

CASE REPORT

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# Effects of physical therapy intervention in the management of neuromyelitis optica: a case report

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## Abstract

**Background:** Neuromyelitis optica is a rare immune-mediated demyelinating central nervous system disorder affecting the spinal cord and optic nerves. There is no permanent cure for this disease, and its management requires a multidisciplinary approach.

**Objective:** The objective of this case report is to see the effectiveness of physical therapy in the management of neuromyelitis Optica.

**Methods:** A case of a 13-year-old female with symptoms of left side weakness, balance, and gait impairments administered a 2-week exercise protocol including progressive resistance training for strength improvements, virtual reality gaming for balance and stability improvements, and modified constraint-induced movement therapy for upper extremity functioning and activities of daily living (ADLs). Pre- and post-outcome measures include manual muscle testing (MMT) scores for strength, ProKin TecnoBody assessment for balance and stability, Functional Independence Measure (FIM), and Capabilities of Upper extremity Questionnaire (CUE-Q) for ADLs.

**Results:** Results showed a marked improvement in the scores of MMT, FIM, CUE, and ProKin TecnoBody post-intervention.

**Conclusion:** Physical therapy is effective in the management of neuromyelitis optica.

**Keywords:** Neuromyelitis optica, Physical therapy, Virtual reality, ProKin

## Introduction

Neuromyelitis optica (NMO) is a rare immune-mediated demyelinating central nervous system disorder that affects the spinal cord and optic nerves, and commonly presents with acute incidents of transverse myelitis and optic neuritis with an incomplete resolution of symptoms between attacks [1]. The term “Neuromyelitis Optica Acuta” was first used by Eugene Devic in a paper communicated in 1894 [2]. Since then, it is also known as Devic’s syndrome or Devic’s disease. Due to the resemblance in clinical and radiological features,

it was considered to be a subtype of multiple sclerosis (MS) until the discovery of autoantibody known as NMO-IgG or AQP4-ab by Dr. Lennon in 2004 [3]. Before the discovery of AQP4-ab NMO is considered to be a monophasic disorder consisting of bilateral optic neuritis and transverse myelitis. AQP4-ab got incorporated into the diagnostic criteria of NMO in 2006 [4] and in 2007 Neuromyelitis Optica Spectrum Disorder (NMOSD) was introduced to incorporate the cases of positive AQP4-ab tests but limited NMO symptoms. In cases with seropositive AQP4-ab, the presence of one of the six core clinical features [longitudinally extensive transverse myelitis] (LETM), optic neuritis and area postrema syndrome (APS), symptomatic brainstem, diencephalic, or cerebral syndromes]

