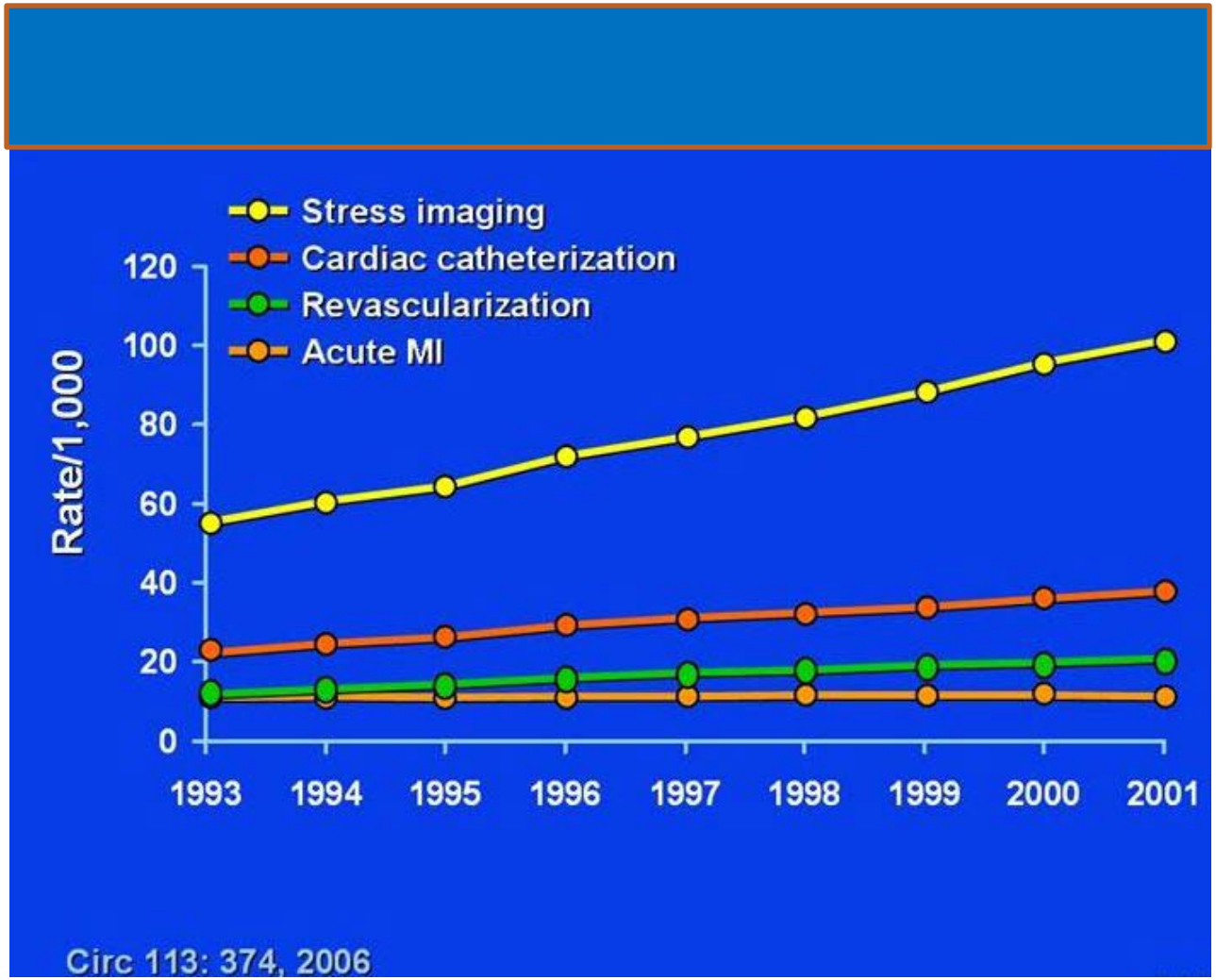
Ο ΡΟΛΟΣ ΤΩΝ ΣΥΓΧΡΟΝΩΝ ΗΧΩΚΑΡΔΙΟΓΡΑΦΙΚΩΝ ΤΕΧΝΙΚΩΝ ΣΤΗΝ ΔΙΑΓΝΩΣΗ ΤΗΣ ΣΤΕΦΑΝΙΑΙΑΣ ΝΟΣΟΥ

Κ. ΑΓΓΕΛΗ

Α ΠΑΝΕΠΙΣΤΗΜΙΑΚΗ ΚΑΡΔΙΟΛΟΓΙΚΗ ΚΛΙΝΙΚΗ

ΙΠΠΟΚΡΑΤΕΙΟ ΝΟΣΟΚΟΜΕΙΟ ΑΘΗΝΩΝ

Cardiac procedures



Cardiac imaging-Echocardiography

- **Most used cardiac imaging test**
  - 23 million echo studies in US annually (UK 1 M)
  - 2.5 million stress echo (UK 10 k)
- **Most common use**
  - LV function assessment
  - Valvular heart disease
  - Haemodynamics
- **Essential in management of all forms of heart disease**

Cardiac imaging in 2020- echocardiography

50 years of innovation

Forms of echocardiography

1. M-mode echocardiography
2. 2D echocardiography
3. Doppler echocardiography
4. Stress echocardiography
5. Transesophageal echocardiography
6. Intraoperative echocardiography
7. Contrast echocardiography
8. Digital echocardiography
9. 3D echocardiography
10. Intracardiac echocardiography

Indications

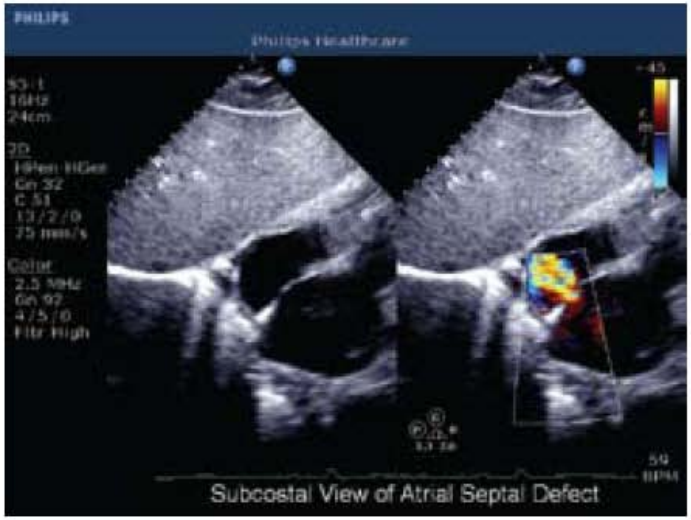
1. Assessment of ventricular size and function, LVH
2. Diagnosis and evaluation of valvular heart disease - severity of valve pathology/ physiology, LV status
3. Chest pain - ischemic and pericardial disease
4. Cardioemboli; AF, masses
5. Congenital heart disease

Parisi A. The miracle of echocardiography: a clinician's retroprospective: The 1996 Inge Edler Lecture. JASE 1997

Progressive miniaturization

2D ΕΙΚΟΝΕΣ ΜΕ ΤΟΝ ΦΟΡΗΤΟ ΜΗΧΑΝΗΜΑ ΥΠΕΡΗΧΩΝ

S5-1 PureWave



X7-2t PureWave

Our battlefield – if your ER doesn't look like this .. It will!

Stress Echocardiography from 1979 to Present

William F. Armstrong, MD, and Thomas Ryan, MD, FASE, *Ann Arbor, Michigan; and Columbus, Ohio*

Journal of the American Society of Echocardiography
January 2008

Table 1 Stress echocardiography methods

Exercise
Postreadmill exercise
Supine or upright bicycle
Handgrip
Pharmacologic
Dobutamine (±atropine)
Dipyridamole (±atropine)
Adenosine (±atropine)
Combined dobutamine + dipyridamole
Pharmacologic ± handgrip
Other
Transesophageal atrial pacing
Transvenous pacing (temporary or permanent)
Ergonovine*
Hyperventilation*
Cold pressor
Mental stress

ACCF/ASE/ACEP/AHA/ASNC/SCAI/SCCT/SCMR 2008 Appropriateness Criteria for Stress Echocardiography.

Circulation. 2008 Mar 3 [Epub ahead of print]

Douglas PS, Khandheria B, Stainback RF, Weissman NJ.

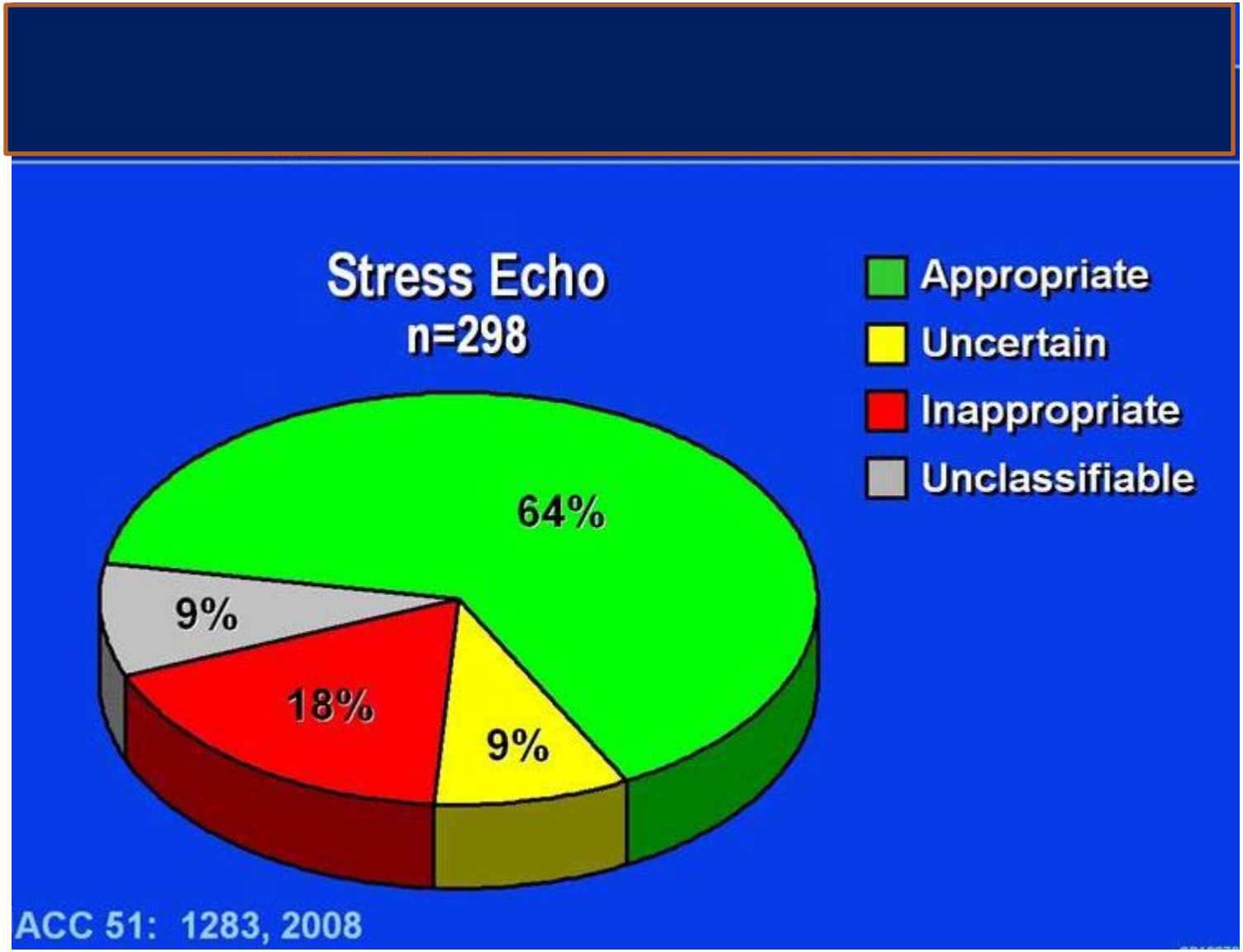
- ***An appropriate imaging study is one in which the expected incremental information, combined with clinical judgment, exceeds the expected negative consequences* by a sufficiently wide margin for a specific indication that the procedure is generally considered acceptable care and a reasonable approach for the indication.***

General Assumptions for Stress Echocardiography

To prevent any nuances of interpretation, all indications were considered with the following important assumptions:

1. All indications are assumed to apply to adult patients (18 years of age or older).
2. The test is performed and interpreted by qualified individuals in facilities that are proficient in the imaging technique.[5–8]

For the 51 indications for the use of stress echocardiography, 22 were found to be appropriate, 10 were uncertain, and 19 were considered inappropriate.


