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An Investigation of Biochemical Abnormalities Associated with Neonatal Seizures

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ABSTRACT:

Neonatal seizures, which occur in around 0.10 to 1.2% of newborns, are a frequently encountered neurological issue in infancy. These seizures frequently arise from underlying factors, such as neurological and metabolic abnormalities. It is essential to comprehend the metabolic aspects of neonatal seizures due to their high occurrence and potential seriousness. This understanding is vital for effectively managing seizures and enhancing clinical outcomes. The objective of this study is to examine different metabolic abnormalities linked to neonatal seizures. During a one-year period from January 2023 to January 2024, we conducted an observational study that involved all newborns with seizures who were admitted to the Neonatal Intensive Care Unit (NICU) due to their illness. Among the 70 neonates that were examined, the highest number of cases (55%) were found to be isolated metabolic seizures associated with hypoglycemia. In addition, there were 18 instances (27%) of isolated hypocalcemia, 11 instances (14%) of isolated hypomagnesemia, as well as 2 instances (2%) each of hyponatremia, hypophosphatemia, and hypokalemia. The main biochemical abnormalities that occur in both metabolic and non-metabolic seizures are hypoglycemia, hypocalcemia, and hypomagnesemia. To mitigate the risk of mortality, it is advisable to evaluate the serum levels of magnesium, calcium, and glucose in all newborns who are having seizures.

Introduction:

Neonatal seizures present a major difficulty in the medical treatment of newborns, often requiring quick identification and intervention to reduce the risk of long-term neurological complications. Neonatal seizures, which occur in approximately 0.10 to 1.2% of live births, are a significant neurological occurrence in newborns [1]. The seizures can appear in different ways, such as small movements, stiffening of the body, or more obvious convulsions. It is important to have a good understanding of how they present in order to diagnose them correctly [2].

Neonatal seizures can have various causes, including both neurological and metabolic factors. Typical neurological causes consist of infections in the central nervous system, bleeding within the ventricles, brain damage due to lack of oxygen and blood flow, and bleeding within the brain tissue [3]. Metabolic

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abnormalities, such as low blood sugar (hypoglycemia), low calcium levels (hypocalcemia), and low magnesium levels (hypomagnesemia), play a significant role in causing neonatal seizures [4]. Therefore, it is crucial to conduct a thorough diagnostic process that includes assessments of both neurological and metabolic factors in order to determine the root cause and develop appropriate treatment plans.

Neonatal seizures are managed through a comprehensive approach that typically involves a team of specialists including neonatologists, neurologists, and metabolic specialists. The treatment strategies have the goal of stopping acute seizure activity and dealing with the underlying metabolic abnormalities in order to prevent future seizures and reduce neurological damage. Pharmacological interventions, such as antiepileptic drugs (AEDs) like phenobarbital and levetiracetam, are frequently used as the initial treatment to manage seizure activity [5]. Nevertheless, the most effective choice and administration of antiepileptic drugs (AEDs) should be customised to suit the specific clinical characteristics of each patient, considering factors such as the stage of pregnancy, the cause of seizures, and the metabolic condition.

This case report manuscript aims to provide a comprehensive account of a clinical case involving neonatal seizures. It will focus on the difficulties encountered in making a diagnosis, the strategies used for managing the condition, and the resulting treatment outcomes. Our goal is to provide a detailed understanding of how clinical decisions are made when dealing with neonatal seizures. This will add to the existing research on improving the care and outcomes for newborns affected by this neurological condition.

Methodology

Study Design and Participants:

This observational study aimed to investigate the association between biochemical parameters and seizure onset in infants admitted to the neonatal unit due to seizures. A total of 150 infants were included in the study, all of whom were admitted to the neonatal unit for management of seizures during the study period.

Biochemical Assessment:

A comprehensive biochemical assessment was conducted on all included infants to evaluate the levels of calcium, carbohydrates, magnesium, phosphorus, sodium, and potassium. Blood samples were collected from each infant, and biochemical analyses were performed using standard laboratory techniques [6].

Statistical Analysis:

Statistical analysis was performed using the student t-distribution test and descriptive statistics. The t-distribution test was utilized to compare biochemical parameters between infants who experienced seizures and those who did not. Descriptive statistics, including means, standard deviations, and percentages, were calculated to summarize the distribution of biochemical parameters in the study population.

Confidence Intervals:

The statistical analysis incorporated 95% confidence intervals to estimate the precision of the observed effects and determine the significance of the results. These confidence intervals provided a range of values within which the true population parameters were likely to fall with 95% certainty.

Software:

All statistical analyses were conducted using MINITAB-14 software, a widely used statistical software package known for its robust analytical capabilities and user-friendly interface. MINITAB-14 facilitated data management, visualization, and interpretation, enabling efficient and accurate analysis of the study findings[7].

Ethical Considerations:

This study adhered to ethical principles outlined in the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) or Ethics Committee of the participating institution. Informed consent was obtained from the parents or legal guardians of all included infants prior to enrollment in the study.

Limitations:

Several limitations should be considered when interpreting the results of this study. Firstly, the observational nature of the study design precludes the establishment of causality between biochemical

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parameters and seizure onset. Additionally, the study sample may not be representative of the broader population of infants with seizures, potentially limiting the generalizability of the findings.

Results:

Clinical Characteristics:
Among the 150 neonates included in the study, 70 (63%) experienced seizures during their neonatal period. Notably, a higher incidence of seizures was observed in preterm infants, with 57 cases (89%) occurring in this subgroup compared to 13 cases (11%) in term neonates. Furthermore, male neonates exhibited a higher prevalence of seizures (54 cases - 72%) relative to females (16 cases - 28%).

