

Comparative Effects of Whole-Body Vibration and Squatting Training on Balance and Mobility in Chronic Stroke Patients. A Randomized Controlled Trial

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ABSTRACT

Background: A stroke occurs when the central nervous system is disrupted by brain injury caused by a cerebrovascular hemorrhage, resulting in hemiparesis, nerve dysfunction, and muscular weakness but the use of innovative modalities for stroke is still unknown. The objective of this study is to investigate the comparative effects of whole-body vibration (WBV) training and squatting performance in chronic stroke patients.

Methods: we reviewed 86 chronic stroke patients with the commencement of more than 6 months in physical therapy department of central park medical college, Lahore (2021-2022). An independent examiner randomized the patients individually after doing the baseline assessment. 86 ambulatory patients (51 men and 35 women) who are recruited in hospital.

Results: During 2020-2021, 86 chronic stroke patients were investigated in hospital of whom all patients had a pre-existing medical condition like uncontrolled hypertension and diabetes. Total number of participants is N=86. Number of male participants N=25 and females N=18 in group A. Number of male participants in group B is 23 while number of females is 20. The participants in both groups demonstrated a significant increase in balance and mobility scores after 6 weeks of WBV training. Experimental group having 6th week BBS mean, standard deviation, 52.37, 1.92 and Control group having 6th week BBS mean, standard deviation 45.25, 4.18 respectively. The participants in both groups demonstrated a significant increase in balance and mobility scores after 6 weeks of WBV training but more pronounce results in experimental group.

Conclusions: The results of this study concluded that whole-body vibration exercise with routine physical therapy treatment is very effective in improving balance, mobility, postural control, muscle strength, tone, power output, coordination reduced muscle spasticity and functional disability in patients with chronic stroke.

Keywords: Whole-Body Vibration, Berg Balance Scale, Squats Exercise, Mechanical Vibrations

INTRODUCTION

Stroke patients experience muscle weakness and movement disorders due to lesions in the descending motor pathway and decreases in skeletal muscle activation.¹ WBV includes standing on a vibration platform placed on a static surface, stimulus that uses vibrations generated on a machine, with oscillatory movement determined by the amplitude and frequency of the vibration.² Squatting training is widely used in the clinic, to improve the muscle strength and balance function in stroke patients.³ In 2021, Burq HSIA, et al, studied that the Augmented response of antigravity muscles due to strengthening exercise is expected to be a contributing factor behind the improved walking speed of the patients.⁴ In 2021, Kim JW, et al, studied that WBV treatment actuate the Ia and II afferent and tonic vibration reflexes by distinguishing the stretch of the muscle. The impacts can work on postural control and hence improve proprioceptive capacity.⁵

In 2021, Cho J-E, et al, reported lower limb impairments after stroke, the inability of the ankle joint to yield normal levels of muscle force. such as locomotion, muscle weakness of the ankle muscles is associated with reduced plantarflexion at the end of the stance phase and reduced dorsiflexion at the swing phase.⁶ In 2019, Zulkifley MA, et al, studied that the squat exercise is full-body training to strengthen core muscles such as quadriceps, hips, hamstrings, and thighs, by flexing the knees, hip, and ankle joints. It is also used to improve postural balance and body endurance, especially in the lower body parts and trunk because this exercise involves every muscle in the human body. patient is required to bend the knee angle between 90° and 120° during the exercise depending on the patient's capability.⁷ In 2017, Souza et al. stated that as the knee angle increases (30°, 45°, 60°), muscle activity increased for the rectus femoris and biceps femoris which are agonists of the lower extremity.⁸

MATERIAL AND METHODS

exploring sampling by using purposive sampling method. The randomized, assessor-blinded, controlled clinical study conducted at the Physiotherapy Department of central park medical college, Lahore, Pakistan, from October 2021 to July 2022, a sample size of 86 patients was calculated. Those included were patients of both genders, aged 30 -70 years having a chronic stroke with a minimum period of 6 months, ability to stand with or without aid for more than 90 seconds, participants could understand the nature of the intervention, participants could perform protocol independently. Those exclude were brainstem cerebellar stroke, neurological disorders (spinal cord injury), severe cardiovascular diseases (a pacemaker, uncontrolled hypertension), pain that affected the ability to participate in physical activities, pregnancy, vestibular conditions, recent fractures or metal implants in the lower limbs.

