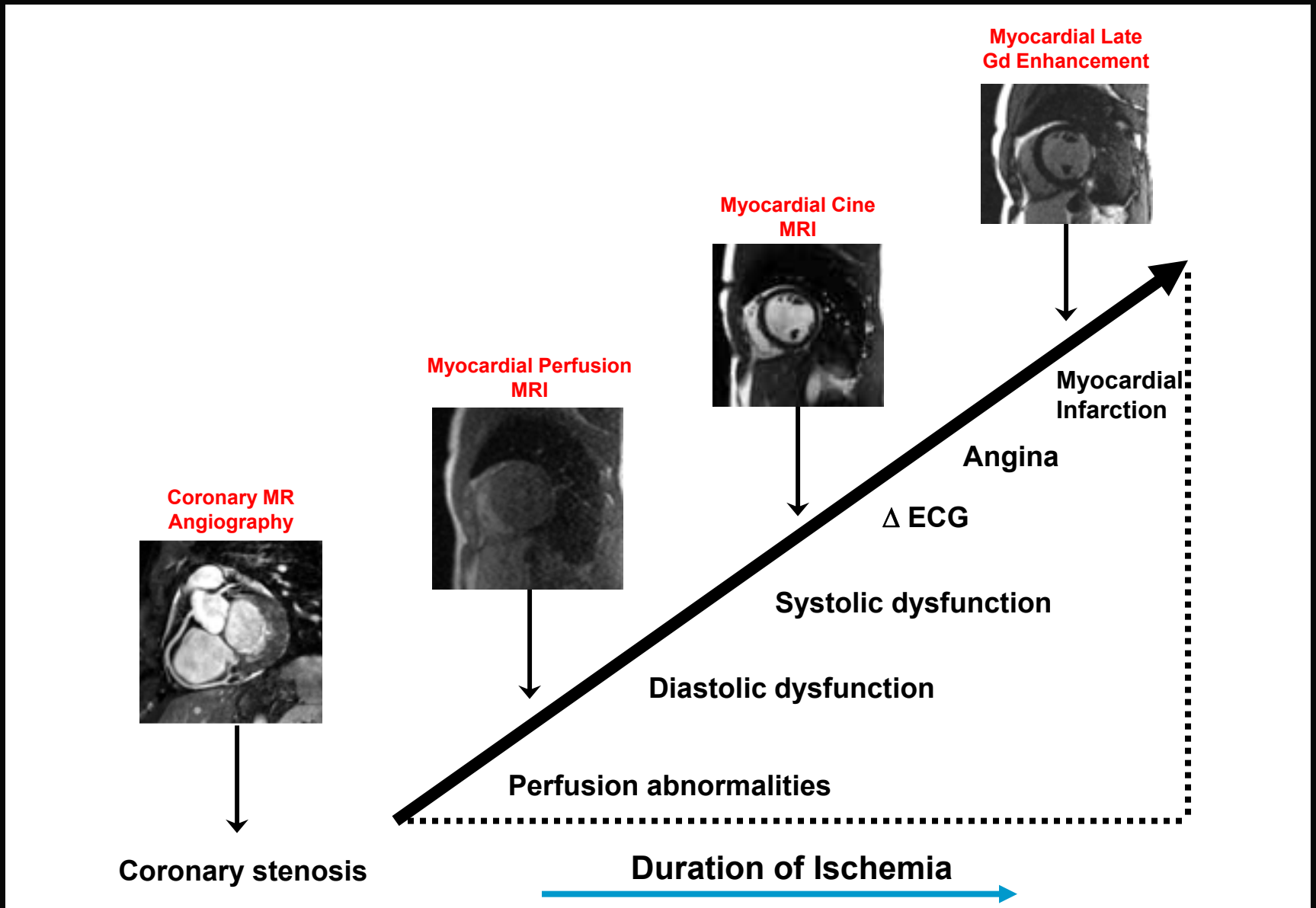
Il Contributo della Cardio RM nella Gestione del Paziente con Cardiopatia Ischemica Cronica

Santo Dellegrottaglie, MD – PhD

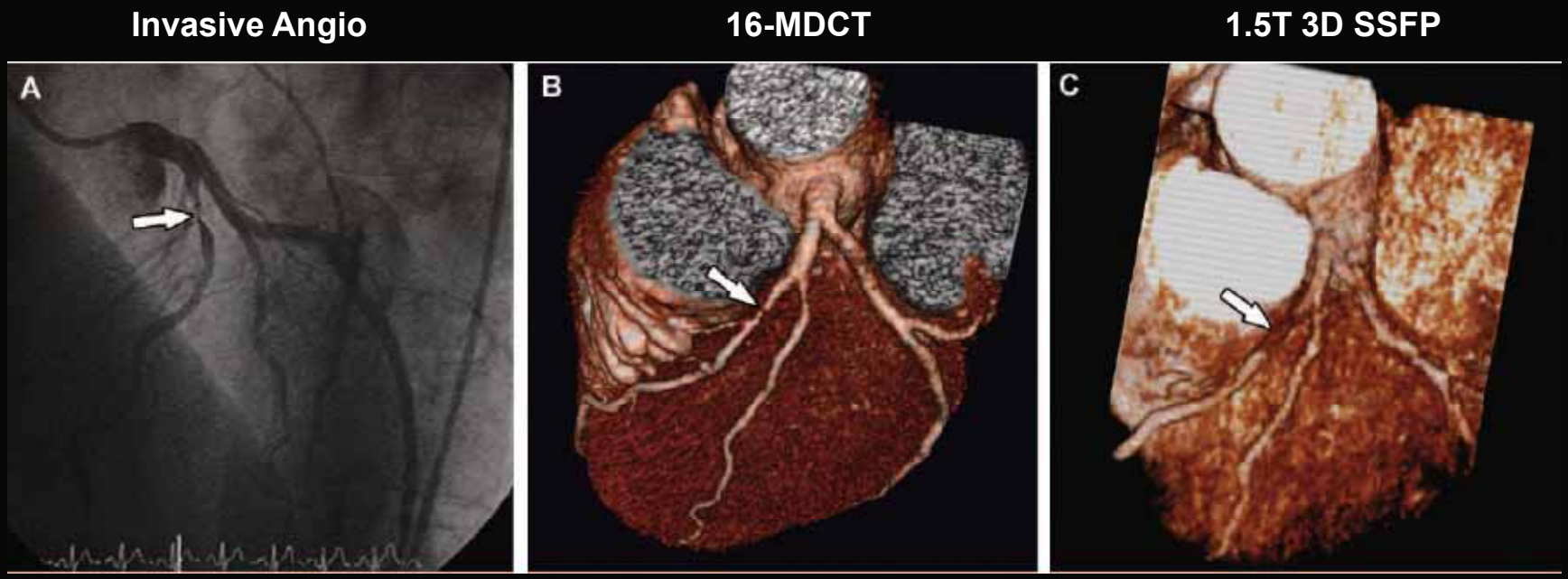
Dip. di Medicina Clinica, Scienze Cardiovascolari ed Immunologiche
Universita' Federico II
Napoli

Cardiac MRI in the Ischemic Heart Disease



Non-Invasive Coronary Angiography: MRA vs. MDCT

N= 108 pts. with suspected CAD
MRA-MDCT time interval: 0.1 days (0-5 days)
Imaging-cath time interval: 0.7 days (0-5 days)



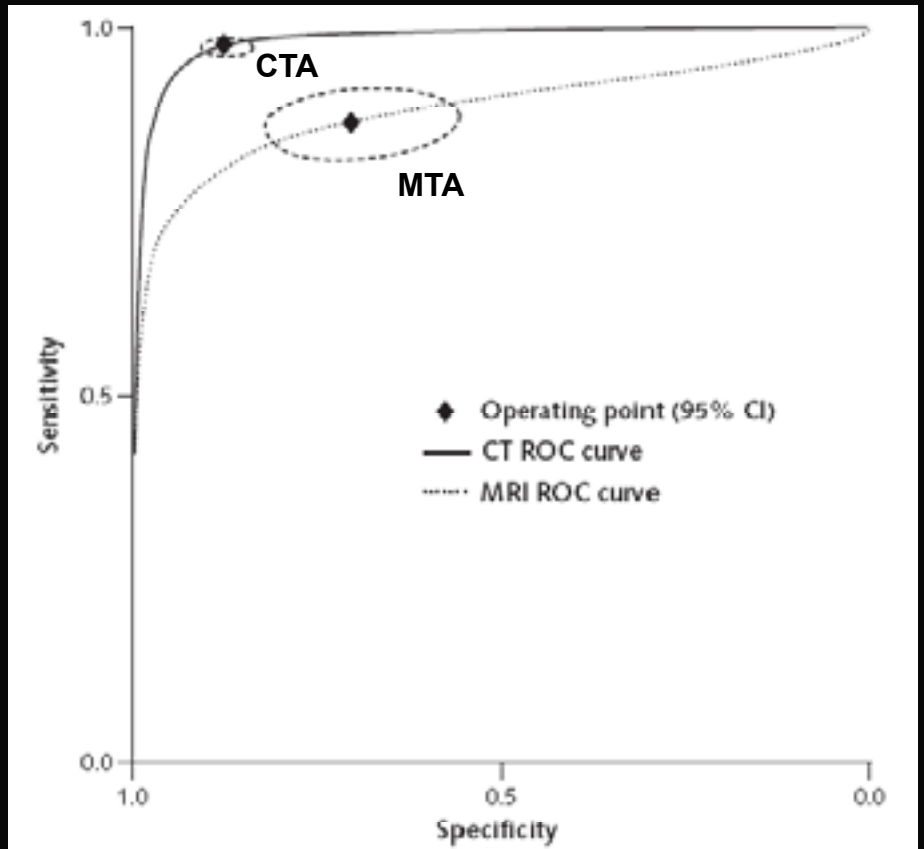
In-plane resolution
0.35 x 0.35 mm

In-plane resolution
0.9 x 0.7 mm

Dewey M. et al., *Ann Intern Med* 2006

Non-Invasive Coronary Angiography: MRA vs. MDCT

N= 89 studies (7516 pts) with CTA + 20 (989 pts) with MRA



	Sensitivity (95% CI)	Specificity (95% CI)	AUC (95% CI)
CT	0.97 (0.96–0.98)	0.87 (0.84–0.90)	0.98 (0.96–0.99)
MRI	0.87 (0.83–0.90)	0.70 (0.60–0.79)	0.89 (0.86–0.91)

Schuetz et al., *Ann Intern Med* 2010

AHA Scientific Statement

Noninvasive Coronary Artery Imaging

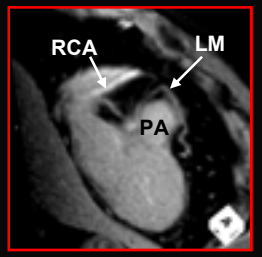
Magnetic Resonance Angiography and Multidetector Computed Tomography Angiography

A Scientific Statement From the American Heart Association Committee on Cardiovascular Imaging and Intervention of the Council on Cardiovascular Radiology and Intervention, and the Councils on Clinical Cardiology and Cardiovascular Disease in the Young

