Imaging Point/ Counterpoint – Coronary CTA vs. Stress Testing for the Intermediate Risk Patient

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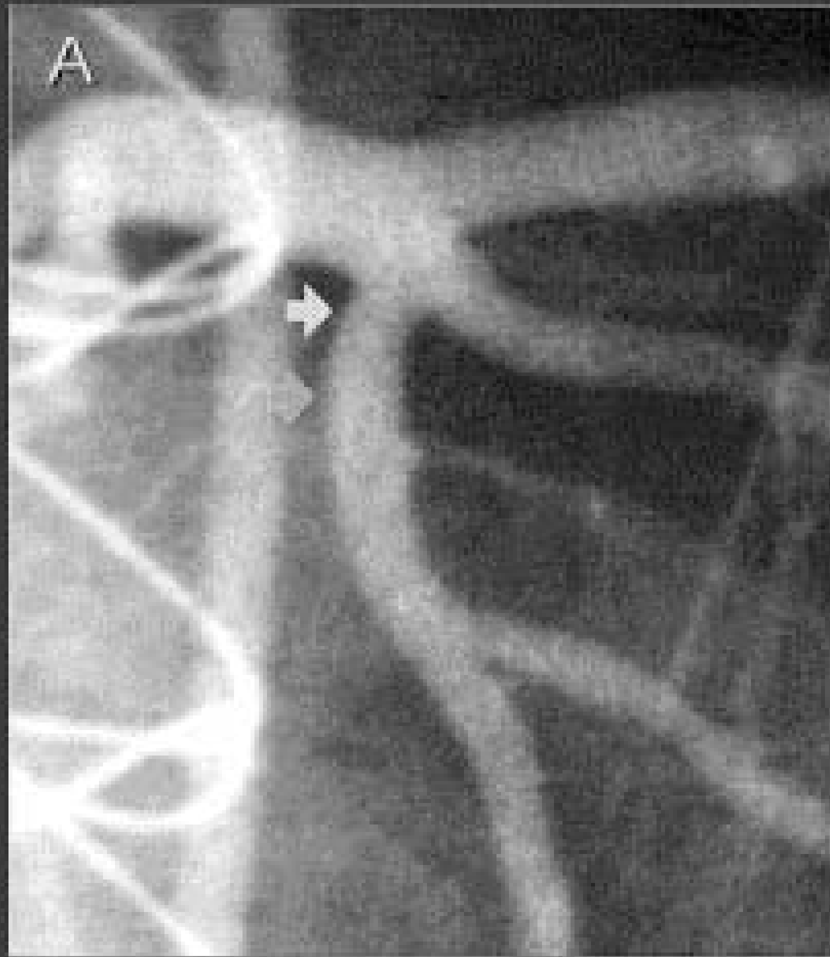
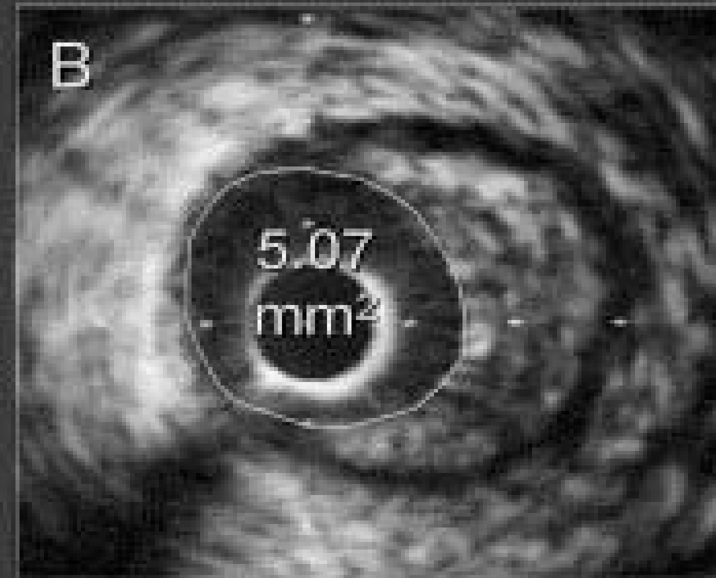
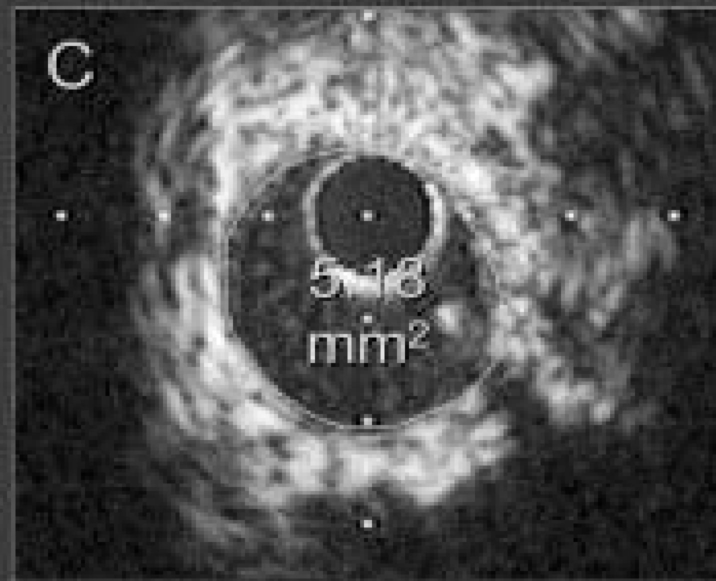
Disclosures

Speaker/Consultant/Research Support:

GE Healthcare, Inc., and Astellas







Topol EJ, Nissen SE. Our preoccupation with coronary luminology: the dissociation between clinical and angiographic findings in ischemic heart disease. *Circulation 1995;92:2333–42.*

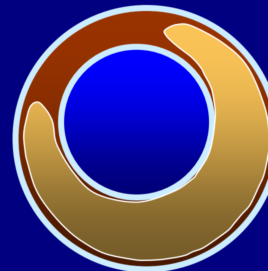
The "Glagov Phenomenon"

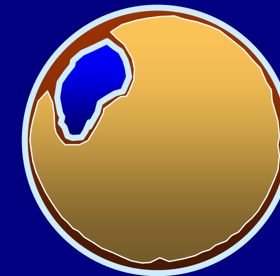
Coronary Compensatory Arterial Remodeling