After taking informed consent from the subjects, they were randomized using the computer number generator method into two equal groups in squatting training and WBV groups. Participants of both groups received routine physical therapy, which includes stretching exercises, strengthening exercises e.g., Wrist and Hand Stretch, Shoulder Openers, Table Towel Slide, Trunk Bends, Knee Rotations, Hip Abduction, Standing Knee Raises, sit to stand from chair, hip thrust, 2sets of 10 repetitions 5 times a week. Balancing exercises e.g., Standing balance exercises move your weight to your right foot from a standing position. Place the sole of your left foot on your ankle, hip, or thigh, or keep it on the side with your heel lifted. Place your hands in a place that is convenient for you. Grasp the setting aimed at up to 1 minute. Then do the complete opposite. Forward to Backward Weight Shifting, Lateral weight shifting, Forward lounges, Single-leg balance exercise. Dynamic balance exercise running in a spiral pattern or reverse.

The WBV therapy was given on a WBV device (Crazy Fit Massage) in an erect standing position with a frequency of (30 Hz, 2.5 mm, 5 min WBV, 1 min inter-set rest intervals, 90° knee joint

angle) at 1st weeks. Frequency, amplitude enhances in 3rd week (40 Hz, 3.5 mm, 3 min WBV, 1 min inter-set rest intervals, 100° knee joint angle). At 6th week (50 Hz, 8 mm, 5 x 1 min WBV, 2 min inter-set rest intervals, 110° knee joint angle). The participants stood upright with hands on the handrails on the WBV platform for effective transmission of vibrations up to the trunk level. Monitoring of adverse events and subjective feelings was done by an experienced physical therapist throughout the sessions for both groups. No adverse event was observed during the sessions.

Assessment of physical function at baseline and post-intervention by an assessor who was an experienced physiotherapist blinded to the allocation process. Age, gender, side of hemiplegia, duration of a stroke, type of stroke, and other medical conditions were recorded. The primary outcome measure was the score of the timed up and go (TUG) test, and the secondary outcome measure was the berg balance scale. Time was recorded with a stopwatch and the entire activity was carried out under the supervision of a physiotherapist who monitored the patients without assistance. Ethical approval of the study was taken from the Institutional Review Board of the University of Lahore. Data analyzed used by chi-square test, independent sample t-test, and paired sample t-test using SPSS 24. Changes in physical function in static body balance, walking ability, dynamic body balance, muscle power, spasticity, muscle tone, postural control, and coordination. All parameters improved significantly from baseline values in both groups but more improved in the wholebody vibration group. Berg balance scale is used to assess balance, increase in numbers showing there is a beneficial effects of vibration therapy, patient is stabilizing independently in sitting and standing position, able to transfer, pick objects from ground and turn to 360 angles without assistance. Time up and go test is used to measure mobility reduction of tug timing in seconds showing improvement in 3-meter walk test. Decrease in timing during rising up from chair, walk 3 steps forward then turn to 180 angles then move backward to chair and sit again.

Figure 2 shows whole-body vibration in a standing position. Figure 2.1 shows wbv in 45% squat position. Figure 2.2 weight shifted on the left side with wbv. Figure 2.3 weight shifted on the right side with wbv. Figure 2.4 shows left and right forward lunges Figure 2.5 shows anterior weight shifting. Figure 2.6 shows posterior weight shifting. Figure 2.7 shows single-leg balance exercise. Figure 2.8 shows electrical muscle stimulation on the left

leg. Figure 2.9 shows an ultrasound on the contracture of the elbow



Figure 1:

RESULT

Table 1: Demographic Characteristics

Demographic data in %			
Characteristics		Control Group (43)	Experimental Group (43)
Age %	30-40 y	2.3	11.6 20.9 34.9
	41-50y	27.3 34.9	32.6
	61-60y	34.9	
	61-70 y		
Gender %	Male	58.1	53.5
	Female	41.9	46.5
BMI %	NW	20.9 39.5	39.5 32.6 16.3
	OW	25.6	11.6
	Obesity class 1	14.0	
	Obesity class 2		
Location %	Left	83.7	60.5
	Right	16.3	39.5
Type %	Ischemic	69.8	55.8
	Hemorrhage	30.2	44.2
Duration %	6 months	44.2 34.9	48.8 39.5
	1-2 years	20.9	11.6
	2-3 years		

Notes: Data are expressed in percentages. the percentages of subjects who had a stroke in the past 3 years, and the percentages of subjects after treatment between the two groups.