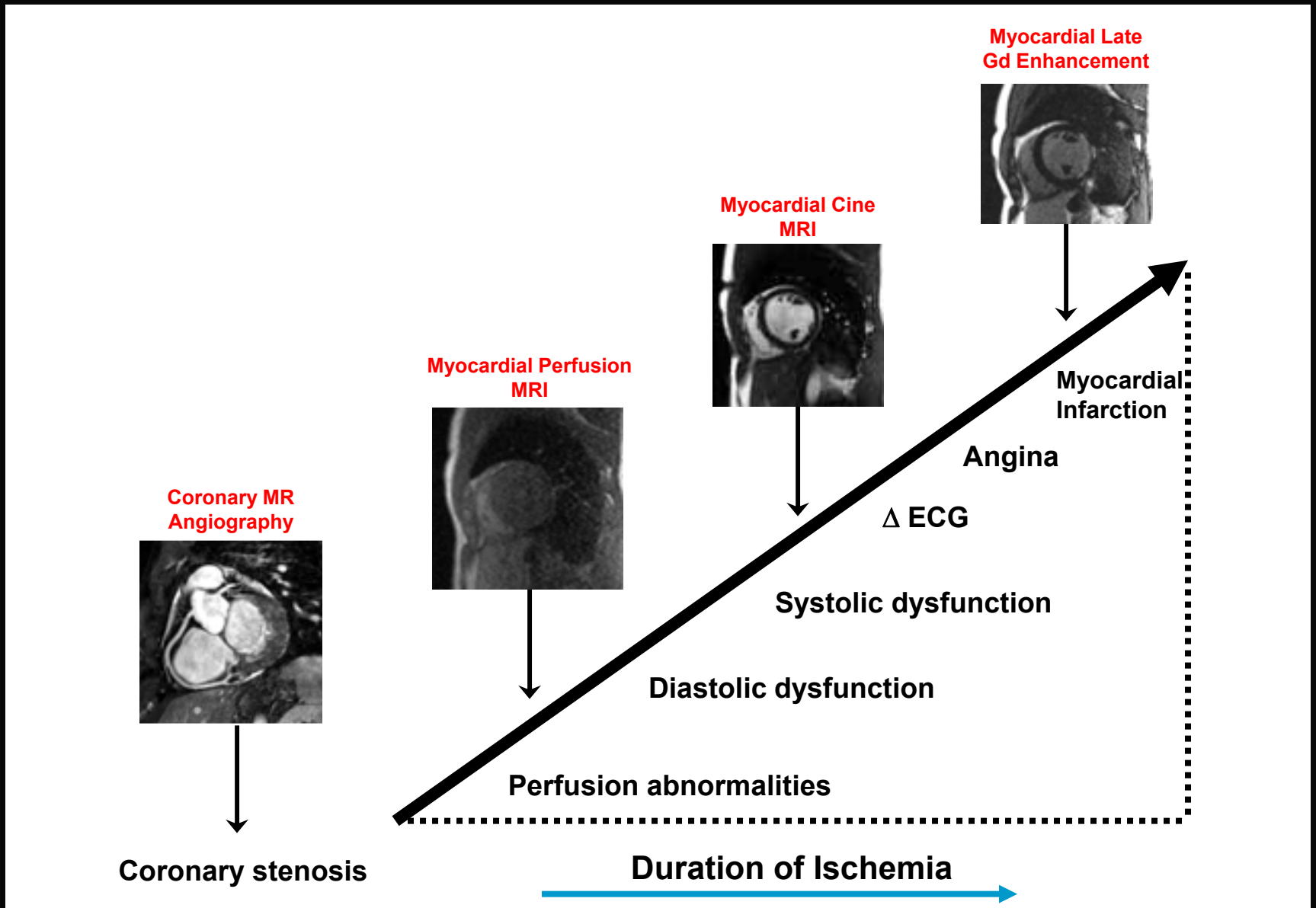
David A. Bluemke, MD, PhD, FAHA, Chair; Stephan Achenbach, MD; Matthew Budoff, MD, FAHA; Thomas C. Gerber, MD, FAHA; Bernard Gersh, DPhil, MD, FAHA; L. David Hillis, MD; W. Gregory Hundley, MD, FAHA; Warren J. Manning, MD, FAHA; Beth Feller Printz, MD, PhD; Matthias Stuber, PhD; Pamela K. Woodard, MD, FAHA

Circulation 2008; 118: 586-606

- **Feasibility and diagnostic performance of coronary MRA for the detection of stenosis is still sub-optimal**
- **Coronary MRA is highly demanding for patients and operators**
- **No multivendor trial data are available for coronary MRA**
- **Coronary MRA has two established applications:**
  - **Recognition of coronary artery bypass graft occlusion**
  - **Characterization of anomalous coronary arteries**



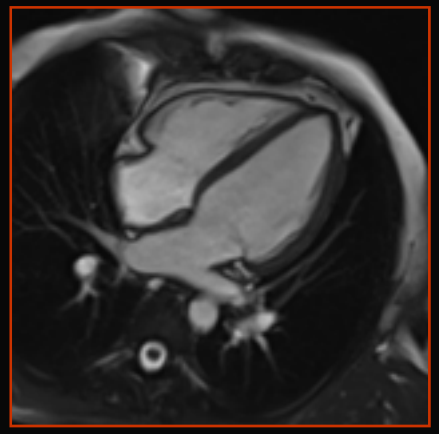
Cardiac MRI in the Ischemic Heart Disease



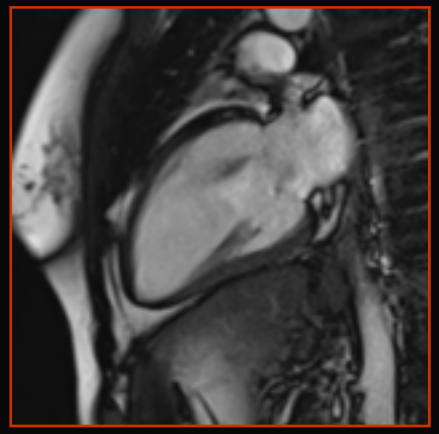
Evaluation of Ventricular Function

Cine-SSFP
ECG gated
Breath-hold (8-12 sec)

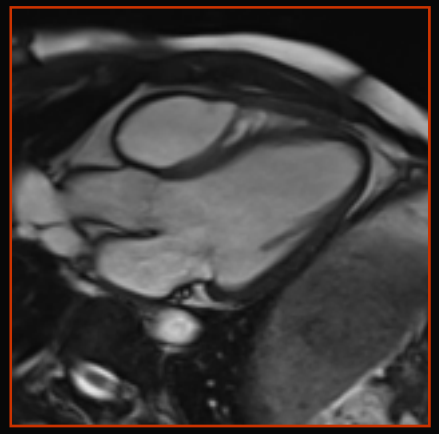
Long-Axis Views



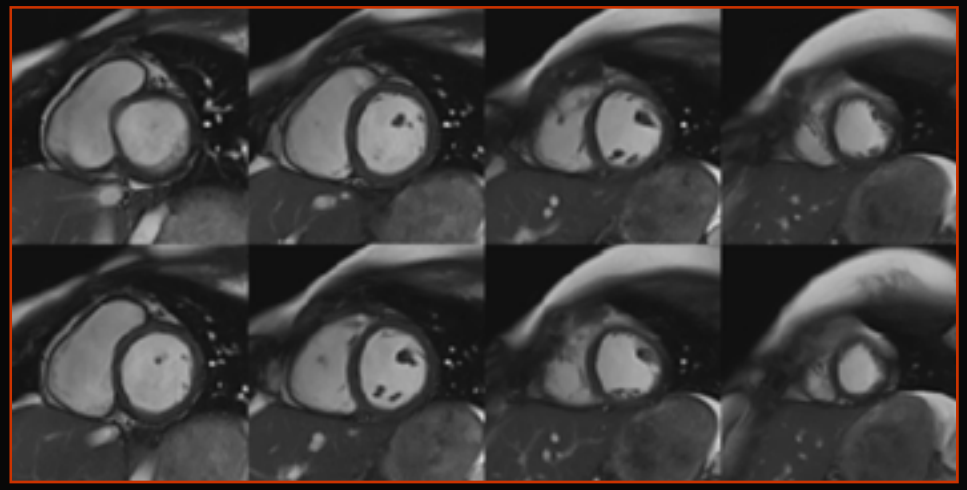
4-Chamber View



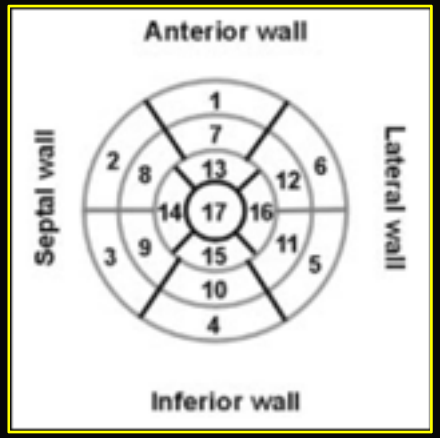
2-Chamber View



3-Chamber View



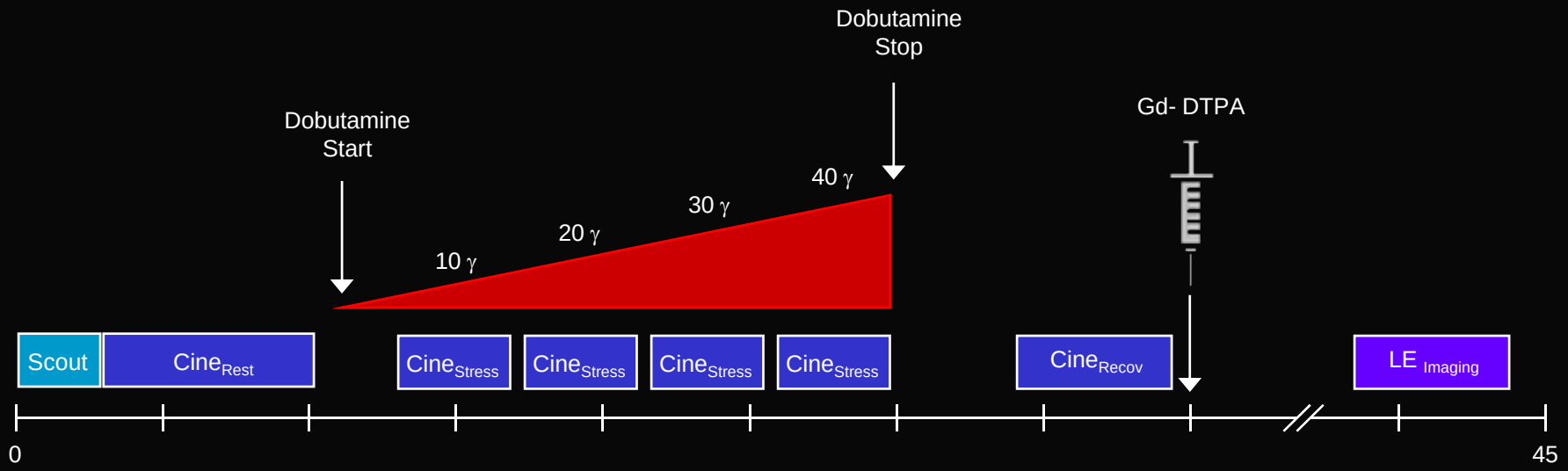
Short-Axis Views

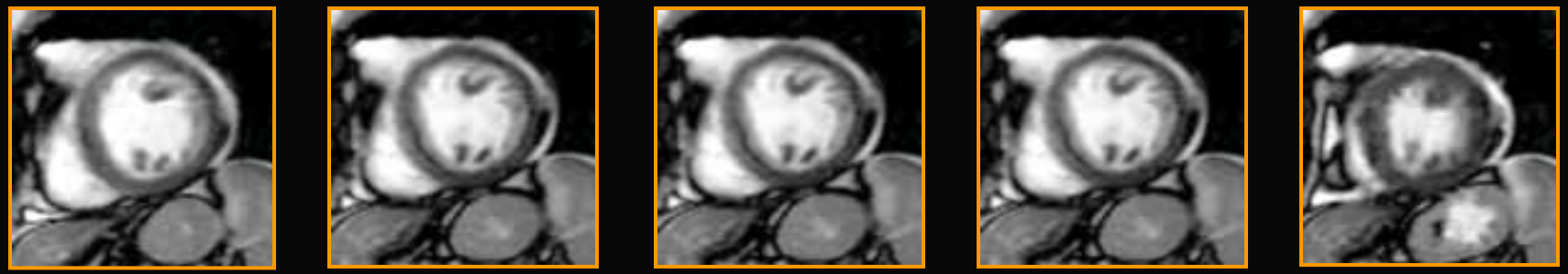


Wall Motion Score Index

0: Normal wall motion
1: Mild/moderate hypokinesia
2: Severe hypokinesia
3: Akinesia
4: Dyskinesia

