Left atrial Function In Echocardiography

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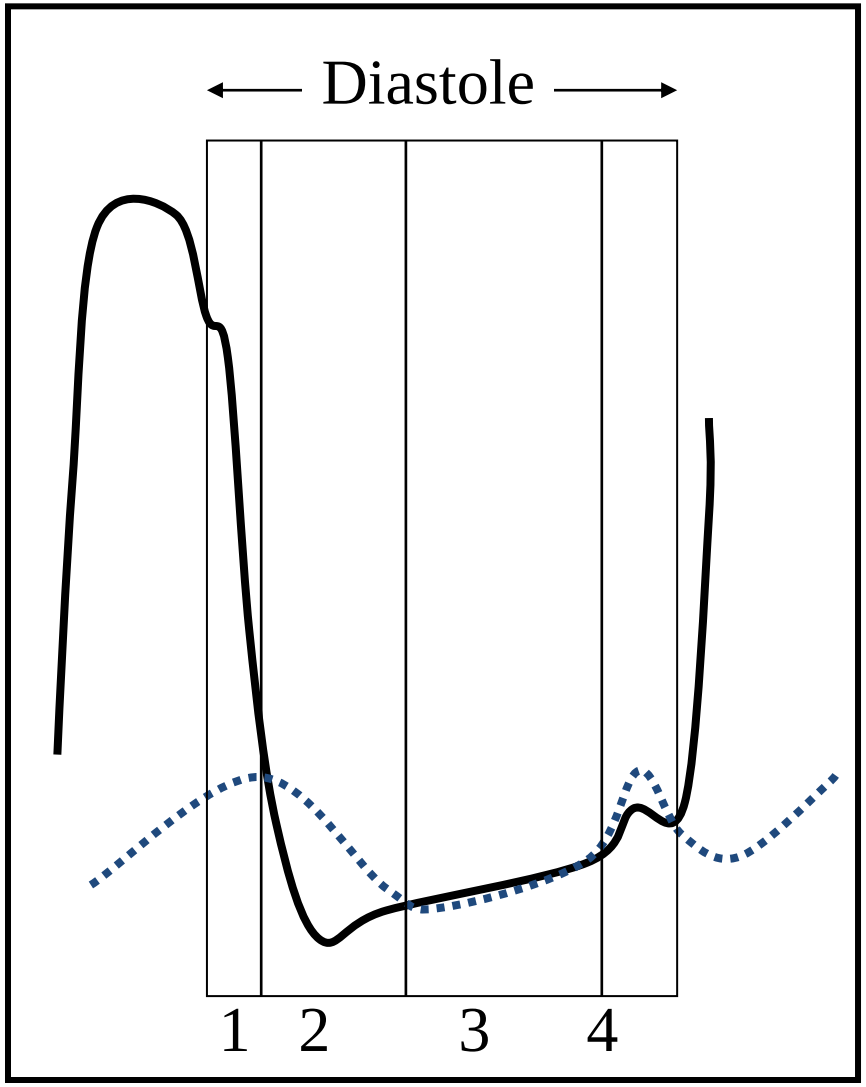
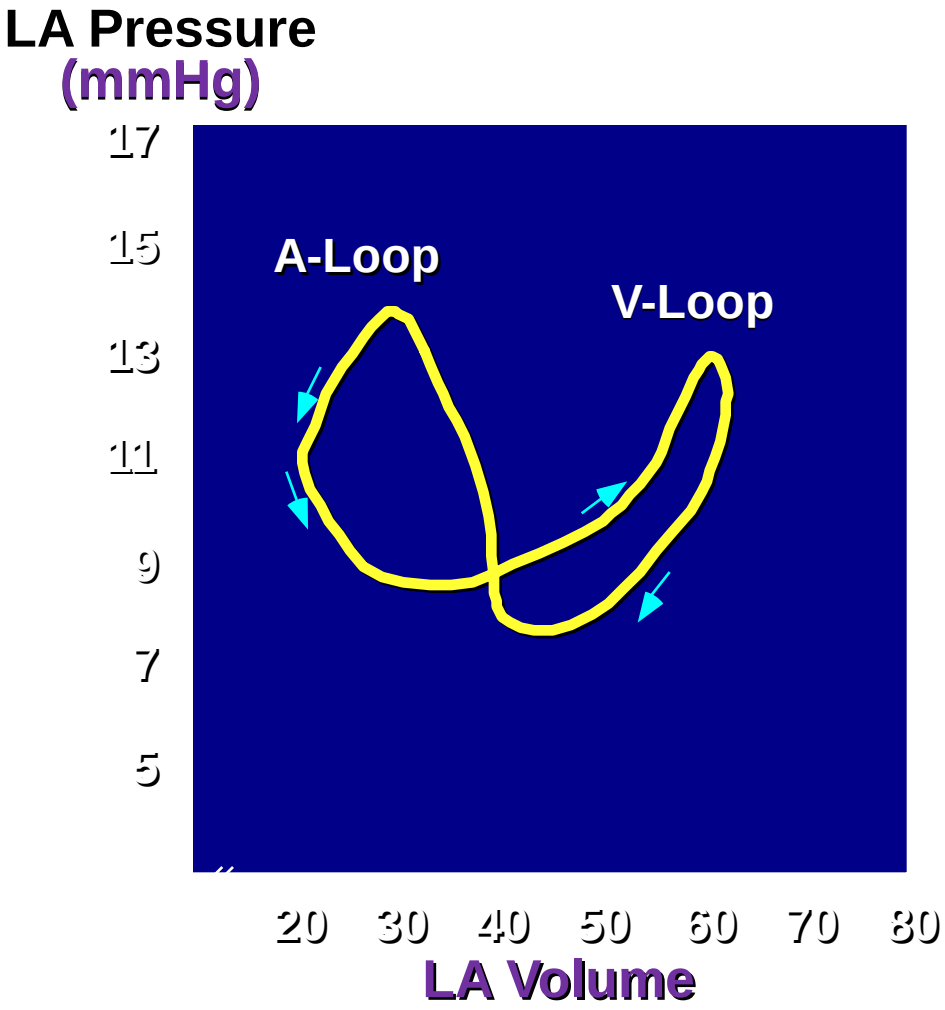
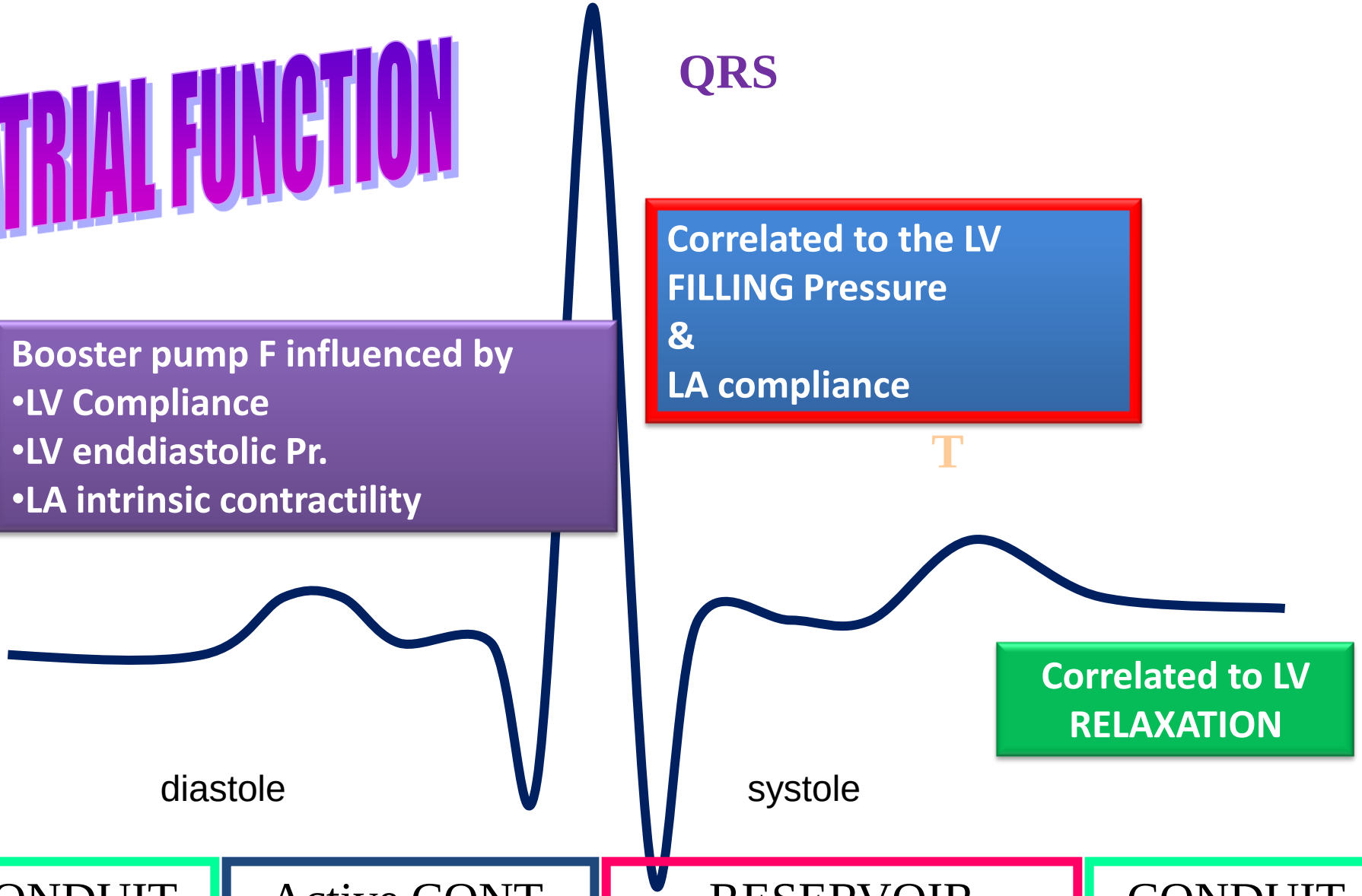
Inserm

LA function


Diastole
1
2
3
4

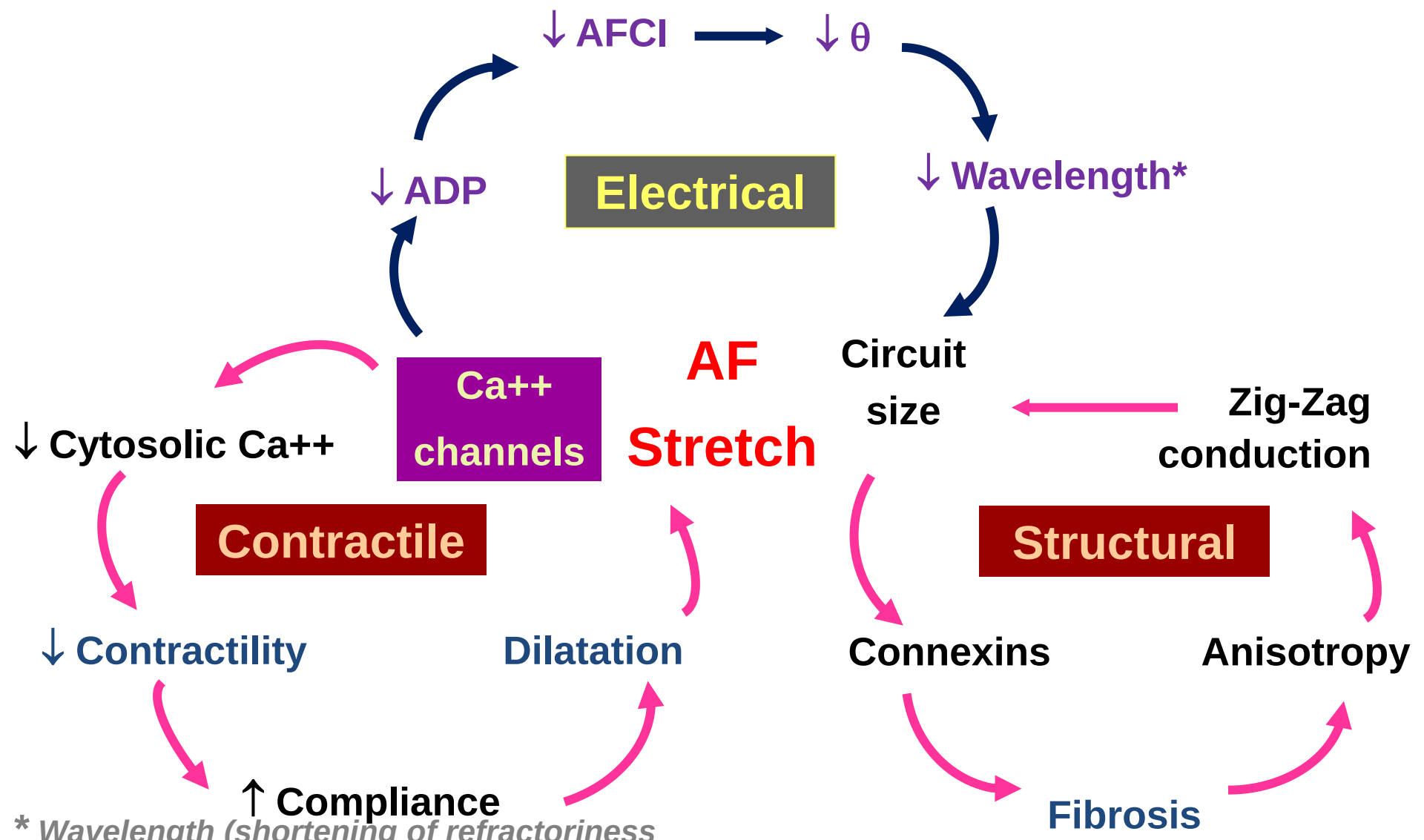

LA Pressure
(mmHg)
17
15
13
11
9
7
5
A-Loop
V-Loop
20
30
40
50
60
70
80
LA Volume

ATRIAL FUNCTION



Donal et al JASE 2006

Atrium as Ventricle is remodeling



* *Wavelength (shortening of refractoriness and slowing of conduction*

Allessie M. Cardiovasc Res 2002 ; 54 : 230-46

Indices of Atriale emptying:
(not used in clinical routine)

1. LA total emptying volume index = LAVImax x LAVImin,
2. LA passive emptying volume index = LAVImax x LAVIpre-a,
3. LA active emptying volume index = LAVIpre-a x LAVImin.

