

CHRONIC CAD DIAGNOSIS

Chest Pain Evaluation

1. Approach to diagnosis of CAD
2. Classification of chest pain
3. Pre-test likelihood CAD
4. Algorithm for chest pain evaluation in women
5. Indications for stress testing
6. High risk indicators-stress testing
7. Indications for myocardial perfusion imaging (MPI)
8. High risk indicators-MPI
9. Coronary Distribution-Polar Map
10. Comparing Perfusion Agents
11. Sensitivity and specificity of cardiac testing

Approach to diagnosis CAD -1-

- Confirm or deny presence of CAD with TMT
- High false positive rate in premenopausal females (up to 50%) or low pre-test likelihood CAD
- Exclude false positives with perfusion imaging
- Assess extent of CAD with perfusion imaging

Approach to diagnosis CAD -2-

- Assess prognosis combining extent of CAD with severity of LV dysfunction:echo/MUGA
- Cardiac Cath:adverse prognostic indicators; refractory symptoms;3VCAD/2VCAD(prox.LAD) plus LV dysfunction (echo or MUGA),AP post MI

Classification of Chest Pain

Typical angina

1. Steady retrosternal component
2. Provoked by exertion or stress
3. Relieved by rest or NTG

Atypical angina

- 2 of 3 criteria

Non-anginal chest pain

- 1 of 3 criteria

Prevalence of CAD (%) in Symptomatic Patients According to Age and Sex

AGE	Typical angina		Atypical angina		Non anginal chest pain	
	Men	Women	Men	Women	Men	Women
30-39	69.7	25.8	21.8	4.2	5.2	0.8
40-49	87.3	55.2	46.1	13.3	14.1	2.8
50-59	92.0	79.4	58.9	32.4	21.5	8.4
60-69	94.3	90.6	90.6	54.6	28.1	18.6
	3 of 3 criteria		2 of 3 criteria		1 of 3 criteria	

1) Retrosternal discomfort.2) Provoked by exercise or stress.3) Relieved by rest or NTG

Indications for Stress Testing

- Objective confirmation of ischaemia
- Assessing extent of ischaemia
- Documenting exercise capacity
- Functional assessment of known CAD
- Determining risk and prognosis
- Determining need for angiography
 - High risk cut points
- Assessing response to treatment

Contraindications for stress testing

- Acute myocardial infarction (within two days)
- Unstable angina pectoris
- Uncontrolled arrhythmias causing symptoms of hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Active endocarditis or acute myocarditis or pericarditis
- Acute aortic dissection
- Acute pulmonary or systemic embolism
- Acute noncardiac disorders that may affect exercise performance or may be aggravated by exercise

Stress Testing Options

- Exercise stress alone (usually Bruce protocol)
- Exercise stress with nuclear myocardial perfusion imaging (MPI)
- Pharmacologic stress nuclear myocardial perfusion imaging (MPI)
- Exercise stress echo
- Pharmacologic stress echo

Sensitivity and Specificity of Non-invasive Tests for the Diagnosis of CAD*

* NEJM Vol. 344, No. 24 June 14, 2001

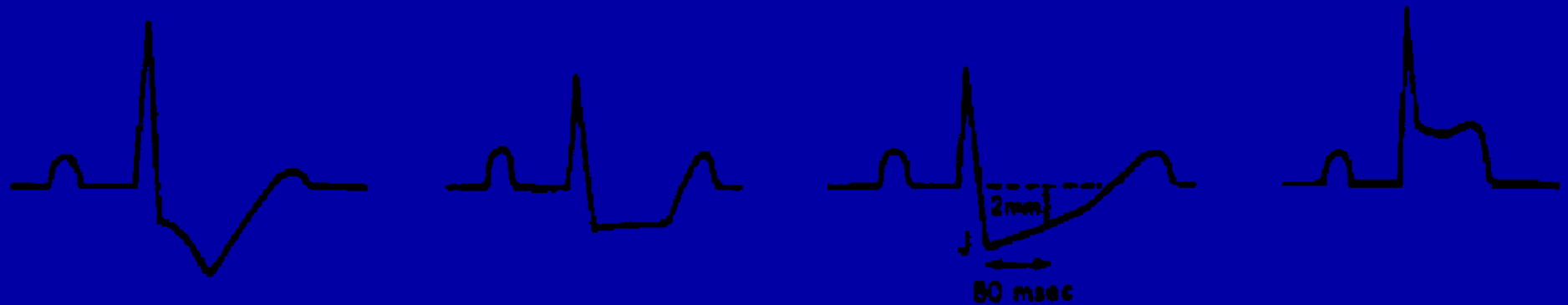
Diagnostic Test	Sensitivity % (range)	Specificity % (range)	# Studies	# Patients
TMT	68	77	132	24,027
Planar MPI	79 (70-94)	73 (43-97)	6	510
SPECT	88 (73-98)	77 (53-96)	8	628
Stress echo	76 (40-100)	88 (80-95)	10	1174

Exercise stress testing

- Treadmill or bicycle ergometer
- Protocols vary - symptom limited
- Bruce most popular
 - 8 stages
 - Incline and speed increment every 3 minutes
- Target 85-100% maximum age predicted HR
- Achieve at least 6 METS for diagnostic accuracy



ECG Patterns Indicative of Myocardial Ischaemia



ECG Patterns Not Indicative of Myocardial Ischaemia

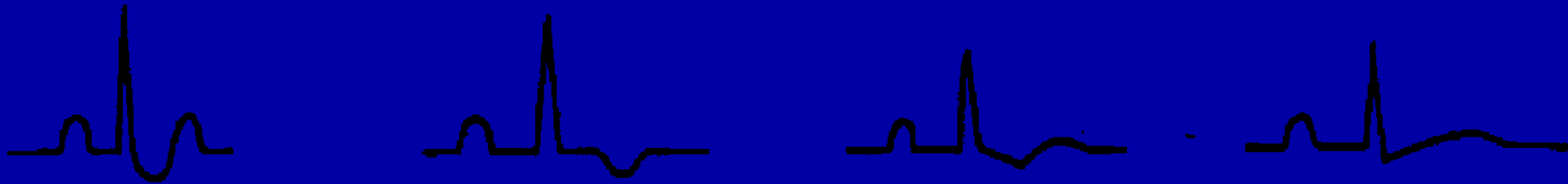


Figure 1. Electrocardiographic criteria for myocardial ischemia consist of at least 1 mm of J point depression with downsloping or horizontal ST segments; slowly upsloping ST segment depression, defined as 2 mm of ST depression measured 80 ms from the J point; and ST segment elevation. Whereas ST segment depression indicates nontransmural ischemia, ST segment elevation often connotes more severe degrees of ischemia reflecting transmural injury. The structure of the ST segment slope is predictive for the severity of coronary disease shown angiographically (5), with downsloping ST depression indicating severe two- and three-vessel coronary artery disease more often than does either horizontal and slowly upsloping ST depression, and ST segment elevation indicating high-grade, usually proximal, arterial obstruction in patients without previous myocardial infarction.

