

Acute Renal Failure in Newborns with Birth Asphyxia

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ABSTRACT

Introduction: Perinatal asphyxia is one of the common causes of neonatal morbidity and mortality. It can affect almost all the body organs and most frequently affected organs are kidneys. Acute Renal Failure is the commonest renal complication, manifested by changes in urine output and blood chemistries. **Aims:** To evaluate the renal function in asphyxiated newborns. **Methods:** This cross-sectional study was conducted, from August 2021 to February 2022, on 95 term neonates admitted in Neonatal Intensive Care Unit of Nepalgunj Medical College, Kohalpur for birth asphyxia as per World Health Organization definition. All neonates with Hypoxic Ischemic Encephalopathy were staged by Sarnat and Sarnat staging. After 48 hours of life, blood sample was sent for investigations. Urine output was monitored and neonates were managed according to the hospital protocol. **Results:** Male to female ratio was M:F 1.90:1. Percentage of acute renal failure was higher in babies with higher Hypoxic Ischemic Encephalopathy grades. It was seen in 12% in Grade I, 82% in Grade II and 100% in Grade III. Renal failure had significant association with Hypoxic Ischemic Encephalopathy staging ($p < 0.05$). The means of serum creatinine significantly increased with the increase in Hypoxic Ischemic Encephalopathy grades ($p < 0.05$). Mean serum creatinine among Grade I, Grade II and Grade III newborns were 0.9 ± 0.44 , 2.2 ± 0.93 and 2.9 ± 0.38 mg/dl respectively. Mean urinary output significantly decreased as the grades of Hypoxic Ischemic Encephalopathy increased ($p < 0.05$) with mean urine output 1.5 ± 0.38 , 1.3 ± 0.53 and 1.1 ± 0.39 ml/kg/hour respectively in Grade I, Grade II and Grade III. **Conclusion:** Neonates with higher grades of Hypoxic Ischemic Encephalopathy had higher values of serum creatinine. Urine output decreased as the grading of asphyxia increased

Keywords: Acute renal failure, Birth asphyxia, Hypoxic Ischemic Encephalopathy, Neonates

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INTRODUCTION

Birth asphyxia is defined by the World Health Organization (WHO) as "Failure to initiate and sustain breathing at birth".¹ The National Neonatology Forum of India has defined birth asphyxia as "gaspings and ineffective breathing or lack of breathing at one minute after birth."² Every year, it is estimated that one million neonates die due to birth asphyxia.³ This life threatening condition results from lack of oxygen or perfusion to fetus or newborn that results in multiple organ dysfunction of sufficient magnitude.⁴ Almost every organ of the body is affected, the most frequently affected organs are kidneys (50%), central nervous system (28%), cardiovascular (25%) and pulmonary system (23%).⁵ Acute Renal Failure is the commonest renal manifestation, which is manifested by changes in urine output and blood chemistries & can have serious clinical consequences.⁴ As kidneys are very sensitive to hypoxia, renal insufficiency may occur within 24 hours of a hypoxic ischemic episode, if prolonged, may even lead to

irreversible cortical necrosis.⁶ The clinical manifestation of hypoxic ischemic injury to central nervous system is termed as Hypoxic Ischemic Encephalopathy (HIE). Early recognition of renal failure in babies with HIE is important for appropriate fluid and electrolyte management to maintain stable biochemical milieu.⁷ In neonates, it is very difficult to diagnose or to recognize renal failure due to maternal influence and poorly established biochemical parameters.^{6,7} With prompt recognition and management, majority of neonates with acute renal failure improve.⁸ This study was undertaken to study renal failure in asphyxiated neonates.

