Hemodynamics and Non-invasive Evaluation in Elderly

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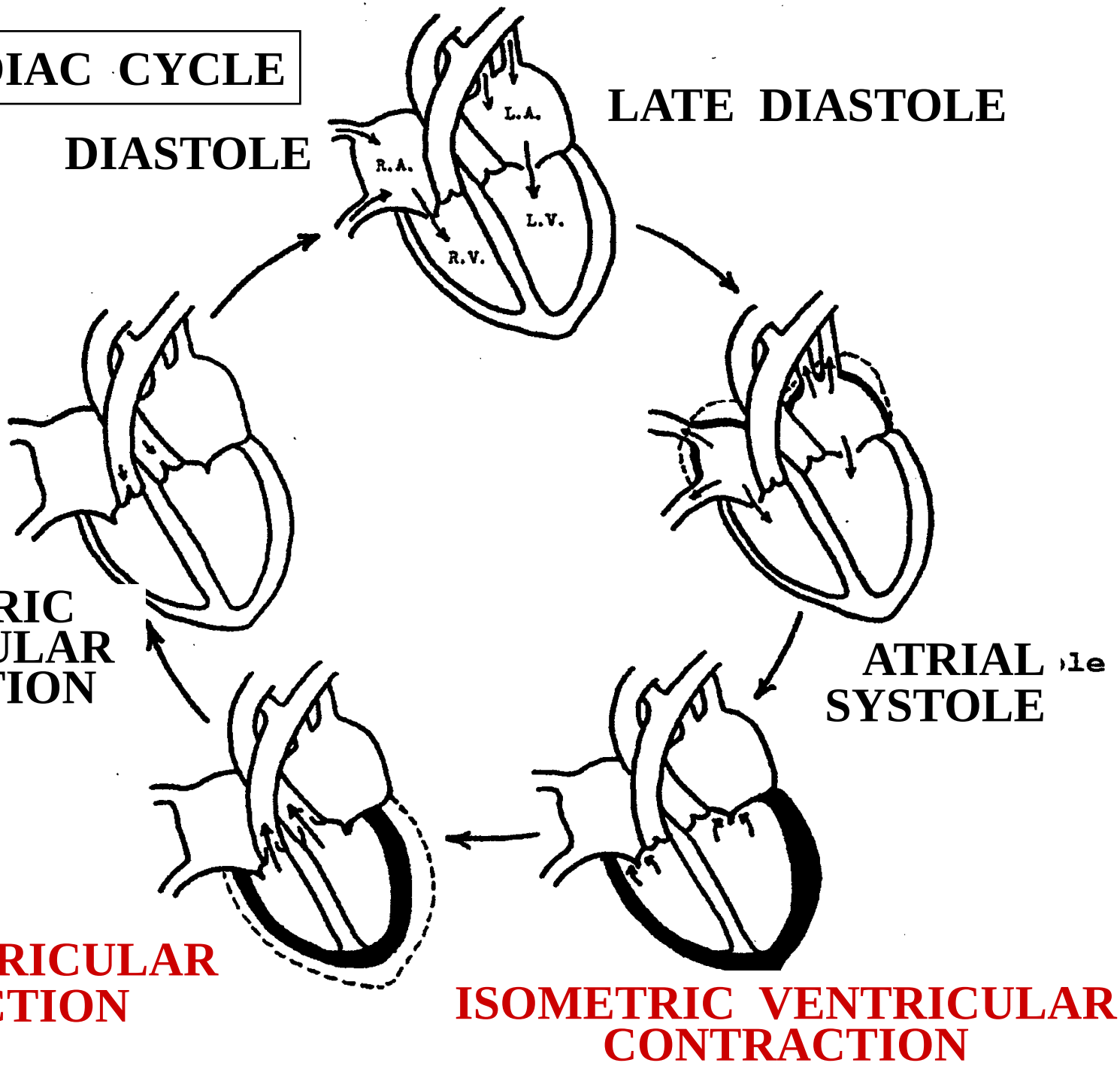
CARDIOVASCULAR DISEASES IN ELDERLY

- Endocardium :
  - Valvular heart disease
  - Infective endocarditis
- Myocardium :
  - Ischemic heart disease
  - Myocarditis
  - Cardiomyopathy
- Pericardial disease
  - Pericarditis
  - Pericardial effusion
- Aortic disease :
  - Aortic aneurysm
  - Aortic dissection
- Coronary heart disease
- Congenital heart disease
- Arrhythmias
- Hypertension
- Peripheral arterial disease
  - Carotid artery stenosis
  - Renal artery stenosis
  - Extremity artery stenosis
- Miscellaneous
  - Pulmonary artery embolism
  - Deep vein thrombosis

CARDIOVASCULAR AGING

THE CARDIAC CYCLE

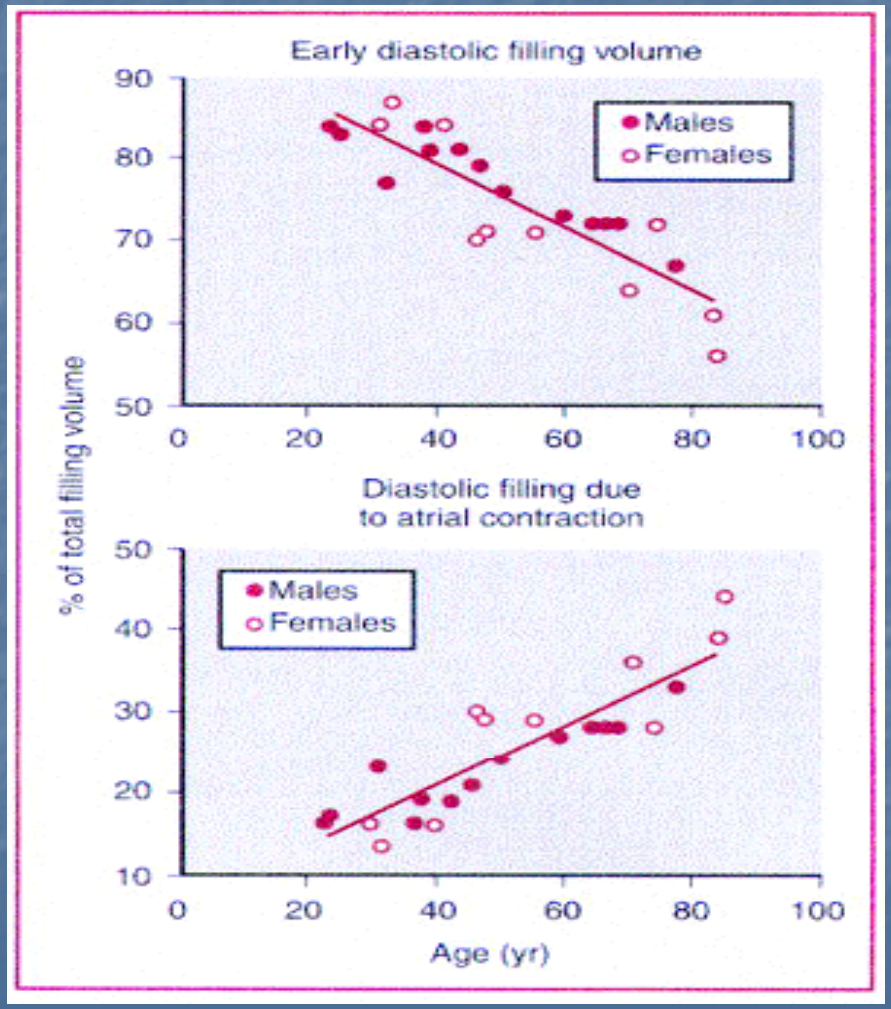


Major Changes; LV Function

Decreased in rate of myocardial relaxation

⇨LV diastolic dysfunction

⇨LV becomes stiffer and takes longer to relax and fill in diastole



Major Changes; Vascular Structure

Decreased elasticity and compliance of aorta and great arteries

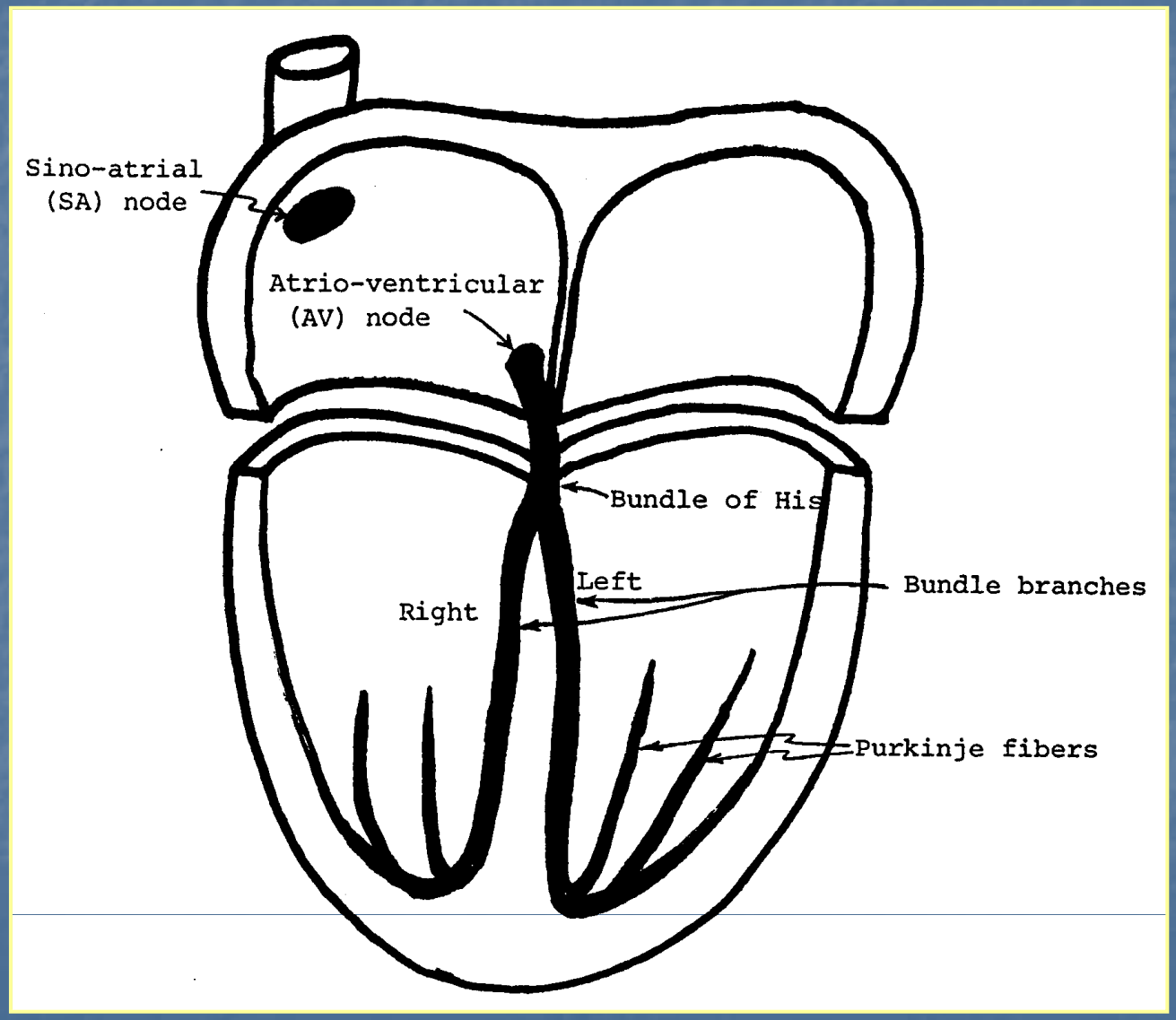
⇨Increased systolic arterial pressure & increased impedance of LV contraction