High Risk Indicators

Exercise Stress Testing

- Early positive-stage I: Mortality $>5\%$ /year
- Strongly positive > 2.5 mm ST depression
- ST elevation > 1 mm in leads without Q waves
- Fall in SBP >10 mm HG
- Early onset ventricular arrhythmia's
- Chronotropic incompetence Ex HR <120 /min not due to drugs
- Prolonged Ischaemic changes in recovery
 > 2 mm lasting > 6 minutes in multiple leads

Indications for Myocardial Perfusion Imaging (Exercise or Pharmacologic Stress)

- Suspected false +ve or -ve TMT
- Resting ST changes
- LBBB, RBBB, LVH, digitalis, pre-excitation or pacemaker
- Women with +ve TMT and low or intermediate probability CAD
- Inability to exercise
- Prognosis of known CAD
- Detecting post PTCA or CABG ischaemia
- Assessing myocardial viability
- Risk evaluation in non-cardiac surgery patients
- Assessment functional significance of documented coronary stenosis

Myocardial Perfusion Imaging

Exercise Stress

- Treadmill
- Bicycle ergometer

Pharmacologic Stress

- Persantine
(dipyridamole)
- Adenosine
- Dobutamine

■ Isotopes

- Thallium 201
- Technesium 99m
 - Sestamibi MIBI
(Cardiolyte)
 - Tetrofosmin (Myoview)
- PET
 - Rubidium 82 (flow agent)
 - FDG (viability)

Persantine (dipyridamole)

Coronary vasodilator

- With coronary stenosis differential dilatation results in differential flow hence differential uptake of isotope
- Side effects
 - Chest pain 20%
 - Dizziness 12%
 - Headache 12%
 - Dyspnea & flushing 5%

Persantine (dipyridamole)

- 4 minute infusion
- Maximum vasodilatation at 3 minutes post infusion
- Circulatory effects peak 7-12 minutes post infusion
- Isotope injected at 7 minutes
- Antidote aminophylline given for side effects
- False negatives with recent caffeine intake

Persantine (dipyridamole) contra-indications

- Recent MI within 72 hours
- Unstable angina
- Severe lung disease or asthma
- Heart failure/severe systolic dysfunction
- 2nd or 3rd degree heart block
- Resting hypotension

Comparing Perfusion Agents

Thallium-201

- K analogue
- uptake proportional to blood flow
- washes out slowly from myocardium-redistribution phase
 - defect normalizes = ischaemia
 - defect unchanged = scar
- ↑TI lung uptake- indicates ischaemic LV dysfunction
- ischaemic LV dilatation on post exercise scan = high risk indicator

Tc 99m-Sestamibi

- uptake proportional to blood flow
- tissue uptake is fixed
 - true perfusion agent
- higher energy/better tissue penetration and images
- tissue fixation permits gated LV Angiogram
 - wall motion
 - ejection fraction

Scanning



The New England Journal of Medicine

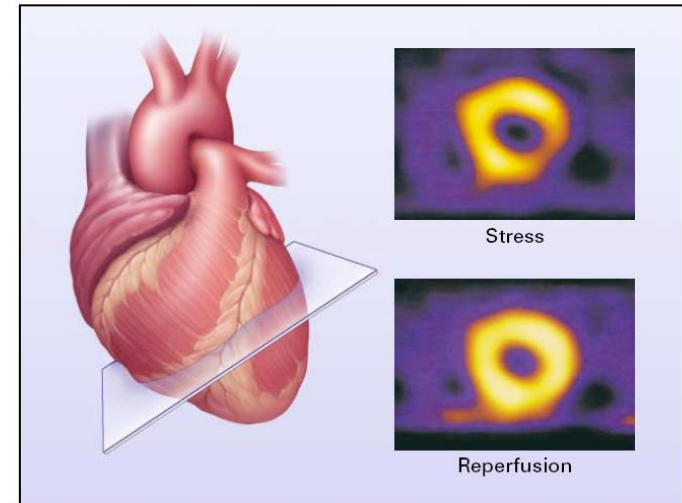
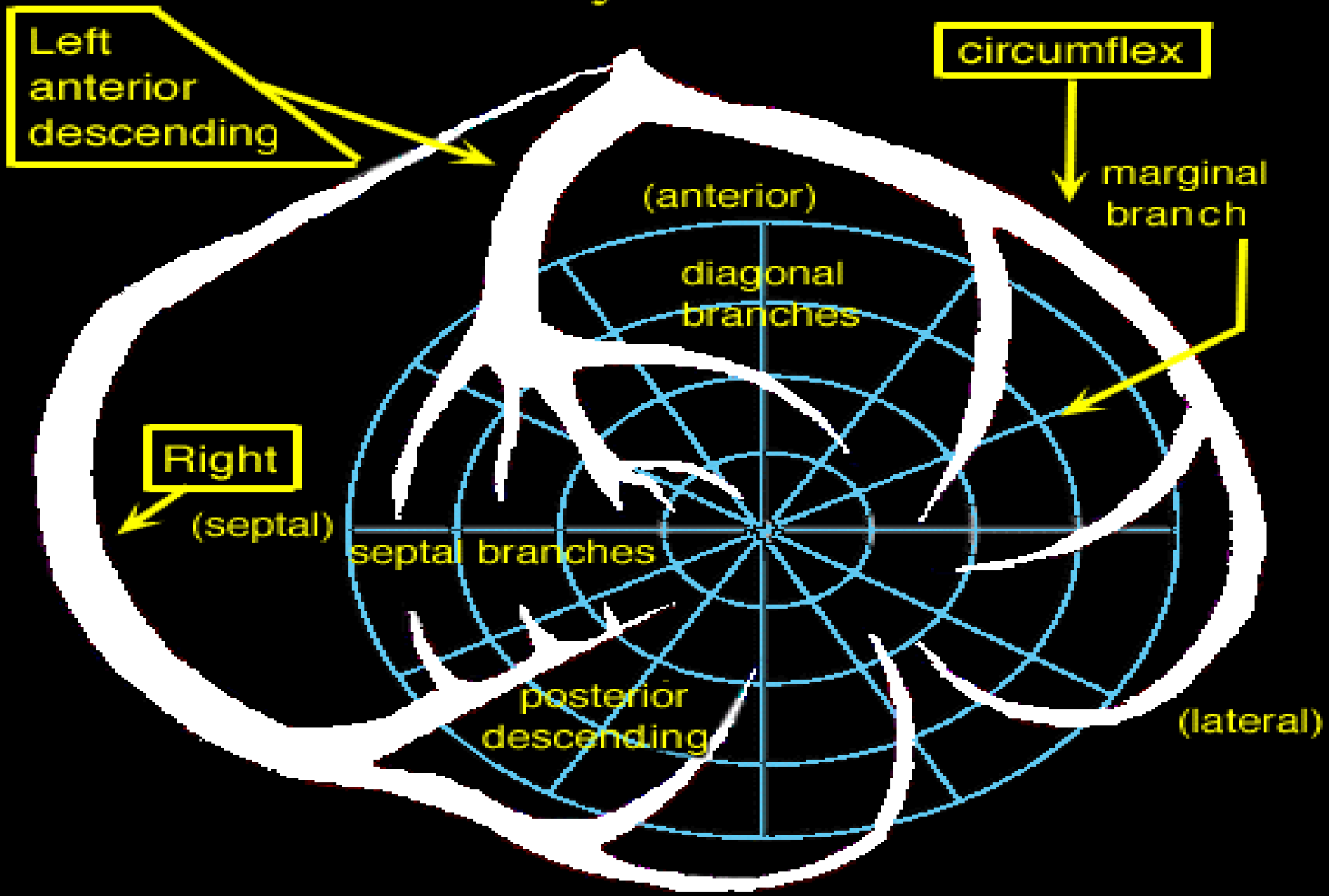


