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Atlantoaxial dislocation in Spastic Cerebral Palsy: A Case Report

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ABSTRACT

Atlantoaxial dislocation (AAD) is a rare but potential condition in children, with great complexity combined with spastic cerebral palsy (CP). This case report present clinical radiological features, and functional outcomes of a 12-year-old girl with spastic CP and AAD who underwent a structured physiotherapy program. The purpose to evaluate the effectiveness of non-surgical, exercise-based rehabilitation approach in improving cervical stability, functional abilities, and motor performance. A comprehensive 12-week physiotherapy intervention was implemented, emphasizing graded cervical mobility exercises, core strengthening, scapular stabilization, postural correction, and balance training. Progressions aligned with clinical tolerance. Standardized tools including Pediatric Balance Scale (PBS), Manual Ability Classification System (MACS), and goniometric cervical ROM assessment were used pre- and post-intervention to quantify functional gains. MRI imaging before and after rehabilitation changes in atlantoaxial distance. Significant improvements were observed following intervention. Cervical ROM increased by 20–25%, accompanied by notable gains in muscle strength across upper and lower limbs. The atlantoaxial distance decreased from 5.4 mm to 3.2 mm, reflecting radiological improvement. PBS improved from 25 to 43, and MACS level improved from Level 3 to Level 2. Enhanced postural control, balance, and independence in daily activities were maintained. This case demonstrates a structured, goal-oriented physiotherapy program serve as effective conservative strategy for managing pediatric AAD associated with spastic CP. Targeted strengthening and stabilization may offer viable alternative to surgery in select cases.

1. INTRODUCTION

Atlantoaxial dislocation (AAD) refers to the loss of normal articulation and stability between the atlas (C1) and axis (C2) vertebrae, commonly resulting from developmental anomalies such as ligamentous laxity, osseous malformations, and abnormal dens development [1]. The atlantoaxial joint (AAJ) plays a vital biomechanical role in stabilising the head and facilitating extensive cervical spine motion. Structurally, the AAJs are characterized by nearly flat and parallel opposing facetal surfaces, with a slight mediolateral slope in the coronal plane and a horizontal orientation in the sagittal plane. These features enable multidirectional movement but also render the AAJs the most mobile and therefore potentially the most unstable segment of the spine [2].

In pediatric populations, AAD presents unique diagnostic and management challenges. The cervical spine, particularly in children under eight years of age, is more susceptible to instability due to ongoing skeletal development. Moreover, in younger children, the craniovertebral junction is more frequently affected [3]. AAD may also coexist with basilar invagination, condition marked by an abnormal relationship between the foramen magnum and the posterior cranial fossa. Central or axial invagination refers specifically to abnormal alignment between the C1 and C2 vertebrae [1,3].

Cerebral palsy (CP) is a non-progressive neurological disorder resulting from early brain injury, leading to chronic disturbances in posture and movement. Spasticity is the predominant motor impairment in most children with CP and is characterized by velocity-dependent resistance to passive stretch or involuntary muscle overactivity

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due to upper motor neuron dysfunction. This spasticity can significantly impair functional independence, disrupt sleep, cause pain, and complicate caregiving. It often limits activities of daily living (ADLs), including ambulation, dressing, and hygiene [4].

While both AAD and spastic CP independently impair motor function, a direct pathophysiological link between them remains insufficiently established. However, rare case reports have documented their coexistence, underscoring the importance of comprehensive neurological and musculoskeletal assessments in complex pediatric presentations [5].

This case report presents an unusual instance of AAD associated with spastic paraparesis, highlighting diagnostic intricacies, radiological correlations, and physiotherapeutic interventions. Such rare combinations contribute to the expanding understanding of motor disorders involving overlapping neuro-orthopedic pathologies.

