Pregnancy and Heart Disease: The Role of Echocardiography

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Overview:

- Normal hemodynamics in pregnancy
- Normal echocardiographic changes in pregnancy
- Case presentation
Hemodynamics During Pregnancy: Heart Rate

Hemodynamics During Pregnancy: Plasma Volume
Hemodynamics During Pregnancy: Stroke Volume

Increased cardiac output (CO = HR X SV)

- Increased metabolic requirements of mom and baby
- Preload↑, afterload↓, HR↑
- Normally CO rises 30-50% (1.8-2.0L)
  - Twins: increased by additional 20%, peaks 30 weeks
- Acutely influenced by posture
  - Highest left lateral decubitus position
  - Lowest supine (compression of IVC by gravid uterus)

- EJECTION FRACTION IS UNCHANGED!
Positional Changes in Cardiac Output

Hemodynamics During Pregnancy: RBC Mass
Hemodynamics During Pregnancy: Hematocrit

Benefits of physiologic anemia?

- Reduces blood viscosity
  - Reduces resistance to flow and facilitates placental perfusion, lower cardiac work

- Absence of physiologic anemia likely harmful
  - Increased risk of stillbirth, preterm, small

Post delivery as much as 500mL of blood sequestered in the uteroplacental unit is autotransfused to the mom

Stephansson et al JAMA 2000
Hemodynamics During Pregnancy: SVR

Drop in SVR

- Why? Low flow low resistance circuit in the uterus/placenta
- How?
  - Increased endothelial prostacyclin
  - Enhanced NO production
  - Reduced arterial stiffness: Relaxin

In animal models estrogen and prolactin can lower vascular resistance and increase cardiac output
Hemodynamics During Pregnancy: Blood Pressure

- Heart rate
- Stroke volume/CO
- Plasma volume
- RBC Mass
- Hematocrit

SBP

% change from pre-pregnancy value

Duration of pregnancy (weeks)

0 - 10 - 20 - 30 - 40 - 50

0 - 8 - 12 - 16 - 20 - 24 - 28 - 32 - 36 - Postpartum

RBC Mass

Hematocrit

SBP

Yucel, DeFaria Yeh. Curr Tr Opt CV Med 2017

Cardiac Output

Heart Rate

Plasma Volume

RBC Mass

Hematocrit

SVR

SBP

Duration of pregnancy (weeks)

Percent change from pre-pregnancy
### Physiologic Changes of Twin Pregnancy

<table>
<thead>
<tr>
<th></th>
<th>Term</th>
<th>Non-preg</th>
<th>Increase</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single (n=50)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood vol</td>
<td>4820</td>
<td>3250</td>
<td>1570</td>
<td>48</td>
</tr>
<tr>
<td>RBC vol</td>
<td>1790</td>
<td>1355</td>
<td>430</td>
<td>32</td>
</tr>
<tr>
<td>Hct</td>
<td>37</td>
<td>41.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Twins (n=30)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood vol</td>
<td>5820</td>
<td>3865</td>
<td>1960</td>
<td>51</td>
</tr>
<tr>
<td>RBC vol</td>
<td>2065</td>
<td>1580</td>
<td>485</td>
<td>31</td>
</tr>
<tr>
<td>Hct</td>
<td>35.5</td>
<td>41</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Labor and uterine contractions: normal heart

- PAP or PCWP (mm Hg): Normal values range from 10 to 20 mm Hg. Wedge pressures might be slightly higher, around 16 mm Hg.
- CVP (mm Hg): Normal values range from 5 to 10 mm Hg, with a slight rise to 20 mm Hg during contractions.
- Uterine pressure (mm Hg): Contractions typically increase pressure, but normal values are not provided in this graph.

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*Pritchard JA. Anesthesiology 1965;26:393.*

Normal Echocardiographic Changes in Pregnancy

Physiologic multivalvular regurgitation during pregnancy

- Campos et al. *Int J Cardiol* 1993 (18 pregnancies)
- Presence of physiologic valve regurgitation

<table>
<thead>
<tr>
<th>Valve</th>
<th>Early pregnancy</th>
<th>Full term</th>
<th>Early post partum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitral</td>
<td>0%</td>
<td>28%</td>
<td>0%</td>
</tr>
<tr>
<td>Aortic</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Tricuspid</td>
<td>39%</td>
<td>94%</td>
<td>83%</td>
</tr>
<tr>
<td>Pulmonic</td>
<td>22%</td>
<td>94%</td>
<td>67%</td>
</tr>
</tbody>
</table>
Echo Assessment of Cardiovascular Hemodynamics in Normal Pregnancy

Desai DK, Moodley J, Naidoo DP. Ob Gyn 2004

Table 6. Longitudinal Echocardiographic Structural and Function Changes in Pregnancy

