

# Η ΣΥΜΒΟΛΗ ΤΗΣ ΑΞΟΝΙΚΗΣ ΤΟΜΟΓΡΑΦΙΑΣ ΣΤΗΝ ΔΙΑΓΝΩΣΤΙΚΗ ΠΡΟΣΠΕΛΑΣΗ ΤΩΝ ΑΣΘΕΝΩΝ ΜΕ ΟΞΥ ΘΩΡΑΚΙΚΟ ΑΛΓΟΣ

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24<sup>ο</sup>

Ετήσιο Σεμινάριο Συνεχιζόμενης  
Ιατρικής Εκπαίδευσης  
Νοσοκομείου «Ο Ευαγγελισμός»



Αθήνα, 18 - 22 Φεβρουαρίου 2019

Δεν υπάρχει σύγκρουση συμφερόντων  
με τις παρακάτω χορηγούς εταιρείες:

PFIZER, JANSSEN ONCOLOGY, SOFMEDICA,  
NOVARTIS, ABBVIE, MSD, WINMEDICA,  
GENESIS, ROCHE, TAKEDA, ASTELLAS,  
AMGEN, ANGELINI, ANTISEL, SERVIER,  
BRISTOL-MYERS SQUIBB, ABBOTT, GILEAD,  
SANDOZ, BIANEΞ, RONTIS, MAVROGENIS,  
AENORASIS, SPECIFAR, KARYO



# ΟΞΥ ΘΩΡΑΚΙΚΟ ΑΛΓΟΣ ΣΤΑ ΕΠΕΙΓΟΝΤΑ

- 2007-2008 : 9% περιστατικών των επειγόντων στις ΗΠΑ
- 13% εξ'αυτών οξύ στεφανιαίο επεισόδιο
- 2<sup>ο</sup> συχνότερο αίτιο στις γυναίκες/ 1<sup>ο</sup> στους άντρες
- 6.392.000 στα επείγοντα/1.976.000 εισαγωγές
- Από το σύνολο των ασθενών που προσήλθαν με οξύ στεφανιαίο επεισόδιο, μόνο στο 25% αποδείχθηκε κατά την νοσηλεία
- 2%-5% (29%) αποτυχία ορθής διάγνωσης στα ΤΕΠ του στεφανιαίου επεισοδίου (μικρότερης ηλικίας, άτυπα συμπτώματα, μη διαγνωστικό ΗΚΓ)
- 25% των νομικών αγωγών για ιατρικά λάθη στους κλινικούς των ΤΕΠ στις ΗΠΑ
- Κόστος νοσηλείας ασθενών με τελικά αρνητικό καρδιολογικό έλεγχο: 6 δις \$



# ΟΞΥ ΘΩΡΑΚΙΚΟ ΑΛΓΟΣ ΣΤΑ ΕΠΕΙΓΟΝΤΑ

- Μελέτη στεφανιαίων αγγείων-ΟΕΜ
- Πνευμονικών αρτηριών (ΠΕ)
- Διαχωρισμός αορτής
- Μυοσκελετικό-κήλες/κατάγματα
- Ενδοπαρεγχυματικές βλάβες-πνευμονία
- Υπεζωκοτικές συλλογές-περικαρδιακές-ταμπονάρισμα
- Υποδιαφραγματικές βλάβες



# ΟΞΥ ΘΩΡΑΚΙΚΟ ΑΛΓΟΣ ΣΤΑ ΕΠΕΙΓΟΝΤΑ-TRIPLE RULE OUT

- Τί μηχάνημα και εξοπλισμό έχουμε στην διάθεσή μας;
- Επιλογή ασθενών
- Προετοιμασία ασθενούς
- Επιλογή πρωτοκόλλου-τεχνικής
- Δόση ακτινοβολίας
- Ποσότητα σκιαγραφικού
- Χρόνος επεξεργασίας εικόνων-εξέτασης-γνωμάτευση



## ΟΞΥ ΘΩΡΑΚΙΚΟ ΑΛΓΟΣ ΣΤΑ ΕΠΕΙΓΟΝΤΑ-TRIPLE RULE OUT

### Triple Rule-out Computed Tomographic Angiography for Chest Pain: A Diagnostic Systematic Review and Meta-Analysis

David Ayaram, MD, M. Fernanda Bellolio, MD, MS, M. Hassan Murad, MD, Torrey A. Laack, MD, Annie T. Sadosty, MD, Patricia J. Erwin, MLS, Judd E. Hollander, MD, Victor M. Montori, MD, MSc, Ian G. Stiell, MD, MSc, and Erik P. Hess, MD, MSc

ACADEMIC EMERGENCY MEDICINE • September 2013, Vol. 20, No. 9 • [www.aemj.org](http://www.aemj.org)

Table 5  
Diagnostic Accuracy of TRO CT Compared to Invasive Coronary Angiography

First Author: Reference No	Year	Number of Coronary Segments Assessed	Sensitivity, % (95% CI)	Specificity, % (95% CI)	LR+ (95% CI)	LR- (95% CI)
Schuchlenz: 39	2010	435	96.6 (90.3–99.3)	98.0 (95.9–99.2)	48.0 (23.0–100.0)	0.04 (0.01–0.11)
Johnson: 19	2008	410	100.0 (78.2–100)	99.0 (97.4–99.7)	85.3 (33.9–214.5)	0.03 (0.00–0.48)
Litmanovitch: 41	2008	130	81.0 (58.1–94.6)	92.7 (86.0–96.8)	11.0 (5.5–22.2)	0.21 (0.09–0.50)
Johnson: 42	2007	20*	94.1 (71.3–99.9)	57.1 (18.4–90.1)	2.2 (0.9–5.2)	0.10 (0.01–0.77)

LR+ = positive likelihood ratio; LR- = negative likelihood ratio; TRO = triple rule-out.  
\*Diagnostic accuracy data were reported on a per-patient level rather than a per-coronary segment level.



## ΕΠΙΛΟΓΗ ΑΣΘΕΝΩΝ

- age older than 40 years
- creatinine clearance greater than 60 mL/min/1.73 m<sup>2</sup>
- no known history of coronary artery disease
- Thrombolysis In Myocardial Infarction Score of 0–2
- negative results for the first set of cardiac biomarkers
- no recent history of cocaine use
- ability to modify the heart rate to 65 beats/min with the use of  $\beta$ -blockers

**any patient who was deemed to have a low to intermediate risk of ACS but was suspected of having additional noncoronary causes of chest pain**



## ΠΡΩΤΟΚΟΛΛΟ ΕΞΕΤΑΣΗΣ

- helical low-pitch (0.2–0.3) acquisition
- FOV of 250 mm
- slice thickness of 0.8 mm
- ECG gating
- effective tube current time product of 600 mAs (tube current x gantry rotation time/pitch) and a tube voltage of 100 kVp
- To maintain image quality, in patients with larger body habitus, effective tube current time product was increased to 800–1000 mA, tube voltage was increased to 120–140 kVp, or both values were increased



