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Anesthesia for Non-Obstetrical Surgery during Pregnancy

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Abstract

The number of surgical procedures in gravid women unrelated to pregnancy itself has been increased over years. In such cases, one must keep in mind the responsibility for two patients, the optimization and maintenance of maternal homeostasis, avoiding alterations on uteroplacental perfusion that can bring harm to the fetus. This review focus on safety to performing these procedures during pregnancy, considering the advances in the prevention and treatment of obstetric and fetal morbidity related to anesthesia.

Background and Objectives: Despite research advances, there is still much controversy in the anesthetic management of obstetric patients. Several studies have demonstrated the safety of anesthesia in this group of patients. In this review an analysis of anesthetics used in clinical practice is proposed as well as the technique to be chosen and its effects on the mother and fetus in non-obstetric surgery during pregnancy.

Content: There was made a revision based on the main articles in the literature encompassing the epidemiology, physiological changes during pregnancy, anesthetic management, possible risks to the fetus due to the use of anesthetic drugs, fetal monitoring, and procedures such as fetal surgery and laparoscopic during pregnancy.

Conclusion: Non-obstetric anesthesia in pregnant patients has proven to be safe in terms of maternal and fetal outcome, maternal morbidity and mortality, teratogenicity, premature birth and fetal loss.

Keywords: Obstetric anesthesia; Non-obstetric surgery; Fetus outcomes

Introduction

An average of 1-2% of pregnant women in developed countries is submitted to anesthesia for non-obstetrical surgery with a range of 80,000 procedures per year [1-5]. Intra-abdominal pathologies are the most commonly encountered surgical emergencies in pregnant women and diagnosis is hampered by factors such as nausea, vomiting, constipation, abdominal distension and pain related to normal pregnancy. Moreover, the physical examination of the abdomen in pregnancy has peculiar features particularly in the last weeks of pregnancy which can lead to late diagnosis.

Appendicitis, cholecystitis, ovarian torsion, maternal malignancies and trauma are among the most common indications for surgical intervention. Appendicectomies are about 25% of these procedures (1:2,000 pregnancies) [6]. The position of the appendix during pregnancy alters, resulting in displacement of the McBurney's point which can difficult diagnosis, and classic signs of peritonitis may therefore be reduced or absent [7,8]. Cholecystectomy is the second most frequently performed procedure (8-10:10,000), due to a state of gallbladder's dyskinesia which increases the chance of stone formation [9].

Anexial disease is also not uncommon and surgery may be required for diagnosis or treatment of ovarian pathology. In such situations, laparoscopic approach is increasingly being used. About 1 to 8% of anexial masses diagnosed during pregnancy are malignant and the delay in addressing them can worsen the outcome [10,11]. Less common are cardiac and neurologic surgeries [12,13].

Deep physiological changes accompany the three trimesters of pregnancy leading to a modified response to anesthesia and surgical procedures [14]. Evidence supports the concept that surgery during pregnancy is safer than it was thought to be in the past. It is recommended that non-obstetrical elective surgery, whenever possible, should be postponed until delivery. In cases which it is not possible, depending on the urgency of the indication, the procedure can be best scheduled in the mid trimester. It is due to a lower risk for teratogenicity which is more likely to happen in the first-trimester of gestation, or preterm labor, with greater risk in the third trimester. After this period functional changes in the fetus may occur, but structural abnormalities are rare. Even though, approximately 42% of surgical procedures occur in the 1st trimester, 35% in the 2nd quarter and 23% on 3rd trimester and the highest rate of first trimester could be explained by the large number of undiagnosed pregnancies [14]. Manley and collaborators showed a 1.2% incidence of pregnancy in adolescents who underwent surgical procedures [15].

The goal is to keep safety both to mother and to the fetus, preventing premature labor triggered by surgical procedure or drugs administered during anesthesia.

Physiological Changes of Pregnancy

The primary physiological changes occur under the influence of pregnancy hormones, which are essential to ensure an adequate supply of oxygen and nutrients to the fetus, and the mother's body

preparation for childbirth. Also secondary changes occur as a result of mechanical effects by the enlarged pregnant uterus [16]. There is a 60% increase in oxygen demand and the mechanical displacement of the abdominal organs leads to a decrease in residual volume. The increased oxygen consumption and increased minute ventilation increases tidal volume about 40%, which rapidly decreases PO_2 during apneia [2]. Maternal obesity, pre-eclampsia, or both can accentuate the risk of hypoxaemia associated with induction of and emergence from general anaesthesia [16]. The tracheal intubation may be more difficult due to airway edema and friability of oropharyngeal tissues, and tracheal tubes of smaller sizes should be used specially in third trimester [17,18]. Studies have shown that problems with airway management are the most common cause of maternal mortality related to anesthesia in pregnant patients [18]. A compensatory respiratory alkalosis with $PaCO_2$ 30-35 mmHg develops. The increase in pH is limited by the increased renal excretion of bicarbonate [17].

