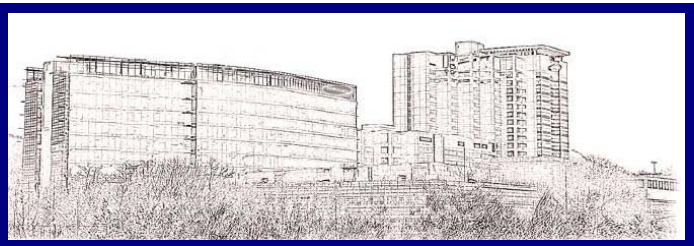

SUNG KYUN KWAN UNIVERSITY

Role of Coronary CT Angiography in Patients with Ischemic Heart Diseases

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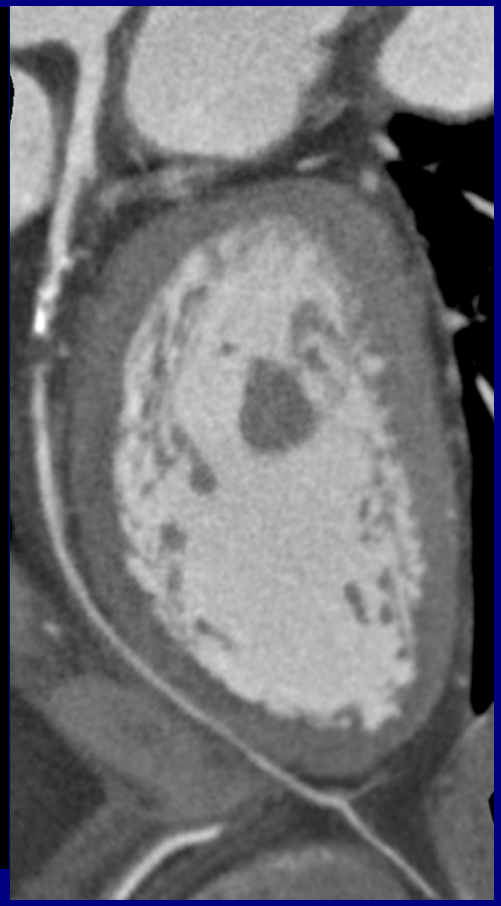
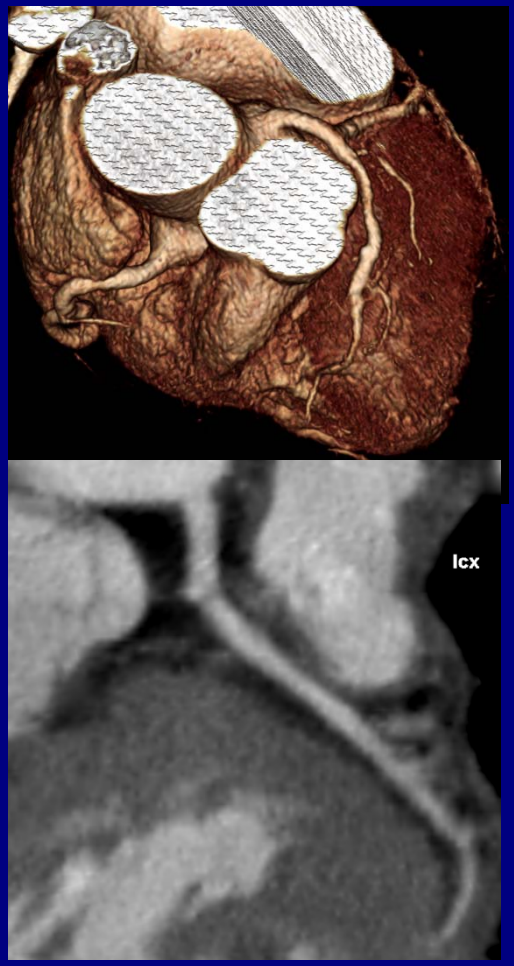
Dept. Radiology
Samsung Medical Center
Sungkyunkwan University
Seoul, Korea

Chest Pain with No CV Risk Factors (F/44)

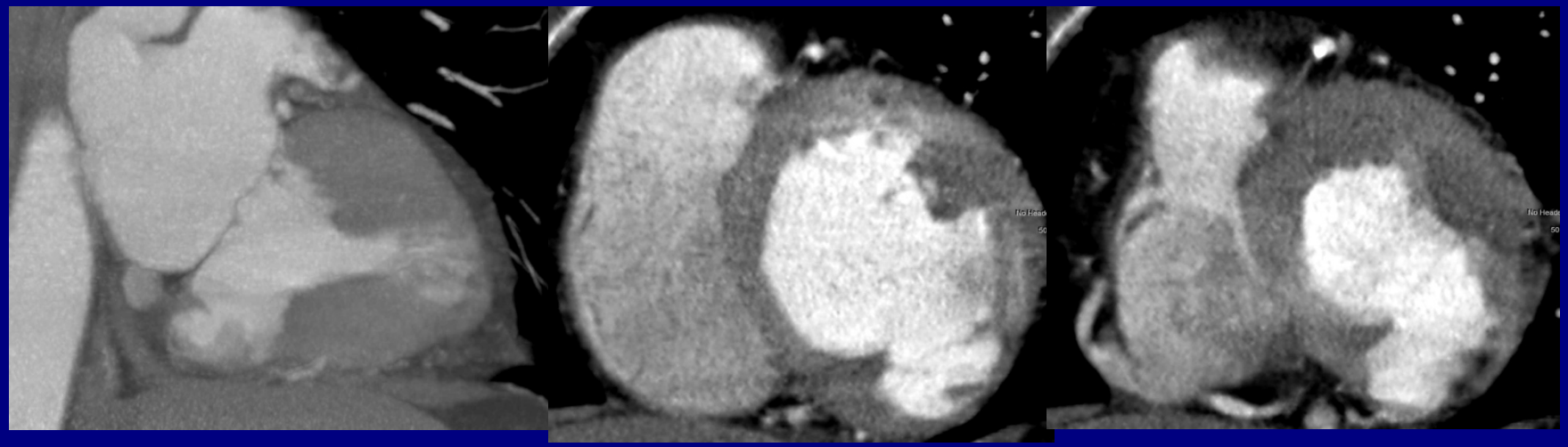


Chest Pain for 5 y (69/F)

- Cardiac angiogram at outside: minimal LAD lesion
- Echo: inferobasal aneurysmal change, C/W ischemic heart disease
- CTA was done.



LV Diverticulum



Versatility of MDCT

- Detection of coronary diseases
- Evaluation of bypass grafts and stents
- Plaque characterization
- LV function
- Myocardial perfusion and viability

MDCT Coronary Angiography

- 64-slice MDCT showed patient-based sens and spec of 86-99% and 79-96% for >50% stenosis of coronary arteries in literature.

- Segment-based pooled sensitivity and specificity for >50% stenosis were 93% (95% confidence interval [CI]: 0.88, 0.97), 96% (95% CI: 0.96, 0.97) according to a meta-analysis

Vanhoenacker. Radiology 2007 ;244:419-28

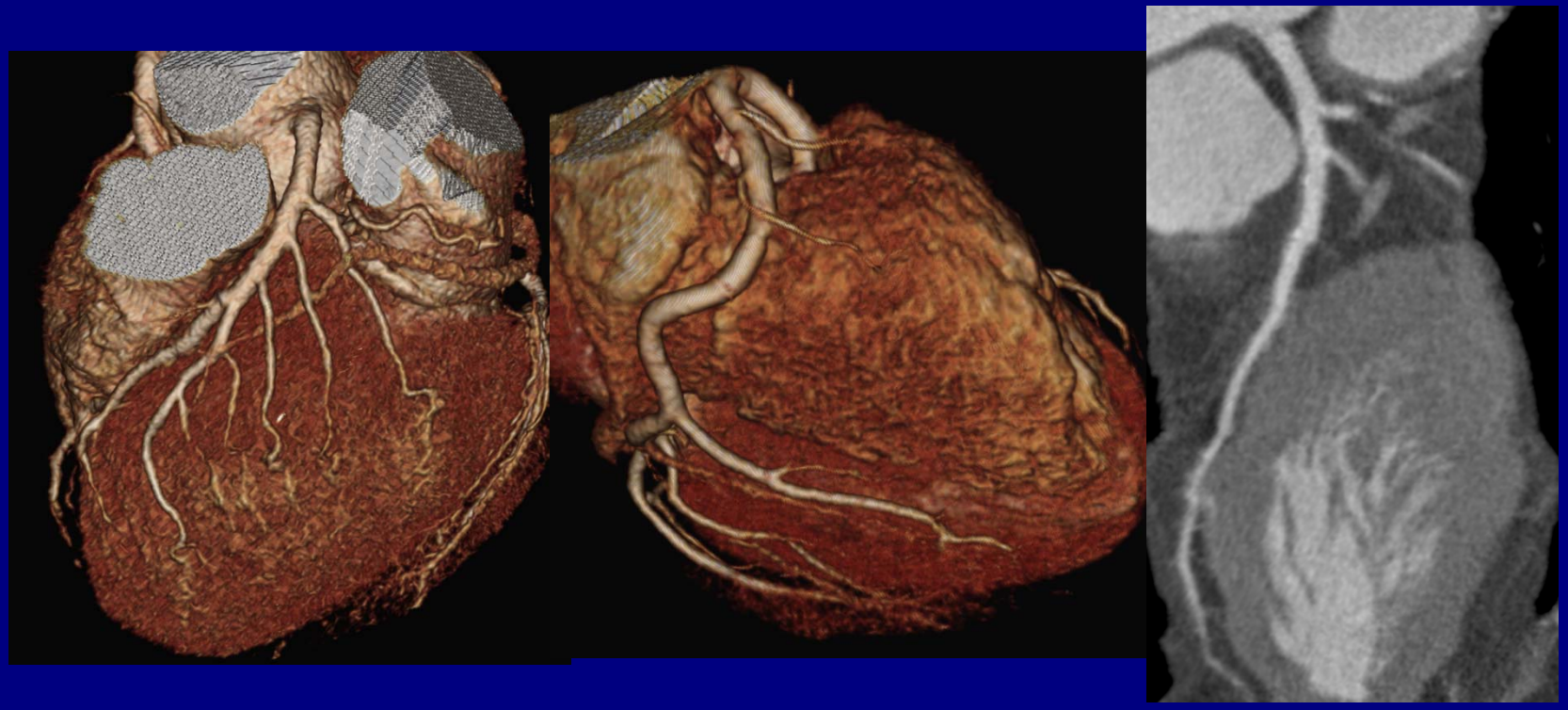
Cardiac MDCT

Appropriate indication of cardiac MDCT for the evaluation of coronary artery by ACCF et al (2006)

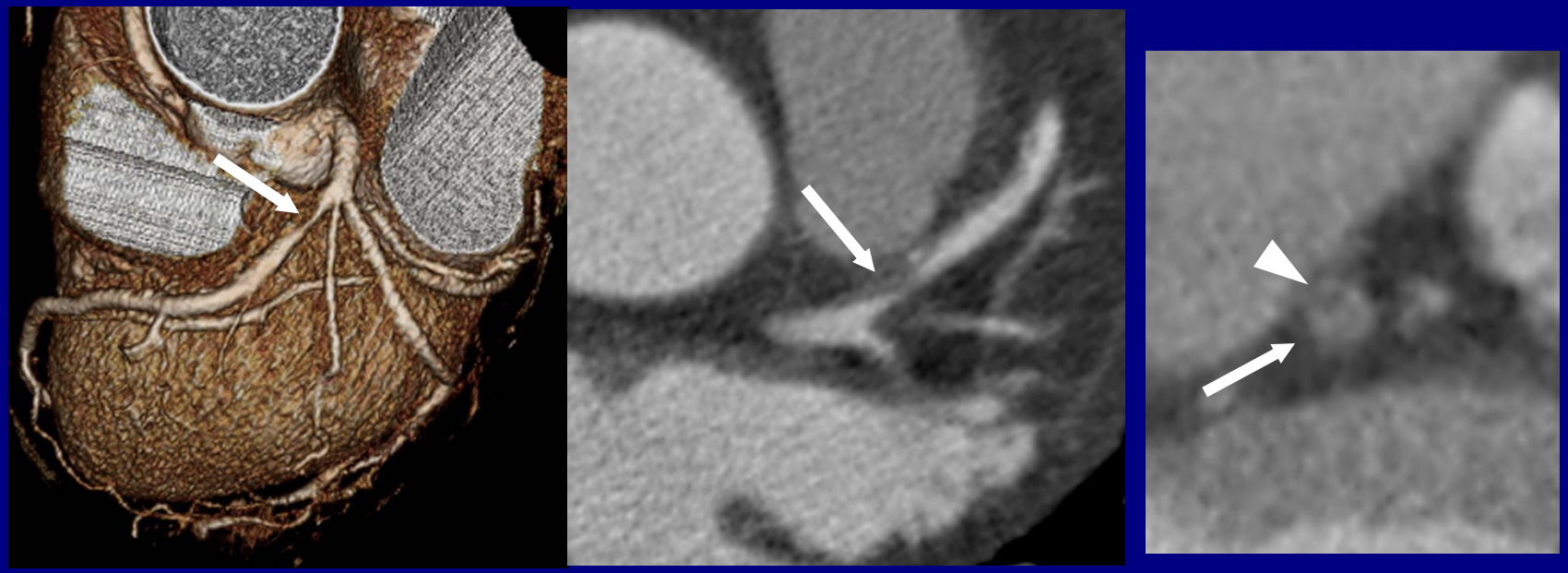
Indications	Median Score
Detection of CAD: Symptomatic - Evaluation of Chest Pain SD - Intermediate pre-test probability of CAD - ECG uninterpretable OR unable to exercise	7
Detection of CAD with Prior Test Results - Evaluation of Chest Pain SD - Uninterpretable or equivocal stress test (exercise, perfusion, or stress echo)	8
Detection of CAD: Symptomatic - Acute Chest Pain - Intermediate pre-test probability of CAD - no ECG changes and serial enzymes negative	7
Detection of CAD: Symptomatic - Evaluation of Intra-Cardiac Structure - Evaluation of suspected coronary anomalies	9
Structure and Function—Morphology - Evaluation of coronary arteries in patients with new onset heart failure to assess etiology	7

CCTA in Symptomatic Patients

TMT-positive case, M/59



Chest Pain, 67/F



NG

Low to Intermediate Pretest Probability Group: Negative Scan

- A negative CT scan was present
  - in 75% of the 66 patients with a low estimated pretest probability
  - in 50% of the 83 patients with an intermediate estimated pretest probability
- The negative predictive value of CTCA to exclude significant CAD was excellent in these patients, reducing the estimated post-test probability to zero.
- These patients would not need further downstream diagnostic tests.

Meijboom at al. J Am Coll Cardiol 2007;50:1469–75

High Estimated Pretest Probability Group

- In the high estimated pretest probability group (n = 105), a negative CTCA reduced the estimated post-test probability to 17%, whereas a positive CTCA increased the estimated post-test probability to as high as 96%.
- The majority of these symptomatic patients are likely to proceed to invasive CCA even if CTCA is negative, since the post-test probability of significant CAD was still >10%.

Meijboom at al. J Am Coll Cardiol 2007;50:1469–75

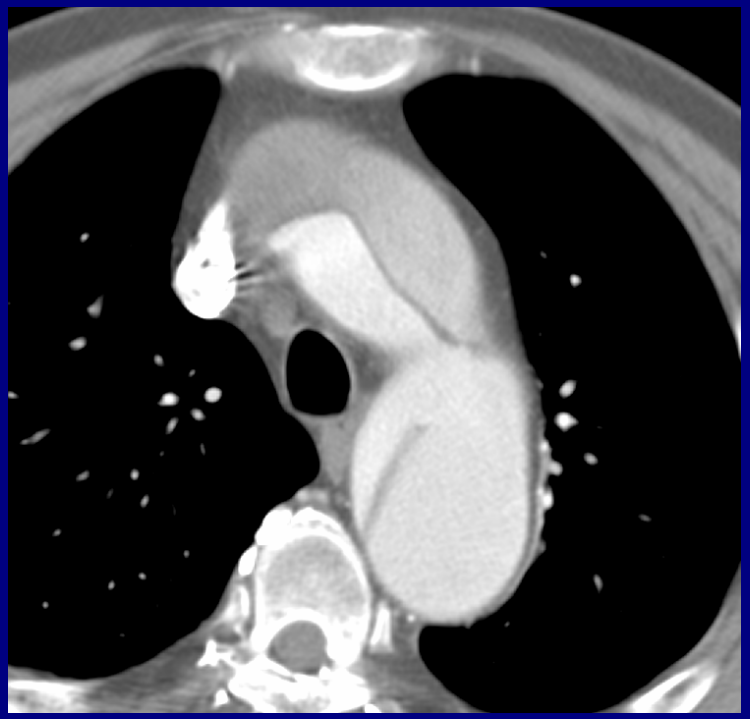
Classification of Acute Chest Pain Syndrome using MDCT

MDCT in Early Triage of Patients with acute chest pain

- ECG-gated coronary CTA(CCTA) provides information on aortic dissection, pulmonary thromboembolism, coronary artery stenosis/occlusion, and myocardial infarction simultaneously.
- CCTA excludes coronary artery disease (87.5%) and help avoid unnecessary patient's admission to hospital in 70% of 40 patients.

