

Asian Society of Cardiovascular Imaging

6 June, 2009

Tokyo, Japan



Contrast-Enhanced MRI of Myocardial Infarction

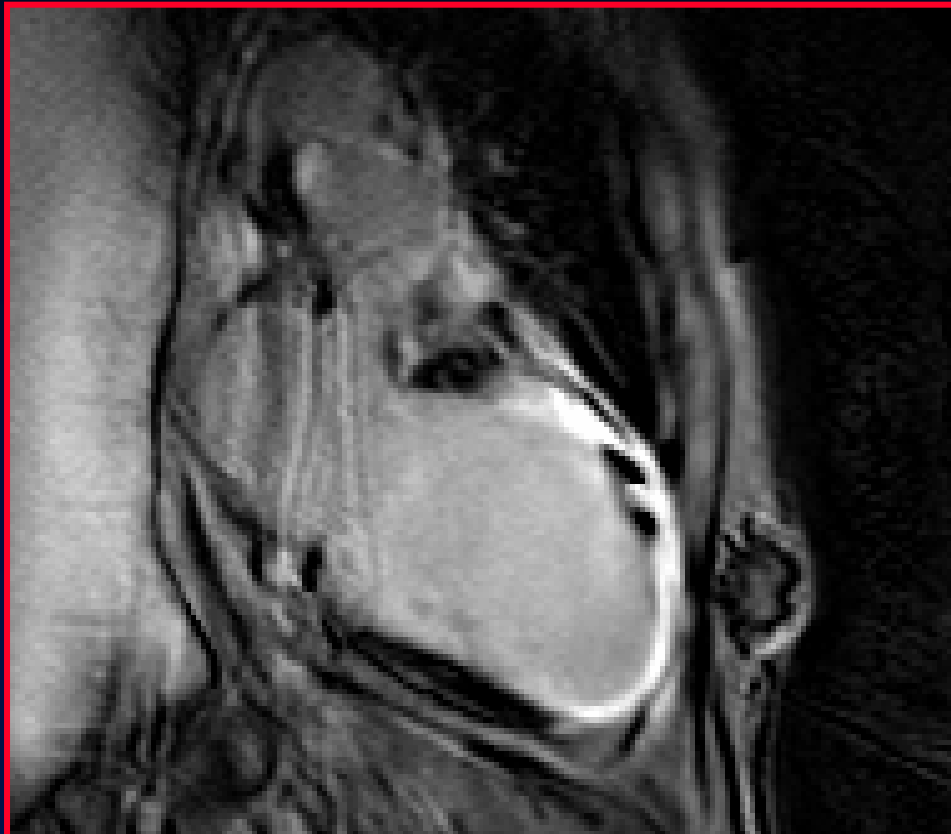
Scott D. Flamm, M.D.

Head, Cardiovascular Imaging

Imaging, and Heart and Vascular Institutes,

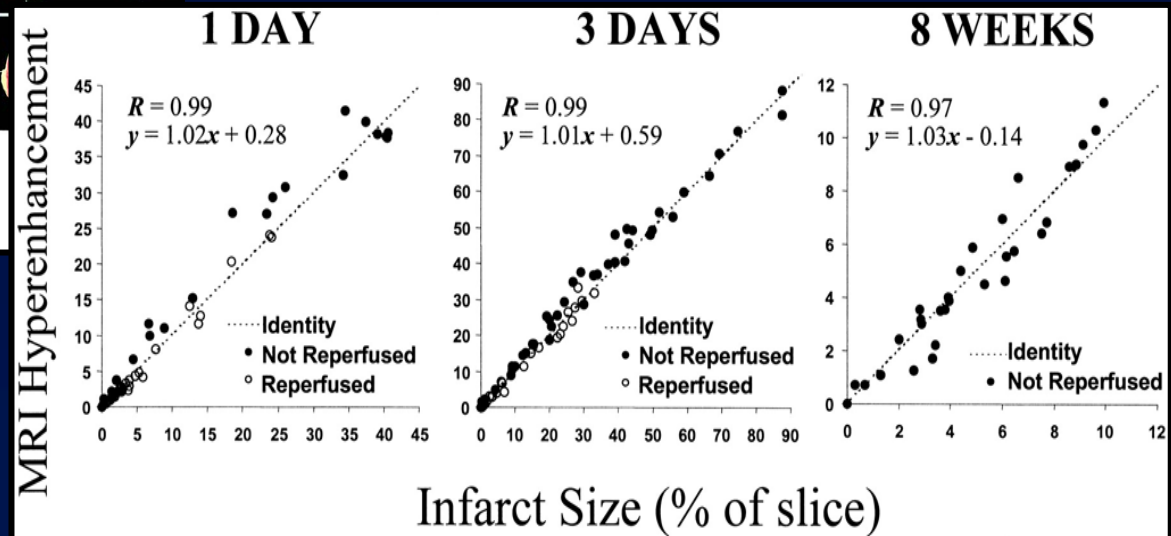
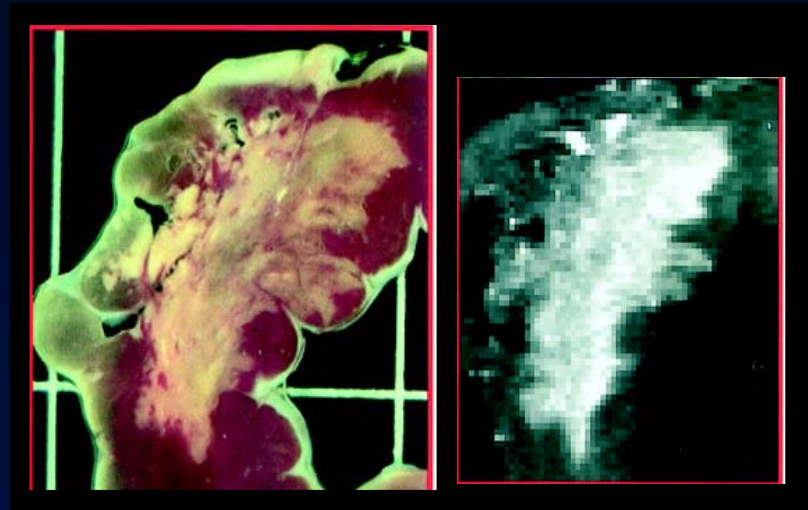
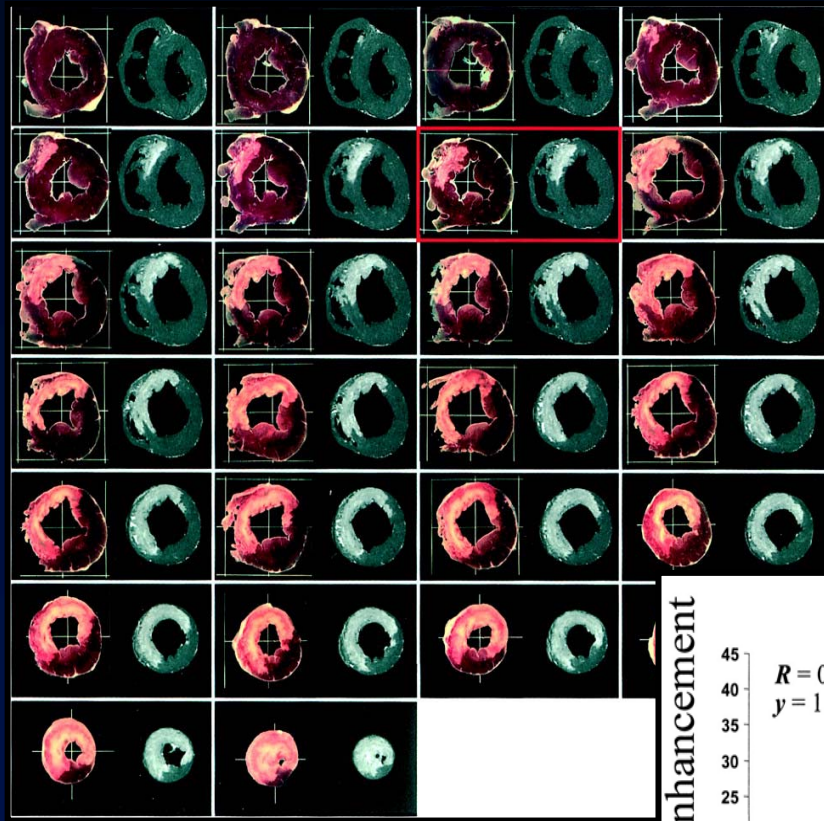
Cleveland Clinic, Cleveland, Ohio

Myocardial Viability



Delayed Enhancement, “Scar”
Magnetic Resonance Imaging

Relationship of MRI Delayed Contrast Enhancement to Irreversible Injury, Infarct Age, and Contractile Function



