Incidence of acute kidney injury in birth asphyxia and its correlation with severity of hypoxic ischemic encephalopathy (HIE) in newborns with perinatal asphyxia in SNCU at DR. BRAM Hospital, Raipur (CG)

Phuljhele S.1, Dewangan S.2, Rathi Y.3

1Dr. Sharja Phuljhele, HOD, Professor, 2Dr. Shashikant Dewangan, Assistant Professor, 3Dr. Yogita Rathi, Resident, all authors are affiliated with Department of Paediatrics, Pt J.N.M. Medical College, Raipur, CG, India

Corresponding Author: Dr. Shashikant Dewangan, Assistant Professor, Department of Paediatrics, Pt J.N.M. Medical College, Raipur, CG, India. E-mail: drshashikandewangan@gmail.com

Abstract

Introduction: Perinatal asphyxia is a significant contributor to neonatal morbidity, mortality and adverse outcome in India. Due to any reason, if blood supply through placenta is hampered, it leads to asphyxial injury. Renal involvement is frequent in perinatal asphyxia. The severity of renal involvement and adverse outcome are correlated with severity of asphyxia and HIE stage. We performed this study to determine the incidence of renal failure in birth asphyxia by estimating urine output, serum creatinine and blood urea. Aim and Objective: To study incidence of Acute Kidney Injury (AKI) in Hypoxic Ischemic Encephalopathy (HIE) and its association with severity of HIE in Newborns. Material Methods: Cross-sectional observational hospital based study was conducted over a period of six months from March 2018 to August 2018 in Special Newborn Care Unit (SNCU) of Dr. BRAM hospital, Raipur. Sarnat and Sarnat staging was used to classify HIE. Statistical analyses were performed by using SPSS21.0 software. Chi square test, P-value and likelihood ratio were calculated using appropriate tests. Result: Total 1318 newborns were admitted in SNCU during study period. 415 newborns were admitted with HIE following perinatal asphyxia. Out of these 52 (12.5%) were HIE-I cases, 242(58.3%) were HIE-II and 121(29.1%) were HIE-III. Total 70(16.9%) newborns developed AKI. None of newborn in HIE I developed AKI. 20(8.2%) newborns with HIE II developed AKI while in HIE III 50 (41.3%) newborns had AKI. There was significant correlation between HIE III and AKI (P value- 0.157). Conclusion: There is significant correlation of HIE with AKI. As severity of HIE progresses from stage-I to stage-III, there is increased risk of developing AKI.

Key words: Acute Kidney Injury (AKI), Hypoxic Ischemic Encephalopathy (HIE), Special Newborn Care Unit (SNCU).

Introduction

Hypoxia-ischemia in the perinatal period is an important cause of cerebral palsy and associated disabilities in children [1]. Perinatal asphyxia is one of the most common causes of neonatal mortality and morbidity in developing countries [2]. Out of 1000 births about 1 to 10 newborns develop HIE due to various reasons [3].

Perinatal asphyxia is a condition characterized by an impairment of exchange of the respiratory gases (oxygen and carbon dioxide) resulting in hypoxemia and hypercapnia, accompanied by metabolic acidosis [4]. WHO has defined perinatal asphyxia as a “failure to initiate and sustain breathing at birth” [5]. The National Neonatal Perinatal Database (NNPD), 2000 used a similar definition for perinatal asphyxia [6]. It defined moderate asphyxia as slow gasping breathing or an Apgar score of 4-6 at 1 minute of age. Severe asphyxia was defined as no breathing or an Apgar score of 0-3 at 1 minute of age.

