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The effect of maternal parameters on umbilical artery blood gas values and neonatal well-being in singleton pregnancies

Huseyin Bilgin[1], Aydın Kosus[2], Nermin Kosus[2], Semra Kara[1], Abdülkadir Eren[1], Deniz Hizli[2]

[1]Department of Pediatrics, Division of Neonatalogy, Turgut Ozal University School of Medicine, Ankara, Turkey
[2]Department of Obstetrics & Gynecology, Turgut Ozal University School of Medicine, Ankara, Turkey

ABSTRACT

Objectives. Umbilical cord blood analysis for assessment of the newborn's acid-base status soon after birth is the most objective way of evaluating the fetal metabolic condition at delivery. We researched the effects of maternal age, multiple gestation, fetal heart rate, gestational age, parity, delivery mode and total duration of labor on fetal well-being as assessed by umbilical cord blood gas parameters. ***Methods.*** Prospective study conducted on 67 singleton pregnant women and their off-spring. Maternal age, multiple gestation, fetal heart rate (FHR), gestational age, parity, delivery mode and total duration of labor were recorded. Umbilical artery blood samples were collected at birth. A blood gas analysis was performed on each collected sample. The relationship between maternal parameters and umbilical cord arterial blood gas were investigated. ***Results.*** We found positive correlation between pH and gravida and parity (p=0.026, p=0.049, respectively), whereas negative correlation between total duration of labor and O2 saturation (p=0.033). Base deficit was negatively correlated with gravida and parity (p=0.025, p=0.011, respectively). In linear regression models, FHR and gravida were a significant predictor of pH value (p=0.029 and p=0.040, respectively). ***Conclusions.*** We found no association between maternal age, gestational age, gravida, parity and duration of labor and neonatal acidemia. Thus, maternal age, gestational age, gravida, parity and duration of labor may not be at increased risk of perinatal morbidity. However, the elevation of FHR was related with an increased risk of neonatal morbidity.

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Keywords: Blood gas analysis; umbilical; newborn; outcome; neonatal well-being; maternal parameters

Introduction

Mortality rates in the perinatal period are used to assess the outcome of pregnancy and monitor the quality of perinatal care. The perinatal mortality rate encloses late fetal and early neonatal mortality. Maternal factors that increase the risk of infant mortality include extremes of maternal age, smoking, unmarried status, multiple gestation, prior stillbirth, ethnicity, gestational age, and multi-fetal pregnancies [1-6]. Among term infants, the important causes of neonatal death were asphyxia, infection, congenital

Address for correspondence:
Huseyin Bilgin, MD., Turgut Ozal University School of Medicine, Department of Pediatric, Division of Neonatalogy, Ankara, Turkey
E-mail: hubilgin@hotmail.com
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malformations, prematurity and sudden infant death syndrome (SIDS) [3].

Umbilical cord blood analysis for assessment of the newborn's acid-base status soon after birth is the most objective way of evaluating the fetal metabolic condition at delivery. There is no consensus concerning indications for umbilical cord blood acid-base analysis post delivery.

The effects of maternal parameters on umbilical cord blood gases have been poorly investigated. In this study, we investigated the effects of maternal age, multiple gestation, fetal heart rate (FHR), gestational age, parity, delivery mode and total duration of labor on fetal well-being as assessed by umbilical cord blood gas parameters.

Methods

This prospective study was conducted in the Department of Obstetrics and Gynaecology, Turgut Ozal University, School of Medicine, Ankara, Turkey. The study protocols were approved by the institutional ethics board of Turgut Ozal University and conducted in medical faculty hospital. After informing the patients, informing consent form was obtained. Infants with maternal history of preeclampsia, eclampsia, infection, hypertension, diabetes, congestive heart failure, chronic kidney disease, chronic respiratory disease and prematüre rupture of membranes were not icluded in the study. Infants with hypoxic ischemic encephalopathy, sepsis, respiratory distress syndrome, vacuum extraction delivery, preterm birth and congenital abnormality were excluded from the study. We recorded the following obstetrical characteristics; maternal age, gestational age at birth, birth weight, parity, mode of delivery (vaginal, instrumental, cesarean section), FHR, and total duration of labor. Gestational age was described as the number of completed weeks of gestation based on an ultrasound screening examination conducted between gestational weeks 18 and 20 as identified by the date of the last normal menstrual period. The neonatal mortality rate (NMR) was defined as the number of neonatal deaths during a year, divided by the number of live births during the same year, expressed per 1000 live births. Perinatal mortality rate (PMR) was defined as the sum of fetal deaths (≥20 weeks gestation) plus neonatal deaths (i.e., deaths within the first 28 days of birth) during a year divided by the sum of live births plus late fetal deaths during the same year, expressed per 1000 live births plus late fetal deaths.

