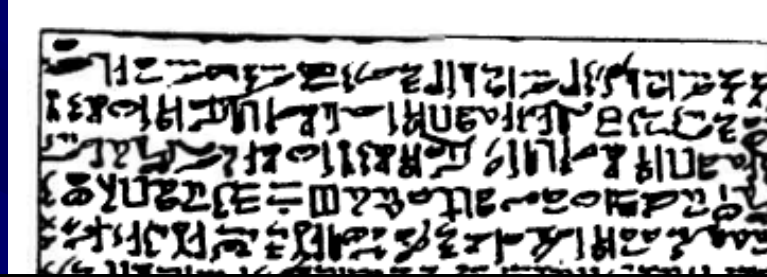


**Non Invasive
Diagnostic Modalities
for Coronary Artery
Disease**

Dr. Amitesh Aggarwal

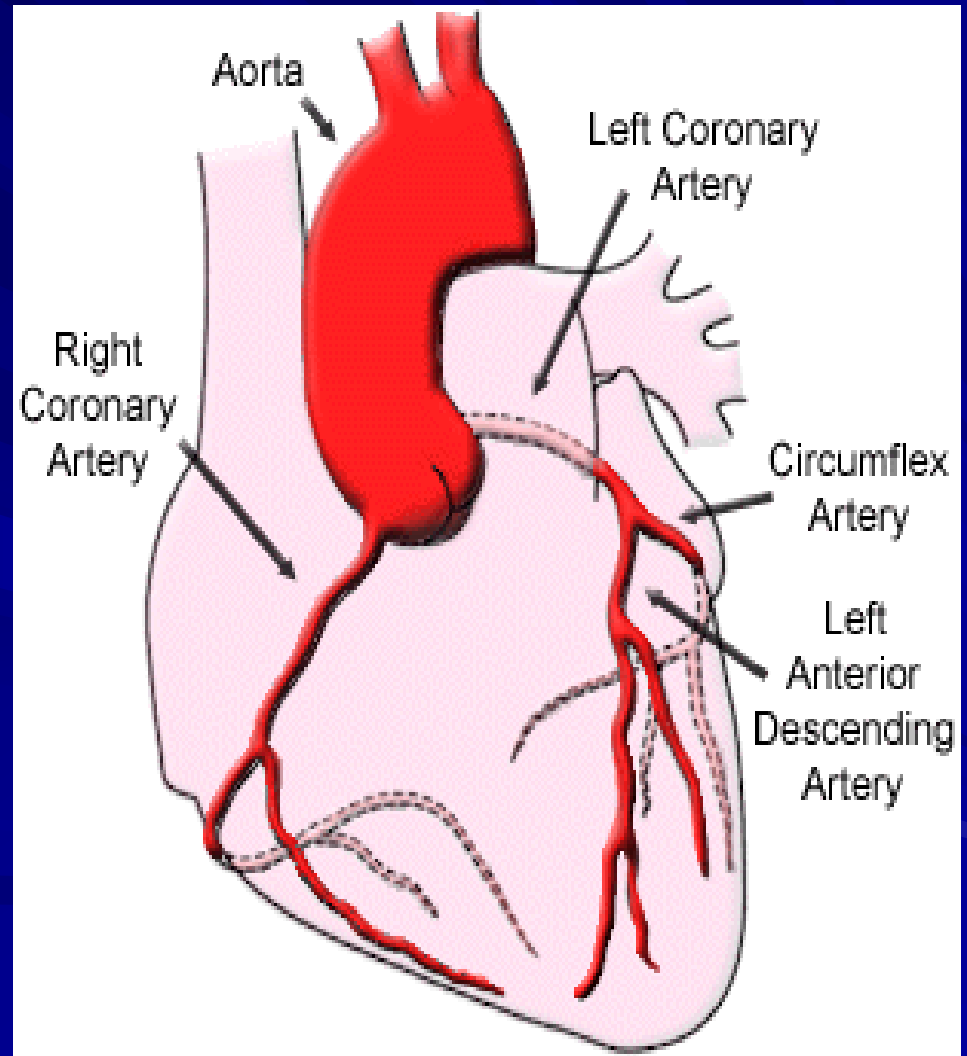
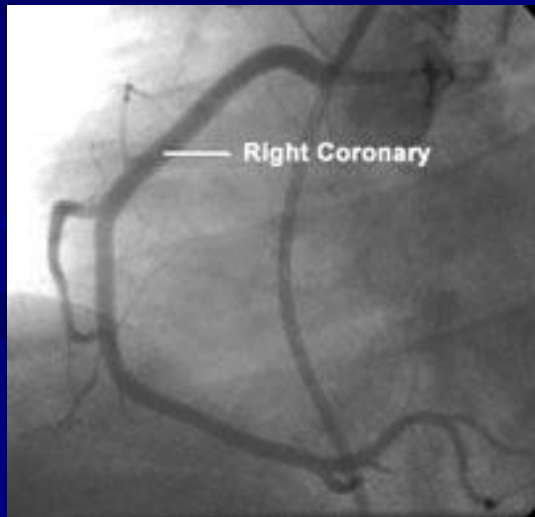
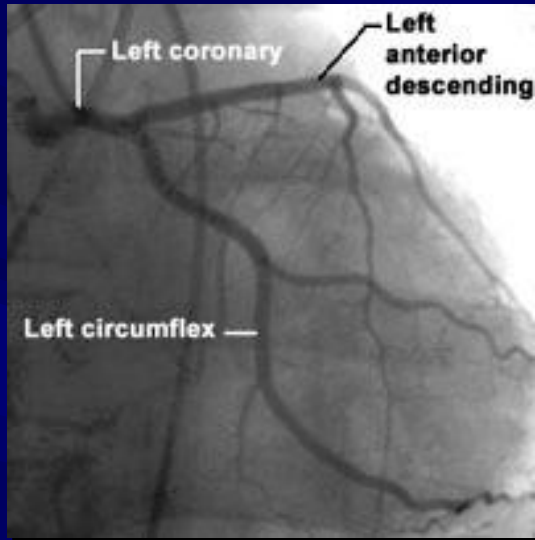
Ebers papyrus, ca. 1555 BCE



“If thou examine a man for illness in his cardia, and he has pains in his arms, in his breasts and on one side of his cardia...it is death threatening him.”



Coronary anatomy



INDICATIONS

- For patients with intermediate risk of CAD
- With contraindications to CAG
- With atypical chest pain and low risk of CAD who might need reassurance about their symptoms

Diagnostic testing is most valuable when the pretest probability of CAD is intermediate

