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# Echocardiographic Evaluation of the Heart Failure Patient

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# Echo in Heart Failure

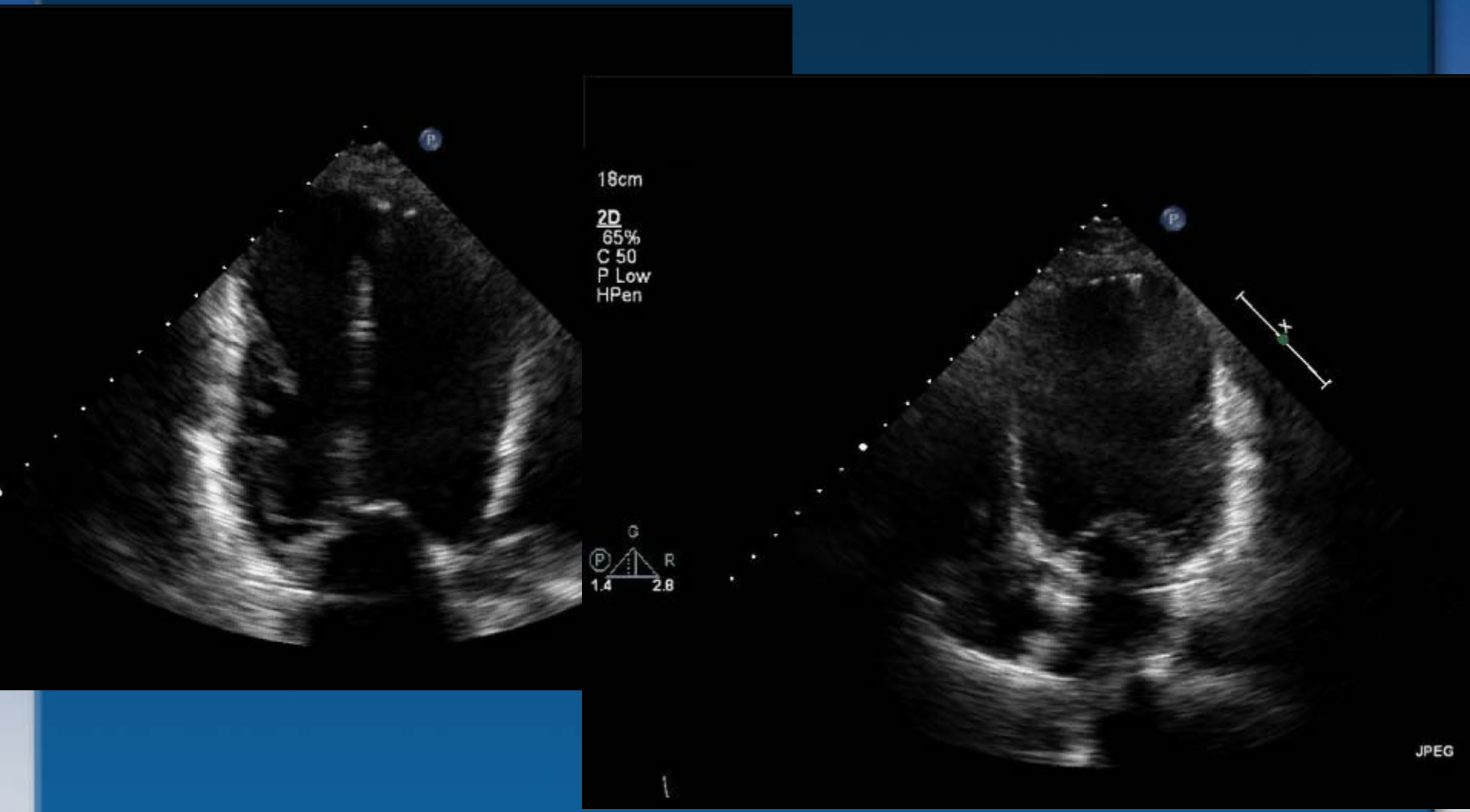
- “The single most useful diagnostic test in the evaluation of patients with heart failure is the comprehensive 2-dimensional echocardiogram coupled with Doppler flow studies…”

Hunt et al., ACC/AHA 2005 Guideline Update for the Diagnosis and Management of Chronic Heart Failure in the Adult., JACC 2005;46:e1-82.

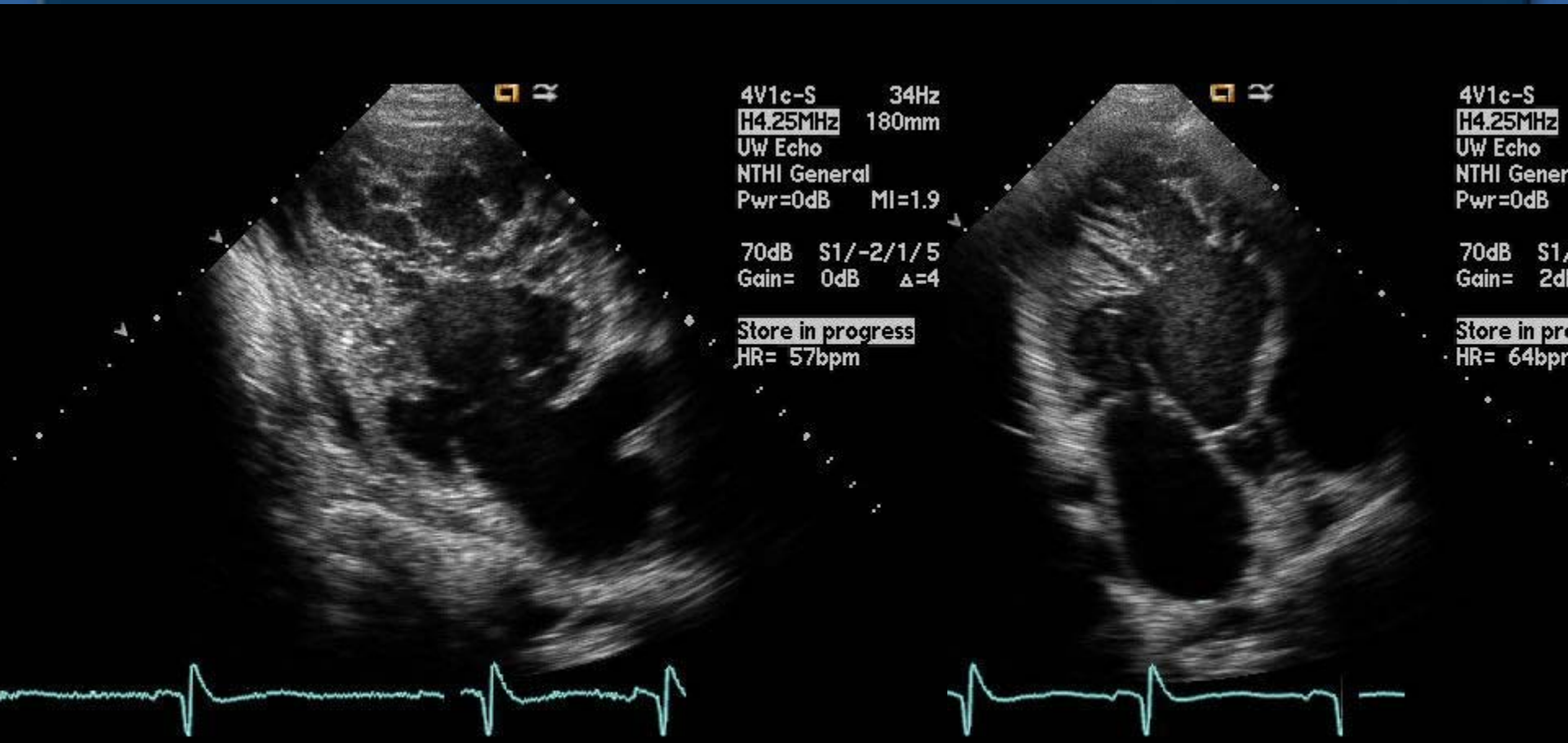
# When to Get an Echo in the Patient with Heart Failure