The samples were drawn from the umbilical arteries by a 0.9-mm needle puncture with minimal manuplation of the cord. A trained person applied this procedure within 4-5 seconds. Each blood gas sample was collected in individual 2 ml preheparinised plastic syringes prepared and a minimum of 0.5 ml of blood from the umblical artery, immediately transported on ice to the laboratory, was used for analyses of umbilical blood pH, PCO_2, PO_2, bicarbonate (HCO_3^-) and base deficit, in a blood gas analyser (ABL 735; Radiometer A/S, Copenhagen Denmark). All samples were taken by the same investigator and analysed according to the manufacturer's recommendation.

Statistical Analysis

SPSS version 16.0 (SPSS, Chicago, IL, USA) for Windows program was used for statistical analyses. Shapiro-Wilk test was used to determine normal distribution. Descriptive statistics were presented as median (minimum-maximum) for not normally distributed data, and as counts and percentages for categorical data. Mann-Whitney test was used for data not normally distributed. Spearman correlation analysis was used to evaluate relationship between parameters. Linear regression analysis was performed to evaluate whether any maternal parameters could potentially predict blood gas values. Multiple logistic regression analysis was performed to assess whether any maternal parameters could predict pH<7.20 value. The statistical significance level was set at $p<0.05$.

Results

A total 67 pregnant women and their offspring were enrolled in the study. Median age, gravida, parity and gestational age were 26 years (range 17-38 years), 2 (range 1-6), 1 (range 1-4), and 39.4 weeks (range 37.0-41.3 weeks), respectively. In correlation analysis, there was positive moderately correlation between pH and gravida and parity ($p=0.026$, $p=0.049$, respectively), whereas negative correlation between total duration of labor and O_2 saturation ($p=0.033$) (Table 1). Base deficit was negatively correlated with gravida and parity ($p=0.025$, $p=0.011$, respectively). In addition, there was positive correlation between HCO_3^- and parity ($p=0.023$) (Table 1).

In linear regression models, FHR and gravida

Table 1. The correlation analysis results between cord blood gases and obstetric data

		pH	pCO_2	O_2 sat	HCO_3^-	BD
Age	Rho	0.035	0.115	-0.003	0.223	-0.151
	p value	0.781	0.356	0.979	0.087	0.227
Gravida	Rho	**0.274***	-0.066	0.086	0.241	**-0.275***
	p value	**0.026**	0.598	0.501	0.063	**0.025**
Parity	Rho	**0.243***	-0.043	0.091	**0.293***	**-0.311***
	p value	**0.049**	0.729	0.474	**0.023**	**0.011**
Gestational age	Rho	-0.151	0.101	-0.125	-0.076	0.157
	p value	0.252	0.445	0.355	0.587	0.234
FHR	Rho	-0.225	0.161	0.060	0.017	0.043
	p value	0.070	0.197	0.636	0.894	0.734
Total duration of labor	Rho	-0.204	0.093	**-0.302***	-0.159	0.170
	p value	0.151	0.517	**0.033**	0.296	0.234

BD=base deficit, FHR=fetal heart rate, Rho=Sperman's correlation analysis (correlation coefficient)

were a significant predictor of pH (p=0.029 and p=0.040, respectively). Moreover, in linear regression models, an increase in gravida was a predictor of increase in pH value, whereas an increase in FHR was a predictor of decrease in pH. The effect of the other parameters were not significant (p>0.05) (Table 2).

