Managing trauma in the pregnant woman

This article discusses the major causes of trauma in pregnancy and outlines management strategies. The resuscitation model of airway, breathing and circulation is emphasized, with modifications appropriate to the physiological changes in pregnancy and the needs of the fetus.

In well-resourced countries, trauma is the commonest cause of death in young adults, including pregnant women, with rates increasing year on year. The majority of maternal deaths from trauma are the result of homicide or motor vehicle accidents. Fetal mortality rates are almost twice those of maternal mortality.

Management of the traumatized pregnant woman is similar to that of the non-pregnant woman, with important modifications to reflect the anatomical and physiological changes of pregnancy. While the mother's well-being always takes priority, effective resuscitation of the mother also provides the best resuscitation for the baby.

Causes and consequences of trauma

A degree of trauma occurs in up to 7% of pregnancies (Hoff et al, 1991). In the USA, motor vehicle accidents account for 55% of trauma cases in pregnancy, with domestic violence (22%) and falls (22%) being other leading causes (Connolly et al, 1997). Of the 261 deaths reported to the UK Confidential Enquiry into Maternal Deaths between 2006–8, 17 involved motor vehicle accidents, 13 were the result of suicide, 11 the result of murder and 1 the result of burns (Centre for Maternal and Child Enquiries, 2011). In the USA, homicide and motor vehicle accidents account for 36% and 32% respectively of deaths from trauma in the obstetric population (Harper and Parsons, 1997). In the 0.5% of pregnancies where severe trauma occurs, maternal mortality may be as high as 10%, with a perinatal mortality of up to 15%.

The commonest causes of maternal death are hypovolaemic shock and head injury. For the fetus, the commonest cause of death, apart from maternal death per se, is placental abruption. This may present some time after the episode of trauma, with concealed maternal blood loss of up to 2 litres.

An Australian population-based cohort study of 600 000 pregnant women reported a hospital admission rate of 3.5 per 1000 as a result of motor vehicle accidents. Immediate delivery was uncommon, but was associated with relatively poor outcomes, including antepartum haemorrhage, prematurity and perinatal death. The vast majority (96%) who remained undelivered following a motor vehicle accident had similar pregnancy outcomes to women not involved in motor vehicle accidents (Vivian-Taylor et al, 2012).

Blunt abdominal trauma, if not fatal for the mother, is usually not associated with poor fetal outcome, although repeated episodes (as is common with domestic violence) carry a poorer fetal prognosis than does a single episode.

Pattern of injury

The gravid uterus alters the pattern of injury in the pregnant female compared to non-pregnant counterparts. Abruption is a possible complication of blunt trauma, resulting from the shearing forces associated with sudden deceleration in motor vehicle accidents. It may lead to premature labour, massive haemorrhage and isoimmunization. Because adverse fetal outcome may occur in the apparent absence of other injuries, all victims of trauma should be closely monitored (Theodorou et al, 2000).

Uterine rupture complicates less than 1% of traumatic injuries, and is usually the result of a direct blow to the abdomen in later pregnancy (ACOG Educational Bulletin, 1998). Fetal death is almost inevitable in such circumstances, and there is a 10% maternal mortality from accompanying abdominal and orthopaedic injuries.

Around 30% of pelvic fractures are associated with injuries to internal organs such as the small bowel or bladder. Pelvic fracture may necessitate caesarean delivery. In late pregnancy, if the fetal head is engaged, pelvic fractures may be associated with fetal skull fractures and intracerebral haemorrhage.

Penetrating injuries such as stabbing and gunshot wounds commonly result in direct fetal injury.

Falls become increasingly common as pregnancy progresses, because of the altered centre of gravity and biomechanics; pregnant women are less stable and mobilize less effectively than their non-pregnant counterparts (Davies et al, 2002). About 27% of women have a fall in pregnancy (a higher incidence than in septuagenarian women), and 20% consult a doctor (Dunning et al, 2010). The resulting injuries range from simple sprains to fetal loss.

Non-accidental injury

Non-accidental injury, usually by a partner, should always be considered in the traumatized pregnant woman, particularly where the stated mechanism of injury is vague or implausible. Where domestic violence occurs, it com-

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monly starts or escalates in pregnancy, presumably because of the added vulnerability of the woman during that time.

