Διαστολική λειτουργία – θέσεις και αντιθέσεις για τη σύγχρονη ταξινόμηση

Καλλιόπη Κεραμιδά

Β' Παν/κή Καρδιολογική Κλινική, Αττικόν, Μονάδα Καρδιακής Ανεπάρκειας και Επισυνέτρια Λέκτορας Καρδιολογίας

Ιατρική Σχολή, Πανεπιστημίου Κύπρου
Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging
New Criteria for Diastolic Function Assessment

In pts with normal LVEF ≥ 50%

1. Septal e’ velocity ≥7 cm/s or lateral e’ velocity ≥10 cm/s
2. Average E/e’ ≤14
3. TR velocity ≤2.8 m/s
4. LA volume index ≤34 mL/m²

≥ 3 Normal

Normal diastolic function

2 and 2

Indeterminate

≥ 3 Abnormal

Diastolic dysfunction

Lateral E/e’ <13

Septal E/e’ <15
In patients with decreased LVEF or with myocardial disease and preserved LVEF:

- AF
- >moderate MS or MR
- >moderate MAC
- MV repair or prosthesis
- LVAD
- LBBB
- Ventricular paced rhythm
- Heart transplant

In the absence of:

In patients with depressed LVEF or normal LVEF and myocardial disease:

If symptomatic consider CAD or proceed to diastolic stress test.

**Mitral inflow**

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

**E/A ≥ 2**

3 criteria to be evaluated:

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

When only 2 criteria are available:

- 2 of 3 negative
- 2 of 3 or 3 of 3 positive

**Normal LAP**

- Grade I diastolic dysfunction

**Cannot determine LAP and diastolic dysfunction grade**

**↑LAP**

- Grade II diastolic dysfunction
- Grade III diastolic dysfunction

**Pulmonary venous S/D > 1**

- ↑LAP
Important points in 2016 guidelines

❖ Consideration of clinical findings and 2D measurements before applying the algorithms

❖ Myocardial disease with preserved LVEF: LV hypertrophy, LA dilatation and evidence of LV systolic dysfunction (MAPSE, mitral annular S’ velocity and global longitudinal strain)

❖ Limitation of indeterminate diastolic function by using: clinical and 2D data plus atrial reversal velocity in pulmonary vein flow, changes in MV inflow pattern with Valsalva, comparison of MV with TV inflow, L wave in MV inflow, LA strain, LV diastolic strain rate and RA pressure.
DD guidelines 2016 and LV filling pressure
PCWP vs LVEDP
Interobserver variability in estimating LV filling pressure

<table>
<thead>
<tr>
<th>Group</th>
<th>Sensitivity (Mean±SD), %</th>
<th>Specificity (Mean±SD), %</th>
<th>Fleiss $\kappa$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>92±0.00</td>
<td>93±6</td>
<td>0.8</td>
</tr>
<tr>
<td>II</td>
<td>91±2</td>
<td>95±2</td>
<td>0.94</td>
</tr>
<tr>
<td>III</td>
<td>88±5</td>
<td>91±7</td>
<td>0.76</td>
</tr>
<tr>
<td>IV</td>
<td>91±3</td>
<td>92±5</td>
<td>0.89</td>
</tr>
</tbody>
</table>

IMPACT OF THE 2016 ASE/EACVI GUIDELINES ON THE EVALUATION OF LEFT VENTRICULAR DIASTOLIC FUNCTION AND FILLING PRESSURES IN 75,650 ECHO STUDIES: A COMPARISON WITH THE 2009 GUIDELINES

<table>
<thead>
<tr>
<th>Diastolic Function</th>
<th>2009</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 75650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeterminate</td>
<td>38640 (51.0%)</td>
<td>15908 (21.0%)</td>
</tr>
<tr>
<td>Normal</td>
<td>17748 (23.5%)</td>
<td>28104 (37.2%)</td>
</tr>
<tr>
<td>Mild</td>
<td>5092 (6.7%)</td>
<td>20391 (27.0%)</td>
</tr>
<tr>
<td>Moderate</td>
<td>2781 (3.7%)</td>
<td>8781 (11.6%)</td>
</tr>
<tr>
<td>Severe</td>
<td>369 (0.5%)</td>
<td>2466 (3.2%)</td>
</tr>
<tr>
<td>Abnormal but cannot be graded</td>
<td>11020 (14.6%)</td>
<td>n/a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LV Filling Pressures</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 75650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeterminate</td>
<td>35561 (47.0%)</td>
<td>5582 (7.4%)</td>
</tr>
<tr>
<td>Normal</td>
<td>28657 (37.9%)</td>
<td>58222 (77.0%)</td>
</tr>
<tr>
<td>Elevated</td>
<td>11432 (15.1%)</td>
<td>11846 (15.6%)</td>
</tr>
</tbody>
</table>

