Current Cardiological Applications of Contrast Echocardiography

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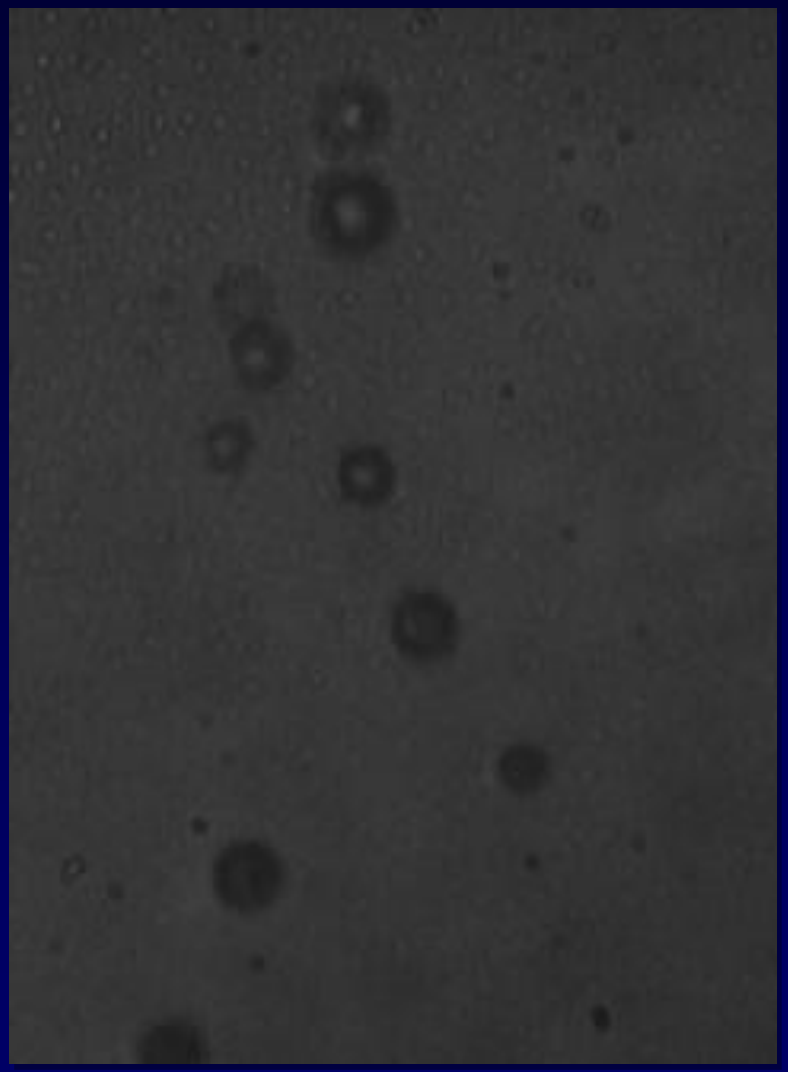
Ultrasound Contrast Agents

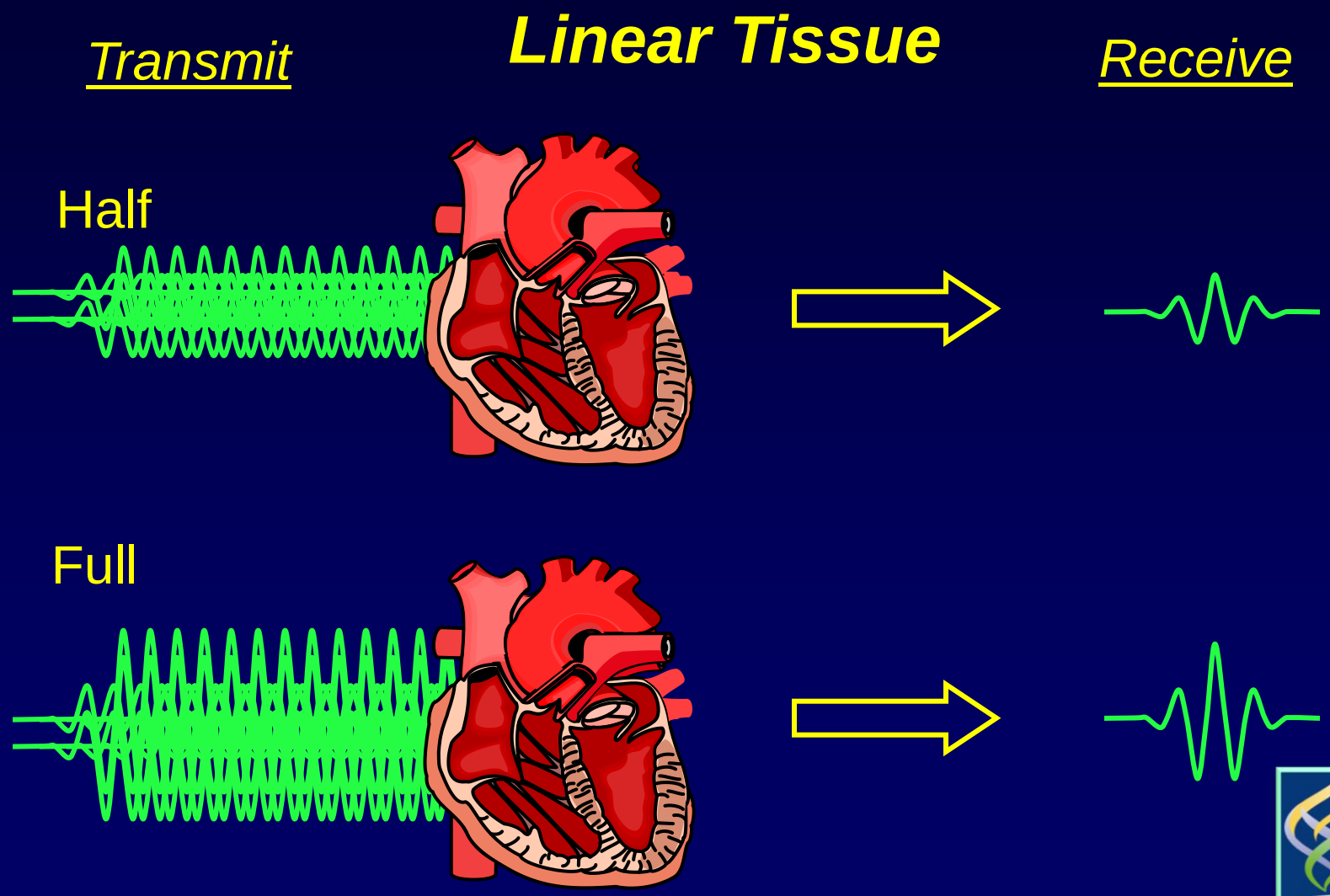
- Levovist
- Albunex; Optison
- Definity
- Sonovue
- Imagent
- Sonozoid
- Cardiosphere
- Imagify

Ultrasound-Microbubble Interaction



Courtesy: Nico deJong

Power Modulation Real-time MCE



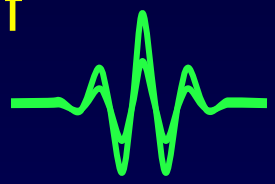
Power Modulation Real-time MCE

Linear Tissue

Receive

Display

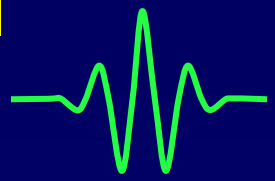
Half



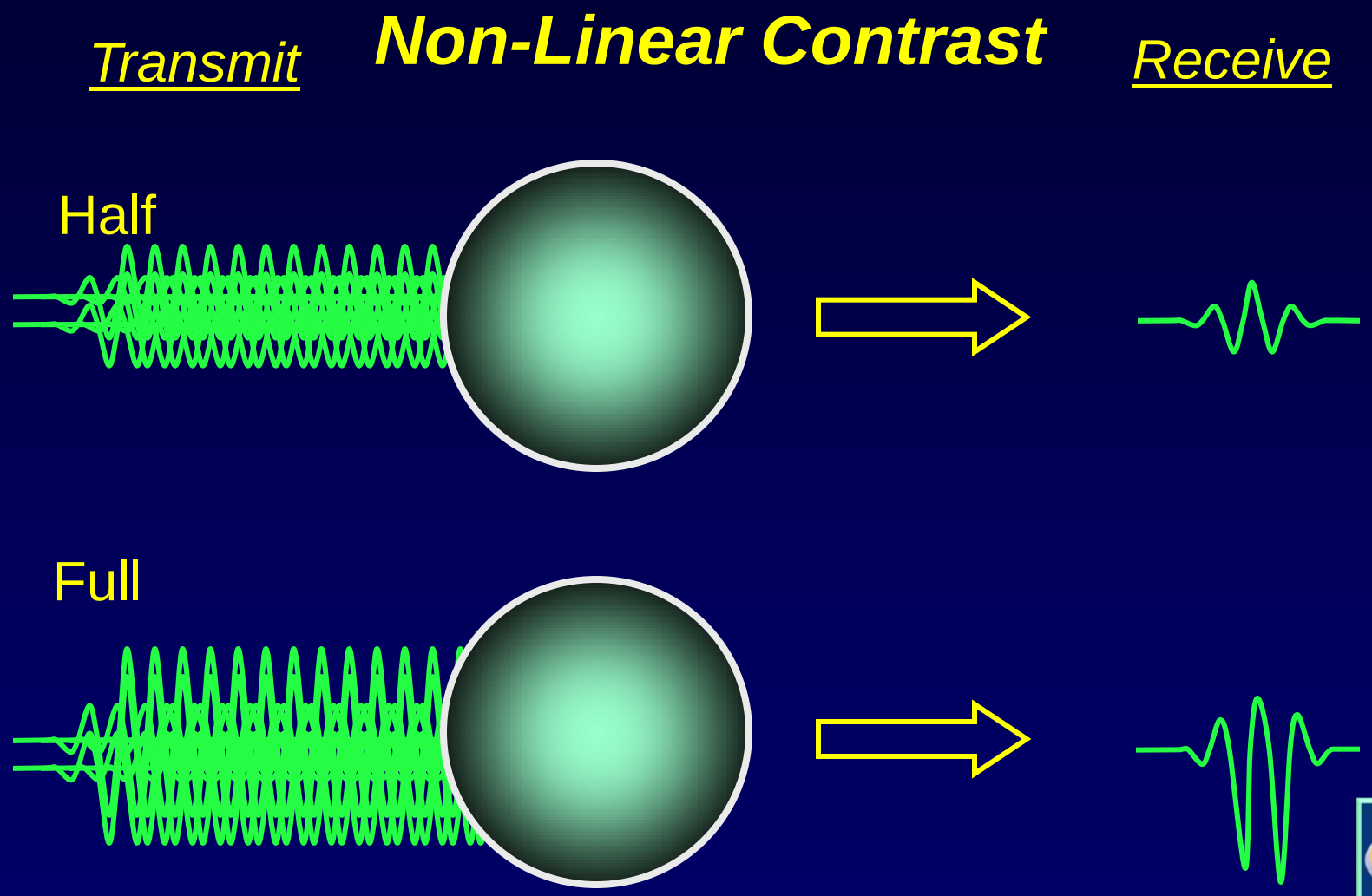
x2

Subtract **=**

Full



Power Modulation Real-time MCE



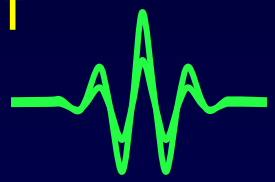
Power Modulation Real-time MCE

<u>Receive</u>

Non-Linear Contrast

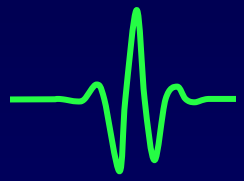
<u>Display</u>

Half

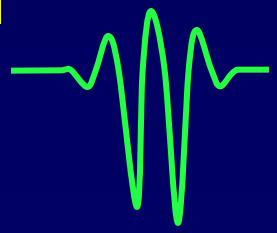


x2

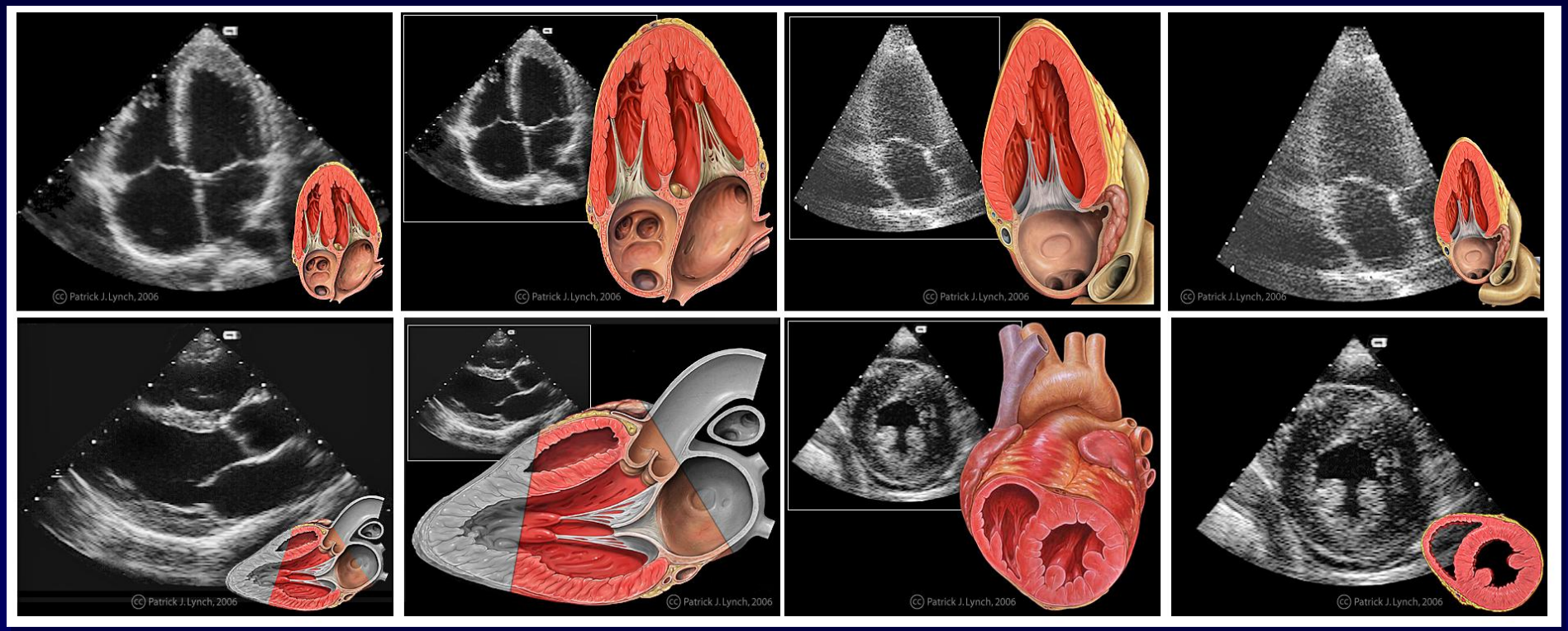
Subtract =



Full



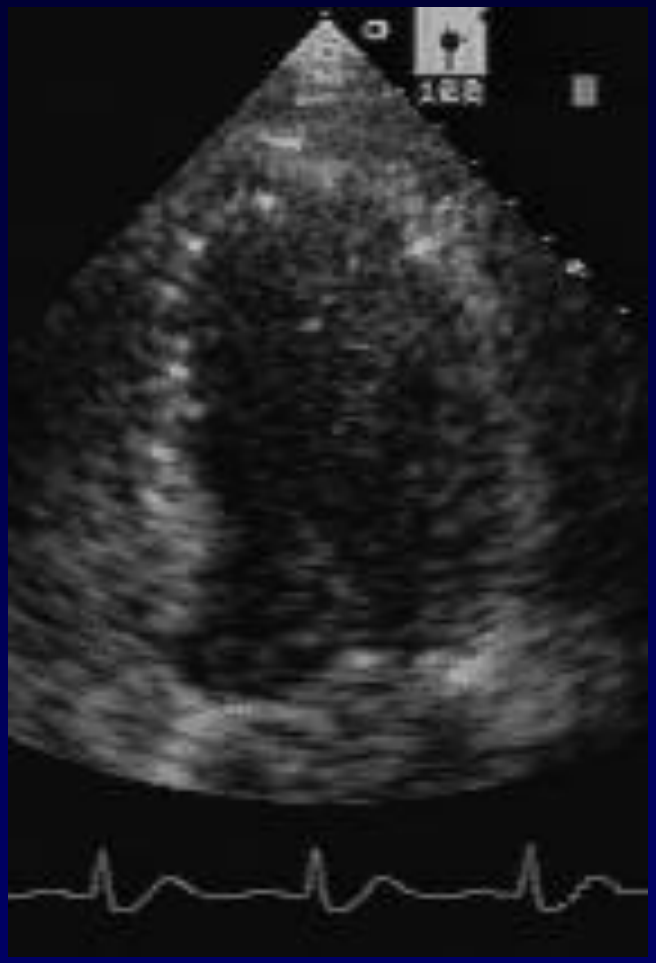
Standard Views of the Heart



CHEST PAIN IN THE ED

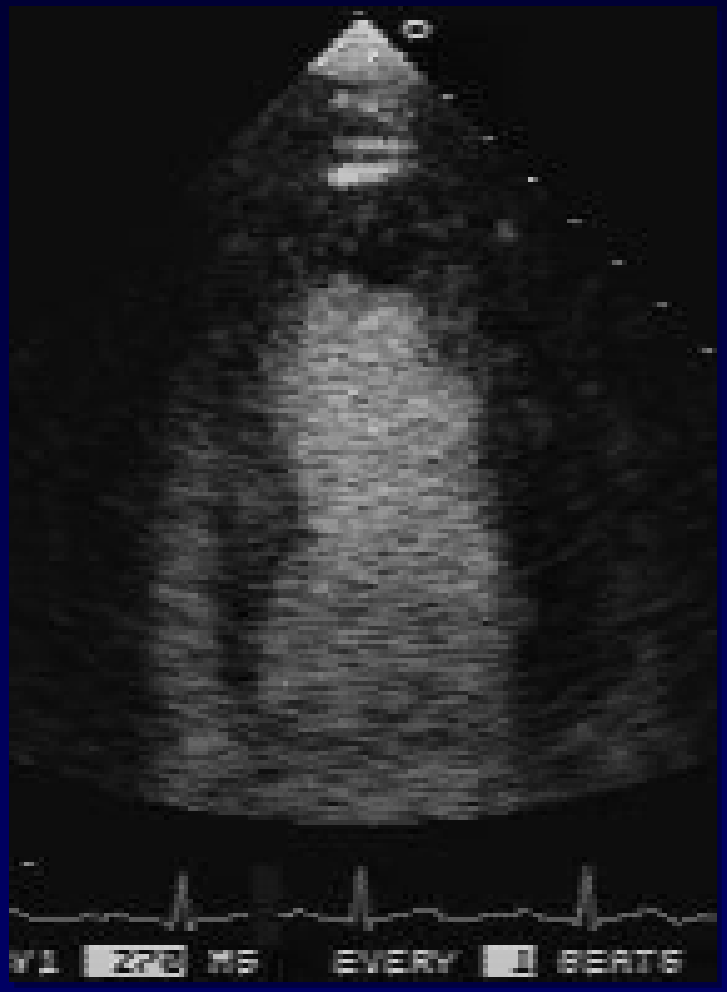
- **20 million ED admissions for Chest Pain annually in the USA**
- **EKG diagnostic in 30-40% of all AMI**
- **Cardiac enzymes take hours to become positive and available**
- **5 million people admitted unnecessarily**
- **15 billion dollars a year**