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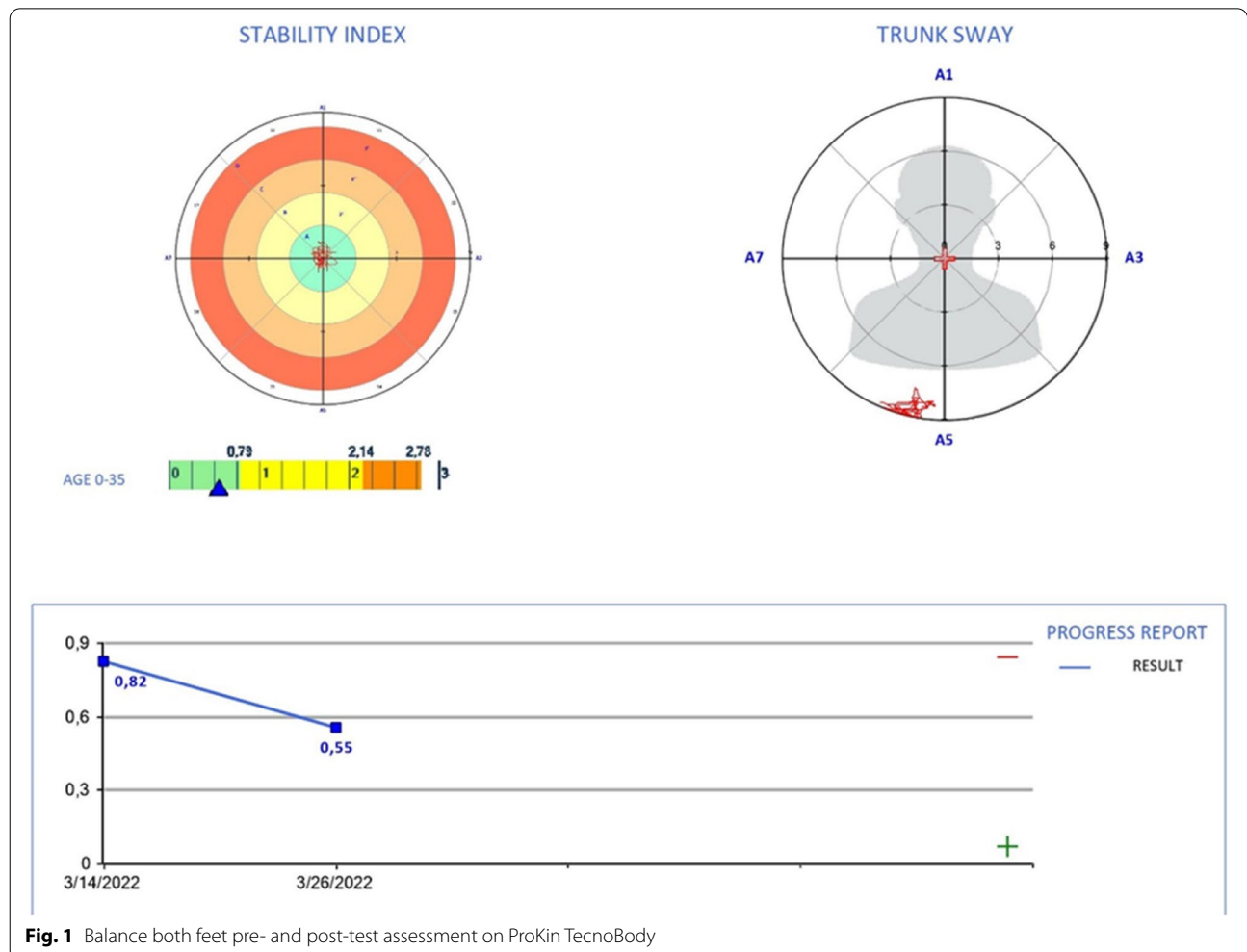
is sufficient to be diagnosed as NMO [5], while in seronegative cases, medical resonance imaging (MRI) finding of LETM with lesion extending at least three vertebral levels and the presence of dorsal medulla level lesion in APS is necessary [6] (Figs. 1 and 2).

This disease is more prevalent in Black, Asian, and Indian populations. In all populations, there is a strong female predominance, with a female-to-male ratio of 3:1. The mean age of onset is approximately 40 years old, although many cases have been reported in childhood. Treatment of NMO needs an interdisciplinary approach. The commonly used drug in NMO is intravenous corticosteroid therapy and immunosuppressive therapy [7]. However, the role of physical therapy is not that well documented in NMO cases due to its' rare finding. This case study focuses on the role of physiotherapy in the management of NMO.