Once the immediate trauma has been addressed, then attention should be turned to encouraging disclosure of any assault. Unfortunately, for a variety of reasons, women commonly deny the cause of their injuries or, having disclosed, decide not to press charges.

Detection of domestic violence and consequent offers of assistance may be aided by discussion with each woman directly at least once during her pregnancy, as well as by the provision of advice posters in the ladies' lavatories in antenatal clinics (Mezey and Bewley, 1997).

Prevention of trauma in pregnancy

Wearing seat belts dramatically decreases the mortality of pregnant women in motor vehicle accidents (Crosby and Costiloe, 1971). Unfortunately, a significant proportion of women are reluctant to wear seat belts when pregnant (Johnson and Pring, 2000) and, if worn incorrectly, a seat belt can contribute to traumatic injuries. The pregnant woman requires the three-point seat belt, comprising lap belt and diagonal strap, as wearing a lap belt alone may contribute to uterine trauma.

A correctly-positioned three-point seat belt reduces the risk of fetal trauma by 70%. The lap portion fits across the thighs and hips and under the 'bump', not across it, and the diagonal strap should lie between the breasts.

Assessment of the pregnant trauma victim

Initial assessment is likely to take place in the emergency department of a general hospital. Ideally, the patient should be seen and assessed by an emergency doctor, an obstetrician and an anaesthetist, as specific considerations need taking into account in the pregnant trauma victim:

1. There is an increased risk of regurgitation and aspiration of gastric contents because pregnancy hormones cause smooth muscle relaxation. This is especially relevant where the conscious level is reduced, making protection of the vulnerable airway essential.
2. The circulating blood volume increases by up to 1.5 litres at full term, and the pulse rate increases by 10–15 beats per minute. The consequent increase in cardiac output means that early signs of blood loss are hidden. Around 30% of the circulating volume may be lost before the blood pressure drops. Respiratory rate, pulse rate and pressure, capillary refill time and urine output all deteriorate before the blood pressure falls.
3. Abdominal findings are modified by the presence of the pregnant uterus, and signs of trauma may be masked. The pregnant uterus may undergo a whiplash-like injury, with consequent severe intra-abdominal bleeding from the veins of the broad ligaments. Retroplacental bleeding from a partial or complete placental abruption may not be immediately evident.
4. In all pregnant women of 20 weeks' gestation or greater, aortocaval compression will occur in the supine position, with consequently reduced venous return and reduced cardiac output. The gravid uterus must be displaced off the aorta and inferior vena cava, either manually by a skilled assistant (the most effective method), or by left lateral tilt of at least 15°. Where spinal trauma is suspected, tilt should occur only if the woman is strapped to a spinal board.

The initial assessment of any traumatized patient is based on the Advanced Trauma Life Support sequence, namely airway, breathing and circulation, with assessment of neurological status (D for disability).

The primary survey

In the primary survey, life-threatening conditions are recognized and treated, before moving on to the secondary survey, where a full assessment of the whole patient is undertaken, front to back and head to toe. The same procedure applies to the injured pregnant woman, but with the following important additions, bearing in mind the points outlined above:

Airway and breathing

Early recourse to intubation is crucial to protect the airway. This is essential where the woman is unconscious as a result of head injury.

Amniotic fluid embolus may accompany uterine trauma; it presents with acute respiratory compromise, cardiovascular collapse and disseminated intravascular coagulation, with catastrophic haemorrhage. The treatment is aggressive, supportive management.

Circulation

Close attention should be paid to the early, more subtle signs of hypovolaemia, as a fall in blood pressure is a late and ominous sign. There may be massive intra-abdominal or retro-placental blood loss without overt bleeding.

Resuscitative laparotomy may form part of the C (circulation) component, and this may include delivery of the fetus by caesarean section.

The feto-placental unit is an end organ, so is a sensitive indicator of maternal blood loss. The mother's physiological response to blood loss is to divert blood away from the placenta; cardiotocographic evidence of fetal distress may be the first sign of maternal hypovolaemia.

