CT or PET/CT for coronary artery disease

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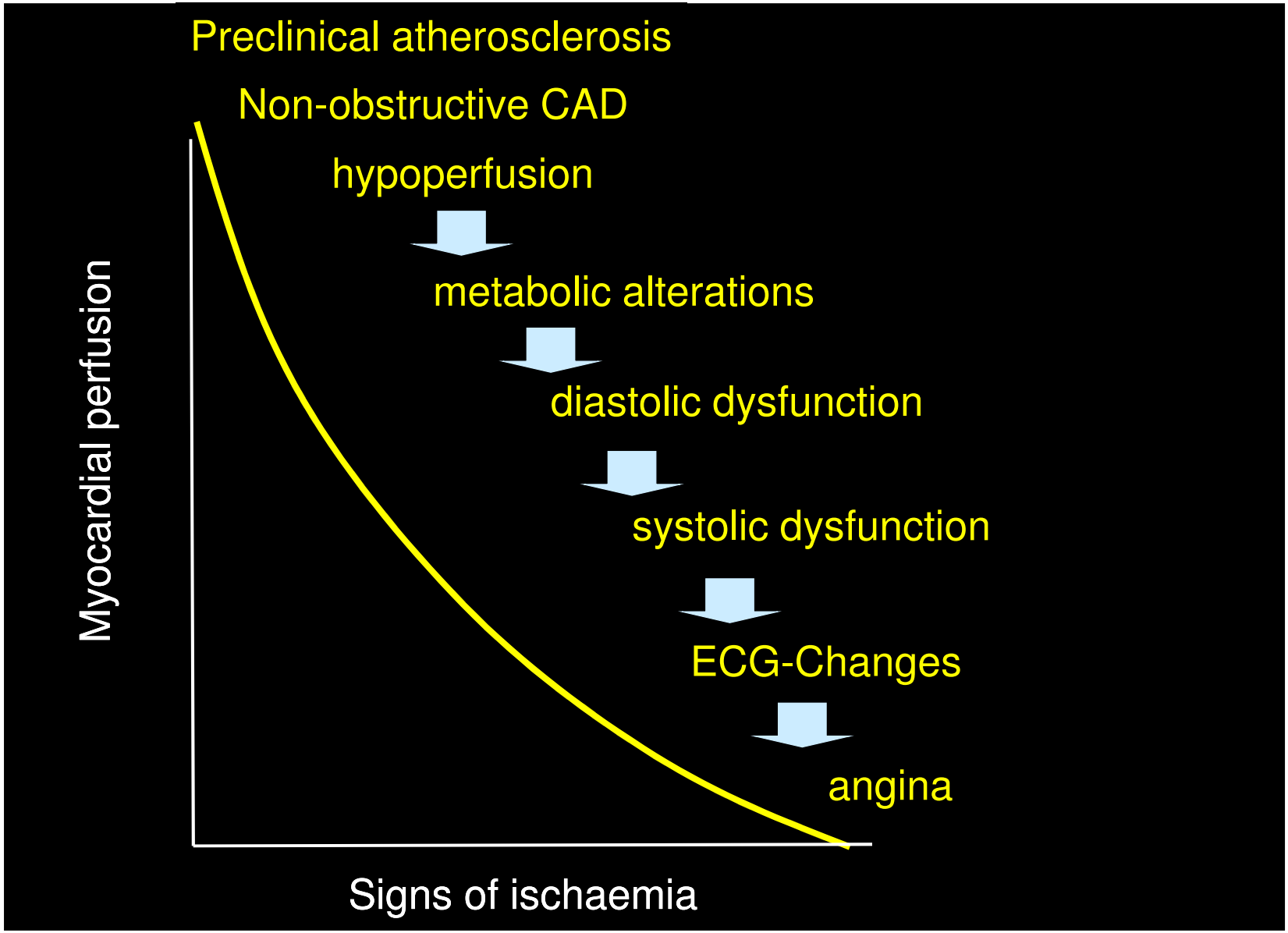
Imaging and CAD
Current main trends

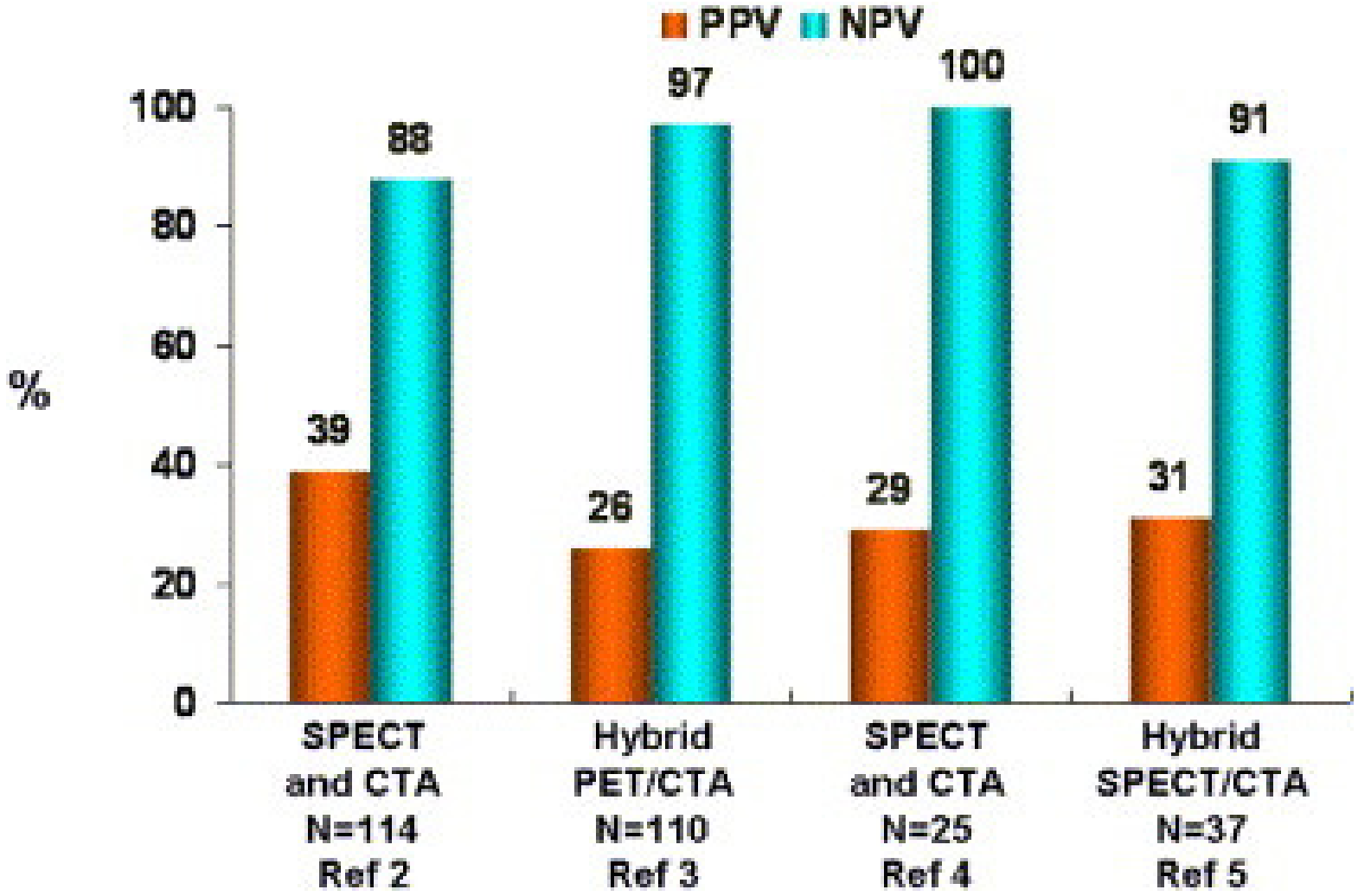
- From ischemic cascade to CAD cascade
- From diagnosis of CAD to guidance of therapy
- Novel imaging applications
  - Quantification
  - Imaging of vulnerable plaque

Paradigm shift 1:
From ischemic to CAD cascade



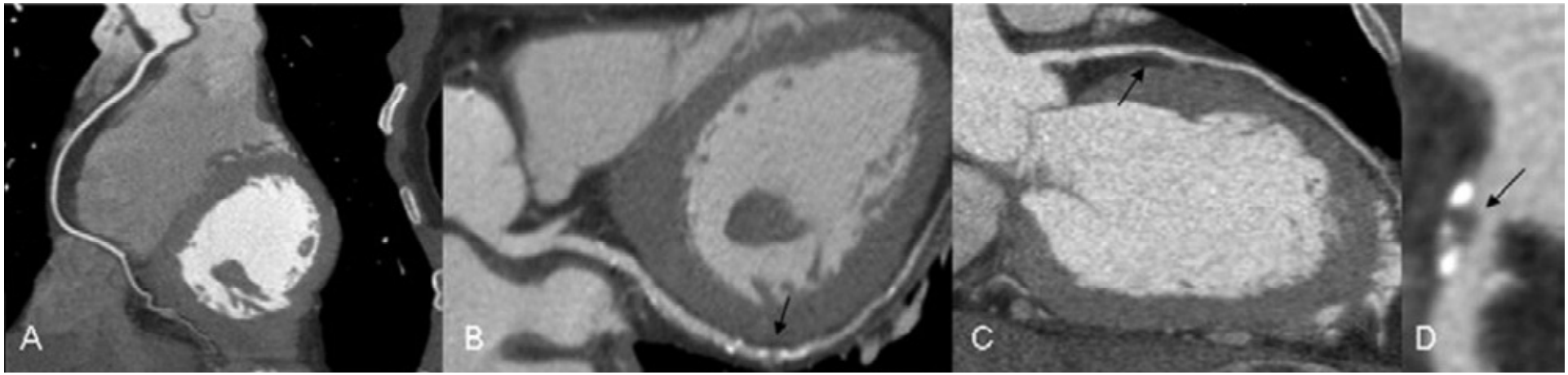
Multislice CT vs. Myocardial Perfusion

Regional comparison in 140 patients



Data from Schuijf et al. 2006, Di Carli et al. 2006, Hacker et al. 2005, and Rispler et al. 2006

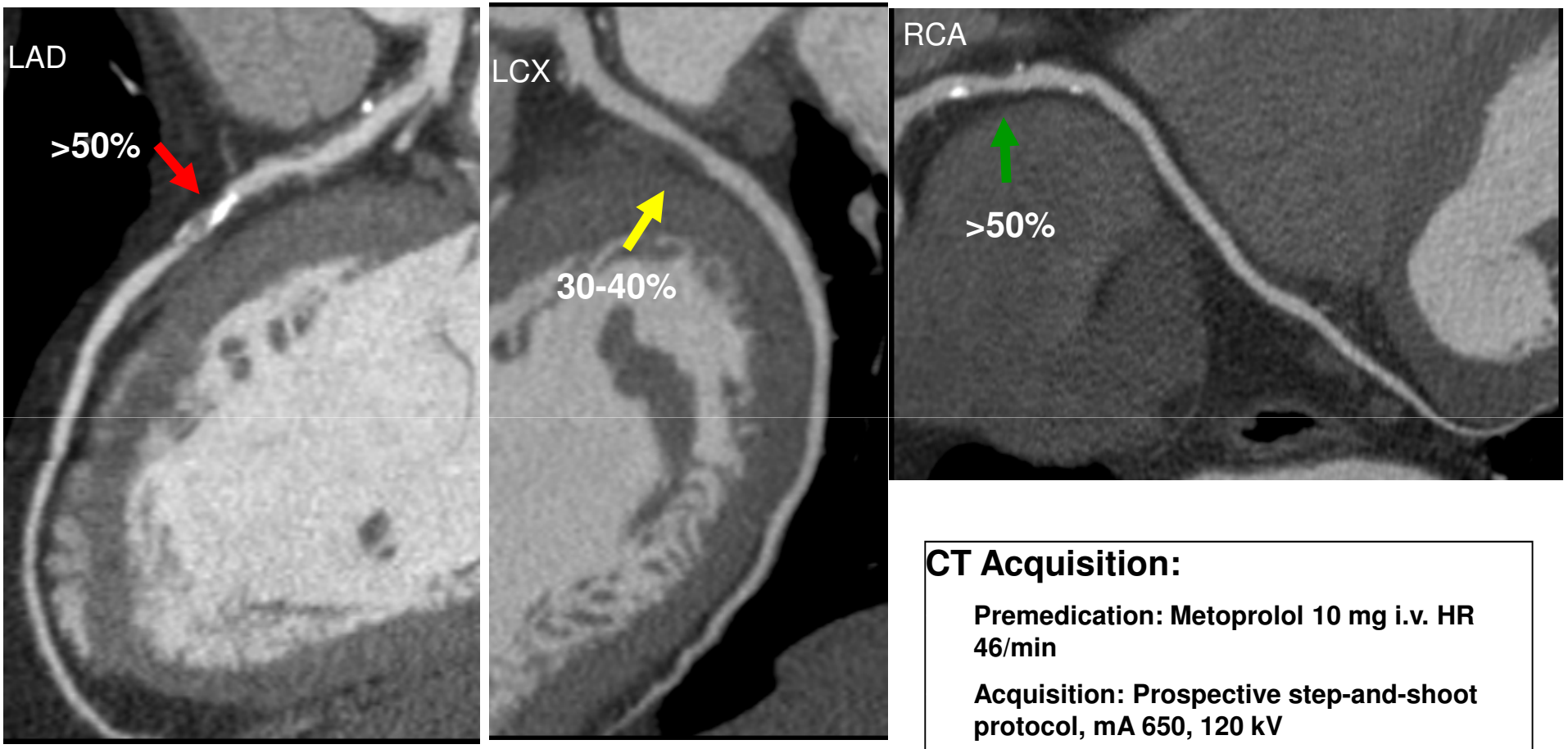
MDCT findings in patients with normal SPECT perfusion imaging result



Werkhoven JM, et al Am J Cardiol. 2008 Jan 1;101(1):40-5.

