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RESEARCH ARTICLE

UMBILICAL ARTERY BLOOD GAS AND LACTATE IN HEALTHY NEWBORNS IN RELATION TO DELIVERY MODE.

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ABSTRACT

To establish the reference range of umbilical artery pH, pCO_2, pO_2 and lactate in healthy newborns in relation to the mode of delivery viz. normal vaginal, instrument assisted and caesarean section.Observational study, conducted at tertiary level neonatal care unit. Umbilical artery gas parameters and lactate from 95 newborns were evaluated. Out of 95 newborns, 10 suffered from perinatal asphyxia. Calculations and statistical analysis was performed using commercially available software Graphpad PRISM 5 (Version 5.03). The quantitative variables between the respective two groups were compared using Student's t- test (unpaired). P value < 0.05 was considered significant. The mean ± SD lactate levels in healthy newborns delivered through normal vaginal, caesarean and instrument assisted mode were 4.34 ± 0.11 mmol/L, 2.90 ± 0.12 mmol/L and 6.49 ± 0.5 mmol/L respectively. The mean ± SD pH levels in normal vaginal, caesarean instrument deliveries were 7.21 ± 0.04, 7.25 ± 0.06 and 7.11 ± 0.09 respectively. The mean ± SD pO_2 values in vaginal, caesarean and instrument group were 23.67 ± 7.76 mmHg, 17.97 ± 7.86 mmHg and 12.8 ± 4.81 mmHg respectively. The mean ± pCO_2 levels in vaginal, caesarean and instrument assisted deliveries were found to be 48.67 ± 5.86 mmHg, 50.90 ± 6.18 mmHg and 61.4 ± 15.75 mmHg respectively.Cord blood lactate and blood gas analysis provides reliable information about the neonatal condition at delivery. The mean lactate levels and cord blood gas parameters in newborns born through different modes of delivery highlight the amount (higher/lesser) of stress that the newborns undergo in respective modes.

Key words: Umbilical artery, Lactate, Blood gases, Delivery mode, Newborns.

INTRODUCTION:

Assessment of newborn status has traditionally been based on the Apgar scoring system (1). However, the system depends on subjective interpretation and may be affected by many factors. For example, Apgar score may be low in a non- asphyxiated preterm baby if the mother has been given sedation.

Assessment of acid-base status of the newborn at birth is valuable because it may give us information about hypoxia in the baby, which may have a long term effect. James et al first reported the relationship between abnormal blood gas and low Apgar score (2), but recent studies have shown that acidotic babies may not have low Apgar score (3- 5). Thus, measurement of acid- base status may be a useful adjunct to evaluate the condition of newborn babies.

Acidosis is divided into respiratory, metabolic and mixed types. Respiratory acidosis can be transient and results from accumulation of CO_2. This can be cleared quickly and is usually transient and harmless to the fetus. If oxygen falls to a level at which the fetus fails to compensate, this will lead to anaerobic metabolism, with lactate and H+ ion as end products. Accumulation of lactate and H+ ions will lead to metabolic acidosis.

Metabolic acidosis represents tissue hypoxia and is associated with risk of vital organ damage. pH alone may not discriminate between metabolic and respiratory acidosis. Lactate levels or pCO_2 together with pH, to calculate base deficit may be necessary for discrimination. Thus, it is of value to measure umbilical artery blood gas and lactate level to evaluate newborn status.

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This study was conducted with an aim to establish the reference range in umbilical artery blood gas parameters and lactate for healthy babies delivered at our institute through different modes and to correlate the various indices to each other and to compare the results observed in the various groups.

MATERIALS AND METHODS:

Ethics:

The study is approved by Ethics Committee and all the procedures followed are in accordance with the ethical standards of the responsible committee.

Study design:

Selection and Description of Participants:

During the study period of January 2009 to January 2010, 95 newborns who were delivered at Himalayan Institute of Medical Sciences, Dehradun were included in the study. Sixty nine (73%) of them were term and 26(27%) were preterm. Among them 44(46%) were vaginal deliveries, 46(49%) were caesarean sections and 5(5%) were instrument assisted deliveries. Out of 95 newborns 10 suffered perinatal asphyxia. The newborns were labelled asphyxiated when the following criteria were met i.e. evidence of fetal distress (e.g. abnormal fetal heart rate and/or metabolic acidosis with cord blood pH < 7.1), immediate neonatal depression (e.g. 5 minute Apgar score is < 5) and neonatal hypoxic ischemic encephalopathy (HIE). In order to establish mean values of umbilical artery blood gas parameters and lactate levels in normal/ healthy newborns the parameters measured in asphyxiated newborns were not included in the calculations. Newborns with life threatening congenital anamolies, sepsis, chromosomal abnormalities and pulmonary disease were also excluded from the study.

