Obstetrical and Pediatric Anesthesia

Cesarean section in a patient with familial cardiomyopathy and a cardioverter-defibrillator

[Une césarienne chez une patiente atteinte de cardiomyopathie familiale et porteuse d'un défibrillateur à synchronisation automatique]

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Purpose: To describe the impact of maternal automatic implantable cardioverter-defibrillator (AICD) therapy on pregnancy outcome, and discuss the clinical rationale for regional anesthesia in parturients with AICDs.

Clinical features: A 20-yr-old primigravida with a history of familial cardiomyopathy and AICD placement presented at 39 weeks gestational age for elective labour induction. Ultimately, the patient underwent a Cesarean section for a failed induction. Her AICD was deactivated during the peripartum period, although the pacing function remained active as she had an underlying heart rhythm of less than 34 beat·min⁻¹. The patient had continuous electrocardiogram monitoring via an external defibrillating unit to which she remained connected by external defibrillator pads. Labour analgesia and surgical anesthesia were provided with a lumbar epidural dosed with varying concentrations of bupivacaine. This management resulted in an excellent maternal and fetal outcome.

Conclusions: Automatic implantable cardioverter-defibrillators are being utilized more frequently in the obstetric population, and appear compatible with good fetal outcomes. Experience with the anesthetic management of these patients is markedly limited – primarily involving reports of general anesthesia for Cesarean section. Epidural anesthesia, however, offers distinct advantages in this patient population including easy conversion from labour analgesia to surgical anesthesia, preservation of fetal-maternal hemodynamics, prevention of increases in plasma catecholamines due to labour or operative pain, and, finally, possible direct suppression of arrhythmias by pharmacologically-active plasma levels of local anesthetic.

Objectif: Décrire l'impact d'un défibrillateur à synchronisation automatique implantable (DSAI) sur l'évolution de la grossesse et discuter de la justification clinique d'une anesthésie régionale chez les parturientes porteuses de DSAI.

Éléments cliniques : Une primigeste de 20 ans, aux antécédents de cardiomyopathie familiale et porteuse de DSAI, s'est présentée à 39 semaines de grossesse pour l'induction réglée du travail. L'induction ayant échoué, la patiente a subi une césarienne. Son DSAI a été désactivé pendant le péripartum tout en gardant active la fonction de stimulation cardiaque, car la fréquence cardiaque de base était de moins de 34 battements·min⁻¹. Un monitoring électrocardiographique continu a été installé au moyen d'une unité de défibrillation externe à laquelle la patiente est demeurée reliée par des électrodes externes de défibrillateur. L'analgésie pour le travail et l'anesthésie chirurgicale ont été administrées par voie épidurale lombaire en variant les concentrations des doses de bupivacaine. Cette mesure a été bénéfique pour la mère et l'enfant.

Conclusion : Les défibrillateurs à synchronisation automatique implantable sont plus souvent utilisés en obstétrique et ne semblent pas nuire au fœtus. Expérience encore très limitée auprès de ces patientes, on la mentionne surtout avec l'anesthésie générale pour la césarienne. L'anesthésie épidurale offre toutefois des avantages distincts en obstétrique, dont la conversion facile de l'analgésie pour le travail en anesthésie chirurgicale, la préservation de l'hémodynamique fœto-maternelle, la prévention de l'augmentation des catécholamines plasmatiques à cause de la douleur du travail ou de l'opération et, enfin, la suppression directe possible des arythmies par des niveaux plasmatiques d'anesthésique local pharmacologiquement actifs.

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THE increasing use of automatic implantable cardioverter-defibrillators (AICDs) in patients of reproductive age presents an unprecedented challenge to the obstetric anesthesiologist. While two recent case reports describe Cesarean deliveries under general anesthesia in patients with AICDs,^{1,2} there has been only one report which cursorily addressed the regional anesthetic management of this unique patient population.³ In this report, we describe the regional anesthetic management of such a patient through labour and eventual Cesarean section, especially with regard to the possible suppression of arrhythmias by clinically relevant plasma concentrations of local anesthetic following epidural anesthesia. Additionally, we discuss what is known about the impact of AICD discharge during pregnancy upon the fetus.

