General anesthesia for obstetrics: a deadly or a winning combination

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YOU are on call for obstetrics and receive a page for a stat Cesarean section in a woman who had a previous Cesarean section. The woman is complaining of severe pain and is hypotensive. The presumed diagnosis is a ruptured uterus and the fetal heart is still present but at a rate of 60 beats·min^{-1}. What are the anesthetic options and how will you make your decision as to the anesthetic that you will provide?

There are several beliefs regarding the use of general anesthesia in obstetrics. These include: spinal anesthesia is as fast as general anesthesia; regional anesthesia is better for the fetus/newborn; general anesthesia is more hazardous than regional anesthesia; the pregnant airway makes intubation more difficult than the non-pregnant airway; rapid sequence induction and intubation are essential when providing general anesthesia to the parturient due to the risk of pulmonary aspiration of gastric contents; and lastly, gastric emptying is delayed in the parturient. All of these seem to suggest that regional anesthesia is the better technique for the parturient and her fetus. Is general anesthesia a benefit or a hazard to the obstetric patient and her fetus?

General anesthesia and obstetrics: a deadly combination?

Studies from the USA and United Kingdom have consistently shown that maternal mortality is greater with general anesthesia than regional anesthesia.[1,2] Most of the deaths were due to hypoxia, secondary to difficult or failed intubation or to pulmonary aspiration of gastric contents. Before deciding that the technique is the underlying factor in these maternal deaths we should review the history of general anesthesia for obstetrics, the physiological changes of pregnancy that may increase the risk and lastly look at the literature and the evidence for using general anesthesia and the background to the increased use of regional anesthesia.

Physiological changes of pregnancy

During pregnancy changes occur to many systems. Of particular importance with respect to general anesthesia are those changes that affect the respiratory system (including the airway) and the gastrointestinal system.

Because of mucosal engorgement and deposition of fat, the airway undergoes significant change during pregnancy. Using photographs taken in a standardized fashion, Pilkington *et al.* showed that the Mallampati classification of the airway changed between the first and third trimesters.[3] As well, there are changes in the Mallampati classification during labour and Cesarean hysterectomy.[4,5]

Increased oxygen consumption and production of carbon dioxide and decreased functional residual capacity mean that the pregnant woman requires more efficient denitrogenation and preoxygenation prior to induction of general anesthesia.[6] This will limit the more rapid decline in oxygen saturation during apnea that occurs in pregnant women compared to non-pregnant women.

The gastrointestinal system also undergoes significant change. Pressure from the enlarging uterus increases intragastric pressure. The lower esophageal sphincter tone decreases secondary to the hormones of pregnancy. As a result barrier pressure (lower esophageal pressure minus intragastric pressure) decreases and reflux occurs.[7] Studies have shown that upward of 80% of women in the third trimester have reflux, even though it may be asymptomatic.[8]

Recent evidence suggests that gastric emptying of fluids is not altered during pregnancy but there is some delay during labour, especially in late labour.[7] This delay is magnified if the woman receives *iv* or *im* opioids. Debate continues as to whether epidural fentanyl causes a delay in gastric emptying with one study suggesting that 100 μg of epidural fentanyl may cause a delay.[7] These studies are problematic as they usually look at a short period of time (two hours or less of an

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epidural infusion containing fentanyl) and all have examined emptying of fluids. Solids do not empty rapidly once labour starts and solids may be present up to 12 hr following ingestion.[7]

Regurgitation/reflux

Regurgitation/reflux is present in about 80% of parturients at term but may be asymptomatic.[8] As reflux may increase the incidence of pulmonary aspiration of gastric contents on induction of general anesthesia, all parturients should be considered at high risk. Two days postpartum there is a significant decrease in gastroesophageal reflux.[8]

Pulmonary aspiration

Mendelson was the first to report the risk of pulmonary aspiration of gastric contents during mask anesthesia.[9] He described 45 out of 66 cases of pulmonary aspiration where the nature of the aspirate was known (40 liquid *vs* five solid). Two of the women who aspirated solid material died while none of those who aspirated liquid died.

