

Perioperative care of a pregnant trauma victim: a review of anesthetic considerations

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Introduction

Trauma is defined as a disease process that occurs with seasonal and geographic variation; it is most prevalent during summer and in industrial (urban) areas.¹ Common risk (trauma-predisposing) factors include environmental conditions such as heavy traffic and bad weather, and/or physical conditions such as intoxication, fatigue, or pregnancy. Trauma in pregnancy is currently a leading cause of non-pregnancy-related maternal death, and maternal death remains the most common cause of fetal demise.²⁻⁵ The most common etiologies of trauma in pregnancy include transportation accidents, falls, violent assaults, and burn injuries.⁶ Women of childbearing age are among the population at greatest risk for trauma. This article will review the current considerations for the optimal obstetric, anesthetic, and surgical management of pregnant trauma victims.

General concepts

The recent literature documenting obstetric, anesthetic and surgical management of pregnant trauma victims is limited.^{4,5,7-9,10-13} In general the difficulty in perioperative management of reproductive age female trauma victims increases from no pregnancy present preoperatively to pregnancy present preoperatively. The difficulty in perioperative management of pregnant trauma victims also increases from elective, to urgent, to emergent situations.^{4,9} The anatomic and physiologic changes of pregnancy such as increased oxygen requirements, decreased functional residual lung capacity, and "full stomach" may increase the difficulty of perioperative management,

while decreasing the time available and the margin of safety.

The pregnant trauma victim presents a unique spectrum of challenges to the trauma healthcare team. The surgical diagnosis may be unknown at the time of incision, as may be the nature and extent of the procedure being undertaken. The fact that pregnancy may not always be known to be present to the health care team (at the scene of transportation accidents, in the emergency room, or in the operating room) additionally complicates the situation. Pregnancy must always be suspected (until proven otherwise) in any female trauma patient of child-bearing age.⁴

Physiologic changes during pregnancy

The perioperative management of pregnant trauma victims requires the obstetrician, the anesthesiologist, and the trauma surgeon to consider and understand the unique changes in anatomy and physiology that take place during pregnancy (Table 1). During the first trimester of pregnancy, the bony pelvis protects the uterus and the fetus from direct injury. During the second trimester, the gravid uterus ascends out of the bony pelvis and displaces abdominal viscera in the cephalad direction. During this time, the anatomic pattern of injury may be more variable, and the gravid uterus may shield other structures (mesentery, stomach) from direct traumatic injury.

The cardiovascular changes during pregnancy may complicate the evaluation of intravascular volume, the assessment of blood loss, and the diagnosis of hypovolemic shock.¹⁴ Maternal hemodynamic measurements may not accurately reflect the status of the uteroplacental circulation. Physicians providing care to pregnant trauma victims should remember that pregnancy maximally dilates the uterine vasculature, so that autoregulation is absent, and uterine blood flow is entirely dependent on maternal mean arterial blood pressure (MAP).

Pregnancy represents a state of accelerated but compensated intravascular coagulation, which has both advantages and dis-

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System involved	Change ("+" increase or "-" decrease)
<i>Central nervous system:</i>	
Minimal alveolar concentration (MAC) for general anesthetics	- 40%
<i>Cardiovascular system:</i>	
Peripheral vascular resistance	-15%
Heart rate	+15%
Stroke volume	+30%
Blood volume	+35%
Cardiac output	+40%
Plasma volume	+45%
<i>Pulmonary system:</i>	
Functional residual capacity (FRC)	-20%
HCO ₃	-15%
PaCO ₂	-15%
PaO ₂	+10%
Respiratory rate	+15%
Oxygen consumption	+20%
Tidal volume (VT)	+40%
Minute ventilation (MV)	+50%
<i>Hematologic system:</i>	
Hemoglobin	-20%
Clotting factors	+50-200%
<i>Renal system:</i>	
Glomerular filtration rate (GFR)	+50%

Pregnancy trimester	Incidence of traumatic injury
First	8%
Second	40%
Third	52%

advantages for the pregnant trauma victim.^{2,14} Increased levels of coagulation factors may improve hemostasis following trauma, however, at the same time parturients remain at increased risk for thromboembolic complications during periods of immobilization. Because buffering capacity during pregnancy is diminished, pregnant trauma victims rapidly develop metabolic acidosis during periods of hypoperfusion and hypoxia.

