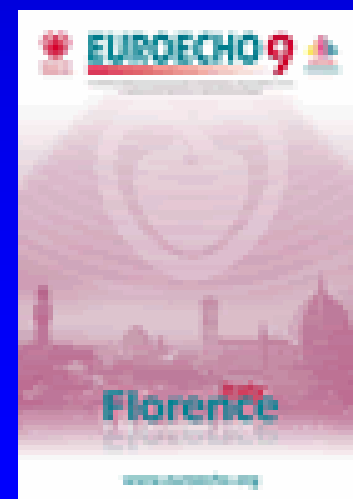




# Restriction or Constriction?

Linda D. Gillam, MD, FACC, FAHA,  
FASE



# Case

- 72 yo male presents with dyspnea and peripheral edema (progressive over 3-4 months)
- BP 110/70
- HR 99
- JVP elevated
- Chest: rales to mid lung field
- Per hx: Echo at outside institution showed LVEF of 65%, no significant valve disease
- Past hx: Chest radiation for lymphoma

# Heart Failure with a Normal EF

- Heart failure with normal systolic function is very common
  - Diastolic heart failure
    - Many causes
      - HTN
      - CONSTRICTION
      - RESTRICTION

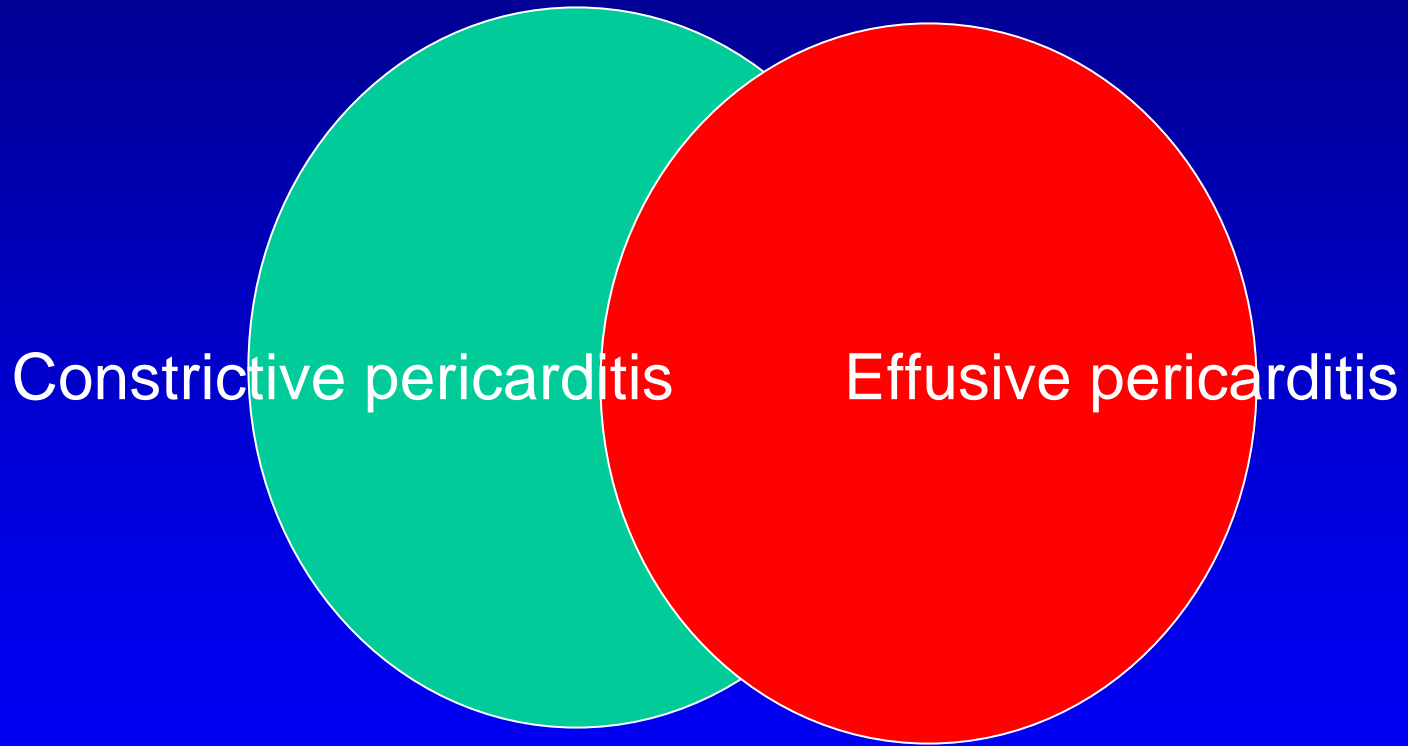
Restriction or Constriction...  
that is the question

# Why is it important to make the diagnosis and distinction?

- Conditions are common (enough) and are associated with significant morbidity and mortality
- Restriction rarely treatable/curable
- Constriction may be improvable/curable with surgery

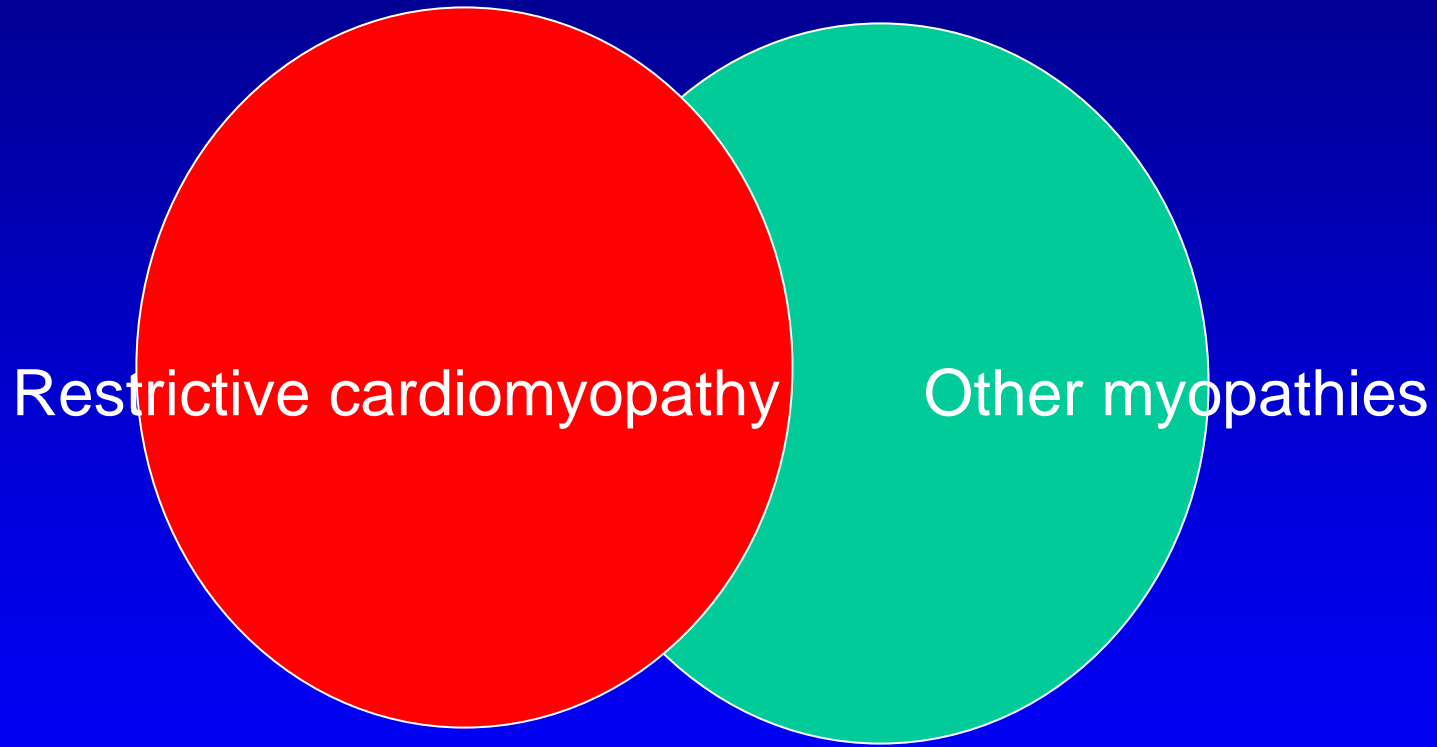
# Since this is an echo talk...

- Emphasis on echo
- Clinical history extremely important
- Other forms of testing extremely important
- There may be overlap...



Constrictive pericarditis

Effusive pericarditis





Constrictive pericarditis

Restrictive cardiomyopathy

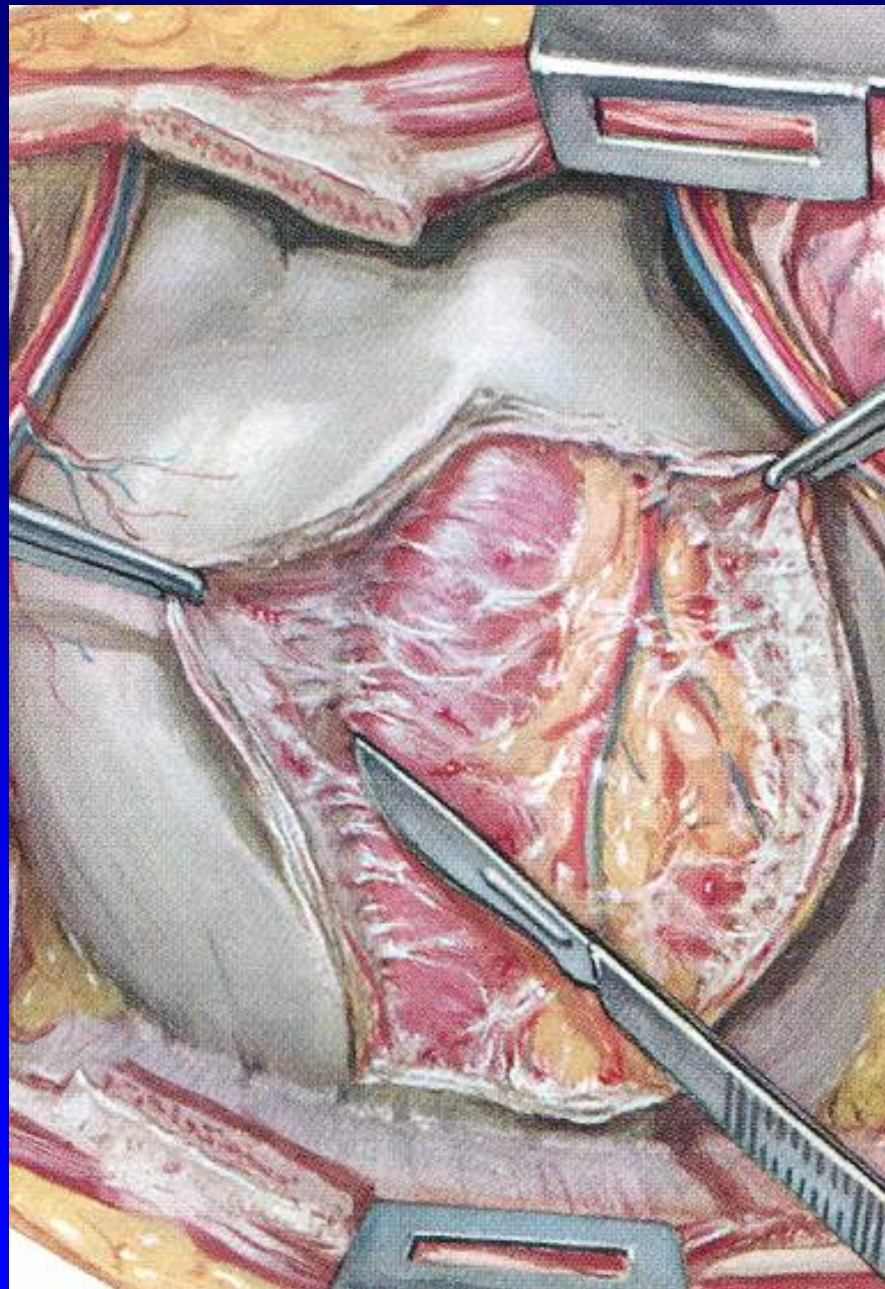
# In classic cases...

