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Original Article

Effectiveness of Virtual Rehabilitation Versus Therapeutic Exercises in the Balance Training of Lower Limb Among Post-Stroke Patients

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ABSTRACT

Background: Stroke is the major source of death and disability and leads to impaired balance in post-stroke patients. Balance training is one of the main components of stroke rehabilitation. Virtual rehabilitation is gaining more popularity as it engages the patients' attention in training. **Objective:** To evaluate the effects of virtual rehabilitation versus therapeutic exercises to improve balance in patients with stroke. **Methods:** This randomized controlled trial was conducted at Abdullah Hospital, Lalamusa from August to December 2022. The sample size of 30 participants was randomly divided into two groups virtual therapy group and versus therapeutic exercises group, after taking their informed consent. Participants were recruited through the non-probability purposive sampling, between the age of 35 to 55 years, post-stroke survivors after 3 months and were able to stand up with or without assistive devices. Participants with auditory or visual dysfunction, a history of deep venous thrombosis, lower limb amputation, severe receptive or expressive aphasia, significant cognitive impairments and unstable hypertension were excluded. The data was collected from the patients by using Berg Balance Scale (BSS) at three different time frames: baseline, mid-intervention and post-intervention. The Shapiro-Wilk test was applied to calculate the normality of the data. For descriptive analysis, quantitative variables were calculated by mean and standard deviation whereas, for qualitative variables, frequency and percentages were used. To find significance an independent sample t-test was applied for between-group analysis and two-way repeated measure ANOVA was used to measure within-group analysis. **Results:** Both groups improved their balance after six months of intervention. Comparative analysis showed a significant improvement with a p-value≤0.05 in both groups. The mean and standard deviation after six weeks of intervention in the virtual training group was 55.4±0.82 and the therapeutic exercise group was 54.47±1.3. This showed that the virtual rehabilitation group had improved balance in patients with stroke. **Conclusion:** Virtual rehabilitation was found to be effective in improving the balance of patients with stroke. It not only improves balance but also engages the patient in the treatment protocol. This rehabilitation is effective for the balance training of post-stroke patients.

INTRODUCTION

In this century, the main cause of disability and mortality is stroke[1] and it also causes sensory, motor, cognitive and visible impairments and restricts the overall performance of everyday living.[2] Stroke is a central nervous system disorder caused by an obstruction in cerebral blood flow exacerbated by the blockage or rupture of a blood vessel.[3] The neural pathways (afferent and efferent) are affected and lead to brain cortex injury, which results in impaired cognitive, motor and sensitive capabilities. Motor and cognitive damage reduce their functional potential and independence.[4]

Atrial fibrillation, diabetes, high blood pressure and smoking are the main risk factors.[5,6] In diseases such as diabetes, high blood pressure and obesity, a stroke can severely damage the brain.[7] Approximately, 83% of stroke survivors display balance impairments.[8] Balance training is one of the key components of stroke rehabilitation aimed at improving static and dynamic balance.[9] Different rehabilitation approaches aimed at improving functional outcomes in stroke survivors are proprioceptive neuromuscular facilitation,[10] Bobath therapy,[11] dual-task training on balance[12] and circuit-class therapy.[13]

Literature has shown that traditional exercise programs appear boring to patients because they require the repetition of similar tasks, leading to a decrease in patient motivation.[14] Virtual reality (VR) is becoming more and more popular in the treatment of stroke patients. It is to keep stroke patients motivated and engaged in exercise.[15] It also improves strength and balance training in the elderly.[16] Patients get fed up with monotonous everyday life and gain new enthusiasm from the game.[17,18] In the era of technology, exercises performed through VR are recognized as an advanced approach to promoting healthy behavior and physical activity. People are seeking recreational activities like video games which provide entertainment. Therefore, a combination of video games and physical activity participation can stimulate their motivation and improve physical activity. [19] The purpose of the study was to check the effects of virtual rehabilitation versus therapeutic exercises to improve the balance of the lower limb of stroke patients.