Imaging modalities



Echocardiography/ 3D Echo



Stress Imaging



Myocardial Perfusion Imaging



CT Angiography/ Cardiac CT



MR Angiography/ Cardiac MR



Coronary Calcium Scoring

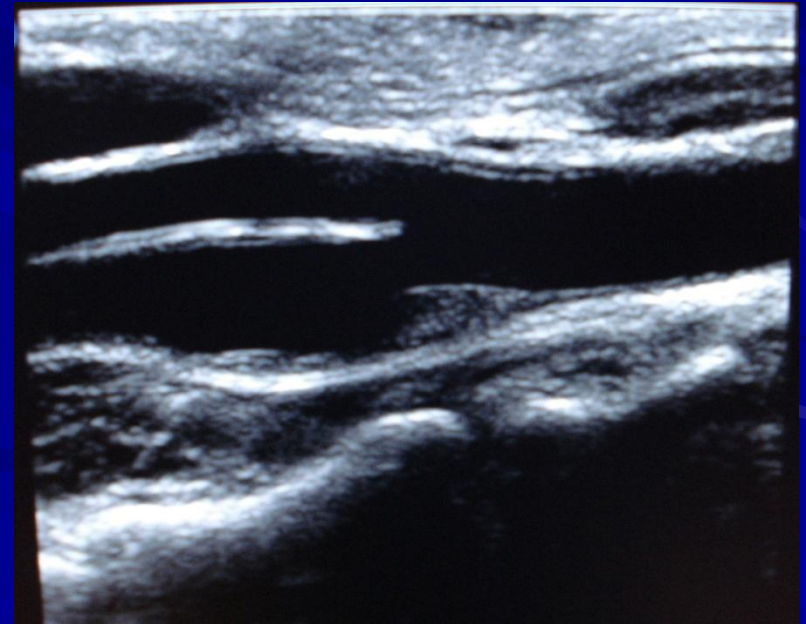
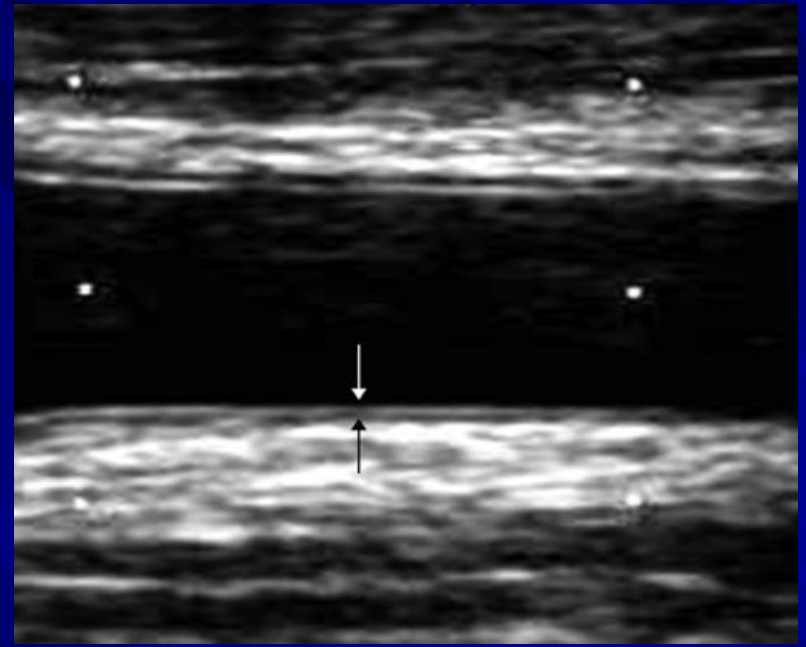
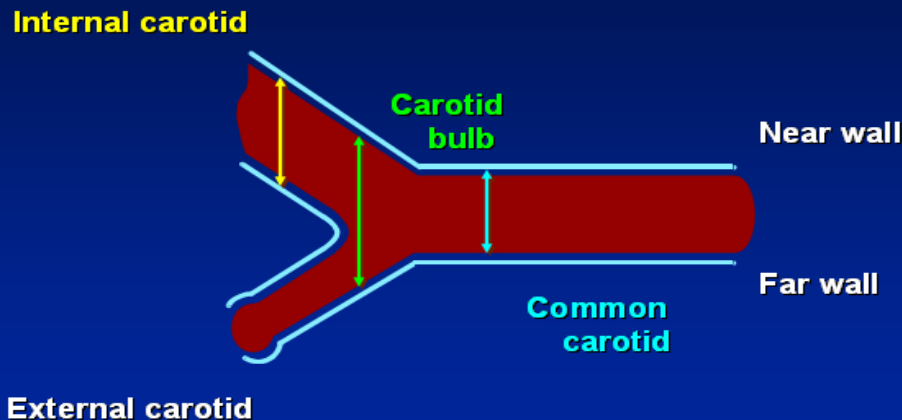


Carotid Intima Media Thickness

CIMT

- Carotid IMT measurement is viable predictor of presence of coronary atherosclerosis and its clinical sequelae

Carotid Artery Segments



Methodology

- Transducer of 5-12 MHz frequency attached to ultrasound machine
- Extra-cranial carotid vessels are scanned from origin of the CCA till the proximal segments of internal and external carotid arteries
- Carotid artery wall is seen as two echogenic lines (intima and adventitia) separated by echolucent zone (media)
- **Carotid plaques**, defined as focal thickening at least 50% greater than the surrounding wall



Definition of Abnormal CIMT

- Relationship between CIMT and cardiovascular risk is a continuous one and no cut-off value is there that clearly separates individuals with high and low risk of adverse cardiovascular events. (0.8-1 mm)

Limitations

- Lack of availability of age and gender specific normal and abnormal values of CIMT
- Not yet been defined how assessment of CIMT affects long-term outcome in patients with or without CVRFs.
- Relative importance of CIMT and carotid plaques is a matter of ongoing debate.

Clinical Applications

Prediction of Cardiovascular Risk

- The risk of MI & Stroke increased in linear fashion with increasing IMT

As a Surrogate Marker of Presence of Disease

Assessment of Response of Therapy

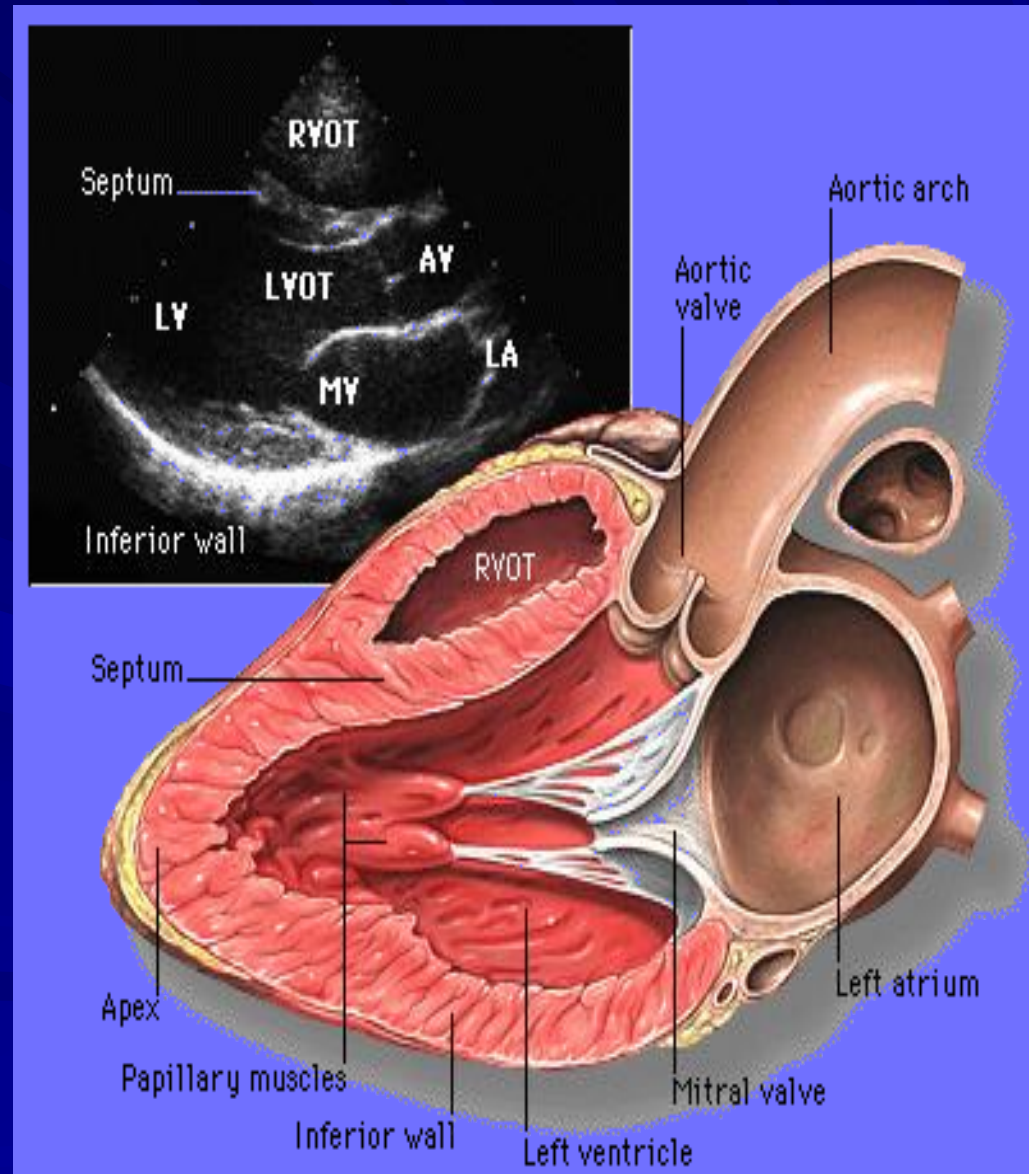
- Clinical trials with lipid lowering therapy, ACE- I, CCB have shown regression of CIMT with the therapy

Carotid IMT or Carotid Plaque?

