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Issue Article

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THREE-DIMENSIONAL FOOT ASSESSMENT AS AN EARLY INDICATOR OF SUSPECTED CEREBRAL PALSY IN A TODDLER: A CASE REPORT

Abstract: *Early diagnosis of cerebral palsy (CP) remains challenging, particularly in children with subtle or minimally expressed neurological manifestations. Three-dimensional (3D) foot analysis provides an objective quantitative assessment of lower extremity alignment and loading patterns. This article describes the case of a 14-month-old boy who underwent three-dimensional assessment of the lower limbs. The examination demonstrated marked asymmetrical biomechanical abnormalities. The obtained findings supported the clinical suspicion of an evolving neurological motor disorder suggestive of early cerebral palsy. This case indicates that 3D foot analysis may reveal early biomechanical manifestations of cerebral motor dysfunction before the appearance of fully developed neurological symptoms.*

Key words: *foot, cerebral palsy, 3D foot analysis.*

Language: *English*

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Introduction

Cerebral palsy (CP) is the most common cause of chronic motor disability in childhood and is characterized by non-progressive disturbances of movement and posture resulting from injury to the developing brain. Early diagnosis is essential because timely rehabilitation and intervention significantly improve functional outcomes and neurodevelopmental prognosis [1, 2].

However, mild or early forms of CP may initially present with subtle and nonspecific clinical manifestations. In some children, abnormal gait initiation, asymmetrical weight-bearing, or altered foot positioning may precede overt neurological deficits. Quantitative biomechanical assessment techniques may therefore provide additional diagnostic information during the early stages of disease development.

Three-dimensional (3D) foot scanning and biomechanical analysis systems enable objective evaluation of foot morphology, alignment, pressure distribution, and angular deformities. These methods have increasingly been used in orthopedic and rehabilitation medicine for assessment of lower limb abnormalities [3, 4, 5].

The present report describes a toddler with minimal clinical manifestations but significant abnormalities detected by 3D foot analysis, which may reflect early neurological motor dysfunction, including possible cerebral palsy.

Case Presentation

A 14-month-old boy was referred for three-dimensional lower extremity and foot assessment after her parents observed abnormal positioning of the right foot during standing and walking attempts. According to parental history, pregnancy and delivery had not been associated with major complications. General psychomotor development of child was considered generally appropriate for age.

During clinical examination, mild asymmetry of the lower extremities and altered foot posture were noted. Although neurological manifestations were not yet fully expressed, the observed asymmetry raised suspicion of an early central motor disorder, including possible cerebral palsy. For further objective evaluation, the patient underwent computerized 3D foot and ankle assessment.

All procedures were conducted under the supervision of a pediatric neurologist to ensure child safety and clinical accuracy.

Methods

To assess foot morphology, we used the UPOD Full Foot Scan system (China), a three-dimensional foot scanner designed for static weight-bearing analysis. Measurements included foot dimensions, arch parameters, hallux angle, hindfoot alignment, malleolar indices, and angular relationships of the foot and ankle structures [6, 7].

Both static and structural parameters of the feet were analyzed and compared bilaterally.

Results

Three-dimensional analysis demonstrated severe bilateral biomechanical abnormalities of the lower extremities and feet. Pronounced asymmetry was identified in foot morphology, volumetric parameters, and ankle region measurements (Fig. 1, Fig. 2).

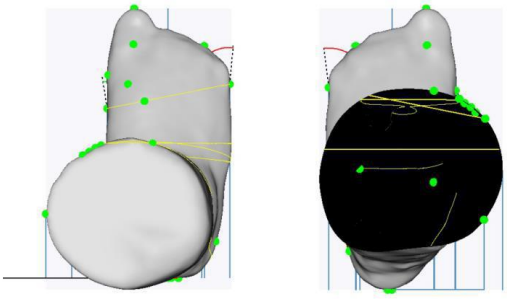

Figure 1. Asymmetry of the lower legs

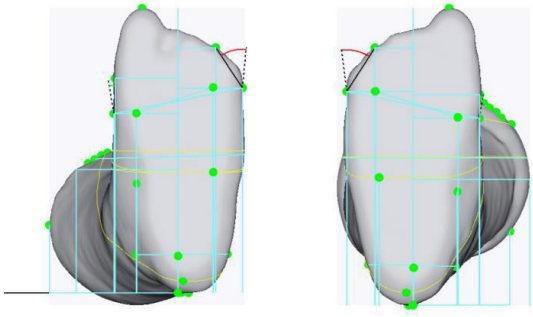

Figure 2. Asymmetry of the feet

Significant differences were identified in hindfoot alignment, foot morphology, and dimensional parameters between the right and left sides. Cross-sectional imaging additionally demonstrated visible asymmetry of the lower legs and feet, including differences in calf contour and foot size. Bilateral pes planus and pronounced asymmetrical hindfoot positioning were observed, supporting the presence of abnormal biomechanical organization of the lower extremities [8, 9, 10].

