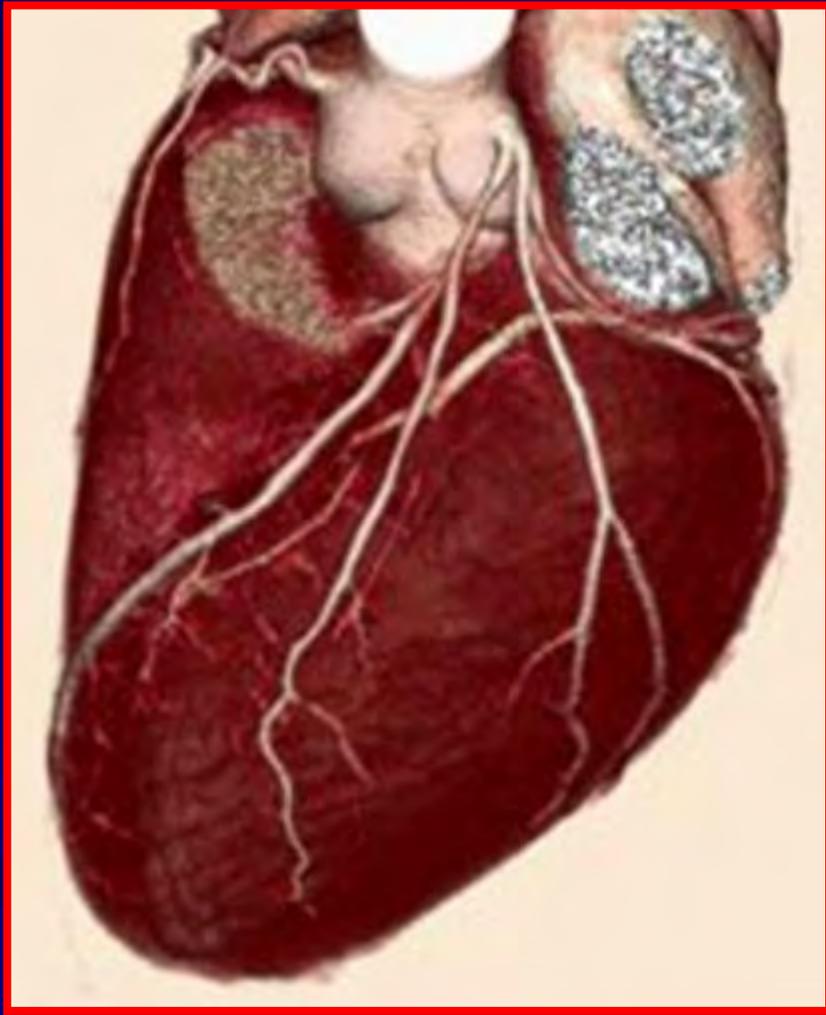


# Is CTA Ready for Routine Use?

Malcolm Bell MBBS, FRACP  
Professor of Medicine  
Mayo Clinic  