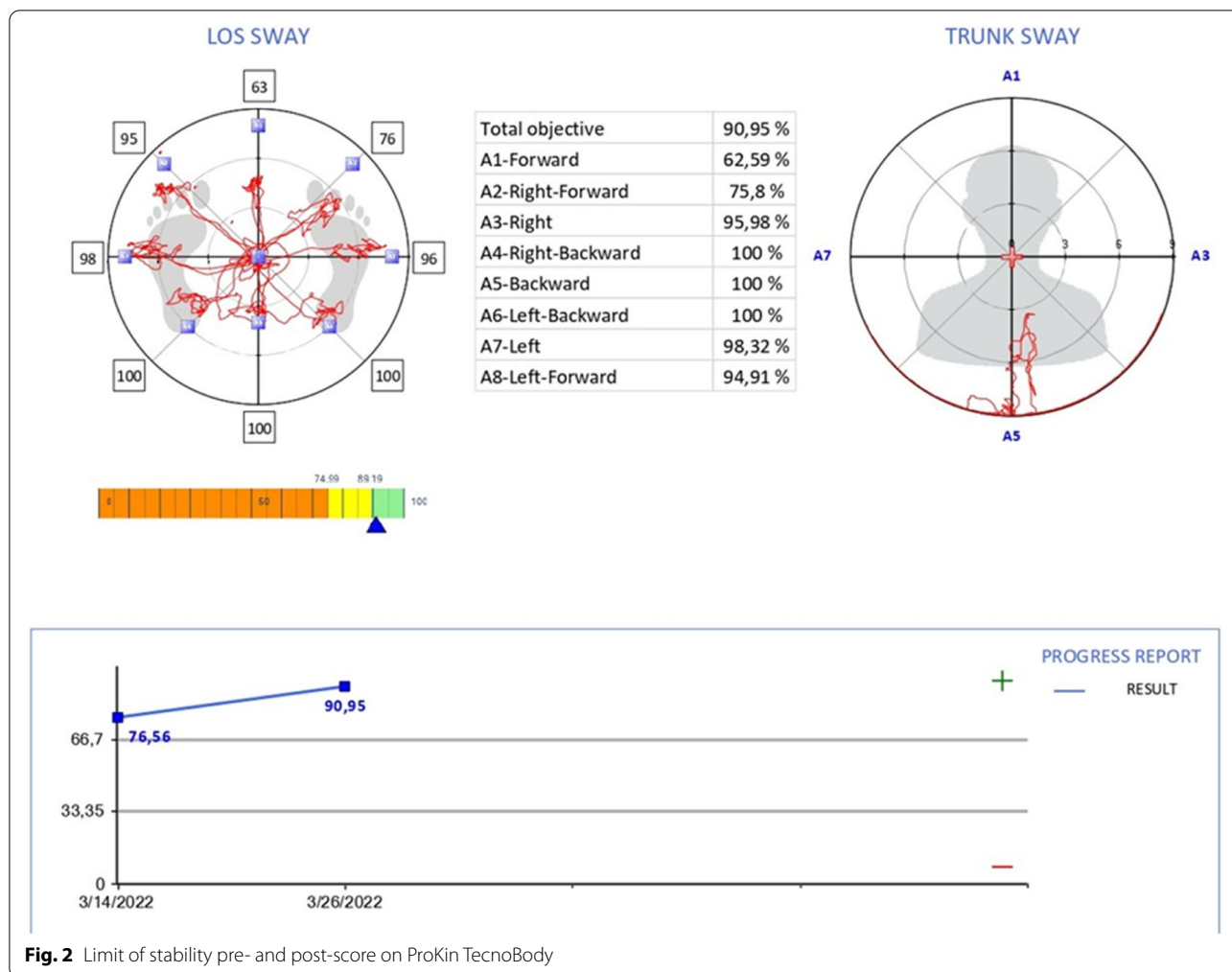
**Case presentation**

We report a case of a 13-year-old female with complaints of blurring of vision (left eye>right eye), left side upper limb and lower limb weakness, and breathlessness.

Previously, the patient had a history of right optic neuritis in the year 2008 which got relapsed after pharmacological treatment, then 2 years back, the patient again develops complaints of decreased vision in the left eye and MRI findings showed left partial optic atrophy leading to left optic neuritis which got improved with methylprednisolone injection. On investigation, MRI of the brain showed left optic nerve thickening suggesting left optic neuritis (subacute/chronic), screening of the cervical spine shows predominant involvement of the central cord and left hemi-cord at the C2–C5 level. Anti Aquaporin-4 Antibody result was seronegative. Non-contrast computed tomography (NCCT) of the brain showed no abnormalities. A cerebrospinal fluid (CSF) examination showed no bacterial growth. Based on the findings, the patient was diagnosed with a case of neuromyelitis optica by the neurologist. Neurological examination showed an asymmetry in muscle strength with a Medical Research Council (MRC) grading of 2+/5 on the left upper extremity, 3/5 on the left lower extremity, and 5/5 on both right upper and lower extremity and normal pathological reflexes.



**Fig. 1** Balance both feet pre- and post-test assessment on ProKin TecnoBody



**Fig. 2** Limit of stability pre- and post-score on ProKin TecnoBody

International Standards of Neurological Classification of Spinal Cord Injury (ISNCSCI) examination showed a diminished sensation over left C4–C8, confirming a case of incomplete injury with (ASIA impairment scale) AIS D and neurological level C3. Visual acuity was checked using a Snellen chart and the score was 20/32.

