IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

ENHANCING LOWER LIMB FUNCTION IN NEUROMYELITIS OPTICA SPECTRUM DISORDER THROUGH VIRTUAL REALITY - A CASE STUDY

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ABSTRACT: *Background: A uncommon autoimmune disease called neuromyelitis Optica spectrum disorder (NMOSD) affects the central nervous system, mainly the spinal cord and optic nerves. Spinal cord involvement frequently results in motor deficits, particularly in the lower limbs, which cause severe functional disability. In order to regain movement and freedom, physiotherapy is essential. With immersive, task-specific training that improves patient engagement and motor recovery, virtual reality (VR) has become a cutting-edge supplement to traditional rehabilitation in recent years.*

OBJECTIVES: *A 40-year-old man with NMOSD presented with bilateral lower limb weakness, decreased balance, and trouble walking. The patient participated in an 8-week physical therapy rehabilitation program that combined VR-based gait and balance training with traditional neurophysiotherapy. In a gamified setting, VR sessions concentrated on dynamic balancing tasks, visual-motor integration, and lower limb movement coordination.*

METHODS*: Pre- and post-intervention assessments using the Berg Balance Scale (BBS), 10-Meter Walk Test (10MWT), and Functional Independence Measure (FIM) revealed marked improvements. BBS improved from 28 to 45, 10MWT time Decreased from 18.5 to 12.4 seconds, and FIM scores showed enhanced independence in mobility and ambulation. The patient also reported increased confidence and motivation due to the interactive nature of VR therapy.*

CONCLUSION*: For case with NMOSD, this instance demonstrates the possible advantages of using virtual reality into physical treatment. In particular, for those with spinal cord involvement, VR-based neurorehabilitation presents a viable, entertaining method to enhance lower limb function, walking, and balance.*

Key Words: *Virtual reality (VR), neuromyelitis Optica spectrum disorder (NMOSD), Berg Balance Scale (BBS), 10-Meter Walk Test (10MWT), and Functional Independence Measure (FIM)*

1.INTRODUCTION:

Neuromyelitis Optica spectrum disorder (NMOSD), commonly referred to as Devic syndrome, is a myelinating illness of the central nervous system that includes both optic neuritis and myelitis. (1) Neuromyelitis Optica spectrum disorder (NMOSD) is an inflammatory disease marked by recurrent flare-ups and remissions of transverse myelitis and severe optic neuritis. (1) It would be incorrect to classify these clinical signs as multiple sclerosis (MS). Winger Chuk et al.'s 2006. (2) The research, which reported an excellent 99% sensitivity and 90% specificity, provided the criteria to diagnose the condition. NMO is characterized by optic neuritis and myelitis, and at least two of the three diagnostic criteria—longitudinally extensive cord lesion, magnetic resonance imaging that is not indicative of multiple sclerosis, and NMO-IgG seropositivity—must be met. (2,3) Often, transverse myelitis causes a flaccid paralysis along the inflammatory region. One method for treating NMOSD is physical therapy. Physical treatment for NMOSD, however, has been the subject of very few reports. (4,5) Virtual reality neurorehabilitation has not been the subject of any published research. This article describes a patient with NMOSD who was treated using Novel physical therapy techniques.

2.NOVEL APPROACHES:

For NMOSD patient to maximize function and quality of life, especially during a recurrence, rehabilitation is essential. The goals of physiotherapy are to increase balance, strength, and mobility. However, it may be difficult for conventional approaches to keep patients motivated and involved. With its immersive, interactive, and task-specific teaching capabilities, virtual reality (VR) has emerged as a cutting-edge method. Studies indicate that by offering real-time feedback, multimodal stimulation, and patient involvement, virtual reality (VR) may foster neuroplasticity and improve motor learning. This case study shows how VR affects functional results and investigates how to include VR into a physiotherapy program for a patient with NMOSD who has lower limb impairment.

