Cardiac MRI

Kristian Fosså / Einar Hopp

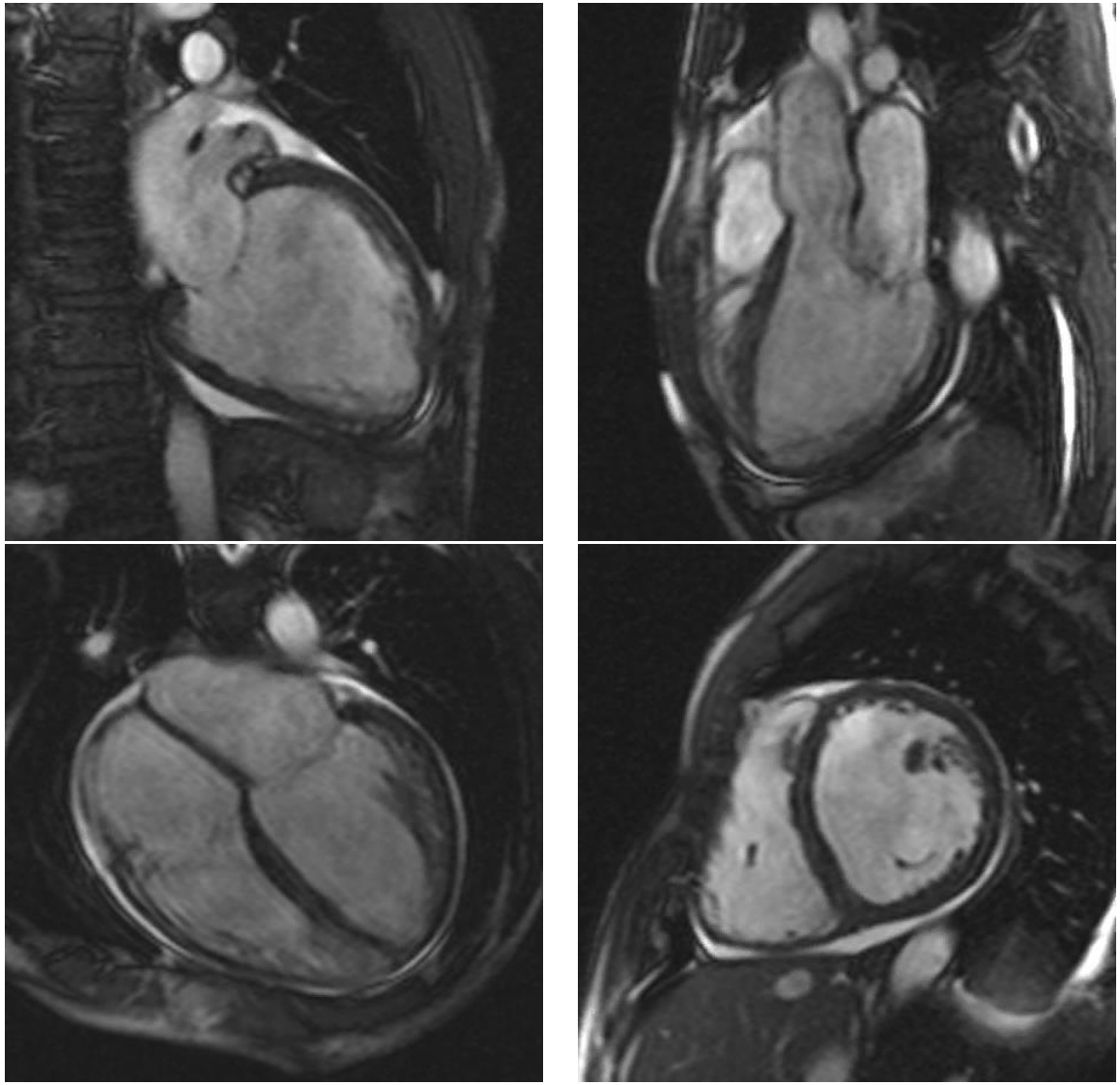
Department of radiology and Nuclear Medicine

Oslo universitetssykehus, Rikshospitalet

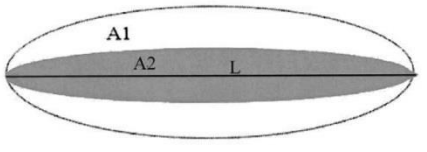
Teaching points

- Strength and weaknesses:
  - Morphology — MRI good
  - Function — MRI good
  - Coronary arteries — MRI inferior, calcification invisible
  - Myocardial characterization — good, new biomarkers coming up

MRI and function: cine imaging

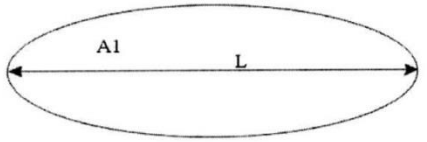


MRI: Calculation methods for global function



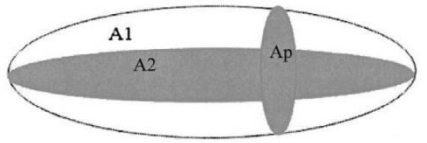
Biplane ellipsoid model:

$LVV = 8 \times A1 \times A2/(3 \times \pi \times L)$



Single-plane ellipsoid model:

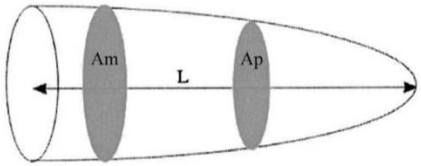
$LVV = 8 \times A1^2/(3 \times \pi \times L)$



Combined triplane model:

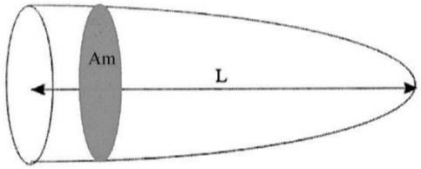
$LVV = (A1 \times A2 \times Ap)^{1/2} \times (4/3)/\sqrt{\pi} \times 0.752$

Thiele et al. 2002)



