

EDITORIAL

Left Atrial Volumetric/Mechanical Coupling Index Is Ready for Prime Time Across Clinical Scenarios

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The left atrium (LA) is a cardiac cavity whose main role is to contain the pulmonary venous flow return during left ventricular (LV) systole and to empty and conduct further pulmonary venous blood into the LV during its diastole. Most of this function is passive as the x-descent of LA pressure, driving LA filling from pulmonary veins, is induced by the LA spherization (from an ellipsoid at end-ventricular-diastole) forced by the traction of LV myocardium during ventricular systole. The only active part of the atrial cycle is the atrial contraction that follows the P-wave of the ECG. This limited active component of the LA myocardium, for which experimental elimination shows little impact on cardiac output in the absence of other myocardial alterations¹ suggested that LA active myocardial function is of low clinical significance. This sentiment was corroborated by the benign nature of lone (isolated) atrial fibrillation,² characterized by a complete loss of atrial function. Thus, LA has been often considered a passive bystander of ventricular or valvular pathophysiologic alterations and is rarely included among items of importance in prognostic scores. LA enlargement has even been considered as modulating clinical consequences of LV disease by buffering elevated filling pressure or volume overload.^{3,4} However, attention has been drawn to evaluating LA characteristics and their implications by our ability to measure

more physiologically LA remodeling by assessing the LA volume index, which showed its link to the subsequent occurrence of atrial fibrillation⁵ and demonstrated in patients with mitral regurgitation in sinus rhythm an independent link to clinical outcome⁶ even for mild enlargement.⁷ Therefore, the status of LA as a nonbystander has been upgraded with LA remodeling measured by LA volume index now widely implemented. Furthermore, the question arises whether LA myocardial function is measurable and whether its alterations have, independently of all clinical and myocardial characteristics, any impact on the status and outcome of patients with cardiac diseases.

See Article by Okada et al.

Unfortunately, assessing LA contractile function is difficult because the LA is thin walled, its afterload is dependent on the LV filling characteristics, and the LA intrinsic contraction is brief and limited in magnitude. Thus, imaging of the LA myocardial function is complex and methods of quantification are time consuming or require dedicated software and mostly focus on passive filling.^{3,8} Therefore, obtaining a measure of the LA contraction is quite challenging by any imaging method.

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In evaluating possible candidate measures, one appealing approach is the calculation of the left atrial volumetric/mechanical coupling index (LACI), as the ratio of the LA volume index to the late diastolic mitral annular velocity in sinus rhythm (a'), which is concomitant and consequential to the LA myocardial contraction. LACI is intuitively attractive by relating the mechanical effects of LA contraction to its “preload” evaluated by the LA volume index or maximal volume preatrial contraction. The clinical advantages are obvious as the components of LACI are easily measurable and of proven validity in routine practice and are integrated into a single software-independent parameter. LACI is thus simple and applicable in routine practice but is it relevant as an incremental prognostic marker?

LACI was introduced in 2010 in a pilot study aiming at identifying patients with hypertension and a history of paroxysmal atrial fibrillation and subsequently was found to detect advanced diastolic dysfunction with possible linkage to outcomes.^{4,9–11} The clinical relevance of LACI was extended in patients with heart failure (HF) with reduced ejection fraction (EF), whereby elevated LACI (mediocre contraction for any given LA volume index) correlated with worse clinical presentation and increased mortality.¹² The concept of elevated LACI as an incremental determinant of outcome in various cardiac diseases was extended to patients with floppy mitral valves with various degrees of mitral

regurgitation.¹³ Furthermore, LACI’s utility in predicting HF hospitalizations, especially in older patients with comorbid conditions, or cardiovascular risk in patients with chronic kidney disease and in the challenging setting of acute HF, has been also observed in other independent studies.^{14,15} Whether LACI plays a similar role among the large contingent of patients with HF with preserved EF has remained uncertain up to now.

THE PRESENT STUDY OF LACI IN PATIENTS WITH HF WITH PRESERVED EF

In this issue of the *Journal of the American Heart Association (JAHA)*, Okada et al. derived from the Japanese-based PURSUIT-HFpEF (Prospective Multicenter Observational Study of Patients With Heart Failure With Preserved Ejection Fraction) registry, a large-scale, prospective evaluation of LACI in patients with HF with preserved EF.¹⁶ They gathered a cohort of 562 rigorously phenotyped patients and examined the association of LACI with other Doppler-echocardiographic indices and with long-term outcomes, with a median follow-up of 40 months. Unlike previous studies, mostly restricted to HF with reduced EF, mitral regurgitation, hypertension, this study affirms the independent link of LACI with subsequent

