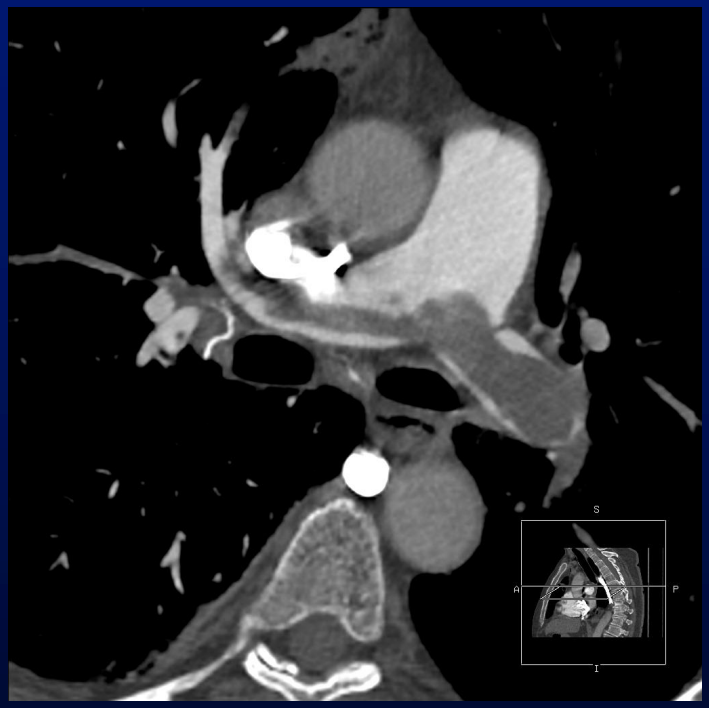
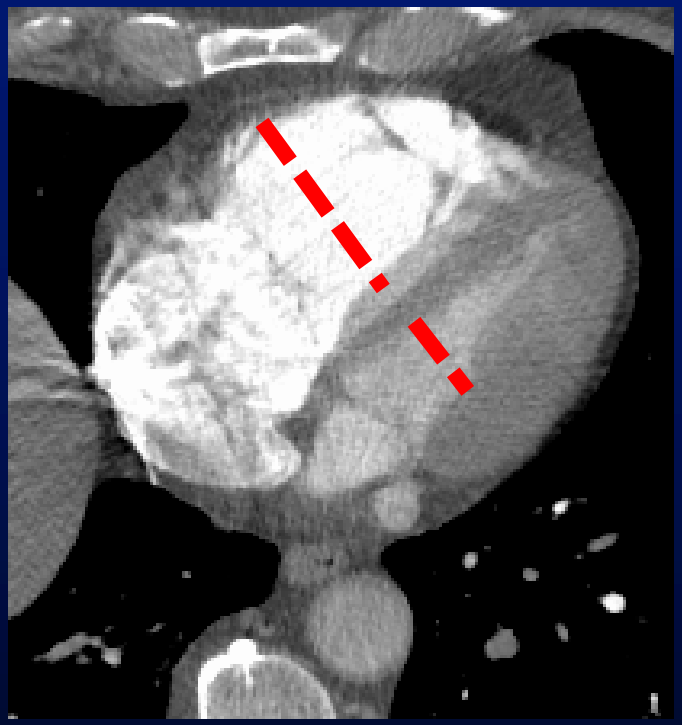
Acute Pulmonary Embolism- FAQs and Cases!





Elena Peña MD

Associate Professor of Radiology

University of Ottawa

Preparing for Call CME Course

Disclosures

- No disclosures

Objectives

1-Review imaging findings of PE and discuss common causes of misdiagnosis

2-Review imaging findings of RV strain and review its clinical importance

3- Diagnostic work up for PE in pregnancy

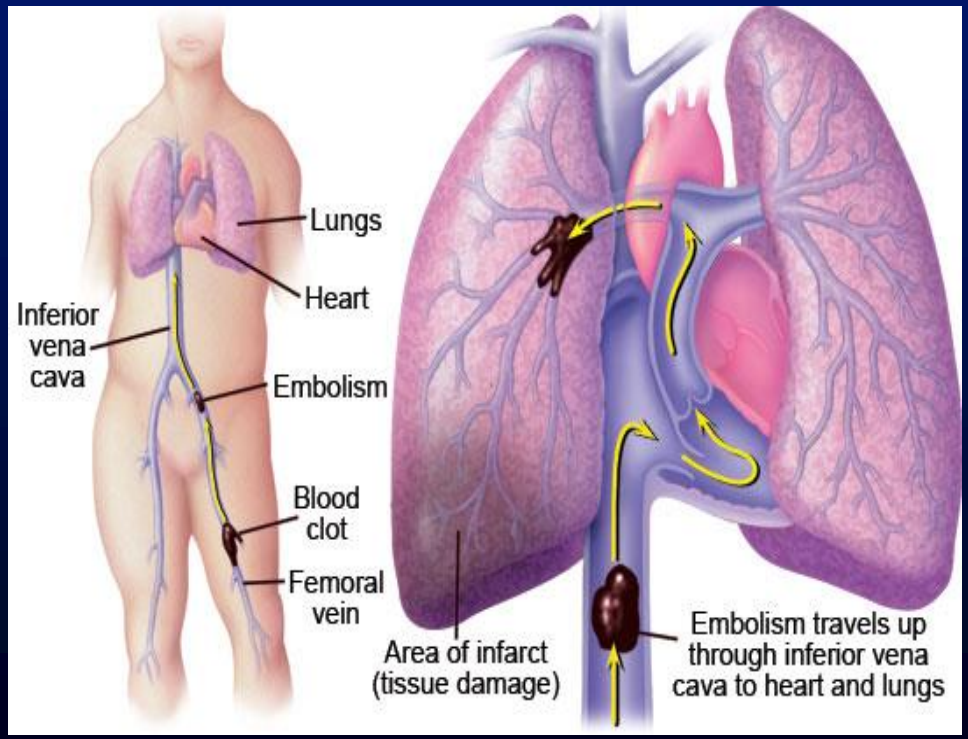
Outline

- Imaging Modalities in work up of PE
- Imaging Findings of PE
- CTPA pitfalls and causes of misdiagnosis
- Detection of RV strain
- Work up of PE in pregnant patients
- Interesting Cases

Venous Thromboembolism

- 2 manifestations of the same disease
  - Deep Vein Thrombosis (DVT)
  - Pulmonary Embolism (PE)

✓ Same treatment



Background

- Reported prevalence of PE is 0.4%
- Third most common acute cardiovascular disease after MI and stroke[1,2]
- Hospital mortality rate is up to 30% for untreated major PE[3]
- Prompt diagnosis and treatment may decrease mortality in 2-10%

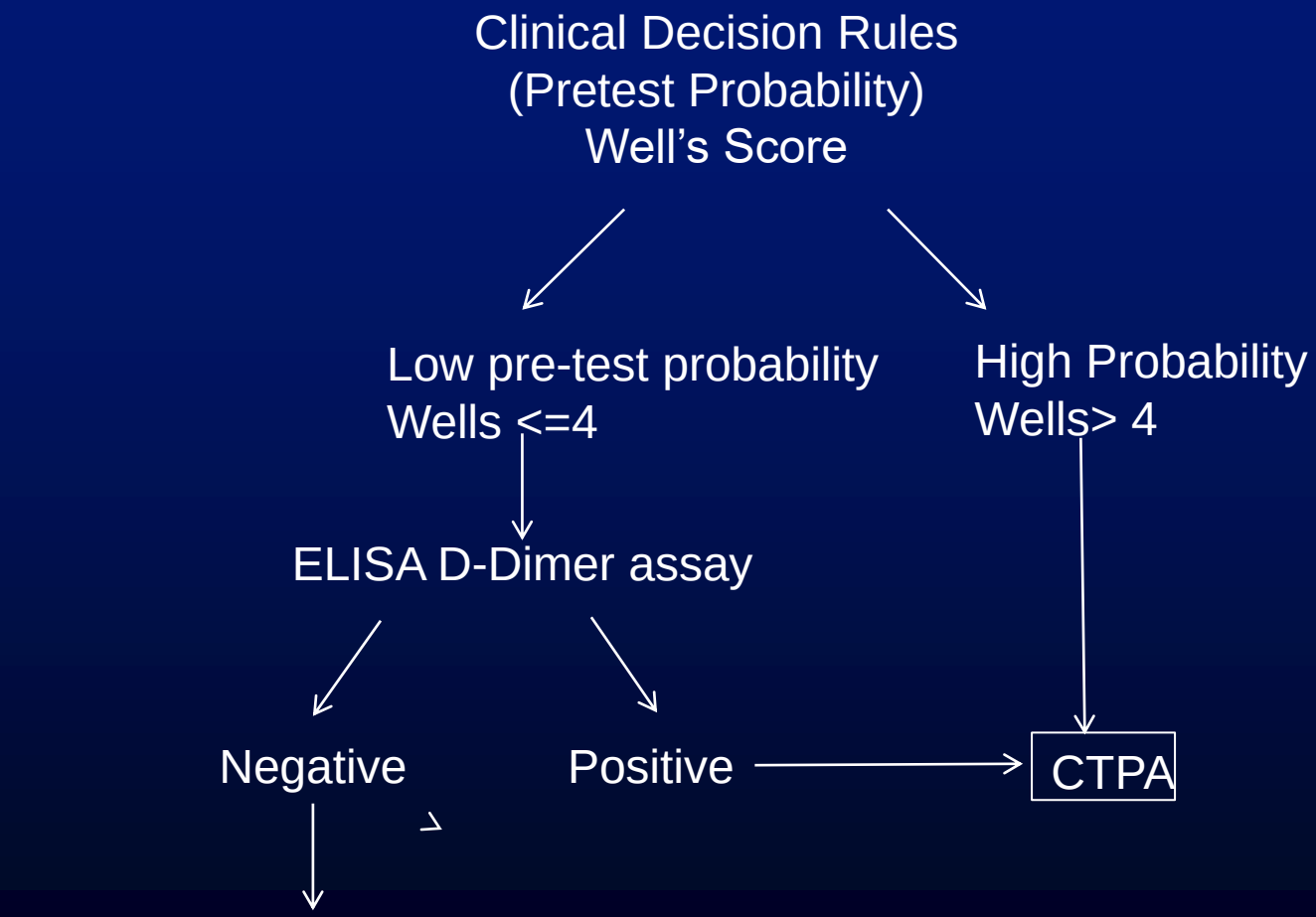
1-Nikolau K et al, J Thorac Imaging 2010;25:151-160
2-Kelly AM et al, Acad Radiol 2006; 13:486-495
3-Carson JL et al, N Engl J Med. 1992:326:1240-1245

A Challenging Diagnosis

- VTE can not be diagnosed on sole clinical basis -lack of sensitivity and specificity of signs and symptoms
- Objective diagnosis is important
  - Potential morbidity and mortality if diagnosis is missed
  - Bleeding risk associated with anticoagulation treatment

Recommended diagnostic algorithms in the patient with suspected PE

Suspected PE



Van Belle A et al. JAMA 2006;295:172-179
Stein, PD. et al. Radiology 2007;242:15-21
2-Carrier M et al. Thromb Haemost 2009;101:886-92

CTPA

- ✓MD-CTPA is the imaging modality of choice when PE is suspected
- ✓Sensitivity (90%) Specificity (95%)
- ✓Widely available
- ✓Offers alternative diagnosis

1-Mamlouk MD et al. Radiology 2010;256:625-632

Can a patient be discharged safely after a negative CTPA for PE without imaging the leg veins?

