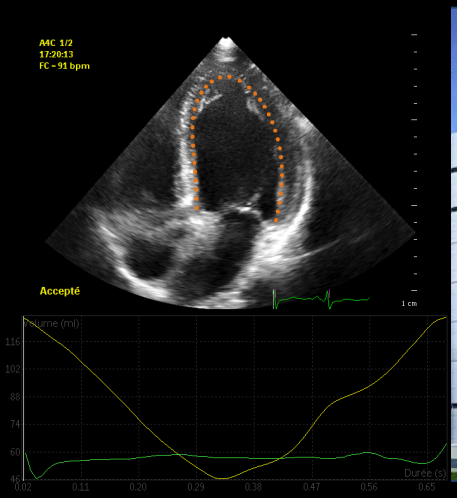
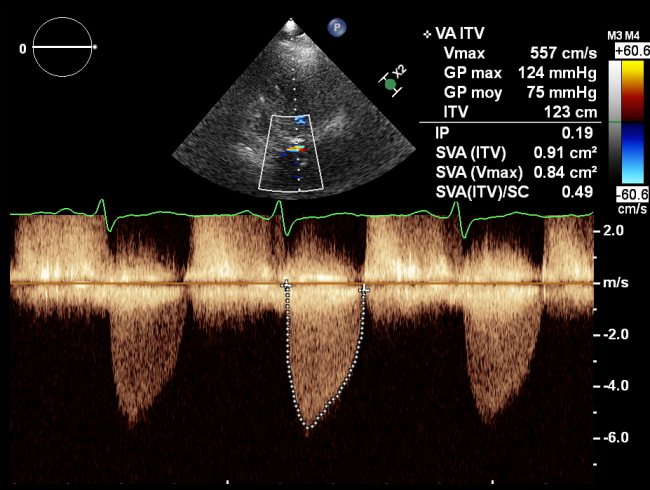
Valvulopathies aortiques asymptomatiques: Opérons nous trop tard?





Jean-Luc MONIN, Alain BERREBI, Emmanuel LANSAC, Mathieu DEBAUCHEZ.

Institut Mutualiste Montsouris, **Paris, FRANCE**

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My disclosures related to this talk

None

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RAC: Cas clinique N°1

- Homme de 73 ans
- Pèse 75 kg pour 170 cm (SC= 1,86 m^2)
- ATL fémorale superficielle (G) 1992
- Asymptomatique dans la vie courante
- Voyage au Mexique réservé (dans 1 mois)

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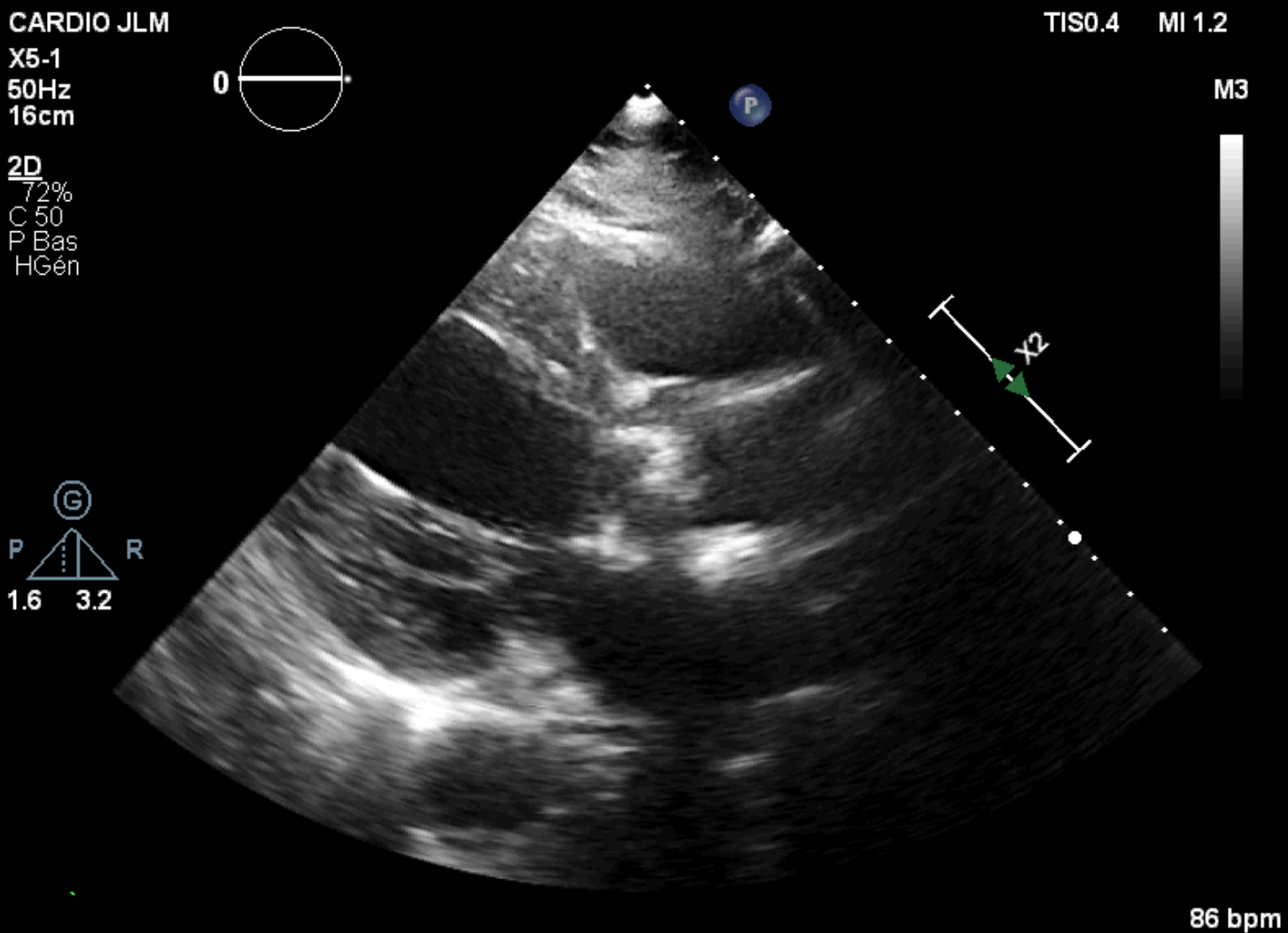
Valve aortique calcifiée / HVG



