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Effectiveness of Mirror Therapy on Sitting Dynamic Balance Skills Among Individuals with Chronic-Stroke

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Abstract:

- ***Background:***

Individuals with Chronic Stroke often struggle with sitting dynamic balance, which is crucial for performing daily activities such as transferring, dressing, and feeding. Impaired sitting balance can significantly impact their ability to perform Activities of Daily Living (ADL) tasks, compromising their independence and quality of life. Mirror therapy is a novel approach, has shown promising improvement in motor function. This study investigates the effectiveness of mirror therapy on sitting dynamic balance skills in chronic stroke patients, with the potential to enhance their ability to perform ADL tasks and regain independence in daily life.

- ***Method:***

A quasi-experimental (Single group Pre and Post-test) study design was conducted. Stroke patients aged 35-65 years were screened and then selected based on inclusion and exclusion criteria with convenient sampling method. Over the course of 12 weeks, a single group will receive an intervention would be carried out for 20 minutes of each session, twice a week.

- ***Results:***

The collected data were analyzed statistically using the Statistical Package for the Social Sciences (SPSS), version 29. An independent samples t-test was applied to compare the outcomes between groups. The findings showed a statistically significant difference in the overall pre- and post-intervention scores between the control and experimental groups. A significant improvement ($p < 0.05$) was also observed in sitting dynamic balance when comparing the two groups. These results indicate that mirror therapy was effective in enhancing sitting dynamic balance abilities in individuals with chronic stroke.

- ***Conclusion:***

This study demonstrates the effectiveness of mirror therapy in improving sitting dynamic balance skills among patients with chronic stroke. It highlights the potential of mirror therapy as a valuable adjunct to traditional rehabilitation approaches.

Keywords: *Chronic Stroke ,Sitting Dynamic Balance ,Mirror Therapy.*

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I. INTRODUCTION

➢ *Stroke*

Stroke is characterized by the rapid development of neurological deficits resulting from disturbances in cerebral blood circulation. It is broadly classified into two major types: ischemic stroke and hemorrhagic stroke. Ischemic stroke occurs when blood flow to the brain is reduced or blocked because of narrowing or occlusion of blood vessels, leading to inadequate oxygen and glucose delivery to the central nervous system. Hemorrhagic stroke, in contrast, results from bleeding within the brain tissue or surrounding areas.

Based on the diagnostic criteria established by the World Health Organization (WHO), approximately 51.7% of stroke cases were identified as ischemic, while 48.3% were hemorrhagic in nature. Among the associated risk factors, hypertension was reported most frequently (75.9%), followed by a positive family history (33.6%), alcohol use (22.4%), smoking (17.2%), and heart failure (17.2%).

Regarding clinical presentation, motor dysfunction was the most commonly observed feature, affecting 90.5% of patients. Other reported symptoms included headache (39.8%), dysarthria (35.2%), sensory deficits (27.3%), vomiting (22.3%), and dysphasia (15.67%). Carotid bruit was the least frequently noted sign, occurring in only 0.3% of cases.

➢ *Balance and Stroke*

Impairments in balance, resulting from altered sensory and motor control, frequently occur after stroke. Approximately 80% of first-time stroke survivors experience balance disabilities. Trunk impairment, restricted balance and impaired postural control increase fall risk and mobility issues, leading to disability and dependence.The core plays a vital role in kinetic chains, influencing upper and lower extremity function. Enhanced core strength, balance and motion optimizes overall functional ability. A stable core enables efficient lower limb use.(15)

Mirror therapy is considered a simple, affordable, and non-invasive intervention that was initially introduced for the management of phantom limb pain. V. S. Ramachandran and Diana Rogers-Ramachandran first described the use of mirror-induced visual illusions as a therapeutic method. In this technique, a mirror is positioned along the patient's midsagittal plane, with the unaffected limb placed in front of the mirror while the affected limb remains hidden behind it. As the unaffected limb moves, the reflected image creates the perception that the affected limb is moving normally.

Research has shown promising outcomes of mirror therapy in individuals with stroke. A Cochrane review published in 2012 reported randomized controlled trials with appropriate methodology supporting its effectiveness. Altschuler et al. demonstrated improvements in upper extremity joint range of motion, movement speed, and movement accuracy among stroke patients receiving mirror therapy. Similarly, Sathian et al. found that after two weeks of treatment, individuals with chronic stroke showed better hand function and increased grip strength in the affected limb.

