Case-Based Studies in CMR – Ischemic Cardiomyopathy

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Definition

Ischemic cardiomyopathy is defined as significantly impaired left ventricular function in the presence of LV dilatation due to coronary artery disease.

Role of CMR in the workup of patients with suspected ischemic CMP

Ischemic cardiomyopathy is the term used to describe significantly impaired left ventricular function (left ventricular ejection fraction ≤35 to 40 percent) that results from coronary artery disease. Despite the common clinical use of the term ischemic cardiomyopathy, ventricular dysfunction caused by coronary disease is not a cardiomyopathy as defined by the 2006 American Heart Association and 2008 European Society of Cardiology statements.

There are two main pathogenetic mechanisms, which carry important implications for the possibility of corrective therapy:

1) Irreversible loss of myocardium due to prior myocardial infarction with ventricular remodeling. Recovery of myocardial function in such patients cannot be achieved by coronary revascularization since the infarcted tissue is not viable.
2) At least partially reversible loss of contractility due to reduced function of ischemic but still viable myocardium, which can be detected on imaging studies. Hibernating myocardium is typically used interchangeably with viable myocardium. However, by strict definition, the term hibernating myocardium refers to contractile dysfunction in viable myocardium that improves after revascularization or perhaps medical therapy. Stunned myocardium refers to transient postischemic dysfunction and can coexist with hibernating myocardium.

Echocardiography is used as the first line imaging modality to assess LV function. If echo is inconclusive, CMR is the test of choice.

Cardiac magnetic resonance imaging with use of bright blood steady state free precession sequences is the standard of reference for assessment of LV function. Often, multi-detector row CT angiography is also performed to assess the presence

and extent of coronary artery disease. The role of CMR overlaps with nuclear medicine techniques such as PET and SPECT. However, because of the better spatial resolution, CMR is regarded by many as superior for viability assessment. Important additional features MRI is able to detect with high accuracy are the presence of LV wall thinning and the presence and extent of myocardial scar tissue. Scar tissue can be recognized as areas of hyperenhanced myocardium visible 10-20 minutes after injection of gadolinium using inversion recovery techniques. In contrast to areas of hyperenhancement associated with viral or infiltrative cardiomyopathies, scar tissue is invariably located subendocardially, with varying degree of transmurality depending on the duration of ischemia and the extent of coronary occlusion. Areas with scar tissue contrast with areas of normal myocardium that appear dark. The transmural extent of myocardial scarring is an important determinant of treatment. If 50% or less of myocardial wall thickness is infarcted then functional recovery is likely and the affected segment is considered 'viable'. If more than half of the wall thickness is infarcted, the chance of functional recovery after revascularization is low (<20%).

Key Imaging Findings at MR in patients with ischemic CMP

- Anatomical images show LV dilatation and (regional) wall thinning.
- Cine images show regional or global hypokinesia or akinesia.
- Delayed enhancement images show the presence or absence, location and size of infarction.
- Coronary MRA (if performed) typically shows extensive disease of all three major coronary arteries.

Differential diagnosis

Key differential diagnoses to consider are:

- Myocarditis (however, no coronary artery disease; typically post-viral infection).
- Infiltrative cardiomyopathy (often presents with diastolic heart failure; typical examples are sarcoid and amyloid; non-ischemic distribution of LGE).
- Restrictive cardiomyopathy (often idiopathic; there is also diastolic heart failure)
- ARVC (predominantly affects RV, but may affect LV is small percentage of cases)
- Idiopathic cardiomyopathy (diagnosis of exclusion).

Conclusions

CMR is a highly valuable technique to assess the presence or absence of typical features of ischemic CMP.

Further Reading

Below are some references that are recommended for further reading. This is a non-exhaustive list. Many more references can be found in these papers.

1. Kwon DH, Halley CM, Carrigan TP, Zysek V, Popovic ZB, Setser R, Schoenhagen P, Starling RC, Flamm SD, Desai MY. Extent of left ventricular scar predicts outcomes in ischemic cardiomyopathy patients with significantly reduced systolic function: a delayed hyperenhancement cardiac magnetic resonance study. JACC Cardiovasc Imaging 2009;2:34-44.
2. Karamitsos TD, Francis JM, Myerson S, Selvanayagam JB, Neubauer S. The role of cardiovascular magnetic resonance imaging in heart failure. J Am Coll Cardiol 2009;54:1407-24.
3. de Haan S, Knaapen P, Beek AM, de Cock CC, Lammertsma AA, van Rossum AC, Allaart CP. Risk stratification for ventricular arrhythmias in ischaemic cardiomyopathy: the value of non-invasive imaging. Europace. 2010;12:468-74.
4. Beek AM, van Rossum AC. Use of cardiovascular magnetic resonance imaging in the assessment of left ventricular function, scar and viability in patients with ischaemic cardiomyopathy and chronic myocardial infarction. Heart 2010;96:1494-501.