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EDITORIAL COMMENT

Cardiovascular dynamics in ischemic cardiomyopathy during exercise

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Both echocardiography and cardiac magnetic resonance imaging (CMR) are currently recognized as accurate and reliable means of evaluating cardiac anatomy and ventricular function. Echocardiography is still the mainstay of assessing left ventricular function but over the past years considerable progress has been made in the field of CMR, providing accurate evaluation of left ventricular function particularly in patients with heart failure due to ischemic cardiomyopathy [1–11]. Stress first-pass contrast-enhanced myocardial perfusion CMR can be used to detect subendocardial ischemia and recent studies have demonstrated the high diagnostic accuracy of stress myocardial perfusion CMR for detecting significant coronary artery disease [12–17]. Magnetic resonance angiography (MRA) has been introduced as a method that can provide visualization of all three major coronary arteries, coronary anomalies, coronary bypasses and the aorta within a single three-dimensional acquisition [18–21]. CMR has become the first choice imaging modality in complex congenital heart disease [22–26] and imaging great vessels [27, 28].

Over the past years, contrast-enhanced CMR has been used to visualize the transmural extent of myocardial infarction with high spatial resolution [29–34]. Infarcted myocardium appears hyperenhanced compared with normal myocardium when imaged by a late enhancement CMR. The transmural extent of delayed gadolinium enhancement predicts functional outcome after interventional procedures performed in patients with acute myocardial infarction and chronic ischemic heart disease [35–39].

In the current issue of the International Journal of Cardiovascular Imaging, Wong et al. [40] reported 43 patients with ischemic cardiomyopathy (age 59 ± 9 years, mean LVEF 24 ± 8%) who underwent cardiopulmonary exercise testing, echocardiography and CMR. The purpose of the study was to examine the relationship between noninvasive measurements of ventricular-vascular coupling (VVC) with exercise tolerance. Measurements of oxygen consumption, carbon dioxide production, heart rate, minute ventilation, tidal volume, and respiratory rate were made both at rest and during exercise. The authors compared the value of VVC versus other traditional determinants of exercise capacity in this population. VVC was defined non-invasively by the ratio of ventricular systolic elastance (Ees) to arterial elastance (Ea). It was clearly shown that both Ea and Ees were markedly depressed at rest irrespective of age

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and gender. There was an unfavorable rightward shift of systolic-pressure–volume relationship implying a reduced stroke efficiency and diminished cardiac reserve during physiological stress. A higher VVC was associated with higher LVEF and RVEF but showed inverse relation to mitral *E* wave velocity. VVC was independent of arterial stiffness and diastolic dysfunction. The authors concluded that ventricular-arterial coupling at rest may be a clinically important parameter in predicting exercise capacity in patients with advanced heart failure, and may become an additional target for therapeutic interventions.

This article is important for several reasons. First, a multimodality imaging approach was used, whereby echocardiography primarily provided important diastolic function data. CMR allowed the measurement of both volumetric parameters and aortic distensibility. Based on the volume data Ees and Ea could be measured as pertinent parameters of intrinsic cardiovascular dynamicics. In previous studies, the Leiden group represented by Baan en Steendijk et al. already gained world-wide recognition using Ees and Ea measurements obtained with a conductance catheter [41]. These measurements provide true and unique insights in myocardial contractility and ventricular dynamics in various cardiac disease states such as hypertrophic cardiomyopathy, ischemic cardiomyopathy, both before and after cardiac surgery [42–44]. Assessing aortic distensibility with CMR has been shown a very reliable way of assessing aortic stiffness in particular in patients with Marfan's disease [45–47]. Measuring aortic stiffness might of course also be of interest in patients with ischemic cardiomyopathy and it is interesting to notice that the authors found a significant correlation between aortic distensibiltiy and maximum oxygen consumption. In addition, patients with systolic heart failure showed markedly reduced distensibility of the proximal aorta. Lastly, all patients were subjected to metabolic exercise testing which is rather unique for a population with ischemic cardiomyopathy and advanced heart failure, allowing the assessment of oxygen uptake kinetics in these patients [48–50]. Although the clinical implication and integration of this approach has to be awaited because of the sophisticated methodology used, this study adds unique physiological information on the ventricular dynamics in patients with ischemic cardiomyopathy.

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