MCE on Presentation



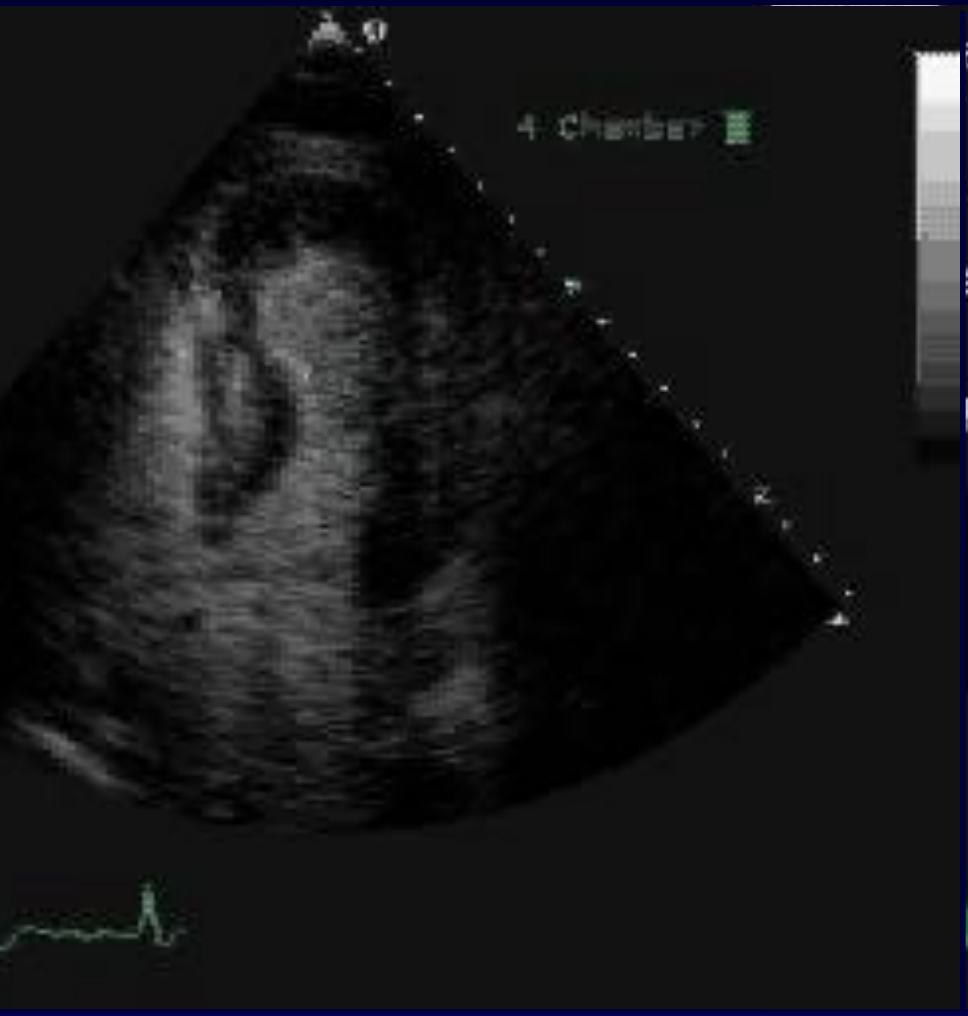
Rinkevich et al, Eur Heart J, 2005

MCE After PCI



Rinkevich et al, Eur Heart J, 2005

MCE on Presentation



Rinkevich et al, Eur Heart J, 2005

Incidence of Events

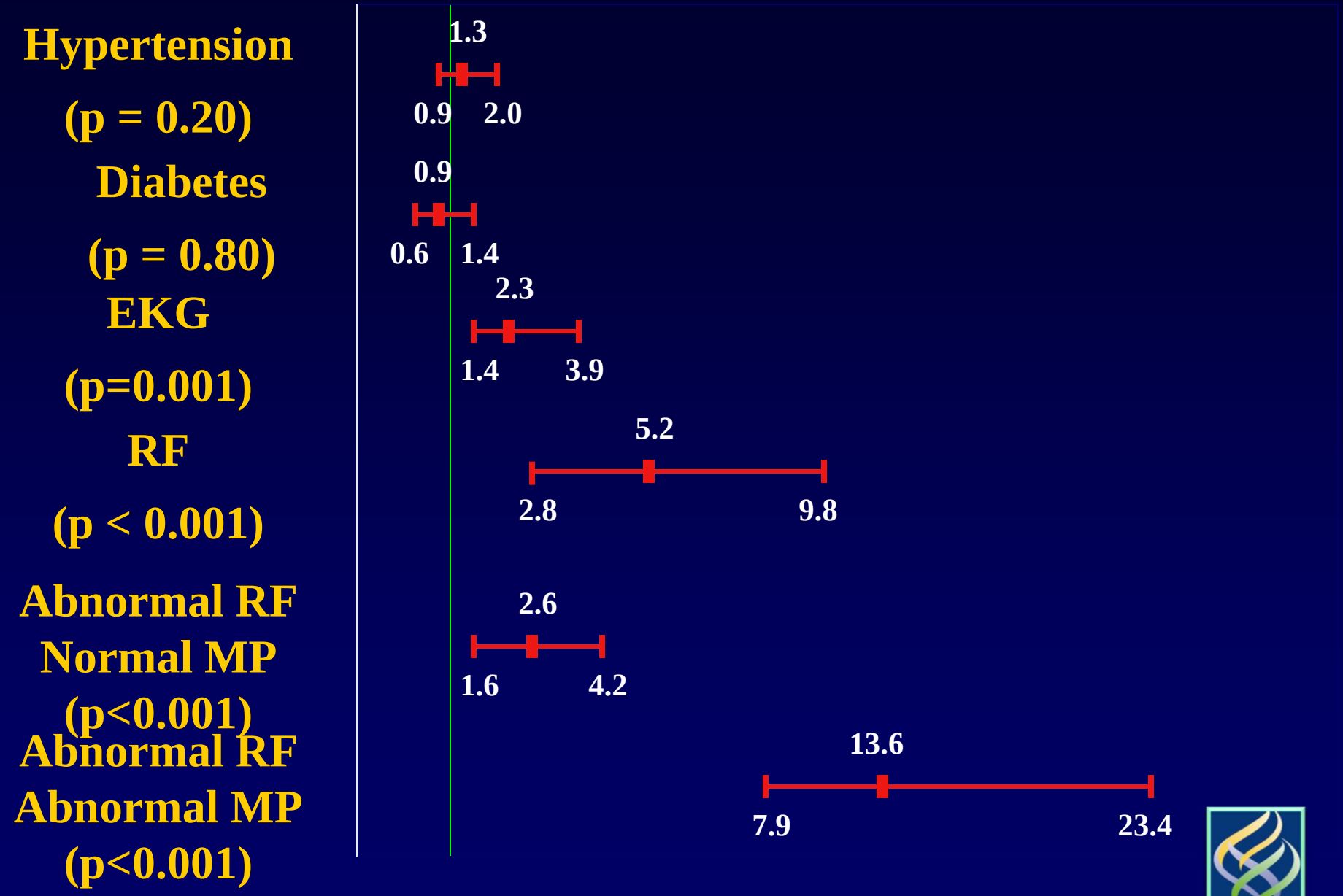
Type of Event	Within 48 Hours (N = 999)*	After 48 Hours (N = 833)**	Total (N = 999)
AMI	(90, 9.0%)	(44, 4.4%)	(134, 13.4%)
Cardiac-related Death	(1, 0.1%)	(18, 1.8%)	(19, 1.9%)
Unstable Angina	(50, 5.0%)	(18, 1.8%)	(68, 6.8%)
CABG	(3, 0.3%)	(10, 1.0%)	(13, 1.3%)
CHF	(13, 1.3%)	(25, 2.5%)	(38, 3.8%)
PTCA	(9, 0.9%)	(11, 1.1%)	(20, 2.0%)
Total	(166, 16.6%)	(126, 12.6%)	(292, 29.2%)

* Subjects at risk

** Subjects at risk after excluding those who had early events

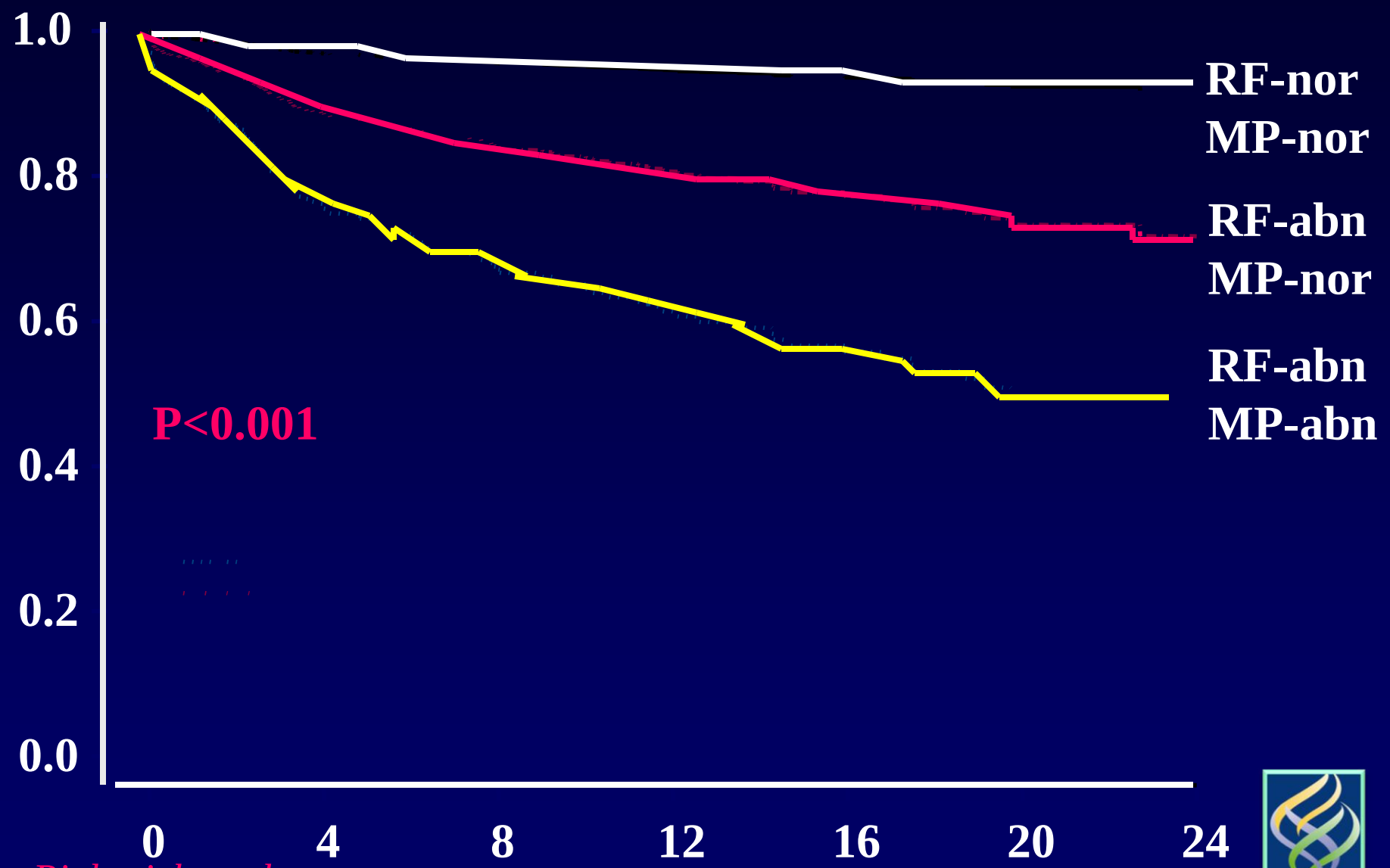
Rinkevich et al, Eur Heart J, 2005

Multivariate Logistic Regression Analyses for Early Events



Rinkevich et al, Eur Heart J, 2005

% Late Event Free-Survival

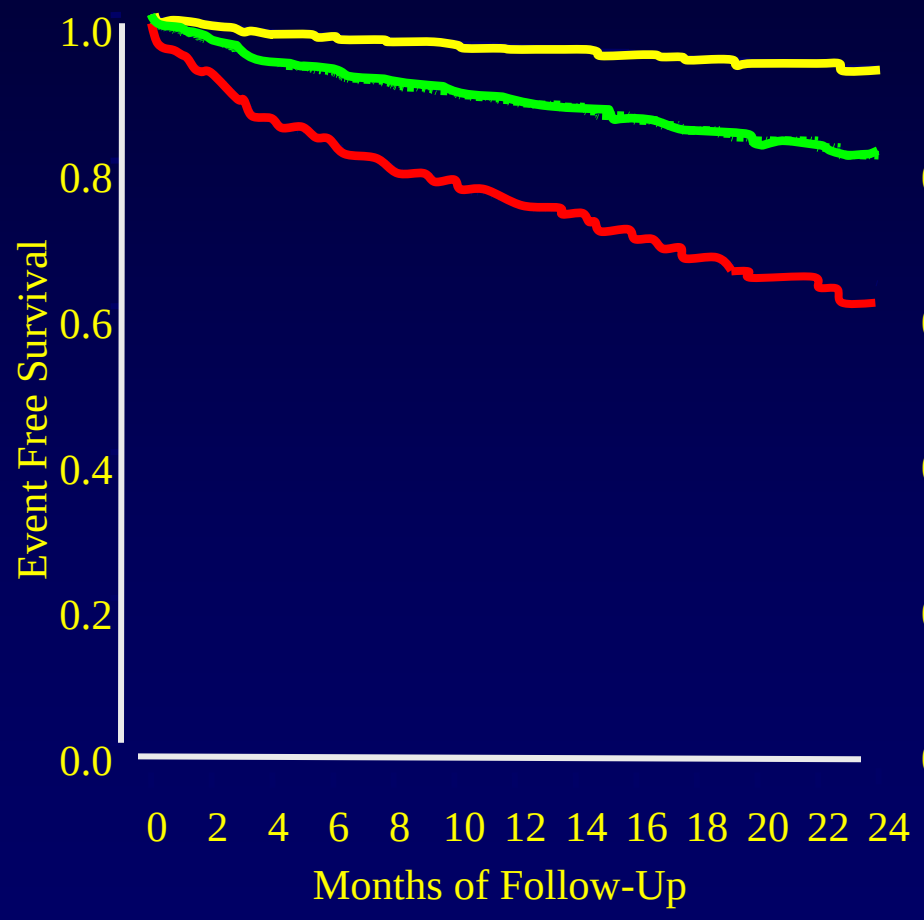


Rinkevich et al,
Eur Heart J, 2005

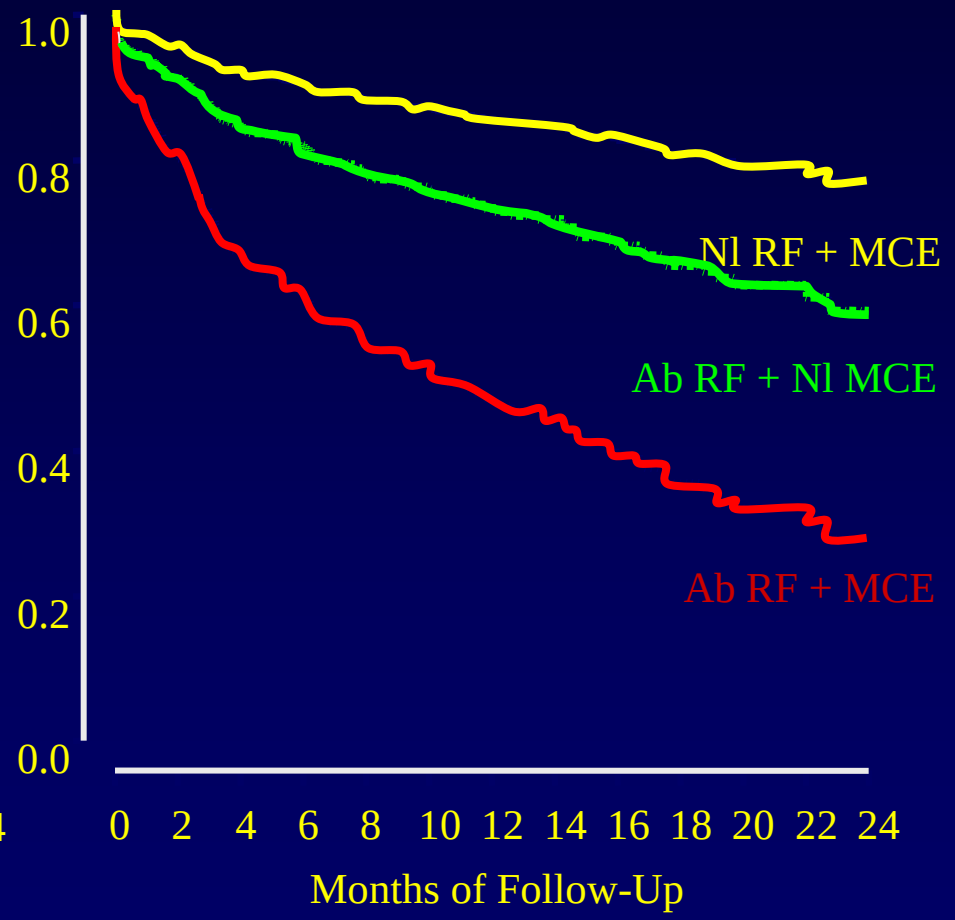
TIMI SCORE (1 to each variable)

1: age ≥ 65 years
2. > 3 CAD risk factors
3. known coronary luminal diameter narrowing of 50%
4. ST-segment deviation on ECG
5. ≥ angina events in the previous 24 h
6. use of aspirin in the previous 7 days
7. ↑ troponin (excluded for modified score).