Stress Echo
n=298
Appropriate
Uncertain
Inappropriate
Unclassifiable
64%
9%
18%
9%
ACC 51: 1283, 2008

Appropriate stress imaging studies

Mayo			
Category	SPECT (N)	Echo (N)	% of inapp
Asymp Low-risk pt	20	25	48
Preop Intermediate-risk surg Good ex capacity	4	12	17
Sx Low pre test Interp ECG, able to exercise	5	7	13
Preop Low-risk surg	2	7	10
These 4 categories			88

Task Force 4: Training in Echocardiogarphy

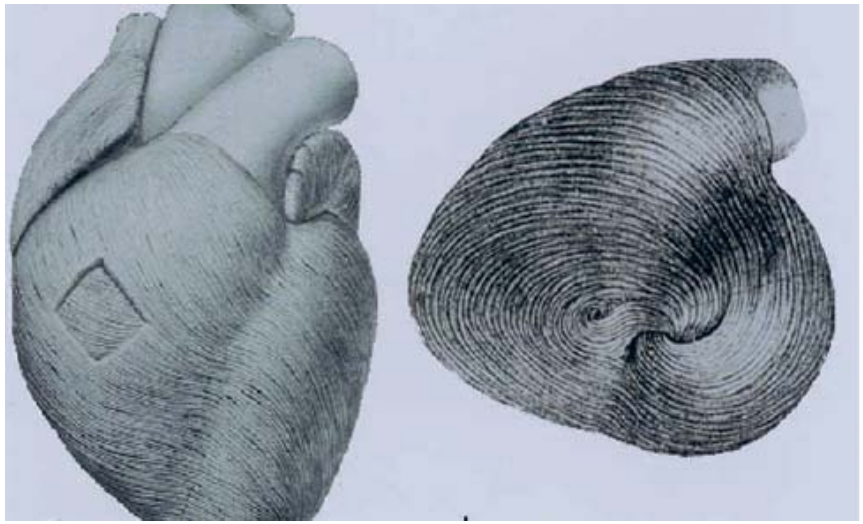
Endorsed by the American Society of Echocardiography

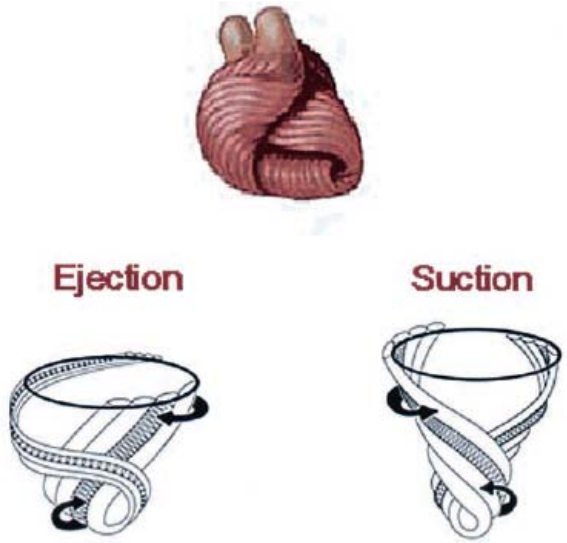
Thomas Ryan, William Armstrong, Bijoy Khandheria

JACC 2008;51:361-7

- Echocardiography is currently the most widely used imaging technique for assessing ***cardiovascular anatomy and function***….
- Today, an echocardiography laboratory can appropriately be called ***an ultrasound imaging and hemodynamic laboratory….***

Basic science review: The helix and the heart
Gerald D. Buckberg
J Thorac Cardiovasc Surg 2002;124:863-883





Assessing mature technology
JACC 2007. Editorial Comment)

Cardiac Imaging

- Cardiac Imaging there is a shift from reports on its diagnostic accuracy toward risk stratification

The growth in cardiac imaging

- The growth in cardiac imaging may also be related to temporal changes in CHD mortality. An analysis of data from Framingham Heart Study from 1950 to 1999 revealed that CHD death rates declined by 59%.
- Is it reasonable to infer that CHD mortality reductions are partially related to greater use of diagnostic tests???

ECHOCARDIOGRAPHY

Function ★

Perfusion ★

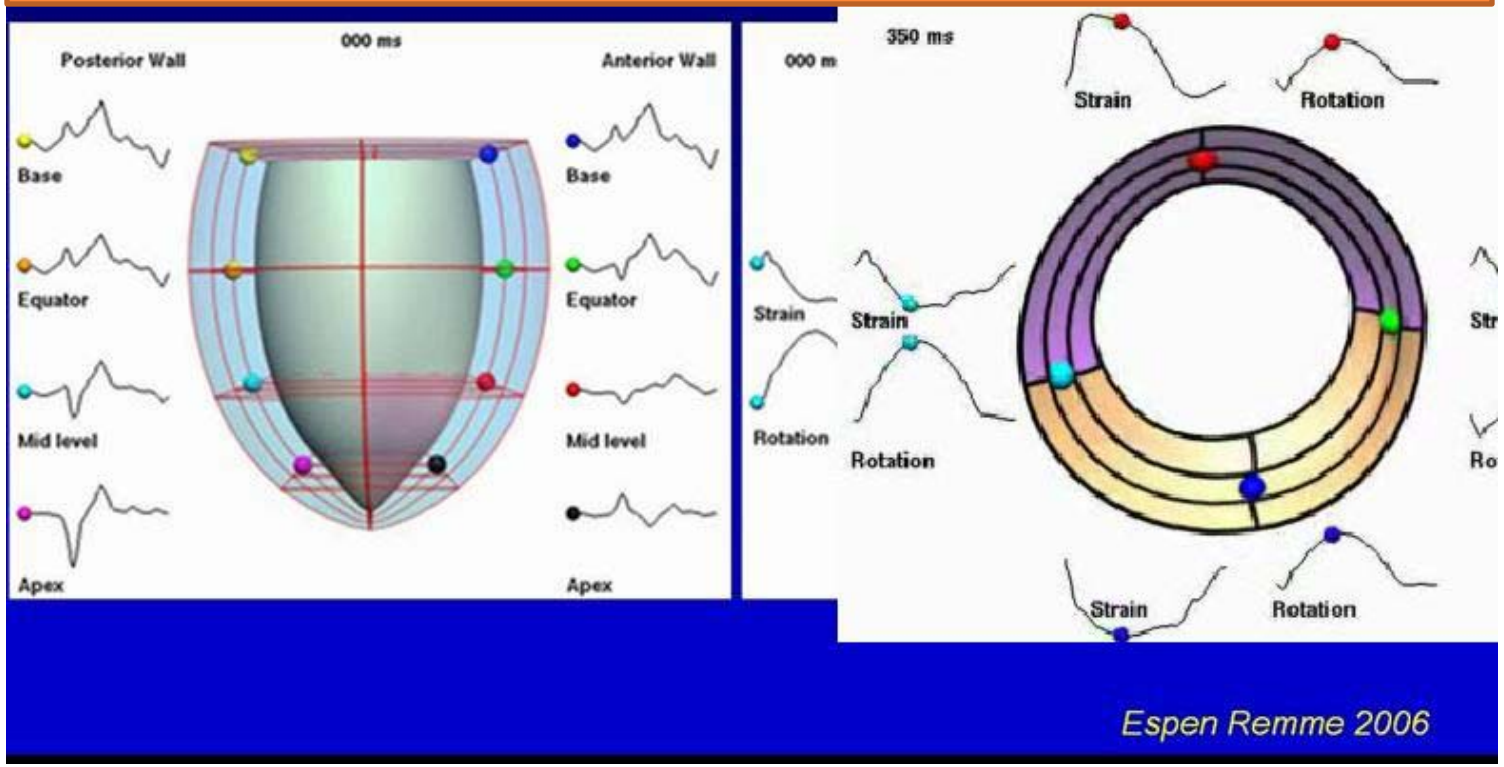
Deformation ★

Fibrosis ???

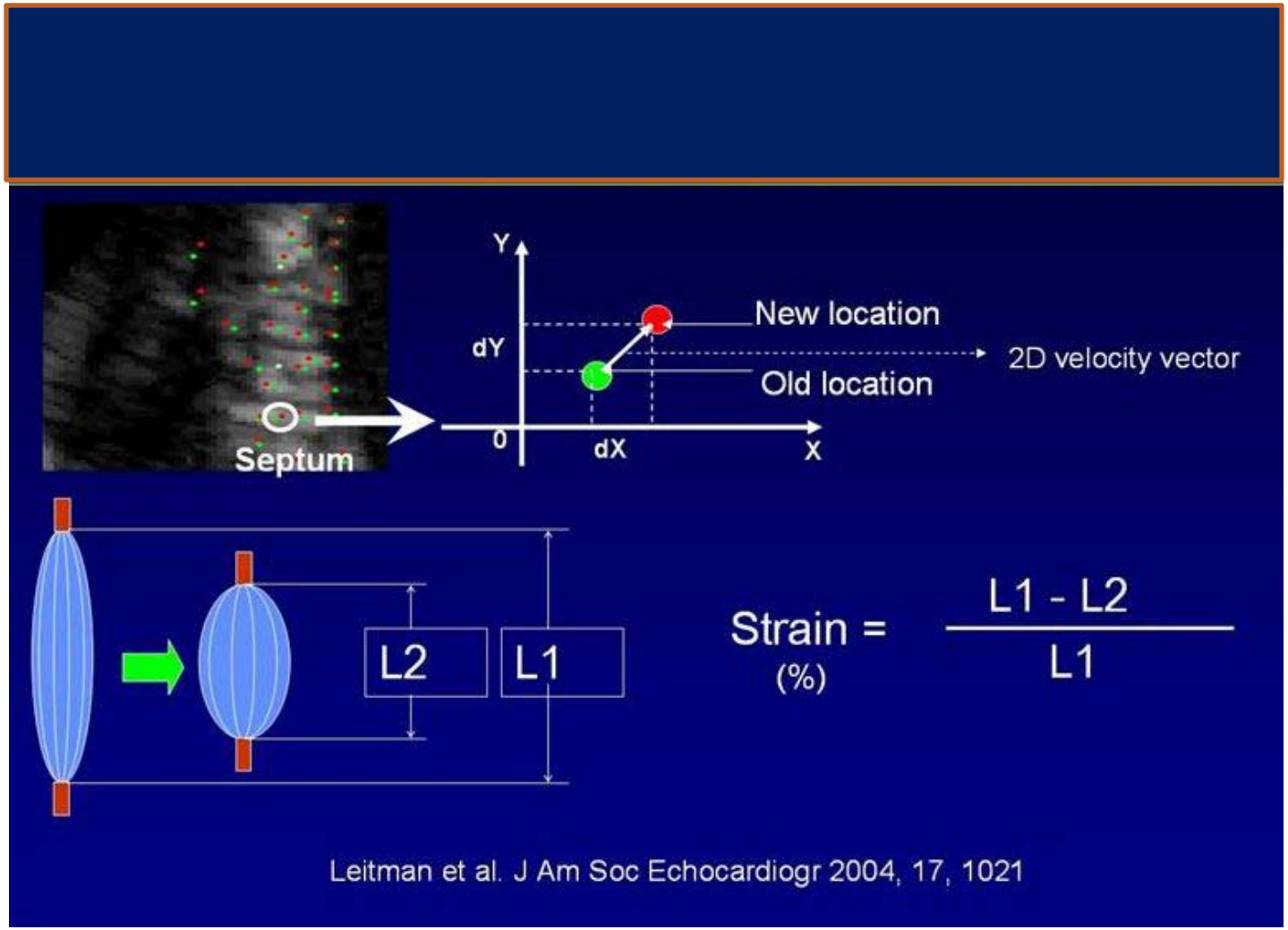
STRESS ECHO

- ADVANTAGES
  - Cheap
  - Availability
  - No radiation
  - Functional information
  - Information for perfusion

