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Original Article

Comparative Effects of Exergaming and Treadmill Training on Balance and Mobility in Patients with Chronic Stroke

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ABSTRACT
Stroke is the chief cause of death and disability in the world that led toward impaired balance and mobility. Treatments that provide feedback, increase practice with multiple repetitions, and motivate patients are essential for rehabilitation after stroke. **Objective**: To determine whether playing video gaming exercises or treadmill training is better for balance and mobility post-stroke. **Methods**: A total of sixteen chronic stroke patients were randomly allocated to either the gaming or control groups. In this group patients were given visual feedback that was displayed on the screen. Participants played games for six weeks, work for 40 minutes per day, three days per week the therapy consisted solely of standing-up gameplay with no baseline therapy. The control group training with baseline treatment for six weeks, work for 40 minutes per day, three days per week. Both groups were tested earlier the study following intervention later 6 weeks. The Berg Balance Scale and TUG were used as outcome measures (Timed Up and Go test). **Results**: No statistically significant difference was found between the groups when analyzed post-treatment, but some significant differences were found within the group. By assuming equal variances and degree of freedom 14, there was no statistically significant difference, the p-value for BBS before VR was .170, and after VR was.686. However, the p-value for BBS before TT was .830, and after TT was .731. For TUG p-value before VR was .264 and after VR was .571. the p-Value for TUG before TT was .908 and after .416. The difference of mean for BBS before VR was .250 and after VR was 1.250 compared before TT 1.00000 and after 2.2500. For TUG, before VR was -1.000 and after VR was -2.250 comparing TUG pre-TT was -.62500 and post TT was -.3750. **Conclusion:** Although there was no statistical distinction between the two categories, the gamers were more excited and driven to be involved in the intervention for a longer period of time. Before considerable gains in commercially available general-purpose games may be realized, therapist guidance in developing more optimal movement choices may be required.

INTRODUCTION
A stroke is a condition in which the blood supply of the brain loses and blood deficient brain cells stop supplying various parts of the body. It is the most serious, common, and alarming health condition globally in many countries it is the 2nd or 3rd and causes death. In most adult population's disability caused by this [1]. Major risk factors are increased blood pressure, cigarette smoking, atrial fibrillation, and diabetes mellitus. [2-3]. Many heart conditions become the reason for stroke in most elderly people. In other conditions like diabetes mellitus, high blood pressure, overweight can cause great damage to the brain if a stroke happened to them [4]. Stroke has various types i.e. hemorrhagic and ischemic. A condition in which an artery in the brain is blocked or obstructed is called ischemic stroke [5]. Hemorrhagic CVA or stroke is another important type of stroke, in this type of stroke main arteries in the brain rupture and too much blood spread into the brain tissues [6]. Patients with stroke exhibit typical symptoms after the attack that is an alarming condition, that time is the most important to see a doctor. Patients usually show symptoms of sudden weakness in one side of the body, numbness in half side and

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paresis of face, weakness of the arm, leg on one side of the body. They have difficulty in speaking and slurred speech and have difficulty in recognizing speech. They have severe headaches and problems seeing both eyes. Most of the patients exhibit loss of balance and coordination, due to this reason they have trouble walking [7]. In the chronic stage that is defined as six months to years after onset, symptoms are usually associated with balance and immobility [8].
In the western world, cerebrovascular accidents are considered the main reason for death and disability in stroke patients. Many patients with stroke have problems in balance and walking. [9]. Due to balance impairments, falling accidents are increasing annually. Sudden paralysis, seizures, and any external pressure cause loss of consciousness. Frequent falling may disturb social and physical activities as there is no injury seen apparently [10]. Over the past 20 years ago, many intervention approaches are used to improve balance and mobility after stroke. Interventions include strength training, balance training, treadmill walking with the use of or without body support. Treadmill exercise can help patients with stroke improve their balance and strength [11].
Virtual reality is gaining popularity in rehabilitation of stroke patients as it keeps them motivated and engaged in exercises [12]. Xbox-Kinect is the tool used for video gaming [13]. It has infrared camera sensors to sense the movements of individuals [14]. It is useful in patients who need physical activity, patients with stroke, neurological disabilities [15-17]. It improves the strength and balance training in geriatric population as well [18]. It is also useful in the betterment of functional outcomes [19]. Such patients get fed up due to monotonous daily routine and this gaming provides them with new enthusiasm [20,21].

