# MY PATIENT NEEDS AN ECHOCARDIOGRAM

Monique Scally DO
COASTAL CARDIOLOGY

# OUTLINE

- How an echo is performed
- Indications: appropriateness criteria
- Limitations/artifact
- The study: chamber size, function, valves etc…

# How an echo is performed

- Disrobe from waist up
- 3 ECG leads placed
- Lateral recombinant and supine
- Gel and a ultrasound probe
- Sound waves

# Appropriateness criteria

- Symptoms potentially due suspected cardiac etiology
- Prior testing that is concerning for heart disease
- Adult congenital heart disease
- Arrhythmias
- LV function
- Pulmonary hypertension
- Hypotension or hemodynamic instability
- AMI/CP; complication of MI
- Evaluation of respiratory failure with suspected cardiac etiology
- Evaluation of a patient with PE to guide therapy

# Appropriateness criteria

- Murmur; suspected structural heart disease
- MVP
- Native valvular stenosis; initial evaluation
  - Yearly evaluation for severe AS
  - Re-evaluation of a patient who have had change in clinical status
- Native valvular regurgitation
  - Yearly evaluation for severe MR
  - Re-evaluation of patient who have had change in clinical status
- Prosthetic valve
  - baseline after placement
  - Suspected dysfunction; thrombus or change in clinical status
- Suspected endocarditis; fever; blood cultures +; new murmur

# Appropriateness criteria

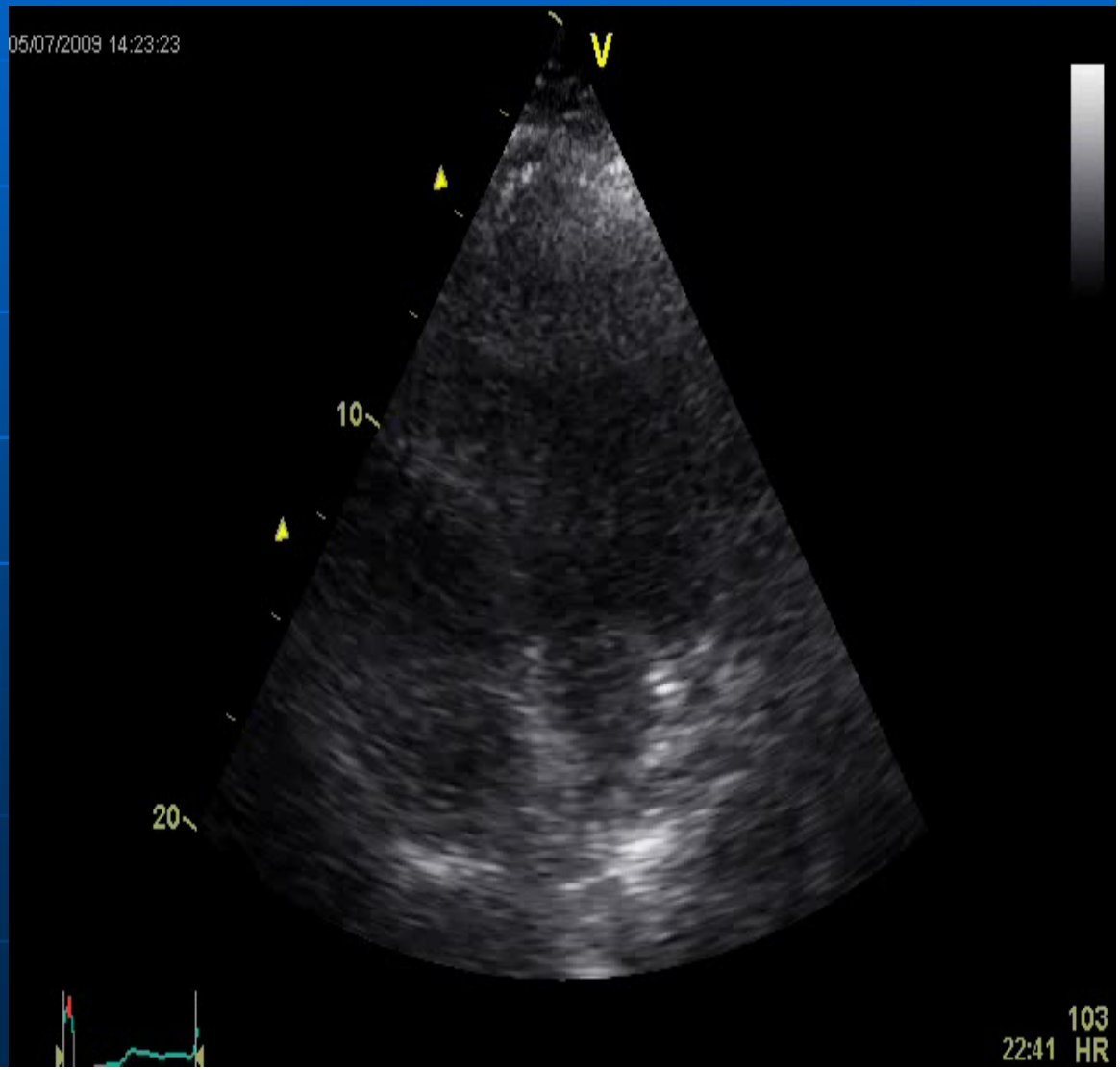
- Evaluation for cardiovascular source of embolic event
  - PFO/ASD; thrombus; neoplasm
- Evaluation of cardiac mass
  - Suspected tumor or thrombus
- Evaluation of pericardial conditions
  - Effusion/tamponade, pericarditis; effusive-constrictive, constriction(post surgery)
- Known or suspected Marfan disease
- Therapy with cardiotoxic agents; baseline and serial re-evaluation

# Appropriateness criteria

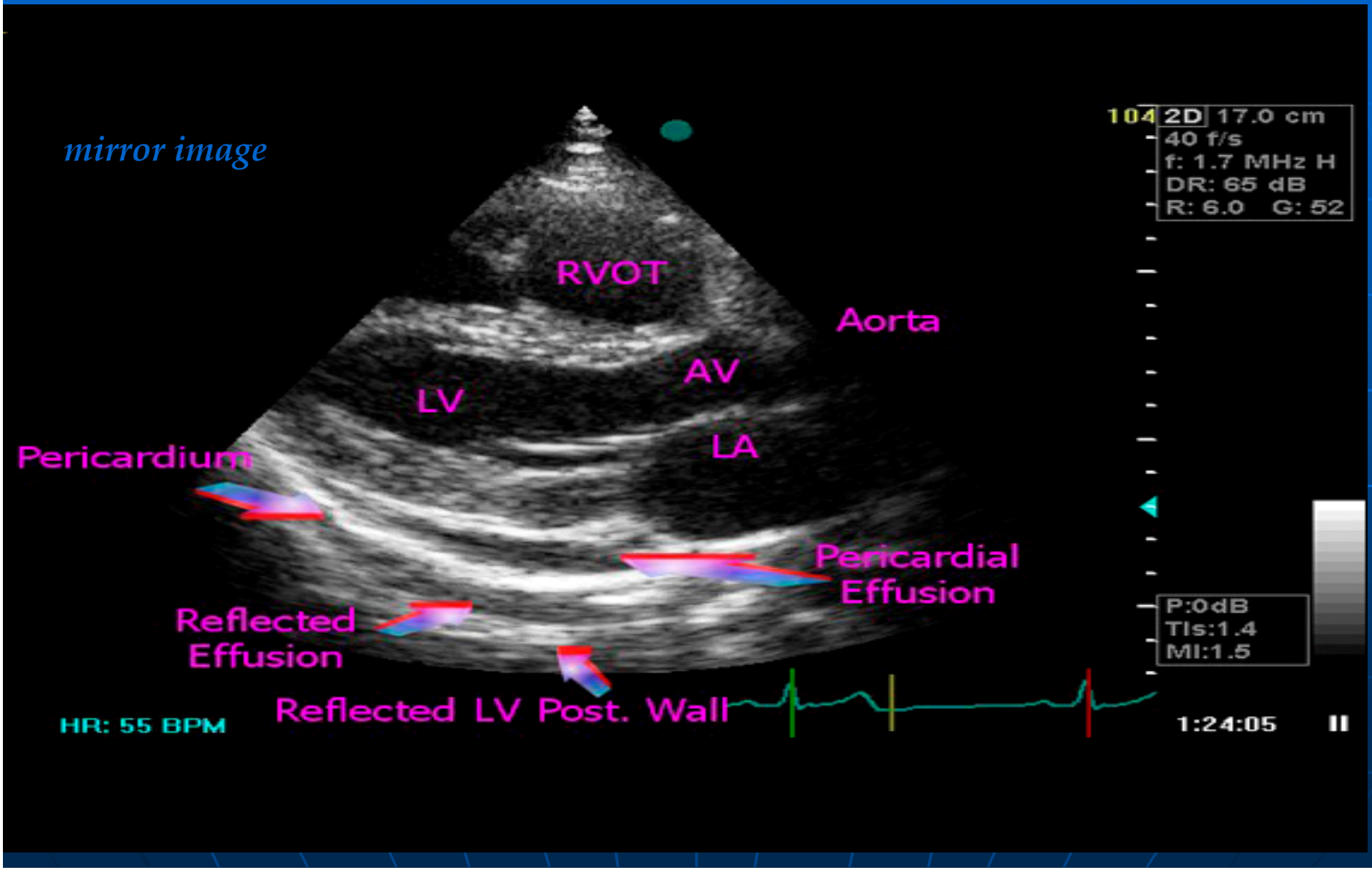
- Initial evaluation of suspected hypertensive heart disease
- Initial evaluation of known or suspected heart failure (systolic or diastolic)
  - Re-evaluation of known heart failure to guide therapy in a patient with a change in clinical status
- Evaluation of dyssyncrony in a patient considered for CRT
  - optimization
- Initial evaluation of known or suspected hypertrophic cardiomyopathy
  - Re-evaluation of known HCM in a patient with change in clinical status
- Evaluation of suspected restrictive, infiltrative, or genetic cardiomyopathy
  - Screening study for structure and function

# Limitations/artifact

- Obesity
- Rib space
- Previous surgery
- COPD



# Limitations/artifact



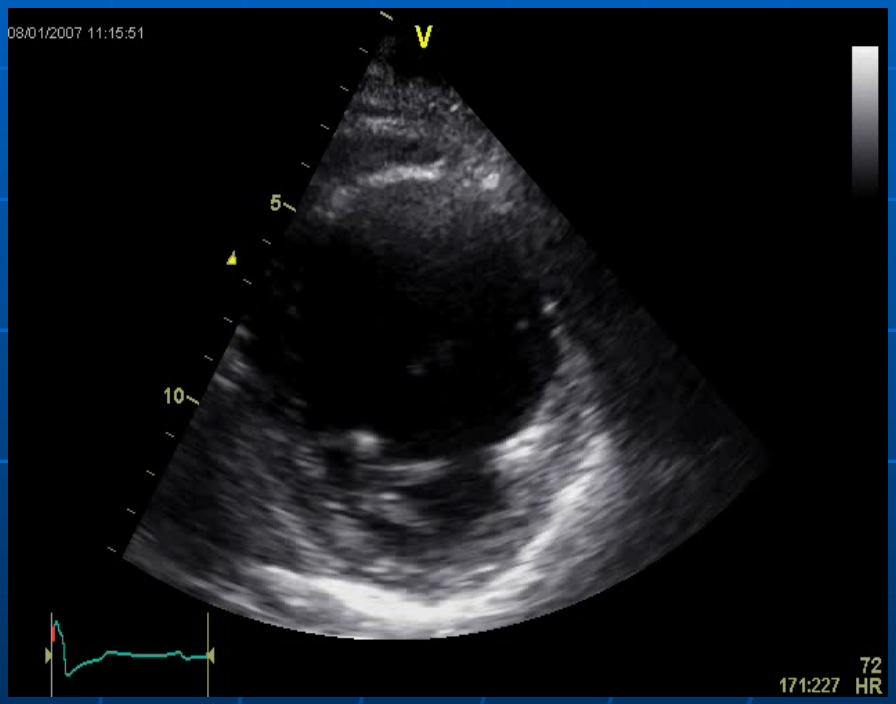
# The Study

- LV and RV size and function (systolic and diastolic)
  - Cardiomyopathies: ischemic; non-ischemic; HCM; infiltrative; noncompaction
- LA and RA size and structures
- Intra-atrial septum
- Valves; regurgitation; stenosis, endocarditis,
- Pulmonary hypertension
- Aorta
- pericardium

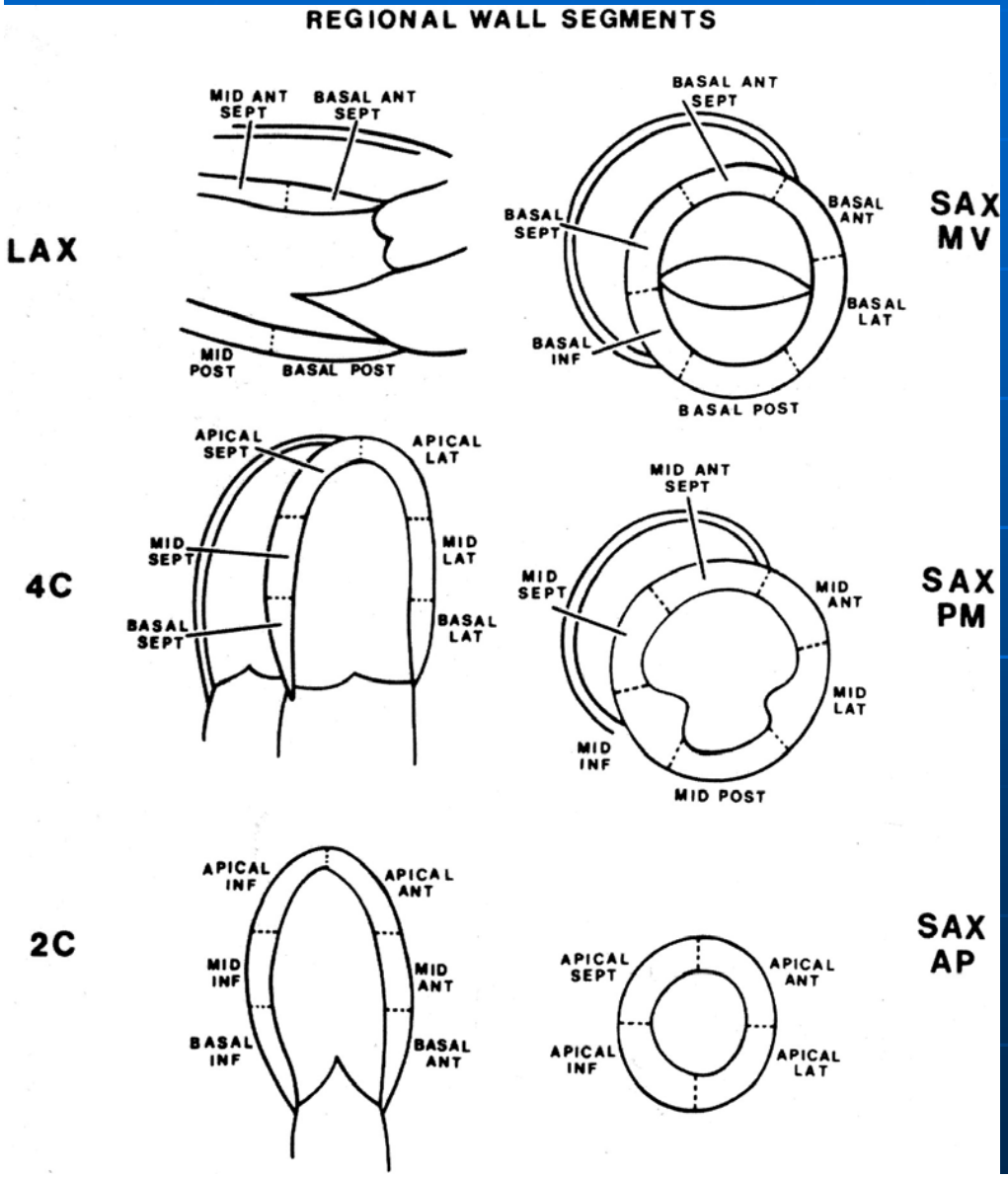
# LV Chamber size

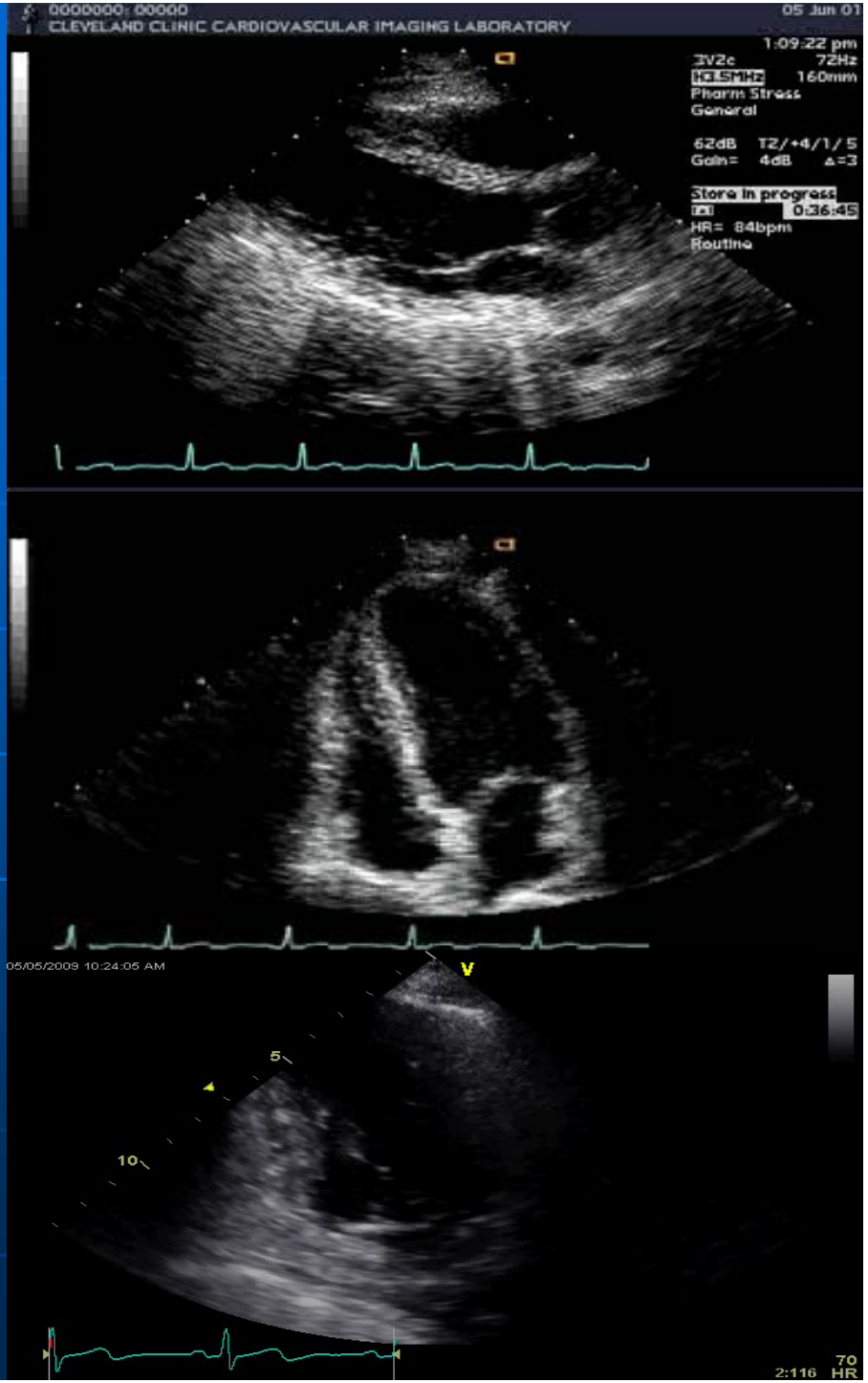
***End diastolic size measured by m-mode or 2 D echo:***

