

## Editorial



# Echocardiographic Hemodynamic Assessment in Patients with Ischemic Heart Disease: the Impact of Diastolic Remodeling on Long-term Prognosis

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► See the article “Pseudonormal or Restrictive Filling Pattern of Left Ventricle Predicts Poor Prognosis in Patients with Ischemic Heart Disease Presenting as Acute Heart Failure” in volume 26 on page 217.

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### Conflict of Interest

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The severity of diastolic dysfunction is related to the development of heart failure (HF) symptoms, hospitalization and cardiovascular death in patients with HF. A previous study revealed that moderate or severe left ventricular diastolic dysfunction was an independent predictor of poor outcomes in patients with HF and preserved left ventricular ejection fraction.<sup>1)</sup> Echocardiography can measure the ventricular filling pattern, the velocity of myocardial motion and the atrial filling pattern, enabling non-invasive and comprehensive evaluation of ventricular diastolic function.<sup>2)3)</sup> In the setting of acute myocardial infarction, the hemodynamic assessment is challenging, but it has critical importance in risk stratification. Clinical surrogate parameters that reflect hemodynamic status, such as low systolic blood pressure in cardiogenic shock and Killip classification, which reflects left ventricular end diastolic pressure, have been used.

Ischemic injury and its associated neurohormonal or hemodynamic alterations cause ventricular remodeling—deleterious changes in ventricular geometry and function. Ventricular remodeling has been classically recognized as chamber enlargement and systolic dysfunction, although it also can be interpreted as various unfavorable changes at the molecular, histologic, neurohormonal and hemodynamic levels.<sup>4)5)</sup> After the first anterior Q-wave myocardial infarction, diastolic dysfunction can be improved in some patients and can worsen in other patients.<sup>6)</sup> In a recent study, adverse diastolic remodeling was associated with myocardial fibrosis.<sup>7)</sup> Circulating type III procollagen, galectin-3 and b-type natriuretic peptide values were increased in patients with aggravated diastolic function and decreased in patients with normalized diastolic function at the 1 year follow-up visit after myocardial infarction. Another study evaluated the mineralocorticoid receptor antagonist eplerenone in patients with ST-segment elevation myocardial infarction (STEMI) without HF and found that the serum level of procollagen type III was higher in patients with older and with worse renal function and correlated with natriuretic peptide. In addition, early treatment with eplerenone was associated with a reduced procollagen type III level.<sup>7)</sup> Determining whether such results can be translated to the prevention of adverse diastolic remodeling after myocardial infarction will require further research.

Adverse diastolic remodeling was associated with poor cardiovascular outcomes.<sup>8)</sup> In patients with STEMI undergoing adequate reperfusion therapy, adverse diastolic remodeling (defined as  $\geq 1$  grade worsened or persistent severe diastolic dysfunction on 2-month follow-up echocardiography) was an independent predictor of long-term adverse cardiovascular events even after adjustment for TIMI risk score, infarct scar size, microvascular obstruction, and left ventricular ejection fraction.<sup>8)</sup> Infarction scar size and baseline restrictive filling profile were the major determinants of adverse diastolic remodeling. Echocardiographic diastolic function parameters reflect ventricular filling pressure and can be used for risk stratification to predict long-term prognosis.<sup>8)9)</sup>

Due to the increasing awareness about the prognostic importance of significant diastolic dysfunction, the guidelines for echocardiographic assessment were recently updated.<sup>3)</sup> The 2016 guidelines from American Society of Echocardiography and European Association of Cardiovascular Imaging recommend the simplified algorithmic approach to diagnose diastolic dysfunction. The number of key variables was reduced to four: mitral E/A ratio, tricuspid regurgitation velocity, average E/e' ratio, and left atrial volume index. Although there was some confusion because the diagnostic criteria differed from those released in 2009, the 2016 guidelines better classify moderate and severe diastolic dysfunction. In the post-MI setting, the choice of the algorithm utilized for patients with depressed left ventricular ejection fraction or underlying myocardial disease is considered reasonable.<sup>9)</sup>