- Both conditions have typical imaging features
- Both conditions are characterized physiologically by diastolic dysfunction
  - Restriction:
    - Typically abnormal relaxation, then later abnormal compliance
  - Constriction:
    - Reduced LV compliance due to external constraint
    - Relaxation typically not impaired
    - Exaggerated respiratory variation

# Constrictive Pericarditis

# Constriction

- Thickening of the pericardium that limits diastolic filling (particularly during inspiration)
- Resultant syndrome mimicking right and left heart failure



# Constriction

- Etiology
  - Idiopathic 33%
  - Post-pericarditis 18%
  - Post-surgical 16%
  - Radiation 14%
  - Rheumatic 6%
  - Infection 3%

# Constrictive pericarditis: clinical findings

- Fatigue, hypotension, tachycardia
- Elevated JVP
- Kussmaul's sign
- Pericardial “knock”
- Ascites, edema

Constriction: other imaging  
findings

# Calcified pericardium

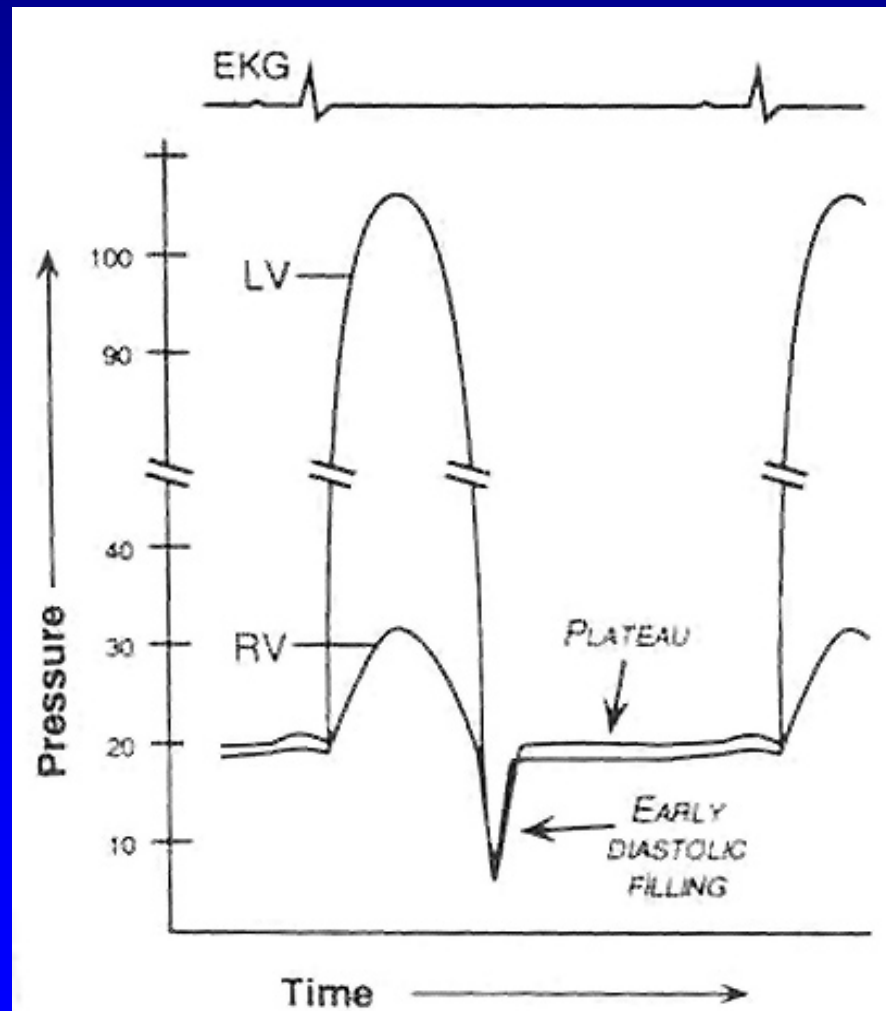


# MRI- Constriction



# Catheterization

# Restriction of diastolic filling



# Diagnosis

## Echocardiography

- Thickened and adherent pericardium
- Small or normal ventricles ( $\pm$ atrial enlargement)
- Exaggerated respiratory variation in:
  - Position of interventricular septum
    - Respiratory “bounce” of septum
  - Doppler inflow patterns
  - Value of M-mode (particularly in a digital lab)

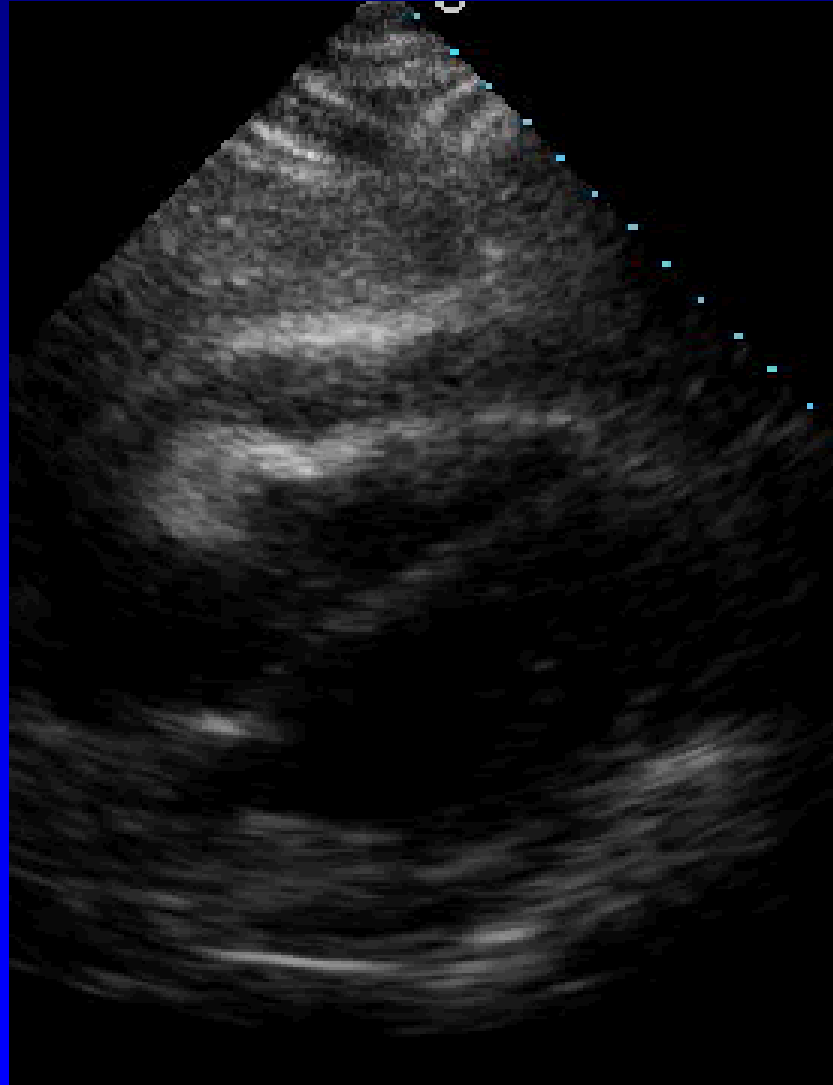
# Diagnosis

## Echocardiography

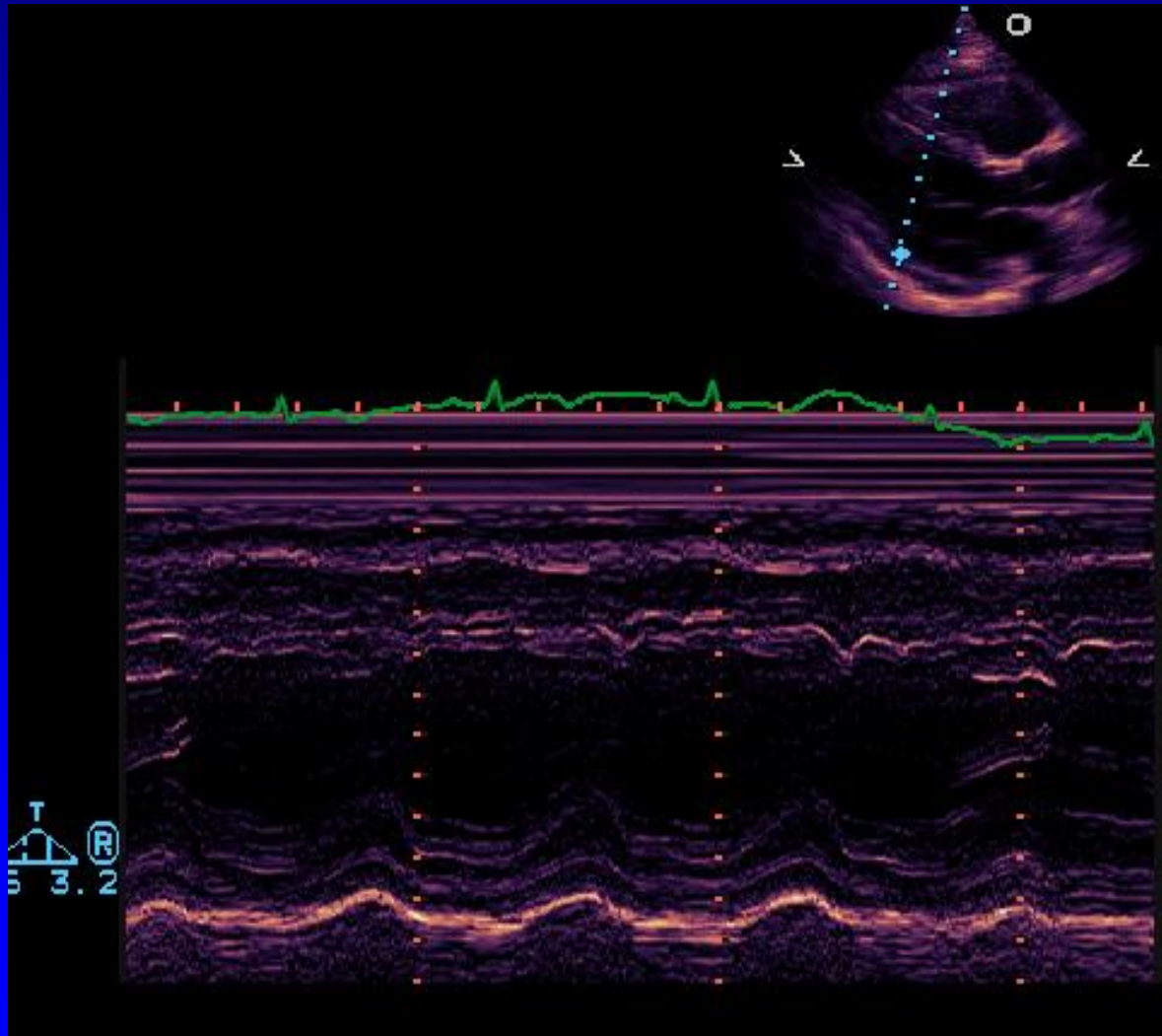
- Doppler atrioventricular valve inflow spectra:
  - high E wave
  - shortened deceleration time
- Normal E' and (loss of A') on tissue Doppler
  - Peak E'  $\geq 8$  cm/s 89% sens, 100% spec for constriction\*
- Color M-mode typically normal
  - Slope  $>100$ cm/s 74% sens, 91% spec for constriction\*
- Paradoxical septal motion
- Premature opening of the pulmonic valve
- Diastolic mitral regurgitation
- Dilated IVC without respiratory variation

