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Comparative Effect of Augmented Reality and Routine Physical Therapy on Balance and Postural Control in Patients with Parkinson's disease

Akasha Ahmad[1], Mehwish Saghir[2], Iqra Shafiq[3], Taliah Bashir[4], Saman Arshad[5], Usama Ahmad Khan[6]

[1, 3-6] Student, university of Lahore, Lahore, Pakistan

[2] Assistant Professor, University of Lahore, Lahore, Pakistan

Author`s Contribution

[2]Conception and design, [3]Collection and assembly of data, [1,2,,3]Analysis and interpretation of the data, Statistical expertise, drafting of article, [4]Critical revision of the article for important intellectual content, [2]Final approval and guarantor of the article.

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Address of Correspondence

Akasha Ahmad

akahmad375@gmail.com

ORCID: 0009-0001-5268-5254

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A B S T R A C T

Background: Parkinson's disease is a neurodegenerative condition that often manifests in old age with generalized slowness of movements (bradykinesia) and a minimum of one additional symptom of tremor at rest or stiffness.

Objective: The purpose is to compare the effects of Augmented Reality and Routine Physical Therapy on balance and Postural Control in Patients with Parkinson's disease.

Methodology: It was a randomized clinical trial done in the Neuro medicine and physiotherapy department of Allied Hospital, Faisalabad. A sample size of 62 patients was divided into two equal groups. Patients in Group A had conventional physiotherapy, while those in Group B received augmented reality and conventional physiotherapy. Non probability sampling technique was used. Data was collected on the baseline and then data was collected after 8th weeks, and final data was collected after 12th weeks. Tools for collection of data were the Berg balance scale, timed up and go, and one leg stance test.

Results: An Independent sample t-test was used to check the difference between groups in pre and post intervention which shows the statistical difference in both groups after the 8th and 12th weeks of treatment. However, mean differences show that group B has more good results. Repeated measure analysis of variance also shows that there is a significant difference between treatment groups in the within-group analysis.

Conclusion: Our study concludes that an augmented reality regimen along with physiotherapy is beneficial for Parkinson's patients to improve balance and postural control.

Key words: Augmented reality, Balance, Posture, Parkinsonism, Postural Equilibrium, Lewy Body Parkinson Disease.

Introduction

Parkinson's disease, also known as PD, is a progressive neurodegenerative condition that frequently appears in old age with widespread slowness of movement (bradykinesia) and at least one additional symptom of tremor at rest or stiffness. It is the world's second most prevalent degenerative problem, Alzheimer's.[1, 2] PD has four key characteristics. Stiffening of the muscles happens when a muscle in the arms as well as the hands, the legs, and the jaw relaxes for a prolonged period. Motion is sluggish. Poor coordination and balance can lead to accidents. [3] Exercise regularly can assist in reducing tension in the muscles in the body. Regular physical activity may boost self-esteem and help you cope with the challenges of everyday life. Regular exercise assists entities with PD to have a milder, less progressive illness progression.[4]

In today's world, novel technologies are rapidly appearing to simplify, optimize, and perfect a few of the tasks we do daily. Amongst these is augmented reality (AR) which involves producing fresh visuals from digital data in an individual's real surroundings, thereby mimicking an environment in which both digital and genuine are blended. AR needs to be distinguished from virtual reality, also known as VR, which introduces extra data that includes music, text, or video, resulting in multimedia virtual worlds.[5] AR is inspired by VR, but it combines virtual and

actual surroundings, boosting engagement with the real world. AR is now being utilized in a variety of sectors, including medicine, psychology, and physical therapy sessions It has mostly been created in therapy for motor and mental rehabilitation, so it is regarded as a novel way of treating PD. Augmented reality rehab may be utilized as a functioning contrivance and to supplement physiotherapy treatment since it creates safe situations that can be comparable to the individual's real environment. Because AR offers better alignment of the exercises towards targets with increased encouragement from patients and is fun to use, rehabilitation with AR has demonstrated better outcomes than repetitive motions practiced independently. [6]

