MYOCARDIAL FIBROSIS EVALUATION

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Nothing to disclose

Pathophysiology of myocardial fibrosis

- **Myocardial fibrosis results from increased myofibroblast activity and excessive extracellular matrix deposition**

- **The detection of myocardial fibrosis relies on:**
- **Serum markers,**
- **Cardiac magnetic resonance imaging (CMR)**
- **Endomyocardial biopsy.**

Types of myocardial fibrosis

- **Replacement fibrosis**: **Irreversible** collagen deposition following myocyte **apoptosis/ necrosis**
- **Diffuse myocardial fibrosis**: **Reversible, early** collagen synthesis/deposition by differentiated myofibroblasts in response to a **variety of stimuli.**
- **Overlap** of replacement and interstitial fibrosis

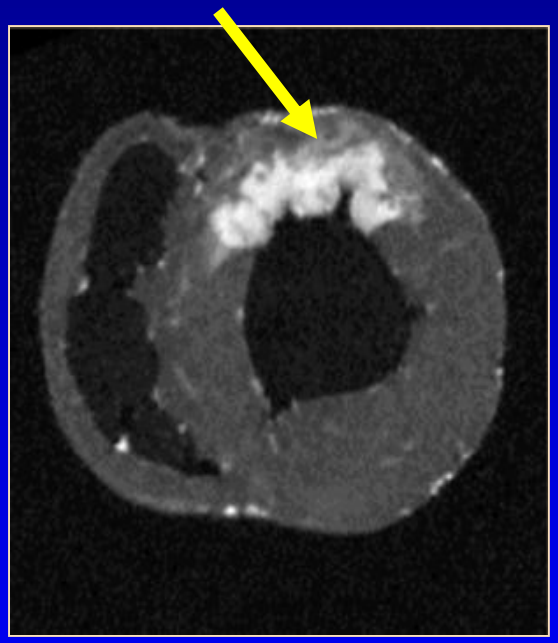
CMR in acute/chronic myocardial infarction

Contrast Enhanced MRI (Ce MRI)

- Gadolinium–chelated contrast agents (Gd) are the only licensed group of paramagnetic agents for cardiac imaging.
- Gd diffuses rapidly into the interstitial space (strictly extracellular), and is eliminated by renal clearance.
- Scar appears bright compared to normal, dark myocardium.
- CMR can visualize as low as 1 gr scar vs. 10 gr with SPECT.
- CeMRI is a robust, well validated and accurate tool to depict myocardial necrosis in both acute/old MI.

