Heart failure: Comprehensive assessment by MRI

Jeroen J Bax
Dept of Cardiology
Leiden Univ Medical Center
The Netherlands
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Heart Failure
Epidemiology

- USA:
  - > 6 million pts with CHF
  - > 500,000 new cases / year
  - > 1 million hospitalizations / year
Severe heart failure

LV function and size?

CAD: yes or no?

CAD: ischemia? viability?

Severe MR?
LV function and size?

Adapted from White et al. NEJM 1986
LV function and size?
LV function and size?
Center-line method to quantify LVEF and volumes

End-diastole

End-systole

Epicardial contour

Endocardial contour
Center-line method
to quantify LVEF and volumes
We need:
- High resolution images in every patient
- Assessment of LVEF but also
  - LV volumes: LVESV, LVEDV
- Exact quantification – prognosis but also for justification of device therapy
LV and RV function and size
LV function – advanced?
CAD: yes or no?

LCA
Whole-heart coronary MRA

42 year-old man with normal coronary arteries

Sakuma et al. Radiology 2005
• We need information:
• On the myocardium:
  – edema, inflammation, fibrosis: myocarditis, amyloidosis?
• On the LV and RV size:
  – dilated CMP, ARVC/D, non-compaction?
Myocardial disease: MRI makes the difference

Mahrholdt, Eur Heart J 2005
Dyspnea

Female 65 years

• History M Waldenstrom

• Progressive dyspnea, NYHA class 3

• Coronary angiography: normal
Suggestive of cardiomyopathy
AL amyloidosis. Pt died 3 months after diagnosis
DE Patterns

Mahrholdt, Eur Heart J 2005
Hypertrophic Obstructive CM

Myocardial fibrosis
DE Patterns

Mahrholdt, Eur Heart J 2005
Prognostic value of LGE-CMR in HOCM

N = 217 HOCM

O’Hanlon et al. JACC 2010
Male 25 years

Out of hospital cardiac arrest: ventricular fibrillation

Resuscitation, defibrillation, intubation

Medical history

• Riskfactor CAD: smoking
• 5-6 days before not feeling well, gastro-enteritis?
ECG at IC
Echocardiography day 1
Coronary angiography:

No significant stenosis, 30% stenosis on proximal LAD
MRI day 5
Echo at 5 months

- Positive IgG and IgM for HHV-6 (previous gastro-enteritis)
- No biopsy
DE Patterns

**Ischemic**
- A. Subendocardial Infarct
- B. Transmural Infarct

**Nonischemic**
- A. Mid-wall HE
  - Idiopathic Dilated Cardiomyopathy
  - Hypertrophic Cardiomyopathy
  - Right ventricular pressure overload (e.g., congenital heart disease, pulmonary HTN)
- B. Epicardial HE
  - Sarcoïdosis, Myocarditis, Anderson-Fabry, Chagas Disease
- C. Global Endocardial HE
  - Amyloidosis, Systemic Sclerosis, Post cardiac transplantation

Mahrholdt, Eur Heart J 2005
Prognostic value of LGE-CMR in myocarditis

N = 222 patients with biopsy proven myocarditis

Grun JACC 2010
Clinical case:

- 64 years-old woman referred to the hospital because of severe chest pain after an emotional stress

- No similar previous episodes or cardiovascular risk factors

- HR : 70 bpm, BP: 130/80 mmHg
- PE: no murmurs, lungs clear

Scholte et al, J Nucl cardiol 2006
Clinical case: ECG

Tp T 0.37 ng/L (normal value <0.09 ng/L)

CPK and CPK-MB negative
Clinical case:
Clinical case:
Clinical case:

Scholte et al, J Nucl cardiol 2006
Clinical case:

3 days later

1 month later
• We need ischemia demonstration to justify revascularization

• We need viability demonstration to justify revascularization
Is there ischemia?

- Angina
- ECG changes
- Systolic dysfunction
- Diastolic dysfunction
- Hypoperfusion

Systolic wall motion imaging

Perfusion imaging

Time from onset of ischemia

Schinkel et al. EHJ 2003
MRI – perfusion imaging

Stress       Rest
Is there viability?

PRE-OPERATIVE

Single Vessel Disease
Occluded L.A.D.

LVEDV 128 ml
LVESV 81 ml
LVSV 47 ml
LVEF 0.37

End-diastole
End-systole

POST-OPERATIVE

8 MONTHS

Patent Coronary By-Pass
Graft to L.A.D.

LVEDV 104 ml
LVESV 25 ml
LVSV 79 ml
LVEF 0.76

Rahimtoola SH. AHJ 1975
Revascularization versus change in LVEF

N=355 pts with LVEF <35%

Schinkel et al. AJC 2004
Is there viability?

• Clinical goal:
  - identify patients with viable tissue
  - with potential to recover function
  - to justify enhanced surgical risk
Chronic LV Dysfunction – Viability with MRI

- Akinetic but viable tissue
  - Can have contractile reserve

- During dobutamine infusion
  - Contraction improves
  - And can be visualized by MRI
Delayed hyperenhancement
Contrast-enhanced MRI – detects scar

- DE = myocardial necrosis
- Resolution allows assessment of
  - transmural extent of necrosis
Infarct (scar) imaging with delayed enhancement CMR
Severe MR?

Lancellotti et al. Circ 2003
Severe MR?

TTE

TEE
Severe MR?
3D Flow Quantification in All Valves

3D volume scan /w 3-dir velocity encoded MRI
3D Flow Quantification in All Valves

MV flow

\[ V_{\text{forward}} = 116 \text{ ml} \]
\[ V_{\text{back}} = 32 \text{ ml} \]
\[ V_{\text{eff}} = 84 \text{ ml} \]

Regurg. Fraction = 27%
Severe heart failure

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