The Effects of Epidural Analgesia during Labor on Maternal and Neonatal Outcomes

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Abstract

Background: The purpose of the study was to investigate the impact of epidural analgesia usage vs. non-epidural labor on maternal and neonatal outcomes.

Methods: We included 129 parturients who had vaginal deliveries in our hospital since December 1, 2018. The women were grouped into the epidural analgesia group or the non-epidural group. In order to investigate the effect of epidural analgesia on mother and newborn outcomes, we evaluated the differences in labor duration, the Apgar score of the newborn, and the overall outcome of the mother and newborn.

Results: Compared to the non-epidural group, the durations of the first and second stages of labor in the analgesia group were significantly longer. In terms of neonatal outcome, the epidural analgesia group had a higher lactate value in the umbilical artery blood and higher pCO_2 of umbilical vein blood of the neonates. However, there were no significant differences in Apgar Score, umbilical blood pH, base excess, or other umbilical cord blood gas analyses (pO_2, HGB, SO_2, HCO_3 -) between epidural analgesia and non-epidural labor groups.

Conclusion: The epidural analgesia prolongs the duration of the first and second stages of labor and affects the level of lactate in umbilical artery blood and the partial pressure of carbon dioxide in umbilical vein blood. There was no significant effect on the basic characteristics of the mothers and neonates, suggesting that epidural analgesia delivery technology is safe, but it may have a particular short-term impact on neonatal outcomes.

1. Background

Labor pain is the most severe type of pain that a woman will experience during her lifetime. Certain psychological, motivational, cognitive, sociological, and cultural factors affect its intensity. Although pain in a healthy delivery does not endanger the mother's life, it can lead to adverse neuropsychological developments, such as postpartum depression and traumatic stress disorder. Thus, painful labor may negatively affect maternal physiology and neonatal outcome [1]. Therefore, seeking a simple, effective, and safe method of painless labor is the main goal for Obstetrics, mothers, and their families. Childbirth delivery options include cesarean section delivery, epidural analgesia labor, and natural childbirth (non-painless) delivery. The ultimate goal of different delivery methods is to ensure the health of the mother and the baby.

In recent years, increasingly more women have chosen pain relief methods during labor. Among a variety of methods for pain relief during labor, an epidural analgesia is accepted as a more effective method and is the standard form of pain relief used during labor in many countries [2]. Although most studies suggested that epidural analgesia is safe for both the mother and the newborn, there are still some adverse effects on the mother, such as: hypotension, an increase in instrumental vaginal delivery, a rise in body temperature, a prolonged second stage of labor, and difficulty in the onset of lactation [2 ~ 6]. The

association between the use of epidural analgesia and its effect on neonates is still controversial. Several systematic reviews did not find a significant relationship between the use of the analgesic and neonatal outcomes such as Apgar scores and pH values of the umbilical artery [2 ~ 4,7,8]. Other studies reported that epidural analgesia might increase the negative outcome of neonates [9 ~ 11]. In terms of the analgesic effect on mothers and newborns, most of the studies compared different modalities of analgesia, only a few studies compared epidural analgesia specifically vs. non-epidural labor [12, 13]. To investigate if the epidural analgesia has any effects on maternal and neonatal outcomes, the baseline characteristics and overall outcomes of both mothers and newborns, including umbilical cord blood gas analysis, were performed in the present study.

2. Methods

2.1 Subjects

We studied a total of 129 parturients who gave birth to a single child by vaginal delivery and were admitted to Binhu hospital, Hefei City, Anhui Province from December 2018 to February 2019. Patients were 19–40 years old (27.99 years old on average), 37 + 1 ~ 41 weeks of gestation (39.53 weeks on average); Inclusion criteria: (1) Age 18–40 years old; (2) gestational age ≥ 37 weeks, and < 42 weeks; (3) single fetus; 4) head basin matching and spontaneous delivery. Exclusion criteria:(1) Gestational age < 37 weeks or ≥ 42 weeks; (2) twin or multiple pregnancy; (3) Cephalopelvic disproportion; (4) severe obstetric complications: preeclampsia, hypertension, diabetes; (5) other: nervous system diseases, mental retardation, anesthesia contraindications, a severe infection. Patients were divided into a control group (non- epidural anesthesia, 64 cases) and epidural analgesia group (epidural anesthesia, 65 cases) according to the wishes of the parturient. The provision of written informed consent was obtained from a guardian or legal representative of each participant.