Augmented reality (AR) technologies offer several important advantages: they deliver novel experiences for individuals throughout physical therapy sessions, enhancing participation and improving tangible results; they may generate intriguing possibilities for inexpensive physiotherapy at home; and the physical therapist may execute assessments of various results using these instruments along with the analysis of data.[7] Despite the fact that the shortcomings are due to a lack of scientific maturation and instrument availability, different kinds of user interfaces have emerged to guarantee user engagement through the augmented reality rehab background, such as portable smart measuring devices, intelligent detectors built into the surroundings, and handheld maneuvers that improve being accessible to this type of technology. Not with standing these potential advantages, there has been little research on AR in physical therapy, as opposed to VR, which has been investigated in a wider range of diseases, largely neurological, including stroke, intellectual disabilities, multiple sclerosis, Parkinson's condition, injury to the spinal cord, and chronic joint pain. [8, 9]

Augmented reality enables digital devices to overlay computer-generated images over a live image from the device's camera. Augmented reality is beneficial in the management of postural issues in PD in providing environmental mapping for visually impaired people. Augmented reality can be used to direct patients through rehabilitation exercises or follow those who have home-based therapy. Augmented reality will be implemented in rehabilitation and neurology settings for Parkinson's disease patients, where it has allowed people with mobility impairments to engage in activities of daily living, training programs, and skill acquisition. In this way, it can be a novel approach where clinicians and patients may have real-time feedback regarding their improvements. It will reduce the overall supervised treatment time with more accurate movement pattern generation, on which rehabilitation will become easier. It can be a great contribution to patients, families, and the overall community. The purpose of the study is to compare the effects of Augmented Reality and Routine Physical Therapy on balance and Postural Control in Patients with Parkinson's disease.

Methodology

A randomized Control Trial was conducted at Department of Neuromedicine and Physiotherapy department of Allied Hospital Faisalabad after the approval from ethical committee of university of Lahore (Ref: REC-UOL-351-04-2023). The sample size was 62 which is 31 allocated in each group by non-probability Purposive sampling technique and it is calculated by open Epi-tool. [10]

Parkinson sufferers ranging in age from 55 to 85 years of age were recruited. [10], Males and females were both recruited, Parkinson's individuals who had not participated in stability or gait training in the six months prior to the study's start were enrolled in the study, and individuals who have unresolved medical issues (e.g., knee arthritis) that might impair balance and walking performance have been included in the study.[11]

Those with depression that remains untreated or substantial visual/auditory impairments weren't eligible, Patients who had previous instances of other neurological, cardiovascular, or orthopedic illnesses that affected the stability of their posture were eliminated, and all individuals who had pacemakers or previous experience of a major cardiac event or respiratory failure were excluded from the trial, Parkinson patients with persistent respiratory disorders such as COPD, pneumonia, or cancer of the lungs were not eligible, Patients who have severe mental retardation or aphasia, making speech challenging and Participants who refused to follow the procedure were eliminated.

It included multi-directional and recurrent range of motion and static exercises of the trunk and lower extremity muscle extends with three sixty second stretches each, as well as strengthening exercises with two bouts of ten repetitions, four sessions per week's work, and one session of one fifty minutes depending on the patient's choice of days and time.[10]

The Microsoft HoloLens 2 augmented reality headset was used to deliver multimodal training. Augmented reality enables the user to interact with the real world while also inserting holograms within it. For instance, the user may see boxes on the surface of the earth that they must walk around. The boxes are holograms that only the user has access to. In the classic multi-modal training group, the augmented reality gadget will teach the participant about the motor and cognitive tasks that ought to be completed concurrently in the same manner as the

physical therapist. The physical therapist supervised the intervention. [10]

Results

The demographic characteristics of participants in both Group A and Group B were comparable, as shown in Table I.

Table I: Descriptive statistics of demographics in both groups.

