Viability Assessment
Which test? What role?

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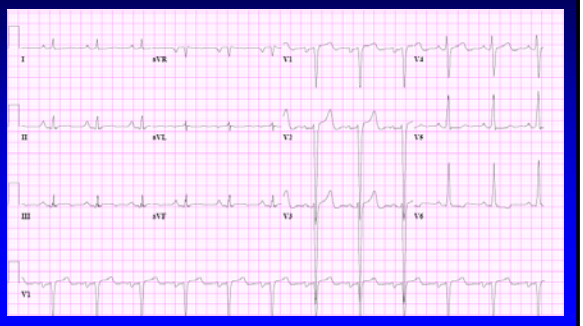
Case

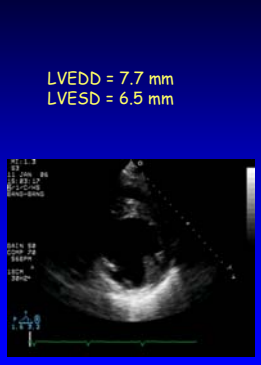
- 56 year old man with exertional angina and mild dyspnea last few months
- Posterior MI in 1992 → PTCA to LCx
- Hypertension, dyslipidemia
- Strong FH of CAD
- Exsmoker, alcohol use
- Current meds:
  ASA, atenolol, lisinopril, atorvastatin

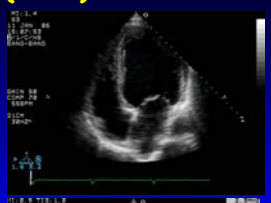
Case 1

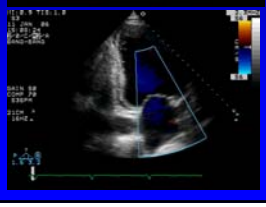


Case 1 (echo)

LVEDD = 7.7 mm
LVESD = 6.5 mm



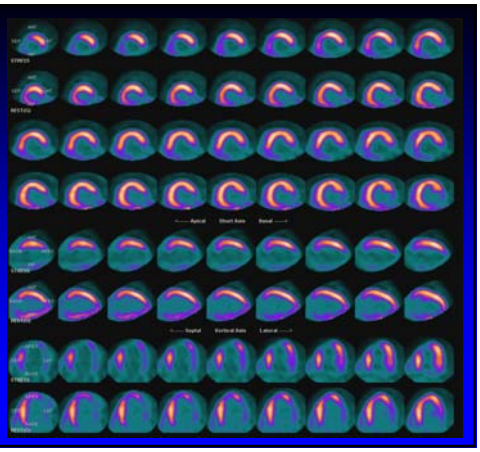




Case 1

Stress

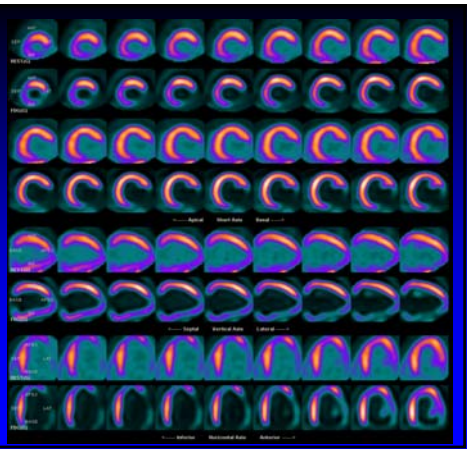
Rest



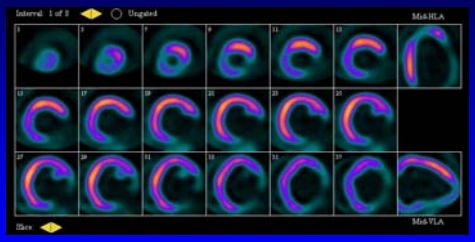
Case 1

Rest

FDG



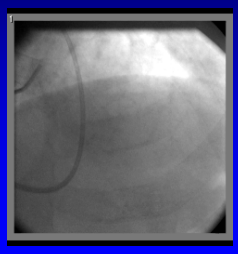
Case 1 (gated)

