Cardiac MRI for the non-cardiologist. Additive or irrelevant?

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No conflicts of interest
The incremental impact of cardiac MRI on clinical decision-making.

Rajwani et al  Br J Radiol 2016; 89: 20150662

Incremental influence on diagnostic thinking – 85% cases
Incremental impact on management – 42% of cases

Figure 5. Overall incremental utility. Frequency (percent) by which incremental and clinically useful information was provided by the CMR study, defined as the presence or absence of any incremental influence on either diagnostic thinking or clinical management. AV, aortic valve; CMR, cardiac MRI; LVSD, left ventricular systolic dysfunction; LVH, left ventricular hypertrophy; RV, right ventricle; VF, ventricular fibrillation; VT, ventricular tachycardia.
In a nutshell

- CMR can image cardiac structure, function and tissue characteristics more comprehensively than any other imaging modality, it is just slower

- and compromised by arrhythmia
Cardiac MRI for non cardiologists

- Three cases,
  - One workhorse indication for CMR and where CMR sits in the diagnostic algorithm.
  - Two rare conditions with actual therapeutic options where CMR can be diagnostic
- Update on devices and MRI compatibility
Case 1: Chest pain middle aged man

- 57 yrs
- Presented in June 2018 to Acute Cardiology ward with troponin negative chest pain on limited medication.
- Allowed home with increased medication, but reviewed in clinic with on-going exertional angina symptoms on 3 anti-anginal agents
  - (Bisoprolol, Amlodipine, Ranolazine)
Options for investigation

1: Invasive angiography (+FFR)
2: Cardiac CT (+Heart flow FFR)

- Treadmill Ex ECG
- Exercise Echo
- Dobutamine Stress Echo
- Myocardial Perfusion (SPECT) Scan
- Vasodilator Stress CMR
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Anatomical

Functional
First you acquire LV Function

- Accurate assessment of overall LV function and regional wall motion abnormalities.
Patient’s Regadenoson Stress CMR

Extensive septal/inferior/lateral perfusion defect
Ischaemic cascade

Stress

Supply–demand imbalance

Systolic dysfunction

Diastolic dysfunction

Abnormal perfusion

Time

Angina

ECG changes
Comparison with post contrast imaging looking for prior infarct

Extensive septal/inferior/lateral perfusion defect

No contrast hence no infarct
Comparison with different patient showing prior infarct

No contrast hence no infarct

Sub endocardial contrast showing old inferior infarct
Gadolinium contrast in infarcts

Experimental infarct in anatomical specimen

MRI scan done ex-vivo
CE Marc study

- Entry criteria History of angina and at least one risk factor
- 752 patients enrolled
- All participants had stress MRI, and nuclear myocardial perfusion study (\(^{99m}\)Tc SPECT), and invasive angiography.
- Comparing the ability of the Adenosine stress MRI against \(^{99m}\)Tc tetrofosmin Adenosine SPECT to identify significant CAD on the angiogram
CMR
positive predictive value 77%
negative predictive value 90%

SPECT
positive predictive value 71%
negative predictive value 79%
Summary paper looking at multiple comparison studies and meta–analyses much beloved of CMR specialists

Robert C. Hendel et al. JIMG 2016;9:1338-1348
Normal post contrast image
no contrast enhancement
Patterns of contrast enhancement and associated disease processes

Transmural LGE
Ischemic DCM (transmural infarct); Sarcoïdosis*; Amyloidosis*; Myocarditis*

Subendocardial LGE
Ischemic DCM (subendocardial infarct); Sarcoïdosis*; Chagas disease*; Myocarditis*; Idiopathic DCM*

Global Subendocardial LGE
Amyloidosis

Epicardial LGE
Myocarditis; Sarcoïdosis; Chagas Disease; Postchemotherapy cardiomyopathy

Midwall LGE
Myocarditis; Idiopathic DCM; HCM*

No LGE
Takotsubo cardiomyopathy; Peripartum cardiomyopathy; Idiopathic DCM; Myocarditis

* Usually not related to a coronary artery territory; may be multifocal
* Usually at RV insertion points or within hypertrophied regions

Case 2: SOBoE in young lady

- 48 year old
- Jan 2015 progressive exertional breathlessness, abdominal bloating and mild ankle oedema. She has also noted her tongue felt too large for her mouth.
- PMHx; MGUS
- ECG sinus rhythm with normal complex size.
- No chest pain, palpitations, cough or spit
- Echo normal LV function, concentric LVH, with bi-atrial dilatation.
- NT pro BNP 1500
- Gastroscopy normal, including biopsy
Just for fun. What is the rare diagnosis

1. Andersen Fabry’s disease
2. Heart Failure with preserved ejection fraction
3. Eosinophilic myocarditis associated with Wegner's Granulomatosis (Granulomatosis with polyangiitis (GPA))
4. Cardiac Amyloid
5. Cardiac sarcoid
CMR images