mTIMI score 0-2

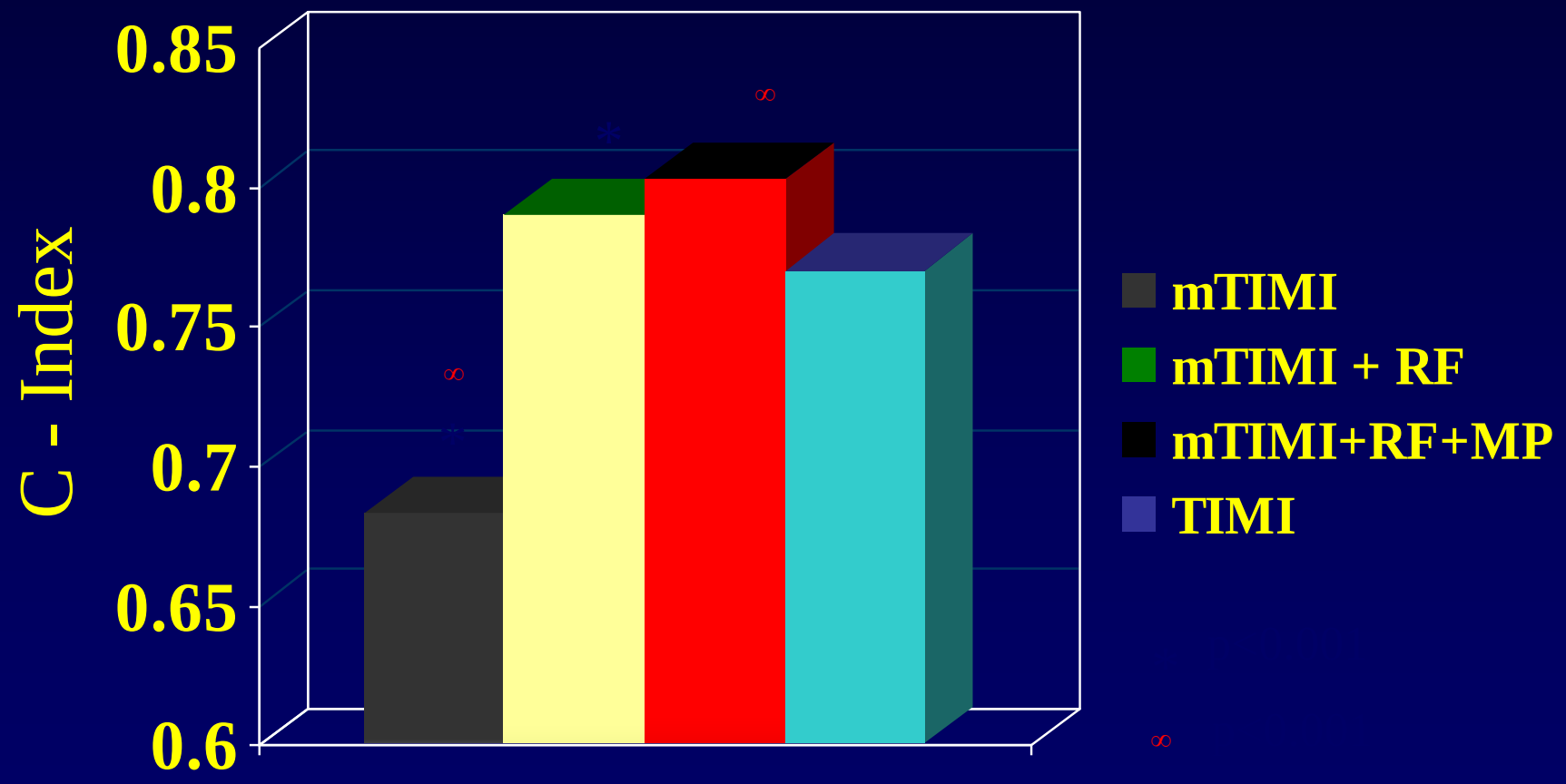


mTIMI score 3-4

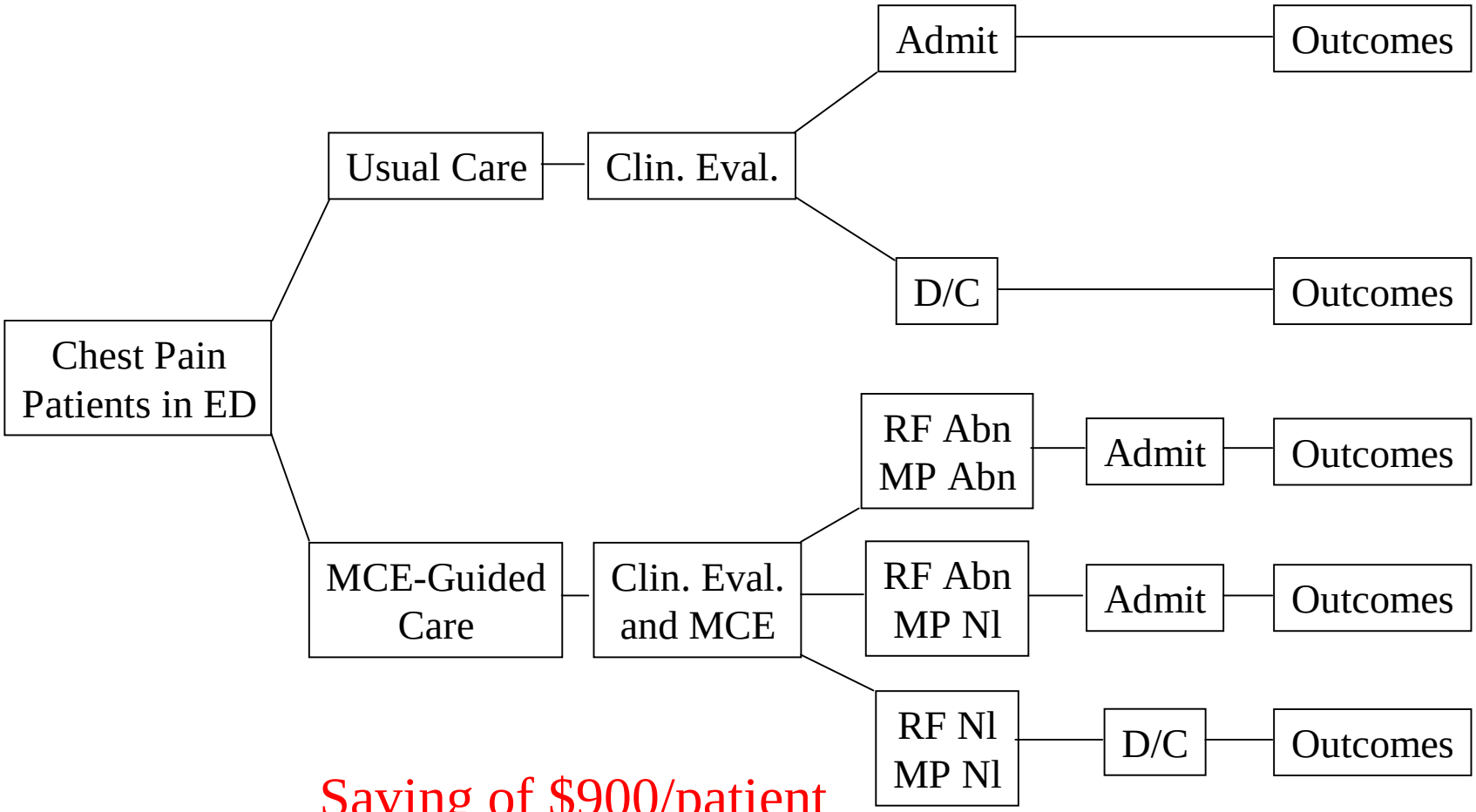


Tong et al, J Am Coll Cardiol 46:920-927, 2005.

Incremental Value of Tests Performed in Hierarchical Order for Predicting Early Events



Tong et al, J Am Coll Cardiol 46:920-927, 2005.



Saving of $900/patient

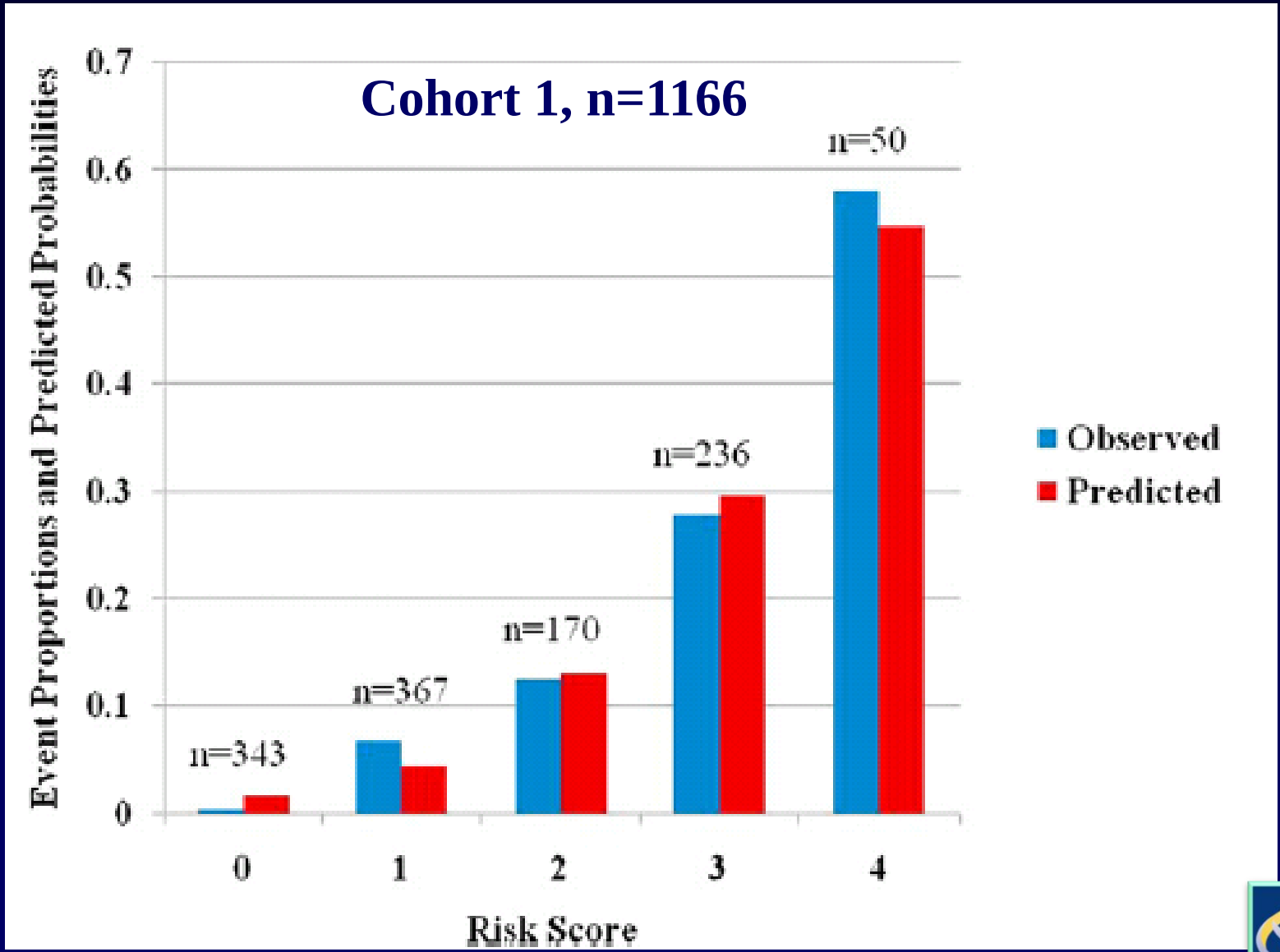
Wyrick et al. Am J Cardiol 102:649-652, 2008

Table 3 Final logistic regression model for event prediction in cohort 1 N=1166

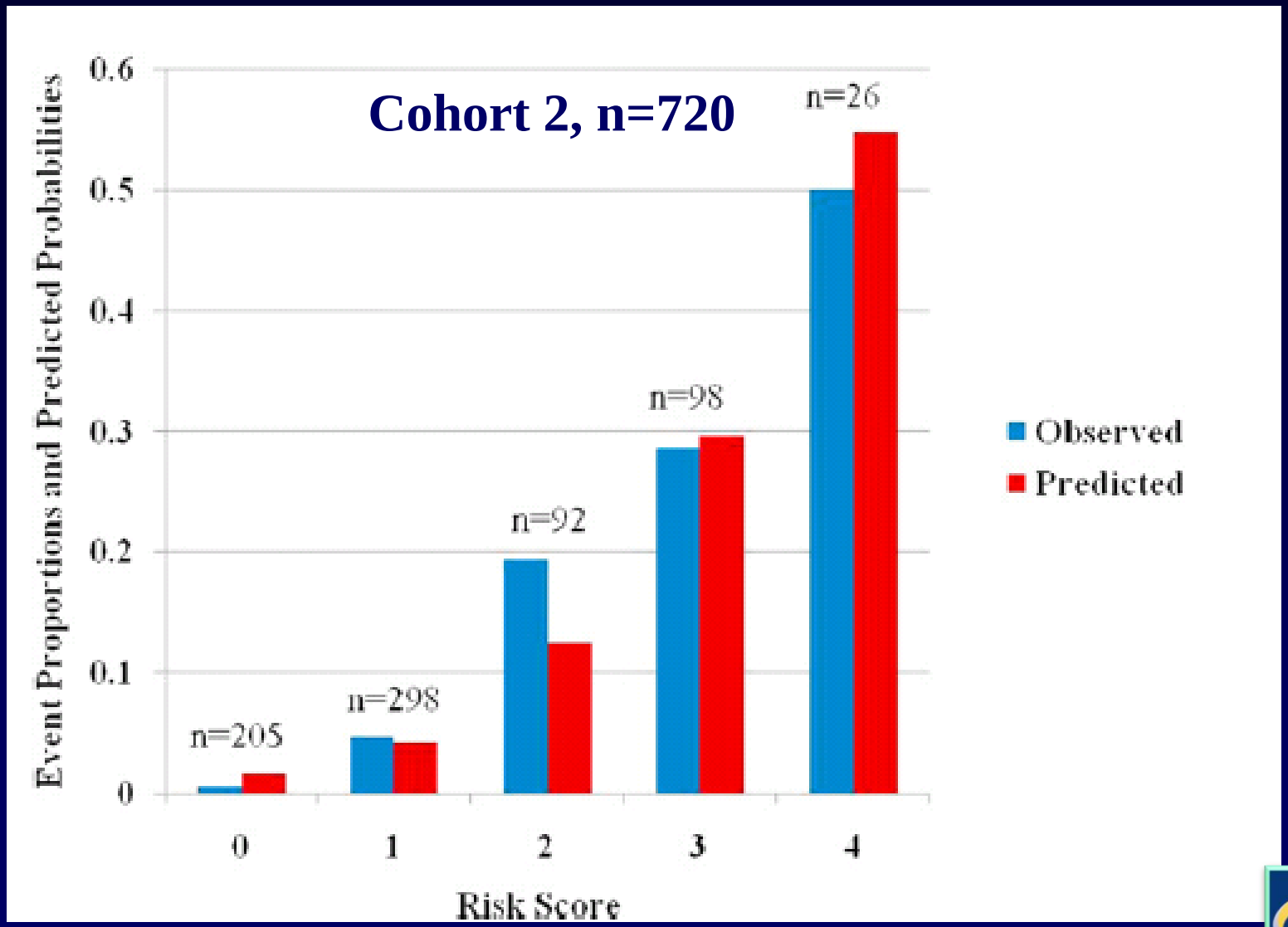
Predictors	OR	95% CI	Regression coefficient	*P* value
Abnormal ECG relative to normal ECG	2.5	(1.4–4.4)	0.9	.002
ST-T changes relative to no ST-T changes	2.9	(1.7–4.8)	1.1	<.001
RF abnormal but MP normal relative to both normal	3.5	(1.8–6.6)	1.2	<.001
RF and MP abnormal relative to both normal	9.7	(5.8–16.0)	2.3	<.001

OR, Odds ratio; *CI*, confidence interval; *ECG*, electrocardiogram; *ST-T*, ST segments or T-wave on ECG; *RF*, regional function; *MP*, myocardial perfusion.

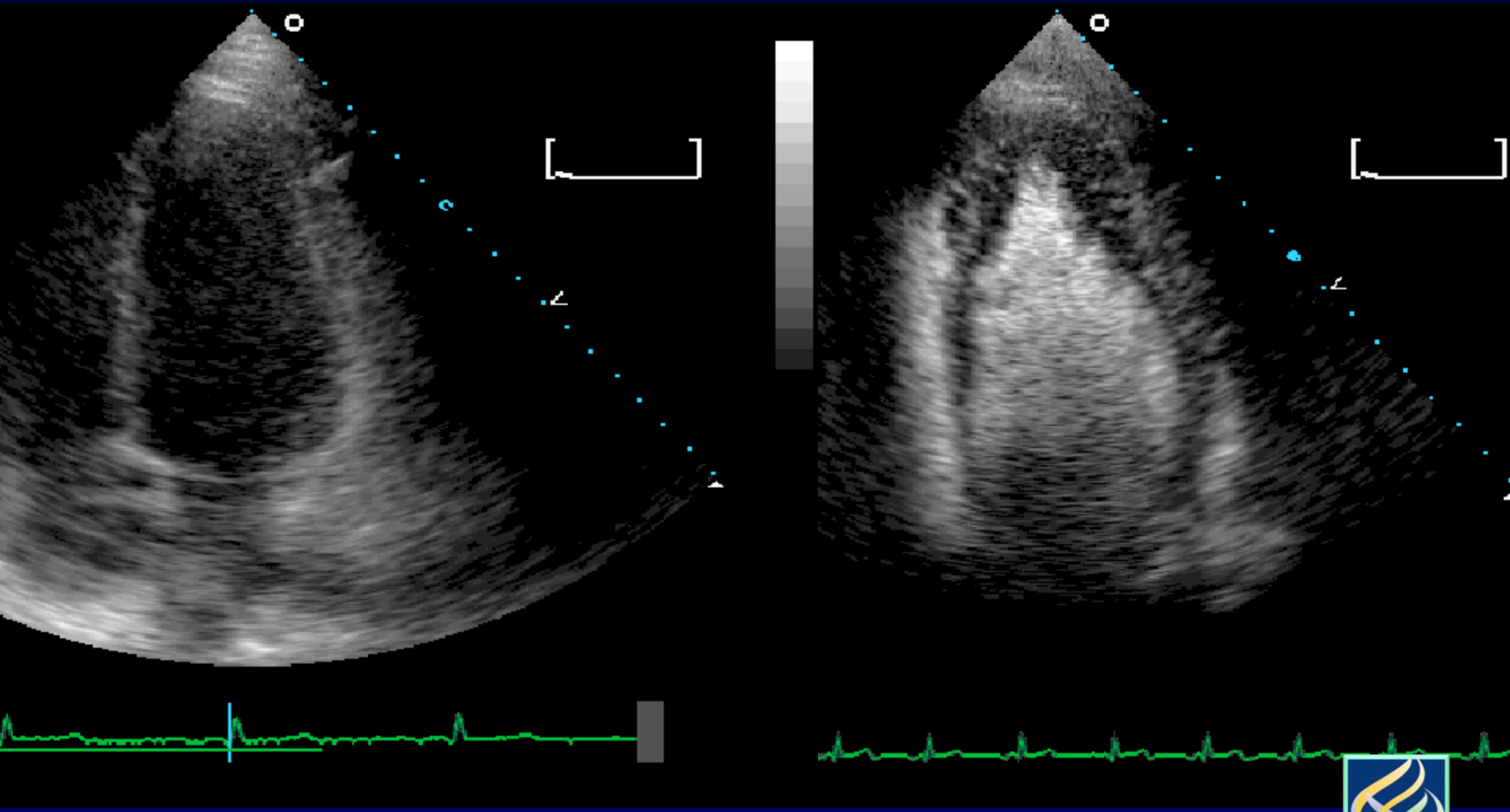
Wei et al, JASE 2010;23:636-642.

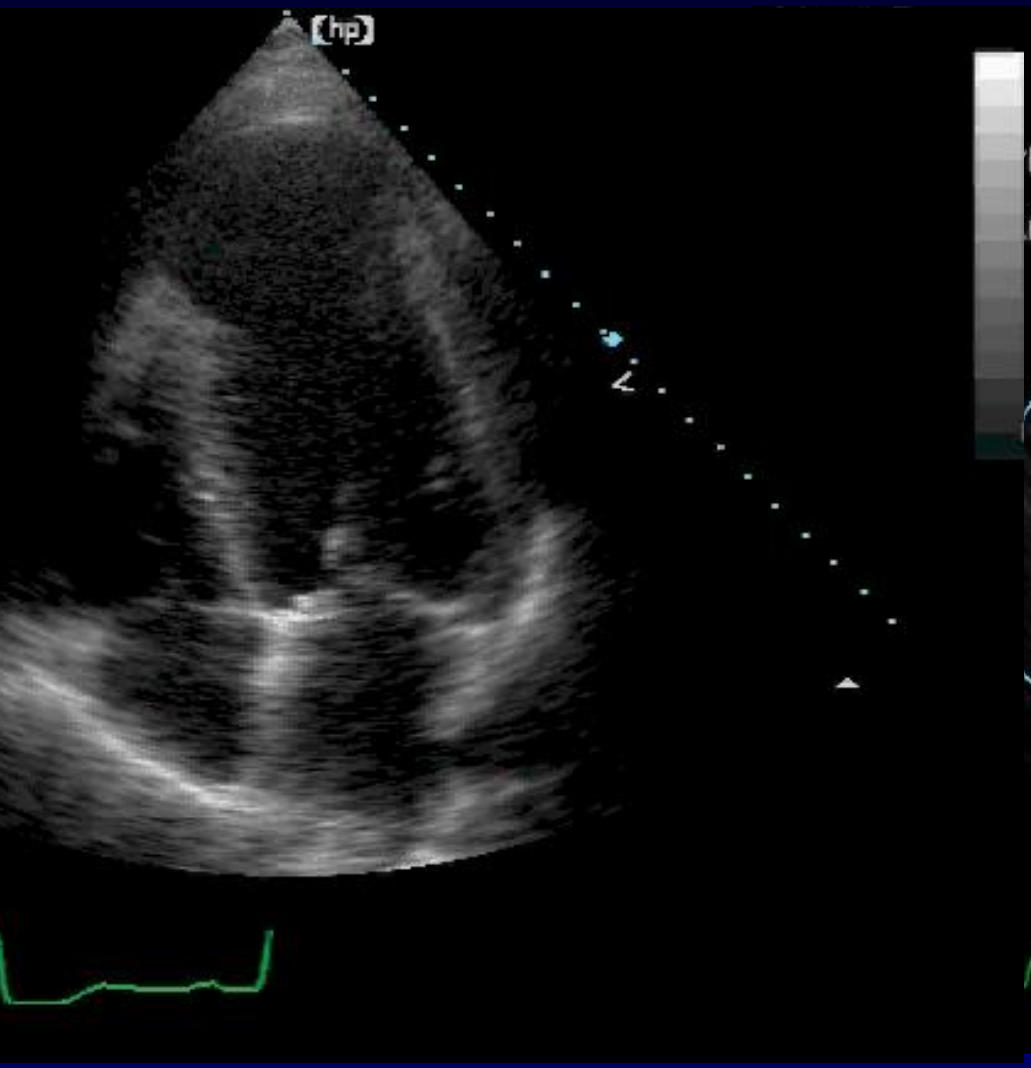


Wei et al, JASE 2010;23:636-642.