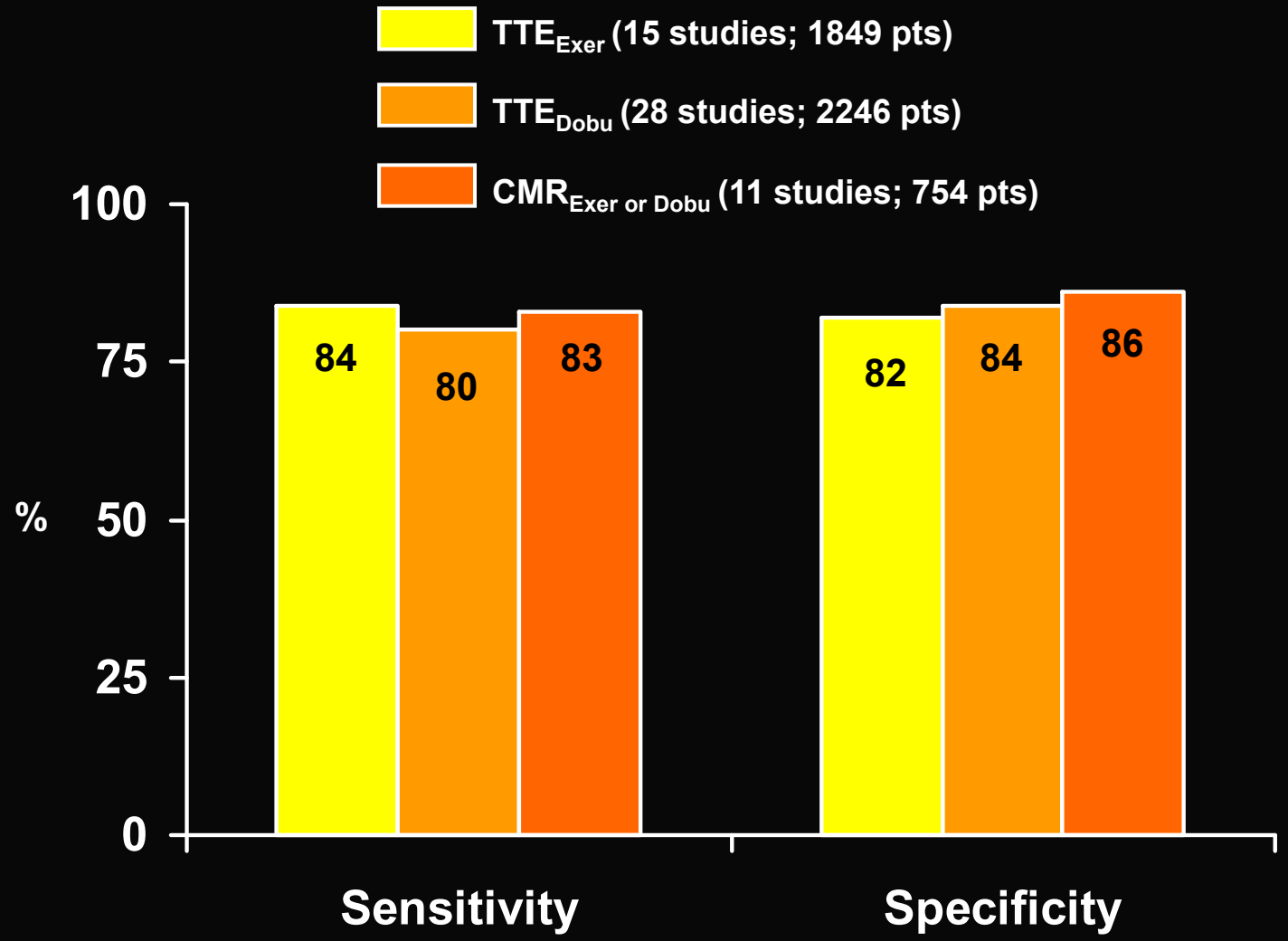
High-Dose Dobutamine Stress CMR Protocol: Wall-Motion Analysis





Basal | 10 µg/kg/min | 20 µg/kg/min | 30 µg/kg/min | 40 µg/kg/min

Ischemia-Induced Wall-Motion Abnormalities in the Detection of Coronary Artery Disease

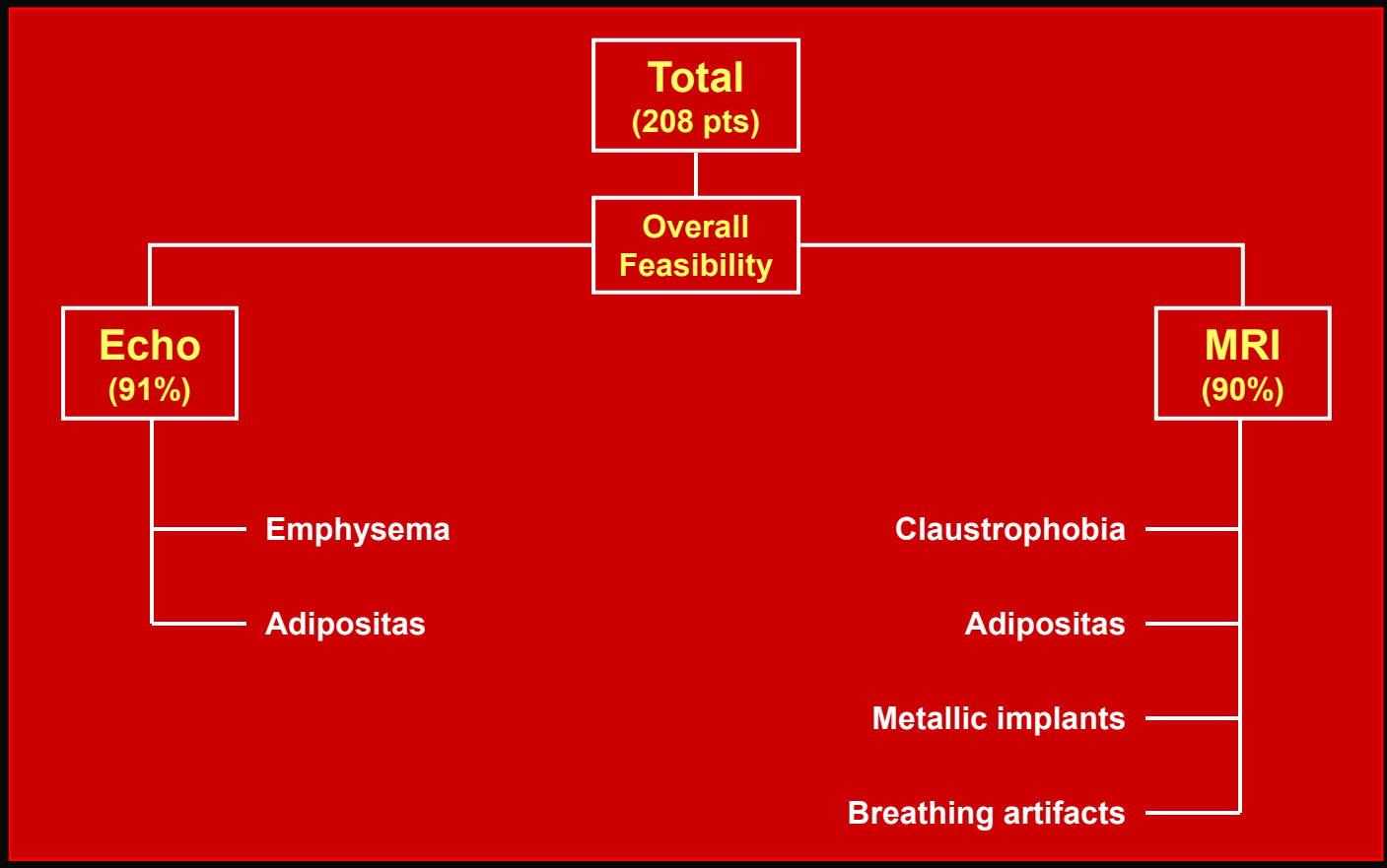


Schuijf JD et al. *Heart* 2005
Nandalur KR et al. *J Am Coll Cardiol* 2007

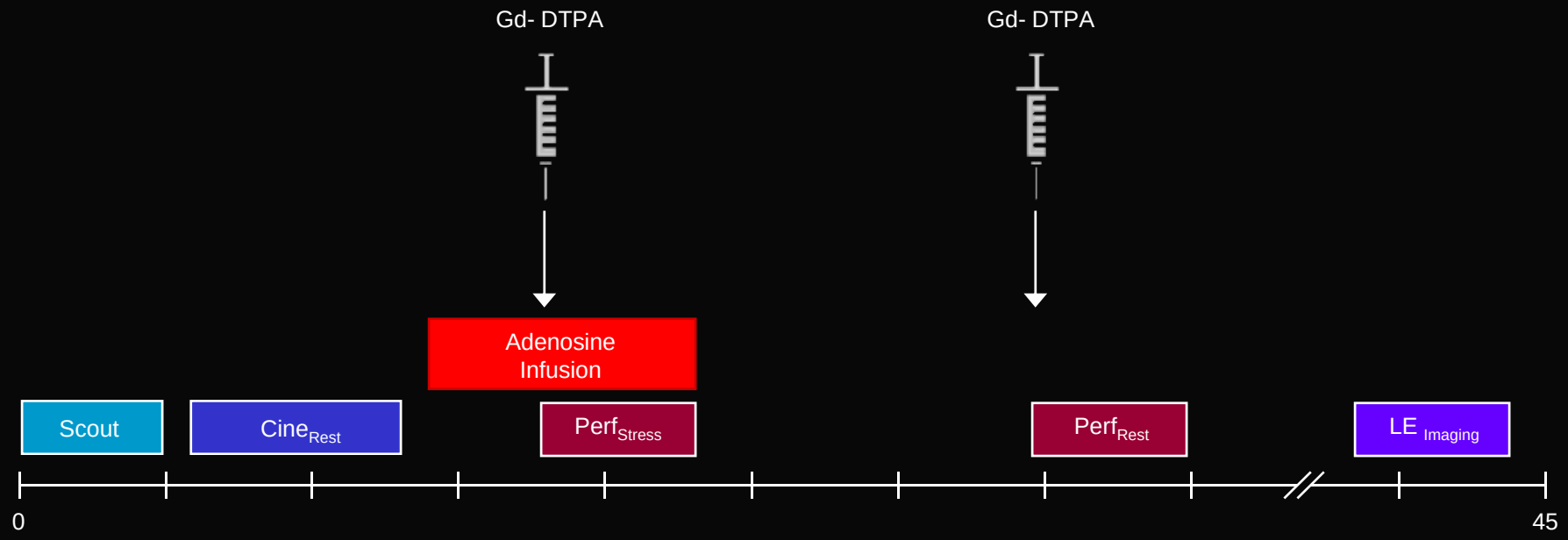
Diagnosis of Ischemia-Induced Wall Motion Abnormalities with the Use of High-Dose Dobutamine Stress MRI: Comparison with Dobutamine Stress Echocardiography