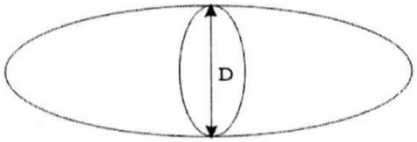
Modified Simpson Rule:

$LVV = \{Am + (Am + Ap)/2 + Ap/3\} \times L/3$



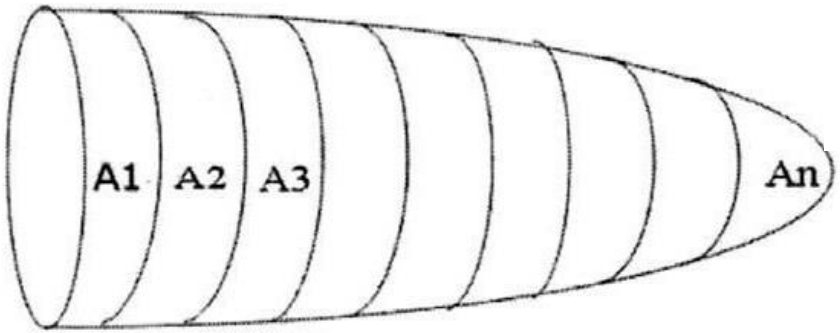
Hemisphere cylinder model:

$LVV = (Am + 2 \times Am/3) \times L/2$



Teichholz model:

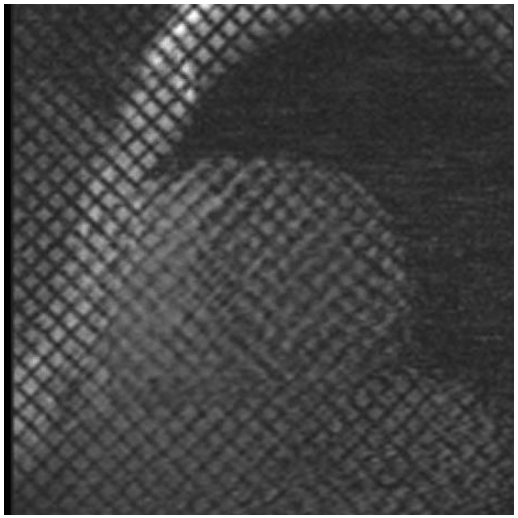
$LVV = 7 \times D^3/(2.4 + D)$

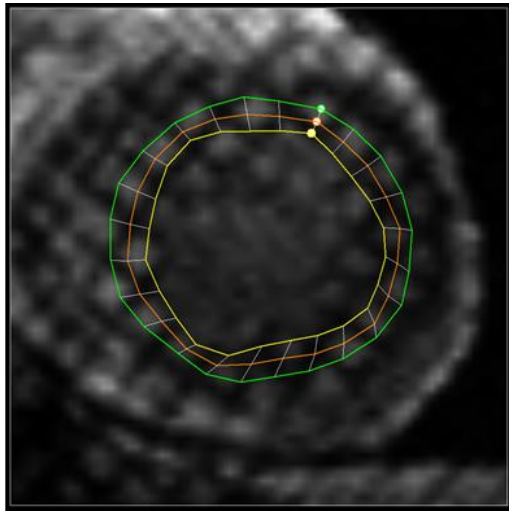


Simpsons method: short axis summation

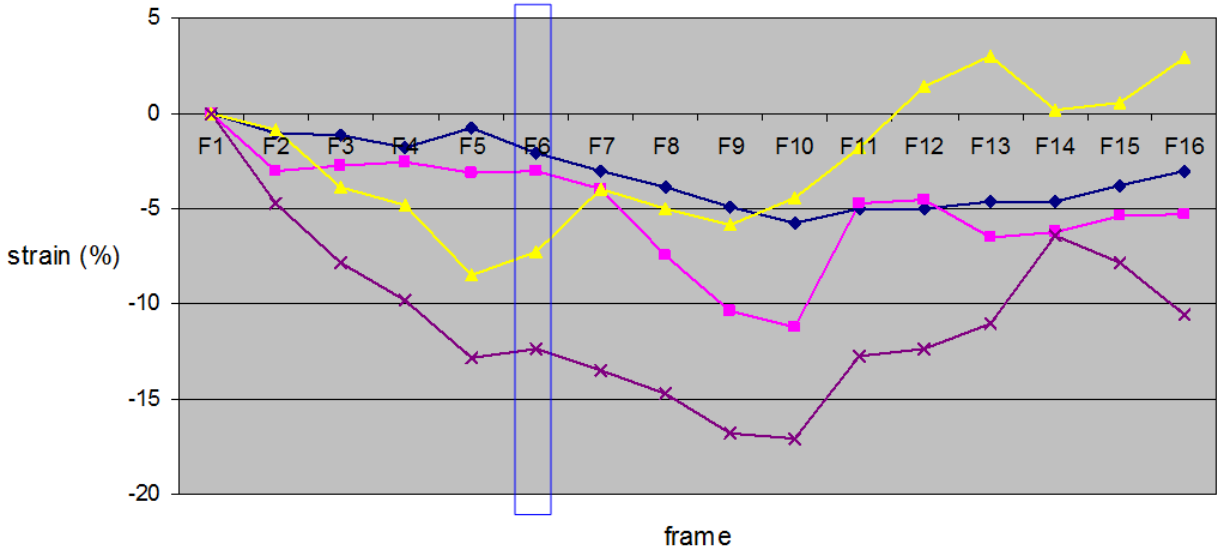
$LVV = (A1+A2+A3+....+An) \times \text{slice thickness}$