⇨Mild LV hypertrophy and interstitial fibrosis

Major Changes; Cardiac Structure

- LV thickness progressively increased with ages
- Increase in average myocyte size but decrease in number (apoptosis)
- Increase in intramyocardial fibrosis
- Decreased in overall LV mass

CONDUCTING SYSTEM



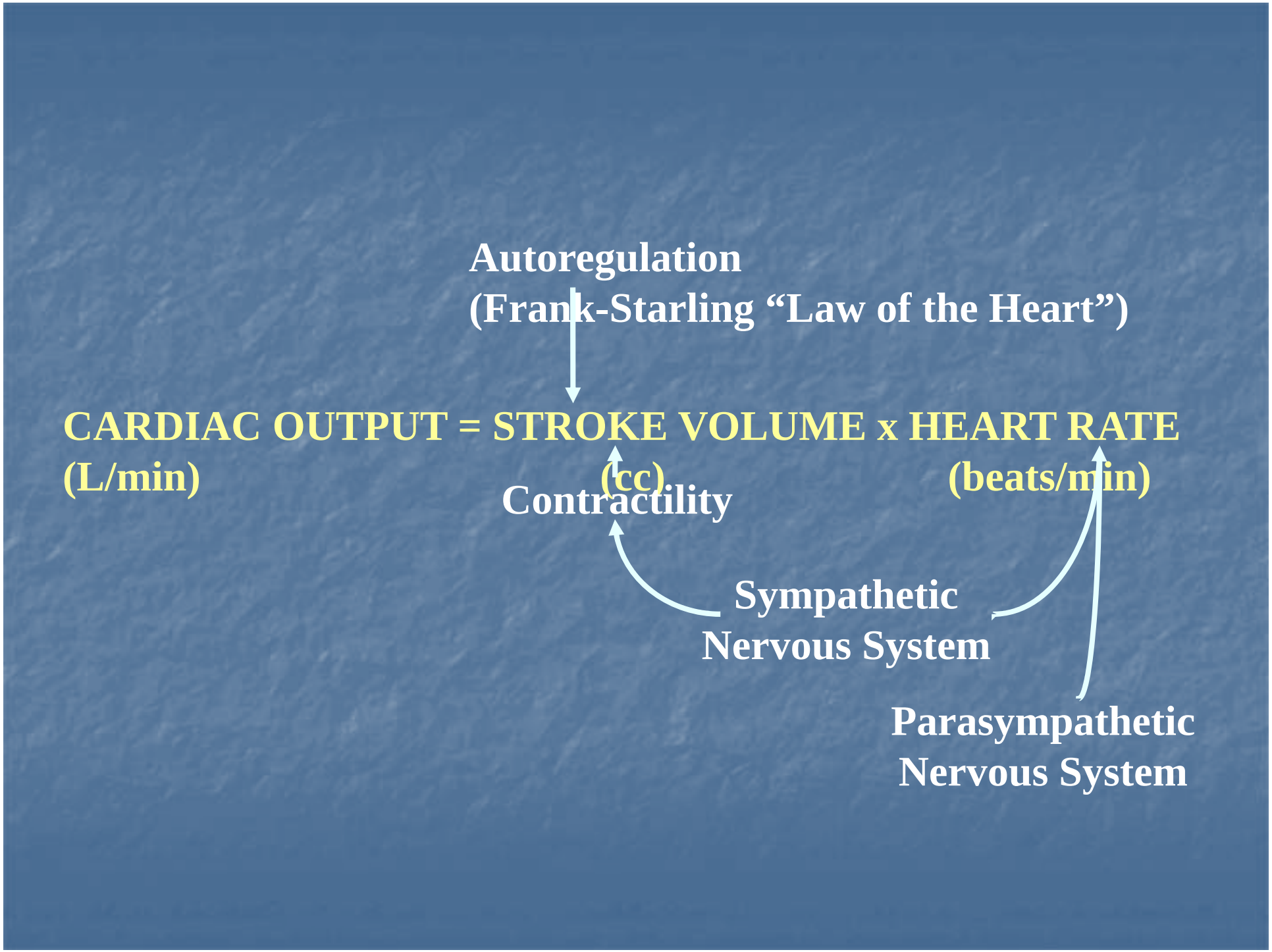
Major Changes; Conduction System

- A 50-75% loss of pacemaker cells in SA node

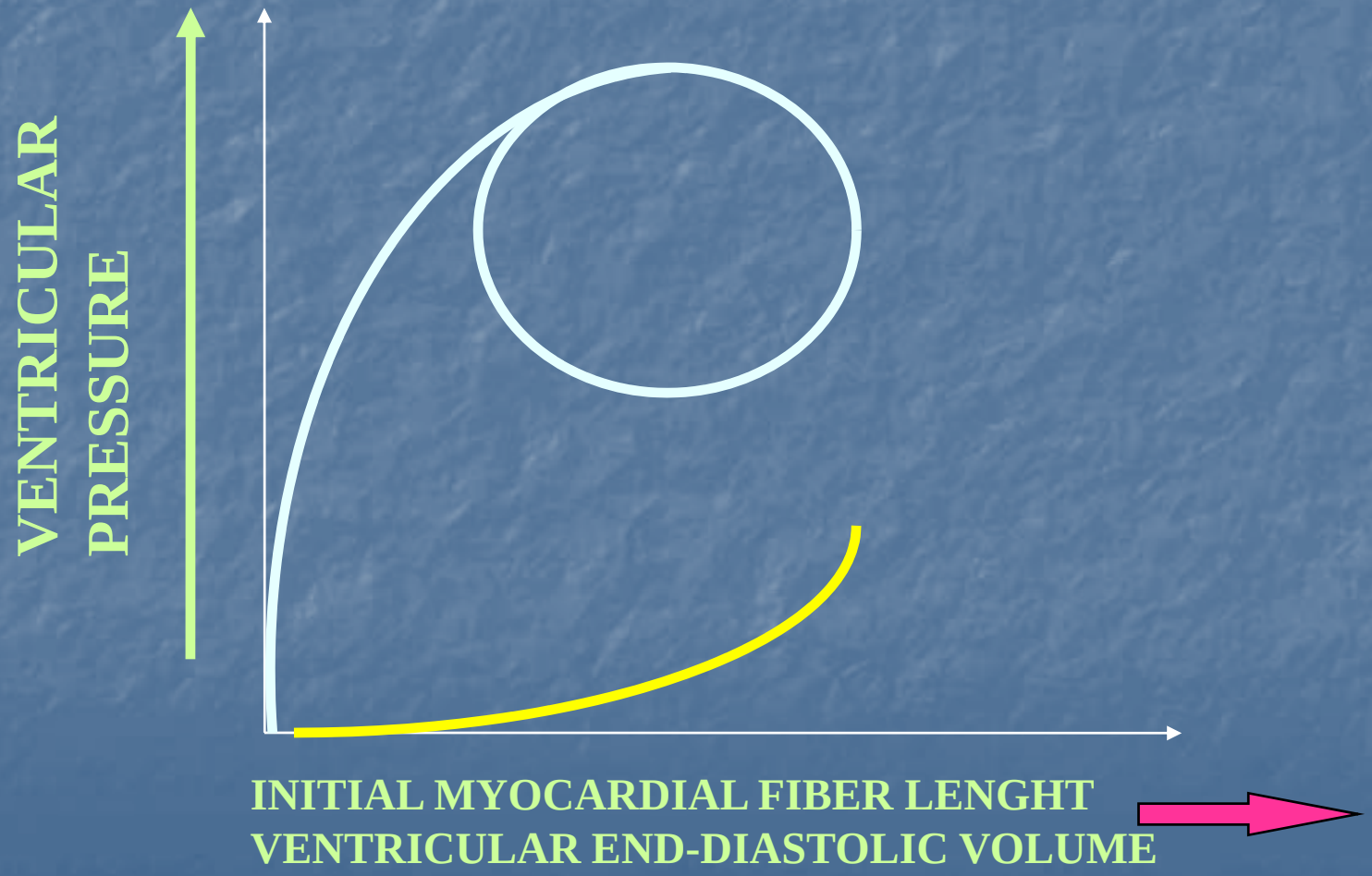
⇨decrease in intrinsic & maximum sinus rate

- Preserved number of AV nodal cells
- Increase in AV nodal delay (PR interval) ⇨ 1st degree AV block
- Fibrosis and loss of specialized cells in His bundle and bundle branches ⇨bundle branch block

- *Decreased responsiveness to beta-adrenergic receptor stimulation*


Autoregulation
(Frank-Starling "Law of the Heart")
CARDIAC OUTPUT = STROKE VOLUME x HEART RATE
(L/min)
(cc)
(beats/min)
Contractility
Sympathetic
Nervous System
Parasympathetic
Nervous System