METHODS

The cross-sectional study was carried out in the Neonatal Intensive Care Unit (NICU) at Nepalgunj Medical College, Kohalpur from August 2021 to February 2022. Ethical clearance was obtained from the Institutional Review Committee, Nepalgunj Medical College and Teaching Hospital

(ref: 498/078-079). Study included 95 term neonates admitted in NICU for birth asphyxia as per WHO definition. Selection of cases was done by convenient sampling method. After obtaining written informed consent, information regarding perinatal events, detailed relevant history, and clinical examination, maternal renal functions (serum urea and serum creatinine) prior to delivery was recorded. Neonates were classified on the basis of APGAR score at 5 minutes into mild (APGAR score of 6 or 7) moderate (APGAR score 5 or 4) and severe asphyxia (APGAR score 3 or less). All neonates with clinical features of HIE were staged by Sarnat and Sarnat scoring system. Renal function tests (RFT)—blood urea, serum creatinine, and serum electrolytes were monitored initially after 48 hours of birth. Urine monitoring was done by applying plastic collection bags around genitals or aseptic bladder catheterization. Cases with abnormal renal functions had their laboratory parameters monitored every alternate day till recovery. Neonates who suffered from renal failure were managed conservatively as per hospital protocol. Abnormal creatinine was considered when serum creatinine was elevated two standard deviations above mean value for term gestation or rising 0.3 mg/dL/day. Impaired urine output was considered if urine output was <1 ml/kg/hr.

IBM SPSS Version 25 was used to analyze the data. Chi Square Test and T-test were used to see the significant association among variables. P value of < 0.05 was considered significant.

RESULTS

Total 95 term newborns with birth asphyxia were taken under study. Males were 63 (66.30%) while females were 32 (33.60%) making the ratio of M:F 1.90:1. The APGAR score at 5 minutes was 0-3 in 14 (14.73%), 4-5 in 30 (31.50%) and 6-7 score was in 51 (53.60%) neonates. Among the study population, 75 developed HIE. Grade I HIE was seen in 51 (68.0%), Grade II was seen in 17 (22.70%) and 7 (9.30%) cases had Grade III HIE.

HIE Grades	Acute Renal Failure						p- value
	Yes		No		Total		
	N	%	N	%	N	%	
Grade I	7	12	44	88	51	100	0.00
Grade II	14	82	3	18	17	100	
Grade III	7	100	0	0	7	100	

Table I: Cross-tabulation of Acute Renal Failure and HIE Grades

Among the neonates with HIE Grade I, acute renal failure was seen in 7 (12%) cases. Similarly, 14 (82%) of Grade II and 100% neonates of HIE Grade III had acute renal failure. Percentage of acute renal failure increased as the HIE Grade increased, which was statistically significant ($p < 0.05$).

Serum Creatinine (mg/dl)	Grade I	Grade II	Grade III	p-value
	(n=51)	(n=17)	(n=7)	
	Mean±SD	Mean±SD	Mean±SD	
	0.9±0.44	2.2±0.93	2.9±0.38	0.00

Table II: Serum creatinine level according to HIE Grades

In the present study, mean serum creatinine among HIE Grade I was 0.9±0.44mg/dl. Similarly, it was 2.2±.93 mg/dl in HIE Grade II neonates and 2.9±0.38 mg/dl among HIE Grade III cases. This showed that mean serum creatinine significantly increased with the increase in HIE Grades ($p < 0.05$).

Urine output (ml/kg/hour)	Grade I	Grade II	Grade III	p-value
	(n=51)	(n=17)	(n=7)	
	Mean±SD	Mean±SD	Mean±SD	
	1.5±0.38	1.3±0.53	1.1±0.39	0.01

Table III: Urine output according to HIE Grades

The volume of mean urine output decreased, among the study population, as HIE Grades increased. In neonates with HIE Grade I, mean urine output was 1.5±0.38 ml/kg/hour whereas in Grade II and Grade III mean urine output was 1.3±0.53 ml/kg/hour and 1.1±0.39 ml/kg/hour respectively. This variation in urine output was statistically significant ($p < 0.05$).