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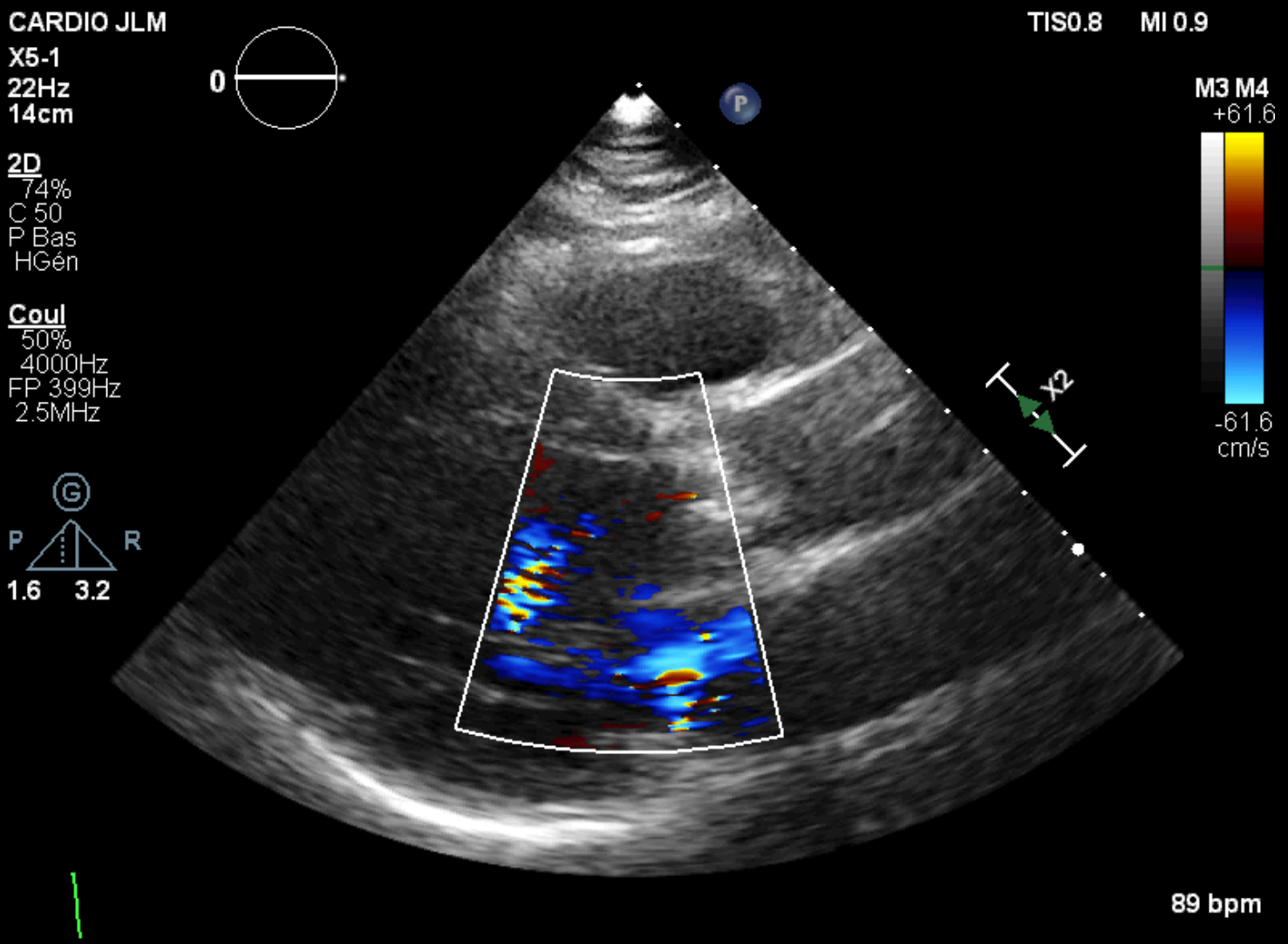
Insuffisance aortique ?



