# Differential imaging: what for which patient?

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## Coronary Atherosclerosis

“Coronary Narrowing”

Transient Ischemia
Angina - Infarction

**“Severity”**

“Vulnerable Plaque”

Myocardial Infarction
Sudden Death

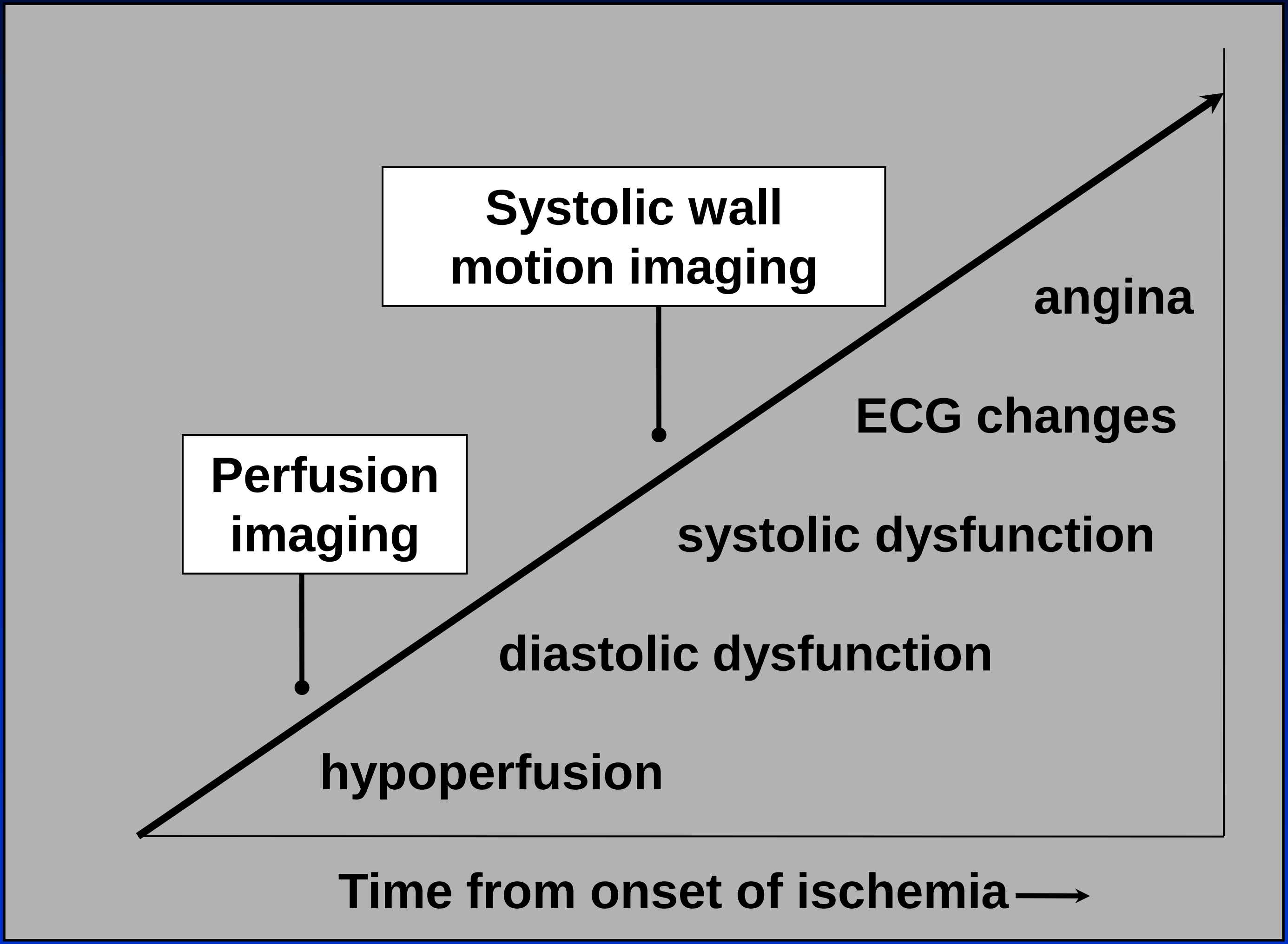
**“Vulnerability”**

# Ischemia – Severity

How to evaluate

non-invasively?

# Diagnosis of ischemia -
# the ischemic cascade



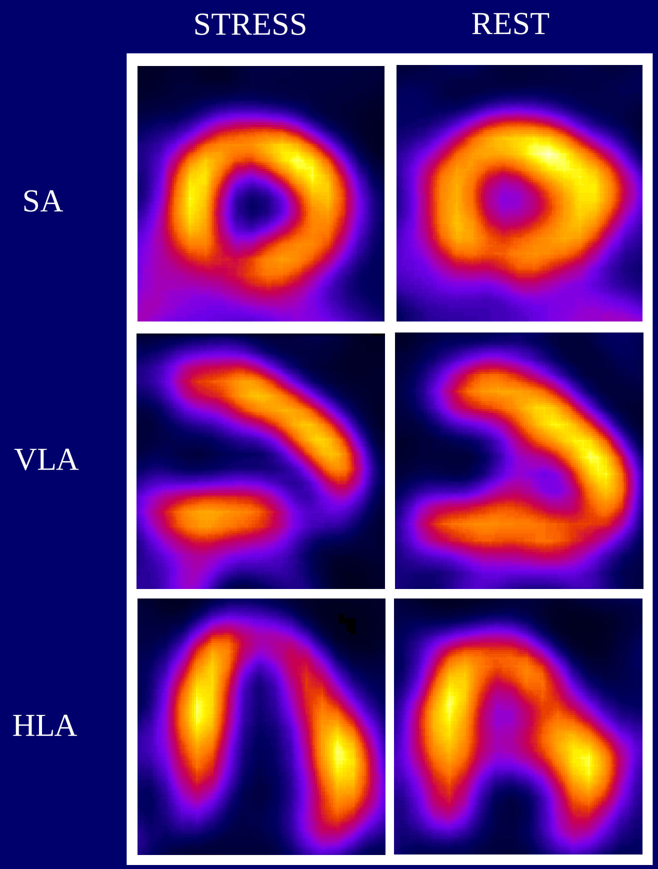

Schinkel et al. EHJ 2003

# Ischemia as an expression of a flow-limiting stenosis

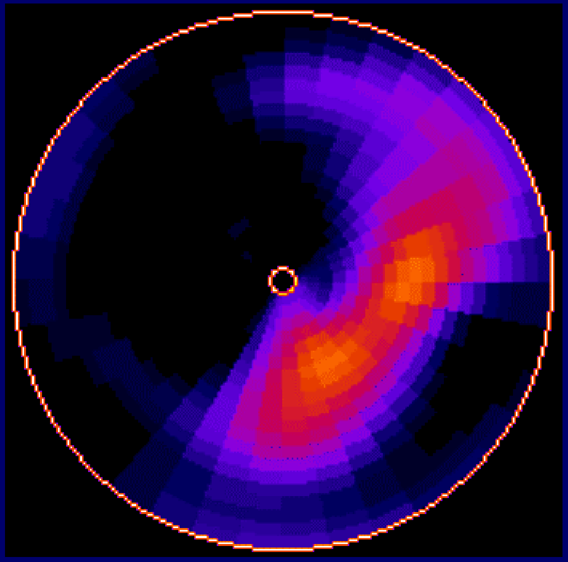
- **Assessment of**
  - **perfusion abnormalities (stress-inducible)**

- **Assessment of**
  - **systolic wall motion abnormalities (stress-inducible)**

# Nuclear perfusion imaging, SPECT

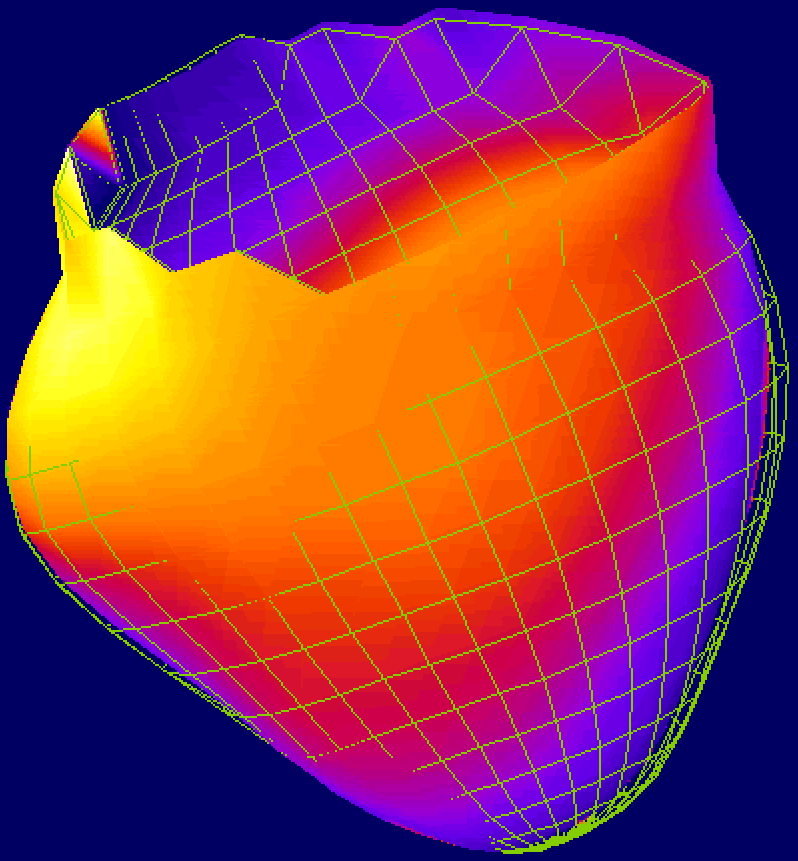



POLAR MAP TO QUANTIFY
EXTENT AND SEVERITY OF ISCHEMIA

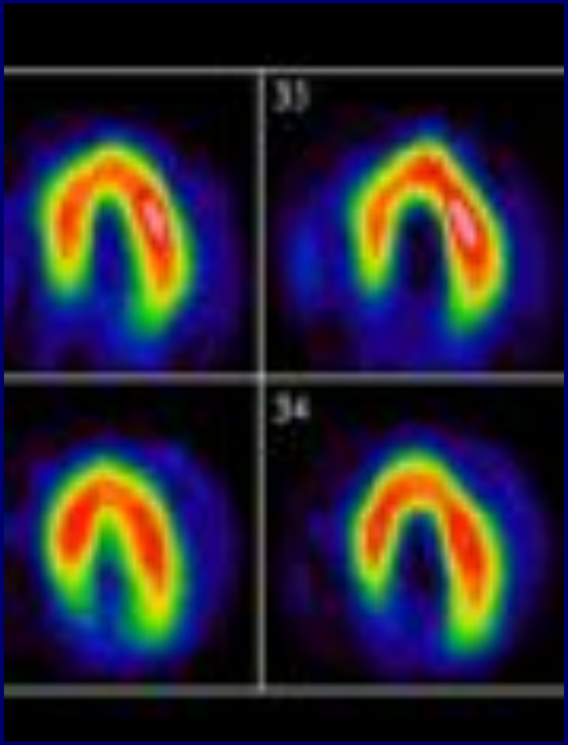


# Nuclear perfusion imaging with ECG gating

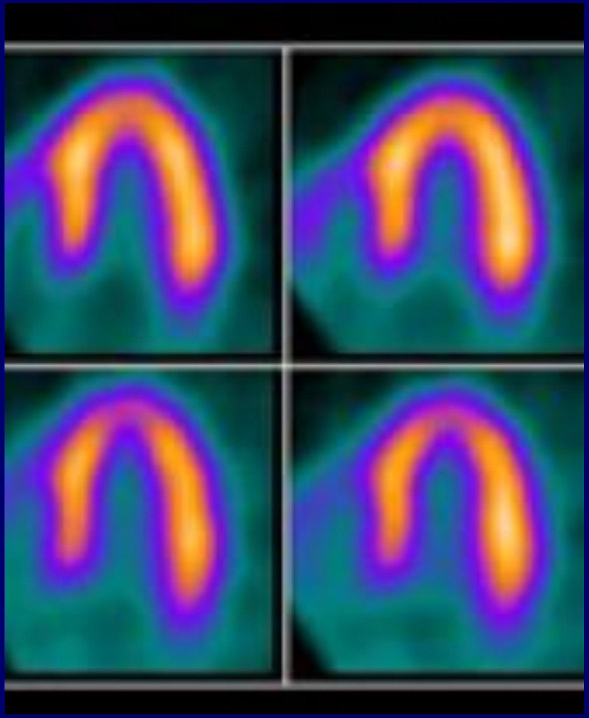
- **Permits assessment of LVEF, LV volumes and regional function**
- **At rest and stress**