Regional function with MRI: tagging



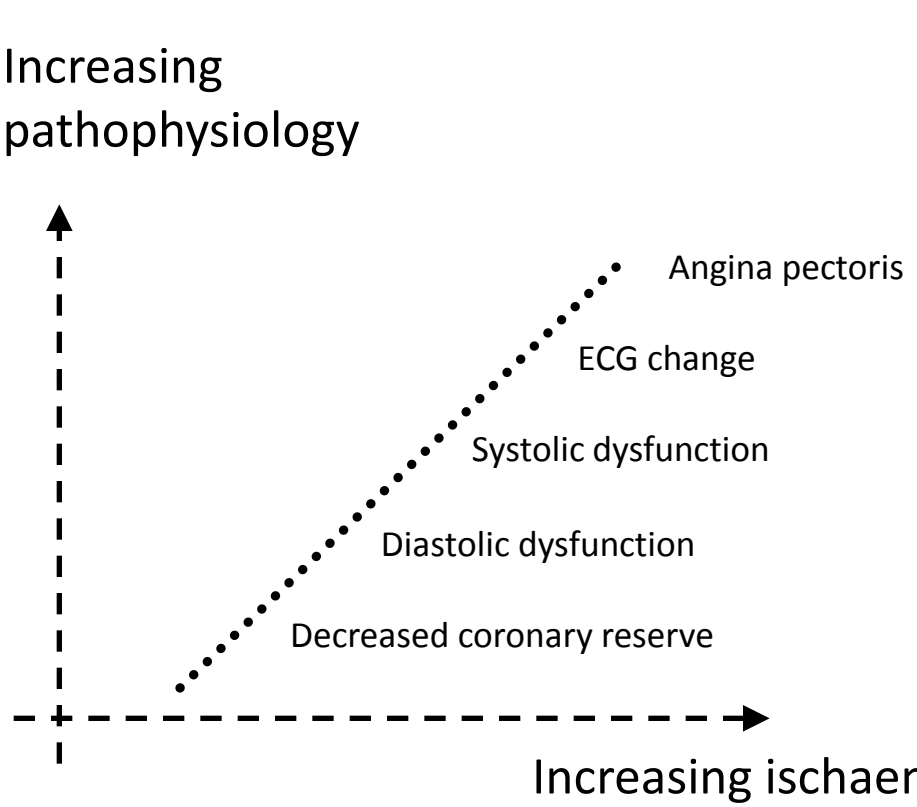


- Demagnetized grid on cine
- The grid follows myocardial motion
- Calculation of strain and twist



