Differential imaging: which imaging when?

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4 major imaging techniques:

- Echocardiography
- Magnetic resonance imaging
- Multi-slice CT
- Nuclear imaging (PET and SPECT)
- Can provide all anatomical and functional information, but use should be clinically driven

Based on the clinical presentation:

Ask yourself questions:

What information do I need to
- diagnose
- treat
this patient

Diagnosis is important

But the imaging results need to have impact on choice of therapy

Man 41 years old

Outpatient clinics:

No symptoms

Risk factors for CAD:

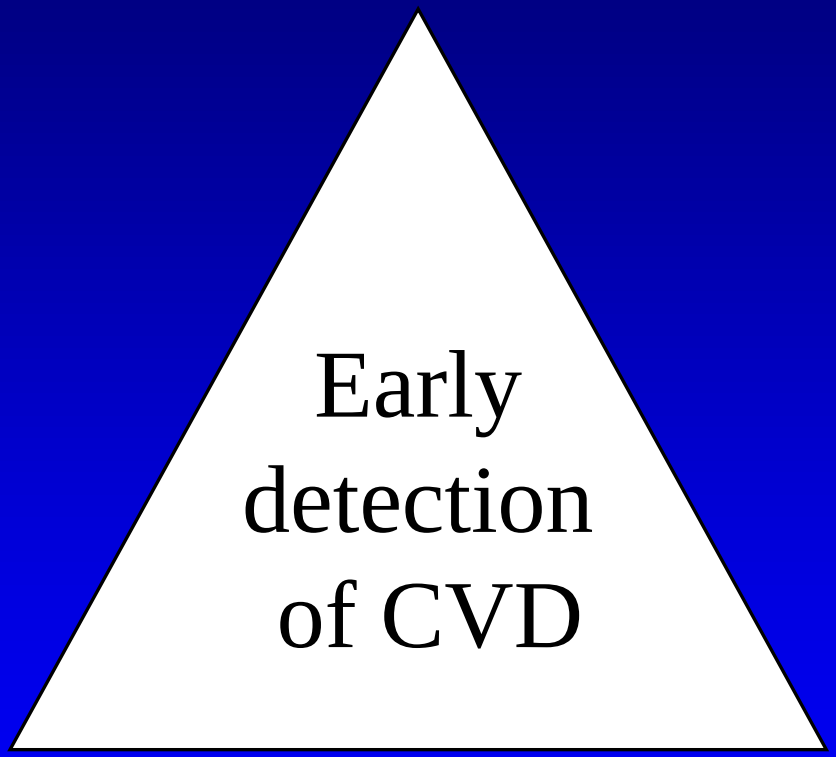
***Brother SCD age 43**

Asymptomatic individual, low risk for atherosclerosis

The question is:

Risk stratification – early detection

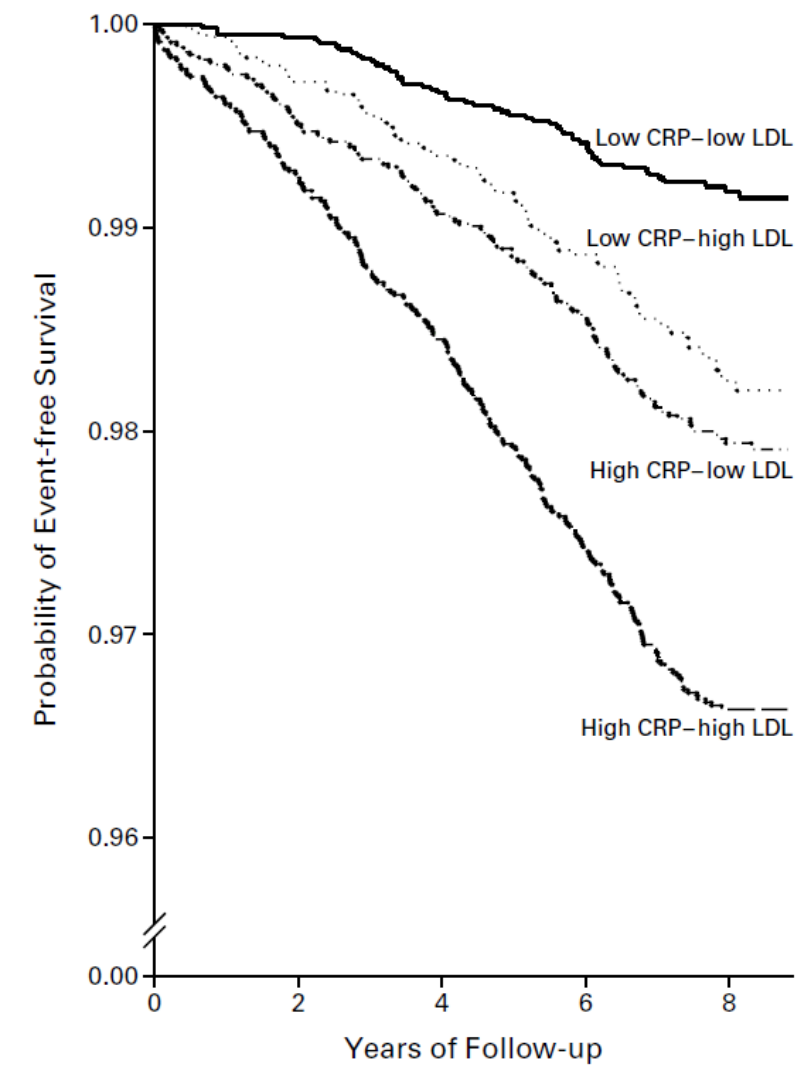
Blood:
biomarkers



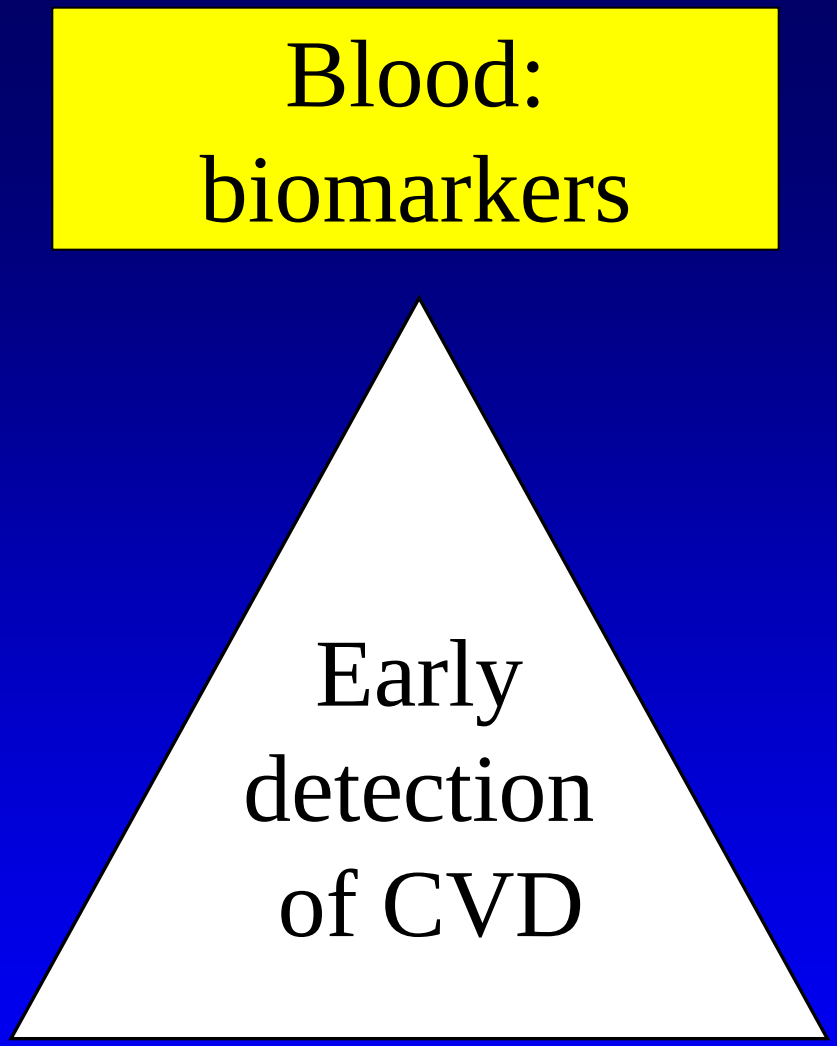
Large arteries:
Global: atherosclerosis

Coronary arteries:
Focal: lesion characteristics

Cardiovascular event-free survival, according to CRP and LDL

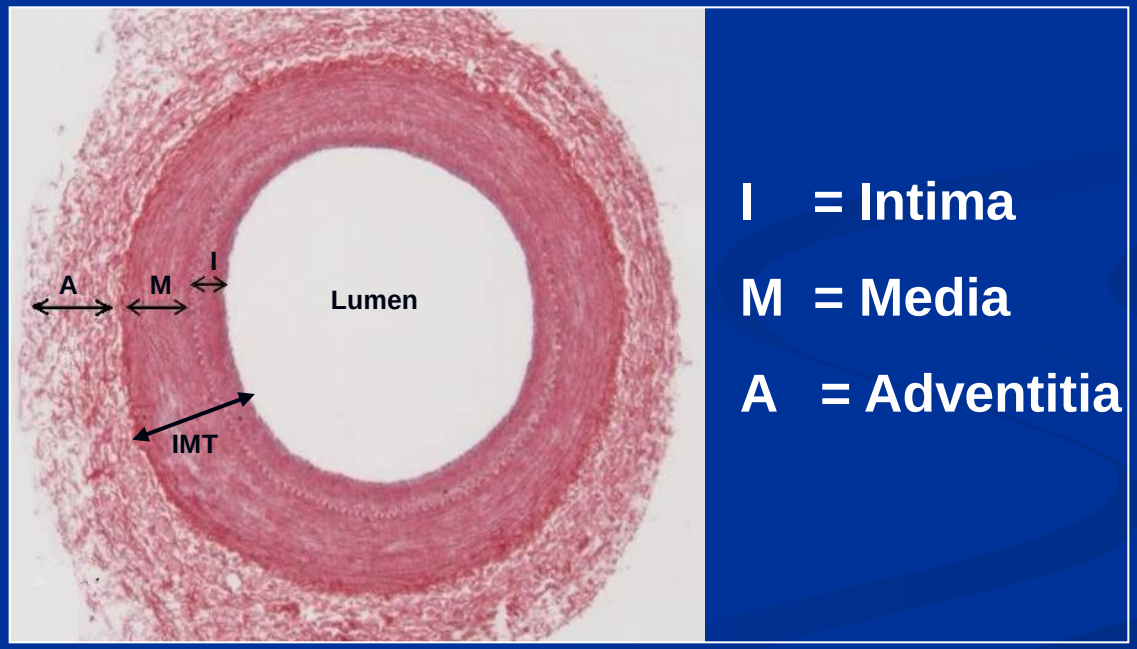


Ridker et al. NEJM 2002


Blood:
biomarkers
Early
detection
of CVD
Large arteries:
Global: atherosclerosis
Coronary arteries:
Focal: lesion characteristics

Carotid Intima Media Thickness (CIMT)

Tissue between luminal edge of the artery and the boundary between media and adventitia



