

ORIGINAL ARTICLE

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EFFECT OF SHOE RAISE ALONG WITH MOTOR RELEARNING PROGRAMME (MRP) ON AMBULATION IN CHRONIC STROKE

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ABSTRACT

Background: Stroke subjects face reduced tolerance to activity and sedentary lifestyle due to various impairments, such as muscle weakness, pain, spasticity, and poor balance. Thus, loss of independent ambulation especially outdoors is generally observed in them.

Methods: Chronic stroke patients (> 6 months) with Functional Ambulation Category score > 2 and able to walk at least 10 meters of distance with and without assistance from a tertiary healthcare centre were selected and treated. Subjects were randomly divided into 2 groups control group (n=14) and experimental group (n=13). Each group received Motor Relearning Programme for 60 minutes, 6 times a week for 4 weeks. The experimental group received an additional shoe-raise of 1 cm on the unaffected side along with while ambulating during therapy as well as at home. Pre and post treatment the patients were assessed for spatio-temporal parameters using foot print analysis method and Rivermead Visual Gait Assessment (RVGA) Score using RVGA scale.

Results: There was significant improvement seen in almost all the spatio-temporal gait parameters and RVGA score in within group analysis. Whereas on between group the results from between group comparison suggests that subjects in MRP with shoe-raise group showed better results in spatio-temporal parameters of gait than subjects receiving MRP alone. But there was no additional benefit of shoe-raise seen on RVGA score and angle of toe-out parameter.

Conclusion: Additional use of shoe-raise helps to improve spatio-temporal gait parameters. However, there was no additional change seen in RVGA score.

Keywords: Stroke; Motor Relearning Programme; Shoerise; Ambulation; Gait training; Foot Print Analysis

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INTRODUCTION

Ambulation is an important movement pattern by which one can move in community [1,2]. Cerebrovascular accident (CVA) or stroke causes disruption of many physiologic systems, because of which the patient tends to lose the mechanical stability in standing and walking which is provided by the lower limbs [1-3].

Cerebrovascular accident is caused due to the shortage of blood supply to the brain, lowering down the supply of oxygen and important nutrients, which further causes damage to its tissues [4]. Its effects depend upon the site and severity of brain injury. The most common symptoms seen in hemiplegic patients are sudden weakness or numbness of the face, arm or leg on one side of the body, difficulty in walking and loss of balance and co-ordination [5].

Gait training is the main goal for the patient as well as for the physiotherapist and various researches is being done to achieve it [2]. Walking is an essential movement which enables us to be active and productive. Normal walking speed for elderly people is 1.3 m/s [6] and walking capacity measured by the distance covered in 6 minutes is 576 meters for men and 494 meters for women [7,8]. After stroke, many patients have lingering walking disabilities. Post stroke many patients could not walk fast enough to do basic activities of daily living leading to restriction of social participation. Due to poor walking ability the patient's quality of life is affected, further affecting the life of their dear ones. These patients are fearful of lifelong dependency on their caretakers more than anything else. Therefore being able to walk independently is their ultimate goal [9]. A community ambulator is active enough to do his household chores and community participation on his own. Thus, much of the drive for stroke rehabilitation rests in the wish to regain normal walking [9].

Previous Motor Relearning Programme (MRP) studies show considerable improvement in functional recovery, walking, motor function, balance and quality of life in acute and sub-acute stroke patients [10-12]. There is a diversity of research done on techniques used to improve ambulation of post-stroke patients. Langhammer B and Stanghelle J K [10] found that in acute stroke rehabilitation MRP is preferable to Bobath approach. Our previous research on comparison of MRP and Bobath approach concluded that MRP showed better improvement than Bobath approach in early enhancement of daily chores and ambulation [12]. In both the above studies, there was active participation and self reliance which helped in motor learning of the pattern of movement, in a given context and task [10,12]. Hence Motor Relearning Programme was used as a common treatment protocol for the both the groups.

