Original Article

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The Relationship between Umbilical Artery PH and Maternal Risk Factors in Premature Birth

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ABSTRACT

BACKGROUND AND OBJECTIVE: In many deliveries, determination of umbilical artery PH is considered a suitable tool for predicting the risk of damage to the fetus and determining the likelihood of associated complications. This study was performed in order to investigate the relationship between maternal risk factors and umbilical artery PH in premature infants.

METHODS: In this case-control study, 600 premature neonates (gestational age of 27-37 weeks), were examined in terms of umbilical artery pH within the first 5 minutes after birth. In total, 181 newborns suffering from acidosis with pH<1.7 (case group) and 419 neonates without acidosis (control group) were compared in terms of maternal history of placental detachment, maternal diabetes, prolonged rupture of membranes, oligohydramnios, chorioamnionitis, multiple birth pregnancy, placental previa, intrauterine growth retardation, and late deceleration of fetal heart rate.

FINDINGS: Fetal acidosis was reported in 7.2% of cases with intrauterine growth restriction (N=30) (OR=3.1), 8.3% of neonates with placental detachment (N=15) (OR=2.25), 7.2% of cases with chorioamnionitis (N=13) (OR=4.54) 14.9% of multiple births (N=27) (OR=1.79), 5.5% of cases with maternal anemia (N=10) (OR= 2.64), and 28.6% of newborns with late deceleration of fetal heart rate (N=44) (OR= 57%) (p=0.001, 0.002, 0.03, 0.03, 0.04, and 0.03, respectively). However, fetal acidosis was not significantly associated with prolonged rupture of membranes, placental previa, oligohydramnios, preeclampsia, maternal diabetes, or diseases of the lung, liver, and kidney.

CONCLUSION: Intrauterine growth retardation, chorioamnionitis, placental detachment, multiple birth pregnancy, maternal anemia, and late deceleration of fetal heart rate increased the risk of fetal acidosis in premature births.

KEY WORDS: Fetal acidosis, umbilical artery PH, obstetric complications, premature birth.

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Introduction

Umbilical artery acidemia is the most critical indicator of fetal hypoxia during labor (1). Fetal blood pH is an important factor for determining the status of the fetus during pregnancy, childbirth, and after birth. Unlike respiratory acidosis, which is common during pregnancy and is not associated with neonatal complications, metabolic acidosis may be correlated with significant risks such as neonatal asphyxia, encephalopathy, and cerebral palsy (2, 3).

Research has shown that by lowering pH to 7 or less, the risk of neonatal mortality and neurological dysfunctions significantly increases. In fact, in preterm infants with umbilical cord pH ≤ 6.8, the risk of death increases by 1400 times (1, 4). Also, the risk of neurodevelopmental delay rises at a pH of 7.2 (5). Moreover, statistics indicate the rising rate of premature birth. In USA, the incidence of premature birth has increased from 9.4% in 1984 to 10.07% in 1989 and 12.3% in 2003 (4). Two important factors leading to the rising rate of premature birth are the increased prevalence of multiple birth pregnancies, following the use of assisted reproductive techniques, and the increased need for preterm delivery due to medical indications (2). Many obstetric complications (e.g. placental detachment, placental previa and premature rupture of membranes, chorioamnionitis, oligohydramnios, renal and liver diseases, maternal lung diseases, anemia, maternal diabetes, intrauterine growth retardation, preeclampsia, and multiple birth pregnancy) lead to preterm labor indications. On the other hand, obstetric complications during labor can affect umbilical artery PH by influencing the placental-fetal blood circulation. Therefore, it seems that the risk of acidosis in preterm labor is higher.

Since the majority of studies have focused on term infants, we aimed to investigate the relationship between maternal complications and umbilical artery PH in preterm infants in order to make a proper and prompt decision by predicting the possibility of fetal acidosis.

Methods

In this case-control study, mothers with preterm birth and gestational age of 27-37 weeks (< 37 weeks since the last menstrual period or sonography during the first trimester), referring to Ayatollah Rouhani Hospital during December 2010-January 2012, were enrolled. The subjects had preterm deliveries due to the spontaneous onset of labor pain, the rupture of membranes, or premature (or term) labor.

According to the statistical counseling, by assuming a 10% risk of associated complications, the calculated sample size was able to identify an odds ratio of two (OR=2) with 95% confidence interval and 80% power. All premature infants with major malformations and mothers with diabetic ketoacidosis (or any other metabolic diseases), leading to maternal acidosis, were excluded from the study.

Meanwhile, written consents were obtained from the parents of all newborns for arterial blood gas (ABG) test. Overall, 600 infants (including multiple births) were evaluated in term of umbilical artery pH. During the study, 1 ml of umbilical artery blood of premature infants was collected during the first 5 minutes after birth. The obtained samples were immediately transferred to the hospital laboratory in an ice bucket for ABG test. The blood samples were analyzed, using Gem 2000, made in USA. The pH values and related data were gathered and recorded in a questionnaire.

The maternal data of the subjects collected by reviewing their physical examination, medical history and medical records were as follows: maternal age, gestational age, record number, date of admission, maternal diseases (e.g., diabetes, hypertension, thyroid disease, and lung, liver, and renal diseases), complications during labor, premature rupture of membranes, oligohydramnios, preeclampsia, chorioamnionitis, placental detachment, placental previa, and multiple birth pregnancies), mode of delivery (vaginal delivery vs. caesarean section), and fetal distress (e.g., meconium and late deceleration of fetal heart rate).