***> 5.6 mm is enlarged***

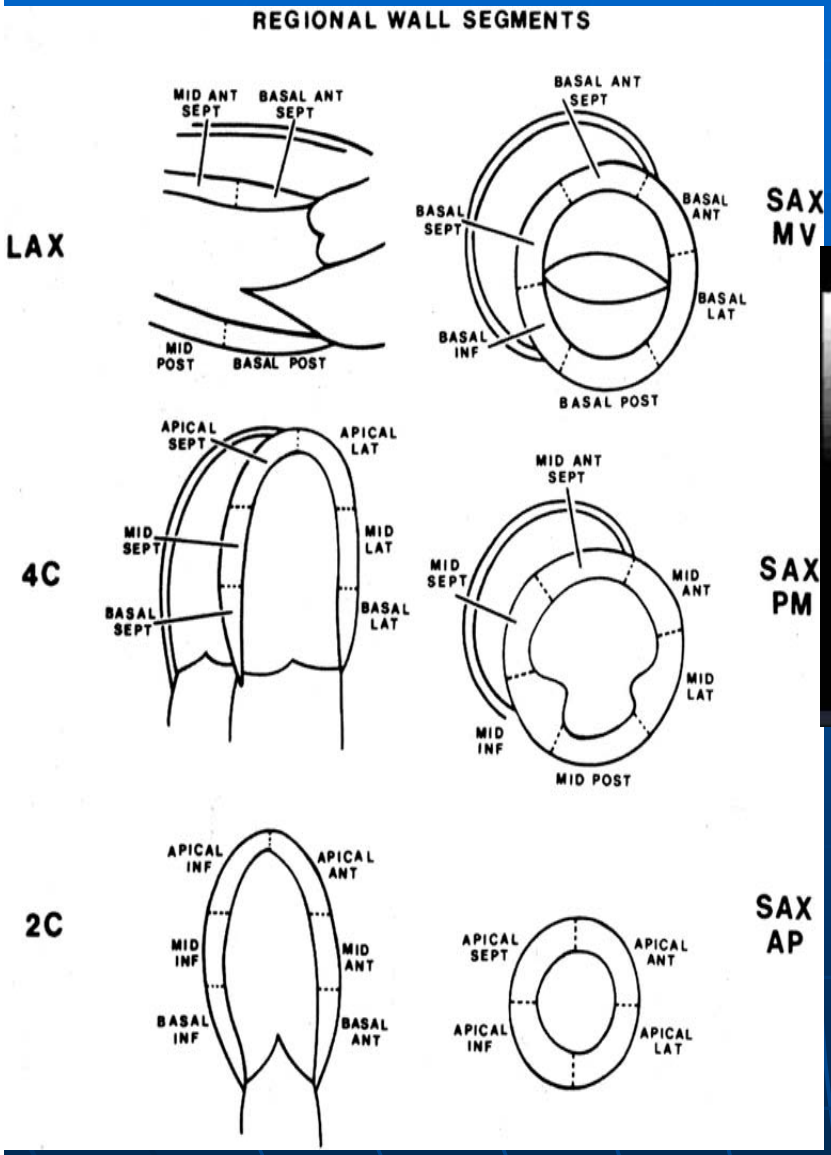


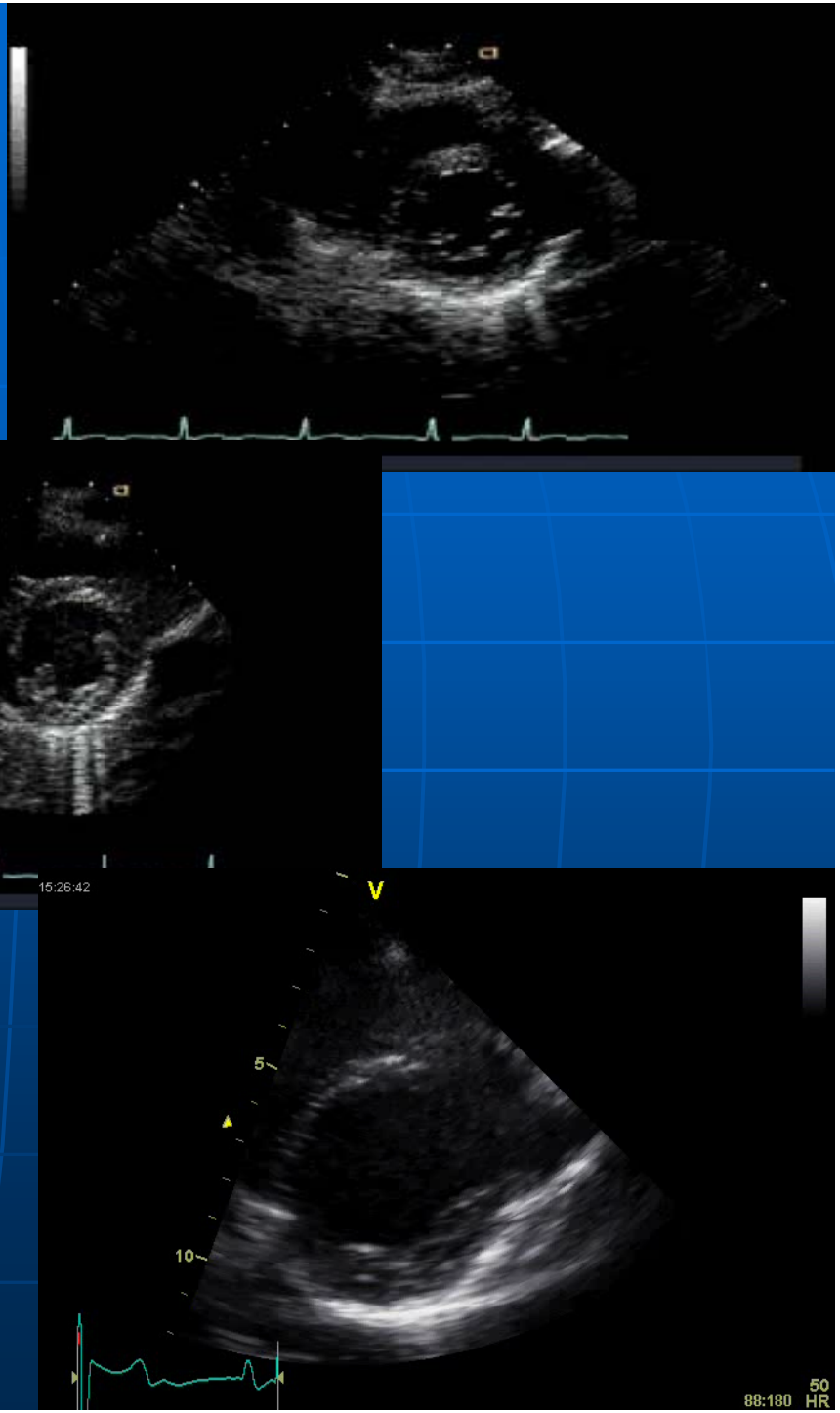
# LVEF: Visual estimation



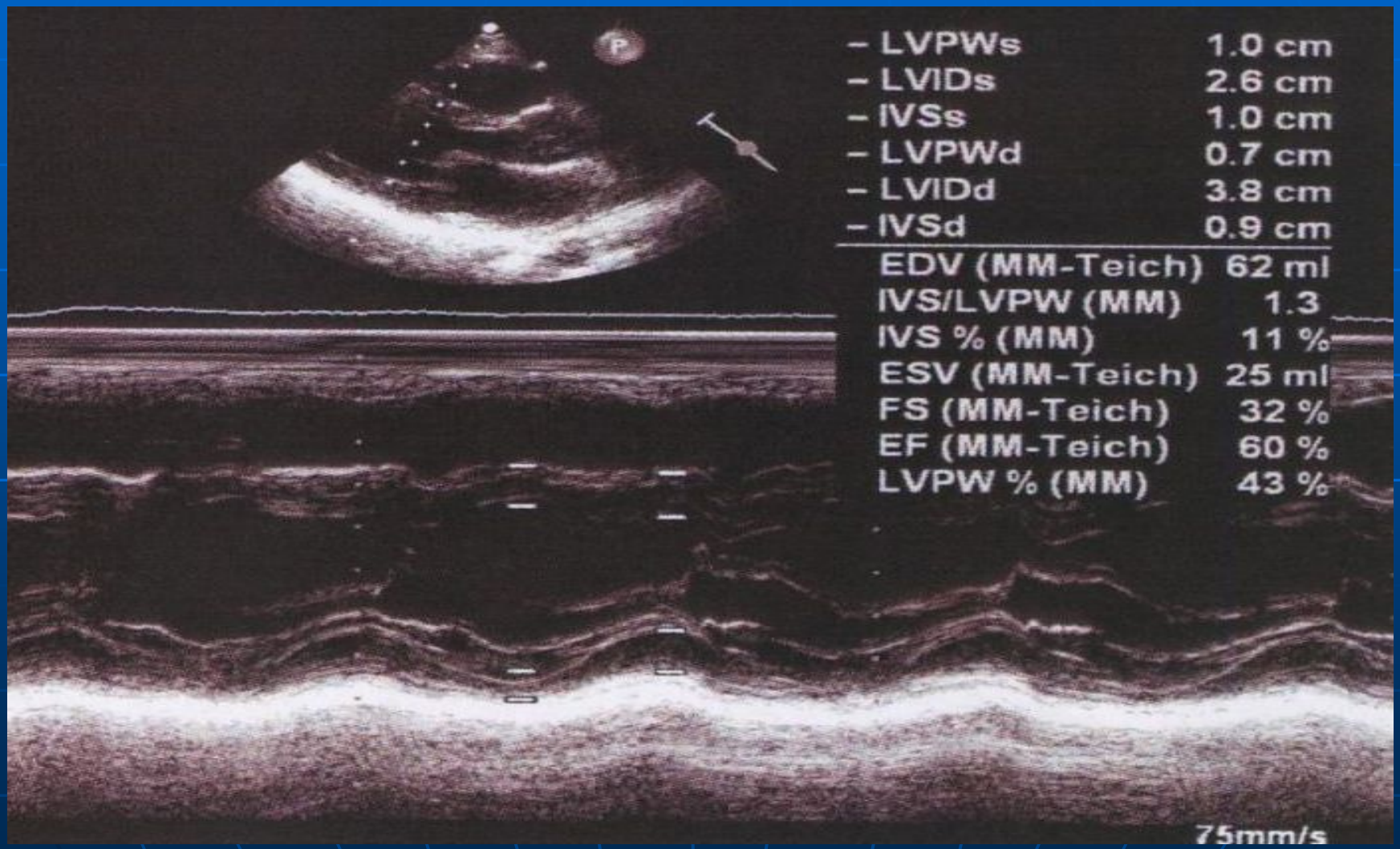



# LVEF Visual estimation

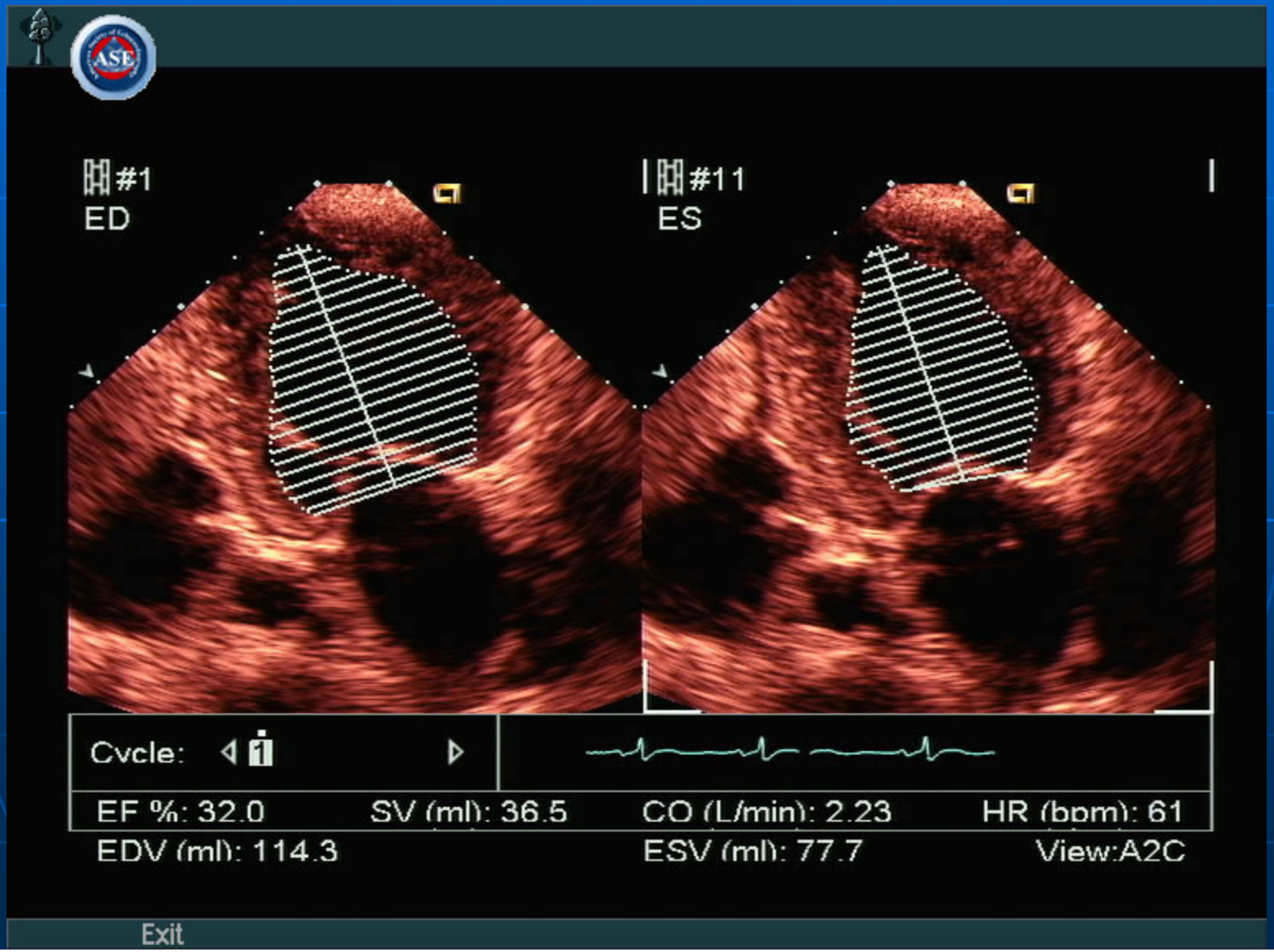


# Fractional Shortening: EF



# Biplane method of discs



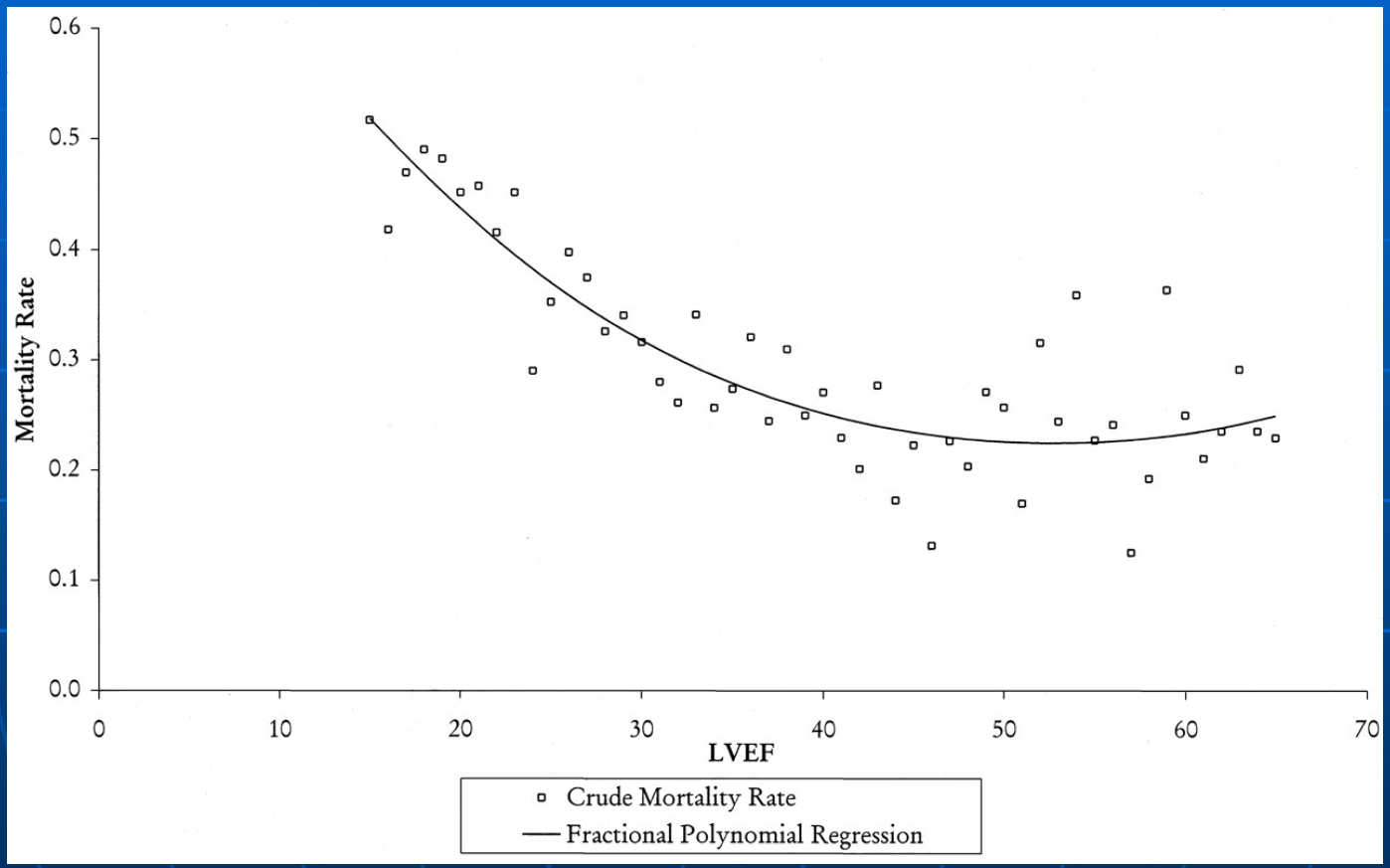
**From American Heart Journal**

**Prognostic Implications of Ejection Fraction From Linear Echocardiographic Dimensions: The Strong Heart Study**

**Conclusions:** LV EF from linear echocardiographic measurements as well as segmental LV dysfunction and EF from 2-D wall motion scores strongly and independently predict cardiovascular mortality. Reduced EF by simple echocardiographic method has estimated population-attributable risks of about 35% for cardiovascular death and 12% for all-cause mortality in a population-based sample of middle-aged to elderly adults.

| | |
|---|---|
| Normal | >55% |
| Low normal function | 50- 55% |
| Mild dysfunction | 40-50% |
| Moderate dysfunction | 30-40% |
| Severe dysfunction | < 30% |

# Linear trend for left ventricular ejection fraction (LVEF) as a continuous variable and unadjusted all-cause mortality

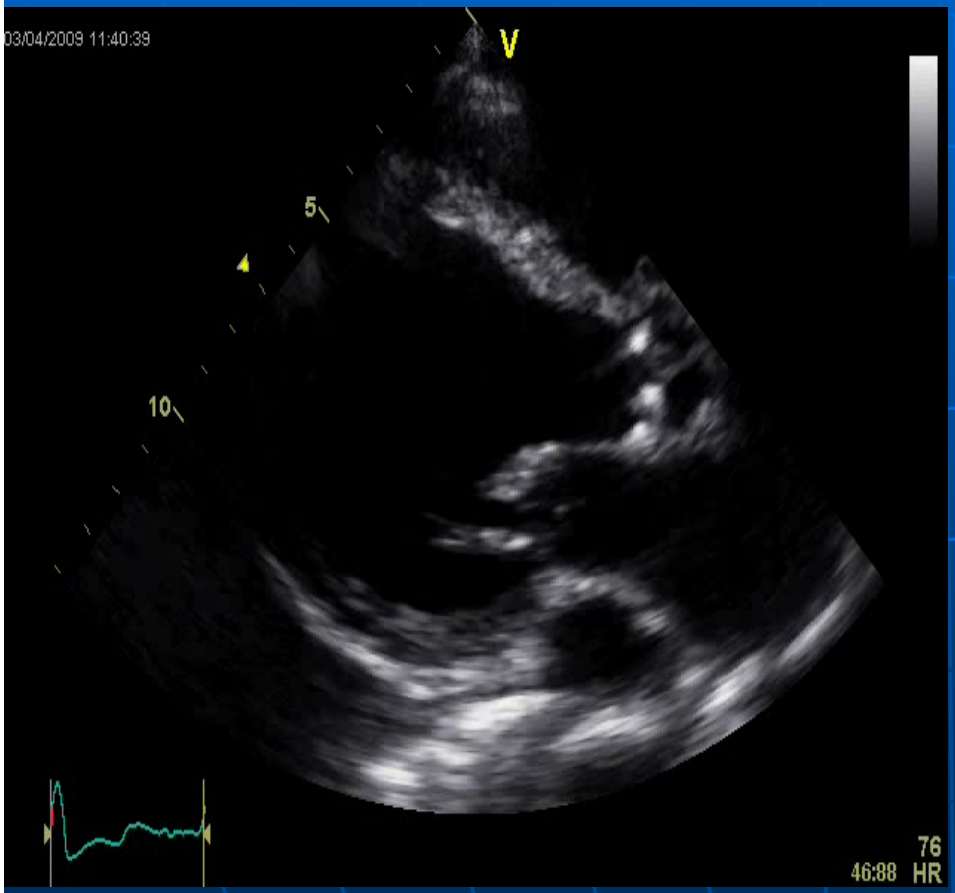


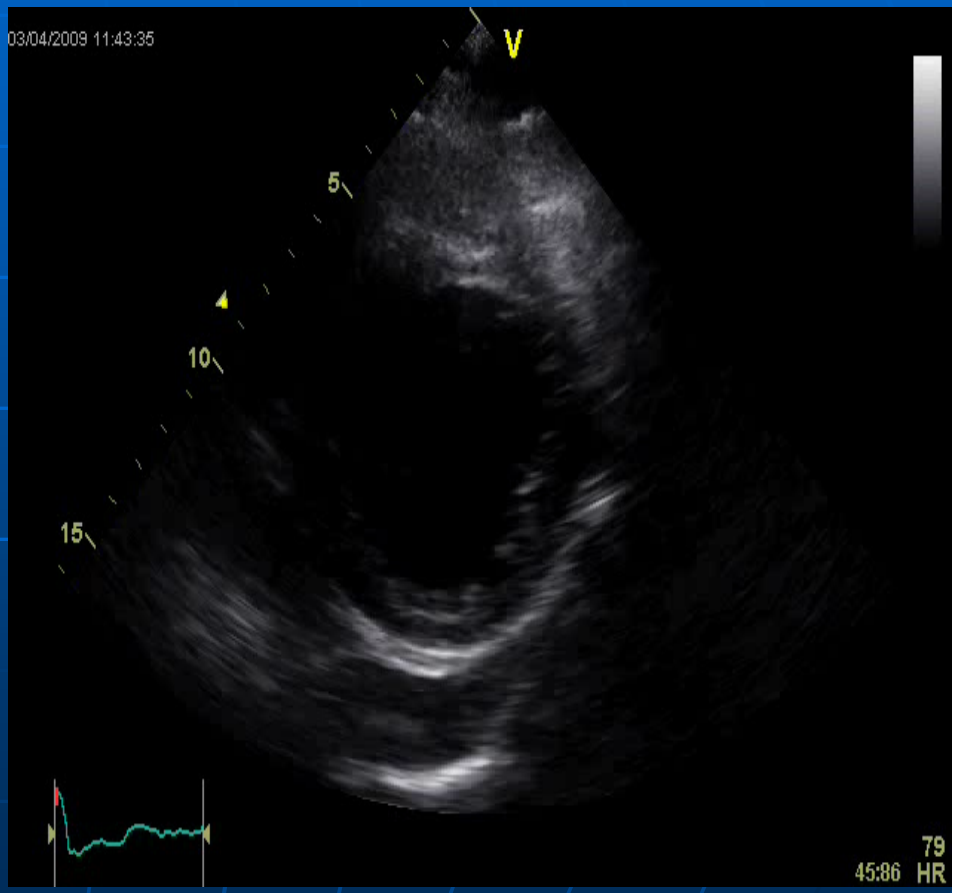

Curtis, J. P. et al. J Am Coll Cardiol 2003;42:736-742

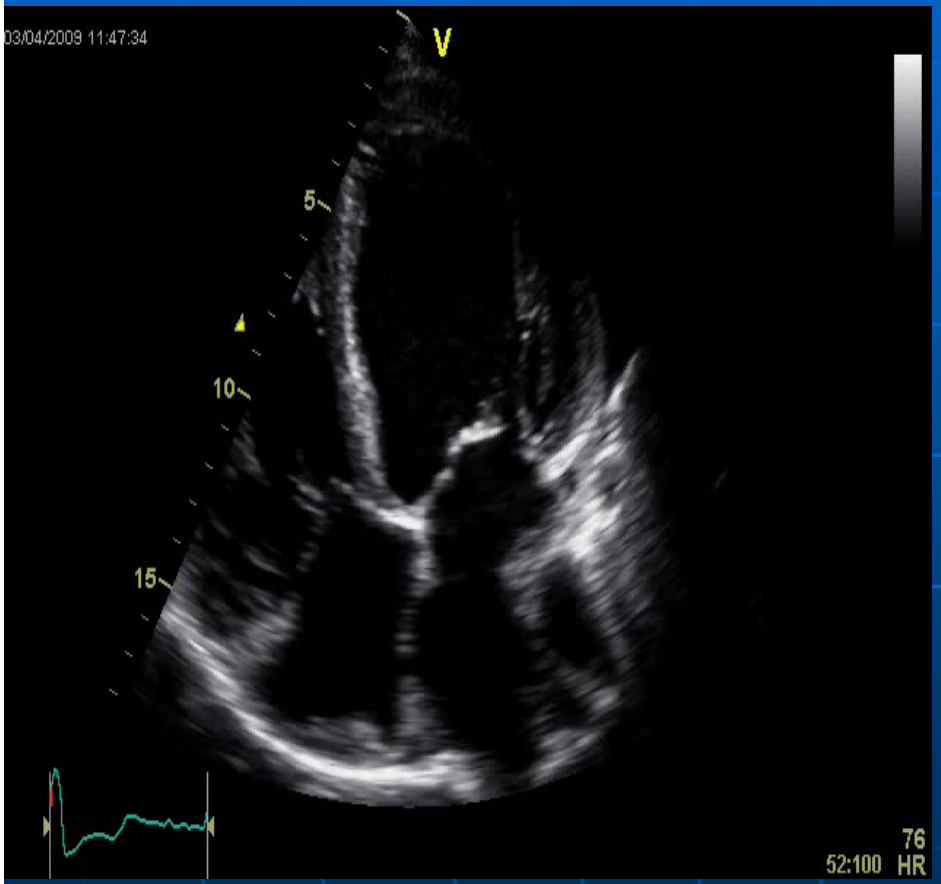


JACC Journal of the American College of Cardiology

# cardiomyopathy

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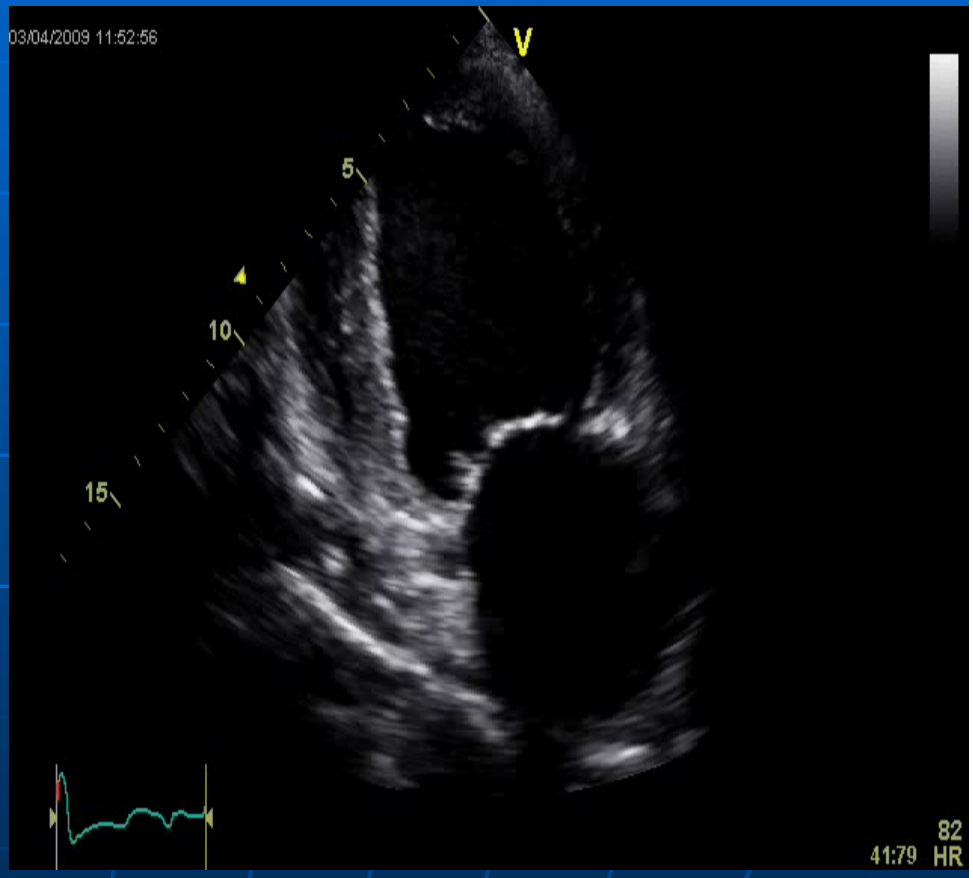
V
5
10
15
76
52:100 HR


03/04/2009 11:52:56
V
5
10
15
82
41:79 HR

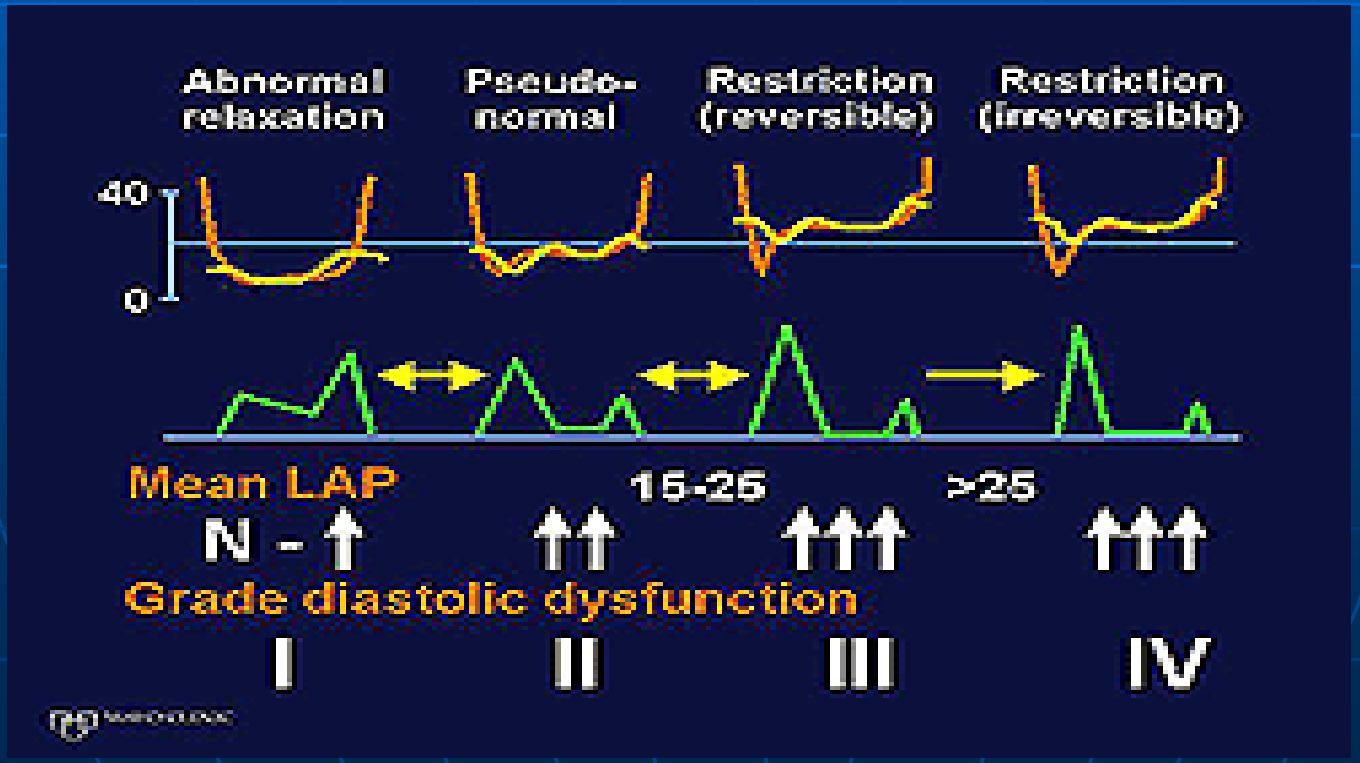
# Diastolic Dysfunction Grading System

Grade I impaired relaxation

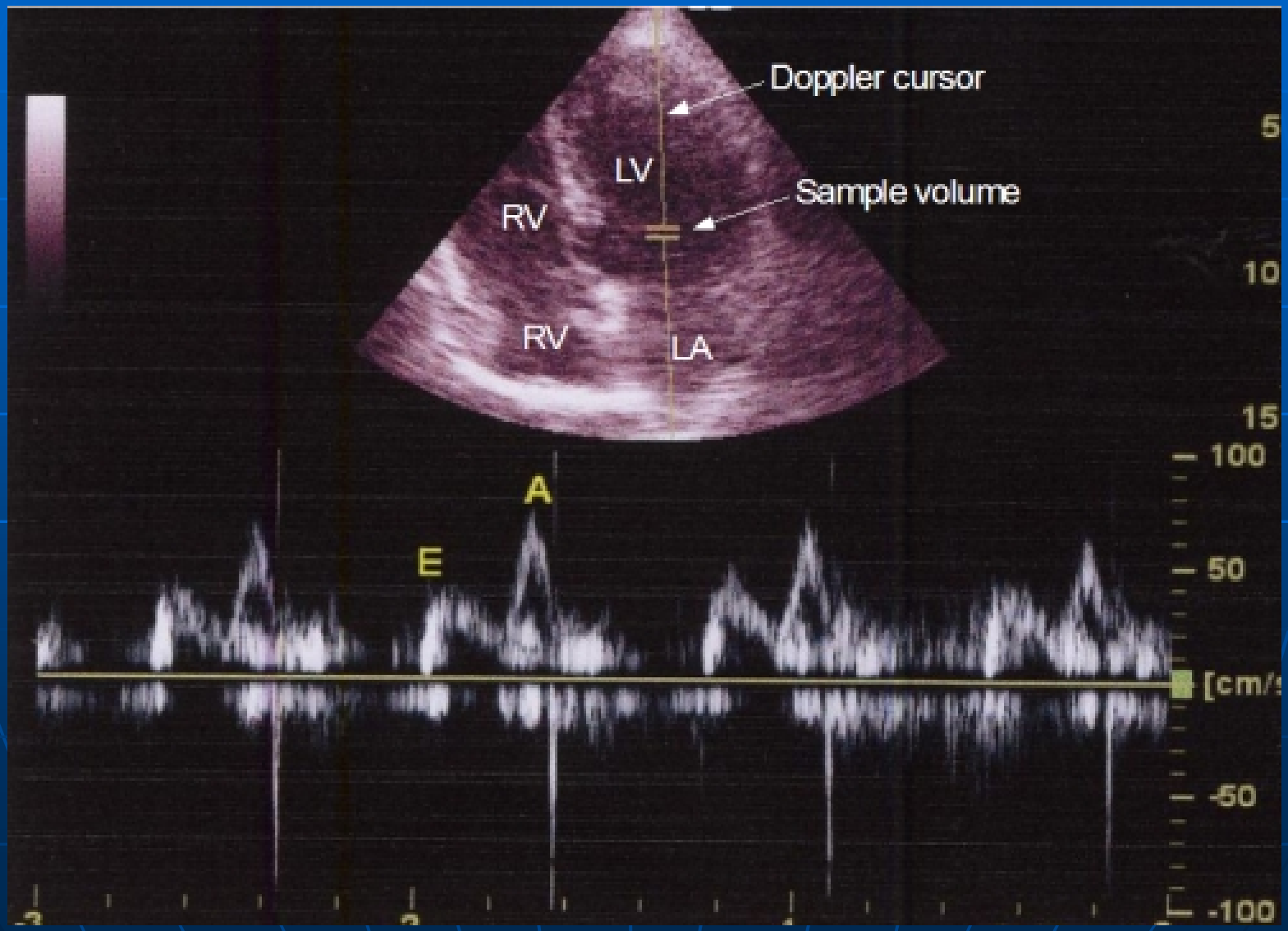
Grade II Pseudo normalization

Grade III Restrictive physiology

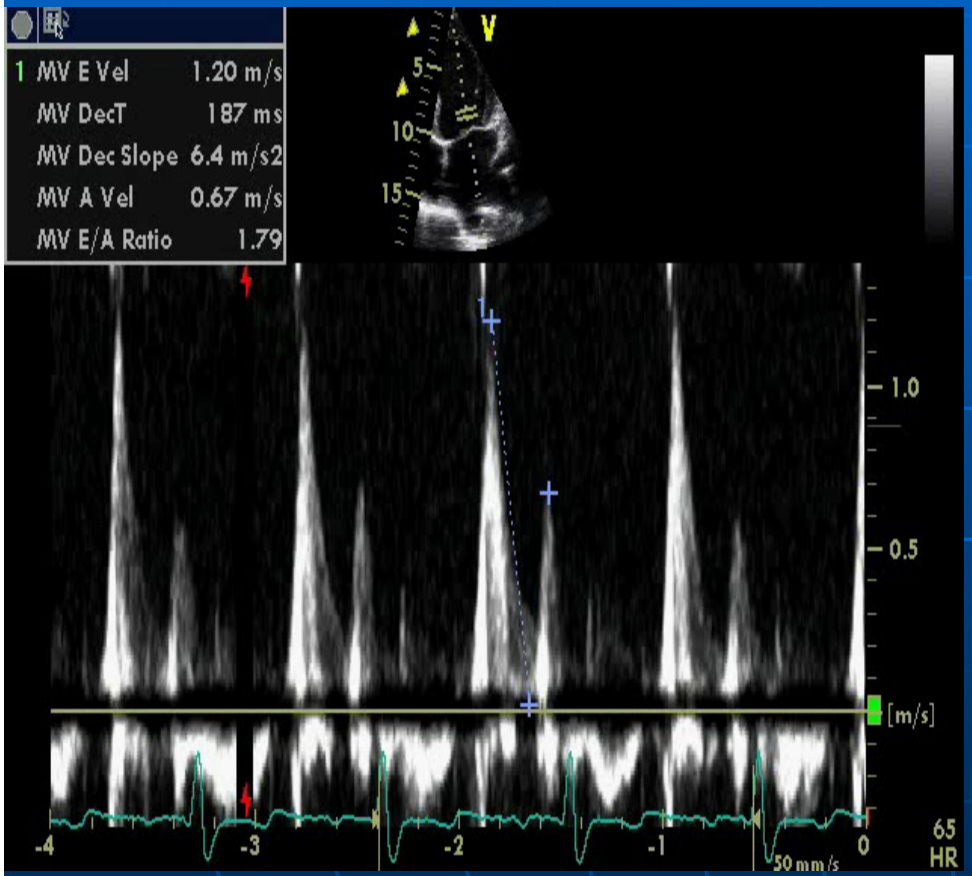
Grade IV Restrictive (irreversible)

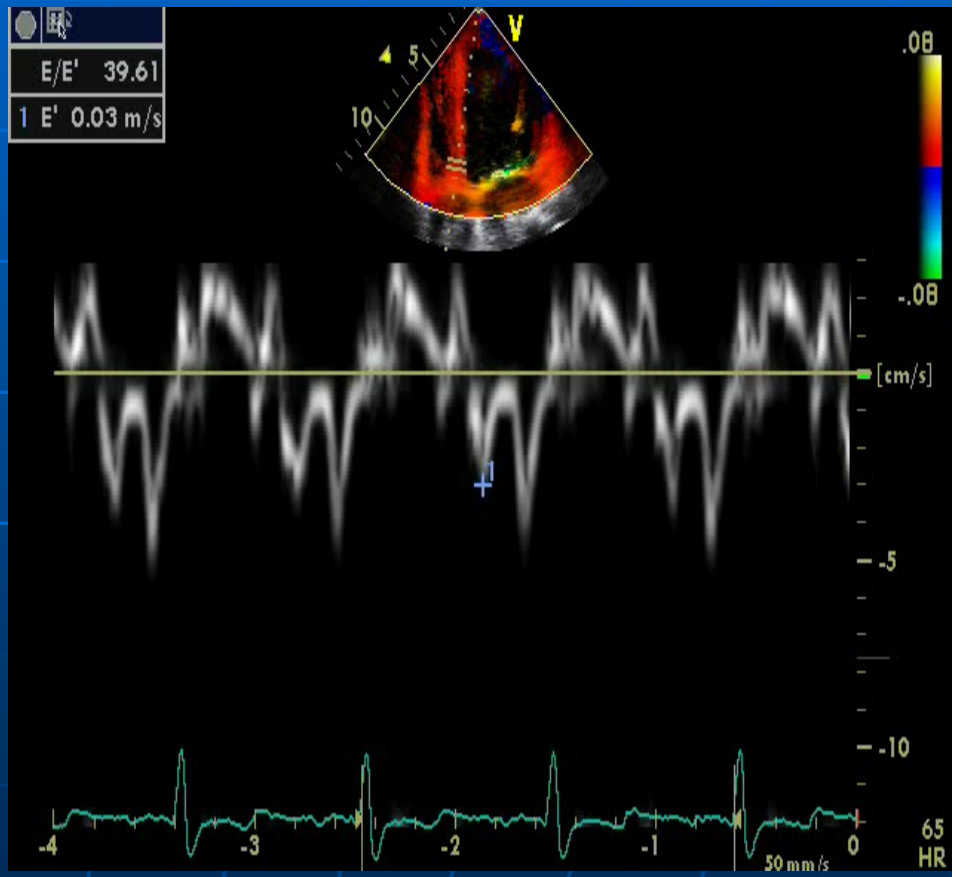


# MV inflow

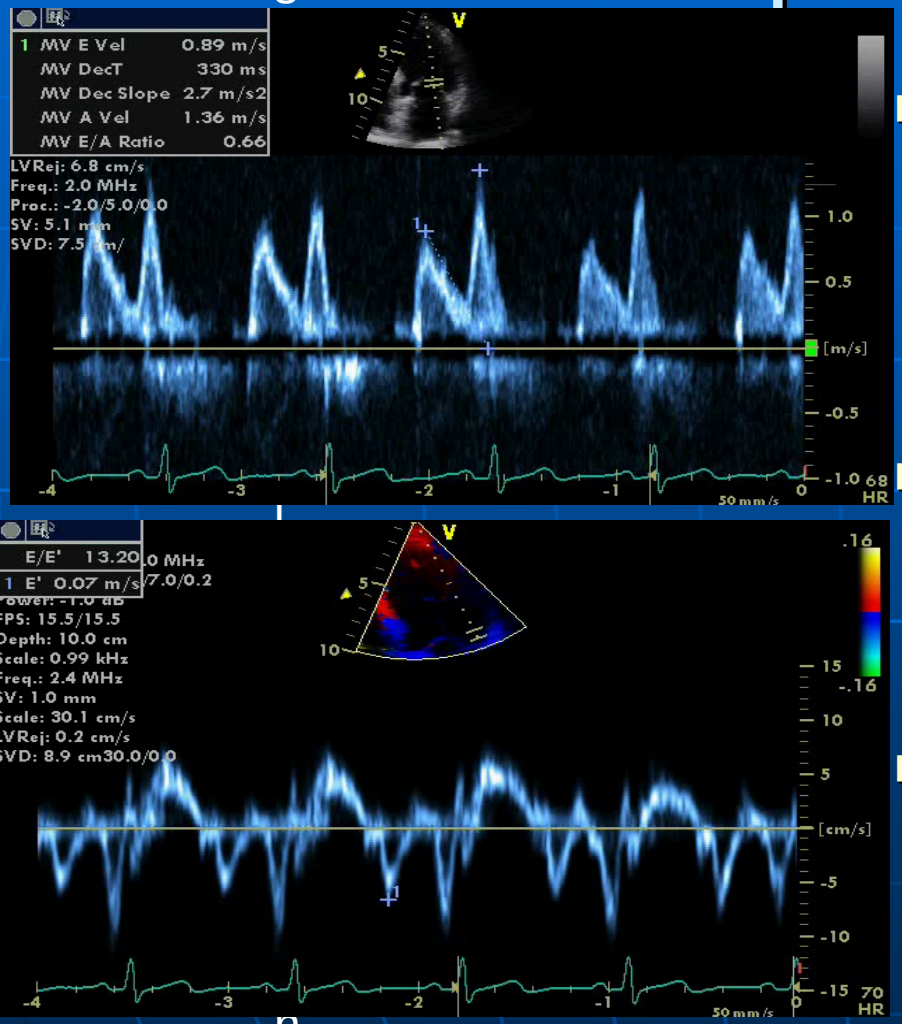

Doppler cursor
LV
Sample volume
RV
RV
LA
A
E
5
10
15
100
50
-50
-100

# restrictive



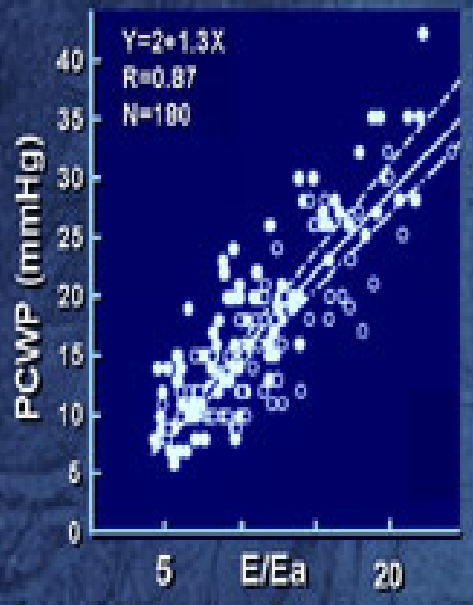
# Tissue Doppler imaging: load independent




