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EFFECT OF VIRTUAL REALITY TRAINING ON DYNAMICBALANCE AND OBSTACLE CROSSING PERFORMANCE INSTROKE PATIENT

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Abstract

Objectives: *In the present study, we investigated the effect of virtual reality on dynamic balance training and crossing over obstacles training on balance of stroke patients.*

Method: *AnExperimental study undertaken on 30 participants age between 35 to 55 years. The participants were randomly divided into two groups 15 in each. The experimental group included 15 participants who received conventional exercises with VR while in the control group the remaining 15 a participant's received conventional exercises. The study was conducted for 4 weeks with sessions 4 times a week lasting for about 30 mins.*

Findings:*The findings of the study suggest training for balance was more effective in the experimental group than in the control group.In the experimental group the outcome value for berg balance test, timed up and go test, Romberg test and tandem test were (p=0.008), (p=0.01), (p=0.001) and(p=0.01) respectively. However, the outcome value for the control group for berg balance test, timed up and go test, Romberg test and tandem test were(p=0.04), (p=0.04), (p=0.01) and (p=0.04). The result from the above studied suggest that the experimental group was found to be statistically more significant than that of the control group*

Novelty: *The present study aimed to improve the balance and postural instability along with functional mobility among stroke survivors by use of virtual reality*

Keywords: Virtual reality, training, dynamic balance, obstacle crossing, stroke patients

INTRODUCTION

Cerebrovascular disorders refer to any dysfunction of the central nervous system that occurs when the regular blood flow to the brain is interrupted. The symptoms of stroke can include, one-sided weakness, slurred speaking, loss of muscle control on one side of your face, blurred vision, loss of coordination etc. This can result in various physical and cognitive impairments, including balance deficits. Patients who have had a stroke often experience balance problem as a result of deficiencies in several different systems. An essential indicator of recovery from a stroke is balance. It is acknowledged that balance and gait status are useful in forecasting overall outcomes, including hospital stay duration and discharge location [1]. Maintaining an upright posture is crucial for balance, and postural control plays a significant role in maintaining balance [2]. Balance is crucial for everyday activities such as walking, standing, and transferring and impaired balance can significantly impact a stroke patient's independence and quality of life. Balance deficits in stroke patients can arise from several factors, including muscle weakness, sensory impairments, coordination problems, and cognitive deficits. Assessing balance is an essential component of stroke rehabilitation to determine the effect of virtual reality training on dynamic balance and obstacle crossing performance on stroke patients [3].The Berg Balance Scale (BBS) is a commonly utilized assessment tool in clinical environments and is regarded as the primary method for evaluating functional balance and the risk of falling in adult individuals [4].A score of 56 points on the Berg Balance Scale indicates good postural balance and a low risk of falls, while a score of 45 points or less indicates an increased risk of falling [5].Scoring between 56 and 41 points on the Berg Balance Scale suggests a low risk of falling, while scoring between 40 and 21 points indicates a medium risk, and scoring between 20 and 0 points suggests a high risk. The assessment typically takes between 10 and 20 minutes to complete [6-9]. The TU & Go is a straightforward assessment that can be conducted in any setting. It involves the participant rising from a chair, walking a distance of three meters, turning around, returning to the chair, and sitting down again.

The constant factor under control is the overall time in seconds that it takes for the participant to complete the test. This time is then compared with the risk of falling [10-12]. If the time taken to complete the test is 10 seconds or less, it is considered normal. If the time falls between 11 and 20 seconds, there is a mild risk of falling, and if the time exceeds 20 seconds, there is a high risk of falling [13]. Virtual reality (VR) has the potential to be a cost-effective, efficient, and engaging tool for rehabilitation and could also be used in the development of fall prevention programs focusing on gait and balance risk factors [14]. Small sample numbers and inconsistent outcomes in the literature on VR for Rehabilitation Virtual reality training provides a safe and controlled environment for stroke patient to practice balance exercise. The immersive nature of virtual reality helps patients focus on their movements and engage their muscles effectively by repeatedly performing balance exercises in virtual reality, patients can enhance their proprioception and postural control, leading to improved balance [15]. Obstacle crossing performance enhancenes virtual reality simulation can recreate real-life scenarios, including various obstacles that stroke patients may encounter during daily activities. By practicing obstacle crossing tasks in a virtual environment patients can improve their ability to navigate around obstacle, adapt their gait pattern, and develop strategies to overcome barriers. This training helps stroke patient regain confidence and independence in their mobility [2]. Thus, in the present study, we aimed to investigate the effects of virtual reality training on dynamic balance and obstacle crossing performance in stroke patients.

