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Original article

Effect of task oriented balance training versus virtual reality based balance training in stroke patients-a comparative study

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Abstract

Background: stroke is neurologic disorder considered the first cause of disability worldwide ,when the blood flow to the brain is impeded due to blockage of vessels, stroke occurs. Virtual reality (vr) seems to be an alternative to conventional therapy, provides virtual environment to train balance in stroke patients. Physical and functional disorders limit mobility over a period of time after stroke which results in difficulties of daily living.

Objective: to find out the effect of task oriented training and virtual reality based training on balance in stroke.

Methodology: 32 patients meeting the inclusion and exclusion criteria were allocated into 2 groups. Group a (n=16) received task oriented training + conventional exercise and group b (n=16) received virtual reality training+ conventional exercise for 3 days a week for 4 weeks.

Result: result of this study showed that there is significant difference in pre and post values for poma, bbs, barthel index scales for both groups independently. On comparison between group a and group b, significant changes were seen statistically in group b virtual reality + conventional group.

Conclusion: It was concluded that their was significant improvement in balance. The participants who received virtual reality training as well as in participants who received task oriented training individually. Also both interventions proved to be effective in terms of improving balance. However, on comparison of two intervention programs there was significant difference in virtual reality training on balance

Key words: virtual reality training, task oriented training, balance, stroke

Introduction:

Stroke is defined as sudden loss of neurological function caused by interrupted blood flow to the brain.[1] stroke is the most common cause of disability in western countries and sequels after a stroke may lead to motor, sensory, perceptual, and/or cognitive deficits and these impairments might impact on the individual functionality.[2,3] there was been reported that upper limb dysfunction may affect the balance more in stroke patients, as well as the relation between lower limb weakness and balance disorder after stroke. Accordingly, some of the forces and moments occur during the movement of upper limb, depending on the weight and dynamics of that arm and such forces and moments may distort the balance, affecting standing still and sitting balance and posture and the ability to change position.[4] the symptoms of a stroke can vary depending on the location and area of affection as well as the amount of collateral blood supply to that area. Early acute onset of care and management determines the severity of the neurological deficits. Symptoms of stroke include dizziness, loss of consciousness, sudden headaches, weakness, numbness or paralysis (particularly on one side of body), impairment of speech, loss of coordination and loss of memory.[5]

The incidence of ischemic stroke in young adults varies considerably between countries, ranging from 7–8 per 100 000 person-years in europe to more than 100 per 100 000 person-years in sub-saharan africa. An increase of up to 40% in the incidence of stroke in young adults has been

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reported over the past decades.[6] as per a study conducted in 2015, in india, crude prevalence of stroke ranged from 44.29 to 559/100,000 persons per year, and cumulative incidence of stroke ranged from 105 to 152/100,000 persons per year, in different parts of the country during past decade.[7]

Task oriented training was a effective method of treatment in any form of stroke survivors to improve the multi system functioning of central nervous system. It include exercises like weight shifting exercises, trunk training exercises, sit to stand training, gait upper limb object reach deep flexion activity training, strength training, task oriented circuit training on stable and unstable surface are used by various researchers to improve the balance and mobility functions after stroke patients.[4]

Virtual reality is been defined as use of interactive simulations created with computer hardware and software to present users with opportunities to engage in environments that appear and feel similar to real- world objects and events. It aids in the practice of specific tasks by providing visual and auditory feedback, by promoting adaptive learning and neural plasticity, by improving balance ,mobility, range of motion and gait performance.[8]

Hence the aim of this study was to investigate the effect of task oriented training with virtual reality based rehabilitative intervention on balance on the functional recovery of patients with stroke.

Material and methodology

It was a comparative study conducted in the department of neuro physiotherapy, after obtaining approval from the institutional ethics committee. Inclusion criteria of the study was participants with age group of 18-60 years having hemiplegic stroke with disease duration < 3 months, mmse score > 24, ability to understand instructions and follow commands, ability to stand for at least 1 minute without any assistance on a stable surface and participants who willing to participate in the study. Whereas the exclusion criteria of the study was participants having presence of previous symptomatic stroke, visual field defect, hemi spatial neglect, severe cognitive impairment, aphasia, uncontrolled blood pressure or any other orthopedic condition.

