DECLARATION OF CONFLICT OF INTEREST
How a Heart Failure CMR Follow-Up can Improve Patient Care

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Gadolinium Enhancement in Infarction

Ex-vivo comparison of TTC and Gd-enhanced CMR

TTC

CMR
Histology vs CMR vs SPECT: Animals

Subendocardial MI: Patient

Subendocardial MI: Patients

Unrecognised MI

Impact of Unrecognized Myocardial Scar Detected by Cardiac Magnetic Resonance Imaging on Event-Free Survival in Patients Presenting With Signs or Symptoms of Coronary Artery Disease

Raymond Y. Kwong, MD, MPH; Anna K. Chan, MBBS; Kenneth A. Brown, MD; Carmen W. Chan, MBBS; H. Glenn Reynolds, MSc; Sui Tsang, BS; Roger B. Davis, ScD
Cardiac Mortality in Unrecognised MI

Kwong. Circulation 2006; 113: 2733-43
Viability – Detection

Transmural Extent of Gd enhancement

All Dysfunctional Segments

Severely Hypokinetic to Dyskinetic Segments

Akinetic to Dyskinetic Segments

Likelihood of Wall Motion Improvement

Prediction of Global Improvement

\[ r = 0.70 \]
\[ p < 0.0001 \]

LGE and Recovery of Function

All Dysfunctional Segments

Segments with Severe Hypokinesia, Akinesia, or Dyskinesia

Improved contractility (%)

Transmural Extent of Hyperenhancement (%)

(156/199) (110/172) (60/62) (156/3) (125) (82/91) (50/71) (30/69) (6/37) (6/23)

LGE and Acute MI

A. ALL DYSFUNCTIONAL SEGMENTS

B. MODERATE TO DYSKINETIC SEGMENTS ONLY

Transmural Extent of Infarction (%)

% Segments That Improved

Choi. Circulation 2001; 104: 1101-7
LGE and Acute MI

B

$\Delta \ln EF$

Dysfunctional But Viable (%LV)

$R = 0.65$

$p = 0.002$
Thinned Wall Viability and LGE
Thinned Wall Viability

John Circulation 2004; 111: e24-25
## Resting Ventricular Volumes/ Function

<table>
<thead>
<tr>
<th></th>
<th>Pre-Op</th>
<th>Post-Op</th>
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<tbody>
<tr>
<td>EDV</td>
<td>167 mL</td>
<td>(normal 52-141 mL) 86 mL</td>
</tr>
<tr>
<td>ESV</td>
<td>127 mL</td>
<td>(normal 13-51 mL) 27 mL</td>
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<tr>
<td>EF</td>
<td>28%</td>
<td>(normal &gt;56%) 68%</td>
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Cardiomyopathies

- Dilated Cardiomyopathy
- Hypertrophic Cardiomyopathy
- Hemosiderotic cardiomyopathy
- Other cardiomyopathy
CMR Study of DCM Patients from HF Clinic

• Controls:
  – 100% had no late-Gd enhancement

• CHF patients with CAD on coronary angio:
  – 100% had late-Gd enhancement
DCM Group 1

- 59% no Gd uptake
  - True DCM no fibrosis

DCM Group 2

- 28% Mid wall Gd uptake
  - True DCM with circumferential fibre fibrosis

DCM Group 3

- 13% typical subendocardial Gd of CAD
  - Wrong diagnosis (or dual pathology)

Diagnosis of DCM

- Using angio and ECG is often incorrect
  - DCM pax may have non-contributory CAD
  - CAD pax may mimic DCM due to recanalisation
- Essential to examine the myocardial substrate
- ?Prognostic importance of fibrosis
Fibrosis in DCM: Death/hospitalization

Assomull. JACC 2006; 48: 1977
Probability of Events: LGE vs EF

Assomull. JACC 2006; 48: 1977
Hypertrophic Cardiomyopathy

CMR be used to predict heart failure
Gadolinium Enhancement in HCM

RK: 0 risk factor for sudden death,
Progressive disease. Gd 38%

Moon JCC. JACC 2003; 41: 1561-7
Fibrosis and Heart Failure in HCM

Moon JCC. JACC 2003; 41: 1561-7

No progressive disease

Progressive disease

Late enhancement %

>=2rfsd

<=1rfsd

26.5%*

*5.4% *p=0.0005
Prospective Occurrence of Heart Failure in HCM

O’Hanlon R. JACC 2010; 56: 867-74
Prospective Occurrence of Heart Failure in HCM

p=0.017

O’Hanlon R. JACC 2010; 56: 867-74
Hemosiderotic Cardiomyopathy

Important cause of heart failure

Many causes which are usually transfusion related
Thalassemia

- Commonest single gene disorder
- 1.5% carrier rate worldwide
- 60,000 affected babies born/year
- 800 patients in UK
Tissue Appearances in Iron Overload

Normal Volunteer

Severe Iron Overload
Measuring Myocardial T2*

Signal = Ke^{-\frac{TE}{T2^*}}

Anderson LJ. Eur Heart J 2001; 22: 2171-9
Kaplan Meier Curves: T2* and Heart Failure

- <6ms
- 6-8ms
- 8-10ms
- >10ms

Follow up time (days)

Proportion of patients with heart failure

Kirk P. Circulation 2009
ROC Curves for Heart Failure

Heart Failure within 1 Year

- 10ms
- 9.2ms
- 2500 ug/L
- Heart T2* ms
- Liver T2* ms
- Ferritin ug/L

Kirk P. Circulation 2009
Severe Cardiac Iron Loading: Heart T2*

Heart T2* (ms)

Months

P=0.010

Tanner MA. JCMR 2008
Severe Cardiac Iron: Combination Therapy

![Graph showing LVEF (%) over Months with EF difference 14%](image)
Change in Cardiac Death in UK Since 2000

Reduction in cardiac death by 71%

Deaths in 5 yr

1950-1954
1955-1959
1960-1964
1965-1969
1970-1974
1975-1979
1980-1984
1985-1989
1990-1994
1995-1999
2000-2004

- Unknown
- Other
- Malignancy
- Iron overload
- Infection
- BMT complication
- Anaemia

T2* CMR

>70 Worldwide Centres with T2*

Prevents up to 30,000 cardiac deaths per year
Myocardial Amyloidosis
LGE and Heart Failure Death in Amyloid

Maceira AM. JCMR 2008
Myocarditis – CMR as Technique of Choice

Presentation, Patterns of Myocardial Damage, and Clinical Course of Viral Myocarditis

Myocarditis

• CMR is the non-invasive diagnosis modality of choice
TakoTsubo – Absent Late Gadolinium

At presentation

Recovery

• Valuable for accurate phenotyping

• Visualisation of myocardial fibrosis
  – Relation to heart failure risk

• Unique in siderotic cardiomyopathy