BRIGHT IS DEAD

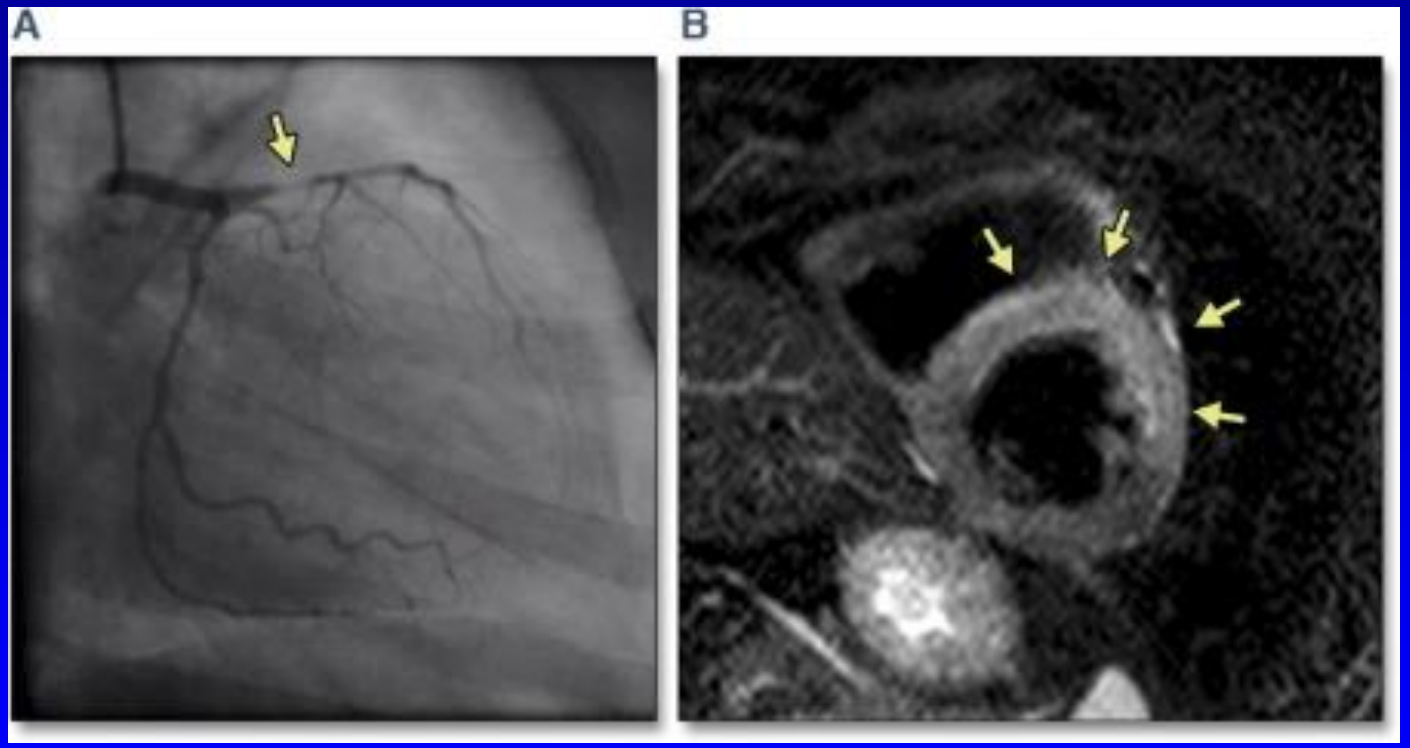
TTC



MRI

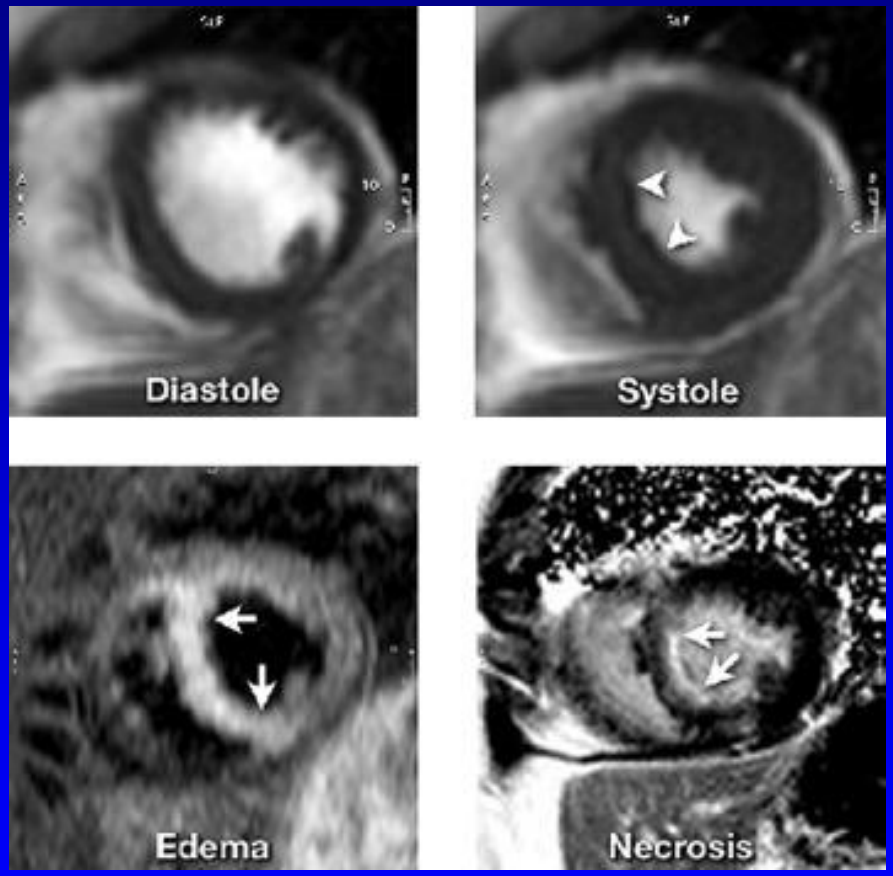
Ex vivo comparison of TTC and Gd-enhanced MRI in infarcted myocardium

