



Clinica Cardiologica
Università degli Studi di Padova
Direttore: Prof. Sabino Iliceto

3D STRESS ECHOCARDIOGRAPHY

Luigi P. Badano**, MD, FESC

**Dr. Badano has received honoraries and research grants from GE Healthcare, Sorin cardio S.p.A., Actelion, Edwards Lifesciences

*No off-label use of device

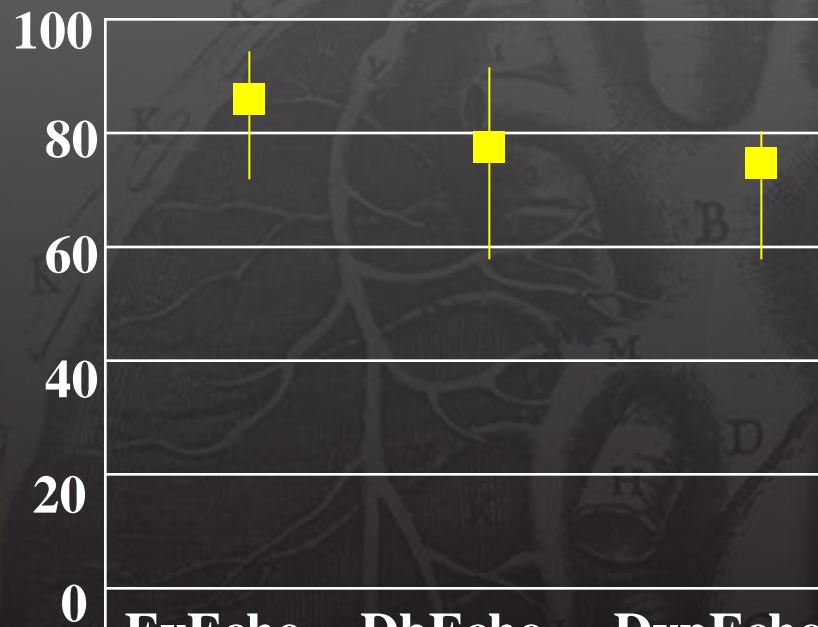


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DIAGNOSTIC ACCURACY OF STRESS ECHO

SENSITIVITY



SPECIFICITY

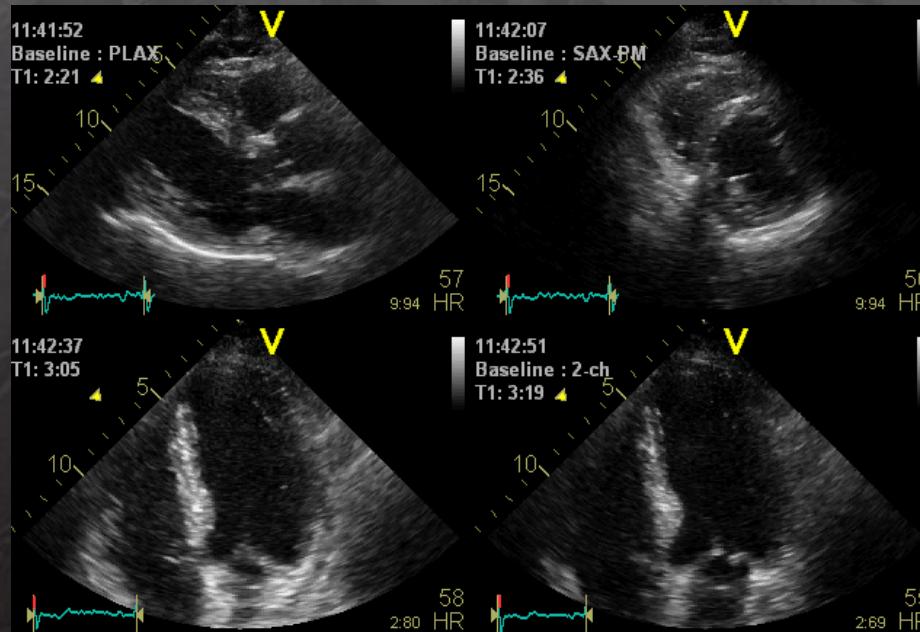


	ExEcho	DbEcho	DypEcho	ExEcho	DbEcho	DypEcho
Highest	97	95	81	86	95	94
Lowest	74	61	61	64	51	90
Mean	88	81	77	79	80	92



STRESS-ECHO

Limitations of current 2D Imaging for stress echo



- Time required for image acquisition (potential missing of ischemia)
- Operator-dependent image acquisition
- Difficult to precisely match myocardial segments between baseline and stress (over- or under-estimation of ischemia)
- Quad screen display does not encompass the entire left ventricle (risk of missing stress-induced wall motion abnormalities)

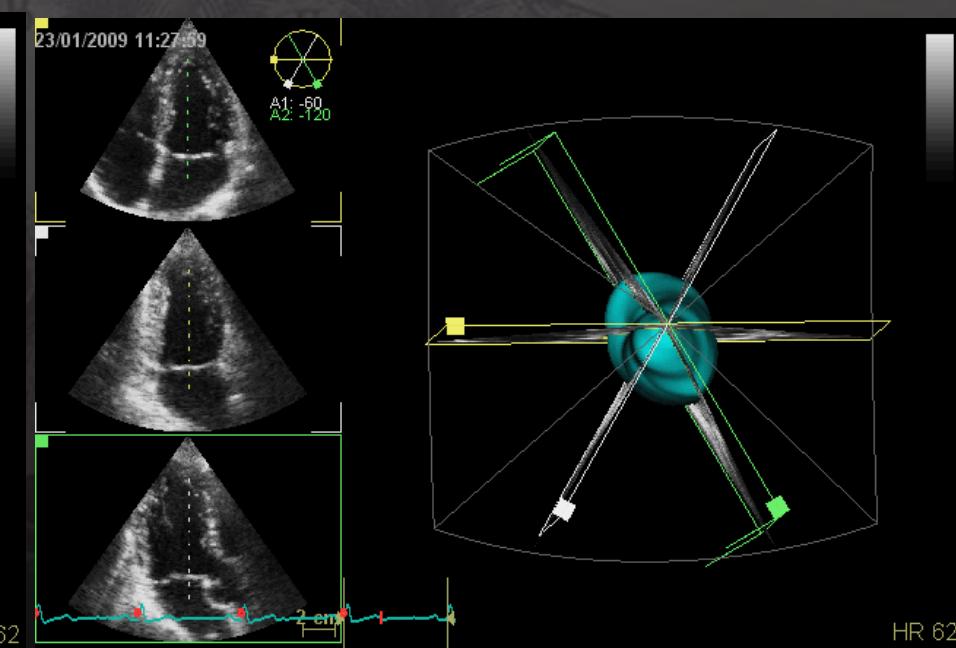
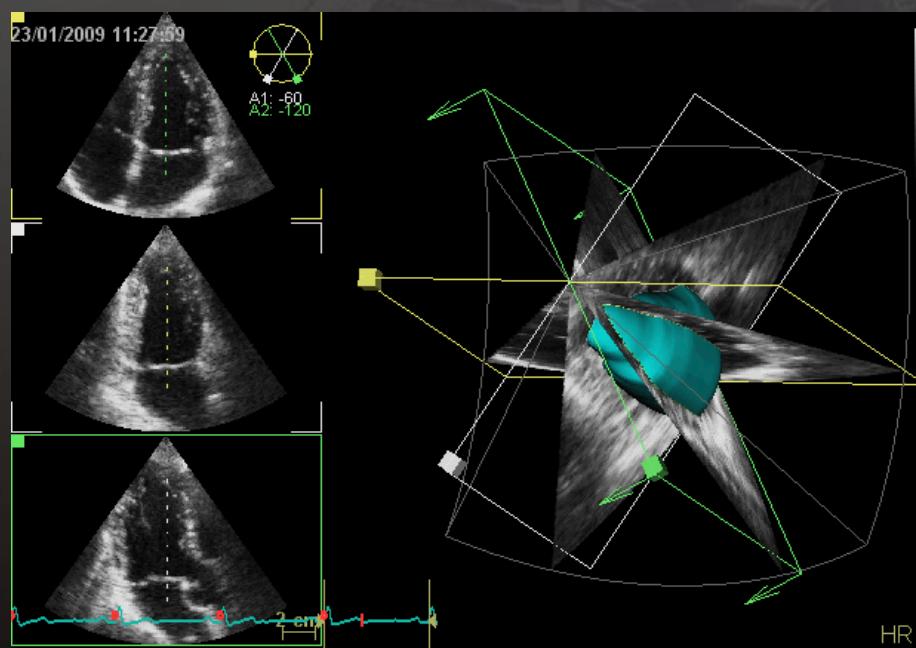