## ΠΡΟΕΤΟΙΜΑΣΙΑ ΕΞΕΤΑΖΟΜΕΝΟΥ

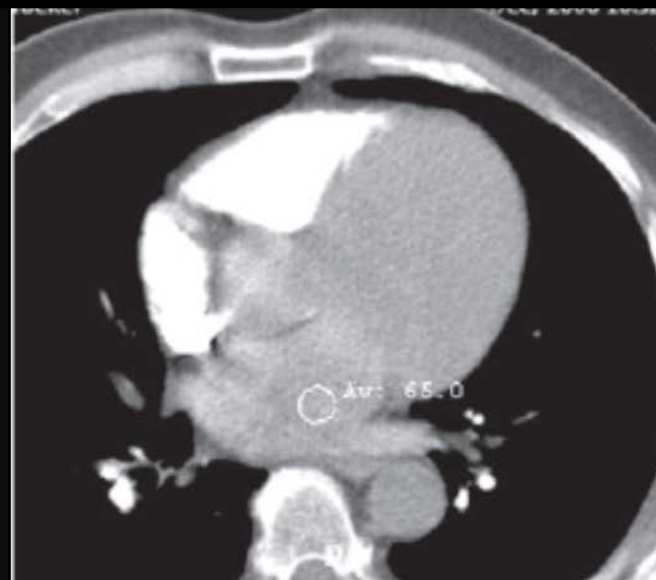
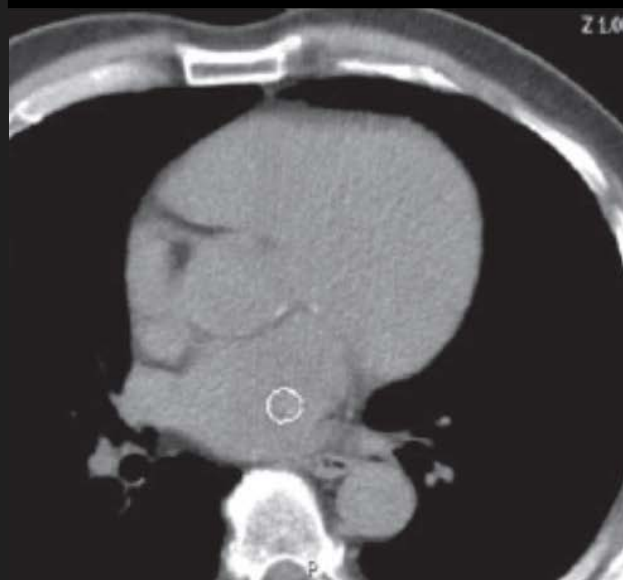
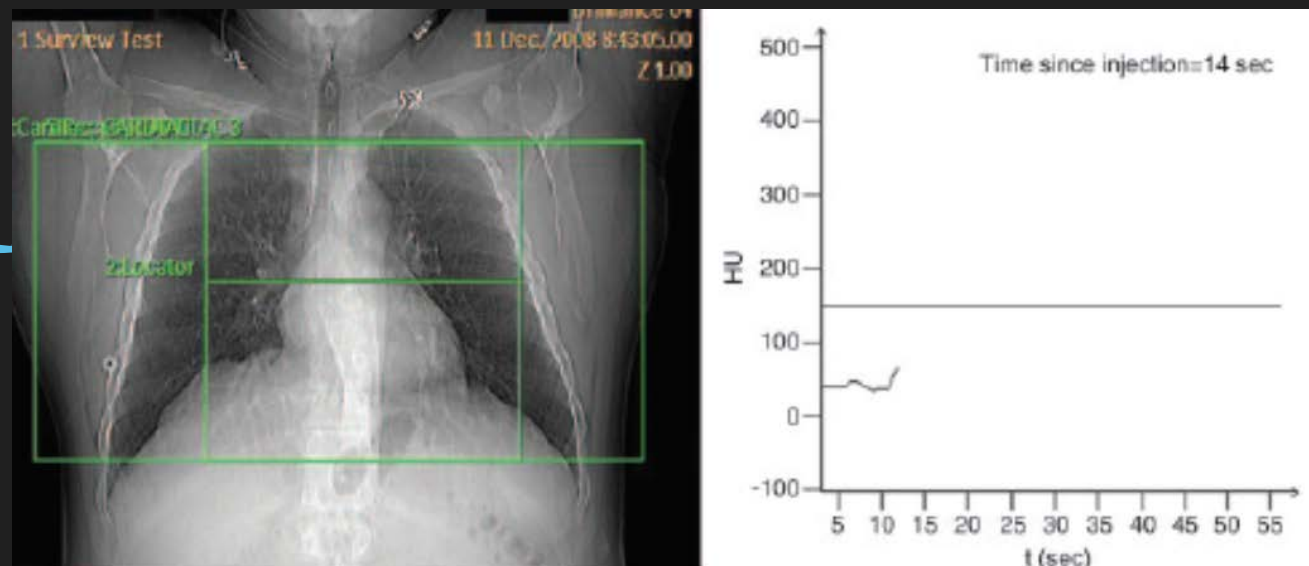
- iv catheter 18-20 g
- Arm position-ECG leads
- caffeine etc.
- $\beta$ -blocker metoprolol was administered to all patients with a heart rate greater than 65 beats/min, unless a history of **active asthma** was noted
- Metoprolol was administered in IV doses of 5 mg given every 5 minutes (up to a maximum dose of 30 mg), until the heart rate stabilized to lower than 65 beats/min or systolic blood pressure dropped to less than 100 mm/Hg
- Sublingual nitroglycerin was administered at a dose of 800  $\mu$ g, approximately 2–3 minutes before initiation of the scan, as long as systolic blood pressure was greater than 100 mm/Hg
- Practice a small breath-hold of 15 sec



## ΧΟΡΗΓΗΣΗ ΣΚΙΑΓΡΑΦΙΚΟΥ-ΤΕΧΝΙΚΗ

- Biphasic contrast injection protocol
- with 60 mL IVC , followed by 60 mL of a 1:1 mixture IVC and saline
- Imaging was initiated by bolus tracking with automatic triggering on the left atrium. The tracker was set to start the scan for an increase in attenuation of 200 HU, with a scan delay of 5 seconds
- However, the scans were almost always manually started with a 5-second delay as soon as contrast medium was visible in the left atrium, to begin imaging earlier in the bolus than would occur with use of the automatic trigger
- This minimized washout of the pulmonary arterial circulation
- Images were obtained in a cranial- to-caudal direction
- All scans extended from 1 to 2 cm above the aortic arch through the base of the heart







## ΔΟΣΗ ΑΚΤΙΝΟΒΟΛΙΑΣ

- Excluding the apices from TRO CT reduces the scan length by approximately 4–5 cm, which we estimate is associated with a 15%–20% reduction in effective radiation dose
- Isolated subsegmental pulmonary embolus above the level of the aortic arch is extremely uncommon
- Manual stopping of the scan at the heart base can reduce scanning length by 1.5–2.0 cm
- The radiation dose estimates of 8.75–18 mSv
- We estimate that the use of real-time monitoring to reduce acquisition length can reduce the radiation dose by another 7%–10%



