Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Paediatrics

Electrolyte Status & Plasma Calcium Levels of Birth Asphyxiated Neonates

Dr. Layla Nasrin[1*], Dr. Muhammad Bipul Islam[2], Dr. I.U.M.A. Kawsar Mir[3], Dr. Muhammad Delwar Hossain[4], Dr. Mohammad Saiful Islam[5], Dr. Mohsin Uddin Ahmed[6]

[1]Senior Consultant (Paediatrics), Shaheed Tajuddin Ahmad Medical College Hospital, Gazipur, Bangladesh
[2]Associate Professor (ENT), Shaheed Tajuddin Ahmad Medical College, Gazipur, Bangladesh
[3]Assistant Professor (Paediatrics), Shaheed Tajuddin Ahmad Medical College, Gazipur, Bangladesh
[4]Assistant Professor (Paediatrics), Shaheed Tajuddin Ahmad Medical College, Gazipur, Bangladesh
[5]Assistant Professor (Neonatology), Shaheed Tajuddin Ahmad Medical College, Gazipur, Bangladesh
[6]Assistant Professor (Paediatrics), Shaheed Tajuddin Ahmad Medical College, Gazipur, Bangladesh

DOI: 10.36347/sjams.2024.v12i06.008 | **Received:** 15.04.2024 | **Accepted:** 27.05.2024 | **Published:** 12.06.2024

***Corresponding author:** Dr. Layla Nasrin
Senior Consultant (Paediatrics), Shaheed Tajuddin Ahmad Medical College Hospital, Gazipur, Bangladesh

Abstract **Original Research Article**

Background: Birth asphyxia presents a significant challenge in neonatal care, marked by impaired gas exchange leading to hypoxia, hypercapnia, and acidosis. The condition necessitates a thorough understanding of its pathophysiology and the management of associated biochemical derangements, particularly electrolyte imbalances and plasma calcium levels. ***Objective:*** This study aimed to evaluate the electrolyte status and plasma calcium levels of birth asphyxiated neonates. ***Methodology:*** A prospective study was conducted involving 50 term neonates, including 25 asphyxiated and 25 non-asphyxiated infants, recruited from the NICU of a 250 Beded District Hospital, Sherpur between April 2020 and July 2021. Cases were designated based on established criteria, and controls were selected accordingly. The study protocol received institutional ethical approval. ***Results:*** Gender distribution ($p = 0.76$) and mode of delivery ($p = 0.65$) were similar between cases and controls. APGAR scores were significantly lower in cases at 1, 5, and 10 minutes ($p < 0.05$). Cases exhibited lower sodium ($p = 0.001$) and higher potassium ($p = 0.001$) levels than controls. Calcium levels were significantly reduced in cases ($p = 0.001$). Across HIE stages, sodium decreased ($p = 0.001$), potassium increased ($p = 0.002$), and calcium decreased ($p = 0.001$) significantly. Results emphasize the importance of monitoring and managing electrolyte imbalances in birth asphyxia for improved neonatal outcomes. ***Conclusion:*** Our findings underscore the importance of monitoring and managing electrolyte imbalances and plasma calcium levels in birth asphyxiated neonates. Early identification and correction of these disturbances are crucial for optimizing clinical outcomes and reducing the risk of long-term sequelae. Further research is warranted to elucidate the underlying mechanisms and refine therapeutic strategies in this vulnerable population.

Keywords: Birth asphyxia, neonates, electrolyte imbalance, plasma calcium levels, hypoxic-ischemic encephalopathy.

INTRODUCTION

Birth asphyxia remains a significant neonatal complication with serious short- and long-term consequences. It is a condition characterized by impaired gas exchange leading to hypoxia, hypercapnia, and acidosis, which can adversely affect multiple organ systems in neonates. Despite advances in neonatal care, birth asphyxia continues to be a major cause of neonatal morbidity and mortality worldwide, particularly in low- and middle-income countries. The condition necessitates a comprehensive understanding of its pathophysiology and the management of various biochemical derangements that arise as a result of hypoxic insult [1-5].

One of the critical aspects of managing birth asphyxia involves monitoring and correcting electrolyte imbalances. Neonates experiencing birth asphyxia often present with significant disturbances in their electrolyte status, which can exacerbate the clinical picture and complicate management [6-9]. Electrolytes such as sodium, potassium, and chloride are crucial for maintaining cellular function, fluid balance, and neuromuscular activity. Disruptions in these electrolytes can lead to severe complications, including cardiac arrhythmias, neuromuscular irritability, and renal dysfunction. Therefore, timely assessment and correction of electrolyte imbalances are vital in the clinical care of these neonates [10-11].

