Epidural extension failure in obese women is comparable to that of non-obese women

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Conflict of interest
Nine of the ten authors have no conflict of interest to declare. Dr Adrian Chin declares the following previous financial relationships (Relevant financial activities outside the submitted work): M4 Healthcare, Sonosite (speaking fee, <$1000AUD), AstraZeneca (travel, educational support, <$5000AUD), Allied Medical (speaking fee, <$1000AUD), Braun (speaking fee, <$1000AUD).

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Submitted 29 November 2017; accepted 10 January 2018; submission 10 August 2017.

Citation
Eley VA, Chin A, Tham I, Poh J, Aujla P, Glasgow E, H. Brown, Steele K, Webb L, Van Zundert A. Epidural extension failure in obese women is comparable to that of non-obese women. Acta Anaesthesiologica Scandinavica 2018

doi: 10.1111/aas.13085

Background: Management of labor epidurals in obese women is difficult and extension to surgical anesthesia is not always successful. Our previous retrospective pilot study found epidural extension was more likely to fail in obese women. This study used a prospective cohort to compare the failure rate of epidural extension in obese and non-obese women and to identify risk factors for extension failure.

Methods: One hundred obese participants (Group O, body mass index ≥ 40 kg/m^2) were prospectively identified and allocated two sequential controls (Group C, body mass index ≤ 30 kg/m^2). All subjects utilized epidural labor analgesia and subsequently required anesthesia for cesarean section. The primary outcome measure was failure of the labor epidural to be used as the primary anesthetic technique. Risk factors for extension failure were identified using Chi-squared and logistic regression.

Results: The odds ratio (OR) of extension failure was 1.69 in Group O (20% vs. 13%; 95% CI: 0.88–3.21, $P = 0.11$). Risk factors for failure in obese women included ineffective labor analgesia requiring anesthesiologist intervention, (OR 3.94, 95% CI: 1.16–13.45, $P = 0.028$) and BMI > 50 kg/m^2 (OR 3.42, 95% CI: 1.07–10.96, $P = 0.038$).

Conclusion: The failure rate of epidural extension did not differ significantly between the groups. Further research is needed to determine the influence of body mass index > 50 kg/m^2 on epidural extension for cesarean section.

Editorial comment
Maternal obesity is known to increase anesthetic technical difficulty. In this study, the rate of failure to extend an existing labor epidural to successful anesthesia for cesarean section was not different for groups of obese parturients compared with a non-obese group. Antenatal involvement of anesthesiologists with obese parturients probably contributed to good results for this group.

Maternal obesity is known to increase the rate of maternal obstetric complications,[1,2] adverse neonatal outcomes[3] and anesthetic technical difficulty.[4] Recent studies have confirmed that the management of labor epidurals in obese pregnant women is difficult, requiring more repeat procedures and providing less successful analgesia.[5,6] Body mass index (BMI) has not been consistently identified as a risk factor for failed epidural extension,[7,8] however, this may be influenced by under-representation in study populations. The effectiveness of epidural extension in obese women is important to know, as epidurals may be placed with the explicit intention of permitting extension for subsequent cesarean delivery if required.[9,10] Our previous retrospective pilot study found epidural extension was more likely to fail in women with BMI ≥ 40 kg/m^2.[11] This study used a prospective cohort at two centers to validate that result.

Methods

This prospective, two-center, (1 : 2) case-control study was undertaken at The Royal Brisbane and Women's Hospital (RBWH) and Logan Hospital (Queensland, Australia). Ethics approval, including waiver of participant consent, was obtained from the Queensland Health Central Office Human Research Ethics Committee, Butterfield St Herston 4006, on 18/08/2014, Protocol Version 4 (HREC/14/QHC/36). The RBWH is a tertiary referral center (Level 6 hospital) with approximately 4000 deliveries per year. Logan Hospital is a large regional hospital (Level 4 hospital) with approximately 3500 deliveries per year. Both departments provide 24-h anesthesiology service to their delivery suites by anesthesiologist trainees on-site, with specialist anesthesiologists providing on-call supervision.