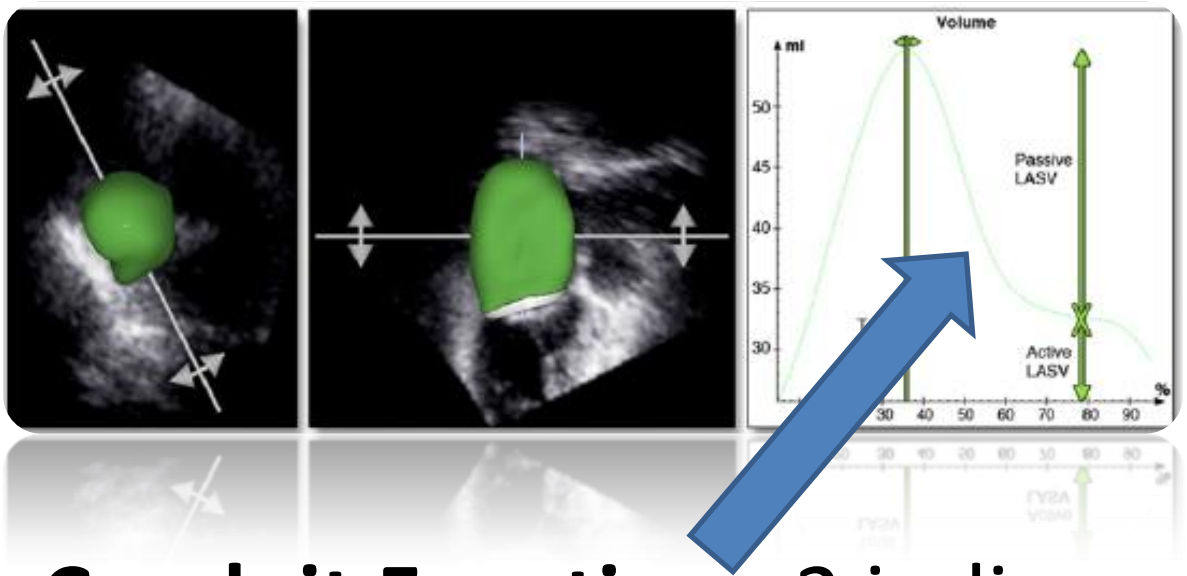
Stefanadis et al. Eur H J 2001 & Manning JACC 1993

Reservoir Function: 2 indices:

1. expansion index = [(LAVImax LAVImin)/LAVImin] x 100

2. diastolic emptying index = [(LAVImax LAVImin)/LAVImax] x 100.

Stefanadis et al. Eur H J 2001 & Manning JACC 1993



Conduit Function : 2 indices:

1. passive emptying % of total emptying =

[(LAVImax x LAVIpre-a)/(LAVImax x LAVImin)] x100

2. passive emptying index =

(LAVImax x LAVIpre-a)/LAVImax x100

Stefanadis et al. Eur H J 2001 & Manning JACC 1993

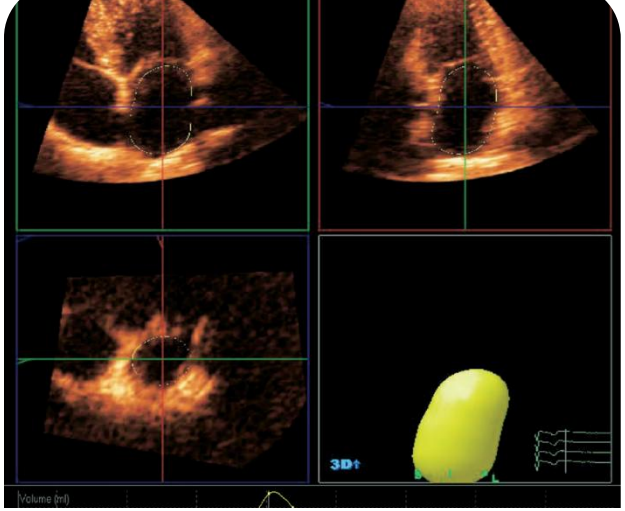
Booster pump function :

2 indices:

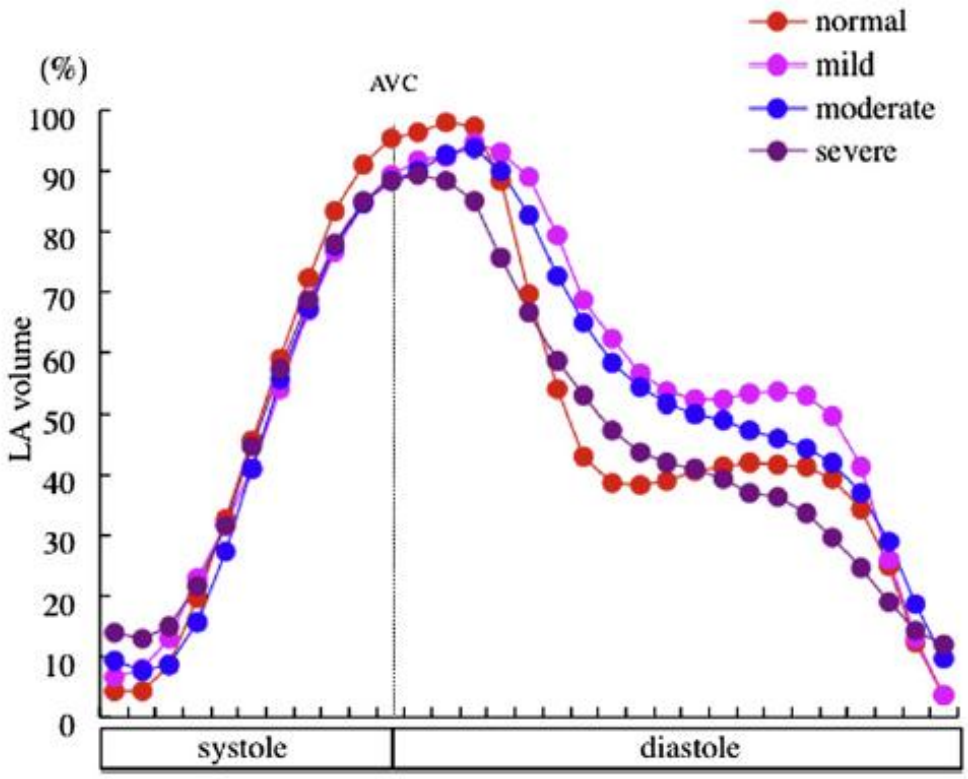
1. active emptying percentage of total emptying = [(LAVIpre-a LAVImin)/(LAVImax LAVImin)] x100

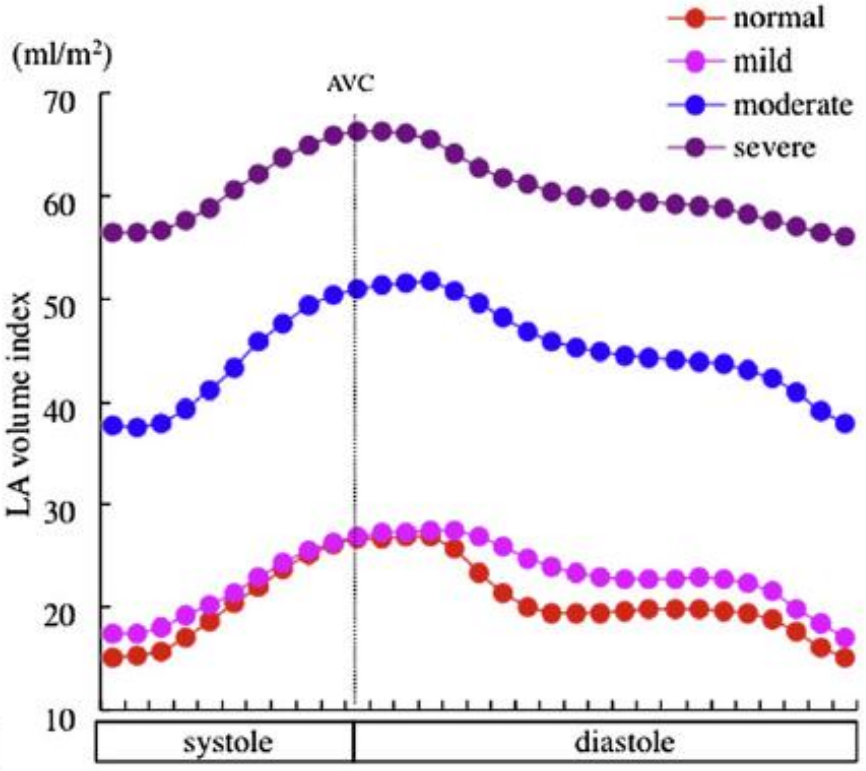
2. active emptying index = (LAVIpre-a LAVImin)/LAVIpre-a x 100.

Stefanadis et al. Eur H J 2001 & Manning JACC 1993



LA Volume assessed by 3D- TTE

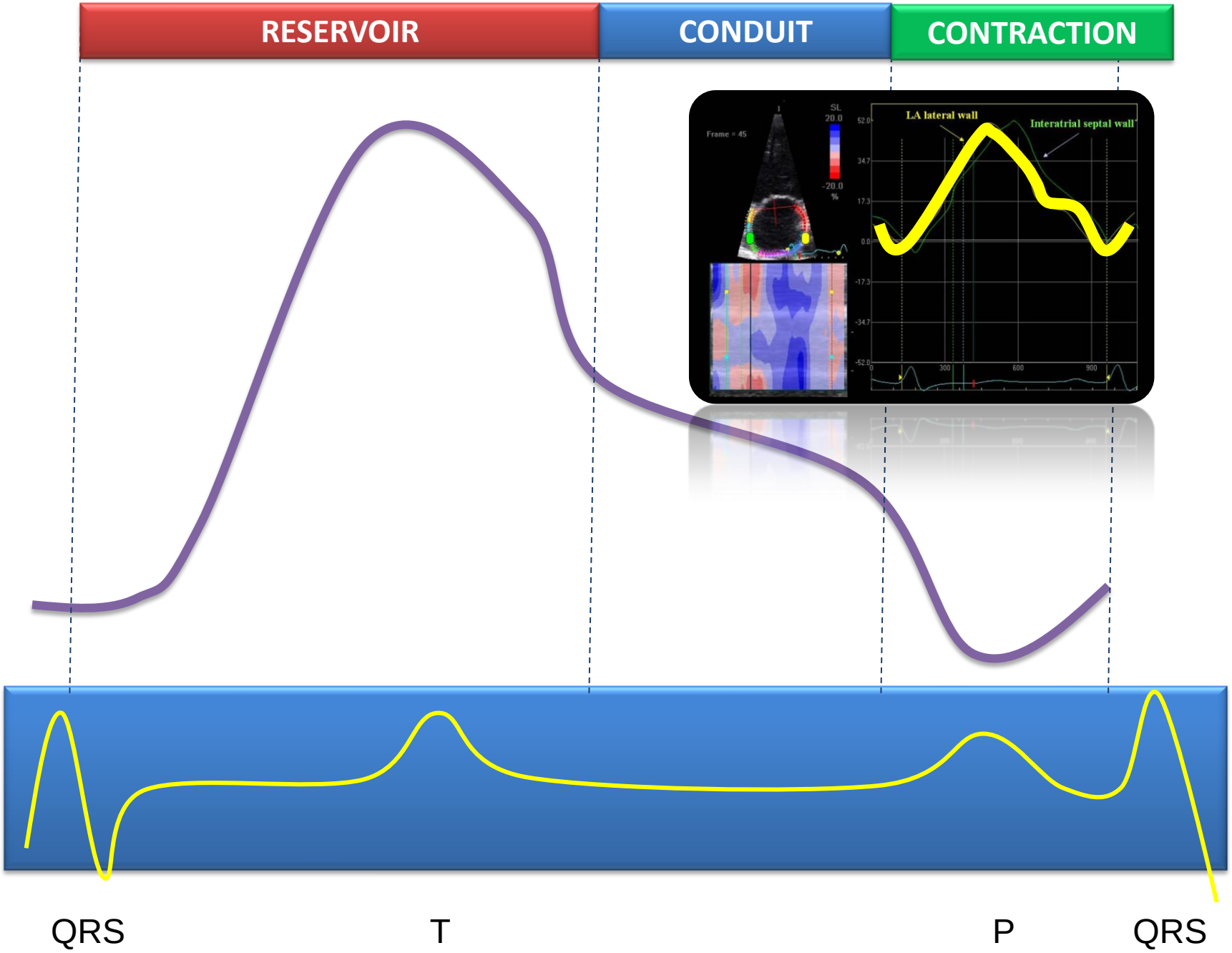


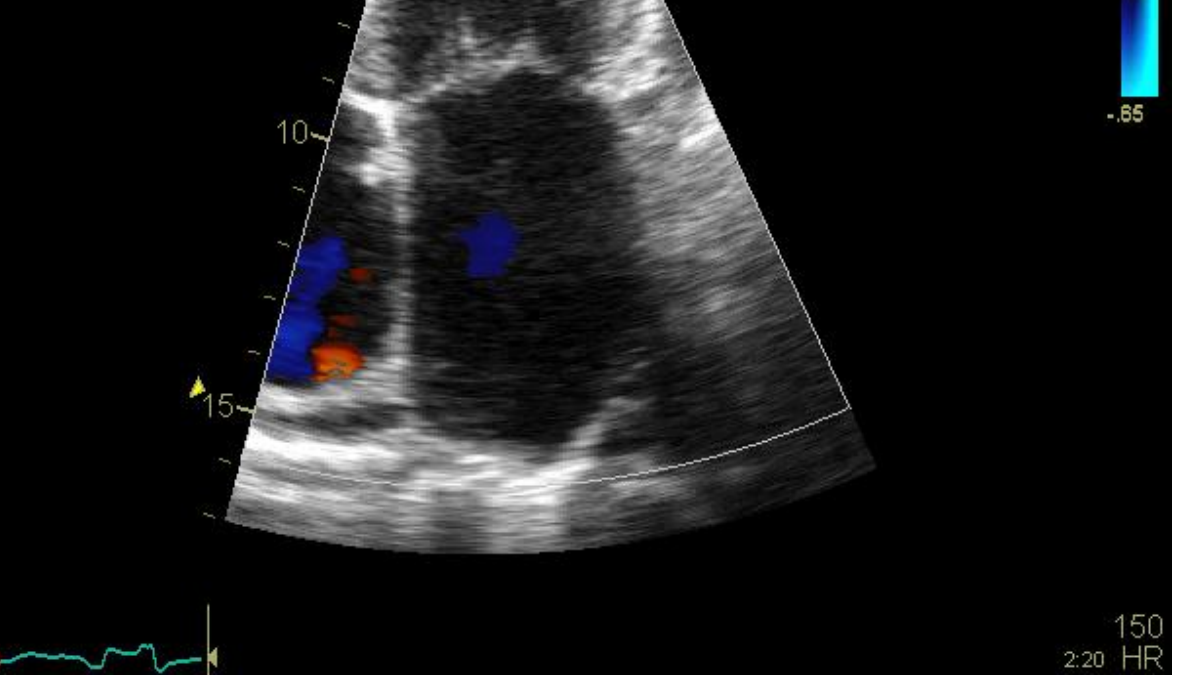


Marsan et al. Am J Cardiol 2008

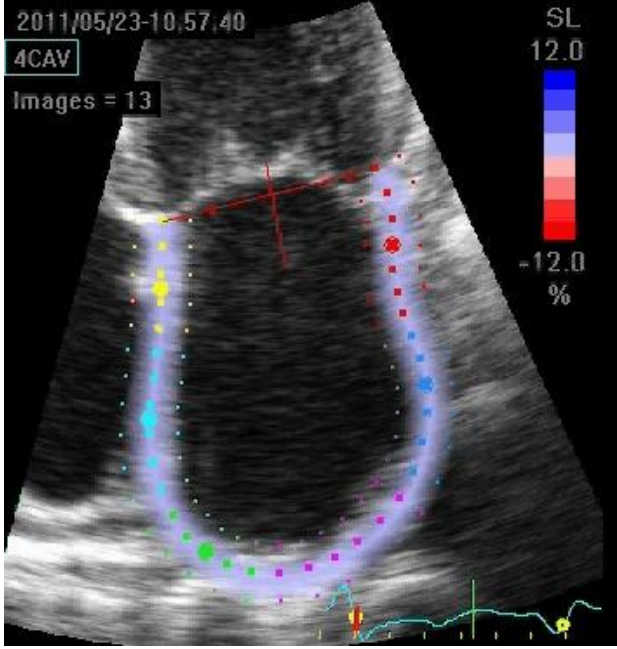
Otani et al. J Am Soc Echocardiogr 2010;23:961-7.

