Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 2s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Feasibility and Safety of Virtual Reality as a Tool for Coordination Training in Traumatic Brain Injury: A Pilot Study

Rinshum Vyas[*1], Dr. Deepak Lohar[2], Dr. Jafar Khan[3], Dr. Deepika Balala[4], Dr. Shubham Menria[5], Dr. Richa Hirendra Rai[6], Dr. Renuka Pal[7], Dr. Bhavini Gurjar[8], Dr. Shilpi Kapoor[9], Dr. Deepak Sharma[10]

[*1]Research Scholar MPT, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[2]Associate Professor, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[3]Dean And HOD, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[4]Assistant Professor, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[5]Assitant Professor, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[6]Professor, School of Physiotherapy, Delhi Pharmaceutical Sciences and Research University, New Delhi, India
[7]Associate Professor, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[8]MPT Scholar, Pacific College of Physiotherapy, Pacific Medical University, Udaipur, Rajasthan, India
[9]Principal, BIMR College Of Professional Studies, Gwalior, MP
[10]Consultant Senior Physiotherapist, Saint Terrasa Hospital, Udaipur, Rajasthan, India

***Corresponding Author:**
Rinshum Vyas
Email id: dr.rinshumvyas888@gmail.com

Cite this paper as: Rinshum Vyas, Dr. Deepak Lohar, Dr. Jafar Khan, Dr. Deepika Balala, Dr. Shubham Menria, Dr. Richa Hirendra Rai, Dr. Renuka Pal, Dr. Bhavini Gurjar, Dr. Shilpi Kapoor, Dr. Deepak Sharma, (2025) Feasibility and Safety of Virtual Reality as a Tool for Coordination Training in Traumatic Brain Injury: A Pilot Study. *Journal of Neonatal Surgery*, 14 (2s), 613-615.

ABSTRACT

Background: Traumatic Brain Injury (TBI) impairs coordination and balance. Virtual Reality (VR) is emerging as a promising modality for enhancing motor learning through interactive and immersive training. This study investigates the feasibility, safety, and efficacy of VR in coordination training in patients with TBI.

Methods: Sixty patients with moderate TBI were randomly allocated to traditional rehabilitation (Group A) or VR-based coordination therapy (Group B) over 24 weeks. Four outcome measures—Barthel Index (BI), Berg Balance Scale (BBS), Functional Reach Test (FRT), and Five Times Sit to Stand Test (FTSST)—were evaluated. Comparative statistics were derived using paired and independent t-tests.

Results: VR therapy yielded superior improvements in coordination and balance outcomes, with no adverse effects. Group B achieved significantly better scores than Group A across all measures.

Conclusion: VR-based rehabilitation is a feasible, safe, and more effective alternative to traditional therapy for coordination training in TBI patients.

1. INTRODUCTION

Traumatic Brain Injury (TBI) remains one of the leading causes of long-term disability in both developing and developed countries. It affects millions of people worldwide and often results in complex neurological impairments that extend beyond the initial trauma. Among these, impairments in balance, postural control, and coordination are especially debilitating. These motor control deficits hinder patients' ability to perform activities of daily living (ADLs), increase the risk of falls, and reduce overall quality of life.

TBI can result in diffuse or focal damage to cortical and subcortical areas, including the cerebellum and basal ganglia, which are crucial for motor coordination. Traditional rehabilitation methods have been moderately successful in addressing these issues through repetitive physical exercises and neuromuscular re-education techniques. However, traditional approaches are

often time-consuming, resource-intensive, and monotonous, leading to reduced patient compliance and motivation over time. Virtual Reality (VR) offers a modern solution to these limitations. VR-based rehabilitation presents task-oriented exercises in an immersive and engaging format. Through the simulation of real-world tasks in a controlled, interactive virtual environment, VR enhances neuroplasticity by facilitating multisensory feedback, attentional engagement, and repetitive training. This can lead to more rapid and comprehensive motor relearning compared to conventional therapy. Emerging research has begun to highlight the potential benefits of VR for stroke, Parkinson's disease, and post-operative orthopedic patients. However, the application of VR in the domain of TBI—especially for coordination training—remains relatively underexplored. Considering the high demand for more effective and patient-centered rehabilitation strategies, there is a pressing need to evaluate the feasibility and effectiveness of VR in improving coordination post-TBI. This study is designed to assess whether VR-based rehabilitation can be a safe and efficient method to improve coordination, balance, and functional performance in patients with moderate TBI. Additionally, this pilot study aims to compare VR training to traditional physiotherapy and measure improvements through standardized outcome measures. By contributing to the growing body of evidence, this work intends to guide future large-scale trials and inform clinical decision-making.

2. METHODOLOGY

Study Design: Randomized Controlled Trial (RCT).