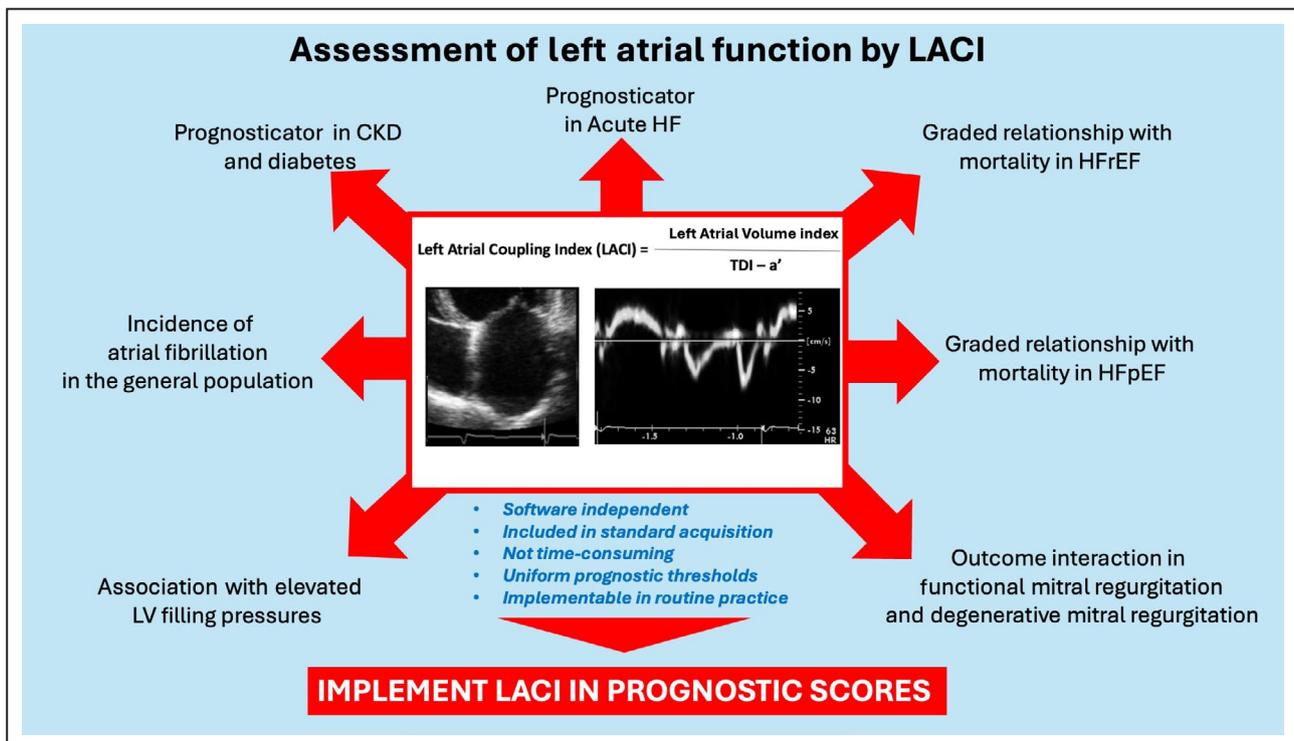


Figure. LACI calculation obtained by dividing left atrial volume index by TDI-a.

The arrows highlight the clinical scenarios in which LACI has been demonstrated as a useful independent prognosticator. CKD indicates chronic kidney disease; HF, heart failure; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; LACI, left atrial coupling index; LV, left ventricle; and TDI, tissue Doppler.

cardiovascular death and HF rehospitalization in the HF with preserved EF subset—a population notoriously difficult to risk-stratify. Rather than relying solely on arbitrary cutoffs, the study demonstrates a linear increase in risk across LACI quartiles, highlighting LACI as a continuous risk marker rather than a binary threshold. The authors show that LACI, computed from standard Doppler-echocardiography, offers prognostic performance comparable to established risk models and may provide additive value when combined. By documenting the correlation of LACI with LV filling pressures and right heart pressures independently of comorbid burden, the authors reinforce LACI's position as a physiologically meaningful, integrative marker of cardiac stress and dysfunction. The article has limitations related to the relatively low mortality, for which it is elusive to assess causes (linked to the low mortality of the Japanese population or some loss of follow-up?). Thus, the lack of statistical link between LACI and cardiac mortality may just be related to low power. Irrespective of this limitation, the important fact is the demonstration of the association between poor atrial myocardial function measured by elevated LACI and the clinical outcome of HF with preserved EF.

WHAT IS NEXT IN EVALUATING LA MYOCARDIAL MECHANICS?

Despite the simplicity of an echocardiographic measure with components acquired systematically within all standard imaging acquisition protocols, LACI shows robust and replicable graded prognostic impact across literature. The multitude of clinical settings in which it has been validated confirms wide applicability in both acute and chronic settings, independent of valvular disease or various overloads (Figure). Additionally, LACI displays a consistent threshold for excess mortality, around the value of 6, across cardiac diseases. Although LACI elevation appears linked to the degree of LV dysfunction, this association is of modest strength, signifying that the myocardial alterations in the various cardiac chambers are additive in term of prognosis. Thus, it is time to widely implement the calculation of LACI in a large variety of cardiac conditions evaluated in routine practice. It is also time, in view of the incremental prognostic power of LACI in patients with HF to add it to clinical scores (such as the Maggic score) that incorporate very few objective measures of cardiac function. LACI is a candidate for such inclusion as well as the severity of functional mitral regurgitation and tricuspid regurgitation, severity of LV diastolic function and pulmonary hypertension, among the major descriptors obtained by cardiac imaging.

Research into the measures of LA contractile function should not stop at LACI and integration with

advanced multimodality imaging and biomarkers (eg, LA strain by different imaging methods, quantification of LA fibrosis by cardiac magnetic resonance, or natriuretic peptides) may unlock deeper insights into atrial pathophysiology and refine prognostication and detection of early dysfunction in HF and a variety of conditions. Prospective interventions aimed at improving LA myocardial function are warranted to test whether these can alter clinical trajectories, not only in terms of mortality but also in terms of preventing heart failure episodes and atrial arrhythmias. For now, given that LACI reflects structural and functional changes in tandem, its role as a dynamic marker of response to therapy remains open and warrants future research.

ARTICLE INFORMATION

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