Among the various biochemical parameters, plasma calcium levels hold particular importance in the

context of birth asphyxia. Calcium plays a pivotal role in numerous physiological processes, including muscle contraction, enzyme activity, and neuronal function. Hypocalcemia, or low plasma calcium levels, is a common finding in birth asphyxiated neonates and can have profound effects on the cardiovascular and neuromuscular systems. It can manifest as seizures, hypotonia, or cardiac dysfunction, further complicating the clinical management of these vulnerable infants. The etiology of hypocalcemia in this setting is multifactorial, involving impaired parathyroid hormone secretion, reduced calcium intake, and renal losses [12].

Given the critical nature of electrolyte and calcium disturbances in birth asphyxiated neonates, early and accurate assessment is essential. This involves routine monitoring of blood gas analyses and serum electrolyte levels to guide appropriate therapeutic interventions. By understanding and addressing these biochemical derangements promptly, healthcare providers can improve the overall outcomes and reduce the risk of long-term sequelae in affected neonates. Thus, ongoing research and clinical focus on electrolyte status and plasma calcium levels are imperative in optimizing the care and prognosis of birth asphyxiated neonates.

Objective

In this study our main goal is to evaluate electrolyte status & plasma calcium levels of birth asphyxiated neonates.

METHODOLOGY

Study Design and Participants

A prospective study was conducted involving 50 term neonates, comprising 25 asphyxiated and 25 non-asphyxiated infants, recruited from the NICU of 250 Beded District Hospital, Sherpur between April 2020 and July 2021. The asphyxiated neonates were designated as cases, while the non-asphyxiated neonates served as controls. The study protocol received approval from the institutional ethical committee of Al Ameen Medical College and Hospital.

Inclusion Criteria

The study included neonates with a gestational age of 37 weeks or more who were admitted to the NICU with perinatal asphyxia. Inclusion criteria were defined by an Apgar score of less than 7 at 5 minutes of life, the absence of stable spontaneous respiration, and the requirement for more than one minute of positive pressure ventilation during resuscitation.

Exclusion Criteria

Neonates with congenital anomalies, those born to mothers with metabolic disorders, and those whose mothers had a history of drug abuse, alcohol use, smoking, or were taking antiepileptic or antidepressant medications were excluded. Additionally, neonates whose parents did not provide consent were not included in the study.

Resuscitation and Care

All asphyxiated newborns were resuscitated according to the guidelines of the Neonatal Resuscitation Program (NRP), with Apgar scores recorded at one and ten minutes. Following resuscitation, the neonates were transferred to a level III nursery for advanced care. Special attention was given to maintaining the infants' body temperature, as temperature fluctuations can impact electrolyte balance.

Data Collection and Classification

The medical records of neonates with perinatal asphyxia were reviewed using a structured proforma. The severity of hypoxic-ischemic encephalopathy (HIE) was classified into mild (HIE I), moderate (HIE II), and severe (HIE III) stages based on the modified Sarnat staging system.

Electrolyte Analysis

Serum electrolyte levels were measured using a standard electrolyte analyzer (Abbott Healthcare, India), following the ion-selective electrode method.

Statistical Analysis

Data entry and analysis were performed using the Statistical Package for Social Sciences version 24 (SPSS, IBM, Chicago, IL, USA). Continuous and categorical variables were expressed as mean ± standard deviation. The comparison of serum electrolytes between cases and controls was conducted using an unpaired student's t-test, with a p-value of less than 0.05 considered statistically significant.

RESULTS

Gender distribution was comparable between the two groups, with 64% males and 36% females in the cases, and 72% males and 28% females in the controls ($p = 0.76$, not statistically significant). Similarly, there were no significant differences in the mode of delivery between cases and controls, with 32% of cases delivered vaginally compared to 28% of controls ($p = 0.65$, not statistically significant). The mean gestational period was also similar between cases (38.13 ± 2.45 weeks) and controls (37.92 ± 4.65 weeks), with no statistically significant difference observed ($p = 0.65$, not statistically significant).

Table 1: Demographics characteristics between cases and controls

APGAR scores	Cases, (n=25) (%)	Controls (n=25), (%)	P value
Gender			
Male	16 (64)	18 (72)	0.76^{NS}
Females	9 (36)	7 (28)	
Mode of delivery			
Vaginal	8 (32)	3 (28)	0.65 ^{NS}
Non-vaginal	17 (68)	22 (72)	
Gestation period (weeks) (mean ± SD)	38.13±2.45	37.92±4.65	0.65 ^{NS}

NS-Non significant

Comparison of APGAR scores between cases (neonates with perinatal asphyxia) and controls (non-asphyxiated neonates) revealed statistically significant differences across all time points. At 1 minute, the mean APGAR score for cases was significantly lower at 4.27 ± 0.98 compared to controls at 7.26 ± 0.87 (p = 0.004). Similarly, at 5 minutes, cases had a significantly lower mean APGAR score of 5.16 ± 0.85 compared to controls at 8.42 ± 1.45 (p = 0.005). By 10 minutes, the difference persisted, with cases showing a mean APGAR score of 7.12 ± 0.76, significantly lower than controls at 9.52 ± 0.65 (p = 0.01).