Due to characteristic hemiplegic gait there is learned disuse of affected limb. In such population weight bearing asymmetry, equinovarus positioning of foot complex, reduced hip extension, hyperextension of knee and pelvic retraction are observed in affected lower extremity while walking. So they are not able to do the necessary hip-knee-

ankle flexion of the affected lower extremity during the swing phase of gait. As a consequence, the affected leg relatively lengthens causing the patient to walk with a hiking or a circumduction gait. Increasing the height of the unaffected side can help to relatively shorten the affected lower extremity, shifting weight on affected side in stance helping symmetrical weight bearing, foot clearance in swing and reduce the effort of walking [13-17]. Few studies showed significant immediate improvement in weight bearing with temporary use of shoe lift on unaffected lower extremity in stroke patients [13-17].

This study thus proposes the use of a 1 cm shoerise on the unaffected side in order to improve the affected gait cycle of stroke patients. Hence, finding out the effect of shoerise on the uninvolved leg along with MRP on spatio-temporal parameters and gait deviations (Rivermead Visual Gait Assessment Score) of the affected gait cycle, is of absolute importance.

METHODOLOGY

Method and materials: It was a Randomized Control Trial. Chronic stroke patients (> 6 months) with Functional Ambulation Category score ≥ 2 and ability to walk a distance of at least 10 meters with and without assistance from a tertiary healthcare centre were selected and treated from March 2014 to March 2015. It was made sure that the patients did not have any cognitive problem, medical problem and previous history of stroke. Materials used were plinths, pillows, pen, paper roll, plate with water & ink, measuring tape, stop-watch, goniometer and 10 meters walkway.

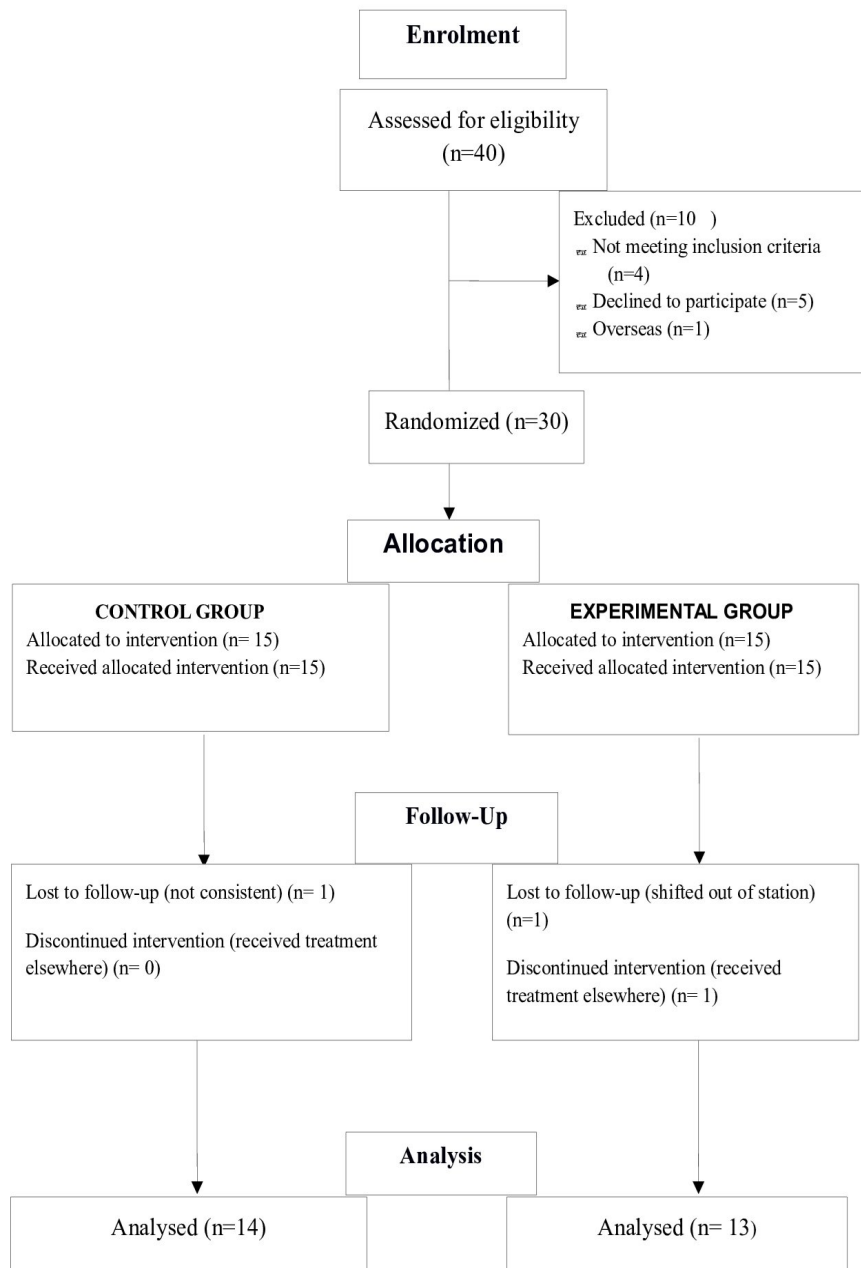
Procedure: A written consent was taken from all the subjects prior the inclusion. Subjects were randomly assigned to 2 groups: control group (n=14) and experimental group (n=13) using chit method as shown in Fig no 1. Each group received Motor Relearning Programme for 60 minutes, 6 times a week for 4 weeks [15].

