OPTIMIZING ECHO ACQUISTION FOR STRAIN AND DIASTOLOGY
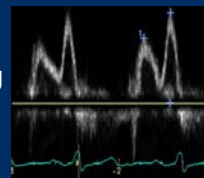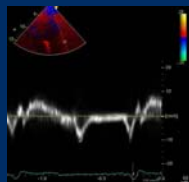
October 8, 2017

Deborah Agler, ACS, RDCS, FASE
Coordinator of Education and Training
Cleveland Clinic

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General Principles
Diastology

- Clinical Data
  - Heart rate/Underlying rhythm
  - Blood pressure
  - Height/Weight (BSA)
- 2D/Doppler findings
  - LV volumes/wall thickness
  - Ejection fraction
  - LA volume
  - Presence and severity of MV disease
- Quality of Doppler signal
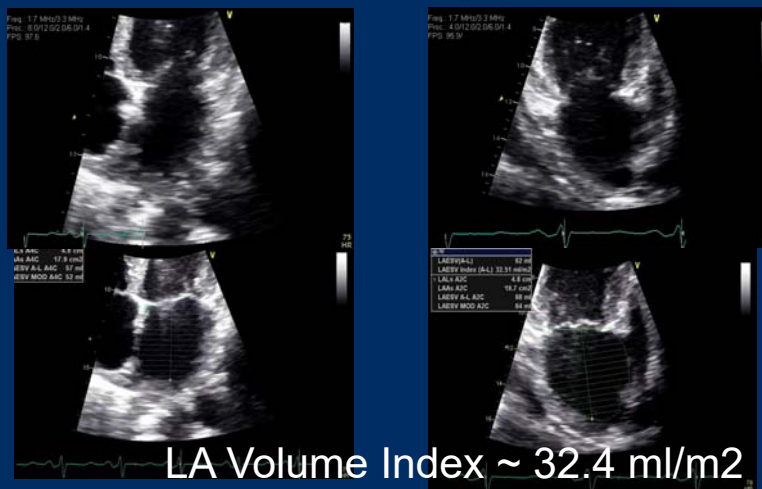- Limitations of parameters
  - Technique is key

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Diastolic Function Exam
LV function

Volumes
Wall Thickness
EF= 65%
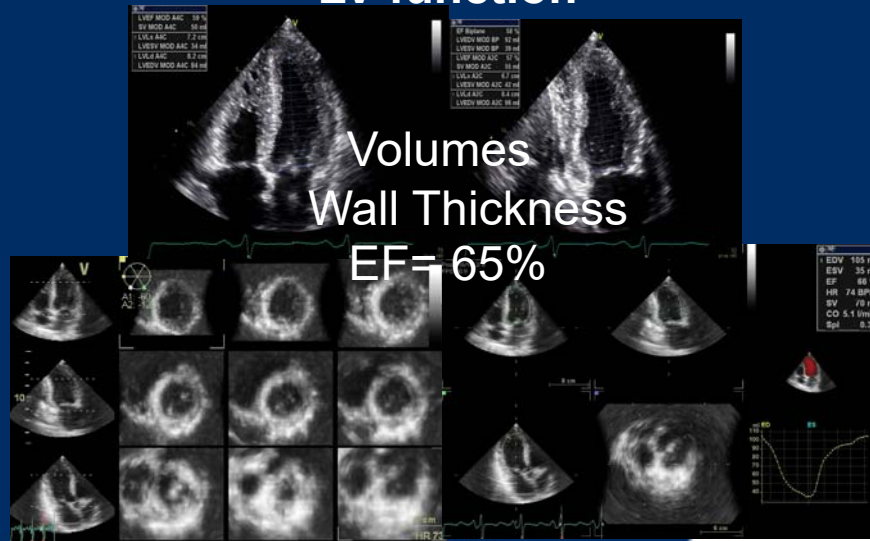
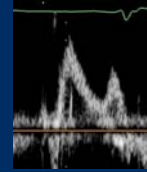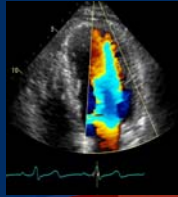**Diastolic Function Exam**
LA Volume

LA Volume Index ~ 32.4 ml/m2

Diastolic Function Exam
## PW Doppler of Mitral valve Inflow

- Apical 4 chamber view
- Color flow imaging for optimal alignment
- SV size 1 – 3 mm placed at leaflet tips
- Optimize spectral gain and wall filters
- Sweep speed 25 to 50 mm/s. measure at 50-100 mm/s

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Diastolic Function Exam
PW Doppler of Mitral valve Inflow

- Measurements: peak E – wave, A – wave, E/A ratio, deceleration time
- Limitations: sinus tachycardia, conduction system disease, arrythmias
- Patterns: normal, impaired relaxation, pseudonormal, restrictive filling

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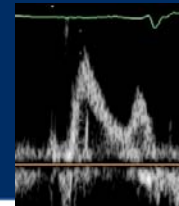
Diastolic Function Exam
MV Inflow PW SV Placement

Incorrect   Correct
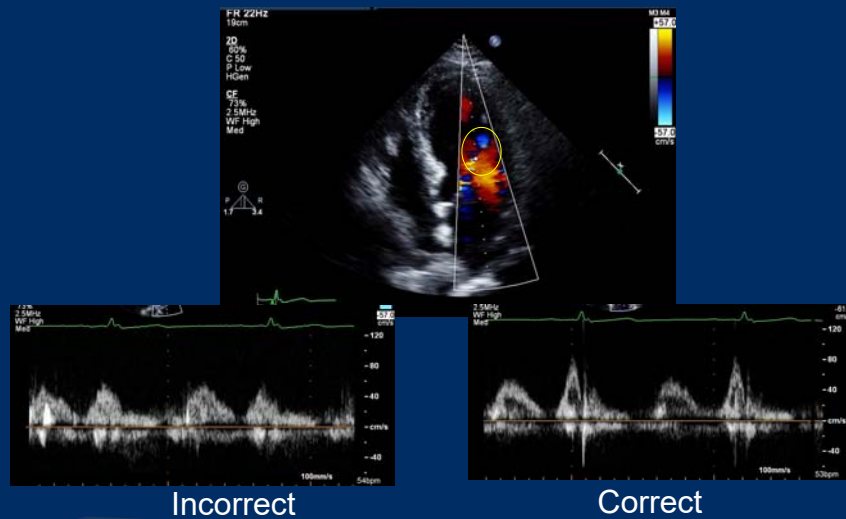
Diastolic Function Exam

