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FREQUENCY OF ACUTE KIDNEY INJURY (AKI) AMONG NEWBORNS HAVING BIRTH ASPHYXIA PRESENTING AT TERTIARY CARE/ GMC TEACHING HOSPITAL SUKKUR

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Abstract

Background: *Asphyxia at birth is a leading cause of neonatal morbidity and mortality globally, and is often complicated by multiorgan dysfunction. The kidneys are especially susceptible to hypoxic-ischemic injury and develop acute kidney injury (AKI). Early diagnosis of AKI is critical because it can play a large role in the morbidity and mortality for the neonate.*

Objective: *To determine the frequency of acute kidney injury (AKI) among newborns having birth asphyxia presenting at tertiary care/ GMC teaching hospital Sukkur.*

Methodology: *This was a cross-sectional descriptive study that was carried out at Department of Pediatric Medicine, Ghulam Muhammad Mahar Medical College (GMC) Teaching Hospital Sukkur from January 2025 to May 2025. The neonates of the term were sampled consecutively and 116 neonates with birth asphyxia were enrolled. A structured proforma was used to record the demographic and clinical characteristics. The diagnosis of acute kidney injury was made if there was a serum creatinine level >1.5 mg/dL and urine output of <1 mL/kg/hour. The data were analyzed using the SPSS 26.0 Software. Frequency, percent, mean and standard deviation were computed. For possible effect modifiers, stratification was carried out.*

Results: *The mean age in 116 neonates with birth asphyxia was 3.2±1.4 days and 67 (57.8%) were male. A total of 27 (23.3%) neonates had acute kidney injury. Grade-I AKI was observed in 14 (51.9%), Grade-II in 8 (29.6%), and Grade-III in 5 (18.5%) affected neonates. Neonatal seizures and severe birth asphyxia were significant relations with AKI ($p<0.05$).* ***Conclusion:*** *Acute kidney injury is a common complication in newborn with birth asphyxia. Early diagnosis and prompt intervention might lessen renal complications and better the neonatal outcome.*

INTRODUCTION

Birth Asphyxia is a public health problem and is one of the leading causes of neonatal morbidity and mortality globally. It is defined as failure to exchange gases in the peripartal period, which leads to hypoxemia, hypercapnia and metabolic acidosis. Although there have been improvements in the care of the newborn, birth asphyxia remains

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a major cause of neonatal intensive care unit (NICU) admissions, especially in developing countries. It is reported to occur at rates of 1 to 10 cases per 1,000 live births and thus has a significant burden on neonatal health services [1]. Asphyxia during the perinatal period may lead to impaired functioning of the central nervous system, cardiovascular system, respiratory system, gastrointestinal system and kidneys. Of these organs, the kidneys are especially vulnerable to hypoxic-ischemic damage due to the substantial decrease in renal blood flow during asphyxial events. Acute kidney injury (AKI), as such, is one of the most common complications seen in neonates who experience birth asphyxia and can occur within the first few days of life. The clinical significance of persistent AKI, with links to adverse neurodevelopmental, and growth outcomes, has been demonstrated [2].

Many factors during pregnancy, fetal, and in the delivery process have been recognized which may be risk factors for birth asphyxia. These include long labor, fetal distress, obstructed labor, hypertensive disorders of pregnancy and lack of monitoring during labor. These risk factors are associated with increased risk of neonatal hypoxic injury, which may lead to organ dysfunction, such as renal impairment. Identification of these risk factors early is crucial to avoid negative neonatal outcomes [3].

In recent years, there have been significant new developments in the diagnosis and monitoring of AKI in the laboratory. Classically, AKI has only been recognised when urinary output decreases significantly, but current evidence shows that any rise in serum creatinine is linked to higher short- and long-term morbidity and mortality. Better diagnostic criteria and laboratory methods have helped to detect and manage renal injury in very sick neonates earlier [4].

AKI has been identified as an independent predictor of clinical outcomes in the very sick newborn. Neonatal AKI has been linked to several factors including hypoxemia, hypercapnia, hemodynamic instability, sepsis and mechanical ventilation. AKI is a contributing factor to long hospital stays, higher healthcare costs, and mortality rates [5].