Rochester, MN. USA  
October 2010

Wow! Easy to Market!



20.0 cm

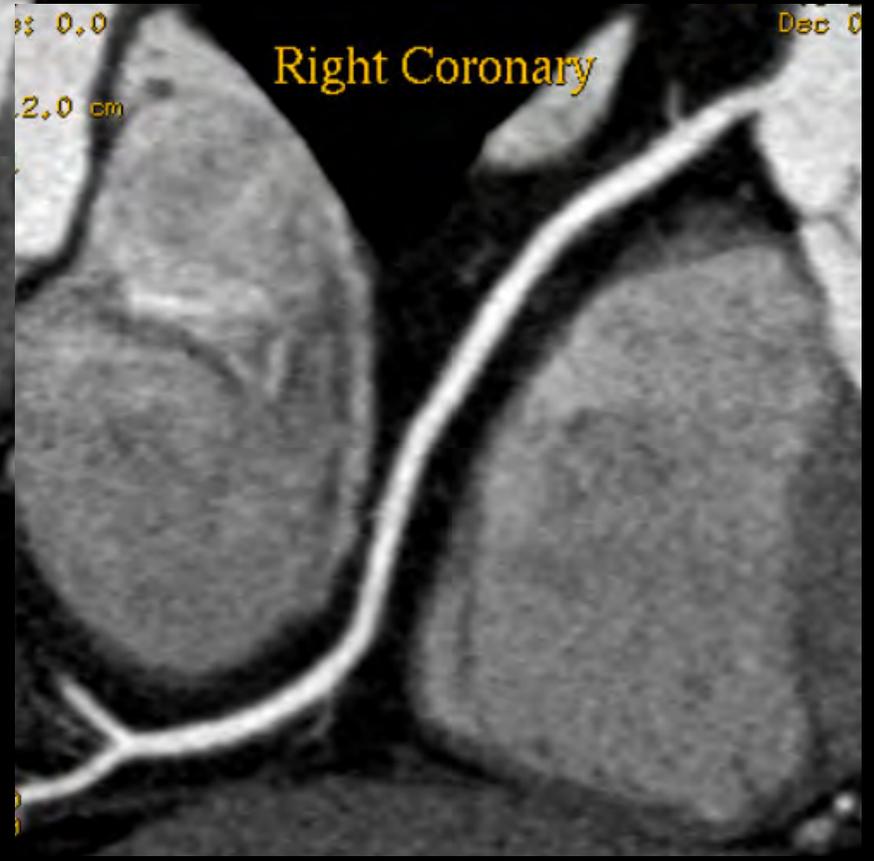
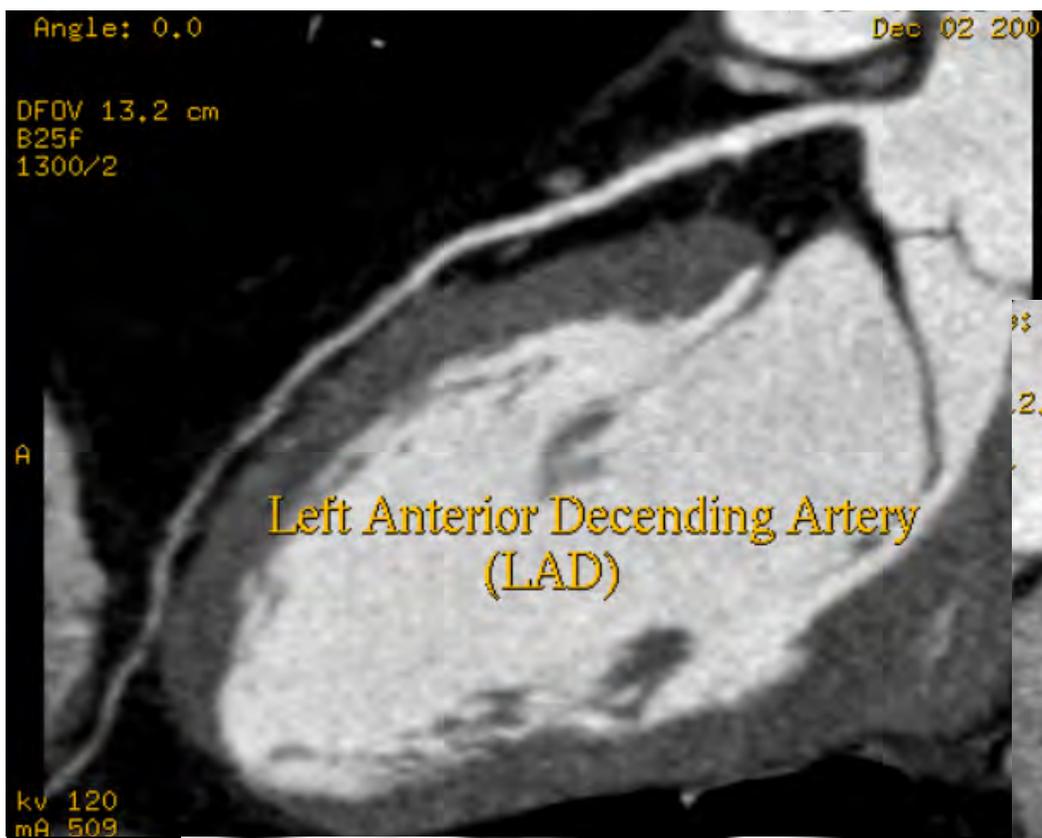
2



