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GLOBAL EXPERTS, LOCAL LEARNING
Solutions for Every Day Problems:
The Inflow and Outflow of the New Diastology Guidelines
How to Assess Diastolic Function?

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Disclosure Information

• I will not discuss off label use or investigational use in my presentation
• I have no financial relationships to disclose
Objectives

- Identify and describe different mechanisms of diastolic dysfunction
- Develop skills and confidence in the interpretation of abnormalities on the echo-Doppler
- Demonstrate utilisation of the echo-Doppler diastolic parameters for clinical decision making
ASE/EACVI GUIDELINES AND STANDARDS

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

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(J Am Soc Echocardiogr 2016;29:277-314.)
Estimating Left Ventricular Filling Pressure by Echocardiography

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Echocardiography Parameters for Estimation of LV Filling Pressure

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

E/A Ratio ≤0.8 + E ≤50 cm/s

Mitral Inflow

Normal LAP

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Algorithm:

1. **Mitral Inflow**
   - E/A Ratio ≤ 0.8 + E ≤ 50 cm/s or E/A > 0.8 to < 2
   - E/A ≥ 2

2. **3 Criteria to be Evaluated**
   - Ratio of mitral peak E velocity to average annular e’ velocity (E/e’ ratio)
   - Peak tricuspid regurgitation velocity
   - Left atrial maximal volume index

3. **Normal LAP**
4. **↑ LAP**

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Mitral Inflow

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

3 Criteria to be Evaluated:
- Ratio of mitral peak E velocity to average annular e' velocity (E/e' ratio)
- Peak tricuspid regurgitation velocity
- Left atrial maximal volume index

E/A Ratio ≤0.8 + E ≤50 cm/s

2 of 3 or 3 of 3 Negative

Normal LAP

↑LAP

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Mitral Inflow

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

3 Criteria to be Evaluated
- Ratio of mitral peak E velocity to average annular e' velocity (E/e' ratio)
- Peak tricuspid regurgitation velocity
- Left atrial maximal volume index

When only 2 criteria are available

E/A ≥ 2

2 of 3 or 3 of 3 Positive

2 of 3 or 3 of 3 Negative

Normal LAP

↑ LAP

Algorithm for Estimating LV Filling Pressure in Depressed LVEF or Normal EF and Myocardial Disease

Mitral Inflow

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

E/A ≥2

3 Criteria to be Evaluated
- Ratio of mitral peak E velocity to average annular e’ velocity (E/e’ ratio)
- Peak tricuspid regurgitation velocity
- Left atrial maximal volume index

When only 2 criteria are available

2 Negative
1 Positive
1 Negative
2 Positive

Cannot determine LAP

↑LAP

Normal LAP

12 Tricks to Assess Diastolic Function
TRICK 1:
Assess LA volumen, always

TRICK 2:

M mode could still be useful
Trick 3
TRICK 3:
Focus pulse Doppler sample volume with color Doppler
Trick 4

Agmon Y. Circulation. 1999;99:e13
TRICK 4:
Look at the QRS, always

Agmon Y. Circulation. 1999;99:e13
Trick 5

Valsalva maneuver

Nishimura RA. J Am Coll Cardiol. 1997;30:8-18
TRICK 5:

Look, also, at A wave during Valsalva maneuver

Schwammenthal E. Am J Cardiol. 2000;86:169-74
Trick 6

TRICK 6:
Raise legs, too

Nishimura RA. J Am Coll Cardiol. 1997;30:8-18
Trick 7

Cohen GI. J Am Coll Cardiol. 1996;27:1753-60
TRICK 7:
Train to see the PVs with the TTE
Trick 8

Trick 8

\[ Y = 1.9 + 1.24 \times \]
\[ R = 0.87 \]
\[ N = 60 \]

TRICK 8:

Not always:

E < A = normal LVFP

TRICK 9:

Are there “oscillations” of the mitral annulus?

Riordan M. Am J Physiol Heart Circ Physiol. 2007;292:H2952-8
Trick 10

Normal Vp > 50 cm/s

Takatsuji H. J Am Coll Cardiol. 1996;27:365-71
TRICK 10:
Color M mode could be useful to estimate LVFP too.