MATERIALS AND METHODS

This was an Experimental study in which through simple randomized sampling technique 30 participants were divided into two groups. Ethical clearance was obtained from all the 30 participants prior to the study. The study was conducted for a duration of 3 months.Group A Experimental group included 15 participants while Group B Control group included 15 participants in the study. All subjects were measured dynamic balance ability using Berg balance Scale (BBS) and Timed Up and Go test (TUG) Romberg test and Tandem test. When testing an elderly person’s static and dynamic balance following a stroke, BBS is a legitimate and reliable tool. TUG is defined as the amount of time (in seconds) needed to complete the following sequence of steps: get out of a chair, move three meters at a typical walking pace, turn around, move back, and sit down. The inclusion criteria for selection were Individual diagnosed with stroke, confirmed by medical records, Age range 35-55 years old and no contraindication to virtual reality exposure (e.g., History of seizures, severe visual impairment). However, the exclusion criteria were Other neurological conditions that may significantly affect balance and mobility, Unstable medical condition that may interfere with the ability to participate in the study and uncooperative patient.

INTERVENTIONS

The study was conducted in Krishna hospital karad and had a sample size of 30 participants. Of the total 30 participants they were randomly divided into two groups with 15 in each group. All subjects underwent a history and physical examination, as well as a neurological or orthopaedic evaluation, prior to the commencement of the trial. Thirty minutes before the intervention began, the subjects underwent a pretest assessment for berg balance scale, timed up and go test, Romberg test and tandem test. Participants in the control group performed dynamic balance exercises along with crossing over obstacles without VR while, in experimental group the same exercises were performed with use of VR. [16-17]

The treatment session was given for 4 weeks with 4 sessions per week which lasted for about 30 mins. Rest period was given to the patient as needed by them.

Week	Control Group	Experimental group (With VR)
1st	• Forward and backward weight shifts- 10 reps, 1 set • Sit to Stand-10 reps • Lateral weight shifts - 10reps • Marching-10reps • Calf Raise-10reps • Heel Raise-10reps	• Forward and backward weight shifts- 10 reps, • Sit to Stand-10 reps • Lateral weight shifts - 10reps • Marching-10reps • Calf Raise-10reps • Heel Raise-10reps
2st	• Forward and backward weight shifts-10 reps • Sit to Stand-10 reps • Lateral weight shifts-10 reps • Marching- 10 reps • Calf Raise- 10 reps • Heel Raise- 10 reps • Side Stepping- 5 reps • Walking backwards- 5 reps	• Forward and backward weight shifts-10 reps • Sit to Stand-10 reps • Lateral weight shifts-10 reps • Marching- 10 reps • Calf Raise- 10 reps • Heel Raise- 10 reps • Side Stepping- 5 reps • Walking backwards- 5 reps
3st	• Forward and backward weight shifts- 15 reps • Sit to Stand- 15 reps • Lateral weight shifts- 15 reps • Marching-15 reps • Calf Raise-15 reps • Heel Raise-15 reps	• Forward and backward weight shifts- 15 reps • Sit to Stand- 15 reps • Lateral weight shifts- 15 reps • Marching-15 reps • Calf Raise-15 reps

	• Side Stepping-5 reps • Walking backwards-5 reps • Side stepping over obstacles-5 reps • Tandem waking- 5 reps • Heel to toe walking-5reps • Marching on foam-10 reps	• Heel Raise-15 reps • Side Stepping-5 reps • Walking backwards-5 reps • Side stepping over obstacles-5 reps • Tandem waking- 5 reps • Heel to toe walking-5reps • Marching on foam-10 reps
4st	• Forward and backward weight shifts-15 reps • Sit to Stand-15 reps • Lateral weight shifts-15 reps • Marching-15 reps • Calf Raise-15 reps • Heel Raise-15 reps • Side Stepping -5 eps • Walking backwards-5 reps • Side stepping over obstacles-5 reps • Tandem waking- 5 reps • Heel to toe walking-5reps • Marching on foam-10 reps • Walking up stairs	• Forward and backward weight shifts-15 reps • Sit to Stand-15 reps • Lateral weight shifts-15 reps • Marching-15 reps • Calf Raise-15 reps • Heel Raise-15 reps • Side Stepping -5 eps • Walking backwards-5 reps • Side stepping over obstacles-5 reps • Tandem waking- 5 reps • Heel to toe walking-5reps • Marching on foam-10 reps • Walking up stairs

