Severe Umbilical Arterial Blood Metabolic Acidosis; A Predictor of Neonatal Encephalopathy

Syed Zulfiqar Haider[1], Lubna Akhtar[1], Mulazim Hussain[1], Sayed Ibrar Hussain[1], Nadeem Ahmed[2] and Syed Mohammad Aleem Haider[1]

ABSTRACT

Objective: To determine the relationship of Severe Umbilical Arterial Blood Metabolic Acidosis to Neonatal Encephalopathy.

Study Design: Descriptive cross sectional study

Place and Duration of Study: This study was conducted at the Department of Pediatrics, Fauji Foundation Hospital, Rawalpindi, over a period of 6 months from April, 2019 to Oct, 2019.

Materials and Methods: Umbilical arterial blood (UAB), samples were collected from all full term, singleton babies of both sexes, delivered by all delivery types, soon after birth. Non-probability consecutive sampling technique was used. Arterial blood gas analysis of these samples was done within half an hour, and babies with severe acidosis in UAB i.e. pH less than 7.0, were separated and included in this study. These neonates were observed for the development of signs of neonatal encephalopathy (NE). A comparison of acid base parameters, including pH, HCO3, and base deficit of these samples was made in neonates who developed NE versus those who did not. A relationship between these parameters and development of NE was established.

Results: It was found that 28.9% (24/83) of neonates with severe metabolic acidosis developed signs of NE within two days of birth. The mean pH and HCO3 were significantly low and BE was significantly high in these neonates; p =0.000.

Conclusion: Severe metabolic acidosis detected in umbilical arterial blood in a new born is an indicator of impending neonatal encephalopathy.

Key Words: Neonatal encephalopathy, umbilical arterial blood, metabolic acidosis.

INTRODUCTION

Increased or decreased body tone and seizures in a new born are indicators of neonatal encephalopathy (NE). NE is a clinical manifestation of neonatal brain dysfunction (NBD), and it can occur due to different etiologies. It occurs due to structural malformations of the brain, infections, metabolic derangements and hypoxia. Hypoxia can lead to serious NBD and NE. Hypoxic ischemic encephalopathy (HIE) resulting from perinatal fetal ischemia (PFI) is the most common cause of NBD and NE[1-2].

1. Department of Pediatrics, Foundation University Medical College, Islamabad.
1. Department of Pediatrics, Children Hospital, PIMS, Islamabad.

Correspondence: Dr. Syed Zulfiqar Haider, Assistant Professor Pediatrics, Foundation University Medical College Islamabad & Fauji Foundation Hospital Rawalpindi.
Contact No: 0333-5107659
Email: drsyedzulfiqarhaider@gmail.com

The incidence of NE in different studies is 2.0 to 6.0 per 1000 live births[3-6], and that of HIE is also 2.0 to 6.0 per 1000 live births.[7-15]

NE is a fairly common occurrence in neonates and results in adverse neurological outcomes later in life[3]. In one international study 167 term neonates with HIE were followed for a period of 3-5 years, 23.3% of these neonates got neurologically affected. Ones with moderate HIE developed cerebral palsy and those with severe HIE developed profoundly handicap[11].

Management planning to minimize adverse neurological outcomes later in life of children suffering from hypoxia in perinatal period, demands an early detection of PFI. In significant PFI the umbilical arterial blood (UAB) has severe metabolic acidosis (MA) with a pH of <7.0, and leads to HIE in 31% patients[12]. Umbilical arterial blood MA can be detected by performing blood gas analysis (BGA) of a fresh UAB sample. The objective of this study was to identify neonates at risk of developing NE by doing arterial blood gas analysis.

MATERIALS AND METHODS

This study was carried out in the Department of Pediatric Medicine, Fauji Foundation Hospital

Rawalpindi, from 22nd April to 23rd Oct 2019, after taking approval from the hospital ethical committee. Non probability consecutive sampling technique was used to collect umbilical arterial blood samples from full term babies delivered by all delivery types. Within half an hour of sampling the samples were sent to hospital laboratory for blood gas analysis and the results were recorded separately for each patient. After taking informed consent from parents, eighty three babies with severe metabolic acidosis i.e. pH less than 7.0, were included in the study.

The selected babies were observed for development of hypotonia, hypertonia and/or seizures. Babies with respiratory acidosis, neonatal sepsis, cardiac or renal disease, and family history of inborn errors of metabolism were excluded from the study. The relationship of umbilical arterial blood parameters including pH, HCO3, and base deficit, was studied against the development of neurological signs. These neonates were kept under observation and discharged once clinically stable and tolerating oral feeds.

The data was analyzed on SPSS version 16.0. Descriptive statistics were used to measure qualitative and quantitative data. Qualitative data were measured by percentages and frequencies and quantitative data was measured as mean ± standard deviation (SD) and if the data were normally distributed, by median and range otherwise.

RESULTS

Mean, median, mode and standard deviation of pH, bicarbonate (HCO3) & base excess (BE) of the umbilical arterial blood samples of the neonates included in the study were calculated. (table-1).