METHODS

The Randomized Controlled Trial was conducted in the physiotherapy department of Services Hospital, Lahore for six months. Sample size calculated by Epitool Software. The sample size of 16 with 08 in each group will be used in this study, calculated by using 95% confidence level and 80% power from the previous study by Stacy L Fritz *et al.,* [28], with no attrition rate**.** Both males and females with aged between 40 and 75 years have a clinical presentation of unilateral hemiplegia of the lower extremity with a duration of more than 6 months after stroke. The ability of the patient to stand with or without an assistive device for 5minutes (Minimal Physical Assistance) Having the capacity to ambulate for 10 feet with/without assistance was included in this study. While patients with inability to walk, Severe hypertension, Arthritis, orthopedic problems, Lower extremity amputation, Severe weight-bearing pain, having visual and auditory impairments, previous history of deep venous thrombosis (DVT) or pulmonary embolism, and history of seizures disorder were excluded from this study. A convenient sampling technique was used to collect the data, but all participants were randomly assigned to one of two treatment groups by lottery method during the research Berg Balance Scale and Timed Up and Go test were used as measuring tools**.** Berg balance scale is used for measuring balance with 95% confidence [29].
Internal consistency (Cronbach's) of BBS total score was calculated as 0.93. In one study Cronbach's α coefficient is higher (i.e., 0.98) for the BBS total score [30]. Timed Up and Go Test is used to assess a person's mobility and requires both static and dynamic balance. Research has shown the Timed up and Go test has excellent interrater (interclass coefficient [ICC] = .99) and inter-rater reliability (ICC = .99) [31]. Two groups. Group A had given video gaming exercises along with baseline treatment of standing March, hurdle walk, and parallel bars while Group B had given treadmill training with conventional physical therapy. The BBS and TUG measurements were taken before and after intervention in the 6th week. In group A, a total of 08 patients were treated with virtual reality training in which different video games are used to engage patients in the treatment session. For this training, the Xbox Kinect system contains a sensor, and a console was used. The kinetic sensor is an infrared camera that can identify the motions and positions of the subject without the requirement of a special controller. All games were involved in Kinect Adventures Package. Treatment session was given for 3 days/week for 6 weeks.
In Group B, 8 patients receive treatment sessions for 3 days per week for 6 weeks. In 40 minutes, a session, 10 minutes are given to baseline treatment which includes standing March, hurdle walk, and walk-in parallel bars. In the next 30 minutes, the patient was treated with treadmill training protocol which is low-speed treadmill walking based on the walking ability of the patient. Data analysis was performed by using the Statistical Package for the Social Sciences (SPSS) for window version 21. The data were analyzed using parametric tests. To find the significance of the interventions between groups, an independent sample t-test was used while a within-group paired sample t-test was used. The significance level set for this study was 95 %($p<0.05$).

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RESULTS

Out of a total 16 participants included in the study, 08 were assigned to Group A which is based on video gaming exercises and 08 were assigned to Group B which is treadmill training. Mean age was comparable at baseline between the two groups. The mean of patients in the video gaming group was 57.62 ± SD 7.999 and for Treadmill training it was 66.25± 8.084 (Table 1,2).

Socio-Demographic Profile		Group A (Video gaming group)	Group B (Treadmill group)
AGE (YEARS)		Mean=57.62	Mean= 66.25
		SD = 7.999	SD = 8.084
Gender	Males	3	3
	Females	5	5
Affected Side	Right	4	5
	Left	4	3

Table 1: Socio-economic profile of both interventional group and control group

Variables	Shapiro- Wilk		
	statistics	df	Sig.
Age	.940	16	.351
Weight	.898	16	.075
Height	.911	16	.122
Left/Right	.638	16	.000
BBS. Pre VR	.968	16	.813
BBS.Post VR	.963	16	.721
TUG Pre VR	.930	16	.243
TUG Post VR	.957	16	.603
BBS.pre.TT	.968	16	.808
BBS.Post. TT	.966	16	.770
TUG. Pre.TT	.973	16	.881
TUG. Post TT	.952	16	.519

Table 2: Test of Normality

Normality tests using Shapiro-Wilk tests showing pre- and post-statistics of (BBS) and Timed Up and Go Test (TUG) along with age, gender, weight, and height. This table showed a p-value > 0.05 i.e., there is an insignificant difference in both groups (Table 3).