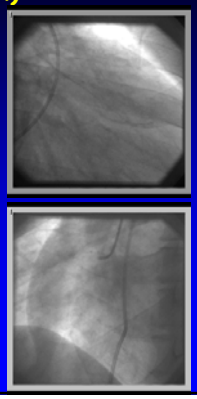


LVEDVI=236ml/m2 LVESVI=196 ml/m2 EF=17%

Case 1 (cath)

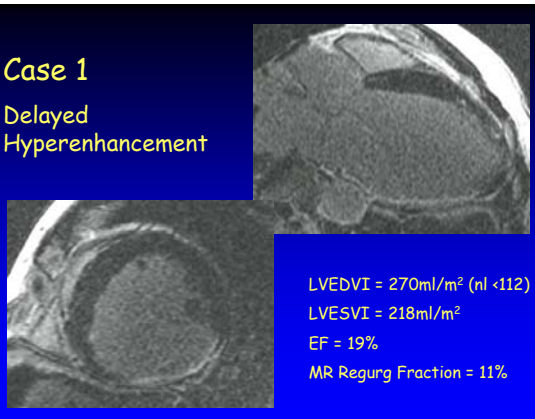
RA = 6 mmHg
RV = 48/7
PA = 47/25
PW = 24





Case 1

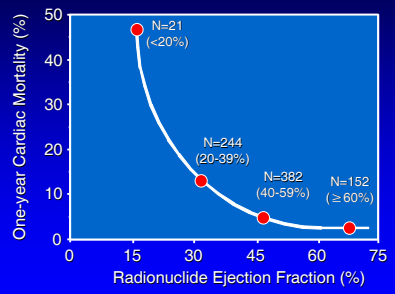
Delayed Hyperenhancement



LVEDVI = 270ml/m² (nl <112)
LVESVI = 218ml/m²
EF = 19%
MR Regurg Fraction = 11%

Ischemic Cardiomyopathy

- CAD is the most common etiology of HF in developed countries



The Multicenter Post Infarction Research Group, N Engl J Med 1982;309

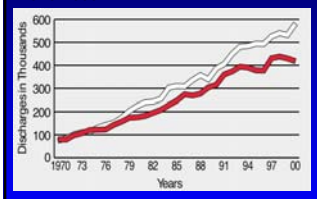
CHF

- Chronic Heart Failure in the US:
  - 550,000 new diagnosis annually each year
  - 5 million patients in the US have chronic HF
  - 1 million annual hospitalizations
  - Diagnostic and therapeutic costs are > 29 billion annually
  - 5-year Mortality from Framingham for the years 1990 – 1999 was 59% for men and 45% for women

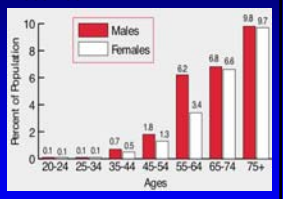
- AHA – 2006 Heart Disease and Stroke Statistics
- Schinkel et al. J Nuc Med 2007
- Schinkel et al. Am J Cardiol 2004

Congestive Heart Failure Facts

Hospital discharges for CHF 1970-2000

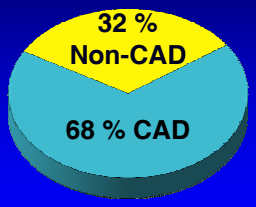


Prevalence of CHF by age and gend 1988-1994



CDC/NCHS

Prevalence of CAD in Heart Failure Treatment Trials



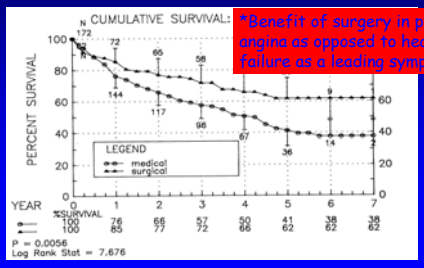
Data from 13 randomized multicenter HF trials in NEJM since 1986