2.2 Epidural labor method

When parturients came to our hospital for baby delivery, the parturient was asked if she preferred epidural analgesia labor or traditional non-epidural labor. For the parturients who chose epidural analgesia usage during labor, the epidural was performed when the cervix of the parturient women was opened to 3 cm. A 19-gauge epidural catheter fixed at 5 cm in the epidural space, at the L2–L3 or L3–L4 interspace, was inserted via a 17-gauge Tuohy epidural needle using a loss of resistance to saline technique. Then, 5–7 ml of 1% lidocaine was added, 10 ml total, and connected to the pulse infusion pump. Ropivacaine 0.83% with 0.2 mg fentanyl with 9 ml first dose was given in incremental doses (3 ml/hr), the self-control dosage was 3 ml / time, and the locking time was 20 min. When entering the second stage of labor, the Patient-controlled epidural analgesia pump was closed. No midwifery was performed in either group.

2.3 Observation indexes

2.3.1 Parturient

The following maternal data was collected and analyzed: the total amount of bleeding during delivery, the duration of the first and second stages of labor, and the length of postpartum hospitalization.

2.3.2 Neonates

2.3.2.1 Apgar score

All newborns were given an Apgar score of 1 min and 5 min immediately after birth. The obstetrician and pediatrician scored separately, and the final score was recorded after being double-checked. Apgar scores of 8–10 points were considered normal for newborns; 4–7 points indicated mild asphyxia, and 0–3 points suggested severe asphyxia.

2.3.2.2 Umbilical cord blood gas analysis

Umbilical cord artery and vein blood were collected according to the standard procedure, from double-clamped cord segments at least 30 seconds after neonatal delivery. Trained midwives collected samples into heparinized syringes. The pH, blood gases, and lactate were measured by an automated analyzer (GEM Premier 3500) located in the labor and delivery ward.

2.4 Statistical analysis

All statistical analyses were conducted with SPSS software, version 19.0 (SPSS Inc., Chicago, USA). Values are presented as mean ± standard deviation (SD). Student's t-test compared quantitative variables (baseline charaterics, labor time, Apgar scores and blood gas analysis) and $\chi 2$ test was used for categorical variables. A p-value of less than 0.05 was considered statistically significant.

3. Results

There were 129 parturients in the group; 65 of which were in the painless delivery group. One of them was given oxygen through the nasal tube during the delivery, and in 3 cases the difference of pH between umbilical arteries and veins was less than 0.02; a total 4 cases were excluded. Among the 64 participants of the non-painless delivery group, 7 cases failed to retain the umbilical artery, 1 case failed to take the umbilical artery and vein, and the difference of pCO_2 between the umbilical artery and vein of was less than 0.5kpa in 2 cases [14]; thus, a total of 10 cases were excluded. Therefore, 61 cases of the painless delivery group and 54 cases of non-painless delivery groups participated in the data analysis.

3.1 Parturient characteristics

A total of 115 parturients were enrolled and eligible for this study, with 61 in the painless group and 54 in the non-painless group. The parturient characteristics in both groups are shown in Table 1. There were no significant differences in age, prenatal weight, body mass index (BMI), prenatal WBC, and HGB of the parturients between the two groups ($p > 0.05$).

Table 1 Parturient characteristics (values expressed as mean ± SD).

	Analgesia (n=61)	non- analgesia (n=54)	t-value	P-value
Age	27.98±3.72	28.00±4.00	-0.23	0.98
Prenatal weight	69.83±8.47	69.17±7.67	0.43	0.66
BMI	27.22±3.10	26.19±2.60	1.91	0.06
WBC (10^9/L)	9.61±2.02	9.13±2.43	1.15	0.25
HGB (g/L)	118.36±8.62	115.17±9.53	1.89	0.06

3.2 General outcomes of parturients

The results showed that the duration of the first and second stages of labor in the painless delivery group was longer than that of the non-painless delivery group (P = 0.01 and P = 0.02 respectively). There was a higher total amount of bleeding in the painless labor group, but there was no significant difference between the two groups (P = 0.37). The postpartum hospital stay was longer in the painless delivery group, but there was no significant difference between the two groups (P = 0.38), see Table 2.