As per the AAP (American academy of Pediatrics) and ACOG (American college of Obstetrics and Gynecology), all the following must be present for designation of asphyxia Viz (a) Profound metabolic or mixed academia (pH< 7.00) in cord. (b) Persistence of Apgar scores 0-3 for longer than 5 minutes. (c) Neonatal neurologic sequelae (eg, seizures, coma, Hypotonia). (d) Multiple organ involvement (eg, of the
kidney, lungs, liver, heart, intestine). Apgar scores are also useful for predicting long term outcome in infants with perinatal asphyxia. Metabolic derangements after asphyxia alters hemodynamics of newborn and a redistribution of cardiac output occur to maintain cerebral, cardiac, and adrenal perfusion while potentially compromising renal, gastrointestinal, and skin perfusion resulting in multiple organ dysfunctions [7-9]. In term neonates with asphyxia Renal, CNS, cardiac and lung dysfunction occur in 50%, 28%, 25% and 25% respectively [7]. AKI may occur within 24 hours of hypoxic–ischemic events resulting from decreased renal flow and deprived oxygen. If this is prolonged then it may result in cortical necrosis and irreversible damage.

High serum creatinine and high blood urea had 100 per cent sensitivity and negative predictive value to predict adverse outcome while serum creatinine >1.5 mg/dl alone had the best specificity and positive predictive value [10]. According to the Acute Kidney Injury Network (AKIN), AKI is an absolute increase in serum creatinine of ≥ 26.4 μmol/l (or a percentage increase in serum creatinine of at least 50%) over two consecutive days [11].

AKI can be of two types based on urine output Oligoanuric and Non oliguric [12]. It can be of 3 types based on the site of origin: Pre renal (75-80%), Intrinsic renal (10-15%) and Post renal (5%) [13]. Early identification and intervention in AKI can prevent dangerous complications. Intrinsic AKI can result in disturbed fluid, electrolyte and acid-base balance [14]. Hence prompt management is important in AKI in ill newborns.

Since HIE is considered as one of the common and dreadful complication of birth asphyxia we performed this study to determine the incidence of AKI in birth asphyxia and to correlate the AKI with severity of HIE grading of asphyxiated neonates.

**Material and Methods**

**Study design:** Cross-sectional observational study

**Setting:** Hospital based study at Special Newborn Care Unit (SNCU) of Dr. BRAM hospital, Raipur (Chhattisgarh)

**Inclusion criteria:** Newborns admitted in SNCU with perinatal asphyxia.

**Exclusion criteria:** Neonates with perinatal history of maternal azotemia or kidney disorders, congenital anomalies of kidney or urinary tract (as detected by antenatal or postnatal ultrasonography) and neonates with other factor which may change kidney function tests such as septicemia, respiratory distress syndrome (RDS), necrotizing enterocolitis (NEC), major congenital anomalies.

**Participants:** Newborns admitted with perinatal asphyxia.

**Variables:** Gestational age, birth weight, sex, HIE, AKI

**Data Source:** A predesigned and pretested proforma was used to collect data

**Bias:** Reporting bias, observation bias

**Study size:** 415 newborns with HIE out of 1318 newborns admitted in SNCU

**Statistical methods:** Statistical analyses were performed by using SPSS21.0 software. Chi square test, P- value and likelihood ratio were calculated using appropriate tests.

**Ethical approval:** The study was conducted after taking ethical approval from the Institute’s Ethical Committee.

**Result**

A total of 1318 neonates were admitted in SNCU for various problems, out of which 415 newborns had perinatal asphyxia. They were 241 (58.1%) males and 174 (41.9%) females. Out of these 52 (12.5%) were HIE-I cases, 242 (58.3%) were HIE-II and 121 (29.1%) were HIE-III.

| Staging of HIE | Number of newborns | Percentage |
|----------------|--------------------|------------|
| HIE I          | 52                 | 12.5       |
| HIE II         | 242                | 58.3       |
| HIE III        | 121                | 29.2       |
| **Total**      | **415**            | **100**    |

Total cases admitted with HIE 415. Majority 242 (58.3%) had HIE II.
Table-2: Gender wise distribution of study population.

| Sex     | I   | II  | III | Total |
|---------|-----|-----|-----|-------|
| Female  | 24  | 111 | 39  | 174   |
| Male    | 28  | 131 | 82  | 241   |
| Total   | 52  | 242 | 121 | 415   |

Out of 415 neonates 241 (58.1%) were males and 174 (41.9%) were females. In HIE III category 67.8% neonates were males.