Figure 1. Use of Radionuclide Scintigraphy to Assess Myocardial Perfusion and Viability. Radionuclide scintigraphy uses computer analysis of the distribution of a radionuclide tracer (e.g., thallium or technetium) to reconstruct slices of the heart at various levels and from various angles. The short-axis view shown here provides information on the presence of the tracer in a cross section of the left ventricle. The image obtained during stress shows little tracer in one segment of the left ventricle. With reperfusion, however, tracer is present throughout the slice. These images suggest the presence of a stress-induced, reversible perfusion defect, indicating viable myocardium.

Coronary Distribution

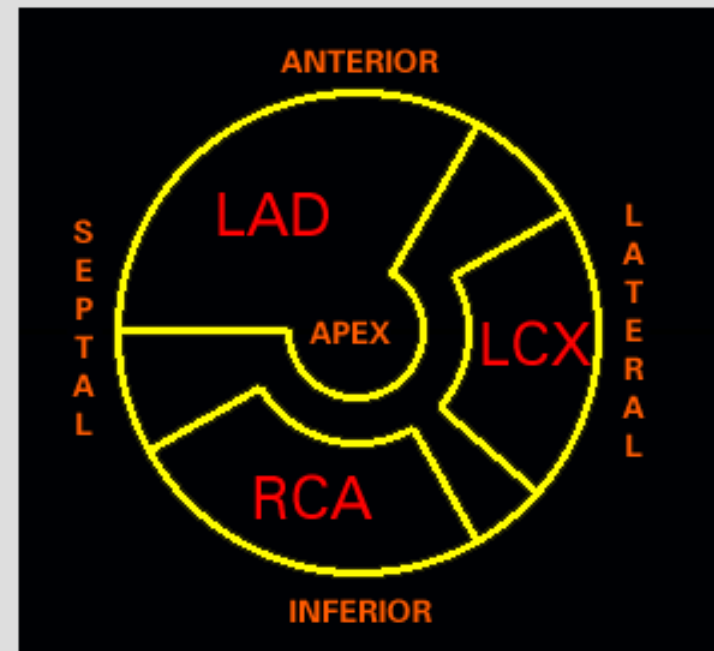
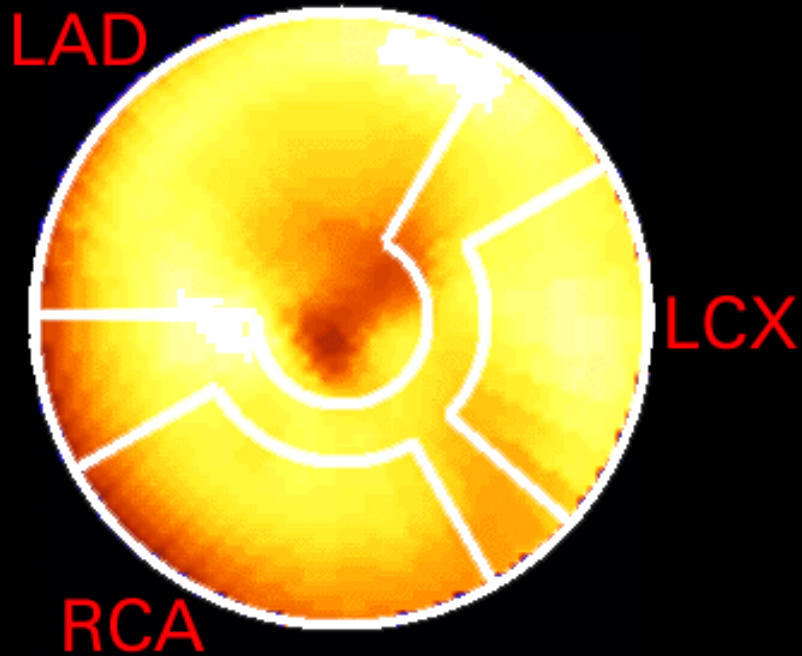