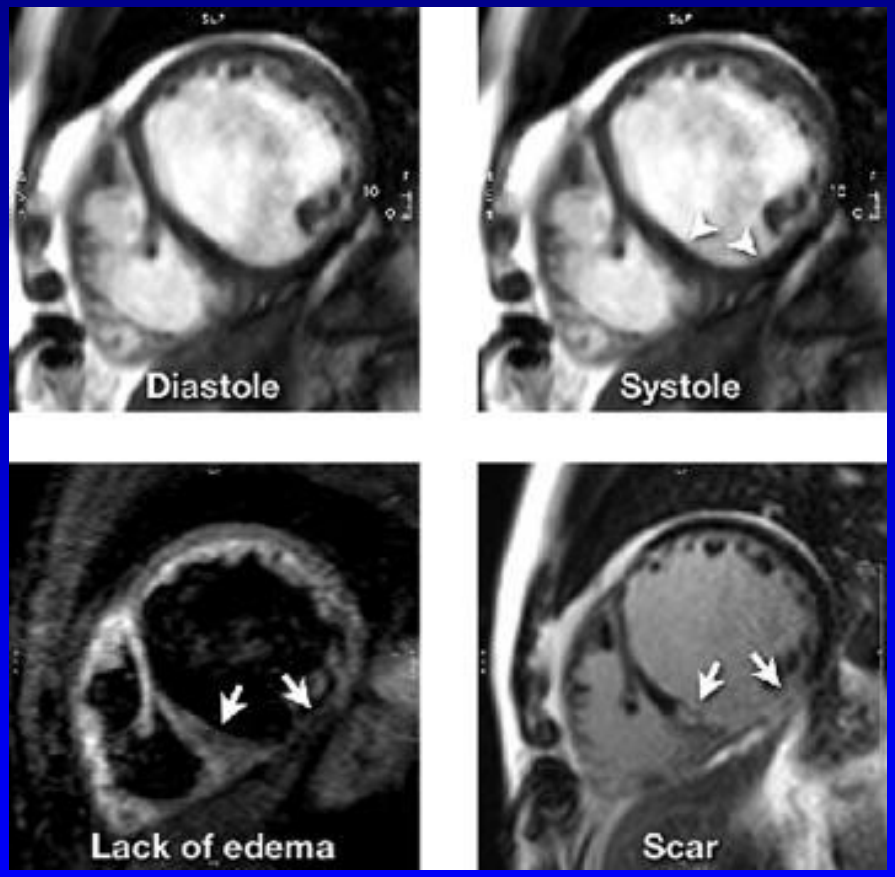
MYOCARDIUM AT RISK



Fuernau G et al JACC Cardiovasc Imaging 2011

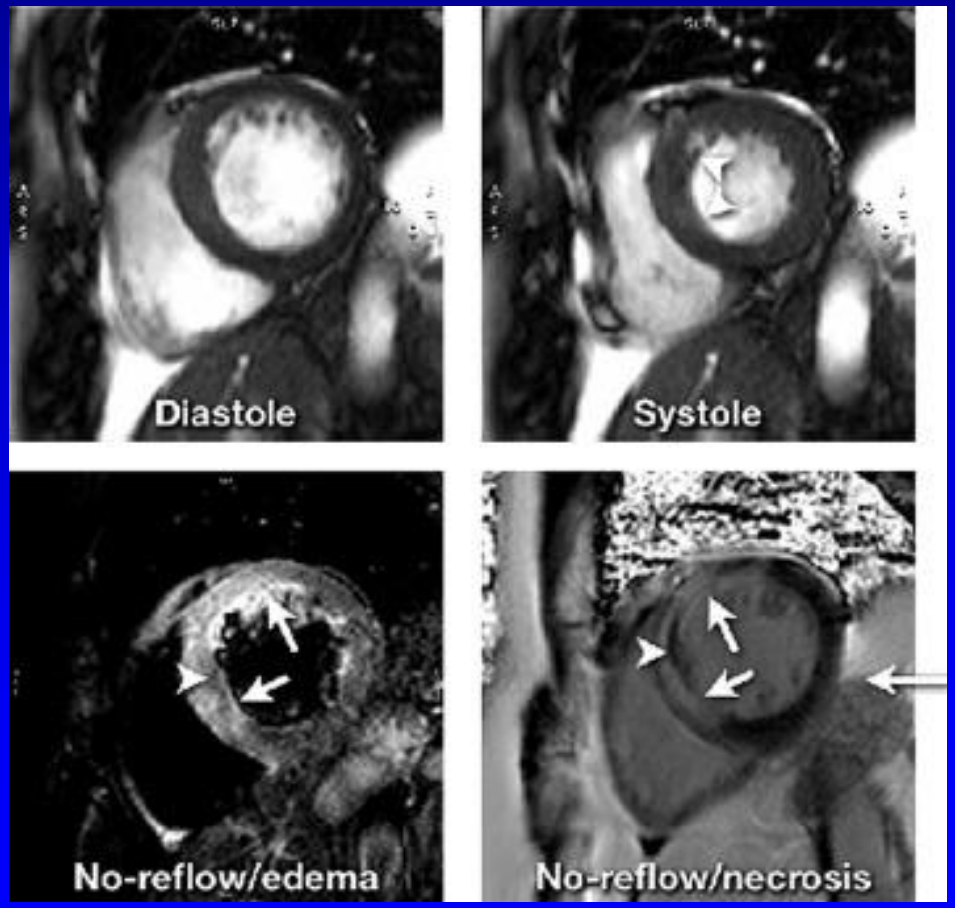
Tissue Characterization of Acute Myocardial Infarction and Myocarditis by CMR





