Patient RM

- 38 y/o female 11 days s/p gastric bypass for obesity with uneventful post-op course, discharged to home eight days ago
- CC: dyspnea
- Associated complaints: back pain radiating to shoulder, nausea, vomiting, hemoptysis x 1, syncope x 1
- On oral contraceptive pills
- Admission O2 sat 80%, RR 40, HR 114, BP 96/34
- Arterial blood gas was 7.47/25/60

Very suspicious for PE
Epidemiology of PE

- Incidence 69/100,000
- 10% of patients with PE die within 1 hour of the event
- Clinically suspected PE in more than 575,000 people in the US
- Up to 30% mortality of untreated PE

Rathbun SW, et al. AIM, 2000, Feb 1. 132(3): 227-32
Clinical Manifestations of PE

- **Risk factors:** Virchow’s triad, recent surgery, malignancy, history of DVT or PE, OCP
- **PE:** dyspnea, pleuritic chest pain, cough, hemoptysis, tachycardia, loud P2, poor hemodynamic status
- **DVT symptoms:** calf pain, edema, venous distention, pain on dorsiflexion, palpable cords

Sabatine MS, Pocket Medicine, 2000, 211-212
DVT and PE

- DVT causes 90% of PE
- 90% of DVT originate in calf
- Thrombosis proximal to popliteal causes most PE
- 30% of patients with PE have a discovered DVT

Radiographics 20; 1187-93; 2000.
Imaging Modalities for Diagnosis of PE

- CXR
- V/Q scan
- CT-Angiography
- Pulmonary Angiography
- DVT: Lower extremity non-invasive (LENI) (ultrasound) / Impedance Plethysmography
One *Proposed* Approach for R/O PE

**Caveat**: If patient has possible PE and has contraindications to anticoagulation, go directly to angiography for possible IVC filter placement.
Patient RM

Normal CXR
Most patients with PE have an abnormality on CXR, which can consist of:

- Decreased lung volume
  - Plate-like atelectasis (most common)
  - Elevation of hemidiaphragm
- Pleural effusion (50%)
- Westermark’s sign (rare)
- Hampton’s hump (rare)
- Normal CXR
Evolving PE on CXR, Day 1
Evolving PE on CXR, Day 2
Evolving PE on CXR

- Serial films show progressive bi-basilar atelectasis and elevation of hemi-diaphragms
Westermark’s Sign

Westermark’s Sign indicates a massive saddle embolus and appears on CXR as an abrupt end to the pulmonary vasculature with a lucent area peripherally.
Hampton’s Hump is a rare sign of pulmonary infarction somewhere along the pleural surfaces. It is a wedge shaped opacity and is most frequently seen laterally.

General Information on CT-A for PE

- Spiral CT for PE can take less than 30 seconds
- Often a non-contrast scan is done first
- Contrast scan is done caudal to cranial to reduce artifact from respiration and concentrated contrast in SVC.
Patient RM

Massive saddle embolus, shown as non-occlusive on adjacent slices.
Patient RM
Signs of PE on CT-A

- Central intravascular filling defect outlined by contrast material within the vessel lumen
- Eccentric tracking of contrast material around a filling defect
- Complete vascular occlusion
- Vascular enlargement
- Lung parenchyma distal to thrombus demonstrates:
  - Oligemia, with decreased number and caliber of vessels
  - Decreased attenuation of vessels
  - Ground-glass attenuation or air-space consolidation
  - Pulmonary infarction
Patient RM

Decreased vascular attenuation peripherally.
Acute PE LLL

Axial Image

Paddlewheel Image

Courtesy, Dr. Philip Boiselle

Paddlewheel schematic

inset BIDMC PACS Patient RM

Courtesy, Dr. Philip Boiselle
Acute PE LLL

Axial Image

Paddlewheel Image

Paddlewheel schematic

Courtesy, Dr. Philip Boiselle

inset BIDMC PACS Patient RM

Courtesy, Dr. Philip Boiselle
Acute PE LUL

Courtesy, Dr. Philip Boiselle
Acute PE LUL

Courtesy, Dr. Philip Boiselle
Acute PE RLL

Axial Image

Paddlewheel Image

Courtesy, Dr. Philip Boiselle
Acute PE RLL

Courtesy, Dr. Philip Boiselle
CT-A for PE

- Sensitivity between 53-100%
  - Depends on the level of pulmonary vasculature studied
- Specificity between 81-100%
- There is insufficient data to thoroughly gauge the utility of CT-A