II  
20  
L2

n / 0.4sp  
t 0.0  
3:16 PM  
4000 L = 750

IAL



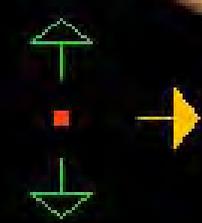
and the not so beautiful.....

et: 5  
Volume Rendering No cut M 74 Det

FOV 20.0 cm  
25f  
04/1

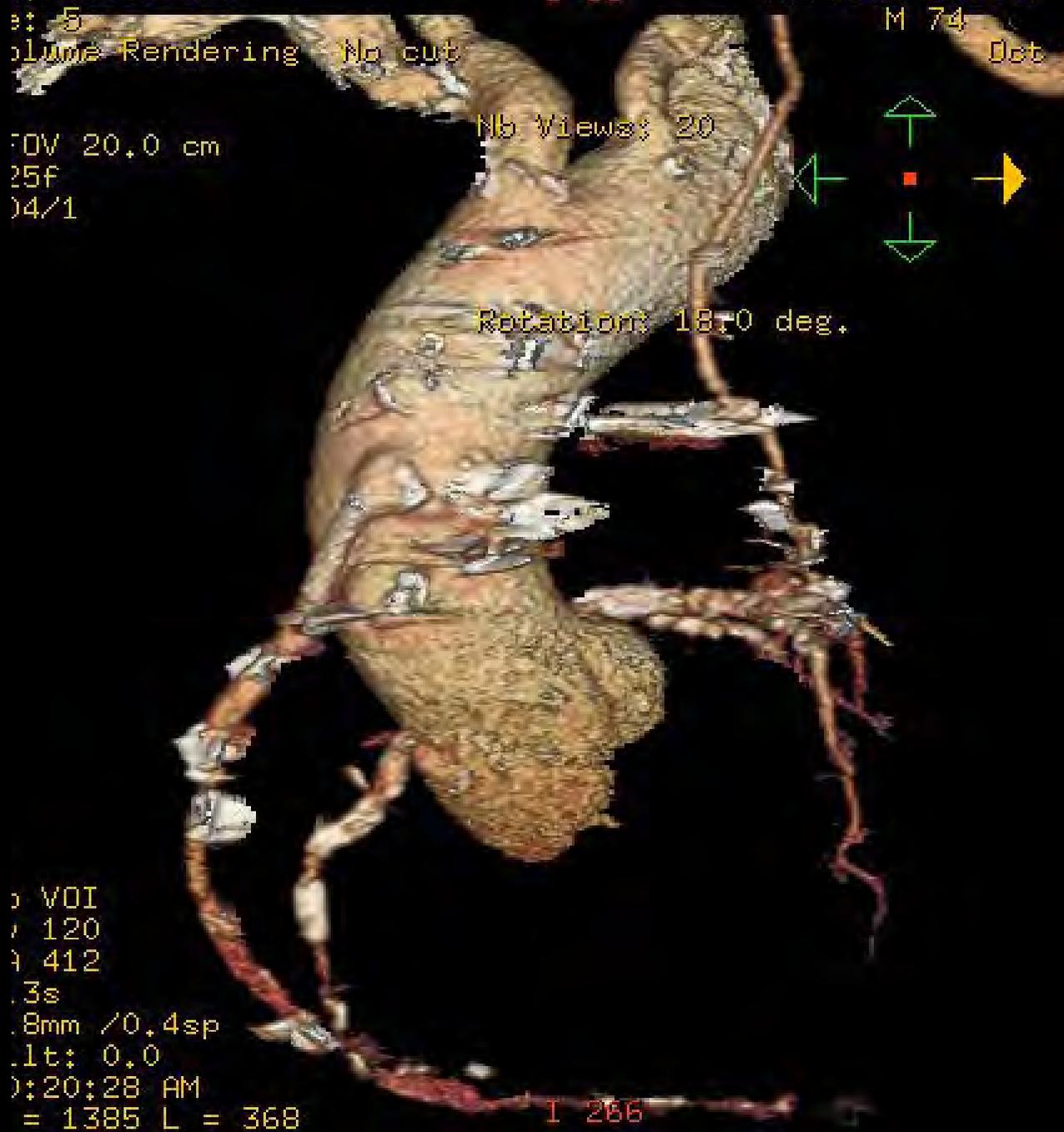
Nb Views: 20

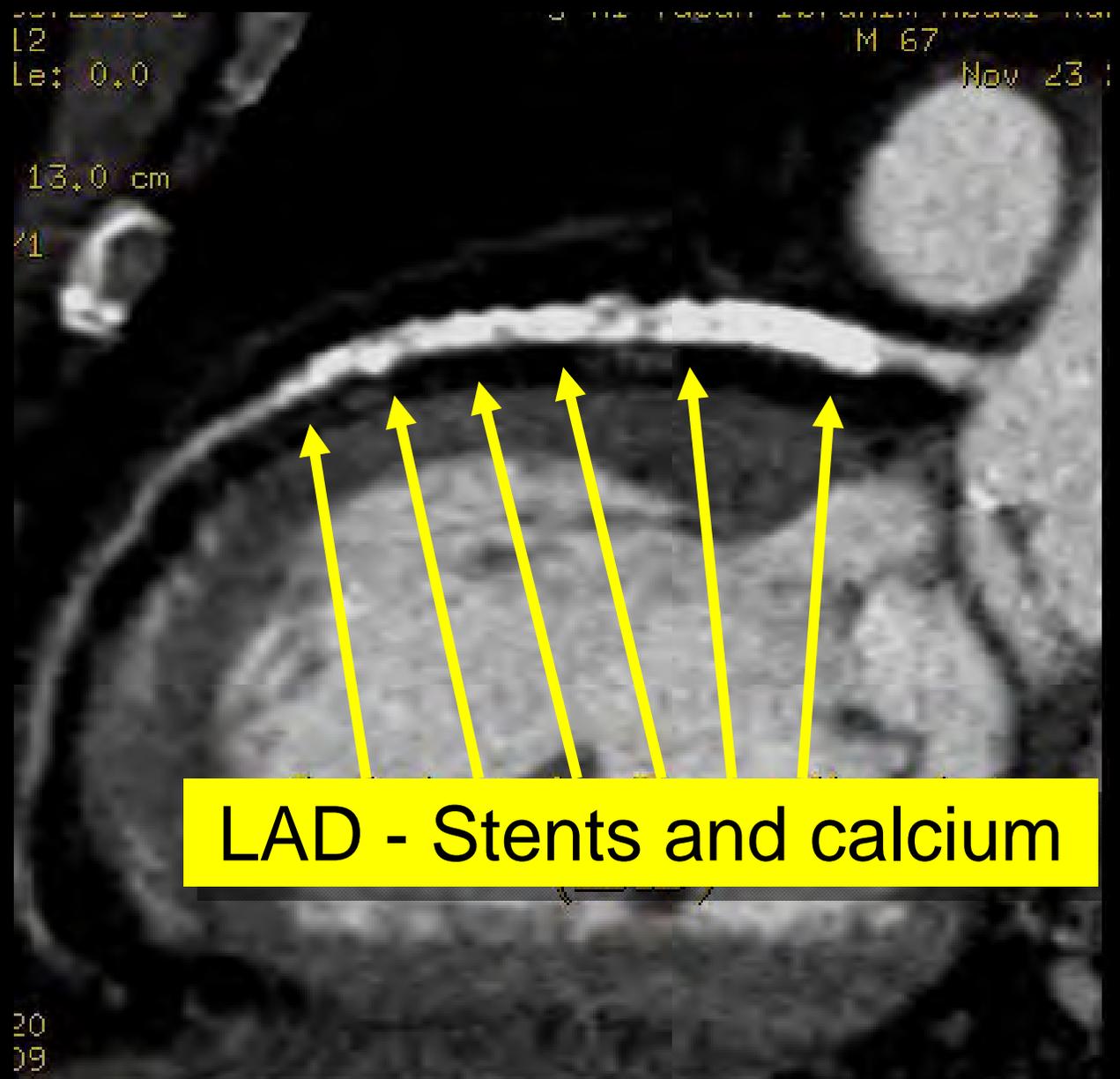
Rotation: 18.0 deg.