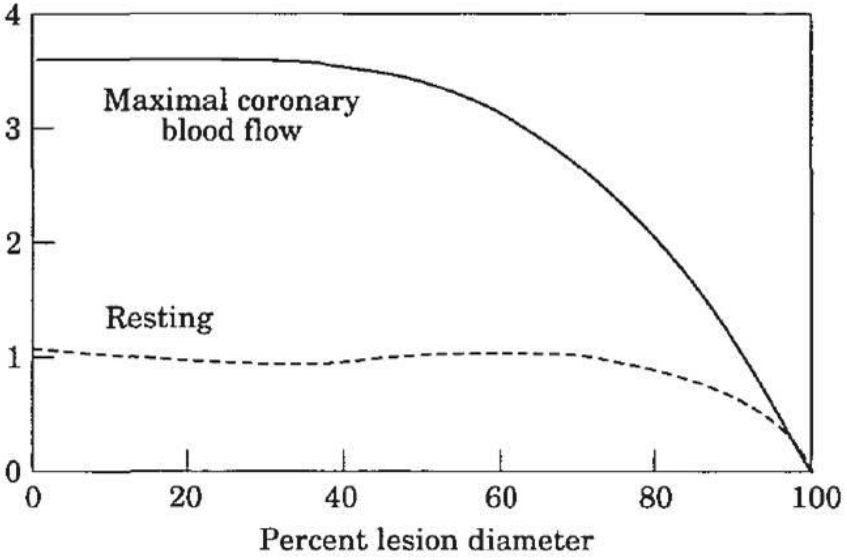
Myocardial perfusion reserve

The ischaemic cascade



Nesto, American Journal of Cardiology, 57 (1987), 23C-30C

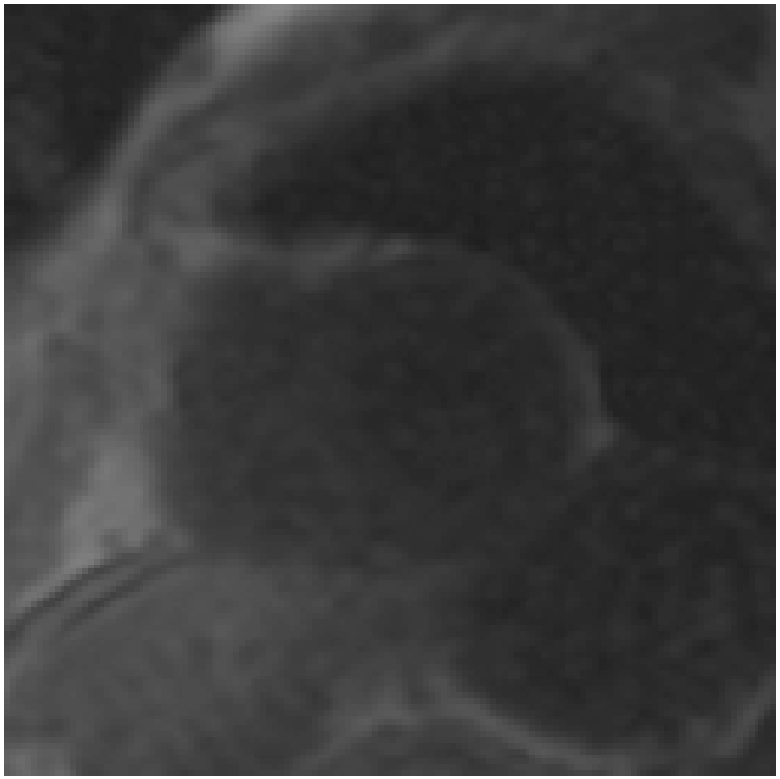
Myocardial perfusion reserve



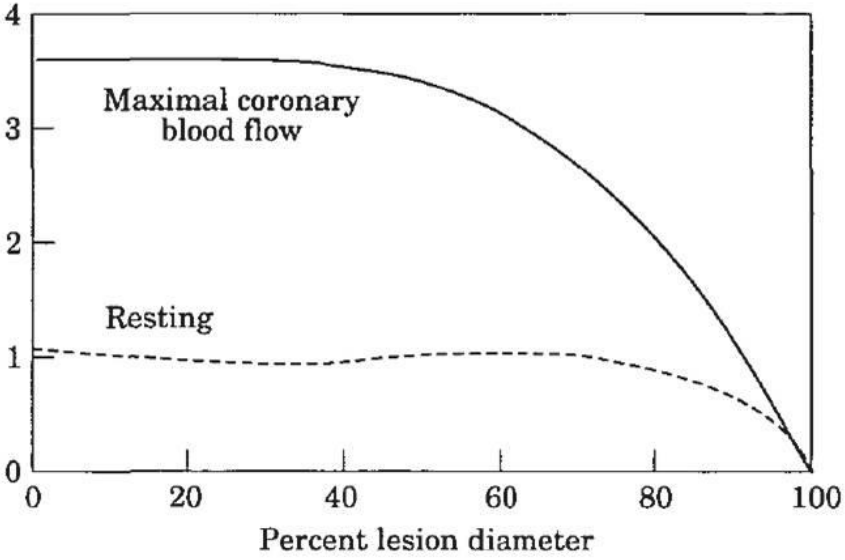
Detry, European Heart Journal, 17S (1996) 48-52
(modified from