Table-3: Distribution of neonates as per birth weight.

| Birth Weight                  | I     | II    | III   | Total |
|-------------------------------|-------|-------|-------|-------|
| Extremely low birth weight    | 0     | 1     | 0.4   | 1     |
| Very low birth weight         | 1     | 5     | 2.1   | 11    |
| Low birth weight              | 21    | 110   | 45.5  | 176   |
| Normal birth weight           | 30    | 126   | 52.1  | 227   |
| Total                         | 52    | 242   | 121   | 415   |

As per birth weight, Most of the HIE around 54.7% were of normal birth weight followed by low birth weight 42.4%

Table-4: Incidence of AKI.

| AKI    | HIE | Total |
|--------|-----|-------|
| NO     | I   | 0     |
|        | II  | 222   |
|        | III | 71    |
| Total  |     | 345   |
| YES    | I   | 0     |
|        | II  | 20    |
|        | III | 50    |
| Total  |     | 70    |

None of newborn in HIE I developed AKI. 20(8.2%) newborns with HIE II developed AKI while in HIE III 50 (41.3%) newborns had AKI.

Table-5: Distribution of Types of AKI.

| HIE | Perinatal | Intrinsic |
|-----|-----------|-----------|
| I   | 0         | 0         |
| II  | 18        | 2         |
| III | 47        | 3         |
| Total | 65     | 5         |

Out of 84 neonatal cases of AKI, 65(92.85%) neonates had pre-renal Azotemia and only 5(7.15%) neonates had intrinsic renal failure.
Table-6: Incidence of Oliguric AKI:

| HIE  | Urine output | Total | %     |
|------|--------------|-------|-------|
|      | Nonoliguric  |       |       |
| I    | 0            | 0     | 0     |
| II   | 20           | 100   | 20    |
| III  | 39           | 78    | 50    |
| Total| 59           | 84.3% | 70    | 100% |

Of all AKI cases, 11(15.7%) babies developed Oliganuric renal failure (urine output <0.5ml/kg/hr) and 59(84.3%) had Non oliguric renal failure (urine output >0.5/kg/hr).

Discussion

In this study we determined the incidence of AKI and its correlation with place of delivery, birth weight and severity of HIE. AKI were classified according to site of origin and urine output.

A total of 1318 neonates were admitted in SNCU for various problems, among them a total of 415 neonates were admitted for management of perinatal asphyxia. Percentage of male babies was higher (58.1% males versus 41.9% females) which was statistically significant (p-value 0.03). Majority (66%) of neonates were out born (p-value 0.001).

In our study majority of neonates had presented with HIE II 242 (58.3%) followed by 121 (29.1%) had HIE-III and only 52 (12.5%) had HIE-I. In 38.6% cases fetal distress resulting in passage of meconium in utero was cause of asphyxia in neonates. Other causes of birth asphyxia were eclampsia, preeclampsia, obstructed labor, cord around neck etc.

In our study 41.3% babies in HIE III developed AKI while in HIE II 8.3% babies and HIE I none developed AKI. As HIE stage progressed, more renal dysfunction was seen in asphyxiated babies. This difference in incidence was found statistically significant (p value <0.05 done by Chi-square test). In a prospective cohort study in Kenya there was 15 fold increased risk of developing AKI in HIE III as compared to HIE I [18].

In a prospective hospital based study in Sudan most of the babies with AKI had HIE II [15]. In an Indian study conducted at a teaching hospital out of 70 asphyxiated babies 33(47.1%) had renal failure majority of which Nonoliguric type (78%) [16]. A similar observation was noted as Non oliguric AKI was much more common (84.3%). In a Tunisian study out of 15 neonates with renal failure 10 had HIE stage II according to sarnat staging [17].