- Some studies suggest that carotid plaque predicts prevalent CAD better than does IMT, and that CAD risk is largely associated with the presence of plaque rather than IMT.
- Other studies have suggested that IMT rather than localized plaque may be a good marker of the total body atherosclerotic burden and hence a better tool

Echocardiography

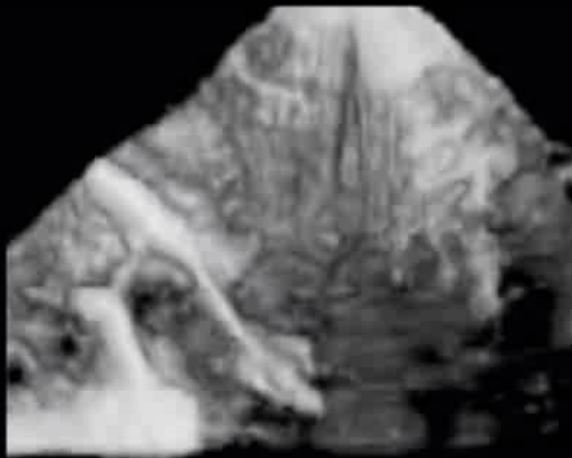
Rest imaging can provide valuable therapeutic guidance and prognostic information in patients especially those with evidence of other forms of heart disease (e.g., hypertensive, valvular)



Parasternal Long-Axis View (PLAX)



3 D Echo



M: 1.0

MODE: 3D
TYPE: Volume
NAME: radical
DATE: 01/01/01
TIME: 10:00

15 MHz



1

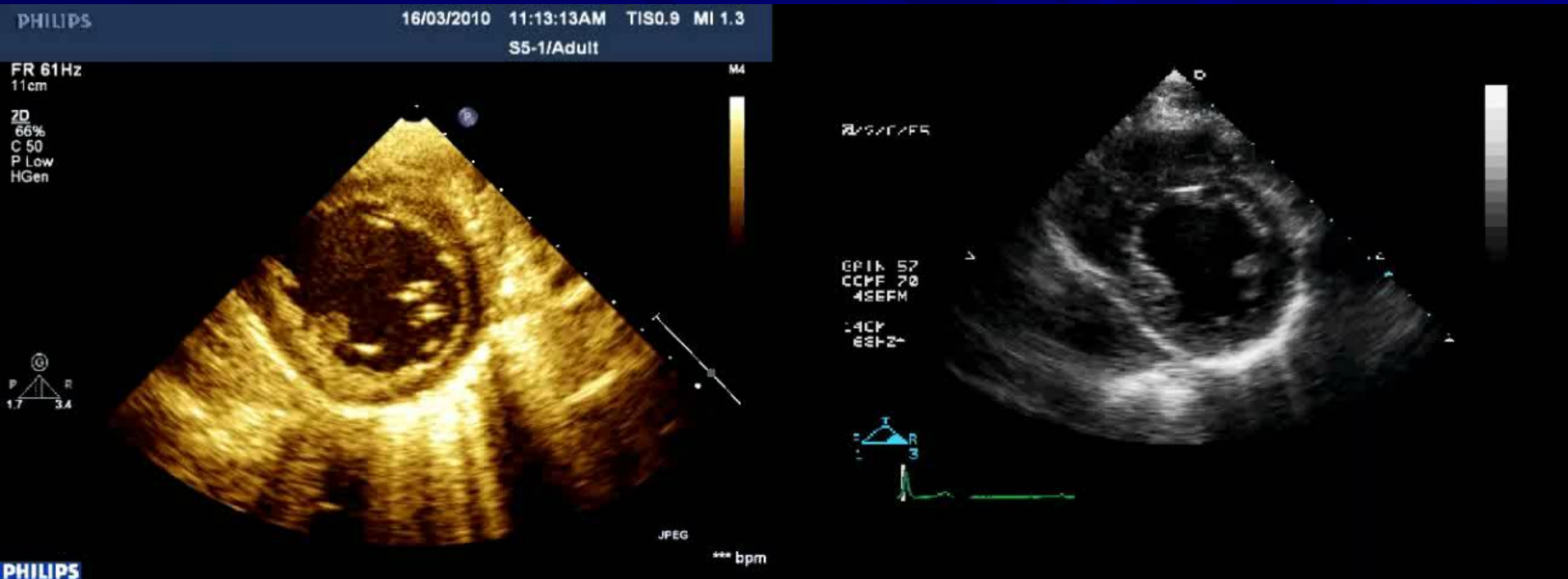


H 1

CAD



CAD



Indications for Stress Testing

- Objective confirmation of ischemia
- Assessing extent of ischemia
- Documenting exercise capacity
- Functional assessment of known CAD
- Determining risk and prognosis
- Determining need for angiography
 - High risk cut points
- Assessing response to treatment
- Indicated in intermediate probability CAD, LBBB, LVH, resting ST changes

Contraindications for stress testing

- Acute MI (within two days)/ UA
- Uncontrolled arrhythmias causing hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic heart failure
- Active endocarditis / myocarditis / pericarditis
- Acute aortic dissection
- Acute pulmonary or systemic embolism

Stress Testing Options

- Exercise stress alone (ECG)
- Exercise stress with nuclear myocardial perfusion imaging (MPI)
- Pharmacologic stress nuclear myocardial perfusion imaging (MPI)
- Exercise stress echo
- Pharmacologic stress echo

Stress Echo

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

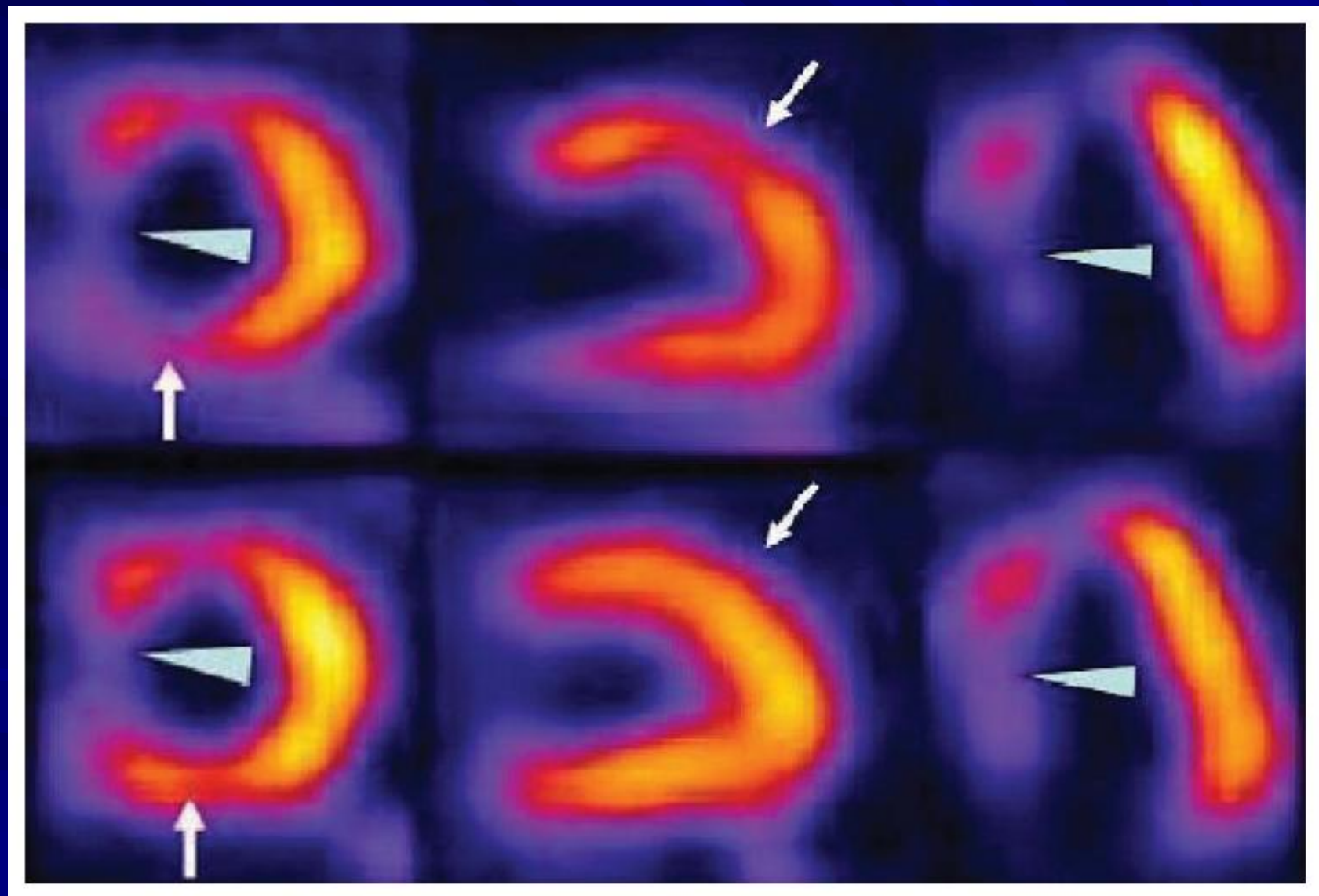
Limitations

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

MYOCARDIAL PERFUSION SCANNING

- Helpful in pt with uninterpretable exercise test
- Accuracy higher than exercise ECG
- Scintiscan of myocardium at rest and during stress after iv radioactive isotopes .
- If Perfusion defect present during stress but not rest -reversible myocardial ischemia
- Persistence perfusion defect during both phase
-previous MI