# Resolution of SPECT vs PET



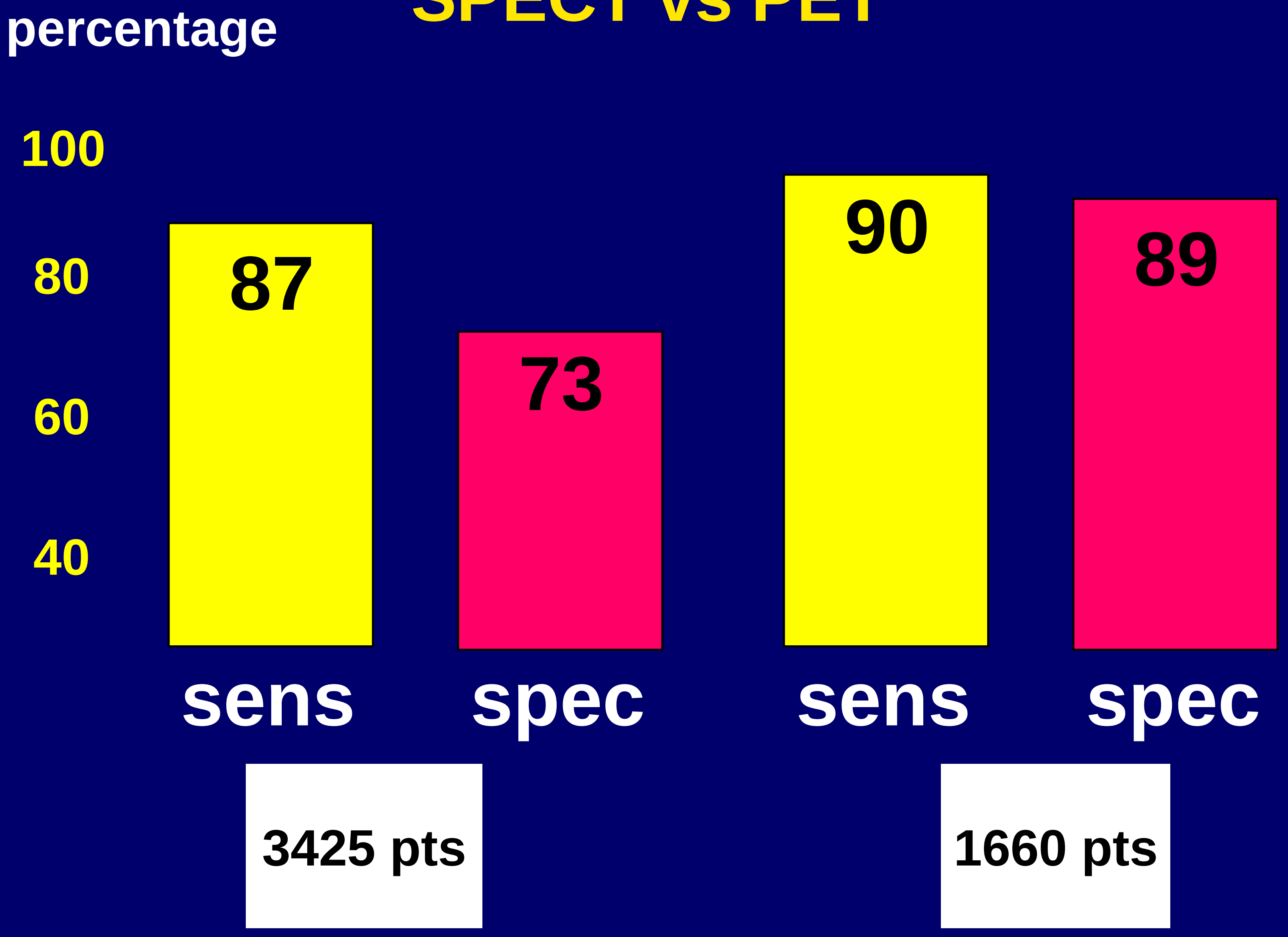
SPECT



PET

Beanlands et al. JNC 2010

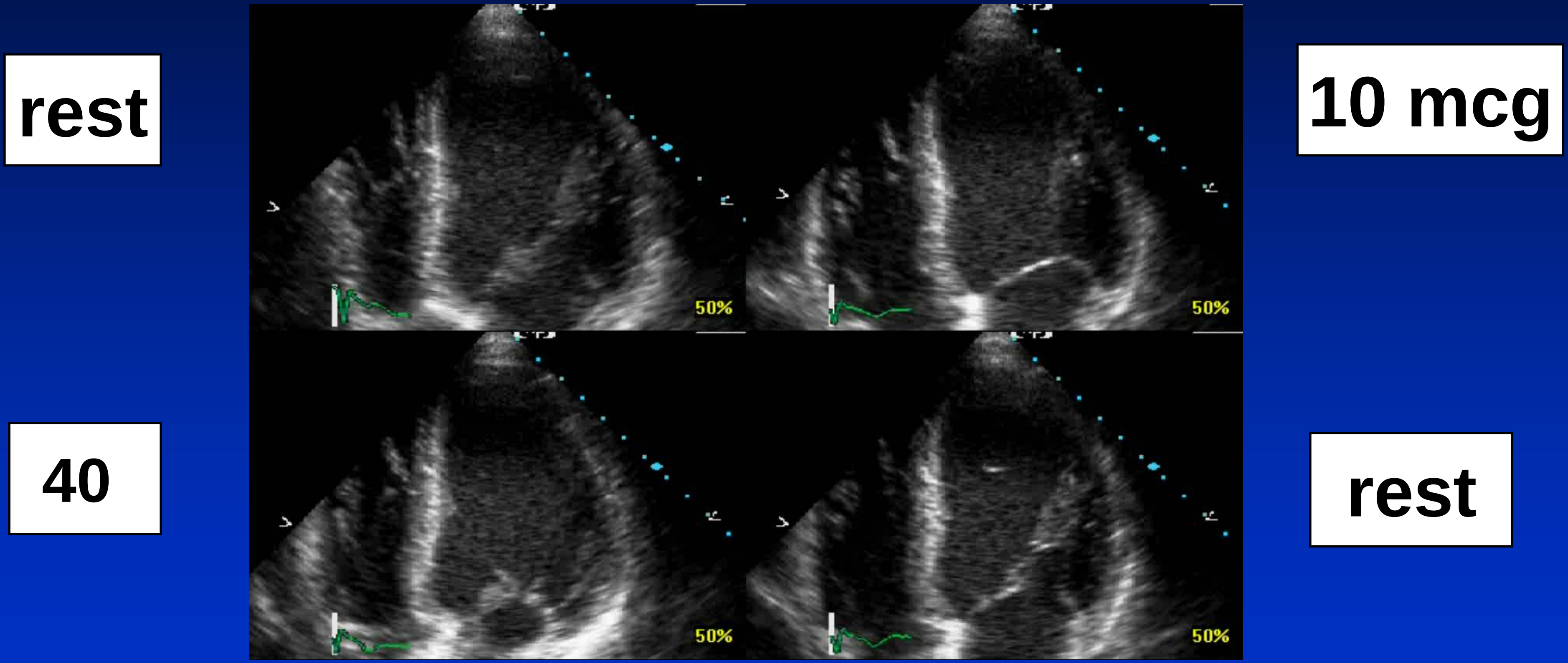
# Diagnostic accuracy
# SPECT vs PET




Underwood et al. EJNM 2004

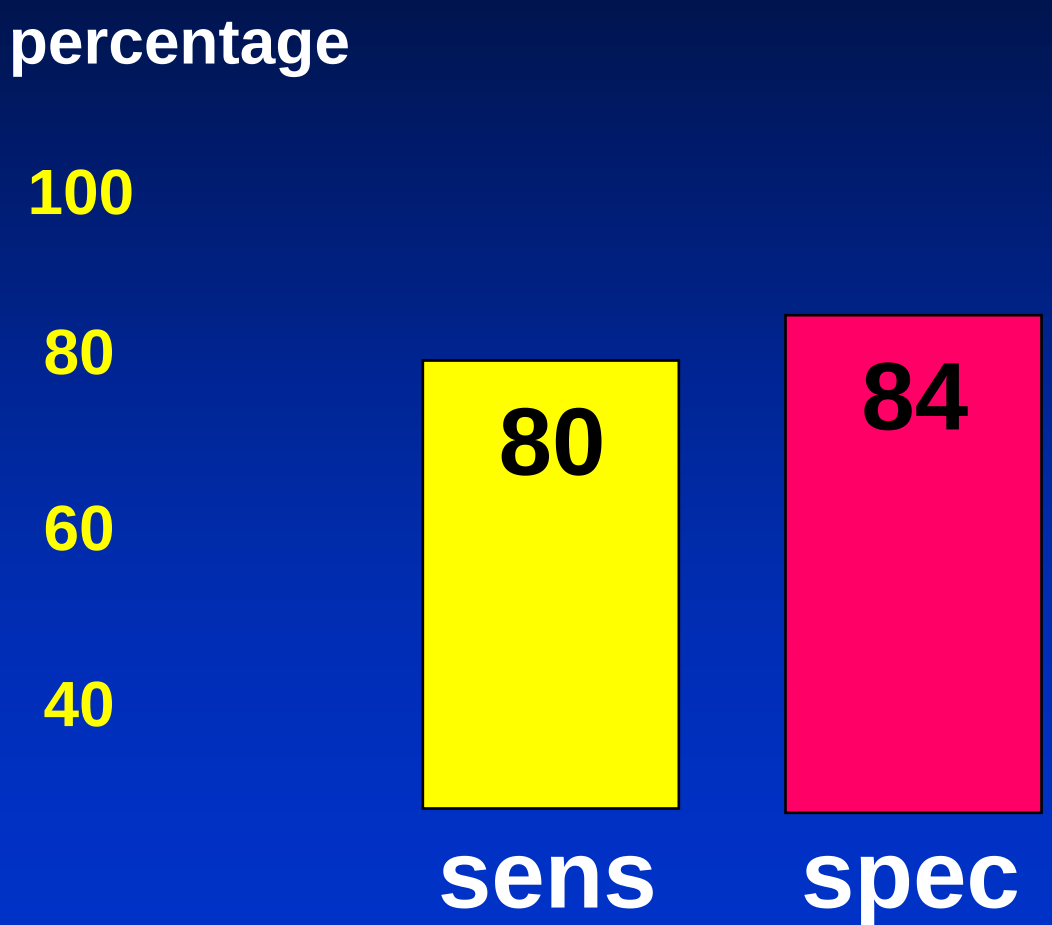
Beanlands et al. JNC 2010

# Stress echo to assess flow-limiting stenosis: wall motion



# Stress echo to detect CAD

## hall mark: WMA

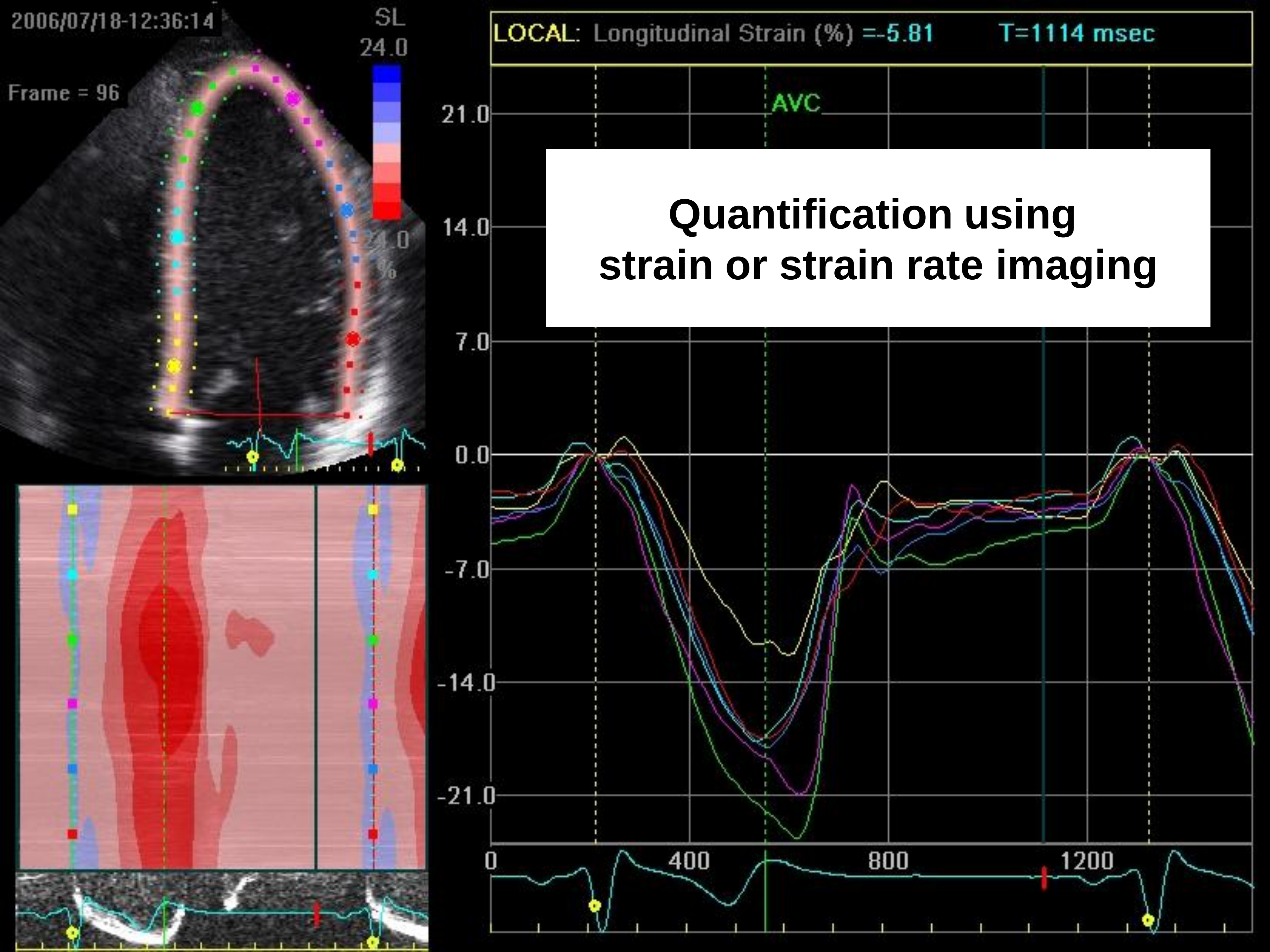



**28 studies**
**2246 pts**

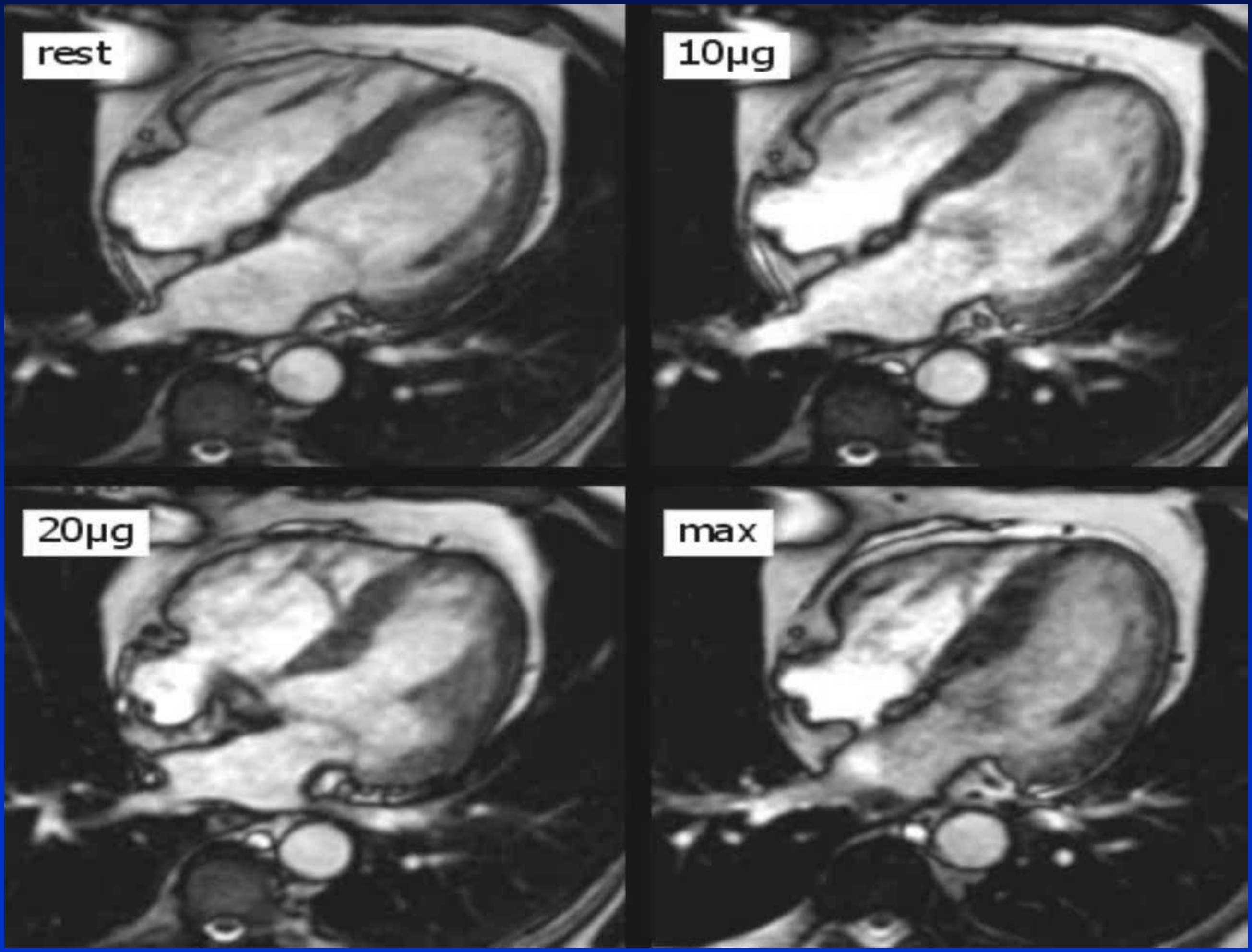
Geleijnse et al. JACC 1997

# Addition on intravenous contrast to improve border opacification

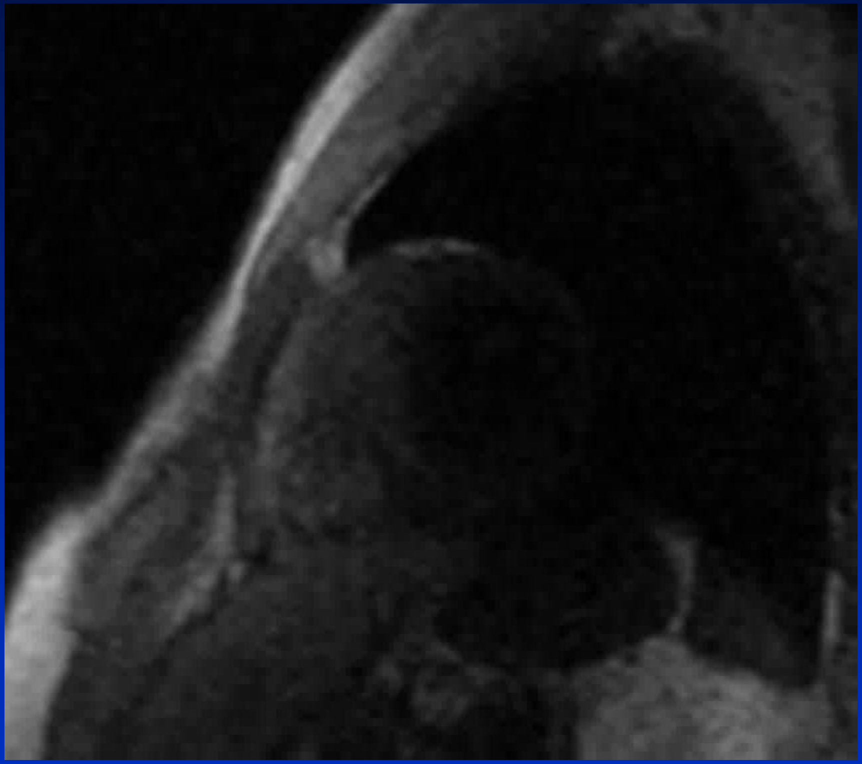

