ROLE OF ECHOCARDIOGRAPHY IN THE DIAGNOSIS OF PATIENTS WITH DIASTOLIC HEART FAILURE

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INTRODUCTION

Diastolic heart failure (DHF) is characterized by heart failure signs and symptoms in the presence of normal ejection fraction (EF). Since it is still debatable whether or not systolic properties are normal, the term "heart failure with normal EF" has been used to describe this syndrome.1 The diagnosis of DHF is based on the presence of three findings: clinical heart failure, normal or only mildly reduced EF, and diastolic dysfunction. Once the clinical criteria are met (pulmonary/ systemic congestion), imaging can be used to satisfy the other two diagnostic components. Given its versatility, good reproducibility, and high feasibility, echocardiography is often the only modality needed to establish the diagnosis and guide therapeutic decisions.

Investigators and clinicians can use echocardiography to reliably measure left ventricular (LV) volumes, mass, and EF.2 An EF of ≥50% is the cutoff recommended to identify DHF. The European guidelines[1] also mandate the presence of a LV end diastolic volume index ≤97 ml/m^2 and an end systolic volume index ≤49 ml/m^2. The vast majority of DHF patients have concentric remodeling or hypertrophy and, rarely, eccentric LV hypertrophy. However, it should be noted that the presence of hypertrophy is not mandatory to establish the diagnosis.

DIAGNOSIS OF DIASTOLIC DYSFUNCTION

Invasive criteria for diastolic dysfunction include any of the following: LV end diastolic pressure >16 mmHg, a pulmonary capillary wedge pressure >12 mmHg, a time constant of LV relaxation >48 ms, and a diastolic LV stiffness constant >0.27.[1] However, invasive criteria are difficult to apply for the majority of patients, whereas echocardiographic measurements are amenable to widespread application. Direct assessment of LV filling pressures is the preferred initial approach, with LV mass and atrial volumes used as indirect circumstantial evidence.

DOPPLER ASSESSMENT OF LV RELAXATION AND FILLING PRESSURES

Tissue Doppler imaging (TOI) of mitral annulus velocities is the most reliable method for assessing LV relaxation and filling pressures in patients with DHF.-M Mitra! annulus e' velocity relates significantly with the time constant of LV relaxation in animals\ and humans.[4,6,8] Furthermore, che ratio of mitral E velocity to micral annulus e' velocity relates well with LV filling pressures.[3,4,6,9] Septal and lateral e' velocities have been used to calculate the E/e' ratio, and two studies have shown the lateral velocity to be more accurate in chat regard.[3,4] However, if the septa! velocity is used, an E/e· ratio <8 favors the presence of normal filling pressures, whereas a ratio >15 is usually associated with increased LV diastolic pressures.[6] If the average of septa! and lateral e' is used, a ratio <8 identifies patients with normal filling pressure, whereas a ratio >13 identifies those with increased filling pressures.[3]

When the ratio falls between these cutoffs, other echocardiographic measurements are needed. These include mitral inflow velocities, pulmonary venous flow velocities, pulmonary artery pressures, and left atrial (LA) volume index. It is recommended that at least two other abnormal measurements should be used in these borderline cases. For mitral inflow, a change in the inflow pattern during the strain phase of Valsalva is sought. Specifically, a reduction in E/A ratio by at least 0.5 supports the presence of increased LV filling pressures. Likewise, a prominent atrial reversal velocity in pulmonary venous flow (>35 *emfs* and a duration that is 30 ms longer than that of amegrade mitral inflow) supports the conclusion that LV end diastolic pressure is increased. Pulmonary artery pressures can be reliably measured by Doppler echocardiography.[10] Increased pulmonary artery systolic and/or diastolic pressure in the absence of pulmonary disease can be used as well. Patients with LV diastolic dysfunction frequently have LA enlargement, and a LA volume index ≥34 ml/m^2 is associated with future events including cardiac death, hospitalizations for heart failure, and atrial fibrillation.[11]

