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Original Article

EARLY DETECTION OF CEREBRAL PALSY IN INFANTS AND YOUNG CHILDREN USING DDST II.

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Abstract

Background

Cerebral palsy (CP) encompasses a collection of enduring motor impairments resulting from non-progressive disruptions in the developing brain of a fetus or infant. Early detection is essential to commence prompt interventions that can greatly enhance functional outcomes and neurodevelopmental pathways.

Objective

To assess the efficacy of DDST II in the early identification of cerebral palsy in infants and young children at a tertiary care facility.

Methods

This observational study began in June 2022 at Jawaharlal Nehru Medical College & Hospital in Bhagalpur. One hundred infants and children, between 6 months to 2 years, with suspected developmental delays were assessed using the Denver Developmental Screening Test II (DDST II). Children designated as "suspect" or "untestable" received further assessment through neurological examination, neuroimaging (MRI), and follow-up consultations to validate the medical diagnosis of cerebral palsy (CP). The correlation between DDST II results and the clinical diagnosis of cerebral palsy was analyzed.

Results

Of the 100 children screened, 34 were categorized as "suspect" and 12 as "untestable" according to the DDST II. Out of these 46 children, 29 were ultimately diagnosed with cerebral palsy through clinical and radiological assessments. The DDST II exhibited a sensitivity of 93.5% and a positive predictive value of 63% in identifying children with cerebral palsy. Delays in gross motor and language skills characterize most cases of cerebral palsy. Children identified by DDST II received earlier therapeutic interventions than those diagnosed subsequently based solely on clinical suspicion.

Conclusion

DDST II serves as an efficient and practical screening instrument for the initial identification of cerebral palsy in infants and young children.

Recommendation

Incorporating it into standard developmental monitoring can assist in early diagnosis and timely intervention, particularly in resource-limited pediatric environments.

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Introduction

Cerebral palsy (CP) is the main reason for physical disability in children, with a global prevalence estimated at 2 to 2.5 per 1,000 live births. It is a non-progressive neurological disorder resulting from injury or malformation of the developing brain, typically occurring during the antenatal, perinatal, or early postnatal periods. Cerebral palsy presents as irregularities in muscle tone, posture, movement, and coordination, frequently associated with sensory, cognitive, and behavioral comorbidities [3].

The prompt recognition of cerebral palsy (CP) is essential due to the brain's plasticity during the initial two years of life, facilitating improved outcomes with timely intervention [4]. In numerous low- and middle-income nations, such as India, diagnosis frequently occurs late, typically when the child is 2–3 years old, owing to insufficient awareness, organized screening, and limited access to neurodevelopmental specialists.

In this context, screening instruments like the Denver Developmental Screening Test II (DDST II) provide a uniform and economical method for evaluating

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developmental progress in children under six years old. The DDST II assesses performance in four domains: personal-social, gross motor, language, and fine motor-adaptive, offering a thorough outline of a child's development [6]. It is especially appropriate for primary and tertiary care settings where comprehensive neurodevelopmental evaluations may be lacking [7].

Multiple studies have confirmed the efficacy of DDST II in identifying global developmental delays; however, its specific use for the prompt detection of cerebral palsy is still underexploited, particularly in Indian healthcare environments [8]. By identifying children at threat for cerebral palsy through an organized screening process, healthcare providers can promptly refer them for neuroimaging, establish a confirmatory diagnosis, and facilitate intervention services such as physiotherapy, occupational therapy, and caregiver education [9].

This study seeks to assess the efficacy of DDST II in detecting early indicators of cerebral palsy in infants and young children at a tertiary care hospital in Bihar, aiming to enhance early detection strategies and mitigate diagnostic delays in neurodevelopmental disorders.

Methodology

Study Design and Setting

This was an observational study conducted in the Department of Pediatrics at Jawaharlal Nehru Medical College & Hospital, Bhagalpur, Bihar, a tertiary care teaching institution. The study commenced in June 2022 and aimed to evaluate the effectiveness of the Denver Developmental Screening Test II (DDST II) for the primary detection of cerebral palsy (CP) in infants and young children.

Study Population

The study encompassed 100 infants and young children, aged 6 to 24 months, who were either referred for developmental issues or undergoing routine well-baby evaluations and displayed indications of neurodevelopmental delay.