- ✓Yes! If CTPA is negative the patient can be safely discharged (if there are no symptoms of DVT)

Safety of a Negative CTPA to rule out PE

- Combination of CPR and negative MD-CTPA
  - 3 month VTE risk 0.6-1.7%[1-3]
  - 2 studies shown that yield of additional CUS in patients with normal MD-CTPA is low (0.9-1.4%)[2,4]
  - Randomized study shown a negative MD-CTPA equally safe as a negative MD-CTPA followed by normal CUS with similar 3-month VTE risk of 0.3%[5]

1-Van VA, et al. JAMA 2006;295:172-9
2-Perrier A et al. N Engl J Med 2005; 352: 1760-8
3-Ghanima W et al. J Thromb Haemost 2005; 3:1926-32
4-Anderson DR. JAMA 2007;298:2743-53
5-Righini M et al. Lancet 2008;307:1343-52

Role of Compression Ultrasound

- Signs and symptoms of DVT –CUS-92 % Sens 98% Specif
  - No symptoms of DVT 55% Sens 94% Specif
- If positive- warrants treatment

➢ The absence of DVT does not exclude PE- Patients with cardiorespiratory symptoms should undergo imaging of the chest

Role of V/Q Scan

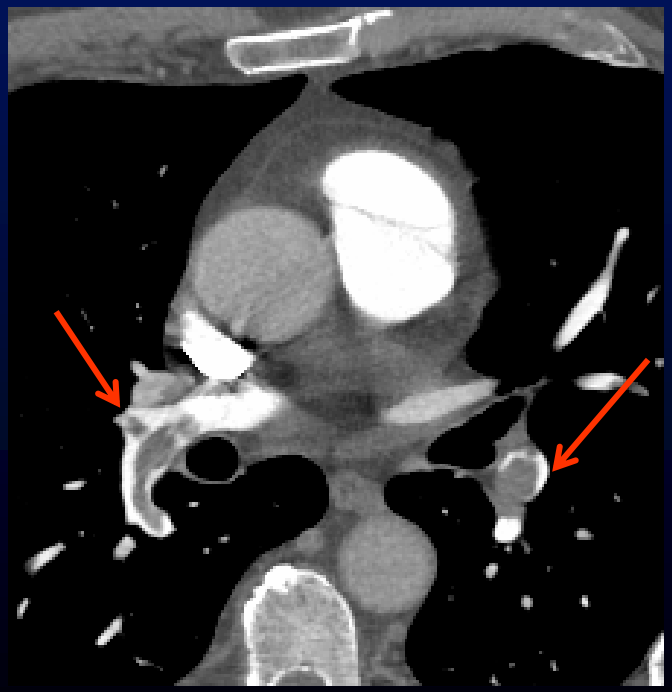
- Excellent accuracy (PPV and NPV>90%)
- Drawback-high number of indeterminate studies (73%)[1]
  - Normal chest radiograph and absence of cardiopulmonary disease –diagnostic in 91%[2]

1-PIOPED Investigators. JAMA 1990;263:2753-2759
2-Forbes KP et al. Clin Radiol. 2001;56:397-400

CTPA Signs of Acute PE

Direct Signs-Vascular Findings of Acute PE

- Partial or complete filling defects
  - Partial: low attenuation intravascular area surrounded by contrast
  - Complete: low attenuation intravascular area that occupies entire lumen



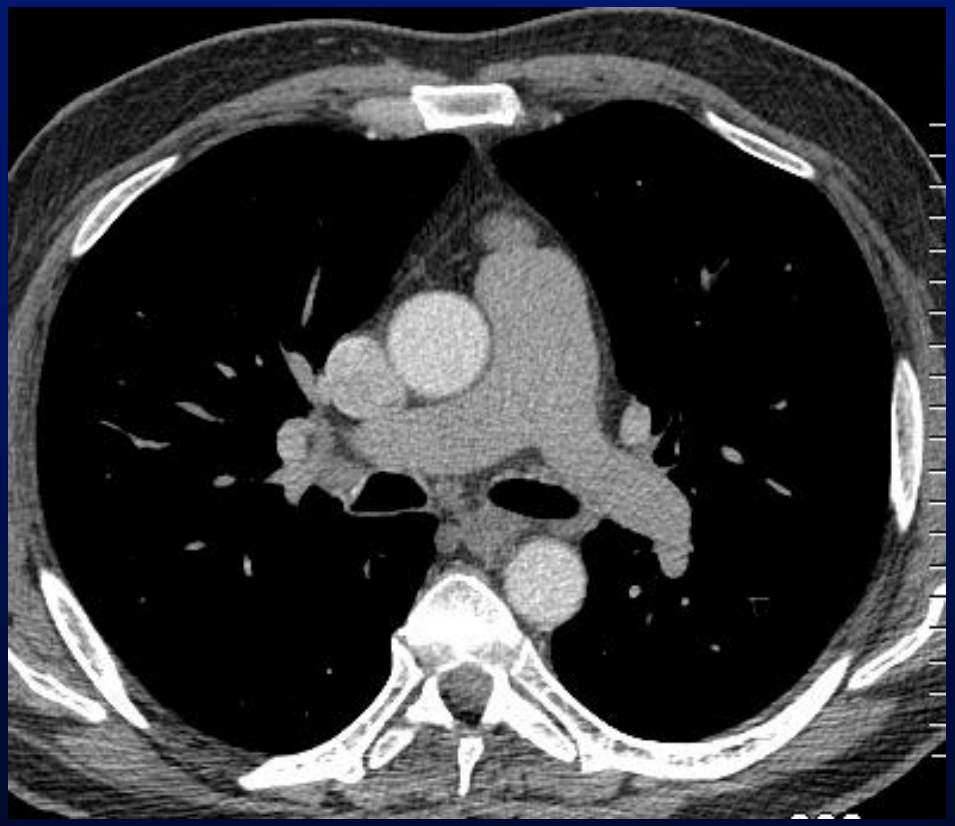
Parenchymal -Signs of PE

Pulmonary Hemorrhage or Infarct

- Peripheral consolidation
- Wedge shaped
- Look for feeding vessel

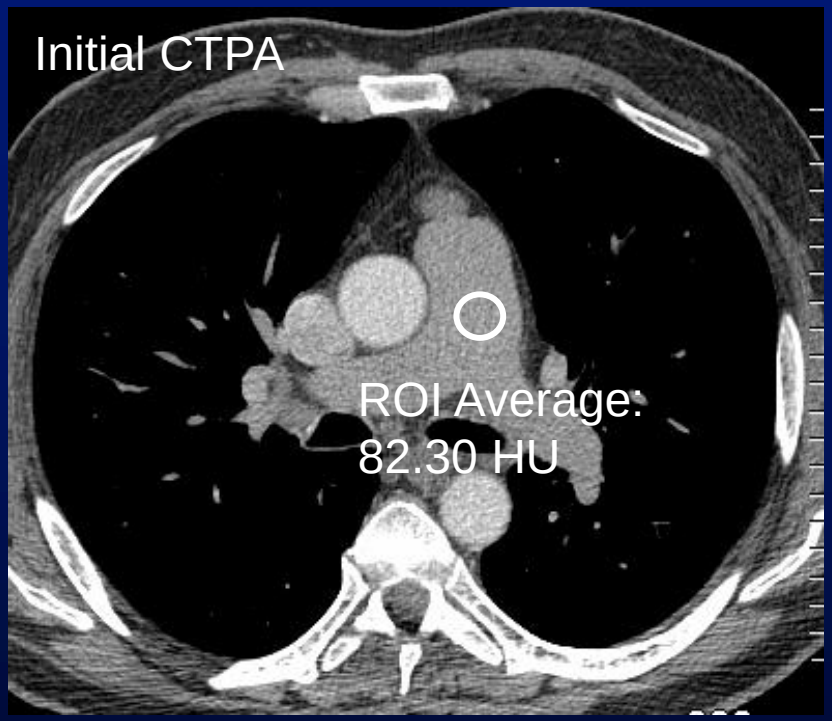
Common Pitfalls and Causes of Misdiagnosis

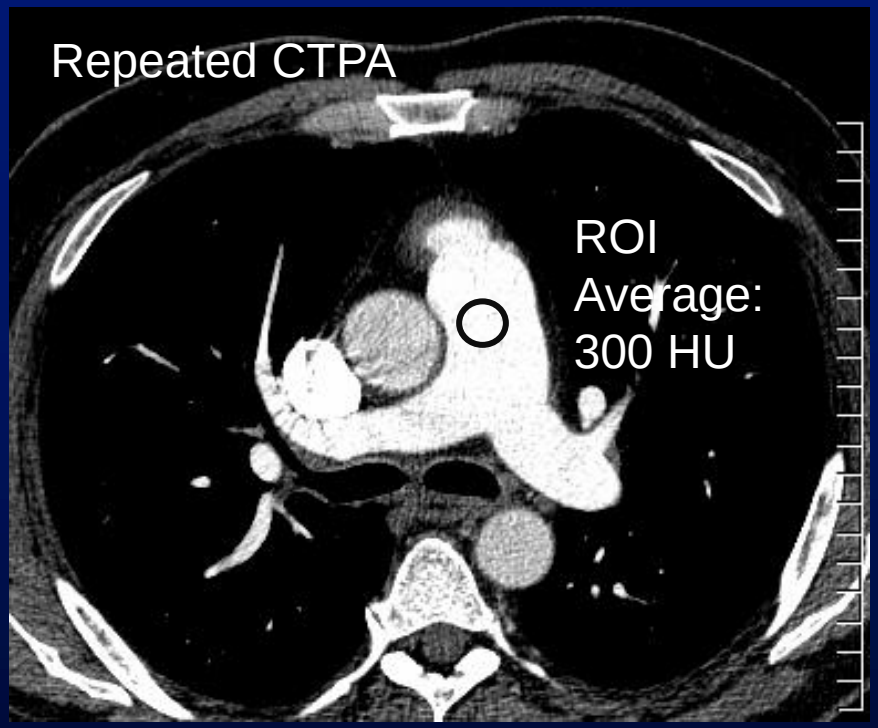
57-year-old man with dyspnea



Do you think the study is appropriate for diagnosis of PE?

