Detecting a Pulmonary Embolism Using Computed Tomography

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Introduction

- A pulmonary embolus is a potentially fatal pathology in which clots form within the pulmonary artery.

- Computed tomography is the choice modality for visualization of the pulmonary artery and diagnosing a pulmonary embolism.

- A computed tomography scan provides the location of an embolus in an accurate and timely manner, deeming it optimal for diagnosis.

What is Computed Tomography (CT)?

- An imaging modality that creates cross-sectional images of the body in different planes, utilizing a rotating x-ray tube.

- Provides images of internal structures free of superimposition by using contrast, varying body positions, and multiple exposures (Long, et al., 2019).

(Hospital for Special Surgery, 2022)

What is a Pulmonary Embolism (PE)?

- Occurs when a clot breaks off from elsewhere in the body, lodges in, and obstructs the pulmonary circulation.

- Usually occurs in multiples and involves the lower lobes of the lung more than the upper lobes, mainly bilateral than in a singular lung.

- With large PEs, the main pulmonary artery is affected. With small PEs, the peripheral arteries are affected (Vyas, & Goyal, 2022).

Signs and Symptoms of a PE

- Sudden shortness of breath

- Sharp chest pain, worsening with breathing

- Dizziness, lightheadedness, or syncope

- Cough, possibly containing blood

- Back and leg pain or edema

- Blue hue to the lips or nails

(American Lung Association, 2023a)

Diagnosing a PE

- A chest x-ray, MRI scan, echocardiogram, ultrasounds, and CT are diagnostic tests to help confirm a PE.

- Lab tests such as a D-dimer test may be used to determine the likelihood of a pulmonary embolism. (Nall, et al., 2021).

CT Pulmonary Angiogram (CTPA)

- The golden standard for diagnosis of a PE which demonstrates the main pulmonary artery and its branches in the arterial phase using either a test bolus or bolus tracking.

- A test bolus consists of injecting a small amount of contrast and obtaining sequential axial slices at a set region, which calculates the time of enhancement for peak contrast to determine a scan delay.

- Bolus tracking involves sequential axial slices taken at a set region while contrast is injected until the threshold is met, triggering a scan.

- The patient lies supine with their arms above their head. The scout image includes the apices to the diaphragm.

- The scan occurs in a caudocranial direction to better demonstrate the lower lobes and remove artifact from the contrast bolus in the superior vena cava.

- The monitoring slice should be placed below the carina, level to the pulmonary trunk. The region of interest (ROI) is placed on the pulmonary artery. (Murphy, et al., 2023).

- A PE may appear on a scan looking like a polo mint sign, a white circular structure, around a blood vessel.

- Other visual appearances may be noticed such as bulging of a vessel, contrast dye parallel to the clot, or a vessel unable to be filled with blood due to the blockage from the clot (Nall, et al., 2021).

Contraindications

- Allergy to iodinated contrast dye

- Kidney disease or decreased function of the kidneys

- Pregnancy (Vyas & Goyal, 2022)