Hoffmann U. AJR 2006; 187:1240-7

61/M with Chest Pain



Usefulness of 64-slice cardiac CT angiography for diagnosing acute coronary syndromes and predicting clinical outcome in emergency department patients with chest pain of uncertain origin

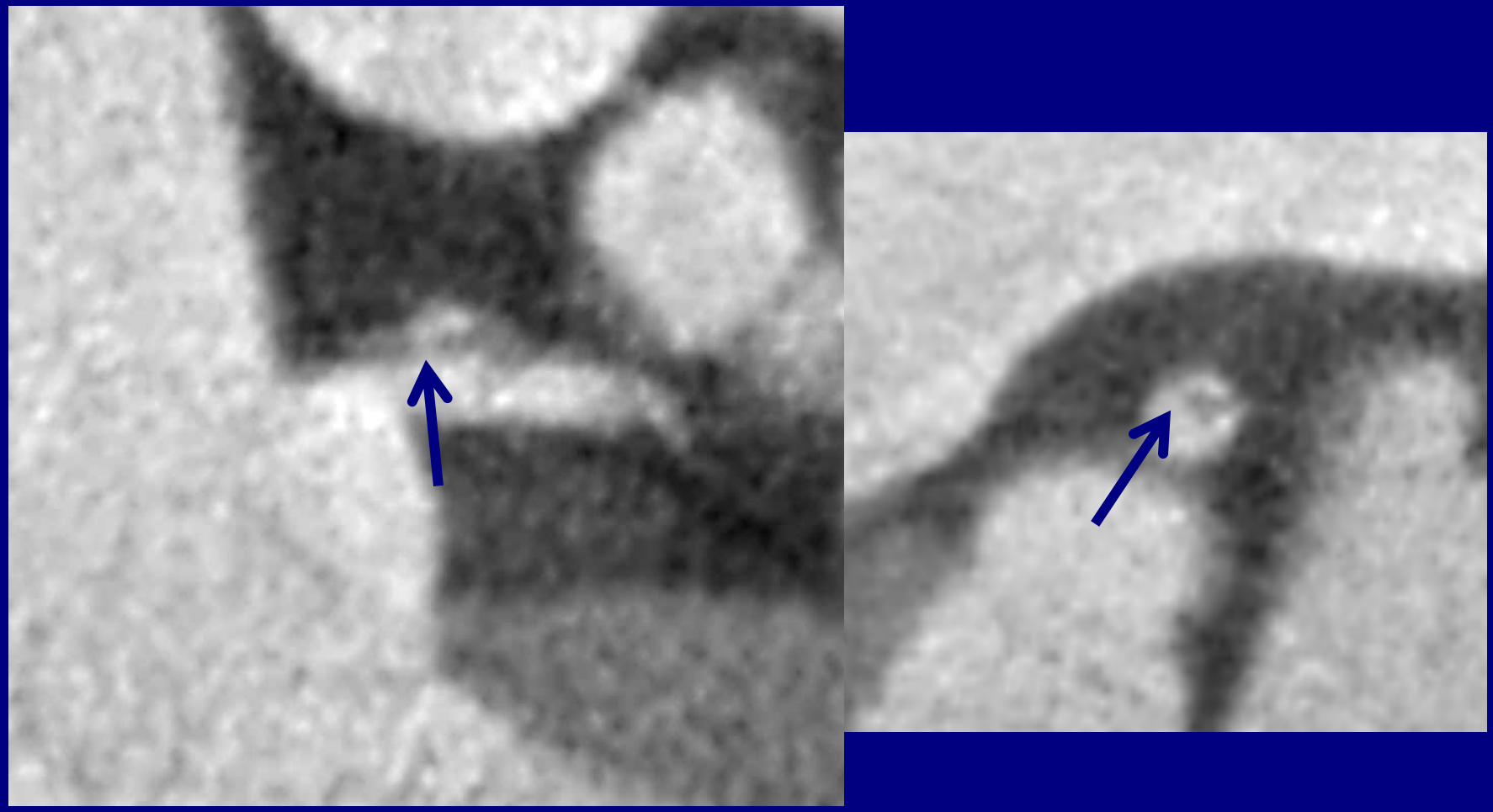
- 58 pts with chest pain w/o ECG change or elevated biomarkers
  - Nonobstructive plaques in 20 pts
  - Stenosis >50% in 23 pts → ACS in 20 of 23
- ED MDCT for ACS
  - Sens = 100% (20/20), Spec = 92% (35/38)
  - Pos pred value = (20/23), neg pred value = 100% (35/35)

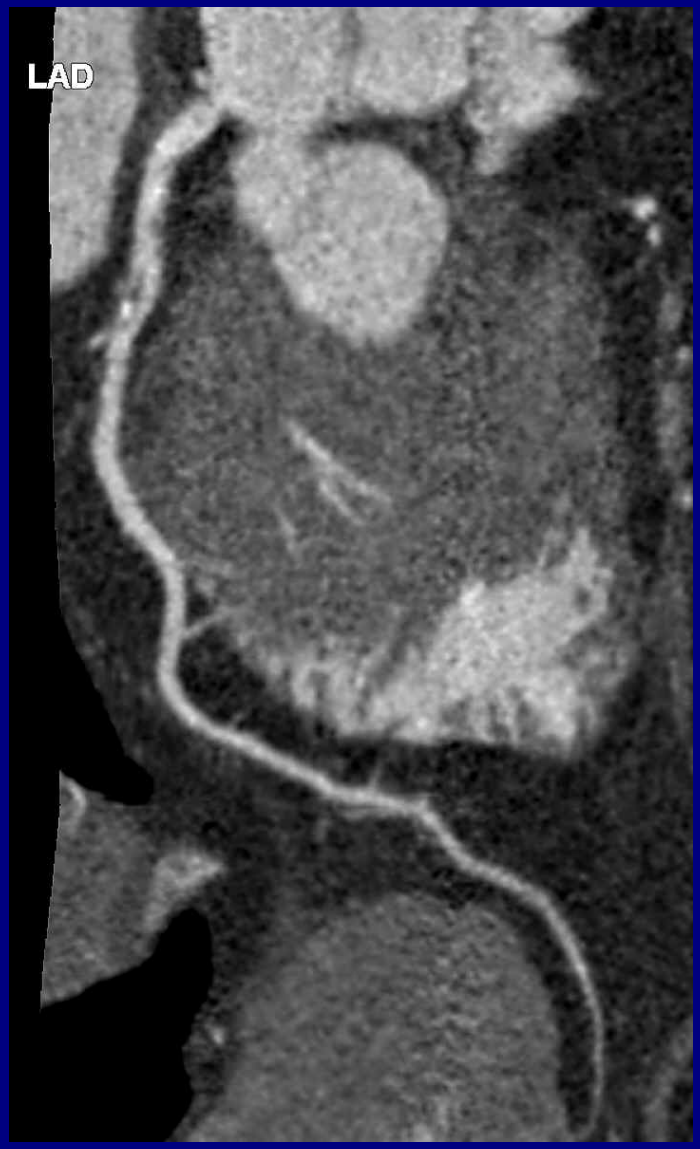
Rubinshtein. Circulation. 2007;115:1762-8

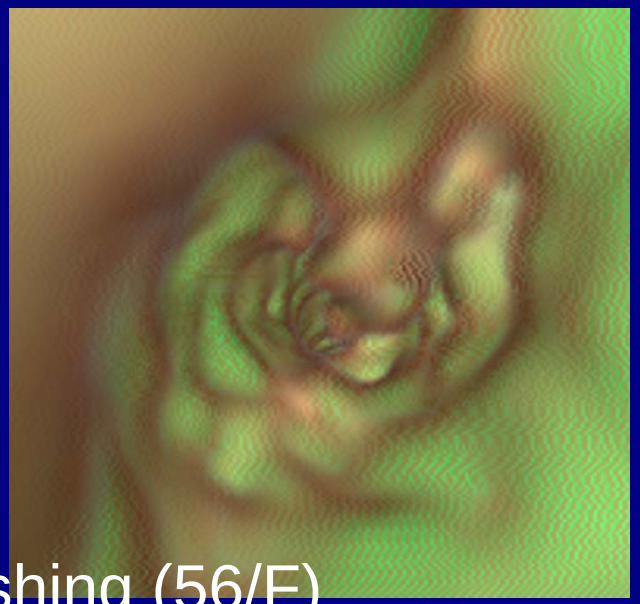
Samsung Medical Center Experience: CCTA Findings of ED Patients

- 63 patients with chest pain at ED
- 16 pts (25%) had coronary artery stenosis >50% in 27 vessels.
- 18 pts (29%) had coronary artery lesions with stenosis <50% in 23 vessels.
- 29 pts (46%) showed normal coronary arteries.

Ulcerated Plaque in L Main



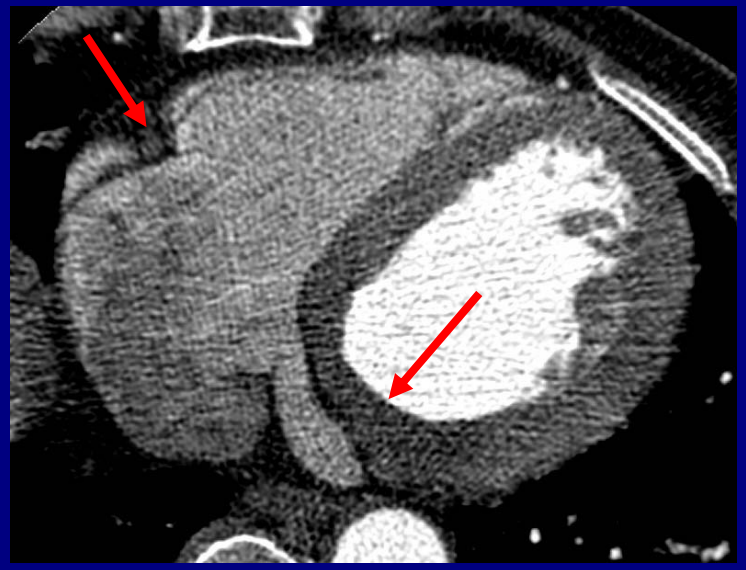




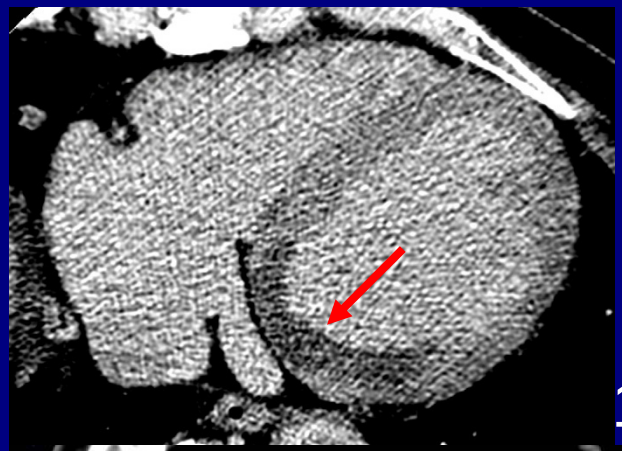
Thrombus

Unstable angina, HT, Cushing (56/F)

Acute MI before PCI



Early CT



10 min CT

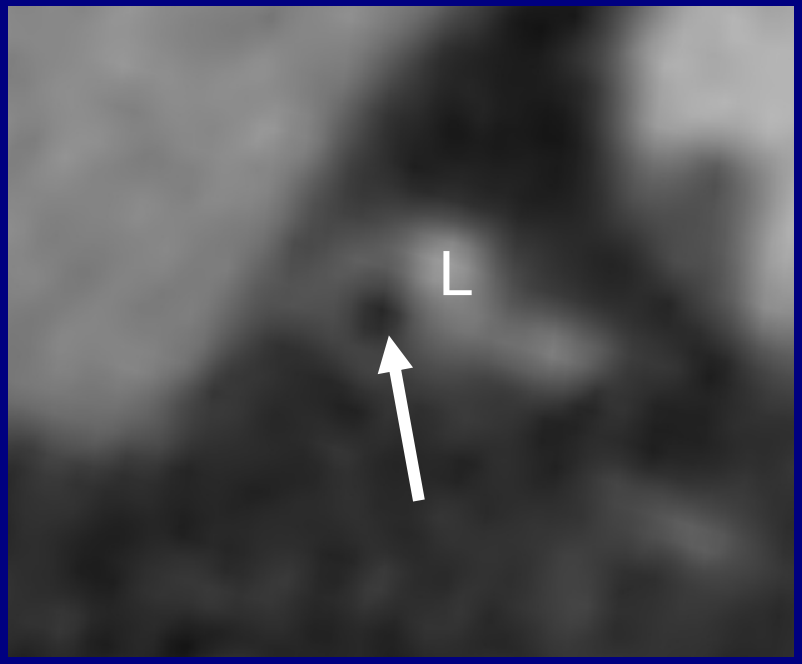
Multislice computed tomographic characteristics of coronary lesions in acute coronary syndromes

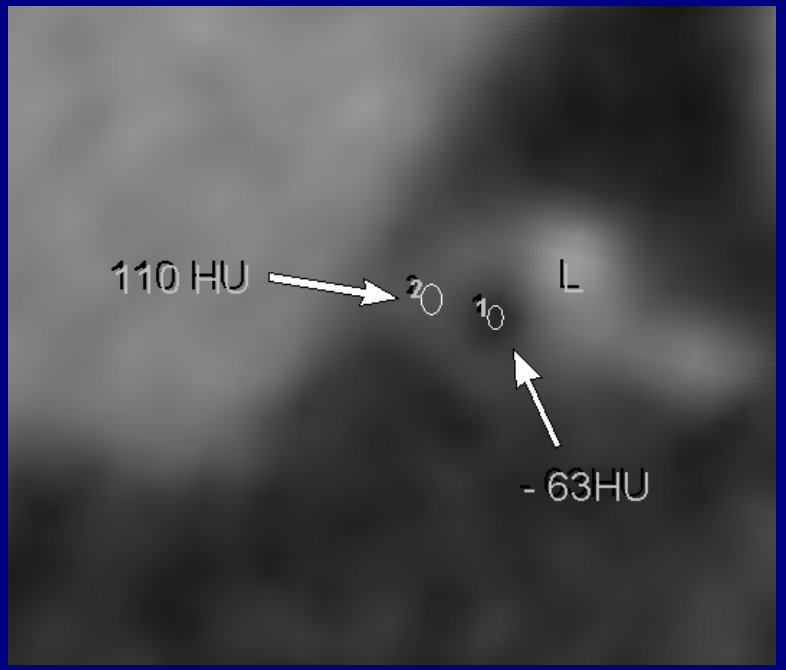
- CT analysis of plaques in culprit ACS, stable angina pectoris (SAP) lesions
- Large calcification: 22% vs. 55%, $p = 0.004$
- Positive remodeling: 87% vs. 12%, $p < 0.0001$
- Non-calcific plaque (NCP) <30 HU: 79% vs. 9%, $p < 0.0001$
- Spotty calcification: 63% vs. 21%, $p = 0.0005$

- Combination of all three characteristics (positive remodeling, NCP <30 HU, spotty calcification): high pos pred value for ACS

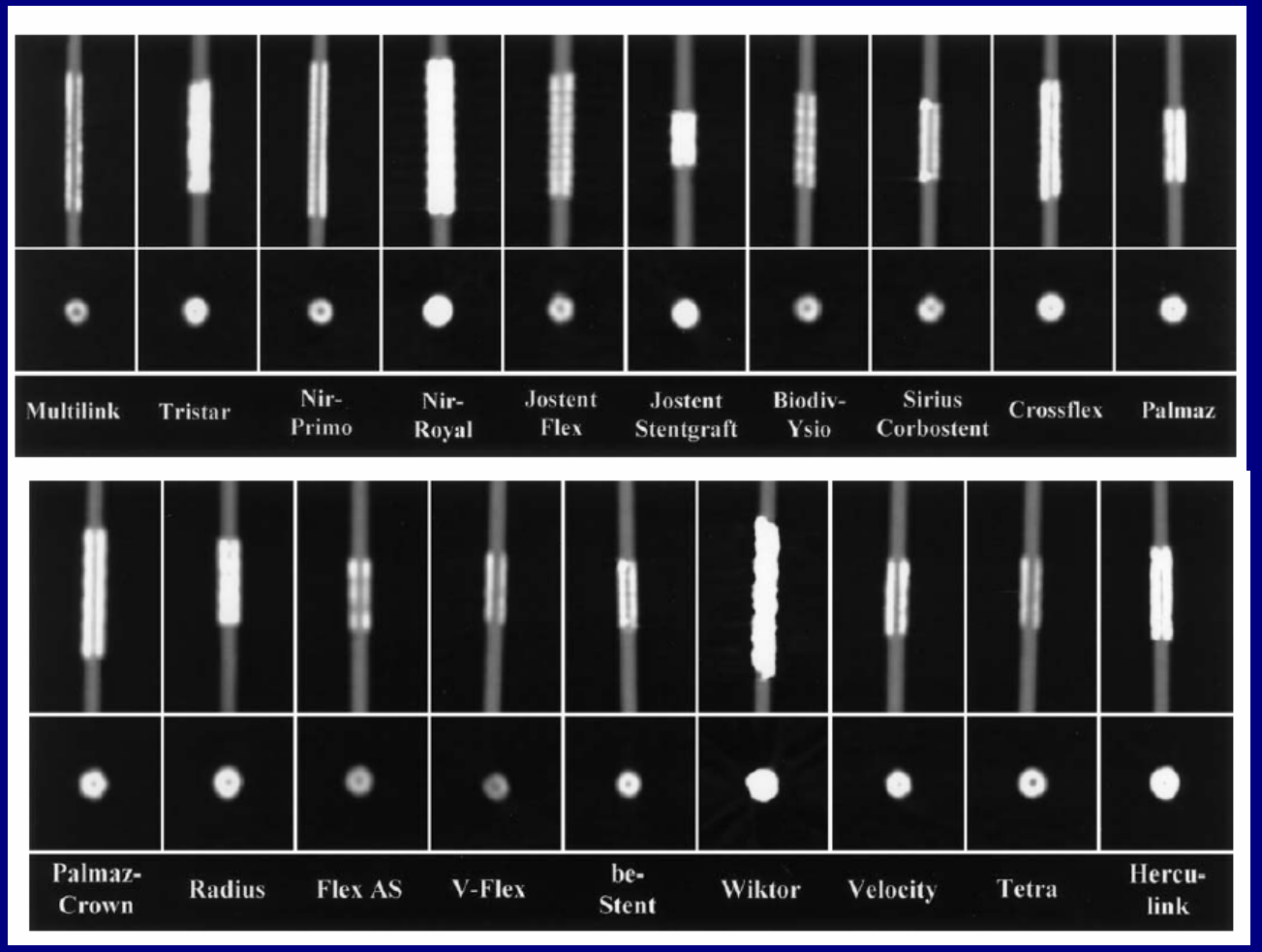
Motoyama et al. J Am Coll Cardiol. 2007;50:319-26.