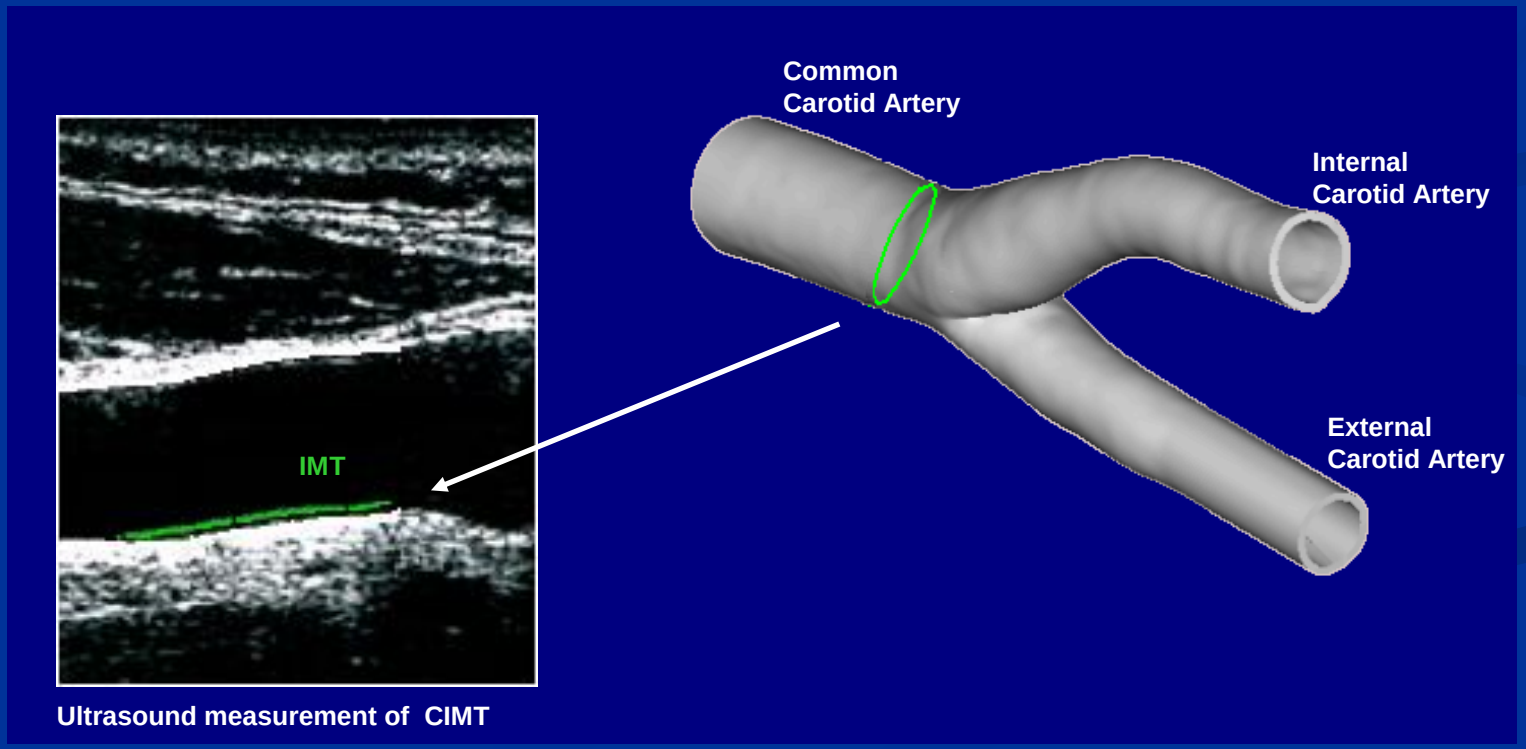
Assessment of CIMT

Semi-automatic B-mode ultrasound measurements

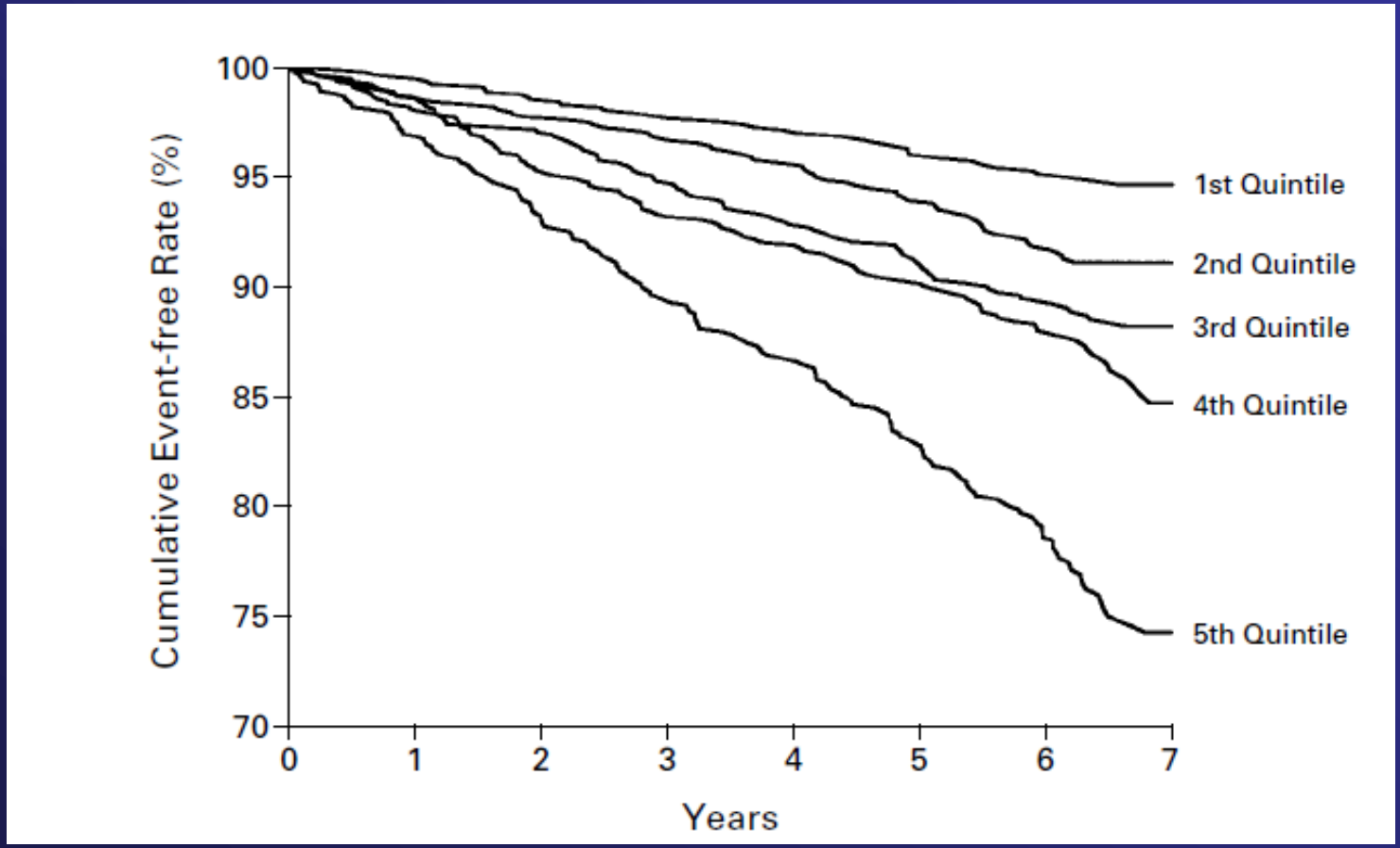
Left and right common carotid artery, directly proximal to the bifurcation

Mean CIMT measurements at four angles

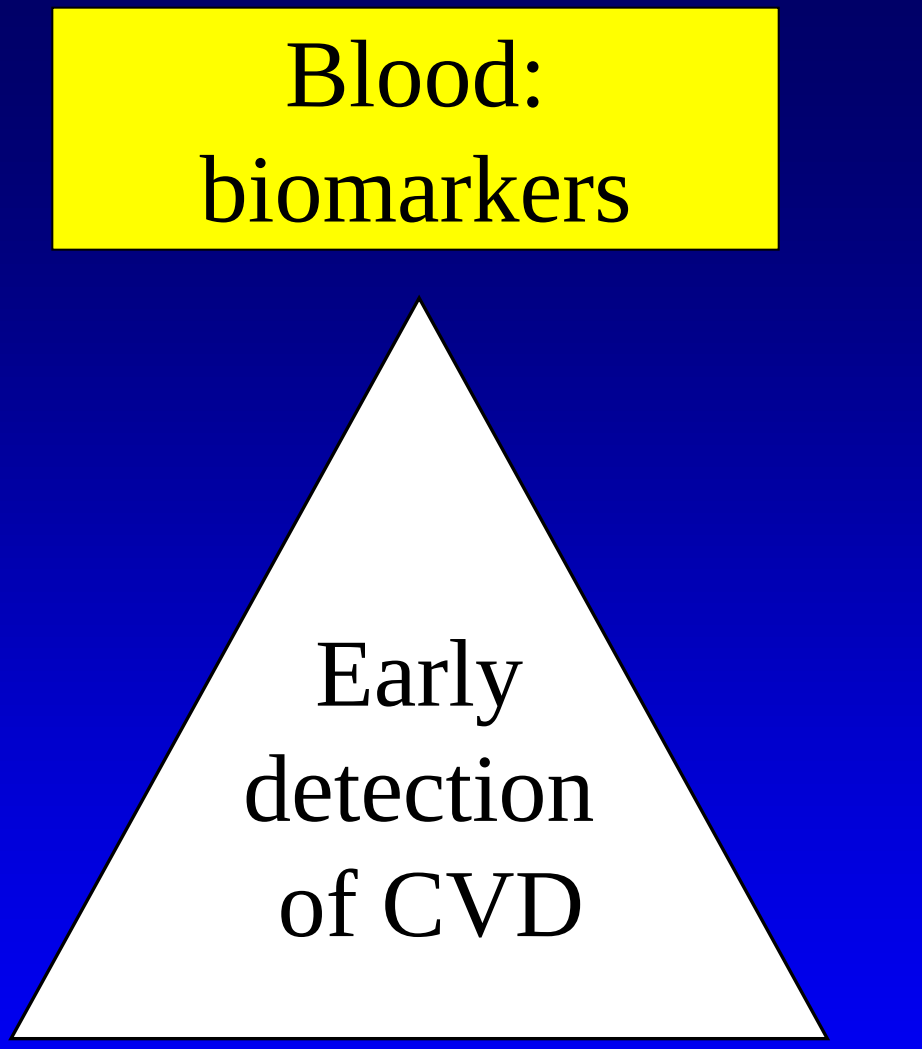
Calculation of the average of 8 mean CIMT per patient



Cumulative event free rate (stroke or MI) according to IMT quintiles



O'Leary et al. N Eng J Med 1999


Blood:
biomarkers
Early
detection
of CVD
Large arteries:
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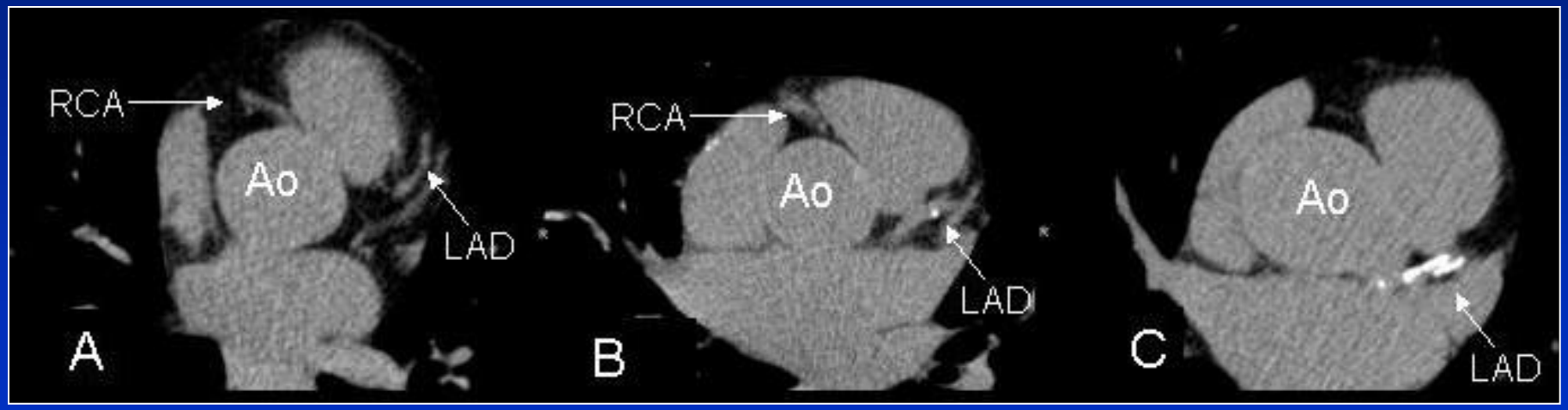
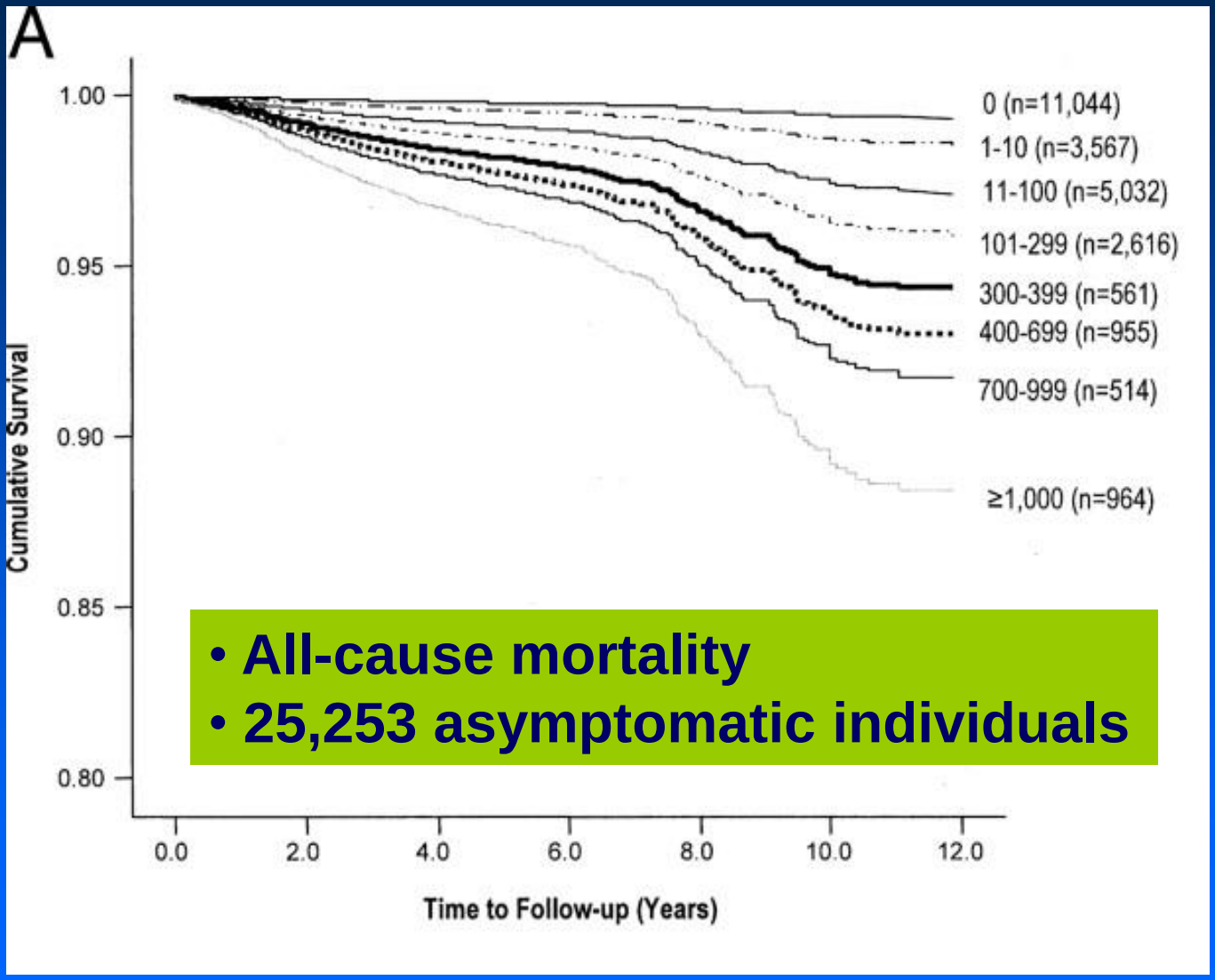
Calcium Scoring (EBCT/MSCT)

No calcification | Moderate calcification | Extensive calcification



Coronary calcifications provide a marker for atherosclerotic disease burden

Calcium score vs risk stratification



Budoff et al. JACC 2007

Man 54 years old

We have screened some years ago: nothing; now the symptoms change and developed 1 RF

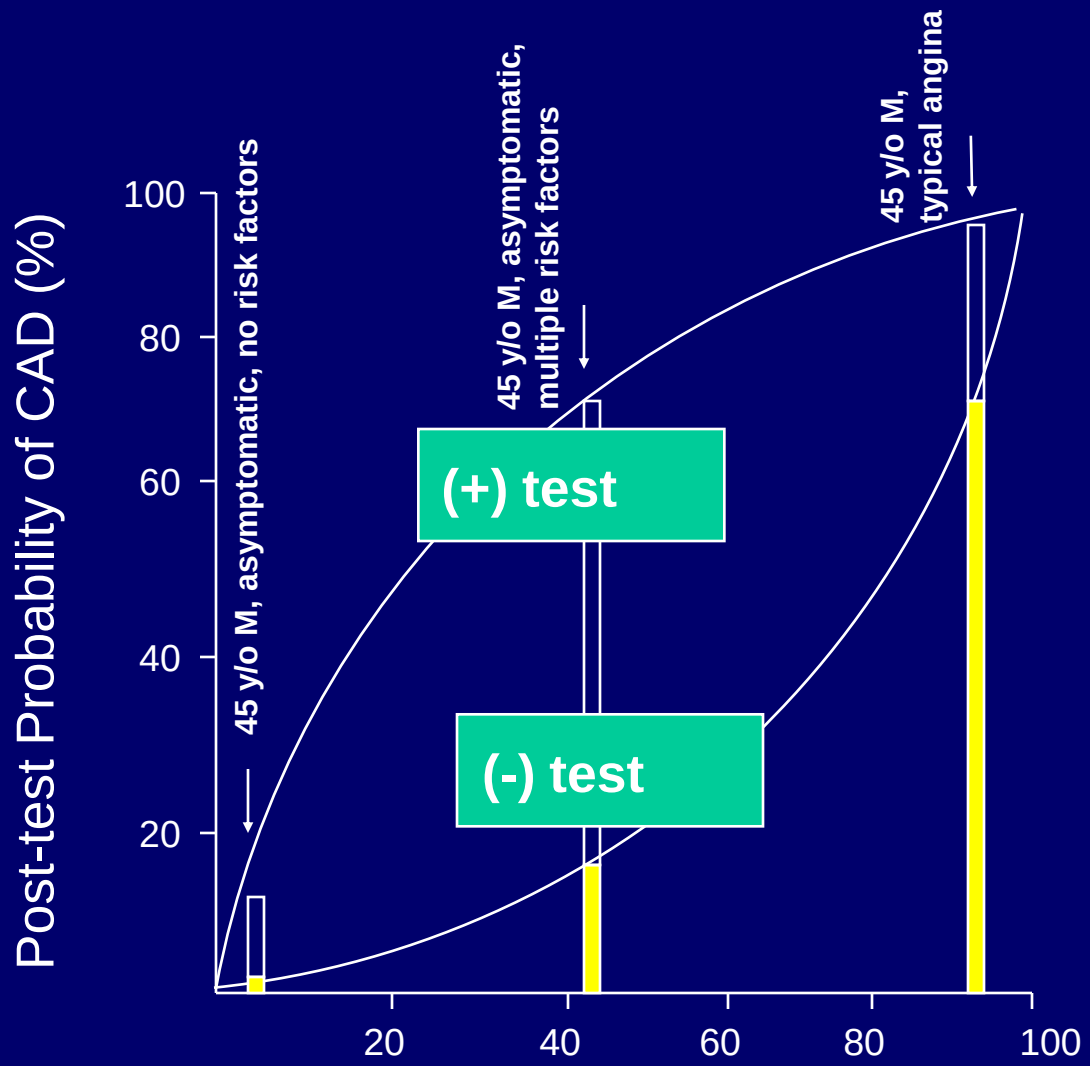
Outpatient clinics:

