

# Predicting early epidurals: association of maternal, labor, and neonatal characteristics with epidural analgesia initiation at a cervical dilation of 3 cm or less

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**Background:** Retrospective studies have associated early epidural analgesia with cesarean delivery, but prospective studies do not demonstrate a causal relationship. This suggests that there are other variables associated with early epidural analgesia that increase the risk of cesarean delivery. This study was undertaken to determine the characteristics associated with early epidural analgesia initiation.

**Methods:** Information about women delivering at 37 weeks or greater gestation with epidural analgesia, who were not scheduled for cesarean delivery, was extracted from the McGill Obstetric and Neonatal Database. Patients were grouped into those who received epidural analgesia at a cervical dilation of  $\leq 3$  cm and  $> 3$  cm. Univariable and multivariable logistic regression was used to determine the maternal, neonatal, and labor characteristics that increased the risk of inclusion in the early epidural group.

**Results:** Of the 13,119 patients analyzed, multivariable regression demonstrated odds ratios (OR) of 2.568, 5.915 and 10.410 for oxytocin augmentation, induction, and dinoprostone induction of labor ( $P < 0.001$ ). Increasing parity decreased the odds of early epidural analgesia (OR 0.780,  $P < 0.001$ ), while spontaneous rupture of membranes (OR 1.490) and rupture of membranes before labor commenced (OR 1.288) were also associated with early epidural analgesia ( $P < 0.001$ ). Increasing maternal weight (OR 1.049,  $P = 0.002$ ) and decreasing neonatal weight (OR 0.943,  $P < 0.001$ ) were associated with increasing risk of early epidural analgesia.

**Conclusion:** Labor augmentation and induction, nulliparity, rupture of membranes spontaneously and before labor starts, increasing maternal weight, and decreasing neonatal weight are associated with early epidural analgesia. Many of these variables are also associated with cesarean delivery.

**Keywords:** early epidural analgesia, labor, pain, analgesia, outcomes

## Introduction

Cesarean delivery increases the risk of maternal and neonatal morbidity and mortality,<sup>1-3</sup> and its incidence is increasing.<sup>4</sup> There has been controversy surrounding the early initiation of epidural labor analgesia, because observational studies have demonstrated its association with increased rates of cesarean delivery.<sup>5-9</sup> However, prospective, randomized controlled trials have not confirmed these results, demonstrating no increased risk of operative deliveries in patients who receive epidural analgesia at an early dilation.<sup>10-14</sup> The disagreement between the randomized controlled trials and observational trials suggests that utilization of epidural analgesia in early labor

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does not increase operative delivery rates, but that women who receive it are at higher risk for operative delivery. It is possible that the factors predisposing women to receive epidural analgesia at an early cervical dilation are also factors that are associated with cesarean delivery.<sup>12</sup> However, little is known about the reasons why women receive epidural analgesia at an early dilation. This study was undertaken to identify the characteristics of women who receive epidural analgesia at an early cervical dilation as compared with those who receive analgesia at a larger dilation.

## Materials and methods

This study received ethical approval from the McGill University research ethics office. Data were extracted from the McGill Obstetric and Neonatal Database, which includes detailed information from all deliveries of neonates larger than 500 g that occur at the Royal Victoria Hospital, a tertiary care hospital affiliated with McGill University. Trained archivists review the chart of each delivery, and extract information concerning maternal demographics, medical and obstetric history, labor management and outcome, results of antenatal testing, and medical interventions utilized. For this study we included all patients who delivered after 37 weeks gestation from 2000 to 2007, from which were excluded all patients who had been scheduled for a cesarean delivery, those who did not receive epidural analgesia, and those whose last cervical examination was longer than 4 hours before epidural catheter placement. Those women who received epidural analgesia at a cervical dilation of 3 cm or less were assigned to the early epidural group, and those at a dilation of 4 cm or more were assigned to the late group.

Epidural analgesia was provided to patients upon request. Epidural catheters were placed by anesthesia residents, fellows, or staff. All epidural labor analgesia was provided via a patient-controlled epidural analgesia infusion of bupivacaine 0.06% with fentanyl 2 µg/mL, set to administer 12 mL of solution per hour, with a bolus of 5 mL and a lockout of 10 minutes. Labor management, including the decision to perform cesarean delivery, was at the discretion of the attending obstetrician. Vaginal dinoprostone and/or intravenous oxytocin was administered for labor induction or for augmentation at the decision of the attending obstetrician. Oxytocin was started at 2 milliunits per minute, and could be increased at a rate of 2 milliunits per minute every 30 minutes. Vaginal examinations were performed on admission, and when determined necessary by the obstetric team.

Variables to be included in the analysis were selected from the database based on their possible contribution to

the management of labor analgesia and on their ability to affect labor pain. These variables included maternal age, height, current weight grouped into categories increasing by 10 kg, starting at 40 kg, parity, gestational age, type of labor categorized into spontaneous, spontaneous with oxytocin augmentation, induction with oxytocin, or induction with dinoprostone, artificial rupture of membranes, if rupture of membranes occurred before labor commenced, presence of abnormal fetal heart rate tracing, presence of prepregnancy hypertension, presence of pregnancy-induced hypertensive disorders, presence of maternal diabetes, and neonatal weight grouped into increasing categories of 200 g, starting at 2,000 g.