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STRESS-ECHO

Limitations of current 2D Imaging for stress echo

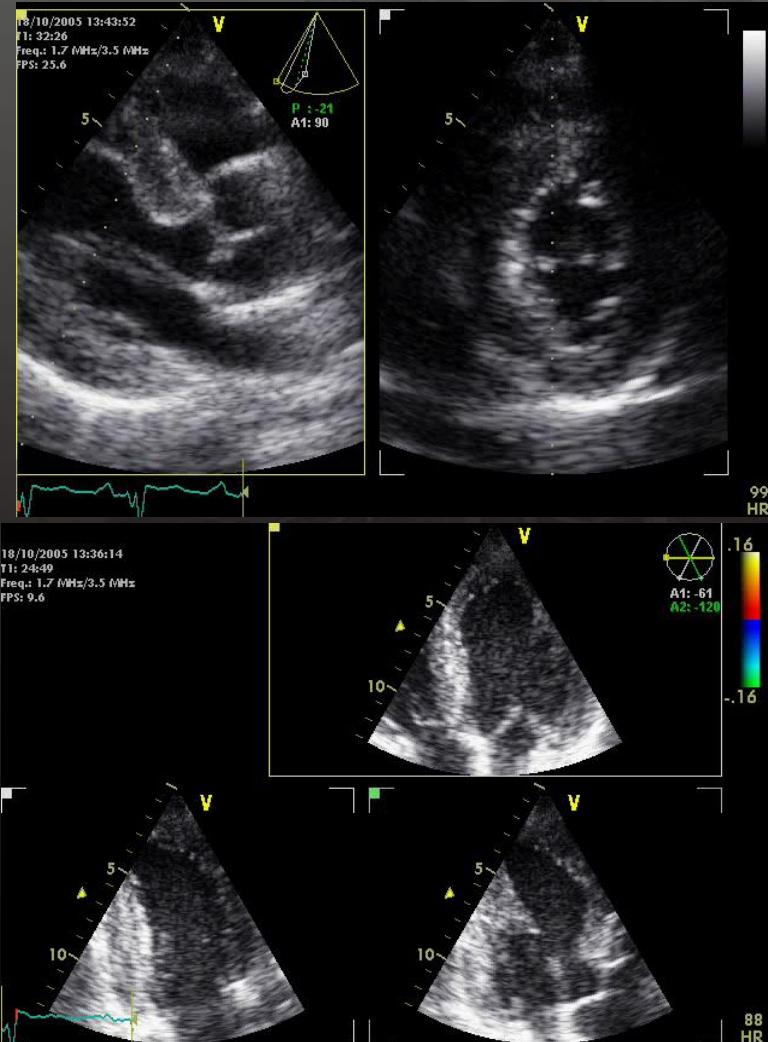


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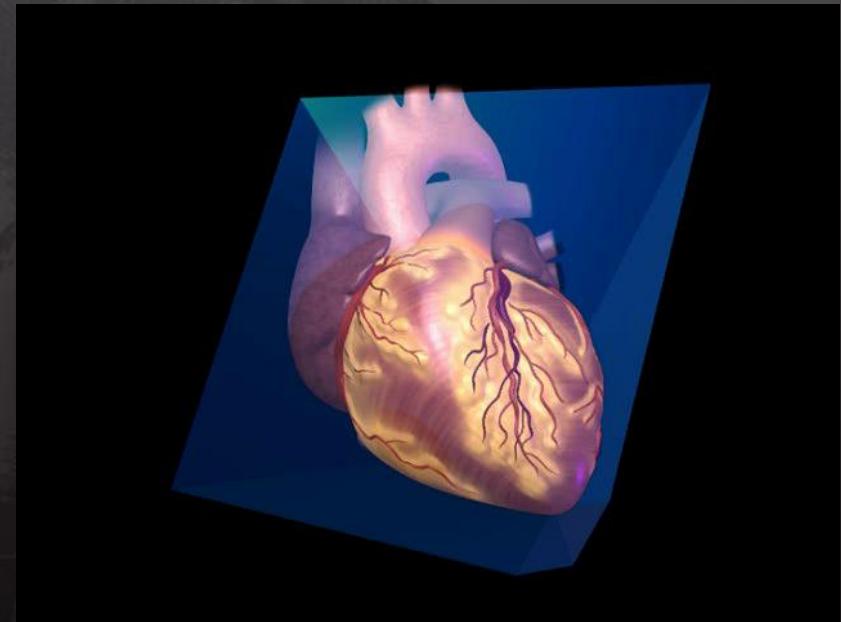


REAL-TIME 4D STRESS-ECHO

The Time Saver



Multiplane



4D Echo (multislice)

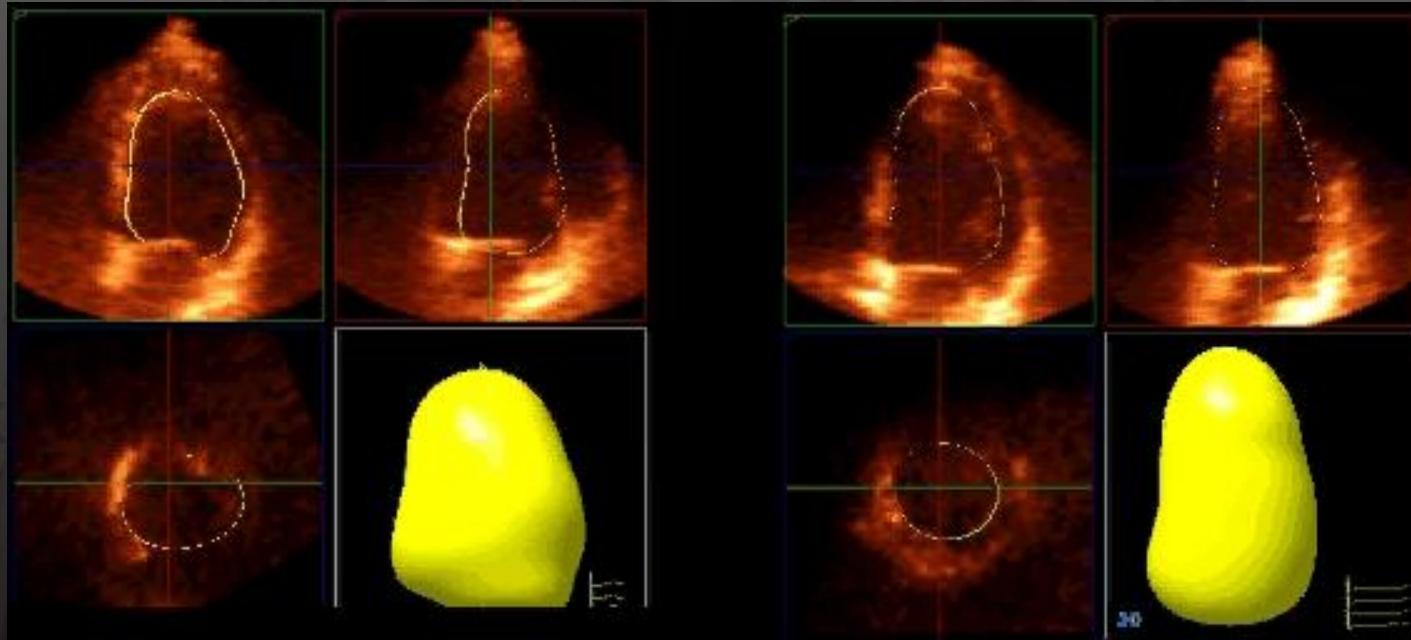


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4D STRESS-ECHO

Limitations of Previous 3D Imaging for Stress-echo



- Limited time resolution
- Reduced image quality vs 2D
- Analysis time prolonged by manual cropping the full-volume data-sets
- Impossibility to side-by-side display of cropped images