Poor opacification of MPA



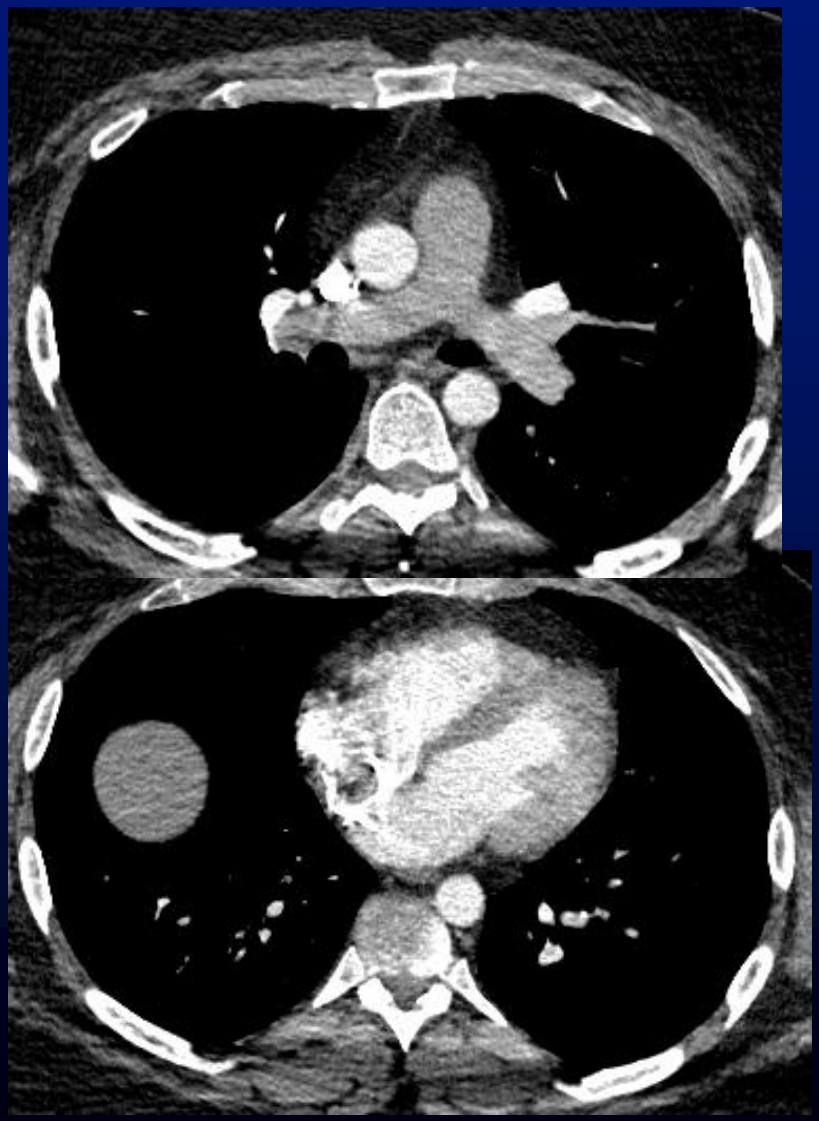


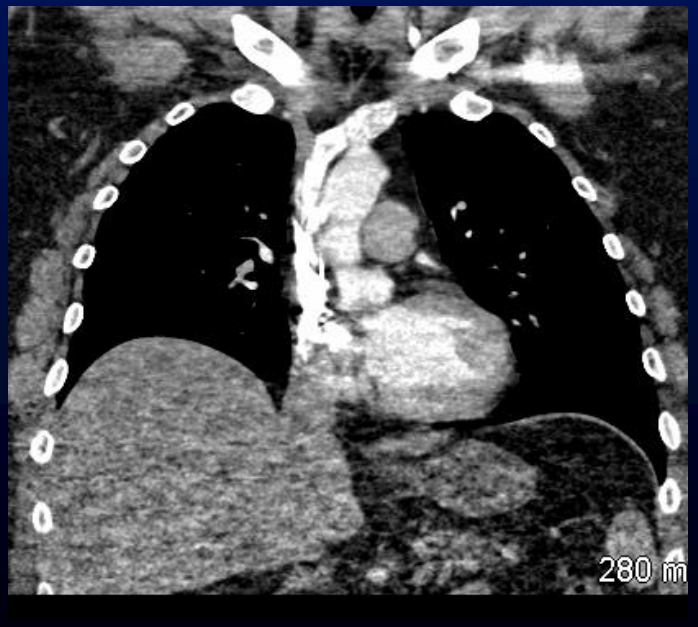
Pitfall- Poor Contrast Enhancement

- Resulting from inaccurate scan delay after contrast injection

✓Trouble shooting tips; use timing bolus or bolus tracking for accurate timing of image acquisition

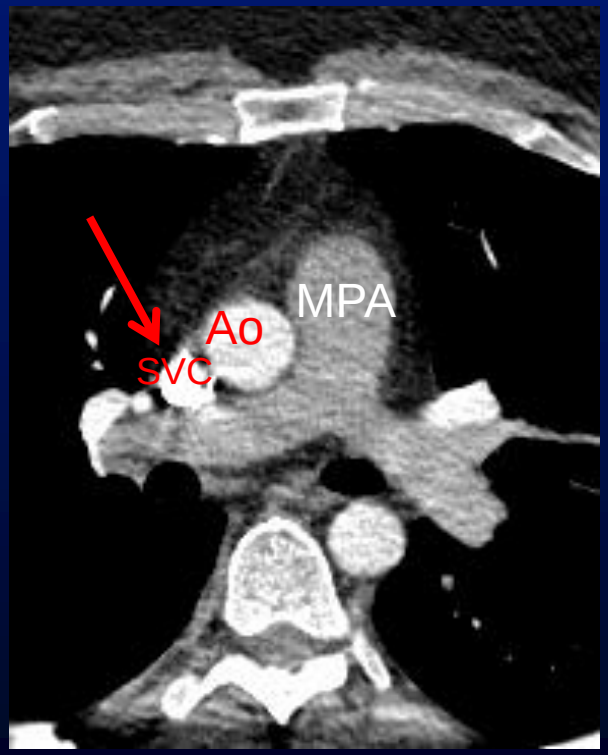
31-year-old male with Factor V Leiden deficiency and pre-syncope. Rule out PE