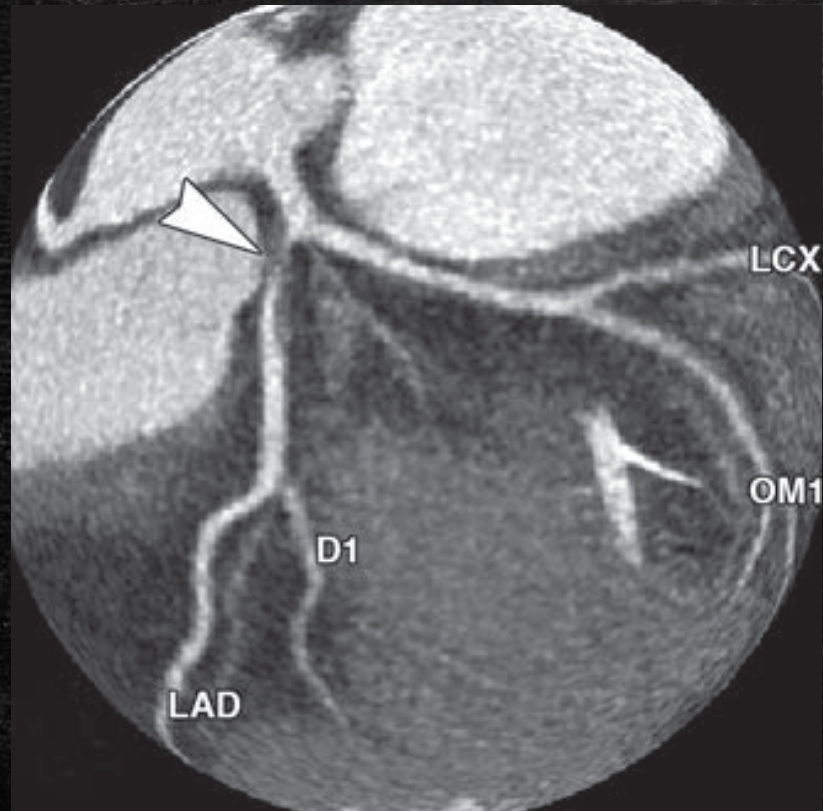
# Diagnostic Yield of Triple-Rule-Out CT in an Emergency Setting

Amelia M. Wnorowski, Ethan J. Halpern, Department of Radiology, Thomas Jefferson University, Philadelphia, *AJR* 2016; 207:W1–W7

- 1196 total cases
- A total of 970 patients (81.4%) had a **negative study result** without a significant coronary or noncoronary diagnosis
- A total of 139 patients (11.7%) had significant coronary artery disease (**50% stenosis or greater**)
- One hundred six patients (8.9%) had a noncoronary diagnosis that could explain chest pain ( $p < 0.02$ ), most commonly **pulmonary embolism** (28 patients [2.3%]), **aortic aneurysm** (24 patients [2.0%]), or **pneumonia** (20 patients [1.7%])
- **Thirty cases (27.3%) of pulmonary embolism and aortic pathologic findings would not have been detected with coronary CT angiography because of unopacified rightside circulation or limited z-axis coverage**
- A total of 528 incidental findings **not considered to explain chest** pain were noted in 418 patients (35.1%)

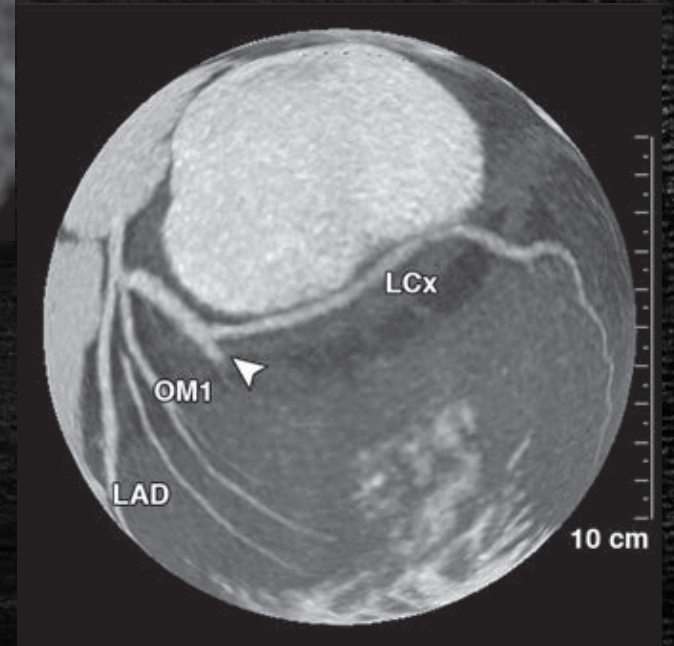
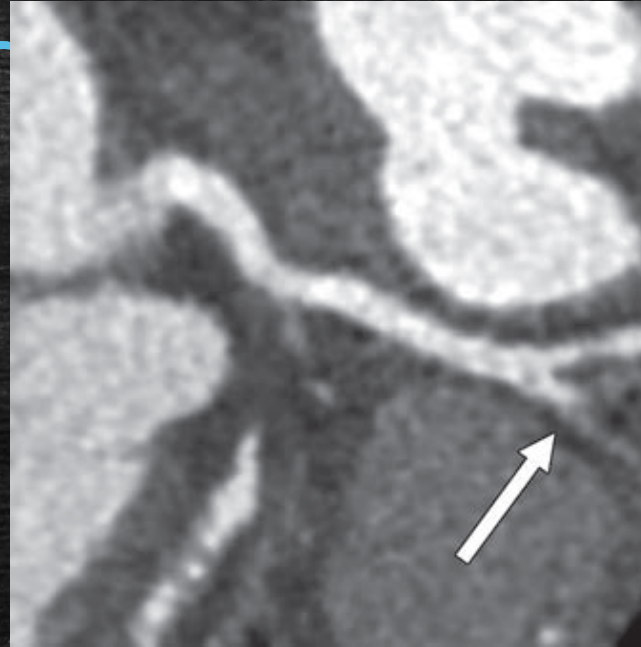


64-year-old man who presented with  
acute  
coronary syndrome



maximum-intensity projection  
image MIP ( $> 70\%$ ) stenosis  
of origin of left anterior  
descending