The Arch Index measured 0.38 bilaterally, corresponding to severe pes planus deformity classified as Low (+++) (Fig. 3):

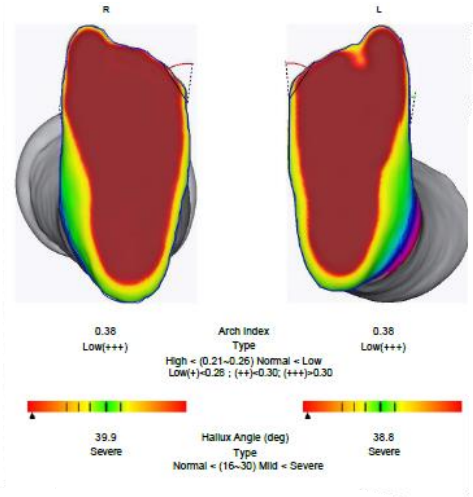

Figure 3. Bilateral arch index analysis.

Marked bilateral hindfoot malalignment was observed. The left heel angle demonstrated severe eversion of 110°, while the right heel angle showed severe eversion measuring 92°. Both findings were categorized as severe deformities (Fig. 4):

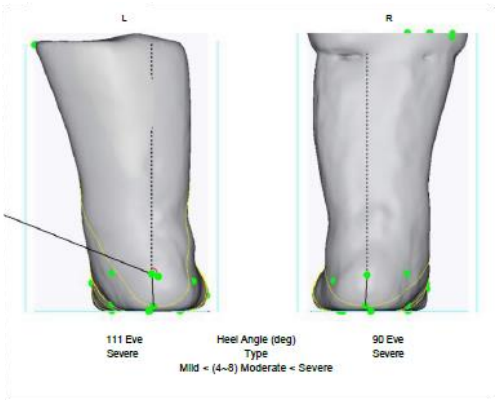

Figure 4. Heel angle type

Overall, the combination of clinical asymmetry and objective 3D biomechanical abnormalities supported the suspicion of an evolving central motor dysfunction compatible with early cerebral palsy.

Discussion

Early identification of cerebral palsy remains a major challenge in pediatric neurology and rehabilitation medicine. In very young children, neurological signs may be subtle, inconsistent, or incompletely developed, delaying diagnosis and intervention.

Abnormal foot posture and asymmetrical lower limb biomechanics are frequently observed in children with CP. These abnormalities may result from altered muscle tone, impaired motor control, abnormal reflex activity, and asymmetrical loading patterns. Importantly, such biomechanical changes may emerge before the appearance of pronounced spasticity or overt gait disturbances.

In the present case, the patient demonstrated clinically subtle asymmetry but significant abnormalities on quantitative 3D assessment. Severe unilateral hindfoot inversion, contralateral eversion, and bilateral pes planus indicated disturbed lower limb alignment and weight-bearing mechanics. The asymmetrical nature of the deformities was particularly suggestive of an underlying neurological origin rather than isolated orthopedic variation. Additional asymmetry was observed in lower limb morphology, including differences in foot dimensions and calf contour on 3D cross-sectional imaging. Mild asymmetry in foot length and midfoot width was identified bilaterally, further supporting abnormal lower extremity biomechanical organization.

Three-dimensional foot analysis offers several advantages in pediatric assessment. Unlike purely observational examination, digital analysis provides reproducible quantitative measurements and may detect early structural deviations not easily appreciated clinically. This may be especially useful in toddlers with borderline or evolving neurological findings.

Although 3D biomechanical assessment alone cannot establish the diagnosis of cerebral palsy, it may serve as an important adjunctive tool supporting early detection and referral for neurological evaluation and rehabilitation.

Further longitudinal studies are needed to determine the predictive value of early foot biomechanical abnormalities in this child at risk for cerebral palsy.

Conclusion

This case demonstrates that quantitative 3D foot and ankle analysis may identify significant asymmetrical biomechanical abnormalities in toddlers with subtle clinical manifestations of central motor dysfunction.

Objective digital assessment of foot posture, hindfoot alignment and asymmetry of the lower legs and feet may contribute to earlier recognition of suspected cerebral palsy and facilitate timely rehabilitation interventions before the development of pronounced neurological impairment.

Ethical Considerations

Written informed consent for publication of anonymized clinical information and images was obtained from the patient's legal guardians.

Conflict of Interest

The authors declare no conflict of interest.

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