ORIGINAL ARTICLE

COMPARISON OF EXERGAMES VERSUS TRADITIONAL BALANCE EXERCISE TO IMPROVE BALANCE AND REDUCE RISK OF FALLS IN CHRONIC STROKE PATIENTS

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ABSTRACT

Objective: The objective of the study was to compare the effects of exergames versus traditional balance exercise to improve balance and reduce the risk of falls in chronic stroke patients.

Materials and Methods: A randomized control trial was conducted on 40 chronic stroke patients. Patients were randomly divided into an exergaming group (n=20) and a control group (n=20), using the coin and toss method. Patients in the control group performed traditional balance exercises while the exergaming group performed supervised exergames along with traditional balance exercises. The treatment duration for both groups was 35-40 minutes/3 times a week for 6 weeks, with 5 minutes of warm-up and cool-down before and after the intervention.

The demographics were recorded, and assessment was done using the Berg balance scale, Time Up and Go test, and Dynamic gait index at baseline and after 6 weeks of intervention. Data were analyzed using SPSS 24.

Results: Of the 46 patients assessed, 40 (86.9%) were included in the study. The overall mean age was 57.78±5.38 years, there were 20 (54.1 %) males and 17 (45.9 %) females. Significant improvements were seen between the groups for the Berg balance scale, Time Up Go test, and Dynamic gait index after six weeks of intervention ($p<0.05$).

Conclusion: Exergames are found to be effective in improving balance and reducing the risk of falls in chronic stroke patients.

Keywords: Exergaming, Stroke, Rehabilitation, Virtual Reality, Exercise training

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INTRODUCTION

Stroke or cerebrovascular accident is the 2nd leading cause of mortality and a first common cause of disability among middle and low-economy countries. [1] Approximately, 13 million stroke cases were annually reported worldwide by World Stroke Organization. [2] In Pakistan, the incidence rate of stroke is 250 per 100,000 population annually, and it is also observed that stroke prevalence is more in the young age group. [3]

Globally, the mortality rate due to stroke has been reduced, however, the number of individuals suffering from post-stroke chronic symptoms is dramatically increasing. [4] This may occur as a result of the absence of neuronal signals from the brain to muscles or due to the disuse of muscle after cerebral injury leading to further atrophy. [5] Stroke is associated with multiple deficits that include impairment of sensory and motor function, dysphagia, speech problems, memory problems, loss of balance, and postural control which increases the risk of fall. [6] The report has shown that falls occurred in 40% of stroke survivors within 12 months after the onset of stroke which leads to delay in recovery of rehabilitation, furthermore, the use of walking aid in the early stage increases fall risk. [7]

Stroke rehabilitation is a multidisciplinary approach, progressive and goal-oriented with the purpose to assess impairment, and disability and engaging a stroke person in a rehabilitation program to achieve the optimum level of function. [8] Among older adults, stroke is considered the most common cause of falls. This is due to the fact that balance disorders, which are a frequent complica-

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tion of stroke that affect activities of daily living (ADL) and increases the risk of falls in stroke patients. [9] Balance training is one of the key components in stroke rehabilitation with the purpose to improve static and dynamic balance. The primary concern in stroke rehabilitation is to prevent falls among patients. For this reason, balance training is included in a rehabilitation program. [10] Different rehabilitation approaches used with the purpose to improve functional outcomes in stroke survivors are Proprioceptive Neuromuscular Facilitation (PNF) [11], Bobath therapy[12], dual-task training on balance [13], Circuit class therapy [14]. Literature showed that traditional exercise programs seemed boring for patients as they involved repetition of similar tasks which result in decreased motivation among them. Exergames using Xbox Kinect-360 is an effective way to motivate and engage stroke patients to improve balance, gait, and motor activity through interactive video games after stroke. [15] Exergames improve sensory, motor, cognitive and mental function through an environment in which an individual performs tasks that feel like in the real world. The virtual environment generated through the game can promote neuroplasticity in various areas of the brain, thereby resulting in improved motor learning and performance. [16] The current study aimed to compare the effect of exergames versus traditional balance exercise to improve balance and reduce the risk of falls in chronic stroke patients. This study will provide a better understanding of which intervention to perform for improving dynamic and static balance control in a stroke patient.

MATERIALS AND METHODS

The study was a randomized control trial conducted at Iqbal Memorial Hospital, Wah Cantt from June 2018 to November 2018 after being reviewed and approved by the Committee for Ethical Review of Research involving Human Subjects. The sample size was calculated using the open epi tool. The sample size was 40 (20 in each group). Participants were recruited through the non-probability purposive sampling technique. Those included were 50 to 70 years old, chronic stroke patients (06 months after onset), both genders, able to stand for 30 seconds, and willing to participate. Those excluded were patients having cognitive impairments, a Brace score >40, severe spasticity, and abnormal synergies. After taking informed consent, participants were randomly divided by tossing a coin into two groups: the exergaming group (EG) and the control group (CG) respectively.