On observation, we noticed an asymmetry of load distribution by the patient during gait and posture evaluation, which is why we decided to check the limit of stability (LOS) of the patient which predicts volitional control of the center of gravity and predicts the risk of fall [8]. The limit of stability and balance on a bipedal stance was assessed by a stabilometric platform (ProKin TecnoBody 252 model). ProKin TecnoBody is a force platform that assesses postural sway off the center of pressure [9].

To begin with, during the test, we first explained the steps that need to be followed to the patient. The patient was asked to step barefoot into the stabilometer platform, we placed the trunk sensor parallel to the T4 spinous process, and we aligned the patient’s foot along with the

*x*-axis and *y*-axis according to the standardized platform. The patient was instructed to keep her hands parallel to the trunk, and in case of uneasiness, she was instructed to call us to stop the test.

To check the balance in a bipedal stance patient was asked to stand steady on the platform by looking at the computer screen with eyes open for 30 s and eyes closed for 30 s. At the end of the test, we recorded the total stability index (measured in degrees), anterior-posterior axis stability index (measured in degrees), and medial-lateral stability index (measured in degrees).

To check the limits of stability, we asked the patient to look at their computer screen which was maintained at their eye level and try to move the cursor on the screen by shifting their center of mass by trunk movements and without changing their foot position as quickly as possible to eight targets positioned at 45° around the center. The patient was instructed not to lift the foot from the platform and to maintain the body in a straight line.

Based on the clinical presentation we administered a 2-week physiotherapy program focusing on strength and balance training and upper limb functioning in the left upper extremity. The outcome measure for ADLs includes the capabilities of the upper extremity questionnaire and the FIM scale. The limit of stability (static) test on TecnoBody showed a result of 76.56 with a trunk standard deviation of 7.65 and asymmetric load distribution with more load transfer on the right lower limb. Balance on bi-pedal stance pre-score assessment showed a score of 0.82.

The patient received a progressive resistance training for the upper limb and lower limb 5 days/week for 2 weeks and balance and stability training was provided in TecnoBody which includes virtual reality balance game training like skii and fruit cutter. The patient was also encouraged to use her left upper extremity for her activities of daily living by constraining her right upper extremity with a mitt as a part of a home exercise program for at least 3 h a day. A daily activity log is maintained for the same. After 2 weeks, post-outcome measures showed improvement in MRC grading of MMT scores with 4/5 in the left upper and lower extremity and 5/5 in the right upper and lower extremity. There is a marked improvement shown in the score of CUE, FIM, and balance assessment scores as well.

## Discussion

Neuromyelitis optica is a rare syndrome having no permanent cure, hence its' management requires a multi-disciplinary approach [10]. Physical therapy can play a great role in the management of the progression of symptoms, a recent study reported physical therapy to be safe for the management of an acute case of neuromyelitis optica [10], but there is a need for more studies to support the role of physiotherapy in the management of neuromyelitis optica. In this case report, we tried to see the effects of physiotherapy intervention in neuromyelitis optica. Since the symptoms of NMO vary according to the stage, it is difficult to come up with a single intervention for NMO cases. This case presented with weakness and balance and stability impairments, so we focused on these symptoms only. The median age of NMO documented in other studies is mid 30's [10], but in this case, the age of the patient is only 13 years. We tried to combine constraint-induced movement therapy (CIMT) also as a part of the home exercise program which showed improvement in the ADL score of the left upper extremity, but since traditional CIMT is a long protocol, it was difficult to administer in inpatient cases. Further study can be done to see the effects of CIMT in upper extremity usage in ADLs in NMO. Earlier studies have been done that used E-link [11] for hand rehabilitation in NMO cases, but this was

the first study that tried to see the effect of modified constraint-induced movement therapy for ADLs. As the disease progresses, there are chances of restriction of mobility. So, a detailed assessment tool is required for a mobility assessment. ProKin TecnoBody provides a complete solution for mobility assessment [12], and to our knowledge, this is the first study to use ProKin TecnoBody for the assessment and management of balance and stability in the case of NMO. Table 1 showed a marked improvement in ProKin scores. From Table 2, we can see the patients' MRC grading got improved from 2+ to 4/5 in just 2 weeks post-treatment showing a good prognosis. A study by Nechemia et al. [11] also concluded that individuals with NMO have a better prognosis than an individual with MS.

