Role of Cardiovascular Magnetic Resonance in Takotsubo Cardiomyopathy

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KEYWORDS

• CMR • Takotsubo cardiomyopathy • Apical ballooning syndrome

KEY POINTS

- Cardiac MRI (CMR) has become an important tool in the diagnosis of cardiomyopathies.
- CMR is a unique tool for further evaluating and characterizing patients with takotsubo cardiomyopathy (TTC) and studying the underlying causes and pathophysiologic mechanisms of TTC.
- Using CMR, regional wall motion abnormalities, right ventricular (RV) involvement, intraventricular thrombi, and reversible myocardial injury (inflammation or ischemic edema) or irreversible myocardial injury (necrosis or fibrosis) can be detected in patients presenting with TTC.
- CMR imaging can distinguish between acute myocardial infarction (AMI) and TTC.

INTRODUCTION

CMR has become an important tool for the evaluation of cardiac diseases. In the clinical setting, CMR is frequently used in the diagnosis of ischemic heart disease and, increasingly in the recent years, in the diagnosis of congestive heart failure/cardiomyopathies.[1] Advances in scanner hardware and novel pulse sequences continue to improve and to expand the diagnostic utility and capability of CMR. The advantages of CMR include the lack of radiation, the variety of tissue contrast mechanisms, and the ability to image the heart in any arbitrary direction. A comprehensive CMR study enables evaluating cardiac structure, function, tissue characteristics, perfusion, and scarring or fibrosis.

Because the underlying pathophysiology of TTC is not yet elucidated, CMR is a unique tool for further evaluating and characterizing patients with TTC, obtaining possible explanations of the underlying cause and pathophysiologic mechanisms, and distinguishing TTC from other cardiac diseases. CMR can accurately visualize regional wall motion abnormalities and allows precise quantification of RV and left ventricular (LV) function. Furthermore, during a CMR study, additional abnormalities can be observed (pericardial and pleural effusion, thrombi, and so forth). CMR is also helpful for distinguishing between reversible injury (inflammation or ischemic edema) and irreversible injury (necrosis or fibrosis). This distinction may be important for verifying TTC and excluding similar acute cardiac diseases, such as myocardial infarction or myocarditis.[2–4]

This article reviews advances in the diagnostic abilities of CMR for evaluating TTC.

LEFT VENTRICULAR FUNCTION AND BALLOONING PATTERN

Functional images of heart contraction throughout the cardiac cycle are obtained in multiple orientations using cine–steady-state free precession (SSFP) pulse sequences. SSFP has become the reference standard for functional cine CMR imaging because of its superior contrast between myocardium and the blood pool.[5] Conventional

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cine gradient-echo pulse sequences have poorer contrast between the blood pool and myocardium but remain useful for evaluating valvular disease due to their inherent dephasing of the regurgitant blood signal. Quantitative evaluation of cine-images provides accurate and reproducible measures of ejection fraction and cardiac chamber dimensions.[6,7] The application of parallel imaging techniques, which reduce the amount of data that need to be collected, has improved the temporal and spatial resolution of single breath-hold cine-SSFP imaging.[8] Techniques for real-time cine imaging, which enable imaging of myocardial function without ECG gating or breath-holds, have extended the usefulness of CMR to patients with cardiac arrhythmias or those who are unable to hold their breath.[9] Thus, CMR has advantages for identification of the peculiar LV form of the TTC. High precision and reproducibility have been reported for the evaluation of the form and function of the LV by CMR, and this imaging modality thus has become the reference standard.[10]

In a large TTC population of 207 patients examined with CMR, within a median of 3 days after presentation, 3 different patterns of LV wall motion abnormalities could be identified.[11] In this CMR study, the majority of the patients (82%) showed apical ballooning with apical akinesia and basal hyperkinesia (**Fig. 1**), whereas 17% of the patients presented with midventricular ballooning and midventricular akinesia, normal motion of the apex, and basal hyperkinesia (**Fig. 2**) and 2 patients (1%) showed an isolated basal ballooning with normokinesia or hyperkinesia of the other LV segments (**Fig. 3**). The frequencies of these wall motion abnormality patterns vary from study to study and it is not clear whether this is related to different patient populations or an effect of the different imaging modalities. In the German Tako-Tsubo Registry, which included 324 patients, the distribution was 64% apical ballooning and 36% midventricular ballooning. No patient with basal ballooning was included in this German registry.[12]

Many recent studies have in common that the number of patients with midventricular ballooning is increasing compared with the initial description of TTC.[13–15] It is still unclear why there are different patterns of regional wall abnormalities. No investigation could identify significant clinical differences between these different manifestations.

RIGHT VENTRICULAR INVOLVEMENT

The RV has long been the forgotten ventricle because it is difficult to assess RV function, especially by standard echocardiography owing to its

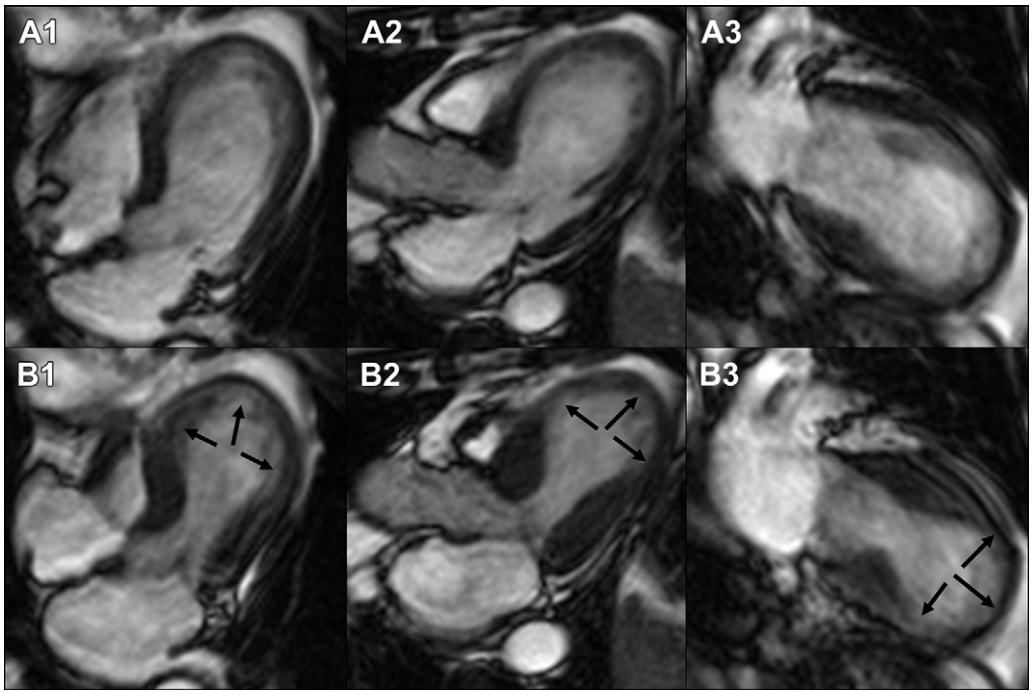

Fig. 1. Representative example of a patient with an apical ballooning. (*A*) Images of end diastole in a 4-chamber view (*A1*), 3-chamber view (*A2*), and 2-chamber view (*A3*). (*B*) Images of end systole in a 4-chamber view (*B1*), 3-chamber view (*B2*), and 2-chamber view (*B3*). *Black arrows* highlight the area of apical akinesia in the different views.