The obstetric airway

The use of general anesthesia has been steadily declining in obstetric patients¹⁵, however, in selected cases (such as an emergent abdominal delivery in a pregnant trauma victim), it may still be necessary. Since difficult intubation is frequently unexpected, careful preanesthetic evaluation of all parturients (including pregnant trauma victims) should identify the majority of patients with difficult airway and subsequently avoid unexpected difficult airway management.¹⁶

Obstetric considerations

Trauma to the abdomen and the gravid uterus threatens both the mother and the fetus.^{2,4,5,11,13} Because the fetus is dependent on its mother for its oxygen requirements, an uninter-

rupted supply of oxygenated blood must be provided to the fetus at all times. Although it occurs infrequently, trauma-related uterine rupture may be life threatening; maternal mortality rates approach 10%, while fetal mortality rates may approach 100%. Placental abruption complicates 1-5% of minor injuries and 20-50% of major injuries. Except for maternal death, placental abruption is the most frequent cause of maternal death after trauma. Fetal death, resulting from injuries to the obstetric patient is most commonly associated with placental abruption.^{2,10}

Compression of the vena cava by the uterus reduces venous return to the heart thereby decreasing cardiac output and exacerbating preexisting shock. Unless a spinal injury is suspected, the pregnant patient should be transported and evaluated on her left side. Although diagnostic irradiation poses a risk to the fetus, necessary radiographic studies should be obtained.^{17,18} If the mother's condition is stable, the status of the fetus and the extent of uterine injury determine further management. A potentially viable fetus that shows no signs of distress should be monitored by external ultrasonography. Since premature labor is always a possibility in these patients, an external tocotransducer should be used to detect the onset of uterine contractions. If premature labor ensues, tocolytic therapy may be initiated. When a viable fetus shows signs of distress, despite successful resuscitative measures, a cesarean delivery must be performed expeditiously. A nonviable fetus may be managed conservatively in utero to optimize maternal oxygenation and circulation. Primary repair of all maternal wounds should be attempted in a critically injured mother carrying a viable gestation, even at the expense of fetal well-being.

Abdominal trauma

Trauma to the abdomen and the gravid uterus may result from MVAs, falls and violent assaults. The prevalence of violence against pregnant women has been reported to range from 0.9 to 20.1%.^{13,19} Gazamarian et al. concluded that violence against pregnant women might be more prevalent than pregnancy specific disorders such as preeclampsia, gestational diabetes, and abnormal placentation.¹⁹ Violent assaults may include blunt trauma or penetrating trauma, or both, to the pregnant women's abdomen. Falls may result from an unstable gait often associated with pregnancy. The incidence of trauma increases with each pregnancy trimester (Table 2); 8% of injuries occur during the first trimester, 40% of injuries during the second trimester, and 52% during the third trimester.² The incidence of splenic injuries and retroperitoneal hemorrhage is greater in pregnancy due to the pregnancy-induced increased tissue vascularity.

Penetrating abdominal trauma usually results from gunshot wounds (GSW) and/or stab wounds to the gravid uterus, or it may be sustained during a MVA. Crosby et al. in a retrospective study of pregnant women involved in MVAs found that maternal death was the most frequent cause of fetal demise.²⁰ After penetrating abdominal trauma fetal death rates often exceed maternal death rates with maternal death rate of 5% of cases and fetal death rate of 59-80% of cases.

Head and neck injury

Head and neck injuries, respiratory failure and hypovolemic shock constitute the most frequent causes of trauma-related

maternal death in pregnancy.² The most common etiologies of head injuries include transportation accidents and falls.²¹

In the head-injured reproductive-age-female trauma victims there appears to be a number of conflicting constraints pertinent to the perioperative management, and particularly to the management of the airway. These usually include: 1) an uncertain intracranial pressure (possibly elevated), 2) an uncertain cervical spine (possibly fractured), 3) an uncertain airway (possibly difficult), 4) an uncertain volume status (possibly decreased), 5) an uncertain level of consciousness (possibly comatose or combative), 6) an "uncertain stomach" (almost always full), 7) an uncertain oxygenation (possibly decreased), and finally 8) an uncertain obstetrical status (possibly pregnant).

If there is an uncertainty about the integrity of the cervical spine, direct laryngoscopy should be avoided, and fiberoptic (awake fiberoptic) intubation of the trachea, if feasible (time constraints, and/or equipment availability), should be considered.⁸ If direct laryngoscopy is deemed necessary, an "in line stabilization" of the head and neck by an assistant to prevent extension and rotation of the cervical spine is indicated. If awake fiberoptic intubation of the trachea is selected it is essential to titrate analgesic and sedative drugs carefully to maintain continual meaningful verbal communication between the anesthesiologist and the patient. Respiratory depression and aspiration of stomach contents during the application of a local anesthetic agent is much less likely to occur if the patient remains awake and alert. In addition, a rational alert mother minimizes the risk of neonatal depression. Midazolam is the benzodiazepine recommended for these purposes, however, it is highly unionized and very lipophilic, and its fetal/maternal ratio is 0.76 at 15-20 minutes after maternal administration. However, unlike other benzodiazepines, the ratio falls rapidly. No adverse fetal effects have been reported.¹⁶

It has been empirically established that trauma victims with a GCS of 8 or less usually require intubation and mechanical ventilation for both, the airway control and control of the intracranial pressure. However, trauma victims with "good" GCS's can "talk and deteriorate/die" following traumatic head injury, particularly an injury associated with loss of consciousness, and delayed deterioration has been observed up to 48 hours after the initial insult.