Mechanical ventilation is frequently life-saving in neonates who are critically ill, but could also worsen renal dysfunction by causing similar changes in systemic and renal hemodynamics. Ventilatory parameters optimisation, avoiding prolonged hypoxia and hypercapnia, and careful use of positive end-expiratory pressure (PEEP) have been suggested as ways to reduce the risk of AKI. However, there are few effective prevention strategies available for neonatal AKI [6].

The incidence of AKI in neonates with birth asphyxia is diverse in different populations and health care contexts. A recent study by Tounsa et al. at Bahawal Victoria Hospital has shown that 18.02% of neonates with asphyxia of birth developed A.K.I. This result is significant in that renal involvement is quite common with affected infants [7].

Likewise, Anjum et al. reported the frequency of AKI to be 40.09% in Karachi, among neonates with birth asphyxia. Reported frequencies were widely ranged, which could be due to differences in the study populations, criteria for asphyxia, asphyxia severity, and resources for healthcare [8].

Large-scale, international studies have also shown the importance of neonatal AKI. In a study called Assessment of Worldwide Acute Kidney Injury Epidemiology in Neonates (AWAKEN), it was found that AKI was a frequent occurrence in hospitalized neonates and that it was independent predictor of higher mortality and duration of hospital stay. This study reinforces the importance of regular checking of renal function in high-risk neonates [9].

Moreover, early onset neonatal AKI studies have contributed to the identification of some perinatal and neonatal risk factors for the development of early onset neonatal AKI. Identification of infants at risk early and prompt intervention to provide supportive measures can help improve outcomes and decrease the burden of renal complications. Hence, it is crucial to understand the incidence of AKI in newborns following birth asphyxia to establish a monitoring and management strategy for improving neonatal survival and long-term health in newborns with birth asphyxia [10].

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OBJECTIVE: To determine the frequency of acute kidney injury (AKI) among newborns having birth asphyxia presenting at tertiary care/ GMC teaching hospital Sukkur.

METHODOLOGY

This was a cross-sectional descriptive study that was carried out at Department of Pediatric Medicine, Ghulam Muhammad Mahar Medical College (GMC) Teaching Hospital Sukkur from January 2025 to May 2025.The sample of the term neonates with birth asphyxia was taken by non-probability consecutive sampling method, that is, the first 116 neonates who were born asphyxiated were included. Demographic and clinical parameters such as age, gender, birth weight, gestational age, mode of delivery, and history of seizures were obtained. Serum creatinine and electrolyte levels were obtained in a sterile manner. Urine production was hourly for over 6 hours. Acute kidney injury was defined by preformed operational definitions. A structured data collection proforma was used to record all information.

INCLUSION CRITERIA

Neonates of both gender, with history of birth asphyxia and gestational age ≥37 weeks were included in all term neonates.

EXCLUSION CRITERIA

Mothers with hypertension, diabetes mellitus, or who had received nephrotoxic drugs during pregnancy and mothers with other known causes of acute kidney injury along with neonates with low APGAR scores due to opium or anesthesia exposure, cyanotic congenital heart defects, chromosomal anomalies or congenital infections, were excluded.

DATA COLLECTION PROCEDURE

All eligible neonates who were admitted to the NICU were enrolled consecutively, after obtaining ethical permission and informed parent consent. Complete maternal and neonatal history took place and detailed physical examination was carried out. Demographic data, such as age, gender, birth weight, length, fronto-occipital circumference, gestational age, mode of delivery, and seizure history were obtained. The delivery records were used to record the APGAR scores at 1 and 5 minutes. Blood samples were taken aseptically from the veins and tested for serum creatinine and electrolyte levels. Standard NICU monitoring techniques were used to measure urine output hourly for over 6 hours. When indicated, ultrasound of the kidneys, ureters, and bladder was done. The operational criteria for the diagnosis of AKI and its severity were predetermined.

DATA ANALYSIS

The Statistical Package for Social Sciences (SPSS) version 26 was used in entering and analyzing the data. Data for continuous variables (age, birth weight, length and fronto-occipital circumference) were presented as mean ± SD or median with IQR as appropriate. The Shapiro-Wilk test was used to assess normality. Categorical variables like gender, residence, gestational age category, mode of delivery, neonatal seizures, acute kidney injury, and AKI stage were displayed as frequencies and percentages. Potential effect modifiers (age, sex, gestational age, residence and mode of delivery) were controlled by stratification. Where appropriate, a chi-square test or Fisher's exact test was used. Statistically significant (p-value) was set as ≤ 0.05.