Most previous studies have mainly examined the influence of mirror therapy on upper limb recovery. However, lower limb impairment following stroke can greatly reduce balance, mobility, and independence in daily activities. Therefore, additional research is needed to determine the potential benefits of mirror therapy for balance control and lower extremity functions

Coordination refers to the capacity to perform smooth, precise, and well-controlled movements. Following a stroke, damage to specific areas of the brain can interfere with the normal integration of motor, sensory, cognitive, and emotional processes. As a result, many individuals experience difficulty in coordinating body movements, maintaining postural stability, and carrying out skilled tasks that require accuracy.

These impairments may reduce a person's ability to perform everyday activities independently and can negatively influence overall quality of life. Difficulties with coordination also create additional barriers during the rehabilitation process, often slowing functional recovery. Several studies have reported that nearly 50–70% of individuals who survive a stroke demonstrate motor coordination problems during the early stage after the event.

II. AIM AND OBJECTIVES

➢ *Aim:*

To determine the effectiveness of mirror therapy in improving sitting dynamic balance skills among individuals with chronic stroke.

➢ *Objectives:*

- To assess sitting dynamic balance skills of individuals with chronic stroke**.**
- To provide mirror therapy intervention for, 5 sessions per week,4 weeks
- To reassess the sitting dynamic balance skills of individuals with chronic stroke after the intervention.
- To compare the pre-test and post-test scores in order to evaluate the effectiveness of mirror therapy on sitting dynamic balance skills among individuals with chronic stroke.

III. REVIEW OF LITERATURE

➢ *(Uthra Mohan, et al.,2013) conducted a study a Effectiveness of mirror therapy on lower extremity motor recovery, balance and mobility in patients with acute stroke: A randomized sham-controlled pilot trial .*

This study explored the effectiveness of mirror therapy in promoting lower limb motor recovery, balance, and mobility among individuals with acute stroke. A randomized, sham-controlled, assessor-blinded pilot trial

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design was used. The research was conducted in an inpatient stroke rehabilitation setting.

Participants included patients experiencing their first episode of stroke, with an average post-stroke duration of 6.41 days, who were able to understand and follow verbal commands. Only individuals classified at Brunnstrom recovery stage 2 or higher were selected for inclusion.

Patients in the mirror therapy group performed functional synergy movements using the non-paretic lower limb for 30 minutes, while the control group received sham therapy for an equal duration. In addition to these interventions, both groups continued to receive standard stroke rehabilitation treatment.

Outcome measures included the lower extremity motor section of the Fugl-Meyer Assessment (FMA), the Brunel Balance Assessment (BBA), and the Functional Ambulation Categories (FAC). A total of 22 participants were enrolled, with 11 individuals assigned to each group. Baseline characteristics were comparable between groups, except for Brunnstrom recovery stage.

The findings showed no statistically significant differences between groups in FMA and BBA scores. However, the mirror therapy group demonstrated a significant improvement in FAC scores ($P = 0.02$). These results indicate that mirror therapy may not provide greater benefits than conventional rehabilitation for lower limb motor recovery or balance in acute stroke patients, although it may contribute positively to functional mobility.

- *(Myoung-Kwon Kim et al.,2016) conducted a study on the Effects of mirror therapy on balance ability in patients with subacute stroke.*

The study was conducted to investigate the impact of mirror therapy on balance performance in individuals with subacute stroke. Participants were randomly divided into two groups: a mirror therapy group ($n = 17$) and a sham therapy group ($n = 17$).

The experimental group received a combination of mirror therapy and conventional rehabilitation, totaling 60 minutes per session. This included 30 minutes of mirror therapy followed by 30 minutes of routine rehabilitation, with a 10-minute rest interval during the session. Treatment was provided five days per week for four consecutive weeks.

The control group underwent sham therapy along with conventional rehabilitation for the same total duration of 60 minutes per day, following an identical schedule.

Balance outcomes were assessed using a balance measurement system, which generated Balance Index (BI) scores. The findings revealed statistically significant improvements in the experimental group compared with the control group in the overall stability index as well as the medial and lateral stability indices ($p < 0.05$).