PW DTI of Mitral Annular Velocities

- Apical views
- SV (5 – 10 mm.) placed at or within 1 cm of mitral leaflet insertion sites
- Optimize gain/filter settings and minimize angulation
- Velocity scale 20 cm/s above below baseline, sweep speed 50 to 100 mm/s
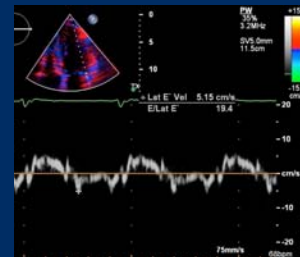
Diastolic Function Exam
PW DTI of Mitral Annular Velocities

- Measure early (e′) diastolic velocities
- Average septal and lateral velocities, calculate E/e′
- Limitations: e′ reduced with MV surgical rings (repair), prosthetic valves, annular calcification and mitral stenosis, e′ increased with > 2+MR
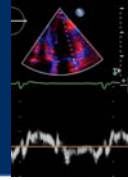
Diastolic Function Exam
PW DTI SV Placement

TDI e′ ?

SV size 5 – 10 mm

TDI e′ 5
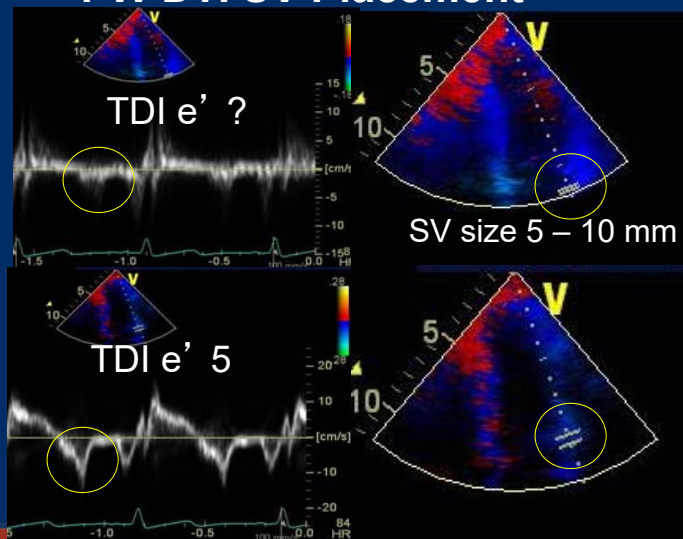
Diastolic Function Exam
Peak TR Velocity

TR Velocity 2.86 m/s

TR Velocity 3.68 m/s
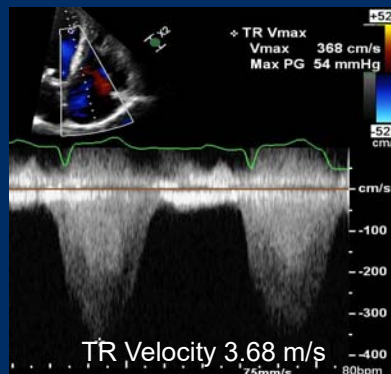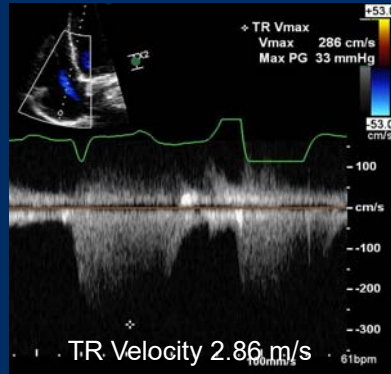
History

- Age: 40, female
- Recent onset of palpitations
- Family history of CAD
- HR 80 bpm, sinus rhythm
- BP 130/85
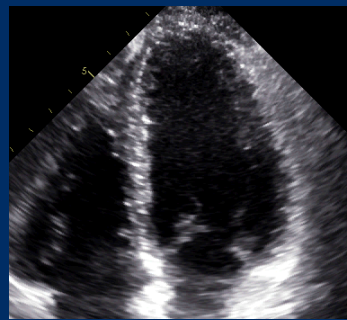
EF 65%
Normal LV wall thickness

Criteria for Diagnosis of
LV Diastolic Dysfunction
Algorithm 1

Diagnosis of Diastolic Dysfunction in Patients with Normal LV EF

① Average E/é >14
② Septal é velocity <7 cm/s or Lateral é velocity <10 cm/s
③ TR velocity >2.8 m/s
④ LA volume index >34 ml/m^2

0 or 1 Positive	2 Positive	3 or 4 Positive
Normal Diastolic Function	Indeterminate	Diastolic Dysfunction

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What Stage of Diastolic Dysfunction?

MV E ~ .75 cm/s

E/e' ~ 9

E   A

e'

e'

Septal e'~ 6 cm/s   Lateral e'~ 11 cm/s

1-Average E/e' > 14
2-Septal e' velocity < 7 cm/s or Lateral e' velocity <10 cm/s
3-TR velocity > 2.8 m/s
4-LA volume index >34ml/m^2

TR < 2.8 m/s

LAVI < 34 ml/m^2

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Criteria for Diagnosis of LV Diastolic Dysfunction
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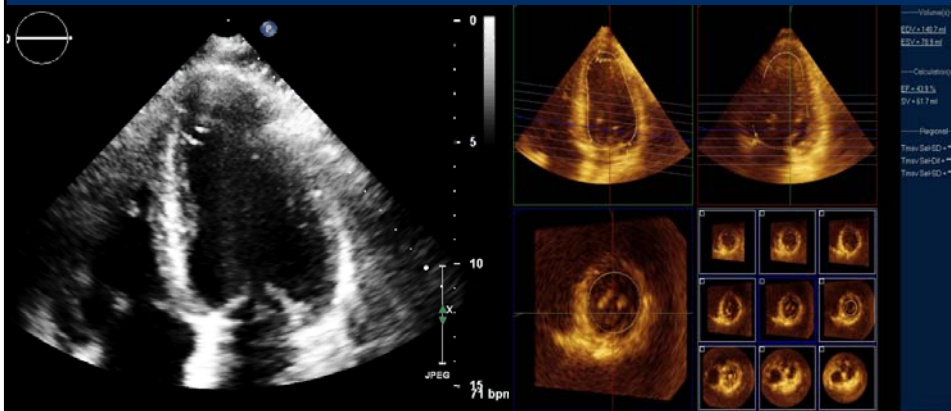
History