Progression

Compensatory expansion maintains constant lumen

Expansion overcome: lumen narrows





Normal vessel

Minimal CAD

Moderate CAD

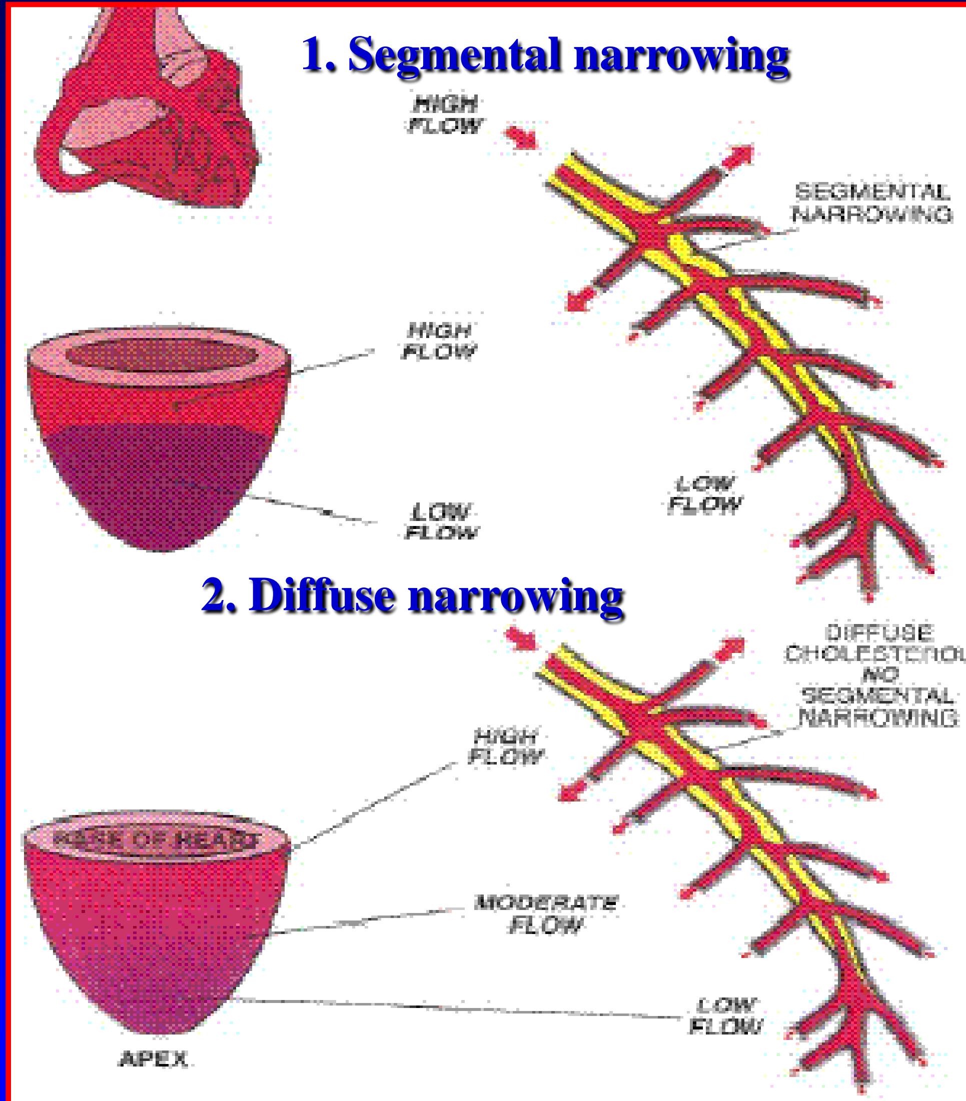
Severe CAD

(Adapted from Glagov et al.)

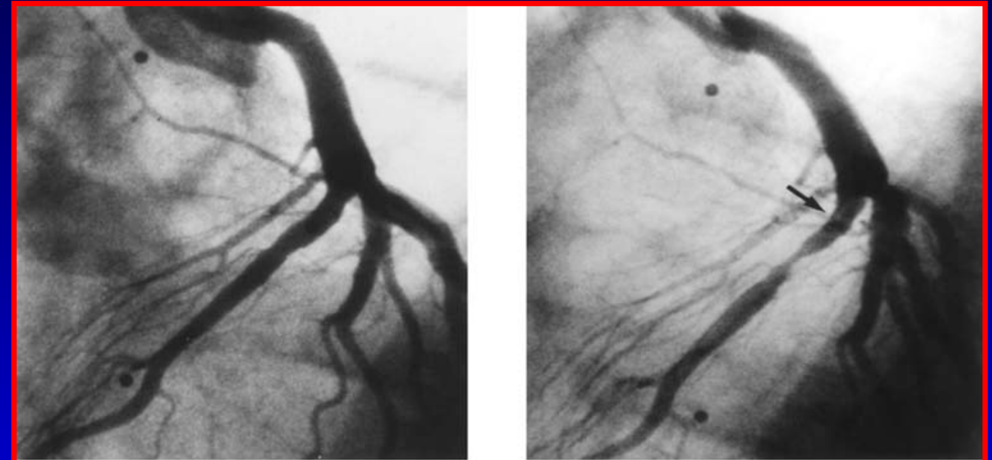
Glagov et al, N Engl J Med, 1987.