Statistical Analysis

Data analysis was performed using the paired -t- tests which was used to measure the level of significance for berg balance scale, timed up and go test, Romberg test and tandem test. In the experimental group the post intervention outcome value for berg balance test was(p=0.008), timed up go test(p=0.01), Romberg test(p=0.001) and tandem test(p=0.01). However, the post intervention outcome for the control group for berg balance test was(p=0.04), timed up go test(p=0.04), Romberg test(p=0.01) and tandem test(p=0.04).

Thus, result suggest both groups showed clinical statistical significance but the that experimental group was more clinically and statistically significant as compared to that of the control group.

RESULTS

Table 1: Demographic data of subjects

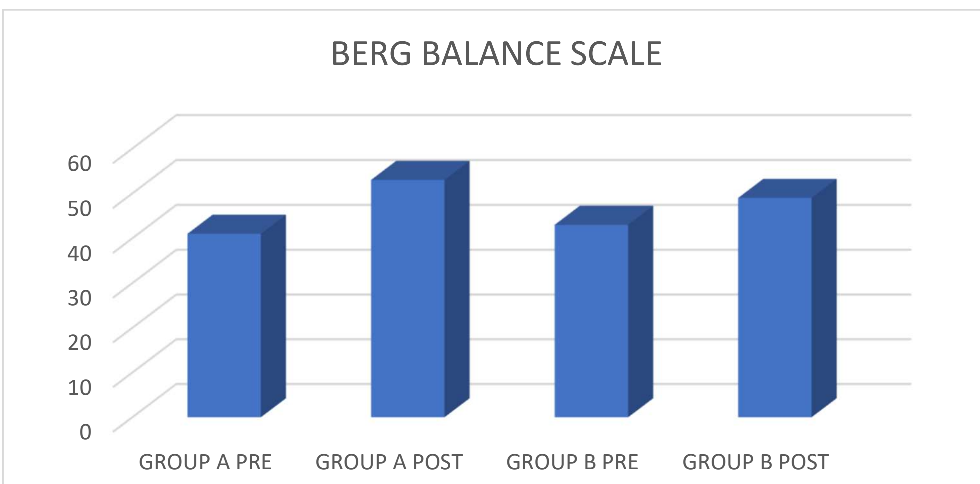
Gender	Male	N= 20
	Female	N= 10
Type	Hemorrhage	N= 3
	Infraction	N= 27
Handedness	Left	N= 2

	Right	N= 28
Age		35-55year
Height(cm)		10.67- 17.02
Weight(kg)		48-120kg

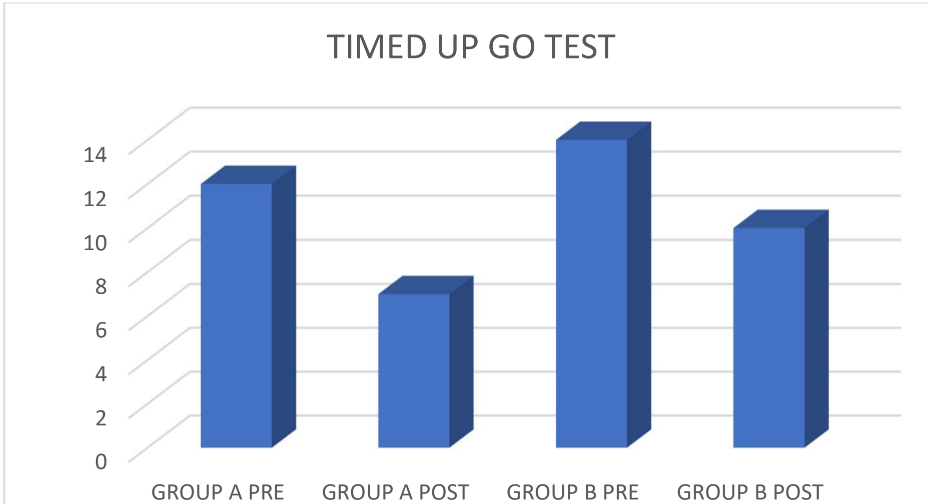
Table 2. Shows the Mean Value of all four outcome measures of both group, pre and post test respectively

