CT Angiography for Pulmonary Embolism diagnosis during pregnancy and post-partum

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During pregnancy and post-partum

- Risk for venous thrombo-embolism increased by a factor of four
  - Heit, Ann Intern Med, 2005

- PE leading cause of maternal death in developed countries
  - Horlander, Arch Intern Med, 2003
What diagnostic algorithm?

- **Evaluating the clinical probability is not possible**
  - No specific score for pregnant/post-partum patients

- **D-dimers are often elevated**
  - Even normal D-dimers exclude PE only if clinical probability not high, which cannot be assessed

  Systematic investigation required
  PE Prevalence usually low (3.6% Shahir, AJR 2010)

  Check for obvious alternative diagnosis
  **CHEST RADIOGRAPHY**
Peripartum cardiomyopathy: a comprehensive review.
What diagnostic algorithm?

- Lower limb ultrasonography
  - Not consensual
  - STR/ATS Recommendation (RSNA 2010): only if symptoms of DVT

- Then Lung Scintigraphy (LS) or CTA?
  - Still debated
Learning objectives

• To review the role of CTA for PE diagnosis during pregnancy and post-partum
  – LS /CTA pros and cons

• To explain how to optimize CTA protocols
  – Low rate of non-diagnostic results
  – Low radiation dose

• To review key imaging findings
Learning objectives

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  – Radiation dose optimization

• To review key imaging findings
LS/CTA during pregnancy

- Fetal radiation dose
  - A little higher with LS
    - During the first and second trimester
    - MonteCarlo simulation
      - (Winer-Muram, Radiology 2002)
  - Quite negligible with both techniques
LS/CTA pros √ and cons ×

− **Lung Scintigraphy**
  × Not always available
  √ Breast radiation dose << << CTA
  √ Inconclusive results < general population

− **CTA**
  × Iodinated contrast medium: fetal thyroid dysfunction?
  √ Allows alternative diagnosis
  × Inconclusive results > general population
Lung Scintigraphy

× Not always available
✓ Breast radiation dose << CTA
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CTA

× Iodinated contrast medium: fetal thyroid dysfunction?
✓ Allows alternative diagnosis
× Inconclusive results > general population
- **Lung Scintigraphy**
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  - ✓ Breast radiation dose << CTA
  - ✓ *Inconclusive results < general population*

- **CTA**
  - ✗ Iodinated contrast medium: fetal thyroid dysfunction?
  - ✓ Allows alternative diagnosis
  - ✗ *Inconclusive results > general population*
Fetal thyroid dysfunction

- No risk before 16 weeks’ gestation
- Hypothyroidism reported with Amiodarone
  - Lomenick et al J Perinatol 2004
- Not with iodinated contrast injection
  - Bourjeily et al. Radiology 2010: « Neonatal thyroid function: effect of a single exposure to iodinated contrast medium in utero »
    - 334 newborns, all had normal T4 level at birth
LS/CTA pros √ and cons ×

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- CTA
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  × **Inconclusive results > general population**
Mycoplasma pneumoniae infection at 25 weeks’ gestation
Chest pain 6 days after vaginal delivery
Hamman’s syndrome

Postpartum pneumomediastinum - 1 in 100,000 deliveries
Louis Hamman

From Wikipedia, the free encyclopedia

Louis Virgil Hamman, M.D. (December 20, 1869 – May 15, 1938) was an American physician who is known for his work in the field of medicine and specifically in the treatment of tuberculosis.

He was graduated M.D. from Johns Hopkins and Johns Hopkins Hospital where he was a student of William Osler.

He said: "The physician, consciously or otherwise, always turns on the patient of his own disease the light of his own experience." Conditions which carry his name: Hamman's sign, Hamman's syndrome.

Environ 22 500 résultats (0,35 secondes)
LS/CTA pros √ and cons ×

- Lung Scintigraphy
  × Not always available
  √ Breast radiation dose << CTA
  √ Inconclusive results < general population

- CTA
  × Iodinated contrast medium: fetal thyroid dysfunction?
  √ Allows alternative diagnosis
  × Inconclusive results > general population
Higher rate of inconclusive CTA

<table>
<thead>
<tr>
<th>General Population</th>
<th>Pregnancy</th>
<th>Post-partum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cahill et al - Obstet Gynecol 2009</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>U-Kim-Im et al - Eur Radiol 2008</td>
<td>27.5%</td>
</tr>
<tr>
<td></td>
<td>Ridge et al - AJR 2009</td>
<td>32%</td>
</tr>
</tbody>
</table>

5 to 10%

- Poor opacification
  - Increased blood volume
    - +50% @ 36 weeks, return to normal 6 month post-partum
  - Increased pulsatility, poor mixing
Poor opacification: risk of false negative
Poor opacification: risk of false positive
Learning objectives

• To review the role of CTA for PE diagnosis during pregnancy and post-partum
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To explain how to optimize CTA protocols
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  – Low radiation dose

• To review key imaging findings
How to perform CTA?