Varnero S et al. Cardiovasc Ultrasound 2008

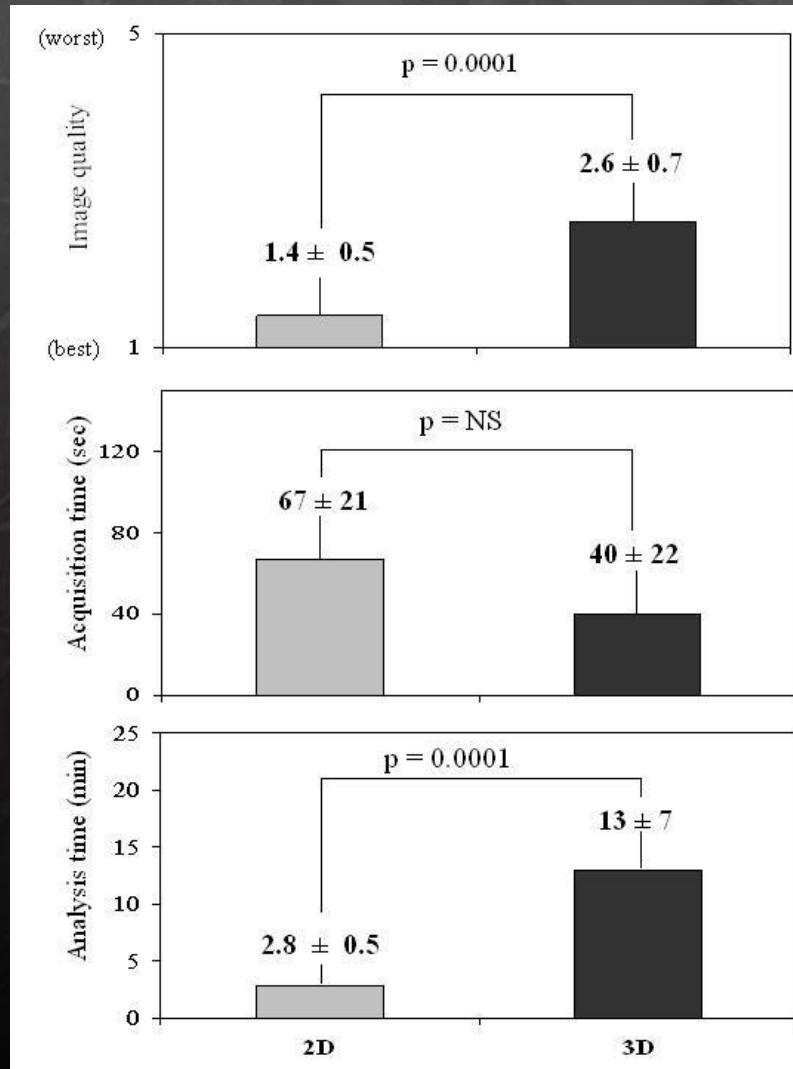


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STRESS-ECHO

Limitations of Previous 3D Imaging for Stress-echo



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Varnero S et al. Cardiovasc Ultrasound 2008



4D DIPYRIDAMOLE STRESS-ECHO (4D DSE)

0.84



Dipyridamole (mg/Kg)

Aminophylline

Time (min)

0

6

8



Baseline



Peak



Recovery



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4D DIPYRIDAMOLE STRESS ECHO

Study Population (December 2008 - January 2010)

Variables	n= 107 pts
Males	67 (63%)
Age (yrs)	68±13
Hypertension	52 (49%)
Smokers	73 (68%)
Diabetes	25 (23%)
Hypecholesterolemia	46 (43%)
Clinical Indication	
Non cardiac surgery pre-op assessment	63 (59%)
Angina pectoris (unable to exercise)	44 (41%)
Previous CAD	
Myocardial infarction	25 (23%)
Previous PCI	13 (12%)
Previous CABG	8 (8%)
Medical therapy	Withdrawn



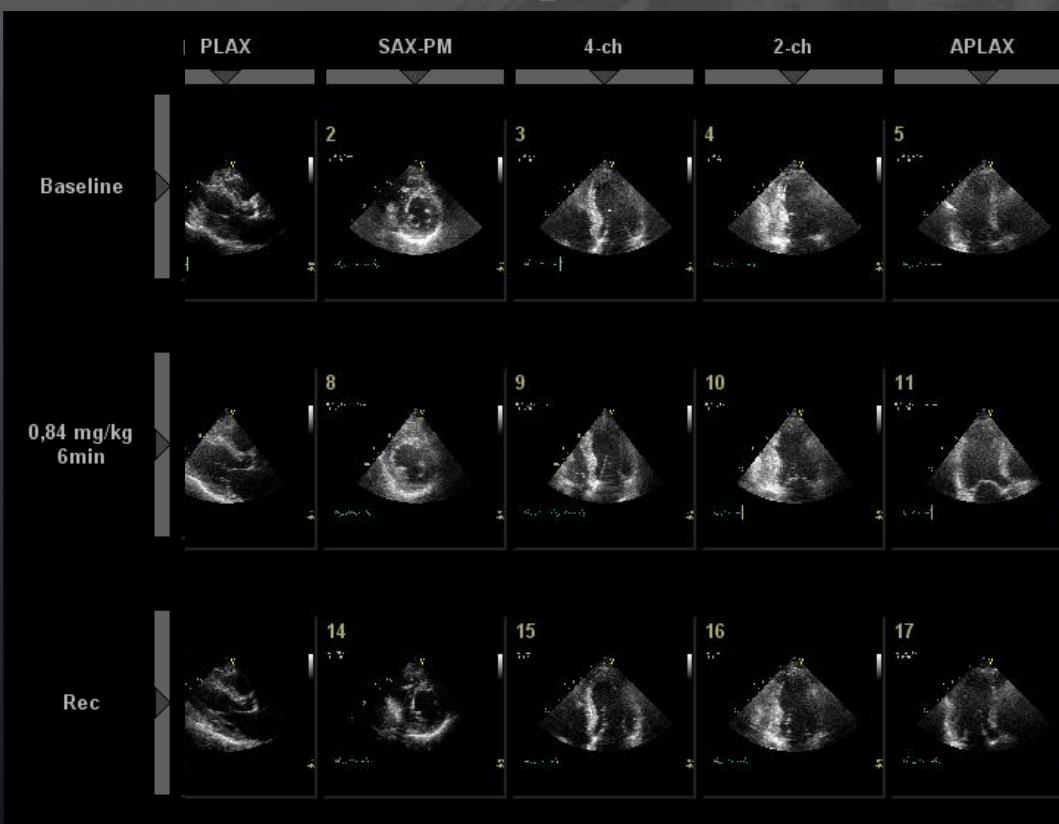
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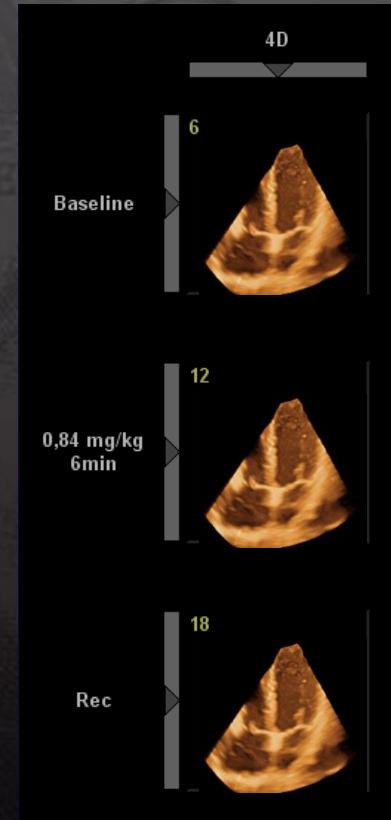
4D DIPYRIDAMOLE STRESS-ECHO

The challenge

2D Acquisition



4D Acquisition



Vs.

Acquisition Time = 65 ± 30 s

Analysis Time= 176 ± 63 s

Temporal resolution= 75 ± 5 fps

Acquisition Time = 16 ± 3 s ($p < 0.0001$)

Analysis Time= 91 ± 5 s ($p < 0.0001$)

Temporal resolution= 41 ± 5 vps ($p < 0.0001$)