\*Rajagopalan N et al AJC 2001 1:87:86-94

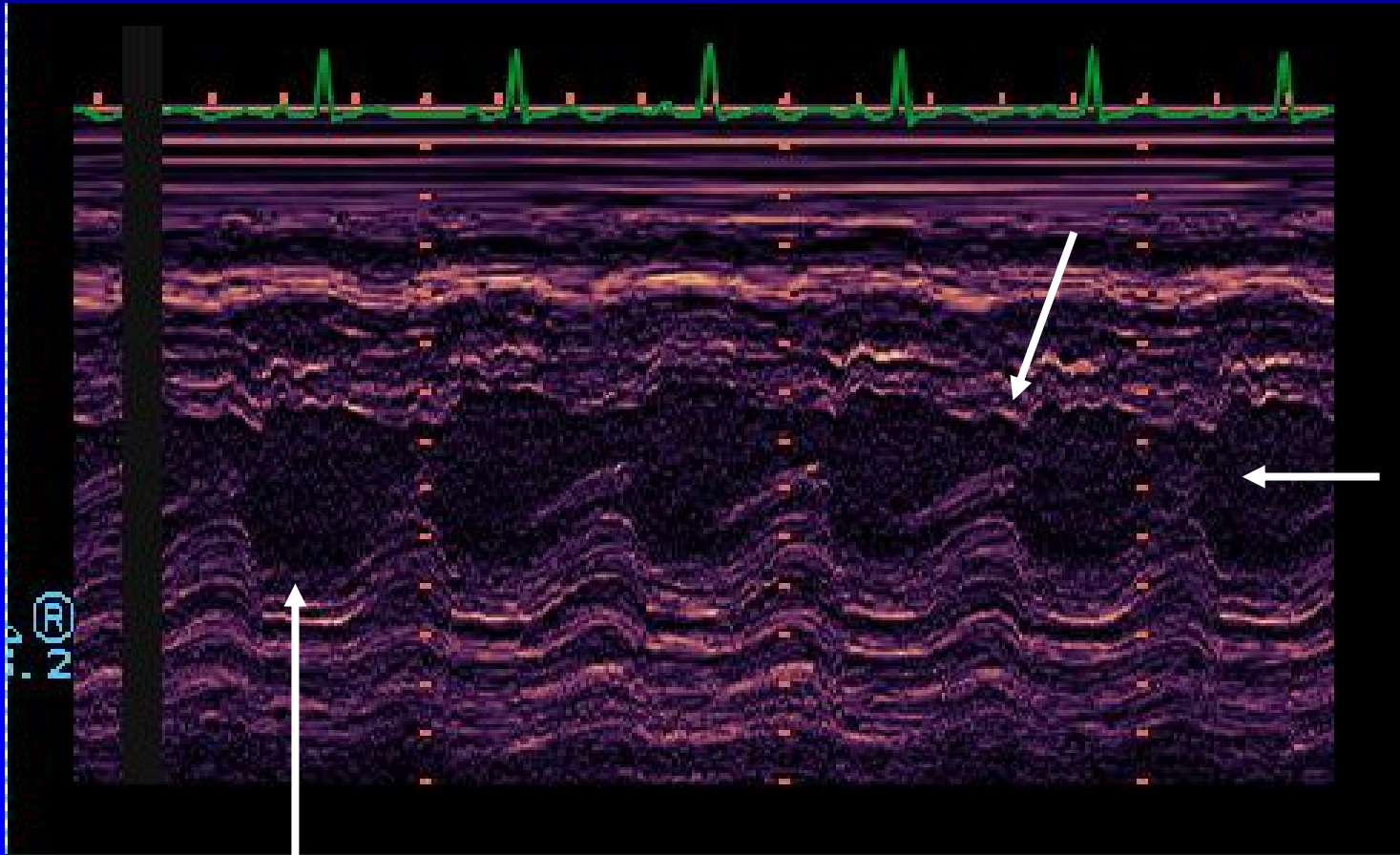
# Thick and adherent pericardium



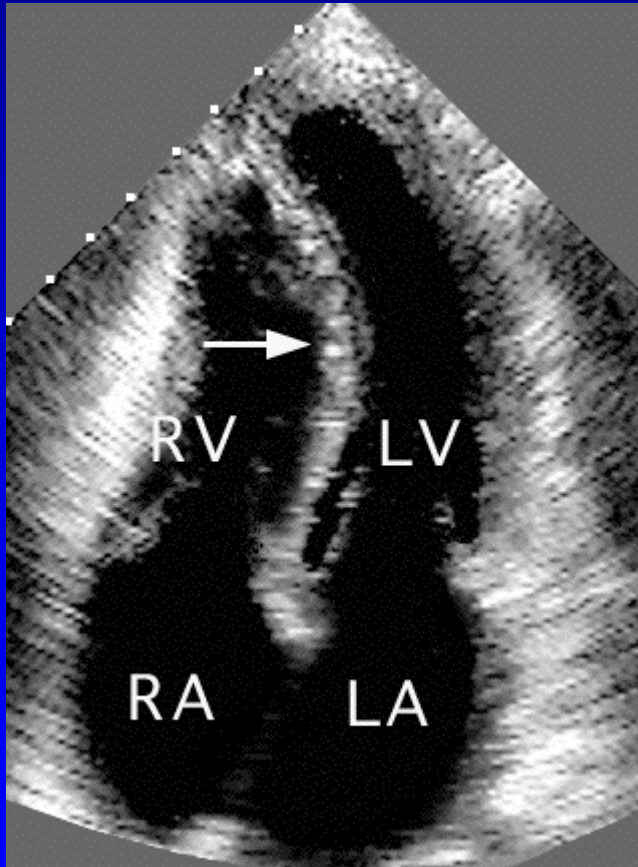
# Thick and adherent pericardium



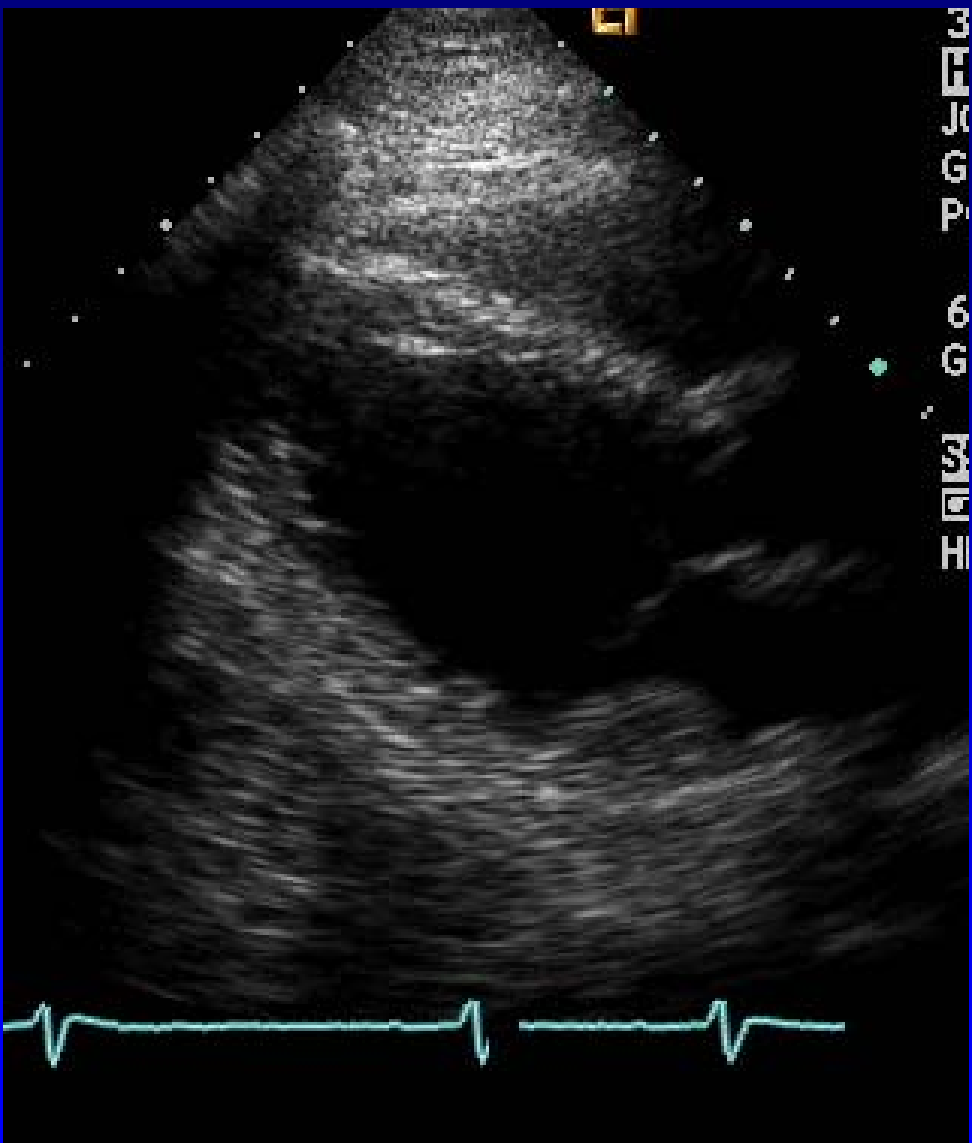
# Other M-mode findings

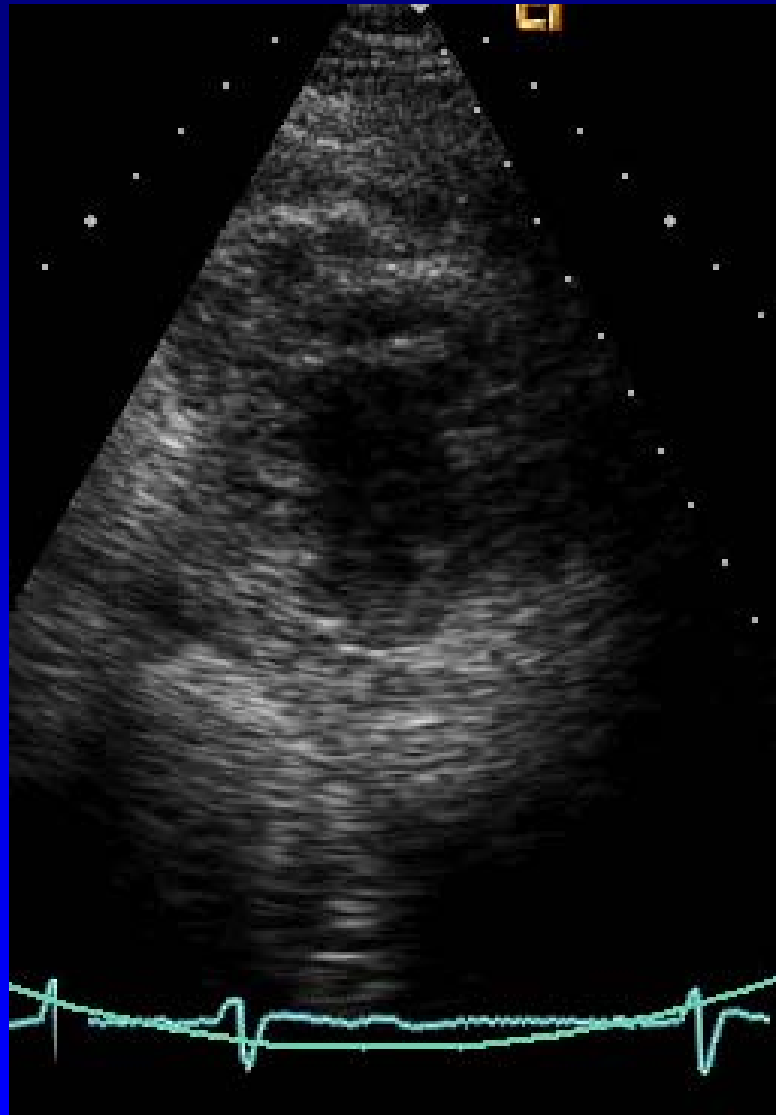


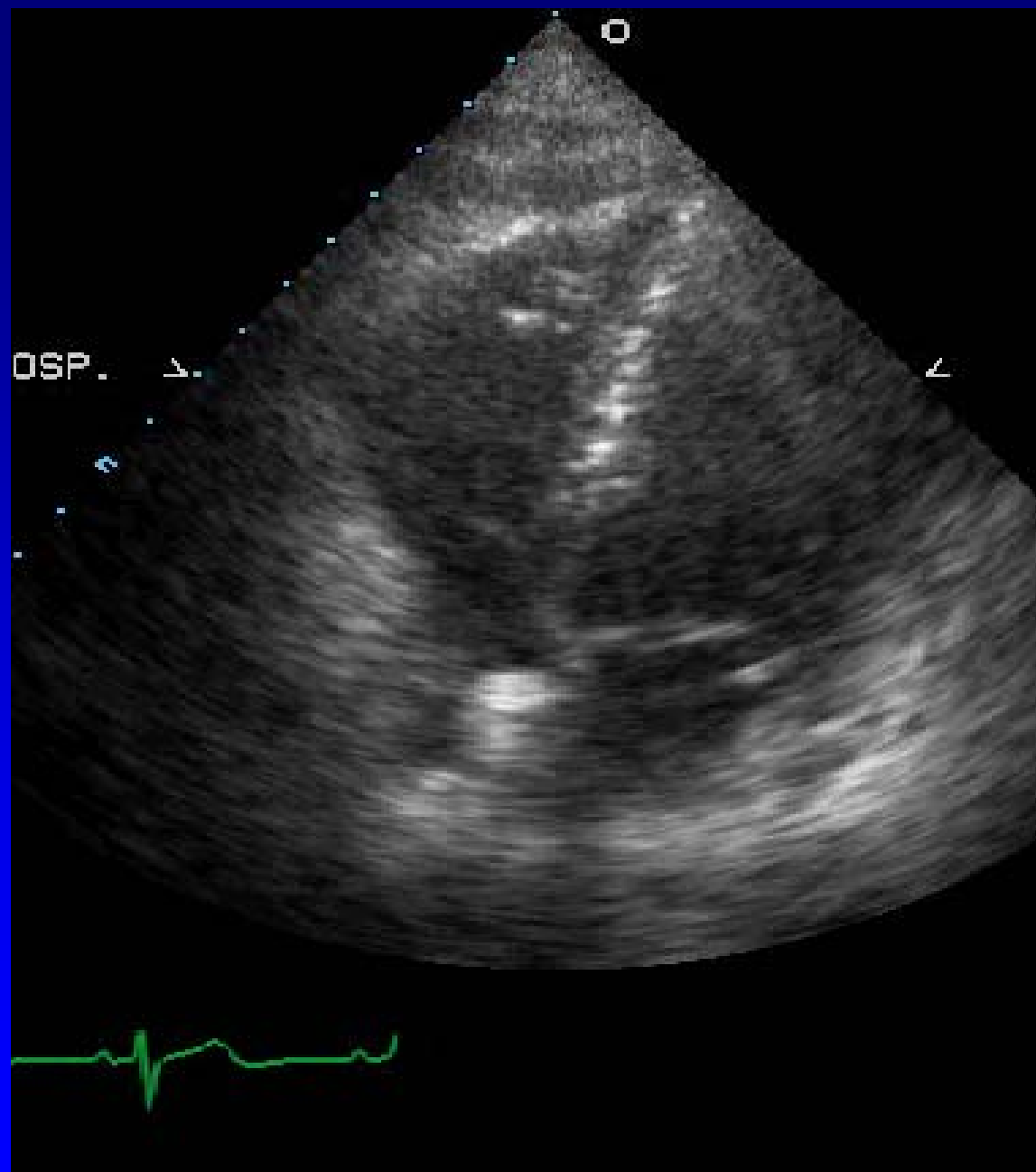
# Diastolic septal bounce with inspiration



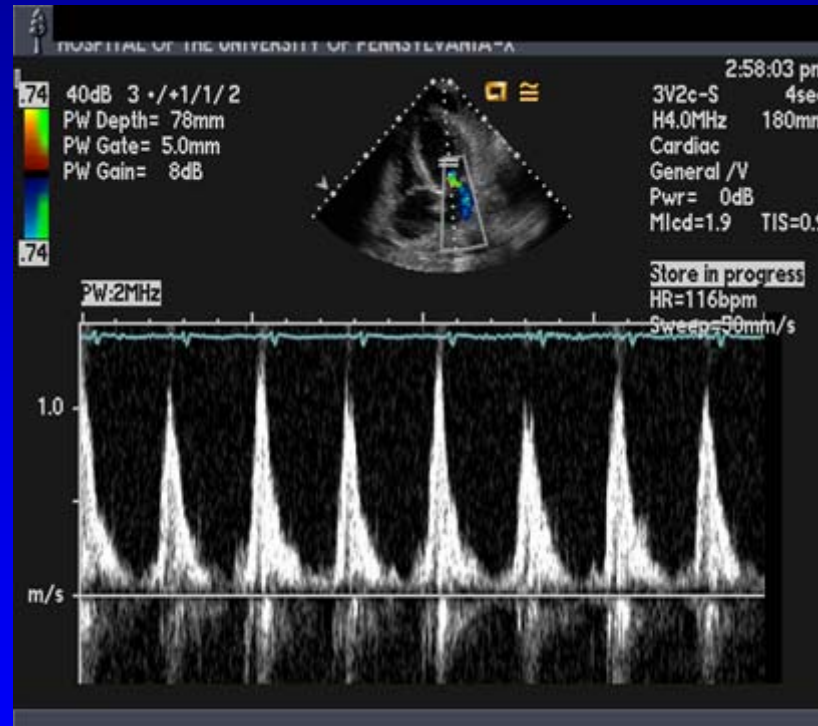
- Venous return increases leading to increased RV volume
- Total cardiac volume constrained by pericardium
- Interventricular dependence leads to septal shift