LENGHT/ TENSION AND THE FRANK-STARLING RELATION



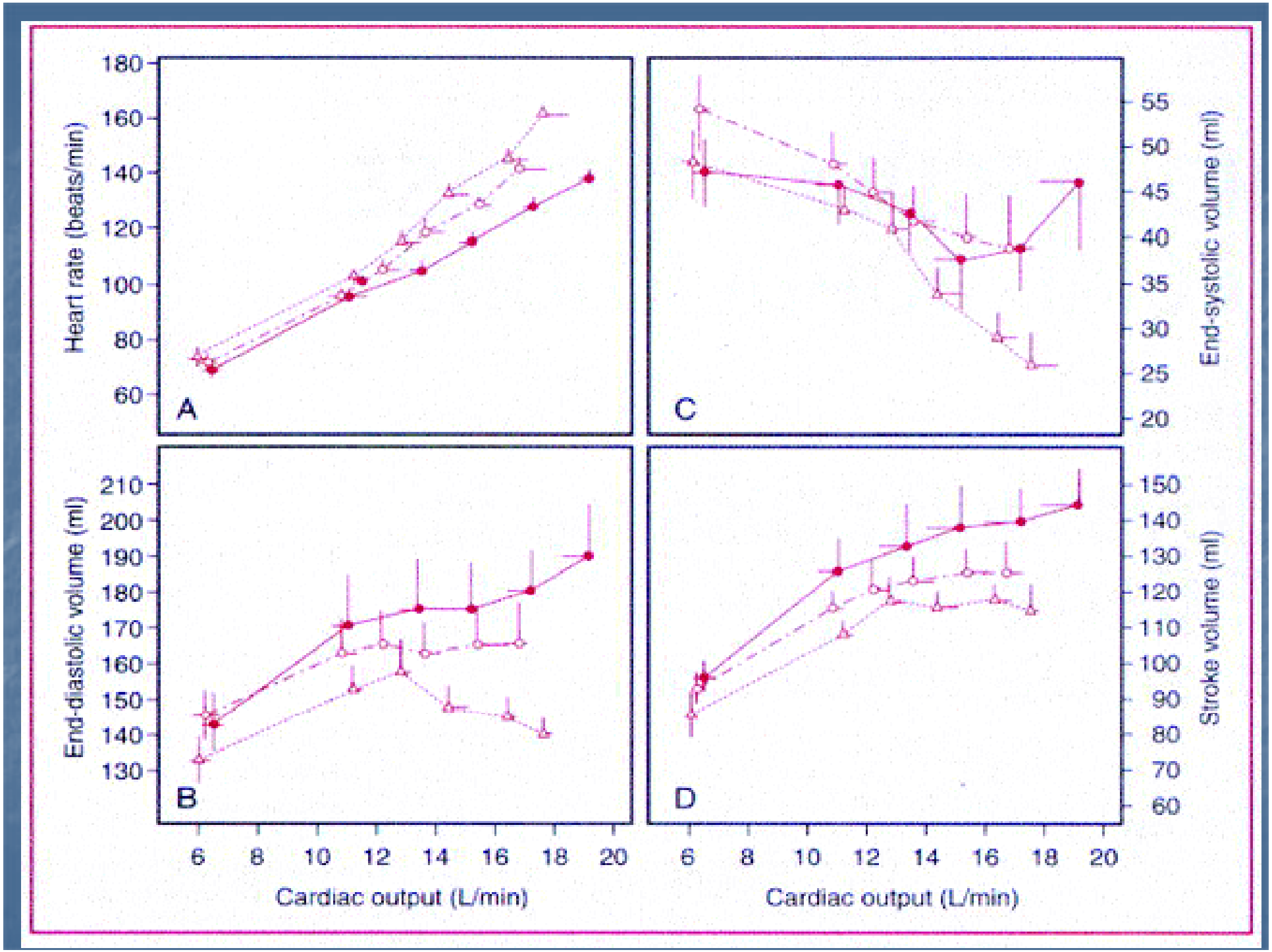
Major Changes; Physiology

- **Cardiac output remains normal at rest, but with slower HR (in elderly)**

⇨ increased end diastolic volume (EDV)

⇨ increase stroke volume & keep cardiac output normal.

- With exercise ⇨ decrease in ability to achieve maximum HR and O_2 consumption.
- However, ejection fraction (EF) is normal by the increased SV as above.


Heart rate (beats/min)
180
160
140
120
100
80
60
A
End-systolic volume (ml)
55
50
45
40
35
30
25
20
C
End-diastolic volume (ml)
210
200
190
180
170
160
150
140
130
B
Stroke volume (ml)
150
140
130
120
110
100
90
80
70
60
D
6
8
10
12
14
16
18
20
Cardiac output (L/min)
Cardiac output (L/min)

Cardiovascular Investigations

AIMS OF INVESTIGATIONS

- FOR DIAGNOSIS
  - History + P.E. + Investigations
- FOR ASSESSMENT OF
  - DISEASE SEVERITY
  - DISEASE PROGNOSIS

CARDIAC INVESTIGATIONS

- **NON-INVASIVE**
  - Blood pressure measurement
  - Oxygen saturation measurement
  - Electrocardiogram (ECG)
  - Chest X-ray (CXR)
  - Laboratory testing
  - 2D-3D Echocardiography
  - Transesophageal echocardiography (TEE)
  - Exercise stress test (EST) or Exercise treadmill test (ETT)
  - Exercise stress- Echocardiographic study
  - Dobutamine stress echocardiographic study
  - Holter monitoring
  - Tilt table test
  - Carotid artery Doppler study
  - Ankle-brachial index (ABI) study
  - CT-angiography : coronary, pulmonary, aorta, renal artery, peripheral artery
  - Cardiac MRI: rest CMR or stress CMR
  - Stress cardiac nuclear study

- **INVASIVE**
  - Coronary angiography
  - Left sided cardiac catheterization
  - Right sided cardiac catheterization
  - Pulmonary artery, carotid artery, renal artery, extremity artery angiography
  - Endomyocardial biopsy
  - Electrophysiologic (EP) study

NONIINVASIVE INVESTIGATIONS

THE ROLES OF NON-INVASIVE INVESTIGATIONS

- Diagnosis
- Risk/Prognostic Assessment
- Management

- Anatomical (non-invasive imaging)
- Functional (non-imaging & imaging)

Multimodality Noninvasive Testing

Prognostic Assessment Role
Predictor of Long-Term Survival with CAD

- Extent of LV dysfunction
- Anatomical extent & severity of atherosclerotic involvement --> number of diseased arteries
- Evidence of recent acute coronary syndrome
- General health & non-coronary comorbidity

Prognostic Assessment Role
Prognostic Information from Stress Testing

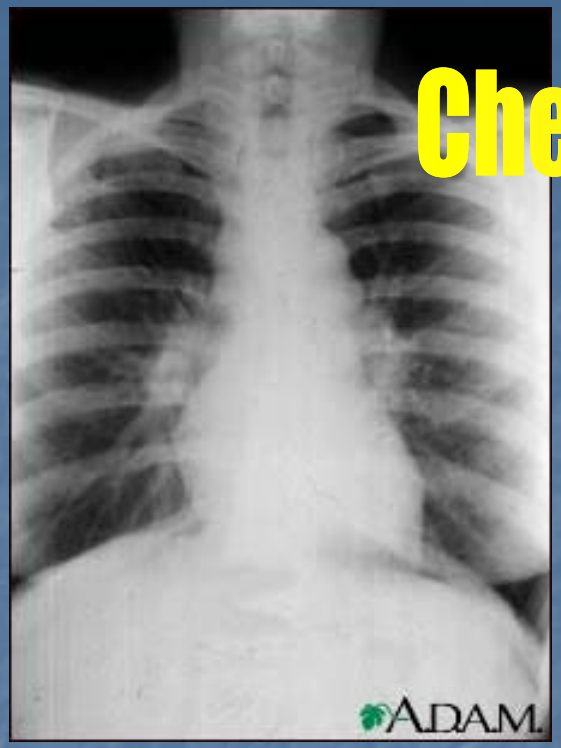
- Detection of :
  - Ischemia threshold
  - Extent and severity of ischemia
  - Functional capacity

CARDIOVASCULAR INVESTIGATION OPTIONS

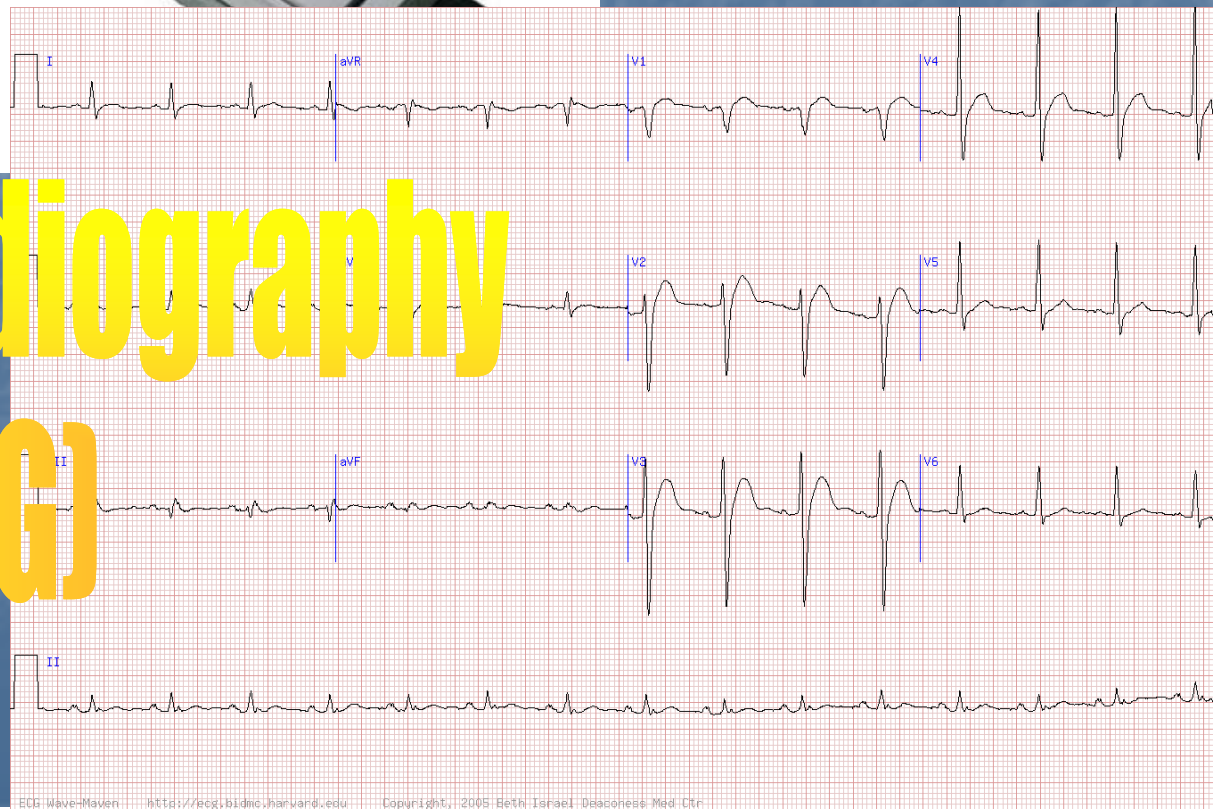
Sphygmomanometer

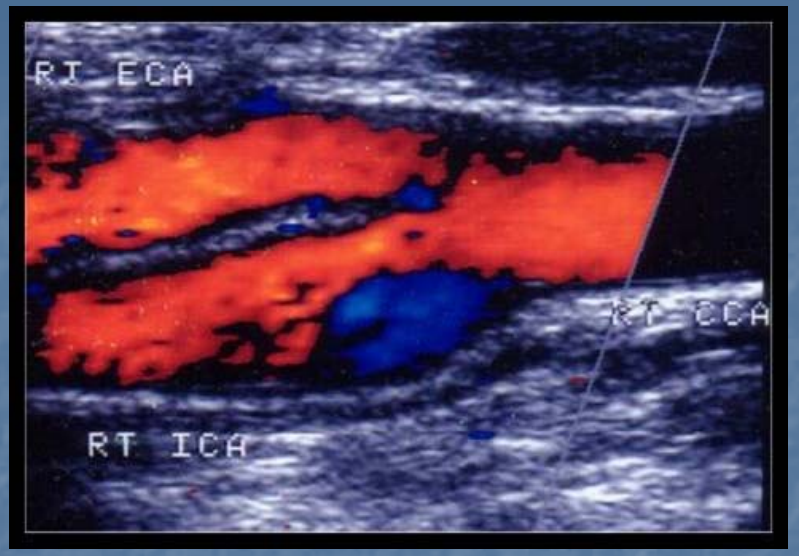
Pulse Oximeter

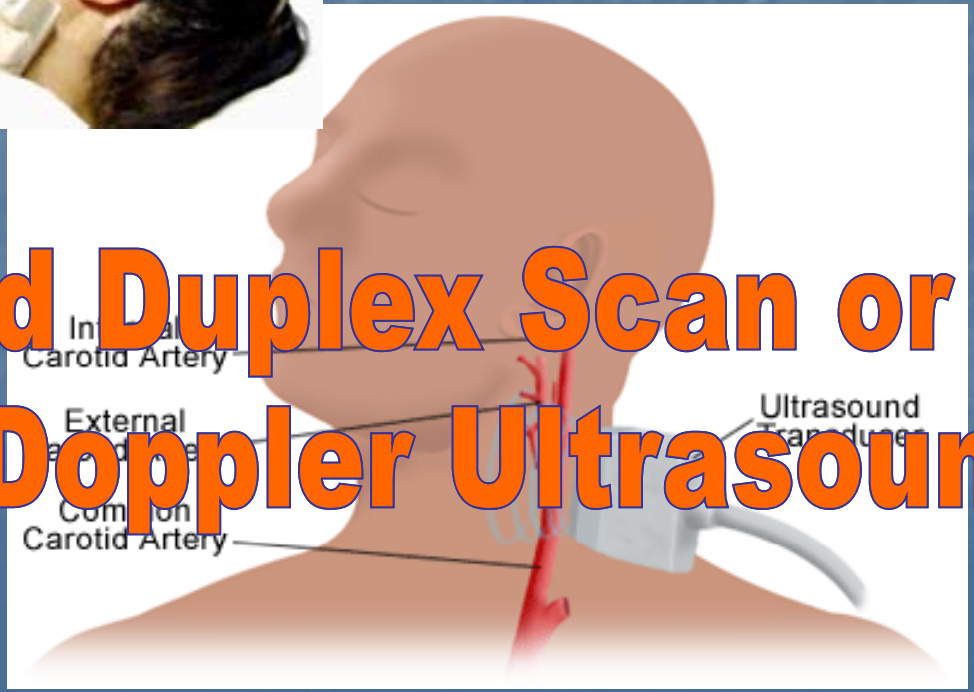
Chest X-ray (CXR)