Nagel E, Lehmkuhl HB, Klein C, et al. *Circulation 1999*

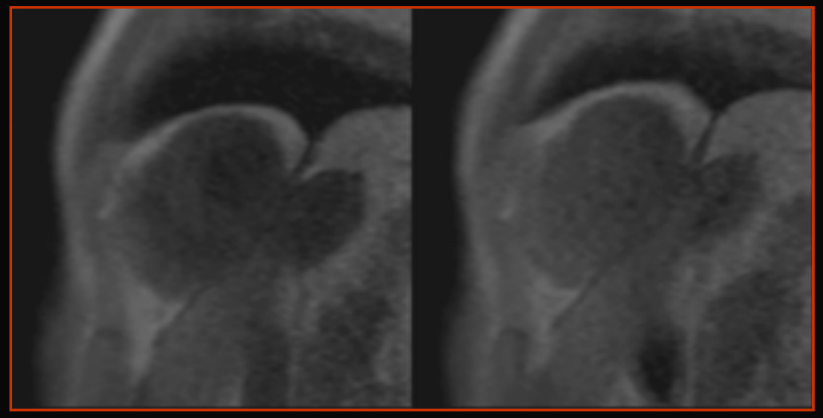
N= 208 pts with suspected CAD
Echo with second-harmonic imaging
1.5T MRI



Adenosine Stress CMR Protocol: Perfusion Analysis

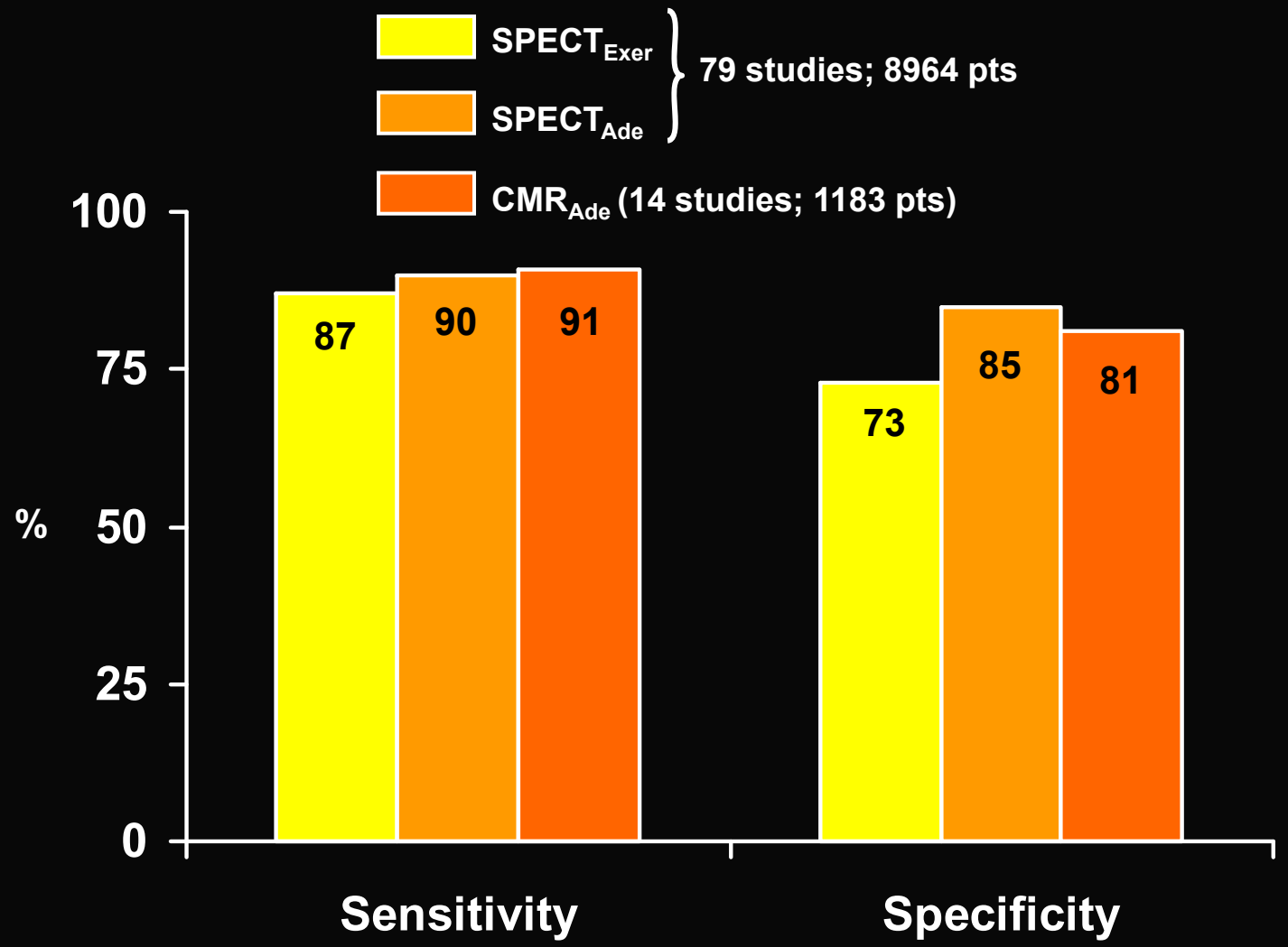


Stress (140 µg/kg/min)



Rest

Ischemia-Induced Perfusion Defects in the Detection of Coronary Artery Disease

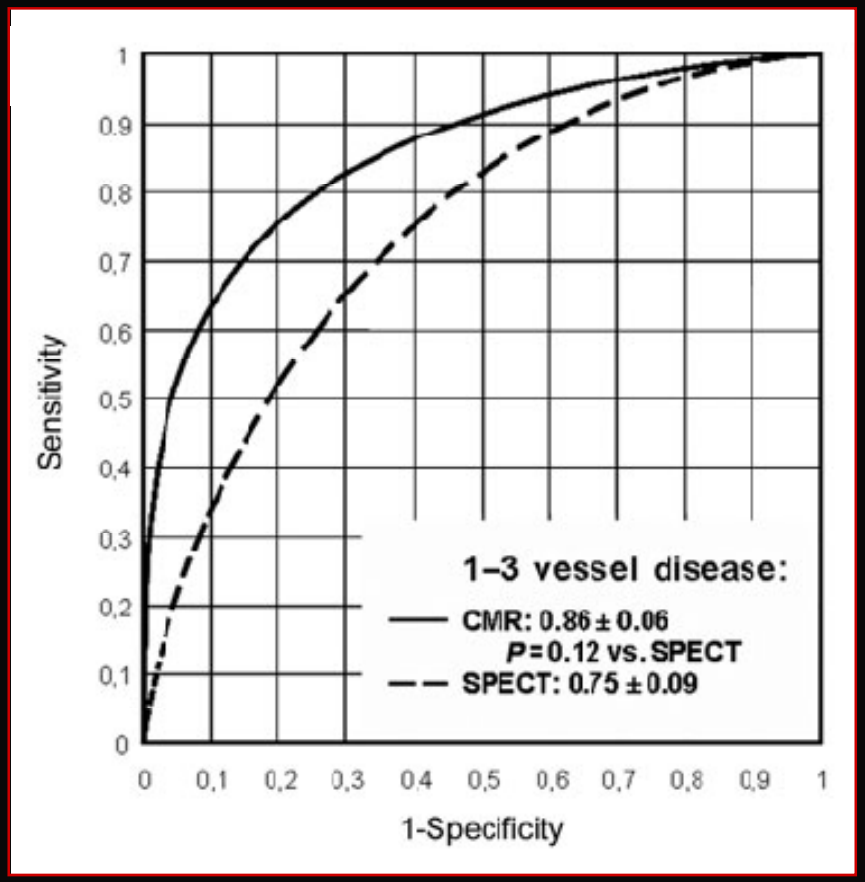


Underwood SR et al. *Eur J Nucl Med* 2004
Nandalur KR et al. *J Am Coll Cardiol* 2007

MR- IMPACT: Comparison of Perfusion-CMR with SPECT for the Detection of CAD in a Multicentre, Multivendor Trial

Schwitter J. et al. *Eur Heart J* 2008

N= 234 pts with suspected CAD (18 Centers)
1.5 T Adenosine-Stress CMR
CAD definition: diameter stenosis ≥50%



Non-Evaluable Studies

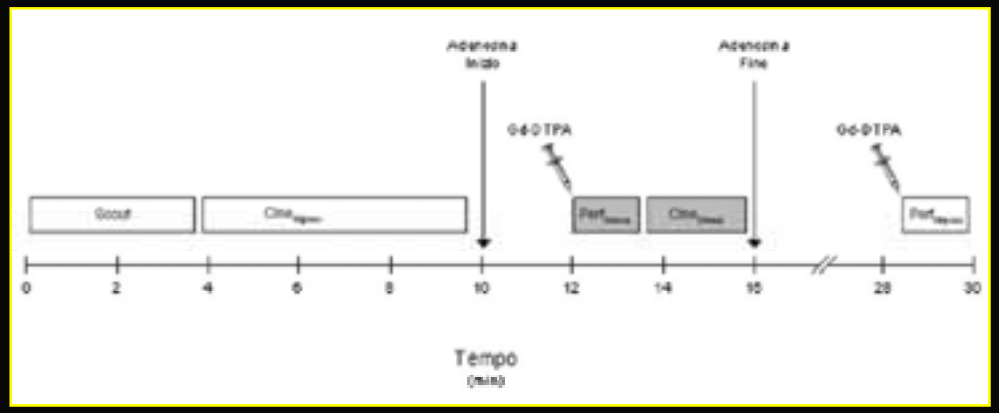
CMR	SPECT
5 (2.2%)	8 (3.6%)

Valutazione Combinata della Perfusione e della Contrattilita' Miocardica Mediante RM con Stress all'Adenosina

Fattibilita' ed Accuratezza nella Diagnosi di Malattia Coronarica

Dellegrottaglie S, Cospite V, Pedrotti P, e coll. *G Ital Cardiol 2009*

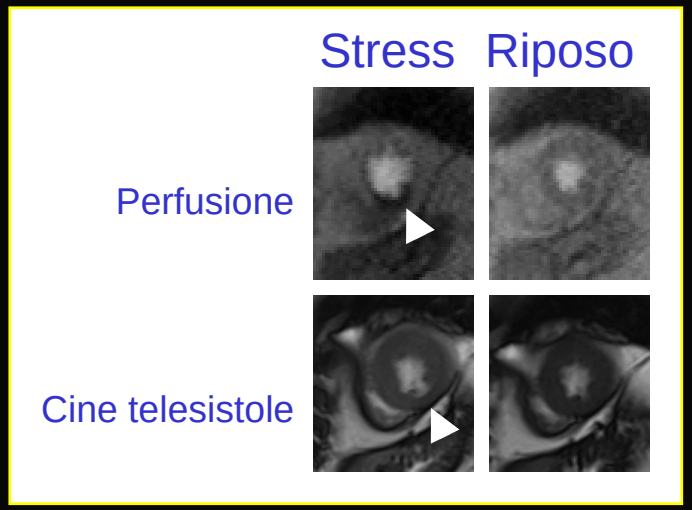
N= 184 pz con CAD nota o sospetta



Studi Non-Valutabili

CMR

2 (1%)