2. MATERIALS AND METHODS

This study followed all ethical standards and received approval from Krishna Vishwa Vidyapeeth Deemed-to-be University, Karad, under reference number [KVV/IEC/04/2025]. Informed consent was obtained from the participant using a volunteer consent form that clearly outlined the purpose of the research, potential risks and benefits, confidentiality provisions, and participants' rights. The study was conducted with ethical principles of the Declaration of Helsinki, ensuring that participant rights, safety, and well-being were prioritized throughout the study's design, procedure, and confidentiality measures.

2.1. Case Presentation

A 12-year-old female presented with complaints of upper limb weakness, tingling, numbness, neck pain, restricted cervical movements, and impaired balance. Symptoms began following a minor fall three months prior. The patient had a history of low birth weight (1200 g), micro-crania (head circumference 42.5 cm), and a two-month NICU stay during which she experienced neonatal seizures. Developmental delays were noted, including inability to stand until age 2. At age 9, she was diagnosed with spastic paraparesis and underwent bilateral open hamstring release, chemodenervation, and percutaneous myofascial release of the gastrocnemius. Post-trauma, worsening pain and functional limitations led to imaging studies and initiation of pharmacological management with transient symptomatic relief. She was referred for physiotherapy and underwent a structured 12-week rehabilitation program.

Informed consent was obtained prior to assessment. On evaluation, the patient had localised tenderness over C1–C2 without signs of inflammation. Sensory exam was intact, and MMSE score was 28/30, indicating normal cognition. Cervical range of motion was restricted. Postural assessment revealed forward head posture and poor alignment. Motor assessment showed upper limb strength of 3/5, lower limb strength of 3+/5, truncal instability, and a spastic gait. Positive Romberg sign and Sharp-Purser test indicated proprioceptive deficits and atlantoaxial instability, respectively.

Initial MRI showed increased atlantoaxial distance (5.4 mm), "Fig.1." 3 mm upward odontoid displacement, and thinning of the distal medulla. Follow-up MRI after physiotherapy showed reduced atlantoaxial distance (3.2 mm) "Fig. 2." and preserved CSF space with no spinal cord compression. The findings suggest effective management of symptomatic atlantoaxial instability through a structured rehabilitation approach.

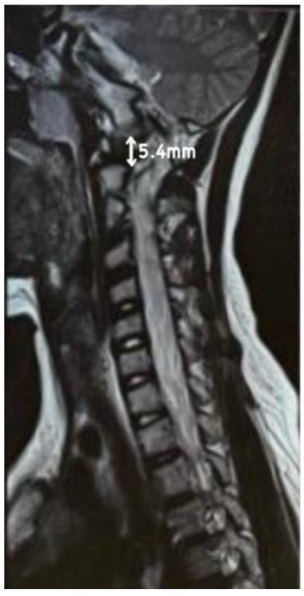

Fig 1. Increased atlantoaxial distance (5.4 mm)

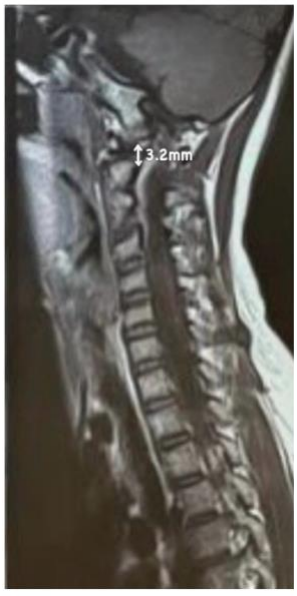

Fig 2. Reduced atlantoaxial distance (3.2 mm)

2.2 Physiotherapy Intervention

Methodology outlines the design structured goal-oriented physiotherapy intervention as given below Table 1.