62-year-old man who presented  
with acute coronary syndrome



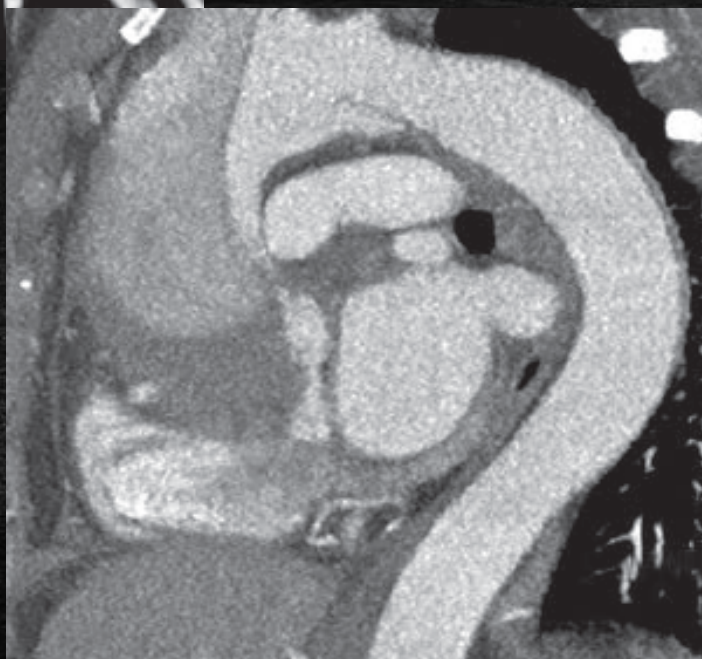
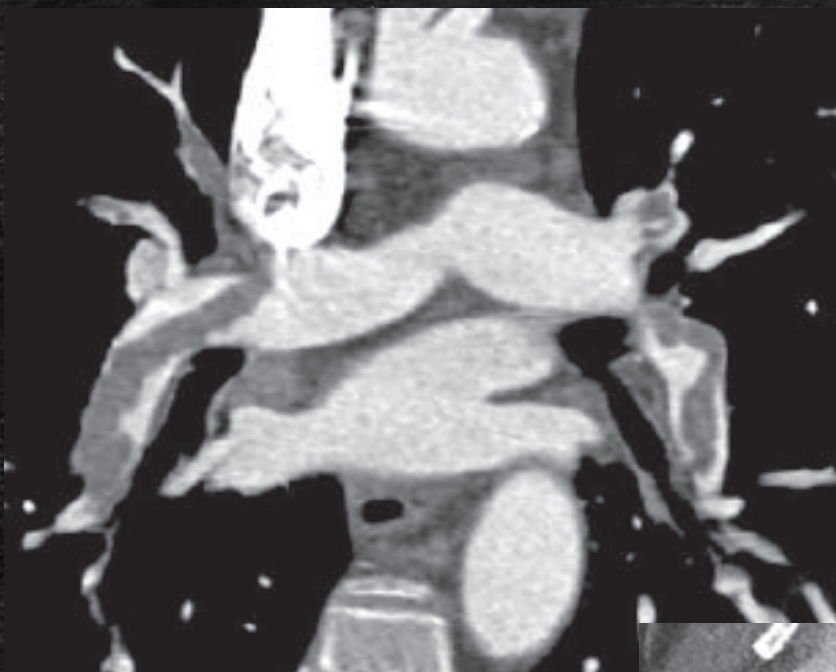


**TABLE 1: Noncoronary Diagnoses That Could Explain the Presentation of Acute Chest Pain**

Diagnosis	Cases, No. (%)
Pulmonary embolism	28 (2.3)
Aortic aneurysm <sup>a</sup>	24 (2.0)
Pneumonia	20 (1.7)
Other cardiac diagnosis	
Endocarditis	2 (0.2)
Intramural course of anomalous coronary artery	12 (1.0)
Pericardial tamponade	2 (0.2)
Other aortic pathologic finding	
Portgraft hematoma	1 (0.08)
Ulcerated plaque	3 (0.3)
Penetrating ulcer	2 (0.2)
Ossaceous finding	
Acute fracture	2 (0.2)
Lytic sternal lesion	1 (0.08)
Metastases	2 (0.2)
Diastasis of the sternum	1 (0.08)
Other lung disease	
Pulmonary edema	3 (0.3)
Pneumothorax or pneumomediastinum	1 (0.08)
Findings suggestive of pulmonary infarct without pulmonary embolism	1 (0.08)
Aortic dissection	4 (0.3)
Abdominal disease, acute pancreatitis	1 (0.08)

<sup>a</sup>With increased size or for which no previous study was available for the purpose of comparison.







A 52-year-old male patient  
with acute onset of severe,  
tearing, and radiating chest pain

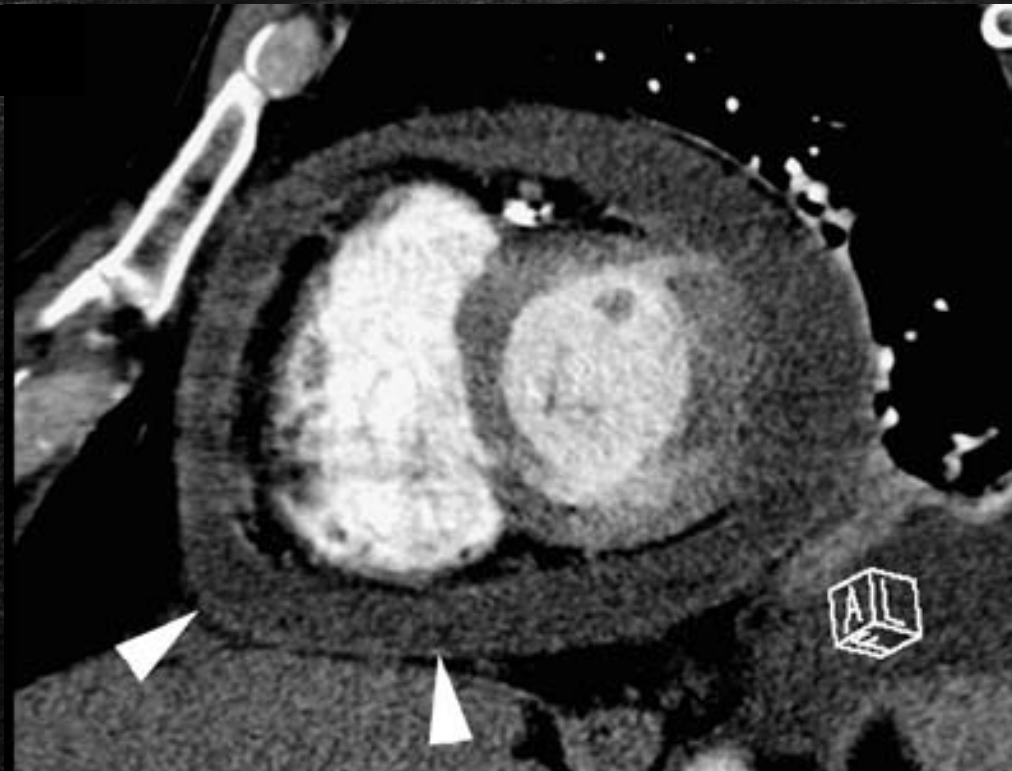


Curved MPR  
of the coronary  
arteries  
demonstrated  
extension of  
the dissection  
flap into the  
right coronary  
artery ostium



# 56-year-old male patient with acute chest pain and tachycardia

short axis reconstruction showed pericardial  
effusion with a slight enhancement-  
pericarditis



axial MPR of an abdominal CT  
obtained 3 days later clearly  
showed the pericardial enhancement





54-year-old female-leftsided  
chest pain. Two years  
earlier, the patients had a myocardial  
infarction

Long axis and sagittal oblique reconstruction of the left ventricle  
large pseudoaneurysm on the apex



