International Journal of Yoga, Physiotherapy and Physical Education
www.sportsjournal.in
ISSN: 2456-5067
Received: 05-03-2021, Accepted: 07-04-2021, Published: 20-05-2021
Volume 6, Issue 3, 2021, Page No. 03-09

A comparative study between virtual reality balance training and conventional therapy in improving balance and gait among parkinson's diseases

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Abstract
Aim: The Aim of this study is to compare the effectiveness of virtual reality balance training and conventional therapy in improving balance and gait among Parkinson's diseases.
Materials and Methods: A Quasi-experimental study design consiting of reviews of charts of Parkinson's diseases. Thirty patients were included, (50%) were females, (50%) were males ; the average age was 55 years. All the patients are presented with idiopathic Parkinsons diseases. Pre- and post-Treatment (virtual reality balance training) and (conventional therapy) scores on the balance and gaitthrough Berg Balance Scale (BBS) and Dynamic Gait Index (DGI) were analyzed.
Results: The pre and post test values were assessed by BBS and DGI in Group A and Group B. The calculated ' t ' values by unpaired ' t ' test were in group A is BBS is 13.42 and DGI is 7.72 respectively the calculated 't' values were more than the table value 2.05 for 5% level of significance at 28 degrees of freedom.
Conclusion: In the present sample, Virtual Reality Balance Training had a positive and significant effect on Balance And Gait, as measured by the BBS and DGI scores before and after therapy.

Keywords: virtual reality balance training (VRBT), berg balance scale (BBS), dynamic gait index (DGI)

Introduction

Parkinson's disease is a chronic, progressive, and disabling disorder that is characterized by both motor and nonmotor symptoms. The disease affects millions of people worldwide and is the second most prevalent neurodegenerative condition next to Alzheimer disease. Patients experience progressive extrapyramidal motor symptoms, including tremor, bradykinesia, rigidity, imbalance, and a variety of nonmotor symptoms such as sleep and mood disorders.

The English physician, James Parkinson, first characterized Parkinson disease in his 1817 monograph "An Essay on the Shaking Palsy." Parkinson described several people who presented with resting tremor, shuffling gait, stooped posture, sleep problems, and constipation. He noted the progressive nature of the disease and the great disability it incurred and called it paralysis agitans. Charcot later expounded on the disease, adding bradykinesia and rigidity to the constellation of symptoms, and renamed the condition Parkinson disease.

Balance control refers to a multisystem function that strives to keep the body upright while sitting or standing and while changing postures balance control is needed to keep the body appropriately oriented while performing voluntary activity, during external perturbation and when the support surface or environment changes.

In recent years, virtual reality (VR) technology is proposed as a new rehabilitation tool with a possible added value over neurorehabilitation research. From the perspective of kinematics learning, VR provides a possibility for high-intensity, task-oriented and multi-sensory feedback training, which can promote patients' visual, auditory and tactile input, and increase their interest in the rehabilitation process by letting patients experience immersion or non-immersion virtual environment, so that patients' treatment compliance is effectively improved.

Previous studies have confirmed that VR technology plays an active role it has been shown that VR can improve the balance function and daily life activities of patients with Parkinson's disease.

Joseph Triegaardt *et al*, suggested that VR used in rehabilitation for patients with PD improves a number of outcomes and may be considered for routine use in rehabilitation.

Cheng Lei *et al*, he suggested that VR is likely to be a more effective means of rehabilitation for PD patients.

This study hypothesized that a specific therapeutic approach for Parkinson's disease by the application of virtual reality can be used for improving balance and gait.

Epidemiology

Parkinson disease affects millions of people worldwide, and the number of affected patients may double by 2030. The annual median age-standardized incidence rates of Parkinson disease in people older than 65 years of age in high-income countries is 160 per 100,000. The lifetime risk of Parkinson disease is 2% in men and 1.3% in woman aged 40 years and older, when accounting for competing risks. The incidence of Parkinson disease prior to age 50 is low but increases with advanced age. Men carry a greater chance of having Parkinson disease than women.