Deformation of Atrial Myocardium

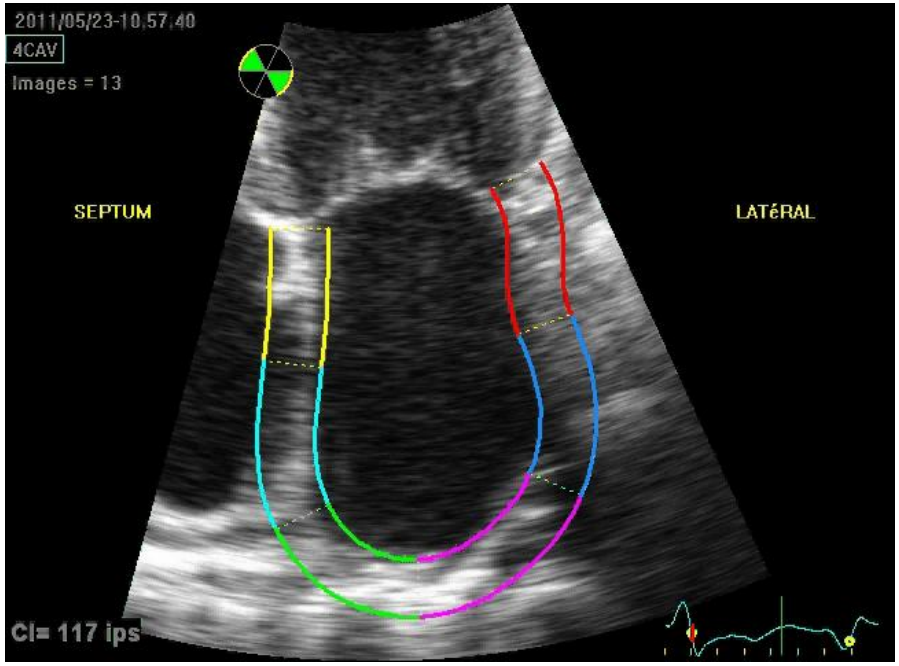




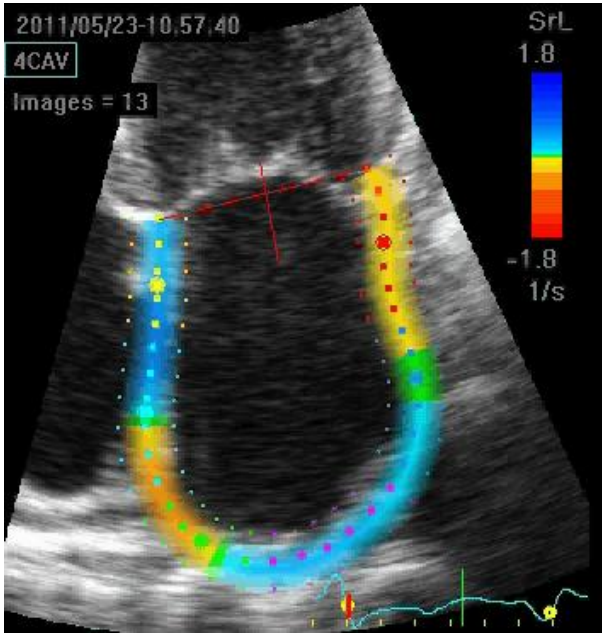
Strain (%)

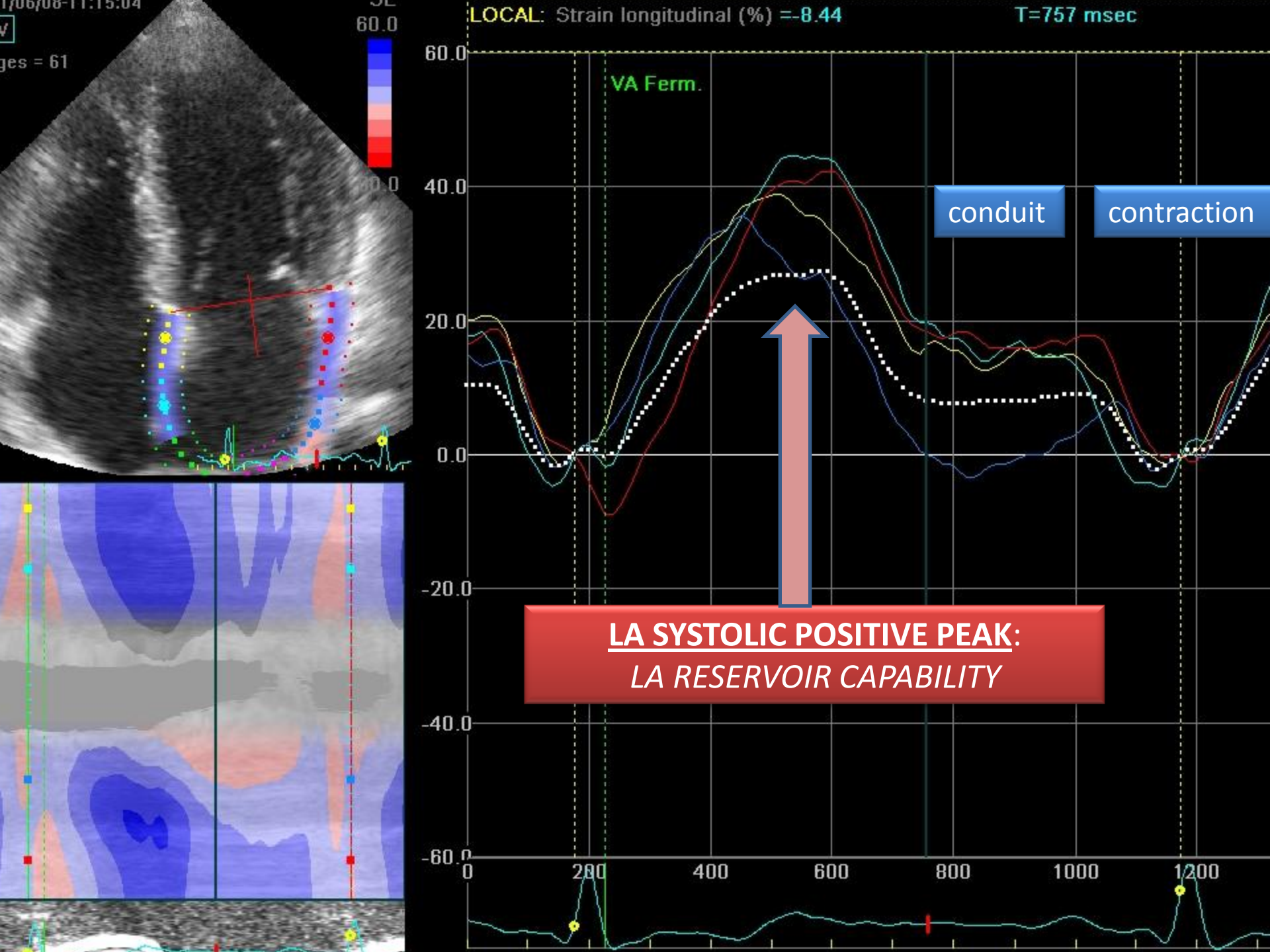


Semi-automatic borders detection

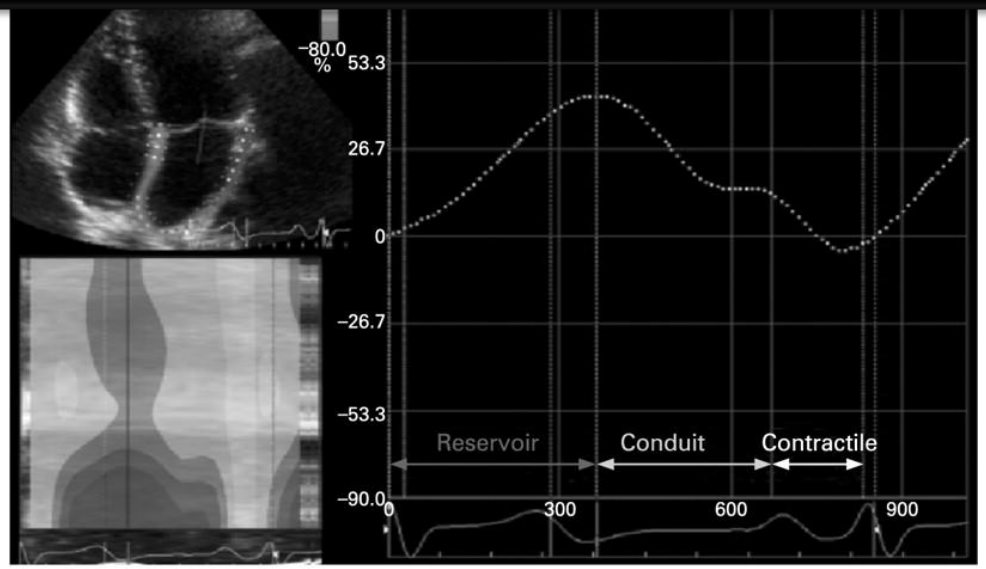


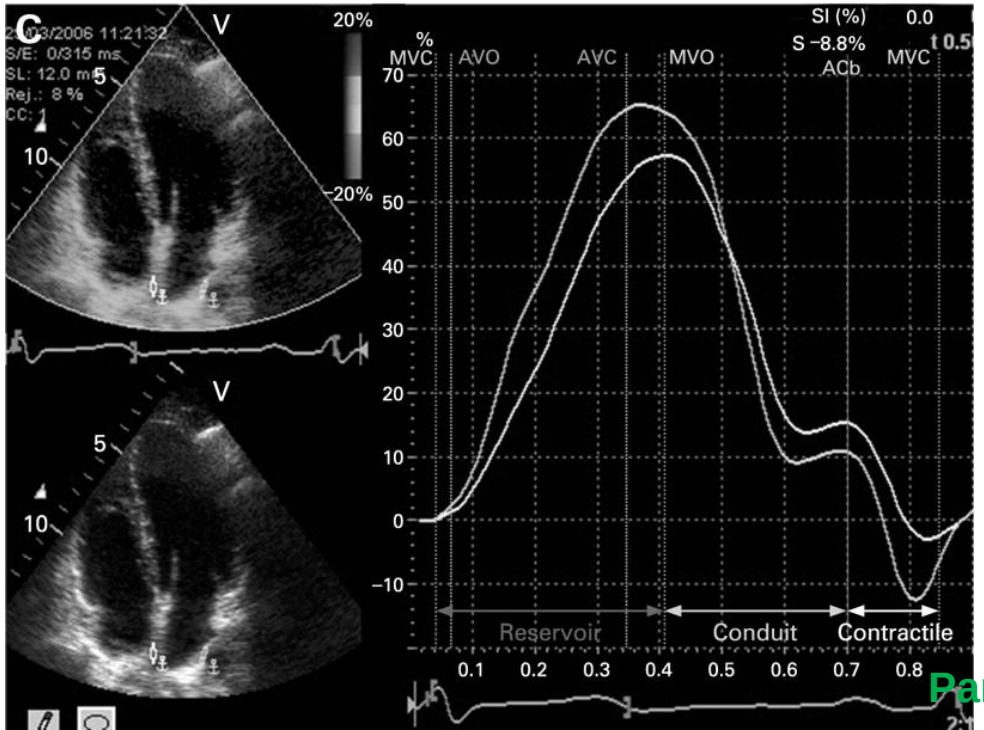
Strain Rate (s-1)




LOCAL: Strain longitudinal (%) =-8.44
T=757 msec
VA Ferm.
60.0
40.0
20.0
0.0
-20.0
-40.0
-60.0
0
200
400
600
800
1000
1200
conduit
contraction
LA SYSTOLIC POSITIVE PEAK:
LA RESERVOIR CAPABILITY

Left atrial strain measurement in a normal subject.





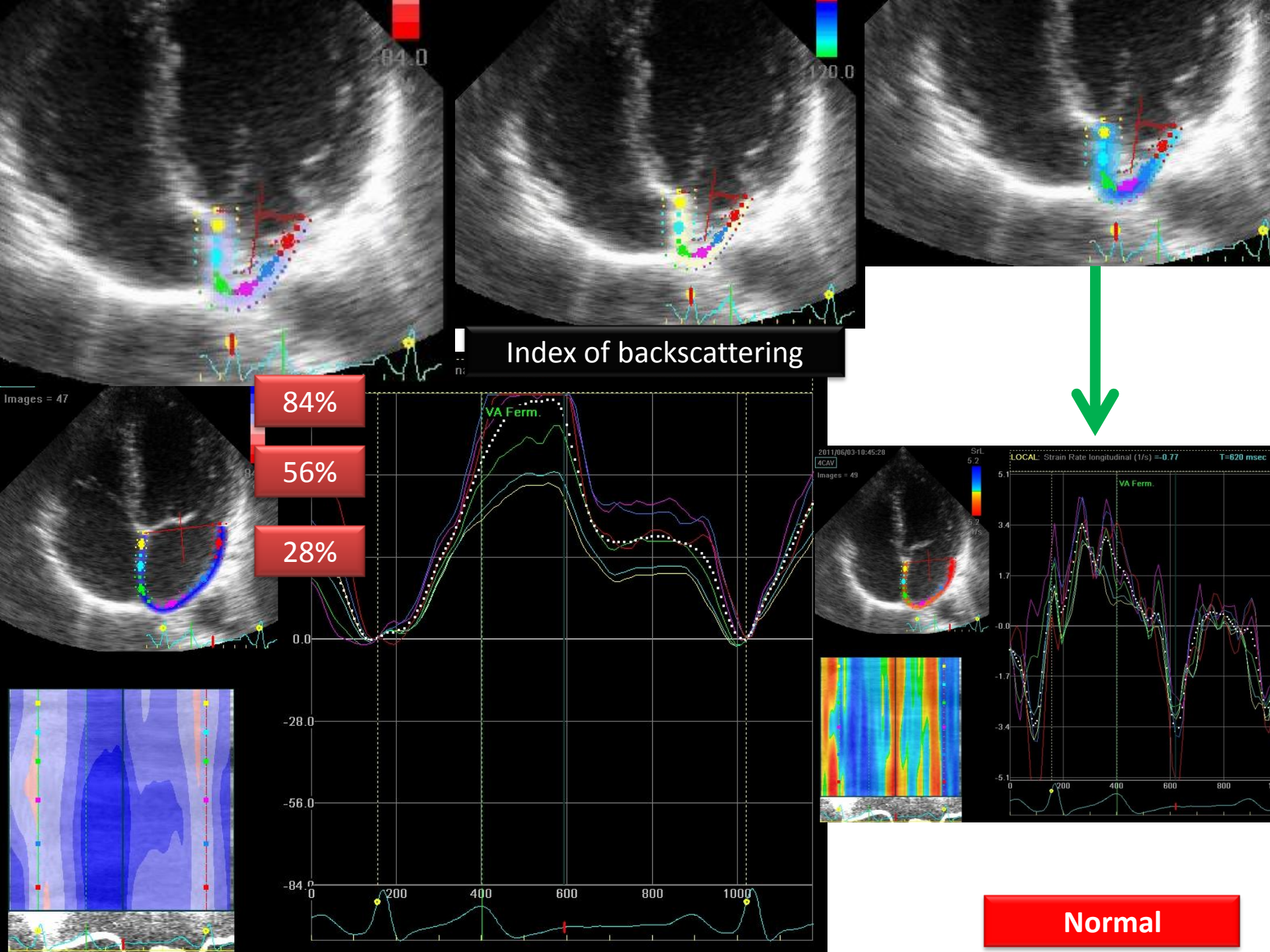
The speckle tracking approach improve deeply the **robustness**