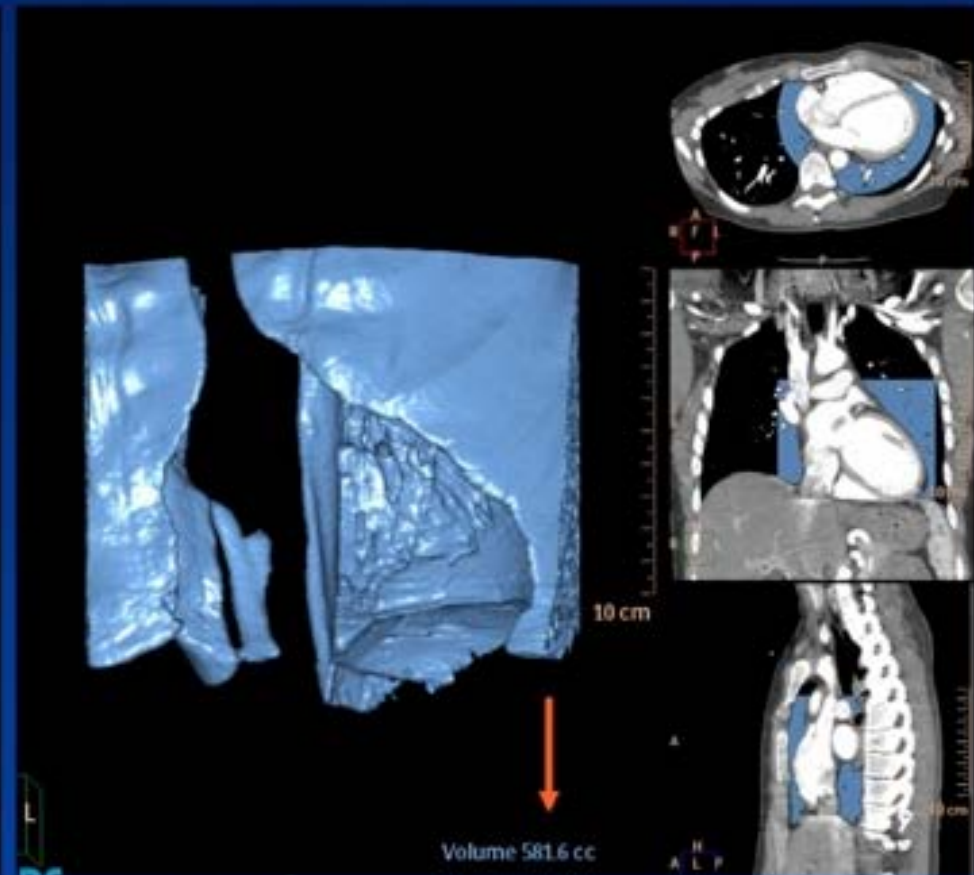
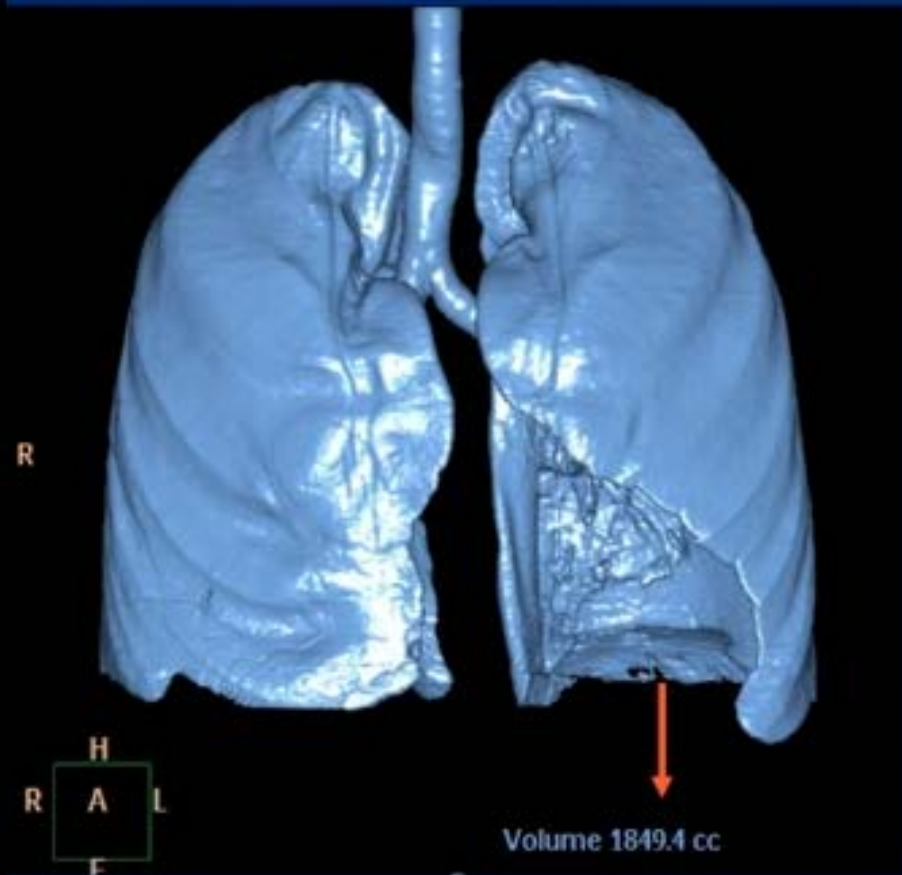


**TABLE 2: Significant Incidental Findings That Required Further Evaluation or Follow-Up But Did Not Explain the Presentation of Acute Chest Pain**

Diagnosis	Findings, No. (%)
Lung nodule or mass size	
≤ 5 mm	99 (8.3)
> 5 but < 10 mm	60 (5.0)
≥ 10 mm	18 (1.5)
Other cardiac finding	
Cardiomyopathy or segmental wall motion abnormality	65 (5.5)
Valve disease	20 (1.7)
Patent ductus arteriosus	1 (0.08)
Patent foramen ovale	7 (0.6)
Atrial septal defect	3 (0.3)
Ventricular septal defect	3 (0.3)
Interatrial septal aneurysm	1 (0.08)
Ventricular aneurysm	5 (0.4)
Coronary artery aneurysm	1 (0.08)
Coronary sinus varix	1 (0.08)
Ebstein anomaly	1 (0.08)
Mediastinal lymphadenopathy or mass	42 (3.5)
Abdominal lesion	
Liver lesion	31 (2.6)
Adrenal lesion	2 (0.2)
Splenic lesion or splenomegaly	4 (0.3)
Renal lesion	1 (0.08)
Ascites	1 (0.08)
Lymphadenopathy	1 (0.08)
Abdominal aortic aneurysm	1 (0.08)
Esophageal finding	
Thickening	13 (1.1)
Dilation	2 (0.2)
Chest wall findings (axillary adenopathy or breast mass)	12 (1.0)
Finding suggestive of pulmonary arterial hypertension	9 (0.8)
Other lung findings (atelectasis with possible underlying mass or pulmonary arteriovenous malformation)	5 (0.4)
Other aortic findings	
Aortic ectasia	1 (0.08)
Fluid of unknown cause around the ascending aorta	1 (0.08)