Operational definition

Parkinsons disease

Parkinson's disease is a multi – attribute neurodegenerative disorder combining motor and non motor symptoms without well defined diagnostic clinical markers. The most common symptoms can also overlap with other neurodegenerative diseases.

James Parkinson

Balance
Balance is defined as the ability to control the body mass of center of gravity to the base of support in order to maintain in an upright posture or a functional equilibrium in dynamic activities

Carolyn Kisner

Gait
Gait is defined as a translator progression of the body as a whole produce by coordinated, rotatory movements of whole-body segments.

Cynthia C. Norkin, 2011

Virtual Reality
Inducing targeted behavior is an organism by using artificial sensory stimulation while the organism has little or no awareness of the interference.

Steven M. Lavalle

Berg Balance Scale
The Berg Balance Scale (or BBS) is a widely used clinical test of a person's static and dynamic balance abilities, named after Katherine Berg, one of the developers. For functional balance tests, the BBS is generally considered to be the gold standard.

Katherine Berg

Dynamic Gait Index
The dynamic gait index has emerged as a valid tool of functional gait abilities for people with balance and vestibular disorders.

Deanna C. Dye

Need for the study
Balance and Gait disturbances are cardinal symptoms in patients with Parkinson's disease. It mainly create negative impacts on the daily activities of patients. Also it affects emotional, physical and functional activities.
Thus, the purpose of this study is to find out the effectiveness of Virtual Reality and Conventional rehabilitation on balance and Gait among Parkinson's disease patients.
So I have decided to conduct my research to improve the balance and gait among Parkinson's disease.

Aim of the study
The aim of the study is to compare the Effectiveness of Virtual Reality and Conventional Physiotherapy in improving balance and gait among Parkinson's disease.

Objectives of the study
- To have depth in knowledge of Parkinson's disease patients.
- To improve the balance and gait in Parkinson's disease patients.
- To find out the effectiveness of virtual reality on balance and gait among Parkinson's disease patients.
- To find out the effectiveness of Conventional Physiotherapy on balance and gait Parkinson's disease patients.
  To compare the effect of virtual reality and Conventional Physiotherapy among Parkinson's disease patients.

Hypothesis
Null Hypothesis
There is no significant difference between the effect Virtual Reality and Conventional Physiotherapy on Balance and Gait in Parkinson's disease patients.

Alternate Hypothesis
There is significant difference between the effect of Virtual Reality and Conventional Physiotherapy on Balance and Gait in Parkinson's disease patients.

Materials and Methodology
Materials
- Treatment couch
- Treatment chair
- Towel
- Stop clock
- Stethoscope
- B.P Apparatus
- Card Board
- Foot Stool
- Wii balance board
- LED TV
- Wii remote and its accessories.

Methodology
- All patients underwent a Neurological Examination.
- The BBS and Dynamic Gait Index test is conducted to confirm diagnose of balance and gait among Parkinson's disease patients.

Population
- Patients with age group of 45-65 years of Parkinson's disease patients.

Criteria for sample selection
Inclusion Criteria
- Patient's willingness to participate in the study.
- Both genders
- Age group of 45-65 years
- Patients with idiopathic Parkinson's disease

Exclusion Criteria
- Exclusion criteria includes progressive medical issues that would affect mobility, presence of any other neurological disorders, musculoskeletal disabilities and unstable cardinal disease.
- Patients with impaired vision
- Seizure disorder
- Impaired higher function
- Spinal cord lesion
- Non Co-Operative patient
- Any other vascular, metabolic, degenerative or neoplastic disorders, which are confirmedly known to cause balance disorders.

Source of Data
- RKR Neuro Speciality Hospital, Erode.
- Senthil Multi Speciality Hospital, Erode.
- Jeyam NeuroPhysiotherapy Center, Erode
- Out Patient Department -Nandha College of Physiotherapy, Erode.

