Original Research

Factors for predicting cesarean section during epidural analgesia: a retrospective study

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Summary

Purpose of investigation: To explore the risk factors for cesarean section during trial of labor with epidural analgesia. *Materials and methods:* A total of 100 parturients who received epidural analgesia were selected for this study. Fifty parturients underwent vaginal deliveries and 50 parturients underwent cesarean sections. Patient-controlled epidural analgesia (PCEA) was carried out with the continuous infusion of 0.125% bupivacaine and 2 mcg/ml fentanyl at 6 ml/h with patient-controlled analgesia (6 ml/time, locked time 15 minutes). *Results:* The univariate analysis showed a significant difference in the gestational age of parturients between cesarean section and vaginal delivery ($p = 0.013$). Compared with the parturients in the vaginal delivery group, cesarean section group parturients showed longer interval time from epidural analgesia to cesarean section ($p < 0.001$), a higher number of analgesia interventions ($p < 0.001$), higher doses of PCEA ($p < 0.001$), and higher number of top-ups ($p = 0.015$). Multivariate analysis revealed that a high gestational age and long interval time were strongly associated with a high possibility of cesarean section during epidural analgesia. *Conclusion:* High gestational age and long interval time are important risk factors for the prediction of cesarean section during epidural analgesia.

Key words: Labor; Epidural analgesia; Cesarean section; Vaginal delivery.

Introduction

Severe pain during labor can make the parturient anxious and increase levels of catecholamine and adrenaline in their blood, thus increasing the risk of high blood pressure and cardiac burden. Furthermore, maternal vocalizations associated with severe pain may lead to excessive ventilation and increased oxygen consumption, thus causing respiratory alkalosis. Moreover, maternal vasoconstriction may reduce the blood supply to the placenta, eventually leading to fetal hypoxemia. Decreased oxygen supply during delivery can also lead to metabolic acidosis, internal environment disorder, and fetal distress [1].

Epidural analgesia can form the dissociative block because low concentration of local anesthetics and opioids in the epidural space can effectively block some sympathetic and sensory nerves without affecting the motor nerves. This treatment can induce an analgesic effect with the retention of motor function, which is particularly applicable to labor analgesia [2].

Ineffective pain relief during labor analgesia include the pain at the beginning of the cervix opening, severe pain after epidural analgesia, and severe and frequent pain after additional doses of epidural analgesia. These conditions are suggestive of a large fetal head circumference, abnormal fetal position (persistent occipitoposterior position and transverse arrest), and the extension or stagnation of the first stage or the second stage of labor.

Prolonged labor can lead to a higher incidence of complications such as maternal fatigue, severe bleeding during childbirth, and prolonged hospital stay [3]. Obstetricians must decide whether to perform a cesarean section when abnormal complications such as these occur during labor analgesia. However, there is little relevant literature or previous experience to guide them in these decisions.

In this study, the authors aimed to investigate the efficacies of some indexes used during labor analgesia, as well as to determine some critical factors relative to cesarean section. This knowledge may help the obstetrician make timely and appropriate decisions on the need for cesarean section.

Materials and Methods

A retrospective review of 100 primiparas who underwent labor analgesia at Brigham and Women's Hospital of Harvard Medical School (Boston, MA, USA) from July, 2015 to December, 2015 was conducted. Primiparas under 35- years-old and with ASA I-II disease grades were included in the study, while primiparas who had undergone induced labor or intravenous drug injection, or had chronic pain or serious systemic diseases were excluded. This study was approved by Partners Human Research Committee (Protocol #: 2016P000334/BWH) and all participants signed the written consent form.

Epidural analgesia was initiated by an anesthesiologist on duty

and 1% lidocaine was applied to the skin. The epidural catheter (about 5.0 cm) was introduced via the L3-4 or L4-5 intervertebral space with the woman in the sitting position. After the testing of 3 ml of 1.5% lidocaine and 1:200,000 epinephrine, a 10–15 ml epidural mixture of 0.125% bupivacaine and 2 mcg/ml fentanyl was given. Then the epidural catheter was linked with a patient-controlled epidural analgesia (PCEA) pump containing a 250 ml epidural mixture of 0.125% bupivacaine and 2 mcg/ml fentanyl at the speed of 6 ml/h, PCEA 6 ml, and lock-out time of 15 minutes.