# Quantification using strain or strain rate imaging

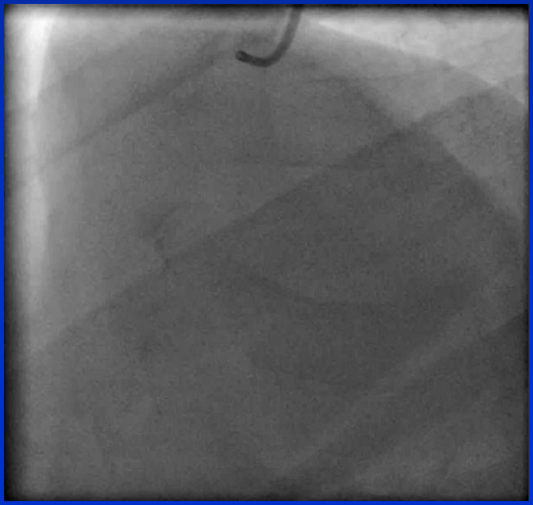


# Stress MRI to assess flow-limiting stenosis: wall motion

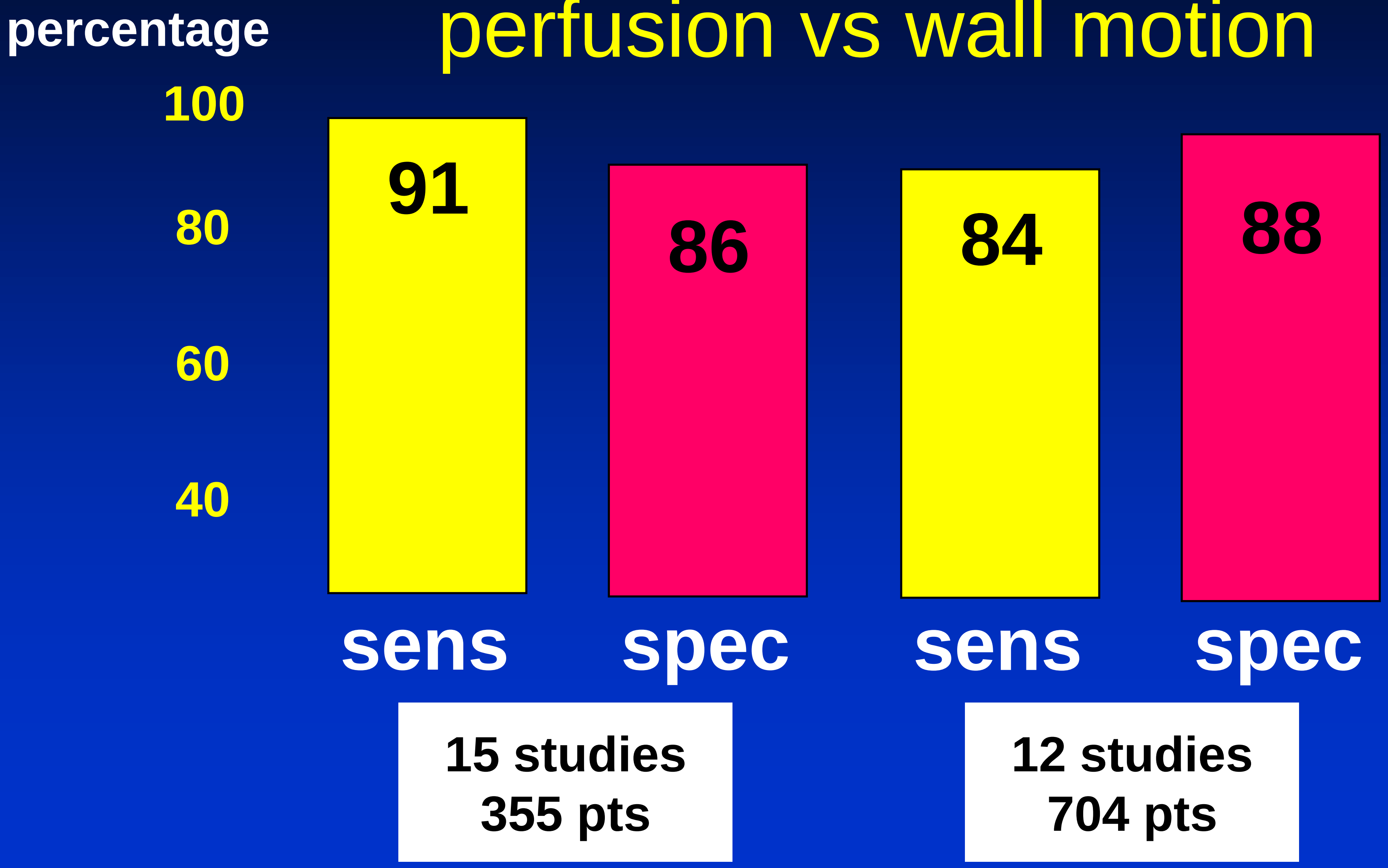


# MRI – perfusion imaging





# Stress MRI to assess flow-limiting stenosis: perfusion vs wall motion



# Comparison of imaging techniques for assessment of ischemia

- all modern techniques
- can assess perfusion
- and systolic function

- perfusion may be more sensitive
- to assess ischemia
- than systolic function

# Plaque – Vulnerability?

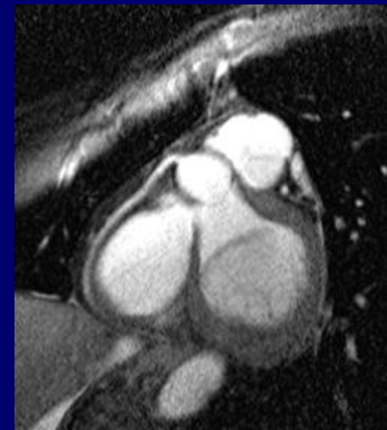
How to evaluate

non-invasively?

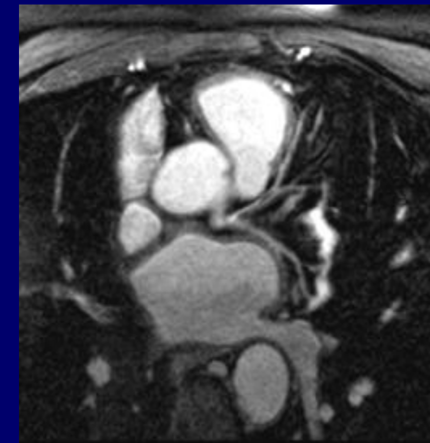
# MRI – angiography (1.5T)