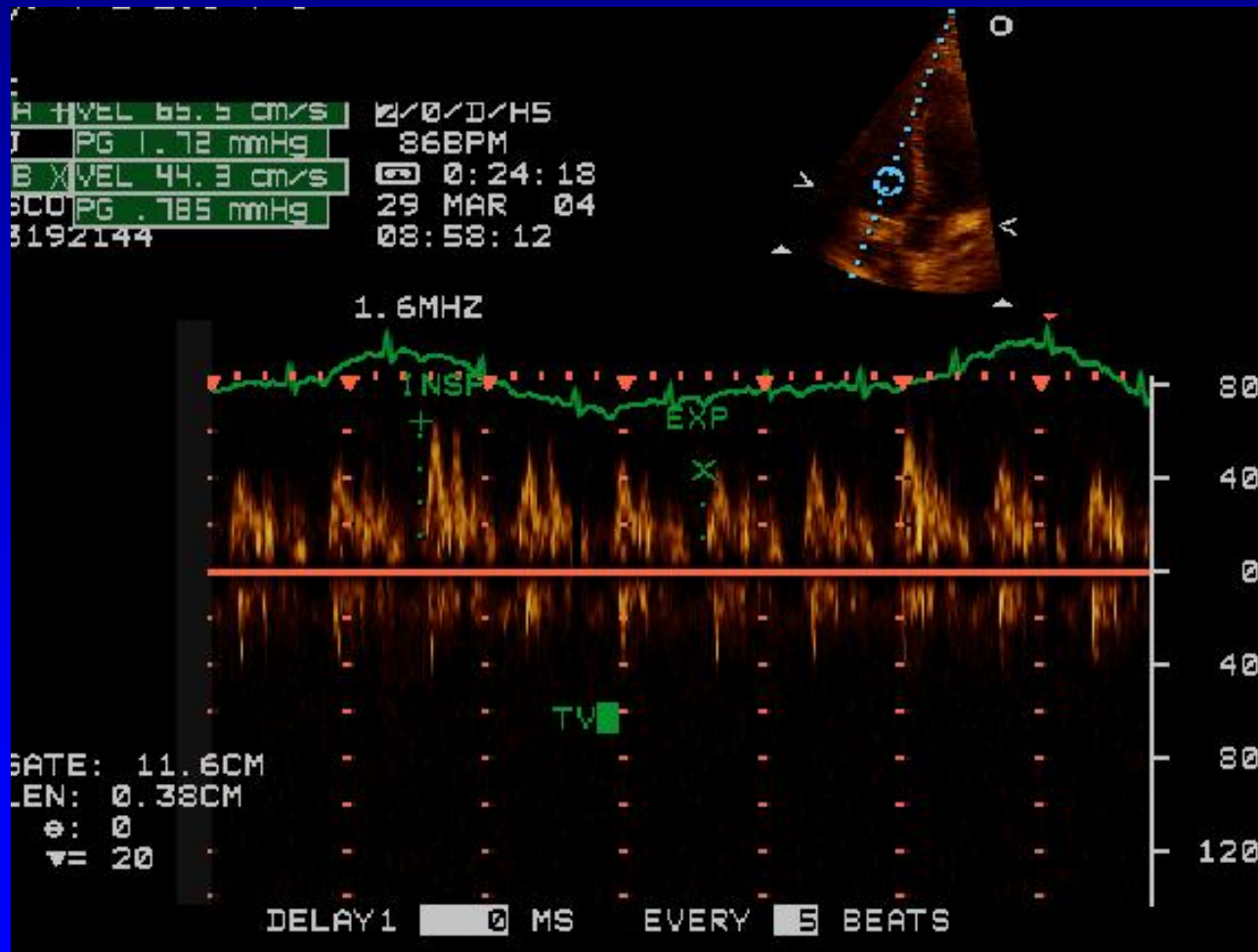




# Mitral inflow

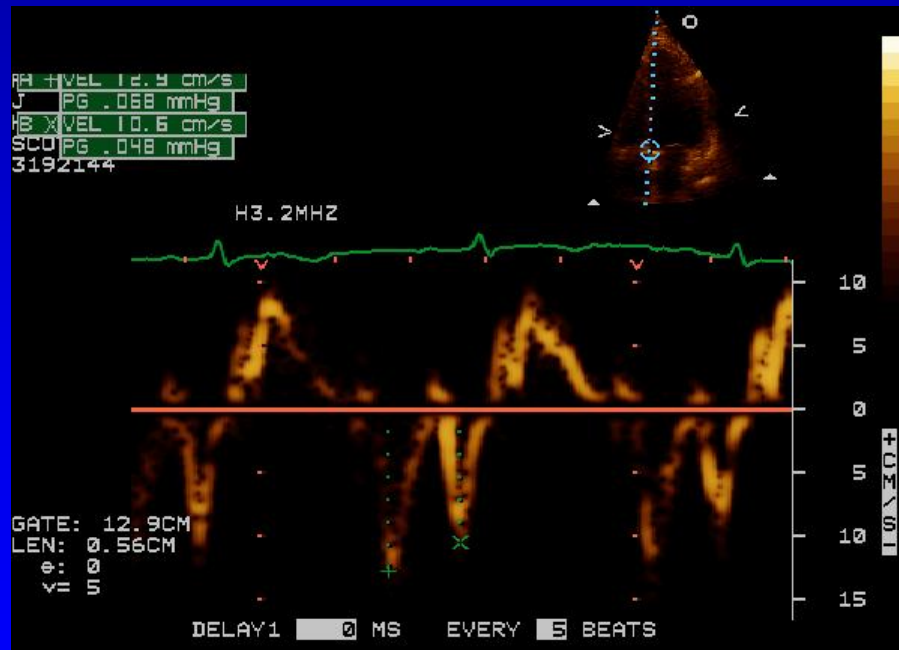


# Note respiratory variation!

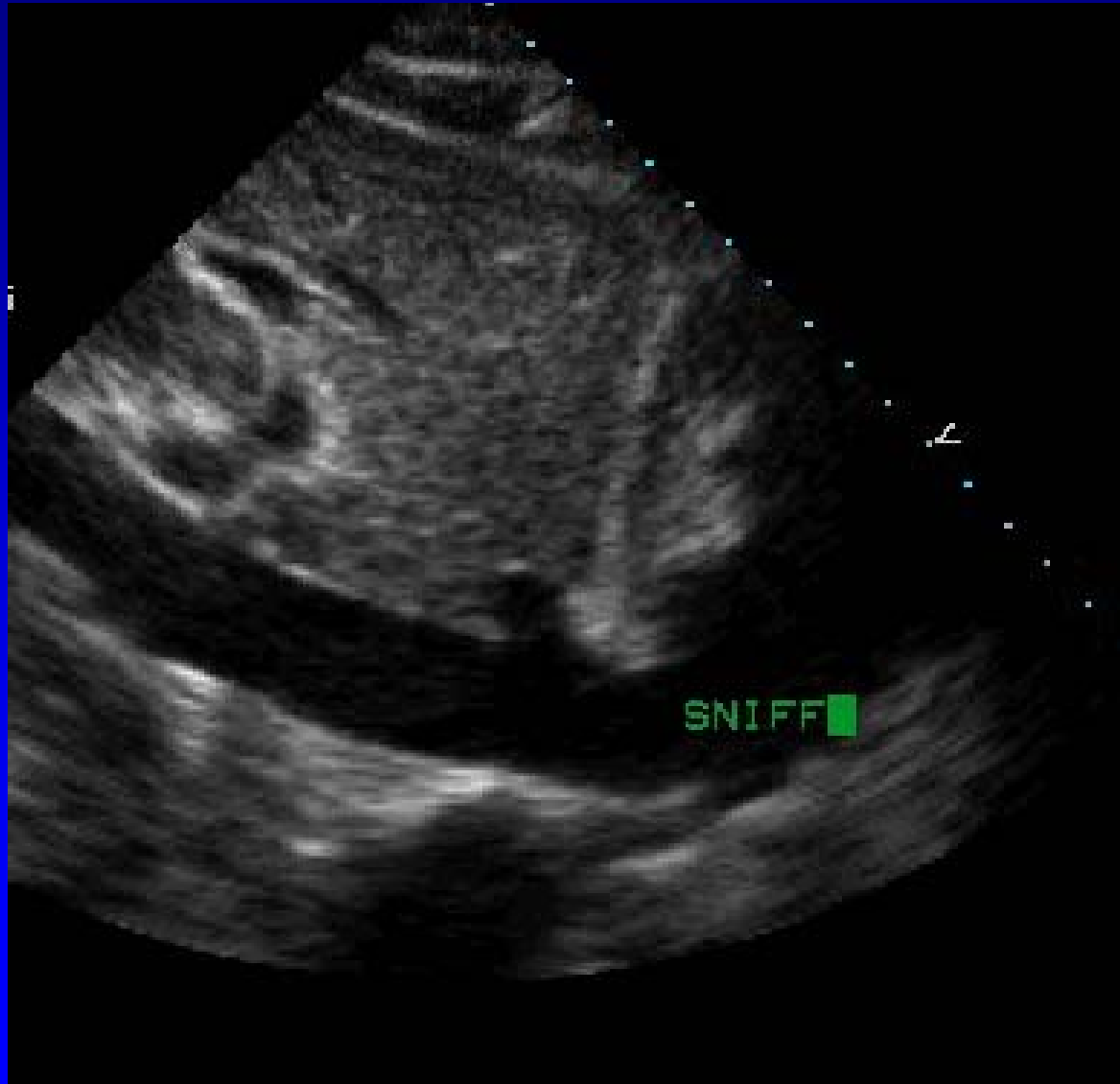


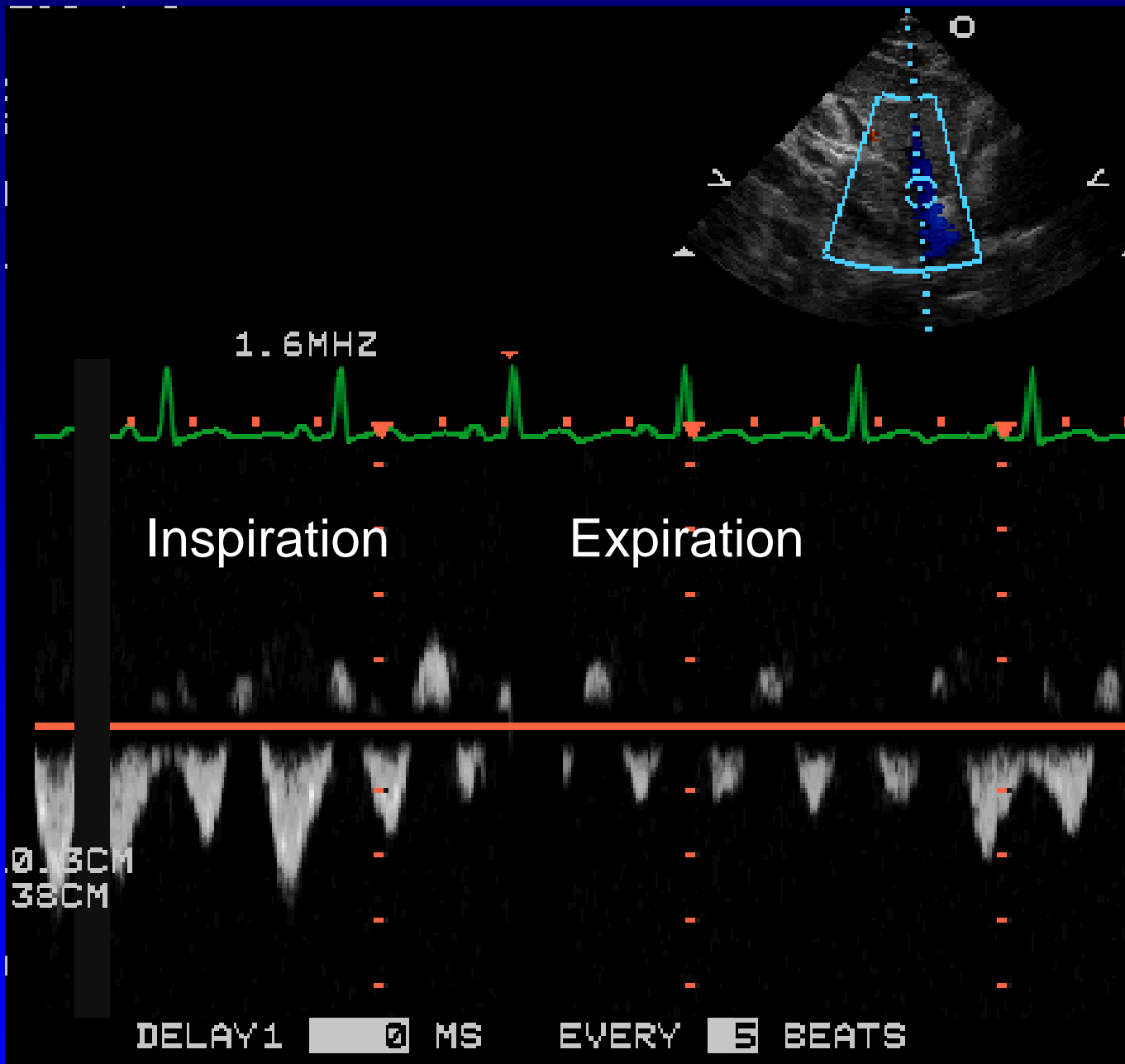
May be enhanced with volume loading

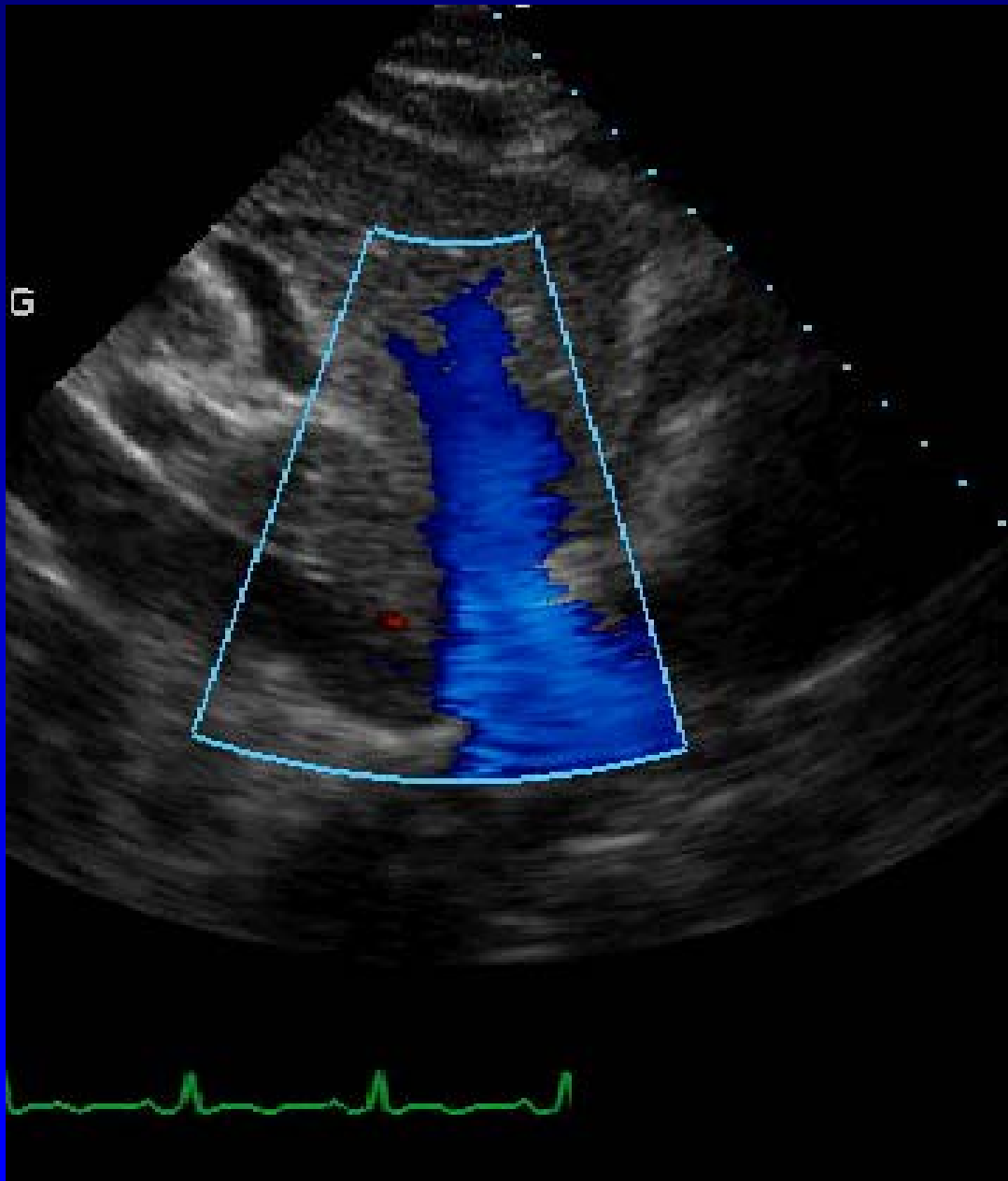
# DTI- note e wave is preserved!



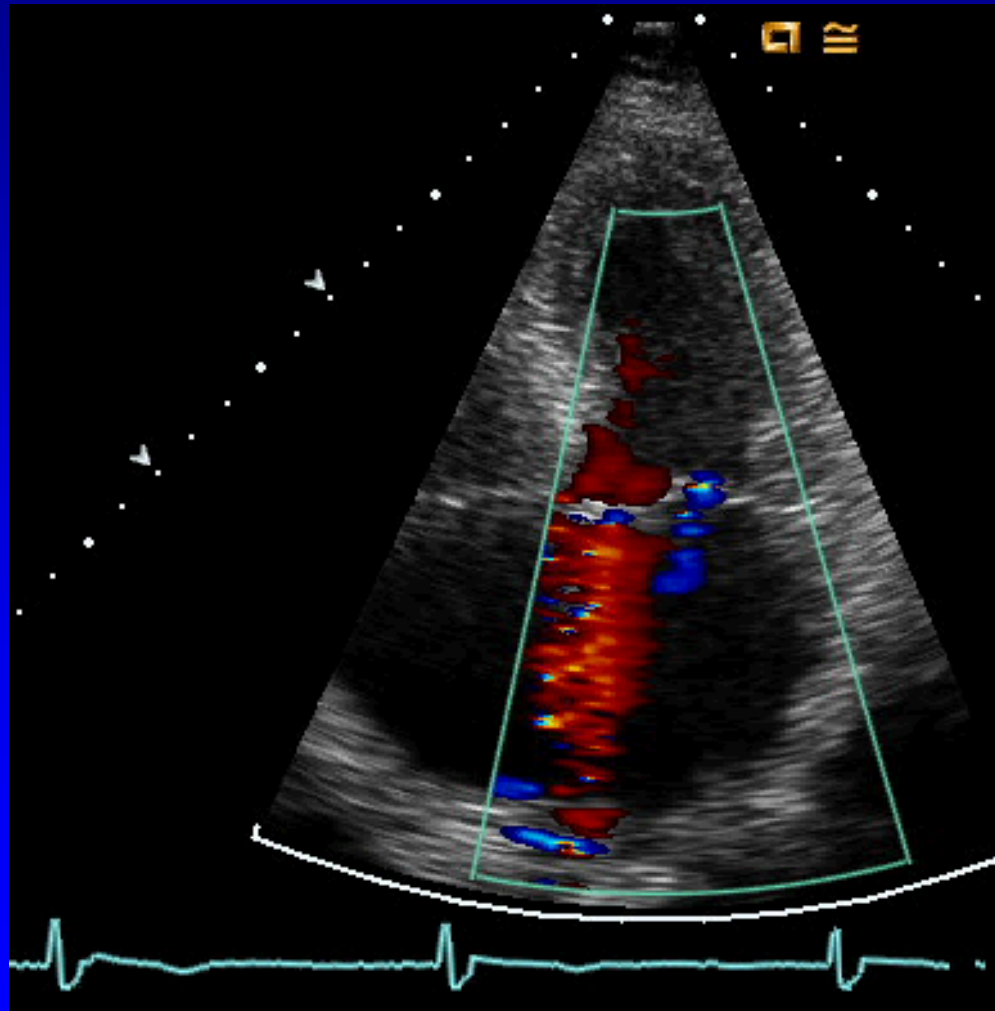
# IVC is dilated and fixed

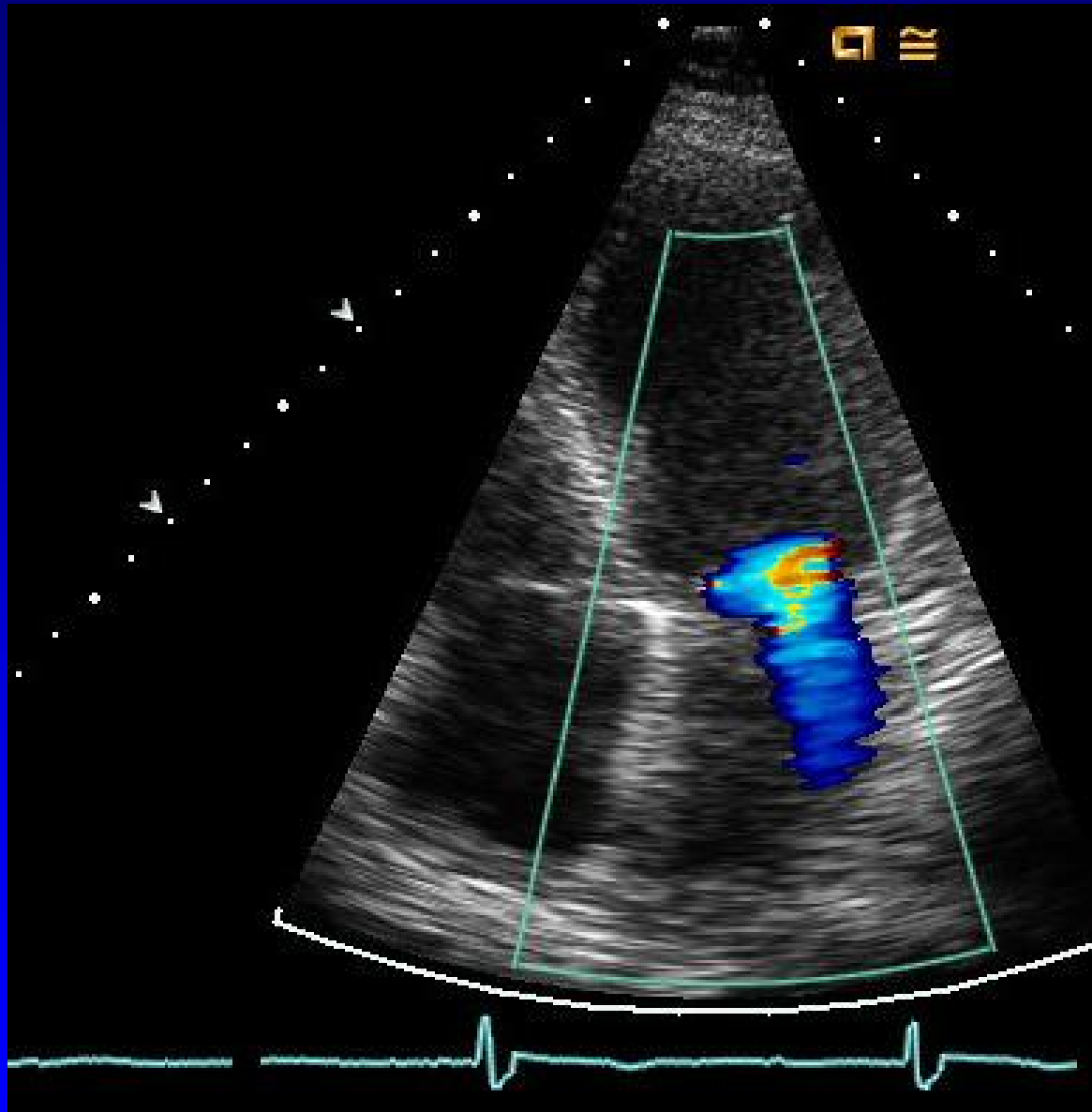






# Diastolic Mitral Regurgitation





# Restrictive Cardiomyopathy

# Restrictive Cardiomyopathies

- Hallmark: abnormal diastolic function