In the EG group, patients performed exergames using Xbox-360 Kinect along with traditional balance training exercises for 35-40 minutes and 3 days per week for 6 weeks. Before the start of the intervention, patients were given an orientation session, which made them familiar with the equipment and games. Total 4 games were included to target the static, dynamic, and anticipatory balance of patients. River rush, water leaks, reflex ridge, and gold rush were performed starting from the basic level and difficulty was increased depending upon the performance of the patient. Games were performed under the supervision of a trained physiotherapist to ensure the safety of and avoid health hazards. Participants of the control group performed traditional balance exercises like tandem walking, heel standing, stepping in a forward direction, side-stepping, crossing over obstacles of varying height, single leg stance, and double leg stance. The treatment duration for the control group was 35-40 minutes/3 times a week for 6 weeks. Both groups performed 5 minutes of warm-up and cool-down before and after the intervention. The demographics of each participant were recorded. Berg balance scale (BBS), Timed Up and Go test (TUG), and Dynamic gait index (DGI) was taken as outcome measures at baseline and after 6 weeks of intervention.

Berg Balance Scale is a 14-item test used for the evaluation of functional balance in older adults and the stroke population. Each item is scored on an ordinal scale, ranging from 0 to 4 (0 = unable to perform, 4 = normal performance). The maximum score is 56 points. The BBS presents excellent values for test-retest (ICC= 0.91) and intra-evaluator reliability (ICC= 0.97). [17]

The TUG is a widely used test of objective clinical measure of functional mobility, balance, and risk of falling. The TUG involves participants standing from a seated position, walking 3 meters, turning around, and returning to sit in the chair. The time to complete this task is recorded using a stopwatch. Among chronic stroke individuals, TUG has been reported Test-retest reliability (ICC=0.95).[18] The DGI is used to evaluate the dynamic balance during walking. It is comprised of 8 items that require participants to maintain balance during normal walking and walking in different situations. Each item is scored from 0 to 3 points and the maximum score is 24. A higher score indicates a higher level of independent functional mobility.[19]

All analyses were carried out using the Windows-based SPSS statistical Package 24.0. Descriptive statistics were used for qualitative and quantitative variables and data was presented as frequencies, percentages, mean and Standard deviation. The normality test was conducted to assess the data distribution for all variables. The p-value of the Shapiro Wilk test for all variables measures was >0.05, an independent sample t-test was used for between-group analysis and paired sample t-test was used to measure within-group analysis. A P-value less than 0.05 was considered significant.

RESULTS

Of the 46 patients assessed, 40 (86.9%) were included and, of them, there were 20 (50%) in each of the two groups (Figure-1). Figure 1: Consort diagram for patient allocation and analysis Overall, the mean age was 57.78±5.38, there were 20 (54.1 %) males and 17 (45.9

%) females. The mean age of subjects in the exergaming group was 57.72±5.67, males 10 (55.6%) and females 8 (44.4%), whereas the mean age of subjects in the control group was 57.84±5.25, males 10 (52.6%) and females 9 (47.4%). Demographic data are presented in Table 1.

Between group analysis showed significant improvement $p<0.05$ in BBS, TUG and DGI after six weeks of intervention (Table 2). In the EG group, BBS mean score at baseline was 36.00±3.57 and after 6 weeks of intervention, the score was 43.38±2.42. TUG mean score was initially 27.39±3.71 and after treatment score was 18.04±3.09. Moreover, DGI means score at baseline was 9.83±1.04 and 14.72±1.63 after 6 weeks of intervention with exergames. In the EG group BBS, TUG and DGI showed significant improvement from baseline to 6 weeks of intervention $p<0.05$ (Figure-2). Figure 2: Within-group Analysis of BBS, TUG, and DGI in the Exergaming group at baseline and after 6 weeks of Intervention Figure 3 showed that in the control group BBS at baseline was 35.31±2.38 and after 6 weeks mean score was 36.15±2.31. Initially, the TUG mean score was 26.71±1.78 and after treatment score was 24.91±2.37. The mean score of DGI at baseline was 9.94±1.31 and the score was 11.05±1.80 after 6 weeks of intervention. In addition, the control group showed a non-significant difference in outcomes measures from baseline to 6 weeks of intervention $p>0.05$. Figure 3: Within-group Analysis of BBS, TUG, and DGI in the Control group at baseline and after 6 weeks of Intervention

