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ESTIMATION OF ACUTE KIDNEY INJURY AND DYSELECTROLYTEMIA IN ASPHYXIATED NEWBORNS - A SINGLE CENTRE STUDY

Neonatology

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ABSTRACT

Background: In babies with perinatal asphyxia, hypoxia and ischemia can cause damage to almost every tissue and organ of the body and kidneys are one of the most commonly affected organs. Renal insufficiency may occur within 24 hours of a hypoxic ischemic episode leading to variable degree of kidney injury. Serum electrolyte levels are also found to be significantly affected in perinatal asphyxia. **Aims & Objective:** Estimation of acute kidney injury and its correlation with severity of perinatal asphyxia and assess electrolyte imbalance in term neonates with perinatal asphyxia. **Materials and Methods:** It is a prospective observational study conducted at a tertiary care centre during the study period. Renal parameters and serum electrolytes of asphyxiated newborns were evaluated and kidney injury was classified on the basis of AKIN criteria. **Results:** Among 175 newborns with perinatal asphyxia, 29.7% had HIE1, 14.3% of them developed HIE 3 while maximum of them (56%) had HIE stage 2. It was observed that 38.3% of the enrolled babies developed acute kidney injury. 14.9 % of cases had stage 1 AKI, stage 2 acute kidney injury was found in 16.6 % of cases and stage 3 acute kidney injury developed in 6.8 % of cases. Among total babies, 77.1% of the babies had hyponatremia while 9.7% of the babies had hyperkalemia. Out of 160 babies who were followed till outcome, 90% discharged while 10% of them died. **Conclusion:** Perinatal asphyxia is an important cause of renal dysfunction which plays an important role in mortality and morbidity of the asphyxiated newborn. Early diagnosis and management of AKI in babies with perinatal asphyxia can improve their outcome. Electrolyte disturbance in the form of hyponatremia and hyperkalemia is also an important derangement in babies with birth asphyxia which needs accurate and careful management for better outcome.

KEYWORDS

INTRODUCTION

Birth asphyxia is a common problem and contributes significantly to neonatal morbidity and mortality. It has an incidence of 1 to 6 per 1000 live full term births.(1) Hypoxia and ischemia can cause damage to almost every tissue and organ of the body and various target organs involved have been reported as kidneys in 50% followed by CNS in 28%, CVS in 25% and lungs in 23% cases.(2) As kidneys are very sensitive to oxygen deprivation, renal insufficiency may occur within 24 hours of a hypoxic ischemic episode, which if prolonged may even lead to irreversible cortical necrosis with onset of acute renal failure which can be temporary or permanent. Early recognition of renal failure is important in babies with birth asphyxia, to facilitate appropriate fluid and electrolyte management, as stable biochemical milieu is vital. However, diagnosis of renal failure is complex in newborns as many of the established clinical and laboratory parameters are unreliable in this age group.

Fluid, electrolyte, and metabolic abnormalities are the most common disturbances which occur in critically ill asphyxiated neonate. Serum sodium, potassium, and calcium are the major electrolytes in the body and any disturbance in their normal level can lead to convulsions and many other complications.

Hence, this study has been directed to get the idea of renal dysfunction and electrolyte abnormalities in asphyxiated neonates. It will help in prediction of its consequence which is important for the clinician to plan treatment, prognosticate outcome and counsel the parents.

MATERIALS AND METHODS

It is a prospective observational study conducted at a tertiary care centre. This study was conducted over a period of 12 months (August 2021 to July 2022) after clearance from the Institutional Ethics Committee and informed parental consent.

Inclusion Criteria

1. Newborns diagnosed with perinatal asphyxia.
2. Term newborns with gestational age of 37 weeks or more.
3. Birth weight ≥2.5 kg.
4. Admitted in NICU within 24 hours of birth.

Exclusion Criteria

1. Newborns having congenital renal malformations.
2. Prenatal exposure to medications that might be responsible for nephrotoxicity and dyselectrolytemia.

Study Process

Neonates fulfilling all inclusion criteria were enrolled for the study. Relevant maternal history of antenatal and perinatal period was recorded. Babies were staged in different grades of HIE as per Levene's staging. Renal dysfunction was assessed using rise in serum creatinine levels (AKIN criteria). Electrolyte imbalance was also studied and babies were categorised in different levels based on the severity of electrolyte derangement. Clinical course of the babies was recorded and they were followed till final outcome.

