

Coronary CT Angiography *Point!*

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INDIANA UNIVERSITY

SCHOOL OF MEDICINE

ACC / November 2008

SPECIAL ARTICLE

Explaining the Decrease in U.S. Deaths from Coronary Disease, 1980–2000

Earl S. Ford, M.D., M.P.H., Umed A. Ajani, M.B., B.S., M.P.H., Janet B. Croft, Ph.D.,
Julia A. Critchley, D.Phil., M.Sc., Darwin R. Labarthe, M.D., M.P.H., Ph.D.,
Thomas E. Kottke, M.D., Wayne H. Giles, M.D., M.S., and Simon Capewell, M.D.

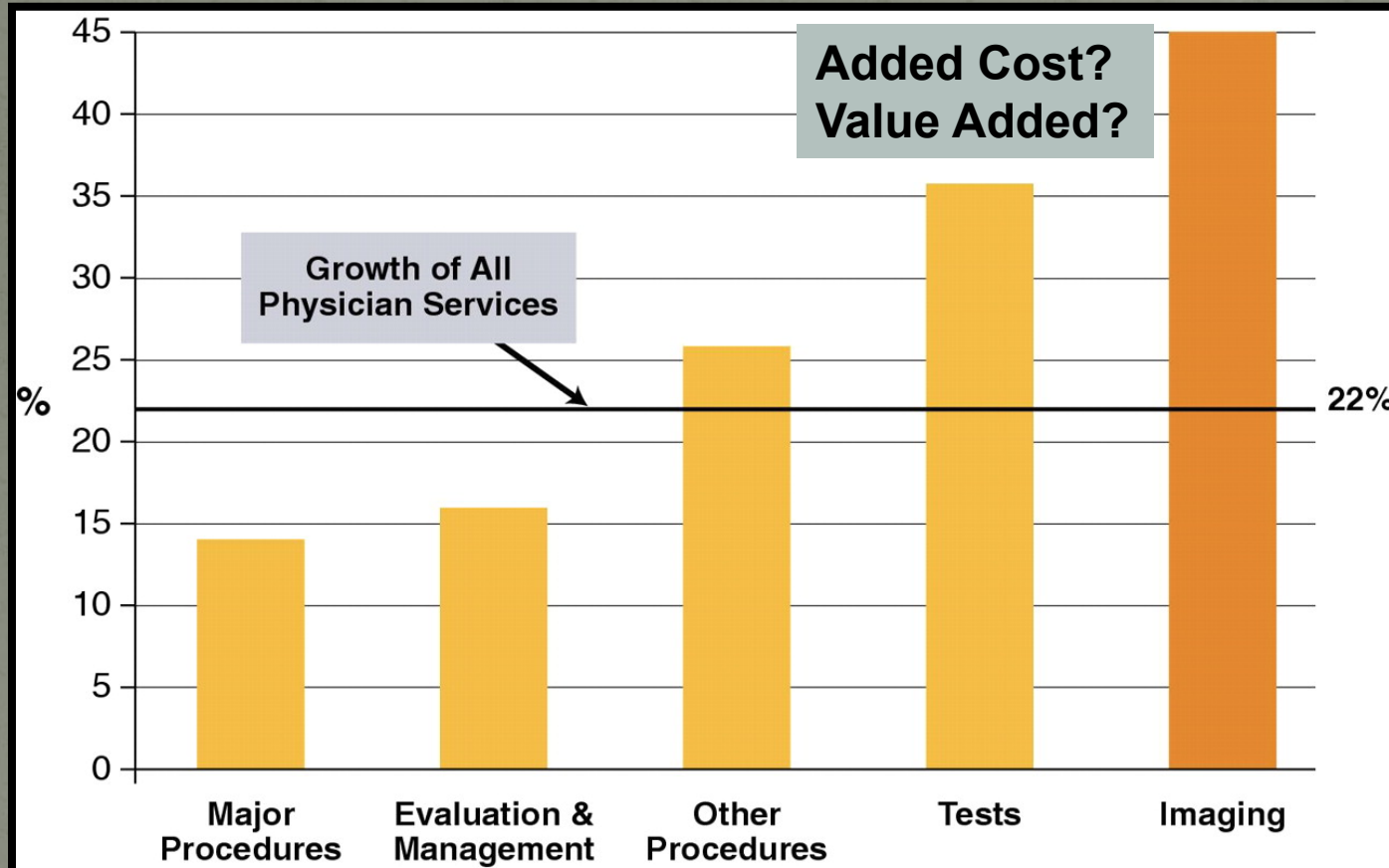
CAD deaths per 100, 000:

	<u>1980</u>	<u>2000</u>
Men	543	→ 267
Women	263	→ 134

Decrease CAD deaths due to:

❖ Risk Factor Modification	44%
❖ Treatment	47%
Secondary Prevention	11%
Treatment of AMI / ACS	10%
Treatment of HF	9%
Revascularization	5%
Other therapies	12%

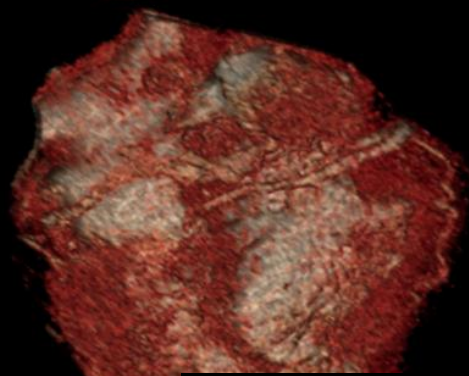
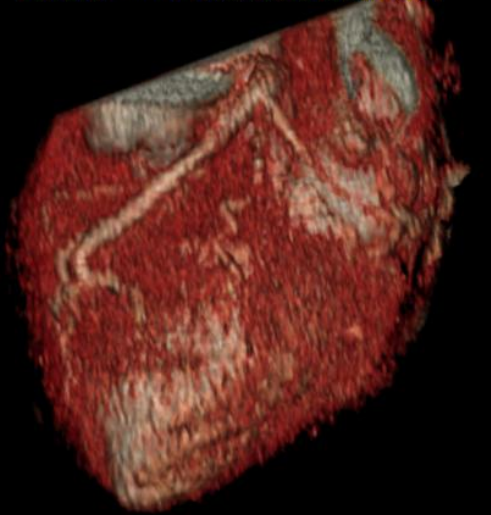
MedPAC Evaluation of Growth in Physician Services From 1999 to 2002



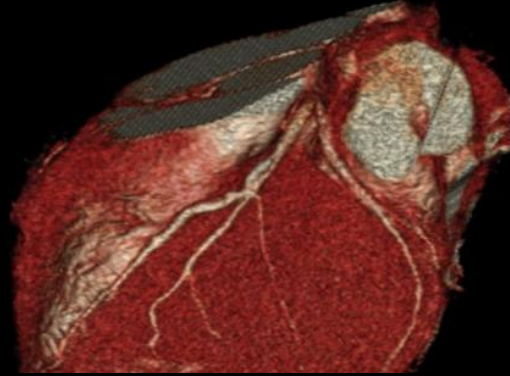
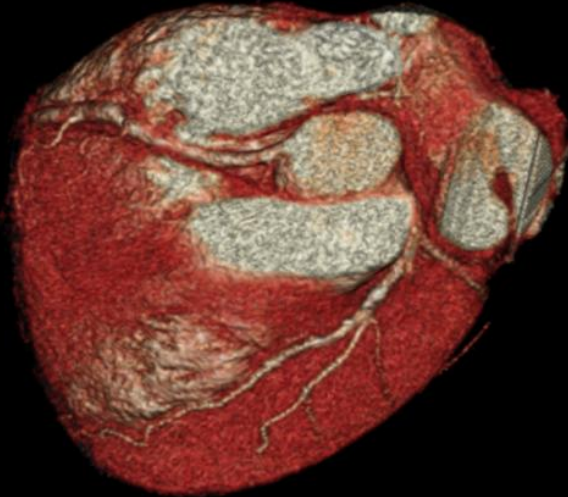
Hendel, R. C. J Am Coll Cardiol Img 2008;1:241-248

Coronary CT Angiography

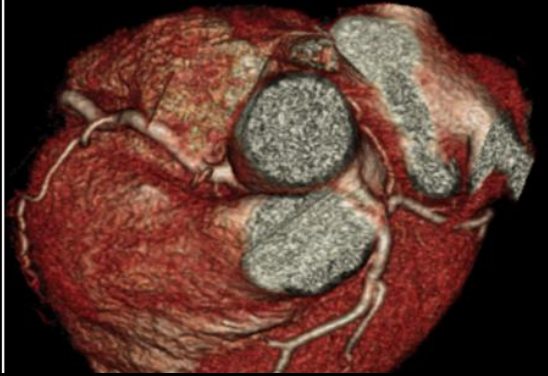
1998 – 4 detector CT



2001 – 16 detector CT



2004 – 64 detector CT



Non-invasive Coronary CT Angiography !!

