

The use of potent inhalational agents for the ex- utero intrapartum treatment (EXIT) procedures: what concentrations ?

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Abstract : The anesthetic management of a parturient undergoing ex-utero intrapartum treatment (EXIT) procedures for airway control of a newborn with a potentially life-threatening difficult airway is complex and often challenging. We herein report on the successful anesthetic management of the EXIT procedure in a 30-year-old primigravida carrying a fetus with large cervical lymphangioma. General anesthesia was maintained with sevoflurane 2%, combined with continuous infusion of nitroglycerine (TNG). Although the use of high concentrations of potent inhalational agents (to keep the uterus fully relaxed) is currently recommended we believe that the use of low concentrations of potent inhalational anesthetics with continuous infusion of TNG may be a safer anesthetic strategy for these operations.

Key words : Pregnancy, Cesarean section, obstetric anesthesia, Fetal surgery ; in utero surgery, EXIT procedure ; anesthesia ; Fetal airway ; difficult airway.

INTRODUCTION

Recent advances in the antenatal diagnosis and treatment of fetal congenital malformations including the malformations of the fetal airway has led to the development of ex-utero intrapartum treatment (EXIT) procedures on the newborn. These very rare procedures which often include the management of the potentially difficult neonatal airway before severing the umbilical cord are performed in conjunction with an elective Cesarean section (1-3). These complex and often challenging procedures are also known as fetal intrapartum operations on placental support (OOPS). The anesthetic management (usually general anesthesia) of parturients undergoing EXIT procedures is complex and very different from standard Cesarean sections (1-3). Although the use of high concentrations of the potent inhalational agents in order to keep the uterus fully relaxed is currently recommended we believe that the low concentrations of potent inhalational agents combined with continuous infusion of nitroglycerine may be an alternative, and safer anesthetic strategy for these procedures. We herein present a case of a parturient who underwent EXIT procedure

under the low concentrations of potent inhalational agents combined with continuous infusion of nitroglycerine.

REPORT OF CASE

A 30-year-old primigravida, who was 157 cm tall and weighed 55 kg, presented to our clinic at 33 weeks of gestation with antenatal diagnosis of fetal congenital anomaly consisting of cervical lymphangioma confirmed by the magnetic resonance imaging (MR) studies. The fetal cervical mass consisted of multiple cystic structures with two largest lesions measuring $42 \times 53 \times 72$ mm (in the left side of the neck) and $22 \times 26 \times 33$ mm (in the right side of the neck), respectively. Because of irregular uterine contractions, polyhydramnion and steady fetal tumor growth elective Cesarean section was scheduled at 34 weeks gestation.

Prior to the induction of general anesthesia, lumbar epidural catheter was placed in a standard manner and fentanyl, 100 µg with morphine, 3 mg were administered through the catheter to supplement general anesthesia. For maternal surveillance, ECG and pulse oximetry, as well as continuous arterial pressure with a radial arterial catheter were

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Figs. 1 and 2. — Neonate with potentially difficult airway (secondary to large cervical lymphangioma) following intubation on placental support during the EXIT procedure.

monitored. General anesthesia was induced in a routine manner (rapid sequence induction with cricoid pressure) with intravenous sodium thiopental, 200 mg and succinylcholine, 60 mg. The anesthesia was maintained with 2% sevoflurane in oxygen. In order to relax the gravid uterus, TNG, 200 μ g was administered intravenously (single bolus) prior to the uterine incision followed by continuous intravenous infusion of TNG at 0.3 μ g/kg/min during the procedure. After uterine incision, the fetal head and neck were delivered while the rest of the body remained in the uterus until the fetal airway was secured (direct laryngoscopy and endotracheal intubation with 3.0 mm internal diameter of tracheal tube) (Figs. 1 and 2). The correct positioning of the endotracheal tube was confirmed with the flexible bronchoscopy. The fetal heart rate and fetal blood oxygen saturation (SpO_2) were monitored with the sterile ultrasound probe on the fetal chest and pulse oxymeter, respectively. Total time from uterine incision to the delivery was 22 minutes. Uterine relaxation was adequately achieved and the patient's hemodynamics remained stable with 5 mg of intravenous ephedrine for a hemodynamic support. Total blood loss was 1540 grams and was replaced with 1000 mL of autologous blood transfusion. The depth of maternal anesthesia was monitored with Bispectral Index (BIS) and remained under 65 throughout the surgery. Total duration of surgery was 65 min without any complications.