- New Diagnosis

# 2-D Echo Measurements in HF



# 2-D Echo Measurements in HF



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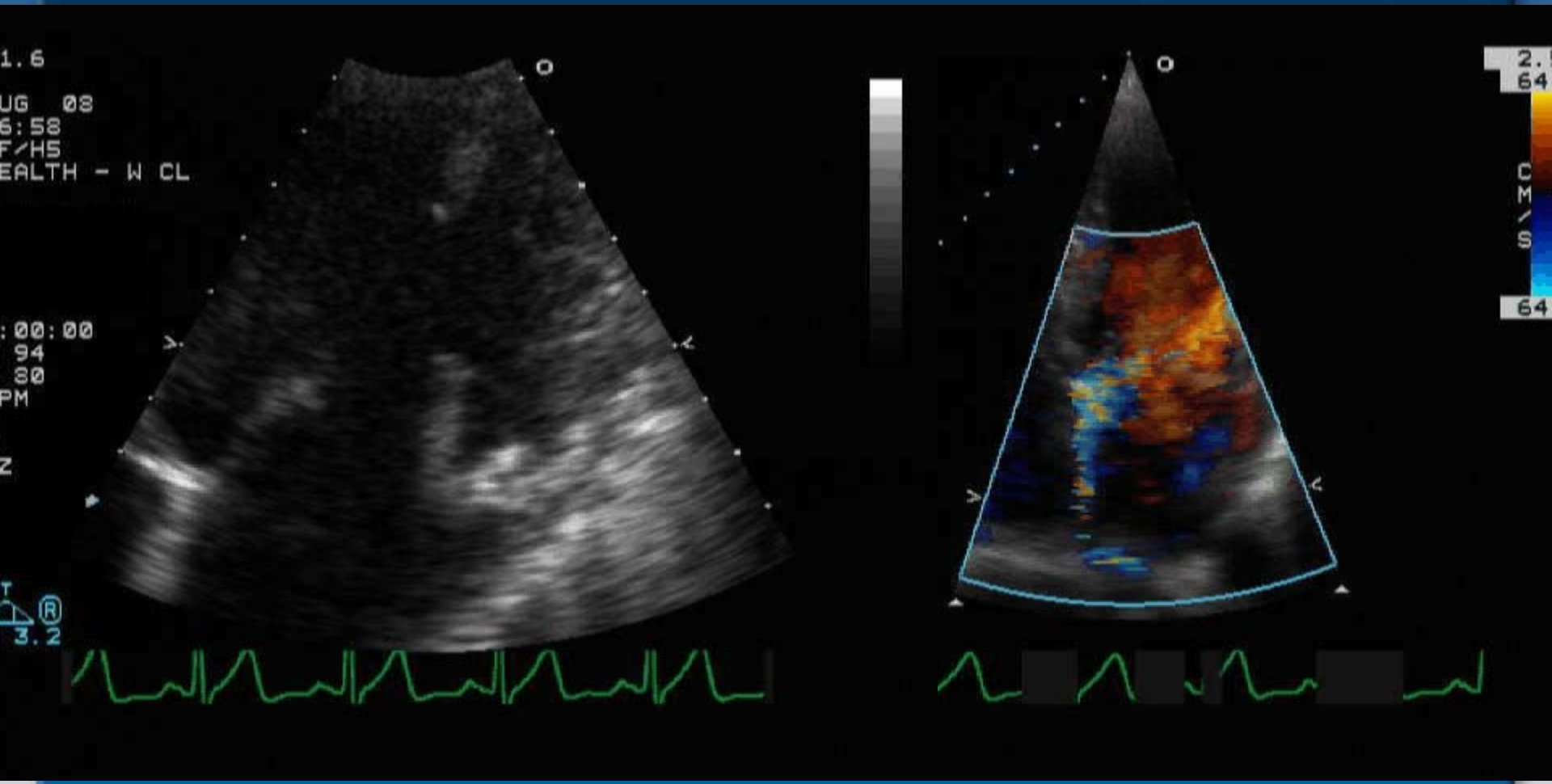


# When to Get an Echo in the Patient with Heart Failure

- New Diagnosis
- Change in clinical status
- After uptitration of medical therapy
- Routine exams
  - ? frequency

# Evaluation of the Heart Failure Patient in the Echo Lab

**Table 1** Evaluation of Standard Doppler Echocardiographic Techniques in HF

| Technique | Strengths | Limitations |
|---|---|---|
| Doppler (hemodynamics) | 1. Facile<br>2. Rapid<br>3. On-line | 1. Requires parallel alignment of Doppler beam<br>2. Pulmonary and tricuspid valve regurgitation not always present<br>3. Stroke volume measurement from LVOT overestimated in significant AI |
| Doppler (diastolic function) | 1. Facile<br>2. Rapid<br>3. On-line<br>4. Prognostic | 1. Requires parallel alignment of Doppler beam<br>2. Heart rate dependent<br>3. Load dependent |
| 2D EF, dimensions and mass | 1. Facile<br>2. Rapid<br>3. Prognostic<br>4. On-line | 1. Dependent on image quality<br>2. Foreshortening common<br>3. High inter- and intra-observer variability<br>4. Requires geometric assumptions<br>5. Does not correlate well with clinical status |

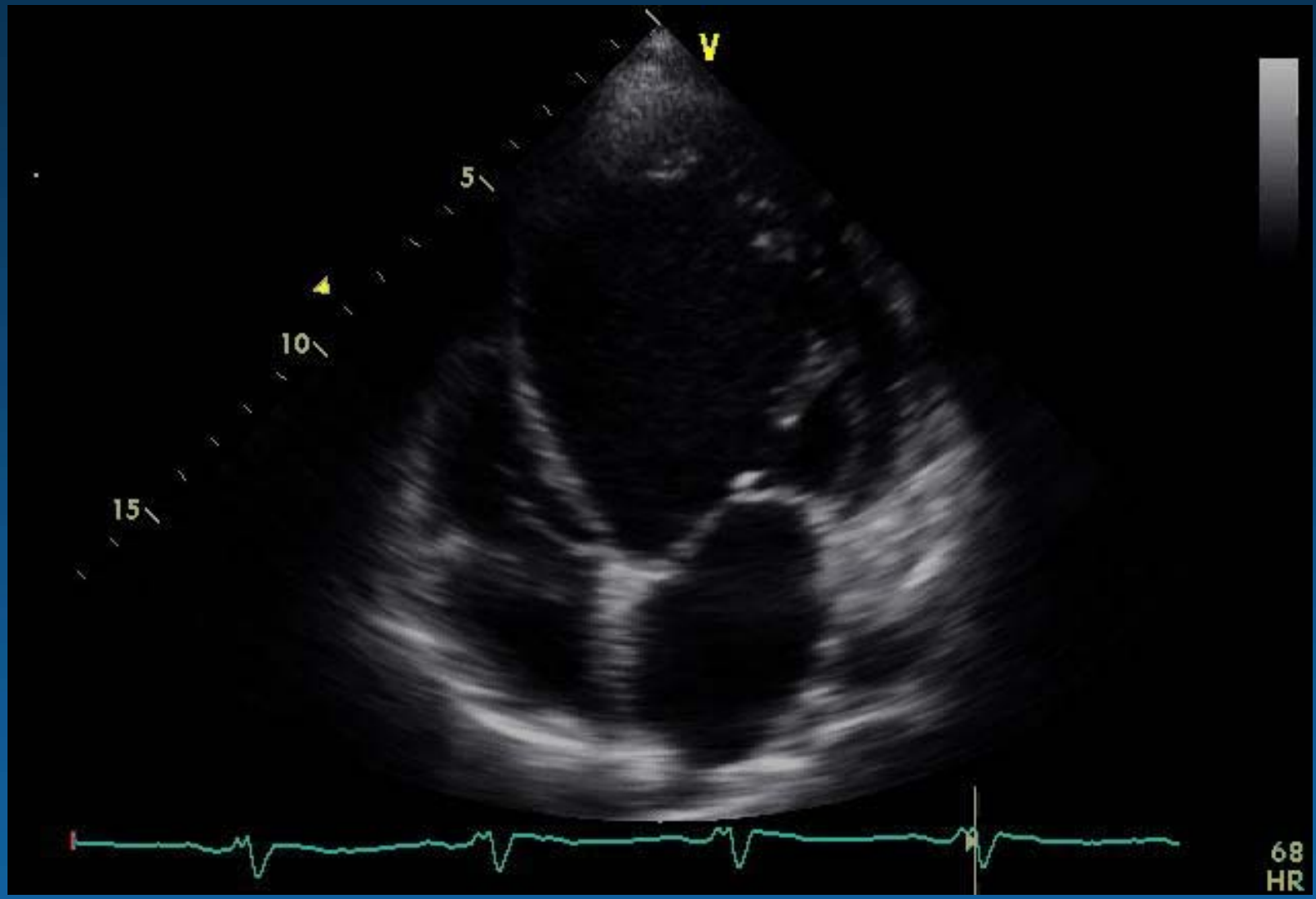
2D = 2-dimensional; AI = aortic insufficiency; EF = ejection fraction; HF = heart failure; LVOT = left ventricular outflow tract.

Kirkpatrick et al., JACC 2007; 50:381-96.