CT angiography

Curved MPR reconstructions of the major coronary vessels



CT Acquisition:

Premedication: Metoprolol 10 mg i.v. HR 46/min

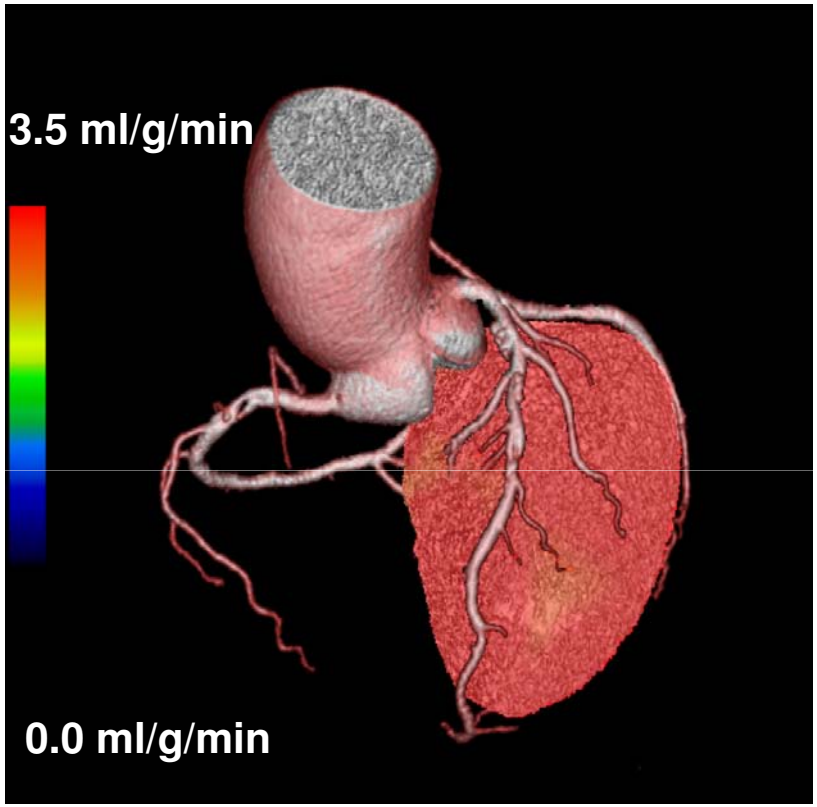
Acquisition: Prospective step-and-shoot protocol, mA 650, 120 kV

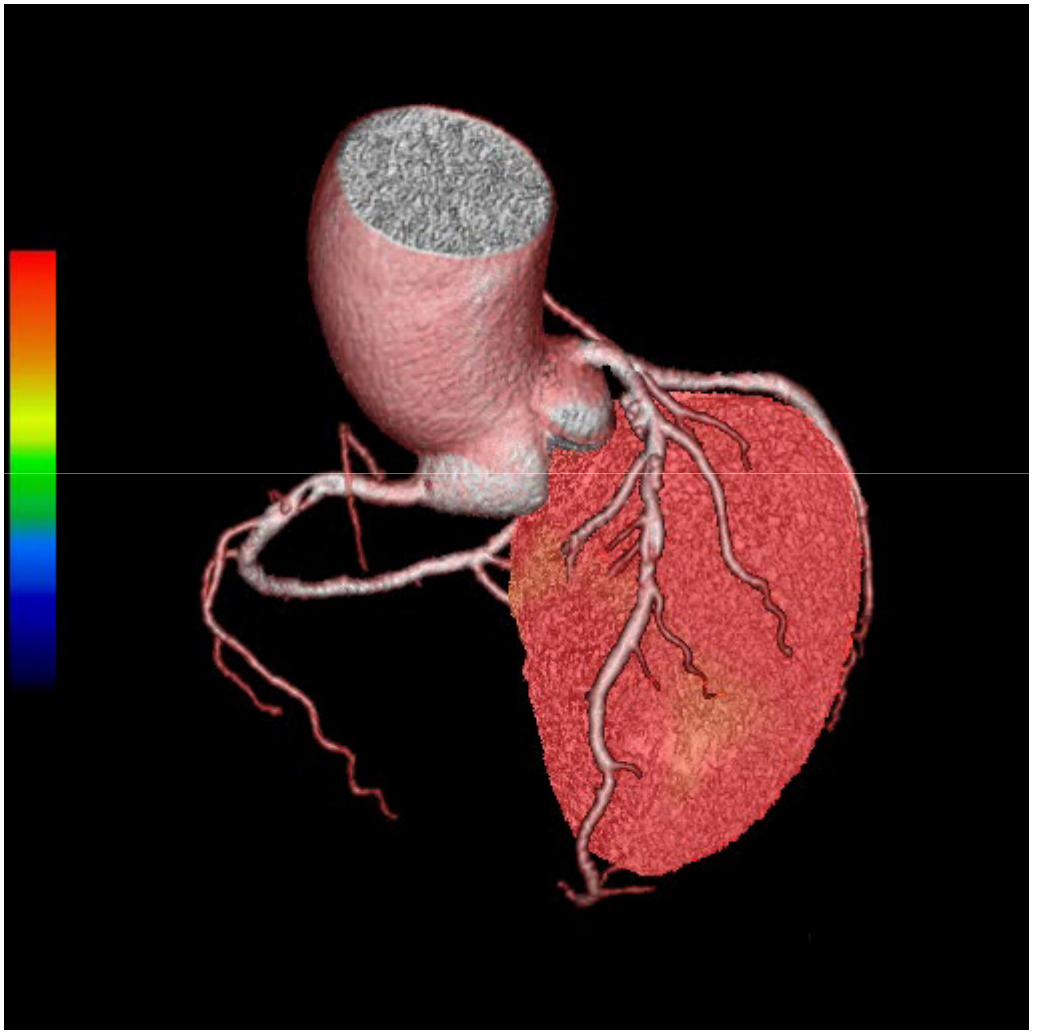
Contrast: Iomeron 400mg/ml 68 ml

Radiation dose 7.4 mSV

PET perfusion imaging during stress

Displayed as fused volume rendered images scaled to absolute scale 0-3.5 ml/g/min
Normal perfusion: above 2.5 ml/g/min: yellow or red



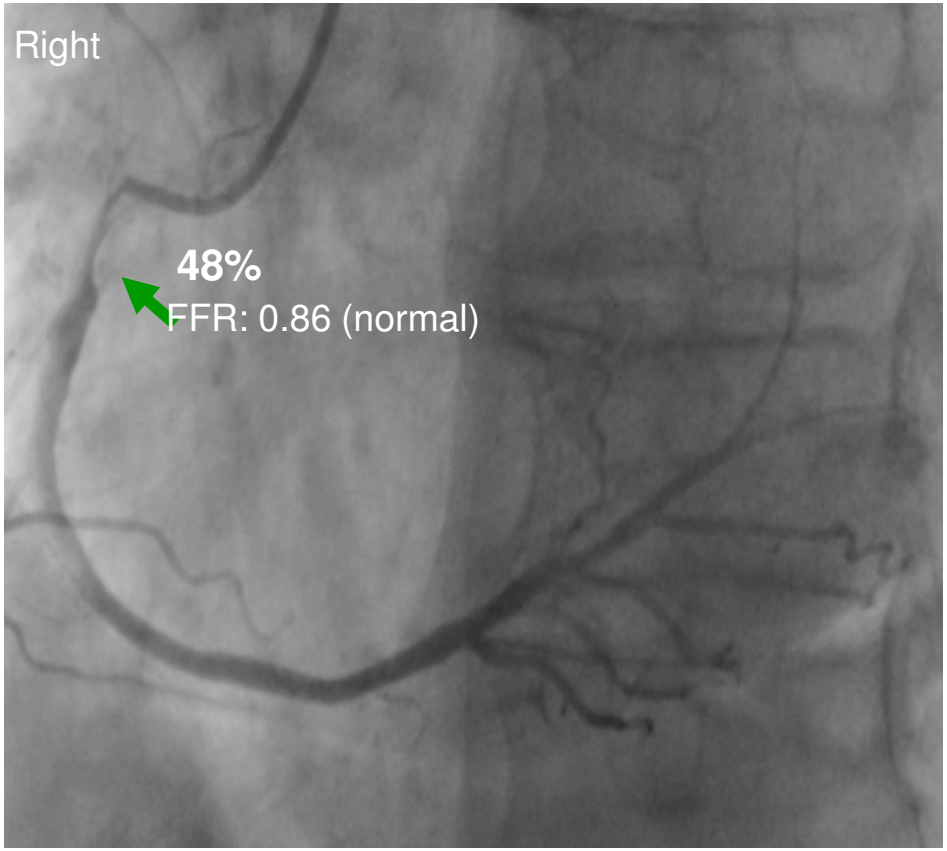


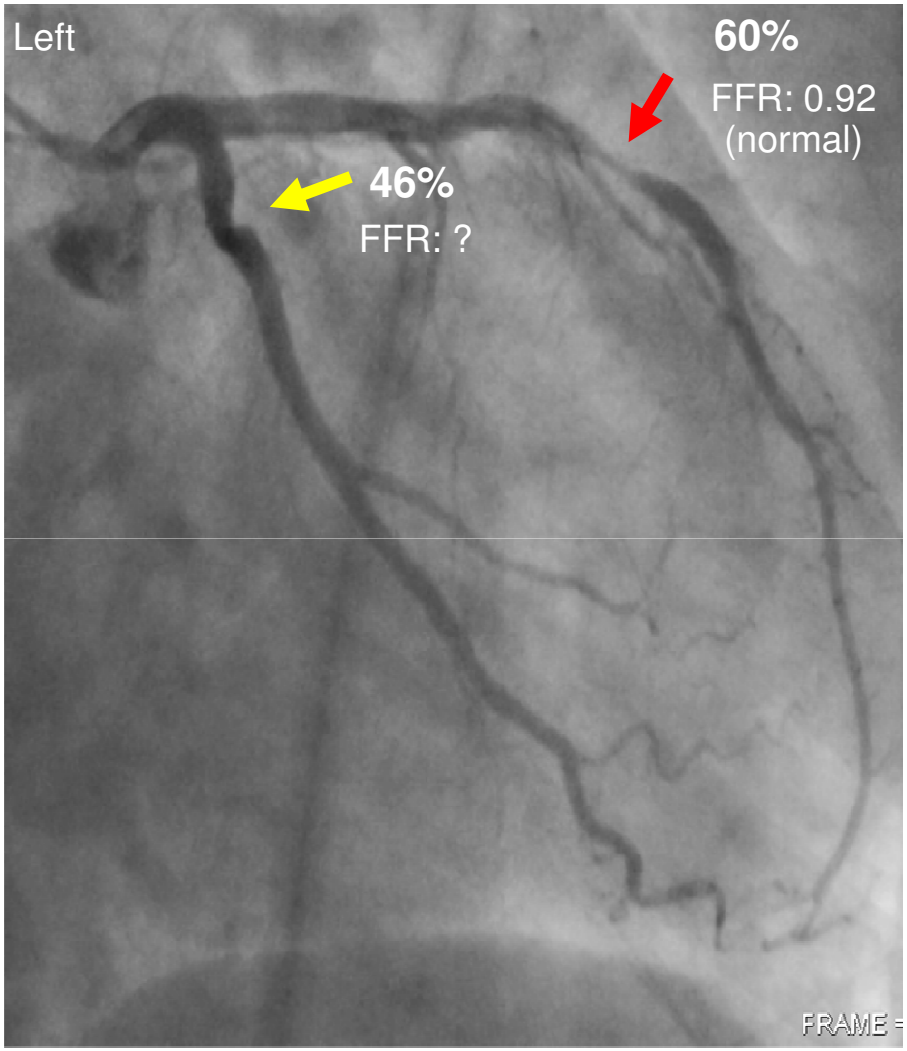
PET Acquisition:

- **Injected Dose: 1100 MBq O-15-water**
- **Stress: Adenosine 140 µg/min/kg for 6.5 min**
- **Acquisition time: dynamic 4.5 min**
- **Radiation dose 0.9 mSV**