Lipid Core





Stents with Blooming Artifacts



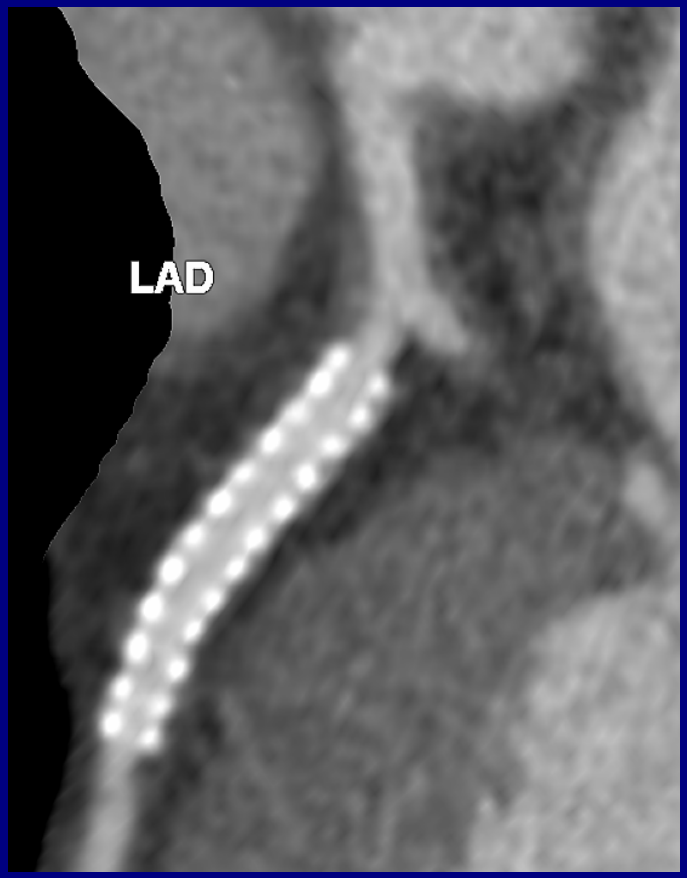
In-stent Restenosis at MDCT Comparison with CAG

- L Main stents in 70 pts

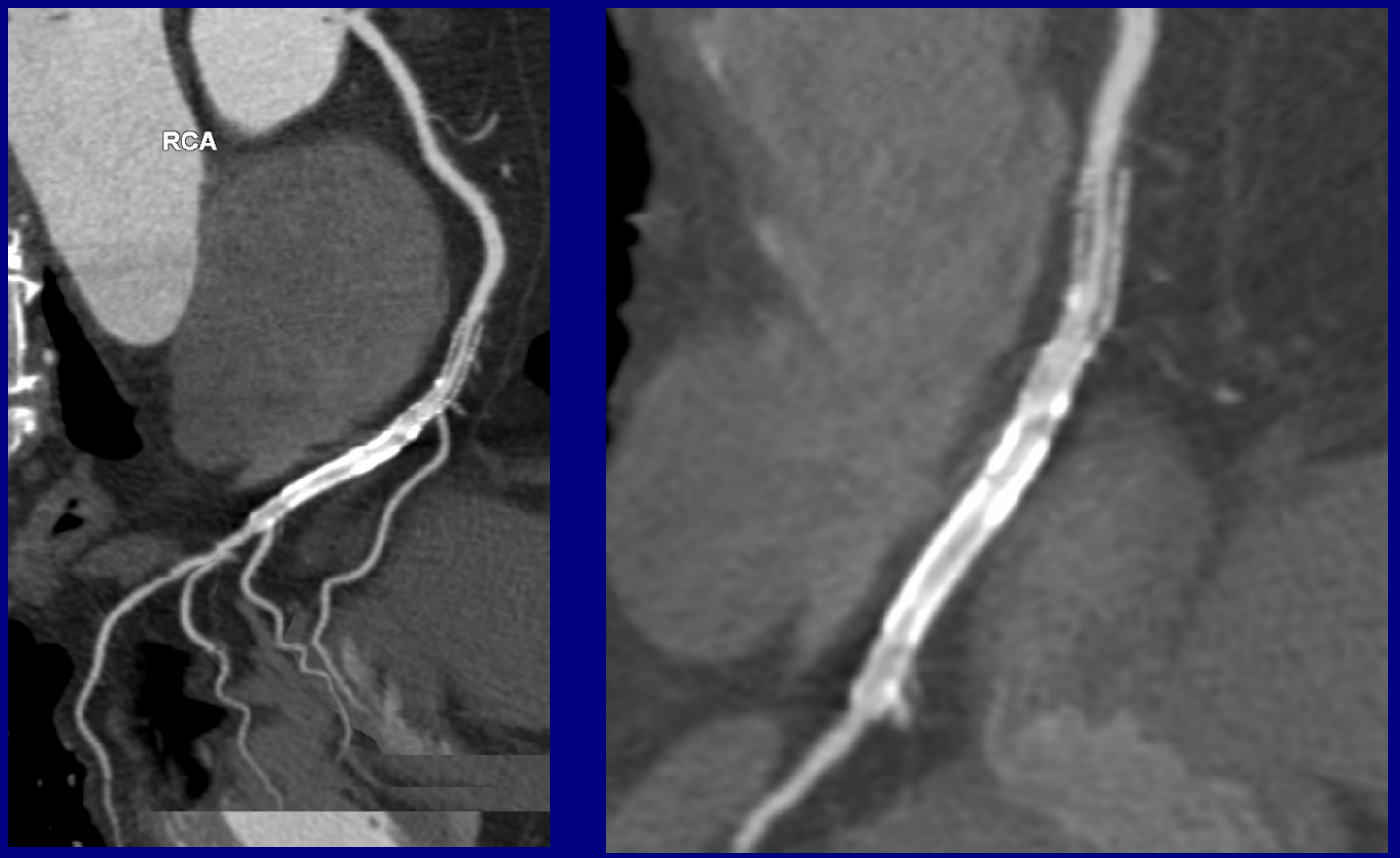
	All pts	Simple Stenting	Complex Bifurcation
Total	70	46	24
Sensitivity	100	100	100
Specificity	91	97	80
Accuracy	93	98	83
Pos Pred Value	67	86	50
Neg Pred Value	100	100	100

Van Mieghem et al. Circulation 2006; 114:645-653

Patent Stent



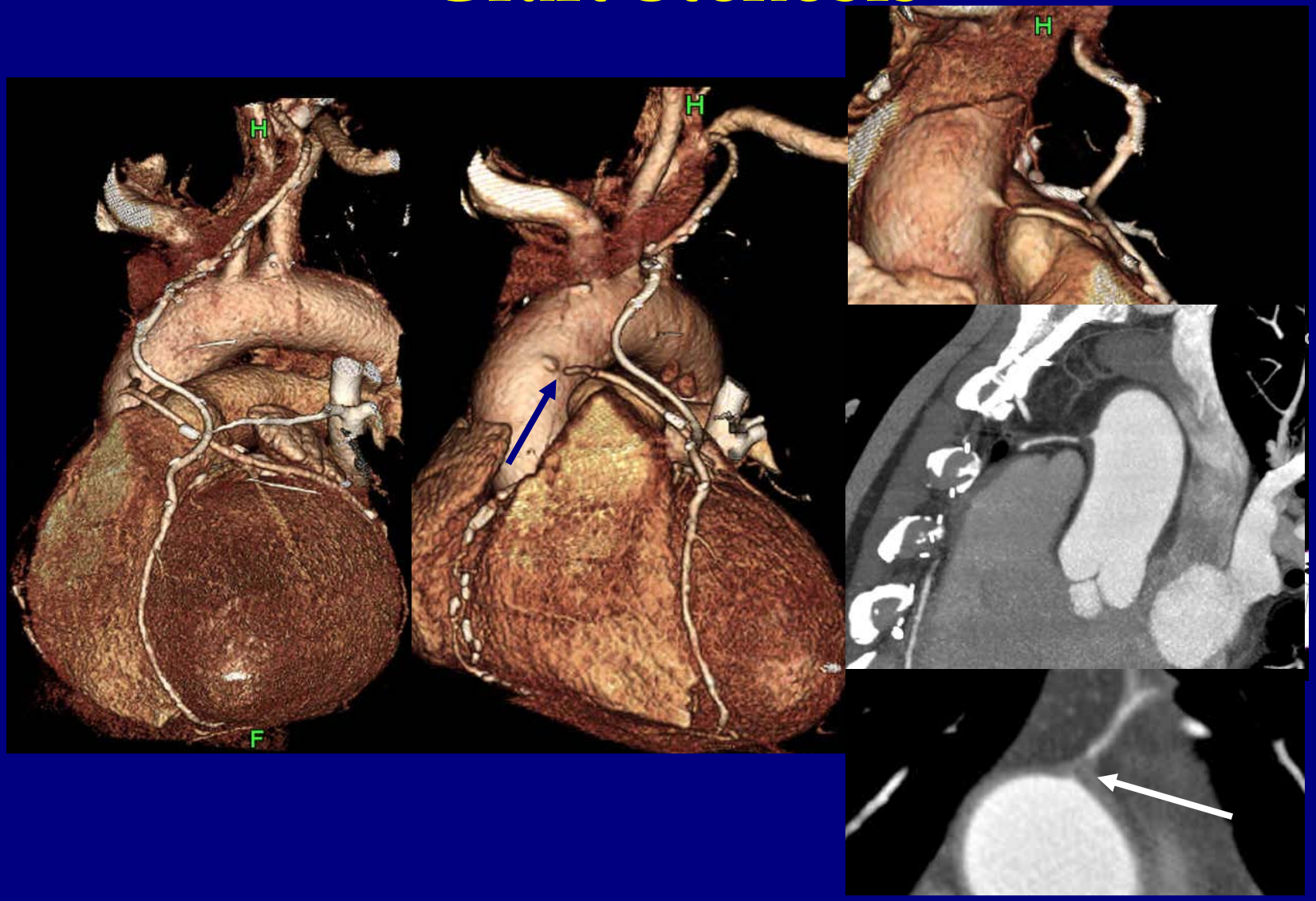
RCA Stent Restenosis

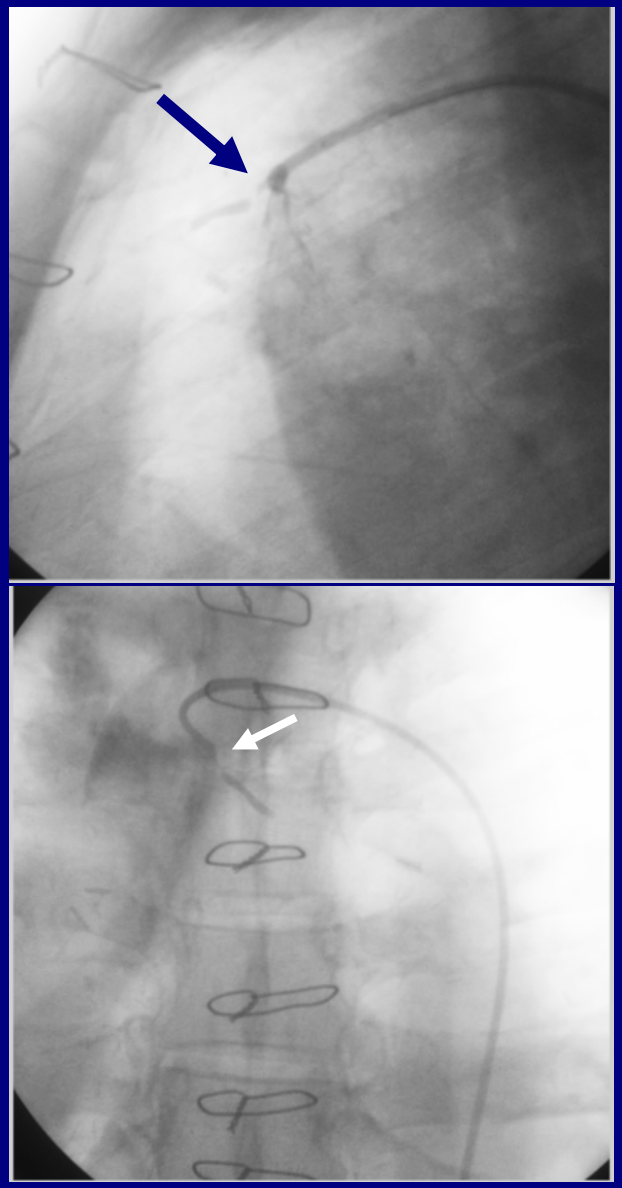


Diagnostic Accuracy of 64-slice MDCT in CABG Evaluation

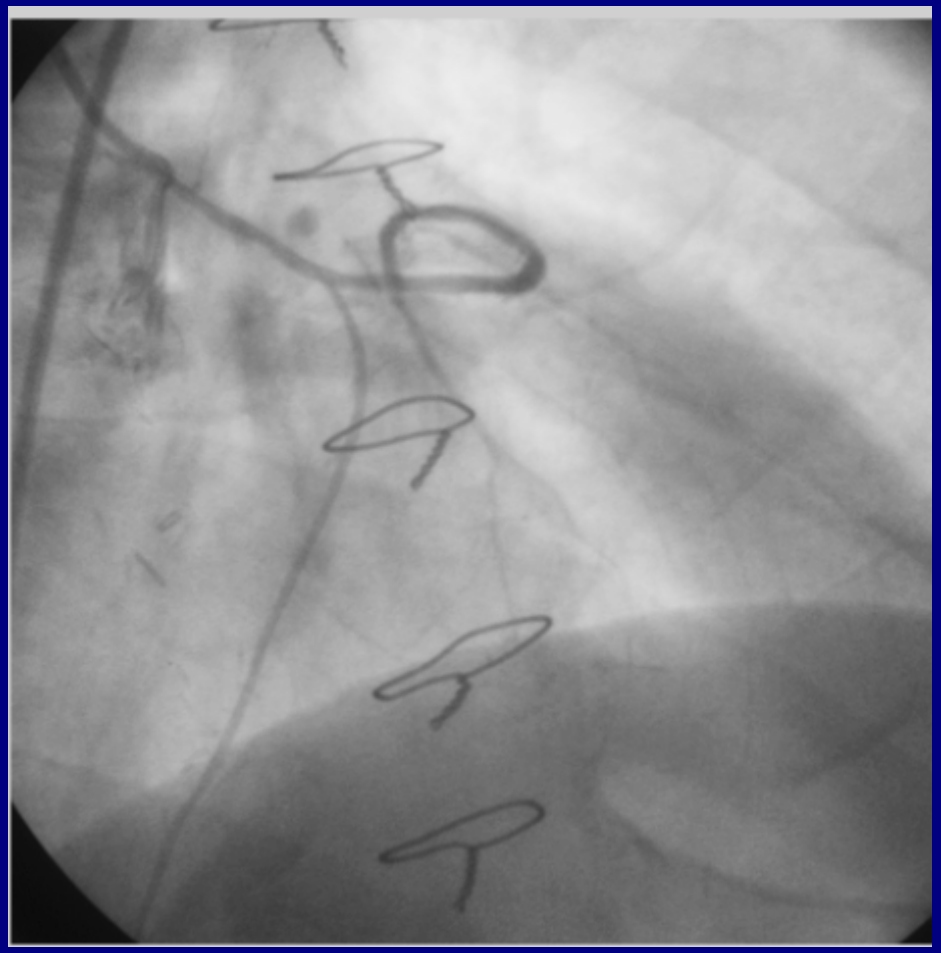
Study	Pts	Artery	Vein	Sens	Spec	PPV	NPV	Accu
Pache	31	23	73	98	89	90	98	94
Malagutti	52	45	64	100	94	79	100	95
Ropers	50	28	72	100	89	94	100	98