In our study around 93% newborn had Prerenal type of AKI. Even in HIE III category 94% had Prerenal AKI while only 6% had intrinsic AKI. In this study overall 84% newborn had Nonoliguric renal failure out of all AKI. Even in HIE III category 78% newborn had Nonoliguric renal failure while in HIE II category all newborn had Nonoliguric renal failure. Karlowicz et al found acute renal failure in 61% neonates with severe asphyxia predominantly of which Nonoliguric type (60%) [19]. In contrasts a study by Jayashree et al I found oliguric renal failure was more common in birth asphyxia [20]. Majority of research finding were suggestive of predominantly Nonoliguric renal failure in birth asphyxia [21-23].

In our study overall mortality rate is 27.5% while most of neonates belong to HIE III (p-value 0.000). In our study Total 32 newborns had shock out of which all newborn had renal failure. This is highly significant (p-value 0.000). 90% newborns in HIE III ultimately developed shock. This means low organ perfusion is also responsible for renal dysfunction irrespective of HIE. As HIE worsen, there is multiorgan dysfunction which also involve renal system. Thus intensive hemodynamic monitoring is necessary for early recognition of shock and appropriate management to prevent renal dysfunction. This finding is similar to previous studies [24-25].

Conclusion

The current study demonstrates frequency of perinatal asphyxia-31%. Out born neonates were found to have higher measurably huge frequency of perinatal asphyxia. The most common perinatal danger component was MSAF (40%). In our study the commonest type of ARF in every one of the three phases of HIE was non-oliguric sort. The frequency of characteristic renal disappointment in our study was 9.4%. Monitoring of blood urea, serum creatinine and
urine yield helps in the early conclusion and administration of renal disappointment. In birth asphyxia, even non-oliguric neonates had ARF. Hence, checking just urine yield does not help in the conclusion of ARF, renal biochemical parameters ought to be observed. ARF in suffocated neonates is dominantly pre-renal and reacts to liquid revival with 100% recuperation.

Shock was observed to be a critical inclining variable and a clinical marker connected with ARF in birth asphyxia. ARF in birth asphyxia demonstrates a solid positive relationship with HIE arranging.

**What this study adds to existing knowledge/practice:**
This study help in early detection of renal dysfunction in asphyxiated babies can help to prepare guidelines for management of these patients. An early intervention can prevent intrinsic renal failure and thus improve survival of these babies and early establishment the best approach to reduce mortality due to renal failure in asphyxiated neonate is to identify high risk cases for perinatal asphyxia in antepartum and intrapartum stage itself, and prevent this unfortunate event.

**Contributions by authors:** Phuljhele S conceived and supervised the study and helped in finalizing manuscript writing. Dewangan S helped in protocol writing and conceptualization, analyzed data, prepared and finalized the manuscript; will be the principal corresponding author. Rathi Y wrote the protocol, recruited patients and helped in data analysis and manuscript writing. The final manuscript was approved by all authors.

**Funding:** Nil, **Conflict of interest:** None initiated, **Permission from IRB:** Yes

**Acknowledgements:** We acknowledge the supporting staff of department of paediatrics and our pediatrics resident doctors who helped and support during study period.

**References**

1. Johnston MV, Hoon AH Jr. Cerebral palsy. Neuro-molecular Med. 2006;8(4):435-50. DOI:10.1385/NMM: 8:4:435

2. Mc Guire W. Perinatal asphyxia. BMJ Clin Evid. 2007 Nov 7; 2007. pii: 0320.

3. National Neonatal Perinatal Database; Report 2002-2003. Available from: http://www.New bornwhocc. Org / pdf/ HRRC Report_2002 03.pdf [Last accessed on 2019 Apr 5]

4. Martín-Ancel A, García-Alix A, Gayá F, et al. Multiple organ involvement in perinatal asphyxia. J Pediatr. 1995 Nov;127(5):786-93.

5. World Health Organizaton. Perinatal mortality: a listing of available information. FRH/ MSM. 96.7. Geneva: WHO, 1996

6. Report of the National Neonatal Perinatal Database (National Neonatology Forum, India) 2000

7. Perlman JM, Tack ED, Martin T, Shackelford G, Amon E. Acute systemic organ injury in term infants after asphyxia. Am J Dis Child 1989; 143: 617-620.