SEPTEMBER 5, 2005

www.time.com AOL Keyword: TIME

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Even the loyal viewers of *The Oprah Show* have never seen Oprah quite like this! It's her heart as seen in the new 64-slice CT scanner.

Though CT scanners have been around for years, the new 64-slice CT scanner's technology actually allows doctors and patients to watch a

heart beating. "If you think about it, the CAT scan takes a picture. If it's your gallbladder, it just sits there and waits for the photo shoot," Dr. Oz says. But to really capture what is happening with a heart, "You need a scanner that can take pictures so fast it can catch the heart in a beat. These new scanners can take almost 200 pictures a second so they can get your heart at so many

Mike Fackelmann, 50, holds a scan of his heart, which revealed a major blockage of a coronary artery (arrow)

Coronary CTA versus Cath

	<u>CCTA</u>	<u>Invasive Angio</u>
Spatial Resolution (mm)	0.4-0.6	0.2
Temporal Resolution (ms)	83-165	5 - 20
Radiation (diagnostic, mSv)	4 -38 (15-18)	5 - 10 (6)
Contrast Volume (ml)	50 - 120	~50
Diagnostic Accuracy (stenosis)	+++	++++
Plaque Assessment	++ / -	+++ (IVUS)
Prognosis	+ / --	++
Intervention	---	++++

CCTA Diagnostic Accuracy

JACC Vol. 48, No. 10, 2006
November 21, 2006:1919-28

Table 1. Accuracy for Detection of Coronary Stenoses Using Coronary Computed Tomography Angiography With at Least 16 Slices (Comparison With Invasive Coronary Angiography)

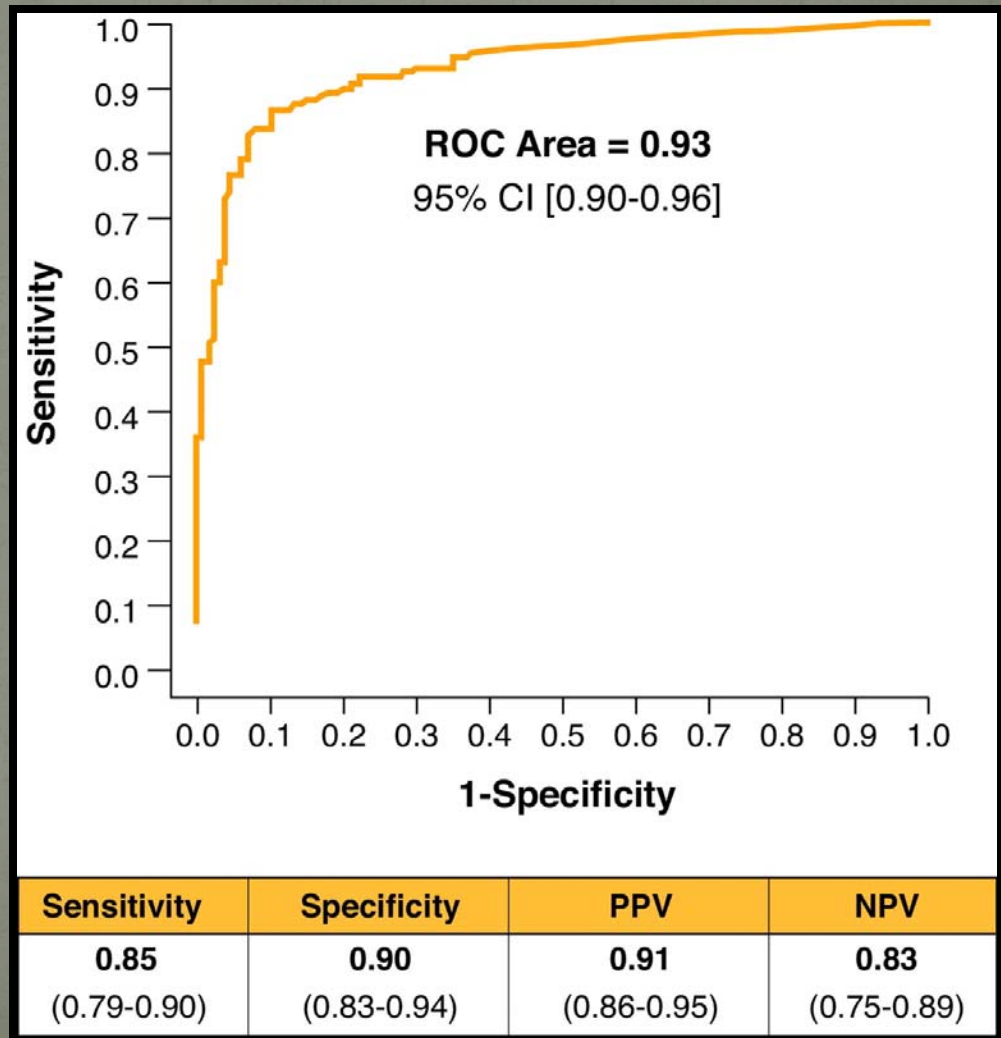
Author	n (Patients)	Collimation (mm)	Gantry Rotation (ms)	Sensitivity (%)	Specificity (%)	NPV (%)	n.e. (%)
Kuettner et al. (15)	124	16 × 0.75	375	85	98	96	7
Mollet et al. (16)	51	16 × 0.75	375	95	98	99	—
Martuscelli et al. (17)	64	16 × 0.625	500	89	98	98	—
Morgan-Hughes et al. (18)	58	16 × 0.625	500	83	97	97	2
Schujif et al. (19)	45	16 × 0.75	420	98	97	100	6
Hoffmann et al. (20)	103	16 × 0.75	420	95	98	99	6
Achenbach et al. (21)	50	16 × 0.75	375	94	96	99	4
Leschka et al. (22)	53	64 × 0.6	370	94	97	99	—
Raff et al. (23)	70	64 × 0.6	330	86	95	98	12
Leber et al. (24)	59	64 × 0.6	330	73	97	99	—
				88*	97*	99*	—
Mollet et al. (25)	52	64 × 0.6	330	99	95	99	2
Ropers et al. (26)	82	64 × 0.6	330	95	93	99	4
Fine et al. (27)	66	64 × 0.6	330	95	96	95	6

Studies performed by 16-slice scanners that did not use all 16 detector rows for data acquisition are not listed. *Analysis in proximal and mid-coronary segments.
n.e. = not evaluable; NPV = negative predictive value.

Diagnostic Accuracy Update

CORE 64 Trial (AHA 2007)

- 350 pts (60% prevalence of CAD, 10% previous PCI)
- CAC > 600 (N=59) excluded
- Multi-center / International (single vendor)
- 97% of all segments evaluable
- Mean HR ~ 65 bpm



Coronary CTA and Pre-Test Risk

1474

Meijboom et al.
CTCA and Pretest Probability for CAD

JACC Vol. 50, No. 15, 2007
October 9, 2007:1469-75

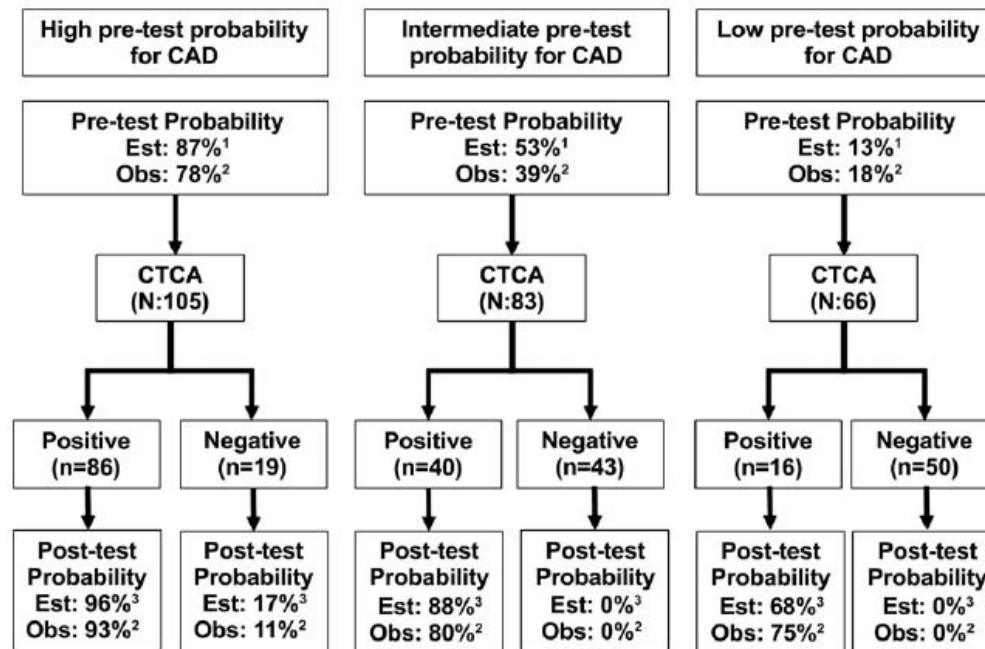


Figure 2 Impact of CTCA on Various Estimated Pretest Probabilities of Significant CAD

¹Estimated using Duke Clinical Score (including Diamond-Forrester criteria and prognostic clinical variables); ²based on conventional coronary angiography (≥ 1 significant coronary stenosis as determined by quantitative coronary angiography); ³calculated using Bayesian statistics (post-test odds = pretest odds \times likelihood ratio). CAD = coronary artery disease; CTCA = computed tomography coronary angiography; Est = estimated; Obs = observed.

