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Epidural analgesia for labor: effects on length of labor and maternal and neonatal outcomes

F.-Y. HE[1], S. WANG[2]

[1]Department of Obstetrics, The People's Hospital of Guangxi Zhuang Autonomous Region, Nanning, Guangxi, China
[2]Department of Obstetrics, The First Affiliated Hospital of Guangxi Medical University, Nanning, Guangxi, China

Abstract. – OBJECTIVE: The aim of the study was to investigate the impact of epidural analgesia on the stages of labor and maternal and neonatal outcomes.

PATIENTS AND METHODS: A retrospective cohort study was conducted in the First Affiliated Hospital of Guangxi Medical University from January 1, 2020 to September 30, 2020. A total of 472 parturient met the inclusion criteria. Of them, 246 parturients received labor analgesia and 226 did not (control group). Their general characteristics, the length of labor, adverse reactions to analgesia, and maternal and neonatal outcomes between the two groups were compared to analyze and evaluate the feasibility of epidural analgesia in labor.

RESULTS: (1) The women in the analgesia group experienced a significantly longer (p<0.001) 1st stage, 2nd stage, and total stage during labor; (2) the usage rate of oxytocin, the rate of external cephalic version, and the success rate of external cephalic version were all significantly higher in the analgesia group (p<0.001); (3) there was no statistically significant difference between the vaginal delivery rate and transit cesarean section rate of the two groups; (4) compared with the control group, the incidence of intrapartum fever was significantly increased in the analgesia group (p<0.05); (5) there was no statistically significant difference between the two groups in postpartum hemorrhage, neonatal Apgar score, and neonatal asphyxia rate.

CONCLUSIONS: (1) Labor analgesia may prolong the 1st and 2nd stages of labor and increases the incidence of intrapartum fever, without increasing the rate of transit to cesarean section and postpartum hemorrhage; (2) labor analgesia does not negatively affect the Apgar score or increase the neonatal asphyxia rate.

Key Words:
Labor analgesia, Prolonged labor, Intrapartum fever, Cesarean section, Neonatal outcomes.

Introduction

Labor pain is generally regarded as one of the most painful occurrences during a woman's life[1]. It can lead to a maternal stress reaction and result in adverse maternal and neonatal outcomes[2-4]. Severe labor pain may also increase the rate of non-medically indicated cesarean sections[5,6]. To avoid severe labor pain some parturients may choose to terminate the pregnancy by elective cesarean delivery, which is one of the reasons why the cesarean section rate in China has been continuously increasing. The cesarean delivery rate in China was 36.7% in 2018, approximately three times the rate of 10-15% recommended by the WHO[7,8].

Multiple methods have been used for pain relief during labor, including spinal epidural, inhaled analgesia, relaxation, acupuncture, and non-opioid drugs[9,10]. A recent systematic review[11] by Cochrane has suggested that epidurals may be more effective in reducing labor pain than any other type of pain relief and increase satisfaction with pain relief in parturients. During epidural analgesia an opioid analgesic substance (e.g., fentanyl or morphine) and a local anesthetic agent (e.g., bupivacaine or lidocaine) are injected into the lumbar epidural space and mainly affect the roots of the spinal nerve[2]. Labor analgesia has been associated with multiple advantages, including improvement in the comfort of labor, less unnecessary oxygen consumption caused by pain, and a potential decrease in non-medically indicated caesarian deliveries[12-14]. Moreover, analgesia does not seem to significantly affect the Apgar score, which reflects the neonatal condition[12,14,15].