Sample collection and Technical information:

Umbilical arterial blood samples were collected within 20 minutes of delivery, after clamping of cord. Umbilical arterial blood is chosen as it most accurately reflects fetal status because the umbilical arterial blood flows directly from the fetus. In contrast, umbilical venous blood returns from the placenta. Samples were collected anaerobically in preheparinized 2ml polyethylene syringes and analyzed immediately for pH, pCO_2, pO_2 and for serum lactate. Lactate levels were estimated on Beckman Coulter Synchron CX9 PRO autoanalyser using spectophotometric method. Arterial Blood Gases were assessed on automated GEM Premier 3000 blood gas and electrolyte analyzer. These measurements were performed in the biochemistry laboratory within 60 minutes of delivery.

All data collection was completed soon after delivery. Calculations and statistical analysis was performed using commercially available software Graphpad PRISM 5 (Version 5.03). The quantitative variables between the respective two groups were compared using Student's t-test (unpaired). P value < 0.05 was considered significant.

RESULTS:

Eighty five newborns met the inclusion criteria. Among them, 40(47%) were delivered through normal vaginal mode, 40(47%) through caesarean section and the remaining 5(6%) through instrument assisted mode. Among them 63(74%) were term while 22(26%) were preterms. Their gestational age ranged from 32 to 42 weeks with a mean ± SD gestation of 38 ± 3.16 weeks. The mean ± SD birth weight of these normal newborns was 2.64 ± 0.54 kg. The mean ± SD 1 minute, 5 minutes and 10 minutes Apgar scores in these newborns were 8.23 ± 0.65, 9.21 ± 0.44 and 10 ± 0 respectively.

Table1 summarizes the mean ± SD for pH, pCO_2, pO_2 and lactate in normal vaginally delivered and caesarean delivered newborns. The pH values in vaginal deliveries were significantly lower than those in caesarean deliveries and the lactate levels were significantly higher in vaginal deliveries in comparison to caesarean deliveries. The pO_2 levels were found to be significantly low in caesarean group than in vaginal deliveries and the pCO_2 levels in caesarean deliveries were higher than that in vaginal deliveries but the difference was not statistically significant.

Table 1: Mean pH, pCO_2, pO_2 and lactate levels of normal (none asphyxiated) newborns in relation to delivery mode viz. normal vaginal and caesarean.

Variables	Newborns (n=80)		
	Vaginal (n=40) Mean ± SD	Caesarean (n=40) Mean ± SD	*P* value
pH	7.21 ± 0.04	7.25 ± 0.06	0.0002
pCO_2 (mmHg)	48.67 ± 5.86	50.90 ± 6.18	0.103
pO_2 (mmHg)	23.67 ± 7.76	17.97 ± 7.86	0.0016
Lactate (mmol/L)	4.34 ± 0.71	2.90 ± 0.08	< 0.0001

Table 2 summarizes the mean ± SD pH, pCO_2, pO_2 and lactate in normal vaginally delivered and instrumental deliveries. All four variables i.e. pH, pCO_2, pO_2 and lactate were significantly different in the two groups. The pH and pO_2 were significantly lower in the instrumental deliveries, while the pCO_2 and lactate values were significantly higher in the instrumental deliveries when compared to normal vaginal group.

Table 2: Mean pH, pCO_2, pO_2 and lactate levels of normal (non asphyxiated) newborns in relation to mode of delivery viz. normal vaginal and instrumental.

