HỘI NGHỊ KHOA HỌC CHẨN ĐOÁN HÌNH ẢNH TP.HCM MỞ RỘNG LẦN THỨ XII–2025

Phiên Kỹ thuật hình ảnh

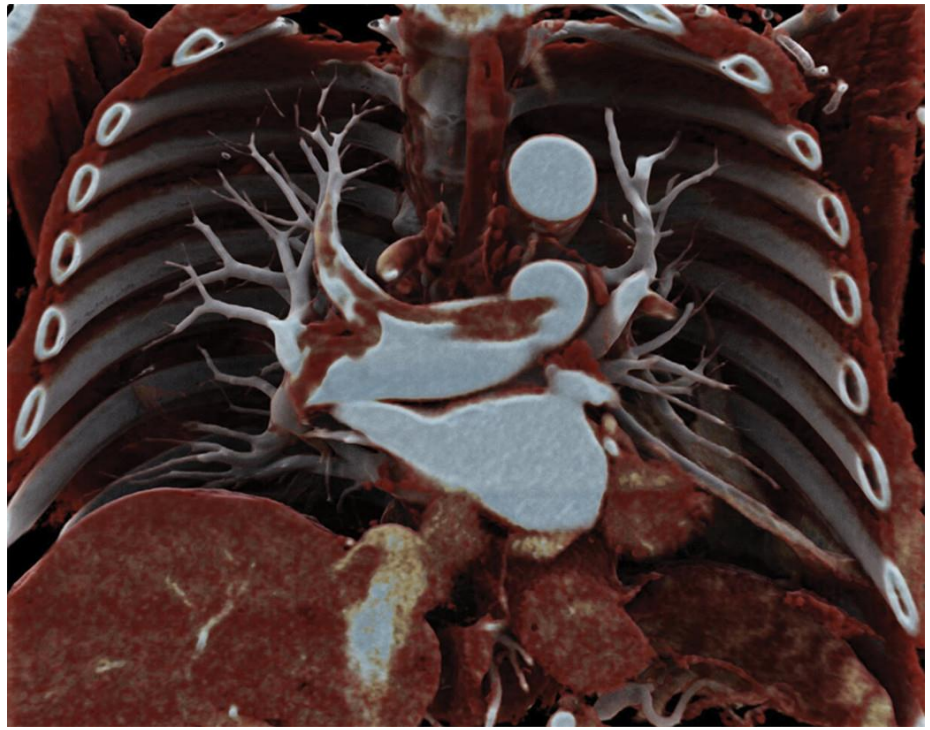
CHỤP CẮT LỚP VI TÍNH ĐỘNG MẠCH PHỔI: THÁCH THỨC VÀ GIẢI PHÁP

KTV. LÊ KIM HẰNG
BSCKII. LÊ MINH THẮNG
BV ĐHYD TPHCM

RSHCM 2025

NỘI DUNG

1. TỔNG QUAN
2. THÁCH THỨC
3. GIẢI PHÁP
4. KẾT LUẬN



TỔNG QUAN

JAMA Network | Open

Original Investigation | Imaging

Trends in Imaging for Suspected Pulmonary Embolism Across US Health Care Systems, 2004 to 2016

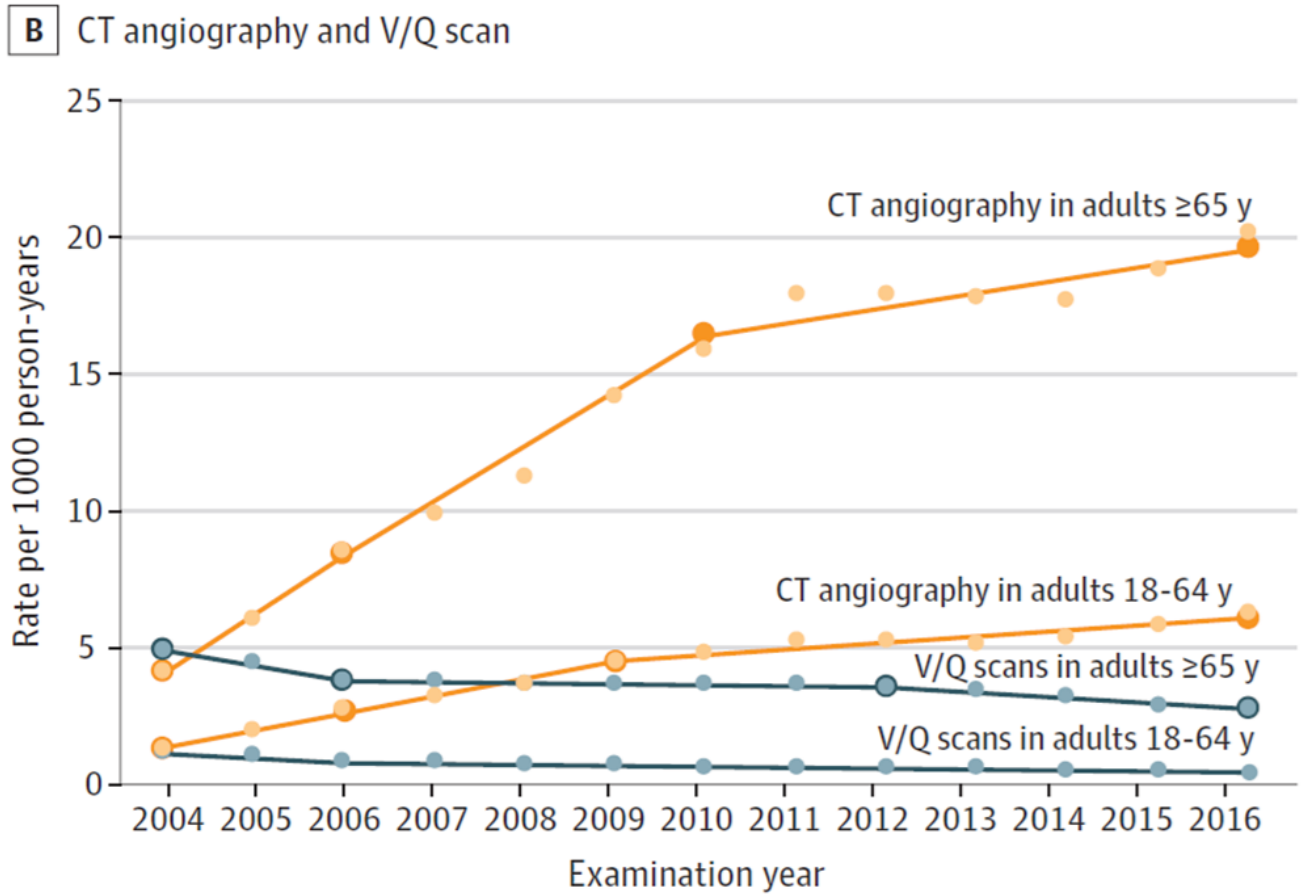


Figure 1. Chest Imaging Rates per 1000 Person-Years by Imaging Test and Age Group, With Annual Percentage Changes in Rates Based on Joinpoint Regression Analysis

The rate of indeterminate CTPA studies is reported to be 0.5-10.8%. Among indeterminate CTPA examinations, poor contrast opacification contributes to 40% of examinations and motion artifact to 74%. It has been suggested that optimal opacification in the main pulmonary artery should be 250 H.

