

Research & Reviews on Pregnancy and Women's Health

Chapter 3

Trauma in Pregnancy

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1. Introduction

Trauma in pregnancy contributes 6% to 8% of all pregnancies and is the leading cause of nonobstetric maternal death. Injuries may be subdivided according to type and include blunt trauma, penetrating trauma, fractures, and thermal injuries. Poor fetal outcome is shown by maternal hypotension and acidosis (hypoxia, lowered pH, lowered bicarbonate) and a fetal heart rate of less than 110 beats/min. Poor socioeconomic conditions, inability to support families on a single income, and desire to pursue careers, have placed more women outside the home and at greater risk to undergo trauma [13].

When the mother sustains life-threatening injuries, there is a 40% chance of fetal death. Traumatic injuries lead to an increased risk for fetal death due to a high incidence of spontaneous abortion, preterm birth, preterm premature rupture of membranes, uterine rupture, cesarean delivery, placental abruption, and stillbirth. Factors associated with an increased risk for traumatic injury during pregnancy include young maternal age, domestic violence, lack of seatbelt use, and drug or alcohol use. Injured pregnant women were more likely to be younger, African American, have a high school degree or less, use public insurance, have high parity (3 or higher pregnancies), and received no prenatal care or less prenatal care especially in the first trimester [7]. The worst complication can be fetal compromise that threatens premature labor or even fetal death. Fetal death usually results from fetal hypoxia. Fetal hypoxia, and acidosis result due to a decrease in maternal hematocrit

The most important surgical risk to the fetus is preterm delivery. Before 23 weeks'

gestation, preterm delivery uniformly results in neonatal mortality. Major long-term defects associated with delivery at 24, 25, 26, and 28 weeks occur in 70%, 50%, 40%, and 20% of neonates, respectively. After 28 weeks' gestation, chances of survival are greater. Preterm labour in a trauma patient usually results from abruptio placentae. When the fetal head is engaged in the pelvis or maternal pelvic fractures are present, the likelihood of fetal skull and brain injuries is increased.

An alarming number of pregnant patients do not use seatbelts, leading to an increase in mortality statistics in road traffic accidents. Unbelted group had sharp increases of fetal deaths between 31 and 38 weeks' gestation. Women are simply unaware about the positioning of seatbelts [12]. During the second and third trimester, even relatively minor trauma can have significant adverse effects on the fetus. Such adverse effects include placental abruption, preterm labor, uterine rupture, and direct fetal injury.

Maternal cardiac death in trauma is related to more chances of failed intubation due to hyperemia, hypersecretion, and edema of the airway. Ventilation perfusion mismatch is poorly tolerated in pregnancy. Aortic caval compression can be seen as early as 20 weeks of pregnancy.

2. Maternal Anatomy and Physiology

2.1. Hemodynamic changes

Heart rate increases throughout pregnancy. Blood volume increases by a mean of 50% and increased uterine flow predisposes to excessive haemorrhage in trauma [15]. Pelvic fracture leads to retroperitoneal haemorrhage. Whiteblood cell count is elevated with increase in clotting factors and fibrinogen. Buffering capacity during pregnancy is diminished, pregnant trauma victims rapidly develop metabolic acidosis during periods of hypoperfusion and hypoxia. Increased levels of coagulation factors may improve hemostasis following trauma. Hypercoagulable state ensues and risk of thrombosis increases as levels of fibrinogen and Factors VII, VIII, IX, and X increase.

Supine hypotension syndrome may occur during the third trimester due to vena cava compression in the supine position.

2.2. Gastrointestinal tract

Shifting of the bowel upwards by gravid uterus serves to protect it during lower abdominal trauma but increases the risk of injury when penetrating trauma to the upper abdomen occurs late in pregnancy. Rebound tenderness and guarding may be less apparent in later gestation. Decreased gastric motility results in a prolonged gastric emptying time thereby increasing the risk of aspiration [16].

2.3. Respiration

Elevated diaphragm and difficult airway is anticipated [14]. Oxygen consumption is usually increased during pregnancy .

2.4. Renal function

Glomerular filtration rate is increased due to increase in renal blood flow. BUN and creatinine levels are decreased in pregnancy [17].