3. CASE PRESENTATION:

A 40-year-old man who had been diagnosed with neuromyelitis optica spectrum disorder (NMOSD) showed signs of a recurrence of the condition, including diminished balance, trouble walking, and new-onset bilateral lower limb weakness. Following a neurological assessment, his motor strength was rated at MRC 3/5 proximally and 2/5 distally, indicating lower extremity paresis.

He had a short-stepped, unstable walk that required significant support, and he had poor static and dynamic balance, needing help to maintain posture. Utilizing a cell-based technique, serum testing verified the existence of aquaporin-4 immunoglobulin G (AQP4-IgG) antibodies, therefore bolstering the diagnosis.

An MRI of the spine showed demyelinating lesions in the thoracic spinal cord, which are consistent with myelitis linked to relapses of NMOSD.

The diagnosis of NMOSD recurrence with thoracic myelitis was established based on the clinical presentation, imaging results, and positive AQP4-IgG serology.

3.INTERVENTION:

At the Sri Ramakrishna Multi-Speciality Hospital's -Department of Physiotherapy in Coimbatore, the patient completed an extensive neurorehabilitation program. It was administered over eight weeks and included both traditional physiotherapy and virtual reality (VR)-enhanced therapy.

The intervention took place five times a week and lasted 50 minutes each time.

The VR-based therapy was created to enhance motor skills and balance by using enjoyable, gamified activities that were customized to the patient's functional capacities. Postural control exercises, strengthening, and gait re-education were the main focuses of traditional physiotherapy. By maximizing functional recovery and boosting general mobility, this combination strategy sought to improve rehabilitation's psychological and physical components.

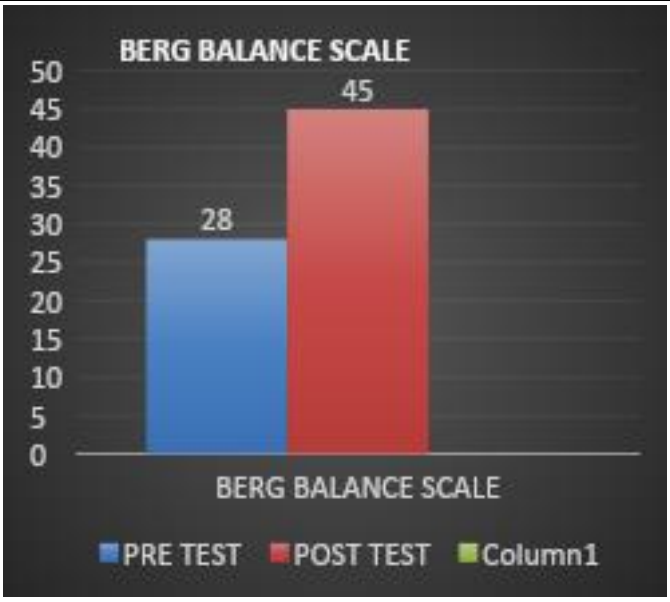
	VIRTUAL REALITY	CONVENTIONAL PHYSIOTHERAPY
TREATMENT DURATION	5 sessions per week / 8 weeks, 30 minutes each	5 sessions per week / 8 weeks, 20 minutes each
TREATMENT	Equipment Used: Semi-immersive VR system with motion sensors and a screen-based feedback system. Tasks Included: ▪ Simulated walking and stair climbing ▪ Obstacle avoidance games ▪ Real-time feedback on balance and posture ▪ Visual-motor integration challenges (e.g., target stepping, ball kicking in virtual environment)	▪ Muscle Strengthening: Focus on proximal and distal lower limb muscles using resistance bands and bodyweight exercises. ▪ Gait Training: Parallel bar walking, treadmill-assisted ambulation, step-over and obstacle training. ▪ Balance Training: Static and dynamic exercises on firm and foam surfaces.