- Age: 65, male
- Previous CABG
- Hypertension
- Pre op clearance for vascular surgery
- HR 72 bpm, sinus rhythm
- BP 138/82

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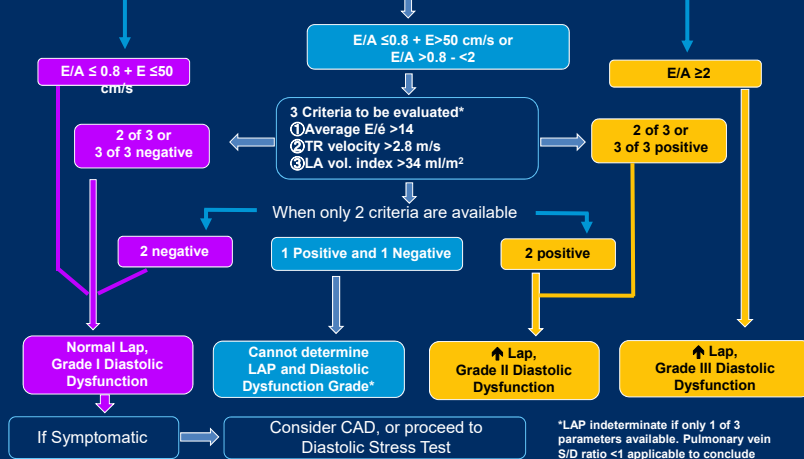
LV Function

Mild LV Systolic Dysfunction (EF - 43.9%)
EDV - 140.7 ml., ESV - 78.9 ml. SV - 61.7 ml.
Wall Thickness ~ Normal

Algorithm 2

Estimation of LV Filling Pressures in
Patients with Depressed LV EF or
Normal EF and Diastolic Dysfunction

E/A ≤0.8 + E>50 cm/s or
E/A >0.8 - <2

E/A ≤ 0.8 + E ≤50 cm/s

E/A ≥2

3 Criteria to be evaluated*
①Average E/é >14
②TR velocity >2.8 m/s
③LA vol. index >34 ml/m²

2 of 3 or
3 of 3 negative

2 of 3 or
3 of 3 positive

When only 2 criteria are available

2 negative

1 Positive and 1 Negative

2 positive

Normal Lap,
Grade I Diastolic
Dysfunction

Cannot determine
LAP and Diastolic
Dysfunction Grade*

↑ Lap,
Grade II Diastolic
Dysfunction

↑ Lap,
Grade III Diastolic
Dysfunction

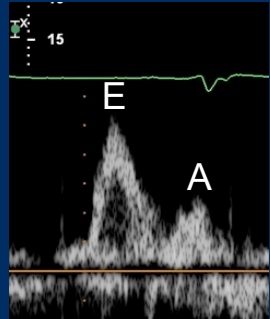If Symptomatic

Consider CAD, or proceed to
Diastolic Stress Test

*LAP indeterminate if only 1 of 3
parameters available. Pulmonary vein
S/D ratio <1 applicable to conclude
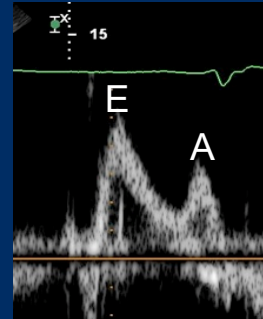elevated LAP in patients with depressed
LVEF

0516-003

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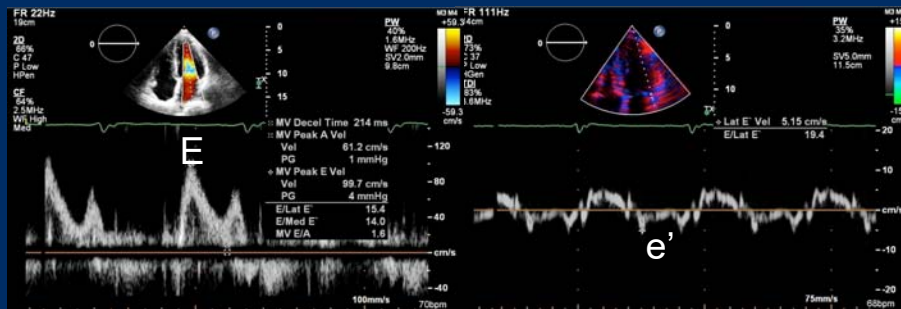
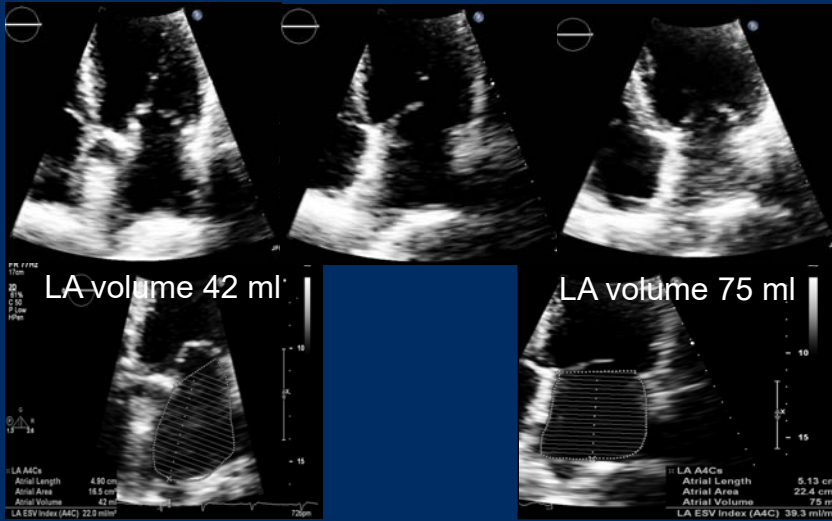**Mitral Valve Inflow**