Coronary Physiology with Abnormal SPECT MPI

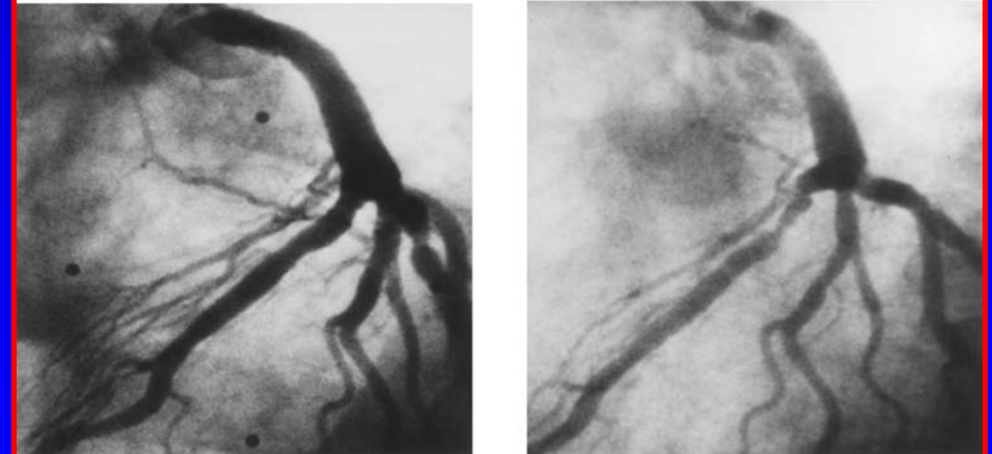
Gould KL *Circ 2000;101:1931*



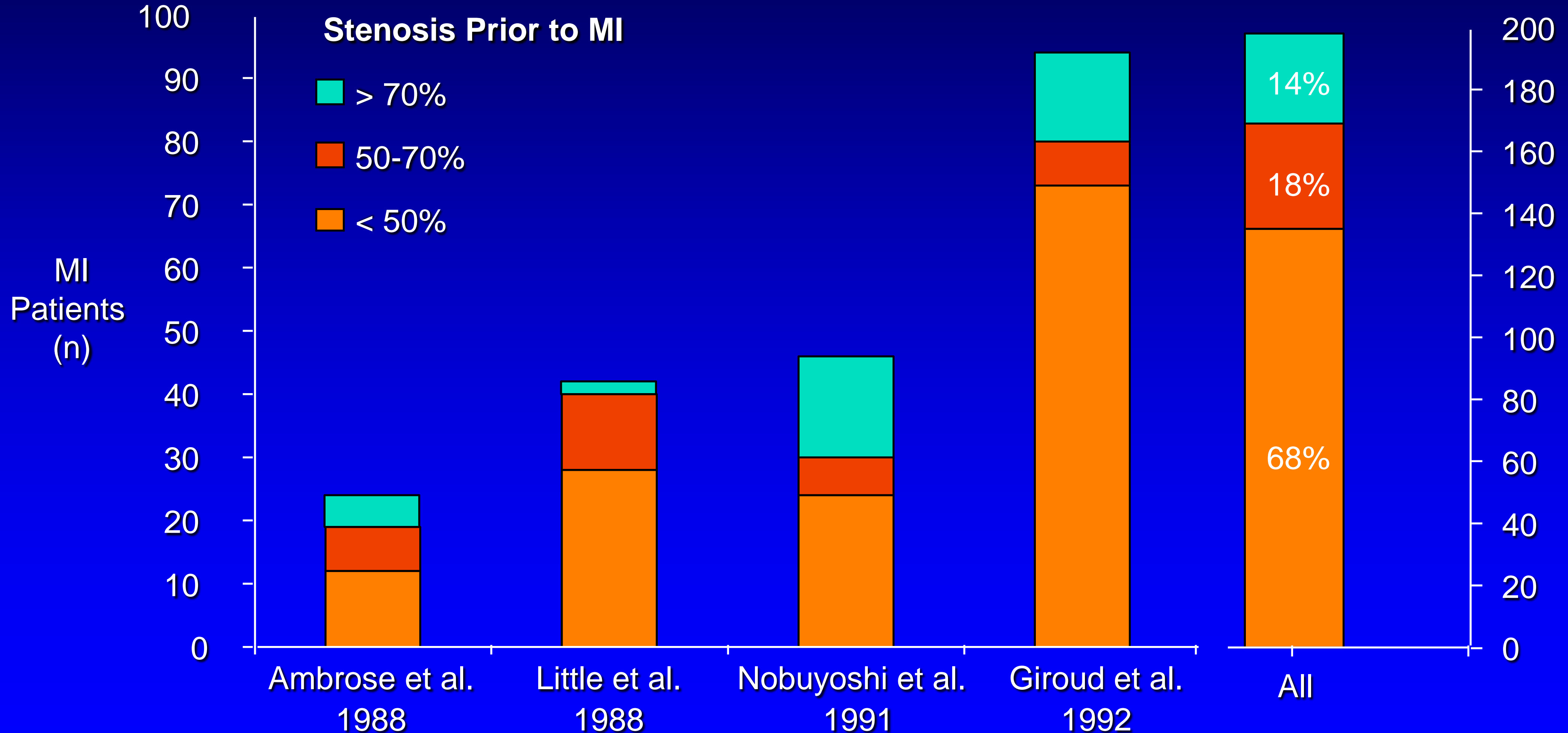
Schachinger V *Circ 2000;101:1899-1906*



3. Vasomotor stress abnormality

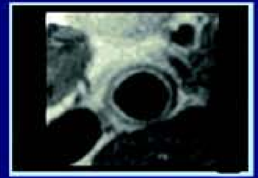


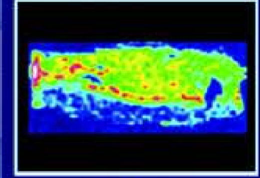
Majority of MIs are Associated with Non-flow Limiting, Unstable Lesions



Falk et al. *Circulation.* 1995;92:657-71.

Vulnerable Plaque


MRI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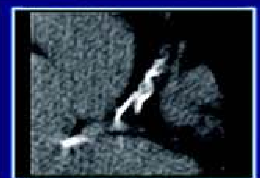
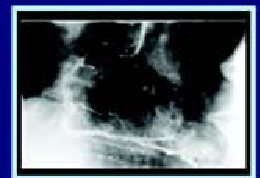
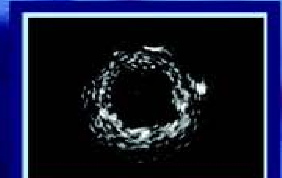

CT

VIRTUAL HISTOLOGY


ANGIOGRAPHY

THERMOGRAPHY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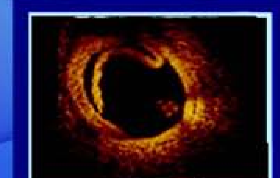