High Risk Indicators

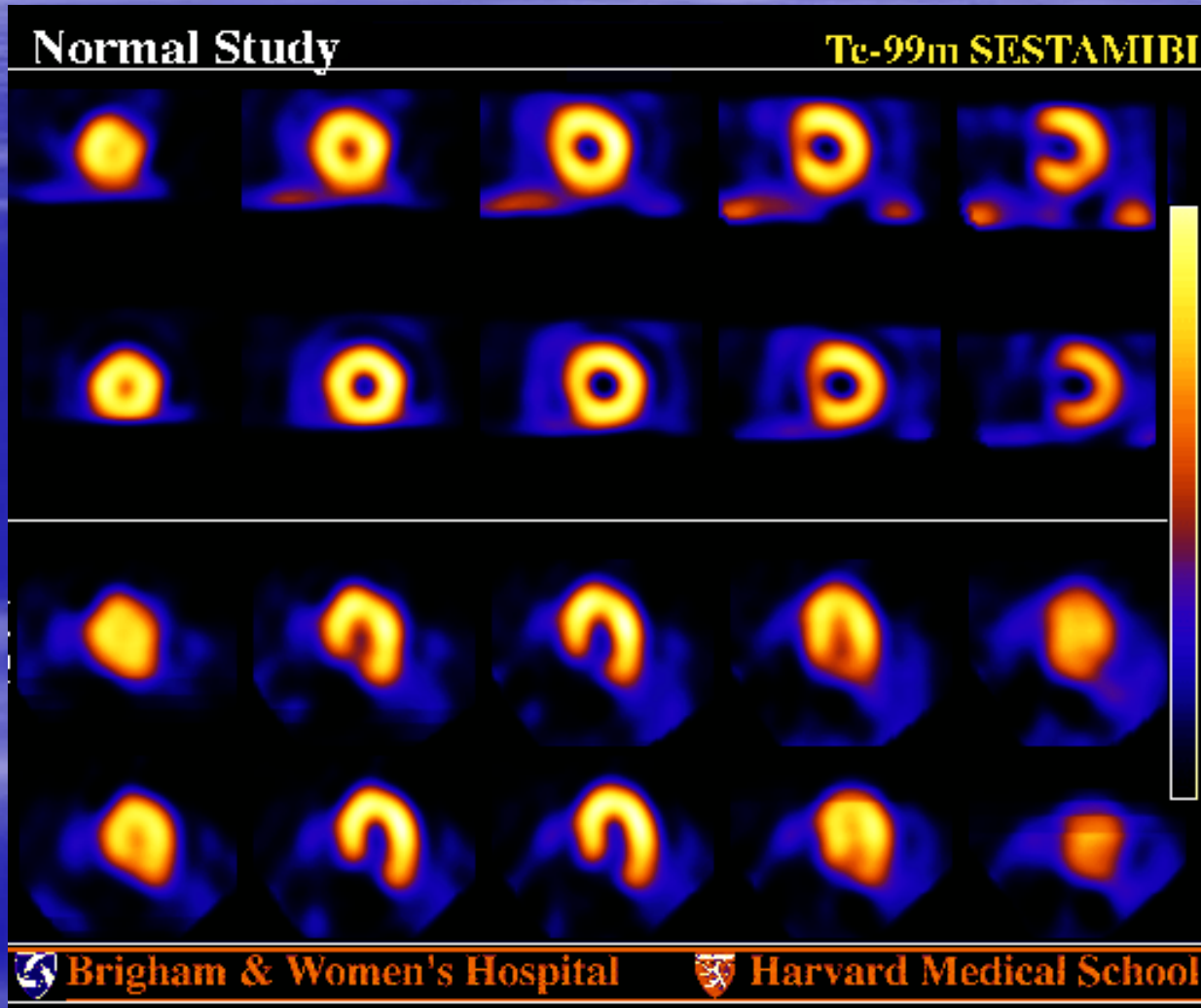
Myocardial Perfusion Imaging

- Increased pulmonary thallium uptake indicating low CO or elevated LVEDP
- Ischaemic LV dilatation (TID)
- Multiple perfusion defects
- Large perfusion defects

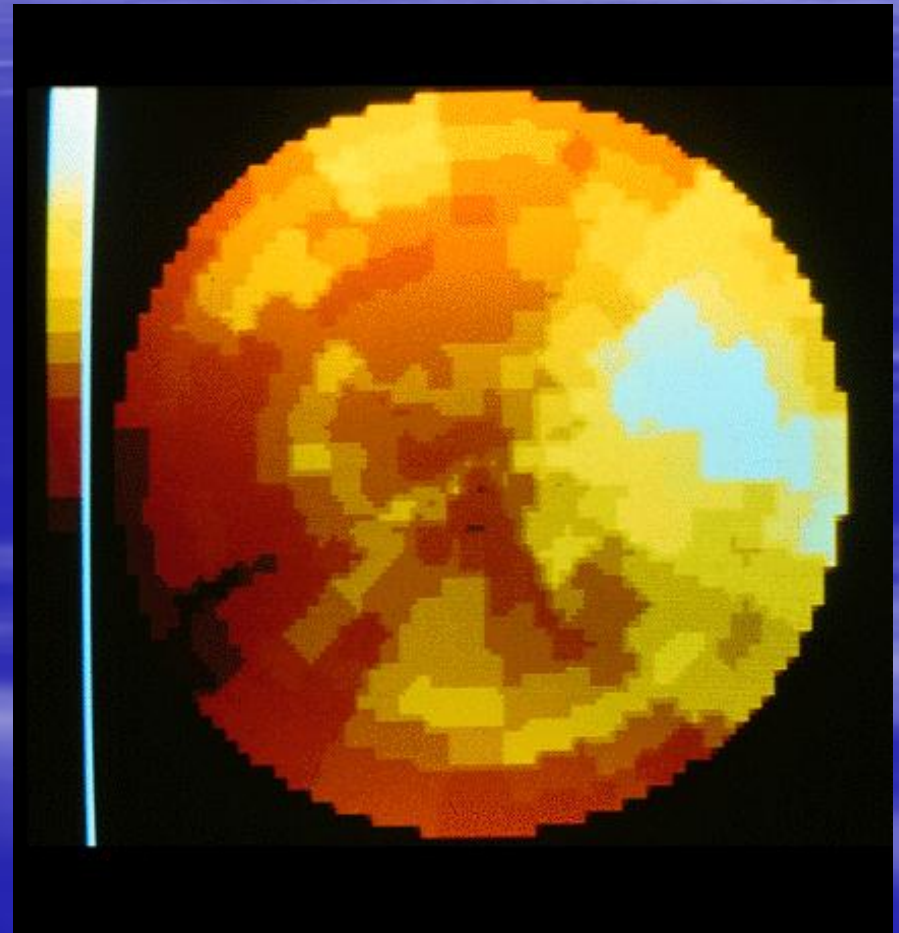
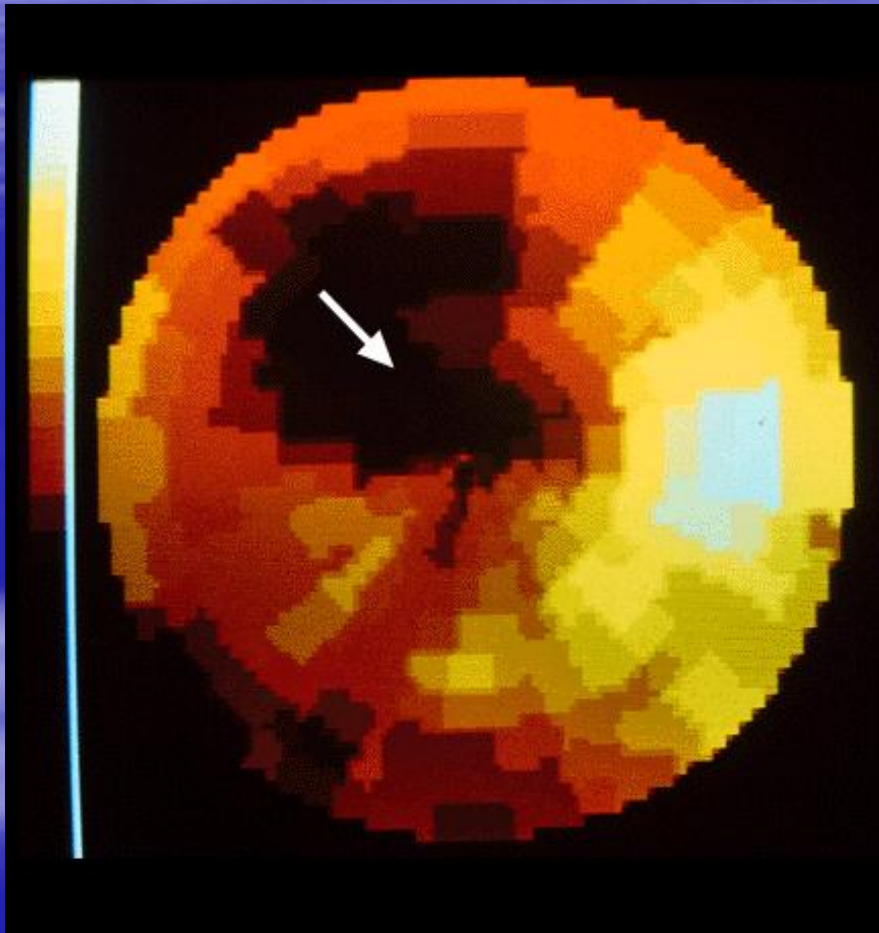
Coronary Territories