SV size 1-3 mm

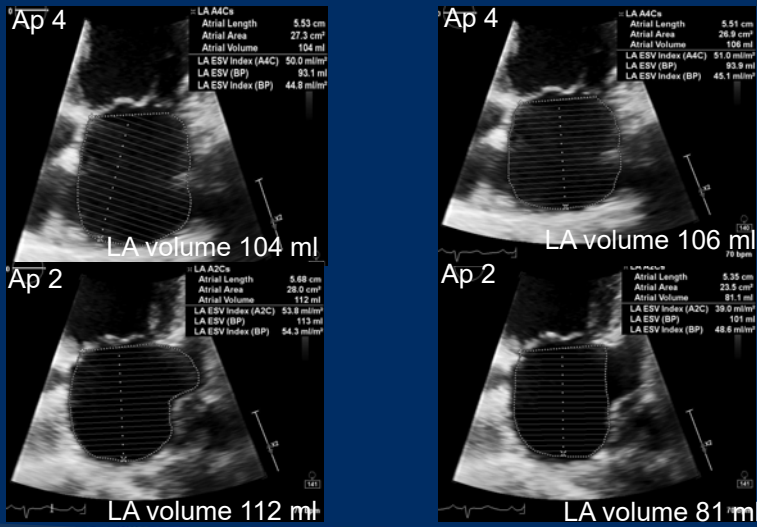Suboptimal

Optimal

E/e'
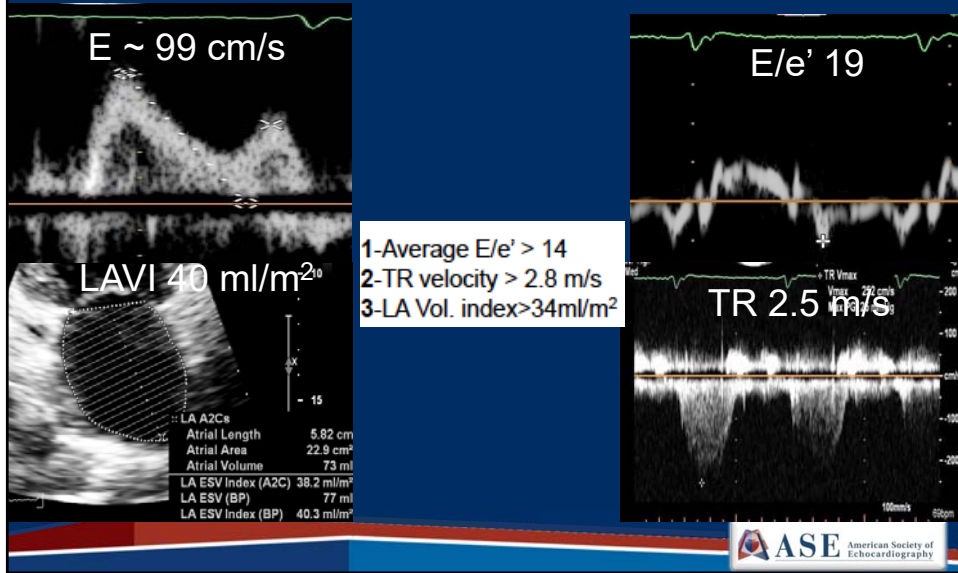**Measurement**

E/e' = 19
MV E 99 / DTI e' 5

LA Volumes

LA volume 42 ml

LA volume 75 ml

LA Volumes

Ap 4

LA volume 104 ml

Ap 2

LA volume 112 ml

Ap 4

LA volume 106 ml

Ap 2

LA volume 81 ml

What Stage Diastolic Dysfunction ?

E ~ 99 cm/s

LAVI 40 ml/m²

E/e' 19

TR 2.5 m/s

1-Average E/e' > 14
2-TR velocity > 2.8 m/s
3-LA Vol. index >34ml/m²

LA A2Cs
Atrial Length   5.82 cm
Atrial Area   22.9 cm²
Atrial Volume   73 ml
LA ESV Index (A2C) 38.2 ml/m²
LA ESV (BP)   77 ml
LA ESV Index (BP) 40.3 ml/m²

TR Vmax   Vmax 250 cm/s

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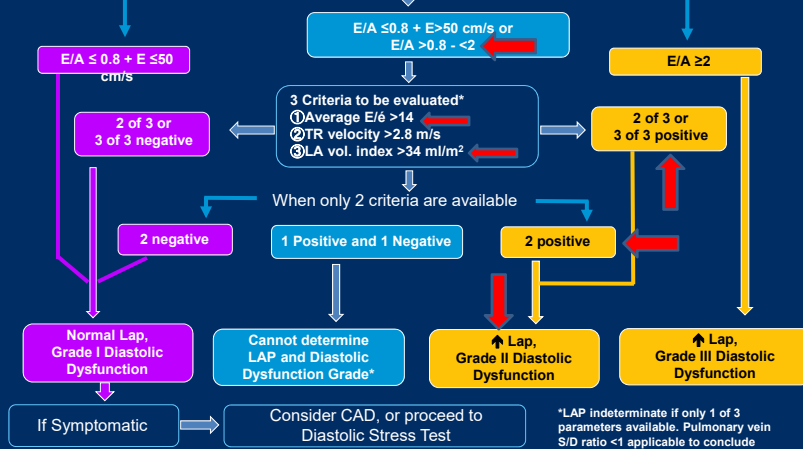## Algorithm 2

Estimation of LV Filling Pressures in Patients with Depressed LV EF or Normal EF and Diastolic Dysfunction