These results indicate that mirror therapy may serve as an effective intervention for enhancing balance ability in patients recovering from subacute stroke.

- *(Hyun-Gyu Chaa and Duck-Won Ohb et al,.2016) conducted a study Effects of mirror therapy integrated with task-oriented exercise on the balance function of patients with post stroke hemiparesis: a randomized-controlled pilot trial*

This study investigated the effectiveness of combining mirror therapy with task-oriented exercise to improve balance in individuals with post-stroke hemiparesis. A randomized controlled trial design was used, in which 20 participants were allocated to either an experimental group or a control group.Both groups participated in a four-week exercise program focused on strengthening the lower limbs and practicing functional balance-related tasks. In addition to the standard program, the experimental group received visual feedback through the use of mirrors during training sessions.The findings demonstrated significant improvements in balance measures, including scores on the Berg Balance Scale and the Timed Up-and-Go Test.These results suggest that incorporating mirror therapy into task-oriented exercise programs may enhance balance rehabilitation outcomes in individuals with post-stroke hemiparesis.

IV. METHODOLOGY

- *Research Design*:
  Quasi experimental study

- *Study Setting:*
  The study was carried out in the Occupational Therapy Unit, Department of Therapeutics, National Institute for Empowerment of Persons with Multiple Disabilities (NIEPMD), Chennai.

- *Sampling Technique:*
  Convenience sampling method was used for the selection of participants.

- *Sample Population:*
  Individuals who have been diagnosed with chronic stroke with having issues with sitting dynamic balance skills

- *Sample Size:*
  Sample size (n) = 10

- *Variables:*

- Dependent variables:-Sitting Dynamic Balance Skills of individuals with chronic stroke
- Independent Variable: Mirror Therapy

- *Screening Criteria*

- *Inclusion Criteria*

✓ Sufficient cognitive ability to follow the instructions (MMSE >23)(26)

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- ✓ Brunnstrom stage 4 and above
- ✓ Individuals with 6 months after onset of stroke

- *Exclusion Criteria*

- ✓ Any Musculoskeletal disorder and post operative condition of the lower extremities
- ✓ Restricted range of motion of the lower extremities.
- ✓ Psychological or emotional problems.

➢ *Screening Tool Used:*

- *Mini Mental State Examination (MMSE)*

The Mini Mental State Examination (MMSE) is a commonly used screening instrument for evaluating cognitive function, particularly in older adults. Cognitive decline is an important concern in this age group, and identifying it at an early stage can support timely management and intervention.

The MMSE consists of 11 items designed to assess five major cognitive domains: orientation, registration, attention and calculation, recall, and language abilities. It is brief, practical, and usually requires only 5 to 10 minutes to complete, which makes it suitable for regular use in clinical settings as well as follow-up assessments.

The tool is useful for detecting possible cognitive impairment, and scores of 23 or below are often considered suggestive of cognitive deficits. However, it should be recognized that the MMSE functions primarily as a screening measure rather than a definitive diagnostic test.

Reliability: The MMSE has good test- retest reliability, with a coefficient of 0.80 - 0.95

➢ *Tool Used*

- *Berg Balance Scale*

The Berg Balance Scale is a five-point ordinal rating scale in which each item is scored from 0 to 4, with a maximum total score of 56. It is commonly used to assess balance performance and functional mobility. Administration of the test usually takes approximately 15 to 20 minutes. Basic equipment required for the assessment includes a stopwatch, ruler, chair, step or stool, and an object that can be lifted from the floor**.** This scale was first used to assess elderly individuals over the years it has been used for neurological conditions like stroke, Parkinson etc. There are 14 tasks in this scale which assess both static and dynamic balance.

- *Interpretation of Berg Balance Scale Scores:*

0–20: Indicates severe balance impairment; individual may be wheelchair dependent.
21–40: Suggests moderate balance impairment; walking is usually possible with assistance.
41–56: Reflects better balance ability and functional independence.

The scale has demonstrated excellent reliability, with an intra-rater reliability of 0.97 and an inter-rater reliability of 0.98 as reported by K. Berg et al. (1995).