According to umbilical artery pH, premature infants were divided into two groups: the case group with acidosis (pH<7.1) and the control group without acidosis (pH>7.1). The definition of acidosis was based on studies by Anderani et al. (2), Yeh (3), and previously conducted research (6-9). All maternal complications were compared between the two groups. T-test and Chi-square were performed, using SPSS. Odds ratio (OR) was calculated using logistic regression model. p-value<0.05 was considered statistically significant.

Results

In this study, the majority of mothers with premature birth were 20-34 years old (787%). The mean age of

mothers was 26.92±5. In this study, the mean gestational age was 34.2+2.2 weeks in premature deliveries. As the results indicated, 378 infants (63%) were born at 34-37 weeks of gestation (late preterm); also, 222 infants (37%) were born at 27-34 weeks of gestation.

Also, in this study, there were 372 male (62%) and 246 female infants (41%). In total, 372 infants (62%) were born via cesarean section and 228 newborns (38%) were delivered via vaginal delivery. In this study, acidosis with umbilical arterial pH >7.1 was reported in 181 cases (30.2%) with premature birth. Premature rupture of amniotic sac, followed by multiple birth pregnancy, was the most common maternal complication during labor. The frequency and percentage of obstetric complications and their correlation with fetal acidosis are presented in Table 1. In terms of pH < 7.1, the odds ratios were 1.7, 1, and 2.08 in three age groups of mothers (≤ 20 years, 20-34 years, and >34 years), respectively (95% CI). According to the odds ratios, the risk of acidosis in mothers aged > 34 years was twice as that of mothers, aged 20-34 years (p=0.02). Based on logistic regression analysis (OR), 5-minute Apgar score lower than 7 was more important than other factors; however, this is not considered a maternal risk factor, but a complication.

Table 1. The frequency of risk factors associated with umbilical arterial pH less than 7.1

Risk factors	Frequency (%)	Odds Ratio (OR)	CI-95%	P-value
Premature rupture of membranes	70(38.7)	0.80	(0.56-1.13)	0.21
Gestational age < 34 weeks	222(37)	1.28	(1.86-1.09)	0.21
Chorioamnionitis	13(7.2)	4.54	(1.78-11.58)	0.002
Oligohydramnios	21(11.6)	1.47	(0.83-2.61)	0.18
Placental detachment	15(8.3)	2.25	(10.9-4.67)	0.03
Placental previa	4(2.2)	1.85	(0.49-6.99)	0.36
Preeclampsia	22(12.2)	1.49	(0.83-2.55)	0.19
Multiple birth	27(14.9)	1.79	(1.05-3.04)	0.03
Anemia	10(5.5)	2.64	(1.05-6.61)	0.04
ITP	3(1.7)	0.56	(0.15-2.03)	0.38
Renal and liver diseases	13(7.2)	1.71	(0.82-3.5)	0.15
Gestational diabetes mellitus	60(33.3)	1.26	(0.87-1.83)	0.22
Thyroid disease	8(4.4)	1.87	(0.72-4.82)	0.19
Late deceleration of fetal heart rate	44(28.6)	0.57	(0.33-0.95)	0.03
5-minute Apgar score < 7	43(23.8)	5.74	(3.32-9.92)	0.001
Intrauterine growth retardation	30(7.2)	3.1	(1.8-5.2)	<0.001

Discussion

The results of this study showed that in preterm delivery, the risk of fetal acidosis (umbilical artery pH<7.1) was higher in cases with intrauterine growth retardation, chorioamnionitis, delayed deceleration of fetal heart rate, multiple birth pregnancies, and placental detachment, respectively. In addition, there was a significant association between maternal anemia and fetal acidosis. However, according to our findings, there was no significant association between fetal acidosis (umbilical artery pH<7.1) and maternal age, diabetes mellitus, renal, cardiovascular, and liver diseases, premature rupture of membranes, placental previa, oligohydramnios, or preeclampsia. In a study by Rossi et al. on term and post-term pregnancies, no significant difference was detected between cases with oligohydramnios and control subjects in terms of fetal acidosis (umbilical artery pH<7) (10). A study by Locatelli et al. showed that intrauterine vascular events including preeclampsia, placental detachment, placental infarction, and birth weight below the 10th percentile might be associated with academia. However, umbilical acidemia had no significant correlation with intrauterine infections, acute obstetric events including sudden bradycardia, absence of changes in fetal heart rate (which was normal in the past), shoulder dystocia, or umbilical cord prolapse. On the other hand, a study by Suzuki et al. indicated that placental abruption with or without chorioamnionitis had no significant effects on

umbilical artery pH (12). A study by Schlapbach et al. on the amount of arterial umbilical cord copeptin showed a significant relationship between acidosis at birth and childbirth-related stress caused by chorioamnionitis, perinatal asphyxia, and premature sepsis (13).

A study by Zhang et al. in China on the amount of umbilical cord arterial lactate showed a significant correlation between increased lactate level in umbilical cord blood, abnormal fetal heart rate and severe variable deceleration (14). In addition, Kazandi et al. indicated that atypical variable deceleration increases the risk of fetal hypoxia and umbilical artery pH<7.20. Moreover, the risk of neonatal admission to the neonatal intensive care units had a 10-fold increase, compared to cases with typical variable deceleration (15). In a study by Takano et al., conducted on some cases of severe neonatal bradycardia (fetal heart rate <80), the incidence of umbilical artery PH lower than 7 was estimated to be 59% (16).

However, in a study by Lopes Ribeiro et al. in 2012, non-stress test was introduced as a reliable tool to identify the status of fetal acidosis (17). According to the findings of this study, the risk of fetal acidosis was higher in cases of intrauterine growth retardation, chorioamnionitis, placental detachment, multiple birth pregnancies, maternal anemia, and delayed reduction in fetal heart rate in premature births.

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