Statistical Analysis

- Data were entered into Microsoft excel sheet and analysed using open sources software.
- Categorical data were expressed in form of proportions and percentage.
- Continuous data were expressed in terms of mean and SD.
- Appropriate test of significance like t test and chi square test were applied wherever necessary and p value of < 0.05 was considered statistically significant

RESULTS

Table 1. Demographic Details Of Neonates In Perinatal Asphyxia

Neonatal factors		Number (n=175)	Percentage %
Gender	Male	95	54.3%
	Female	80	45.7%
Admission	Inborn	102	58.3%
	Out born	73	41.7%
Birth weight	2.5-2.9 kg	92	52.6%
	3-3.4 kg	68	38.9%
	>3.5 kg	15	8.5%

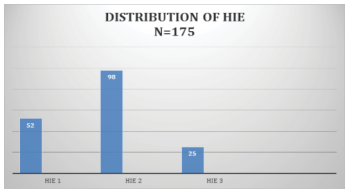

Figure No .1 Distribution Of HIE

Out of total 175 asphyxiated newborns, 29.7% had HIE1, 14.3% of them developed HIE 3 while maximum of them (56%) had HIE stage 2.

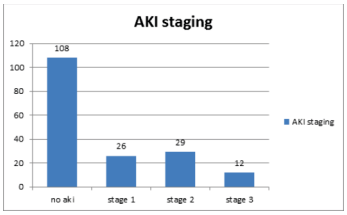

Figure No.2 Distribution Of AKI

Table 2. Correlation Of AKI Staging With HIE Staging

	AKIN Staging				p-value
	No AKI	Stage 1	Stage 2	Stage 3	
HIE staging	N=108 (%)	N=26 (%)	N=29 (%)	N= 12 (%)	
1	39 (36.1%)	6 (23.1%)	7 (24.1%)	0 (0.0%)	0.000
2	66 (61.1%)	16 (61.5%)	10 (34.5%)	6 (50.0%)	signi-
3	3 (2.8%)	4 (15.4%)	12 (41.4%)	6 (50.0%)	ficant

- In the present study 38.3% of the total asphyxiated babies had acute kidney injury. In babies with stage 1 AKI, majority (61.5%) belonged to HIE 2 while in babies with stage 2 AKI, there were 41.4 % of the cases with HIE 3 and in babies with stage 3 AKI, there was equal distribution in HIE 2 and HIE 3 (50%) and no case belonged to HIE 1.
- It can be concluded that as the HIE staging progresses renal injury also progresses. It is statistically significant. (p value < 0.05).

Table 3. Distribution Of Electrolyte Imbalance

Sodium levels	Severity of electrolyte derangement	Day 1 Number (%) (N = 175)	DAY 3 Number (%) (N = 175)
	Mild hyponatremia	36 (20.5%)	46 (26.3%)
	Moderate hyponatremia	58 (33.2%)	58 (33.1%)
	Severe hyponatremia	41 (23.5%)	10 (5.8%)
	Normal	40 (22.8%)	61 (34.8%)
Potassium levels	Mild hyperkalemia	9 (5.1%)	17 (9.7%)
	Moderate hyperkalemia	7(4%)	9 (5.2%)
	Severe hyperkalemia	1 (0.6%)	0 (0%)
	Normal	158 (90.3%)	149 (85.1%)

Table 4. Relation Of Outcome Of Babies With Stages Of AKI

Outcome	AKIN Staging				p-value
	0 (N=98)	1 (N=25)	2 (N=25)	3 (N=12)	
	Number %	Number %	Number %	Number %	
Death N=16	6 (6.1%)	3 (12%)	4 (16%)	3 (25%)	0.12
Discharged N=144	92 (93.9%)	22 (88%)	21 (84%)	9 (75%)	

In this study, it was noticed that there were maximum discharges (93.9%) in babies with no AKI while maximum mortality (25%) was seen in the babies with AKI stage 3. These results were not statistically significant.

DISCUSSION

Perinatal asphyxia is one of the most common primary causes of neonatal mortality and morbidity in India. It has an incidence of 1 to 6 per 1,000 live full-term births. (1) According to latest estimates by World Health Organization (WHO), approximately 4 million babies die in neonatal period. Kidneys are the most commonly affected organs (50%) in the setting of perinatal asphyxia followed by CNS in 28%, CVS in 25% and lungs in 23% cases.

In this study, among 175 enrolled patients, males predominated (54.3%). In the study by Yadav et al. (2), similar findings were reported with 54.4% males. In this study, the inborn babies were 58.3%, while the outborns were 41.7%. The predominance was seen for inborns. In the current study, the percentage of babies belonging to different weight bands ranging between 2.5-2.9 kg, 3-3.4 kg and greater than 3.5 kg were 52.6%, 38.9% and 8.6% respectively. The birth weight of 2.5-2.9 kg was seen to be predominant. In a study conducted by BC Yelamali et al. (3), among 163 asphyxiated newborn, 49.07% babies weighed between 1.5 to 2.5kg, 83 (50.09%) were >2.5 kg. Since we excluded the babies weighing less than 2.5 kg, these results cannot be compared.

In this study, we observed that there were 29.7% of the total babies had HIE 1, 56% had HIE 2 while HIE 3 was present in remaining 14.3 % of the cases while in study by Roy et al.(4) distribution of HIE 1, 2 and 3 were 55%, 35% and 9% respectively.

