RESEARCH ARTICLE

EFFECTS OF COMPELLED BODY WEIGHT SHIFT TECHNIQUE BY USING INSOLE FOR REHABILITATION OF INDIVIDUALS WITH CHRONIC STROKE

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ABSTRACT

Background: Stroke is one of the leading causes of long-term disability worldwide. The stroke survivors usually become complicated with sensor and motor problems which lead to compromised walking ability and functional limitation, after stroke occurrence the recovery of walking ability is considered one of the vital outcomes of stroke rehabilitation. **Objective**: To determine the effects of Compelled Body Weight Shift (CBWS) technique by using insole in the individuals with chronic stroke. **Materials and methods**: A randomized control trial (NCT04479774) was conducted from March 2020 to August 2020. The data was collected through non probability convenient sampling technique. The duration of the study was 6 months after the approval from Rehman medical Institute and Northwest General Hospital. A total n=27 were divided into control n=14 which received conventional physical therapy (CPT) and experimental group n=13 additionally received compelled body weight shift (CBWS) technique using insole shoe lift of 0.6 cm thickness. The tinetti (POMA) for balance and gait, 10 Meter walk test for gait parameters and analogue weight scale for weight distribution on both limbs were assessed at the baseline and after 6th week of intervention. **Results**: The mean age and BMI of the study participants was 49.84±6.18 years and 34±5.13 kg/m^2 respectively. Between the groups analyses showed that all the domains showed no significant difference, but step length showed significant difference ($p<0.001$) after 6th week. The stride length showed significant difference after 3rd week and 6th week ($p<0.01$). while the cadence showed significant difference after 3rd week only ($p=0.02$) and no significant difference was observed after the 6th week of the treatment. **Conclusions**: There was slight improvement in cadence, stride length and step length after the treatment. Furthermore, it is evident that CBWS is effective for improving gait parameters.

Keywords: Balance, gait training, physical therapy, stroke, stroke rehabilitation.

INTRODUCTION

Stroke is the prompt development of a focal neurologic deficit triggered by a complete or partial loss of blood supply to brain and its parts[1]. The World Health Organization (WHO) also estimates that a stroke occurs every 5 seconds[2]. The stroke survivors are often left with number of impairments, typically includes paralysis of one side of body may lead to permanent disability if left un treated[3]. It is important to recognize symptoms of stroke and treat them on time to minimize morbidity and mortality[4].

The major impairments related to strokes are sensorimotor and coordination control leads to problem of ambulation and difficulty in performing activity of daily living (ADLs)[5]. Several studies have been reported the temporal asymmetry in stance time, single stance time, double support time, and swing time and spatial asymmetry that is mainly concerned with step length in individuals after stroke[6, 7]. The stroke survivors having ambulatory problems, avoid participation and there is presence of psychological issue[8].

The stroke rehabilitation involves a large number of therapeutic approaches which take part during the whole process of rehabilitation and all approaches have the purpose to limit the impact of stroke and bring back the stroke survivor towards normal activities of daily life services[9,10]. The Compelled Body Weight Shift (CBWS) treatment by using insole includes lifting the non-impaired lower limb by means of a shoe lift and this lift can help the asymmetrical stance to become symmetrical[11].

It is obvious from results of many studies that asymmetry seems to degrade in chronic stages after stroke and rehabilitation often fail to improve the gait symmetry in majority of stroke survivors by using insoles and may lead to muscular imbalance and Knee osteoarthritis (OA)[6, 11]. Moreover the asymmetrical weight bearing non paretic limb causes number of musculoskeletal disorders including knee osteoarthritis and muscles imbalance[12]. During the time this study was conducted, no such study was found in Peshawar, Pakistan to evaluate these outcomes. There has always been a difference in management and patient care between developed and developing countries. So this study will provide evidence in the population of developing country like Pakistan. The purpose of this study was to determine the effects of Compelled Body Weight Shift (CBWS) technique by using insole in the individuals with chronic stroke.