DISCUSSION

Birth asphyxia is an insult to the fetus or to the newborn due to lack of oxygen (hypoxia) and/or lack of perfusion (ischemia) to various organs of sufficient magnitude and duration to produce functional and/or biochemical changes. It is associated with tissue lactic acidosis and hypercapnia.⁹ As kidneys are very sensitive to hypoxia, renal insufficiency may occur within 24 hours of a hypoxic ischemic episode, if prolonged, may even lead to irreversible cortical necrosis.⁶ Acute Renal Failure is the commonest renal complication which, with prompt recognition and management, improves in majority of neonates.^{4,8}

In the present study males were 66.30% and females were 33.60% similar to the study by Jha et al where 54% were males and 46% were females.¹⁰ Also in the study by Shrestha et al males were greater in number than that of females.¹¹ Jha et al observed the APGAR score of the asphyxiated babies at 5 minutes was 0-3 in 27 (26.5%), 4-5 in 43 (42.16%) and 6-7 in 32 (31.4%) neonates.¹² Gupta et al reported Apgar score of the asphyxiated babies at 5 minutes was 0-3 in 17 (17.3%), 4-5 in 30 (30.6%) and 6-7 in 23 (23.4%).⁵ This is in contrast to the present study where higher neonates had APGAR score of 6-7 in 53.60% rather 4-5 in 31.50%, and 14.73% had score of 0-3 at 5 minutes. The selection method being convenient sampling method might be the reason for this contrast. Shrestha et al reported in their study that 21% cases had HIE grade I, 69% grade II HIE, and 10% had Grade III.¹¹ Also in the study by Roy et al 31.25% cases had HIE Grade I, 40.62% had Grade II, and 28.12% patients had HIE Grade III.¹³ Panthee et al observed 24.4% cases developed HIE Grade I, 23.17% developed HIE Grade II and the remaining 9.75% cases developed HIE Grade III.¹⁴ In the present study, Grade I HIE was seen in 68.0% neonates, Grade II was seen in 22.70% and 9.30% cases had Grade III HIE. Although distribution of HIE Grades is variable in different studies, the percentage of neonates with HIE Grade III is less in all studies which shows very less proportion of newborns suffer severe HIE.

In the present study, among neonates with HIE Grade I, acute renal failure was seen in 12% cases. Similarly, 82% of Grade II and 100% neonates of HIE Grade III had acute renal failure. Percentage of acute renal failure increased as the HIE Grade increased, which was statistically significant ($p = 0.00$). Similar to the study by Chetty et al where 55% newborns in HIE Grade I, 88% in HIE Grade II and 100% in HIE Grade III had acute renal failure which was statistically significant ($p < 0.001$)¹⁵ The result is also consistent with the study by Murmu et al.¹⁶ Babies with higher grade of HIE had higher incidence of acute renal failure secondary to birth asphyxia.

In this study, results of serum creatinine were significantly associated with the Grades of HIE ($p = 0.00$). Grade I patients had mean level of 0.9 ± 0.44 mg/dl. Similarly, it was 2.2 ± 0.93 mg/dl in HIE Grade II neonates and 2.9 ± 0.38 mg/dl in HIE Grade III cases. These results were in accordance with El-Gamasy et al who correlated renal function with severity of HIE and stated that serum creatinine levels significantly raised with increasing severity of HIE ($p = 0.01$).¹⁷ Similar results were observed by Gupta et al in their study where rising trend in concentration of blood creatinine was observed as HIE staging progressed and the difference was statistically significant ($P < 0.05$).⁵

In a study by Roy et al the mean urine volume gradually decreased as HIE grading increased and it was statistically significant ($p < 0.05$).¹³ Also Rai et al in their study stated that mean urinary output in severely asphyxiated babies was significantly lower as compared to mildly and moderately asphyxiated babies ($p < 0.01$).¹⁸ Similar to the present study where mean urine output in HIE Grade I neonates was 1.5 ± 0.38 ml/kg/hour whereas in Grade II and Grade III mean urine output was 1.3 ± 0.53 ml/kg/hour and 1.1 ± 0.39 ml/kg/hour respectively. The change in urine output was statistically significant ($p = 0.01$).

LIMITATIONS

This study does not include preterm newborns which might have affected the results. The sample size was small with convenient sampling method. Arterial blood gas (ABG) analysis, which is essential to define asphyxia, could not be done in all asphyxiated cases due to financial problem and technical difficulty. Neonatal EEG, while staging HIE, was not done as it is available in our center.

CONCLUSION

Neonates with higher grades of HIE had higher values of serum creatinine. Urine output decreased as the grades of HIE increased. Early diagnosis of renal failure can be made by monitoring serum creatinine level and urine output.

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