Can Coronary CTA Quantify stenosis?

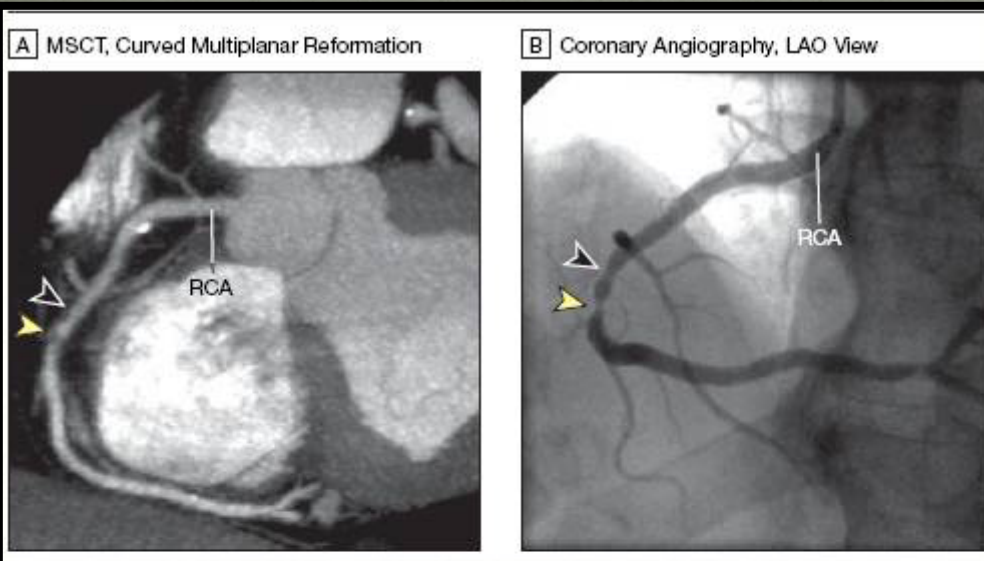
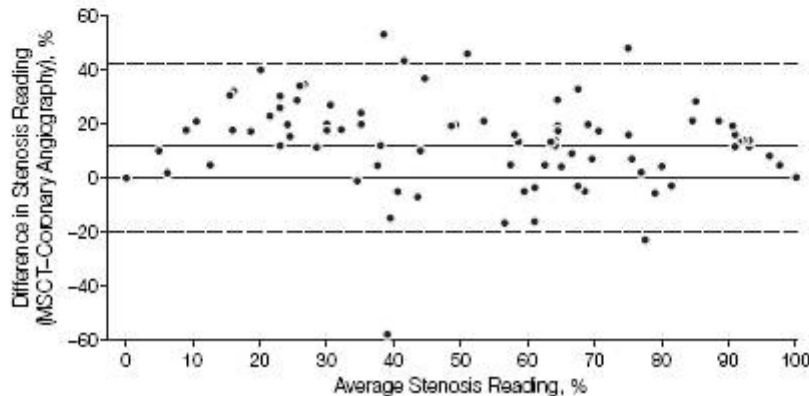


Figure 5. Bland-Altman Analysis of Stenosis Grading Using Multislice Computed Tomography (MSCT) vs Conventional Invasive Coronary Angiography



Dashed lines indicate 95% confidence limits; bold line, bias.

Hoffmann et al. JAMA 2005

- Significant Correlation to Cath
- Wider limits of agreement
- CT overestimates luminal disease

CCTA Luminal Reporting (Qualitative)

- Mild (30-49% or <50%)
- Moderate (50-70%)
- Severe ($\geq 70\%$)
- Complex/ Mod to severe (>60 - 90%)

Coronary CTA - *Point # 1*

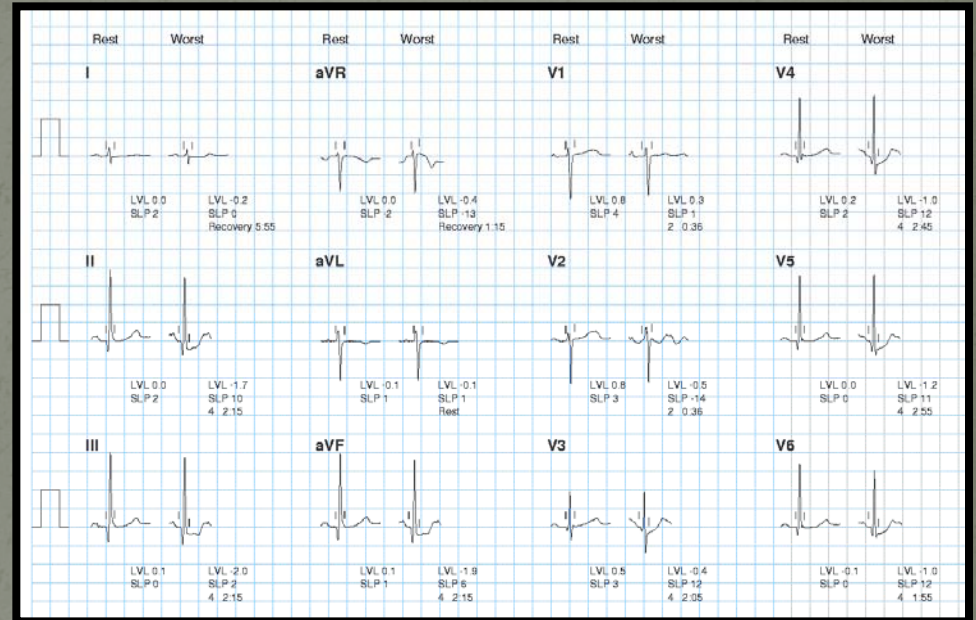
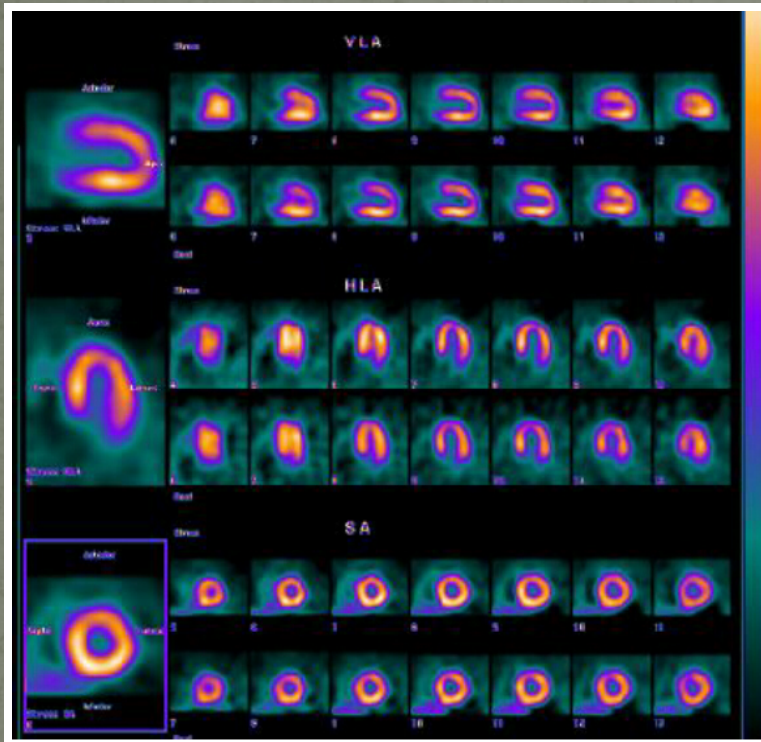
- 1. Acceptable non-invasive alternative for CATH**
- 2. Most useful in low to intermediate risk symptomatic patients**
- 3. Acceptable CATH correlation for grading luminal disease**

Non-invasive Coronary CTA

Who Should be Considered for Coronary CTA?