Management of labor analgesia and epidural extension was not protocolized. Both institutions utilize epidurals for labor analgesia. The RBWH uses a 0.1% bupivacaine solution with fentanyl 2 mcg/ml for maintenance analgesia. At Logan Hospital, a 0.2% ropivacaine solution with fentanyl 2 mcg/ml is used for maintenance analgesia. Epidural extension at both institutions utilizes 2% lidocaine with adrenaline or ropivacaine 0.75%, with variable additives.

Obese participants were identified at the time of their cesarean section: they had a BMI ≥ 40 kg/m^2 based on a weight obtained at a gestation greater than 30 weeks and were allocated sequentially to Group O if they had utilized labor epidural analgesia and subsequently required Category 1 or 2 cesarean section (according to criteria of The Royal Australian and New Zealand College of Obstetricians and Gynaecologists).[12] While the BMI measured in early pregnancy is readily obtained, the BMI measured at greater than 30 weeks gestation was chosen as it is more relevant to the provision of anesthetic care and was consistently available, compared with a weight at delivery which was not routinely recorded. Exclusion criteria included: age in years ≤ 15 or ≥ 45; acute hemorrhage or sepsis identified prior to delivery; known intrauterine fetal death prior to delivery; failure to attend at least one antenatal appointment; cardiovascular or respiratory disease with New York Heart Association (NYHA) classification > 3;[13] severe cognitive impairment, mental illness or intellectual disability ('severe difficulty in social, occupational or school functioning').[14]

Controls (Group C) were identified at the time of their cesarean section, as two patients (subsequent to the identification of an obese participant) who utilized epidural labor analgesia and met the following criteria: BMI ≤ 30 kg/m^2 at a gestation of > 30 weeks; required Category 1 or 2 cesarean section; none of the above exclusion criteria. Because participants were identified at the time of their cesarean section, the information regarding their labor analgesia was necessarily retrospective in nature. The information regarding their cesarean section was prospectively collected.

The primary outcome measure was the rate of failure to extend an existing labor epidural to successful anesthesia for cesarean section, described as an odds ratio (OR). Failure was defined as:

1. use of an alternative neuraxial technique
2. general anesthesia was administered:
   a. as a pre-operative decision, before skin incision
   b. as an intra-operative decision, after skin incision

This liberal definition of extension failure was used in our pilot study[11] and has been used previously.[15] Regional anesthesia (RA) was defined as epidural extension or a new neuraxial technique being successfully used for the duration of surgery. General anesthesia (GA) was defined as the administration of GA preoperatively or intra-operatively, defined above. A conversion to GA was considered to have occurred in any patient who subsequently utilized GA.[16] The use of supplemental analgesia, sedation or nitrous oxide was not considered as 'failure' of extension.

Demographic data, details of antenatal care, co-morbidities, insertion of the labor epidural, the maintenance infusion utilized on labor ward and nature of the infusion program used. Analgesia was recorded as 'ineffective' if ≥ 1 intervention was required by anesthetic staff for inadequate analgesia (e.g., top-up dosing or withdrawal of catheter), after the initial loading dose. Anesthetic management for cesarean section, were extracted from the electronic medical records by dedicated consultant anesthesiologists and provisional fellows in obstetric anesthesia; missing information was obtained by directly contacting the treating anesthesiologists. Definitions were applied to assess the presence of gestational hypertension[17] and diabetes.[18] Asthma was documented if any reliever medication (such as salbutamol) was prescribed antenatally. Number of attempts of epidural insertion was taken from the epidural record and was not defined. The indication for cesarean section was classified according to whether it was primarily for maternal or fetal reasons (maternal reasons: pre-existing condition, pregnancy-related condition, complication of labor or delivery; fetal reasons: CTG abnormal, abnormal presentation). Failure to progress, a common indication for cesarean section was considered a maternal indication, unless there was evidence of fetal compromise, in which case it was classified as a fetal indication (CTG abnormal). Seniority of the anesthesiologist performing the epidural and cesarean section were defined as 'senior' if they were Senior Registrars (year 5 of a 5-year program) or specialist anesthesiologists. The reasons for failing to extend the epidural or conversion into GA were obtained directly from the treating anesthesiologists if they were not clearly documented. The volume and content of the epidural extension were collected, along with the provision of supplemental analgesia or sedation.