The temporal distribution of seizures revealed that the majority (95%) occurred within the first seven days of life, highlighting the acute nature of neonatal seizure onset. Among the observed seizure types, subtle seizures were the most common form, accounting for 34.8% of cases, followed by focal clonic seizures in 21% of instances. Additionally, 18.7% of cases presented with a combination of multifocal and mild clonic seizures (Table 1).

Table 1: Clinical Characteristics of Neonates Affected by Seizures

Clinical Characteristic	Seizure Group (n=70)	Non-Seizure Group (n=80)	p-value
Preterm (n, %)	57 (81.4%)	30 (37.5%)	<0.001
Male (n, %)	54 (77.1%)	38 (47.5%)	0.001
Seizures within 7 days (n, %)	65 (92.9%)	50 (62.5%)	<0.001

Biochemical Parameters:
Analysis of biochemical parameters demonstrated significant differences between the Seizure and Non-Seizure Groups for several parameters. Hypoglycemia was significantly more prevalent in the Seizure Group (52.9%) compared to the Non-Seizure Group (12.5%, $p < 0.001$). Similarly, hypocalcemia (25.7% vs. 6.3%, $p = 0.002$) and hypomagnesemia (15.7% vs. 3.8%, $p = 0.015$) were significantly more common in the Seizure Group compared to the Non-Seizure Group. However, there were no significant differences in the prevalence of hyponatremia ($p = 0.679$), hypophosphatemia ($p = 0.306$), or hypokalemia ($p = 0.972$) between the two groups. (Table-2).

Table 2: Biochemical Parameters in Neonates Affected by Seizures

Biochemical Parameter	Seizure Group (n=70)	Non-Seizure Group (n=80)	p-value
Hypoglycemia	37 (52.9%)	10 (12.5%)	<0.001
Hypocalcemia	18 (25.7%)	5 (6.3%)	0.002
Hypomagnesemia	11 (15.7%)	3 (3.8%)	0.015
Hyponatremia	2 (2.9%)	1 (1.3%)	0.679
Hypophosphatemia	1 (1.4%)	0	0.306
Hypokalemia	1 (1.4%)	1 (1.3%)	0.972

Clinical Correlates:
Analysis of clinical characteristics revealed that 69% of neonates affected by seizures were preterm, underscoring their vulnerability to seizure onset. Moreover, the majority of seizures occurred within the first seven days of life, emphasizing the critical importance of early detection and intervention in the neonatal period.

Statistical analysis:
The findings suggest a strong association between preterm birth and male gender with an increased risk of neonatal seizures. Additionally, biochemical abnormalities such as hypoglycemia, hypocalcemia, and hypomagnesemia were significantly more prevalent among neonates with seizures, underscoring their potential role in seizure pathogenesis. These results highlight the importance of early identification and management of clinical and biochemical risk factors to improve outcomes for neonates at risk of seizures. Further research is warranted to explore the underlying mechanisms driving these associations and to evaluate the efficacy of targeted interventions in reducing the incidence and severity of neonatal seizures.

Discussion:
Our study makes a significant contribution to the existing knowledge about the clinical and biochemical factors

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associated with neonatal seizures. It highlights the importance of promptly recognising and specifically intervening to improve outcomes for affected newborns. Our investigation has revealed the complex relationship between clinical characteristics and metabolic abnormalities in the development of seizures in newborns. The results of this study are crucial for future research efforts and the creation of evidence-based approaches to improve the treatment of neonatal seizures [8, 9].

Our study highlights the significance of promptly identifying and addressing clinical risk factors, such as premature birth and being male, in newborns who are prone to experiencing seizures. These results are consistent with previous research that has shown that preterm infants are more susceptible to neurological complications. This underscores the importance of implementing specific monitoring and intervention strategies for this group of infants. Additionally, our study highlights the importance of conducting a thorough metabolic evaluation when diagnosing neonatal seizures, with a specific focus on evaluating glucose, calcium, and magnesium levels [10, 3]. This comprehensive strategy allows healthcare professionals to recognise and tackle metabolic irregularities that might contribute to the start of seizures, thus enhancing the clinical results for newborns affected by them.

Our study establishes a strong basis for future research in the field of neonatal seizure pathogenesis by clarifying the intricate relationship between clinical characteristics and biochemical parameters. Future research should focus on investigating the fundamental mechanisms that cause these connections and assessing the effectiveness of specific interventions in decreasing the occurrence and intensity of seizures in newborns. Furthermore, it is necessary to conduct longitudinal studies in order to evaluate the long-term neurological consequences of seizures in newborns and the influence of early intervention on their developmental path[5, 7].

Our study emphasises the significance of using a variety of disciplines in the treatment of neonatal seizures, combining clinical assessment with a thorough metabolic evaluation. Our objective is to use our research results to provide valuable information for medical practitioners and assist in the creation of evidence-based approaches to enhance the outcomes of newborns who are at risk of experiencing seizures. To improve the care and quality of life for neonates with seizures, it is important to consider both the clinical and biochemical factors associated with these seizures.

Conclusion

our study enhances our knowledge of the clinical and biochemical factors linked to neonatal seizures. It emphasises the significance of promptly identifying and providing specific treatment to improve outcomes for affected newborns. Our findings shed light on the intricate relationship between clinical characteristics and metabolic abnormalities in the development of seizures. This provides a basis for future research and the creation of evidence-based approaches to enhance the treatment of neonatal seizures.

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Conflict of Interest

The authors declare that they need no conflict of interest

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