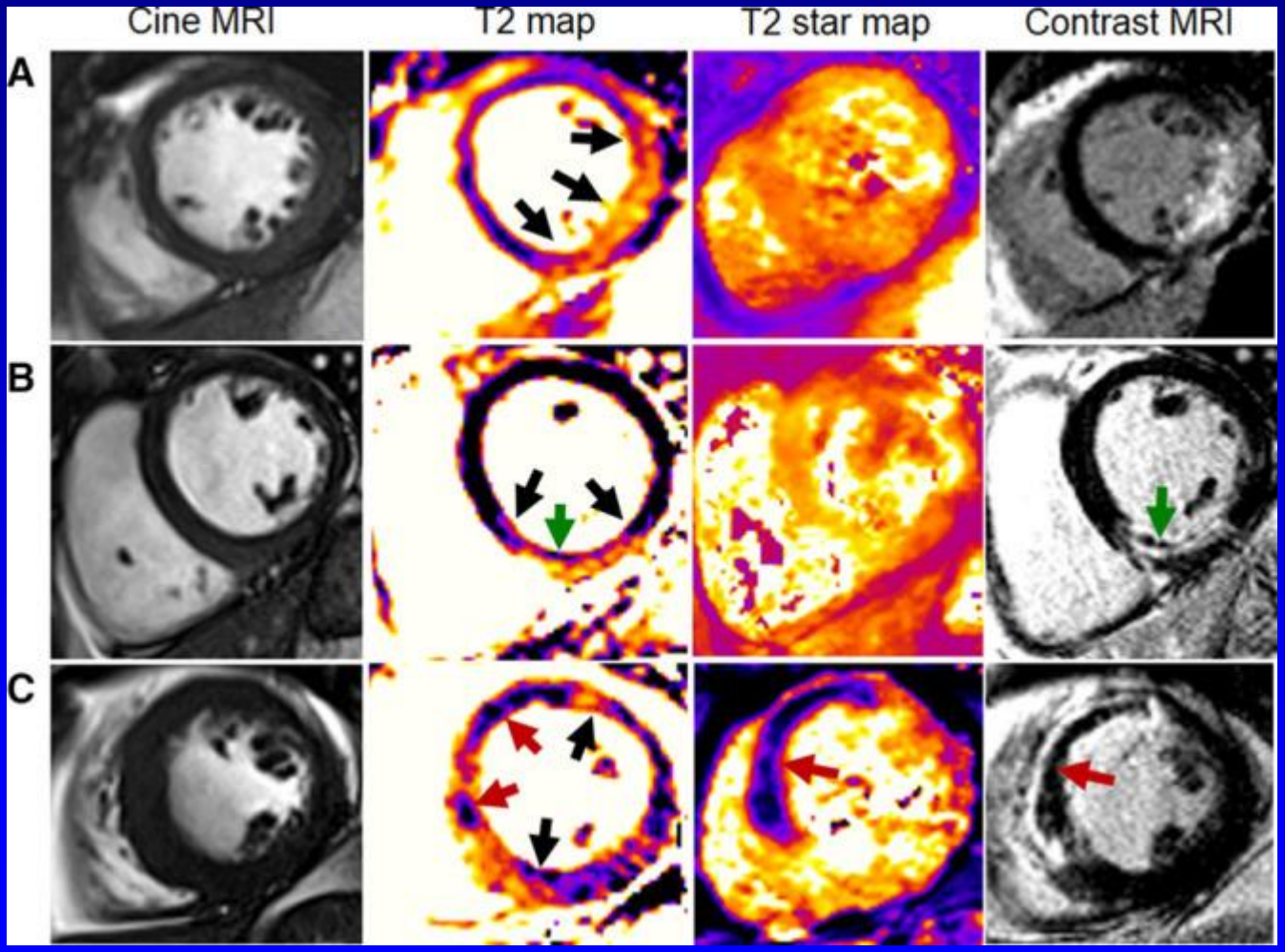
Friedrich M. JACC 2008

Transmural MI With No-Reflow in a Patient With Reperfused Infarction, Who Presented Late After Onset of Symptoms