VOI  
120  
412  
3s  
8mm / 0.4sp  
1t: 0.0  
):20:28 AM  
= 1385 L = 368

I 266





**LAD - Stents and calcium**

256

128

64

32

16

12

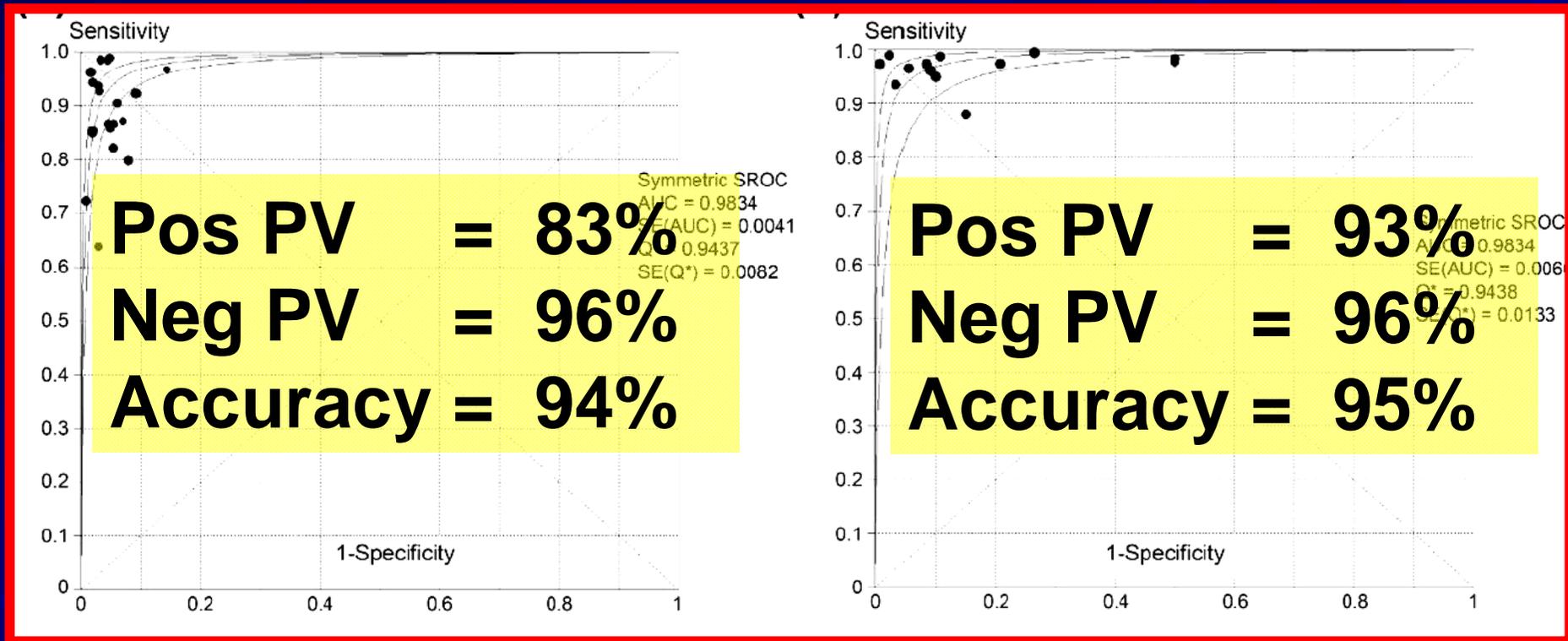
8

4

Single source  
Dual source



# 64-slice CT vs Coronary Angiography Meta-analysis



Per-segment (19 studies)

Per-patient  
(875 from 13 studies)

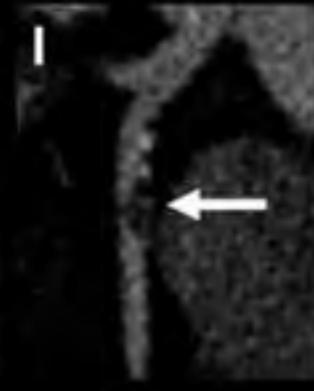
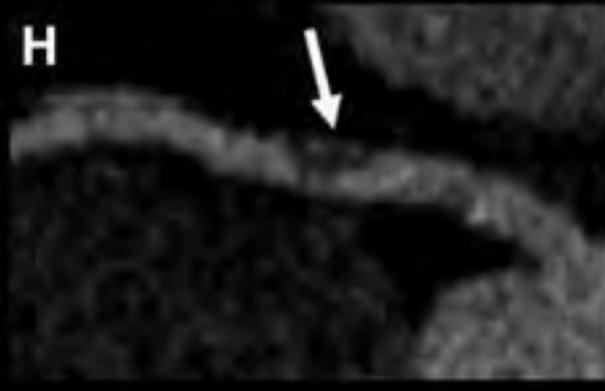
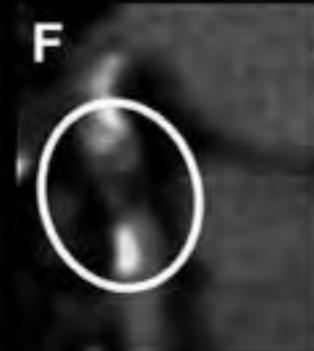
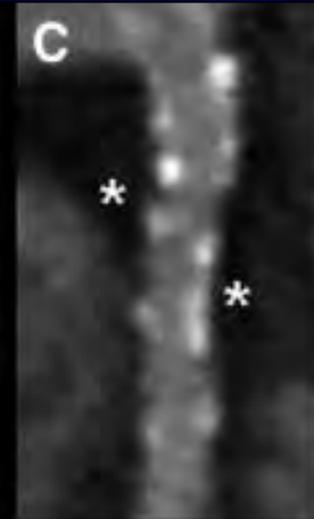
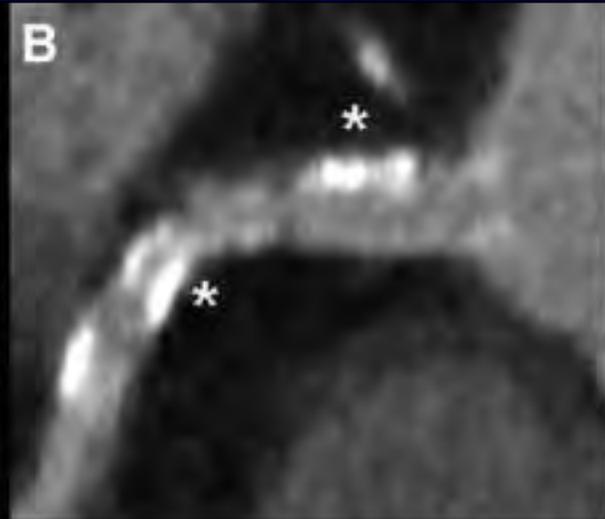
# Caveats

- Some patients precluded
- Up to 12% segments excluded
- Motion artifacts
  - breath holding, stable and slow HR
  - 90% need beta blockers
  - <60% achieve adequate heart rate control
- Stents, metal clips, and  $\text{Ca}^{++}$  are **BIG** issues
- High prevalence of CAD

# Diagnostic Performance of 64-row CTA

## The CORE 64 Multicenter Trial

- 405 eligible patients with suspected CAD
  - almost 100 excluded with very high Ca++ scores
- Detected presence and severity of obstructive CAD with **sensitivity 85%, NPV 83%**
- Identified those who later underwent revascularization
- Conclusion:
  - “negative and positive predictive values indicate that ...CTA cannot replace conventional CA at present”



**When should it be used?**

# ACC/AHA ( $\pm$ ESC) Professional Guideline Recommendations

Document	Use of CTA
2007 - Chronic angina	None
2007 - Unstable angina	None
2009 - STEMI	None
CAD screening	None