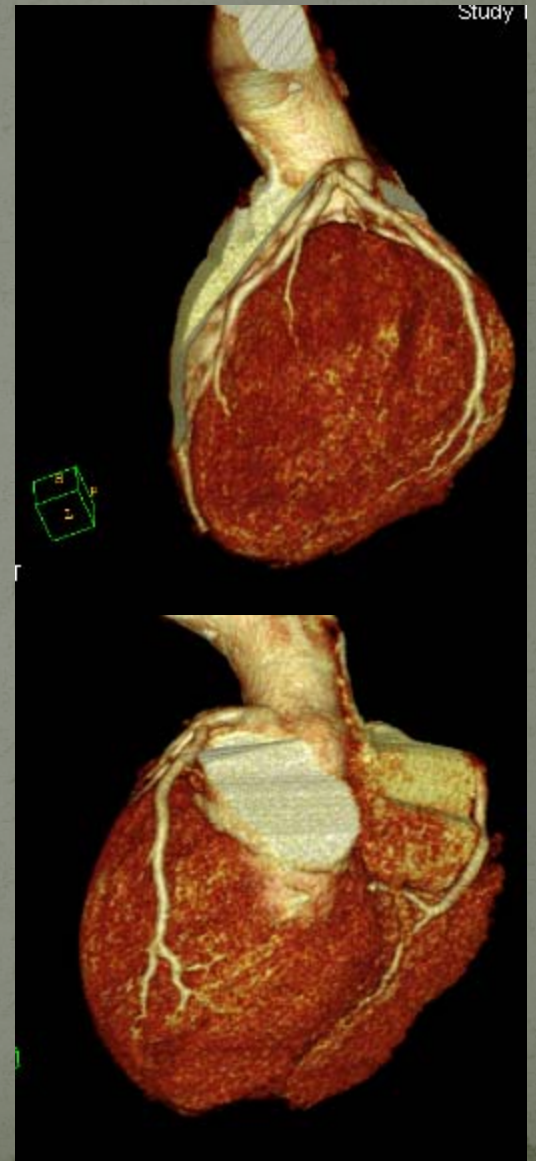
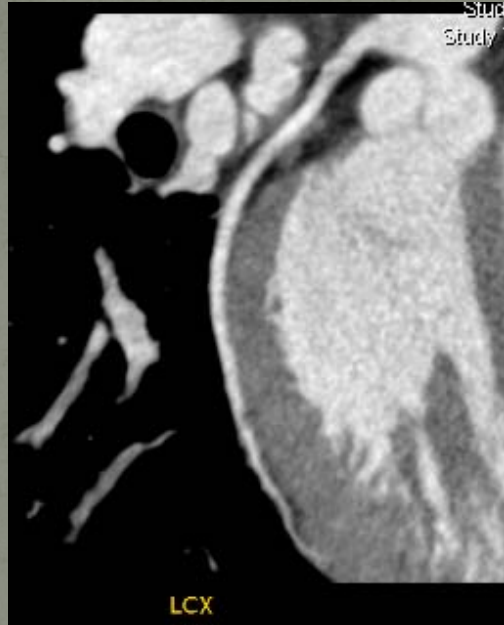
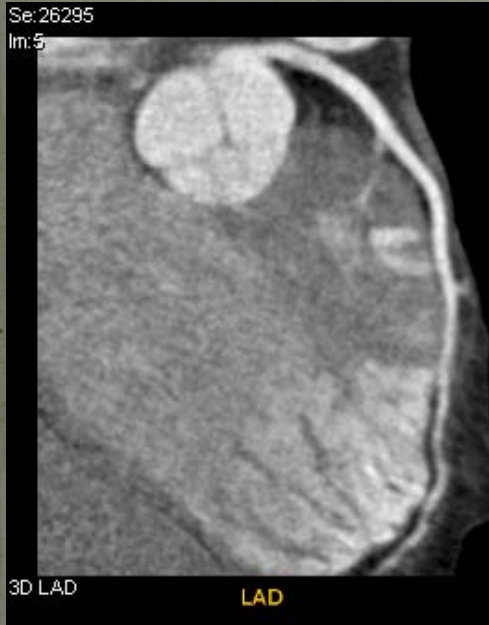
Clinical Examples.....

Clinical Scenario: CCTA



Equivocal Stress in a low-intermediate risk male with chest pain

Clinical Scenario: Equivocal Stress



Clinical Scenario: Coronary CTA

Journal of the American College of Cardiology

Vol. 48, No. 10, 2006

Journal of the American College of Cardiology
© 2005 by the American College of Cardiology Foundation
Published by Elsevier Inc.

Vol. 45, No. 11, 2005
ISSN 0735-1097/05/\$30.00
doi:10.1016/j.jacc.2005.02.069

Coronary Stenosis Detection by 16-Slice Computed Tomography in Heart Transplant Patients Comparison With Conventional Angiography and Impact on Clinical Management

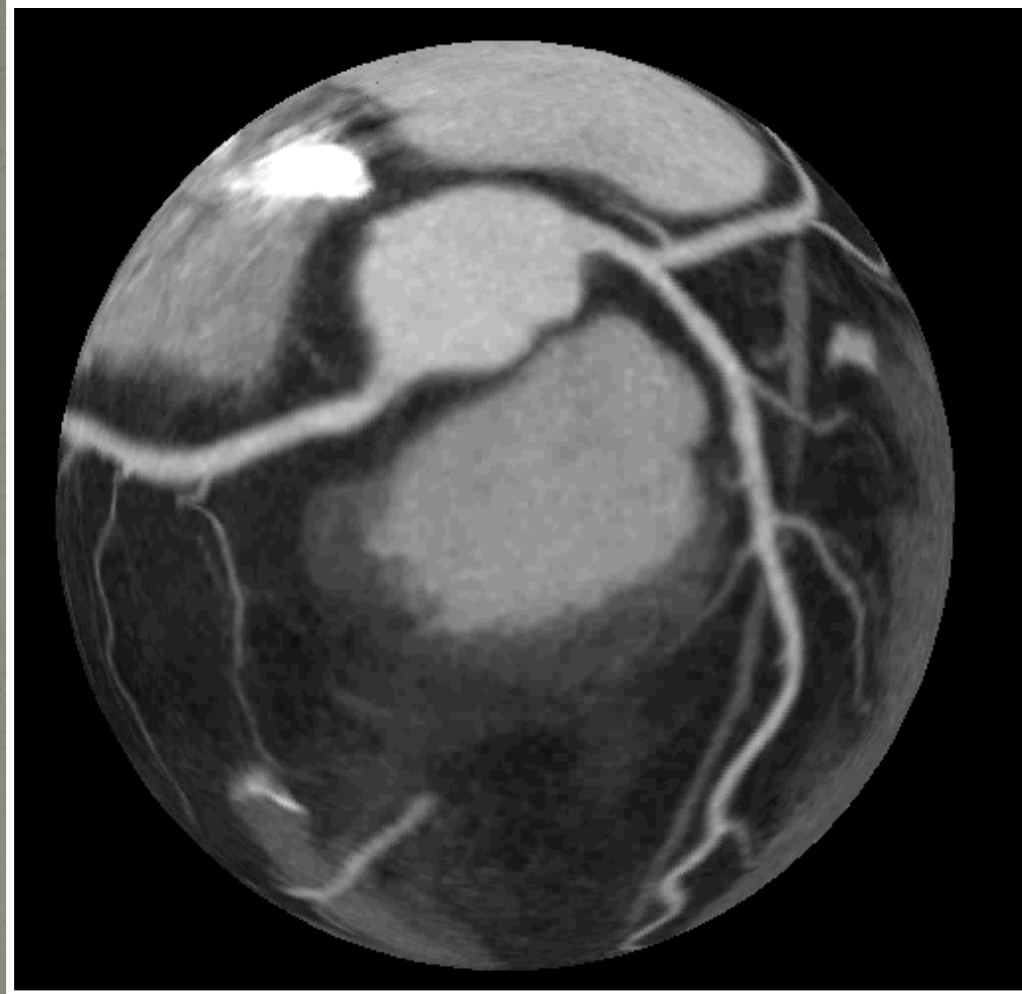
Journal of the American College of Cardiology
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Published by Elsevier Inc.