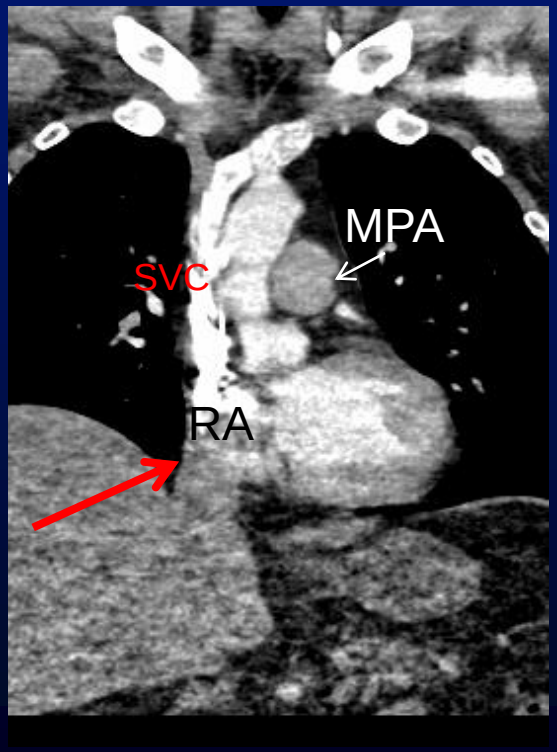




Transient interruption of contrast

- Inspiration -unenhanced blood entering the RA, RV and PA from the IVC

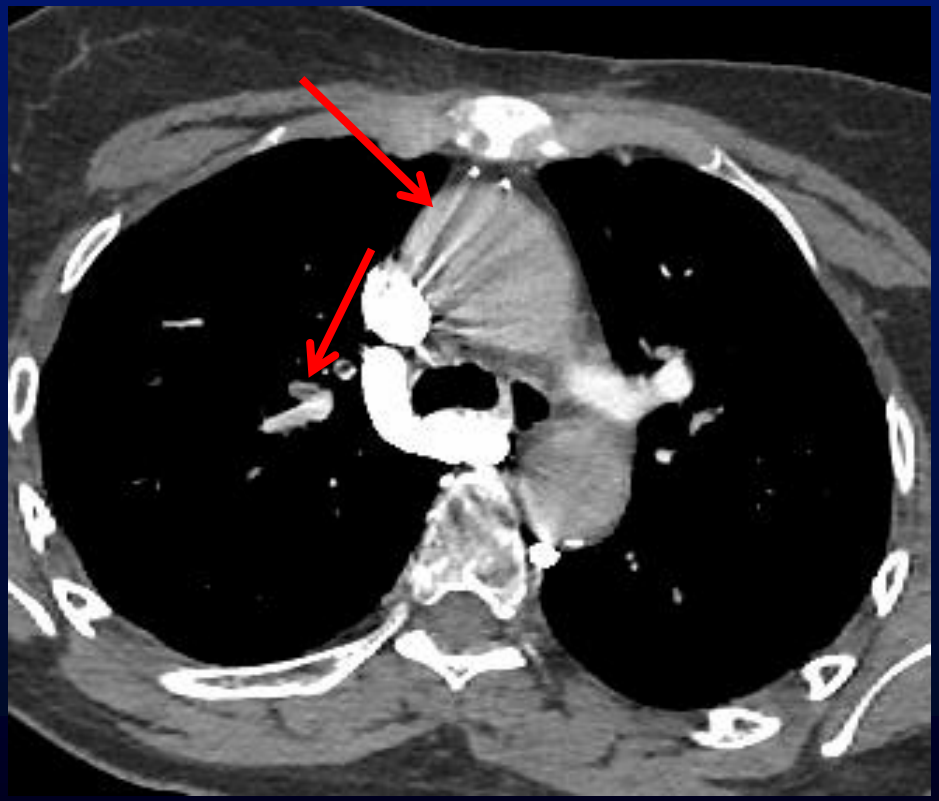


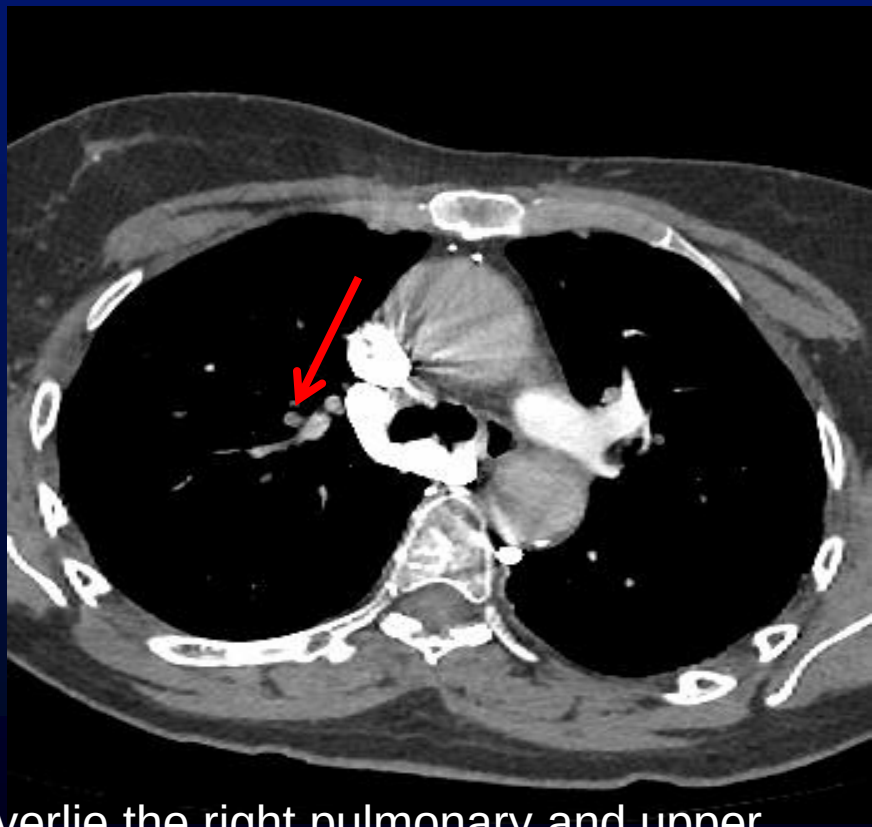


Characteristic pattern of enhancement-contrast in SVC and Aorta, but decreased attenuation in the pulmonary circulation

✓ Trouble-shooting-repeat study with suspend respiration

76-year-old female with sudden onset of right flank pain and shortness of breath. Rule out PE





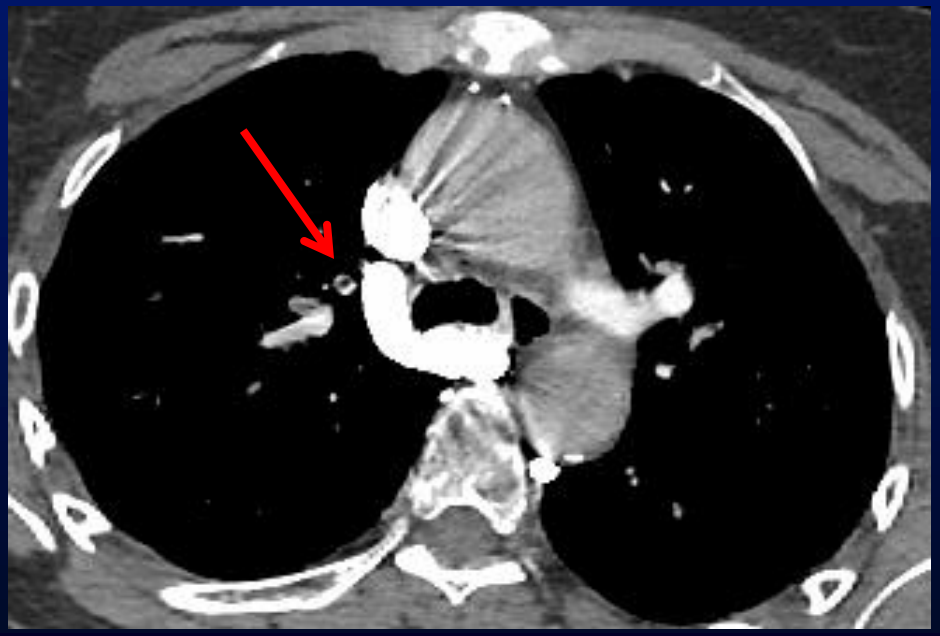
Dense contrast material within the SVC can overlie the right pulmonary and upper lobe arteries.

Non anatomic, poorly defined, radiating nature

Pitfalls-Technical Factors

- Streak artifact from contrast in SVC

  -Non anatomic radiating dark and bright lines



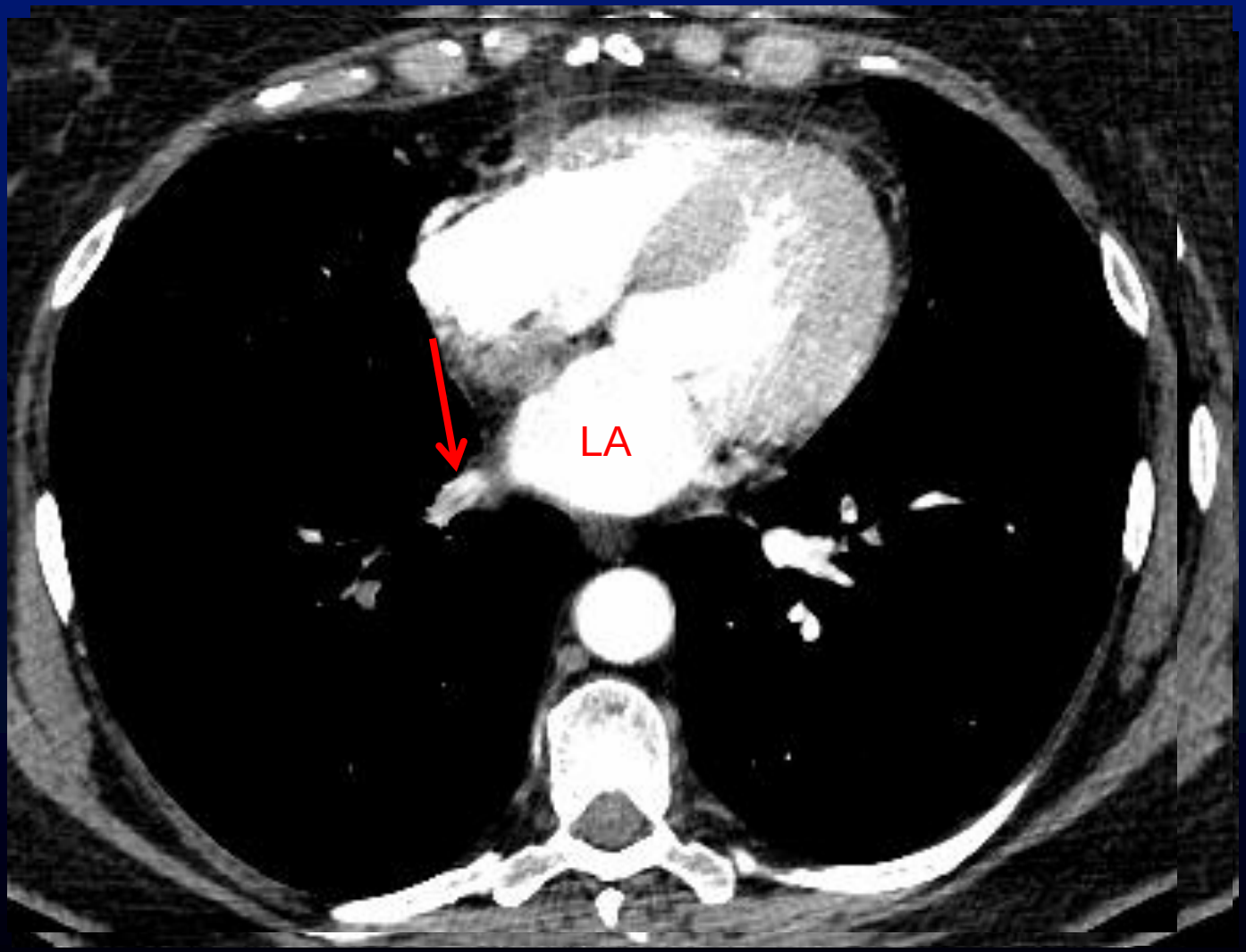
✓Trouble shooting: Use saline chaser to flush the SVC with saline using dual chamber injector

Pitfalls-Technical Factors

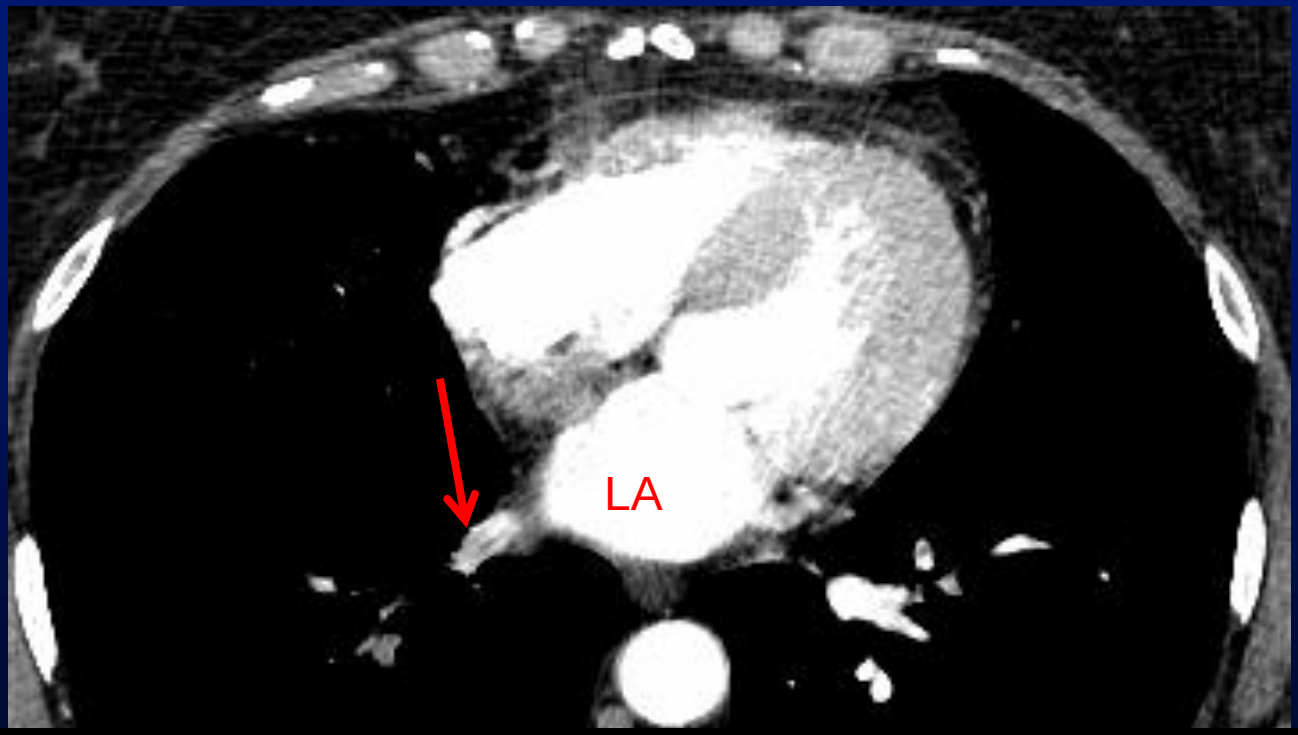
- Window/Level Settings
  - Bright vessels can obscure small pulmonary embolism on conventional mediastinal windows (W: 400/L: 40)

