

## Objectives for «Update of obstetric anesthesia» lecture

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The objective of my talk is to review clinically relevant articles of the literature pertinent to obstetric anesthesiologists in the following domains:

- a) Labor analgesia
- b) Cesarean delivery anesthesia
- c) Complications of pregnancy including antenatal factors; intraoperative occurrences and postpartum issues
- d) Fetal and neonatal issues

### LABOR ANALGESIA

The combined spinal epidural (CSE) technique has become a frequently used method of providing labor analgesia in North America. While they provide rapid onset analgesia without causing significant motor nerve block, anesthesiologists must balance the additional risks of this technique. Risks include postdural puncture headache secondary to the intentional breach of the dura mater, infectious complications including meningitis, and association with fetal heart rate abnormalities. Two studies from the United States, where the CSE technique is used commonly, evaluate the traditional epidural with CSE for labor<sup>(1,2)</sup>. Goodman et al in a randomized clinical trial studied 100 multiparous women who desired epidural analgesia for labor and who were less than 5 cm dilated at the time of request for regional anesthesia<sup>(1)</sup>. Women were randomized to a CSE technique receiving 2.5 mg bupivacaine and fentanyl 25 µg spinally or an epidural technique of 16 mL bupivacaine 0.125% + fentanyl 50 µg. Maintenance of labor analgesia was achieved using a continuous epidural infusion of bupivacaine 0.0625% with fentanyl 2 µg / mL. The primary outcome of the study was the incidence of top-ups required during the labor period. As well, they evaluated maternal pain scores during the first 30 minutes of labor, side effects of the analgesic techniques and time to first top-up request. The number of women requesting top-ups was not different between

the two groups (44% for CSE vs 51% for epidural) however, maternal VAS pain scores were significantly lower at 10 minutes and 30 minutes in the CSE group compared to the epidural group. It appears that with this dosing the CSE technique does not reduce workload requirements, but does provide quicker pain relief.

Investigators in Boston anecdotally observed that women with CSE analgesia for labor had more reliable sacral root coverage at time of delivery than women with traditional epidural techniques<sup>(2)</sup>. They hypothesized that the dural puncture of the CSE procedure allows more effective passage of epidurally-administered medication to reach the spinal column and tested this in a randomized trial of 80 nulliparous women in labor, of less than 5 cm dilation. These women were randomized to either a traditional epidural initiated with 12 mL of bupivacaine 0.25% or to receiving a dural puncture with a 25 gauge spinal needle followed by epidural catheter placement and administration of the same 12 mL of bupivacaine. No medication was given in the spinal space with the CSE technique. The investigators looked for the incidence of 1<sup>st</sup> sacral root sensory block to pinprick and a VAS score of less than 10 / 100 at 20 minutes after analgesia initiation. Again there was no difference in the proportion of women with sacral block at 20 minutes (46% dural puncture epidural group vs 37% in traditional epidural group) but more importantly in the entire labor period 92% of women in the dural puncture group had a sacral block compared to only 70% in the traditional epidural group. It appears that the CSE guided dural puncture may provide some longer lasting labor analgesic effects even after the initial spinal drug effect has worn off.

The CSE or single shot spinal technique during pregnancy has a higher paresthesia rate than in patients of the same age not pregnant. Paresthesias are associated with unwanted patient movement that can complicate the regional procedure (inadvertent dural puncture with a large Tuohy needle) as well as associations with neurological morbidity. An

interesting case series from Takiguchi et al demonstrates with MRI imaging in 3 women at term pregnancy and then again at 3 – 10 months postpartum the epidural space in the lumbar region<sup>(3)</sup>. Serial imaging demonstrates the posterior displacement of the dural sac and contents within the bony framework of the spinal column secondary to engorged anterior epidural veins during pregnancy. This displacement increases moving in a caudal direction and the images within the same women clarify why our spinally directed needles so often elicit a paresthesia during pregnancy. We should be cognizant of this to slowly move our needles into the intrathecal space.

