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RESEARCH ARTICLE

Effectiveness of Virtual Reality-Based Physiotherapy in Enhancing Balance and Mobility Among Post-Stroke Patients

Sri Valli Chekuri[1]*, Dr. V.V. Manjula Kumari[2], Dr. Kanchan Kholiya[3]

[1]*Physiotherapist and International Research Coordinator, Varanaa's Healthcare Research and Training Organization LLP, Nellore, Andhra Pradesh, India
[2]CEO and Senior Consultant Physiotherapist, Varanaa's Healthcare Research and Training Organization LLP, Nellore, Andhra Pradesh, India.
[3]Associate Professor, Mahaveer University, Moradabad, Uttar Pradesh, India.

*Corresponding Author
Dr. Sri Valli Chekuri

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Abstract:

Aim: The goal of this study was to see how well virtual reality (VR) physiotherapy worked to help post-stroke patients improve their balance and mobility. A comparison was made between VR rehabilitation and traditional physiotherapy. The goal was to find out if VR therapy leads to better functional outcomes. ***Methodology***: A randomised controlled trial was performed involving 60 post- stroke patients aged 40 to 75 years. The participants were randomly divided into two groups: a VR group with 30 people and a control group with 30 people. At the start and after six weeks, we looked at balance (BBS, FRT) and mobility (TUG, 10MWT). ***Results***: Fifty-six patients finished the trial, with 28 in the VR group and 28 in the Control group. The VR group had much bigger improvements in balance than the control group (BBS +10.6, FRT +7.7 cm vs. BBS +5.2, FRT +3.3 cm). Mobility outcomes also favoured VR, with bigger drops in TUG (–6.2 s vs –2.6 s) and 10MWT (–6.5 s vs –2.9 s) times. ***Conclusion:*** Virtual reality-based physiotherapy was more effective than traditional physiotherapy in improving balance and mobility in post-stroke patients. The results back up the idea of using VR as an extra tool in stroke rehabilitation programs. It is advisable to conduct additional large-scale trials to confirm these findings

Keywords: Virtual reality, Physiotherapy, Stroke rehabilitation, Balance, Mobility.

INTRODUCTION

Stroke is a leading cause of long-term disability worldwide, often resulting in motor, sensory, and cognitive impairments that reduce independence and quality of life. Among these, balance and mobility deficits are particularly disabling, as they increase fall risk and slow functional recovery. Conventional physiotherapy—focused on task-specific training, strength exercises, and gait rehabilitation—has long been the standard of care. However, many patients experience plateaued improvements, highlighting the need for novel strategies that enhance motivation and neuroplasticity.

Virtual reality (VR) has emerged as a promising adjunct to stroke rehabilitation, offering immersive, interactive environments that replicate real-life tasks while providing immediate feedback. VR enables task-oriented, repetitive practice essential for motor relearning, while its game-like features boost patient engagement and adherence (Laver et al., 2017) [1]. Growing evidence supports its effectiveness: Saposnik et al. (2010) [2] demonstrated improved motor function and balance with Wii™-based therapy; Bower et al. (2014) [3] reported gains in walking speed and balance; and Karasu et al. (2018) [4] confirmed benefits in postural control and mobility. Advances from non-immersive consoles to semi- and fully immersive systems further enhance rehabilitation experiences, improving sensorimotor integration and cortical reorganization (Thielbar et al., 2020) [5]. Meta-analyses also confirm significant benefits of VR for motor, balance, and mobility outcomes (Shen et al., 2023) [6], while personalized approaches improve clinical applicability (Demeco et al., 2023) [7].Given this growing evidence, the present study evaluates the efficacy of VR-based physiotherapy versus traditional physiotherapy, focusing on functional outcomes including the Berg Balance Scale, Functional Reach Test, Timed Up and Go Test, and 10-Meter Walk Test.

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Methodology

This randomised controlled trial involved 60 post-stroke patients (3–12 months post-stroke, aged 40–75 years) with their first ischaemic or hemorrhagic stroke, an MMSE score exceeding 24, and the capacity to stand independently for a minimum of one minute. Patients exhibiting significant sensory deficits, comorbidities impairing mobility, epilepsy, or uncontrolled cardiovascular disease were excluded.

There were two groups of 30 people each, and they were chosen at random. The experimental group underwent VR-based physiotherapy (utilising Nintendo Wii™, Kinect, or head-mounted VR systems) that included balance and gait exercises for 45 minutes per day, five days a week, over a duration of six weeks. The control group received conventional physiotherapy of equivalent duration, incorporating task-specific exercises, gait training, and balance board activities.The results were looked at at the beginning (T0) and again after six weeks (T1). The Berg Balance Scale (BBS)

and Functional Reach Test (FRT) were used to measure balance, and the Timed Up and Go Test (TUG) and 10-Meter Walk Test (10MWT) were used to measure mobility. The data were analysed using descriptive statistics, paired t-tests for intra-group variations, and independent t-tests for inter-group disparities, with significance established at $p < 0.05$. The protocol is consistent with earlier VR-based stroke rehabilitation research (Saposnik et al., 2010; Bower et al., 2014; Karasu et al., 2018; Shen et al., 2023; Demeco et al., 2023)..