Coagulopathy, frequently severe and of rapid onset, may occur as a consequence of traumatic injury, as well as in the obstetric patient. Experience from trauma management in conflict zones suggests that early use of packed red cells and fresh frozen plasma in a ratio of 1:1 can help mitigate the severity of coagulopathy (Henning et al, 2011). Tranexamic acid is being increasingly used to prevent fibrinolysis developing, but its use has not been validated in pregnancy (Novikova and Hofmeyr, 2010).

Aortocaval compression must be minimized at all times.

If spinal trauma is diagnosed or suspected, the pelvis must not be tilted. If the woman is strapped to a spinal board, a wedge may be placed under the board, otherwise manual displacement of the gravid uterus is required.

In all cases of major trauma, including burns, the tetanus status of the victim should be ascertained, and appropriate action taken.

Uterine tightenings and abdominal tenderness frequently accompany blunt abdominal trauma, but in most cases they do not lead to premature labour (Pak et al, 1998). A period of observation of up to 72 hours is advisable under these circumstances, and opinions vary as to the advisability of administering tocolytics (Svinos, 2009).

A Kleihauer test detects fetal red blood cells in the maternal circulation. This may help detect placental abruption, irrespective of the woman's rhesus status, and is advised for all pregnant trauma victims (Muench et al, 2004).

A multidisciplinary faculty on the Management of Obstetric Emergencies & Trauma (MOET) course teaches a standardized approach to management, which reinforces the Advanced Trauma Life Support method, with the above modifications for the pregnant woman (Grady et al, 2007).

Managementofthepregnanttraumavictim

Assessment of the abdomen and fetus takes place between the primary and secondary surveys. Inspection and palpation of the abdomen may reveal bruising and tenderness, suggesting uterine trauma. A transverse or oblique fetal lie, with easily palpable fetal parts, may raise the suspicion of uterine rupture.

Fetal heart rate monitoring should be begun as soon as possible after basic maternal resuscitation, as it is a sensitive early indicator of abruption and fetal distress. Continuous electronic monitoring is more reliable than intermittent auscultation. Monitoring uterine activity will also help detect abruption. In prospective studies frequent uterine contractions in the first few hours after trauma are associated with serious injury and abruption, so a minimum of 4 hours' electronic fetal monitoring is advisable (ACOG Educational Bulletin, 1998).

Patients with less than one contraction per 10 minutes, no signs of fetal distress, no uterine tenderness and no serious maternal injuries do as well as their non-injured counterparts (Pearlman et al, 1990).

Investigations

Potentially life-saving investigations and interventions should not be delayed or omitted because of concerns about the unborn baby. The risk of missing maternal injury certainly outweighs the potential risk to the fetus.

Because of the increased incidence of childhood leukaemia with low doses of radiation, where possible the pregnant abdomen should be shielded and imaging involving non-ionizing radiation should be used, e.g. magnetic resonance imaging and ultrasound (ACOG Committee on Obstetric Practice, 2004). Ultrasound is recommended to detect previously unsuspected pregnancy in female trauma victims of reproductive age (Bochicchio et al, 2002).

Focussed assessment with sonography for trauma (FAST) is an established technique for detection of intraperitoneal haemorrhage. It has the same specificity and sensitivity (98 and 83% respectively) in pregnant and non-pregnant trauma victims (Goodwin et al, 2001), and can also assess fetal presentation, cardiac activity and amniotic fluid volume.

Delivery

The decision as to whether or not to deliver the baby by caesarean section depends on the severity of the injury, the need for other surgery and the gestation of the fetus, as well as the facilities and clinical skills available on site. Where potentially life-threatening maternal haemorrhage is suspected from uterine rupture or major placental abruption, or where amniotic fluid embolus is the working diagnosis, then the fetus must be delivered irrespective of gestational age and potential viability. Where fetal distress is diagnosed in a stable woman, delivery must be carefully considered, as neonatal survival is poor below 24 weeks' gestation.

If abdominal trauma is diagnosed or suspected, a trauma laparotomy is carried out, usually via a midline incision. In advanced pregnancy, the fetus should first be delivered by caesarean section, in order to gain access to the abdominal contents, which are generally 'shielded' by the gravid uterus. This applies even if the fetus is dead.