Viability “Scar” Technique:

Pulse sequence

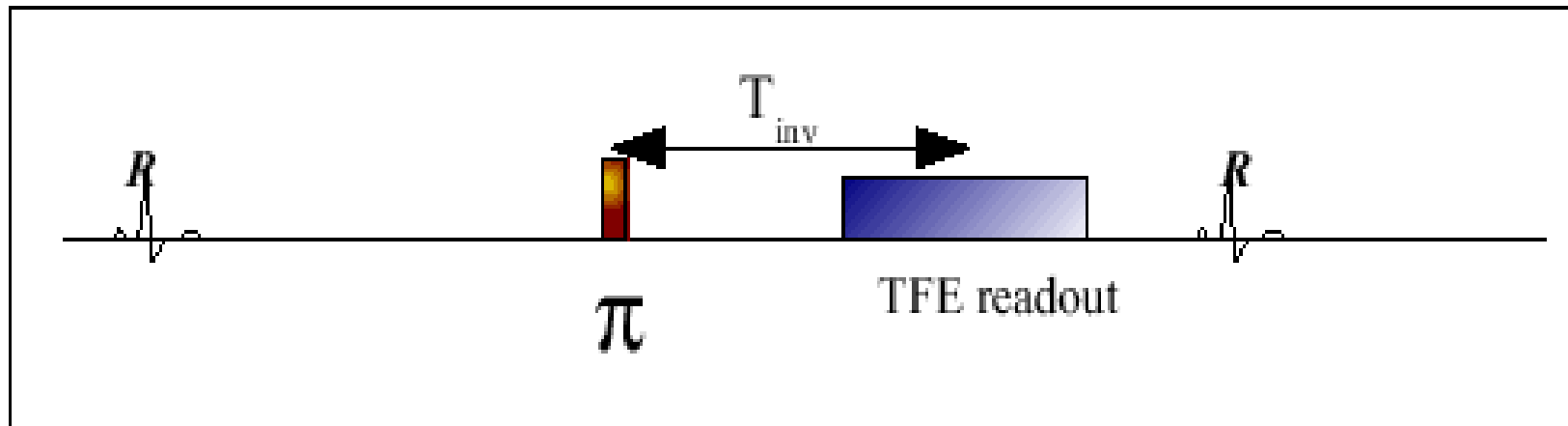
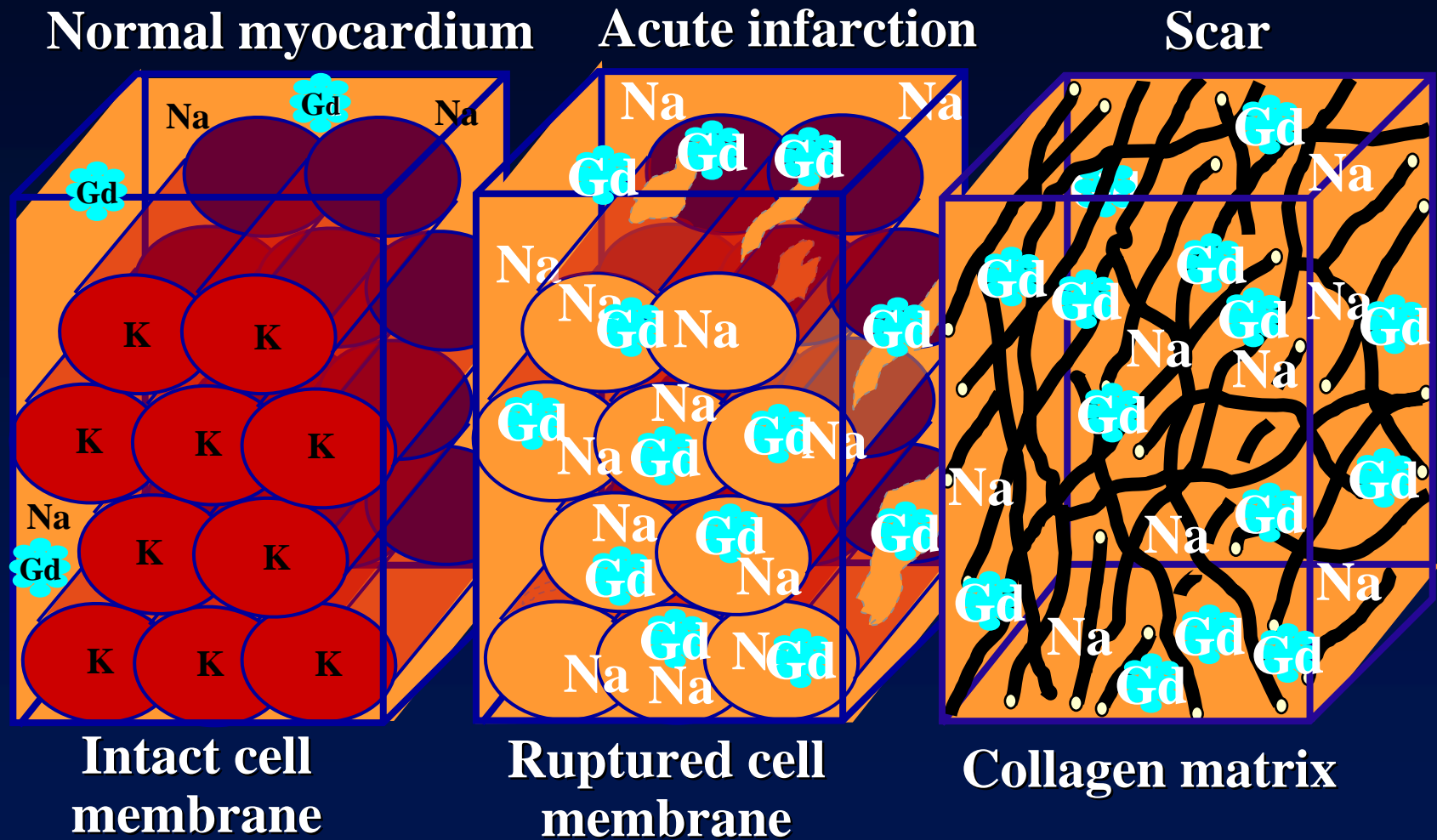


Figure 01: Pulse-sequence Schematic

DE-MRI – How does it work?

- Takes advantage of more Gd contrast in irreversibly damaged tissue
 $\uparrow \text{Gd} \rightarrow \text{shorter } T_1 \rightarrow \text{brighter}$
- At least 2 mechanisms:
 - 1) *Differential wash-in and wash-out rates*
 - 2) *Different volume of distribution*
 - normal tissue: small interstitial space
 - acute MI or scar: large interstitial space

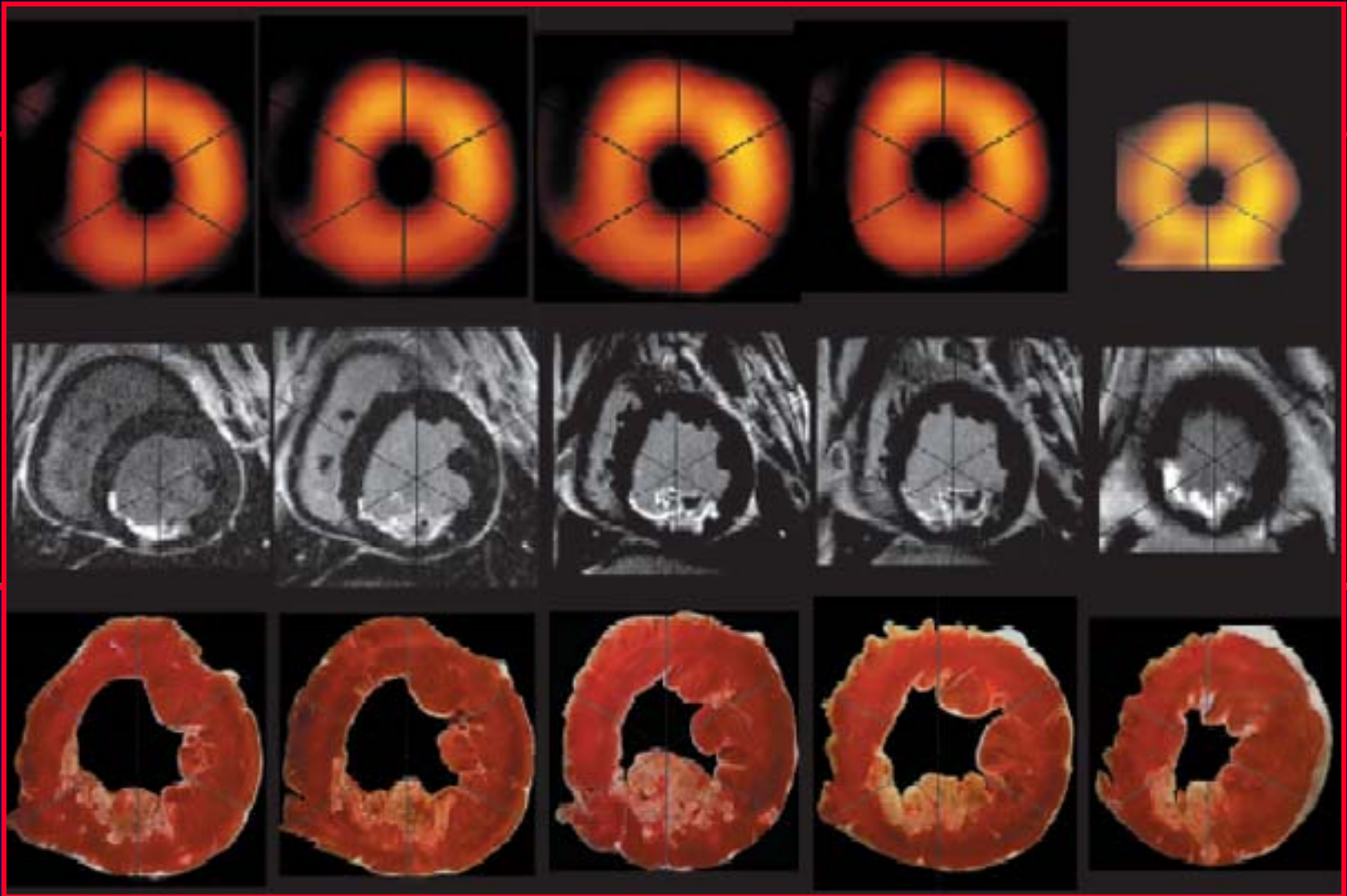
Mechanism of “Scar” Imaging:



Viability “Scar” Technique: Delayed Hyperenhancement Protocol

- Advantages:
 - highest spatial resolution $\approx 1.5 \times 1.5$ mm in-plane
 - contrast resolution – scar signal $\approx 5x$ normal
 - no radiation
 - resting study – no stress needed

DE-MRI vs. SPECT:

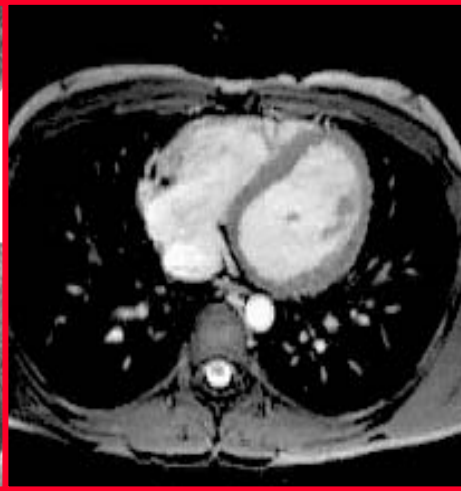


Viability Protocol:

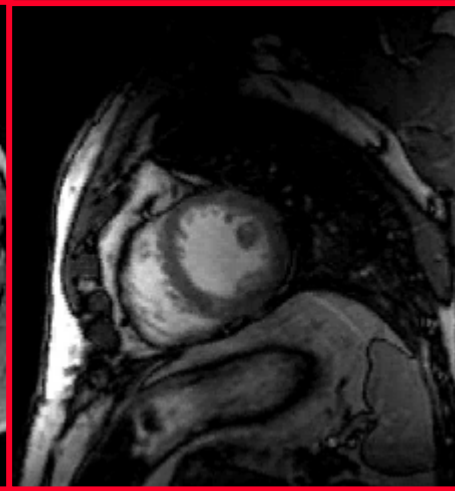
≈ 20-50 minutes



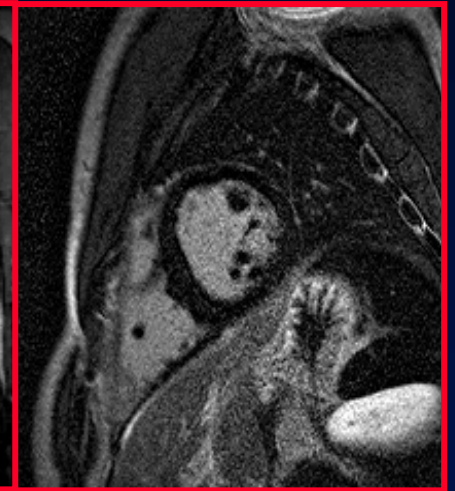
Scout



Ax Stack
SSFP



Function
SSFP



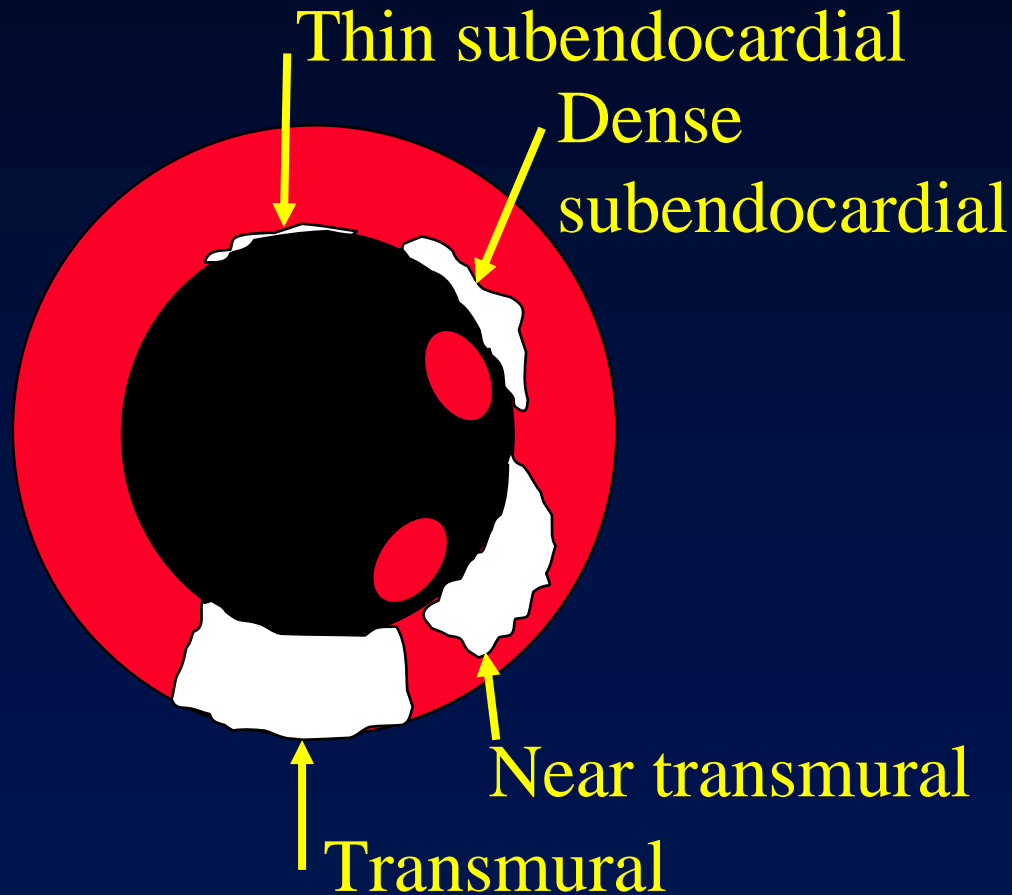
Viability/Scar
2D-BH
2D PSIR-BH
3D-BH
2D-SS
3D-Navigator