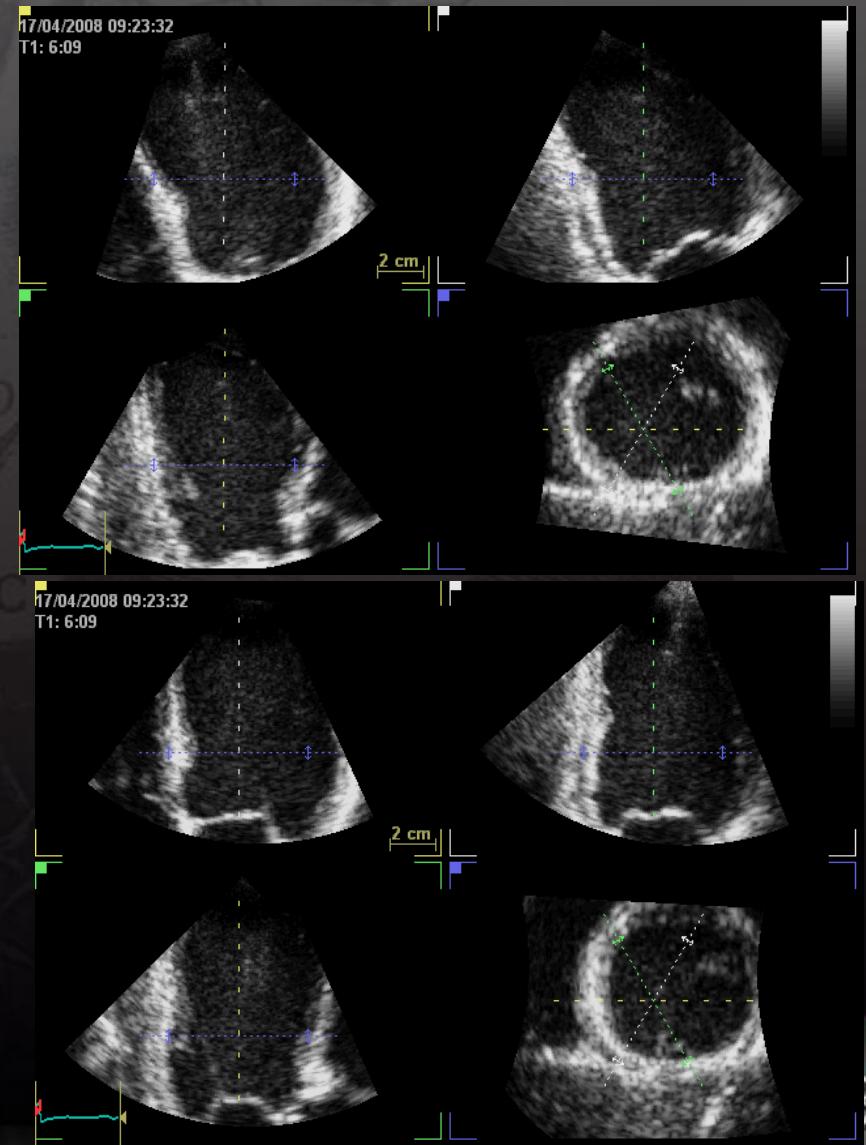
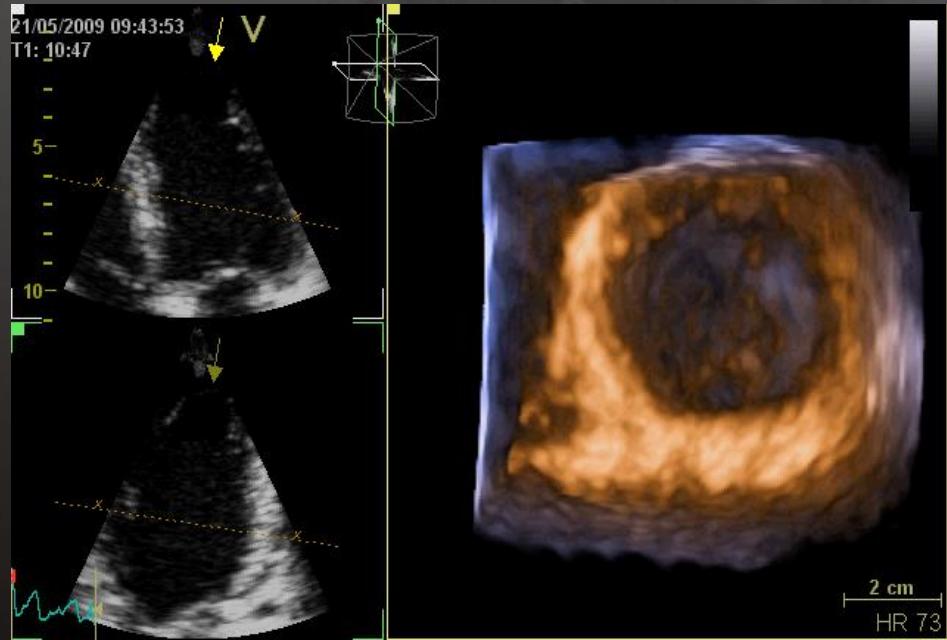


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Badano LP, Muraru D et al. J Am Soc Echocardiogr 2010



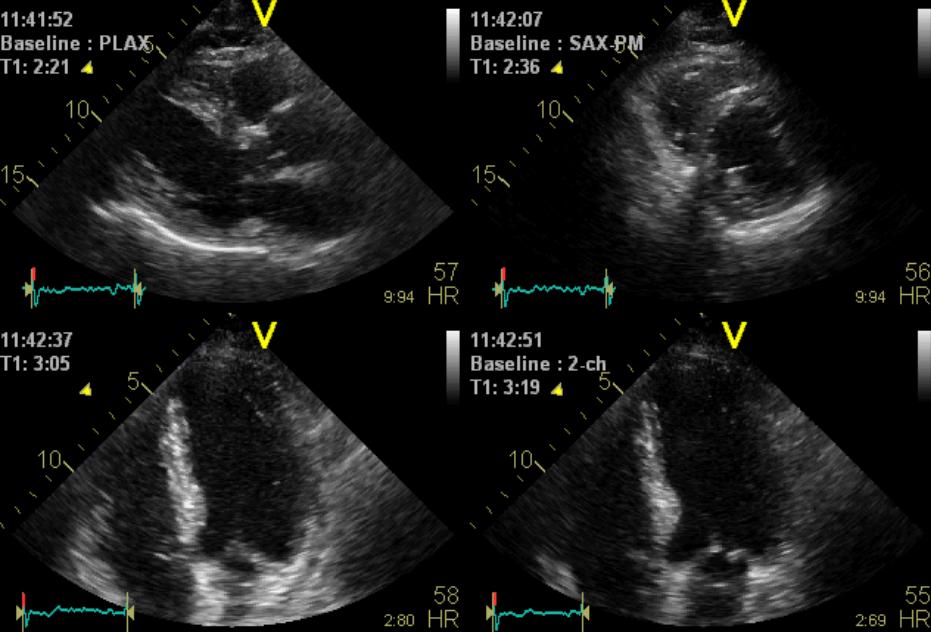
4D DIPYRIDAMOLE STRESS-ECHO Image Acquisition



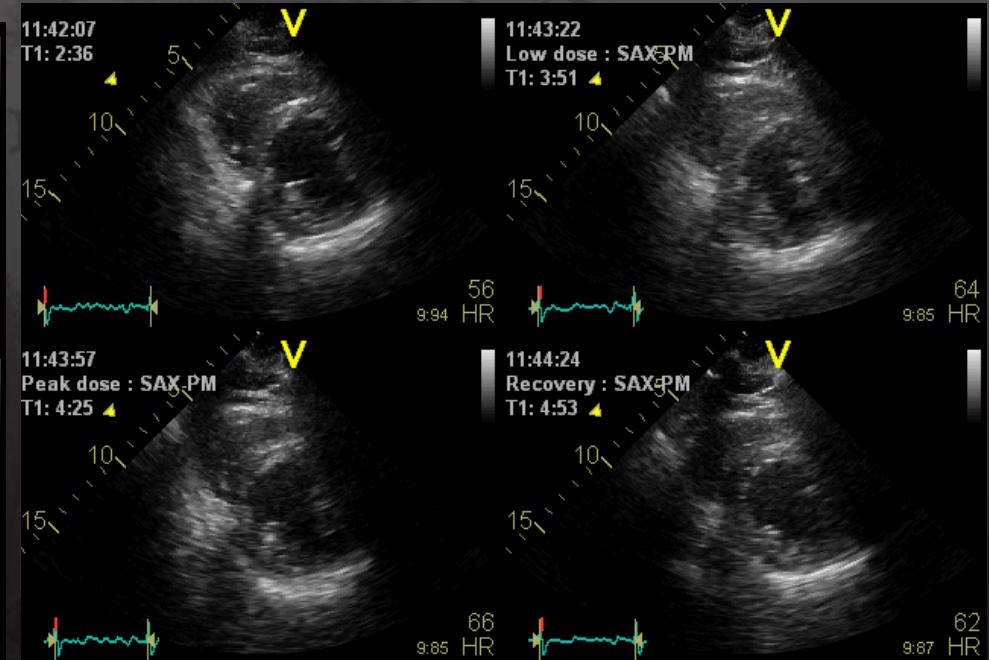
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4D DIPYRIDAMOLE STRESS-ECHO