Inclusion Criteria

• Children between 6 months to 2 years of age
• Evidence or indications of developmental delay (motor, social, or speech)
• Parental consent acquired for participation

Exclusion Criteria

• Identified genetic syndromes or chromosomal anomalies (e.g., Down syndrome)
• Significant sensory impairments (e.g., congenital blindness or deafness) that would influence DDST II assessment
• Children previously diagnosed with cerebral palsy before study participation
• Lack of caregiver consent

Data Collection Tools and Procedure

Every enrolled child participated in a systematic assessment comprising:

1. Comprehensive medical history (including birth history, perinatal complications, neonatal intensive care unit admission, seizures, etc.)
2. Physical and neurological assessment
Developmental evaluation utilizing the Denver Developmental Screening Test II, conducted by qualified pediatricians or therapists. The DDST II evaluates four domains:
Gross motor skills, language, Personal-Social, and Fine motor-adaptive skills
Children were categorized according to DDST II outcomes into:
• Normal • Suspect (one or more delays or two or more warnings)
• Unassessable (if an adequate number of items could not be evaluated)
Children classified as "suspect" or "untestable" received additional assessment:
• Clinical evaluation by a pediatric neurologist
• Neuroimaging (MRI of the brain)
• Quarterly follow-up assessments for clinical validation of the CP diagnosis utilizing established diagnostic criteria (abnormal tone, posture, reflexes, delayed milestones)

Outcome Measures

• Primary: Sensitivity and specificity of the Denver Developmental Screening Test II for the early detection of Cerebral Palsy

• Secondary: Average age of detection through DDST II compared to clinical diagnosis, domain-specific delay patterns, and duration until intervention commencement

Statistical Analysis

Data were input and analyzed using SPSS Version 26.0. Categorical variables were displayed as frequencies and percentages. The Chi-square test was utilized to evaluate the relationship between DDST II outcomes and the conclusive CP diagnosis. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of the DDST II were calculated. A p-value below 0.05 was considered statistically significant.

Results

A total of 100 infants and young children, aged 6 to 24 months, were enrolled in the study beginning in June 2022. The average age at screening was 14.3 ± 4.1

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months, comprising 58% males and 42% females. The predominant presenting issues were motor delay (71%), speech delay (54%), and inadequate head control or atypical posturing (39%).

DDST II Screening Outcomes

According to the Denver Developmental Screening Test II (DDST II) evaluations:
• 54 children were categorized as "Normal"
• 34 children were designated as "Suspect"
• 12 children were deemed "Untestable"
All children with "Suspect" and "Untestable" scores received comprehensive neurological assessment and neuroimaging (Table 1). Among these items:

Of the 34 children classified as "Suspect," 21 (61.8%) were confirmed to have cerebral palsy (CP).
Eight out of twelve (66.7%) "Untestable" children received a diagnosis of cerebral palsy (CP).
Only one child in the "Normal" group was subsequently diagnosed with cerebral palsy during follow-up.
Consequently, DDST II exhibited:
• Sensitivity: 29 out of 31 equals 93.5%
• Specificity: 53 out of 69, equating to 76.8%
• Positive Predictive Value (PPV): 29 out of 46 equals 63.0%
• Negative Predictive Value (NPV): 53 / 54 = 98.1%

Table 1: DDST II Outcome vs Confirmed CP Cases (n=100)

DDST II Outcome	Total Cases	Confirmed CP Cases
Normal	54	1
Suspect	34	21
Untestable	12	8

Table 2: Domain-Specific Developmental Delays in Confirmed CP Cases (n=29)

Developmental Domain	Number of CP Cases with Delay
Gross Motor	29
Fine Motor	18
Language	22
Personal-Social	12

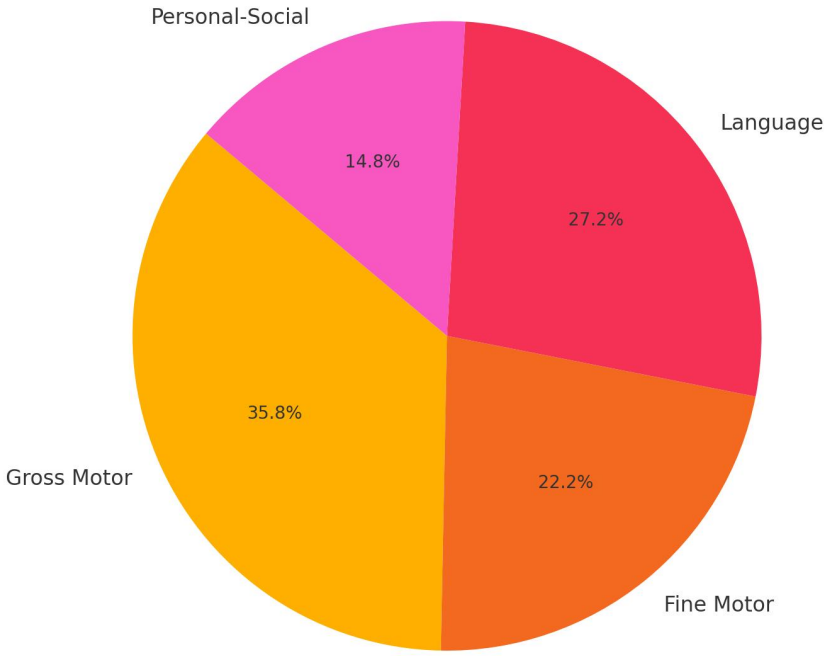

Figure 1: Distribution of Developmental Delays Among Confirmed CP Cases

Domain-Specific Developmental Delays

Delays were predominantly noted among the 29 children with confirmed cerebral palsy (Table 2; Figure 1):
• Gross motor domain – 29 children (entire cohort)
• Language domain – 22 children (75.9%)
• Fine motor-adaptive domain – 18 children (62.1%)
• Personal-social domain – 12 children (41.4%)

Age at Detection

• The average age of cerebral palsy suspicion according to the Denver Developmental Screening Test II was 13.2 months.
• In contrast, the average age of formal clinical diagnosis was 17.6 months ($p < 0.001$), indicating a significant diagnostic advantage.