Inject Contrast

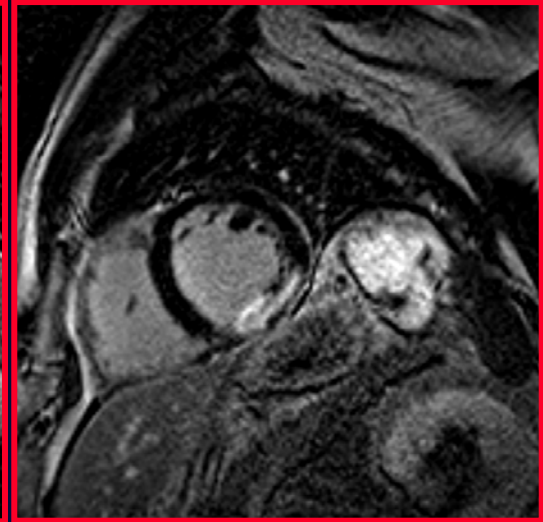
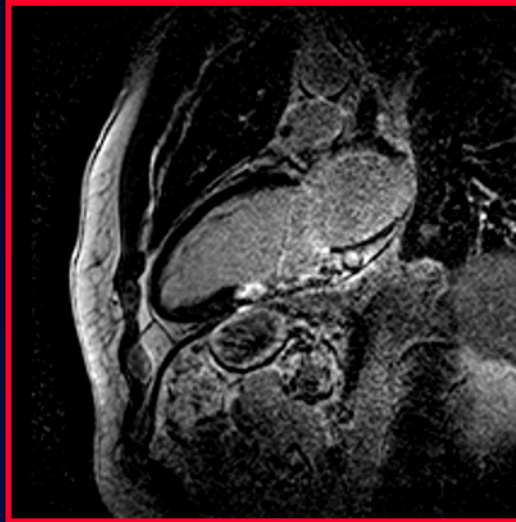
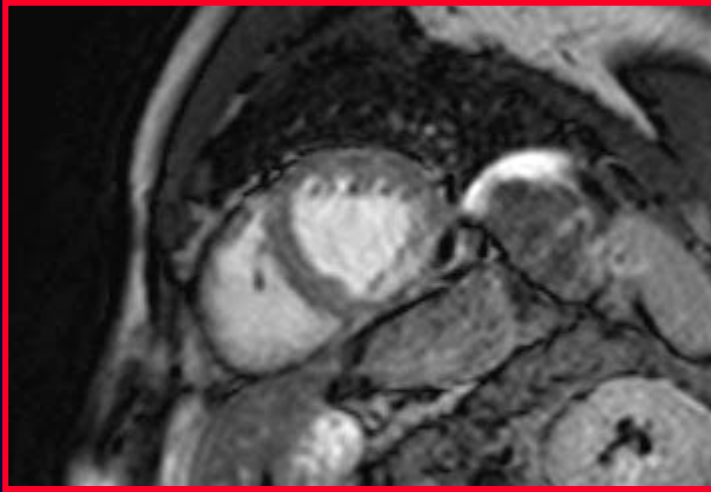


DE-MRI Ischemic Pattern:

Clinical grading

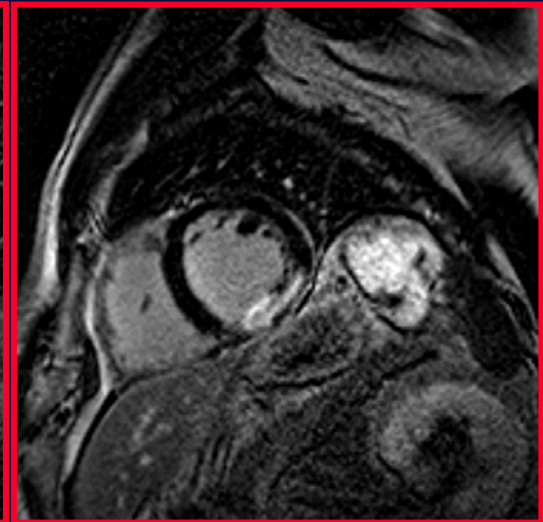
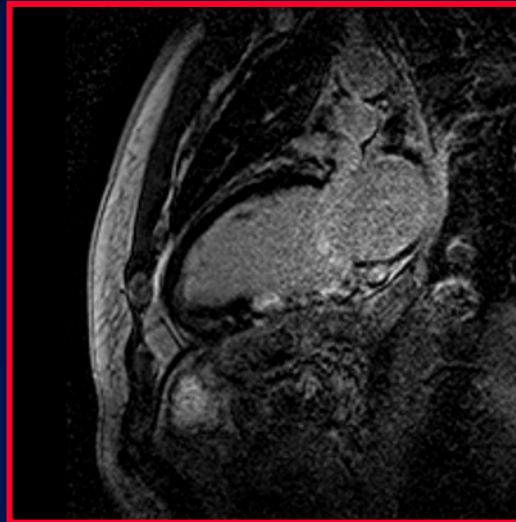
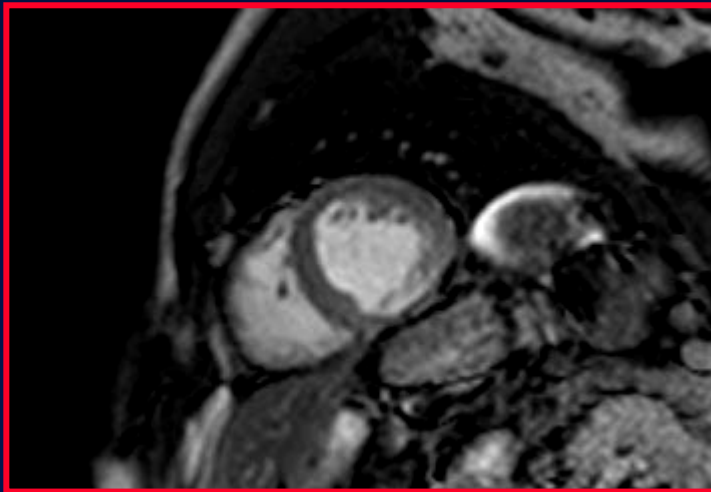


Non-Viability by DE-MRI:



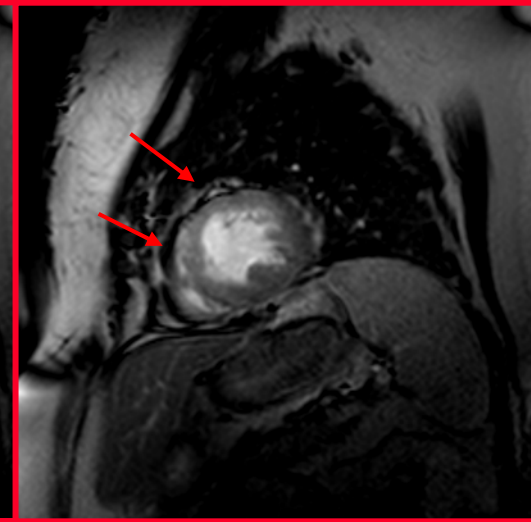
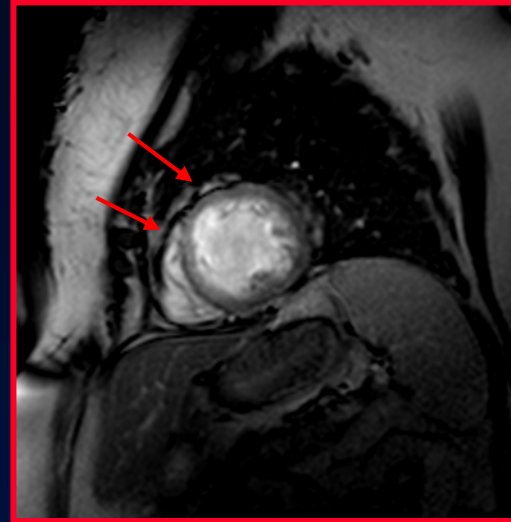
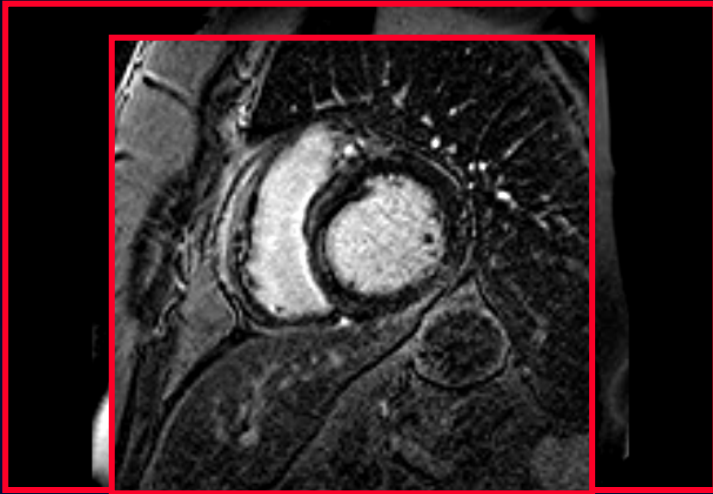
Follow up

