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Original Contribution

Increasing body mass index predicts increasing difficulty, failure rate, and time to discovery of failure of epidural anesthesia in laboring patients☆

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ABSTRACT

Study objective: Obese parturients both greatly benefit from neuraxial techniques, and may represent a technical challenge to obstetric anesthesiologists. Several studies address the topic of obesity and neuraxial analgesia in general, but few offer well described definitions or rates of "difficulty" and "failure" of labor epidural analgesia. Providing those definitions, we hypothesized that increasing body mass index (BMI) is associated with negative outcomes in both categories and increased time needed for epidural placement.
Design: Single center retrospective chart review.
Setting: Labor and Delivery Unit of an inner city academic teaching hospital.
Patients: 2485 parturients, ASA status 2 to 4, receiving labor epidural analgesia for anticipated vaginal delivery.
Interventions: None.
Measurements: We reviewed quality assurance and anesthesia records over a 12-month period. "Failure" was defined as either inadequate analgesia or a positive test dose, requiring replacement, and/or when the anesthesia record stated they failed. "Difficulty" was defined as six or more needle redirections or a note indicating difficulty in the anesthesia record.
Main results: Overall epidural failure and difficulty rates were 4.3% and 3.0%, respectively. Patients with a BMI of 30 kg/m^2 or higher had a higher chance of both failure and difficulty with two and almost three fold increases, respectively. Regression analysis indicated that failure was best predicted by BMI and less provider training while difficulty was best predicted by BMI. Additionally, increased BMI was associated with increased time of discovery of epidural catheter failure.
Conclusions: Obesity is associated with increasing technical difficulty and failure of neuraxial analgesia for labor. Practitioners should consider allotting extra time for obese parturients in order to manage potential problems.

1. Introduction

Physicians worldwide are faced with increasing numbers of obese patients, including obese parturients [1]. The global obesity pandemic brings unique difficulties to anesthesiologists on labor and delivery units [2,3]. More than one third of U.S. adults were obese, as defined by the World Health Organization (WHO) as a Body Mass Index (BMI; in kg m^{-2}) ≥ 30) in 2011–2012 [4]. Prevalence has remained stable between 2009–2010 and 2011–2012 [5]. More than one third of women are obese, more than half of pregnant women are overweight or obese [6,7], with obesity representing a risk factor for multiple co-morbidities including gestational diabetes, gestational hypertension, preeclampsia and even death [7–9]. Obese parturients are also at greater risk for both instrumental and caesarean delivery (CD) [1–3,9] which emphasizes the need for successful neuraxial analgesia. Failed regional techniques may lead to general anesthesia which potentially includes difficult airway, aspiration pneumonitis and failed resuscitation from hemodynamic collapse [7,10,11].

While earlier studies defined predictive factors or characteristics associated with difficulty or failure of neuraxial anesthesia, few have focused on the obese parturient, or precisely defined "difficulty" and "failure" or provided exact rates [12–16]. Yet, obese patients may benefit most from regional anesthetic management. We hypothesized that increasing BMI would be associated with increased neuraxial analgesic failure and difficulty as well as time needed for epidural placement.

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2. Methods

Our Institutional Review Board approved this study, including a waiver of patient consent for this retrospective analysis. We reviewed quality assurance (QA) data and anesthesia records of all parturients receiving any form of anesthesia care over a 12-month period (January to December 2008) in one of the obstetric teaching hospitals of the Medical College of Wisconsin: Wheaton Franciscan Healthcare St. Joseph Hospital, Milwaukee, WI. There, neuraxial blocks are performed by residents under the supervision of an attending anesthesiologist. Only patients who received epidural analgesia for labor pain and planned vaginal delivery were studied, including those who eventually had to undergo an unplanned CD. Planned CDs were not included in this particular study.

Data collected included age, height, weight, co-morbidities, anesthetic technique, indications of difficulty, indications of failure, epidural placement duration, time between placement and failure decision, and training level of the anesthesiology resident. Specifically, indications of "difficulty" included the number of lumbar interspaces attempted, greater than six epidural needle redirections or a note in the QA form and/or the anesthesia record. Indications of "failure" included the number of clinician boluses of local anesthetic to the epidural catheter beyond the initial bolus dosing, the need for catheter replacement, a statement indicating failure on the QA form or anesthesia record, or a positive intravascular test dose. "Epidural placement duration" was recorded from the time the anesthesiology team entered the parturient's labor room until the time they exited the room, and included positioning, working time with the actual catheter placement, and administration of drugs. "Training level" was recorded as months in anesthesiology residency. Minutes between placement of labor epidural and determination of failure were recorded to see any difference between obese and non-obese parturients. Accidental dural punctures were recorded as a separate complication and not counted as failure.

3. Statistical analysis

All data are expressed as mean ± standard error or as percentages. Multiple regression analysis was used for factor analysis. Unpaired student *t*-tests, Mann-Whitney *U* tests and Chi-square tests were used to directly compare two groups for parametric, non-parametric and categorical data, respectively (SigmaStat 3.5, Systat Software Inc., San Jose, CA). Correlation between BMI and determination of catheter failure was performed using IBM SPSS Statistics. Statistical significance (*) was assumed when $p < 0.05$ (two-tailed). Binning was used for regression analysis and display of difficulty, failure, and duration of placement with BMI.