- Trouble shooting: Set Window/Level =700/100HU

53-year-old female incidental PE in outside institution



53 year old female incidental PE in outside institution

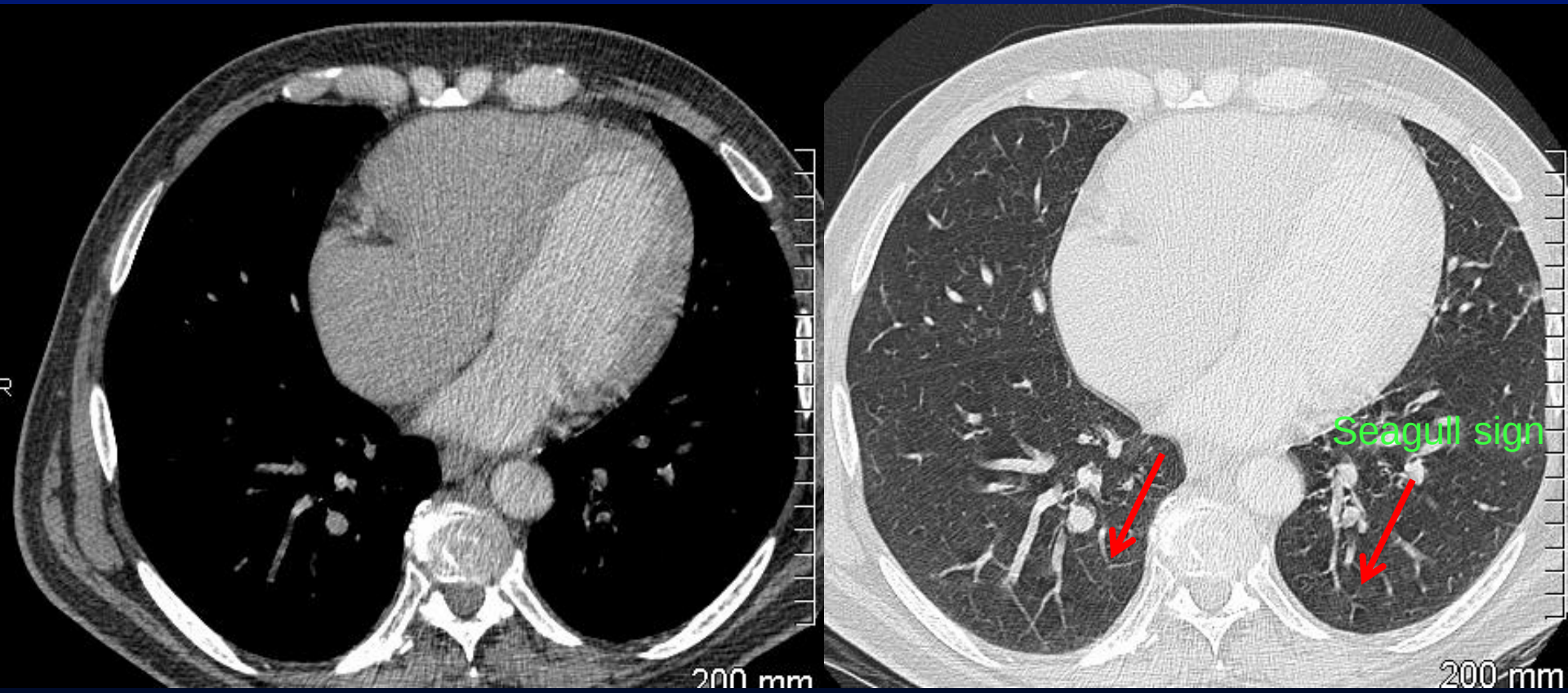


✓Know your anatomy

✓Pulmonary veins do not accompany bronchi (pulmonary arteries do)

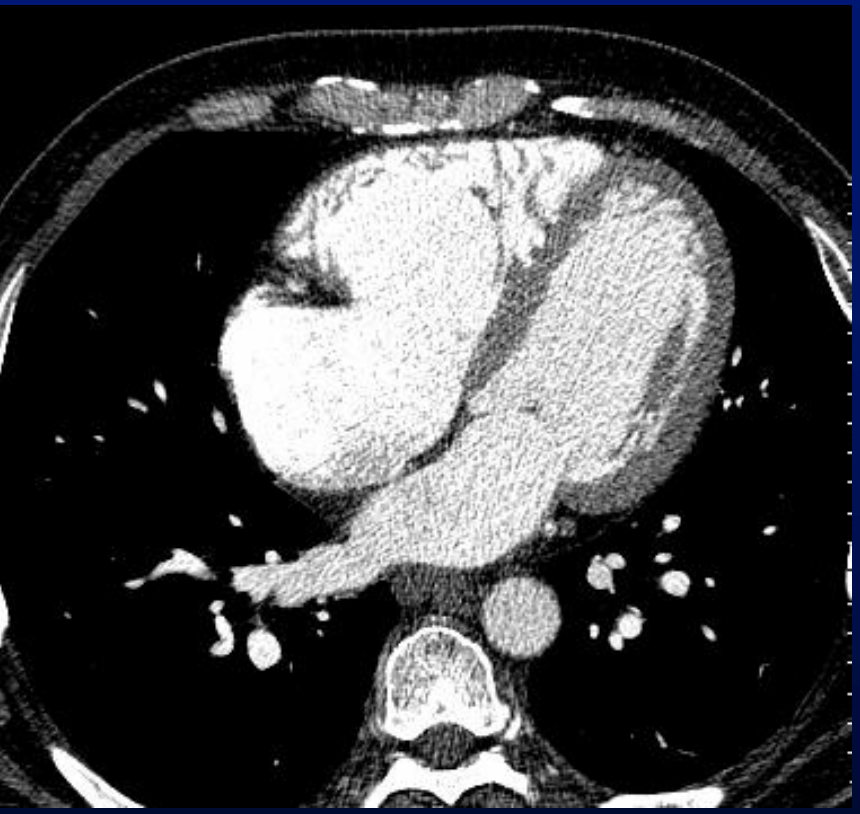
✓Follow the vessel to the left atrium confirming its venous nature

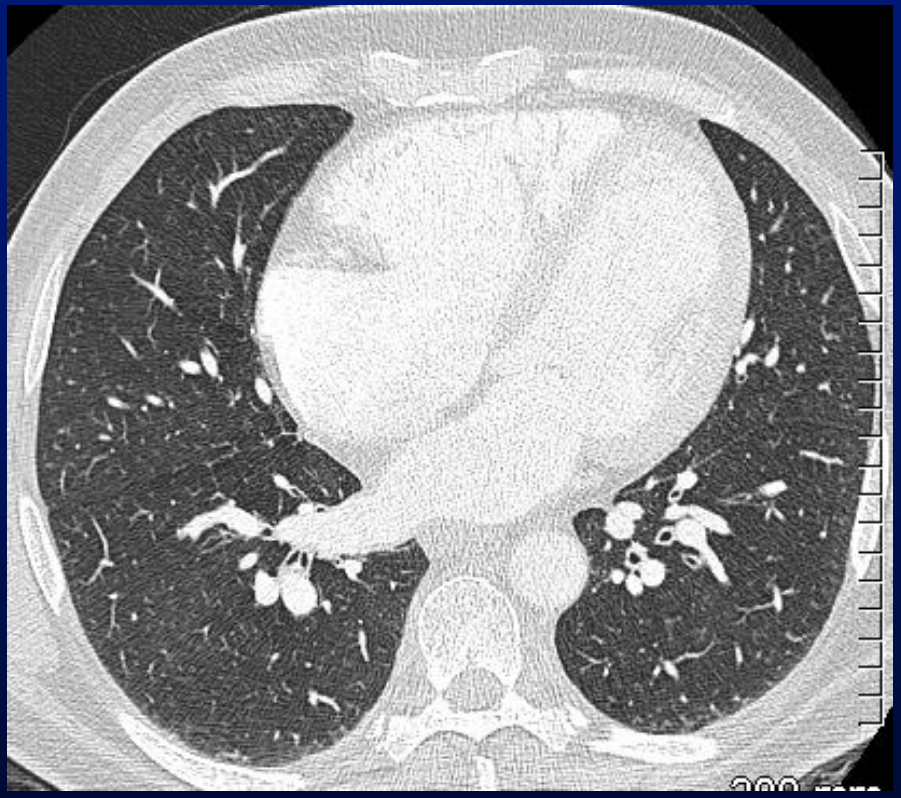
57-year-old male with dyspnea. Rule out PE



Poor opacification and Breathing artifact

CT was repeated



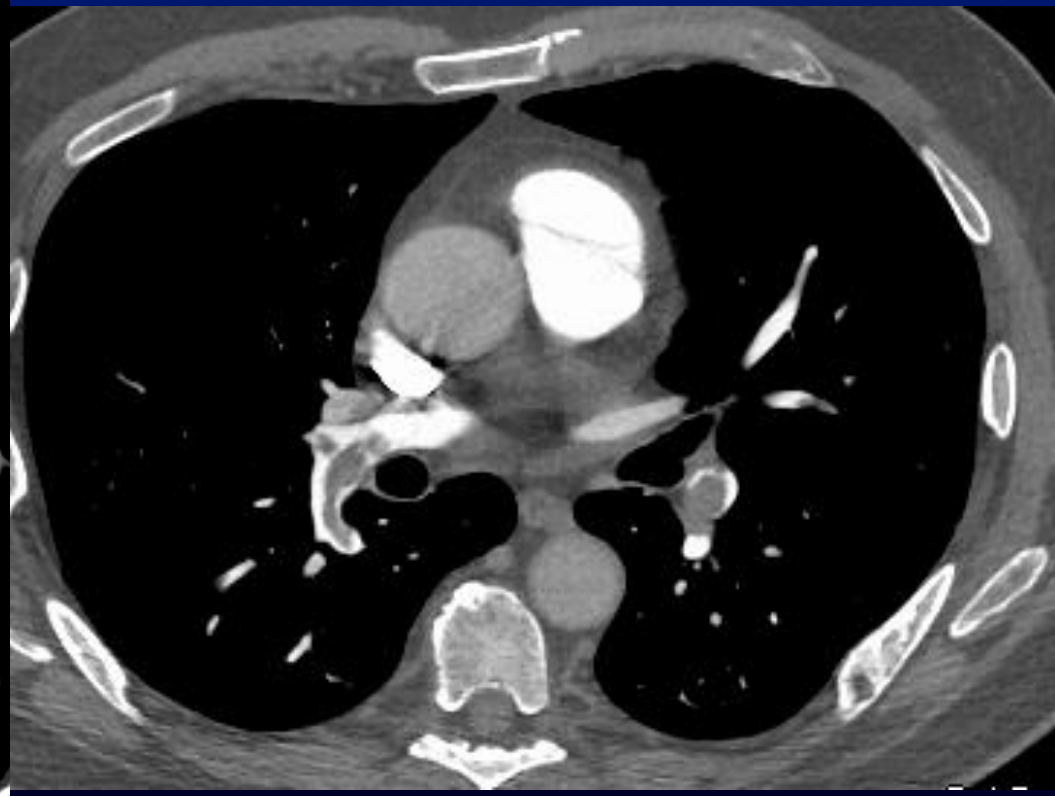


Trouble shooting Tips for Breathing Artifacts:

- Hyperventilation preceding breath hold for dyspneic patients
- Decrease Z axis coverage (from aortic arch to inferior pulmonary veins)

CTPA Predictors of Severity

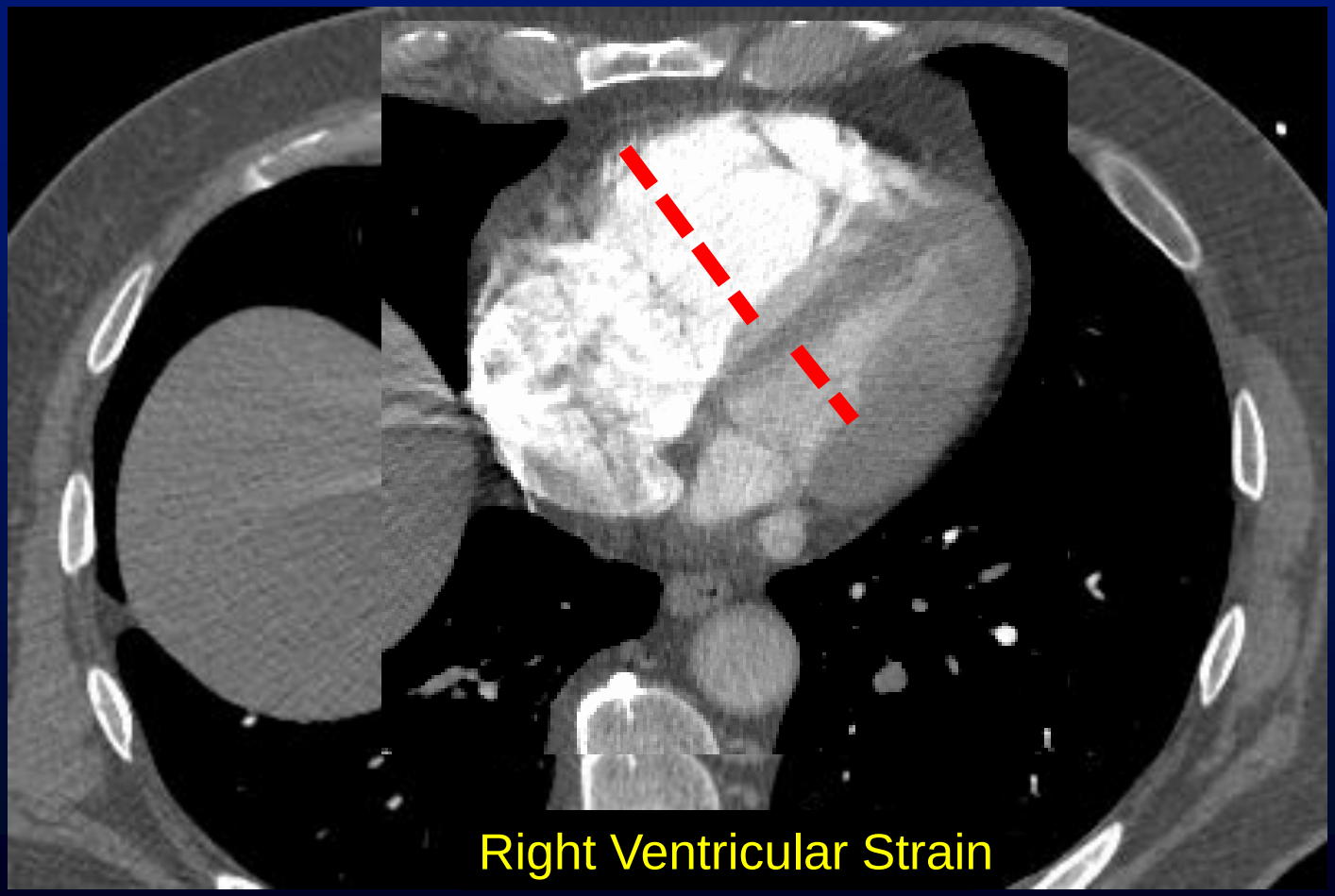
51-year-old man with pleuritic chest pain and sudden dyspnea



Which is the next slice that will provide clinically relevant information on this CTPA?

Slice at the level of the heart (mid ventricular level)

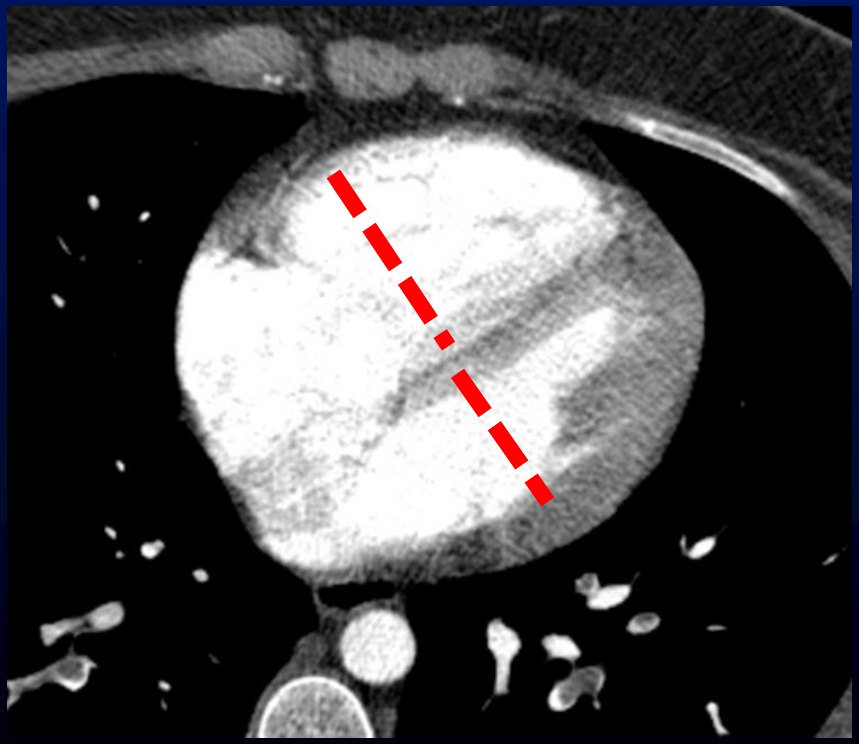
What important clinically relevant information could you provide from this image?



- ✓ The referring physician should be notified of this asap
- ✓ This should be mentioned in the body and impression of your radiology report

How should you measure the ventricles to detect RV strain?

Tricuspid and mitral valves level, widest diameter from inner wall to inner wall in axial slices



Contribution of Imaging to Risk Assessment

- ✓ RV dysfunction needs rapid diagnosis
- ✓ Shock and hypotension – circulatory collapse
- ✓ May happen in normotensive patients
- ✓ Patients need more aggressive treatment – thrombolysis and in some cases embolectomy

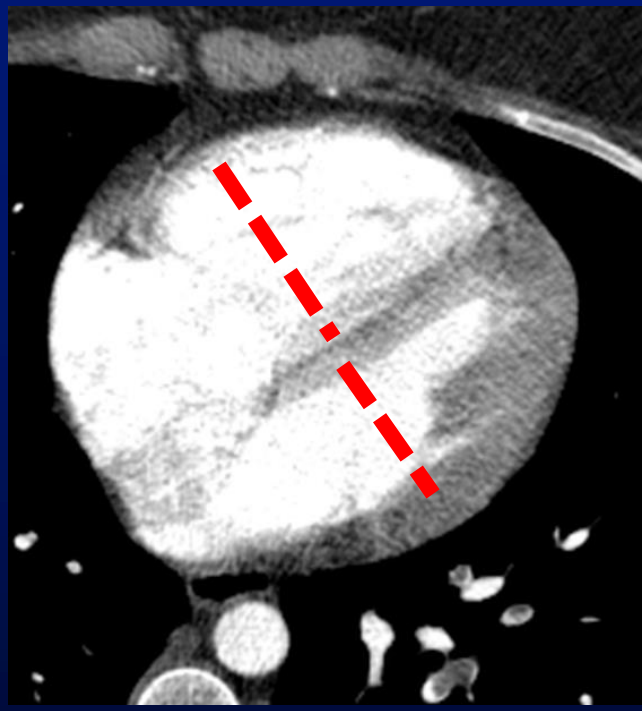
CT Predictors of PE Severity

- RV/LV ratio ≥ 1.0 – RV strain

  – 2.5 fold-risk all-cause mortality and adverse outcome

  -5 fold- risk for pulmonary embolism-related mortality

  – Useful in normotensive, stable



Meinel FG et al. Am J Med 2015; 128 (7): 747-759

Isolated Subsegmental Pulmonary Emboli (SSPE)

- Single or multiple filling defects at the subsegmental level without PE proximally
- May represent a lower severity of illness
- May resolve spontaneously and may not need treatment if not associated DVT

➢ It is important to report level of the PE

Pregnancy and PE

- Leading cause of maternal death in developed countries
- Major concern
  - Carcinogenesis due to low ionizing radiation exposure
    - Mother: Lung and breast CA (CTPA>V/Q)
    - Fetus:
      - Lower radiation from CT than V/Q scan (decrease differences towards the end of pregnancy, equivalent)
      - Gadolinium and iodinated contrast crosses placenta (no known mutagenic or teratogenic effects)
      - Iodine may suppress thyroid function after delivery (a single dose of low osmolar iodinated contrast is unlikely to have effect on thyroid function at birth)

