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August 2021 Imaging Case of the Month: Unilateral Peripheral Lung Opacity

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Clinical History: A 56-year-old post-menopausal woman was referred to endocrinology after a routine screening bone densitometry scan suggested osteoporosis. She had undergone this testing after she developed back pain following a pulled muscle for which she saw a chiropractor. The patient had no significant past medical history and she was actively involved in exercise. She denied use of alcohol, drugs, and smoking. She had no allergies and was not taking any medications. Her past surgical history included Lasik surgery, breast augmentation 15 years earlier, and surgery for a deviated septum.
Physical examination showed a thin patient, afebrile, with a largely normal physical exam, although her pulse was intermittently irregular. Her blood pressure was 130 / 80 mmHg with a normal respiratory rate. Pulse oximetry showed a room air saturation of 98%.

When asked about her irregular pulse, the patient recalled that she had episodes of "heart racing" for which she had undergone evaluation several years earlier by an outside cardiologist. These records were subsequently located and showed supraventricular tachycardia with interventricular conduction delay superimposed on a normal baseline sinus rhythm with occasional premature atrial contractions. The patient indicated that her "heart racing" episodes were often accompanied by nausea, fatigue, and sometimes dizziness, and that they would come and go, starting about 7 years earlier, not necessarily precipitated by exercise. The patient refused further evaluation of this issue and over the next year, continued to intermittently experience these same complaints. When she re-presented to her primary care physician, she had undergone repeat assessment with an outside cardiologist who again performed a 24-hour ambulatory cardiac monitor which disclosed intermittent atrial fibrillation. The patient was tried on flecainide and metoprolol, which she did not tolerate. She expressed interest in an electrophysiology consolation, but did not flow up.

Approximately 2 years later, the patient again presented to her primary care physician after experiencing abrupt onset of cough productive of sputum a small amount of blood associated with a burning sensation in the chest, starting about one month earlier, for which she had been treated by an outside

cardiologist with doxycycline for presumed pneumonia. She completed that therapy 8 days prior to re-presentation and indicated her symptoms had improved, but not resolved. She has remained afebrile throughout the entire course of this illness. The patient's complete blood count and serum chemistries showed entirely normal values. The patient had undergone frontal and lateral chest radiography (Figure 1) at the outside institution at the recommendation of her cardiologist and chiropractor.

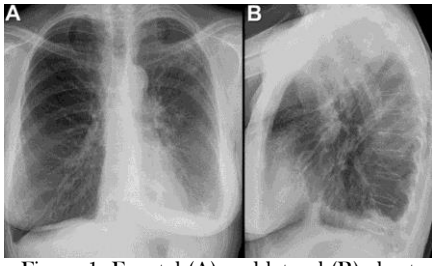

Figure 1. Frontal (A) and lateral (B) chest radiography at presentation.

Key Words: pulmonary venous infarction, interlobular thickening, cardiac ablation, atrial fibrillation, complication, pulmonary venous occlusion, CT scan, chest x-ray, venous angiography, venous stent,

Which of the following represents ***an appropriate interpretation*** of her frontal chest radiograph?

1. Frontal chest radiography shows cardiomegaly and increased pressure pulmonary edema
2. Frontal chest radiograph shows left upper and lower lobe consolidation and a left pleural effusion
3. Frontal chest radiography shows multiple small nodules
4. Frontal chest radiography shows mediastinal lymphadenopathy
5. Frontal chest radiography shows a pneumothorax

Correct!

2. Frontal chest radiograph shows left upper and lower lobe consolidation and a left pleural effusion

The frontal chest radiograph shows patchy, somewhat nodular, areas of left upper and lower lobe consolidation and a small left pleural effusion. The right lung appears clear and no pleural abnormality is seen on that side. There is no evidence of lymphadenopathy in either the peribronchial regions or mediastinum, nor is pneumothorax seen. No nodules are evident. There is no evidence to suggest increased pressure (hydrostatic) pulmonary edema.

An outside CT (Figure 2) performed the same day as the presentation chest radiograph (Figure 1) was located.