METHODOLOGY

The study design was randomized control trial (NCT04479774) at outpatient physical therapy department of Northwest general hospital Peshawar (NWIHS-0001/IRB/01) after the approval from research and ethical committee (REC) of Riphah International University Islamabad (RIPHAH/RCRS/REC/00553). The data was collected from March 2020 to August 2020. A non-probability purposive sampling technique was used to collect the sampling. A total n=28 participants were randomly divided into control and experimental group. The n=1 participant was unable to continue follow up due to accessibility in control group and n=2 were in experimental group respectively. A total of n=25participants were analyzed at the end of intervention. (Figure 1).
Before the start of the study written informed consent from all participants were obtained. The tinetti (POMA) for balance and gait, 10 Meter walk test for gait parameters including walk speed, cadence, step rate, stride length. The analogue weight scale (Camry ZT-160, Camry Electronic Ltd Zhaoqing, Guangdong, China) was also used for evaluation of weight distribution on both limbs. The data was assessed at the baseline, after 3rd week and after the 6th week of intervention.
Both groups received routine physical therapy including the muscle re-education exercises, task-oriented balance training and gait training. The muscle re-education exercises were performed for 10 minutes in which progressive strength training including sit to stand exercise for hamstrings, quadriceps, gluteal muscles, and supported heel raise and supported squats for calf muscles and tibialis anterior muscles. In task-oriented balance training stepping exercise, tandem standing, and reaching exercise while standing was performed for 15 minutes. Finally, the gait training for 15 minutes was performed, which was comprised of ten rounds of forward walk in the parallel bars and forward and backward step training with body weight at unaffected ankle. The experimental group performed all above-mentioned exercises additionally with shoe lift for throughout the intervention plan with 0.6 cm thick insole. All participants performed 40 minutes exercises, 3 times per week for 6 weeks.
The descriptive statistics were used to present the data including n(%), mean±Sd. The assumptions of the parametric test were met so with-in group analysis RM ANOVA was used with pairwise comparison. While for group comparison independent t-test was applied at each level of assessment till after 6th week intervention. The Statistical Package for the Social Sciences (SPSS) version 25.0 was used for statistical analysis. The level of significance was set at $p<0.05$.