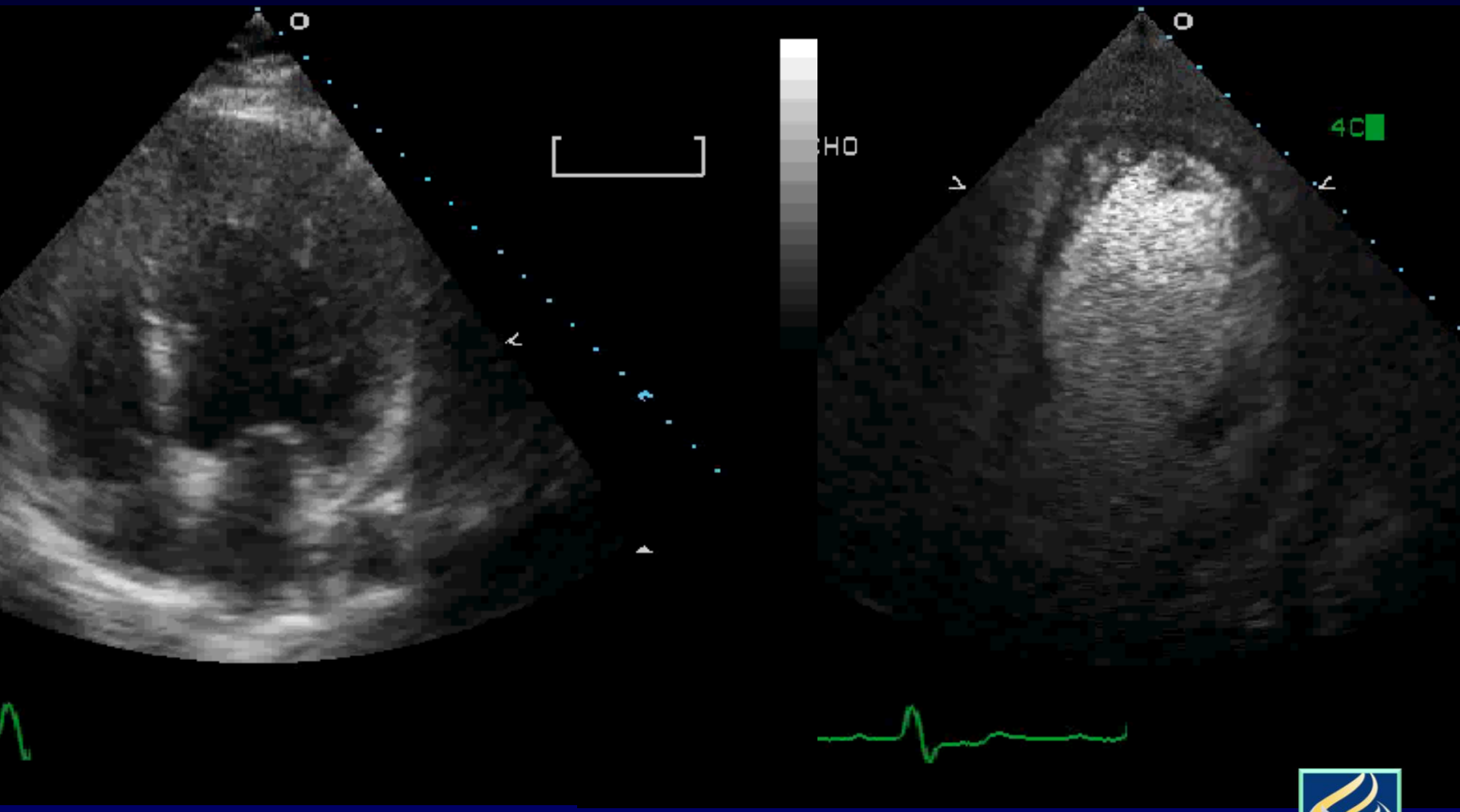


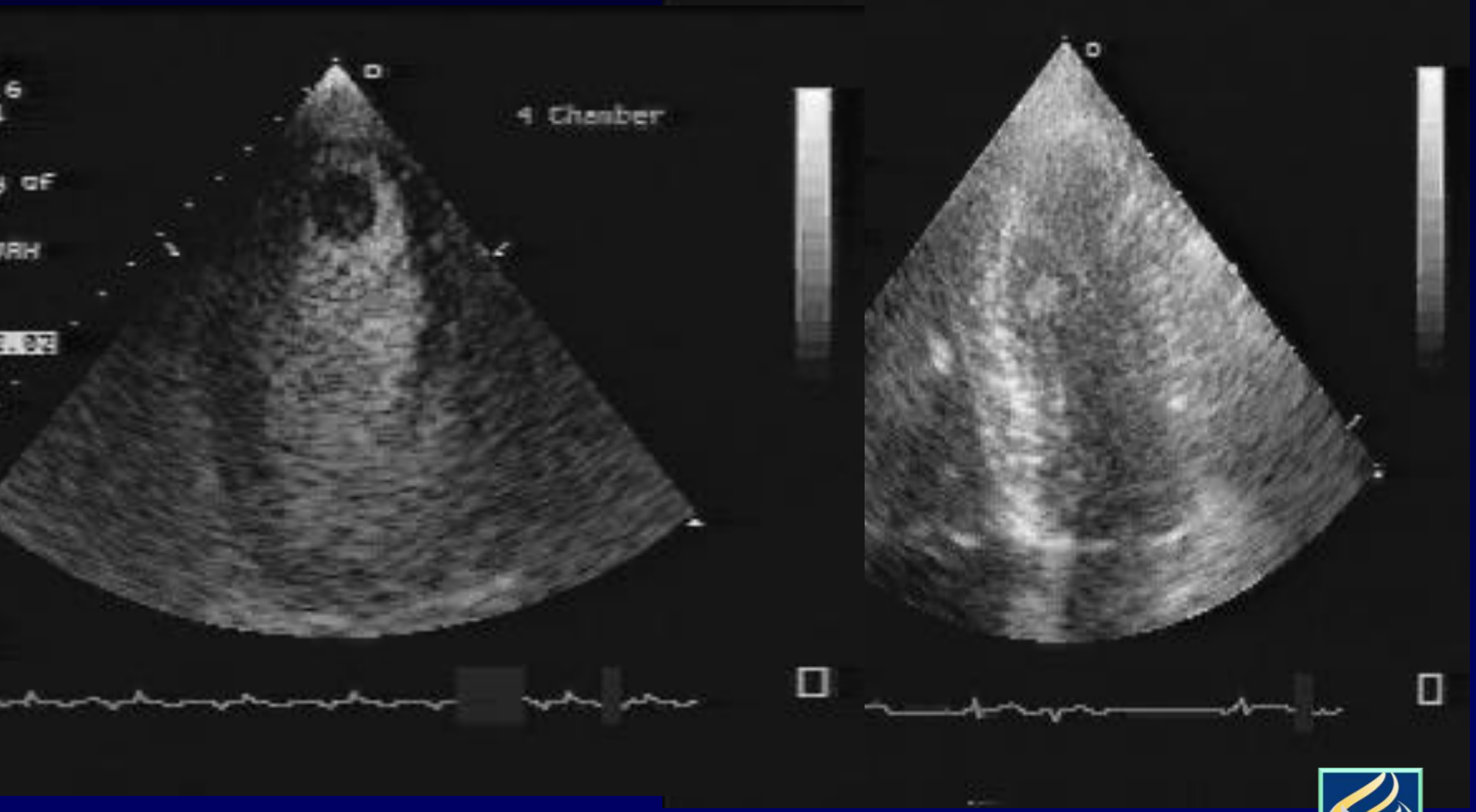
Wei et al, JASE 2010;23:636-642.




(hp)

(hp)
3.5MHz
PRF
3.0
E
AB


4C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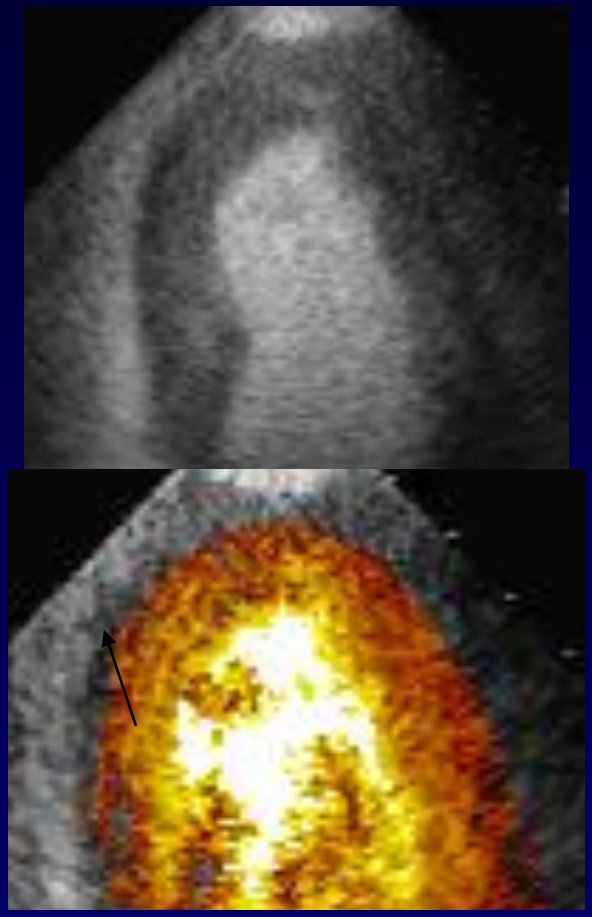
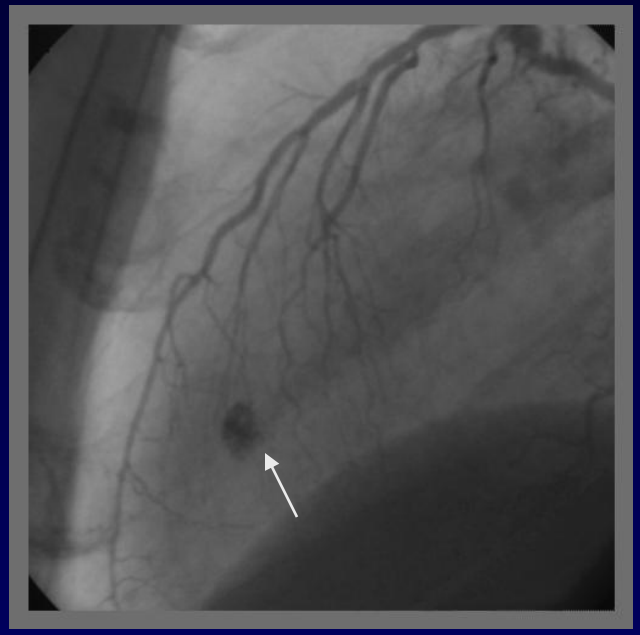
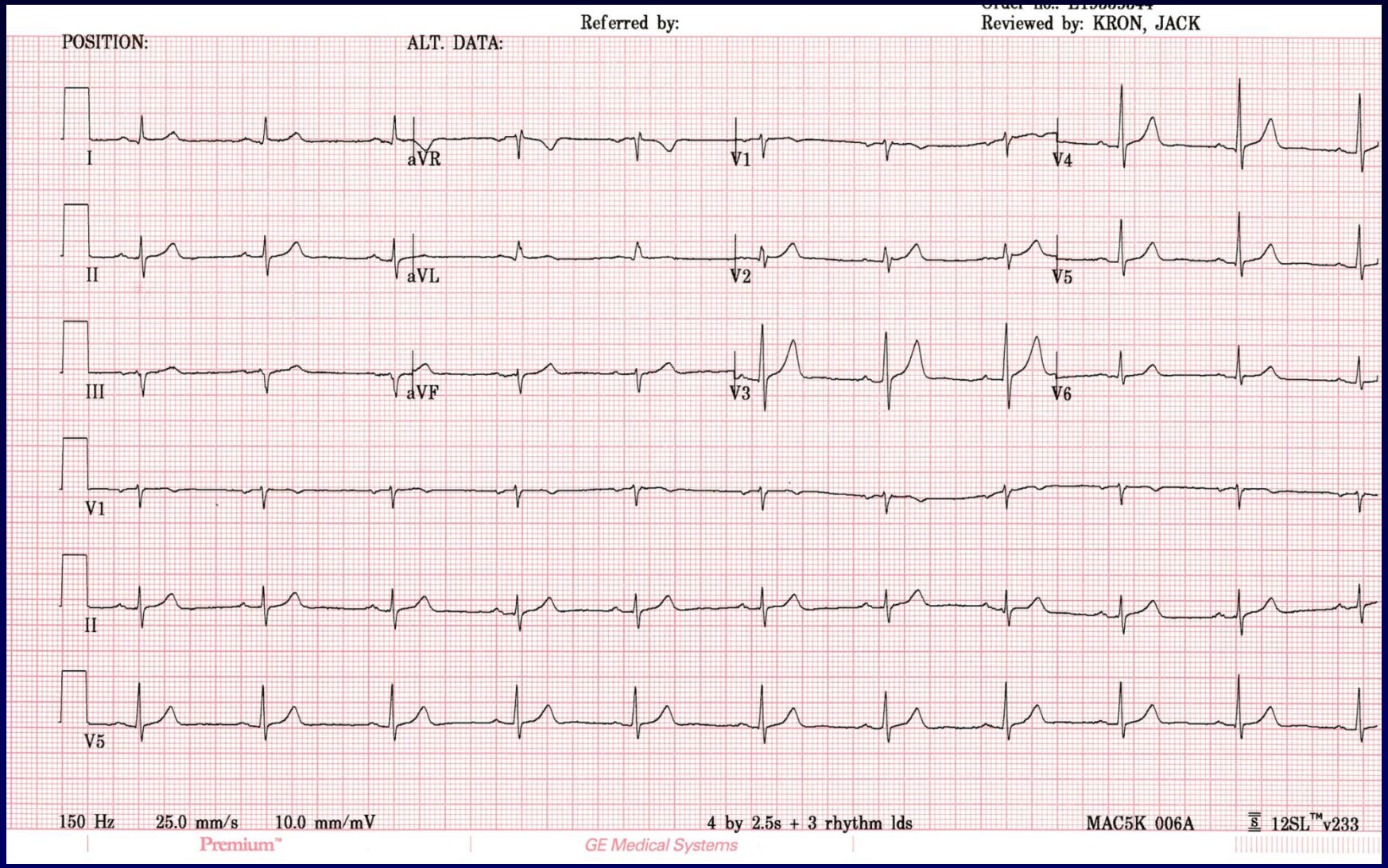
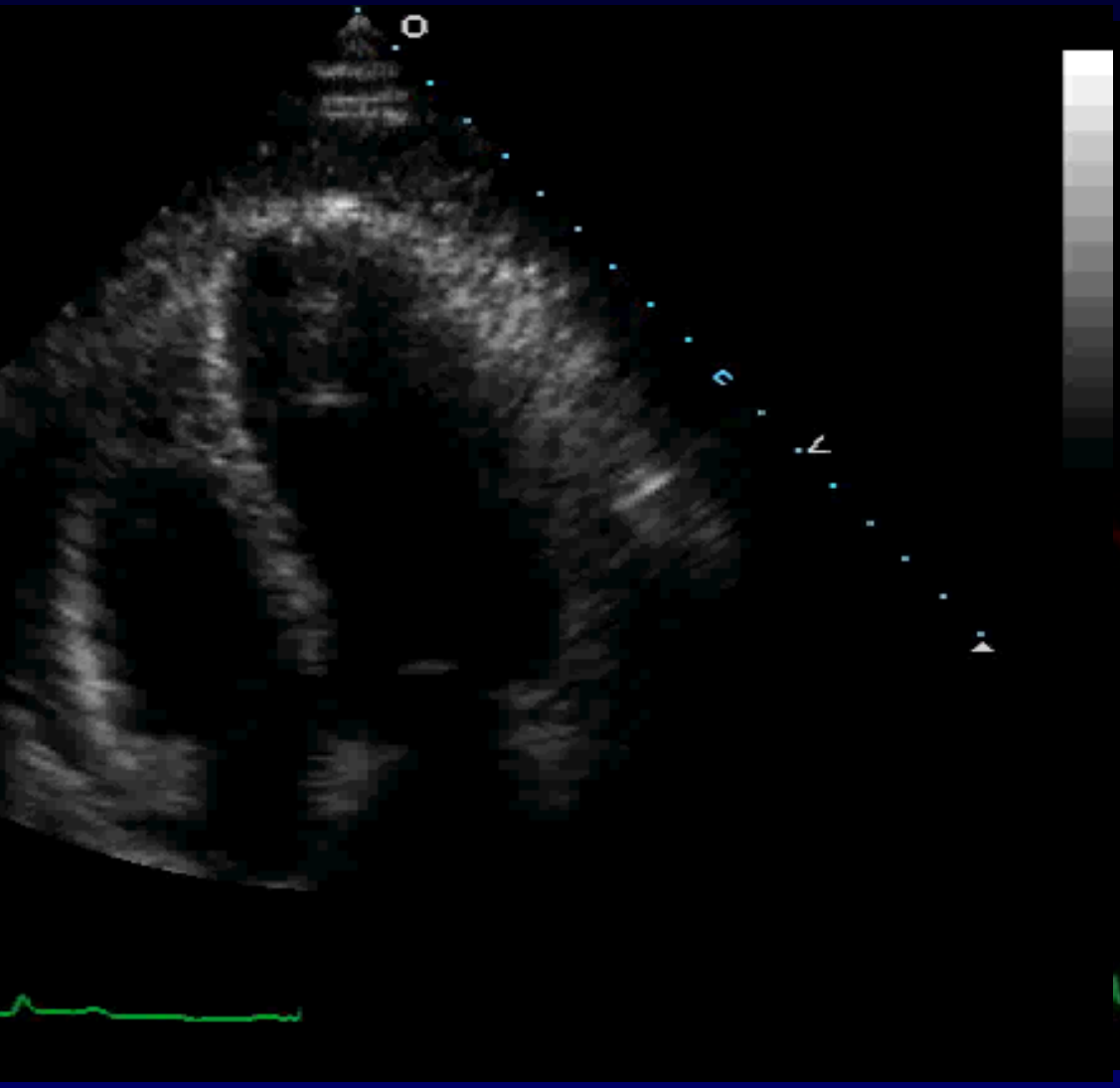
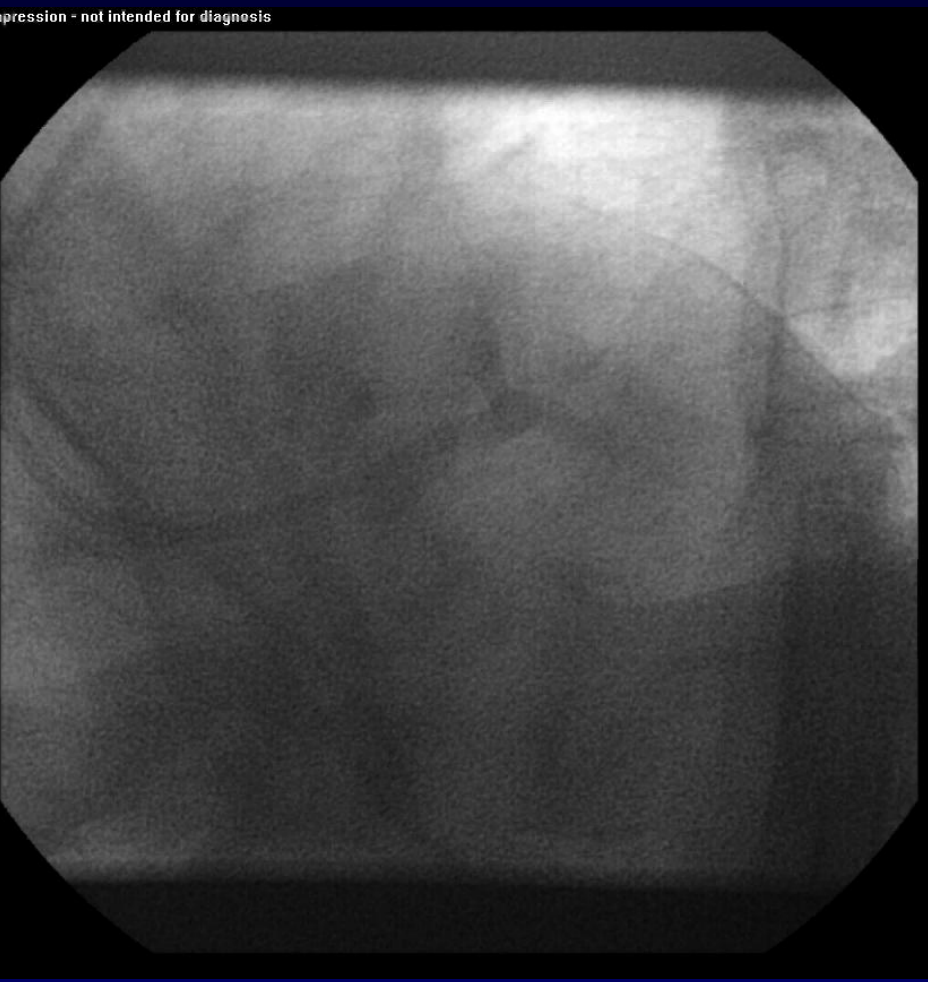