Patient with reversible perfusion defect in the inferior and anterior wall and an irreversible perfusion defect in the septum



Myocardial Perfusion Imaging

Exercise Stress

- Treadmill
- Bicycle ergometer

Pharmacologic Stress

- Dipyridamole
- Adenosine
- Dobutamine

■ Isotopes

- Thallium 201
- Technetium 99m

■ Sestamibi MIBI

■ Tetrofosmin

– PET

■ Rubidium 82 (flow agent)

■ FDG (viability)



High Risk Indicators

Myocardial Perfusion Imaging

- Increased pulmonary thallium uptake indicating low CO or elevated LVEDP
- Ischemic LV dilatation
- Multiple perfusion defects
- Large perfusion defects

Coronary calcium Scoring

- Calcium is deposited in the coronary arteries only as a result of vascular injury with consequent development of atherosclerosis and not through any other mechanism
- Presence of calcium is considered pathognomonic of atherosclerosis
- Once deposited within plaques, it stabilizes them and thereby decreases vulnerability of plaques to rupture
- People who have calcified plaque also have a large number of non-calcified plaques prone to rupture
- Presence of soft plaques increases the risk of acute coronary events and not presence of calcified plaques
- Calcified plaques serve as a marker of increased risk and not as the underlying cause.

Technique

- CCS is performed using specialized CT scanners.
 - Electron beam CT (EBCT)
 - Multi-detector CT (MDCT)
- EBCT utilizes electromagnetically rotated electron beams for scanning
- MDCT utilizes the traditional X-ray beam for imaging
- Minimum slice thickness EBCT - 1.5 mm, MDCT - 0.5 mm
- Owing to the longer acquisition time, need to control heart rate is greater with MDCT (<65 bpm) compared to EBCT (<110 bpm)

- Quantification of coronary calcium burden
 - Conventional Agatston system
 - Volume score method

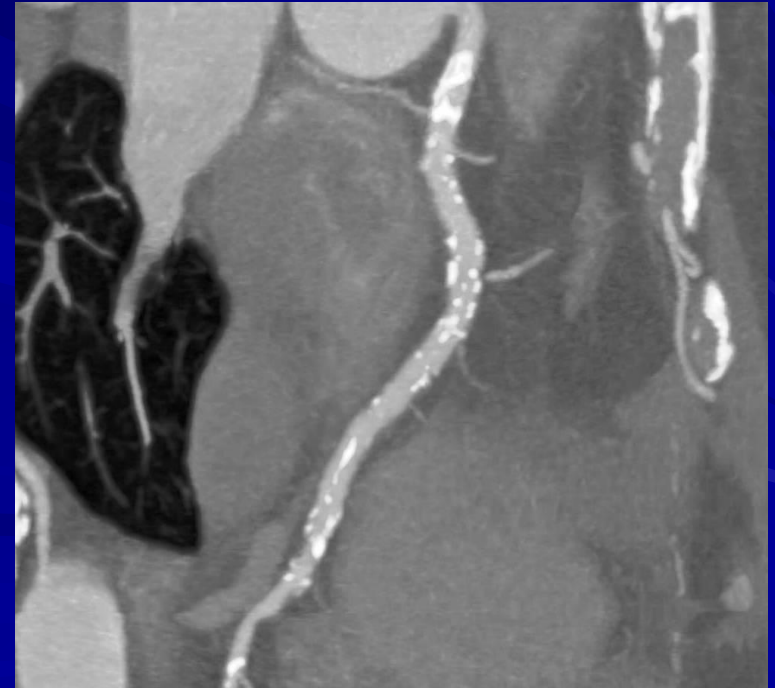
1. Threshold CT density > 130 HU for pixel areas $> 1\text{mm}$

2. Score each **region of interest** by multiplying the **density score** and the area

3. Total coronary calcium score determined by adding up each lesion score for all sequential slices

	1	2	3	4
Hounsfield units	131–199	200–299	300–399	400

Significant Coronary Artery Calcium (Score >400)



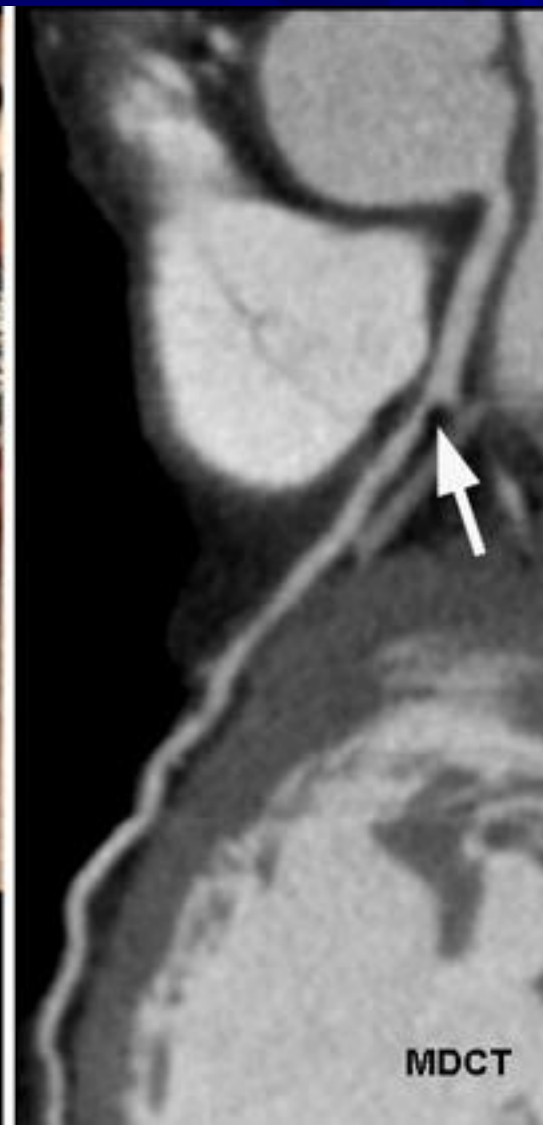
Clinical Implications

- **Prediction of CV Risk**
- RR of CVD death or MI over 3-5 years' follow-up was 4.3 with any measurable calcium compared to zero CCS
- Further refine the CV risk in patients who belong to the intermediate risk group based on the Framingham score
- **Assessment of Symptomatic Patients**
- Although a high CCS predicts presence of significant CAD on angiography, it is not site-specific
- **Limitations**
- 6-11% may have only noncalcified plaque, which would be missed on coronary calcium scoring
- High sensitivity, low specificity

CT Angiography

- Assessment of symptomatic patients for the assessment of obstructive disease
- Can assess ventricular function and perfusion
- Visualizing coronary arteries
- Allows for the noninvasive visualization of anatomic CAD with high resolution images similar to invasive CAG