Gould, American Journal of Cardiology, 34 (1974) 48-55)

MRI: perfusion imaging

Short axis perfusion MRI



Myocardial perfusion reserve



Detry, European Heart Journal, 17S (1996) 48-52
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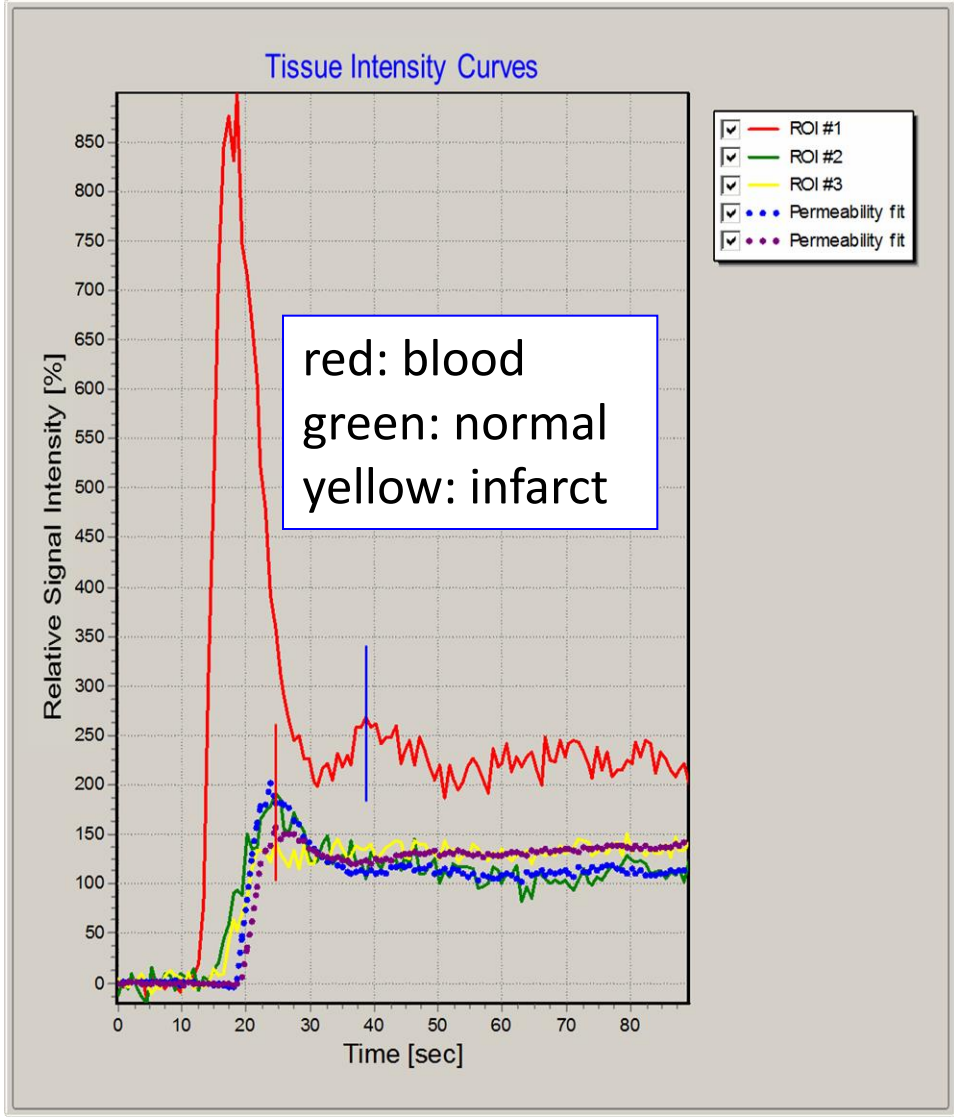
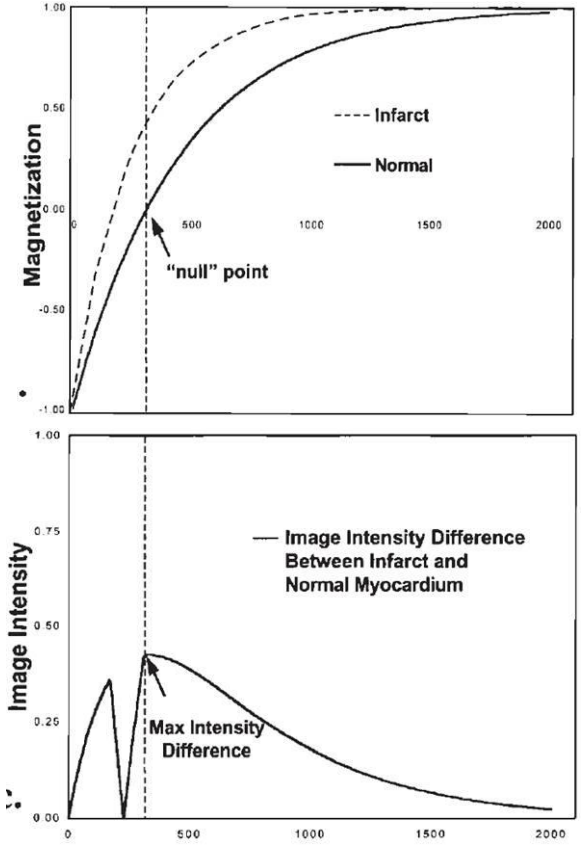
Contrast media distribution over time