Age				
Groups	N	Minimum	Maximum	Mean±S.D
Group A	31	54.0	78.0	64.00±6.56
Group B	31	55.0	78.0	65.08±6.01
Gender				
			Frequency	Percentage
Group A	Male		21	67.7%
	Female		10	32.3%
Group B	Male		22	71.0%
	Female		9	29.0%
Comorbidities				
			Frequency	Percentage
Group A	HTN		8	25.8%
	DM		7	22.6%
	Both		16	51.6%
Group B	HTN		10	32.3%
	DM		6	19.4%
	Both		15	48.4%

The mean age in Group A was 64.00 years (±6.56), while in Group B, it was 65.08 years (±6.01). Gender distribution revealed a slight predominance of males in both groups, with 67.7% in Group A and 71.0% in Group B. Regarding comorbidities, hypertension (HTN) and diabetes mellitus (DM) were prevalent, with 51.6% of participants in Group A having both conditions, compared to 48.4% in Group B. Table II presents the outcomes of the independent sample t-tests for Timed Up and Go (TUG), One Leg Stance (OLST), and Berg Balance Scale (BBS).

Table II: Independent Sample t-test for Timed Up and Go, One Leg Stance, and Berg Balance Scale

	Study Groups (TUG)		
TUG	**Group A**	**Group B**	**P-value**
Baseline	24.51±3.00	24.19±3.44	0.696
At 8th week	19.32±2.76	15.83±.2.84	0.000
At 16th week	14.58±2.98	9.06±1.71	0.000
	Study Groups (OLST)		
OLST	**Group A**	**Group B**	**P-value**
Baseline	35.45±8.02	34.48±8.97	0.656
At 8th week	26.90±5.93	29.87±.6.69	0.073
At 16th week	20.74±4.87	16.41±4.71	0.001
	Study Groups (BBS)		
BBS	**Group A**	**Group B**	**P-value**
Baseline	21.29±5.56	21.48±5.25	0.888
At 8th week	25.90±5.09	37.16±6.76	0.000
At 16th week	38.93±5.37	52.97±2.60	0.000

Table III: Repeated Measure ANOVA for TUG, OLST, BBS

TUG					
Multivariate effects /TUG and groups	Value	F	Hypothesis df	Error df	sig
Pillai's trace	0.48	24.972	2.000	59.000	0.00
Wilks lambda	0.54	24.972	2.000	59.000	0.00
Hotelling's trace	0.84	24.972	2.000	59.000	0.00
Roy's largest root	0.84	24.972	2.000	59.000	0.00
OLST					
Multivariate effects /OLS and groups	Value	F	Hypothesis df	Error df	sig
Pillai's trace	0.32	14.236	2.000	59.000	0.00
Wilks lambda	0.67	14.236	2.000	59.000	0.00
Hotelling's trace	0.48	14.236	2.000	59.000	0.00
Roy's largest root	0.48	14.236	2.000	59.000	0.00
BBS					
Multivariate effects /BBS and groups	Value	F	Hypothesis df	Error df	sig
Pillai's trace	0.81	129.777	2.000	59.000	0.00
Wilks lambda	0.18	129.777	2.000	59.000	0.00
Hotelling's trace	4.39	129.777	2.000	59.000	0.00
Roy's largest root	4.39	129.777	2.000	59.000	0.00
TEST OF BETWEEN-SUBJECTS EFFECTS					
TUG					
Source	**f**	**Df**	**Mean square**	**Type III sum of square**	**Sig**
Groups	24.40	1	449.038	449.038	0.000
OLST					
Source	**f**	**Df**	**Mean square**	**Type III sum of square**	**Sig**
Groups	0.38	1	28.651	28.651	0.000
Groups	20.94	1	178.935	449.038	0.000

Significant improvements were observed in TUG, OLST, and BBS scores in both groups over the 16-week intervention period, with Group B demonstrating consistently superior outcomes compared to Group A. Repeated Measure ANOVA in Table III further supports these findings, indicating significant multivariate effects for TUG, OLST, and BBS scores between the groups ($p < 0.05$). Additionally, the test of between-subjects effects revealed significant differences in TUG and OLST scores between the groups ($p < 0.05$), highlighting the efficacy of the intervention in enhancing mobility and balance among participants.

