Diagnosis of Venous Thromboembolism During Pregnancy & Postpartum

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Objectives

- To review evidence-based strategies for diagnosing VTE during pregnancy and postpartum
- To understand why CT and V/Q imaging perform differently in pregnant and postpartum women compared to nonpregnant populations
- To feel comfortable counseling women regarding risks and benefits of CT and V/Q imaging during pregnancy and postpartum
Case

• 38 yo G1 P0 @ 20 weeks with trichorionic triplets presents to the ED complaining of shortness of breath and pleuritic chest pain for the last hour.
Case

• This pregnancy was conceived via IVF after many failed cycles.
• The patient has significant anxiety related to this pregnancy, and has been on self-prescribed bedrest.
• No personal or family history of clotting.
Case

- Vitals: HR 120, BP 100/70, RR 30, SaO2 94% on room air
- Appears to be in mild distress
- Tachycardic on exam
- Lungs clear to auscultation bilaterally
- Mild symmetric lower extremity edema.
Case

• ED provider calls you for help.
• “I think she may have a PE. How do I work this up?”
VTE during pregnancy and postpartum

• Definition
  • VTE = DVT + PE

• Incidence
  • 0.76 to 1.72 per 1000 pregnancies
  • 4 times the risk of nonpregnant population
  • 2/3 of DVTs occur antepartum
    • Distributed relatively equally among all 3 trimesters
  • 43-60% of PEs occur postpartum
  • PE is leading cause of maternal death in developed countries
    • 1.1 to 1.5 deaths per 100,000 deliveries in U.S. and Europe
    • Accounts for 1/3 of all maternal deaths in the U.K.
VTE during pregnancy and postpartum

• Risk factors
  • History of VTE
  • Inherited or acquired thrombophilias
  • Black race
  • Heart disease
  • Sickle cell disease
  • Diabetes

• Lupus
• Smoking
• Multiple gestation
• Age >35 years
• Obesity
• Cesarean delivery (especially emergent during labor)
VTE during pregnancy and postpartum

• Classic signs/symptoms may be associated with normal pregnancy
  • Leg swelling
  • Tachycardia
  • Tachypnea
  • Dyspnea

• VTE confirmed in <10% of pregnant women in whom VTE suspected

• Objective testing should be performed expeditiously because of risk for sudden death

• Initiating treatment pending test results may be prudent
D-dimer
D-dimer

D-dimer

• Increases with advancing gestational age
• Relative increase with multiple gestation
• A negative result may spare a pregnant woman expensive imaging studies and radiation exposure (negative predictive value 100%)
• Cost analysis would be helpful
  • Would perform a lot of relatively cheap blood tests to avoid obtaining one relatively expensive imaging study
Compression ultrasonography

• Noninvasive, no radiation, risk-free
• 97% sensitivity, 94% specificity in the general population with symptomatic, proximal DVT
  • Less accurate for isolated calf and iliac vein DVTs
• Recommended in women with signs/symptoms of lower extremity DVT
• Consider in women with suspected PE and no signs/symptoms of lower extremity DVT
  • 30% of apparently isolated PEs associated with “silent” DVT
Compression ultrasonography

Before compression

With compression

Vein completely compressed

Vein does not compress
Chest imaging

- Plain film
- Computed tomography (CT)
- Ventilation/perfusion (V/Q, scintigraphy)
- All require use of ionizing radiation
### Table 2. Effects of Gestational Age and Radiation Dose on Radiation-Induced Teratogenesis

<table>
<thead>
<tr>
<th>Gestational Period</th>
<th>Effects</th>
<th>Estimated Threshold Dose*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before implantation (0–2 weeks after conception)</td>
<td>Death of embryo or no consequence (all or none)</td>
<td>50–100 mGy</td>
</tr>
<tr>
<td>Organogenesis (2–8 weeks after conception)</td>
<td>Congenital anomalies (skeleton, eyes, genitals)</td>
<td>200 mGy</td>
</tr>
<tr>
<td></td>
<td>Growth restriction</td>
<td>200–250 mGy</td>
</tr>
<tr>
<td>Fetal period</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8–15 weeks</td>
<td>Severe intellectual disability (high risk)</td>
<td>60–310 mGy</td>
</tr>
<tr>
<td></td>
<td>Intellectual deficit</td>
<td>25 IQ-point loss per 1,000 mGy</td>
</tr>
<tr>
<td></td>
<td>Microcephaly</td>
<td>200 mGy</td>
</tr>
<tr>
<td>16–25 weeks</td>
<td>Severe intellectual disability (low risk)</td>
<td>250–280 mGy*</td>
</tr>
</tbody>
</table>

*Data based on results of animal studies, epidemiologic studies of survivors of the atomic bombings in Japan, and studies of groups exposed to radiation for medical reasons (e.g., radiation therapy for carcinoma of the uterus).

*Because this is a period of rapid neuronal development and migration.