Table 1. Structured physiotherapy protocol

Week	Exercise	Reps
0–4 Weeks	1. PROM Exercises – Cervical 2. Gentle Trunk & Head Control Exercises 3. Soft Tissue Mobilization – Gentle Myofascial Release (MFR) 4. Breathing Exercises – Diaphragmatic breathing	10 repetitions × 3 sets
4–8 Weeks	1. AAROM Exercises – Cervical 2. Isometric Holds on Unstable Surface 3. Prone Neck Extension Strengthening 4. Scapular Stabilization – Shoulder blade squeezes 5. Seated Balance Exercises	10 repetitions × 3 sets each exercise
8–12 Weeks	1. Dynamic Cervical ROM Exercises 2. Balance Board Exercises 3. Core Strengthening 4. Shoulder Shrugs 5. Perturbation & Balance Training	10 repetitions × 3 sets each exercise

3. RESULTS

There was an improvement in the PBS, Cervical ROM using Goniometer & MACS as shown in Table 2. Table 3. Table 4.

Table 2. Range of motion of cervical region

	Pre-Score	Post-Score
Pediatric Balance Scale	25/56	43/56

Table 3. MACS level description

Cervical Movement	Pre-Test	Post-Test
Flexion	35 degree	45 degree
Extension	45 degree	55 degree
Lateral Flexion	35 degree	40 degree
Rotation	40 degrees	70 degree

Table 4. Pediatric Balance Scale (PBS)

	MACS	LEVEL
Pre-Rehab	Handles object with difficulty needs help to prepare/modify activities ; Slow performance with limited success.	L-3
Post-Rehab	Handles objects with somewhat reduced quality &/or speed. May avoid certain activities but generally independent.	L-2

4. DISCUSSION

This case highlights the effectiveness of a structured physiotherapy rehabilitation programme in the conservative management of pediatric atlantoaxial dislocation (AAD), focusing on improvements in cervical range of motion, balance, and muscle strength. AAD, although rare in children, requires a multidisciplinary approach for optimal outcomes. Physiotherapy plays a critical role in both conservative and post-operative management of C1–C2 instability, with core objectives of restoring function, reducing pain, and preventing further neurological deterioration [6]

In the present case, a 12-week, individualized physiotherapy protocol led to significant clinical improvements. Standardized assessment tools such as the Manual Ability Classification System (MACS), Pediatric Balance Scale (PBS), and the WeeFim were used to measure functional gains. Post-rehabilitation findings revealed marked improvements in cervical mobility, postural stability, and overall muscular strength, consistent with the findings of Kapre et al. [7]. who emphasized the importance of structured rehabilitation in enhancing motor control, reducing weakness, and increasing independence in daily activities.

In the acute phase, immobilization using rigid cervical collars, such as the Philadelphia collar, is considered essential for preventing excessive cervical motion and allowing soft tissue healing. As Di Rocco et al.[8] noted, cervical orthoses aid in stabilising the atlantoaxial junction and help mitigate further risk, especially in non-surgical cases.

Overall, this case reinforces the value of a patient-specific, phased physiotherapy programme integrating postural correction, proprioceptive training, motor control exercises, and caregiver education. Such interventions are vital in pediatric AAD for promoting recovery, functional independence, and quality of life. With careful assessment and timely physiotherapeutic intervention, conservative management can yield substantial outcomes, often avoiding the need for surgical intervention in select pediatric patients.

5. Conclusion

This case underscores the potential of strength training as a non-surgical intervention in managing congenital AAD. The significant radiological and clinical improvements observed in this patient challenge the traditional method of exclusive surgical management and highlight the need for further research in this area.

Conflict of Interest

The authors declared that there are no conflicts of interest related to the publication of this case study.

Ethics Committee

This study followed all ethical standards and received approval from Krishna Vishwa Vidyapeeth Deemed-to-be University, Karad, under reference number [KVV/IEC/04/2025].

Author Contributions

Study Design, SRS and MM; Data Collection, MRAB and SRS; Statistical Analysis, MRAB; Data Interpretation, MM and SRS; Manuscript Preparation, MRAB, MM and SRS; Literature Search, MRAB, MM and SRS. All authors have read and agreed to the published version of the manuscript

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