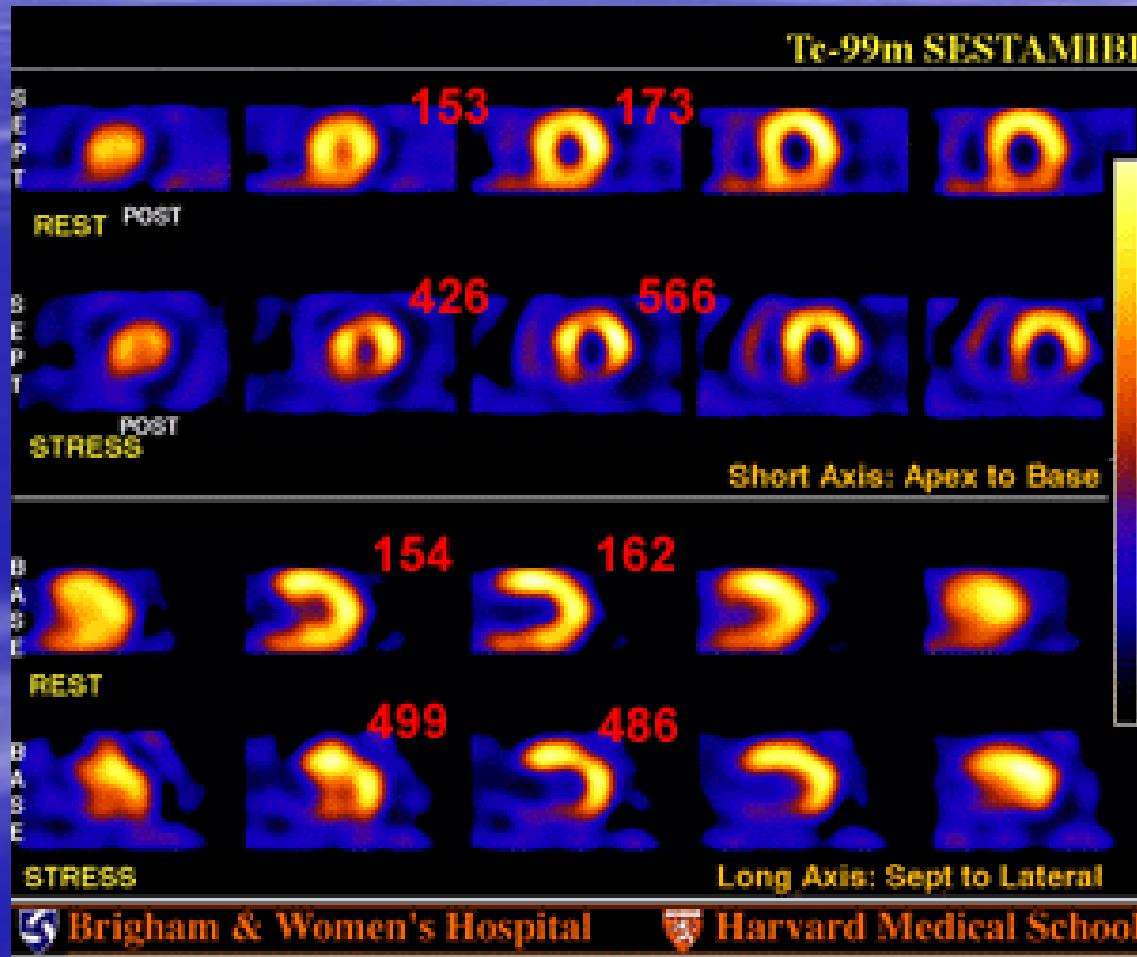
Normal Study



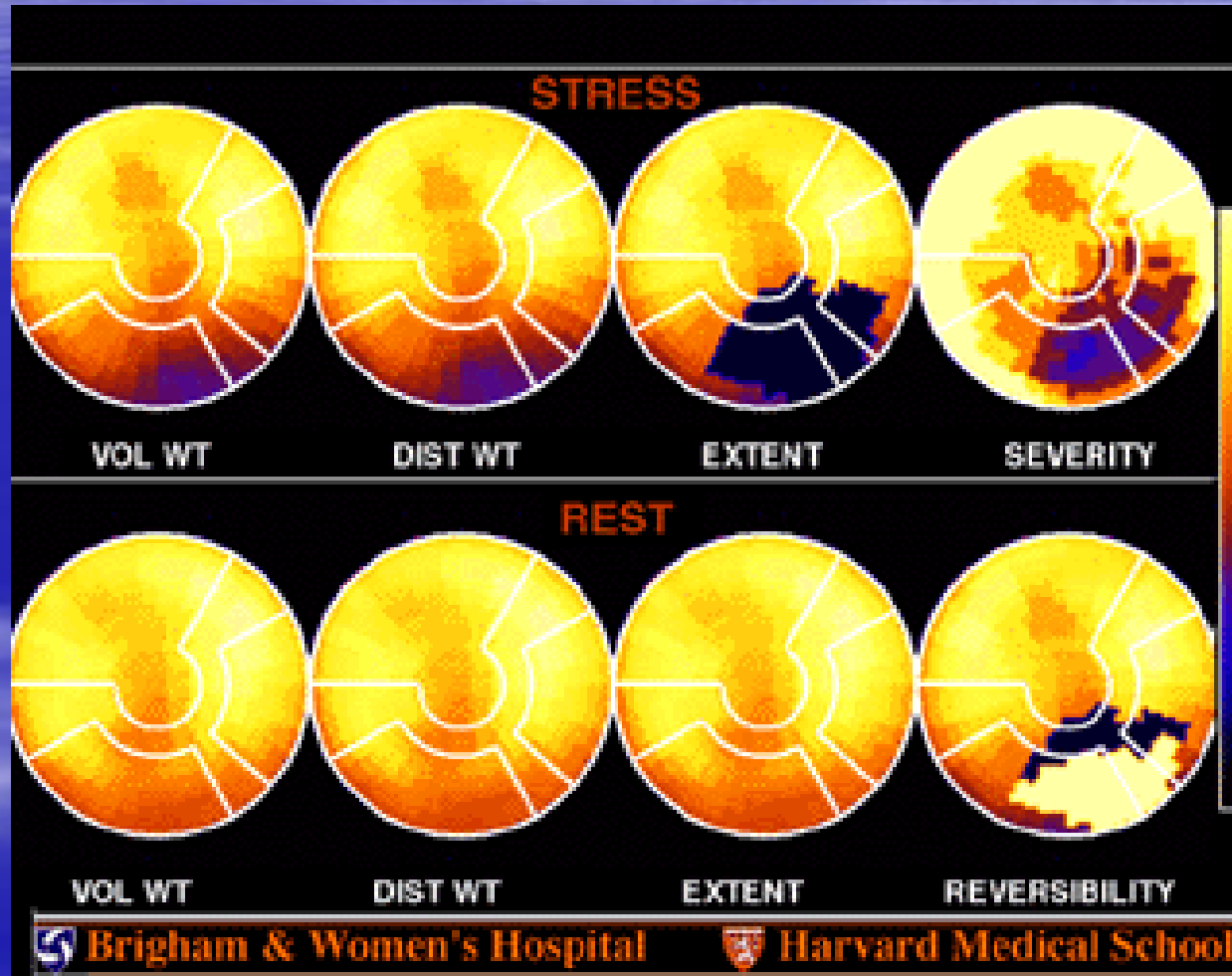
Reversible LAD Ischaemia