E/A ≤0.8 + E>50 cm/s or E/A >0.8 - <2

E/A ≤ 0.8 + E ≤50 cm/s

E/A ≥2

3 Criteria to be evaluated*
① Average E/é >14
② TR velocity >2.8 m/s
③ LA vol. index >34 ml/m²

2 of 3 or 3 of 3 negative

2 of 3 or 3 of 3 positive

When only 2 criteria are available

2 negative

1 Positive and 1 Negative

2 positive

Normal Lap, Grade I Diastolic Dysfunction

Cannot determine LAP and Diastolic Dysfunction Grade*

↑ Lap, Grade II Diastolic Dysfunction

↑ Lap, Grade III Diastolic Dysfunction

If Symptomatic

Consider CAD, or proceed to Diastolic Stress Test

*LAP indeterminate if only 1 of 3 parameters available. Pulmonary vein S/D ratio <1 applicable to conclude elevated LAP in patients with depressed LVEF

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## Diastolic Function Exam
Valsalva Maneuver

- Distinguish normal from pseudonormal
- Decreases preload during strain phase
- Forceful expiration to generate increase in intrathoracic pressure
- Maintain SV placement with decrease of 20 cm/s in peak MV E velocity unmasking an "A" wave
- + Valsalva response is change In E/A ratio > 0.5
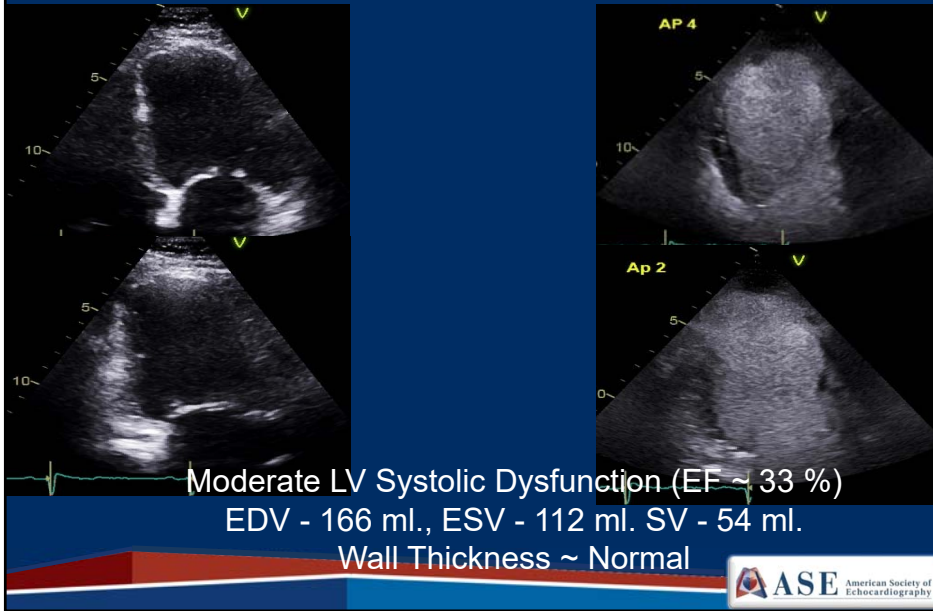- Limitations: difficult to perform adequately
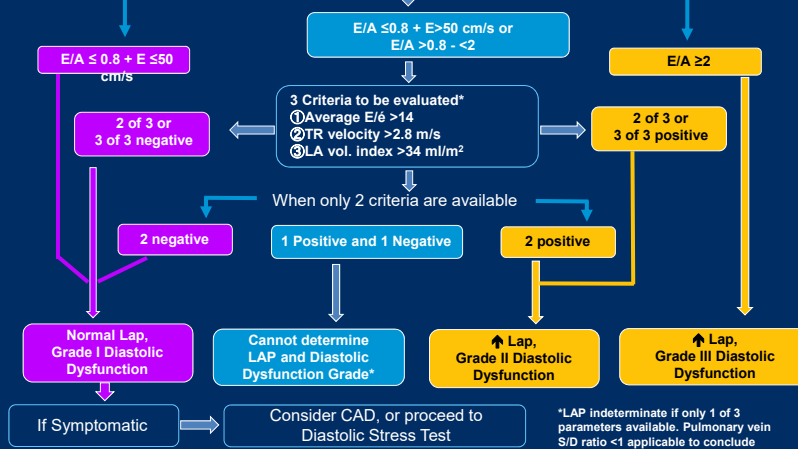
Valsalva Maneuver

Response to Valsalva

Pseudonormal:
↑ Filling Pressures
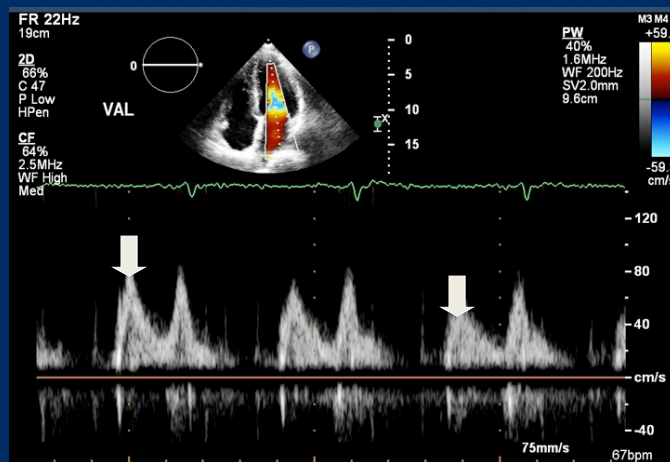
Baseline · E · A · Valsalva · E · A
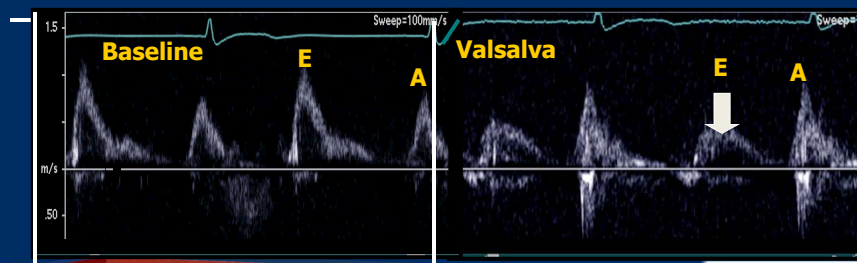
History

