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Comparison of early term results of umbilical arterial blood gas measurement among uncomplicated primiparous and multiparous vaginal deliveries and elective cesarean section

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Abstract

Aim: This study aims to investigate the early effects of the mode of delivery on the newborn in cases of non-complicated primiparous and multiparous vaginal deliveries who were admitted to the clinic in active labor, and elective cesarean section by analyzing fetal umbilical cord blood gas.

Materials and Methods: In this retrospective study, 120 cases were enrolled in the study, including 40 primiparous cases, 40 multiparous cases, and 40 elective cesarean section cases. Age, pregnancy history, medical history, age of gestation at birth, delivery type, fetal Weight, APGAR score, baby gender and fetal blood gas values were statistically analyzed.

Results: Statistically significant differences were found between the primiparous vaginal delivery group and the cesarean section and multiparous vaginal delivery groups in the parameters of age, gravidity, parity, and fetal Weight, with primiparous vaginal delivery showing significantly lower parameters. When compared with multiparous and primiparous vaginal delivery, a statistically significant difference was observed in APGAR 1 score, with C/S births having lower scores. In primiparous vaginal delivery, it was found that pH, pH(T), Base(Ecf)c, $cHCO_3$(P)c, $cHCO_3$(p,st)c, cBase(B,ox)c, and cBase(Ecf,ox)c were significantly lower compared to other groups, while only higher levels of pCO_2 and mOsmc were observed. In the cesarean section group, lower levels of ctHb, Hctc, cCa, cGlu, and cLac parameters were observed compared to other groups, while the cNa level was significantly higher. Significant differences were found only between primiparous vaginal delivery and cesarean section groups in the parameter cK, with a significantly lower cK value in the C/S group.

Conclusion: Primiparous pregnant women exhibited lower birth weight, lower pH in umbilical cord blood, and higher levels of pCO_2, while in the cesarean group, lower APGAR score at 1 minute, lower levels of hemoglobin, calcium, glucose, lactate, and potassium were observed.

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Introduction

With the increasing rates of cesarean section (C/S) globally, it is expected that the C/S rate will be over 60% in countries by the year 2030. The World Health Organization (WHO) has warned about the increase in C/S rates and recommended that countries aim for a rate of 10% to 15% for C/S births [1]. In Turkey, the overall CS births rate was 57.55% from 2018 to 2023 [2]. Despite studies showing that C/S may lead to some complications, many mothers still prefer C/S delivery over vaginal delivery (VD). There is a need to increase awareness among pregnant women about the outcomes of different delivery methods [3]. While C/S delivery can be a lifesaving medical procedure, it is also a significant risk factor for the mode of delivery in subsequent pregnancies. After a previous supported vaginal delivery, a high rate of spontaneous VD can be expected [4]. After birth, umbilical cord blood flow typically continues for a few more minutes. Routine

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practice recommended by ACOG after birth is to delay umbilical cord clamping for 30 to 60 seconds [5]. There is ample evidence demonstrating the benefits of delayed cord clamping, for example, clamping the cord 60 seconds after birth, for term babies [6].

In labor, it causes a sudden increase in fetal catecholamine levels, especially in the second phase of labor; it ensures continued blood flow to the brain, heart and adrenal glands; it improves adaptive changes in postpartum blood circulation and increases postpartum surfactant levels. Although the fetal stress response is positive, maternal hyperventilation in response to pain has negative effects on the fetus, such as respiratory alkalosis and a left shift in the oxygen dissociation curve. In addition, labor stress and cortisol and catecholamine secretion can also prolong labor and reduce blood flow to the placenta and cause fetal asphyxia [7]. Anesthetic drugs used in cesarean section, spinal anesthesia or general anesthesia directly and indirectly affect the fetus and can cause cord blood gas changes [8].

As the WHO definition, Birth asphyxia is the failure to initiate and sustain breathing at birth [9]. Additionally, it is described as a five-minute APGAR score of less than 7. In studies, the factors associated with birth asphyxia are expressed as the relationship between predisposing factors, infections and birth complications [10]. These factors include intrapartum complications such as preeclampsia, obstructed labor, prolonged labor, presentation anomalies, labor induction, and meconium-stained amniotic fluid [11].