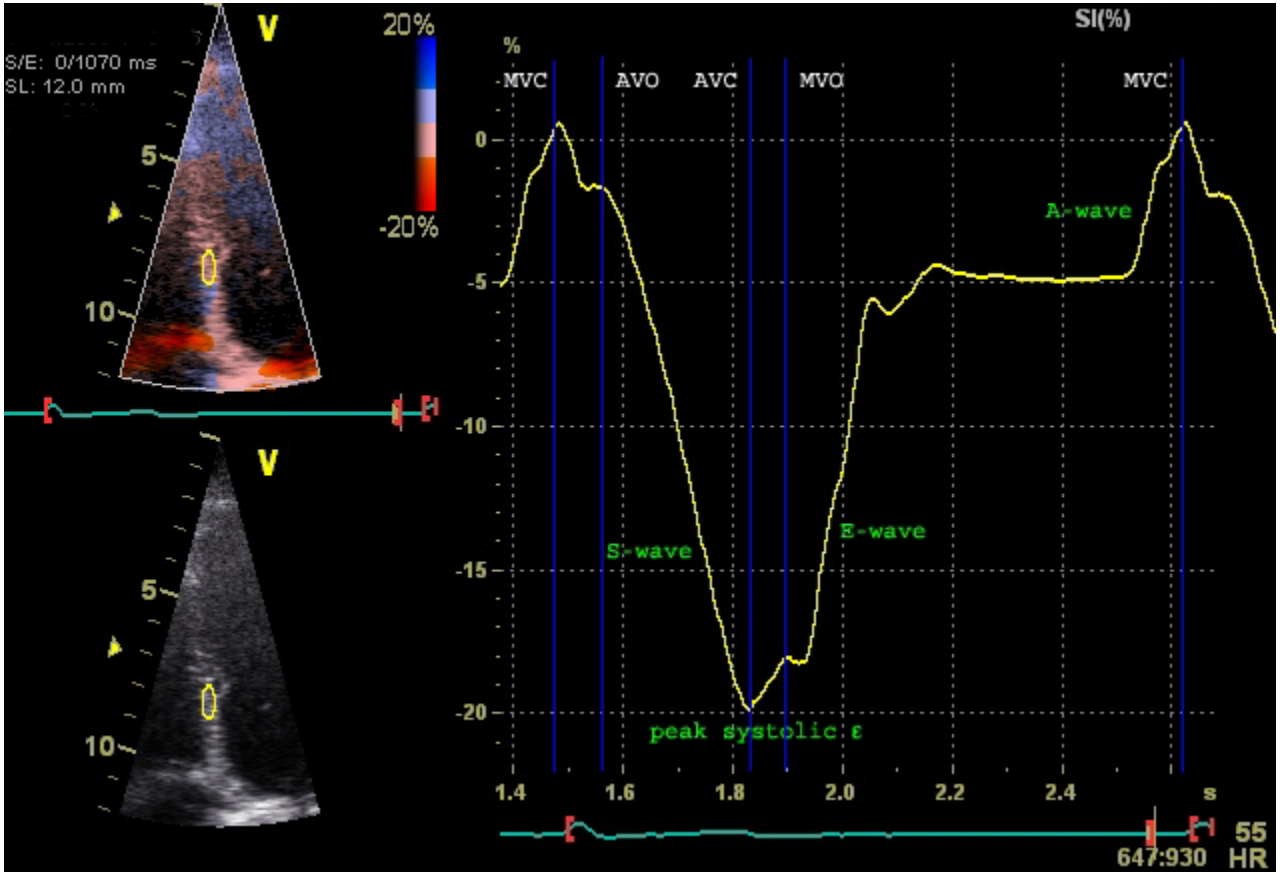
Quantifying LV deformation



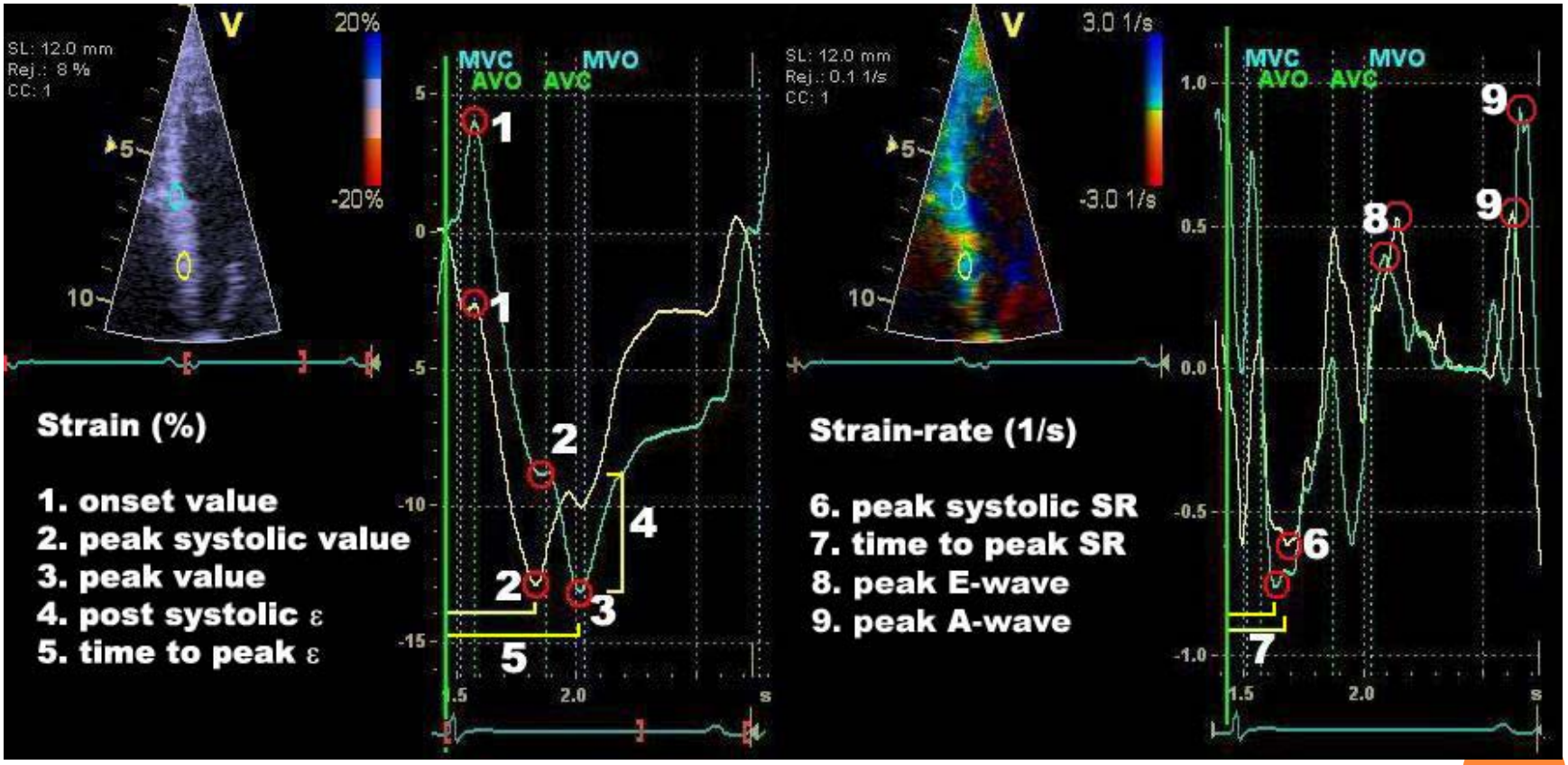
Speckle (2D) strain



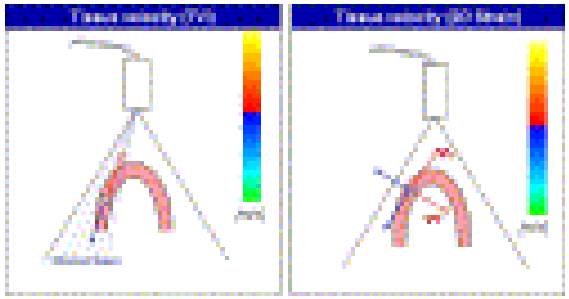
STRAIN-STRAIN RATE: EXAMPLE OF LONGITUDINAL STRAIN GRAPH (DOPPLER DERIVED).

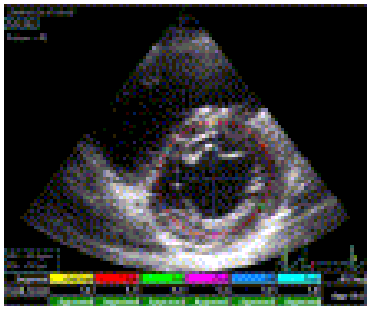


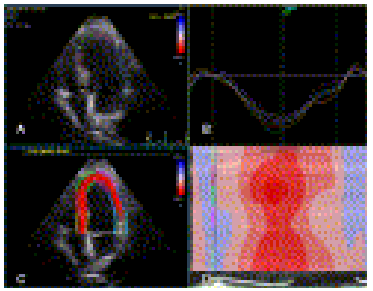
Strain and strain-rate parameters



2D-STRAIN, STRAIN RATE







- Non-Doppler 2D strain imaging by echocardiography is a new technique that allows rapid and accurate assessment of LV function. It is easily obtained, has a low rate of intraobserver and interobserver variability, and correlates well with measurements obtained by tissue Doppler–based technique. Given the high reproducibility, angle independence, and automated tracking system (which allows even inexperienced observers to perform accurate measurements), it is likely to become a widespread technique, with many clinical implications.

Experimental Validation of Circumferential, Longitudinal, and Radial 2-Dimensional Strain During Dobutamine Stress Echocardiography in Ischemic Conditions

Patricia Reant, MD,*† Louis Labrousse, MD,*† Stephane Lafitte, MD, PHD,*† Pierre Bordachar, MD,*† Xavier Pillois, PHD,* Liliane Tariosse, MS,* Simone Bonoron-Adele, MS,* Philippe Padois, MS,* Claude Deville, MD,† Raymond Roudaut, MD,† Pierre Dos Santos, MD, PHD*†

Bordeaux, France

(J Am Coll Cardiol 2008;51:149–57

Speckle-Derived Strain

A Better Tool for Quantification of Stress Echocardiography?*

Theodore P. Abraham, MD, FACC, Aurelio C. Pinheiro, MD, PHD

Baltimore, Maryland

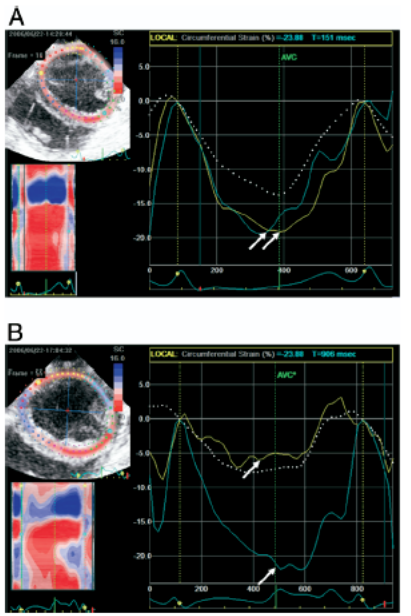


Figure 1 Example

Quantification of peaks (white arrows) in circumferential strain in end systole in risk areas (yellow curve) and control areas (blue curve) in the (A) absence of coronary stenosis and (B) presence of flow-limiting stenosis 25%.

We feel that 2D strain represents a better parameter than WT for early detection of myocardial contraction abnormalities during DSE. The 2D strain can evaluate longitudinal or circumferential abnormalities, which precede the decrease in radial deformation in ischemia. Since subendocardial myocardial fibers, which are mainly longitudinally oriented, are more susceptible to ischemia, it might be expected that the longitudinal function is altered earlier than the radial function (as assessed by the WT parameter)

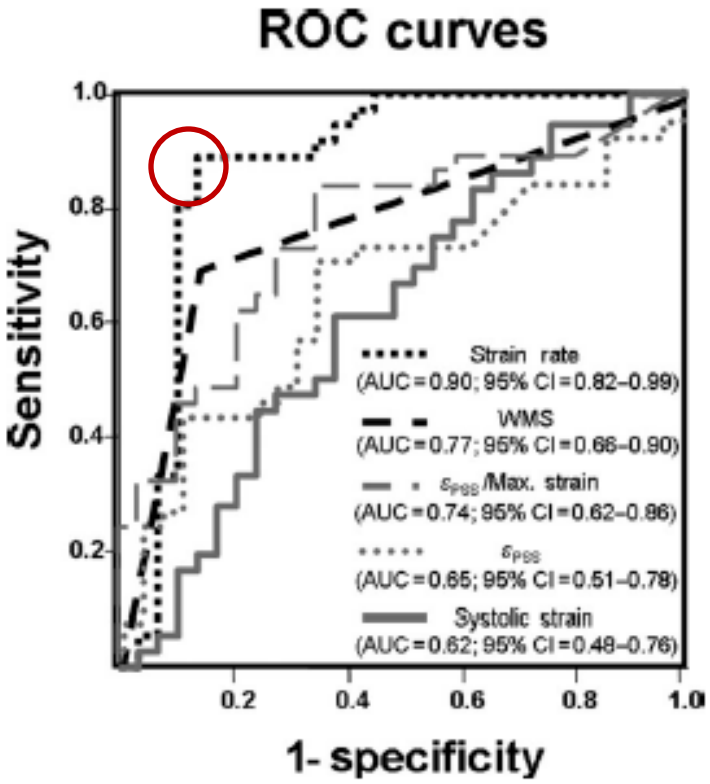
Conclusions

The 2D strain is a new technique with real potential for quantitative evaluation of myocardial function. During DSE under ischemic conditions, abnormalities in CS and LS were detected before radial dysfunction, and thus they provide an earlier indication of coronary stenosis. Clinical studies with 2-dimensional strain during DSE are needed to confirm these experimental findings.

Assessment of the contractile reserve in patients with intermediate coronary lesions: a strain rate imaging study validated by invasive myocardial fractional flow reserve

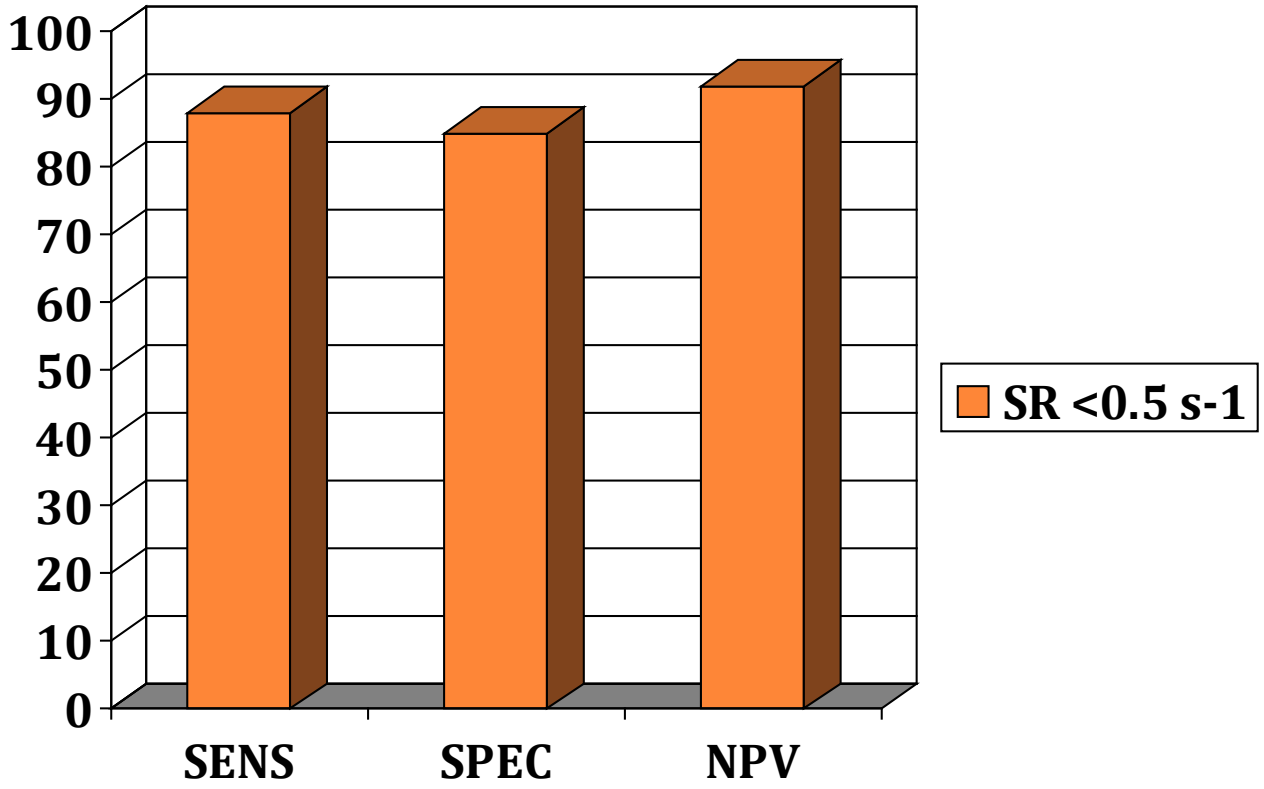
Frank Weidemann*†, Philip Jung, Caroline Hoyer, Jens Broscheit, Wolfram Voelker, Georg Ertl, Stefan Störk, Christiane E. Angermann, and Joerg M. Strotmann