When both guidelines were successful in grading diastolic function and/or estimating filling pressures for the same study, there was agreement of diastolic function grade and filling pressures in 68% and 86% of the cases, respectively.

McFarlane D. et al. 2017
Invasive Validation of the Echocardiographic Assessment of Left Ventricular Filling Pressures Using the 2016 Diastolic Guidelines: Head-to-Head Comparison with the 2009 Guidelines

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 guidelines</td>
<td>0.69</td>
<td>0.81</td>
<td>0.77</td>
<td>0.77</td>
<td>0.75</td>
</tr>
<tr>
<td>2009 guidelines</td>
<td>0.79</td>
<td>0.70</td>
<td>0.69</td>
<td>0.80</td>
<td>0.74</td>
</tr>
</tbody>
</table>
Comparison of DD grading (2016 ASE/EACVI vs BSE guidelines)
Euro Filling Study

E/e' lateral was significantly related to LVEDP in patients with preserved LVEF

Sensitivity 43%
Specificity 75%
AUC 0.68

E/A ratio best correlated with invasive LVEDP in patients with reduced LVEF

Sensitivity 75%
Specificity 74%
AUC 0.78
Diagnosis of HFpEF

**TABLE 4** Accuracy of Diagnosis of Elevated LV Filling Pressure: Total Population

<table>
<thead>
<tr>
<th></th>
<th>Clinical (95% CI)</th>
<th>Echocardiographic (95% CI)</th>
<th>p Value* Clinical vs. Echo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>74 (68-79)</td>
<td>87 (81-91)</td>
<td>0.001</td>
</tr>
<tr>
<td>Specificity</td>
<td>69 (62-75)</td>
<td>88 (82-93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PPV</td>
<td>77 (71-82)</td>
<td>91 (86-94)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>NPV</td>
<td>65 (58-72)</td>
<td>83 (76-88)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>72 (67-76)</td>
<td>87 (84-91)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Values are %. *Based on McNemar test.
CI = confidence interval; echo = echocardiography; NPV = negative predictive value; PPV = positive predictive value; other abbreviations as in Table 1.

Patient with Suspected HFrEF

Assessment of Pretest Probability

Clinical history: older age, typical comorbidities (e.g. obesity, HTN, DM), HF specific symptoms like orthopnea or PND,
Physical examination: edema, jugular venous distension, gallop, rales
NP levels: ↑NT-proBNP or ↑BNP
Chest x-ray, ECG: pulmonary congestion, LVH, atrial fibrillation
Rest Echocardiography: ↑LA volume, ↑LV mass, ↑E/e’, ↑TR velocity

Intermediate pretest probability
- Consider Exercise Doppler Echo
  - Clearly Negative
    - No Further Testing Required
  - Positive or equivocal
    - Diagnosis remains uncertain, Consider Invasive Exercise Test

Very low or very high pretest probability
- Probable diagnosis made, Further Testing usually unnecessary
  - Definitive classification still needed
Predictive value of DD (2016) - survival