Vol. 49, No. 20, 2007
ISSN 0735-1097/07/\$32.00
doi:10.1016/j.jacc.2007.01.086

Cardiac Imaging

Diagnostic Accuracy of Multidetector Computed Tomography Coronary Angiography in Patients With Dilated Cardiomyopathy

Clinical Scenario: LBBB

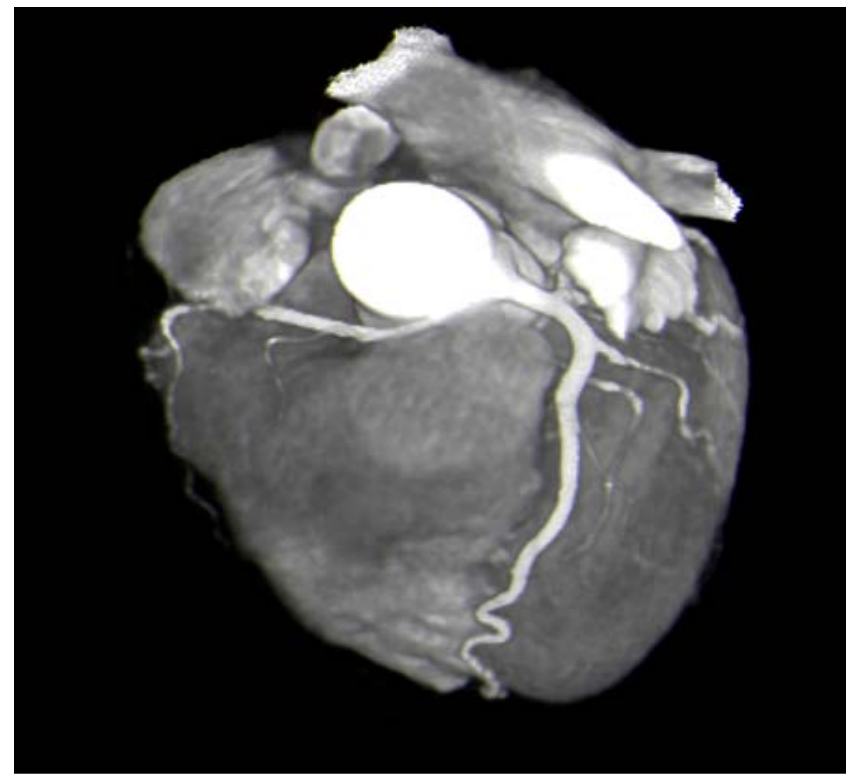
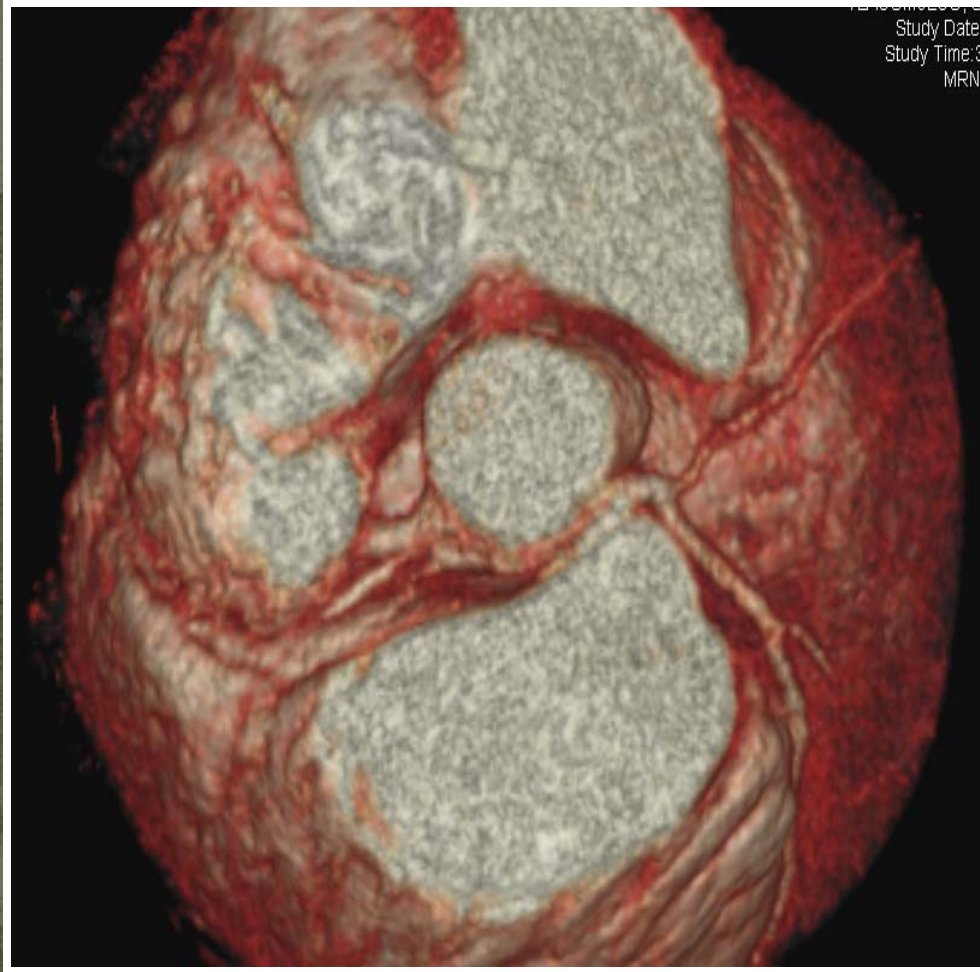


Clinical Scenario: Acute Chest Pain

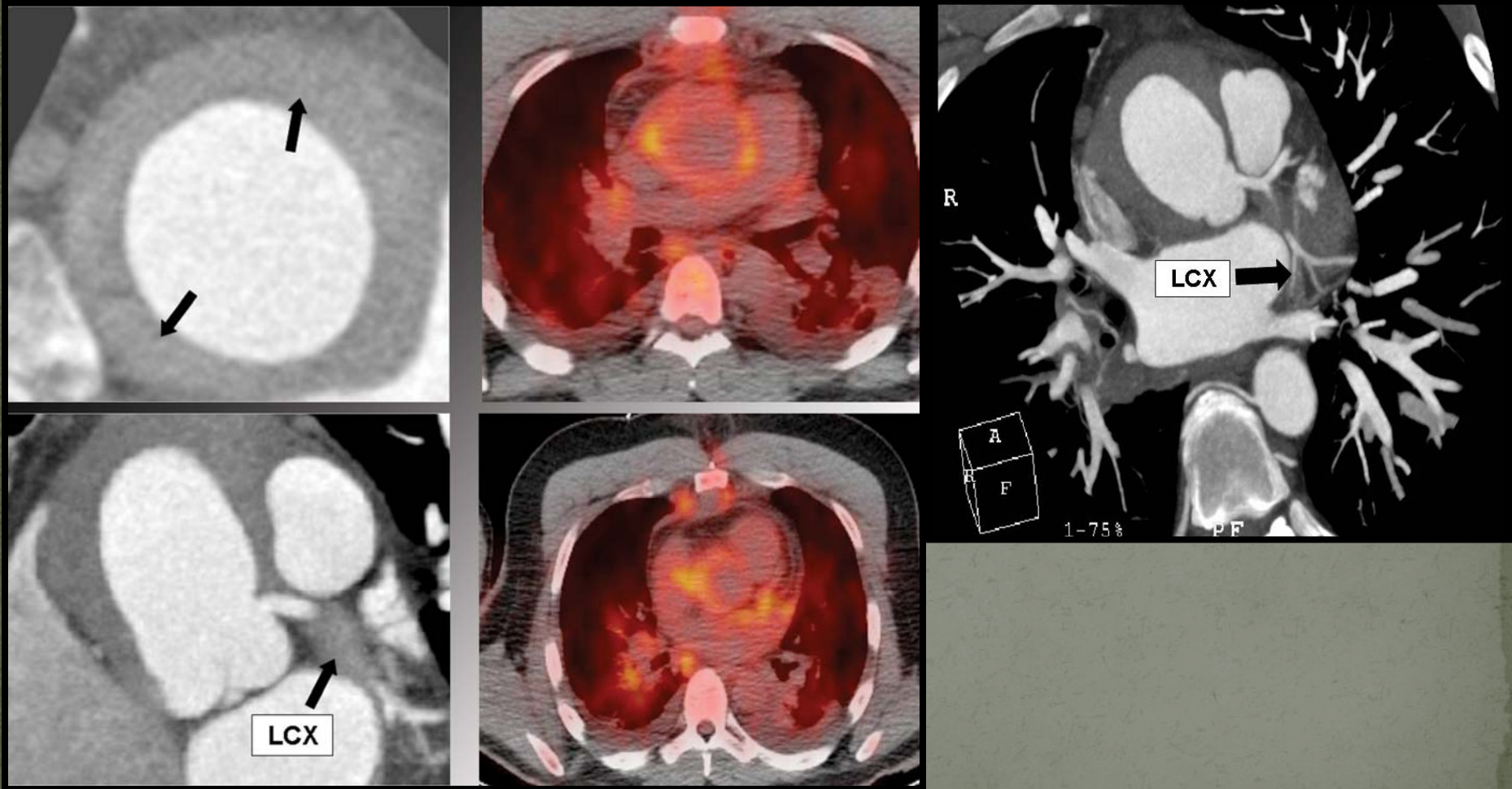
- Hoffmann et al. *Circulation* 2006
104 pts from ED with chest pain (no enzymes, no EKG)
14/14 pts with CAD were detected
(Sensitivity 100%, Specificity 82%)
- Goldstein et al. *JACC* 2007
297 pts acute chest pain (low risk) randomized in ED

MDCT	3.4 hrs , \$ 1586
Std of Care	15 hrs , \$ 1872
- Larger multi-center prospective ED trial ongoing