Graft Stenosis

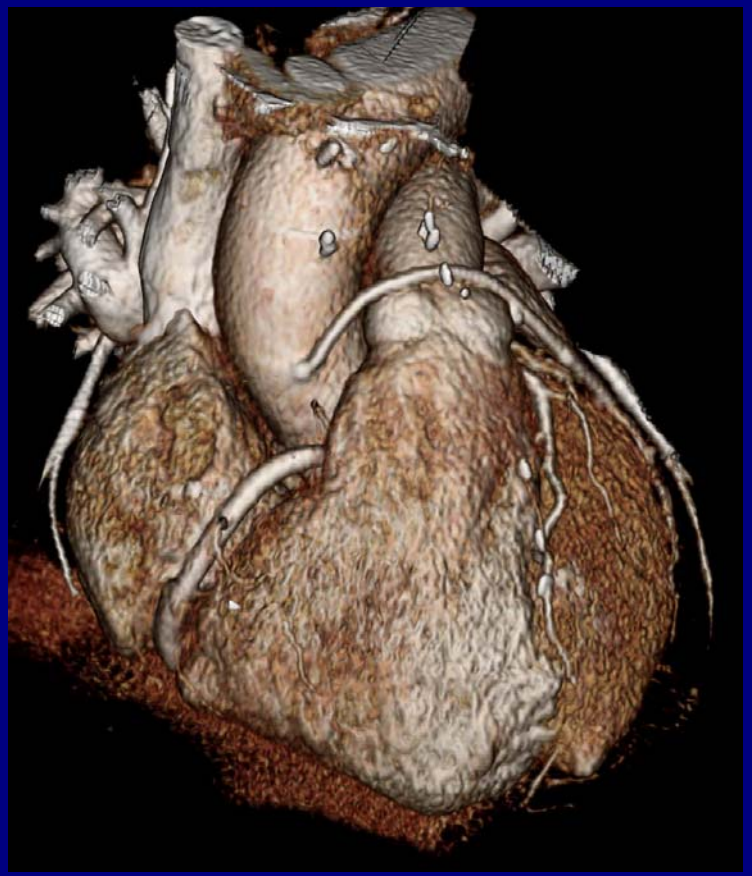


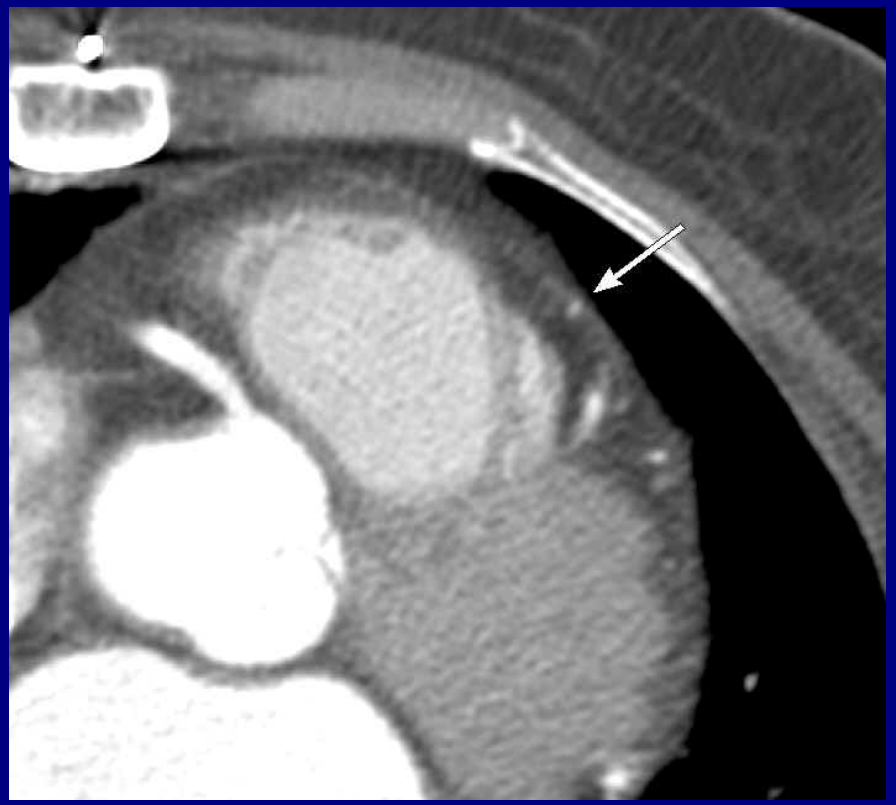


After Balloon Dilatation

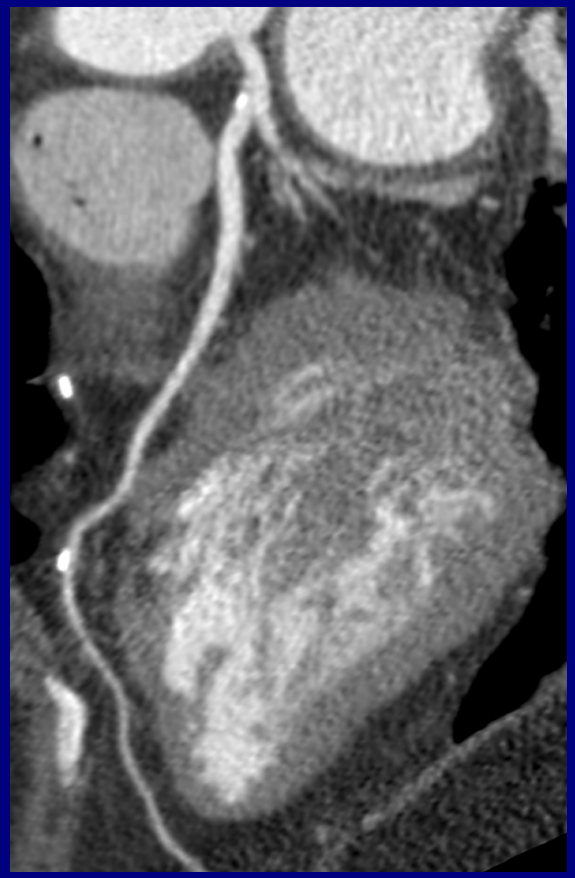


LIMA graft: not visible?





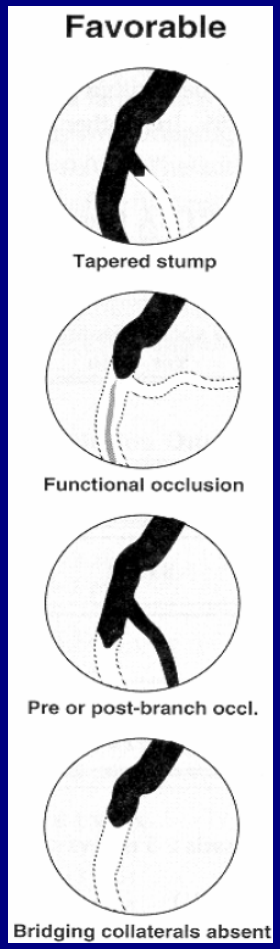
Auto-regulation

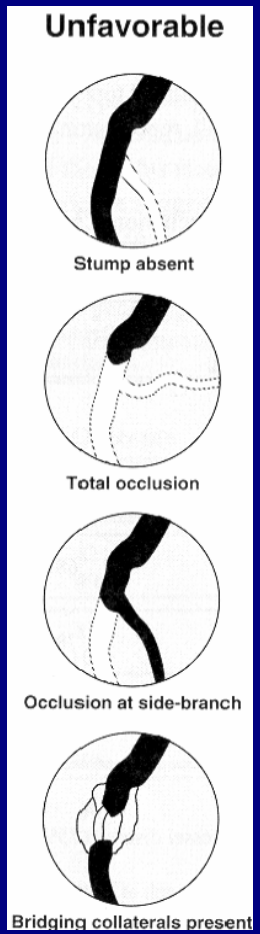


Role of CT in CTO PCI

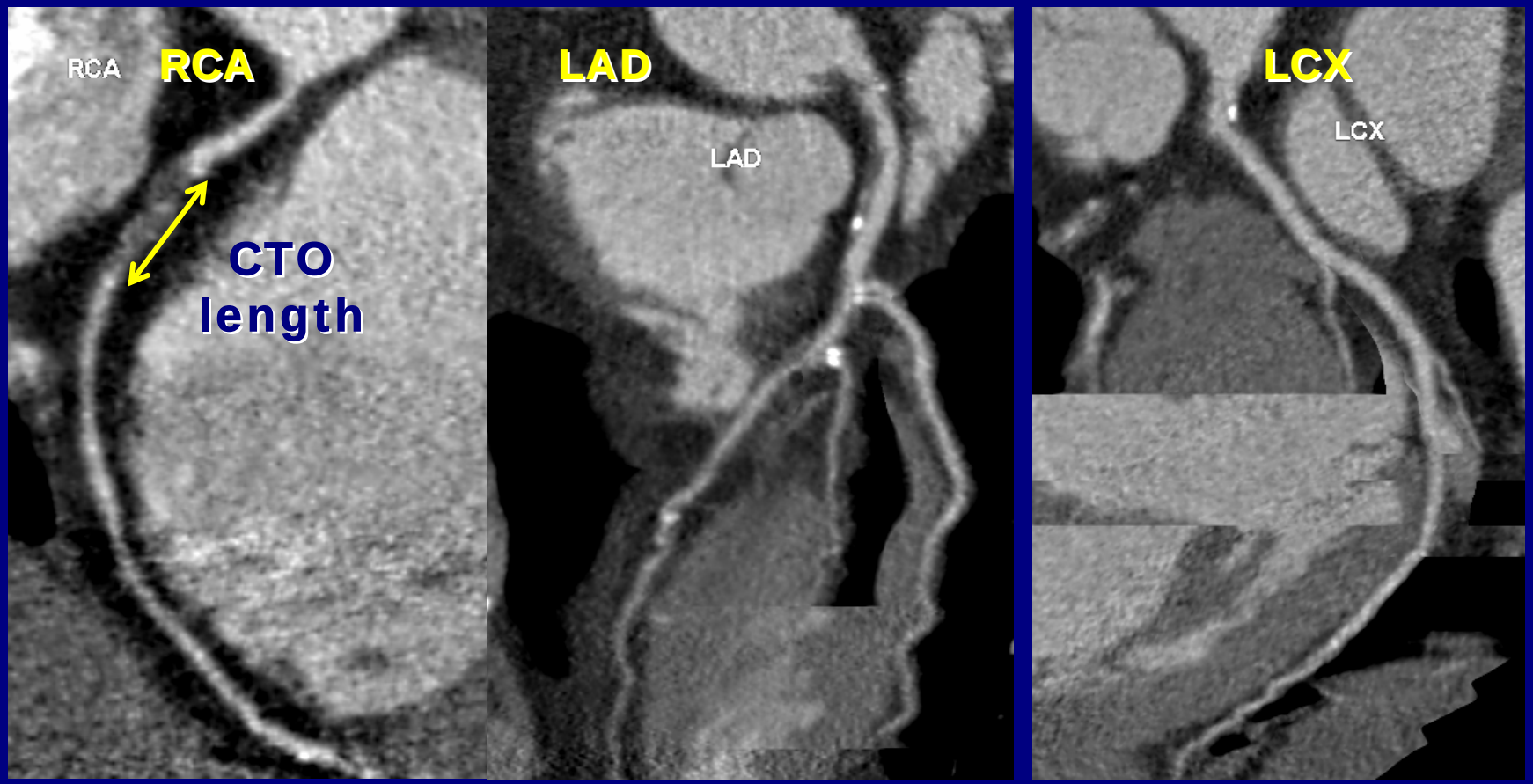
- **Determine revascularization strategy**
  - **PCI or CABG**
- **Predict CTO PCI success**
  - CTO occlusion length
  - Calcification (and plaque composition ?)
- **Help PCI strategy**
  - Myocardial ischemia and viability
  - Guidewire roadmap
  - Distal vessel evaluation
  - PCI of unidentified or unusually located vessels

Angiographic predictors of success and failure





- **Occlusion duration: longer**
- **Occlusion length > 15 mm**
- **Significant calcification**

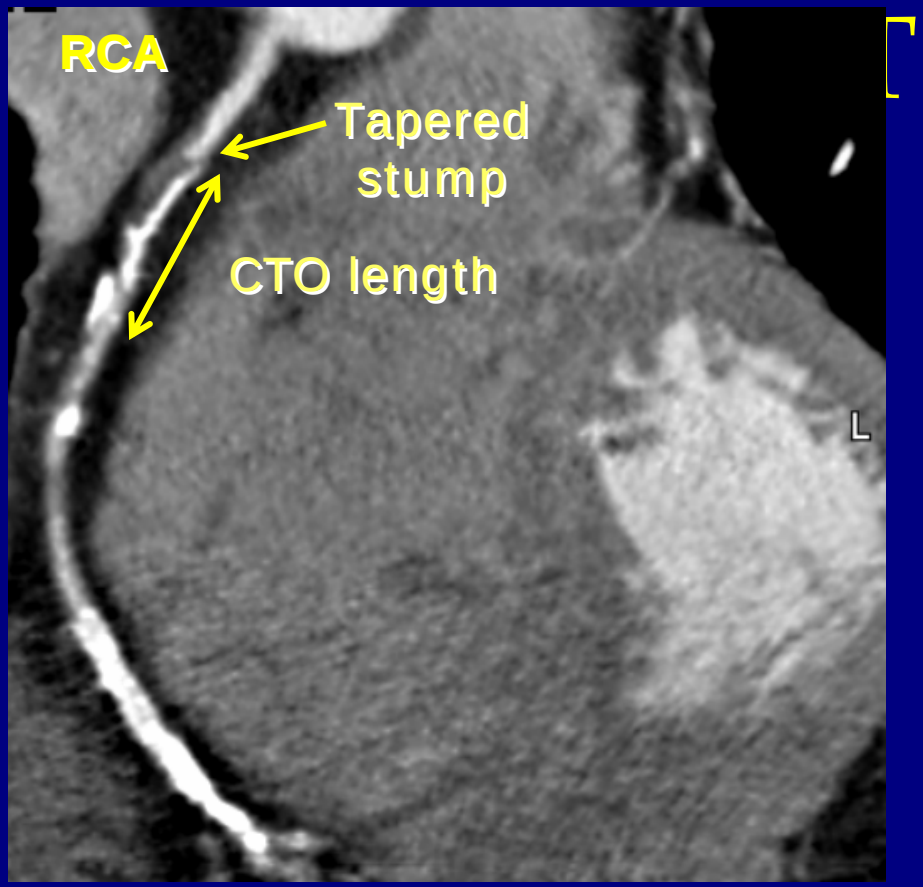


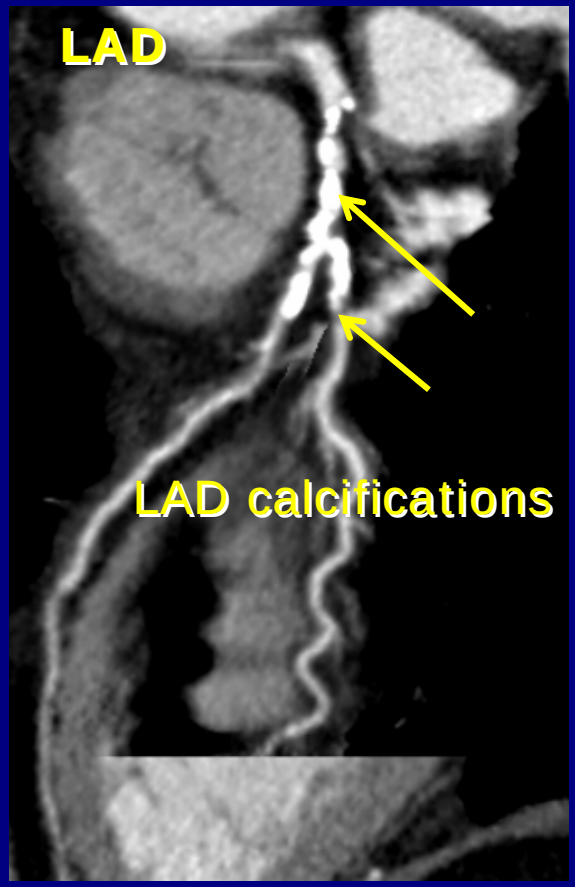
CTO length > 15 mm

CTO Stump is blunt

Mid LAD and distal LAD lesions

LCX is OK





CTO tip is tapered end → good news!

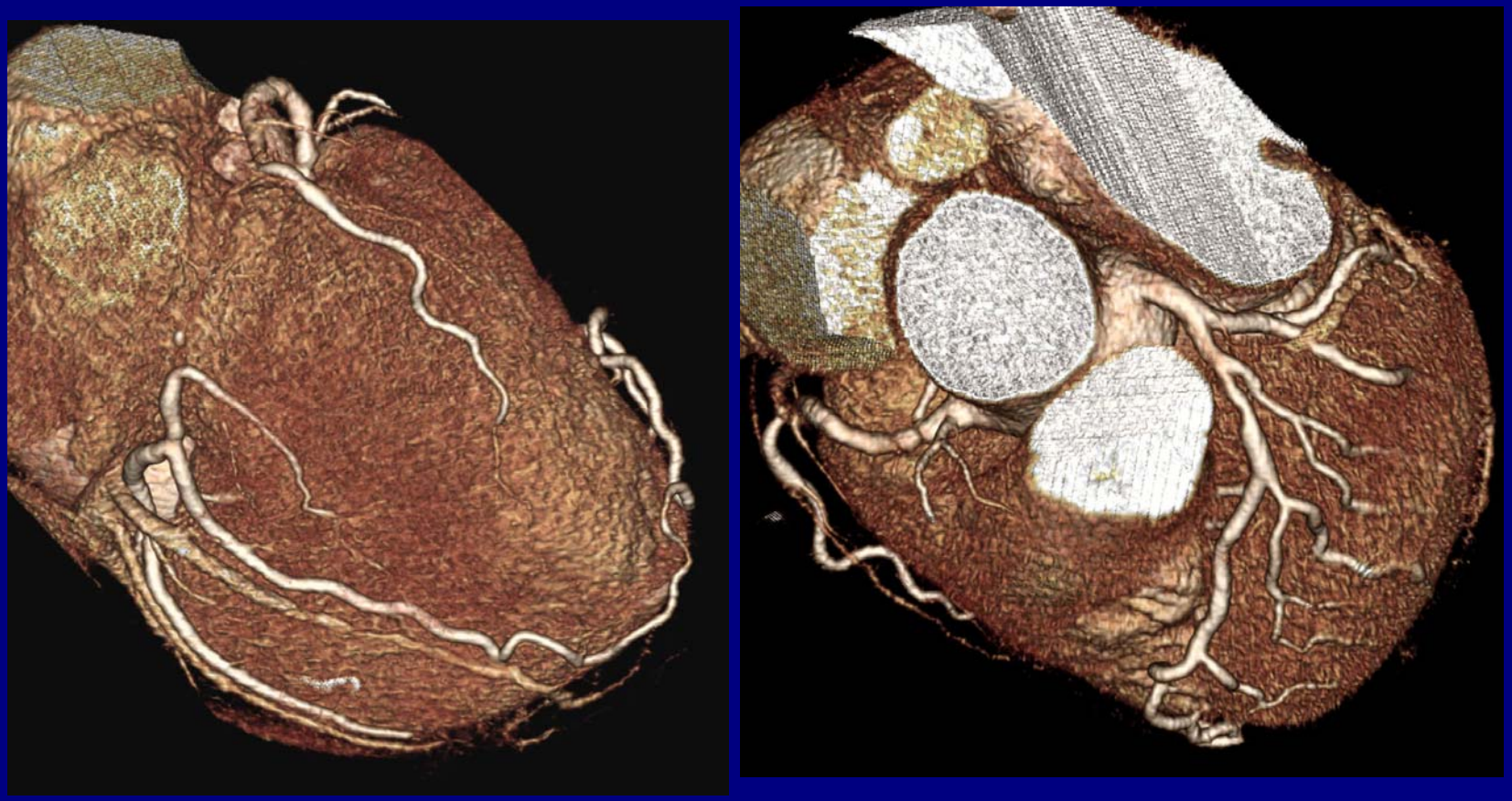
Wire course:

Outer curvature → enter inner curvature at the mid RCA calcification

LAD:

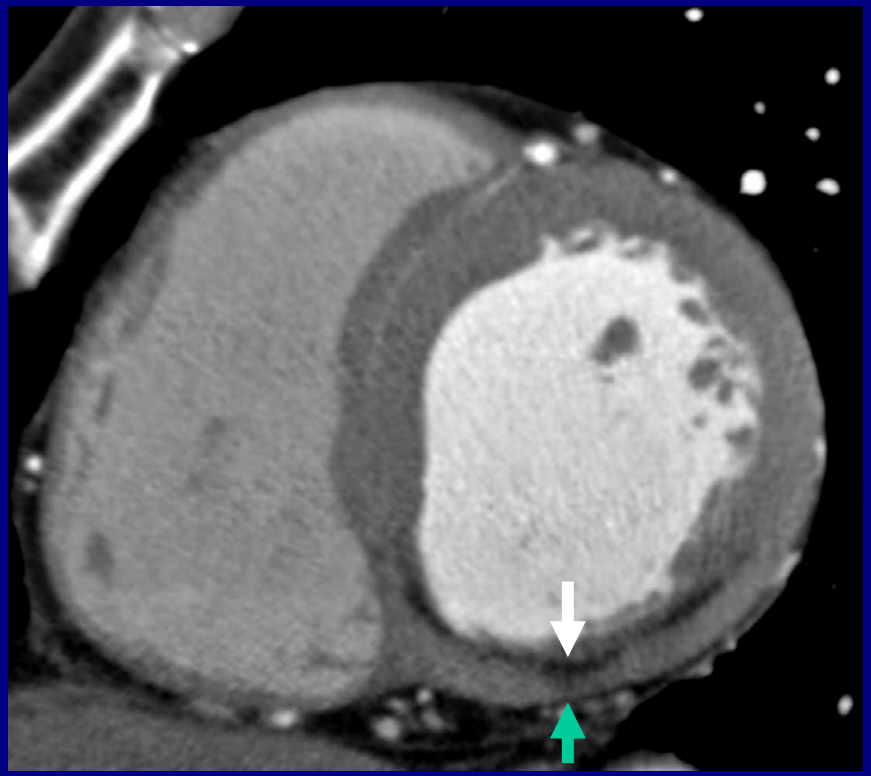
multiple calcific lesions → may be not good candidate for PCI

RCA CTO with Apical Collateral Circulation

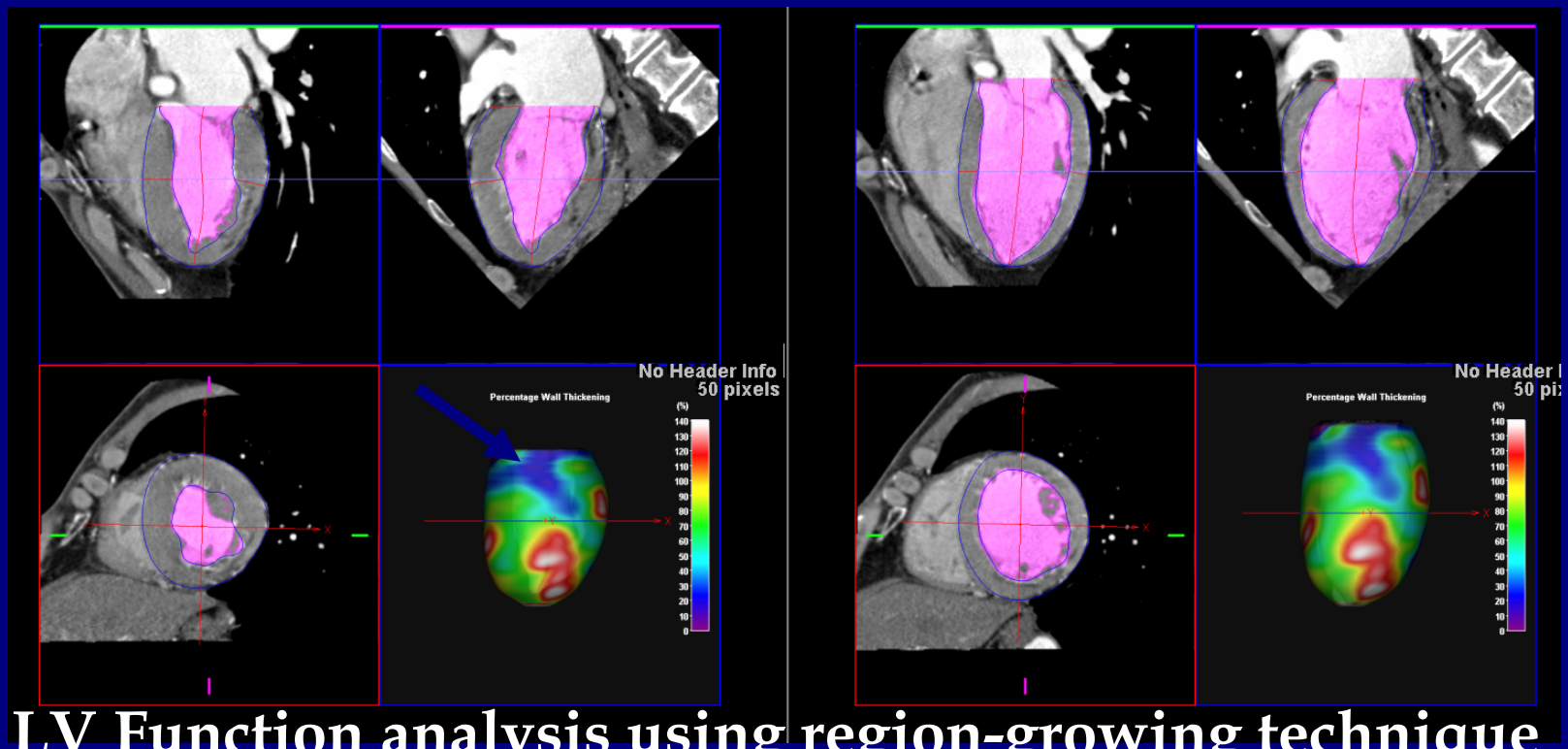


Evaluation of Ventricular Function

RCA Occlusion with Inferior OMI (M/60)



Ventricular End Diastolic Volume: 175.65 ml
Ventricular End Systolic Volume: 69.26 ml
Ejection Fraction: 60.6%
Stroke Volume: 106.40 ml
End-diastolic Myocardial Volume: 170.56 cm^3



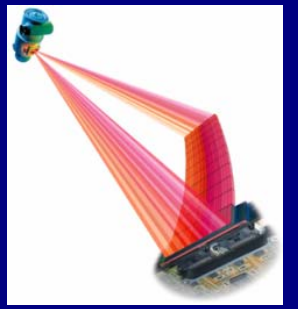
LV Function analysis using region-growing technique

LV Function Analysis: MDCT vs. MRI

Authors	No. Pts	LVEDV		LVESV		EF		Mass	
		MD	CC	MD	CC	MD	CC	MD	CC
Kim (SMC)	49	-1.0	0.69	5.9	0.76	5.4	0.64	-0.6	0.92
Grude	30	14	0.80	17	0.89	-9	0.85		
Yamanuro	50	-0.4	0.97	1.1	0.99	-1.2	0.96	2.5	0.96
Heuschmid	31	*13.2*	0.86	*4.6*	0.91	1.4	0.87	*11.5*	0.88
Koch	19	-4.2	0.98	-6.9	0.98	3.0	0.95		
Jeurgens	30	-8.2	0.93	-1	0.94	0.2	0.88		

MD = mean difference, CC = correlation coefficient

MDCT Diagnosis of Myocardial Infarction

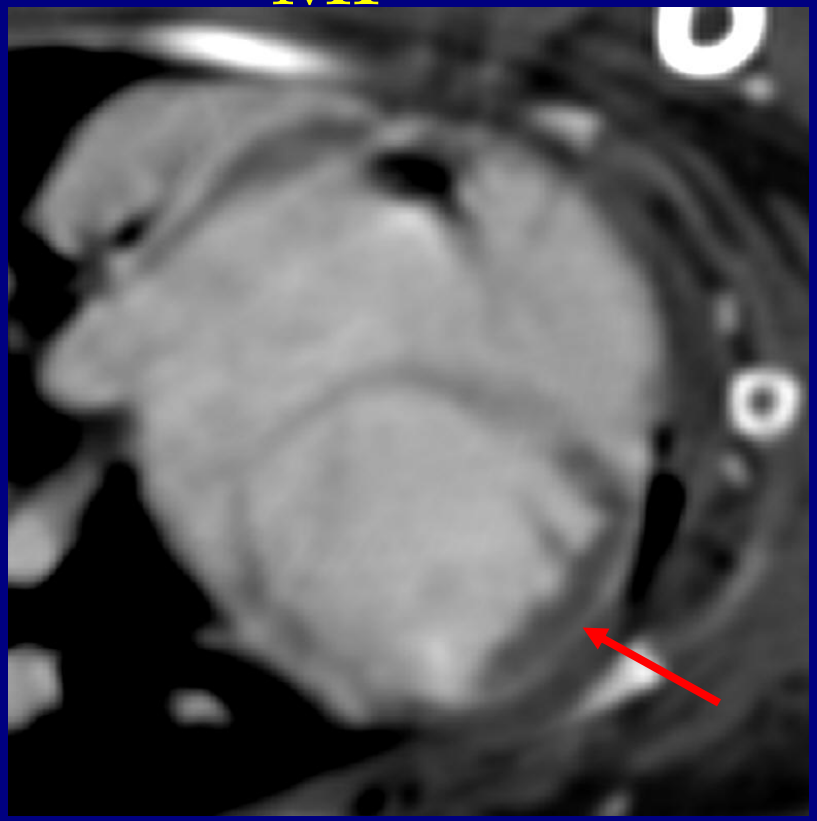


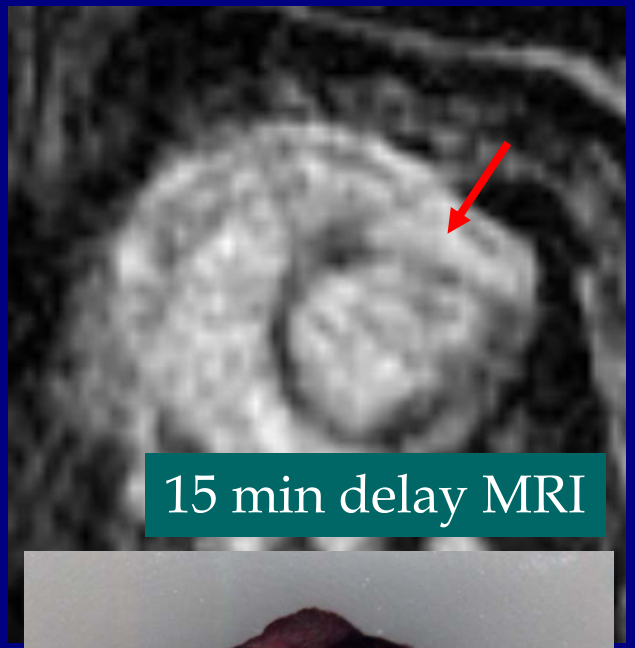
MDCT Viability Imaging After Myocardial Infarction in Animals

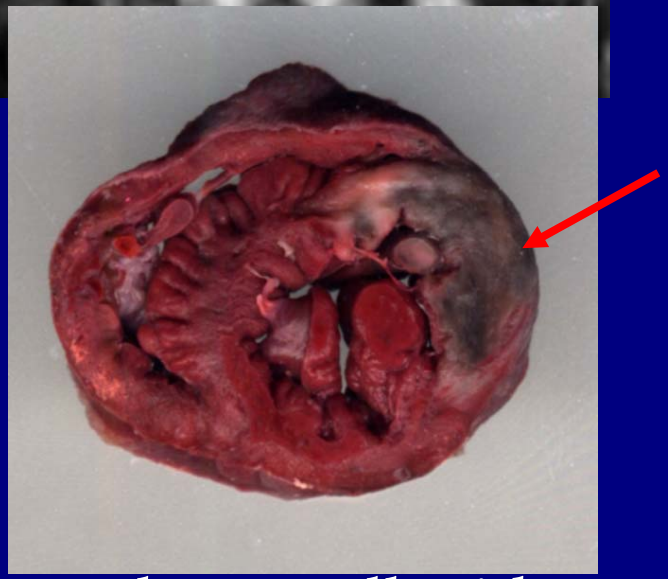
- Acute and chronic infarcts by MDCT were characterized by hyperenhancement.
- Regions of microvascular obstruction characterized by hypoenhancement.
- MDCT infarct volume compared well with triphenyltetrazolium chloride staining (acute infarcts 21.1±7.2% vs 20.4±7.4%; chronic infarcts 4.1±1.9% versus 4.9±2.0%) and accurately reflected morphology and transmural extent of injury in all.

Lardo AC. Circulation. 2006;113:394-404

Early CT, Reperfusion Model of MI

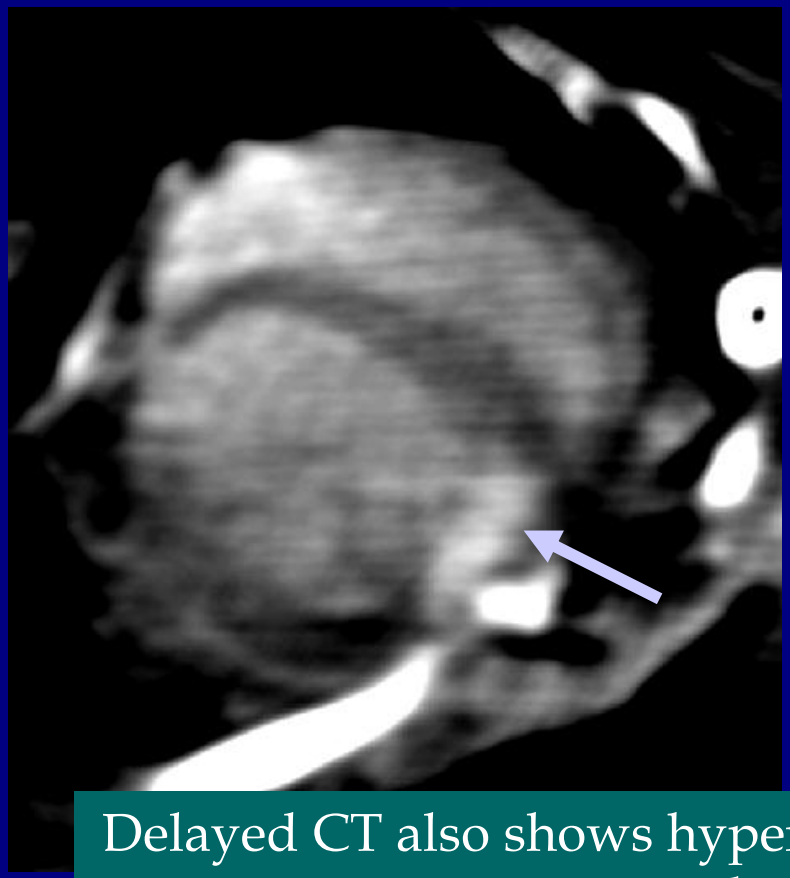


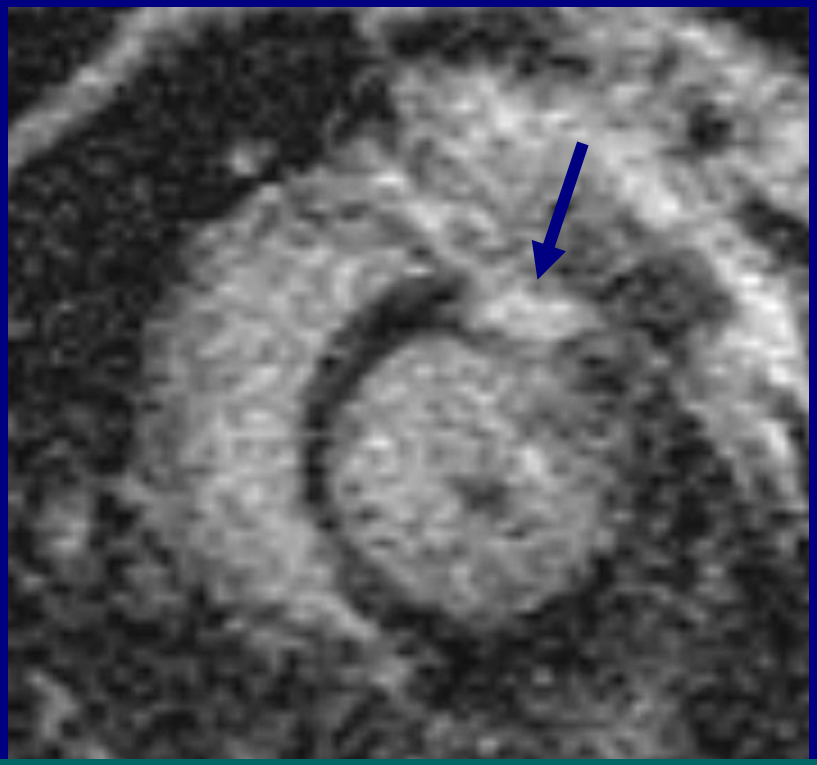




A large perfusion defect on CT correlates well with hyperenhanced area on 15-min MRI and specimen.