2D Image Analysis



Baseline



Stress-echo

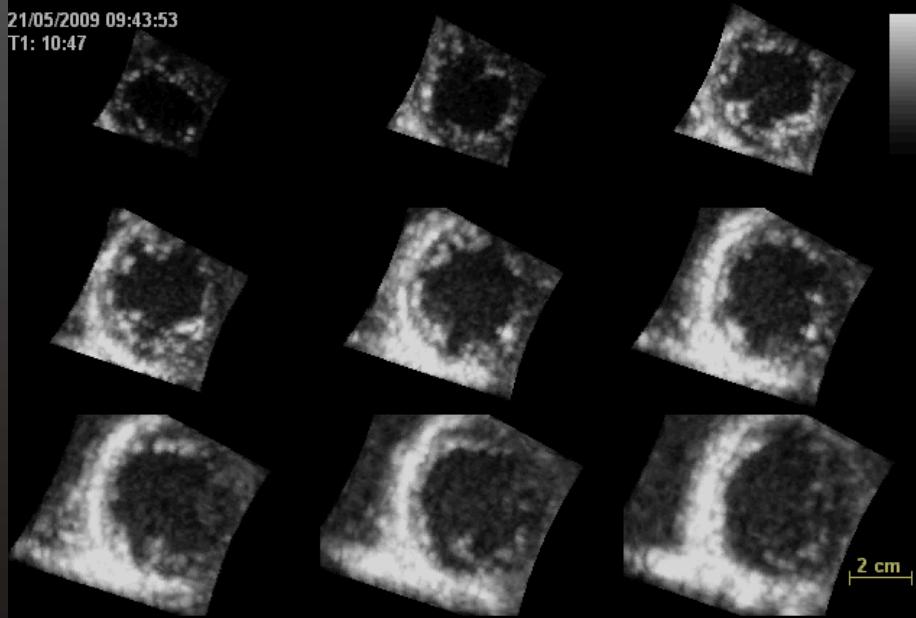


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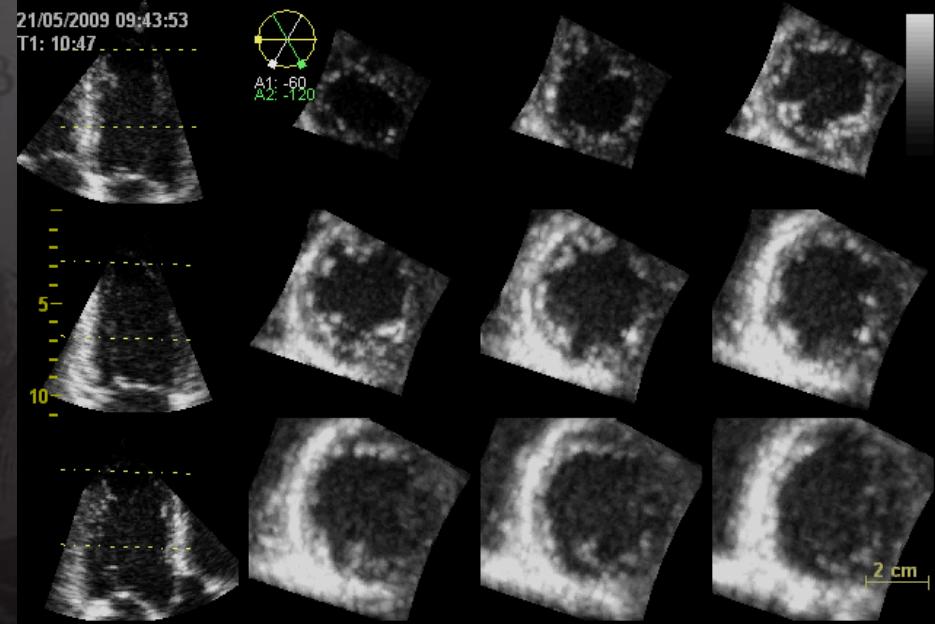


4D DIPYRIDAMOLE STRESS-ECHO

Baseline 4D Image Analysis



9 slices



12 slices

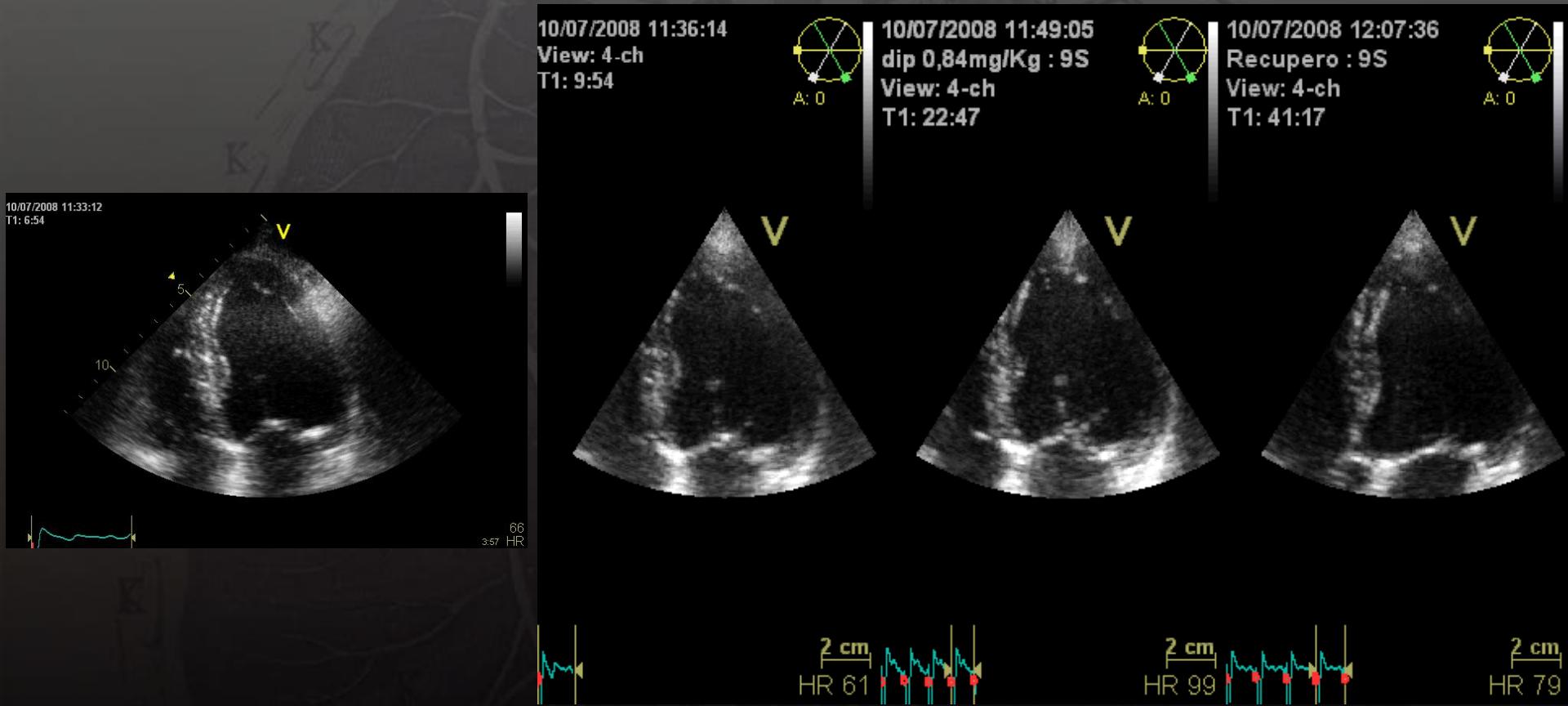


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4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (4CH-view)



2D



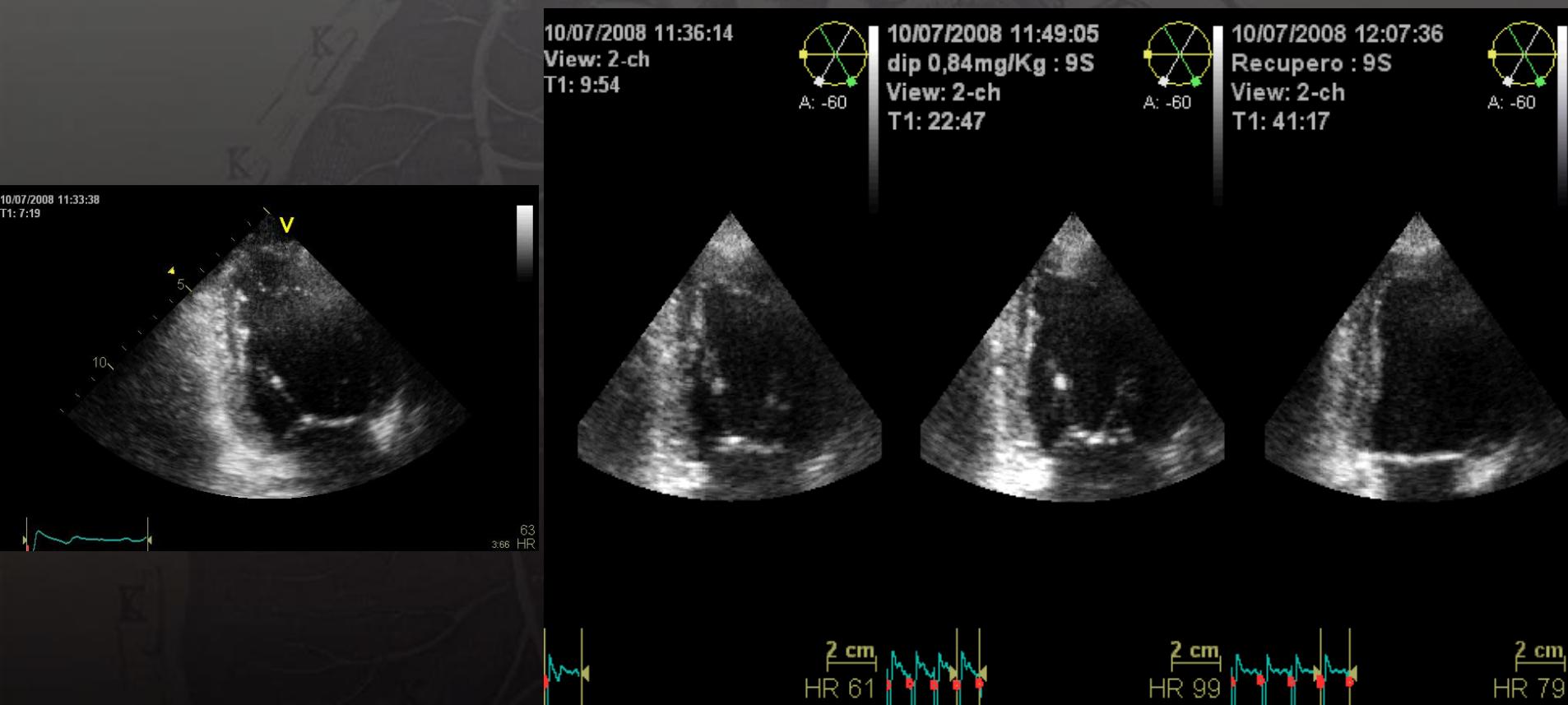
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4D



