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Effect of Virtual Reality Game Based training in Gait Improvement of Post Stroke Patients: A Quasi-experimental Study

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ABSTRACT

Background: Stroke, also known as a cerebro-vascular accident (CVA), is the second largest cause of mortality and the top leading cause of disability worldwide, with 6.7 million people dying from stroke attacks each year. Stroke patients face different difficulties in which gait abnormalities is the most common.

Objective: The objective of this study was to determine the effect of virtual reality game based training for improving gait in post stokes patients.

Methodology: This was a quasi-experimental study (single group) with non-probability convenient sampling for which sample size was 40, calculated through Open Epi. Baseline assessment was taken at start of study and final assessment was done after 8 weeks through outcome measures (TUG test, MAS scale, forward stepping test and Functional reach test). SPSS version 23 was used to analyze and record the data. Descriptive statistics were used to calculate mean and SD for all continuous data and percentages were calculated for all categorical data. Paired T test was used to compare mean change in data before and after intervention.

Results: Although there was some improvement post scoring on outcome measurement scales applied in this study, still there was no significant difference between pre and post walking speed (P = 0.702), TUG test (P = 0.146), MAS scale (P = 0.227), forward stepping test (P = 0.089) and functional reach test (P = 0.415).

Conclusion: This study concluded that, VR game based task specific training has improved the gait in post stroke patients but statistically there was no significant difference.

Key Words: Cerebrovascular Accident, Gait, Stroke, Virtual reality.

Introduction

Cerebro-Vascular Accident (CVA) or stroke is the second leading cause of mortality and first leading cause of disability throughout the world and 6.7 million people died due to stroke attack annually.[1] Approximately 10 percent of annual death and 70% of post stroke deaths occur in low income countries and the trend is expected to increase over the next 2 decades.[2] In United States of America, it is the third leading cause of death with more than 140,000 patients annually.[3] The prevalence of stroke in the united states is approximately 269 per 100,000 individuals.[4] In Europe, stroke incidence ranges between 95 per 100,000 population for women and 141 per 100,000 population for men per annum.[5]

Difficulty in safe walking and dependency regarding Activities of daily living (ADL) are part of disability and it is stated that approximately 80 % of acute stroke patients lose their ability of walking.([6] Walking competency is the prerequisite of many activities. Adequately walking means to ensure active

participation in ADL.[7] Typical Walking include loss or decreased flexion of knee in stance, reduced dorsiflexion of the ankle at heel contact and during swing, and loss of ankle plantar flexion (push-off) at toe off.[8] Large mass of evidence shows that intensive, goal directed therapy have been proved improvement in function for post-stroke patients in both the chronic stages, and acute stage.[9]

Therefore, the major component to be improved for the stroke patient is to improve their gait. In fact walking restoration was considered by patients post-stroke as one of the important rehabilitative goals.[10] The standard of care for restoration of walking include pre-gait activity, Body Weight-Supported Treadmill Training (BWSTT), and task-specific training. These techniques are being applied to restore mobility of individuals post-stroke that contains and motor imagery.[11]

The most commonly used approaches for post stroke patients include Bobath's neurodevelopmental techniques Proprioceptive Neuromuscular Facilitation (PNF) technique, Constrained Induced Movement Therapy (CIMT), Motor Relearning Program (MRP) or task specific approach.[12] Intensive rehabilitation training shows significant improvement in ADLs, such as upper limb function ,balance and coordination and the walking competency, and lessens length of hospital stay.[13]

Currently, Virtual reality has been considered fruitful in the promotion of auditory, visual, motor learning, motivation and tactile input, used for motor skills after stroke.[14] Virtual reality training creates an environment where participants feel engaged in a computer-generated world. Users can explore and interact with virtual features. This distinguishes VR from other visual imaging methods.

Gait is the ultimate desire of every stroke survivor for active participation in the community. Exercises used in traditional rehabilitation can get boring and repetitious, which lowers patient interest and motivation. The immersive and engaging nature of VR training grabs the patient's attention and makes therapy more fun. This higher level of involvement may help with better program adherence and better results.[15] This study will determine the effect of virtual reality game based training in gait improvement of post stroke patients.

Methodology

This single group quasi-experimental study was conducted at Rafsan Neuro Rehab Center, Peshawar from October 2021 to February 2022. The sample size of study was 40, calculated through Open Epi with confidence interval of 95%. Stroke patients who were diagnosed on physical findings and other investigation like CT and MRI and admitted in the center in last 2 months.

The inclusion criteria were set as post-stroke patients for more than 3 months, with 20 and above score on MAS scale and age of 55 to 65 years, while the exclusion criteria were defined as participants having traumatic brain injuries, degenerative brain diseases, post craniotomy tumor patients leading to hemiplegia, patients having recurrent episodes of stroke, stroke patient with dementia and score on MAS scale below 20.

Data were collected from the participants after the administrative permission from the HOD of respective institution. Information sheet was provided to each participant and consent form was signed from the patients or their near relatives. Baseline assessment was taken at start of study and final assessment after 8 weeks through outcome measurement scales.

In intervention the participants took part in the VR training. The X-BOX 360 (Augmented virtual reality) device was used. The participants were guided about the virtual reality training including Kinect sports gamming (Trail 1. badminton, beach volley ball, Soccer goal keeping). Each training was performed for 15 minutes with 5 minutes break time. The whole training was performed for 8 weeks. After eight weeks' final assessment was done through outcome measuring tools: TUG (Used for balance, mobility and risk fall), MAS (To assess the motor functions of both upper and lower limb.it has eight components each with score from 0-6), Forward Stepping test (Also used for balance testing) and Functional Reach Test (Use to measure the stability both anterior and posterior which are important for both balance and normal gait).