LVEDV: 221 cc, LVESV: 117 cc, EF: 47%

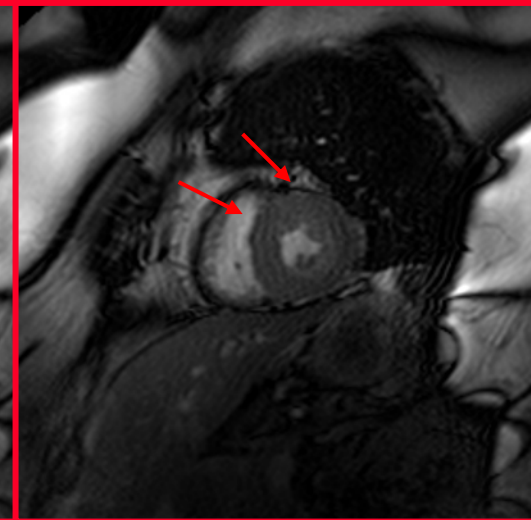
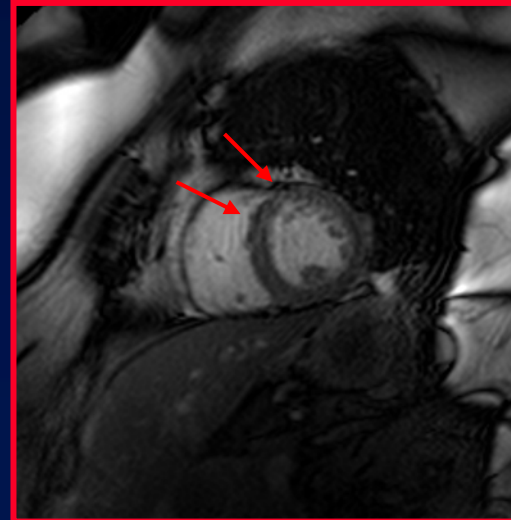
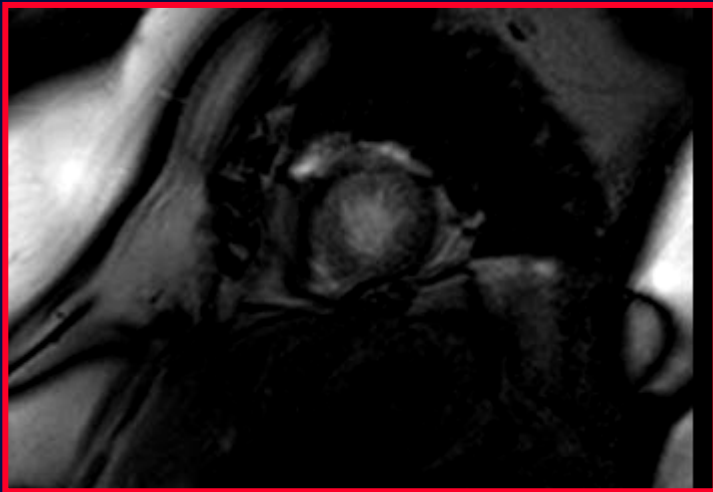


LVEDV: 228 cc, LVESV: 119 cc, EF: 48%

Viability by DE-MRI:



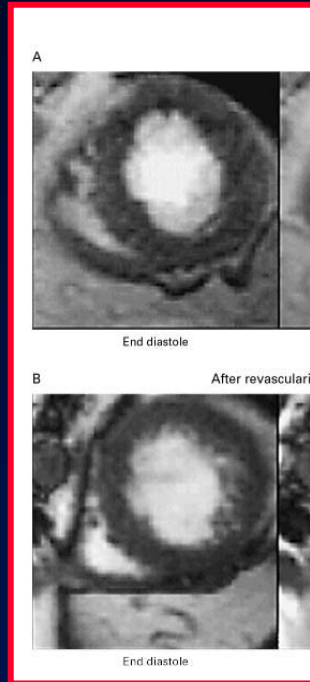
Follow up



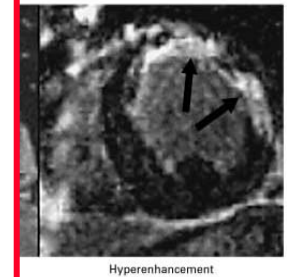
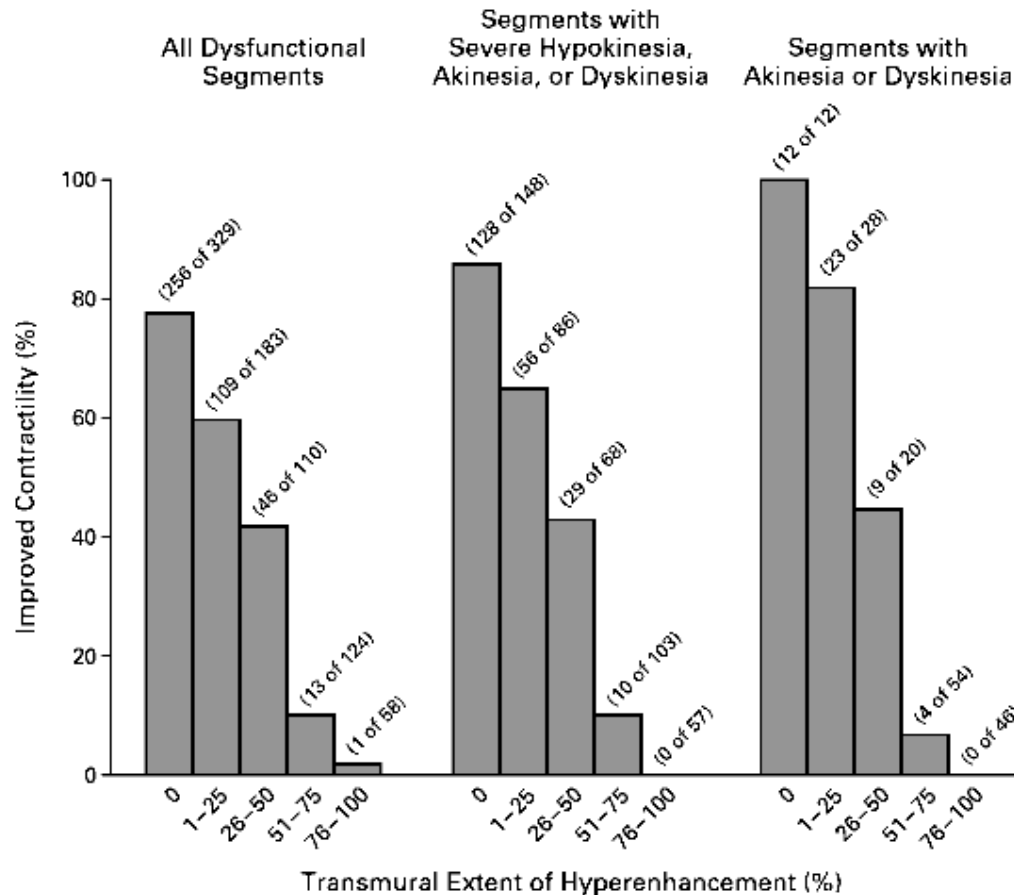
LVEDV: 203 cc, LVESV: 129 cc, EF: 37%

LVEDV: 166 cc, LVESV: 80 cc, EF: 52%

The Use of Contrast Enhanced Magnetic Resonance Imaging to Identify Reversible Myocardial Dysfunction