Treatment protocol-

The control group received MRP for gait training which consisted of 4 steps.

- 1) Analysis of walking
- 2) Practice of missing components of walking
- 3) Practice of walking
- 4) Transference of training into daily life

Picture 1: Showing enrolment layout



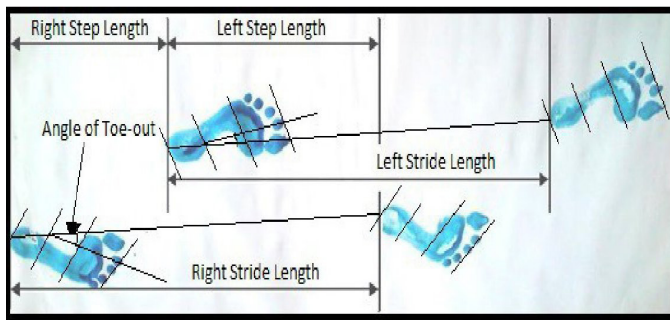
The experimental group received an additional shoe-raise of 1 cm on the unaffected side while ambulating during therapy as well as at home in Fig no 2 [16,18]. Shoe to be used in the experiment was a pair of floaters. A raise with height of 1 cm was prepared according to the shoe base shape. Material of the raise was of light weight cork. Being light weight it was made sure not to add unnecessary weight on patient's limb while walking. Pre and post treatment the patients were assessed for step length, stride length, angle of toe-out, cadence, gait velocity using foot print analysis method as shown in Fig no 3. And Rivermead Visual Gait Assessment (RVGA) Score using RVGA scale [19-21], during foot print analysis participants' feet were dipped into the ink plate. They were asked to walk barefoot at their regular speed across the paper, looking straight ahead. A therapist walked sideways along to ensure safety of the patient. The first two footprints up to the edge of the third heel strike were not taken. Similarly the

last two footprints were excluded from the calculation. Cadence is defined by number of steps covered in 1 minute. Participants were asked to walk 10 meters of distance. Simultaneously a stop watch was used to record the time taken for walking in order to calculate gait velocity.