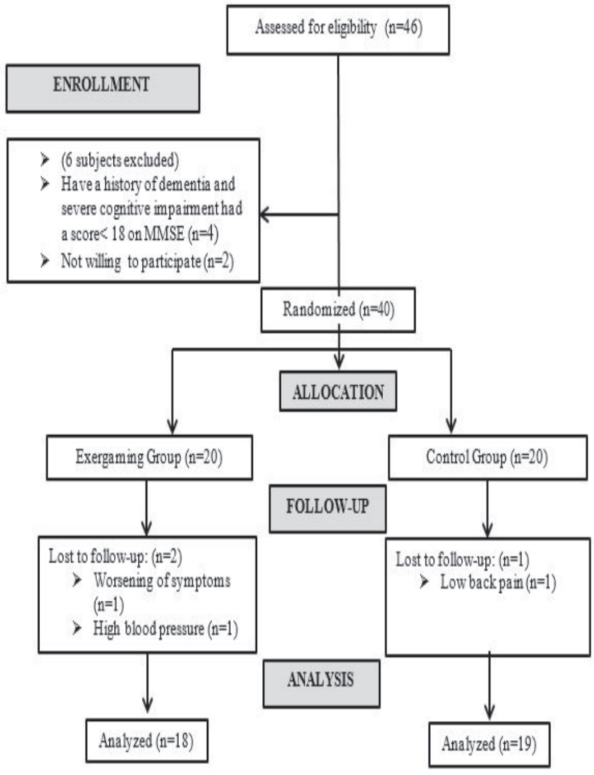

Fig 1: Consort diagram for patient allocation and analysis

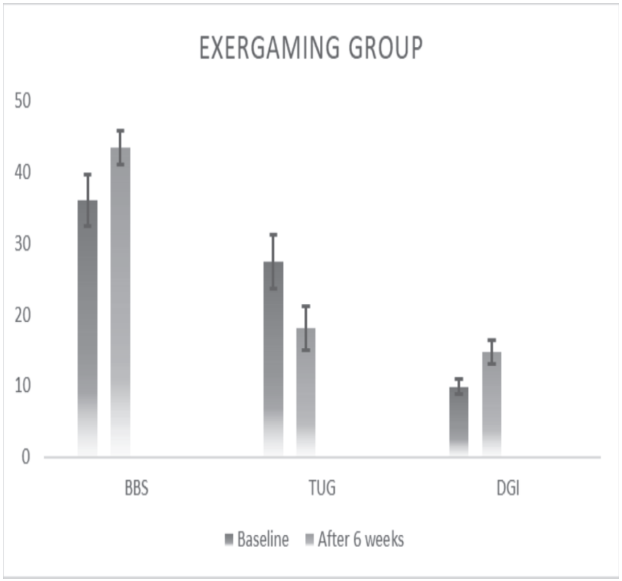

Fig 2: Within-group Analysis of BBS, TUG, and DGI in the Exergaming group at baseline and after 6 weeks of Intervention

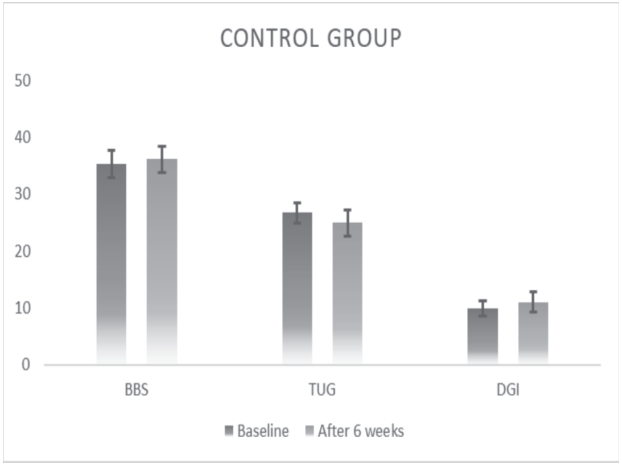

Fig 3: Within-group Analysis of BBS, TUG, and DGI in the Control group at baseline and after 6 weeks of Intervention

Table 1: Demographic data

VARIABLES	n (%) n=37	Between groups	
		EG n=18	CG N=19
Gender			
Male	20 (54.1%)	10 (55 .6 %)	10 (52.6 %)
Female	17 (45.9%)	8 (44.4 %)	9 (47.4%)
Type			
Infarct	28 (75.7%)	14 (77.8 %)	14 (73.7 %)
Hemorrhage	9 (24.3%)	4 (22.2%)	5 (26.3 %)
Hemiplegia			
Right	21 (56.8%)	10 (55 .6 %)	11 (57.9 %)
Left	16 (43.2%)	8 (44.4 %)	8 (42.1 %)