European Heart Journal (2007) 28, 1425–1432

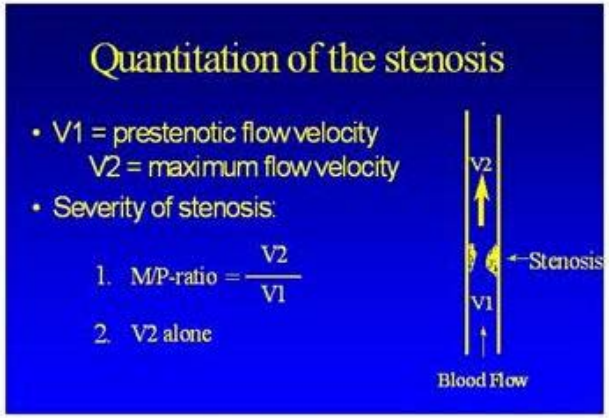


Quantitative dobutamine stress echocardiography for the early detection of cardiac allograft vasculopathy in heart transpant recipients

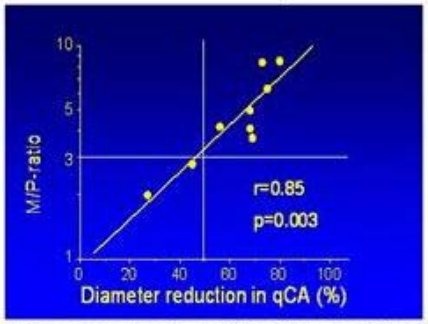
Eroglu E., et al. Heart 2007 Oct 4;



Coronary flow reserve

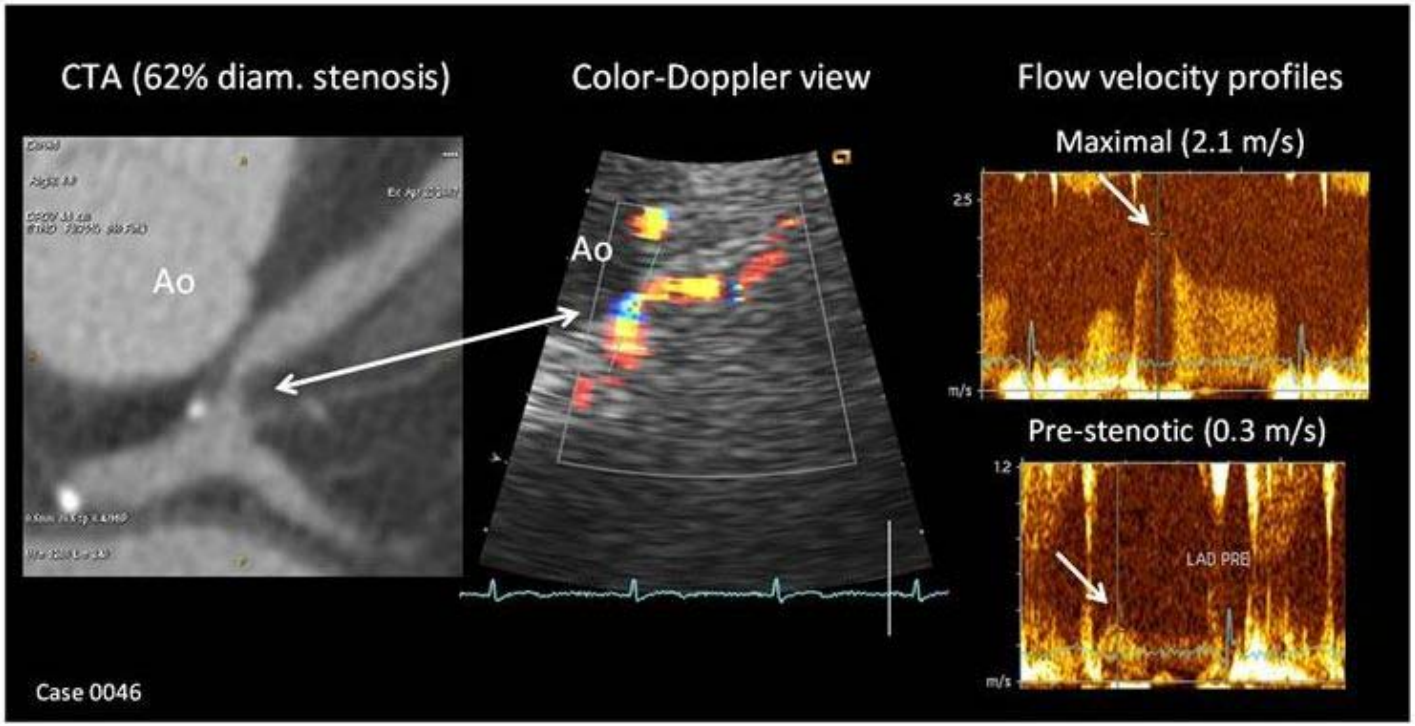


Coronary flow velocity increase in TTDE is proportional to the severity of stenosis



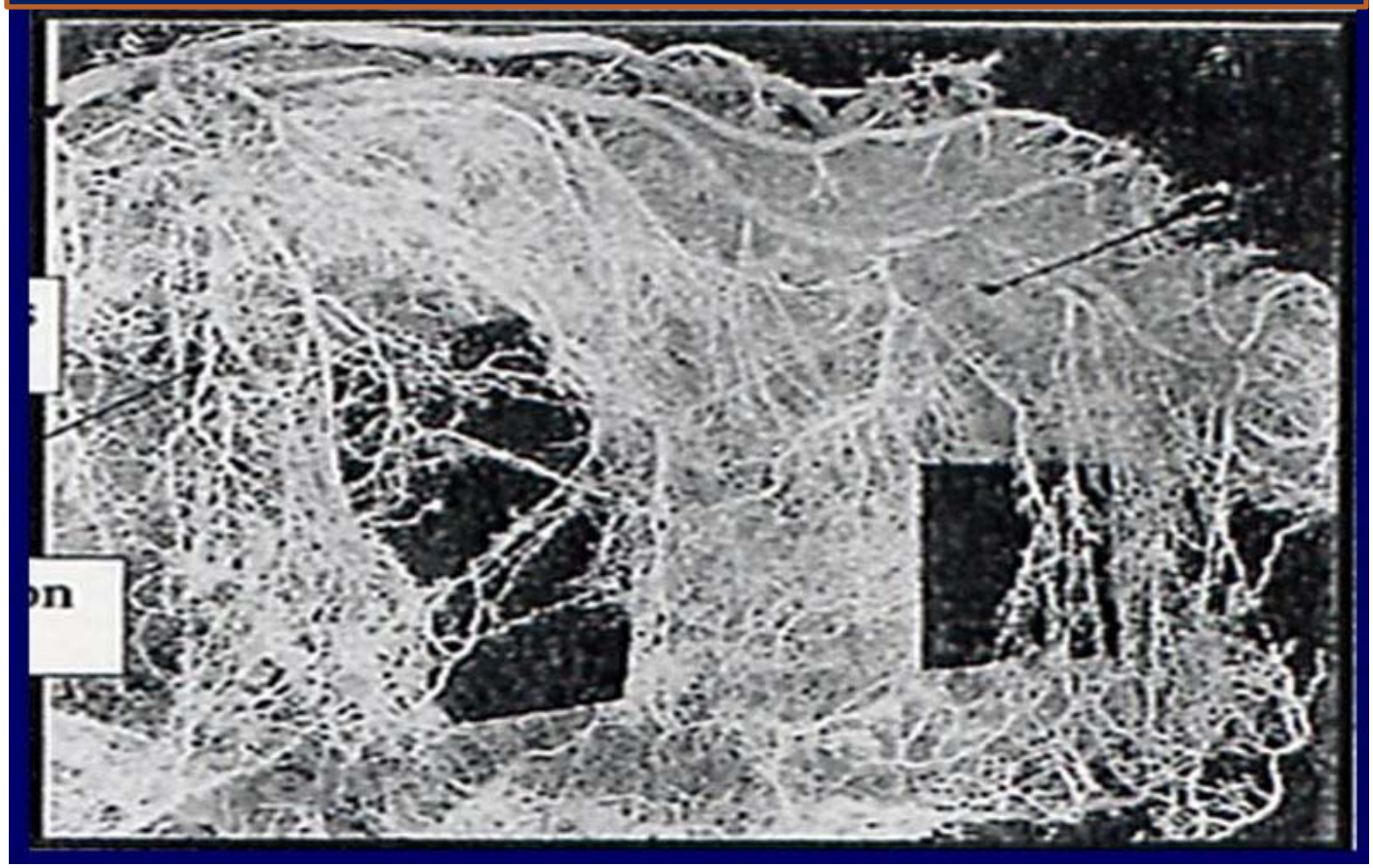
Saraste M et al. Clin Physiol 2000

Proximal LAD stenosis



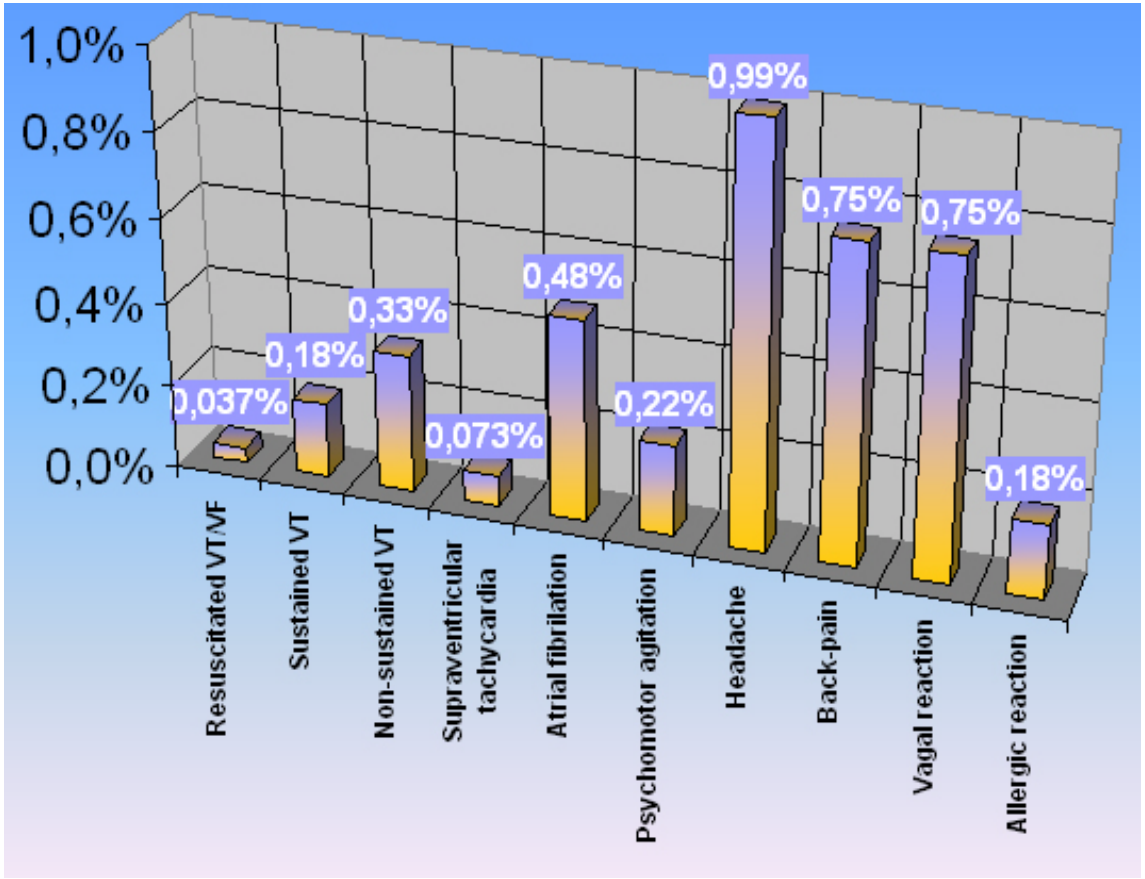
Η υπερηχοκαρδιογραφια αντιθεσησ στην εφαρμογη του stress echo

Coronary arterial tree and microvasculature



Safety of Stress-Contrast Echo

Aggeli C. et al. Heart 2008 May



Safety and diagnostic accuracy of stress-contrast echocardiography in octogenarians.