Dyspnea or atypical chest pain at exercise

Risk factors for CAD:

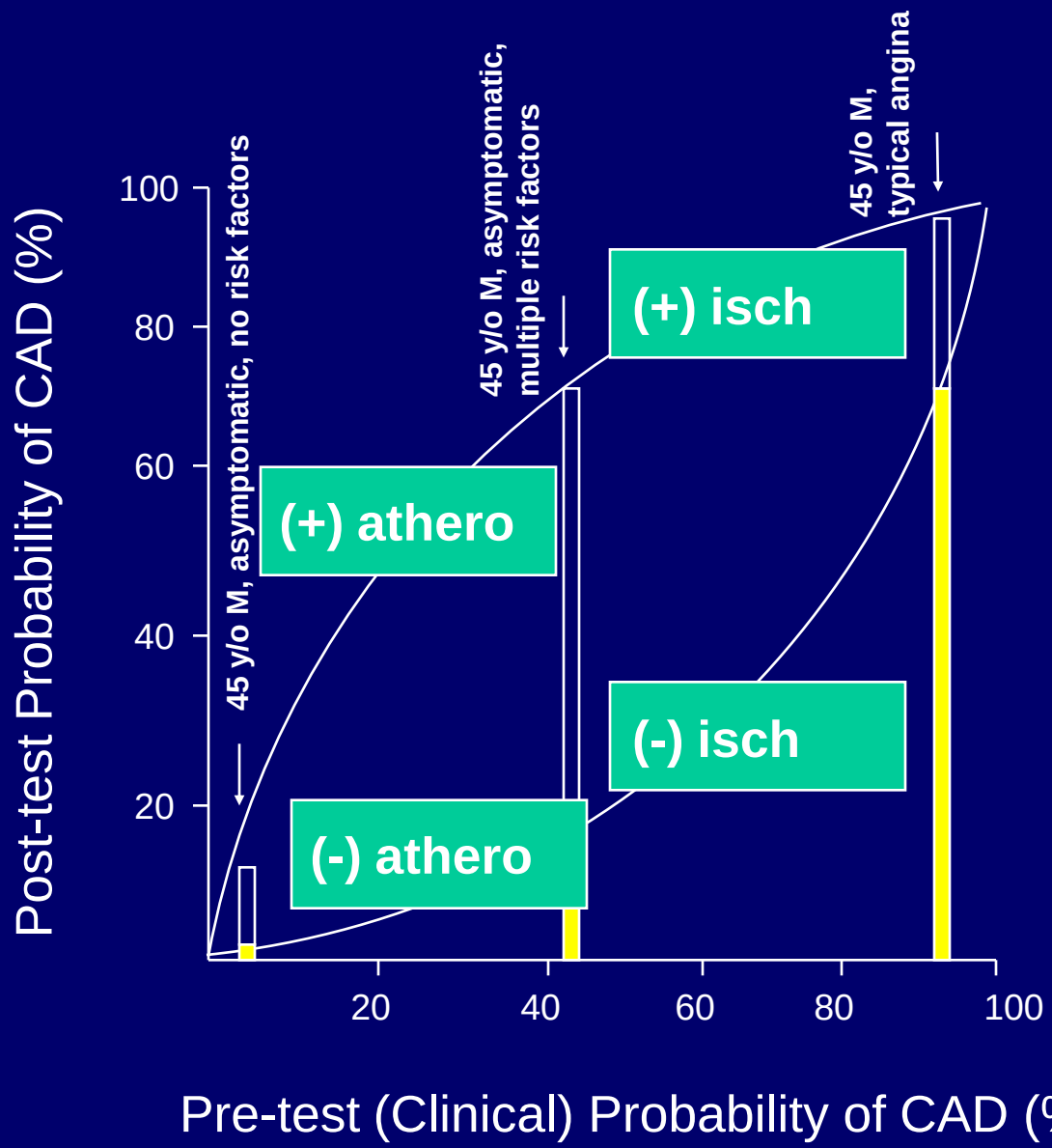
***Dyslipidemia**

Non-invasive assessment of CAD: Which Patients?



Patterson et al. JACC 1989

Non-invasive assessment of CAD: Which Patients?



Patterson et al. JACC 1989

Symptomatic patient, low-intermed risk

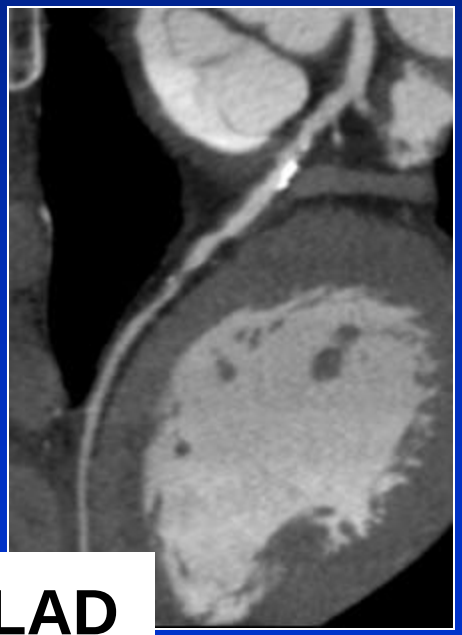
The question is:

Atherosclerosis? (medical therapy needed and follow-up or discharge?)

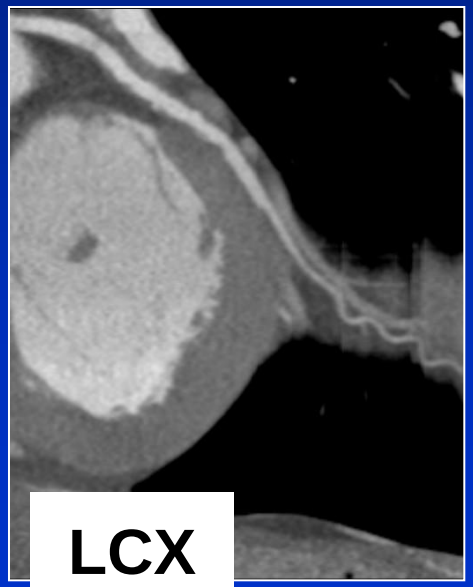
☞ We order a non-invasive anatomical test to detect /exclude atherosclerosis

curved MPR

RCA

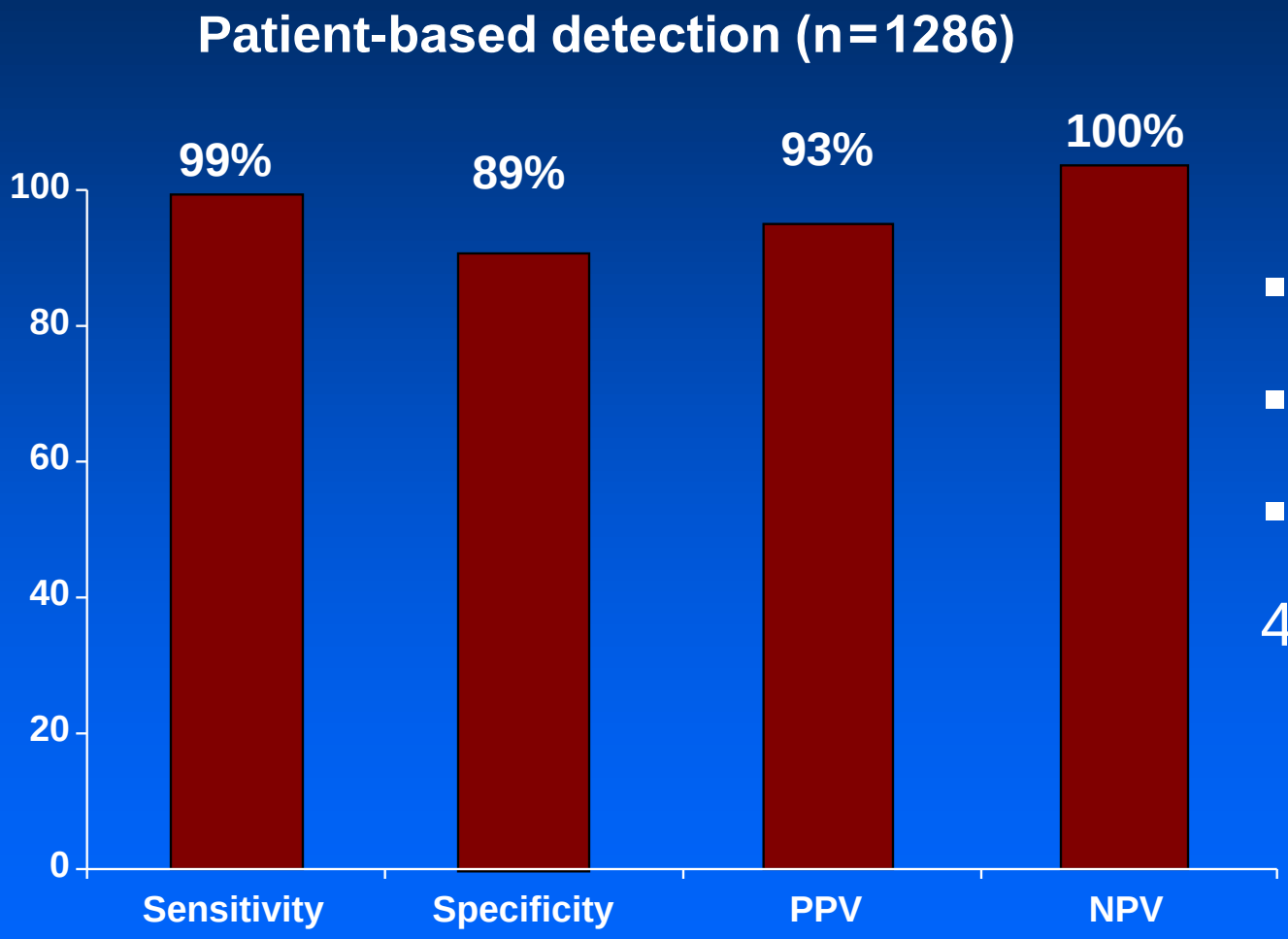


LAD



LCX

Meta-analysis 64-slice CT

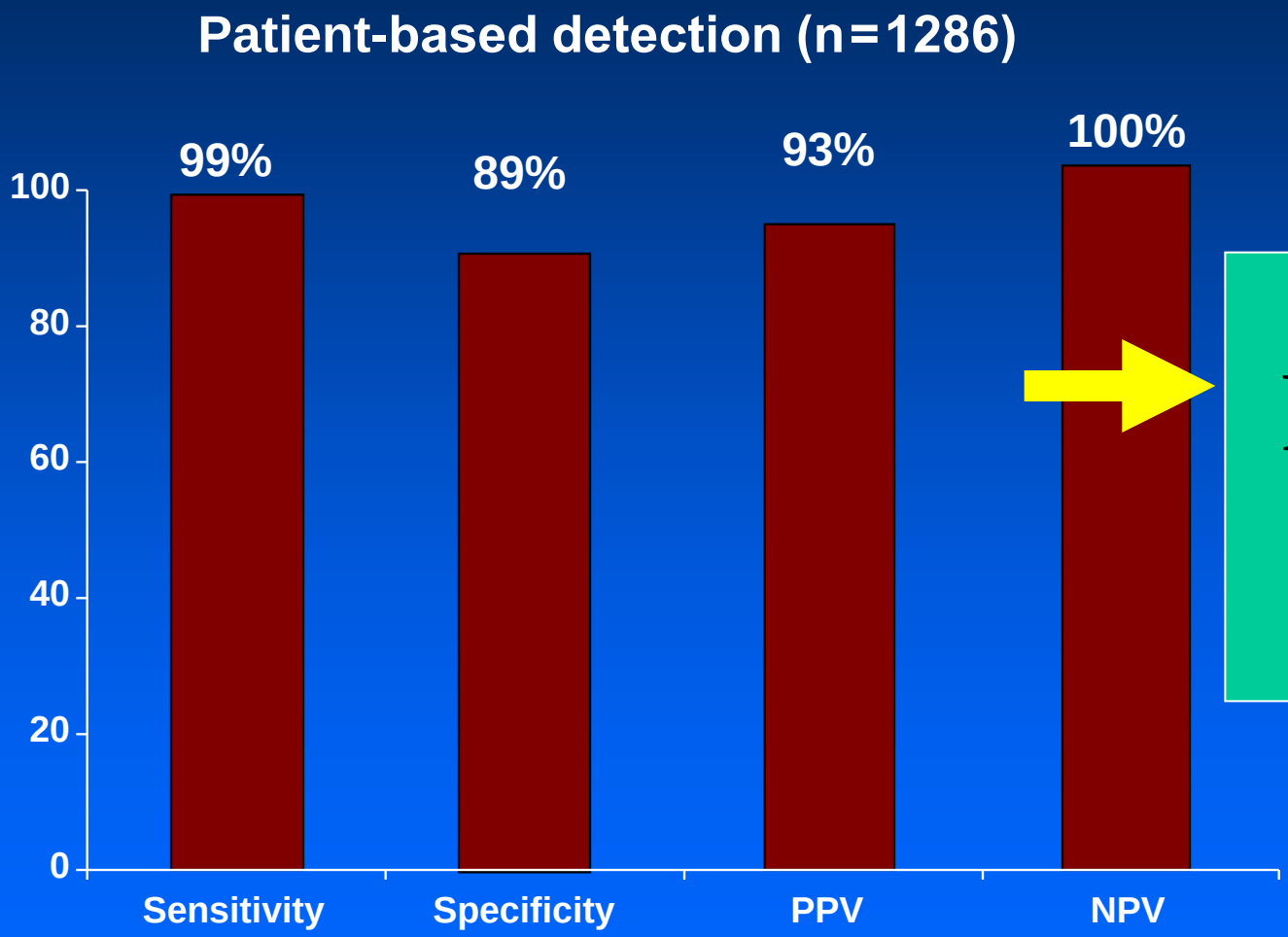


- ≥ 50% stenosis
- versus CAG
- Not assessable:

4% (0-14%)