Sample Sizes
Sample size is 30 subjects
- Group A-15 patients
- Group B-15 patients

Study Design
Quasi Experimental design
- Pre and Post experimental Study Design

Sampling Method
Convenient Sampling Method

Duration of the study
8 Months

Treatment Duration
- Study was carried out for 6 weeks for each individual.
- Group A underwent Virtual Reality Balance Training - 40 minutes session 3 times/ week for 6 weeks.
- Group B underwent Conventional Physiotherapy- 40 minutes session 3 times/ week for 6 weeks.

Parameters
a) Berg Balance Scale
b) Dynamic Gait Index

PROCEDURE
- Subjects were selected by convenient sampling method. 30 subjects who fulfilled inclusion and exclusion criteria were selected, out of them 15 were allotted in Group A and 15 in Group B.
- Subjects were clearly explained about the study and written informed consent was obtained from the subjects who fulfilled the criteria.
- After completing the informed content and they were explained about a scale and that scale was administered.
- Proper instructions such as purpose, safety measures, comfort, precautions and psychological support were given to the subjects.
- All vital signs were checked.
- While doing the assessment, the subject's willingness to continue the procedure with or without rest was given preference.
- Both Group A and Group B subjects were involved for pre test assessment.
- Group A underwent Virtual Reality Balance Training - 40 minutes session 3 times/ week for 6 weeks.
- Group B underwent Conventional Physiotherapy - 40 minutes session 3 times/ week for 6 weeks.
- The total duration is 40 minutes.

A. Virtual reality balance training- procedure
The subjects of the Virtual Reality Balance Training performed 30 -minutes with Nintendo Wii games three times a week for 30 minutes for each session for 6 weeks and Conventional Physiotherapy for 10 minutes, inbetween rest mayor maynot be given.
The game/task type used for the treatment of balance and gait were (Perfect 10, Tilt Table, Balance Bubble, Island Cycling, Hula Hoop, Soccer Heading, Penguin Slide).

Game/Task Type

1. Perfect 10
Stand on the Wii Balance Board. Shake your hips and do the math! This tests the body and mind coordination. Shake your hips back, front, left or right to add up to the given number. Light up the numbers that 8will add up to 10. Hit the numbers whenever you want to turn them off.

2. Table Tilt
Stand on the Wii Balance Board. Control the tilt of a virtual board by shifting the body weight. This task is making us to balls on the tilting board to fall in the hole on the board, not to fall out of the board.

3. Balance Bubble
Stand on the Wii Balance Board. Shift your weight forward to move. Lean left and right to steer. This tests your lower body balance and agility.

4. Island Cycling
Stand on the Wii Balance Board. Control the virtual Bicycle to cruise around the streets by shifting body weight.

5. Hula Hoop
Stand on the Wii Balance Board. Sway your Hips to spin the Hula Hoop. Get a good workout and help to align your pelvis. Twirl your hips in circular motion. The trick is to move your hip in large neat circle.

6. Soccer Heading
Stand on the Wii Balance Board. Head the soccer balls as they get kicked at you but dodge other flying objects. Tilt your body to left or right to head the soccer balls. Focus on your lower body.

7. Penguinslide
Stand on the Wii Balance Board. Shift your body rapidly to the left and right to tilt the ice berg and feed the penguin- Shift your body to right or left to catch as much as fish you can.

B. Conventional physiotherapy-procedure
The following Conventional Physiotherapy exercises were performed three times a week for 40 minutes for each session for 6 weeks

Muscle Strengthening
The patients were asked to do each exercise ten times and each exercise slowly and in a controlled way
1. Sit and stand tall, keeping arms straight, slowly touch fits together in front and then behind the back. Pull the shoulder blades together as you touch in back.
2. Sit in a chair, slowly straighten out one leg, hold and lower. Repeat with other leg. To increase the resistance and a small weight around ankle.
3. Stand with back against a wall. Hold a small weight in each hand. Keeping the elbow against the wall, lift one arm to the shoulder level and lower and repeat with other arms.

4. Step sideways across the room, lifting knees as high you can. Pretend you are stepping over sticks. Side step backs
5. Stand behind a chair. If necessary, rest your hands on the back for support. Go up on toes and come down flat.