Case:LP

Invasive angiography + FFR

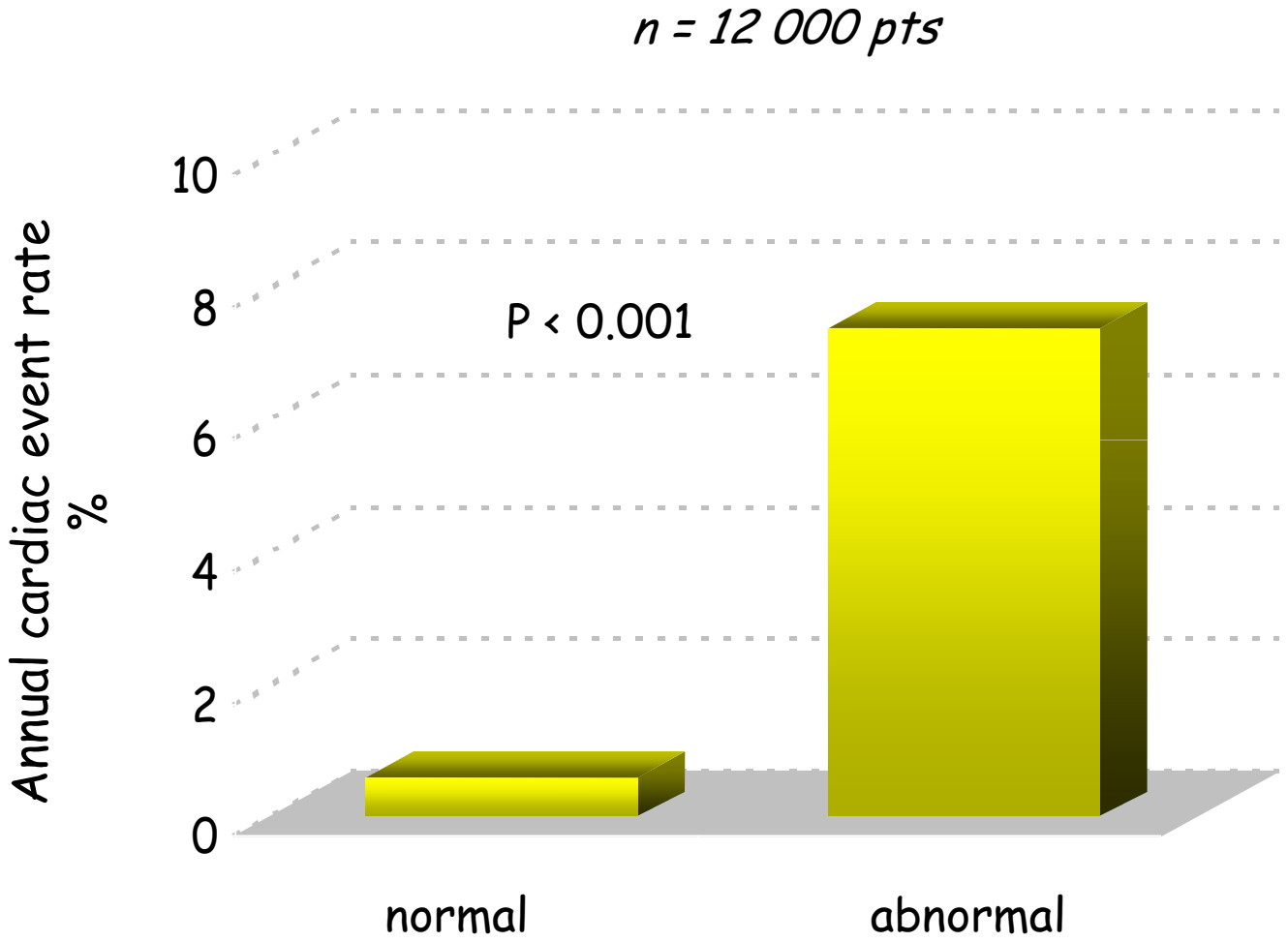




FFR = Fractional flow reserve – invasive measurement of the stenosis functional gradient during adenosine infusion

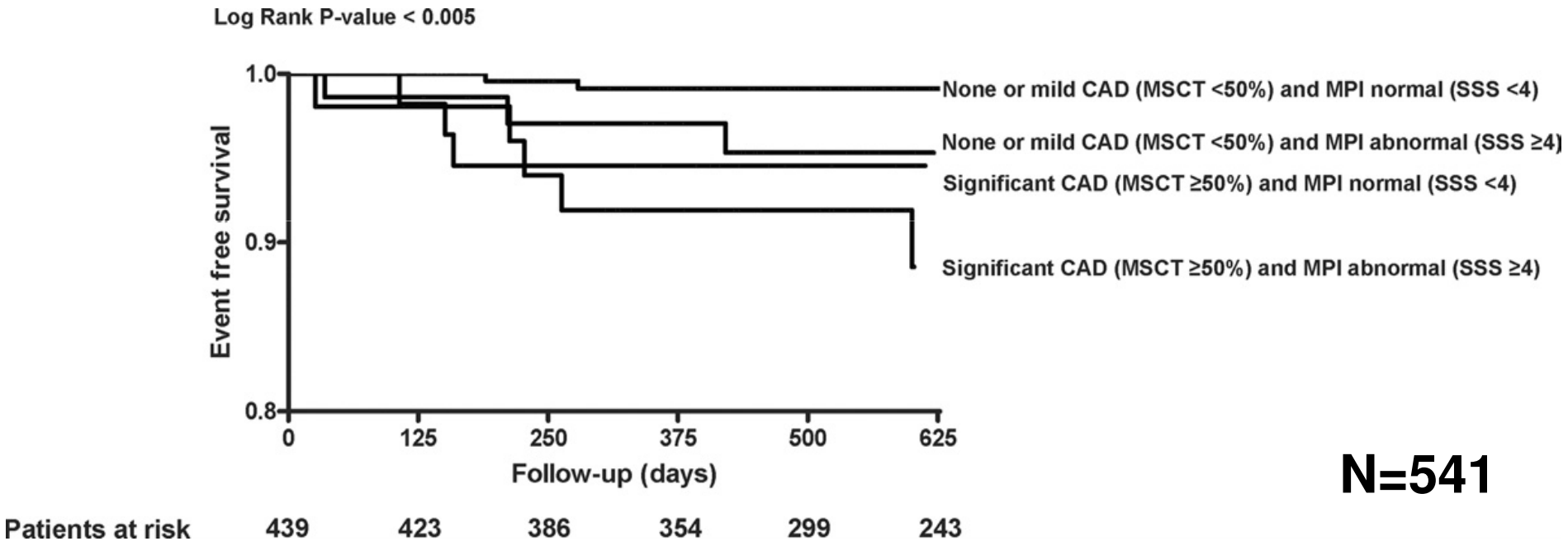
Case:LP

Prognostic Value of Myocardial Perfusion SPECT



Iskander S et al. JACC 1998;32:57

Additional prognostic value of CT and perfusion imaging



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Van Verkhoven et al J Am Coll Cardiol 2009;53: 623–32

Imaging and CAD
Current main trends

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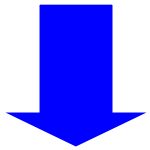
Paradigm shift 2:
From diagnosis to guidance of therapy

Anatomy (Obstructive CAD)

Flow-Limiting (Perfusion, FFR)



Optimal Medical Treatment

Complete Functional Revascularization and optimal medical treatment

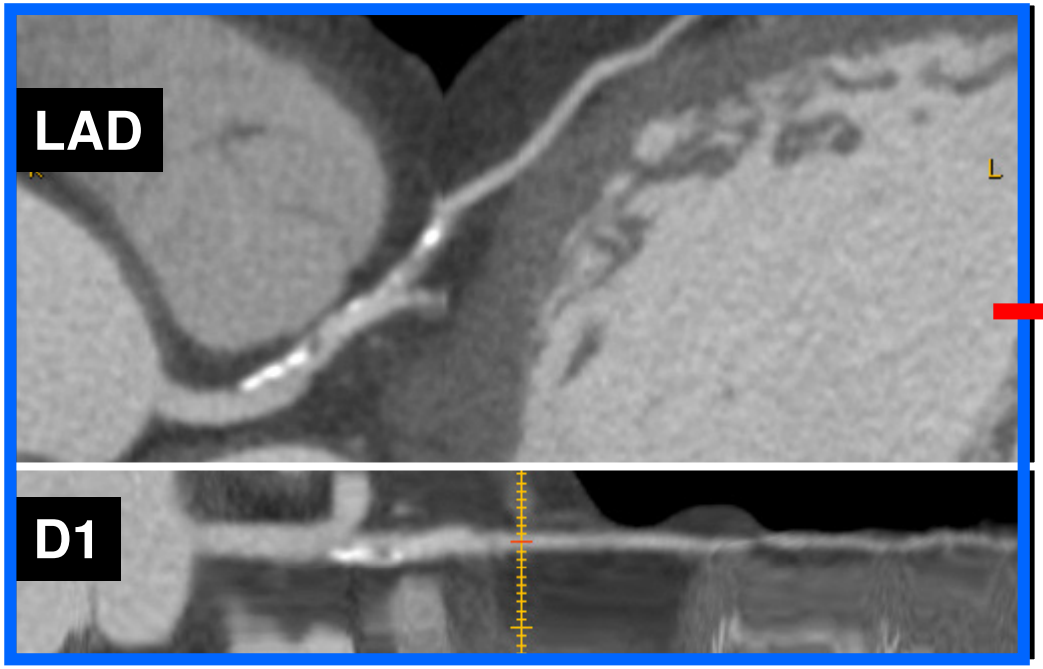
Noninvasive function: Perfusion, WMA

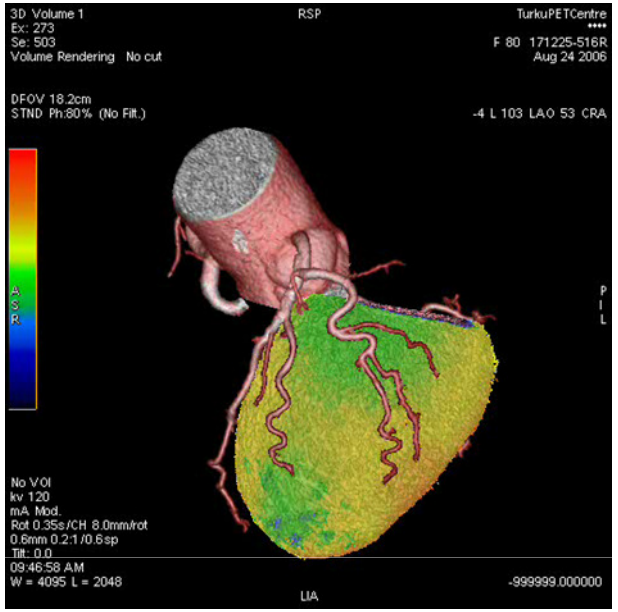
Hachamovitch Circulation 2003;107:2900
COURAGE NEJM 2007;356:1503
COURAGE Circulation 2008;117:1283

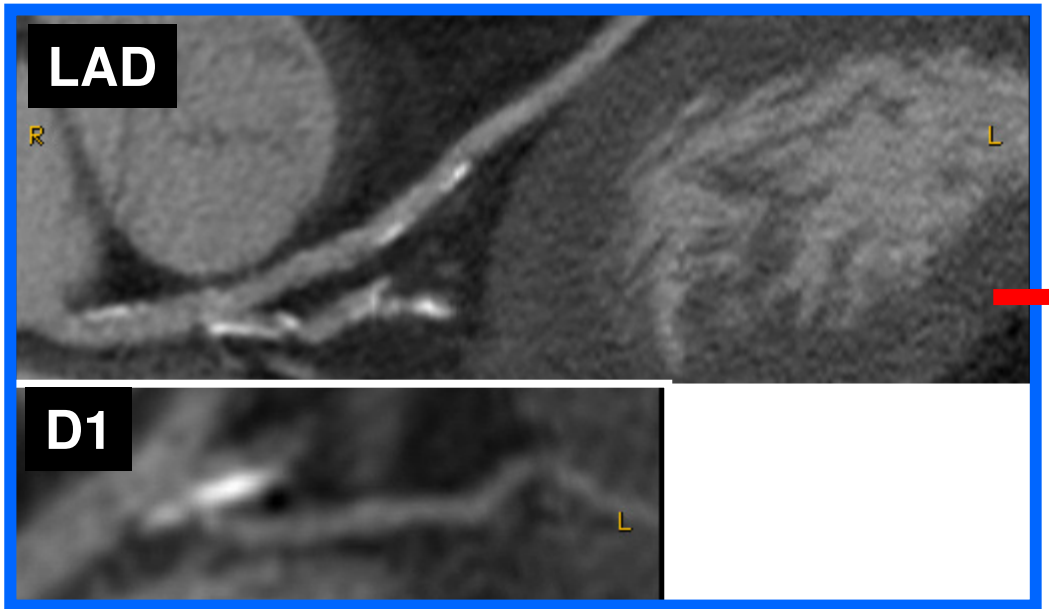
Invasive function: FFR

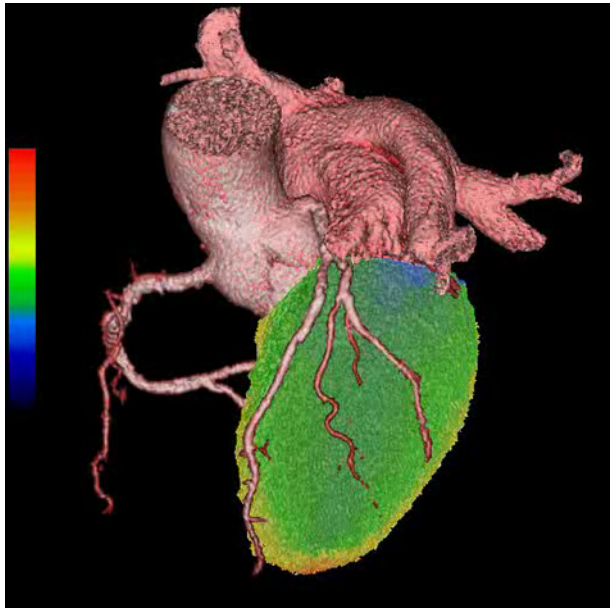
DEFER JACC 2007;49:2105
FAME NEJM 2009;360:213
FAME JACC 2010;56:177