Electrocardiography (ECG)

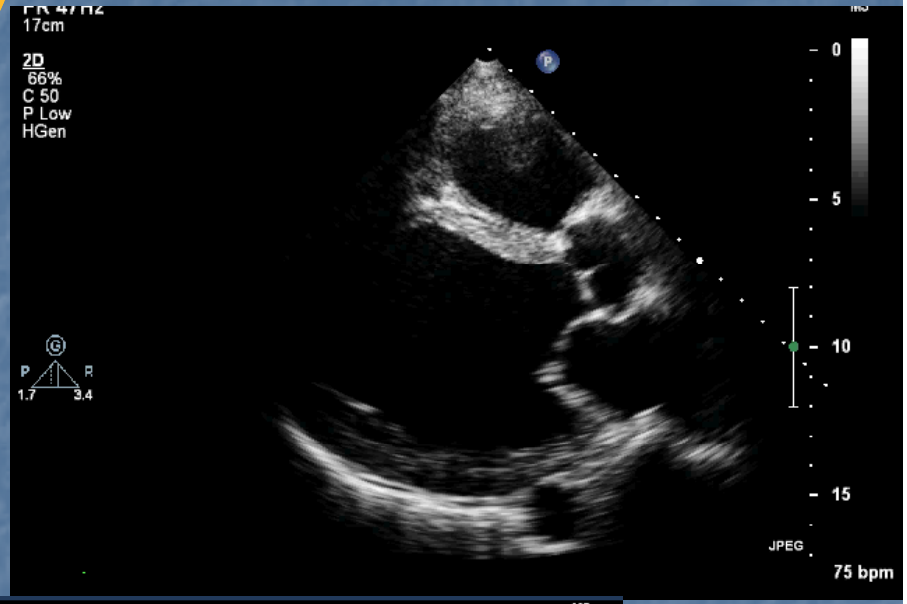


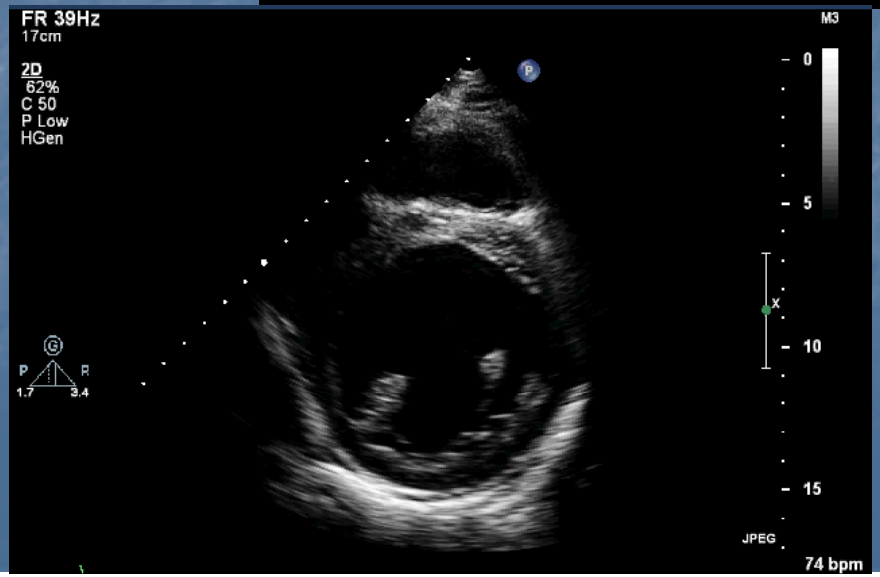




Carotid Duplex Scan or Carotid Doppler Ultrasound

2Dimensional Echocardiography (2D-Echo)



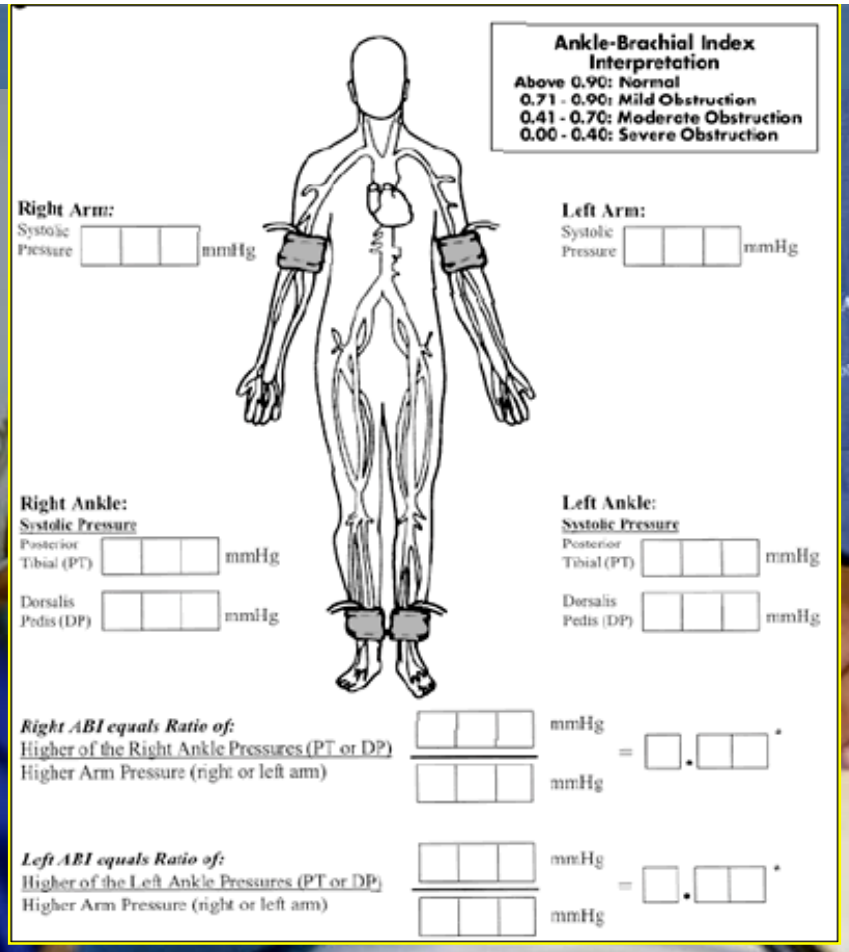


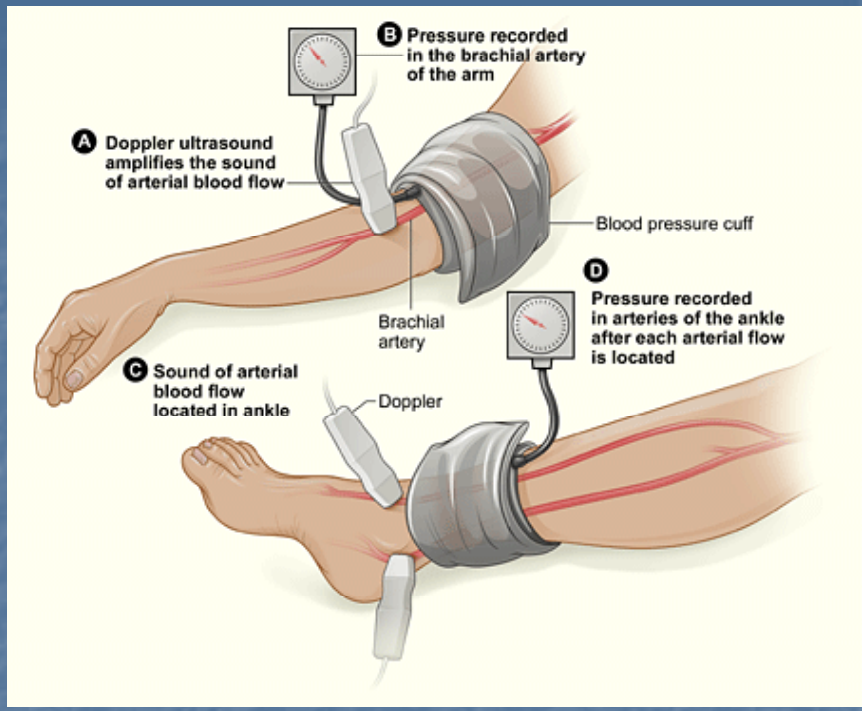
EXERCISE STRESS TEST
EXERCISE TREADMILL TEST