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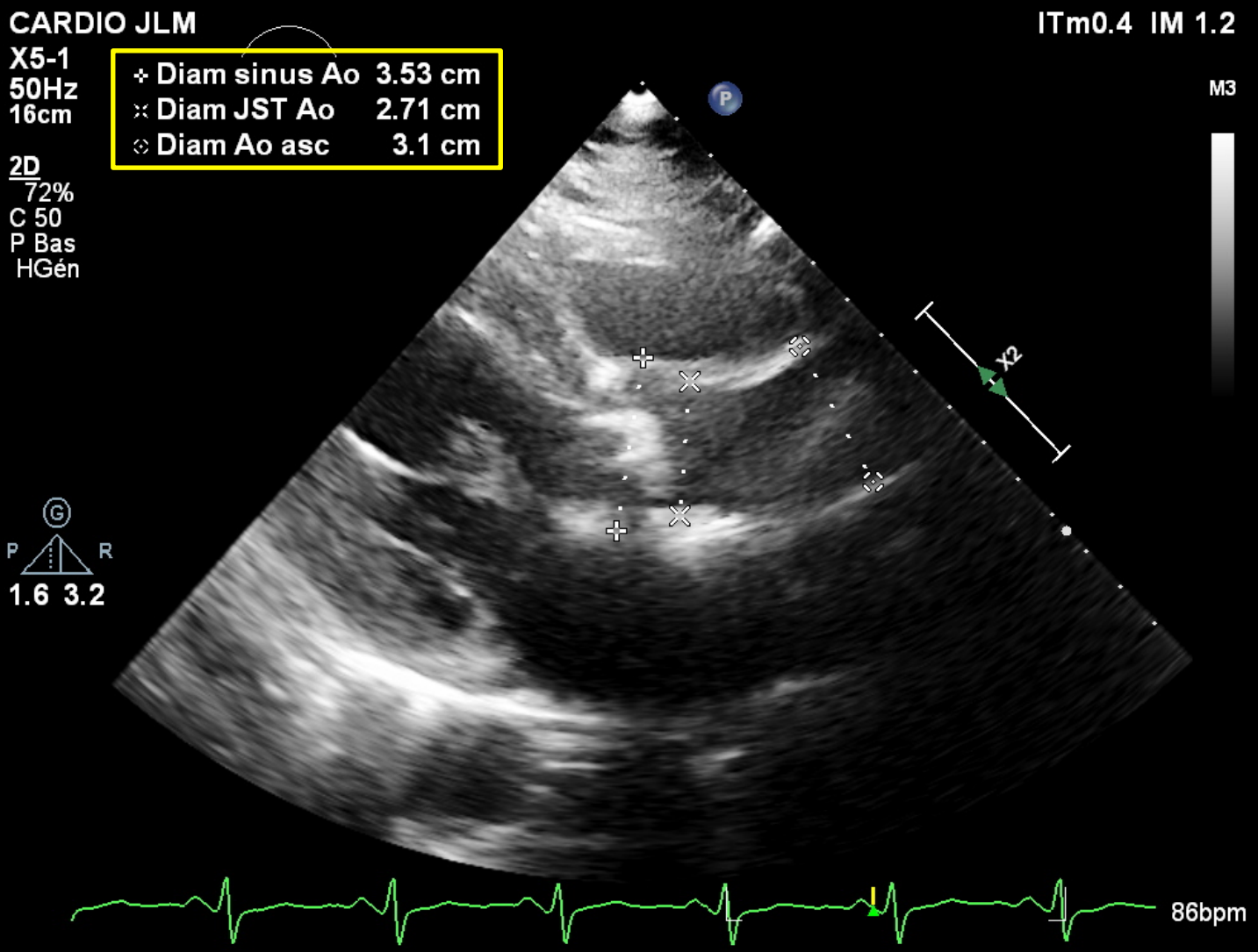
Aorte initiale non dilatée