Thoracic Imaging

The Indeterminate CT Pulmonary Angiogram: Imaging Characteristics and Patient Clinical Outcome[1]

RESULTS: The cause cited for indeterminism was most often motion (74%), followed by poor contrast enhancement (40%). Contrast attenuation in the MPA was 245 HU ± 80 (standard deviation) in patients and 339 HU ± 88 in control subjects ($P < .001$). Only 46% of indeterminate studies met institutional criteria for adequate contrast attenuation in the MPA. Rereview of studies demonstrated five missed PEs. A total of 81 patients (33%) underwent follow-up imaging within 5 days, with one positive pulmonary angiogram and four positive lower-limb US scans. Reread or follow-up images depicted thromboembolic disease in 4.2% of patients. Nineteen patients (8%) with indeterminate final result were treated for thromboembolic disease with either anticoagulation or IVC filters. Reports on 22% of indeterminate studies contained recommendations for follow-up imaging, and those recommendations nonsignificantly increased the rate for those examinations from 13% to 19%. Review of discharge summaries showed 22% of studies are clinically interpreted as negative.

CONCLUSION: The two major causes of indeterminism are motion artifacts and poor contrast enhancement.

© RSNA, 2005

Radiology 2005; 237:329 –337

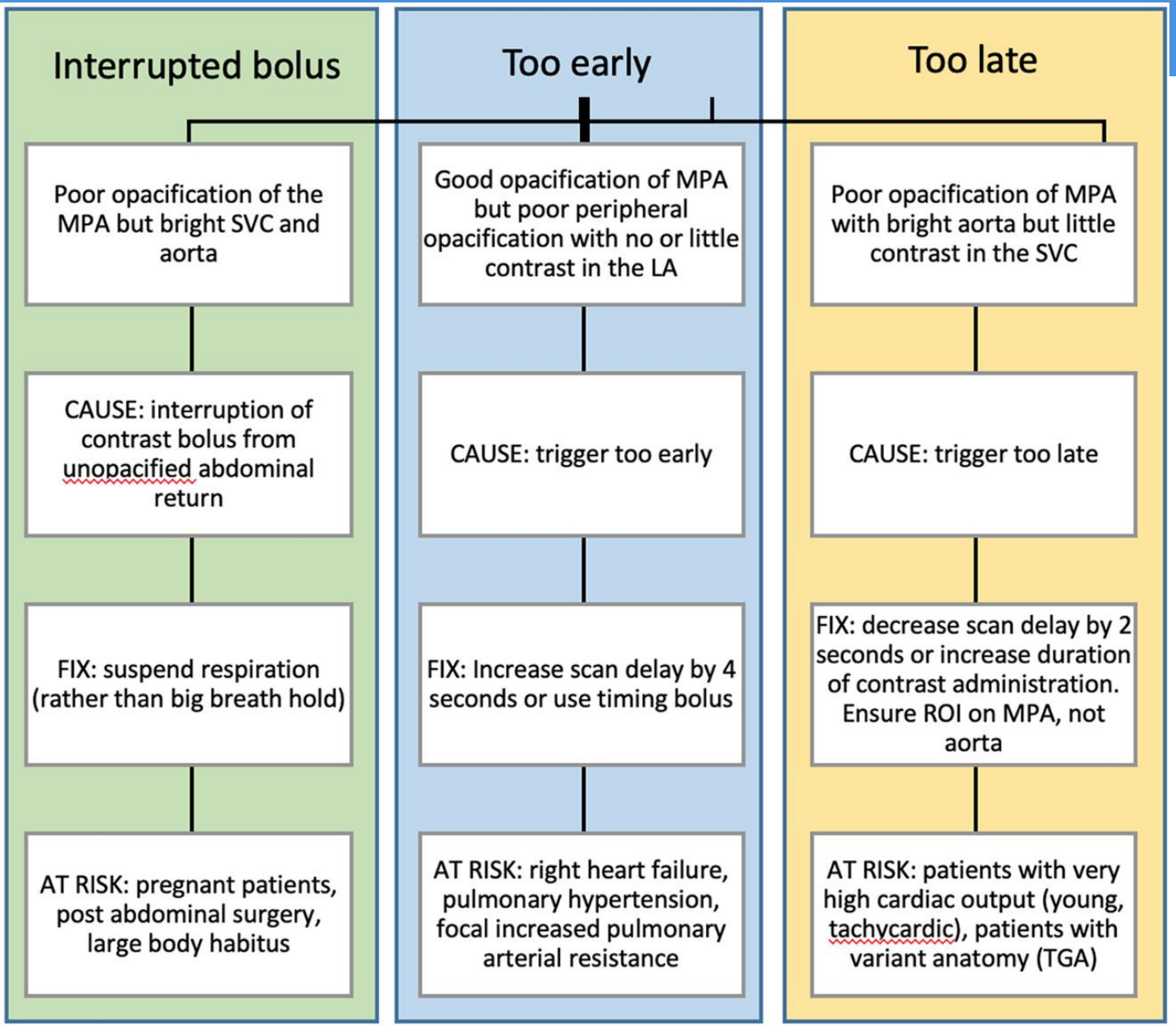
THÁCH THỨC

Table 1 Different causes of abnormal contrast flow, key imaging findings and solutions to obtain a diagnostic CTA

Etiology of altered contrast flow	Key imaging features	Solution
Access cannula and vein mismatch	1. Suboptimal target vessel opacification 2. Injection flow rate may be lower than planned	1. New cannula or access vein 2. When access veins are small: Dual energy scan with 50–60 keV monoenergetic reconstruction
Incorrectly placed region of interest	1. Assess location of region of interest from the bolus tracker/ bolus timing images	Correct placement of ROI, reinjection, and reimage
Extravasation	1. No target vessel opacification 2. Contrast presence in soft tissues of access vein extremity	1. New cannula and access vein at a different site
Thoracic venous outlet obstruction	1. Contrast pooling in the collaterals around axilla & chest wall	1. Asymptomatic: reinjection with arm down position 2. Symptomatic: new access site in contralateral extremity
Transient interruption of contrast bolus	1. Transient decreased contrast attenuation. 2. Presence of normal contrast in upstream vessels	1. Shallow breath hold 2. End expiratory imaging 3. Free breathing high pitch acquisition
Differential enhancement in pulmonary artery		1. Delayed acquisition 2. Biphasic injection
Differential enhancement in aorta		1. Multiplanar reformats to evaluate coarctation, shunts.
Mixing artifact in aorta	Contrast blood level, dependent pooling of contrast	1. Assessment of cardiac function Repeat delayed (30 sec) limited Z axis scan
Mixing artifact in left atrium	Contrast blood level in left atrium, pulmonary veins	Assessment of cardiac function
Poor opacification of left ventricle	No opacification of left ventricle on a pulmonary artery CTA	Assessment of cardiac function
Early enhancement on left compared to right heart	Intracardiac shunt	Assessment of cardiac function
Asystole	Dependent pooling of contrast in central veins, liver	Initiate cardiopulmonary resuscitation and page the code team