Umbilical cord blood gas analysis, initially used only in high-risk cases as of 1962, became routine in 1970 [12]. Saling's implementation of fetal scalp blood sampling (FBS) to determine PH levels in the laboratory led to the widespread acceptance of FBS with subsequent facilitation of sampling and evaluation of cord blood. ACOG defines metabolic acidosis as cord artery pH <7 and Base Deficit (BD) $\geq$12 mmol/L [11]. BD between 12 and 16 mmol/L may lead to complications as encephalopathy or respiratory problems in 10% of newborns, while BD $>$16 mmol/L was found to be associated with this ratio being 40%. Lactate, among the blood gas parameters, is a robust parameter that can be used to indirectly evaluate the hemodynamic system [13]. In critical cases, lactate elevation due to the production of lactic acid in anaerobic metabolism is a classic marker associated with more morbidity and mortality [13].

Since the lauching of the system of APGAR scoring by Virginia Apgar in 1953, it has been used by obstetricians and pediatricians not only as an index for neonatal assessment but also for evaluating asphyxial damage during the neonatal period [14]. However, APGAR score assessment by midwives or obstetricians is highly subjective. It has been reported to have a false diagnosis rate of 50-80% showing high sensitivity but low specificity [15]. Population-based studies have associated significant differences between venous and arterial pH values(ΔpH), low 5-minute Apgar score, continuous positive airway pressure requirement, and lower perinatal morbidity risk, including admission to the NICU when UApH is above 7.15 [16].

Vaginal delivery (VD) is the most suitable method of delivery according to human nature; however, C/S is performed when necessary conditions cannot be met. Fetal blood sampling during the antenatal period is only possible through cordocentesis, whereas during labor, it can be obtained through both cordocentesis and fetal scalp blood sampling. After birth, umbilical cord blood is used for this purpose. Thus, fetal distress, fetal hypoxia, fetal acidosis, and asphyxia are attempted to be diagnosed by determining the acid-base status and blood gas values of the newborn. This study aims to investigate the early effects of delivery method on the baby by comparing the results of fetal umbilical cord blood gas obtained in the early period (1 minute) among uncomplicated primiparous, multiparous, and planned C/S delivery pregnancies.

Materials and Methods

Ethics committee approval for this study was received from local ethics committee (Siirt University Ethics Committee) with the decision dated 18.10.2023 and numbered 2023/10/01/04.

Patient selection

This study is a retrospective study consisting of a similar number of patients between July 2023 and September 2023 The data of the cases were recorded from the our hospital information system, hospital computer, and patient files. As exclusion criteria, pregnant women with preeclampsia, gestational diabetes, gestational hypertensive disorders, early membrane rupture, preterm labor, oligohydramnios, polyhydramnios, presentation anomaly, fetal distress, intrauterine growth restriction, preeclampsia, placental abruption, placental invasion anomaly, placental positioning anomalies, and women with a history of gestational diabetes, were considered.

As inclusion criteria, women beyond the 37th gestational week (including the 37th week), in active labor (with vaginal dilation of 4 cm or more), without any complications at birth, without fetal arrhythmia, without significant anomalies detected by ultrasound, singleton pregnancies, and pregnancies without major congenital anomalies, were considered.

In the study, a total of 120 pregnant women were evaluated in 3 groups: 40 planned cesarean section (C/S), 40 primiparous women with vaginal delivery (VD), and 40 multiparous women with vaginal delivery. The age of the women, obstetric history, medical history, gestational age at birth, mode of delivery, fetal Weight, APGAR score (at 1st and 5th minutes), baby gender (female or male), and fetal blood gas values were recorded. In our clinic, umbilical cord blood gas sampling from newborns is routinely performed. All cesarean sections consisted of repeat cesarean cases and were performed under spinal anesthesia. The outcomes of the babies were obtained from the hospital information system. The gestational age of the women was calculated either according to the confirmed last menstrual period or first trimester ultrasound measurements. The APGAR score is evaluated based on 5 physical characteristics, each scored from 0 to 2, at 1 and 5 minutes after birth, with a total score of 10 points. A newborn with an APGAR score of 8 or above is considered a normal newborn, a score between 4-7 is considered

mild asphyxia, and a score below 4 is considered severe asphyxia [17]. The neonatal team did the scoring in the delivery room or operating room. Neonatal weights were measured naked on a digital scale.

