

## Original Research Article

## A study of renal parameters and serum electrolytes level in newborns with birth asphyxia

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**Abstract**

**Aims:** The present study was planned for evaluation of renal parameters and serum electrolytes level in newborns with birth asphyxia. **Material and methods:** This was a prospective case-control study conducted in the Department of Pediatrics, Kalawati Saran Children Hospital, New Delhi, India for 1 year. Total 160 Newborn out of which 80 were study group and 80 were control group were included for the study. Birth asphyxia was diagnosed by APGAR score and hypoxic ischemic encephalopathy was diagnosed by SARNAT staging. All the newborn were evaluated for renal parameters such as Serum creatinine, blood urea nitrogen (BUN), Serum Electrolytes from blood sample and Urine sodium, Urine Potassium from urine sample. **Results:** Total 160 newborns out of which 80 were included in study group and 80 were included in control group. Out of 80 asphyxiated newborn 50(62.5%) were males and 30(37.5%) female. So there was higher incidence seen in the male babies. The BUN levels were 28+8.98 in the asphyxiated newborns as compared to controls who had BUN level was 20.3+2.65 and it was statistically significant. BUN level was higher among cases as compared to control and it was statistically significant. The mean serum creatinine levels were 1.7+0.29 in case group and 1.12+0.4 in control and it was statistically significant difference between both the groups. **Conclusion:** Perinatal asphyxia is an important cause of neonatal renal failure. Monitoring of blood levels of urea, serum creatinine, serum calcium and urine output helps in the early diagnosis and management of renal failure in birth asphyxia. Serum electrolytes levels and renal parameters had a linear correlation with severity of birth asphyxia.

**Keywords:** Perinatal hypoxia, HIE, APGAR score, Serum electrolytes levels, Renal parameters.

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**Introduction**

The incidence of perinatal asphyxia is 1–1.5 % in most developed countries and is inversely related to gestational age and birth weight.[1] In India the incidence of perinatal hypoxia is as high as 8-9% and it accounts for 28.8% of neonatal deaths and 45.1% of fresh still births.[2] According to the latest estimates by World Health Organization (WHO), approximately 4 million babies die each year before they reach the age of one month, ninety eight percent of these neonatal deaths take place in the developing countries. WHO has defined perinatal asphyxia as a failure to initiate and sustain breathing at birth.[3]

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The National Neonatal Perinatal Database (NNPD) 2000 used a similar definition for perinatal asphyxia. It defined moderate asphyxia as slow gasping breathing or an Apgar score of 4-6 at 1 minute of age and severe asphyxia was defined as no breathing or an Apgar score of 0-3 at 1 minute of age.[4]

There has long been a scientific debate over whether newborn infants with asphyxia should be resuscitated with 100% oxygen or normal air.[5] It has been demonstrated that high concentrations of oxygen lead to generation of oxygen free radicals, which have a role in reperfusion injury after asphyxia.[6] Research by Ola Didrik Saugstad and others led to new international guidelines on newborn resuscitation in 2010, recommending the use of normal air instead of 100% oxygen.[7] There is considerable controversy over the diagnosis of birth asphyxia due to medicolegal reasons.[8] Because of its lack of precision, the term is eschewed in modern obstetrics.

Early recognition of renal injury is important for maintenance of fluid and electrolyte homeostasis. Renal failure has also been found to correlate with mortality and long term neurological outcome of asphyxiated babies.[9,10] The diagnosis of renal dysfunction in neonates is however difficult because the routine clinical and biochemical parameters are affected by many non-renal factors and maternal parameters. Calculated renal indices may also be affected by the difficulty in collecting urine samples and interference by interventions like saline bolus, diuretics or aminophylline.[11] Therefore excretion of many low molecular weight proteins such as b2-microglobulin, myoglobin, retinol binding protein and N-acetyl-b-D-glucosaminidase (NAG) has been used to detect renal tubular dysfunction.[12,13] Of these, b2-microglobulin and NAG have shown promise. In cases of birth asphyxia most of the organs like brain, kidneys, heart, lungs can be affected but kidneys are more sensitive to oxygen deprivation so they lead to renal insufficiency approximately within 24 hours of hypoxic ischemic injury. Hence based on above findings the present study was planned for evaluation of renal parameters and serum electrolytes level in newborns with birth asphyxia.

### Material and methods

This was a prospective case-control study conducted in the Department of Pediatrics, Kalawati Saran Children Hospital, New Delhi, India for 1 year. Total 160 Newborn out of which 80 were study group and 80 were control group were included for the study.