Aggeli C., Giannopoulos G., Roussakis G., et al. ECS 2008

Supine Bicycle Echocardiography

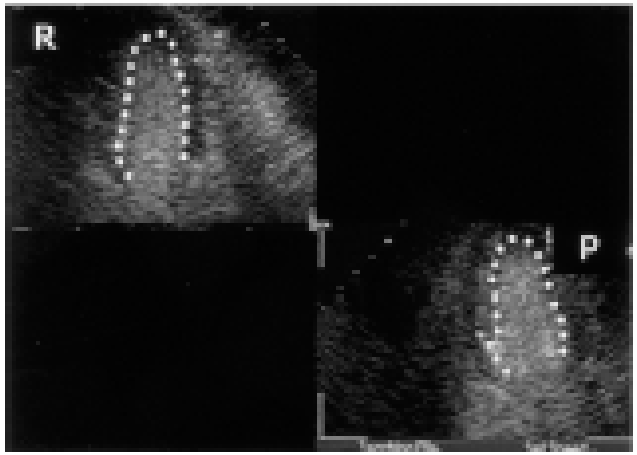
Improved Diagnostic Accuracy and Physiologic Assessment of Coronary Artery Disease With the Incorporation of Intermediate Stages of Exercise

Tae-Ho Park, MD, Nawar Tayan, MD, Kimiko Takeda, MD, Hui-Kyung Jeon, MD, Miguel A. Quinones, MD, FACC, William A. Zoghbi, MD, FACC

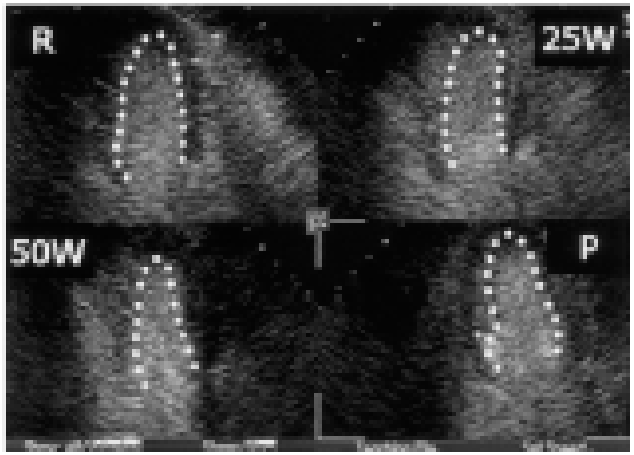
Houston, Texas

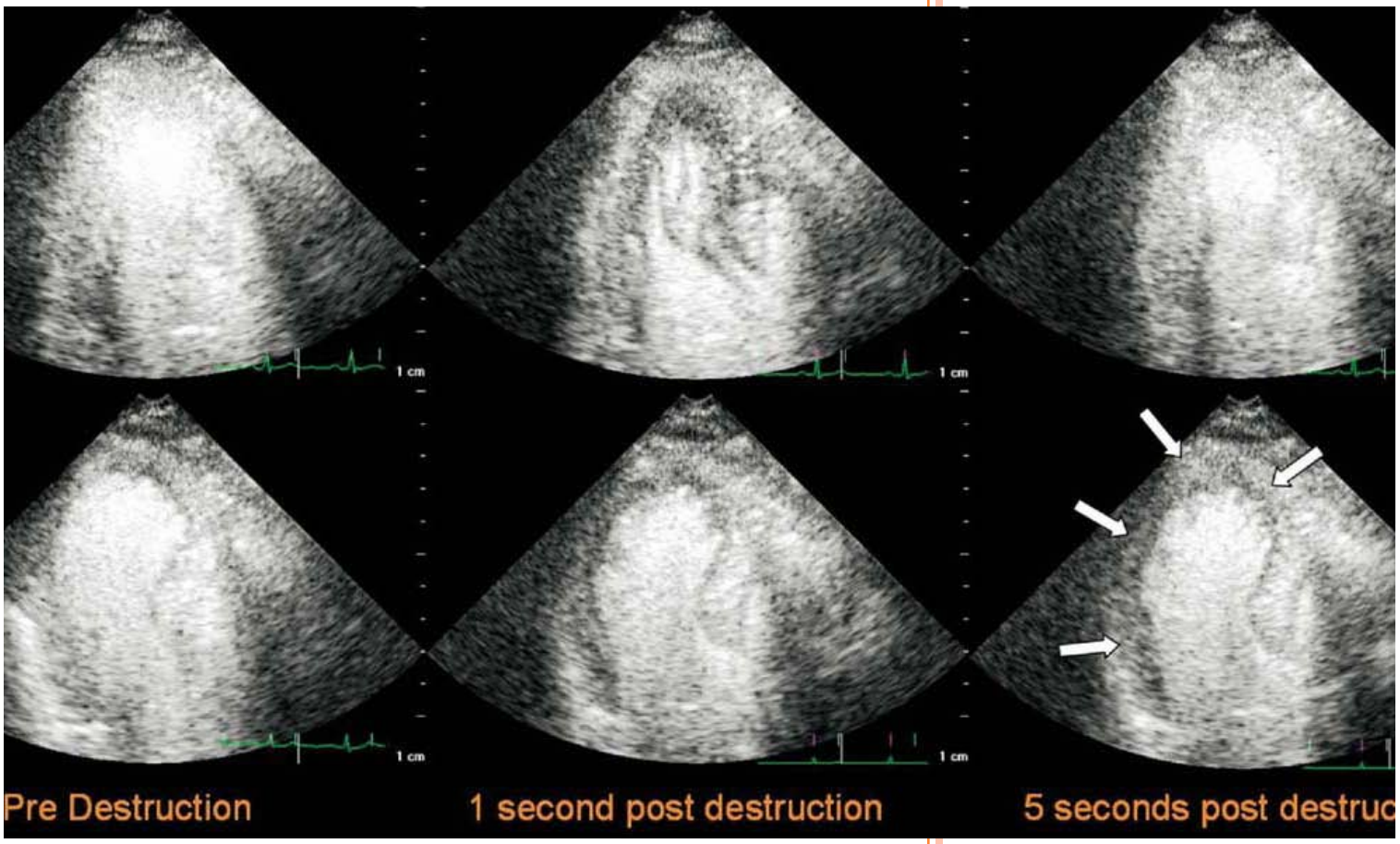
(J Am Coll Cardiol 2007;50:1857–63)

Rest - Peak



Rest - Intermediate Stages - Peak

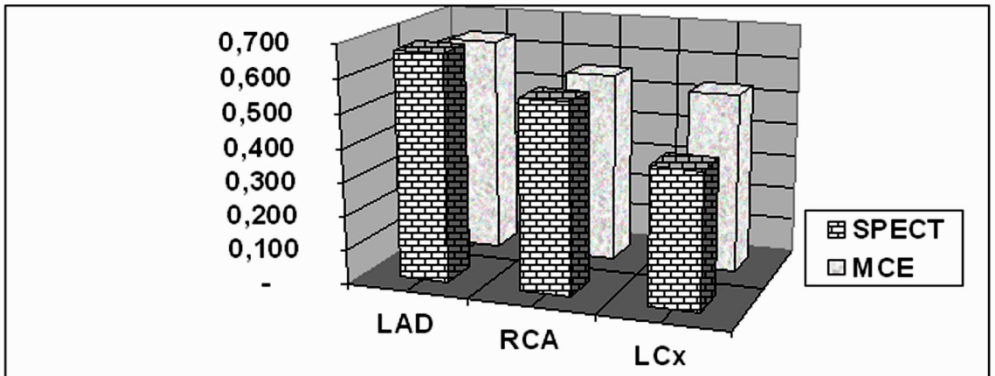




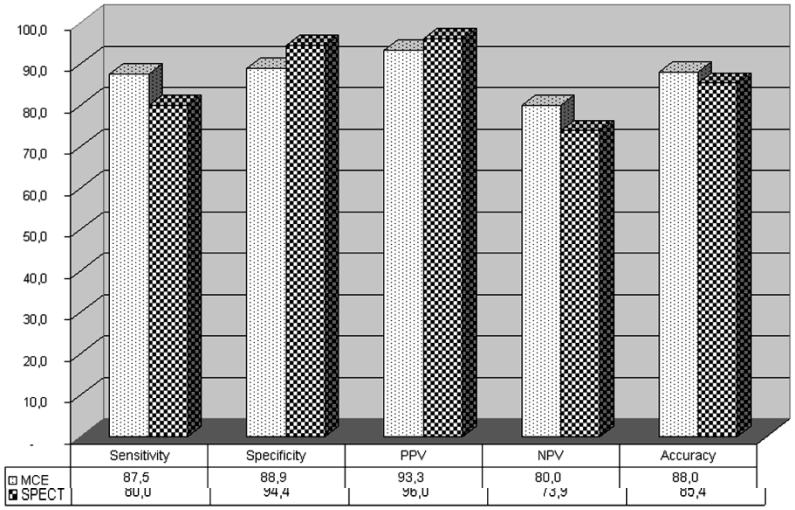
Myocardial Contrast Echocardiography
for the Detection of Coronary Artery Stenosis (J Am Coll Cardiol 2006;47:141–5)

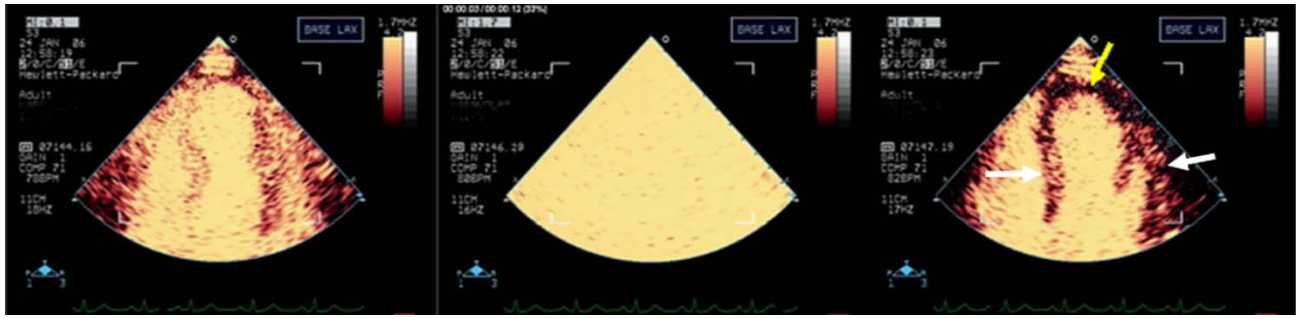
The Diagnostic Value of Adenosine Stress-Contrast Echocardiography for Diagnosis of Coronary Artery Disease in Hypertensive Patients - Comparison to Tl-201 Single-Photon Emission Computed Tomography