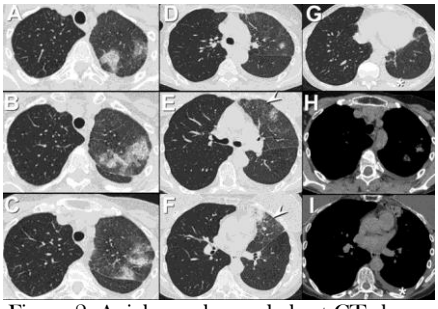

Figure 2. Axial unenhanced chest CT shows patchy, nodular areas of ground-glass opacity in the left upper lobe associated with lingular consolidation and a small left pleural effusion (*). Volume loss in the left upper lobe, evidenced by anterior retraction of the left major fissure, is present. Mild smooth interlobular septal thickening (arrowheads) is present in the same regions involved by ground-glass opacity.

Which of the following represents ***an appropriate interpretation*** of this chest CT?

1. Unenhanced chest CT shows numerous small nodules
2. Unenhanced chest CT shows multifocal mediastinal and peribronchial lymph node enlargement
3. Unenhanced chest CT shows multifocal consolidation, ground-glass opacity
4. Unenhanced chest CT shows bronchiectasis
5. Unenhanced chest CT shows pneumothorax

Correct!
3. Unenhanced chest CT shows multifocal consolidation, ground-glass opacity

The unenhanced chest CT shows patchy, nodular areas of ground-glass opacity in the left upper lobe associated with lingular consolidation and a small left pleural effusion. There is no evidence of significant enlargement of either peribronchial or mediastinal lymph nodes nor is there bronchiectasis. Small nodules are not present and there is no evidence of pneumothorax.

The patient underwent frontal and lateral chest radiography (Figure 3) 3 weeks after for comparison to the presentation chest radiograph (Figure 1) performed at an outside institution.

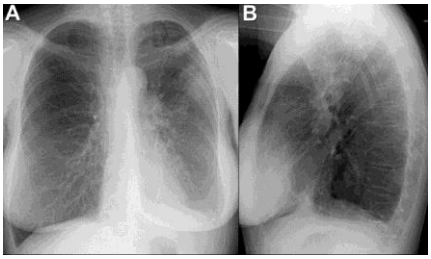

Figure 3. Frontal and lateral chest radiography 3 weeks following presentation and after doxycycline therapy shows that the left upper lobe consolidation is more circumscribed and pronounced, but the left lower lobe opacity and left pleural effusion have diminished. Prominent linear opacities consistent with interlobular septal thickening (arrowhead) are more evident on this examination.

Which of the following represents ***an appropriate interpretation*** of her frontal chest radiograph?

1. Frontal chest radiography shows *resolution* of the previous left-sided abnormalities
2. Frontal chest radiograph shows *worsening* of the previous left-sided abnormalities
3. Frontal chest radiography shows *no change* since the prior chest radiograph
4. Frontal chest radiography shows *worsening* of opacities in some areas and *improvement* in findings in other areas
5. Frontal chest radiography shows *new* right-sided abnormalities

Correct!

4. Frontal chest radiography shows worsening of opacities in some areas and improvement in findings in other areas

The repeat frontal and lateral chest radiography (Figure 3) shows that the left upper lobe opacity is more circumscribed and pronounced than at presentation, but the left lower lobe consolidation and left pleural effusion have diminished. No new right-sided abnormalities are seen and no nodules are evident.

Which of the following represents ***an appropriate approach*** for the patient's management?

1. Extend the course of antibiotics and switch to a more broad-spectrum therapy
2. Testing for fungal infection, such as coccidioidomycosis
3. Obtain CT pulmonary angiography for possible pulmonary embolism
4. Obtain follow up chest radiography in 2 weeks following a new antibiotic regimen
5. More than one of the above

Commented [R1]:

Commented [R2R1]:

Correct!

5. More than one of the above

All of the approaches are reasonable. Given that there has been some change on the chest radiograph and the patient reports some improvement in symptoms, a conservative approach with follow up chest radiography is appropriate. Given the persistence of symptoms and chest radiographic abnormalities, however, changing the antibiotic regimen to an agent with a broader activity is appropriate. Furthermore, given that a substantial fraction of community-acquired pneumonias in the desert Southwest are due to coccidioidomycosis, testing for this organism is appropriate.)

The patient was treated with a broad-spectrum antibiotic of a different class than the medication used initially and was seen in follow up one month later. Repeat frontal chest radiography (Figure 4) was performed.