V. PROCEDURE

- ➢ The objectives and procedures of the study were clearly to all participants and their caregivers.
- ➢ Written informed consent was obtained from the participants or, when necessary, from their caregivers before the commencement of the study.
- ➢ Privacy and confidentiality of all collected information were maintained throughout the research process.
- ➢ Participants were recruited using a convenience sampling method. The study was carried out in the Department of Occupational Therapy at National Institute for Empowerment of Persons with Multiple Disabilities (NIEPMD), Chennai.
- ➢ Ten individuals with chronic stroke who met the predetermined inclusion and exclusion criteria were enrolled in the study.
- ➢ Baseline assessment of all participants was performed using the Berg Balance Scale (BBS).
- ➢ Eligible participants were randomly allocated to either the experimental group or the control group.
- ➢ Both groups received conventional therapy for 30 minutes prior to their respective intervention sessions.
- ➢ The experimental group underwent 30 minutes of mirror therapy, five days per week, for a duration of four weeks.
- ➢ The control group received 30 minutes of sham therapy, five days per week, for four weeks**.**
- ➢ The mirror therapy sessions involved performing functional movements of the non-paretic lower limb in front of a mirror, which created a reflective illusion of the paretic limb moving.
- ➢ After completing the 4 week intervention, the participants were reassessed using the BBS test
- ➢ The collected data were analyzed using the SPSS software.
- ➢ Descriptive statistics and inferential statistics were used to compare the pre-test and post-test scores of the mirror therapy group and the control group
- ➢ The results of the study were obtained and interpreted in the context of the research question.
- ➢ The findings of the study were used to determine the effectiveness of mirror therapy on sitting dynamic balance skills among individuals with chronic-stroke.

VI. INTERVENTION PROTOCOL

Participants in the experimental group underwent a combined intervention consisting of mirror therapy and conventional rehabilitation for a total duration of 60 minutes per session, including 30 minutes of mirror therapy and 30 minutes of conventional rehabilitation. The treatment program was administered five days per week for four consecutive weeks.

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A. Control Group

➢ *Conventional Rehabilitation Therapy*

- *Facilitation Techniques and Sensory-Motor Re-Education (10 Minutes)*

Conventional rehabilitation therapy included neurodevelopmental facilitation techniques. Participants in the control group received sham therapy along with conventional rehabilitation for a total of 60 minutes per session, consisting of 30 minutes of sham therapy and 30 minutes of conventional rehabilitation on the same day.

- *Active Exercises and Mobility Training (10 Minutes)*

✓ Sit-to-Stand: Practice transitions with therapist assistance, ensuring proper foot placement and symmetrical effort.
✓ Reaching Tasks: Encourage the patient to reach forward or sideways while maintaining stability in a seated or standing position.

- *Balance and Gait Training (10 Minutes)*

✓ Facilitate walking on a flat surface
✓ Practice maintaining balance while standing and stepping over obstacles (23)

➢ *Sham Therapy (for Control Group)*

- Duration and Frequency: Participate in sham therapy for 30 minutes, 5 days a week, for 4 weeks .(16)
- Setup: Position the mirror between the two lower extremities, with the non reflective surface facing the non-paretic limb.
- Exercises: the non-reflecting surface of the mirror was kept facing the non-paretic limb

Perform the following exercises in 2 sets of 10 repetitions:

✓ Hip-knee-ankle flexion
✓ Knee extension with ankle dorsiflexion
✓ Knee flexion beyond 90°
✓ Restrictions: Only move the non-paretic lower limb during sham therapy. Do not move the paretic limb.

B. Experimental Group

➢ *Conventional Rehabilitation Therapy (Ndt)*

- *Facilitation Techniques and Sensory-Motor Re-education (10 minutes)*

Reflex-Inhibiting Postures: Place the affected limb in extended or neutral positions to reduce spasticity (e.g., shoulder abduction with elbow extension).

Encourage side-to-side weight shifts in sitting or standing while focusing on proper alignment.

- *Active Exercises and Mobility Training (10 minutes)*

✓ Sit-to-Stand: Practice transitions with therapist assistance, ensuring proper foot placement and symmetrical effort.
✓ Reaching Tasks: Encourage the patient to reach forward or sideways while maintaining stability in a seated or standing position.