Exercise-Stress Echocardiographic Study

Dobutamine-Stress Echocardiographic Study

TILT- TABLE TEST



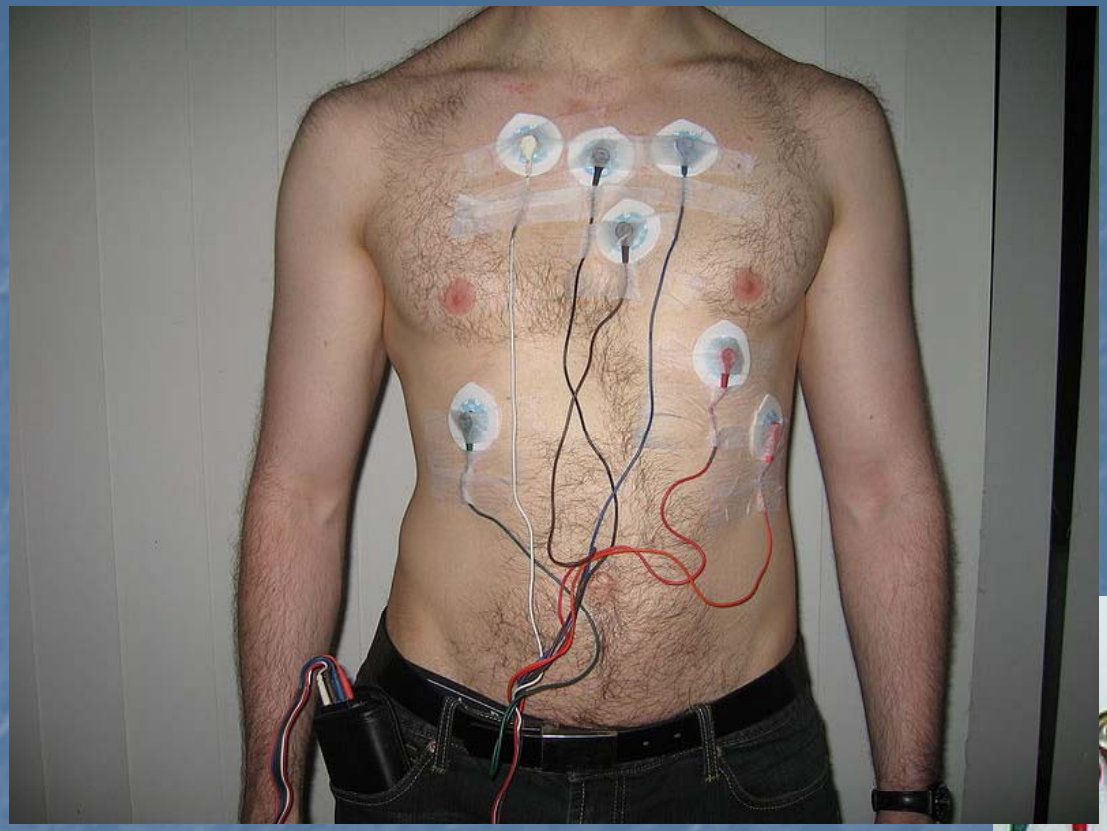


ANKLE-BRACHIAL INDEX (ABI)

Detects PAD

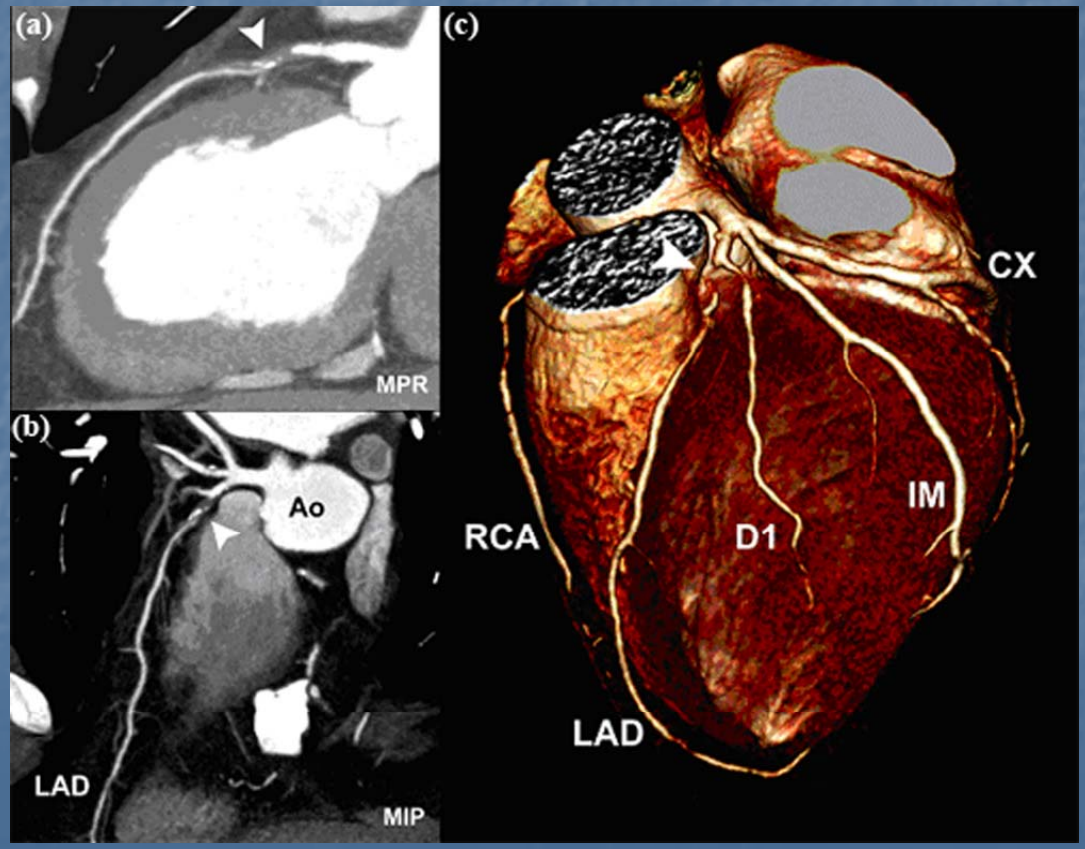
Normal ABI > 0.9

CAVI 6.0-8.0



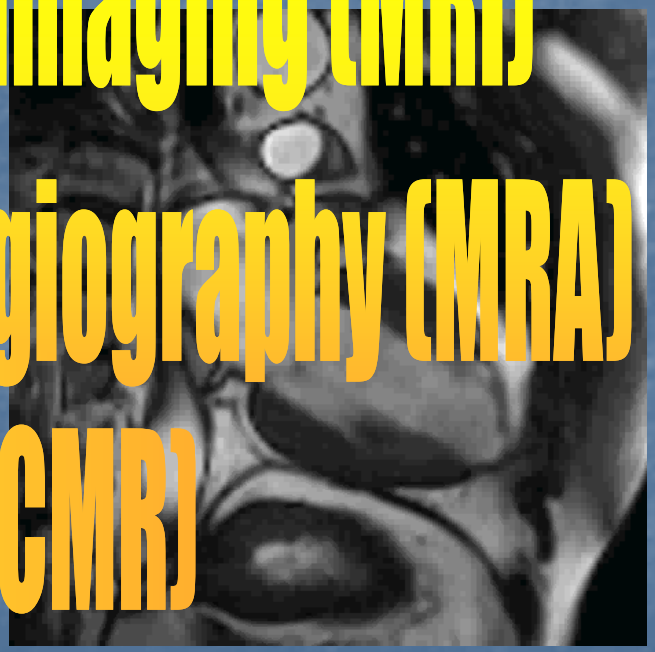
Holter Monitoring

Computed Tomography (CT) Angiography (CTA)



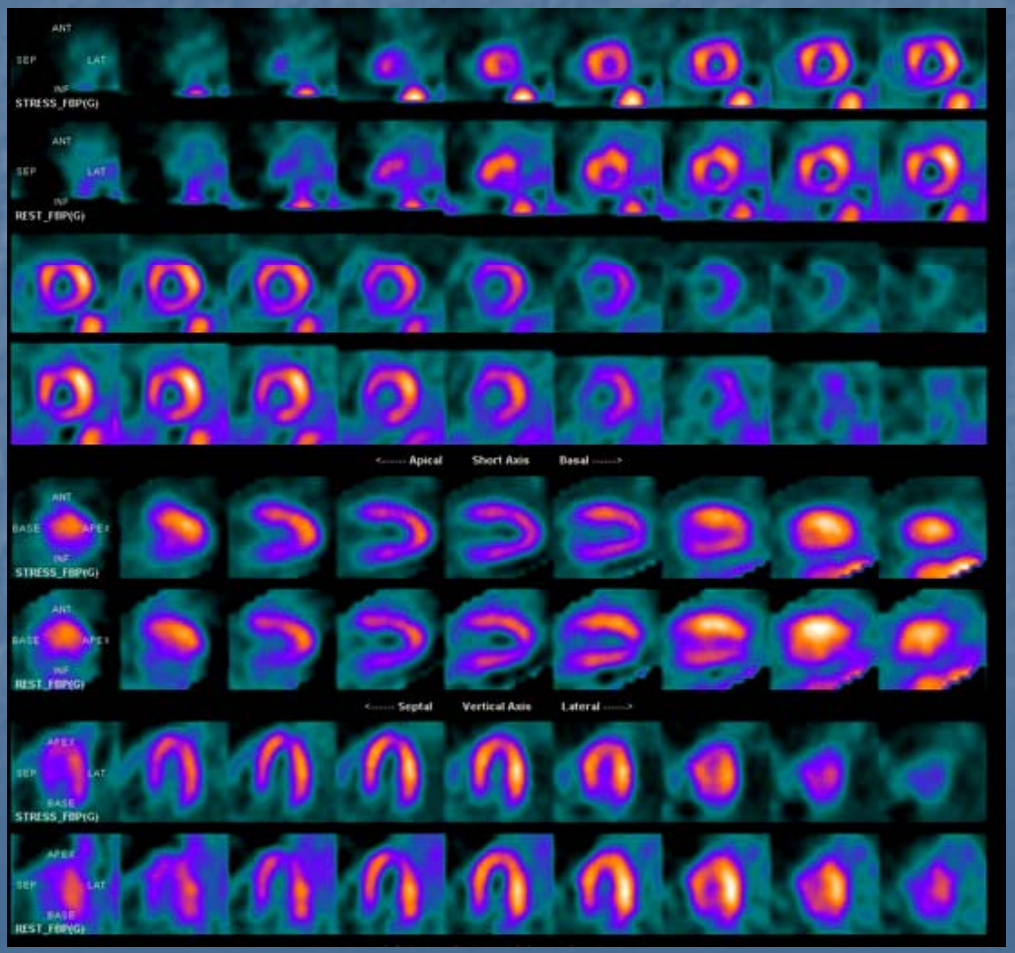
Magnetic Resonance Imaging (MRI)

Magnetic Resonance Angiography (MRA)