Flexibility Exercise

Flexibility exercises exercises are another important component of an exercise routine for people with PD. The following muscles are stretched passively 3-5 times and hold for 30 seconds.

A. Hip flexor stretch
B. Trunk twist
C. Hamstring step stretch
D. Calf stretch

Balance and gait training

- The patient can marching in place, emphazing high stepping to strengthen hip flexors.
- Weight transference can be practice using stepping movements forward and backward.
- Side stepping and crossed step walking can be practiced.
- Visual cues can improve the gait of patients with Parkinson's disease.
- The problem of a shuffling gait can often times be remedied by using small blocks of about 2 to 3 times (5 to 7.5 cm) to provide target for the patient to step overBrightly colored transverse lines can be effective in initiating and controlling steps.
- Foot print walking.

Data presentation and analysis

Statistical tools

For the pre and post test experimental study, both paired and unpaired 't' test was used for each parameter in an in an intra group analysis to find out the significance of improvement achieved through intervention. Then unpaired 't' test was used to find out the significance of the changes between two groups i.e., inter-group analysis.

Paired t-test

To compare the effect between two groups students 't' test for paired values.

Formula paired t-test

$$S = \frac{\Sigma d^2 - \frac{(\Sigma d)^2}{n}}{n-1}$$

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

d = difference between the pre testV_s post test

$\bar{d}$ = Mean difference

n = Total number of subjects

S = Standard deviation

Unpaired t- test

The unpaired t-test was used to compare the effects between two groups, students 't' test for unpaired values

Formula unpaired t –test

$$S = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}$$

$$t = \frac{|\bar{x}_1 - \bar{x}_2|}{s\sqrt{\frac{1}{n_1}+\frac{1}{n2}}}$$

n_1 = Total number of subject in Experimental Group

n_2 = Total number of subject in Control Group

$\overline{X_1}$ = Mean difference between pre test and post test of Experimental group.

$\overline{X_2}$ = Mean difference between pre test and post test of Control Group.

S_1 = Difference between pre test and post test of Experimental Group.

S_2 = Difference between pre test and post test of Control Group.