Concerning the cardiovascular system, the blood volume increases by fifty percent while the amount of red blood cells increases by 25%, causing a physiologic anemia in pregnancy [19]. Thus, there is a higher volume of distribution of drugs [4]. A physiological hypoalbuminemia in pregnancy is accompanied by an increase in the concentration of alpha-1-glycoprotein, changing the free fraction of drugs and increasing their toxicity [9].

The uterine enlargement from week twenty causes compression of the vena cava and descending aorta in the supine position, decreasing the venous return about 20%. Pregnant women outweigh this hypotension increasing sympathetic tone, by vasoconstriction and tachycardia, which may decrease uterine blood flow, causing stress to fetus [17]. Particularly, in the presence of neuraxial anaesthesia, the supine position can predispose the mother to hypotension, especially after the 20th week of gestation [16].

Due to compression of the vena cava detailed above, the patient should be placed in the left lateral decubitus or the operating table rotated by 15° to the left, if possible, to increase venous return and decrease hypotension leading to decreased uterine flow and harm the fetus after 20-24 weeks of pregnancy [20]. The physiological demands of pregnancy over the cardiovascular system may precipitate descompensation of heart valve disease or aortic dissection in susceptible patients [12].

In early pregnancy, gastric emptying remains the same [21]. With the evolution of pregnancy, higher intra-abdominal pressure and decreased pressure of the lower esophageal sphincter may increase the risk of aspiration. In this context the cricoid pressure must be used to prevent aspiration during intubation [2]. In these patients, the tone and gastric motility also decreases as a result of increased levels of progesterone and displacement of the stomach by enlarged uterus [17]. Gastric emptying time is not prolonged during pregnancy, but overall gastrointestinal time is [22]. During pregnancy the response of the autonomic nervous system against hemodynamic changes is biphasic. In the first trimester, there is an increased vagal tone and decreased sympathetic activity. A gradual transition occurs from the second trimester, leading to a lower vagal tone and increased sympathetic activity [23].

Studies in pregnant women have shown a reduction of up to 40% on the minimum alveolar concentration of volatile anesthetics due to progesterone's effects [14,24]. The total volume of the epidural and subarachnoid spaces is reduced during pregnancy, once the compression of the inferior vena cava produces engorgement of the epidural venous plexus. This fact leads to more extensive spreading of local anesthetic agents administered during the neuraxial block in these patients [14].

Coagulation also changes from the first weeks of pregnancy until the last trimester. There is a hypercoagulable state due to an increase in coagulation factors VII, VIII, IX and X, fibrinogen, plasminogen and decreased antithrombin III, protein C and S. Estrogens may also increase blood viscosity [25,23]. The platelet production is increased, but total count may be decreased due to dilution. Therefore, pregnancy itself is a risk factor for venous thromboembolism [26]. Of main importance is early mobilization in postoperative period, with compressive devices to the lower limbs and prophylactic anticoagulation which is recommended for patients who cannot deambulate [26].

Teratogenicity

Definitive answers about anesthetic effects on the developing human fetus have not been achieved yet. It's well known that anesthetic drugs affect cell signalling, mitosis, and DNA synthesis, which are involved in cellular differentiation and organogenesis [4]. The most vulnerable period of fetal organogenesis is between days 15-56. As such, any drug given during pregnancy could have a deletery effect in the fetus depending on the dose, the route of administration, and the timing of exposure [27]. Despite years of animal studies and observational studies in humans, no anaesthetic drug has been shown to be clearly dangerous to the human fetus and there is no optimal anaesthetic technique. The search for a clear answer is hampered by the fact that it would not be ethical to conduct a randomized trial on pregnant patients and no animal model perfectly mimics human gestation [27].

Fetal Hypoxia

It is extremely important maintaining homeostasis in the intrauterine environment during the perioperative period. The major risk factor for the fetus during maternal surgery is intrauterine asphyxia. The challenge for anesthesiologist in this context is to maintain the normal maternal hemodynamics and oxygenation, thus preventing fetal asphyxia. Maternal oxygenation, hyper or hypocarbia, hypotension, uterine hypertonus are factors that must be controlled to prevent fetal asphyxia. Short periods of hypoxia are well tolerated, but prolonged periods lead to vasoconstriction, reducing uteroplacental perfusion, resulting in fetal hypoxia, acidosis, and finally death [14,28]. Other studies have shown that fetal morbidity is most related to underlying diseases of the fetus and not actually by the effects of anesthetic agents [20].

Premature Birth

The risk for preterm labor is increased after intra-abdominal surgery, in consequence of mechanical disruption, local inflammation or both [29]. After non-obstetric surgery patient should be monitored and in the presence of any signs of preterm labor, tocolytic therapy should be started [30].