# 2-D Echo Measurements in HF

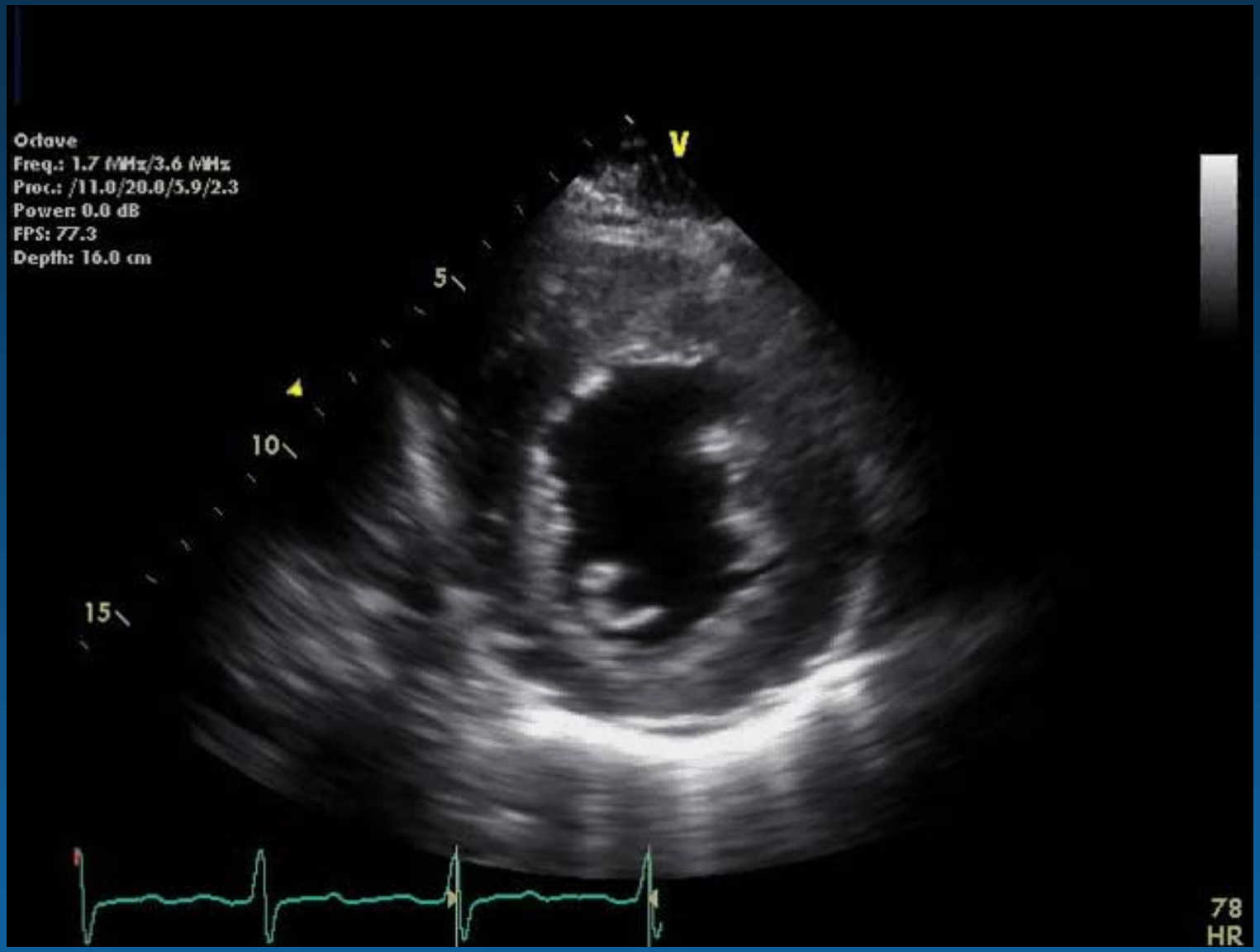
- Left ventricle:
  - Dimensions
  - Ejection fraction
  - Volumes

# 2-D Measurements of the LV



- EF and LV dimensions do NOT correlate with:
  - HF symptoms
  - Exercise capacity
  - Myocardial oxygen consumption

# 2-D Echo Measurements in HF



# Ejection Fraction

- There is a difference between normal EF and normal stroke volume.
  - Severe concentric hypertrophy
  - Severe mitral regurgitation.

# Right Ventricle

- Very hard to quantify.
- Difficult to assess size with certainty.
- Multiple images imperative.
- Subcostal and Parasternal long are probably most important.

# Mass and Volumes

- Important markers of disease progression and prognosis.
- Require careful comparison of serial echos.
- Rarely done in quantitative fashion in clinical practice.
- Unlikely to appear in a boards question.

# Hemodynamic Assessment in the Echo Lab

- Left sided filling pressures
  - Mitral inflow
  - Pulmonary vein flow
  - Tissue Doppler of mitral annulus

Diastolic Function Assessment

- Cardiac Output
  - 2-D dimension and pulse wave Doppler of LVOT
- PA pressures
  - Continuous wave Doppler of TR
- CVP
  - IVC Imaging

# Hemodynamic Assessment in the Echo Lab

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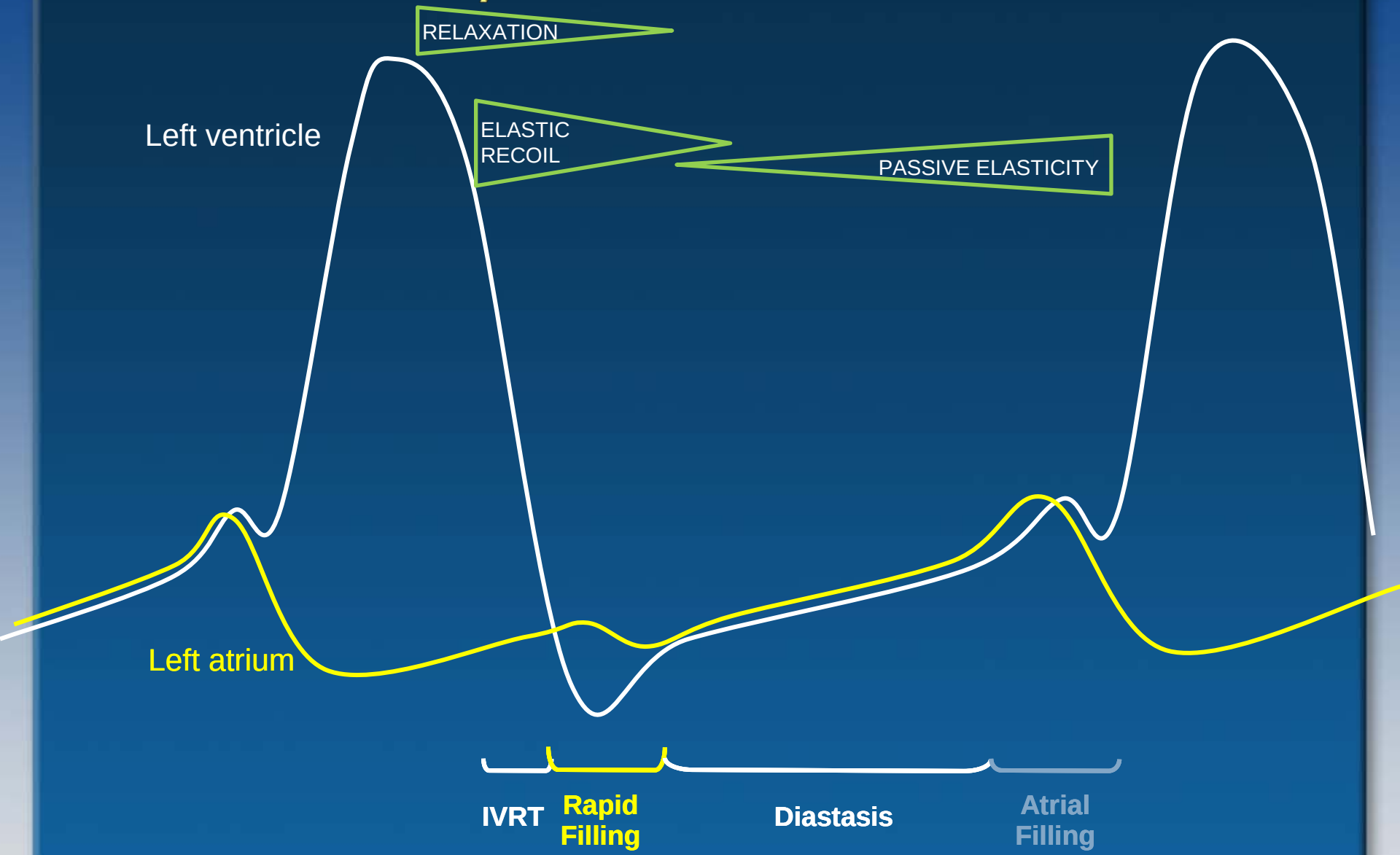
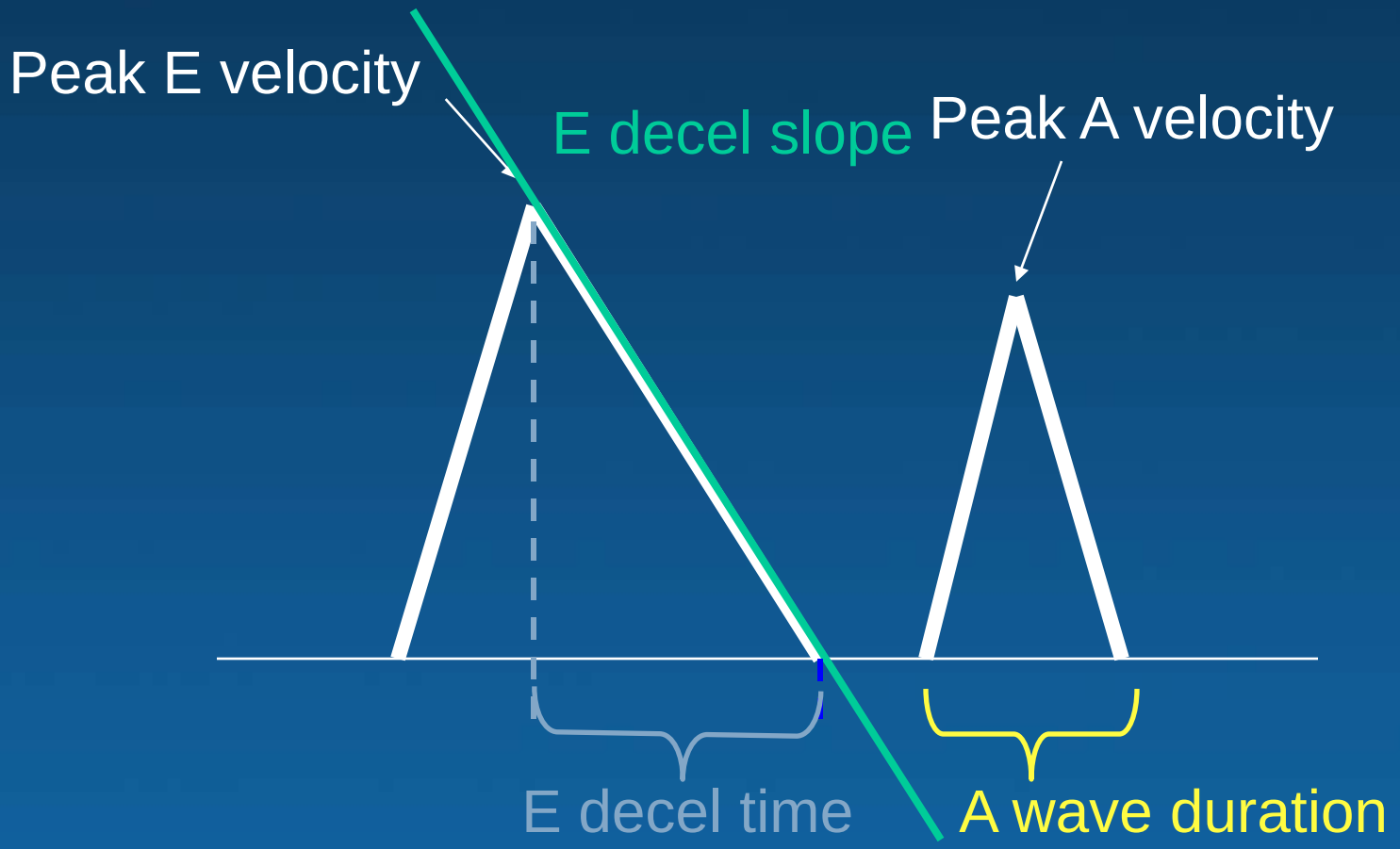
# Diastolic Dysfunction