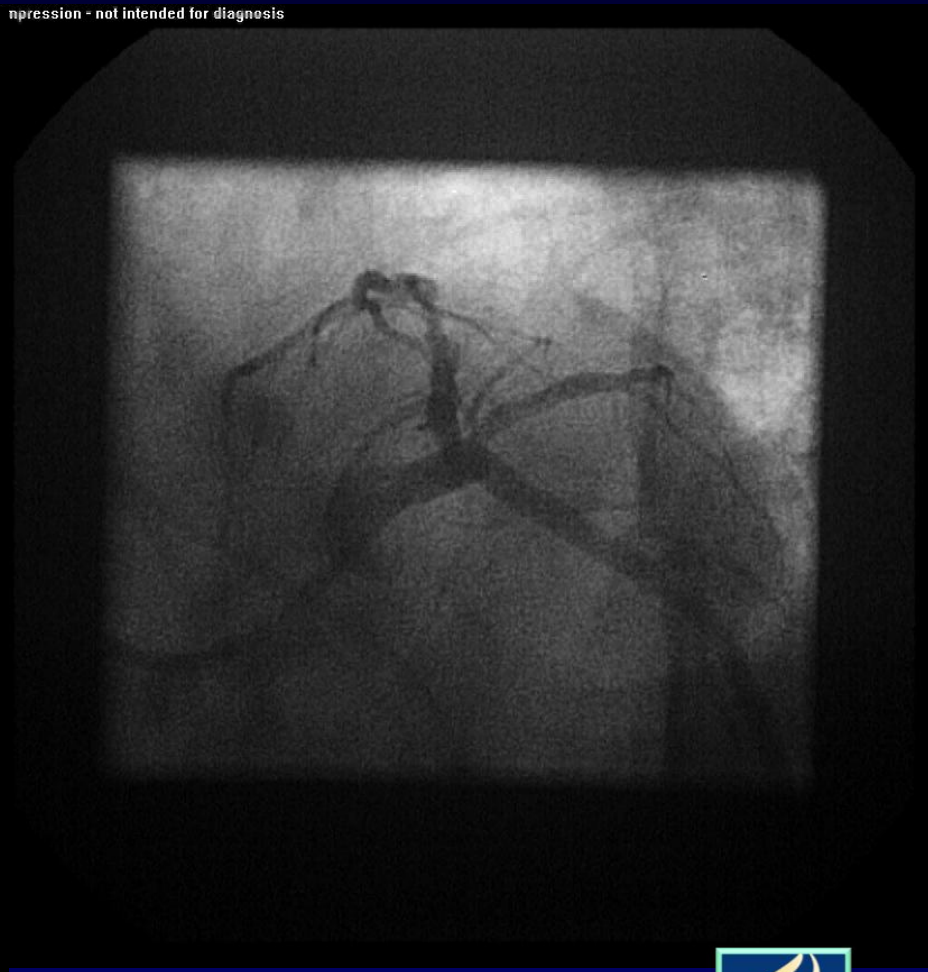


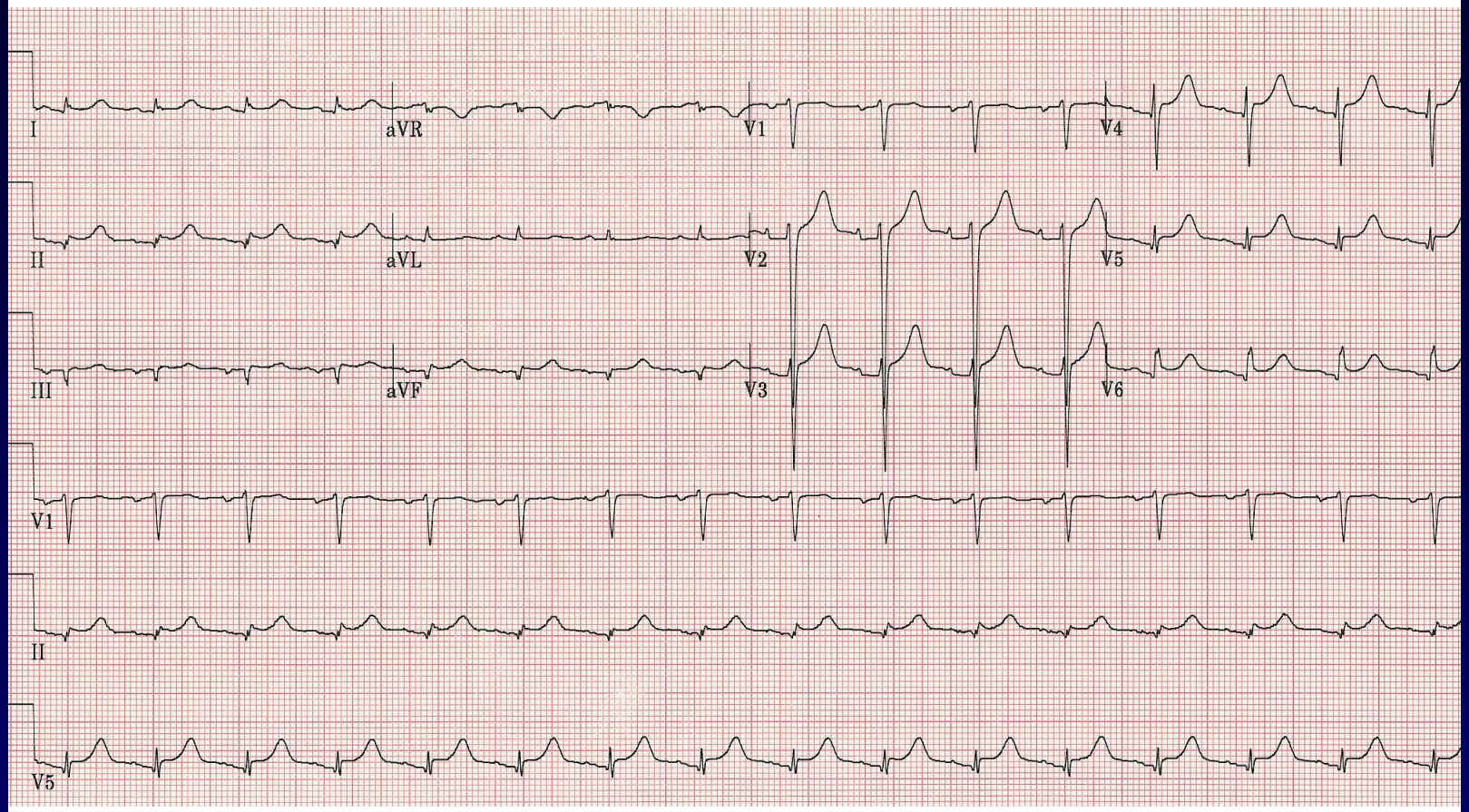

Referred by:
Reviewed by: KRON, JACK
POSITION:
ALT. DATA:
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5
150 Hz
25.0 mm/s
10.0 mm/mV
4 by 2.5s + 3 rhythm lds
MAC5K 006A
12SL™v233
Premium™
GE Medical Systems