- Age: 65, female
- Ischemic cardiomyopathy, S/P PCI
- CHF
- Diabetic
- Symptomatic
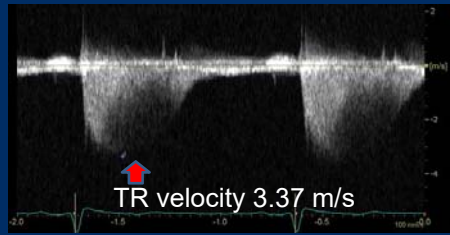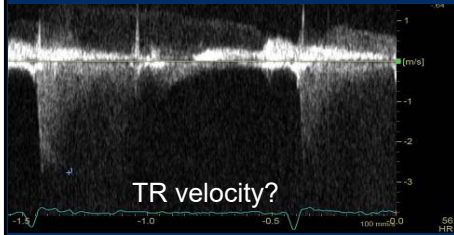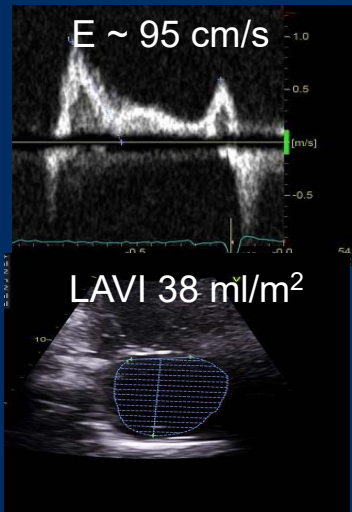- HR 61 bpm, sinus rhythm
- Blood pressure 116/56

LV Function

Moderate LV Systolic Dysfunction (EF ~ 33 %)
EDV - 166 ml., ESV - 112 ml. SV - 54 ml.
Wall Thickness ~ Normal

Algorithm 2

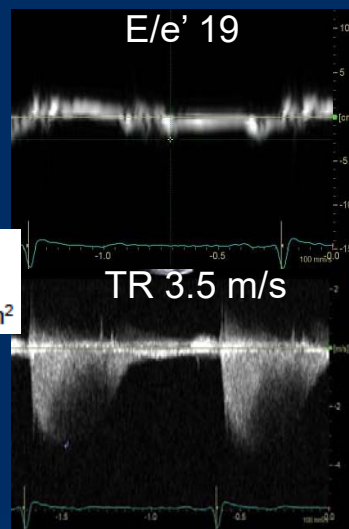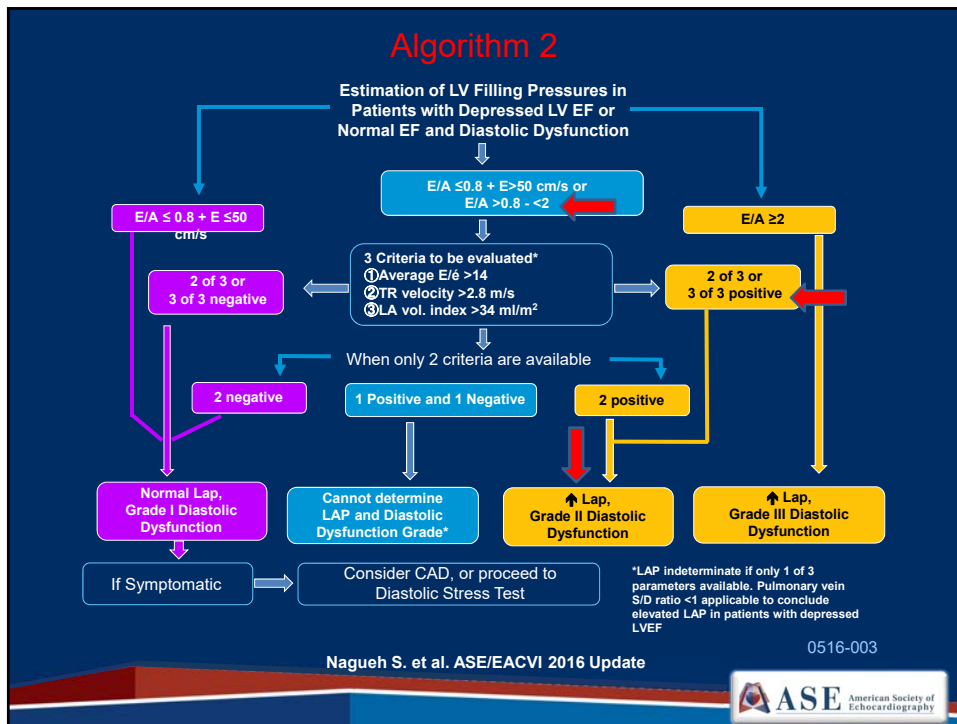Estimation of LV Filling Pressures in Patients with Depressed LV EF or Normal EF and Diastolic Dysfunction

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TR Velocity Contrast

TR velocity?

TR velocity 3.37 m/s

What Stage Diastolic Dysfunction ?

E ~ 95 cm/s

E/e' 19

LAVI 38 ml/m²

TR 3.5 m/s

1-Average E/e' > 14
2-TR velocity > 2.8 m/s
3-LA Vol. index>34ml/m²

Algorithm 2

Estimation of LV Filling Pressures in Patients with Depressed LV EF or Normal EF and Diastolic Dysfunction

E/A ≤0.8 + E>50 cm/s or E/A >0.8 - <2

E/A ≤ 0.8 + E ≤50 cm/s

E/A ≥2

3 Criteria to be evaluated*
① Average E/é >14
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2 of 3 or 3 of 3 negative

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When only 2 criteria are available

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Normal Lap, Grade I Diastolic Dysfunction

Cannot determine LAP and Diastolic Dysfunction Grade*

↑ Lap, Grade II Diastolic Dysfunction

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If Symptomatic

Consider CAD, or proceed to Diastolic Stress Test

*LAP indeterminate if only 1 of 3 parameters available. Pulmonary vein S/D ratio <1 applicable to conclude elevated LAP in patients with depressed LVEF

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2D Strain Workflow

- Complete TTE (IAC standard)
- Incorporate into your routine study
- 2D Strain
  - ➤ HFR imaging (40-90 fps)
  - ➤ LV - Apical 3, 4, 2 chamber views
  - ➤ RV - Apical 4 chamber view
  - ➤ LA - Apical 4, 2 chamber views
  - ➤ On/Offline analysis
  - ➤ Recommend on line while patient is still present