Insights Imaging (2017) 8:127–140

Poor pulmonary arterial contrast opacification



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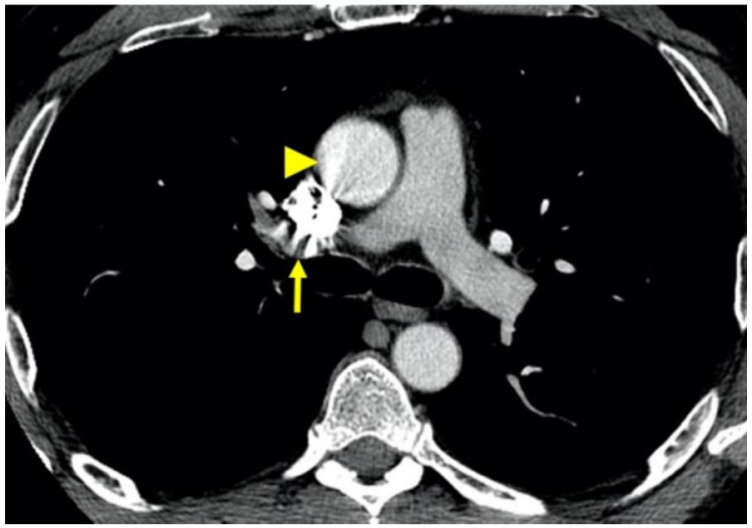
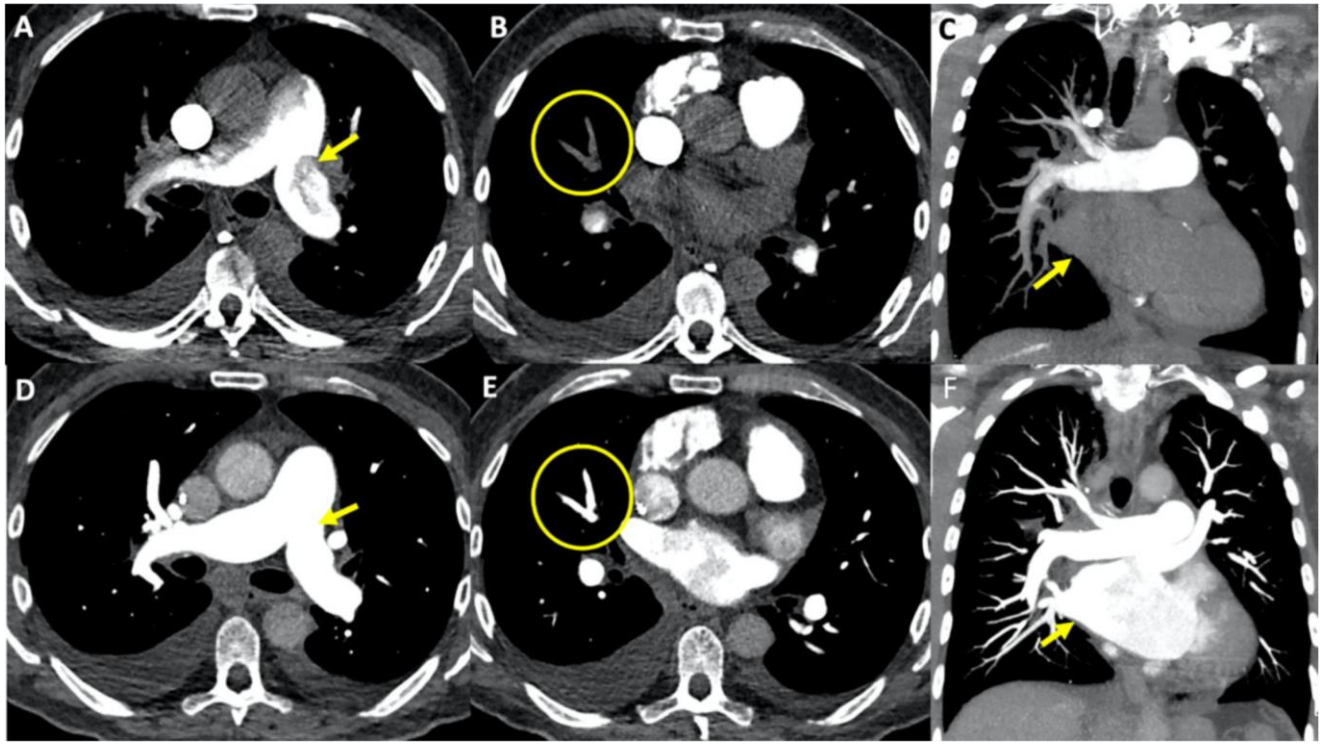


Too late



Too early

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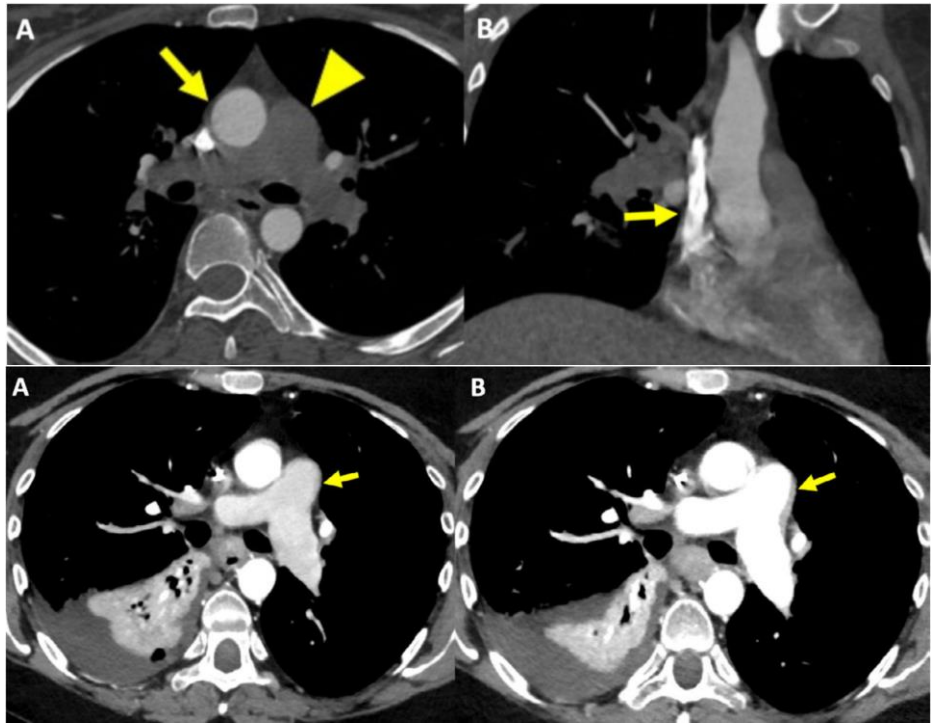
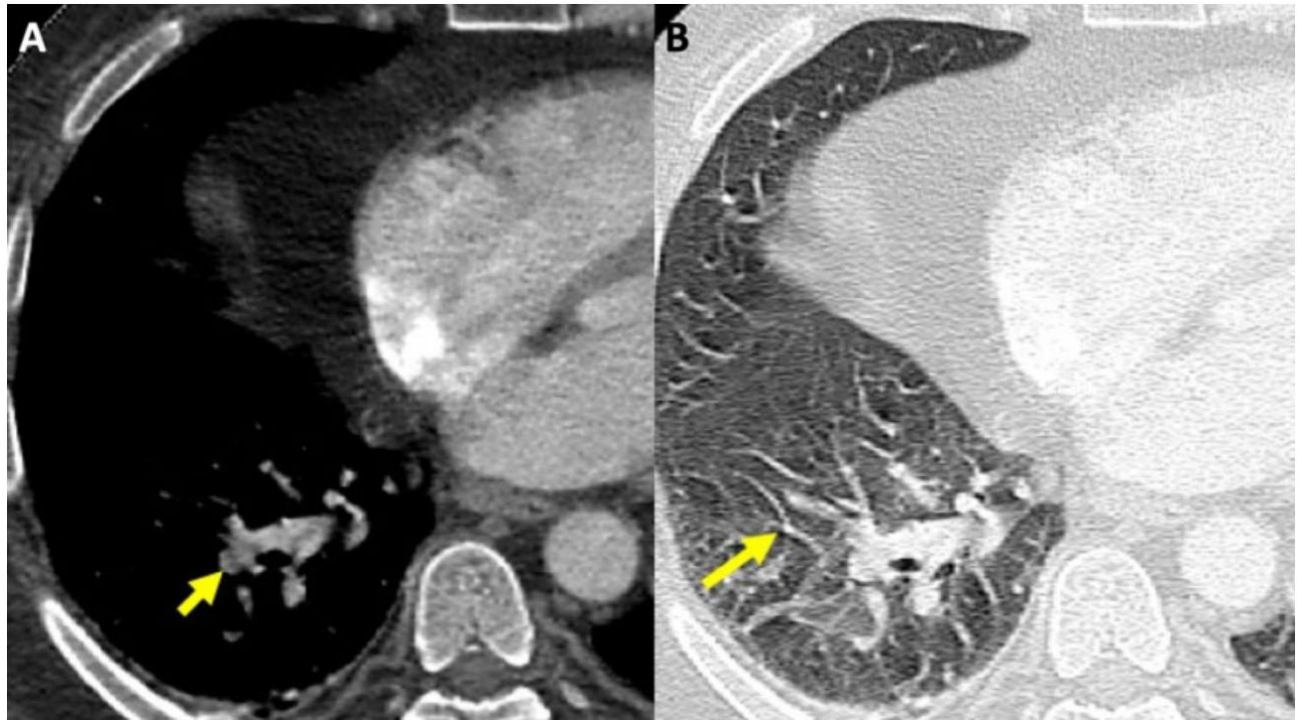


