Extended Abstract | Cardiovascular Investigations: Open access | 2020 | Vol.04 No.2

Cardiologist 2018: Note: Diastology: Pathophysiology of relaxation and filling pressure

Fabiola B Sozzi

Ospedale Maggiore Policlinico Cà Granda, Italy

Doppler echocardiography can characterize left ventricular diastolic function through a combination of measurements, which show evidence of slowed ventricular relaxation, increased left ventricular stiffness or abnormal left ventricular filling. Doppler echocardiography can also provide an estimate of left ventricular filling pressures, one component of diastolic function that reflects pulmonary capillary wedge pressure. These parameters have been shown to correlate with exercise capacity. A normal diastolic function response to exercise is characterized by normal and similar resting and exercise E/e' measurements. Elevated left ventricular filling pressure is a cardinal feature of heart failure with preserved ejection fraction (HFpEF). The ratio of transmitral E to mitral annular e' velocities (E/e') at Doppler echocardiography has been proposed as a non-invasive measure of left ventricular filling pressure and endorsed by professional guidelines as a surrogate parameter of invasive left ventricular filling pressure in the diagnostic workup of HFpEF. The diagnosis of HFpEF is straightforward when patients are acutely decompensated. To make matters more complex, many patients with HFpEF display normal left ventricular filling pressures at rest, with abnormalities that develop during stresses like exercise. Invasive hemodynamic exercise testing has emerged as the gold standard to diagnose or exclude HFpEF in patients with exertional dyspnea of unclear etiology, but cost, risk, and the requirement for specialized training and equipment may limit its broad application in practice and in clinical trials. Therefore, Doppler echocardiography plays a central role in the non-invasive evaluation and grading of diastolic dysfunction. The American College of Cardiology Foundation/American Heart Association Guidelines define HFpEF as clinical signs and symptoms of HF, preserved ejection fraction, and no other obvious explanation for symptoms. This scheme works well for patients with a high likelihood of disease on the basis of clinical indicators of congestion.

To address the patients without overt congestion, more recent guideline statements from the European Society of Cardiology (ESC) and American Society of Echocardiography/European Association of Cardiovascular Imaging (ASE/EACVI) require objective evidence of high left ventricular filling pressures.

Before evaluating diastolic function it is important to differentiate between patients with normal left ventricular EF and reduced left ventricular EF or structural heart disease since the focus is a different one (existence of diastolic dysfunction vs. estimation of filling pressures). However, in both cases you need to obtain the average E/e', LA maximum volume index and peak TR velocity. In patients with normal EF you need to additionally evaluate either septal or lateral e', while in patients with reduced EF you need to evaluate peak E wave velocity and E/A ratio.

Since you need the peak E wave velocity for E/e' it is a good idea to start with the mitral inflow pattern, although the pattern itself is only important in patients with reduced EF. The peak of the passive filling of the LV (peak E wave) and the active contraction of the left atrium in atrial systole (peak A wave) should be assessed, and an E/A ratio should be calculated. The next step is to assess septal and lateral e' and calculate an average E/e' to get all specific parameters of diastolic function, since the LA maximum volume index and peak TR velocity are usually part of every echocardiographic exam.

Specific situations

Diastolic stress testing:

Indication: If resting echo does not explain the symptoms of heart failure or dyspnea especially with exertion. It is considered positive if all three criterias apply:

This work is partly presented at 24th Annual Cardiologists Conference in June 12-13, 2018 held at Barcelona, Spain

average E/e´ > 14 or septal E/e´ ratio > 15 with exercise

peak TR velocity > 2.8 m/sec with exercise

septal e´ velocity is < 7 cm/s or lateral is < 10 cm/s at baseline

Pitfalls & Tipps

L-Wave: Under normal conditions during diastasis there is no flow from the left atrium to the LV. If flow occurs (usually during bradycardia) this wave is called an L-Wave and denotes elevated filling pressures. Supernormal filling: In young, fit and healthy individuals you can see a very tall E-wave, a normal DT, a very small A-wave and an E/A ratio >2 which looks like a restrictive filling pattern. This is due to a very strong suction of the LV during diastole. Be aware that suboptimal Doppler signals can lead to misinterpretation. You should not interpret such a signal. Be aware that one normal parameter (e.g. a normal sized left atrium) does not automatically indicate normal diastolic function and exclude diastolic dysfunction.

Note IVRT is prolonged in impaired relaxation, gets shorter with left atrial pressure (LAP) elevation. Be aware that IVRT becomes longer when people get older and influenced by heart rate and systolic function.

Be aware that in young healthy individuals the S/D ratio of pulmonary venous flow is often below 1. Be aware that you can not measure E/A ratio in the presence of atrial fibrillation (AFIB), significant mitral regurgitation, significant mitral annular calcification, left bundle branch block (LBBB), paced rhythm or mitral stenosis. In patients with AFIB you can use E/e´ ratio and IVRT which is shortened. Be aware that when you measure E/e´ ratio the variables are measured at different times in the cardiac cycle. It is age dependent, preload dependent and it varies when left ventricular systolic function changes. You should not measure e´ when a prosthetic valve, an annuloplasty or mitral annular calcification is present. Left atrial (LA) maximum volume index gives diagnostic and prognostic information. There is still no targeted therapy for patients with diastolic dysfunction. Left atrial (LA) maximum volume index gives diagnostic and prognostic information. Note that an increased LA volume index can also be found physiologically in well-trained athletes with bradycardia. There is still no targeted therapy for patients with diastolic dysfunction.

fabiola.sozzi@policlinico.mi.it

This work is partly presented at 24th Annual Cardiologists Conference in June 12-13, 2018 held at Barcelona, Spain