In this study, AKI was reported in 38.3 % cases. The distribution of AKI along different stages of AKI 1,2 and 3 was 14.9%, 16.6% and 6.8% respectively. In a study by Medani et al. (5) , 54.1% of the asphyxiated neonates had AKI while in a similar study by Gupta et al. (6) 47.1 % of the asphyxiated newborns developed AKI. Amongst babies with HIE 1, stage 1 and stage 2 AKI was seen in 23.1 % and 24.1 % patients respectively, while none had stage 3 AKI. Of all 98 babies with HIE 2, majority (61.5%) had stage 1 AKI followed by stage 2 and stage 3 seen in 34.5% and 50% respectively. We had total 25 babies with HIE 3 which had maximum (41.4%) cases of stage 2 AKI. These findings were statistically significant. (p value < 0.05). A study by Dan Alaro et al. (7) concluded that AKI was highest in the neonates with HIE 3 (42.9%) and lowest in HIE 1 (4.6%). This can be attributed to the fact that severe is the asphyxia, more ischemic insult will be caused to kidneys leading to greater incidence and severity of renal damage.

In the current study, mild hyponatremia cases were 20.5%, moderate hyponatremia cases were 33.2%, severe hyponatremia cases were 23.5%, and normal sodium level was found in 22.8% of the total babies. Moderate hyponatremia had the highest prevalence (33.2%). A study by Gupta BD et al. (6) observed that asphyxiated babies had hyponatremia as compared to non asphyxiated babies. Similar findings were reported in a study by Pallab Basu et al. (8) where sodium levels were significantly lower and potassium levels were higher in cases as compared to controls. This can be explained by possible dilutional hyponatremia caused by inappropriate secretion of anti diuretic hormone that lowers serum sodium levels in perinatal asphyxia.

In this study, it was found that the distribution of mild, moderate and severe hyperkalaemia was 5.1%, 4% and 0.6% while 90.3% of the total cases had normal potassium values

The serum potassium values were higher among the cases as compared to controls in a study done by Bansal S et al (9). This rise in potassium levels can be explained with a fact that asphyxia is associated with acidosis, and in metabolic acidosis, more than one-half of the excess hydrogen ions are buffered in the cells. In this setting, electroneutrality is maintained partially by the movement of intracellular potassium into the extracellular fluid. It can also be due to acute renal failure secondary to birth asphyxia which leads to reduced excretion of potassium and hence hyperkalemia. It is close to the findings of a study conducted by Masood Najaf (10) and his colleagues which showed that serum potassium levels were observed in high normal range in birth asphyxia cases while the levels were in the range of lower normal levels in non asphyxiated babies. Results in their study were statistically significant. A study by Lackmann et al. (11) measured potassium levels in 98 asphyxiated newborns , and none of them showed significant hyperkalemia in the initial 144 hours of life. It was observed in our study that 6 (8.9 %) babies of the total 67 babies with AKI , had hyperkalemia .

In this study, there were total of 16 deaths (9.1%). The distribution of deaths in different stages of AKI as 1, 2 and 3 are 12%, 16% and 25% respectively. These findings were not statistically significant. Among the total 163 newborns of birth asphyxia 33 (20.24%) newborns died as observed in a study by BC Yelamali et al.(3). In the present study where 160 babies with perinatal asphyxia were followed till final outcome, 144 (90%) of them got discharged while 16 (10%) of them died, 15 of the total enrolled patients took leave against medical advice hence they were not included in the analysis of outcome. A study by Medani et al. (5) all the neonates with AKI as a consequence of perinatal asphyxia received supportive treatment with good outcome where 91.3% of babies had full recovery and death occurred in 8.7% of the cases.

CONCLUSION

Estimation of acute kidney injury in 175 babies with perinatal asphyxia

was done, and it was found in nearly 40 % of them. Hence, we can say that perinatal asphyxia is an important cause of neonatal renal dysfunction. This dysfunction of kidneys plays an important role in mortality and morbidity of the asphyxiated newborn. Monitoring of blood levels of urea, serum creatinine and urine output helps in the early diagnosis and management of renal failure in babies with perinatal asphyxia to improve the outcome.

Electrolyte disturbance is also one of the major concerns in the setting of perinatal asphyxia, and it is thought to be the major cause of adverse outcomes. Hyponatremia is predominant abnormality asphyxiated newborns which needs prompt and careful management.

It can be concluded from this study that besides neurological outcomes, renal impairment and electrolyte disturbances should also be identified timely and renal protective strategies should be applied in the management of asphyxiated newborns for better outcome.

LIMITATIONS

Pre admission treatment details of many enrolled outborn newborns were not available. Fluid management after resuscitation and during transport of such babies could have affected blood parameters. Since follow up of the babies after discharge was not done, long term outcome of the babies with kidney injury could not be assessed.

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