Discussion

Evaluation of the immediate impact on postural control (PC) and executive function (EF) in people with Parkinson's disease (PD) of augmented reality (AR), virtual reality (VR), and Neurofunction physiotherapy (NPT). For 50 minutes each, 40

healthy volunteers in mild-to-moderate stages of Parkinson's disease (PD) who had no cognitive impairment had 1 period of NPT, 1 period of AR, and 1 period of VR. PC was assessed using a force platform in bipedal positions, including tandem with eyes open (EO), tandem with eyes closed (EC), and with a double-task and one-legged stance, both before and after each session. With the Trail Making Test (TMT), EF was evaluated. After the three modalities, PC got better. The modalities were identical to one another. The PC and EF of PD subject patients were improved by the three treatment regimens. Additionally, for both outcomes in these patients, AR and VR produced immediate effects that were comparable to NPT.[12] In this study, demonstrate the comparative effect of augmented reality and routine physical therapy on balance and postural control in patients with PD. Took Sixty-two participants for this study and divided them into two groups. Evaluate the effect by using these three tests: Timed-up-and-go (TUG), One Leg Stance test, and Berg Balance Scale (BBS) at baseline, in the 8th week, and 16th week.

Augmented reality (AR)-based therapies can improve balance, positional sense, and flexibility comparable with physical therapy (PT). 39 willing volunteers from the general public were allocated into two groups at random. Following that, PT was functional in the baseline group and AR in the experimental group. Tetrax was used to assess static balance, the Y-balancing test to assess dynamic balance, the CSMI to assess proprioception, and the sit-and-reach test to assess flexibility. All measurements were examined using the independent and paired t-tests. As a result, AR can be regarded as a successful therapy modality and can be chosen by unique situations.[13] In this, study, investigate the comparative effect of augmented reality and routine physical therapy on balance and postural control in patients with Parkinson's disease. Took Sixty-two participants for this study and divided them into two groups. Group A, performed augmented reality therapy with physical therapy, and Group B, performed only conventional physical therapy. Evaluate the effect by using these three tests: Timed-up-and-go (TUG), One Leg Stance test, and Berg Balance Scale (BBS) at baseline, in the 8th week, and the 16th week. All measurements were analyzed using an independent t-test and repeated measure ANOVA.

This study investigates the comparative effect of augmented reality and routine physical therapy on balance and postural control in patients with PD. Took Sixty-two participants for this study with age group 54 to 78 years and divided them into two groups. Group A, performed augmented reality therapy with physical therapy, and Group B, performed only conventional physical therapy. Evaluate the effect by using these three tests: Timed-up-and-go (TUG), One Leg Stance test, and Berg Balance Scale (BBS) at baseline, in the 8th week, and in the 16th week. The results show that augmented reality therapy with a physical therapy group is more effective for Parkinson's patients.

Kashif et.al demonstrates the Equilibrium, mobility, and ADLs in PD patients: combined effects of Virtual reality besides Motor imagery methods. Idiopathic PD was present in a total of 44 individuals. Physical therapy (PT) was administered to both groups, with the investigational group (N: 20) additionally receiving Virtual reality besides Motor imagery. For 12 weeks, on alternating days, each group received the prescribed treatment for three days each week. The Unified Parkinson's Disease Rating Scale (UPDRS), Berg Balance Scale (BBS), and Activities-specific Balance Confidence (ABC) Scale were used as results assessment for mobility, equilibrium, and Activity of daily living. The first, sixth, and twelfth weeks of treatment were evaluated. VR by MI methods combined with regular Physiotherapy considerably enhanced mobility, equilibrium, and Activity of daily living in Parkinson's disease sufferer associated to Physiotherapy.[14] In this study, check the comparative effect of augmented reality and routine physical therapy on balance and postural control in sufferers with PD. Took Sixty-two participants for this learning and distributed them into 2 groups. Group A, performed augmented reality therapy with physical therapy and group B, performed only conventional physical therapy. Where evaluate the effect by using these three tests: Timed-up-and-go (TUG), One Leg Stance test, and Berg Balance Scale (BBS) at baseline, at the 8th week and at 16th week. The results shows that augmented reality therapy with physical therapy group are more effective for Parkinson's patients than only conventional physical therapy.

Conclusion

Our investigation concluded that both approaches to treatment were enforceable for Parkinson's disease patients in terms of balance and postural control, but the augmented reality protocol combined with physical therapy produced a significantly greater result than the simple physical therapy plan. This rehabilitative program ought to be included in standard clinical practice in Pakistan to produce better and earlier outcomes, and it can also impact improved posture management and balance.

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