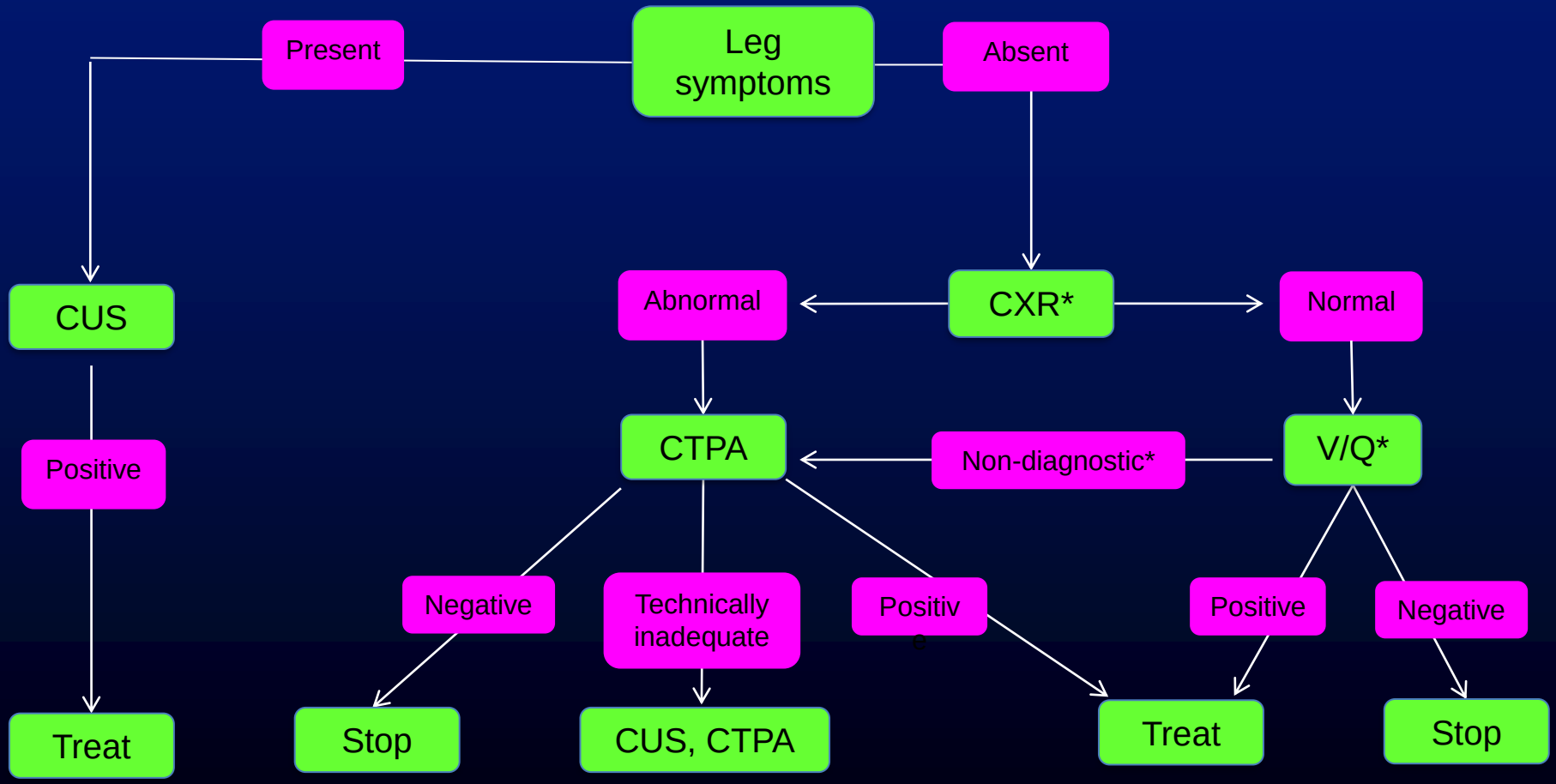
Pregnancy and PE

- 2011 New Guidelines American Thoracic Society/Society of Thoracic Radiology
- Wells criteria not validated in pregnancy
- D-dimer not useful as screening in pregnancy

Leung N A, et al. Am J Respir Crit Care Med 2011;184:1200-8

Suspected PE in Pregnant Patients
ATS/STR Clinical Practice Guidelines 2011

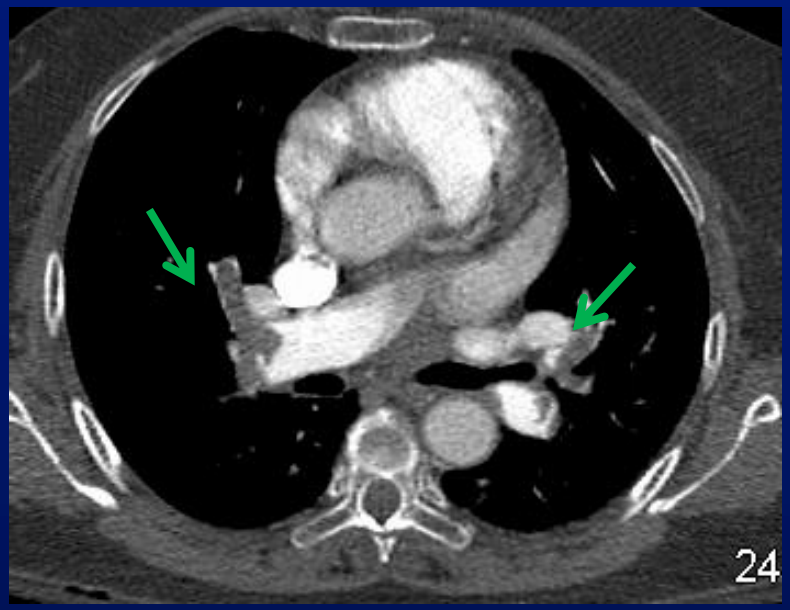
Leung AN et al. Am J Respir Crit Care Med 2011;184:1200-1208



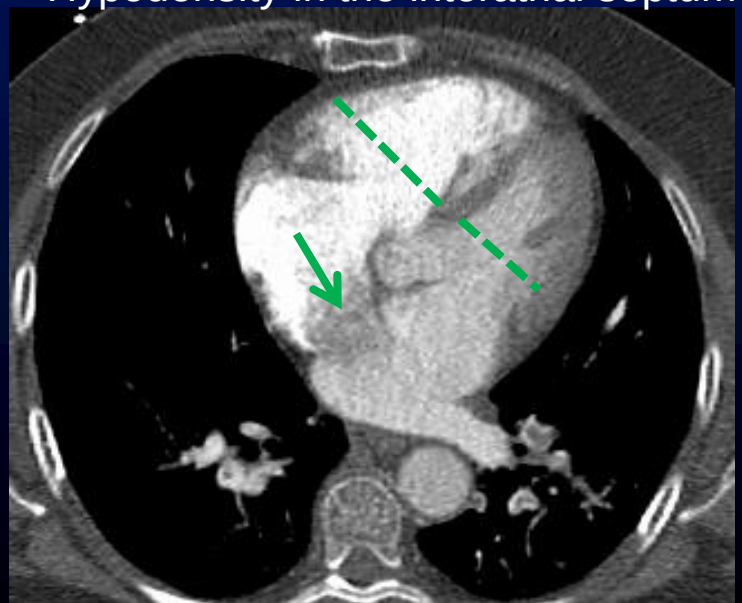
Courtesy of Dr. Dennie, University of Ottawa

- 67-year-old woman presents with facial numbness and chest, back and abdominal pain.

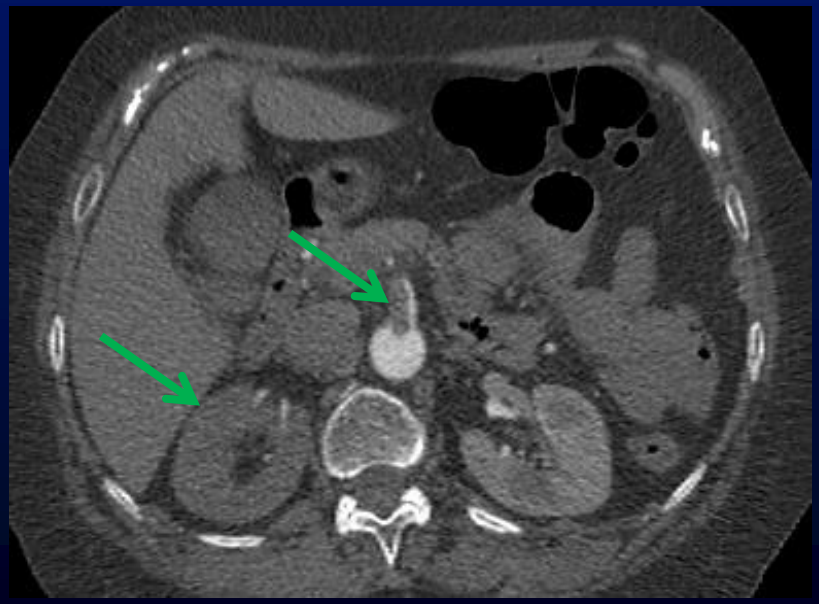
Multiple Filling Defects in Pulmonary Arteries



Enlargement of RV (RV/LV>1)
Hypodensity in the interatrial septum



Filling Defect Superior Mesenteric Artery
Asymmetric Enhancement of kidneys
(Infarction of right kidney)