2.5. Musculoskeletal system

There is widening of symphysis pubis and increase in sacroiliac joint space.

3. Types of Trauma

- Blunt
- Penetrating
- Domestic violence
- Thermal burns
- Falls

3.1. Blunt trauma

Injury to the gravid uterus in second trimester leads to uterine laceration or rupture. Involvement of its contents (abruptio placentae or direct fetal injury), or adjacent organs (bladder rupture) are more likely to occur. There may be increased chances of retroperitoneal hemorrhage as a result of blunt abdominal trauma. The rate of fetal mortality after maternal blunt trauma is 3.4 to 38%. Generally maternal injury from blunt trauma is related to the large, engorged pelvic vessels that surround the gravid uterus. Damage to this vasculature can contribute to massive retroperitoneal bleeding with associated pelvic fractures.

Head and neck injuries, respiratory failure, and hypovolemic shock constitute the most frequent causes of trauma related maternal death in pregnancy [3]. This risk is associated with systemic and cerebral consequences of post-traumatic arterial hypotension, anoxia or anemia. Severe or prolonged traumatic coma is unpredictable because the maternal outcome remains largely unknown for days or weeks. In the head-injured reproductive-age-female trauma victims there is an unpredictable intracranial pressure ,possibly fractured cervical spine, an uncertain airway and an uncertain volume and CNS status.

3.2. Penetrating injuries

Penetrating abdominal trauma usually results from gunshot wounds and/or stab wounds

to the gravid uterus. Pregnant women are at decreased risk of death from penetrating abdominal trauma. The incidence of splenic injuries and retroperitoneal hemorrhage is greater in pregnancy. Penetrating trauma poses major risk for complex maternal bowel injury. Penetrating trauma to the uterus is strongly associated with poor fetal outcome [4]. Fetal death is dependent upon the degree of placental or umbilical cord disruption. Maternal injury associated with penetrating trauma depends on location and nature of the insult.

Penetrating injury mechanism, severity of abdominal injury and maternal hypotension on admission were independently associated with an increased risk for fetal demise following traumatic insult during pregnancy. Penetrating trauma poses major risk for complex maternal bowel injury because of the compartmentalization of the bowel in the upper abdomen by the enlarged uterus [21].

Gunshot wounds with peritoneal penetration need operative exploration because of a high visceral injury rate. Incidence of fetal mortality is high if the bullet entered the uterus especially if the placenta is torn by the bullet.

3.3. Road traffic accidents

Motor vehicle accidents may result in placental abruption and fetal loss because of exposure to the shearing acceleration-deceleration forces. Lack of seatbelt use has been found to be associated with fetal loss, particularly if the mother has experienced ejection from the vehicle and head trauma. Injury severity, associated abdominal and pelvic trauma and gestational age at MVA have shown to predict pregnancy outcomes after MVA. Clinically evident abruption occurs in as many as 40% to 50% of cases of severe blunt maternal trauma [19].

3.4. Falls

Loss of balance in pregnancy is common. Women in third trimester are at increased risk for preterm labor, placental abruption, cesarean delivery, fetal distress, and fetal hypoxia. Women in third trimester were at increased risk for preterm labor, placental abruption, cesarean delivery, "fetal distress," and fetal hypoxia [18].

3.5. Domestic violence

The prevalence of violence against pregnant women varies between 0.9% and 22.0%. Victims of physical abuse during pregnancy show occurrence of unspecified pregnancy diseases and also deliver more frequently a small-for-gestational-age newborn infant.

Women who are subjected to violence are more likely to smoke, drink alcohol, and use illegal drugs, and these unhealthy behaviors may be associated with preterm delivery. High physical demanding activity, sexually transmitted diseases, and nutritional deprivation are at-

tributing factors. Assaults are significantly associated with uterine rupture and lead to placental abruption and low birthweight. Intentional trauma during pregnancy has a 2.7-fold risk for preterm birth and low birthweight [20].

3.6. Thermal burns

Major burns (>50%TBSA) may result in maternal hypovolemia and cardiovascular instability in addition to sepsis, respiratory distress, renal failure, and liver failure. Preterm labor may result from maternal hypovolemia, which can also result in decreased uteroplacental perfusion.