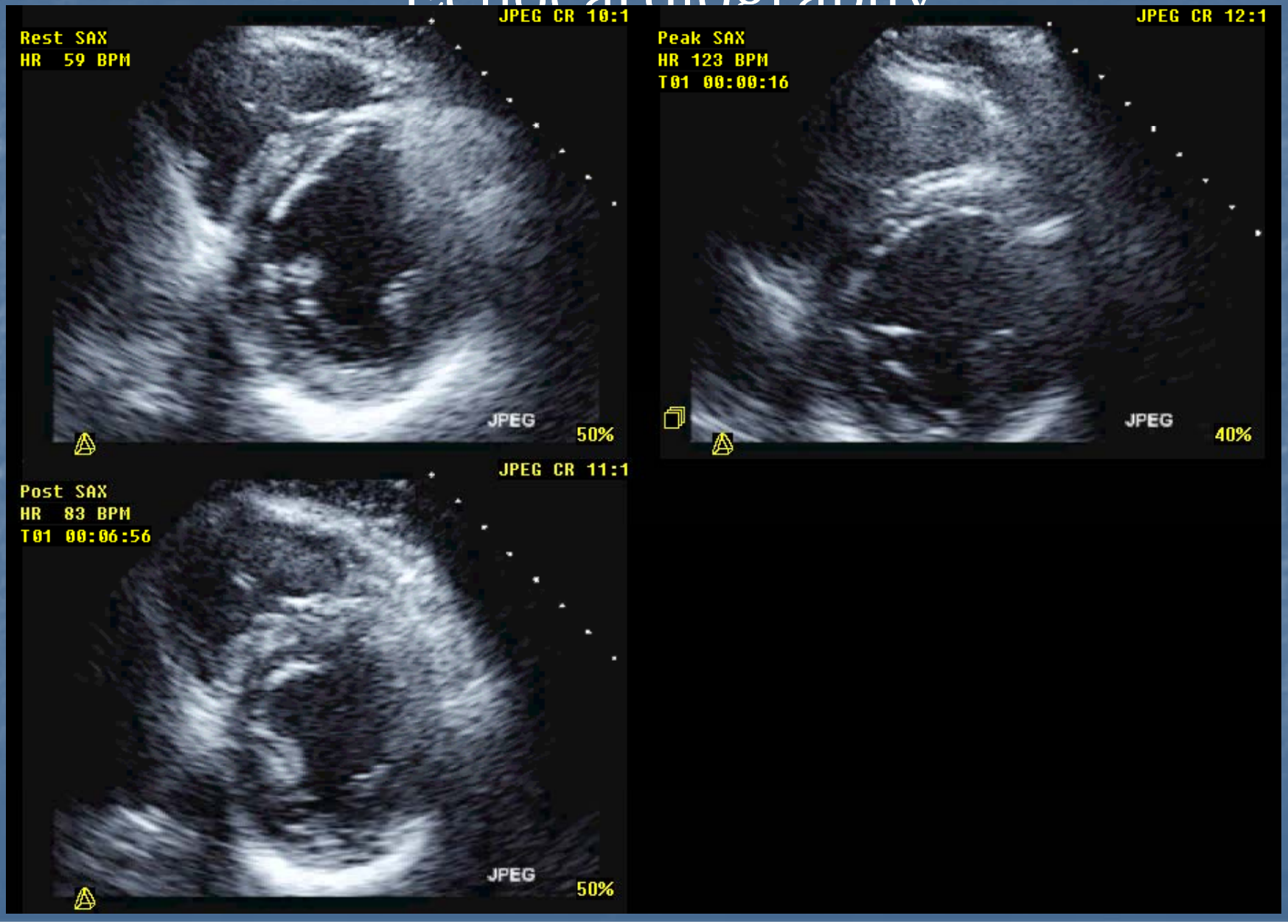


Cardiac MRI (CMR)

Cardiac Nuclear Study



Exercise or Dobutamine Stress Echocardiography



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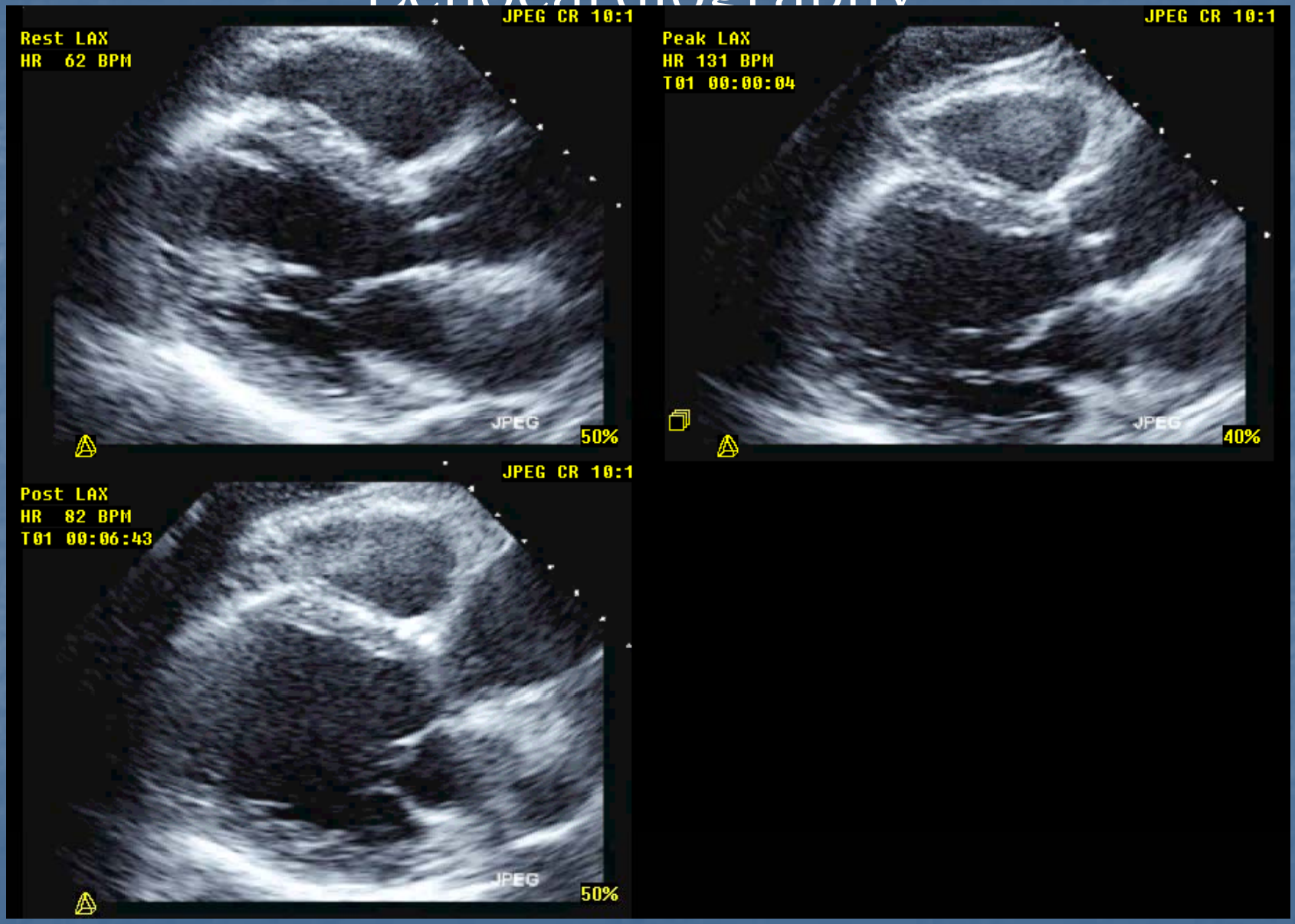
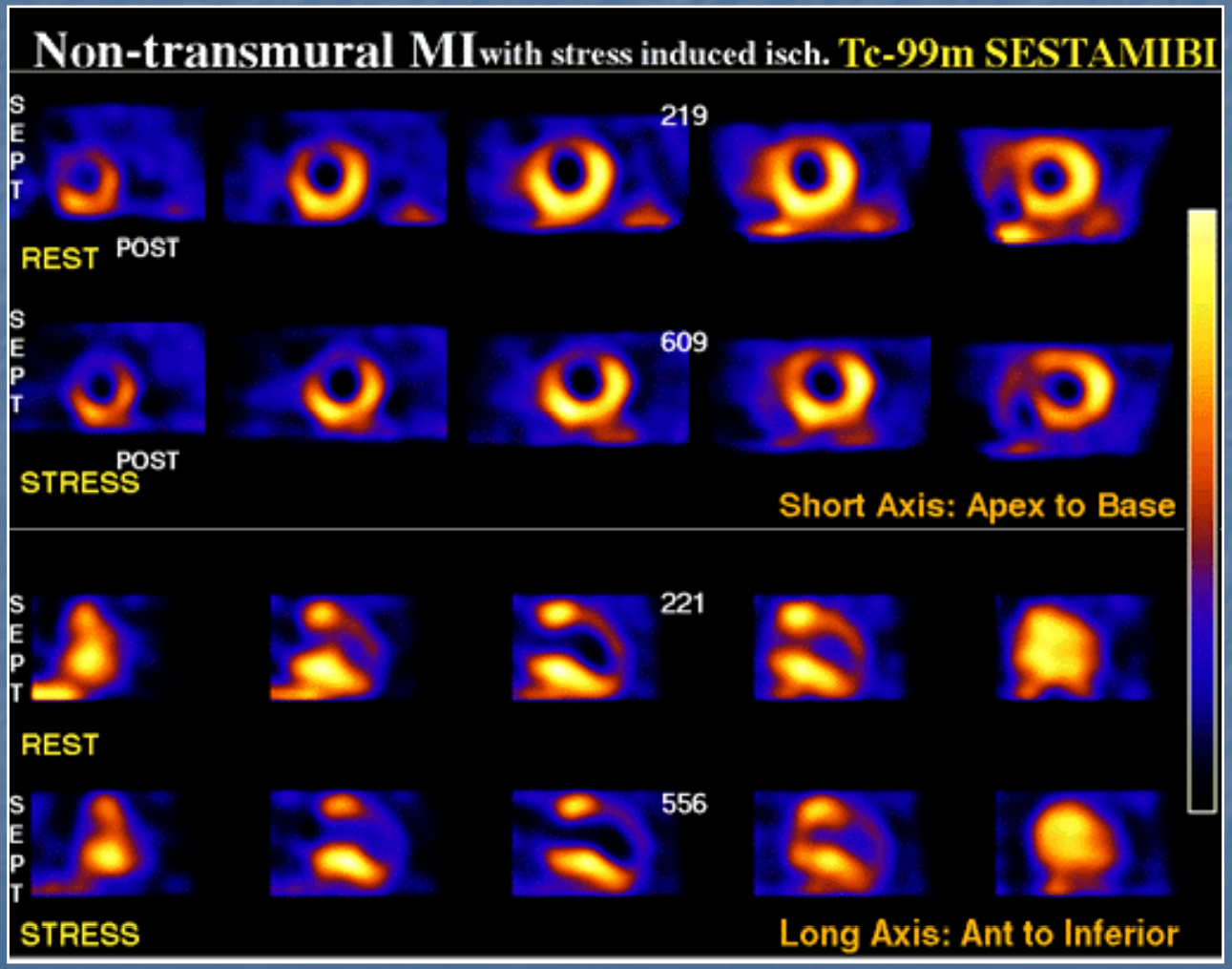
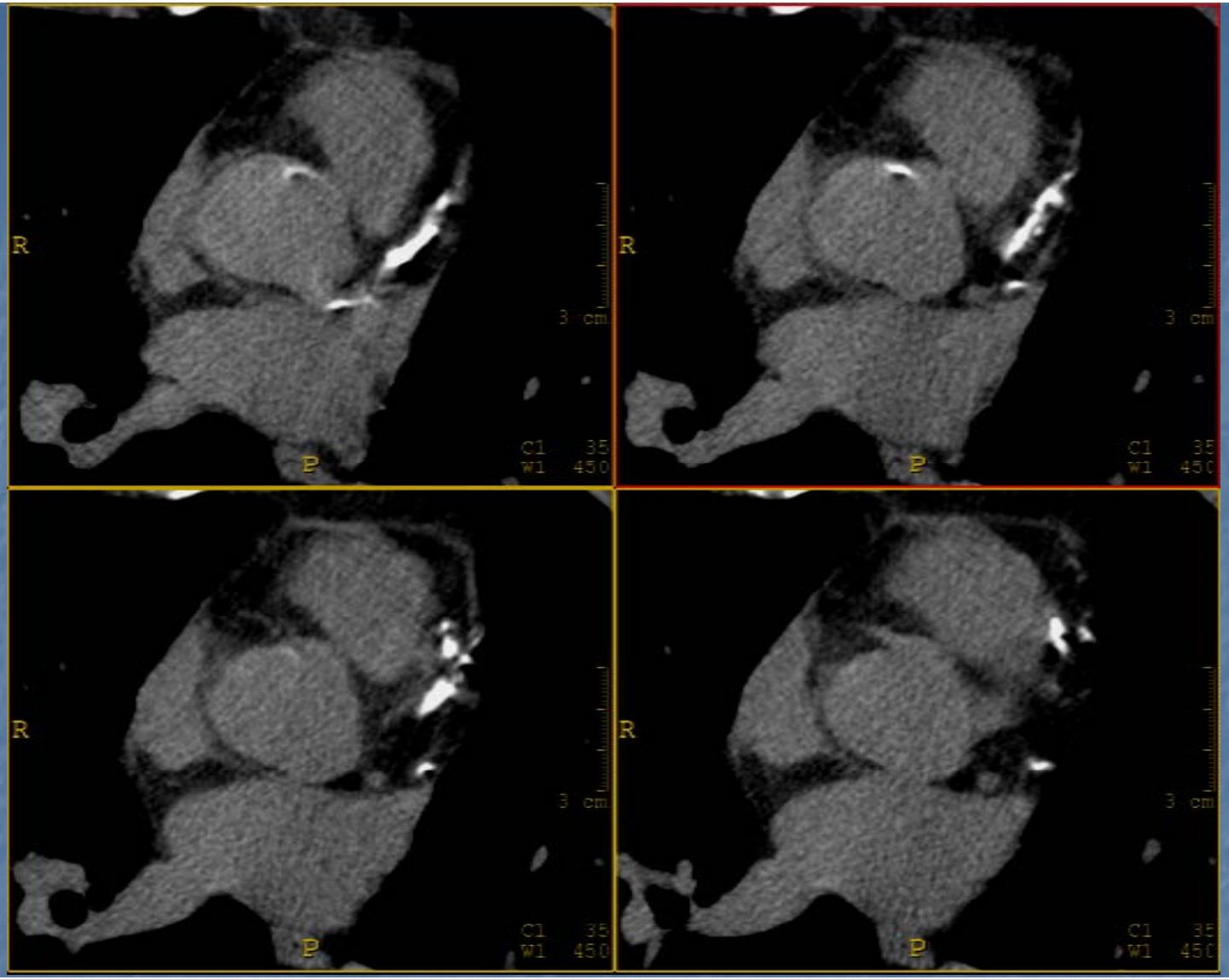