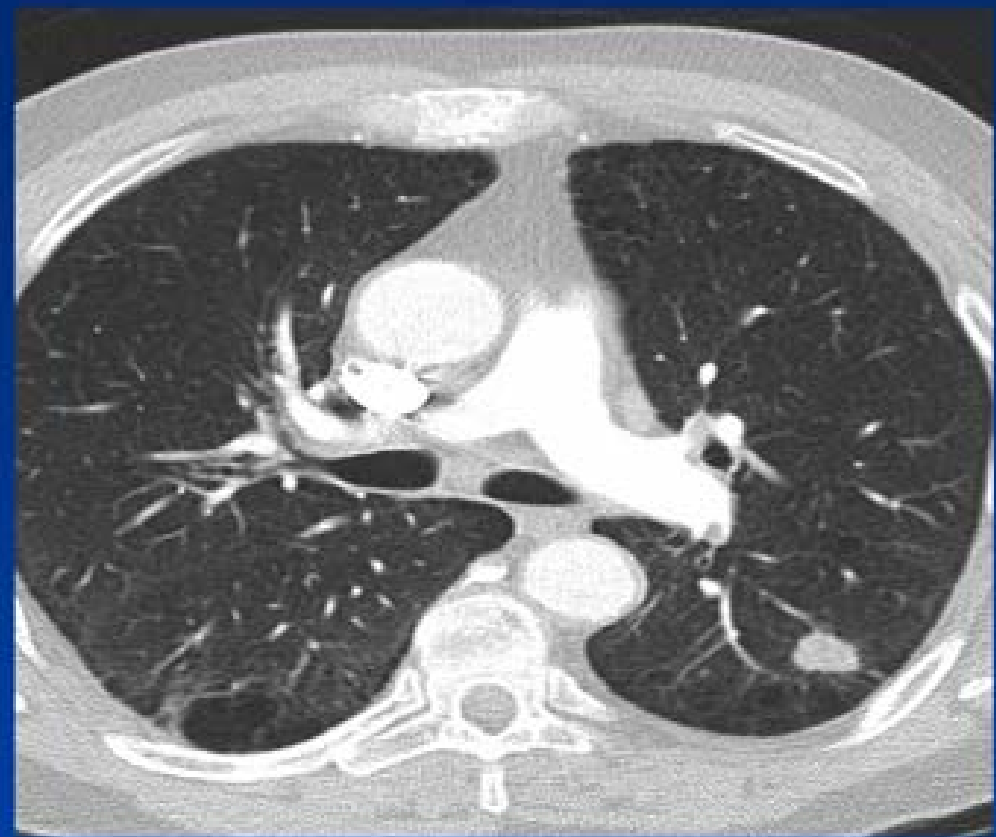
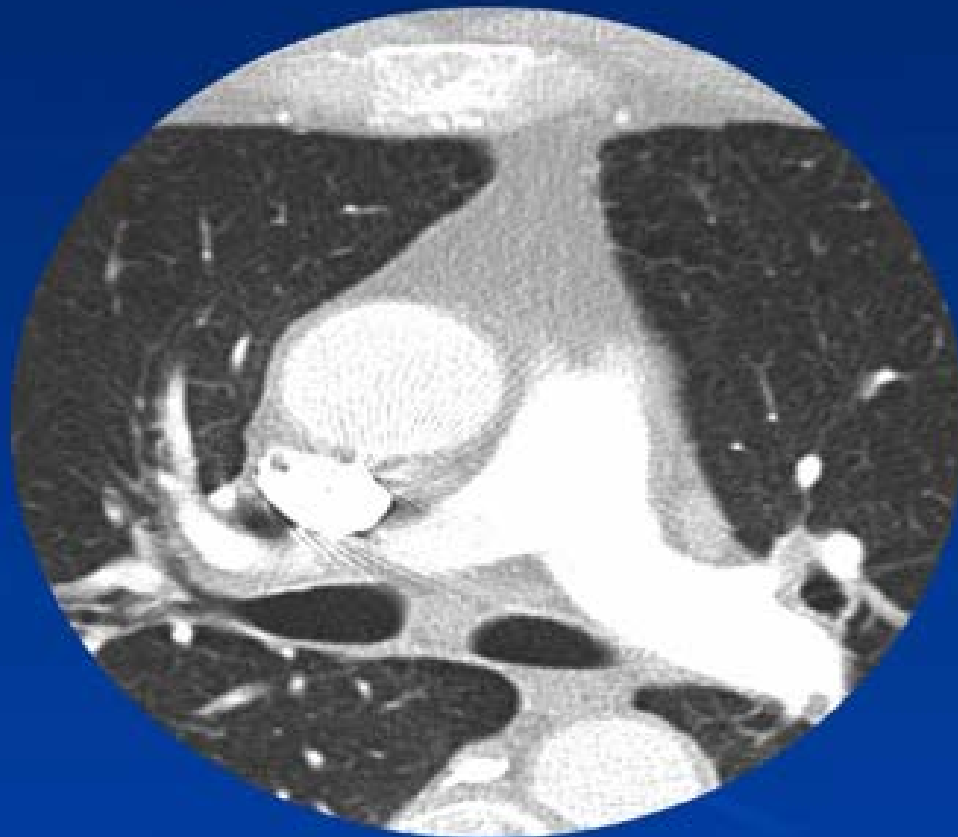
## ?PERCENT LUNG IN CARDIAC FOV



$$581/1849 = 31.4\%$$



# INCIDENTAL FINDINGS OUT OF FOV





# RADIATION EXPOSURE

	Dose (mSv)
Background - Yearly	3.6
Chest radiograph	0.05
Sesta/Thal – rest/stress	1.5-5/6-25
Cardiac Cath	3-15
Chest CT (conventional)	5
Gated CT - retro	9-15
Gated CT – dose modulated	6-9
Triple Rule-out	20-30