OCT

ANGIOSCOPY

Assessment of Plaque By CT

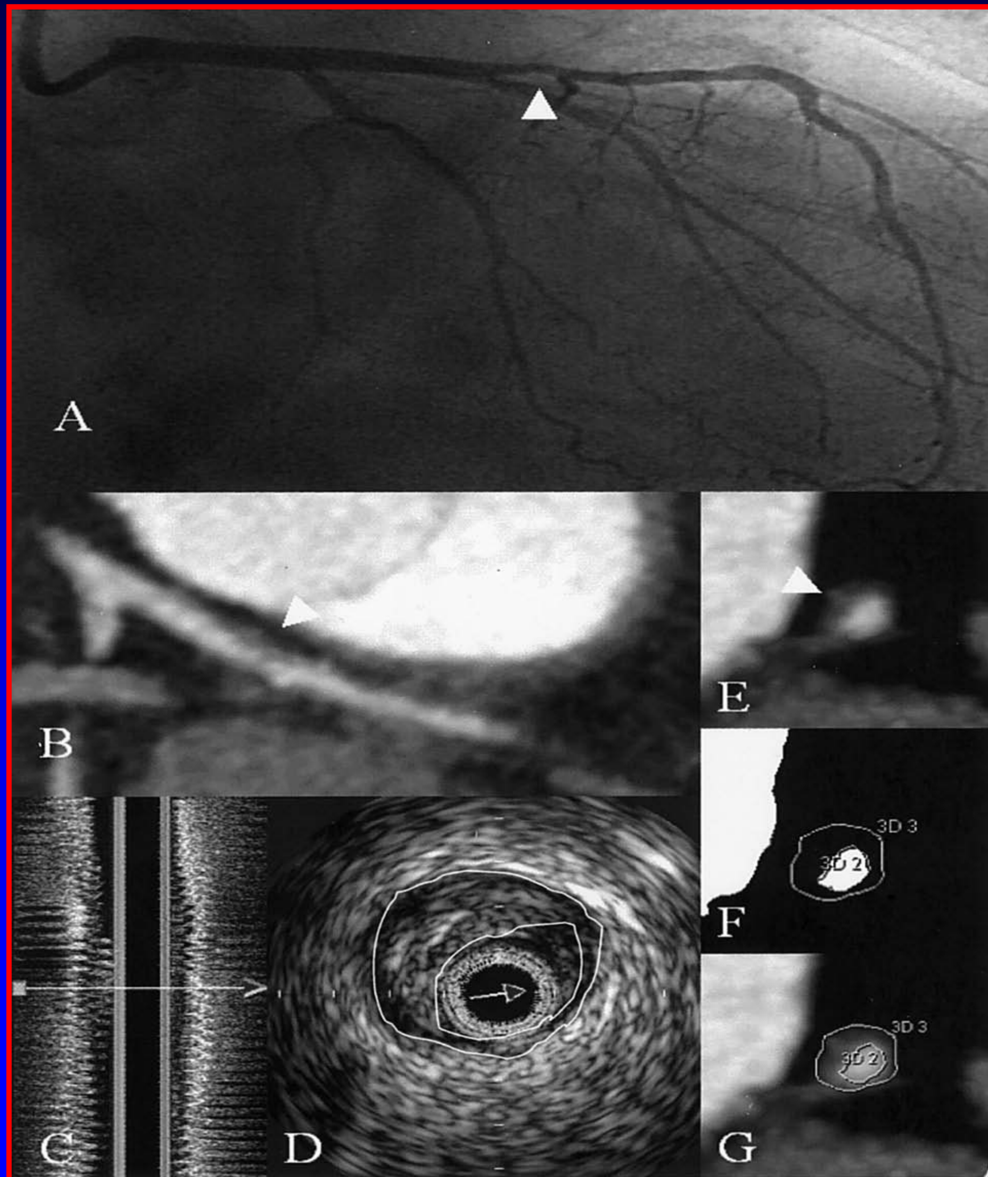


Figure 1 Angiographically nonobstructive lesion of the left anterior descending artery. (A) Invasive angiogram: arrow indicates a nonobstructive smooth lesion. (B) 64-slice computed tomography: arrowheads indicate a noncalcified plaque in the left anterior descending artery. (C) Intravascular ultrasound: longitudinal reconstruction. (D) Intravascular ultrasound cross section: lumen area 4 mm2, plaque area 11 mm2. (E) Cross-sectional view of the coronary vessel. (F) Window setting for lumen measurements: width is reduced to 1 HU, window level is set to 65% (210 HU in this case) of the mean intensity measured in the lumen. (G) Window level to determine outer vessel boundaries (width at 155% of mean value within the lumen, level at 65% of mean value). Lumen area is 4 mm2, plaque area is 1 mm^2. Leber, A. W. et al. J Am Coll Cardiol 2005;46:147-154

Imaging in Patients with Chest Pain

- Who is at Intermediate or High Risk?
  - Asymptomatic Patients with Risk Factors
    - *Framingham Risk Score (age, gender, risk factors)*
    - *Women*
    - *African Americans*
    - *Diabetics*
    - *Renal Failure*
    - *Patients unable to exercise*
  - Symptomatic Patients
    - *Diamond and Forrester (N Engl J Med 1979;300:1350-8)*

Evaluation of Patients Presenting with Chest Pain

Age	Gender	Typical	Probable	Nonanginal	Asymptomatic
30-39	Men	**I**	**I**	L	VL
	Women	**I**	VL	VL	VL
40-49	Men	**H**	**I**	**I**	L
	Women	**I**	L	VL	VL
50-59	Men	**H**	**I**	**I**	L
	Women	**I**	**I**	L	VL
60-69	Men	**H**	**I**	**I**	L
	Women	**H**	**I**	**I**	L

Typical angina = 1) substernal location, 2) provoked by exercise or emotion, 3) relieved with rest or NTG (Diamond and Forrester, NEJM 1979)*