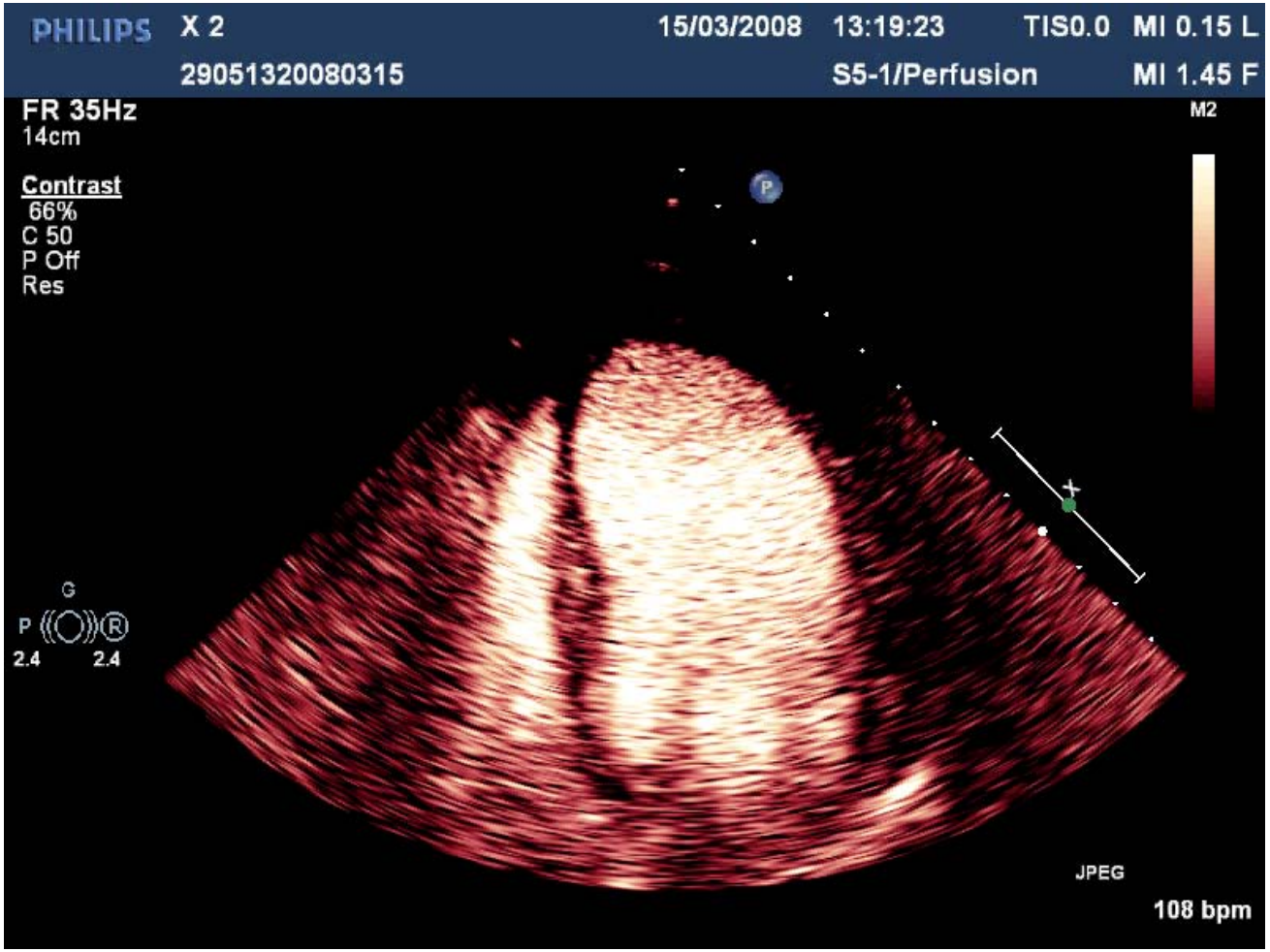
C. Aggeli, et al. Am J Hypert 2007

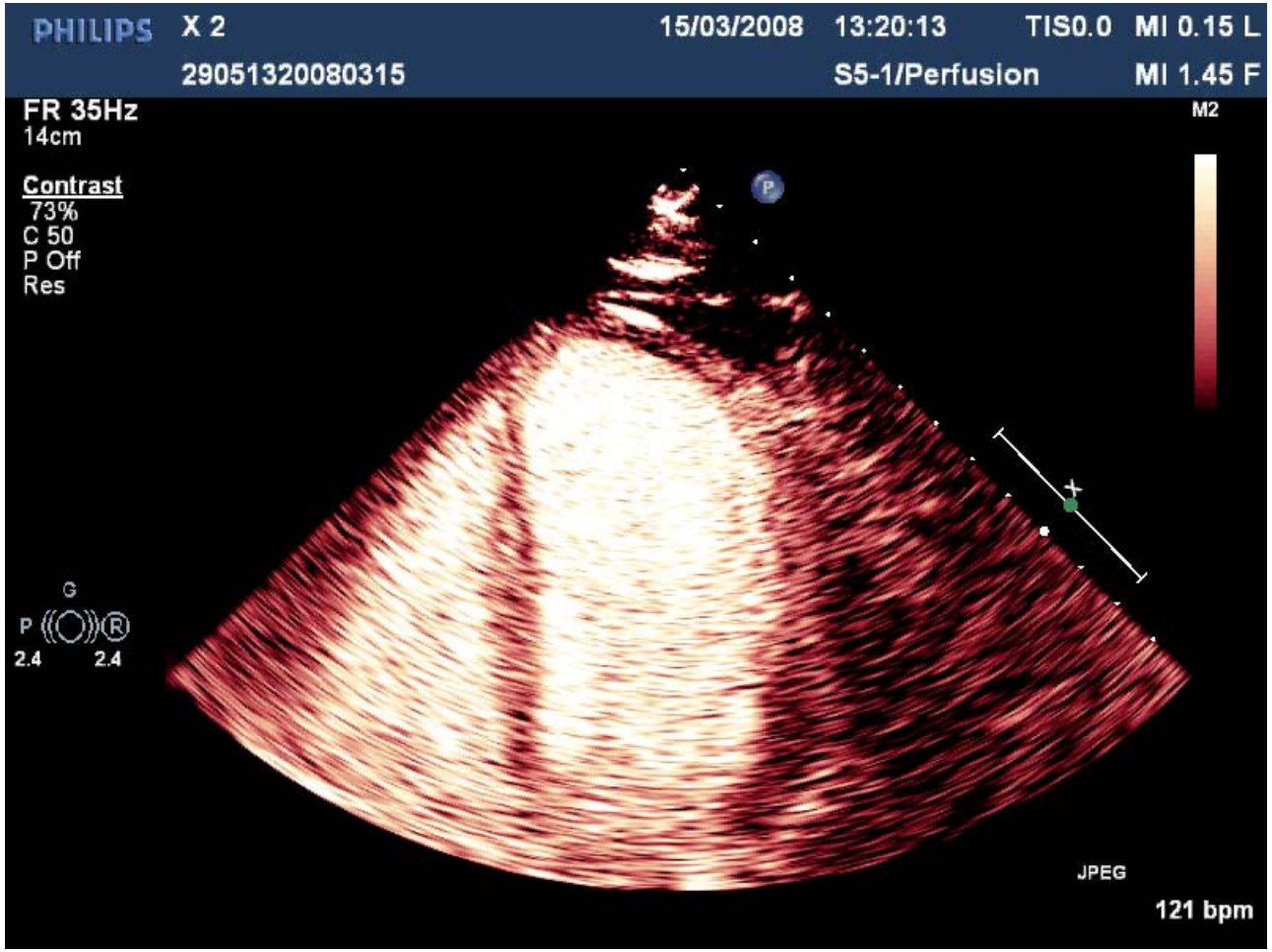


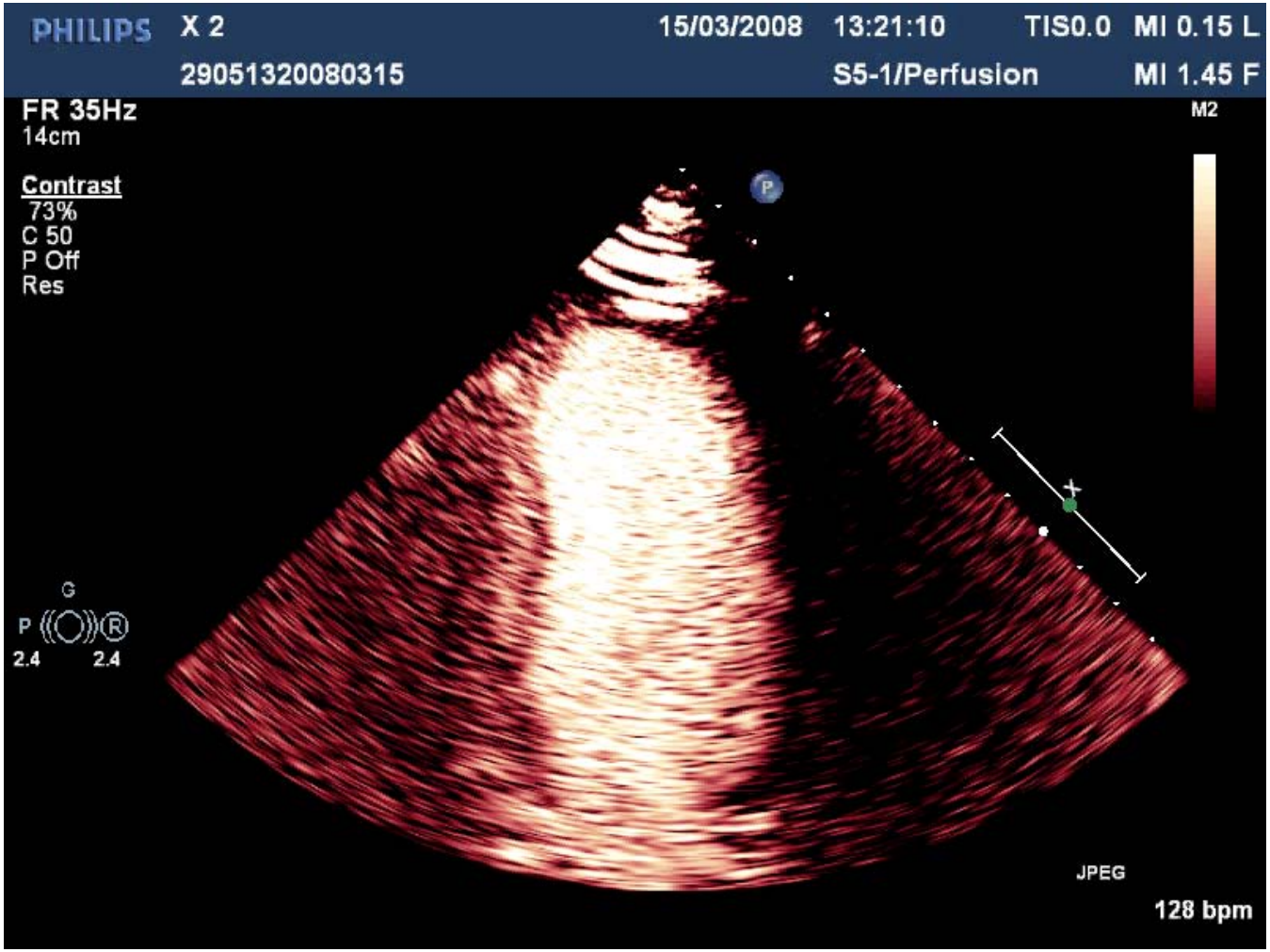
	LAD	RCA	LCx
SPECT	0,671	0,559	0,400
MCE	0,640	0,561	0,533






PHILIPS
X 2
15/03/2008
13:19:23
TIS0.0
MI 0.15 L
29051320080315
S5-1/Perfusion
MI 1.45 F
FR 35Hz
14cm
M2
Contrast
66%
C 50
P Off
Res
G
P
2.4
2.4
JPEG
108 bpm


PHILIPS
X 2
15/03/2008
13:20:13
TIS0.0
MI 0.15 L
29051320080315
S5-1/Perfusion
MI 1.45 F
FR 35Hz
14cm
M2
Contrast
73%
C 50
P Off
Res
G
P
R
2.4
2.4
JPEG
121 bpm


PHILIPS
X 2
15/03/2008
13:21:10
TIS0.0
MI 0.15 L
29051320080315
S5-1/Perfusion
MI 1.45 F
FR 35Hz
14cm
M2
Contrast
73%
C 50
P Off
Res
G
P
R
2.4
2.4
JPEG
128 bpm


PHILIPS
XX1
15/03/2008
12:12:49
TIS0.0
MI 0.15 L
33431120080315
S5-1/Perfusion
MI 1.45 F
FR 34Hz
15cm
M2
Contrast
74%
C 50
P Off
Res
G
P
2.4
2.4
JPEG
89 bpm


PHILIPS
XX1
15/03/2008
12:15:18
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MI 0.15 L
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S5-1/Perfusion
MI 1.45 F
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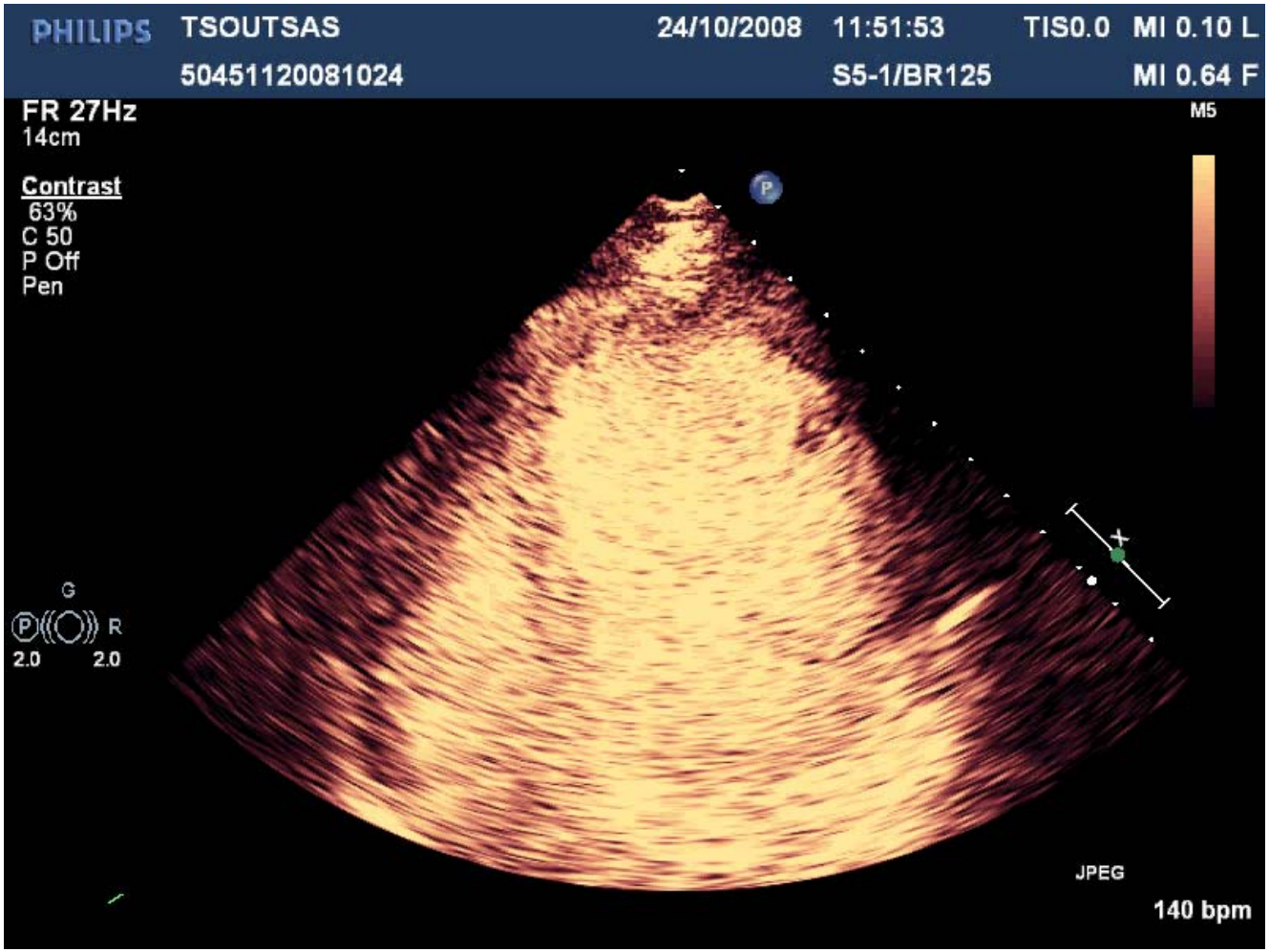
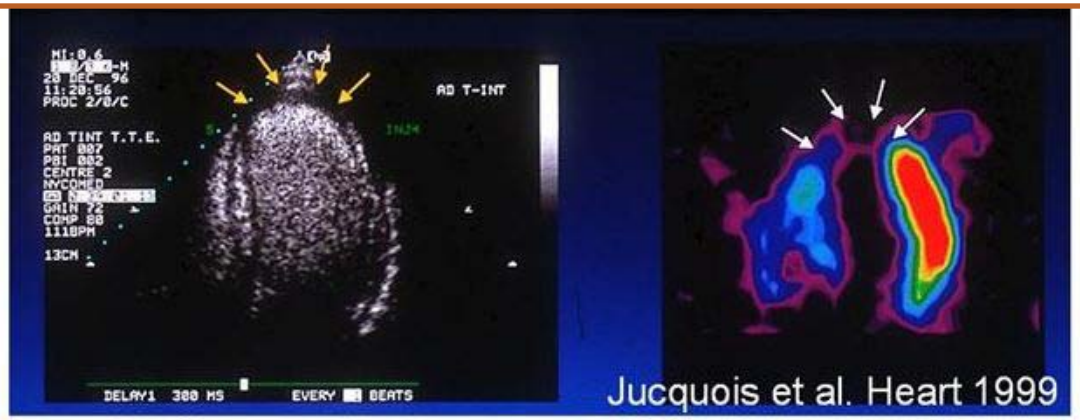
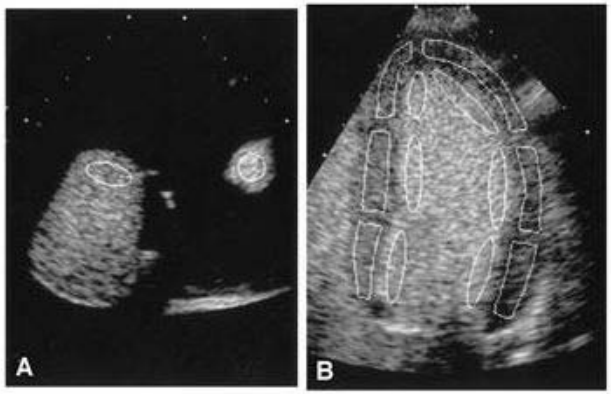
15cm
Contrast
74%
C 50
P Off
Res
M2
G
P
2.4
2.4
JPEG
117 bpm

