ISSN: 2091-2749 (Print)
2091-2757 (Online)

Analysis of umbilical cord blood gas in term and near term asphyxiated newborn babies

Amrit Ghimire,[1] Laxman Shrestha,[2] Merina Shrestha[3]

[1]Lecturer, Department of Pediatrics, Patan Academy of Health Sciences, Lalitpur, Nepal; [2]Professor, [3]Associate Professor, Department of Pediatrics, Tribhuvan University Teaching Hospital, Kathmandu, Nepal

Correspondence
Dr. Amrit Ghimire
Lecturer, Department of Pediatrics, Patan Academy of Health Sciences, Lalitpur, Nepal
Email: amrit_sathi@yahoo.com

Peer Reviewers

Jay N Shah
Patan Academy of Health Sciences

Suchita Joshi
Patan Academy of Health Sciences

ABSTRACT

Introductions: Birth asphyxia is failure breathing causing severe consequences or death. This study aims to determine the incidence of perinatal asphyxia in neonates with low Apgar and Hypoxic Ischemic Encephalopathy (HIE) in asphyxiated babies.

Methods: This was a cross sectional study from November 1, 2010 to July 30, 2011. Babies with Apgar score of less than seven at five minute were enrolled in the study. Blood was drawn from umbilical cord artery for blood gas analysis. Neonates were followed up in every six hours for at least 48 hours. Staging of HIE according to Sarnat staging was done in babies with Apgar score of <7 at five minutes within 24 hours of birth. Data was analysed using SPSS version 16.0.

Results: Total of 2,425 live births, 56 (2.30%) were born with an Apgar of < 7 at five minute, six were excluded (due to set exclusion criteria) and remaining 50 were analysed. Thirty-four (68% of 50) of babies with low Apgar score had maternal risk factors – meconium stained liquor being the commonest risk factor. Majority (46%) had cord blood pH of >7.2, 40% had between 7.1 to 7.2, 12% between 7 to 7.1 and remaining 2% had pH < 7. HIE developed in 22% (11/50) of the asphyxiated babies.

Conclusions: More than 1/3rd (46%) of babies with low Apgar had low cord blood pH, 1/4th (26%) had base excess, and 22% developed features of HIE. Cord blood pH were better predictors than Apgar in asphyxiated babies.

Keywords: Apgar score, cord blood, hypoxic ischemic encephalopathy (HIE)

INTRODUCTIONS

The World Health Organization (WHO) defines birth asphyxia as failure to initiate and sustain breathing at birth.[1] The WHO estimates that globally, between four and nine million newborns suffer birth asphyxia each year. Of those, an estimated 1.2 million die and almost the same number develop severe consequences.[2] This study was conducted to determine the incidence of perinatal asphyxia in term and near term (>35 weeks) neonates with low Apgar score and to evaluate risk factors for asphyxia and hypoxic ischemic encephalopathy in asphyxiated babies.

METHODS

An observational study was carried out at the Department of Paediatrics, Tribhuvan University Teaching Hospital (TUTH), Nepal, during November 2010 to July 2011. Live born neonates more than or equal to 35 weeks gestation and low Apgar Score (<7) at five minutes were enrolled in the study. Gestational age of <35 weeks, major congenital abnormalities suggestive of diaphragmatic hernia or congenital heart disease, neonates with dysmorphic features suggestive of chromosomal anomalies or structural brain abnormalities, maternal general anaesthesia or maternal sedation or analgesia with pethidine or morphine given within the last 4 hours, condition where parents/caretakers refused to give consent, were excluded from the study. Ethical clearance was taken from Institutional Review Board (IRB). Parents/caretakers were explained in detail about the nature of the study and consent was taken prior to the delivery or immediately after delivery.

Paediatric team on duty attended all deliveries with perinatal asphyxia and conducted resuscitation. Immediately after the delivery of the neonate in a depressed state, a segment of umbilical cord was double-clamped, divided, and placed on the delivery table. If the five-minute Apgar score was satisfactory and the infant appeared stable and vigorous, the segment of umbilical cord was discarded. If five-minute Apgar was <7, blood was drawn from the artery of cord segment and sent immediately for blood gas analysis. Following initial resuscitation, all the neonates were brought to neonatal intensive care unit (NICU). If Apgar score at five minutes was <3, neonates were observed in NICU for at least 24 hours. If Apgar at five minutes was four to six, neonates were observed for at least four hours in NICU and if found stable, were transferred to mother side in the maternity ward. Neonates were followed up in NICU or maternity ward and clinical examination was done every six hours for at least 48 hours. The diagnosis of perinatal encephalopathy required an abnormal neurological examination on the first day following birth according to the staging of Hypoxic Ischemic Encephalopathy (HIE) by Sarnat and graded accordingly in all babies with Apgar score of <7 at five minutes within 24 hours of birth. Data was analysed using SPSS version 16.0.

