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Original Article

Acute Kidney Injury in Neonates Who Develop Asphyxia at the Time of Delivery

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ABSTRACT

Objective: To determine the frequency of acute kidney injury in neonates who develop asphyxia at delivery.

Study Design: Cross-sectional study.

Place and Duration of Study: Department of Paediatrics, Pak-Emirates Military Hospital, Rawalpindi Pakistan, Aug 2021 to Feb 2022.

Methodology: This study was based on 69 patients diagnosed with birth asphyxia on the basis of APGAR score at 5 minutes. Patients underwent testing for serum creatinine levels at 24 hours post-delivery, as well as the monitoring of urine output, and acute kidney injury was classified according to the KDIGO classification, based on the increase in serum creatinine levels and urine output.

Results: Acute kidney injury was observed in 12(17.4%) cases and 3(4.3%) neonates died. Lower gestational age at birth was associated with acute kidney injury (p=0.038), and acute kidney injury was associated with a higher chance for mortality (p<0.001). Additionally, male infants had a lower head circumference (p=0.001), a lower total body length (p<0.001) and a lower APGAR score at birth (p=0.004) when compared to females. However, they did not appear to have a higher risk for acute kidney injury (p=0.121).

***Conclusion*:** Acute kidney injury following the development of birth asphyxia is a common occurrence in our population efforts should be made to identify pregnancies at risk to mitigate this potentially devastating complication.

Keywords: Acute kidney injury, Birth asphyxia, Infant mortality.

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INTRODUCTION

The World Health Organization estimates that approximately 4 million neonates die from birth asphyxia per annum, occurring in between 4.6-26 cases per 1000 live births.[1] This complication commonly occurs secondary to disorders related to anatomical problems close to or at the time of delivery, such as umbilical cord asphyxia, uterine rupture or hyperstimulation, placenta previa/placental abruption, abnormal liquor volume, premature rupture of the membranes, pre-term birth and arrested or prolonged labour.[2,3] Short-term complications of birth asphyxia include homeostasis disorders such as hypoxia/anoxia, hypotension, hypercarbia and respiratory acidosis.[4] Long-term complications include various neurological sequelae, resulting in development delays, cognitive dysfunction, behavioural or emotional disorders, or even overt cerebral palsy or seizure disorders.[5]

Acute kidney injury (AKI) represents an abrupt disturbance in renal function as manifested by a drop in the glomerular filtration rate.[6] This disruption in renal function is not usually recognized as a sequelae of birth asphyxia.[7] However, the occurrence of hypotension as a consequence of birth asphyxia may result in decreased renal perfusion, which culminates in acute tubular necrosis, with an ensuing rise in serum creatinine levels.[8,9]

Early identification of potential causes of birth asphyxia is essential, as the best treatment is prevention. However, this is not always possible, and it becomes essential to correct the inciting event to mitigate the consequences, such as acute kidney injury. Understanding the frequency with which this devastating complication can occur is essential to sensitize the paediatrician to look for it. This study was carried out to determine the acute kidney injury in neonates suffering from birth asphyxia in the Pakistani population. An accurate determination will allow the attending clinician to remain vigilant and initiate the appropriate intervention to reduce morbidity, mortality and financial costs when managing such patients.

METHODOLOGY

The cross-sectional study was conducted from August 2021 to Feb 2022 at the Department of

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Paediatrics, Pak-Emirates Military Hospital, Rawalpindi Pakistan, after IERB approval. The WHO sample size calculator was used to calculate the sample size, keeping an anticipated population proportion (P) of 11.7% of AKI in asphyxiated neonates.[9]

Inclusion Criteria: All neonates of either gender delivered at term (between the start of the 37th week and the end of the 42nd week of gestation) were included in the study.

Exclusion Criteria: Neonates with gross congenital anomalies, especially malformations of the tracheobronchial tree such as tracheo-oesophageal fistulas, cleft palate and out-of-hospital birth were excluded.

Birth asphyxia was defined as a failure to initiate and maintain normal breathing on delivery, with/without clinical signs of hypoxic ischaemic encephalopathy and an APGAR score of 3 or less at five minutes post-delivery.[10] All patients were tested for serum creatinine levels at 24 hours post-delivery, and acute kidney injury was defined according to the KDIGO classification, i.e., a rise in serum creatinine of ≥0.3 mg/dL or a drop in urine output of <0.5 mL/kg/h for six to twelve hours, or both.[11]

Statistical Package for Social Sciences (SPSS) version 26.0 was used for the data analysis. Quantitative variables were expressed as Mean±SD and qualitative variables were expressed as frequency and percentages. Chi-square test was applied to explore the inferential statistics. The *p*-value of ≤0.05 was set as the cut-off value for significance.

