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RESEARCH ARTICLE

The effect of mirror therapy on the gait of chronic stroke patients: A randomized controlled trial

Sirajahemad H Bhoraniya, Daxa G Mishra, Shweta M Parikh

Department of Physiotherapy, K M Patel Institute of Physiotherapy, Karamsad, Gujarat, India

Correspondence to: Sirajahemad H Bhoraniya, E-mail: siraj.habibbhai@gmail.com

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ABSTRACT

Background: Stroke is a leading public health issue around the world. Stroke leads to a sequence of sensory-motor impairments inclusive of muscle weakness, altered selective motor control, spasticity, and proprioceptive deficits which retard normal gait. Mirror therapy is helpful in improving the gait in subacute stroke. **Aims and Objectives:** The objective of this study is to know the effect on the gait of chronic stroke patients by mirror therapy. **Materials and Methods:** A total of 26 participants with more than 6 months duration of stroke with a mean age of 60.96 years participated and were allocated randomly into two groups by systematic randomization. Participants were taken from the Physiotherapy Department of the Shree Krishna Hospital, Karamsad and its extension centers. Group A received mirror therapy and conventional therapy while Group B received only conventional therapy. The outcome was measured in terms of spatiotemporal gait parameters such as step length (paretic and non-paretic), stride length (paretic and non-paretic), cadence, and velocity. Paired and unpaired *t*-test were done to find out the difference before and after the intervention. **Results:** The results showed that there was improvement in both groups of gait parameters, but Group A showed statistically significant difference ($P < 0.05$) in all gait parameters. **Conclusion:** Mirror therapy was helpful in improving the gait ability in chronic stroke patient compared to conventional therapy.

KEY WORDS: Chronic Stroke; Mirror Therapy; Gait

INTRODUCTION

Stroke is defined by the World Health Organization as "abruptly developing clinical signs of focal (or overall) disruption of cerebral function, unceasing >24 h or resulting in death, without an evident cause except that of vascular origin."[1] Stroke is a vital reason for disability and early death.[2,3] In India, adjusted stroke prevalence rate in rural areas is 84–262/100,000 and in urban areas 334–424/100,000. The incidence rate is 119–145/100,000 studies in India.[4] The risk of stroke after 55 years of age is 1 in 5 for women and 1 in 6 for men.[5] Post-stroke impairments in strength, coordination, and balance lead to gait complications and gait recovery is the major goal for individuals with stroke.[6] More than 60% of stroke survivors have impaired activities of daily living due to persistent neurological deficits.[4] Lower extremity motor function is usually affected after a stroke, causing restrictions in mobility.[7] Changes in muscle firing patterns trigger an abnormal gait after stroke, thus the biggest goals of rehabilitation for hemiplegic patients are to achieve a fast and efficient gait and improve to near normal gait pattern.[8,9]

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Mirror therapy was first introduced to treat the phantom limb pain by Ramachandran and Rogers-Ramachandran.[10] Mirror therapy may be an appropriate selection due to its low cost and ease. In stroke patients, it involves executing

movements of the unaffected extremity, while observing its mirror images superimposed over the unseen affected extremity, thus generate an image of enhanced movement of the impaired limb.[11] Neurophysiologically, mirror therapy techniques facilitate motor learning and result in cortical reorganization associated with effective motor recovery.[12-14] The neurons get activated by the performing movement of an unimpaired limb in the mirror. The firing of such neurons may result in specific cortical reorganization and associated motor control.[15-17] Stroke patients showed improvement in upper extremities by mirror therapy.[18,19] Patients who received mirror therapy showed improved upper and lower extremity functions in subacute stroke patients.[10] Mirror therapy in stroke by doing ankle movements may induce neural activation of the ipsilesional sensory-motor cortex and that cortical reorganization may be useful for motor rehabilitation.[20] One study demonstrated that mirror therapy helpful in improving gait ability in subacute stroke.[21] The purpose of the study is to find out the effect on the gait of chronic stroke patients by mirror therapy.

MATERIALS AND METHODS

The present study was a systemic randomized controlled trial research had been approved by the ethical committee. Total 26 stroke patients were included only if they had a history of first attack of unilateral ischemic or hemorrhagic cerebrovascular accident with the onset of more than 6 months, spasticity as per the modified Ashworth scale score <3, no significant cognitive deficit (score more than 25 in the mini-mental state examination scale), able to walk independently with or without use of walking aids or other support. They were excluded if they had a muscular-skeletal disorder and surgical intervention of the lower extremities, unilateral neglect, hemianopia or apraxia.