Intra-observer variability = 8%

Inter-observer variability 9.5%

Time required for the LA function assessment 3.8minutes

Paraskevaidis I A et al. Heart 2009;95:483-489


Index of backscattering
84%
56%
28%
VA Ferm.
0.0
-28.0
-56.0
-84.0
0
200
400
600
800
1000
Images = 47
Images = 49
LOCAL: Strain Rate longitudinal (1/s) =-0.77
T=620 msec
5.1
3.4
1.7
-0.0
-1.7
-3.4
-5.1
Normal

GLOBAL ATRIAL SYSTOLIC AND DIASTOLIC STRAIN RATE are:

I. Highly sensitive

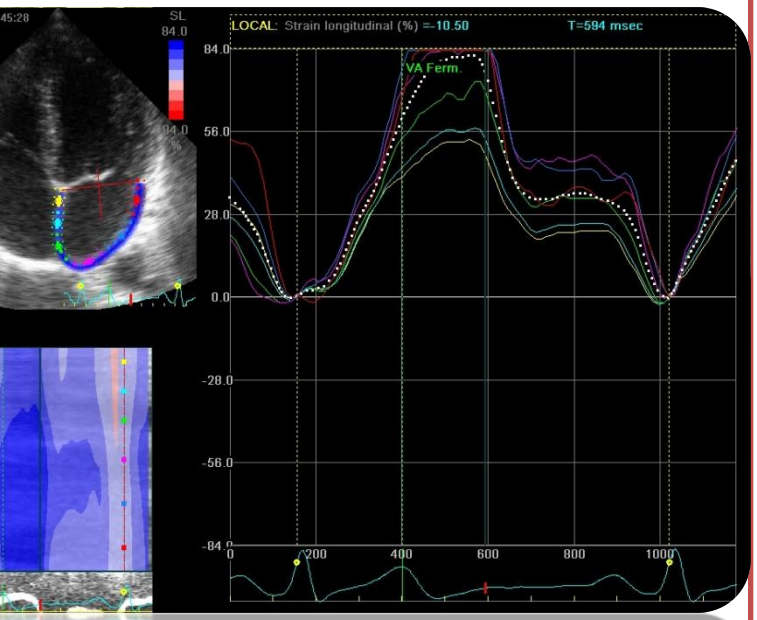
II. Load dependent

III. Related somehow to LV longitudinal function

IV. Age related (changes have been demonstrated very early before ATRIAL PHASIC **VOLUME PARAMETERS.**

Boyd et al. Heart 2011; 97: 1513

►Left Atrial Strain Is demonstrated as a Surrogate Marker for Detection of Atrial Fibrillation in Cryptogenic Strokes

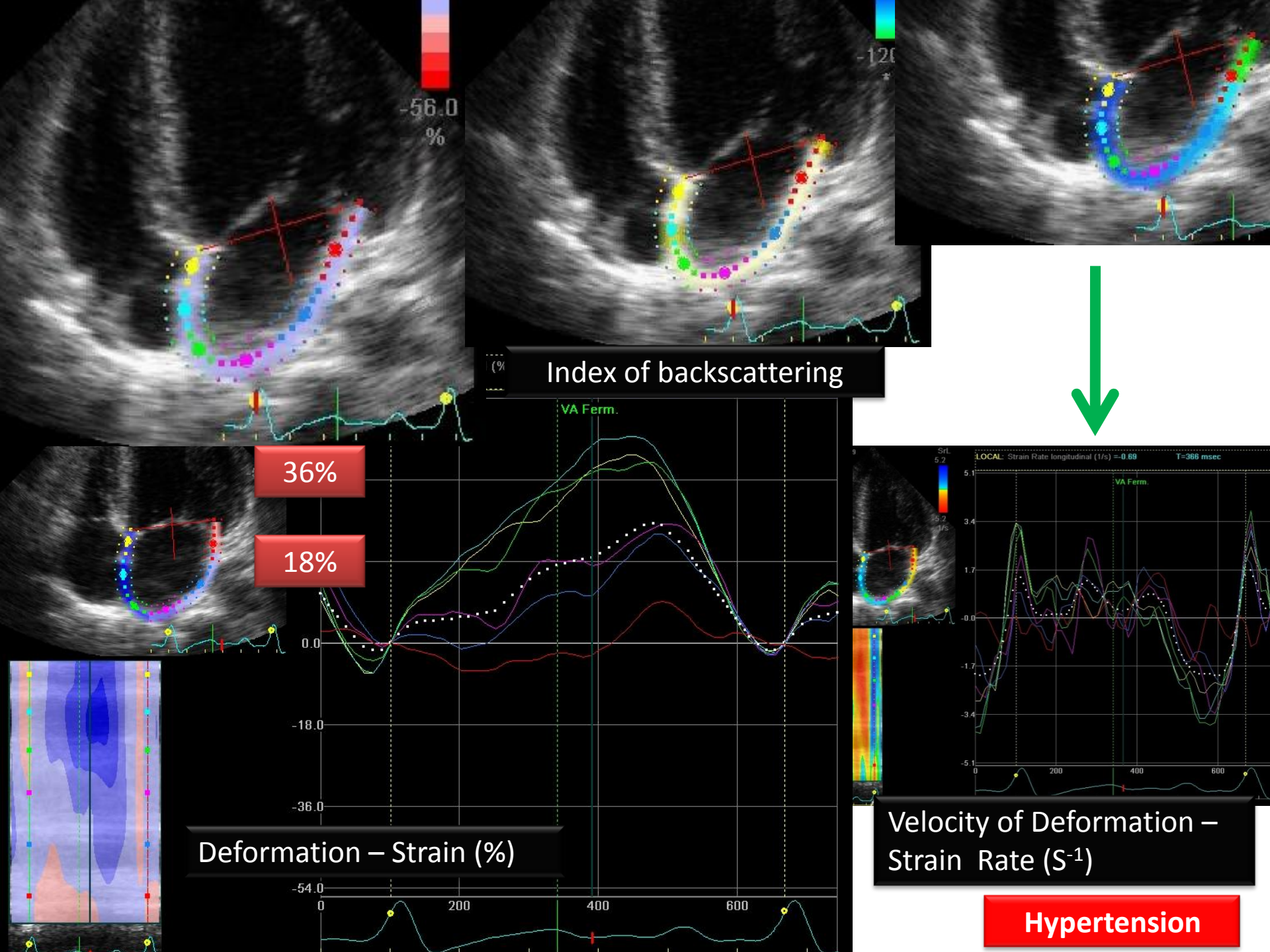


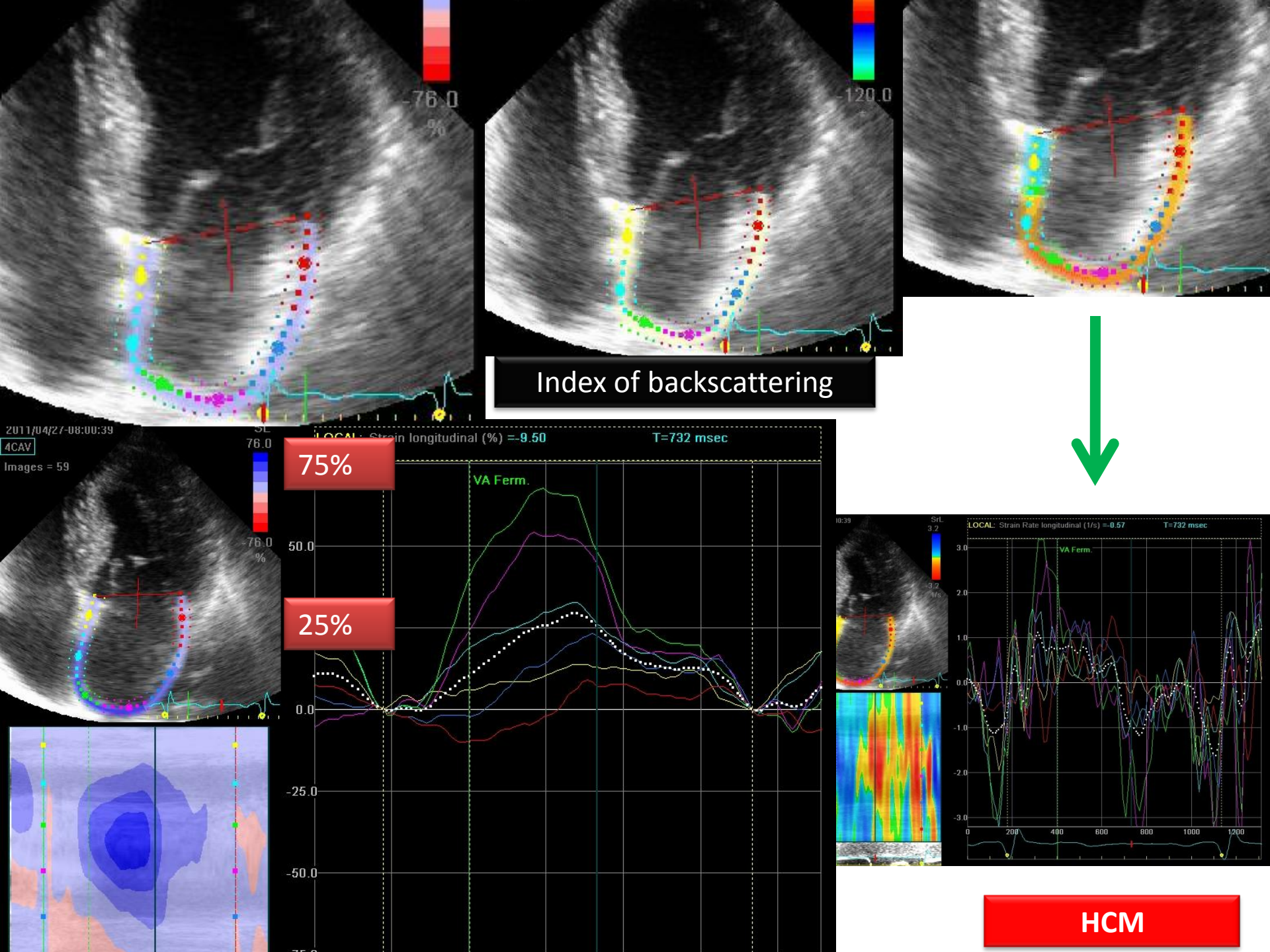
Stroke 2014; 45(8):e164-e166
JASE 2011; 24: 898-908
Heart 2011; 97: 1513

LA-deformations are impaired in patients with hypertension and diabetes with normal LA size.

►with ageing

- **❖LA conduit ↘**
- **❖LA reservoir is supposed to be constant**
- **❖LA booster pump function increase slightly**

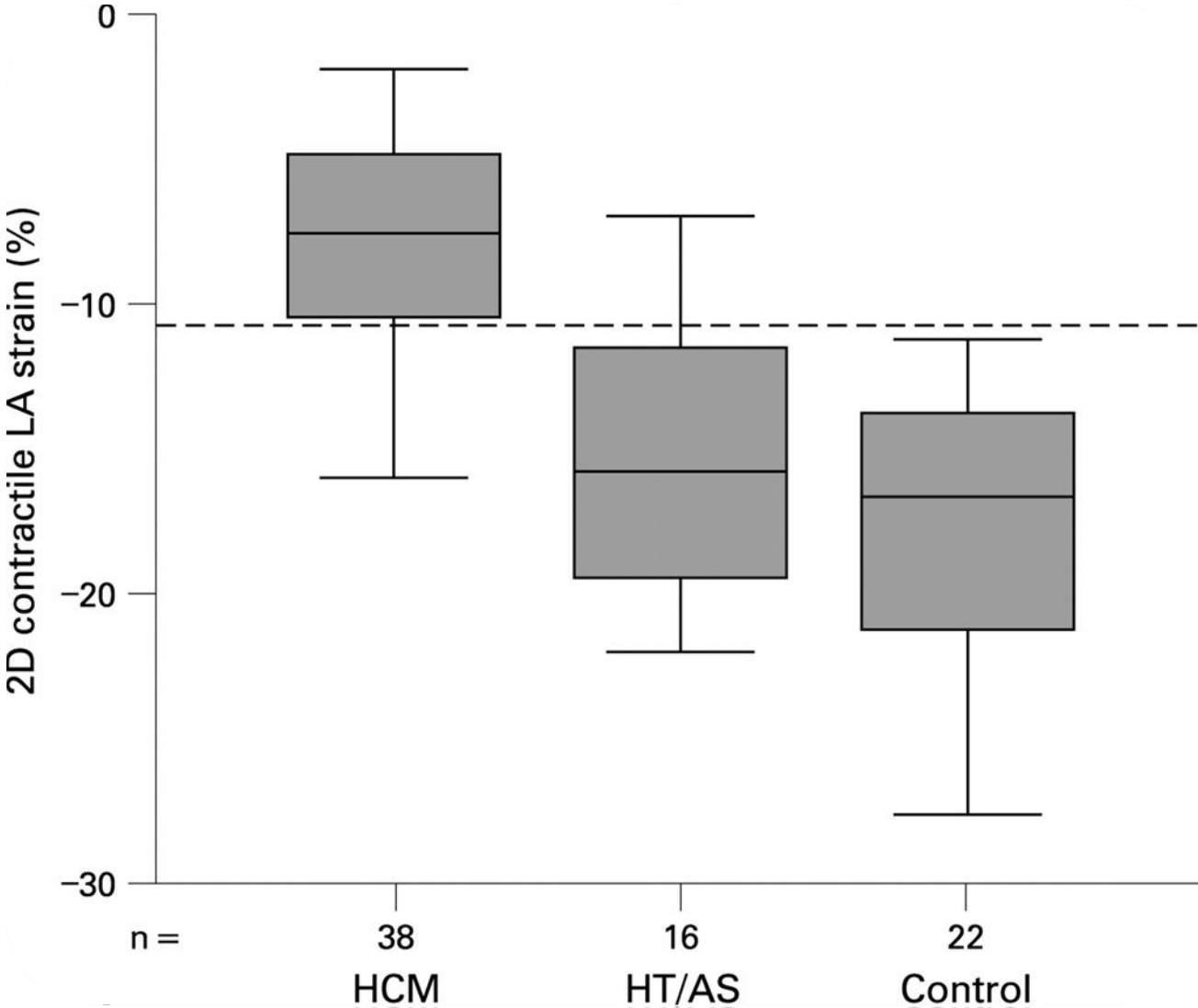

-56.0
%
Index of backscattering
VA Ferm.
36%
18%
0.0
-18.0
-36.0
Deformation – Strain (%)
-54.0
0
200
400
600
LOCAL: Strain Rate longitudinal (1/s) =-0.69
T=368 msec
VA Ferm.
5.1
3.4
1.7
-0.0
-1.7
-3.4
-5.1
0
200
400
600
Velocity of Deformation – Strain Rate (S-1)
Hypertension