Post contrast 4c

Post contrast short axis
1. Andersen Fabry’s disease
2. Haemachromatosis and iron overload cardiomyopathy
3. Eosinophilic myocarditis associated with Wegners Granlomatosis (Granulomatosis with polyangiitis (GPA))
4. Cardiac Amyloid
5. Cardiac sarcoid
Subsequent progress

2015 Feb Given chemotherapy with Dex, Cyclophosphamide, and Bortezemib (Velcade) to induce remission.
2016 April Stem cell transplant done successfully.
2019 January well and still able to cycle round Keilder reservoir
admittedly she has an electric bike for the uphills!!!
# Amyloid classification for dummies

<table>
<thead>
<tr>
<th>AL amyloid</th>
<th>ATTR amyloid</th>
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<tbody>
<tr>
<td>- due to deposition from myeloma or MGUS</td>
<td>- Not due to haematological malignancy, senile familial and racial groups, AS</td>
</tr>
<tr>
<td>- SAP scan at National amyloid centre</td>
<td>- Bone scan!!</td>
</tr>
<tr>
<td>- Prognosis remains poor, but can improve with therapy</td>
<td>- New therapies Patisiran</td>
</tr>
<tr>
<td>- Median survival now 1 year, hampered by late diagnosis</td>
<td>- Median survival up to many years</td>
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T1/T2 mapping

- All tissues have a T1 and T2 values time constants for tissue protons to return to baseline position
- Water (i.e. Oedema increases the values for myocardial muscle)
- Fat or iron decreases the value for myocardial muscle
- These new techniques give you a number which represents the myocardial value, and the number can be used to identify tissue composition.
Extra cellular volume

- Myocardial ECV can be calculated via a complex formula, which the software does for you.

  \[ ECV = (1 - \text{HCT}) \times \frac{\text{Post Gad T1 muscle} - \text{pre gad T1 muscle}}{\text{Post Gad T1 blood} - \text{Pre gad T1 blood}} \]

  Fibrosis and oedema increase ECV
  Fat decreases ECV
Case 3: Breathless middle aged man (67 years)

- Initially presented June 2015 with progressive insidious exertional breathlessness. Resulting in failure to maintain allotment. Difficulty in bending to weed.
- Ex smoker 20 yrs (52 pack years) +ve FHx CAD.
- Infrequent atypical chest pain, no orthopnoea no PND, no cough or spit.
- Spirometry, CXR, MPS, Echo all normal. ECG atrial ectopics, otherwise normal.
- CT thorax shows pericardial calcification, nil else
- Coronary angiogram, minor LAD disease (<40%).
Just for fun. What is the diagnosis?

- 1: Chronic thromboembolic disease
- 2: Paroxysmal atrial fibrillation
- 3: Anaemia
- 4: Constrictive pericarditis
- 4: Deconditioning and weight gain
Pericardial calcification on CT
CMR prominent pericardium
CMR – free breathing – ventricular interdependence

Pericardial constriction
Subsequent progress

- Underwent pericardial stripping Late 2018
- Recovered well but felt no better still had profound breathlessness and neck vein distension
- Re-scanned Jan 2018, still shows ventricular interdependence
- Somewhat improved on prednisolone and spironolactone.
Pericarditis

- Black blood looking at pericardial thickness
- STIR imaging, bright is acute inflammation
- Post contrast imaging bright is enhancement suggesting inflammation
Implantable cardiac Devices and MRI

It is possible to get an MRI scan for a patient with a device in, although it requires more effort.

Pt with device likelihood of getting an MRI scan per year = 0.32% vs 15% of age, sex and co-morbidity matched cohorts.
MRI Conditional systems

All major manufacturers produce MRI conditional systems
MRI in conditional systems
- all components being of the same manufacturer not mix and match.
- Correct scan set-up
- Programming pre and post scan
- Monitoring during scan.

NO PACEMAKERS
1.5T studies, 500 PPM and 500 ICD non conditional systems. No redundant wires.
Non thoracic MRI
No deaths.
1 ICD (incorrectly programmed for scan) needed immediate replacement.
6 cases AF/flutter, 6 partial electrical reset
Small numbers of lead parameter changes
Conclusions

- CMR adds value in most indications.
- Stress CMR has highest sensitivity and specificity for Coronary Artery Disease.
- Comprehensive CMR studies can be diagnostic in restrictive cardiomyopathies.
- Pericardium and the right heart are best imaged on CMR.
- Cardiac MRI for the non-cardiologist is now feasible to get an MRI scan on a patient with a device if you can justify MRI imaging above all others, and they do not have redundant leads.

www.NECMR.org
Thank you

Any Questions?

Everyday Life in Northumberland