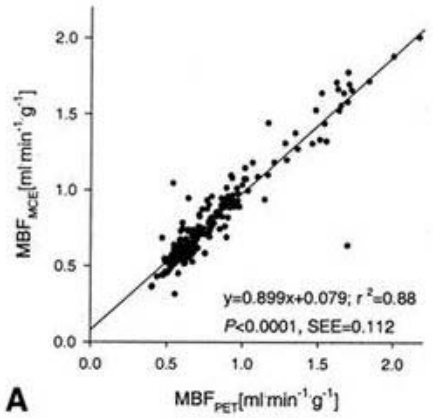

PHILIPS
TSOUTSAS
24/10/2008
11:51:53
TIS0.0
MI 0.10 L
50451120081024
S5-1/BR125
MI 0.64 F
FR 27Hz
14cm
Contrast
63%
C 50
P Off
Pen
M5
G
R
2.0
2.0
JPEG
140 bpm

CONTRAST ECHOCARDIOGRAPHY





Vogel R, et al .J Am Coll Cardiol. 2005 Mar 1;45(5):754-62.

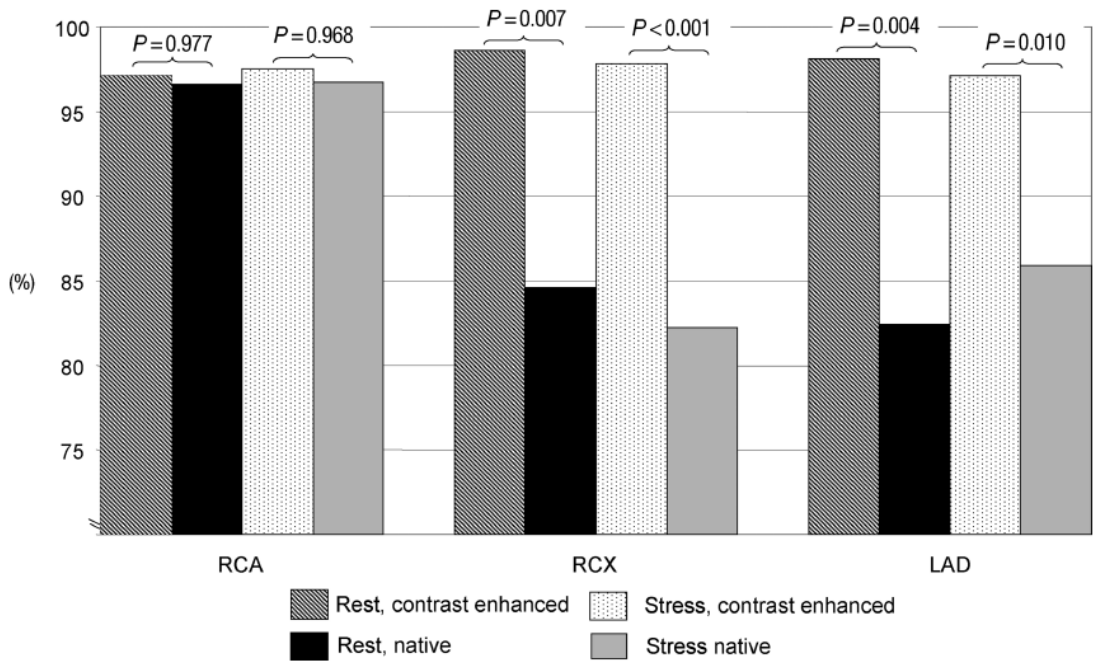


Effect of contrast application on interpretability and diagnostic value of dobutamine stress echocardiography in patients with intermediate coronary lesions: comparison with myocardial fractional flow reserve

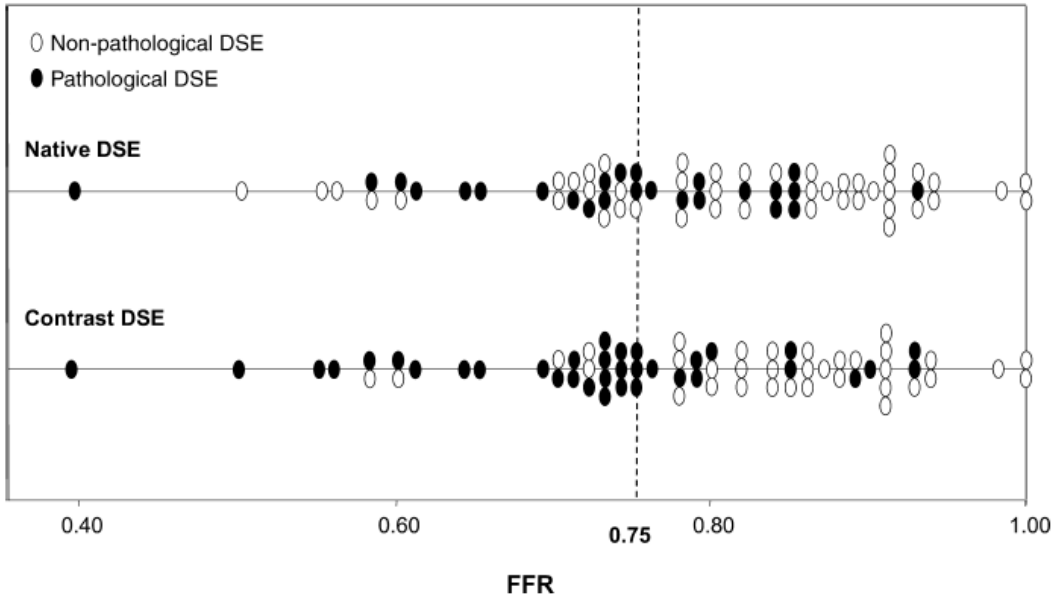
Philip H. Jung[1*†], Johannes Rieber[1†], Stefan Störk[2], Caroline Hoyer[2], Isabelle Erhardt[1], Anja Nowotny[2], Wolfram Voelker[2], Frank Weidemann[2], Georg Ertl[2], Volker Klauss[1], and Christiane E. Angermann[2]

[1]Department of Internal Medicine, Division of Cardiology, Medizinische Poliklinik Innenstadt, Ludwig-Maximilians-University, Ziemssenstrasse 1, 80336 Munich, Germany; and [2]Department of Internal Medicine I, Center for Cardiovascular Medicine, University of Würzburg, Germany

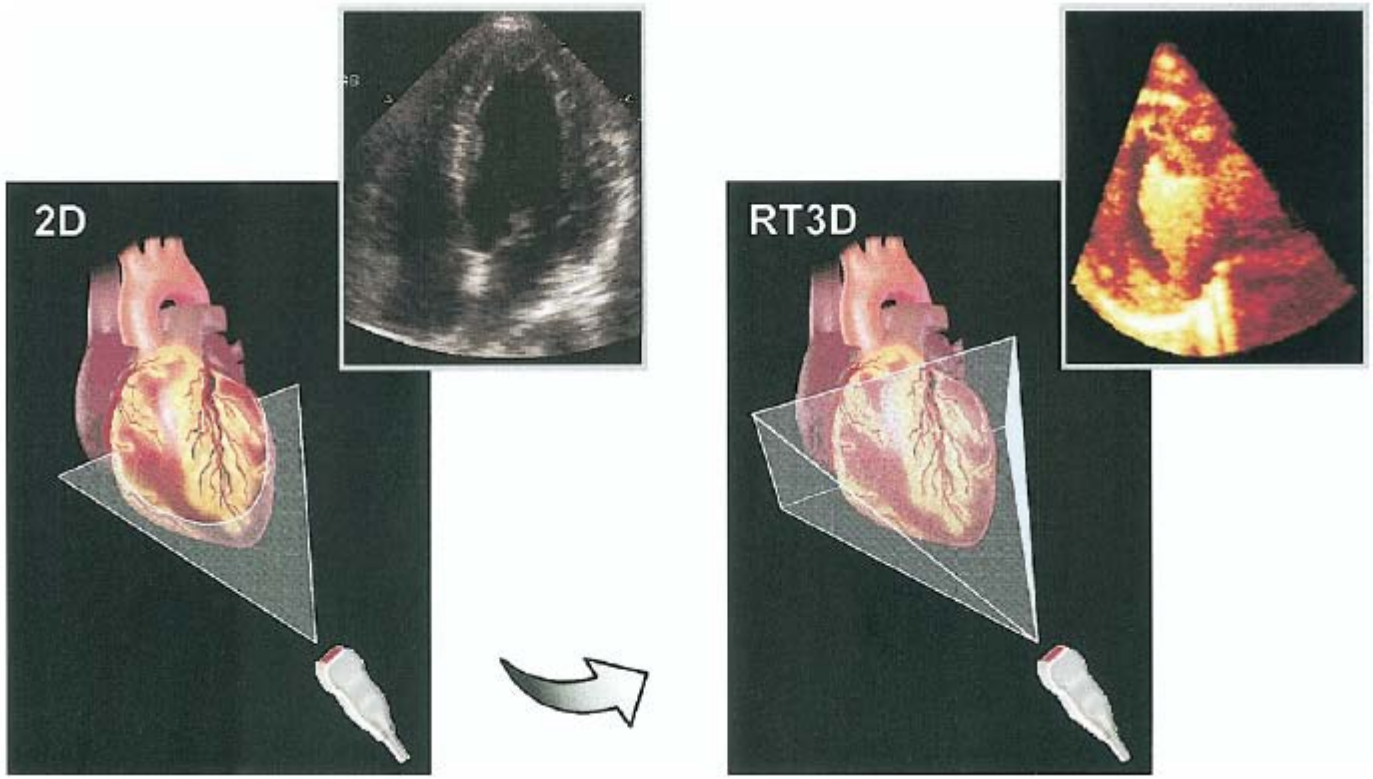
Received 1 October 2007; revised 3 April 2008; accepted 28 April 2008



Results of dobutamine stress echocardiography of all patients during negative and contrast-enhanced DSE in comparison with the fractional flow reserve (FFR)measurement



The transition of 2D to 3D imaging



Real-time 3-Dimensional Contrast Stress Echocardiography: A Bridge Too Far? Krenning B., et al. JASE 2007

- Benefits of real-time 3dimensional echocardiogarphy
  - Rapid image acquisition
  - Less operator dependent
  - Reproducible views for analysis
  - Unlimited number of cross sections
  - Absent left ventricular foreshortening

Clinical research

Non-invasive assessment of myocardial ischaemia using new real-time three-dimensional dobutamine stress echocardiography: comparison with conventional two-dimensional methods