#### Inclusion Criteria

- Term (37-41 weeks), appropriate for gestational age (inborn and outborn)
- Outborn with history of birth asphyxia (delayed cry of 5-10 min) and inborn with Apgar score at 1 min (less than 7)

#### Exclusion Criteria

- Babies with congenital cardio pulmonary malformation
- Mother with diabetes mellitus and hypertension treated with diuretics,
- Any apparent major congenital abnormality
- Preterm babies

#### Methodology

A detailed physical and systemic examination was done for all the patients. Gestational age was calculated by applying modified Ballard's score. Birth

asphyxia was diagnosed by APGAR score and hypoxic ischemic encephalopathy was diagnosed by Sarnat staging.[14]

All the newborns were evaluated for renal parameters such as serum creatinine, blood urea nitrogen (BUN), Serum Electrolytes from blood sample and Urine sodium, Urine Potassium from urine sample.

### Results

The mean gestation, birth weight, modes of delivery and concomitant illnesses were similar between the two groups. As expected, the 5 min Apgar scores were significantly lower in the cases (Table 1). This study interprets the association of electrolytes imbalance with severity of asphyxia. The study was done in total 160 newborns out of which 80 were included in study group and 80 were included in control group. Out of 80 asphyxiated newborns 50(62.5%) were males and 30(37.5%) female. So there was higher incidence seen in the male babies. (Table 2) The BUN levels were 28+8.98 in the asphyxiated newborns as compared to controls who had BUN level was 20.3+2.65 and it was statistically significant. BUN level was higher among cases as compared to control and it was statistically significant. (Table 3)

The mean serum creatinine levels was 1.7+0.29 in case group and 1.12+0.4 in control and it was statistically significant difference between both the groups. Serum creatinine levels were higher in cases as compared to controls and the difference between the groups was statistically significant. In our study urine sodium was found higher among the cases as compared to controls and the difference between the groups were statistically significant. (Table 3) The serum sodium value was 134.5+3.42 mEq/L among the cases as compared to controls had 139.4+4.12 mEq/L. The mean serum potassium value was 5.5+0.84 mEq/L among the cases as compared to controls had 4.6+0.32 mEq/L. Serum potassium was found higher in study group as compared to control and the difference between both the groups was statistically significant. The mean serum calcium value among the cases was 7.7+0.81 mg/dL as compared to controls had 8.8+0.24 mg/dL. The serum calcium level was found lower among cases as compared to control population and the difference between the groups were statistically significant. (Table 4)

**Table 1: Baseline characteristics**

Baseline characteristics	Study group =80	Control group=80
Gestation (wks) (mean sd) (Range)	36.5+1.6(35-39)	36.3+ 1.7 (33-39)
Weight(gms) (mean sd) (Range)	2277 +387 (1400-2980)	2367 +400 (1470-3045)

Cesarean delivery	30 (37.5 per cent)	50 (62.5 per cent)
Respiratory distress	20 (25 per cent)	16 (20 per cent)
Hyperbilirubinemia	18 (22.5 per cent)	15 (18.75 per cent)
5 min Apgar* (mean sd) (Range)	5.7 +1.4 (1-8)	7.8+ 1.4 (6-8)

**Table 2: Gender distribution in study groups and control groups**

Gender	Study group		Control group	
	N=80	%	N=80	%
Male	50	62.5 %	32	40 %
Female	30	37.5 %	48	60 %

**Table 3: Renal parameters among cases and controls**

Parameters	Group	Mean (mg/dL)	Std.Deviation	Z
BUN	Study group	28	8.98	Z value-4.511 P<0.0001
	Controls	20.3	2.65	
Serum creatinine	Study group	1.7	0.29	Z value-6.47 P<0.0001
	Controls	1.12	0.4	
urine sodium	Study group	38	8.433	Z value-17.03 P<0.0001
	Controls	16.1	2.67	
Urine creatinine	Study group	26.8	8.21	Z value-5.39 P<0.0001
	Controls	19.3	6.29	

**Table 4: Serum electrolytes level among cases and controls**

	Group	Mean (mEq/L)	Std. Deviation	P value
Serum sodium	Study group	134.5	3.42	P<0.0001
	Controls	139.4	4.12	
Serum potassium	Study group	5.5	0.84	P<0.0001
	Controls	4.6	0.32	
Serum calcium	Study group	7.7	0.81	P<0.0001
	Controls	8.8	0.24	

## Discussion

Asphyxia can have serious impact on various organ systems. Impairment of renal functions can jeopardize the success of this transition. Perinatal hypoxia contributes significantly to neonatal mortality and morbidity. HIE is the major consequence of perinatal asphyxia. In asphyxiated newborn most of the organ can be affected but the brain, myocardium, kidneys and bowels appear to be more sensitive to HIE. Kidneys are involved in 50%, brain involved in 28%, heart in 25% and lungs in 23% of cases. In cases of birth asphyxia Kidneys are more sensitive to oxygen deprivation which leads to renal insufficiency approximately within 24 hours of hypoxic ischemic injury.