8. Cohn HE, Sacks EJ, Heymann MA, et al. Cardiovascular responses to hypoxemia and acidemia in fetal lambs. Am J Obstet Gynecol. 1974 Nov 15; 120 (6): 817-24.

9. Rudolph AM. The fetal circulation and its response to stress. J Dev Physiol. 1984 Feb;6(1):11-9.

10. Aggarwal A, Kumar P, Chowdhary G, et al. Evaluation of renal functions in asphyxiated newborns. J Trop Pediatr. 2005 Oct;51(5):295-9. Epub 2005 Jul 6.

11. Mehta RL, Kellum JA, Shah SV, et al. Acute Kidney Injury Network: report of an initiative to improve outcomes in acute kidney injury. Crit Care. 2007;11(2):R31. DOI:10.1186/cc5713

12. Gouyon JB, Guignard JP. Management of acute renal failure in newborns. Pediatr Nephrol. 2000 Sep; 14 (10-11): 1037-44.

13. Hentschel R, Lödige B, Bulla M. Renal insufficiency in the neonatal period. Clin Nephrol. 1996 Jul; 46(1): 54-8.

14. Askenazi D, Smith LB, Furth S, Warady BA. Acute kidney injury and chronic kidney disease. In: Avery’s Diseases of the Newborn. 9th ed. Philadelphia: Elsevier Saunders; 2012. p. 1205-21

15. Medani SA, Kheir AE, Mohamed MB. Acute kidney injury in asphyxiated neonates admitted to a tertiary neonatal unit in Sudan. Sudan J Paediatr. 2014; 14 (2):29-34.

16. Gupta BD, Sharma P, Bagla J, et al. Renal failure in asphyxiated neonates. Indian Pediatr. 2005 Sep;42 (9): 928-34.
17. Nouri S, Mahdhaoui N, Beizig S, et al. Acute renal failure in full term neonates with perinatal asphyxia. Prospective study of 87 cases. Arch Pediatr. 2008 Mar; 15(3): 229-35. doi: 10.1016/j.arcped.2008.01.011. Epub 2008 Mar 7.

18. Alaro D, Bashir A, Musoke R, et al. Prevalence and outcomes of acute kidney injury in term neonates with perinatal asphyxia. Afr Health Sci. 2014 Sep;14(3):682-8. doi: 10.4314/ahs.v14i3.26.

19. Karlowicz MG, Adelman RD. Nonoliguric and oliguric acute renal failure in asphyxiated term neonates. Pediatr Nephrol. 1995 Dec; 9(6):718-22.

20. Jayashree, G., et al. “Acute renal failure in asphyxiated newborns.” Indian pediatrics 28.1 (1991): 19-23.

21. Gupta BD, Sharma P, Bagla J, et al. Renal failure in asphyxiated neonates. Indian Pediatr. 2005 Sep; 42 (9): 928-34.

22. Aggarwal A, Kumar P, Chowdhary G, et al. Evaluation of renal functions in asphyxiated newborns. J Trop Pediatr. 2005 Oct; 51(5):295-9. Epub 2005 Jul 6. DOI: 10. 1093/tropej/fmi017

23. Pammi V, Mohan, Pragnya M. Pai. Renal insult in asphyxia neonatorum. Indian Pediatr 2000;37:1102-1106

24. Stapleton FB, Jones DP, Green RS. Acute renal failure in neonates: incidence, etiology and outcome. Pediatr Nephrol. 1987 Jul;1(3):314-20.

25. Hentschel R¹, Lödige B, Bulla M. et al. Renal insufficiency in the neonatal period. Clin Nephrol. 1996 Jul; 46(1):54-8.

How to cite this article?
Phuljhele S, Dewangan S, Rathi Y. Incidence of acute kidney injury in birth asphyxia and its correlation with severity of hypoxic ischemic encephalopathy (HIE) in newborns with perinatal asphyxia in SNCU at DR. BRAM Hospital, Raipur (CG). Int J Pediatr Res. 2019; 6(06): 304-309. doi: 10.17511/ijpr.2019.i06.07