Blood gas measurement method

After the baby's initial examination following birth, umbilical cord blood gas and pH analysis were performed by taking blood from the umbilical cord, at least 1 minute after birth [18], using 2 Kocher clamps, leaving at least 10 cm distance between them. Then, up to 2 cc of blood gas was drawn into a syringe. The blood gas was analyzed within 15 minutes using the ABL 800 device in the hospital laboratory.

Statistical analysis

Statistical analyzes were performed with IBM® SPSS® 26 (SPSS Inc., Chicago, IL, USA). The conformity of the variables to the normal distribution was examined using analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). Descriptive analyzes were given as mean±standard deviation for continuous data. Descriptive statistics were made by giving frequency and percentage values of categorical variables obtained from sociodemographic and clinical information. In continuous data (blood gas parameters etc.), one-way ANOVA was used for independent groups when it showed normal distribution, and after post hoc Bonferroni's test used to compare binary groups. A p-value below 0.05 were considered statistically significant.

Results

Statistically significant differences were found among groups regarding age, gravidity, parity, fetal Weight, and APGAR 1 score. Significant differences were found between primiparous VD group and C/S and multiparous VD groups in terms of age, gravidity, parity, and fetal weight parameters, and primiparous VD was found to be significantly lower. The difference in APGAR 1 scores between C/S and multiparous and primiparous VD groups were statistically significant. It was observed that fetal Weight in primiparous VD was lower than the other groups (Table 1).

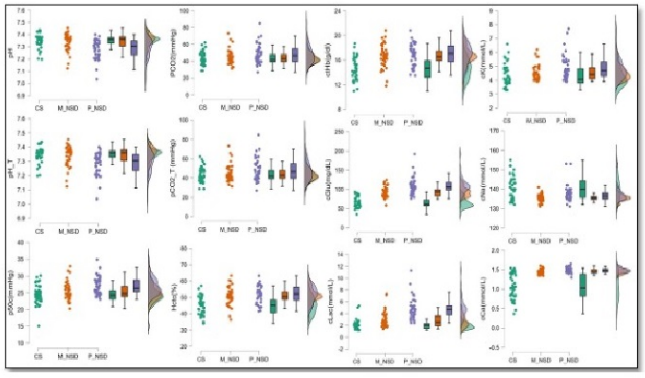

Figure 1. Comparison blood gas Parameters (p50c, ph, htc, pCO_2, dLac, cGlu, cHb, cCa, cNa and cK) among groups.

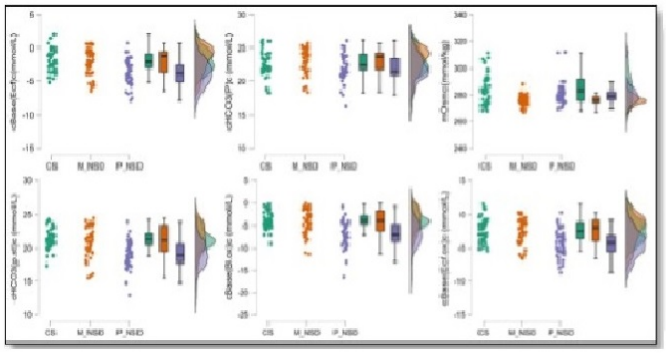

Figure 2. Comparison blood gas Parametresi ($cHCO_3$, cBAse and mOsmc) among groups.

When the results of blood gas parameters among groups were evaluated, significant differences were found between C/S and multiparous VD compared to primiparous VD in terms of pH, pCO_2, pH(T), cBase(Ecf)c, $cHCO_3$(P)c, $cHCO_3$(p,st)c, cBase(B,ox)c, and cBase (Ecf,ox)c parameters, with these parameters being significantly lower in the primiparous VD group except for pCO_2. Significant differences were found between multiparous and primiparous VD groups and the C/S group regarding ctHb, Hctc, and cCa parameters, with these parameters being significantly lower in the C/S group. Significant differences were only found between primiparous VD and C/S groups in the cK parameter, with the cK value being significantly lower in the C/S group. There was a significant difference in the cNa parameter between the C/S group and multiparous and primiparous VD groups, with the cNa parameter being significantly higher in the C/S group. Significant differences were found between primiparous VD and multiparous VD and C/S groups, as well as between multiparous VD and C/S groups, in terms of cGlu and cLac parameters. It was observed that there was a remarkable decrease in cGlu and cLac levels from the last group to the first group. Significant differences were found between primiparous VD and multiparous VD and C/S groups in terms of pCO_2 (T) and p50c parameters, with pCO_2 (T) and p50c levels being significantly higher in the primiparous VD group compared to the other groups. Significant differences were found in the mOsmc parameter between the primiparous VD group and C/S and multiparous VD groups, with the mOsmc level being higher in the primiparous VD group compared to the other groups (Table 2, Figure 1 and 2).