Mean difference between group a and group b of BBS and DGI

Table 1

Groups	Mean difference	
	BBS	DGI
Group-A	30.40	12.33
Group-B	19.46	9.93

Mean difference between group a and group b of BBS and DGI

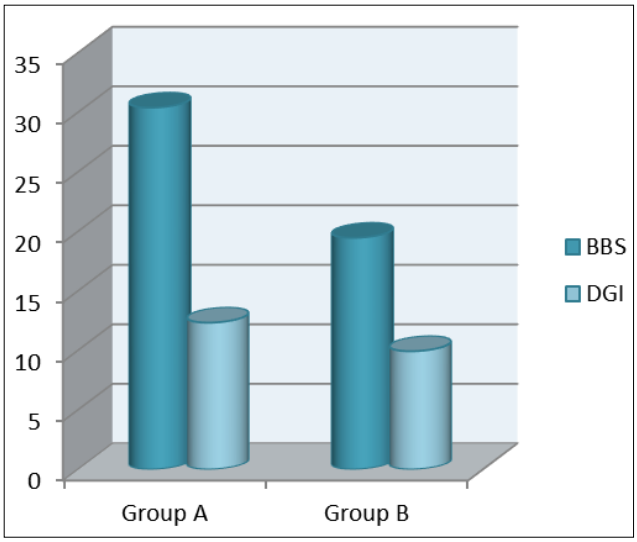

Fig 1

Standard deviation between group a and group B OF BBS AND DGI

Table 2

Groups	Standard deviation	
	BBS	DGI
GROUP A	2.50	1.92
GROUP B	0.96	0.72

Standard deviation between group a and group B of BBS and DGI

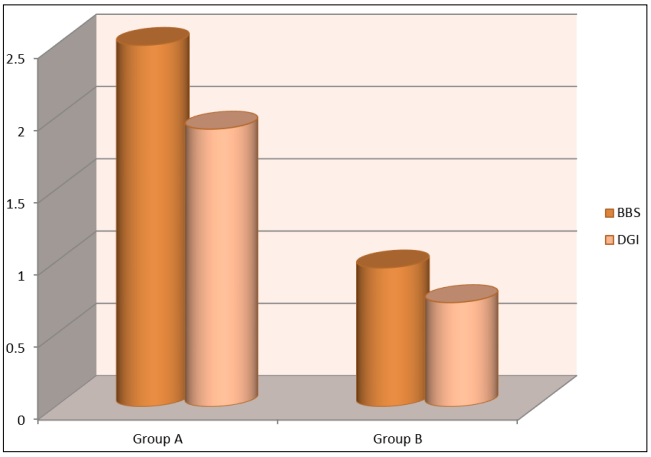

Fig 2

Comparision of the paired 't' test and table value between group A and group B

Table 3

Groups	Calculated ' t' value		Table Value	Significance
	BBS	DGI		
Group A	45.52	65.99	2.15	Significant
Group B	35.19	40.02	2.15	Significant

Comparision of the paired 't' test and table value between group A and group B

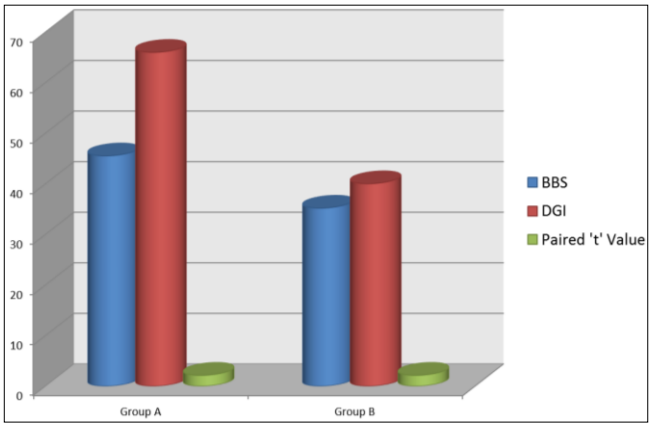

Fig 3

Comparision of calculated unpaired't' test and table value of BBS and DGI

Table 4

Parameters	Unpaired 't' test	Table value	Significance
BBS	13.42	2.05	Significant
BI	7.72	2.05	Significant

Comparision of calculated unpaired 't' test and table value of BBS and DGI

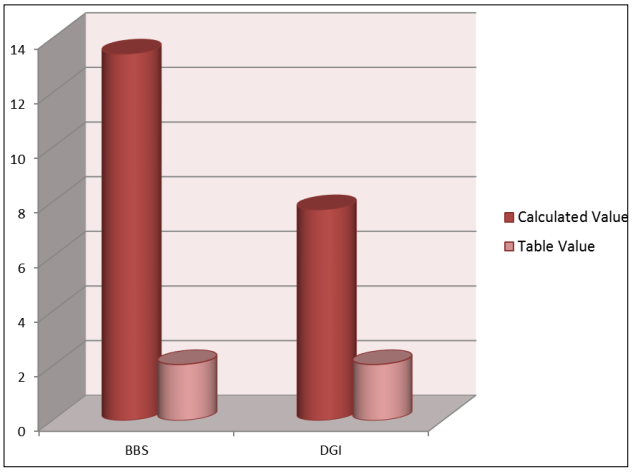

Fig 4

Results and Discussion

Results

The study sample comprised 30 patients, of which 15 were male and 15 were female. The mean age of patients was 50 years. The median time interval between BBS and DGI assessment is applied before and after therapy was 6 weeks. Among 30 patients, 15 were treated with Virtual Reality Balance Training, and 15 were treated with Conventional Physiotherapy. The pre and post test values were assessed by BBS and DGI in group A and group B. The mean difference value for group A and group B of BBG is30.40and 19.46 and DGI is12.33 and 9.93respectively. The standard deviation value for group A and group B of BBG is2.50and 0.96and DGI is1.92 and0.72 respectively. The paired 't' value of BBS is 45.52 and 35.19 and DGI is65.99 and 40.02 respectively. The paired 't' test value is more than table value 2.15 for 5% level of significance at 14 degrees of freedom. The calculated 't' values by unpaired 't' test of BBS is 13.42and DGI is 7.72 respectively the calculated 't' values were more than the table value 2.05 for 5% level of significance at 28 degrees of freedom. The paired 't' test values have shown that Virtual Reality Balance Training was more effective than Conventional Physiotherapy in improving balance and gait in Parkinson's disease Patients. The unpaired 't' test values have shown that there was significant difference between two groups in showing improvement in their quality of life in Parkinson's disease patients.