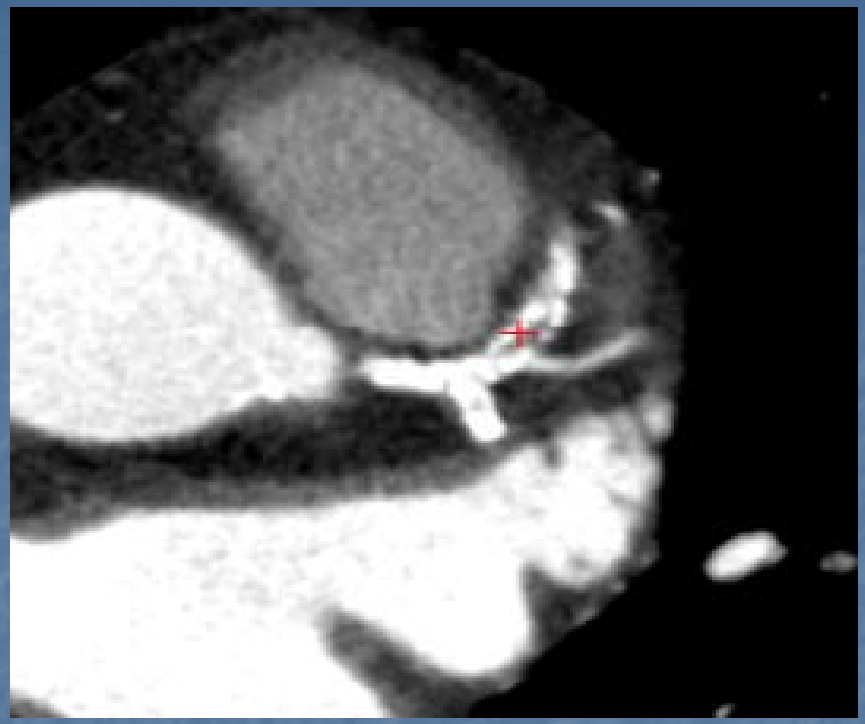
Exercise or pharmacological stress SPECT myocardial perfusion imaging

