Diagnosi di cardiopatia ischemica cronica: vantaggi e limiti relativi delle tecniche a confronto

Medicina Nucleare

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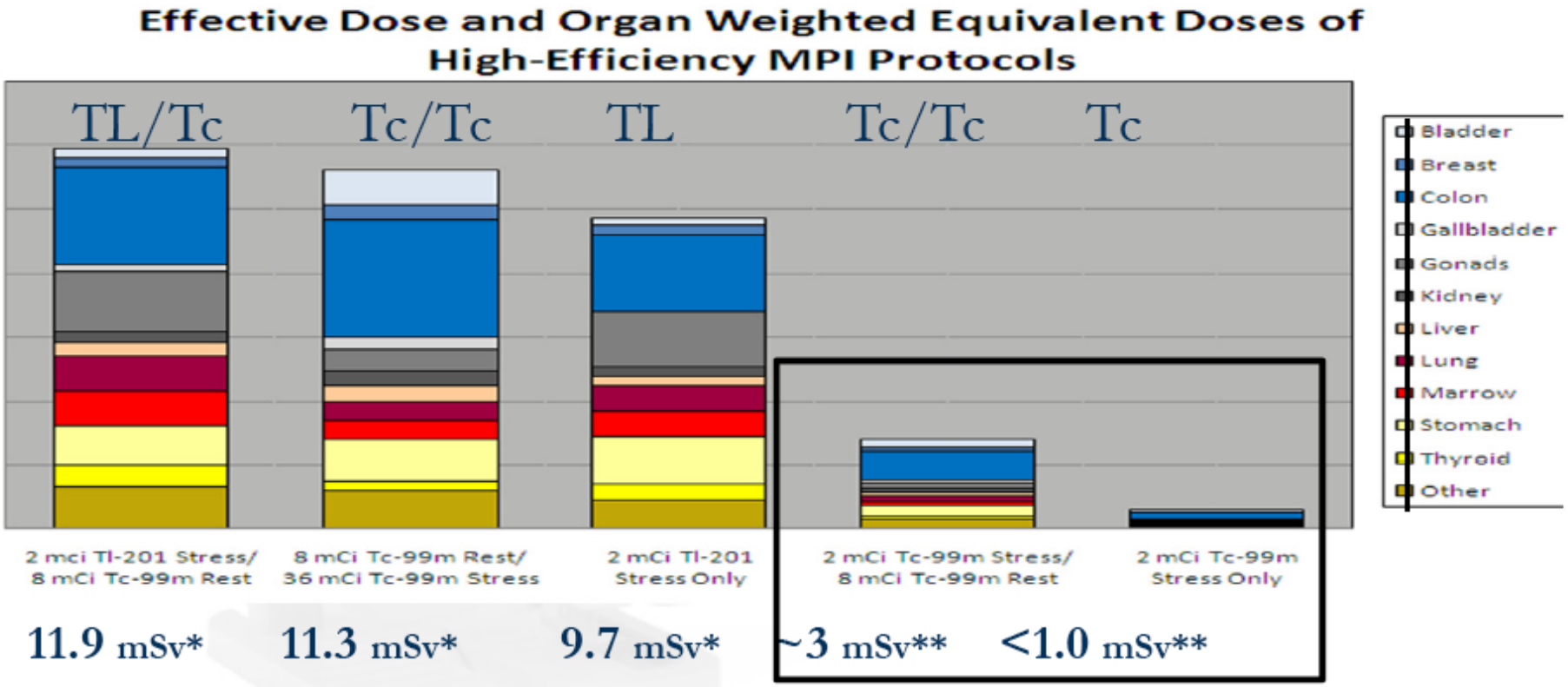
Fondazione CNR/Regione Toscana G. Monasterio

Fusion CCTA-SPECT Imaging

(Exercise Stress SPECT)

Limits

Radiation exposure



CZT SPECT

The Continuum of Coronary Artery Disease

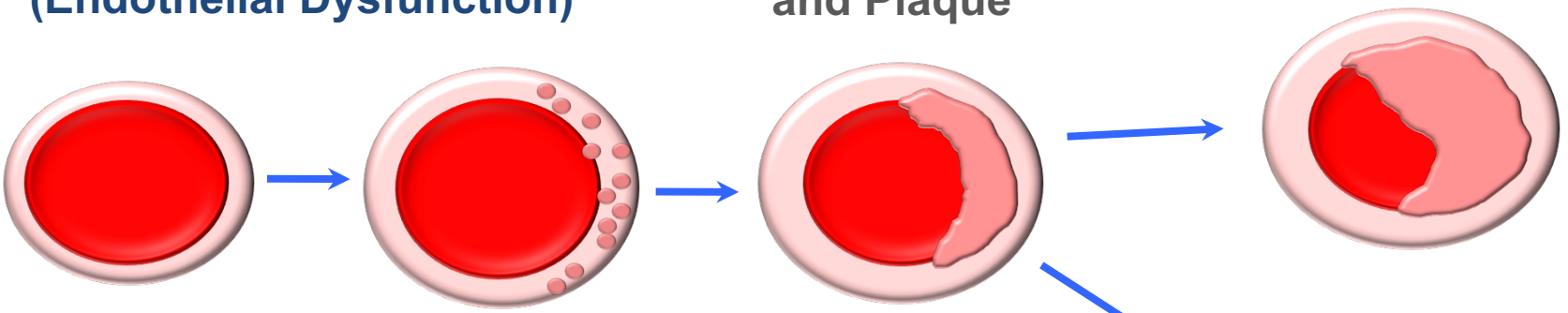
Preclinical Disease

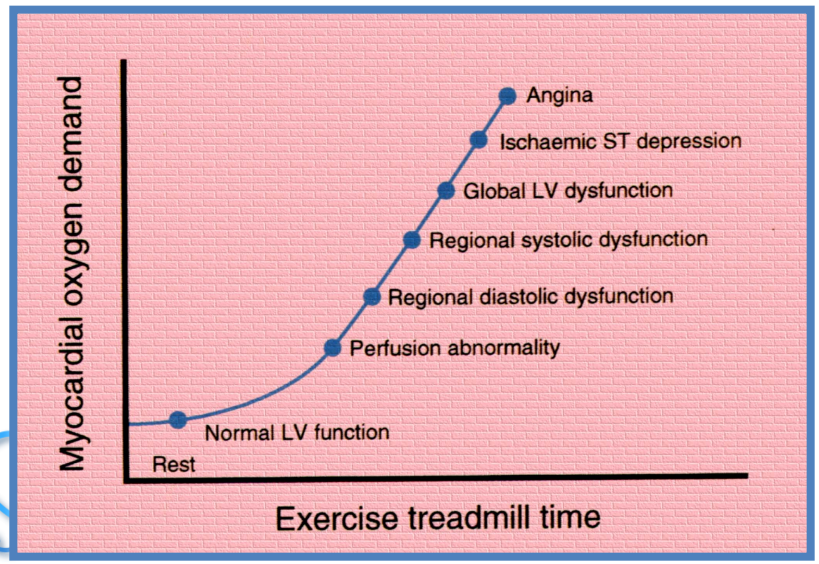
Clinical Disease

Abnormal Vascular Reactivity (Endothelial Dysfunction)

Vascular Remodeling and Plaque

Stable Flow Limiting Coronary Stenosis





Acute Occlusion

Microcirculation

The tip of the iceberg
Resolution >500 µm

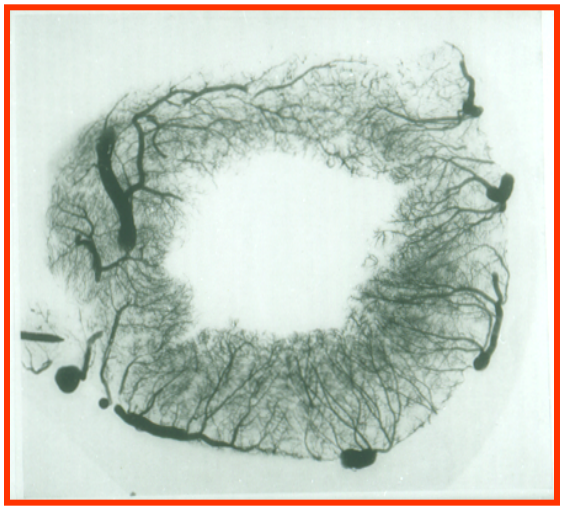
The hidden side of the iceberg
Resolution <500 µm

Coronary Microvascular Dysfunction

MACRO vessels

Even in the absence of stenosis

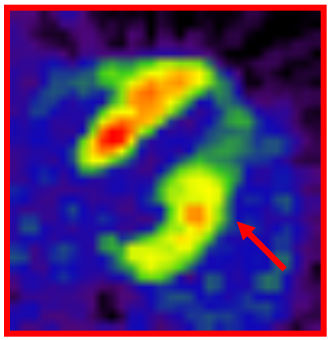
MICRO vessels



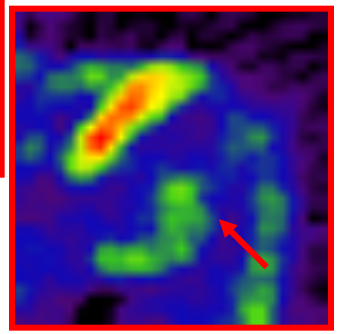
… blood flow can be blunted at the Microvascular level

