Magnetic Resonance Imaging in Various Non-ischemic Cardiomyopathies

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Introduction

The cardiomyopathies include a variety of disease where the primary pathology directly involves the myocardium. Although ischemic CMP is the most common cause of heart failure in developed countries, non-ischemic CMP is not as frequent as is commonly assumed. The incidence of non-ischemic CMP is increasing in developed countries due to the aging of the population. The clinical presentation of non-ischemic CMP is variable and may be asymptomatic. Early diagnosis and management in these conditions is essential. This will discuss the merit and the potential role of CMR in the evaluation of various non-ischemic cardiomyopathies.

MR Techniques for Assessment of Cardiomyopathy

The diagnosis of CMP is established by exclusion of other cardiovascular entities and an accurate characterization of the phenotype. Treatment is guided by the stage and hemodynamic relevance of the disease and long-term follow-up after therapy is needed. Thus, imaging techniques are important in the diagnosis and therapy of cardiomyopathies.

- SSFP sequence: morphologic and functional information
- VENC: evaluation of diastolic and systolic function
- DE-MRI: identification of myocardial necrosis and fibrosis
- Myocardial perfusion MRI: presence or extent of inducible ischemia
- Spin-Echo images (T1-, T2-weighted images): identification of signal change of myocardium
- MR spectroscopy: for the evaluation of metabolic state

Clinical Impact of Cardiac MRI

Dilated Cardiomyopathy

DCM is characterized by progressive dilatation of the LV or biventricular enlargement with loss of contractile function.

- The main target of MRI
  - Differentiation from an ischemic origin (DE-MRI)
  - Prediction of functional improvement (DE-MRI)
- Advantage of CMR
  - Morphology and function: clearly delineated
  - Superior depiction of dilatation of the LV
  - Delay enhancement MRI (DE-MRI)
  - no enhancement in a majority
  - only mid-myocardium in a non-coronary pattern in some patients: prognosis is poor
  - The degree of enhancement: correlates with the severity of functional abnormality.

Figure 1. Enhancement type on DE-MRI (Alcoholic CMP)

Hypertrophic Cardiomyopathy

HCM is characterized by myocardial hypertrophy with impaired diastolic and systolic function (mainly diastolic dysfunction) due to myocardial disarray as well as patches of myoccardial scarring.

- The main target of MRI
  - To determine phenotypes such as apical form ( cine MRI using SSFP sequences)
  - Assessment of regional myocardial hypertrophy
  - To differentiate from constrictive pericarditis
  - Evaluation of post-surgical change
  - Objective monitoring and quantification after treatment

Figure 2. Typical findings of DE-MRI in patient with ischemic CMP

Restrictive Cardiomyopathy

DCM is characterized by restrictive filling and reduced diastolic size of either and both ventricles with normal or near-normal systolic function.

- The main target of MRI
  - To determine phenotypes such as myocardial infiltrative disease (Spin-echo Images, DE-MRI)
  - Identification of myocardial fibrosis (cine MRI using SSFP sequences)
- Advantage of CMR
  - Clearly depict the anatomic and functional abnormalities
  - Define myocardial infiltrative disease such as amyloidosis on the basis of typical findings on DE-MRI
  - Objective monitoring and quantification after treatment

Figure 3. Typical findings of DE-MRI in patient with ischemic CMP

Arrhythmogenic RV dysplasia (ARVD)

- Advantage of CMR
  - Regional thinning and wall-motion abnormality of right ventricle: clearly delineated
  - Detailed differentiation between myocardium, epicardial fat, trabeculae and myocardial fatty infiltration

Figure 4. Restrictive CMP due to infiltrative disease. Case (A) and T2-weighted (B) MR image shows diffuse high signal intensity at entire myocardium of right and left ventricle. Area, thickness of right ventricle is increased up to 70 mm, DE-MRI (C) nicely demonstrates diffuse subendocardial enhancement at right and left ventricle.

Stress-Induced Cardiomyopathy

- Advantage of CMR
  - Evaluation of hypokinesia at apico to mid entire wall with hypercontractile basal entire wall

Figure 5. A 19-month-old patient with Stress-induced Cardiomyopathy. Oblique PA (A) shows abnormal enlarged left heart border. Cine MR (A) reveals global right ventricular dilatation with hypokinesia. DE-MRI (C) nicely demonstrates diffuse subendocardial hyperenhancement of left ventricle (B) suggesting extensive fibrosis.

Non-compaction

Non-compaction is characterized by prominent trabeculation and recess and noncompaction/compact layers > 2.0 on end-systolic phase.

Figure 7. A 25-year-old female with LV non-compaction. Cine MRI on 4-chamber view and 2 chamber view (B) shows prominent trabeculation and recessus in left ventricle. DE-MRI (C) nicely demonstrates non-compaction layer at apex (arrow). End-diastolic image nicely demonstrates non-compaction layer at apex (arrow).

Diverticulum

- Morphology: saccular with narrow neck, Location: apex or basal
- Two types
  - muscular type: saccular with narrow neck, contractility (+), DE-MRI (-)
  - fibrous type: contractility (+), DE-MRI (+)

Figure 8. A 5-year-old boy with LV diverticulum. On routine echocardiography, LV diverticulum was suspected. Case (A) shows focal outpouching lesion at basal infero-lateral wall with narrow neck and saccular shape. Note this lesion is normal contractile during cardiac cycle. T2WI (B) shows hypointense signal on LV diverticulum (A), a hypointense signal on LV diverticulum in T1-weighted (C) suggesting muscular type.

Myocarditis

- DE-MRI
  - Enhancement predominantly in lateral wall (associated with active inflammation)
  - enhancement in 88% of patients with myocarditis
- Follow-up: decreased extent of enhancement
- T2WI: High signal intensity on involve myocardium

Figure 6. A 45-year-old female with Stress-induced Cardiomyopathy. She had experienced psychological stress, and also suffered from afebrile chondromyopathy with ARF. Cine MRI on short axis view (A) and 2 chamber view (B) shows hypercontractile basal entire wall, but contractility at basal level is well preserved. Note that there is no enhancement on DE-MRI (C). Conventional coronary angiography revealed no significant atherosclerotic lesion.

Conclusion

The understanding of various cardiomyopathies and knowledge of characteristic MR findings is provided more valuable information for the accurate diagnosis and proper management. With the advances of MRI technology and, it will more increase the role MRI for the assessment of various cardiomyopathies.