Total = 20,190 patients

Gheorghiade and Bonow, Circ 1998

Ischemic Cardiomyopathy

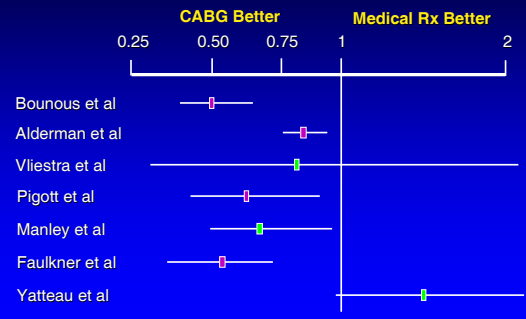
- CASS study showed survival benefit of CABG over medical tx in pts with severe LV dysfunction



*Benefit of surgery in pts with angina as opposed to heart failure as a leading symptom

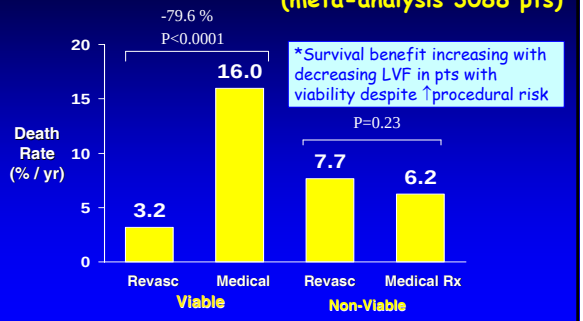
Alderman et al, Circulation 1983;4:785

Cohort Studies of CABG vs Medical Treatment for Patients With LVEF ≤40%



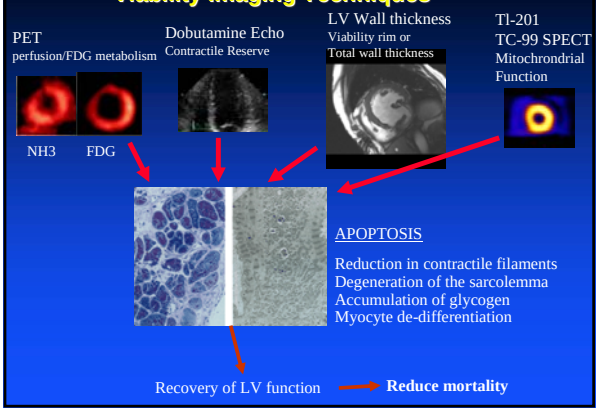
Baker et al, JAMA 1994

Impact of viability testing on prognosis (meta-analysis 3088 pts)



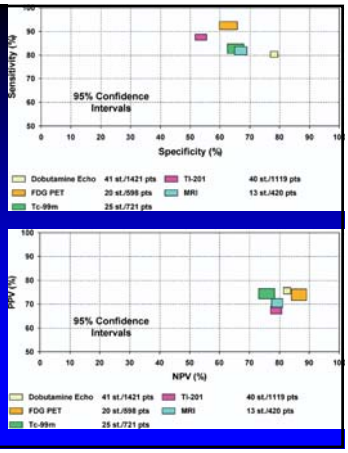
Allman et al, JACC 2002

Viability Imaging Techniques



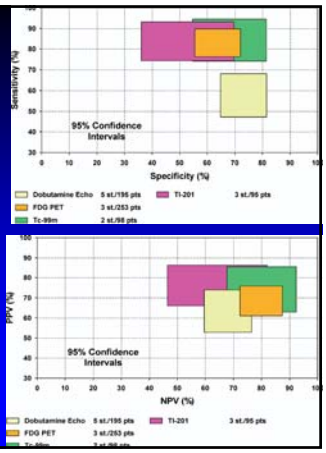
Viability Detection

- Highest Sensitivity: FDG PET
- Highest Specificity: Dobutamine ECHO



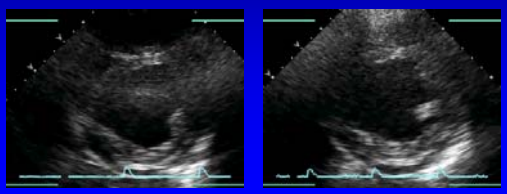
Recovery of Global Function

- Nuclear techniques are the most sensitive
- ECHO is the most specific



Dobutamine Echo for viability

- Improved WM with low dose Dobutamine (5-10mcg/kg/min)
- Improvement with low dose then worse with higher dose (biphasic response)
- Worsening WM even with low dose (ischemia)