4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (2CH view)



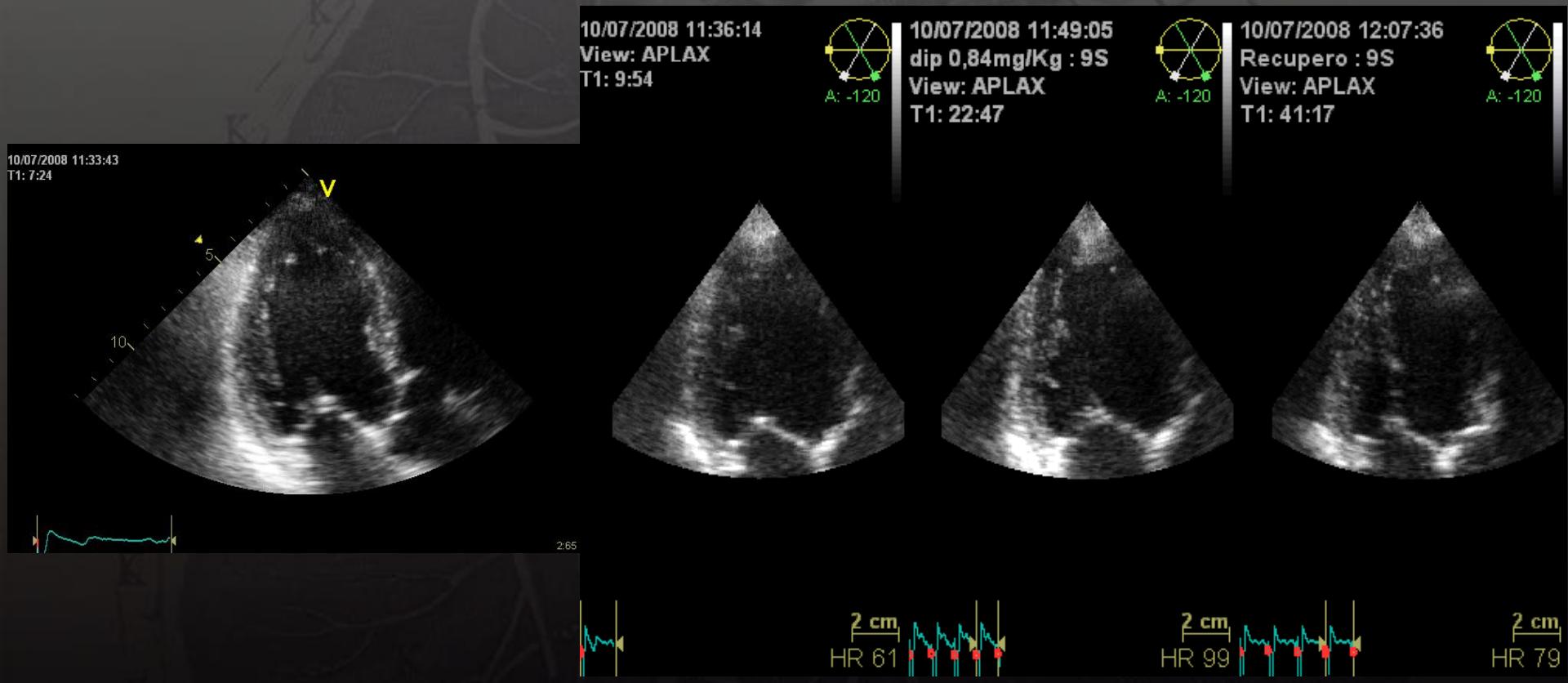
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4D



4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (ApLAX view)



2D



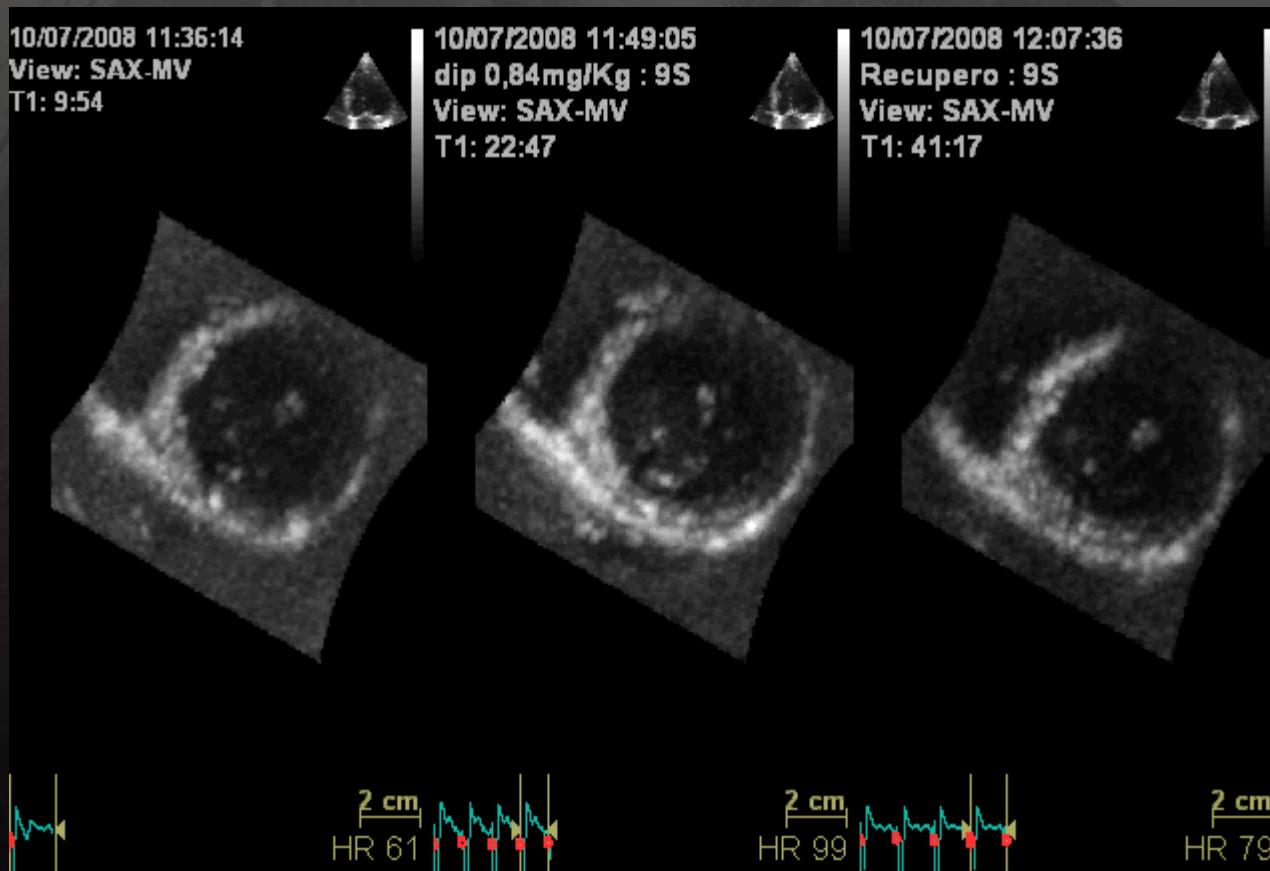
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4D