Between-group differences were assessed using the Student's *t*-test or Mann–Whitney *U* test as appropriate. Univariate regression was performed to determine the relationship of these variables with early initiation of epidural analgesia. A multivariate binary logistic regression was then created with all of these variables entered in one step to determine the relative contribution of each variable to the outcome of early epidural analgesia initiation. Statistical analysis was performed using Statistical Package for the Social Sciences version 19 software (SPSS Inc., Chicago, IL, USA).

## Results

We identified 20,632 patients who delivered after 37 weeks' gestation. From these, we excluded 3,501 patients who had been scheduled for a cesarean delivery, 3,316 patients who did not receive epidural analgesia, and 696 patients who had longer than 4 hours between cervical examination and initiation of epidural analgesia. This left 13,119 patients for analysis, with 6,890 (52.5%) in the early group and 6,229 (47.5%) in the late group. The demographic information for each group is presented in Table 1. Single variable examination demonstrated many significant associations with early epidural analgesia (Table 2). Univariate odds ratios were significant for increasing gestational age, increasing maternal weight, decreasing parity, labor augmentation and induction, spontaneous rupture of membranes, rupture of membranes before labor commencement, fetal heart rate tracing abnormalities, increased duration of time between admission to hospital and initiation of epidural analgesia, the presence of prepregnancy and pregnancy-related hypertension, maternal diabetes, and decreasing neonatal weight. However, in the multivariate regression, the OR remained significant only for maternal weight, parity, labor type, spontaneous rupture of membranes, rupture of membranes before labor commencement, and neonatal weight (Table 3).

**Table 1** Characteristics of patients who delivered after 37 weeks' gestation with epidural analgesia

Characteristic	Early epidural	Late epidural	P
Age (years)	31 (5)	31 (4)	0.22
Gestational age (days)	278.3 (8.5)	277.9 (7.9)	0.01
Height (cm)	163 (7)	164 (7)	0.24
Weight (kg)	79 (14)	78 (13)	<0.001
Parity	0 (1–14)	1 (1–14)	<0.001
Labor type			<0.001
Spontaneous	649 (9.4%)	1,824 (29.3%)	
Spontaneous with oxytocin augmentation	2,974 (43.2%)	2,945 (47.3%)	
Induction with only oxytocin	1,878 (27.3%)	1,055 (16.9%)	
Induction with dinoprostone	1,389 (20.2%)	405 (6.5%)	
Spontaneous rupture of membranes	2,975 (43.2%)	2,377 (38.2%)	<0.001
Rupture of membranes before labor commenced	2,620 (38.0%)	1,721 (27.6%)	<0.001
Time interval between admission and epidural initiation (hours)	5.2 (6.7)	3.3 (5.0)	<0.001
Fetal heart rate tracing abnormalities	5,032 (73.0%)	4,351 (69.9%)	<0.001
Prepregnancy hypertension	79 (1.1%)	46 (0.7%)	0.019
Pregnancy-related hypertension	344 (5.0%)	157 (2.5%)	<0.001
Diabetes	454 (6.6%)	346 (5.6%)	0.014
Neonatal weight (g)	3,451 (462)	3,498 (457)	<0.001

**Note:** Data are presented as the mean (standard deviation), median (interquartile range, range), or number of patients (%).

## Discussion

As stated by Wong et al,<sup>14</sup> “the request for analgesia early in labor may be a marker for some other risk factor for cesarean delivery”. In this sample of over 13,000 patients who gave birth with epidural analgesia, we found that early initiation was associated with induction of labor, labor augmentation with oxytocin, lower parity, spontaneous rupture of membranes or rupture before the start of labor, increasing maternal weight, and decreasing neonatal weight. Many of these associations can be easily understood. The most strongly associated characteristics were artificial induction and augmentation of labor, which may cause more painful contractions earlier in labor. The strong association of nulliparity also makes sense, because nulliparous women start labor with a smaller cervical dilation, have a prolonged labor progress, and could therefore have a higher risk for pain at a smaller cervical dilation. Early membrane rupture may produce stronger and more painful contractions, which may predispose to an earlier epidural analgesia request, and artificial rupture of membranes is often delayed until after the initiation of epidural analgesia. Other associations are

**Table 2** Odds of a patient being included in the early epidural group based on the univariate logistic regression of patient characteristics