Dobutamine for Viability

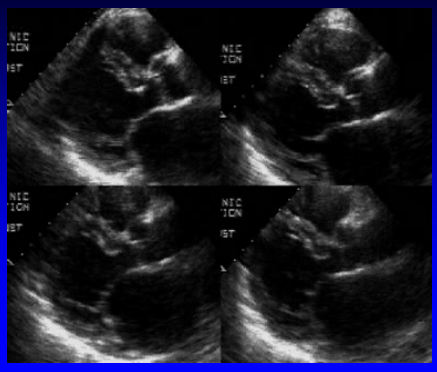
- Can use either a low dose dobutamine echo (LDDE) or high dose (HDDE) protocol
- Like with all echo techniques, since the myocardium is directly being visualized, the contractility of the wall segments is what is evaluated
- Subject to the same limitations of any general ECHO study – Body habitus, contraindication to dobutamine, etc.

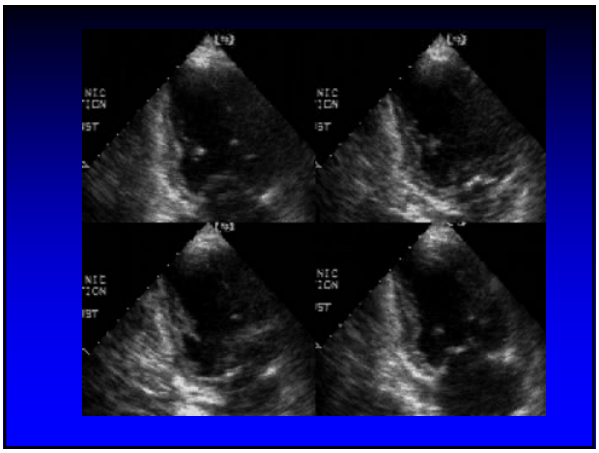
Response to Dobutamine

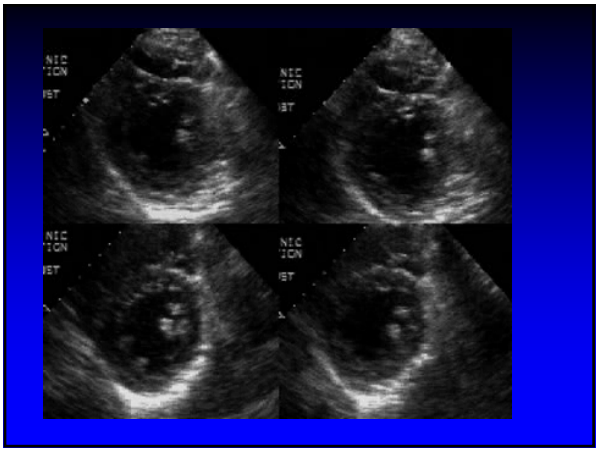
- Augmentation of segmental function (thickening) with low dose dobutamine and then increasing dysfunction at higher doses correlates with myocardial viability
- Additionally, myocardial segments that are less than 5-6mm in thickness are unlikely to recover function after coronary revascularization
  - Segment thickness:
    - < 6 mm – 5% likelihood of functional improvement after revascularization
    - > 6 mm – 50% likelihood of functional improvement after revascularization

Responses to Dobutamine

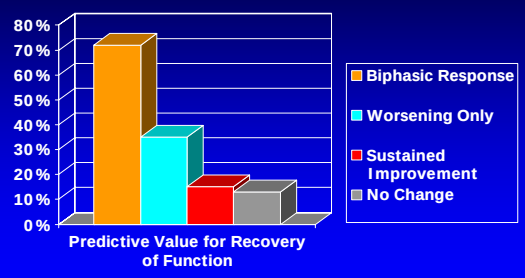
1. Biphasic – Initial improvement followed by worsening of wall motion
   - Viability w/ superimposed ischemia
2. Worsening – Direct deterioration of wall motion without initial improvement
   - Severe ischemia in an area supplied by a critically stenosed artery
3. Sustained Improvement – Improvement of wall motion without any subsequent deterioration
   - Subendocardial necrosis
4. No Change – No change throughout the entire study
   - Transmural scar







DSE Predicts Viability in CAD and CHF



Afridi et al. *Circ* 1995; 91(3): 663-670.