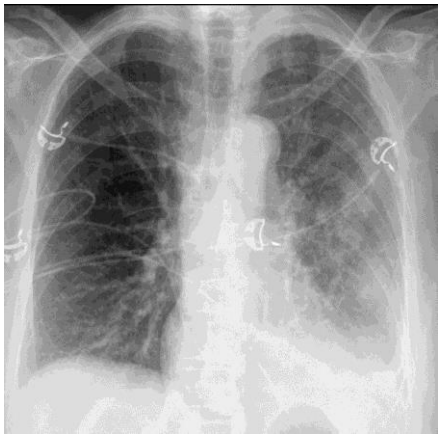

Figure 4. Repeat frontal chest radiograph after 1 month of the second antibiotic.

Which of the following represents ***an appropriate interpretation*** of her frontal chest radiograph?

1. Frontal chest radiography shows *resolution* of the previous left-sided abnormalities
2. Frontal chest radiograph shows *worsening* of the previous left-sided abnormalities
3. Frontal chest radiography shows *no change* since the prior chest radiograph
4. Frontal chest radiography shows *worsening* of opacities in some areas and *improvement* in findings in other areas
5. Frontal chest radiography shows *new* right-sided abnormalities

Correct!
2. Frontal chest radiograph shows worsening of the previous left-sided abnormalities

The frontal chest radiograph shows possible worsening of the left lung findings, particularly at the left base, although the current chest radiographic quality is somewhat suboptimal compared to the two prior chest radiographs.

The patient returned for evaluation after seeing an outside physician and undergoing repeat unenhanced chest CT (Figure 5).

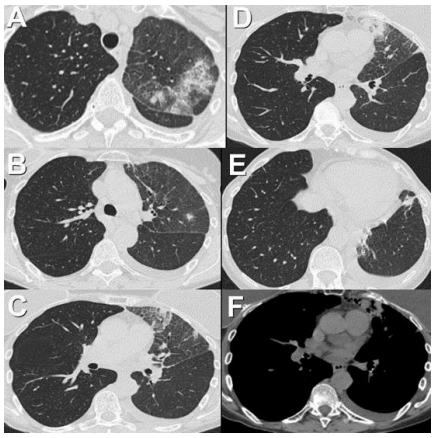

Figure 5. Axial unenhanced chest CT

Which of the following represents the ***least likely*** differential diagnostic consideration for this patient's condition?

1. Multicentric mucinous pulmonary adenocarcinoma
2. Cryptogenic organizing pneumonia
3. Fungal pneumonia
4. Bacterial pneumonia
5. Viral pneumonia

Correct!

4. Bacterial pneumonia

The patient's clinical course is increasingly unlikely attributable to bacterial pneumonia. She has remained afebrile and has not responded to two courses of different broad-spectrum antibiotic treatments over a period of just greater than 2 months. Fungal and viral pneumonias remain considerations, and a non-infectious pulmonary process, such as organizing pneumonia, is a possibility. Whenever persistent pulmonary ground-glass opacity is present without a clear infectious explanation, mucinous adenocarcinoma of the lung should be considered.

The patient continued to complain of cough, occasionally with blood-streaked sputum as well as shortness of breath.

Which of the following represents ***an appropriate next step*** for the evaluation of this patient's condition?

1. Diagnostic thoracentesis
2. Bronchoscopy with bronchoalveolar lavage and transbronchial biopsy
3. Repeat chest imaging
4. Testing for coccioidomycosis
5. More than one of the above

Correct!
5. More than one of the above

The persistence of the left-sided lung opacity and pleural effusion both present targets for obtaining diagnostic tissue and sampling of either or both sites are appropriate. Testing for fungal infection, which would explain the persistence of lung opacities despite appropriate broad-spectrum antibiotic therapy, is also reasonable. Finally, repeat imaging to assess the evaluation of the pulmonary findings is also reasonable.

Testing for coccidioidomycosis was negative. Bronchoscopy with bronchioloalveolar lavage and transbronchial biopsy was unrevealing-adequate tissue was obtained, but no features diagnostic of a particular disorder was evident. Diagnostic thoracentesis with removal of 750 mL cloudy, orange fluid was performed and showed 559 µL nucleated cells (normal, <500 cells µL) with 82% lymphocytes, LDH= 146 (serum = 130 U/L, normal serum = 100-190 U/L), total protein= 3.6 gm/dL (serum = 6.8 gm/dL), glucose = 126 mg/dL (serum = 103 mg/dL), and pH >7.5. Testing for vasculitis, including anti-nuclear antibodies (ANA), anti-neutrophil cytoplasmic antibodies (ANCA), and other auto-antibodies, was negative. Testing for inflammation, including C-reactive protein, while elevated at 18.9 mg/dL (normal, ≤8 mg/dL), was decreased from 27.1 mg/dL one year earlier. The erythrocyte sedimentation rate was 5 mm/hr (normal, 0-29 mm/hr), also decreased from one year earlier (13 mm/hr). A respiratory viral panel was completely negative, and testing for acid-fast bacilli and other pathogens, including *Rickettsia* and *Legionella*, was also negative.