Variables		Levene's Test for Equality of Variances		T-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std.Error difference	95% confidence interval of the Differences	
									lower	Upper
BBS.pre. VR	Equal variances Assumed	2.090	.170	.085	14 12.191	.933 .933	.250 .250	2.932 2.932	-6.039 -6.128	6.539 6.628
	Equal variances not assumed			.085						

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BBS.post. VR	Equal variances assumed	.170	.686	.380 .380	14 13.66 2	.710 .710	1.250 1.250	3.294 3.294	- 5.81 4 - 5.83 1	8.314 8.331
	Equal Variance not assumed									
TUG.pre. VR	Equal variances assumed	1.353	.264	-.784 -.784	14 11.34 7	.446 .446	-1.000 -1.000	1.275 1.275	- 3.73 4 - 3.79 5	1.734 1.795
	Equal variances not assumed									
TUG.post. VR	Equal variance assumed	.337	.571	-1.123 -1.123	14 13.85 5	.280 .280	-2.250 -2.250	2.003 2.003	- 6.54 7 - 6.55 1	2.047 2.051
	Equal variances not assumed									
BBS.pre.T T	Equal variances assumed	.048	.830	.395 .395	14 13.91 5	.699 .699	1.00000	2.53194 2.53194	- 4.43 047 - 4.43 357	6.43047 6.43357
	Equal variances not assumed						1.00000			
BBS.post. TT	Equal variances assumed	.123	.731	.909 .909	14 13.62 3	.379 .379	2.25000	2.47397 2.47393	- 3.05 614 - 3.06 994	7.55614 7.56994
	Equal variances not assumed						2.25000			
TUG.pre.T T	Equal variances assumed	.014	.908	-.476 -.476	14 13.83 2	.641 .641	-.62500 -	1.31186 1.31186	- .343 866 - .344 188	2.18866 2.19188

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	Equal variances not assumed						.62500			
TUG.post. TT	Equal variances assumed	.576	.416	-.219 -.219	14 13.35 1	.830 .830	-.37500 -	1.71065 1.71065	- 4.04 399 - 4.06 079	3.29399 3.31079
	Equal variances not assumed						.37500			

Table 4: Independent sample t-test

Comparison of means by Independent t-test for Berg Balance Scale and Timed Up and Go test before and after the intervention. This table showed that assuming equal variances and degree of freedom 14, there was no significant difference, the p-value for BBS before VR was .170, and after VR was .686. However, the p-value for BBS before TT was .830, and after TT was .731. For TUG p-value before VR was .264 and after VR was .571. the p-Value for TUG before TT was .908 and after .416. The difference of mean in this table for BBS before VR was .250 and after VR was 1.250 compared before TT 1.00000 and after 2.2500. For TUG, before VR was -1.000 and after VR was -2.250 comparing TUG pre-TT was -.62500 and post TT was -.3750 (Table 4).

Variables		Mean	N	SD	SE Mean
Pair 1	BBS.pre.VR				
	BBS.post.VR	37.63	16	5.667	1.417
Pair 2	TUG.pre.VR	45.63	16	6.397	
	TUG.post.VR				1.599
Pair 3	BBS.pre.TT			2.517	
	BBS.post.TT	19.25	16		.629
Pair 4	TUG.pre.TT	13.75	16	4.041	
	TUG.post.TT				1.010
				4.91935	
		37.7500	16		1.22984
			16	4.91935	
		45.2500			1.22984
				2.55522	
					.63881
		20.4375	16	3.31097	
			16		.82774
		14.1875			

Table 5: Paired Sample Statistics

Comparison using Paired t-tests in both group A and B for Berg Balance Scale before VR was 37.63 and after VR was 45.63 whereas BBS before TT was 37.7500 and after TT was 45.2500. For TUG mean value before VR was 19.25 and after 13.75. The mean of TUG before TT was 20.4375 and after TT WAS 14.1875. Therefore, this table shows that by comparing means of both groups with each other there was no significant difference but by comparing within the groups the difference was present (Table 5). By using Paired t-test for correlations for Group A and Group B, the correlation of the Berg Balance Scale before and after Virtual reality training was .781with p-value of 0.000 and the correlation of Berg Balance Scale before and after Treadmill training was .931 with a p-value of 0.000. Whereas the correlation of Timed up and go test before and after VR was .551 with a p-value of 0.27, and the correlation of Timed up and go test before and after Treadmill training was .691 with a p-value .003. Hence, this table elaborated that there was no significant difference between Berg Balance Scale for both groups but there was some significant difference between the timed up and go test for both groups (Table 5).