RESULTS

Out of the total 2,425 live births during the study period, 56 (2.3%) were born with an Apgar of <7 at five minutes. Six asphyxiated babies were excluded from the study as they met exclusion criteria or adequate sample of arterial blood could not be obtained. Out of the remaining 50 asphyxiated babies, (2.06% of 2425 total), 31 (62% of 50) were male and 19 (38%) female. Maternal risk factors were found in more than 34 (68%) babies with low Apgar (Table 1). Cord blood pH was <7.2 in 27% meconium stained liquor (Table 2) and Cord blood pH <7.1 in 14% with low Apgar (Table 3). Out of 27 babies with pH <7.2, eight developed HIE of different severity (Table 4).

DISCUSSIONS

In developed countries, perinatal asphyxia varies from 1.8 to 6.7 per 1000 live births.[2] Birth asphyxia is a major reason of neonatal admissions in hospitals in Nepal. A study in 2000-2001 showed it to be the commonest cause for neonatal admissions in Paropakar

Maternity Hospital, Thapathali, Kathmandu, accounting for 30% of the admissions. In Patan Hospital and in TUTH, also a significant number of neonatal admissions were attributed to perinatal asphyxia at 7% and 13% respectively.[3] A study at TUTH by Shrestha et al. in 2008 found 9% of the term babies were asphyxiated at one minute of birth.[4]

Table 1. Maternal risk factors associated with asphyxiated babies (n=50) with low Apgar score (<7)

Maternal Risk Factors	Frequency	%
Meconium Stained Liquor	23	46
Foetal Distress	3	6
Premature Rupture of Membrane (PROM)	1	2
Cord Prolapsed	1	2
Poor Maternal Effort	1	2
Oligohydramnios	3	6
Eclampsia	2	4
No Risk Factors	16	32
Total	50	100

Table 2. Meconium stained liquor and cord blood pH in asphyxiated babies (n=50)

	Cord Blood pH		
	<7.2	>7.2	Total
Liquor Meconium Stained	15	8	23
Liquor No Meconium Stained	12	15	27
Total	27	23	50

Table 3. Apgar score and cord artery blood pH in asphyxiated babies (n=50)

		Cord Blood pH				
		<7	7 -7.1	7.1 - 7.2	>7.2	Total
Apgar at 1 min	Less than or equal to 3	1	6	13	10	30
	More than 3	0	0	7	13	20
Apgar at 5 min	Less than or equal to 3	1	1	0	1	3
	More than 3	0	5	20	22	47

Table 4. Hypoxic Ischemic Encephalopathy (HIE) grading and cord blood pH in asphyxiated babies (n=50) with low Apgar score (<7)

	Cord Blood pH				
	<7	7 - 7.1	7.11 - 7.2	>7.2	Total
No HIE	0	2	17	20	39
HIE 1	0	3	1	2	6
HIE 2	0	0	1	0	1
HIE 3	1	1	1	1	4
Total	1	6	20	23	50

According to American College of Obstetricians and Gynaecologist (ACOG)[5] and the American Academy of Paediatrics (AAP),[6] a neonate is labelled to be asphyxiated if the following conditions are satisfied: (1) Umbilical cord arterial pH less than 7; (2) Apgar score of zero to three for longer than five minutes; (3) Neonatal neurologic manifestations (eg. seizures, coma, or hypotonia); and (4) Multisystem Organ Dysfunction, eg.

cardiovascular, gastrointestinal, hematologic, pulmonary, or renal system.

Apgar scores are lower as a result of intrauterine asphyxia and there is an apparent discrepancy between Apgar scores and the severity of acidosis at birth, as determined by pH measurements on umbilical arterial blood.[7] Though Apgar score is still used to categorize the asphyxia, it do not correctly diagnose perinatal asphyxia and predict long-term neuro developmental disabilities. Study by D'souza showed that babies who are in depressed condition at birth with acidosis had neurological abnormality in comparison with those without acidosis.[8] In addition, the score assessment may variy according to individual health care providers.

Based on the criteria for defining asphyxia, the incidence of perinatal asphyxia in TUTH during the study period was 0.4 per thousand live births.[4] The incidence is comparable with studies from KK Women's Children Hospital, Singapore where it was 0.3 per 1000 live births in 2004.[9] This incidence is low in current study compared to other studies in which asphyxia was defined on the basis of Apgar score alone. These include rates of birth asphyxia in other developing countries, including 26 per 1000 live births in Nigeria.[10] Apgar <7 at five minutes was found in 2.3% of total deliveries in current study. We found similar sex distribution, 31 (62% of 50) male and 19 (38%) female, compared to previous study by Shrestha et al. in TUTH with 61% male and 39% female.[4] Only term and near-term babies (>35 weeks) were included in this study. The reason for excluding preterm babies was to avoid neonatal depression secondary to prematurity and abnormal muscle tone.