4. Results

During the 12-month study period, anesthesia providers cared for 3229 out of 4103 patients who delivered at our institution. Of these, 2485 patients received epidural analgesia for labor pain and planned vaginal delivery. We excluded 113 patients due to lack of information in their anesthesia records. Patient characteristics are displayed in Table 1. Obesity as defined by BMI ≥ 30 was not associated with age, but with co-morbidities such as hypertension including pregnancy-induced hypertension (PIH), asthma, obstructive sleep apnea, gastroesophageal reflux disease, gestational and non-gestational diabetes mellitus, preterm labor and fetal distress. Higher BMI was also associated with an increased rate of CDs (Table 2). Our emergent CD rate overall was 0.24%, and 0.09% in non-obese vs. 0.36% in obese, but because of the low numbers this was not significant with Chi-square ($p = 0.35$).

Overall epidural failure and difficulty rates were 4.3% and 3.0%, respectively. Obese patients had a higher chance of both difficulty in epidural placement and failure of epidural analgesia, and an increased time needed for placement. Rate of difficulty and failure increased 2.5 and 2.1 fold, respectively, in obese vs. non-obese patients. Increased BMI was associated with the need for one or more clinician boluses (*41.5 vs. 35.1%). When clinician boluses were necessary, their number was higher with increased BMI (*1.63 ± 0.05 vs. 1.43 ± 0.04). *9.7 vs. 6.4% of the obese vs. non-obese patients needed to have attempts at more than one lumbar interspace to place the epidural catheter. There was no significant difference in the number of levels when more than one level was necessary (Table 2). As a result, obese parturients required more clinician boluses and lumbar interspace level attempts than non-obese; the same was true when placement failed. For accidental dural punctures and difficult placements, however, only the number of levels was significantly different, not the number of clinician boluses needed.

Although epidural placement time was only 2.5 min or 9% longer in average obese (*30.4 ± 0.3 min) vs. non-obese patients (27.9 ± 0.3 min) as defined by BMI, every one point increase in BMI prolonged placement by *13 ± 3 s (Fig. 1) and added *0.4 ± 0.1% and *0.2 ± 0.0% to the overall rate of difficulty and failure of epidural placement, respectively (Fig. 2). Moreover, we observed a greater variation (heteroscedasticity) in all parameters as BMI increased, indicating decreased predictability of placement time, difficulty and failure rates at higher BMI.

Placement duration, difficulty, and failure were additionally interrelated. Placement duration increased by 20 min or 70% when the placement was difficult (*48.7 ± 2.3 min) vs. not difficult (28.7 ± 0.2 min). Conversely, when placement was difficult (Table 3), patients had a higher BMI (*36.5 ± 0.9 vs. 31.8 ± 0.1) and providers had a trend towards less experience (20.8 ± 1.1 vs. 22.9 ± 0.2 months anesthesia training, $p = 0.08$). Epidural failure was also associated with increased

Table 1
Patient characteristics and prevalence of co-morbidities in obese, non-obese and all patients.

	All patients ($n = 2485$)	BMI < 30 ($n = 1095$)	BMI ≥ 30 ($n = 1390$)	*p* value
Age (years)	26.2 ± 0.1	26.2 ± 0.2	26.2 ± 0.2	0.862
Height (inches)	64.6 ± 0.1	64.8 ± 0.1	64.4 ± 0.1	0.001
Weight (kg)	85.9 ± 0.4	71.3 ± 0.3	97.4 ± 0.5	<0.001
HTN (%)	2.4	0.6	3.8	<0.001
PIH (%)	9.8	6.7	12.3	<0.001
OSA (%)	0.3	0.0	0.5	0.049
Asthma (%)	12.6	11.0	13.8	0.038
GERD (%)	16.5	14.6	18.0	0.028
Non-gestational DM (%)	0.9	0.2	1.4	0.002
Gestational DM (%)	3.4	2.4	4.3	0.015

Data are mean ± standard error or percentage. *$p < 0.05$.
Abbreviations: BMI = body mass index; HTN = hypertension; PIH = pregnancy induced hypertension; OSA = obstructive sleep apnea; GERD = gastroesophageal reflux disease; DM = diabetes mellitus.

Table 2
Rate of prior and subsequent Cesarean Delivery and their indications, and characteristics of epidural placements in obese, non-obese and all patients.

	All patients ($n = 2485$)	BMI < 30 ($n = 1095$)	BMI ≥ 30 ($n = 1390$)	*p* value
Overall CD (%)	11.4	6.8	15.1	<0.001
FTP (%)	7.0	3.7	9.5	<0.001
FTD (%)	1.0	0.5	1.4	0.026
Fetal distress (%)	3.5	2.1	4.5	0.001
Prior CD (%)	0.6	0.3	0.8	0.150
Placement time (min)	29.3 ± 0.2	27.9 ± 0.3	30.4 ± 0.3	<0.001
Difficulty (%)	3.0	1.6	4.1	<0.001
Failure (%)	4.3	2.7	5.6	<0.001
Clinician bolus (%)	38.3	35.1	41.5	<0.001
>1 interspace (%)	8.1	6.4	9.7	0.003
Dural puncture (%)	0.4	0.4	0.4	0.952

Data are mean ± standard error or percentage. *$p < 0.05$.
Abbreviations: BMI = body mass index; CD = cesarean delivery; FTP = failure to progress; FTD = failure to descend.