Interrupted bolus



Artifact

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KỸ THUẬT KHẢO SÁT CTPA

KHÔNG ĐƯỢC LỰA CHỌN

- Người bệnh
  - Tình trạng sức khỏe
  - Đường truyền tĩnh mạch
- Máy CT Scan
- Chất tương phản - Saline
  - Nồng độ
  - Tốc độ tiêm

ĐƯỢC LỰA CHỌN

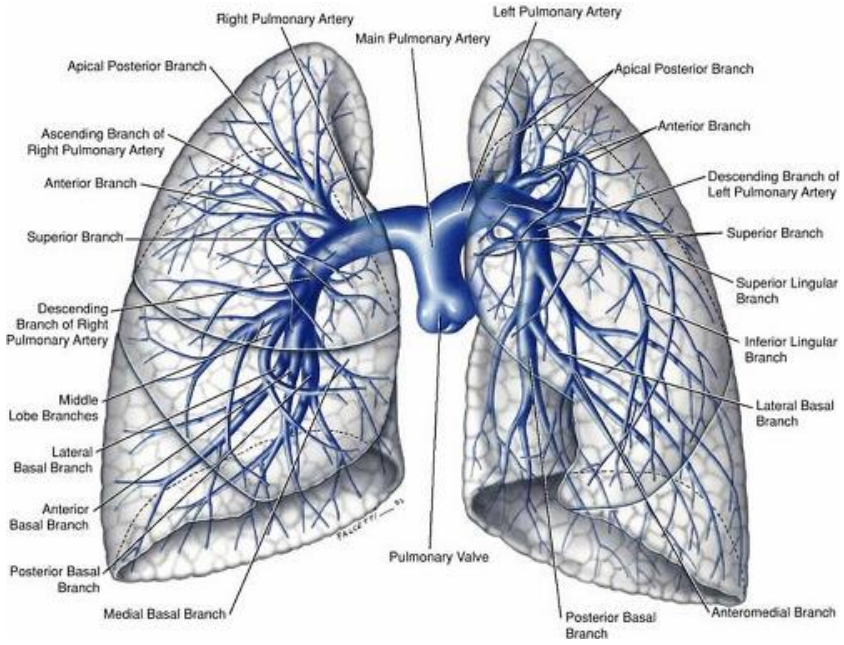
- Các yếu tố kỹ thuật
  - Kỹ thuật Test / Care bolus
  - Vị trí / Ngưỡng ROI
  - +/- Đồng bộ ECG
  - Lượng chất tương phản
  - Các thì khảo sát

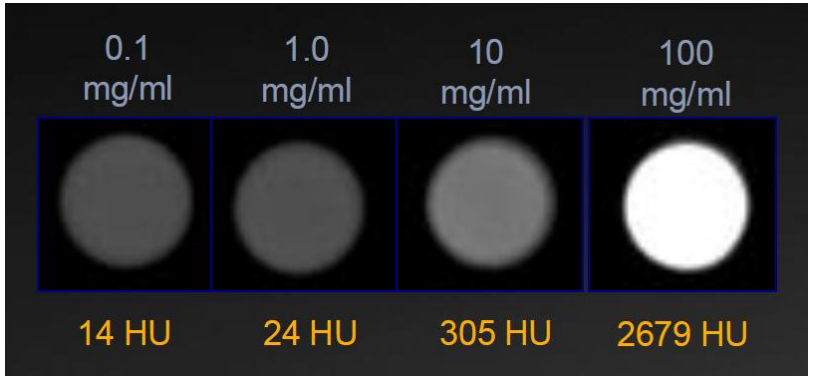
GIẢI PHÁP

ĐÚNG THỜI ĐIỂM

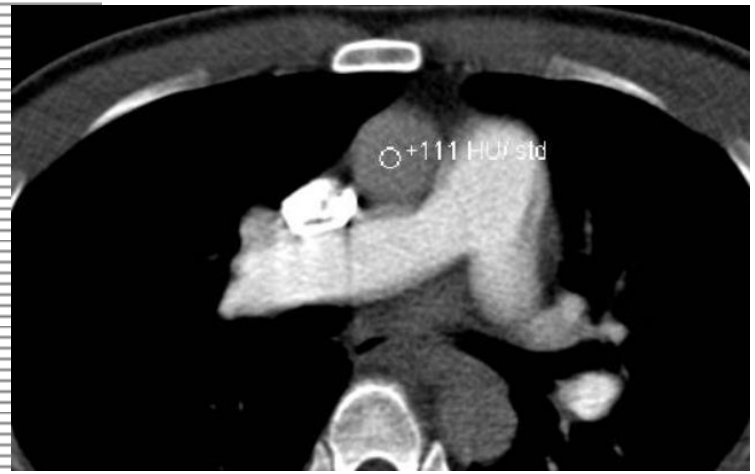
- Động mạch phổi tại vị trí khảo sát lấp đủ cản quang
- Không xảo ảnh chuyển động

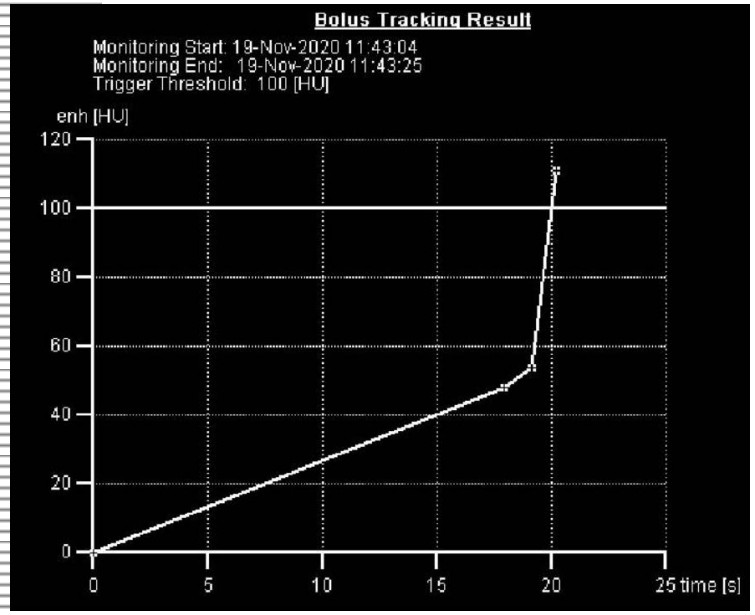
?