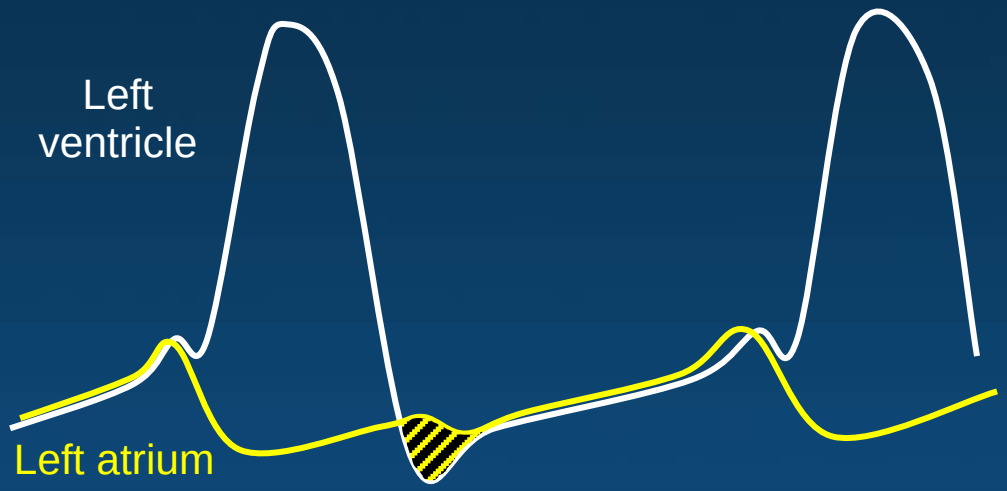


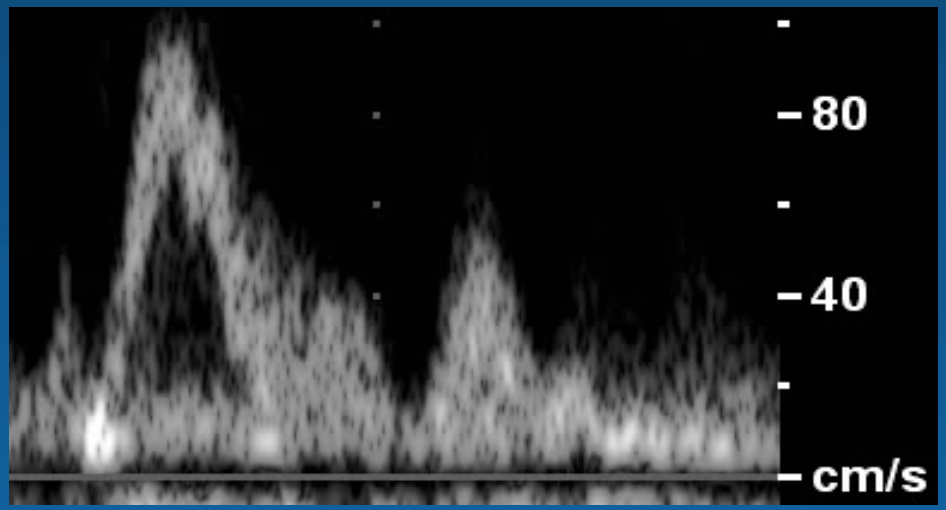

Diastole is divided into 4 phases

# Echo Assessment of Diastole: Mitral Inflow Pattern



# Diastolic Filling Measured Non-Invasively



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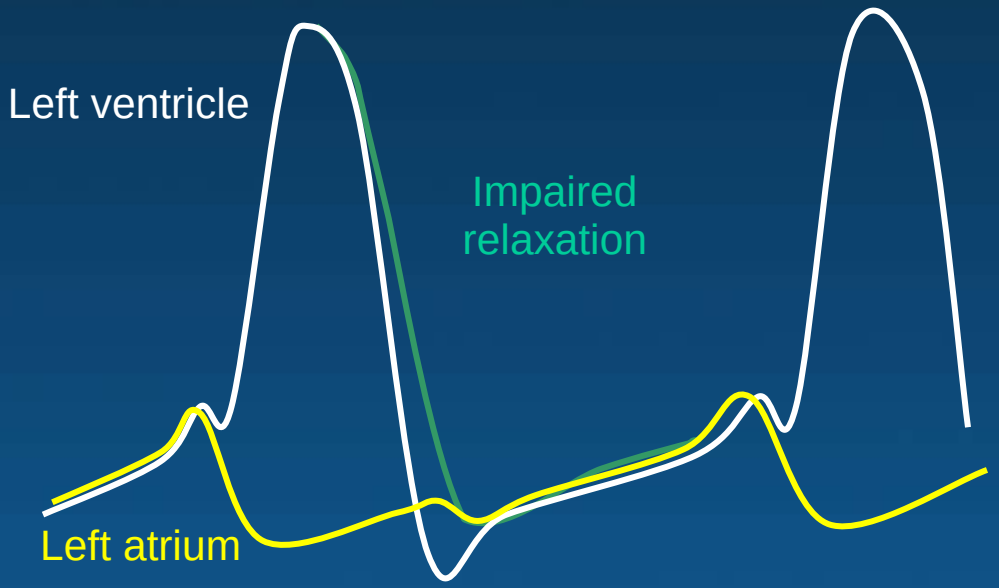