Before starting the procedure an informed written consent form was obtained from the patients. 32 patients were selected and were randomly divided into 2 groups, 16 patients in group a and 16 patients in group b. Amongst those 32 patient there were no dropouts (group ‘a’- task oriented balance training + conventional exercises), (group ‘b’-virtual reality based balance training + conventional exercises).in group b a set of ten serious games was given to the patients by vr head set for the intervention. The subject was well instructed for the each game and if they have any query the subject can stop the game in between. Each game offers different difficulty levels, ranging from 1 (lowest degree of difficulty) to 5 (highest degree of difficulty). The frequency of every session was 30 mins per session 3 times per week for 4 weeks and every session of the patient was recorded to see the progression of patient. Both the groups received intervention for 4 weeks. The exercise training program consisted of 3 sessions per week for 4 weeks, 30 minutes of intervention and 15 minutes of conventional training for each session. The intervention program for each group is as follows: conventional exercises

i. Mat exercises: stretching and strengthening of lower limb muscles.
ii. Sitting on a swiss ball with eyes open and closed.
iii. Sitting position reach outs
iv. Standing and reach outs
v. Range of motion exercise

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Group 'a' (task oriented balance training)

Exercises	Repetitions	Frequency
1. Motor task: i. Bubble blower ii. Brisk walking iii. Trunk training exercises iv. Pertubations on swiss ball v. Obstacle walking vi. Reach outs vii. Task oriented circuit training	4 mins 4 mins 4 Mins 5 Reps x 2 sets x 2 cycles	30 mins sessions 3 times per weekfor 4 weeks

obstacle walking

perturbation on swiss ball

trunk training exercises

Virtual reality based balance training program

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Sr. No.		Start position
1	**Balloon popper**	The goal of the game is to pop the balloons that appear on the screen. To pop the balloons, the patient should move the hips in all directions (shifting the weight) to reach the balloons. To score points, the patient should pop red balloons. If the patient pops blue balloons instead, an "x" icon appears on the screen showing that he/she made an error. A big blue hand represents the patient's Movements as an avatar.
2	**Bubbles**	The objective of this game is to pop the bubbles that appear inside a Cauldron. The patient is represented as a wooden stick. The hips areused to pop the bubbles
3	**Fire fighter**	In this game a 3d avatar man inside a barn will represent the patient. To score points, the patient should step over a fire that appears around him/her (in eight different directions). To extinguish the fire, the patient needs to stay a determined amount of time over the flame. If the patient does not extinguish it, the hay bales that are in the barn May burn and the patient will lose points.
4	**Animal hurdler**	The objective of this game is to pop the bubbles that appear inside a Cauldron. The patient is represented as a wooden stick. The hips areused to pop the bubbles
5	**Fruit catcher**	The objective of the game is to catch apples falling from the top of the tree. In "fruit catcher" the patient will be represented as a 3d avatar man represented in front of a tree with a basket on the head. To catch the fruit, the patient should shift the body weight or step to the sides. The patient will score points when the fruits fall into the Basket placed over the avatar´s head.
6	**Hay collect**	The objective of this game is to shift the body weight to the left or to the right, and score points collecting the hay bales scattered around the field. In this game the patient´s avatar is driving a tractor Travelling forward automatically. The score decreases when the

		Patient does not collect the bales or if the avatar hits against rock Formations.
7	**Scare crow**	The objective of this game is that the patient increases his balance and equilibrium. In this game, a scarecrow placed in a crop field represents the patient. Birds come from the sky to alight upon you. If the patient moves when the birds are approaching to the avatar, the Birds will be scared and the patient looses points.
8	**Pump the wheel**	In this game the patient should raise both legs alternately, as previously described in "animal hurdler". The patient is represented by a 3d avatar man that operates a pump connected to an empty flat of a tractor that is in front of the avatar. Patient operates the pump rising and lowering the legs at both sides alternatively. A blue arrow indicates which leg the patient has to lift and the height necessary to Achieve points.
9	**Horse runner**	The patient has to stand up to run faster and getting floating honey jars (it give you points) and to sit down to run slower and avoiding branches (figure 2). An avatar of a man who is on the top of a horse represents the patient. The horse is running in the woods and Advances automatically.
10	**Butterfly catcher**	The objective of this game is to catch butterflies appearing from one side of the screen to the other. A floating butterfly net represents the patient, who has to use the body movements to catch butterflies (moving the hips). If the patient catches dragonflies instead of 7butterflies, he/she looses points.