- *Balance and Gait Training (10 minutes)*

✓ Facilitate walking on a flat surface
✓ Practice maintaining balance while standing and stepping over obstacles (23)

➢ *Mirror Therapy Program (for Mirror Group)*

- Duration and Frequency: Participate in an additional 30 minutes of mirror therapy program, 5 days a week, for 4 weeks .(16)
- Setup: Position the mirror between the two lower extremities, with the reflective surface facing the non-paretic limb. Mount the mirror with a tilt towards the paretic side to prevent the paretic limb from being viewed.
- Exercises in Sitting Position: Perform the following exercises in 2 sets of 10 repetitions:

✓ Hip-knee-ankle flexion
✓ Knee extension with ankle dorsiflexion
✓ Knee flexion beyond 90°
✓ Restrictions: Only move the non-paretic lower limb during mirror therapy. Do not move the paretic limb.

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VII. PROCEDURAL FLOW CHART

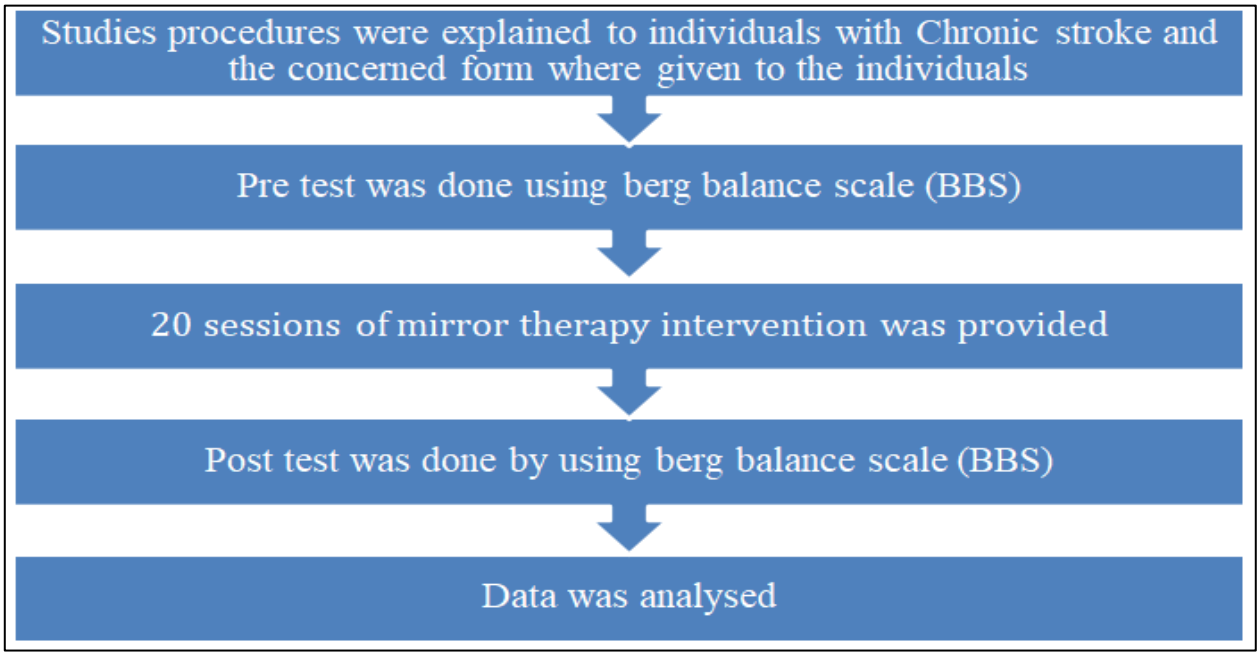

Fig 1 Procedural Flow Chart

VIII. RESULTS

Table1 Descriptive Statistics for Age

n= 10	Range	Mean	S.D
Age(years)	39 to 51	44.80	3.94

The participants' ages ranged from 39 to 51 years, with a mean age of 44.80 ± 3.94 years.

Table 2 Distribution of Gender and Groups

		Frequency	%
Gender	Male	6	60
	Female	4	40
Groups	Experimental	5	50
	Control	5	50

Among the 10 participants, majority were male (60%); and 40% were females. The experimental group consists of 50% of the participants; and the control group includes 50% .