In a multi-institutional retrospective cohort study, 32 emergency Caesarean sections were performed over an 8-year period, with a mean estimated gestational age of 33 weeks (22–40 weeks). Fetal survival was 75% for those over 26 weeks' gestation with fetal heart activity present at the time of emergency caesarean section. Fetal deaths occurred where diagnosis of fetal distress was delayed in women with less severe injuries (Morris et al, 1996).

Where a patient has sustained pelvic trauma, massive concealed blood loss may occur, and the pelvis should be restored manually to its anatomical position. This is equally true in pregnancy, but the gravid uterus makes reduction of the fractures and application of an external fixator very difficult. Consequently, urgent caesarean section may be required in order to carry this out.

In severely traumatized patients, cardiopulmonary resuscitation may be required. Airway protection, minimizing aortocaval compression and ensuring early uterine evacuation are crucial factors in such life-threatening situations (Morris and Stacey, 2003).

Perimortem caesarean section

Perimortem caesarean section is required in the event of maternal cardiac arrest, to allow more effective cardiopulmonary resuscitation (Whitten and Irving, 2000). If the circulation has not been restored by 4 minutes of full resuscitation, then immediate steps should be taken to deliver the fetus, preferably within 5 minutes of the diagnosis of cardiac arrest. This will require the procedure to be carried out on the spot (usually in the accident and emergency department), using a pair of gloves and a scalpel. The midline incision is preferred, to allow trauma laparotomy if required. The choice of uterine incision, either classical or lower segment, will depend on surgical access, as well as the skill and experience of the operator.

Cardiopulmonary resuscitation must be continued throughout the operation, with the airway protected by endotracheal intubation. Where defibrillation is required, all staff should stand clear as usual. Bleeding is generally not encountered until cardiac output is restored. At this stage, a pack should be placed over the wound, and the woman taken to theatre for completion of the operation in sterile conditions, under general anaesthetic.

The secondary survey

The secondary survey takes place once life-threatening conditions have been detected and treated, and once fetal assessment and any necessary urgent interventions have been carried out. This is the opportunity to assess all systems in a systematic manner, in order to detect, and institute management of, any other injuries, including neurological and musculoskeletal.

Once the patient is stabilized, consideration may be given to organizing transfer to another unit for specialized further management. It must also be remembered that the pregnant trauma victim is at particularly high risk of venous thromboembolism, especially if pelvic trauma has been sustained. Appropriate thromboprophylaxis must therefore be instituted once haemorrhage has been controlled.

Burns

The incidence of severe burns in pregnancy is generally low. Where they do occur, be they flame, scald, chemical or electrical, multidisciplinary input should take place as soon as possible. Management is the same as for the non-pregnant patient, bearing in mind that in assessment of the extent of the area burnt, the pregnant abdomen will represent more than the notional 9% of body surface area.

Both maternal and perinatal mortality increase significantly if more than 50% of the body surface is burnt. Consequently, this is considered an indication for urgent delivery. Where the burn is less than 30%, then maternal and fetal survival are generally good.

KEY POINTS

- Pregnant women are at particular risk of aspiration of stomach contents. This may occur under anaesthesia, or where the conscious level is reduced by head injury or by drugs.
- Aortocaval compression is dangerous to mother and fetus, and must be minimized during assessment and treatment.
- A fall in blood pressure in the pregnant trauma victim is a late and ominous sign. Tachypnoea and tachycardia should be considered pointers to imminent hypovolaemic shock.
- Apparently minor abdominal trauma in pregnancy may lead to placental abruption, and appropriate assessment and monitoring should be instituted.
- FAST scanning is a safe and effective diagnostic tool in the pregnant trauma victim.
- The possibility of domestic violence should always be considered in the traumatized pregnant woman.