- Compare
  - Mitral inflow E velocity
  - TDI E' velocity
- Calculate E/E' ratio
  - E/E' < 8
  - E/E' > 12/15
- Septal wall vs. Lateral wall

# Left atrial pressure

## Calculation of LAP by E/Ea




LAP=
E/Ea x1.25+1.9

Can be used in:

- afib and
- sinus tach

Nagueh et al 1997

ECHOinContext

## Relation of LAP to E/Ea

LAP = (E/Ea x 1.25) + 1.9

- An E/Ea ratio ≥ 10 is: *95% sensitive*
  *82% specific*
- Mean LAP > 15 mmHg
- Allows estimation of pressures in the absence of sinus rhythm

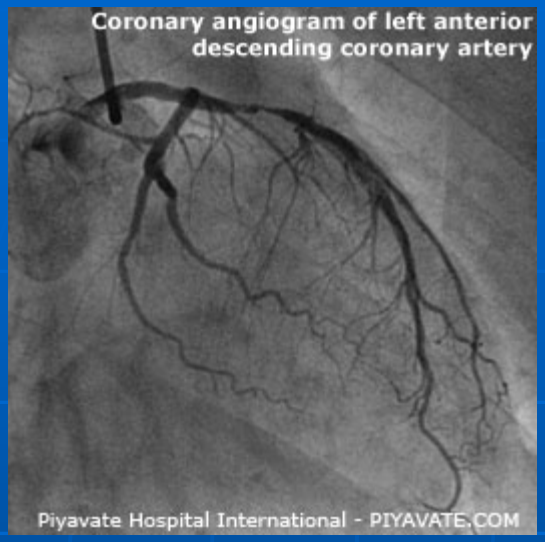
Nagueh et al, JACC 1997;20:1627

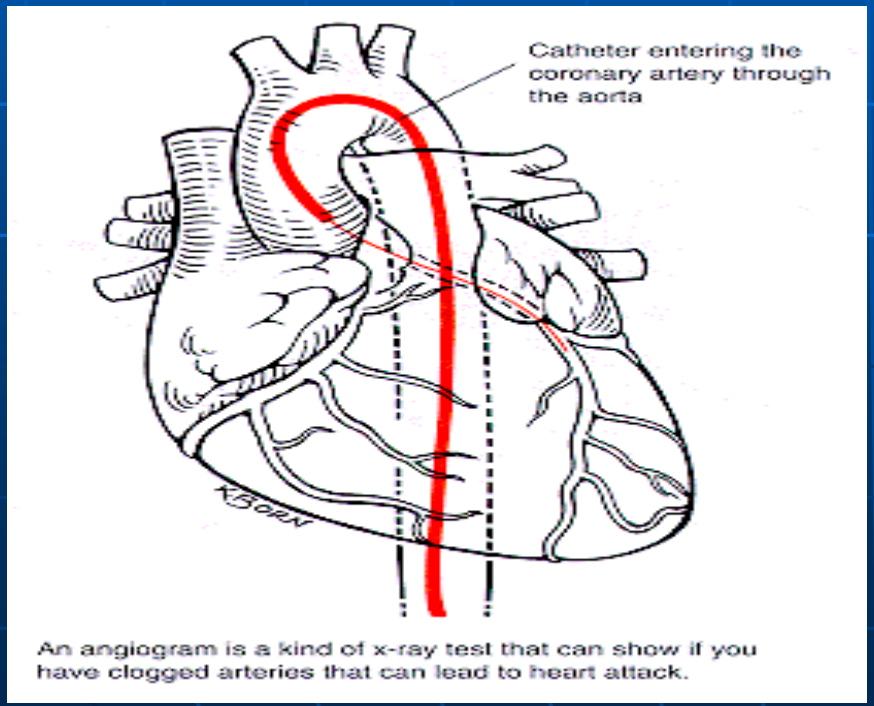
ECHOinContext

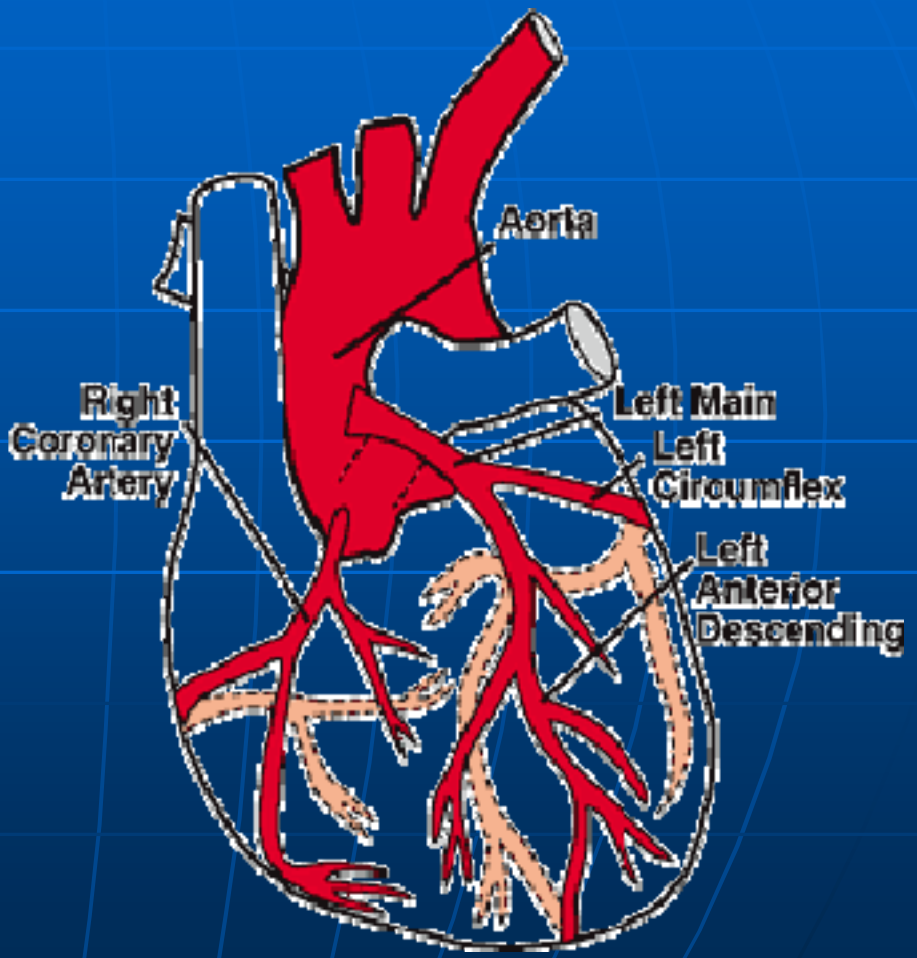
## *DIASTOLIC DYSFUNCTION*

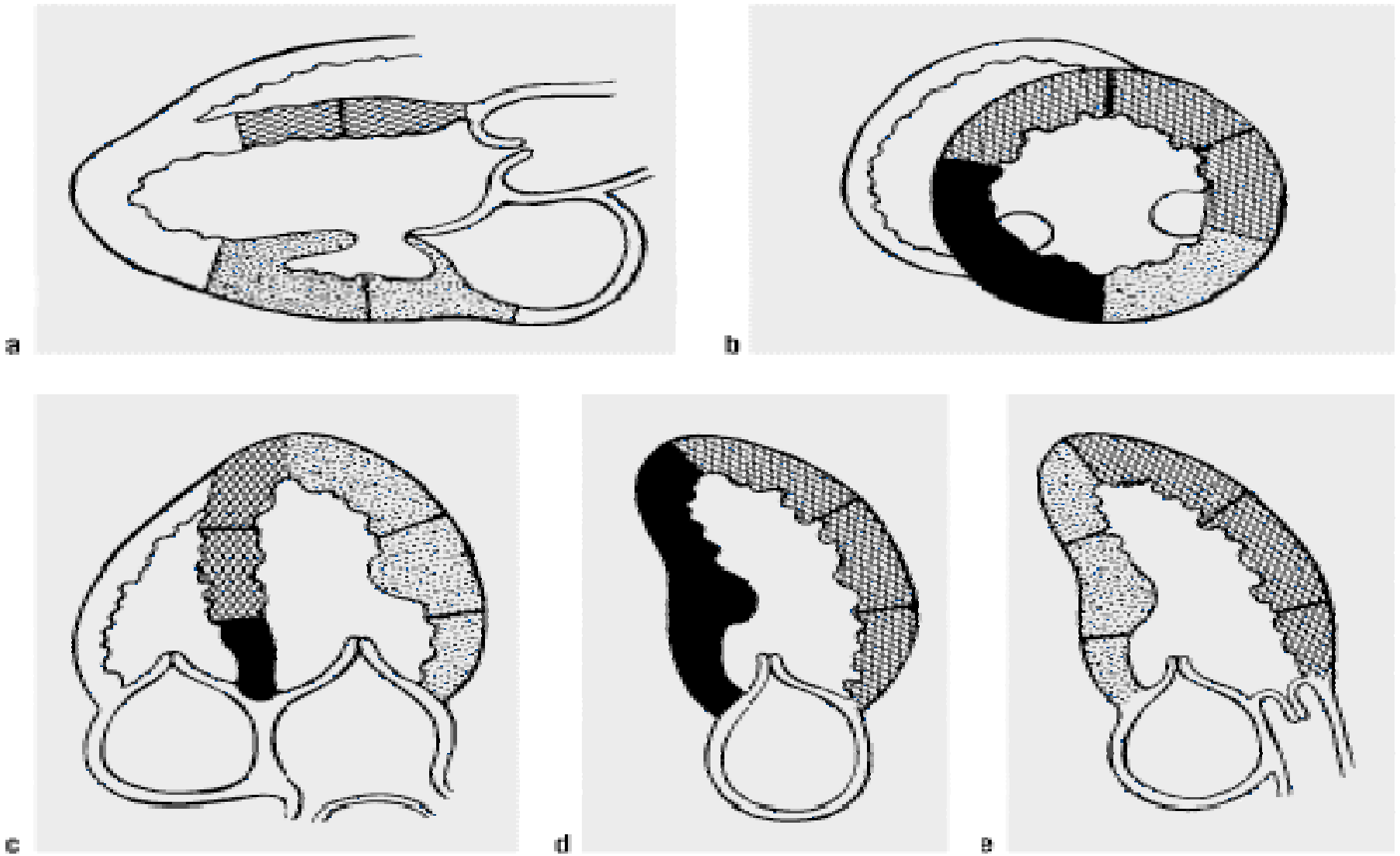
| MAJOR CAUSES | LESS COMMON CAUSES |
|---|---|
| Systemic hypertension | Primary restrictive cardiomyopathy |
| Ischemic heart disease | Constrictive pericarditis |
| Diabetic heart disease | Hypertrophic cardiomyopathy |
| Metabolic syndrome (obesity, sleep apnea) | Infiltrative disorders (amyloidosis, storage disorders, hemochromatosis) |
| | Valvular heart disease |

# Wall motion abnormalities



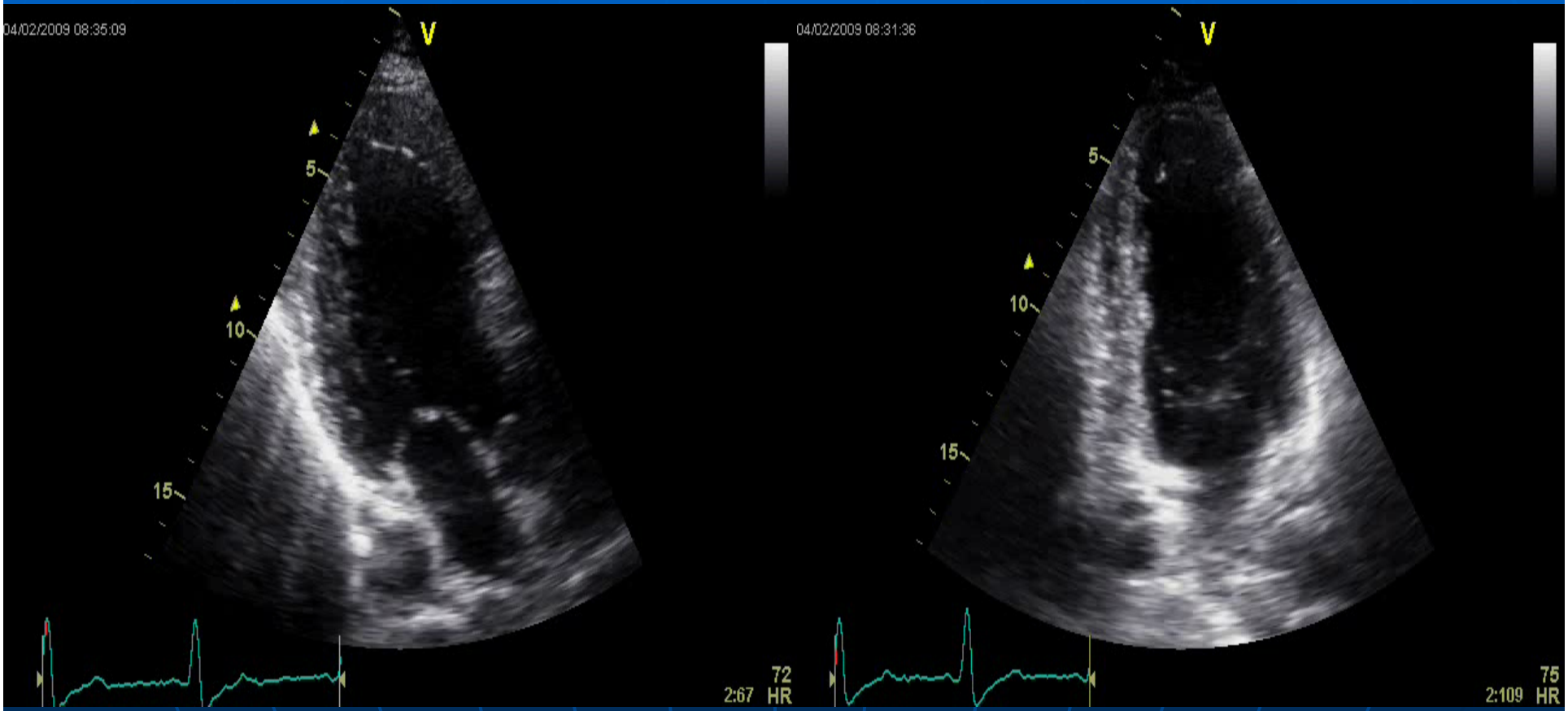





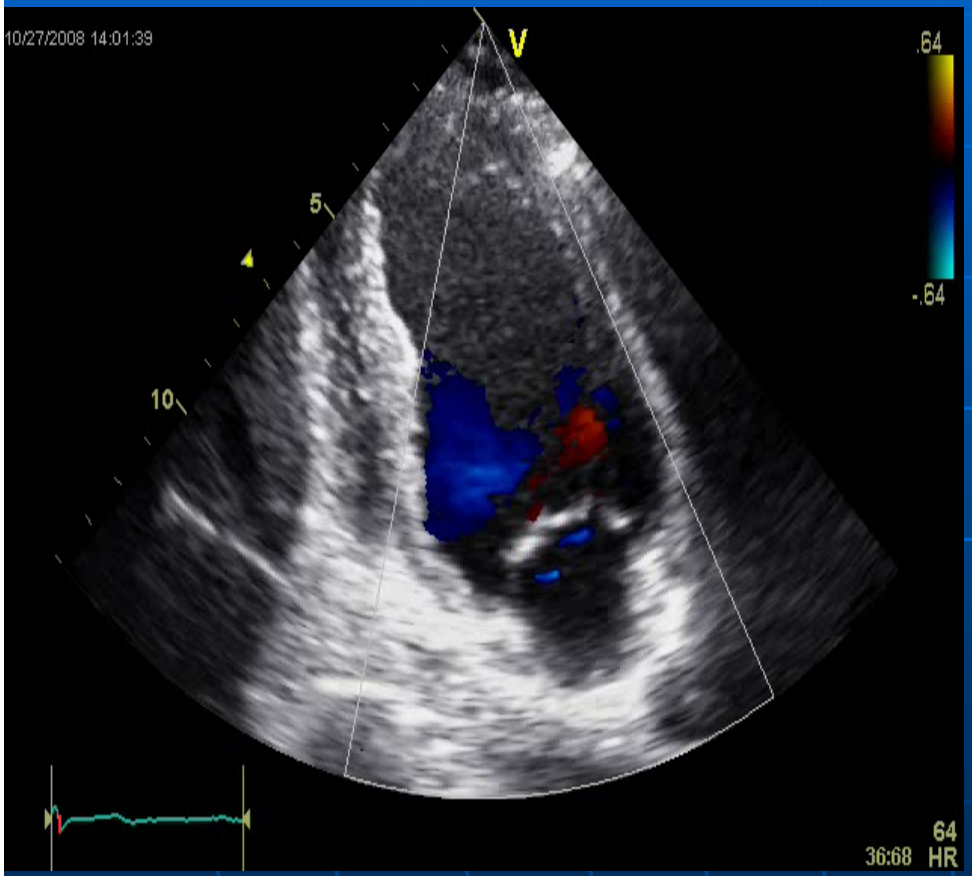

Illustrations: Medical Art Services

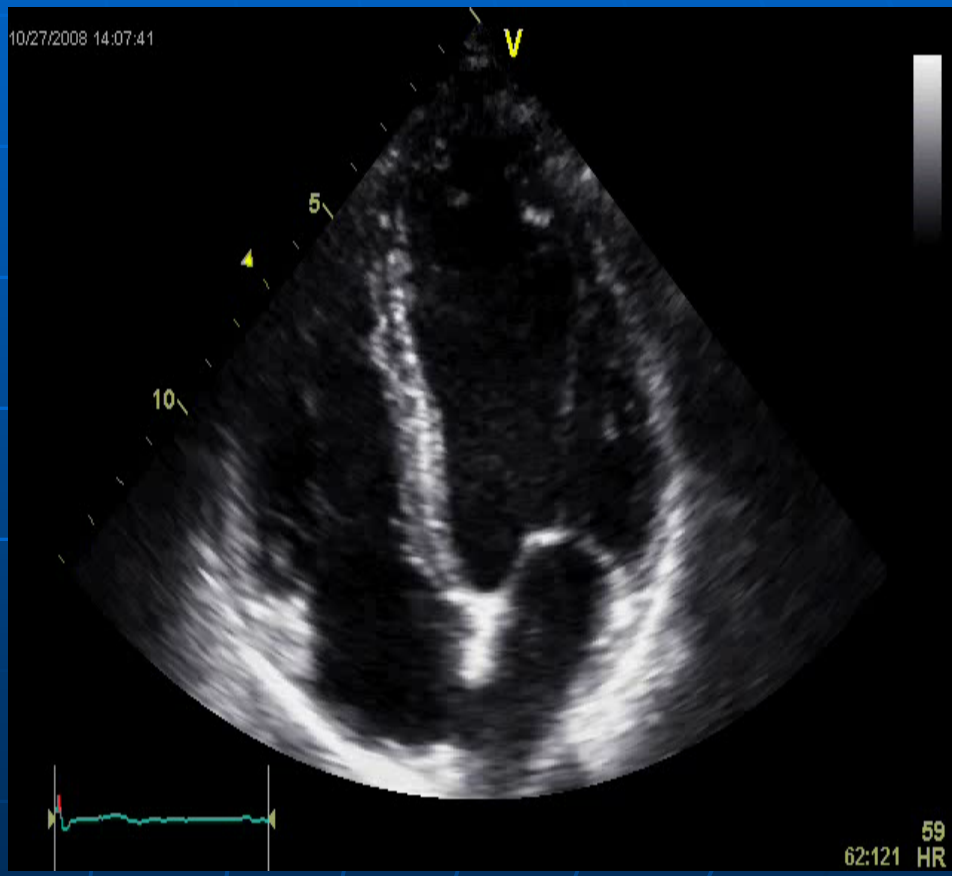
Figure 3. Division of echocardiographic views into segments and assignment to specific coronary arteries. a. Parasternal long axis. b. Parasternal short axis. c. Apical 4. d. Apical 2. e. Apical 3. LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery.

# Apical wall motion



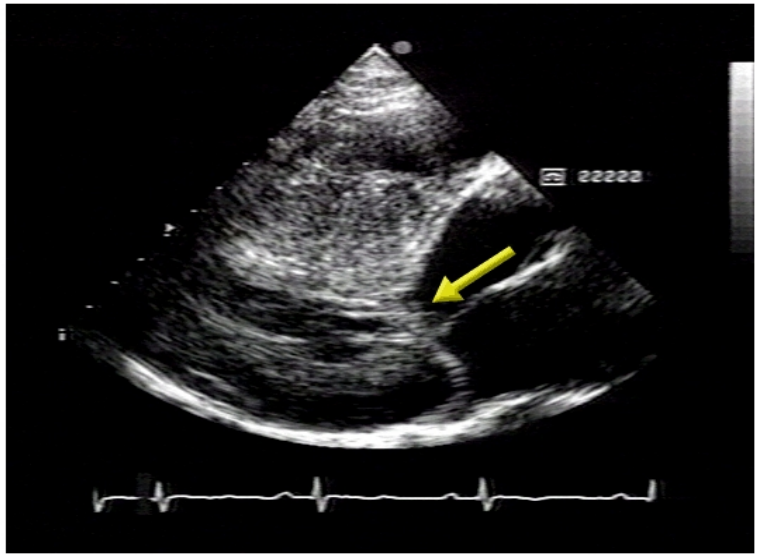
# Inferior wall motion

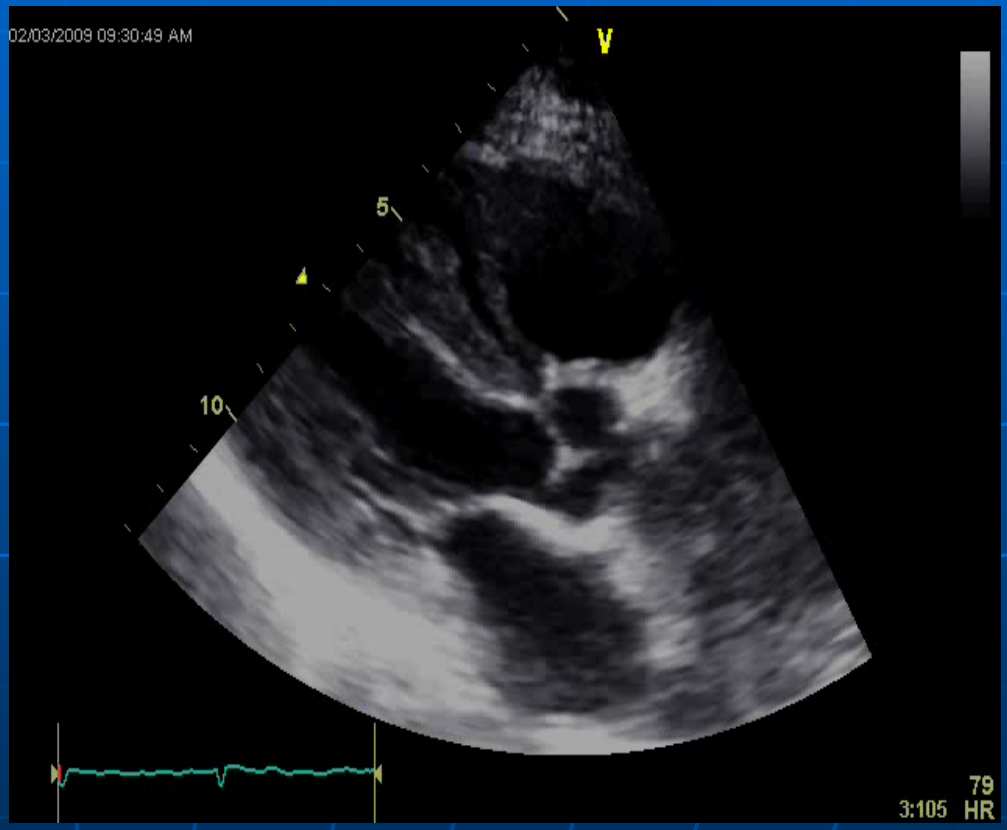


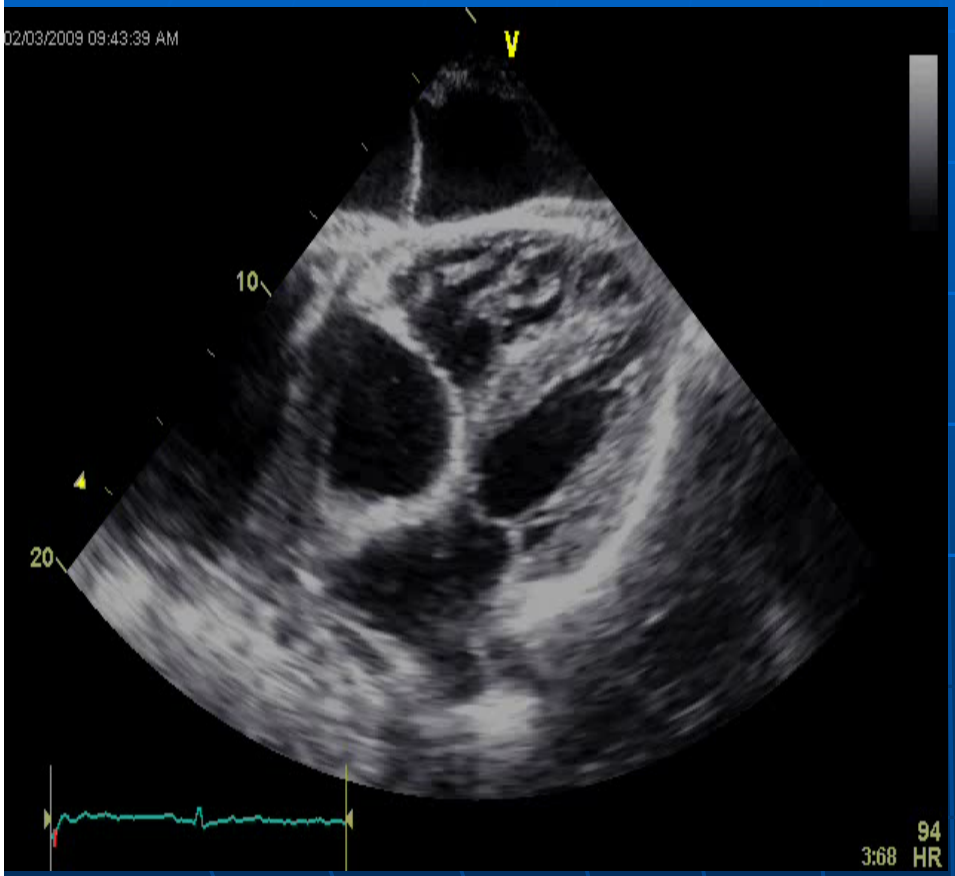
# Hypertrophic cardiomyopathy

- Significant concentric LVH
- SAM
- Mitral regurgitation





# HCM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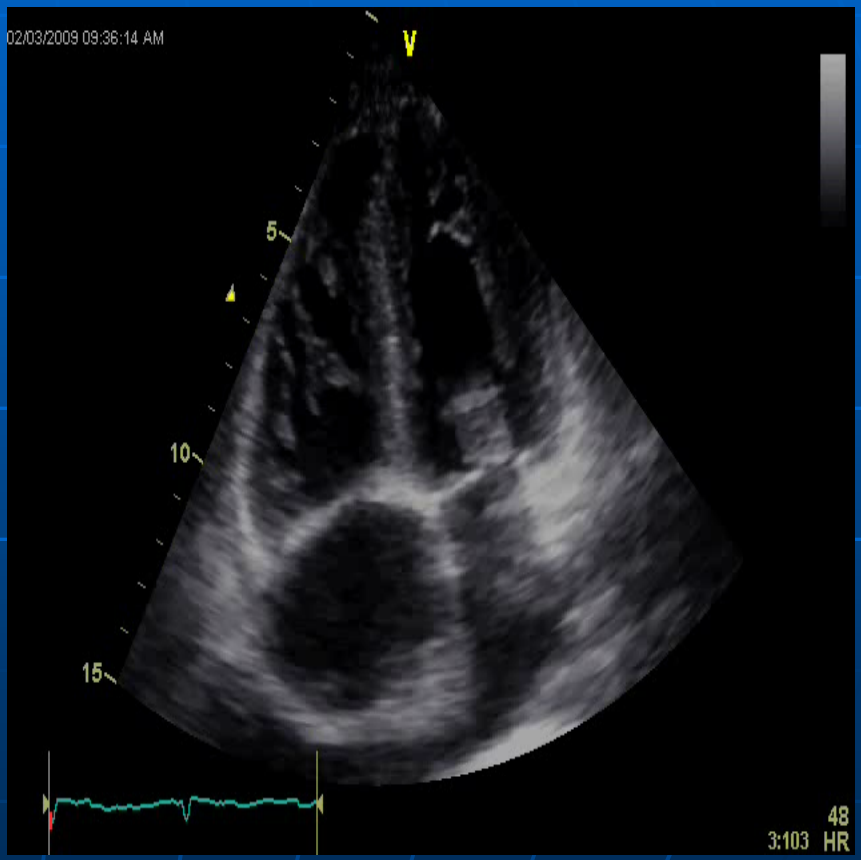
V
10
20
94
3:68 HR


02/03/2009 09:36:14 AM
V
5
10
15
48
3:103 HR

# HCM

Medscape® www.medscape.com

## Risk Factors for Sudden Death in Patients with Hypertropic Cardiomyopathy

- Major risk factors
  - Cardiac arrest (ventricular fibrillation)
  - Spontaneous sustained ventricular tachycardia
  - Family history of sudden death*
- Minor risk factors
  - Unexplained syncope defined as two or more episodes of syncope within 1 year
  - Left ventricular wall thickness >30 mm
  - Abnormal blood pressure on exercise†
  - Nonsustained ventricular tachycardia‡
  - Left ventricular outflow obstruction
  - Microvascular obstruction (which can be detected as perfusion defects on nuclear imaging or MRI)
  - High-risk genetic defect

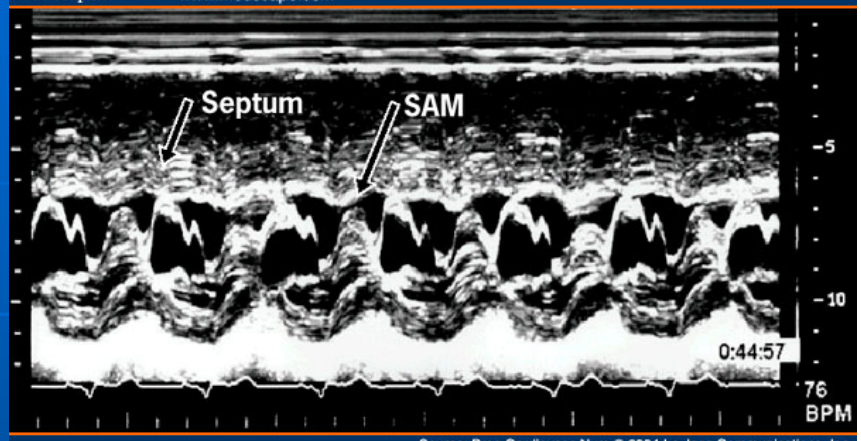
*This risk factor is defined as sudden death from hypertrophic cardiomyopathy in two or more first-degree relatives younger than 40 years of age. (Some institutions defined it as sudden death from hypertrophic cardiomyopathy in one or more first-degree relatives younger than 40 years of age.)