Predictive value of DD (2016) - MACEs

<table>
<thead>
<tr>
<th>Disease</th>
<th>Echocardiographic measurements and cutoff values</th>
</tr>
</thead>
</table>
| AF1341-99                                   | Peak acceleration rate of mitral E velocity (≥ 1900 cm/sec²)  
|                                             | IVRT (≤ 65 msec)  
|                                             | DT of pulmonary venous diastolic velocity (≤ 220 msec)  
|                                             | E'/E' ratio (≥ 1.4)  
|                                             | Septal E'/E' ratio (≥ 11)  
| Sinus tachycardia44                          | Mitral inflow pattern with predominant early LV filling in patients with EFs < 50%  
|                                             | IVRT ≤ 70 msec is specific (79%)  
|                                             | Pulmonary vein systolic filling fraction ≤ 40% is specific (88%)  
|                                             | Average E'/E' > 14 (this cutoff has highest specificity but low sensitivity)  
|                                             | When E and A velocities are partially or completely fused, the presence of a compensatory period after premature beats often leads to separation of E and A velocities which can be used for assessment of diastolic function |
| HCM100-106                                   | Average E'/E' (> 14)  
|                                             | Ar-A (≥ 30 msec)  
|                                             | TR peak velocity (> 2 m/sec)  
|                                             | LA volume (> 34 mL/m²)  
| Restrictive cardiomyopathy14-107-109        | DT (< 140 msec)  
|                                             | Mitral E/A (> 2.5)  
|                                             | IVRT (< 50 msec has high specificity)  
|                                             | Average E'/E' (> 14)  
| Noncardiac pulmonary hypertension22         | Lateral E'/E' can be applied to determine whether a cardiac etiology is the underlying reason for the increased pulmonary artery pressures  
|                                             | When cardiac etiology is present, lateral E'/E' is > 13, whereas in patients with pulmonary hypertension due to a noncardiac etiology, lateral E'/E' is < 8  
| Mitral stenosis410                          | IVRT (< 60 msec has high specificity)  
|                                             | IVRT/Te- (< 4.7)  
|                                             | Mitral A velocity (> 1.5 m/sec)  
| MR10-112                                    | Ar-A (≥ 30 msec)  
|                                             | IVRT (< 60 msec has high specificity)  
|                                             | IVRT/Te- (< 5.6) may be applied for the prediction of LV filling pressures in patients with MR and normal EFs  
|                                             | Average E'/E' (> 14) may be considered only in patients with depressed EFs  

Proposed Clinical Algorithm for Estimation of Left Ventricular Filling Pressure in Subjects With Mitral Annular Calcification

Initial Cohort (n=50):
Sensitivity: 81%
Specificity: 100%

Mitral E/A

- <0.8
  - Normal LVFP
    - Initial: 8/9 (89%)
    - Total: 12/13 (92%)

- 0.8-1.8
  - IVRT
    - ≥80 ms
      - Normal LVFP
        - 4/9 (44%)
        - 9/14 (64%)
    - <80 ms
      - High LVFP
        - 16/16 (100%)
        - 23/24 (96%)

- >1.8
  - High LVFP
    - 10/10 (100%)
    - 11/11 (100%)

Total Cohort (n=71):
Sensitivity: 85%
Specificity: 95%

Abudiab et al: Am Coll Cardiol Img, 2017
Algorithm for estimation of LVFP in patients with LVAD

Mitral E/A

E/A ≤1
+ any 1 parameter

E/A >1, ≤2*
+ 2 of 3 parameters

E/A >2
+ any 1 parameter

(a) RAP ≤10 or sPAP ≤40 mm Hg
(b) LAVi ≤33 mL/m²
(c) E/e’ ≤14

PCWP ≤15

(a) RAP >10 or sPAP >40 mm Hg
(b) LAVi >33 mL/m²
(c) E/e’ >14

PCWP >15
Evaluation of diastolic function in asymptomatic patients

Normal clinical findings and normal 2D echo

Evaluate annular e' velocity, LA maximum volume index, average E/e' ratio, peak TR velocity

Diastolic dysfunction absent

Consider above signals in addition to other measurements as GLS, MAPSE and LA strain

Diastolic dysfunction Present

Apply algorithm in the Central Illustration to determine if LVFP is elevated

LVFP elevated

Dyspnea due to elevated LVFP and CHF is confirmed

LVFP normal

Dyspnea not due to elevated LVFP at rest

LVFP indeterminate

Consider invasive study: LV cath or right heart cath at rest or both at rest and exercise

Normal clinical findings and 2D echo

Clinical and or 2D echo consistent with cardiac disease

Apply algorithm in central illustration to determine if LVFP is elevated

If concerns remain about cardiac etiology, then noninvasive diastolic stress test or if inconclusive, invasive diastolic stress test.