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Variables		Paired differences					t	df	Sig. (2-tailed)
		Mean	SD	SE Mean	95% Confidence interval of differences				
					Lower	Upper			
Pair 1	BBS.pre.VR BBS.post.VR	-8.000	4.5050	1.012	-10.15	-5.845	-7.902	15	.000
Pair 2	TUG.pre.VR TUG.post.VR	5.500	3.386	.847	3.696	7.304	6.49	15	.000
Pair 3	BBS.pre.TT BBS.post.TT	-7.50000	1.82574	.45644	-8.47287	-6.52713	-16.432	15	.000
Pair 4	TUG.pre.TT TUG.post.TT	6.25000	2.40832	.60208	4.96670	7.53330	10.381	15	.000

Table 6: Paired sample statistics

The paired t-test shows paired t-test value for the Berg balance scale before and after VR in groups A and B was -7.902 and for TT was -6.52713 with a degree of freedom was 15 and a p-value of .000. However, for the Timed up and Go test before and after VR in both groups were 7.304 and for Treadmill training both groups A and B were 10.381 with a degree of freedom 15 and p-value was 0.000 (Table 6).

DISCUSSION

The objective of this study was to find out the comparative effects of video gaming exercises and treadmill training on balance and mobility in chronic stroke patients. Many studies have been conducted to check the effects of virtual reality training in stroke patients for Balance and Mobility. This study was the first attempt to compare the effect of Exergaming and Treadmill training for maintaining balance and mobility in stroke patients in the chronic phase. Most of the studies emphasize functional independence in stroke patients after the loss of balance and inability to walk independently. Nowadays active video gaming exercises consider much effective and suitable for patients with stroke. In these treatment approaches, patients feel comfortable and engaged for a long time by playing different games by using their upper and lower limbs. Other than video-gaming activities, treadmill training is much useful for improving walking ability. Many studies augments treadmill training as beneficial for stroke patients rather than other physical therapy interventions alone. But in this study, the effects of video games exercises and treadmill training have been seen in stroke patients.

AL Aramaki *et al.*, in 2019 did a study on virtual reality in the rehabilitation of stroke patients. The results show that dynamic balance markedly improved in virtual reality as compared to conventional treatment static balance shows the same results [14]. These results were similar to my study as virtual reality increases dynamic stability. Yo Soon Bang (2016) favored the effectiveness of virtual reality training using Nintendo Wii and treadmill-based exercises on balance and walking for stroke patients. Both groups showed statistically significant differences in left/right and ant/post-weight-bearing for balance across the groups. There were significant differences in stance phase, swing phase, and cadence for walking in the video gaming group. Thus, virtual reality training proved to be much suitable for individuals who want balance and walking ability by developing their interest in planned and organized exercises. But results of my study showed no obvious significant difference between groups. S. A. Graham *et al.,* did the study on walking and balance outcomes of stroke patients with body-weight-supported treadmill training concluded that additional mobility challenges to treadmill training do not lead to more improvement [32]. the results were similar to my study.Han Suck Lee (2019) with his Colleagues did a Meta-analysis to examine either Virtual reality (VR) training is effective for upper extremity, lower limb, or overall function in patients of stroke in the chronic phase. For VR total effect size after the rehabilitation process was 0.440.

Thus, video game workouts were found to be the most beneficial in improving stroke patients' function with a modest effect size, as well as for both the upper and lower limbs [33]. But in my study, no significant difference was a note with Virtual reality (VR) training Belgian Erhan (2018) with his coworkers did a study in which body weight supported Treadmill training effect was seen on the static and dynamic balance in stroke patients. This study proved that the combined effect of the treadmill plus conventional therapy is much effective than the Treadmill technique alone in regaining balance, mobility, and fear of falling parameters in stroke patients [34]. Hence, this study emphasis on the significant different effect of video games and treadmill training in stroke patients. In Berg Balance Scale, P-value < 0.05 shows some significant difference

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and in the TUG scale, P-value > 0.05 shows no significant difference i.e., group A receiving Video gaming therapy and B carrying Treadmill training.

CONCLUSIONS

The study concluded that Video gaming therapy along with standing March, walk-in parallel bars, and hurdle walk showed some significant improvement within the group under the evaluation based on the score of Berg Balance Scale (BBS) and Timed Up and Go test (TUG) when compared with initial data. But there is no significant difference between both groups so, this study determined that the effect of Exergaming is similar to that of Treadmill training with conventional therapy.

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