NOVEL ECHOCARDIOGRAPHIC INDICES

Recent studies evaluated the application of diastolic myocardial deformation indices for regional and global diastolic function.[12-15] The global diastolic strain rate during the isovolumetric relaxation period relates well to the time constant of LV relaxation in animals and humans, and the ratio of micral

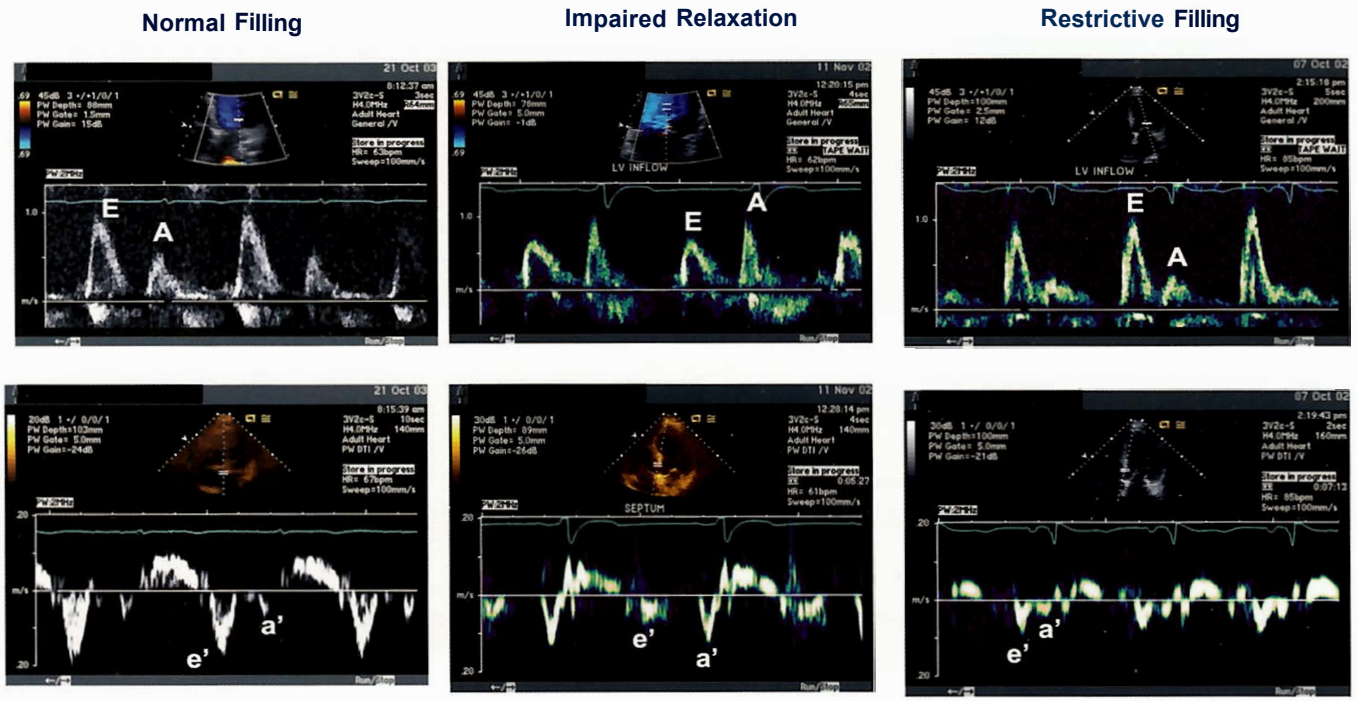

Figure 1. Upper panel shows mitral inflow velocity, and lower panel shows tissue Doppler (TD) derived mitral annulus velocities at the septal side of the annulus. The left panel of images is from a normal subject, the middle one was recorded from a patient with impaired relaxation, and the right one was obtained from a patient with restrictive LV filling. E stands for mitral early diastolic velocity, A stands for mitral late diastolic velocity, 8' stands for mitral annulus early diastolic velocity by TD, and a stands for mitral annulus late diastolic velocity by TD. The normal subject has an e' velocity of 18 cm/s, whereas e' is reduced in the other two patients. The reduced e' velocity signifies the presence of abnormal LV diastolic function.

