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A comparative study on the effect of mirror visual feedback therapy verses conventional physiotherapy in the improvement of the hemiplegic gait rehabilitation in subjects with chronic stroke

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Abstract
Background Approximately 80% of stroke survivors suffers motor impairment in upper or lower limbs shortly after the onset of stroke. Two-thirds of patients with lower limb impairment are unable to walk independently immediately after their stroke and only half of patients with lower limb impairment are able to walk independently after rehabilitation. Although various rehabilitation approaches have been studied in past, majority of them are labor-intensive due to which providing extensive care to all patients is challenging. Mirror visual feedback therapy (MVFT), also known as Mirror therapy (MT), may be an appropriate alternative treatment approach for lower limb rehabilitation among stroke survivors because of its low cost and simplicity. Objective To evaluate the effectiveness of MVFT on lower limb functional mobility during gait rehabilitation; and to compare the effect of MVFT and conventional therapy in improvement of hemiplegic gait in chronic stroke subjects. Method 40 stroke subjects were randomly assigned to two different groups where Group A received conventional treatment and Group B received MVFT. The therapist guided treatment was given for a period of 12 weeks and outcome measures Dynamic gait index (DGI) and Berg balance scale (BBS) were assessed before the intervention at day 1 and after the treatment at the end of 12 weeks. Result Both groups showed improvement in the outcome measures after 12 weeks, however there was no significant difference between the groups. Conclusion MVFT is a simple, safe and inexpensive method without requiring any assistance that can be applied in addition to conventional rehabilitation program to improve the gait in hemiplegic stroke subjects.

Keywords: Stroke, mirror visual feedback therapy, mirror therapy, gait rehabilitation

1. Introduction
World Health Organization has defined stroke as, “Rapidly developing clinical signs of focal (or global) disturbances of cerebral function, lasting more than 24 hours or leading to death”. [1] Every year, almost nine million people have their first stroke, making it one of the leading causes of long-term disability, especially in high- and middle-income countries [2]. Stroke frequently causes long-term physical, sensory, cognitive, and visual impairments, as well as spasticity, limiting an individual's ability to perform activities of daily life such as dressing, feeding, and walking [3]. Approximately 80% of stroke survivors suffer motor impairment in upper or lower limbs shortly after the onset of stroke [4]. Two-thirds of patients with lower limb impairment are unable to walk independently immediately after their stroke and only half of patients with lower limb impairment are able to walk independently after rehabilitation [5]. Stroke patients have a typical walking pattern known as hemiplegic gait, which is defined by a flexed upper arm, adducted and internally rotated shoulder, and an internally rotated lower limb with knee extended and ankle plantar flexed [6]. Although some percentage of stroke survivors achieves walking independence after few months, they continue to have mobility issues owing to poor balance, motor weakness, and slower walking speeds [7]. Neurological impairments and an altered gate pattern contribute to poor balance, a greater tendency to fall, and higher energy expenditure when walking [8, 9].
After a stroke, abnormal gait is caused by changes in muscle firing patterns; therefore, the most important goals of rehabilitation for hemiplegia patients are to achieve a fast and efficient gait and to restore their normal gait pattern so that they can carry out daily activities without

difficulty [10]. Various rehabilitation approaches for improving motor control, such as robotic-assisted rehabilitation [11] and bilateral leg exercise [12], have been studied in a number of publications. However, because the majority of treatment regimens are labor-intensive, providing extensive care to all patients is challenging.

Because of its low cost and simplicity, mirror visual feedback therapy (MVFT), also known as Mirror therapy (MT), may be an appropriate alternative treatment approach for lower limb rehabilitation among stroke survivors [13]. MVFT is a form of mental practice that stimulates the primary motor cortex and elicits movement of the paralyzed side, with patients visually validating movement of the non-paralyzed side [14]. It was initially reported for phantom pain by Ramachandran [15], and it now has a wide range of applications, including complex regional pain syndrome and peripheral nerve injury [16]. Mirror therapy was used with stroke patients by Altschuler *et al*. [17], who demonstrated its effects on upper extremity joint range of motion, motion velocity, and accuracy. Stevens and Stoykov [18] found that three to four weeks of mirror therapy improved Fugl–Meyer Assessment scores, active range of motion, movement speed, and hand dexterity in two stroke patients. Sathian *et al*. [19] discovered that a chronic stroke patient regained grip strength and hand mobility in the paretic limb following two weeks of mirror therapy.