There is a large intercountry variation in the rate of epidural analgesia use during labor. According to a report from the CDC, 61% of women

Corresponding Author: Sumei Wang, MD; e-mail: 187176076@qq.com

in the USA received epidural or spinal anesthesia during delivery, while this rate is 19% in the UK[16,17]. A much lower rate is found in China, where the application of epidural analgesia has doubled over the last ten years to approximately 10%[18]. Multiple studies[11,19,20] have shown a negative association between low rates of epidural analgesia and high rates of caesarean section. Although labor analgesia has been widely applied in some countries, the potential impact of it on the progress of labor, the mode of delivery, duration, and outcomes of labor is still being debated. Unclarity on the outcomes could affect the potential application of labor analgesia in countries like China. Therefore, a comprehensive evaluation of epidural analgesia on neonatal and maternal outcomes in China is urgently needed. The present retrospective cohort study investigated the effectiveness of epidural analgesia on labor stages and maternal and neonatal outcomes. The results could provide references for its clinical application.

Patients and Methods

Study Population

Women who gave birth in the First Affiliated Hospital of Guangxi Medical University from January 1, 2020 to September 30, 2020 were included in this single-center retrospective cohort study. The clinical data was extracted from digital medical records. The following inclusion criteria were applied: low-risk pregnant women with singleton pregnancy, spontaneous onset of labor at a gestational age between 37 and 42 weeks, fetal cephalic position, and intention of having a vaginal birth. The exclusion criteria included deliveries at gestational age < 37 weeks or > 42 weeks, multiple pregnancy, elective or medically indicated cesarean sections, antenatal analgesia or sedative medication, contraindication for epidural analgesia, induced labor, and complicated pregnancies (hypertension, diabetes, high risk of postpartum hemorrhage, antenatal fever, restricted intrauterine growth).

Parturients that were willing to receive epidural analgesia belonged to the analgesia group (n=246), while those who refused epidural analgesia during delivery were classified as control group (n=226). The study protocol was approved by the Ethics Committee of the Guangxi Medical University.

Analgesia Procedure

The analgesia procedure was carried out as follows: the patient was first assisted into a right lateral or sitting position, then, the puncture site was located at L2-L3 by an experienced anesthesiologist. After reaching the epidural cavity, the epidural catheter was inserted 4-5 cm rostral ward. The analgesic region was injected intermittently with a first dose of 0.1% Ropivacaine and 5 μg Sufentanil in 6-10 ml normal saline and the anesthesia plane was maintained below T10. The catheter and the analgesic pump were then connected. The analgesic pump consisted of a 100-ml mixture of 18 ml 0.1% Ropivacaine, 0.1 mg Sufentanil, and 0.9% sodium chloride solution on a maintenance rate of 5 ml/h, or a self-control dosage of 5 ml per bolus. The epidural analgesia was discontinued 2 hours after labor ended.

Outcomes

The baseline demographic data of the included participants in this study included gestational age, maternal age, parity, BMI before pregnancy, BMI at delivery, and birth weight. Primary outcomes included vaginal delivery duration of 1st, 2nd, and total stages, mode of delivery, oxytocin administration, intrapartum fever, acute chorioamnionitis, postpartum hemorrhage, Apgar scores at 1 and 5 min, and neonatal asphyxia. Secondary outcomes included comparing the effect of oxytocin administration, external cephalic version, and fever on neonatal Apgar scores in the analgesia group.

Statistical Analysis

Data management and statistical analysis was conducted by using SPSS 23.0 (IBM Corp., Armonk, NY, USA). The baseline and measured data were expressed as mean ± SD. The mean of the two groups had a normal distribution as indicated by the normality test. *t*-test was used to compare the difference between groups. The results are expressed in number of cases and percentage. The outcomes were evaluated with a χ^2-test and $p<0.05$ was considered as statistically significant.

Results

A total of 2341 deliveries were recorded at the First Affiliated Hospital of Guangxi Medical University between January 1, 2020 and September 30, 2020. After applying the inclusion and exclusion criteria, 472 were included in the analysis,

Table I. Demographic characteristics of participants in the analgesia group and control group.