Leiden, NL

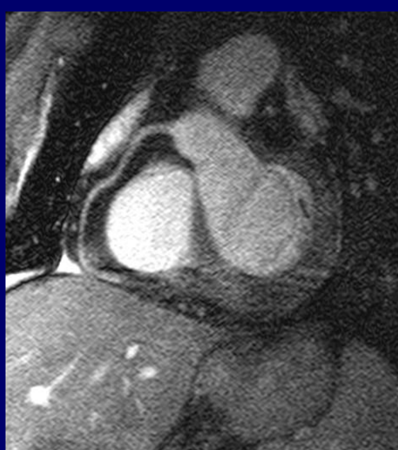
Aarhus, DK



Munich, GER



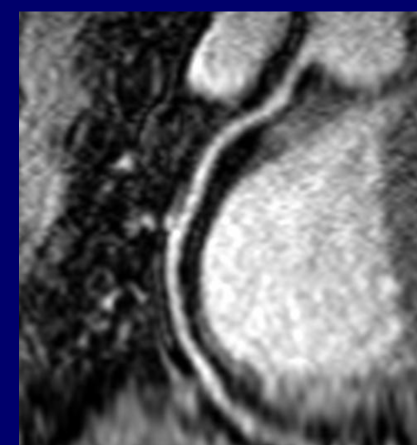
Boston, USA



Berlin, GER

Leeds, UK

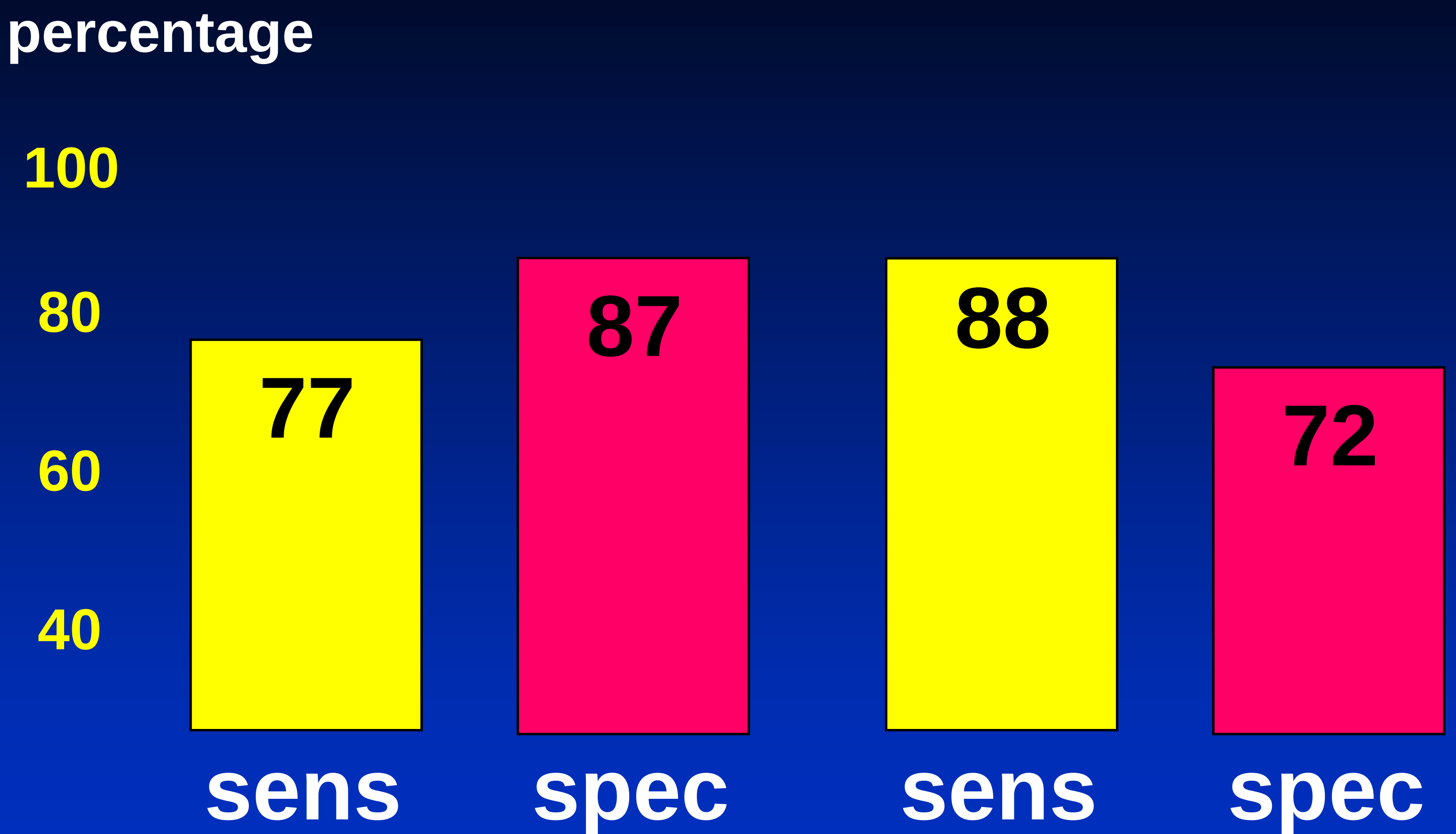
Kurashiki, JP



St. Louis, USA

NEJM 2002

# MRI to detect CAD



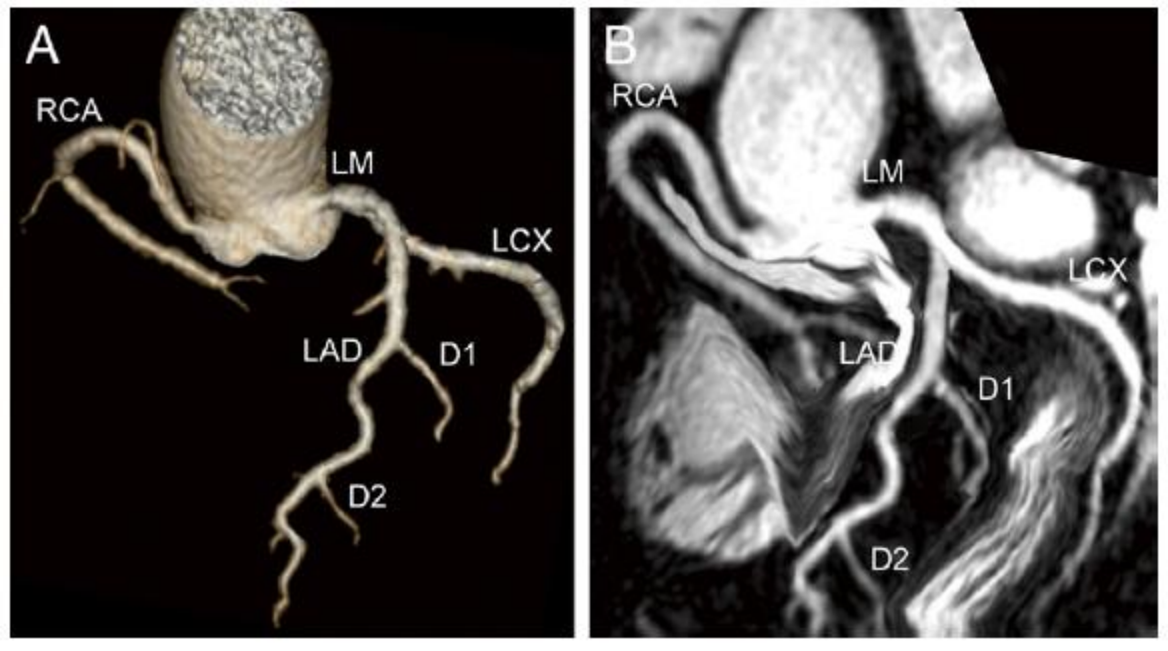

23 studies
761 pts

Multi-center trial 2010
7 hosp, 138 pts

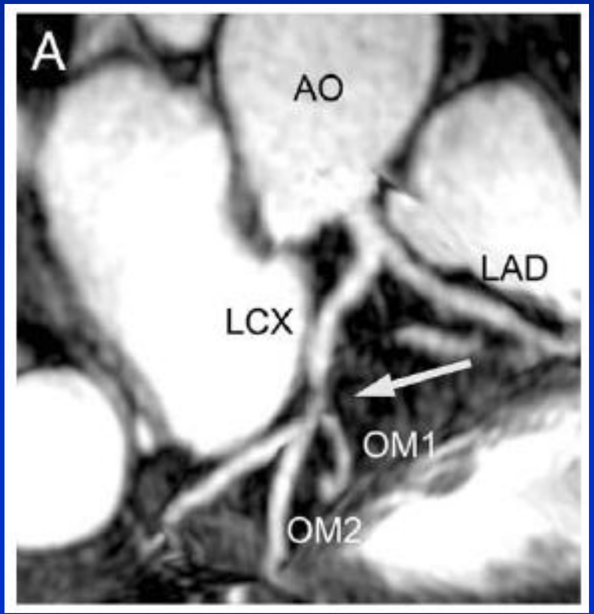
Schuijf et al. AHJ 2006

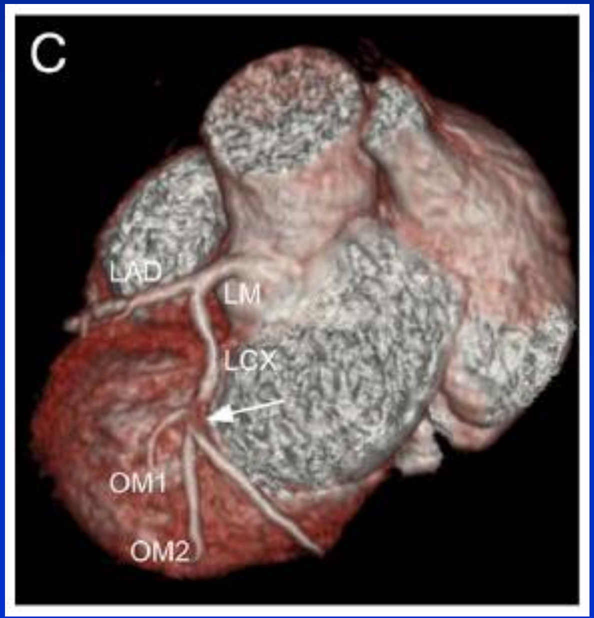
Kato et al. JACC 2010

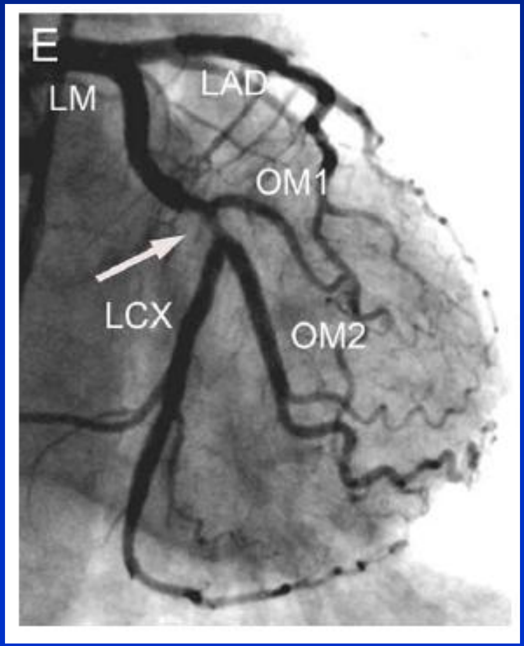
# MRI - angiography




Stronger magnets:
3T coronary imaging

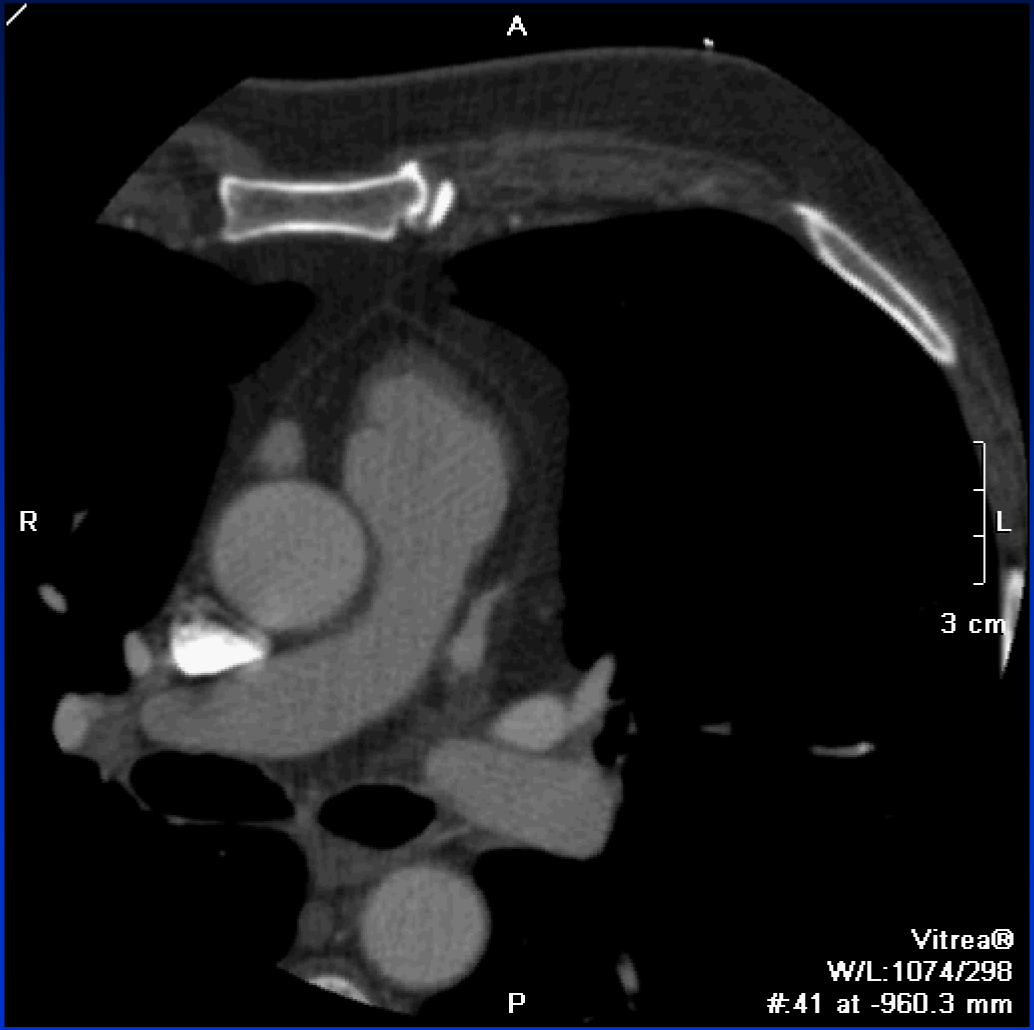


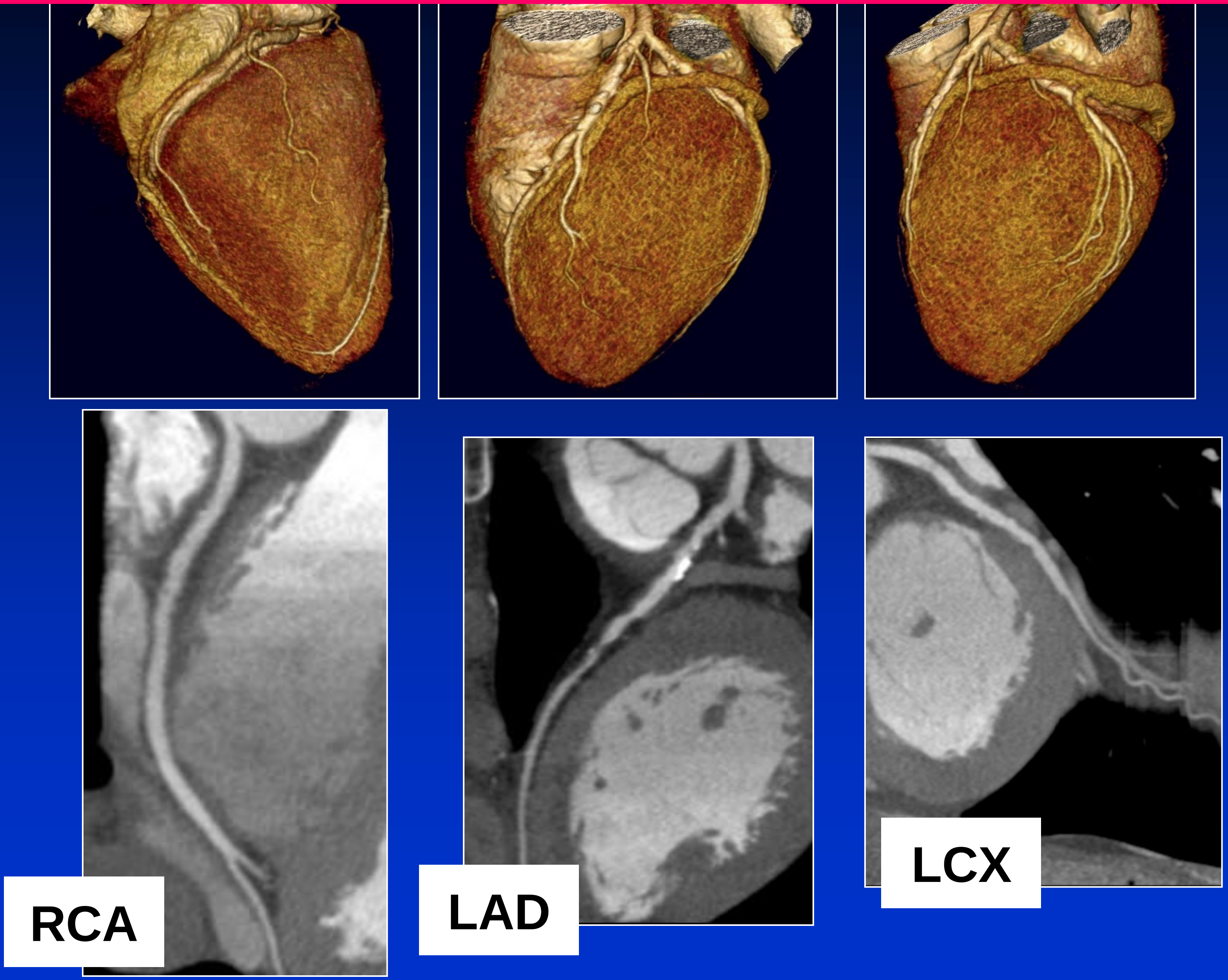




**Yang et al. JACC 2009**

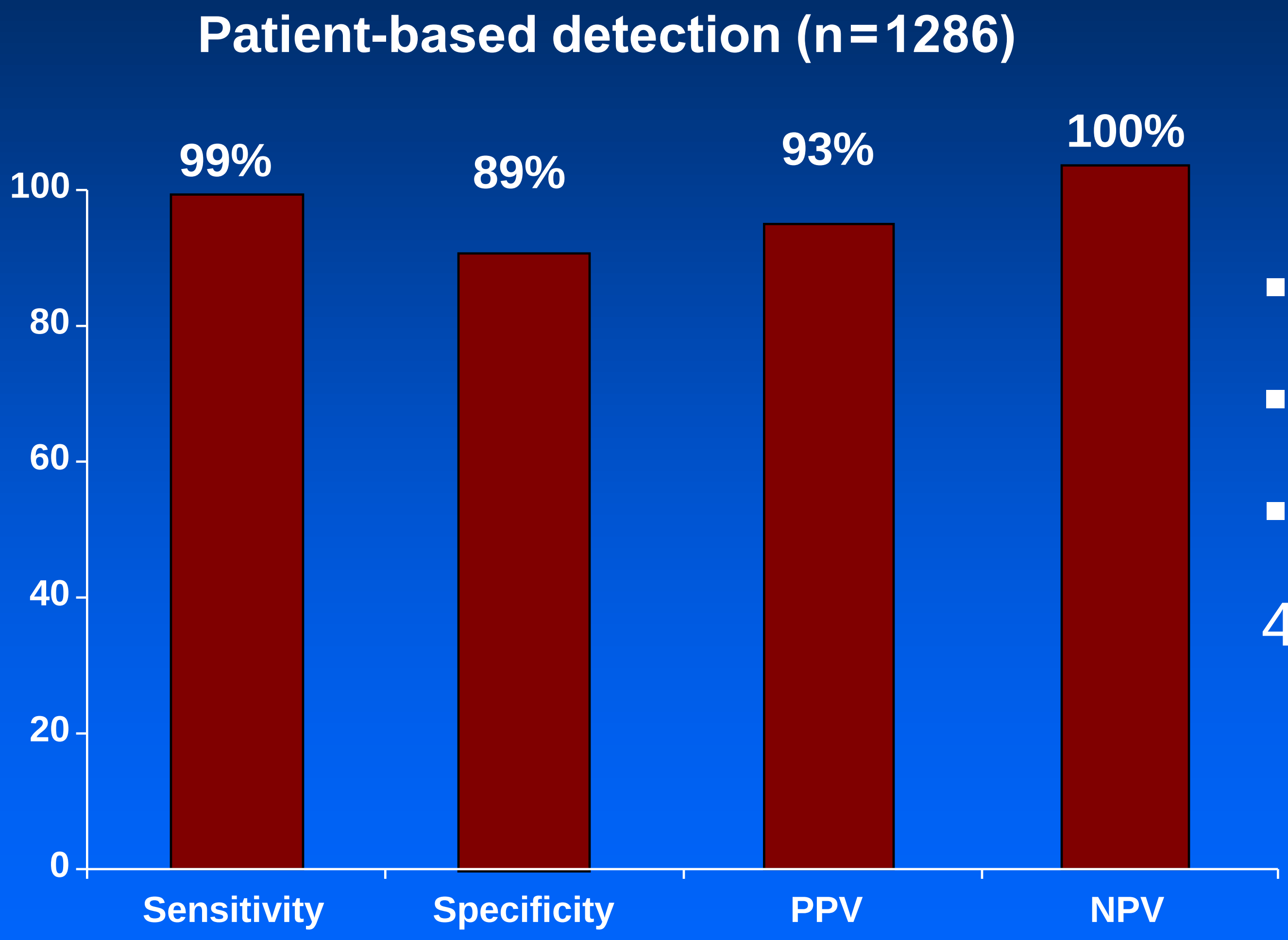
# CT angiography - raw data



# curved MPR



# Meta-analysis 64-slice CT




- ≥ 50% stenosis
- versus CAG
- Not assessable:

4% (0-14%)

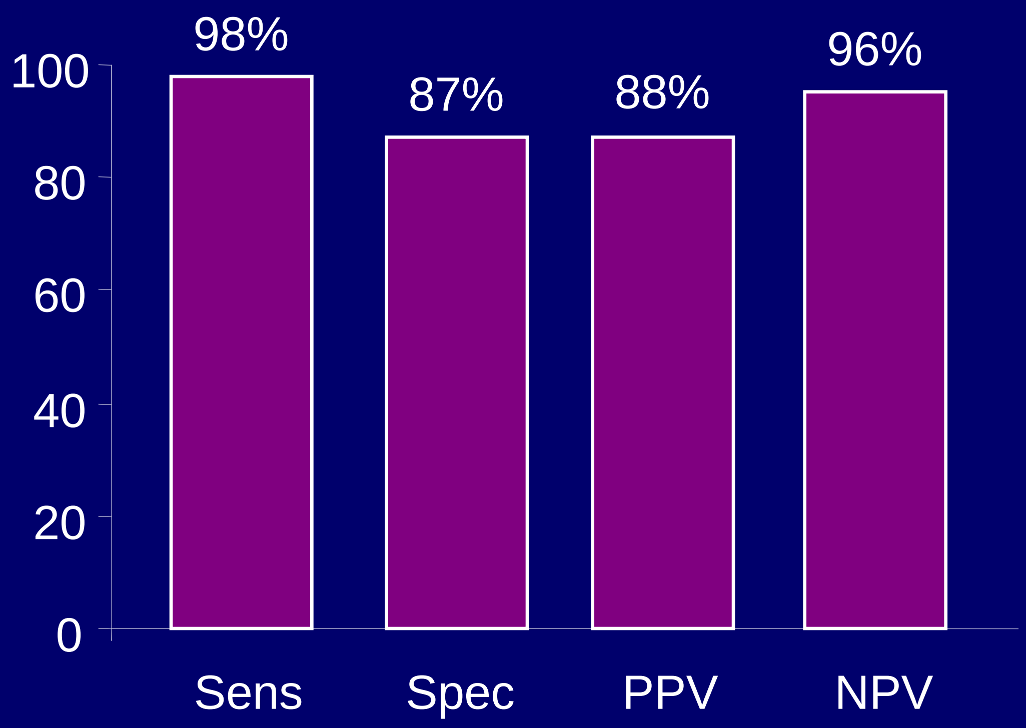
Mowatt et al *Heart* 2008

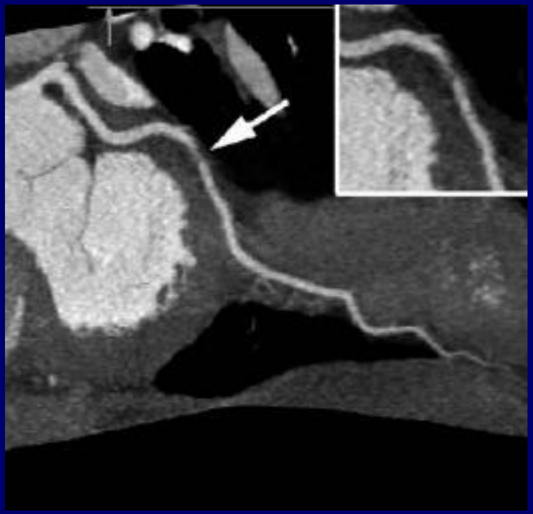
# Technical developments

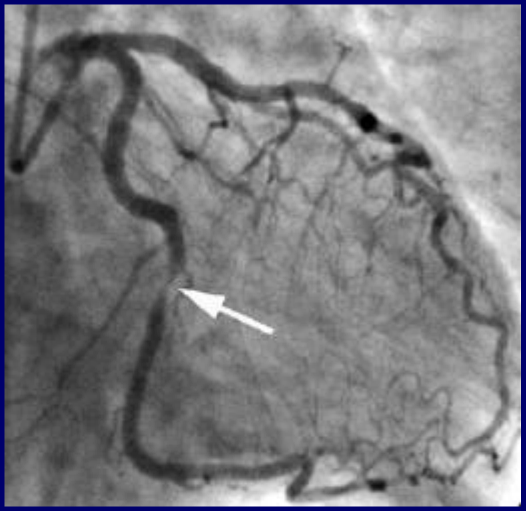
- Dual-source CT: higher temporal resolution
- Prospective gating: lower radiation
- 256- and 320-slice CT