# CTA Inappropriate Indications

**Table 9.** Inappropriate Indications (Median Score 1–3)

Indication	Appropriateness Criteria (Median Score)
<b>Detection of CAD: Symptomatic—Evaluation of Chest Pain Syndrome (Use of CT Angiogram)</b>	
3. • High pre-test probability of CAD	I (1)
<b>Detection of CAD: Symptomatic—Acute Chest Pain (Use of CT Angiogram)</b>	
8. • High pre-test probability of CAD • ECG—ST-segment elevation and/or positive cardiac enzymes	I (1)
<b>Detection of CAD: Asymptomatic (Without Chest Pain Syndrome) (Use of CT Angiogram)</b>	
10. • Low CHD risk (Framingham risk criteria)	I (1)
11. • Moderate CHD risk (Framingham)	I (2)
<b>Risk Assessment: General Population (Use of CT Angiogram)</b>	
13. • Low CHD risk (Framingham)	I (1)
<b>Detection of CAD With Prior Tests (Use of CT Angiogram)</b>	
17. • Evidence of moderate to severe obstructive CAD (by other means)	I (2)
<b>Risk Assessment: Coronary Calcium Scoring (Use of CT Angiogram)</b>	
18. • Prior calcium score with obstructive CAD (by other means)	I (1)
<b>Risk Assessment: Coronary Artery Disease (Use of CT Angiogram)</b>	
19. • High CHD risk (Framingham) • Within 2 years of acute coronary syndrome without significant obstructive disease	I (2)
20. • High CHD risk (Framingham) • Prior acute coronary syndrome without significant obstructive disease	I (3)
<b>Risk Assessment: Preoperative Cardiac Surgery—Low-Risk Surgery (Use of CT Angiogram)</b>	
21. • Preoperative cardiac surgery—Low-Risk Surgery (Use of CT Angiogram)	I (1)
<b>Risk Assessment: Preoperative Cardiac Surgery—Intermediate-Risk Surgery (Use of CT Angiogram)</b>	
26. • Preoperative cardiac surgery—Intermediate-Risk Surgery (Use of CT Angiogram)	I (2)
26. • Preoperative cardiac surgery—Intermediate-Risk Surgery (Use of CT Angiogram)	I (3)
27. • Preoperative cardiac surgery—Intermediate-Risk Surgery (Use of CT Angiogram)	I (2)
<b>Risk Assessment: Preoperative Cardiac Surgery—High-Risk Surgery (Use of CT Angiogram)</b>	
27. • Preoperative cardiac surgery—High-Risk Surgery (Use of CT Angiogram)	I (2)
<b>Other Indications (Use of CT Angiogram)</b>	
30. • Evaluation of LV function following myocardial infarction OR in heart failure patients	I (3)

**Exhaustive!**

# CTA Appropriate Indications

## Symptomatic Patients Only

### ■ Chest pain

- Intermediate pre-test probability of CAD
- ECG uninterpretable or unable to exercise
- Uninterpretable stress test

### ■ Suspected coronary anomalies

### ■ Acute Coronary Syndromes - ??

# Risks and costs

# The New York Times

THE CONSUMER

## With Rise in Radiation Exposure, Experts Urge Caution on Tests

By RONI CAROL RABIN  
Published: June 19, 2007

Advances in radiology have radically transformed medical practice with CT scans and nuclear medicine exams providing physicians the ability to quickly pinpoint internal bleeding, diagnose kidney stones or confirm appendicitis, assess thyroid function and identify and clear blockages in the blood vessels to the heart.

Enlarge This Image



Lou Beach

The downside is that Americans are being exposed to record amounts of ionizing radiation, the most energy-hazardous form of radiation.

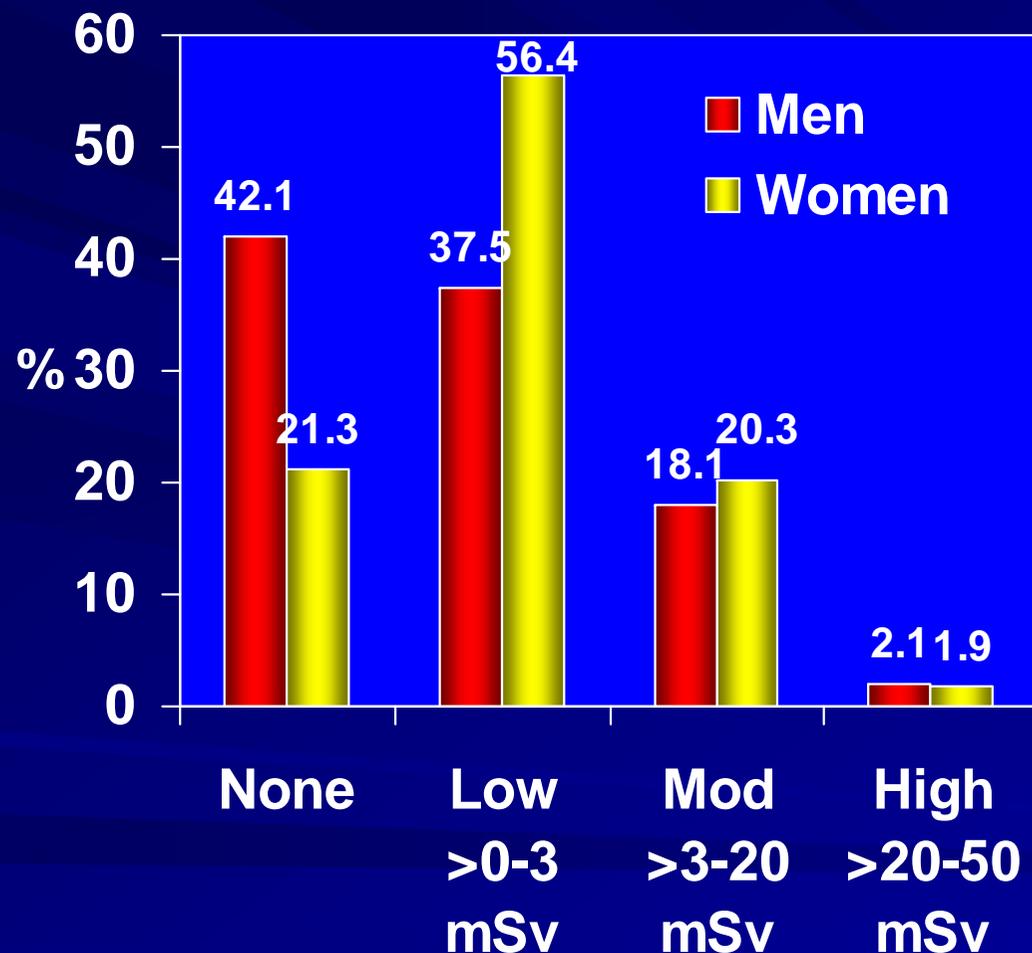
According to a new study, the percentage of ionizing radiation from clinical imaging exams in the United States increased almost 600 percent from 1980 to 2006. In the past, natural background radiation was the leading source of human exposure; that has been displaced by diagnostic imaging procedures, the authors said.