The sample size was determined from a pilot study conducted at the RBWH,[13] using identical outcome definitions. Based on a failure rate of 15.9%[11] in the control group and using 2 : 1 matching of controls to participants, it was calculated that 100 obese participants and 200 control participants would detect an OR of at least 2.27 ($\alpha = 0.05$ and $\beta = 0.2$). SPSS Version 22 was used for statistical analyses. Chi-square statistics were used to analyze the primary outcome. Comparisons between BMI groups and the primary outcome were performed with Mann-Whitney *U*, Chi-square, or Fisher's exact tests. As a secondary outcome, risk factors of extension failure in the obese group were identified, using binary logistic regression, with failure of epidural extension as the binary outcome. Variables that were found to have a difference significance of $P = 0.2$ or less were trialed as factors. Variables were removed by backwards elimination until only significant variables remained ($P \leq 0.05$). The hospital site variable was forcibly kept in the model.

Results

Participants were identified between January 2015 and January 2017. There were 20 extension failures (20%) in the obese group and 26 (13%) in the control group; OR (95% CI) 1.69 (0.88–3.21), $P = 0.11$. There was no significant difference between the two groups. Figures 1 and 2 show the anesthetic management of the participants in Group C and Group O, after presenting for cesarean section with a labor analgesia catheter in situ. The demographic and antenatal details of 100 obese women and 200 controls are presented in Table 1. There were significant differences between the groups in terms of gestational diabetes, gestational hypertension, asthma and obstructive sleep apnea. There was no significant difference between groups in terms of cardiovascular, thromboembolic, neurological or hematologic diseases. There were no difficult intubations predicted or recorded in either group.

The details of labor analgesia provided are presented in Table 2. The selected maintenance infusion was divided according to institutional practice. There were two dural punctures in each group ($P = 0.6$). Those participants who utilized intrathecal analgesia or anesthesia, as a complication of their labor epidural, were retained in the cohorts. Senior anesthesiologists were significantly more likely to be involved in the care of women in Group O.

The detail regarding anesthesia for cesarean section is presented in Table 3. Two intrathecal catheters were successfully used for anesthesia in Group O compared with one in Group C. There were two episodes of desaturation < 93% (during GA) prior to delivery in Group O compared with one in Group C.

Variables considered for inclusion in logistic regression modeling included: BMI, presence of a co-morbidity, seniority of anesthesiologist performing the labor epidural, epidural maintenance program, catheter dwell time, fixation device, distance to epidural space, length of catheter in the space, ineffective analgesia requiring anesthesiologist intervention, urgency category of cesarean section, volume of local anesthetic in the epidural extension. Dermatomal level and degree of motor block were not considered due to the amount of missing data. Only three variables were included in the final model (including the hospital site variable). BMI and ineffective analgesia requiring anesthesiologist intervention were both significantly associated with failure of epidural extension. An obese woman experiencing inadequate labor analgesia had an OR of failure of 3.94 (95% CI: 1.16–13.45, $P = 0.028$). An obese woman with a BMI > 50 kg/m^2 had an OR of failure of 3.42 (95% CI: 1.07–10.96, $P = 0.038$).