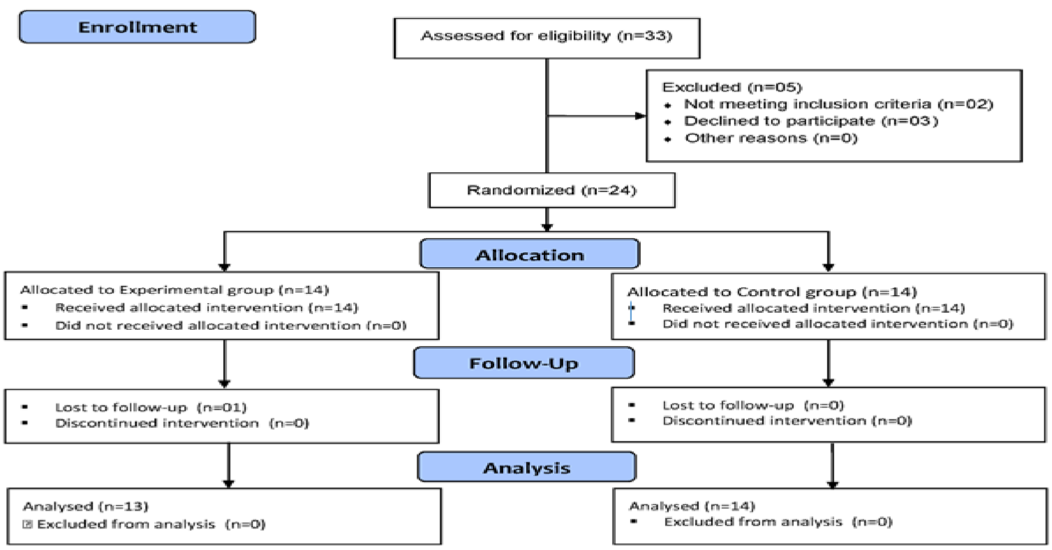

Figure 1: CONSORT flow diagram

RESULTS

The mean age and BMI of the study participants was 49.84±6.18 years and 34±5.13 kg/m^2 respectively. A total of n=15 were male and remaining n=10 were female in the study. The n=12 participants had right hemiplegia while n=12 had left hemiplegia. The mean duration of stroke occurrence was 15.40±5.91 months.

Within group analysis the experimental group showed significant improvement from baseline to 6^{th} week ($p<0.001$) in 10 MWT-Self Selected, 10 MWT-Fast Velocity percentage of Weight Bearing, Cadence, Step Length (m), Stride Length (m) (p=0.007) except tinetti score which is only significant at baseline to 3^{rd} (p=0.005) week after that there is no significant ($p\geq0.05$) improvement was observed at the end of treatment. The pairwise comparison showed that there was no improvement was observed at baseline to 3^{rd} week in percentage of Weight Bearing (p=1), Cadence (p=0.67) and Step Length (p=1) but after 3^{rd} weeks to 6^{th} week there was significant improvement ($p\leq0.05$) was observed after the intervention. (table 1)

While control group showed significant improvement in tinetti score ($p\leq0.05$), 10 MWT -Self Selected ($p\leq0.05$), Cadence(p=0.005) and stride length (p=0.02) but there was no significant improvement ($p\geq0.05$) was observed in 10 MWT (Fast Velocity), Percentage of Weight Bearing, Step Length (m) and Stride Length (m). The pairwise comparison showed that there was no improvement was observed at baseline to 3^{rd} week in tinetti score (p=0.11) and cadence (p=0.92), the 10 MWT-Self Selected showed improvement after 6^{th} week intervention before that from baseline to 3^{rd} week (p=0.49) and 3^{rd} week to 6^{th} week (p=0.05) there was no significant improvement was observed. Stride Length showed significant improvement from baseline to 3^{rd} week and after 6^{th} week of intervention between this duration from 3^{rd} week to 6^{th} week no improvement was seen after the treatment. (table 1)

Between the groups analyses showed that all the domains showed no significant difference but step length showed significant difference ($p<0.001$) after 6^{th} week, where experimental group showed slight improvement 62.75 ± 3.16 compare to the control group 55.38 ± 7.77. stride length showed significant difference after 3^{rd} week and 6th week ($p<0.01$), where experimental group showed slight improvement 56.08 ± 8.05 compare to the control group 42.69 ± 6.86 while the cadence showed significant difference after 3^{rd} week only (p=0.02) and no significant difference was observed after the 6^{th} week of the treatment, where control group showed slight improvement 48.83 ± 5.99 compare to the experimental group 55.15 ± 7.47. (Table 2)