# Accuracy dual-source CT

24 studies, 801 pts
gold standard ≥ 50% stenosis on angiography



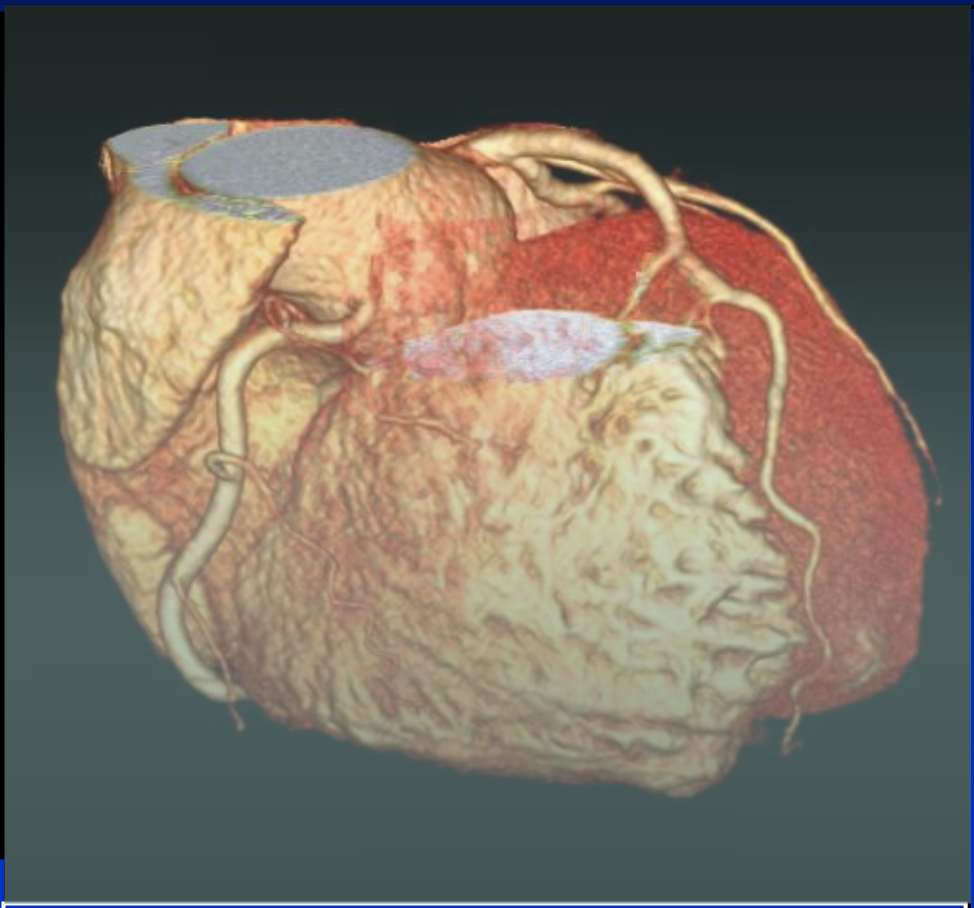


Guo et al. Int J Cardiovasc Imaging 2011

Achenbach et al. EHJ 2010

# 320-CT

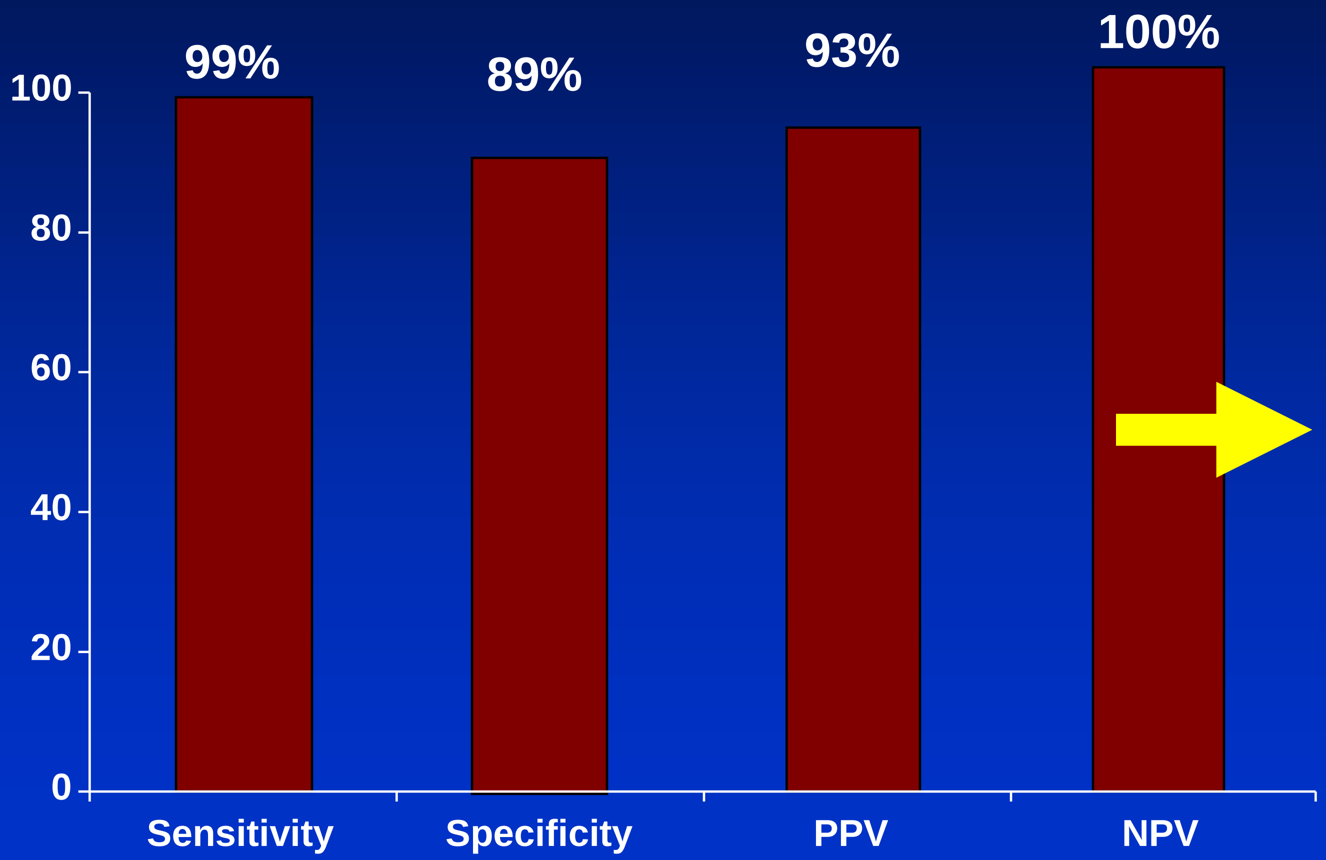
## Coverage of the heart in 1 rotation



16 cm

# Meta-analysis 64-slice CT

**Patient-based detection (n=1286)**




Rule out CAD

Mowatt et al *Heart* 2008

# Patient example

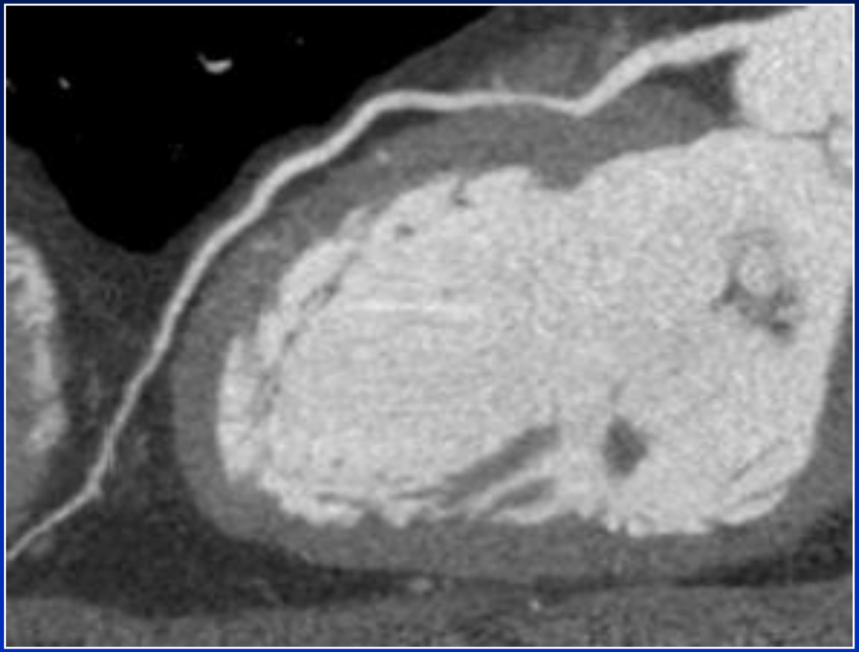
**Man 47 years old**

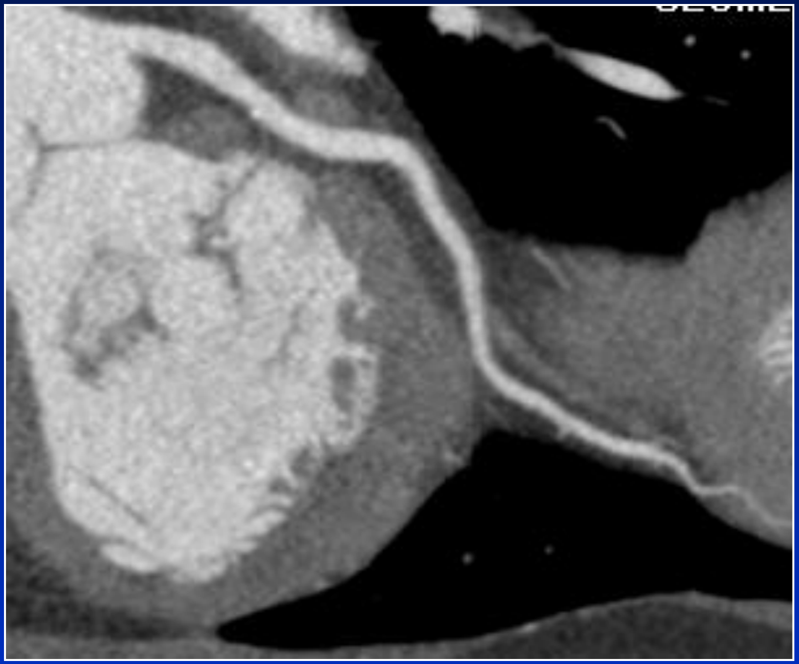
**Outpatient clinics:**

**Dyspnea or atypical chest pain at exercise**

**Risk factors for CAD:**
***Dyslipidemia**

# Non-invasive angiography - MSCT





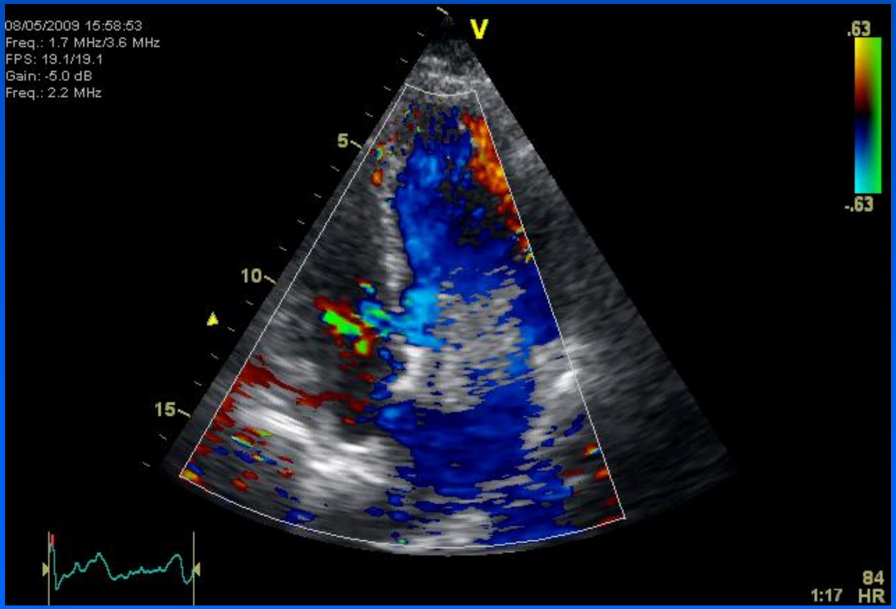
LAD: normal,

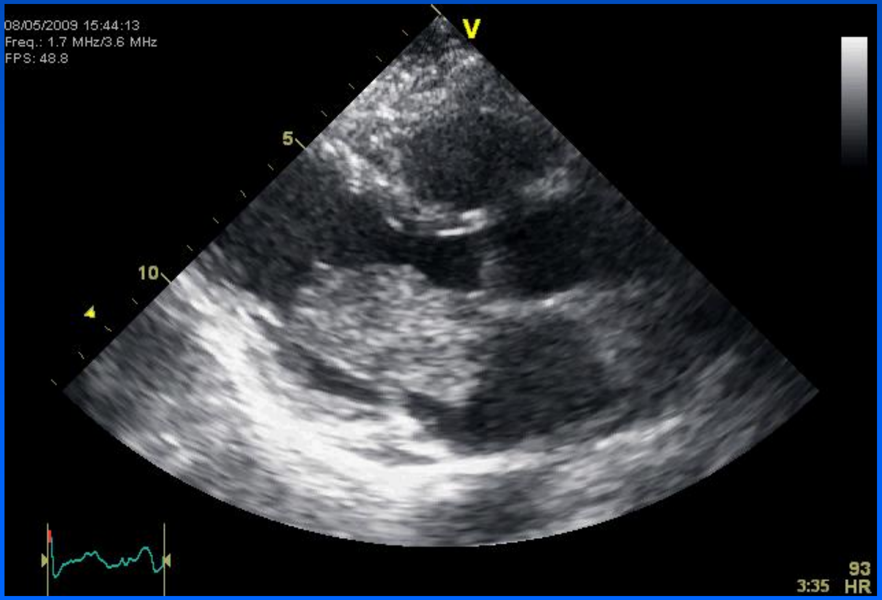
intramural course mid

LCx: normal

# 320-CT – rule out CAD

57 yr old woman, 2x TIA
Analysis cardiac source of embolism



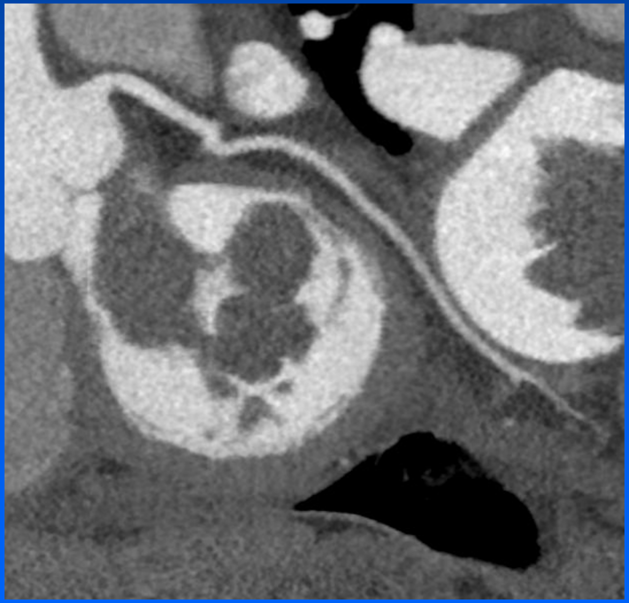
# 320-CT – rule out CAD

Smoking 39 pack years

Severe dyslipidemia (chol 7.8 mmol/L)