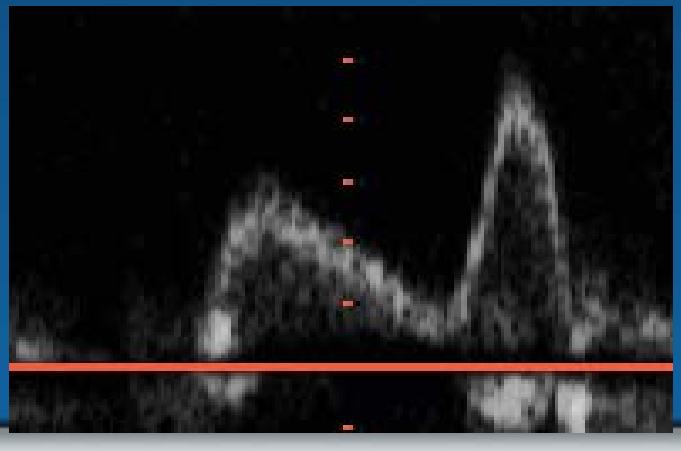

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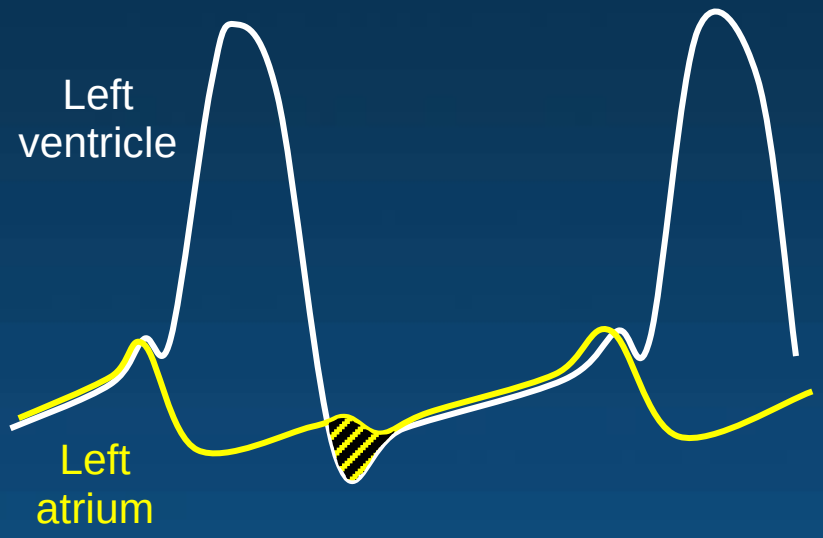
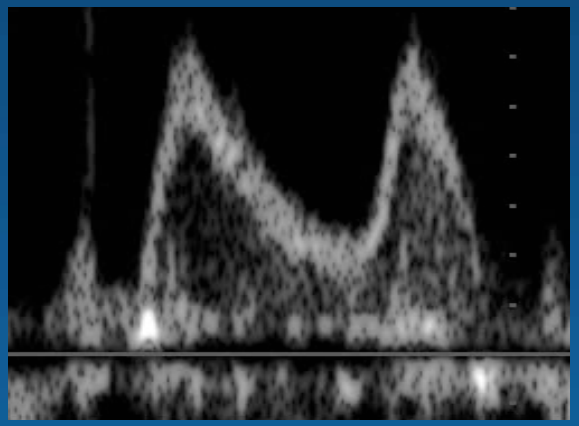
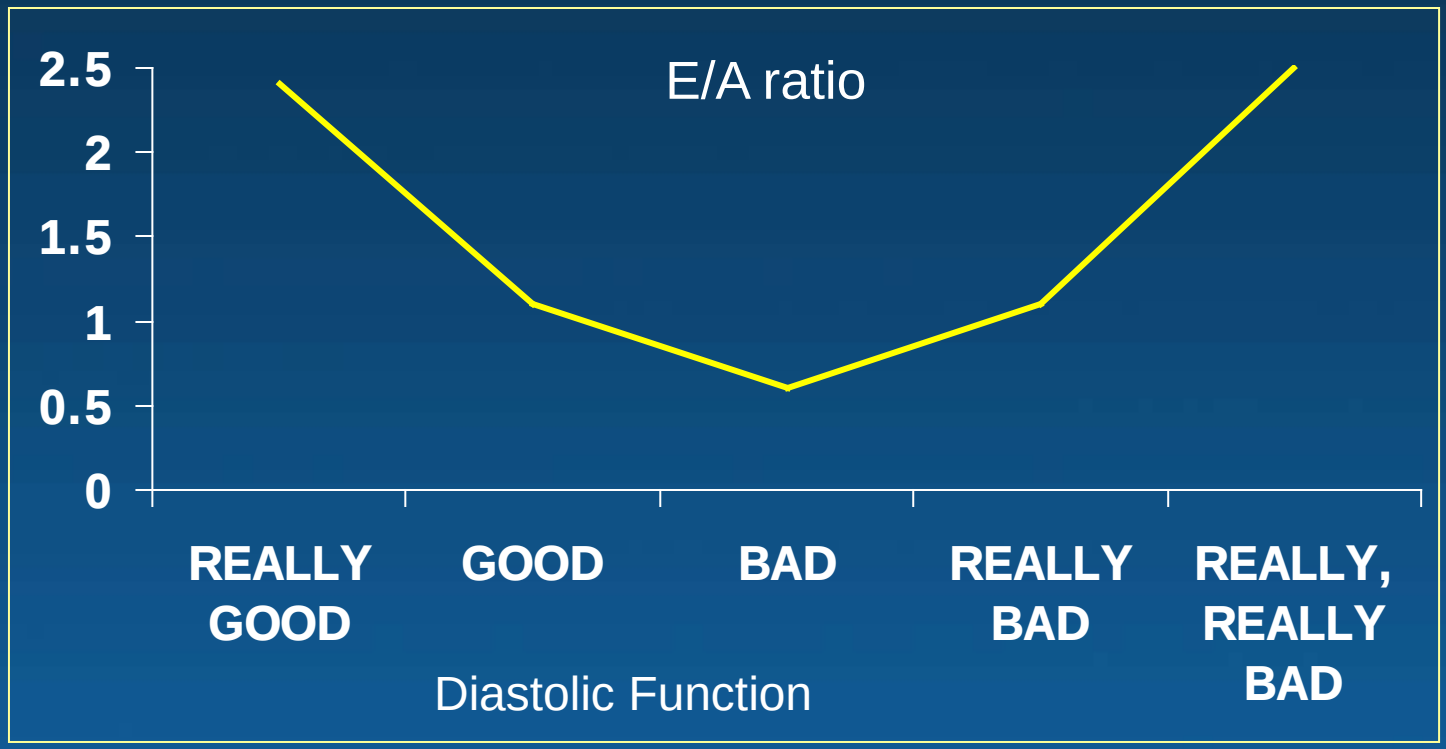


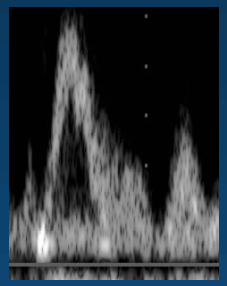
Normal or Pseudonormal?

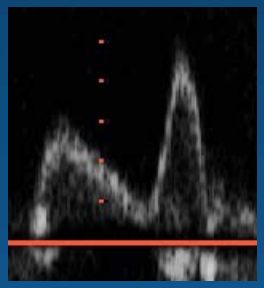
# Echo Assessment of Diastole

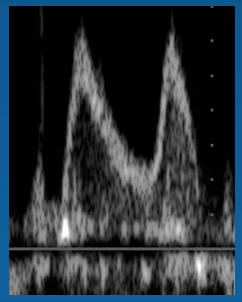



Hess et al. 1999. Dialogues in Cardiovascular Medicine, 4:211-5.

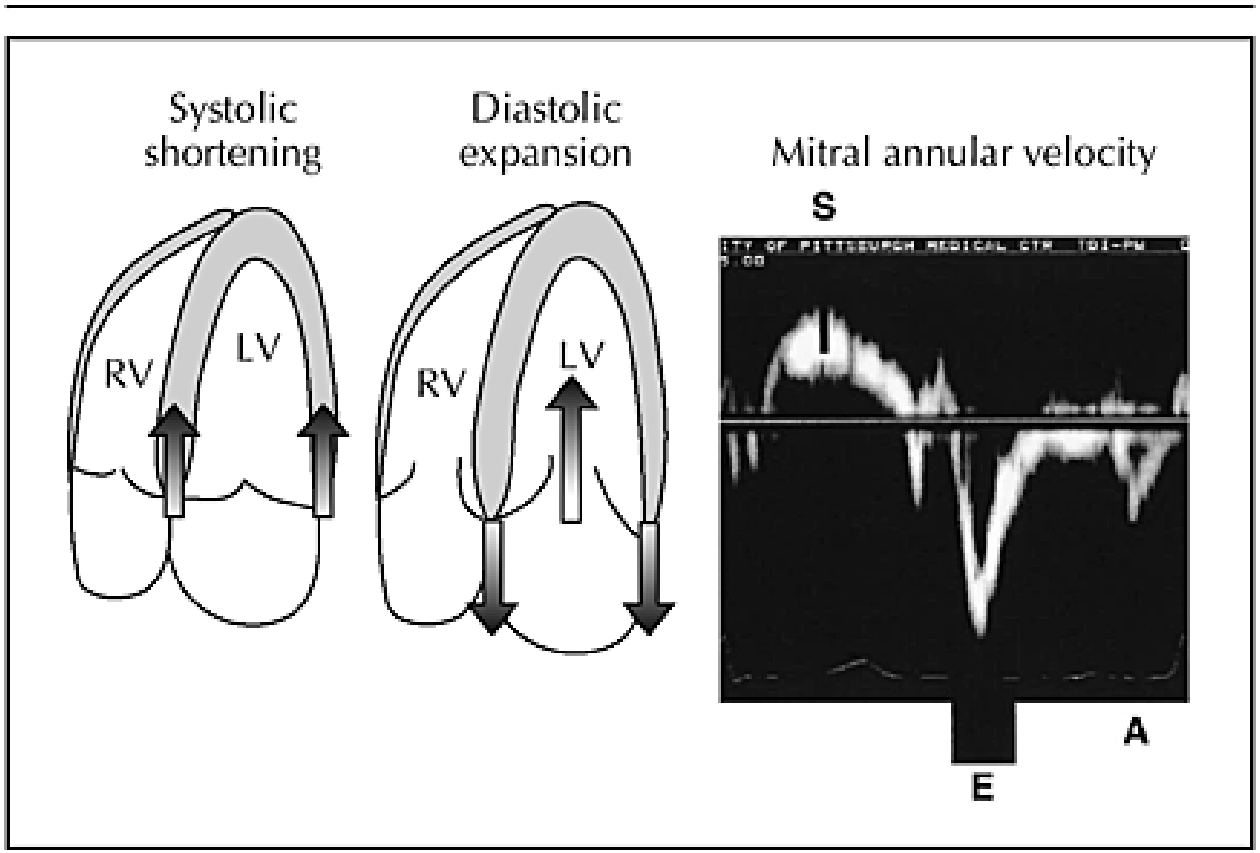
# Tissue Doppler Imaging Annular Velocities







