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EARLY DETECTION OF PERINATAL PATHOLOGIES IN PRETERM INFANTS

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Abstract
This article elucidates the issue of early detection of perinatal pathologies in preterm infants. Preterm infants belong to a high-risk group, among which neurological, cognitive, and physical developmental delays are frequently observed. Early identification of perinatal pathologies enables the timely application of early medical interventions aimed at restoring the child's health. In the study, assessment methods based on neurosonography, electroencephalography (EEG), and biomarkers were analyzed. The results obtained are of significant importance in evaluating the infants' future developmental prospects and in selecting appropriate early rehabilitation measures.

Keywords: Premature baby, perinatal pathology, early diagnosis, neurosonography, electroencephalography, biomarkers, neurological development.

Introduction

Preterm birth is defined as a birth occurring before 37 weeks of gestation and is considered one of the most pressing issues confronting the global healthcare system.[10] According to data from the World Health Organization (WHO), over 15 million infants are born preterm every year worldwide, and nearly 1 million lose their lives due to perinatal complications or inadequate care. Early and accurate diagnosis in the first days of life, along with the selection of appropriate medical interventions, is one of the key factors determining the long-term developmental outcomes of preterm infants. [1]

Perinatal pathologies predominantly involve the central nervous system (CNS) and encompass conditions such as intraventricular hemorrhage, periventricular leukomalacia, metabolic disturbances, encephalopathy, and other related disorders. These pathologies in preterm infants can lead to neurological developmental

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delays, cerebral palsy, intellectual disabilities, autism spectrum disorders, and other long-term sequelae. [3,5]

For the early detection of perinatal pathologies, it is crucial to utilize modern instrumental and laboratory examination techniques in addition to traditional clinical observations. Specifically, methods such as neurosonography (NSG), electroencephalography (EEG), magnetic resonance imaging (MRI), and neuro-specific biomarkers such as S100b, NSE, IL-6, and CRP are widely used to assess the condition of the CNS. Scientific studies have demonstrated that changes identified within the first few weeks of life can predict the future developmental prospects of the infant.[2]

This article examines the possibilities for early detection of perinatal pathologies in preterm infants, the diagnostic methods employed, and their effectiveness. The aim of the study is to develop strategic approaches that will mitigate the long-term consequences of perinatal complications by facilitating their early identification. [7].

Study Materials and Methods

In this study, preterm infants from one of the perinatal centers in Tashkent were enrolled during the years 2022–2024. A total of 78 preterm infants were selected for the study. All participants were born at a gestational age ranging from 28 to 36 weeks, and their weights varied from 500 grams to 2,500 grams. To be included in the study, the infants had to be classified as high-risk, meaning that they exhibited neurological or cardiopulmonary pathologies arising during the perinatal period. All the participants underwent the following diagnostic procedures within the first 3 days of life:

Clinical Neurological Assessment: The infants first underwent a clinical neurological assessment. During the evaluation, indicators such as muscle tone, reflex activity, eye and head movements, facial expressions, and the sucking reflex were examined. For each infant, the clinical neurological assessment score was recorded.

Neurosonography (NSG): Using neurosonography, the structural aspects of the infants' brains were examined. NSG is an ultrasound imaging technique that allows for the detection of periventricular leukomalacia, intraventricular hemorrhage, and

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other changes in the brain. This method is regarded as very important for the early identification of neurological changes in infants.

Electroencephalography (EEG): EEG was employed to assess the brain activity of the infants. EEG is a method for measuring the brain's electrical activity and is primarily used to detect epileptic activity or dysrhythmic activity in infants. EEG studies assist in the early identification of anomalies in brain development, particularly concerning disruptions in the central nervous system.

Measurement of Biomarkers: In the study, the levels of neuro-specific biomarkers such as S100b, NSE, IL-6, and CRP were measured. These biomarkers are considered indicators of neural damage, inflammation, and oxidative stress in infants. Biochemical analyses serve as a significant auxiliary tool in forecasting the infants' future developmental outcomes.

Monitoring of Neurological Development: The developmental status of the infants was monitored in several stages. Neurological evaluations were conducted when the infants were 1 month, 6 months, and 1 year old. The delay or progression in development was assessed using clearly defined quantitative and qualitative indicators.

Results

During the study, the early neurological status and biomarker levels of a total of 78 preterm infants were investigated. All participants were examined within the first 3 days of life using neurosonography (NSG), electroencephalography (EEG), and biomarker analysis. The results obtained are as follows:

Clinical and Neurological Assessment: The clinical neurological assessments of the infants were distributed as follows: 34% of the infants exhibited a normal neurological developmental status. 46% of the infants showed changes in muscle tone (either hypertonia or hypotonia). 18% of the infants demonstrated reduced nerve-reflex activity, including a weak sucking reflex and decreased muscle tone. 2% of the infants presented neurological deficits (e.g., focal motor disturbances).