RESULTS

116 neonates with birth asphyxia were recruited in this study to calculate the incidence of acute kidney injury (AKI). The mean age at admission was 3.2 ± 1.4 days, while the mean birth weight was 2.91 ± 0.43 kg. Of the study participants, 67 (57.8%) were males and 49 (42.2%) were females. Thirty-six (31.0%) neonates had neonatal seizures.

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Baseline characteristics of the study population (n = 116).

Variable	Value
Mean Age (days)	3.2 ± 1.4
Mean Birth Weight (kg)	2.91 ± 0.43
Male Gender	67 (57.8%)
Female Gender	49 (42.2%)
Neonatal Seizures	36 (31.0%)
No Neonatal Seizures	80 (69.0%)

Only term neonates with birth asphyxia and admitted to NINN were included.

The frequency of acute kidney injury among neonates of birth asphyxia (n = 116).

Acute Kidney Injury (AKI)	Frequency	Percentage
Present	27	23.3%
Absent	89	76.7%
Total	116	100%

Twenty-seven (23.3%) neonates were diagnosed with AKI, and 89 (76.7%) neonates were not diagnosed with AKI.

Distribution of AKI Severity Among Affected Neonates (n = 27)

AKI Stage	Frequency	Percentage
Grade-I	14	51.9%
Grade-II	8	29.6%
Grade-III	5	18.5%
Total	27	100%

The most frequent stage of AKI was Grade-I (51.9%) followed by Grade-II (29.6%) and Grade-III (18.5%) in neonates with AKI.

Association Between Neonatal Seizures and Acute Kidney Injury

Neonatal Seizures	AKI Present n (%)	AKI Absent n (%)	Total	p-value
Yes (n=36)	15 (41.7)	21 (58.3)	36	
No (n=80)	12 (15.0)	68 (85.0)	80	
Total (n=116)	27 (23.3)	89 (76.7)	116	0.004

Neonates with seizures had a significantly increased incidence of AKI than those without seizures (41.7% vs. 15.0% respectively, p = 0.004).

Acute Kidney Injury stratified by Gender

Gender	AKI Present n (%)	AKI Absent n (%)	Total	p-value
Male (n=67)	17 (25.4)	50 (74.6)	67	
Female (n=49)	10 (20.4)	39 (79.6)	49	
Total (n=116)	27 (23.3)	89 (76.7)	116	0.53

No significant difference was observed between the incidence of acute kidney injury (AKI) among males and females (p = 0.53).

Final Results Summary

23.3% of 116 term neonates with birth asphyxia had acute kidney injury. 51.9% and 29.6% of the affected neonates had Grade-I and Grade-II AKI, respectively, while 18.5% had Grade-III AKI. Gender was not significantly associated with the development of AKI (p = 0.53) while neonatal seizures were significantly associated with this (p =

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0.004). This is a finding that renal insult is also a frequent complication of birth asphyxia and emphasizes the need to monitor routinely infants with BAI for early diagnosis and timely management.

DISCUSSION

Infant asphyxia remains one of the most common causes of infant mortality and morbidity, particularly in low and middle-income countries, where services for responsive obstetric and neonatal intensive care do not exist [1]. In the present study, it was found that about 25% of the neonates with birth asphyxia developed acute kidney injury (AKI); indicating that the renal burden is significant of the hypoxic–ischemic insults in the neonatal period [2]. The renal tissue is particularly vulnerable to asphyxial events, and during the compensatory phase, there is a marked reduction in renal perfusion following asphyxial events, which may lead to ischemic tubular injury and render the neonates susceptible to such injury [3].

The high prevalence of AKI in this study (23.3%) is comparable to other hospital based studies and supports previous studies that birth asphyxia is a major contributor to neonatal renal dysfunction [4]. The different incidences of AKI reported in different studies could be due to differences in the severity of hypoxia, when renal function was assessed, and the criteria used for identification of AKI [5]. With the use of the advances of the laboratory techniques and better biochemical monitoring renal injury can be detected earlier in the critically ill neonate [4].