The case report has some limitations as well. Firstly, we cannot generalize the results of physical therapy intervention by just one case report. Modified constrained induced movement therapy cannot be properly administered to the patient because of its' long intervention hours. More studies can be done focusing on the effects of constrained-induced movement therapy for ADLs. The intervention period is short in this study due to the limited inpatient stay of the patient. Since the disease is relapsing and remitting in nature further studies can be done to see the long-term effects of physical therapy intervention.

## Conclusion

This case report showed physical therapy is effective in improving muscle strength, balance, gait impairments, and ADLs in patients with NMO. However, there is a

**Table 1** Pre- and post-scores of limits of stability and balance on bipedal stance on ProKin

	Pre-test score	Post-test score
Balance bipedal stance		
Total stability index [°]	0.82	0.55
AP axis stability index [°]	0.48	0.43
ML axis stability index [°]	0.67	0.34
Trunk Tot. St. Dev. [°]	1.06	0.83
Limits of stability		
Total objective	76.56%	90.95%
A1-forward	45.13%	62.59%
A2-right-forward	33.18%	75.8%
A3-right	89.02%	95.98%
A4-right-backward	100%	100%
A5-backward	100%	100%
A6-left-backward	99.93%	100%
A7-left	81.53%	98.32%
A8-left-forward	63.66%	94.91%

**Table 2** Pre- and post-intervention scores of CUE (capabilities of upper extremity questionnaire), FIM (Functional Independence Measure), and MMT (manual muscle testing) scores

	Pre-test score	Post-test score
CUE	214	222
FIM	120	126
MMT scores (left UL)		
Shoulder flexors	2+/5	4/5
Shoulder extensor	2+/5	4/5
Shoulder abductor	3/5	4/5
Shoulder adductors	3/5	4/5
Elbow flexors	3/5	4/5
Elbow extensors	3/5	4/5
Wrist flexors	4/5	5/5
Wrist extensors	4/5	5/5
Finger flexors	4/5	5/5
Finger extensors	4/5	5/5

need for further studies focusing on the role of physiotherapy in the management of NMO, and the inclusion of recent technologies like virtual reality, and TecnoBody needs to be addressed with better outcome measures for the study. Since NMO comes with a broad clinical presentation, other aspects of the disorder like cognition, fatigue, bowel, and bladder management should also be addressed.

#### Abbreviations

ADLs: Activities of daily living; MMT: Manual muscle testing; FIM: Functional Independence Measure; CUE-Q: Capabilities of Upper extremity Questionnaire; MS: Multiple sclerosis; NMO: Neuromyelitis optica; NMOSD: Neuromyelitis Optica Spectrum Disorder; LETM: Longitudinally extensive transverse myelitis; APS: Area Postrema Syndrome; MRI: Medical resonance imaging; MRC: Medical Research Council; ISNCSCI: International Standards of Neurological Classification of Spinal Cord Injury; CSF: Cerebrospinal fluid; NCCT: Non-contrast computed tomography; LOS: Limit of stability.

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#### Authors' contributions

We affirm that the submission represents an original work that has not been published previously and is not currently being considered by another journal. Also, we confirm that each author has seen and approved the contents of the submitted manuscript. This work was carried out in collaboration with all authors. Sneha Chakraverty designed the study, wrote the protocol, and wrote the first draft of the manuscript. Sayak Dutta and Himadri Das managed the data collection for the study. The authors read and approved the final manuscript.

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#### Availability of data and materials

The data collected and/or analyzed during the study are available from the corresponding author on reasonable request.

## Declarations

#### Ethics approval and consent to participate

The study was done at Abhinav Bindra Sports Medicine and Research Institute, Bhubaneswar. Prior to this study, ethical clearance was taken from the ethical committee of the institute and consent was taken from the parents of the child. The study is not a clinical trial, so no clinical trial registration has been done. Prior to the start of the study, each procedure has been explained to the patient and her parents, and written consent has been taken at the same time.

#### Consent for publication

The informed written consent form was signed by the parents before participation in the study and agreed to the publication of the treatment results.

#### Competing interests

The authors declare that they have no competing interests.

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