†Defined as failure of the blood pressure to rise by more than 25 mm Hg from baseline or a decrease of more than 10 mm Hg from the maximal blood pressure during exercise in an upright position.

‡This risk factor can be defined as the presence, on either Holter monitoring or exercise testing, of one or more runs of three or more consecutive ventricular extrasystoles with a rate higher than 120 beats per minute and a duration of less than 30 seconds.

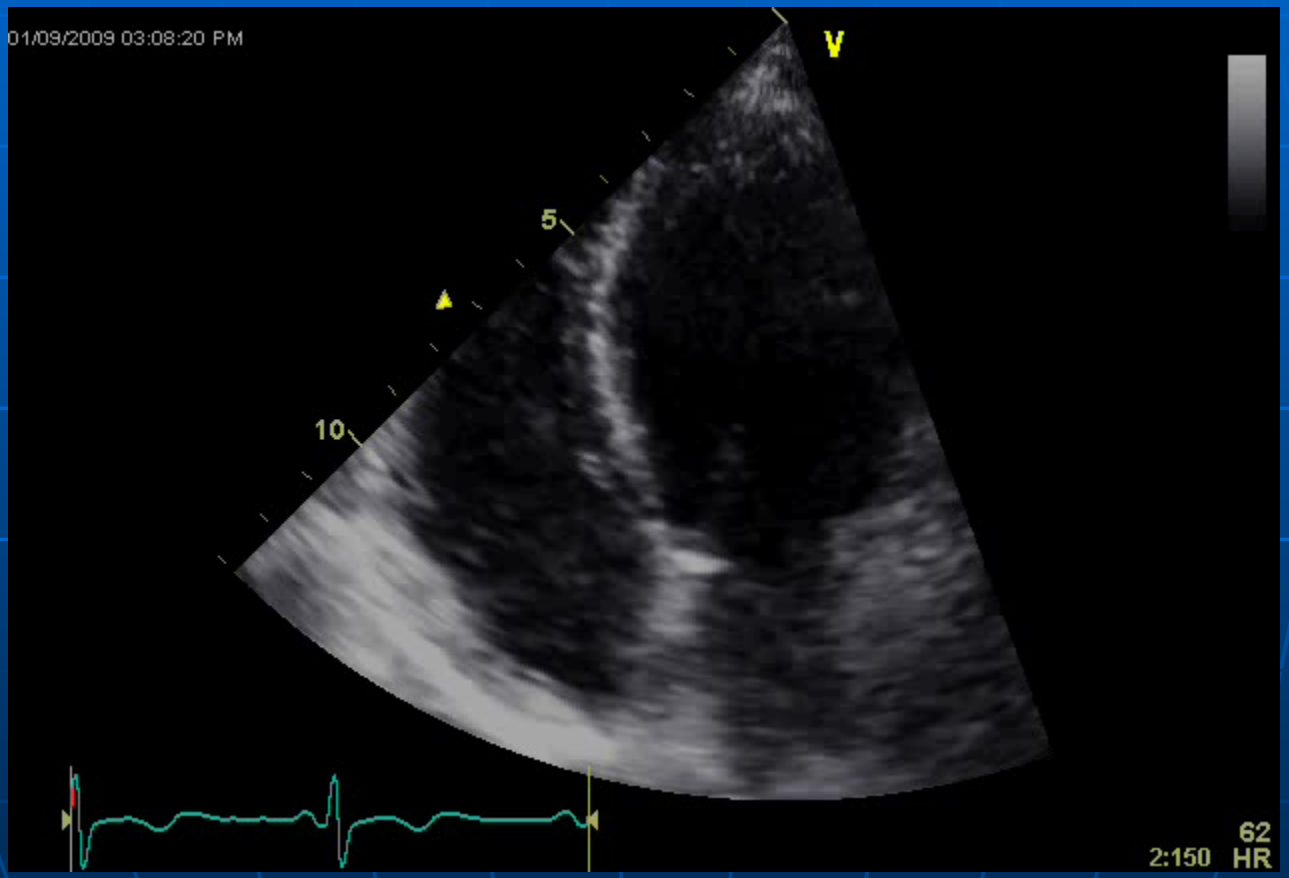
Source: Cardiosource © 2007 by the American College of Cardiology Foundation

Medscape® www.medscape.com

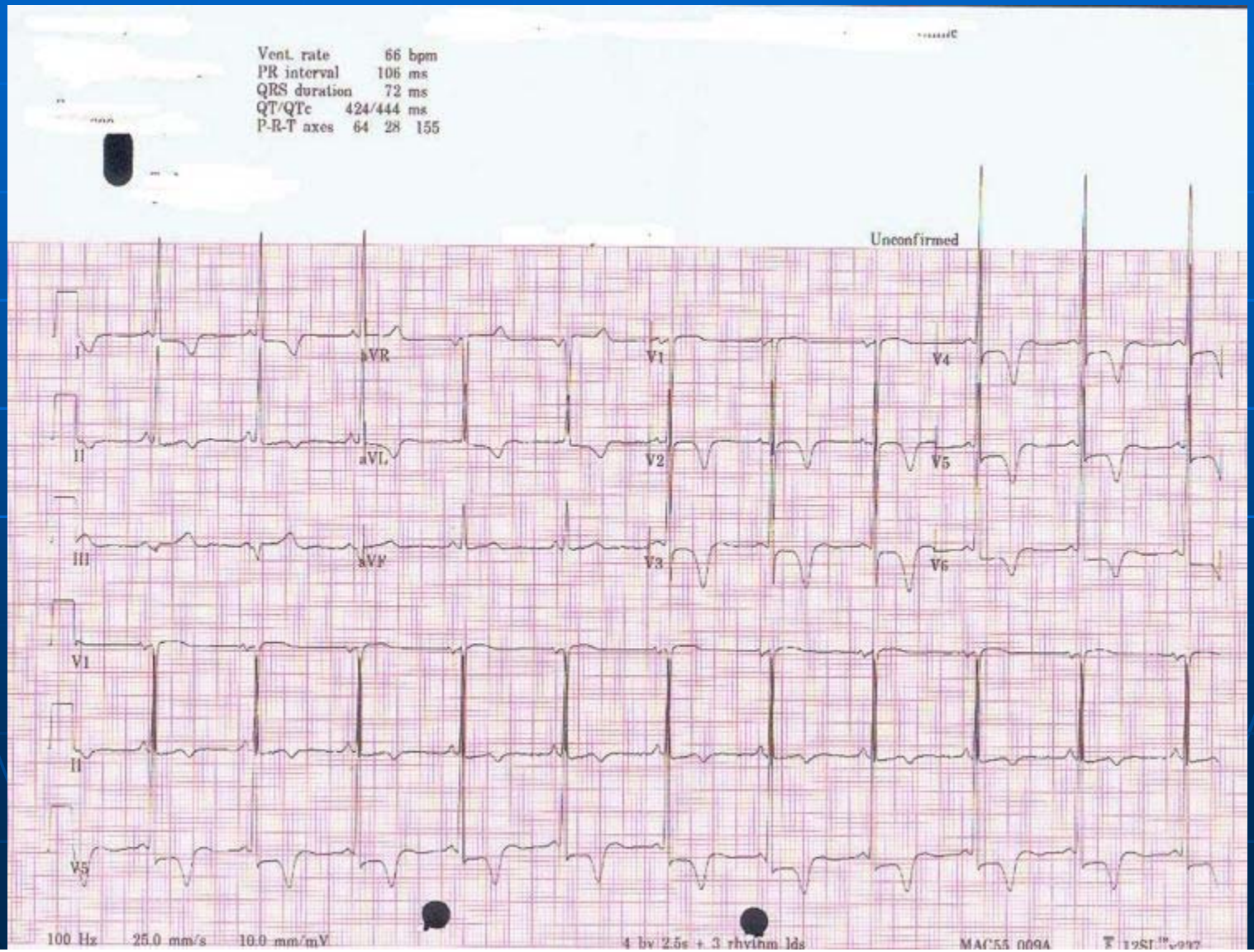



Source: Prog Cardiovasc Nurs © 2004 Le Jacq Communications, Inc.