Mean gestational age was 38^{+6} weeks. Most of the newborns (82%) were between 2,500 to 4,000 grams. Low birth weight and gestational age did not correlate well with low cord blood pH. Nergesh Tejani in 1989 showed correlation between low birth weight and low cord blood pH (<7.1).[11] It also correlated mortality with gestational age (<28 weeks). Their sample size was large (392) and preterm babies were not excluded which is different from our study.

Since Apgar score has many limitations, umbilical arterial pH has been proposed as better markers.[12] Umbilical cord arterial blood acid-base and gas assessment remains the most objective determination of the foetal metabolic condition at the moment of birth. In newborn babies whose Apgar remained below seven at five minutes of birth, the umbilical cord pH ranged from 6.93 to 7.37 with an average of 7.18 ± 0.09. This finding is comparable with the study done by S D'Souza in 1983 at St. Mary's Hospital, Manchester where mean cord arterial pH was 7.265 ± 0.07.[8]

In the current study, 14% of those with low Apgar had cord pH <7.1. This is comparable to the study by Sykes and co-workers where 20% of the neonates with Apgar scores of six or less had cord pH values of 7.10 or less.[7] Reduced vigor, or a depressed condition at birth may be induced by conditions other than intrauterine asphyxia. Also, the assessment of muscle tone and reflex excitability is more subjective compared with remaining components of Apgar score.[8] In this study, 26% of babies with low Apgar had base excess more than minus 12 and the maximum was -18.9. Average base excess was -9.16. Socol ML et al. from January 1984 through December 1991 studied a population of 28 newborns with Apgar score at five minutes <3 and found a significantly greater mean base deficit (14.8 ± 6.3 mmol/L).[13] In the current study, only three babies (6%) had Apgar less than or equal to three at five minutes and this could not be compared with study by Socol. Low cord blood pH was significantly associated with increasing base excess in the current study ($p = 0.018$). A prospective case control study done by Hassan Boskabadi et al. between October 2006 to December 2008 at Ghaem Hospital, Iran, found base excess was -3.24±4.81 for the control group and -11.58±10.12 for cases. This study comprised of 49 healthy neonates (control) and 49 with features of asphyxia.[14] Low and co-workers, who have written extensively on this subject, and noted that "threshold for significant metabolic acidosis" is a base deficit between 12

and 16 mmol/liter. An increased number of neurological abnormalities were encountered in infants as the degree of acidosis worsened.[15]

In this study, low Apgar at one min (p value = 0.05) and five min (p value = 0.001) was associated with low cord pH. Two of three babies with Apgar less than or equal to three at five minutes had cord blood pH less than 7.2. However, low Apgar was not correlated with increased base excess in the current study. Out of three babies with Apgar <3 at five min, two babies had base excess > -12. No significant correlation between Apgar <3 at five minutes and base excess > -12 could be due to small no of population in the study.

Low arterial umbilical cord pH had a strong and consistent association with important maternal risk factors like meconium stained liquor. Meconium stained liquor accounting for 46% of total cases included. The likelihood ratio of having low pH (<7.2) in those with meconium stained liquor was 2.178. David R Hall et al. reports similar finding of 47% meconium stained liquor among asphyxiated babies.[16]

Eleven newborns (22%) had had features of HIE according to Sarnat stages of encephalopathy. Among them, 6 (54%) had HIE-I, 1 (9%) HIE-II and 4 (36%) HIE-III. Seven out of eleven cases with HIE, had cord pH <7.2. Severity of encephalopathy was significant with low cord pH (p value = 0.004). Eight out of eleven cases with HIE had base excess more than -12, a significant correlation (p value = 0.017). Goodwin et al. in 1992 found that association between umbilical arterial acidosis and adverse neurological events among term, singleton infants with cord arterial pH. Once severe acidosis is present, the likelihood of adverse sequelae rises sharply with worsening acidosis. It was found that HIE occurred in 12% of infants with cord pH <7.0, 33% with cord pH 6.9, 60% with cord pH <6.8, and 80% with cord pH <6.7. In a study of term deliveries with cord blood gas measurements, no infant was live born with pH <6.6.[17]

Umbilical cord blood gas analysis is now recommended in all high-risk deliveries by both the British and American Colleges of Obstetrics and Gynaecology; and in some centres, it is practised routinely following all deliveries. Besides being invasive and expensive procedure, it also requires logistics of collecting and analysing the samples immediately after birth and expertise in interpretation which may not be available in delivery rooms at all times in low resource settings. With available resources and expertise, it has clinical and medicolegal importance that clinicians caring for newborn infants be familiar with the evidences and practice of cord blood gas values.