Variables	Newborns (n=45)		
	Vaginal (n=40) Mean ± SD	Instrumental (n=5) Mean ± SD	*P* value
pH	7.21 ± 0.04	7.11 ± 0.09	< 0.0001
pCO_2 (mmHg)	48.67 ± 5.86	61.4 ± 15.75	0.0007
pO_2 (mmHg)	23.67 ± 7.76	12.80 ± 4.81	0.004
Lactate (mmol/L)	4.34 ± 0.71	6.49 ± 1.20	< 0.0001

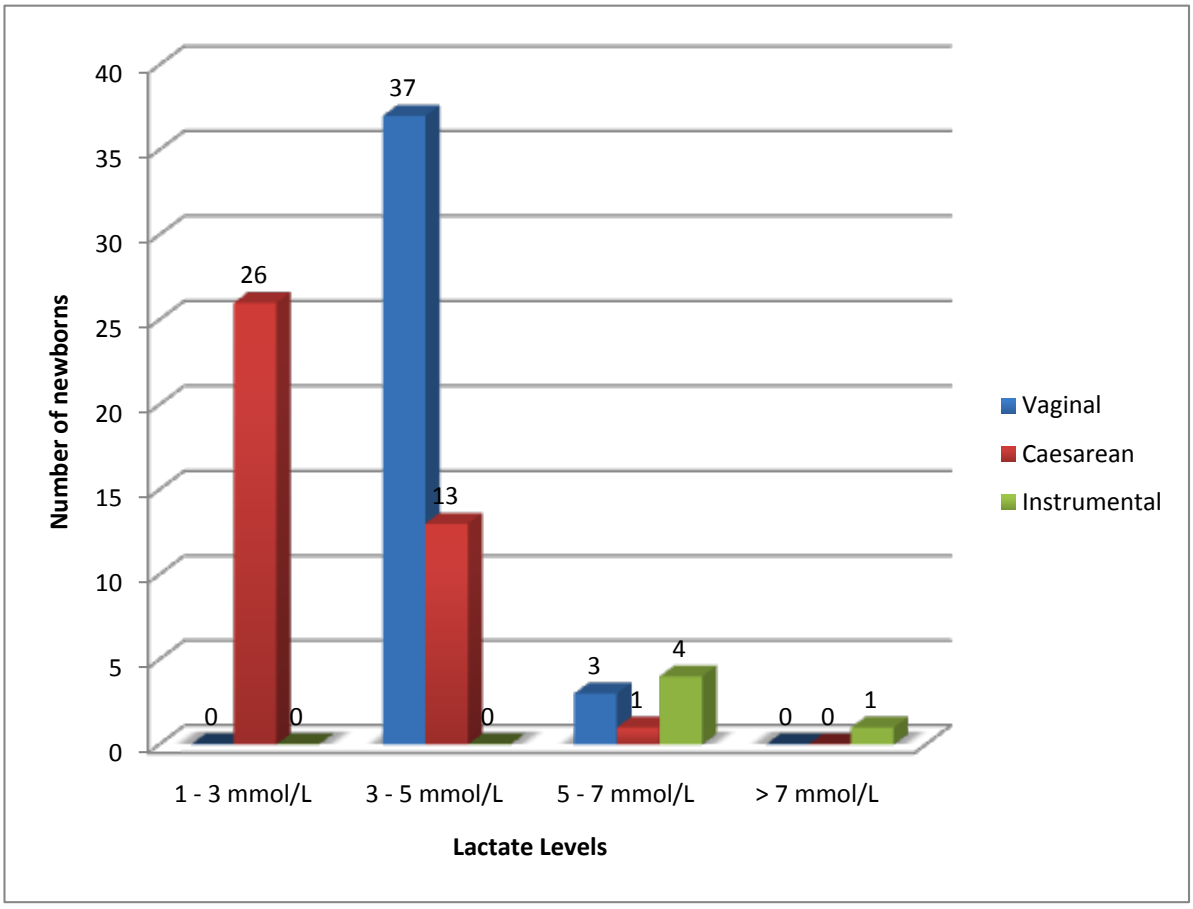

Figure 1: Cord blood lactate levels in normal vaginal, caesarean and instrumental deliveries (n = 85).

Fig. 1 denotes cord lactate levels in newborns in various delivery modes. Lactate levels in majority of caesarean babies were in 1-3 mmol/L range. In normal vaginal mode majority had levels between 3-5 mmol/L while the instrumental category had lactate levels between 5-7 mmol/L.

DISCUSSION:

The Apgar score has been widely used for diagnosis of fetal asphyxia since 1953 (1). However, it is subjective and can be influenced by many factors other than hypoxia. The Apgar score may be low in a nonhypoxic baby if the mother was given sedation. Immature development of muscle tone and reflex may cause low Apgar score although the babies are not asphyxiated. (6-7).

In recent years, acid- base balance has been widely studied because it reflects hypoxic events during labor and delivery (2-5). Many of these studies have shown that acid- base status and Apgar score do not have good correlation (3-5). pH is a good indicator of acidosis but it cannot differentiate metabolic acidosis from respiratory acidosis. Lactate is an end product of anaerobic metabolism which is associated with tissue hypoxia. Measurement of blood lactate may better reflect the metabolic status of newborn.