Table 2: Comparison of APGAR scores between cases and controls

APGAR scores (Min)	Cases (n=25)	Controls (n=25)	P value
1	4.27 ±0.98	7.26±0.87	0.004*
5	5.16±0.85	8.42±0.1.45	0.005*
10	7.12±0.76	9.52±0.65	0.01*

*Significant p<0.05

Cases exhibited lower mean sodium levels (129.78 ± 4.18 meq/L) compared to controls (140.76 ± 9.76 meq/L), with a significant p-value of 0.001. Similarly, potassium levels were significantly elevated in cases (7.12 ± 0.32 meq/L) compared to controls (5.05 ± 0.12 meq/L), with a p-value of 0.001. Additionally, calcium levels were notably reduced in cases (8.12 ± 2.87 mg/dl) compared to controls (10.42 ± 3.12 mg/dl), with a significant p-value of 0.001.

Table 3: Serum electrolytes level between cases and controls

Electrolytes	Normal range	Cases (n=25)	Controls (n=25)	P value
Sodium (meq/L)	134-146	129.78±4.18	140.76±9.76	0.001*
Potassium (meq/L)	3.0-6.0	7.12±0.32	5.05±0.12	0.001*
Calcium (mg/dl)	9.0-11.6	8.12±2.87	10.42±3.12	0.001*

Unpaired student t test * denotes significant p<0.05

The comparison of serum electrolyte levels among asphyxiated neonates according to hypoxic-ischemic encephalopathy (HIE) stages revealed significant differences across all parameters. In neonates with HIE stage I (Mild), mean sodium levels were 133.65 ± 5.76 meq/L, while in HIE stage II (Moderate) and HIE stage III (Severe), sodium levels decreased to 129.16 ± 6.12 meq/L and 125.97 ± 4.87 meq/L, respectively (p = 0.001). Similarly, potassium levels increased progressively from HIE stage I (4.12 ± 0.98 meq/L) to HIE stage III (5.65 ± 0.565 meq/L), with a significant p-value of 0.002. Furthermore, calcium levels decreased across HIE stages, with mean levels of 9.12 ± 2.34 mg/dl in HIE stage I, 8.42 ± 1.76 mg/dl in HIE stage II, and 7.98 ± 1.05 mg/dl in HIE stage III (p = 0.001).

Table 4: Comparison of serum electrolytes level in asphyxiated babies according to HIE stages

Serum electrolytes	HIE stage I (Mild, n=14)	HIE stage II (Moderate, n=8)	HIE stage III (Severe, n=3)	P value
Sodium (meq/L)	133.65±5.76	129.16±6.12	125.97±4.87	0.001*
Potassium (meq/L)	4.12±0.98	5.05±0.77	5.65±0.565	0.002*
Calcium (mg/dl)	9.12±2.34	8.42±1.76	7.98±1.05	0.001*

One way ANOVA, * denotes significant p<0.05

DISCUSSION

Perinatal asphyxia, characterized by hypoxic-ischemic insult, primarily affects tissue integrity, particularly brain tissue, leading to electrolyte imbalances [10]. In our study of 25 neonates, a higher incidence of asphyxia was observed in males (64%), consistent with previous reports. This gender disparity may be attributed to the vulnerability of respiratory control neurons in the male brainstem. APGAR scores at 1, 5, and 10 minutes were significantly lower in asphyxiated cases compared to controls, indicating the severity of perinatal distress. Previous research suggests that low APGAR scores at 1 minute correlate with a higher risk of severe asphyxia [11-14]. Asphyxiated neonates exhibited significant alterations in serum sodium, potassium, and calcium levels compared to controls, consistent with findings from prior studies [15-16]. Majority of neonates in our study were classified as HIE stage 1 (low severity), similar to other reports citing various risk factors contributing to hypoxic-ischemic insult. Notably, hyponatremia, hyperkalemia, and hypocalcemia were more pronounced in HIE stage 3 compared to HIE stage 2 and 1, consistent with findings indicating a correlation between electrolyte abnormalities and the severity of HIE [17-18]. However, our study is limited by its small sample size and single-institutional nature. Additionally, other parameters such as electroencephalogram and stretch reflexes were not evaluated, and maternal factors influencing electrolyte abnormalities in asphyxiated neonates were not correlated.