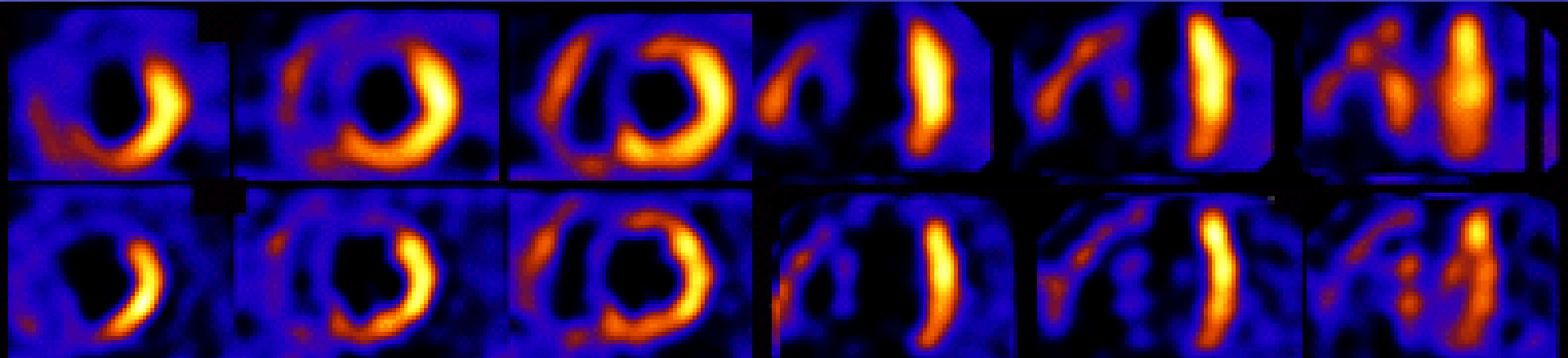
SVD - RCA



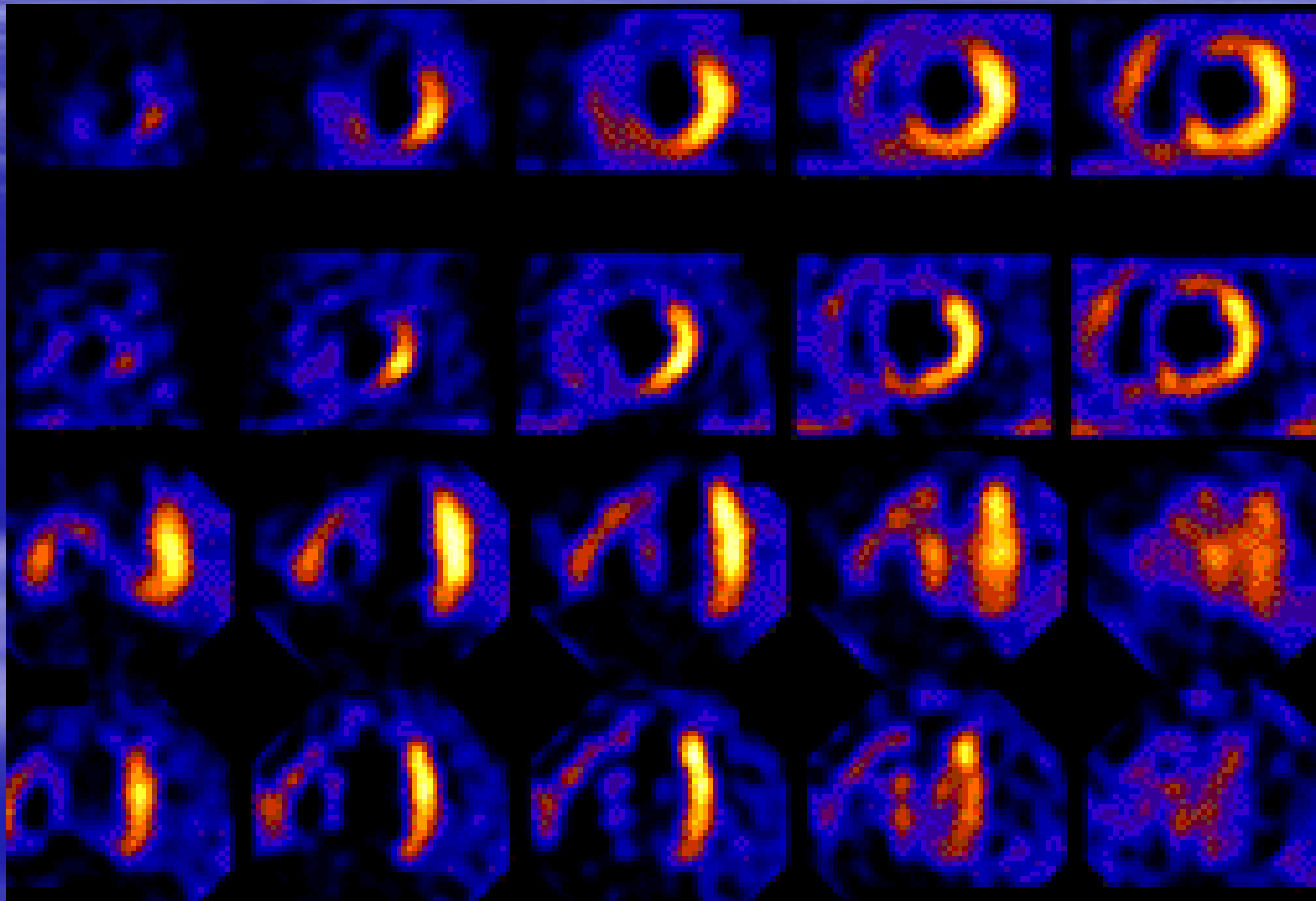
SVD-RCA



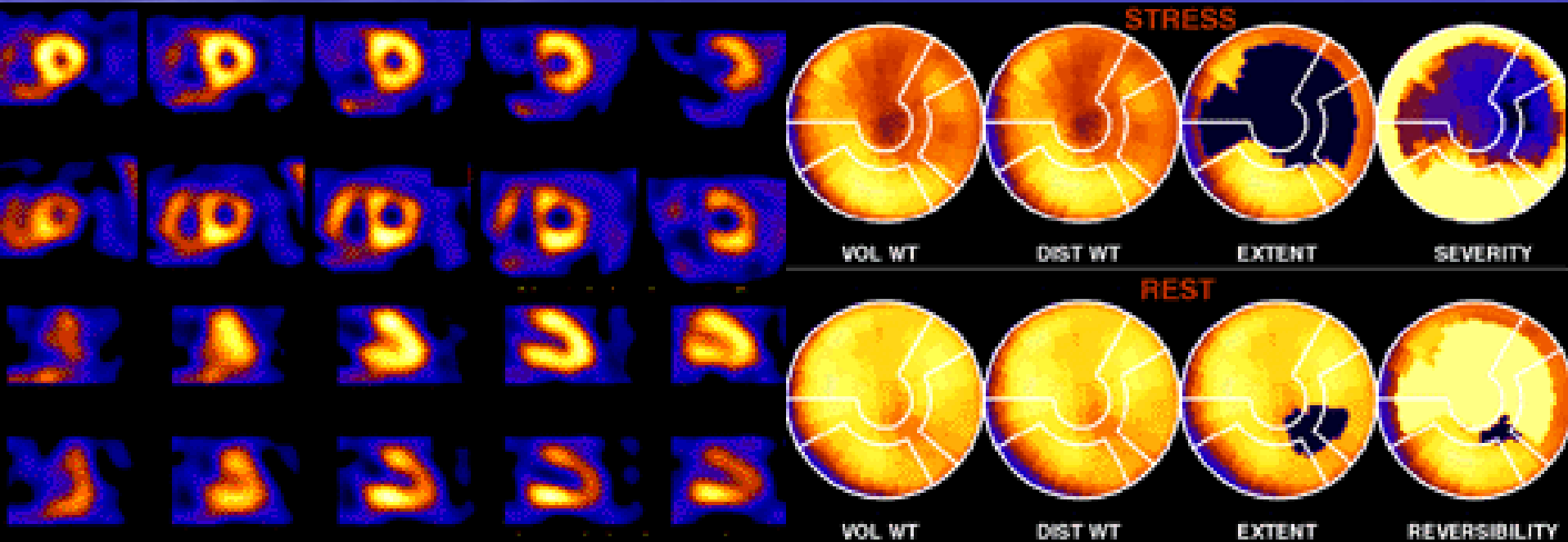