Fetal acidemia has been traditionally defined as umbilical artery pH < 7.2 (8-9). However, many newborns with a normal Apgar score have an umbilical artery pH < 7.2 and they do not suffer from any neonatal complications (10-11). Recent studies have suggested that a cut off value for diagnosis of significant acidemia should be < 7.0 (11-13). However, the normal/ reference range for blood lactate that may provide the cut off value for diagnosis of fetal asphyxia has still not been determined (14-15).

We compared blood gas parameters and lactate concentrations between newborns delivered through various modes (Table1 & 2). The lactate levels in normal vaginal deliveries were significantly higher than the caesarean deliveries ($p < 0.0001$). Also the lactate levels in instrument assisted deliveries were significantly higher than normal vaginal deliveries ($p < 0.0001$). The difference in the pH values of caesarean and normal vaginal groups was also statistically significant ($p = 0.0002$). The mean pCO_2 values in caesarean deliveries were high in comparison to the normal vaginal group but the difference was not statistically significant ($p = 0.103$). The mean pO_2 levels in caesarean deliveries were significantly higher than the vaginal group ($p = 0.0016$). The pH in instrument assisted deliveries was significantly lower than vaginal deliveries ($p < 0.0001$). The difference in the mean pCO_2 levels in vaginal and instrumental deliveries were statistically significant ($p = 0.0007$). Also, there was a significant difference in the mean pO_2 values in normal vaginal and instrument assisted deliveries ($p = 0.004$).

The increased incidence of lactacidemia and hypoxia in newborns who underwent normal vaginal delivery with respect to caesarean section and instrument delivery with respect to normal vaginal delivery highlight the increased amount of stress that the newborns had to undergo in respective modes. Westgren et al (16) conducted a similar study on newborns and derived similar conclusions especially with respect to pCO_2 and pO_2 levels of vaginal and caesarean delivered newborns. However, the baseline lactate levels in respective modes in their study were lower compared to our levels. The mean lactate levels in their study in normal vaginal, instrument and caesarean delivered neonates were 1.87± 0.94 mmol/L, 2.65± 1.20 mmol/L and 1.44± 0.10 mmol/L respectively. The pH values in normal vaginal, instrument and caesarean groups were 7.27± 0.09, 7.18± 0.10 and 7.27± 0.08 respectively. Also the pCO_2 levels in the respective categories were 46± 13 mm Hg, 53± 17 mm Hg and 50± 13 mm Hg. Lastly the pO_2 levels in the three respective groups were 25± 14 mm Hg, 25± 16 mm Hg and 21± 15 mm Hg. The above results point towards the need for further studies in order to analyse the levels extensively.

In another study conducted by Dinleyici et al (17), acid base status and lactate levels in term and preterm newborns in relation to their delivery mode were assessed. The mean lactate levels in normal vaginal deliveries (3.20 ± 1.6 mmol/ L [28.9 mg/dl]) were significantly higher than those in caesarean deliveries (1.99 ± 0.9 mmol/L [18.0 mg/dl]). However, the other three variables (pH, pO_2 and pCO_2) were not comparable to our study.

Lactate values should be obtained in high risk deliveries and whenever newborn depression occurs. The addition of lactate to conventional umbilical cord blood gas analysis has helped in the prediction of adverse fetal outcome. Various studies have been done in various populations so as to establish normal and abnormal range of umbilical artery blood gas and lactate levels. Through this observational study we could establish a range of blood gas parameters and lactate levels in various delivery modes in non asphyxiated newborns in one section of Indian population. However the limitations of our study may include small sample size, single postnatal lactate assessment instead of serial lactate levels, lab errors and risk of observer bias. Both blood gas parameters and lactate may be of more value in excluding birth asphyxia than the Apgar score alone. In India, limited work has been done on the present subject of interest. Hence, this study provides a platform of scope for future research.

CONCLUSION:

Cord blood lactate and blood gas analysis provides reliable information about the neonatal condition at delivery. The mean lactate levels and cord blood gas parameters in newborns born through different modes of delivery highlight the amount (higher/lesser) of stress that the newborns undergo in respective modes. Also, knowledge of the normal range and cut off limits of arterial lactate and blood gas parameters in newborns would aid in determining newborns at risk of complications.

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