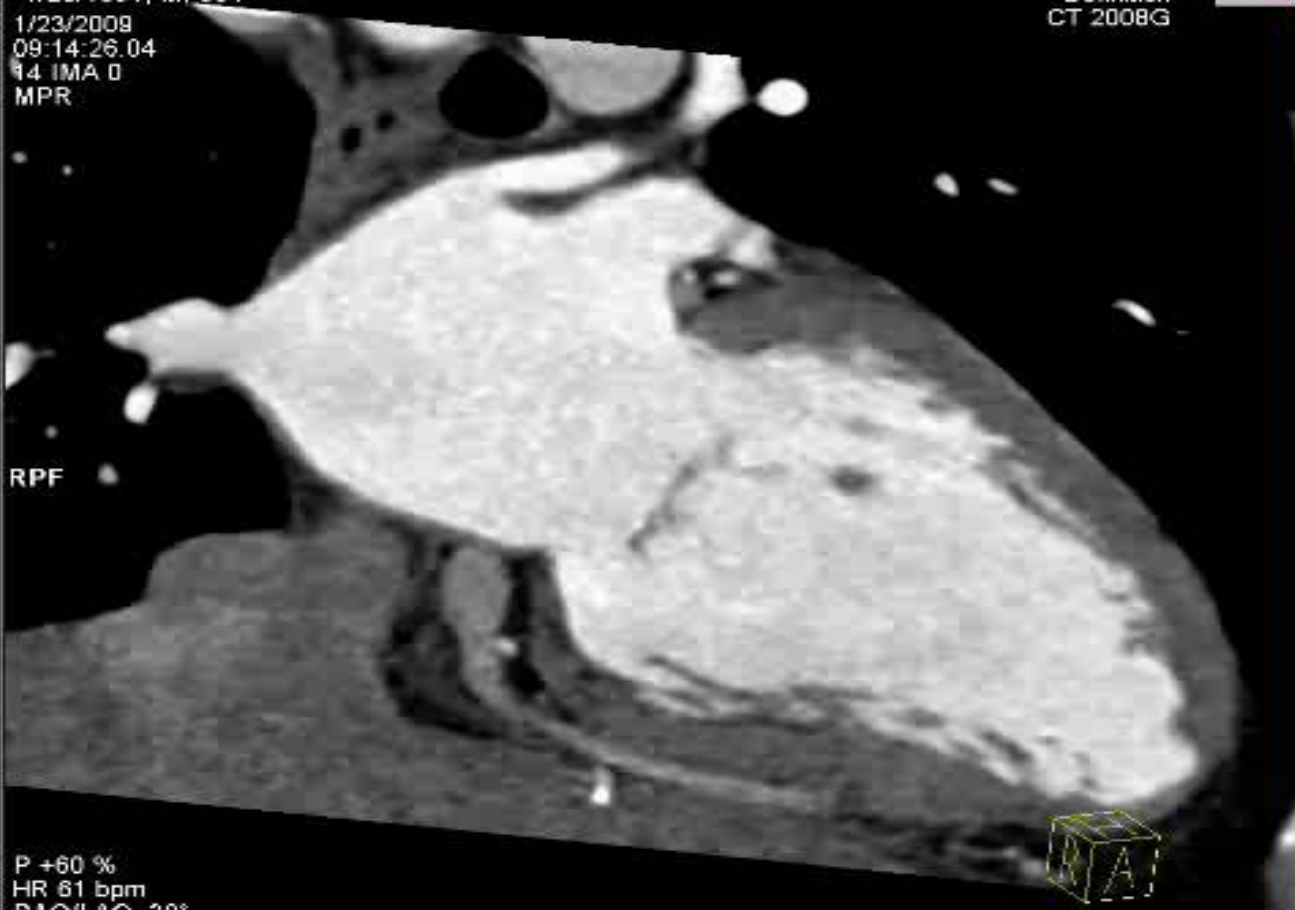
CT Angiography



CTA

RAO. M R. 55/M
250/01/09
*1/23/1954, M, 55Y
1/23/2009
09:14:26.04
14 IMA 0
MPR

HPL CARE HOSPITAL, Banjara Hills, HYD
Ref.: DR. B. SOMA RAJU
Definition
CT 2008G

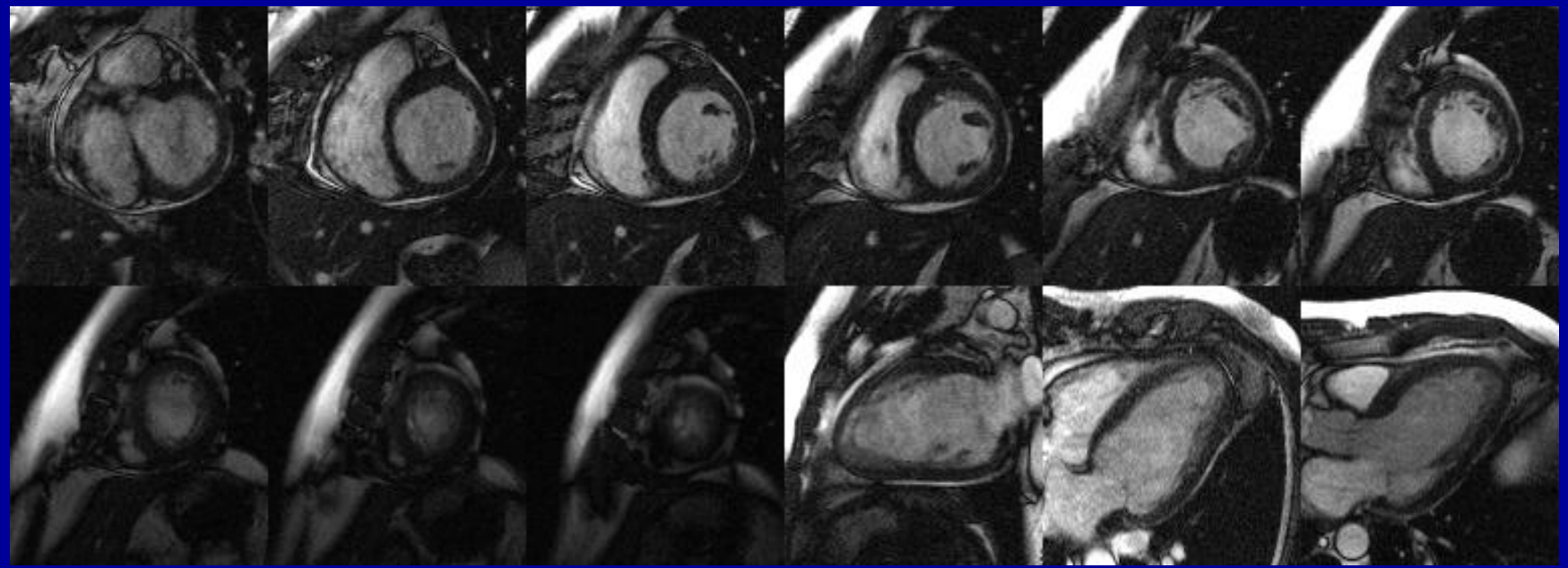
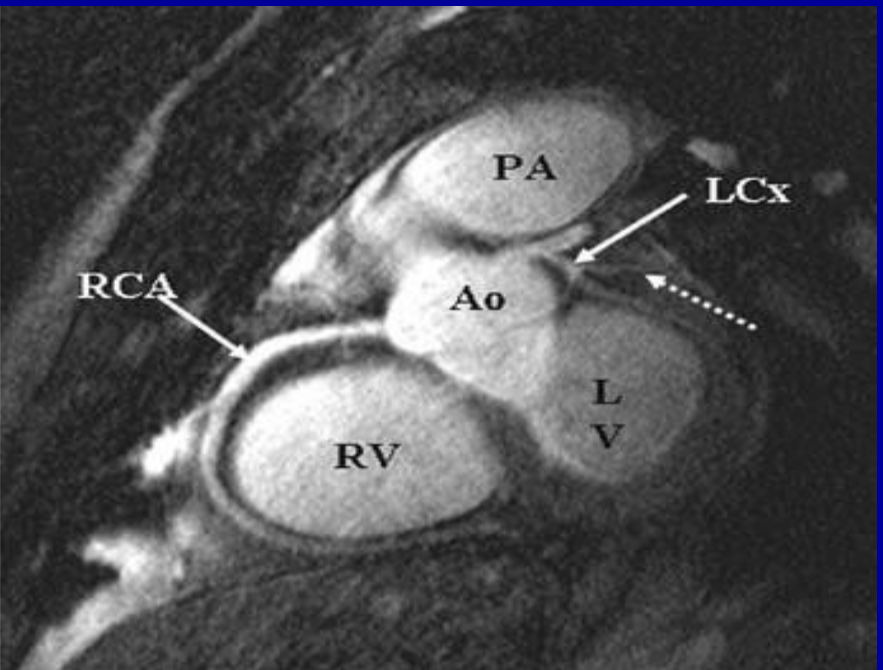
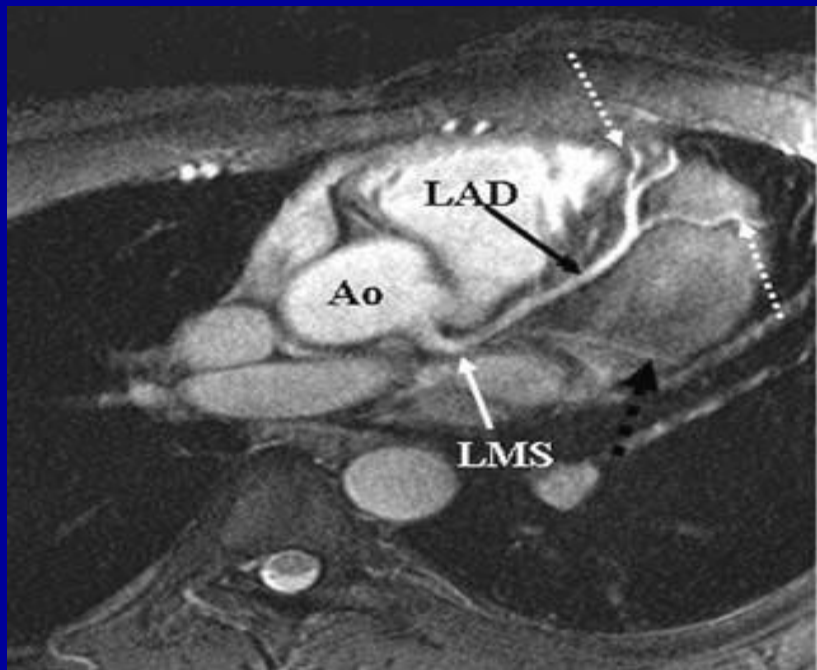