Table 2 Labor characteristics (values expressed mean ± SD)

	Analgesia (n=61)	non- analgesia (n=54)	t-value	P-value
Stage-I (min)	484.43±224.38	372.39±254.71	2.51	0.01
Stage-II (min)	43.80±27.53	33.27±17.90	2.40	0.02
Total bleeding (ml)	268.03±148.05	246.30±104.54	0.90	0.37
Postpartum stay (hr)	88.24±16.32	84.94±22.98	0.88	0.38

3.3 Baseline characteristics of neonates

Comparison of the general condition of newborns in painless delivery group and non painless delivery group: there was no significant difference in gestational age (weeks), birth weight (gram), or delayed cord ligation time (seconds) between the two groups (P > 0.05), as shown in Table 3.

Table 3 Baseline characteristics of neonates (mean ± SD)

	Analgesia (n=61)	non- analgesia (n=54)	t-value	P-value
Fetal age (w)	39.50±0.81	39.56±0.98	-0.37	0.71
Birth weight (g)	3329.67±281.96	3393.33±376.82	-1.02	0.31
Delay ligation (s)	86.69±30.57	89.69±34.39	-0.49	0.62

3.4 Apgar score

The Apgar scores of neonates at 1 and 5 minutes following delivery were 9.97 ± 0.18, and 9.98 ± 0.13 in the painless group, and 9.89 ± 0.32, and 9.91 ± 0.29 in the non-painless group, respectively. No significant differences were found in Apgar scores between the 2 groups (all *P* > 0.05) (Table 4)

Table 4 Apgar scores (values expressed mean ± SD)

	Analgesia (n=61)	non-analgesia (n=54)	t-value	P-value
1 min	9.97±0.18	9.89±0.32	1.60	0.11
5 min	9.98±0.13	9.91±0.29	1.77	0.08

3.5 Umbilical blood gas analysis

3.5.1 Umbilical artery blood gas

The umbilical blood gas analysis directly from the fetus reflects respiratory exchanges, hypoxia, acidosis, metabolism, and the electrolytic state, so it is an important measurement in evaluating the abnormality of fetal oxygenation and acid-base metabolism [15]. In this study, the pH value of the painless delivery group was slightly lower (7.20 ± 0.06) compared to the non-epidural group (7.21 ± 0.06), but there was no significant difference between the two groups (P = 0.07). The oxygen partial pressure (pO_2) and carbon dioxide partial pressure (pCO_2) of the umbilical artery blood are two indicators that reflected fetal breathing. The pO_2 was lower (20.52 ± 6.37 vs. 21.33 ± 8.51) and the pCO2 was higher (60.26 ± 8.42 vs.57.44 ± 8.31) in the painless delivery group, but there were no significant differences between these two groups (P = 0.56 and P = 0.07, respectively). Similarly, oxygen saturation (SO_2) and standard bicarbonate (HCO_3^-) also did not show any significant difference between the two groups (P = 0.48 and P = 0.72, respectively). Base excess (BE) is a parameter that evaluates the excess of base. The negative value indicates there is a lack of base and that the subject is in a condition of metabolic acidosis. The BE in the painless group was more negative (-6.17 ± 2.75) than in the non-epidural group (-5.52 ± 2.64), but the difference is not statistically significant (P = 0.20). Lactate (Lac) reflects the fetal anaerobic metabolism during the process of delivery. The lactate concentration was significantly higher in the group of painless delivery (5.47 ± 1.71) compared to the group of non-analgesia delivery (4.87 ± 1.32) (P = 0.04), suggesting that the fetal anaerobic metabolism in the painless delivery group was more prominent.

Table 5 Umbilical artery blood gas analysis (values expressed mean ± SD)

	Analgesia (n=61)	non-analgesia (n=54)	t-value	P-value
pH	7.20±0.06	7.21±0.06	-1.83	0.07
pCO_2 (mmHg)	60.26±8.42	57.44±8.31	1.80	0.07
pO_2 (mmHg)	20.52±6.37	21.33±8.51	-0.58	0.56
SO_2 (%)	24.36±13.59	26.39±17.17	-0.71	0.48
HCO_3- (mmol/L)	23.27±2.53	23.12±2.31	0.36	0.72
BE (mmol/L)	-6.17±2.75	-5.52±2.64	-1.29	0.20
Lac	5.47±1.71	4.87±1.32	2.12	0.04