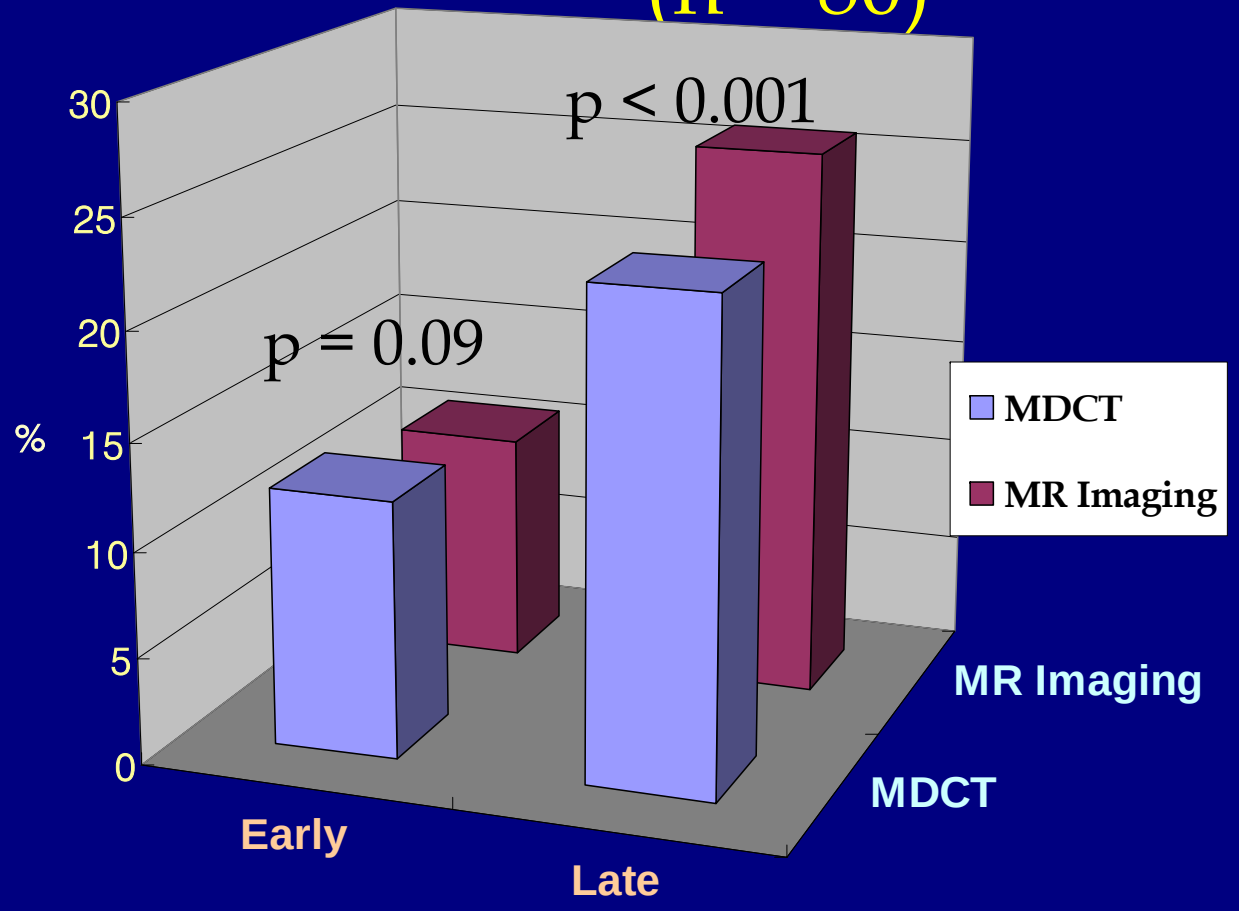
Late CT and MRI, Reperfusion Model





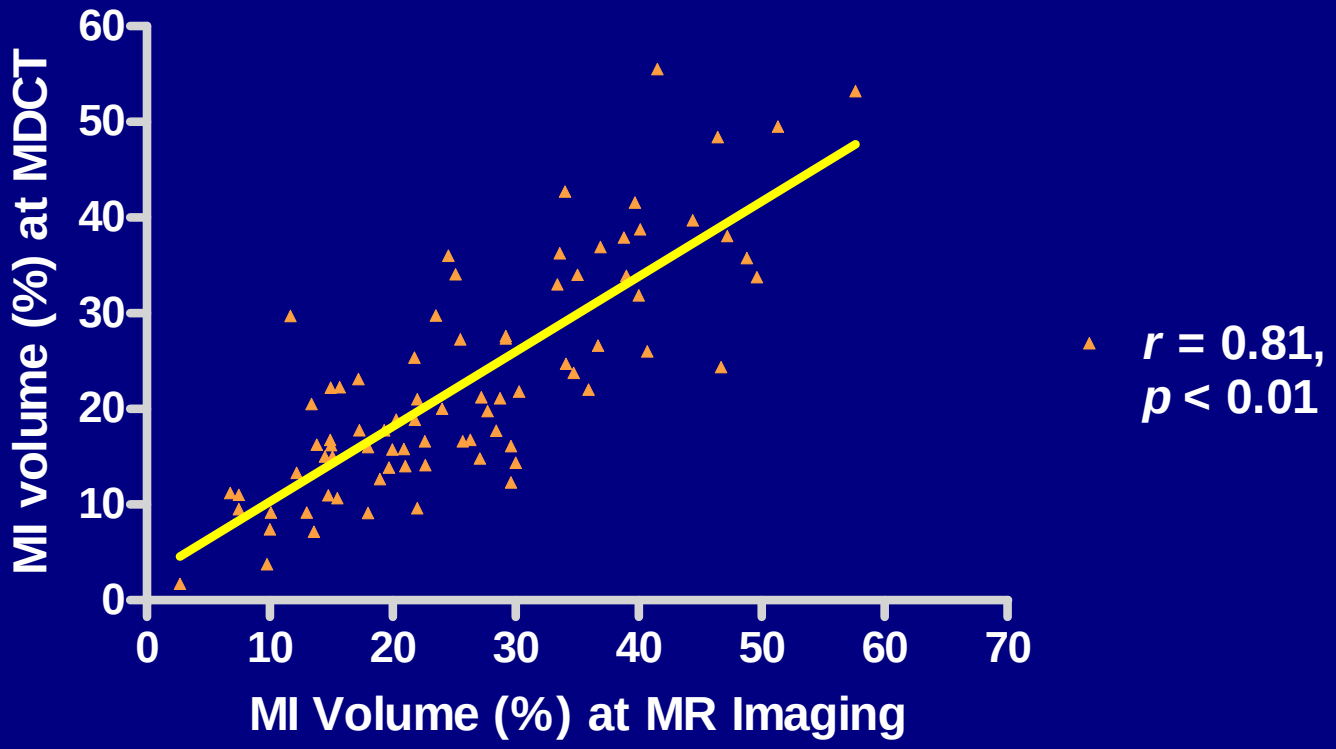
Delayed CT also shows hyperenhancement of reperfused infarction as also shown by MRI.

Mean MI Volume (%) between Early- and Late-Phase MDCT and MR Imaging (n = 80)

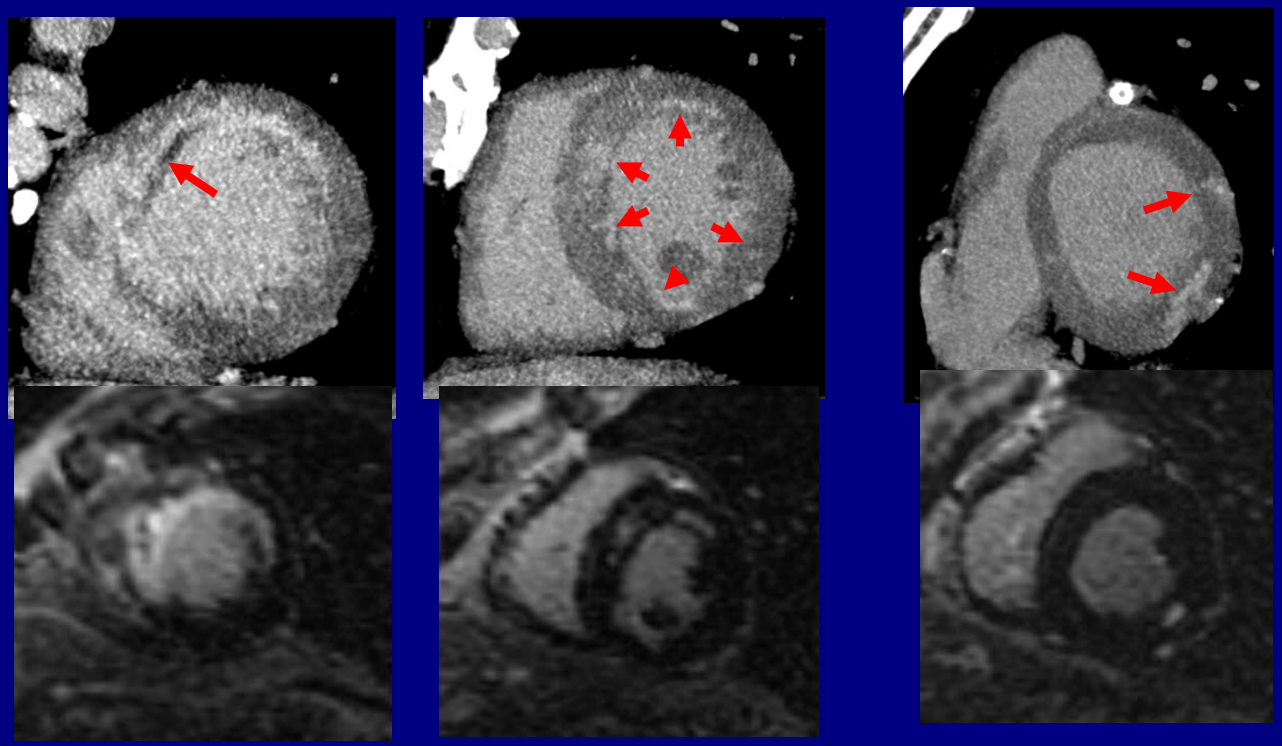


Choe YH et al. Eur J Radiol 2008

Late Phase Exams

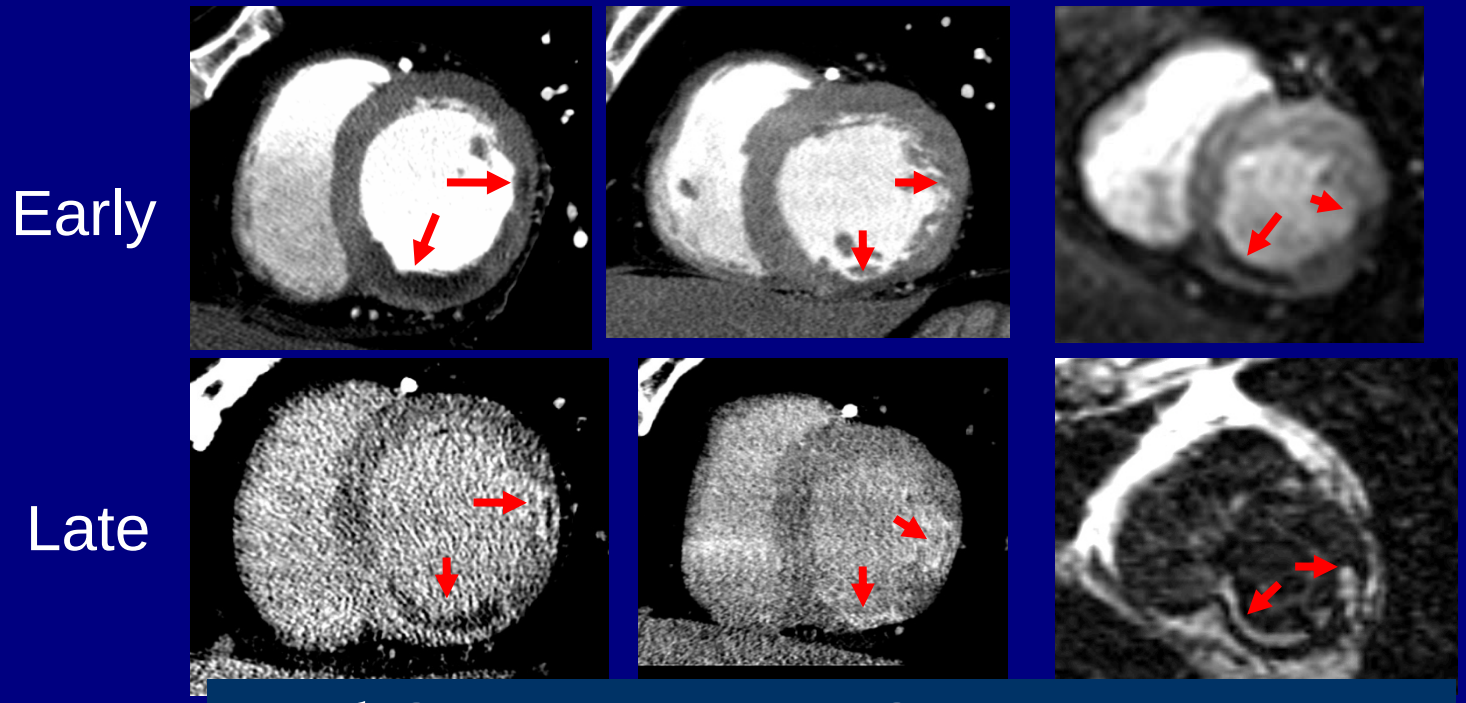


Multifocal Involvement of AMI: Late CT > MRI



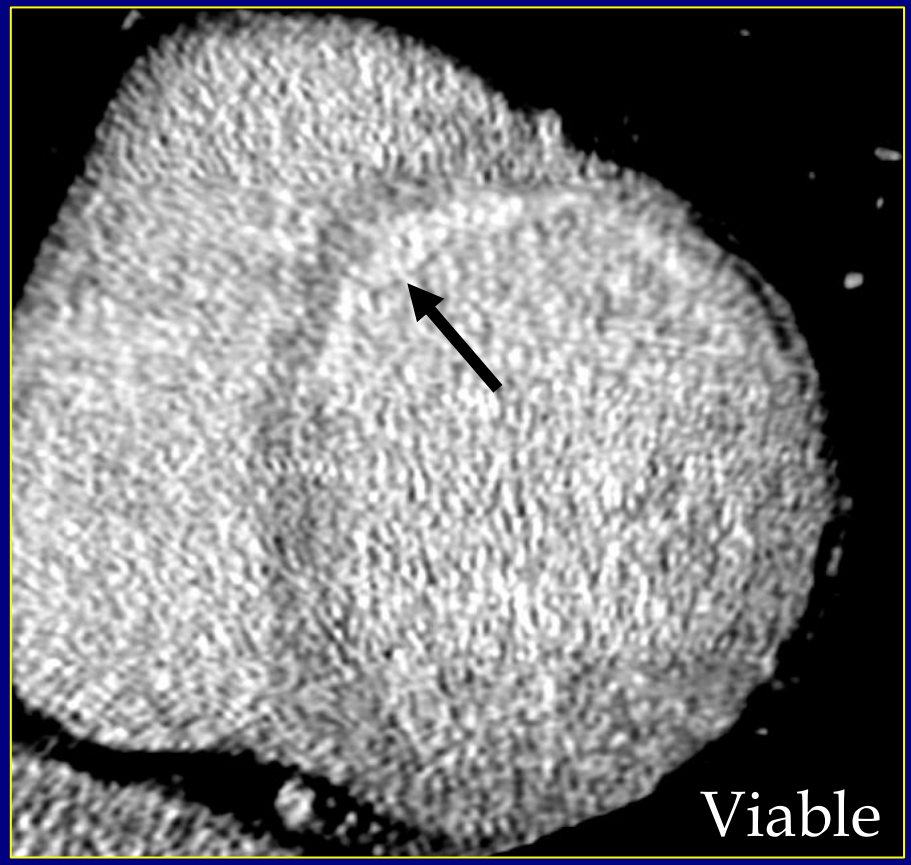
Small foci of infarction are more clearly visible on CT than on MRI.

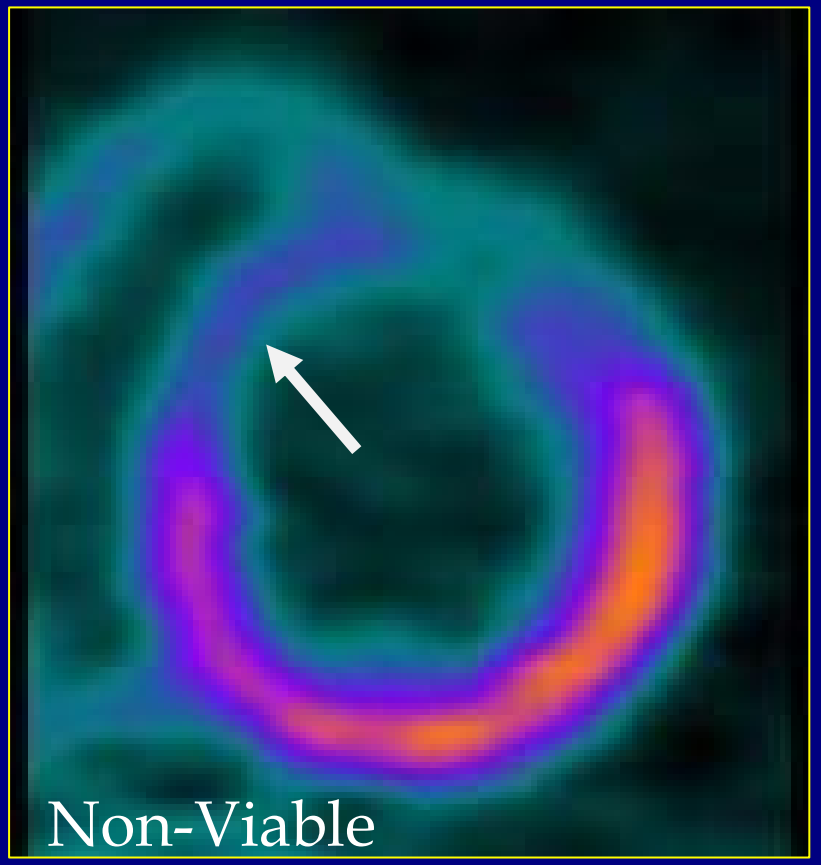
F-up CT of AMI, 2 Vessel Disease



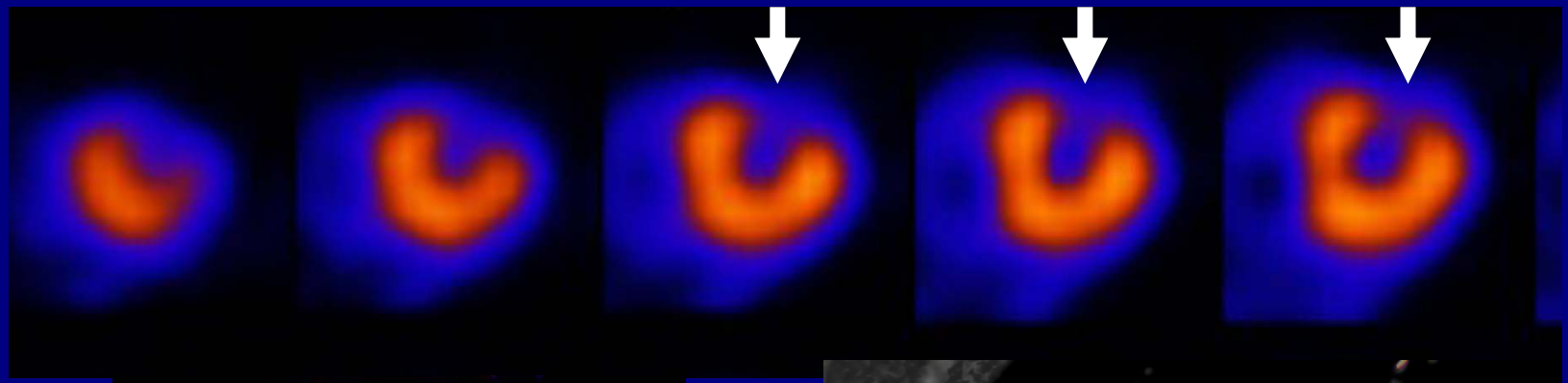
Two separate vessel territory lesions are visible on early and late CT. On 5 month follow-up, there is more prominent wall thinning in inferior wall. Perfusion defect is no longer visible on late CT.