The possibility of organizing pneumonia was considered, although the presence of the pleural effusion and intermittent hemoptysis was considered atypical for that diagnosis. Combined corticosteroid and azithromycin therapy were begun, and repeat chest CT (Figure 6) was performed several weeks into this new regimen.

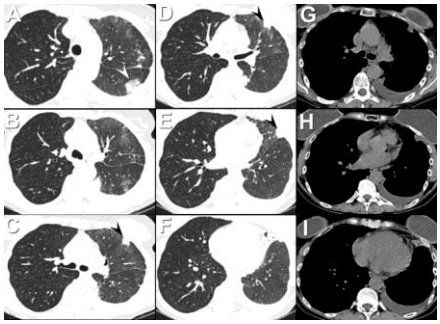

Figure 6. Repeat axial unenhanced chest CT

Which of the following represents ***an appropriate interpretation*** of this chest CT?

1. Unenhanced chest CT shows development of *new* bilateral nodular lung disease
2. Unenhanced chest CT shows *worsening* interlobular septal thickening
3. Unenhanced chest CT shows *new* pericardial effusion
4. Unenhanced chest CT shows that foci of ground-glass opacity and consolidation have evolved and contracted into subpleural nodular foci
5. Unenhanced chest CT shows an *enlarging* pleural effusion

Correct!

4. Unenhanced chest CT shows that foci of ground-glass opacity and consolidation have evolved and contracted into subpleural nodular foci

Axial unenhanced chest CT shows that areas of ground-glass opacity and consolidation have partially resolved and contracted into subpleural nodular foci. While nodular opacities are indeed developing, they are restricted to the subpleural regions of the left upper and lower lobes; the right lung is not involved. The prominent smooth interlobular septal thickening seen on previous CT scans has regressed. The left pleural effusion- small- has remained stable. No pericardial effusion is evident.

An outside CT of the chest (Figure 7) was located, performed 6 months prior to the patient's presentation chest radiograph and CT, obtained for pulmonary venous radiofrequency ablation planning for the patient's atrial fibrillation. Despite several physician encounters over the course of the patient's presentation, she had failed to mention she had undergone this procedure at an outside facility. This study showed no previous underlying structural lung disease, excluding the possibility of previous differential diagnostic considerations, particularly multicentric mucinous adenocarcinoma. Given the newly discovered history of catheter radiofrequency pulmonary venous isolation / ablation, cardiology was consulted and recommended contrast enhanced chest CT (Figure 8).

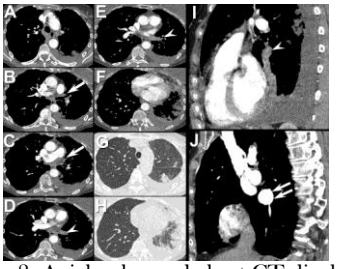

Figure 8. Axial enhanced chest CT displayed soft tissue (A-F) and lung windows (G and H), as well as sagittal reconstructions displayed in soft tissue windows (I and J).

Which of the following represents ***an appropriate interpretation*** of this chest CT?

1. Enhanced chest CT shows *new* right pulmonary findings and right pleural effusion
2. Enhanced chest CT shows *new* pulmonary emboli
3. Enhanced chest CT shows left-sided pneumothorax
4. Enhanced chest CT shows left-sided pulmonary venous occlusion
5. Enhanced chest CT shows *improvement* in the previous left lower lobe opacities

Correct!

4. Enhanced chest CT shows left-sided pulmonary venous occlusion

Axial enhanced chest CT shows *worsening* of the subpleural left lower lobe ground-glass opacity compared to previous studies, and the left pleural effusion is slightly larger than previous also. No new right lung abnormalities are evident and there is no evidence of right pleural effusion. The left superior pulmonary vein is not visualized, and the left inferior pulmonary vein is poorly enhanced, suggesting thrombosis and occlusion. There is no evidence of pulmonary arterial thromboembolic disease. No pneumothorax is identified.