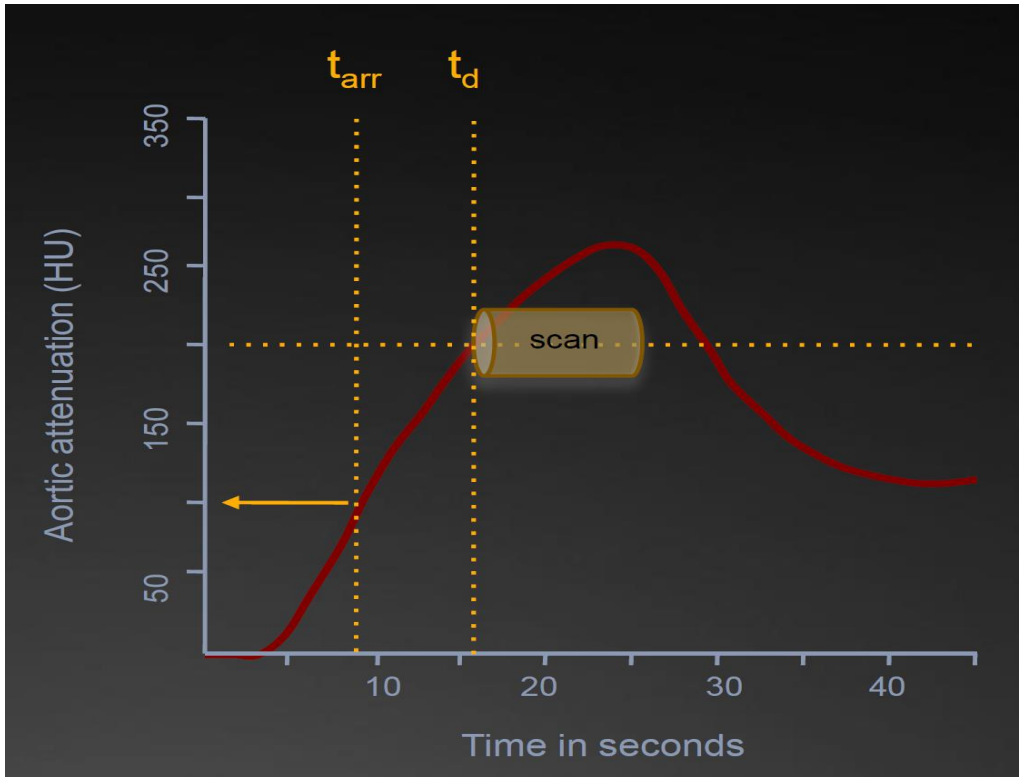


Test bolus / Care bolus

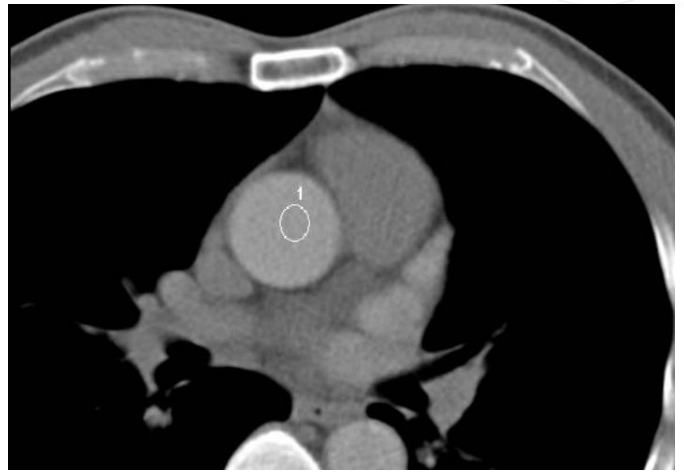


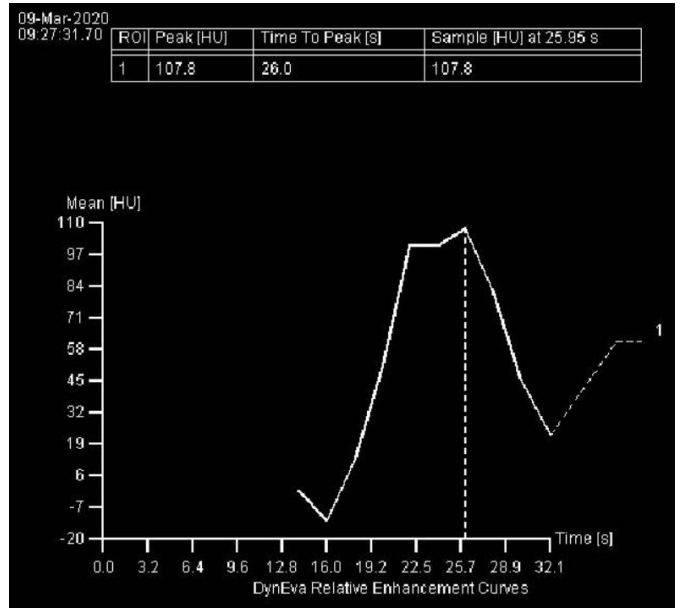


Care bolus



Contrast media arrival time (T_{arr}):
T_{arr} = Thời gian chất tương phản đạt ngưỡng ở cấu trúc mục tiêu





Test bolus

Care bolus

- ❖ Thuận lợi
  - Đơn giản
  - Giảm lượng chất tương phản
- ❖ Bất lợi
  - Chỉ chụp một lần → Không đánh giá nguy cơ sai sót