Functional consequences of stenoses









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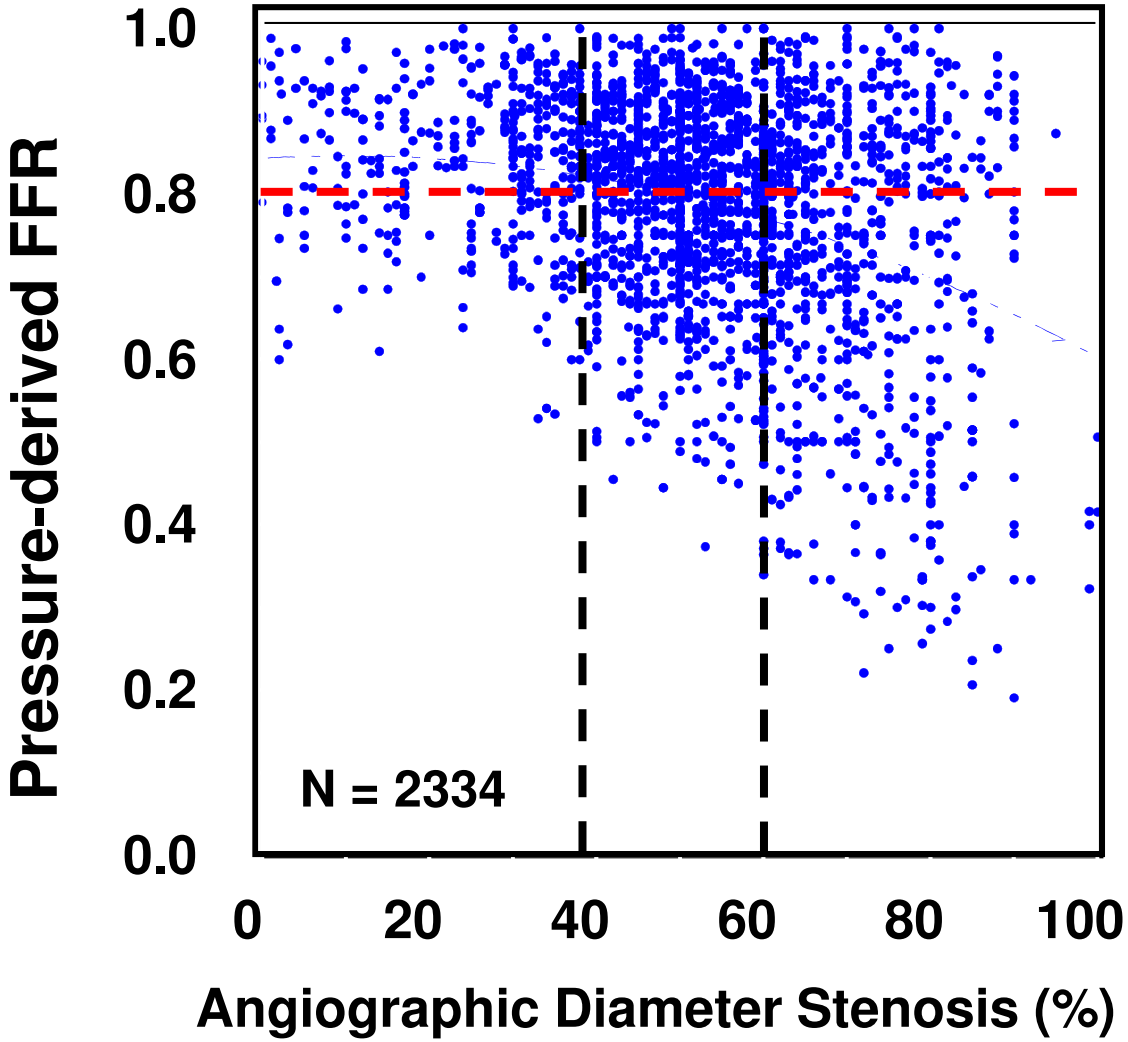
Invasive Anatomy vs. Functional Consequences

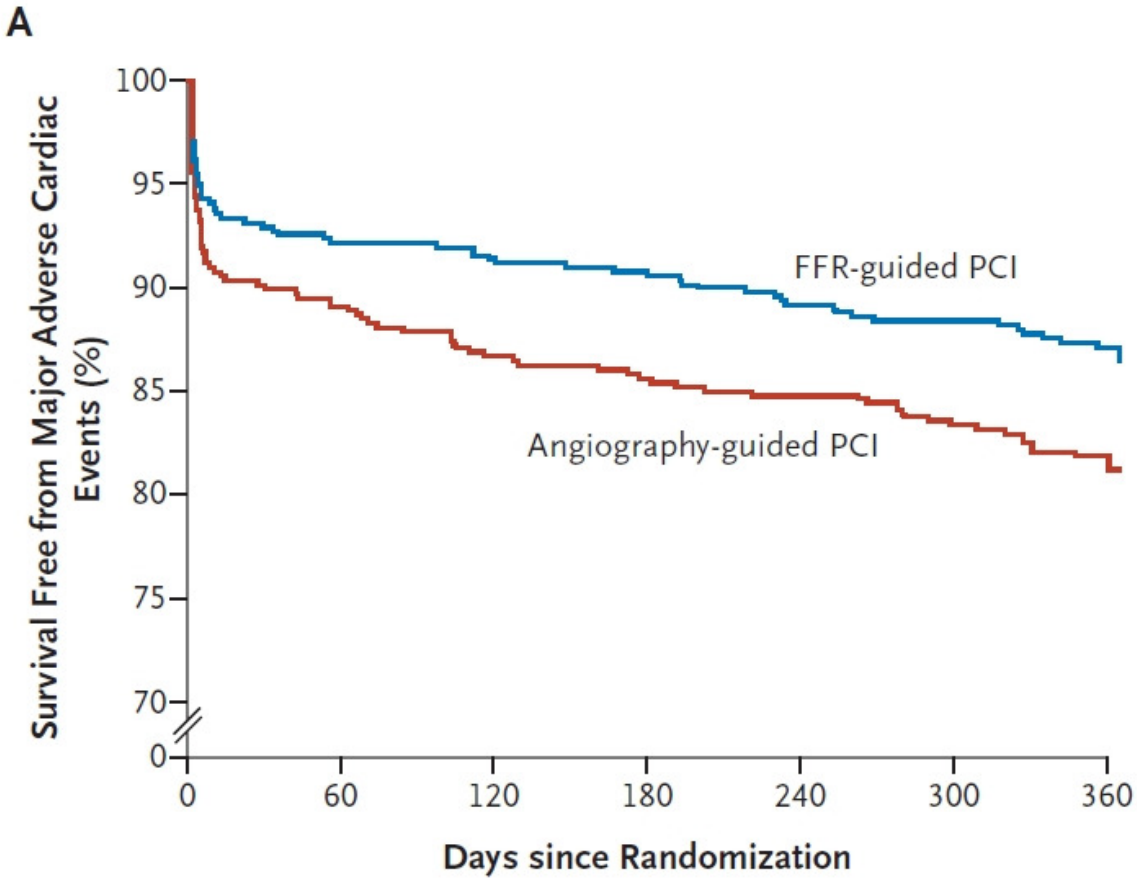


Wijns, de Bruyne, Vanhoenacker, JNC 2007;93:856-61

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JANUARY 15, 2009 VOL. 360 NO. 3

Fractional Flow Reserve versus Angiography for Guiding Percutaneous Coronary Intervention



Tonino et al. FAME

CT angiography

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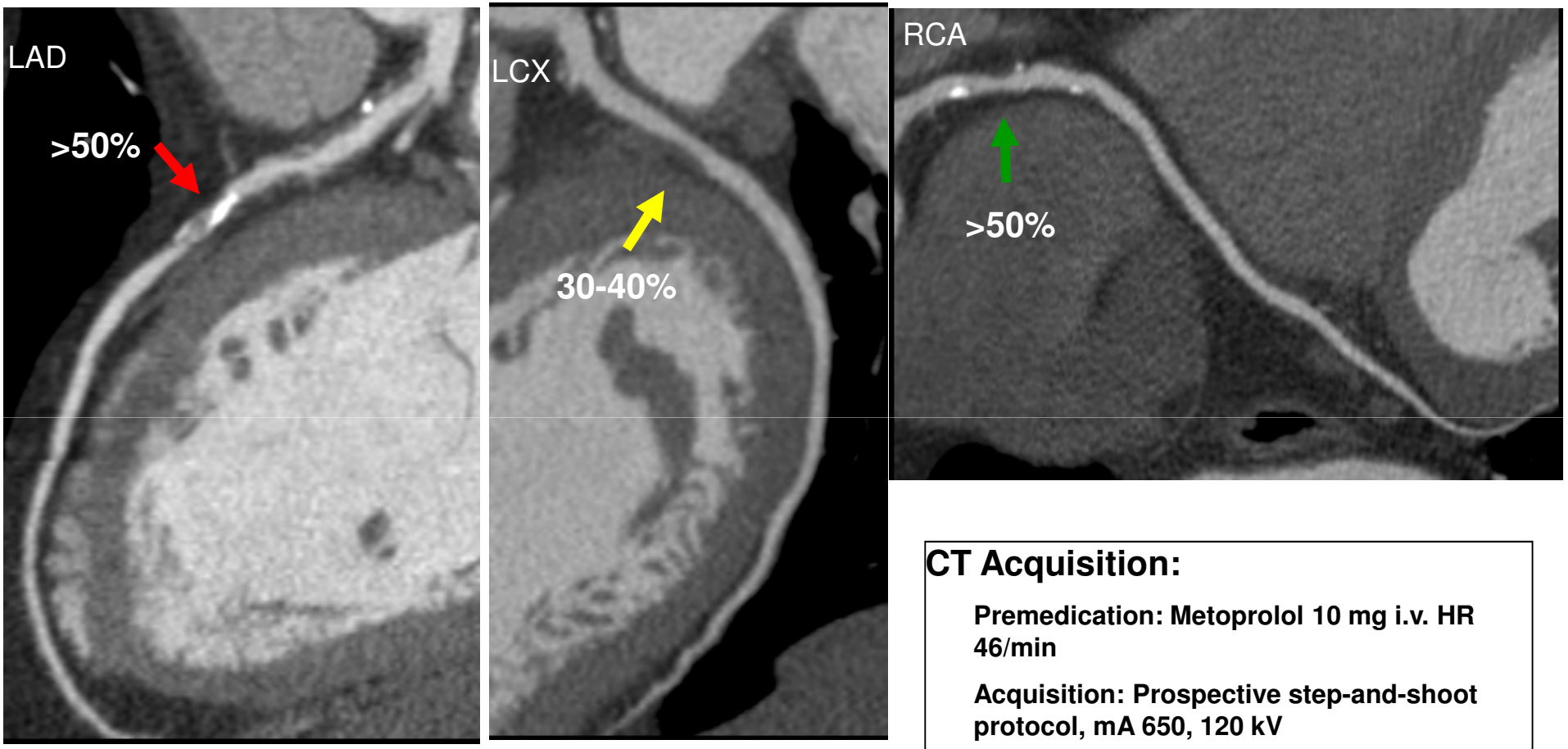

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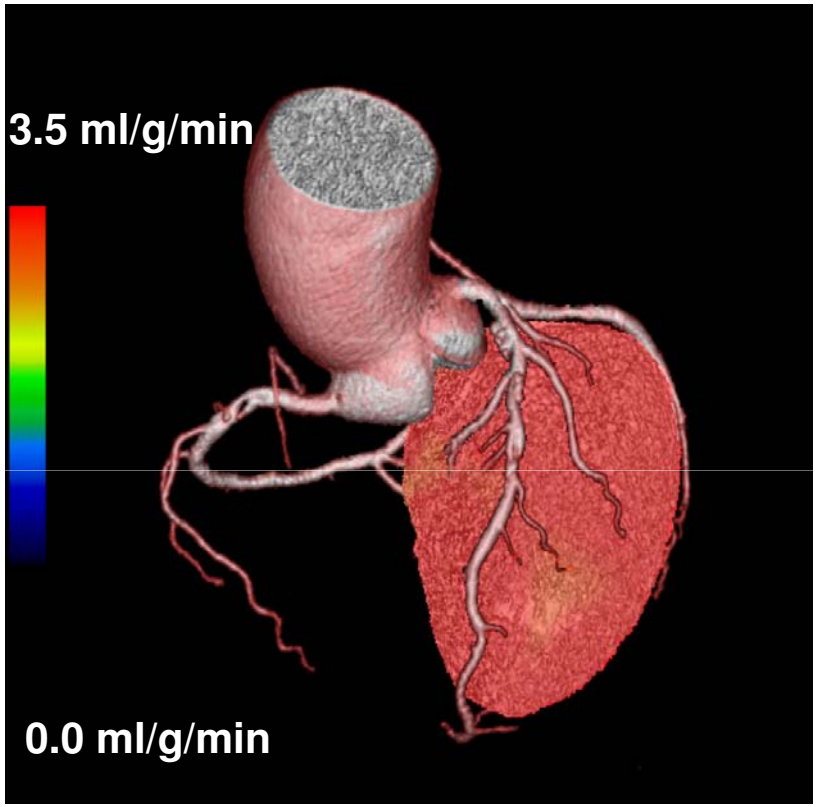