Participants who fulfill the inclusion and exclusion criteria were systematically randomized into two groups, Group A (experimental) and Group B (control). Both group participants were assessed as per the neurological examination format on day 1. Step length, stride length, cadence, and velocity were assessed by making participants walk on the test corridor [Figure 1] and were recorded by digital camera. An ordered, routine physiotherapy program was designed and given for both the groups. Group A received 15 min of mirror therapy [Figure 2] and 30 min of conventional therapy in the form of custom-made program. Group B received 45 min of only conventional therapy in the form of custom-made program. Participants in both the groups received therapy for 45 min, 5 times a week for 4 weeks. The patient will be reassessed at the end of the study to note the changes.

Statistical Analysis

Statistical analysis of the study was done using the SPSS 14 version software. The data were entered into the computer using Microsoft excel sheet, tabulated and subjected to statistical analysis. Descriptive analysis was used for characteristics of patients and to calculate frequency, mean and standard deviation. The data were represented as mean ± standard deviation. Paired sample *t*-test was used to compare the difference of pre- and post-intervention values of step length, stride length, cadence, and velocity of Group A and Group B. Independent *t*-test was used to compare the differences between two groups. $P < 0.05$ was considered statistically significant.

RESULTS

All 26 participants completed 4 weeks of intervention. Table 1 summarizes demographic data. Table 2 summarizes asymmetry in step length. In Group A, paretic step length is shorter than the non-paretic step length while in Group B showed longer paretic step length than the non-paretic step length. Paired sample *t*-test revealed that in Group A (mirror therapy with conventional therapy) suggests that the mean change in step length, stride length, cadence, and velocity is highly statistically significant from baseline over a period of 4 weeks [Table 3]. In Group B (conventional therapy) suggests that no statistically significant difference in mean change in step length, stride length, cadence, and velocity while paretic step length and non-paretic stride length showed a statistically significant difference from baseline over a period of 4 weeks [Table 4]. Independent sample *t*-test showed outcome measures in Group A and Group B suggests statistically significant difference in

Table 1: Demographic data

Variables	Group A	Group B
Participant	*n*=13	*n*=13
Age (mean in years)	60.61	61.30
Male/female	9/4	12/1
Ischemic stroke	8	8
Hemorrhagic stroke	5	5
Duration of stroke (months)	29.39	31.69

Table 2: Comparison of pre-assessment of step length, stride length, cadence, and velocity for Group A and Group B

Variables	Side of extremity	mean±SD	
		Group - A	Group - B
Step length (cm)	Paretic side	25.07±7.21	28.23±8.66
	Non-paretic side	28.15±7.78	27.62±6.39
Stride length (cm)	Paretic side	44.23±14.34	49.69±17.60
	Non-paretic side	46.92±15.11	50.00±14.31
Cadence (steps/min)		75.15±13.99	71.77±8.69
Velocity (meter/min)		19.06±11.59	21.32±10.26

SD: Standard deviation

Table 3: Intragroup analysis of gait parameters for Group A before treatment and after 4 weeks of treatment

Variables	Side of extremity	mean±SD		*P*
		Pre-treatment	Post-treatment	
Step length (cm)	Paretic side	25.07±7.21	28.77±7.54	0.001*
	Non-paretic side	28.15±7.78	31.85±8.47	0.001*
Stride length (cm)	Paretic side	44.23±14.34	51.31±14.10	0.001*
	Non-paretic side	46.92±15.11	53.00±14.24	0.001*
Cadence (steps/min)		75.15±13.99	82.15±12.88	0.001*
Velocity (meter/min)		19.06±11.59	27.41±11.86	0.001*

SD: Standard deviation

Table 4: Intragroup analysis of gait parameters for Group B before treatment and after 4 weeks of treatment

Step length (cm)			
Paretic side	28.23±8.66	28.76±8.81	0.047*
Non-paretic side	27.62±6.39	27.62±6.60	0.190
Stride length (cm)			
Paretic side	49.69±17.60	50.31±17.98	0.150
Non-paretic side	50.00±14.31	50.76±14.81	0.011*
Cadence (steps/min)	71.77±8.69	72.31±8.02	0.406
Velocity (meter/min)	21.32±10.26	22.85±11.56	0.059

Figure 1: Patient walking on the test corridor

Figure 2: Patient with left hemiplegia taking mirror therapy)

the patient who received mirror therapy and conventional therapy (Group - A) as compared to only conventional therapy (Group - B) [Table 5].