# ED CT CP FOV

TRIPLE R/O



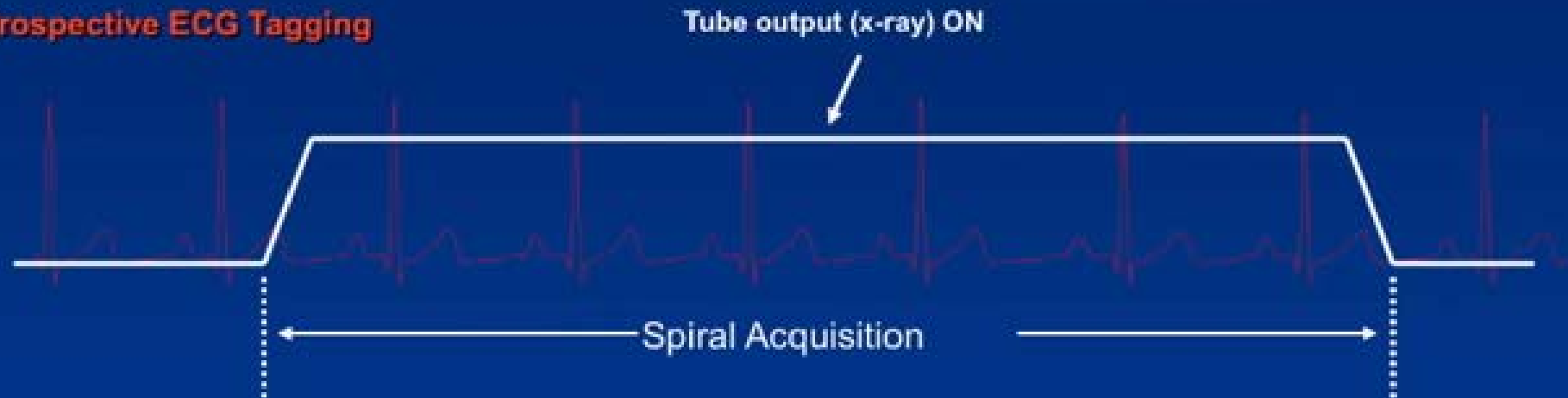
TRIPLE R/O - LIMITED



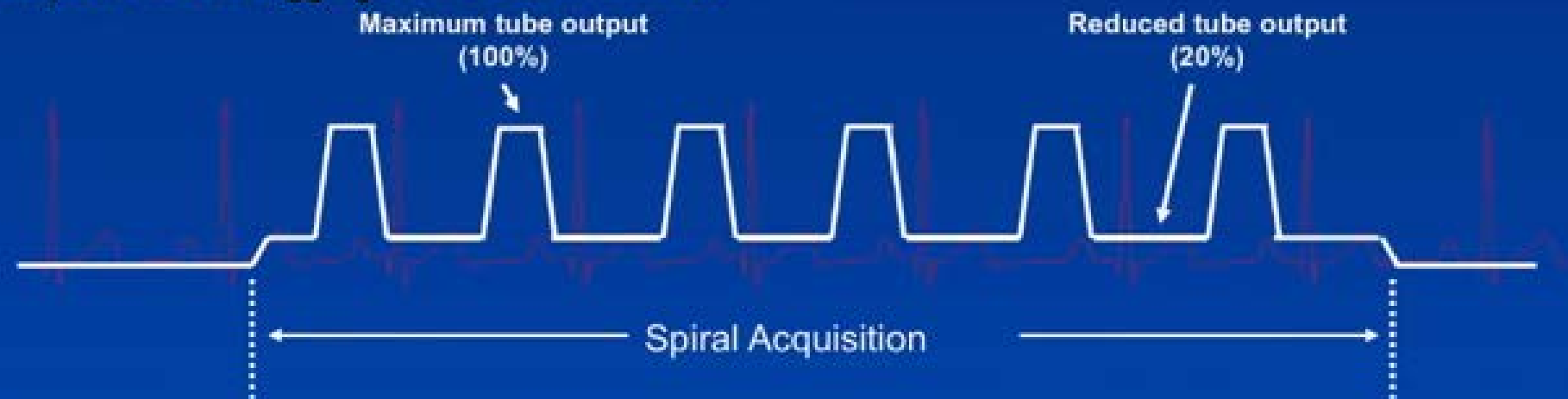


# RETROSPECTIVE GATING

## Retrospective ECG Tagging



## Retrospective ECG Tagging With Dose Modulation





# RETROSPECTIVE GATING WITH DOSE MODULATION

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**Radiation Dose in a “Triple Rule-Out” Coronary CT Angiography Protocol of Emergency Department Patients Using 64-MDCT: The Impact of ECG-Based Tube Current Modulation on Age, Sex, and Body Mass Index**

“The overall effective radiation dose for triple rule-out coronary CTA was reduced by more than 50% with ECG-based tube current modulation without loss of image quality.”

# PROSPECTIVE GATING



**Retrospective ECG  
Tagging**





# PROSPECTIVE GATING – TRIPLE R/O

**Whole-Chest 64-MDCT of  
Emergency Department Patients  
with Nonspecific Chest Pain:  
Radiation Dose and Coronary  
Artery Image Quality with  
Prospective ECG Triggering Versus  
Retrospective ECG Gating**

Retrospective:  $31.8 \pm 5.1$  mSv (range, 27.3–40.5 mSv).

Prospective:  $9.2 \pm 2.2$  mSv (range, 7.2–11.6 mSv)

**= 71% dose savings**

# RADIATION EXPOSURE

	Dose (mSv)
Sestamibi – rest/stress	1.5-5/6-25
Cardiac Cath	3-15
Gated CT	10-15
Gated CT – dose modulated	6-9
Gated CT- prospective axial	3-4
Gated CT – iterative recon	2-3
Triple R/O	20-30
Triple R/O-prospective axial	7-10
Triple R/O-iterative recon	5-7



# Συνδυασμός ΥΤ-Αγγειογραφίας πνευμονικών με ΥΤ-Φλεβογραφία πυέλου και κάτω άκρων

## CT Venography: A Necessary Adjunct to CT Pulmonary Angiography or a Waste of Time, Money, and Radiation?<sup>1</sup>

Lawrence R. Goodman, MD  
H. Dirk Sostman, MD  
Paul D. Stein, MD  
Pamela K. Woodard, MD

Fleischner Society: *The added yield is marginal...and...CT venography should be used selectively.*

Remy-Jardin et al (1)

PIOPED II: *Most...investigators recommend CT angiography and venography.*

Stein et al (2)

*CTV does not appear to improve the diagnostic yield...enough to justify the additional irradiation.*

Perrier and Bounameaux (3)

*Despite potential...accuracy of [64 slice] multi-detector row CT...CT venography increased the diagnosis of VTE in 27.4% of patients.*

Ghaye et al (4)

*A strategy combining...D-dimer...and MSCT was non-inferior to a similar strategy using D-dimer followed by venous...ultrasonography.*

Righini et al (5)

PIOPED II: *The sensitivity of CTA...was 83 percent...and the specificity was 96 percent...The sensitivity of...CTA-CTV...was 90 percent...and the specificity was 95 percent.*

Stein et al (6)

*CTV may be of benefit in patients who have a high likelihood of pulmonary embolism, particularly those with previous VTE and possibly those with malignancy.*

Hunsaker et al (7)

venous thrombosis (DVT), CT venography has approximately the same accuracy as compression ultrasonography (US) of the lower extremities.

As is clear from the quotations that appear before this editorial, many research studies and position papers reached different conclusions about the role of imaging of the lower extremities after CT angiography—often after analyzing studies that have yielded similar results. This editorial will review some articles on the subject; try to reconcile their diverse conclusions; and suggest for which patients CT venography, or US, may be valuable. In other words, can one improve the risk-benefit ratio?

### Benefits of CT Venography

CT venography has several diagnostic benefits:

1. With single- and four-detector scanners, CT venography often missed PEs in the smaller vessels, and negative findings at CT venography were reassuring in that an untreated DVT was not overlooked in the deep veins of the pelvis or thighs.

2. When findings at CT angiography are equivocal or suboptimal (approximately 3%–8% of studies), the results of CT venography (positive or negative) reinforced the decision to treat or not to treat the patient (9,10).

3. By using CT venography, the entire work-up for VTE can be completed in approximately 20 minutes—an efficient use of time for the radiologist, the clinician, and the patient.

4. Only minimal additional resources are required for CT venogra-

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10.1148/radiol.2502081075  
Radiology 2009; 250:327–330

<sup>1</sup> From the Department of Radiology, Medical College of Wisconsin, 9200 W Wisconsin Ave, Milwaukee, WI 53226-3596 (L.R.G.); Corporate Offices, the Methodist Hospital, Houston, Tex (H.D.S.); Department of Research, St Joseph Mercy Oakland Hospital, Pontiac, Mich (P.D.S.);