Figure 2: Shoe raise



Figure 3: Foot print analysis



RESULT AND DATA ANALYSIS

Data was analysed using Statistical Package for Social Sciences (SPSS) version 20. Baseline values were determined for all gait parameters and RVGA score. Within group analysis for all gait parameters and RVGA score for both the groups was done using Wilcoxon Signed Rank test). Between groups analysis for all gait parameters and RVGA score for both the groups was done using Mann Whitney U test. Level of significance was set at $p \leq 0.05$.

Table 1: Demographic characteristics of subjects

Sl. No.			MRP	MRP + Shoe raise
1.	Age (years)	MEAN \pm SD	54.42 \pm 7.12	54.53 \pm 7.53
2.	Gender	MALES	7	8
		FEMALES	7	5
3.	Side Affected	RIGHT	6	5
		LEFT	8	8

Values: mean \pm standard deviation or number.

MRP, Motor Relearning Programme.

Demographic characteristics of the subjects as seen in table no 1: The subjects for this study included 7 male and 7 female patients in MRP group and 8 male and 5 female patients in MRP with shoeraise group. Then 6 right hemiplegics and 8 left hemiplegics in MRP group and 5 right hemiplegics and 8 left hemiplegics in MRP with shoeraise group. The mean age of patients in each group was as follows 54.42 \pm 7.12 years for MRP group and 54.53 \pm 7.53 years for MRP with shoeraise with no significant difference between the groups.

Table 2: Showing baseline values of outcome measures for both the groups

Sl. No.	Outcome Measures	MRP	MRP with Shoe-raise	p Value
1	Paretic limb Step length (cm)	40.78 \pm 11.65	47.53 \pm 7.51	0.098
2	Paretic limb Stride length (cm)	79.78 \pm 22.66	83.23 \pm 19.33	0.610
3	Paretic limb Angle of Toe- out (degree)	11.71 \pm 1.54	11.69 \pm 1.60	0.960
4	Non-Paretic limb Step length (cm)	37.14 \pm 10.65	43.15 \pm 7.45	0.132
5	Non-Paretic limb Stride Length (cm)	73.21 \pm 21.68	75.38 \pm 19.78	0.716

6	Non-Paretic limb Angle of Toe-out (degree)	7.57 \pm 0.51	7.61 \pm 0.50	0.820
7	Cadence (steps/min)	61 \pm 18.88	66.30 \pm 16.32	0.206
8	Gait Velocity (m/second)	0.81 \pm 0.26	0.78 \pm 0.18	0.884
9	RVGA Score	26.85 \pm 5.47	25.46 \pm 2.36	0.248

Values: mean \pm standard deviation or number.

$p > 0.05$ by Mann Whitney U test.

MRP, Motor Relearning Programme.

Baseline values of both groups as seen in table no 2: Pre-treatment evaluation showed no significant differences between the groups for any of the parameters.

Table 3: Showing within group analyses of outcome measures for both the groups

Limb	Outcome Measures	Group	Pre Rx	Post Rx	p Value
Paretic limb	Step length (cm)	MRP	40.78 \pm 11.65	43.71 \pm 11.83	0.001*
		MRP + shoeraise	47.53 \pm 10.65	51.69 \pm 11.24	0.001*
Non Paretic limb	Step length (cm)	MRP	37.14 \pm 7.51	40.42 \pm 7.39	0.001*
		MRP + shoe raise	43.15 \pm 7.45	47.53 \pm 7.35	0.001*
Paretic limb	Stride length (cm)	MRP	79.78 \pm 22.66	85.85 \pm 22	0.001*
		MRP + shoe raise	83.2 \pm 19.33	100 \pm 18.33	0.001*
Non Paretic limb	Stride length (cm)	MRP	73.21 \pm 21.68	75.38 \pm 20.48	0.001*
		MRP + shoe raise	79.64 \pm 19.78	91.38 \pm 18.63	0.001*
Paretic limb	Angle of toe-out (degree)	MRP	11.71 \pm 1.54	11.69 \pm 1.32	0.000*
		MRP + shoe raise	11.69 \pm 1.60	9.61 \pm 1.19	0.000*
Non Paretic limb	Angle of toe-out (degree)	MRP	7.57 \pm 0.51	7.61 \pm 0.51	1.000
		MRP + shoe raise	7.57 \pm 0.50	7.61 \pm 0.50	1.000
	Cadence (steps/min)	MRP	61 \pm 18.88	68.14 \pm 18.63	0.001*
		MRP + shoe raise	66.30 \pm 16.32	82 \pm 15.34	0.001*
	Gait Velocity (m/seconds)	MRP	0.18 \pm 0.26	0.97 \pm 0.33	0.001*
		MRP + shoe raise	0.78 \pm 0.18	1.10 \pm 0.31	0.001*
RVGA score	MRP	26.85 \pm 5.47	20.21 \pm 4.35	0.001*	
	MRP + shoe raise	25.46 \pm 2.36	15.84 \pm 4.70	0.001*	