Discussion

This is the first study to prospectively examine the outcomes of epidural extension in women with a BMI ≥ 40 kg/m^2 and directly compare them with those of non-obese women. There was no statistically significant difference in epidural extension failure between the two groups. The clinical significance of these failure rates is important, given that higher rates of cesarean section and instrumental delivery are observed in obese pregnant women.[19] The epidural extension failure rates of 13% and 20% in our two groups are both within the wide range of published failure rates (0–21%).[15,20–24]

Our results highlighted that women in the obese group were managed very differently by anesthesiologists to those in the control group. Obese parturients had their epidurals inserted at an earlier cervical dilatation, were more likely to have a senior anesthesiologist perform a labor epidural, more likely to have pre-procedural neuraxial ultrasound, and had a longer length of catheter left in the epidural space. It is likely that anesthesiologists at these institutions instigated these specific management approaches to optimize the success of the labor epidural and subsequent extension. The significantly longer catheter dwell time and insertion at an earlier cervical dilatation, were not associated with extension failure. This result is important, given suggestions by experts and international guidelines, that epidurals be inserted early in labor, for obese women.[9,25,26]

The technical difficulty of inserting and managing labor epidurals in obese pregnant women has been documented previously[5,6] and is confirmed in this cohort. These difficulties occurred despite the mitigating approaches taken by anesthesiologists, detailed above. Women in Group O required more insertion attempts, more epidural re-sites and required intervention for inadequate analgesia more often than non-obese women. Dural puncture, high surgical block and desaturation after induction occurred more often in Group O, although the sample size was not intended to consider these infrequent complications. Anesthesiologists should discuss the potential for these difficulties when providing antenatal counseling to obese pregnant women.

It is likely that the presence of in situ epidurals reduced the overall need for general anesthesia in this cohort of obese women. In the absence of an in-situ epidural, regional anesthesia remains an option for obese women requiring a cesarean delivery during labor. However there is the potential for neuraxial technical difficulty to occur in the face of clinical urgency. This may account for increased decision-to-delivery intervals that have recently been reported in obese

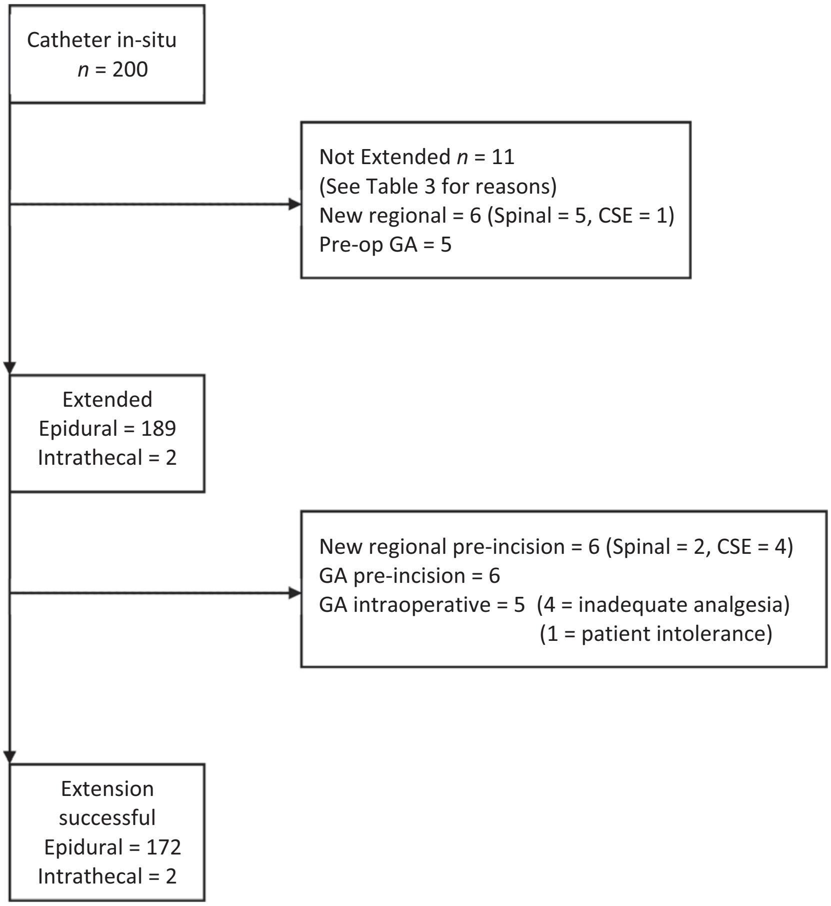

Fig. 1. Control Group. Flowchart of anesthesia management in 200 women presenting for emergency cesarean section with a neuraxial catheter in situ, body mass index ≤ 30 kg/m^2. CSE, combined spinal-epidural; GA, general anesthesia.