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Workflow For GLS

Know your patients history
- LV function
- LVH
- Amyloid
- Constriction
- Oncology
- Valve Disease
- RV Function
- LA Function

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Optimize 2D Strain images

- On axis images - seeing endocardium to epicardium
- Decrease depth (seeing only base of LA)
- Narrow sector width without losing apex
- Acquire views consecutively to assure same depth and frame rates
- Employ breathing techniques

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Optimize 2D image
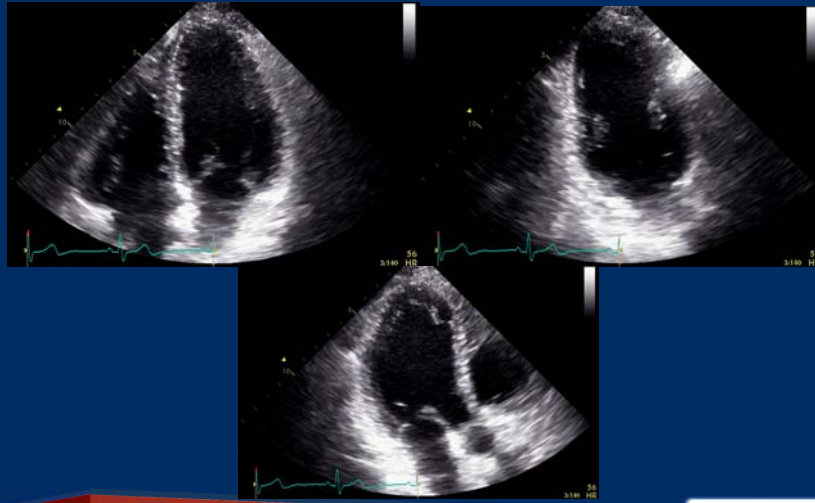
High Quality ECG
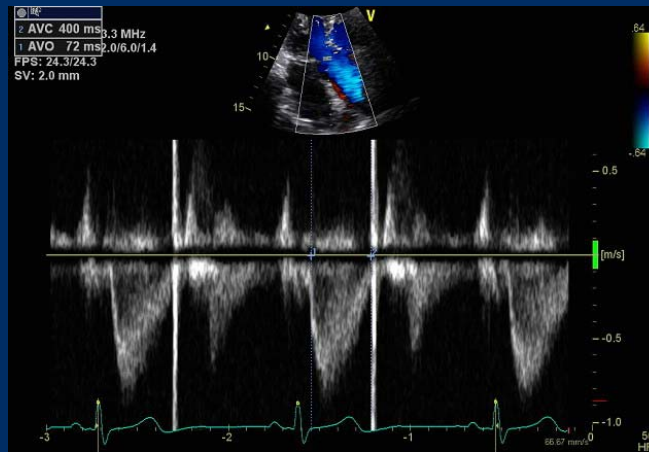
Calculating Strain
Begin by placement of Regions of Interest
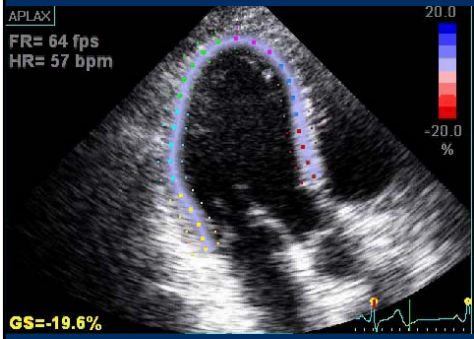ROI