Table 1. With-in group changes in both groups

		Experimental (n=12)				Control (n=13)			
		Mean	SD	MD/F(df)	p-value	Mean	SD	MD/F(df)	p-value
Tinetti Score	Baseline	12.50	7.25	1.83	0.005**	13.77	6.66	0.30	0.11
	After 3^{rd} Week	14.33	6.76	.83	1	14.08	6.56	0.92	0.007**
	After 6^{th} Week	15.17	7.62	1.10(1.05,11.60)	0.32	15.00	6.39	24(1.35,16.20)	0.00***
10 MWT (Self Selected)	Baseline	27.94	4.87	0.007	0.16	26.31	5.66	0.002	0.49
	After 3^{rd} Week	28.33	5.87	0.006	0.081	26.31	5.66	0.004	0.05
	After 6^{th} Week	27.83	5.72	1.10(1.93,19.64)	0.00***	25.54	5.23	9(1.76,19.64)	0.002**
10 MWT (Fast Velocity)	Baseline	27.50	6.05	0.008	0.005**	23.08	5.43	0.002	0.49
	After 3^{rd} Week	27.17	6.43	0.01	0.024*	23.15	5.52	5.26	1
	After 6^{th} Week	26.08	6.80	23.33(1.41,15.44)	0.00***	23.15	5.78	1(1,15.59)	0.33
Percentage Of Weight Bearing	Baseline	17.27	1.32	0.02	1	17.74	1.63	0.13	1
	After 3^{rd} Week	17.30	.50	4.55	0.01*	17.61	2.29	1.8	0.37
	After 6^{th} Week	21.83	3.45	12.17(1.43,15.82)	0.00***	19.41	3.66	2.09(1.51,15.82)	0.145
Cadence	Baseline	53.31	9.09	4.48	0.67	51.75	7.83	3.4	0.92
	After 3^{rd} Week	48.83	5.99	12.41	0.002**	55.15	7.47	12.3	0.02*
	After 6^{th} Week	36.41	7.05	13.59(1.66,18.31)	0.00***	42.84	11.99	6.77(1.92,23.06)	0.005**
Step Length (m)	Baseline	39.41	5.72	.25	1	40.53	5.39	0.61	1
	After 3^{rd} Week	39.16	5.40	16.91	0.00***	41.15	5.35	1.5	1
	After 6^{th} Week	56.08	8.05	23.51(1.48,16.30)	0.00***	42.69	6.86	0.55(1.64,1.68)	0.54
Stride Length (m)	Baseline	73.25	10.19	9.41	0.07	69.38	9.72	14.84	0.008**
	After 3^{rd} Week	63.83	8.22	1.08	1	54.53	7.96	.84	1
	After 6^{th} Week	62.75	3.16	6.85(1.78,19.65)	0.007**	55.38	7.77	13.88(1.10,13.29)	0.02*

[a]baseline to after 3^{rd} weeks, [b]after 3^{rd} week to after 6^{th} week, [c]baseline to 6^{th} week.
Level of significance: p<0.05, p<0.01**, p<0.001****

Table 2. Comparison between both groups

		Experimental (n=12)		Control (n=13)		p-value
		Mean	SD	Mean	SD	
Tinetti Score	Baseline	12.50	7.25	13.77	6.66	0.65
	After 3rd Week	14.33	6.76	14.08	6.56	0.92
	After 6th Week	15.17	7.62	15.00	6.39	0.95
10 MWT (Self Selected)	Baseline	27.94	4.87	26.31	5.66	0.44
	After 3rd Week	28.33	5.87	26.31	5.66	0.39
	After 6th Week	27.83	5.72	25.54	5.23	0.30
10 MWT (Fast Velocity)	Baseline	27.50	6.05	23.08	5.43	0.06
	After 3rd Week	27.17	6.43	23.15	5.52	0.10
	After 6th Week	26.08	6.80	23.15	5.78	0.25
Percentage Of Weight Bearing (%)	Baseline	17.27	1.32	17.74	1.63	0.43
	After 3rd Week	17.30	.50	17.61	2.29	0.68
	After 6th Week	21.83	3.45	19.41	3.66	0.10
Cadence (cm)	Baseline	53.31	9.09	51.75	7.83	0.65
	After 3rd Week	48.83	5.99	55.15	7.47	0.02*
	After 6th Week	36.41	7.05	42.84	11.99	0.11
Step Length (m)	Baseline	39.41	5.72	40.53	5.39	0.62
	After 3rd Week	39.16	5.40	41.15	5.35	0.36
	After 6th Week	56.08	8.05	42.69	6.86	0.00***
Stride Length (m)	Baseline	73.25	10.19	69.38	9.72	0.34
	After 3rd Week	63.83	8.22	54.53	7.96	.009**
	After 6th Week	62.75	3.16	55.38	7.77	.006**

Level of significance: p<0.05, p<0.01**, p<0.001****

DISCUSSION

The primary finding of the current study was that when participants underwent treatment using a CBWS approach—the forced transfer of body weight toward the participant's affected side—their weight bearing symmetry improved and there was a clinically noticeable increase in gait velocity. The study's findings are consistent with the initial hypothesis that adding a shoe lift to the unaffected side during rehabilitation will somewhat enhance symmetry in weight bearing and gait speed.