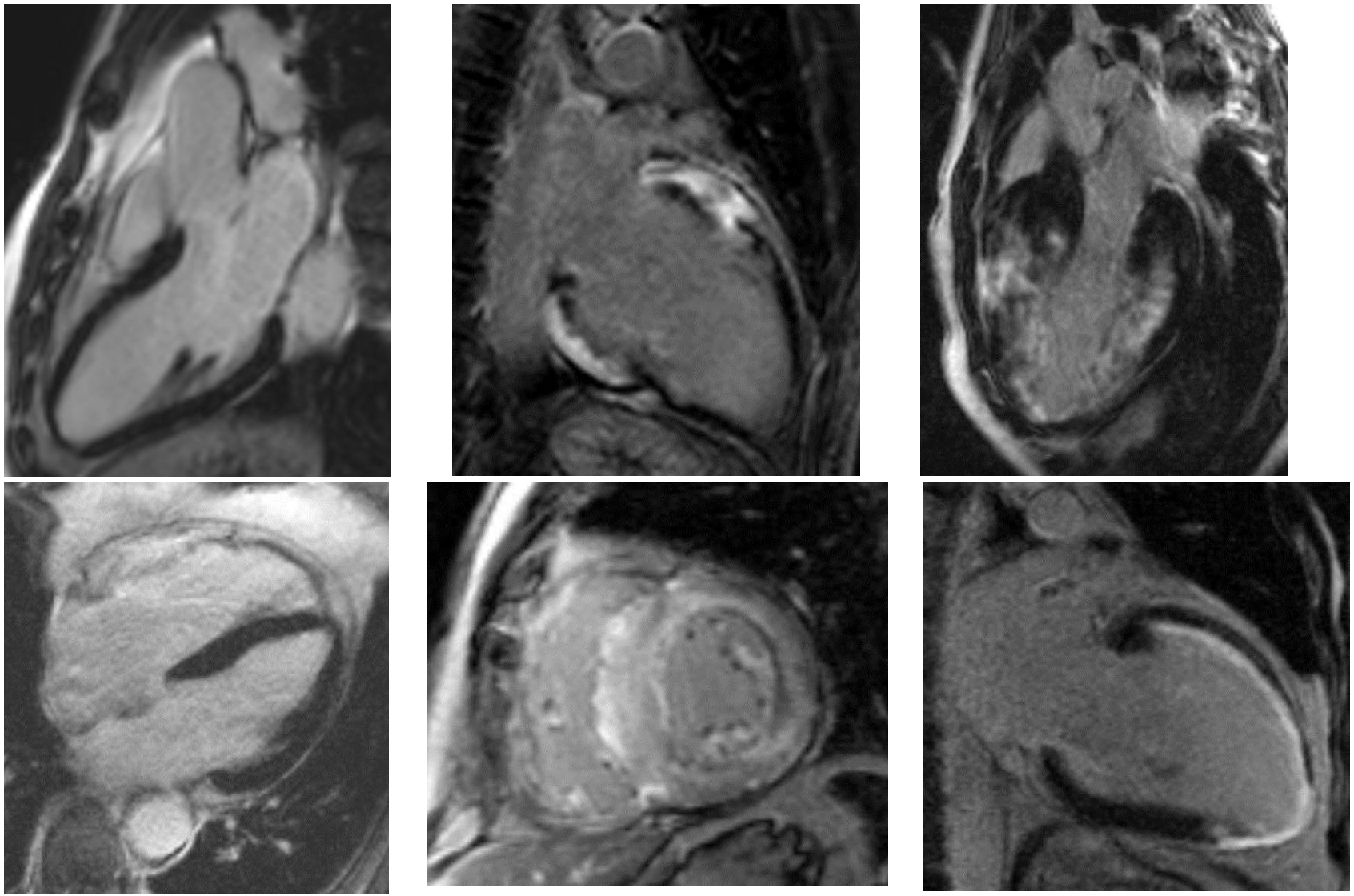




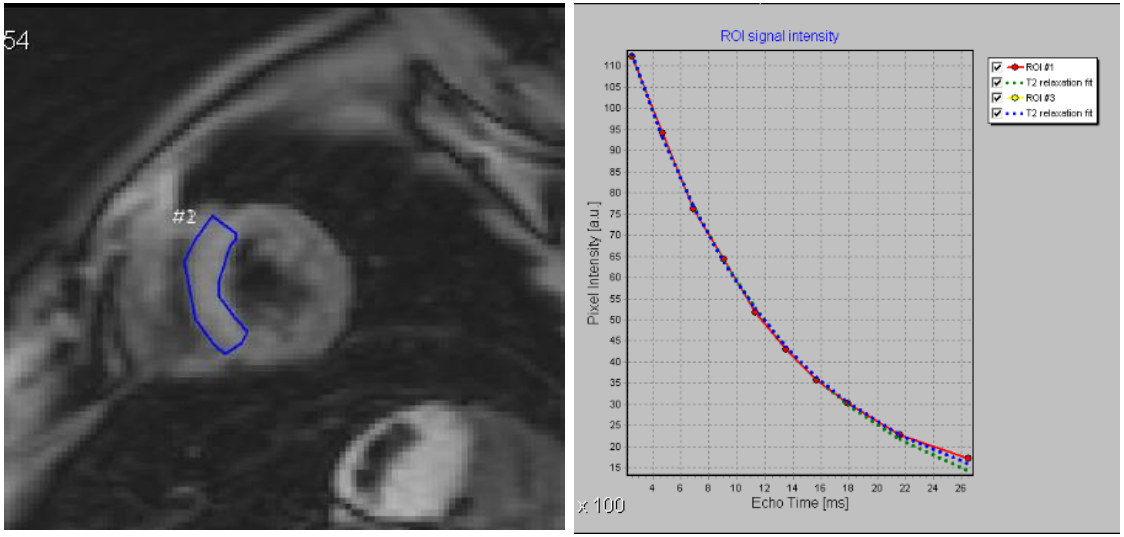
Inversion time is chosen to provide maximum greyscale contrast between infarct and normal tissue.