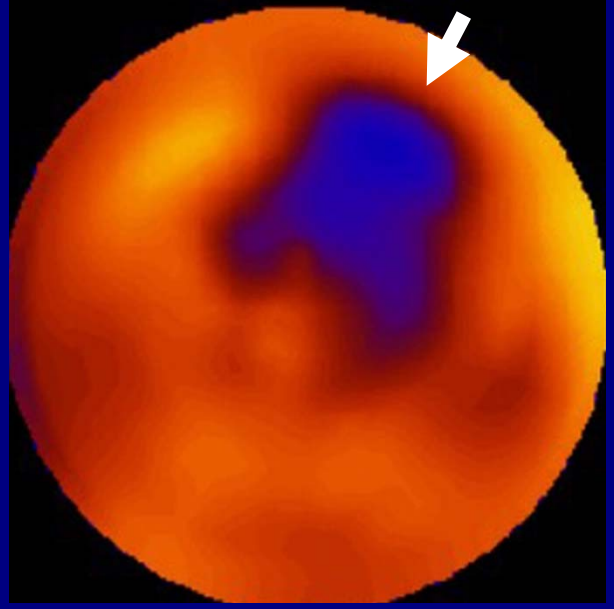
AMI, CT > PET

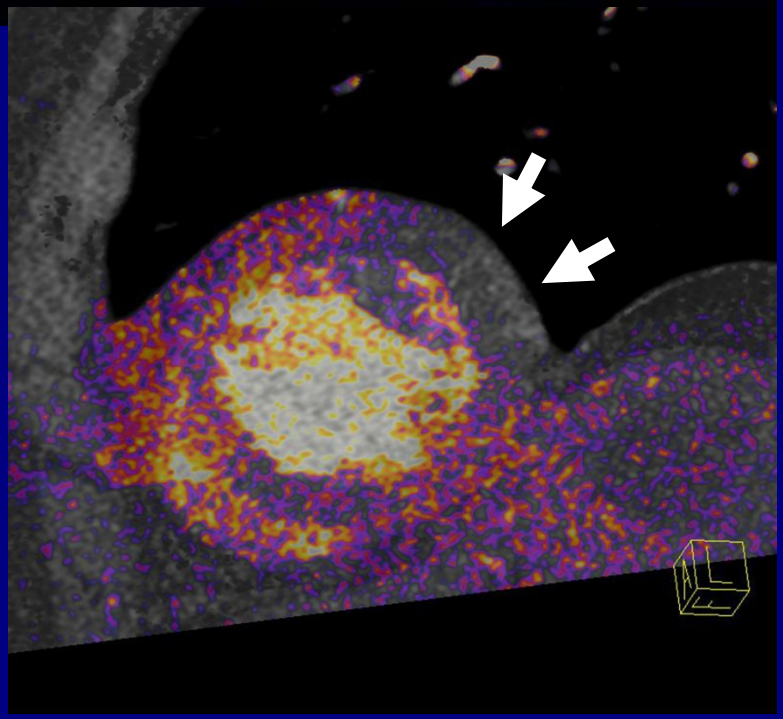




SPECT versus Dual-Energy CT



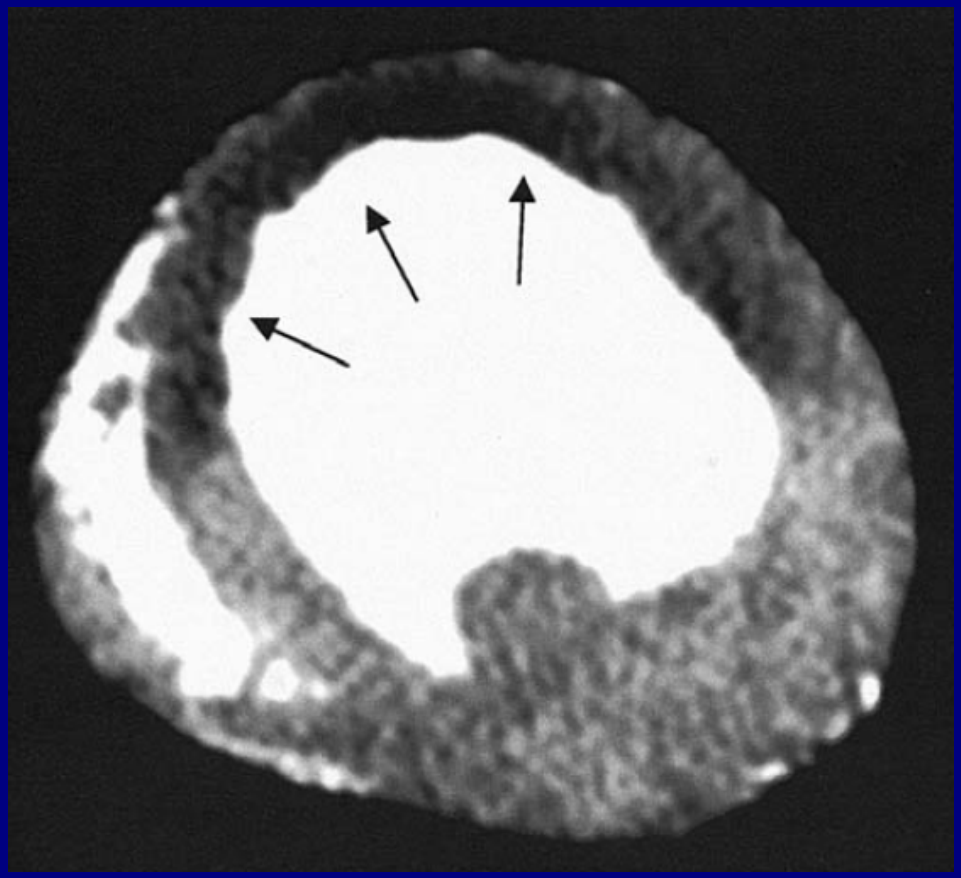




77/F, Chest Pain

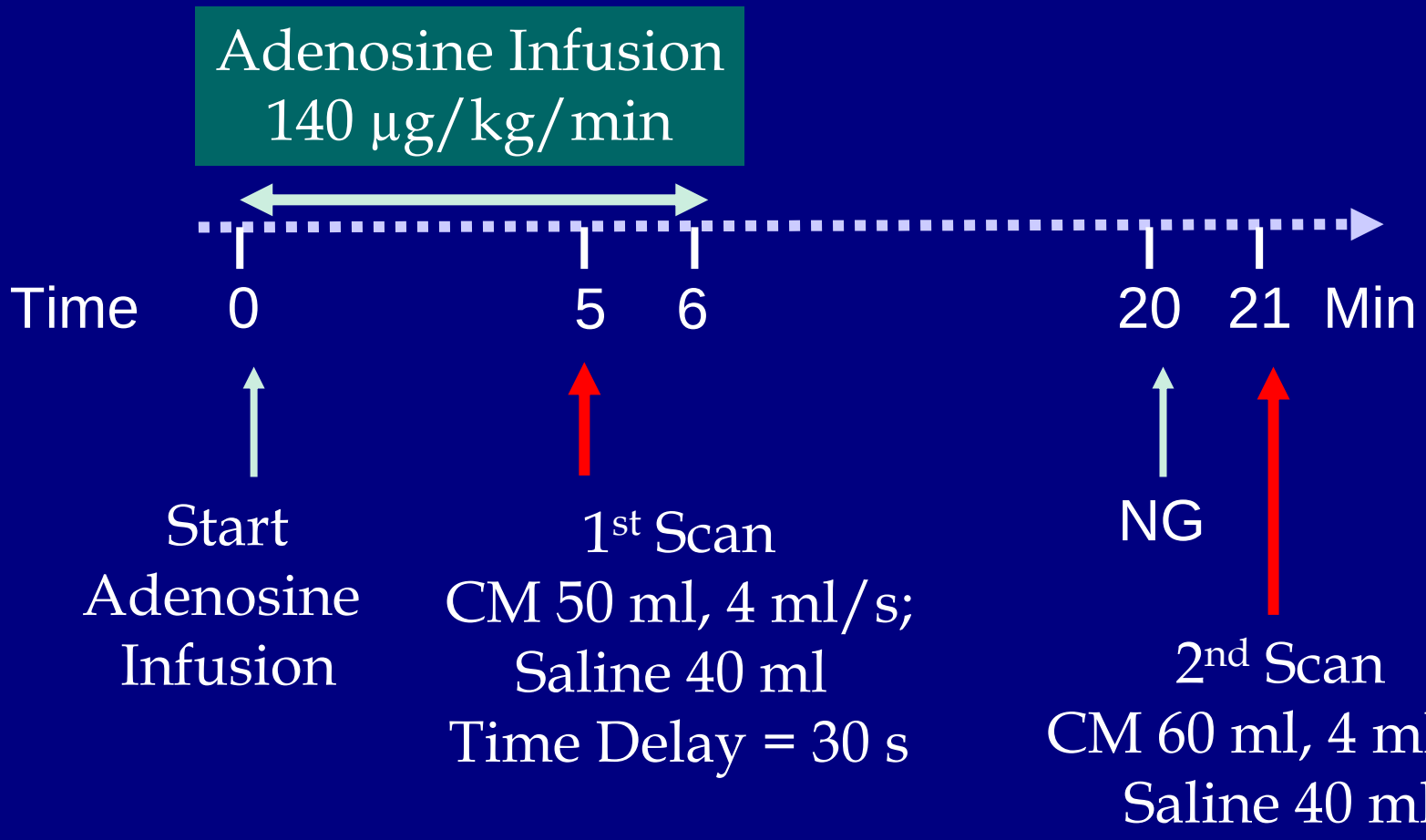
B. Ruzsics et al., Circulation, 2008; 117: 1244-1245

Adenosine-stress CT in Animals



George RT. J Am Coll Cardiol 2006;48:153–60

Adenosine Stress Perfusion CT Protocol (64 MDCT with Dose Modulation)



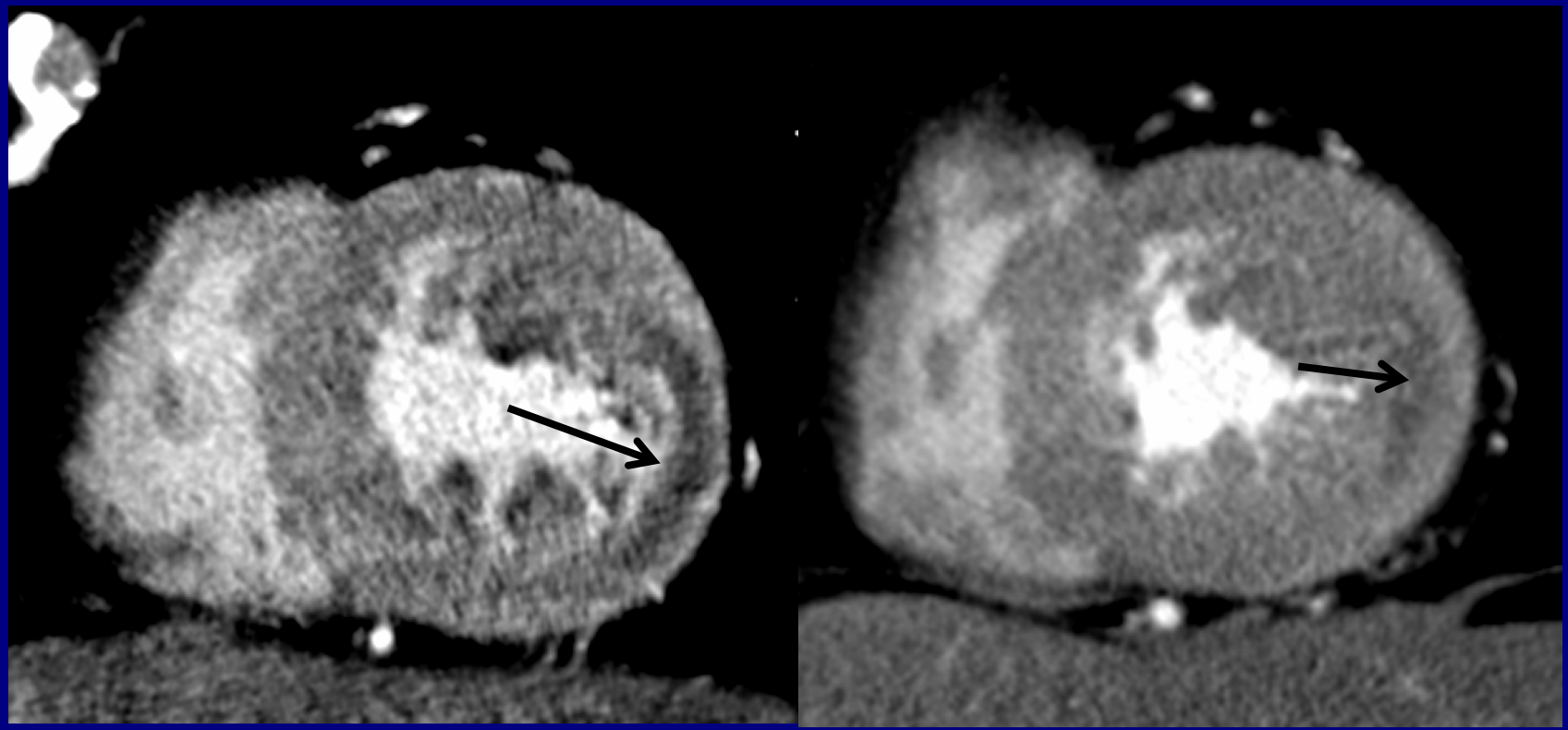
Adenosine-stress MDCT in the Detection of Myocardial Ischemia: A Feasibility Study in 88 Patients

- In 27 vessels of 23 patients, MDCT angiograms depicted significant coronary artery stenosis >50%.
- 13 of 23 patients (56.5%) had significant myocardial perfusion defects either during adenosine infusion (n = 6) or during stress and resting state (fixed defects, n = 7).
- The latter group (fixed PD) represented old myocardial infarction (n = 6) or very severe myocardial ischemia due to severe stenosis/occlusion of coronary arteries (n =1).

NASCI 2007

- Subsequent coronary angiography revealed significant coronary artery stenosis in these patients with stress perfusion defects.
- Sensitivity, specificity, and diagnostic accuracy of adenosine-stress myocardial perfusion MDCT based on coronary CT angiography and catheter coronary angiography findings were 37.5%, 100%, and 87.7% respectively.