Table 3 Comparison of Sitting Dynamic Balance Scores within the Groups.

		Mean	S.D.	"t"	p value
Experimental group	Pre-test	40.80	2.17	-8.44	0.001*
	Post-test	47.00	3.08		
Control group	Pre-test	38.20	2.95	-1.73	0.160
	Post-test	39.20	3.11		

The paired t-test was applied to compare sitting dynamic balance scores within each group. A statistically significant improvement ($p < 0.05$) was observed in the experimental group. In contrast, the control group showed no significant change ($p > 0.05$) in sitting dynamic balance between the pre-test and post-test assessments.

Table 4 Comparison of Sitting Dynamic Balance Between Groups

Total score		Mean	S.D	"t"	p value
Pre-test	Experimental group	40.80	2.17	1.59	0.151
	Control group	38.20	2.95		
Post-test	Experimental group	47.00	3.08	3.67	0.006*
	Control group	39.80	3.11		

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The independent samples t-test was used to compare sitting dynamic balance scores between the groups. During the pre-test assessment, no significant difference ($p > 0.05$) was observed in dynamic balance between the experimental and control groups. However, during the post-test assessment, a statistically significant difference ($p < 0.05$) in sitting dynamic balance was found between the two groups.

Table 5 Comparison of Effectiveness (Pre-Post) in Sitting Dynamic Balance Between Groups

Effectiveness		Mean	S.D.	"t"	p value
Total score (Pre-post)	Experimental group	-6.20	1.64	-3.89	0.005*
	Control group	-1.60	2.07		

The independent sample "t test" was used to compare effectiveness in sitting dynamic balance between groups. There was a Rajesh significant difference ($p<0.05$) in the effectiveness in sitting dynamic balance between the groups.

