Hemodynamic Changes in Obstetric Anesthesia

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Pregnancy is a “normal” healthy condition and is simultaneously the most common altered physiologic state to which human beings are subject.
Gestational Cardiovascular “Pathophysiology”

Spinal induced hypotension for Cesarean Delivery

Hemodynamics in Preeclampsia

Uterotonic medications: hemodynamic influences
Cardiovascular physiologic changes in pregnancy

**Body Water**

- estrogen
- renin increase
  - active sodium reabsorption in the renal tubules
  - increase in total body water from 6.5 to 8.5 L by the end of gestation
Cardiovascular physiologic changes in pregnancy

Edema

- ↓ Colloid Osmotic Pressure (COP)
  25 mm Hg → 18-20 mm Hg

- ↑ Capillary hydrostatic pressure ($P_c$)

- Total body water ↑ 6-8 L

- 4-6 L ↑ interstitial fluid

- Retention of 1000 mEq sodium

- 8/10 women have obvious edema during pregnancy
Cardiovascular physiologic changes in pregnancy

**Blood Volume**

Increased very early in the pregnancy, (6\textsuperscript{th} week) and reaches a 50\% increase by the 2\textsuperscript{nd} trimester.

Plasma volume increases by approximately 50\%, while the red blood cell mass by only 33\%.

- decreased Hb concentration
- diminished \(O_2\) carrying capacity
Cardiovascular physiologic changes in pregnancy

Cardiac output is gradually increasing at 8-10 wks gestation and reaching a 50% increase by term.

Thorn SA. Pregnancy in Heart Disease. Heart 2004; 90: 450-6
Cardiac Output Distribution

- 400 ml to the uterus
- 300 ml to the kidneys
- 300 ml to skin
- 300 ml to GIT, breast & heart
## Hemodynamics at Term

<table>
<thead>
<tr>
<th></th>
<th>Non pregnant</th>
<th>Pregnant</th>
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<tbody>
<tr>
<td>Cardiac output (l/min)</td>
<td>4.3 ± 0.9</td>
<td>6.2 ± 1.0</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>71 ± 10</td>
<td>83 ± 10</td>
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<tr>
<td>SVR (dyne-cm-sec^{-5})</td>
<td>1530 ± 520</td>
<td>1210 ± 266</td>
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<tr>
<td>PVR (dyne-cm-sec^{-5})</td>
<td>119 ± 47</td>
<td>78 ± 22</td>
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<tr>
<td>COP (mm Hg)</td>
<td>20.8 ± 1.0</td>
<td>18 ± 1.5</td>
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<tr>
<td>PCWP (mm Hg)</td>
<td>6.2 ± 2.1</td>
<td>7.5 ± 1.8</td>
</tr>
<tr>
<td>CVP (mm Hg)</td>
<td>3.7 ± 2.6</td>
<td>3.6 ± 2.5</td>
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Supine Hypotensive Syndrome of Pregnancy

Aortocaval compression

supine position

compression of the inferior vena cava by the enlarged uterus

obstruction of venous return

degreased cardiac output

degreased placental perfusion

degreased fetal oxygenation
ECG changes

- Attributed to the changes in the position of the heart
- The axis - left shifted by 15 – 28°
- QRS complexes become of low voltage
- T wave flattened in lead III, V1, V2
- Q waves may be present in leads III and AVF
Echocardiography in Pregnancy

- ↑ LA size
- ↑ Tricuspid valve area
- ↑ Mitral valve area
- ↑ LV wall thickness and mass (most persistent)
- Pericardial effusion
- Pulmonary regurgitation
- Tricuspid regurgitation
- Mitral regurgitation
- Mitral valve prolapse

Gestational Cardiovascular “Pathophysiology”

Symptoms
- Dyspnea on exertion
- Dizziness/fatigue
- Palpitations, orthopnea
- Edema
- Chest pain

Physical Exam
- Basilar pulmonary crackles
- S3 gallop (> 75%)
- Systolic flow murmur (> 90%)
- JVD
- CXR: cardiomegaly, pericardial effusion
Hemodynamics made simple

↓↓ SVR

↑↑ HR

↑↑ Vascular Volume

↓↓ COP
The pregnant patient with normal cardiac function can accommodate significant alterations in the CV system without difficulty.

However, these changes have major implications for anesthetic management, especially in high-risk patients.
Spinal anesthesia for Cesarean Section

Spinal block causes peripheral vasodilation and venous pooling, which may result in maternal hypotension.

Spinal induced hypotension without prophylactic measures, has a very high incidence (80%-100%).
(Why) Is Hypotension Bad?

What are we trying to prevent/treat?

**Uteroplacental hypoperfusion**
- 😞 Fetal acidosis
- 😞 Base deficit ⇒ ? Injury

**Maternal symptoms**
- 😞 Dizziness/“malaise”
- 😞 Nausea/Vomiting
Spinal anesthesia for Cesarean Section

Prophylactic measures include:

1) left lateral tilt
2) fluid preload
3) vasopressors
4) low dose spinal anesthesia
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