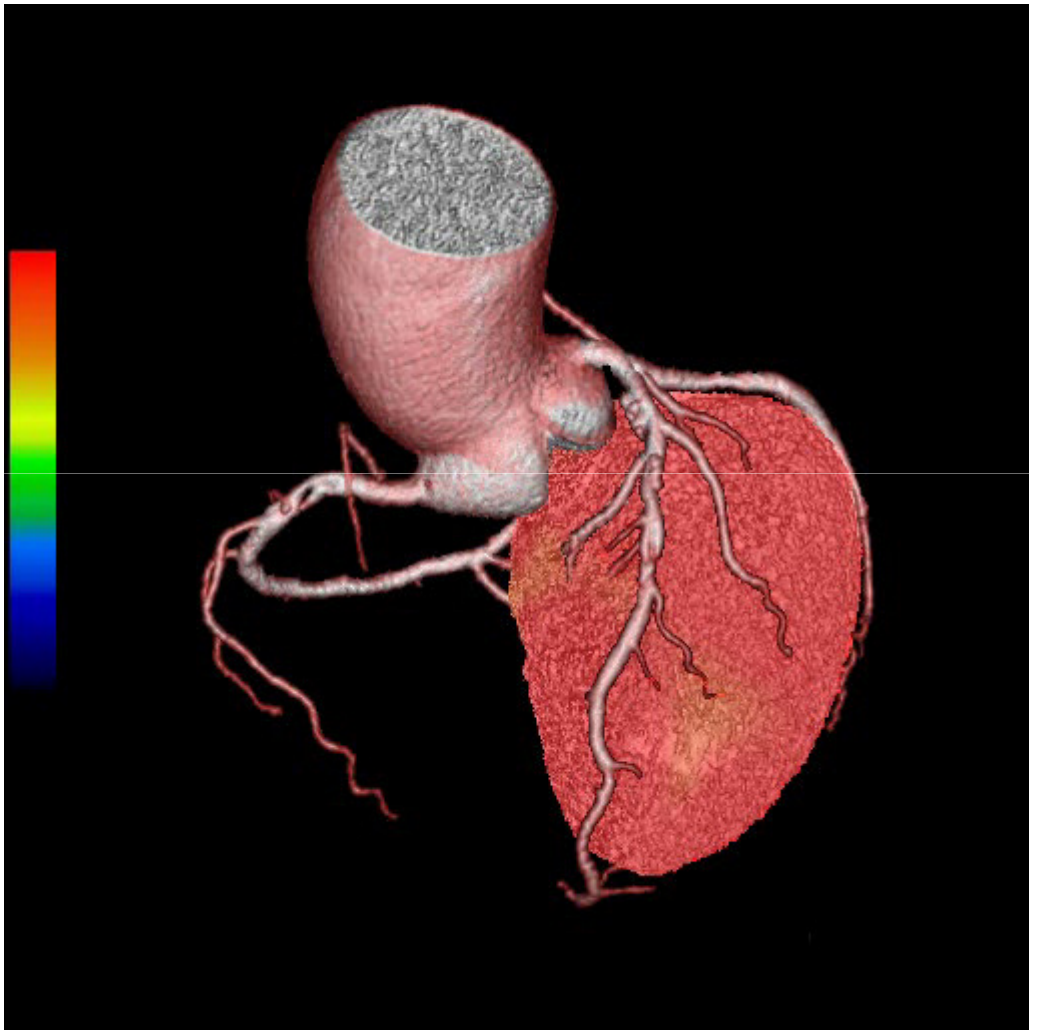

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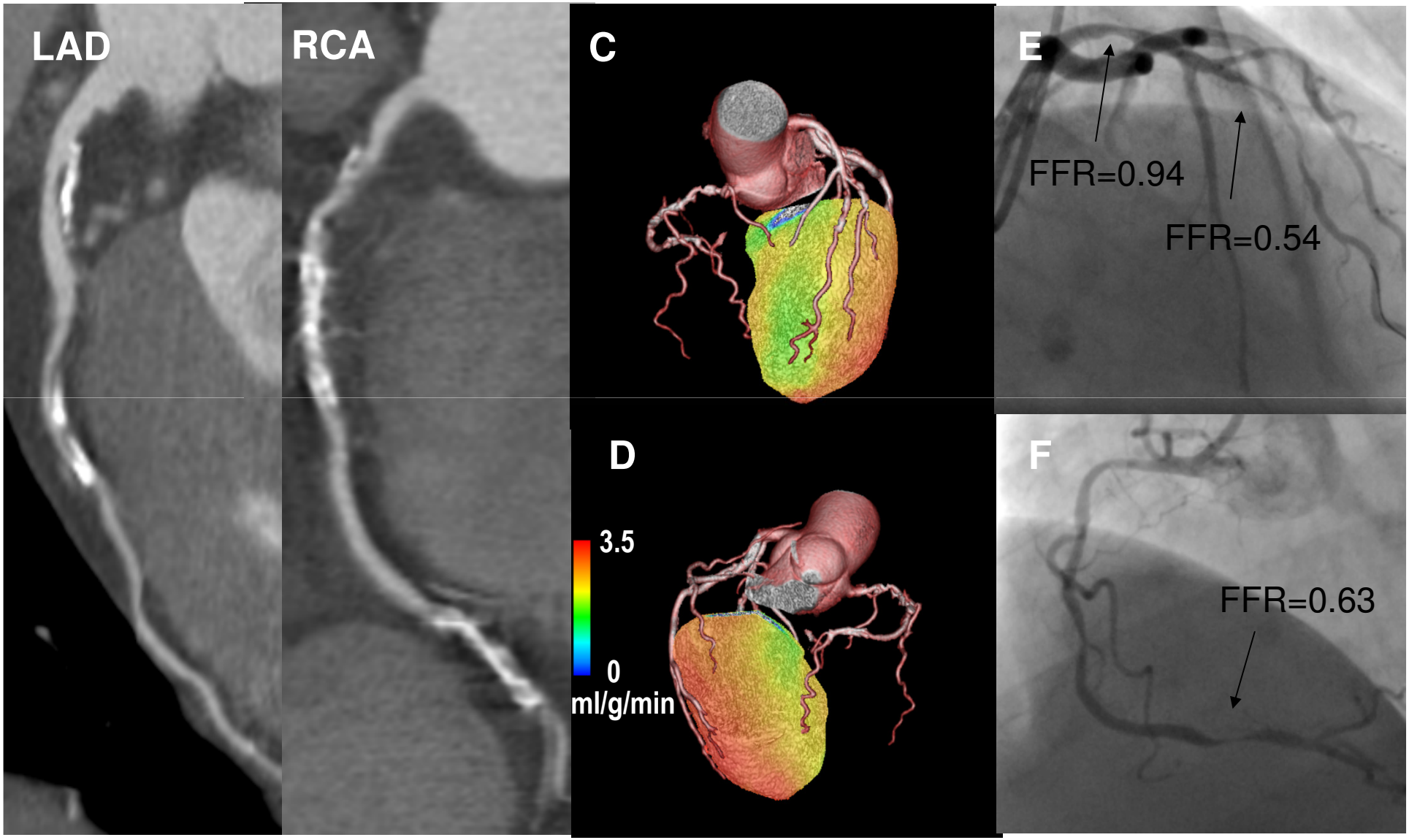
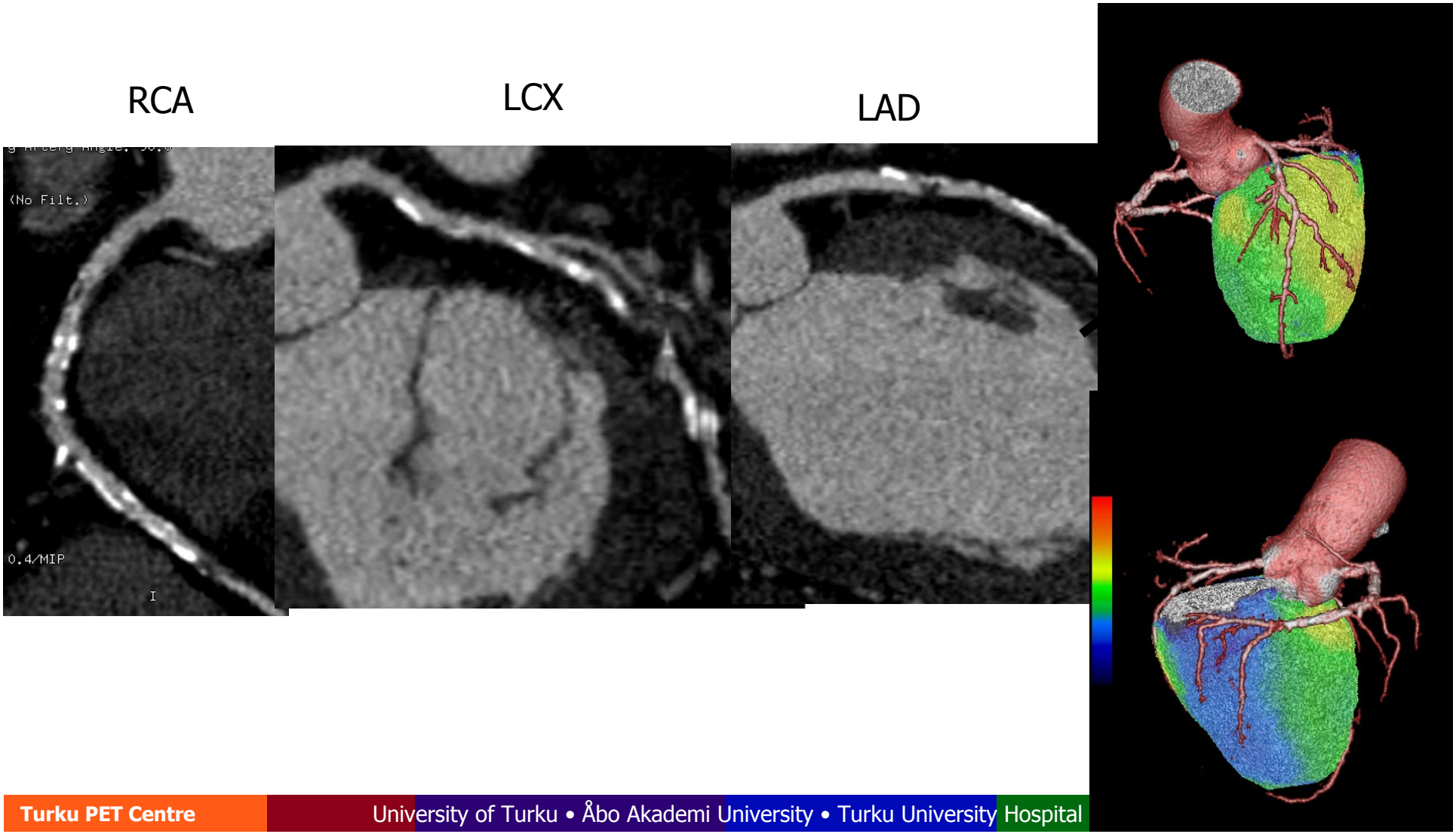
Case:LP

Multivessel disease: What is the culprit lesion?



Multivessel disease: What is the culprit lesion?

Case: stenoses in all major vessels; RCA is culprit

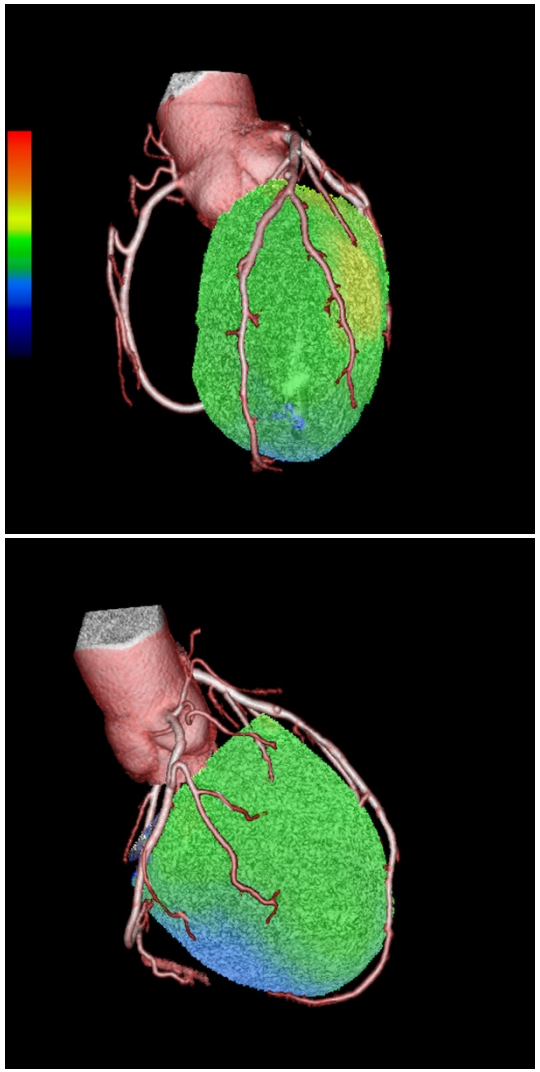


Microvascular disease

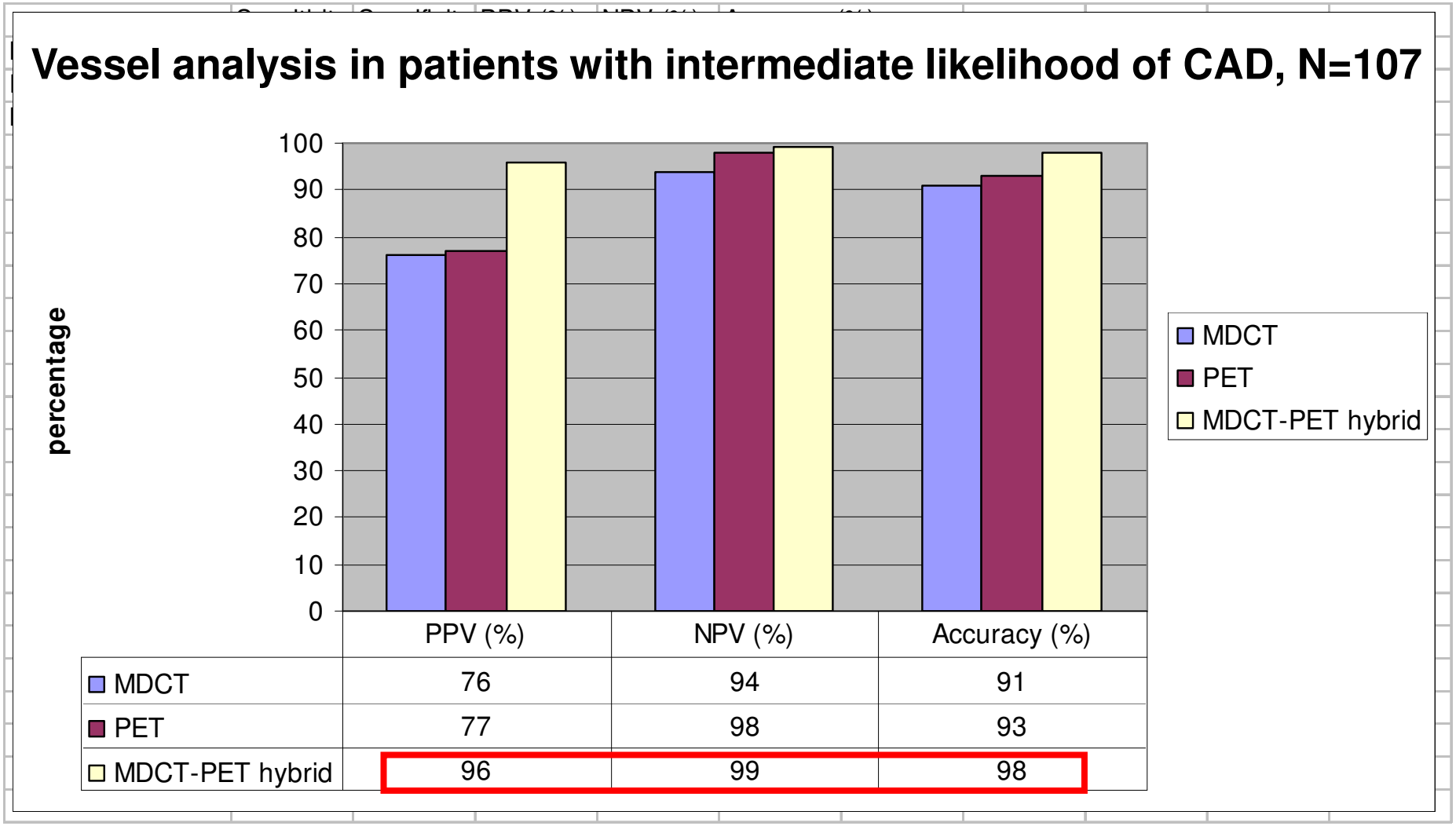
Absolute perfusion decreased but no epicardial disease