women[27] and supports the suggestion of inserting epidurals early, in laboring women who are obese.

Our study examined risk factors for failure of epidural extension. A BMI > 50 kg/m^2 and ineffective analgesia during labor increased the odds of failure. Inadequate labor analgesia has consistently been identified as a factor associated with extension failure[7,20–24] and this relationship is also demonstrated in this cohort. Published data on pregnant women with 'extreme obesity' (BMI 50 kg/m^2) have estimated a prevalence of 1 : 1000 in the United Kingdom[28] and 2.1 : 1000 in Australia.[29] These cohort studies have identified a significantly higher rate of cesarean section, general anesthesia and problems or failure of neuraxial anesthesia in this group.[28,29] International maternity care guidelines make recommendations regarding the care of pregnant women with a BMI > 40 kg/m^2, but do not differentiate between levels of BMI greater than 40 kg/m^2.[25,26,30] Pregnant women with a BMI > 50 kg/m^2 may present specific management difficulties, necessitating different 'ideal' obstetric and anesthetic management.

Consistent with current literature, women in Group O had significantly higher rates of gestational diabetes and gestational hypertension.[1,2] The incidence of asthma in Group O, at 24%, was also significantly higher than estimates of 8–13% in general maternity populations.[30] However, none of these co-existing conditions were associated with extension failure. The significantly higher rate of asthma in the obese women supports the use of regional rather than general anesthesia in this population of obese pregnant women.

This study has limitations. Our liberal definition of failure is not used by all studies

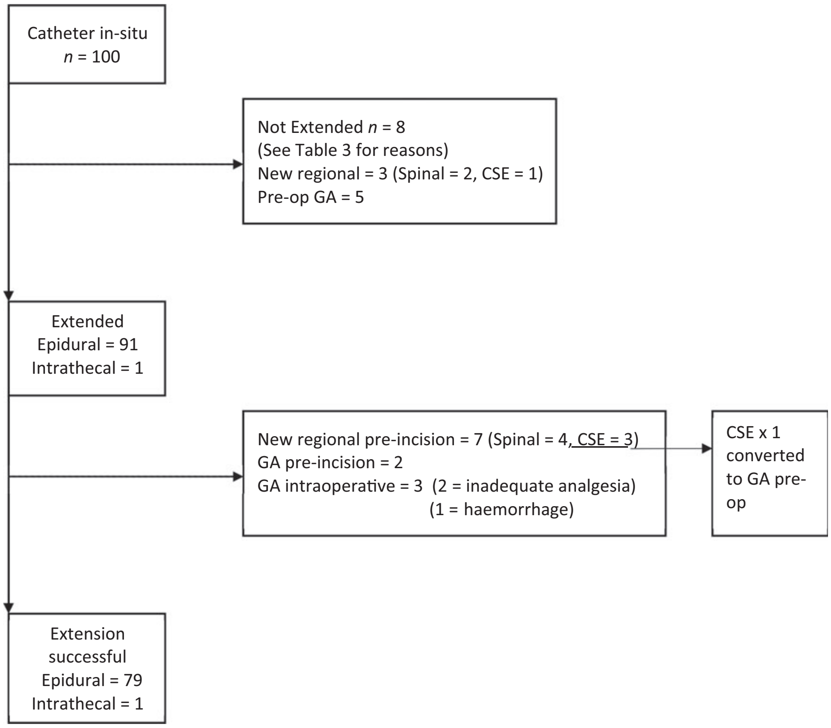

Fig. 2. Obese Group. Flowchart of anesthesia management in 100 women presenting for emergency cesarean section with a neuraxial catheter in situ, body mass index ≥ 40 kg/m^2. CSE, combined spinal-epidural; GA, general anesthesia.