2 Vessel Disease LAD & RCA



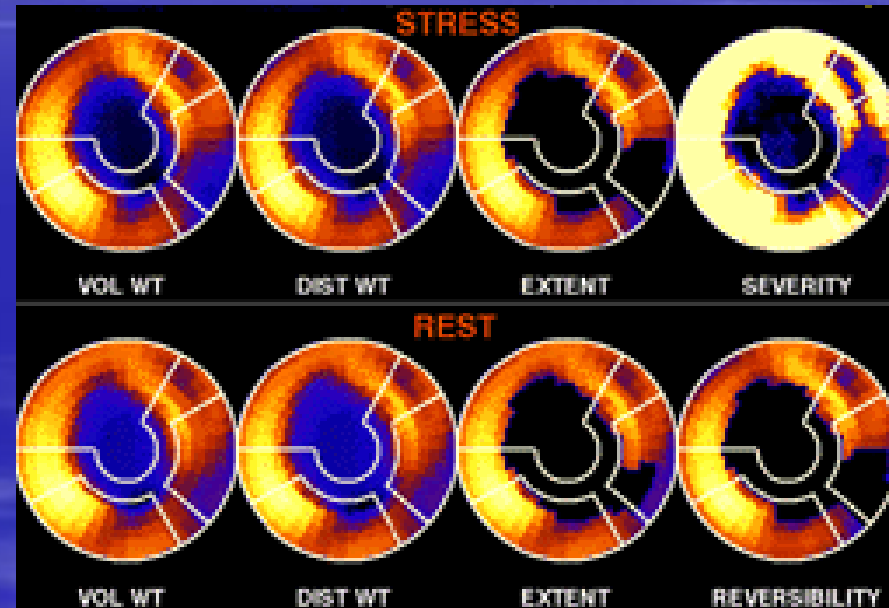
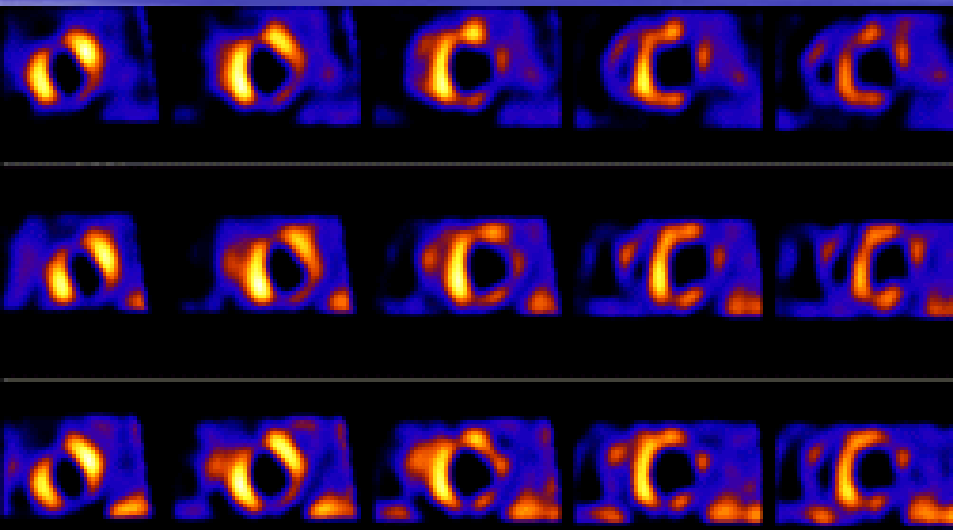
2 Vessel Disease LAD & RCA