CONCLUSIONS

The umbilical arterial pH is better than Apgar score in evaluating the risk factors for asphyxia and hypoxic ischemic encephalopathy (HIE) in asphyxiated babies. More than 1/3rd (46%) of babies with low Apgar had low cord blood pH, 1/4th (26%) had base excess, and 22% developed features of HIE.

REFERENCES

1. World Health Organization. Guidelines on basic newborn resuscitation. 2012:15. http://apps.who.int/iris/bitstream/10665/75157/1/9789241503693_eng.pdf
2. Lawn Joy E, Cousens S, Zupan J. 4 million neonatal deaths: When? Where? Why? Lancet. 2005 Mar;365(9462):891-900. DOI: http://dx.doi.org/10.1016/S0140-6736(05)71048-5
3. Maternal and Perinatal Death Review in Nepal, January 2008. DFID;2008. Report No.: 630/04/DFID. http://s3.amazonaws.com/zanran_storage/www.safemotherhood.org.np/ContentPages/2469459184.pdf
4. Shrestha M, Shrestha L, Shrestha PS. Profile of asphyxiated babies at Tribhuvan University Teaching Hospital. Journal of Nepal Paediatric Society 2009;29:3-5. DOI: 10.3126/jnps.v29i1.1592
5. Committee on Fetus and Newborn, American Academy of Pediatrics, and Committee on Obstetric Practice, American College of Obstetricians and Gynaecologists. Use and abuse of the Apgar score. Pediatrics.1996 Jul;98(1):141-2. Available from:

http://pediatrics.aappublications.org/content/pediatrics/98/1/141.full.pdf
6. Gilstrap LC, Oh W. Care of the neonate. Guidelines for perinatal care. American Academy of Pediatrics. 2002. p. 196-7.
7. Sykes G, Johnson P, Ashworth F, Molloy P, Gu W, Stirrat GM, Turnbull AC. Do Apgar scores indicate asphyxia? The Lancet. 1982 Feb;319(8270):494-6. https://doi.org/10.1016/S0140-6736(82)91462-3
8. D'Souza SW, Black P, Cadman J, Richards B. Umbilical venous blood pH: a useful aid in the diagnosis of asphyxia at birth. Archives of disease in childhood. 1983 Jan;58(1):15-9. http://dx.doi.org/10.1136/adc.58.1.15
9. Simunek V Z. Definition of intrapartum asphyxia and effects on outcome. Journal de Gynecologie, Obstetrique et Biologie de la Reproduction. 2008;37(1):S7-S15. DOI: https://doi.org/10.1016/j.jgyn.2007.11.006
10. Costello AM, Manandhar DS. Perinatal asphyxia in less developed countries. Arch. Dis. Child: Fetal Neonatal Ed. 1994 Jul;71(1):F1-F3. Available from: http://fn.bmj.com/content/fetalneonatal/71/1/F1.full.pdf
11. Tejani N, Verma UL. Correlation of Apgar scores and umbilical artery acid-base status to mortality and morbidity in the low birth weight neonate. Obstetrics & Gynecology. 1989;73(4):597-600. Available from: http://journals.lww.com/greenjournal/abstract/1989/04000/correlation_of_apgar_scores_and_umbilical_artery.12.aspx
12. Westgate J, Garibaldi JM, Greene KR. Umbilical cord blood gas analysis at delivery: a time for quality data. BJOG: An International Journal of Obstetrics & Gynaecology. 1994 Dec;101(12):1054-63. DOI: 10.1111/j.1471-0528.1994.tb13581.x
13. Socol Michael L, Garcia Patricia M, Riter Susan. Depressed Apgar scores, acid-base status and neurologic outcome. Am J Obstet Gynecol. 1994;170:991-9. http://dx.doi.org/10.1016/S0002-9378(94)70092-3
14. Hassan Boskabadi, Gholamali Maamouri, Mohammad Hadi Sadeghian, et al. Early diagnosis of perinatal asphyxia by nucleated red blood cell count: a case-control study. Archives of Iranian Medicine. 2010 Jul;13(4):275-81. Available from: http://www.ams.ac.ir/AIM/010134/005.pdf
15. Low JA, Lindsay BG, Derrick EJ. Threshold of metabolic acidosis associated with newborn complications. American journal of obstetrics and gynecology. 1997 Dec;177(6):1391-4. https://doi.org/10.1016/S0002-9378(97)70080-2
16. Hall DR, Smith M, Smith J. Maternal Factors Contributing to Asphyxia Neonatorum. Journal of Tropical Pediatrics. 1996;42(4);192-5. DOI: https://doi.org/10.1093/tropej/42.4.192
17. Goodwin TM, Belai I, Hernandez P, et al. Asphyxial complications in the term newborn with severe umbilical academia. Am J Obstet Gynecol. 1992;167:1506-12. DOI: http://dx.doi.org/10.1016/0002-9378(92)91728-S