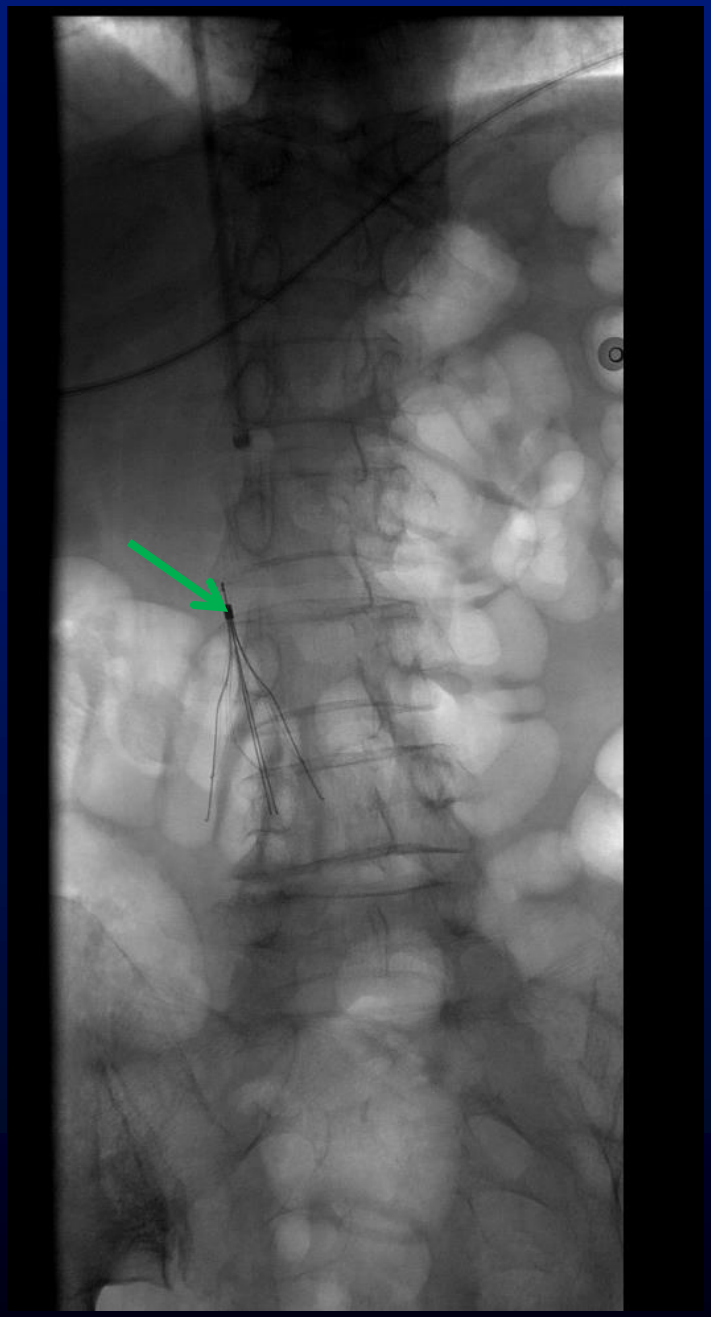


- Transesophageal echocardiogram :

✓ Large PFO with right to left shunt
✓ No intracardiac thrombus
✓ RV dilatation and dysfunction
✓ Pulmonary Hypertension

- The SMA thrombus was removed with surgical embolectomy

- Patient had an IVC filter implanted

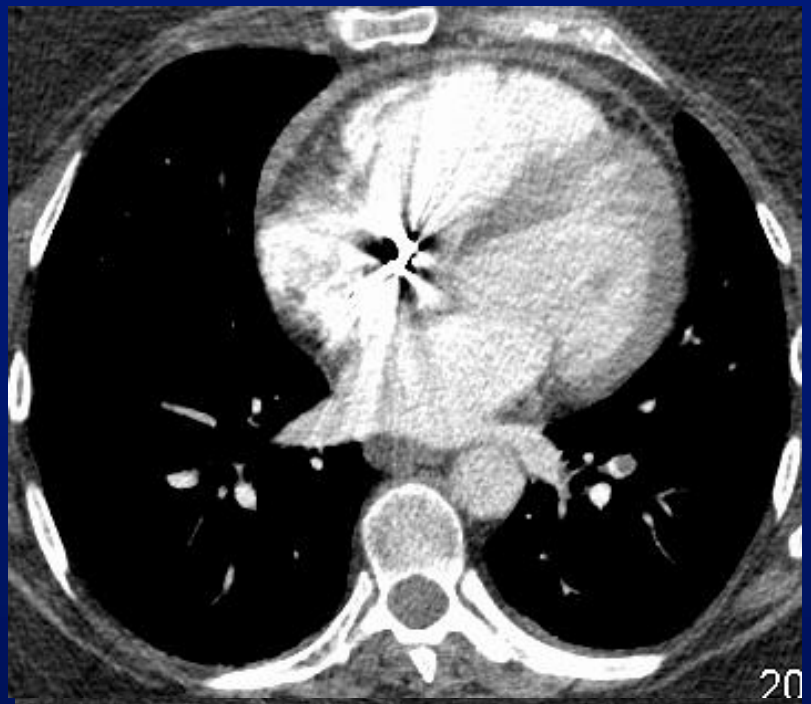


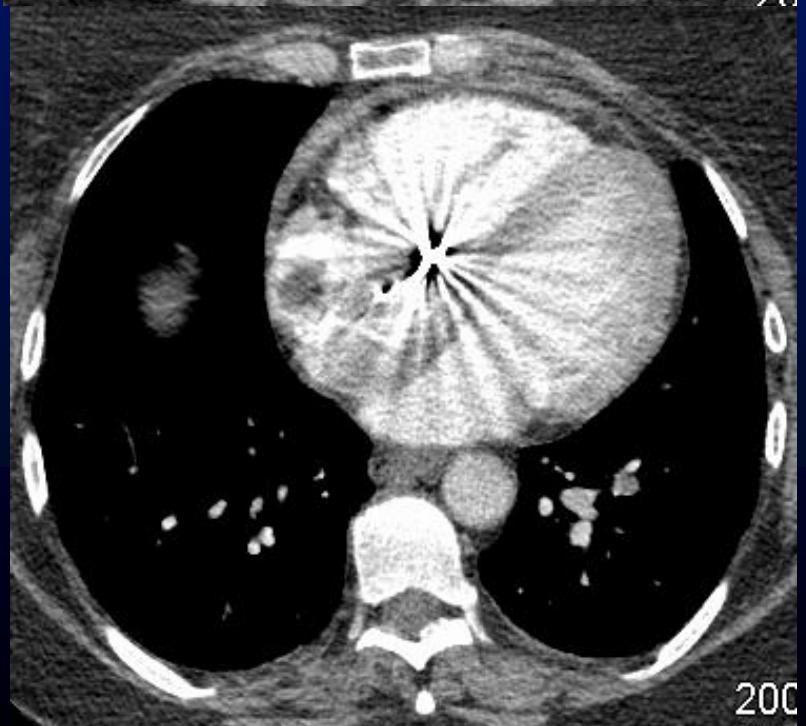
Paradoxical Embolism

- Thrombi from venous system reaches the arterial system through an abnormal communication between heart chambers resulting in systemic embolism

Saremi F et al, Radiographics 2014 Oct;34(6):1571-92

Cases

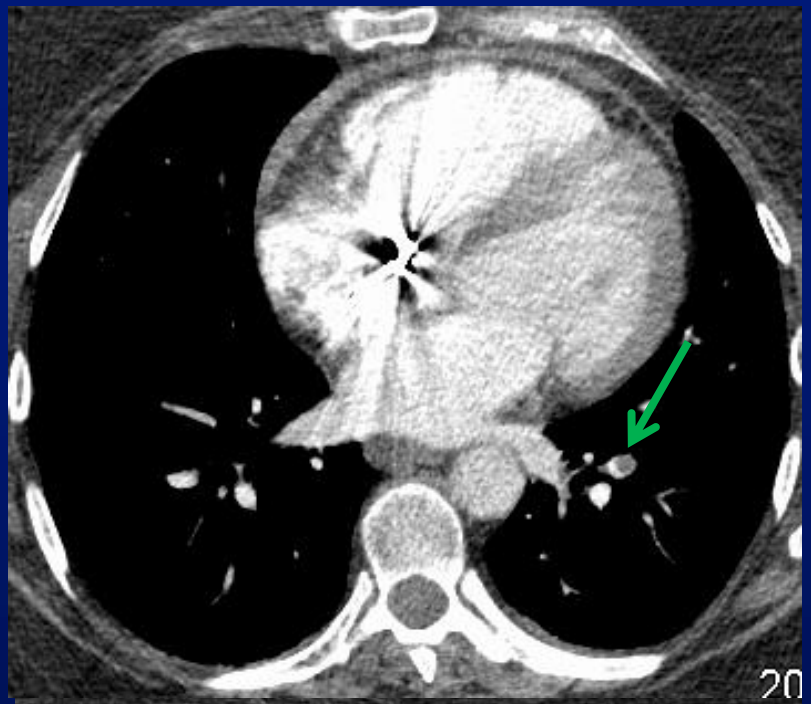


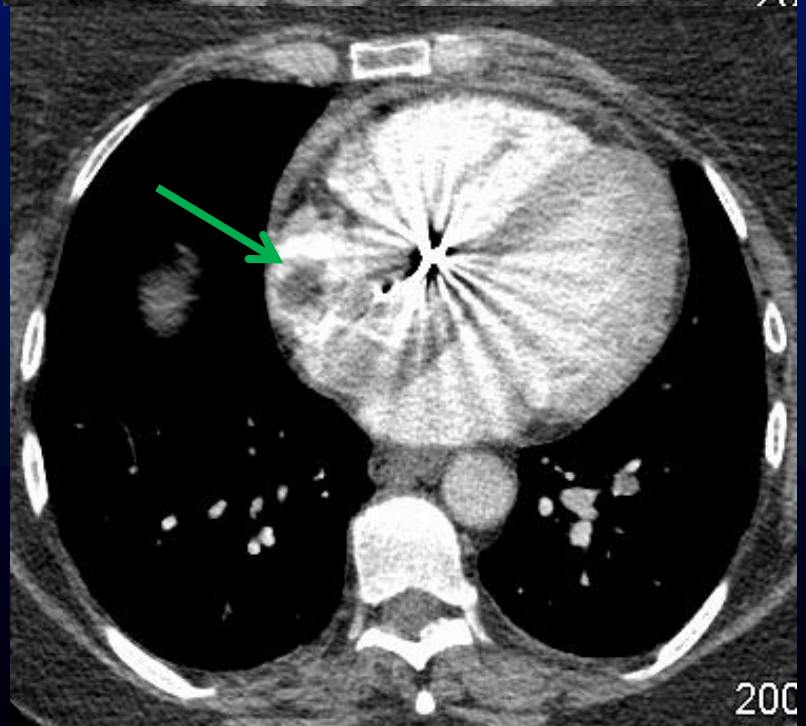


56-year-old female with sudden onset of chest pain and dyspnea.

Tachycardia.

Rule out PE.





Segmental Pulmonary Embolism

Right Heart Thromboemboli

Mobile Right Heart Clot In-Transit

- Associates massive PE and increased risk of mortality (27%)
- Detection of right heart clot may have therapeutic implications
- May require sternotomy and embolectomy and/or thrombolysis
- Important finding that should be reported to referring physician

Mollazadeh R et al. Clin Cardiol. 2009; 32(6):E27-31
Rose PS et al. Chest 2002;121:806-814

Acute Pulmonary Embolism-Reporting Checklist

- Is the study diagnostic? Are there any pitfalls?
- Level of embolism
- Signs of RV strain
- Any in-transit embolism?
- Any PFO/ASD?

Take Home Messages

- ✓ Most effective diagnostic strategy in suspected PE
  - ✓ CPR+/-D-Dimer+/-CTPA
- ✓ CTPA-imaging modality of choice
- ✓ Negative CTPA excludes PE without need of imaging the leg veins
- ✓ CUS-option in presence of DVT symptoms
- ✓ V/Q scan -patients with normal radiograph and contraindications for CTPA
- ✓ Guidelines for pregnancy

Thank you for your attention!

epena@toh.ca