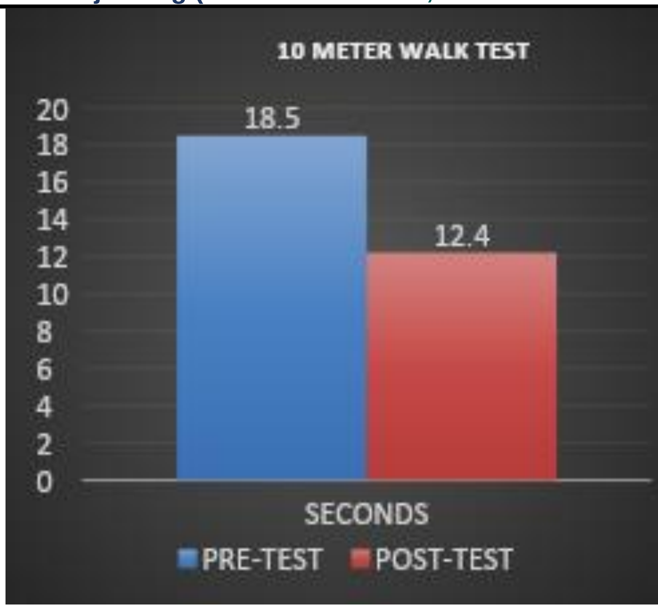
4. OUTCOME:

Better Balance and a lower risk of falls were suggested by BBS improvement. The 10MWT time decrease indicated faster and more effective walking.

Greater freedom in everyday movement and transfers was reflected in the FIMscore.

Furthermore, the patient's subjective comments included: A greater sense of delight throughout therapy sessions Increased self-assurance when trying to walk alone Increased drive to keep up at-home workouts.





MEASURE	PRE-TEST	POST-TEST
FUNCTIONAL INDEPENDENCE MEASURE	MODERATE INDEPENDENCE	INDEPENDENT (WITH AID)

5. DISCUSSION:

For patients with spinal cord involvement from NMOSD, this instance demonstrates the usefulness of using virtual reality into neurorehabilitation. VR offers special benefits by boosting patient engagement, producing captivating training settings, and encouraging neuroplasticity through repeated, goal-directed movement, even if traditional therapy is still the mainstay of motor rehabilitation.

VR therapies may hasten the relearning of motor patterns by simulating real-life situations and provide immediate feedback. Better attention, adherence, and enjoyment—all of which are sometimes difficult in traditional therapy—are also encouraged by VR's immersive qualities. In this instance, virtual reality probably helped with improved neuromuscular coordination, higher therapeutic dose, and increased motivation.

Research on VR in stroke and traumatic brain injury rehabilitation is expanding, although there are still few studies on NMOSD. This example adds to a modest but growing body of research that shows virtual reality (VR) can be a helpful supplement in the treatment of uncommon neurological illnesses. The BBS and 10MWT gains imply that VR can greatly improve gait and balance in patients recuperating from spinal cord injuries.

6. CONCLUSION:

This case demonstrates is integrating virtual reality (VR) into neurorehabilitation can significantly improved the lower limb function, gait, and balance in patients with NMOSD.

The combination of interactive, gamified tasks and traditional physiotherapy enhances motivation, confidence and functional recovery, offering a promising adjunct to conventional treatment for individuals with spinal cord involvement.

7. LIMITATIONS:

The fact that this case study only focuses on one patient limits the capacity to extrapolate findings. Additionally, the 8-week period could not fully capture the long-term impacts of VR treatment, and results could be impacted by individual variations in adherence and motivation.

8. RECOMMENDATIONS:

Future studies is should be involve larger cases, diverse patient groups and include long-term follow-up to assess sustained benefits.

VR methods that are customized for each patient's need may improve results. Virtual reality (VR) combined with other therapies, such as robotic assistance, and real-time monitoring to modify intensity will further improve the efficacy of rehabilitation.

9. ETHICAL APPROVAL AND CONSENT TO PARTICIPATENT:

Sri Ramakrishna Institute of Paramedical Sciences institutional review board granted ethical approval. Every respondent consented to take part in the study, and participant gave their informed consent. No participant name or any other information that might be used to identify them was disclosed, and their privacy was protected.

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