Table 1 Demographic and antenatal details of Group C (BMI ≤ 30 kg/m^2) and Group O (BMI ≥ 40 kg/m^2).

Variable	Group C (*n* = 200)	Group O (*n* = 100)	*P* value
BMI kg/m^2, median (IQR)*	27 (25–28)	44 (41–49)	NA
Age years, median (IQR)	29 (25–32)	29 (24–33)	0.96
Nulliparous, *n* (%)	160 (80.0)	74 (74.0)	0.24
Gestation at delivery weeks, median (IQR)	40 (39.0–41.0)	40 (39.0–41.0)	0.06
Gestational hypertension *n* (%)	8 (4.0)	18 (18.0)	< 0.001
Gestational diabetes *n* (%)	19 (9.5)	25 (25.0)	< 0.001
Asthma, *n* (%)	15 (7.5)	24 (24.0)	< 0.001
Obstructive Sleep Apnea, *n* (%)†	0 (0.0)	5 (5.0)	0.004

*BMI based on a measured weight at a gestation of ≥ 30 weeks and the height at booking-in; †Diagnosed or suspected and documented.

examining epidural extension, limiting potential comparisons. We believe that this definition is pragmatic and reduces the influence of investigator bias. The extension failure rate used in the sample size calculation was also based on this definition.[11] The non-significant result may be due to a lower epidural extension failure rate found in the obese group, than was observed in the pilot study, with subsequent under-powering of this study. The management at the two centers was not standardized and this may have influenced the results. The labor ward analgesia data was, by design, collected retrospectively which may compromise its accuracy. Levels of dermatomal and motor block were not included in the logistic regression model due to missing data. The presence or absence of tunneling or suturing epidural catheters was not documented, although our observations are that this is not common practice in these institutions. Predictors of extension failure were secondary outcomes and the absolute numbers of events small, resulting in large confidence intervals. Our prospectively collected data allowed us to identify the reasons these epidurals were not extended, or were converted to GA, elements missing from both small and large published retrospective cohorts.[31,32]

Table 2 Labor epidural analgesia details for Group C (BMI ≤ 30 kg/m^2) and Group O (BMI ≥ 40 kg/m^2).

Variable	Group C (*n* = 200)	Group O (*n* = 100)	*P* value
Cervical dilatation cm, median (IQR)*	4 (3–6)	3 (2–5)	0.001
Senior anesthesiologist, *n* (%)	27 (13.5)	26 (26.3)	0.025
Sitting position, *n* (%)	191 (97.9)	100 (100.0)	0.30
Ultrasound used, *n* (%)	0 (0.0)	8 (8.0)	< 0.001
Attempts ≥ 2, *n* (%)	32 (16.0)	37 (37.0)	< 0.001
Depth to space cm, median (IQR)	5.0 (4.5–5.5)	7.0 (6.5–8.0)	< 0.001
Length of catheter in space cm, median (IQR)	4.5 (4.0–5.0)	5.0 (4.5–5.0)	< 0.001
Catheter dwell time mins, median (IQR) Control *n* = 198	338 (195–525)	441 (278–636)	0.007
Fixation device, *n* (%)			
Lock-it†	125 (62.5)	59 (59.0)	0.77
Other‡	75 (37.5)	41 (41)	
Re-site, *n* (%)	7 (3.5)	10 (10.0)	0.022
Ineffective analgesia, *n* (%)§	12 (6.0)	17 (17.0)	0.002
Maintenance Solution, *n* (%) Control = 197, Obese = 98			
0.1% bupivacaine, fentanyl 2 mcg/ml	120 (60.9)	60 (61.2)	0.96
0.2% ropivacaine, fentanyl 2 mcg/ml	77 (39.1)	38 (38.8)	
Maintenance Program, *n* (%) Control = 197, Obese = 98			
Patient controlled bolus with infusion	168 (85.3)	81 (82.7)	0.38
Programmed intermittent bolus	22 (11.2)	10 (10.2)	
Other	7 (3.6)	7 (7.1)	