	Analgesia (n = 246)	Control (n = 226)
Maternal age (years), mean (SD)	27.3 (3.4)	27.6 (3.2)
Gestational age (weeks), mean (SD)	39.3 (1.6)	39.2 (1.2)
Nulliparous (n, %)	212 (86%)	166 (73%)
BMI before pregnancy (kg/m^2), mean (SD)	20.2 (2.1)	20.3 (2.4)
BMI at delivery (kg/m^2), mean (SD)	25 (2.3)	25.3 (2.4)
Birth weight (g), mean (SD)	3087 (411)	3128 (365)

of which 246 received epidural analgesia and 226 had no analgesia. The demographic characteristics of the participants included in the analysis are shown in Table I.

Comparison of the Delivery Duration

As shown in Table II, the mean duration of the 1st, 2nd, and total stages in delivery were significantly prolonged in the analgesia group compared to those of the control group (1st stage: 656 min *vs.* 455 min, $p<0.001$; 2nd stage: 79 min *vs.* 57 min, $p<0.001$; total: 735 min *vs.* 521 min, $p<0.001$).

Maternal and Neonatal Outcomes

There was no significant difference in mode of delivery between the two groups ($p>0.05$). Significant differences in rates of oxytocin usage and external cephalic version (Table III) were found between the two groups ($p>0.05$). Furthermore, the incidence of intrapartum fever was significantly higher in the analgesia group than in the control group (n=32 *vs.* n=7, $p<0.001$). No significant differences were found in rate of postpartum hemorrhage, Apgar scores, and neonatal asphyxia (Table III).

Effect of Interventions and Intrapartum Fever on Neonatal Apgar Score

The results as shown in Table II indicate that only the outcomes of oxytocin administration, external cephalic version, and intrapartum fever were significantly different between the women who received labor analgesia and those who did not. Significantly, more women in the analgesia group received these interventions and experienced fever. To evaluate these results further, we investigated the effect of these interventions and intrapartum fever on neonatal Apgar score in the analgesia group (Table IV). The results showed that there was no significant difference in neonatal Apgar score whether or not oxytocin was administrated, external cephalic version was applied, or intrapartum fever occurred within the analgesia group ($p>0.05$).

However, the external cephalic version had a significantly higher success rate in the analgesia group (20 out of 30 attempts successful, 66.7%, $p=0.042$) than in the control group (3 out of 10 attempts successful, 30%, $p=0.042$).

Discussion

The rate of caesarean deliveries is higher in China than in most other developed countries, while the application of epidural analgesia during labor is lower. Obstetricians and policy makers have been trying to promote ways to reduce labor pain and are striving for a more comfortable labor experience[18]. However, the ongoing debate on whether labor analgesia has potential negative effects on maternal and neonatal outcomes could stand in the way of woman requesting analgesia during labor and physicians offering it. The present retrospective cohort study was conducted to investigate the impact of epidural analgesia on the stages of labor and maternal and neonatal outcomes.

Table II. Comparison of the labor duration (mean ± SD, min).

Group	N	1st stage	2nd stage	3rd stage	Total
Analgesia	246	656.0 ± 297.9	79.3 ± 28.4	8.6 ± 3.8	735.2 ± 310.8
Control	226	455.3 ± 209.0	57.2 ± 23.8	8.9 ± 3.9	521.4 ± 218.5
t		7.574	5.139	-0.431	7.731
p		0.000	0.000	0.667	0.000

Table III. Maternal and neonatal outcomes.

	Analgesia (n = 246)	Control (n = 226)	χ^2/t	p
Vaginal delivery (n, %)	188 (76.4)	189 (83.6)	3.804	0.051
Cesarean section (n, %)	58 (23.6)	37 (16.4)	4.175	0.053
Oxytocin administration (n, %)	56 (22.8)	34 (15.0)	4.549	0.033
External cephalic version (n, %)	30 (12.1)	10 (4.4)	9.169	0.002
Intrapartum fever (n, %)	32 (13.0)	7 (3.1)	15.263	0.000
Acute chorioamnionitis (n, %)	2 (0.81)	1 (0.44)	0.256	0.613
Postpartum hemorrhage (n, %)	14 (5.7)	9 (4.0)	0.742	0.389
Apgar score 1min (mean± SD)	9.9 ± 0.5	9.9 ± 0.4	-0.953	0.342
Apgar score 5 min (mean ± SD)	10.0 ± 0.2	10.0 ± 0.2	1.619	0.106
Neonatal hypoxia (n, %)	2 (0.8)	1 (0.4)	0.256	0.613