Sicurezza della Stress-RMC

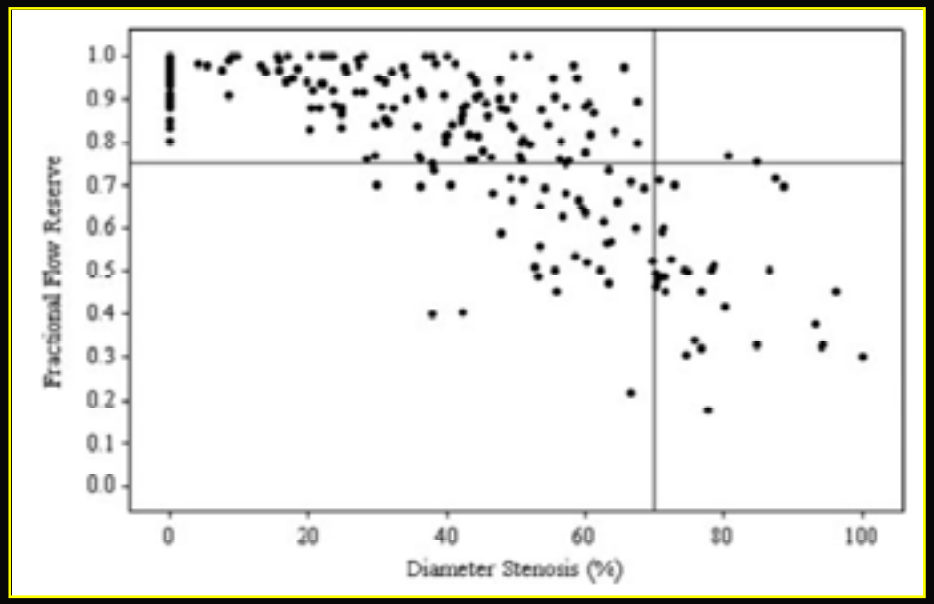
12 pz (7%) con eventi avversi lievi (dolore toracico, flushing, polipnea)

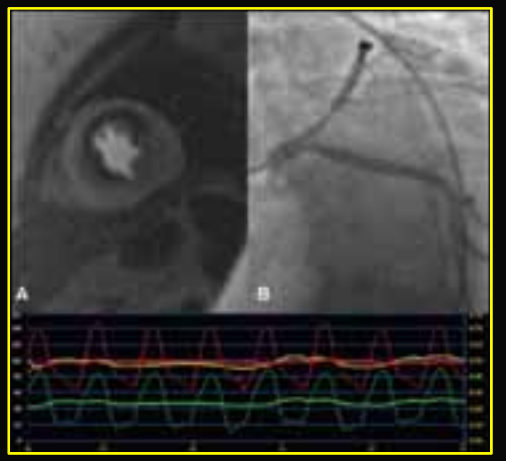
2 pz (1%) con eventi avversi moderati (broncospasmo severo, ischemia miocardica persistente)

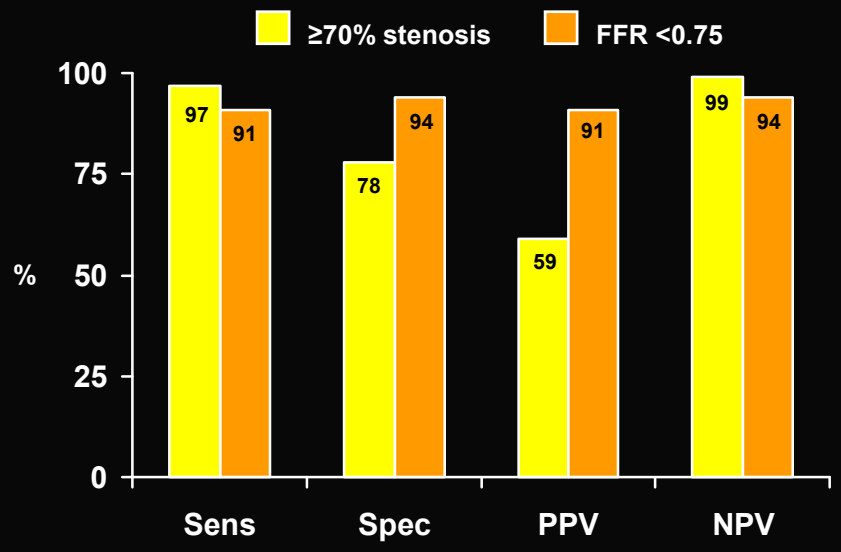
Validation of MR Myocardial Perfusion Imaging With Fractional Flow Reserve for the Detection of Significant Coronary Heart Disease

Watkins S. et al. *Circulation* 2009

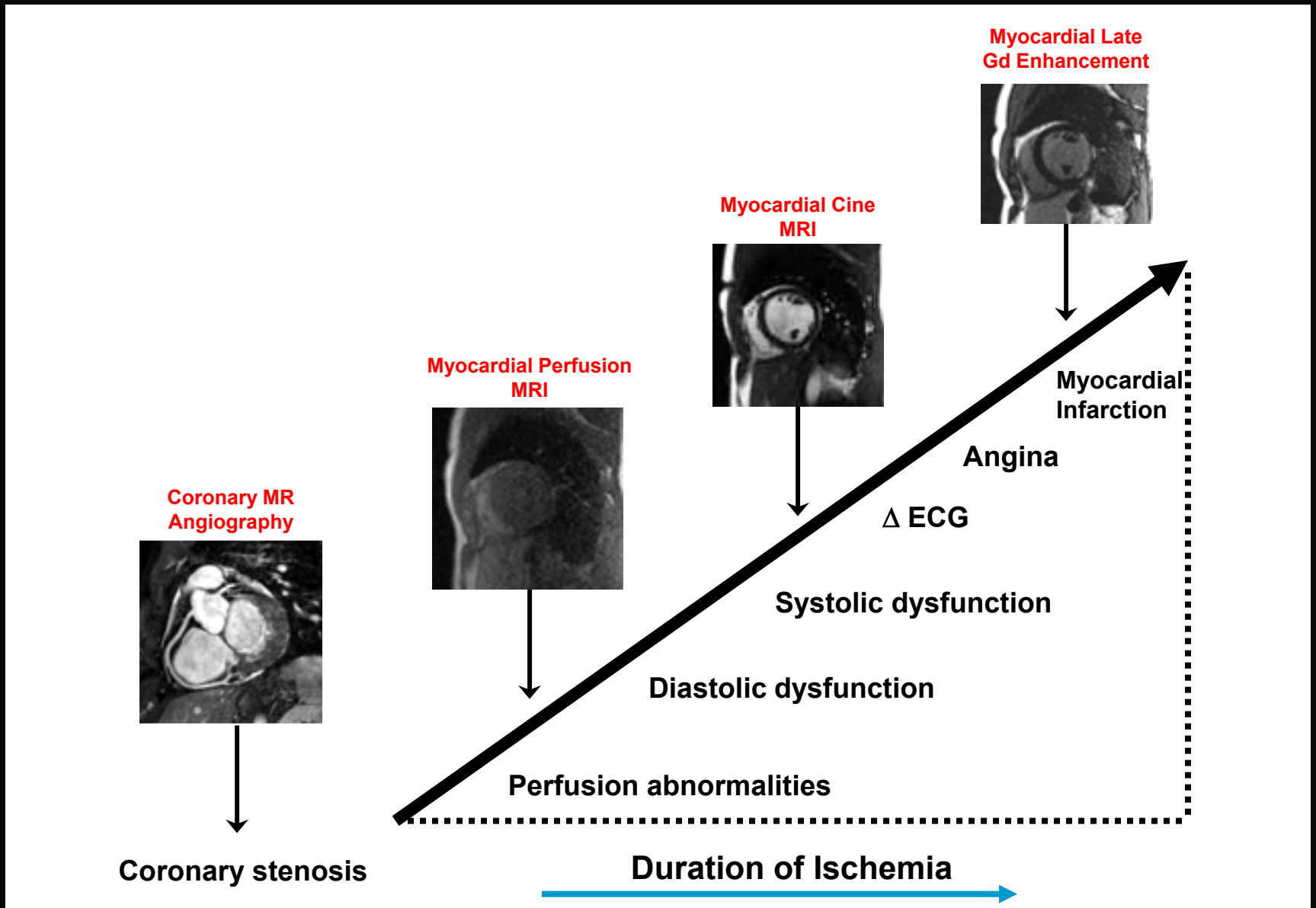
N= 103 pts with suspected CAD
1.5 T Adenosine-Stress CMR
FFR in major epicardial coronaries



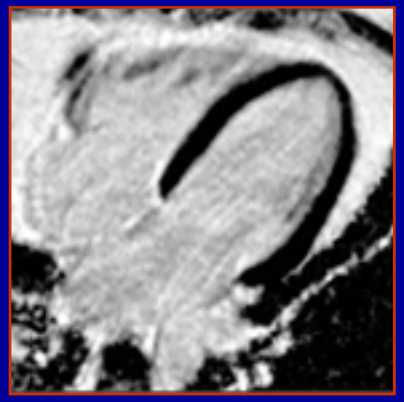


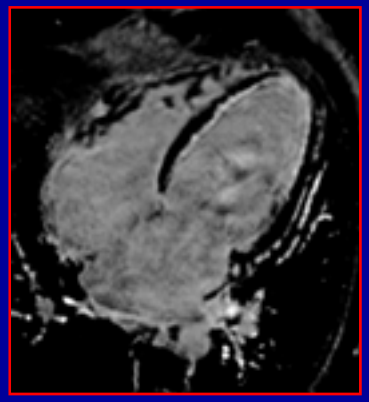


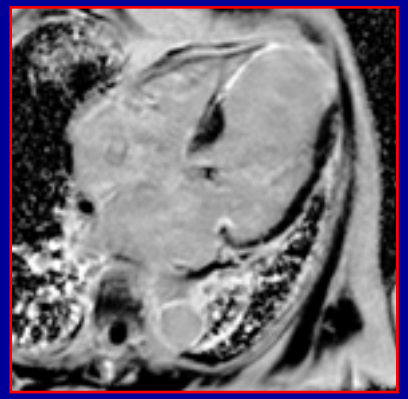
Cardiac MRI in the Ischemic Heart Disease



LE-CMR: An Improved CMR Technique for the Visualization of Myocardial Infarction







Segmented inversion-recovery turbo fast low-angle shot (FLASH)

Gd-based contrast agent injection

(0.10-0.30 mmol/kg/min)

5-30 min

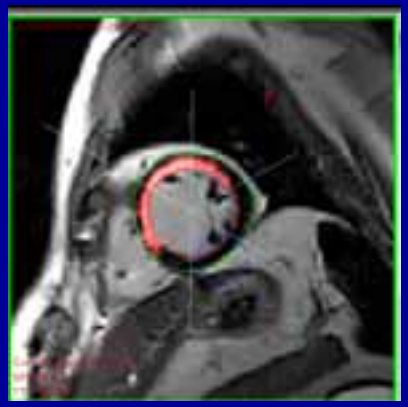
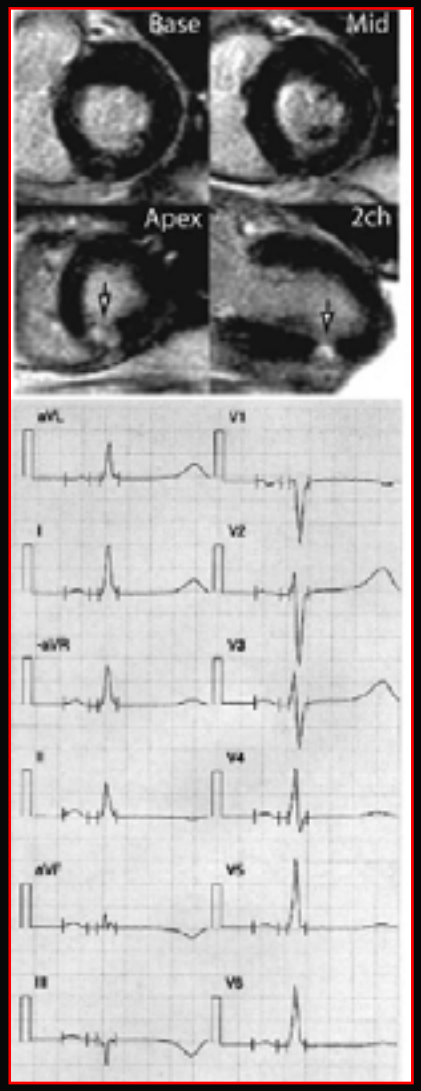