MSCT angiography to exclude (?) CAD

LAD

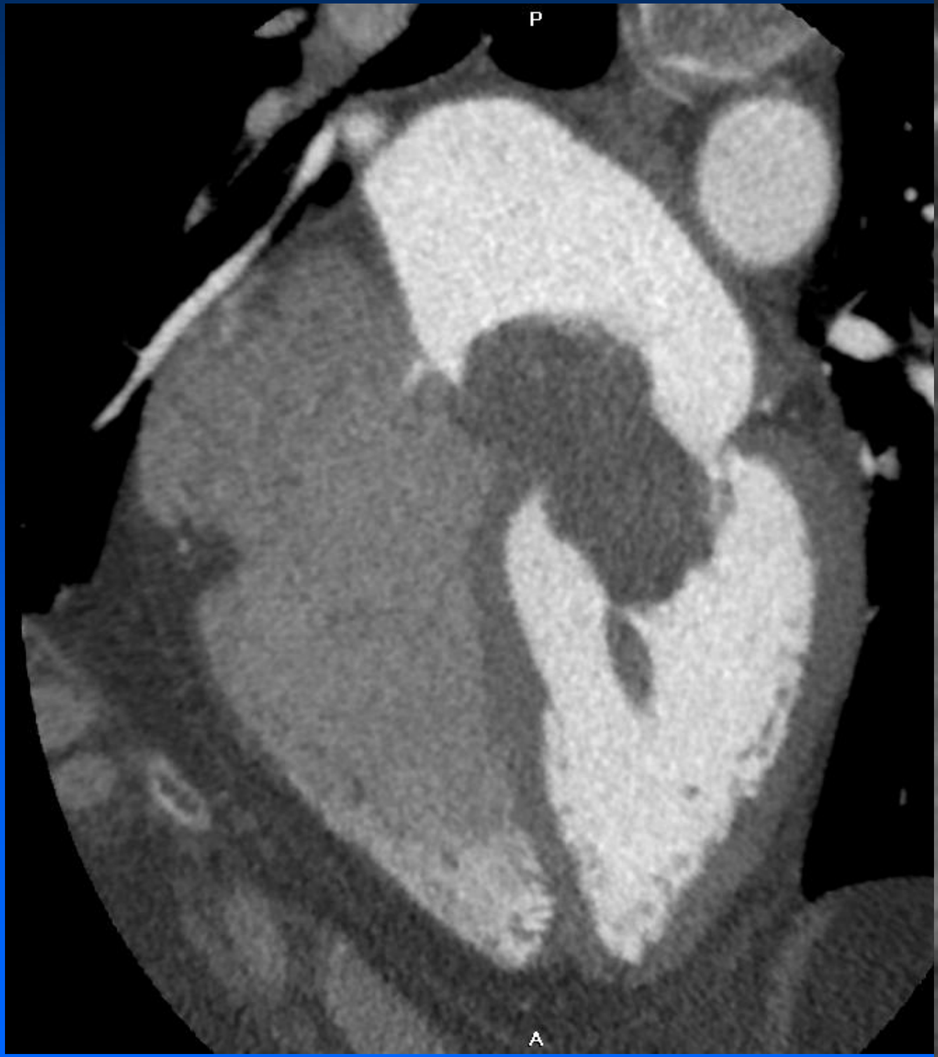


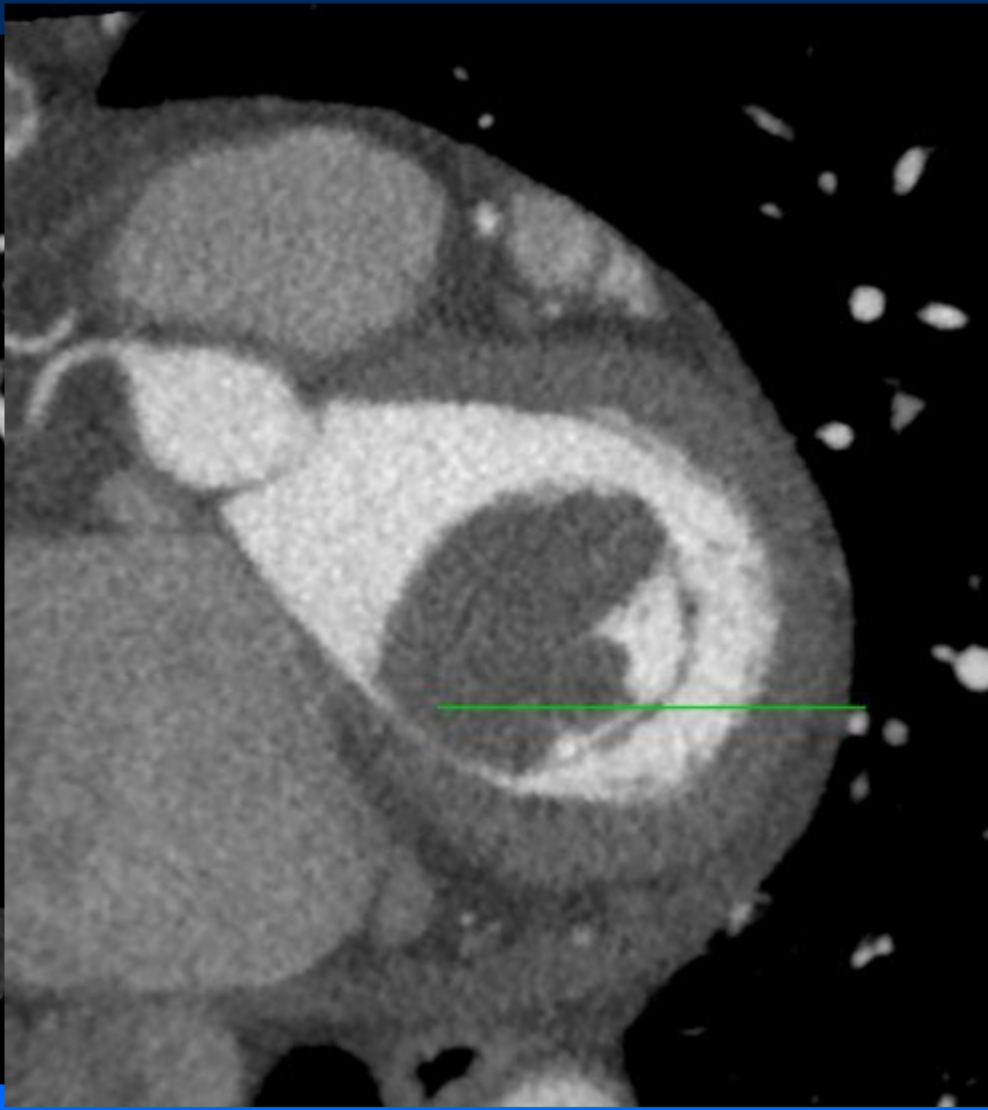
LCx

RCA

No significant stenosis

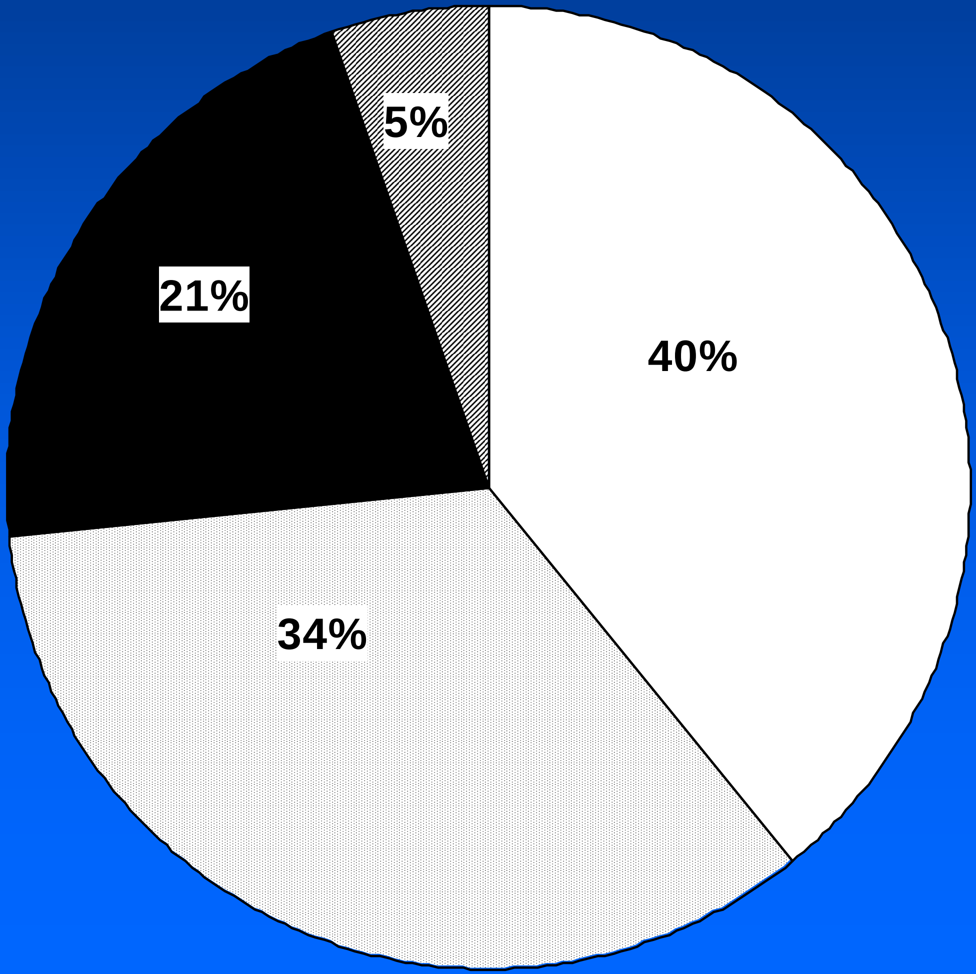
# 320-CT



# MSCT coronary angiography for actual rule out of CAD

*N=340*




***No CAD: 40%***

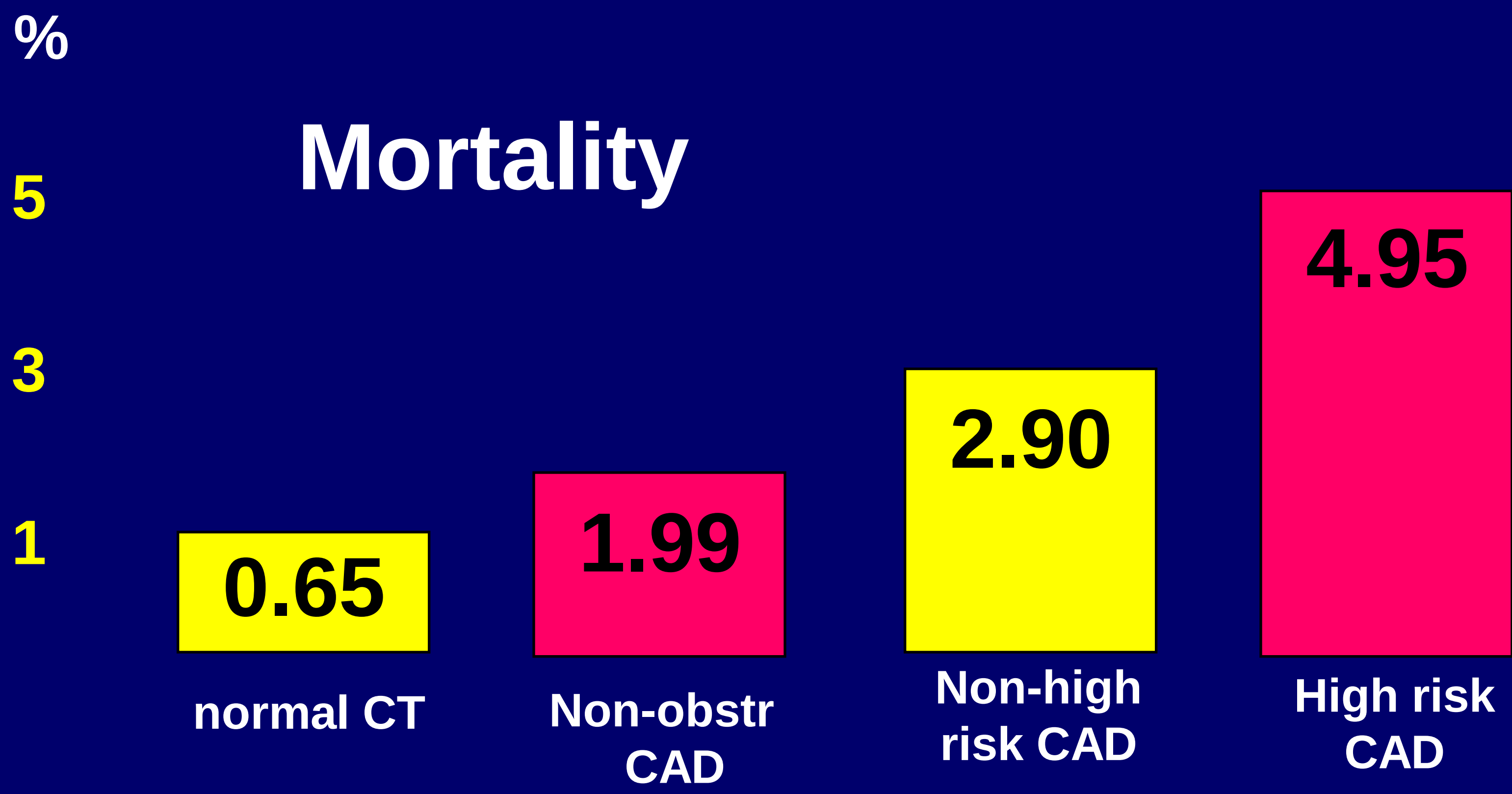
*Non-obstructive CAD: 34%*

*Obstructive CAD: 21%*

*Uninterpretable: 5%*

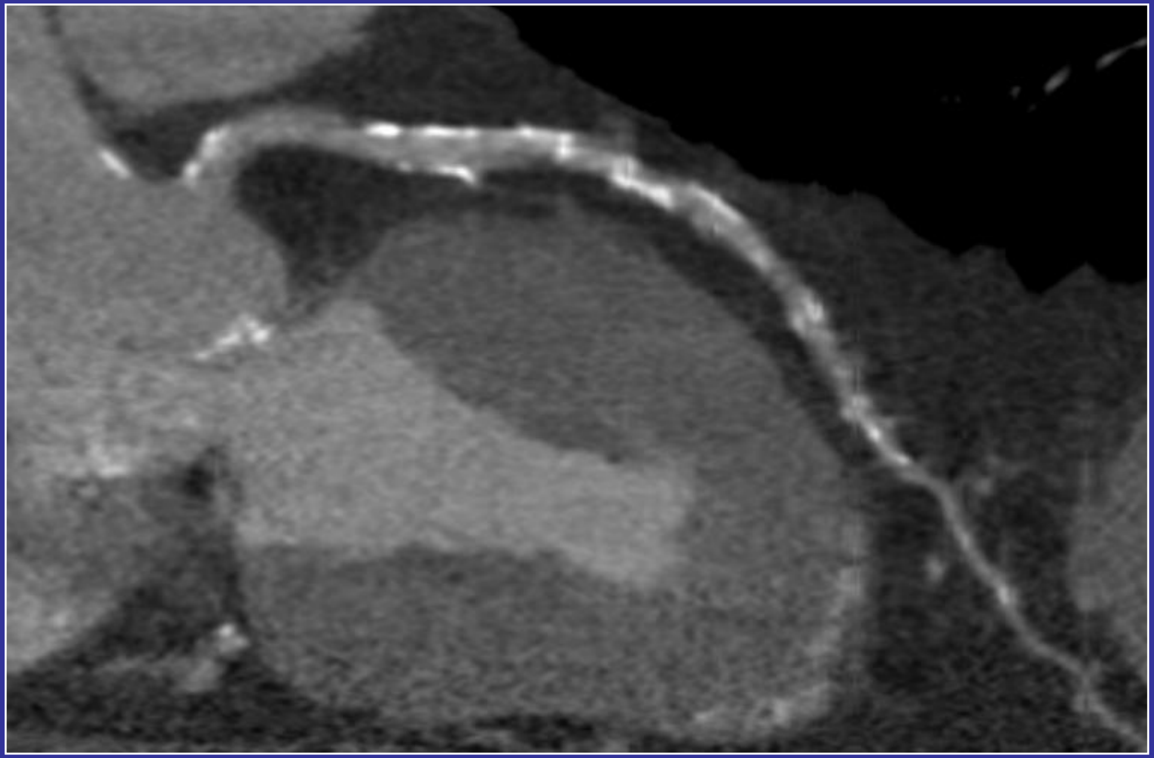
**Henneman et al. EHJ 2008**

# Prognosis MSCT
# 13,966 pts, mean F-up 22.5 months




Chow et al. Circ 2011

# If there is atherosclerosis, then which of these lesions is vulnerable?



# EXAMPLE

- Male, 45 years, no cardiac history
- Presented at ED with acute chest pain

**Risk factors for CAD:**

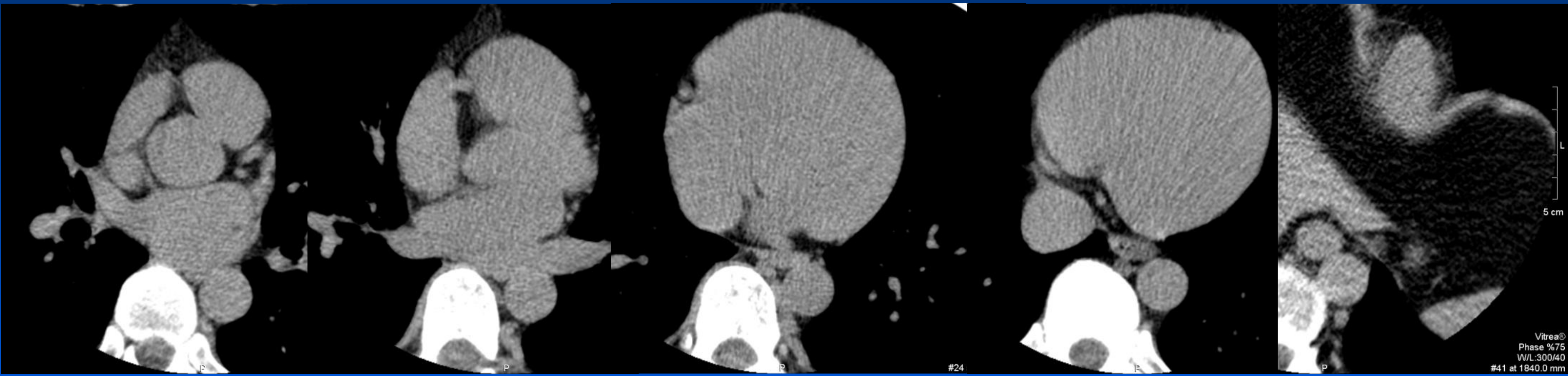
- Hypertension and positive family history

**LAB and ECG:**

- ECG: no ST elevation, no Q waves
- Troponin borderline elevated

ACS?