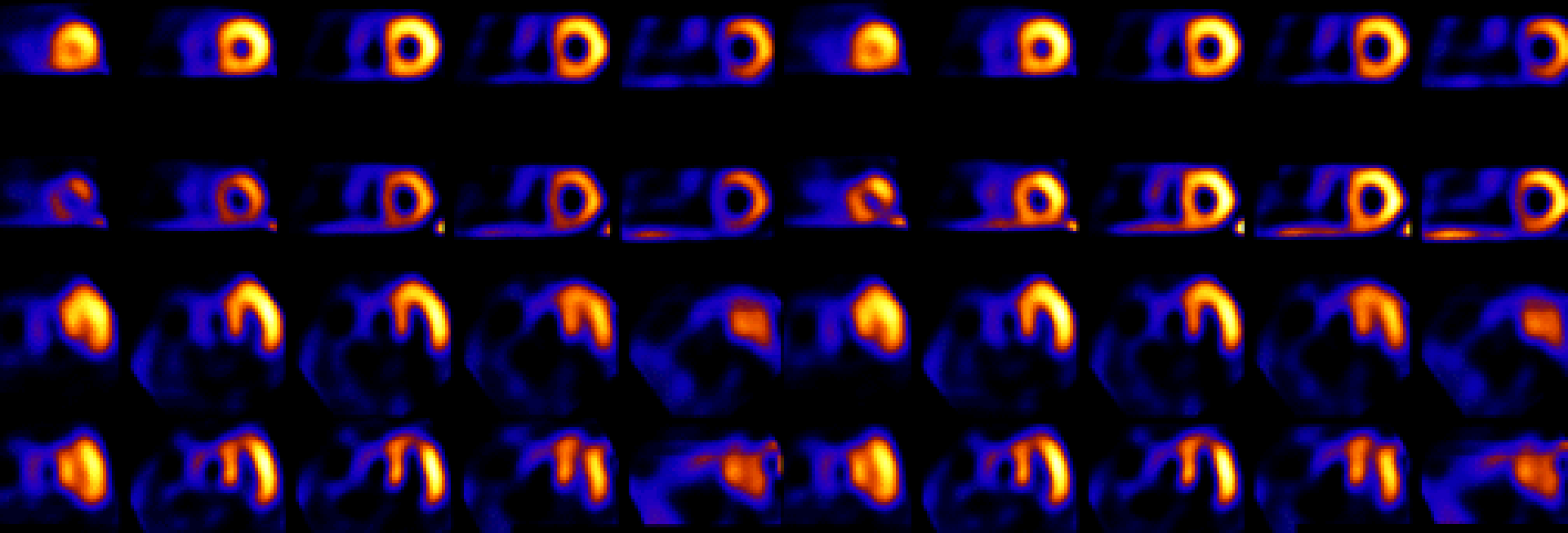
Left Main Disease



Triple Vessel CAD



Global Ischaemia



Stress Echo

- Based on principle that ischaemic myocardium becomes hypokinetic
- Baseline echo to identify regional LV function
- Exercise or pharmacologic stress
- Immediate echo to look for changes in wall motion

20010716-06:59:23

Rest : PLAX

T1: 13:04



20010716-07:15:42

Peak [0] : PLAX

T1: 29:24

T2: 14:57



DP: 3.0 18: 0

Rest



Peak [0]



20010716-07:00:02

Rest : PSAX

T1: 13:44



20010716-07:15:59

Peak [0] : PSAX

T1: 29:42

T2: 15:14



Rest



Peak [0]



Exit

< >



Stress Echo

- Indicated to increase sensitivity and specificity of stress testing
- Pharmacologic stress-usually dobutamine if exercise no possible
- Indicated in women with intermediate probability CAD, LBBB, LVH, resting ST changes

Stress Echo Limitations

- Technical quality of images
 - COPD
 - Obesity
- Timing of acquisition of images
- Learning curve
- Operator dependent
- Reproducibility

Dobutamine Stress Echo

- Positive inotrope and chronotrope
- Given in incremental doses 5-10 $\mu\text{g}/\text{kg}/\text{min}$ up to 30-40 $\mu\text{g}/\text{kg}/\text{min}$ to simulate exercise
- Induces ischaemia via
 - Increased HR, BP & contractility
- Preferred agent if
 - Persantine or aggrenox on board
 - History of asthma or COPD
 - Critical carotid stenosis

Dobutamine Echo contraindications

- Ventricular arrhythmias
- Recent myocardial infarction (one to three days)
- Unstable angina
- Hemodynamically significant left ventricular outflow tract obstruction
- Severe aortic stenosis
- Aortic aneurysm or aortic dissection
- Systemic hypertension

Dobutamine Stress Echo

- Half life 2 minutes/steady state 10 minutes
- Atropine needed concurrently to increase HR 36% of time
- Side effects
 - Palpitation 35%
 - Chest pain 19%
 - Nausea 8%
 - Anxiety 6%

Dobutamine Stress Echo

- Development of new wall motion abnormalities indicates ischaemia
- Improvement of existing wall motion abnormalities indicates viable myocardium
- Wall motion may worsen at higher doses with onset of ischaemia

Prognostic value of stress echo compared with stress thallium in patients evaluated for CAD

- 248 patients, age 56 ± 12 yrs, simultaneous treadmill stress echo and SPECT thallium studies
- Follow up 3.7 ± 2.0 years
- Outcome: death, MI, revascularization, hospitalization for congestive heart failure or unstable angina

Indications for Coronary Angiography

- High risk stress test
 - ECG
 - Hemodynamic
- High risk perfusion study
 - Multiple defects
 - Severe perfusion defects
 - TID
- Ongoing symptoms
- Unstable angina
- Post MI angina
- CHF
- Vocational indication
 - Pilots
 - Truck/bus drivers
- Diagnostic uncertainty