Anesthesia Techniques

Both general and regional anesthesia can be used [31]. If general anesthesia is chosen, it is important to take into account the physiological changes discussed above and proceed denitrogenation,

rapid sequence induction and Sellick maneuver, after aspiration prophylaxis [30]. It is important to remember that, during pregnancy, plasma cholinesterase levels are reduced by 25% since the beginning of pregnancy until the 7th day postpartum. The neuromuscular block may be prolonged with the use of nondepolarizing agents [14].

Regional anesthesia (spinal/epidural) for smaller abdominal surgery is associated with lower drug exposure, less effect on the variability of fetal heart rate and better postoperative analgesia. However, there is no evidence showing that the type of anesthesia (local or general) influence the outcome [32,33]. Propofol may be a good option for keeping uterus relaxed, but its effects in the fetus still lack of consistent information [34]. While some authors have found no adverse effects, others have shown ataxy and hallucinations in the newborns whose mothers were submitted to a propofol prolonged infusion [35,36]. Isoflurane is known to produce neurotoxicity in the fetus while it's controversy if sevoflurane and desflurane can cause same damages [37]. Despite sevoflurane is one of the most used agentes it was recently suggested that it could lead to neurotoxicity in newborn mices [37,38]. It's known that nitrous oxide has effects on the DNA synthesis and thus can lead to teratogenicity [39]. Some studies have shown that newborns who were exposured to nitrous oxide in utero during the third trimester of pregnancy or during labour may have transient neurological sequel and impared neurocognitive development [40].

Remifentanil is a good option for these patients once unlike other opioids, it is rapidly metabolized by nonspecific blood and tissue esterases. The context-sensitive half-time is only 3 to 4 minutes, regardless the duration of infusion [38]. Some studies have reported association between cleft palate, cardiac malformations and benzodiazepines exposure during pregnancy. Nevertheless, later studies have failure in demonstrate this correlation [16,41].

Fetal Monitoring

The decision to use fetal monitoring should be individualized. Some case reports have shown that continuous intraoperative fetal monitoring, when possible, avoids bad outcomes for the fetus. The monitoring strategy is chosen influenced by factors such as whether fetal monitoring will alter the handling of the case, if it is physically possible to carry out continuous monitoring intraoperatively, and if there is fetal viability [4]. It's mandatory to verify the fetal condition and presence or absence of uterine contractions [21]. One must have knowledge of the effects of anesthetic drugs on fetal heart rate, not wrongly interpreting variations in fetal heart rate induced by drugs [42].

Anesthesia in Special Situations

Trauma

The incidence of trauma in pregnancy is around 6-7% [43]. According to the ATLS priorities, the care and treatment of traumatized pregnant women are the same as non-pregnant patient, but the anesthesiologist must keep in mind the changes in anatomy and physiology that alter the usual responses to anesthesia, as discussed above [43].

Laparoscopic Surgery

Recently, studies have shown that laparoscopic procedures can be performed during pregnancy with good fetal outcomes and maternal satisfactory. A study in Sweden with about 2 million pregnant women who underwent laparotomy or laparoscopy procedures showed no differences in outcome of pregnancy comparing both techniques [16]. Some details should be observed such as: use an open technique to enter the abdomen, monitor maternal end-tidal PCO_2 to avoid fetal hypercarbia and acidosis, maintain low pneumoperitoneum pressure or use gasless technique, limit the extent of Trendelenburg or reverse Trendelenburg positions and initiate any position slowly, and, finally, monitor fetal heart rate and uterine tone when feasible [16].

Anesthesia for Treatment Extrautero Intrapartum (EXIT)

The EXIT procedure (ex utero intrapartum treatment) consists in keeping the placental circulation during cesarean until the airway of the fetus can be ensured. These procedures are performed with some frequency in the presence of cervical or oropharyngeal masses, or other issues that may compromise the airway of newborn [43]. Cesarean section is normally taken under general anesthesia, the fetal head is immersed, but the placental circulation is maintained intact until the neonatal airway is secured by intubation or surgical means. This king of procedure is only performed in some ultra-specialized centers with very precise indications (eg, myelomeningocele). The anesthetic technique for this procedure should offer: Anesthesia for mother, adequate uterine relaxation, anesthesia and immobility of the fetus during its manipulation [43,44].

Conclusion

Non-obstetric surgery during pregnancy is not uncommon and can have excellent results, providing that it takes into account the physiological and anatomical changes in these patients. The challenges include maintenance of normal maternal physiological function, optimize or maintain utero-placental blood flow and oxygen demand, avoid stimulating the myometrium and prevent harm to the fetus. One must keep in mind, however, that most of the studies regarding teratogenicity of anesthetic drugs, for ethical reasons were performed in animals and their results can't be extrapolated to humans.

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