"This is an absolutely sentinel event, a wake-up call," said

Radiation from clinical imaging exams in the US increased almost 600% from 1980-2006

June 19, 2007

# Annual Low-dose Ionizing Radiation Exposure from Medical Imaging



**82%**  
outpatient setting

**75%**  
CT or nuclear  
imaging

Claims data United Healthcare (Fazel R: NEJM 2009)

# Radiation Dose in Cardiac Imaging

	Effective dose (mSv)
CXR	0.08
Coronary angiogram	6
Single source CTA-64 slice	9-14
– with ECTCM	4-7
Sestamibi (30 mCi + 30 mCi)	18
$^{13}\text{NH}_3$ PET (20 mCi + 20 mCi)	3.3
Background rad <sup>n</sup> in USA (per yr)	3

Data Courtesy of C. McCollough, 2006; Coles DR, JACC 2006; Thompson RC, J Nuc Card 2006

## CT heart scans may carry breast cancer risk for young women

Updated 244d ago | Comments: 3 | Rec



Enlarge

Columbia Uni

Newer CT scan devices offer this image, but they require a higher dose of radiation. Researchers found that a 20-year-old woman is 23 times more likely to develop cancer from the tests than a 40-year-old man who is scanned.

**CTA:**

Lungs (42-80 mSv)

Breast (50-80 mSv)

Life-time cancer risk for  
20-yr woman ~ 1:143

Einstein AJ: JAMA 2007

who also are prone to developing breast cancer. Men at 40 face a 1-in-1,241 risk of developing lung cancer.

# Radiation Risks with CTA

## Dose is cumulative:

- Younger patients have higher life-time risk if repeated exams
- Risk will increase with misuse and overuse
  - Worried patients and nervous doctors
  - Ordered by non-cardiologists
- Additional risks if triggers inappropriate CA and PCI

# Unnatural Radiation



## Japanese A-bomb survivors

↑Cancer deaths (5-150 mSv)  
Mean 40 mSv

## Nuclear reactor workers

↑Cancer deaths  
Mean 20 mSv

## Single CT Chest

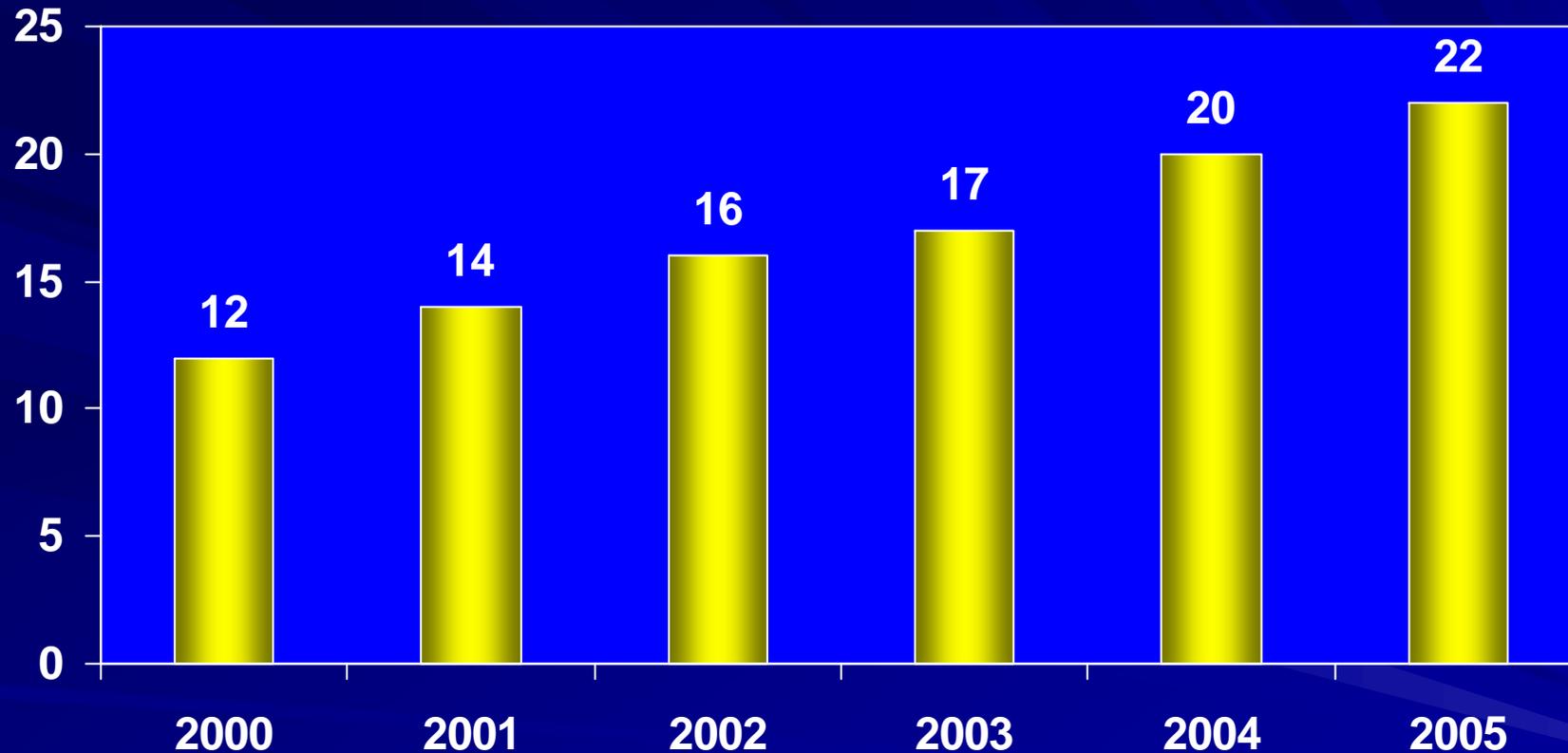
Equivalent to 3 years of  
background radiation\*

2% of cancer in USA  
due to CT radiation

Preston DL: Radiat Res 2004; Cardis E: Radiat Res 2007; Brenner DJ: NEJM 2007;\* Assume 3 mSv per year background radiation (FDA)