Individuals who suffer from major burns may also sustain inhalation injuries, which carry higher maternal mortality and fetal risk [23].

4. Management

4.1. Initial assessment

The most important initial step in the management of the pregnant trauma victim is a thorough evaluation and stabilization. The CDC panel recommends that women with a pregnancy of at least 20 weeks' gestation be transported to a trauma center with access to obstetric care. Following steps should be undertaken:-

4.1.1. Preparation and position of patient

- Position (tilt or wedge) is done to reduce the effects of aortocaval compression in the supine position,
 - Left lateral 15-30° (right side up) [23].
 - Manual displacement of uterus
 - Place wedge under spinal board if necessary
- Routinely administer Oxygen therapy
- Large-bore IV access
- Volume resuscitation (Crystalloid infusion)

4.1.2. Airway management

Early ETT intubation

- Pre-oxygenation
- Consider cricoid pressure
- Consider smaller ETT
- Insert orogastric tube

4.1.3. Respiratory compromise

High-flow Oxygen 100%

- Consider tube thoracostomy in 3rd or 4th rib space if pneumothorax or haemothorax
- Control obvious haemorrhage
- 2 x large-bore IV access- hand and arms are easier to cannulate than lowerlimbs
- Recognise occult bleeding
- Commence Crystalloid infusion
 - Assess response
 - Avoid volumes > 2 L
- FAST
- Consider Massive Transfusion Protocol (MTP) activation
- Rapid transfer to O Tincase of penetrating injuries

5. Evaluation on Labor and Delivery

A thorough head to toe examination is performed for pregnant trauma patients and inspection of abdomen is done to look for ecchymosis or asymmetry as the injuries might suggest violence as a causative factor. Patients should be examined with scrutiny especially for any concealed haemorrhage. Assessment of uterine tone, contractions, rigidity, tenderness, palpable fetal parts is done.

Pelvic examination begins with sterile speculum examination to allow direct visualization to enable detection of possible trauma in the genital tract, the degree of cervical dilation, and the source of any observed vaginal fluid. Vaginal bleeding suggests placental abruption, and a watery discharge suggests rupture of the membranes.

Abdominal computed tomography may be considered as an alternative to diagnostic peritoneal lavage or open lavage when intra-abdominal bleeding is suspected.

6. Fetal Evaluation

History should be taken for foetal age. All pregnant women more than 20 weeks should be monitored by cardiotopography for atleast 6 hours. The standard FAST exam is performed to evaluate for intraperitoneal hemorrhage .

If fetus is at or beyond 24 weeks' gestation, the recommended time for monitoring is at least 4 hours from the occurrence of the trauma¹. Monitoring should be continued in abnormal fetal heart activity or vaginal bleeding is present. If deteriorating fetal status is apparent, delivery is indicated at a viable gestational age even if placental abruption is not clinically evident. Anti-D immunoglobulin should be given to all rhesus D-negative pregnant trauma

patients'

Additional dosing may then be supplemented by Kleihauer-Betketest . Rh antigen develops by 6th week gestation age. As little as 0.001 ml of blood may sensitize a RH negative mother. Kleihauer-Betke should be performed in all Rh negative patients with more than 12 week-gestation. Kleihauer-Betke is beckoned as a predictor of preterm labour [9]. If the Rh status of the fetus is unknown within 72 hours of delivery, Rh immune globulin should be administered.

An urgent obstetrical ultrasound scan should be undertaken when the gestational age is undetermined and need for delivery is anticipated.

Hospitalization and intermittent fetal heart rate and uterine activity monitoring by electronic foetal monitoring for 24 hours for patients with

- uterine tenderness,
- significant abdominal pain,
- vaginal bleeding

Ultrasonography is a rapid, non-invasive, valuable tool in the assessment of pregnant trauma patients. FAST is an easy and rapid modality that has the added advantage of avoiding fetal exposure to ionizing radiation, it should therefore be part of the secondary survey in pregnant patients with major trauma.

Ultrasonography may assist in:

- determination of gestational age
- demonstration of fetal cardiac rate and rhythm
- placental localization
- assessment of amniotic fluid volume
- cervical length assessment
- fetal well-being (biophysical profile)

7. Complications

7.1. Placental injury

The leading cause of fetal death after blunt trauma is placental abruption. Placental separation results when the inelastic placenta shears away from the elastic uterus during sudden deformation of the uterus. It occurs in 5-50% of cases, depending on the severity of injury. It is the most common cause of fetal death in cases of blunt trauma.