Two crucial objectives

1- Low rate of non-diagnostic results
   Optimizing opacification

2- Low radiation dose
   Low breast radiation dose
Optimizing opacification

≈ Three RULES

1. Use sufficient amount of contrast

2. Avoid deep inspiration

3. Do not start acquisition immediately after apnea
1. Use sufficient amount of contrast

- At least 100 cc
- Increased blood volume during pregnancy and post-partum
- Ridge et al. 32% inconclusive CTA results only 75 cc
2. Avoid deep inspiration

Increases Inferior Caval blood flow (non-opacified blood)

Inferior caval blood flow affects the quality of CTPA during pregnancy-Karabulut. Eur Radiol 2009
3. To not start acquisition immediately after apnea

Transient decrease of superior caval blood flow (opacified blood)
Optimizing opacification

Take a deep breath and stop!
Optimizing opacification

- Avoid deep breath, sufficient amount and rate, start @18-25 s rather than bolus triggering
Radiation dose optimization

• Acquisition parameters

• Shielding
  – Bismuth shielding
  – Lead shielding
Acquisition parameters

- Limitation in Z axis

- Pitch, mA, kV, rotation time
  - Adaptation of parameters depends on CT unit manufacturer
    - Siemens: radiation dose is not lower with higher pitch
    - GE: dose modulation: requires increasing noise index
  - Check estimated DLP

- Litmanovich et al JACT 2009 (Reduction in Z axis, 200 mA, 100kV)
  mean effective dose: 5.21±1.54 mGy
Bismuth SHIELDING

- Used for pediatrics (Fricke et al AJR 2003)
Bismuth SHIELDING

• For adults
  – Controversial data
    • Hurwitz et al AJR 2009: 55% dose reduction without quality loss
    • Yilmaz JCT 2007: 40% dose reduction without quality loss
    • Vollmar et al Eur Radiol 2008: 50% dose reduction with noise increase (+ 40%) and artefacts

• Alternative: Organ-based Angular Tube Current Modulation
  – Flohr T. rsna 2006: 30 to 40% breast dose reduction
  – Wang et al RSNA 2010: > breast shielding
Lead shielding

- For fetal dose reduction (negligible)

- **Does not stop trans-diaphragmatic diffusion**
  - Barium ingestion...

- Efficient
  - Doshi et al Br J Radiol 2008: 35% dose reduction

- **After the scout view!!!**
LS/CTA during pregnancy

- **LS**: Recommended if chest radiography is normal (CAHILL et al Obstet Gynecol. 2009)
  - And no history of asthma, no alternative diagnosis suspected, available

- **CTA**: Recommended by the Fleishner society after negative US

128 patients, @22 weeks’ GA, 43 CTA & 94 LS
## Results

<table>
<thead>
<tr>
<th>Result</th>
<th>CTA</th>
<th>LS</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>16% (7/43)</td>
<td>11% (10/94)</td>
<td>0.35</td>
</tr>
<tr>
<td>-</td>
<td>65% (28/43)</td>
<td>68% (64/94)</td>
<td>0.73</td>
</tr>
<tr>
<td>?</td>
<td>19% (8/43)</td>
<td>21% (20/94)</td>
<td>0.72</td>
</tr>
<tr>
<td>Need for other test</td>
<td>5% (2/43)</td>
<td>7% (7/94)</td>
<td>0.42</td>
</tr>
<tr>
<td>Alternative Diagnosis</td>
<td>28% (12/43)</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Kappa value</td>
<td>0.84 (0.68- 0.99)</td>
<td>0.75 (0.63- 0.87)</td>
<td></td>
</tr>
</tbody>
</table>
LS/CTA during pregnancy

- **Similar performance**
- Scintigraphy
  - Lower breast radiation dose
- CTA (more available in emergency)
  - Better agreement
  - Allows alternative diagnosis

**Shahir et al- AJR 2010:** The choice of study should be based on other considerations, such as radiation concern, radiographic results, alternative diagnosis, and equipment availability. Reducing the amount of radiation to the maternal breast favors use of perfusion scanning when the radiographic findings are normal and there is no clinical suspicion of an alternative diagnosis.
Post-partum

- Same problems
  - Same hemodynamic changes
  - Same technique, plus **CT venography**
  - Increased detection of VTE and alternative diagnosis:
    - **Direct impact on clinical management in 18% of the patients**
Post-partum

- Increased VTE detection rate
- Diagnosis of ovarian vein thrombosis
Ovarian vein thrombosis
Alternative diagnosis

- Subcapsular liver hematoma complicating pre eclampsia
Summary

PE suspicion during pregnancy and post partum

- No specific score, Ddimers not useful
- Chest radiography must be performed
  - Alternative diagnosis? Estimate risk of inconclusive LS
- When CTA performed
  - Has to be conclusive
    - no deep breath /at least 100cc@4cc/s /start with a 18 -25 s delay
  - Low radiation dose
    - Z axis limitation, noise index increase, bismuth shiedling are good options!
This should be avoided....
Conclusive CTA with low radiation dose
Thank you

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