Mowatt et al *Heart* 2008

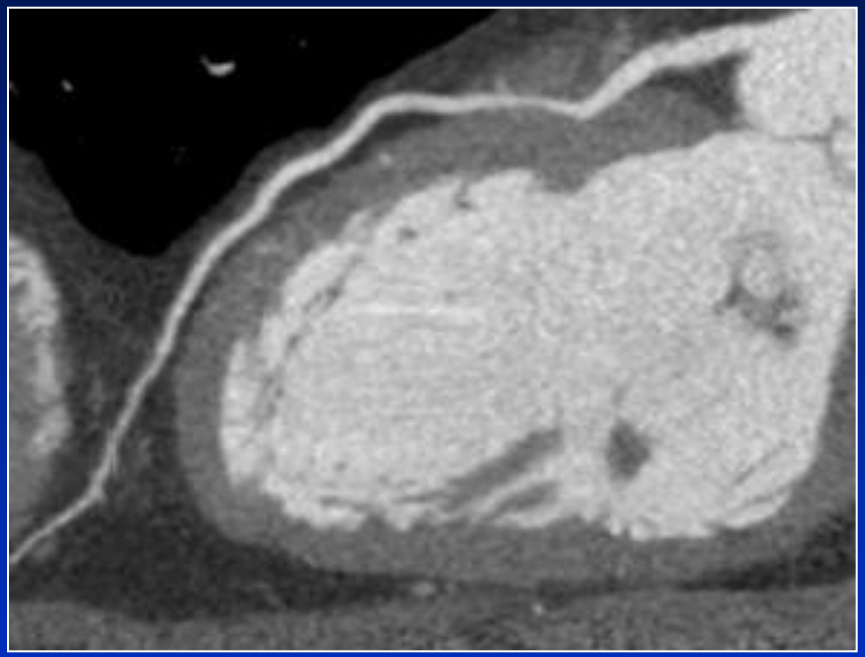
Meta-analysis 64-slice CT



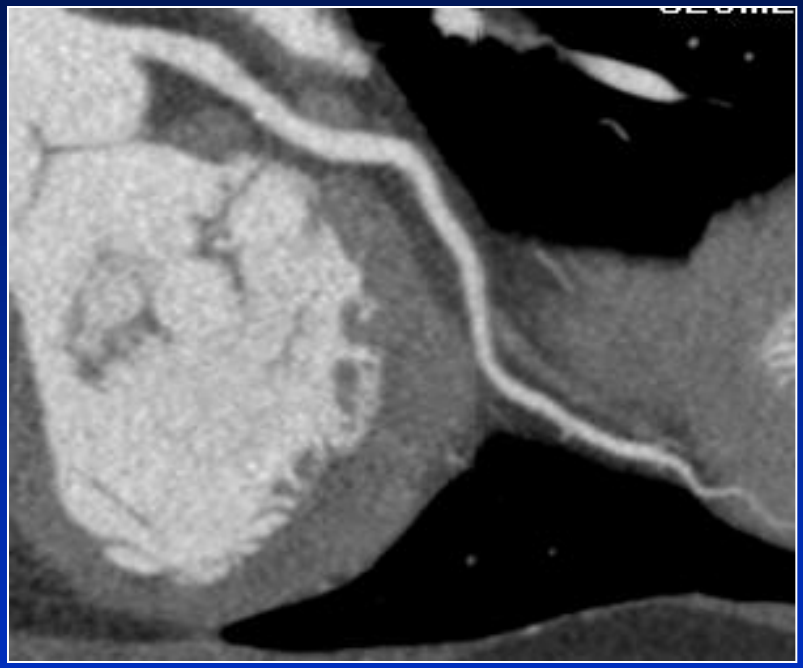
Rule out CAD

Mowatt et al *Heart* 2008

Non-invasive angiography - MSCT

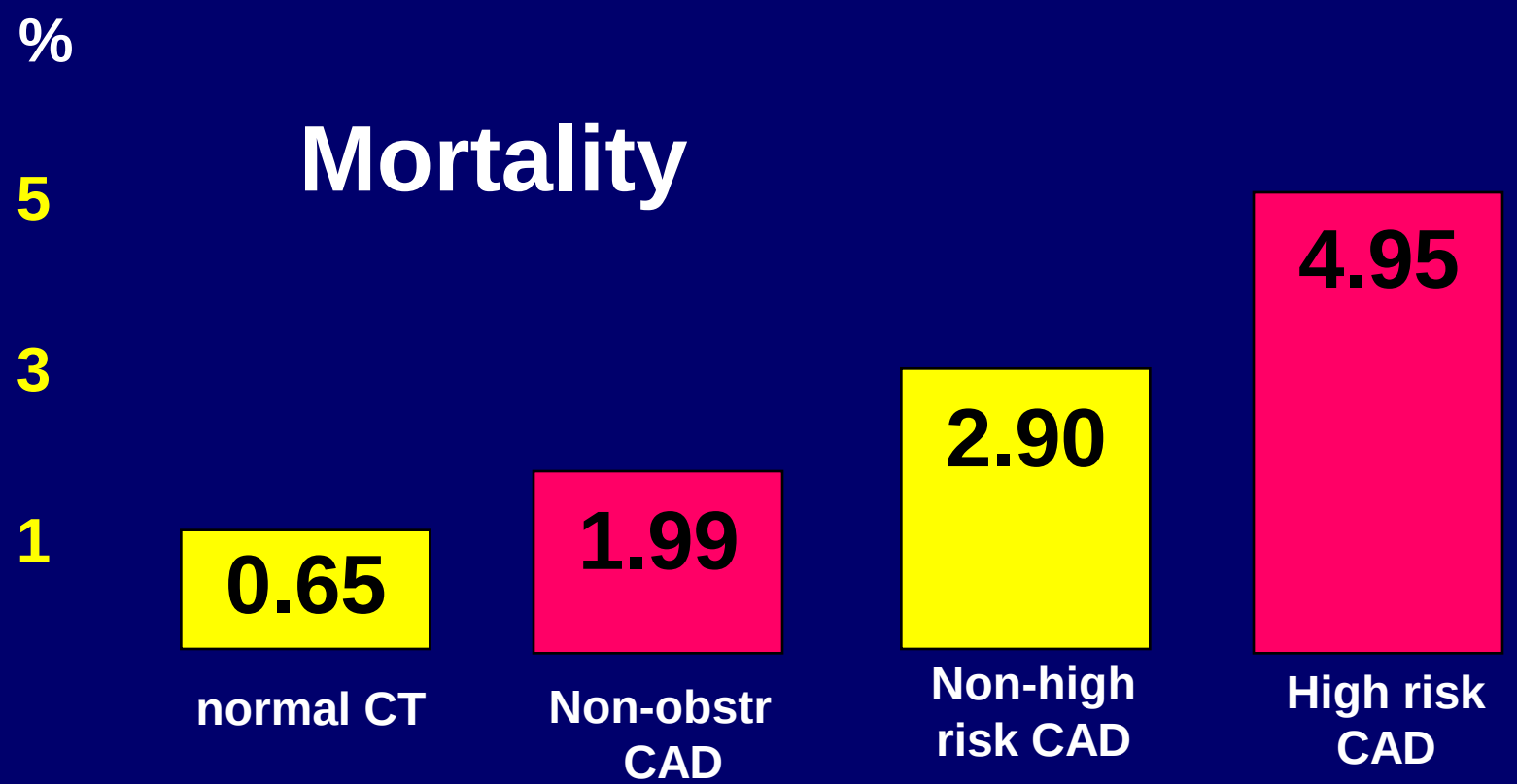


LAD: normal



LCx: normal

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



Chow et al. Circ 2011

Man 61 years old

Earlier on no atherosclerosis, but RFs have increased, symptoms have changed

Outpatient clinics:

chest pain at rest, sometimes stress

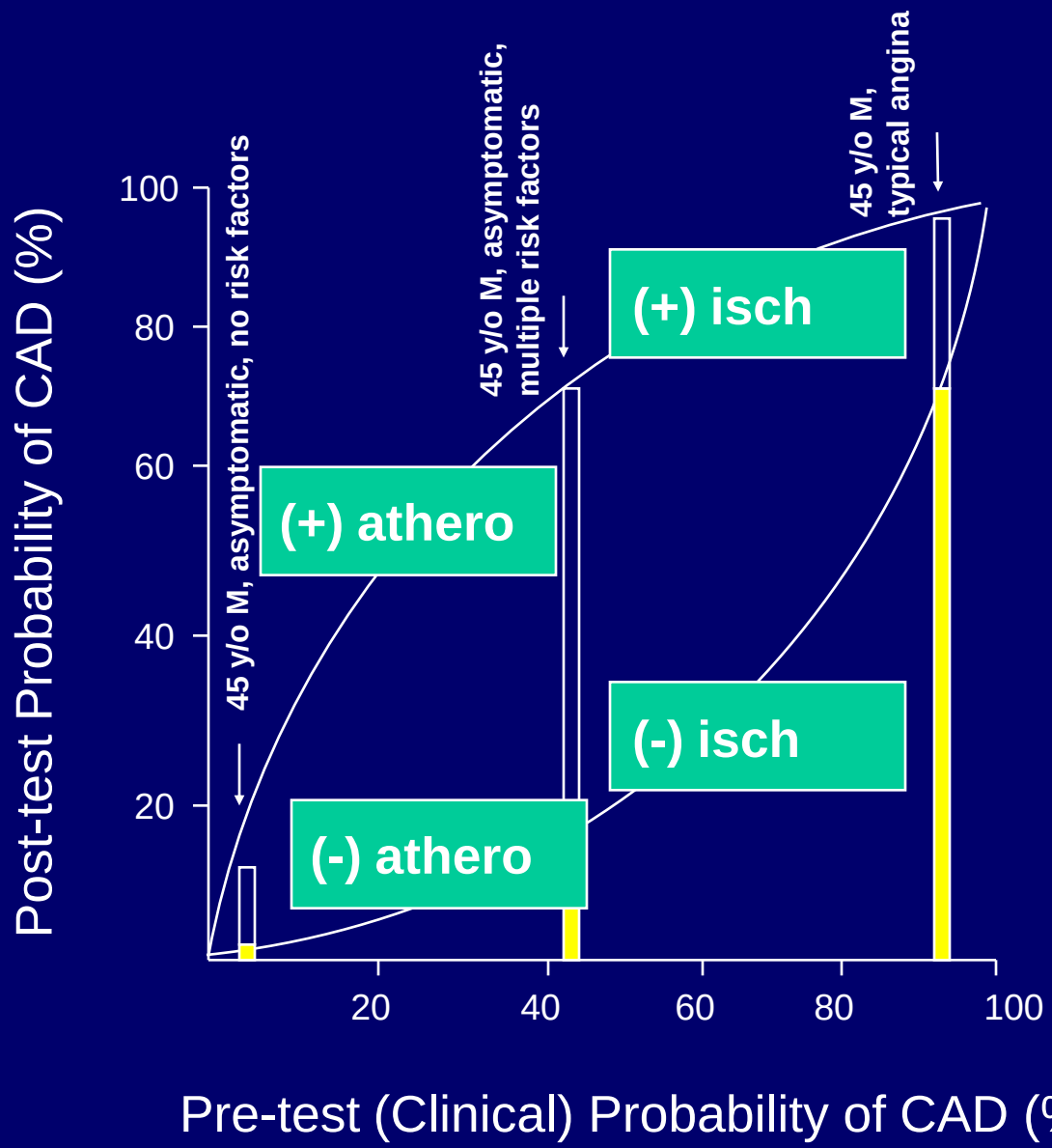
Risk factors for CAD:

*Hypercholesterolemia

*Hypertension

*Smoking

Non-invasive assessment of CAD: Which Patients?



Patterson et al. JACC 1989

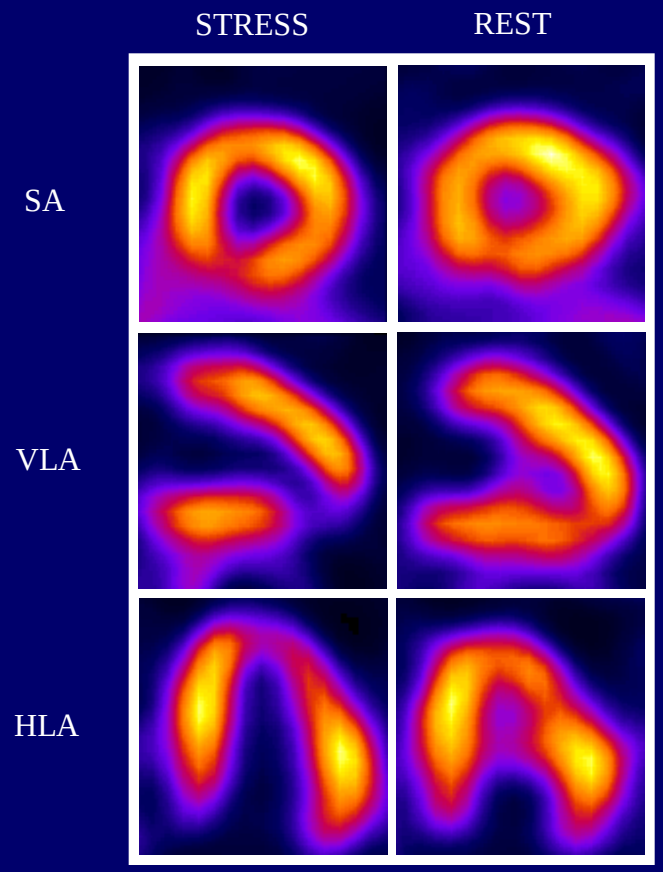
Symptomatic patient, intermed – high pre-test likelihood

The patient has high likelihood to have atherosclerosis

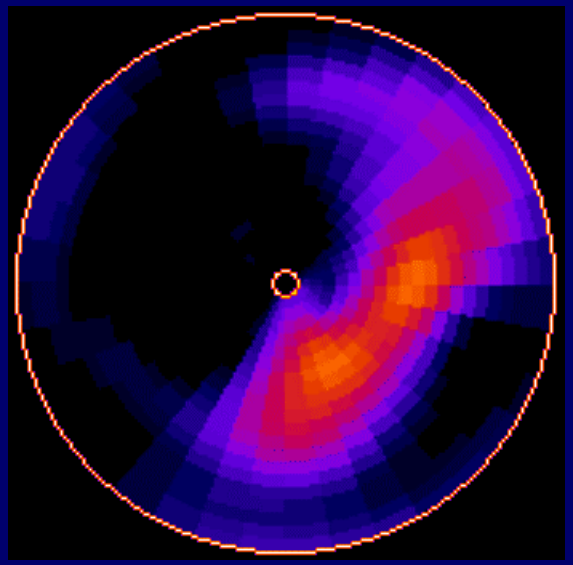
The question is: does he have ischemia? (is intervention needed?)