<table>
<thead>
<tr>
<th>Gestation (wk)</th>
<th>Left atrium</th>
<th>Left atrium/aorta</th>
<th>Left ventricle filling*</th>
<th>L ventricle mass (g)</th>
<th>Left ventricle mass index (g/m²)</th>
<th>Left ventricle systolic function (%)³</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-19</td>
<td>3.0 ± 0.2</td>
<td>1.18 ± 0.12</td>
<td>2.1 ± 0.6</td>
<td>102 ± 16 (-15)</td>
<td>63 ± 10 (-15)</td>
<td>32 ± 4</td>
</tr>
<tr>
<td>20-23</td>
<td>3.1 ± 0.6</td>
<td>1.34 ± 0.28</td>
<td>2.1 ± 0.4</td>
<td>127 ± 18 (6)</td>
<td>77 ± 11 (4)</td>
<td>34 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.391</td>
<td>.428</td>
<td>.495</td>
<td>.038³</td>
<td>.099</td>
<td>.014⁴</td>
</tr>
<tr>
<td>24-27</td>
<td>3.2 ± 0.5</td>
<td>1.38 ± 0.23</td>
<td>2.1 ± 0.5</td>
<td>124 ± 23 (3)</td>
<td>75 ± 12 (1)</td>
<td>34 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.088</td>
<td>.431</td>
<td>.303</td>
<td>.096</td>
<td>.889</td>
<td>.277</td>
</tr>
<tr>
<td>28-31</td>
<td>3.2 ± 0.5</td>
<td>1.35 ± 0.23</td>
<td>2.0 ± 0.6</td>
<td>131 ± 24 (9)</td>
<td>78 ± 11 (5)</td>
<td>34 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.171</td>
<td>.335</td>
<td>.067</td>
<td>210</td>
<td>.376</td>
<td>.03²</td>
</tr>
<tr>
<td>32-36</td>
<td>3.2 ± 0.5</td>
<td>1.37 ± 0.23</td>
<td>1.8 ± 0.3</td>
<td>139 ± 30(16)</td>
<td>81 ± 13 (9)</td>
<td>33 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.457</td>
<td>.244</td>
<td>.208</td>
<td>.003²</td>
<td>.072</td>
<td>.074</td>
</tr>
<tr>
<td>37-term</td>
<td>3.5 ± 0.4</td>
<td>1.46 ± 0.17</td>
<td>1.8 ± 0.3</td>
<td>151 ± 55(26)</td>
<td>87 ± 15 (18)</td>
<td>35 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.016⁴</td>
<td>.006³</td>
<td>.309</td>
<td>.027²</td>
<td>.948²</td>
<td>.369</td>
</tr>
<tr>
<td>Postpartum</td>
<td>3.0 ± 0.5</td>
<td>1.27 ± 0.21</td>
<td>2.0 ± 0.5</td>
<td>120 ± 31 (0)</td>
<td>74 ± 16 (0)</td>
<td>32 ± 4</td>
</tr>
<tr>
<td>P</td>
<td>.002³</td>
<td>.005³</td>
<td>.045⁵</td>
<td>.001²</td>
<td>.003²</td>
<td>.130</td>
</tr>
</tbody>
</table>

Data are presented as absolute mean ± 1 standard deviation (percent change from baseline).

Percent change from baseline is calculated by comparing mean value for the measured parameter to the postpartum value.

P values indicate statistical change from preceding gestational period.

* Reflected by early diastolic to atrial filling ratio.

² Expressed as fractional shortening.

³ Statistically significant.

Maternal left ventricular diastolic and systolic long-axis function during normal pregnancy


- Transmirtal A velocity increases
- E/A ratio decreases over the course of a pregnancy
- Post partum returns to prepregnancy values
Normal echocardiographic changes

- Increased stroke volume thus increased LVOT VTI
  - Increased gradients across stenotic lesions
- Increase in all chamber sizes
- Increased disdensibility of the aorta
- IVC plethoric
- Ejection fraction should remain constant
- Slight decreases in E/A ratio
- Increase in valvular regurgitation (exception of aortic)
- Small pericardial effusion

Case:

- 22F G1P0 at 34 gestation who presents with increased dyspnea, orthpnea and palpitations
Heart Failure: Peripartum Cardiomyopathy

Idiopathic heart failure with reduced LVEF during late pregnancy or several months post partum

Peripartum Cardiomyopathy

Change in Incidence of Disease

**Peripartum Cardiomyopathy Risk Factors**

- Older maternal age, teenage pregnancy
- Multiparity
- Multiples pregnancy
- African descent, Haiti
- Hypertension, diabetes
- Prior toxin exposure (cocaine)
- Preeclampsia
- Smoking

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**Peripartum Cardiomyopathy**

*Time of Diagnosis*

![Graph showing number of patients diagnosed with peripartum cardiomyopathy by time of diagnosis. The graph indicates that the majority of diagnoses occur within the first month postpartum.](image)

Effect of Subsequent Pregnancy on Left Ventricular Function in Peripartum Cardiomyopathy

Elkayam U, et al. NEJM 2001;344:1569

Maternal Complications During Subsequent Pregnancies

Summary:

- Pregnancy is a stress test!
  - Increase HR, increased plasma volume, increased contractility
  - Underlying cardiac disease unmasked 28-32 weeks
- Chamber dimensions all increase in pregnancy as does valvular regurgitation, E/A may decrease a bit
  - All should return to normal post partum
- Hemodynamic shifts are not over when the baby is out!
  - Remember the post partum rise in SVR can uncover heart failure

Thank You!

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