Friedrich M. JACC 2008

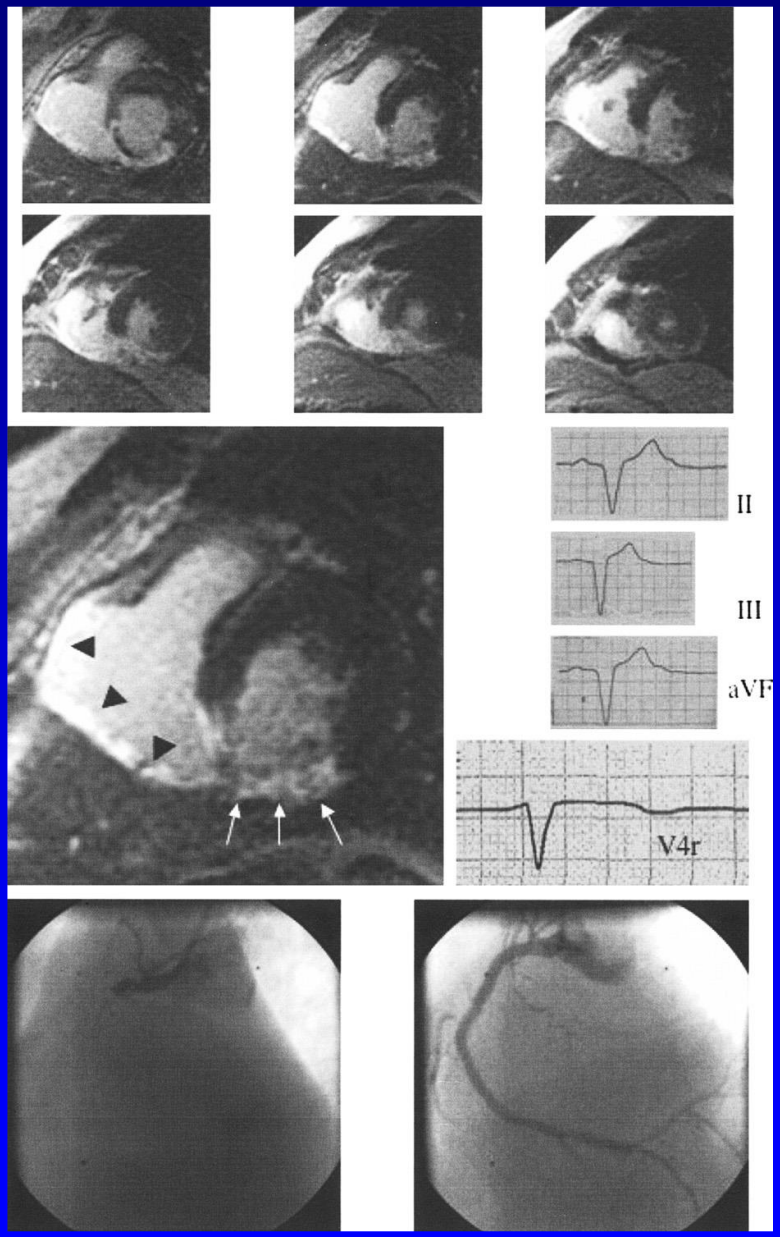
Three patients with acute ST-segment–elevation MI treated by primary PCI using the same antithrombotic strategies



- **A**, Patient with no evidence of myocardial hemorrhage or MVO.
- **B**, Patient with T2-hypointense core and MVO, in the absence of hemorrhage.
- **C**, Patient with myocardial hemorrhage

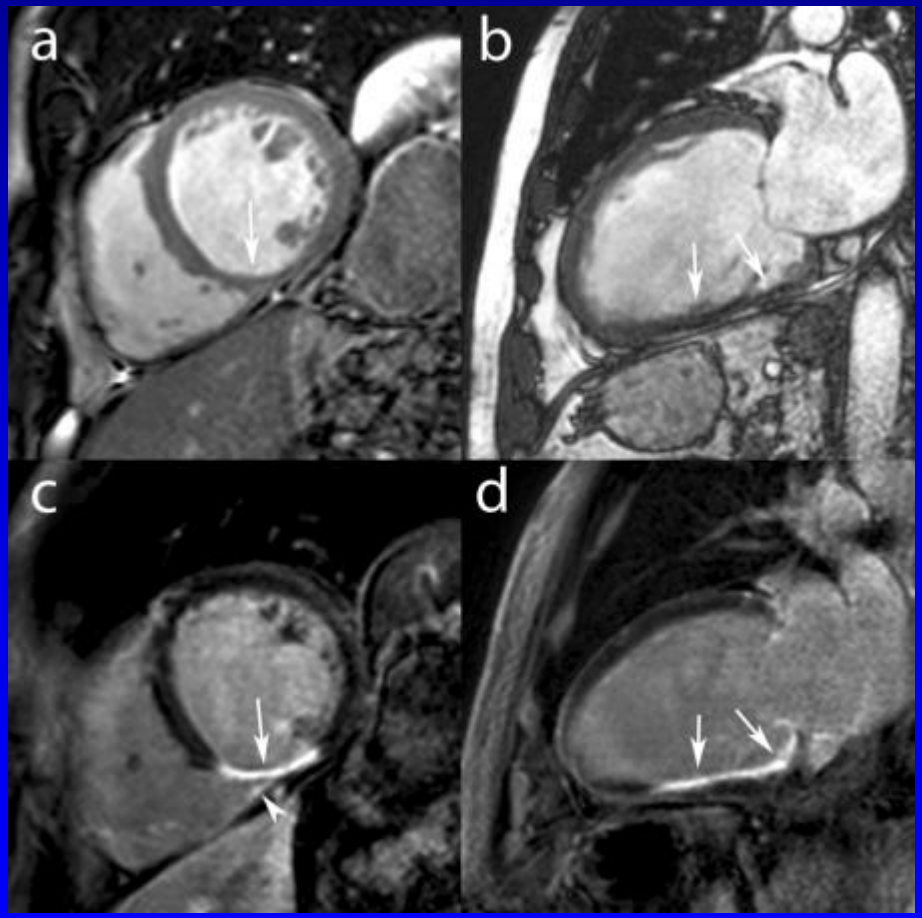
Carrick D et al. Circulation Cardiovasc Imag 2015