Which of the following represents the ***most likely*** explanation for the patient's waxing and waning pulmonary abnormalities?

1. Recurrent aspiration
2. Pulmonary venous infarction
3. Organizing pneumonia
4. Diffuse alveolar hemorrhage
5. Chronic eosinophilic pneumonia

Correct!
2. Pulmonary venous infarction

The presence of left-sided pulmonary venous stenosis and occlusion provides the vascular etiology for pulmonary infarction, and the subpleural, non-segmental areas of ground-glass opacity and consideration are consistent with that process. While organizing pneumonia can present similarly, the data to date- including that lack of appropriate histopathology following lung biopsy, the lack of response to corticosteroid therapy, the presence of hemoptysis, and the presence of pleural effusion- do not support this diagnosis, and an alternative explanation- pulmonary venous infarction is evident. While elements of pulmonary hemorrhage are undoubtedly present, given the underlying pulmonary venous stenosis and occlusion with infarction, the hemorrhage is the result of pulmonary infarction, not capillaritis or other histopathologic derangements typically associated with diffuse alveolar hemorrhage. Recurrent aspiration is a consideration for recurrent and migratory pulmonary opacities, but no predisposing factors for aspiration have been noted in the patient's clinical history and the CT abnormalities are entirely left-sided and non-segmental in appearance. While chronic eosinophilic pneumonia typically presents as peripheral, often frankly subpleural, non-segmental areas of ground-glass opacity and consolidation, typically pulmonary opacities are bilateral, not unilateral, and the patient's complete blood count did not reveal peripheral eosinophilia. Furthermore, pulmonary tissue sampling did not reveal the presence of eosinophilia and the patient's lung abnormalities did not respond to corticosteroid therapy.

The patient was referred to cardiology and transesophageal echocardiography was performed and showed left superior pulmonary venous occlusion and severe stenosis with slow flow in the left inferior pulmonary vein. The left atrium and left atrial appendage were patent and cardiac function was normal. The patient was referred for pulmonary venous stent placement (Figure 9) which was successful.

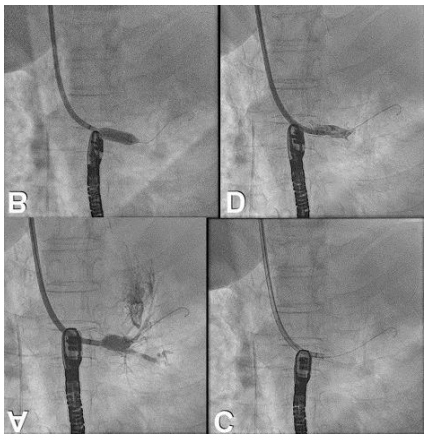

Figure 9. Catheter pulmonary venous angiography with angioplasty and stent placement shows the left inferior pulmonary vein crossed with a wire (A) and subsequently dilated with a balloon (B). A stent was subsequently placed into the left inferior pulmonary vein (C) and subsequently injected and shown to be patent (D).

The patient recovered uneventfully and repeat CT (Figure 10) showed a patent pulmonary venous stent with decreased, and eventual resolution of the previously noted left-sided pulmonary opacities and left pleural effusion.

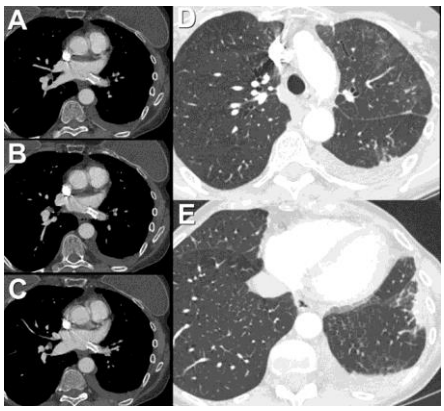

Figure 10. Representative images from axial enhanced CT performed following the catheter pulmonary venous stent placement shows a patent left inferior pulmonary venous stent and decreased left pleural effusion. The left upper and lower lobe foci of consolidation and ground-glass opacity have regressed.

Diagnosis: Pulmonary venous infarction following pulmonary vein stenosis occlusion induced by radiofrequency ablation for atrial fibrillation

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