TISSUE perfusion

<< *Resting MBF*



<< *Max MBF*



… causing reduced myocardial perfusion and even ischemia

ESC Guidelined on Stable CAD 2013

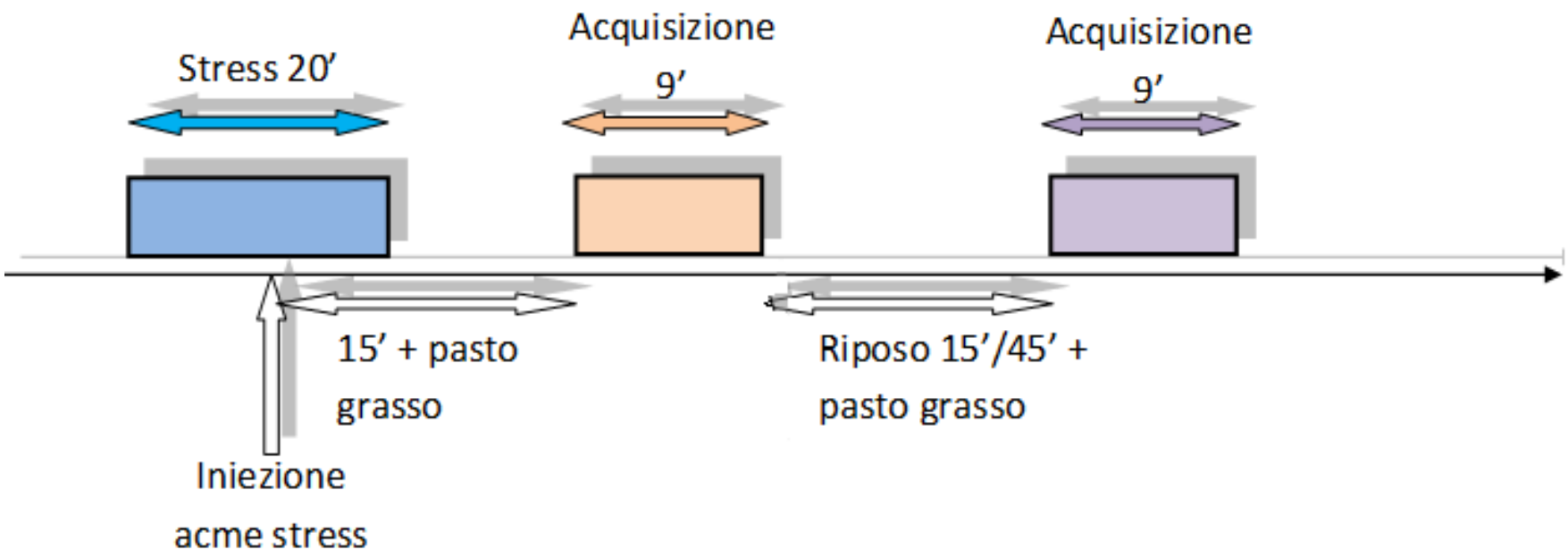
Table 3 Main features of stable coronary artery disease

Pathogenesis
Stable anatomical atherosclerotic and/or functional alterations of epicardial vessels and/or microcirculation
Natural history
Stable symptomatic or asymptomatic phases which may be interrupted by ACS
Mechanisms of myocardial ischaemia
Fixed or dynamic stenoses of epicardial coronary arteries;
Microvascular dysfunction;
Focal or diffuse epicardial coronary spasm;
The above mechanisms may overlap in the same patient and change over time.
Clinical presentations
Effort induced angina caused by: • epicardial stenoses; • microvascular dysfunction; • vasoconstriction at the site of dynamic stenosis; • combination of the above.
Rest angina caused by: • Vasospasm (focal or diffuse) • epicardial focal; • epicardial diffuse; • microvascular; • combination of the above.
Asymptomatic: • because of lack of ischaemia and/or of LV dysfunction; • despite ischaemia and/or LV dysfunction.
Ischaemic cardiomyopathy

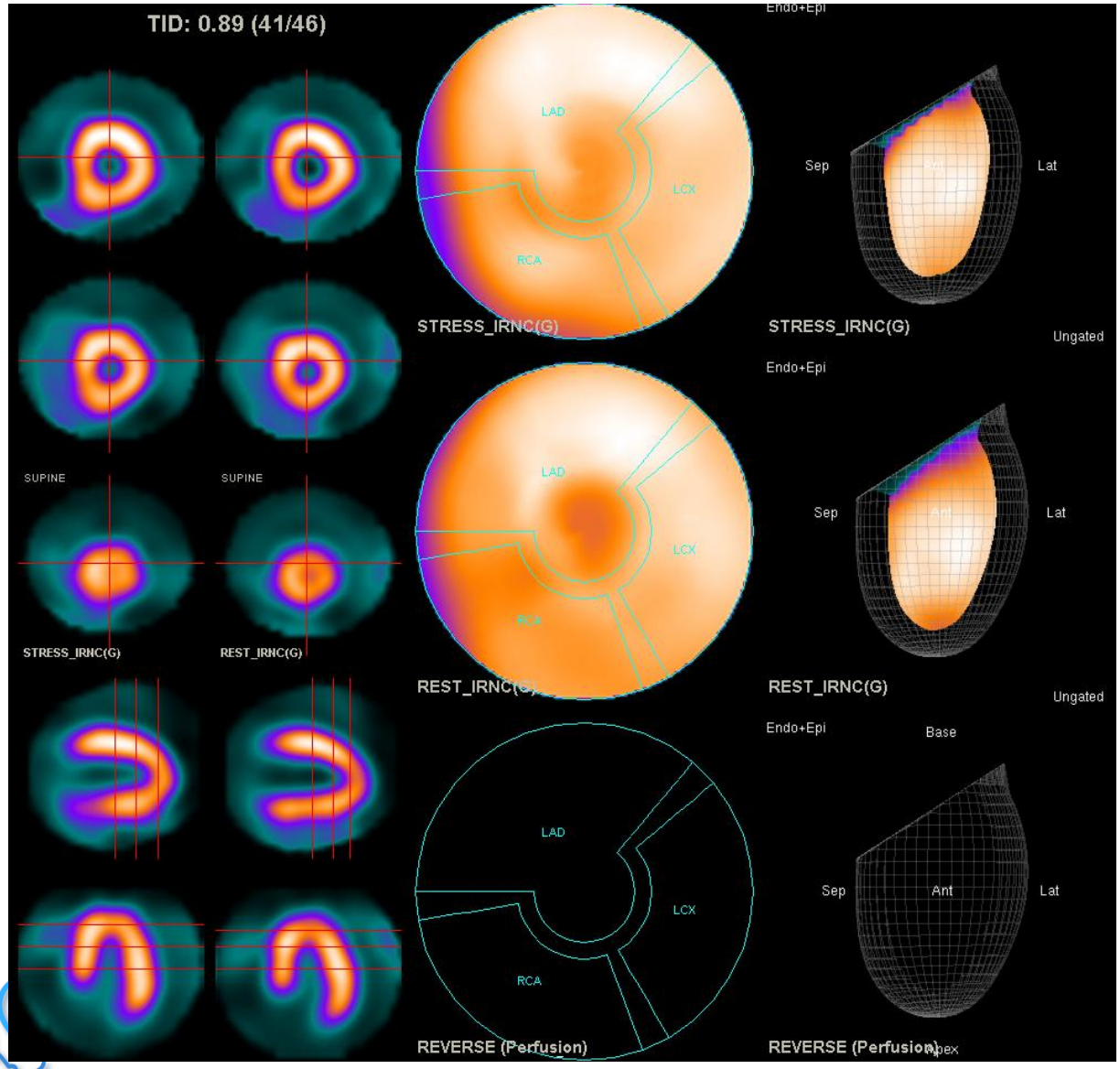
ACS = acute coronary syndrome; LV = left ventricular; SCAD = stable coronary artery disease.

Advantages

Acquisition Protocol



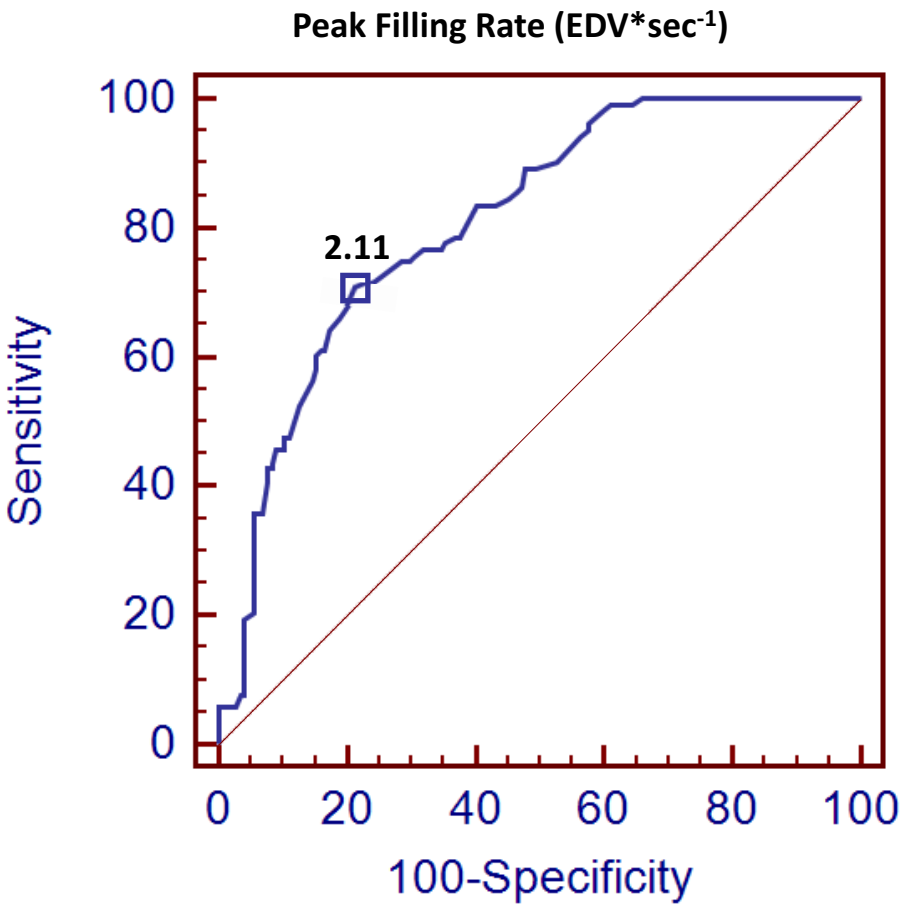
Normal stress-rest MPS (CZT – low dose, ultra fast protocol)