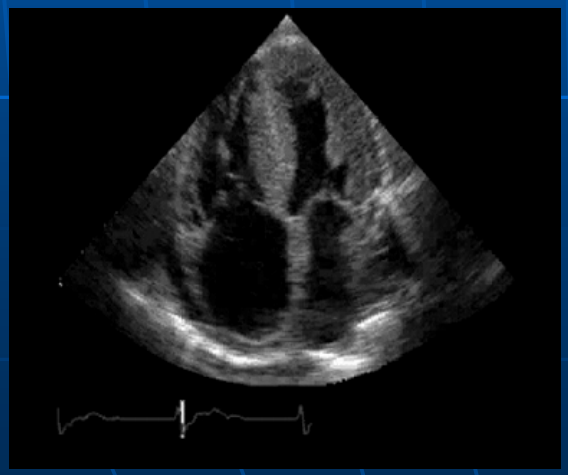
# Apical HCM

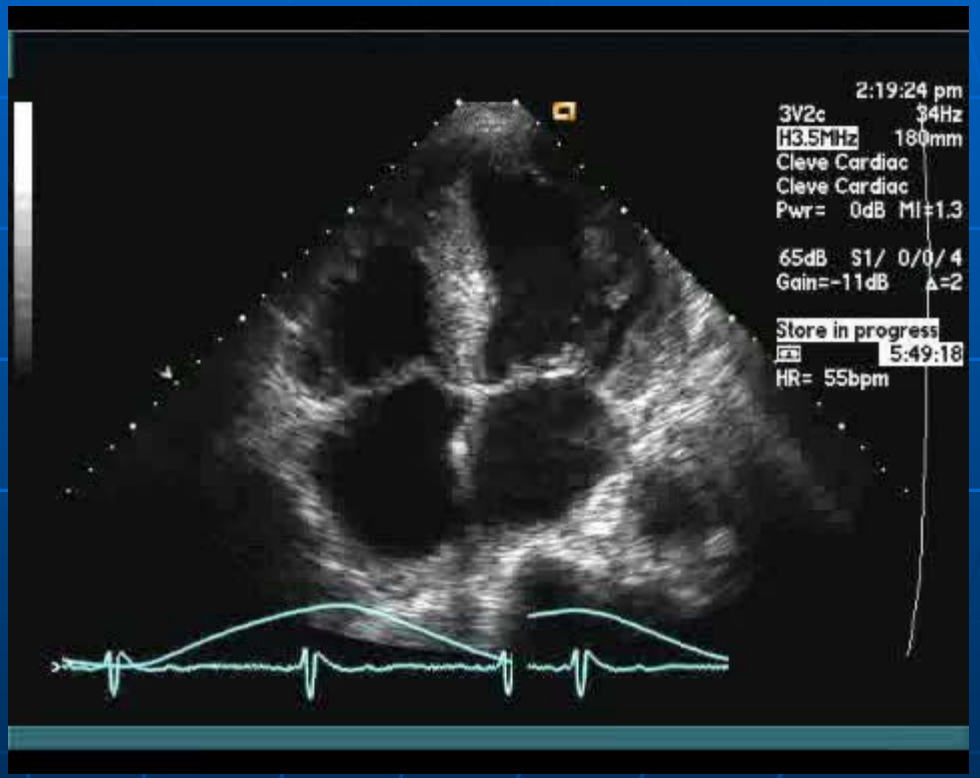


# Apical hypertrophy

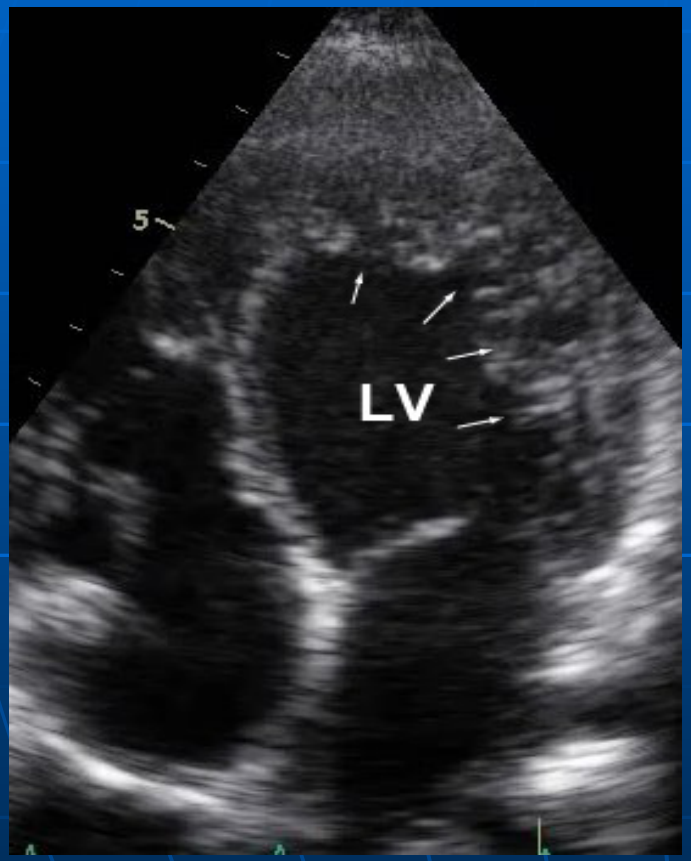


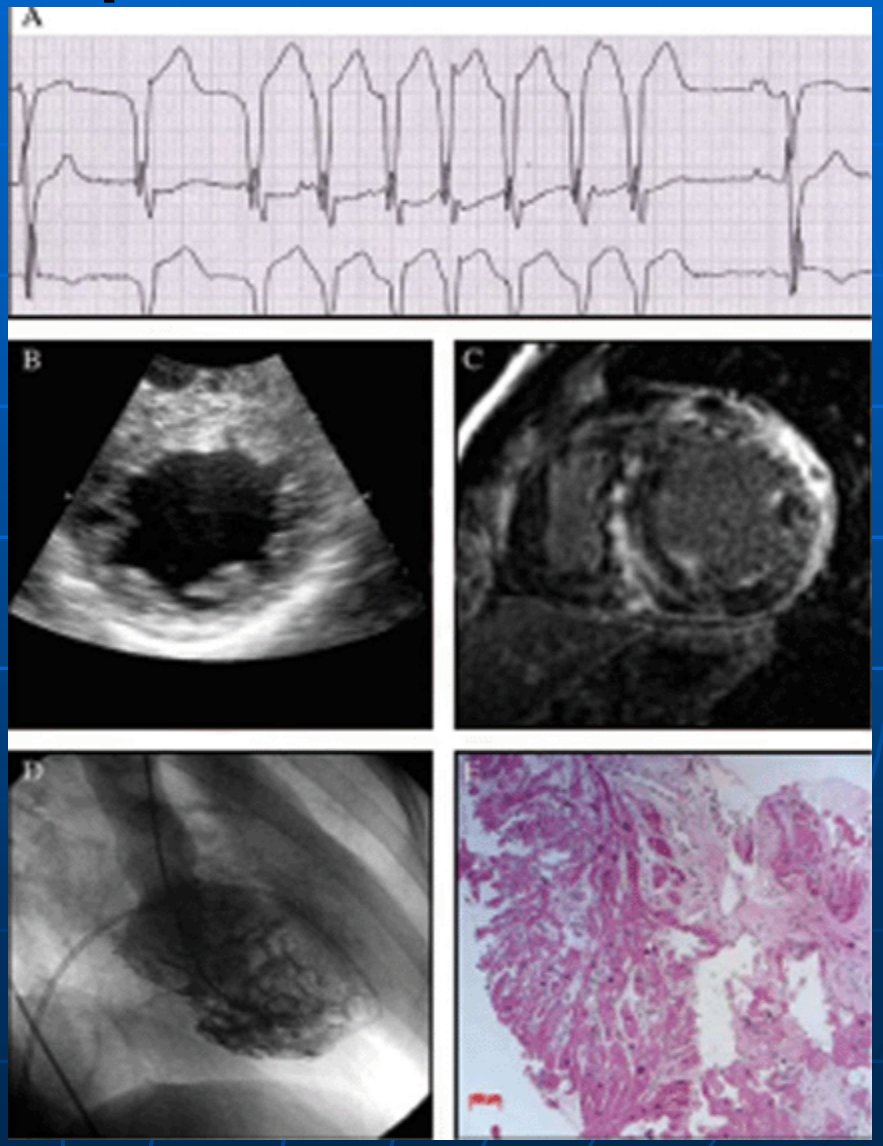
# Other cardiomyopathies

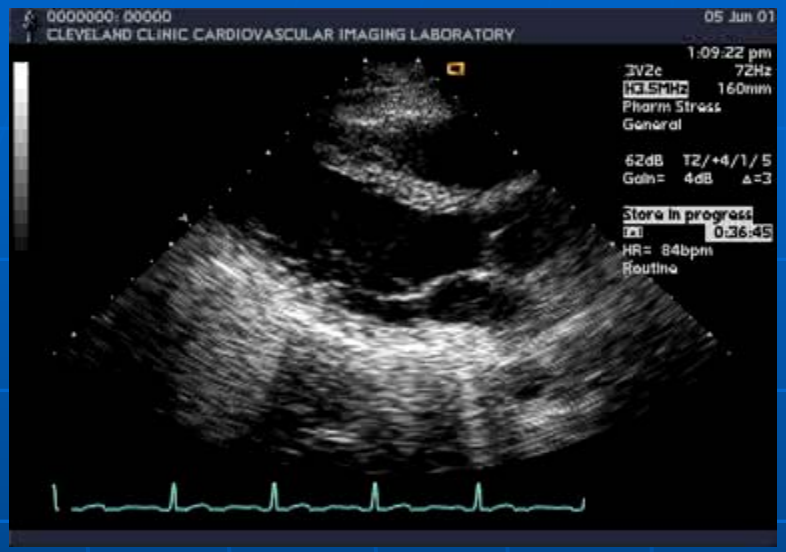


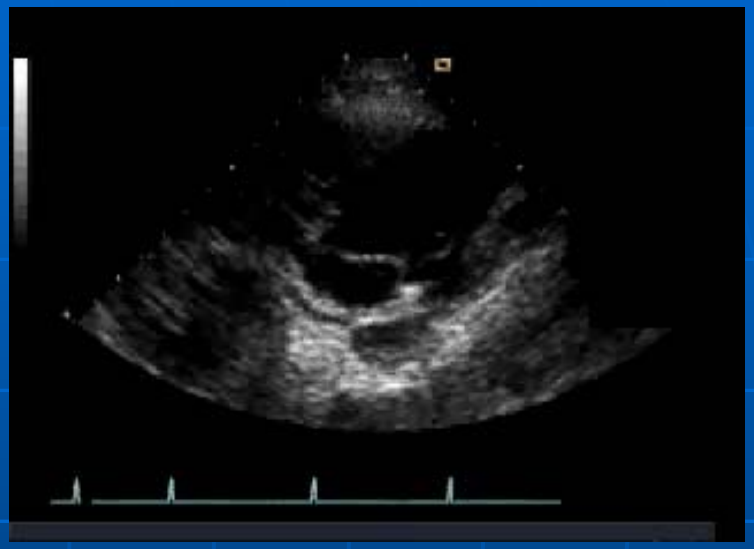
# noncompaction

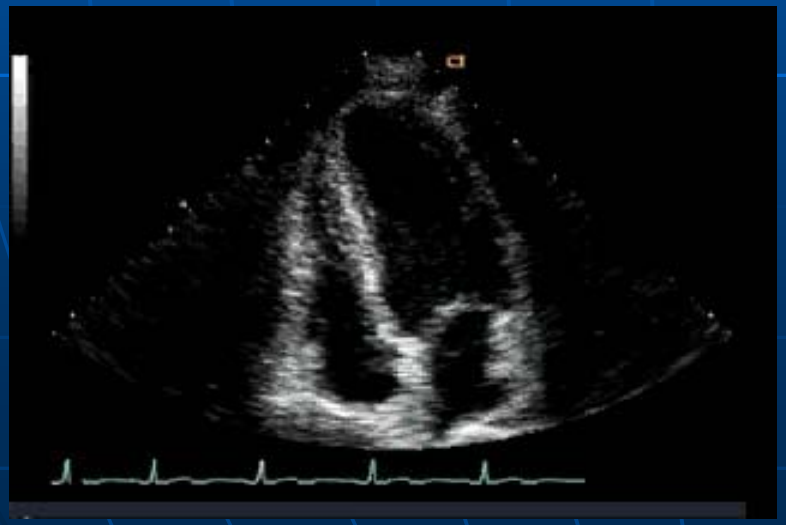


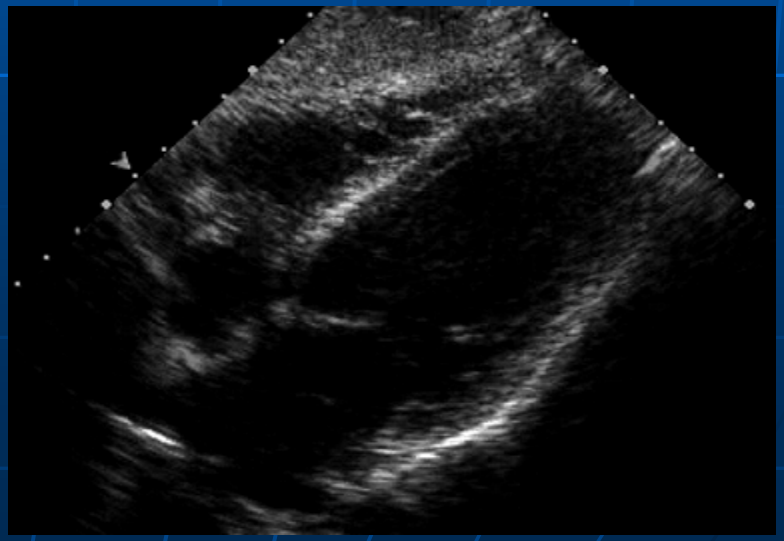



# Right ventricle

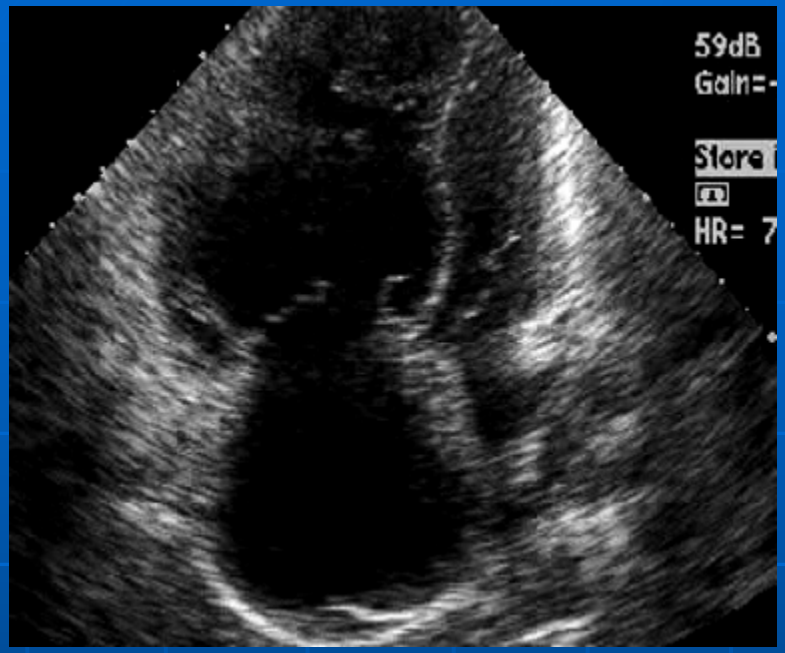


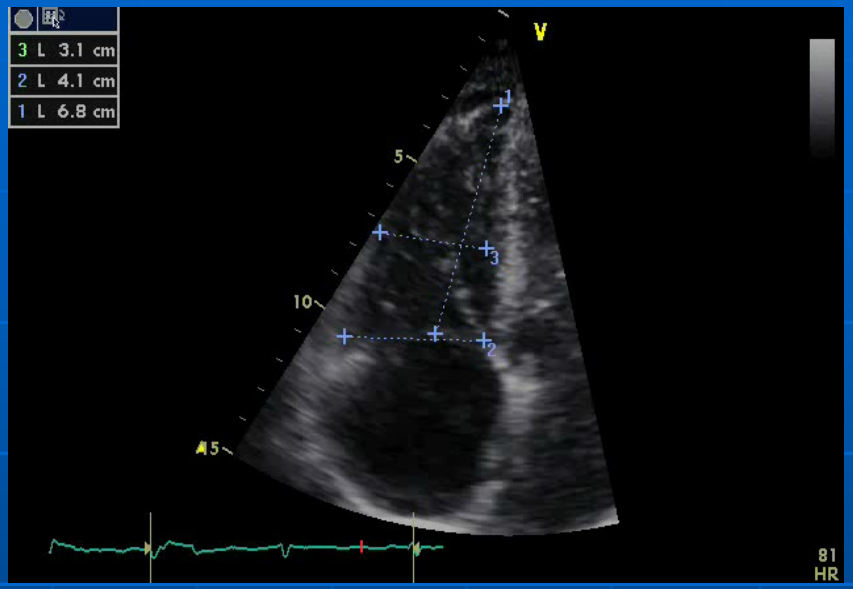



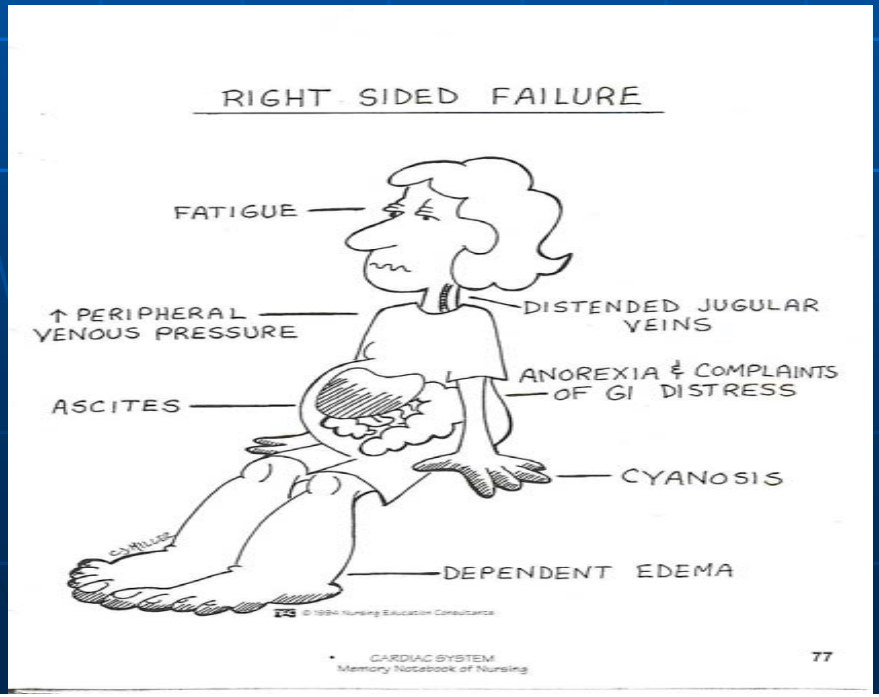


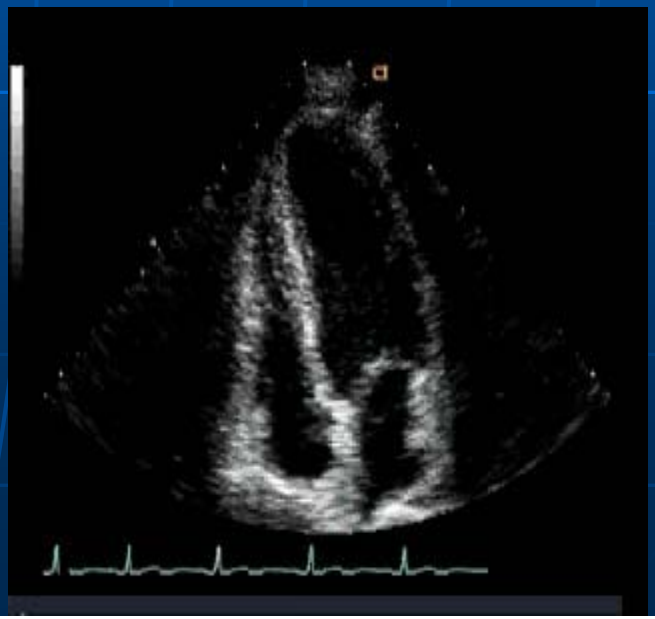


# RV size and function



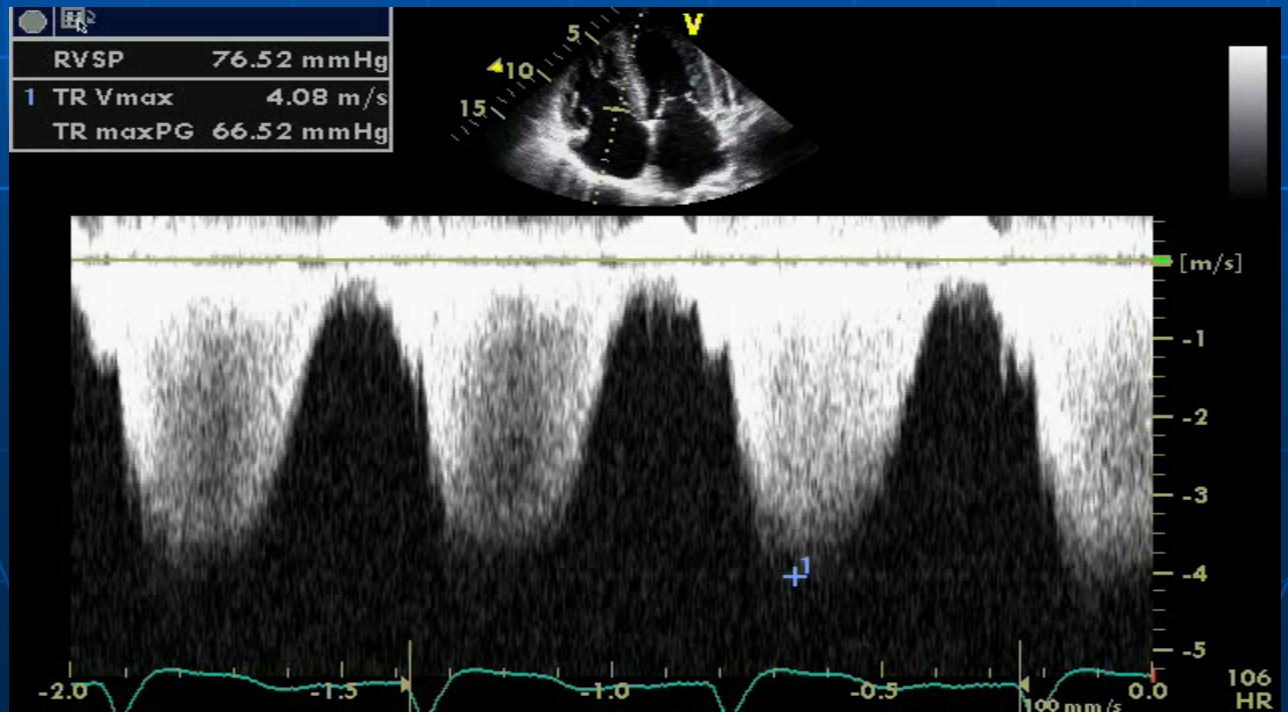



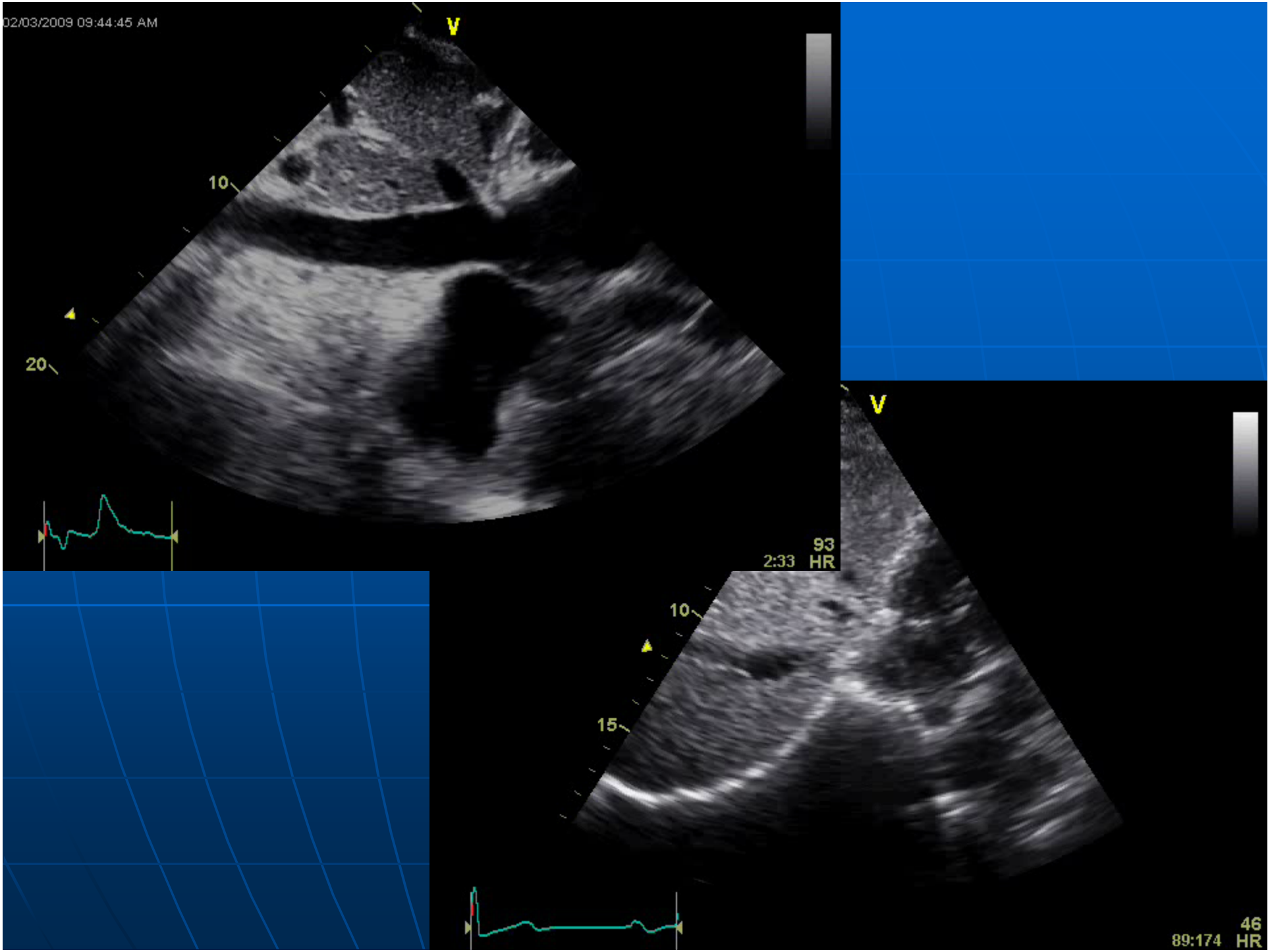
# Assessment of right heart pressures

- Right ventricular systolic pressure
- RVSP = PAP ( in absence of PS or RVOT obstruction)
- RVSP = gradient across the TV + RA pressure
- Obtain peak TR velocity by CW = 4(TR velocity)2 + RA



# Estimation of RA Pressure

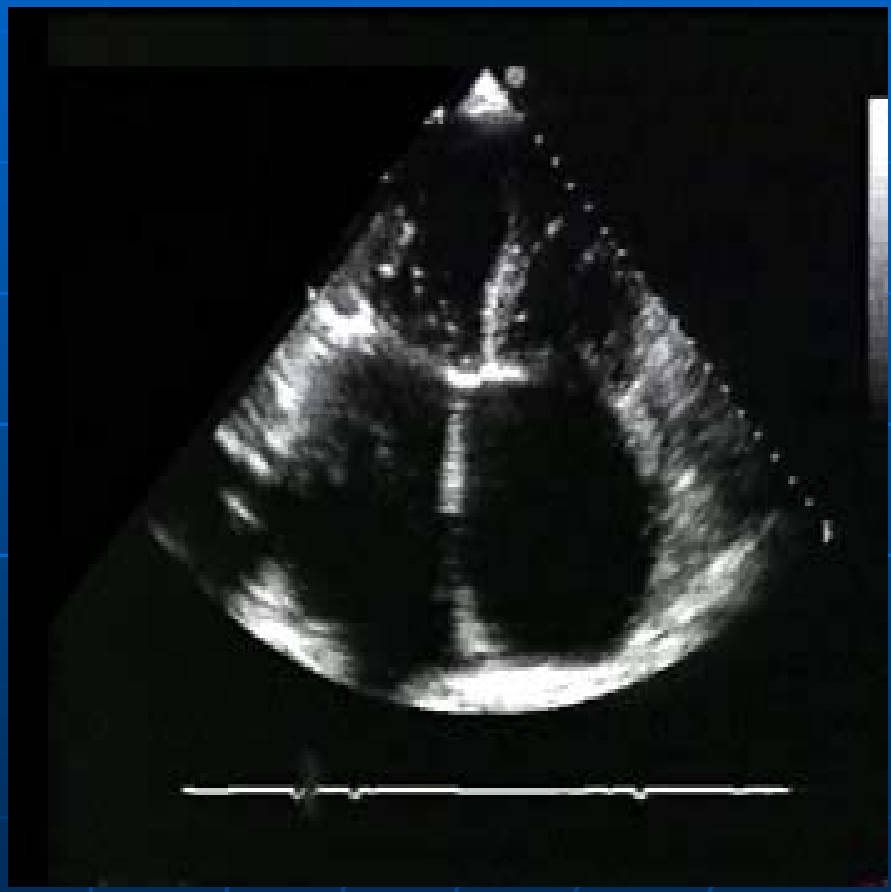
| IVC SIZE | INSPIRATORY COLLAPSE | RA PRESSURE ESTIMATE |
|---|---|---|
| Normal | > 50% | 5 mmHg |
| Normal | < 50% | 10 mmHg |
| Dilated | Decreased | 15 mmHg |
| Dilated | No collapse | 20 mmHg |


02/03/2009 09:44:45 AM
V
10
20
93
2:33 HR
V
10
15
46
89:174 HR

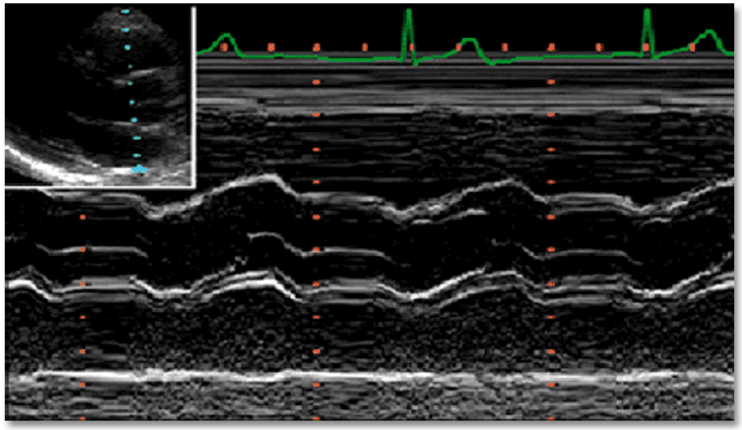
# Pulmonary Hypertension

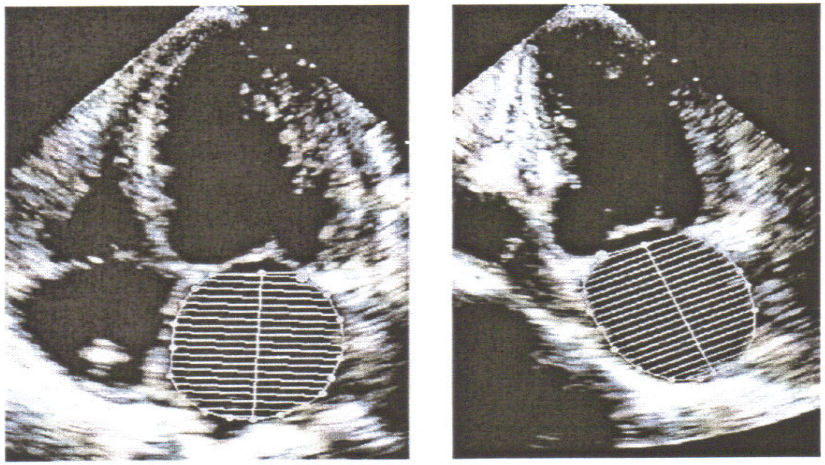
- Most labs assume RA pressure of 10 mmHg
- 35-39 mmHg borderline
- 40-49 mmHg mild
- 50-59 mmHg moderate
- >60 mmHg severe

# R and L Atrial size



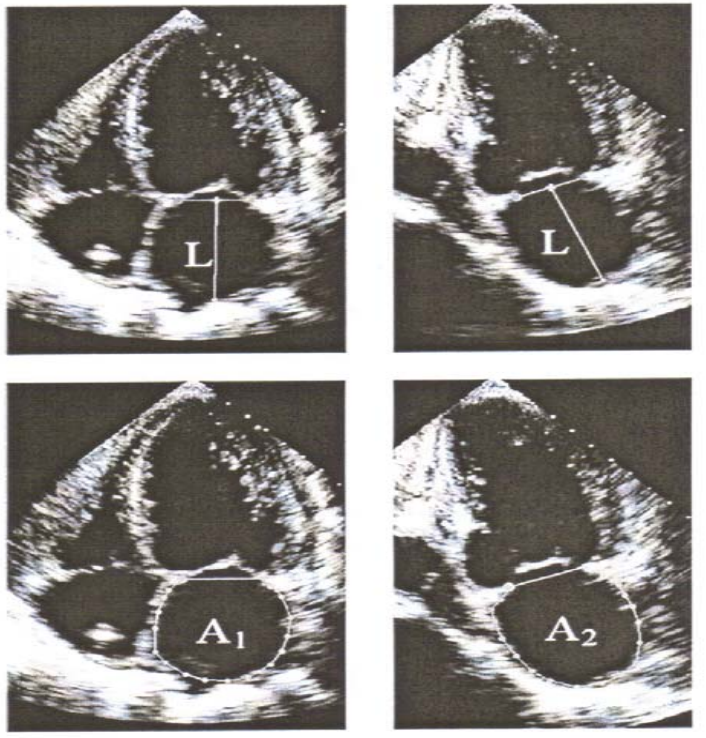
# LA size





A4C A2C

**Figure 17** Measurement of left atrial (LA) volume from biplane method of disks (modified Simpson's rule) using apical 4-chamber (*A4C*) and apical 2-chamber (*A2C*) views at ventricular end systole (maximum LA size).

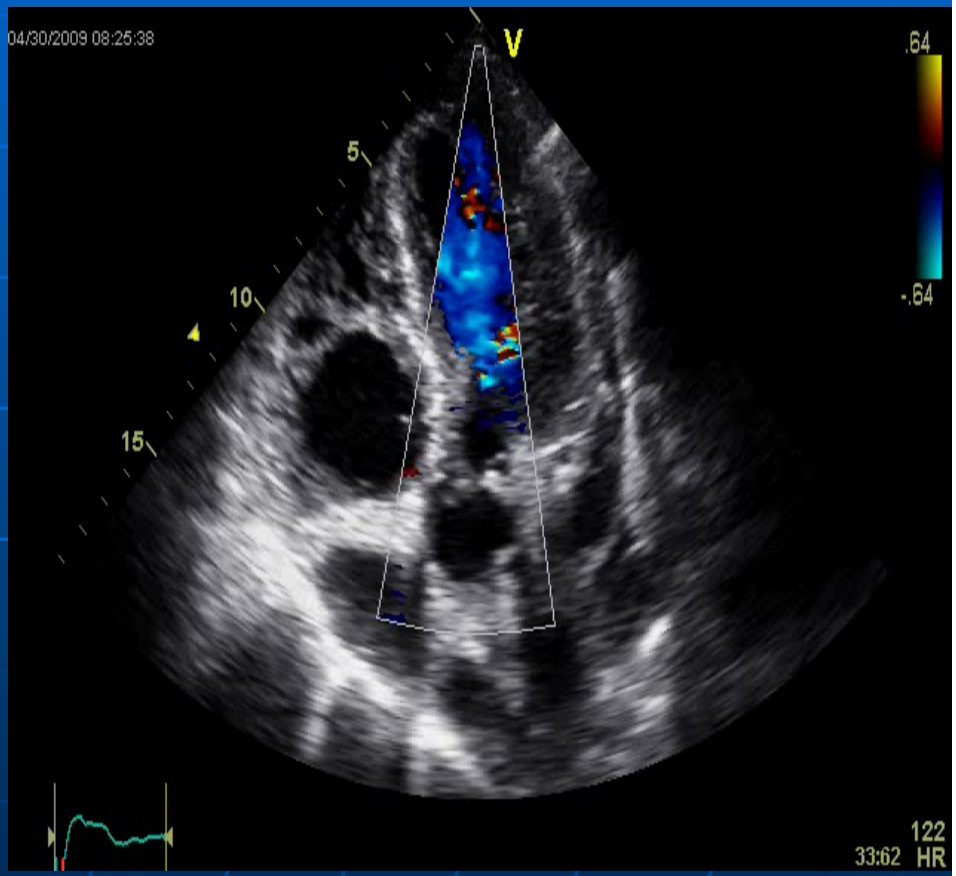



**Left Atrial Volume =**

$$8/3\pi[(A_1)(A_2)/(L)]\ *$$

* (L) is the shortest of either the A4C or A2C length

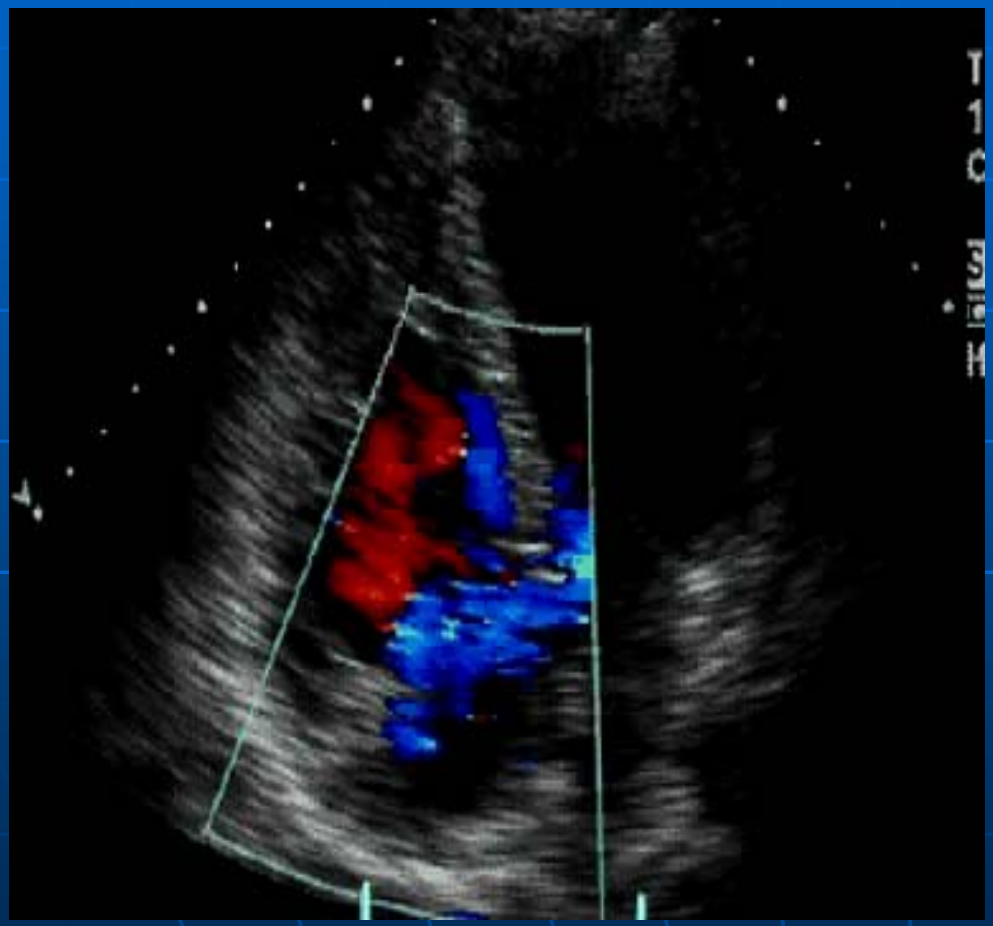
# Other atrial structure



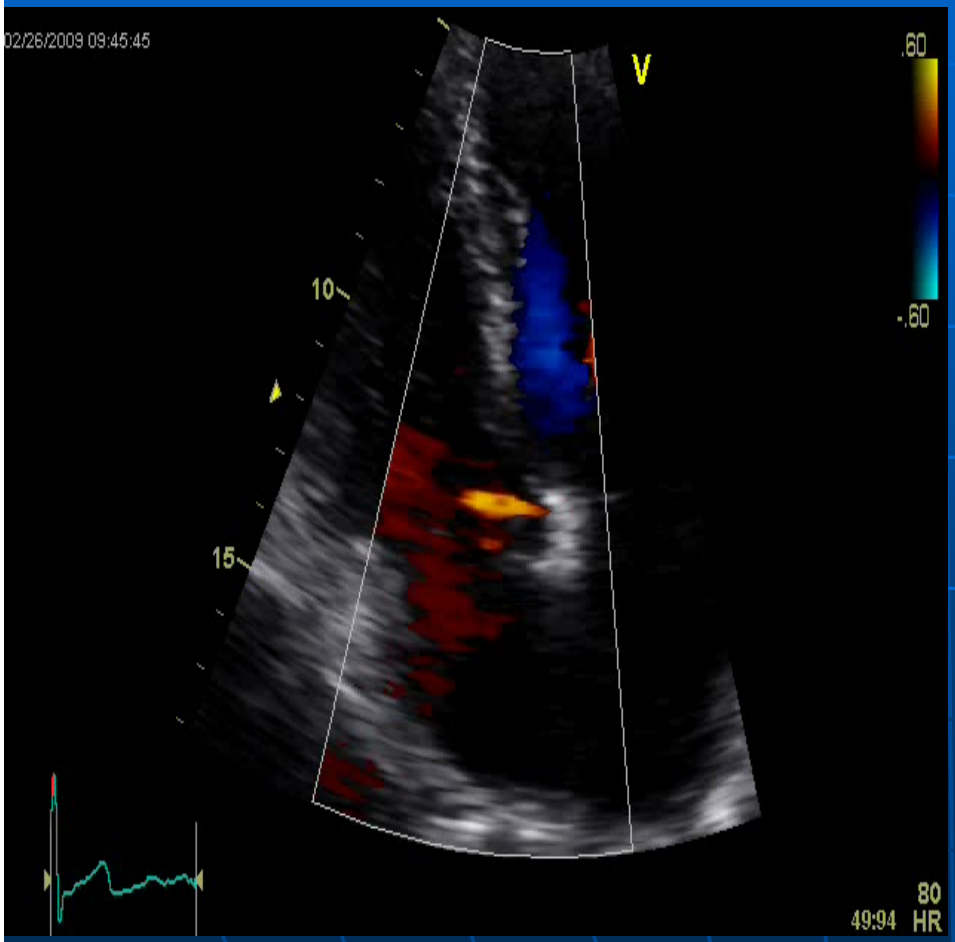
# PFO

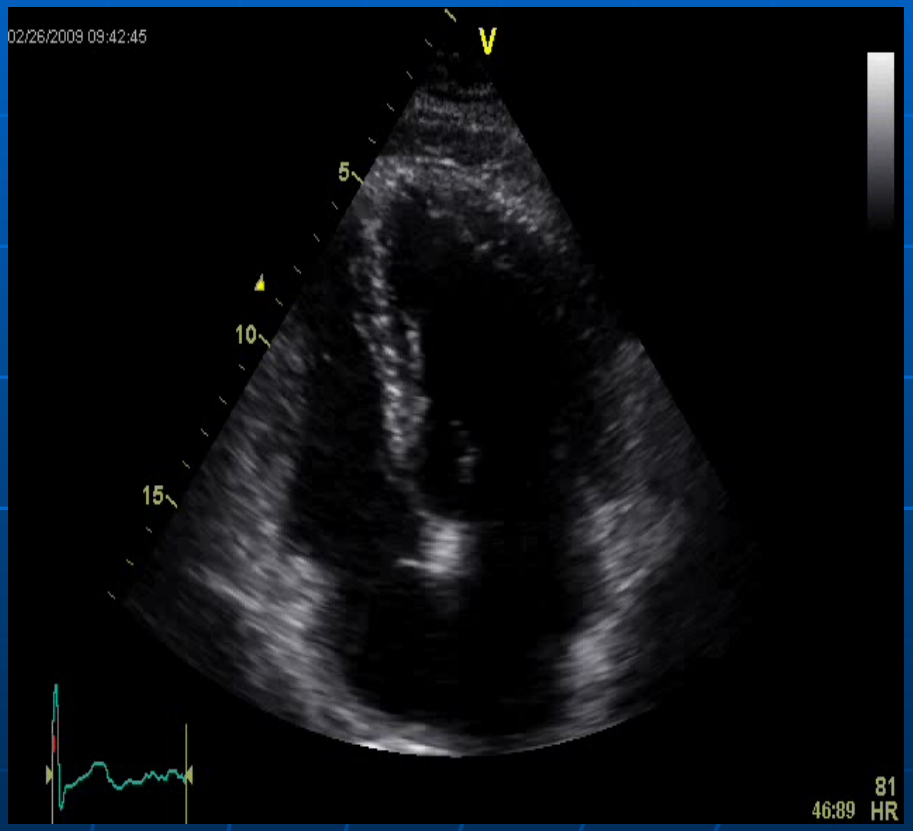

TE-V5M
7.0MHz
TEE
General
Pwr= -3dB MI=0.2
Lens Temp=35.6°C
75dB
Gain= 0dB
Store in progress
1:19:02
No R Trig
No trigger detected - defaulting to 1 second capture(s)

