



# Radiology Rounds

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Department of Radiology



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Janet Cochrane Miller, D.Phil., Author

Susanna I. Lee, M.D., Ph.D., Editor

## Diagnosis of Pulmonary Embolism

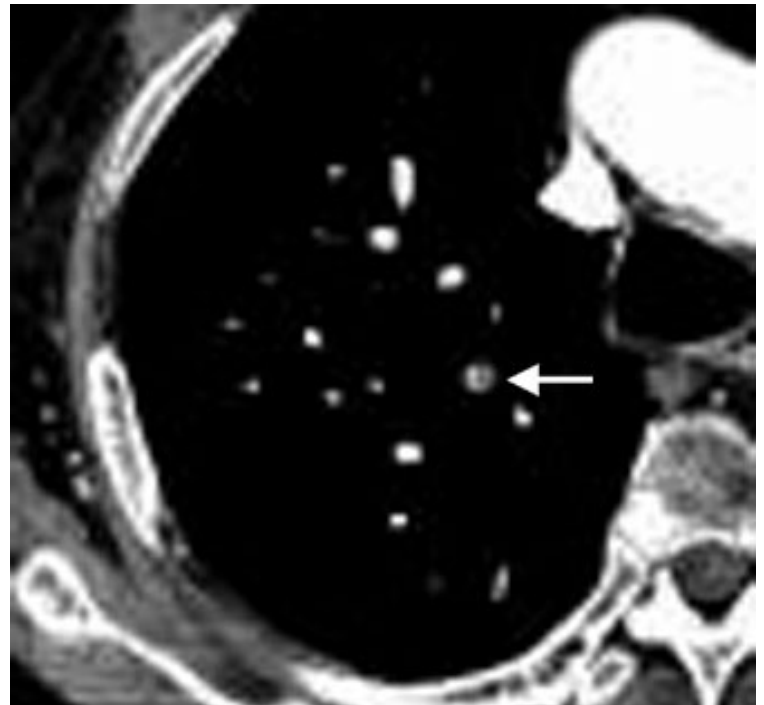
**T**he diagnosis of pulmonary embolism should be considered in any patient who presents with shortness of breath and pleuritic chest pain, even though most cases occur in patients with known risk factors, such as a history of deep venous thrombosis, immobilization, estrogen or birth control pill use, or recent surgery. More than 300,000 cases of pulmonary embolism are diagnosed each year and 50,000 people die from this disease.

However diagnosis of pulmonary embolism is difficult and many cases are missed or the diagnosis delayed. The symptoms may be mild and are similar to a number of other disorders, some of which are benign. Pulmonary angiography, performed after percutaneous catheterization, is still considered to be the diagnostic gold standard although, as an invasive test, it is not a routine diagnostic procedure. However, MGH has had no mortality associated with pulmonary angiography and the morbidity, essentially due to the administration of contrast agent, is likely less than 0.5%.

Up until recently, patients with suspected pulmonary embolism were most commonly referred for ventilation/perfusion (V/Q) lung scanning. CT pulmonary angiography (CTA) is an alternate and now frequently used method of visualizing perfusion for the diagnosis of pulmonary embolism. At MGH, on average, there are now 5-6 CTA scans for pulmonary embolism performed every day. But is it really a better diagnostic tool than pulmonary ventilation and perfusion scanning?

MGH is participating in the Prospective Investigation of Pulmonary Embolism Diagnosis II (PIOPED II) which will provide a definitive answer in the fall of 2004. Meanwhile, the selection of diagnostic technique must depend on other criteria.

One advantage of the CTA procedure is that it routinely includes CT venography (CTV) from the iliac crest to the tibial plateau to detect deep vein thromboses in the legs