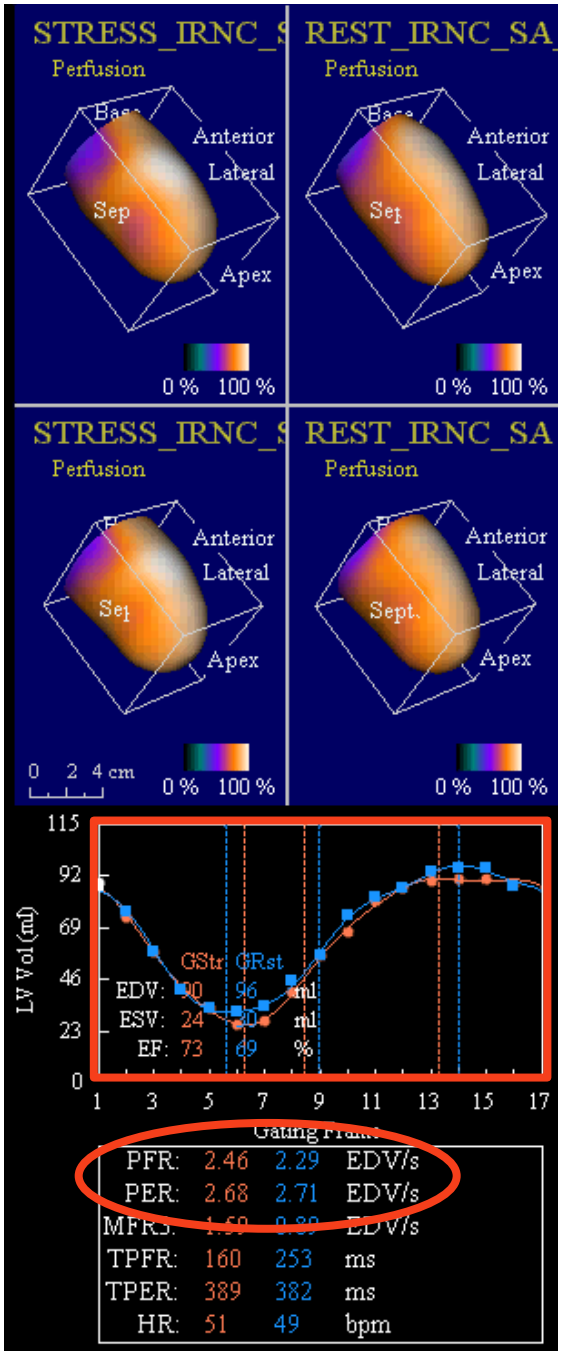


Dosimetry 4.3 mSv

	REST	STRESS
RPP	9103	23550
LVEF %	53	52
EDV ml	129	127
ESV ml	60	62
PFR EDV/sec	2,16	
Mass gr	147	
SDS semiquant	2	

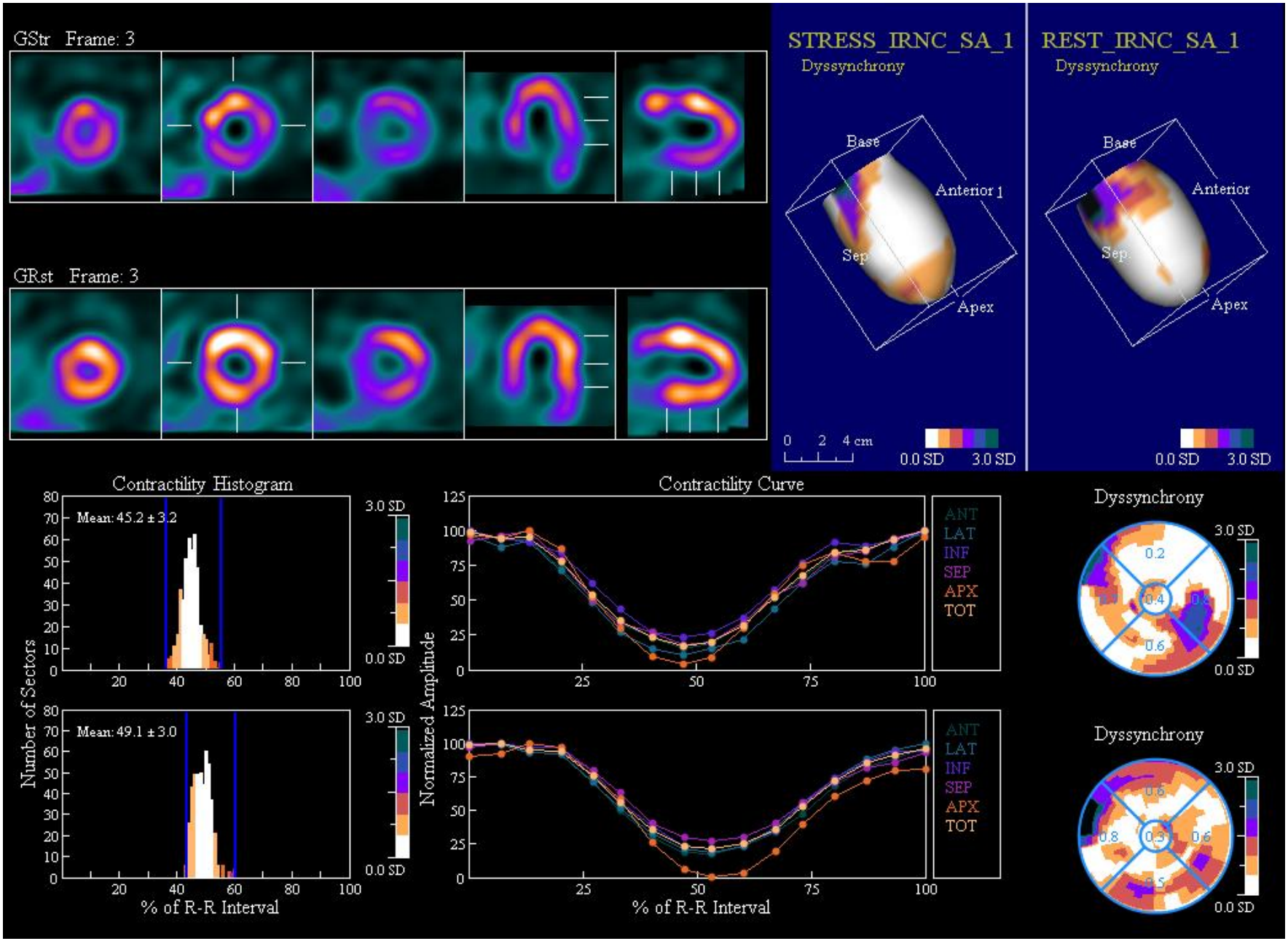
Diastolic Function





Gimelli et al, EHJCVI 2014

Dyssynchrony (Corridor 4DM ™, GE Xeleris III)



Case #1

Male, 63 yrs

SSS 19

SRS 8

SDS 11

FE stress 34%

VTD stress 185 mL

VTS stress 125 mL

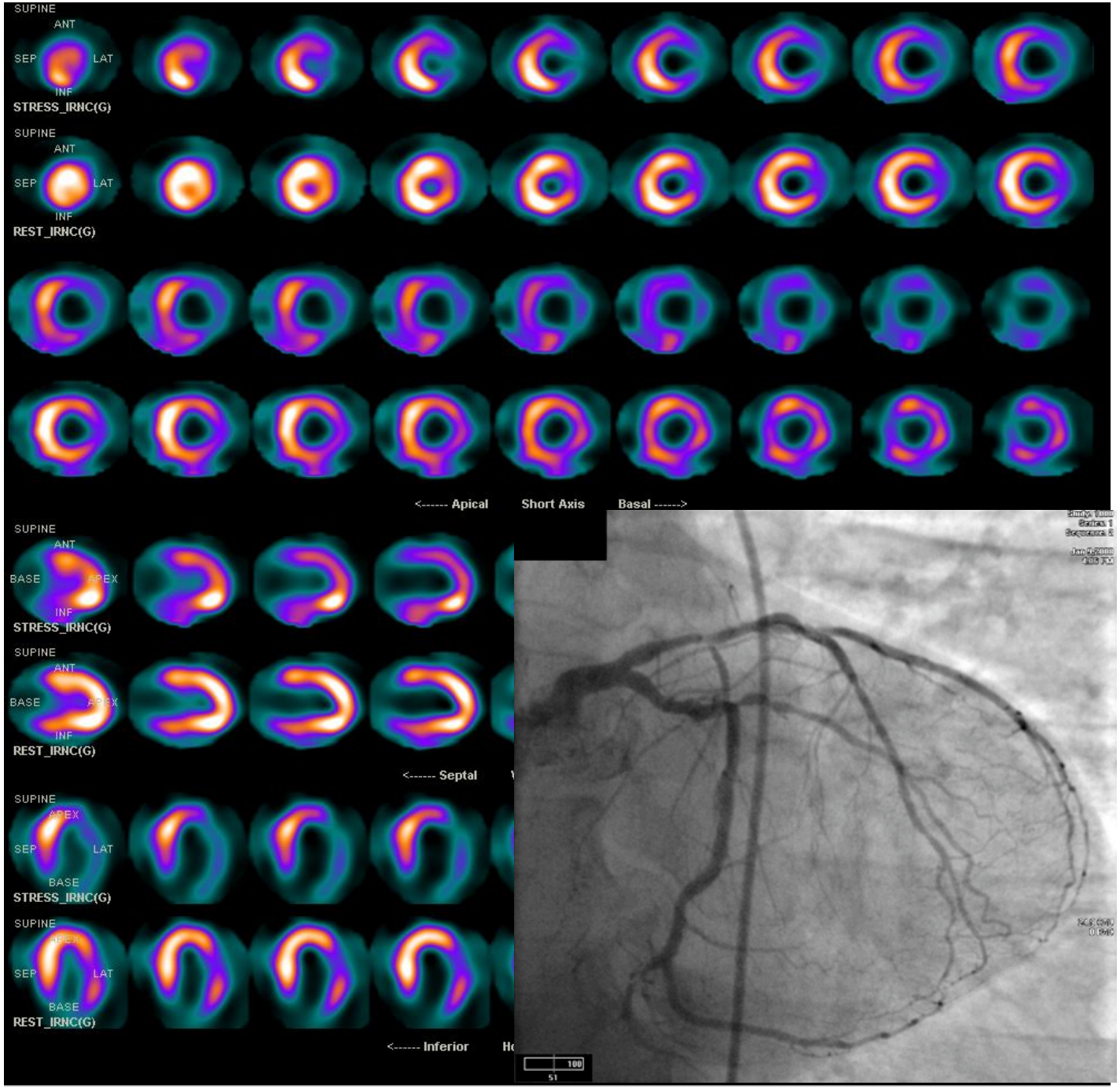
FE rest 40%

VTD rest 155 mL

VTS rest 195 mL

Average radioexposure (mSv)

3.9



Case #2

LR, male, 46 yrs

Risk factors: family history for CAD, hypertension

2008: anterior MI> LAD stent
Echo: LVEF 47% Akinesis of the apex, hypokinesis of anterior wall and apical antero-septal region, EF 47%