Clinical Scenario: Coronary Anomalies



Clinical Scenario: Aortic Pathology



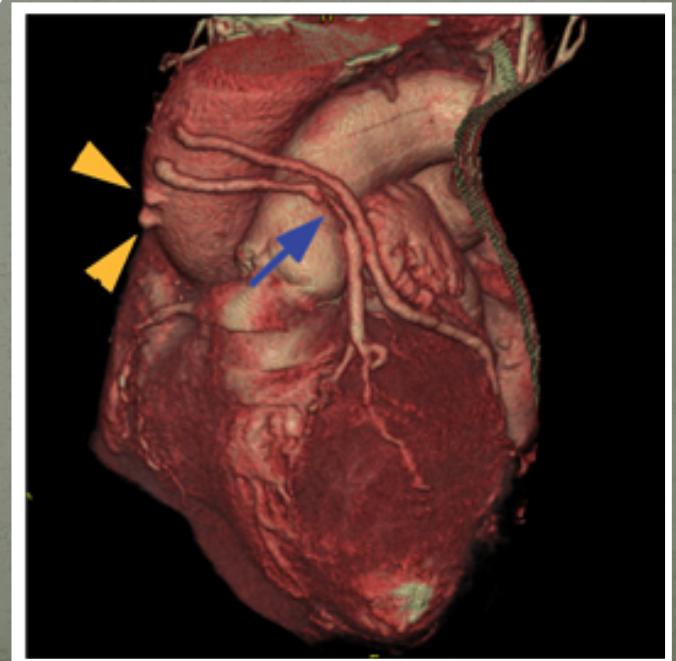
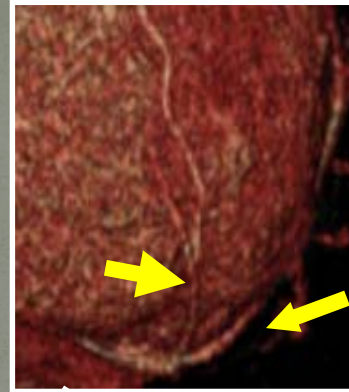
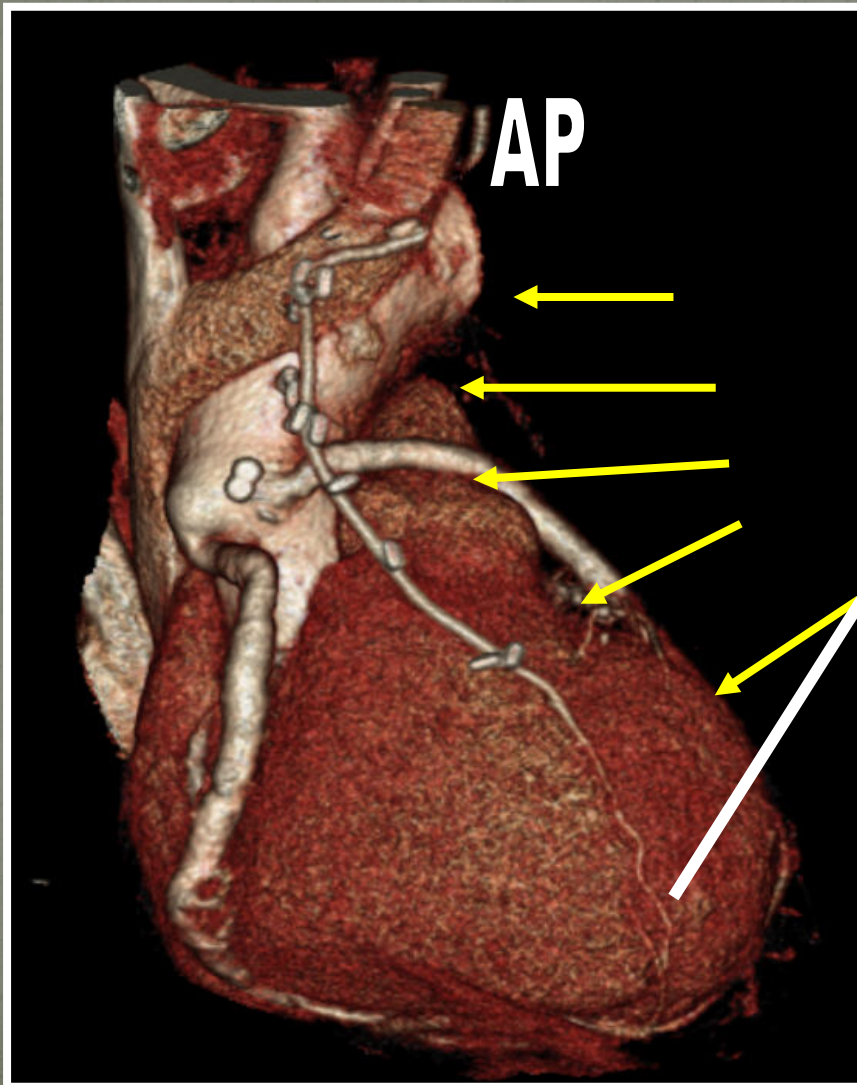
"Appropriate" Use for Coronary CTA

- **Symptomatic intermediate risk pts with un-interpretable EKG or unable to exercise (7)**
- **Chest pain syndrome (intermediate risk) pts with equivocal stress test (8)**
- **Acute Chest pain intermediate risk, normal EKG / enzymes (7)**
- **Exclusion of CAD in low-intermediate risk pts with new onset heart failure, LBBB / dilated cardiomyopathy (7)**
- **Symptomatic suspected coronary anomalies (9)**
- **Peri-operative CAD risk prior to cardiac surgery in low risk patients ("Uncertain",6)**
- **Suspected Aortic / Pericardial pathology as a cause of chest pain (7)**

Coronary CTA - Point # 2

1. **Good alternative to CATH to exclude CAD**
2. **Appropriate patient selection for coronary CTA**
3. **Best for coronary anomalies, aortic, pericardial pathology (large FOV)**

CCTA and Revascularization



Coronary CTA in CABG

948 Meyer *et al.*
Bypass Angiography by 64-Slice CT

JACC Vol. 49, No. 9, 2007
March 6, 2007:946-50

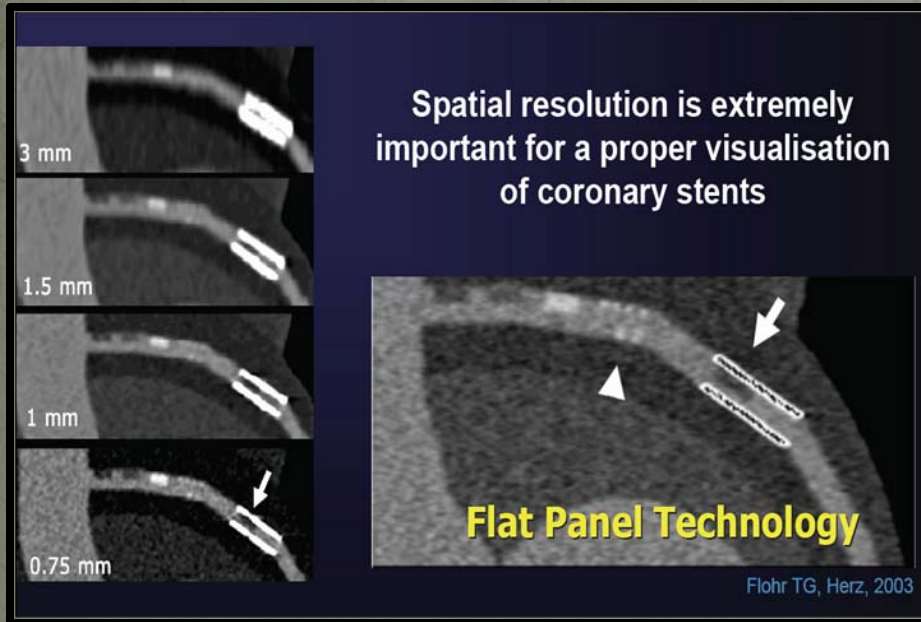
Table 2 Diagnostic Accuracy of 64-Slice CTA in the Detection of Significant Bypass Graft Disease

	Evaluability	Sensitivity	Specificity	PPV	NPV
All bypass grafts	397/406 (98)	113/116 (97% [92%-99%])	273/281 (97% [96%-99%])	113/121 (93% [87%-97%])	273/276 (99% [96%-99%])
Arterial grafts	144/147 (98)	25/27 (93% [75%-99%])	113/117 (97% [91%-99%])	25/29 (86% [68%-96%])	113/115 (98% [93%-99%])
Venous grafts	253/259 (98)	88/89 (99% [93%-99%])	160/164 (98% [93%-99%])	88/92 (96% [89%-98%])	160/161 (99% [96%-99%])
Without arrhythmias	273/273 (100)	79/81 (98% [91%-99%])	187/192 (97% [94%-99%])	79/84 (94% [86%-98%])	187/189 (99% [96%-99%])
With arrhythmias	124/131 (95)*	34/35 (97% [85%-99%])	86/89 (97% [90%-99%])	34/37 (92% [78%-98%])	86/87 (99% [93%-99%])
Heart rate <65 beats/min	262/263 (100)	68/69 (99% [92%-99%])	187/193 (97% [93%-98%])	68/74 (92% [83%-96%])	187/188 (99% [97%-99%])
Heart rate ≥65 beats/min	135/143 (94)*	45/47 (96% [85%-99%])	86/88 (98% [92%-99%])	45/47 (96% [85%-99%])	86/88 (98% [92%-99%])

Data are n (% [95% confidence interval]). *p < 0.05.