Conclusions

This article has presented an outline of the management of trauma in the pregnant woman, emphasizing the basic resuscitation model of airway, breathing and circulation. Circumstances and concerns specific to pregnancy have been detailed, including avoidance of aortocaval compression, and the technique of perimortem caesarean section. **BJHM**

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ACOG Educational Bulletin (1998) Obstetric aspects of trauma management. *Int J Gynaecol Obstet* **64**: 87–94

ACOG Committee on Obstetric Practice (2004) ACOG Committee Opinion No. 299: Guidelines for diagnostic imaging during pregnancy. *Obstet Gynecol* **104**(3): 647–51

Bochicchio GV, Haan J, Scalea TM (2002) Surgeon performed focused assessment with sonography for trauma as an early screening tool for pregnancy after trauma. *J Trauma* **52**(6): 1125–8

Centre for Maternal and Child Enquiries (2011) Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer: 2006–08. The Eighth Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG* **118** (Suppl 1): 1–203

Connolly AM, Katz VL, Bash KL, McMahon MJ, Hansen WF (1997) Trauma and pregnancy. *Am J Perinatol* **14**(6): 331–6

Crosby WM, Costiloe JP (1971) Safety of lap-belt restraints for pregnant victims of automobile collisions. *N Engl J Med* **284**(12): 632–6

Davies J, Fernando R, McLeod A, Verma S, Found P (2002) Postural stability following ambulatory regional analgesia for labor. *Anesthesiology* **97**(6): 1576–81

Dunning K, Lemasters G, Bhattacharya A (2010) A major public health issue: the high incidence of fall during pregnancy. *Matern Child Health J* **14**(5): 720–5

Goodwin H, Holmes JF, Wisner DH (2001) Abdominal ultrasound examination in pregnant blunt trauma patients. *J Trauma* **50**(4): 689–93

Grady K, Howell C, Cox C (2007) *Managing Obstetric Emergencies & Trauma; the MOET Course Manual.* RCOG Press, London

Harper M, Parsons L (1997) Maternal deaths due to homicide and other injuries in North Carolina: 1992-1994. *Obstet Gynecol* **90**(6): 920–3

Henning J, Woods K, Howley M (2011) Management of major trauma. *Anaesth Intens Care Med* **12**(9): 383–6

Hoff WS, D'Amelio LF, Tinkoff GH et al (1991) Maternal predictors of fetal demise in trauma during pregnancy. *Surg Gynecol Obstet* **172**(3): 175–80

Johnson HC, Pring DW (2000) Car seatbelts in pregnancy: the practice and knowledge of pregnant women remain causes for concern. *BJOG* **107**(5): 644–7

Mezey GC, Bewley S (1997) Domestic violence and pregnancy. *BJOG* **104**(5): 528–31

Muench MV, Baschat AA, Reddy UM et al (2004) Kleihauer-betke testing is important in all cases of maternal trauma. *J Trauma* **57**(5): 1094–8

Morris JA, Rosenbower TJ, Jurkovitch GJ et al (1996) Infant survival after Cesarean section for trauma. *Ann Surg* **223**(5): 481–91

Morris S, Stacey M (2003) ABC of resuscitation: Resuscitation in pregnancy. *BMJ* **327**(7426): 1277–9

Novikova N, Hofmeyr GL (2010) Tranexamic acid for preventing postpartum haemorrhage. *Cochrane Database Syst Rev* **7**: CD007872

Pak LL, Reece EA, Chan L (1998) Is adverse pregnancy outcome predictable after blunt abdominal trauma? *Am J Obstet Gynecol* **179**(5): 1140–1

Pearlman MD, Tintinalli JE, Lorenz RP (1990) A prospective controlled study of outcome after trauma during pregnancy. *Am J Gynecol* **162**(6): 1507–10

Svinos H (2009) BET2 The use of of tocolytic therapy in a pregnant trauma patient. *Em Med J* **26**(3): 203–4

Theodorou DA, Velmahos GC, Souter I et al (2000) Fetal death after trauma in pregnancy. *Am Surg* **66**(9): 809–12

Vivian-Taylor J, Roberts CL, Chen JS, Ford JB (2012) Motor vehicle accidents during pregnancy: a population-based study. *BJOG* **119**(4): 499–503

Whitten M, Irvine LM (2000) Postmortem and perimortem caesarean section: What are the indications? *JRSM* **93**(1): 6–9