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

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

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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. They evaluate the use of CMR in heart failure of unknown aetiology, a retrospective analysis of 243 patients referred for CMR for this indication showing a new diagnosis in nearly 40% of cases and changing management in 17%. 7% 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 easily 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 aetiology in cases eluding echocardiography.

CMR has the advantage of allowing precise quantification of myocardial volumes and contractility: highly relevant when left ventricular ejection fraction is the parameter which most strongly guides heart failure interventions. It is a widely applicable technique, with the advantage of no ionising radiation, however technical limitations mean scan times of 30 to 45 minutes, difficulties in patients with arrhythmia and it being contra-indicated 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 the cost implication over an echocardiogram must be considered when it is used widely.

CMR’s unique advantage is, however, that of myocardial tissue interrogation, for which there is an ever-expanding toolkit of techniques. Late Gadolinium imaging in CMR revolutionised the field: the pattern of enhancement allowing the differentiation of infiltration, infarction, oedema 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 diagnosis, while location and burden of scar can predict mortality and heart failure hospitalisation. By gauging the volume of infarcted myocardium by late gadolinium imaging, myocardial viability for revascularisation in the setting of ischaemic cardiomyopathies can be assessed. Late gadolinium imaging together with assessment of inducible ischaemia 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 which 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 reliably discriminate 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 oedema, therefore helpful in acute pathology and can help diagnosis of MINOCA or prognostic evaluation of acute myocarditis [8]. T2* mapping is sensitive
to iron content, and can demonstrate myocardial iron deposition in haemochromatosis or acute myocardial haemorrhage in infarction, again guiding treatment and giving useful prognostic data. Research is increasingly focussed on methodology to make CMR scans quicker, improve processing, eliminate the need for contrast administration and remove limitations around breathholding or arrhythmia and the field continues to evolve. The introduction of artificial intelligence has allowed for more automation of the analysis process and in future will allow nuance to be brought to the analysis of mapping data beyond what the human eye is capable of.

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

REFERENCES