Perinatal hypoxia contributes significantly to neonatal mortality and morbidity. HIE is the major consequence of perinatal asphyxia. In asphyxiated newborn most of the organ can be affected but the brain, myocardium, kidneys and bowels appear to be more sensitive to HIE. Kidneys are involved in 50%, brain involved in 28%, heart in 25% and lungs in 23% of cases.[15]

This study interprets the association of electrolytes imbalance with severity of asphyxia. The study was done in total 160 newborns out of which 80 were

included in study group and 80 were included in control group. Out of 80 asphyxiated newborn 50(62.5%) were males and 30(37.5%) female. So there was higher incidence seen in the male babies. In other study which was done by Mac Donald shows that incidence of asphyxia was 54% in male babies and 46% in female babies.[16]

Finally this study interprets the statistically significant difference between the renal parameters. This study shows BUN levels was 28+8.98 in the asphyxiated newborns as compared to controls who had BUN level was 20.3+2.65 and it was statistically significant. In other similar study like Jayashree and her colleagues found BUN was 94+34.7mg/dl among the cases as compared to controls who had a mean value of 25.6 mg/dl with majority of cases belonging to stage III HIE.

Similarly Gupta et al studied 70 asphyxiated neonates with mean blood urea value of 35.72+17.87 and other like Aggarwal and her colleagues studied 25 asphyxiated neonates and found the mean serum urea value was 33.6+11.5 mg/dl and among the cases was 25.7+7.2 mg/dl.[17-19] In our study we found mean serum creatinine levels was 1.7+0.29 in case group and

1.12+0.4 in control and it was statistically significant difference between both the groups. While in Jayashree et al study found serum creatinine levels was 1.58+0.58 mg/dl among the cases as compared to controls it was 0.9 mg/dl, with majority of cases belonging to stage III HIE. In other study like Gupta and colleagues studied 70 asphyxiated neonates and found the mean serum creatinine values were 1.08+0.49 as compared to controls was 0.88+0.26 mg/dl. Aggarwal and her colleagues studied 25 asphyxiated neonates and found the mean serum creatinine value was 1.0+0.5 mg/dl as compared to controls was 0.7+0.2 and it was statistically significant.[18-20] In our study serum sodium value was 134.5+3.42 mEq/L among the cases as compared to controls had 139.4+4.12 mEq/L as compared to similar study like P K Misra and colleagues also shows that decreased serum sodium levels in cases (128.28 + 0.45 mEq/L) as compared to controls (135.7 + 0.68 mEq/L). In other study which was done by B D Gupta with his colleagues found that babies with asphyxia had higher incidence of hyponatremia and the mean serum sodium levels in study group was 132.82+ 5.73 mEq/L which was lower than the control group of 135.82 + 3.99mEq/L.

As well as Pallab Basu and coworkers also found that mean serum sodium levels were significantly lower in asphyxiated babies (122 + 6.0 mEq/L) as compared to controls (138.8 + 2.7 mEq/L) and thy all study shows the similar as compared to our study.[17, 21, 22]

The mean serum potassium value was 5.5+0.84 mEq/L among the cases as compared to controls had 4.6+0.32 mEq/L. P K Misra with his coworkers found that serum potassium levels were increased in asphyxiated neonates as compared to controls. A similar study done by Pallab Basu and colleagues found that mean serum potassium levels were higher in asphyxiated babies as compared to controls with p value of<0.001.[21,22] The mean serum calcium value among the cases was 7.7+0.81 mg/dl as compared to controls had 8.8+0.24 mg/dl. Pallab Basu and colleagues found that mean serum calcium levels were lower in asphyxiated babies (6.85 + 0.95 mg/dl) as compared to controls (9.50 + 0.51mg/dl) with p value of<0.001[21]

## Conclusion

Perinatal asphyxia is an important cause of neonatal renal failure. Monitoring of blood levels of urea, serum creatinine, serum calcium and urine output helps in the early diagnosis and management of renal failure in birth asphyxia. The biochemical parameters in both blood and urine should be monitored. The renal indices should be calculated, as fractional excretion of sodium

is preferred to classify the renal failure into pre renal or intrinsic renal failure as management differs for both entity. This study found that monitoring of serum electrolytes and renal parameters helps in the early diagnosis and management of renal failure. This study shows that serum electrolytes levels and renal parameters had a linear correlation with severity of birth asphyxia.