- Rigid ventricular wall with impaired ventricular filling

# Classification

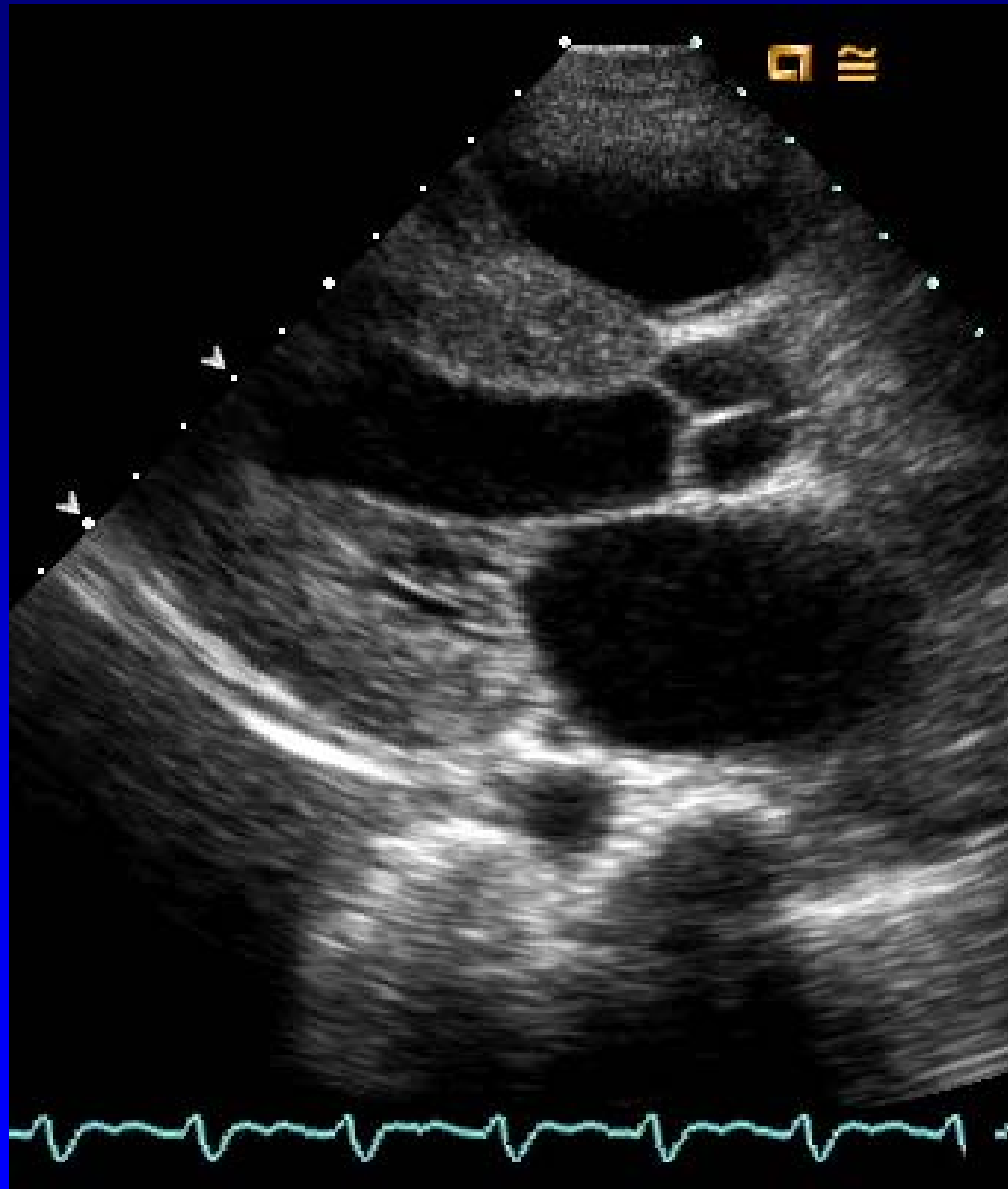
- Idiopathic
- Myocardial
  1. Noninfiltrative
    - Idiopathic
    - Scleroderma
  2. Infiltrative
    - Amyloid
    - Sarcoid
    - Gaucher disease
    - Hurler disease
  3. Storage Disease
    - Hemochromatosis
    - Fabry disease
    - Glycogen storage
- Endomyocardial
  - endomyocardial fibrosis
  - Hyperesinophilic synd
  - Carcinoid
  - metastatic malignancies
  - radiation, anthracycline

