Assessment of diastolic function has emerged as another important contribution of echocardiography to the clinical care of patients. Diastolic dysfunction as diagnosed by echocardiography carries a negative prognostic value,1–3 and diastolic assessment is now a routine part of any complete echocardiographic report.4 Bhella et al5 in this issue of Circulation: Cardiovascular Imaging, investigate the reliability of several echocardiographic diastolic parameters in predicting the pulmonary capillary wedge variation in individual subjects subjected to preload manipulation. Bhella et al controversially conclude that “Noninvasive indices do not adequately track changes in left-sided filling pressures as these pressures vary within individual subjects.” The findings are in contrast to a recent clinical paper published by Nagueh et al6 in a previous issue of the Circulation: Cardiovascular Imaging. Those authors demonstrated clinical utility of the same indices in patients with acute decompensated heart failure. How can these findings be reconciled, and what is the practicing cardiologist to do? Are the currently available diastolic parameters a bunch of meaningless numbers or crucial information in the treatment of patients?

The first well-accepted parameter of diastolic function, the mitral valve filling pattern assessed by Doppler velocity measurements, reflects the gradient between the left atrium (LA) and left ventricle (LV) in diastole. The gradient is specifically sensitive to LA pressure and LV relaxation. In general, the ratio of the early wave velocity (E) to the late velocity after atrial contraction (A) was helpful in identifying the diastolic function in individual patients. However, the clear preload dependence of the E/A ratio as well as its unreliability in tachycardia, moderate diastolic dysfunction with moderately elevated LA pressures (pseudonormalization), and other issues led to the search for more reliable parameters. The most recent assessment of diastolic dysfunction recommended by the American Society of Echocardiography and the European Association of Echocardiography (ASA/ESA) applies an algorithm that takes into account not only the E/A ratio but the deceleration time of the E wave, the early and late velocities of the mitral annulus measured by tissue Doppler (e’ and a’), the LA volume, the pattern of pulmonary vein flow, and the duration of reversed flow into the pulmonary veins during atrial contraction.7 The algorithm includes the parameter E/e’, which has emerged as powerful variable in diastolic assessment. It is primarily this variable that the Bhella report calls into question. Both reports also investigate the color M-mode velocity of propagation of the mitral inflow toward the apex. A rapid velocity coincides with normal diastolic function, whereas a slower velocity indicates delayed relaxation. There remains considerable variability in the literature as to technique with consequent variability in correlation of Vp to diastolic function.8–11 This editorial will focus on the other assessments of diastolic function.

Bhella et al compare previously reported data in 24 healthy elderly subjects, 12 healthy young subjects, and 11 elderly patients with heart failure with preserved ejection fraction (HFpEF), all with EF >50%. The patients underwent right heart catheterization and hemodynamic manipulation of preload with lower body negative pressure to lower preload and rapid saline infusion to increase it. The results were no surprise because all of the individual groups had been previously reported12–15 and this study is a compilation of that previously reported data, albeit with new interpretation. The authors were able to vary the pulmonary capillary wedge pressure (PCWP) from 0.8 to 28 mm Hg and noted that in these subjects, the 2 diastolic indices, E/e’ and E/velocity of propagation, perform poorly in predicting the change in PCWP in the overall group (Figure 1, from Bhella et al8). Thus, they conclude that the parameters are not useful in detecting changes in PCWP in patients with HFpEF.

Is this conclusion justified by the data? The astute reader will note that this editorial has until now conflated “diastolic function” with PCWP. However, these two are separate concepts, although interdependent. Echocardiography can distinguish systolic dysfunction from preserved ejection fraction (determined by LVEF ≥50%). The question is whether Doppler parameters can be used to further categorize patients with congestive heart failure into the 4 broad categories of systolic dysfunction with normal or elevated LA pressure and preserved systolic function with normal or elevated LA pressure. This is the clinically relevant issue. For example, it has previously been shown that these diastolic parameters can distinguish patients with hypertrophic cardiomyopathy from those with hypertrophy as the result of athlete’s heart. The athletes had entirely normal diastolic function and LA pressure as assessed by echocardiography.16

It is well known that the diastolic parameters useful in systolic dysfunction do not accurately predict LA pressure in subjects with normal hearts. Simply put, an elevation in the E-wave...
velocity may be due to an increase in LA pressure but may also be due to excellent lusitropic function. The reasoning is similar with tissue Doppler measurement of $e'$, and clearly, the ratio will be unreliable as well.17 The Bhella et al report confirms this finding. They also demonstrate a much better correlation between $E/e'$ and PCWP in patients with HfPEF and healthy elderly control subjects, who are known to have a degree of diastolic dysfunction with aging (Figure 2, from Bhella et al15). However, they demonstrate discordant findings in several of the subjects who are elderly or have HfPEF. In these cases, the PCWP decreased whereas the $E/e'$ increased. All but one of these discordant findings occurred with variations in the PCWP below 15 mm Hg, arguably not a hemodynamically significant finding if the goal is to categorize patients into the 4 broad hemodynamic presentations of congestive heart failure.

In contrast, the Nagueh report found that $E/e'$ was helpful in assessing patients with acute decompensated systolic heart failure. The patient group had an average LVEF of 23%. In this study of patients undergoing clinically indicated right heart catheterization, the ASE/EAE diastolic algorithm was applied to assess LA pressure. The algorithm, which includes $E/e'$, had a higher accuracy in determining PCWP compared with its individual components and a sensitivity of 98% with a specificity of 91%. Only 3 of the 75 patients had a mean wedge incorrectly predicted by the algorithm, suggesting that it is an excellent tool in the assessment of patients with systolic heart failure. In addition, this group found that the relationship between $E/e'$ and PCWP was less robust in patients with left bundle-branch block or CRT, an important caveat. It should also be noted that the feasibility of performing all of the components in each patient was not high. These authors also reported on 12 of the patients who had repeat Swan measurements of PCWP after treatment. The majority of these had a clinically significant change in their PCWP on the second measurement. The change in PCWP correlated well with the Doppler parameters, with an $r$ value of 0.75 ($P=0.005$). Nagueh et al conclude that in this group of patients, who are quite different in composition from the Bhella study group, “Doppler echocardiography can be used to reliably assess LV and right ventricular hemodynamics in patients with acute decompensated heart failure.”

Based on the data from both reports, it is safe to conclude that the ASE/EAE algorithm including $E/e'$ can be used to categorize patients into clinically significant groups of LA pressure (PCWP <15 and >18), with a middle group that requires assessment by the entire algorithm. The goal of using repeated Doppler measurements to guide therapy must be used with caution as demonstrated by Bhella et al, but their findings do not refute the utility of Doppler parameters in the initial assessment of patients. It should be noted that neither group reports variability in measurements, which has been reported as unacceptable high in at least one study.18

Finally, we are left with the question of whether it is clinically necessary to follow PCWP invasively or noninvasively once the hemodynamics of an individual patient have been clarified. The repeated calls from the intensive care unit to “assess volume status” have, at least at our institution, in some cases replaced careful clinical assessment by physical examination and review of daily weights, I’s and O’s, A-a gradient, and so forth. The ESCAPE trial is frequently quoted as the reason to avoid Swan’s for ongoing PCWP measurement in patients hospitalized with congestive heart failure.19 A simple noninvasive measurement, such as $E/e'$, would be an attractive alternative. However, there is no evidence that repeated noninvasive assessment will fare any better compared with carefully applied clinical parameters in the care of patients with heart failure.

Disclosures

None.

References


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Diastolic Echo Parameters: Meaningless Numbers or Crucial Information?
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