RESULTS AND OBSERVATIONS:

Out of the 60 participants initially recruited, 56 patients completed the trial (VR group = 28, Control group = 28), yielding a dropout rate of 6.7%. Baseline demographic and clinical characteristics were comparable between groups with no statistically significant differences ($p > 0.05$). Balance outcomes, as shown in Table 1, indicated that participants in the VR group achieved a mean increase of 10.6 points on the Berg Balance Scale (BBS) (from 38.6 ± 5.2 at baseline to 49.2 ± 4.7 post-intervention), which was highly significant both within the group ($p < 0.001$) and compared to the control group ($p < 0.01$). The control group also improved, with a mean change of +5.2 points ($p = 0.01$), though the gains were less pronounced. Similarly, in the Functional Reach Test (FRT), the VR group improved by 7.7 cm (from 18.4 ± 4.3 to 26.1 ± 4.8, $p < 0.001$), while the control group gained 3.3 cm ($p = 0.02$), with between-group differences favoring VR ($p < 0.05$). Mobility outcomes are summarized in Table 2, where the VR group showed a 6.2-second reduction in Timed Up and Go (TUG) scores (from 18.6 ± 3.7 to 12.4 ± 2.9, $p < 0.001$), compared to a 2.6-second reduction in the control group ($p = 0.03$), with significantly greater gains in the VR group ($p < 0.01$). In the 10-Meter Walk Test (10MWT), the VR group achieved a mean reduction of 6.5 seconds (from 21.1 ± 5.4 to 14.6 ± 3.8, $p < 0.001$), compared with 2.9 seconds in the control group ($p = 0.04$), again showing superior improvement in the VR group ($p < 0.05$). Collectively, these results demonstrate that VR-based physiotherapy significantly enhances both balance and mobility in post-stroke patients compared with conventional physiotherapy (Tables 1 and 2).

Table 1. Effect of VR-Based Physiotherapy on Balance Outcomes (BBS, FRT)

Outcome Measure	Group	Baseline (Mean ± SD)	Post-Intervention (Mean ± SD)	Mean Change	*p* (within)	*p* (between)
Berg Balance Scale (BBS)	VR	38.6 ± 5.2	49.2 ± 4.7	+10.6	<0.001	<0.01
	Control	39.1 ± 5.0	44.3 ± 5.1	+5.2	0.01	
Functional Reach Test (cm)	VR	18.4 ± 4.3	26.1 ± 4.8	+7.7	<0.001	<0.05
	Control	17.9 ± 4.6	21.2 ± 4.5	+3.3	0.02	

Table 1 shows that the VR group achieved significantly greater improvements in balance compared to the control group, particularly in BBS scores ($p < 0.01$).

Table 2. Effect of VR-Based Physiotherapy on Mobility Outcomes (TUG, 10MWT)

Outcome Measure	Group	Baseline (Mean ± SD)	Post-Intervention (Mean ± SD)	Mean Change	*p* (within)	*p* (between)
Timed Up & Go (sec)	VR	18.6 ± 3.7	12.4 ± 2.9	–6.2	<0.001	<0.01
	Control	18.3 ± 3.9	15.7 ± 3.2	–2.6	0.03	
10-Meter Walk Test (sec)	VR	21.1 ± 5.4	14.6 ± 3.8	–6.5	<0.001	<0.05
	Control	20.8 ± 5.7	17.9 ± 4.2	–2.9	0.04	

Table 2 demonstrates that VR-based physiotherapy led to significantly greater improvements in mobility outcomes (TUG and 10MWT) than conventional therapy ($p < 0.05$).

DISCUSSION

This randomised controlled trial demonstrated that VR-based physiotherapy markedly enhanced balance and mobility relative to conventional therapy in post-stroke patients. These findings are consistent with previous literature supporting VR as an effective adjunct in neurorehabilitation. Garay-Sánchez et al. (2023) [8] and Patsaki et al. (2022) [9] assert that VR's task-specific, repetitive, and gamified environments enhance neuroplasticity and elevate patient engagement.

Meta-analytic evidence corroborates these benefits. Yoo et al. (2025) [10] confirmed the positive impact of virtual reality (VR) on upper and lower limb functions, while Wang et al. (2024) [11] demonstrated VR's

effectiveness in telerehabilitation, improving accessibility and long-term adherence. Bargeri et al. (2023) [12] also said that VR can be used for personalised training because it can help with balance, walking speed, and motor skills. Prior studies, such as Mekki et al. (2015) [13], validate the effectiveness of virtual reality in improving gait and balance recovery when combined with conventional approaches.

Along with improving motor outcomes, VR interventions may also improve mental health. Bonanno et al. (2025) [14] and Han et al. (2025) [15] noted improvements in motivation, satisfaction, and quality of life, which likely promote adherence and functional recovery. Consistent with these findings, Mugisha et al. (2022) [16] demonstrated enhancements in mobility and autonomy through the incorporation of virtual reality into multidisciplinary rehabilitation. Overall, our trial and other studies [8–16] demonstrate that VR-based physiotherapy not only enhances balance and mobility but also addresses issues associated with traditional rehabilitation, such as reduced patient engagement and adherence. However, there are still questions about how long these benefits will last, what the long-term effects will be, and how easy it will be to get to them in places with few resources.

In conclusion, VR is a useful and interesting way to help people recover from strokes, and it could work well with other therapies that are already available. Future research should investigate long-term effects, cost-effectiveness, and broader clinical applicability.

CONCLUSION

Virtual reality–based physiotherapy significantly improved balance and mobility compared to conventional physiotherapy in post-stroke patients. The VR group achieved superior outcomes in both BBS and FRT scores as well as TUG and 10MWT performance. These findings highlight VR as an effective adjunctive tool for stroke rehabilitation. Larger multicenter studies are needed to confirm long-term benefits and clinical applicability

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