EXPERIMENTAL GROUPGROUP - A				CONTROL GROUPGROUP- B		
OUTCOME	**PRE-TEST MEAN**	**POST-TEST MEAN**	**P VALUE**	**PRE-TEST MEAN**	**POST-TEST MEAN**	**P VALUE**
BBS	41	53	0.008	43	49	0.04
TUG	12	7	0.01	14	10	0.04
ROMBERG	20	9	0.001	14	10	0.01
TANDEM	1	3	0.01	1	3	0.04

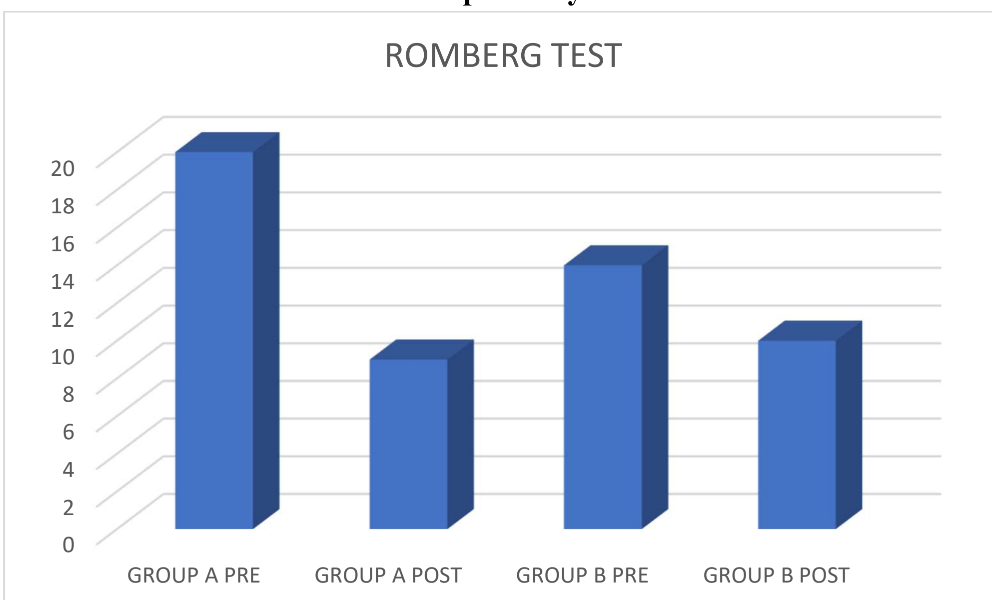
Graph 1. Shows Mean Value for Berg Balance Scale of both groups, pre and post the intervention respectively



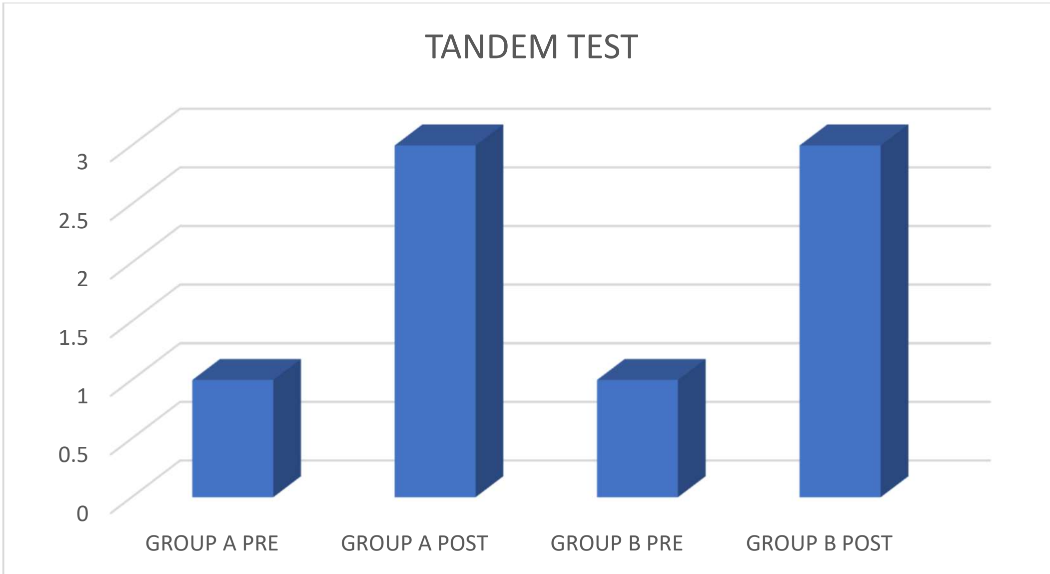
Graph 2. Shoes Mean Value for Timed Up and Go Test for both groups, pre and post the intervention respectively