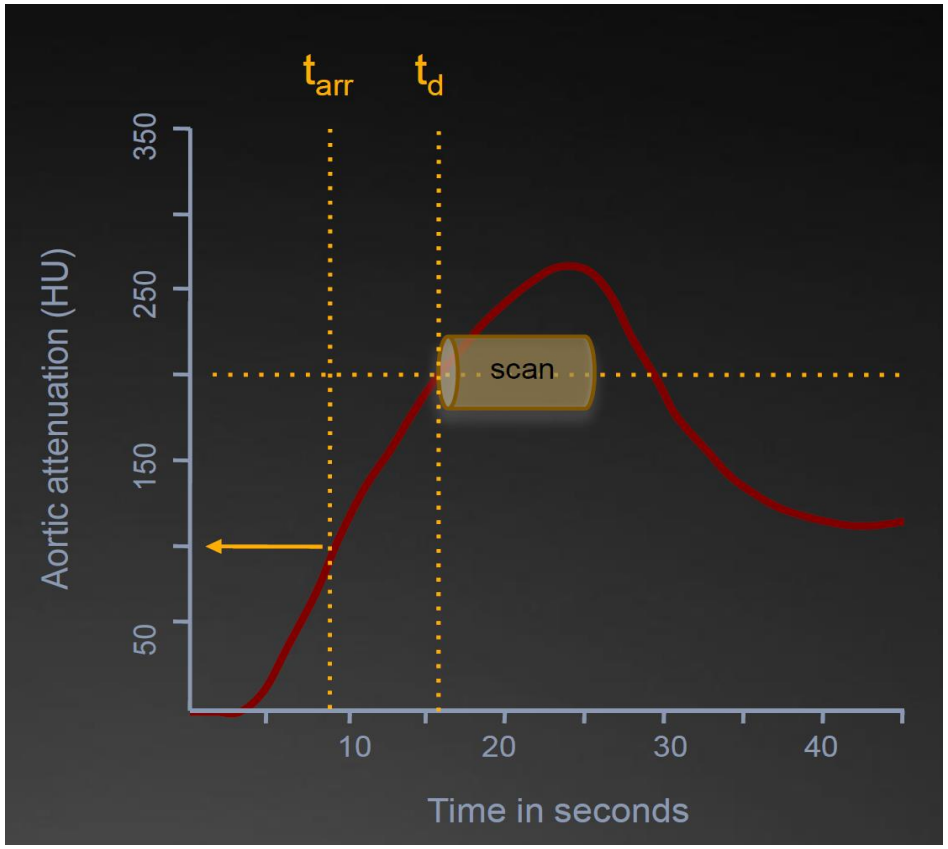
Test bolus

- ❖ Thuận lợi
  - Kiểm tra đường truyền
  - Có thể ROI nhiều vị trí
  - Có thể lặp lại
  - Tránh xảo ảnh
  - Kiểm tra phản ứng của NB
- ❖ Bất lợi
  - Tổn thời gian
  - Hai lần tiêm → Tăng lượng chất tương phản

T_{arr} = Thời gian chất tương phản đạt ngưỡng ở cấu trúc mục tiêu

Ngưỡng: 100 /120 / 150 HU

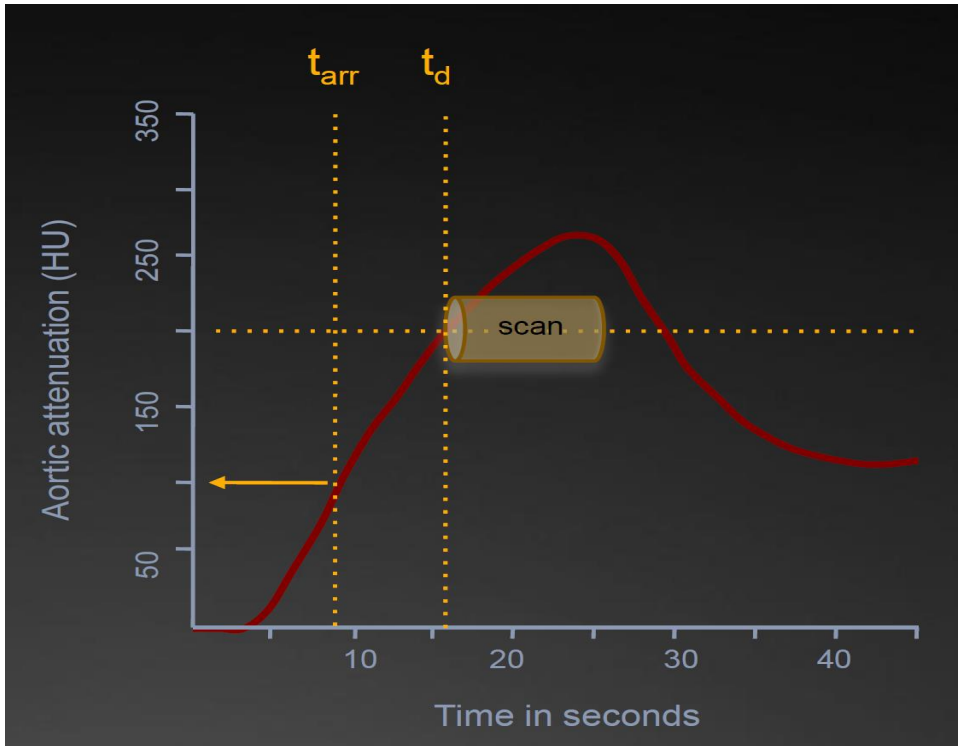
Thất phải / ĐM phổi chính / Nhĩ trái



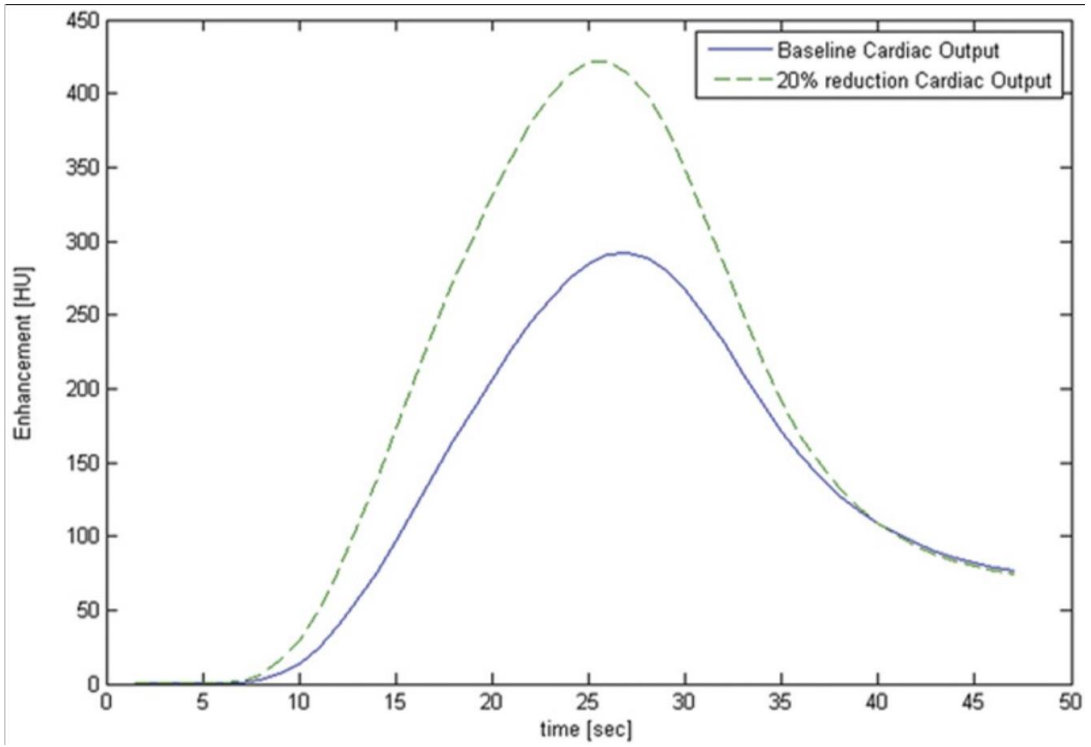
Delay time (T_d): Thời gian từ lúc đạt ngưỡng HU đến lúc bắt đầu khảo sát