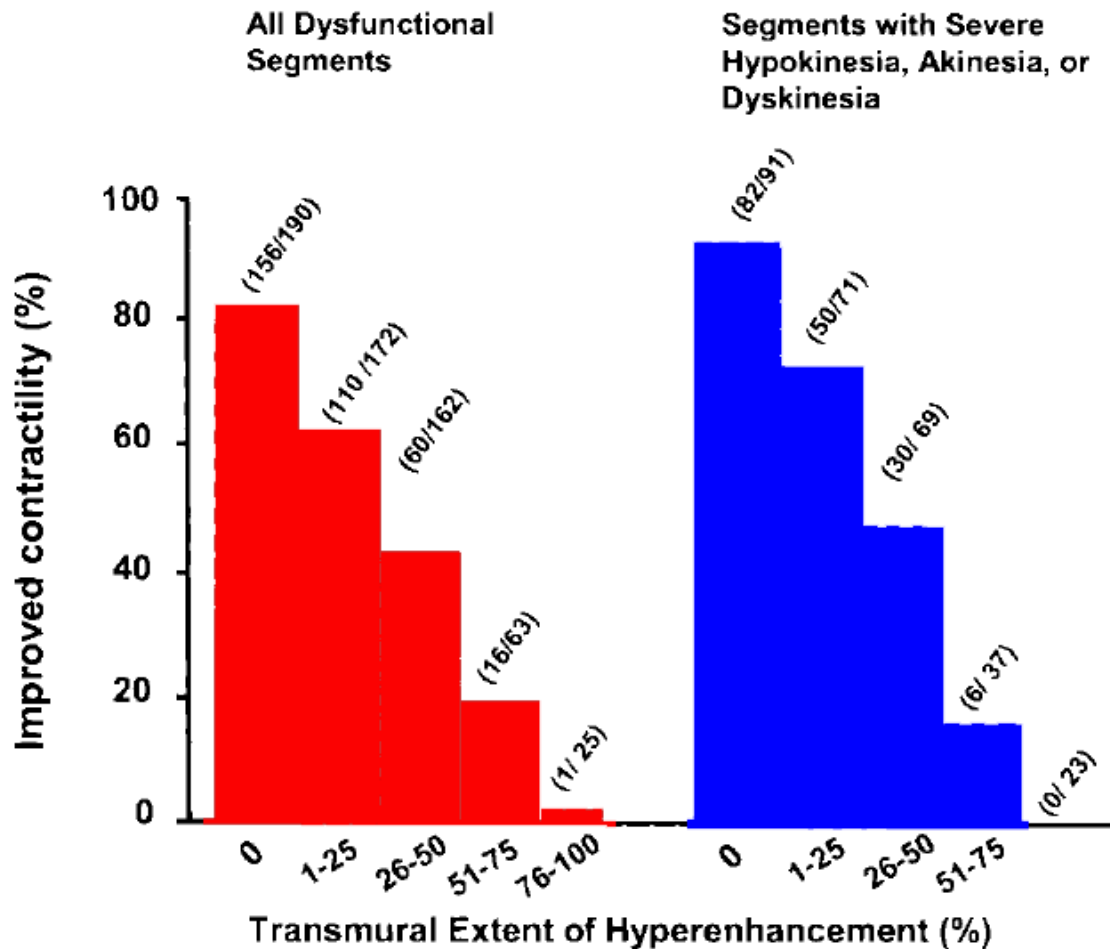


Revers

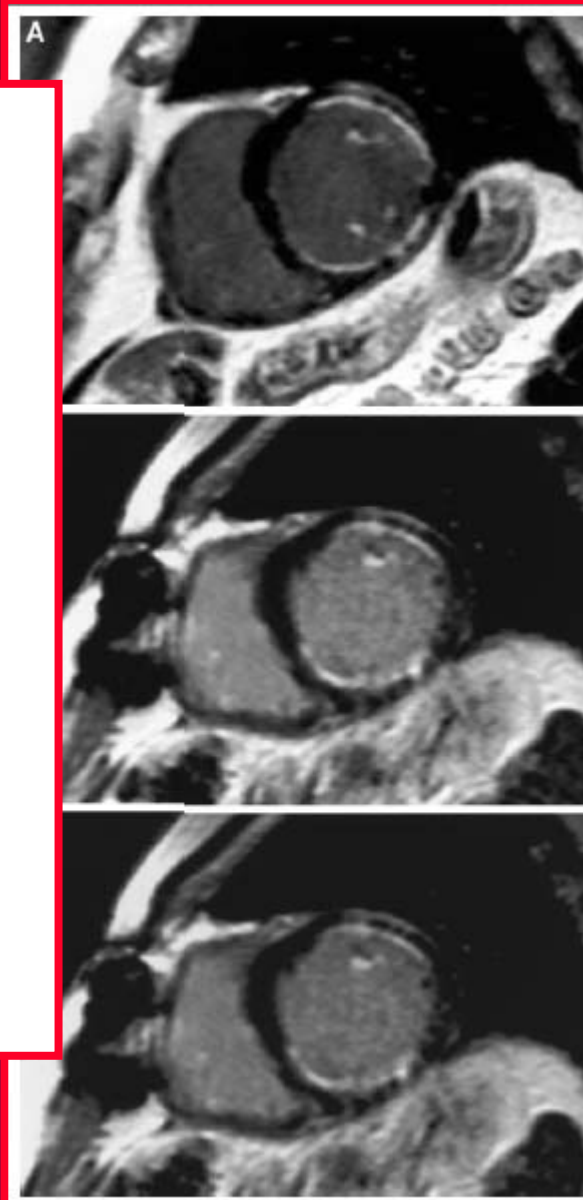


function

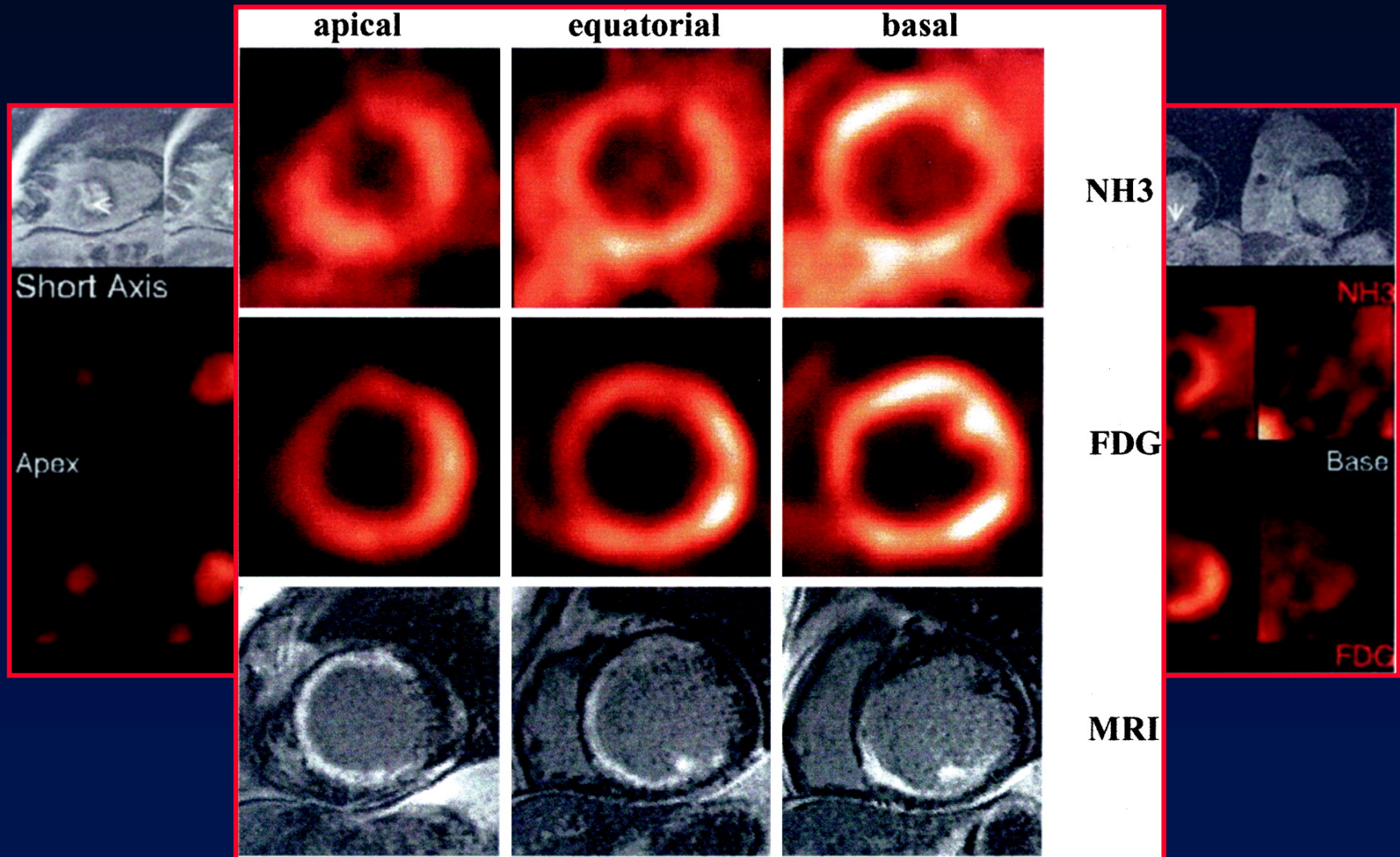
Value of DE-MRI in Predicting Myocardial Viability after Surgical Revascularization