Rathbun SW, et al. AIM, 2000, Feb 1. 132(3): 227-32
V/Q Scan for PE

- Has been 1st line test for PE for more than 20 years
- Good test if patient has normal CXR
- Few complications
- 60-70% are non-diagnostic

V/Q Scan for PE

- Takes approximately 30 min.
- May use macro-aggregated albumin (MAA) tagged with Tc-99m for perfusion.
- For ventilation, may use aerosolized Xenon.
- MAA lodges in 0.1% of pre-capillary arterioles.
- Look for mismatches in V/Q.
- Modify procedure when imaging PHTN, pediatric patients, or patients s/p pneumonectomy or lung transplant.
Normal V/Q Scan

http://www.derriford.co.uk/nucmed/teaching/images/lungs/lung_images.htm
Abnormal V/Q Scan

RLL perfusion defect c/w PE

http://www.derriford.co.uk/nucmed/teaching/images/lungs/lung_images.htm
Abnormal V/Q Scan

http://www.derriford.co.uk/nucmed/teaching/images/lungs/lung_images.htm
PIOPED and Its Utility

- Prospective study of 993 conducted in 1980’s to assess the sensitivity and specificity of V/Q scanning for the diagnosis of acute PE.
- Found that combining the results of V/Q scan with the clinical suspicion of PE had improved sensitivity and specificity versus V/Q alone.
- Has been modified based on subsequent study of the data set to improve diagnostic accuracy.
## Modified PIOPED Criteria

<table>
<thead>
<tr>
<th>Scan Classification</th>
<th>Signs on V/Q</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Probability</strong></td>
<td>2 or more large segmental mismatches, or&lt;br&gt;1 large plus 2 or more moderate mismatches, or&lt;br&gt;4 or more moderate mismatches</td>
</tr>
<tr>
<td><strong>Intermediate Probability</strong></td>
<td>1 moderate segmental mismatch plus 1 large mismatch&lt;br&gt;Up to 3 moderate mismatches&lt;br&gt;1 moderate mismatch&lt;br&gt;Not normal, low, or high probability</td>
</tr>
<tr>
<td><strong>Low Probability</strong></td>
<td>Multiple matched defects with some areas of normal perfusion,&lt;br&gt;Nonsegmental perfusion defect&lt;br&gt;CXR abnormality substantially larger than the perfusion defect&lt;br&gt;Small perfusion defects with a normal CXR</td>
</tr>
<tr>
<td><strong>Normal</strong></td>
<td>No perfusion defects&lt;br&gt;Perfusion outlines the shape of the lungs seen on CXR</td>
</tr>
</tbody>
</table>

## PIOPED Results

<table>
<thead>
<tr>
<th>Scan Classification</th>
<th>High Probability</th>
<th>Intermediate Probability</th>
<th>Low Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Probability</td>
<td>96%</td>
<td>88%</td>
<td>56%</td>
</tr>
<tr>
<td>Intermediate Probability</td>
<td>66%</td>
<td>28%</td>
<td>16%</td>
</tr>
<tr>
<td>Low Probability</td>
<td>40%</td>
<td>16%</td>
<td>4%</td>
</tr>
<tr>
<td>Near normal/normal</td>
<td>0%</td>
<td>6%</td>
<td>2%</td>
</tr>
</tbody>
</table>

PIOPED II "Prospective Investigation of Pulmonary Embolism Diagnosis II"

Description:

Dr. Victor Tapson, Dr. Tony Smith, Dr. Ed Coleman, Dr. Page McAdams

PIOPED II is a NIH sponsored multicenter, prospective, nonrandomized clinical study intended to determine the value of spiral computed tomography (CT) scanning for diagnosing acute pulmonary embolism.

This study is ongoing and will further characterize the relative utility of CT-A versus V/Q and angiography.
Pulmonary Angiogram of Pulmonary Embolus
Pulmonary Angiogram of Pulmonary Embolus
Sincere Thanks to:

- Toseef Khan, MD
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  our Webmasters
- Gillian Lieberman, MD
- Pamela Lepkowski
I Hope This Talk Wasn’t too painful...
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