Cardiac magnetic resonance imaging in heart failure: The added value of tissue characterization

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Related article
by Ojrzyńska-Witek et al.

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The article by Ojrzynska-Witek et al. [1] published in this month's edition of the journal showcases the abilities of cardiac magnetic resonance (CMR) in modern cardiology. The authors evaluate using CMR in heart failure of unknown etiology. A retrospective analysis of 243 patients referred for CMR for this indication resulted in a new diagnosis in nearly 40% of cases and changing management in 17%. Seven percent of patients were discovered to have myocarditis, 5% restrictive cardiomyopathy, 3% left ventricular non-compaction, and 3% end-stage hypertrophic cardiomyopathy. In 10% of patients, a previously undiagnosed myocardial infarction was discovered, and in 2%, a valvular heart disease.

Heart failure is a clinical syndrome due to a structural and/or functional abnormality of the heart [2]. The diagnosis of heart failure is based on the presence of clinical symptoms and signs; however, the diagnosis of the structural and/or functional substrate is based on cardiovascular imaging. The first-line imaging modality is echocardiography [3]. Echocardiography has the benefit of easy access; it is less expensive, more portable, available in more countries, and more tolerated by the patient. Echocardiography, therefore, makes an appropriate modality for emergency presentations, urgent assessments, screening, or the investigation of patients with concomitant valvular heart disease. CMR is an appropriate tool for non-urgent assessment, for subjects with challenging echocardiographic windows, and for the diagnosis of heart failure etiology in cases eluding echocardiography.

CMR has the advantage of allowing precise quantification of myocardial volumes and contractility, which is highly relevant when left ventricular ejection fraction is the parameter that most strongly guides heart failure interventions. It is a widely applicable technique, with the advantage of no ionizing radiation. However, technical limitations require scan times of 30 to 45 minutes and may cause difficulties in patients with arrhythmia. It is contraindicated in those with MR unsafe devices. CMR may be considered as a screening test, where precise volume quantification is useful to uncover subtle deficits in contractile dysfunction; however, its cost in comparison with an echocardiogram must be considered when it is used widely.

CMR's unique advantage is, however, that it interrogates myocardial tissue, for which there is an ever-expanding toolkit of techniques. Late Gadolinium imaging in CMR revolutionized the field: the pattern of enhancement allowed the differentiation of infiltration, infarction, edema, and other causes of myocardial dysfunction [4]. As a common pathway for different forms of heart failure is fibrosis, late gadolinium imaging would seem ideally suited to making a diagnosis, while location and burden of scar can predict mortality and heart failure hospitalizations. By gauging the volume of infarcted myocardium by late gadolinium imaging, myocardial viability for revascularization in the setting of ischemic cardiomyopathies can be assessed. Late gadolinium imaging together with assessment of inducible ischemia also play an important role

in diagnostic and prognostic evaluation of patients with heart failure with preserved ejection fraction [5].

In recent years, mapping techniques have further expanded the range of diagnoses that can be assessed with CMR [6]. T1 mapping and extracellular volume quantification allow evaluation of inflammatory or infiltrative conditions, aiding diagnosis and assessing prognosis or guiding treatment. T1 mapping can discriminate reliably between amyloidosis, Anderson-Fabry, or other infiltrative conditions affecting the whole myocardium without the need for contrast administration. Accurately determined left ventricular mass, together with late gadolinium imaging, detected fibrosis, and native T1 values predict prognosis in patients with heart failure with preserved ejection fraction [7]. T2 mapping is sensitive to edema, therefore, helpful in acute pathology; it can also help with the diagnosis of MINOCA or prognostic evaluation of acute myocarditis [8]. T2* mapping is sensitive to the iron content and can demonstrate myocardial iron deposition in hemochromatosis or acute myocardial hemorrhage in infarction, again guiding treatment and giving useful prognostic data.

Research is increasingly focused on methodology to make CMR scans quicker, improve processing, eliminate the need for contrast administration and remove limitations around breath-holding or arrhythmia, and the field continues to evolve. The introduction of artificial intelligence has allowed for more automation in the analysis process and, in the future, will allow nuancing of the analysis of mapping data beyond the capability of the human eye.

Ultimately, CMR's utility as a "one-stop shop", with the unique ability to offer myocardial tissue characterization in addition to accurate chamber quantification, detection of inducible ischemia, and valvular or structural heart disease, can save patients undergoing multiple diagnostic procedures. The key steps in heart failure diagnosis, the assessment of left ventricular systolic function and determination of etiology, can be reliably performed using one technique. The article by Ojrzynska-Witek et al. [1], as well as a wealth of emerging evidence, demonstrate that the added value of CMR in all types of heart failure (with reduced, mid-range, or preserved ejection fraction) derives from myocardial tissue characterization.

Article information

Conflict of interest: None declared.

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