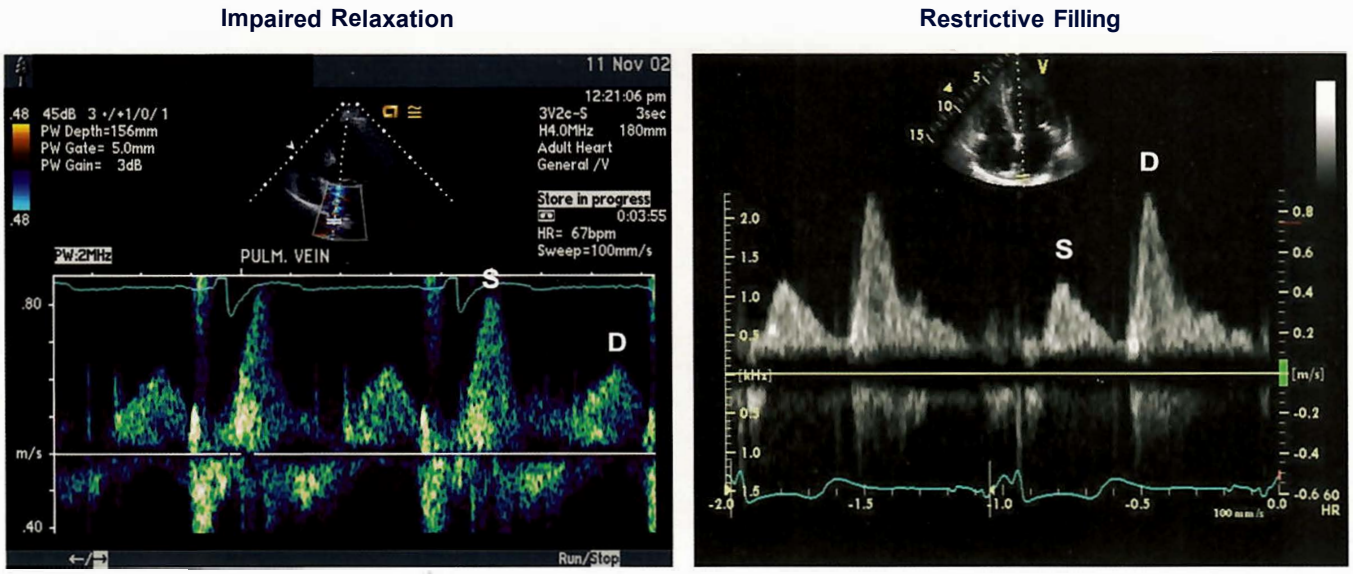

Figure 2. Pulmonary venous flow from two patients, one with impaired LV relaxation and normal filling pressures (left), and the other has increased LV filling pressures (right). S stands for systolic velocity, and D stands for diastolic velocity. Notice that in the patient with normal filling pressures (left), S/D ratio is >1, whereas it is <1 in the patient with increased filling pressures.

E velocity to this strain rate is more accurate than E/e' ratio in patients with normal EF.[15] Additional studies are needed to determine its full clinical potential.

Left ventricular twist mechanics can now be reliably measured by speckle tracking echocardiography.[16] Initial studies suggested that LV untwisting rate is a measure of LV relaxation.[18] However, we noted in animal and human studies that LV end systolic volume has the best correlation with LV untwisting rate.[19] Furthermore, it did not predict the time constant of LV relaxation in patients with diastolic heart failure.[19] Measurement of LV untwisting rate is not currently recommended for the clinical evaluation of LV diastolic function.

CONCLUSIONS

Echocardiography plays an essential role in the evaluation of patients with diastolic heart failure. The technique provides important diagnostic and prognostic information in this population.[20, 21]

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