☞ We order a non-invasive ischemia test

Nuclear perfusion imaging, SPECT



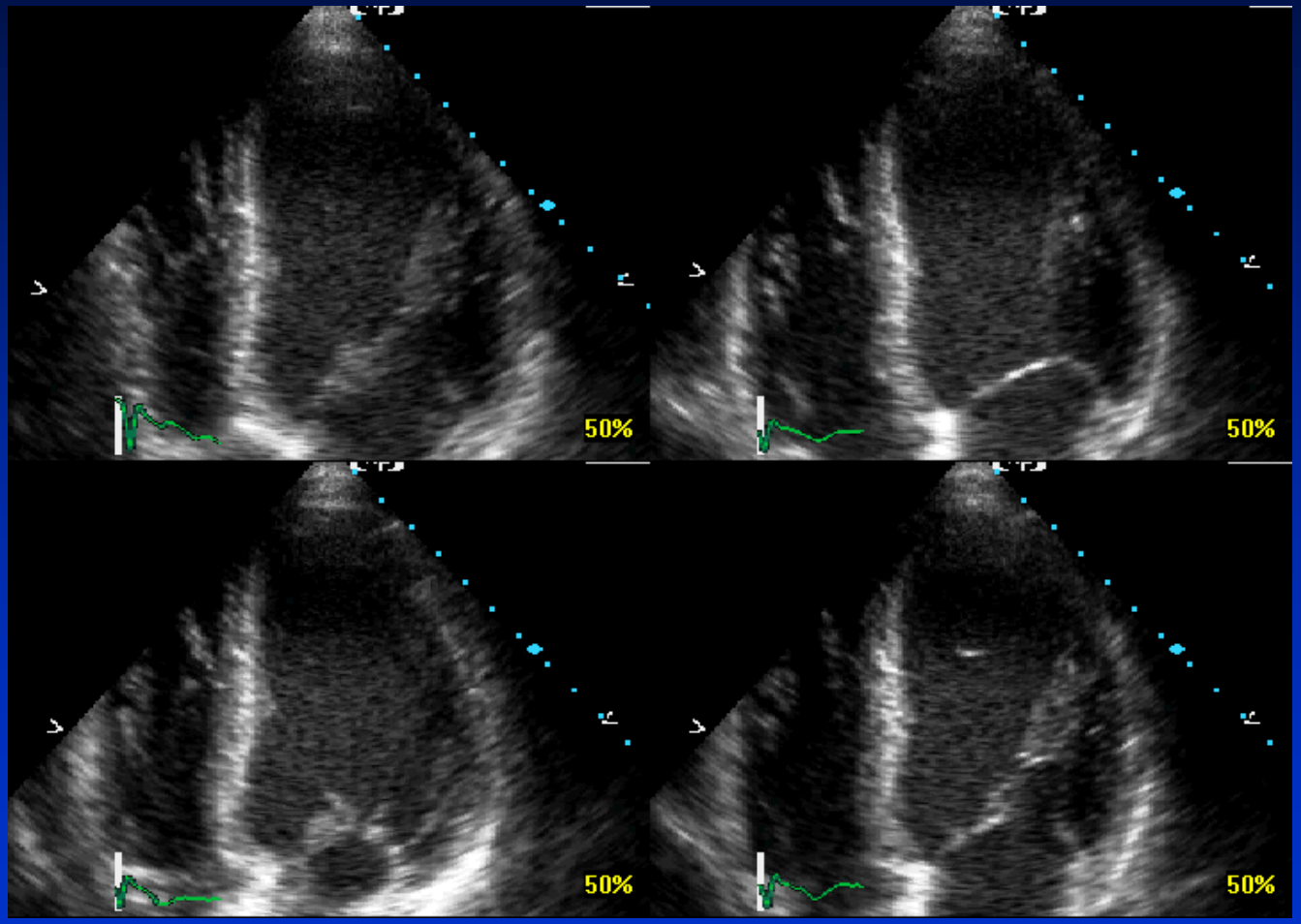
POLAR MAP TO QUANTIFY
EXTENT AND SEVERITY OF ISCHEMIA



Stress echo to assess flow-limiting stenosis: wall motion

rest

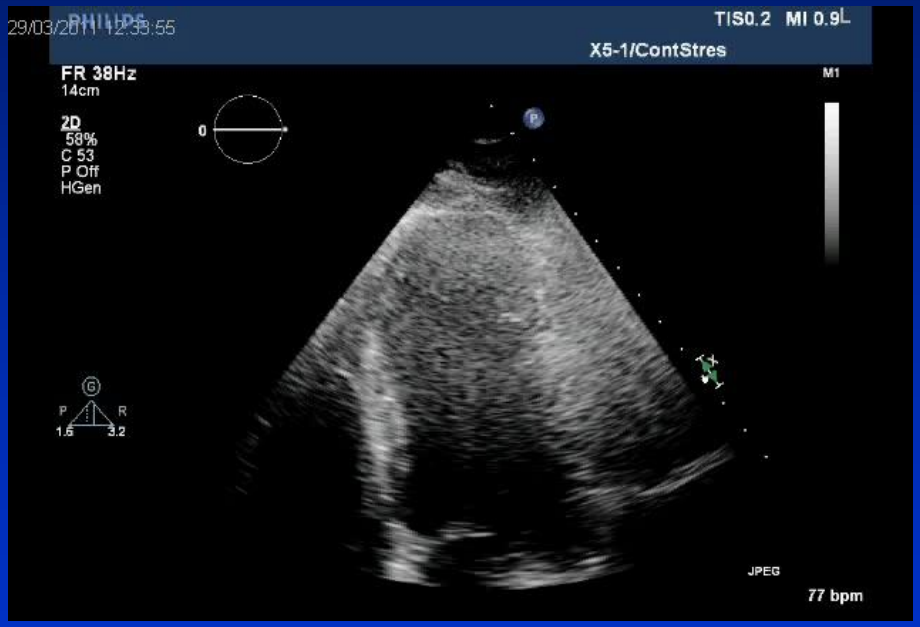
10 mcg



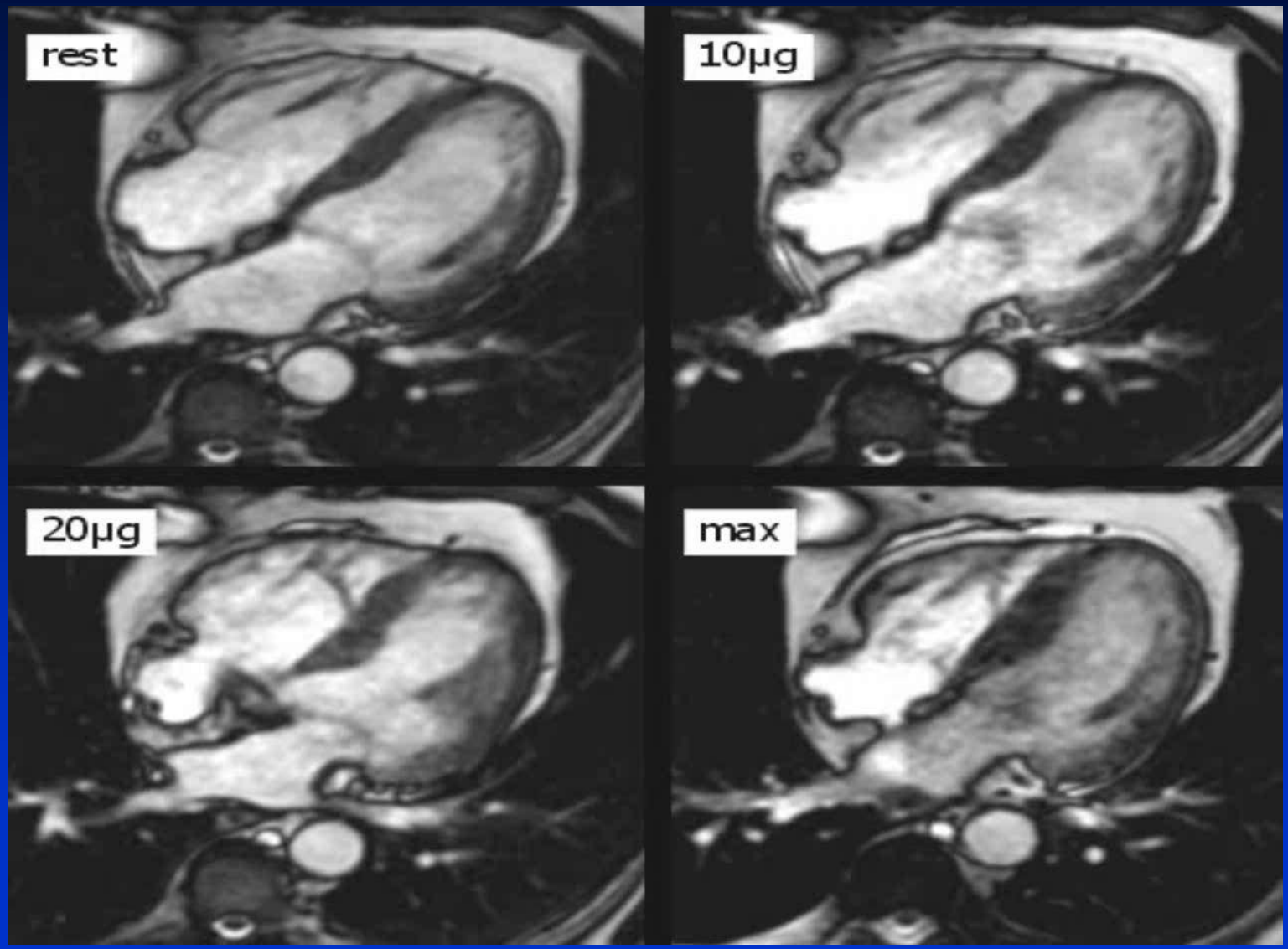
40

rest

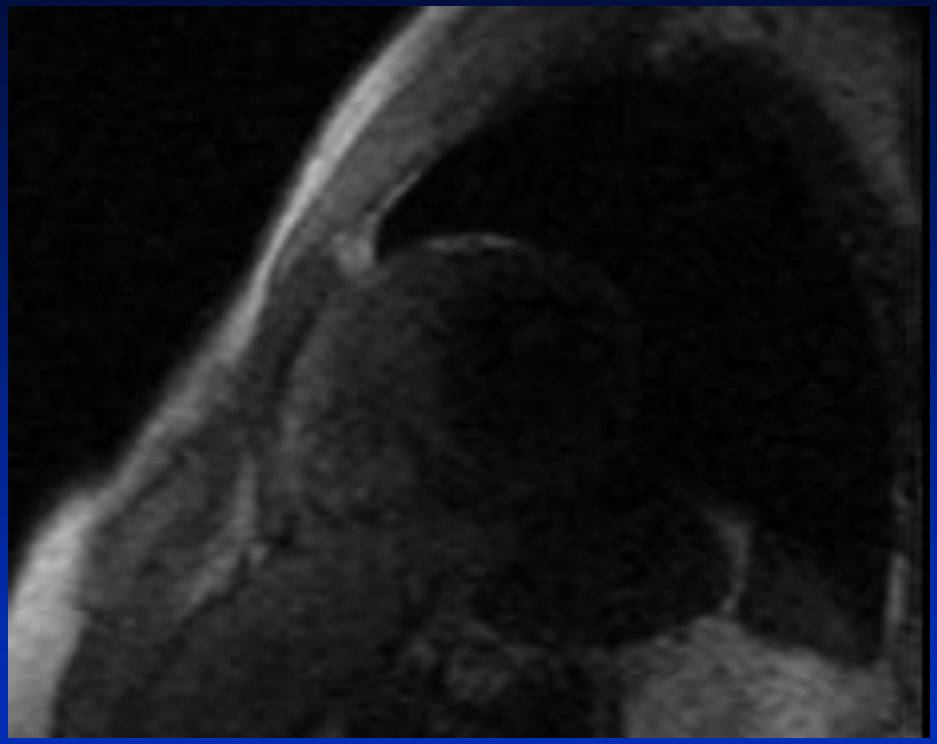
Addition on intravenous contrast to improve border opacification

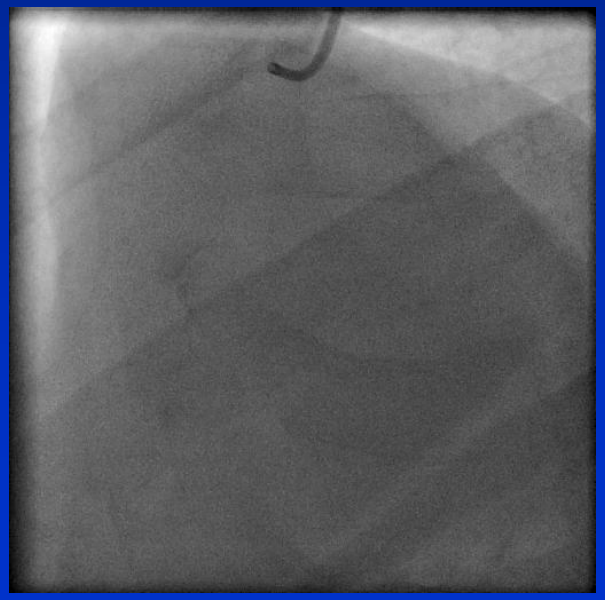


Stress MRI to assess flow-limiting stenosis: wall motion



MRI – perfusion imaging





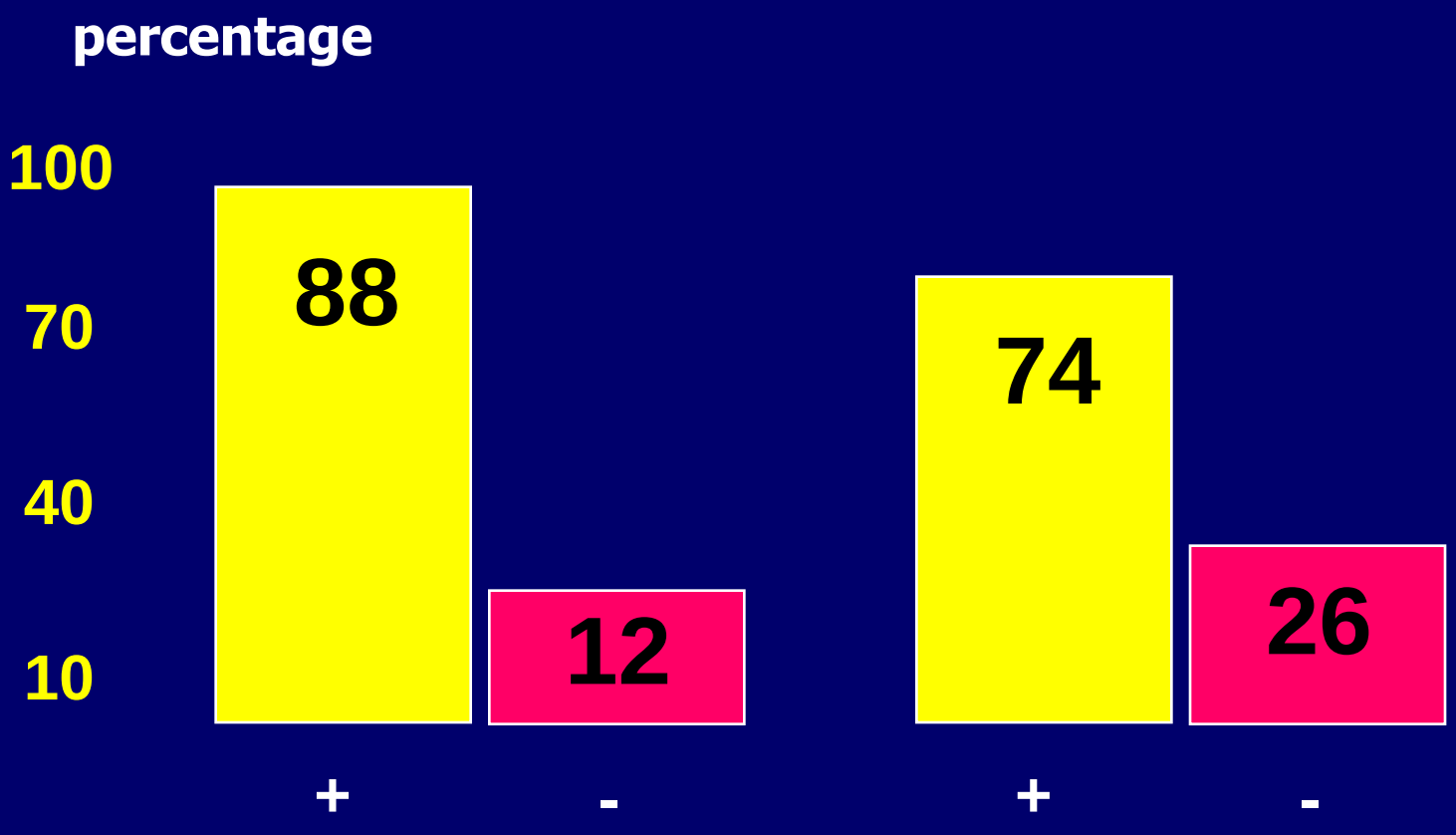
Man 61 years old

Outpatient clinics:

He has developed CAD, we treated based on ischemia

Now the patient developed PAF

AF ablation: success and failure



Oral H et al. NEJM 2006; Khan et al. NEJM 2008

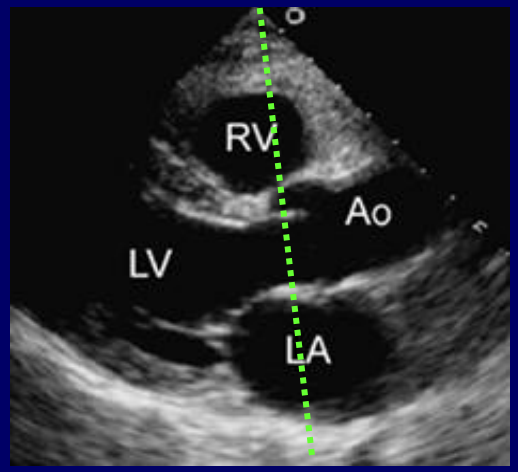
☞Prediction of successful RFCA

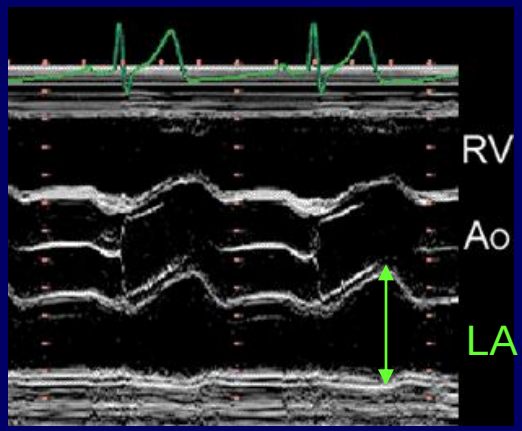
Assessment of substrate for AF

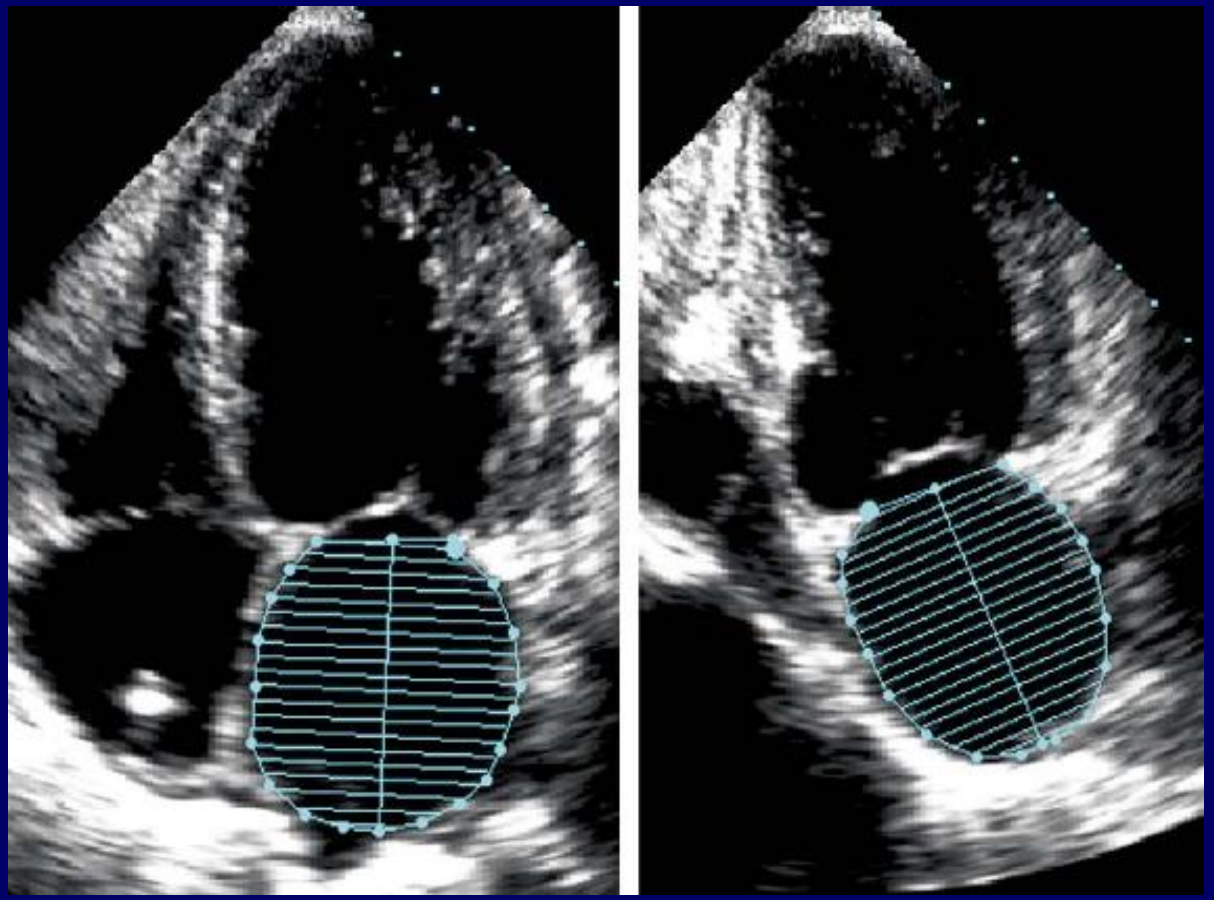
- LA enlargement
- LA fibrosis
  - Direct assessment
  - Indirect assessment
    - Mechanical consequence
    - Electrical conduction heterogeneities

Left atrial dimensions

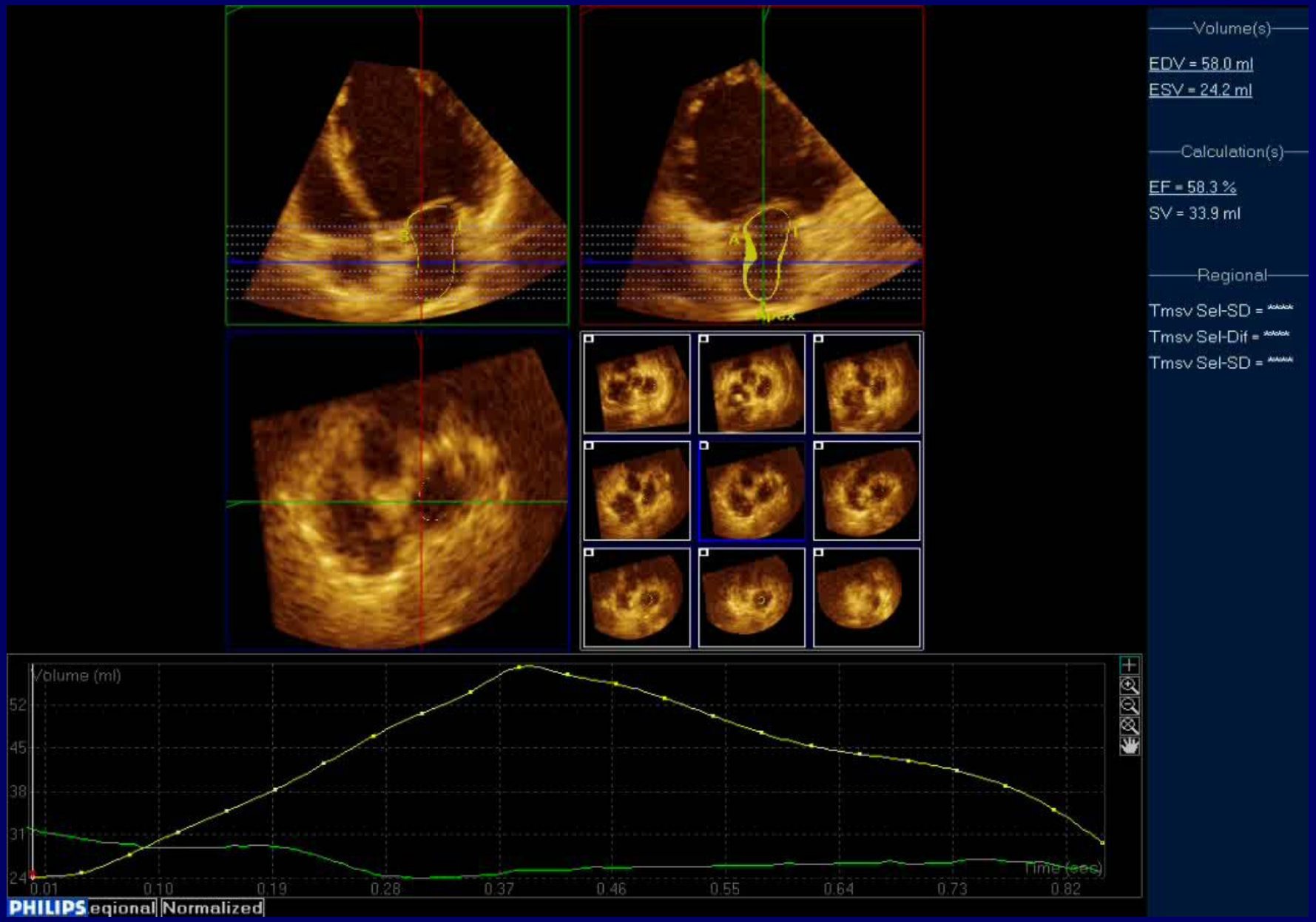
Linear dimensions AP diameter	LA volume Modified Simpson's rule