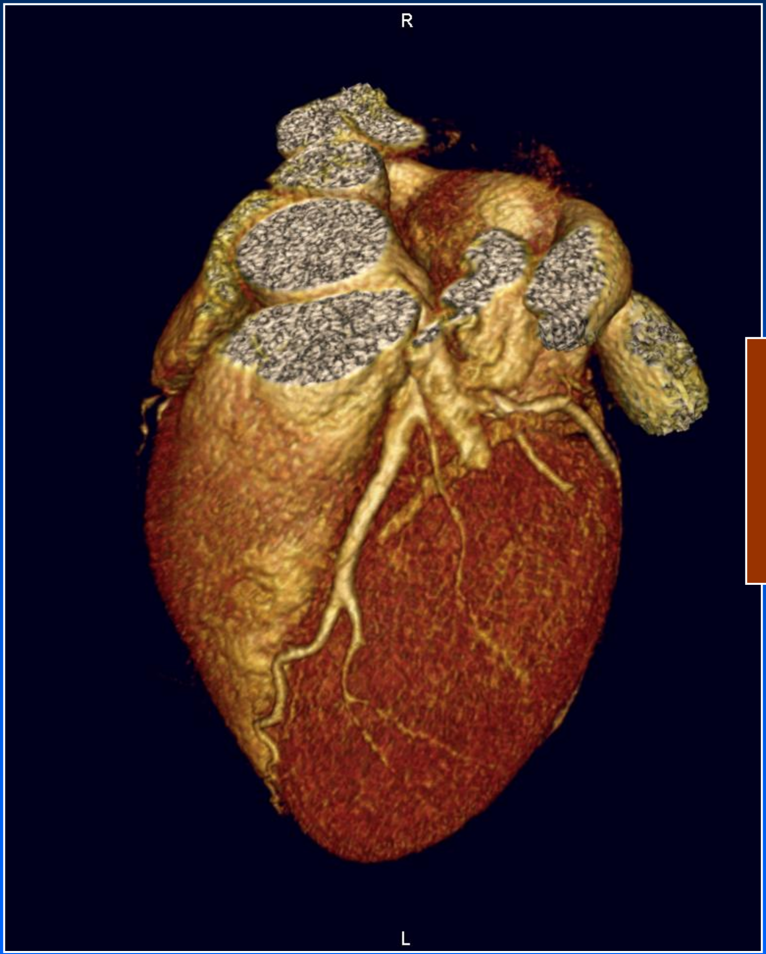
# MSCT calcium

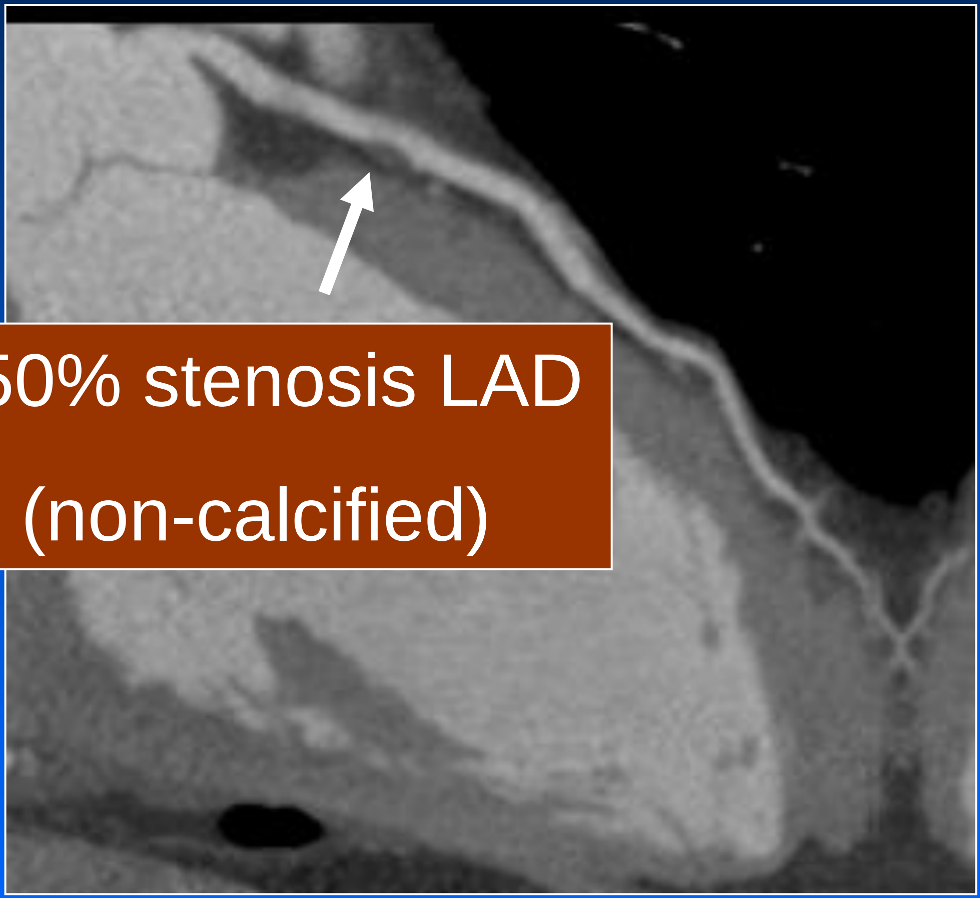



**CALCIUM = 0**

**No significant CAD?**

# MSCT coronary angiography

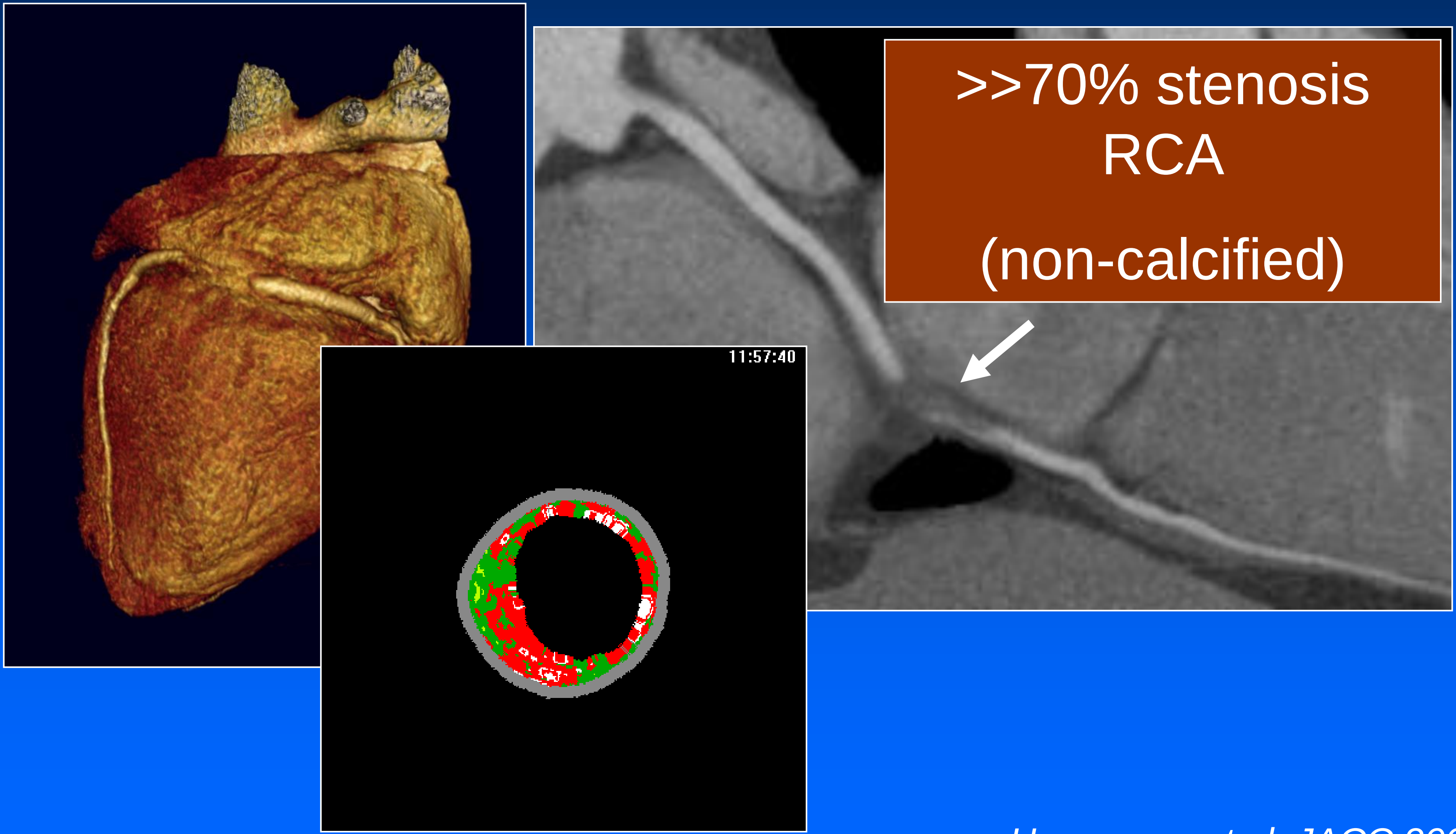


<50% stenosis LAD

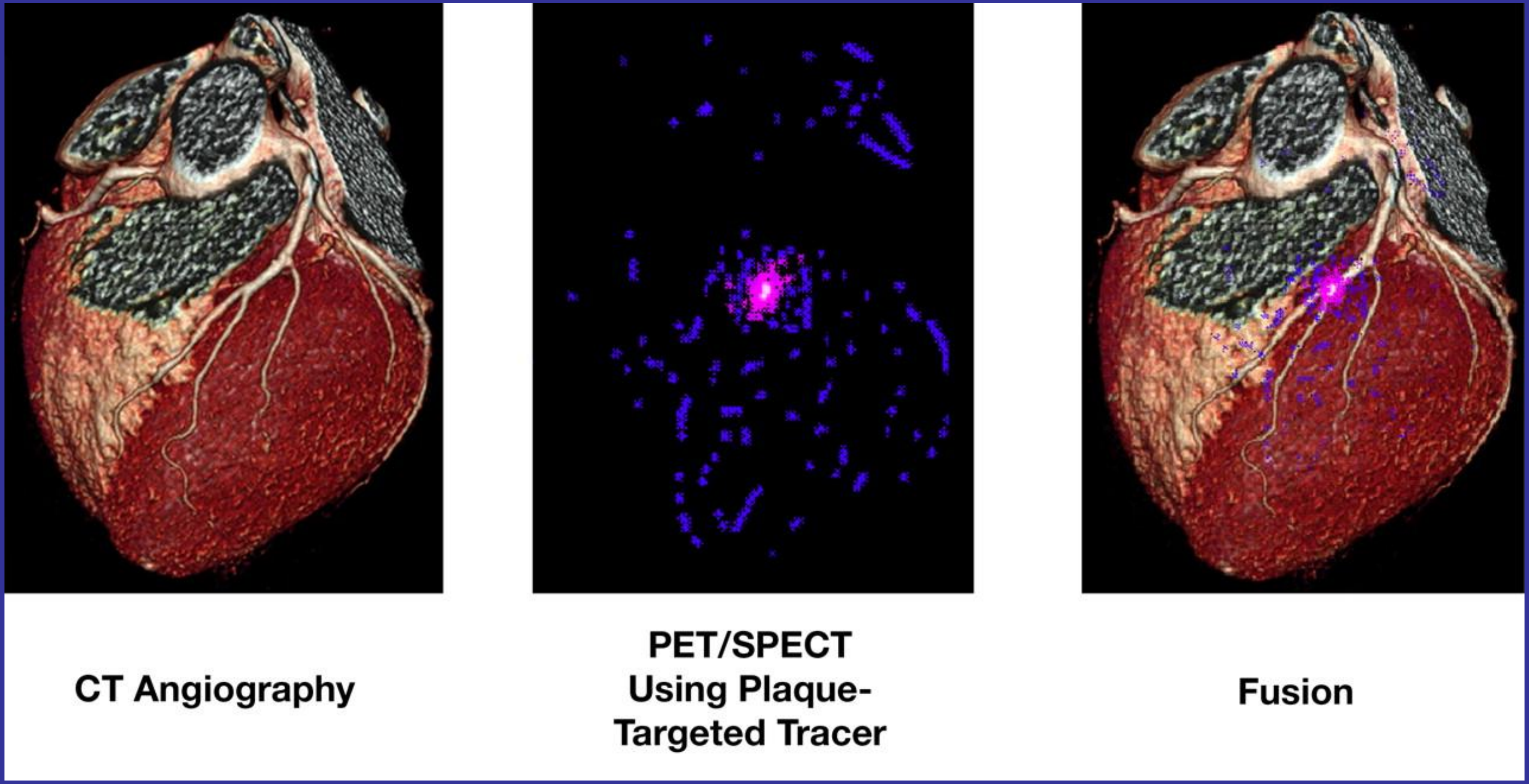
(non-calcified)

# MSCT coronary angiography




*Henneman et al. JACC 2008*

# Fusion between anatomic and functional imaging: PET/SPECT-CT

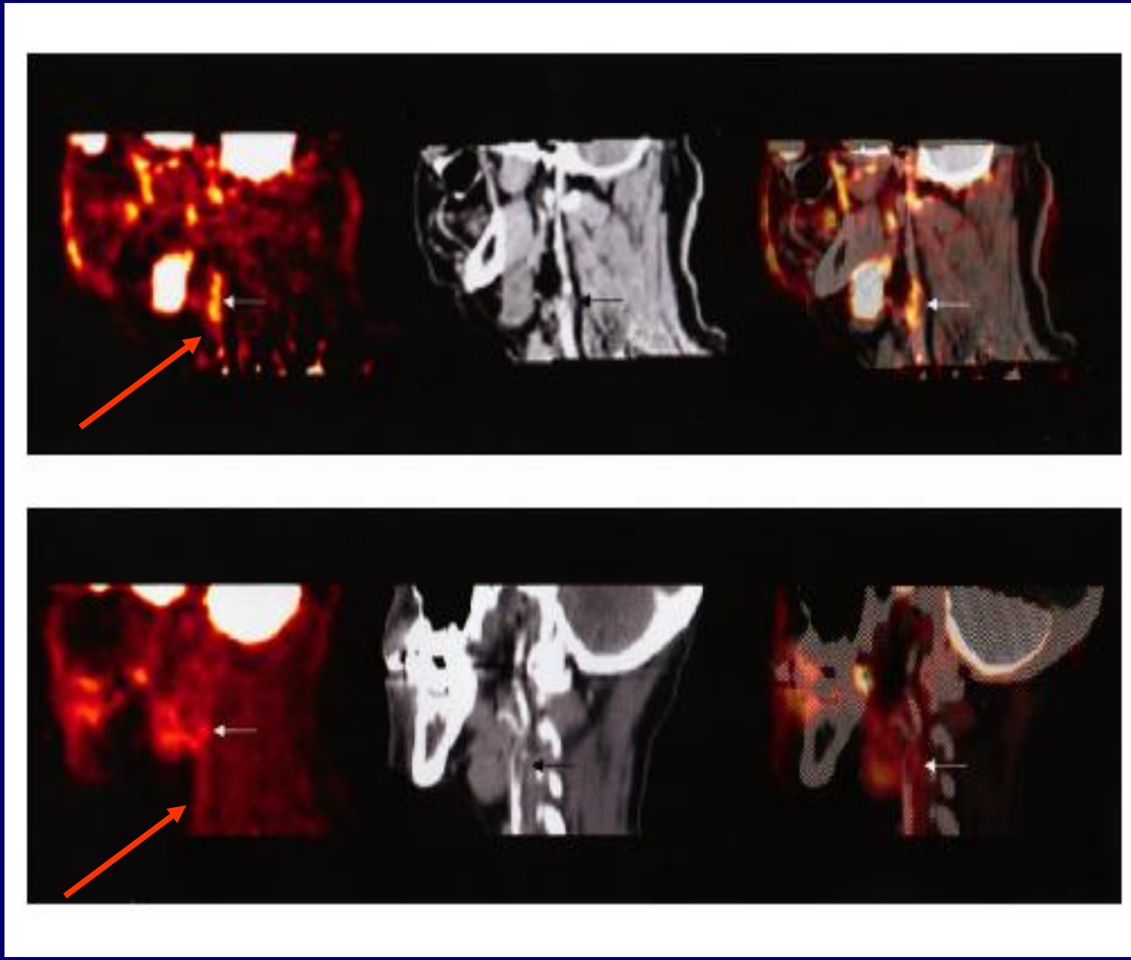



Wu et al. Radiology 2007

# Fusion of anatomic and functional imaging (PET-CT) - carotid arteries

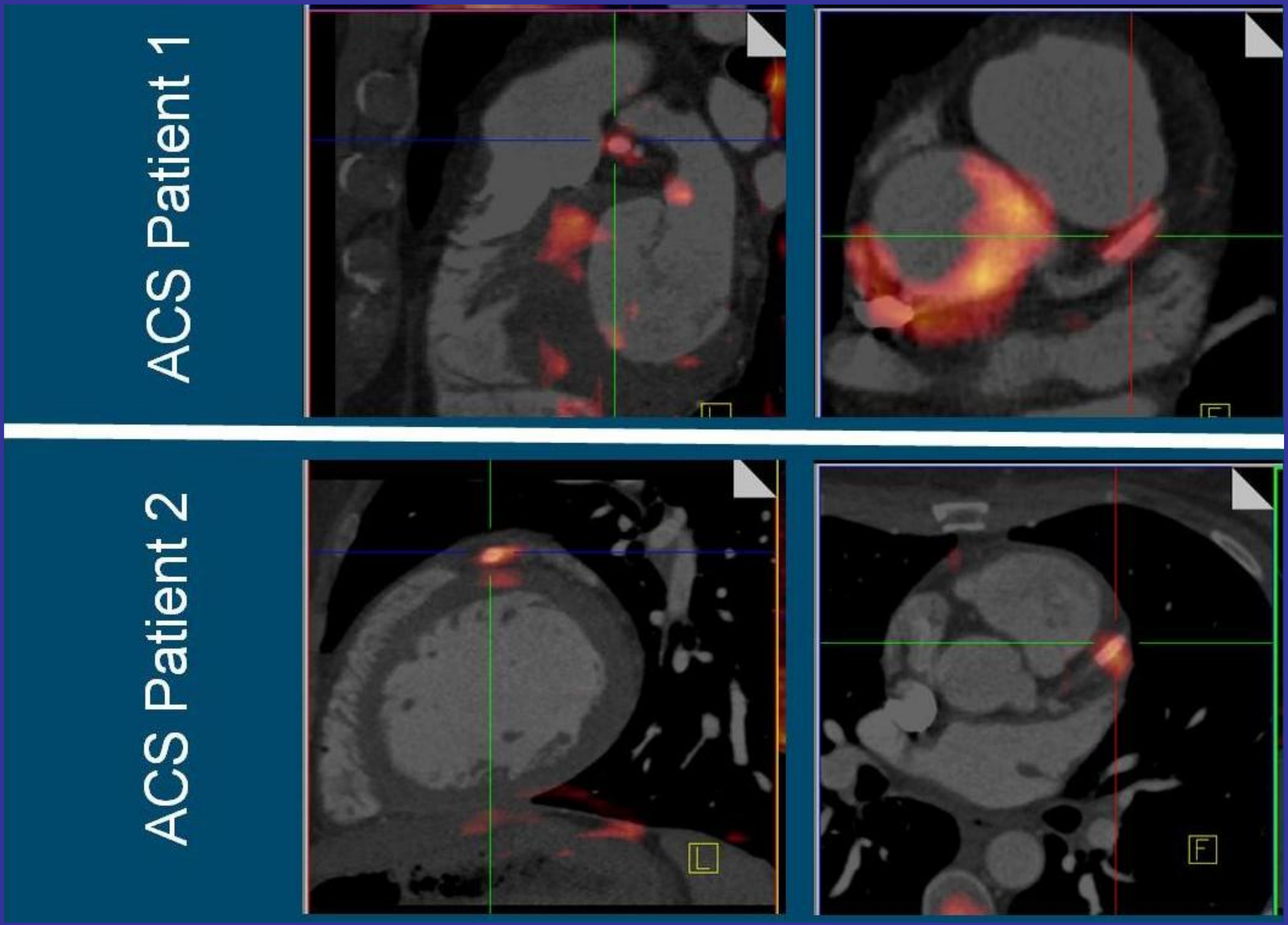
Unstable
(recent TIA)

Stable



Rudd et al. Circ 2002

# Plaque inflammation on FDG PET - CTA




Coregistered FDG-PET and CTA images demonstrating increased FDG uptake in LAD plaques stented for ACS

Rogers et al ACC 2008

# Assessing vulnerable plaque:

- What are the characteristics?
- Which imaging technology?

- When to assess?
- Do we need to assess periodically?

- Will it improve outcome?
- What are the therapeutic consequences?