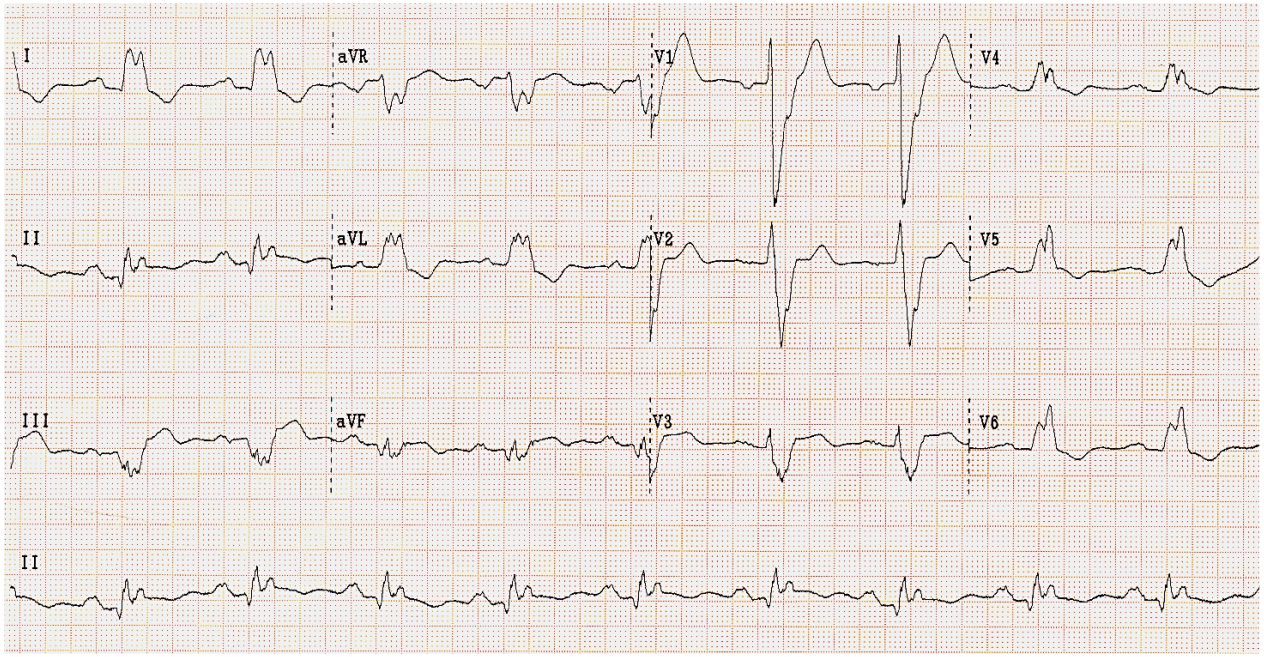
Therapy: aspirin, ACE-inhibitors, beta-blockers,

Progressive reduction of exercise tolerance

2013: no angina, NYHA IIb

Echo EF 47% (2008) > EF 34% (2013)

Case #2



Rest EKG

RSR 60/min, PR 200 ms, QRS 240 ms, LBBB

Case #2: Several issue

Ischaemia: Yes or No?

CAD: Yes or No?

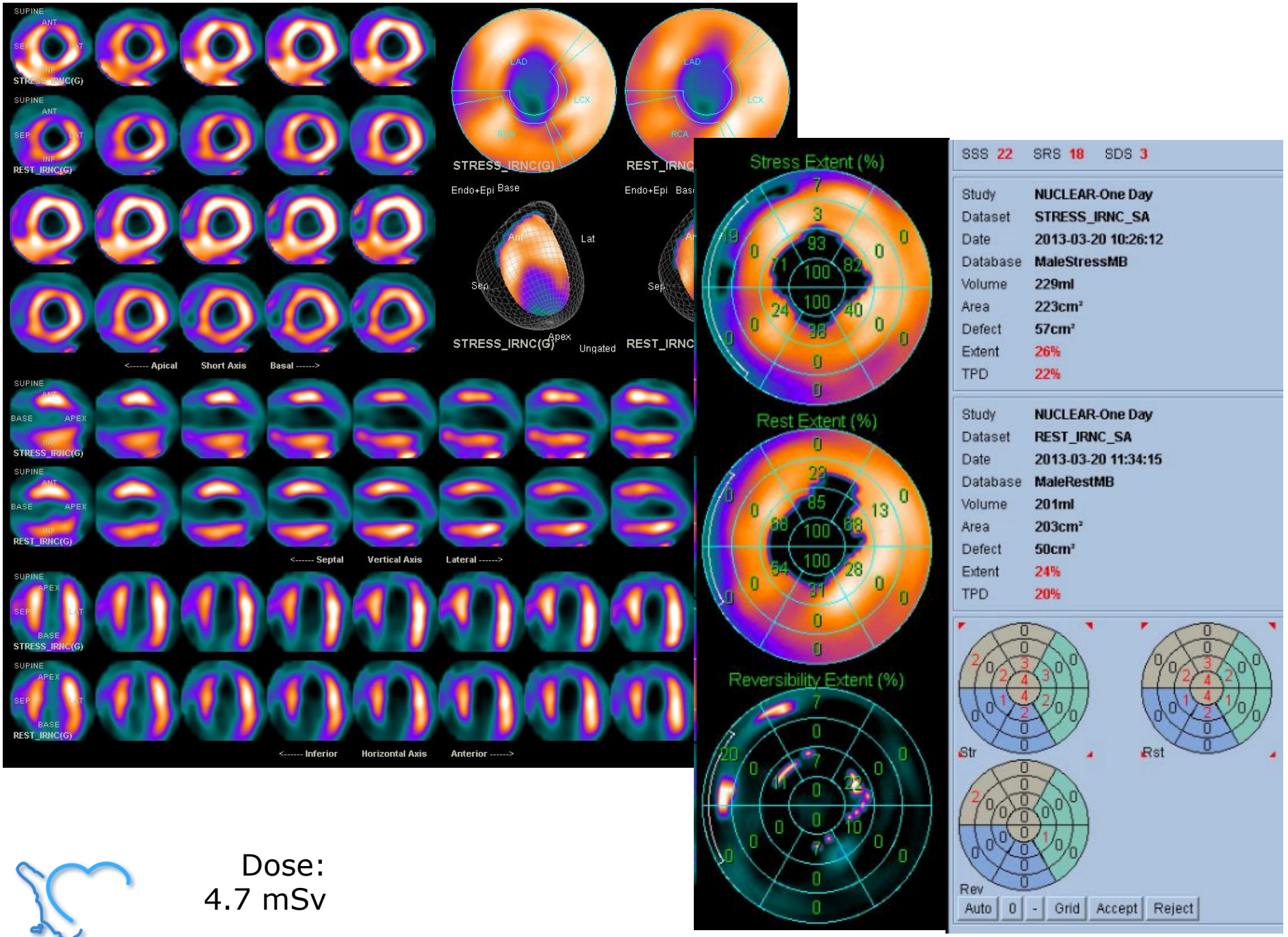
LV Function and Size?

Viability: Yes or NO?

Clinical Decision making

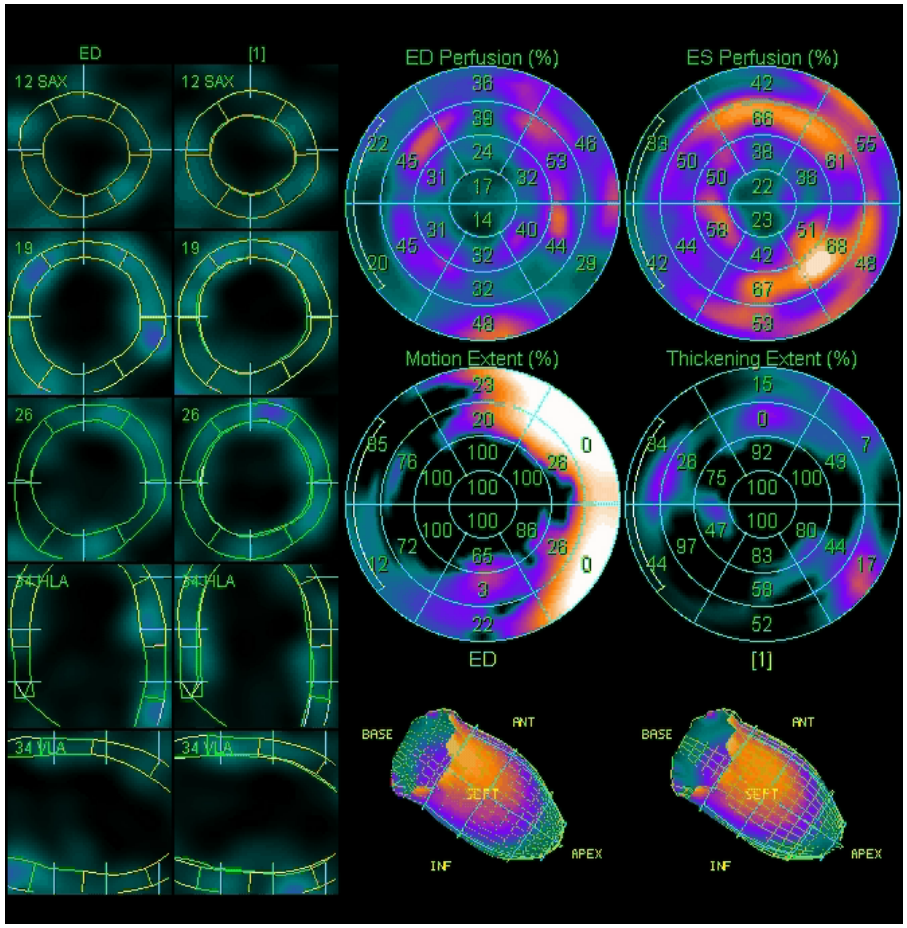
Gated SPECT provides:

- Ischaemia and viability identification, semiquantitative
- ED-ES volumes (absolute and normalized to BMI or BSA)
- EF%
- LV mass (absolute/normalized)
- LV Peak Filling Rate as EDV/sec
- Synchronicity of LV contraction as SD of LV histogram


SUPINE
STRESS_IRNC(G)
REST_IRNC(G)
LAD
LCX
RCA
Endo+Epi Base
Ant
Lat
Sep
Apex
Ungated
<------ Apical Short Axis Basal ------>
BASE APEX
<------ Septal Vertical Axis Lateral ------>
<------ Inferior Horizontal Axis Anterior ------>
Stress Extent (%)
Rest Extent (%)
Reversibility Extent (%)
SSS 22 SRS 18 SDS 3
Study NUCLEAR-One Day
Dataset STRESS_IRNC_SA
Date 2013-03-20 10:26:12
Database MaleStressMB
Volume 229ml
Area 223cm²
Defect 57cm²
Extent 26%
TPD 22%
Study NUCLEAR-One Day
Dataset REST_IRNC_SA
Date 2013-03-20 11:34:15
Database MaleRestMB
Volume 201ml
Area 203cm²
Defect 50cm²
Extent 24%
TPD 20%
Str
Rst
Rev
Auto 0 - Grid Accept Reject