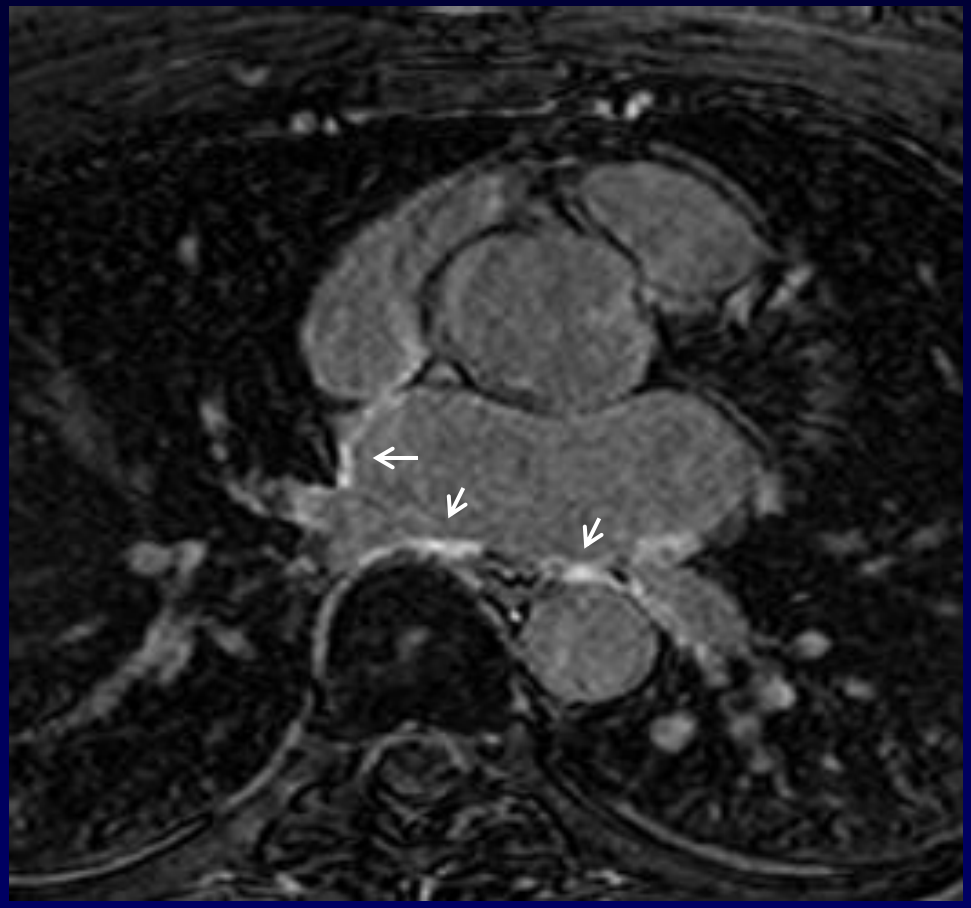


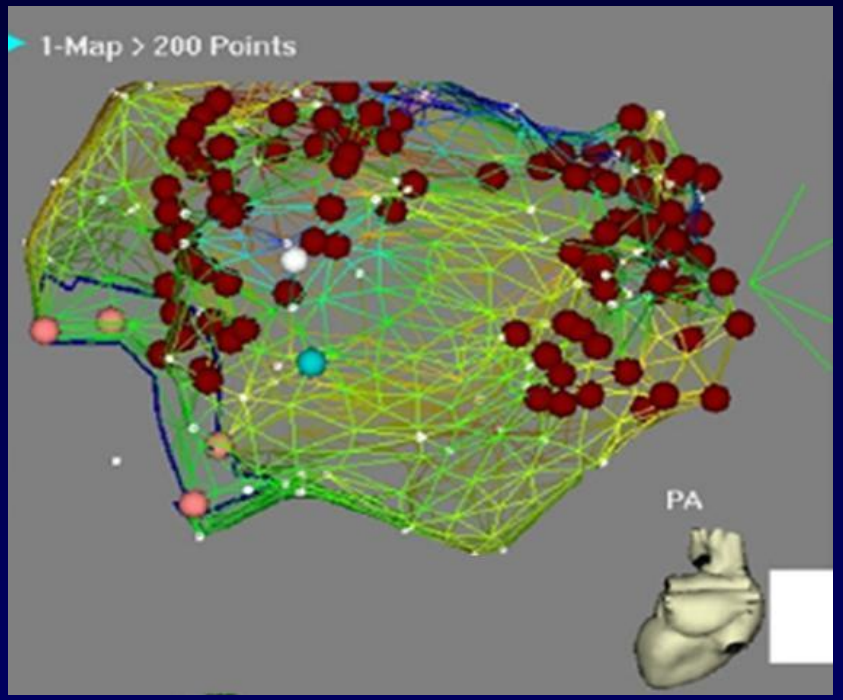


Real-time 3D echocardiography



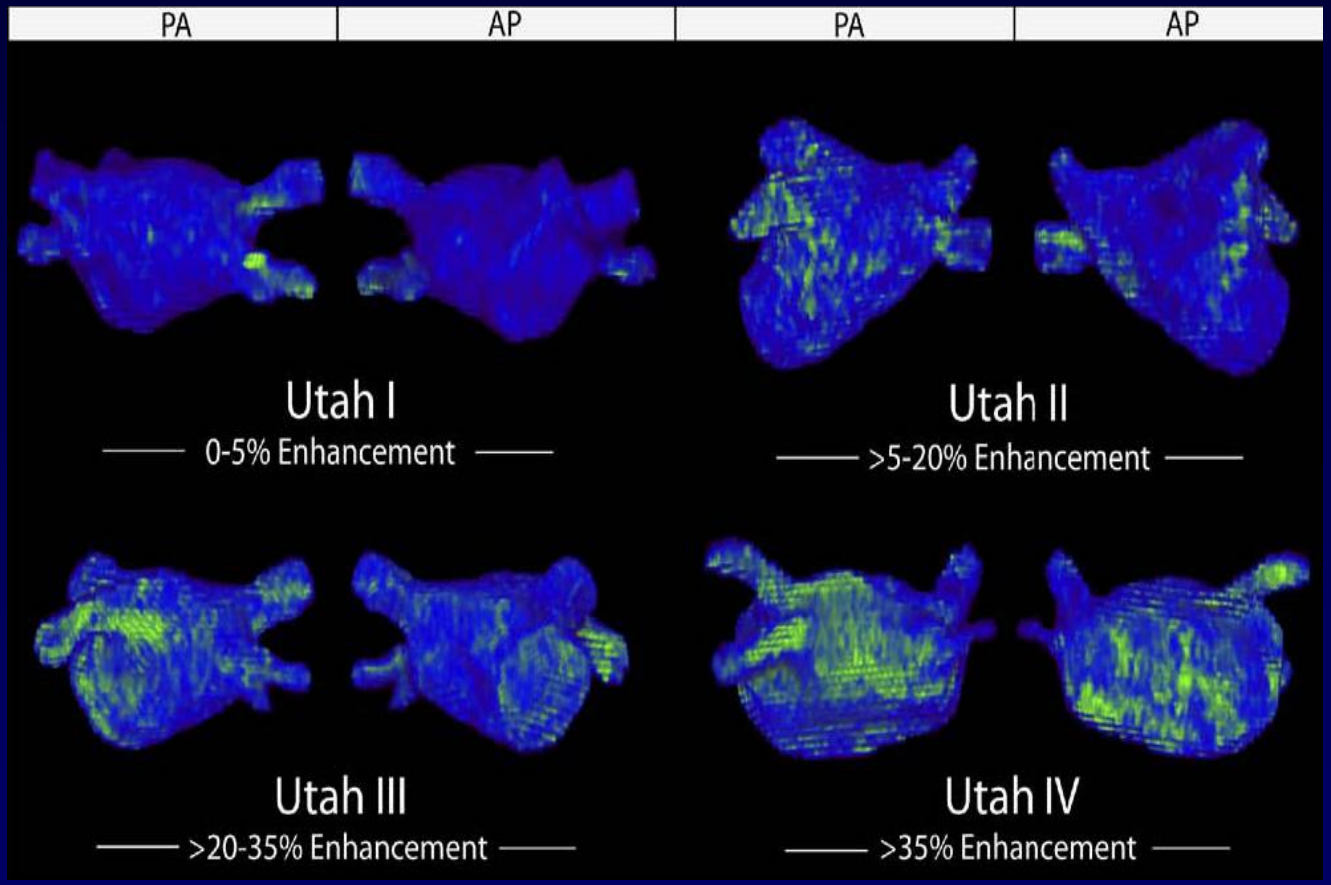
Left atrial fibrosis imaging - MRI





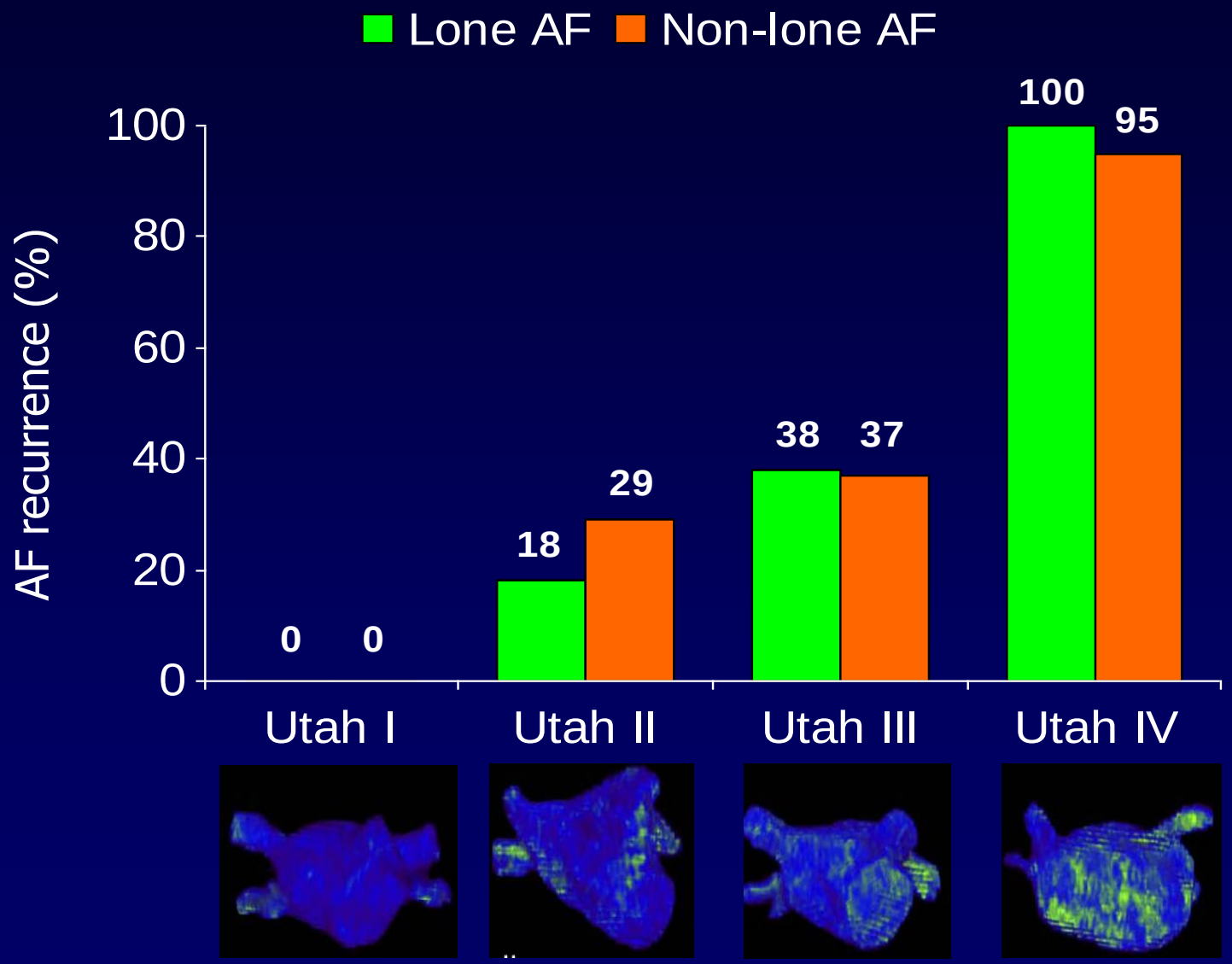
Taclas et al. Heart Rhythm 2010

- **N = 333 AF patients**
- **LA fibrosis before RFCA: DE-MRI**

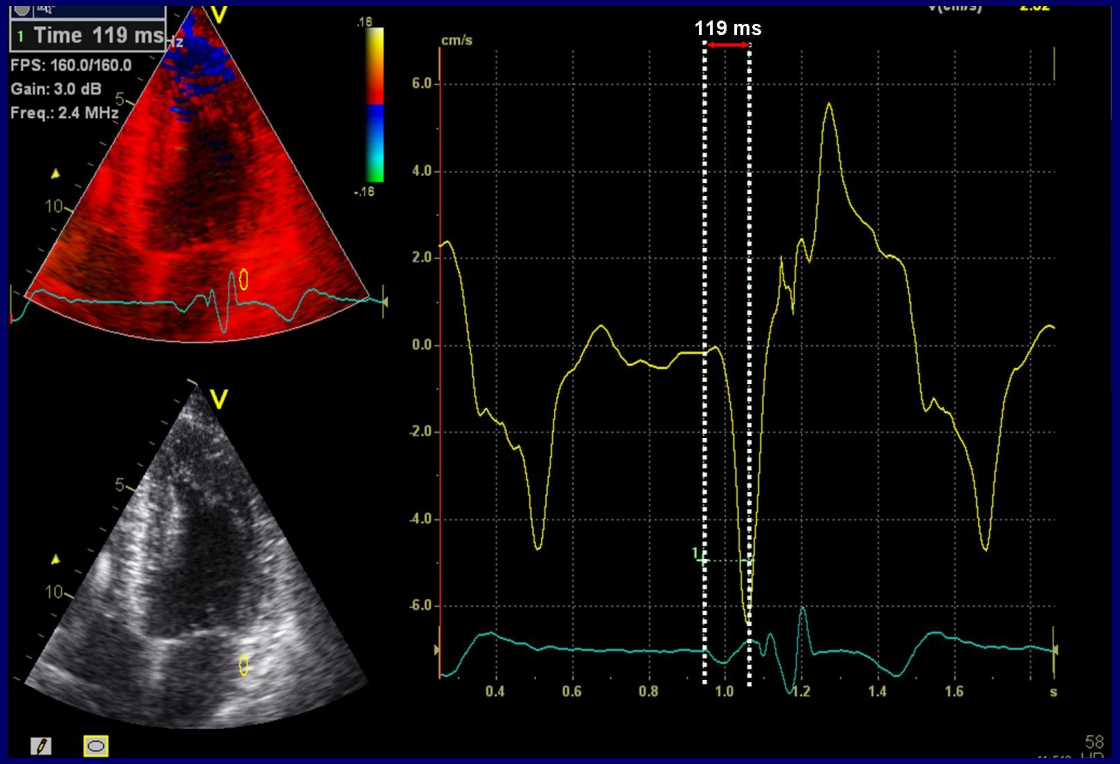


Mahnkopf et al. Heart Rhythm 2010

LA fibrosis vs. RFCA outcome



Left atrial electro-mechanical properties



TDI

↓

Total atrial conduction time (PA-TDI)

↓

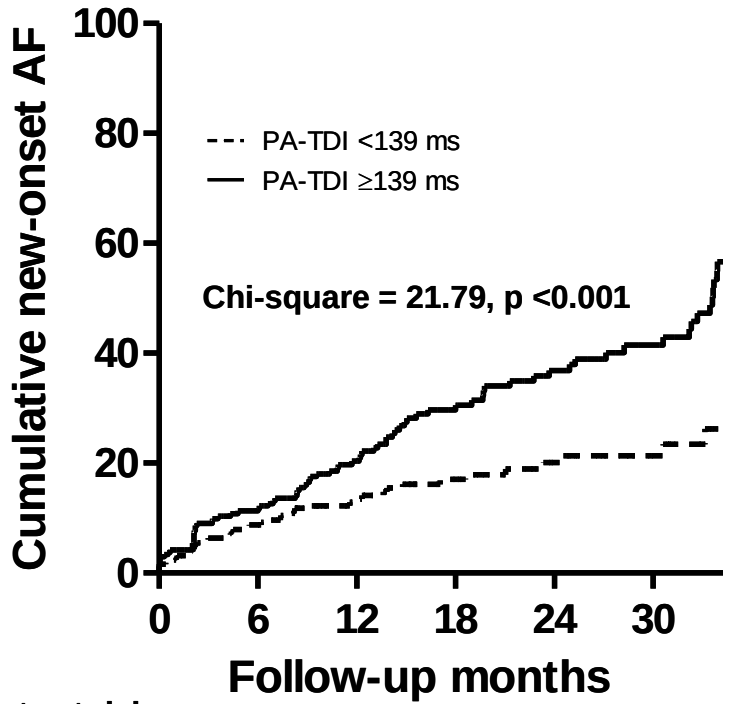
Time interval from the onset of the P-wave to the A'-wave peak

- PA-TDI as predictor of new onset AF in heart failure patients

N = 495

79% male

21% previous paroxysmal AF



Number of patients at risk:

PA-TDI duration <139 ms	253	226	140	94	66	38
PA-TDI duration ≥139 ms	242	193	133	83	64	43

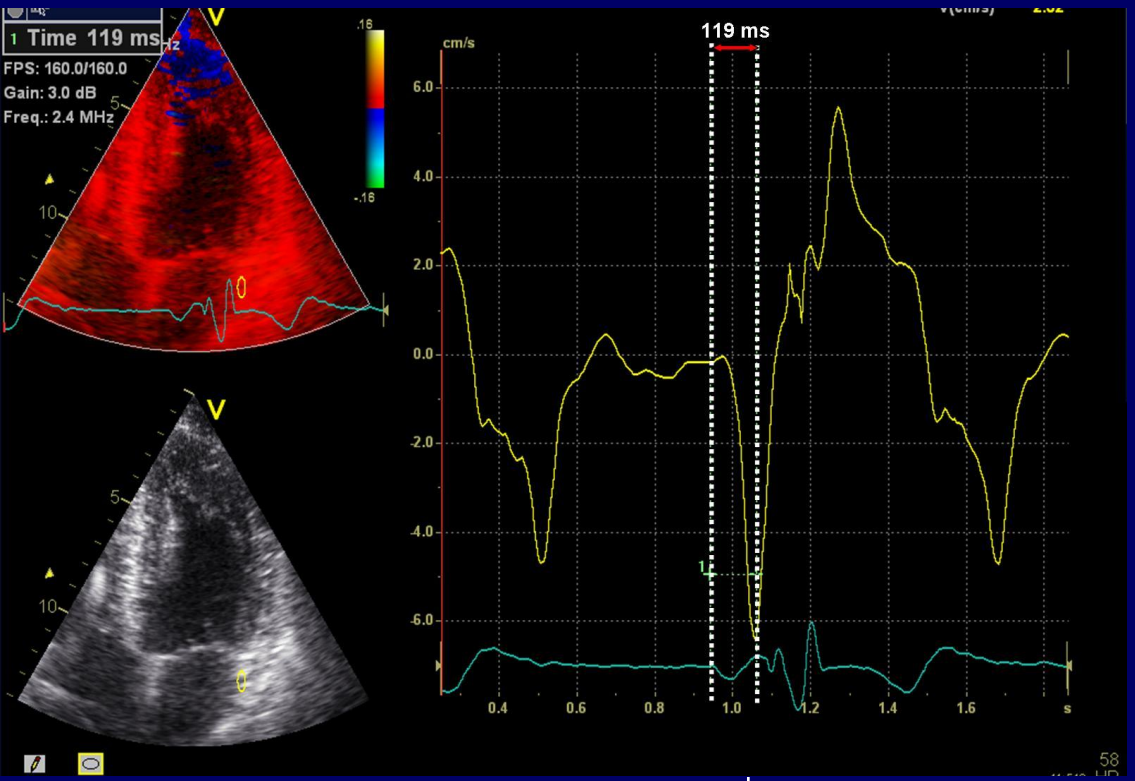
PA-TDI

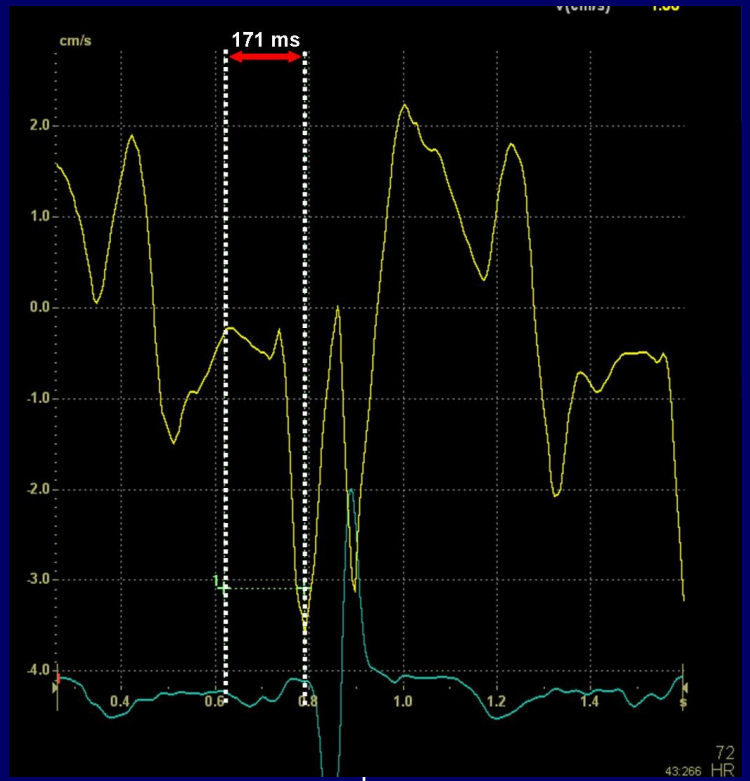
HR: 1.01 (1.01-1.02)