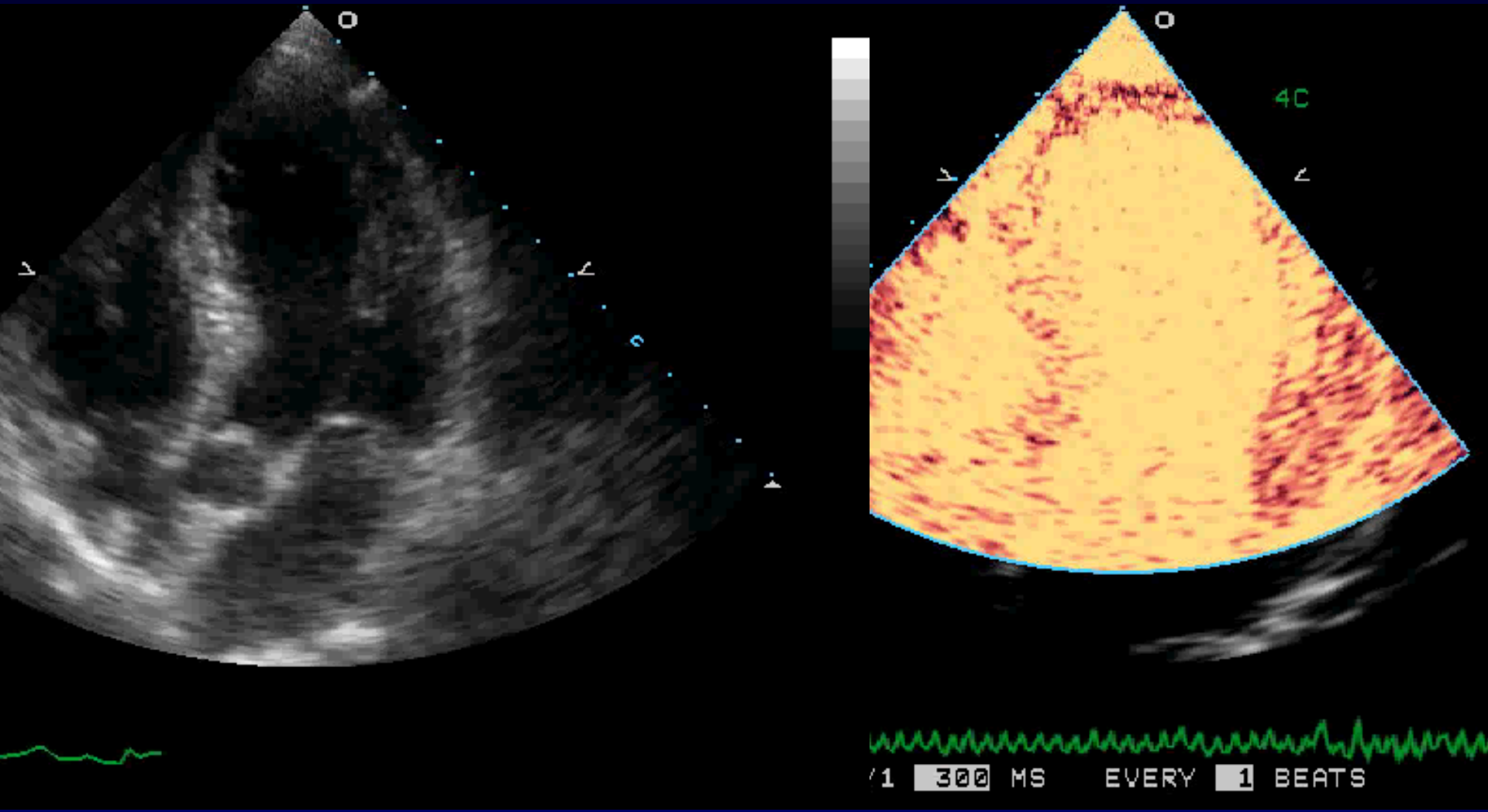


4C

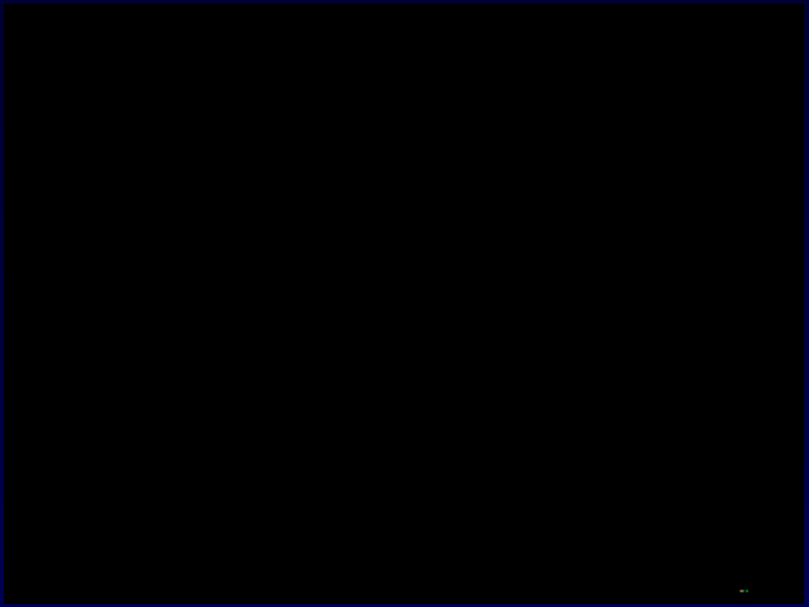

pression - not intended for diagnosis

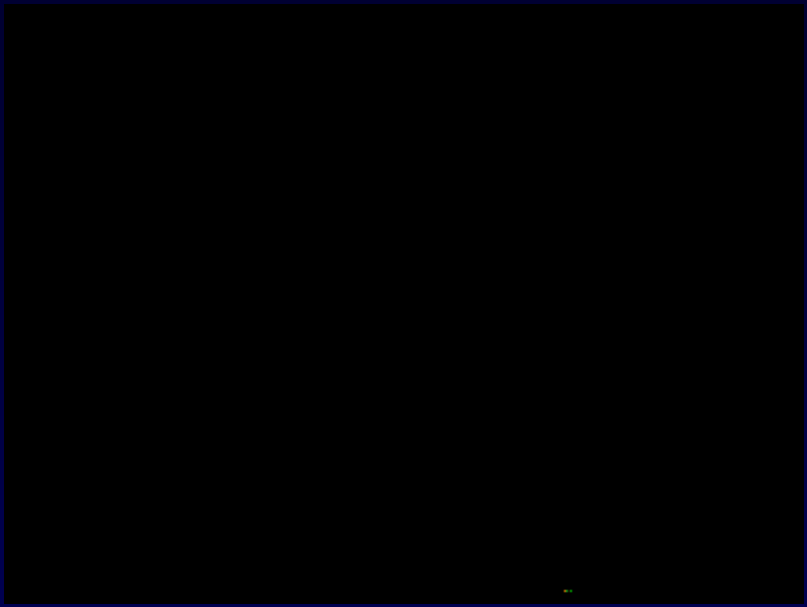

npression - not intended for diagnosis

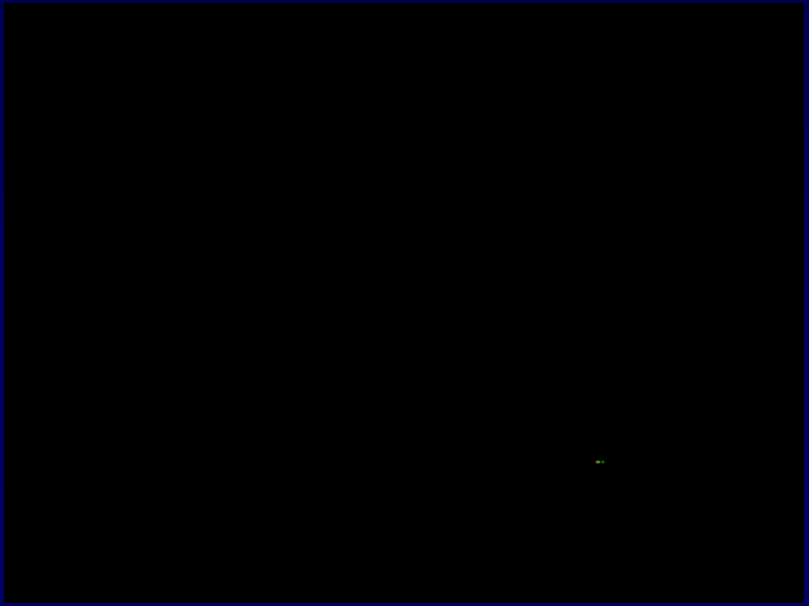

I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
V1
II
V5

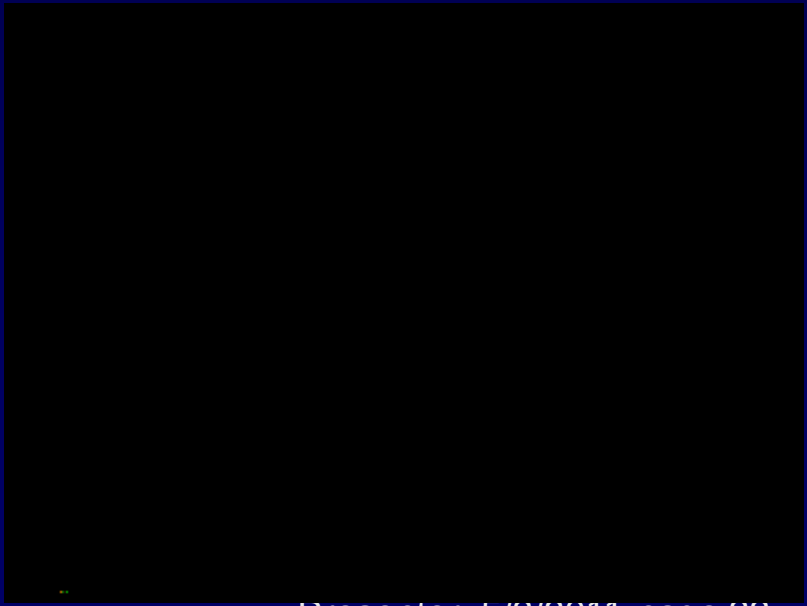

4C
/1 300 MS EVERY 1 BEATS

Stress Echocardiography

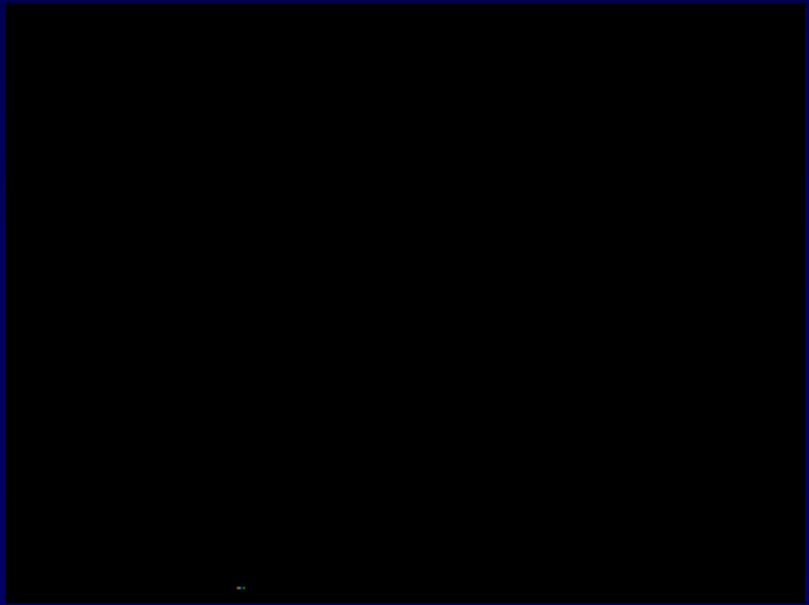




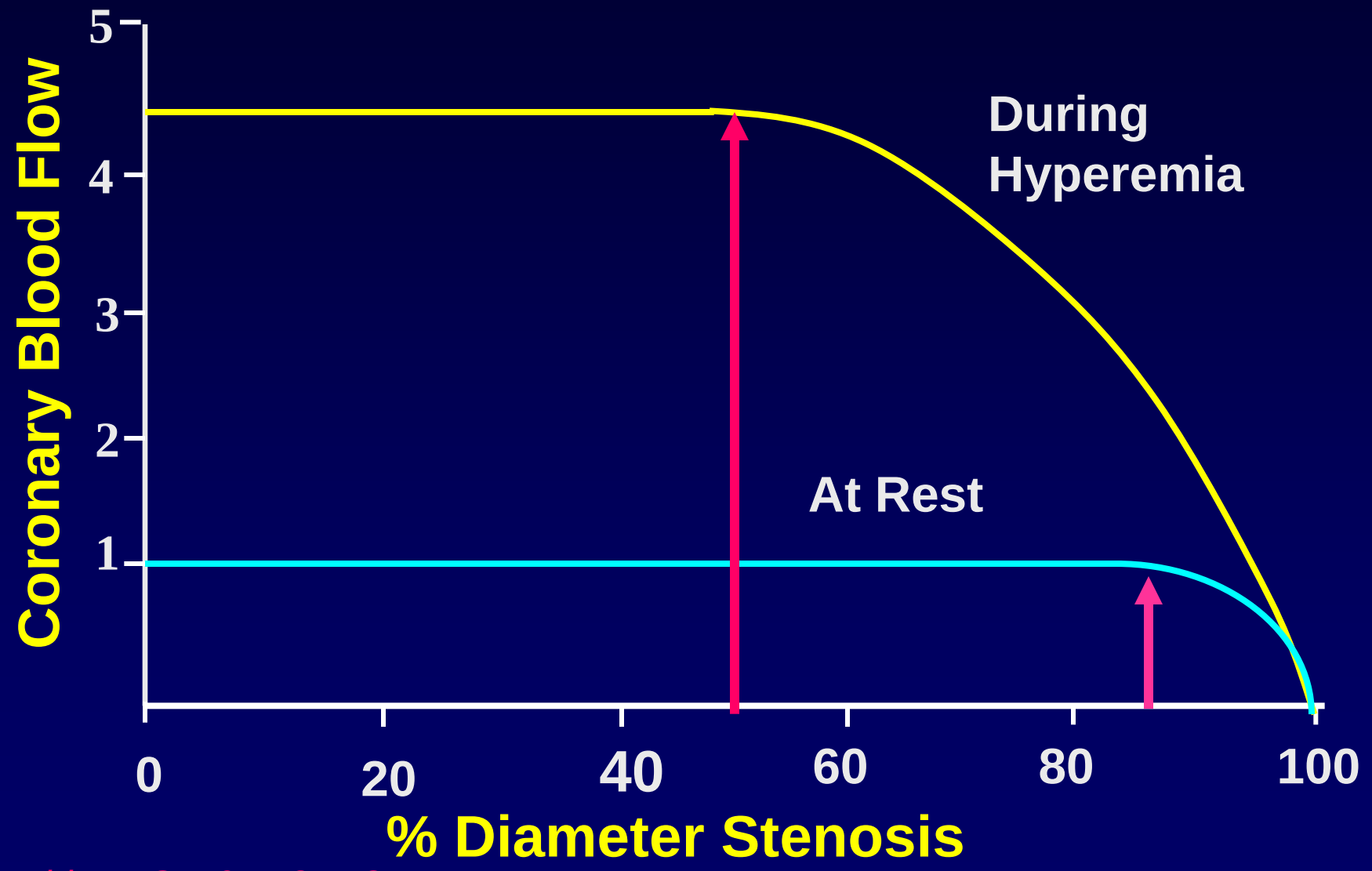




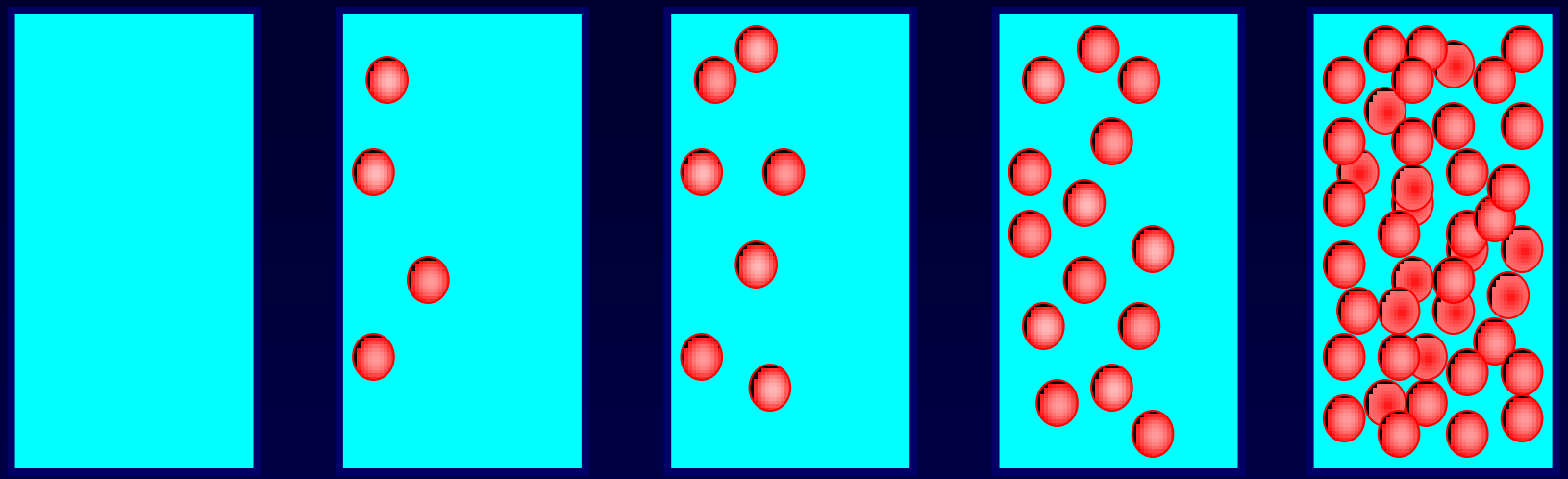
Stress Echocardiography



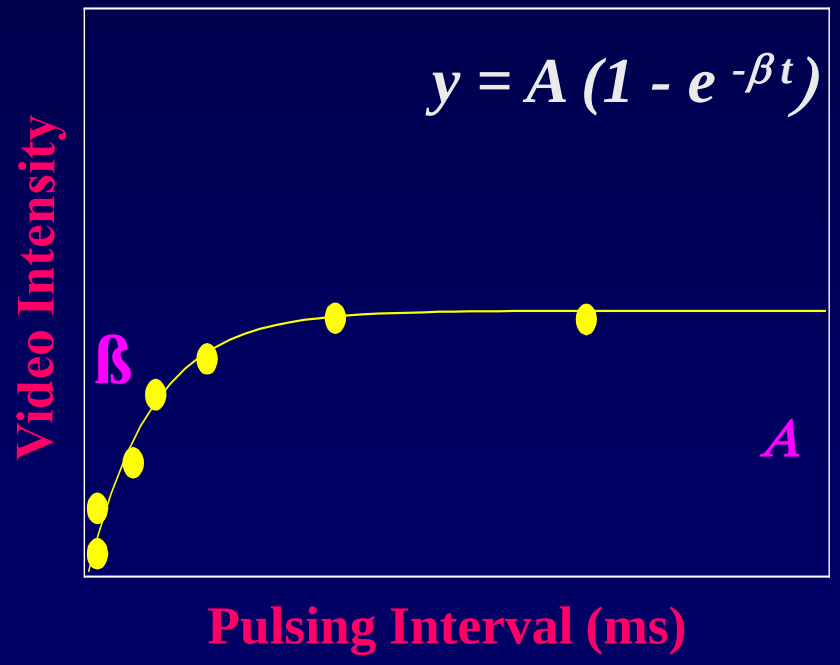
Coronary Blood Flow Reserve



Gould , AJC, 1974;34:48-55.



time = 0 s = 1 s = 2 s = 3 s = 4 s



y = VI at PI "*t*"

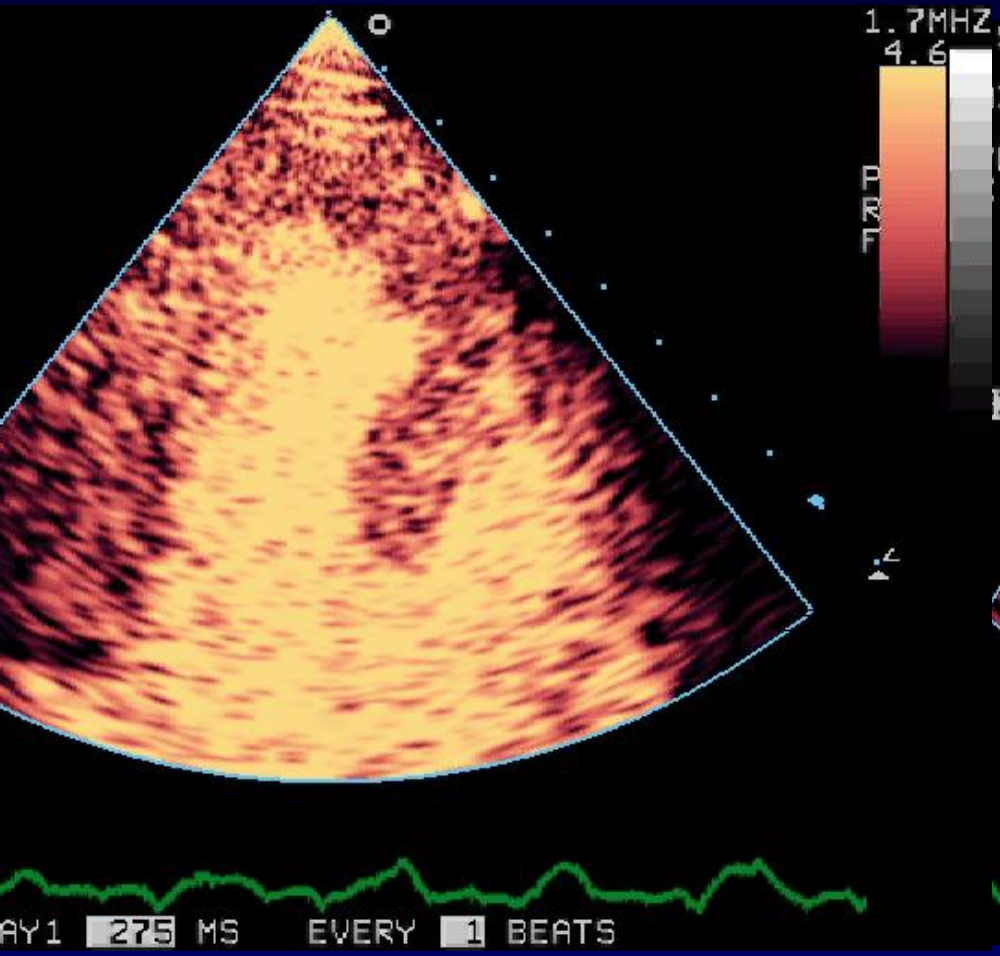
A = plateau VI (MBV)

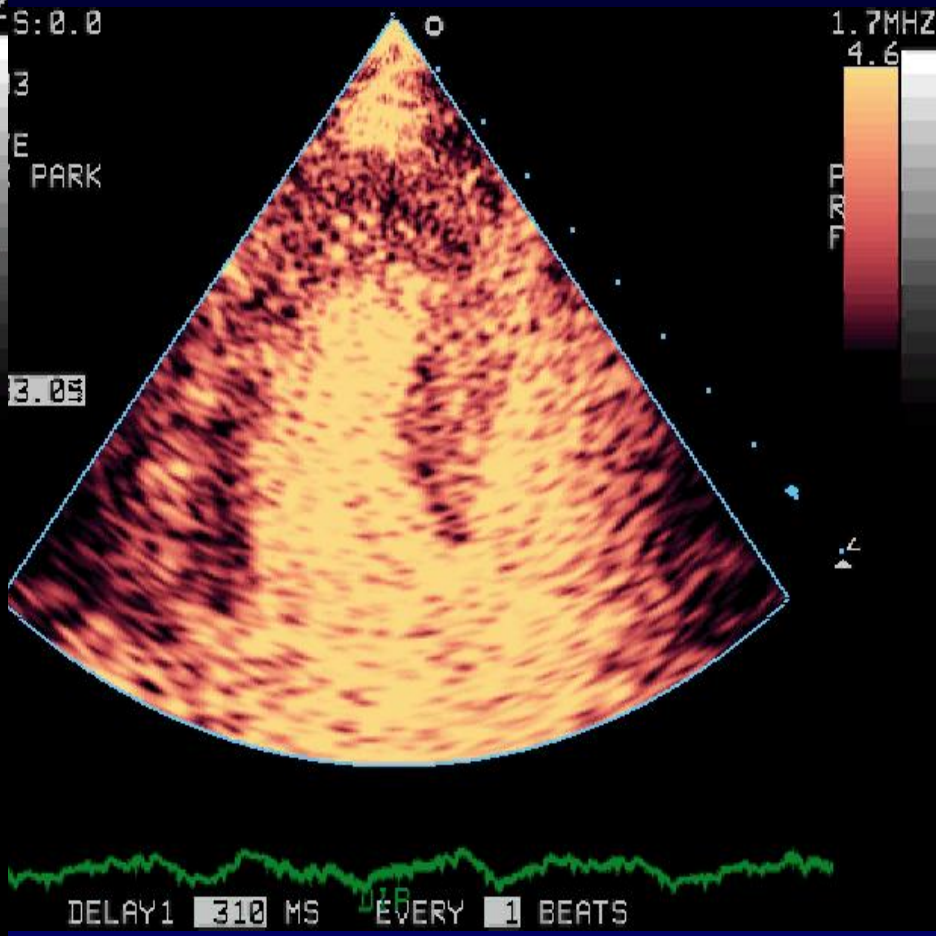
ß = rate of rise of VI (mean microbubble velocity)

A • ß

Wei et al, Circulation 97:473-483, 1998.