3.5.2 Umbilical vein blood gas

The umbilical vein carries oxygenated, nutrient-rich blood from the mother to the fetal heart, and then to all the remaining organs and tissues of the body. Therefore, the umbilical vein blood reflects more the state of the mother and the placenta. The umbilical vein's blood gas can be used to distinguish the umbilical artery and vein but also to judge the location of ischemia and anoxia and to evaluate the prognosis and severity of newborns. The pH value of the painless delivery group was slightly lower (7.31 ± 0.06) compared to the non-analgesia group (7.33 ± 0.07), but there was no significant difference between the two groups (P = 0.05). Interestingly, the pCO_2 of the painless delivery group was significantly higher (42.75 ± 8.18) than that of the non-painless delivery group (39.41 ± 6.55) (P = 0.02); the pO_2 of the painless delivery group was slightly lower than that of the non-painless delivery group, but there was no significant difference between the two groups (P = 0.13). Similar to the arterial blood gas, there were no significant differences between the painless and non-epidural groups in SO_2, HCO3- and BE (P = 0.77, P = 0.15, and P = 0.94, respectively). The lactate of the painless delivery group was higher (4.50 ± 1.52) than those of the painless delivery group (4.14 ± 1.28), but there was no significant difference between the two groups (P = 0.18,), as shown in Table 6.

Table 6 Umbilical vein blood gas analysis (values expressed mean ± SD)

	Analgesia (n=61)	non-analgesia (n=54)	t-value	P-value
pH	7.31±0.06	7.33±0.07	-1.97	0.05
pCO_2 (mmHg)	42.75±8.18	39.41±6.55	2.40	0.02
pO_2 (mmHg)	28.62±9.24	31.06±7.90	-1.51	0.13
SO_2 (%)	46.26±21.05	52.78±17.65	-1.79	0.07
HCO_3- (mmol/L)	21.33±2.21	20.75±2.01	1.45	0.15
BE (mmol/L)	-4.83±2.17	-4.79±2.48	-0.07	0.94
Lac	4.50±1.52	4.14±1.28	1.36	0.18

Discussion

The efforts toward reducing adverse anesthesia-related maternal and neonatal outcomes are an important aspect of labor analgesia. Present results found no significant difference in the baseline characteristics of parturients (age, prenatal weight, BMI, prenatal WBC, and HGB) and neonates (gestational age, birth weight, and delayed cord ligation time) between the epidural analgesia and non-epidural groups. Apgar scores of the two groups at 1 and 5 minutes after birth also did not show any difference. Our results confirmed that the stages of laboring were significantly longer in the epidural analgesia group compared to the non-epidural group. The lactate value of the umbilical artery blood in the painless delivery group was significantly higher than that in the non-epidural delivery group, and the pCO_2 of the umbilical vein blood in the painless delivery group was also significantly increased, suggesting that epidural analgesia usage during labor may have adverse effects on newborns.

Painless delivery technology is the gold standard to reduce pain during labor. Although a large amount of literature reports that painless delivery is beneficial, the impact on maternal and neonatal outcomes is still controversial. In this study, the total amount of bleeding during labor, the duration of the first and second stages of labor, and the length of postpartum hospitalization were summarized. It was found that the total amount of bleeding increased, and the length of hospitalization was longer in the painless delivery group, but there was no significant difference between the two groups. The duration of the first and second stages of labor in the painless delivery group were significantly prolonged. These results further support previous literary reports [16, 17]. Other studies also found that early epidural analgesia use in labor (when the cervix is less than 4.0 cm dilated) resulted in faster delivery compared to initiating the epidural later in labor [18, 19]. A recent meta-analysis did not find an association between low-

concentration epidural analgesia and the duration of labor, but this meta-analysis is based on small trials of low quality [20]. These conflicting results may be due to different methodologies and how the labor onsets define the timing for initiating the epidural.

The neonatal outcomes are usually assessed by Apgar scores, and there was no significant difference in painless and non-epidural groups. This is in line with other studies that showed no difference in Apgar scores in epidural analgesia and no analgesia groups [21 ~ 23]. However, neonates with good Apgar scores still have a risk of neonatal acidaemia and adverse outcomes [24]. Both pH and BE values can be used to assess fetal metabolic acidosis during delivery. Umbilical cord blood pH is an important outcome indicator in obstetrics. Low arterial umbilical cord pH is closely related to the neonatal mortality (hypoxic-ischemic encephalopathy, seizures, intraventricular hemorrhage, periventricular leukomalacia, and cerebral palsy) incidence rate [25]. In normal healthy fetuses, a slight decrease in pH may not have clinical significance, but for fetuses with predisposing factors, even a slight decrease in pH may cause adverse neurological sequelae [26]. The present study did not find significantly low umbilical cord pH values in the epidural analgesia delivery group. However, some neonates with a normal pH at birth might still develop a hypoxic condition [27, 28]. The pCO_2 of umbilical vein blood in the painless delivery group was significantly higher than that of the non-epidural delivery group, which may be related to the decrease of transitional ventilation caused by pain relief. In this study, the lactate, pCO2, and HCO3 - of umbilical artery blood - were significantly higher in the epidural analgesic delivery group than those of the non-epidural delivery group, which was consistent with previous reports, suggesting that the painless delivery group may increase the level of anaerobic metabolism due to the prolonged labor process, and the pain relief is also lower in pH, which requires the body to use reserve alkali, resulting in lower BE and HCO_3-.