The last aspect of labor analgesia topics to introduce is the emerging usefulness of ultrasound to facilitate epidural and spinal anesthesia for obstetrics<sup>(4-6)</sup>. Three articles are mentioned which provide introductory anatomical descriptions to lumbar visualization with ultrasound and to its usefulness in finding the midline structures in hard to palpate backs as well as confirming the interspinous level at which needles are introduced.

## CESAREAN DELIVERY ANESTHESIA

Two aspects of patient care during cesarean delivery that are not initiated by anesthesiologists but are provided by us include administration of antibiotics to prevent maternal infectious complications and of oxytocin to prevent uterine atony. Recent evidence suggests changes in our usual practice of administering these two medications.

Antibiotic therapy during cesarean delivery has traditionally been given after the umbilical cord has been clamped and cut, avoiding administration to the neonate. However, this policy is in direct contrast to our usual perioperative care of non-obstetric patients for non-sterile surgery, where we administer antibiotics prior to skin incision. Two recent papers examined the change in cesarean delivery practice to give antibiotics prior to the start of surgery<sup>(7,8)</sup>. The first paper is a meta-analysis of all randomized clinical trials in cesarean delivery patients which compare the traditional timing of administration to giving antibiotics earlier<sup>(7)</sup>. The studies demonstrate conclusively that maternal infectious complications are reduced by 50% by giving antibiotics prior to skin incision. Infectious complications included endometritis, wound infections and febrile episodes. The second study was from a single institution which changed its practice of giving antibiotics from after umbilical clamping to prior to skin incision. At this site, the incidence of overall surgical site infections fell from 6.4% to 2.5% with the change in practice. For the mothers' benefit it appears we should be administering antibiotics earlier, especially for women in labor who require cesarean delivery.

A follow-up study from the authors interested in the minimum effective dose of oxytocin to provide uterine contractility, 30 women requiring cesarean delivery for arrest of labor were evaluated to determine the effective dose of oxytocin required to provide adequate uterine contractions in 90% of women (ED90)<sup>(9)</sup>. Balki et al identified the ED90 for an oxytocin bolus dose as 3.0 IU intravenously in women requiring a cesarean delivery after a labor. I believe our past use of 5 – 10 IU of oxytocin IV bolus given during cesarean delivery as excessive when administering to women already at risk for hypotension (due to spinal or epidural sympathetic blockade). The Confidential Enquiries in Great Britain have identified in recent evaluations that the use of oxytocin boluses in combination with significant neuraxial blockade increases the risk of cardiac arrest due to hypotension.

Spinal anesthesia-induced hypotension is a particular problem in the pregnant population and a study by Hanss et al has identified an interesting use of heart rate variability technology to potentially prevent this problem<sup>(10)</sup>. Advances in the understanding of autonomic nervous system function, specifically the balance between sympathetic and parasympathetic functions, has lead to using heart rate variability analysis to predict the development of spinal induced hypotension. Differences between individual's autonomic nervous systems may explain the variability in the incidence of hypotension and may highlight individuals at increased risk for hypotension. In a randomized study using preoperative heart rate variability analysis prior to elective cesarean delivery, Hanss et al hypothesized that women with increased low to high frequency (LF / HF) ratios would benefit from preoperative prehydration or prophylactic vasopressors prior to spinal anesthesia.

Sixty-three women with LF / HF ratios of  $> 2.5$  received either a standard anesthetic or prophylactic fluid or vasopressor around administration of spinal anesthesia for elective cesarean delivery. Fluid therapy consisted of a variable amount of 6% 130/0.4 hydroxyethyl starch up to 1,500 mL prior to spinal anesthesia or infusion of vasopressor therapy immediately following induction of spinal anesthesia. 90% of women receiving standard anesthetic care with high LF / HF ratios had hypotensive episodes, compared to 15% receiving colloid therapy pre-spinal and 5% receiving prophylactic vasopressor therapy. Interestingly, the group receiving pre-spinal colloid therapy had their LF / HF ratios reduced to a target of a ratio  $< 2.5$ . This particular technology required five-minute recordings around each event, and was analyzed using fast Fourier transformation. Assessment of individual's LF / HF ratio appears to be an increasingly feasible preoperative test, especially for delivery units with high cesarean delivery rates and spinal anesthesia.