Several changes to general anesthesia for obstetrics occurred as a result of this landmark study. These changes included limiting food and fluids during labour (often ice chips or water), rapid sequence *iv* induction of general anesthesia, application of cricoid pressure followed by tracheal intubation with a cuffed tube and use of antacid prophylaxis. Maternal mortality secondary to aspiration has steadily declined since the 1950s, partly due to the increased use of regional anesthesia for Cesarean section,[7] but also secondary to the use of the measures described above.

There is a belief that the parturient needs to eat during labour to maintain her strength and to promote efficient uterine contractions. Unfortunately, this will usually increase the volume of gastric contents and the potential for pulmonary aspiration of gastric contents. Fasting leads to ketosis but there is no evidence that ketosis affects uterine function or outcome of labour.[7] Ingestion of a light diet prevents ketosis but results in an increased gastric volume while ingestion of an isotonic "sports" drink does not increase gastric volume.

Intubation

Maternal mortality also occurs secondary to difficult/failed intubation with or without subsequent pulmonary aspiration of gastric contents. Is the pregnant airway more difficult than the non-pregnant airway? As noted above the physiological changes of pregnancy alter the maternal airway, but do these changes make intubation more difficult? Studies of difficult intubation suggest that there is a higher incidence of failed intubation in parturients (1:250).[10,11] Are there factors, other than airway changes, that are responsible for this increase?

Situations that lead to the administration of general anesthesia are the need for emergent delivery of a fetus (as in the example, above), contraindication to the use of regional anesthesia, patient preference, failed regional and unexpected prolonged or difficult surgery. All of these situations are stressful and, because of the need to rapidly induce anesthesia, alterations in technique may occur, making intubation more difficult. Added to this are inappropriately applied cricoid pressure and lack of expert assistance in the event that difficulty is encountered.

A major problem identified in the confidential enquiry into maternal deaths from the United Kingdom is the inexperience of the individual doing the intubation, often without expert back-up. This is most likely to occur, at least in the UK, on nights and for emergencies.[10,11]

Recent publications should reassure the obstetric anesthesiologist that if intubation fails use of a face mask or laryngeal mask airway (LMA) are reasonable and, in the majority of situations, safe alternatives.[12,13] In the prospective study by Han on the use of LMA for elective Cesarean section in 1,060 parturients there were no cases of aspiration.[13] However, conditions were ideal in that all women were fasted, received antacid prophylaxis and had no risk factors for difficult intubation or evidence of reflux. One should not assume that this is an acceptable technique.

When faced with a failed intubation, it is important to ventilate the woman and providing there is no urgent need to proceed with a Cesarean section to waken the woman and switch to regional anesthesia. If one has to proceed one should ask the surgeon to avoid applying abdominal pressure (use forceps or vacuum to assist with delivery) in order to avoid aspiration of gastric contents.[8]

My personal belief is that the pregnant airway is more difficult but that we make it more difficult by failing to optimize the woman's position prior to induction of anesthesia, failing to ensure good vision and not waiting until the woman is adequately relaxed prior to attempting intubation. As well, we have to ensure that the person providing cricoid pressure knows where to apply it and the correct pressure to use.

Cricoid pressure

Fifteen years following Mendelson's publication on pulmonary aspiration Sellick reported on the use of cricoid pressure to prevent gastric contents entering

the pharynx and ultimately larynx.[14] In a cadaver study, Sellick found that backward pressure of the cricoid cartilage against the bodies of the cervical vertebrae prevented passive regurgitation of fluid from the stomach into the pharynx in the Trendelenburg position. This was followed by application of the technique during induction in 26 anesthetized and paralyzed high-risk cases. Twenty-three of them (one pregnant, the rest had intestinal obstruction or were at high risk for regurgitation) had no evidence of regurgitation or vomiting. In three cases, (one forceps delivery, one malignancy of the lower esophagus, one intestinal obstruction), release of cricoid pressure after intubation was followed by visible reflux into the pharynx.