Viability in CAD and CHF

274 patients with CAD and EF < 40% underwent LDDE

CABG (n=118)

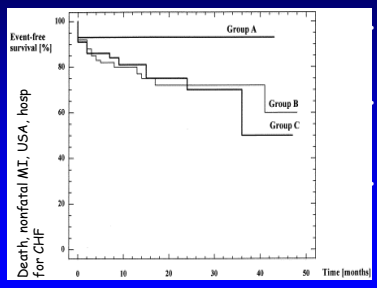
PTCA (n=15)

2D echo repeated at 3-6 months post revascularization

Follow up for 20 ± 12 months

Meluzin et al. *JACC* 1998; 32(4): 912-920.

Viability in CAD and CHF



- Group A
  - > 6 viable segments
- Group B
  - 2-5 viable segments
- Group C
  - nonviable

Meluzin et al. *JACC* 1998; 32(4): 912-920.

Viability in CAD and CHF

- 318 patients with CAD and LVEF ≤ 35%
- Viability defined as 4 or more dobutamine-responsive segments
- Decision to revascularize made by physician, not randomized
- Follow up for 18 ± 10 months

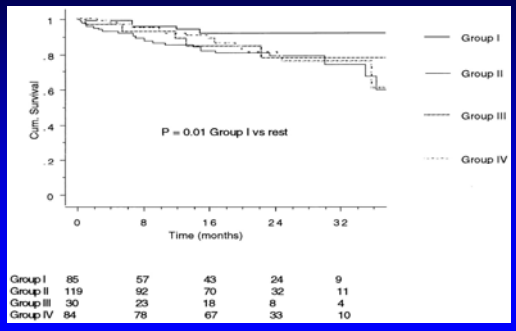
Afridi et al. *JACC* 1998; 32(4): 921-926.

Viability in CAD and CHF

Group I (n=85)	Viable, Revascularized
Group II (n=119)	Viable, Not Revascularized
Group III (n=30)	Not Viable, Revascularized
Group IV (n=84)	Not Viable, Not Revascularized

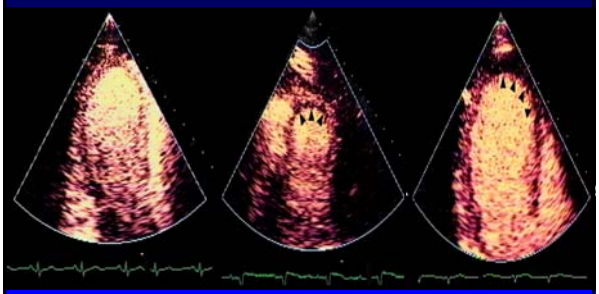
Afridi et al. *JACC* 1998; 32(4): 921-926.

Viability in CAD and CHF



Afridi et al. *JACC* 1998; 32(4): 921-926.

Grading of Myocardial Perfusion



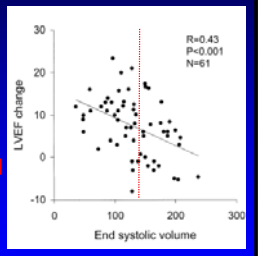
Normal = 2 Patchy = 1 Absent = 0

Studies Assessing the Predictive Accuracy of IV MCE in the Prediction of Functional Recovery following AMI

	Swinburn et al, 2001	Main et al, 2001
# of patients included in data analysis	96	34
# of patients revascularized during adm.	27 (28%)	30 (88%)
Mean # of akinetic segments within the IRA	4.2	6.0
Contrast agent used	Optison	Optison
Sensitivity(%) / Specificity(%)	59 / 76	77 / 83
PPV/ NPV	47 / 84	90 / 63

Why do patients with isch CMP and substantial amount of viable myocardium not always recover function after revascularization ?