P +60 %
HR 61 bpm
RAO/LAO 30°
CRAN/CAUD 26°
M 512x512
SL 0.75

CT:-761 W 600
C 200

MRA

- Assessment of Ventricular volumes, mass, function
- Assessment of myocardial infarction and viability
- Stress ventriculography
- Coronary angiography and flow
- Identification of plaque components
- Non-invasive and no radiation
- Not useful for screening purpose



Risks

- Drug specific adverse events (dobutamine: ventricular arrhythmias; dipyridamole/adenosine: bronchospasm).
- Nuclear perfusion imaging and CCTA, CAG – ionizing radiation
- CCTA - Use of contrast agents can cause allergic reactions
- Contrast agents also can affect renal function in CKD
- Gadolinium contrast agents (nephrogenic systemic fibrosis)
- CMR might be contraindicated in patients with claustrophobia or implanted devices

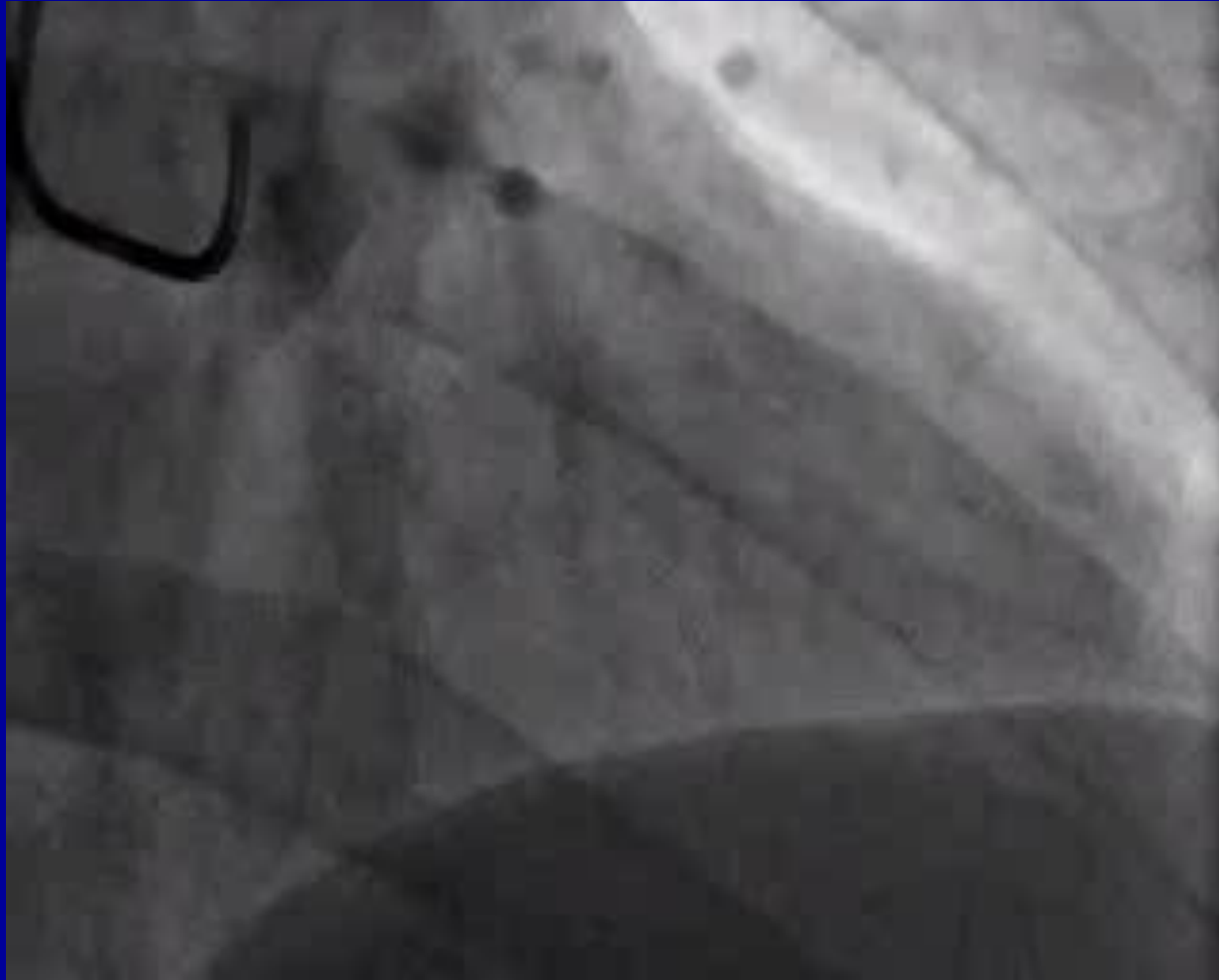
Coronary angiography

- Gold standard for CAD diagnosis
- Indicated in patients with chest pain and high risk of CAD
- Benefits :
 - Visualize arteries anatomically, presence and severity of coronary luminal obstruction
 - Combine diagnosis and treatment in one step
- Disadvantages :
 - Invasive, bleeding at access site, injury to coronary artery
 - inability to perform functional assessment
 - interobserver reliability
 - does not distinguish between vulnerable & stable plaque

CAG

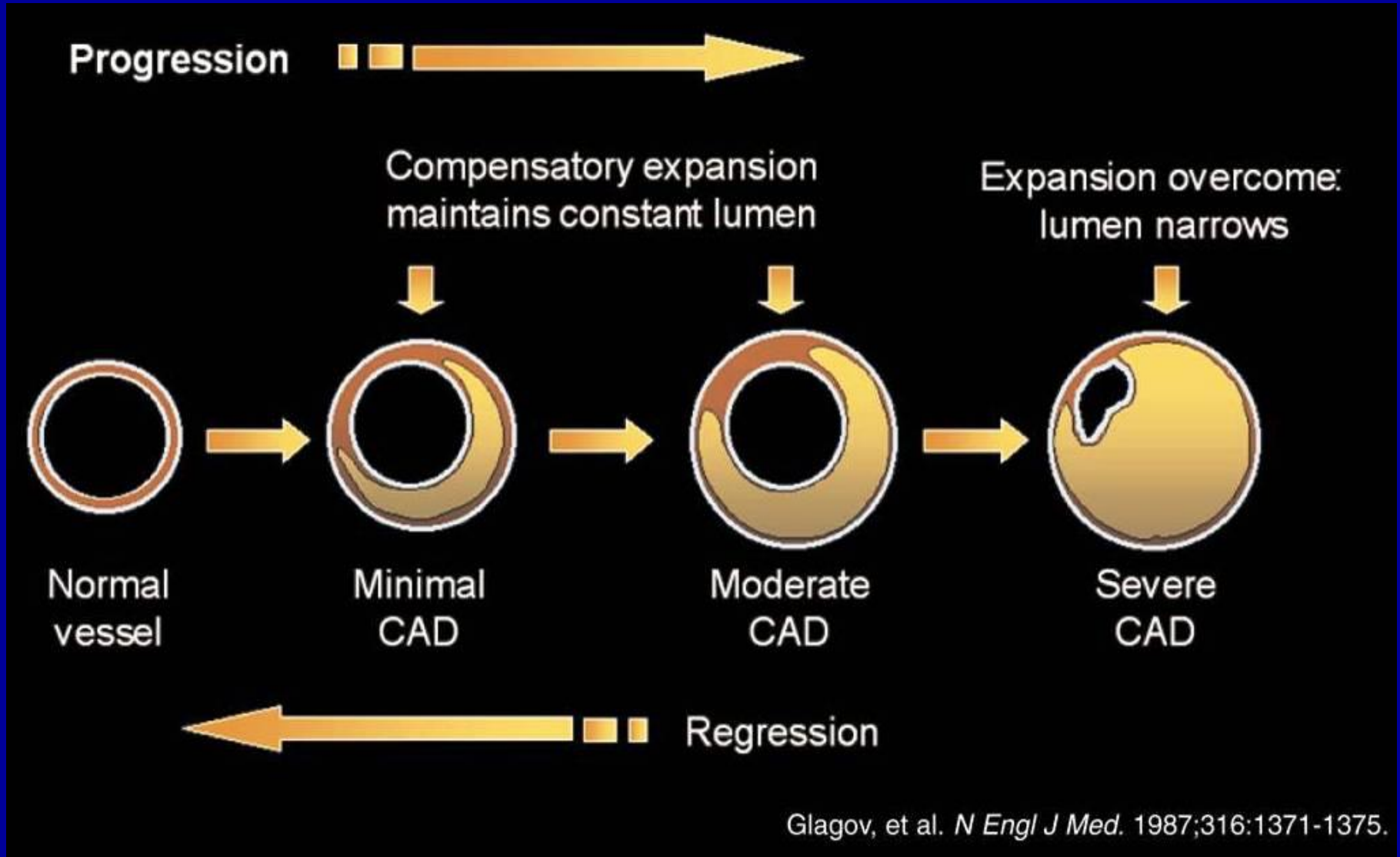
- ❑ Extent of disease is defined as 1-vessel, 2-vessel, 3-vessel, or left main disease, with a significant stenosis $>$ 70% diameter reduction.
- ❑ Left main disease has been defined as a stenosis $>$ 50%.