Relative perfusion

Absolute perfusion



Hybrid noninvasive (PET/CT) vs. Hybrid invasive (ICA + FFR)



	PPV (%)	NPV (%)	Accuracy (%)
MDCT	76	94	91
PET	77	98	93
MDCT-PET hybrid	96	99	98

Kajander et al Circulation 2010

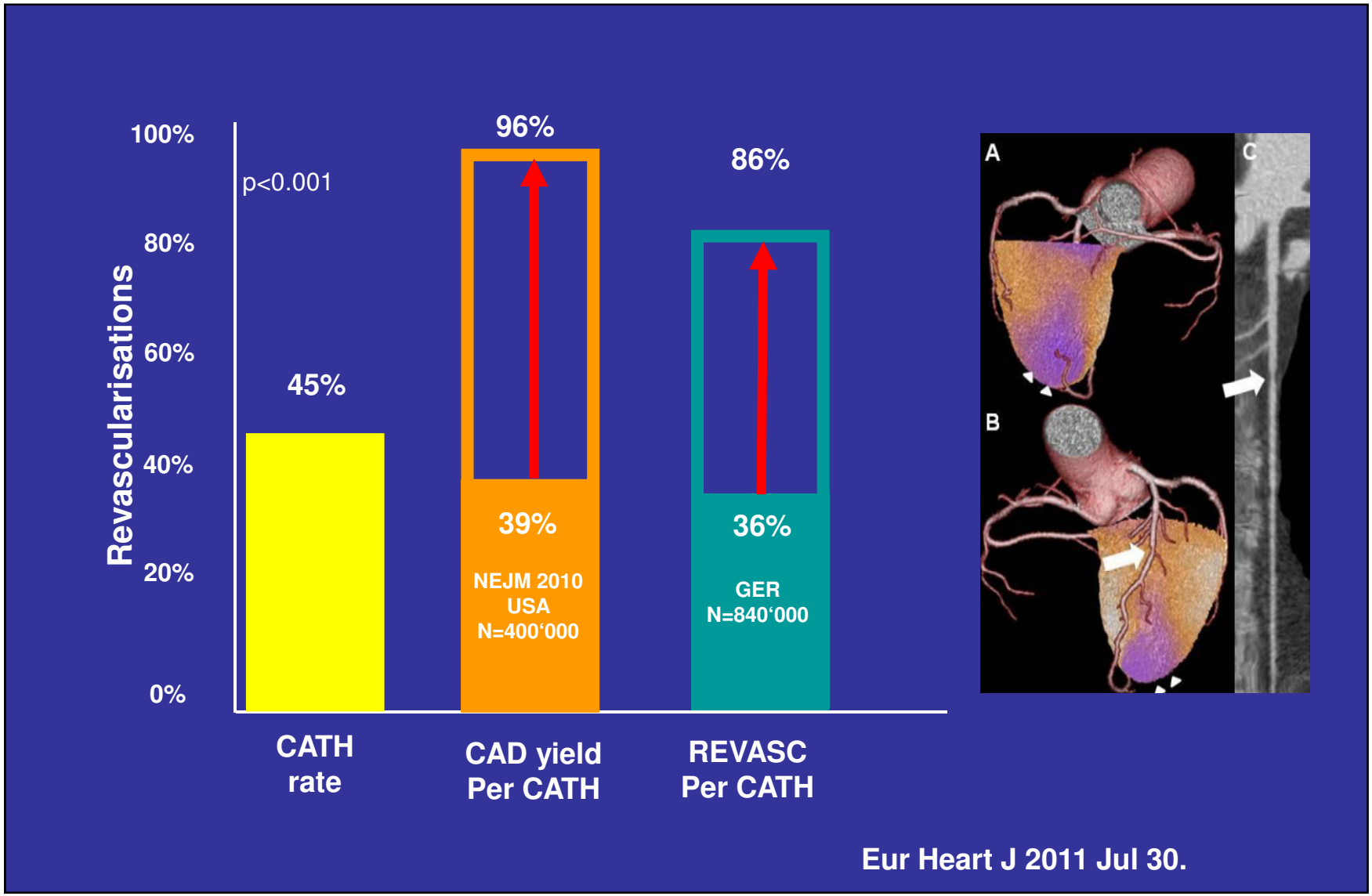
Challenges and solutions of perfusion imaging

Challenge	Solution
LM disease	?
Balanced 3 vessel disease	?
Multivessel disease	?
Anatomical location	?
Non-ischemic CAD	?
Microvascular disease	?

Challenges and solutions of ischemia imaging

Challenge	Solution
▪ LM disease	**Hybrid**
▪ Balanced 3 vessel disease	
▪ Multivessel disease	
▪ Anatomical location	**Hybrid**
▪ Non-ischemic CAD	**Hybrid**
▪ Microvascular disease	/ **Hybrid**

Impact of hybrid imaging on downstream resource utilization



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Current main trends

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Challenges and solutions of CAD/ishchemia imaging

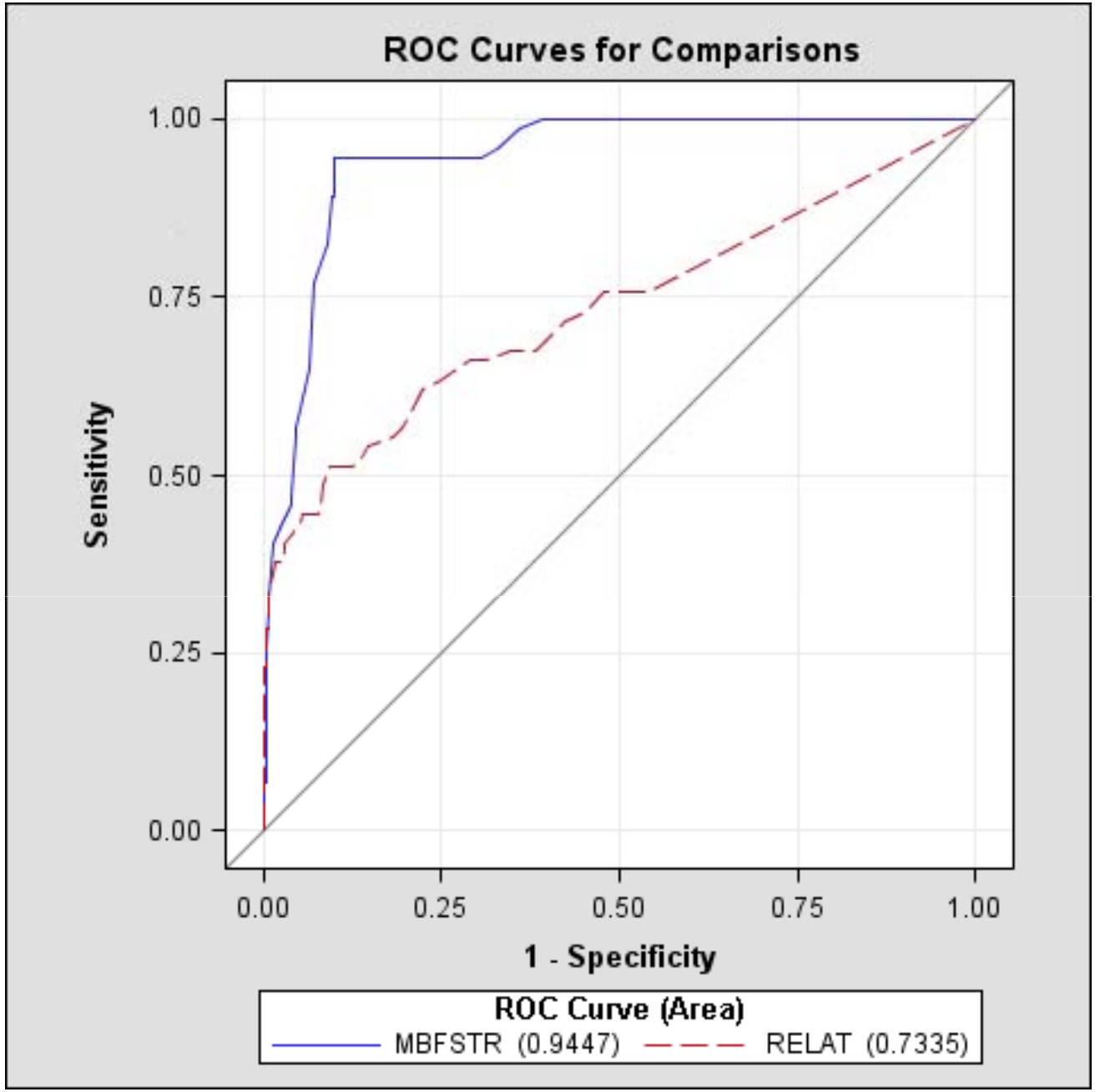
Challenge	Solution
LM disease	Hybrid
Balanced 3 vessel disease	**Quantification**
Multivessel disease	**Quantification**
Anatomical location	Hybrid
Non-ischemic CAD	Hybrid
Microvascular disease	**Quantification**/ Hybrid

Quantification of myocardial perfusion

Which patients will benefit?

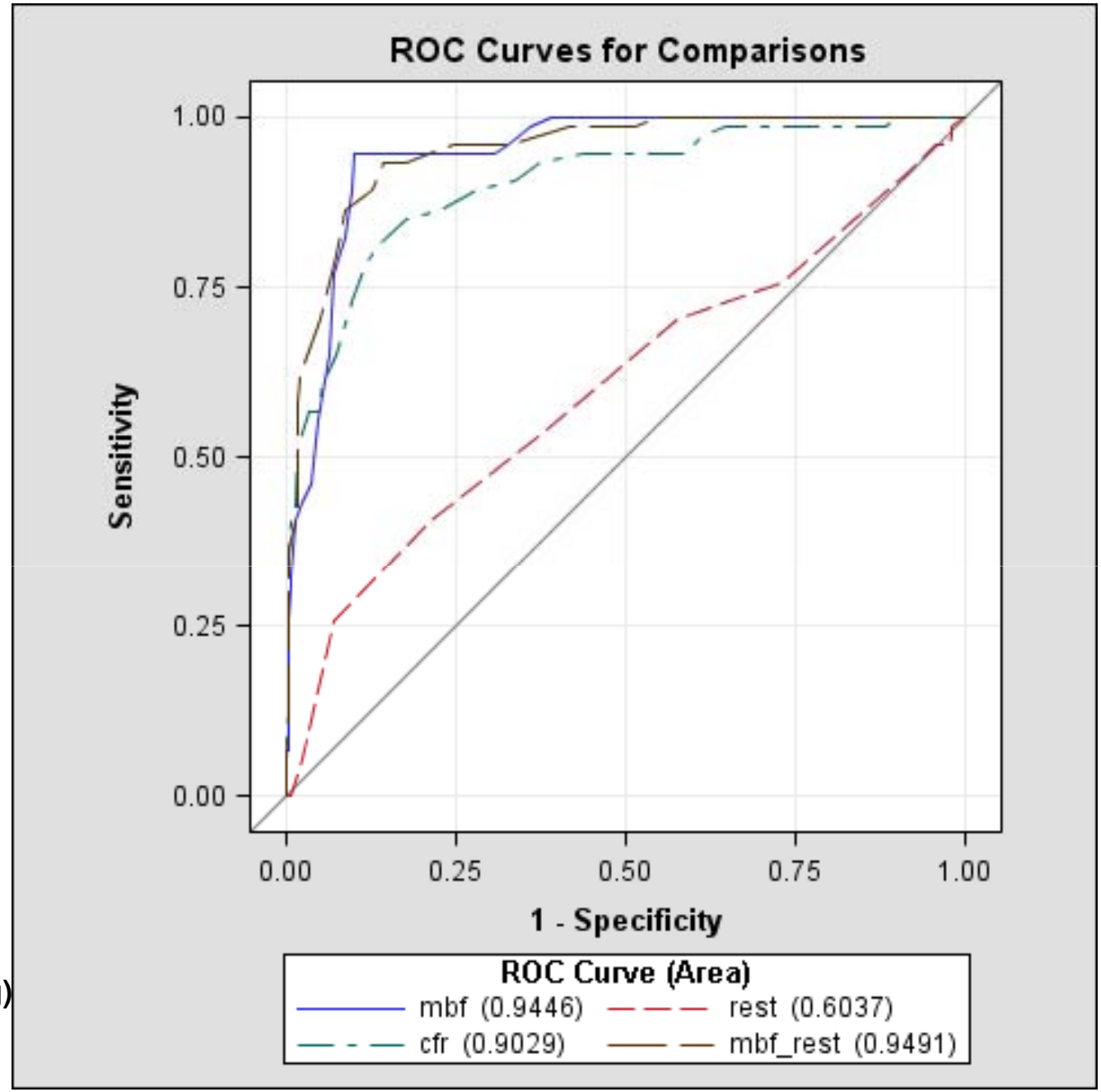
- Balanced 3 vessel or multivessel disease
- Culprit lesion vs. non-culprit lesion in multi vessel disease
- Early changes in coronary dysfunction

Absolute flow vs Relative flow



Kajander et al Circ Cardiovasc Imaging. 2011

Absolute flow is as good as flow reserve!