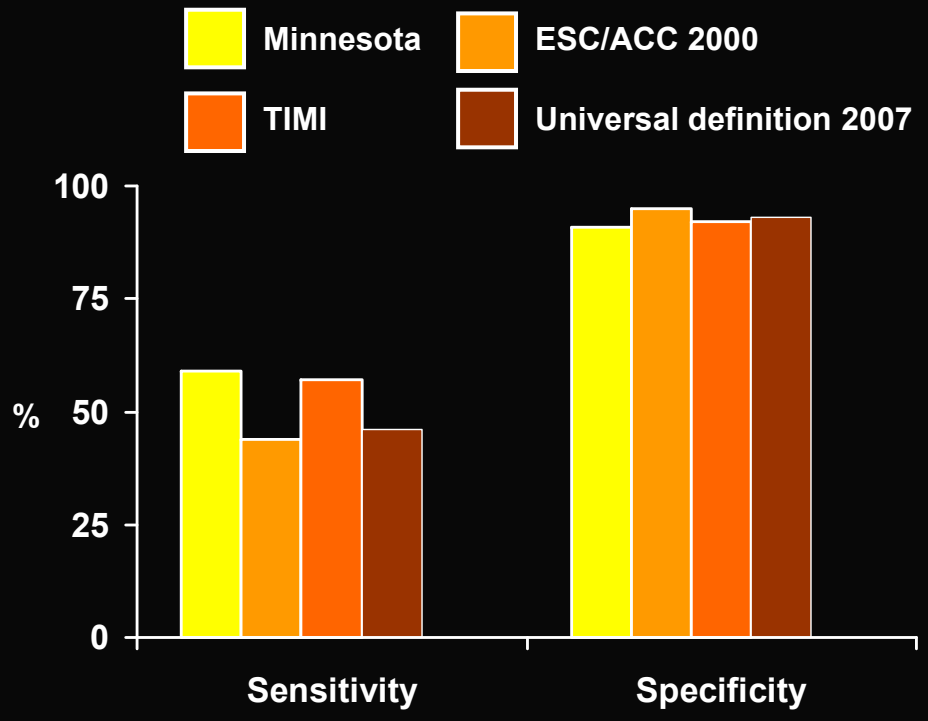
Image acquisition

Dellegrottaglie S et al. Fundamental Principles of MRI.
In: Mukherjee D, Rajagopalan S, Dellegrottaglie S eds.
CT and MR Angiography of the Peripheral Circulation. 1st edition.
Taylor & Francis Group, 2007

Limited Sensitivity of ECG Criteria for Healed MI in Comparison With Cardiovascular Magnetic Resonance

Krittayaphong R et al. *Am J Cardiol* 2009

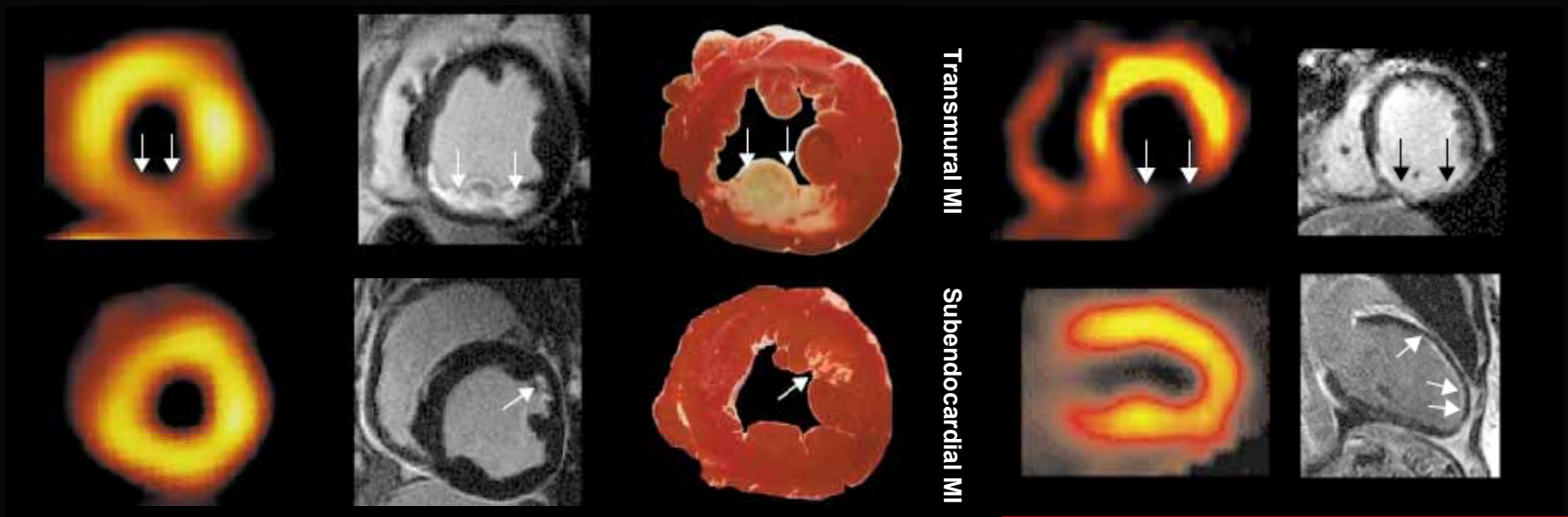


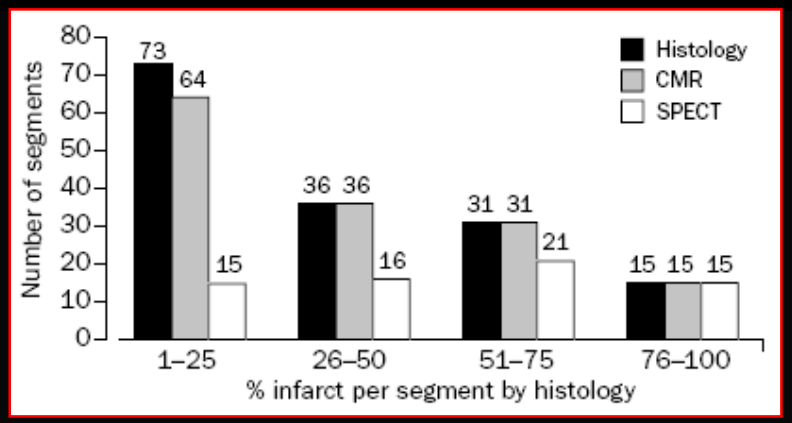


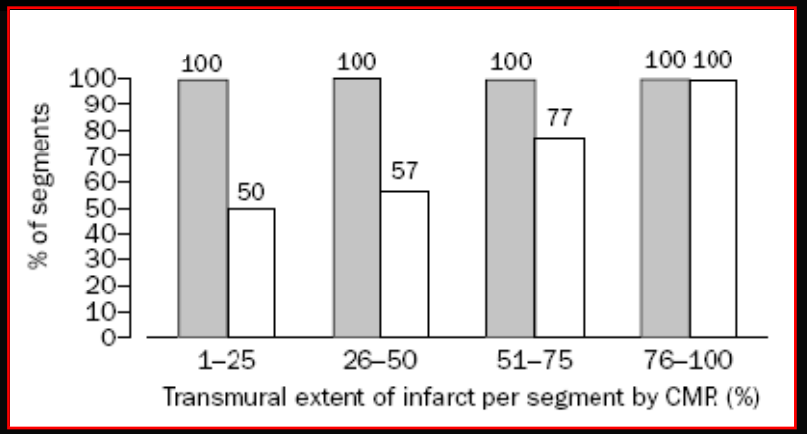
Contrast-enhanced MRI and Routine SPECT Perfusion Imaging for Detection of Subendocardial Myocardial Infarctions

Wagner A et al. *Lancet* 2003

N= 91 pts with suspected or known CAD
and 12 dogs with MI
CE CMR and ^{99m}Tc SPECT

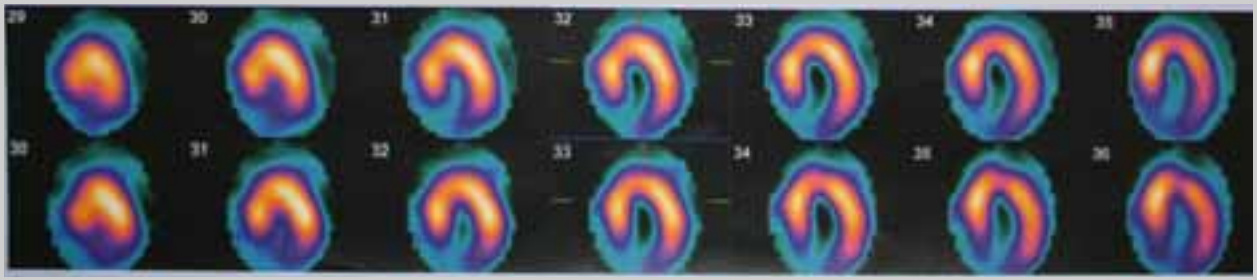




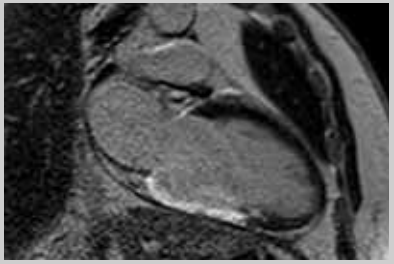


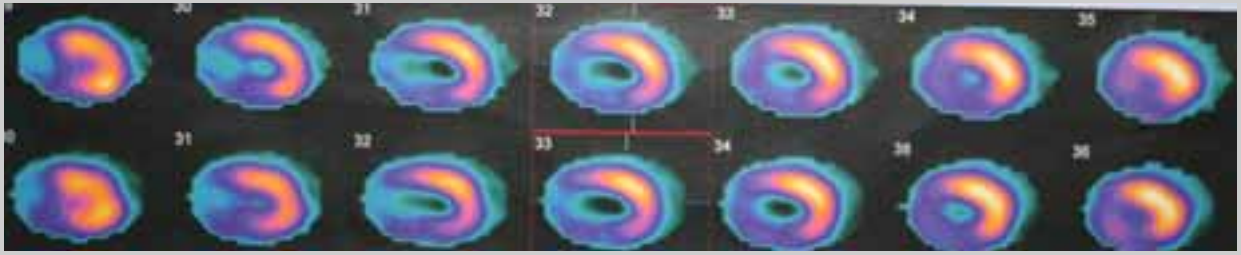
T.D.