After the pain evaluation, the top-up (6 ml epidural mixture) was administered by the anesthesiologist when parturients were not satisfied with pain relief. A total of 100 mcg fentanyl was given when the cervix was fully opened. Blood pressure, heart rate, and blood oxygen saturation were monitored, and the level of sensory block and the lower extremity of the motor nerve were detected.

The pain was evaluated using the visual analogue scale (VAS); the maximum score is 10 (severe pain), and the minimum score is 0 (no pain). Analgesia was deemed effective when scores were less than 3 and the patient did not complain of discomfort.

A variety of demographic data including age, height, weight, and gestational age were collected. The main observation index was cesarean section. The secondary indexes including the interval time from labor analgesia to surgery, total number of analgesia intervention, average interval of analgesia interventions, total dose of PCEA, number of top-ups, number of pain reductions after top-ups, the incidence of hypotension, and fetal heart rate deceleration (FHRD).

Data are presented as mean ± standard deviation (SD). To assess the association between cesarean section and hypotension or FHRD, exact logistic regression was used to estimate odds ratios (OR) of cesarean section *vs.* vaginal delivery. For inpatient stay, a generalized linear model with log link was used. A modified Poisson regression with robust error variance [4] was used to estimate confidence intervals for relative risks.

Risk factors included age, height, weight, BMI, gestational age, interval time, total number of analgesia interventions, total dose of PCEA, number of top-ups, and pain reduction. The relative risk regression was constructed through a backward elimination variable selection process. The process started with all the candidate variables and sequentially-removed variables with $p > 0.05$, and with the least significant variable. Only those with $p < 0.05$ were analyzed in the final model. The relative risk regression rather than logistic regression was chosen because the incidence of cesarean section is common (50% of the participants), so the ORs are an overestimate of the relative risk.

All analyses were performed using SAS version 9.4, and a two-tailed p value of < 0.05 was considered statistically significant for all comparisons.

Results

There were no significant differences in age ($p = 0.095$), height ($p = 0.416$), weight ($p = 0.172$), and BMI ($p = 0.068$) between the cesarean section and vaginal delivery groups (Table 1). However, the mean gestational age of primparas in the cesarean section group was significantly older than that in the vaginal delivery group (39.9 ± 0.94 *vs.* 39.43 ± 0.89 weeks) ($p = 0.013$, Table 1).

The mean interval time from epidural analgesia to sur-

Table 1. — *Demographic characteristics of primparas and potential risk factors for cesarean section.*

Vatiabtes	Cesarean section (n=50)	Vaginal delivery (n= 50)	*p* value
Age (years)	28.6±4.32	27.06±4.79	0.095
Height (m)	1.62±0.08	1.63±0.06	0.416
Weight (kg)	84.29±17.92	79.88±13.89	0.172
BMI (kg/m²)	32.09±5.91	30.1±4.78	0.068
Gestational age (w)	39.9±0.94	39.43±0.89	0.013*

* *represents statistical significance*

gery in the cesarean section group was significantly longer than that in the vaginal delivery group (13.47 ± 4.57 *vs.* 7.5 ± 3.28 hours, $p < 0.001$, Table 2). The average number of analgesia intervention was 7.84 ± 2.79 in the cesarean section group and 4.4 ± 2.04 in the vaginal delivery group, respectively ($p < 0.001$, Table 2). Accordingly, the total dose of PCEA in cesarean section group was significantly more than that in the vaginal delivery group ($p < 0.001$, Table 2). Moreover, the number of top-ups in the cesarean section group was significantly higher than that in the vaginal delivery group ($p = 0.015$, Table 2). However, there were no significant differences in the interval time between two interventions ($p = 0.75$) and number of pain reductions ($p = 0.693$) between cesarean section and vaginal delivery groups (Table 2).