METHODS

This study was a randomized controlled trial conducted at Abdullah Hospital, Lalamusa from August to December 2022 after being approved and reviewed by the ethical committee of the University of Chenab. The sample size of 30 participants was randomly divided into two groups (virtual therapy group versus therapeutic exercises group), after taking their informed consent. Both groups were allocated with 15 patients in each group. Participants were recruited through the non-probability purposive sampling, between the age of 35 to 55 years, post-stroke survivors after 3 months and were able to stand up with or without assistive devices.

Participants with auditory or visual dysfunction, a history of deep venous thrombosis (DVT), lower limb amputation, severe receptive or expressive aphasia, significant cognitive impairments and unstable hypertension were excluded. The therapeutic exercise group performed balance exercises such as the double leg stand, forward striding, heel stand, side step, single leg stand and tandem walk for 35-40 minutes, 3 days/week for 6 weeks. The exercises were done under the supervision of a physiotherapist. The experimental group used X-box and Kinect connected to the laptop. This group performed training for 35 to 40 minutes, 3 days/week for 6 weeks. The repetitions

increased according to the performance of the patient. Games were started from the basic level and their levels were increased according to the patient's performance. The training was done under the supervision of a trained physiotherapist to avoid any hazards.

The data was collected from the patients by using Berg Balance Scale (BSS) at three different time frames: baseline, mid-intervention and post-intervention. The BSS is a 14-item test used to assess balance in older adults and stroke patients. Each item is scored on an ordinal scale ranging from 0 to 4, with 0 indicating inability to perform and four indicating normal performance. The maximum possible score is 56 points. The BBS has excellent test-retest reliability (ICC= 0.91) and intra-evaluator reliability (ICC= 0.97).[20] The statistical software used to analyze and enter the data was Statistical Package for Social Sciences (SPSS) version 24. The Shapiro-Wilk test was applied to calculate the normality of the data. For descriptive analysis, quantitative variables were calculated by mean and standard deviation whereas, for qualitative variables, frequency and percentages were used. To find significance an independent sample t-test was applied for between-group analysis and two-way repeated measure ANOVA was used to measure within-group analysis. All results were analyzed with a 95% confidence interval, and p-values less than 0.05 were considered significant.

RESULTS

Of 34 patients, two were excluded because they did not meet the inclusion criteria and 32 were assessed. About 16 patients were included in the therapeutic group and 16 were in the virtual rehabilitation group. In the virtual rehabilitation group, one patient lost the