Abruption can occur with little or no external sign of injury to the abdominal wall. Classic clinical findings of abruption are vaginal bleeding, abdominal cramps, uterine tenderness, maternal hypovolemia (up to 2 L of blood can accumulate in the gravid uterus), or a change in the fetal heart rate. Placental abruption is associated with an increased risk of stillbirth (>20 weeks) and preterm delivery (before 37 weeks) even with minor abruption.

Women with placental abruption are more likely to have coagulopathies than those without abruption. The injured placenta can release thromboplastin into the maternal circulation, resulting in DIC,

7.2. Uterus rupture

It is seen more frequently with a scarred uterus or with direct abdominal impact during the latter half of pregnancy. Majority of uterine ruptures involve the fundal area. The degree of rupture may vary from complete avulsion of the uterus to serosal haemorrhage. Suspected uterine rupture with maternal and/or fetal compromise should prompt urgent laparotomy to control bleeding and facilitate resuscitation.

Amniotic fluid transmits high pressures efficiently, blast injuries can follow blunt trauma, resulting in rupture of the uterine fundus, maternal diaphragm and liver, or specific intracavityfetal injury [11].

7.3. Preterm labour

Trauma is associated with a 2-fold higher risk of preterm delivery. The risk is higher with increasing injury severity and among those injured early in gestation. Signs of preterm labour should be sought in every patient with a viable fetus. Foetal monitoring should be used to assess regularity and frequency of contractions.

7.4. Direct foetal injury

Direct fetal injury from blunt abdominal trauma often involves the fetal skull and brain. One possible mechanism involves fracture of the maternal pelvis in late gestation with engaged head. Fetal demise was found to be associated with increasing ISS, increasing face and abdominal AIS, increasing fluid requirements, maternal acidosis and maternal hypoxia [10].

7.5. Preterm premature rupture of membranes

Premature rupture of membranes (PROM) is the rupture of the fetal membranes before the onset of labor. In most cases, this occurs near term, but when membrane rupture occurs before 37 weeks' gestation, Placental abruption is seen in 4% to 12% of pregnancies complicated by preterm PROM, and is more common in pregnancies complicated by preterm PROM prior to 28 weeks [24].

Preterm PROM is associated with a 4-fold increase in perinatal mortality and a 3-fold increase in neonatal morbidity,

8. Exploratory laparotomy in pregnant patients

Indications for surgical exploration include penetrating trauma to the upper abdomen, gunshot wounds to the abdomen, clinical evidence of active intraabdominal hemorrhage, or suspicion for bowel injury.

Fetal death occurring prior to surgical exploration, vaginal delivery after induction of labor may be a preferable approach. Surgical uterine evacuation is done if the mother is under the effect of anesthesia. Caesarean delivery is planned in non-reassuring foetal status.

9. Prevention from Trauma

Pregnant women should wear their seatbelts with the shoulder harness portion positioned over the collarbone between the breasts and the lap belt portion under the pregnant abdomen as low as possible on the hips and across the upper thighs and not above or over the abdomen.

Risk factors for poor mental health during pregnancy include past personal or family history of psychiatric illness or substance abuse, past personal history of sexual, physical or emotional abuse, current exposure to intimate partner violence, current social adversity and coincidental adverse life events.

There is a much higher prevalence of antenatal depressive disorder at 12–16 weeks (6.1%) as opposed to the third trimester (4.4%) of pregnancy [25].

Improving maternal mental health should be the norm in developing countries by raising awareness, securing appropriate care to family members, reduce stigma and strengthen emotional well-being.

All pregnant women should be screened for domestic violence during each trimester. There should be education seminars for clinicians to perform cardiopulmonary resuscitation (CPR) for the pregnant woman.