HLA

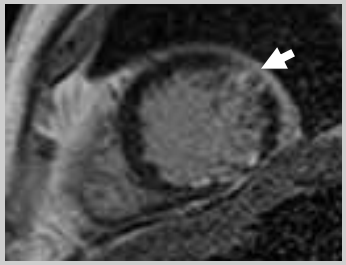


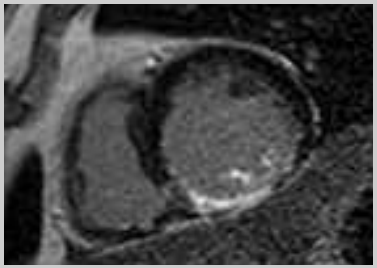
VLA

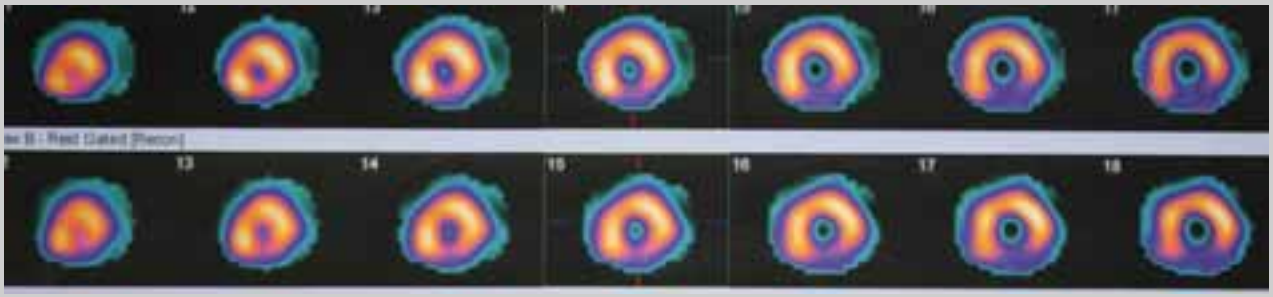




SA







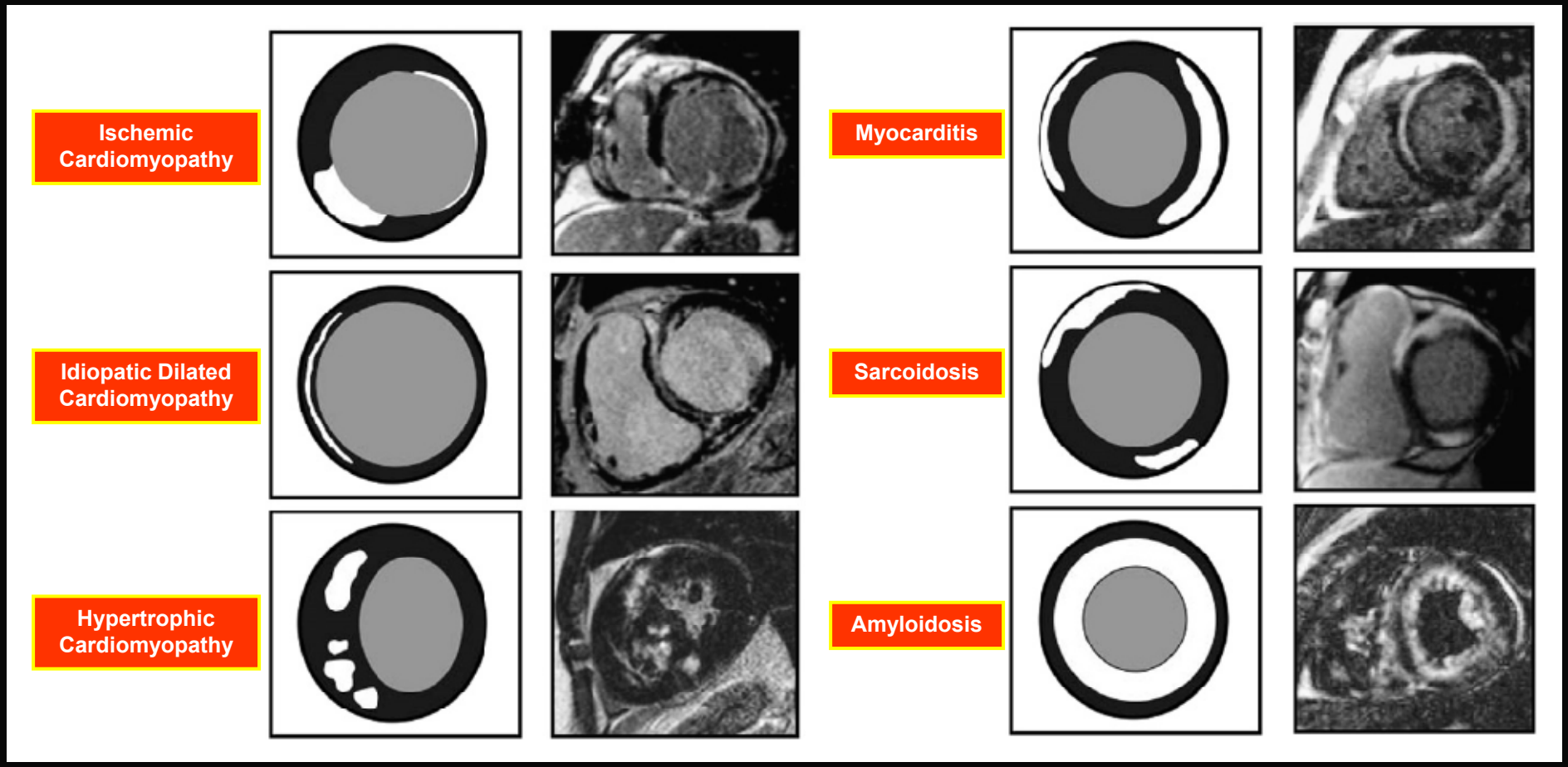
Cath:

- occluded II OM

- >90% PDA

Characteristic Patterns of Late Enhancement in Specific Cardiomyopathies

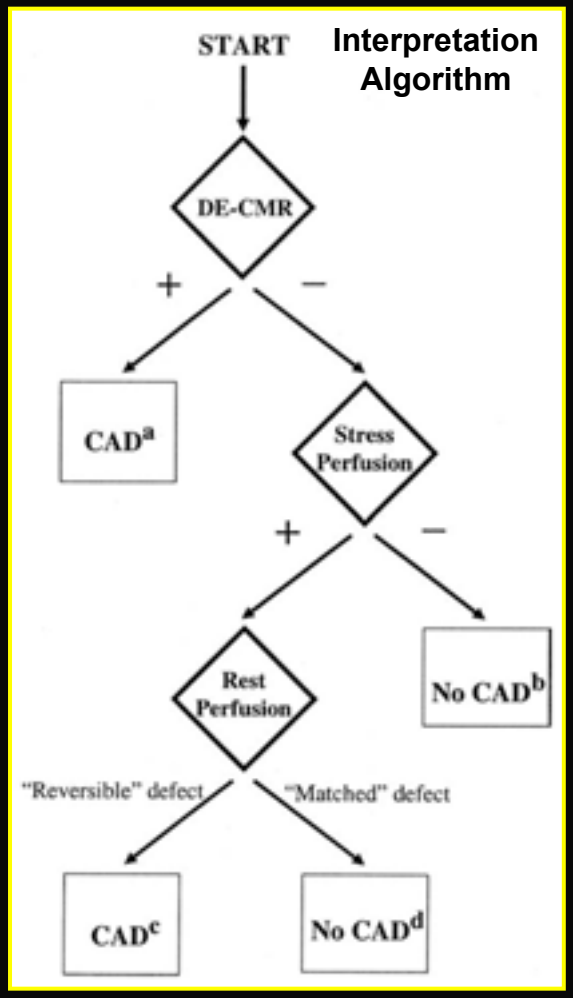
White JA and Patel MR. *Cardio Clin* 2007

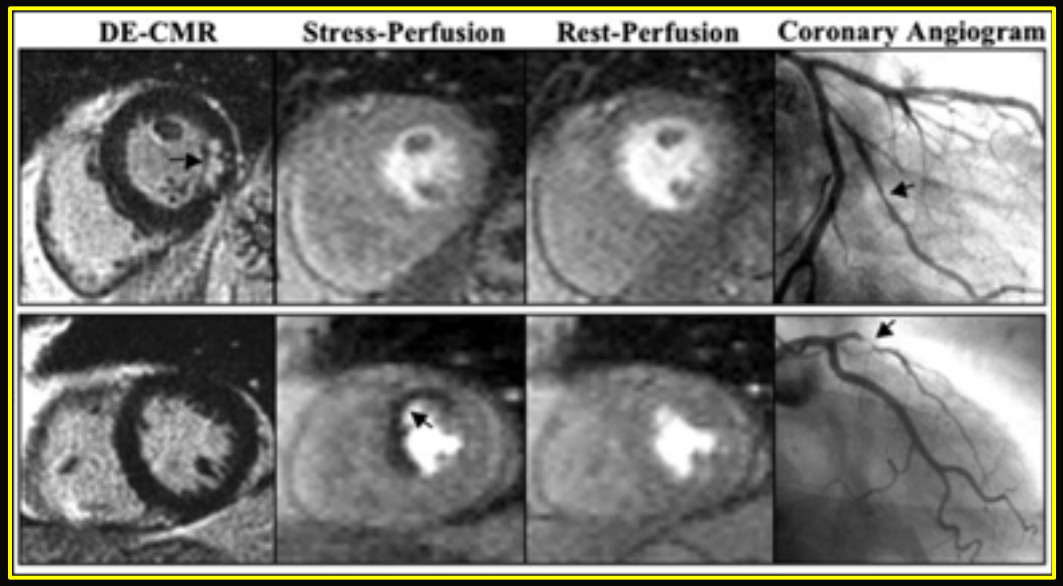


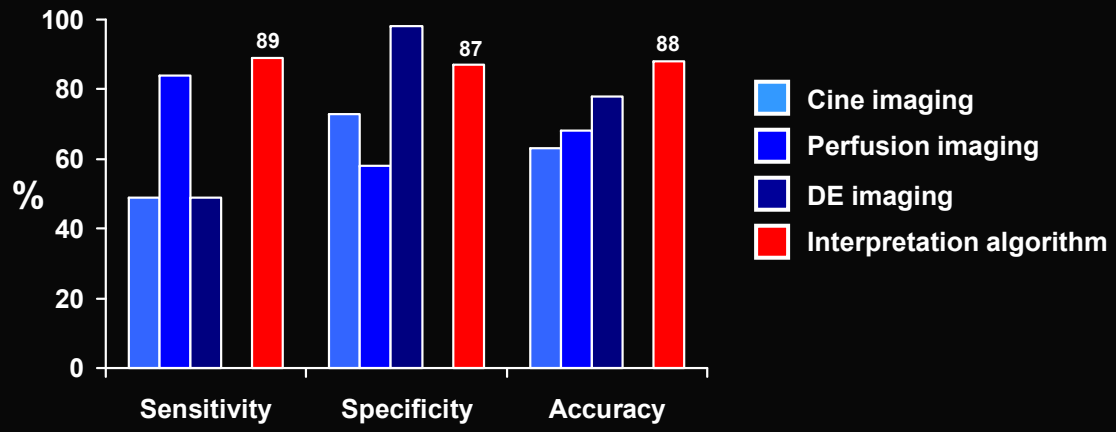
Improved Detection of CAD by Stress Perfusion CMR With the Use of Delayed Enhancement Infarction Imaging

Klem I et al. *J Am Coll Cardiol* 2006

N= 92 pts with suspected CAD and scheduled for Cath (CAD with stenosis >70%)