-76.0
%
-120.0
Index of backscattering
2011/04/27-08:00:39
4CAV
Images = 59
SL
76.0
-76.0
%
LOCAL: Strain longitudinal (%) =-9.50
T=732 msec
75%
VA Ferm.
50.0
25%
0.0
-25.0
-50.0
SrL
3.2
-3.2
1/s
LOCAL: Strain Rate longitudinal (1/s) =-0.57
T=732 msec
VA Ferm.
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
0
200
400
600
800
1000
1200
HCM

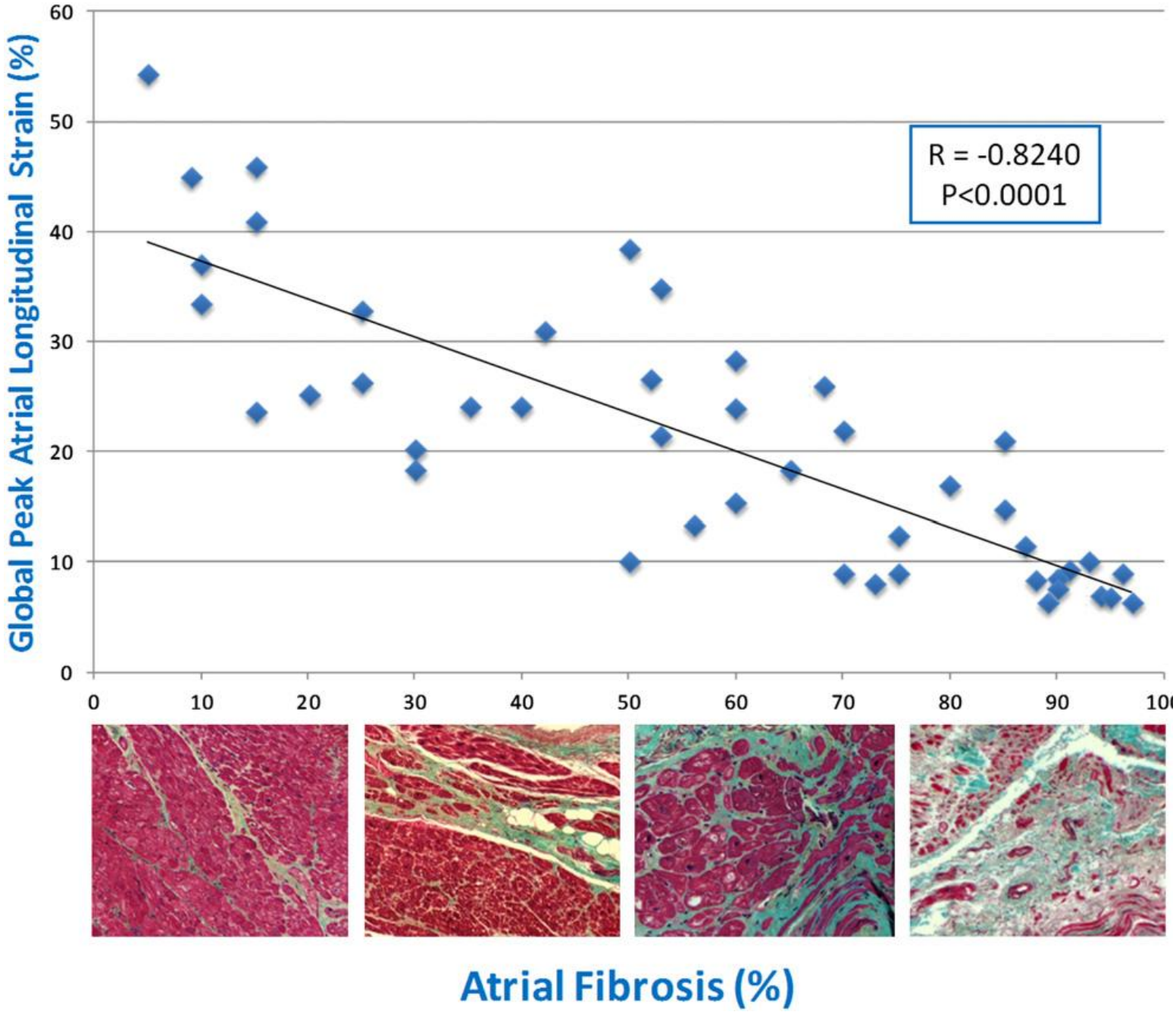
contractile left atrial (LA) strain in patients with hypertrophic cardiomyopathy (HCM), hypertension or aortic stenosis (HT/AS) and normal controls.

HCM

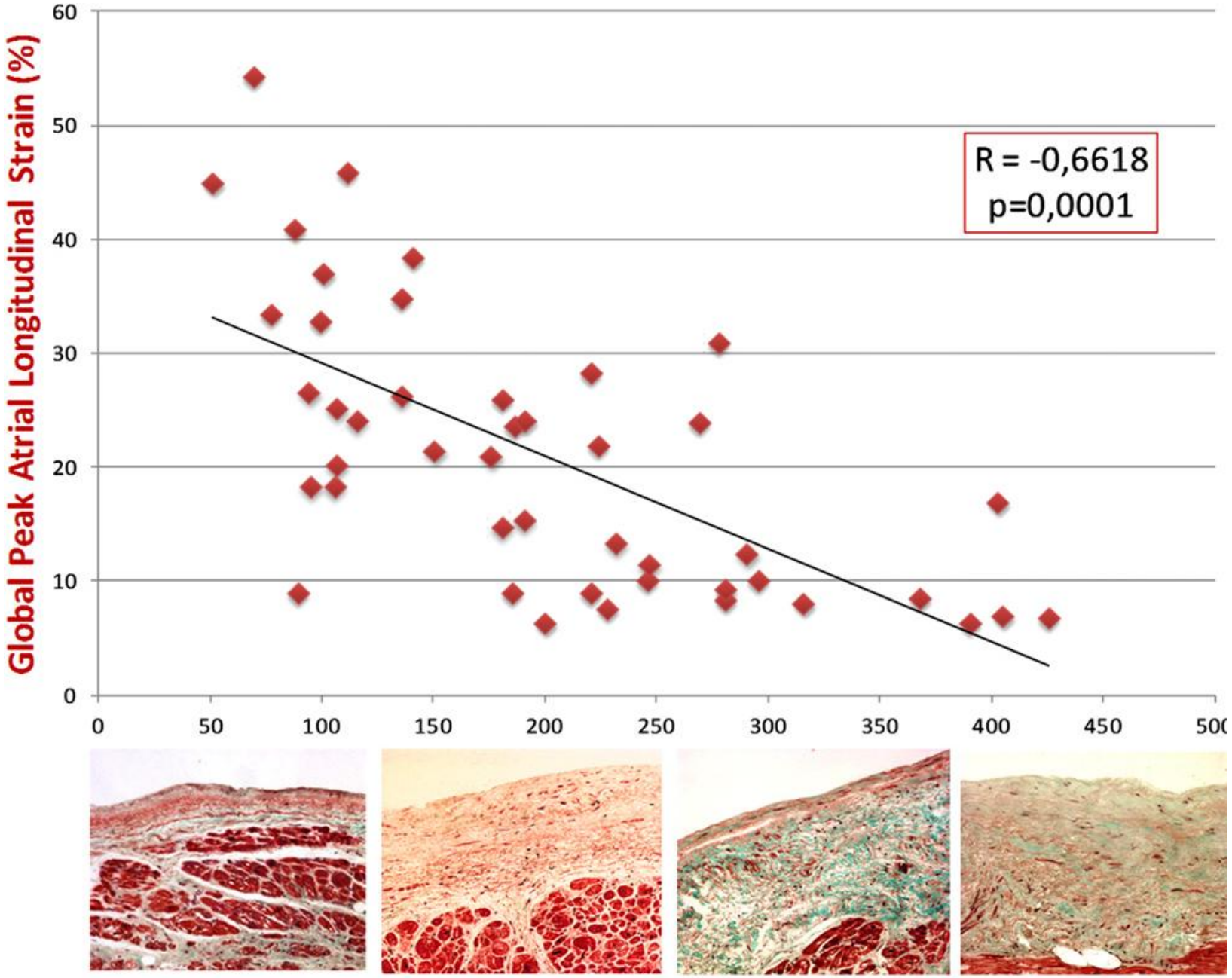
LA Reservoir:
- HCM 22±8%
- LVH 38±4%
- Control 42±4%



Paraskevaidis I A et al. Heart 2009;95:483-489



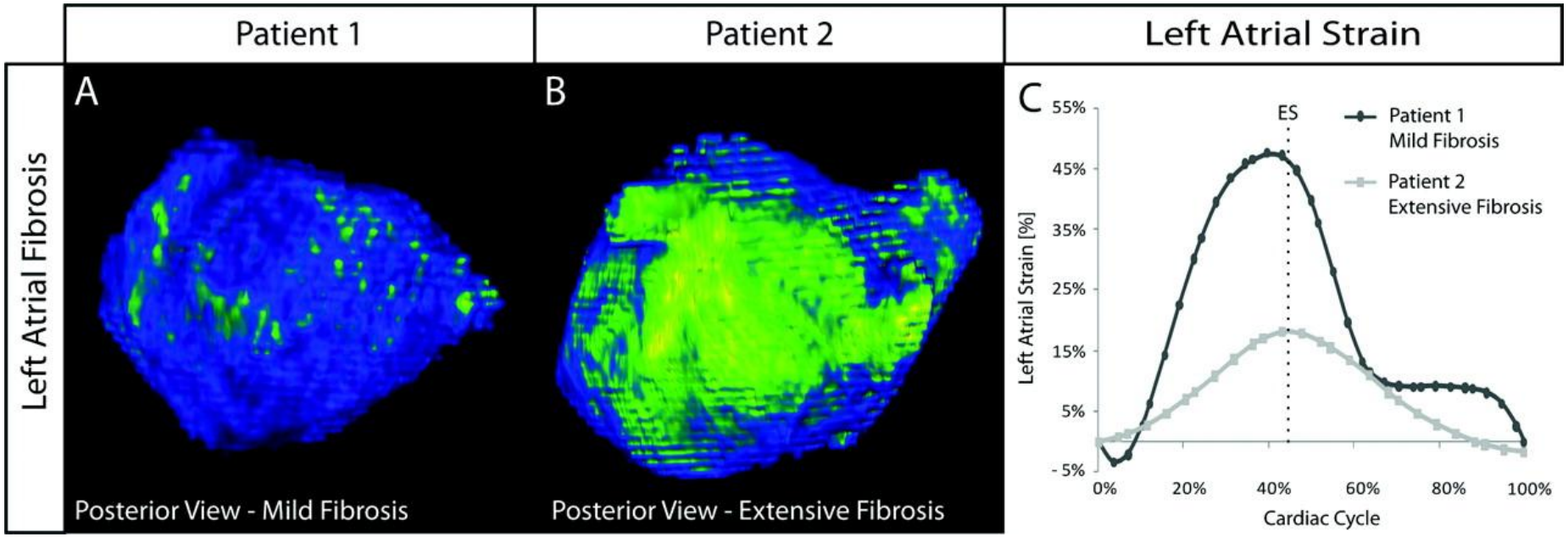
Cameli et al. Am J cardiol 2013


Global Peak Atrial Longitudinal Strain (%)
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
400
450
500
R = -0,6618
p=0,0001
Atrial Endocardial Thickness (µm)

Left Atrial Strain and Strain Rate in Patients With Paroxysmal and Persistent Atrial Fibrillation

Relationship to Left Atrial Structural Remodeling Detected by Delayed-Enhancement MRI

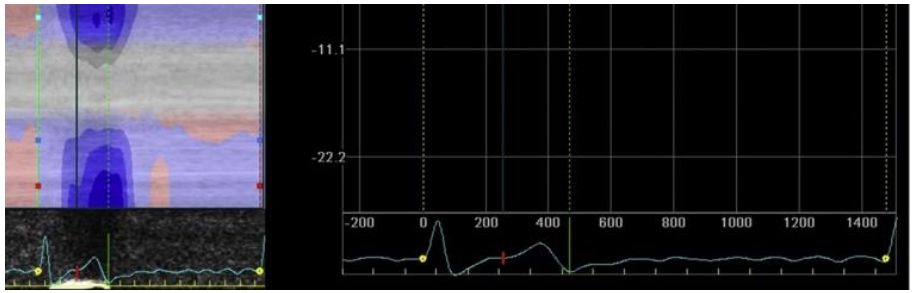
Conclusions—LA wall fibrosis by delayed-enhancement MRI is inversely related to LA strain and strain rate, and these are related to the AF burden. Echocardiographic assessment of LA structural and functional remodeling is quick and feasible and may be helpful in predicting outcomes in AF. (***Circ Cardiovasc Imaging*. 2010;3:231-239.**)

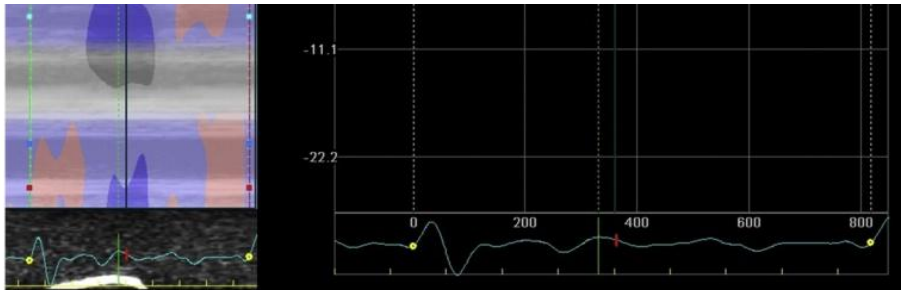


Kuppahally S S et al. Circ Cardiovasc Imaging. 2010;3:231-239

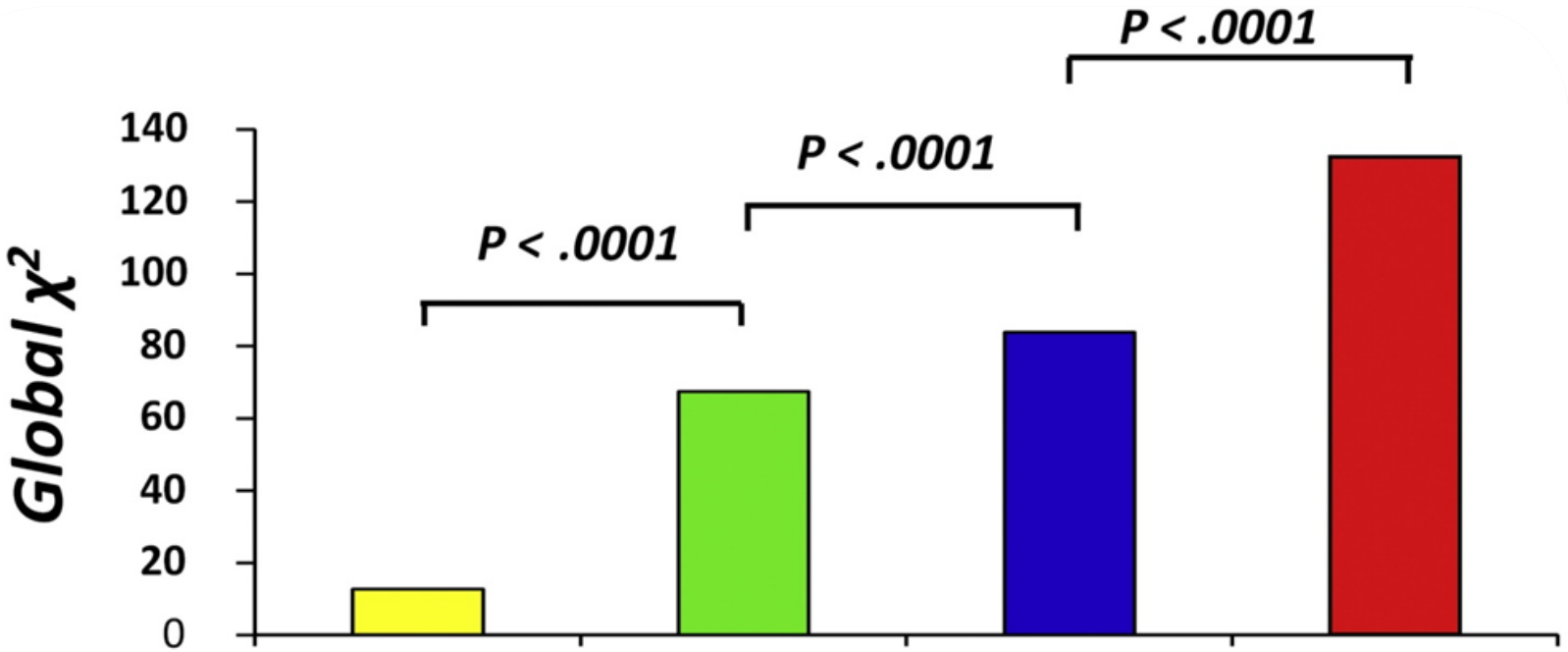
LA Strain Provides Incremental Value for Embolism Risk Stratification over CHA2DS2-VASc Score and Indicates Prognostic Impact in Patients with AFib