Discussion

The aim of this study is to compare the effectiveness of Virtual Reality Balance Training and Conventional therapy in improving balance and gait among Parkinson's diseases.

The study sample comprised 30 patients, of which 15 were male and 15 were female. The mean age of patients was 50 years. The median time interval between BBS and DGI assessment is applied before and after therapy was 6 weeks. Among 30 patients, 15 were Group A underwent Virtual Reality Balance Training, and 15 were in Group B underwent Conventional Physiotherapy. The pre and post test values were assessed by BBS and DGI in group A and group B.

The results of this study indicate that Virtual Reality Balance Training group improved significantly in balance measured with BBS and DGI outcomes measures whereas no significant differences were found in balance scores of the control group. Also there is marked improvement in gait. This suggest that even the statistical meaningless baseline BBS scoring and small magnitude change at post intervention is capable of reducing the psychological impact of balance impairment and also improves the gait in Parkinson's disease patients.

Mansoom M Abbas *et al*, Parkinson's disease is common with increasing age and shows male predominance. The PD prevalence and incidence rates are slightly lower in the east compared to the West. Smoking, caffeine intake, pesticide exposure. Both east and west suggest a role for both environmental and genetic risk factors in PD causation. Both East compared to the West. Both East West suggest a role for both environmental and genetic risk factors in PD causation, smoking, caffeine intake, pesticide exposure increases the risk of PD.

AnatMirelman *et al* has suggested that Motor imagery (MI) and virtual reality (VR) are two evolving therapeutic approaches that make use of cognitive function to study and enhance movement, in particular, balance and mobility of people with Parkinson's disease (PD). Sixteen studies were identified; 4 articles used MI and 12 used VR for assessment and treatment of gait impairments in PD. Encouraging findings on the potential benefits of using MI and VR in PD were found, although further good-quality research is still needed.

Maria Izabel *et al* study has assess the effectiveness of balance exercises by means of virtual reality games in Parkinson's disease. Methods: Sixteen patients were submitted to anamnesis, otorhinolaryngological and vestibular examinations, as well as the Dizziness Handicap Inventory, Berg Balance Scale, SF-36 questionnaire, and the SRT, applied before and after physiotherapy with virtual reality games. The Tightrope Walk and Ski Slalom virtual games were shown to be the most effective for this population.

Hence several studies have noted that Virtual Reality Balance Training is safe and cost effective among parkinson's disease patients. Moreover, some studies reported that VR provides enriched motivational training and goal-orientated tasks which integrate multisensory stimulation of visual, auditory, tactile, and somatosensory systems to provide a realistic environment. Hence, this present study concludes that VR therapy is effective among parkinson's disease patients in improving balance and gait.This study has proved that Virtual Reality Balance Training is more effective.

Summary and Conclusion

The study sample comprised 30 patients of Parkinson's disease, of which 15 were male and 15 were female. The mean age of patients was 50 years. Among 30 patients, 15 were Group A underwent Virtual Reality Balance Training, and 15 were in Group B underwent Conventional Physiotherapy for 6 weeks. The pre and post test values were assessed by BBS and DGI in group A and group B.

Virtual Reality Balance Training are effective in improving balance and gait among the Parkinson's diseases patients. The results of this study suggest us that Virtual reality balance training leads to improvement of balance, gait and subjective confidence to carry out the activities of daily life. Through the results, alternate hypothesis is accepted and also the study could be concluded that there is a significant difference in Virtual Reality Balance Training in improving Balance and Gait in Parkinson's disease patients.

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