MCE vs SPECT in pt. with no prior MI

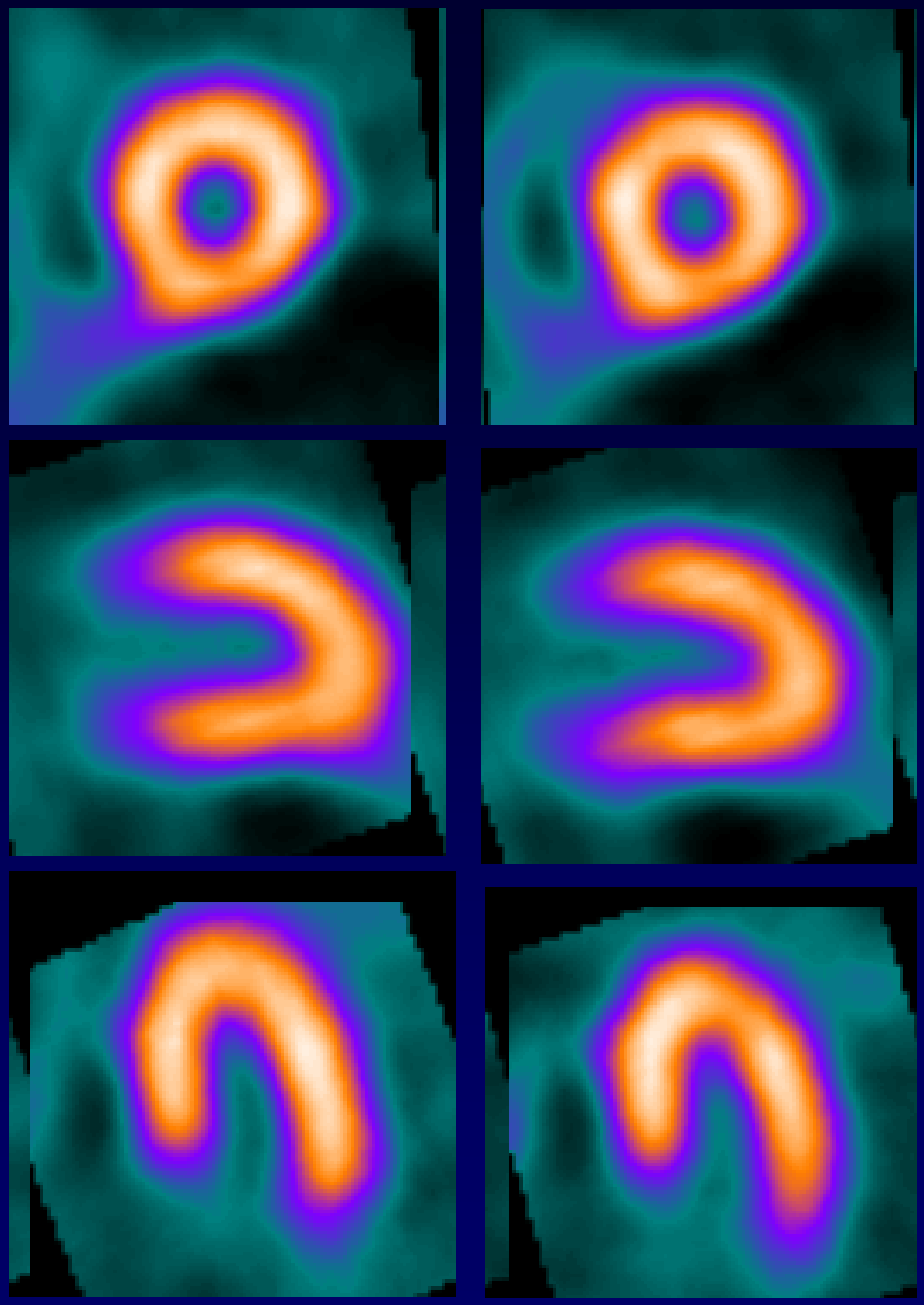




Rest

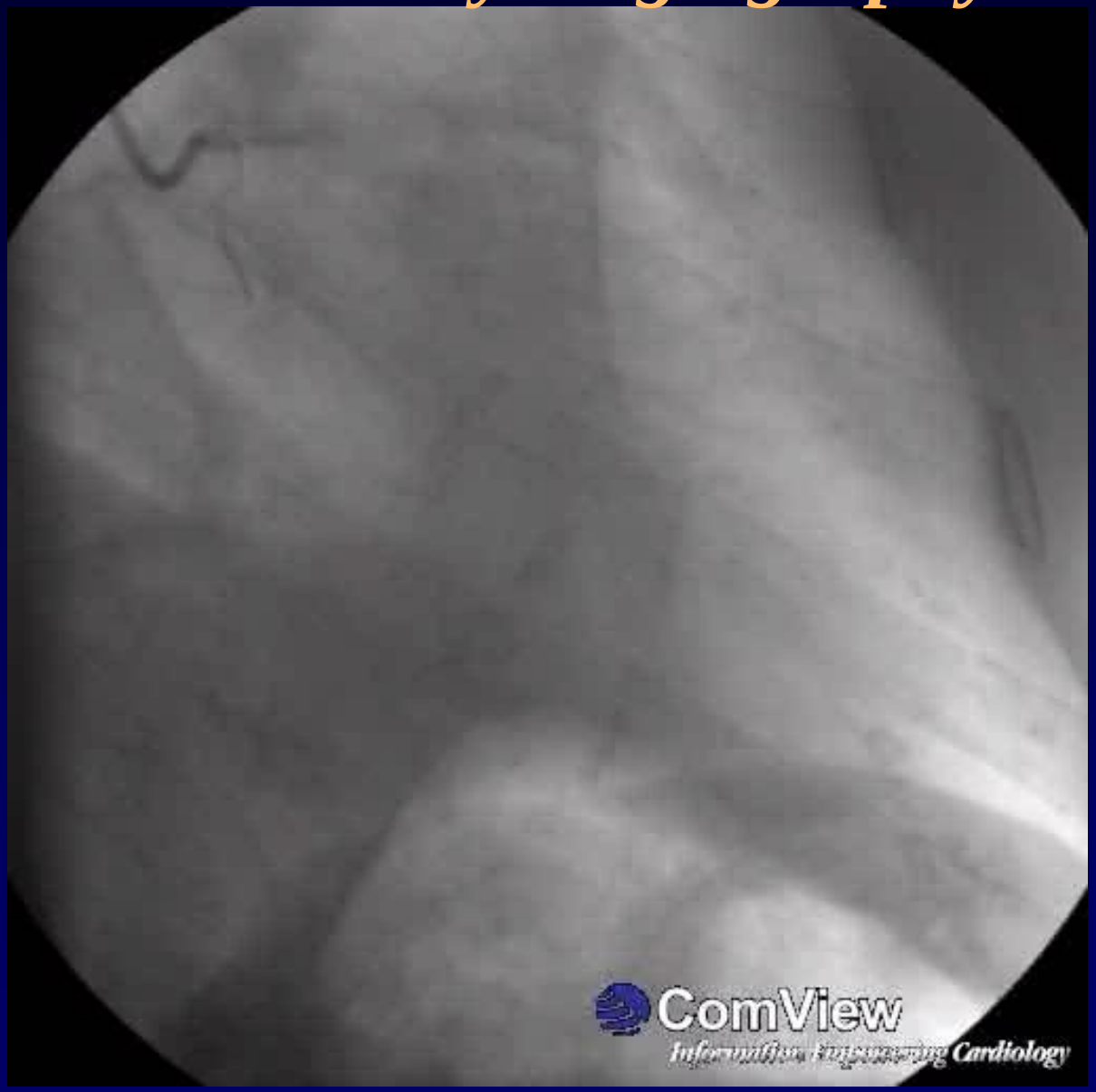
Dipyridamole

Rest

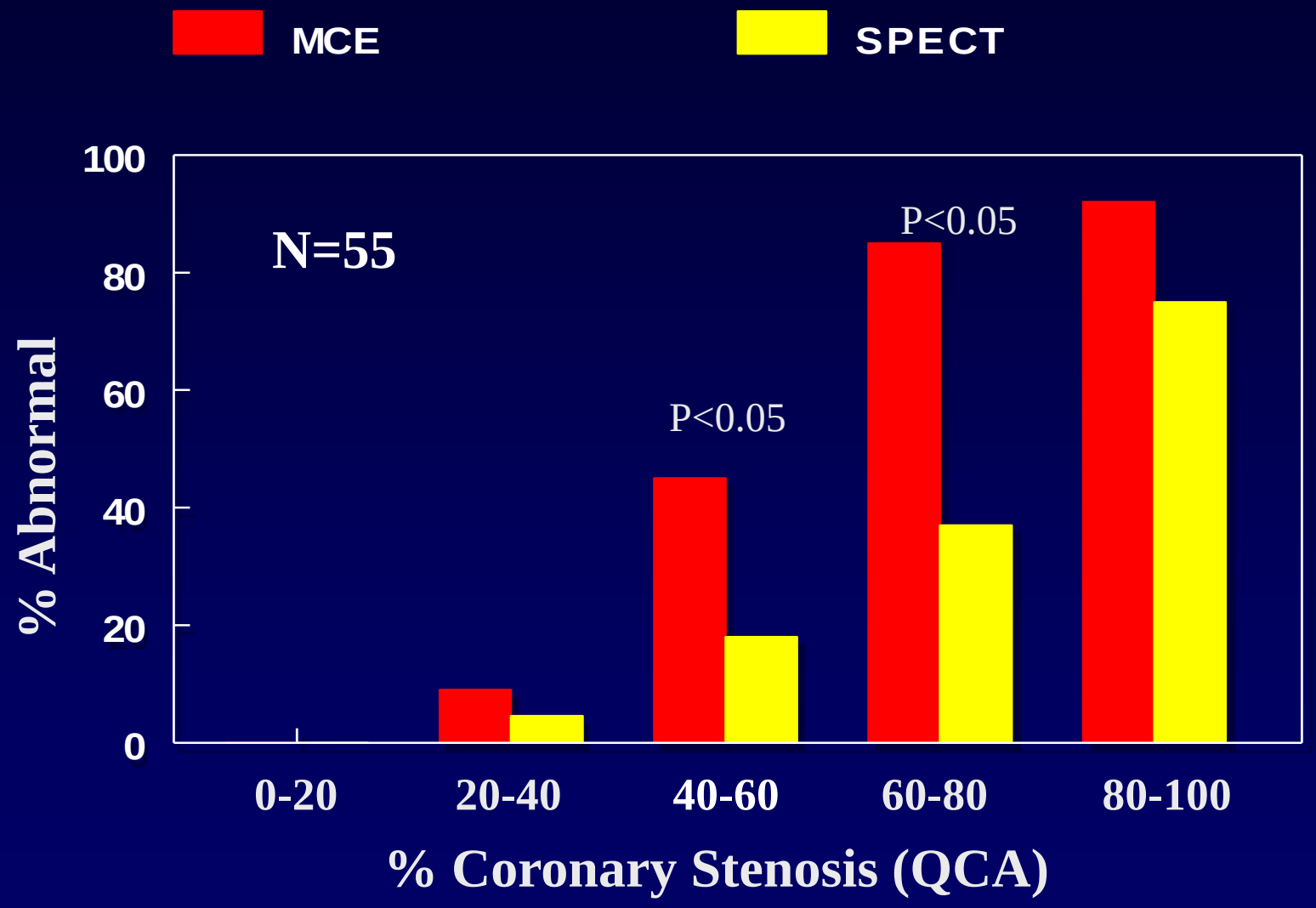


DP

Coronary Angiography



MCE vs SPECT in Patients with no Prior MI and Normal Regional and Global LV Function



Senior et al. Am Heart J 2004;147:1100-1105.

Ischemic cascade

Blood flow mismatch

Perfusion defects on nuclear imaging, MCE

Diastolic dysfunction

Systolic dysfunction

Wall motion abnormalities on echocardiography/MRI

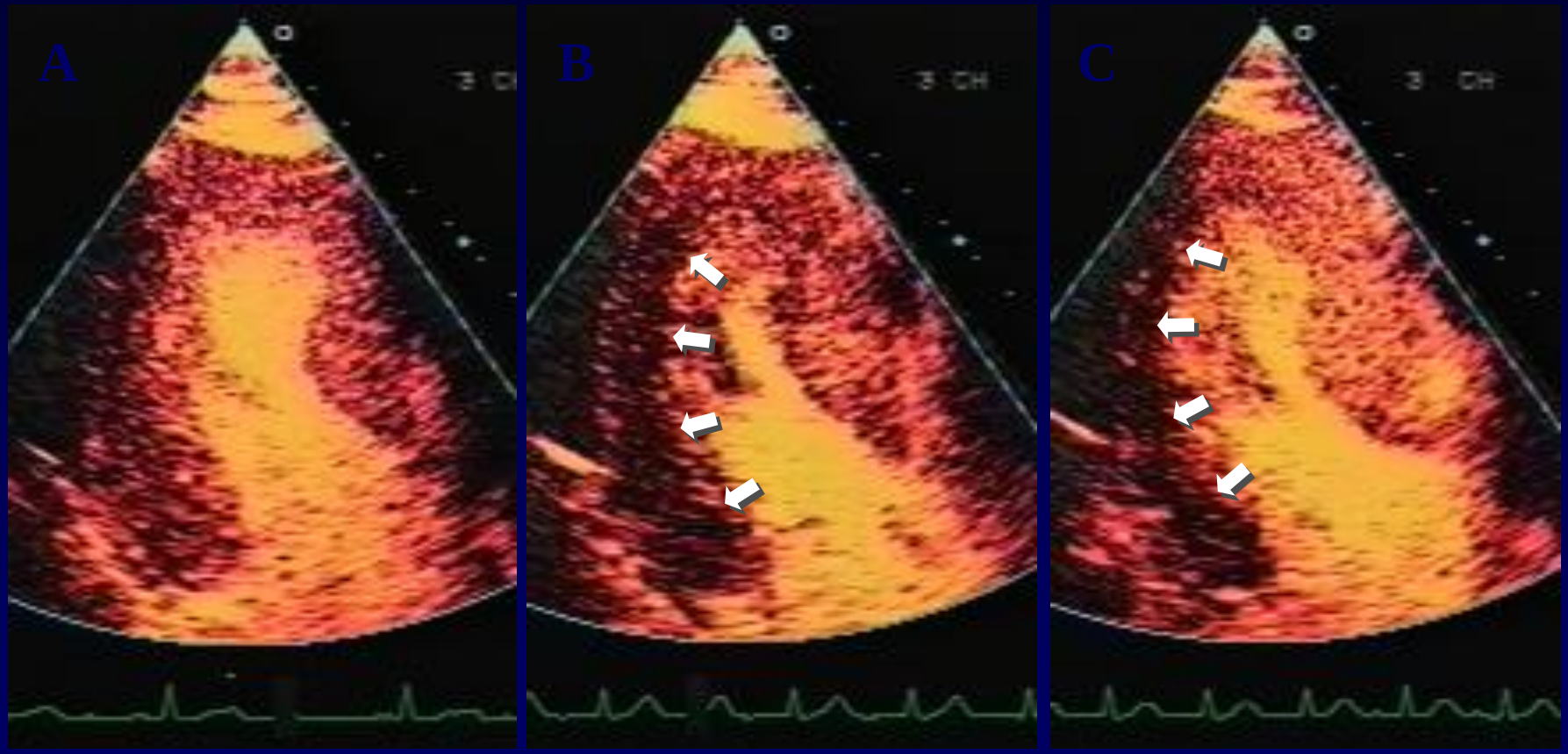
EKG abnormalities

ST↓on ECG

Angina

Symptoms

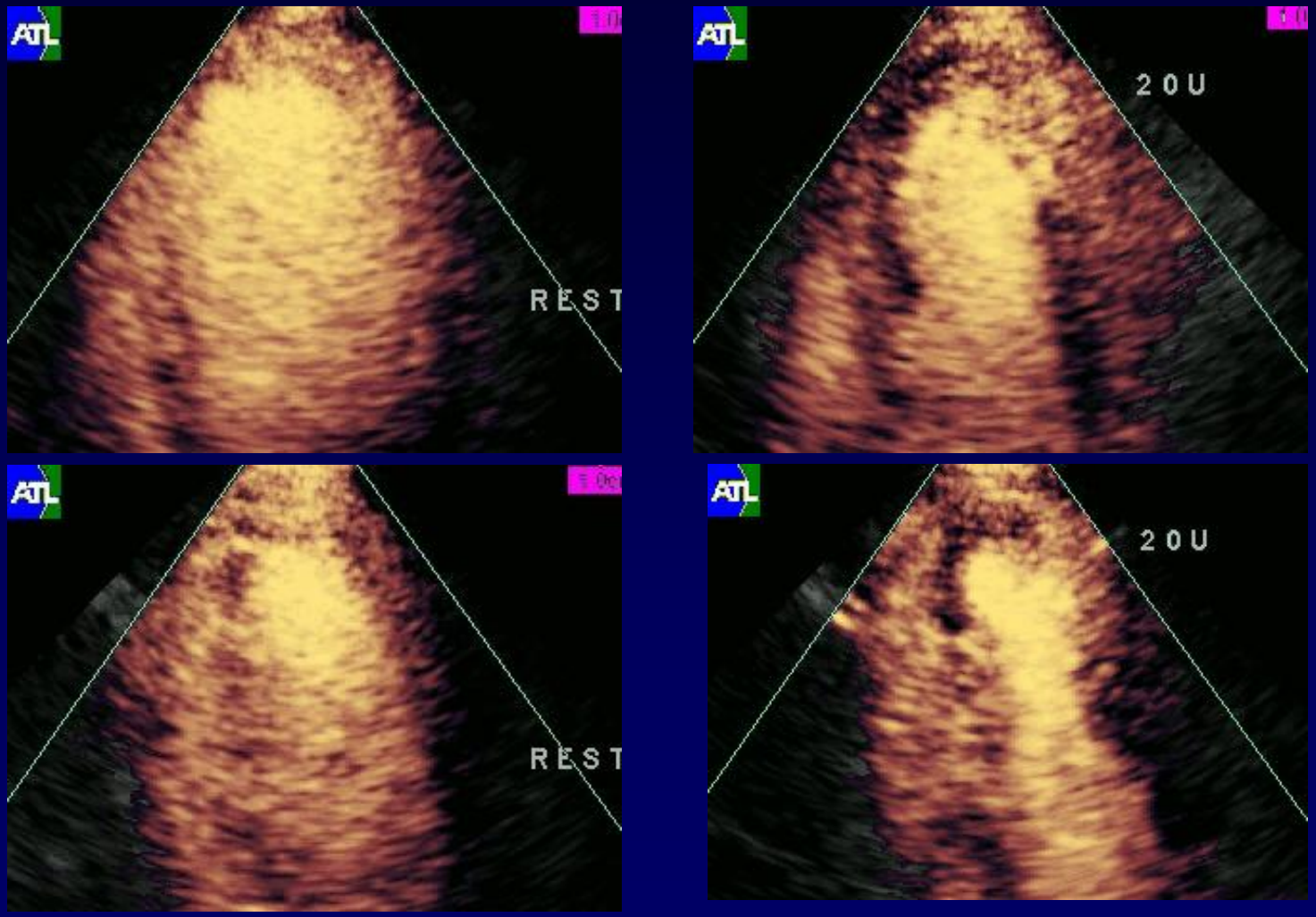
‘Real-time’ Low-MI Dobutamine MCE



Rest **20 $\mu g \cdot kg^{-1} \cdot kg^{-1} \cdot min^{-1}$** **40 $\mu g \cdot kg^{-1} \cdot kg^{-1} \cdot min^{-1}$**