SPSS version 23 was used to analyze and record the data. Descriptive statistics was used to calculate mean and SD for all continuous data and percentages were calculated for all categorical data. Paired T-test was used to compare mean change in continuous data before and after intervention.

The study was ethically approved by the Ethical Review Board of Khyber Medical University Peshawar. The protocol of the study was registered with clinicaltrials.gov. The trial registration number is NCT05570032 and the Ethical approval number is KMU/IPMR/MSPT/788.

Results

A total of 40 patients took participation in the study for which the mean (SD) of patients age were 59.20±3.006 years. Out of 40 participants 26 (65 %) were male and 14 (35%) were female. The descriptive analysis of Onset & Type of stroke of

the participants shown that there were 26 (65%) patients with acute stroke and 14(35%) patients having chronic stroke. The ischemic stroke was in 31 (77.5%) patients and hemorrhagic stroke in 9 (22.5%) patients. (Table I)

Paired t-test was applied on outcome measures; the walking speed test, TUG test, Forward Stepping test and Functional reach test. The walking speed was improved, as the mean and standard deviation of pre-walking speed test score 22.48±1.1617 were raised to score 36.30±4.648 after the completion of treatment. The p-value was (.702) that shows no significant difference between pre and post-walking speed test scores. The mean and standard deviation of pre-TUG test score 20.50±2.320 were reduced to score post-TUG 11.93±2.336 after the completion of treatment, which shows improvement as the task has been performed in less time post training as compared to pre-training. The p-value was greater than .05.

Table I: Demographic data.

Variables		Frequency(n)	Percentage%
Gender	Male	26	65
	Female	14	35
Onset of Stroke	Chronic	26	65
	Acute	14	35
Types of stroke	Ischemic	31	77.5
	Hemorrhagic	9	22.5

For assessment of motor function, score of MAS was improved that the mean and standard deviation of pre-MAS score 25.58±1.152 were raised to score 28.68±.971 after the completion of treatment. The p-value was (.227). In Forward Stepping, the mean and standard deviation of pre- Forward Stepping Test score 11.28±1.450 were raised to score 14.53±1.377 after the completion of treatment. The p-value was greater than .05. The functional reach was improved as the mean and standard deviation of pre- Functional Reach Test score 17.63±1.079 were raised to score 22.13±2.311 after the completion of treatment. The p-value was greater than .05. The details are mentioned in table II.

Table II: Comparison of pre and post treatment through different outcome measuring tools.

Training	Pre-treatment (Mean ± S.D)	Post-treatment (Mean ± S.D)	P-value
Walking Speed/(Steps/Minute)	22.48±1.1617	36.30±4.648	0.702
Time Up & Go Test (Seconds)	20.50±2.320	11.93±2.336	0.146
Motor Assessment Scale	25.58±1.152	28.68±.971	.227
Forward Stepping Test	11.28±1.450	14.53±1.377	.089
Functional Reach Test (Cm)	17.63±1.079	22.13±2.311	0.415

Discussion

This study revealed that virtual reality games based task specific training has improved the gait of post stroke patients. The speed of the gait was improved measuring through walking speed. The participants were initially assessed and then were followed for eight weeks. After eight weeks they were reassessed. Improvement was observed after training sessions were completed in walking speed, forward stepping and functional reaching.

A systemic review with meta-analysis in Netherland. 398 RCTs were identified and 21 studies were included in review among which 8 studies results are the favor of virtual reality for enhancing walking speed which is similar to the results of this study regarding score improvement, balance was improved on B.B.S is similar to the results of current study as in this gait score was improved, TUG score was improved while using virtual reality, which shows similarity with the current study.[16] So all the studies included in that systematic review favored the same concept as of our study emphasizing use of virtual reality for improvement of gait and dynamic and static balance

Anna Aminov et al conducted another systemic review with meta-analysis, thirty-three RCTs, were recognized for the review with 971 participants. Total 492 virtual reality treated patients were compared with other conventional therapies for stroke rehabilitation. This review suggested the virtual reality has significant effects on body structure, improvement in cognitive symptoms and behavior, ADL, independence. Virtual reality is more effective when it applying in conjunction with other NDT techniques.[17]

The results of another systematic review by David Corbetta showed significant improvement in walking speed while using virtual reality-based training in combination with other standardized training similar to current study. Balance improvement is similar to the results of current study as in this, gait score was improved while using MAS scale. Mobility was improved while using TUG, which shows further similarities with the current study as the score was also improved.[18]

Ilona JM de Rooij et al conducted RCT about the feasibility and effectiveness of virtual reality training for improving balance and gait. Total 16 patients of sub-acute stroke patient, received virtual reality training for four weeks along with inpatient rehabilitation program. Patients showed positive results regarding feasibility, balance and gait on outcome measures BBS, center of pressure velocity, functional ambulation category, and 10-meter walk test.[19]

Another hospital based RCT was conducted in Seoul South Korea by Nara Kim et al about the effectiveness of Virtual

Reality Treadmill Training for balance and gait training. Total 27 participants were randomly assigned in three groups. Virtual reality treadmill training, community ambulation training group, and control group. The results of this study revealed that virtual reality treadmill and community ambulation are feasible and showed significant improvement of post stroke patients as compared to control group.[20]

Conclusion

This qausi-experimental study (single group) conducted at Rafsan Neuro Rehab Center; Peshawar shows that virtual reality based training has improved the gait of stroke patients. As improvement was observed in walking speed, forward stepping and functional reach further study is needed as it was a single group study and the device used in the study was of low quality but statistically there was no significant difference.

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