# ASD



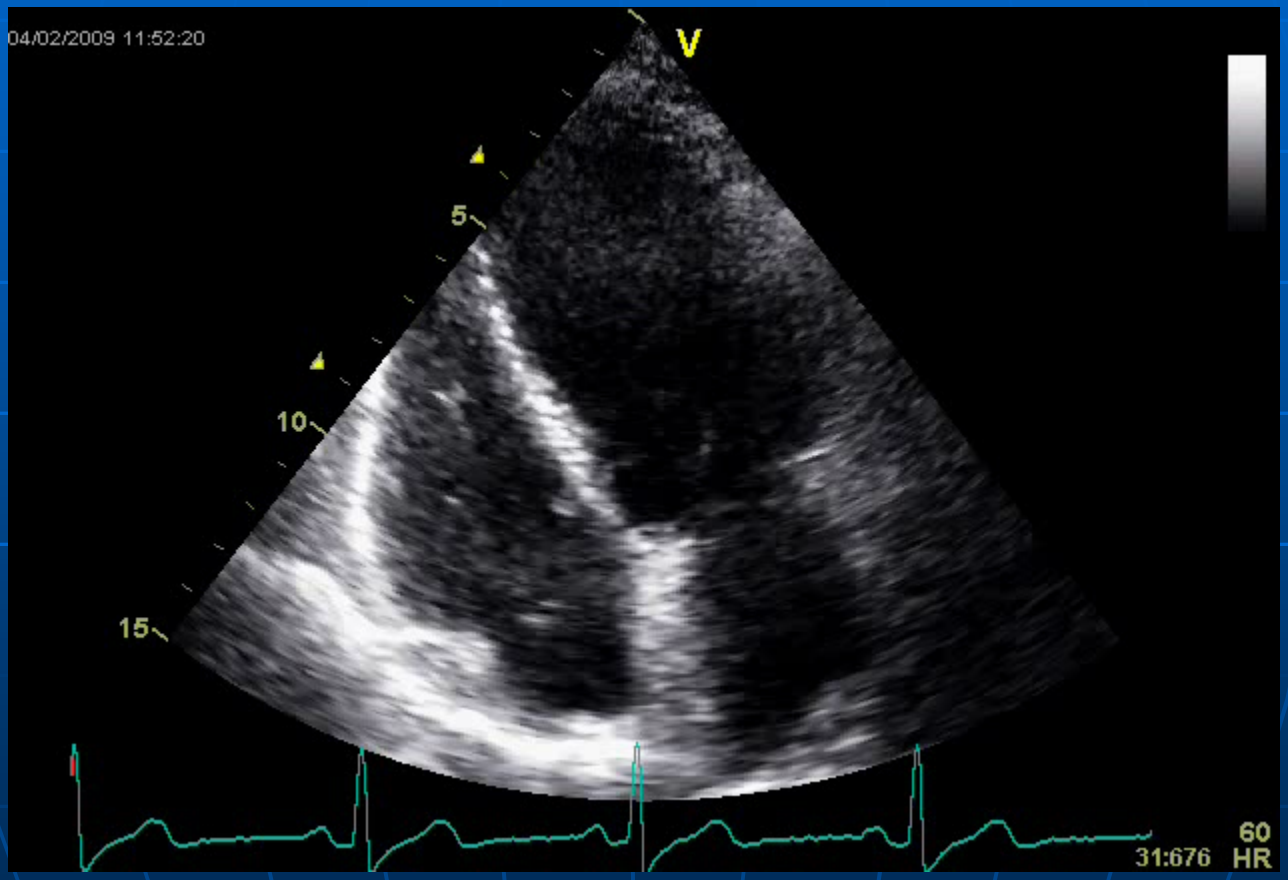
# ASA/PFO


02/26/2009 09:45:45
V
.60
-.60
10
15
80
49:94 HR

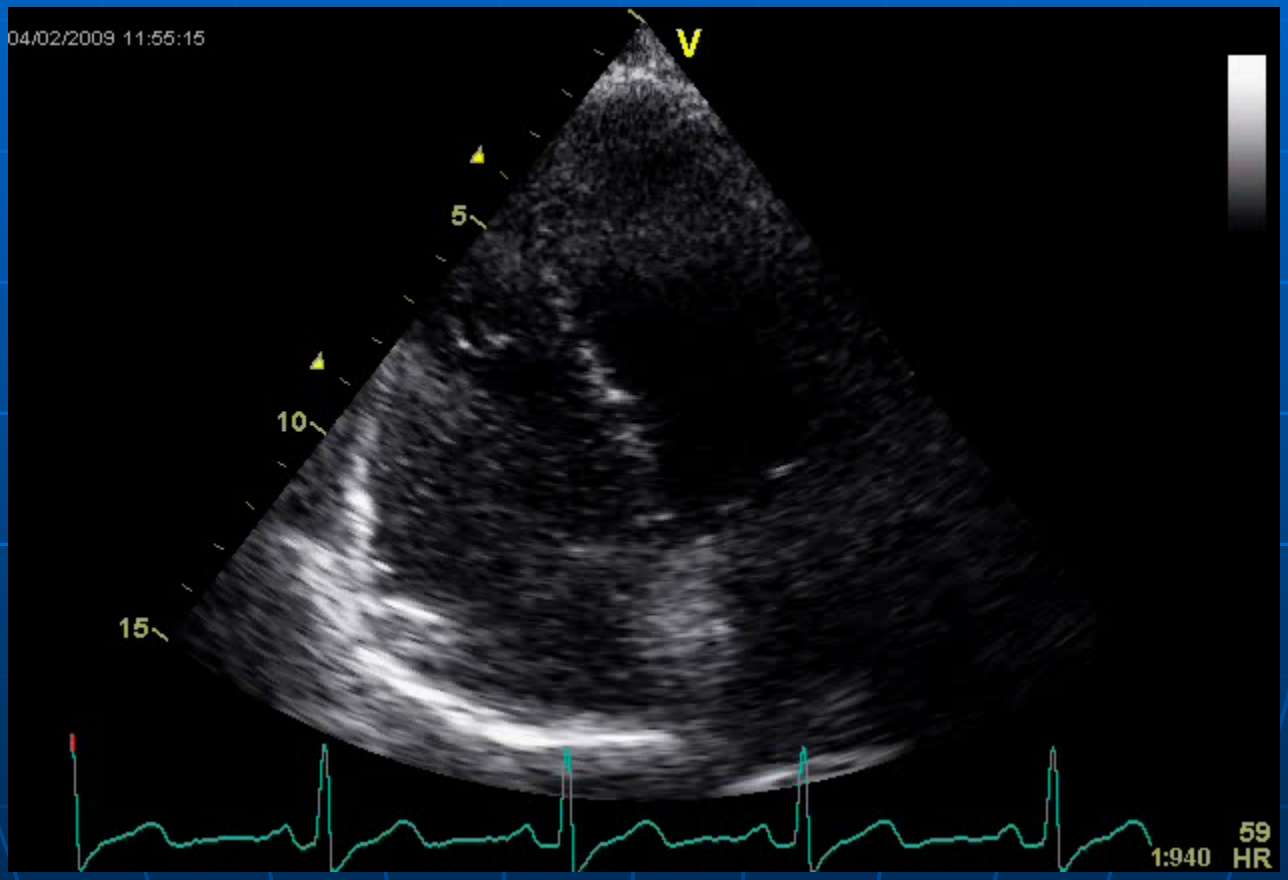

02/26/2009 09:42:45
V
5
10
15
81
46:89 HR

# ATRIAL SEPTAL ANEURYSM

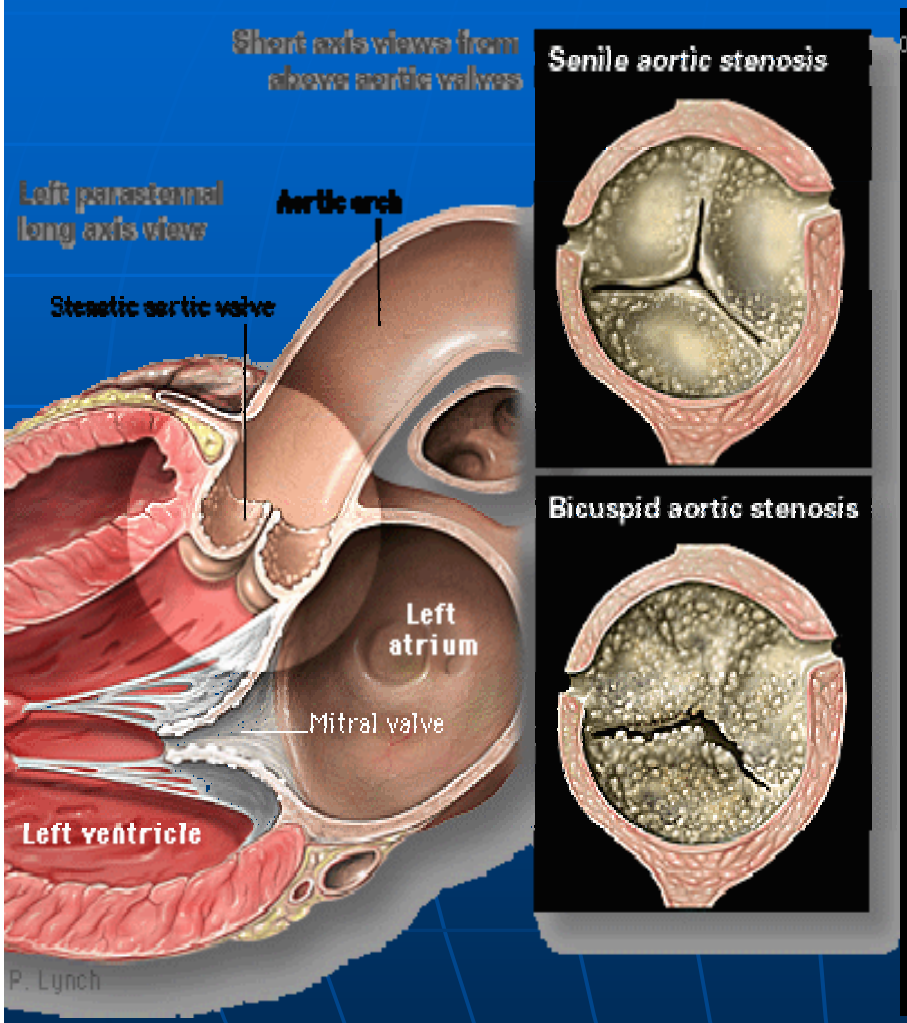
# Bubble study



# Pulmonary AV malformation

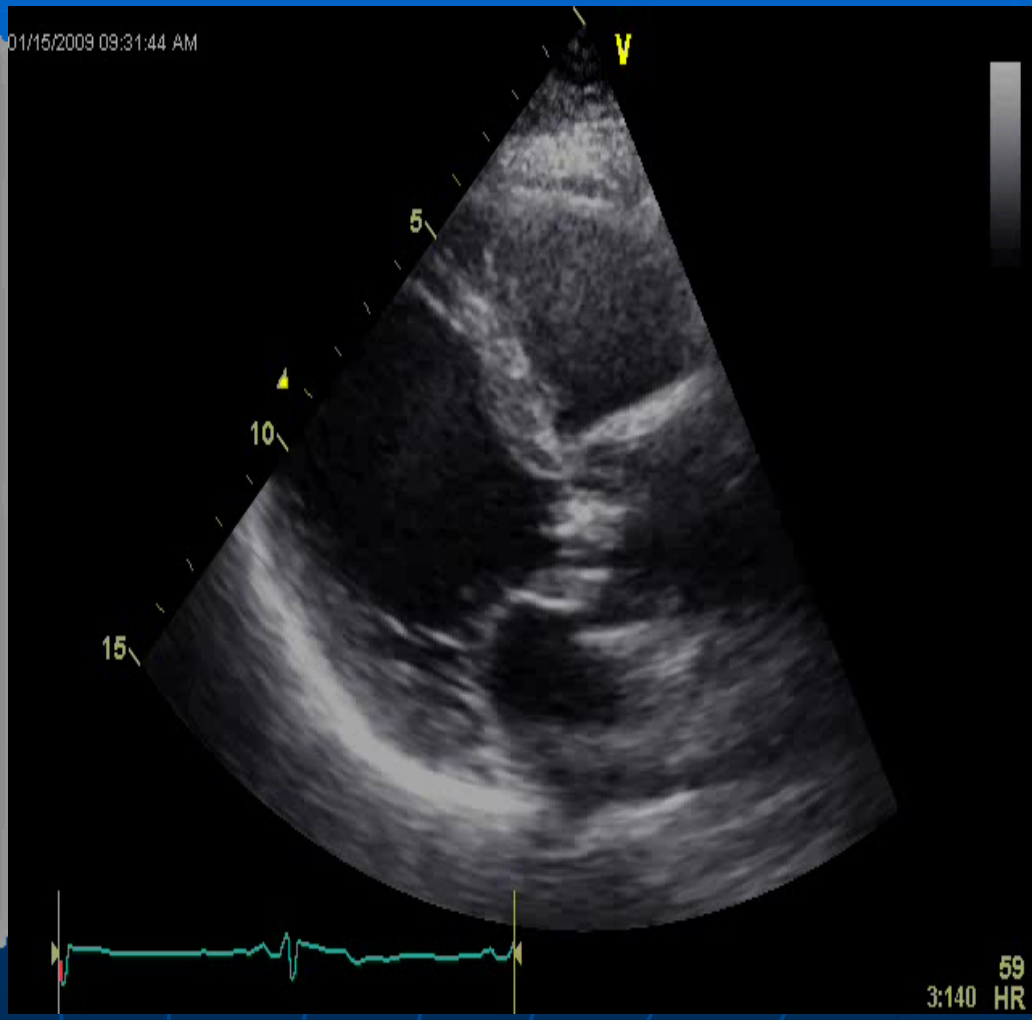


# Aortic stenosis

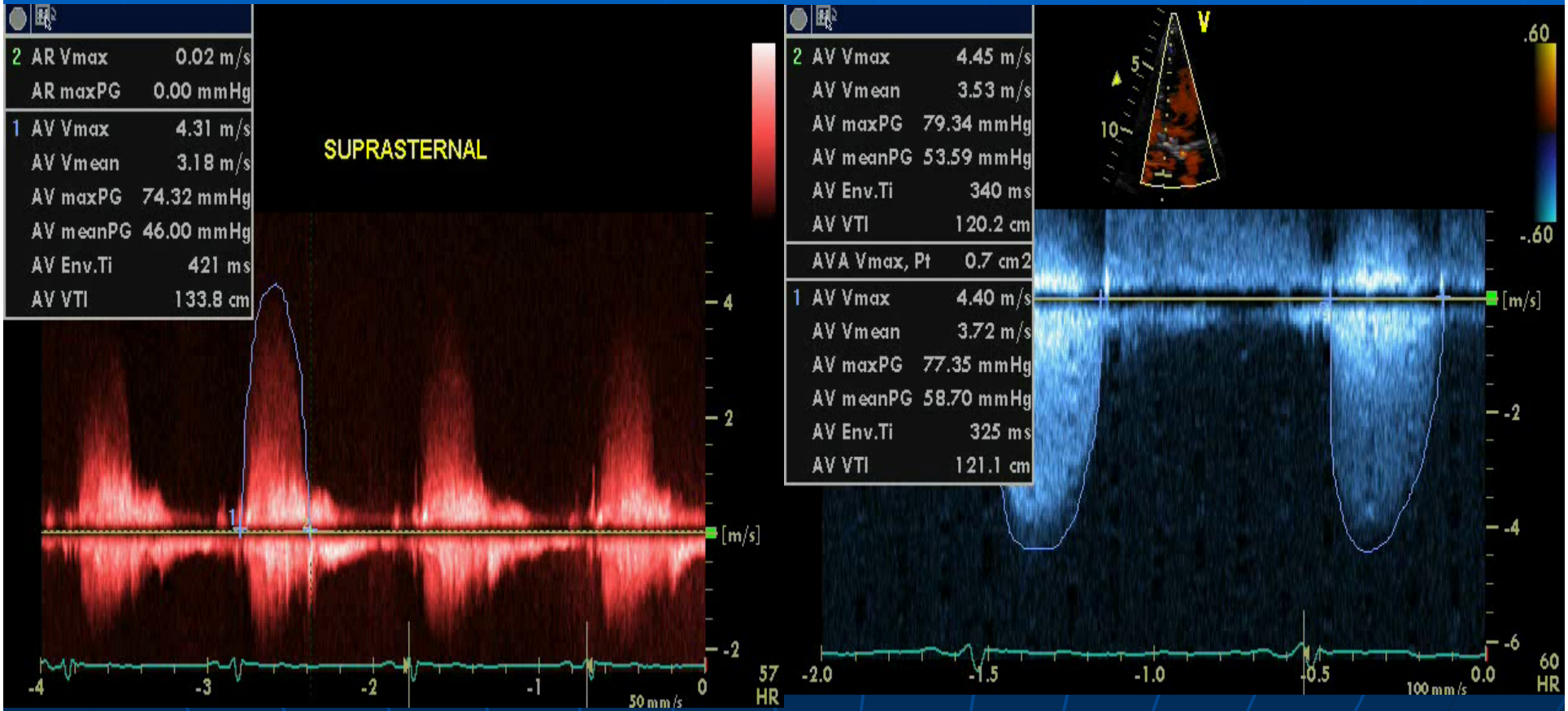




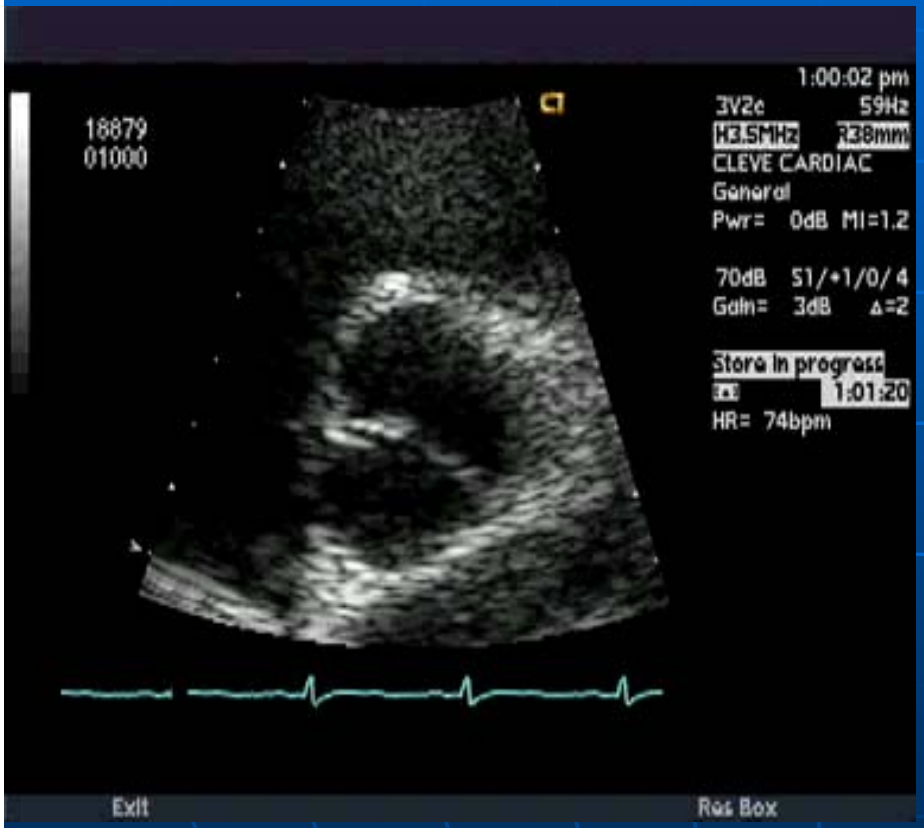


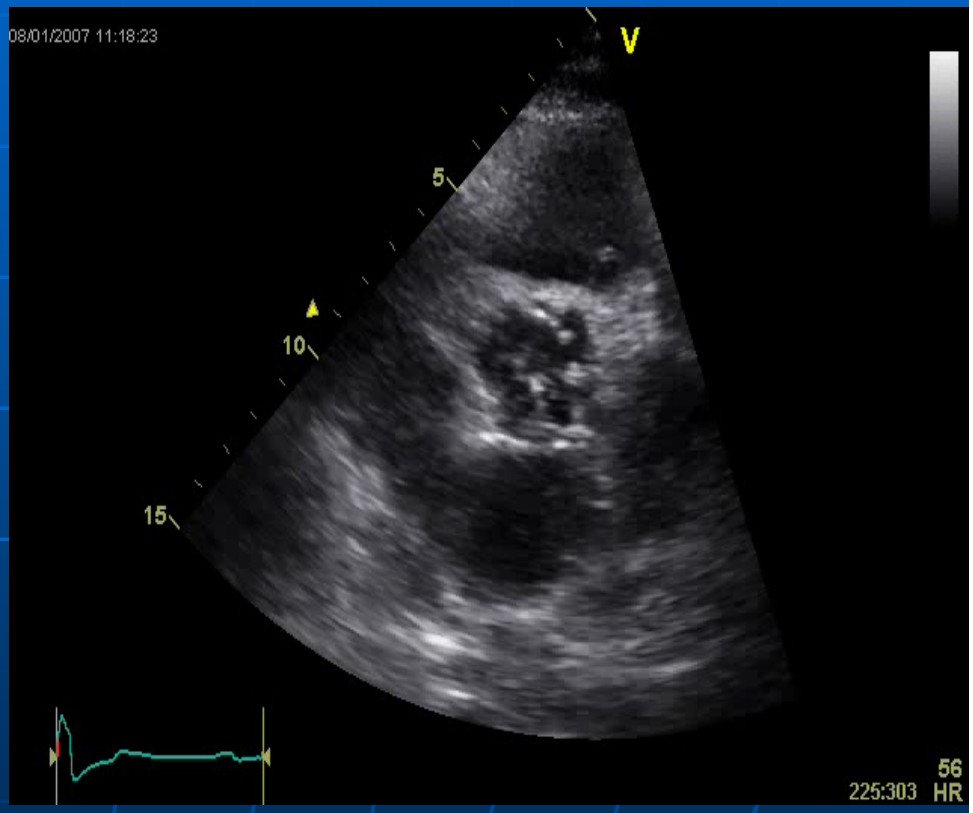


# Aortic stenosis

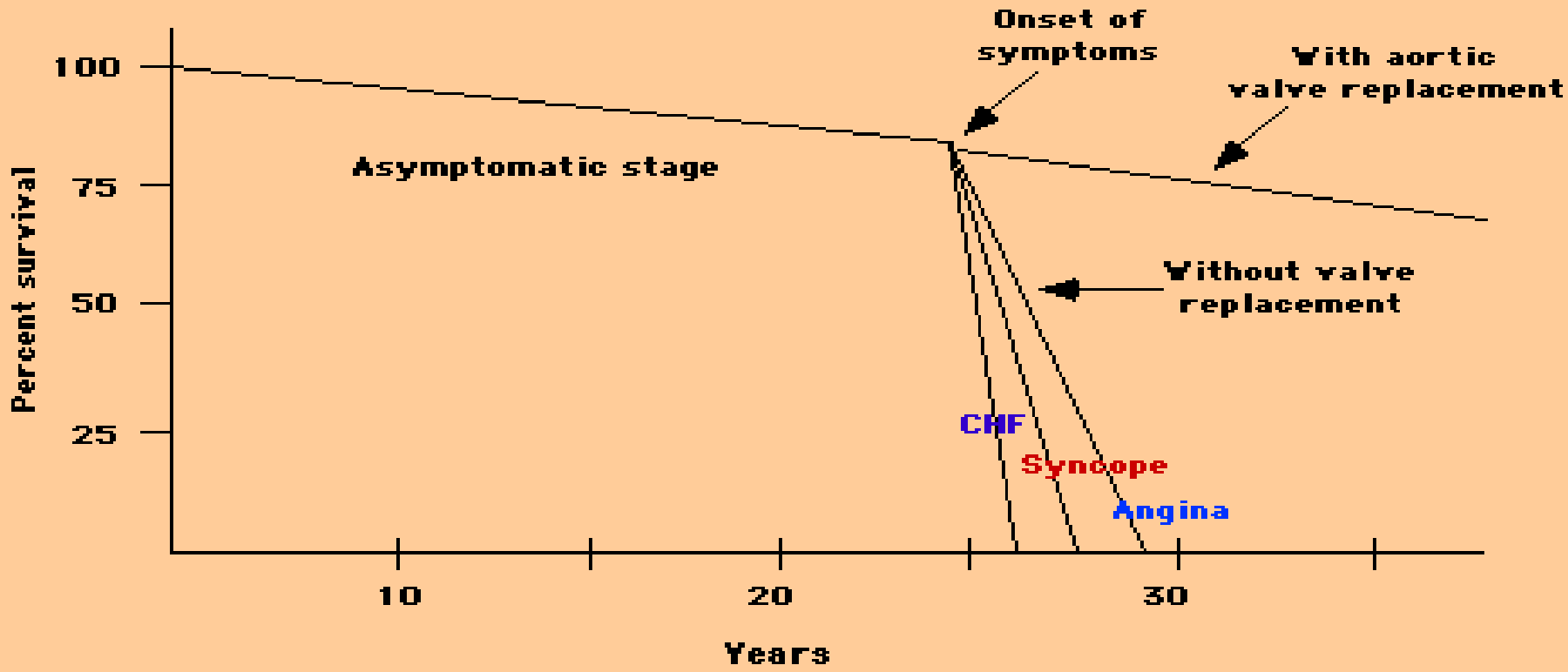


# Aortic valve



# Natural history of AS




**Natural history of aortic stenosis** Schematic representation of the natural history of aortic stenosis and of the major impact of aortic valve replacement. Survival is excellent during the prolonged asymptomatic phase. After the development of symptoms, however, mortality exceeds 90 percent within a few years. Aortic valve replacement prevents this rapid downhill course.

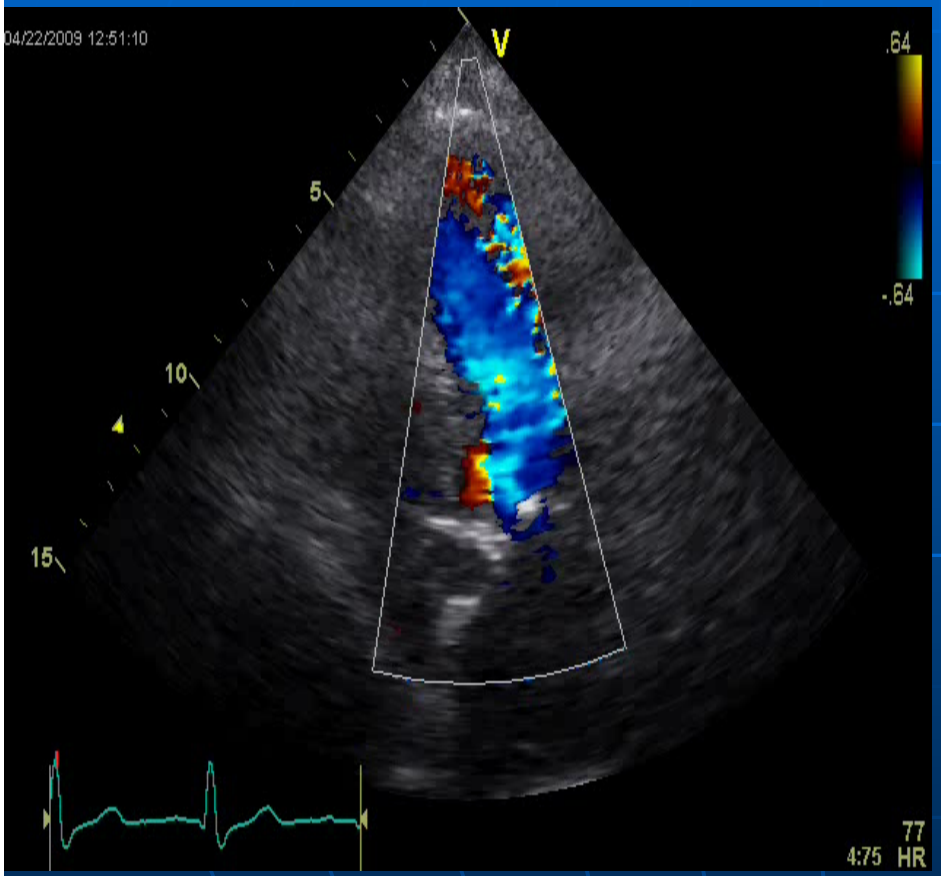
## Recommendations for classification of AS severity

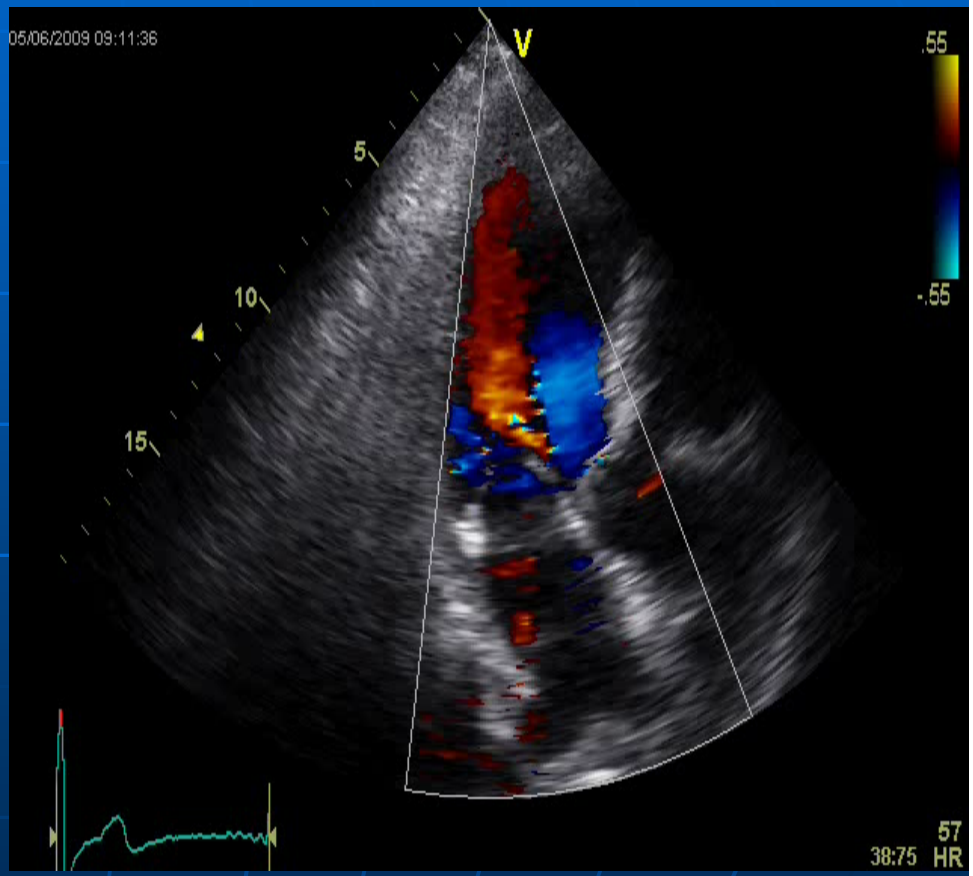
| | Aortic sclerosis | Mild | Moderate | Severe |
|---|---|---|---|---|
| Aortic jet velocity (m/s) | ≤2.5 m/s | 2.6-2.9 | 3.0-4.0 | >4.0 |
| Mean gradient (mmHg) | – | <20 (<30[a]) | 20-40[b] (30-50[a]) | >40[b] (>50[a]) |
| AVA ($cm^2$) | – | >1.5 | 1.0-1.5 | <1.0 |
| Indexed AVA ($cm^2/m^2$) | | >0.85 | 0.60-0.85 | <0.6 |
| Velocity ratio | | >0.50 | 0.25-0.50 | <0.25 |

aESC Guidelines.
bAHA/ACC Guidelines.

Normal adult AVA = 3-4 cm2

# Aortic regurgitation



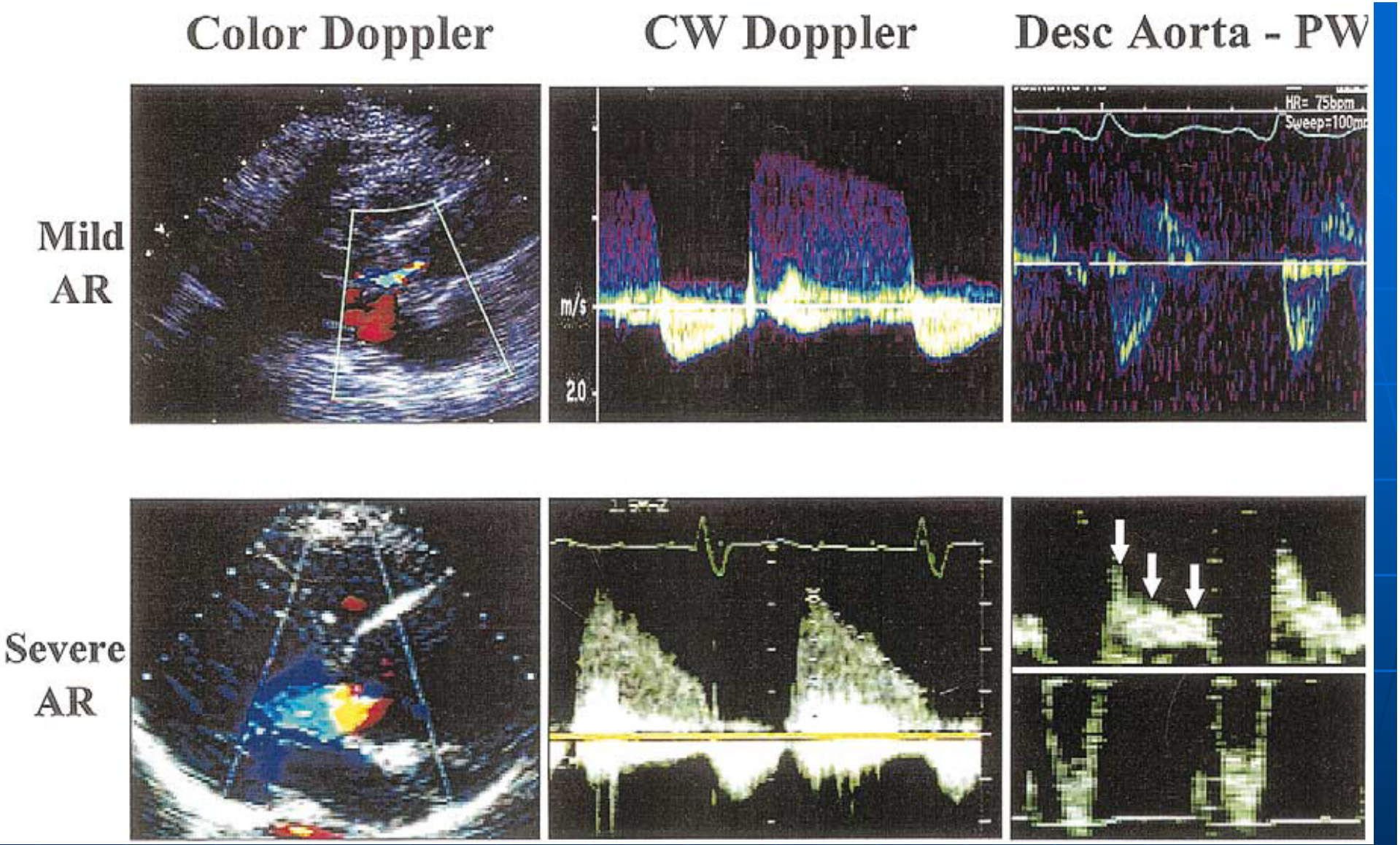
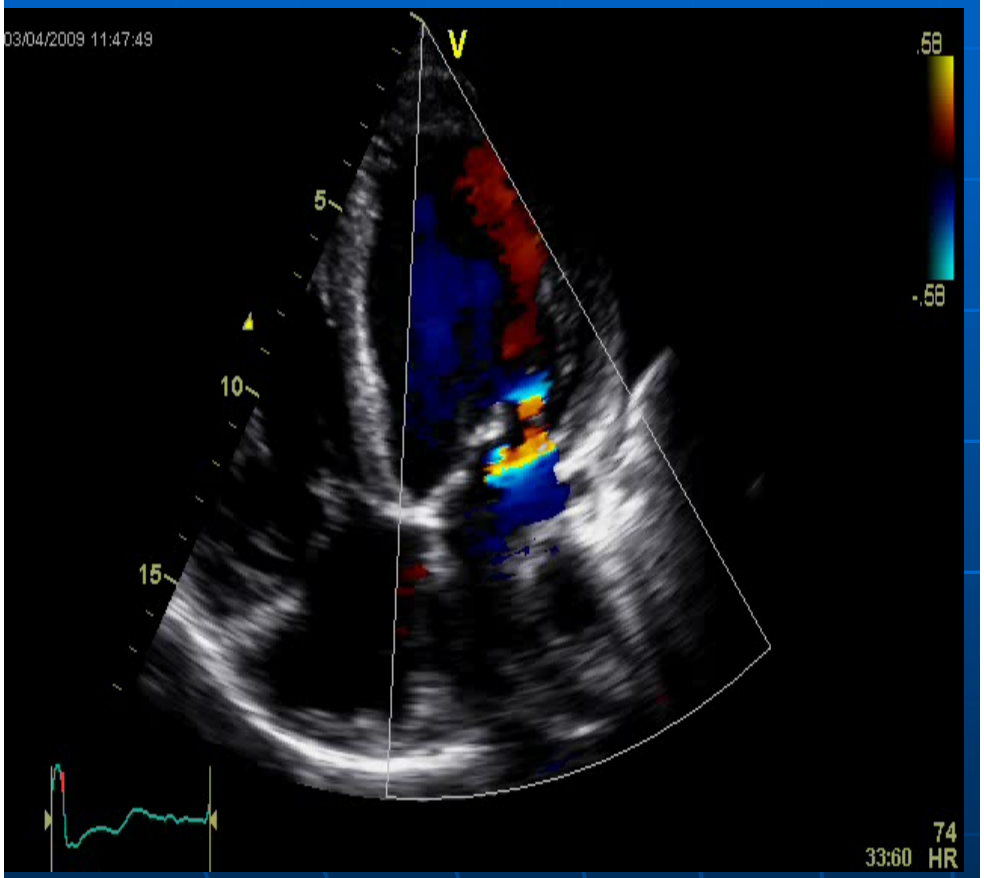
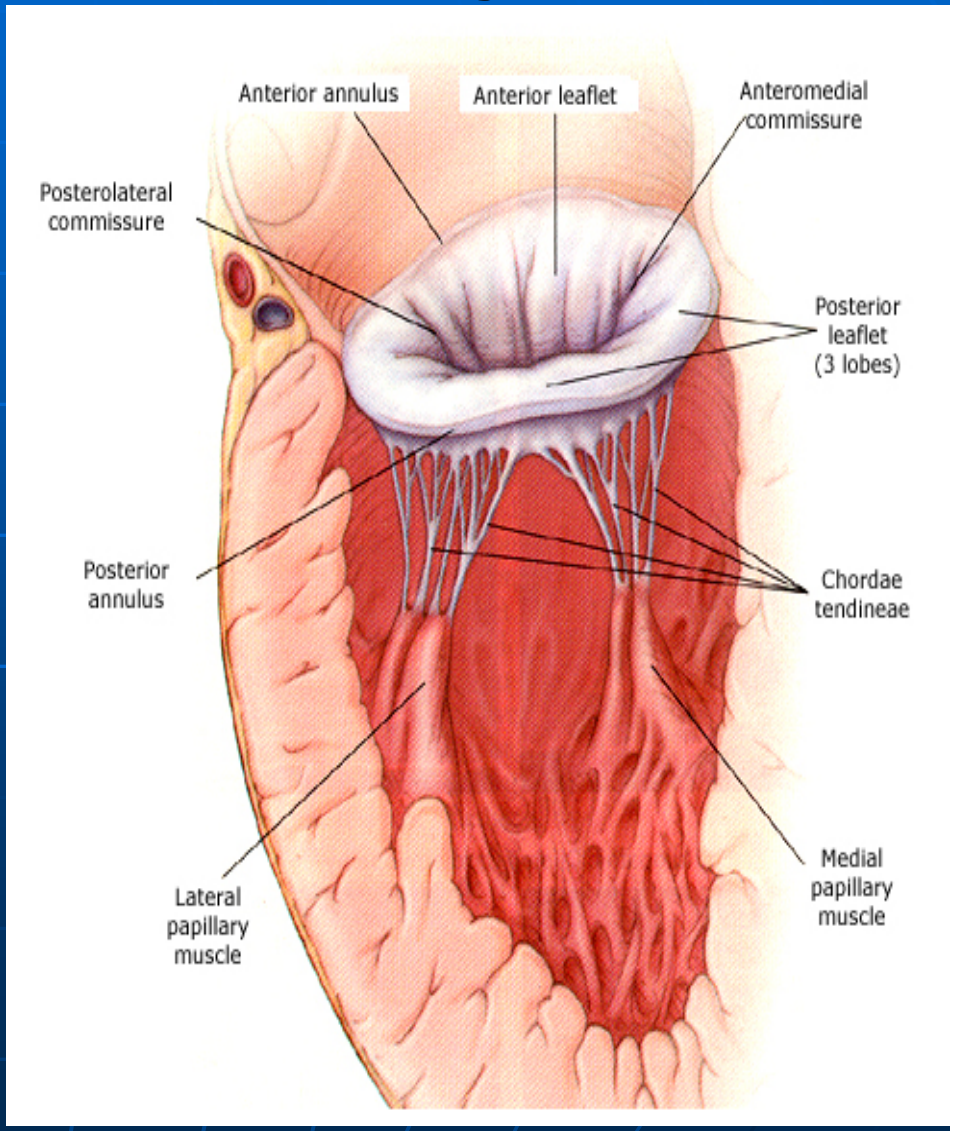



**Figure 6** Color Doppler and continuous wave (*CW*) Doppler recordings of the regurgitant jet as well as pulsed wave (*PW*) Doppler recording of flow in the descending thoracic aorta in examples of mild and severe aortic regurgitation (*AR*). Compared to the mild AR, the case of severe AR has a large jet width in the left ventricular outflow, a steep deceleration rate of the AR velocity by CW Doppler, and a holo-diastolic flow reversal in the descending (*desc*) aorta (*arrows*).