Despite the numerous experimental research and reviews concentrating on MVFT for upper extremity pain management and motor recovery after stroke, studies focusing on lower limb pain management and motor recovery have been few. Because MVFT is a potentially repetitive, safe, and cost-effective exercise modality, might provide therapists with a means to enhance their patients' rehabilitation regimen. Therefore the present randomised control study was conducted to evaluate the effectiveness of MVFT on lower limb functional mobility during gait rehabilitation; and to compare the effect of MVFT and conventional therapy in improvement of hemiplegic gait in chronic stroke subjects.

2. Methodology

2.1. Participants

Both male and female subjects diagnosed with stroke by a neurophysician and aged between 45 to 60 years were considered for the study. The inclusion criteria were subject with a history of single episode of unilateral with 12 months post stroke, Brunnstrom recovery Stages of 5 or above for the lower limb and Mini mental state examination score more than 30. No restriction was placed based on the side affected. Similarly, the subjects who were unable to communicate or comprehend the instructions; subjects with previous musculoskeletal or neurological conditions that could alter the study result; subjects with previous history of gait or balance impairment; and subjects with severe visual field deficit and complain of respiratory distress were excluded from the study. After giving due considerations to inlusion and exclusion criteria, the total 40 subjects were included.

2.2. Procedure

Ethical clearance was obtained from the Florence College of physiotherapy Bangalore as per ethical guidelines from biomedical research on human subjects, ICMR, New Delhi. The included 40 subjects were randomly assigned into two groups with 20 subjects each. Subjects in the Control Group i.e. Group A received conventional physiotherapy treatment (CT) whereas those in Experimental Group i.e. Group B received mirror visual feedback therapy (MVFT). Each session of both CT and MVFT lasted for around forty minutes with 5 to 10 repetitions of each exercise and 5 minutes of rest whenever required. The treatment was given three sessions per week for total 12 weeks. Dynamic gait index (DGI) and Berg balance scale (BBS) were used as outcome measures and were assessed before the intervention at day 1 and after the treatment at the end of 12 weeks.

2.3 Intervention

2.3.1. Conventional Treatment

Group **A** received only conventional physiotherapy treatment based on neurodevelopment facilitation techniques, active exercises balance and gait training guided by physiotherapist. The exercises were performed in supine lying, long sitting, high sitting or sitting comfortably feet touching the ground. The CT constituted following exercises performed: Active or active assisted hip movements; Straight leg raising with or without assistance; Active or active assisted knee movements; ankle movements; Knee extension in high sitting followed with ankle in dorsiflexion; Symmetrical weight bearing training; Weight shifting; Stepping training (swinging/clearance); Heel strike; Single leg standing; Push off / calf raise exercise and circuit training (reaching in sitting, standing and sit to stand, step-ups heel lifts isokinetic strengthening, walking over obstacles up and down slopes).

2.3.2. Mirror Visual Feedback Therapy

The subjects in experimental group, Group B received therapist guided mirror visual feedback therapy. The MVFT program consisted of functional movement synergies using sound limb performed in long sitting, high sitting, sitting comfortably feet touching the ground. The exercises included Hip movements; Straight leg raise with or without assistance as much as the subject was able to perform; Knee movements; Ankle joint and Toe movements.

2.3.4 Placement of Mirror

The MVFT was performed in the mid sagittal plane with the subject in a long or high sitting position and a mirror between the two lower extremities. The mirror was positioned parallel to the subject's midline so that the afflicted limb was hidden from the subject's viewpoint. The subject could see the reflection of the sound limb in the mirror in place of the afflicted limb since the affected limb was hidden behind the mirror. The goal of this arrangement was to produce a visual illusion in which the patient mistook the movement of the sound limb for that of the affected limb.

The stroke subjects were administered MVFT in both standing and sitting positions by strategically arranging various mirror sizes. The subjects were told to do all of the simple functional movements while looking in the mirror [20].

3. Result

Data analysis was performed by SPSS (version 17) for windows. Alpha value was set as 0.05.. Descriptive statistics and Chi square test were used to analyse baseline data for demographic data. Wilcoxon signed ranked test and Mann Whitney U test were used to analyse the outcome measure within and between the groups respectively.