*Cervical 'dilatation documented closest to the time of epidural insertion. †'Lock-it': an adhesive dressing with a central hard plastic clip. The catheter is fed through the hole and the clip snapped shut. ‡'Other' fixation referred to coiling of the catheter under an adhesive dressing. §'Ineffective analgesia': ≥ 1 intervention required by anesthetic staff for inadequate analgesia (e.g., top-up dosing or withdrawal of catheter), after the initial loading dose.

There was no statistically significant difference in epidural extension failure between obese and non-obese women. Obese parturients received different care by anesthesiologists, which may have attenuated the extension failure

Table 3 Cesarean section anesthesia details for Group C (BMI ≤ 30 kg/m^2) and Group O (BMI ≥ 40 kg/m^2).

Variable	Group C (*n* = 200)	Group O (*n* = 100)	*P* value
Category 1 CS, *n* (%) Control *n* = 199	21 (10.6)	16 (16.0)	0.18
Indication, *n* (%)			
Maternal	128 (64.0)	69 (69.0)	0.38
Fetal	64 (32.0	25 (25.0)	
Shift, *n* (%)			
Day 08:01–18:00	78 (39.2)	43 (43.0)	0.27
Evening 18:01–22:30	37 (18.6)	24 (24.0)	
Night 22:31–08:00	84 (42.2)	33 (33.0)	
Senior anesthesiologist, *n* (%)	72 (36.0)	37 (37.0)	0.96
Local anesthetic volume ml, (median, IQR)	15 (10–20)	15 (15–20)	0.77
Local anesthetic, *n* (%)			
Lidocaine2%/adrenaline	174 (93.5	83 (91.2)	0.76
Ropivacaine 0.2%	8 (4.3)	5 (5.5)	
Other	4 (2.2)	3 (3.3)	
Additive			
Fentanyl	138 (74.2)	70 (76.9)	0.82
Other	14 (7.6)	5 (5.5)	
No additive	34 (18.3)	16 (17.6)	
Supplementation, *n* (%)			
Nil	166 (91.7)	70 (85.4)	0.21
IV analgesia	9 (5.0)	8 (9.8)	
IV sedative	1 (0.6)	1 (1.2)	
IV analgesia plus sedative	3 (1.7)	0 (0.0)	
IV analgesia plus nitrous oxide	2 (1.1)	3 (3.7)	
General anesthesia, *n* (%)	16 (8.0)	11 (11.0)	0.39
Reasons: intra-op conversion GA Control = 5, Obese = 3			
Inadequate analgesia	4	2	NA*
Patient intolerance	1	0	
Hemorrhage	0	1	
High block†	1 (0.5)	4 (4.5)	0.04
Reason not extended, *n* (%)‡ Control = 11, Obese = 8			
Poor function during labor	5 (45.5)	3 (37.5)	NA*
Time Critical	4 (36.4)	2 (25.0)	
Time Critical and poor function during labor	1 (9.1)	1 (12.5)	
Patient preference	0 (0.0)	1 (12.5)	
Anesthesiologist preference	0 (0.0)	1 (12.5)	
Equipment failure	1 (9.1)	0 (0.0)	

*Inconclusive due to small numbers. †High block = any sensory or motor deficit in the hand or face. ‡Includes participants in which extension of the in situ epidural was not attempted.

rate. These results may assist anesthesiologists in their antenatal discussions with obese pregnant women, regarding the utility of early epidural analgesia in labor. Further research will focus on the specific anesthetic needs of pregnant women with a BMI > 50 kg/m^2.

Acknowledgements

This research was funded by departmental funds only.

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