The present results indicate that the interval time from epidural analgesia to surgery and number of top-up were significant risk factors for cesarean section.

There were two hypotension patients in each group, two FHRD patients in the cesarean section group, and one FHRD patient in the vaginal delivery group. Due to small sample size, exact logistic regression is the legitimate method for the analyses. There was no significant association between hypotension and cesarean section, with an OR of 1.0 (0.1, 14.3) and a p value of 1.000 (Table 3). Similarly, there was no correlation between FHRD and cesarean section, with an OR of 2.0 (0.1, 122.9) and a p value of 1.000 (Table 3).

Multivariate logistic regression analysis of discrepant factors showed that BMI (95% CI 1.02 [1.00, 1.05], $p = 0.048$), gestational age (95% CI, 1.31 [1.10, 1.55], $p = 0.002$), and interval time (95% CI, 1.11 [1.08, 1.14], $p < 0.001$) were associated with cesarean section (Tables 4 and 5, Figure 1).

Discussion

Due to widespread application of epidural analgesia, this research aimed to identify the factors for predicting cesarean section during epidural analgesia. Childbirth is the most painful experience in the lives of most women. Severe pain causes significant physical and mental stress to the parturient, which may trigger a series of adverse effects [5].

Table 2. — *Potential risk factors in the labor epidural analgesia associated with cesarean section.*

Variables	Cesarean section (n=50)	Vaginal delivery (n=50)	*p* value
Interval time (h) from analgesia to surgery	13.47±4.57	7.5±3.28	<0.001*
Total number of analgesia intervention	7.84±2.79	4.4±2.04	<0.001*
Interval time between two interventions (h)	1.77±0.44	1.81±0.56	0.75
Total dose of PCEA (ml)	79.89±29.61	44.21±20.58	<0.001*
Number of top-up	1.52±1.59	0.84±1.09	0.015*
Number of pain reduction	0.9±0.95	0.82±1.06	0.693

Table 3. — *Exact logistic regression of hypotension and FHRD.*

Exact logistic regression of hypotension - parameter estimates					
Parameter	Estimate	Standard Error	95% Confidence	Limits	Two-sided *p* value
Cesarean section vs. vaginal delivery	5.371E-16	1.0155	-2.6615	2.6615	1.000
Exact logistic regression hypotension - odds ratios					
Parameter	Estimate	95% Confidence	Limits	Two-sided p value	
Cesarean section vs. vaginal delivery	1.00	0.07	14.32	1.000	
Exact logistic regression of FHRD - parameter estimates					
Parameter	Estimate	Standard Error	95% Confidence	Limits	Two-sided *p* value
Cesarean section vs. vaginal delivery	0.7069	1.2359	-2.2788	4.8111	1.000
Exact logistic regression of FHRD - odds ratios					
Parameter	Estimate	95% Confidence	Limits	Two-sided *p* value	
Cesarean section vs. vaginal delivery	2.03	0.10	122.87	1.000	

Table 4. — *Parameter estimates in full and final relative risk models.*

Parameter	Estimate	Full model Stderr	*p*	Estimate	Full model Stderr	*p*
Gestational age	0.2487	0.0870	0.0043	0.2680	0.0881	0.0023
Interval time	0.1117	0.0759	0.1413	0.1076	0.0139	<0.0001
Total number of anesthesia intervention	0.0596	0.0422	0.1576			
Total dose of PCEA	-0.0051	0.0122	0.6770			
Number of top-up	-0.0291	0.0563	0.6051			

