Case presentation

28 Y F, 35 wks pregnant, MVA
PH: nil, Rh +ve
HPI: Driver, belted, rear ended by another car
C/O: abdominal pain
Unsure about fetal movements
ABC stable, BP 100/50 HR 118 RR 22
No signs of injuries on exam
FHR 140, no uterine contractions palpable, no guarding, no lap belt sign, no PV bleeding

Contents

- Physiological alterations
- Anatomical alterations
- Unique problems
- Diagnostic studies
- Management

Physiological alterations

- Minute ventilation
- Heart rate
- Cardiac output
- Blood volume
- Glomerular filtration rate
- Gastric emptying time
- pCO2
- Hematocrit
### Hemodynamic Changes of Pregnancy (Mean Values)

<table>
<thead>
<tr>
<th></th>
<th>Non P.</th>
<th>Trim. 1</th>
<th>Trim. 2</th>
<th>Trim. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>70</td>
<td>78</td>
<td>82</td>
<td>85</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>115</td>
<td>110</td>
<td>102</td>
<td>114</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>70</td>
<td>60</td>
<td>63</td>
<td>70</td>
</tr>
<tr>
<td>Cardiac Output</td>
<td>4.5</td>
<td>4.5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>CVP</td>
<td>9.0</td>
<td>7.5</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Blood Vol (ml)</td>
<td>4000</td>
<td>4200</td>
<td>5000</td>
<td>5600</td>
</tr>
<tr>
<td>Hct (%)</td>
<td>40</td>
<td>36</td>
<td>34</td>
<td>36</td>
</tr>
<tr>
<td>WBC (cell/mm³)</td>
<td>7200</td>
<td>9100</td>
<td>9700</td>
<td>9800</td>
</tr>
</tbody>
</table>

### Fetus shock first
- With maternal blood loss, fetal distress precedes change in maternal vital signs

### Mother shock later
- As much as 30% of the maternal blood volume may be lost with little change in maternal vital signs; however, there may be severe reduction in placental blood flow, causing fetal distress or death
- Maternal death is the most frequent cause of fetal death after trauma

### Supine hypotensive syndrome
- At least 10% of women in late pregnancy will develop hypotension if placed in the supine position

### Coagulation studies
- During pregnancy, blood becomes hypercoagulable
  - Increased: factors VII, VIII, IX, X, XII, fibrinogen (double)
  - Decreased: plaminogen activator
Coagulation studies

- Normal concentrations of coagulation factors in critically ill pregnant woman → DIC
- Decreasing fibrinogen levels are the most sensitive indicator of DIC in pregnant woman with placental injury and are an indication for prompt induction of labor

Alterations in anatomy

- 12th week
  - Becomes abdominal organ
- 20th wk
  - At umbilicus
- 34~36 wk
  - At costal margin
- 38~40 wk
  - Head engages pelvis

Abdominal pain

- Peritoneum → decreased sensitivity during pregnancy → less pain and tenderness → more difficult to diagnose intraabdominal injury based on Hx and PE

Trauma risks

<table>
<thead>
<tr>
<th>1st Trimester</th>
<th>2nd Trimester</th>
<th>3rd Trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Abortion</td>
<td>1. Abruptio placenta</td>
<td>1. Pelvic fractures</td>
</tr>
<tr>
<td></td>
<td>3. Isoimmunization</td>
<td>3. Direct fetal injury</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Abruptio placenta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Amniotic fluid embolism</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Isoimmunization</td>
</tr>
</tbody>
</table>

Trauma risks

- Aspiration risk
- Difficult ventilation
- Failure to recognize blood loss early
- Eclampsia
Blunt trauma

- Injury types
  - Head injury - most common
  - Retroperitoneal hemorrhage
  - Abruptio placenta
  - DIC
  - Uterine Rupture

Traumatic death

<table>
<thead>
<tr>
<th>Maternal death</th>
<th>Fetal death</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Head trauma</td>
<td>1. Maternal death / shock</td>
</tr>
<tr>
<td>2. Hemorrhagic shock</td>
<td>2. Abruptio placenta</td>
</tr>
</tbody>
</table>

Resuscitation of the mother takes precedence over that of the fetus

Seatbelt use

- 3 points restraints
- 1/3 ~1/2 improperly or don’t use belts
- 2.3 x give birth <48 h
- 4.1 x fetal death

Management

- Same as nonpregnant
- Same as nonpregnant
- Caution – chest tube placement
- Displace uterus and volume infusion
  - Caution – fetal shock
- Eclampsia vs brain injury
  - Caution – CT to exclude hematoma
- Same as nonpregnant

Cardiotocographic monitoring

- Essential for all pregnant women with trauma
- At least 4 h
  - Rate (120-160); if <100 → severe hypoxia
  - Beat-to-beat variability
  - Baseline variability
  - Decelerations, esp. late
Cardiotocographic monitoring