Previous research showed that in patients with acute and chronic stroke, a lift to the unaffected side was related with an immediate improvement in the symmetry of weight bearing[13, 14]. As a result, it was noted that a 1.2-cm lift helped to enhance weight bearing on the affected side, which went from 38.8% to 48% to 39.9% to 47%[14]. Additionally, in patients with acute stroke, the restoration of weight bearing symmetry was achieved by placing a 5° wedge on the unaffected side[13]. Additionally, in patients with acute stroke, a 0.9-cm shoe elevation on the unaffected side enhanced static and dynamic postural control[9]. The results of these trials, however, did not reveal whether the enhanced weight-bearing symmetry was maintained after just one experimental session. The improvement of weight-bearing symmetry and gait velocity was demonstrated in one patient with prolonged use of the shoe lift[11]. The results of the current study expand prior findings to a group of chronic stroke patients who showed improvement in their symmetry of weight bearing following a 6-week course of CWBS treatment. It is significant to note that the control group of individuals also had an increase in weight bearing on the affected side, however the rate of this gain with therapy was not markedly different. In the experimental group, the mean Tinetti score was 12.50 before therapy and 15.17 after treatment, whereas in the control group, the mean score was 13.77 before treatment and changed to 15.00 after six weeks, respectively. This less difference in the improvement of weight bearing on the affected side in the experimental group points to the effect of the lift insert and may be due to some other confounding factor which was not significantly noted. Individuals in the control group were not given a lift insert and both groups underwent a similar treatment.

Following treatment, the gait velocity in the control group reduced by 53.31 steps/min to 36.41 steps/min, as clinically observed, while it increased by 51.75 steps/min to 42.84 steps/min in the experimental group. This finding confirms earlier research showing that walking function did not improve following symmetrical weight bearing retraining with a feedback device[15]. Our strategy was distinct in that forced weight bearing was accomplished throughout the course of treatment, throughout all routine daily activities, including ambulation. The clinically observed increase in gait speed shows that the patient's capacity to overcome acquired disuse of the afflicted leg was unaffected by the forced change in body weight.

It's also crucial to note that there was a variation in the groups' initial gait velocities. According to gait speed norms, neither group changed their ambulation categories while receiving therapy, but by the conclusion of the retention period, the experimental group had made the smallest clinically significant difference[16].

In the current study, the gait parameters including step length, stride length and cadence were figured out along with ten meter walk test which was used to assess the improvements in gait of patients. The mean value of step length in experimental group was 39.41cm before treatment and after treatment it increased to 56.08 cm while in control group step length was 40.53 cm before treatment and after six-week treatment it became 42.69 cm patient. The gait velocity is commonly used measure of the ambulation assessment. Another investigation done by Aruin et al on people with incessant stroke utilizing a finished insole for about a month and a half which showed improvement in stride speed, while members of control group didn't indicate any improvement. Moreover, step speed improved much progressively over the 4-months maintenance period during which the people did not utilize the insole[6]. The study by Seok Hyun Nam et al 2017 conducted study on Changes of gait parameters following constrained-weight shift training in patients with stroke and according to results the constrained weight shift training group showed a significant increase in the contact with surface of the hind foot compared to the control group, and the step length and walking speed were significantly longer and faster[17].

The limitation of the study is the sampling technique, as the sample of convenience may affect the external validity of the study.

CONCLUSION

The compelled body weight shift (CBWS) intervention may lead to an improvement in the gait parameters as well as balance if conducted for longer duration. It is also recommended that spasticity must be considered in future study as it may affect the progress in chronic stroke.

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