10. References

1. Pearlman MD, Tintinalli JE, Lorenz RP. A prospective controlled study of outcome after trauma during pregnancy. *Am J Obstet Gynecol.* 1990; 162(6): 1502-1510.
2. Schiff M, Holt V. Pregnancy outcomes following hospitalization for motor vehicle crashes in Washington State from 1989 to 2001. *American Journal Epidemiology.* 2005; 161(6): 503.
3. Connolly A, Katz VL, Bash KL, McMahon MJ, Hansen WF. Trauma and pregnancy. *Am J Perinatol* 1997; 14: 331-336.

4. American College of Obstetrics and Gynecology. ACOG criteria set. Initial maternal – fetal assessment following acute abdominal trauma. *Int J Gynecol Obstet* 1996; 53: 93-94.
5. Daponte A, Khan N, Smith MD, Gegiannis E. Trauma in pregnancy. *S Afr J Surg* 2003; 41: 51-54.
6. El-Kady D, Gilbert WM, Anderson J, Danielsen B, Towner D, Smith LH. Trauma during pregnancy: An analysis of maternal and fetal outcomes in a large population. *Am J Obstet Gynecol.* 2004; 190(6): 1661-1668.
7. Petrone P, Talving P, Browder T, et al. Abdominal injuries in pregnancy: A 155-month study at two level 1 trauma centers. *Injury.* 2011; 42(1): 47-49.
8. Muench MV, Baschat AA, Reddy UM, Mighty HE, Weiner CP, et al. (2004) Kleihauer-Betke testing is important in all cases of maternal trauma. *J Trauma* 57: 1094-1098.
9. Hoff WS, D'Amelio LF, Tinkoff GH, et al. Maternal predictors of fetal demise in trauma during pregnancy. *SurgGynecol Obstet.* 1991; 172: 175–180.
10. Hyde, Cook, Olson Effect of motor vehicle crashes on adverse foetal outcomes ACOG 2003; 102(2): 279-286.
11. Johnson HC, Pring DW. Car seatbelts in pregnancy: The practice and knowledge of pregnant women remain causes for concern. *BJOG* 2000; 107: 644–647.
12. Rudra A Ray A, Chatterjee S, Bhattacharya C, Kirtania J, Kumar P, Das T, Ray V. Trauma in pregnancy *Ind J Anaes* 2007; 57(2): 100.
13. Baker BW. Trauma. In: Chestnut DH, editor. *Obstetric Anesthesia: Principles and Practice.* St Louis: Mosby; 1999; 1041-1050.
14. Kuczkowski K. M., Reisner L. S., Benumof J. L., Airway Problems and New Solutions for the Obstetric Patient, *J ClinAnest* 2003; 5: 552-563.
15. Van Hook JW. Trauma in pregnancy. *Clin Obstet Gynecol.* 2002; 45: 414-424.
16. Stone K. Acute abdominal emergencies associated with pregnancy. *ClinObstetGynecol* 2002; 45: 553-561.
17. Naylor DF Jr, Olson MM. Critical care obstetrics and gynecology. *Crit Care Clin .* 2003; 19: 127-149.
18. Schiff MA: Pregnancy outcomes following hospitalization for a fall in Washington State from 1987 to 2004 *BJOG* 2008; 115: 1648.
19. Muench MV, and Canterino JC: Trauma in pregnancy. *Obstet Gynecol Clin North Am.* 2007; 34: 555.
20. Wiencrot A, Nannini A, Manning SE, and Kennelly J: Neonatal outcomes and mental illness, substance abuse, and intentional injury during pregnancy. *Matern Child Health J.* 2012; 16: pp. 979-988.
21. Brown HL: Trauma in pregnancy. *Obstet Gynecol* 2009; 114: 147.
22. Maghsoudi H, Samnia R, Garadaghi A, et al: Burns in pregnancy. *Burns* 2006; 32: pp. 246.
23. Tsuei BJ: Assessment of the pregnant trauma patient. *Injury* 2006; 37: 367.
24. Gonen R, Hannah ME, Milligan JE. Does prolonged preterm premature rupture of the membranes predispose to abruptio placentae? *Obstet Gynecol.* 1989; 74: 347–350.
25. Bunevicius R, Kusminskas L, Bunevicius A, Nadisauskiene RJ, Jureniene K, Pop VJ. Psychosocial risk factors for depression during pregnancy. *Acta Obstet Gynecol Scand.* 2009; 88: 599–605.