Discussion

In this study, which investigated the measurement of early umbilical artery blood gases of the newborn according to the type of birth (elective cesarean section, primiparous and multiparous vaginal birth), lower birth weight and lower pH, higher pCO_2 levels were detected in umbilical cord blood in primiparous mothers, while in the C/S group, lower APGAR scores at 1 minute, lower levels of hemoglobin (Hb), calcium (Ca), glucose, lactate, and potassium (K) were found. This study is important in terms of being an evaluation of birth method based on fetal umbilical cord blood gas results.

Table 1. Comparison of demographical and clinical parameters among C/S and NSD groups.

Variables	1) C/S (n=40)	2) Multiparous VD (n=40) Mean±SD [95% CI]	3) Primiparous VD (n=40)	p value	Difference
Age (years)	27.5±3.9 [26.2-28.7]	28.3±5.5 [26.6-30.1]	22.5±2.8 [21.6-23.3]	**<0.001**	1>3 ; 2>3
Gravidy	3.5±1.8 [2.9-4.1]	3.9±2.0 [3.2-4.5]	1.3±0.8 [1.1-1.5]	**<0.001**	1>3 ; 2>3
Parity	1.9±1.4 [1.4-2.3]	2.6±1.8 [2.0-3.1]	0±0 [0-0]	**<0.001**	1>3 ; 2>3
Gestational Week at Birth	38.8±0.5 [38.3-39.0]	38.9±0.4 [38.7-39.0]	38.8±0.4[38.6-38.9]	0.498	-
Fetal Weight (g)	3163.1±358.2 [3048.6-3277.7]	3197.4±354.6 [3084.0-3310.8]	2971.4±395.4 [2844.9-3097.8]	**0.015**	1>3 ; 2>3
Apgar 1	7.9±0.3 [7.8-8.0]	8.0±0.0 [8.0-8.0]	8.0±0.2 [7.9-8.0]	**0.025**	2>1 ; 3>1
Apgar 5	9.0±0.2 [8.9-9.0]	9.0±0.0 [9.0-9.0]	9.0±0.0 [9.0-9.0]	0.371	-

One-way ANOVA and post hoc Bonferroni test used. p<0.05 considered significant. NS; not significant, VD; vaginal delivery.

Table 2. Comparison of biochemical blood gas parameters among C/S and VD groups.