Table 2: Comparison Of The Therapeutic Effect Between The Two Groups

Variables	Control Group A			Experimental Group B		
	Mean	Std. deviation	P-value	Mean	Std. deviation	P-value
BBS						
Baseline	11.2558	6.42574	0.200	21.8605	7.85458	0.200
Week 1	23.4651	6.38953	0.200	33.6977	5.59564	0.200
Week 3	35.4186	5.64097	0.000	43.2326	3.67642	0.044
Week 6	45.2558	4.18667	0.000	52.3721	1.92754	0.000
TUG						
Baseline	48.8837	9.24072	0.200	37.7442	5.46457	0.046
Week 1	36.6279	6.64409	0.000	27.6977	5.54005	0.060
Week 3	26.2558	4.34847	0.003	20.6279	3.72906	0.003
Week 6	18.3721	3.89152	0.0	14.5116	2.24003	0.000

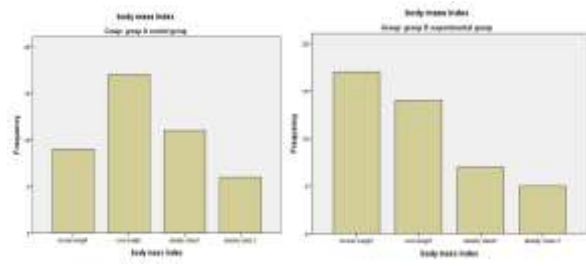


Figure 2:

Data are expressed as mean ± standard deviation for TUG, and BBS and physical function parameters measure in percentage between the two groups. The means of baseline BBS 21.86 ± and TUG 37.74± in the experimental study is high as compared to the baseline of BBS± 11.25 and TUG 48.88± in the control group. After 6 weeks of treatment BBS mean 45.25± and TUG mean 18.37± in experimental group. Mean BBS 52.37± and TUG mean14.51± in control group. Statistically, the experimental group shows a significant difference in the study because the p-value is < 0.05, that's why this study has a positive impact on the chronic stroke patients.

In 2022, Alashram AR et al investigates that Ultrasound therapy help to reduce spasticity. A direct pulse wave can be used

because the wave is in the form of a force that is turned into the proper temperature in the muscle that leads to relax the spastic muscle, it is best suited for the situation of a spastic stroke where the joint is stiff owing to contraction. Electrical stimulation (E, stim) can help you overcome many of the side effects of initial strokes, from enhancing motor abilities to preventing atrophy.⁹

In 2021, Kim JW, et al reported that the improvement of walking ability after WBV training is considered a result of the neural plastic change. The vibration has a positive effect on spasticity by affecting presynaptic inhibition. Presynaptic inhibition of Ia-afferents reduces the release of neurotransmitters to the motoneurons, and thereby weakens the effects of Ia-afferents on motoneurons, resulting in inhibition of the H-reflex amplitudes.⁵ In 2019, Salazar AP et al proposed that Passive stretching increases intramuscular tension and stimulates the Golgi tendon organ, which acts as a defensive mechanism to inhibit muscle contraction and give muscle relaxation. As a result, exercise is an important part of spasticity treatment.¹⁰ So, we conclude that based on this present study we can use whole body vibrators as a useful modality in chronic stroke patients as statistically, their results are beneficial in this disease. squats exercise also has positive effects on the lower limb of stroke patients as their leg muscles are severely compromised in hemiplegia but during squatting training, all legs along with trunk muscles are activated and contribute to building posture again but whole-body vibrator as a modality is a useful innovation in physical therapy field.

DISCUSSION

This study has 86 patients with stroke for 6-weeks treatment sessions. All of the subjects received the standard rehabilitation program for 30 minutes (EMS, strengthening exercises, balance, and strengthening exercises). Group A receives whole-body vibration 5 times per week Group B receives Squatting training with special exercises 5 times a week for 6 weeks session. Data are expressed as mean \pm standard deviation for TUG, and BBS and physical function parameters measure in percentage between the two groups. The means of baseline BBS $21.86 \pm$ and TUG $37.74 \pm$ in the experimental study is high as compared to the baseline of TUG $48.88 \pm$ and BBS $11.25 \pm$ in the control group. Statistically, the experimental group shows a significant difference in the study because the p-value is < 0.05 . The recent findings imply that WBV improves balance and ambulation in stroke survivors. Whole body vibration is employed to treat patients in this study, and there is always an advantage, which could be attributed to the greater transfer of flexible side vibration to the hip abductor in chronic side patients. To increase the efficacy and sharpness of the assessment side, the results of the current study can be harmonized by posting a combination of upright posture, deep vibration training, and a better workout program. Strengthening activities include Wrist and Hand Stretch, Openers Shoulder, Table Towel Slide, Trunk Bends, Knee Rotations, Hip Abduction, Standing Knee Raises, posture, hip thrust, and exercise balance, and strong balance have improved antigravity muscle reaction.