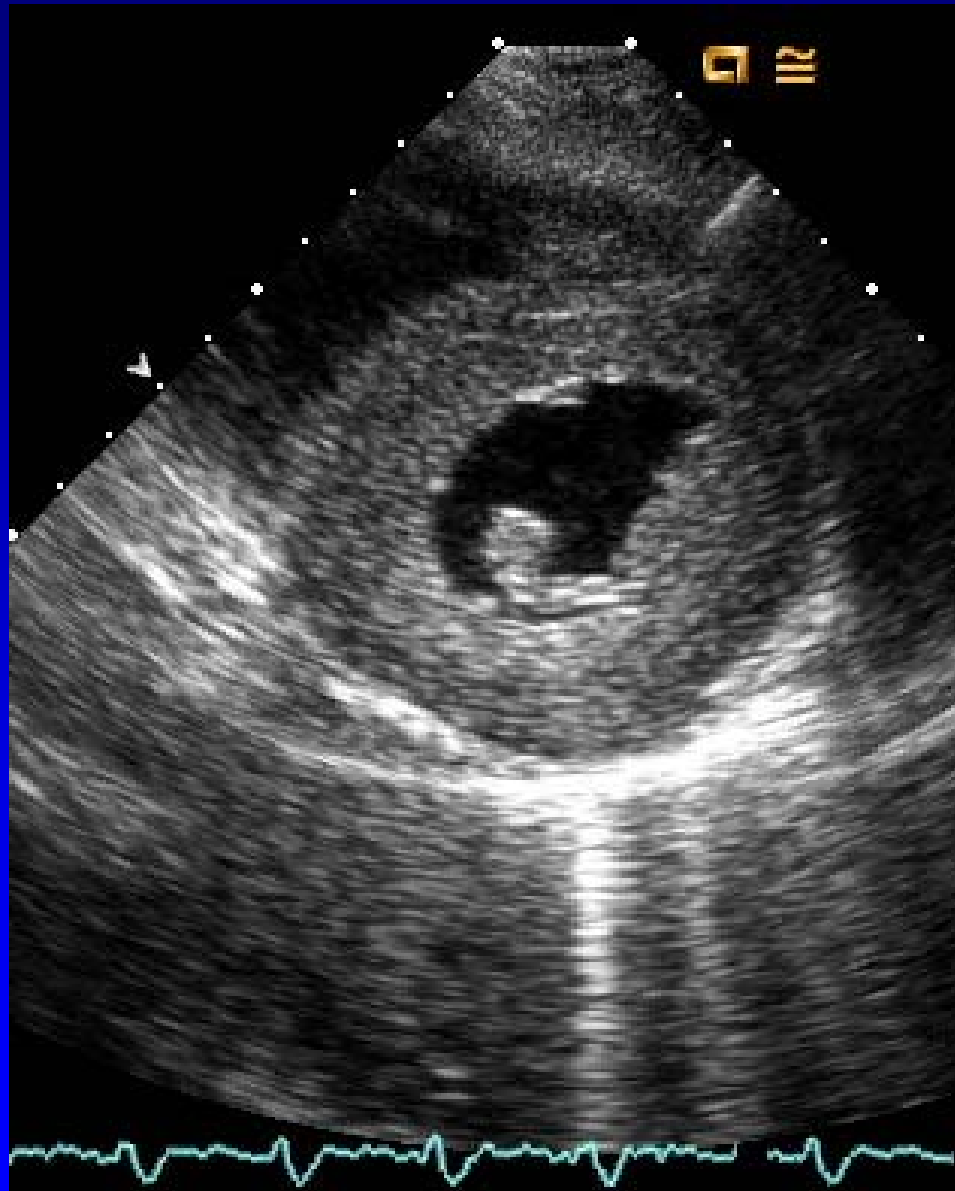
# ECG

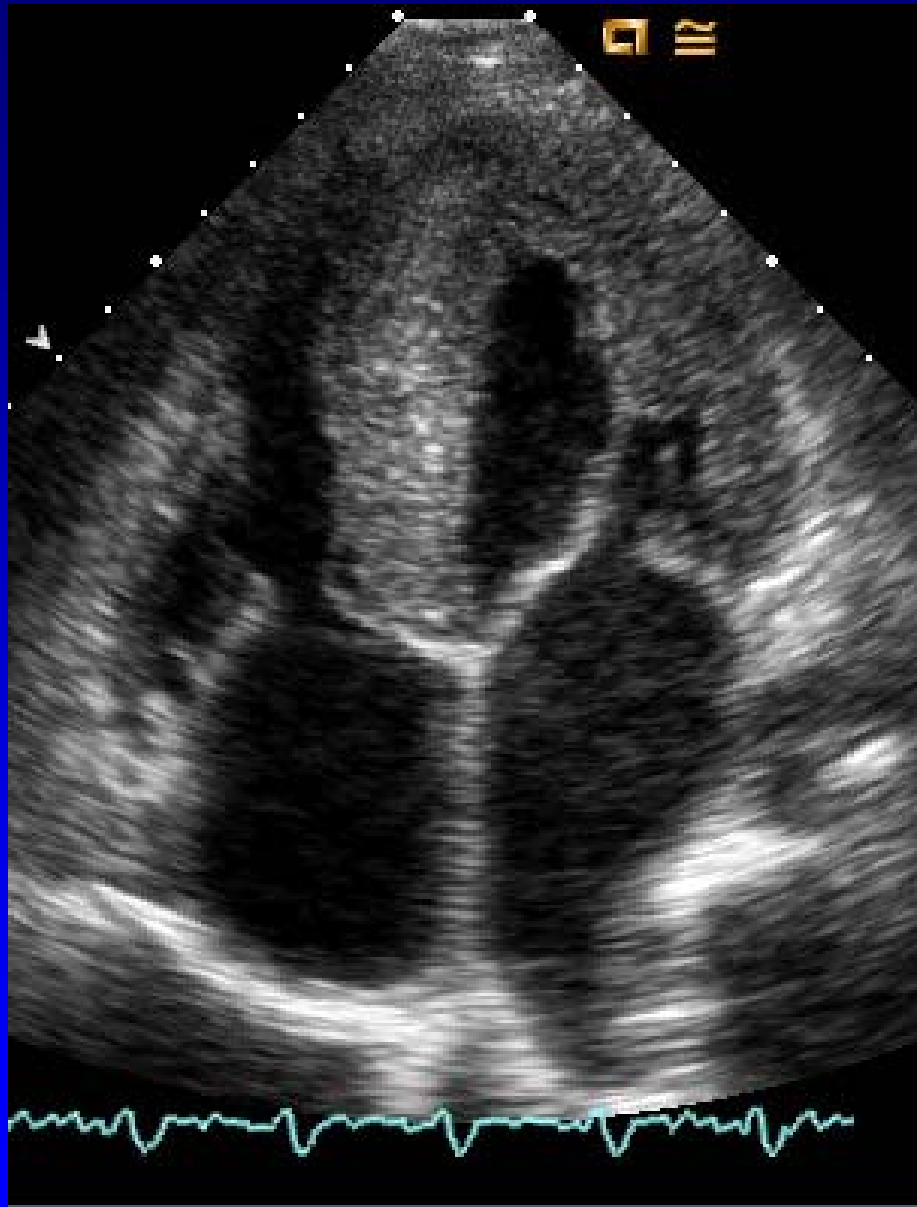
- Low voltage
  - For degree of “hypertrophy”
  - Nonspecific ST-T changes
  - Conduction disturbances

# Echo Findings

- Imaging features on echo unique to each condition
  - Increased wall thickness common

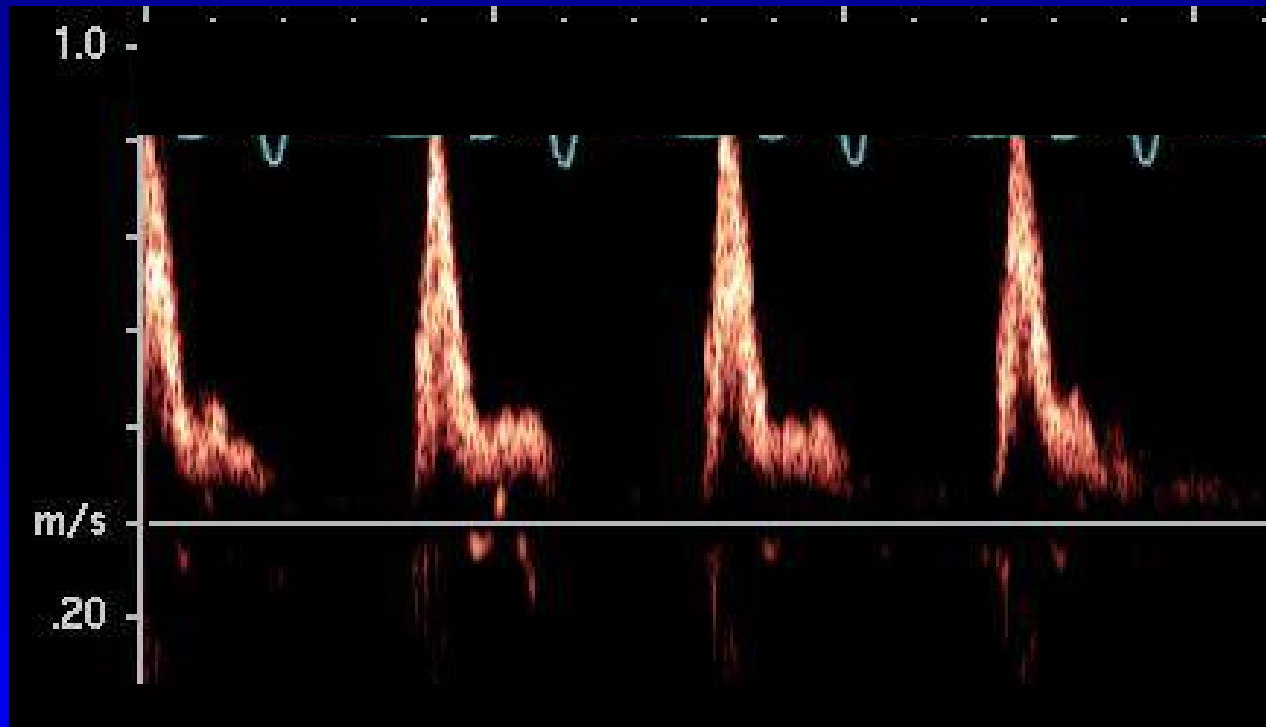






What are the physiologic findings?