The succinylcholine-induced ICP increase has been a concern in the past, nevertheless; recent analysis of the problem has shown that the magnitude and clinical importance of this increase have been grossly exaggerated. It is currently believed that when there is an urgent need to secure an airway in the head-injured pregnant trauma victim, succinylcholine is an appropriate and safe drug, and it should be used. All of the intravenous anesthetic agents (except ketamine) cause some degree of vasoconstriction, and therefore decrease in cerebral blood flow (CBF). All of the inhaled agents have some cerebral vasodilatory effect; however, their administration is usually consistent with acceptable ICP levels.^{22,23}

There seems to be no ideal "best" way of perioperative management of the head-injured pregnant trauma victim. The best approach should incorporate all the various factors listed above, and should be determined by the relative weight of these factors. Nevertheless, the A.B.C or resuscitation should always be an initial higher priority than ICP of neuroanesthesia, and aggressive maternal resuscitation should always be the

initial highest priority, which often proves lifesaving for both the parturient and her fetus.

Burns

The incidence of pregnancy in women admitted to hospital with thermal injuries has been estimated at 6.8 to 7.8%.^{24,25} The maternal and fetal outcome is related to the extent, presence or absence of complications of thermal trauma and to the gestational age of the fetus. In parturients with 25-50% of the total body surface area (TBSA) burned the mortality rates reach 63% for both the mother and the fetus.²⁶ Urgent delivery has been considered the treatment of choice in term or near term pregnant women with extended burn injury.²⁷ As is true for any trauma victim, initial treatment of the parturient with thermal injury should involve attention to the airway, breathing, and circulation. Pulmonary function can be directly or indirectly affected by thermal injury. Direct inhalational injury is usually manifested as upper airway edema, which can lead to life-threatening airway obstruction. However, lower airways can also be subjected to direct thermal injury or can be injured by exposure to smoke and/or toxic products of combustion.

Indications of inhalational injury include facial burns, singed nasal hair or eyebrows, stridor, hoarseness, soot in sputum, respiratory distress, or history of combustion in a close space. Many patients with inhalational injury, however, do not demonstrate any signs until several hours post-exposure. Major burns can alter pulmonary function even in the absence of direct lung injury. For example, vascular permeability can be increased throughout the entire microcirculation system and may contribute to the development of pulmonary edema and acute respiratory distress syndrome (ARDS). Within hours after a burn the patient becomes hypermetabolic. The manifestations usually include hyperthermia, increased oxygen consumption, tachypnea, tachycardia, and increased serum catecholamine levels.²⁸

Indications for early intubation include the presence of copious secretions, hypoxia and/or upper airway edema that may subsequently progress to airway obstruction. If in doubt, the trachea should be intubated before edema develops and intubation becomes technically difficult. Timely and aggressive anesthetic (including early control of the airway) and obstetric (including early delivery) management of the pregnant thermal trauma victim is vital for optimal maternal and fetal outcome.

Summary

The first priority in resuscitation of a pregnant trauma victim is stabilization of the mother, and only then should attention be directed to the fetus.²⁹ In general the initial resuscitation of the pregnant trauma victim should follow advanced trauma life support (ATLS) principles. Electronic fetal heart rate (FHR) monitoring helps guide obstetric, surgical and anesthetic management during maternal resuscitation, surgery and postoperative management in the intensive care unit.

Provision of care for the trauma patients (including pregnant trauma victims) is perhaps the highest challenge of the practice of obstetric and obstetrical anesthesia. It requires simultaneous provision of anesthesia and intensive care (volume resuscitation) to patients with injuries, which may not be fully assessed, and co-existing diseases, which may not be fully

known perioperatively. At the same time, provision of care to the trauma victims exposes the trauma health care provider to professional hazards such as hepatitis and the human immunodeficiency virus (HIV) as well as to medicolegal liability. Accidental injury, unplanned surgery, pregnancy loss, and the lack of established physician-patient relationship all may contribute to the risk of litigation.

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