Variables	1) C/S (n=40)	2) Multiparous VD (n=40) Mean±SD [95% CI]	3) Primiparous VD (n=40)	p value	Difference
pH	7.35±0.05 [7.33-7.37]	7.34±0.07 [7.32-7.36]	7.29±0.08 [7.26-7.31]	**<0.001**	1>3 ; 2>3
PCO_2(mmHg)	43.30±7.5 [40.90-45.70]	44.68±8.66 [41.91-47.45]	48.45±11.42 [44.79-52.10]	**0.042**	1>3 ; 2>3
pO_2(mmHg)	21.60±6.61 [19.49-23.72]	22.57±7.14 [20.29-24.86]	21.02±6.74 [18.86-23.17]	0.590	-
ctHb(g/dl)	14.63±1.80 [14.06-15.21]	16.62±1.83 [16.03-17.20]	16.91±1.75 [16.35-17.47]	**<0.001**	2>1 ; 3>1
Hctc(%)	44.87±5.41 [43.14-46.60]	50.83±5.51 [49.06-52.59]	51.77±5.26 [50.09-53.45]	**<0.001**	2>1 ; 3>1
sO_2(%)	42.21±20.29 [35.72-48.69]	42.83±20.88 [36.15-49.50]	35.62±19.27 [29.46-41.78]	0.212	-
FO_2Hb(%)	41.43±19.93 [35.06-47.81]	41.92±20.14 [35.48-48.36]	35.14±19.00 [29.06-41.21]	0.232	-
FCOHb(%)	0.28±0.53 [0.11-0.45]	0.61±1.14 [0.25-0.98]	0.26±0.60 [0.07-0.45]	0.091	-
FHHb(%)	55.97±19.21 [49.83-62.12]	56.07±20.82 [49.41-62.73]	63.41±18.96 [57.35-69.47]	0.157	-
FMetHb(%)	1.25±0.43 [1.11-1.38]	1.14±0.39 [1.02-1.27]	1.14±0.32 [1.03-1.24]	0.373	-
cK(mmol/L)	4.35±0.79 [4.10-4.60]	4.55±0.57 [4.37-4.73]	4.91±0.88 [4.63-5.19]	**0.004**	3>1
cNa(mmol/L)	140.53±5.91 [138.64-142.41]	135.48±1.97 [134.84-136.11]	137.35±4.32 [135.97-138.73]	**<0.001**	1>2 ; 1>3
cCa(mmol/L)	1.05±0.32 [0.95-1.15]	1.46±0.06 [1.44-1.48]	1.48±0.07 [1.46-1.51]	**<0.001**	2>1 ; 3>1
cCl(mmol/L)	110.88±3.10 [109.88-111.87]	109.63±2.5 [108.83-110.42]	109.6±2.46 [108.81-110.39]	0.058	-
cGlu(mg/dL)	65.1±13.22 [60.87-69.33]	93.30±14.07 [88.80-97.80]	109.35±21.61 [102.44-116.26]	**<0.001**	3>1; 3>2 ; 2>1
cLac(mmol/L)	2.08±0.86 [1.81-2.36]	2.90±1.36 [2.47-3.34]	4.86±1.79 [4.28-5.43]	**<0.001**	3>1; 3>2 ; 2>1
ctBill(mg/dl)	1.46±0.77 [1.21-1.70]	1.38±0.78 [1.13-1.63]	1.10±0.73 [0.87-1.33]	0.090	-
pH(T)	7.35±0.05 [7.33-7.37]	7.34±0.07 [7.32-7.36]	7.29±0.08 [7.26-7.31]	**<0.001**	1>3 ; 2>3
pCO_2(T)(mmHg)	43.3±7.5 [40.90-45.70]	44.67±8.66 [41.90-47.44]	48.45±11.42 [44.79-52.10]	**0.042**	3>1 ; 3>2
pO_2(T)(mmHg)	21.58±6.62 [19.47-23.70]	22.57±7.14 [20.29-24.86]	21.02±6.74 [18.86-23.17]	0.588	-
ctO_2c(Vol%)	8.39±3.97 [7.12-9.66]	9.58±4.84 [8.03-11.13]	8.16±4.33 [6.77-9.55]	0.304	-
p50c(mmHg)	24.47±2.81 [23.57-25.36]	25.46±2.72 [24.59-26.33]	27.07±2.57 [26.25-27.89]	**<0.001**	3>1 ; 3>2
cBase(Ecf)c(mmol/L)	-1.84±1.76 [-2.40- (-1.28)]	-1.89±2.07 [-2.56- (-1.23)]	-3.76±1.98 [-4.39- (-3.12)]	**<0.001**	1>3 ; 2>3
$cHCO_3$(P)c (mmol/L)	22.85±1.89 [22.20-23.50]	23.09±1.87 [22.49-23.68]	21.90±2.01 [21.25-22.54]	**0.016**	1>3 ; 2>3
mOsmc(mmol/kg)	284.71±11.55 [281.02-288.41]	276.01±3.97 [274.74-277.28]	280.72±8.65 [277.95-283.48]	**<0.001**	1>2 ; 3>2
$cHCO_3$(p,st)c(mmol/L)	21.32±1.48 [20.85-21.79]	20.96±2.38 [20.17-21.79]	19.01±2.06 [18.35-19.67]	**<0.001**	1>3 ; 2>3
cBase(B,ox)c(mmol/L)	-3.84±1.87 [-4.43-(-3.24)]	-4.28±2.86 [-5.19-(-3.36)]	-7.01±2.92 [-7.94-(-6.08)]]	**<0.001**	1>3 ; 2>3
cBase(Ecf,ox)c(mmol/L)	-2.37±1.72 [-2.92-(-1.82)]	-2.41±2.12 [-3.09-(-1.73)]	-4.35±1.99 [-4.98-(-3.71)	**<0.001**	1>3 ; 2>3

One-way ANOVA and post hoc Bonferroni test used. p<0.05 considered significant. NS; not significant, VD; vaginal delivery.