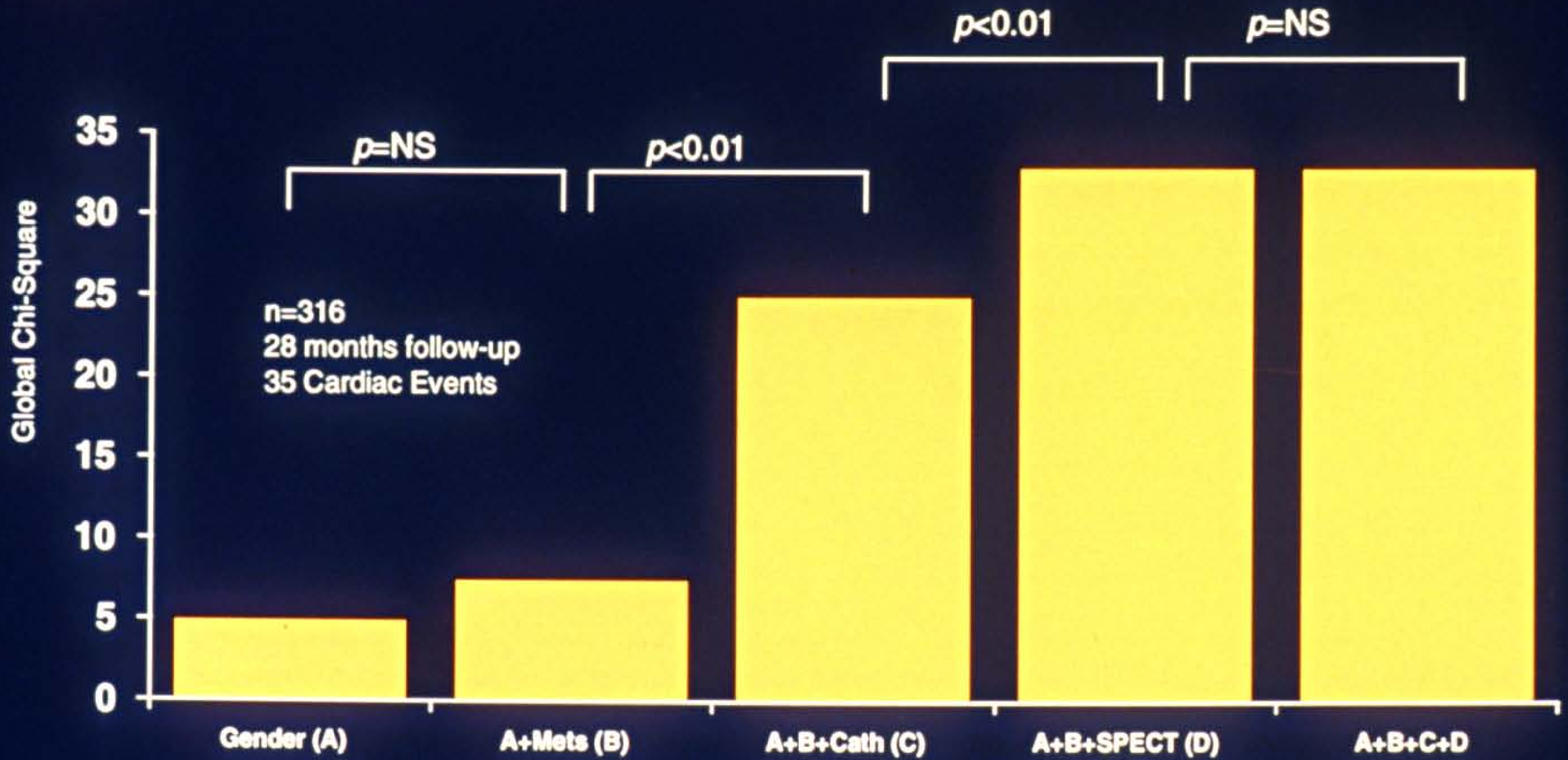
High Risk Features in SPECT

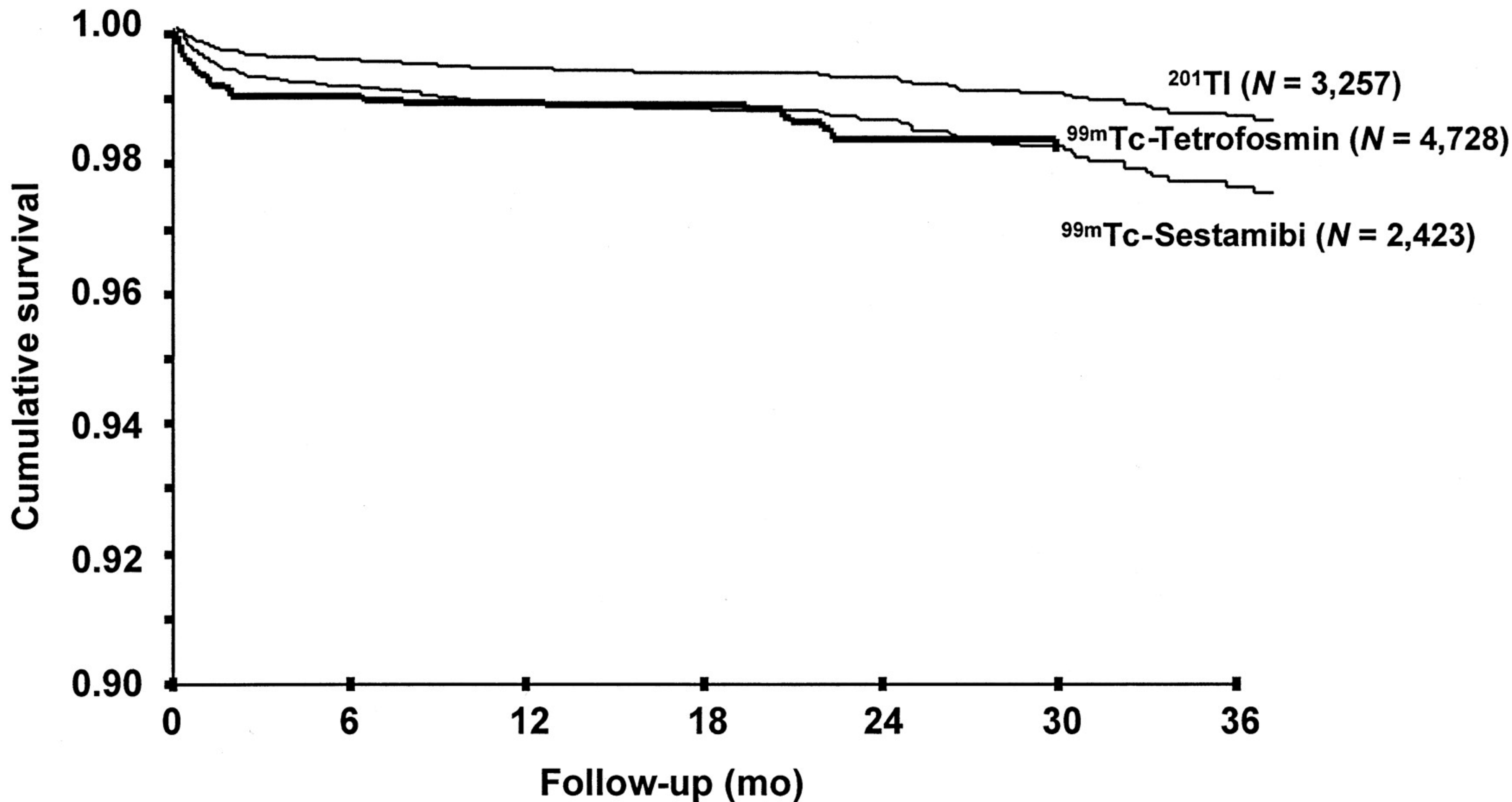
- Proximal LAD Involvement
- Multivessel Territory
- High Extent Score
- High Summed Stress Score
- High Reversibility Score
- Transient Ischemic Dilation
- Increased RV Uptake with Exercise
- Maximum Count Location Change (1)

Stress Tetrofosmin
Rest Thallium-201
Short Axis
5 6 7 8
Vertical Long Axis
0.69 Cm/Slice
3 4 5
Horizontal Long Axis
0.69 Cm/Slice
3 4 5

1. ***Williams KA***, *et al. Correct Normalization of Myocardial Perfusion SPECT Improves Image Interpretation in Multivessel Coronary Artery Disease. J Nucl Cardiol. 2003 Jul-Aug;10(4):353-60.*