Intervention

Early intervention services, including physiotherapy, occupational therapy, and caregiver counseling, commenced in 25 of 29 confirmed cases of cerebral palsy within one month of DDST II screening, underscoring the tool's efficacy in facilitating prompt management.

Discussion

This study illustrates that the Denver Developmental Screening Test II (DDST II) is an effective and sensitive instrument for the early identification of cerebral palsy (CP) in infants and young children. The screening tool demonstrated a sensitivity of 93.5% and a negative predictive value of 98.1%, effectively identifying a substantial number of children at risk for cerebral palsy prior to their formal clinical diagnosis. These findings are especially pertinent for resource-limited environments, where early neurodevelopmental monitoring is restricted.

The prevalence of CP in our high-risk screened cohort was 29%, aligning with studies indicating a higher incidence of CP in children with perinatal complications or early developmental issues [10]. All affected children exhibited gross motor delays, with notable impairments in language (75.9%) and fine motor skills (62.1%) also commonly observed. This corroborates previous findings that cerebral palsy impacts various domains, although motor impairment persists as the primary diagnostic criterion [11].

Prior research by Reilly et al. and Einspieler et al. has underscored the significance of early detection of atypical movement patterns and developmental delays in predicting cerebral palsy [12,13]. Although instruments such as the General Movements Assessment (GMA) and Hammersmith Infant Neurological Examination (HINE) exhibit high sensitivity, their implementation may be impractical in certain clinical environments owing to requisite training. Conversely, DDST II provides a pragmatic, user-friendly option, particularly for pediatricians and primary care practitioners [14].

The clinically significant diagnostic gap of 4–5 months between DDST II detection and formal CP diagnosis identified in this study is noteworthy. Early intervention, especially during the initial 18 months of life, has demonstrated enhancements in gross motor function, cognitive outcomes, and familial adaptation [15,16]. In our study, approximately 86% of youngsters with confirmed cerebral palsy were discussed to early intervention programs shortly after DDST II screening, illustrating the tool's effectiveness in initiating timely care pathways.

The notably elevated positive predictive value (63%) and specificity (76.8%) of DDST II in this study indicate its effectiveness as a primary screening instrument, albeit not as a diagnostic tool. Children with "suspect" or "untestable" scores should be swiftly referred for specialized evaluation and neuroimaging to verify the diagnosis and exclude alternative causes of developmental delay [17].

A significant strength of this study is its emphasis on a tertiary care center in a rural/semi-urban Indian context, illustrating that DDST II can be effectively utilized in comparable settings with constrained neurodevelopmental resources. Nonetheless, specific constraints are present. The sample size was limited, and extended follow-up is required to assess the outcomes of children initially identified as "suspect" but not diagnosed with CP during the study period. Furthermore, inter-observer variability in the administration of DDST II, despite being mitigated through training, may still affect outcomes.

Notwithstanding these constraints, the results robustly advocate for the incorporation of DDST II into standard pediatric examinations, particularly for high-risk infants. Considering that numerous children with cerebral palsy remain undiagnosed until their second or third year of life, this tool can facilitate early detection and significantly enhance the timing and quality of care provided.

Conclusion

This study's findings unequivocally demonstrate that the Denver Developmental Screening Test II (DDST II) is a practical, sensitive, and effective instrument for the early identification of cerebral palsy (CP) in infants and young children. In our cohort, DDST II identified most children subsequently diagnosed with CP, significantly

lowering the average age of suspicion and facilitating earlier intervention.

Due to its simplicity of administration, affordability, and suitability for both urban and resource-constrained environments, DDST II can function as a crucial first-line developmental screening tool in pediatric outpatient clinics. The incorporation of this into standard child health surveillance programs, particularly in tertiary and primary healthcare environments, could significantly enhance long-term functional results for kids with cerebral palsy by facilitating prompt referral, diagnosis, and treatment.

We advocate for the incorporation of DDST II screening as a standard element of well-baby examinations, especially for children exhibiting risk factors such as prematurity, perinatal asphyxia, or delayed developmental milestones. Additional multicenter research with greater sample sizes and longitudinal follow-up are necessary to confirm its long-term predictive accuracy and cost-effectiveness across various populations.

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