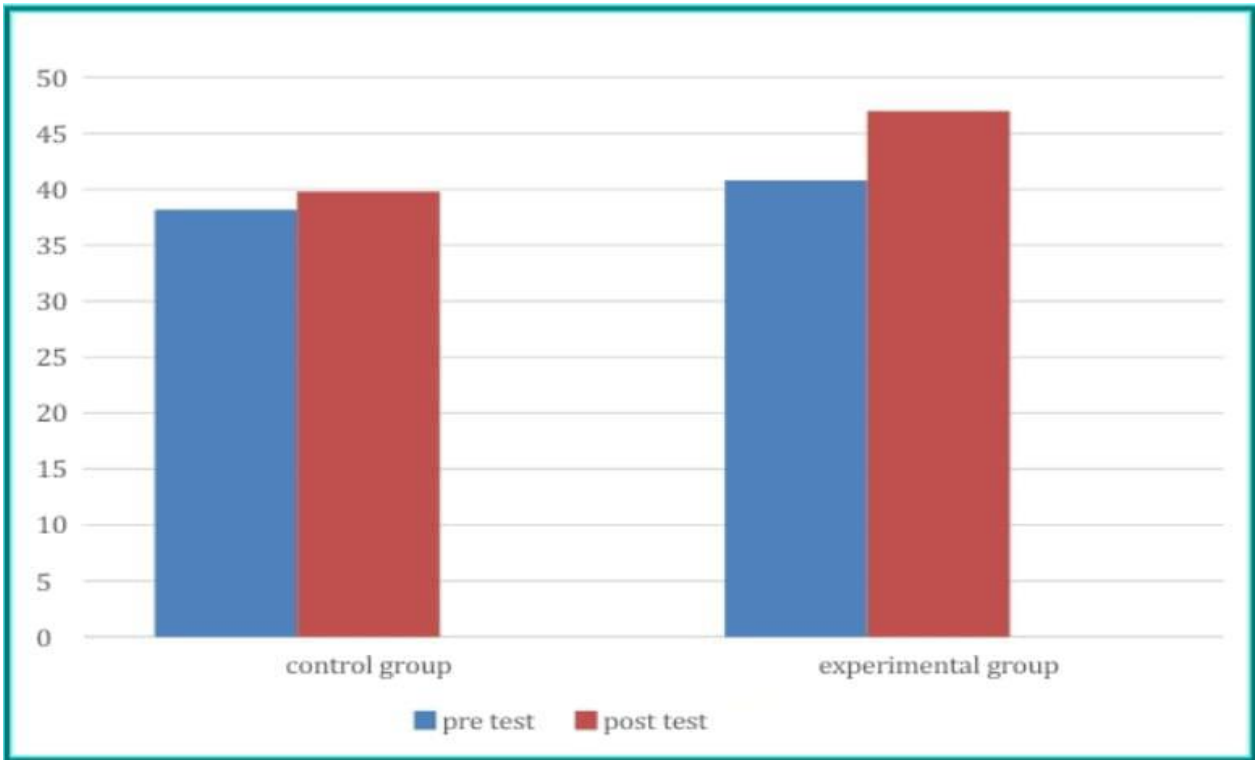

Fig 1 Sitting Dynamic Balance According to Groups

IX. DISCUSSION

This study aimed to assess effectiveness of mirror therapy on sitting dynamic balance skill among individuals with chronic stroke. This research focuses on sitting dynamic balance since it requires more complex physical, neurological and sensory components such as core stability, postural alignment , weight shifting, trunk control, proprioception, coordination and ADLskills.As mentioned in the study by Myoung -Kwon Kim and Sang-Gu Ji , a significant difference in post training gains for the overall stability index and medial and lateral stability index was observed between the two groups. This study suggests that mirror therapy shows a positive result in improving static dynamic balance among individuals with stroke.These finding align with the results of others studies ,such as those by Wouter J. Harmsen and Johannes B. J. Bussmann , which suggests that mirror therapy–based Action observer protocol contributes to motor learning after stroke and improve sitting dynamic balance among individuals with chronic-stroke.The results of this analysis were performed using the independent sample "t" test to compare the effectiveness of pre and post test in sitting dynamic balance between experimental and control groups using Berg balance scale with the help of SPSS software version 29th edition

In table 1 it indicates the total number of samples participated in the study ,and the age group of the participants. Total 10 participants with age ranged from 39 to 51 years participated.

In table 2 indicates the distribution of gender and groups. This table implies among the total participants 60% were male making them the majority and 40% were females. This table also shows that experimental group consist of 50% of participants and the control group with same 50% of participants

In table 3 it indicates the comparison of sitting dynamic balance within the groups. The mean difference of pre test score and post test score of experimental group is

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40.80 and 47.00 respectively and p value of experimental group is 0.001 that shows there was a difference ($p < 0.05$) in sitting dynamic balance among the experimental group.Among control group the mean difference of pre test and post test score is 38.20 and 39.80 respectively and the p value is 0.160 , hence there was no differences ($p > 0.05$) in sitting dynamic balance from pre to post test . Hence the mirror therapy was found to be effective in improving the sitting dynamic balance skills among chronic stroke cases.

In table 4, it indicates the comparison of sitting dynamic balance between groups. The independent sample sample "t" test was used to compare sitting dynamic balance between groups. During pre-test there was no difference ($p>0.05$) In dynamic balance between experimental and control groups. There was a significant difference ($p<0.05$) in sitting dynamic balance was found between experimental and control; during post test.

In table 5, it indicates the comparison of effectiveness (pre-post) in sitting dynamic balance between groups. The independent sample "t test" was used to compare effectiveness in sitting dynamic balance between groups. There was a significant difference ($p<0.05$) in the effectiveness in sitting dynamic balance between the groups.

X. CONCLUSION

The study demonstrates the effectiveness of mirror therapy in improving sitting dynamic balance among individuals with chronic stroke. The results suggest that mirror therapy can be a valuable adjunct to traditional rehabilitation programs, enhancing recovery and functional ability. While limitations exist, the findings provide promising evidence for the therapeutic potential of mirror therapy in stroke rehabilitation, warranting further research and clinical application.

LIMITATION

➢ *Limitation*

- This study's limitations include a small sample size, which may not be representative of the larger population.
- Variability in stroke severity and type also affects the generalizability of the findings
- The short intervention period may not capture the full potential benefits of mirror therapy.

➢ *Recommendation*

- The training duration could be increased to explore the additional benefits of treatment programme
- The study with large population could be increased to investigate further
- Declaration by Authors
- Ethical Approval: Approved.

➢ *Acknowledgement:*

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None.

➢ *Conflict of Interest:*

The authors declare that there is no conflict of interest.

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