Joutsiniemi et al (Circ Imaging)

Imaging and CAD
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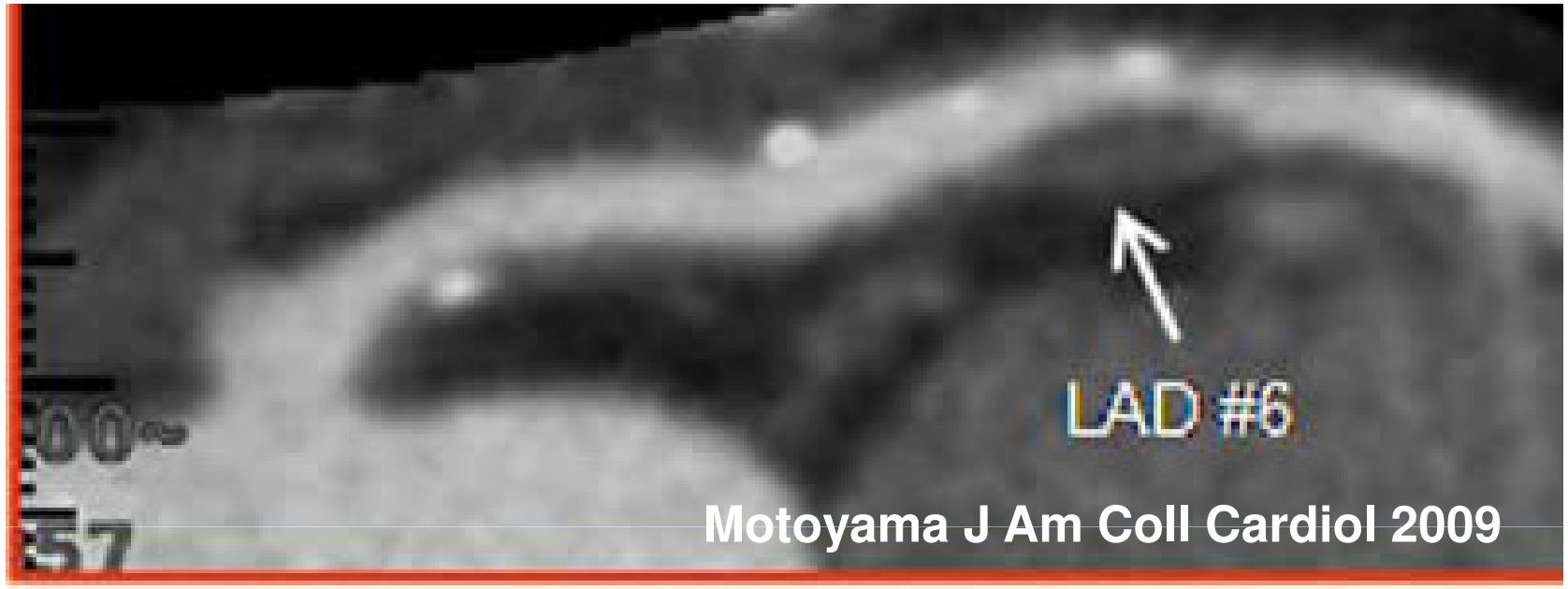
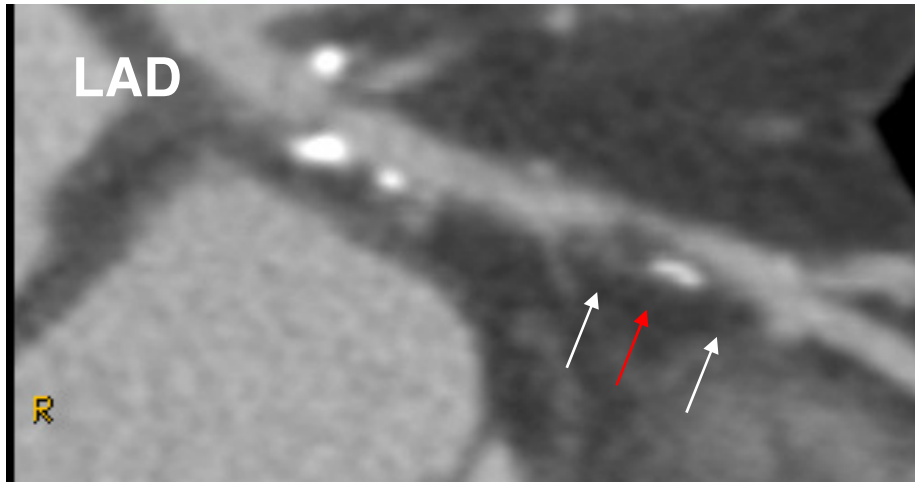
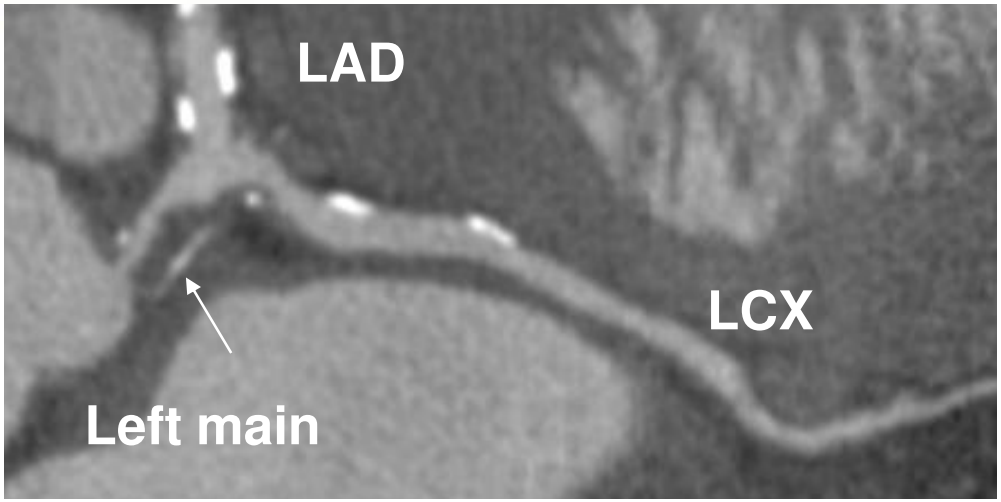
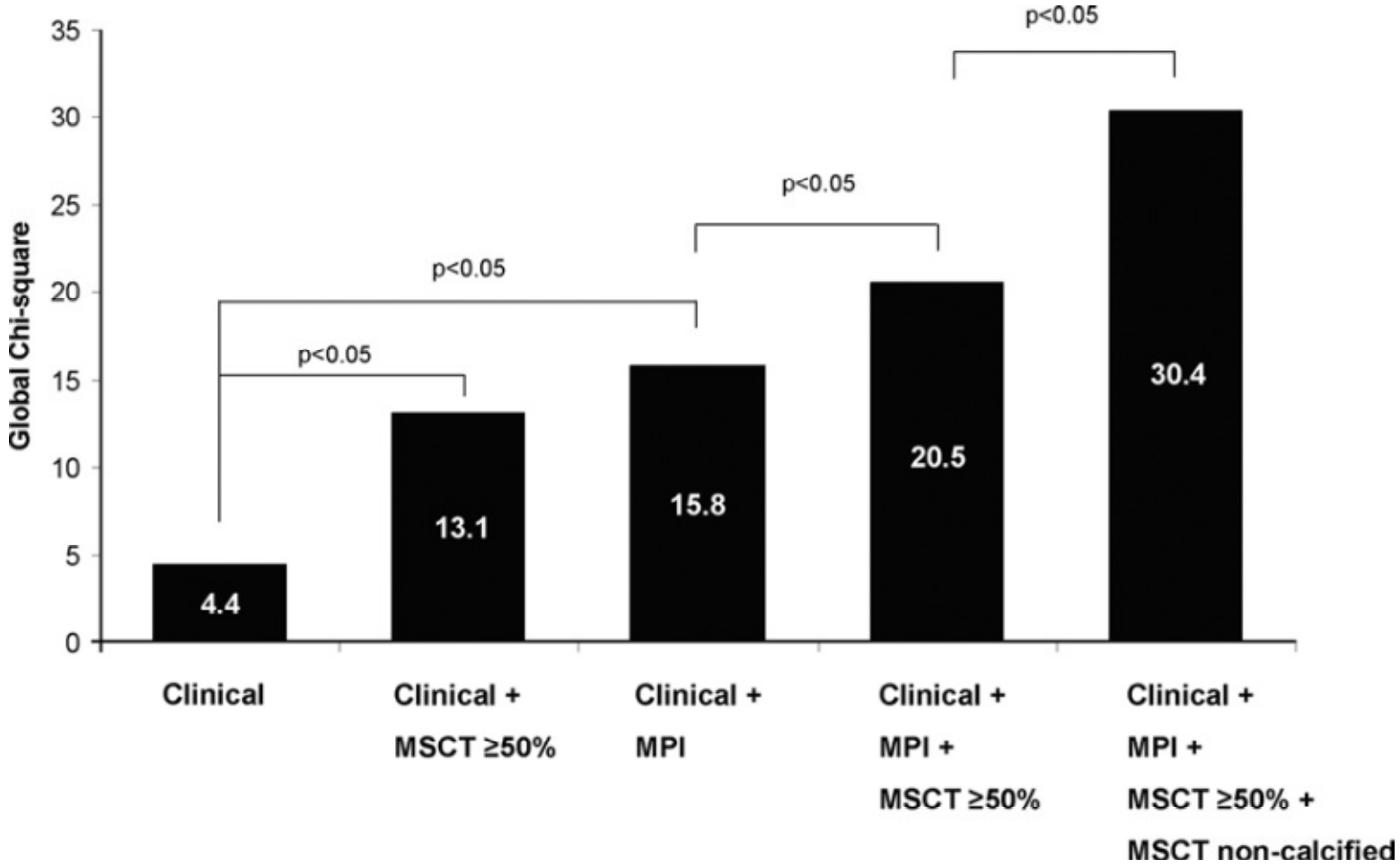
MDCT Characterization of Coronary Plaques







Plaque characterization using CT vs. Myocardial Perfusion SPECT

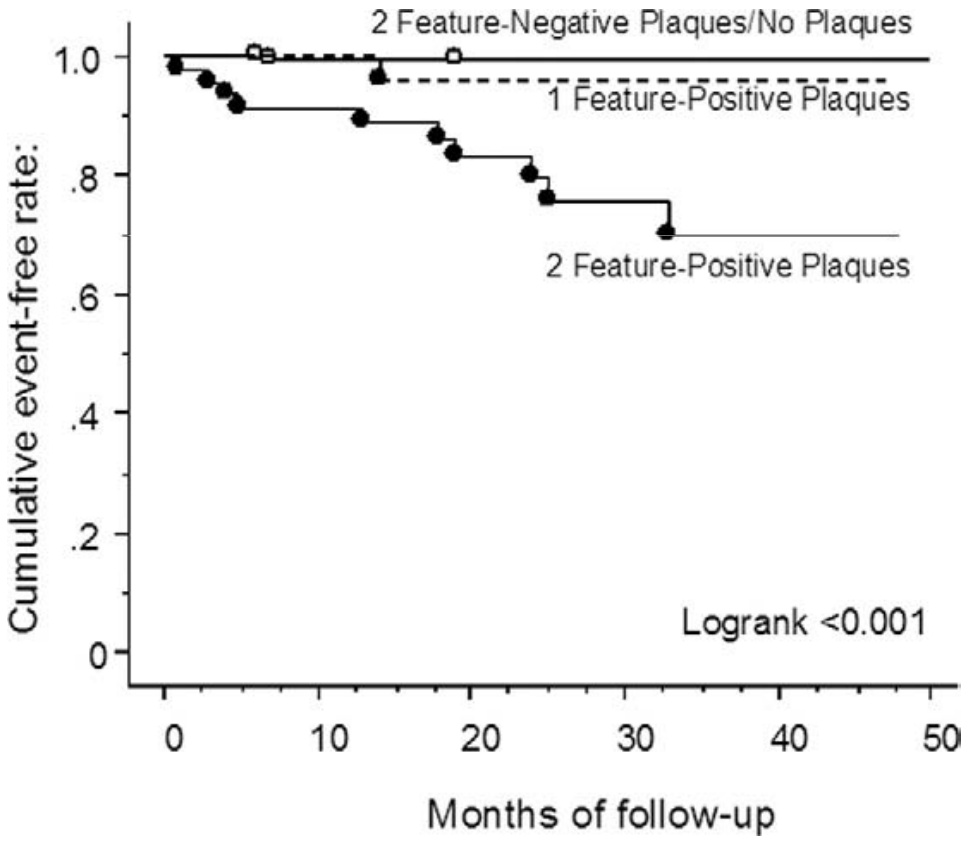


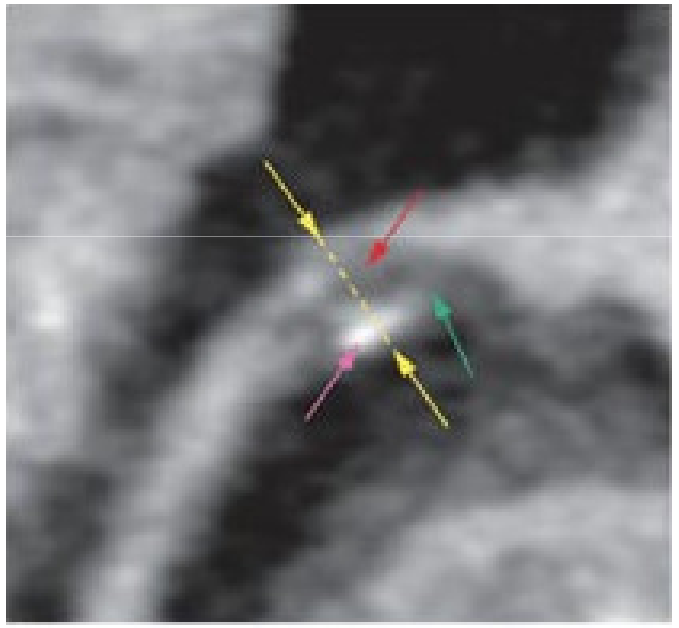
Van Verkhoven et al J Am Coll Cardiol 2009;53: 623–32