# Mitral valve anatomy



## Causes of Chronic Mitral Regurgitation

### Leaflet

- Rheumatic fever
- Systemic lupus erythematosus
- Infective endocarditis (acute and chronic)
- Scleroderma
- Connective tissue disorders
  - Marfan's
  - Ehlers-Danlos
  - Pseudoxanthoma elasticum
- Congenital
  - Mitral valve clefts
  - Parachute mitral valve
  - Endocardial cushion defects
- Myxomatous degeneration (mitral valve prolapse)
- Left atrial myxoma
- Hypertrophic cardiomyopathy (systolic anterior movement of mitral valve)
- Fenfluramine-phentermine

### Chordae tendineae

- Myxomatous degeneration (mitral valve prolapse)
- Infective endocarditis (acute and chronic)
- Trauma
- Rheumatic fever
- Rupture
  - Spontaneous
  - Myocardial infarction
  - Trauma
  - Myxomatous degeneration
  - Endocarditis

### Papillary muscles

- Papillary muscle dysfunction
  - Ischemia
    - Myocardial infarction
    - Dilated cardiomyopathy
    - Left ventricular aneurysm
    - Infiltration (amyloid, granulomas)
    - Infection (endocarditis, abscess)
- Papillary muscle rupture
  - Myocardial infarction
  - Trauma

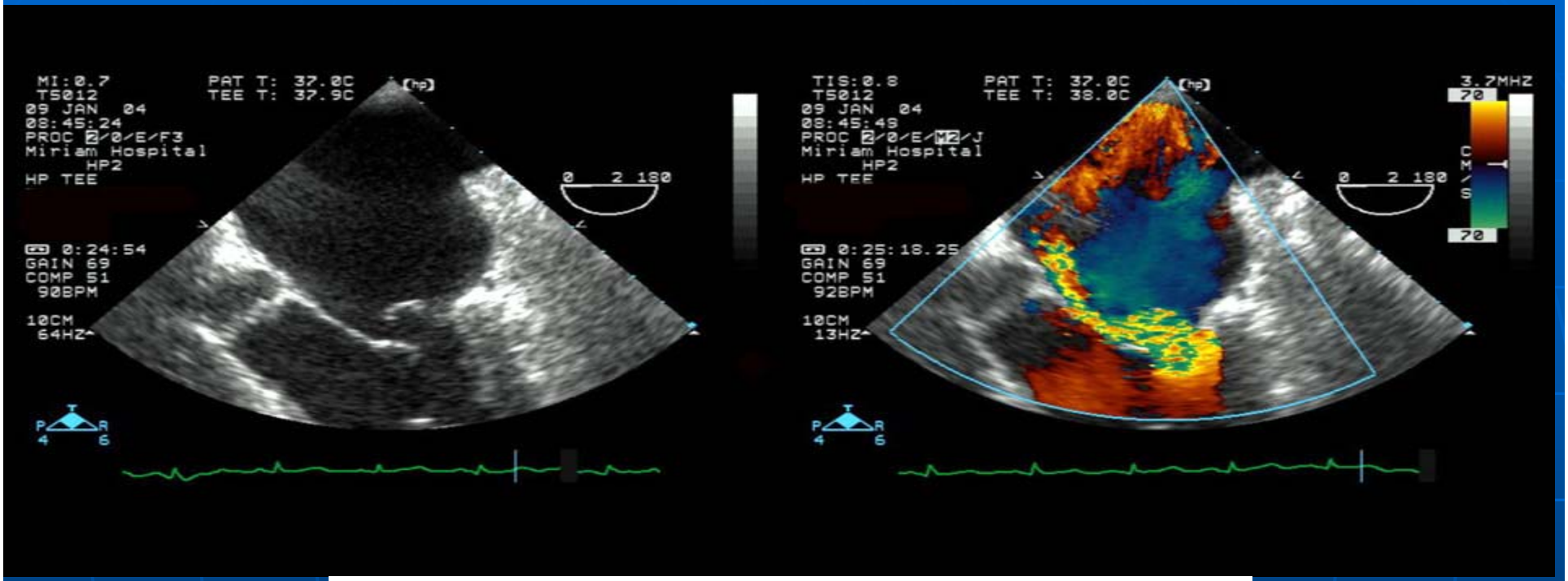
### Mitral annulus

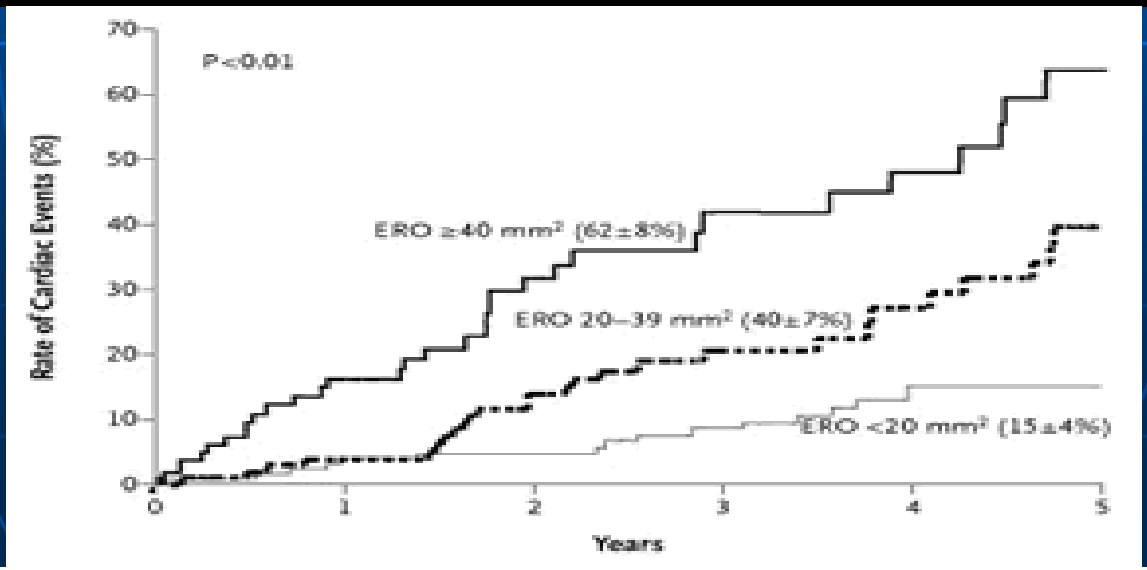
- Calcification
  - Idiopathic
  - Rheumatic fever
  - Chronic renal failure
  - Hyperparathyroidism
- Dilatation
  - Connective tissue disorder
  - Dilated cardiomyopathy

### Prosthetic valve

- Paravalvular leak
- Infective endocarditis
- Ring or strut fracture
- Disc or ball dysfunction or dislodgement
- Leaflet deterioration (tissue valves)

# Mitral regurgitation



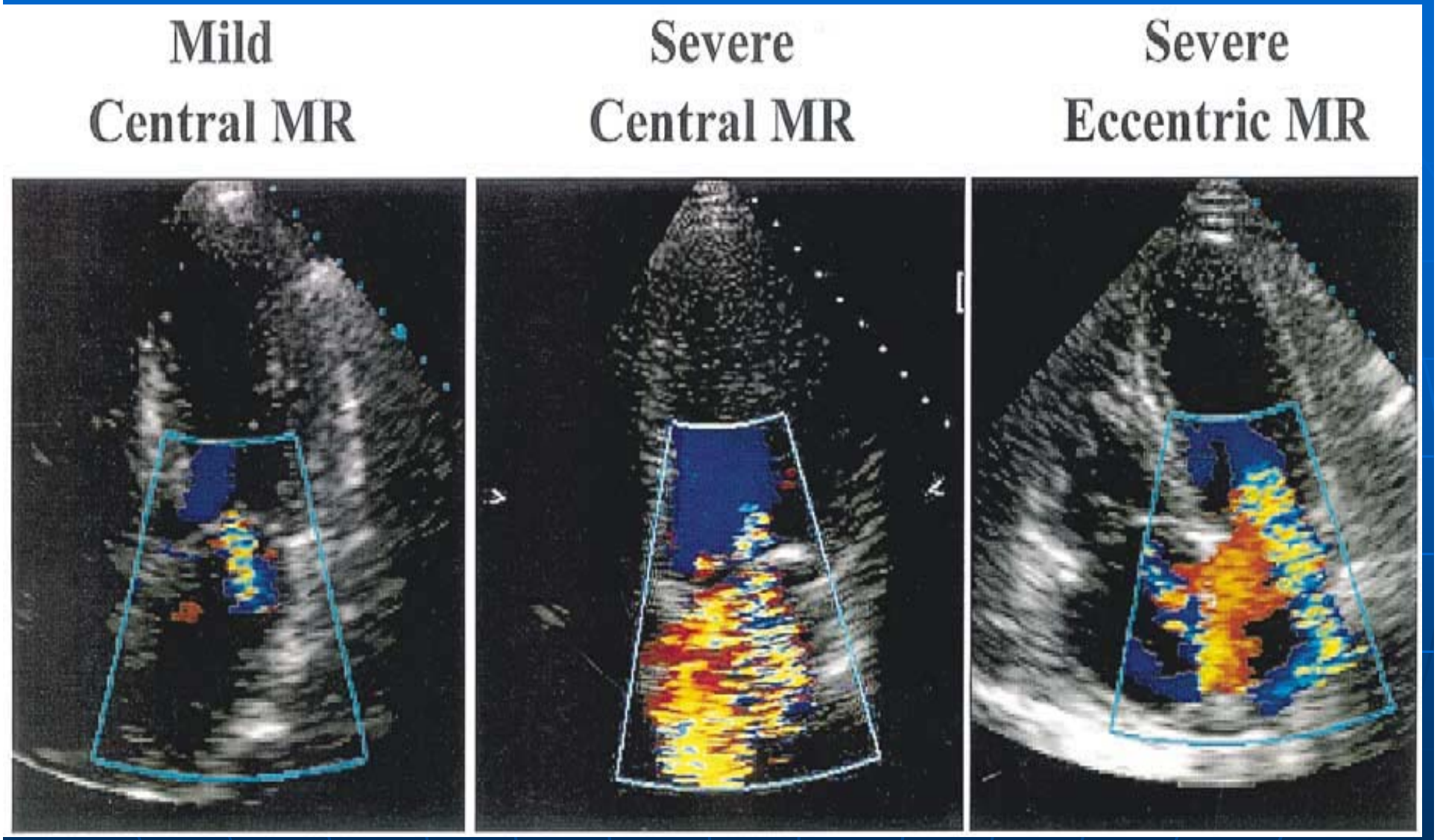



**Figure 3** Examples of color flow recordings of different mitral regurgitation (*MR*) lesions from the apical window. The case of mild regurgitation has no flow convergence, a small regurgitant jet area, in contrast to that of severe central MR, which shows a prominent flow convergence and a large regurgitant jet area. The example with severe eccentric MR has a small jet area impinging on the wall of the left atrium but a large flow convergence and a wide vena contracta.

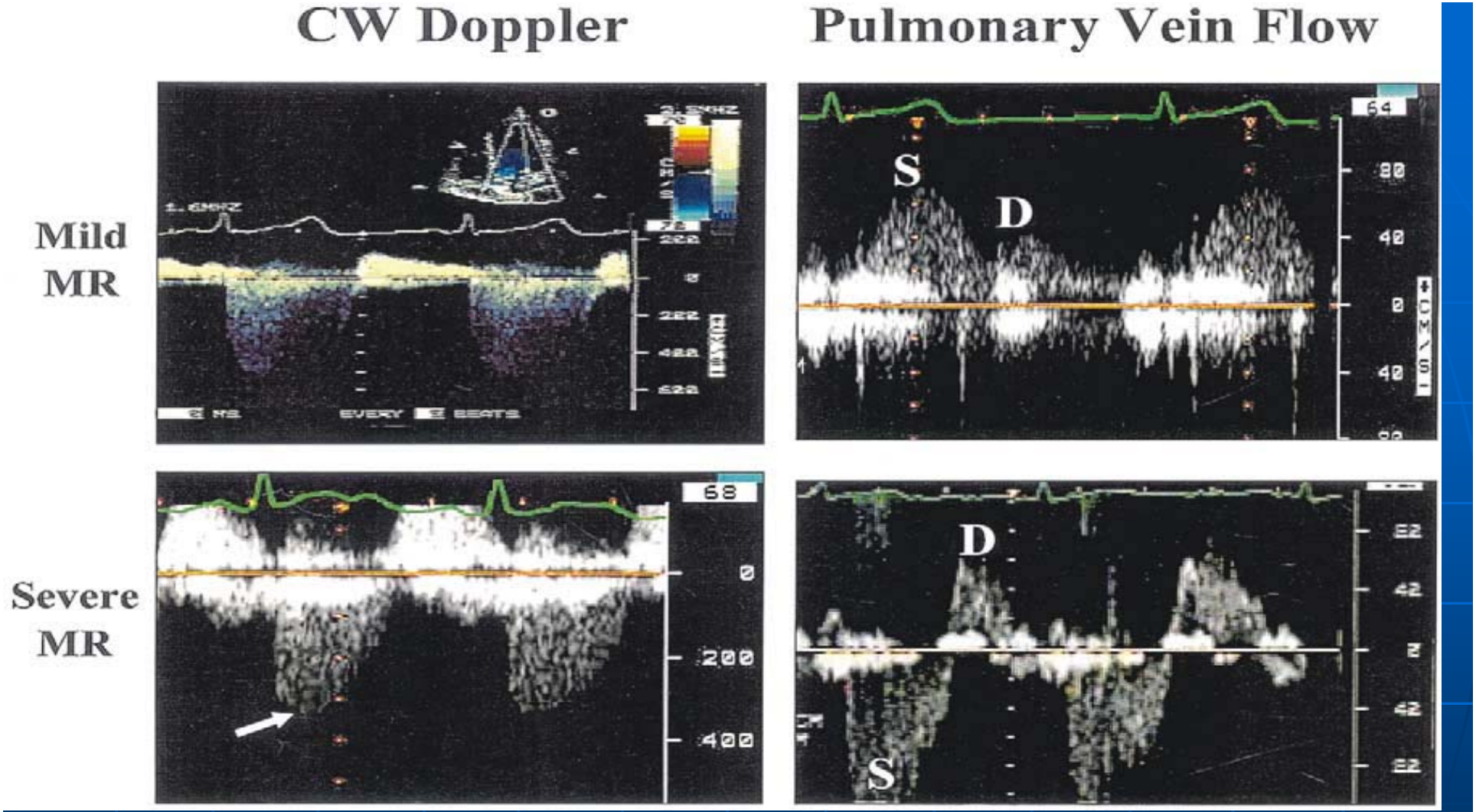
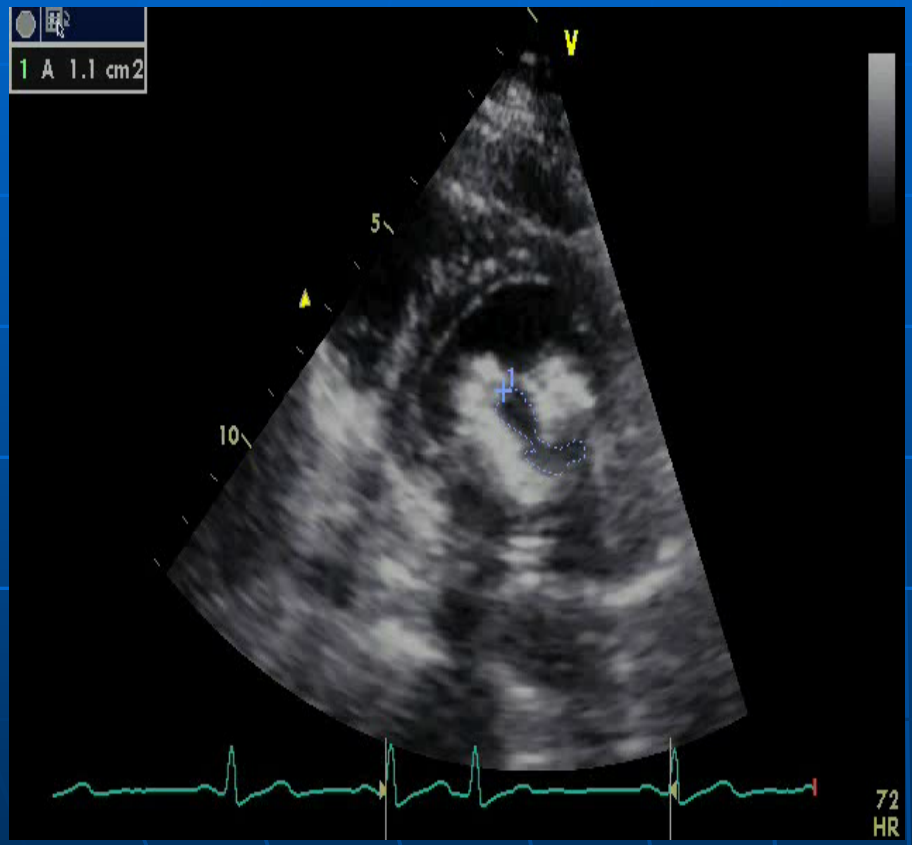
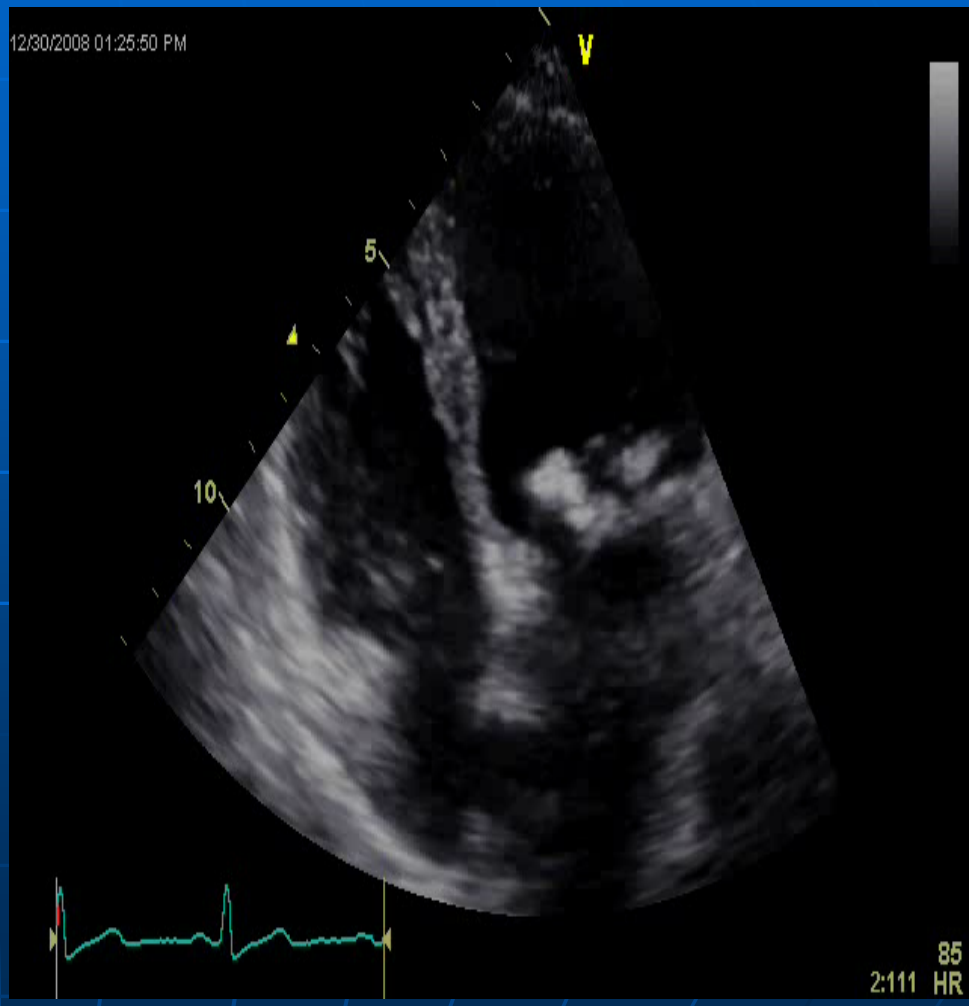


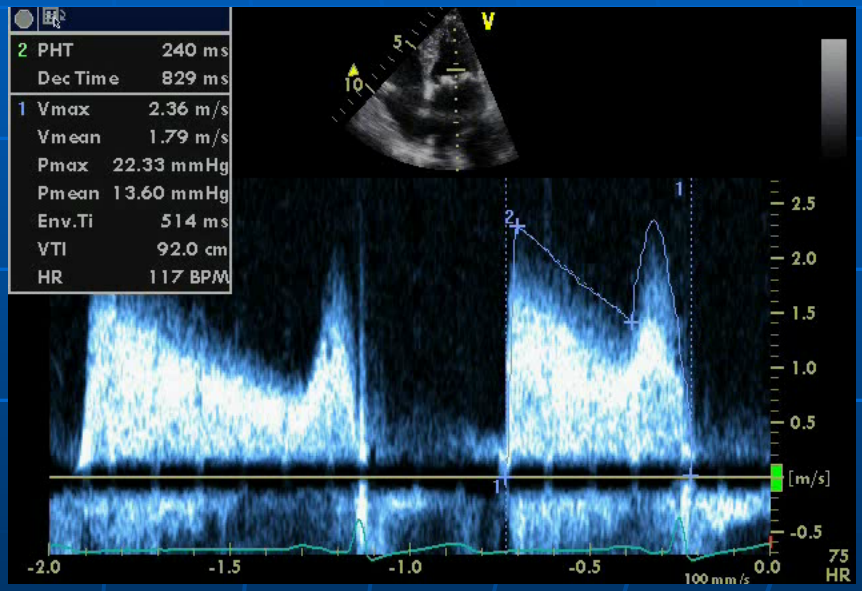

**Figure 4** Example of findings of continuous wave (*CW*) Doppler recordings and pulmonary vein flow by pulsed Doppler in a case with mild and another with severe mitral regurgitation (*MR*). In mild MR, spectral recording of the jet has a soft density with a parabolic, rounded contour of the regurgitant velocity
whereas in severe MR, the jet is dense with a triangular, early peaking of the velocity (*arrow*). Pulmonary vein flow is normal in mild MR with predominance of systolic flow (*S*). In contrast, the case with severe MR displays systolic flow reversal. *D*, Diastolic flow velocity.

# Mitral valve stenosis



# Mitral Stenosis

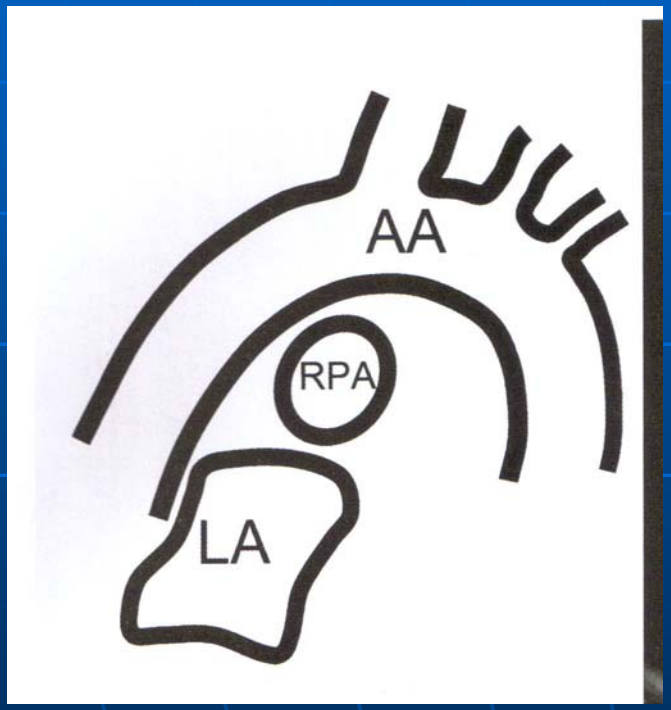



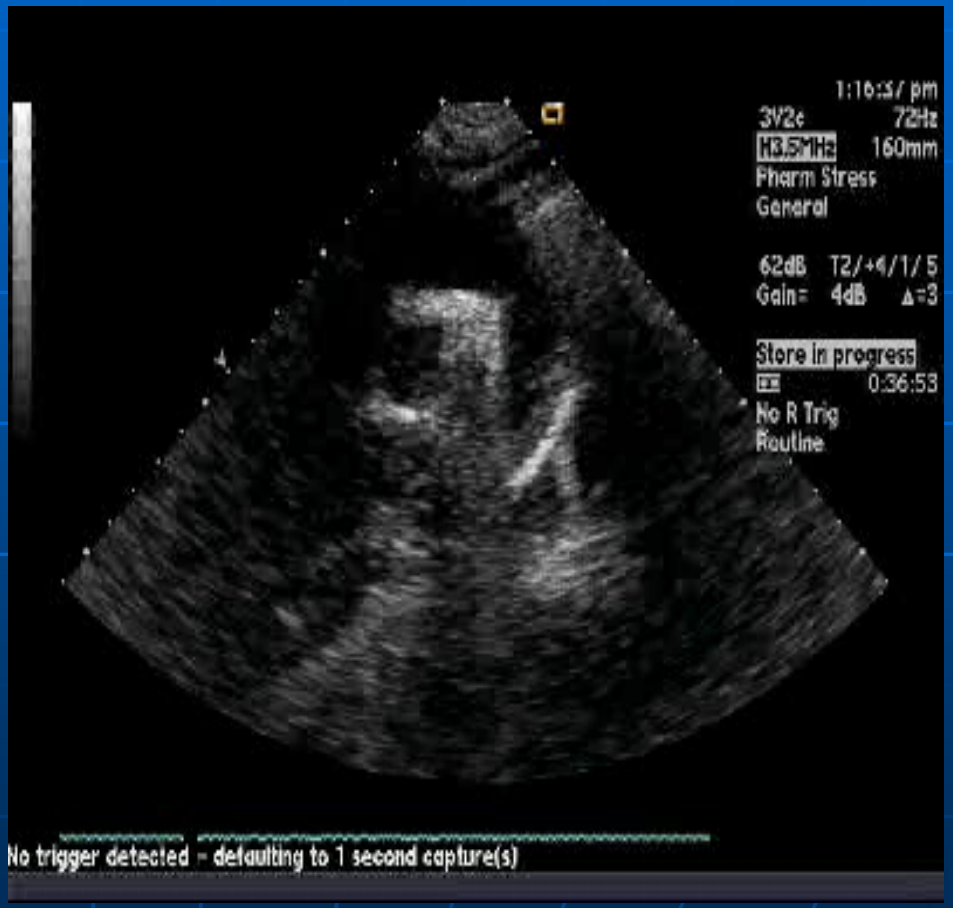
Recommendations for classification of mitral stenosis severity

| | Mild | Moderate | Severe |
|---|---|---|---|
| Specific findings | | | |
| Valve area ($cm^2$) | >1.5 | 1.0–1.5 | <1.0 |
| Supportive findings | | | |
| Mean gradient (mmHg)[a] | <5 | 5–10 | >10 |
| Pulmonary artery pressure (mmHg) | <30 | 30–50 | >50 |

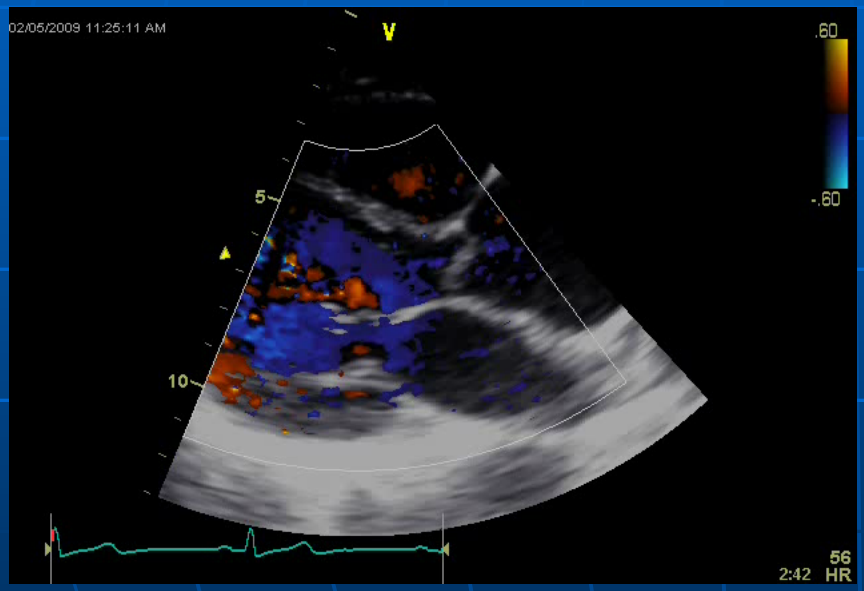
aAt heart rates between 60 and 80 bpm and in sinus rhythm.