RV myocardial infarction



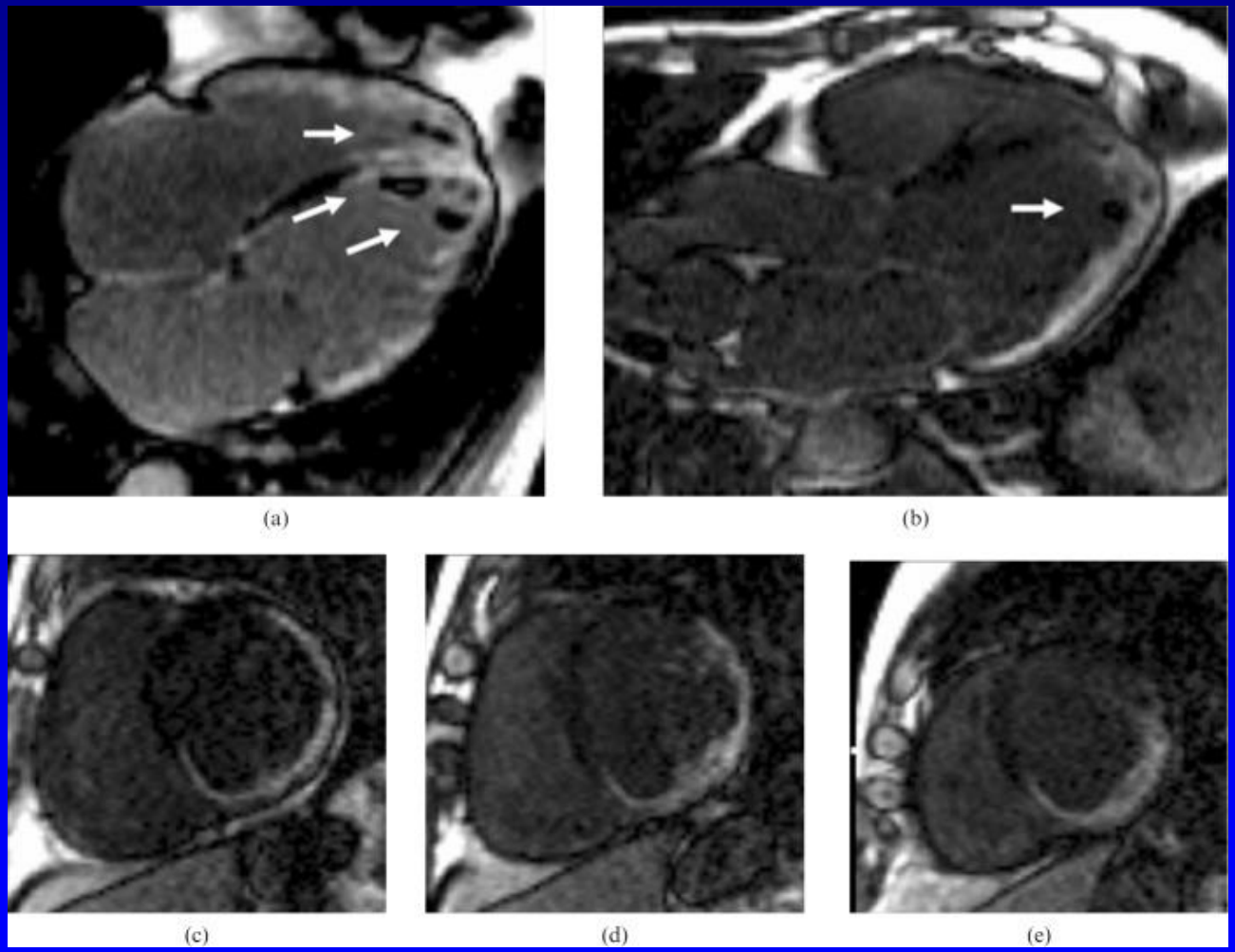
- Patient with acute inferior and right ventricular (RV) infarction on LGE. (Upper panels)
- Short-axis LEG showing contrast enhancement of the RV. (Middle panels, left).
- Enlarged short-axis view with infarction of the RV wall (black arrowheads) and the inferior left ventricle (white arrows).
- (Middle panels, right) Electrocardiogram with ST-segment elevation in V4r.
- (Lower panels) Culprit right coronary artery lesion in a right dominant perfusion pattern before (left) and after (right) angioplasty. Echocardiography revealed RV hypokinesis and dilatation.