# Οξεία Πνευμονική εμβολή- ΥΤ Αγγειογραφία PIOPED II

**P**rospective **I**nvestigation **o**n **P**ulmonary **E**mbolism **D**iagnosis  
study **II**.

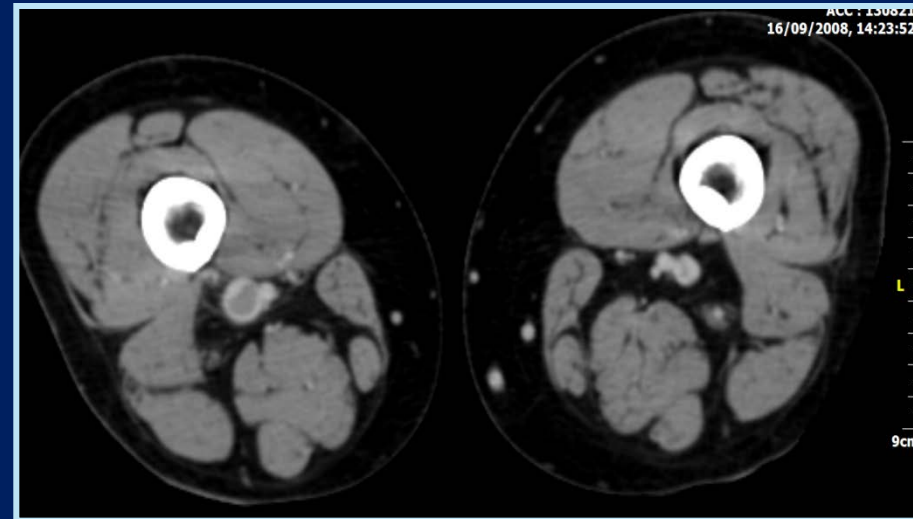
- 825 ασθενείς, 51 (6%) μη διαγνωστικές εξετάσεις.
- **Ευαισθησία 83%  $\implies$  90% + CTV.**
- Ειδικότητα 96%.
- Θετική προγνωστική αξία 86%.
- **Αρνητική προγνωστική αξία 95%  $\implies$  97% + CTV**
- 105 ασθενείς με θρομβοφλεβίτιδα, μόνο 3 με προσβολή της κάτω κοίλης ή των πυελικών φλεβών χωρίς συμμετοχή των φλεβών των κάτω άκρων.
- Θετική προγνωστική αξία και αρνητική προγνωστική αξία 96% σε υψηλή και χαμηλή κλινική υποψία αντίστοιχα.

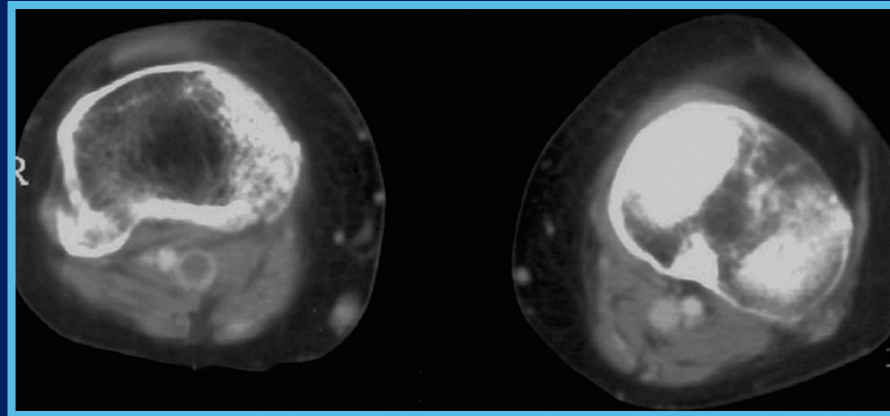
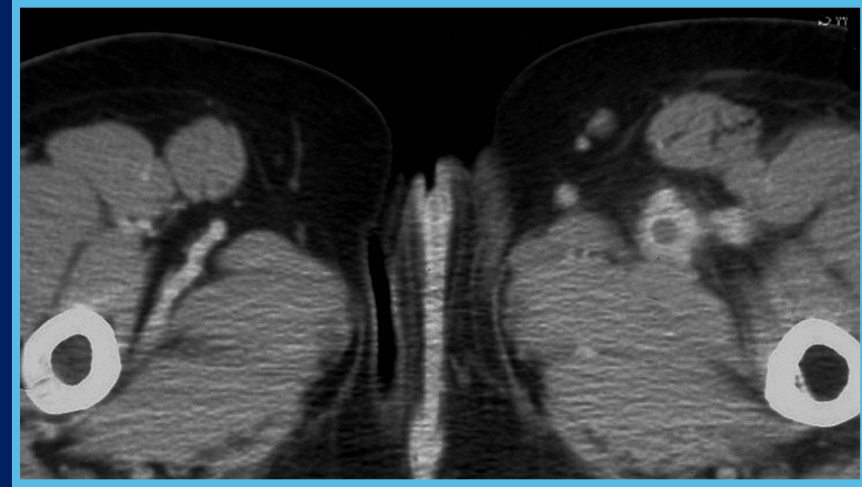
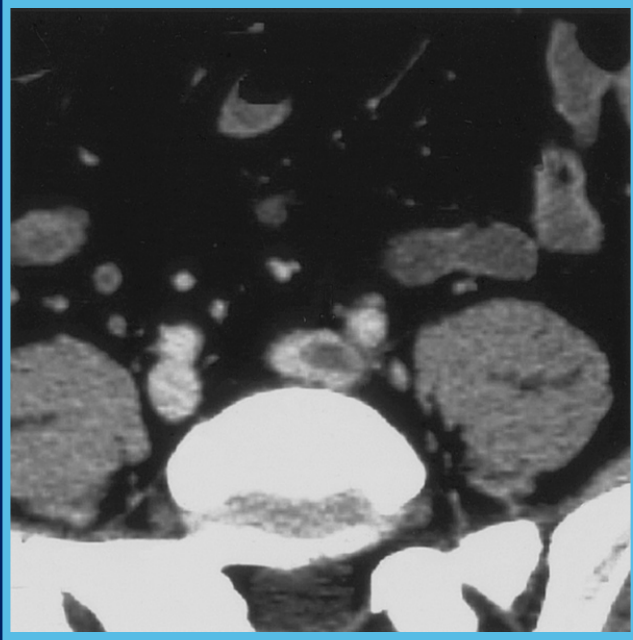
1. Υψηλή PPV και NPV όταν υπάρχει συμφωνία με την κλινική υποψία της νόσου. 17% ψευδώς αρνητικά, περαιτέρω έλεγχος όταν υπάρχει υψηλή κλινική υποψία.
2. Απαιτείται προσθήκη της ΥΤ Φλεβογραφίας.



## CTV: Διαγνωστικά κριτήρια θρομβώσεως φλεβών

- Έλλειμμα σκιαγραφίσεως
- Μη σκιαγραφημένο τμήμα φλέβας
- *Διάταση φλέβας, θολερότητα του λίπους γύρω από τη φλέβα (οίδημα), σκιαγράφιση παράπλευρων φλεβών*









# ΣΥΜΠΕΡΑΣΜΑΤΑ

- TRO τεχνική επιτρέπει την ασφαλή διαλογή ασθενών, ιδίως αυτών με μικρό/μέσο κίνδυνο OEM-οξέος στεφανιαίου επεισοδίου
- Επιλογή ασθενών, προετοιμασία, τεχνική έγχυσης σκιαγραφικού, τεχνική εξέτασης
- Σε αντιδιαστολή με τις συμβατικές μεθόδους αντιμετώπισης του θωρακικού άλγους στα επείγοντα, η ορθή χρήση της τεχνικής:
  - **Μειώνει σημαντικά τον χρόνο διαλογής και διαχείρισης των ασθενών**
    - **Μειώνει σημαντικά τον αριθμό των απαιτούμενων διαγνωστικών εξετάσεων**
    - **Μείωση του κόστους νοσηλείας**
    - **Μείωση της έκθεσης ακτιβόλησης του εξεταζομένου**