Assess Tracking
- Adjust if necessary
  - May need to widen or narrow ROI

Approve Tracking

Display of Strain Values
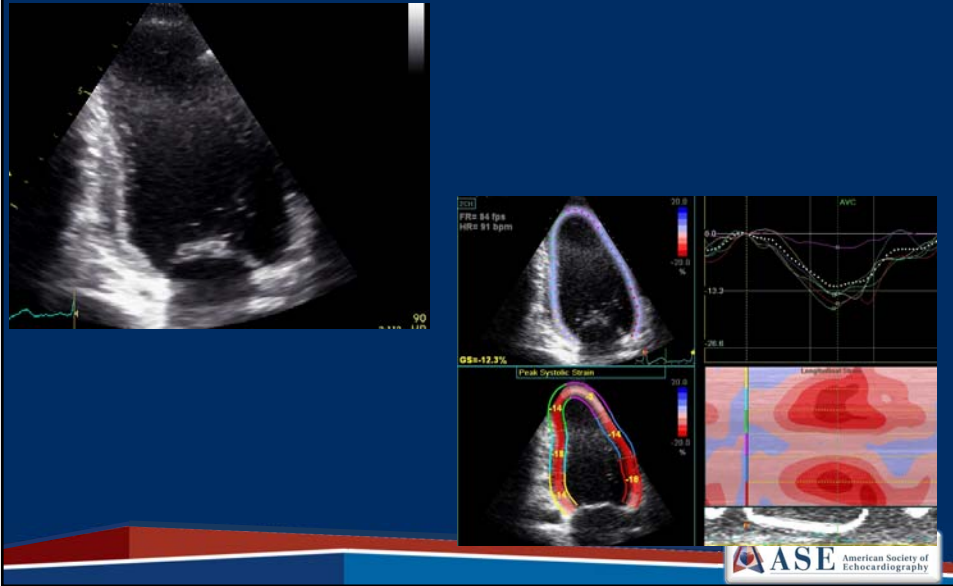

Display of Strain Values
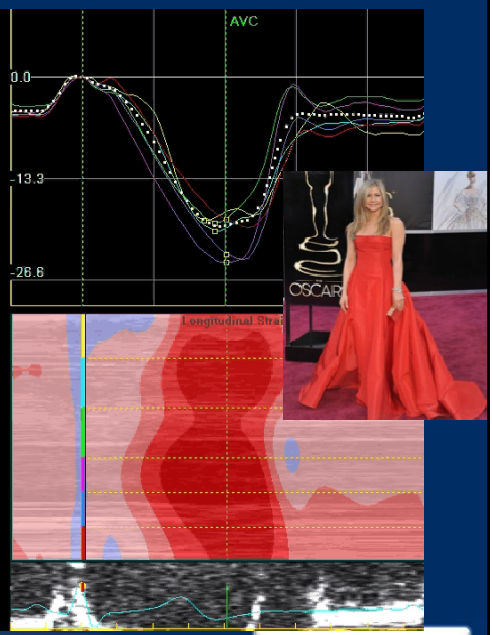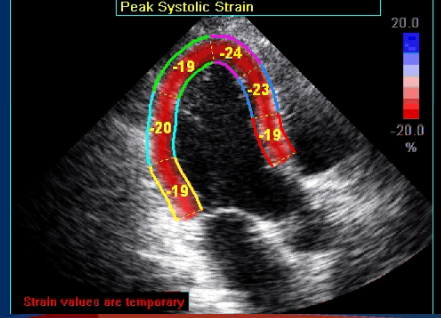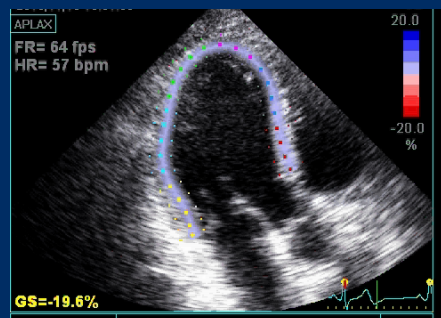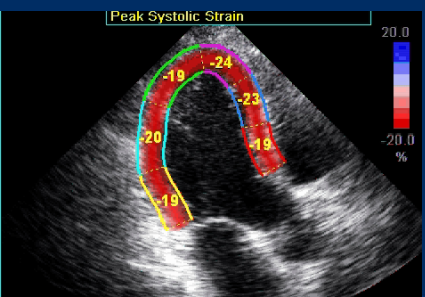
Pitfalls of 2D Strain

- Poor Image quality
- Sector does not include entire LV wall thickness
- Poor ECG signal
  - Unable to clearly identify p/qrs/t waves
- Too Different heart rate
- Positive values provided when segment appears to be contracting well

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Poor Image & Tracking

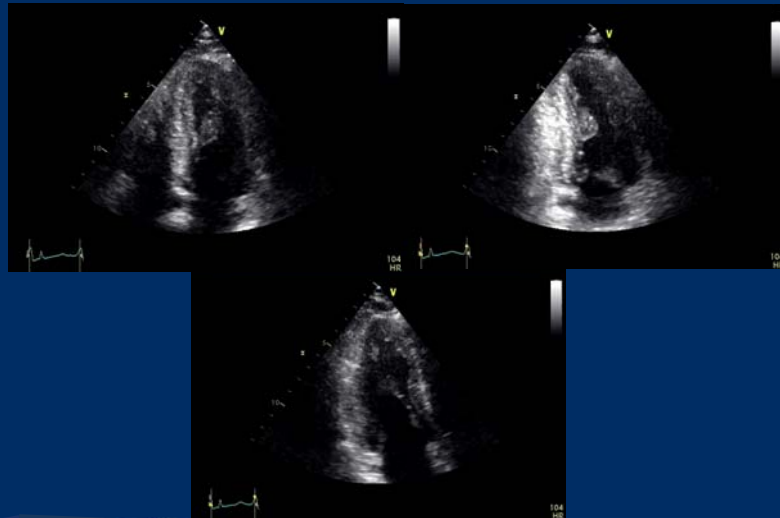ASE American Society of Echocardiography
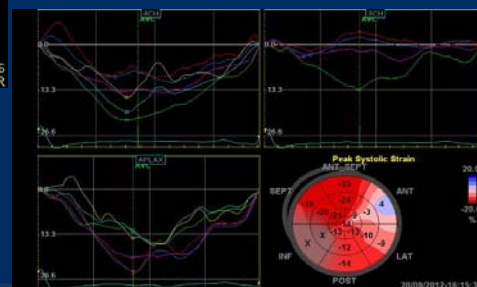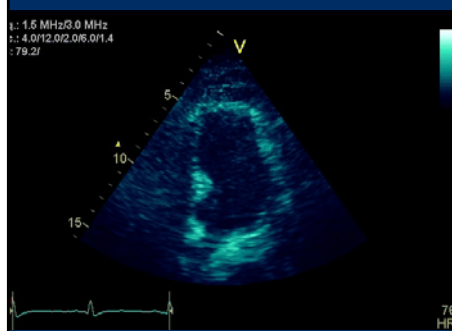
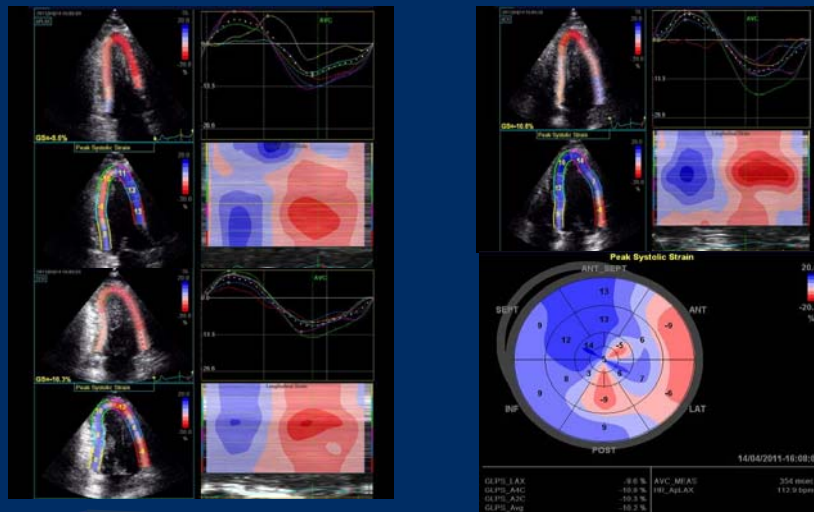## Narrow Sector Width

Summary

- Provide your physicians with high quality 2D imaging and Doppler flows.
- Use 3D echo and contrast enhancement when needed

Thank you!

2D Strain

2D Strain

2D Strain