Table 2: Independent sample T-test between group Analysis

Variable	Group (n=37)	Mean±SD	p-value
BBS-pre	Exergaming group (n=18)	36.00±3.57	0.312
	Control group (n=19)	35.31±2.38	
BBS-post	Exergaming group (n=18)	43.38±2.42	0.003***
	Control group (n=19)	36.15±3.67	
TUG-pre	Exergaming group (n=18)	27.39±3.71	0.250
	Control group (n=19)	26.71±2.78	
TUG-post	Exergaming group (n=18)	18.04±3.09	0.008***
	Control group (n=19)	24.91±2.37	
DGI-pre	Exergaming group (n=18)	9.83±1.04	0.772
	Control group (n=19)	9.94±1.31	
DGI-post	Exergaming group (n=18)	14.72±1.63	0.005***
	Control group (n=19)	11.05±1.83	

DISCUSSION

The present study suggests that exergames are effective in improving balance and reducing the risk of falls in chronic stroke patients. Exergames seemed more interesting and fun for patients in comparison to traditional balance exercises by improving significant improvements in scores of BBS, TUG, and DGI. Literature also suggests that this innovative technology enhances patient motivation and improves motor learning in a playful manner. [16] Hsin-Chieh Lee et al in their study on fifty chronic stroke patients found significant improvement in scores of BBS (P = 0.000) and TUG (P = 0.005) in their virtual reality balance training group as compared to the traditional exercise group. They concluded that balance training by using X-box Kinect and traditional method had beneficial effects on the balance of chronic stroke patients. They also reported that patients in the virtual reality group found a pleasurable experience with this newer technology. [20] The same findings were observed in the latest study conducted by Patrícia P.B. Henrique et al. on post-stroke patients concluded that exergames were an effective alternative for maintaining balance and upper limb motor function. There were significant improvements in values of BBS scores (P < .001) from pre-intervention to post-intervention. In a recent trial exergaming also showed significant improvement from baseline to 6 weeks of intervention having p <0.05 in BBS and TUG. Dae-SungPark PT and colleagues in their trial on twenty hemiplegic stroke patients found that 30 minutes of virtual training using Xbox Kinect-based games plus conventional physical therapy treatments showed a significant difference in BBS, TUG, and 10MWT (*P* <0.05) after 6 weeks of intervention as compared to control group. [22] While in our study control group showed a non-significant difference in outcomes measures from baseline to 6 weeks of intervention (p >0.05). Roghayeh Mohammadi et al in their review found significant improvements in the inter-group analysis of virtual reality and conventional physical therapy treatment groups on outcome measures that include BBS and TUG with medium effect size in comparison with the conventional treatment only. Their review also concluded that virtual reality plus conventional therapy is moderately beneficial in improving balance in chronic stroke patients[23]. While the results of our study showed marked improvement in Exergames by improving the balance impairments and functional disabilities as both BBS and TUG showed significant p-value (<0.05). Nikita Girishbhai Shobhana and Shweta Rakholiya in their study found significant improvement in BBS, 6MWT, and gait parameters in the VR group. They proposed that virtual reality training by using X-box 360 Kinect platform was an effective therapeutic approach along with physical therapy in stroke patients' rehabilitation for improving balance and gait as compared with the only physical therapy intervention. They further added that the VR group experienced higher pleasure as compared to the conventional physical therapy group. [24] This study also correlates the findings of our study by improving balance scores in post-stroke patients.

The study has certain limitations such as small sample size and we included only patients with the first instance of stroke. Hence, the findings of this trial may not be generalizable to those patients who have undergone multiple episodes of strokes. Another non-negligible factor that we noticed in our study was that certain patients suffered from poor muscle tone and lack of motivation. Therefore, we recommended a multicenter trial should be conducted including large sample size and intrinsic motivation inventory to promote the outcomes of exergaming. We also recommended the use of rehabilitation and other tools for objective assessment in multiple episodes of stroke patients.

CONCLUSION

Exergames along with traditional balance exercises are found to be effective in improving balance and reducing the risk of falls in chronic stroke patients.

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AUTHOR'S CONTRIBUTION

Following authors have made substantial contributions to the manuscript as under

Khattak GH: Concept, Study design, Data collection, Manuscript writing.

Arshad H: Data collection, Statistical Analysis, inter pretation, Manuscript writing.

Anwar K: Literature search

Majeed Y: Data collection, Bibliography

Malakandi HB: Critical review of Manuscript

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.