No any factor was found to be effective in predicting patients with pH below 7.20 levels when pH limit is taken as 7.20 (p>0.05) (Table 3). Patients were divided into two groups according to pH values as ≥7.20 and <7.20. There was no significant difference between groups in terms of numerical data (p>0.05) (Table 4). When the investigation carried out with categorical data, no difference were detected between groups with pH above and below 7.20, in terms of induction, type of delivery, the presence of meconium and variability factors (p=0.717, p=0.567, p=0.425 and p=0.417, respectively) (Table 5).

Discussion

The effects of maternal parameters during pregnancy on the fetus have always been worrying. Maternal parameters may cause fetal hypoxia, leading to changes in umbilical arterial blood gas. There are scarce studies that investigating relationship between maternal age, gestational age, gravida, FHR, parity

Table 2. Linear regression analysis results for maternal factors that may affect pH values

	Unstandardized Coefficients		Standardized Coefficients		
	Beta	**SE**	**Beta**	**t**	***p***
Constant	70.849	0.396		190.806	**<0.001**
Age	0.000	0.002	-0.080	-0.435	0.666
Gravida	0.015	0.007	0.292	20.120	**0.040**
Parity	-0.015	0.029	-0.268	-0.533	0.597
Gestational age	-0.004	0.008	-0.079	-0.541	0.591
Total duration of labor	-0.002	0.005	-0.086	-0.516	0.608
FHR	-0.003	0.001	-0.311	-20.254	**0.029**

FHR=fetal heart rate, SE=standard error

Table 3. Logistic regression analysis results for parameters that may affect pH <7.20 levels

	B	SE	*p*	Exp(B)
Group	-0.195	10.112	0.861	0.822
Age	-0.006	0.126	0.963	0.994
Gravida	-0.336	10.403	0.811	0.715
Parity	0.448	10.401	0.749	10.565
Gestational age	-0.372	0.465	0.423	0.689
FHR	-0.116	0.081	0.149	0.890
Labor	-0.951	10.244	0.445	0.386
Total duration of labor	-0.211	0.229	0.356	0.810
Delivery mode	0.707	10.631	0.664	20.029
Constant	10.897	0.438	**<0.001**	60.667

Exp (B)=the ratio of hazard rates, FHR=fetal heart rate, SE=standard error

Table 4. The comparison of groups at pH below and above 7.20 levels

	Age	Gravida	Parity	FHR	Gestational age	Total duration of labor
***p* values**	0.800	0.629	0.649	0.172	0.468	0.847

FHR=fetal heart rate

Table 5. The comparison of categorical data in groups at pH below and above 7.20 levels

		<7.20	≥7.20	*p*				<7.20	≥7.20	*p*
Induction	Count	3	23	0.717	Labor	C/S	Count	1	11	0.567
	%labor	11.5	88.5				%delivery mode	8.3	91.7	
	%pH 7.20	33.3	39.7				%pH 7.20	11.1	19.0	
	% of Total	4.5	34.3				% of Total	1.5	16.4	
Spontaneous	Count	6	35			NSVD	Count	8	47	
	%labor	14.6	85.4				%delivery mode	14.5	85.5	
	%pH 7.20	66.7	60.3				%pH 7.20	88.9	81.0	
	% of Total	9.0	52.2				% of Total	11.9	70.1	

		<7.20	≥7.20	*p*				<7.20	≥7.20	*p*
Meconium (-)	Count	4	34	0.425	Variability	Little	Count	0	4	0.417
	%group	10.5	89.5				%variability	.0	100.0	
	%pH 7.20	44.4	58.6				%pH 7.20	.0	6.9	
	% of Total	6.0	50.7				% of Total	.0	6.0	
Meconium (+)	Count	5	24			Normal	Count	9	54	
	%group	17.2	82.8				%variability	14.3	85.7	
	%pH 7.20	55.6	41.4				%pH 7.20	100.0	93.1	
	% of Total	7.5	35.8				% of Total	13.4	80.6	

C/S=caesarean section, NSVD=normal spontaneous vaginal delivery

and duration of labor and umbilical arterial blood pH, PCO_2, PO_2, bicarbonate and base deficit in an uncomplicated singleton pregnancies. We found positive correlation between pH levels and gravida and parity. In current study, base deficit was negatively correlated with gravida and parity. There was positive correlation between HCO_3^- and parity, whereas negative correlation between total duration of labor

and O_2 saturation. Moreover, an increase in gravida was a predictor of increase in pH value, whereas an increase in FHR was a predictor of decrease in pH value.