4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (SAX Basal)

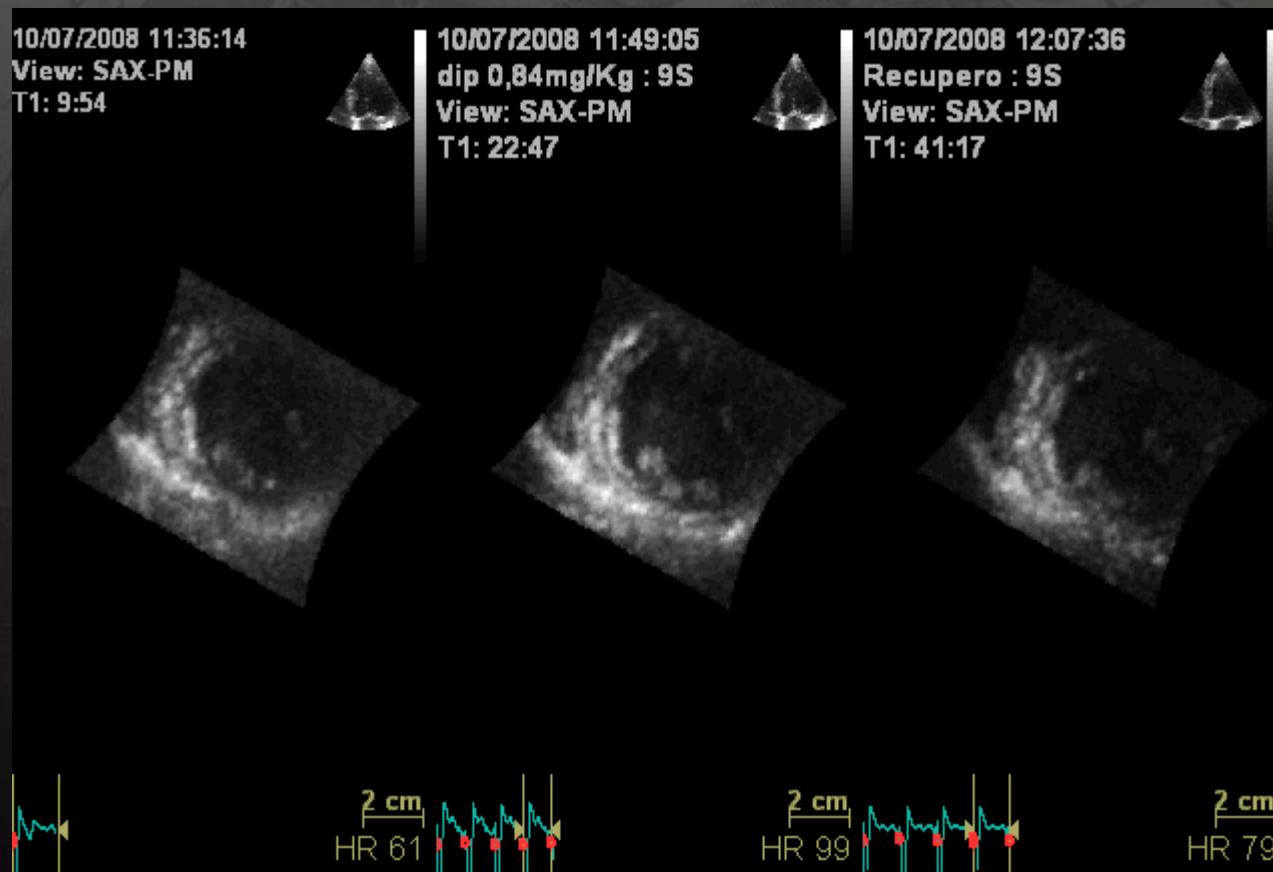


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4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (Sax Mid)

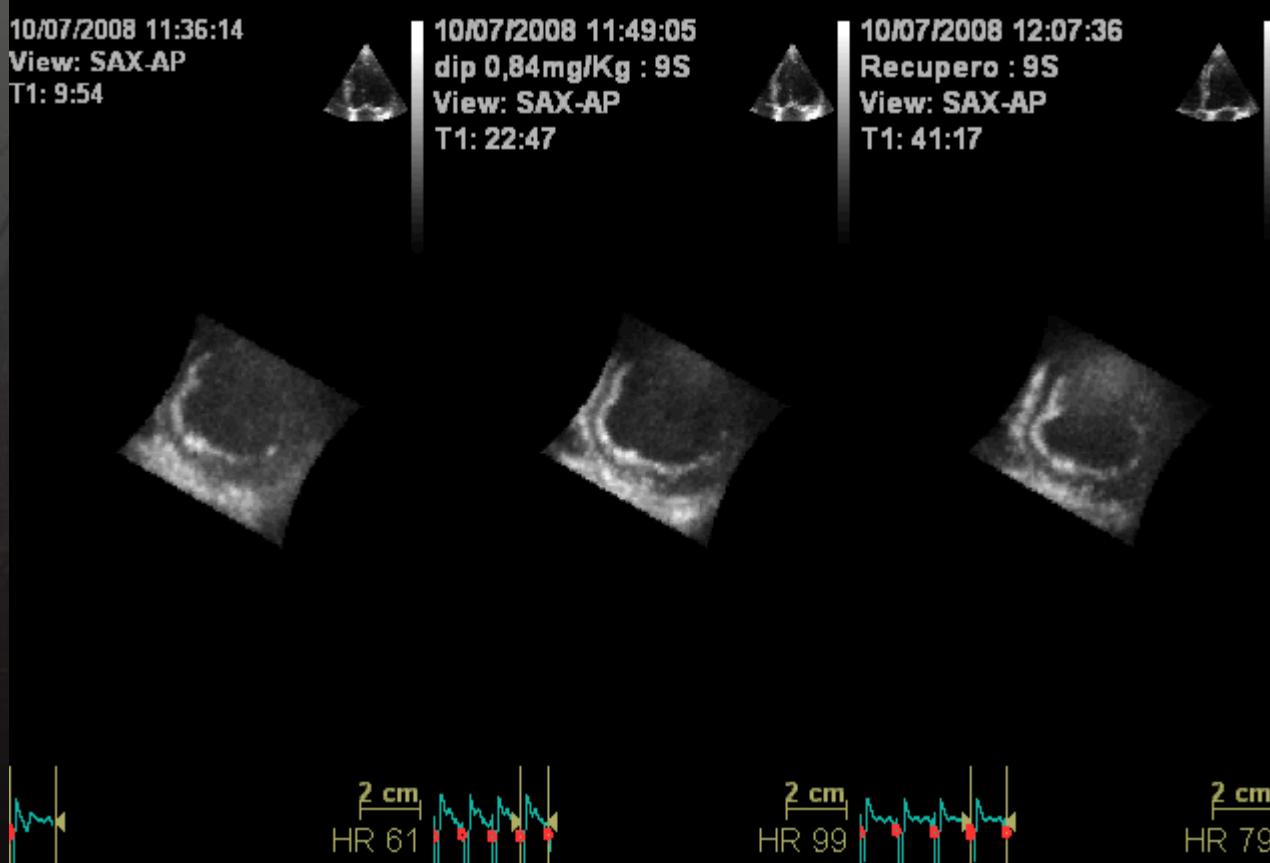


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4D DIPYRIDAMOLE STRESS-ECHO

Stress-Echo 4D Image Analysis (SAX Apex)



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4D DIPYRIDAMOLE STRESS ECHO

Results

Variables

n= 107 pts

Adequate 4D imaging

84 (79%)

Reasons for test termination

End of the protocol

46 (55%)

New or worsening wall motion

38 (45%)

LV segments available for analysis

1428 x 2

Uninterpretable segments at 2DE

311

Baseline

197 (14%)

Peak stress

114 (8%)

Unininterpretable segments at 4DE

213 (p<0.001 vs 2DE)