MRI study in a 58 year old male recently diagnosed with dilated cardiomyopathy (LV EF 20%).



Florian A et al J Med Life 2011

ICM in a patient with 3VD



Quarta G et al Br J Radiology 2011

Impact of unrecognized myocardial scar detected by CMR on event-free survival in patients presenting with signs or symptoms of CAD

Myocardial scar detected by cardiac magnetic resonance imaging is the best predicting factor for patient's survival, better than ejection fraction and angiographic findings

Kwong RY Circulation 2006; 113(23):2733-43.

Effect of Posterolateral Scar Tissue on Clinical and Improvement After Cardiac Resynchronization Therapy

- CRT does not reduce LV dyssynchrony in patients with transmural scar tissue in the posterolateral LV segments, resulting in clinical and echocardiographic nonresponse to CRT.

Bleeker G et al Circulation. 2006;113:969-976

Comparison of 18F SPECT with PET in myocardial imaging: a realistic thorax-cardiac phantom study.

- For smaller defects the 99mTc/18F SPECT imaging cannot entirely replace the more expensive 82Rb/18F PET for myocardial perfusion/viability imaging, due to poorer image spatial resolution and poorer defect contrast.

Knesaurek K et al. BMC Nuclear Medicine 2006

Assessment of Myocardial Scar; Comparison Between F-FDG PET, CMR and Tc-Sestamibi.

- There is considerable variation amongst these 3 techniques in identifying scarred myocardium in patients with CAD and heart failure.
- More segments were identified as nonviable scar using MIBI than with FDG or CMR.
- We recommend that MIBI should not be used as the sole imaging modality in patients undergoing assessment of myocardial viability.

Crean A et al. Clin Med Cardiol 2009

Systematic review and modelling of the cost-effectiveness of CMR compared with current existing testing pathways in ischaemic cardiomyopathy.

- All diagnostic pathways are a cost-effective use of NHS resources.

- The cost-effectiveness analyses suggest that CE CMR and revascularising everyone were the optimal strategies.

- Future research should look at:
- implementation costs for this type of imaging service,
- provide guidance on reporting of diagnostic testing for viability
- focus on the impact of revascularisation or best medical therapy

Campbell F et al. Health Technol Assess. 2014

CMR in diffuse myocardial fibrosis

Assessment of interstitial fibrosis

- **T1 mapping: Measured without Gd, reflects the combined intracellular+extracellular compartments. Values increase with a greater burden of fibrosis and are usually measured on a per-segment basis.**

- **ECV% (percentage) and iECV (mL or mL/m^2) use Gd to target the extracellular space.**

- **Combination of CMR T1 mapping and LGE offers a comprehensive assessment of myocardial disease that is currently unmatched by any other modality**

Clinical significance of T1 mapping

T1 mapping in CAD

- In myocardial infarction T1 mapping can:

- Quantify infarct size and
- Differentiate reversible/irreversible myocardial injury

- Provide prognostic importance of native T1 and ECV in non-infarcted myocardium.

T1 mapping in DCM

- 1/3 of DCM demonstrates a non-ischaemic pattern of LGE (mid-wall or subepicardial), which is again a predictor of adverse outcomes (HF, VT)

- T1 mapping may discriminate healthy from diseased myocardium, correlating with histology.

- T1 mapping is a strong predictor of all-cause mortality and HF, death or hospitalisation, independent of standard measures of risk such as ejection fraction and functional status

T1 mapping in aortic stenosis (AS)

- The presence of both infarct and non-infarct LGE is independently associated with mortality and once established, replacement fibrosis progresses rapidly and does not regress after TAVI.

- Correlations between diffuse fibrosis parameters (native T1, ECV% and iECV) and histology;

T1 mapping in hypertrophic cardiomyopathy

- Both presence+quantity of LGE are independently associated with all-cause and cardiac death.

- The risk of SCD appears to increase with increasing LGE burden a minimum threshold for LGE volume may be of more clinical use.