Recently the use of cricoid pressure has been questioned due to evidence that it decreases lower esophageal tone,[15] may make intubation more difficult[8] and the cricoid cartilage and the esophagus are not aligned in close to half of adult patients.[16] Additionally, the technique of cricoid pressure is often inappropriately applied.[17] Appropriate application of cricoid pressure in an upward and backward direction may improve the view at laryngoscopy.[18]

Rapid sequence *iv* induction

Recently, there have been several reports of inhalation induction when there was no *iv* access (due to patient refusal of *iv* access while awake or difficult access), severe asthma or potentially difficult airway. These are unusual circumstances and as regional anesthesia is contraindicated one has to proceed in as safe a manner as possible.[19]

What about the fetus/neonate?

Studies have consistently shown that infants delivered under general anesthesia are more likely to be depressed and require active resuscitation than those delivered under regional anesthesia.[20] However, with appropriate care the infants are indistinguishable after the first few minutes of life.

Benefits of general anesthesia

The principle advantage of general anesthesia is the ability to *rapidly* induce anesthesia allowing the obstetrician to deliver a fetus that is "distressed." Although delay in rapid delivery is more likely secondary to factors other than induction of anesthesia (such as time to decision and time to transfer the woman to the operating room), delay in induction of anesthesia will add to the delay, potentially increasing the risk of neonatal asphyxia.

Some suggest that spinal anesthesia can be induced as rapidly as general anesthesia.[21] While it is true that the time to insert a spinal may be as fast as inducing and intubating a parturient, providing both have normal anatomy, the time to surgical anesthesia is longer with spinal anesthesia. Gunka and Douglas found that, on average, there was a six-minute difference in time to surgical anesthesia due to the time needed for the spinal anesthetic to work.[22]

Situations where minutes may count for the fetus include ruptured uterus (fetus at risk if extruded through rupture), placental abruption (blood supply to the fetus interrupted), umbilical cord prolapse with persistent fetal bradycardia and fetal bradycardia/decelerations with failure of recovery from unknown cause.[23] Situations where rapid induction may be needed for maternal safety include uncontrolled hemorrhage (placenta previa, placental abruption, trauma, ruptured vessel) and high block.

Challenges of general anesthesia

One always has to be prepared to induce general anesthesia, even when the original plan for anesthesia is a regional technique. This may occur secondary to failure of regional anesthesia, prolonged surgery (exceeding the duration of the block - especially with spinal) or patient discomfort for other reasons (hemorrhage leading to hypotension, nausea, vomiting). As well, the woman may choose to have general anesthesia, rather than regional anesthesia, or there may be a contraindication to regional anesthesia. Therefore, it is essential that one is skilled in providing general anesthesia and has the opportunity to maintain those skills.

Failed intubation occurs unexpectedly in both the obstetric and non-obstetric populations. Strategies and algorithms for its management have been well described and are similar in both populations.[24] In the past fears of applying positive pressure oxygenation using a face mask in the pregnant population in order to avoid pulmonary aspiration led to an increase in maternal mortality secondary to hypoxia. Prolonged and persistent attempts at intubation lead to more airway trauma, edema and may make mask ventilation more difficult.

A major challenge facing obstetric anesthesiologists is teaching general anesthesia to new trainees.[25] With the steady decrease in the use of general anesthesia, residents may go through the majority of their residency without administering general anesthesia for a Cesarean section. Use of a simulator to teach management of obstetric emergencies may become an important tool in overcoming this deficiency. Additionally, one should use every opportunity to administer general anesthesia to obstetric patients under controlled conditions. Appropriate assessment of the woman and

the situation (degree of urgency) should allow formation of an appropriate anesthetic plan and a back up plan should complications arise. Administration of general anesthesia in an elective situation in a fasted parturient with a normal airway will optimize conditions for learning.

Conclusion

For the foreseeable future, there will still be a need and a place for general anesthesia in obstetrics. To prevent the associated risks more research is needed. For example, does cricoid pressure decrease the risk of pulmonary aspiration or does it add one more hazard to intubation? Is the decrease in pulmonary aspiration due to cricoid pressure or is it due to other measures such as avoidance of solids during labour and antacid prophylaxis? Answers to these questions may increase the safety of general anesthesia. Although there will always be a concern when general anesthesia is administered to the obstetric patient, appropriate patient selection and attention to detail should result in general anesthesia being a winning combination for the mother and her fetus/neonate.

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