T_{arr} = Thời gian chất tương phản đạt ngưỡng ở cấu trúc mục tiêu
T_d = Thời gian từ lúc đạt ngưỡng HU đến lúc bắt đầu khảo sát

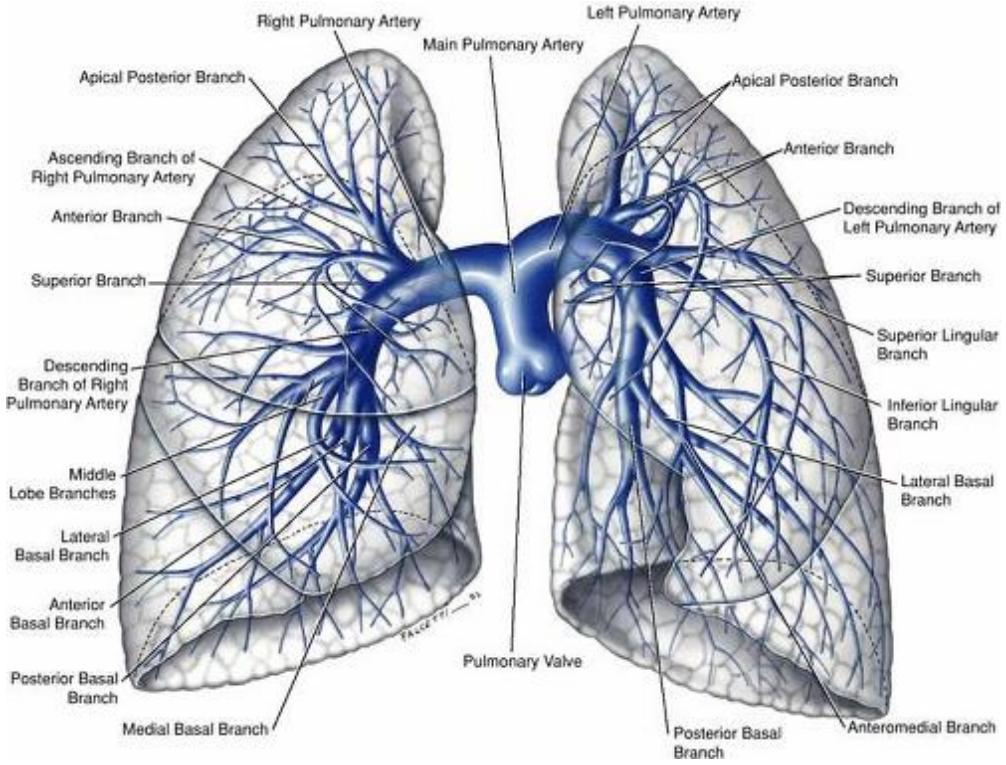
Cấu trúc mục tiêu # Động mạch phổi tại vị trí khảo sát
Ngưỡng HU # Đậm độ lòng mạch



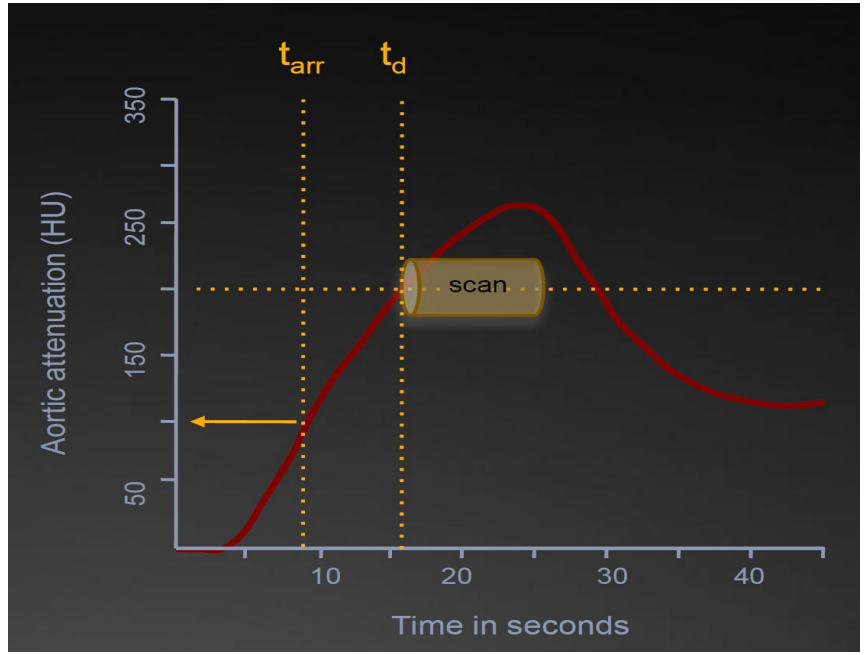
Cardiac output



T_{scan} = Thời gian khảo sát



+/- ECG

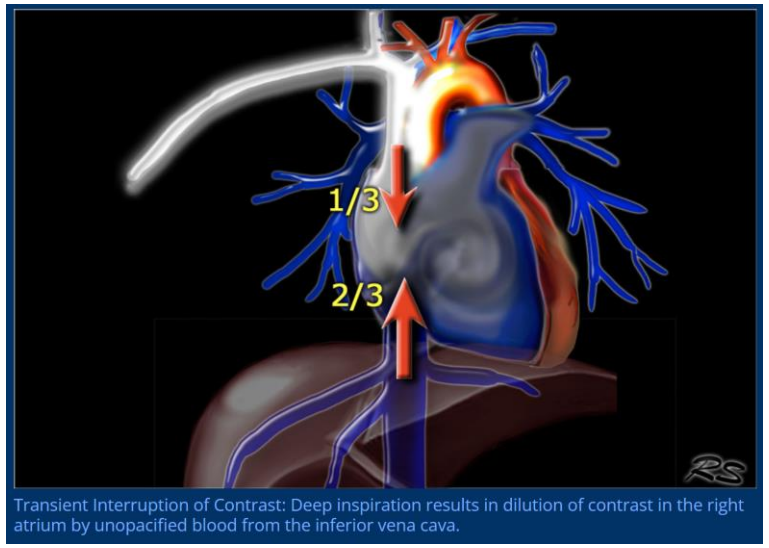


T_{scan} → $V_{contrast} = t_{scan}$ x flow (ml/s)

Motion artifact

RESEARCH ARTICLE

Incidence of transient interruption of contrast (TIC) – A retrospective single-centre analysis in CT pulmonary angiography exams acquired during inspiratory breath-hold with the breathing command: "Please inspire gently!"



Transient Interruption of Contrast: Deep inspiration results in dilution of contrast in the right atrium by unopacified blood from the inferior vena cava.

