Echocardiographic Assessment of Diastolic Function

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DISCLOSURE

Relevant Financial Relationship(s)
None

Off Label Usage
None
Objectives

• Review essential components of diastolic function
• Review of ASE grading system
• Clinical application of the grading system

85 year old woman presents to ER with dyspnea
EF 71%  Mild LVH  LA 40 cc/m^2

? Elevated filling pressure

E/A: 2.33
Decel time 142 msec
Essential Components

- LA volume (cc/m²): > 34 cc/m²
- Mitral velocity flow profile
- Annular e’ velocity: septal e’ < 7 cm/sec; lateral < 10 cm/sec;
- E/e’ ratio: average > 14
- Peak TR velocity: > 2.8 m/sec

LA Volume Index (cc/m²)

<table>
<thead>
<tr>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-34</td>
<td>35-41</td>
<td>42-48</td>
<td>&gt; 48</td>
</tr>
</tbody>
</table>

LA Dilation
1. Bradycardia
2. High output states
3. OHT
4. A fib/flutter
5. Athlete’s heart

JASE 2015; 28:1-39
JASE 2016; 29(4):277
Diastolic Dysfunction

- Diastolic dysfunction is present when an increase in filling pressure is necessary to achieve normal LV filling (normal EDV)
- The first abnormality is a delay in relaxation

Circ 2000;101:2020
Grade I
Normal LAP

Grade II
LAP

Grade III
LAP

Strain Phase of Valsalva

E/A 1.5

E/A 0.5
Grading LV filling pressures
Depressed EF/ myocardial disease and normal EF

- E/A ≤ 0.8 + E < 50 cm/s
  - Normal LAP
  - Grade I DD
  - 2/3 or 3/3 negative

- E/A ≤ 0.8 + E > 50 cm/ OR E/A > 0.8 - < 2
  - 1. Av E/e' > 14
  - 2. TR > 2.8 m/s
  - 3. LA vol > 34 cc/m²

- E/A ≥ 2
  - 2/3 or 3/3 positive
  - Grade III DD

When only 2 criteria are available

1. Av E/e' > 14
2. TR > 2.8 m/s
3. LA vol > 34 cc/m²

- 2 negative
  - Normal LAP
  - Grade I DD

- 1 positive/1 negative
  - Indeterminate diastolic function grade

- 2 positive
  - Grade II DD

With depressed EF, can use pulmonary vein S/D < 1= elevated LAP

JASE 2016; 29(4):277
Assessment of Diastolic Dysfunction in Patients with Normal LVEF

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

<50% positive
- Normal diastolic function

50% positive
- Indeterminate

>50% positive
- Diastolic dysfunction

Caveats: E/e’ ratio

• Mitral stenosis
• MAC
• MV Prosthesis
• Annuloplasty rings
• > Moderate MR
• Constriction
Case

• 78 year old male presents to ER with chest pain and dyspnea
• BP 200/100 mmHg
• Creatinine 5.5 mg/dl
• Troponin T: 0.12 ng/ml
• BNP: 1400 pg/ml

EF 33% LAVI 83cc/m²
What grade diastolic dysfunction?

1. Grade III reversible
2. Grade III irreversible
3. Grade II
4. Grade I

LAVI: 83 cc/m²
E/A: 1.5
E/e’: 30
TRV 3.5m/sec
Grade II DD
(LV dysfunction)
Moderately elevated filling pressure

E/A ≤ 0.8 + E > 50 cm/s OR E/A > 0.8- < 2

1. Average E/e’ > 14
2. TR velocity > 2.8 m/s
3. LA volume index > 34 cc/m²

JASE 2016;29(4):277
Case

- 71 year old male
- Ischemic CMP
- MI 2004
- BiV ICD 2012
- NYHA class II

EF 16%   LAVI 68 cc/m²
Grade II DD with Valsalva

E/A ratio: 1.1
E/e’: 40
TRV 2.8 m/sec

Valsalva
E/A ratio: 0.5

59 male: renal transplant evaluation

EF 45% LAV 50 cc/m²
Septum 15 mm Posterior wall 13 mm
What grade diastolic dysfunction?