Effects of Labor Analgesia on Delivery Progress

Our study demonstrated that the 1st stage of labor was 201 min (by average) longer in the analgesia group and 2nd stage 22 min longer than in the control group ($p<0.001$). A Cochrane review and other studies[11,21] have also found that labor analgesia prolonged the duration of the 1st and 2nd stage of labor similar to our study. However, some other studies[22,23] have reported that they only observed a longer duration during the 2nd stage and not in the 1st stage. The prolonged duration of the 1st stage in the analgesia group could have been potentially caused by changes in the cycle and strength of uterine contraction and diminished uterine electric activities, inadequate internal rotation of the fetal head and abnormal fetal position, resulting from analgesic loosening of pelvic floor muscles[24,25]. The prolonged 2nd stage (by 22 min) that we observed in parturients with analgesia in comparison to those with no analgesia($p<0.001$), is also reported in other studies. The prolonging is potentially caused by the unsynchronized exertion of the parturient as analgesia leads to the relieve of pain by weakening both the perception of the pressure of the fetal head against the musculi levator ani and perineal body, as well as the sensation of uterine contractions[22,26]. In addition, literature suggests that the prolongation of the 2nd stage of labor may also be related to the type and dose of local anesthetics. Qian et al[27] have confirmed that 0.0625% levobupivacaine has a stronger inhibitory effect on abdominal muscle contraction in the 2nd stage of labor than uterine contractions, which can prolong the 2nd stage by approximately 30 min.

Effects of Labor Analgesia on Maternal Outcomes

Mode of Delivery

Research on whether labor analgesia affects the rate of non-medically indicated cesarean sections has shown varying outcomes. Some scholars[14,28] have reported that it may reduce the number of caesarean sections as the result of relieving pain, which increases the confidence in vaginal delivery. Others have indicated that they did not find significant differences between woman who received epidural analgesia and those who did not[29,30]. Similar to these studies, we found no significant difference between the two groups in the mode of delivery. This may be attributed to the following reasons: first, parturients had sufficient rest and energy supply in the prolonged 1st stage, which may have provided them with

Table IV. Effect of interventions and intrapartum fever on neonatal Apgar score in analgesia group.

	Number of cases (n)	1 min Apgar score (mean ± SD)	5 min Apgar score (mean ± SD)	χ^2/t	p
Oxytocin administration	Yes (56)	9.65 ± 0.39	9.83 ± 0.19	3.326	0.604
	No (190)	9.72 ± 0.27	9.92 ± 0.26		
External cephalic version (mean ± SD)	Yes (30)	9.52 ± 0.79	9.79 ± 0.32	4.126	0.052
	No (216)	9.77 ± 0.50	9.88 ± 0.23		
Intrapartum fever	Yes (32)	9.75 ± 0.62	10.0 ± 0.00	1.556	0.121
	No (214)	9.89 ± 0.44	9.99 ± 0.153		

enough strength to complete a vaginal delivery and second, labor analgesia blocks adverse signals and diminishes the excessive release of catecholamines mediated by psychoactive factors, which reduces the risk of fetal distress and neonatal asphyxia by improving the uterine contraction ability and blood perfusion[31].

Furthermore, the relaxation of pelvic floor muscles increases the success rate of external cephalic version[32,33]. In our study, a higher rate of external cephalic version and its success rate was found in the analgesia group. Most of the parturients with an abnormal fetal position could continue with natural delivery *via* effective external cephalic versions. However, due to the small number of parturients in the two groups who received external cephalic version, its relationship still needs to be further verified by large samples.