Delayed umbilical cord clamping allows for the transfer of warm, oxygenated blood from the placenta to the newborn. In a recent study, positive outcomes of delayed cord clamping for newborns and infants up to 12 months old were reported in babies born vaginally or via primary cesarean section, with gestational age $>$ 37 weeks and no or low risk of birth complications [19]. While Rana et al. suggested a cutoff of 61 seconds for early cord clamping, other authors explained advantageous effects between 60 to 120 seconds, indicating that effects may be better when the umbilical cord is cut later due to placental blood perfusion [20]. Consistent with the literature, delayed cord clamping was set at 60 seconds in this study. This study differs from other studies only in evaluating newborns' early blood gases.

Consonni et al. [21] demonstrated that delayed cord clamping after the newborn's first breath is associated with higher neonatal hematocrit (Hct) in cesarean deliveries, but this is not valid for elective ones. Strauss et al. [22] found that newborns delivered by cesarean section with cord clamping after 60 seconds had a lower red blood cell (RBC) count compared to those born vaginally. Two previously conducted randomized controlled trials showed that in term newborns delivered by elective cesarean section,

hemoglobin (Hb) and Hct levels were higher after umbilical cord clamping at 60 seconds [23, 24]. In contrast, Zhou et al. showed decreased placental transfusion during cesarean section in a systematic review and meta-analysis [25]. In this study, higher Hb levels were detected in the babies of primiparous and multiparous pregnant women who had VD compared to the babies of elective C/S deliveries.

A recent study found that delayed cord clamping after evaluating elective C/S-born term infants had no effect on SpO_2, whether clamping was done urgently or with delay [26]. Similarly, this study showed no statistical difference in pO_2 and sO_2 in newborns after delayed cord clamping following primiparous VD, multiparous VD, and elective C/S births.

Midwives and clinicians assess umbilical cord blood gas to ensure quality of obstetric care and is fundamental in resolving legal issues related to the diagnosis of severe fetal hypoxia in research [27]. Cantu et al. demonstrated the usefulness of venous pH as an indicator of arterial pH in their study [28]. However, the scientific value of veno-arterial differences in pH, also known as ΔpH, has not been largely determined [29]. Further studies are needed to consider changes in ΔpH associated with carbon dioxide and oxygen levels in umbilical cord blood gases [16]. Clinicians often rely on the use of APGAR scores to predict poor neonatal outcomes in hypoxic newborns [30]. However, more definite markers for fetal asphyxia need to be identified due to interobserver variability in measurements [31]. There is no global consensus on the definition of normal umbilical cord blood gases in the literature. The Danish Society of Obstetrics and Gynecology measured the average pH level as 7.26 and the average -2 SD level as 7.10 in a review of 26 studies ranging from 1964 to 2004, with varying qualities and involving 61 to 24,390 births [32]. In this study, fetal metabolic acidosis was not detected among newborns since the pH values of the cases were above 7.20 and BD $<$ 12.0 mmol/L. However, pH levels were statistically significantly higher in multiparous VD and elective C/S deliveries than primiparous VD.

Due to the perceived practicality and safety of spinal anesthesia compared to general anesthesia for cesarean delivery in mothers, it is assumed to be safer for newborns as well. Furthermore, in a meta-analysis of 27 studies evaluating newborn acid-base levels with different anesthesia methods, Reynolds and Seed [33] demonstrated that spinal anesthesia is associated with a higher levels of fetal metabolic acidemia compared to general anesthesia or epidural anesthesia. The average ± SD umbilical artery pH reported by pooling data from the presented article and 24 studies including arterial data was 7.253 ± 0.062 (N=527) for cesarean delivery with spinal anesthesia, 7.274 ± 0.049 (N=1203) for general anesthesia, and 7.269 ± 0.053 (N=630) for epidural anesthesia. Reynolds and Seed [33] concluded that using spinal anesthesia for cesarean delivery cannot be considered among several good reasons for newborn care and that spinal anesthesia may not be more secure for the fetus compared to other methods. Differences in the use of higher doses of ephedrine among spinal and epidural anesthesia may explain this discrepancy. In this study, cases were electively taken for cesarean delivery under spinal anesthesia, and the mean pH level was calculated as 7.35 ± 0.05. However, the high pH results of newborns despite only receiving spinal anesthesia in the cases differ in terms of being from a single center and consisting of a small number of cases.