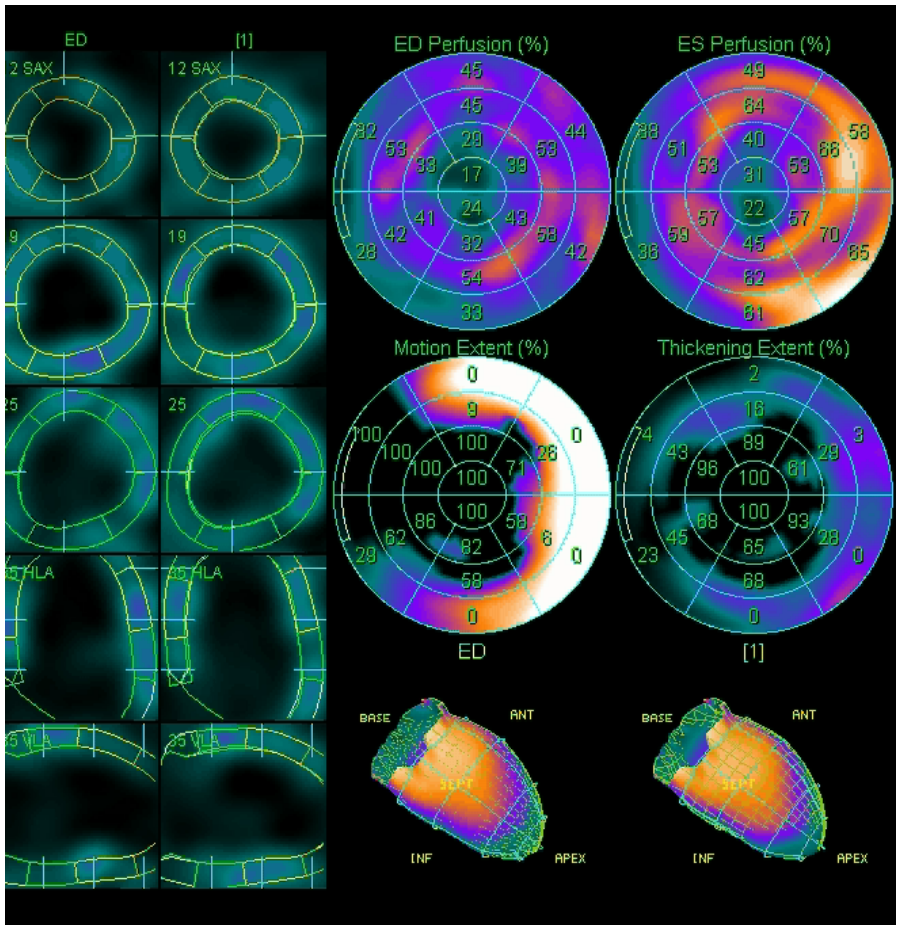
Dose:
4.7 mSv

STRESS

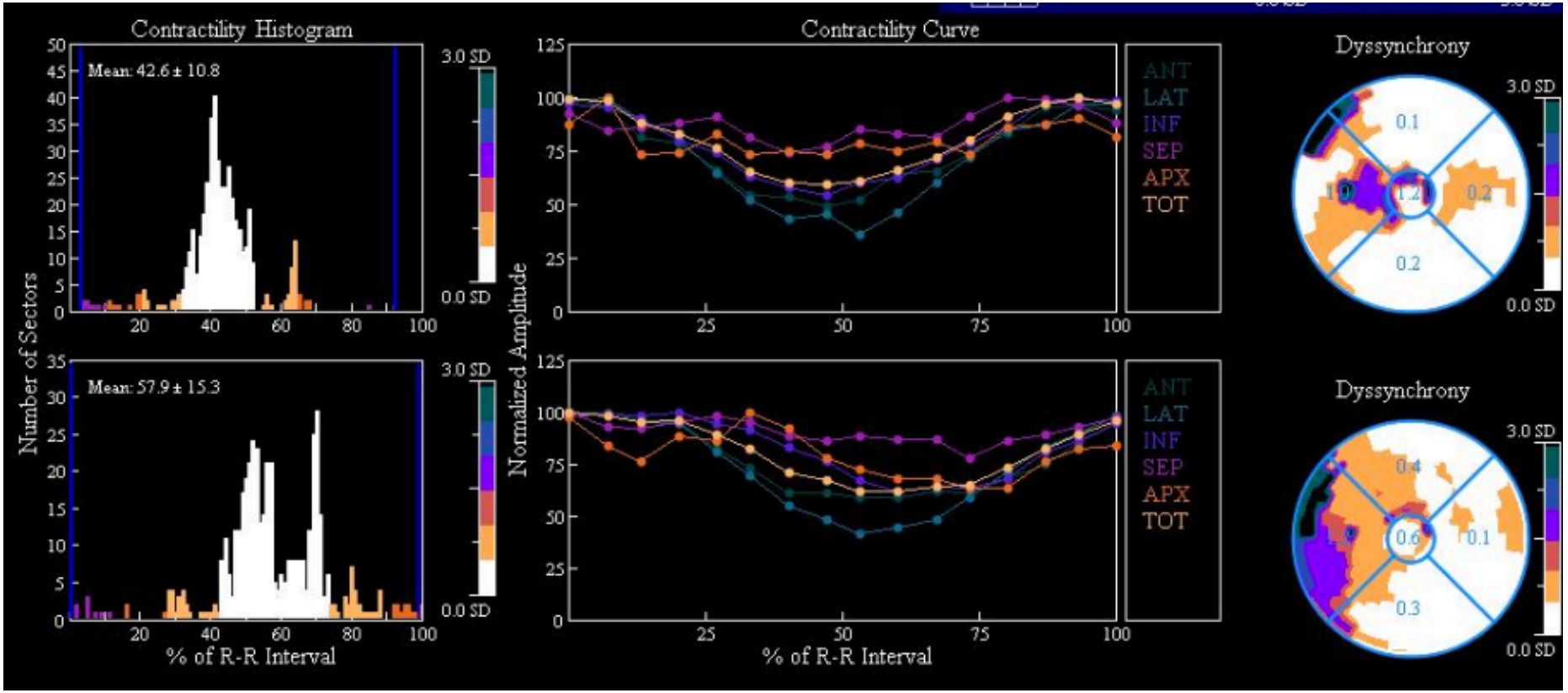


EF 33%
EDV 285 mL
ESV 183 mL

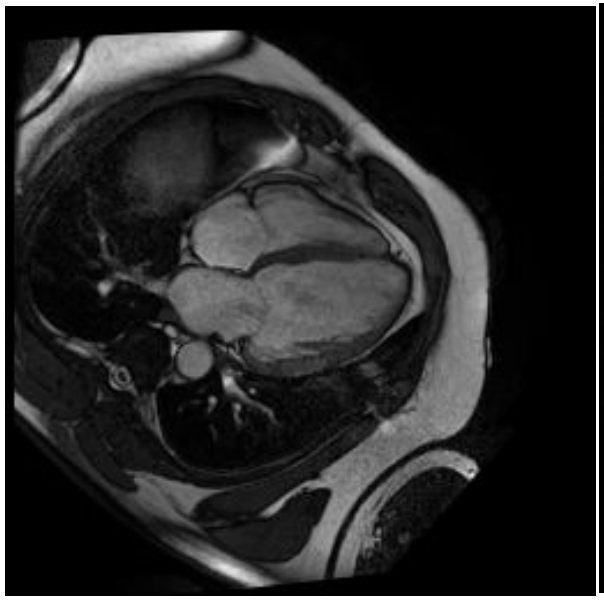
REST

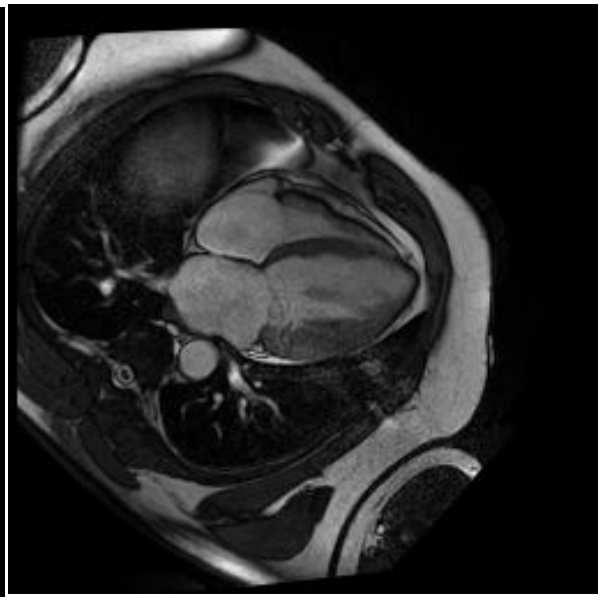


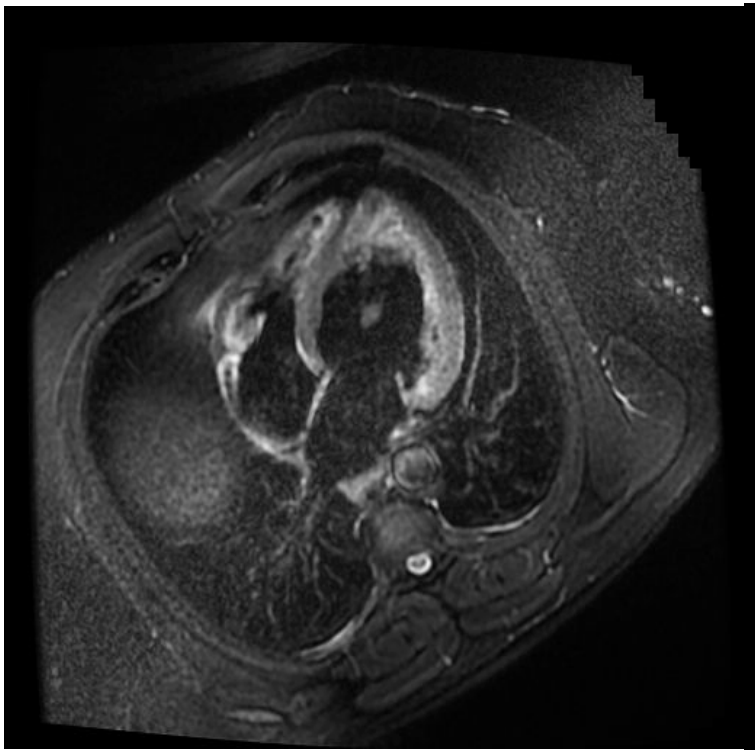
EF 35%
EDV 270 mL
ESV 167 mL

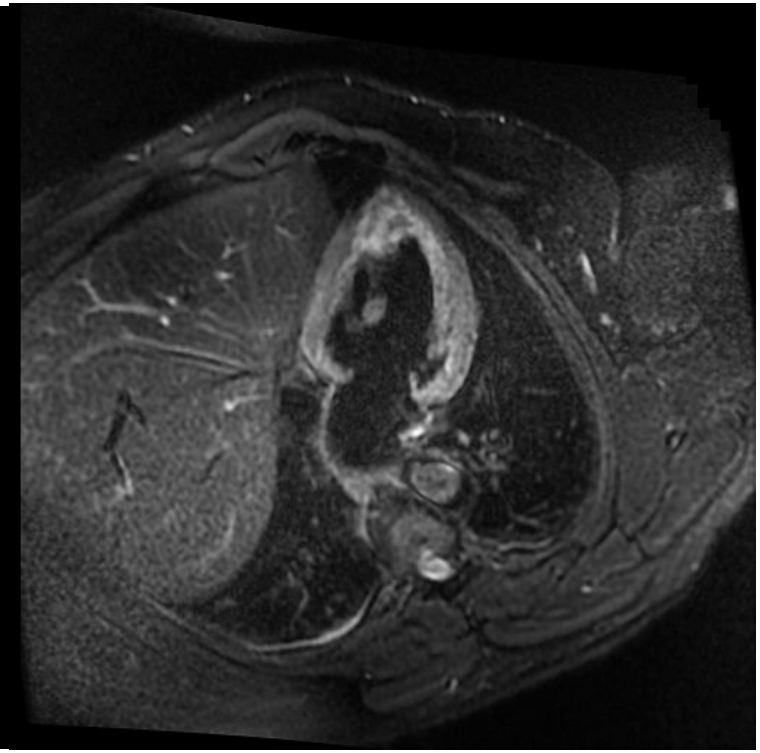

Contractility Histogram
Mean: 42.6 ± 10.8
Mean: 57.9 ± 15.3
Number of Sectors
% of R-R Interval
3.0 SD
0.0 SD
Contractility Curve
Normalized Amplitude