Table 5. — *Relative risks from final relative risk model.*

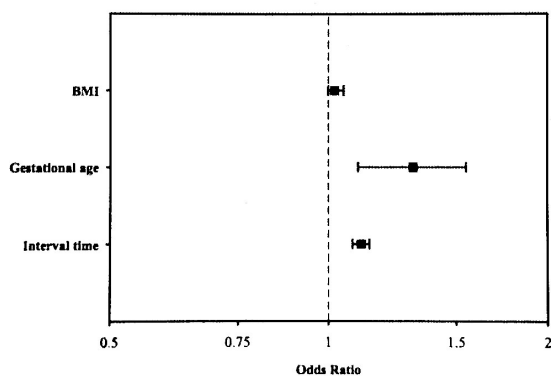| Risk Factor	RR (95% CI)	*p* value
BMI	1.02 (1.00, 1.05)	0.048
Gestational age	1.31 (1.10, 1.55)	0.002
Interval time	1.11 (1.08, 1.14)	< 0.001

Figure 1. — Relative risks from final relative risk model.

Labor analgesia, also known as "painless childbirth", is used under the premise of protecting maternal and fetal safety. Indeed, epidural analgesia administered during delivery makes parturients feel more comfortable. Labor analgesia can largely reduce the pain, which may shorten the labor time, reduce physical exertion for the parturient, and promote postpartum recovery [6].

Despite epidural analgesia being the most effective method for relieving maternal pain during childbirth, the incidence of cesarean section is higher in women who receive labor analgesia [7]. However, a review published in 2005 found that there was no direct correlation between labor analgesia and cesarean section [1]. Cesarean section is often caused by abnormal maternal and fetal conditions rather than labor analgesia.

Here the authors found that BMI was associated with cesarean section during labor analgesia—parturients who underwent cesarean section showed higher BMI compared with those underwent vaginal delivery. A previous study also found that the rate of primary cesarean delivery increased with increasing maternal BMI class, regardless of

parity [8]. Due to soft tissue dystocia and uterine hypocontractility, obese women usually experience longer labor than women of normal weight.

It is widely accepted that effective epidural analgesia prolongs labor [9]. This point was supported by the study of labor analgesia with 0.25% bupivacaine, which is much higher than that in this study. Some literature revealed that epidural analgesia using 0.25% bupivacaine resulted in a higher instrumental vaginal delivery rate than that using 0.0625% bupivacaine plus 2 mg of fentanyl [10, 11]. In the present study, the authors used 0.125% bupivacaine and 2 mcg/ml fentanyl for epidural analgesia, which did not prolong the second stage of the labor.

About 20% of parturients experience abnormal labor including dystocia, dysfunctional labor, failure to progress, and failure to descend, which is the most common indication for cesarean section [12]. Preferred methods for treating abnormal labor are still controversial. Obstetricians mostly decide the timing of cesarean section [13]. The most common symptom of abnormal labor is the prolonged second stage of labor. Altman *et al.* found that there was a close correlation between prolonged second stage of labor and low five-minute Apgar score. The OR of five-minute Apgar score < 7 is generally increased with prolonged second stage of labor [14].

Lieberman *et al.*, using serial ultrasound to evaluate the change in the fetal position during epidural analgesia, found that there was an association between epidural analgesia and fetal occiput posterior position at delivery [15]. In the present study, the primparas in the cesarean section group underwent more analgesia interventions, which may have caused abnormal fetal position. However, it is controversial whether labor analgesia confers risks to mothers and infants, such as increased cesarean section rate, forceps and perineum side-cut, birth trauma, fetal malposition, prolonged labor, oxytocin use, postpartum hemorrhage, neonatal asphyxia, neonatal intubation, neonatal antibiotics, and neonatal intensive care unit admission (NICU) [16].

In this study, the authors observed two patients with hypotension in each group, two FHRD patients in the cesarean section group, and one FHRD patient in the vaginal delivery group. Due to this small sample size, no association between hypotension/FHRD and cesarean section was seen. The concomitant use of fentanyl and low concentrations of bupivacaine decreases side effects such as hypotension and motor block. However, this evidence should be assessed in a large cohort of patients.

Conclusion

The gestational age and interval time from epidural analgesia to vaginal delivery or surgery are risk factors for predicting cesarean section, which may help obstetricians to decide the timing of cesarean section and thus reduce maternal and infantile complications.

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