REVIEW

Maternal morbid obesity and anesthesia management

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The effects of obesity on pregnancy

Pregnancy in an obese woman is always high-risk. Relative to their non-obese counterparts, obese pregnant women have higher rates of infertility, early miscarriages, and birth defects such as neural tube defects.1,2) Obesity is also associated with a significantly higher incidence of gestational diabetes, gestational hypertension, preeclampsia, macrosomia, preterm delivery, operative vaginal and cesarean delivery, and longer hospital stays.3,4) Newborns of obese pregnant women are more likely to weigh more at birth and are more prone to obesity in adolescence.5–7) Both pregnancy and obesity are risk factors for general anesthesia-associated maternal death. The risks of aspiration, failed mask ventilation, and failed endotracheal intubation are high for normal pregnant women requiring general anesthesia for emergency cesarean sections; these risks are even higher in obese patients. According to a Confidential Inquiry into Maternal and Child Health (CEMACH) report, 30% of maternal deaths from 2000 to 2002 comprised obese women, and 50% of those from 2003 to 2005 were associated with obesity.8,9)

Definition of obesity and weight trend in adult women

There is no accepted definition of obesity in pregnancy. Most anesthesiologists use BMI to define obesity with or without pregnancy. BMI is an individual’s weight in kilograms divided by an individual’s height in meters squared. The National Institutes of Health now defines overweight individuals as those with a BMI of 25 kg/m² or higher, and obese individuals as those with a BMI of 30 kg/m² or higher. Obesity classes I, II, and III are each defined by BMI values ranging from 30 to 34.9 kg/m², 35 to 39.9 kg/m², and over 40, respectively.10) Regarding prevention of weight gain during pregnancy, “body obesity” requires an individual response from the viewpoint of prevention of gestational diabetes, preeclampsia, and prevention, with a BMI that is somewhat higher than 25.0. The U.S. Institute of Medicine (IOM) guidelines have defined limits for weight gain in pregnancy that are based on the initial (pre-pregnancy) BMI; however, less than one-third of pregnant women currently stay within the guidelines for recommended weight gain, with the majority gaining more than the...
IOM-recommended amounts in the U.S.11–13) While the rest of the developed world seems to be struggling with obesity as a common issue, weight issues among women in their 20 s and 30 s in Japan have tended to move in the opposite direction from those of the rest of the world. In 2015, 50% and 44.9% of Japanese women in their 20 s and 30 s, respectively, were underweight (BMI < 20), while the percentage of obese people (BMI ≥ 30.0) was 2.4% and 0.6% for women in their 20 s and 30 s, respectively. In Japan, the likelihood of needing to treat an obese pregnant woman is much lower than that in the U.S.; understandably, anesthesiologists in Japan are relatively inexperienced with treatment strategies for obese pregnant women.14)

Physiological changes caused by pregnancy and obesity

Physiological changes caused by obesity are fairly similar to those caused by pregnancy. The most important changes occur in the respiratory tract and cardiovascular system. Specifically, physiological changes caused by pregnancy and obesity reduce function and physiological tolerance, while also increasing obstetric risk and that for anesthesia.

Effects on the airway and gastrointestinal system

Pregnancy increases both the risk of aspiration and that for Mendelson’s syndrome.14–16) Increased adipose tissue makes mask ventilation and intubation difficult. Rahman and Jenkins et al. found that 15.5% of obese pregnant women with a BMI of 35 kg/m² or greater were unable to be intubated.19) Pilkington et al. reported that the Mallampati classification increases with pregnancy, and that the rate of intubation difficulty increases by about 8 times compared to that with non-pregnant patients.17,18) It follows then, that the combination of pregnancy and obesity increases the difficulty of mask ventilation and intubation even further.

Impact on respiratory function

Pregnancy and obesity change both oxygenation and ventilation. The enlarged uterus and fatty tissue decrease the expiratory reserve volume, residual volume, and functional residual capacity (FRC), which can create a closing capacity that exceeds the FRC, causing airway obstruction.19–22) However, respiratory function including FRC is partially improved by pregnancy, especially among obese patients.23) Hormonal changes decrease airway pressure and influence respiratory function in obesity through the prostaglandin smooth muscle relaxant effect.24) Dempsey et al. demonstrated that weight gain increases linearly with increased oxygen consumption and CO₂ production.25) As a result of this change, obese pregnant women develop hypoxia relatively quickly in a short time during the induction of general anesthesia. As such, pre-administration of oxygen before general anesthesia is very important for obese parturients.