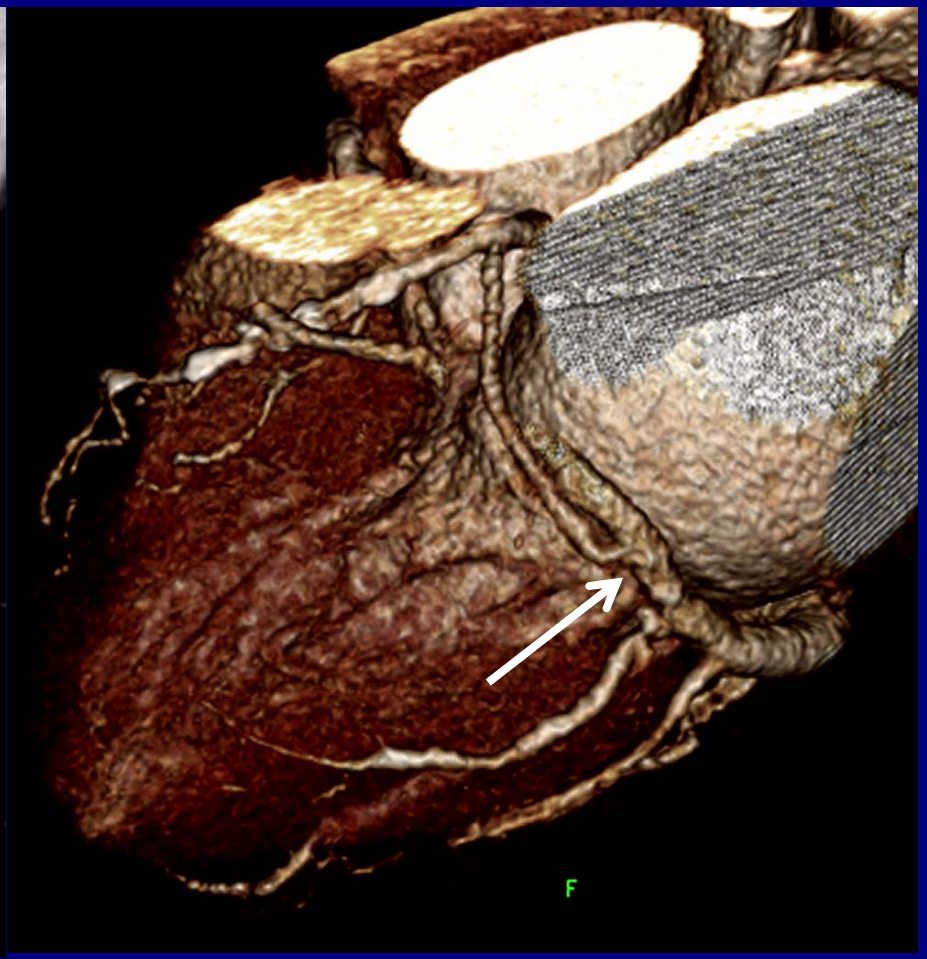
Stable Angina (72/M)

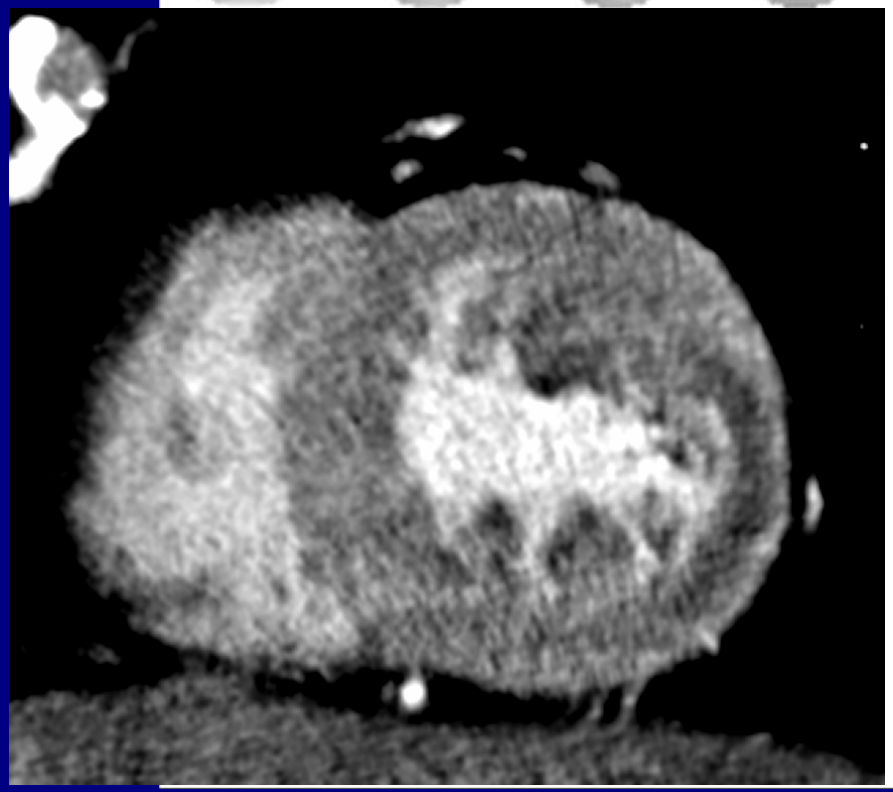


Adenosine stress

Rest

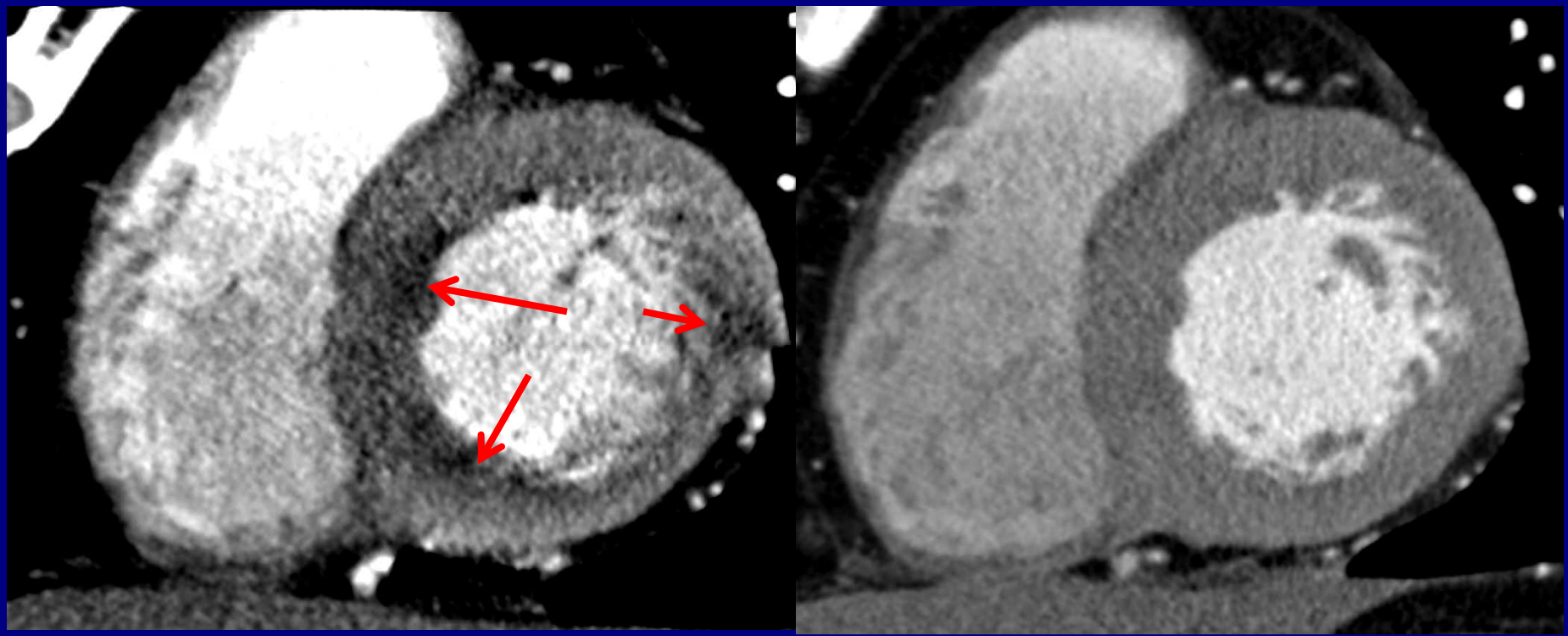
LAD Stenosis and LCX Occlusion





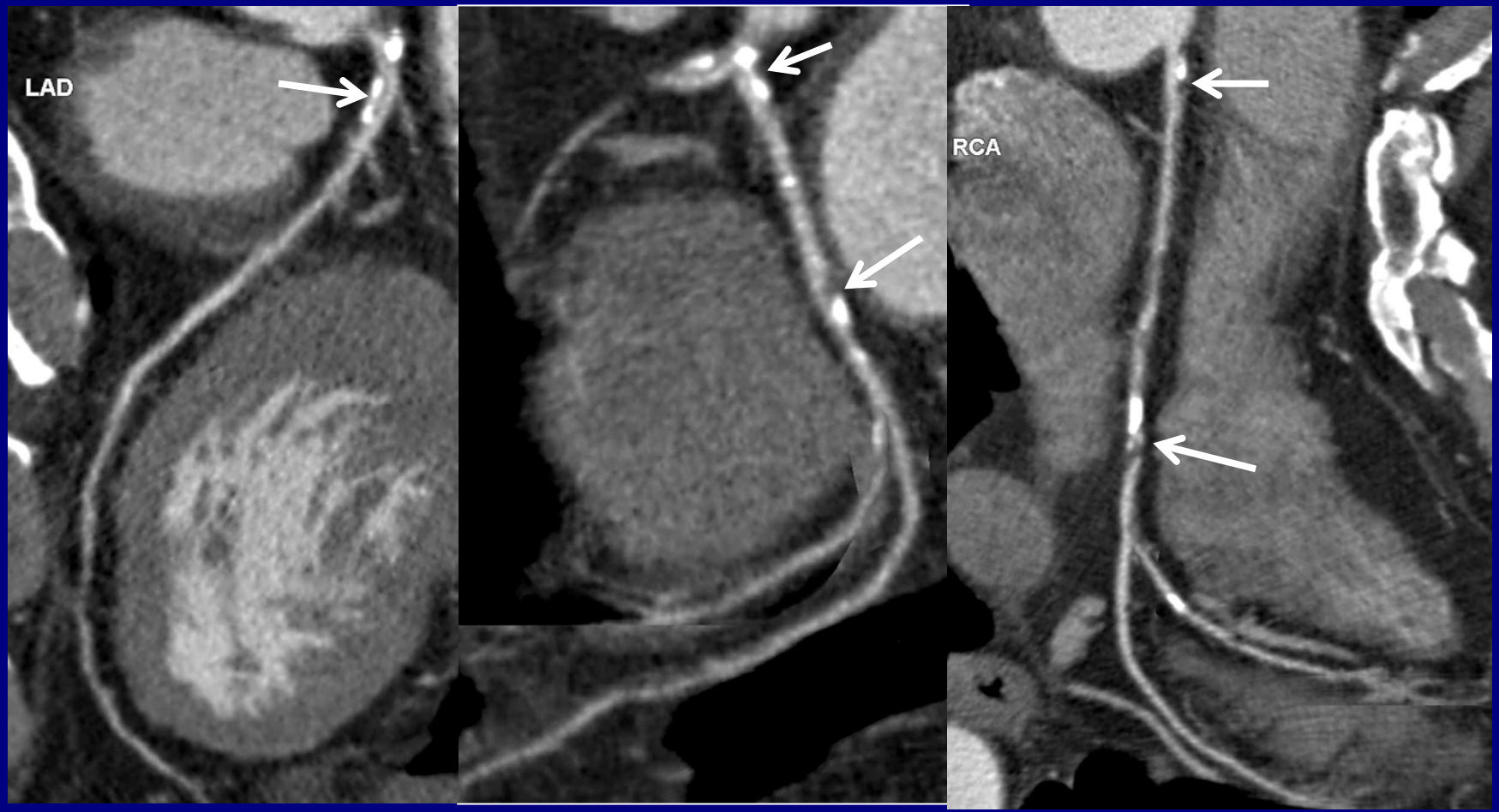
Adenosine-stress SPECT vs MDCT

Stable Angina (67/M)



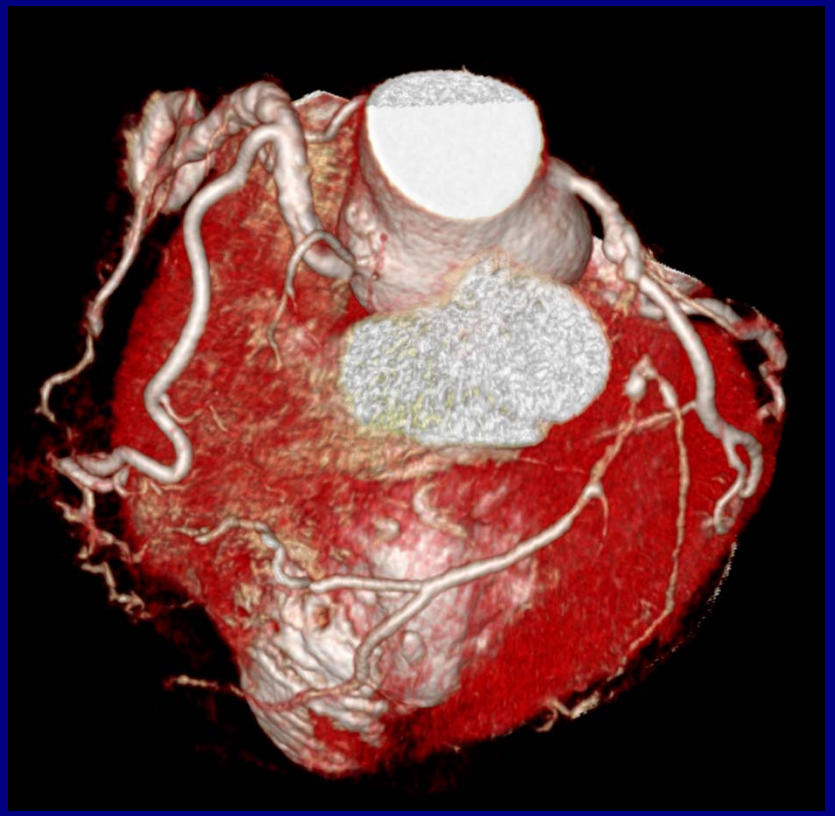
Adenosine stress

Rest


LAD
RCA

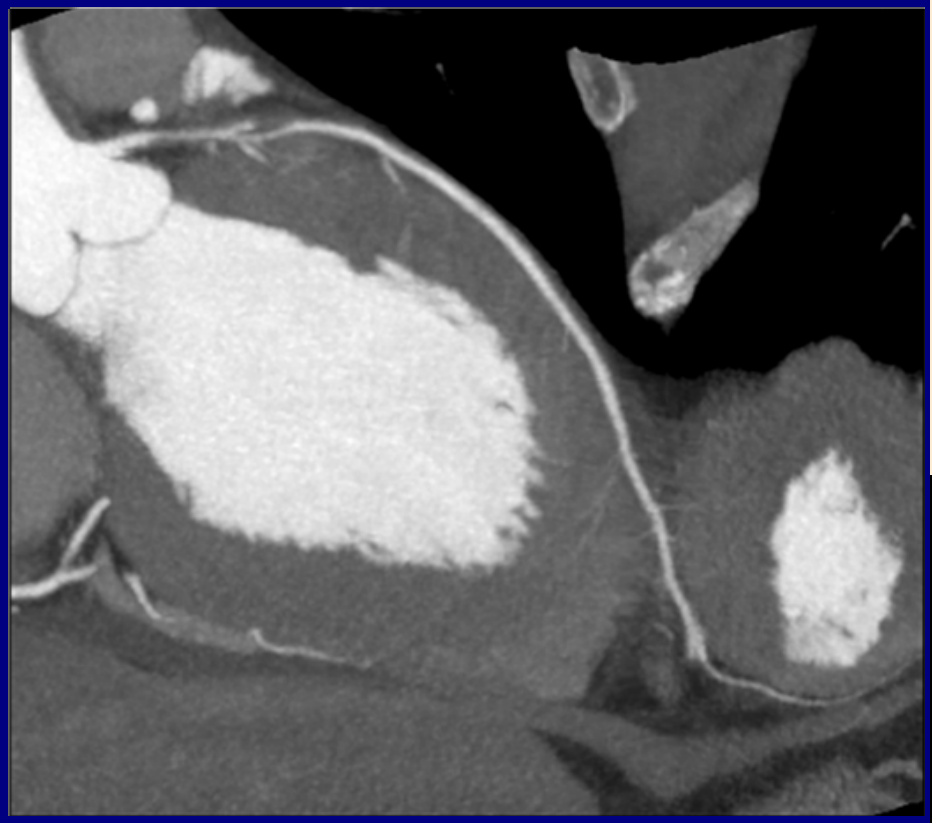
New Developments

- 256- or 320-slice CT
- 128-slice dual-source CT

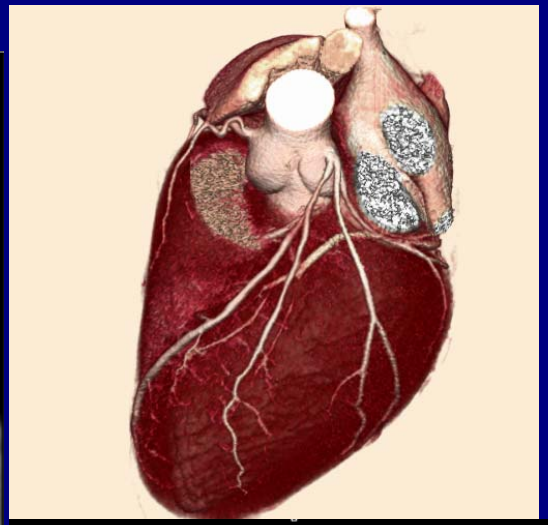


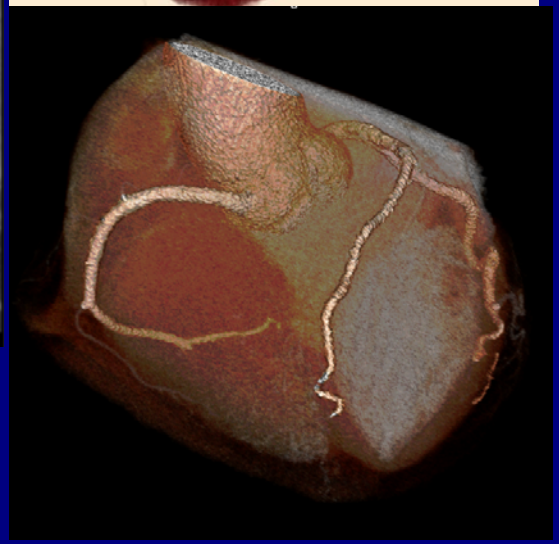
Dual-source CT with 83 msec resolution

320-slice Area-detector CT



0.35 sec scan





Summary

- CCTA directly visualizes stenotic coronary lesions and helps exclude significant coronary artery disease in patients with intermediate risk of disease.
- CCTA detects non-occlusive coronary artery disease and differentiate fibrofatty from calcific plaques.

Summary

- CCTA helps classify acute coronary syndromes.
- MDCT shows microvascular occlusion and damaged myocardium in acute and chronic MI.
- MDCT has potential in diagnosis of stress-induced myocardial ischemia.