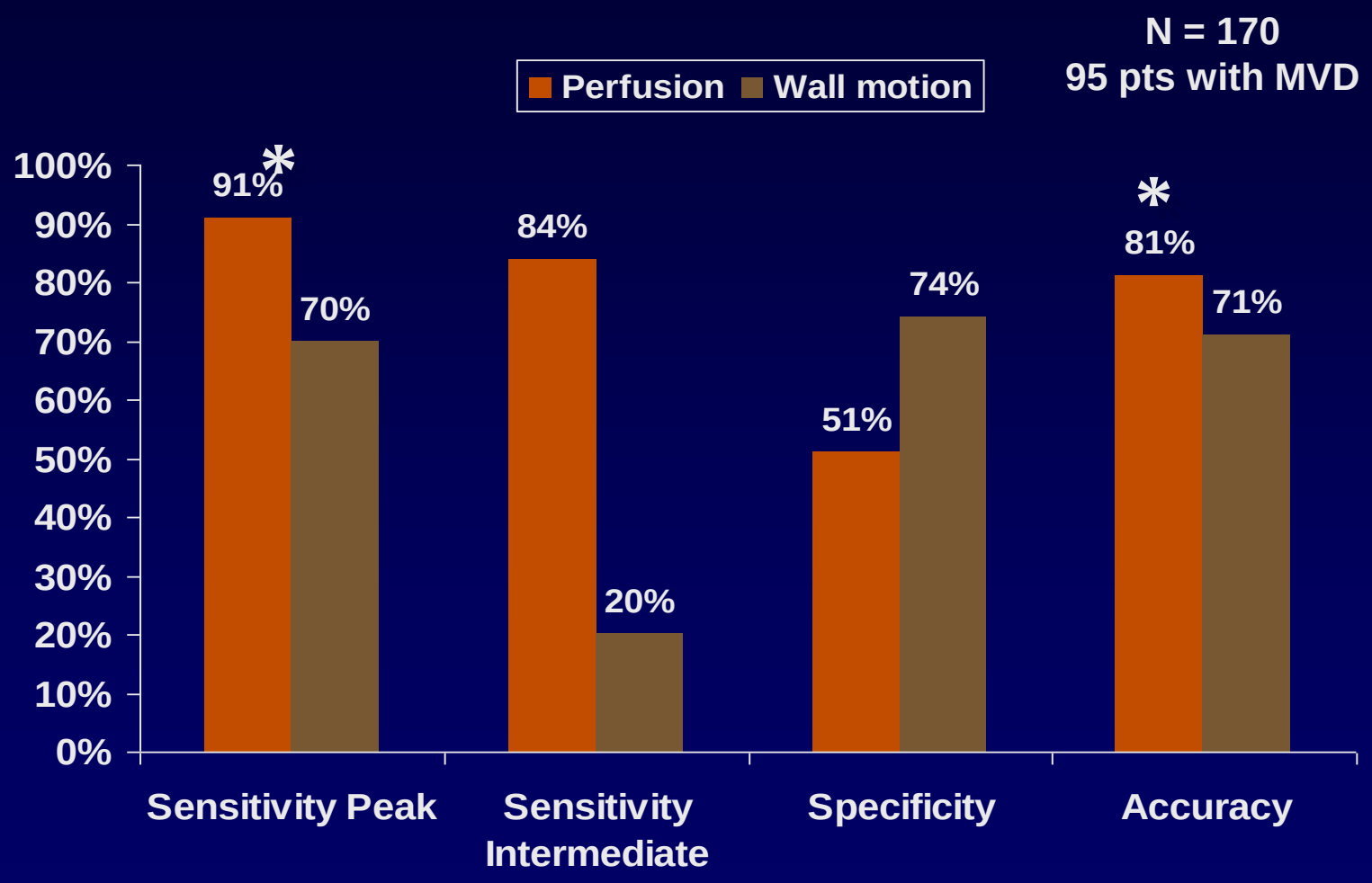
Lepper et al, Circulation109;3132-3135

‘Real-time’ Low-MI Dobutamine MCE



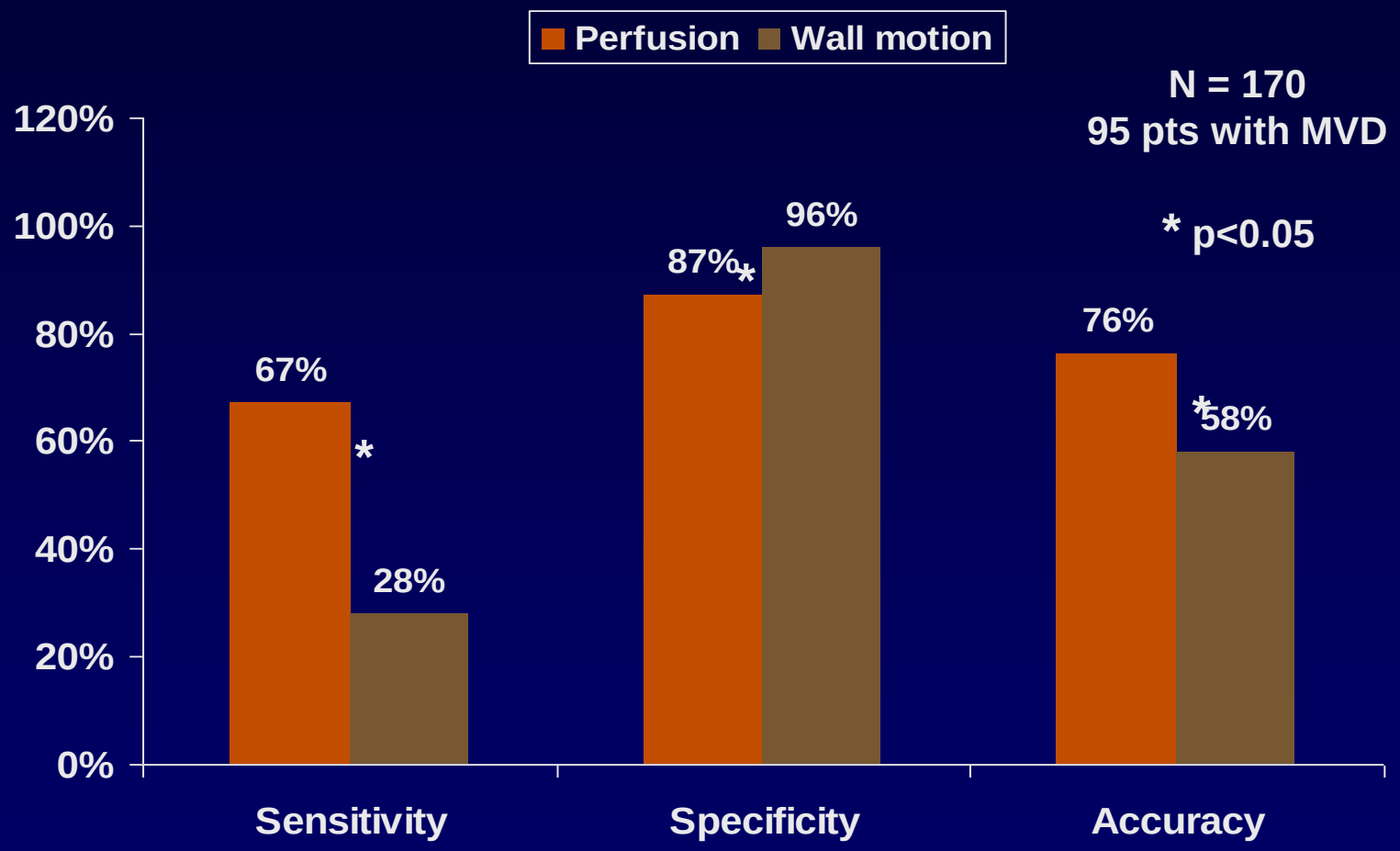
Elhendy et al. JACC 2004;44:2185-2191.

‘Real-time’ Low-MI Dobutamine MCE



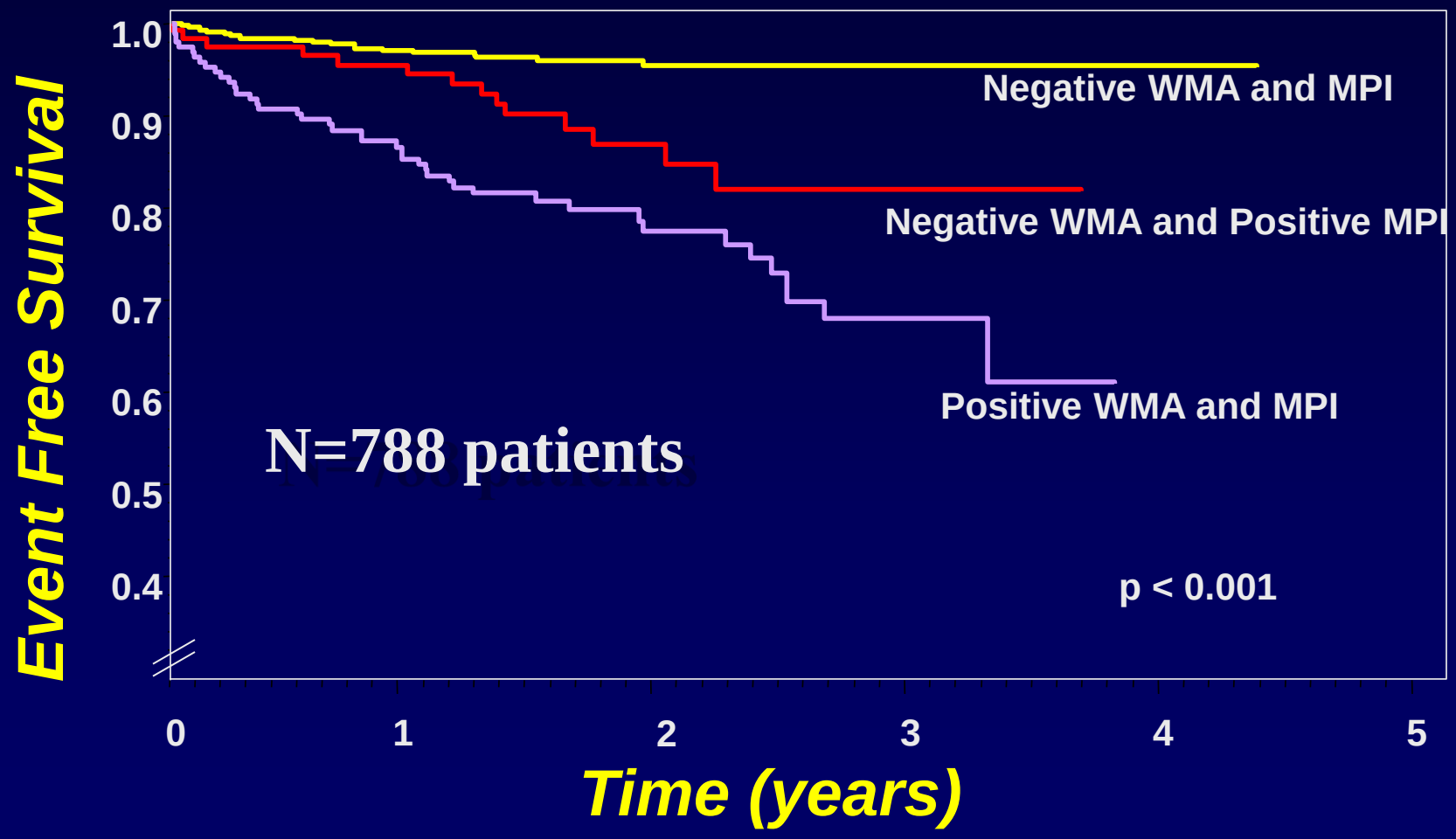
Elhendy et al. JACC 2004;44:2185-2191.

Detecting Multivessel CAD



Elhendy et al. JACC 2004;44:2185-2191.

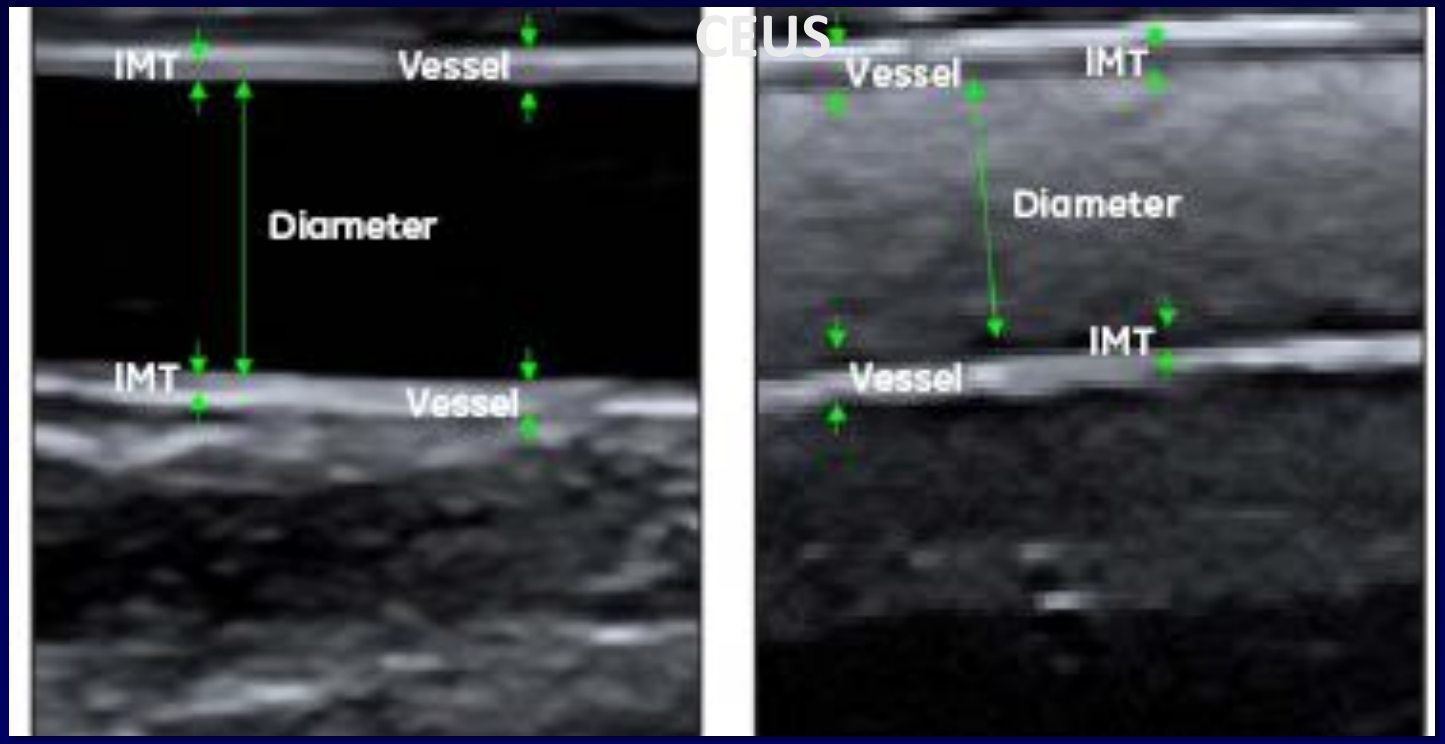
Predictive Power Over WMA: Event-Free Survival by WMA and MPI



Tsutsui J et.al. Circulation 2005;112:1444-50

CEUS enhanced c-IMT
(near and far walls)

Pre CEUS **Post CEUS**

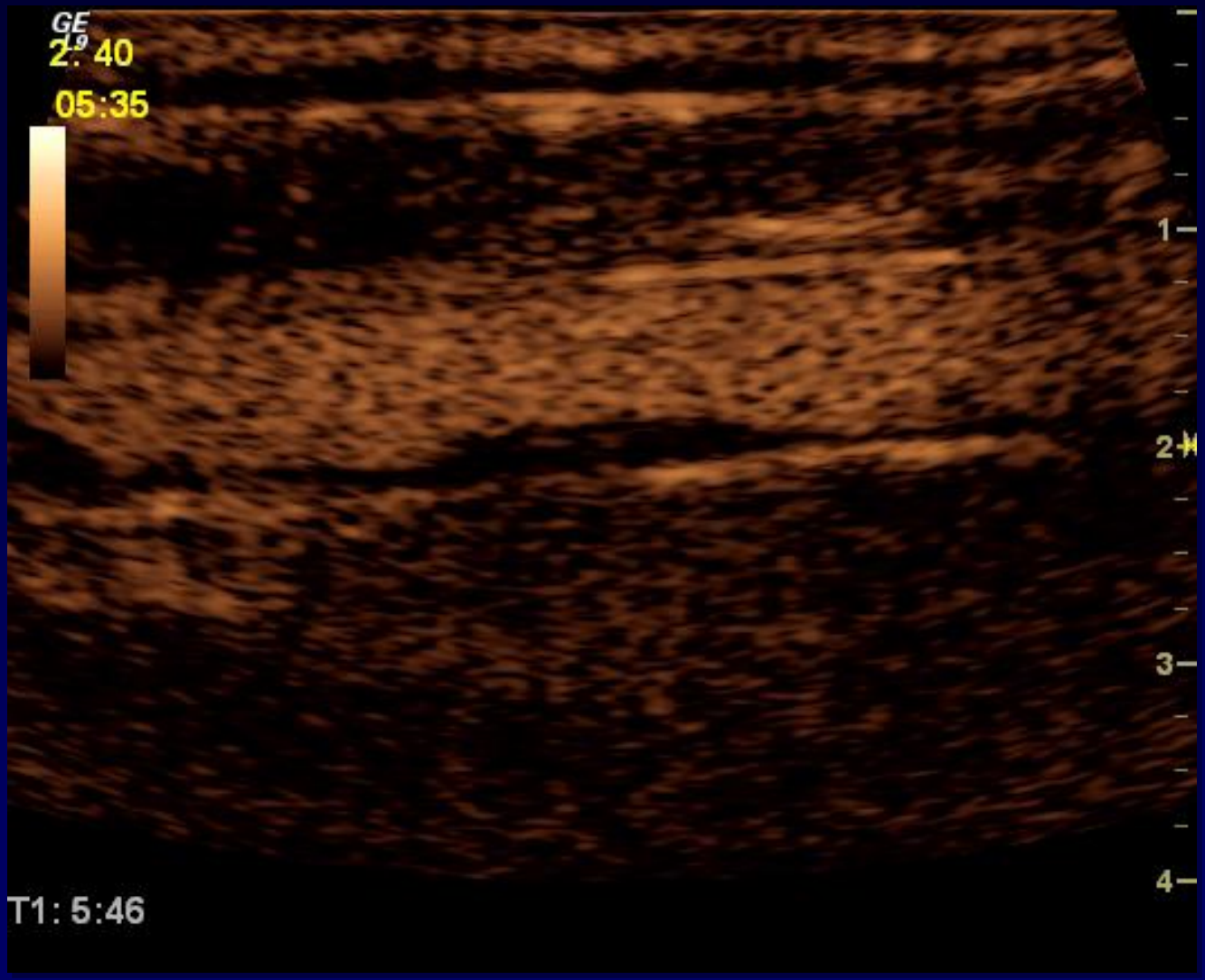


Courtesy Steven B. Feinstein, MD

Enhancement of Carotid artery Luminal Morphology (ulcer and plaque detection)

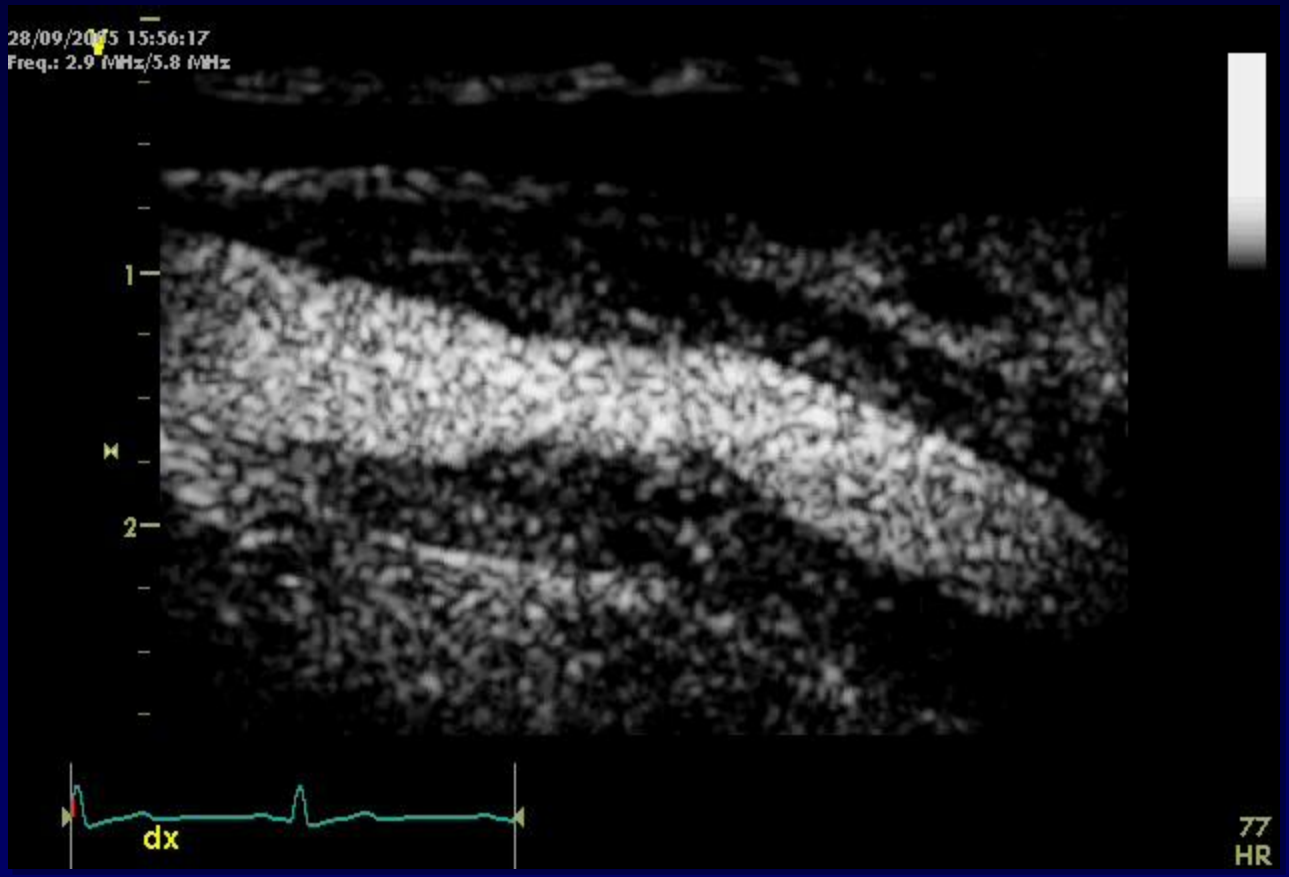
Courtesy Steven B. Feinstein, MD

Identification of Arterial Wall Vasa Vasorum



Courtesy of Hans-Peter Weskott

Takayasu: Carotid Angiogenesis



Courtesy Attilio Maseri, MD