Methods: Consecutive patients with paroxysmal or persistent AF with acute embolism (82 patients) or without (20- controls) were prospectively enrolled. Global peak LA longitudinal strain during ventricular systole (LA_S) was as sessed during AF rhythm. Global LA_S was compared between the groups in the first cross-sectional study Then, the 82 patients with acute embolism were prospectively followed during the second prospective cohort study

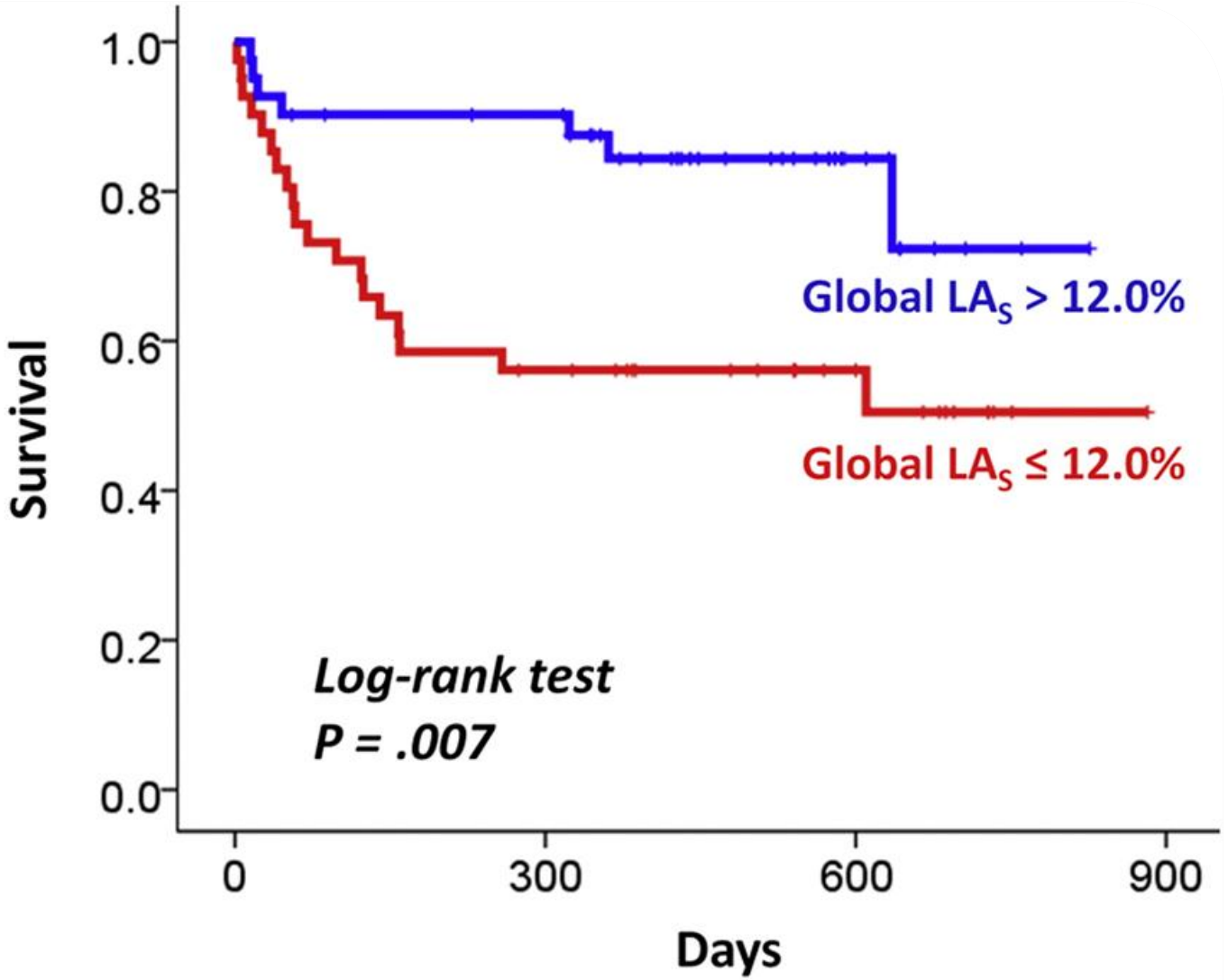




Conclusions: In this observational study, LA strain provided incremental diagnostic information over that provided by the CHA_2DS_2-VASc score, suggesting that LA strain analysis could improve the current risk stratification of embolism in patients with AF. LA strain can also predict poststroke mortality. (J Am Soc Echocardiogr 2014;27:709-16.)

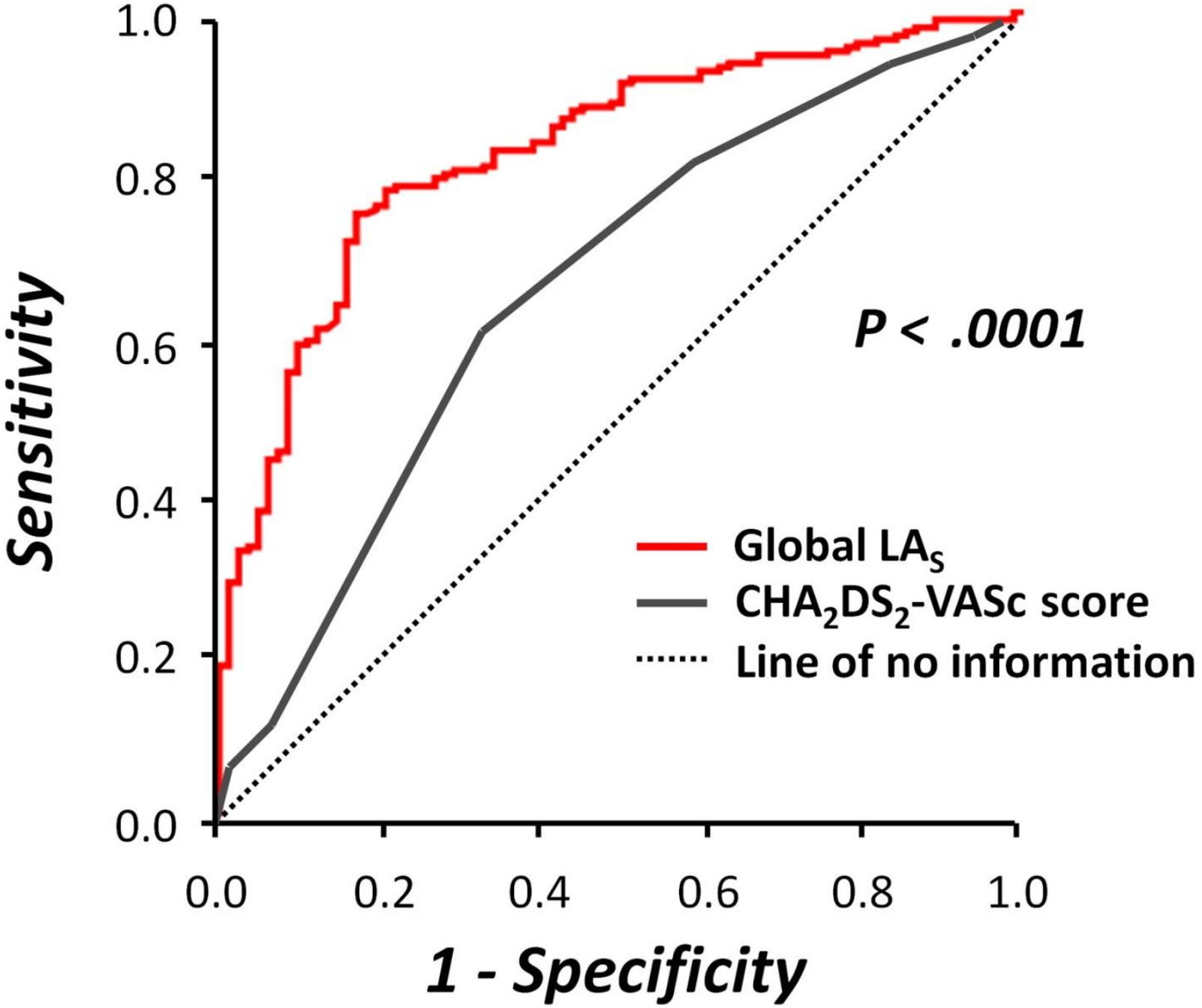


Models	Model 1 (χ2 12.8)	Model 2 (χ2 67.4)	Model 3 (χ2 83.9)	Model 4 (χ2 132.4)
Variable	CHA_2DS_2-VASc score	+ OAC use	+ LA emptying fraction	+ Global LA_S
CHA_2DS_2-VASc score	1.35 (1.14-1.61) *P* < .001	1.47 (1.21-1.79) *P* < .001	1.45 (1.19-1.76) *P* < .001	1.11 (0.88-1.40) *P* = .362
OAC use	-	0.12 (0.06-0.22) *P* < .001	0.12 (0.06-0.23) *P* < .001	0.10 (0.05-0.21) *P* < .001
LA emptying fraction	-	-	0.95 (0.92-0.98) *P* < .001	0.98 (0.95-1.01) *P* = .151
Global LA_S	-	-	-	0.75 (0.68-0.83) *P* < .001

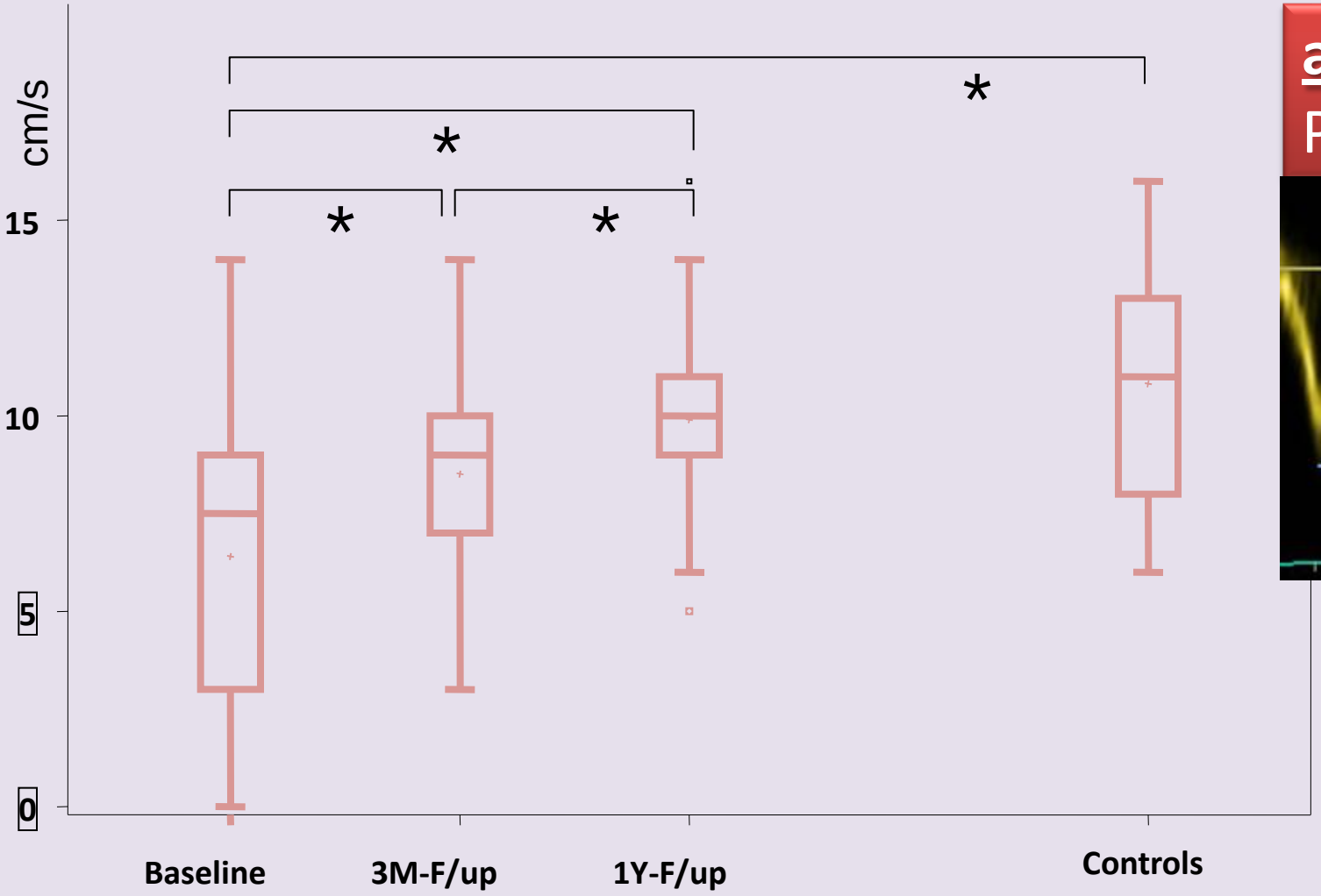


Number at risk

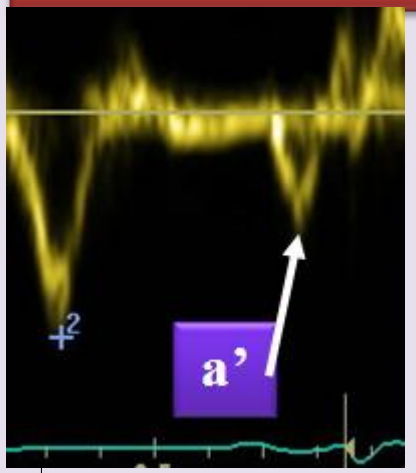
Global LA$_S$>12.0%	41	34	10
Global LA$_S$≤12.0%	41	22	10