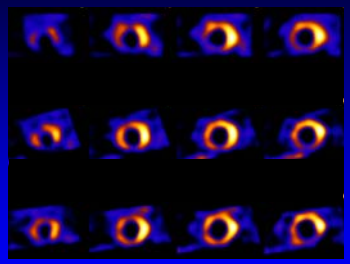
Clinical features	Patients with improvement (n = 41)	Patients without improvement (n = 20)	P value
Age (y)	61 ± 10	60 ± 9	.84
Male gender	33 (80%)	16 (80%)	1
Previous infarction	35 (85%)	20 (100%)	.18
Number of stenosed arteries	2.7 ± 0.6	2.7 ± 0.5	.54
NYHA functional class	2.8 ± 1.2	3.1 ± 1.2	.29
Baseline LVEF	28% ± 7%	28% ± 6%	.78
Number of viable segments	6.7 ± 2.5	6.7 ± 2.0	.96
End diastolic volume (mL)	174 ± 49	194 ± 65	.18
End systolic volume (mL)	121 ± 43	153 ± 41	.007



- 61 pts with viability in >25%LV on DE
- ESV >140 ml had the highest sensitivity & specificity to predict absence of LVF improvement

Schinkel et al, J Thorac Cardiovasc Surg 2004;127

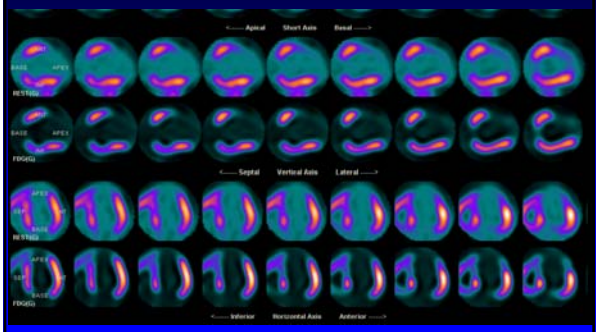
Tl^{201} late-redistribution vs. reinjection



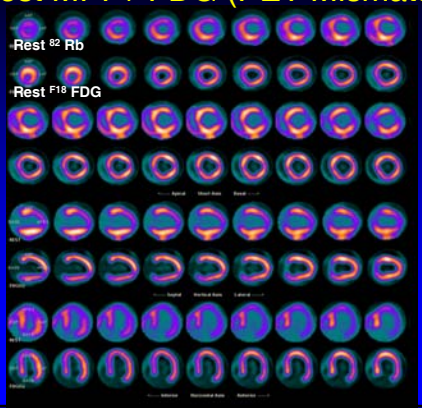
Stress→Rest→Reinjection 1-2mCi & image in 20min

Rest→Redistribution in 3-4 hrs

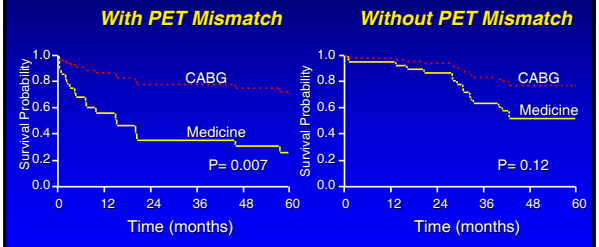
Rest MPI + FDG (PET Match)



Rest MPI + FDG (PET Mismatch)

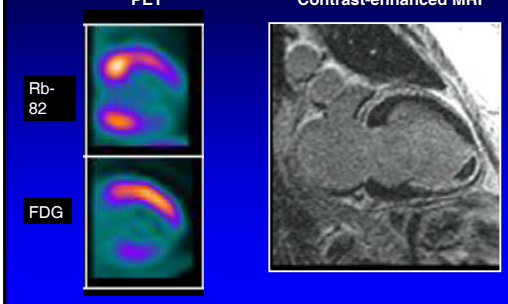


Long-Term Prognosis of Patients With LV Dysfunction by PET Pattern of Viability and Mode of Treatment