1. Grade II
2. Grade III (reversible)
3. Grade III (irreversible)
4. Grade Ia
**Diastolic function**

*Grade III (reversible)*

- $E/A > 2$ and decel time $< 160$ ms
- Change in $E/A$ (valsalva) $> 0.5$

*Grade III (irreversible)*

- $E/A > 2$ and decel time $< 160$ ms
- Change in $E/A$ (valsalva) $< 0.5$

**EF 65%  LA 45cc/m²  TRV 2.9 m/sec**
Grade II diastolic dysfunction

E/A 1.2

E/e’ 20

LAV: 45 cc/m²; E vel 1.2 m/sec; E/A: 1.2; TRV: 2.9 m/sec

- E/A ≤ 0.8 + E ≤ 50 cm/s: Normal LAP, Grade I DD
- E/A ≥ 2: Grade III DD
- E/A < 0.8 + E > 50 cm/s OR E/A > 0.8 - < 2
  - 1. Av E/e’ > 14
  - 2. TR > 2.8 m/s
  - 3. LA vol > 34 cc/m²
  - 2/3 or 3/3 positive
  - Grade II DD
  - 2/3 or 3/3 negative

JASE 2016; 29(4):277
72 year old male: NYHA Class III

- Peak E velocity: 1m/s
- DT (msec): 148
- E/e’: 15

IVRT = 45 ms

Diastolic function in atrial fibrillation (depressed EF)

- Increased filling pressures
- DT ≤ 160 ms
- IVRT ≤ 65 ms
- Septal E/e’ ≥ 11
Other Indices

IVRT

Pulmonary veins

Pulmonary Vein A wave duration/velocity

PV A wave duration-
MV A wave duration

\((A_r - A) > 30 \text{ ms} = \text{increased LVEDP}\)
Diastolic MR

E/A ratio: 0.73, DT 205 ms; E/e’: 11

L wave
Triphasic mitral inflow with mid-diatolic flow is related to elevated filling pressures, delayed relaxation and slow heart rate indicating advanced diastolic dysfunction.

JASE 2004; 17:428

In patients with LVH, the mitral L wave appears to be a marker for pseudonormal LV filling and predictor of future heart failure events.

JASE 2005; 18:336
Presence or Absence of L Wave

![Graph showing cumulative hazard over time with two lines representing L wave present and L wave absent.]

<table>
<thead>
<tr>
<th>Time (days)</th>
<th>Cumulative Hazard</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30</td>
<td>0.05</td>
</tr>
<tr>
<td>60</td>
<td>0.05</td>
</tr>
<tr>
<td>90</td>
<td>0.05</td>
</tr>
<tr>
<td>120</td>
<td>0.05</td>
</tr>
<tr>
<td>150</td>
<td>0.05</td>
</tr>
<tr>
<td>180</td>
<td>0.10</td>
</tr>
<tr>
<td>210</td>
<td>0.10</td>
</tr>
<tr>
<td>240</td>
<td>0.15</td>
</tr>
<tr>
<td>270</td>
<td>0.15</td>
</tr>
<tr>
<td>300</td>
<td>0.20</td>
</tr>
<tr>
<td>330</td>
<td>0.20</td>
</tr>
</tbody>
</table>

JASE 2005; 18:336

EF 71%  Mild LVH  LA 40 cc/m²

![Echocardiogram image with measured values: EF 71%, Mild LVH, LA 40 cc/m².]

2/14/2017
? Elevated filling pressures

E/A: 2.33  E/e’: 20
Decel time 142 msec

Heart Failure/Preserved EF

Year

Survival

P=0.036

1.0
0.8
0.6
0.4
0.2
0
1987-91
1992-96
1997-01

NEJM 2006; 355:251
The Natural History of Diastolic Function and LV Filling

- Normal
- Abnormal relaxation
- Pseudo-normalization (reversible)
- Restriction (reversible)
- Restriction (irreversible)

<table>
<thead>
<tr>
<th>Mean LAP</th>
<th>n/t</th>
<th>↑</th>
<th>↑</th>
<th>↑</th>
<th>↑</th>
</tr>
</thead>
<tbody>
<tr>
<td>e'</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>LAV</td>
<td>N</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Grade DD</td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td></td>
</tr>
</tbody>
</table>

Mean LAP:
- e': Decrease
- LAV: Normal
- Grade DD: I, II, III, IV