% of R-R Interval
ANT
LAT
INF
SEP
APX
TOT
Dyssynchrony
0.1
0.2
0.2
0.4
0.6
0.1
0.3

Cardiac MRI









Come back to Case #2

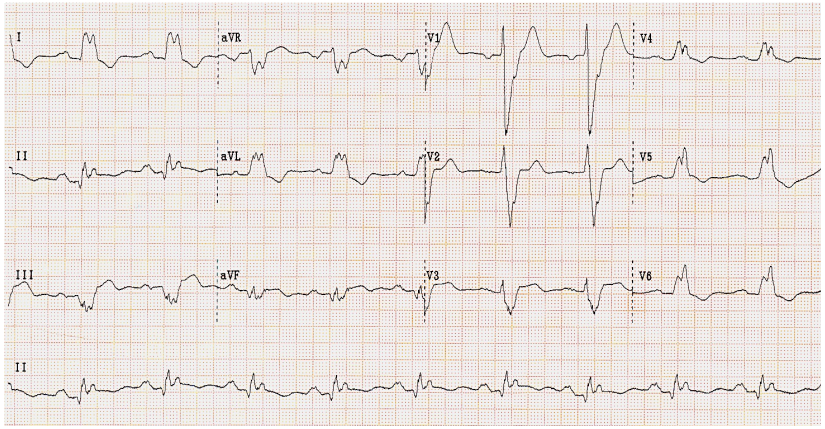
Ischaemia: Yes

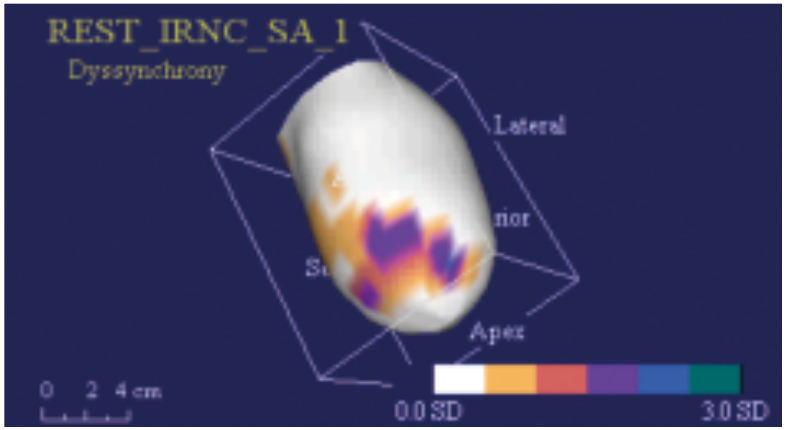
CAD: Yes

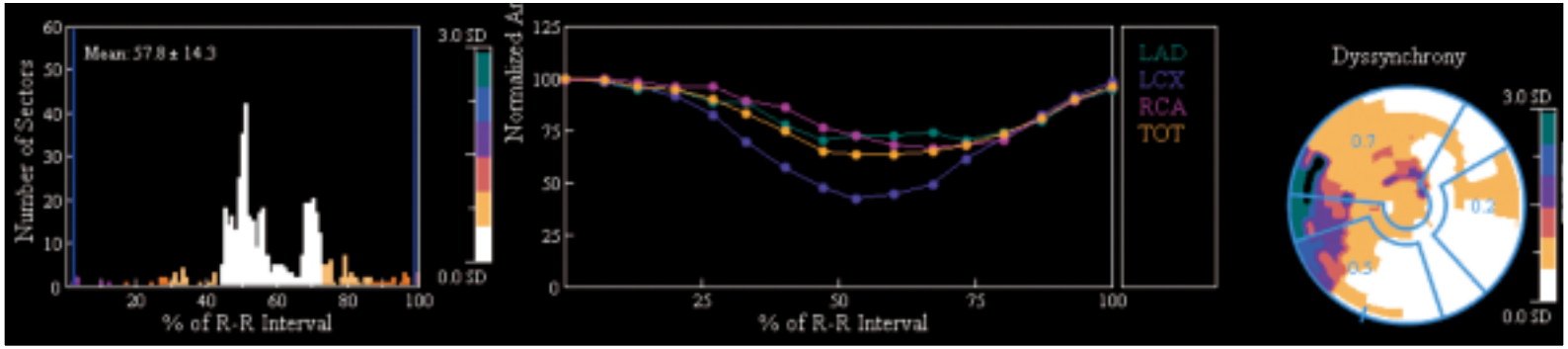
LV Function and Size: Yes

Viability: Yes

Clinical Decision making







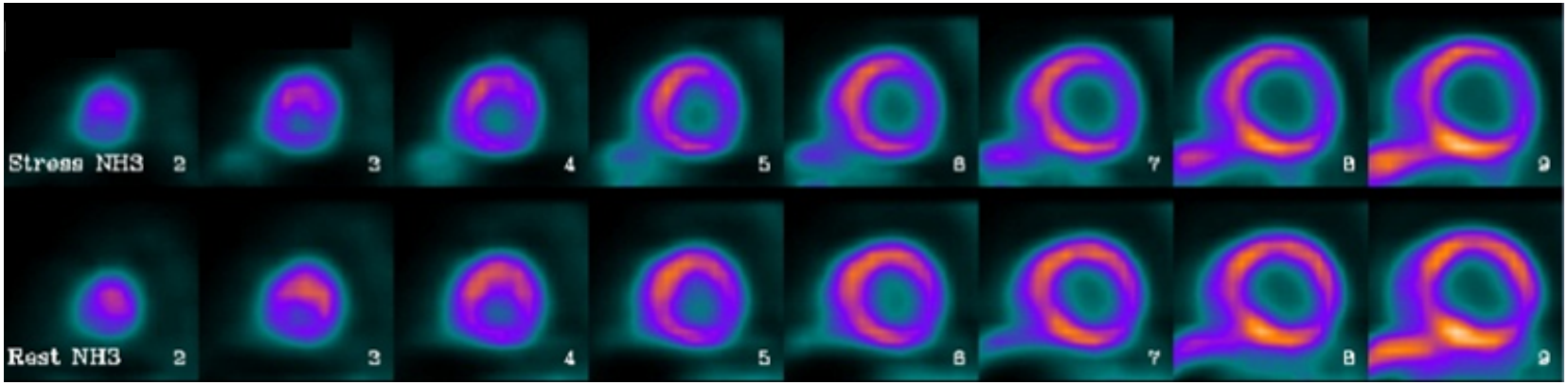
Summary: Volume overload and dyssynchrony rather than ischaemia are responsible for HF symptoms