Impact on cardiopulmonary function

Pregnancy in it of itself can cause great physiological changes in cardiovascular function. While the changes in respiratory function caused by pregnancy have some positive effect on obesity, there is no such advantage with regard to changes in cardiovascular function.26,27) Cardiac output is increased by pregnancy—up to 75% more than pre-pregnancy—and reaches its highest value immediately after parturition.28) For every increase in 100 g of fat, cardiac output can increase by up to 50 ml/min.29) The increase in circulating blood volume in pregnancy is even greater if pregnant women are obese. Obesity during pregnancy is also accompanied by hypertension, hemoconcentration, poor cardiac function, and pulmonary hypertension from airway obstruction, sleep apnea, and hypoxia.30) Supine hypotension syndrome, in which the cardiac output and placental blood flow decrease due to the compression of the aortic vein in the supine position during pregnancy, is exacerbated by the massive amount of abdominal adipose tissue in obese patients.31)

The choice of local anesthetic dose in a morbidly obese parturient

The choice of local anesthetic dose for a morbidly obese parturient remains controversial.32) It has been a long-held belief that neuraxial local anesthetic doses should be reduced in obese patients due to the possibility of an unpredictable and exaggerated spread of local anesthetic, resulting in a high block.33) Obese patients have reduced lumbar cerebral spinal fluid (CSF) and epidural volume because of the fatty tissue and engorgement of the epidural veins.32,33) However, many reports advocate for the use of the same doses of local anesthetic as required by a non-obese parturient.34,35) For epidurals and continuous spinal local anesthetic in our obese parturients, we use the same regimens used for labor analgesia in non-obese patients, adjusting divided boluses or continuous speed (Tables 1, 3).21,36) We also use a reduced spinal dose in the combined spinal and epidural (CSE) technique and use an epidural bolus to adjust anesthesia levels because the spinal one-shot effect can be unpredictable in obese patients (Table 2).
Anesthesia management for emergency cesarean sections: Advantages of epidurals in labor as part of strategic obstetric anesthesia management for obese pregnant women

The cesarean section rate is significantly higher in obese patients than their non-obese counterparts.2,3 The rate doubles in women with a BMI of 35 kg/m² or higher, and increases with weight gain.7 Furthermore, in the case of obese pregnant women, the probability of an emergency caesarean section due to stagnation of parturition or fetal heart rate abnormalities is very high. In the case of emergency caesarean sections, it is technically difficult and time-consuming to use spinal subarachnoid anesthesia or epidural anesthesia on obese women because they will reach critical satiation, necessitating general anesthesia. According to Hawkins et al., the mortality rate due to general anesthesia during caesarean sections is 16.7 times that of neuraxial anesthesia, because of difficult intubation, aspiration, and hypoxia.37 In addition, the combination of obesity and pregnancy increases maternal mortality rates when general anesthesia is involved. The use of general anesthesia in obese pregnant women should be avoided at all costs, due to potential complications.8,9,38,39

The American Society of Anesthesiologists guidelines recommend early epidural catheter placement for gynecological or anesthesia high-risk patients who attempt vaginal deliveries, in order to reduce the need for general anesthesia at the time of caesarean section. We recommend catheter placement either in early labor, when pain is relatively mild and the intervals between contractions are longer, or before a scheduled induction is started, because epidural catheter placement is much more difficult and time-consuming in obese patients.

In the U.S. and many European countries, epidurals in labor are very common, but in Japan, only 5% of women use epidurals in labor. We do, however, encourage obese patients to receive an epidural during labor, and to have the epidural in place early in labor, so that the catheter is ready for an emergency cesarean section.

If an emergency caesarean section is needed, the labor epidural anesthesia can be converted to surgical anesthesia by administering a bolus of local anesthetic (10–20 ml 2% xylocaine or 10–20 ml 0.25% bupivacaine, Table 1) from this catheter, making it possible to avoid general anesthesia and maternal death.

### Table 1. Continuous Epidural Catheter Management for Labor Analgesia or Emergency Cesarean Section

| Anesthetics                                                                 |
|-----------------------------------------------------------------------------|
| Intermittent bolus: 0.125–0.25% bupivacaine 1.75–2.5 mg + fentanyl 3–5 μg/ml, 5 ml × 2 (repeat as needed) |
| Continuous infusion: 0.0625–0.125% bupivacaine + fentanyl 2 μg/ml at 6–16 ml/h |
| PCEA with basal infusion: 0.0625–0.125% bupivacaine + fentanyl 2 μg/ml at Basal rate: 6–12 ml/h, bolus dose: 5–6 ml, lockout 8–12 ml Hourly limit: 20–30 ml setting |
| Cesarean section: 2% xylocaine total 10–20 ml or 0.25% bupivacaine total 10–20 ml (5 ml every 5 minutes until sensory Th4 level) |