The combination of spinal anesthesia and preeclampsia has become more routine, and Dyer et al have contributed to

our understanding of why this method of anesthesia may be safe for fetal health<sup>(11)</sup>. Our usual anesthesia goal of maintaining maternal blood pressure is based upon the theory that this maneuver best maintains uteroplacental perfusion. There has been earlier work that suggests maternal cardiac output is a better indicator of uteroplacental perfusion and this is investigated by Dyer in 15 severe pre-eclampsics. The study uses new technology which monitors cardiac output non-invasively, the LiDOCoplus monitor. The women received a acceptable dose of spinal anesthesia for cesarean delivery with subsequent monitoring indicating that cardiac output was not different than baseline during surgery (except for an increase following delivery) despite decreases in maternal mean arterial pressure.

For the woman who requires general anesthesia for cesarean delivery two studies have evaluated the addition of remifentanyl at induction for its maternal cardiovascular effects and neonatal effects at birth<sup>(12,13)</sup>. Both studies demonstrate a clear advantage in blunting hemodynamic stimulation to laryngoscopy in doses of 0.5 – 1.0  $\mu\text{g}$  / kg compared to the usual agents. However both studies had neonates in the remifentanyl group that required either naloxone administration or intubation. A separate health care provider must be present for neonatal resuscitation should mothers require general anesthesia induction especially with the use of remifentanyl boluses at induction.

Lastly I would like to identify two excellent articles prospectively reviewing difficult airway and awareness incidences in obstetric populations for cesarean delivery in 18 hospitals of Australia and New Zealand<sup>(14,15)</sup>. One in 274 general anesthetics to pregnant women resulted in failed intubation, but all cases were rescued by the use of laryngeal masks. The incidence of awareness following GA for cesarean delivery was one in 382 women.

## COMPLICATIONS OF ANESTHESIA AND OBSTETRICS

Obesity has become an increasing problem in most of the Western world. Ogden et al, in JAMA, reported on obesity incidence among women of reproductive years<sup>(16)</sup>. This population-based survey examines the health of a randomly-sampled group of children between the ages of 2 to 19 years and adults aged 20 years and older which represent the United States population. Almost 30 percent of women 20 years or older are obese, defined as a body mass index (BMI) of  $> 30$ . This proportion of the female population has appeared to stabilize during the six most recent years of survey examination.

The obese parturient is at increased risk for medical and obstetric complications during pregnancy, and there is evidence that anesthetic difficulties can arise for these patients as well. Technical difficulties with provision of neuraxial

anesthetic techniques are well known, as are problems with ventilation following induction of general anesthesia. Recent research has focused on differences in anesthetic requirements for the obese population. In a study of analgesic requirements during labor, Panni and Columb determined the minimum local anesthetic concentration (MLAC) of bupivacaine<sup>(17)</sup>. Women were placed into one of two groups based on BMI: a BMI  $\leq 30$  or BMI  $> 30$ . The MLAC for obese women was reduced by 41% compared to women with BMI  $\leq 30$ . Despite a reduction in local anesthetic concentrations, the upper extent of sensory block to ice was found to be higher in the obese group. It appears that there is a greater distribution of epidural local anesthetic in the obese parturient, as the pain scores at time of request were no different between the groups. The appreciation of altered epidural anesthetic requirements for labor in the obese parturient needs to be incorporated into our clinical plan for this group.

Ruppen et al from the United Kingdom reported on neurological complications of obstetric epidural anesthesia, following a systematic review of observational studies<sup>(18)</sup>. This article provides a succinct estimation of risk for obstetric anesthetic providers with the incidence quoted as follows: risk of epidural hematoma one in 183,383 women receiving neuraxial anesthesia, persisting neurological deficit one in 256, 979 women and transient neurologic injury one in 3,887 women. Clearly women are worried about life-threatening and life-altering complications but more common problems such as a numb, anterior thigh from a lateral femoral cutaneous nerve injury should also be discussed.