Setting: Physiotherapy Department, Pacific Medical College and Hospital, Udaipur

Participants:

Inclusion: Adults 18–65 years with TBI (MMT ≥ grade 3)

Exclusion: Visual, vestibular, cognitive deficits, or prior VR exposure

Sample Size: 60 patients

Intervention Duration: 24 weeks, 3 sessions/week, 45 minutes/session

Group A (Traditional): PNF techniques, balance board, mirror therapy

Group B (VR): Immersive virtual tasks targeting trunk control, upper-limb coordination, and postural stability Assessment Tools:

1. **Barthel Index** (BI) – Functional independence
2. **Berg Balance Scale** (BBS) – Balance proficiency
3. **Functional Reach Test** (FRT) – Anterior stability
4. **Five Times Sit to Stand Test** (FTSST) – Dynamic lower limb control

Statistical Analysis: SPSS v26. Significance set at $p<0.05$

3. RESULTS

Baseline Characteristics

Characteristic	Group A (n=30)	Group B (n=30)	p-value
Mean Age (years)	36.2 ± 11.3	37.5 ± 12.6	0.712
Gender (M/F)	18/12	19/11	0.793
Mean BI	49.6 ± 8.5	50.3 ± 9.1	0.688
Mean BBS	34.2 ± 4.1	33.9 ± 4.6	0.815

Post-intervention Outcome Comparison

Outcome Measure	Group A (Traditional)	Group B (VR)	p-value
BI (Mean ± SD)	+8.2 ± 1.8	+11.1 ± 2.1	<0.001
BBS (Mean ± SD)	+6.9 ± 2.6	+9.7 ± 2.4	0.002
FRT (Mean ± SD)	+4.1 ± 1.4	+6.4 ± 1.3	0.001
FTSST (Mean ± SD)	–3.3 ± 1.5	–5.6 ± 1.2	<0.001

Within-Group Improvements

Measure	Group A: Pre	Group A: Post	p-value	Group B: Pre	Group B: Post	p-value
BI	49.6	57.8	<0.001	50.3	61.4	<0.001
BBS	34.2	41.1	<0.001	33.9	43.6	<0.001
FRT (cm)	20.7	24.8	0.004	21.2	27.6	<0.001
FTSST (sec)	16.3	13.0	0.002	15.9	10.3	<0.001

Safety: No adverse events (nausea, dizziness, disorientation) were reported. All patients completed the program.

4. DISCUSSION

This study highlights that VR-based therapy yields greater improvements in coordination and functional independence compared to traditional rehabilitation in TBI. VR offers dynamic, adaptive feedback, which likely enhances motivation and motor learning. FRT and FTSST gains suggest superior control of core and lower limbs in the VR group. Additionally, real-time feedback may accelerate balance adaptation and proprioceptive recalibration. The results align with VR research in stroke and Parkinson's but are unique in their focus on coordination-specific recovery in TBI—a relatively underrepresented field in neurorehabilitation literature. Limitations include a relatively small sample size and lack of long-term follow-up. Future research should aim at larger multicentric trials with diverse age groups and follow-up to assess the sustained benefits of VR therapy.

5. CONCLUSION

VR-based coordination training is a feasible, safe, and more effective modality than traditional rehabilitation for enhancing postural control and ADL performance in TBI patients. This pilot study warrants larger, multi-center trials.

REFERENCES

[1] Laver KE et al. Virtual reality for stroke rehabilitation. Cochrane Database Syst Rev. 2017.
[2] Sveistrup H. Motor rehabilitation using VR. J NeuroEng Rehabil. 2004;1:10.
[3] Gil-Gómez JA et al. Wii-based balance therapy for acquired brain injury. J NeuroEng Rehabil. 2011;8:30.
[4] Mirelman A et al. Gait training in VR for older adults. Stroke. 2010;41:169–74.
[5] Fung V et al. Use of Wii Fit in orthopedic rehab. Physiotherapy. 2012;98(3):183–8.
[6] Saposnik G et al. Effectiveness of VR in stroke rehab. Stroke. 2011;42:1380–86.
[7] Rizzo A, Koenig S. Clinical virtual reality. Neuropsychology. 2017;31(8):877–99
[8] Choi SD et al. VR for fall prevention in elderly. Appl Ergon. 2017;65:570–81.
[9] Maier M et al. Principles of VR neurorehab. Front Syst Neurosci. 2019;13:74.
[10] Cameirão MS et al. The Rehabilitation Gaming System. J NeuroEng Rehabil. 2010;7:48.
[11] Howard MC. Meta-analysis of VR rehab. Comput Human Behav. 2017;70:317–27.
[12] Schultheis MT, Rizzo AA. Applications of VR in rehab psychology. Rehabil Psychol. 2001;46:296–311.
[13] Reid DT. Effects of VR on children with CP. Occup Ther Int. 2004;11(3):131–44.
[14] Lohse KR et al. VR in physical rehab: meta-review. PLoS One. 2014;9(3):e93318.
[15] Weiss PL, Katz N. The potential of VR for rehabilitation. J Rehabil Res Dev. 2004;41(6A):15–25.