Case report

A 20-yr-old, 155 cm, 90 kg, primigravida with a history of familial cardiomyopathy with complete atrioventricular block presented for labour induction at 39 weeks gestational age. She did not experience any arrhythmic episodes or symptoms of heart failure during this pregnancy. Physical examination was negative for signs of heart failure and was otherwise unremarkable. An antepartum echocardiographic study demonstrated a left ventricular ejection fraction of 55% while in a paced rhythm. A transvenous combined AICD/DDD pacemaker had been placed prepectorally 12 months earlier after presentation to the local emergency room with complete heart block and symptomatic hypotension. This device was placed prophylactically because of a history of inducible ventricular arrhythmias in a younger sister and multiple episodes of sudden cardiac arrest in her father, both of whom were diagnosed with cardiomyopathy. The AICD was deactivated by a cardiologist upon arrival to the delivery suite. However, the pacemaker function was allowed to remain active as the patient had no underlying native rhythm below the pacer limit of 34 beat·min⁻¹. Induction of labour began at 11:00 A.M. with 25 µg misoprostol administered intravaginally which was repeated 2.5 hr later. The following morning, at a cervical dilation of 3 cm, an *iv* oxytocin infusion was initiated and titrated to produce a contraction every five minutes.

Early initiation of epidural anesthesia was recommended to provide excellent labour analgesia and prevent any pain-induced increases in circulating epinephrine⁴ which might precipitate a tachydysrhythmia. It was also felt that the plasma concentrations of local anesthetic achieved after epidural dosing might have

an antiarrhythmic effect (*vide infra*). External defibrillator pads were applied, and a paced rhythm was noted on continuous electrocardiography. A defibrillator unit was placed at the patient's bedside throughout the peripartum period. After a 750-mL *iv* bolus of lactated Ringer's solution, the patient was turned to the left lateral decubitus position for placement of a lumbar (L₃–L₄) epidural catheter. A test dose of 3 mL of 0.25% bupivacaine was injected without any signs/symptoms of intrathecal or *iv* injection. Nine millilitres of bupivacaine 0.25% with fentanyl 50 µg were injected incrementally over 15 min – achieving a sensory level to the T10 dermatome, which was maintained by the continuous epidural infusion of bupivacaine 0.125% with fentanyl 2 µg·mL⁻¹ at 10 mL·hr⁻¹.

Early the following morning a Cesarean section was planned secondary to a failed vacuum extraction for failure of descent. The patient, along with the external defibrillator, was brought to the operating room where 25 mL of bupivacaine 0.5% with fentanyl 50 µg were given epidurally in incremental doses to achieve a T5-sensory level. The electrocautery grounding pad was placed on the patient's right thigh in an effort to minimize possible interference with the pacing function of the AICD. A low-transverse Cesarean section was performed resulting in delivery of a female infant with Apgar scores of 9 and 9 (at one and five minutes, respectively). At no time during surgery did electrocautery result in pacemaker malfunction. Patient-controlled epidural analgesia with 0.1% ropivacaine containing fentanyl 10 µg·mL⁻¹ provided postoperative pain control. Her AICD was reactivated in the postpartum period. No dysrhythmias were observed during her hospital stay.

Discussion

Traditional therapy for patients suffering an episode of sudden cardiac death has focused on antiarrhythmic drugs, surgical ablation of the arrhythmogenic focus, and cardiac pacing.³ Side-effects of these modalities have limited their use. The AICD has become a valuable therapeutic option for survivors of sudden cardiac death.⁵ It is designed to treat the recurrence of malignant ventricular arrhythmias by defibrillation, and provide antitachycardia pacing to prevent sudden cardiac arrest.⁶ The use of these devices in younger female patients has resulted in an increasing number reaching their reproductive years.⁷

Cardiac disease complicates approximately 1% of all pregnancies; however, women with arrhythmias comprise only a small portion of these cases.⁷ An increased incidence of supraventricular tachycardia, due either to accessory pathway-mediated (50%) or atrioven-

