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REVIEWS

STATE-OF-THE-ART PAPERS

Cardiac Imaging to Evaluate Left Ventricular Diastolic Function

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CME Objective for This Article: At the end of this activity the reader should be able to: 1) review the physiology and pathophysiology of left ventricular diastolic function, including the relation to imaging parameters; 2) understand how different cardiac imaging techniques assess left ventricular diastolic function, and which limitations exist for these approaches; and 3) summarize the published experience with cardiac imaging from clinical trials in which left ventricular diastolic function was important for selection of patients or as an outcome variable.

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Cardiac Imaging to Evaluate Left Ventricular Diastolic Function

ABSTRACT

Left ventricular diastolic dysfunction in clinical practice is generally diagnosed by imaging. Recognition of heart failure with preserved ejection fraction has increased interest in the detection and evaluation of this condition and prompted an improved understanding of the strengths and weaknesses of different imaging modalities for evaluating diastolic dysfunction. This review briefly provides the pathophysiological background for current clinical and experimental imaging parameters of diastolic dysfunction, discusses the merits of echocardiography relative to other imaging modalities in diagnosing and grading diastolic dysfunction, summarizes lessons from clinical trials that used parameters of diastolic function as an inclusion criterion or endpoint, and indicates current areas of research. (J Am Coll Cardiol Img 2015;8:1071–93) © 2015 by the American College of Cardiology Foundation.

The concept of left ventricular (LV) diastolic function as a characteristic separated from systolic function is not immediately compelling. Classic functional diagrams of LV function, like the pressure-volume loop, show a smooth transition between systolic and diastolic pressure-volume data. Furthermore, the term *function*, although appealing for the pump action of the LV in systole, seems less appropriate for the partially passive ventricular filling phase changes in volume and pressure. Nevertheless, the term *diastolic function* has become firmly rooted in cardiology and denotes the ability of the LV to fill sufficiently to produce the requested stroke volume without exceeding certain pressure limits during filling. LV pressure during diastole is nearly identical to left atrial (LA) and pulmonary capillary pressure because the latter structures have an open communication with the LV during diastole. Increased LA pressure implies pulmonary congestion, which accounts for dyspnea in patients with left heart failure. Clinical interest has been boosted by the realization that about one-half of patients presenting with heart failure symptoms have a "preserved" LV ejection fraction (>50%), although at closer inspection, systolic functional abnormalities such as reduced longitudinal LV shortening are often present. Hence, it has been assumed that a large proportion of the "heart failure epidemic" is primarily caused by diastolic LV dysfunction, and this has been termed heart failure with preserved ejection fraction (HFpEF). However, because symptoms of heart failure, in particular dyspnea, are not always cardiac in origin, direct evidence of such diastolic dysfunction should be sought before settling on the diagnosis of diastolic dysfunction to explain HFpEF. Alternative diagnoses include noncardiac disorders such as pulmonary disease and obesity. Furthermore, valvular disease, such as mitral stenosis, constrictive pericarditis, congenital heart disease, pulmonary arterial hypertension, and others, may cause HFpEF and should be ruled out. Because exertional dyspnea is a common symptom of coronary artery disease, this disease also needs to be considered. Direct evidence of diastolic LV dysfunction can be provided by invasive measurements (LV pressure tracings or ideally pressure-volume data), natriuretic peptide levels indicating myocardial stretch, or cardiac imaging—first and foremost, echocardiography (1). Imaging techniques, however, lack the capability of directly measuring pressures, although they can measure volumes and blood and tissue velocities; therefore, by nature, they only provide indirect evidence of diastolic pressures or pressure-volume relationships.

Like in any other diagnostic work-up, a clinical question should always be the starting point. Reasons for referring patients for evaluation of diastolic function include: 1) symptoms or signs of heart failure in patients with preserved LV ejection fraction; 2) the need for an estimate of LV filling pressure in patients with known heart disease; and 3) assessment of cardiovascular risk.

In the following, we will review current knowledge on how to assess diastolic LV function by cardiac imaging, how well validated such assessment is, and which prognostic implications these data have. We will also describe the most important current open questions and unmet needs.