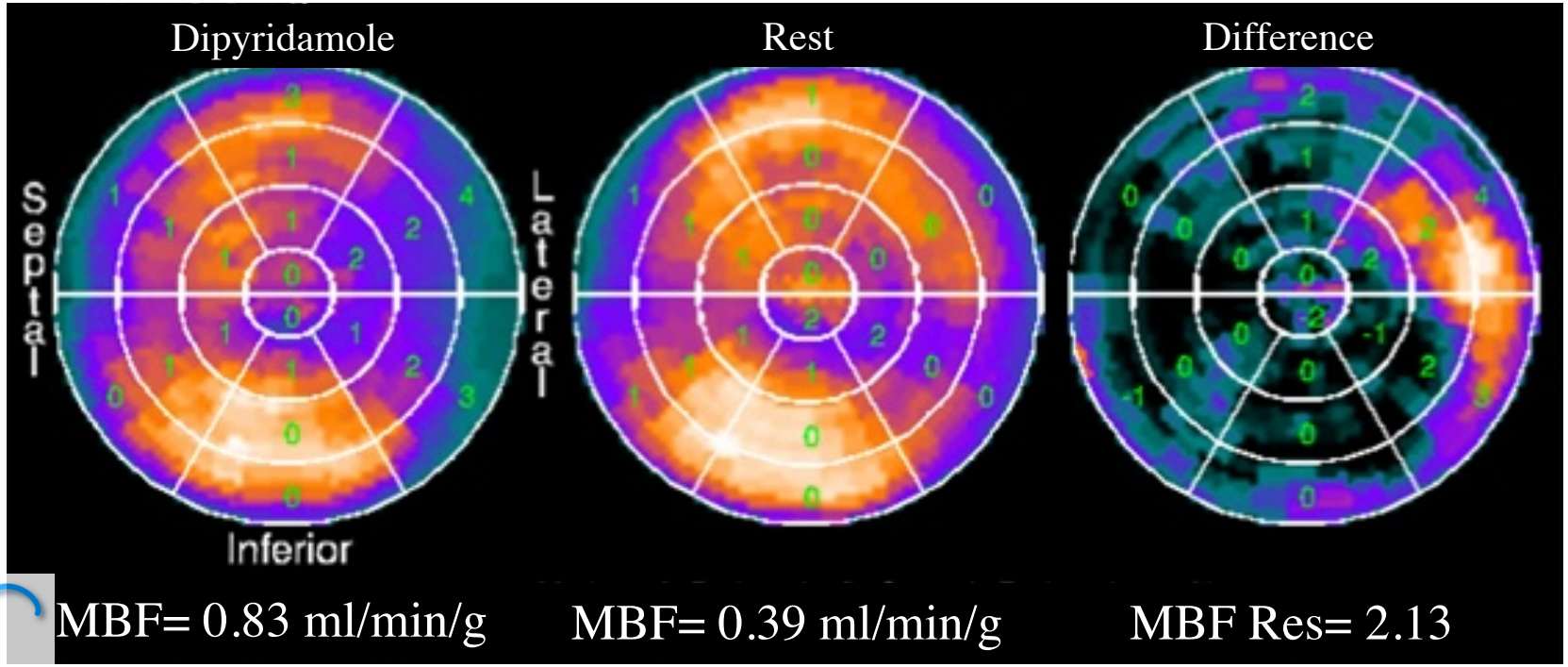
Management: CRT-P

Evaluation of Myocardial Blood Flow

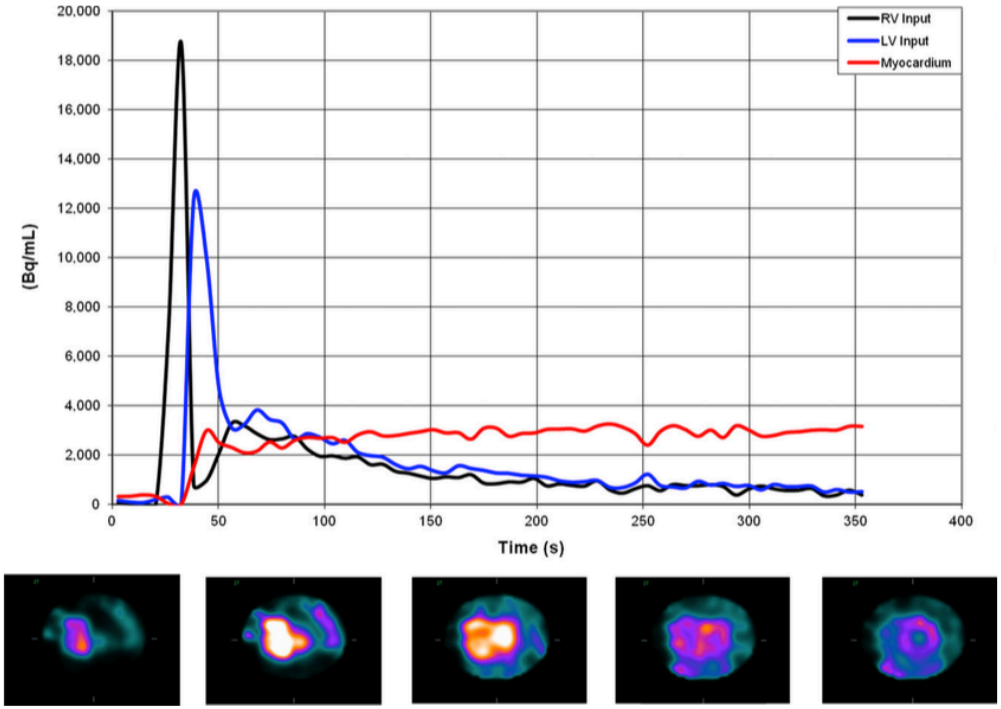
Evaluation of MBF by NH3-PET

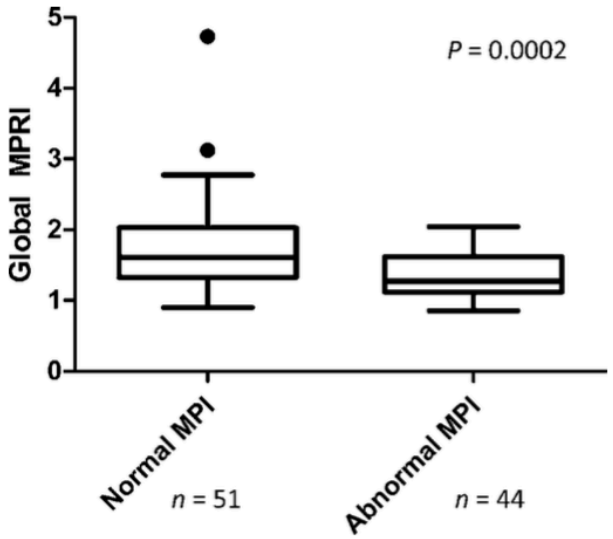
Regional and Global MBF Impairment





MBF and Coronary Flow Reserve





Global MPR index in normal and abnormal MPI. Filled circles represent data points outside error bars.

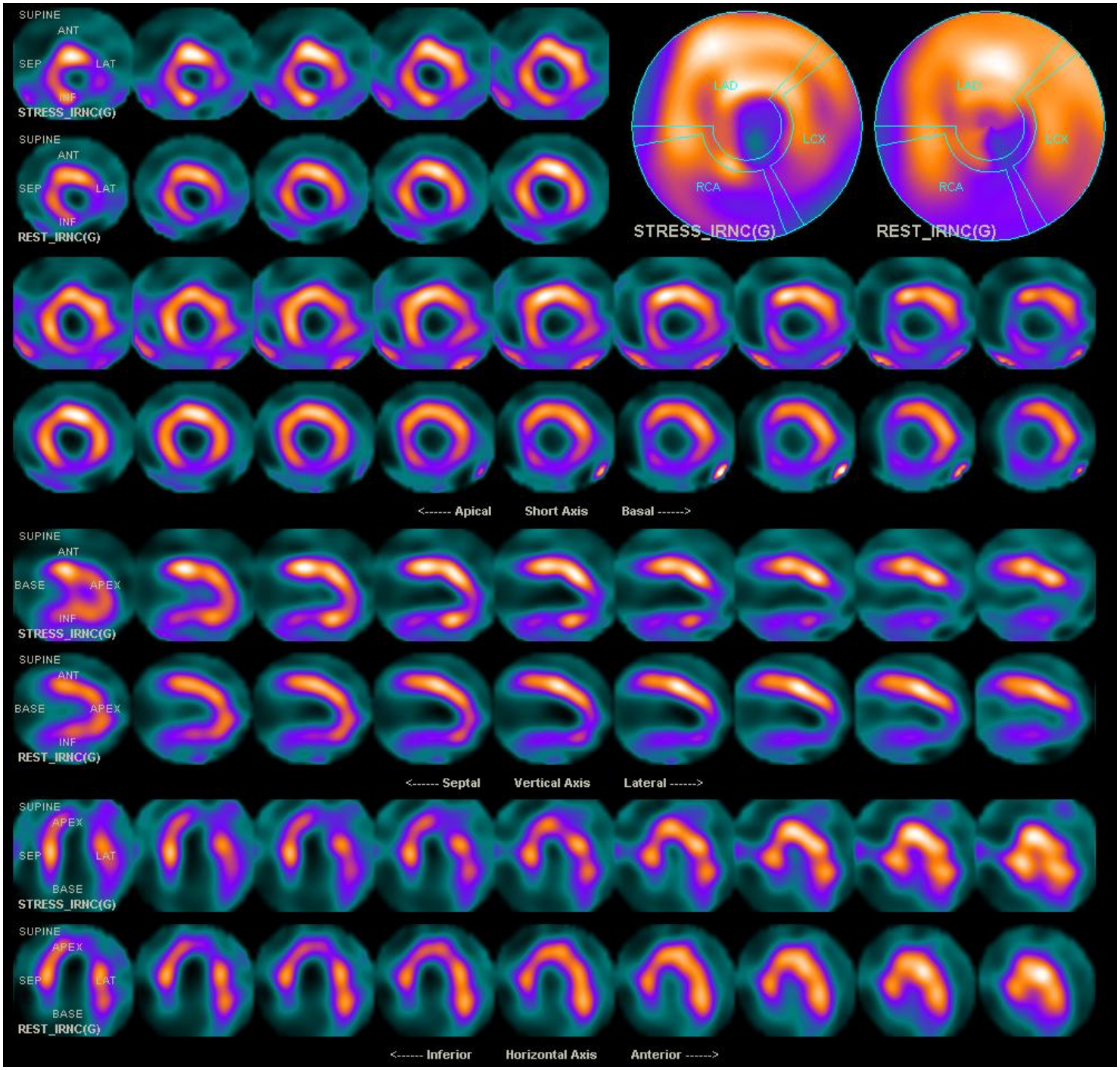
Simona Ben-Haim et al. J Nucl Med 2013; 54: 873-9.