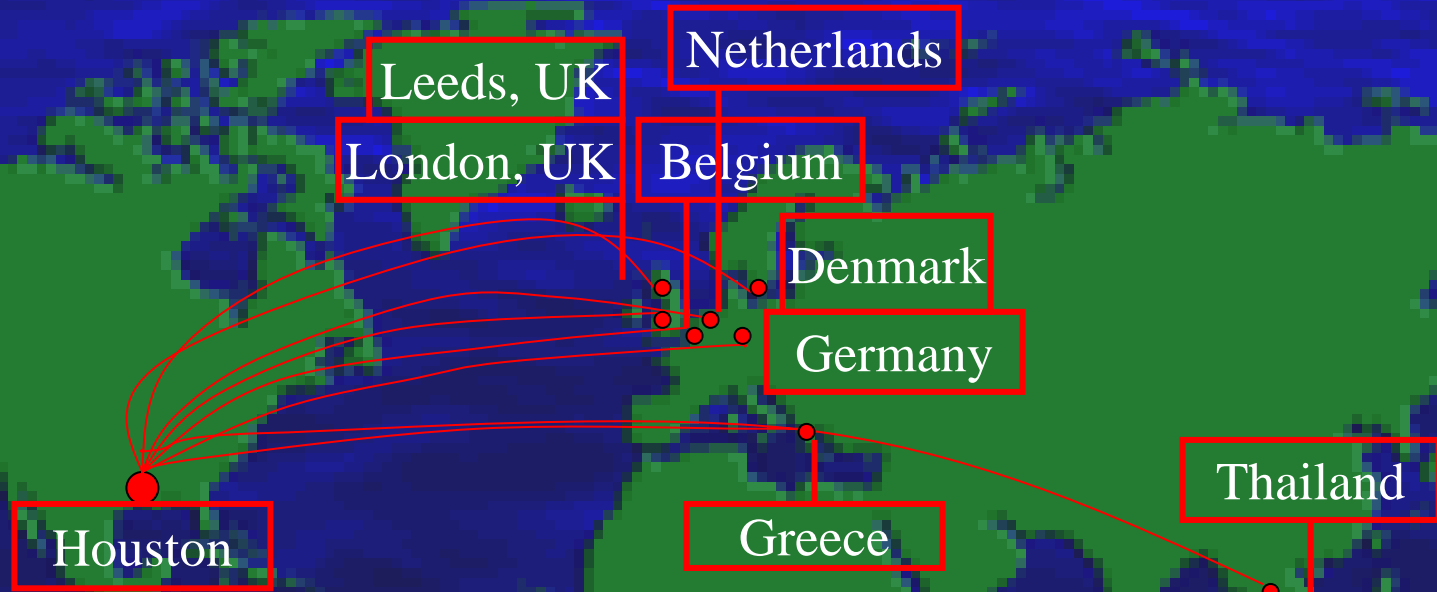
52 patients



Assessment of Myocardial Viability with Contrast Enhanced Magnetic Resonance Imaging: Comparison with Positron Emission Tomography



Multicenter Myocardial Viability Trial*



Initiating Site/Corelab:

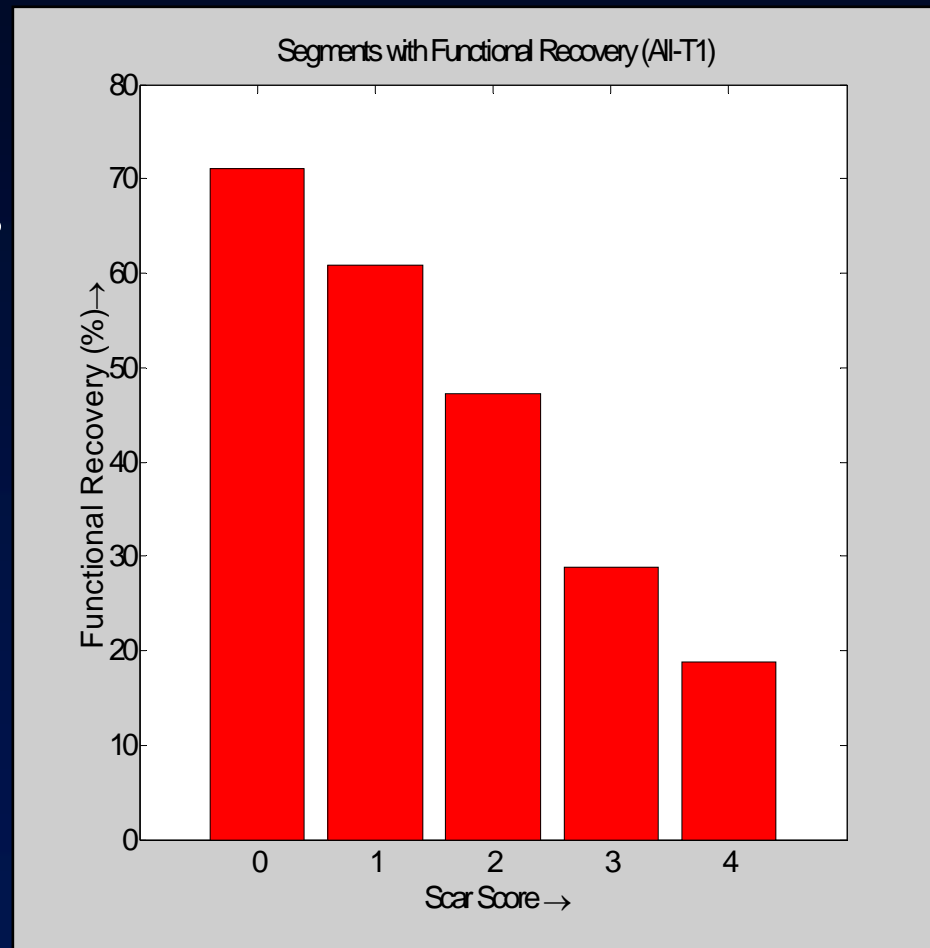
St. Luke's Episcopal Hospital/Texas Heart Institute

Houston, Texas

** by the Philips CVMR Users Group*

Multicenter Viability Trial:

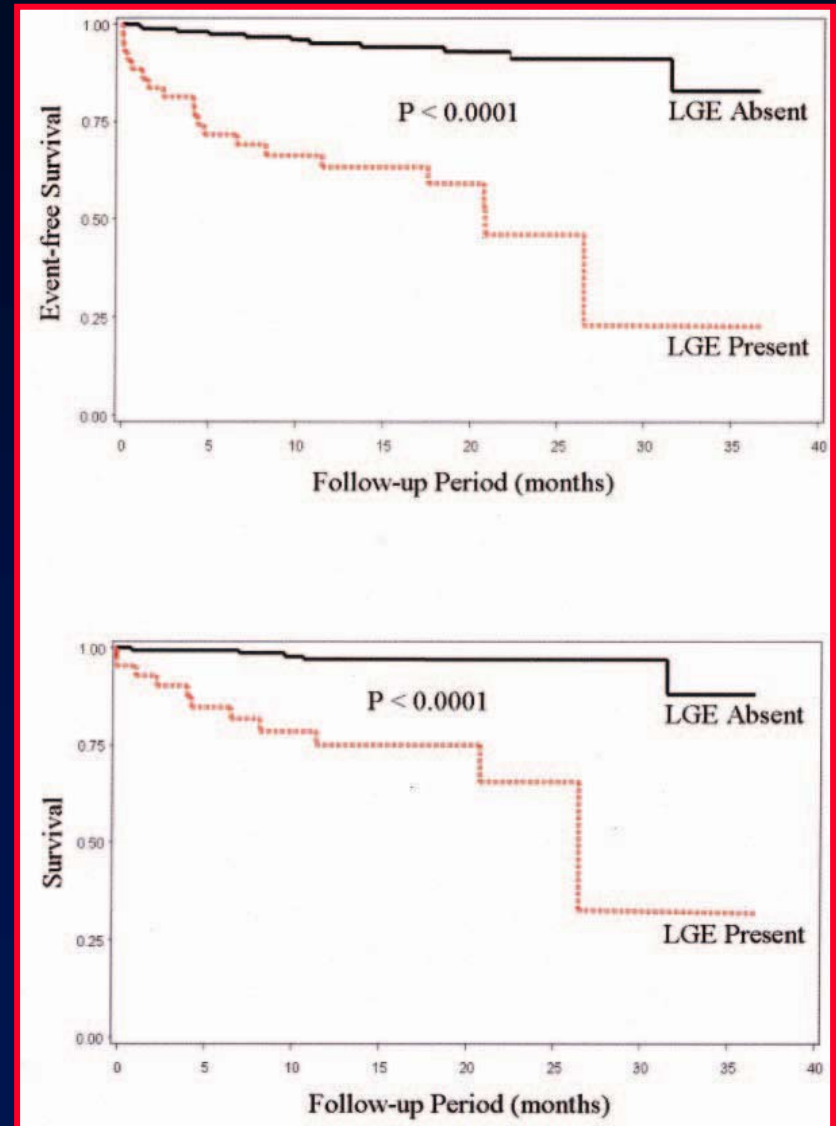
- 12,274 myocardial revascularized segments were analyzed.
- 5,580 /12,274 (46%) segments had some degree of LV dysfunction and 2,974/12,274 (24%) segments had DE before revasc.
- Extent of scar and functional recovery were inversely related.
- No difference in functional recovery between those who underwent PTCA or CABG (p=NS).