Moreover, Lee et al.<sup>10)</sup> reported on the prognostic association of advanced diastolic dysfunction, defined by restrictive filling pattern (RFP) of mitral inflow, and cardiovascular events (hospitalization due to HF and all-cause death) in patient with acute HF from an ischemic etiology and revealed that the two-year event-free survival rate was higher in patients with RFP, chronic kidney disease and higher NYHA functional class. Several issues are needed to be considered when interpreting this article. The systolic function of the overall study population was reduced, and the left ventricular ejection fraction of the group with RFP and that without RFP was  $37.4 \pm 12.1\%$  and  $45.9 \pm 15.9\%$ , respectively. All study participants had active or a previous history of ischemic heart disease, but the number of patients with acute coronary syndrome was not specified. Patients with acute HF caused by the failure of volume status control, instead of significant myocardial ischemia, may be included, but it remains unclear whether the abnormal diastolic parameter is associated with a poor prognosis in such patients. The 2016 guidelines for the echocardiographic evaluation of left ventricular diastolic function reveal that more than 10-15% of patients belong to the indeterminate grade.<sup>3)</sup> Although it was not clarified how these patients were categorized, the conclusions would not be altered, as RFP is highly specific for advanced diastolic dysfunction. Chronic kidney disease as an unfavorable predictor in diastolic dysfunction is compatible with other studies.<sup>7)</sup>

In conclusion, advanced diastolic dysfunction in patients with acute HF and myocardial ischemia is associated with higher risk in the short-term and long-term clinical course independent of systolic dysfunction. Patients with more severe myocardial damage and more severe diastolic dysfunction in the acute phase seem to have the greater risk to develop adverse diastolic remodeling. Unresolved questions remain and will be answered in future studies. Who is more vulnerable to myocardial fibrosis and at risk for adverse diastolic remodeling after an acute myocardial infarction? Could treatment for myocardial fibrosis reduce the risk of myocardial remodeling, or could it induce reverse remodeling? New insights into a patient's cardiac hemodynamics obtained from comprehensive diastolic evaluation contribute to the formulation of the best treatment for patients with acute HF.

## REFERENCES

1. Persson H, Lonn E, Edner M, et al. Diastolic dysfunction in heart failure with preserved systolic function: need for objective evidence: results from the CHARM Echocardiographic Substudy-CHARMES. *J Am Coll Cardiol* 2007;49:687-94.  
[PUBMED](#) | [CROSSREF](#)
2. Nagueh SF, Appleton CP, Gillebert TC, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography. *J Am Soc Echocardiogr* 2009;22:107-33.  
[PUBMED](#) | [CROSSREF](#)
3. Nagueh SF, Smiseth OA, Appleton CP, et al. Recommendations for the evaluation of left ventricular diastolic function by echocardiography: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *J Am Soc Echocardiogr* 2016;29:277-314.  
[PUBMED](#) | [CROSSREF](#)
4. Konstam MA, Kramer DG, Patel AR, Maron MS, Udelson JE. Left ventricular remodeling in heart failure: current concepts in clinical significance and assessment. *JACC Cardiovasc Imaging* 2011;4:98-108.  
[PUBMED](#) | [CROSSREF](#)
5. Sekaran NK, Crowley AL, de Souza FR, Resende ES, Rao SV. The role for cardiovascular remodeling in cardiovascular outcomes. *Curr Atheroscler Rep* 2017;19:23.  
[PUBMED](#) | [CROSSREF](#)
6. Ferreira JP, Bauters C, Eschaliér R, et al. Echocardiographic diastolic function evolution in patients with an anterior Q-wave myocardial infarction: insights from the REVE-2 study. *ESC Heart Fail* 2018 Nov 20 [E-pub ahead of print], <https://doi.org/10.1002/ehf2.12359>.  
[PUBMED](#)
7. Ferreira JP, Duarte K, Montalescot G, et al. Effect of eplerenone on extracellular cardiac matrix biomarkers in patients with acute ST-elevation myocardial infarction without heart failure: insights from the randomized double-blind REMINDER Study. *Clin Res Cardiol* 2018;107:49-59.  
[PUBMED](#) | [CROSSREF](#)
8. Nguyen TL, Phan J, Hogan J, et al. Adverse diastolic remodeling after reperfused ST-elevation myocardial infarction: An important prognostic indicator. *Am Heart J* 2016;180:117-27.  
[PUBMED](#) | [CROSSREF](#)
9. Prasad SB, Lin AK, Guppy-Coles KB, et al. Diastolic dysfunction assessed using contemporary guidelines and prognosis following myocardial infarction. *J Am Soc Echocardiogr* 2018;31:1127-36.  
[PUBMED](#) | [CROSSREF](#)
10. Lee JG, Beom JW, Choi JH, Kim SY, Kim KS, Joo SJ. Pseudonormal or restrictive filling pattern of left ventricle predicts poor prognosis in patients with ischemic heart disease presenting as acute heart failure. *J Cardiovasc Imaging* 2018;26:217-25.  
[CROSSREF](#)