1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
0.0
0.2
0.4
0.6
0.8
1.0
1 - Specificity
P < .0001
Global LA$_S$
CHA$_2$DS$_2$-VASc score
Line of no information

effects of RF-Ablation of paroxysmal or persistent Afib on left atrial function

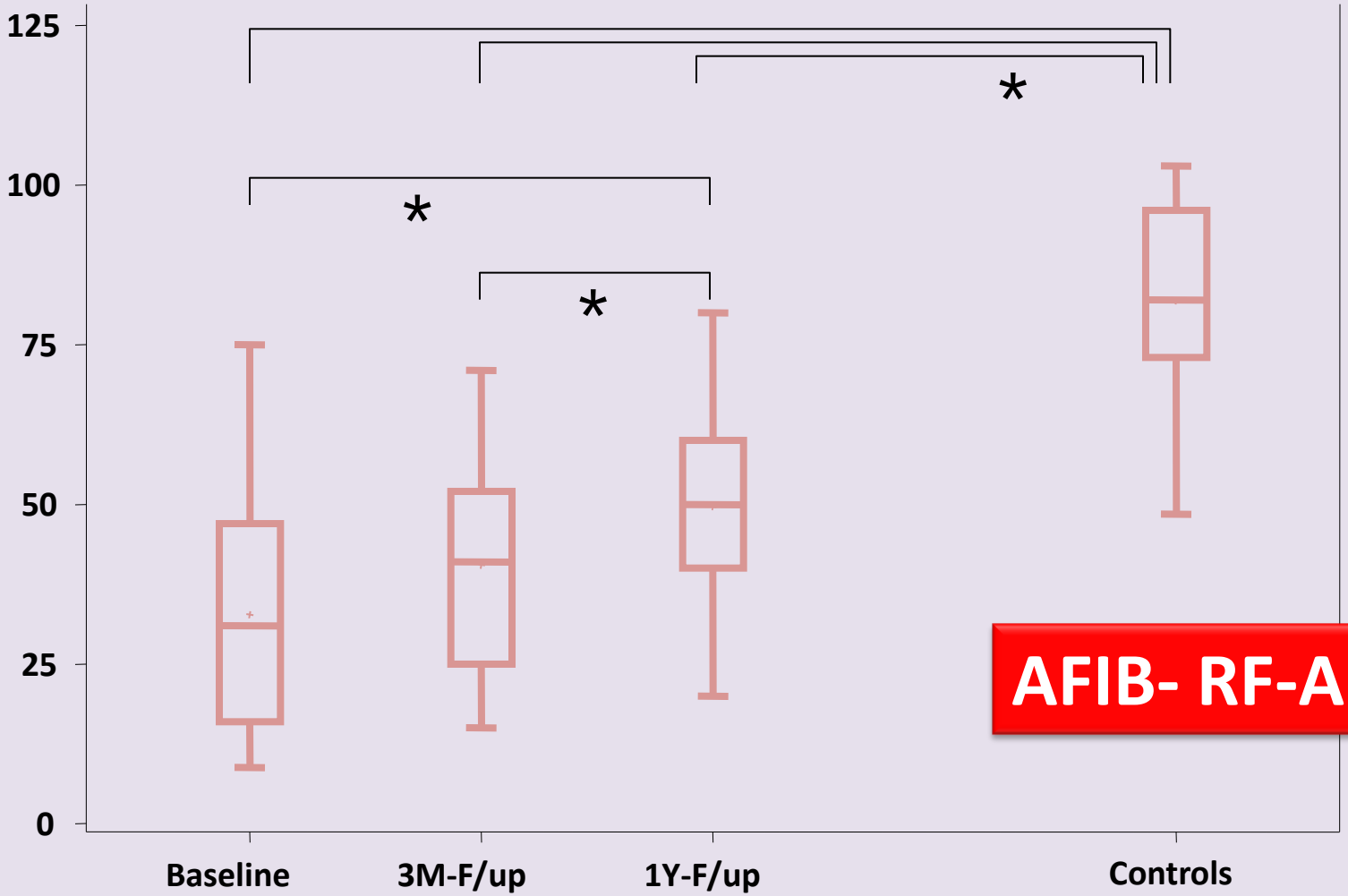


a'
Pulsed DTI



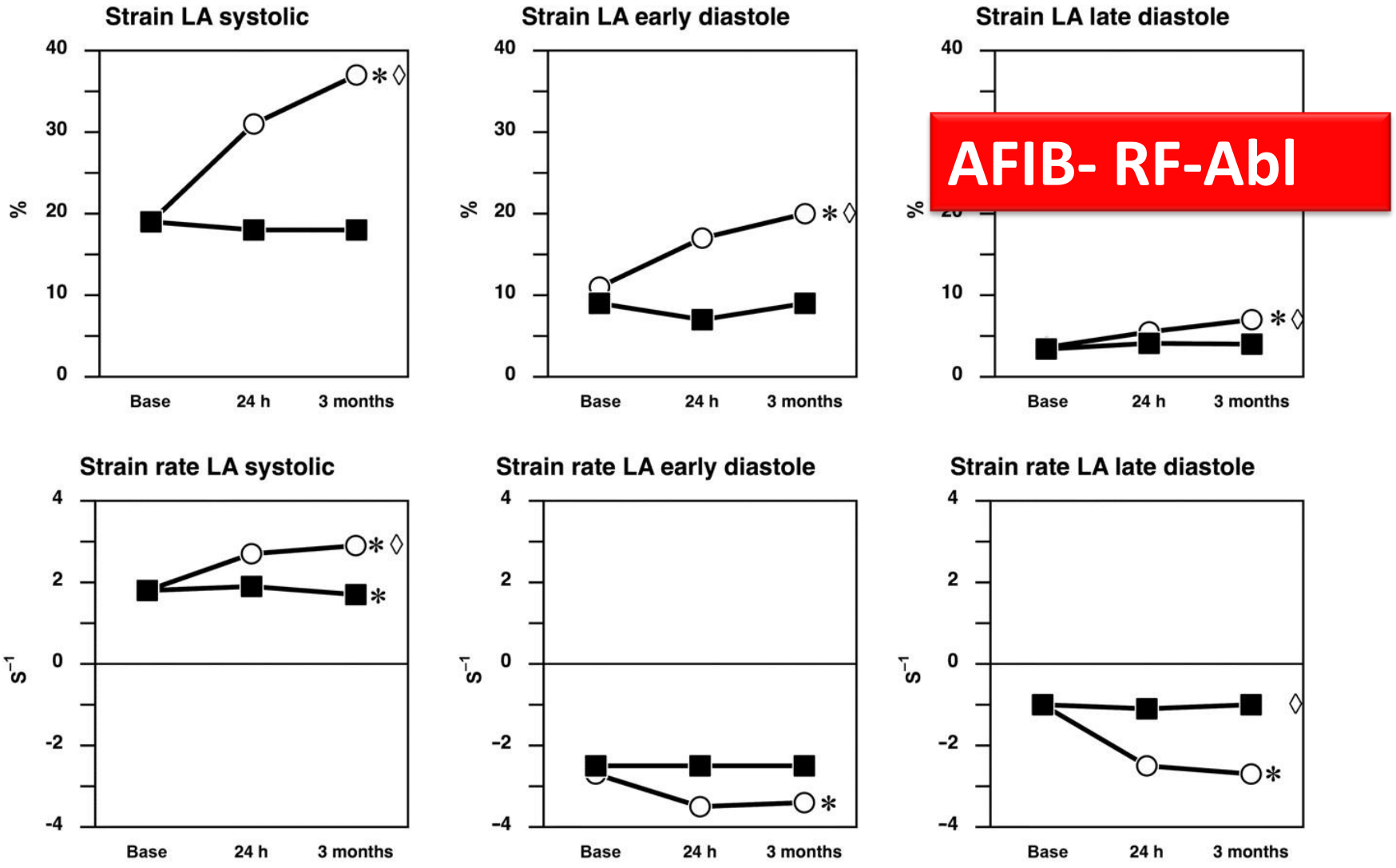
Donal et al Eur J Echocardiogr. 2010 Dec;11(10):845-52

LA Lateral ε (%)

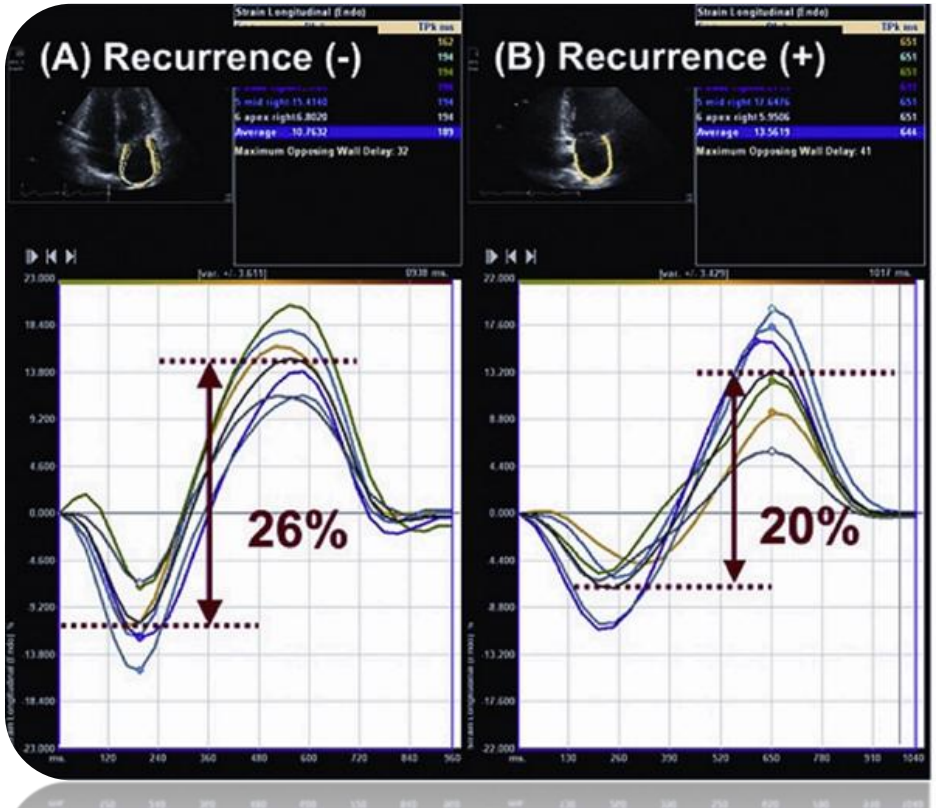


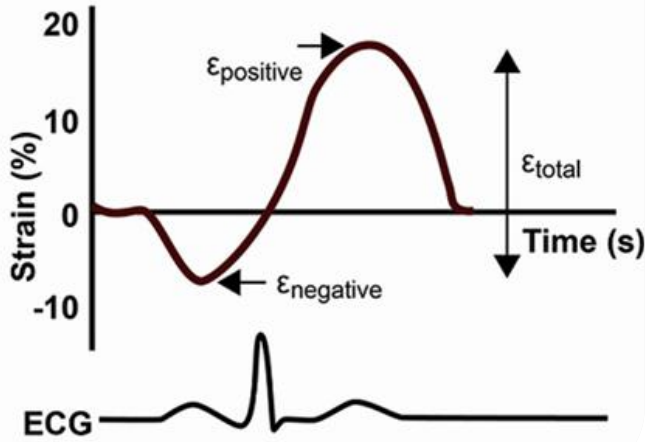
AFIB- RF-Abl

Donal et al Eur J Echocardiogr. 2010 Dec;11(10):845-52

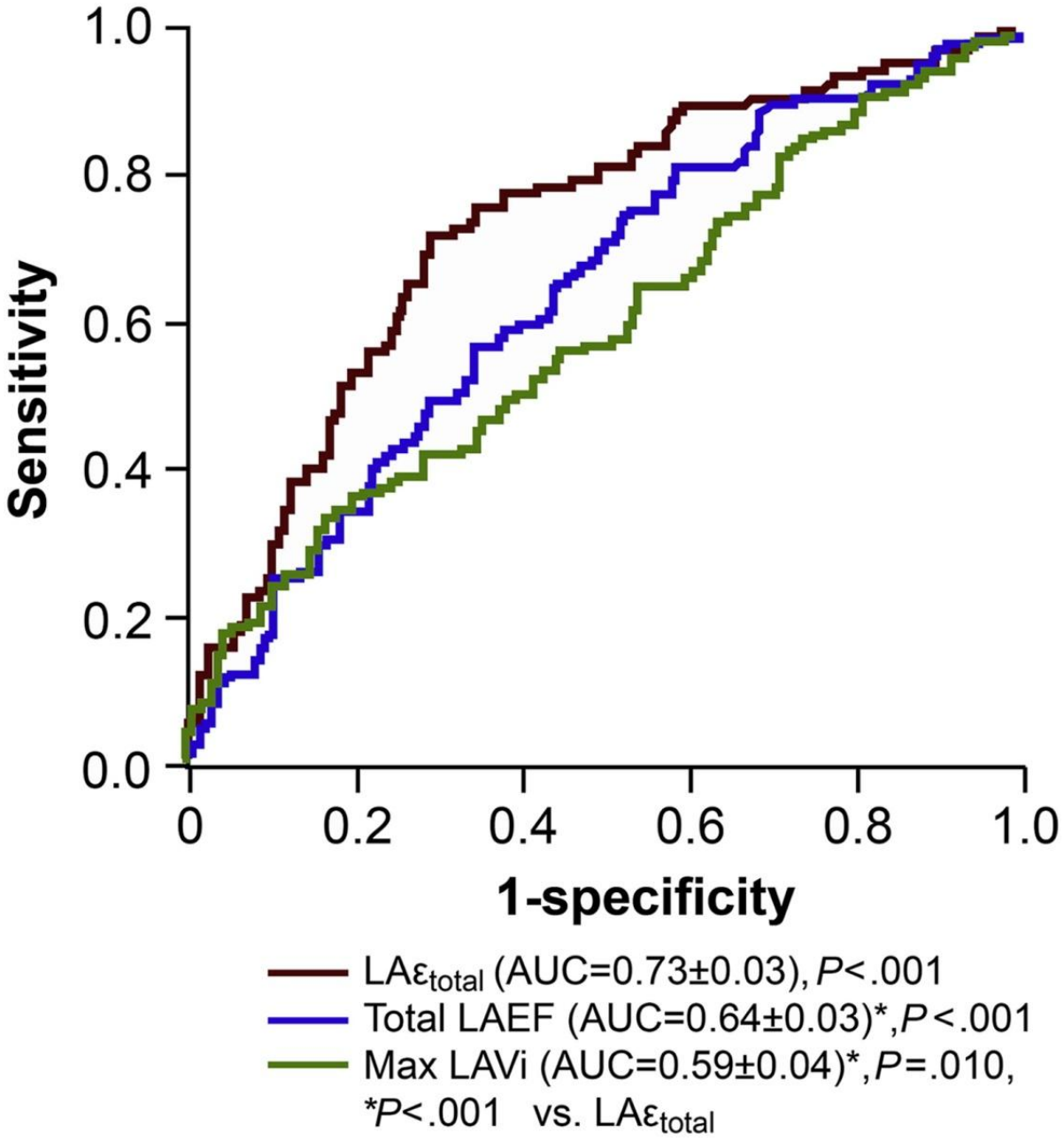

Strain LA systolic
Strain LA early diastole
Strain LA late diastole
AFIB- RF-Abl
Strain rate LA systolic
Strain rate LA early diastole
Strain rate LA late diastole
%
s^{-1}
40
30
20
10
0
2
-2
-4
Base
24 h
3 months
O : maintained SINUS Rhythm
■ : recurrence of A Fib
* P <0.05
Schneider C et al. Eur Heart J 2008;29:1397-1409