Quantification of Myocardial Perfusion Reserve Using Dynamic SPECT Imaging in Humans: A Feasibility Study

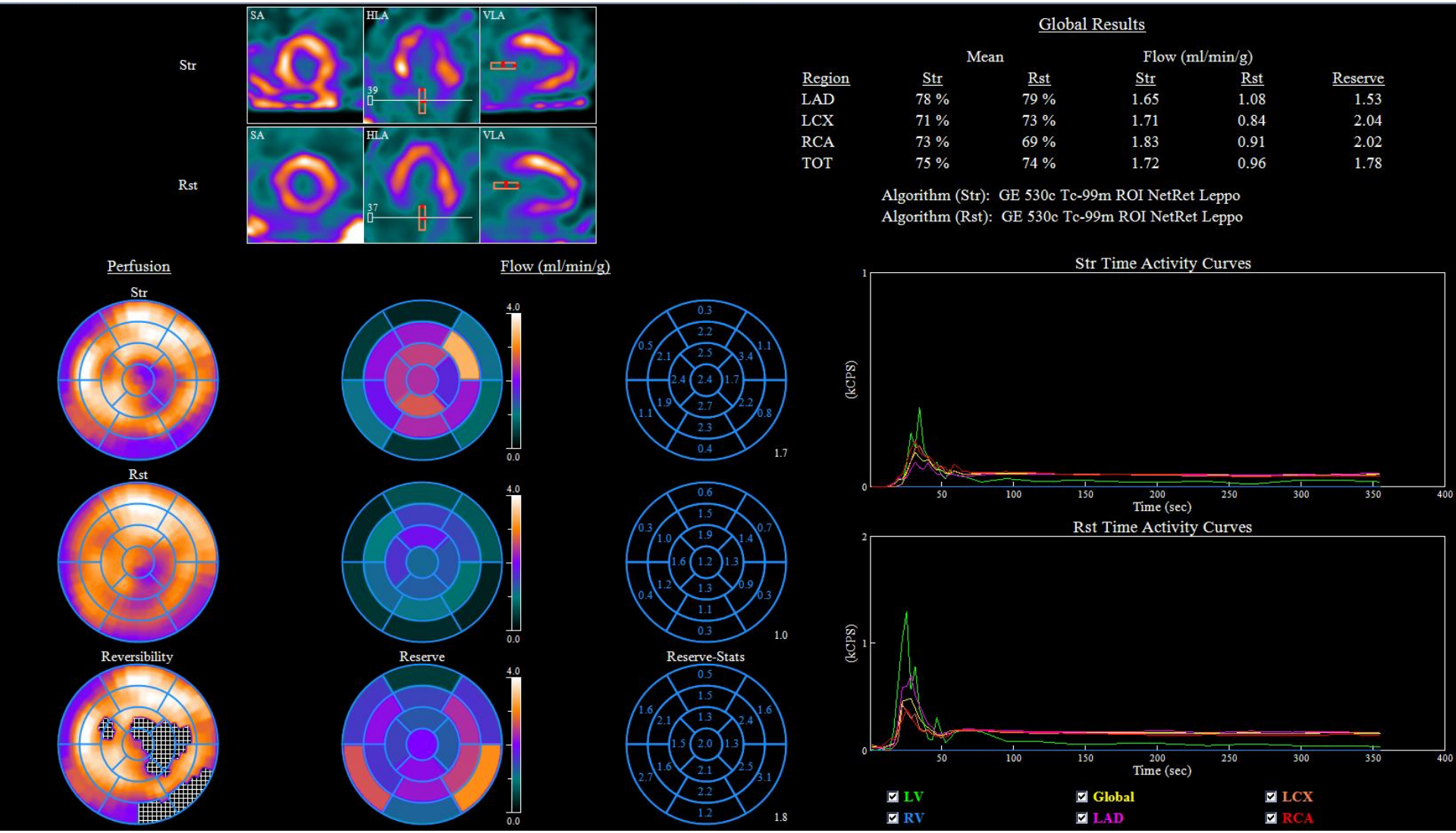
Simona Ben-Haim[1–3], Venkatesh L. Murthy[4,5], Christopher Breault[6], Rayjanah Allie[1], Arkadiusz Sitek[6], NathanielRoth[7], Jolene Fantony[6], Stephen C. Moore[6], Mi-Ae Park[6], Marie Kijewski[6], Athar Haroon[1], Piotr Slomka[8], Kjell Erlandsson[2], Rafael Baavour[7], Yoel Zilberstien[7], Jamshed Bomanji[1–3], and Marcelo F. Di Carli[4,6]

[1]Institute of Nuclear Medicine, University College London Hospitals, NHS Trust, London, United Kingdom; [2]University College London, London, United Kingdom; [3]Institute of Nuclear Medicine, Chaim Sheba Medical Center, Tel Hashomer, Israel; [4]Division of Cardiovascular Medicine, Department of Internal Medicine, and Divisions of Nuclear Medicine and Cardiothoracic Imaging, Department of Radiology, University of Michigan, Ann Arbor, Michigan; [5]Noninvasive Cardiovascular Imaging Program, Departments of Medicine (Cardiology) and Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts; [6]Division of Nuclear Medicine and Molecular Imaging, Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts; [7]Spectrum-Dynamics, Caesarea, Israel; and [8]Departments of Imaging and Medicine and Cedars-Sinai Heart Institute, Cedars-Sinai Medical Center, Los Angeles, California

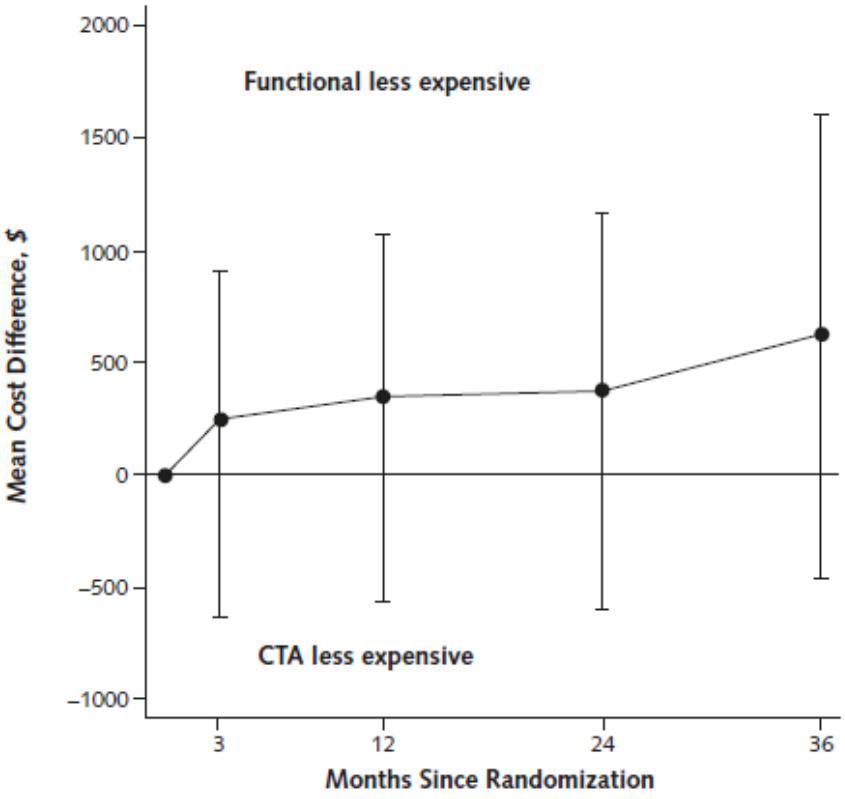
Pt #3

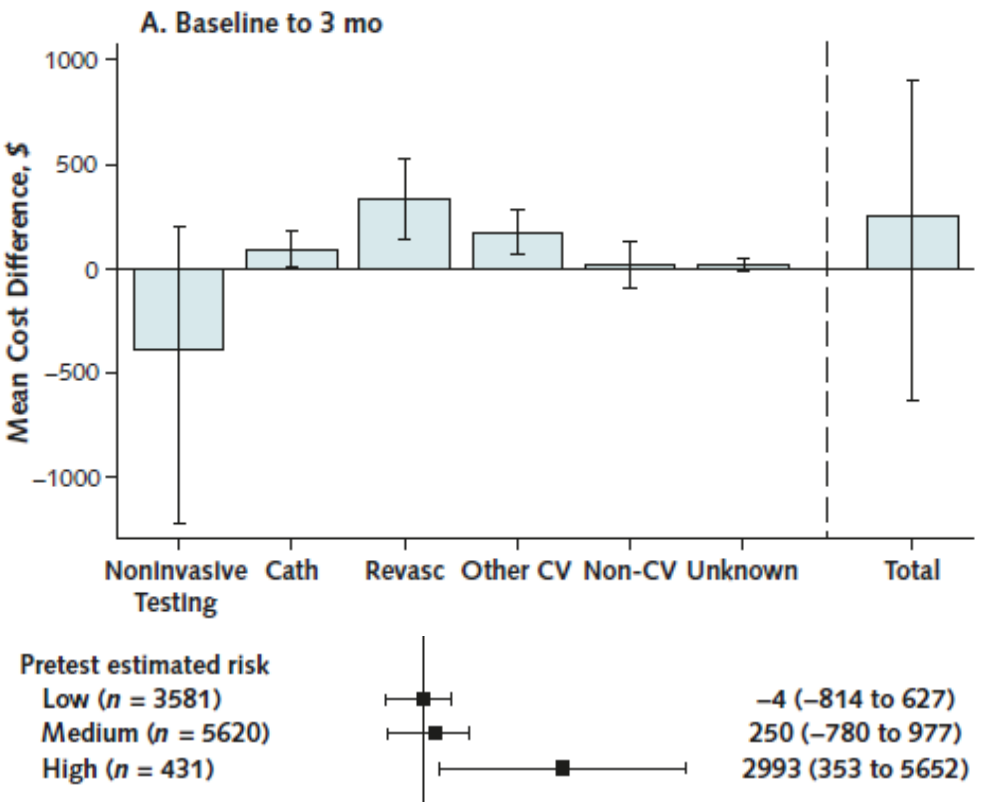

SUPINE
ANT
SEP
LAT
INF
STRESS_IRNC(G)
SUPINE
ANT
SEP
LAT
INF
REST_IRNC(G)
LAD
LCX
RCA
STRESS_IRNC(G)
LAD
LCX
RCA
REST_IRNC(G)
<------ Apical Short Axis Basal ------>
SUPINE
ANT
BASE
APEX
INF
STRESS_IRNC(G)
SUPINE
ANT
BASE
APEX
INF
REST_IRNC(G)
<------ Septal Vertical Axis Lateral ------>
SUPINE
APEX
SEP
LAT
BASE
STRESS_IRNC(G)
SUPINE
APEX
SEP
LAT
BASE
REST_IRNC(G)
<------ Inferior Horizontal Axis Anterior ------>

Pt #3


Str
Rst
SA
HLA
VLA
39
37
Global Results
Mean
Flow (ml/min/g)
Region Str Rst Str Rst Reserve
LAD 78 % 79 % 1.65 1.08 1.53
LCX 71 % 73 % 1.71 0.84 2.04
RCA 73 % 69 % 1.83 0.91 2.02
TOT 75 % 74 % 1.72 0.96 1.78
Algorithm (Str): GE 530c Tc-99m ROI NetRet Leppo
Algorithm (Rst): GE 530c Tc-99m ROI NetRet Leppo
Perfusion
Flow (ml/min/g)
Str
Rst
Reversibility
Reserve
Reserve-Stats
4.0
0.0
1.7
1.0
1.8
Str Time Activity Curves
Rst Time Activity Curves
(kCPS)
Time (sec)
LV
RV
Global
LAD
LCX
RCA

PROMISE: cost-effectiveness analysis





No significant difference in costs between functional and anatomical testing, however, trend in favour of functional testing driven less revasc in the first 3 months after testing and lower costs in the high PTP group.

Mark DB et al. Ann Intern Med. 2016;165:94-102

Fusion CCTA-SPECT Imaging

(Exercise Stress SPECT)

Thank you