## References

1. Hansen AR, Soul JS. Perinatal asphyxia and Hypoxic ischemic encephalopathy in Manual of neonatal care. 7th ed India- Wolters Kluwer. 2011; 711-728;350-376.
2. Ilah BG, Aminu MS, Musa A, Adelakun MB, Adeniji AO, Kolawole T. Prevalence and risk factors for perinatal asphyxia as seen at a specialist hospital in Gusau, Nigeria. Sub-Saharan Af J Med. 2015;2(2):64.
3. World Health Organization. Perinatal mortality-a listing of available information. World Health Organization. 1996.
4. Network NN. National Neonatal Perinatal Database-report for the year 2002–2003. NNF NNPD network; New Delhi. 2005.
5. Davis PG, et al. Resuscitation of newborn infants with 100% oxygen or air: a systematic review and metaanalysis". The Lancet. 2004; 364(9442):1329-1333.
6. Kutzsche S, et al. Hydrogen peroxide production in leukocytes during cerebral hypoxia and reoxygenation with 100% or 21% oxygen in newborn piglets. Pediatric Research. 2001; 49(6):834–842.
7. ILCOR Neonatal Resuscitation Guidelines 2010.
8. Blumenthal I. Cerebral palsy—medicolegal aspects". Journal of the Royal Society of Medicine. 2001; 94(12):624–7.
9. Perlman JM, Tack ED. Renal injury in the asphyxiated newborn infant: Relationship to neurologic outcome. J Pediatr 1988; 113: 875–79.
10. Misra PK, Kumar A, Natu SM, Kapoor RK, Srivastava KL, Das K. Renal failure in symptomatic perinatal asphyxia. Indian Pediatr 1991; 28: 1147–51.
11. Roberts DS, Haycock GB, Daton RN, Turner C. Prediction of acute renal failure after birth asphyxia. Arch Dis Child 1990; 65: 1021–28.
12. Watanabe K, Kojima T, Fakuda Y, Ohbayashi K, Kobayashi T, Iwase S, Kobayashi Y. Reliability of urinary NAG as an indicator of renal tubular damage in neonates. Biol Neonate 1987; 52: 16–

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21.

13. Bernard AM, Morean D, Lauwers R. Comparison of retinol binding protein and b2-Microglobulin determination in urine for early detection of tubular proteinuria. *Clin Chim Acta* 1982; 126: 1–7.
14. Ballared JL, Khouri JC, Wedig K. New Ballared Score, expanded to include extremely premature infants. *J Pediatr* 1991;119(3):417-23.
15. Roberto Antonucci, Annalisa Porcella, Maria Dolores Pilloni. Perinatal asphyxia in the term newborn. *J Pediatric Neonatal Individualized Med* 2014;3(2):e030269.
16. Mac Donald HM, Mulligan JC, Allen AC, Taylor PM. Neonatal asphyxia. Relationship of obstetric and neonatal complication to neonatal mortality in 38,405 consecutive deliveries. *J Pediatr* 1980;96:898-902.
17. Gupta BD, Sharma P, Bagla J, Parakh M and Soni J P. Renal failure in asphyxiated neonates. *Indian Pediatr* 2005;42:928- 934.
18. Jayashree G, Dutta AK, Sarna MS and Saini A. Acute renal failure in asphyxiated Newborns. *Indian Pediatrics* 1991; 28:19-23.
19. Aggarwal A, Kumar P, Chowdhay G, Mazumdar S and Narang A. Evaluation of renal functions in asphyxiated newborns. *J Trop Pediatr*. 51(5):295-9.
20. Mangi Z A, Bouk G R, Junejo B, Junejo A A, Shaikh S and Jamro S. Birth asphyxia relation between hypoxic ischemic encephalopathy grading and development of acute renal failure in indoor term neonates at Chandka Medical College children hospital Larkhana. *Medical Channel*: 2009:148-152.
21. Basu P, Som S, Das H and Chudhuri N. Electrolyte status in birth asphyxia. *Indian J Pediatr* 2010;77:259-262.
22. Misra PK, Kumar A, Natu SM, Kapoor RK, Srivatsava KL and Das K. Renal failure in symptomatic perinatal asphyxia. *Indian Pediatr* 1991;28:1147-51.

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