CONCLUSION

In our study, we observed a higher incidence of hyponatremia, hypocalcemia, and hypoglycemia among asphyxiated neonates compared to controls. Furthermore, the severity of electrolyte disturbances was notably elevated in neonates classified with HIE stage 3.

REFERENCE

1. Berhe, Y. Z., Kebedom, A. G., Gebregziabher, L., Assefa, N. E., Berhe, L. Z., Mohammednur, S. A., ... & Teka, H. G. (2020). Risk factors of birth asphyxia among neonates born in public hospitals of Tigray, Northern Ethiopia. *Pediatric health, medicine and therapeutics*, 13-20.
2. World Health Organization. ICD-10. 2010. Avaialble at: https://icd.who.int/browse10/2010/en#/P21. Accessed on 25th March 2023.
3. Sankar, M. J., Neogi, S. B., Sharma, J., Chauhan, M., Srivastava, R., Prabhakar, P. K., ... & Paul, V. K. (2016). State of newborn health in India. *Journal of perinatology*, *36*(3), S3-S8.
4. Sarnat, H. B., & Sarnat, M. S. (1976). Neonatal encephalopathy following fetal distress: a clinical and electroencephalographic study. *Archives of neurology*, *33*(10), 696-705.
5. Kardana, I. M. (2016). Risk factors of perinatal asphyxia in the term newborn at sanglah general hospital, bali-indonesia. *Bali Medical Journal*, *5*(1), 175-178.
6. Basu, P., Som, S., Das, H., & Choudhuri, N. (2010). Electrolyte status in birth asphyxia. *The Indian Journal of Pediatrics*, *77*, 259-262.
7. Verma, R. P., Shibli, S., & Komaroff, E. (2017). Postnatal transitional weight loss and adverse outcomes in extremely premature neonates. *Pediatric reports*, *9*(1), 6962.
8. Moen, V., & Irestedt, L. (2010). Hyponatremia in birth asphyxia—Cause or effect?. *The Indian Journal of Pediatrics*, *77*, 1049-1050.
9. Thakur, J., Bhatta, N. K., Singh, R. R., Poudel, P., Lamsal, M., & Shakya, A. (2018). Prevalence of electrolyte disturbances in perinatal asphyxia: a prospective study. *Italian journal of pediatrics*, *44*, 1-6.
10. AN, O. (2011). Prevalence of neonatal hypocalcaemia among full-term infants with severe birth asphyxia. *Pacific Journal of Medical Sciences*, 3-12.
11. Sarnat, H. B., & Sarnat, M. S. (1976). Neonatal encephalopathy following fetal distress: a clinical and electroencephalographic study. *Archives of neurology*, *33*(10), 696-705.
12. Bahatkar, K., & Aundhakar, C. D. (2021). Electrolyte status and plasma glucose levels in birth asphyxia: A case–control study. *Journal of Medical Sciences*, *41*(1), 17-21.
13. Masood, N., tul Muntiha, S., Sharif, M., & Asghar, R. M. (2016). Correlation of serum electrolyte changes with severity of birth asphyxia in newborns. *Journal of Rawalpindi Medical College*, *20*(1).
14. Mage, D. T., & Donner, M. (2006). Female resistance to hypoxia: does it explain the sex difference in mortality rates?. *Journal of women's health*, *15*(6), 786-794.
15. Aliyu, I., Lawal, T. O., & Onankpa, B. (2018). Hypoxic-ischemic encephalopathy and the Apgar scoring system: The experience in a resource-limited setting. *Journal of Clinical Sciences*, *15*(1), 18-21.
16. Simiyu, I. N., Mchaile, D. N., Katsongeri, K., Philemon, R. N., & Msuya, S. E. (2017). Prevalence, severity and early outcomes of hypoxic ischemic encephalopathy among newborns at a tertiary hospital, in northern Tanzania. *BMC pediatrics*, *17*, 1-6.
17. Acharya, A., Swain, B., Pradhan, S., Jena, P. K., Mohakud, N. K., Swain, A., & Mohanty, N. (2020). Clinico-biochemical correlation in birth asphyxia and its effects on outcome. *Cureus*, *12*(11).
18. Bhat, J. A., Sheikh, S. A., & Ara, R. (2019). Prevalence of electrolyte imbalance in hypoxic-ischemic encephalopathy: a hospital-based prospective observational study. *Iranian Journal of Neonatology*, *10*(3).