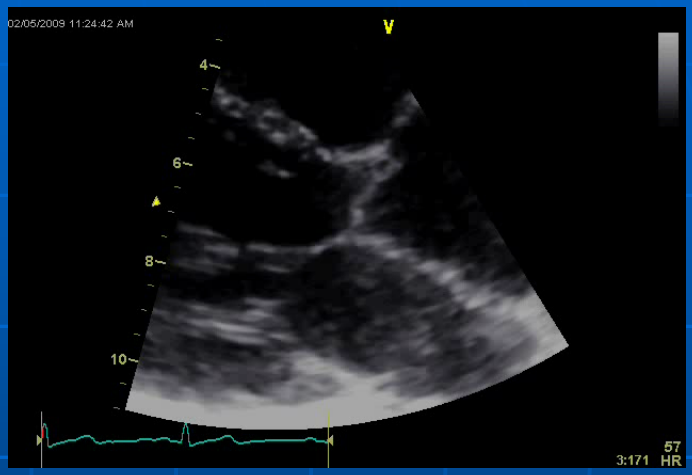
# Aortic arch

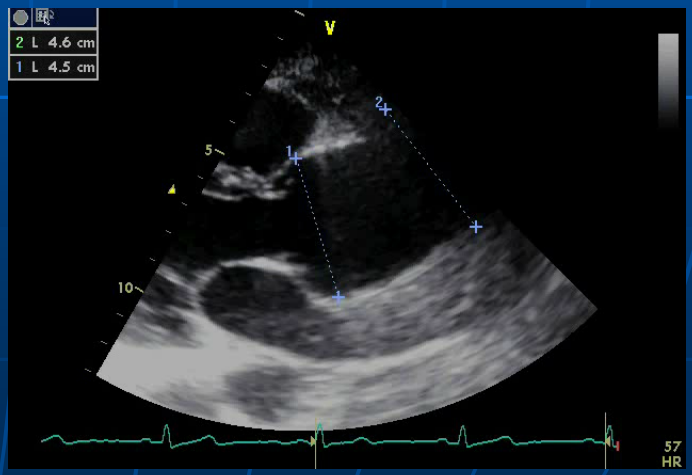

AA
RPA
LA


1:16:57 pm
3V2c
72Hz
H3.5MHz
160mm
Pharm Stress
General
62dB
Gain= 4dB
Store in progress
0:36:53
No R Trig
Routine
No trigger detected - defaulting to 1 second capture(s)

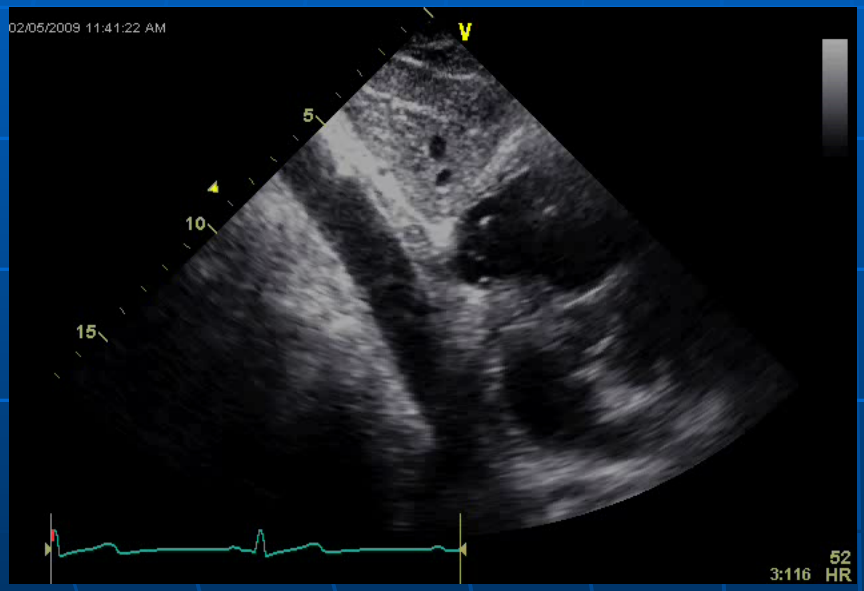
# Aorta root/ascending

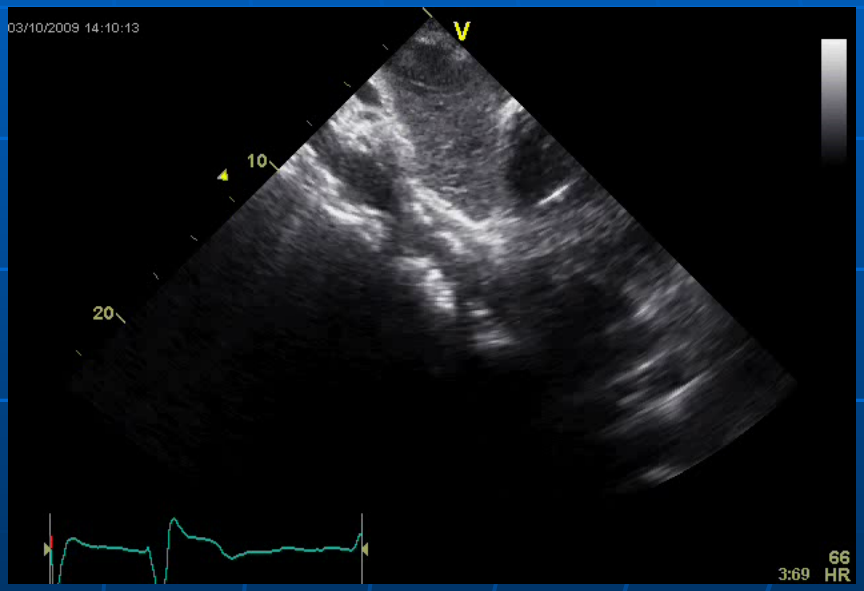


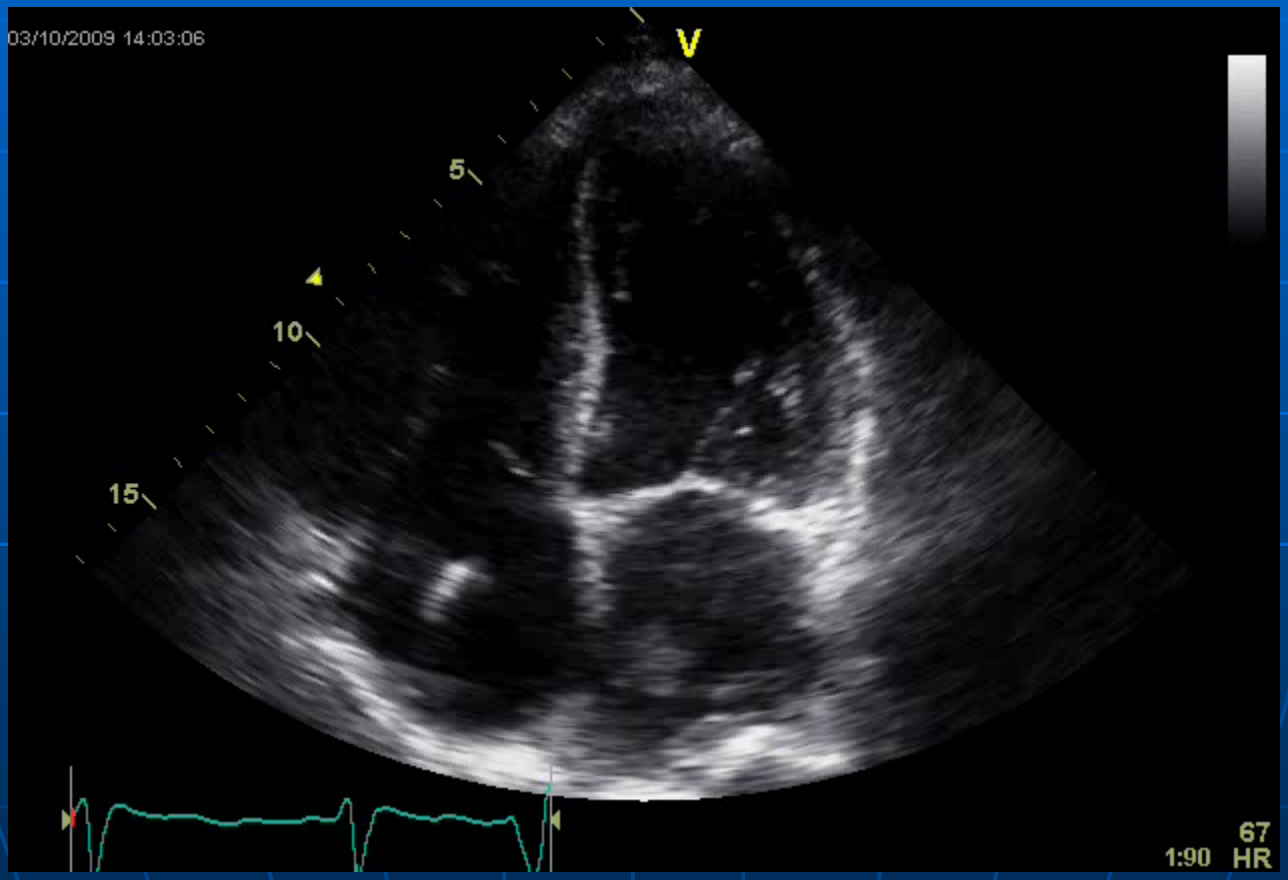



# Abdominal aorta

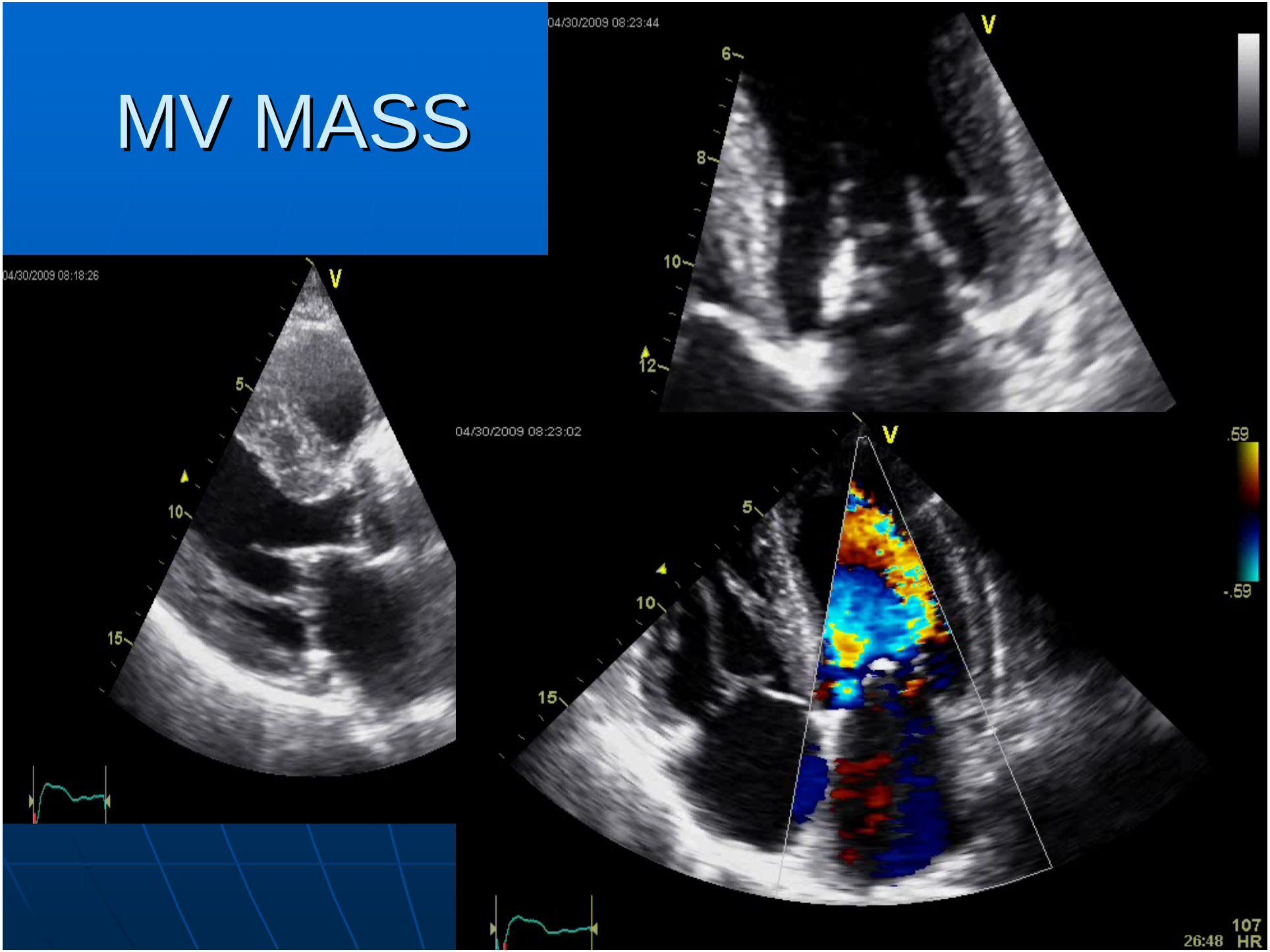


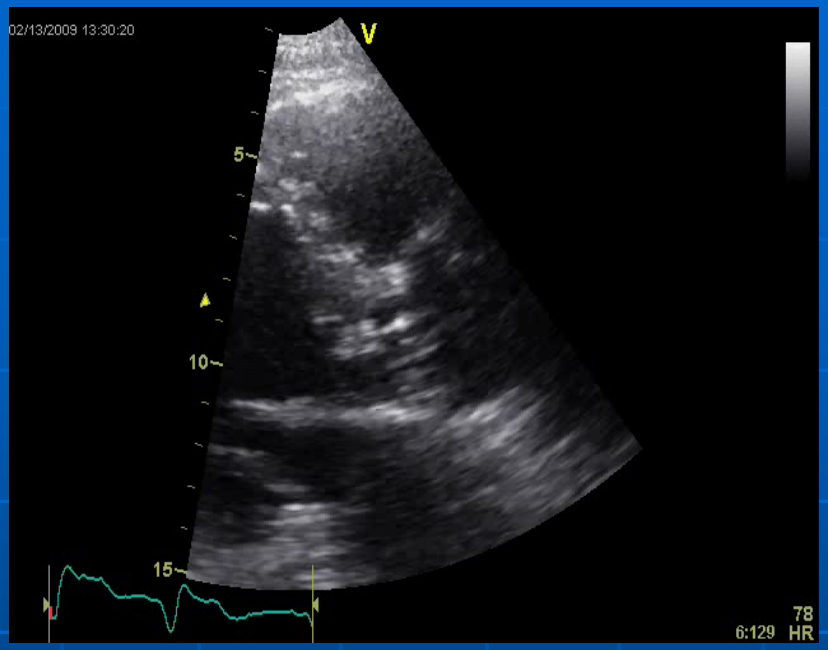
# masses

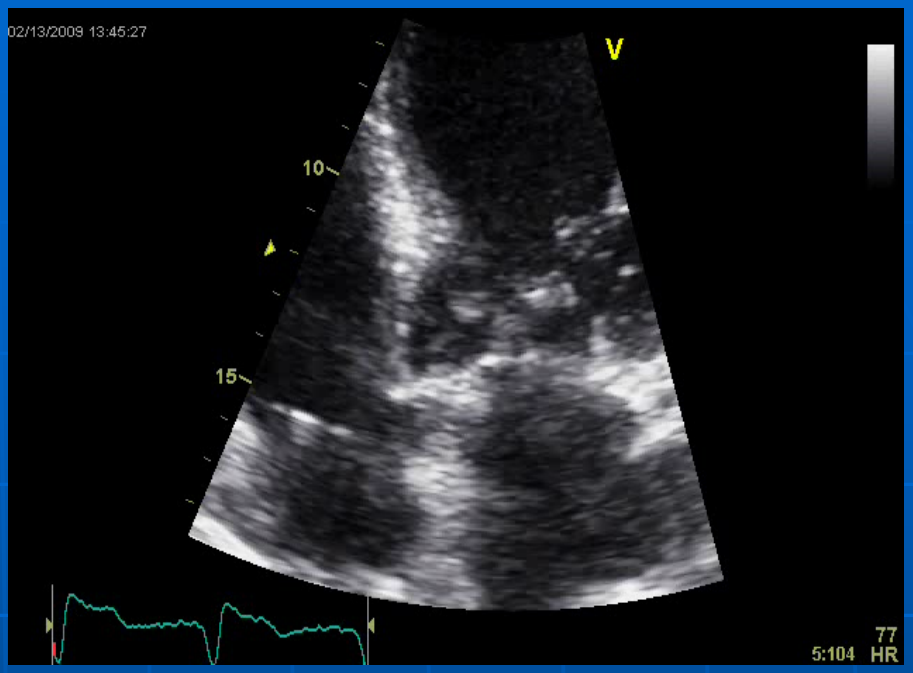


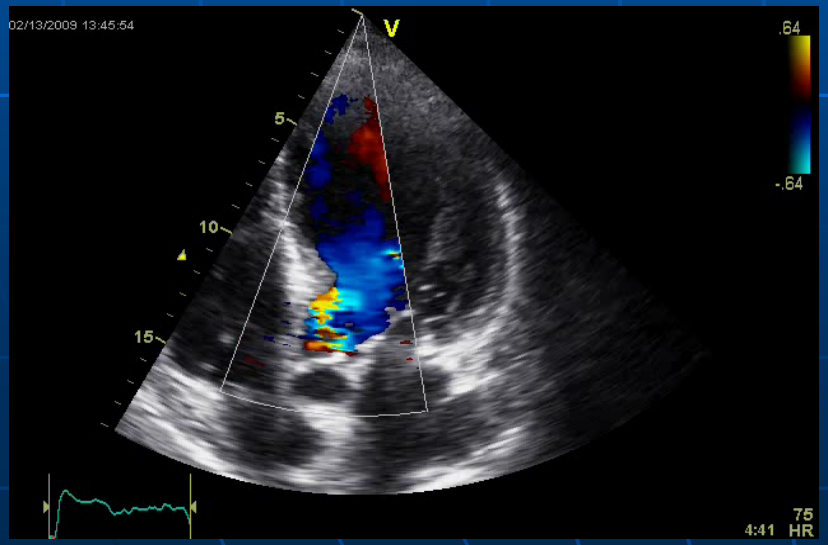
# MV MASS

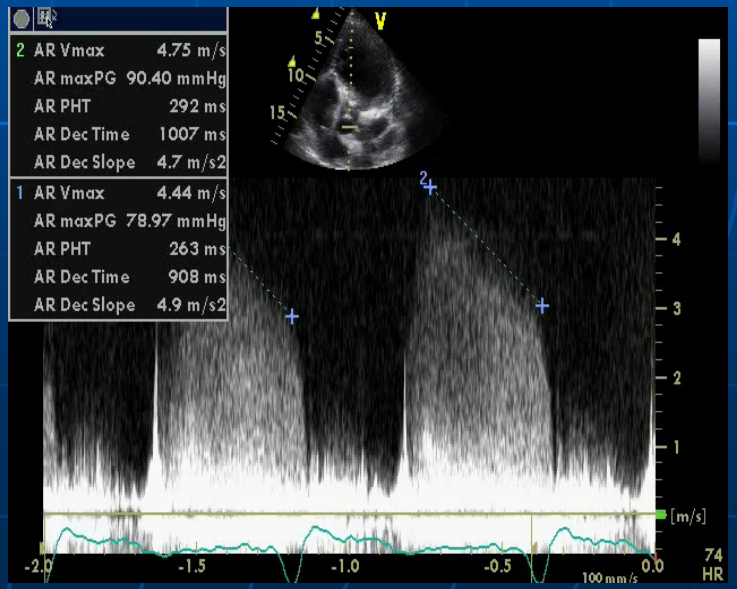

04/30/2009 08:23:44
V
6
8
10
12
04/30/2009 08:18:26
V
5
10
15
04/30/2009 08:23:02
V
5
10
15
.59
-.59
107
26:48 HR

# AV mass

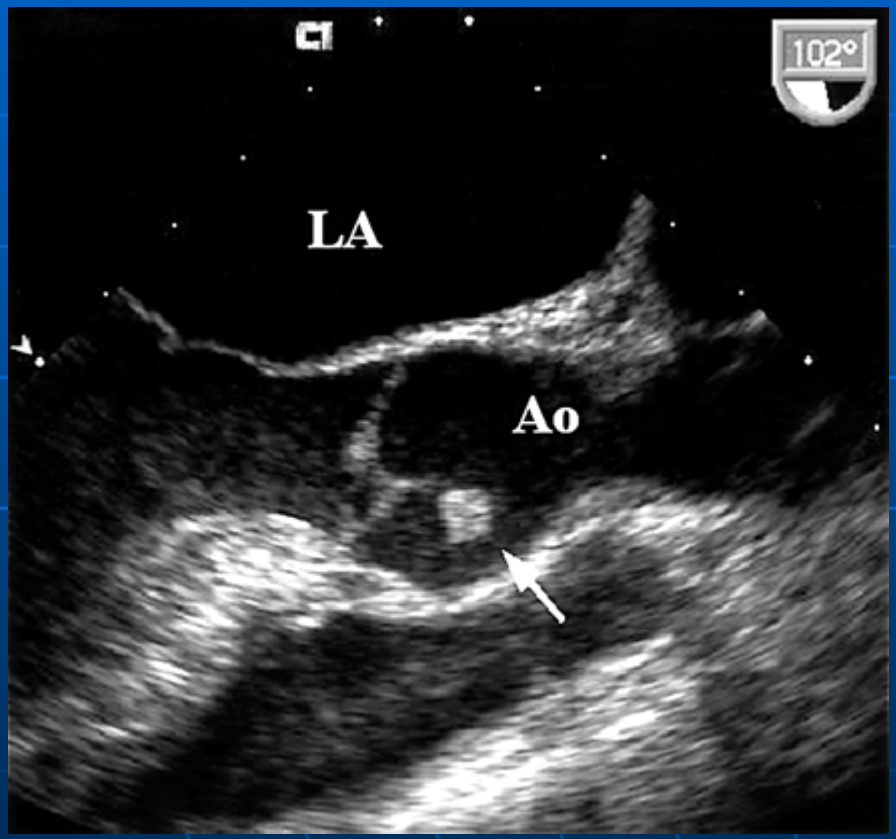

02/13/2009 13:30:20
V
5
10
15
78
6:129 HR

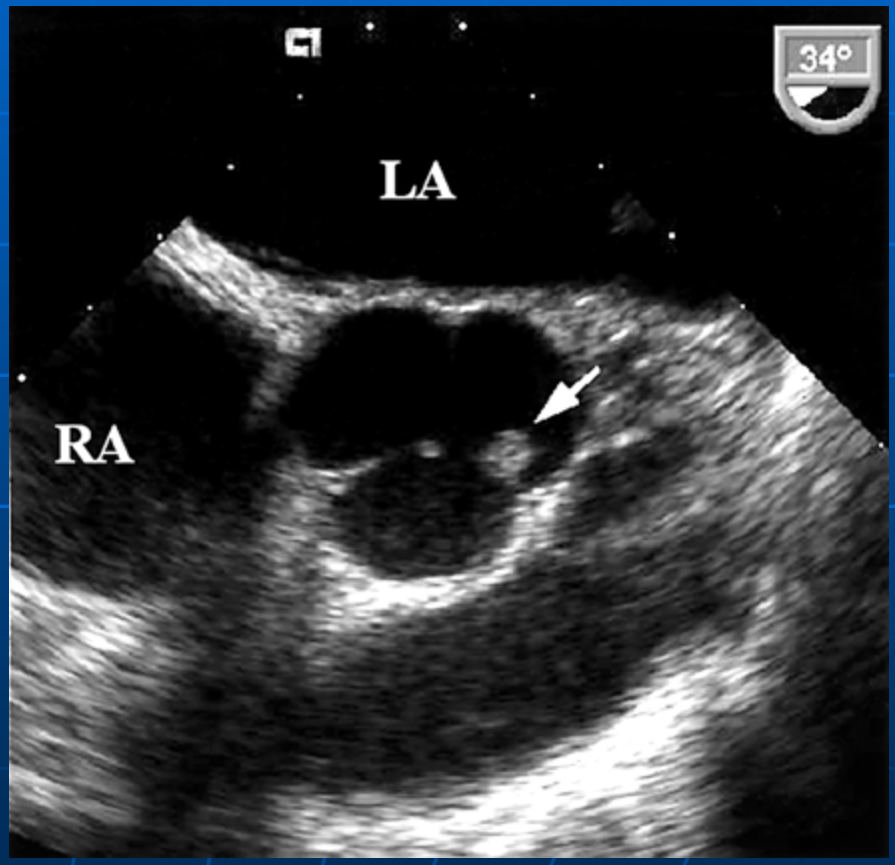

02/13/2009 13:45:27
V
10
15
77
5:104 HR


02/13/2009 13:45:54
V
.64
-.64
5
10
15
75
4:41 HR

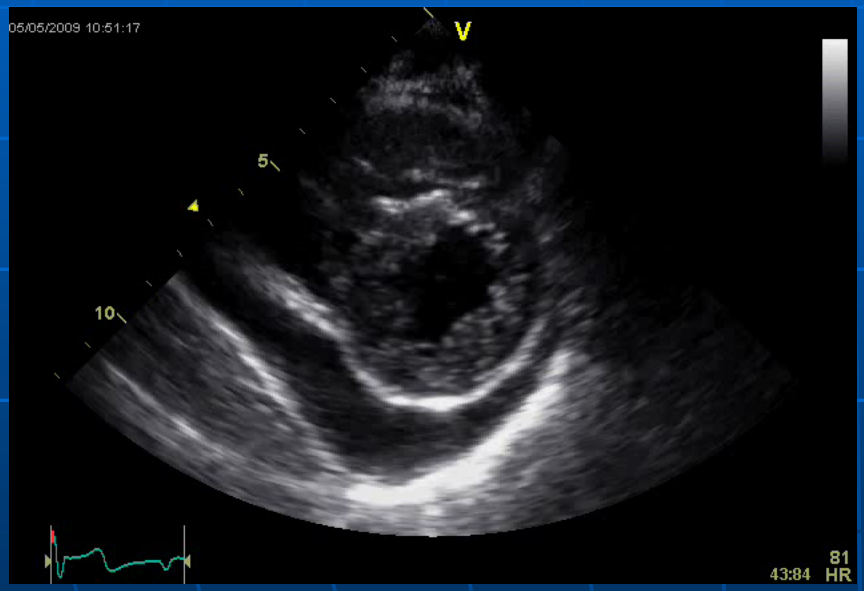

2 AR Vmax 4.75 m/s
AR maxPG 90.40 mmHg
AR PHT 292 ms
AR Dec Time 1007 ms
AR Dec Slope 4.7 m/s2
1 AR Vmax 4.44 m/s
AR maxPG 78.97 mmHg
AR PHT 263 ms
AR Dec Time 908 ms
AR Dec Slope 4.9 m/s2
V
[m/s]
-2.0
-1.5
-1.0
-0.5
0.0
100 mm/s
74 HR

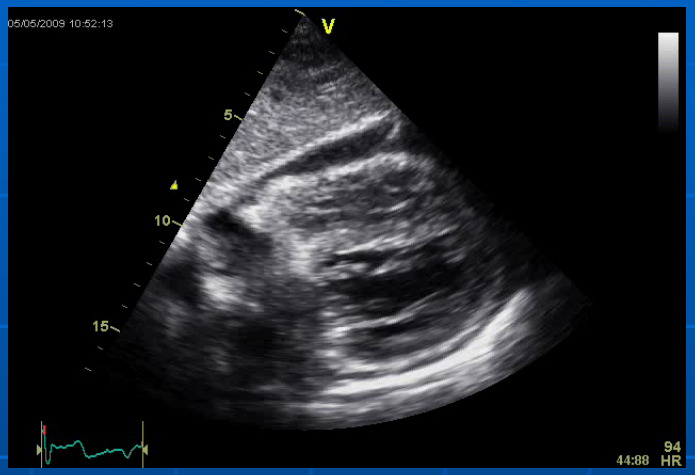
# Papillary fibroelastoma

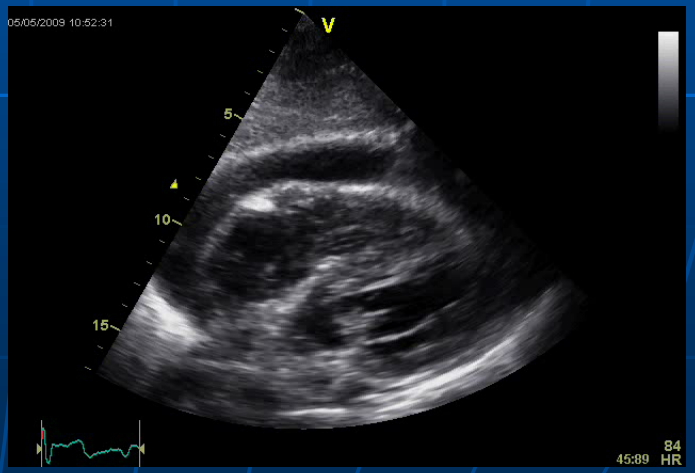


# PERICARDIAL EFFUSION

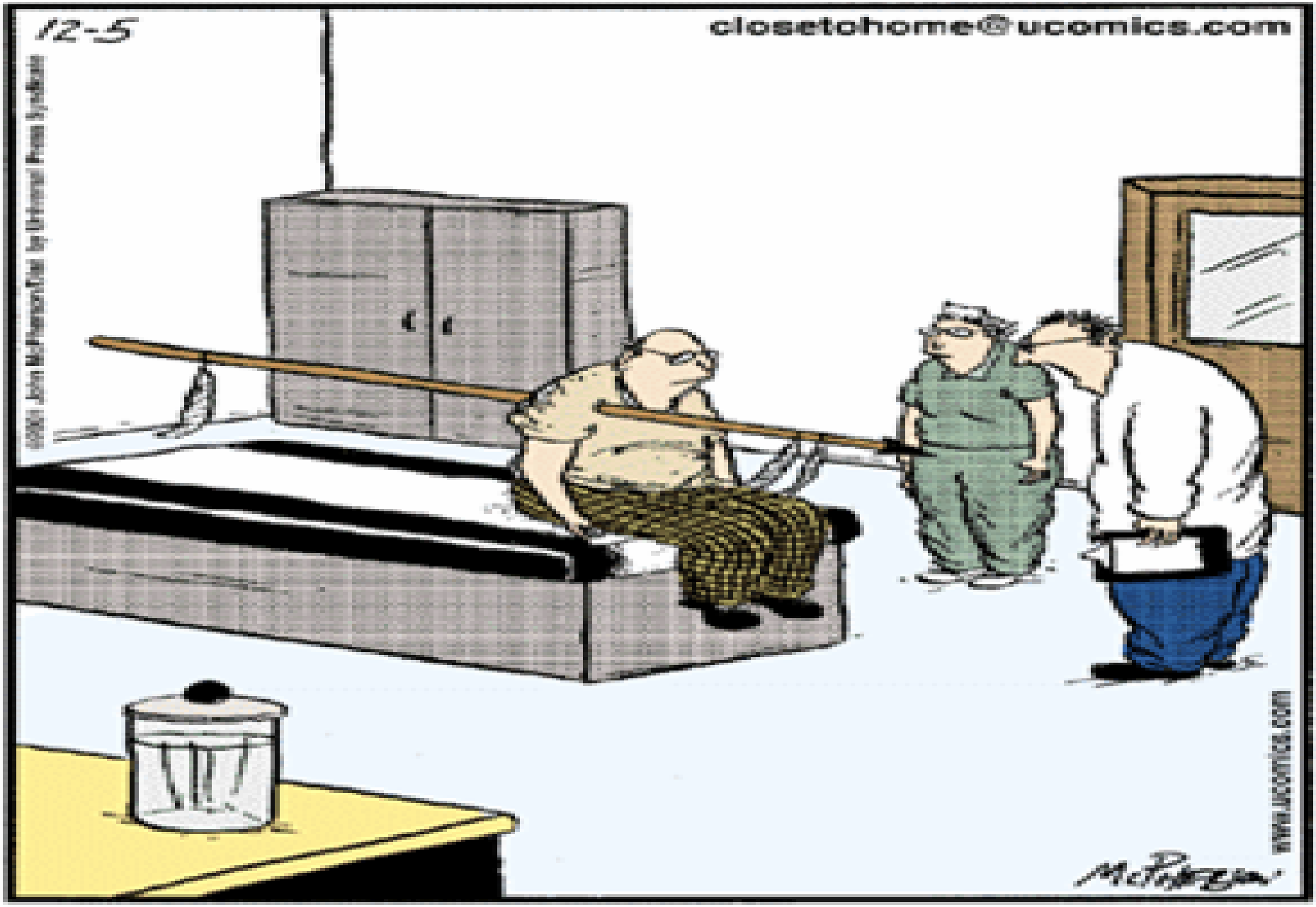


# THANK YOU

# QUESTIONS?




"We can't be absolutely certain until we run some tests, but your initial blood work indicates that you may have a large spear through your right shoulder."