Table 1: Descriptive statistics of demographic variables

Variable	Group A	Group B	p value
Age	53.30±4.23	52.30±3.92	>.443
Gender (M/F)	13/7	11/9	>.519
Side (Rt / Lt)	12/8	13/7	>.744

Table 2: Descriptive statistics of outcome variable

Variable	Group A	Group B	p value
DGI	15.85±1.23	15.20±1.36	>.127
BBS	43.60±3.84	43.30±4.19	>.862

Table 3: Pre- Post data within group A

Variable	Pre	Post	p value
DGI	15.85±1.23	21.40±1.47	<.0001
BBS	43.60±3.84	50.95±2.16	<.0001

The pre and post value of DGI in subjects of Group A were 15.85±1.23 and 21.40±1.47 respectively with the p-value <.0001. Similarly the pre and post value o BBS were 43.60±3.84 and 50.95±2.16 respectively wit p-value <.0001. The result showed that the difference was statistically significant for both outcome measures which mean that conventional physiotherapy treatment was effective in improving the hemiplegic gait among the stroke subjects.

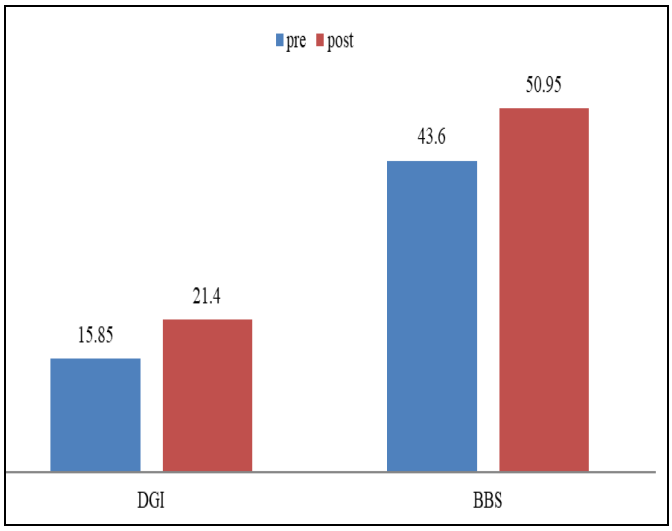

Fig 1: Outcome Meaures within Group A

Table 4: Pre post data within group B

Variable	Pre	Post	p value
DGI	15.20±1.36	20.75 ±1.37	<.0001
BBS	43.30±4.19	51.20±2.50	<.0001

In Group B, the DGI value was 15.20±1.36 before treatmnt and 20.75 ±1.37 after treatment with the p value <.0001. Similarly, BBS value was 43.30±4.19 before treatment and 51.20±2.50 after treatment with the p value <.0001. The statistically significant difference between the pre and post value of outcome measures shows that the MVFT was effective in improving gait among hemiplegic stroke subjects.

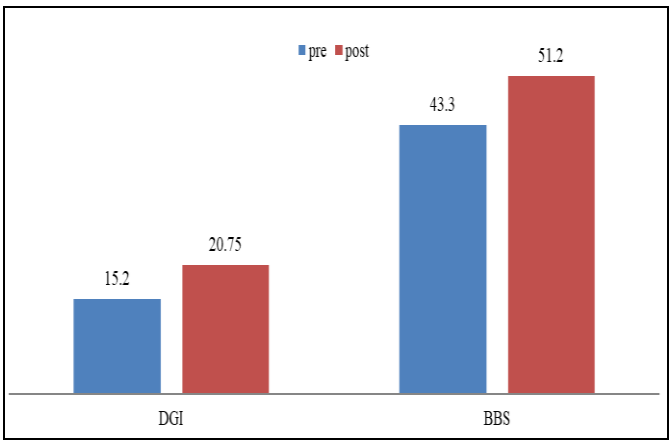

Fig 2: Outcome Meaures within Group B

Table 5: Difference between groups

Variable	Group A	Group B	p value
DGI	21.40±1.47	20.75 ±1.37	>.221
BBS	50.95±2.16	51.20±2.50	>.698

Table V shows the comparison of outcome measures among the groups. Both the outcome measures had no statistical significant difference between the groups with p value more than >.221 and >.698 for DGI and BBS respectively.

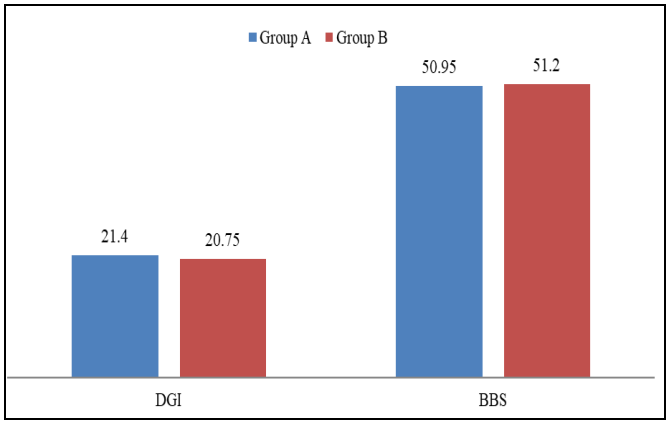

Fig 3: Outcome measures between the groups

4. Discussion

The present study was conducted to compare the effectiveness of mirror visually feedback therapy and conventional physiotherapy for the improvement of hemiplegic gait in subjects with chronic stroke. The result showed that even though the difference of outcome measures before and after the intervention was statistically significant for both groups, the difference was not statistically significant between the groups. It can be interpreted as even though both the treatment options were effective in improving the gait pattern among hemiplegic stroke survivors, there was no superiority of one treatment approach over another.