Kim, JCMR, 2003 (5) 505-14

MRI: Late enhancement imaging – different patterns

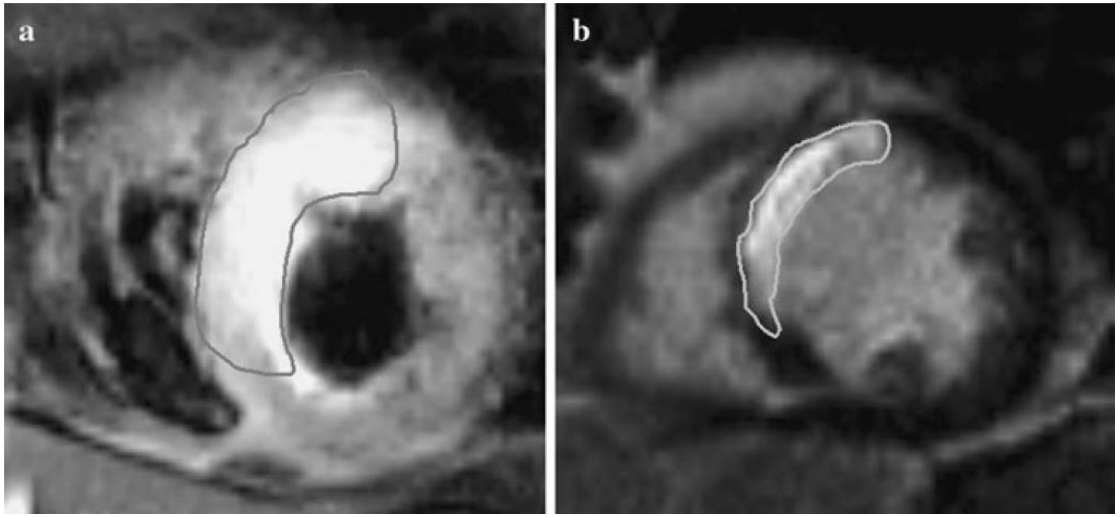


Parametric MRI: mapping of T2* and T2



T2*-measurement: 11 ms
moderate iron deposition

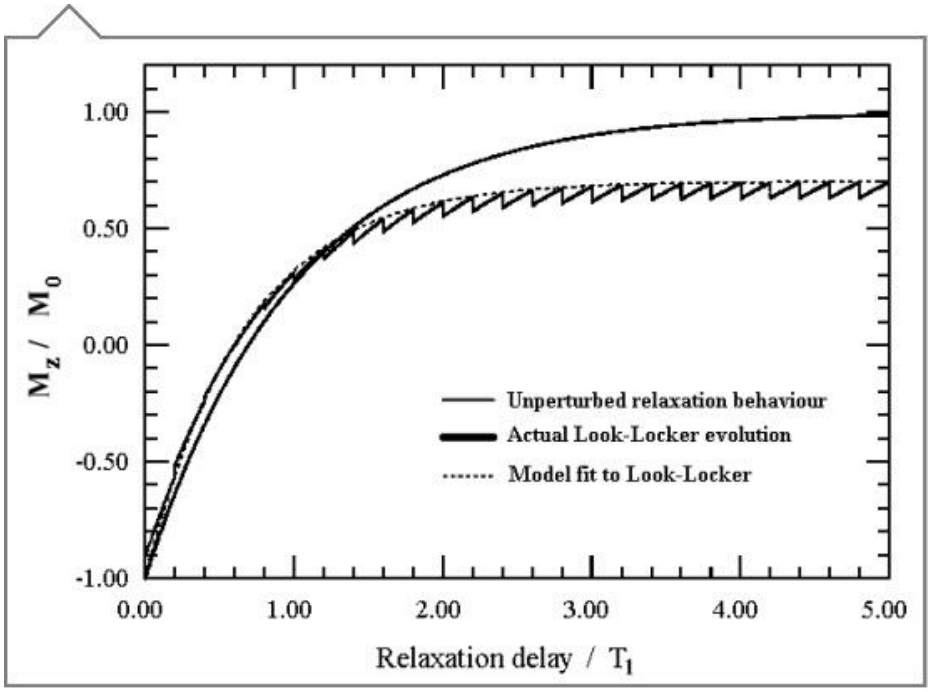
from Oliver Geier



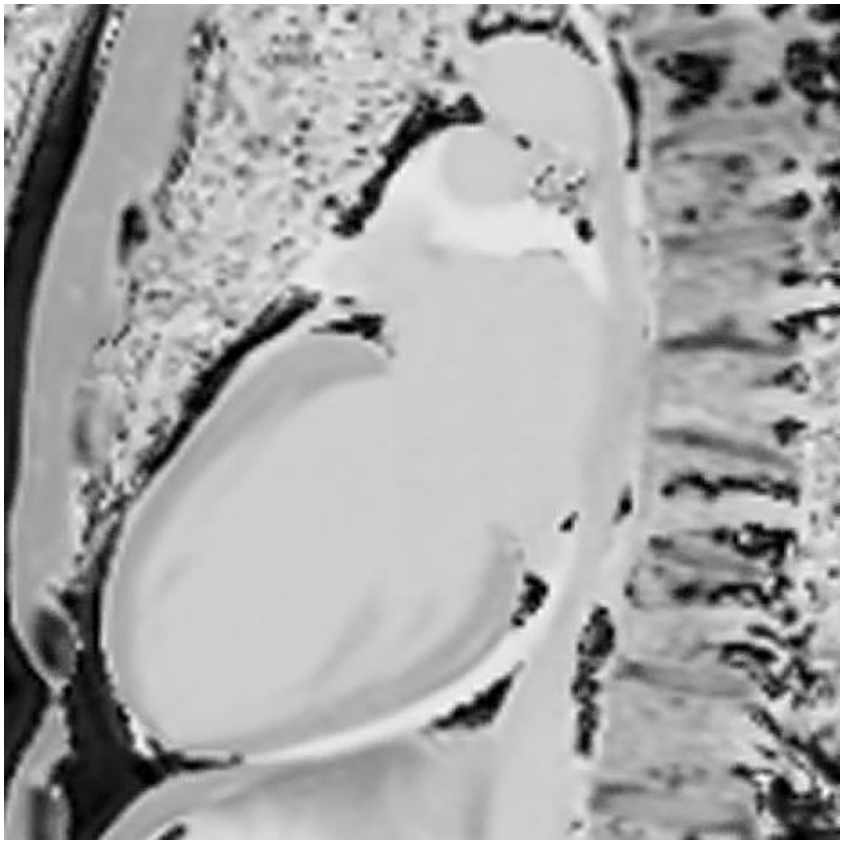
T2 mapping in acute infarct
- T2: edema
- Late enhancement: infarct
- Difference: area at risc

Lønborg et al., Int J Cardiovasc Ima 2012

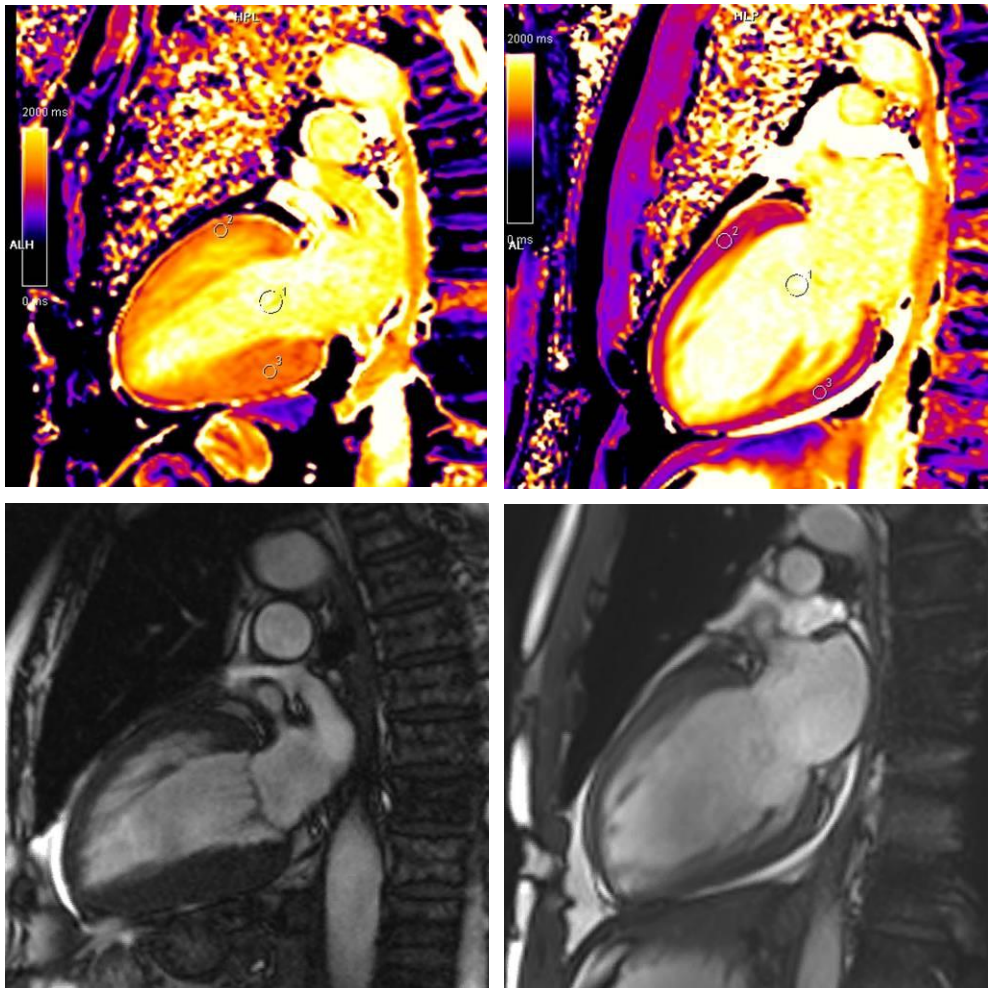
Molli (T1 mapping)