Radiation exposure

**Table 3. Fetal Radiation Doses Associated With Common Radiologic Examinations**

<table>
<thead>
<tr>
<th>Type of Examination</th>
<th>Fetal Dose (mSv)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Very low-dose examinations (&lt;0.1 mSv)</strong></td>
<td></td>
</tr>
<tr>
<td>Cervical spine radiography (anteroposterior and lateral views)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Radiography of any extremity</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mammography (two views)</td>
<td>0.001–0.01</td>
</tr>
<tr>
<td><strong>Chest radiography (two views)</strong></td>
<td>0.0003–0.01</td>
</tr>
<tr>
<td><strong>Low- to moderate-dose examinations (0.1–10 mSv)</strong></td>
<td></td>
</tr>
<tr>
<td>Radiography</td>
<td></td>
</tr>
<tr>
<td>Abdominal radiography</td>
<td>0.1–3.0</td>
</tr>
<tr>
<td>Lumbar spine radiography</td>
<td>1.0–10</td>
</tr>
<tr>
<td>Intravenous pyelography</td>
<td>5–10</td>
</tr>
<tr>
<td>Double-contrast barium enema</td>
<td>1.0–20</td>
</tr>
<tr>
<td>CT</td>
<td></td>
</tr>
<tr>
<td>Head or neck CT</td>
<td>1.0–10</td>
</tr>
<tr>
<td><strong>Chest CT or CT pulmonary angiography</strong></td>
<td>0.01–0.68</td>
</tr>
<tr>
<td>Limited CT pelvimetry (single axial section through the femoral heads)</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td></td>
</tr>
<tr>
<td>Low dose perfusion scintigraphy</td>
<td>0.1–0.5</td>
</tr>
<tr>
<td>Technetium 99m bone scintigraphy</td>
<td>4–5</td>
</tr>
<tr>
<td>Pulmonary digital subtraction angiography</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Higher dose examinations (10–50 mSv)</strong></td>
<td></td>
</tr>
<tr>
<td>Abdominal CT</td>
<td>1.3–35</td>
</tr>
<tr>
<td>Pelvic CT</td>
<td>10–50</td>
</tr>
<tr>
<td>(^{18}F) FET/CT whole-body scintigraphy</td>
<td>10–50</td>
</tr>
</tbody>
</table>

*Radiation doses are not cumulative and depend on the specific examination, patient size, and other factors. Clinical judgment is required when evaluating radiation risk.*

“With few exceptions, radiation exposure through radiography, computed tomography scan, or nuclear medicine imaging techniques is at a dose much lower than the exposure associated with fetal harm. If these techniques are necessary in addition to ultrasonography or magnetic resonance imaging or are more readily available for the diagnosis in question, they should not be withheld from a pregnant patient.”

-ACOG

Computed tomography

• Test of choice for imaging pulmonary vasculature in nonpregnant population

• Involves injection of iodinated contrast into a peripheral vein, then timing the scan so that contrast is passing through the pulmonary arteries while images are obtained

• The quality of CT depends on good contrast delivery and PERFECT TIMING
  • Frequently poor quality in young patients, ESPECIALLY PREGNANT WOMEN, because high cardiac output results in dilution of contrast and poor enhancement
Computed tomography

1. Optimal contrast timing.
2. Too late!
Computed tomography

• Modified protocol in pregnancy can improve adequacy of study from 64% to 90%

• Modifications include
  • Shallow inspiration breath-hold
  • High concentration/high rate of injection
  • High volume of contrast material

Ridge CA et al. AJR 2011.
Ventilation/perfusion

• Performs poorly in nonpregnant population

• Involves injection of radiolabeled chemical into maternal vein and inhalation of radiolabeled gas into maternal airway, then comparing distribution of radioisotope via ventilation and perfusion to look for a mismatch
  • Technetium 99m
  • Perfusion-only imaging can lower fetal radiation dose

• Adequacy of study adversely affected by respiratory comorbidities, which are relatively uncommon in pregnant population
  • V/Q MAY OUTPERFORM CT IN PREGNANT WOMEN as long as a chest X-ray is normal
Ventilation/perfusion

[Image of ventilation/perfusion scans]
Perfusion-only imaging
**CT vs V/Q**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>CT</th>
<th>V/Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondiagnostic rate</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Maternal radiation dose</td>
<td>2.2-6.0 mSv</td>
<td>1.4 mSv</td>
</tr>
<tr>
<td>Radiation-related maternal breast cancer risk</td>
<td>13% increase (1 in 8 baseline risk)</td>
<td>No increase (1 in 8 baseline risk)</td>
</tr>
<tr>
<td>Fetal radiation dose</td>
<td>3-131 uGy</td>
<td>640-800 uGy</td>
</tr>
<tr>
<td>Radiation-related childhood cancer risk</td>
<td>&lt;1 in 1 million</td>
<td>1 in 280,000</td>
</tr>
<tr>
<td>Breastfeeding</td>
<td>No interruption</td>
<td>May recommend interruption for 6 hours</td>
</tr>
</tbody>
</table>

Marik & Plante. NEJM 2009.
Published algorithm

Summary

• Role of D-dimer in evaluation of pregnant and postpartum women is unclear (cost analysis)

• Compression ultrasonography recommended if clinical concern for DVT, but negative result does not exclude possibility of clot (pelvis)

• Can also consider compression ultrasonography if clinical concern for PE but not DVT (30% incidence of “silent” DVT)

• V/Q performs better in pregnant and postpartum women than in nonpregnant populations, and has a lower nondiagnostic rate than CT

• Tradeoffs in risk for radiation-associated cancers for mother and child with CT and V/Q
Case

- I would start with a CXR
- If normal, consider V/Q
  - Talk to the radiologist at your institution before ordering an exam
- If abnormal, proceed with CT
- Consider a standardized protocol agreed upon by obstetricians and radiologists to improve efficiency
Questions?