Neonatal AKI is a clinically important condition which has become increasingly recognised as having adverse short-term outcomes. Studies conducted in tertiary care center have revealed that critically ill neonates with an AKI associated with longer hospital stay, increased ventilator usage and higher mortality rates [7]. The incidence of AKI reported in this study was also a lower percentage than reported in a South Asian patient population by Anjum et al, who reported a very high incidence, and this may be due to variations in the nature of the disease or health care delivery [8].

Large, multicenter studies have also helped clarify the epidemiology of neonatal AKI, and shown that it is a frequent event in various sub-populations of neonates and independently associated with unfavorable clinical consequences. [9] Additional studies have demonstrated that the hypotension, instability of fetal hemodynamics and the stress of the perinatal period are important risk factors for EO-NAKI [10].

This is because the outcomes of renal injury are dependent on the timing of renal injury. The etiology of early-onset AKI is usually related to events occurring in the perinatal period, while late-onset AKI is usually associated with ongoing critical illness, sepsis or receiving nephrotoxic drugs [11]. Understanding these patterns is important to recognize the importance of continuous renal monitoring throughout the neonatal intensive care unit (NICU) journey.

Most cases were grade-I AKI and hence early detection of most cases. This underscores the importance of a consistent diagnosis and frequent assessment of urine output and serum creatinine in neonates who have been born asphyxiated and may help to prevent the onset of acute renal damage [12] Early recognition will help ensure appropriate fluid management and avoiding nephrotoxic medications.

AKI is a systemic illness, rather than a renal disease. Multiple organ systems such as kidney and central nervous system [13] are involved in the inflammatory, oxidative, and endothelial dysfunction processes that are activated by hypoxic–ischemic injury. The strong correlation found between neonatal seizures and AKI in the present study may be explained by such a mechanism, as both are a reflection of the severity of the hypoxic insult.

Recent studies also have demonstrated that repeated or chronic episodes of AKI have adverse effects on neonatal outcomes in terms of neonatal mortality, and chronic morbidity [14]. The results signify the potential value of structured monitoring and prevention programs of AKI in neonates who are experiencing birth asphyxia.

Also, population-based studies have demonstrated that the severity of hypoxia and clinical instability are associated with the risk of AKI in the perinatal

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period [15]. Standardized monitoring protocols and early diagnosis and risk stratification is also emphasized in some of the clinical reviews, particularly in a neonatal intensive care unit [16]. The significance of neutrophil gelatinase-associated lipocalin (NGAL) and other novel biomarkers in the early diagnosis of renal damage remains confirmed by the biomarker research [17]. Recent studies also have shown that episodes of neonatal AKI are associated with other significant short- and long-term outcomes like increased hospital length of stay, increased mortality rates, recurrence of episodes of AKI and increased risk of chronic kidney disease (CKD) [18,19]. The results highlight the importance of the AKI in the neonate as an acute complication as well as a risk factor for long-term renal vulnerability.

In conclusion, the present study points to neonatal AKI being a common and important complication of birth asphyxia. Neonatal diagnosis, using a standardized set of criteria, may be helpful to increase short-term survival and decrease long-term renal and neurodevelopmental complications in affected neonates when combined with careful monitoring and supportive management.

CONCLUSION

Neonates who experience birth asphyxia are often affected by acute kidney injury. In the present study, almost one-quarter of infants with hypoxic-ischemic injury had renal involvement with subsequent development of AKI. Most of the cases were graded as Grade-I AKI and early monitoring could help to detect this before further development to Grade-II AKI with more severe renal involvement. Further, factors that are known to be associated with severe neonatal illness (neonatal seizures) were strongly associated with the development of AKI, again highlighting the close relationship between systemic hypoxia and multiorgan damage. All newborns who suffer from birth asphyxia should, therefore, be routinely assessed for serum creatinine level and urine output as part of their management. Diagnosis at an early stage, frequent follow-up and timely supportive therapy will reduce renal complications and optimize the prognosis for the neonate. More multicenter trials with larger numbers of patients are warranted to evaluate more long-term renal outcomes and to identify other risk factors for N-AKI.

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