- Monitor >24 h if:
  - Vaginal bleeding
  - Spontaneous rupture of membrane
  - Fetal heart tone abnormality
  - Uterine contractions for at least four hours
  - High-risk mechanism of injury (automobile vs. pedestrian injury, high-speed MVA)
  - Uterine tenderness
  - Abdominal pain
  - Maternal anesthesia

When to consider fetal injury

- Vaginal bleeding
- Abruption placenta
- Uterine tenderness
- Uterine rupture
- Labor

Increased fetal mortality

Maternal hypotension
High maternal injury Severity Score
Ejection from a motor vehicle
Maternal pelvic fracture
Automobile versus pedestrian accidents
Maternal history of alcohol use
Young maternal age
Motorcycle crashes
Maternal smoking history
Uterine rupture

Radiographic studies

- American College of Obstetricians and Gynecologist (ACOG):
  - exposure to x-rays during a pregnancy is not an indication for therapeutic abortion
- Risk of spontaneous abortion, major malformations, mental retardation and childhood malignancy
  - Adverse effects are unlikely at less than 5-10 rads
  - It takes 50-100 rads to double the baseline mutation rate
  - Greatest risk at 10-17 wk of gestation (neurodevelopment)
Contrast-enhanced CT: large discontinuity representing uterine rupture (blue arrow). There is a considerable amount of blood (red arrow) in the pelvis.

Placental separation in a pregnant patient after trauma. CT scan shows submembranous and subchorionic hemorrhage.

Ultrasound

- Indicated for all pregnant women with moderate-to-severe abdominal trauma
  - Abdomen (FAST)
  - Uterus / placenta
  - Fetus

Uterine rupture

Bandl’s ring - a constriction located at the junction of the thinned lower uterine segment with the thick retracted upper uterine segment, resulting from obstructed labour. This is one of the classic signs of impending rupture of the uterus.

Chemical dependency

- For all injured pregnant women, the possibility of chemical dependency must be considered in the initial assessment
  - Screen for alcohol and illicit drugs

<table>
<thead>
<tr>
<th>Examination type</th>
<th>Estimated fetal dose per examination (rad)*</th>
<th>Number of examinations required for a cumulative 5-rad dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain films</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skull</td>
<td>0.004</td>
<td>1,250</td>
</tr>
<tr>
<td>Dental</td>
<td>0.0001</td>
<td>50,000</td>
</tr>
<tr>
<td>Cervical spine</td>
<td>0.002</td>
<td>2,500</td>
</tr>
<tr>
<td>Upper or lower extremity*</td>
<td>0.001</td>
<td>5,000</td>
</tr>
<tr>
<td>Chest (two views)*</td>
<td>0.00007</td>
<td>71,429</td>
</tr>
<tr>
<td>Mammogram</td>
<td>0.020</td>
<td>250</td>
</tr>
<tr>
<td>Abdominal (multiple views)*</td>
<td>0.245</td>
<td>20</td>
</tr>
<tr>
<td>Thoracic spine</td>
<td>0.009</td>
<td>555</td>
</tr>
<tr>
<td>Lumbarosacral spine</td>
<td>0.359</td>
<td>13</td>
</tr>
<tr>
<td>Intravenous pyelogram</td>
<td>1.308</td>
<td>3</td>
</tr>
<tr>
<td>Pelvis*</td>
<td>0.040</td>
<td>125</td>
</tr>
<tr>
<td>Hip Single view*</td>
<td>0.213</td>
<td>29</td>
</tr>
</tbody>
</table>
Kleihauer-Betke test

- Used to measure the amount of fetal hemoglobin transferred from a fetus to a mother's bloodstream
- Performed on Rh-negative mothers to determine the required dose of Rho(D) immune globulin (RhoGAM®)

RhoGAM for every trauma

- Rh-negative mothers receive immunoglobulin therapy, unless injury remote from uterus

Rho(D) immune globulin

RhoGAM® 300 µg: For antenatal and postpartum use, second- and third-trimester pregnancy terminations, or transplacental hemorrhage
MCIRhoGAM® 50 µg: For use immediately after first-trimester pregnancy termination

Kleihauer-Betke test

- RhoGAM® dose if KB test negative
  - Gestation under 13 wk: 50 µg
  - Gestation over 13 wk: 300 µg
- RhoGAM® dose based on KB test
  - 300 µg per 30 ml fetal whole blood
  - 300 µg per 15 ml pRBC

Take home message

1. Fetus shock first
2. Ultrasound and fetal monitoring >4 h
3. X-rays and CT if needed (~5 rads)
4. Fibrinogen level if placental injury
5. RhoGAM / KB test
What is best for the **mother** is best for the fetus!