# Tissue Doppler Imaging
# Annular Velocities



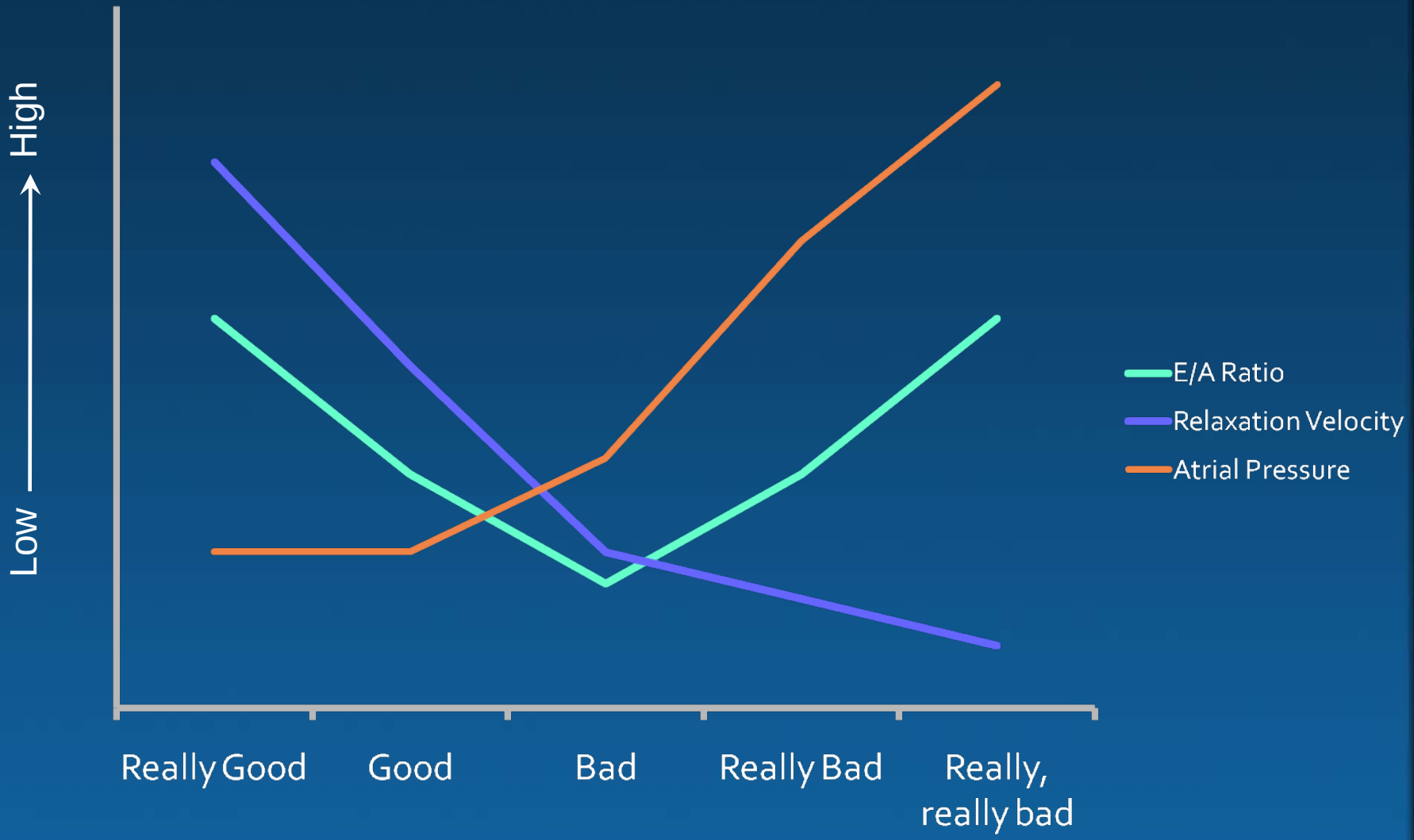

S, peak systolic velocity; E, peak early diastolic velocity; A, peak atrial velocity.

$E_a$

E’

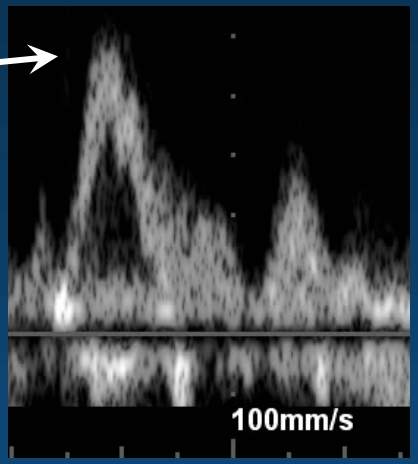
$E_m$

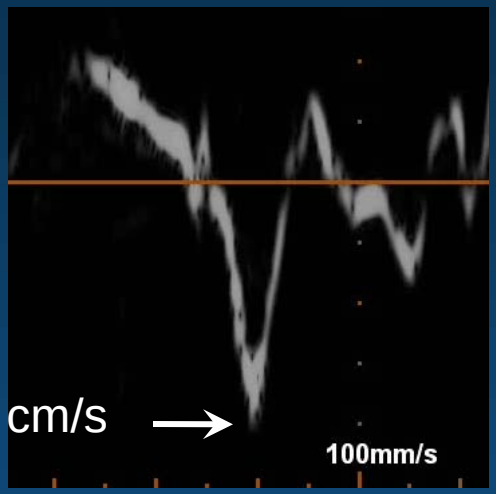
# Echo Assessment of Diastole



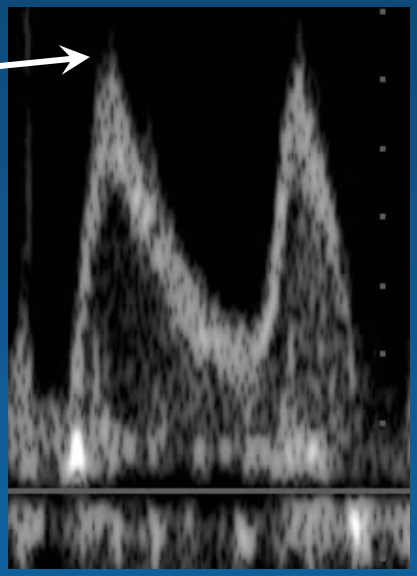
# Diastolic Filling Measured Non-Invasively