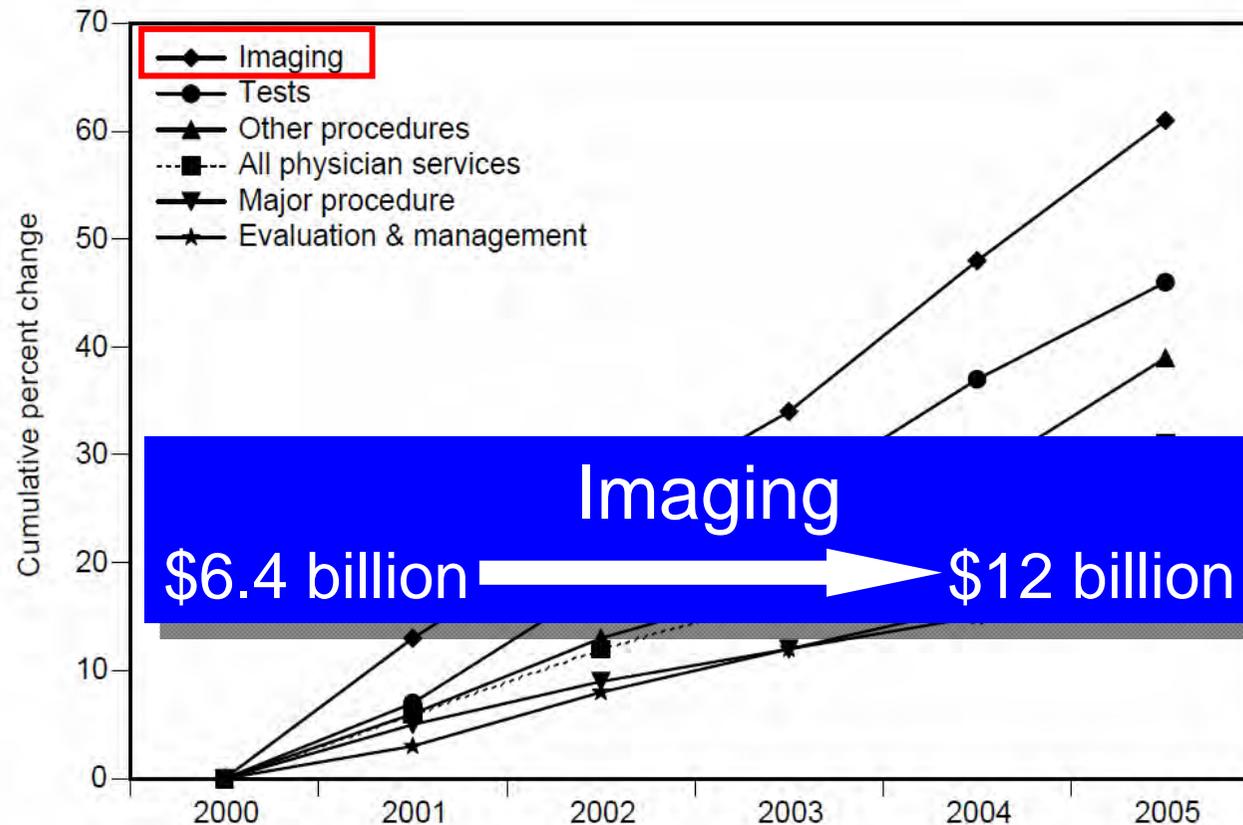
# CT Scans in the United States

Scans per 100 population - all payers



Tynan, Ann, Robert A. Berenson and Jon B. Christianson, Issue Brief No. 118, Center for Studying Health System Change, Washington, D.C. (February 2008). Source - McKinsey Global Institute

# Physician Services per Medicare Beneficiary, 2000-2005



Note: Includes only services paid under the physician fee schedule.

Source: Analysis of physician claims data for 100 percent of Medicare beneficiaries.

# Summary of State of the Art

## **WHAT WE DO KNOW**

Mesmerizing images

Accuracy is relatively good

But not good enough to replace conventional CA

Radiation exposure is a concern

Do not need more diagnostic accuracy studies!!!!

## **WHAT WE DON'T KNOW**

Does use of CTA improve patient outcome?

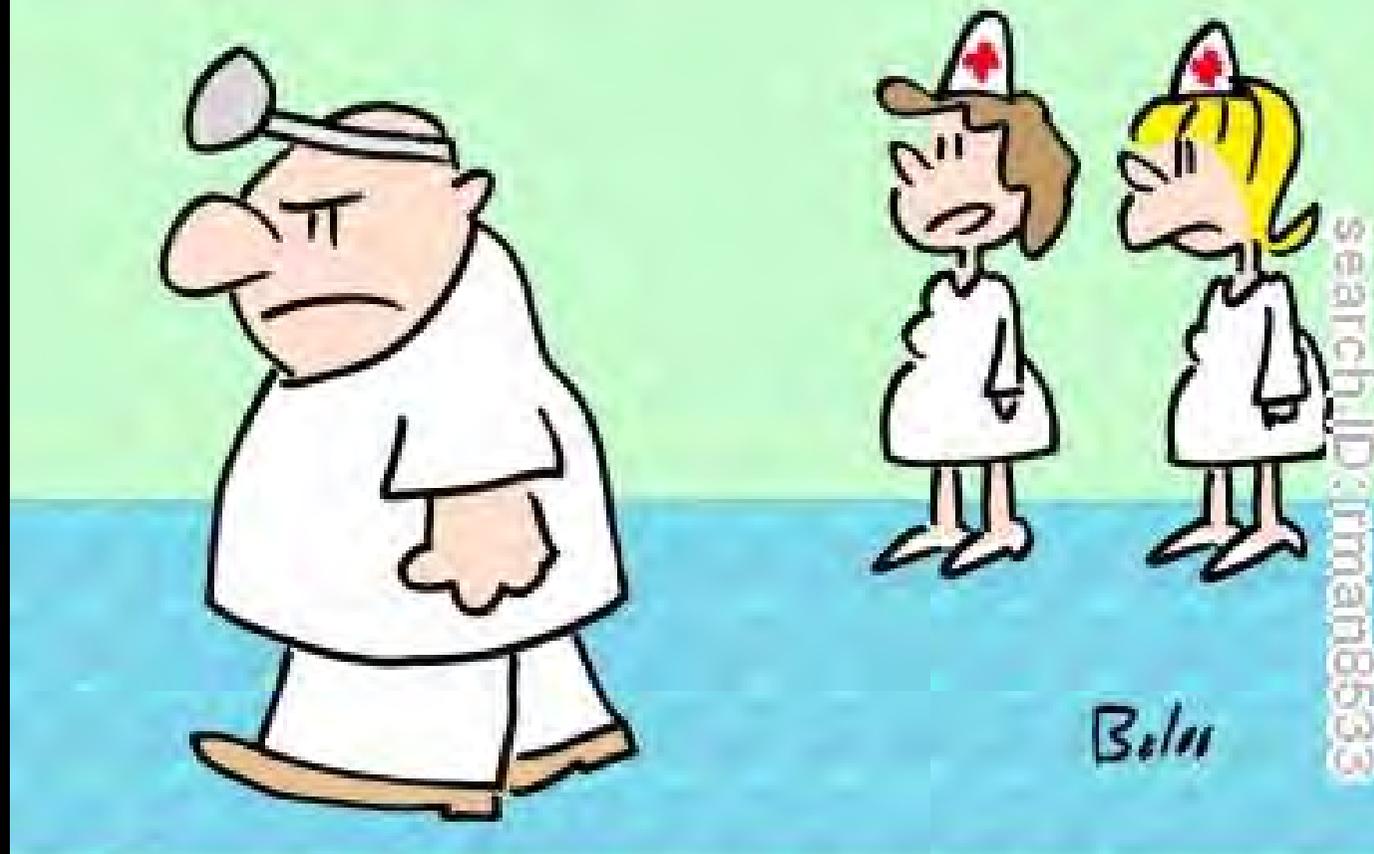
# “Pay Now, Benefits May Follow”