Coronary angiography

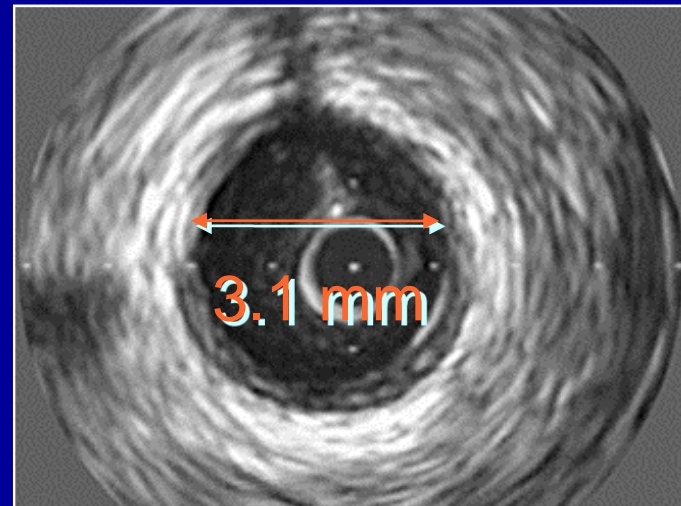
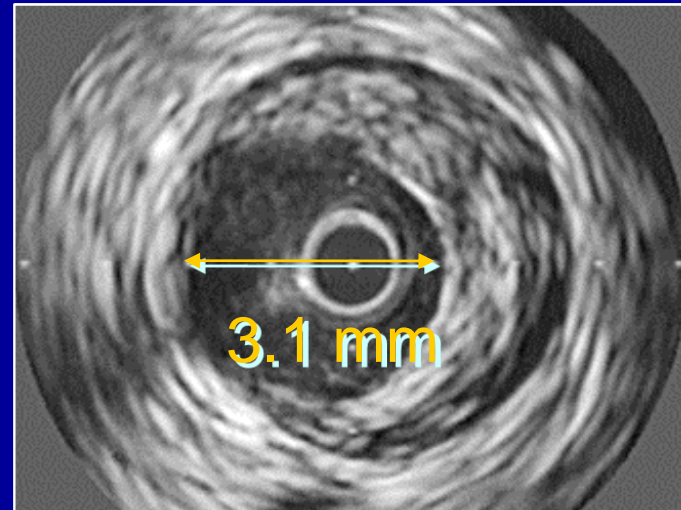
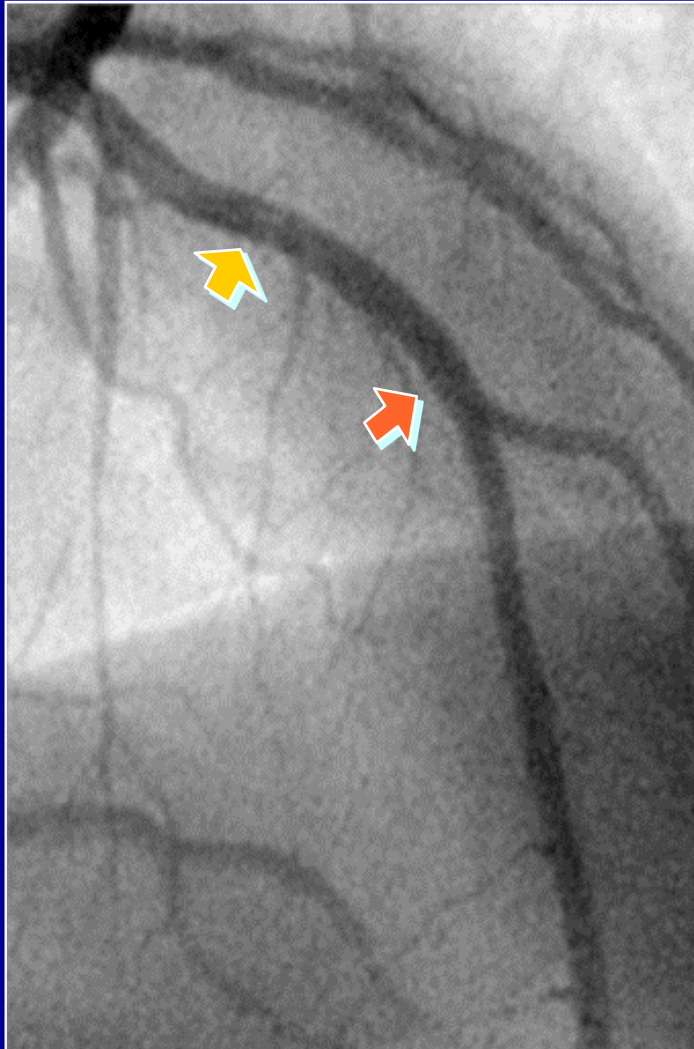