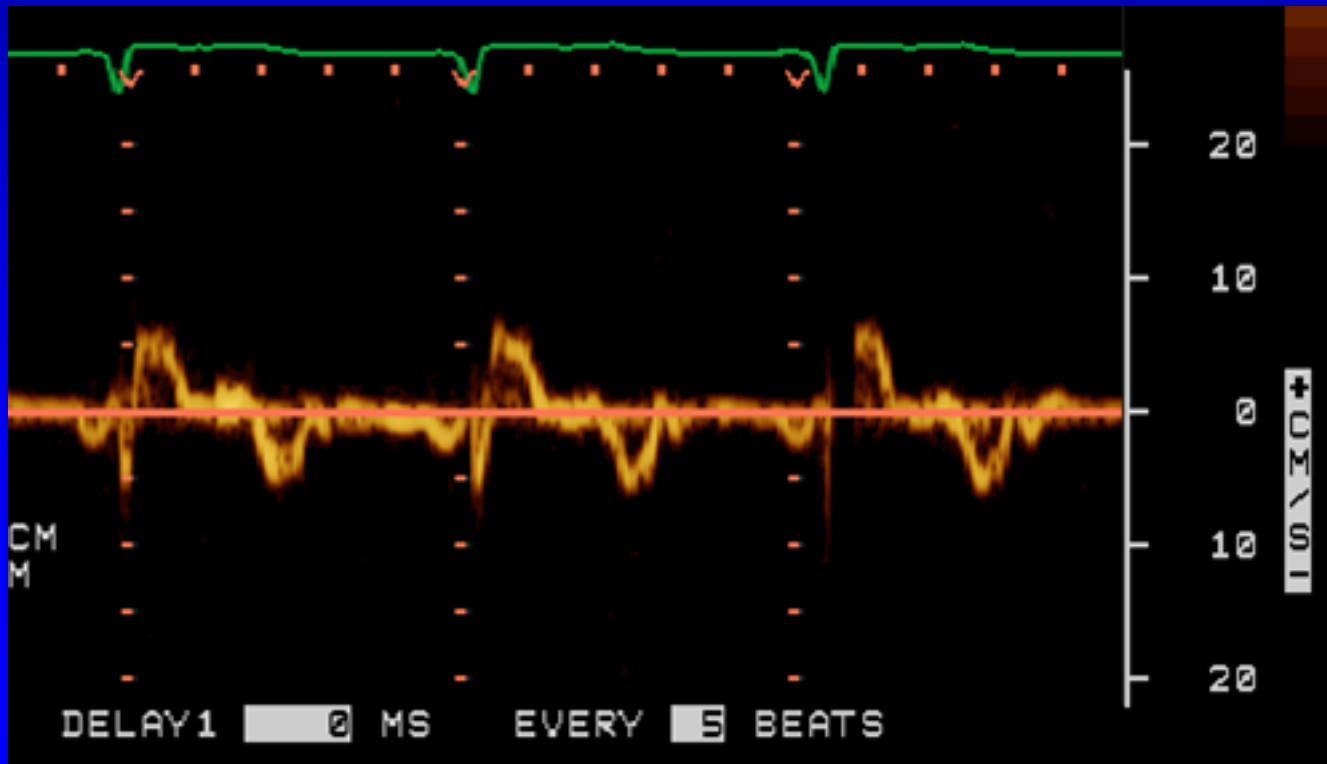
# Restrictive filling pattern



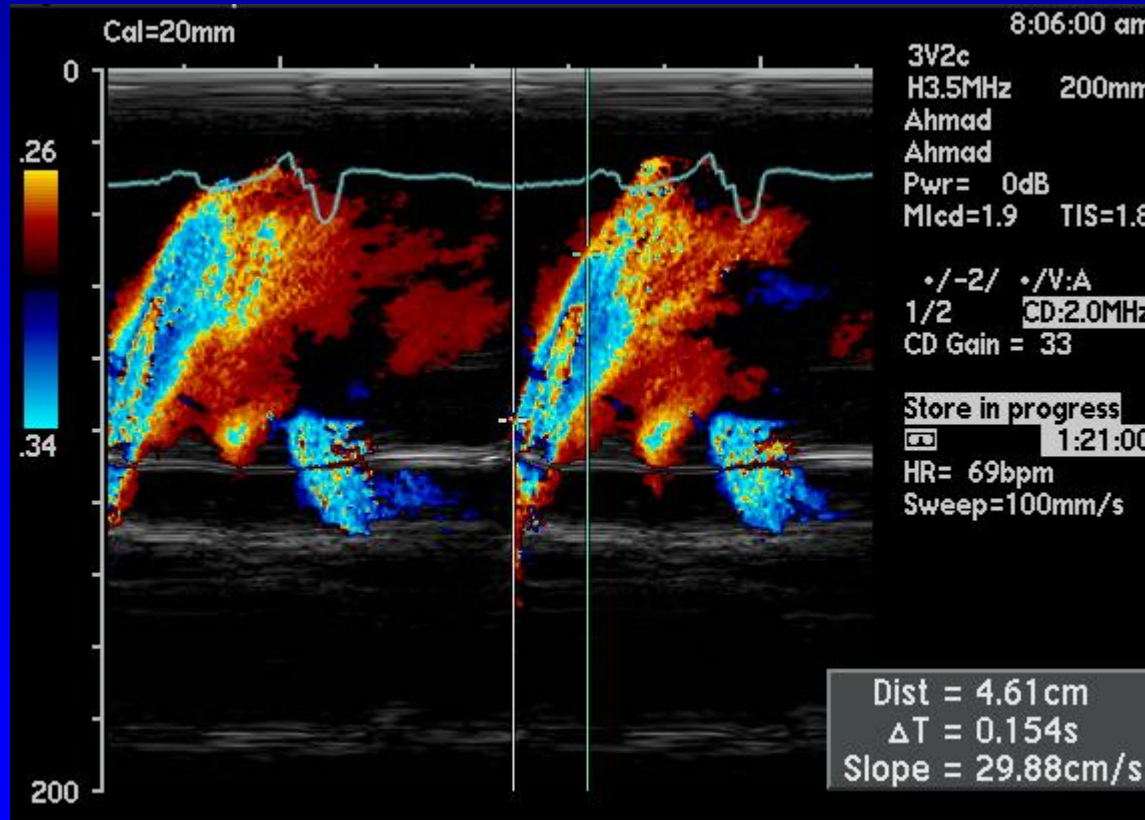
**Decel time= 102 msec**

# Tissue Doppler

- Abnormally low E'
- (Atrial mechanical failure)
- (Low systolic velocity)



# Impaired relaxation- reduced propagation velocity



# Constriction vs. Restriction

History and other tests can  
provide important clues

# Constriction vs. Restriction

## Echo-Doppler

- Features in common:
  - Mitral inflow\*\*
    - Increased E wave
    - Shortened decel time
  - Normal ventricular systolic function
  - Dilated and fixed IVC

\*\* may demonstrate other patterns earlier in the disease

# Major Distinguishing Features

- DTI of mitral annulus
  - Constriction: Normal E wave
  - Restriction: Reduced E wave (<8-10cm/s)
- Respiratory variation (Constriction)
  - Septum
  - Mitral/tricuspid E wave
  - IVRT
  - Hepatic vein flow

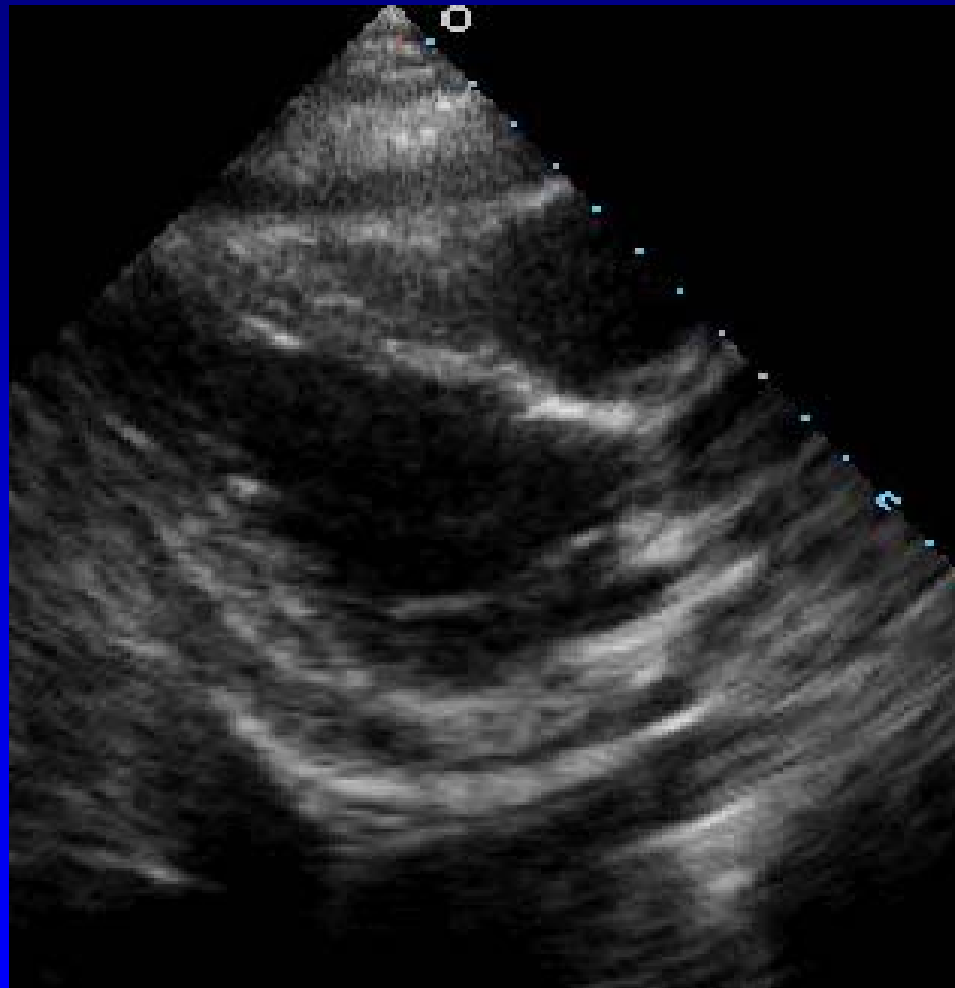
# Major Distinguishing Features

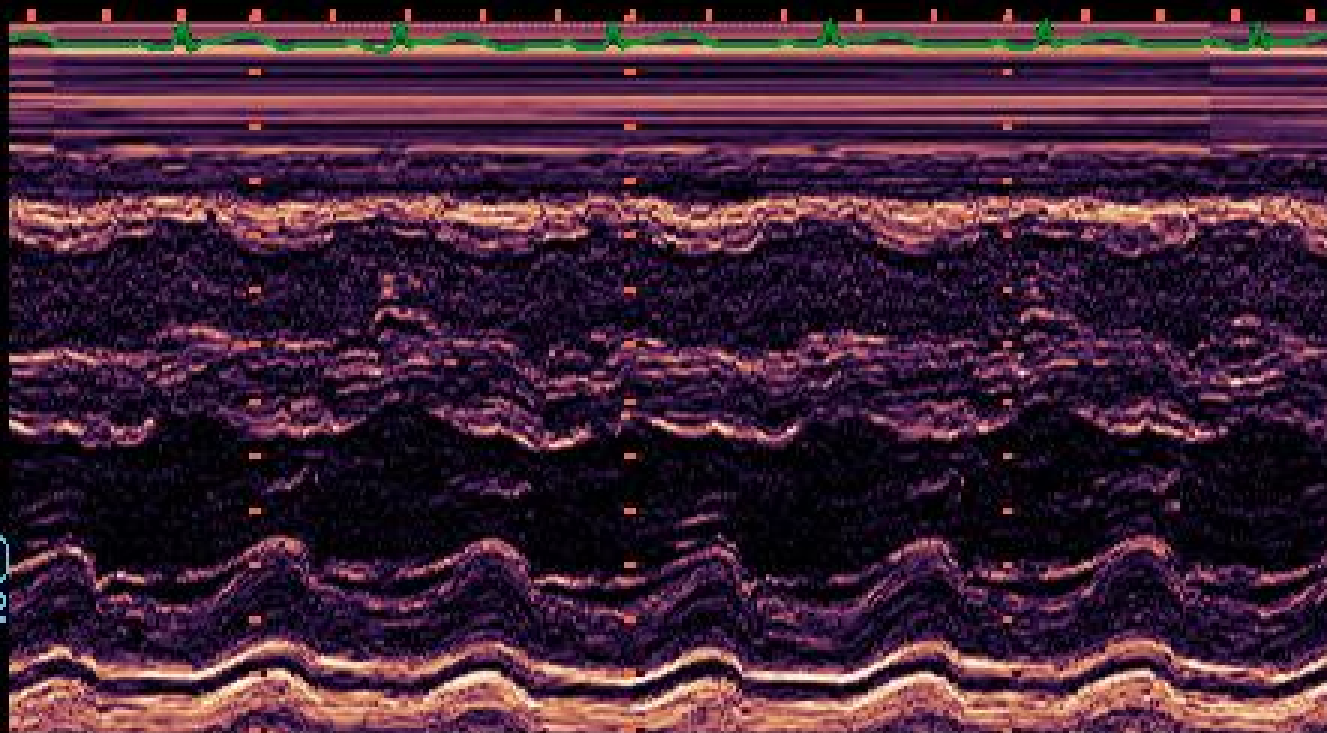
- Appearance of the pericardium
- Appearance of the myocardium
- Color M-mode (index of relaxation)
  - Normal in constriction
  - Abnormal in restriction

# Minor Distinguishing Features

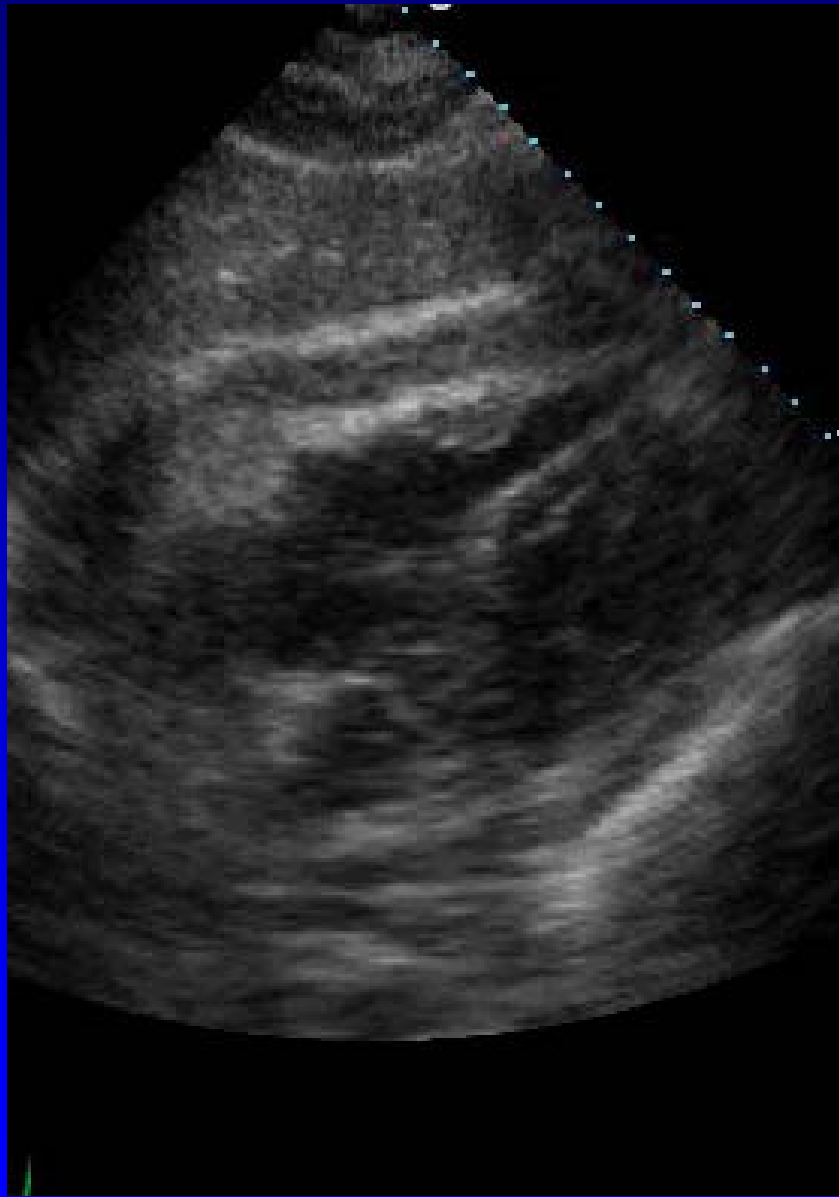
- Atrial size
  - More likely to be normal in constriction
- Septal motion
  - More likely to be normal in restriction
- PA pressure
  - More likely to be elevated in restriction
- MR, TR
  - More likely to be present in restriction