RESULTS

We studied 69 neonates, of which 44(63.8%) were male. The mean maternal age was 26.65±3.54 years, with a mean parity of 2.54±1.53 (*p*=0.748). A total of 37 (53.6%) patients received antenatal care. The mean gestational age at delivery of the sample was 38.78±1.29 weeks. The mean birth weight was 3158.62±484.13 g, while the mean length at birth was 51.77±3.78 cm. The mean head circumference of the neonates at birth was 35.64±2.28 cm. The mean APGAR score at birth of the entire sample was 3.41±1.51. Acute kidney injury occurred in 12(17.4%) cases, and 3(4.3%) neonates died (Table-I). It is pertinent to note here that male infants were seen to have a lower head circumference (*p*=0.001), a lower total body length (*p*<0.001) and a lower APGAR score at birth (*p*=0.004) when compared to females. Lower gestational age at birth was associated with an increase in the AKI (*p*=0.038) and AKI itself was associated with a higher chance for mortality (*p*<0.001) (Table-II).

Table-I. Pre-Delivery and Post-Delivery Characteristics of Neonates (n=69)

Characteristics	Male	Female
Gender	44(63.8%)	25(36.2%)
Maternal Age (years)	27.1±3.48	26.0±3.61
Parity	2.68±1.55	2.28±1.49
Antenatal Care Received	24(54.5%)	13(52.0%)
Gestational Age at Birth	38.86±1.25	38.64±1.38
Mode of Delivery		
Vaginal	32(72.7%)	19(76.0%)
Caesarean Section	12(27.3%)	6(24.0%)
Birth-Weight (g)	3081.82±441.61	3290.80±533.68
Length (cm)	50.23±3.74	54.48±1.87
Head Circumference (cm)	34.98±2.38	36.80±1.58
APGAR Score at Birth	3.02±1.56	4.08±1.15
Acute Kidney Injury	10(22.7%)	2(8.0%)
Mortality	3(6.8%)	-

Table-II: Distribution of Neonates according to Acute Kidney Injury (n=69)

Characteristics	Acute Kidney Injury Present	Acute Kidney Injury Absent	*p*-value
Gender			
Male	10(83.3%)	34(59.6%)	0.121
Female	2(16.7%)	23(40.4%)	
Maternal Age (years)	26.08±3.45	26.77±3.58	0.545
Parity	2.67±1.44	2.51±1.56	0.748
Antenatal Care Received	6(50.0%)	31(54.4%)	0.782
Gestational Age at Birth	38.08±0.793	38.93±1.33	0.038
Mode of Delivery			
Caesarean Section	3(25.0%)	15(26.3%)	0.925
Vaginal	9(75.0%)	42(73.7%)	
Birth-Weight (g)	3078.92±470.32	3175.40±489.9	0.534
Length (cm)	51.18±4.25	51.87±3.71	0.574
Head Circumference (cm)	35.1 ±2.44	35.74±2.26	0.435
APGAR Score at Birth	3.08±1.68	4.08±1.47	0.419
Mortality	3(6.8%)	-	<0.001

DISCUSSION

Our study showed that neonates born with shorter gestations were more susceptible to the development of AKI when compared to those with longer ones, and AKI was associated with a significant increase in mortality. We attribute the increase in the frequency of AKI in neonates born earlier to foetal lung immaturity: renal injury occurs secondary to hypoxia, as the renal tubules are remarkably sensitive to oxygen deprivation, which results in disordered homeostatic function of the kidney (which may be unrecoverable), the accumulation of toxins and ultimately cell death.[10-12]

Our study showed a preponderance of male neonates affected by birth asphyxia, accounting for 44(63.8%) cases. This was in line with other studies, such as Mohamed *et al*. and Chiabi *et al*. who also reported that male neonates were at an increased risk of developing asphyxia at birth.[13,14] A possible explanation for the preponderance of males is the presence of lower anthropometric indices at birth in males.[15] Our study showed that males had a lower total body length (p<0.001) and a lower head circumference (p=0.001) than females. Mean birth weight was also lower. However, this difference did not achieve statistical significance (p=0.08). These findings are at odds with studies comparing neonatal anthropometric variables across genders: males tend to be larger than females during gestation and at birth, up to 12 months of age.[16,17] We believe the difference here has arisen due to the different populations studied; these studies looked at healthy neonates, while ours looked at sick ones. Thus, birth asphyxia itself served to confound the results. Studies have shown that males with lower birth weights are at an increased risk of critical illness compared to females.[18]

In our study of neonates afflicted by birth asphyxia, the frequency of acute kidney injury was 12(17.4%), of which 3(4.3%) died. All of these patients were male, although the difference between genders was insignificant for AKI or mortality (with p=0.121 and p=0.182, respectively). The acute kidney injury secondary to birth asphyxia was lower in our study compared to international literature, but it was still substantial. Obstetric vigilance is of utmost importance in the management of such patients. Forming hospital protocols for recognising at-risk populations and preventing and managing this complication is the need of the hour.

LIMITATIONS OF STUDY

Several factors limited our study. Firstly, our sample was derived from a population of military personnel or their families. Thus, the results may not apply to the general population. Second, we did not consider complications during the pregnancy before delivery or look at maternal comorbidities. Lastly, our study lacked a Control arm for comparison, i.e., the frequency of acute kidney injury at birth in patients unaffected by birth asphyxia.

CONCLUSION

This study showed that males were more prone to birth asphyxia and had a higher frequency of development of acute kidney injury as a consequence. Moreover, early birth during the term was also considered a risk factor.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

SZ: & MTN: Critical review, data acquisition, drafting the manuscript, approval of the final version to be published.

LG: Conception, study design, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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