PCEA: Patient Controlled Epidural Analgesia

### Table 2. Combined Spinal and Epidural Dose for Cesarean Section

| Anesthetics                                                                 |
|-----------------------------------------------------------------------------|
| Spinal injection for cesarean section: Initial spinal injection: 0.5% bupivacaine 5.0–8.0 mg (1–1.4 ml) + fentanyl 15–20 μg |
| Additional epidural boluses: 2% xylocaine 5 ml every 5 minutes until sensory Th4 level |

### Table 3. Continuous Spinal Catheter Management

| Anesthetics                                                                 |
|-----------------------------------------------------------------------------|
| Labor analgesia: Intermittent bolus: 0.25% bupivacaine 1.75–2.5 mg + fentanyl 15–25 μg (every hour if needed) |
| Continuous infusion: 0.0625–0.125% bupivacaine + fentanyl 2 μg/ml at 1–2 ml/h |
| Cesarean section: Initial bolus: 0.5% bupivacaine 8.0 mg (2 ml) + fentanyl 15–20 μg |
| Additional boluses every 5 minutes: 2% 1.25–2.5 mg (0.25–0.5 ml) until sensory Th4 level |
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Anesthesia management for scheduled cesarean sections

Neuraxial anesthesia is always encouraged for scheduled cesarean sections, regardless of patient weight. Local anesthetic should not be introduced in proportion to body weight, because, as mentioned above, the spinal one-shot effect is unpredictable for obese patients. That said, a lengthy surgical time is always anticipated due to the combination of the high amount of adipose tissue and large newborns. Therefore, the dose of anesthetic in spinal anesthesia is more difficult to predict for obese patients. We recommend using the CSE anesthesia technique for obese patients who are scheduled for cesarean section. A decreased initial bolus should be used in the subdural space, followed by epidural catheter placement, using an epidural bolus to adjust the anesthesia level and adding the local anesthetic for prolonged cesarean section (Table 2).

Epidural catheter placement for labor analgesia in obese pregnant women

In the case of obese patients, the spinous processes cannot be felt, and the location of the median is difficult to determine. Therefore, a seated position is best for locating the median in obese patients. Ultrasound or careful observation of the skin secant line on a patient in a seated position is useful for confirming the location of the spinous processes.

The most important step is the insertion of an effective epidural catheter. A local anesthetic should be administered after the epidural catheter insertion, and its level, as well as the difference between left and right, should be tested frequently. If an effective anesthetic level cannot be obtained, the catheter should be replaced immediately, without hesitation.

CSE is not good for obese patients, because the spinal anesthesia effect masks the effect of the epidural catheter and delays the replacement of the ineffective epidural catheter. If the epidural catheter is ineffective just prior to the emergency cesarean section, general anesthesia should be selected; for these reasons, CSE is not suitable as a method of labor analgesia in obese patients.

Intrathecal catheter placement for obese pregnant women

Another effective painless delivery method in obese patients is continuous spinal anesthesia. Because the adipose tissue is thick, requiring a deep puncture depth, the epidural needle puncture becomes much more difficult, and often results in an unintentional dural puncture. When this happens, the epidural catheter would be deep in the subarachnoid space, providing continuous spinal anesthesia. Ineffective epidural anesthesia occurs at a certain rate, even when performed by skilled anesthesiologists; however, as such ineffectiveness does not occur with persistent spinal anesthesia, this method can be used as the most reliable anesthesia route. The risk is the occurrence of total spinal or high spinal anesthesia through mistaken epidural dose local anesthetic bolus; to prevent this risk, labeling and communication between staff is critical. Development of a headache following dural puncture is certainly a risk, but a small one for obese patients.41 The increase in epidural pressure observed in obese patients may decrease the pressure gradient from the intrathecal to the epidural space, resulting in less CSF leakage through the dural puncture site and a lower incidence of PDPH.40,41 Doses of continuous spinal anesthesia for labor pain and cesarean sections are shown in Table 3.21,36

Summary

The proportion of obese people in Japan is lower than that of other countries. The incidence of obesity in pregnant women worldwide has increased, but that among Japanese women in their 20 s and 30 s has not. The probability of anesthesiologists having to care for an obese pregnant woman in Japan is low, but these patients are always considered high-risk, as the rates of mask or intubation difficulties and aspiration of gastric contents are very high and represent important risk factors associated with anesthesia-related maternal death. Pregnancy can improve respiratory function to some extent in obese women, but cardiovascular function suffers greatly in obese pregnant women. Given the risks of aspiration and hypoxia, general anesthesia should be avoided as much as possible. When treating obese pregnant women in early labor, insertion of a catheter that can be used for regional anesthesia is recommended as the best way to avoid general anesthesia for emergency cesarean sections and decrease the likelihood of anesthesia-related mortality.

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