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The value of exercise echocardiography in heart failure with preserved ejection fraction

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diastole, echocardiography, stress echocardiography, heart failure

Abstract

Diastolic stress test is something that is now acknowledged in the recommendations and guidelines for diagnosing heart failure with preserved ejection fraction. This is mainly a submaximal exercise stress test, while the maximal exercise stress test is used in the research of ischemia. Echocardiography can be performed at rest and during submaximal exercise stress test. Few papers have proposed exercise echocardiography as a relevant diagnostic tool in heart failure with preserved ejection fraction. The E/e' ratio and the estimated pulmonary artery pressure by maximal tricuspid regurgitation velocity should be measured during standardized exercise. Stroke volume and its change during exercise should be also assessed. In fact, unlike in a normal compliant heart, there is no increase in left ventricular end-diastolic volume during exercise and consequently no increase in cardiac output in heart failure with preserved ejection fraction. The absence of increased cardiac output during exercise is, like E/e' and estimated pulmonary artery pressure, a major parameter to be investigated during submaximal exercise performed to confirm the diagnosis of heart failure with preserved ejection fraction as an etiology of dyspnea.

Heart failure (HF) with preserved ejection fraction (HFpEF) is a complex pathophysiological entity. Echocardiographic parameters offer a key tool for the diagnosis of the syndrome, as indicated in the new ESC guidelines[1]. HFpEF is defined as typical heart failure symptoms and signs with normal or preserved left ventricular ejection fraction (LVEF) and normal or small left ventricular (LV) volumes, structural heart disease [LV hypertrophy/left atrial (LA) enlargement], and evidence of diastolic dysfunction (abnormal E/e' ratio (averaged ≥13) and abnormal e'<9 cm/s). Few papers have proposed exercise echocardiography as a relevant diagnostic tool in HFpEF. Importantly, Erdei *et al*. published an important paper highlighting the fact that diastolic exercise stress test should be performed with the aim of estimating filling pressure and systolic-diastolic reserve when exercising[2]:

- Complete echocardiography at rest
- Complete echocardiography at 100–120 beats /min (submaximal exercise stress echocardiography)
- Echocardiography at the peak of exercise for excluding ischemic heart disease that could explain the clinical situation.

The relevance of echocardiographic parameters that could be recorded during exercise remains an issue especially in this complex HFpEF syndrome[3]. A strong correlation between E/e' and physical activity has been demonstrated in many patients, including patients with HFpEF. E/e' has been compared to an invasive hemodynamic measurement during exercise and the correlation was demonstrated acceptable. However, in the case of echocardiography, a multi-parametric approach instead of a single parameter approach should be used[4]. Therefore, looking only for a change in E/e' is clearly insufficient[5,6].

E/e' and the estimated PAP by TR maximal velocity should be measured during standardized stress test. Stroke volume and its change during exercise should be also assessed[7]. In fact, unlike in normal compliant heart, there is no increase

Parameters	HFpEF *vs* controls	
VO_2 peak	↘	
Δ output	↘	Chronotropic incompetence
Δ A-V O_2 ≠ ce	↘	
Δ HR	↘	
Δ LV and diastolic Vol	↔	
Δ LV and systolic Vol	↘	Absence of contractile reserve
Δ LV EF	↘	
Δ Systemic vascular resistance	↔	

Fig. 1. *The impact of submaximal exercise on parameters measurable by echocardiography in patients with heart failure with preserved ejection fraction*

in LV end-diastolic volume during exercise and then no increase in cardiac output in HFpEFn. The absence of increased cardiac output during exercise is, like E/e' and estimated sPAP, a major parameter to be investigated during submaximal exercise performed to confirm the diagnosis of HFpEF as an etiology of dyspnea[8] (Fig. 1).

The prognostic value of these parameters has also been demonstrated. The goal now is to use the existing tests and to improve the diagnosis, thereby improving the prognosis of HFpEF. Exercise training might be a way as it should decrease LV afterload.

To conclude, diastolic stress test is a submaximal exercise stress test. It is useful for diagnosing and for estimating the prognosis of HFpEF patients. A lot remains to be done for improving the quality of life and survival of these patients[9].

Note: the European Association for Cardio-Vascular imaging (EACVI) is strongly involved in the education in the field of echocardiography and other cardio-vascular imaging modalities. In addition to its educational goals, research is promoted and the recent Eurofiling study has been accepted for publication in the European Heart Journal-Cardiovascular Imaging Journal[10]. It was conducted in 10 EACVI echocardiographic laboratories and it demonstrated that E/e' is not always the perfect tool to trust in. The estimation of filling pressure has to be multiparametric.

Conflict of interest

The author does not report any financial or personal connections with other persons or organizations, which might negatively affect the contents of this publication and/or claim authorship rights to this publication.

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