Finding the Missing Link:
A Radiological Assessment of Septic Pulmonary Embolism

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Objectives

To understand:

1. The common presentation of septic pulmonary embolism (SPE)
2. The characteristic signs of SPE on chest radiograph and CT
3. The possible causes of SPE
4. The important radiological tools in the assessment of patient with Septic PE
5. The imaging modalities available for work up of patients with unknown source of infection
Our Patient: History

- Hx: 32F w/ hx of eczema and recent sore throat presenting with:
  - Pleuritic anterior chest pain
  - Tachycardia
  - Tachypnea
  - Fever
  - Neck tenderness
  - left-sided calf pain

- PMH/Shx:
  - Severe eczema treated w/ systemic steroids and mycophenolate motefil
  - No IV drug use

- Labs: + Fusobacterium species
Patient with suspicion of acute or unstable cardiopulmonary disease:
  1. Chest X-Ray

  • Findings:
    • Bilateral, multifocal opacities

  • Differential:
    • Multifocal Pneumonia
    • Septic Pulmonary Emboli
Our Patient: Diagnostic Imaging 2

- Positive chest radiograph, multiple, diffuse, or confluent opacities:
  2. CT Chest w/o contrast

- Findings:
  - Multiple bilateral nodules w/ peripheral predominance
  - Small cavitary lesions
  - Wedge-shaped lesions peripherally
  - Feeding vessel sign
Likely Diagnosis?

- Fever, bacteremia, and sepsis
- Multifocal, bilateral and cavitating lung lesions

**Septic Pulmonary Embolism**
*Embolization of infected thrombus into the lungs via the pulmonary arterial system*
Septic PE: What’s the Source?

1) Right-Sided Infective Endocarditis

- Accounts for about 10% of all IE
- Occurs predominantly in IV drug users
- High Clinical Suspicion:
  - IV Drug Users
  - Artificial or damage heart valves
  - New heart murmur

Pathogenesis of Infective Endocarditis

Transient bacteremia leading to infection and deposition of thrombotic products on endocardial surfaces, usually the valves.

Diagnostic Imaging 3: TTE and TEE

1) Companion Patient 2: TTE
- Negative TTE
- High clinical suspicion

2) Companion Patient 3: TEE
- 95% sensitivity
- Invasive
- User dependent

65% sensitivity
- Non-invasive
- User dependent

Our Patient: An Unlikely Case of Infective Endocarditis

Does not fulfill Duke’s Criteria:

• Negative culture for usual organisms
• No evidence of pericardial involvement
  • If clinical suspicion for IE remain, repeat in 7-10 days.
• No major risk factor (IVDU, catheter)

Explore other sources of infection
2) Septic Thrombophlebitis

*Infection, inflammation, and thrombosis in venous structures that drain nearby nonvascular infections*

**Mechanism of thrombophlebitis**

- **Extrapulmonary infectious source**
- **Venous drainage (systemic)**
- **Infectious organism**
- **Venous drainage (pulmonary circuit)**
- **Septic pulmonary emboli**
- **Septic thrombophlebitis**

Veins commonly Involved

- IVC, SVC, peripheral veins
  - IV drug use, soft tissue infections, burns
  - Central or peripheral catherization

- Pelvic Veins
  - C-section, septic abortion
  - Intra-abdominal infection

- Internal Jugular Vein (Lemierre’s Syndrome)
  - Tonsillitis
  - Pharyngitis
  - Dental Infection
  - Fusobacterium most common pathogen


Our Patient: Radiological Work-Up

1. Leg Pain:
   a) Lower limb thrombus
      1. Venous doppler ultrasound of lower limb
      2. CT pelvis
   b) and/or associated soft tissue infection/abscess
      1. Contrast CT leg
      2. MRI of L-spine

2. Current neck tenderness, previous pharyngitis infection, + fusobacterium, young adult:
   a) Lemierre’s Syndrome
      • Venous doppler internal jugular vein
      • Contrast CT of head and neck
Radiology of Thrombophlebitis

US:
- Thrombosis
- Decrease doppler flow
- Inflammation around vein

Contrast CT:
- Rim-enhancing hypodense lesion (abscess)
- Also can show venous thrombosis

Evaluating for Venous Obstruction using Compression Ultrasonography: Companion Patient 6

Assessment:
- Compressibility
- Doppler color flow
- Presence of echogenic band
- Changes in diameter with the valsalva maneuver