Although the present study shows that the pH slightly decreased, it did not reach a significant level, while the lactate level was significantly increased in the painless delivery group compare to the non-epidural group. Both lactate and pH values have been reported to be the best indicators of neonatal oxygenation index and acid-base status, and lactate has the most robust discrimination [29]. Two extensive studies on 2554 [24] and 1709 [25] neonates of singleton deliveries proved that the lactate of the umbilical artery has higher sensitivity and specificity for fetal asphyxia at delivery than that with the pH and base excess. Westgren et al. (1995) [30] analyzed 4045 cord samples and demonstrated that within the 1 minute Apgar score, the difference between pH value and lactate was the largest. For the Apgar score at 5 minutes, lactate was the best identification index. The sensitivity, specificity, positive, and negative predictive value of lactate in morbidity and mortality are comparable to pH and base deficits. Lactate significantly correlated with fetal pH, hemoglobin, base deficiency, pCO_2, and HCO_3-. Although pH is more often used as an indicator of neonatal disease than lactate in clinical practice, more blood samples and sophisticated equipment are required to measure pH and base excess than that required of measuring lactate; thus, the lactate measurement has a lower cost and is easier to maintain[31]. Epidural anesthesia results in transient uterine-placental dysfunction due to maternal and infant body temperature rise, which leads to a decrease in fetal tissue oxygen supply. When maternal vascular resistance decreases, it can

reduce maternal systolic blood pressure. The lower blood pressure may result in uterine placental dysfunction and increase lactate level in neonatal tissues [32.]

There were some limitations to the present study. Firstly, the sample size is relatively small; a larger number of subjects could increase the strength of the results in a future study. Secondly, our results may be affected by confounding factors that were not collected, as we were unable to collect essential results such as anesthesia levels and subjective pain scores during labor. Thirdly, the subjective evaluation of cervical dilatation by obstetricians of differing experiences may differ, which may affect the actual evaluation of the duration of labor. Fourthly, although nurses strictly define the indications of umbilical cord blood collection, there are some differences between individual nurses in clinical practice. Finally, the present study only observed short-term (1 and 5 min Apgar score) neonatal outcomes; the long-term outcome needs to be investigated in the future.

Conclusion

The present study showed that the duration of the first and second stages of labor are significantly longer in the analgesia group compare to the non-analgesia group. The epidural analgesia delivery mainly affects the value of lactate in umbilical artery blood and the partial pressure of carbon dioxide in umbilical vein blood. There were no significant difference in basic characteristics of parturients and neonates, Apgar score, pH, BE, HCO_3-, etc., between two groups, suggesting that epidural analgesia delivery technology is safe, but may have a particular impact on short-term neonatal outcomes.

Abbreviations

BE Base excess

BMI Body mass index

HCO_3^- standard bicarbonate

HGB Hemoglobin

Lac Lactate

pO_2 oxygen partial pressure

pCO_2 carbon dioxide partial pressure

SO_2 oxygen saturation) and

WBC white blood cells

Declarations

- Ethics approval and consent to participate

This study was approved by the Binhu Hospitals Research Ethics Board.

Informed consent: Informed consent was obtained from all patients included in this study.

The ethics approval and informed consent were obtained by written.

- Consent to publish

Not Applicable

- Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request

- Competing interests

The authors declare no competing interests that might have influenced the work described in this manuscript.

- Funding

Not Applicable

- Authors' Contributions

J-H.H. drafted the protocol and manuscript; acquired, analyzed, and interpreted the data.. M.Yu. helped drafted the protocol, acquired, analyze and interpret the data. D-B.Z., J-P.P., X-T.C., Q.L., and M. Yang all contributed to acquired, analyze and interpret the data and all authors have read and approved the manuscript.

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Not Applicable

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