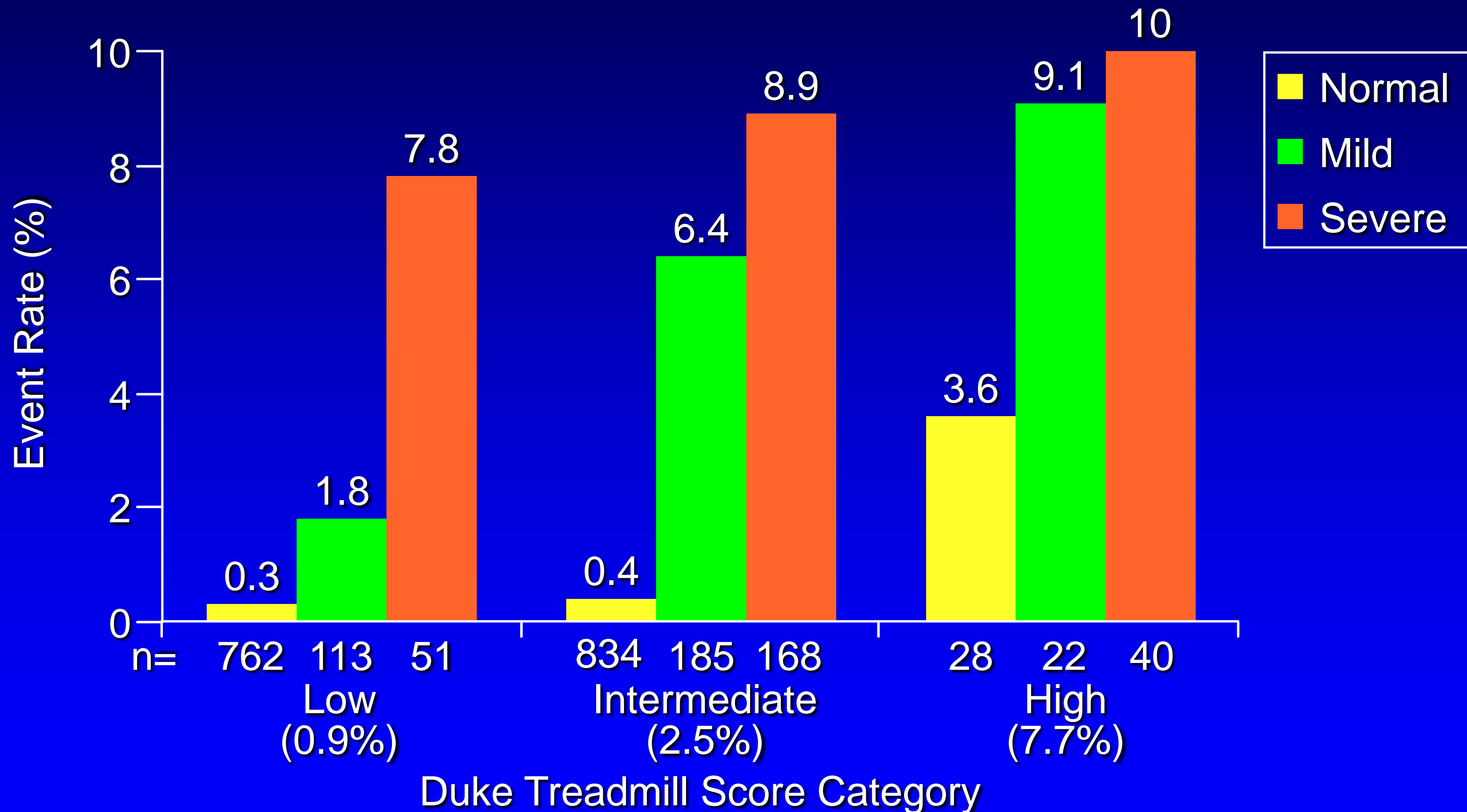
Incremental Prognostic Value





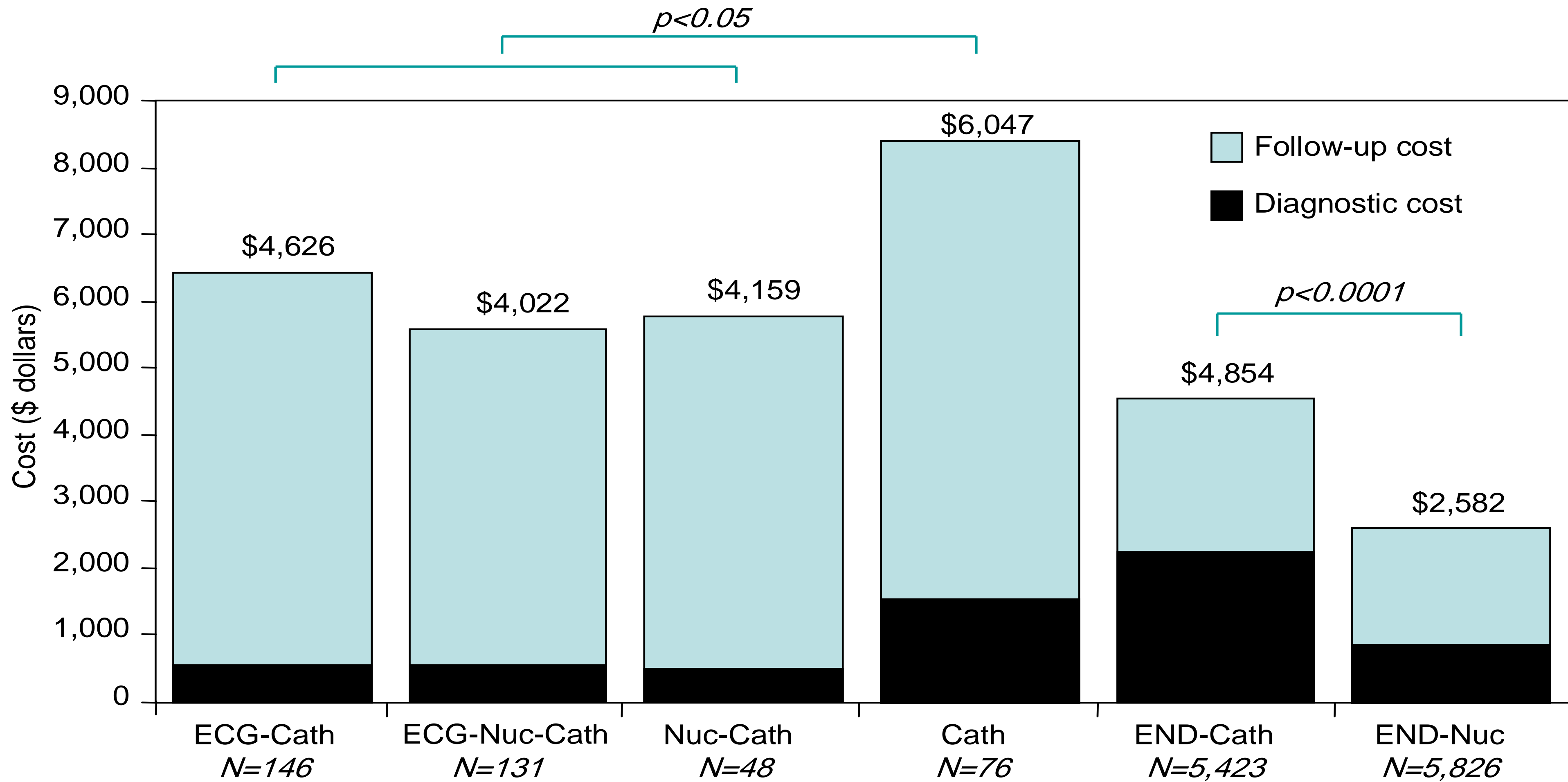
From: *Shaw LJ, Hendel R, Borges-Neto S, et al. Myoview Multicenter Registry. Prognostic value of normal exercise and adenosine (99m)Tc-tetrofosmin SPECT imaging: results from the multicenter registry of 4,728 patients. J Nucl Med. 2003 Feb; 44(2): 134-9.*

Incremental Prognostic Value of SPECT in Patients Without Known CAD



From Hachamovitch et al. Circulation 1996;93:905.