Obstetric hemorrhage is still a major cause of developed world morbidity and developing world maternal mortality. A unique study quantified the inaccuracies in our estimation of obstetric blood loss<sup>(19)</sup>. Bose et al recreated 12 common obstetric hemorrhage scenarios to assess the accuracy of estimating lost blood volume amongst anesthesia providers, obstetricians, nurses, midwives and health care assistants. All types of health care providers tended to underestimate the blood loss of the scenarios (5 of 12 stations with statistical underestimates), and no scenario was consistently overestimated. Anesthesiologists were the most accurate estimators of all providers, but were more likely to overestimate loss by 4%. Visual depiction of the 12 scenarios were felt to be helpful reminders to health care providers in estimating overall blood loss and were recommended for posting within labor and delivery units.

Labor and delivery units that function within a hospital which provides interventional radiological services have developed unique uterine-preserving embolization strategies. In women who are stable enough to be transported to radiology suites, uterine artery embolization can help stop or slow bleeding either before or after hysterectomy. As well, uterine atony, a common cause of postpartum hemorrhage

has been temporized using this technology<sup>(21)</sup>. This particular article reviews the experience of two UK hospitals experience for 31 women.

Another increasingly referenced agent used in «last-resort» scenarios of massive hemorrhage is Factor VIIA, a recombinant activated factor to initiate the extrinsic coagulation cascade. Sobieszczyk et al report on the use of Factor VIIA in 25 obstetric cases as reported to a European internet-based registry between 2001 and 2003<sup>(21)</sup>. This collection represents the largest series to date in obstetric patients. The majority of the cases followed cesarean delivery and the use of Factor VIIA often accompanied other lifesaving therapies, including surgical vessel ligation and anti-fibrinolytic medications. The median dose used was 32 µg / kg (range 10 – 137) and most women (20 / 25) received a single dose.

The last topic of the complications section is focused on maternal mortality. The Lancet has long focused on maternal mortality and morbidity throughout the world and provides an excellent review of the worldwide causes of maternal deaths<sup>(22)</sup>. Two recent articles are important readings for anesthesiologists providing obstetric anesthesia care, as they summarise recent maternal deaths in the UK and in the US. The bulk of anesthesia related deaths occur due to respiratory obstruction, often occurring post-operatively, or with cardiovascular collapse following neuraxial anesthesia<sup>(23,24)</sup>.

## FETAL AND NEONATAL ISSUES

The last section of this review focuses on the fetus and neonate. New developments in fetal surgery procedures, one of

them being the extra-utero intrapartum therapy (EXIT) procedure, have provided options for children with massive airway tumors or significant pulmonary defects, such as diaphragmatic hernia. Several references review current anesthetic management techniques for these multi-disciplinary cases<sup>(25-27)</sup>.

Concern has been raised following results from animal studies indicating that anesthetic agents with NMDA and GABA-receptor activity can cause neurological degeneration in brains during the period of synaptogenesis<sup>(28-31)</sup>. This has implications for obstetric anesthesiologists as we provide general anesthesia to pregnant mothers for non-obstetric surgeries, such as appendectomies or cancer surgeries which cannot wait until the pregnancy has ended. The US Federal Drug Agency has established an Advisory Committee that will review the evidence in animal studies and provide some suggestion to human studies to evaluate this concern. At the present time we cannot provide reassurance to pregnant mothers requiring surgery, but consideration of regional anesthetic options should be done wherever possible.

## CONCLUSION

New systems and technologies are developing to provide consistent and safe anesthetic care to pregnant mothers. Increasing age and co-morbidities of mothers are making pregnancy a more challenging time, and anesthesiologists are called upon during the period of most risk, labor and delivery, to ensure their safe passage.

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