD pairwise com.	v/s B	v/s C	v/s A	v/s B	v/s C	v/s A
Result with mean diff.	0.933 N/Sig.	0.133 N/Sig.	0.80 N/Sig.	2.134 N/Sig.	4.067 Sig.	1.933 N/Sig.

Graph No. 3: Graphical representation at Pre and after post score measurements of FMA-LE score between Group A, Group B and Group C.

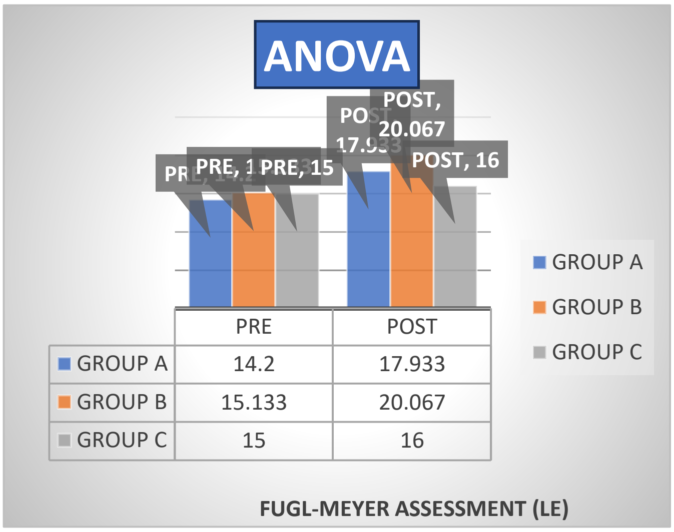


Table No. 5: ANOVA Comparison at Pre and after post score measurement of FAC score between Group A, Group B and Group C.

ANOVA	FUNCTIONAL AMBULATION CATEGORY					
	FUNCTIONAL AMBULATION PRE			FUNCTIONAL AMBULATION POST		
	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	GROUP C
MEAN	2.600	2.667	2.733	3.333	3.533	3.067
S.D.	0.828	0.724	0.594	0.976	0.743	0.884
NUMBER	15	15	15	15	15	15
MAX.	4	4	4	5	5	5
MIN.	1	1	2	1	2	2
Df	44			44		
F-TEST	0.128			1.079		
P-VALUE	0.880			0.349		
RESULT	Not-Significant			Not-Significant		
TURKEY'S METHOD pairwi	v/s B	v/s C	v/s A	v/s B	v/s C	v/s A

se com.						
Result with mean diff.	0.067 N/Sig.	0.066 N/Sig.	1.33 N/Sig.	0.20 N/Sig.	0.467 N/Sig.	0.266 N/Sig.

Graph No. 4: Graphical representation at Pre and after post score measurements of FAC score between Group A, Group B and Group C.

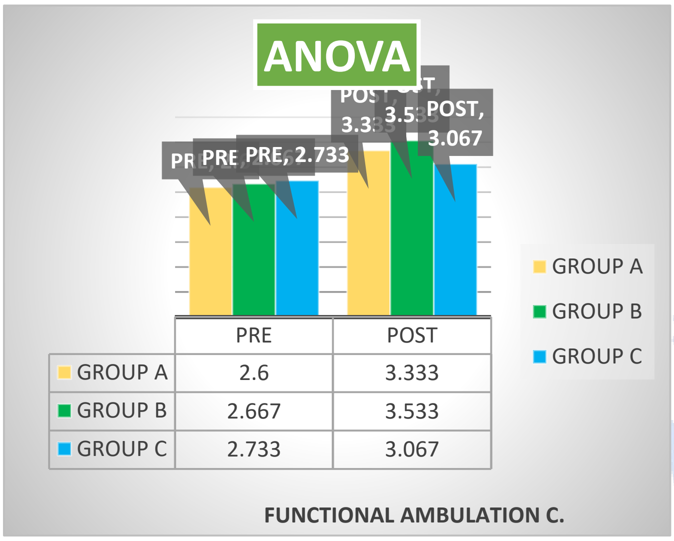
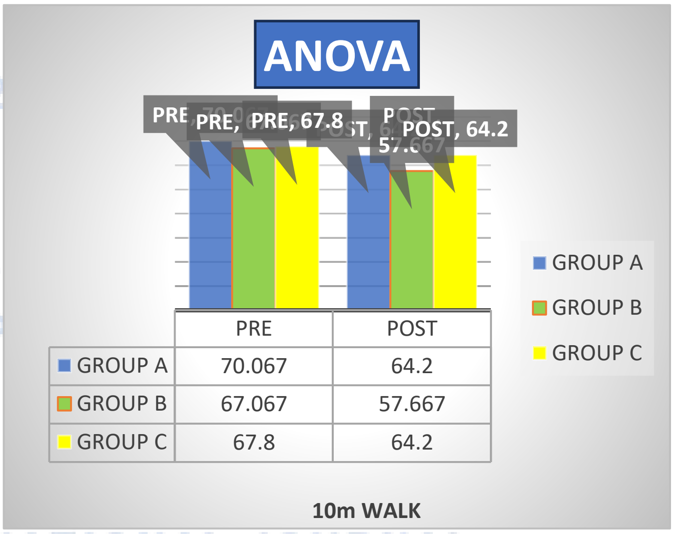


Table No. 6: ANOVA Comparison at Pre and after post score measurement of 10m WALK score between Group A, Group B and Group C.