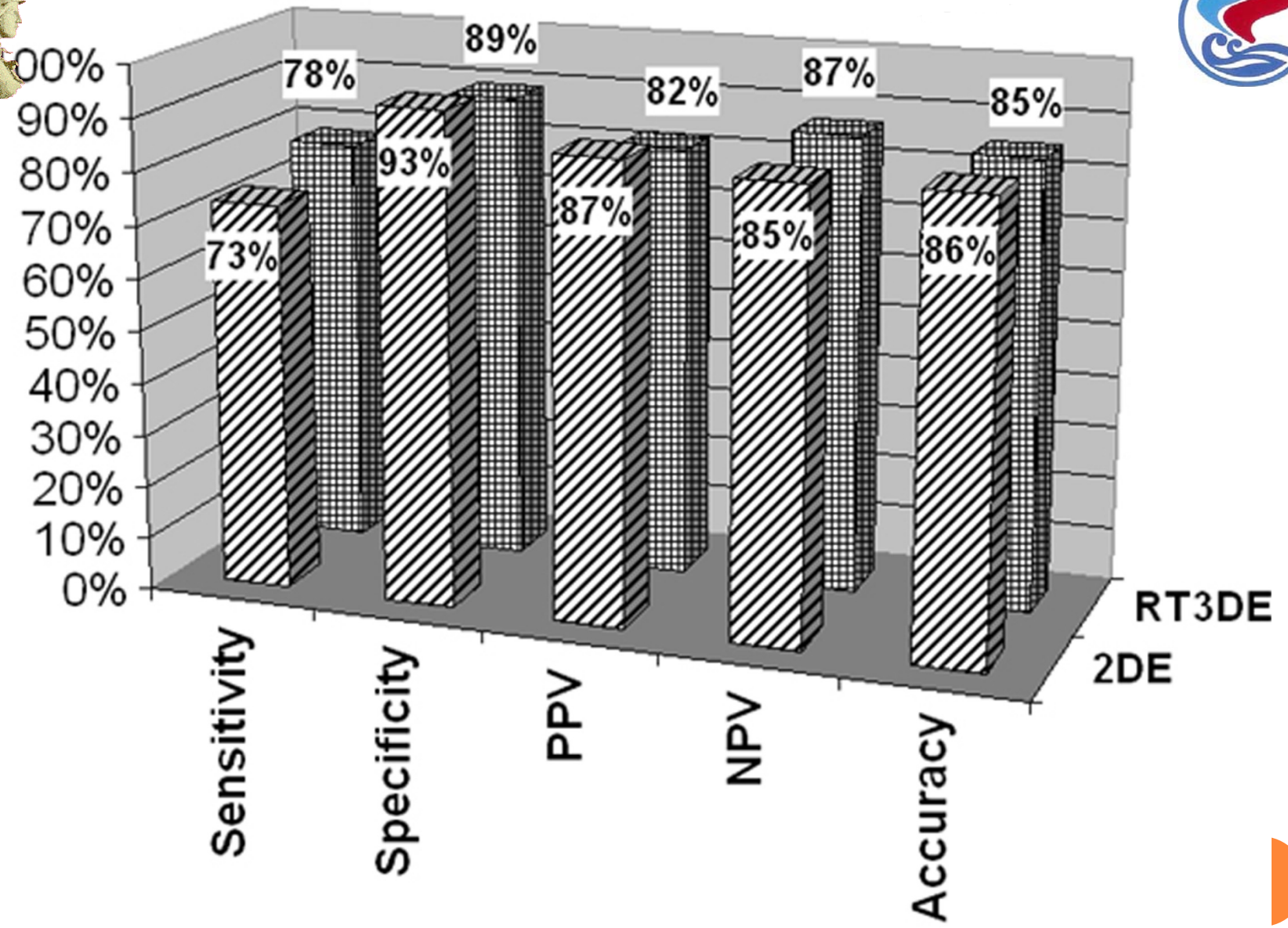
Yoshiki Matsumura, Takeshi Hozumi*, Kotaro Arai, Kenichi Sugioka, Keiji Ujino, Yasuhiko Takemoto, Hiroyuki Yamagishi, Minoru Yoshiyama, and Junichi Yoshikawa

The Department of Internal Medicine and Cardiology, Osaka City University Medical School, 1-4-3 Asahi-machi, Abeno-ku, Osaka 545 8585, Japan

Received 24 August 2004; revised 29 January 2005; accepted 3 February 2005

Real-time three-dimensional dobutamine stress echocardiography in detection of myocardial ischemia - validation with coronary angiography

Aggeli C, et al.*Heart 2007*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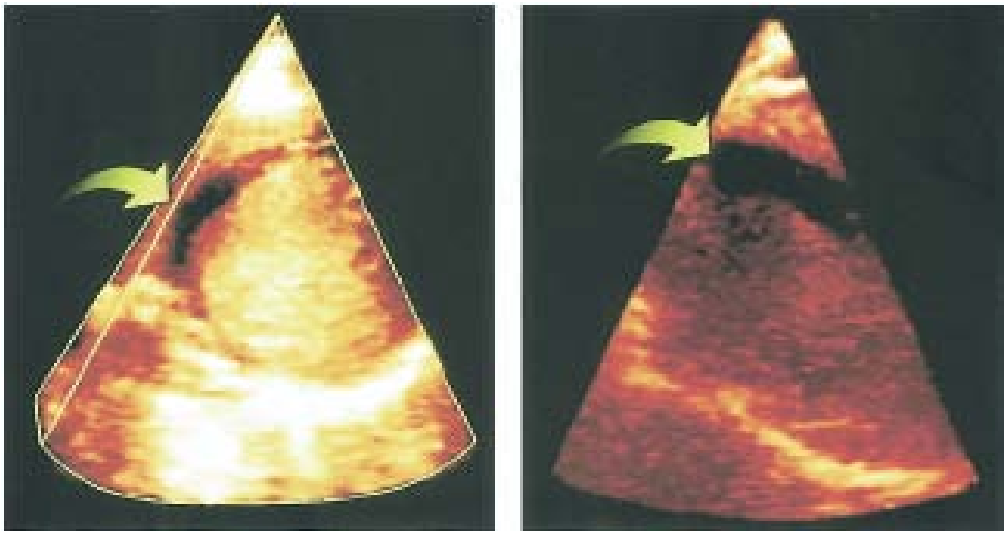
85%
Sensitivity
Specificity
PPV
NPV
Accuracy
RT3DE
2DE

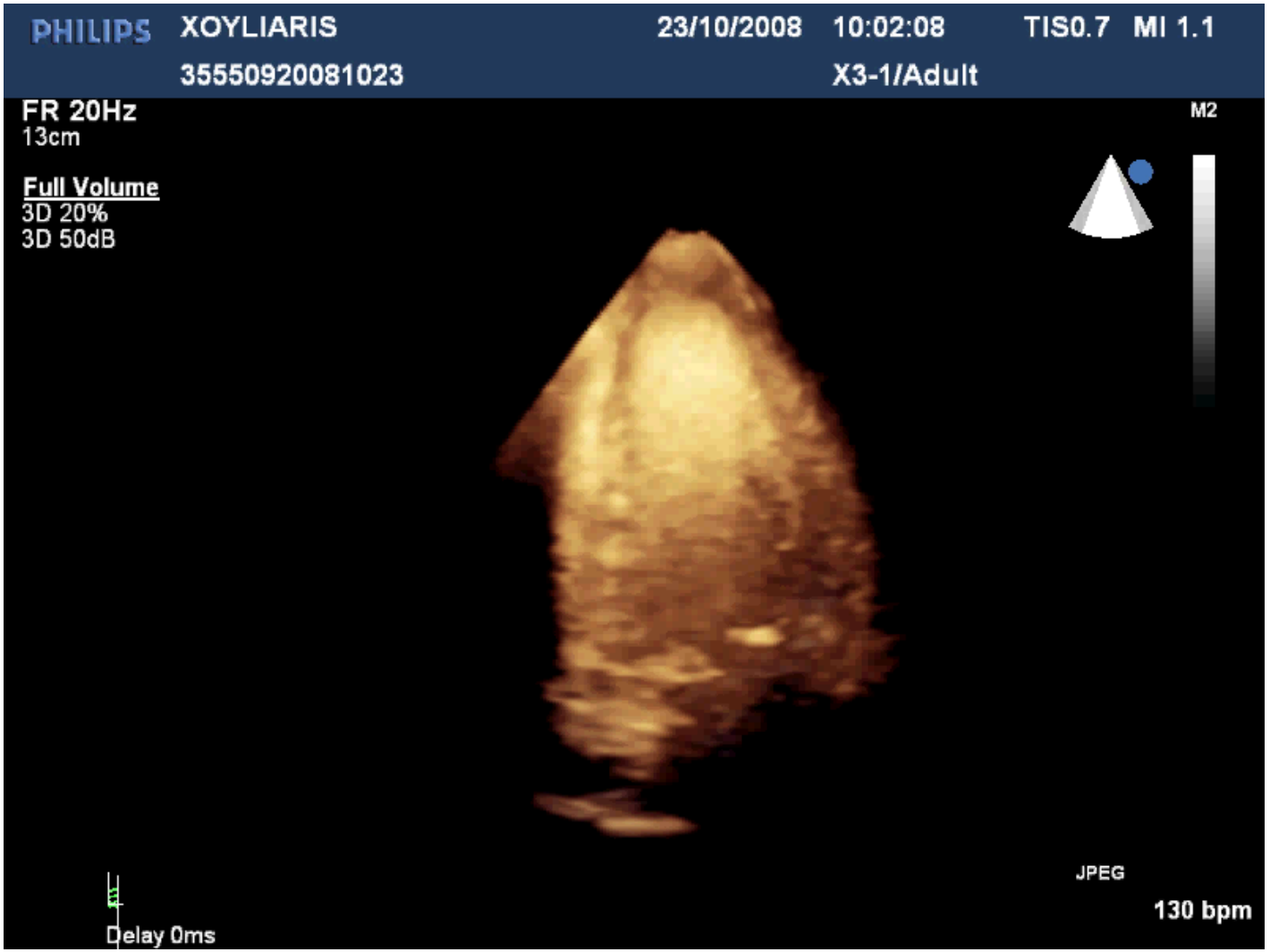
Diagnostic parameters of 2- and 3-dimensional dobutamistress echocardiography for the detection of coronary artery disease ne a (>50% stenoses were deemed as significant). In all cases, the differences between the two modalities were not statistically significant

		Sensitivity	*Specificity*	*PPV*	*NPV*	*Accuracy*	*kappa*
LAD	**2D echo**	78%	92%	95%	82%	85%	0.748
	3D echo	85%	90%	88%	87%	88%	0.749
RCA	**2D echo**	75%	90%	79%	86%	86%	0.646
	3D echo	80%	86%	76%	89%	84%	0.654
LCX	**2D echo**	65%	96%	85%	86%	86%	0.638
	3D echo	65%	92%	79%	86%	84%	0.600

LAD: left anterior descending artery, LCX: left circumflex artery, NPV: negative predictive value, PPV: positive predictive value, RCA: right coronary artery

Real time 3D visulalization of myocardial perfusion

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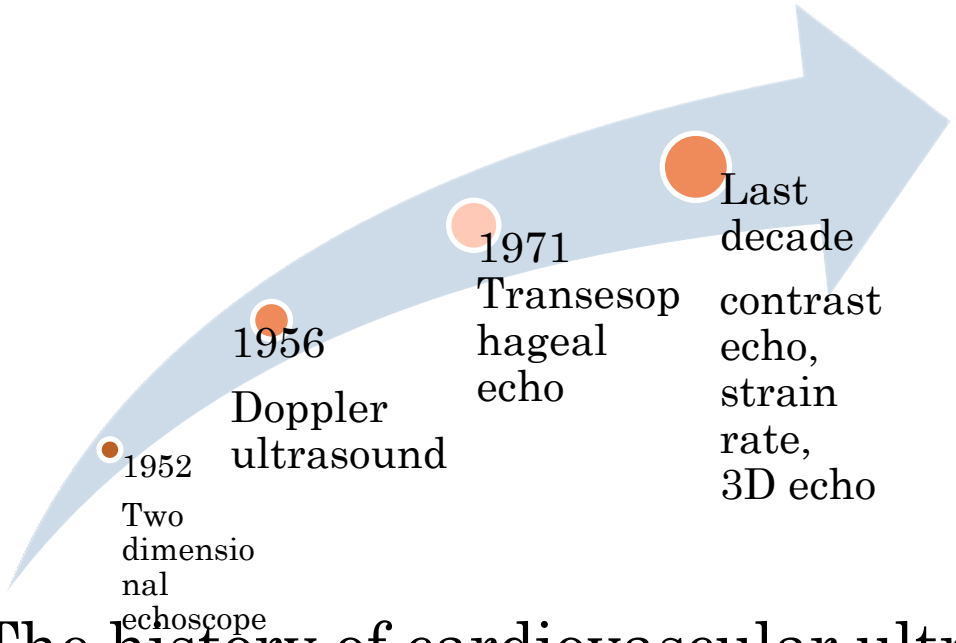
AMERICAN SOCIETY OF ECHOCARDIOGRAPHY NEWS

President's Message

THE TIME FOR 3D



Michael Picard, MD
President
American Society of Echocardiography

- The history of cardiovascular ultrasound is a history filled with innovation. Three dimensional imaging is one of these innovations. I suspect that in a few years, it will be a routine part of our ultrasound evaluation of the heart.

At the end of the road…

Real-time 3D stress echocardiography without any doubt will be the fastest and probably sometime the best way to do a stress echo.