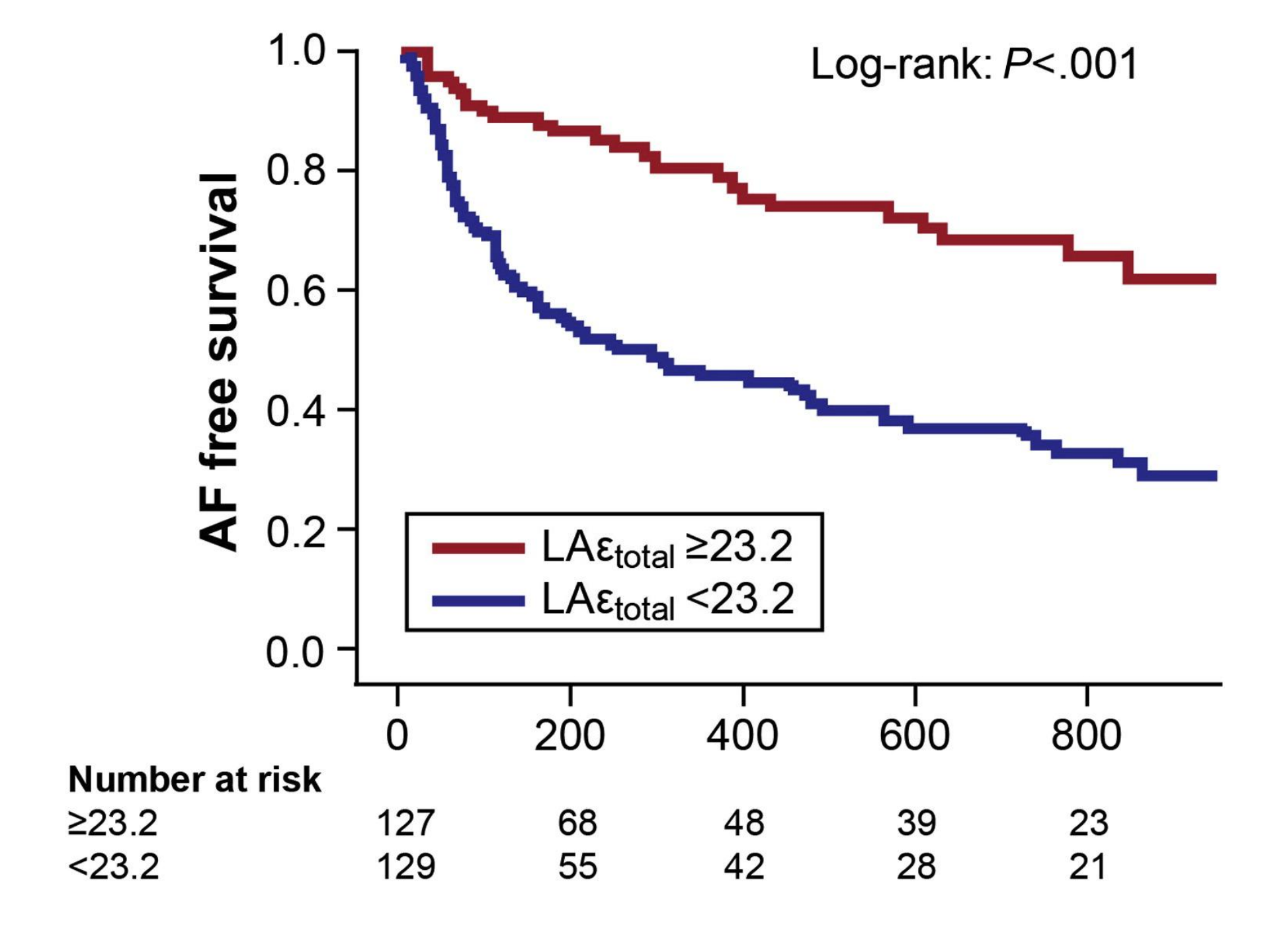
Global LA Strain in the Prediction of Sinus Rhythm Maintenance after Catheter Ablation for AFib

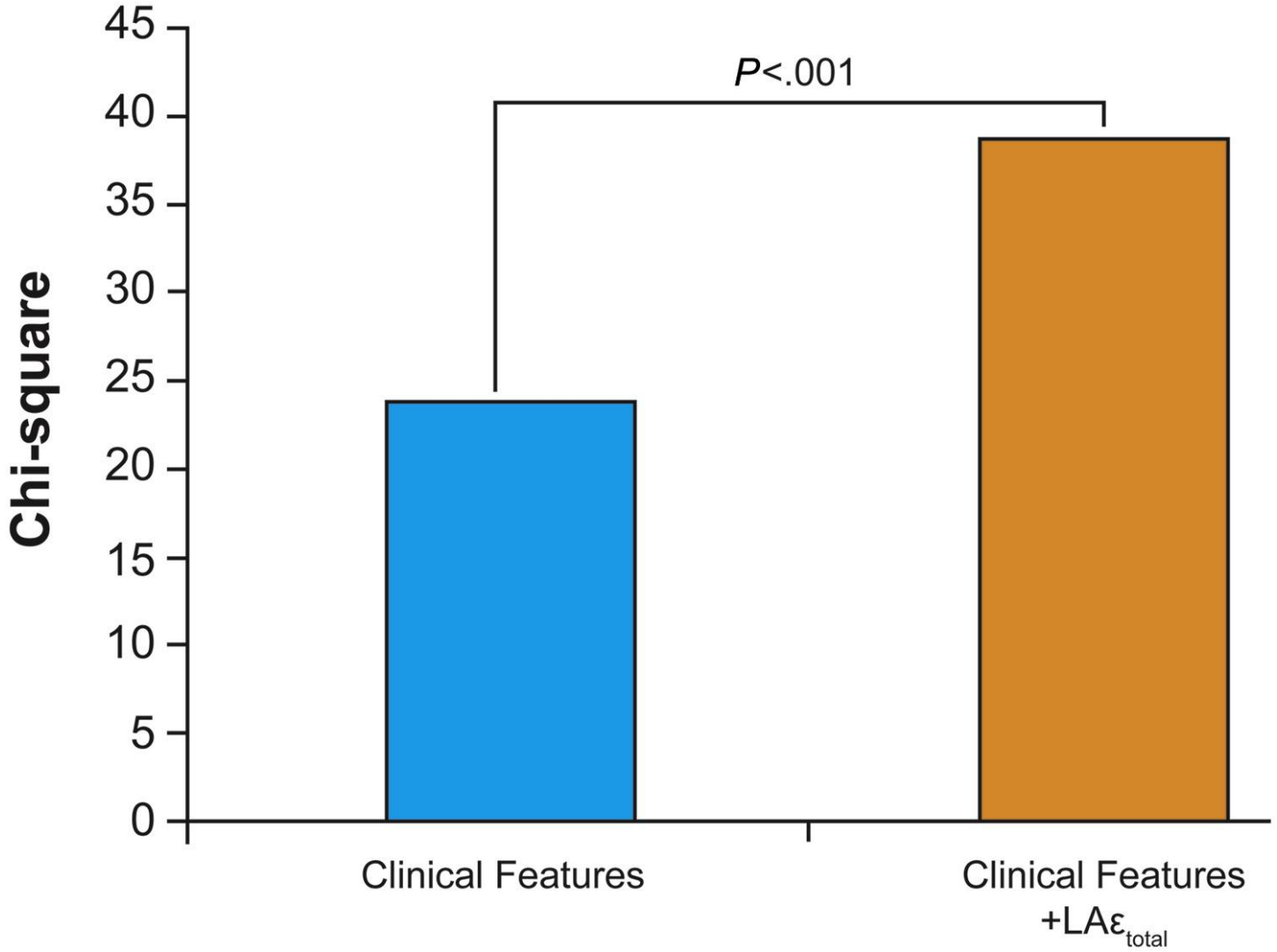




Methods: In 256 patients with AF (paroxysmal, 204; persistent, 52), comprehensive echocardiography was performed with assessment of LAε by using Velocity Vector Imaging to calculate average strain values from apical four- and two-chamber views before ablation (median, 41 days; interquartile range, 1–95 days).


1.0
0.8
0.6
0.4
0.2
0.0
Sensitivity
0
0.2
0.4
0.6
0.8
1.0
1-specificity
LAε$_{total}$ (AUC=0.73±0.03), P<.001
Total LAEF (AUC=0.64±0.03)*, P<.001
Max LAVi (AUC=0.59±0.04)*, P=.010,
*P<.001 vs. LAε$_{total}$

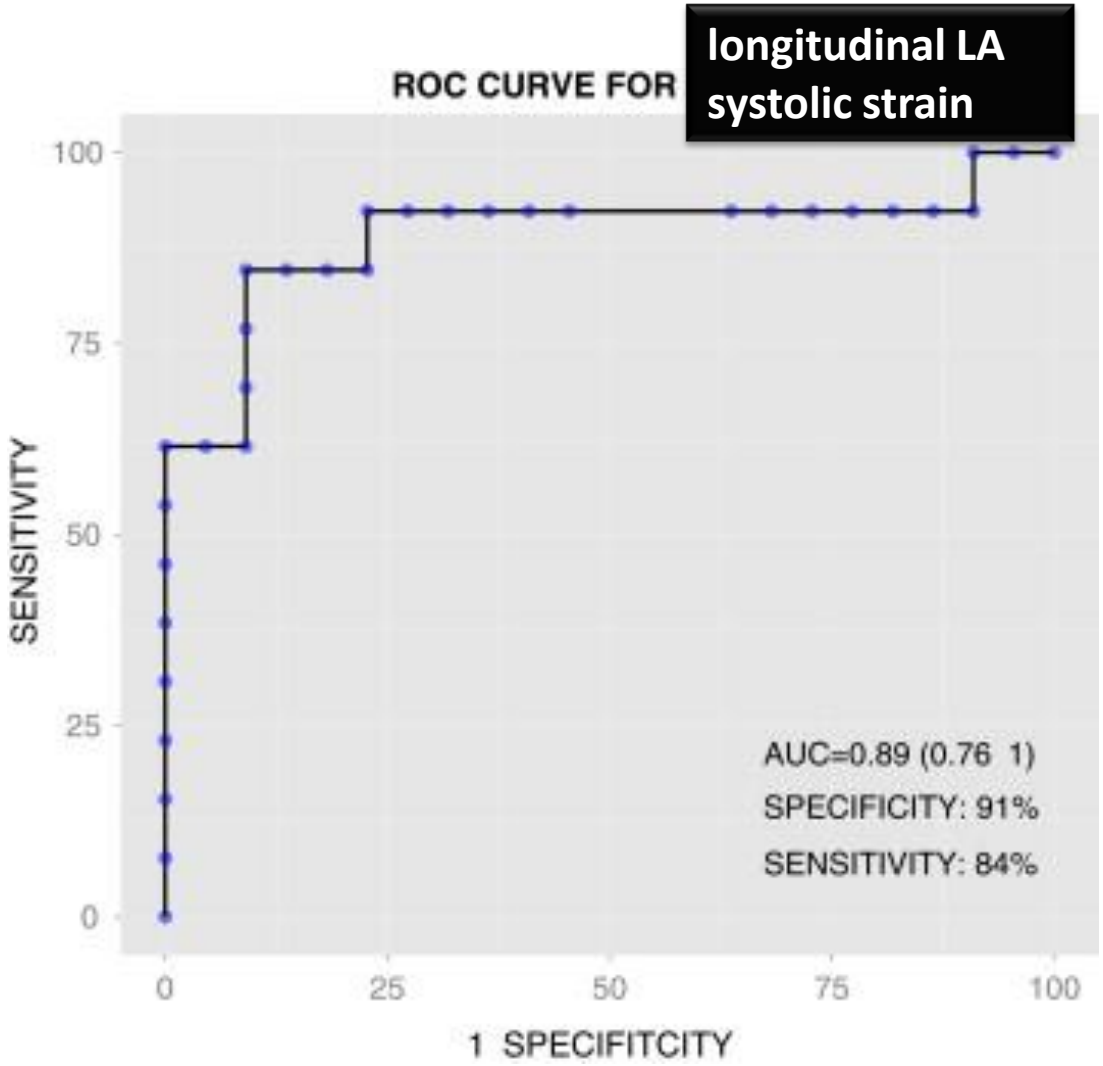

Log-rank: P<.001
AF free survival
1.0
0.8
0.6
0.4
0.2
0.0
LAε_total ≥23.2
LAε_total <23.2
0
200
400
600
800
Number at risk
≥23.2 127 68 48 39 23
<23.2 129 55 42 28 21



clinical features : age, sex, AF duration, AF type, prior AF ablation, CHADS2 score, and permanent pacemaker or cardioverter-defibrillator implantation.

ROC-curve of LASs for predicting arrhythmia elimination with a second radiofrequency catheter ablation.

Keep in mind a cut-off value of +-|20|%



Left atrial deformation predicts success of first and second percutaneous AF on ablation

Sílvia Montserrat et al Heart Rhythm, 2014

Take Home messages

Atrial function can be assessed especially using the speckle tracking approach for a relevant assessment of LA Remodeling in many clinical condition

Great expectations for the assessment of the atrial Reservoir function in many clinical condition

A lot of researches and validations remain necessary

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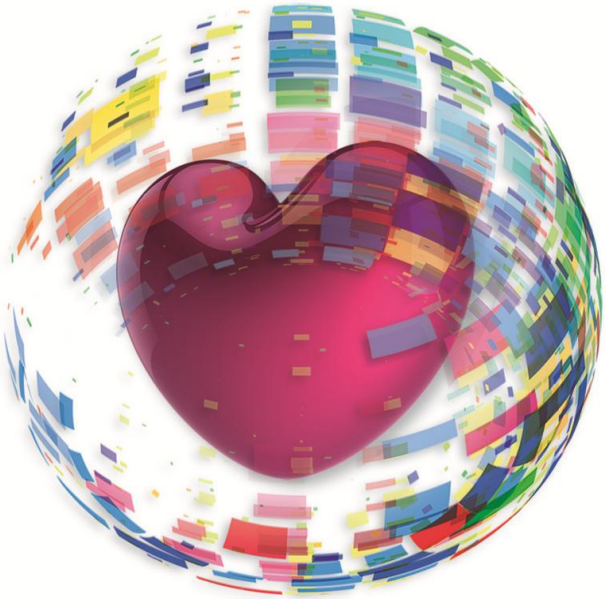

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