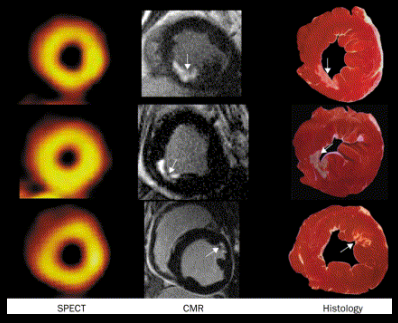


Di Carli et al, JTCVS 1998

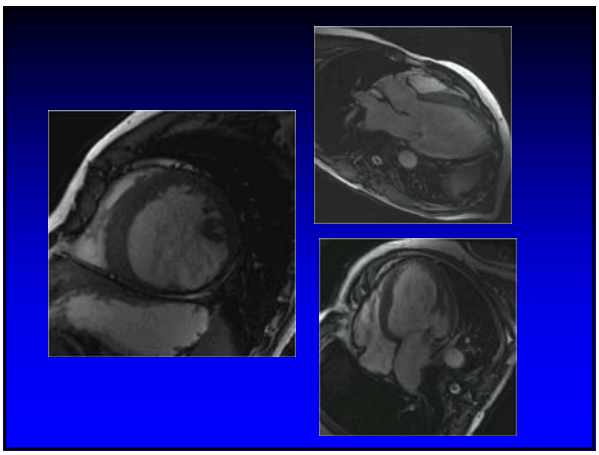
Extent of Viable and Nonviable Myocardium



Comparison of MRI and SPECT for Detecting Myocardial Infarction

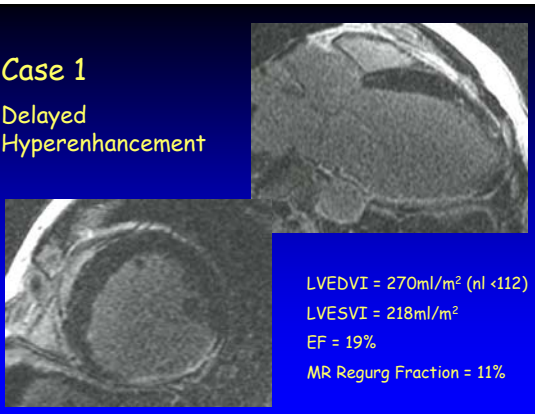


Wagner et al. Lancet 2003; 361: 374



Case 1

Delayed Hyperenhancement



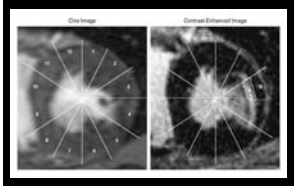
LVEDVI = 270ml/m² (nl <112)

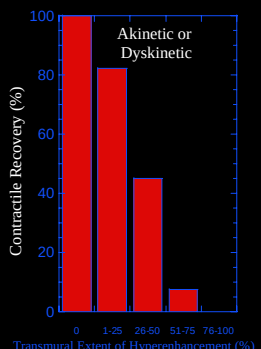
LVESVI = 218ml/m²

EF = 19%

MR Regurg Fraction = 11%

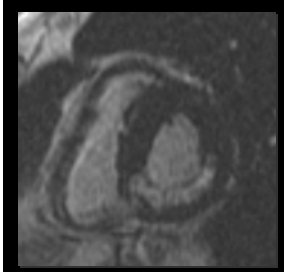
Transmural Extent of Hyperenhancement Predicts Functional Recovery