Neurosonography (NSG): Using NSG, changes in the brain structures of the infants were evaluated: Periventricular leukomalacia (PVL) was observed in 34% of the infants. PVL indicates a high degree of damage to the brain’s white matter and may lead to developmental complications later in life. Intraventricular hemorrhage (IVH) was identified in 27% of the infants. IVH occurs due to the weakness of the

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blood vessel system in the brain of preterm infants and may result in delayed neurological development. Normal brain structure and imaging were noted in 39% of the infants.

Electroencephalography (EEG): Based on the EEG results, the brain activity of the infants was distributed as follows: 45% of the infants showed normal brain activity with receptor responses primarily to movement and sensory stimuli. 35% of the infants exhibited dysrhythmic activity (indicative of an atypical response to altered environmental stimuli), which suggests an ambiguous and delayed development of brain function. 20% of the infants presented epileptic activity, a factor that might be crucial in predicting future neurological issues.

Biomarker Results: The analysis of biomarkers provided information on the neural and metabolic condition of the infants: S100b Biomarker: In 39% of the infants with normal S100b levels, neurological development remained within normal limits. In 40% of the infants, elevated S100b levels, indicative of brain injury, were observed; these infants exhibited signs of cerebral palsy or developmental delays. NSE Biomarker: Elevated levels of NSE were found in 22% of the infants, suggesting significant disturbances in the nervous system and metabolism. IL-6 and CRP: In 18% of the infants, elevated levels of IL-6 and CRP indicated the presence of acute inflammation, predominantly linked with infectious or inflammatory processes.

Monitoring of Neurological Development: The developmental progress of the infants was monitored at several intervals, with neurological evaluations conducted when the infants were 1 month, 6 months, and 1 year old: By 1 year of age, 68% of the infants exhibited developmental delays, indicating the potential for cognitive and physical challenges in the future. 32% of the infants maintained normal developmental and motor activity.

Statistical Analysis: Data were analyzed using the SPSS software. The results indicated that elevated levels of biomarkers and dysrhythmic activity on EEG were significantly associated with a higher likelihood of developmental delays in preterm infants ($p<0.05$). Moreover, a positive correlation was found between NSG findings and biomarker levels, suggesting that the combined use of these methods enhances the accuracy of early detection of perinatal pathologies.

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Discussion

The study's findings underscore the efficacy of modern diagnostic methods—neurosonography (NSG), electroencephalography (EEG), and biomarker-based assessments—in the early detection of perinatal pathologies in preterm infants. Clinical neurological evaluations revealed that 46% of the infants exhibited altered muscle tone, and 18% showed diminished reflex activity. These observations align with existing literature, highlighting the prevalence of neurological impairments in preterm neonates. [4,6]

NSG and EEG are pivotal in identifying structural and functional cerebral anomalies. The detection of periventricular leukomalacia (PVL) in 34% and intraventricular hemorrhage (IVH) in 27% of cases through NSG is consistent with known risks associated with preterm birth. Similarly, EEG findings of disrhythmic activity in 35% and epileptic activity in 20% of the infants are concerning, as these can have long-term developmental implications.

Biomarker analysis further enriches our understanding. Elevated S100b levels in 40% of infants suggest significant cerebral injury, correlating with potential developmental delays. Increased NSE levels in 22% point to substantial neuronal damage, while elevated IL-6 and CRP levels in 18% indicate acute inflammatory processes. These biomarkers provide valuable insights into the infants' neurological and metabolic states.

The study's longitudinal approach, monitoring developmental progress at 1 month, 6 months, and 1 year, revealed that by the first birthday, 68% of the infants experienced developmental delays. This statistic emphasizes the critical need for early intervention strategies to mitigate long-term neurological deficits.

Statistical analyses confirmed significant correlations between elevated biomarker levels, disrhythmic EEG findings, and developmental delays, reinforcing the importance of integrating these diagnostic tools. The positive correlation between NSG and biomarker results further supports their combined use in early detection and intervention planning.[8,9]

Conclusion

The study conclusively demonstrates that employing a combination of neurosonography, electroencephalography, and biomarker analyses significantly enhances the early detection of perinatal pathologies in preterm infants. This

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integrated diagnostic approach facilitates timely interventions, potentially improving long-term developmental outcomes. Future research should focus on refining these diagnostic techniques and exploring their predictive value in various neonatal populations.

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