Group 'b' (virtual reality based balance training)

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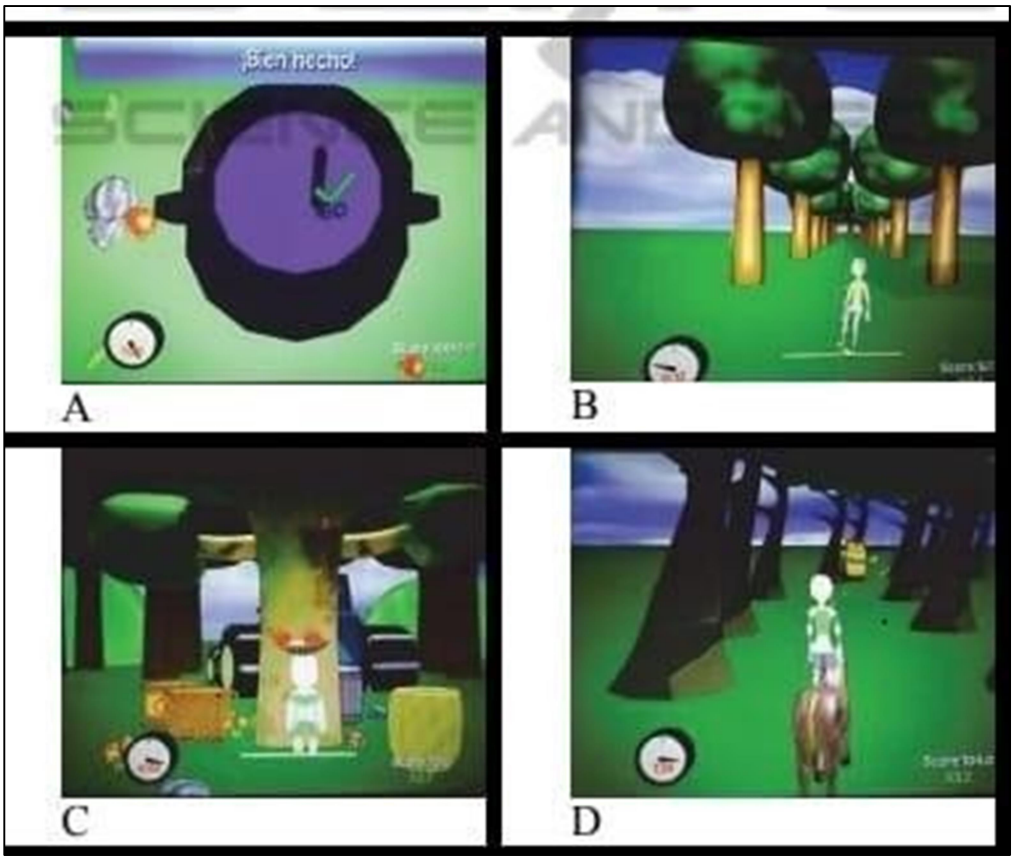
Videogames screenshots: a. Bubbles; b: animal hurdler; C. Fruit catcher; d. Horse runner



Statistical analysis:

Analysis was done using spss version 20 (ibm spss statistics inc., chicago, illinois, usa) windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The data were checked for normality before statistical analysis using kolmogorov simonov test. The mann–whitney u-test (for quantitative data to compare two independent observations) and wilcoxon signed-rank test(for quantitative data to compare before and after observations) were applied. The chi square test was used for quantitative data comparison of all clinical indicators. Level of significance was set at $p \leq 0.05$ and highly or considerably significant with '$p' < 0.001$.

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Results:

Table 4.1 comparison of pre and post –intervention score in group a

Outcome measures		Mean±sd	T value	P value	Results
Performance oriented Mobility assessment	Pre	20.50±1.86	3.87	0.001	Highly significant
	Post	22.25±2.01			
Berg balance scale	Pre	42.88±5.65	5.41	0.001	Highly significant
	Post	46.63±5.25			
Barthel index	Pre	52.44±9.45	3.21	0.001	Highly significant
	Post	55.81±10.95			