Positive CTPA for PE

Photo of a saddle PE. The darkening within the artery demonstrates an embolus or clot.
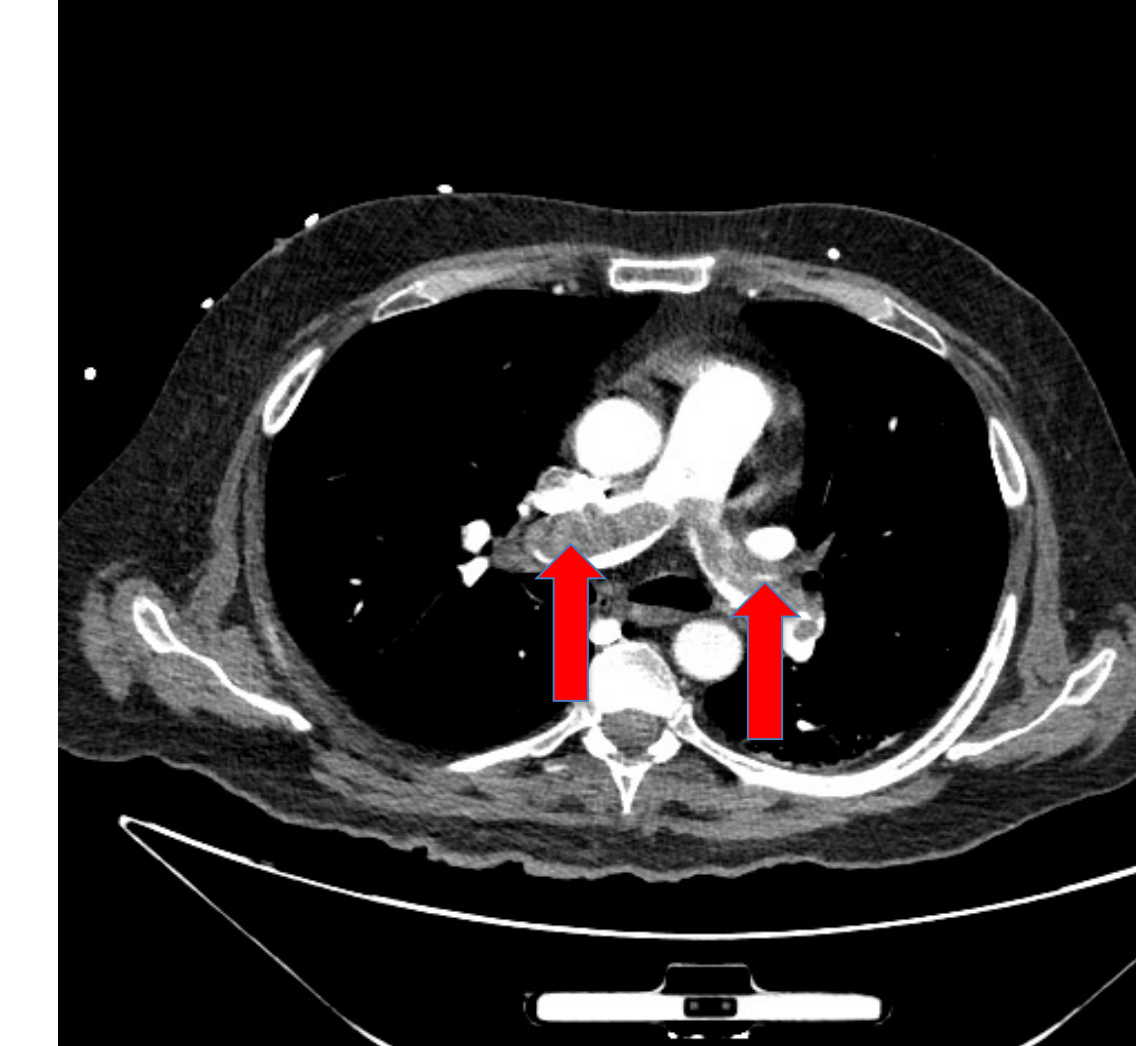
(Clinical Affiliate Site, 2023a)

Negative CTPA for PE

Photo of a negative PE study. No visual indications are present to indicate a PE.

(Clinical Affiliate Site, 2023b)

Other CT Studies Performed for Detection

- Advances in technology have led to the introduction of dual-energy computed tomography (DECT), which uses both x-rays and less powerful x-rays to create images.

- According to a recent study using 182 patients, 108 patients were positive for a PE using DECT, showing that DECT imaging is accurate for diagnosis (Abdellatif, et al., 2020).

- According to another study using DECT, a PE can be visualized in the venous phase rather than the arterial phase.

- The images from the DECT were compared to a normal CTPA, and diagnosis was based on vascular perfusion. The sensitivity ranged from 90-100%, showing that DECT could be an alternative to a CTPA (Foti, et al., 2021).

- A PE can also be detected on a non-contrast chest CT, if a CTPA is contraindicated or not accessible (Zaher Elia, et al., 2021).

Treatment and Management

- Keeping the clot from getting larger and preventing the formation of new clots is the main form of management.

- Blood thinners or anticoagulants are given upon diagnosis and transitioned to a three-month pill regimen at home.

- For life-threatening situations, clot dissolvers can be given.

- An inferior vena cava filter can be placed to prevent clots from entering the lungs.

- An embolectomy can be performed for large, life-threatening clots (American Lung Association, 2023b).

Statistics

- The occurrence of pulmonary emboli ranges from 39 to 115 per 100,000 population every year.

- Acute pulmonary embolism is the third most common type of cardiovascular disease.

- A pulmonary embolism is more common in males than females.

- Due to the nonspecific and variety of signs seen in patients, diagnosis of a PE can be difficult.

- In the United States, pulmonary emboli causes 100,000 deaths every year.

- About 30% of untreated patients with a pulmonary embolism die, but only 8% die after intervention.

- Case-fatality rates of pulmonary emboli have decreased due to improvement of diagnostic exams and early intervention (Vyas & Goyal, 2022).

Conclusion

- A large fraction of the population within the United States are affected by pulmonary emboli every year.

- More advancements are being made with computed tomography technology and other diagnostic exams, which has helped decrease fatality rates within the United States.

- Although interventions vary case by case, timely management and treatment is pertinent to ensure the health of the patient improves.