Due to the many factors that affect the APGAR score, the APGAR score often does not reflect the degree of acidosis at birth. Zaigham et al. [34] have clearly shown that a low APGAR score is not equivalent to neonatal asphyxia. Sykes et al., in their study on 1210 newborns, showed the positive predictive value of the 1-minute APGAR score for severe acidosis to be 21%, with a sensitivity of 27%, and stated that the APGAR score did not identify 73% of those with severe acidosis, thus indicating a weak relationship between APGAR score and umbilical artery pH [35]. In this study, however, it was found that the 1-minute APGAR scores of cases undergoing primiparous vaginal delivery and multiparous vaginal delivery were higher compared to those undergoing cesarean section, and this difference was statistically significant. However, while 1-minute APGAR scores were higher than 7, there was no statistically significant difference among the three groups regarding 5-minute APGAR scores. The difference in 1-minute APGAR scores may be related to cesarean section and the type of spinal anesthesia.

Since lactate changes in both the artery and vein of the umbilical cord with gestational age from the 34^{th} to the 35^{th} week of gestation, it is impossible to determine any cut-off value for pathological values in terms of gestational age. Accordingly, it will be 9 mmol/L at 37 and 11 mmol/L at 42 weeks [36]. Establishing a limit for hyperlactatemia is hard unless the clinical condition of the newborn and the evaluation time for hyperlactatemia are well defined. In a meta-analysis, it was shown that lactate levels higher than 4 mmol/L are associated with greater mortality (OR, 5.61 [95% CI, 2.27-13.84]; I2 = 76%; n = 1009; p = 0.0002) [37]. However, when lactate is analyzed as a continuous variable, the survival group's mean lactate level was higher than 4 mmol/L in 20 studies.

It should be noted that a high lactate level should always be considered as a warning sign requiring evaluation [13]. Therefore, without specifying the clinical picture and evaluation time, using lactate levels alone as a screening test for adverse outcomes in newborns is impossible. However, since newborns with the highest risk of death have higher lactate concentrations, lactate levels can be used to classify those at greater risk of adverse results. These remarks are consistent with pediatric studies. In this study, the lowest levels of lactate were found in those undergoing elective C/S delivery, followed by those undergoing multiparous VD, and the highest levels were found in the primiparous VD group, which was statistically significant. However, in cases of primiparous VD, the pH level was inconsistent with acidosis, and the 1^{st} and 5^{th} minute APGAR scores were normal. Discrepancies between Apgar score and umbilical artery pH are well known [38]. However, Van de Riet et al. suggest, in a meta-analysis, that while umbilical artery pH <7.00 has the strongest triple relationship with neonatal death, both low Apgar score and weak Sarnat score have stronger relations with the progress of cerebral palsy [39]. A study covering 27,233 births conducted

with matched umbilical cord blood samples showed that the time elapsed from taking the blood sample to analysis could affect the blood gas results and lactate values [40]. Conversely, in cords clamped by two clamps and kept in room air, it was also demonstrated that pH, pO_2, pCO_2, and base deficit did not undergo statistically significant changes for up to 40 to 60 minutes after sampling [41]. Consistent with the literature, in this study the duration of the analysis of umbilical cord blood gas was measured on average as 15 minutes.

The strengths of this study lie in its single-center evaluation of early outcomes of cord blood gases after delayed cord clamping in cases of uncomplicated primary vaginal delivery, multiparous delivery, and elective cesarean delivery. However, due to the study's retrospective nature, limitations include the dissimilarity in age and newborn weights of the participants, heterogeneity, limited number of cases, and the unknown anesthetic agent used for spinal anesthesia.

Conclusion

In this study, lower birth weight, lower pH, and higher pCO_2 levels were found in babies of primiparous mothers , while in the cesarean group, lower Apgar scores at 1 minute, lower levels of Hb, Ca, glucose, lactate, and K were observed. Pregnant women should be individually evaluated, and the risks of vaginal delivery and cesarean section should be explained to make a joint decision for the health of both the baby and the mother. More studies with a larger number of cases are needed to clearly explain the relationship between fetal umbilical cord blood gas and birth mode.

Ethical approval

Ethics committee approval for this study was received from local ethics committee (Siirt University Ethics Committee) with the decision dated 18.10.2023 and numbered 2023/10/01/04.

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