## What is added value of CTA?

### Obstacles to an Evidence-based approach

- Faith in technology
- Mistaken belief that tests predict heart attacks
- Influence of lobbying on Medicare policy
- Fee-for-service system (and no oversight)
- Lack of consensus that benefit is required before widespread use of a technique

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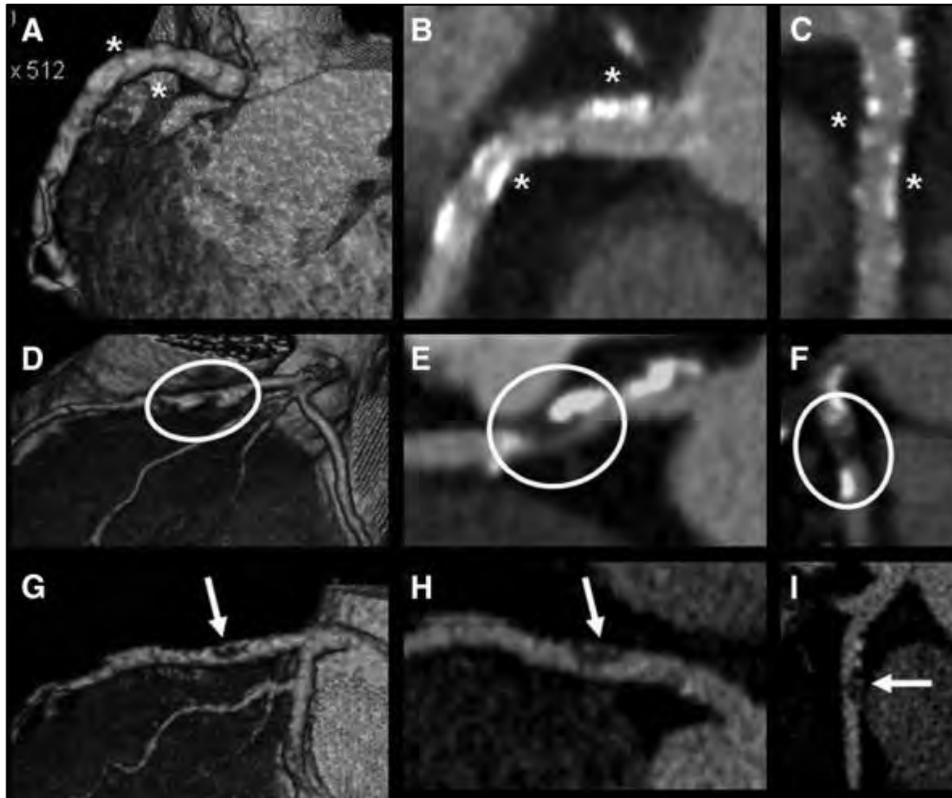


*“He seems cranky, but his heart  
is in the right place – we gave  
him a CT scan to be sure.”*

# Comparison of CTA and Conventional Coronary Angiography

Issue	CTA	Invasive CA
Contrast vol, ml	80-120	15-80
Radiation dose	high	lower
Vascular needs	wide open veins	a pulse
Calcium, stents etc.	difficult	unimportant
Heart rate or rhythm	critical	unimportant
Need beta blockers	90%	never
Long breath hold	yes	no
Large BMI problem	yes	only if extreme
Patient excluded	sometimes	<b>very rare</b>

Figure 1.



**Incremental Prognostic Value of Coronary CT Angiography in Patients With Suspected Coronary Artery Disease.**

Russo, Vincenzo; MD, PhD;  
Zavalloni, Andrea; Reggiani, Maria;  
Letizia Bacchi MSc, MStat; Buttazzi, Katia;  
Gostoli, Valentina; Bartolini, Simone;  
Fattori, Rossella

Circulation: Cardiovascular Imaging.  
3(4):351-359, July 2010.

DOI:

10.1161/CIRCIMAGING.109.880625

Figure 1. A through I, nine multiplanar curved CT images showing different types of coronary plaques. Calcified (asterisks in A through C), mixed (circles in D through F), and noncalcified (arrows in G through I) lesions are represented.

# Growth of Advanced Medical Imaging

- CT, MRI, PET fastest growth of physician service expenditure
- Rapid growth → driving up Medicare costs and premiums \$\$\$\$\$\$
- Many are untrained in medical imaging
- Financially driven self-referral

*Quality – safety - cost*