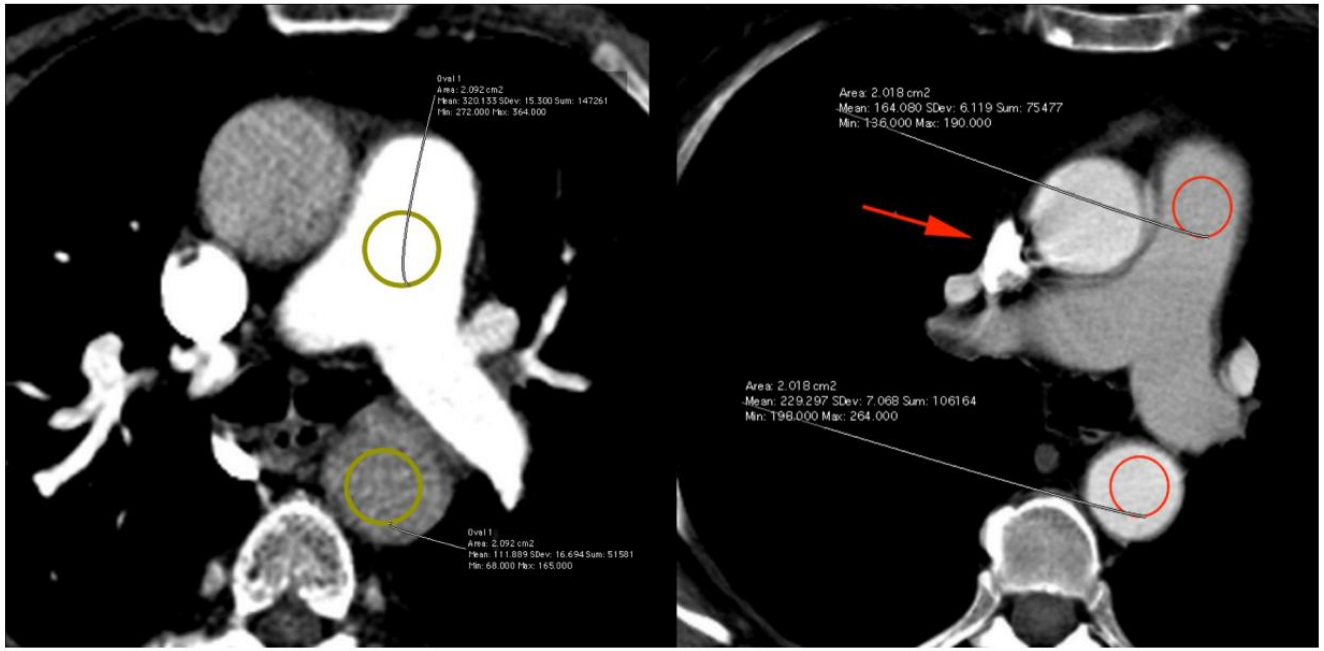


Fig 1. Aorto-pulmonary ratios <1 and >1 –Examples. a) Case of a patient presenting with an aorto-pulmonary ratio < 1. b) Case of a patient with TIC, presenting with an aorto-pulmonary ratio > 1, while contrast material inflow can still be seen within the compressed/ collapsed aspect of the *SVC* superior vena cava (SVC) (red arrow).

Conclusions

TIC is a common phenomenon in CTPA studies with inspiratory breath-hold commands after patients were told to inspire gently with an incidence of 22% in our retrospective cohort. Occurrence of TIC shows a significant negative correlation with increasing age and disproportionately often occurs in patients with lower absolute contrast density values within their pulmonary arteries.

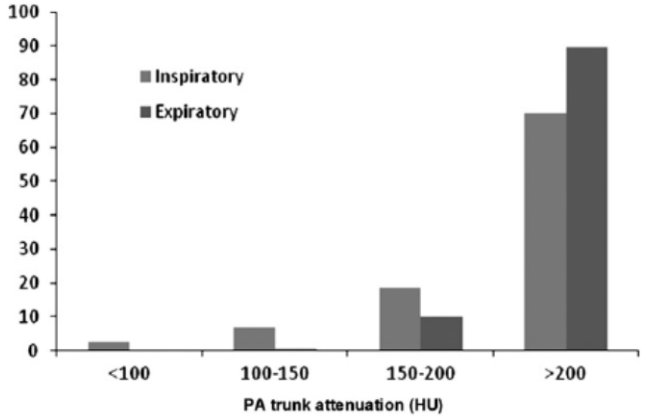
After we received the study results, we changed the breathing command of the CTPA studies at our site to "end-expiratory breath-hold" and are planning a large randomised prospective trial where the reduction of TIC as one factor leading to reduced image quality and consecutively reduced diagnostic power of the CTPA exam will be further examined. One patient

Contents lists available at ScienceDirect

Clinical Radiology

journal homepage: www.elsevierhealth.com/journals/crad

Use of expiratory CT pulmonary angiography to reduce inspiration and breath-hold associated artefact: Contrast dynamics and implications for scan protocol



Pulmonary CT Angiography Protocol Adapted to the Hemodynamic Effects of Pregnancy

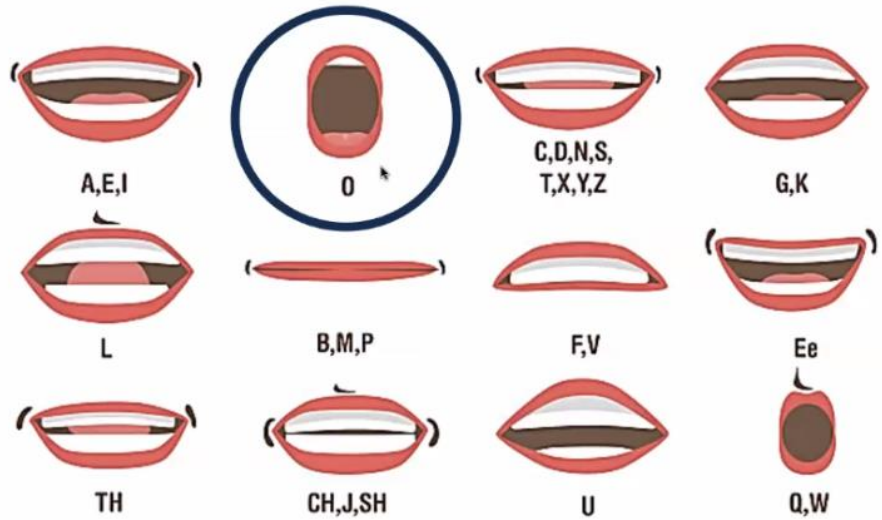
Transient Interruption of Contrast Material by Unopacified Blood From the Inferior Vena Cava

This artifact was confirmed in 11 of 28 CTA studies in group A (39%) and two of 20 CTA studies in group B (10%) ($p = 0.05$). Of

TABLE 1: Pulmonary CT Angiography Contrast Medium Administration Parameters

Image Acquisition Parameter	Group A	Group B
Breathing instruction	Deep inspiration breath-hold	Shallow inspiration breath-hold
Contrast medium		
Volume (mL)	75	95
Concentration (mg I/mL)	370	370
Injection rate (mL/s)	4	6
Bolus triggering	Yes	Yes
Scan delay (s)	5	5

Breath-hold Solution



Mouth open with the tongue depressed increases the volume of air entry without increasing intrathoracic pressure

Guerbet

Retrieved on 15/5/2021 from: https://www.freepik.com/free-vector/mouth-animation-set_9176068.htm

MEDICAL IMAGING INSTITUTE

KẾT LUẬN

- Vấn đề chính ảnh hưởng chất lượng hình ảnh CTPA: Không đủ cản quang lòng động mạch và xảo ảnh chuyển động.
- Cần nắm vững nguyên lý xác định đúng thời điểm khảo sát

+ Contrast media arrival time (T_{arr})

+ Delay time (T_d)

+ Scan time (T_{scan})

- Phương pháp thở phù hợp

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Cám ơn đã theo dõi!

RSHCM 2025