Graph 3. Shows Mean Value for Romberg test for both groups, pre and post the intervention respectively



Graph 4. Shows Mean Value for Tandem test of both groups, pre and post the intervention respectively



DISCUSSION

Balance is a complex phenomenon which minimizes the centre of mass in proportion to the base of support and maintains an optimal posture appropriately by responding to perturbation. Balance is an important component needed during community ambulation and for various activities of daily living. Balance can be affected due to proprioception deficit, muscle weakness, immobilized joint, pain and visual deficit. However, about 25-75% of stroke patients are observed to have significant impairment in balance making them prone to higher risk of fall. Postural imbalance among stroke patients is evident during standing resulting in increased weight bearing towards the non-paretic side, reduced standing balance and decreased weight bearing on the paretic side. However, basic functional movements like standing up from a chair, walking and climbing upstairs are mainly impaired among stroke patients due to reduced ability of bearing weight on the paretic side [1]. Physiotherapy interventions have found tobe effective in management of stroke.[20]

Thus, the present study was conducted to investigate the effect of VR training on dynamic balance and obstacle crossing performance in stroke patients. A total of 30 participants were included in the study. They were then equally divided into two groups. One group that is the control group performed obstacle crossing and dynamic balance exercises. While, the other group that is the experimental group performed same obstacle crossing and dynamic balance exercises but with use of Virtual reality device. The pre and post intervention values were measured through berg balance test, timed up go test, Romberg test and tandem test. Aprevious study conducted by Kim et.al reported that the experimental group receiving training by virtual reality showed significant difference than the control group who received training without virtual reality. The result showed significant difference in the berg balance score to greater extent in the experimental group than the control group [18]. Also, a previous study by Yang et.al conducted a balance training using the virtual reality treadmill training for 3 weeks. The study reported the postural sway was significantly reduced in the experimental group than in the control group. The result of the current study from the statistical analysis stated the dynamic balance exercises and crossing over obstacles with use of VR was more effective and statistically more significant than performing dynamic balance exercises and crossing over obstacles without the use of VR [19].

The use of virtual reality (VR) training in stroke rehabilitation has gained significant attention in recent years. The results of the study likely demonstrated that VR training has a positive impact on the dynamic balance of stroke patients. VR-based exercises can provide a challenging and engaging environment for patients to practice balance control, weight shifting, and postural stability. This can lead to improvements in dynamic balance, which is crucial for functional mobility and fall prevention in stroke survivor's [4].

The study has also showed that VR training contributes to improved obstacle crossing performance in stroke patients. VR simulations can create realistic environments with virtual obstacles, allowing patients to practice navigating through different terrains and obstacles. This can help patients improve their gait pattern, step length, and obstacle negotiation strategies, leading to better performance in real-life situations. The study also highlighted could also focus on the underlying mechanisms of how VR training had influence dynamic balance and obstacle crossing in stroke patients. VR exercises can promote neuroplasticity by providing repetitive and task-specific practice, which is essential for motor learning and recovery of function after stroke. The immersive and interactive nature of VR environments also engage multiple sensory modalities, potentially enhancing sensorimotor integration and motor relearning [4]. Thus, VR can be clinically implicated in practice as VR-based rehabilitation programs have the potential over traditional therapy approaches by offering a motivating and enjoyable platform for stroke patients to engage in intensive and task-oriented training. Additionally, VR systems canalso be tailored to individual patient needs, allowing for personalized and progressive rehabilitation programs. Therefore, from the present study training for balance through dynamic balance exercises along with crossing over obstacles using VR showed better results.

CONCLUSION

The findings of this study suggest that VR training has a positive effect on dynamic balance and obstacle crossing performance in stroke patients. The findings of this review also suggest that VR training can provide an engaging and motivating platform for stroke patients to practice dynamic balance and obstacle crossing skills, ultimately improving their daily activities and quality of life. However, further research is needed to establish the optimal parameters for VR interventions targeting these specific impairments, as well as to compare the effectiveness of VR training with traditional rehabilitation approaches.

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CONFLICT OF INTEREST:

None

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