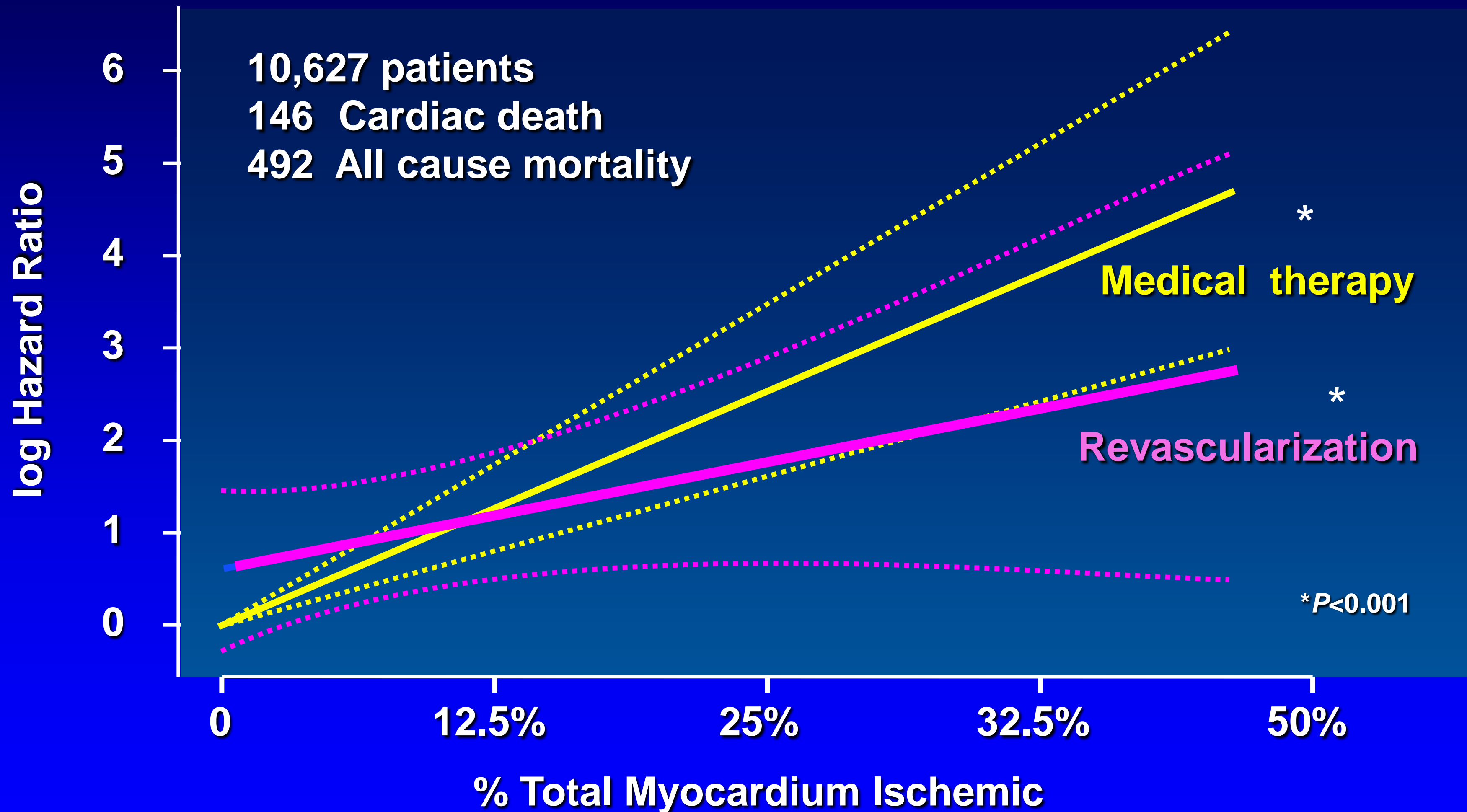
Figure 4. 2-3 Year Costs for Varying Diagnostic Strategies: Economics of Myocardial Perfusion Imaging in Europe (EMPIRE) & Economics of Noninvasive Diagnosis (END) Registries including Intermediate Risk Patients with Stable Chest Pain Symptoms



Diagnostic Strategies:

1. *ECG-Cath=Exercise electrocardiography followed by selective catheterization,*
2. *ETT-Nuc-Cath=Exercise electrocardiography followed by selective SPECT imaging and catheterization,*
3. *Nuc Cath=SPECT imaging followed by selective catheterization,*
4. *Cath=Direct coronary angiography*
5. *END-Cath=Direct coronary angiography*
6. *END-Nuc=SPECT imaging followed by selective catheterization,*

Risk of Cardiac Death and Inducible Ischemia Role of Post-SPECT Therapy



Hachamovitch R, et al. *Circulation.* 2003;2900-2907.

Nuclear Imaging in the ED

- Randomized trials: *Imaging making a difference? (13)*
  - *ERASE Chest Pain Trial*

13. Udelson JE, et al. JAMA. 2002;288:2693-2700.

Nuclear Imaging in the ED

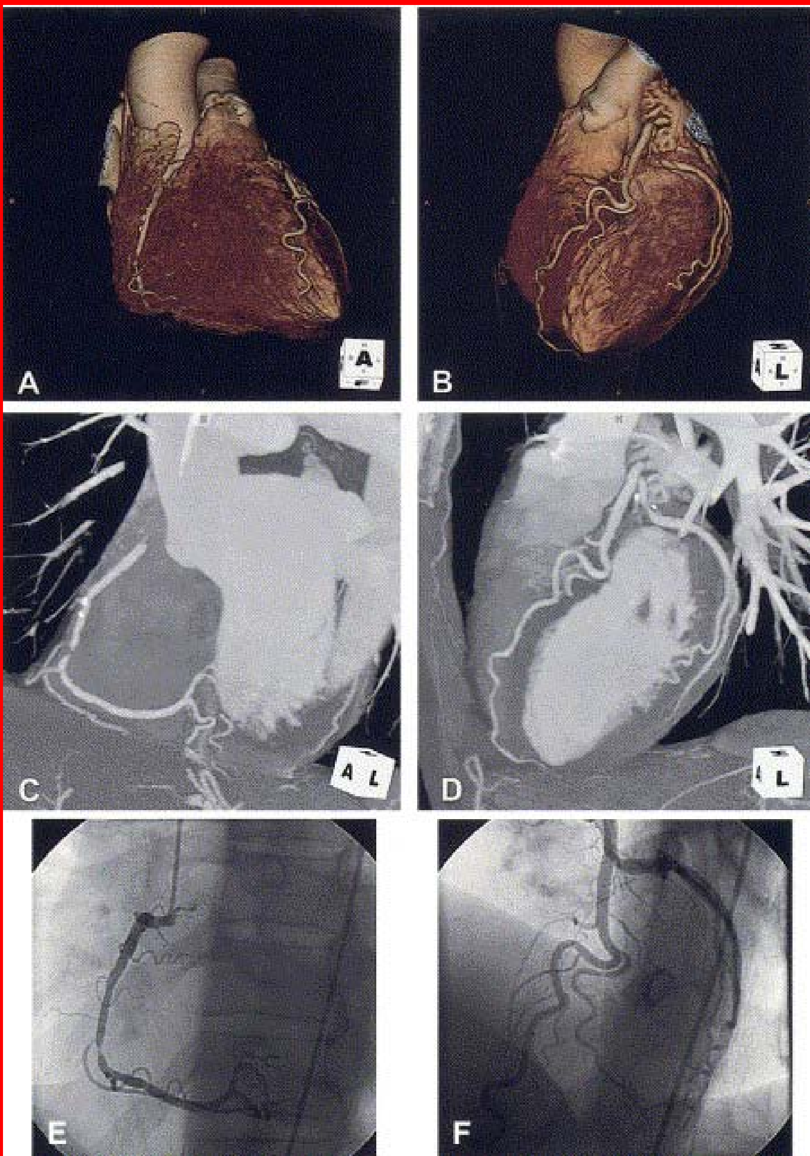
- Randomized trials: *Imaging making a difference? (12)*
  - *Rest* ***Tc-99m-Tetrofosmin*** *SPECT performed*
  - *Randomly assigned to inform ED MD of results or not*
  - *Evaluation including SPECT results had:*
    - 50% lower length of stay
    - 50% lower hospital costs
    - similar rates of in-hospital events
    - similar 30-day follow-up events