DISCUSSION

As per the above results, this study consisted of 5 females and 21 males. Group A (experimental group) consisted of four females and nine males. Group B (control group) consisted of one female and 12 males [Table 1]. Gender differences in stroke recovery, female stroke survivors had poor quality of life and lower functional recovery in acute stroke as well as 3-month postdischarge. Before stroke depressive symptoms and physical functioning are major factors of sex differences in stroke recovery.[22,23] However, though the present study did not consider the pre-stroke physical activity level and gender difference in stroke recovery, results showed that Group A had higher recovery, which consisted more females than Group A. In the present study, the ratio of ischemic-to-hemorrhagic stroke is 2:1 [Table 1]. Ischemic stroke is the most common approximately 83%.[24] In the present study, asymmetry of pre-intervention gait parameters noted in step length [Table 1]. The asymmetrical nature of hemiparetic walking is a well-known fact in stroke survivors,[25,26] along with the asymmetries in kinetic, spatiotemporal, and kinematic parameters of gait associated with disturbances in motor coordination.[27] Compensatory strategies may cause step length asymmetry that increases or decreases the step length of either the paretic or non-paretic leg.[28]

The results of the present study support the experimental hypothesis which stated that there is a significant difference in all gait parameters in Group A. Group B revealed improvement in gait parameters, but significant improvement was seen in paretic step length and non-paretic stride length without affecting cadence and velocity; however, this requires further study. When compared the mean difference change in gait parameters of Group A and Group B, statistically significant improvement was seen in the Group A as compared to Group B [Table 5].

Effect of mirror therapy on motor recovery after stroke was explained by several mechanisms. Mirror therapy gives "proper visual input" to the affected body side for absent or reduced

Table 5: Intergroup analysis of mean differences in gait parameters for Group A and Group B

Variables	Side of extremity	Group - A mean±SD (diff.)	Group - B mean±SD (diff.)	*P*
Step length (cm)	Paretic side	3.69±1.65	0.54±0.88	0.001*
	Non-paretic side	3.69±2.01	0.23±0.60	0.001*
Stride length (cm)	Paretic side	7.08±6.03	0.62±1.44	0.001*
	Non-paretic side	6.08±5.09	0.77±0.92	0.001*
Cadence (steps/min)		7.00±4.36	0.54±2.26	0.001*
Velocity (meter/min)		8.36±4.56	1.52±2.63	0.001*

SD: Standard deviation

proprioceptive input.[29] Mirror therapy might also facilitate spatial attention and self-awareness by activating the superior temporal gyrus, posterior cingulate cortex, and precuneus.[30,31] Neural activation of primary motor cortex and recruitment of the premotor cortex toward the affected hemisphere, which helps in motor improvements by mirror therapy.[31-33] Movement-related mirror neurons along with motor neuron are bimodal visuomotor neurons found in the frontal and parietal lobes that are active during action observation, mental stimulation (imagery), and action execution.[34,35] Visual inspection of skill helps in the learning of new skills by these neurons. Mirror therapy effects might work on the mirror neuron.[13] In chronic stroke patients, positive cortical reorganization has been observed after mirror therapy.[36] In the premotor cortex, the mirror neurons get activated during observation of the goal-directed tasks.[37,38] Visual feedback by the mirror may help to activate the premotor cortex through the intimate connection between premotor areas and visual input in chronic stroke.[32] Increase neural activity in motor areas located in the affected hemisphere by observing mirrored movements, resulting in cortical reorganization and improved function. Research in healthy subjects has provided evidence to support such mechanisms by either transcranial magnetic stimulation or functional magnetic resonance imaging.[39] Mirror therapy of lower limb movement will induce activation of the frontal gyrus, parietal lobule, and superior temporal gyrus in the ipsilateral hemisphere.[40] In chronic stroke, research has indicated that the mirror neuron system may potentially be involved in motor recovery.[41] It is conceivable that mirror-induced visual illusion of lower limb movements promotes motor recovery in a similar way. Hence, this study concluded that mirror therapy in conjunction with conventional therapy is more effective for improving gait ability in chronic stroke patients.

Strength and Limitation

In this study, we have investigated the effect of mirror therapy on the gait of chronic stroke. Limitation of the study to know the effectiveness of mirror therapy by following up after few months post-intervention and small sample size, and further study can be done using an advanced gait analyzer for better gait assessment, gender difference in stroke recovery by mirror therapy and on a large sample size.

CONCLUSION

This study concluded that mirror therapy in conjunction with conventional therapy is more effective for improving gait ability in chronic stroke patients.

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