A few researches have been published to analyze the influence of MVFT on lower extremity motor function and ambulation, and the findings have shown that MVFT is a viable treatment option. Hassan *et al.* [21] investigated whether MT, administered following chronic stroke, was more successful than conventional therapy in improving motor recovery of the lower limb and walking speed. According to the findings, combining MT with a conventional stroke

rehabilitation program improves lower-extremity motor recovery and walking speed in chronic stroke patients. They observed no effect on spasticity, though. Another research by Ji *et al*. reached the same conclusion, stating that mirror therapy might help improve the effects of stroke on gait abilities [22].

Thieme *et al*. [23] conducted a comprehensive review to highlight the effectiveness of MT in improving motor function, daily living activities, pain, and visuospatial neglect in stroke patients. They found minimal evidence that MT improves visuospatial neglect, although it may have a favorable effect on motor function, ADL, and pain. Sutbeyaz *et al*. [24] found that MT enhanced lower extremity motor and function recovery better than sham treatment in a randomized controlled trial with sub acute stroke patients. Although these improvements were only evaluated immediately after the intervention, and no long-term effect of the mirror therapy modality was assessed by the study, the results indicated substantial positive effects of mirror therapy on motor recovery and gait speed after stroke. Other research has found that the effects of mirror therapy in stroke patients might persist up to six months [24]. Sütbeyaz *et al*. [25] conducted a research in which 40 stroke patients were randomly allocated to either the mirror group or the control group; both groups' Functional Ambulaton Category scores changed significantly, but there was no significant difference between them. Visual feedback training was shown to be more effective for balance training than oral suggestion and tactile sensory input in improving the proprioceptive senses impaired after a stroke [26]. According to Patel *et al*. [27], vision and visual perception are inextricably linked to the maintenance of postures and balance. As a result, it's critical to properly integrate these sensory inputs and use them therapeutically. According to Buccino *et al*. [28], if a person watches others' actions or his or her own movements reflected in a mirror, the relevant mirror nerve cells will respond. In addition, the area of the brain that controls actual movements will respond as well. As a result, the individual will learn to recognize the pattern of specific behaviors and selectively mimic the parts required to learn movement [29].

Despite the fact that the specific mechanism of MVFT is unclear, two ideas have been proposed to explain its effect [30]. The first is the mirror neuron system, which works by activating mirror neurons while watching or doing something. As a result, it's assumed that looking in the mirror at the unaffected extremity stimulates the mirror neurons in the brain [31]. The other theory is the primary motor cortex mechanism, in which the primary motor cortex is activated during the ipsilateral extremity movement and while watching contralateral extremity movements in the mirror [32]. Both of these conditions facilitate neuroplasticity and functional recovery.

According to Dennis *et al*. [33], mirror therapy is a safe form of treatment that may be administered in a sitting position for both ambulatory and nonambulatory stroke survivors. Because of the modality's simplicity, it may be performed by rehabilitation assistants or even stroke patients in their own homes without the need for direct supervision by a physiotherapist. Balance deficits have been found to restrict the potential of individuals with chronic stroke [34], thus effective sitting exercises may be an accessible approach for patients to improve their walking without having supervision to do walking practice. Because stroke patients tend to remain sedentary and only move for brief periods of time after release from the hospital, it's critical to figure out how to enhance engagement and improve health after a stroke [35].

The study's main limitations are a small sample size and a short follow-up period. Furthermore, no radiological techniques were used to demonstrate the MVFT's radiographic effects on the primary motor cortex and mirror neuron system mechanisms.

5. Conclusion

The study concluded that mirror visual feedback therapy or mirror therapy is a simple, safe and inexpensive method without requiring any assistance that can be applied in addition to conventional rehabilitation program to improve the gait in hemiplegic stroke subjects. Nonetheless, there is a need for further studies of MVFT with larger populations and longer follow-up periods to understand the benefits of the treatment better.

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