Balance exercises such as Knee flexion, extending to the right weight change, are explicit actions such as 45degree squats (weight change to the affected side but as much as might be expected). In patients with progressive stroke, Antero back weight shift work out (raising and lowering heels), one leg standing on the other side, running forward (flexing the affected leg forward), and bending 90degree knee flexion, applied on the chronic stroke patients to focuses on postural control, balance, flexibility, muscle strength, tone, yield strength, decreased muscle spasticity.

Patient mobility is likely to improve in both groups as a result of exercise. Stretching exercises are a key element of all the tests used to treat spasticity, and they're highly crucial. Passive stretching increases intramuscular tension and stimulates the Golgi tendon organ, which acts as a defensive mechanism to inhibit muscle contraction and give muscle relaxation. As a result, exercise is an important part of spasticity treatment. Exercise and ultrasound therapy help to reduce spasticity. A pulse wave can be

used to make the US indefinitely. Because the wave is in the form of a force that is turned into the proper temperature in the muscle and muscles to relax the spastic muscle, it is best suited for the situation of a spastic stroke where the joint is stiff owing to contraction. Electrical stimulation has numerous advantages for stroke sufferers. Electrical stimulation (E, stim) can help you overcome many of the side effects of initial strokes, from enhancing motor abilities to preventing atrophy. The duration of the study in this study is 6 weeks, which is quite inexpensive and time-saving, but it has demonstrated that vibration therapy for a shorter amount of time has favorable benefits on stroke patients. Patients are given a total of 5 sessions each week, implying that more vibration training is better. The platform's amplitude vibration and frequency employed in prior experiments ranged from 0.44 to 5mm and 20 to 40Hz, correspondingly. 43 Various intensities, including 2.5, 3.5, and 8-mm amplitude and 30Hz, 40Hz, and 50Hz frequency, were employed for 6 weeks in this investigation. During the treatment period, the amplitude and frequency of vibrations were gradually raised in this investigation. The optimal exercise program for the experimental and control groups could explain why both groups improved, but whole-body vibration had extra benefits for the experimental group. Vibration stimulates antigravity's primary endothelium nerve terminals, sending Ia afferent impulses to II inhibitory interneurons and alpha motor neurons in the spinal cord. The tonic vibration reflex (TVR) creates involuntary access to the vibrating muscle and blocks the opposing muscle with this unique approach. As a result, vibratory movements have typically been used against the spastic muscle equivalent to alleviate hemiplegic joint spasticity

The squat exercise, which involves bending the knees, hips, and ankle joints, is one of the most common techniques to develop important muscles such as the quadriceps, hips, hamstrings, and thighs. Because this exercise engages nearly every muscle in the human body, it is also utilized to enhance postural balance and endurance, particularly in the lower body and trunk. Standing upright with feet apart and bringing the hands to the sides of the body is how a standard squat is done. Before straightening his legs, the person must first bend his legs till his thighs are level with the ground while keeping his heels up and down.

Based on the results of this study, the improvement of walking ability after WBV training is considered a result of the neural plastic change. The vibration has a positive effect on spasticity by affecting presynaptic inhibition. Presynaptic inhibition of Ia-afferents reduces the release of neurotransmitters to the motoneurons, and thereby weakens the effects of Ia-afferents on motoneurons, resulting in inhibition of the H-reflex amplitudes. By measuring the long-term effects of repeated WBV on neural plasticity in stroke patients, WBV can be suggested as an ancillary rehabilitation treatment method for use with these patients. Changes in static body balance, walking ability, dynamic body balance, muscle power, spasticity, muscle tone, postural control, and coordination. All parameters improved significantly from baseline values in both groups but more improved in the whole-body vibration group. Berg balance scale is used to assess balance, increase in numbers showing there is a beneficial effects of vibration therapy, patient is stabilizing independently in sitting and standing position, able to transfer, pick objects from ground and turn to 360 angles without assistance. Time up and go test is used to measure mobility reduction of tug timing in seconds showing improvement in 3-meter walk test. Decrease in timing during rising up from chair, walk 3 steps forward then turn to 180 angles then move backward to chair and sit again. So, we conclude that based on this present study we can use whole body vibrators as a useful modality in chronic stroke patients as statistically, their results are beneficial in this disease. squats exercise also has positive effects on the lower limb of stroke patients as their leg muscles are severely compromised in hemiplegia but during squatting training, all legs along with trunk muscles are activated and contribute to building posture again but whole-body vibrator as a modality is a new innovation in physical

therapy field as it gives sudden positive results in days and weeks so it can be used in the chronic stroke patients. 44

CONCLUSIONS

Physical activity in the form of whole-body vibrations combined with Physical Therapy exercises improved balance, mobility, and quality of life among chronic stroke patients, as per the results of this study.

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