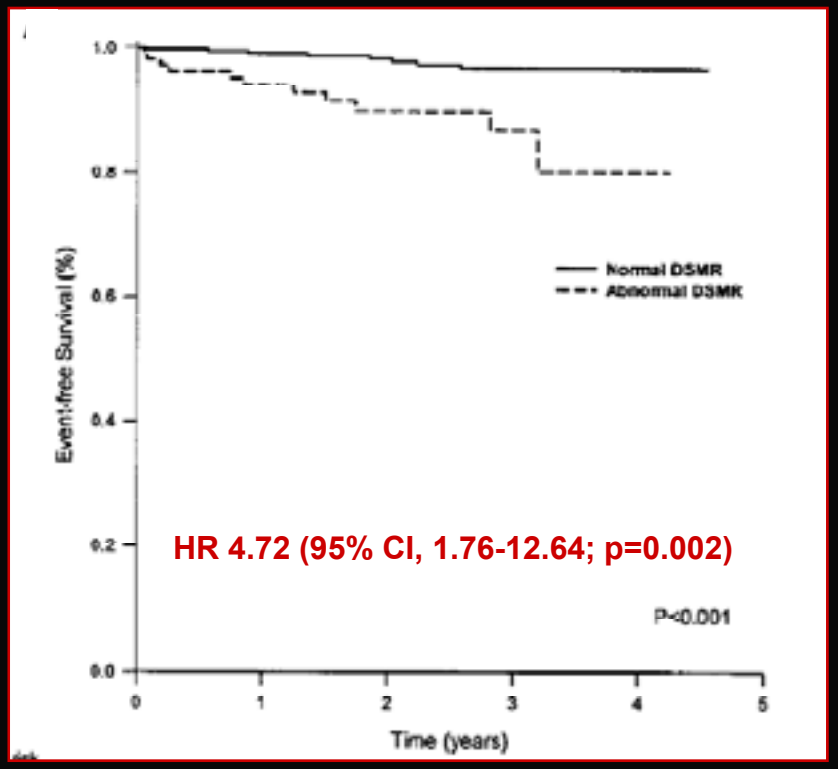


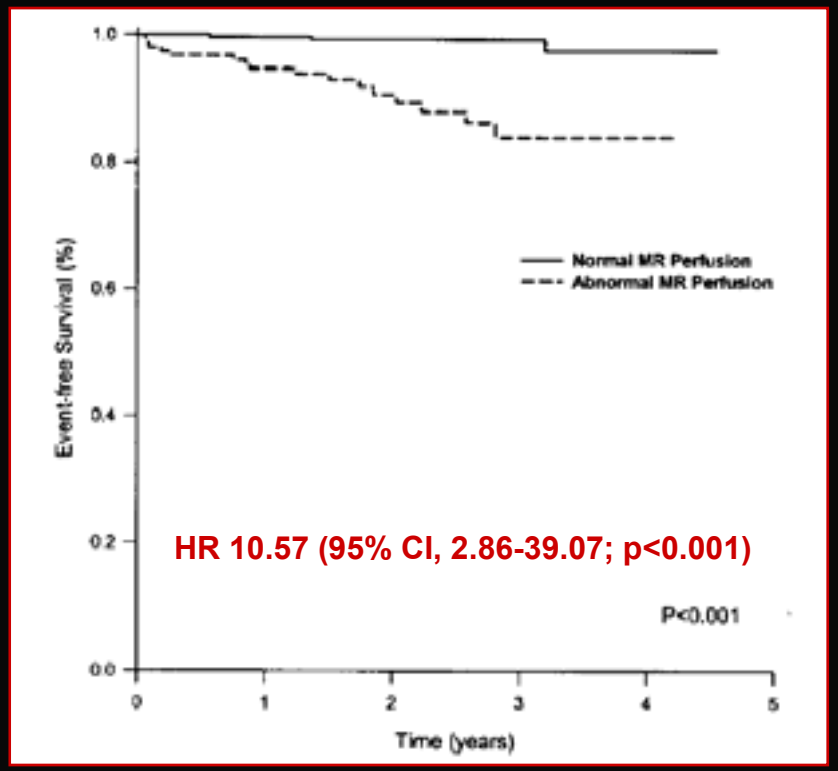
Prognostic Value of Cardiac MR Stress Tests

Adenosine Stress Perfusion and Dobutamine Stress Wall Motion Imaging

Jahnke C, Nagel E, Gebker R, et al. *Circulation 2007*

N= 513 pts with known or suspected CAD
1.5T CMR
Combined Ade-Dob single-session stress CMR
Median follow-up 2.3 years
19 cardiac events (death, non-fatal MI)





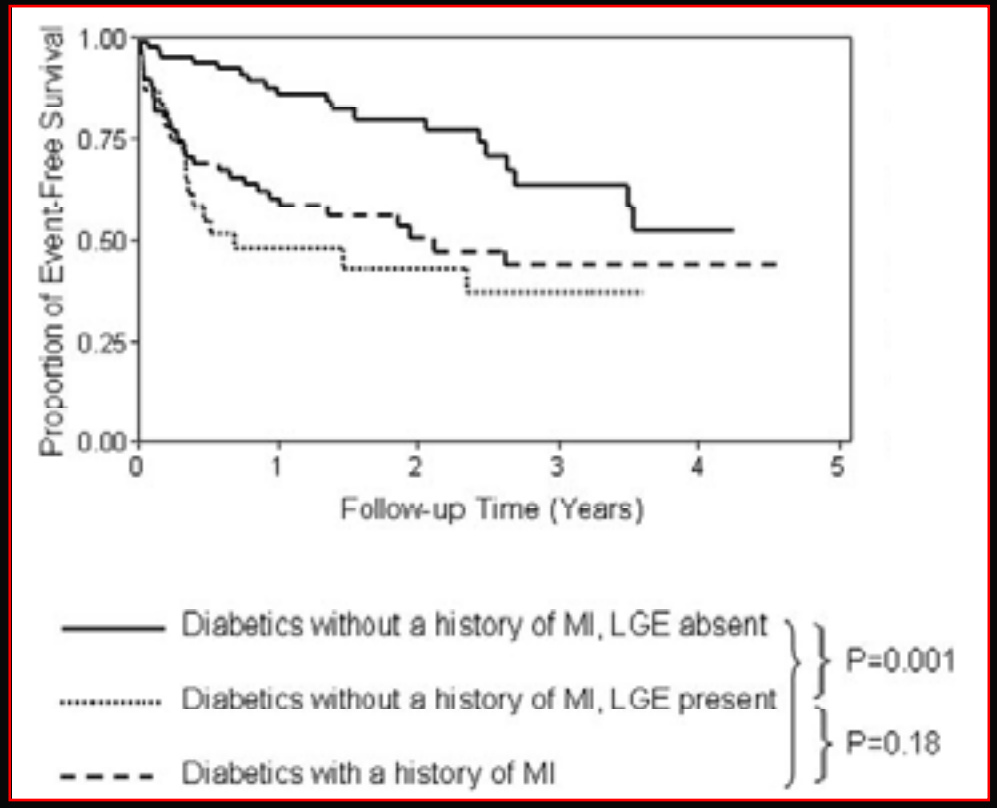
For patients with normal cardiac MR stress test the 3-year event-free survival was 99.2%

Incidence and Prognostic Implication of Unrecognized Myocardial Scar Characterized by Cardiac MR in Diabetic Patients Without Clinical Evidence of MI

Kwong R.Y. et al. *Circulation* 2008

N= 181 DM pts with or without clinical evidence of MI
CE-MRI
Median follow-up = 17 months
MACEvents = cardiac death, MI, unstable angina, new CHF, stroke, smajor ventricular arrhythmias.

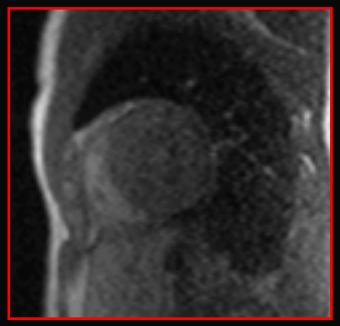
LGE by CMR was present in 28% of pts without clinical evidence of MI.

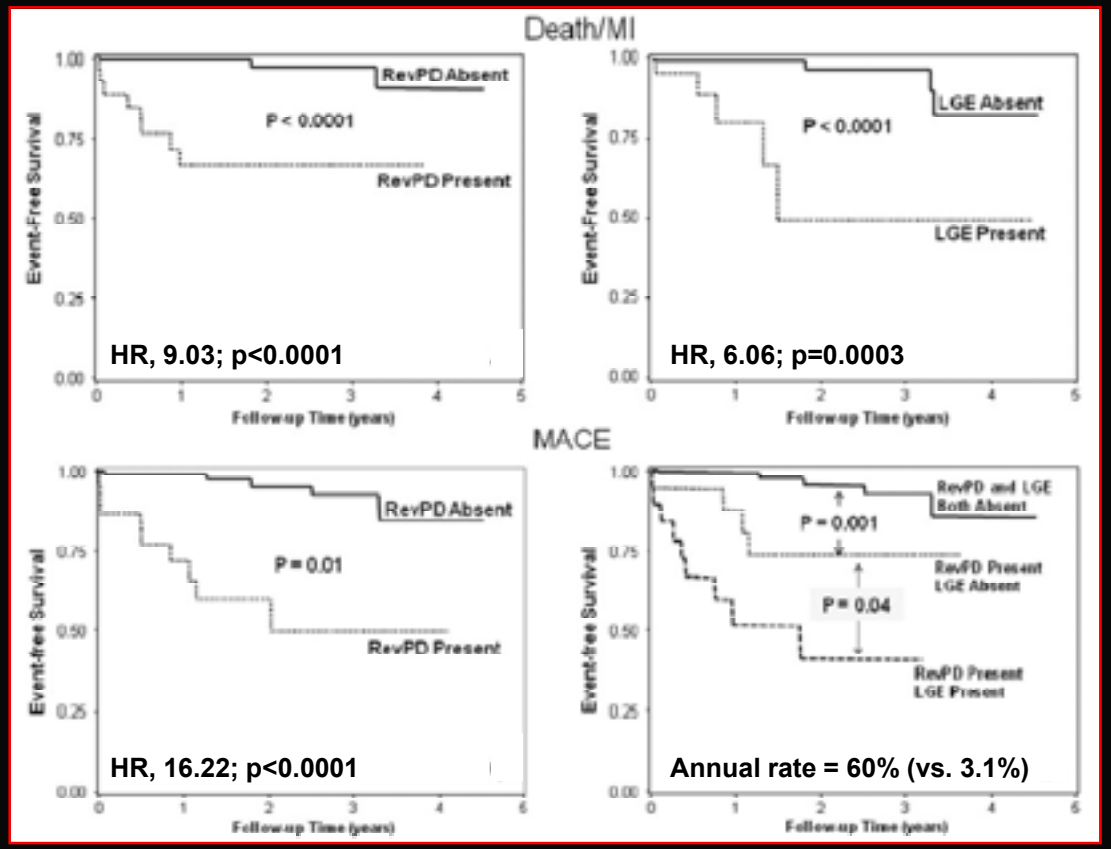


Complementary Prognostic Values of Stress Myocardial Perfusion and Late GE Imaging by Cardiac MR in Patients Without Clinical Evidence of Myocardial Infarction

Steel K. et al. *Circulation* 2009

N= 198 pts with suspected CAD and without history of MI
Median follow-up = 17 months
MACEvents = cardiac death, MI, unstable angina





EuroCMR Registry

Results of the German Pilot Phase

Bruder O. et al. *J Am Coll Cardiol* 2009

Baseline Characteristics	N= 11,040 from 20 Centers
All	100 (11,040)
Male	63.7% (7,020/11,017)
Female	36.3% (3,997/11,017)
Age (yrs)	60 (47–70)
BMI (kg/m^2)	26.2 (23.7–29.4)
Field	
1.0-T	1.1% (116/11,002)
1.5-T	98.2% (10,801)
3.0-T	0.8% (85)
Stress	
No stress	68.5% (7,565/11,040)
Adenosine	20.9% (2,309)
Dobutamine	10.6% (1,166)
Reader	
Cardiologist	78.2% (8,619)
Team of cardiologist and radiologist	20.1% (2,215)
Radiologist	1.7% (187)
Primary indication for CMR	
Myocarditis/cardiomyopathies	31.9% (3,511/11,026)
Suspected CAD/ischemia in known CAD	30.8% (3,399)
Myocardial viability	14.7% (1,626)
Valvular heart disease	4.8% (531)
Aortic disease	3.4% (372)
Congenital heart disease	1.6% (181)
Ventricular thrombus	1.4% (154)
Cardiac masses	1.2% (129)
Pulmonary vessels	1.1% (126)
Coronary vessels	0.2% (25)
Other than above	8.8% (972)

Impact of CMR on Patient Management by Indication

	Suspected CAD/Ischemia
All (from n = 11,040)	30.8%
Completely new diagnosis not suspected before	19.6%
Therapeutic consequences	
Change in medication	25.9%
Intervention/surgery	6.7%
Invasive angiography/biopsy	15.6%
Hospital discharge	3.6%
Hospital admission	0.2%
Impact on patient management (new diagnosis and/or therapeutic consequence)	71.2%

From April 2007 and January 2009

Il Contributo della Cardio RM nella Gestione del Paziente con Cardiopatia Ischemica Cronica

Santo Dellegrottaglie, MD – PhD

Dip. di Medicina Clinica, Scienze Cardiovascolari ed Immunologiche
Universita' Federico II
Napoli