Outcomes:

Impact of Unrecognized Myocardial Scar by CMRI on Event-Free Survival

- 195 patients
- DE-MRI and function;
mean LVEF = 54%
- Median 16 month FU
- MACE (18%); death (10%)
- DE strongest independent predictor of MACE



Demographics of patients with and without events

Total n = 386	No events (n=328)	Events (n=58)	P value
Age	64 ± 12	67 ± 11	0.10
Male*	251 (77%)	37 (64%)	< 0.05

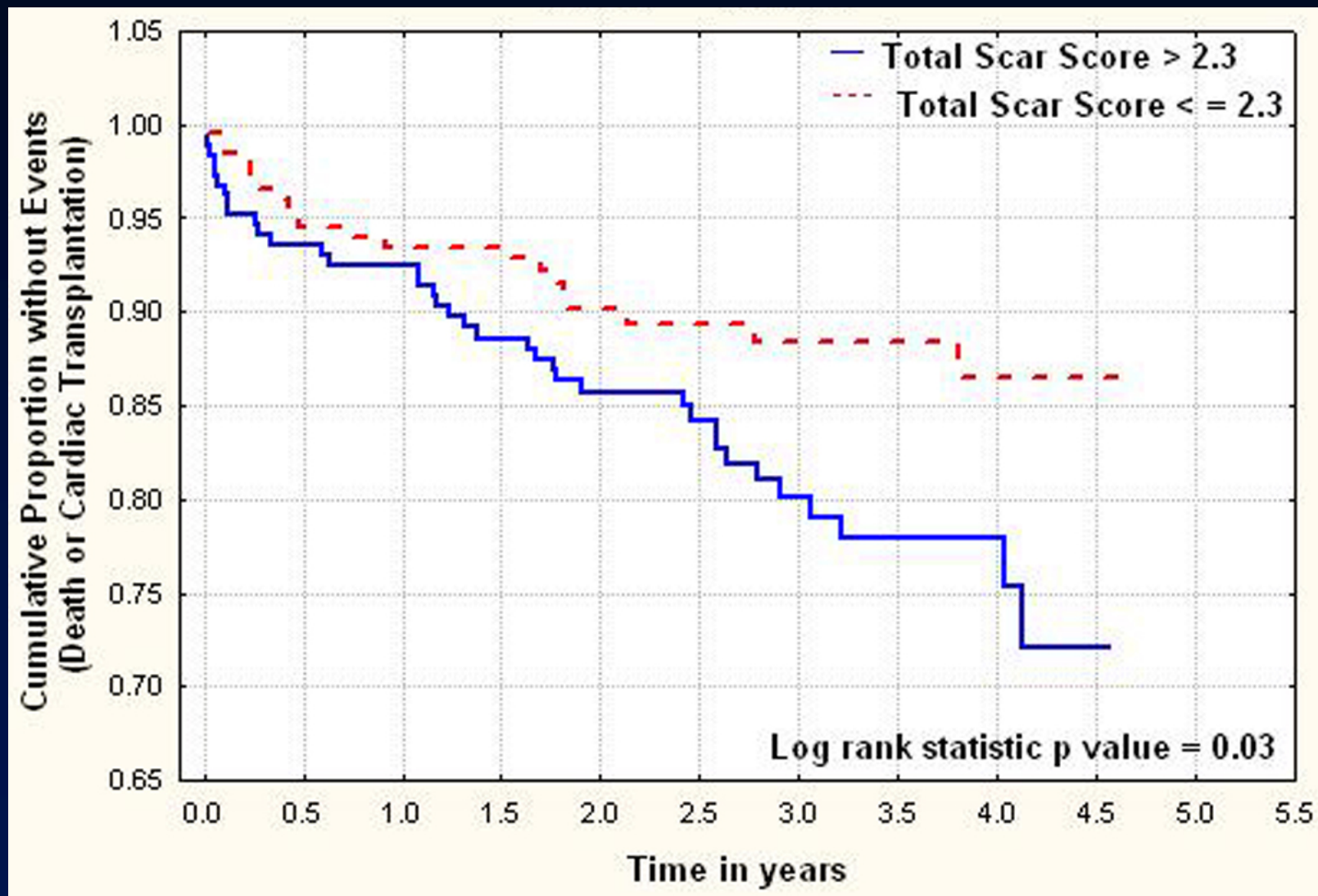
386 patients with severe LV dysfunction
($LVEF = 24 \pm 8$)

All with angiographically proven CAD

Median FU = 2.2 years

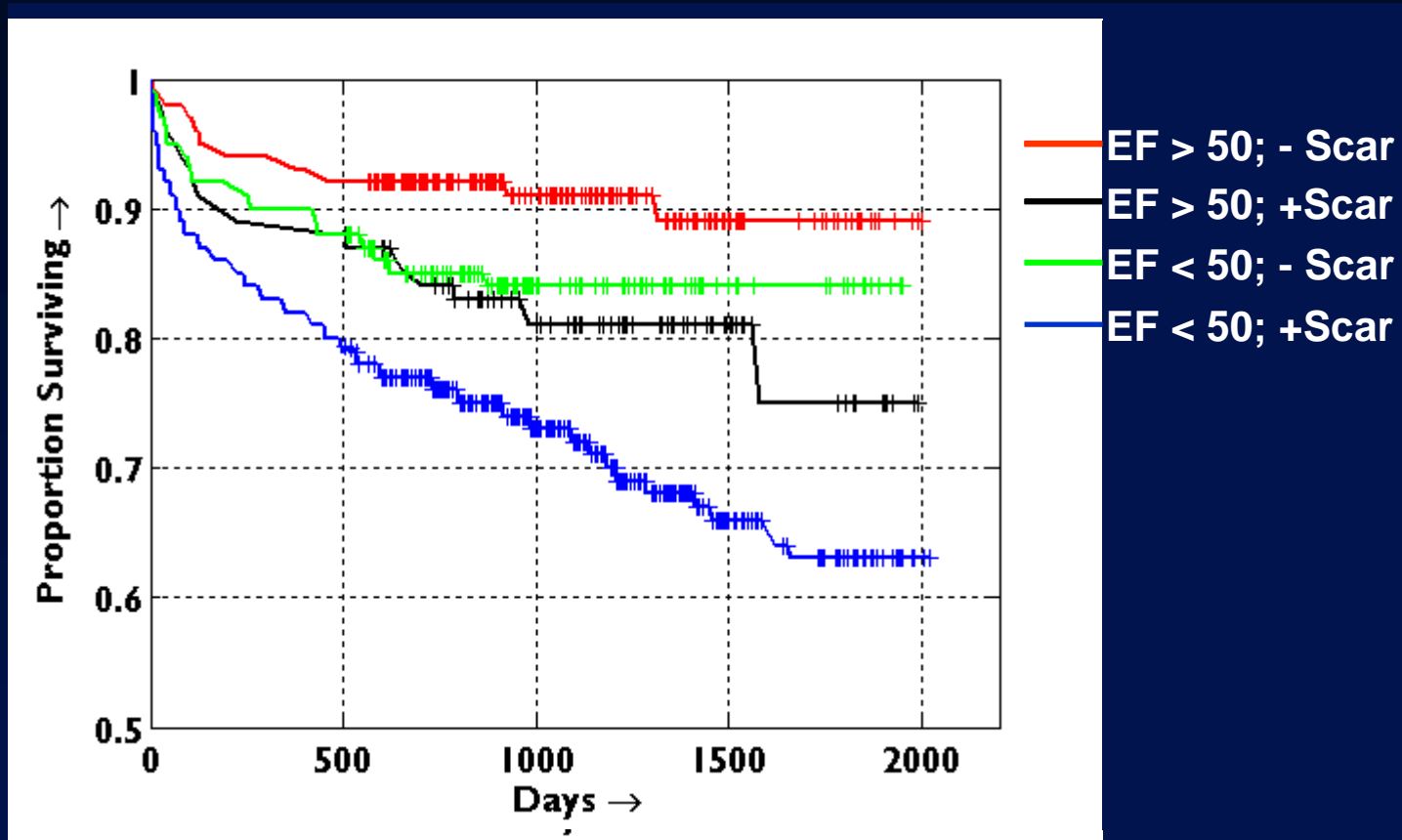
LVEF (%)	24 ± 8	22 ± 7	0.26
LVEDV (ml)	234 ± 124	226 ± 101	0.66
LVESV (ml)	130 ± 82	141 ± 106	0.43
Post CMR PCI/CABG	78 (24%)	14 (24%)	0.9
Post CMR ICD or CRT	93 (28%)	13 (23 %)	0.38

Univariate survival analysis and scar extent



Results in 888 patients with moderate LV dysfunction; 900+ day followup

KAPLAN-MEIER SURVIVAL CURVE



EF > 50 without scar vs EF > 50 with scar $\rightarrow p < 0.025$
EF < 50 without scar vs EF < 50 with scar $\rightarrow p < 0.003$

The Case for DE-MRI:

- Identifies irreversibly damaged myocardium
- Accurate, quantifiable
- Reproducible
- Validated in animal and human studies (*multi*)
- Highest spatial resolution
- Simple to perform:
 - resting study
 - no pharmacologic stress
 - no radiation
- Outcomes data available