

Evaluation of Cardiac Function: Clinical Needs

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Highlights

- Assessment of ventricular structure and function plays an important role in clinical decision-making.
- Sicker, older patients provide a challenge to cardiovascular imaging.

Target audience: Basic scientists, Clinicians, Clinician-Scientists, Technologists

Purpose: This lecture will review the basic applications of CMR functional analysis, including size, thickness, and systolic and diastolic function. Challenges of imaging “real-life” patients will also be discussed.

Basic goals of a cardiovascular imaging assessment include the structure, size, and global and regional function of the cardiac chambers. Ventricular size and systolic function are key determining factors in clinical decision-making and provide prognostic information(1,2,3).

The decision to replace dysfunctional aortic and mitral valves hinges upon specified thresholds of left ventricular size and declining systolic function(4). Device implantation can also benefit from cardiovascular imaging with left ventricular ejection fraction playing a weighted role in the decision to insert automatic implantable cardioverter defibrillators(5). Assessment of regional function and strain, integrated with late gadolinium enhancement and electrocardiographic data may also assist in determining which patients might best respond to cardiac resynchronization therapy(6).

Analysis of subclinical myocardial dysfunction may play a role in management of the heart failure patient and patients with hypertrophic cardiomyopathy. Historically, many of the strain methods that are easily available require time-consuming post-processing which limits practical clinical use; however, there is the promise of newer, faster analysis schemes which may allow for more routine use of strain imaging(7,8,9).

Dobutamine stress CMR provides information regarding ischemic risk and even myocardial viability. Dobutamine regional wall motion assessment may be particularly important in patients with contraindications to the commonly used vasodilators or with concerns for contrast administration. Imaging may be performed with standard sequences such as steady state free precession, tagged imaging sequence, or more advanced methods of assessing regional strain(10,11). While the regularity with which dobutamine CMR is utilized may be dependent upon the institution, it is universally recognized that dobutamine cine CMR can provide prognostic data(12).

Right ventricular size and function also provide diagnostic and prognostic information. The 2010 modified Task Force Criteria for the diagnosis of arrhythmogenic right ventricular dysplasia incorporate information regarding right ventricular volumes, systolic function, and regional wall motion abnormalities(13). It is important to note that from an imaging standpoint, the crucial information to be defined are structural and functional findings and not related to specific tissue identification of fat or even fibrosis. Right ventricular size and systolic function are determinants of surgical intervention in patients with congenital disease, such as patients with repaired Tetralogy of Fallot, Ebstein’s anomaly, or patients with pulmonic valve disease from other etiologies (14,15).

With a growing number of heart failure patients with otherwise intact left ventricular systolic function, attention to diastolic function has gained emphasis. In general, echocardiography has dominated the diastology field as most CMR methods of diastolic assessment have proven time-consuming. CMR assessment of diastolic function is not

performed in all institutions, but the means to assess transmitral flow, pulmonary venous inflow, and myocardial velocities are available using phase contrast techniques(16). Additional assessment using tags or other means of myocardial strain or even stiffness (e.g., elastography (17)) require more advanced knowledge of the techniques and processing methods. However, as with other labor-intensive analyses, there is hope for future improvements.

One of the biggest challenges to CMR assessment has been the ability to acquire high quality data in patients who aren't straightforward when it comes to their cardiac rhythm or ability to stay in an MRI scanner for long periods of time. Sicker patients potentially have the most to gain from advanced cardiovascular imaging; however, with sicker patients come more complex issues such as patients who are not able to lie supine for prolonged periods of time, patients who present with arrhythmias, e.g., atrial fibrillation or frequent ventricular ectopy, and patients who are unable to breath-hold. Today, advances in real-time cine imaging and motion-corrected processing techniques have allowed for good quality imaging in these specifically difficult patients(18).

In summary, cardiovascular magnetic resonance provides crucial information in its basic, non-contrast structural and functional assessment of the heart. Clinical decision-making relies upon accurate and reproducible imaging--that can be performed on even the sicker patients--as well as streamlined post-processing.

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