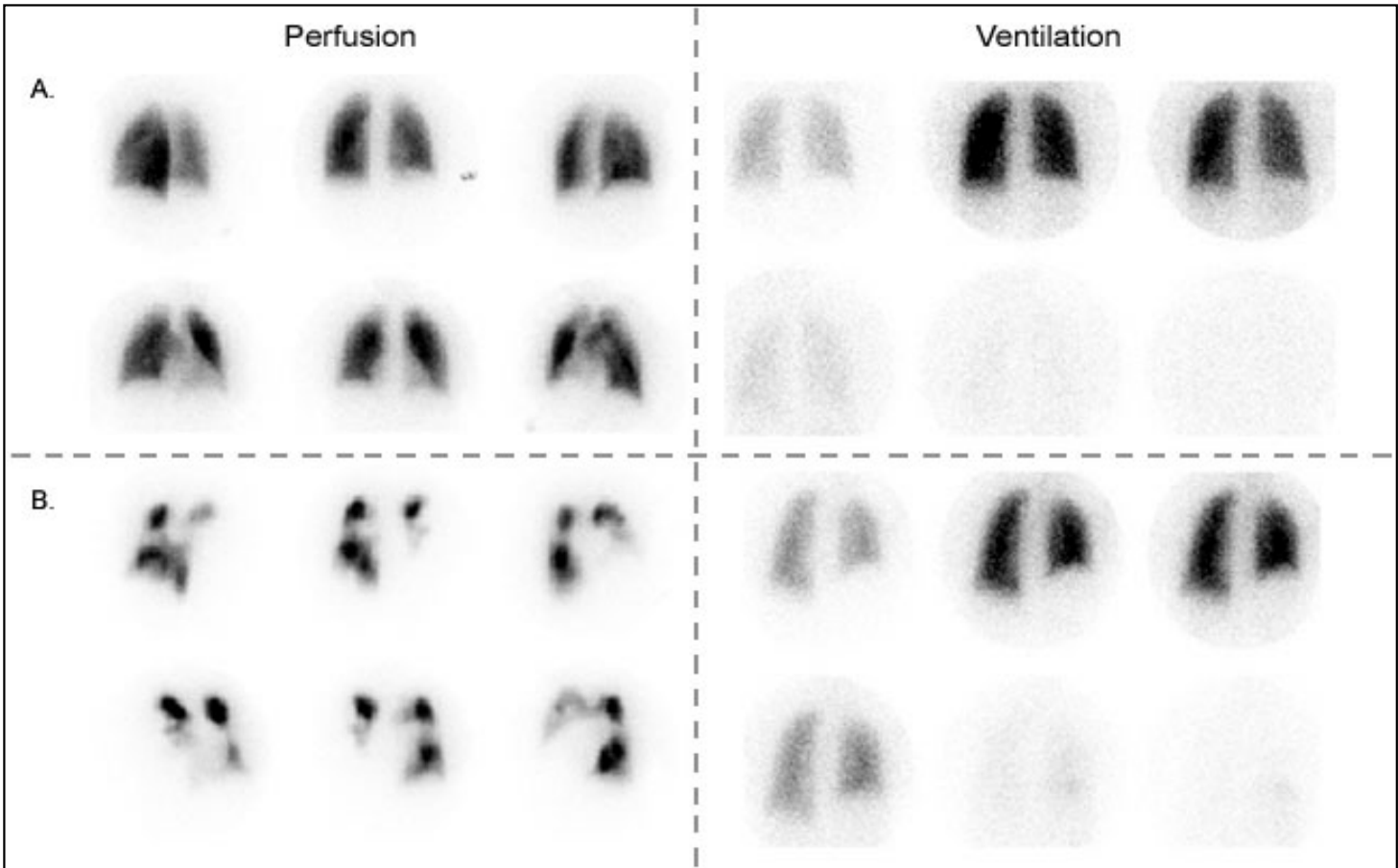


**CT Pulmonary Angiography.** Arrow points to thrombus in right upper lobe pulmonary artery.

and pelvis. Both CTA and CTV scans are accomplished with the same bolus of contrast agent, first as it flows through the pulmonary arteries, 20-25 seconds after the start of the injection and then as it flows through the veins 3<sup>1/2</sup> minutes later. The full CT procedure can be completed within 20 minutes. Unlike lower extremity US, CTV can image the external and internal iliac veins, resulting in the detection of a number of deep vein thromboses that cannot be seen with ultrasound. CTA and CTV can also be performed when the patient is in a cast. Since thromboses are fairly common after major trauma, this is an important advantage. The combined cost of V/Q imaging and lower extremity ultrasound is comparable to CTA/CTV.

