OPTIMIZING ECHO ACQUISITION FOR STRAIN AND DIASTOLOGY

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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
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

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
Diastolic Function Exam
MV Inflow  PW SV Placement

- 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/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 > 34 ml/m²

- 0 or 1 Positive
  - Normal Diastolic Function

- 2 Positive
  - Indeterminate

- 3 or 4 Positive
  - Diastolic Dysfunction

What Stage of Diastolic Dysfunction?

MV E ~ .75 cm/s  E/e' ~ 9
E A
Septal e' ~ 6 cm/s  Lateral e' ~ 11 cm/s
TR < 2.8 m/s  LAVI < 34 ml/m²

Nagueh S. et al. ASE/EACVI 2016 Update 0516-001
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/m²

- 0 or 1 Positive
- 2 Positive
- 3 or 4 Positive

Normal Diastolic Function

Indeterminate

Diastolic Dysfunction

History

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

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

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

$E/A \leq 0.8 + E > 50 \text{ cm/s}$ or
$E/A > 0.8 - < 2$

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

When only 2 criteria are available
- 1 Positive and 1 Negative
- 2 negative

Normal Lap, Grade I Diastolic Dysfunction

If Symptomatic
- Consider CAD, or proceed to Diastolic Stress Test

Cannot determine LAP and Diastolic Dysfunction Grade*

Lap, Grade II Diastolic Dysfunction

Lap, Grade III Diastolic Dysfunction

*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

Algorithm 2

Nagueh S. et al. ASE/EACVI 2016 Update
Mitral Valve Inflow

SV size 1-3 mm

Suboptimal

Optimal

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

LA volume 42 ml

LA volume 75 ml

Ap 4

LA volume 104 ml

LA volume 106 ml

Ap 2

LA volume 112 ml

LA volume 81 ml
What Stage Diastolic Dysfunction?

E ~ 99 cm/s

LAVI 40 ml/m²

TR 2.5 m/s

E/e' 19

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

3 Criteria to be evaluated*

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

When only 2 criteria are available

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LAP, Grade I Diastolic Dysfunction

LAP, Grade II Diastolic Dysfunction

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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

2 of 3 or 3 of 3 positive

2 of 3 or 3 of 3 negative

When only 2 criteria are available

1 Positive and 1 Negative

Cannot determine LAP and Diastolic Dysfunction Grade*

Consider CAD, or proceed to Diastolic Stress Test

LAP, Grade I Diastolic Dysfunction

LAP, Grade II Diastolic Dysfunction

LAP, Grade III Diastolic Dysfunction

*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

Nagueh S. et al. ASE/EACVI 2016 Update
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
Response to Valsalva

Pseudonormal: ↑ Filling Pressures

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

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

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

When only 2 criteria are available
1 Positive and 1 Negative
2 of 3 or 3 of 3 negative

③ E/A ≤ 0.8 + E ≤50 cm/s or
2 of 3 or 3 of 3 positive

Lap, Grade I Diastolic Dysfunction

If Symptomatic
Consider CAD, or proceed to Diastolic Stress Test

Lap, Grade II Diastolic Dysfunction

Lap, Grade III Diastolic Dysfunction

*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

Algorithm 2

Nagae S. et al. ASE/EACVI 2016 Update
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 > 34 ml/m²
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

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

When only 2 criteria are available
1 Positive and 1 Negative
Cannot determine
LAP and Diastolic Dysfunction Grade*

2 Positive
Normo Lap, Grade I Diastolic Dysfunction

2 of 3 or 3 of 3 positive
Lap, Grade II Diastolic Dysfunction

2 of 3 or 3 of 3 negative
Consider CAD, or proceed to Diastolic Stress Test

2D Strain Workflow

1. Complete TTE (IAC standard)
2. Incorporate into your routine study
3. 2D Strain
   a. HFR imaging (40-90 fps)
   b. LV - Apical 3, 4, 2 chamber views
   c. RV - Apical 4 chamber view
   d. LA - Apical 4, 2 chamber views
   e. On/Offline analysis
   f. Recommend on line while patient is still present
Workflow For GLS

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

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
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
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

Poor Image & Tracking
• Provide your physicians with high quality 2D imaging and Doppler flows.
• Use 3D echo and contrast enhancement when needed

Summary
Thank you!

2D Strain