Table No.1: Descriptive statistics for umbilical artery acid base parameters

	pH	HCO3	BE
Mean	6.86	7.7241	-22.62
Median	6.89	8.10	-22.20
Mode	6.79	8.20	-20.90
Std. Deviation	0.13	1.53	2.37
Minimum	6.00	3.40	-28.20
Maximum	6.99	10.60	-18.60

The umbilical arterial blood, acid base parameters were compared in neonates who developed NE versus those who did not (table-2). It was found that out of the eighty three babies with severe umbilical arterial blood metabolic acidosis, 24 (28.9%) developed neonatal encephalopathy within two days of birth. The acid base parameters of these neonates showed pH 6.75±.20, HCO3 5.98±1.22 and BE -24.71±1.96. The mean pH and HCO3 of these neonates were significantly lower and mean BE was significantly higher; p =0.000.

Table No.2: Umbilical arterial acid base parameters in neonates with Hypoxic ischemic encephalopathy versus neonates with no neurological sign

Umbilical arterial blood acid base parameters	Hypoxic ischemic Encephalopathy	No neurological sign	P value
pH	6.75±.20	6.90±0.06	0.00
HCO3	5.98±1.22	8.43±0.99	0.00
BE	-24.71±1.96	-21.77±1.97	0.00

DISCUSSION

Adverse neurological outcomes associated with NE include cerebral palsy, epilepsy, cognitive, developmental and behavioral problems, and even death[3]. Ethical, social, legal, and financial costs involved in such outcomes are enormous[13,14]. This necessitates testing and early detection of NE, especially due to perinatal fetal ischemia (PFI), in order to improve perinatal care and to take timely decisions of intervention[16].

For the early detection of perinatal fetal ischemia, different investigations are done including umbilical arterial blood gases for metabolic acidosis, Apgar score, serum lactate, placental histology, heart rate decelerations, electrocardiographic & cardiotocographic monitoring, MRI and electroencephalogram of newborns[16-22]. These parameters are used in different combinations depending upon availability of resources in a particular setup and this significantly increases the possibility to diagnose NE.

Among these investigations UAB metabolic acidosis has been consistently included by majority of criteria for diagnosis of perinatal ischemia and is considered the single most sensitive indicator of intrapartum fetal ischemia by the British and American Colleges of Obstetrics and Gynecology[23]

In a study done by Wayenberg, moderate or severe NE occurred in 26% of patients with UAB base deficit higher than 10mmol/L and in 79% of those with base deficit higher than 18mmol/L. In our study 28.9% neonates developed clinical signs of NE and they had base deficit 18.60 to 28.20 mmol/L with SD 2.37. The similarity in two studies is higher percentage of neonates developing NE with a rising base deficit. A difference in base deficit values of the two studies can be noted and it is explainable by the fact that base deficit values are calculated entities and not measured ones and are therefore are subject to variation[16].

V Modarressnejad at Kerman University of Medical and Health Sciences, Iran, conducted a prospective cross-sectional study. Four hundred singleton term babies delivered by all delivery types were included in the study. Mean (SD) umbilical cord blood pH was 7.25 +/- 0.14. Eighty-one of these patients showed pH <7.1. This low pH was found related to development of poor

neurological outcomes. Our inclusion criteria was babies with severe metabolic acidosis, UAB pH <7.0, thus umbilical cord blood pH mean (SD) in our study was 6.86 +/- 0.13 and range 6.00 to 6.99, SD 0.13. In our study neonates, who developed signs of NE, had pH 6.75±.20. The pH values of the two studies for the affected children are in keeping with each other.[24]

Victory R, using database of St. Joseph's Health Care, London, studied term neonates for a relationship of umbilical cord arterial & venous blood pH and base deficit along with Apgar score <7 at 5 minutes, to the chances of intensive care unit admissions & need for mechanical ventilation. A progressively higher risk with increasing metabolic acidosis was found. This relationship was independent of whether the blood was taken from the umbilical artery or vein. Our study with all its simplicity reached the same conclusion of increased risk with increasing metabolic acidosis. We monitored only clinical signs of NE and yet the results were similar, and this was indeed an advantage for our local setups[25].

Our study was exquisitely simple, conducted in available hospital resources and needed no additional funding from any agency. This excluded possible bias related to cost and benefit gains. Moreover, it is applicable in most hospital settings of Pakistan and provides opportunity to improve management & outcome. The short coming of our study was that the affected neonates were followed only for a short period of time, i.e. till stability and discharge, and late complications and outcomes were not monitored. Though it was beyond the scope of our study, it would be worth doing in a future.

CONCLUSION

Severe metabolic acidosis in umbilical arterial blood of a neonate, detected soon after birth, is a reasonably reliable indicator of ischemia and predictor of impending neonatal encephalopathy. It can be used to treat these newborns and improve outcome.

Author's Contribution:

Concept & Design of Study:	Syed Zulfiqar Haider
Drafting:	Lubna Akhtar, Mulazim Husssain
Data Analysis:	Sayed Ibrar Hussain, Nadeem Ahmed, Syed Mohammad Aleem Haider
Revisiting Critically:	Syed Zulfiqar Haider, Lubna Akhtar
Final Approval of version:	Syed Zulfiqar Haider

Conflict of Interest: The study has no conflict of interest to declare by any author.