Baseline

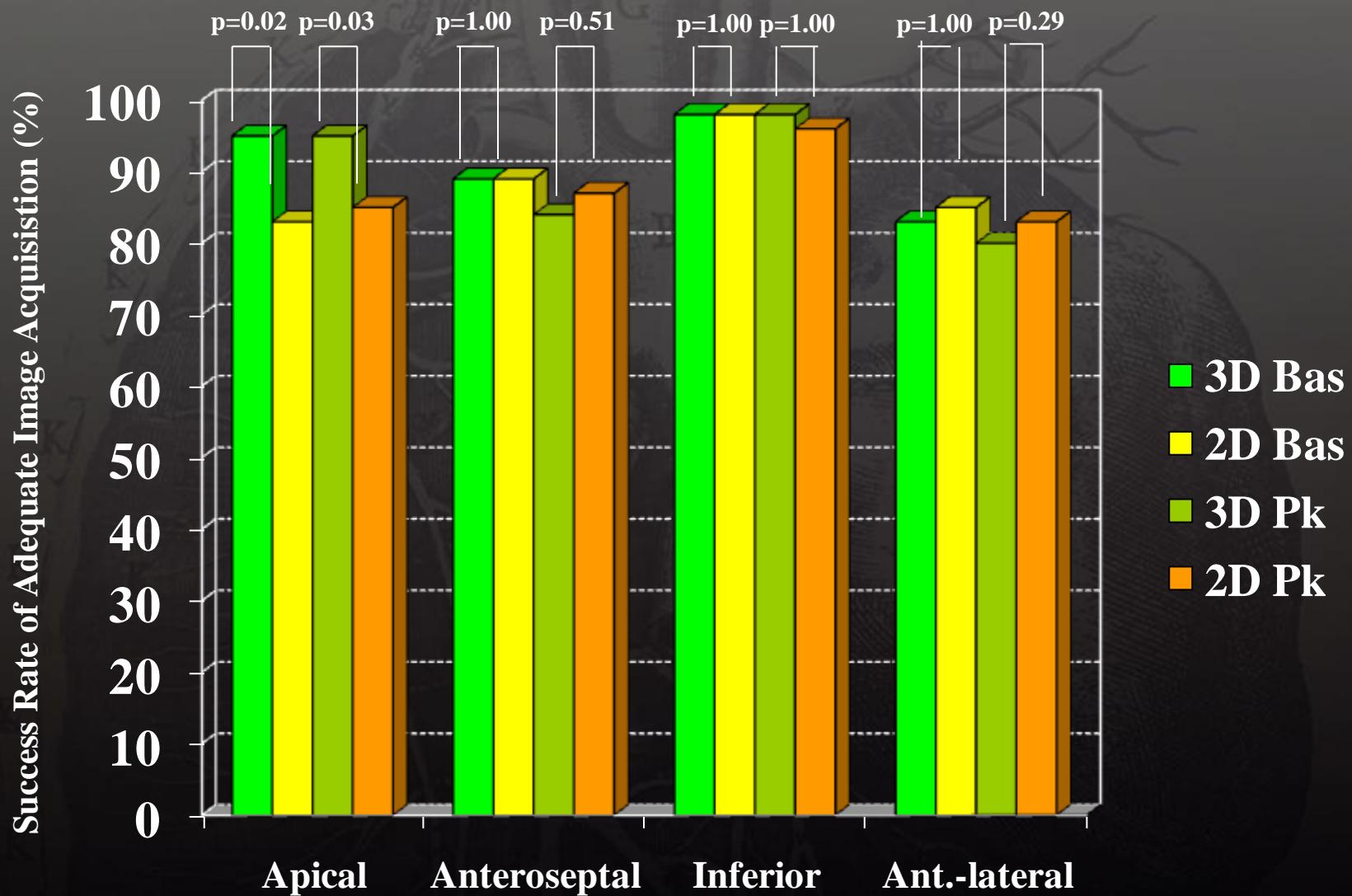
127(9%) (p<0.03 vs 2DE)

Peak stress

81 (6%)



4D DIPYRIDAMOLE STRESS-ECHO

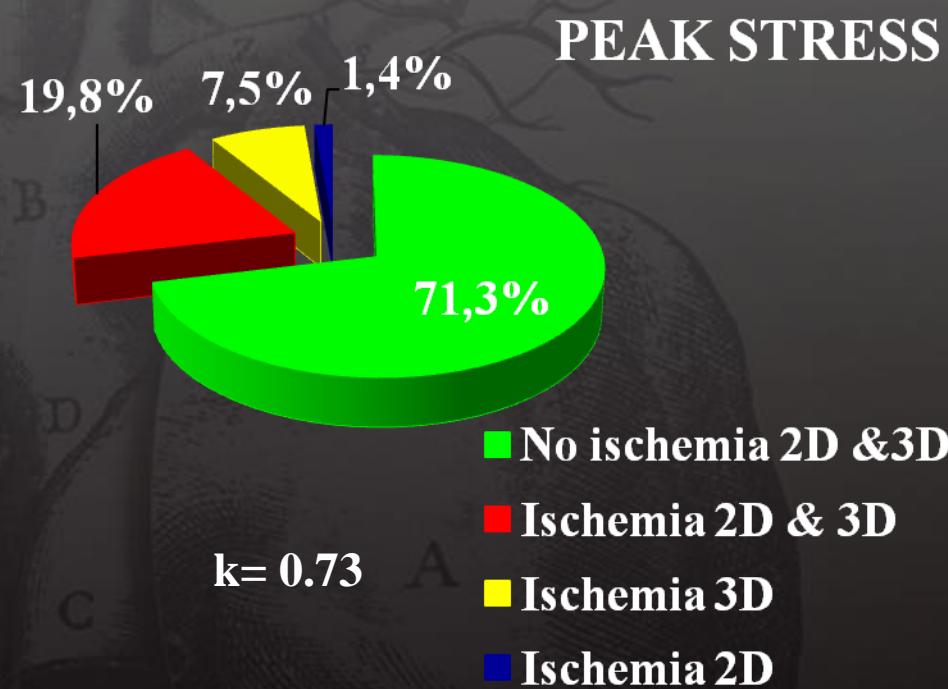
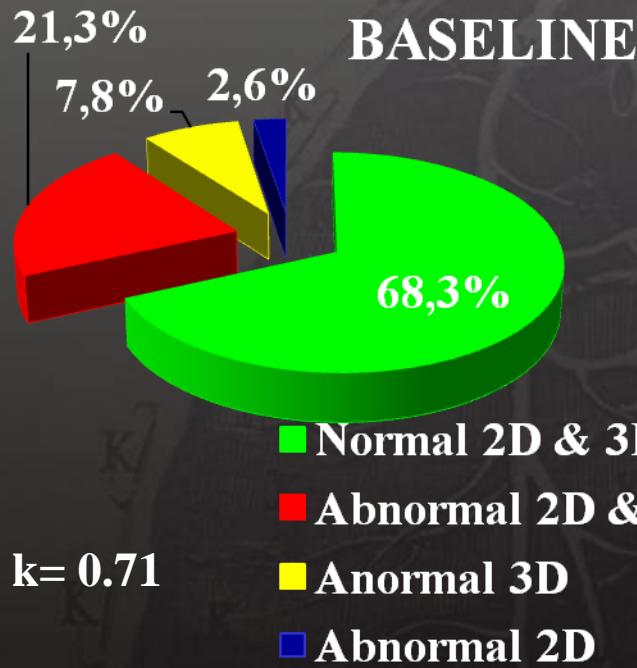


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4D DIPYRIDAMOLE STRESS-ECHO Results



WMSI	2DE	3DE	p Value
Baseline	1.041 ± 0.015	1.049 ± 0.01	NS
Peak stress	1.21 ± 0.025	1.29 ± 0.0253	0.011
Apical	1.34 ± 0.057	1.55 ± 0.078	<0.0001



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4D DIPYRIDAMOLE STRESS ECHO

Results

Coronary angiography **35 pts.**

1 vessel disease	9
2 vessel disease	17
3 vessel disease	9

	Sensitivity (%)			Specificity (%)		
	RT3DE	2DE	p	RT3DE	2DE	p
All territories	80	78	NS	87	91	NS
LAD territory	87	78	0.02	90	93	NS
RCA territory	82	77	NS	85	88	NS
LCX territory	65	63	NS	94	92	NS



4D DIPYRIDAMOLE STRESS-ECHO Results

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Reasons for test termination	
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New or worsening wall motion	38 (45%)
LV segments available for analysis	1428 x 2
Uninterpretable segments at 2DE	311
Baseline	197 (14%)
Peak stress	114 (8%)
Unininterpretable segments at 4DE	213 (p<0.001 vs 2DE)
Baseline	127 (9%) (p<0.03 vs 2DE)
Peak stress	81 (6%)



4D DIPYRIDAMOLE STRESS-ECHO

Conclusions

PROS:

- Simultaneous acquisition of all views;
- Quick (around 30 s);
- Comprehensive assessment of the whole LV (long. and circumf. extension of ischemia) ;
- Precise anatomically correct tomographic LV sections;
- No foreshortening of the apex;
- Reduced operator skill needed for acquisition
- Image quality competing with 2D
- Cost/effectiveness

CONS:

- (Temporal resolution (41 vps))
- Atrial fibrillation
- Nearly real time
- (Visual assessment only)
- No contrast → Feasibility 78%





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