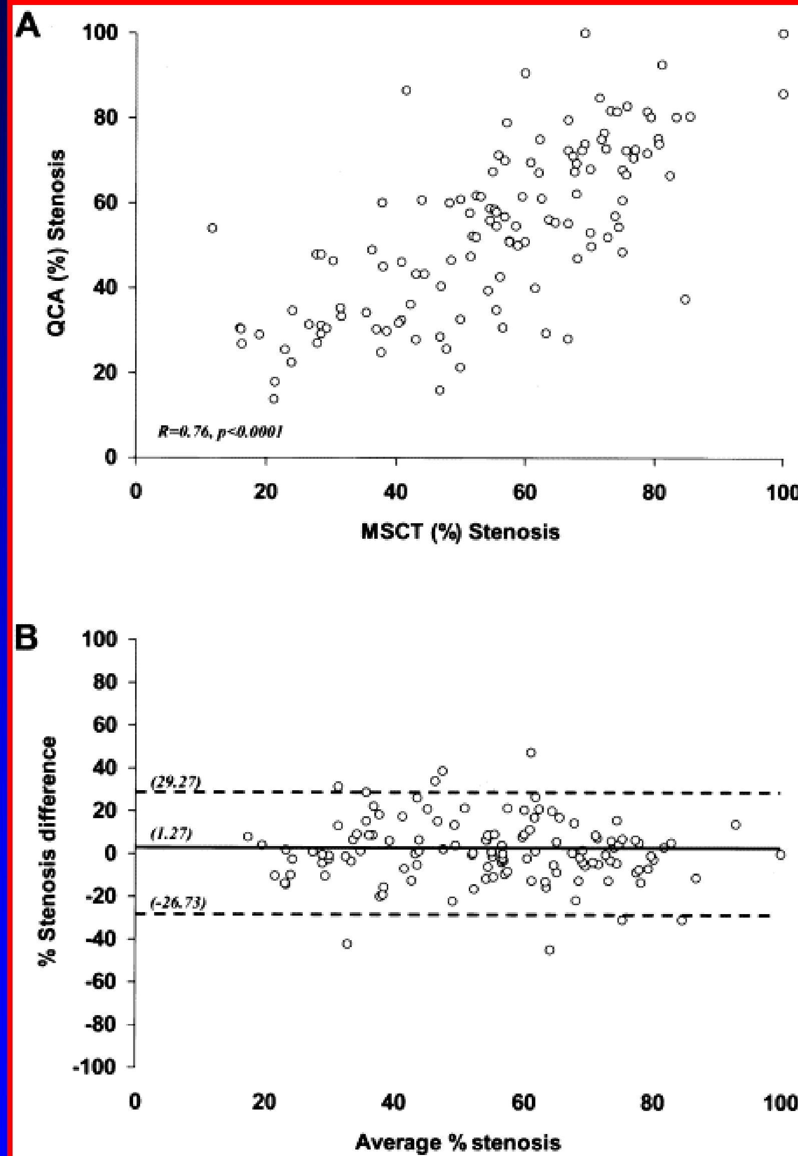
12. Stowers SA, et al. Ann Emerg Med. 2000;35:17-25.

Acute Chest Pain: SPECT vs. CT

- What’s the Gold Standard?
- Diagnosis or Prognosis?
- Anatomy or Physiology?

Cardiac CT with 64 Slice MDCT





Raff GL, et al. Diagnostic accuracy of noninvasive coronary angiography using 64-slice spiral computed tomography. JACC 2005;46(3):552-7.

Table 1. Baseline Characteristics*

Characteristic	No. (%) Scan Strategy (n = 1215)	No. (%) Usual Care (n = 1260)	*P* Value
Age, mean (SD), y	53 (13)	53 (14)	.68
Women	566 (47)	642 (51)	.03
Race			
White	753 (62)	810 (64)	
Black	309 (25)	277 (22)	
Hispanic	129 (11)	150 (12)	.26
Asian	21 (2)	18 (1)	
Other	3 (0.3)	5 (0.4)	
Chief complaint of chest pain	1043 (86)	1081 (86)	.98
Symptoms on ED arrival	1048 (86)	1102 (87)	.41
History of coronary artery disease	162 (13)	149 (12)	.26
History of hypertension	526 (43)	538 (43)	.76
History of hypercholesterolemia	421 (35)	460 (37)	.35
History of diabetes	153 (13)	188 (15)	.10
Current smoker	345 (28)	334 (26)	.30
Final diagnosis			
Acute cardiac ischemia	165 (14)	164 (13)	.68
Acute myocardial infarction	26 (2)	30 (2)	.69
Unstable angina	139 (11)	134 (11)	.53
Not acute cardiac ischemia	1050 (86)	1096 (87)	.68

*Percentages have been rounded. ED indicates emergency department.

7955 Patients Assessed for Eligibility

4802 Ineligible
- 1737 Had Diagnostic ECG for Acute Ischemia
- 1349 Had History of Prior MI
- 425 Had Both of Above
- 510 Symptoms Ended >3 h Earlier
- 221 Clinically Became Unstable
- 102 Previously Enrolled
- 83 Needed Ventilation-Perfusion Scan
- 375 Other

3153 Protocol Eligible

245 Not Eligible for Consent
- 177 Physician Refused
- 25 Left Against Medical Advice
- 5 Transferred to Another Hospital
- 38 Other

2908 Eligible for Consent

433 Refused Participation

2475 Randomized

1215 Assigned to Scan Strategy
- 1191 Underwent Scan as Assigned

1260 Assigned to Usual Care

1208 Completed 30-Day Follow-up

1249 Completed 30-Day Follow-up

1213 Included in Primary Analysis
- 2 Missing Data

1260 Included in Primary Analysis

Table 2. Effect of Sestamibi Imaging on ED Triage Decisions*

	No. (%)			
	Scan Strategy (n = 1215)	Usual Care (n = 1260)	RR (95% CI)	*P* Value†
Hospital admission rate	576 (47.5)‡	707 (56.1)	0.87 (0.81-0.93)	<.001
Triage disposition	1212§	1258§		
CCU	76 (6.3)	66 (5.2)		<.001
Telemetry ward	368 (30.4)	465 (37.0)		
Chest pain unit	131 (10.8)	174 (13.8)		
Home from ED	637 (52.6)	553 (44.0)		

*RR indicates relative risk; CI, confidence interval; CCU, coronary care unit; and ED, emergency department.
†Cochran-Mantel-Haenzel *P* values adjusted for site effect.
‡n = 1213, as 2 patients were missing data for admission status (and for triage disposition).
§For scan strategy, 3 patients were missing data; for usual care, 2 patients were missing data.

13. Udelson JE, et al. JAMA. 2002;288:2693-2700.

Nuclear Imaging in the ED

- Randomized trials: *Imaging making a difference? (13)*
  - *ERASE Chest Pain Trial: Tc-99m-sestamibi SPECT*
  - *Randomized to a usual ED care or SPECT*
  - *Imaging associated with favorable decision-making*
  - *Less often unnecessarily admitted or held for observation*
  - *More often discharged home directly from ED*

13. Udelson JE, et al. JAMA. 2002;288:2693-2700.