Limitations of Ultrasound:
- User dependent
- Limited in deep pelvic veins
- Positive in only 50% of patients with PE**

Our Patient: Several Studies Later

- No evidence of venous obstruction in lower limbs or internal jugular vein indicated on ultrasound.
- No evidence of soft tissue infection or abscess in the legs, oropharynx, or vertebral spine on ultrasound, CT, or MRI.
- *Continued signs of infection despite rigorous antibiotic therapy.*
Nuclear Medicine Evaluation for Unknown Infection Site

• **18F-FDG PET CT**
  - 18F-FDG accumulates in cells with high glycolytic activity
  - 1-2 hours

• **Tagged White Blood Cell Scan**
  - White blood cells localized to infectious sites
  - In-111: 24 hours
  - Tc-99: 1-4 hours

• **Gallium and Dual Tracer Scan**
  - Gallium 67 citrate binds to lactoferrin and bacterial siderophores at infectious sites
  - 48 hours

**Downsides:**
- Expensive
- High radiation dose
- Highly non-specific
- Most have limited ability to define location
- Time to imaging can be hours to days
# WBC Scan vs FDG-PET/CT in Localizing Infection

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<thead>
<tr>
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<th>Labeled Leukocyte Scanning</th>
<th>FDG-PET Imaging</th>
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<tbody>
<tr>
<td><strong>Mechanism</strong></td>
<td>Migration of WBCs in areas of infection</td>
<td>Localization in areas of increased glycolysis</td>
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<tr>
<td><strong>Sensitivity</strong></td>
<td>Low with previous Abx</td>
<td>High sensitivity</td>
</tr>
<tr>
<td><strong>Resolution</strong></td>
<td>Low resolution</td>
<td>High anatomic and spatial resolution</td>
</tr>
<tr>
<td><strong>Injection to Imaging Time</strong></td>
<td>18-30 hours</td>
<td>1-2 hours</td>
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<tr>
<td><strong>Chronic Osteomyelitis</strong></td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Axial Skeletal</strong></td>
<td>Poor Sensitivity</td>
<td>Normal activity</td>
</tr>
<tr>
<td><strong>Fever of Unknown Origin</strong></td>
<td>Focal occult infections only</td>
<td>Inflammatory, malignant, infectious</td>
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<tr>
<td><strong>Septic verses aseptic</strong></td>
<td>Unable to differentiate</td>
<td>Unable to differentiate</td>
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Our Patient: FDG-PET/CT

Imaging

• Findings:
  1. Increase radiotracer uptake in the left sacroiliac joint
  2. Slight increase radiotracer uptake in pharynx and associated lymph node
  3. Nodular uptake in lungs, bilaterally

• Interpretation: highly non-specific, but infection likely considering
  1. Unilateral uptake
  2. Clinical setting of unresolved infection
Findings:
- **Edema and inflammation** surrounding left sacroiliac joint
- No evidence of osteomyelitis

Interpretation:
- Considering clinical scenario, consistent with septic arthritis.
Patient Summary

• The exact cause of pts septic pulmonary embolism has not be identified, but Lemierre’s syndrome is possible considering:
  • Young adult with recent pharyngitis with subtle radiological evidence on FDG scan.
  • Positive fusobacterium, the most common pathogen implicated in Lemierre’s syndrome.
  • Thrombophlebitis of IJV\(\rightarrow\) disseminated infection/bacteremia\(\rightarrow\) septic arthritis (relatively common outcome)\(\rightarrow\) poor response to Abx and persistent infection.

• Varies studies report septic arthritis as a possible primary source of SPE.

• Patient was discharged with PICC line for long-term Abx treatment.

Conclusions

• A septic pulmonary embolism is an overall uncommon phenomenon, especially in non IV drug users.
• SPE has a relatively characteristic appearance on CXR and CT, and its diagnosis should be considered in pts with bacteremia, fever, certain risk factors.
• Infective right-sided endocarditis is the most common cause in the western world, but not the only cause and failure to diagnose IE should prompt further evaluation for infected source.
• It is important to identify the source of infection, as treatment of an abscess will typically require surgical debridement.
• The sensitivity and global activity of nuclear medicine makes it a fundamental tool in cases where an infection site cannot be localized.
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References

- Grant BJB. Diagnosis of suspected deep vein thrombosis of the lower extremity. Available at: UpToDate. Accessed April 22, 2016.
References