CTA = computed tomography angiography; NPV = negative predictive value; PPV = positive predictive value.

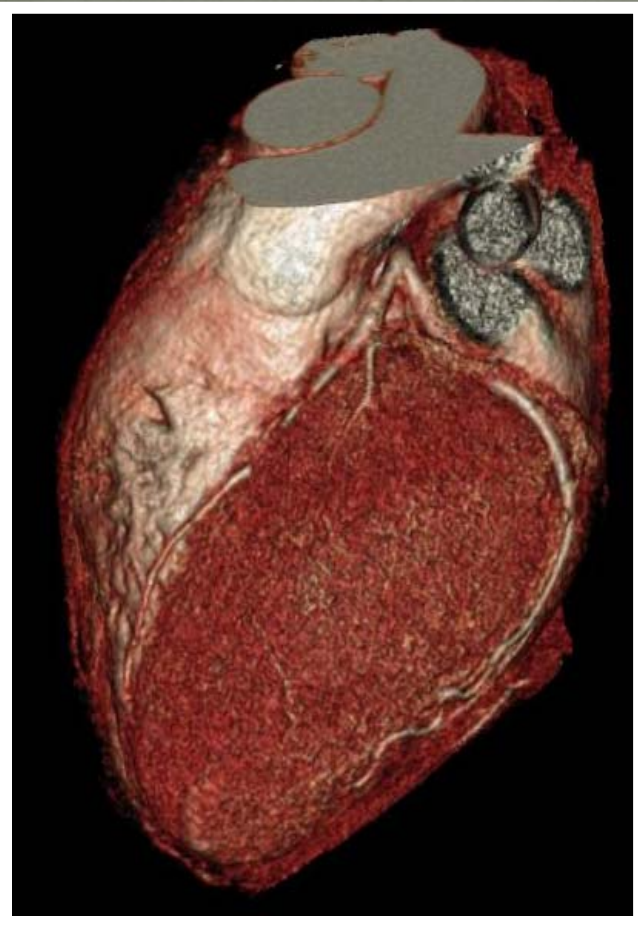
Coronary CTA: Post PCI /Stent



- Heterogeneous Published Data
- ~ 40% Non-Evaluative Stents
- CCTA for proximal stents, low body weight, larger stent (>3mm)
- Low PPV (more false positives)

Coronary CTA for CTO/PCI

- *Lesion Length*
- *Location of Lesion*
- *Extent of Calcium*

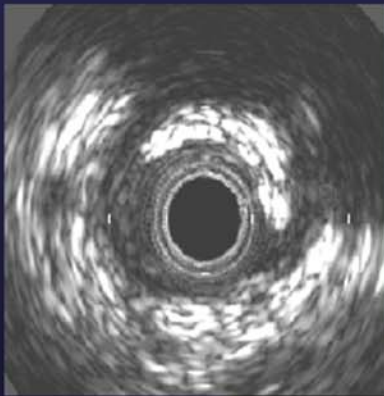


Value of Preprocedure Multislice Computed Tomographic Coronary Angiography to Predict the Outcome of Percutaneous Recanalization of Chronic Total Occlusions

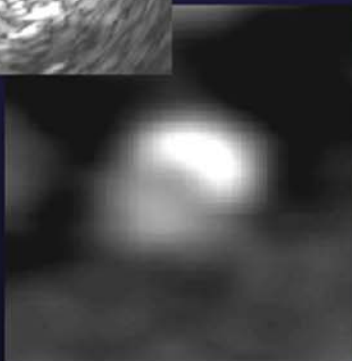
(Am J Cardiol 2005;95:240-243)