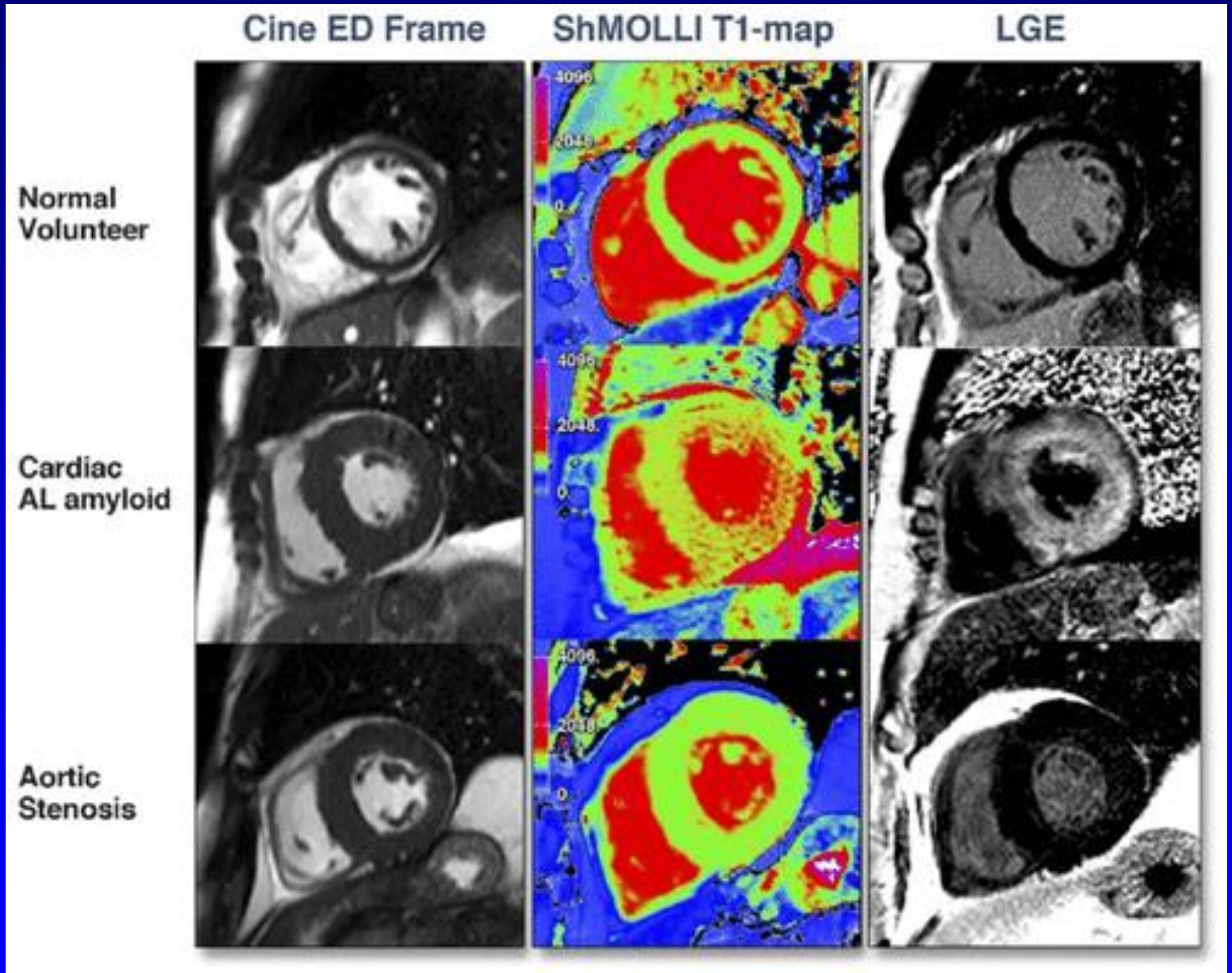
T1 mapping in myocarditis

- **Both native T1 and ECV demonstrate superior correlation with endomyocardial biopsy compared with Lake Louise criteria for the diagnosis of acute myocarditis (defined in this study as ≤14 days; area under the curve 0.77, 0.75 and 0.52, respectively).**

- **T1 mapping detects oedema and reactive fibrosis in the early inflammatory response.**
- **However, its value is diminished if symptoms >14 days.**

T1 mapping in infiltrative diseases

- **LGE in a characteristic pattern has a high sensitivity and specificity for cardiac amyloidosis as well as prognostic power for mortality.**
- **ECV% and native T1 are associated with mortality.**
- **LGE imaging is recommended in the current 2014 Heart Rhythm Society expert consensus criteria to aid in the diagnosis of cardiac sarcoidosis.**


Cine ED Frame
ShMOLLI T1-map
LGE
Normal Volunteer
Cardiac AL amyloid
Aortic Stenosis
4096
2048
0

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“USE CMR TO LEARN PATHOPHYSIOLOGY!”

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