Garcia M. J Am Coll Cardiol. 1997;29:448-54
Trick 11

Trick 11

TRICK 11:
Assess right side hemodynamics

Abbas A. J Am Coll Cardiol 2003;41:1021-7
TRICK 12:
Evaluate diastolic stress

Erdei T. Eur J Heart Failure 2014:16,1345-61
Take-Home Messages

1. When assessing diastolic function take also into account the systolic function
2. Don’t just trust your eyes, measure!!!
3. LA volume is the best parameter for chronic increase of LV filling pressures
4. The ratio E/E’ is the best parameter of current of LV filling pressures
5. Note the "peripheral hemodynamics"
6. Integrate echocardiographic information and other biomarkers
7. Stress-echo could add important information
Everything should be made as simple as possible, but not simpler

Albert Einstein (1879-1955)
Thank you
LV Diastolic Dysfunction in Subjects 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
LV Diastolic Dysfunction in Subjects With Normal LVEF

- Average E/e’ > 14
- Septal e’ velocity < 7 cm/s or Lateral e’ velocity < 10 cm/s
- TR velocity > 2.8 m/s
- LA volume index > 34 ml/m²

<50% positive

Normal Diastolic function
LV Diastolic Dysfunction in Subjects 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 >34ml/m²

<50% positive

Normal Diastolic function

>50% positive

Diastolic Dysfunction
LV Diastolic Dysfunction in Subjects 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
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEFs and With Myocardial Disease and Normal LVEF

Mitral Inflow

E/A ≤ 0.8 + E ≤ 50 cm/s

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic

Consider CAD, or proceed to diastolic stress test
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEFs and With Myocardial Disease and Normal LVEF

Mitral Inflow

- E/A ≤ 0.8 + E ≤ 50 cm/s
  
  - Normal LAP
  
  - Grade I Diastolic Dysfunction
    
    - If Symptomatic
      
      - Consider CAD, or proceed to diastolic stress test

- E/A ≥ 2
  
  - ↑ LAP
  
  - Grade III Diastolic Dysfunction
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEFs and With Myocardial Disease and Normal LVEF

Mitral Inflow

E/A ≤ 0.8 + E ≤ 50 cm/s

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic
Consider CAD, or proceed to diastolic stress test

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

E/A ≥ 2

↑ LAP
Grade III Diastolic Dysfunction
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEFs and With Myocardial Disease and Normal LVEF

Mitral Inflow

- E/A ≤ 0.8 + E ≤ 50 cm/s
  - E/A ≤ 0.8 + E ≥ 50 cm/s or 
  - E/A ≥ 0.8 - <2
  - 3 criteria to be evaluated*

- E/A ≥ 2
  - ↑ LAP
  - Grade III Diastolic Dysfunction

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic
Consider CAD, or proceed to diastolic stress test
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEFs and With Myocardial Disease and Normal LVEF

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 Vol. index > 34ml/m²

2 of 3 or 3 of 3 Negative

Normal LAP
Grade I Diastolic Dysfunction

If Symptomatic
Consider CAD, or proceed to diastolic stress test

2 of 3 or 3 of 3 Positive

↑ LAP
Grade II Diastolic Dysfunction

↑ LAP
Grade III Diastolic Dysfunction

↑ LAP
Grade IV Diastolic Dysfunction
Estimation of LV Filling Pressures/Grading LV Diastolic Function in Patients With Depressed LVEF and With Myocardial Disease and Normal LVEF
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

Diastolic dysfunction Present

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

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

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
Indeterminate
Diastolic dysfunction Present

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

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

Evaluation of diastolic function and LV filling pressure (LVFP) in patients with dyspnea
Evaluation of diastolic function and LV filling pressure (LVFP) in patients with dyspnea

- 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
    - Indeterminate
    - Diastolic dysfunction Present
      - Consider above signals in addition to other measurements as GLS, MAPSE and LA strain
      - Apply algorithm in the Central illustration to determine if LVFP is elevated

- Clinical and or 2D echo consistent with cardiac disease
  - Apply algorithm in central illustration to determine if LVFP is elevated
    - LVFP elevated
    - LVFP indeterminate
    - LVFP normal
      - Dyspnea due to elevated LVFP and CHF is confirmed
      - Consider invasive study: LV cath or right heart cath at rest or both at rest and exercise
      - Dyspnea not due to elevated LVFP at rest
        - If concerns remain about cardiac etiology, then noninvasive diastolic stress test or if inconclusive, invasive diastolic stress test.