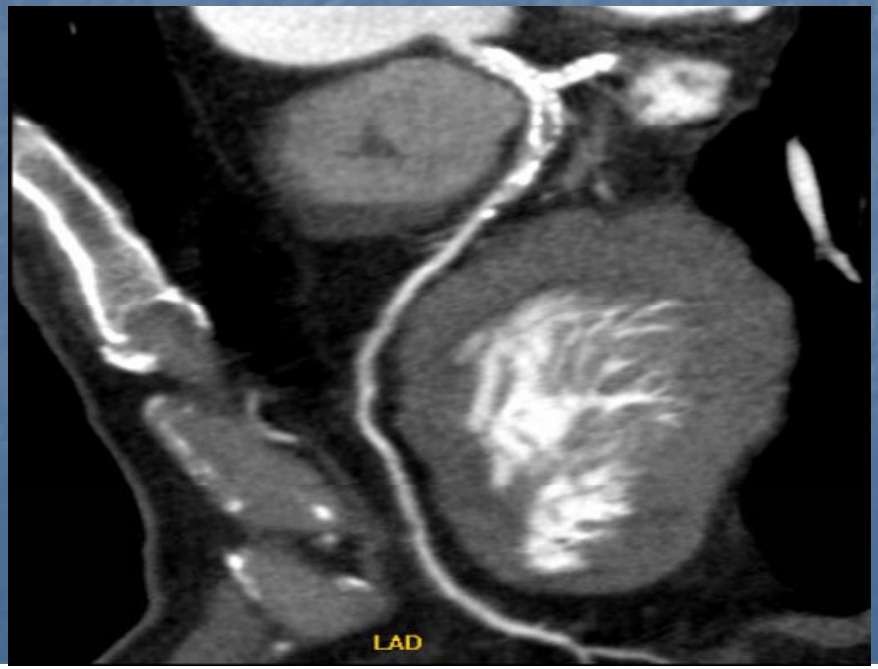


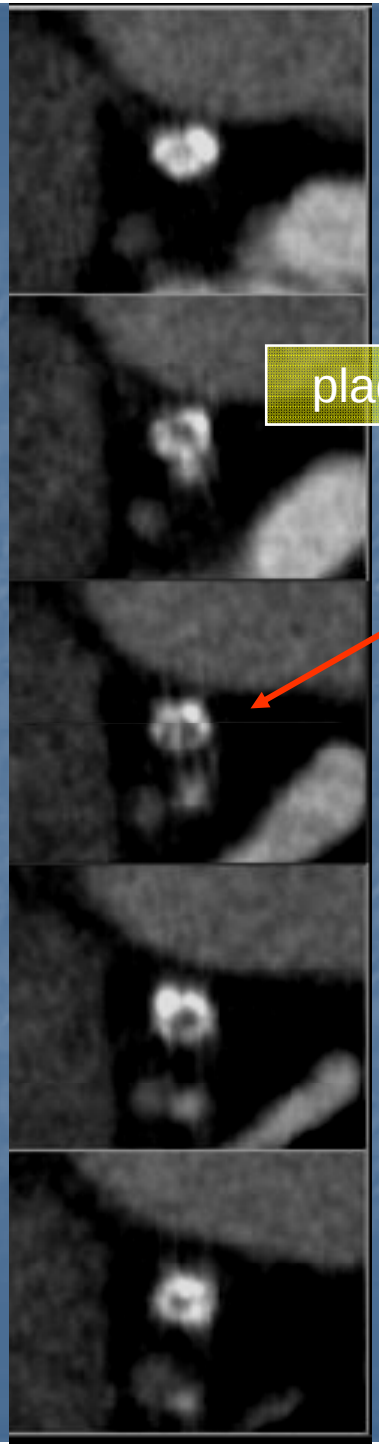


Coronary Artery Calcium score (CACS) : LM=27.5, LAD=973, LCX469, RCA=4.7, RI=46

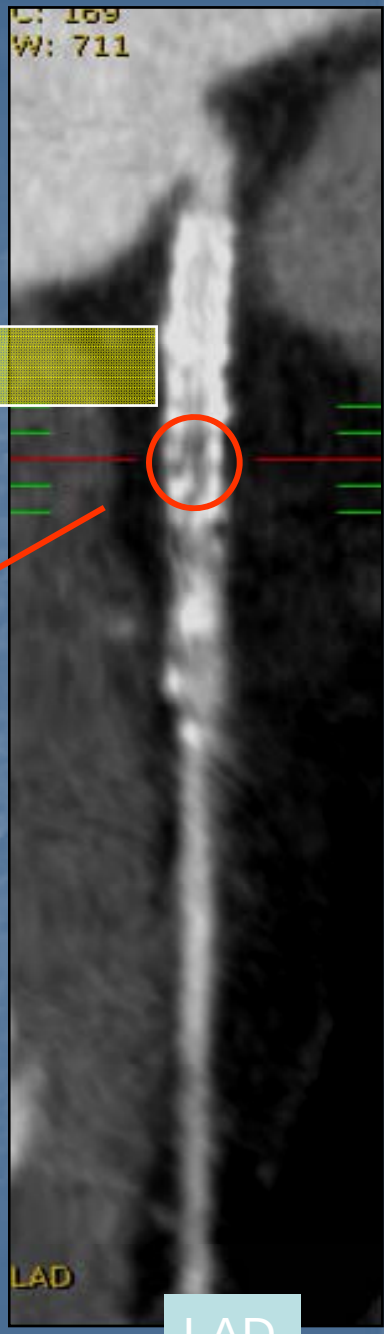
Total CAC score = 1521.4





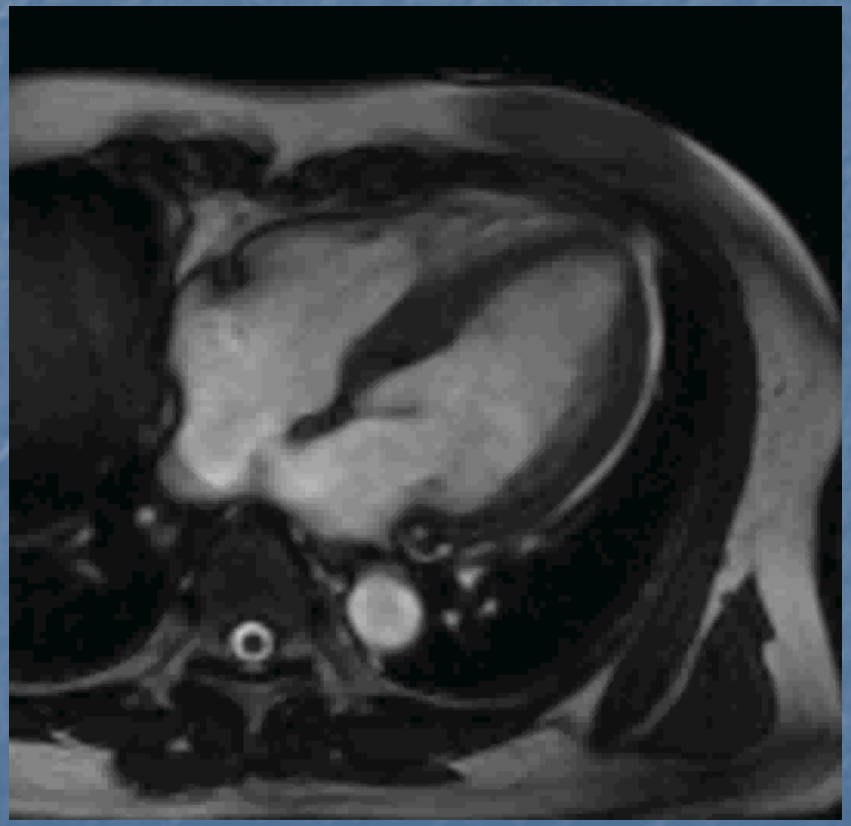


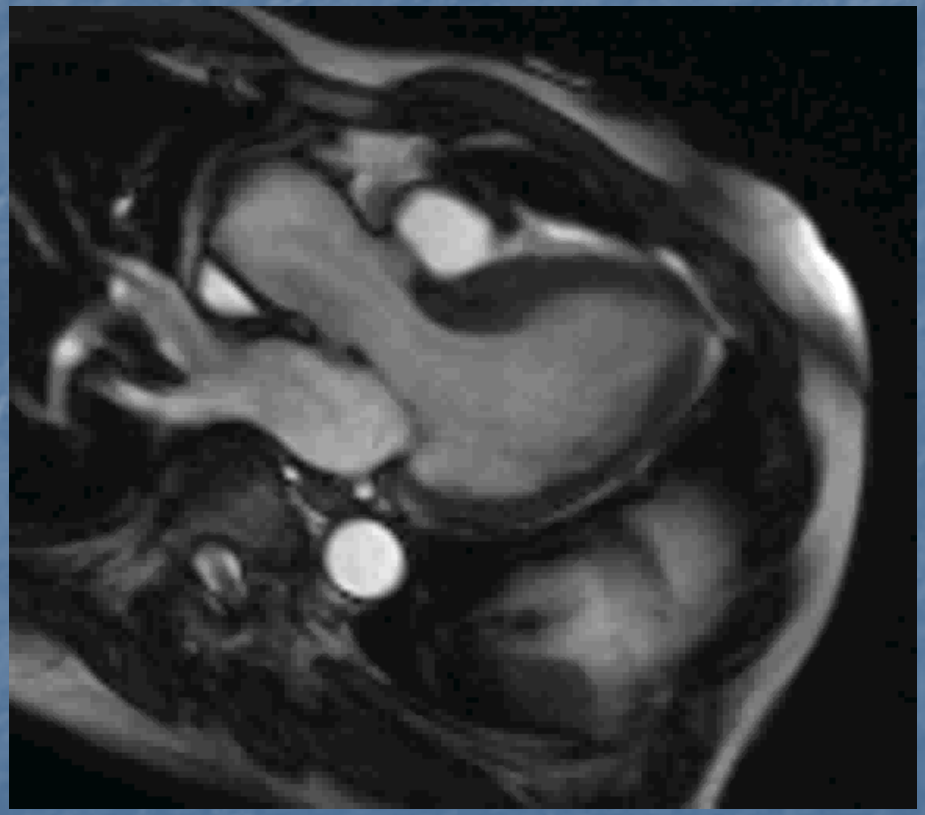
plaque



LAD

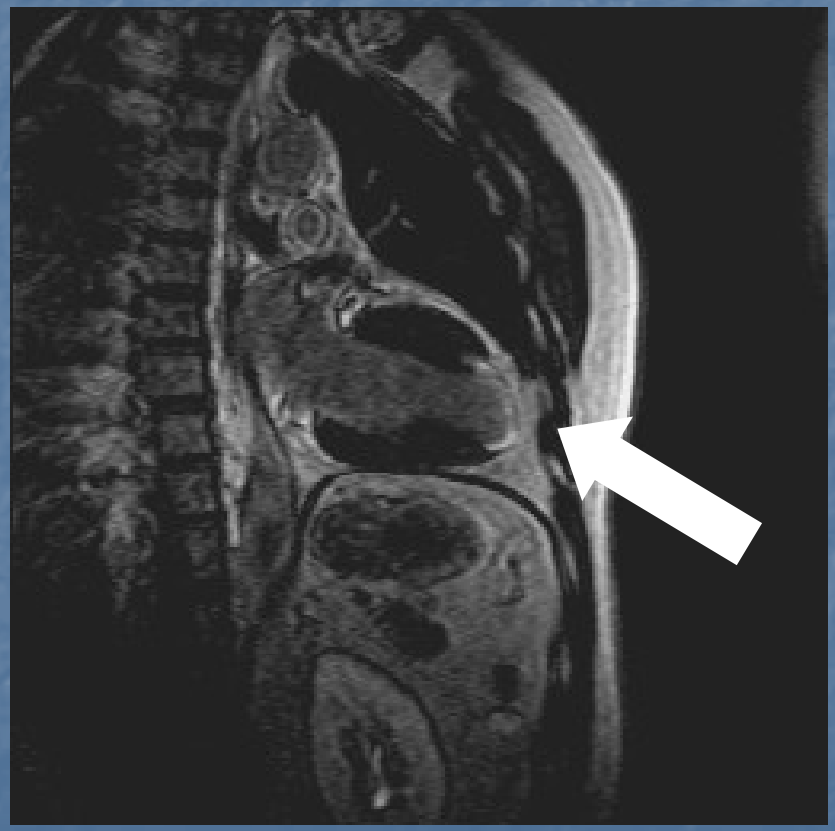
Cardiac MRI (CMR)

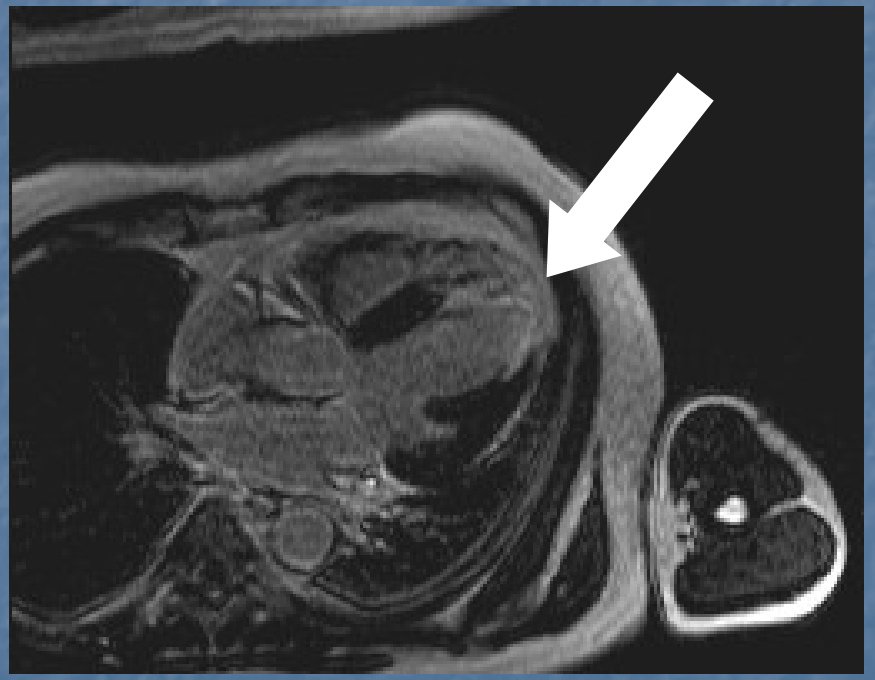




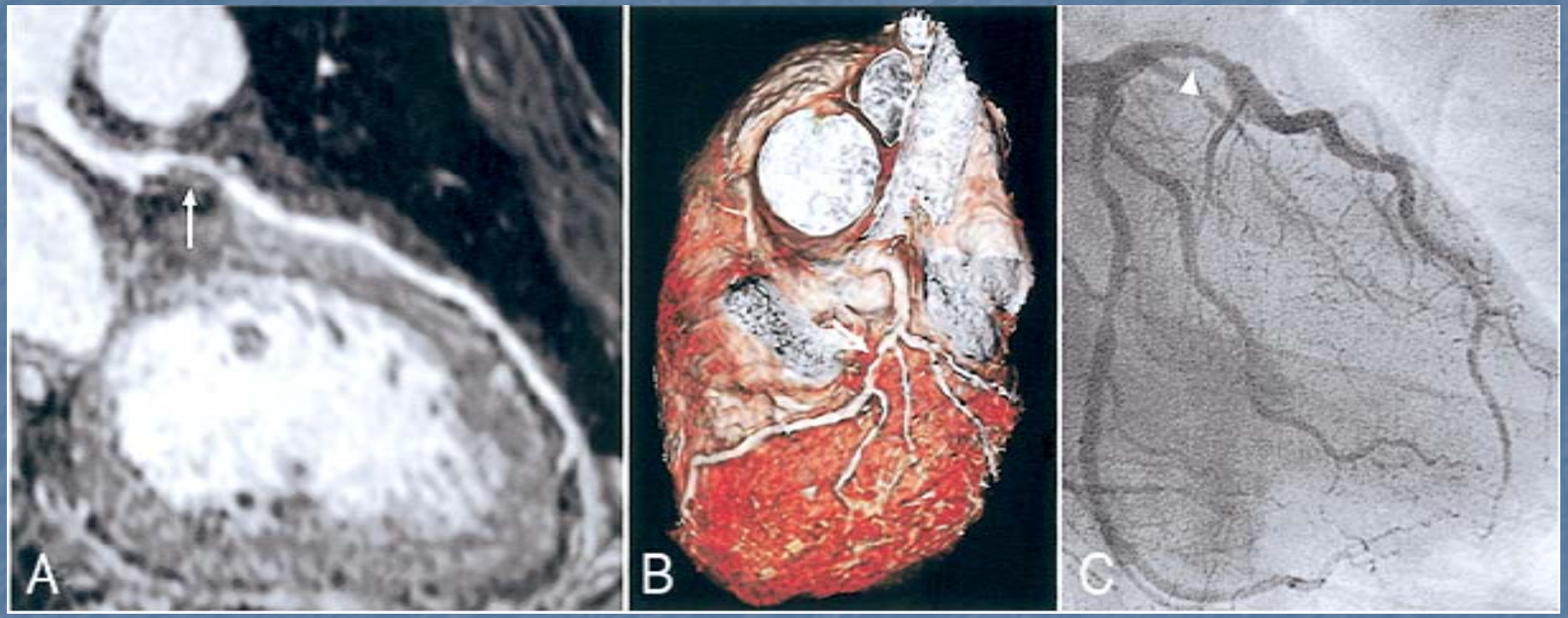
Pharmacological Stress CMR

Male 69 yr, history of MI
Contrast-enhanced delayed perfusion MR





Visualization of a stenosis in the LAD with whole-heart coronary MRA



Diagnostic accuracy in identifying significant CAD

~ 72-75%

J Am Coll Cardiol 2006;48:1946-50.

SUMMARY

- Several hemodynamics and physiologic changes occur during aging process
- Many cardiovascular investigations [Multi-modality investigation] are essential for cardiovascular disease diagnosis, severity & prognosis evaluation