	10m WALK					
ANOVA	10m WALK PRE			10m WALK POST		
	GROUP A	GROUP B	GROUP C	GROUP A	GROUP B	GROUP C
MEAN	70.067	67.067	67.800	64.20	57.667	64.20
S.D.	24.763	22.244	15.594	23.860	21.107	16.244
NUMBER	15	15	15	15	15	15
MAX.	125	119	96	117	110	94
MIN.	48	42	48	41	35	43
Df	44			44		
F-TEST	0.081			0.501		
P-VALUE	0.922			0.610		
RESULT	Not-Significant			Not-Significant		
TURKEY'S METHOD pairwise com.	v/s B v/s C v/s A			v/s B v/s C v/s A		

Graph No. 5: Graphical representation at Pre and after post score measurements of 10m WALK score between Group A, Group B and Group C.



DISCUSSION

This study evaluated and compared the effects of Movement-Based Mirror Therapy (MBMT), Activity-Based Mirror Therapy (ABMT), and Conventional Therapy (CT) on lower extremity motor function and ambulation in individuals with subacute stroke. All three groups demonstrated significant within-group improvements in motor recovery (Motricity Index and Fugl-Meyer Assessment for Lower Extremity) and functional mobility (10-Meter Walk Test and Functional Ambulation Category) following four weeks of intervention.

Among the interventions, ABMT produced the most prominent gains, particularly in the Fugl-Meyer Assessment of Lower Extremity (FMA-LE), where post-intervention scores were significantly higher in Group B compared to Group C. This suggests that

ABMT, which incorporates goal-directed and functionally relevant tasks, may more effectively stimulate the mirror neuron system than MBMT. The functional context of ABMT likely enhances cognitive and motor engagement, contributing to superior motor recovery outcomes.

These results align with previous studies, such as those by Arya et al.[11], who reported that task-based mirror therapy significantly enhanced FMA-LE scores in stroke patients. Similarly, Paik et al.[17,18] demonstrated that mirror therapy combined with task-oriented activities yielded better outcomes than movement imitation alone, reinforcing the effectiveness of ABMT in improving lower limb function. These findings support the theory that meaningful, action-oriented mirror therapy activates sensorimotor networks more robustly than passive or isolated movement observation.

Although improvements in ambulation outcomes were observed within all groups, no statistically significant intergroup differences were noted in either the Functional Ambulation Category (FAC) or 10-Meter Walk Test (10mWT). This is consistent with the findings of Mohan et al.[19], who also reported functional gains in ambulation following mirror therapy but without significant intergroup differences. The absence of significant between-group changes in ambulation may be attributed to the relatively short intervention period or the limited sensitivity of FAC and 10mWT in detecting subtle gait improvements over a short duration.

Notably, the FMA–LE was the only outcome measure to show consistent and significant intergroup differences post-intervention, highlighting its clinical utility and sensitivity in detecting motor changes in the lower extremity among subacute stroke patients. This reinforces the value of using FMA-LE as a primary measure in stroke rehabilitation research.

The rationale for preferring ABMT in clinical practice is grounded in the functional responsiveness of the mirror neuron system. Previous studies suggests that the mirror neuron system is more effectively activated by object- or goal-directed action observation than by passive, non-contextual movements. Hence, ABMT, through its integration of purposeful and functional movements, may provide a stronger stimulus for cortical motor reorganization and recovery in post-stroke patients. This could explain its superior effect compared to MBMT in facilitating lower limb motor function recovery of patients with stroke[16].

CONCLUSION

Both MBMT and ABMT are successful rehabilitation program for improving the lower limb motor function and ambulation among population of subacute stroke. Though, null hypothesis was accepted and alternate hypothesis was rejected. There was certainly no significant difference between the actual effect of MBMT and ABMT on all the parameters of motor function and ambulation except Fugl Meyer Assessment-LE. Nevertheless, ABMT appears to be at higher ranking as compared to MBMT for improving lower extremity motor function.

LIMITATIONS AND FUTURE SCOPE

This study was limited by a relatively small sample size and a short 4-week intervention period. Furthermore, lack of blinding and absence of follow-up assessments restrict generalizability. Future studies should involve multicentric recruitment, extended follow-up, and integration of advanced neurophysiological tools to validate findings.