Presence of dynamic coronary vascular lesions, spasm or thrombosis

Plaque remodeling



Angiography Fails to Depict Coronary Arterial Remodeling



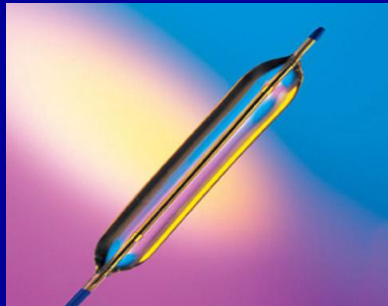
PCI/ PTCA



Guiding catheters



Guidewires



Angioplasty balloon



Stent on balloon

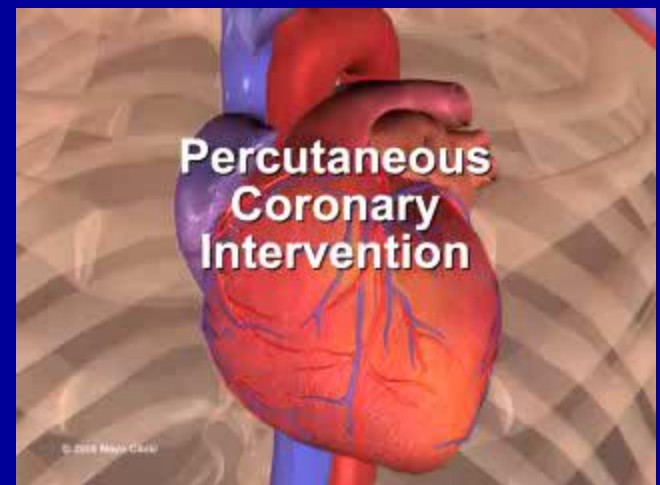
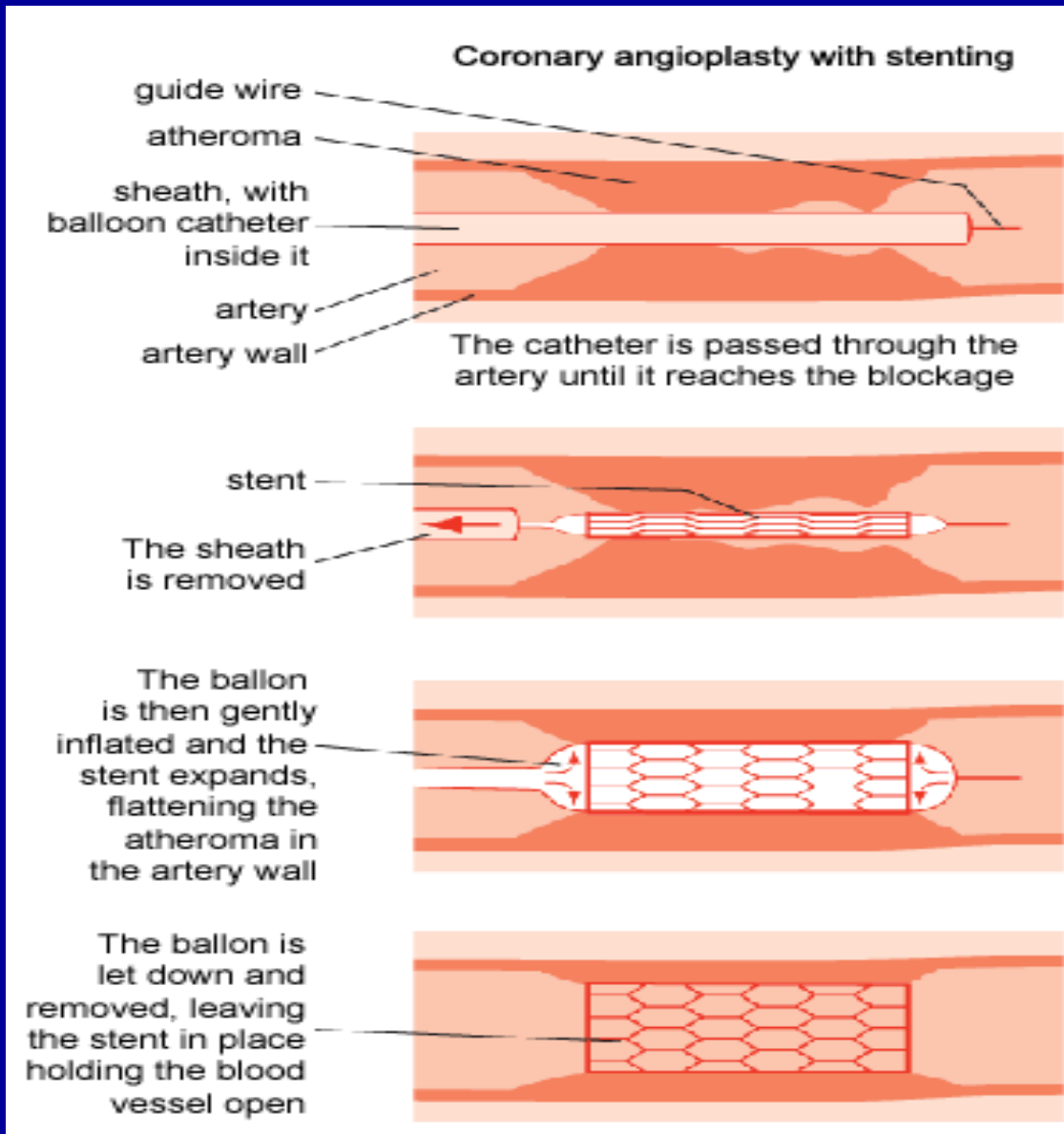
Deployed stent



Percutaneous Coronary Interventions

- Balloons 10%
- Stents 80%
- Atherectomy 10%
- AngioJet suction device

Technique



PCI

- ❑ As an alternative to thrombolytic therapy
- ❑ C/I to thrombolytic therapy
- ❑ Recurrent infarction or ischemia
- ❑ Cardiogenic shock or hemodynamic instability
- ❑ Angioplasty of the infarct-related artery stenosis within 48 hr following successful thrombolytic therapy
- ❑ LVEF<0.4, CHF, serious ventricular arrhythmias
- ❑ All patients after a non-Q-wave MI

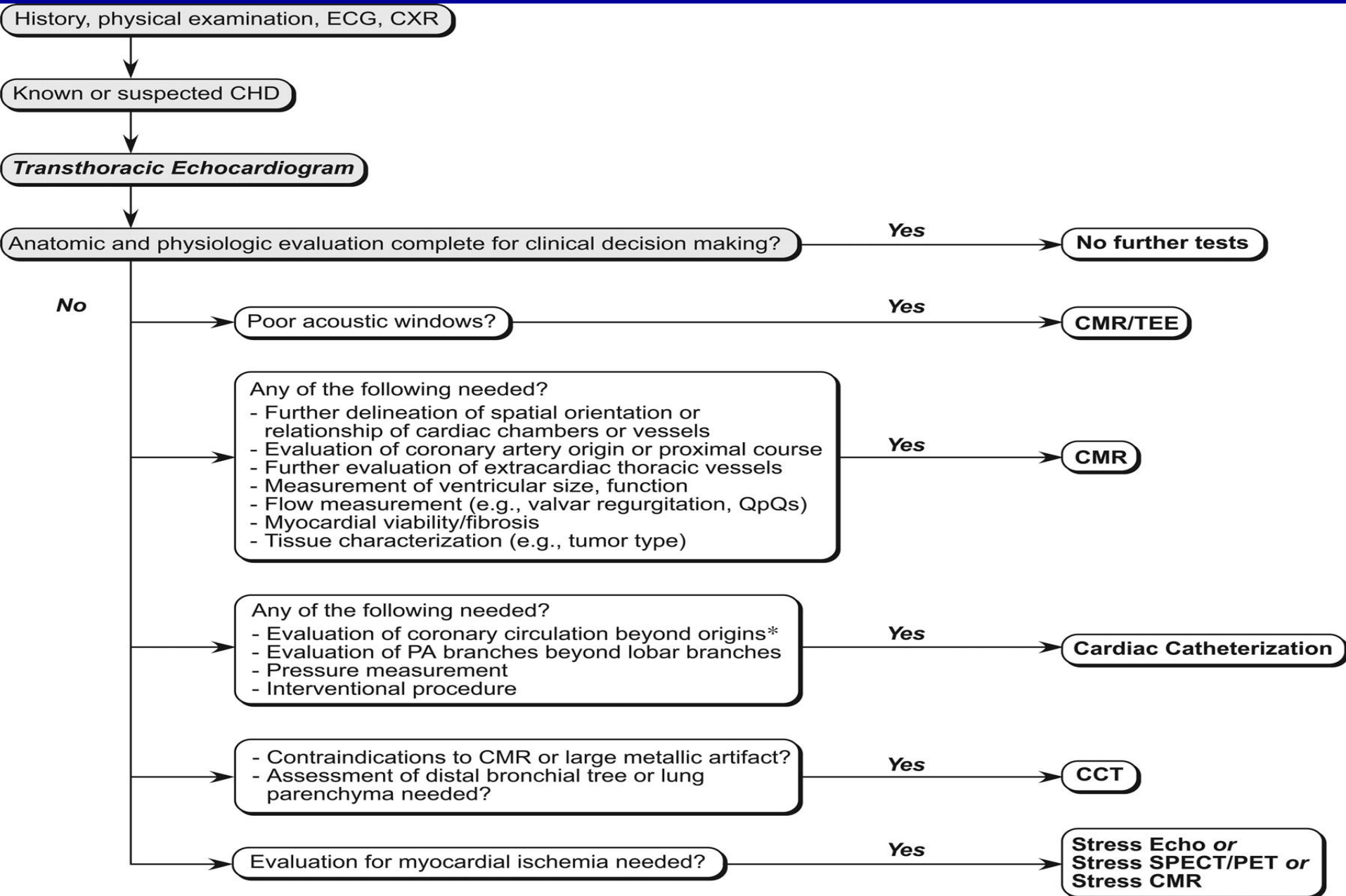
Sensitivity and Specificity of Noninvasive Tests

Diagnostic Test	Sensitivity	Specificity
MPI	88 (73-98)	77 (53-96)
Stress echo	76 (40-100)	88 (80-95)
CMR	83	86
CCTA	93-97	80-90
CCS	85	75

Conclusions

Diagnostic accuracy of detecting CAD with anginal chest pain but with no known CAD appeared to be better (in descending order) for CCTA, MPI, ECHO, CMR, ECG.

General diagnostic algorithm for the evaluation of patients with known or suspected CHD.



*Can also be imaged by CCT in selected patients.

Thank you



Access this powerpoint at

<http://dramiteshaggarwal.yolasite.com>