Intrapartum Fever

Labor analgesia has been associated with multiple side effects and intrapartum fever is one of the most important[34]. According to the guideline published by the American College of Obstetricians and Gynecologists in 2017, intrapartum fever occurs in 30% of parturients with epidural analgesia, and this number constantly rises as the duration of labor becomes longer[35]. In our study, a significantly higher percentage of intrapartum fever was found in the analgesia group. However, in our experience, the temperature returned to normal within 24 hours after labor in most cases. Fever after labor analgesia has been commonly associated with chorioamnionitis[36]. However, in this study only two cases of chorioamnionitis were found after pathological examination of the placenta, suggesting that this was not the main reason for intrapartum fever in most parturients. Although the cause could be non-infectious, excluding infections causing the intrapartum fever should be actively conducted in the clinic. Cesarean section should be carried out immediately once any infection is confirmed. Moreover, intrapartum fever caused by infection could lead to increased oxygen consumption and prolonged labor, which may increase the risk of fetal distress due to less heat dissipation and more oxygen consumption of the fetus[37,38]. In our study, beside those two cases of confirmed chorioamnionitis, the remaining 30 parturients with fever were more likely to receive cesarean section due to fetal distress and labor stagnation. For this reason, exploration of a safe duration of natural delivery in parturients with non-infectious fever is needed.

Postpartum Hemorrhage

Previous studies[30,39] demonstrated that labor analgesia may increase the risk of postpartum hemorrhage, which is considered a consequence of changes in labor progress and prolonged duration of vaginal delivery. There is no direct evidence of its relationship with epidural labor analgesia. On the contrary, other studies[40,41] indicated that labor analgesia decreases postpartum hemorrhage due to the active collaboration of parturients; following pain relieve, the physical consumption, acid-base imbalance, and uterine atony decreases. In this study, we found that labor analgesia did not increase the risk of postpartum hemorrhage, even though the 1st and 2nd stages of labor in the analgesic group were significantly longer. This may be due to the use of oxytocin and potent uterotonic agents in the postpartum period[42].

Effects of Labor Analgesia on Neonatal Outcomes

Labor analgesia may affect the fetus by direct penetration through the placenta and indirectly through a maternal complication (for example, intrapartum fever)[43]. With the current methods used in labor analgesia, including epidural and combined spinal-epidural techniques, opioids and sedatives are less likely to pass the placental barrier, and are even less likely to become accumulated in the fetus[44]. Deceleration observed on fetal monitoring induced by labor analgesia is mostly transient and does not affect the prognosis of neonates, as other studies have reported[45,46]. In this study, no significant difference in neonatal outcomes between the two groups was found consistent with other research[11,39].

Intrapartum fever potentially increases maternal oxygen consumption, which could decrease the oxygen content in cord blood[47]. This increases the risk of fetal distress. In our study, 13 parturients with fever in the analgesia group underwent cesarean section due to unfavorable conditions for vaginal delivery. Our findings did not indicate significant differences in Apgar scores between the fever and non-fever cases, which may be associated with the course of delivery. Therefore, prompt management of intrapartum fever during epidural labor analgesia is sufficient in preventing adverse effects on the neonates.

Conclusion

Labor analgesia is the hallmark of modern obstetrics. Prolonged labor during the 1st and 2nd stages and intrapartum fever are associated with labor analgesia. However, no increased adverse effects on neonatal outcomes or postpartum hemorrhage were observed in parturients receiving labor analgesia. The findings in this study indicate that labor analgesia is in general safe to neonates and effective in parturients.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethical Approval

The study protocol was approved by the Ethics Committee of the Guangxi Medical University and conducted in accordance with the Declaration of Helsinki.

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Authors' Contribution

Fengying He and Sumei Wang both contributed to the conception and design of the study; Fengying He collected and analyzed the data; Fengying He drafted the manuscript; Sumei Wang revised the manuscript and provided supervision; all authors approved the final version of the manuscript.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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