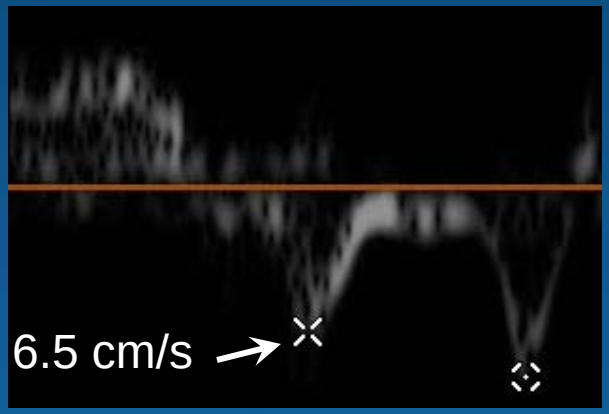
92 cm/s



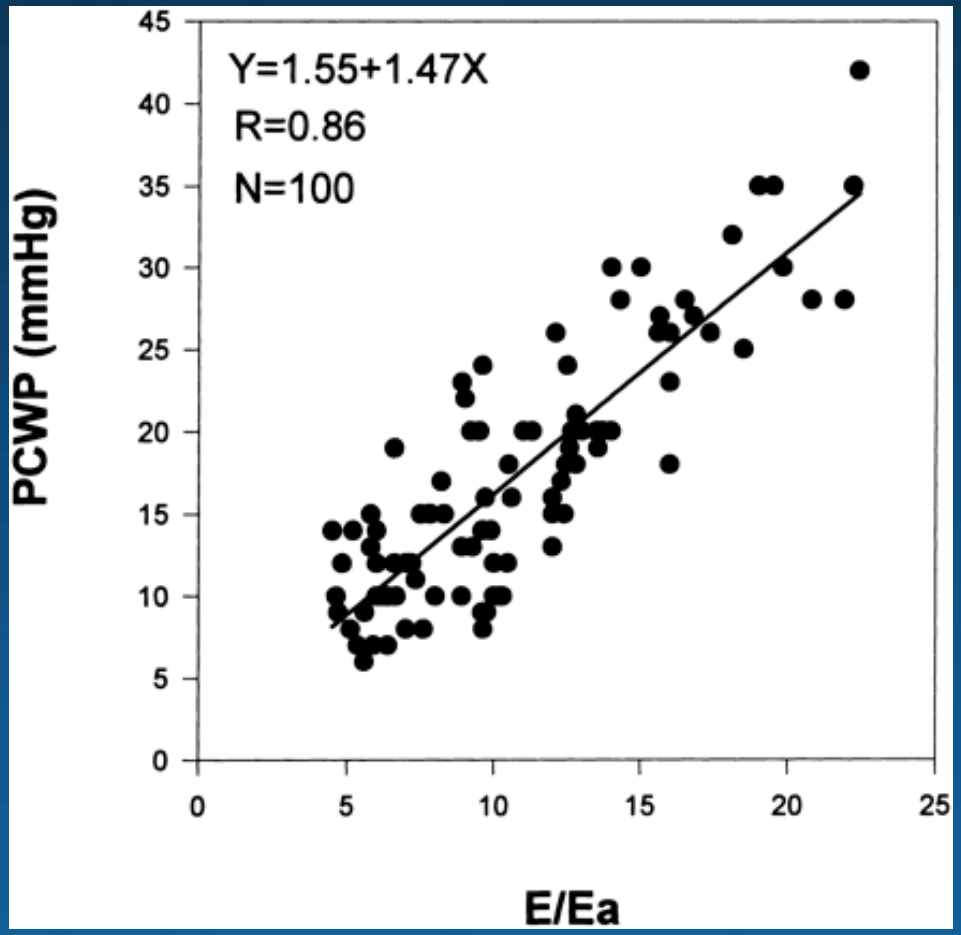




127 cm/s



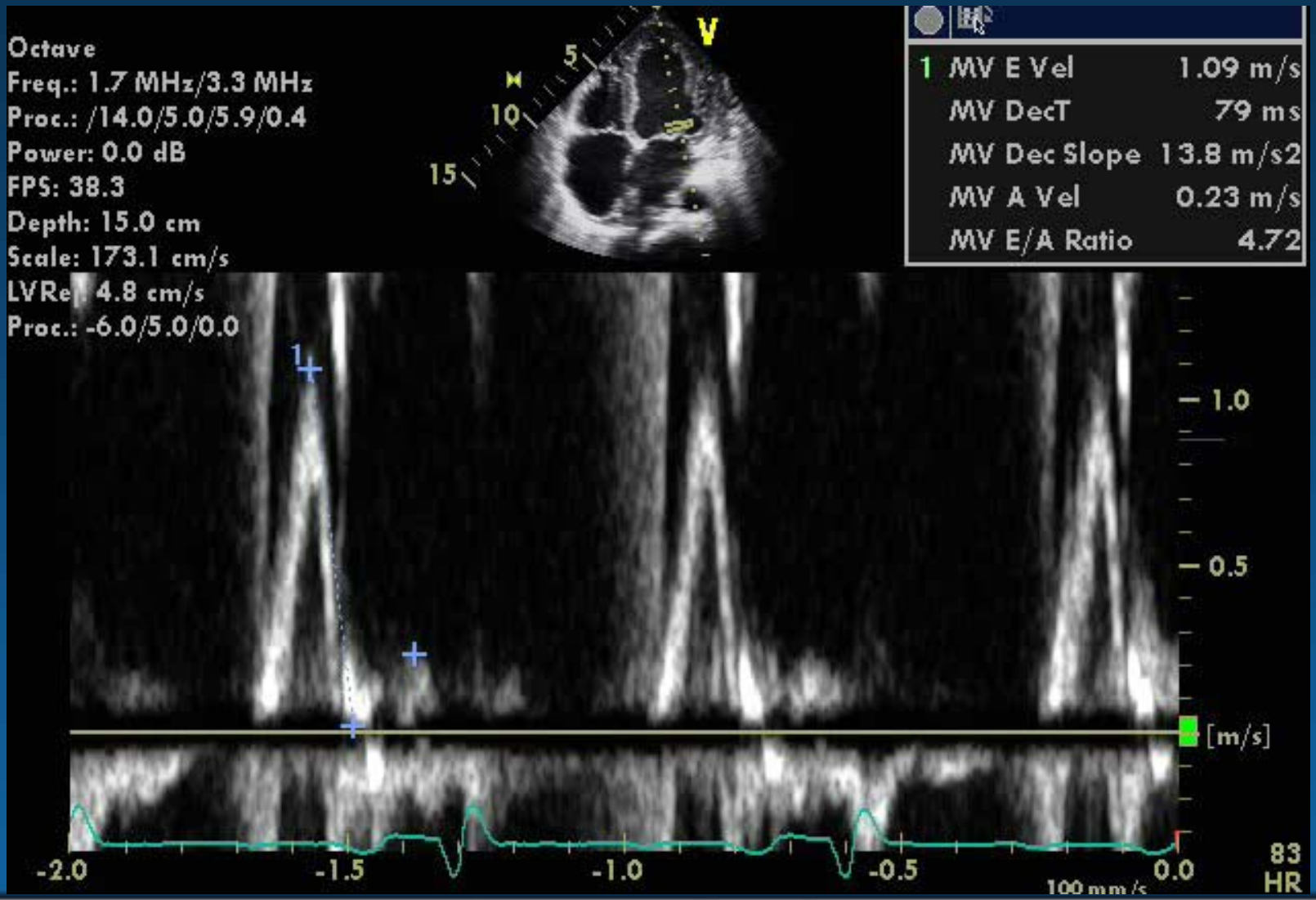


# Assessment of LA Pressure by Echo

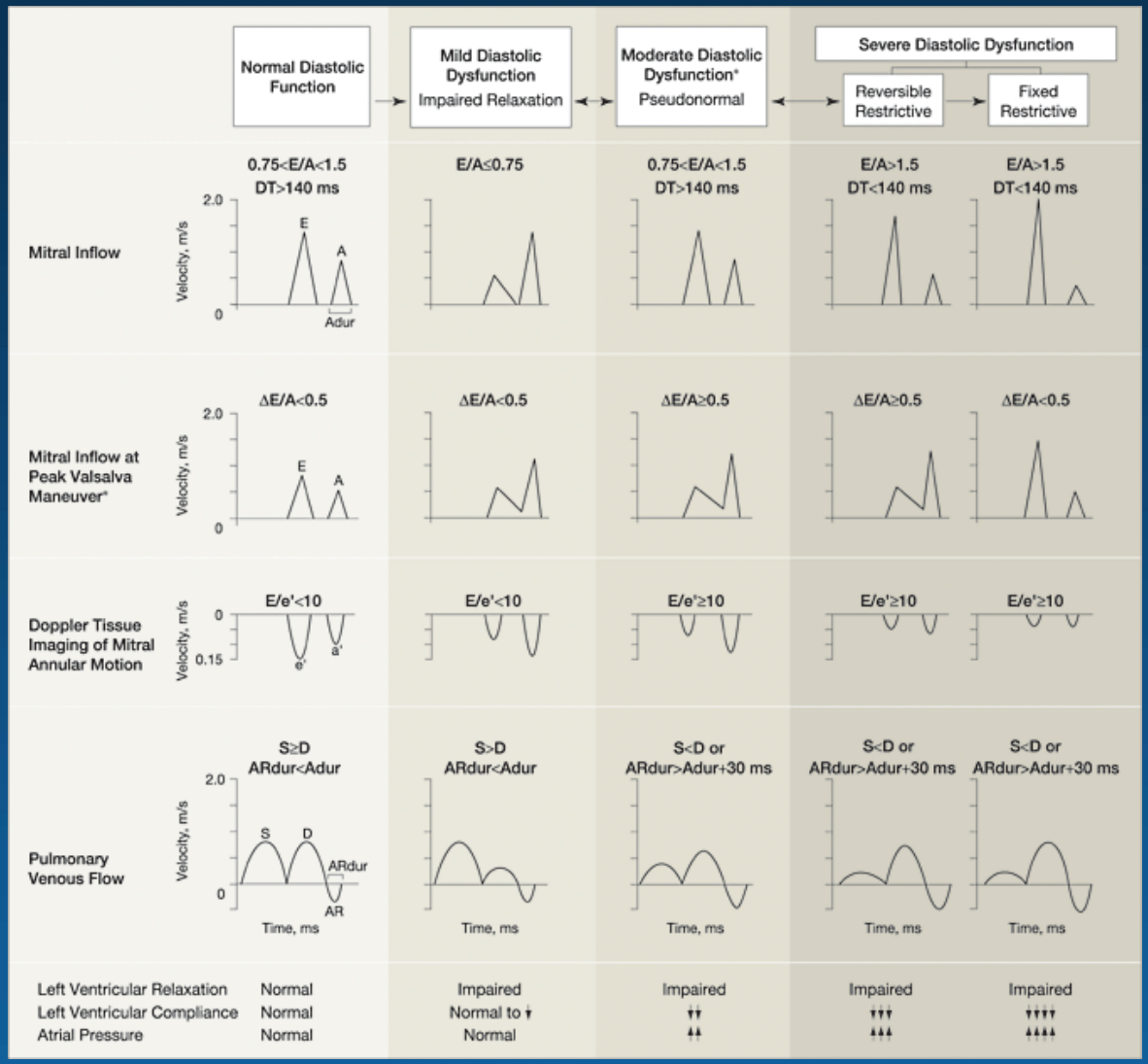



Nagueh et al , JACC 1997;30:1527-1533

# Restrictive Filling



# Diastolic Heart Failure Assessment




Redfield, et al. JAMA. 2003;289:194-202

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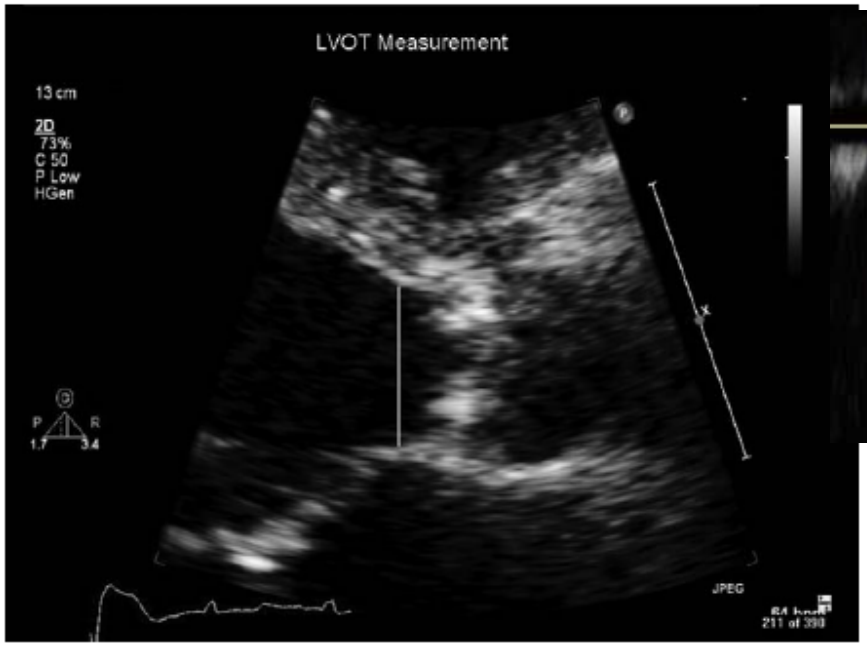


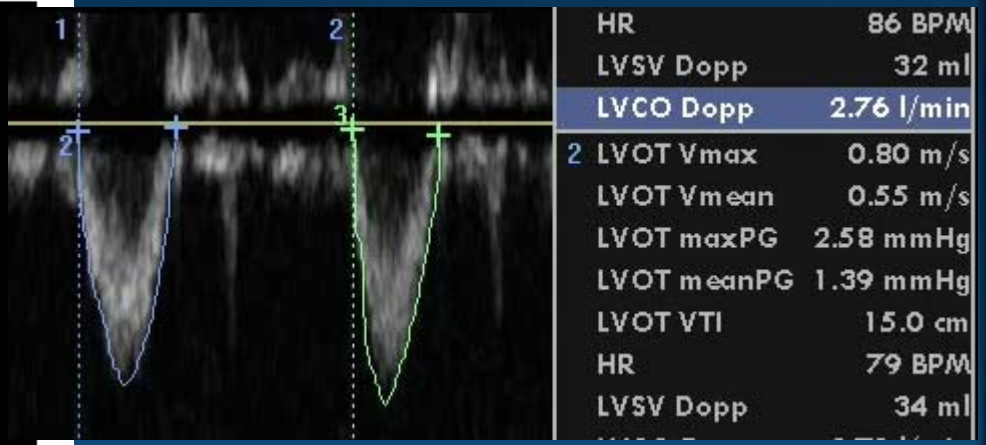


Figure 5 Left ventricular outflow tract diameter is measured in the parasternal long-axis view in mid-systole from the white–black interface of the septal endocardium to the anterior mitral leaflet, parallel to the aortic valve plane and within 0.5–1.0 cm of the valve orifice.

$$SV = (\text{LVOT diameter}/2)^2 * 3.1415 \times \text{LVOT VTI}.$$

Baumgartner et al, Echocardigraphic Assessment of Valve Stenosis: EAE/ASE Recommendations for Clinical Practice. 2008.