Values: mean \pm standard deviation or number.

* $p < 0.05$ by Wilcoxon Signed Rank test

MRP, Motor Relearning Programme.

Pre-post treatment comparison as seen in table no 3: The results from pre-post treatment comparison suggests that both the groups showed significant improvement in

all spatio-temporal parameters and RVGA score in both groups except for angle of toe-out parameter of non-paretic lower limb.

Table 4: Showing between group analyses of changed score of outcome measures for both the group

Limb	Outcome Measures sMeasure	MRP	MRP + shoeraise	p Value
Paretic limb	Step length (cm)	2.92+1.31	4.15+0.18	0.001*
Non Paretic limb	Step length (cm)	3.28+2.01	4.38+1.66	0.042*
Paretic limb	Stride length (cm)	6.07+2.67	16.78+5.64	0.000*
Non Paretic limb	Stride length (cm)	6.42+3.25	16+5.98	0.000*
Paretic limb	Angle of toe-out (degree)	1.92+1.32	2.07+1.11	0.321
Non Paretic limb	Angle of toe-out (degree)	0	0	1.000
	Cadence (steps/min)	7.14+1.46	15.69+2.69	0.000*
	Gait Velocity (m/seconds)	0.16+0.15	0.32+0.13	0.003*
	RVGA score	6.64+2.64	9.62+5.37	0.185

Values: mean ± standard deviation or number.

*p<0.05 by Mann Whitney U test.

MRP, Motor Relearning Programme.

Comparison between the groups as seen table no 4: The results from between group comparison suggests that subjects in MRP with shoe-raise group showed better results in step length, stride length, cadence and gait velocity than subjects receiving MRP alone. But there was no additional benefit of shoe-raise seen on RGVA score and angle of toe-out parameter

DISCUSSION

Stroke subjects life end up to sedentary lifestyle due to various impairments, such as muscle weakness, pain, tone abnormalities, and poor balance as seen in studies done by Michael K M et al in 2005 and Janice J Eng et al in 2007 [22,23]. Thus, loss of independent ambulation especially outdoors is generally observed in them [2,24]. This study was done to find out the effect of shoe raise on the unaffected leg with the MRP in improving the spatio-temporal parameters and RVGA score of the affected gait cycle, to promote ambulation in such patients.

Spatial temporal parameters: On within group analysis, both control and experimental group subjects showed improvement in step length, stride length, angle of toe-out of both paretic and non-paretic limb, cadence and gait velocity, with 4 weeks of intervention program. Similar study which was done by Chan D Y et al in 2006 [25]. concluded that motor relearning programme improved the functional recovery of stroke patients than conventional rehabilitation. The result of the current study also comes in agreement with Geurts A C H et al, [26] who reported in 2005

that weight shift toward either leg is a must for independent walking and learning to load and offload the affected leg while standing is critical for balance and gait training in stroke patients .

On between group analysis subjects in MRP with shoe-raise group showed improvement in all the spatio-temporal parameters except for the angle of toe-out parameter.