N=541

MDCT Characterization of Coronary Plaques - Prognosis

Large low attenuation plaque area
Positive remodeling
Spotty calcification

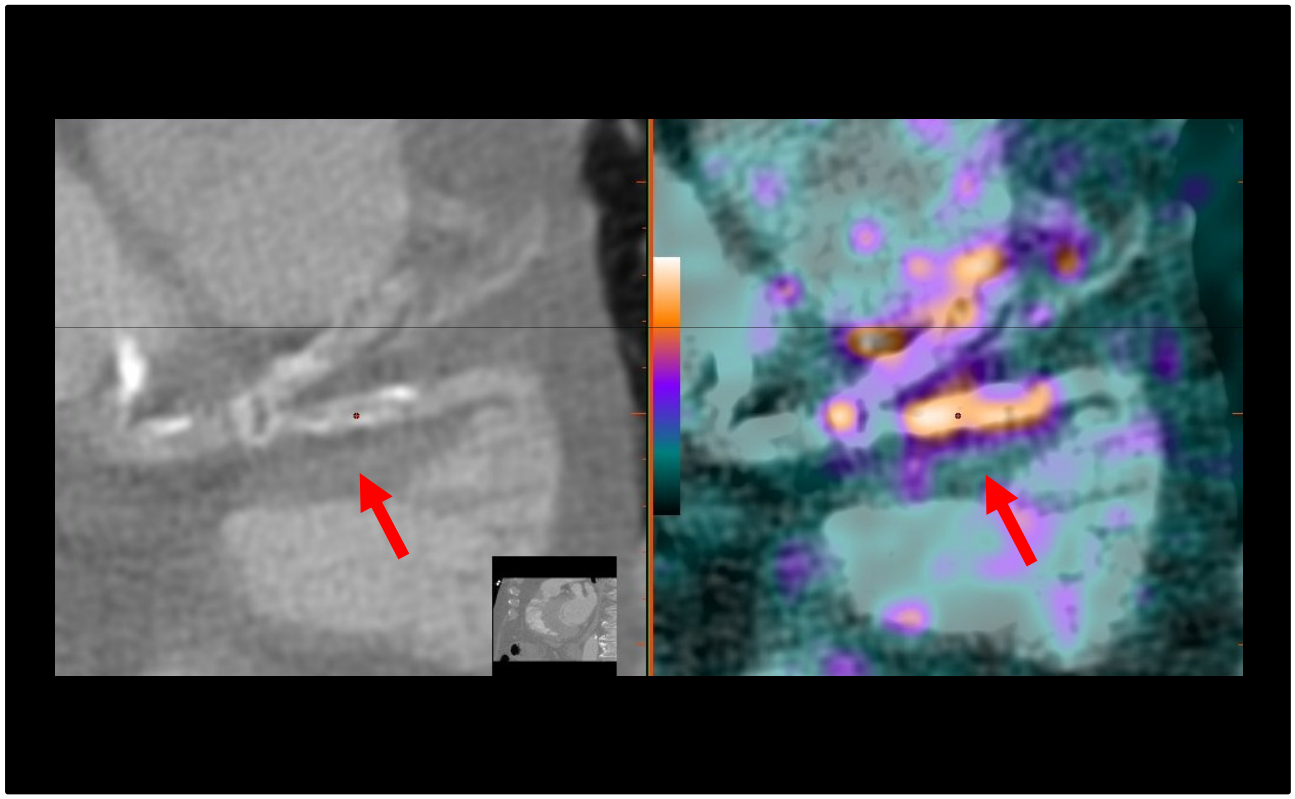




15 ACS in 1059 patients

Motoyama J Am Coll Cardiol 2009

Dual gated ^{18}F-FDG PET/CT of coronary arteries in ACS patients

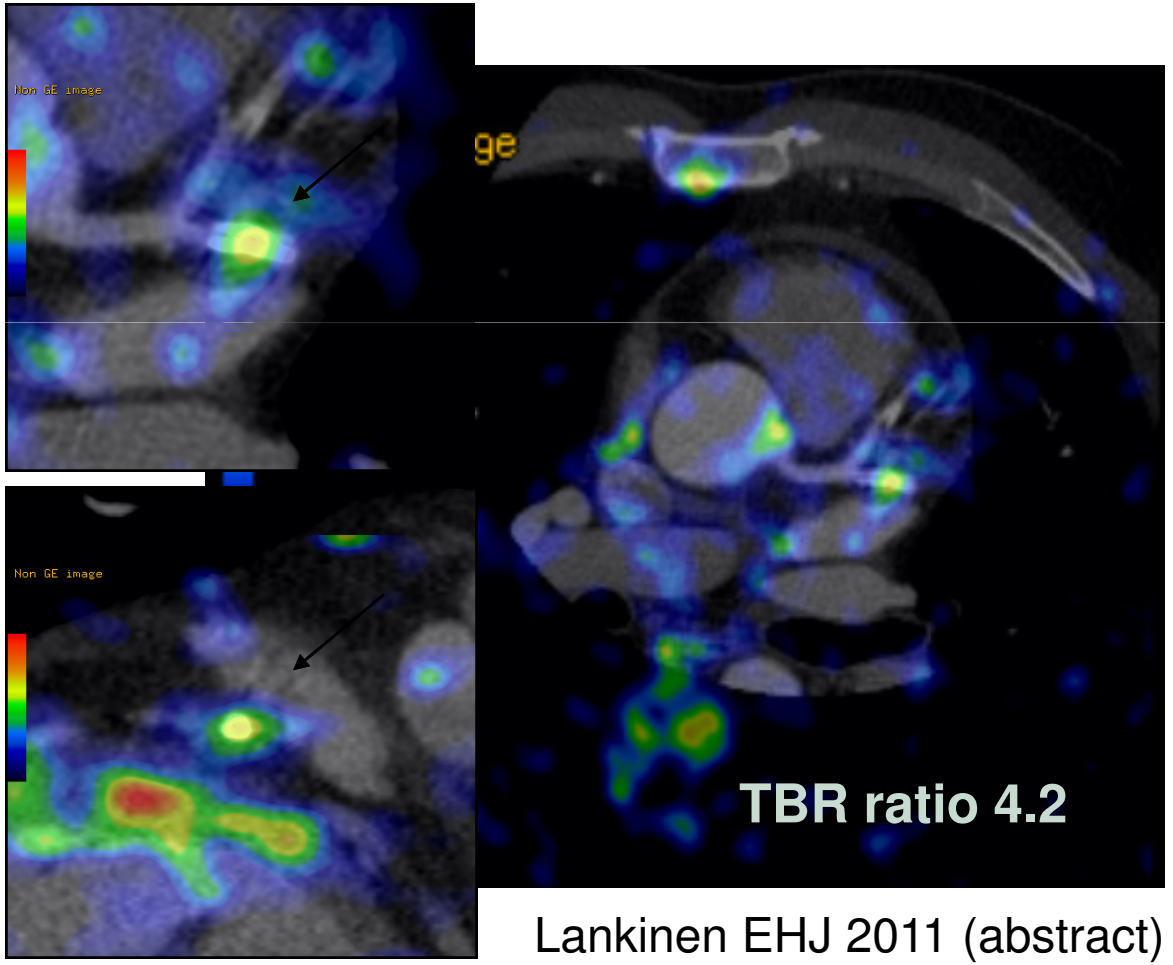


Myocardial FDG uptake supressed by low carbohydrate, high fat diet

Lankinen at al ICNC 2011

Dual gated ^{18}F-FDG PET/CT of coronary arteries in ACS patients

- **39 year old man**
- **Risk factors of CAD:**
  - **Smoking**
  - **Family history +**
- **5 days of UAP**
- **ECG: lateral T-inversion**
- **TNT +**
- **LCX subtotal occlusion stented**



Lankinen EHJ 2011 (abstract)

Turku PET Centre, Finland

Dual gated ^{18}F-FDG PET/CT of coronary arteries in ACS patients

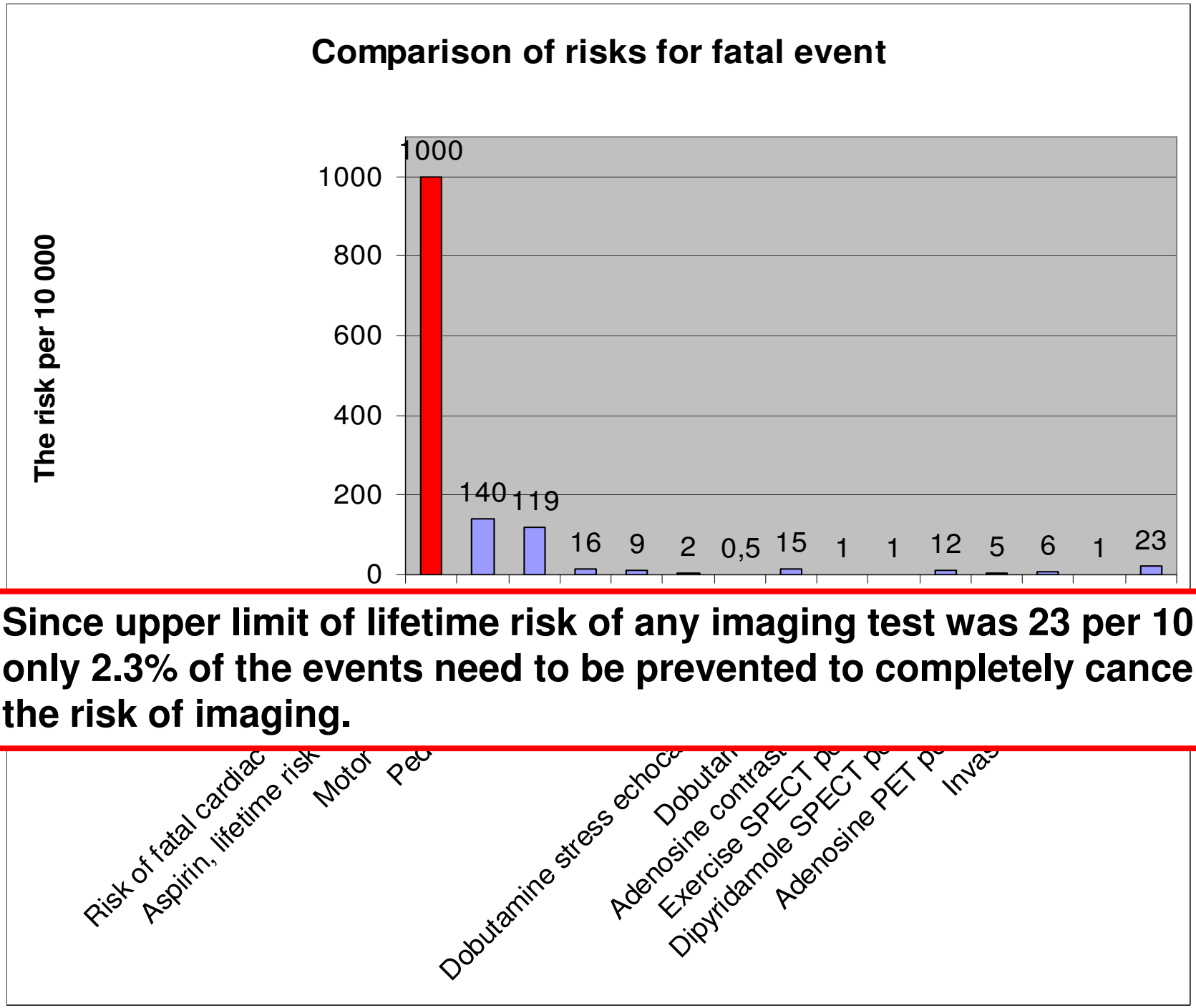
- **20 ACS (non-STEMI or UAP) patients**
- **Dual-gated ^{18}F FDG PET/CT (3d after onset of symptoms)**
- **High-fat diet intervention to suppress myocardial uptake (Williams AJR 2008)**

- **Visual coronary FDG uptake in 80% of patients (3 prior to intervention)**
- **TBR 3.2±1.3 (range 1.8-5.4)**

Lankinen EHJ 2011 (abstract)

Concerns on sequential / hybrid imaging for CAD

- Complicated for patients (sequential)
- Logistic challenges (hybrid)
- Higher work load
- Non-standardized image analysis
- Radiation burden
- Lacking evidence and indications
- Costs and cost-effectivenes



Since upper limit of lifetime risk of any imaging test was 23 per 10 000 only 2.3% of the events need to be prevented to completely cancel the risk of imaging.