tricular nodal reentrant mechanisms (46%), may be seen in pregnant women who are otherwise healthy.⁸ These same women may also experience episodes of ventricular tachycardia, which may be triggered by hemodynamic changes and autonomic nervous system alterations.⁷ Pregnancy in a patient with an AICD presents additional considerations for fetal safety. Recurrence of maternal ventricular tachycardia is the primary fetal risk as it results in maternal hypotension followed by placental hypoperfusion.³ Additionally, with subsequent cardioversion, the energy of the AICD shock could be shunted to the fetal heart with unpredictable effects. However, as the fetal heart has a high-fibrillation threshold, and the current reaching the uterus should be very small (as therapy from internal defibrillation is directed), it is unlikely that AICD discharges could cause life-threatening fetal arrhythmias.⁷ Fortunately, this prediction appears to be true. Natale *et al.*⁷ discussed the fetal outcome in a series of 44 women with AICDs, 11 of whom experienced discharges while pregnant. In the shocked group, eight patients experienced one shock, two experienced five shocks, and one patient experienced 11 shocks. Birth outcomes included nine healthy infants, one case of neonatal hypoglycemia thought to result from antiarrhythmic therapy, and one stillbirth secondary to a cord accident (in which the fetus was known to be viable post-AICD discharge). However, due both to the unpredictable fetal risk from AICD firing during delivery, along with maternal, fetal, and surgical team risks of repetitive triggering secondary to electrocautery during Cesarean section, the device was inactivated and external defibrillator electrodes were applied for the duration of the peripartum interval.

Lumbar epidural analgesia was chosen to provide labour pain relief, as well as providing an opportune anesthetic technique in the event the patient required urgent Cesarean section. An Arrow Flex-Tip[®] catheter (Arrow International, Inc.; Reading, PA, USA) was used, as these catheters have been shown to have a reduced risk of intravascular placement.⁹ Epinephrine-containing solutions were avoided for testing epidural placement secondary to concerns about eliciting malignant tachyarrhythmias. Bupivacaine, perhaps a controversial choice in this patient with cardiomyopathy, was chosen to provide a slow onset block with a stable hemodynamic profile. It was felt that this was more important than the largely theoretical risk of bupivacaine-induced cardiotoxicity with a properly placed, tested, and dosed epidural catheter. Additionally, it is known that the epidural administration of local anesthetics (including bupivacaine) often results in pharmacologically-active levels of these drugs in the

circulation.¹⁰ The levels of local anesthetic achieved in this patient's serum, therefore, might be expected to suppress any inherent arrhythmogenicity. More specifically, it has been shown that administration of 0.25% bupivacaine epidurally to parturients in labour results in peak serum concentrations of approximately $2.4 \mu\text{mol}\cdot\text{L}^{-1}$,^{11,12} whereas caudal administration of this drug to children results in serum concentrations of approximately $5 \mu\text{mol}\cdot\text{L}^{-1}$.¹³ Furthermore, in a study involving 20 parturients randomized to receive either 0.5% bupivacaine or 2% lidocaine for elective Cesarean section (ten in each arm), serum concentrations of bupivacaine were found to range from 1.5 to $3.8 \mu\text{mol}\cdot\text{L}^{-1}$ (mean $2.7 \mu\text{mol}\cdot\text{L}^{-1}$),¹⁴ concentrations which are below those associated with clinical toxicity (completely absent at levels less than $4.9 \mu\text{mol}\cdot\text{L}^{-1}$).⁵ When 2% lidocaine was utilized, potentially toxic serum concentrations of local anesthetic occurred in two subjects ($31 \mu\text{mol}\cdot\text{L}^{-1}$ and $41 \mu\text{mol}\cdot\text{L}^{-1}$, respectively),¹⁴ which were markedly greater than the reputed toxic threshold of $13\text{--}21 \mu\text{mol}\cdot\text{L}^{-1}$.¹⁵ While none of the patients receiving lidocaine for Cesarean section developed outward signs of clinical toxicity, this may have been simply a result of interpatient differences in sensitivity. Nevertheless, based upon the peak serum concentrations of bupivacaine and lidocaine achieved in the above study, along with consideration of the reported toxic serum concentrations of these drugs, bupivacaine would appear to have a larger margin of safety than lidocaine when administered through a proven epidural catheter. Finally, the concentrations of bupivacaine utilized in the previously mentioned studies are in the range that has been associated with antiarrhythmogenic effects in both an *in vitro* model of ischemia/reperfusion injury,¹⁶ and an *in vivo* postinfarction model of arrhythmia.¹⁷ As predicted based upon all of the above considerations, this technique provided a stable, controlled fetal-maternal hemodynamic environment throughout labour and during the ensuing Cesarean section.

Due to the complex interactions between maternal-fetal physiology and the operating room environment in the patient with an AICD, close coordination between the anesthesiologist, cardiologist, and obstetrician regarding peripartum management is of highest importance.

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