Coronary Plaque by CCTA

calcified

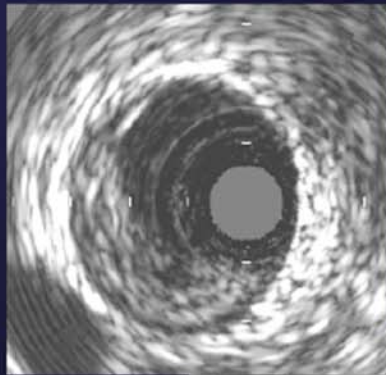


361 HU

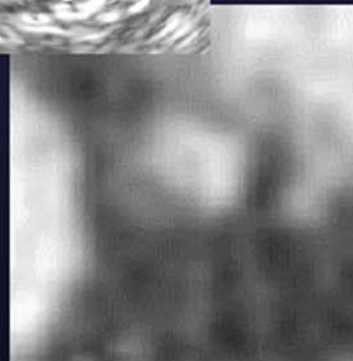


Sensitivity 95%

fibrous

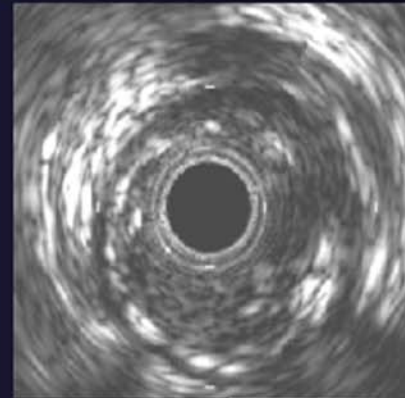


91 HU

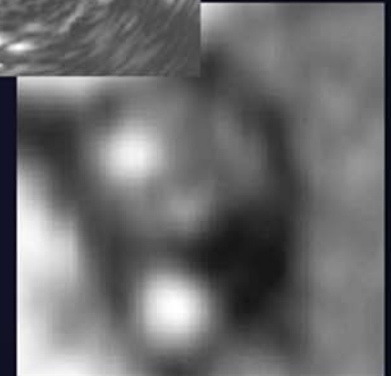


Sensitivity 78%

Soft

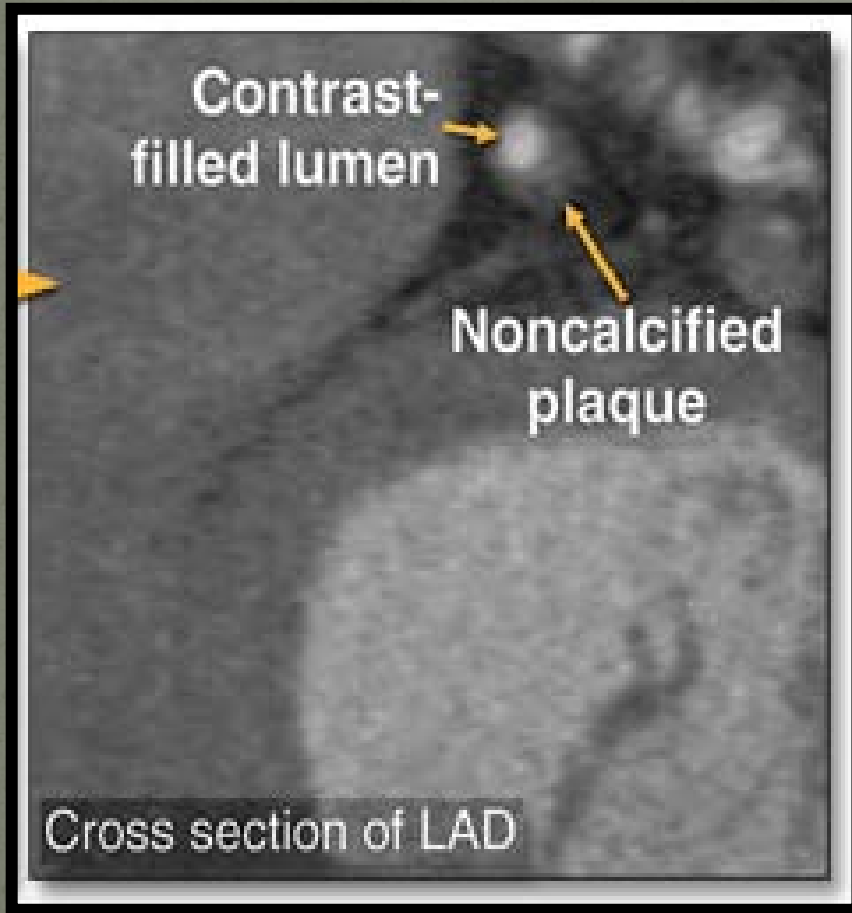


49 HU



Sensitivity 78%

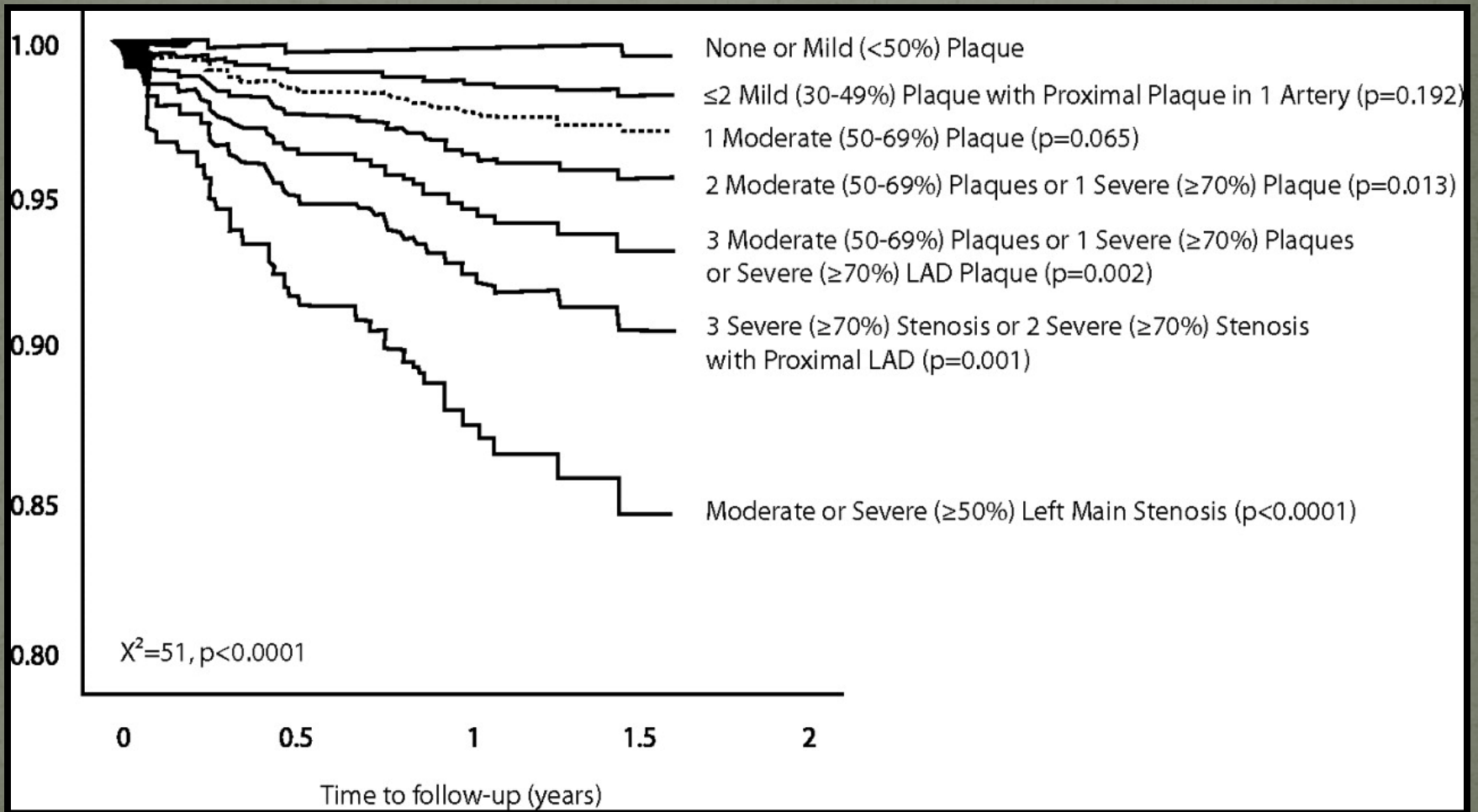
ACS Potential Plaque on CCTA



- ACS plaque have more positive remodeling
- Less Frequently Calcify (Spotty Calcification)
- Lower CT attenuation (lipid core)

Leber et al. AJC 2003
Schuff et al. Acad Radiol 2007
Motoyama et al. 2007

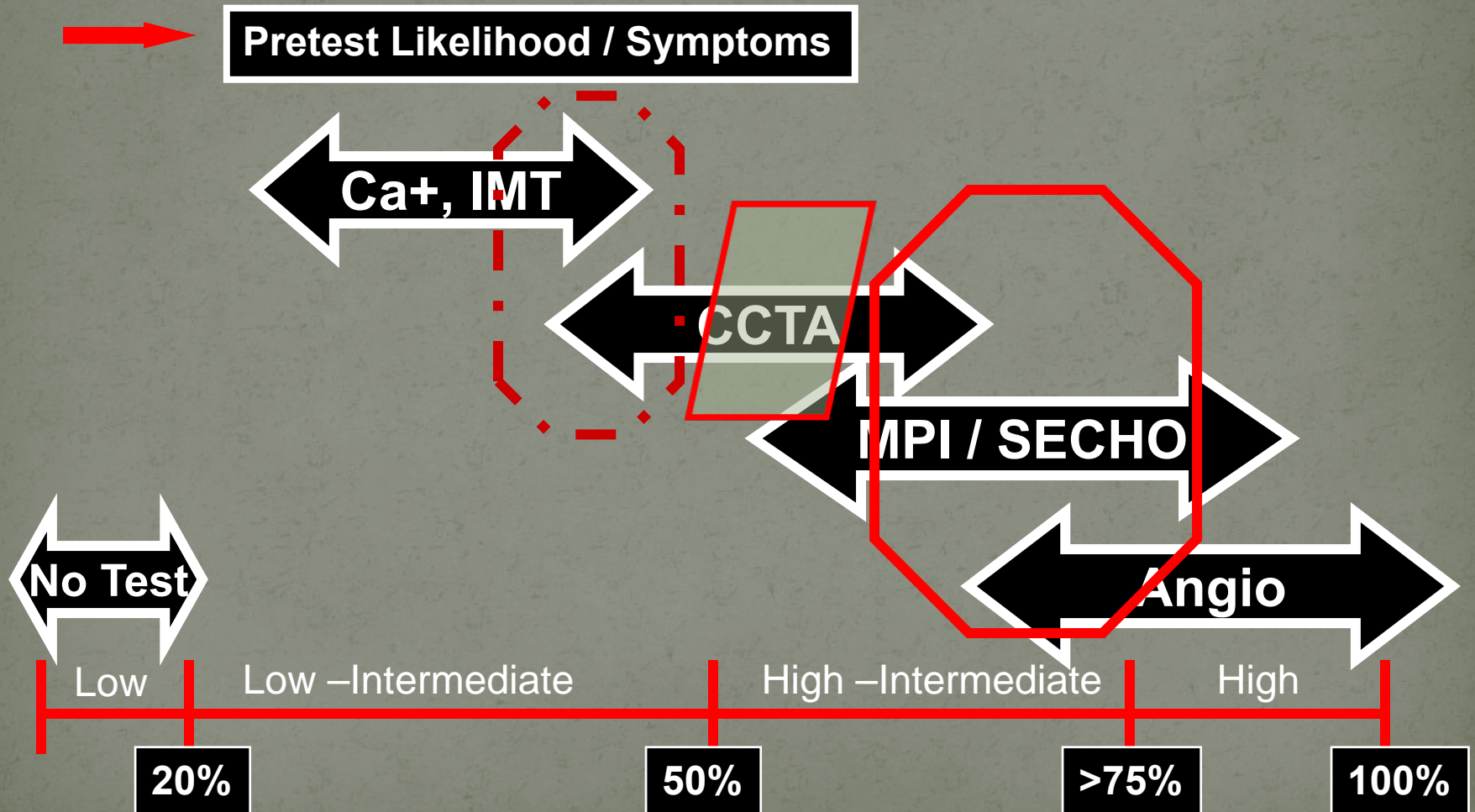
Prognostic Role of Coronary CTA



Coronary CTA - *Point # 3*

- 1. Selective use in CABG / PCI patients**
- 2. “Vulnerable plaque / patient” assessment**
- 3. CAD prognostic risk assessment is emerging**

Diagnostic Fit of Coronary CTA



Coronary CT Angiography Summary

- *CCTA offers a unique “niche” in CAD Imaging*
- *Many current and evolving potential applications*
- *Needs “selective” use for CAD evaluation*
- *Ideal for exclusion of CAD non-invasively*
- *Promising prognostic implications in CAD*
- *Need more prospective randomized trials*
- *Continued technological evolution is ongoing*
- *Future for Coronary CTA is only just beginning!!..*

Coronary CT Angiography



THANK YOU