

Left atrial strain imaging: ready for clinical implementation in heart failure with preserved ejection fraction

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This editorial refers to ‘Left atrial reservoir strain improves diagnostic accuracy of the 2016 ASE/EACVI diastolic algorithm in patients with preserved left ventricular ejection fraction: insights from the KARUM hemodynamic database’, by A. Venkateshvaran et al., <https://doi.org/10.1093/ehjci/jeac036>.

Introduction

Echocardiography is the primary imaging modality to assess diastolic function and plays a pivotal role in the diagnosis of heart failure with preserved ejection fraction (HFpEF). The diagnosis of HFpEF is based on a combination of symptoms and signs, presence of normal or preserved ($\geq 45\%$) ejection fraction (EF), and objective evidence of left ventricular (LV) diastolic dysfunction. A diagnostic hallmark of HFpEF is elevated LV filling pressure at rest or during exercise, which is a compensatory mechanism to maintain adequate stroke volume.¹

The first-line echocardiographic parameters for assessment of diastolic dysfunction are LV filling pattern, measured as mitral early-diastolic (E) and atrial induced (A) flow velocities and their ratio (E/A), LV lengthening velocity (e') and the consequence of increased filling pressure on left atrial (LA) volume and on pulmonary arterial pressure [assessed by tricuspid regurgitation (TR) velocity]. According to the 2016 ASE/EACVI guideline, low $E \leq 50$ cm/s with $E/A \leq 0.8$ is consistent with normal LA pressure, whereas a tall E and $E/A \geq 2.0$ indicates elevated LA pressure. However, in patients with E/A between 0.8 and 2.0 or $E/A \leq 0.8 + E > 50$ cm/s, additional parameters are needed to evaluate filling pressure.² The presence of ≥ 2 of the following three criteria are consistent with elevated LV filling pressure: (i) average $E/e' > 14$, (ii) TR velocity > 2.8 m/s, and (iii) indexed LA volume > 34 mL/m². This approach is not feasible, however, when one parameter is missing and

the remaining two are incongruous. In this situation, further assessment is necessary to evaluate LV filling pressure.

When investigating patients for potential pulmonary hypertension, estimation of peak TR velocity is often challenging as around 40% of patients have suboptimal or absent tricuspid regurgitant jet.³ Furthermore, since pulmonary hypertension may also have non-cardiac causes, TR velocity has limited ability to reflect LV filling pressure. The 2016 ASE/EACVI algorithm for estimation of LV filling pressure has also been shown to have varying diagnostic accuracy.^{4,5} This calls for alternative indices, which can be incorporated into the algorithm to accurately diagnose HFpEF.

LA strain

LA strain has been proposed as a useful echocardiographic marker in a range of cardiac diseases.⁶ Both LA reservoir and pump strains measured by speckle tracking echocardiography are recently introduced as markers of LV filling pressure. A previous study in 229 patients with normal EF showed that LA reservoir strain was able to differentiate accurately between different grades of diastolic dysfunction.⁷ In a recent study in 322 patients, both LA reservoir and pump strain were associated with LV filling pressure, especially in patients with reduced LV systolic function.⁸ This association was weaker in patients with normal systolic function defined by LV global longitudinal strain $> 16\%$ and EF $\geq 50\%$. When LA strain was added to the 2016 algorithm, feasibility was improved and 99% of patients could be classified. However, there was no further increase in accuracy when determining LV filling pressure (83% vs. 82%). In the recent EACVI recommendations for multimodality imaging in HFpEF, LA reservoir strain was included in the refined diagnostic algorithm for assessing LV filling pressure in situations when the traditional criteria give inconclusive results.¹

The opinions expressed in this article are not necessarily those of the Editors of *EHJCI*, or the European Society of Cardiology.

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LA reservoir strain's role in the diagnosis of HFpEF

The current article by Venkateshvaran *et al.*⁹ nicely shows the incremental value of LA reservoir strain to the 2016 ASE/EACVI algorithm for estimation of LV filling pressure in patients with unexplained dyspnoea and preserved LV EF. In a retrospective analysis of 480 patients undergoing right heart catheterization due to dyspnoea, they selected patients with normal EF without limiting conditions known to affect the algorithm. The final cohort consisted of 210 patients of which 45 (21%) had elevated filling pressure defined as a pulmonary capillary wedge pressure (PCWP) ≥ 15 mmHg. LA reservoir strain demonstrated a strong diagnostic ability to identify elevated PCWP [area under the curve (AUC)=0.76, confidence interval (CI) 0.68–0.84; $P < 0.001$]. A cut-off for LA reservoir strain of $< 18\%$ showed the overall highest accuracy for identifying elevated PCWP and was used for further analysis. The 2016 ASE/EACVI algorithm was applied to the study cohort and showed 71% sensitivity, 68% specificity, and 68% accuracy at identifying elevated PCWP (AUC=0.69, CI 0.60–0.78; $P < 0.001$). The investigators then proceeded to test if LA reservoir strain was of incremental value to the 2016 ASE/EACVI algorithm in three different models. In the first model, TR velocity > 2.8 m/s was substituted with LA reservoir strain $< 18\%$. In the second model, LA reservoir strain $< 18\%$ was substituted for the missing criteria when two available criteria were incongruent, which is in agreement with the refined algorithm from the EACVI.¹ The third model added LA reservoir strain $< 18\%$ to the existing three criteria, and categorized patients as having elevated pressure if three of the four criteria were positive. Model 1, where TR velocity > 2.8 m/s was substituted with LA reservoir strain $< 18\%$, showed the highest ability to identify patients with elevated PCWP of all the models (69% sensitivity, 84% specificity, 81% accuracy, AUC=0.77, CI 0.67–0.85; $P < 0.001$). Model 2, which applied the refined algorithm from the EACVI, showed the highest feasibility (98%).

Although the study population had a low proportion of patients with elevated LV filling pressure (21%), it shows interesting results and substantiates the use of LA strain in the evaluation of LV filling pressure. There was a large proportion of patients with pulmonary vascular or parenchymal disease (60%), which is not uncommon in patients presenting with dyspnoea. This most likely explains the superior performance of the article's first model for estimation of LV filling pressure, where TR velocity was substituted with LA reservoir strain. In patients with normal LV filling pressure and pulmonary hypertension of non-cardiac origin, TR velocity will be elevated while LA reservoir strain will be normal.

Clinical perspective

The diagnosis of HFpEF is challenging and requires an integrated approach including history taking, physical examination, and standard diagnostic tests. There is strong evidence to suggest that LA strain is an important index of LV filling pressure.¹⁰ One should be aware that LA strain is age dependent, and optimal age adjusted cut-offs for LA reservoir and pump strain in HFpEF diagnostics need to be further refined.¹¹ The current study shows how LA strain is superior to TR velocity as a marker of filling pressure and provides additional support for incorporating LA reservoir strain when evaluating patients with heart failure like symptoms and normal LV EF.

Conflict of interest: O.A.S. has filed patent on 'Estimation of blood pressure in the heart' and has received one speaker honorarium from GE Healthcare. E.B. has nothing to disclose.

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