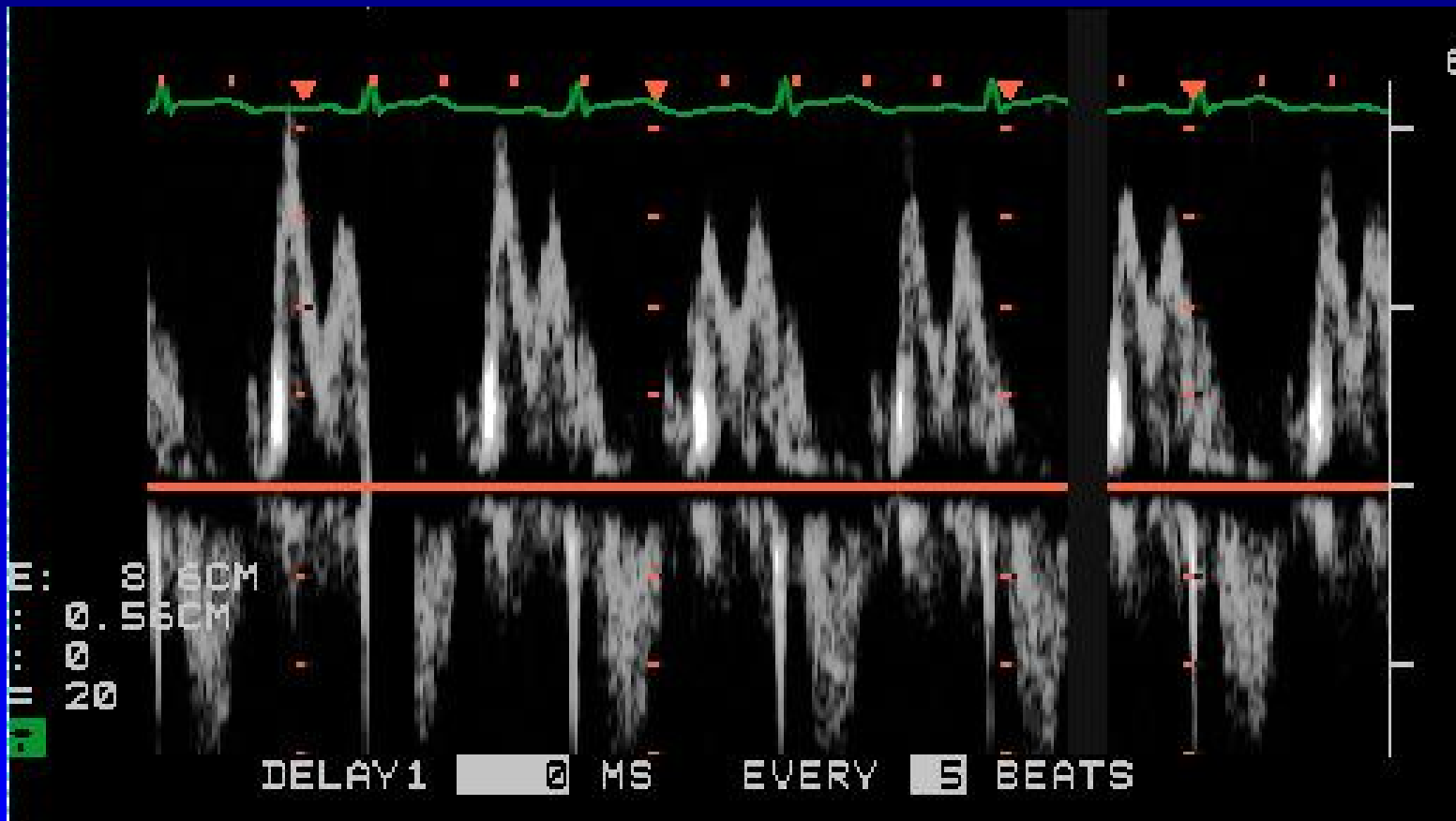
Our patient



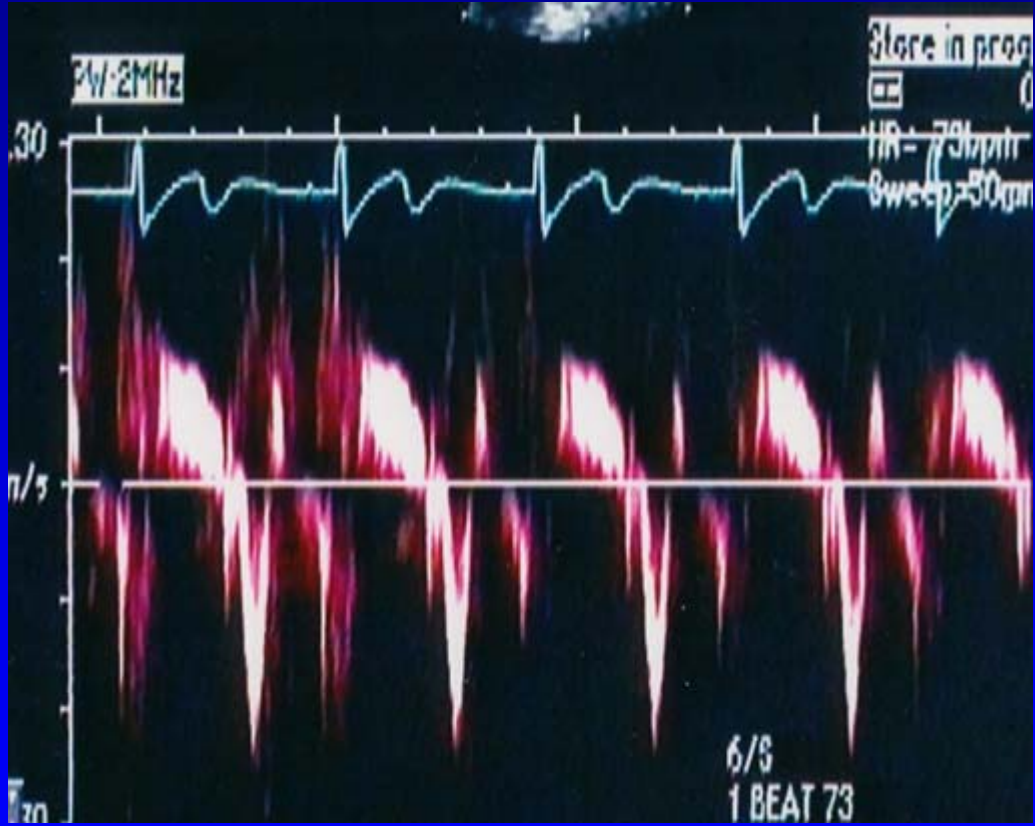


4.2 (R)





# ***DOPPLER TISSUE IMAGING (DTI)***



.2

GAIN 61 COMP 70

P. 16CM

2/0/D/H5

103BPM

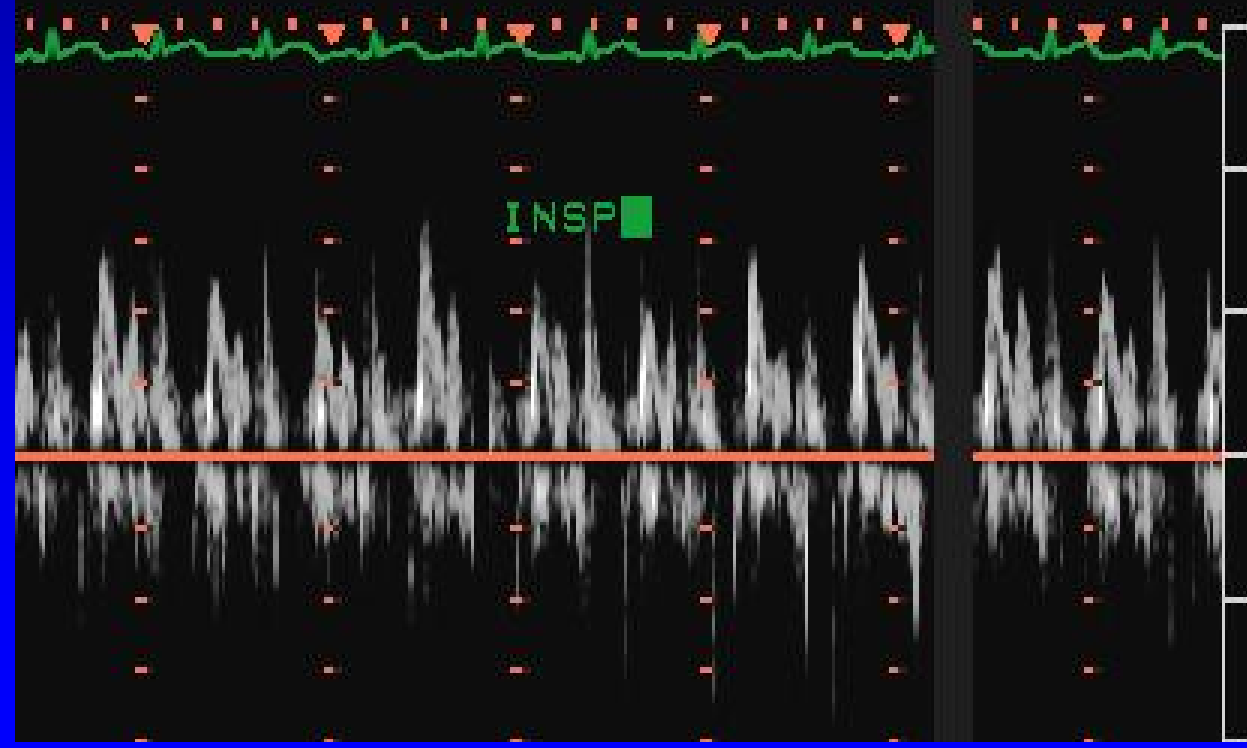
1:39:03

04 APR 03

11:38:42



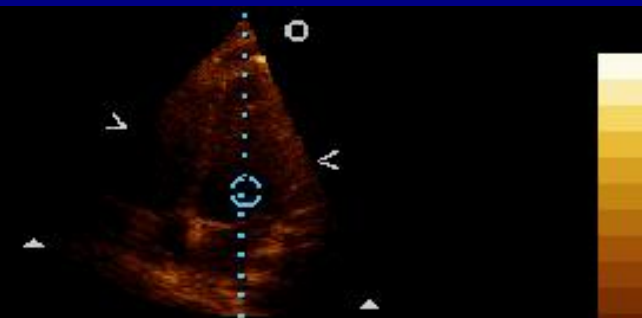
1.6MHZ



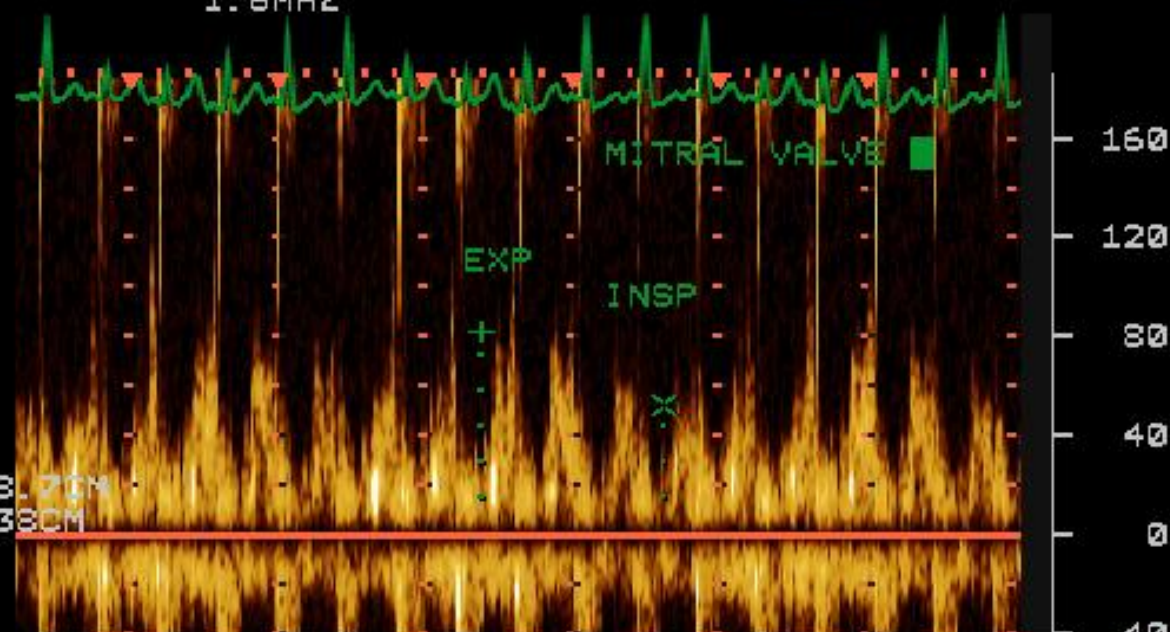
GAIN 77 COMP 50  
15CM

A + VEL 82.9 cm/s  
MI: PG 2.75 mmHg  
B X VEL 53.0 cm/s  
HAR PG 1.12 mmHg  
AGILENT # 7  
JPM

2/0/D/H5  
123BPM  
0:15:02  
19 OCT 05  
13:33:47



1.6MHZ



GATE: 8.7CM  
LEN: 0.38CM  
e: 0  
v= 20

2D HOLD

P 13





# Constrictive Pericarditis

That concludes restriction-  
constriction 101