P<0.001

Patient 1

Patient 2





No AF

New onset AF

Different patient: extensive CAD

Male, 72 yrs

- 2001: Infero-postero-lateral infarct – PCI
- 2002: 2003: Antero-septal infarct - PCI
- 2004: CABG: LIMA-graft LAD,
  venous graft MO-LCX and RDP/RCA
- 2004: LV dilated, EF 28%

Co-morbidities

- Diabetes II

Man 72 years old

CAD has been treated

History of MI, EF is reduced

Outpatient clinics:

Does he need an ICD?

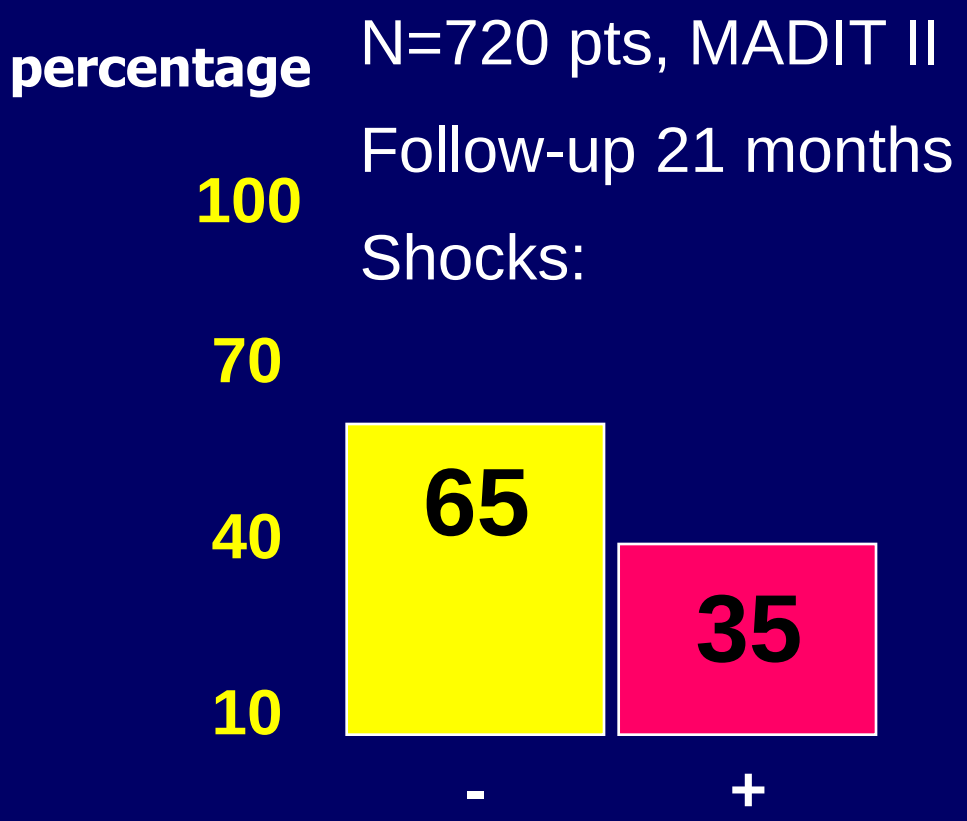
Does he need an ICD?

- Patients with:
  previous infarction
  LVEF <30-35%

- Benefit from ICD:
- MADIT II: improved survival

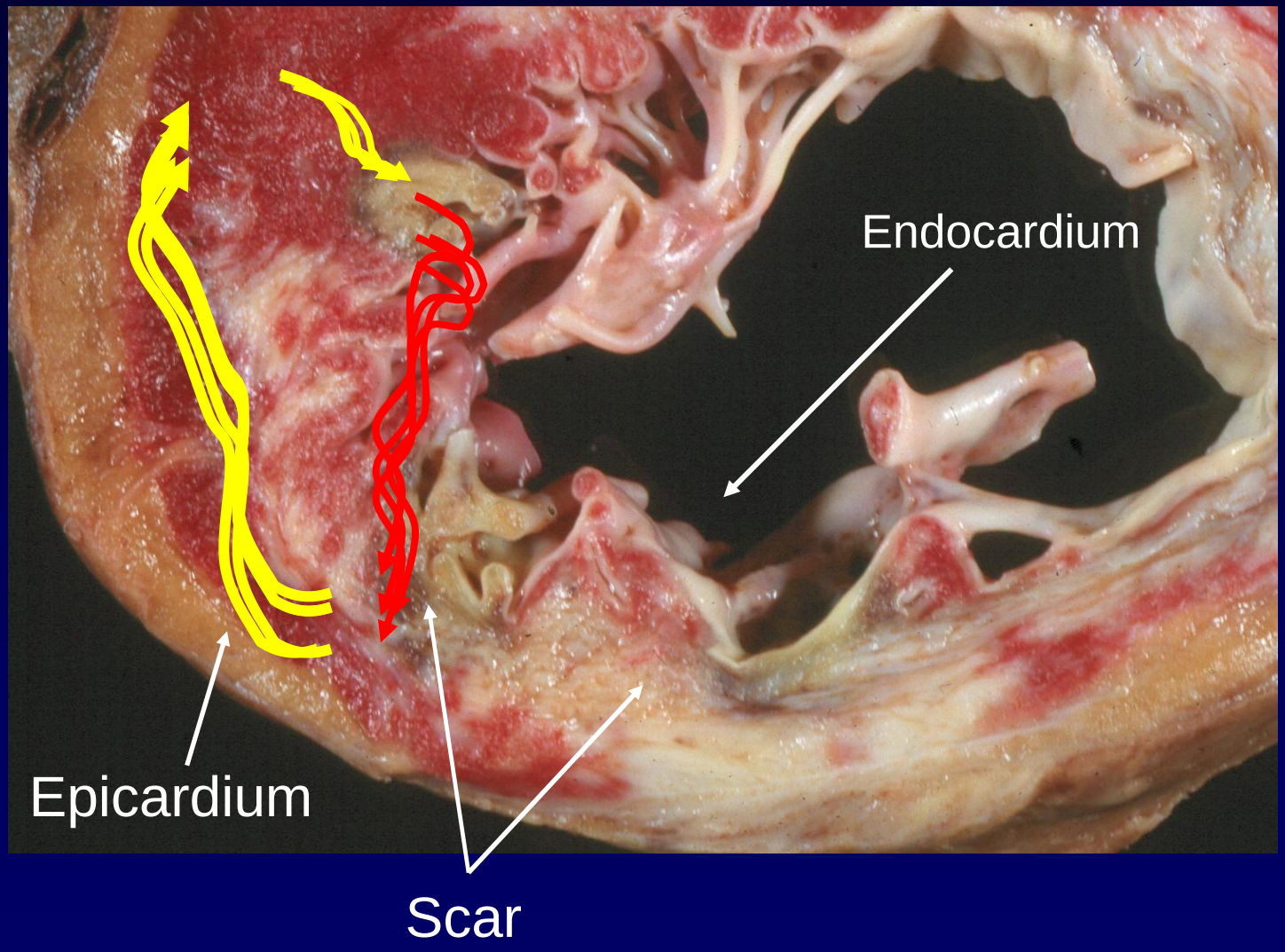
ICD needed?

ICD shocks in primary prevention



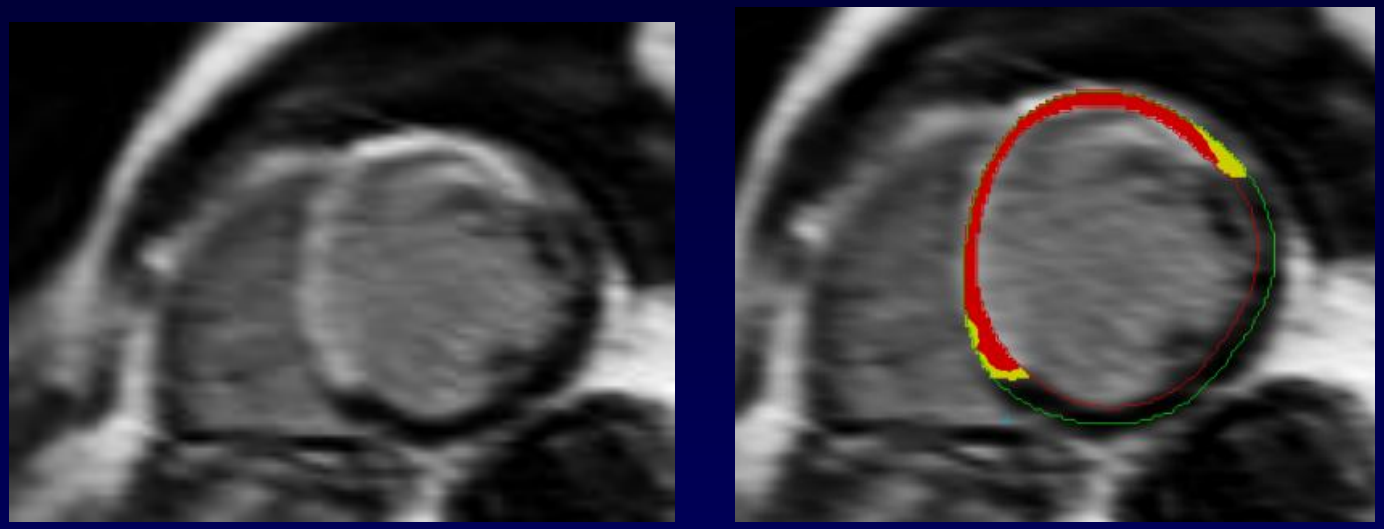
Moss et al. Circ 2004

What is the pathophysiological substrate for SCD in CAD?



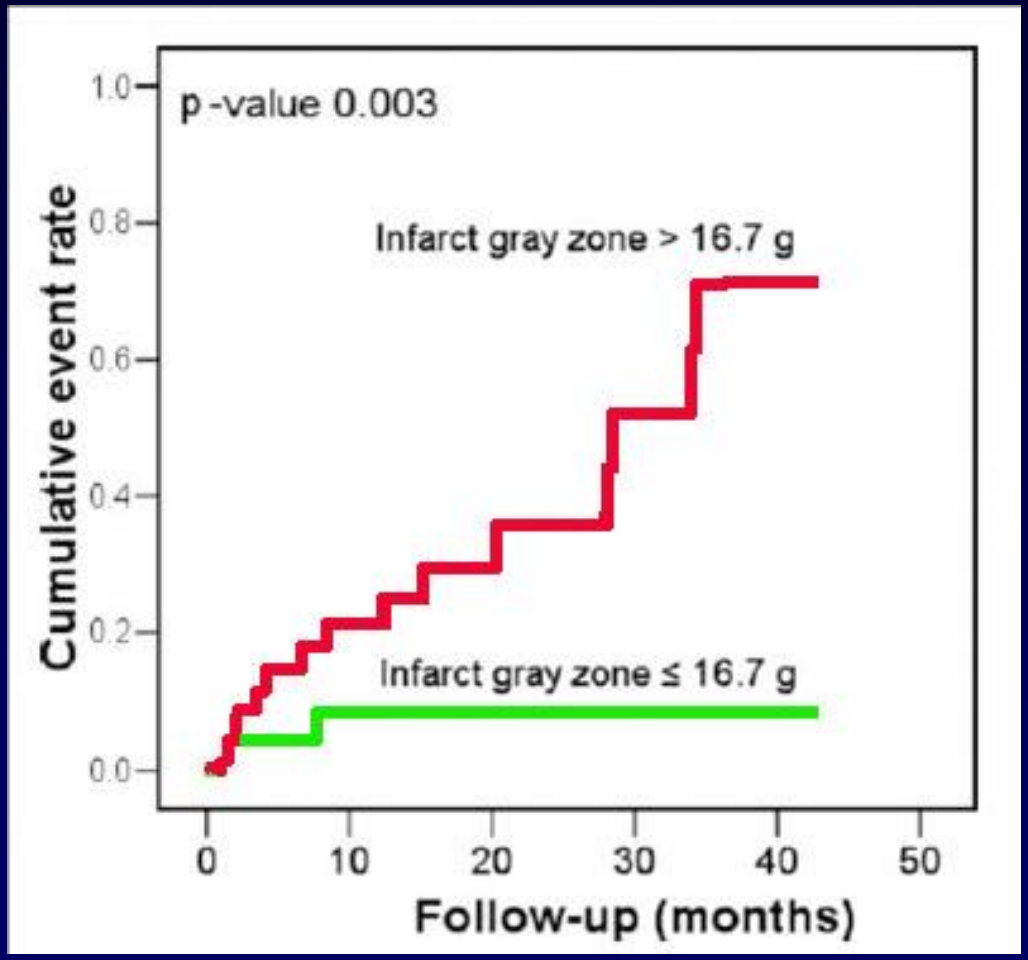
Courtesy W Stevenson

MRI to assess arrhythmogenic substrate:



- Late-gadolinium enhancement: scar area and peri-infarct zone

Value of border zone to predict VTs



HR (95%CI): 1.47 (1.04 to 2.08)
P = 0.003

Roes et al. Circ Cardiovasc Imaging 2009

Conclusions

- **Virtually all anatomical and functional information can be obtained by (a combination) of the available imaging techniques**

- **The choice of techniques should be guided by the information needed (the questions we need answers to)**

- **The imaging results must affect treatment**