Figure I: CONSORT Layout
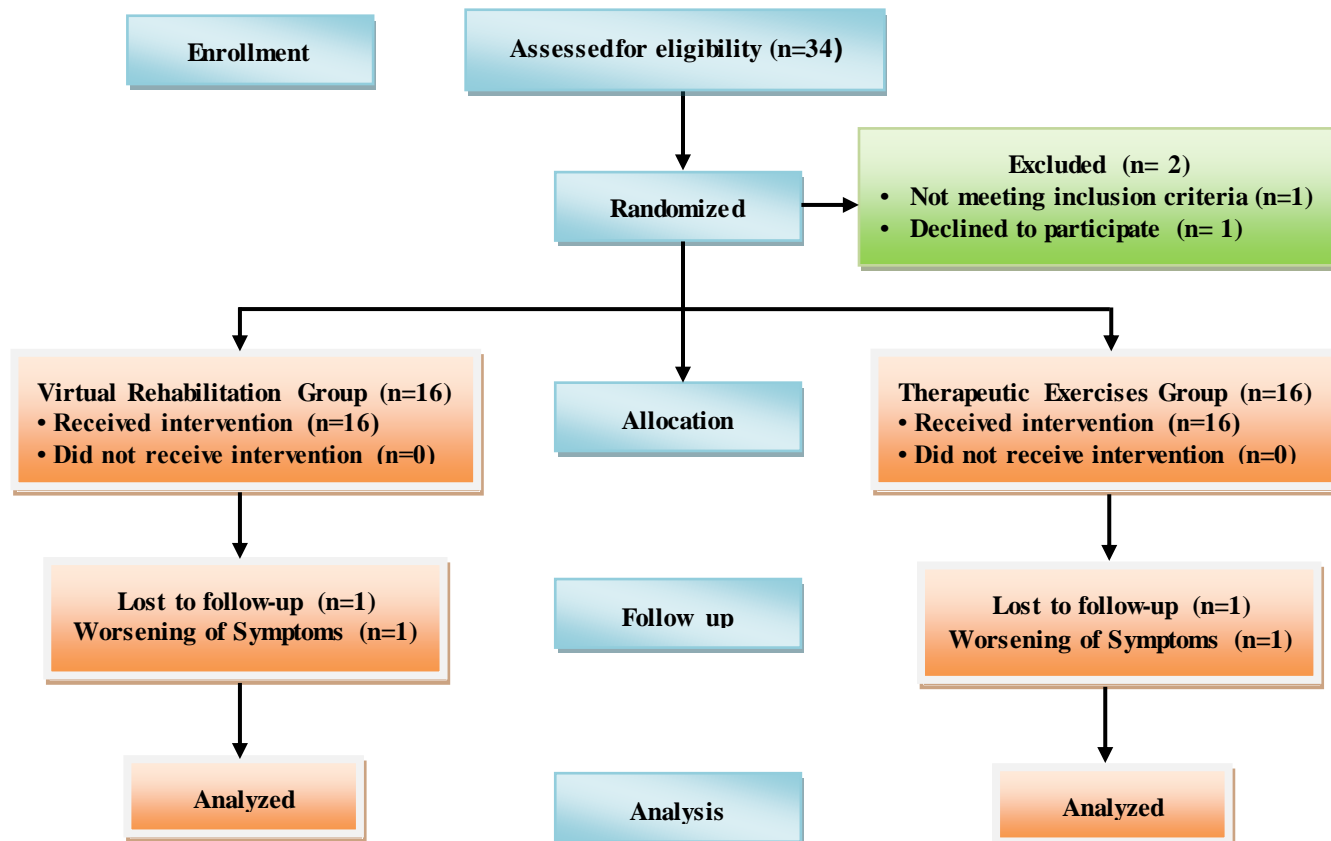
About 30 stroke patients was shown in table I. In the therapeutic exercise group, there were 15 patients out of which 8(53.3%) were males and 7(46.7%) were females. In the VR group, follow-up because of high blood pressure and in the therapeutic group, one patient lost the follow-up because of the worsening of his symptoms. The data of a total of 30 patients were analyzed. About 7(46.7%) were males and 8(53.3%) were females. The patients in the therapeutic exercise group were 7(46.7%) from rural and 8(53.3 %) from urban areas while in the other group, 7(46.7%) were from rural and 8(53.3%) from urban areas. The mean age in the therapeutic exercise group

was 48.40±2.75 and in the VR group, it was 48.60±2.7.

The mean and standard deviation at the baseline of the VR group was 16.67±1.5 and the therapeutic exercise group was 15.53±1.64. After 3 weeks of intervention, the mean and standard deviation of the VR group was 37.87±0.99 and the therapeutic exercise group was 36.00±1.81. The mean and standard deviation of the VR group was 55.4±0.82 and the control group was 54.47±1.3 in the 6th week (Table II).

Between-group differences at baseline were p>0.05. There was a significant improvement at end of 3rd week of intervention (p<0.05).

Table I: Demographics

		Virtual Reality Group n=15	Control Group n=15
Gender	Male	7 (46.7)	8 (53.3)
	Female	8 (53.3)	7 (46.7)
Location	Rural	7 (46.7)	7 (46.7)
	Urban	8 (53.3)	8 (53.3)
Age (years)	Mean±SD	48.6 ± 2.75	48.4 ± 2.75

Table II: Between-group Differences using Independent Sample t-test

Beg Balance Scale	Therapeutic Exercise Group n=15	Virtual Reality Group n=15	t	p-value	Mean Difference	95% Confidence Interval of the Difference	
	Mean (S.D)					Lower	Upper
Baseline	15.53 (1.64)	16.67 (1.5)	-1.97	.058	-1.13	-2.31	.04
3rd Week	36 (1.81)	37.87 (0.99)	-3.50	.002	-1.87	-2.97	-.76
6th Week	54.47 (1.3)	55.4 (0.82)	-2.34	.028	-.93	-1.76	-.11

Table III: Pairwise Comparison of Berg Balance Scale

Time		Mean Difference	p-value	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Baseline	3rd week	-20.833*	.000	-21.247	-20.420
	6th week	-38.833*	.000	-39.388	-38.279
3rd week	6th week	-18.000*	.000	-18.493	-17.507

The analysis revealed a significant improvement (p<0.05) in the 6th week (Table III). The statistical analysis showed significant differences in the comparison of baseline measurement with 3rd week p<0.05 and baseline with 6th week also showed significant differences p<0.05. The comparison of the berg balance scale measurement of the 3rd and 6th weeks showed significant improvement p<0.05.