Characteristic	OR	95% CI	P-value
Maternal age	1.004	0.997–1.011	0.217
Gestational age	1.006	1.001–1.010	0.010
Height	0.997	0.992–1.002	0.237
Weight (per 10 kg)	1.062	1.036–1.089	<0.001
Parity	0.758	0.729–0.788	<0.001
Labor type			
Spontaneous	Reference category		
Spontaneous with oxytocin augmentation	2.838	2.560–3.146	<0.001
Induction with only oxytocin	5.003	4.450–5.624	<0.001
Induction with dinoprostone	9.639	8.360–11.114	<0.001
Spontaneous rupture of membranes	1.231	1.143–1.310	<0.001
Rupture of membranes before labor commenced	1.607	1.493–1.730	<0.001
Time interval between admission and epidural initiation	1.065	1.057–1.073	<0.001
Fetal heart rate trace abnormalities	1.169	1.084–1.261	<0.001
Prepregnancy hypertension	1.559	1.082–2.246	0.017
Pregnancy-related hypertension	2.032	1.677–2.463	<0.001
Diabetes	1.199	1.038–1.386	0.014
Birthweight (per 200 g)	0.956	0.942–0.971	<0.001

**Abbreviations:** CI, confidence interval; OR, odds ratio.

more difficult to explain. Increasing maternal weight may cause altered labor progress, or pain sensation, that could result in early epidural analgesia initiation, but this remains unclear. The association of decreased neonatal weight with early epidural analgesia initiation could be perhaps due to different labor progress of smaller fetuses, including possible earlier descent causing increased pain early in labor, but may also be related to the association of smaller fetal weights with other variables that were not measured.

Nulliparity, induction of labor, use of oxytocin, and increasing maternal weight are factors that have also been linked to an increased rate of cesarean delivery,<sup>15</sup> which may explain why previous retrospective studies of early epidural analgesia initiation have shown an increased risk of cesarean section. However, some of these factors were controlled in these retrospective studies. Traynor et al<sup>5</sup> included only nulliparous patients and Lieberman et al<sup>7</sup> included only nulliparous spontaneously laboring patients, and used propensity scores to control for maternal weight. Both studies still demonstrated an increased rate of cesarean delivery in women requesting an epidural at a smaller cervical dilation. However, these studies did not control for other significant factors associated with early epidural catheter placement,

**Table 3** Odds of a patient being included in the early epidural group based on the multivariate logistic regression of patient characteristics

Characteristic	OR	95% CI	P-value
Maternal age	1.007	0.999–1.015	0.069
Gestational age	1.003	0.998–1.008	0.231
Height	0.995	0.989–1.000	0.064
Weight (per 10 kg)	1.049	1.018–1.080	0.002
Parity	0.780	0.747–0.814	<0.001
Labor type			
Spontaneous			
Spontaneous with oxytocin augmentation	2.568	2.307–2.858	<0.001
Induction with only oxytocin	5.915	5.177–6.757	<0.001
Induction with dinoprostone	10.410	8.759–12.373	<0.001
Spontaneous rupture of membranes	1.490	1.364–1.629	<0.001
Rupture of membranes before labor commenced	1.288	1.179–1.406	<0.001
Time interval between admission and epidural initiation	0.992	0.985–1.000	0.052
Fetal heart rate trace abnormalities	1.056	0.973–1.146	0.198
Prepregnancy hypertension	0.810	0.540–1.216	0.310
Pregnancy-related hypertension	1.207	0.976–1.494	0.083
Diabetes	0.902	0.770–1.056	0.198
Birthweight (per 200 g)	0.943	0.926–0.960	<0.001

**Abbreviations:** OR, odds ratio; CI, confidence interval.

including use of oxytocin augmentation or timing of membrane rupture.

To aid in the comparison of the two groups, we included a table of their demographic characteristics (Table 1). Due to the large sample size, some of the differences between groups were statistically significant, but so small as to be clinically irrelevant. Notable examples of this are the findings of increased gestational age and weight in the early epidural group. More relevant are the results of the multivariate regression, which demonstrates that an increase in weight by 10 kg will increase the odds of being in the early epidural group by 1.049, and that there is no effect of gestational age.

This study has some limitations. It was a retrospective analysis, and as such can only demonstrate associations of variables. We used data from 2000 to 2007, which was the last year for which data had been collected, but our labor and analgesia practices have not changed greatly since the data were collected, and should remain applicable to current patients. Although we attempted to include all variables that would have an impact on the timing of initiation of epidural analgesia, there may be significant variables that were not included in the regression model. Also, because cervical examinations are not performed routinely before epidural insertion at our institution, there may have been some time

delay between examination and epidural catheter placement. However, this reflects clinical practice in many centers where cervical examinations are not performed at regular time points. Observational studies such as this do not eliminate coincidental issues, and thus are not able to refute previous randomized trials. In addition this observational study from a single institution does not provide a cause-effect relationship between findings. The study is not strong enough to provide arguments for or against guidelines concerning epidural timing, and was not devised for that purpose. However, even with these limitations, we feel that the study provides meaningful information on predictors of early epidural analgesia initiation. This study examined the association of maternal, labor, and neonatal characteristics with the initiation of epidural analgesia early in labor. This information may help us understand more fully the relationship between patient characteristics, labor pain, labor analgesia, and labor outcomes.

## Disclosure

The authors report no conflicts of interest in this work.

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