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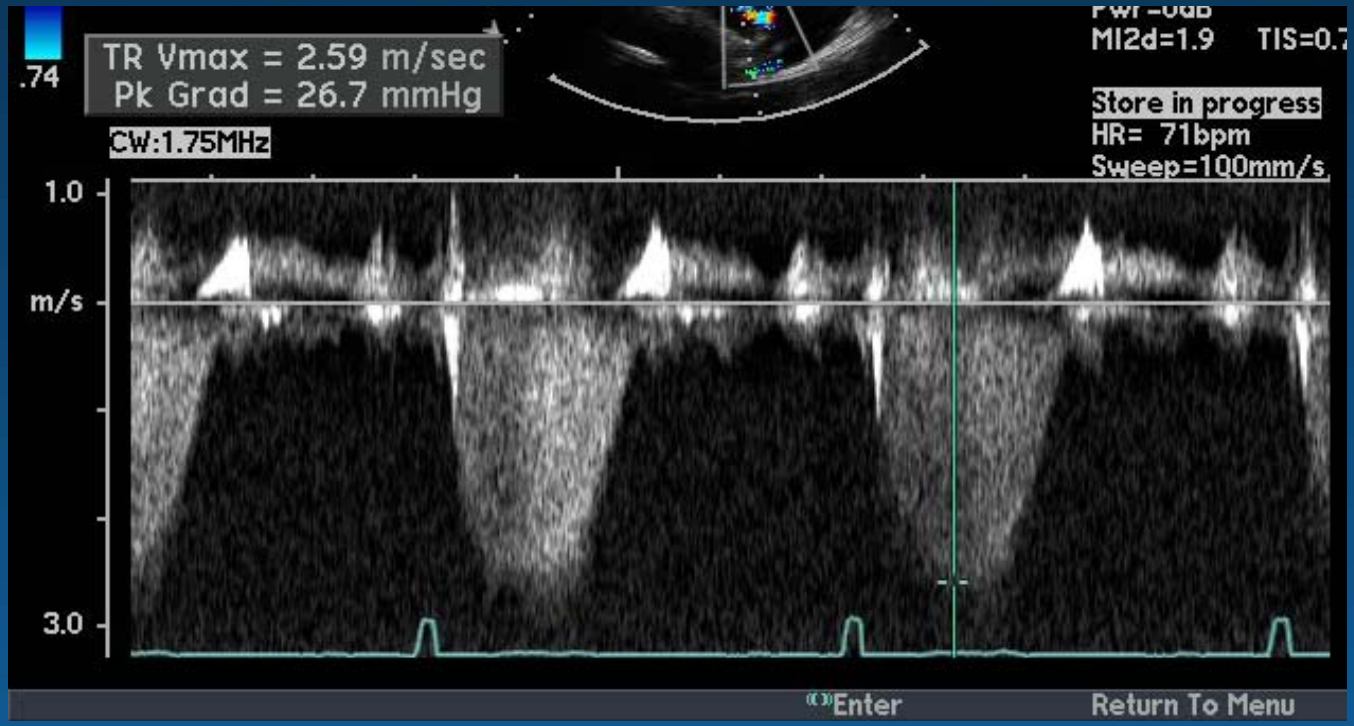
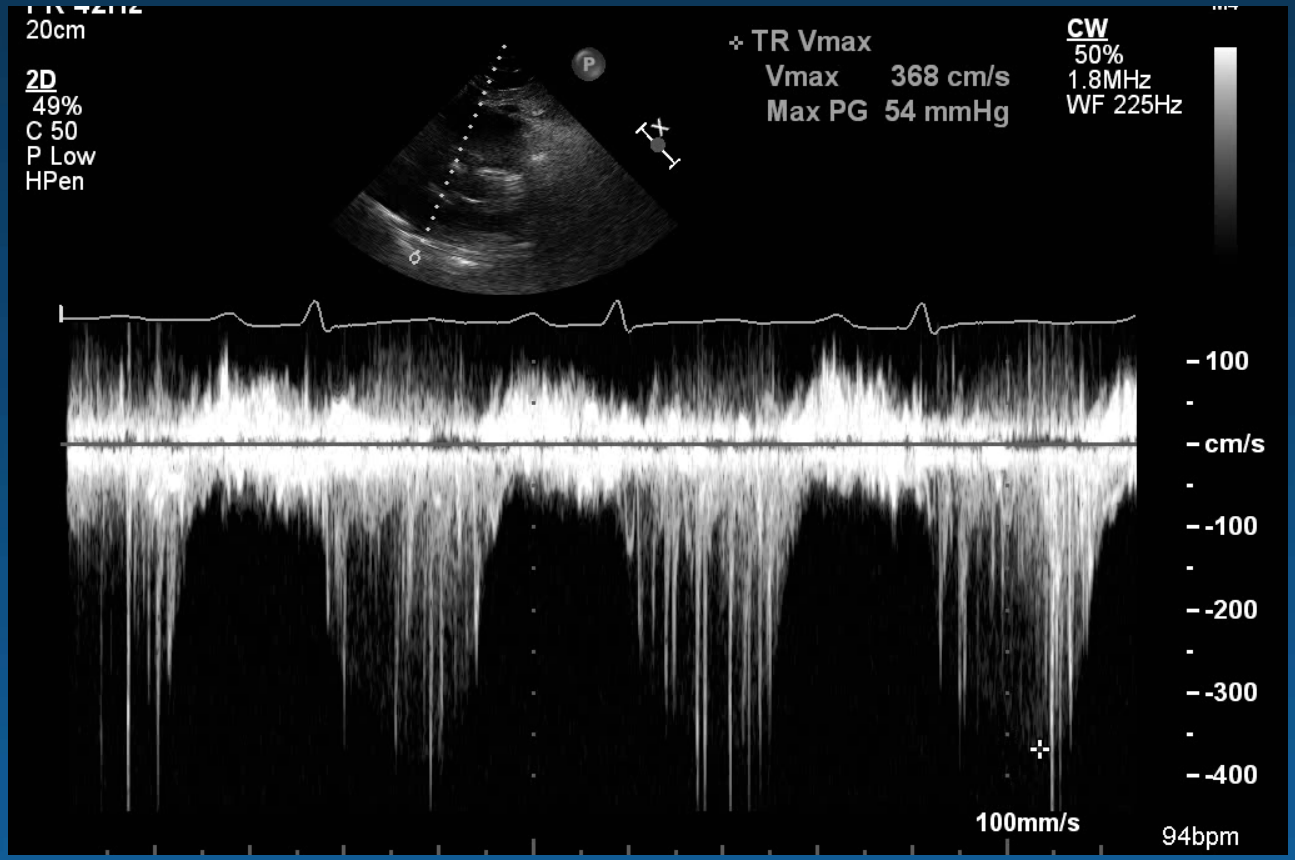

.74
TR Vmax = 2.59 m/sec
Pk Grad = 26.7 mmHg
CW:1.75MHz
MI2d=1.9
Store in progress
HR= 71bpm
Sweep=100mm/s
1.0
m/s
3.0
Enter
Return To Menu


20cm
2D
49%
C 50
P Low
HPen
TR Vmax
Vmax 368 cm/s
Max PG 54 mmHg
CW
50%
1.8MHz
WF 225Hz
100
cm/s
-100
-200
-300
-400
100mm/s
94bpm

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# Newer Echo Techniques that may have utility in Heart Failure

**Table 2** Evaluation of Novel Doppler Echocardiographic Techniques in HF

| Technique | Strengths | Limitations |
|---|---|---|
| Real time 3D for EF and volumes | 1. Eliminates foreshortening<br>2. Geometric assumptions not required<br>3. Simultaneous assessment of all wall segments | 1. Highly dependent on image quality<br>2. Extra expense of software and probe<br>3. Incremental value over 2D not well established<br>4. Sonographer expertise required<br>5. Not widely available |
| Tissue Doppler, strain, and strain rate | 1. Prognostic<br>2. Most parameters load independent<br>3. Widely available (tissue velocity)<br>4. Less dependent on image quality | 1. Angle dependent<br>2. Strain and strain rate require off-line analysis<br>3. Low signal/noise ratio |
| Tissue tracking | 1. Not angle dependent<br>2. Able to assess torsional mechanics | 1. Extra expense of software<br>2. Incremental value over TDI not well established<br>3. Speckles move in and out of plane (requires mathematical assumptions to compensate)<br>4. Requires off-line analysis<br>5. Not widely available |

Kirkpatrick et al., JACC 2007; 50:381-96.