DECLARATION BY AUTHORS

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

11 Sacco RL, Kasner SE, Broderick JP et al. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013 Jul;44(7):2064-89.

12 May Hİ, Özdolap Ş, Mengi A, Sarıkaya S. The effect of mirror therapy on lower extremity motor function and ambulation in post-stroke patients: A prospective, randomized controlled study. Turkish Journal of Physical Medicine and Rehabilitation. 2020 Jun;66(2):154

13 Ramachandran VS, Rogers-Ramachandran D, Cobb S. Touching the phantom limb. Nature. 1995 Oct 12;377(6549):489-90.
14 Altschuler EL, Wisdom SB, Stone L, Foster C, Galasko D, Llewellyn DM, Ramachandran vs. Rehabilitation of hemiparesis after stroke with a mirror. The Lancet. 1999 Jun 12;353(9169):2035-6.
15 Hung GK, Li CT, Yiu AM, Fong KN. Systematic review: Effectiveness of mirror therapy for lower extremity post-stroke. Hong Kong Journal of Occupational Therapy. 2015 Dec;26(1):51-9.
16 Brunner IC, Skouen JS, Ersland L, Grüner R. Plasticity and response to action observation: a longitudinal FMRI study of potential mirror neurons in patients with subacute stroke. Neurorehabilitation and Neural Repair. 2014 Nov;28(9):874-84.
17 Michielsen ME, Smits M, Ribbers GM et al. The neuronal correlates of mirror therapy: an fMRI study on mirror induced visual illusions in patients with stroke. Journal of Neurology, Neurosurgery & Psychiatry. 2011 Apr 1;82(4):393-8.
18 Sütbeyaz S, Yavuzer G, Sezer N, Koseoglu BF. Mirror therapy enhances lower-extremity motor recovery and motor functioning after stroke: a randomized controlled trial. Archives of Physical Medicine and Rehabilitation. 2007 May 1;88(5):555-9.
19 Sameer AM, Afolabi H, Sheikh A et al. The effectiveness of mirror therapy on lower extremity motor function among stroke patients: A review. Altamash Journal of Dentistry and Medicine. 2022 Apr 20;1(1):1-8.
20 Yavuzer G, Selles R, Sezer N et al. Mirror therapy improves hand function in subacute stroke: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2008 Mar 1;89(3):393-8.
21 Arya KN, Pandian S, Kumar V. Effect of activity-based mirror therapy on lower limb motor-recovery and gait in stroke: a randomized controlled trial. Neuropsychological Rehabilitation. 2019 Sep 14;29(8):1193-210.
22 Fayazi M, Dehkordi SN, Dadgoo M, Salehi M. Test-retest reliability of Motricity Index strength assessments for lower extremity in post stroke hemiparesis. Medical journal of the Islamic Republic of Iran. 2012 Feb; 26(1):27.
23 Peters DM, Fritz SL, Krotish DE. Assessing the reliability and validity of a shorter walk test compared with the 10-meter walk test for measurements of gait speed in healthy, older adults. Journal of Geriatric Physical Therapy. 2013 Jan 1;36(1):24-30.
24 Busk H, Holm P, Skou ST, Seitner S, Siemsen T, Wienecke T. Inter-rater reliability and agreement of 6-minute walk test and 10-meter walk test at comfortable walk speed in patients with acute stroke. Physiotherapy Theory and Practice. 2022 Feb 10:1-9.
25 Mehrholz J, Wagner K, Rutte K, Meibner D, Pohl M. Predictive validity and responsiveness of the functional ambulation category in hemiparetic patients after stroke. Archives of Physical Medicine and Rehabilitation. 2007 Oct 1;88(10):1314-9.
26 Bai Z, Zhang J, Zhang Z, Shu T, Niu W. Comparison between movement-based and task-based mirror therapies on improving upper limb functions in patients with stroke: a pilot randomized controlled trial. Frontiers in Neurology. 2019 Mar 26; 10:288.
27 Paik YR, Kim SK, Lee JS, Jeon BJ. Simple and task-oriented mirror therapy for upper extremity function in stroke patients: a pilot study. Hong Kong Journal of Occupational Therapy. 2014 Jun;24(1):6-12.
28 Haji Alizade N, Abdolvahab M, Bagheri H et al. The effect of task-based mirror therapy on upper limb functions and activities of daily living in patients with chronic cerebrovascular accident: A randomized control trial. Journal of Basic and Clinical Pathophysiology. 2017 Mar 1;5(1):1-2.
29 Mohan U, Kumar KV, Suresh BV, Misri ZK, Chakrapani M. Effectiveness of mirror therapy on lower extremity motor recovery, balance and mobility in patients with acute stroke: A randomized sham-controlled pilot trial. Annals of Indian Academy of Neurology. 2013 Oct;16(4):634