Hemiplegic gait presents with weight bearing asymmetry, equinovarus positioning of foot complex, reduced hip extension, hyperextension of knee and pelvic retraction. Due to these factors the patients' are not able to do the required hip-knee-ankle flexion of the involved lower extremity during the swing of walking. Reduced ability to do hip knee flexion in swing phase leads to inability to shorten the leg, giving rise to a circumduction gait, excessive shifting of weight on unaffected side, hip hiking, short stepping, wide base, excessive out toeing and toe drag of affected side . If hemiplegic patients can't shorten the leg in swing phase, then this can be done by increasing the length of opposite leg using shoe raise. Hence by increasing the length of unaffected leg with shoe-raise of 1 cm, the affected leg is relatively shortened. the effort of walking needed during swing phase is consequently reduced [17,18]. This makes the foot clearance on the affected leg easy improving the step and stride lengths. There is equal weight bearing on bilateral lower extremities which corrects the asymmetry and improves balance [22]. A hemiplegic subject also doesn't shift weight on affected side during stance phase leading to uneven stepping on unaffected and affected legs. Use of shoe raise on unaffected side causes forced shifting of weight on affected leg. This helps in improving equal weight bearing on both leg, reduced the non use phenomenon of affected lower leg during walking. The improvement of the step length and stride step length of the unaffected side can be attributed to the correction of weight bearing asymmetry, as mentioned above, due to lack of weight bearing on affected side the distance covered by unaffected leg while walking is less (table 3) [18]. The progress seen in cadence and gait velocity is due to the increased distance covered in less time [15,16,17]. The effort of walking is minimized with improved symmetrical weight bearing and balance on affected side, as a result cadence is increased in MRP with shoe-raise group. However no change was observed in the angle of toe-out parameter as shoe-raise. (Table 3)

A range of studies have been done to find out the effects of shoe lift on weight bearing symmetry, gait performance and balance in stroke patients. A study done by Chaudhury S showed significant improvement in stance and weight bearing with the use of 0.9 cm high shoe- lift on unaffected side [17]. The same result was observed in a study done by Rodriguez G M 14 Kitisomprayoonkul W et al 30 found improvement in weight bearing symmetry in 10 stroke patients with the use of 1 cm Shoe Lift on the unaffected side. Chitra J and Mishra S [18] did a study and found that combination of 1 cm of insole on unaffected leg with conventional physiotherapy, promoted symmetrical weight distribution during standing and walking, improved gait

performance and balance in people with stroke.

RGVA scores: RVGA is a scale which assesses the severity of gait deviations. Lesser the score obtained, lesser is the severity of gait deviations. On pre-post statistical analysis (within group) both control and experimental group subjects showed reduction in RVGA score, suggesting that both MRP and MRP with shoerise was equally effective in reduction of RVGA score. In MRP all these missing components of gait are observed and trained accordingly with repetitive practice in varying environment, with constant feedback and symmetrical weight bearing. Thus reduction was seen in RVGA score in within group analysis (table 4) [15].

However, on between group statistical analyses, it was found that there is no additional benefit of using shoe-raise on unaffected side in hemiplegic patients on RVGA score, because it only focuses on compelled body weight shift theory (table 4). There might be no learning of dynamic patterns of recruitment by using shoe raise, as it may not work on the biomechanical and functional phases of gait cycle [18].

In this present study, our results indicate that if improving the spatio-temporal parameters is the main goal of stroke rehabilitation, the physiotherapists may choose to use MRP with shoe-raise treatment protocol.

CONCLUSION

This study concludes that addition of shoe-raise on unaffected side helps to improve step length, stride length cadence & gait velocity as compared to MRP alone. However, there was no additional change seen in Rivermead Visual Gait Assessment Score with the use of shoe raise.

ABBREVIATIONS

CVA : Cerebrovascular Accident

MRP : Motor Relearning Programme

RVGA : Rivermead Visual Gait Assessment

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