Balance and gait impairment after stroke were measured by using performance oriented mobility assessment the mean value in group a before intervention was 20.50±1.86 and after intervention it was 22.25±2.01 respectively. Score of group a, it was observed that this difference is highly significant (‘p’ 0.001) ‘t’= 3.87. Balance impairment after stroke were measured by using berg balance scale. The mean value of bbs score in group a before intervention was 42.88±5.65 and after intervention was 46.63±5.25 respectively. Score of group a, it was observed that this difference is highly significant (‘p’ 0.001) ‘t’= 5.41. activities of daily living after stroke were measured by using barthel index the mean value in group a before intervention was 52.44±9.45 and after intervention it was 55.81±10.95 respectively. Score of group a, it was observed that this difference is highly significant (‘p’ 0.001) ‘t’= 3.21.(table 4.1)

Table 4.2 comparison of pre and post –intervention score in group b

Outcome measures		Mean±sd	T value	P value	Results
Performance oriented Mobility assessment	Pre	19.88±1.708	12.63	0.001	Highly significant
	Post	24.75±1.52			
Berg balance scale	Pre	43.31±4.19	8.46	0.001	Highly significant
	Post	51.50±2.44			
Barthel index	Pre	64.75±9.32	12.32	0.001	Highly significant
	Post	86.63±7.65			

Balance and gait impairment after stroke were measured by using performance oriented mobility assessment the mean value in group b before intervention was 19.88±1.708 and after intervention it was 24.75±1.52 respectively. Score of group b, it was observed that this difference is highly significant (‘p’ 0.001) ‘t’= 12.63 . Balance impairment after stroke were measured by using berg balance scale. The mean value of bbs score in group b before intervention was 43.31±4.19 and after intervention was 51.50±2.44 respectively. Score of group b, it was observed that this difference is highly significant (‘p’ 0.001) ‘t’=8.46 .activities of daily living after stroke were measured

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by using barthel index the mean value in group b before intervention was 64.75±9.32 and after intervention it was 86.63±7.65 respectively. Score of group b, it was observed that this difference is highly significant ('p' 0.001) 't'=12.32 .(table 4.2).

Discussion:

This study was conducted to examine effectiveness of task oriented exercises and virtual reality based balance training in stroke patient. According to the results, the study showed pre and post comparison of both task oriented training group and virtual reality based training group and there was significant effect on balance and mobility using poma , bbs, barthel index scores.

Several systematic reviews have been published on the use of vr, via the use of game consoles, which inform of significant changes in the motor function of patients after a stroke, with the use of specific implemented protocols, as used in our research[9]. However, prior research indicates that protocols with low times and intensity, as well as a low number of sessions and weeks of treatment, do not produce significant differences in outcome measures (<30min/session, <3 sessions/week, with a frequency <4 weeks and unsupervised treatment)[10].

In the present study, bbs score between groups comparison found that the difference was more in group b compared to group a. Comparable findings were reported in patients with stroke, parkinson's disease and multiple sclerosis. Similarly for these same populations, the addition of virtual reality training to conventional physical therapy or no therapy was consistently found to improve balance[11,13]. When training duration was matched between the experimental and control group, some studies found greater improvement in the virtual reality training group[14,17], yet other studies found no differences between the groups [18,20]. Virtual reality games have thus proven to be at least as effective, and maybe even more effective, in improving balance than conventional treatment. It should be noted that most games examined in these studies were not designed for rehabilitation, therefore greater improvements may be possible when games are specifically developed for patients[21]

Virtual reality is more effective in improving poma score because it mainly focuses on ability to maintain balance during the functional activities. If it is affectedit can affect the risk of falling in stroke patients.stroke is one of the most common causes of impairment for motor function and gait in adults[22], which also depends on the location and severity of brain damage. The main motor issues in stroke survivors are movement limitations, changes in muscle tone, spasticity and impaired motor control[23]. In addition to motor dysfunctions, sensory functions such as visual and vestibular inputs are altered in stroke[25]. As a result of this, stroke survivors experience imbalance due to muscle instability or altered proprioception, decreased postural control, poor voluntary control, misperception of verticality sense[26], and body misalignment.[27] different studies, including ours, confirm that balance is altered in stroke patients, resulting in a postural control deficit[28,29]. Related to this global balance reduction, falls are the leading cause for the loss of independence observed across stroke patients[30].

This is one of a kind study done to compare the effects of task oriented exercise and virtual reality in stroke. Larger sample size can be taken for further evaluation of results.

Conclusion:

The documented results of this study demonstrated that the balance improves significantly in the participants who received virtual reality as well as in participants who received task oriented exercise individually. Also both interventions proved to be effective in terms of improving functional balance. However, on comparison of two intervention programs there was significant difference in effect on virtual realitybalance training in stroke patients.

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