Thoracic Imaging

Bayer HealthCare Pharmaceuticals

Case 5 CT in Acute Pulmonary Embolism

Case Courtesy of:
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History

A 21-year-old healthy female presented to the emergency department with a four-day history of left-sided pleuritic chest pain. The pain worsened with deep inspiration, coughing, or sneezing. She has no significant past medical history. She is currently taking oral contraceptives and had undertaken a six-hour bus ride five days ago, suggesting the possibility of pulmonary embolism. Multidetector CT pulmonary angiography (CTPA) combined with indirect CT venography (CTV) was performed using 100 mL of nonionic intravenous contrast (Ultravist 300; iopromide) injected at a rate of 4mL/sec, followed by 20 cc of saline at 4 mL/sec. Administration of contrast is critical to determine the presence of pulmonary embolism. The scan parameters used for CTPA and CTV are depicted in the table.

CT pulmonary angiography and CT venography protocol.

	CT Pulmonary Angiography	*CT Venography*
Detector collimation	64x0.625	64x0.625
Slice thickness	1.25 mm	7.5 mm
Reconstruction interval	0.625 mm	7.5 mm
Pitch	0.984:1	1.375:1
Table speed	39.37 mm per rotation	55 mm per rotation
Gantry rotation speed	0.6 seconds	1.0 seconds
Beam collimation	40 mm	40 mm
Injection to scan delay	27 seconds	3 minutes

Equipment	*Manufacturer*
Scanner: 64-slice LightSpeed VCT scanner	GE Healthcare; Milwaukee, WI
Power Injector: Stellant	MEDRAD; Indianola, IN

Multiplanar reformations were obtained for three-dimensional assessment of the pulmonary vascular tree. There were multiple bilateral lobar, segmental, and subsegmental pulmonary emboli, as well as deep venous thrombosis in the left common iliac vein.

Comment

Pulmonary embolism is a life-threatening disease that most commonly results from dislodgement of thrombi from the deep veins of lower extremities. The diagnosis of pulmonary embolism poses a challenge to both clinicians and radiologists because its signs and symptoms are nonspecific[1]. Untreated, pulmonary embolism has a mortality rate of up to 30%[2]. The mortality rate decreases markedly with anticoagulation treatment, to an estimated mortality rate of 8%[2]. However, due to the significant risks associated with anticoagulation, a reliable diagnostic test is highly desirable. CT pulmonary angiography combined with CT venography allows for accurate and rapid detection of thromboembolic disease using one procedure and a single injection of contrast.

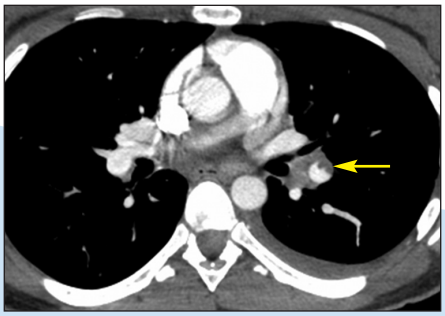

Figure 1. CT pulmonary angiogram shows an incomplete filling defect in the left lower lobe pulmonary artery (arrow) that forms acute angles with the arterial wall, indicating an acute pulmonary embolus. Note there is also a small left pleural effusion.

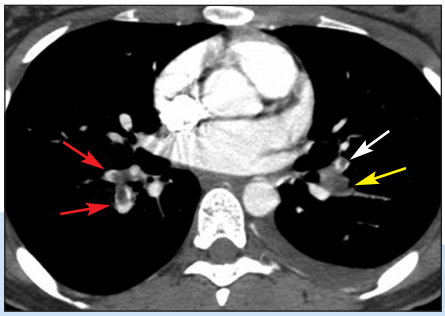

Figure 2. At a more caudal level than Figure 1, multiple bilateral segmental pulmonary emboli are demonstrated. The "rim sign" is illustrated in the anterior and lateral basilar segmental arteries of the right lower lobe (red arrows) and the anteromedial basilar segmental artery of the left lower lobe (white arrow). There is also complete occlusion and distension of the left lower lobe lateral basilar segmental artery (yellow arrow).