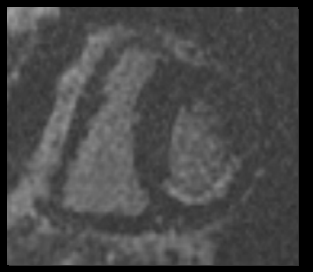


Kim RJ et al. NEJM 2000;343:1445

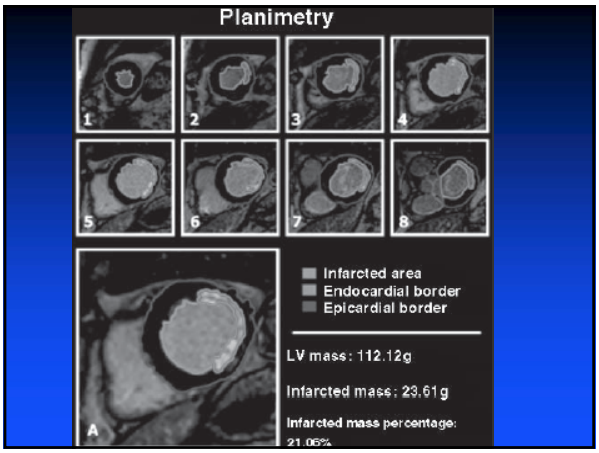
Infarct Convolution



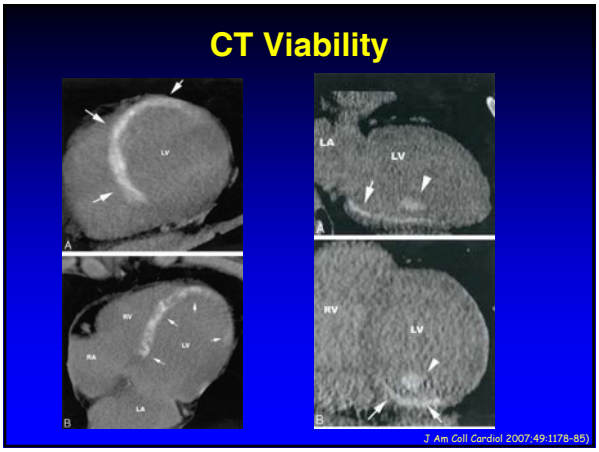
Early



3 Months Later



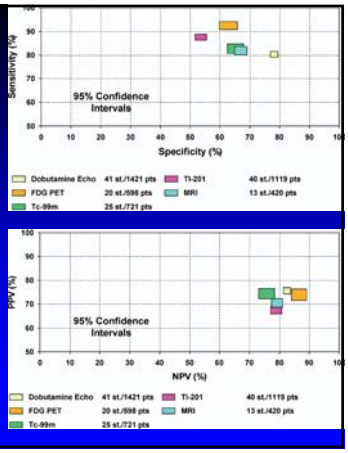
CT Viability



J Am Coll Cardiol 2007;49:1178-85)

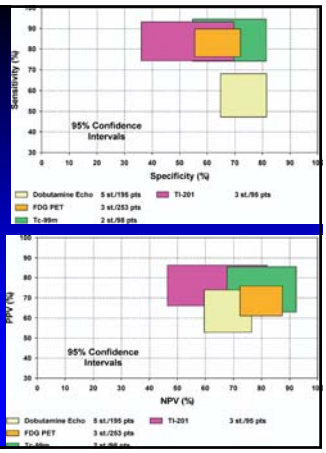
Viability Detection

- Highest Sensitivity: FDG PET
- Highest Specificity: Dobutamine ECHO

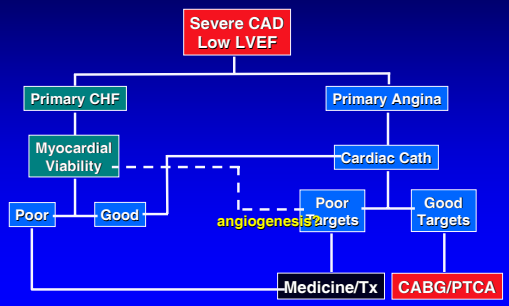


Recovery of Global Function

- Nuclear techniques are the most sensitive
- ECHO is the most specific



Role of Ischemia/Viability Assessment in Management Decisions in Patients With LV Dysfunction



Art of predicting functional recovery Things to consider…

- Presenting symptoms (angina vs HF)
- Amount of ischemia, viable tissue, scar
- LV volumes/severity of remodeling
- Completeness of revascularization and quality of target vessels
- Time to revascularization
- ? role of surgical ventricular restoration

In Conclusion…

- There is a continuum of structural and pathophysiological changes in chronically dysfunctional myocardium
- Different imaging methods are looking at different aspects of viability and can provide complimentary information.
- Nuclear techniques are considered more sensitive and DE more specific for LVF recovery post-revascularization
- Assessment of viability prior to CABG is currently recommended in pts with ischemic CMP with EF<35% and no definite angina