Intrapartum evaluation of umbilical cord arterial blood gas values is a decisive method of diagnosis in birth management. Moreover, as a retrospective idea about fetal well-being during delivery, it contributes to the management of the neonatal term and to decisions about possible attempts at neonatal resuscitation in this term. Umbilical cord blood gas measurement conducted at delivery is an objective indicator of fetal acid-base balance, and it is also accepted as the fetal response to birth [7]. When the umbilical cord arterial blood pH value is ≤7.20, the condition is described as fetal acidosis; however, a pH≤7.0 is considered pathological acidosis. In term neonates born with an umbilical cord arterial blood pH>7.0, no increase has been noted in long-term morbidity [8]. The metabolic component of fetal acidemia (base deficit and bicarbonate) is the most important variable for predicting neonatal morbidity. The results of a study showed that moderate and severe newborn encephalopathy, respiratory complications, and composite complication scores >3 were enhanced in newborns with an umbilical artery base deficit greater than 12 to 16 mmol/L compared to those with lower base deficits [9]. A base deficit higher than or equal to 12 mmol/L proposes metabolic acidosis and is related with an elevated risk of neonatal morbidity. Umbilical artery PO_2 and O_2 saturation are not predictive of any neonatal morbidity.

Older maternal age is related with an elevated risk of stillbirth in both nulliparous and multiparous women [10, 11]. Large scale studies propose that an elevated risk of unexplained stillbirth late in pregnancy persists in older women, even after controlling for risk factors such as hypertension, diabetes, placenta previa and multiple gestations [11-13]. Moreover, there seems to be an interaction between first birth and advanced maternal age that places primiparous older women at an elevated risk [11]. In a recent study, a significant relationship was reported between advanced maternal age and an increased likelihood of a caesarean section irrespective of parity [14]. Salem Yaniv *et al.* [15] investigated the perinatal outcomes in elderly nulliparous women and showed a significant linear association between advanced maternal age and adverse perinatal outcome. Prematurity is an important contributor to neonatal and infant mortality. PMR and NMR rise with reducing gestational age in premature infants. Multiple gestations are a powerful risk factor for neonatal mortality.

FHR accelerations and variability are reassuring findings that propose the fetus is neither hypoxemic nor acidotic. The parasympathetic nervous system applies a progressively higher influence on FHR as gestational age advances. FHR variability is infrequently present before 24 weeks of gestation, while the absence of variability is abnormal after 28 weeks of gestation since the parasympathetic nervous system is consistently developed by the third trimester. Absent variability with any of the following FHR changes is predictive of abnormal fetal acid-base status [16].

The Limitations of the Study

Limitations in this study should be noted. This was a cross-sectional study; thus, we were unable to determine effects of maternal parameters on long term neonatal outcomes. Another limiting factor of our study was that a cord venous blood gas analysis was not determined. However, in the case of fetal acidemia and hypoxia, changes first appear in umbilical arterial blood gases. In addition, when umbilical cord venous blood gas values are at normal levels, acidemia may happen in the umbilical artery [17]. Hence, in current study, umbilical arterial blood gas parameters were analyzed.

Conclusions

We found no association between maternal age, gestational age, gravida, parity and duration of labor and neonatal acidemia. Our results suggest that maternal age, gestational age, gravida, parity and duration of labor may not affect fetal well-being in patients with no comorbidities such as gestational diabetes or hypertension. We found that only elevated FHR is related with an increased risk of neonatal morbidity.

Conflict of interest

The authors disclosed no conflict of interest during the preparation or publication of this manuscript.

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