Imaging of Muscular Dystrophy Cardiomyopathy

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- Financial: None
- Off label use of Gadolinium in CMR
Muscular dystrophy (MD)

- Group of disorders causing progressive muscle weakness and wasting
- Duchenne (DMD) and Becker muscular dystrophy (BMD) are most common (over 80%), with cardiac involvement.
- Life expectancy ~ 25 yrs (15-45 yrs)
- Others: Limb-girdle, Facio-scapulo-humeral, congenital, distal muscular, myotonic, Emery-Dreifuss, oculopharyngeal
Dystrophinopathies: pathology

- DMD and BMD are X-linked disorders
- Mutations lead to absence (DMD) or reduced amount (BMD) of dystrophin protein found in muscle fiber membrane
- Dystrophin links actin in cytoskeleton and dystroglycans of the muscle cell plasma membrane (sarcolemma)
Dystrophinopathies: pathology

- Loss or reduced dystrophin destabilizes the sarcolemma causing contraction injuries.
- Repeated episodes cause necrosis, regeneration and eventually fibrosis and fatty replacement of muscle tissue.
Cardiac Disease in DMD/BMD

- Progressive, leading to ventricular dysfunction and dilation
- Pathology: cardiomyocytes hypertrophy, atrophy and fibrosis
- Majority of DMD pts have cardiomyopathy by third decade but overt heart failure may be absent
- Cardiomyopathy main cause of death in DMD
Non-invasive assessment - EKG

- Electrocardiography changes:
  - Most common: sinus tachycardia and tall R waves in V1, deep Q waves in V4-6
  - Reduced heart rate variability
  - Short PR interval
  - Conduction abnormalities
  - Arrhythmias (WPW syndrome)
Imaging: Echo

- Echocardiography findings:
  - Reduced left ventricular (LV) function: ejection fraction shortening (<25%), ejection fraction <45%
  - Akinesia/hypokinesia (posterobasilar and lateral walls of LV)
  - LV dilation, LV hypertrophy, left atrial enlargement late finding
Imaging: Cardiac MRI

- Cardiac MRI findings:
  - Late gadolinium enhancement (LGE) of subepicardial fibrosis in infero-lateral wall (most common location)
  - Eventual transmural fibrosis seen as LGE
  - Decreased LV systolic function
  - Abnormal wall motion detection (post contrast T1 myocardial tagging)- late finding
New CMR techniques, such as post contrast T1 mapping is used to detect diffuse myocardial fibrosis in DMD

Turkbey, Bluemke et al. Heart Rhythm 2012; 9: 1691-1697
CMR Protocol for Muscular Dystrophy

- Retrospective ECG-gated segmented steady state free precession (SSFP)
  - Cine FISP short axis
  - Cine FISP breath hold: vertical long axis, 4 chamber
- 2D T2 breath hold: short axis
- Gadolinium injection: 0.2 mmol/kg with 10-15 mins delay
  - 2D PSIR breath hold with optimized T1 in short axis and horizontal long axis
In DMD patients, LGE occurs early, is progressive and increases with both age and decreasing LVEF.

Segmentally, the incidence of the number of positive LGE segments increase with age and lower LVEF. Older patients and those who died during the study period had more septal LGE involvement.

The current studies suggest that the time course and distribution of LGE-positivity may be an important clinical biomarker to aid in the management of DMD-associated cardiac disease.

Hor et al. Journal of Cardiovascular Magnetic Resonance 2013, 15:107
• Early start of heart failure treatment may delay progression of LV dysfunction

  Raman, Hor et al. Lancet Neurol 2015; 14: 153-161

• Cardioprotective Agents: Diuretics, B-blockers, ACE inhibitors, Angiotensin receptor inhibitors
Myocardial fibrosis may be present, seen as LGE, even if echocardiographic evaluation is normal.


Application of CMR in MD

- Screening tool to detect patients at high risk for ventricular arrhythmias, more advanced disease with adverse LV remodeling

Predictive value of myocardial delayed enhancement in Duchenne muscular dystrophy.
Menon SC, Etheridge SP, Puchalski MD et al. Salt Lake UT
An impaired LV systolic function (LV-EF ≤45%) and a “transmural” pattern of myocardial fibrosis independently predict the occurrence of adverse cardiac events in DMD/BMD patients. Even in DMD/BMD patients with relatively preserved LV-EF (>45%), the simple and visually assessable parameter “transmural LGE” is of additive prognostic value.

Florian et al. Journal of Cardiovascular Magnetic Resonance 2014, 16:81
Summary

- CMR is an important tool in diagnosis and progression of cardiac involvement in muscular dystrophies
- LGE pattern and distribution is an excellent prognostic indicator of LV dysfunction