REFERENCES

1. Nelson KB, Leviton A. How much of neonatal encephalopathy is due to birth asphyxia? Am J Dis Child 1991;145:1325–31.
2. Volpe JJ. Neurology of the newborn. 4th edition. Philadelphia: WB Saunders Company;2001.p. 217–76.
3. Evans Evans K, Rigby AS, Hamilton P, Titchner N, Hall DM. The relationship between neonatal encephalopathy and cerebral palsy: a cohort study. J Obstet Gynaecol 2001;21:114–20.
4. Badawi N, Kurinczuk JJ, Keogh JM, Alessandri LM, O'Sullivan F, Burton PR, et al. Intrapartum risk factors for newborn encephalopathy: the Western Australia case–control study. Br Med J 1998;317:1554–8.
5. Ellis M, Manandhar N, Manandhar DS, Costello AM. Risk factors for neonatal encephalopathy in Kathmandu, Nepal, a developing country: unmatched case–control study. Br Med J 2000; 320:1229–36.
6. Brown JK, Purvis RJ, Forfar JO, Cockburn F. Neurological aspects of perinatal asphyxia. Dev Med Child Neurol 1974;16:567–80.
7. Smith J, Wells L, Dodd K. The continuing fall in incidence of hypoxic–ischaemic encephalopathy in term infants. Br J Obstet Gynaecol 2000;107: 461–6.
8. Badawi N, Kurinczuk JJ, Keogh JM, Alessandri LM, O'Sullivan F, Burton PR, et al. Intrapartum risk factors for newborn encephalopathy: the Western Australia case–control study. Br Med J 1998;317:1554–8.
9. Thornberg E, Thiringer J, Odeback A, Milsom I. Birth asphyxia: incidence, clinical course and outcome in a Swedish population. Acta Paediatr 1995;84:927–32.
10. Itoo BA, Al-Hawsawi ZM, Khan AH. Hypoxic ischemic encephalopathy, incidence and risk factors in North Western Saudi Arabia. Saudi Med J 2003;24:147–53.
11. Airede AI. Birth asphyxia and hypoxic–ischaemic encephalopathy incidence and severity. Ann Trop Paediatr 1991;11:331–5.
12. Hull J, Dodd KL. Falling incidence of hypoxic–ischaemic encephalopathy in term infants. Br J Obstet Gynaecol 1992;99:386–91.
13. Levene ML, Kornberg J, Williams THC. The incidence and severity of post-asphyxial encephalopathy in full-term infants. Early Hum Dev 1985;11:21–6.
14. Finer NN, Robertson CM, Richards RT, Pinnell LE, Peters KL. Hypoxic–ischemic encephalopathy in term neonates: perinatal factors and outcome. J Pediatr 1981;98:112–7.

15. MacDonald HM, Mulligan JC, Allen AC, Taylor PM. Neonatal asphyxia. I. Relationship of obstetric and neonatal complications to neonatal mortality in 38,405 consecutive deliveries. J Pediatr 1980;96: 898–902.

16. Wayenberg JL. Threshold of metabolic acidosis associated with neonatal encephalopathy in the term newborn. J Matern Fetal Neonatal Med 2005; 18(6):381–385.

17. Laptook AR. Neonatal and infant death: the Apgar score reassessed. Lancet 2014;384(9956):1727–1728.

18. East CE, Leader LR, Sheehan P, et al. Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace. Cochrane Database Syst Rev 2015;105(5): CD006174

19. Neilson JP. Fetal electrocardiogram (ECG) for fetal monitoring during labour. Cochrane Database Syst Rev 2015;358(12):CD000116.

20. Leviton A. Why the term neonatal encephalopathy should be preferred over neonatal hypoxic-ischemic encephalopathy. Am J Obstet Gynecol 2013;208(3):176–180.

21. Van Laerhoven H, de Haan TR, Offringa M, Post B, van der Lee JH. Prognostic tests in term neonates with hypoxic-ischemic encephalopathy: a systematic review. Pediatr 2013;131(1):88–98.

22. Del Río R, Ochoa C, Alarcon A, Arnáez J, Blanco D, García-Alix A. Amplitude integrated electroencephalogram as a prognostic tool in neonates with hypoxic-ischemic encephalopathy: a systematic review. PLoS One 2016;11(11): e0165744.

23. Baier RJ. Genetics of perinatal brain injury in the preterm infant. Front Biosci 2006;11:1371–87.

24. Modarressnejad V. Umbilical cord blood pH and risk factors for acidaemia in neonates in Kerman. EMHJ-Eastern Mediterranean Health J 2005;11 (1-2):96-101.

25. Victory R, Penava D, Da Silva O, Natale R, Richardson B. Umbilical cord pH and base excess values in relation to adverse outcome events for infants delivering at term. Am J Obstet Gynecol 2004;191(6):2021-8.