Simon J Doran; home page
http://personal.ph.surrey.ac.uk/~phs3sd/research2.htm



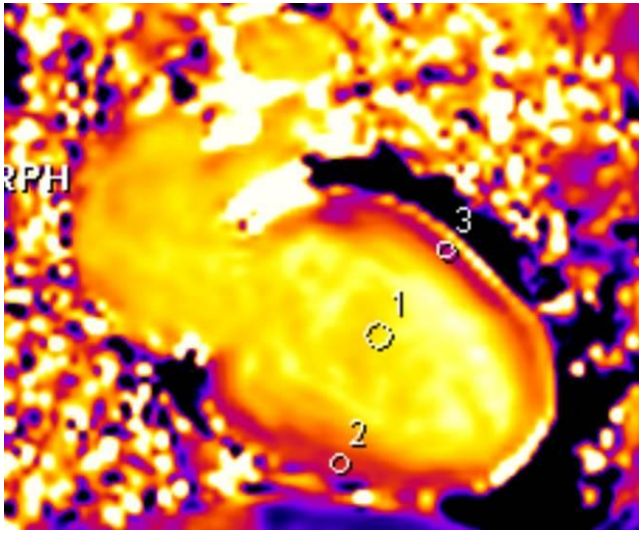
MRI Molli: native T1

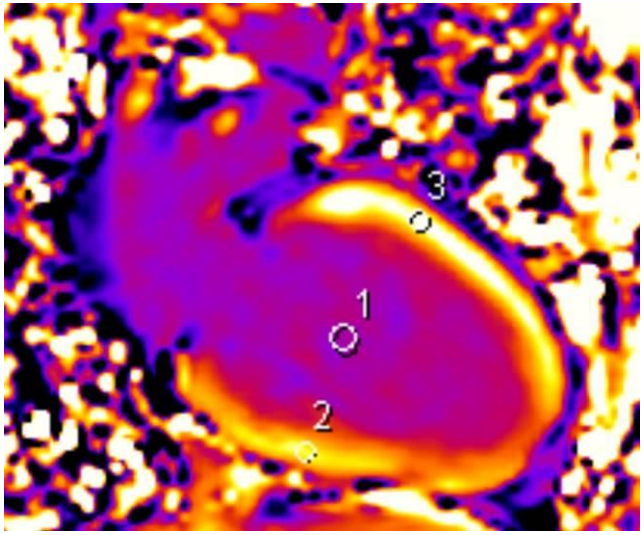


amyloidosis:
T1 = 1490 ± 50 ms
healthy:
T1 = 1160 ± 50 ms

Karamitsos et al., JACC CardVasc Imaging 2013

MRI Molli with and without contrast: ECV





ECV (= extracellular volume):

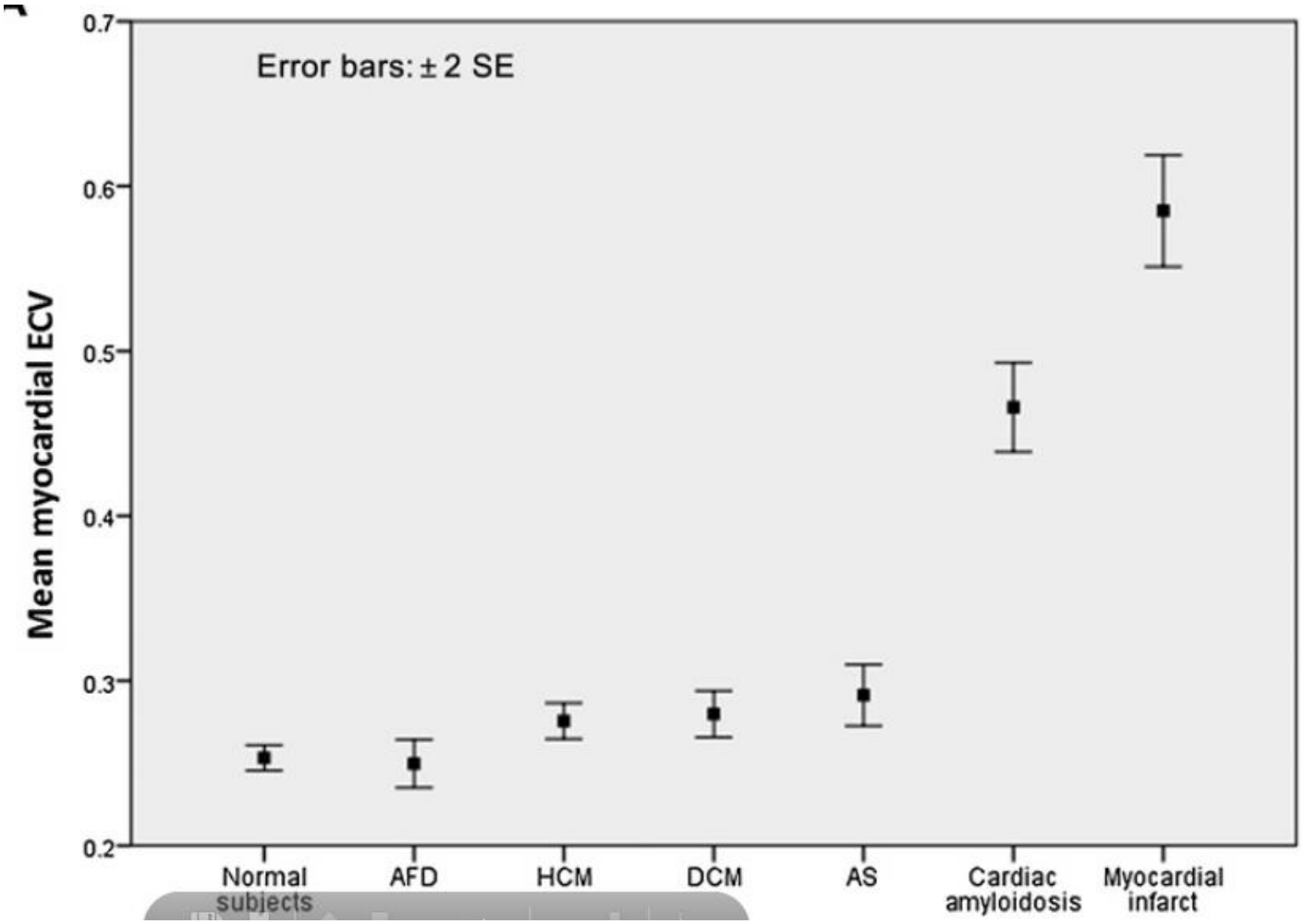
$$ECV = \lambda(1-hct) = \frac{\Delta R1_m}{\Delta R1_b}(1-hct) = \frac{\frac{1}{T1_{mpost}} - \frac{1}{T1_{mpre}}}{\frac{1}{T1_{bpost}} - \frac{1}{T1_{bpre}}}(1-hct)$$

T1 before iv contrast medium:
myocardium: 1239 ms
blood: 1743 ms

T1 after iv contrast medium:
myocardium: 520 ms
blood: 343 ms
hematocrite (hct) = 0,44 (= 44 %)

ECV = 0,26 = 26 %

MRI Molli: Increased extracellular volume



Sado et al., Heart 2012

Teaching points

- Strength and weaknesses:
  - Morphology — MRI good
  - Function — MRI good
  - Coronary arteries — MRI inferior
  - Myocardial characterization — good, new biomarkers coming up