The Role of Cardiac Magnetic Resonance Imaging in Assessment of Myocardial Viability

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Disclosure

Cardiac MRI delayed enhancement viability imaging is a non-FDA approved indication for use of Gadolinium based MRI contrast.
CMR- development toward clinical reality for IHD imaging

ECG gating
Carbon fiber leads
Segmented k space acquisition of data
Faster reconstruction algorithms
New pulse sequences

Hardware advances
gradients and channels
Improved coil design
Shorter bore magnet
Gadolinium contrast

Clinical validation

3.0 Tesla clinical imaging
MRI Viability Assessment

Magnetic resonance spectroscopy
Chemical shift imaging
phosphorus-31, creatine, sodium-23, and potassium-39

Wall thickness and thickening
Rest and dobutamine
10mcg/kg/min

Tissue characterization
T1 weighted spin echo
Gadolinium enhanced imaging

Beer M et al. MAGMA 13(2): 70-5
Contrast Enhanced CMR

Gadolinium shortens T1 recovery post inversion pulse
Infarct signal intensity 500% normal myocardium
Rapid imaging ↓ motion artifact (k space segmentation)
Diastolic imaging (trigger delay)
Optimal contrast (“TI”)

Hyperenhancement = Infarction

Animal Evidence

<table>
<thead>
<tr>
<th>NON-REPERFUSED</th>
<th>10 Days</th>
<th>4 Weeks</th>
<th>8 Weeks</th>
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<tbody>
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<td>4 Hours</td>
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<td><img src="image2" alt="Image" /></td>
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Fieno et al. JACC 2000; 36(6) 1985-91

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Hyperenhancement = Infarction
Human Evidence


Wu E. et al., Lancet 2001;357:21-28,
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Case

- 63 yr hyperlipidemic, diabetic male, 12 years post CABG
- Increasing nocturnal breathlessness
- Knee arthritis limits mobility

Catheterization:
- Two occluded vein grafts
- Atretic LIMA
- Occluded LCx (fills with collaterals)
- Occluded RCA (fills with collaterals)
- Severe disease (90%) LAD
Question 1
Transmural Extent Predicts Recovery
Acute Infarction

Transmural Extent of Acute Myocardial Infarction Predicts Long-Term Improvement in Contractile Function

Kelly M. Choi, MD; Raymond J. Kim, MD; George Gubernikoff, MD; John D. Vargas, BS;
Michelle Parker, MS, RN; Robert M. Judd, PhD

Choi et al, Circulation 2001; 104:1101

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Transmural Extent Predicts Recovery

Chronic CAD

Transmural Extent of Hyperenhancement

Kim et al. NEJM 2000;343: 1445-53

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Case

- 45 yr man
- Chest pain and nausea Oct 2003
- Further chest pain Dec/03
- CXR cardiomegaly and failure
- Catheterization:
  - 100% LAD, 100% LCx, 95% RCA,
  - EF 15%
- Management decisions:
  - Amount of viable myocardium?
  - Is he a candidate for a high risk revascularization attempt and if so, which vascular territory?
Question 2

Infarct % LV 34%
Infarct % LV
ceCMR
46 %
How ceCMR Compares with PET


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How ceCMR Compares with SPECT

Wagner et al, Lancet 2003; 361 :374-79

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How ceCMR Compares with SPECT

Nelson et al, JACC 2004; 43:1248-56

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Case

- 75 year old male, 12 hours chest pain, troponin elevation
- Prior inferior MI by echocardiography with at least moderate MR
- Atrial fibrillation of recent onset
- Catheterization:
  - EF ~35%, large posterolateral akinetic segment.
  - 100% RCA, a large distal posterolateral fills from LCA
  - 100% large first marginal
  - 80% diagonal
Question 3
Pre operative  8/7/2003
EDV 196ml, EF 25%, CI 2.0L/min

Post operative  9/18/2003
EDV 189ml, EF 40%, CI 2.8L/min
Thin Akinetic Segments Can Recover

End Diastolic Wall Thickness (mm)

>50%  <50%

Transmural extent of ceCMR

Shah et al. AHA November 2003

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Case

- 67 year old, diabetic with progressive fatigue
- Multiple prior PTCA/ Stent: November 2002
- Catheterization
  - diffuse 3VD and in stent re-stenosis LAD
  - Dyskinetic LAD territory, akinetic distal inferolateral wall
- MPS (another hospital)
  - ischemic inferior and mid anterior walls
  - EF 25%
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EF 33%
LVEDV indexed 92 ml/m²
SV indexed 31 ml/m²

EF 55%
LVEDV indexed 83 ml/m²
SV indexed 46 ml/m²
Case

• 66 year old presents with progressive SOB over 1 week

• Angiogram 1 year before:
  – mild AS
  – moderate 3VD
  – EF 30% with global hypokinesis
Rest TI-201

24 hour

Rest TI-201

24 hour

Rest TI-201

24 hour

Rest TI-201

24 hour

EF 19%

Question 4
Question 4

Defect extent

14% LV
Defect extent 33% LV by ceCMR
<table>
<thead>
<tr>
<th>ceCMR</th>
<th>vs</th>
<th>PET or SPECT</th>
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<tr>
<td>✔️</td>
<td></td>
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<tr>
<td>• Accurate identification of myocardial scar</td>
<td></td>
<td>• Accurate identification of viable myocardium</td>
</tr>
<tr>
<td>• Resolution</td>
<td></td>
<td>• Resolution clinically adequate</td>
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<tr>
<td>• Attenuation free</td>
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<td>• Wealth of prognostic data</td>
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<tr>
<td>• Specific for infarction/scar</td>
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<td>• Relatively inexpensive and available (SPECT)</td>
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<td>• Fast and Robust</td>
<td></td>
<td>• Jeopardized myocardium identified</td>
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<tr>
<td>• Expense and availability</td>
<td></td>
<td>• Resolution and artifacts</td>
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<tr>
<td>• Technically challenging</td>
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<td>• Time consuming</td>
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<tr>
<td>• Jeopardized myocardium?</td>
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Thank you for your interest and attention.
Animal Evidence

Normal myocardium

Acute infarction

Scar

Intact cell membrane  Ruptured cell membrane  Collagen matrix

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