Guidelines for Selection of Diagnostic Scan for PE

|   | V/Q                           | CTA                  |
|---|-------------------------------|----------------------|
| <b>Normal Chest X-ray</b>   | Yes                           | Yes                  |
| <b>Abnormal Chest X-ray</b>   | No                            | Yes                  |
| <b>Contraindications to CT contrast agents</b><br>- Renal insufficiency (creatinine > 1.8 mg/dL)<br>- Severe contrast allergy | Yes                           | No                   |
| <b>Inability to lie flat, severe claustrophobia, or over 350 lbs.</b>   | Yes                           | No                   |
| <b>Concurrent evaluation for deep vein thromboses</b>   | No                            | Yes                  |
| <b>Pregnancy</b>  | Yes, with signed release form | Can do chest CT only |
| <b>After 5 pm, weekends, and holidays</b>   | If needed - Staff on call     | Yes - Staff in house |



**Ventilation / Perfusion Scans**  
 A. Very Low Probability of Pulmonary Embolism  
 B. High Probability of Pulmonary Embolism

## Limitations

Both V/Q and CTA scanning can fail to give a definitive diagnosis, although fewer CTA scans are reported as indeterminate than V/Q scintigraphy. If either scan fails to give a diagnosis, the patient may be scanned by the alternate technique.

A normal V/Q scan essentially rules out pulmonary embolism. About 2/3 of the V/Q scans performed on patients with normal chest X-rays at MGH fall into the Normal, Low, or Very Low Probability category. Of the patients in these categories who go on to have invasive pulmonary angiography, about 90% do not have a pulmonary embolus. About 27% of the scans at MGH fall in the Indeterminate Probability category.

CTA can fail because of motion artifacts if the patient is unable to hold his breath for the duration of the scan. With scanners now in common use at MGH, this time is 25 seconds. However, the introduction of 16-slice multidetector CT imaging will reduce this time to 7 seconds. In addition, CTA is more likely to be indeterminate in obese patients and CTA has limited ability to detect emboli in subsegmental arteries. While thromboses in these smaller arteries may have little physiological impact, they may provide a warning of future larger thromboemboli.

## Alternative Diagnoses from CTA

One major advantage of CTA is that a definitive diagnosis of another disorder can be made in 50-60% of those cases in which pulmonary embolism is not present.

### Alternative Diagnoses from CT Pulmonary Angiography

- Pneumothorax
- Pneumonia
- Pleural effusion
- Pericarditis
- Aortic dissection
- Congestive heart failure
- Rib fracture
- Lung Cancer

## References

Richman, PB, Courtney, DM, Friese, J, Matthews, J, Field, A, Petri, R and Kline, JA (2003). *Chest CT Angiography (CTA) to Rule-out Pulmonary Embolism (PE) Frequently Reveals Clinically Significant Ancillary Findings: A Multi-Center Study of 1025 Emergency Department Patients*. Acad Emerg Med **10**: 564-5.

Ruiz, Y, Caballero, P, Caniego, JL, Frieria, A, Olivera, MJ, Tagarro, D, and Alvarez-Sala, R (2003). *Prospective comparison of helical CT with angiography in pulmonary embolism: global and selective vascular territory analysis. Interobserver agreement*. Eur Radiol **13**: 823-9.

## Scheduling

CT pulmonary angiography can be performed in the Emergency Department or can be scheduled at any of the scanners on the main campus or in the MGH Imaging Centers by calling **4-XRAY (617-724-9729)**. CT technologists and radiologists are on duty 24 hours a day, 7 days a week at MGH and the scan will be read promptly after the procedure at any time of day or night.

V/Q scans are performed in the Nuclear Medicine Division at MGH and not in any of the off-campus MGH imaging centers. V/Q exams can be scheduled through **4-XRAY** if they are routine and they will be fitted into the next available slot, usually the next working day via the scheduling method.

If an emergency V/Q scan is needed, it should be scheduled by calling **6-8352** or by paging the Nuclear Medicine resident between 5pm and 11pm. V/Q scans are not generally done after 11pm unless the referring physician personally indicates that this is a medical emergency that can be handled via no other method.

## Further Information

For questions on CTA, contact Jo-Anne Shepard, M.D. [jshepard@partners.org](mailto:jshepard@partners.org)

For questions on V/Q imaging, contact James Scott, M.D. [scott@helix.mgh.harvard.edu](mailto:scott@helix.mgh.harvard.edu)

[Chest CT – Pulmonary Embolus Policy and Protocol \(Download .pdf\)](#) (**Internal access only**)

Cardiology Patient Page on [Pulmonary Embolism and Deep Vein Thromboses \(Download .pdf\)](#) (Circulation 2002; 106:1426-1438)

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[Janet Cochrane Miller, D. Phil., Author](#)  
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