DISCUSSION

The anesthetic management (usually general anesthesia) of pregnant women undergoing EXIT

procedures is significantly different from anesthetic considerations for a standard Cesarean section (1-8). First, unlike a standard Cesarean section there is no need to limit induction of anesthesia to delivery time (1-3). Second, the deep volatile anesthesia (often exceeding 2 MAC) with sevoflurane or isoflurane (often in combination with continuous intravenous infusion of nitroglycerine) is recommended by most authors to maintain full uterine relaxation (4-7). Third, maintenance of maternal intraoperative blood pressure and cardiac output might at times necessitate continuous intravenous infusions of dopamine (1-3). The fetus is only partially delivered from the uterus with maintenance of placental support for the duration of time needed to establish the fetal airway.

During the EXIT procedure for airway control of a newborn with a potentially life-threatening (difficult) airway, general anesthesia with high concentration of inhalational anesthetic has been traditionally recommended (4-7). Although uterine relaxation effect of the potent inhaled anesthetic agents may provide adequate conditions necessary for the EXIT procedure, there is little information available regarding the potential side effects of these high concentrations of anesthetic agents on the mother and the fetus (or the newborn). One may anticipate that high concentration of inhalational anesthetic could depress cardiac contractility and decrease cardiac output of the fetus or the newborn in spite of the fact that the blood pressure and the fetal O_2 saturation (SpO_2) were maintained during the procedure (4-6). Because inhalation agents readily cross the placenta they may directly affect the fetal condition. Furthermore, duration of inhalational anesthetic exposure may be prolonged in the

EXIT procedure as compared to the routine Cesarean section. Some fetuses subjected to the EXIT procedure may be preterm, as in our case, and therefore more sensitive to the effects of inhalation agents in high concentrations. In consideration of these inhibitory effects of the inhaled anesthetics on the maternal and fetal hemodynamics, we believe that the concentrations of inhalational anesthetic agent should be reduced (if possible) to those commonly used (e.g., 0.5-1.0 MAC) for routine Cesarean sections.

To avoid the risks of general anesthesia, CLARK *et al.*, reported on the use of the combined spinal-epidural (CSE) anesthesia in conjunction with the intravenous infusions of NTG (8). Although the case reported by the authors was uneventful, it is possible that the CSE technique combined with intravenous NTG infusion may increase the risk of severe hypotension. In fact, the patient reported by CLARK *et al.*, required two intravenous boluses of phenylephrine, 75 µg (on each occasions) and two boluses of ephedrine, 10 mg (on each occasion) to maintain the maternal blood pressure within normal limits. Furthermore, the dose of nitroglycerine used by CLARK *et al.*, was 100 µg, followed by 40 µg/min. This may be below the dose required to maintain the peak concentration following the initial bolus, as well as in our case. In consideration of mean volume distribution of NTG, 3.8 L and the drug clearance $4.4 \text{ L} \cdot \text{min}^{-1}$ in some patients (9), the appropriate dose to maintain the peak concentration following the initial bolus of 100 µg will be $100 \cdot 4.4 \cdot 3.8^{-1} = 118 \text{ µg/min}$.

Therefore, in conclusion we believe that the potent inhalational anesthetic agents used in routine

(e.g., 0.5-1.0 MAC) concentrations combined with intravenous infusions of nitroglycerine seem a reasonable and safe alternative strategy for anesthetic management of EXIT procedures.

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