DISCUSSION

There has been a developing interest in the use of new technology, consisting of virtual reality in stroke rehabilitation. Literature suggests this innovative technology increases patient engagement and improves motor learning in a fun way.[21] Hsin-Chieh Lee et al. conducted a study of 50 chronic stroke patients, results showed significantly higher BBS (P<0.001) and TUG (P=0.005) scores in the virtual reality balance training group compared to the traditional exercise group. They concluded that balance training using the Xbox Kinect and traditional methods had a positive effect on balance in chronic stroke patients. They also reported that patients in the virtual reality group found the new technology to be an enjoyable experience.[16] But in our study the effects of Virtual rehabilitation are seen alone, not with the combination of any other therapy. The results showed positive impacts in virtual reality gaming groups for the treatment of stroke victims. In another study, Dae-Sung Park et al. checked the outcomes of VR combined with conventional exercises. 20 hemiplegic stroke patients were included in the study and found that 30 minutes of virtual exercise using Xbox Kinect-based games and conventional physical therapy were associated with BBS, TUG and 10MWT resulted in significant differences in (P<0.05) after 6 weeks of intervention compared with the control group.[22] In our study the comparison between the virtual reality group and the therapeutic group showed a significant difference in outcomes measures from baseline to 6 weeks of intervention.

This showed that virtual reality can be used alone in improving the balance of post-stroke patients. Nikita Girishbhai Shobhana et al. found significant improvements in BBS, 6MWT, and gait parameters in the VR group. They found that virtual training utilizing the X-Box with Kinect was an effective therapeutic approach when merged with physiotherapy for the rehabilitation of stroke survivors, improving balance and gait compared to physiotherapy intervention alone.

They further added that the VR group experienced higher levels of pleasure compared to the traditional physical therapy group.[23] In our study there were significant differences in BBS but virtual reality was used alone for the treatment and patients were more motivated and interested while performing virtual reality training as compared to therapeutic training. This suggested that virtual reality is a fun way of training balance in post-stroke patients which not only improves their balance but also keep them motivated during the rehabilitation period. This study correlates the fact with our study that virtual reality is an effective and pleasurable way of training. In a randomized controlled trial, Hafsah Arshad et al. included 40 chronic stroke sufferers. In the therapeutic group, patients performed conventional therapy and in the experimental group, the patients performed exergames with conventional therapy. After six weeks of intervention, the Berg balance scale, Time Up Go test, and Dynamic gait index showed significant differences between groups. This suggested that exergames and conventional therapy improve balance and decrease the danger of falling.[24] Our study also showed significant differences in lower limb balance between groups. Both improved the balance but the virtual reality was a more effective and fun experience for the patient. The current study gives a better understanding that virtual reality can be used alone for the rehabilitation of balance. But this study had certain limitations which were; the small screen was used for the virtual reality training so a few patients with weak eyesight had a bit of difficulty assuming the pattern of exercise. So, larger screens should be used for the next studies to get better results. Secondly, we haven't used immersive virtual reality as it requires a huge setup for the proper treatment so, we were unable to use it because of a lack of resources and funding, 3D virtual reality should be used in future studies. This study

was hospital-based and we were unable to perform it on a larger scale because of lack of time, next studies should focus on a larger area to get better results.

CONCLUSION

The study concluded that virtual reality training showed significant improvement within the group under the evaluation based on Berg Balance Scale when compared with the baseline outcome measures. Virtual Reality was an effective way of treatment for the balance training of stroke patients. It can also be used alone for the balance rehabilitation of stroke patients. It not only improves balance but is a fun way of treatment that engages the patient in the treatment program.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.
Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.
Competing interests: None
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