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For many years, ventilation-perfusion scintigraphy was the primary diagnostic test for clinically suspected pulmonary emboli. Normal and high probability ventilation-perfusion scintigraphy scans are very useful to either exclude or confirm the presence of pulmonary emboli. However, a large proportion of these tests are low and intermediate probability (34% & 39% in the PIOPED study[3]), requiring additional testing for definitive diagnosis. CT pulmonary angiography has now become the first-line imaging test for patients with suspected pulmonary embolism. On CTPA, emboli are seen as intraluminal filling defects within the contrast-filled pulmonary arteries. Administration of contrast is critical as emboli are only rarely seen on noncontrast images, appearing as hyper- or hypo-attenuating areas[4]. For optimal opacification of the pulmonary arteries, accurate timing of contrast bolus is of paramount importance. This can be achieved by various techniques, like fixed delay from injection to scan time (20-25 sec), timing bolus to calculate scan delay by placing region of interest in pulmonary artery, or by bolus tracking with trigger scanning at a preset threshold. Secondary CT findings of pulmonary embolism include pulmonary hemorrhage and infarction, oligemia of affected segment, atelectasis, and pleural effusion. Use of Ultravist in this case allowed for exquisite depiction of the pulmonary vasculature, and demonstration of pulmonary emboli at the lobar, segmental, and subsegmental levels. The patient subsequently received anticoagulation and is doing well on followup.

Indirect CT venography can be combined with CT pulmonary angiography, providing a single comprehensive test for the detection of both pulmonary embolism and deep venous thrombosis. These conditions are different manifestations of the same disease process, which is better known as venous thromboembolic disease. No additional contrast administration is required to perform the indirect CT venography, and the examination only takes few additional minutes to perform[1]. Furthermore, CT venography also allows good visualization of the inferior vena cava and iliac veins, which are not seen on ultrasound.

These are the results of one patient. Not all patients would have the same results.

References:

1. Patel S, Kazerooni EA. Helical CT for the evaluation of acute pulmonary embolism. *AJR* 2005 Jul;185(1): 135-149.
2. Dalen JE, Alpert JS. Natural history of pulmonary embolism. *Prog Cardiovasc Dis.* 1975;17:259-270.
3. Value of the ventilation/perfusion scan in acute pulmonary embolism: results of the prospective investigation of pulmonary embolism diagnosis (PIOPED). The PIOPED investigators. *JAMA* 1990 May 23-30;263(20):2753-2759.
4. Chiles C, Carr J. Vascular diseases of the thorax: evaluation with multidetector CT. Radiol Clin North Am 2005; 43: 543-569.

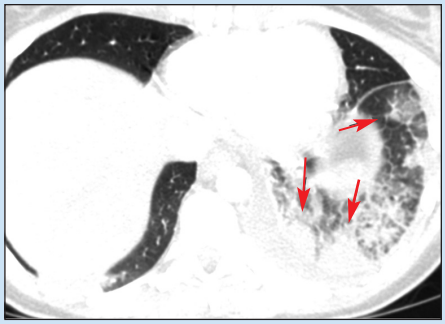

Figure 3. Lung windows demonstrate peripheral wedge-shaped lung infarcts (arrows) in the left lower lobe and a small left pleural effusion.

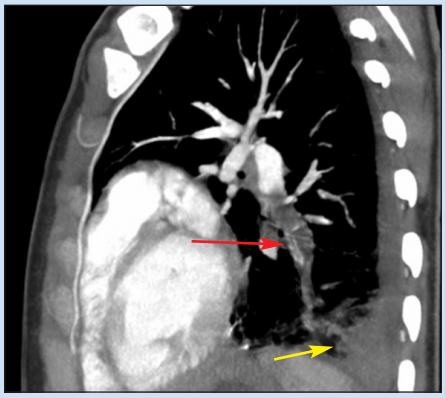

Figure 4. Sagittal CT reformation demonstrates left lower lobe pulmonary embolism (red arrow) with a wedge-shaped pulmonary infarct posteriorly (yellow arrow).

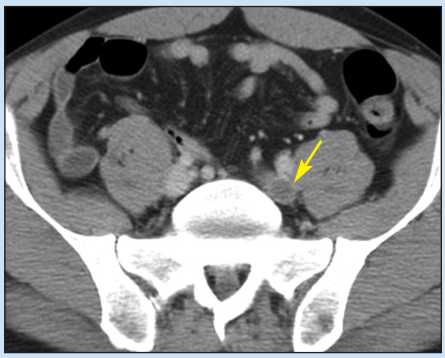

Figure 5. Indirect CT venography demonstrates a nonocclusive filling defect in the left common iliac vein (arrow), representing deep venous thrombus.