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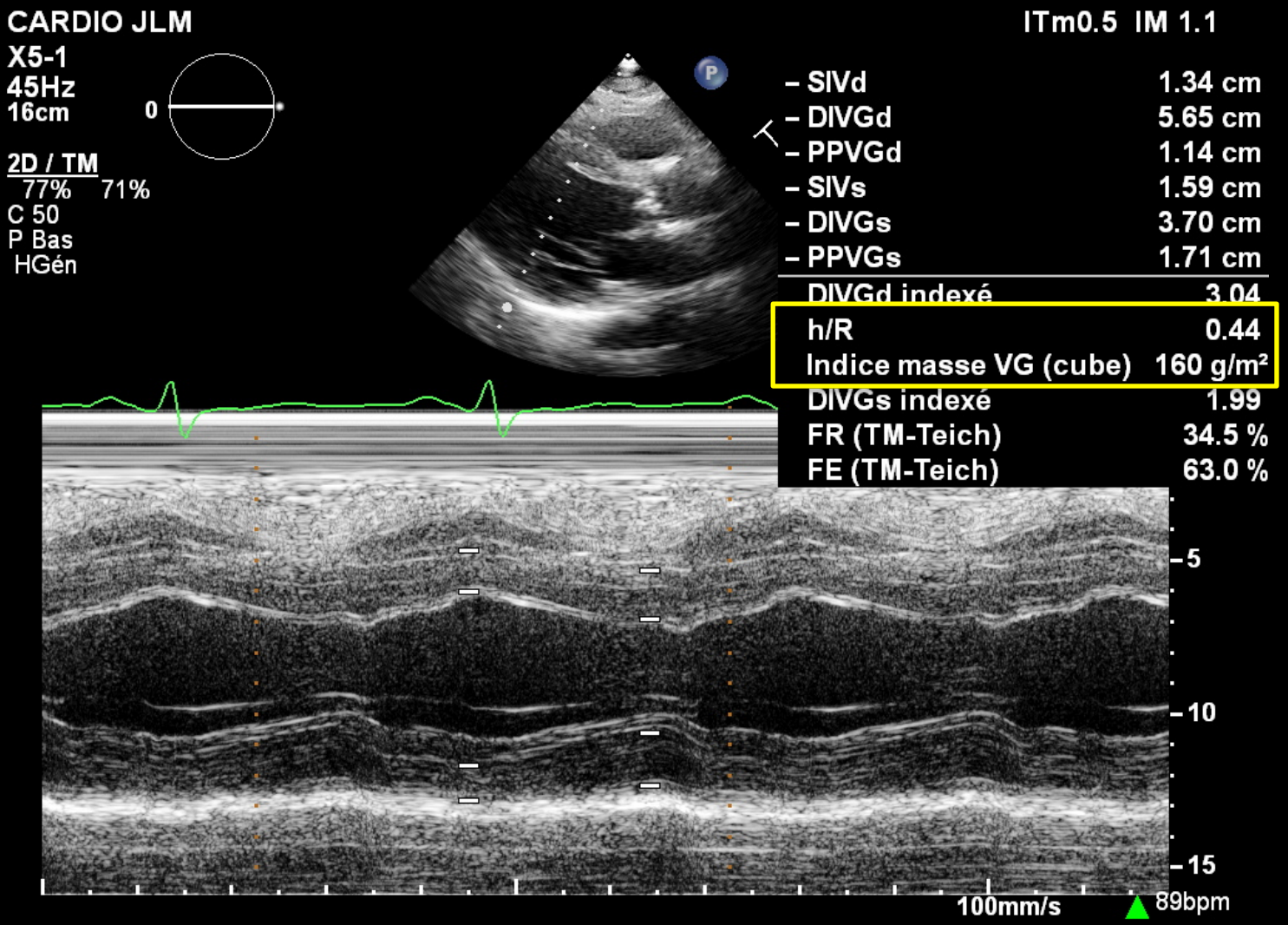
HVG (concentrique ?)



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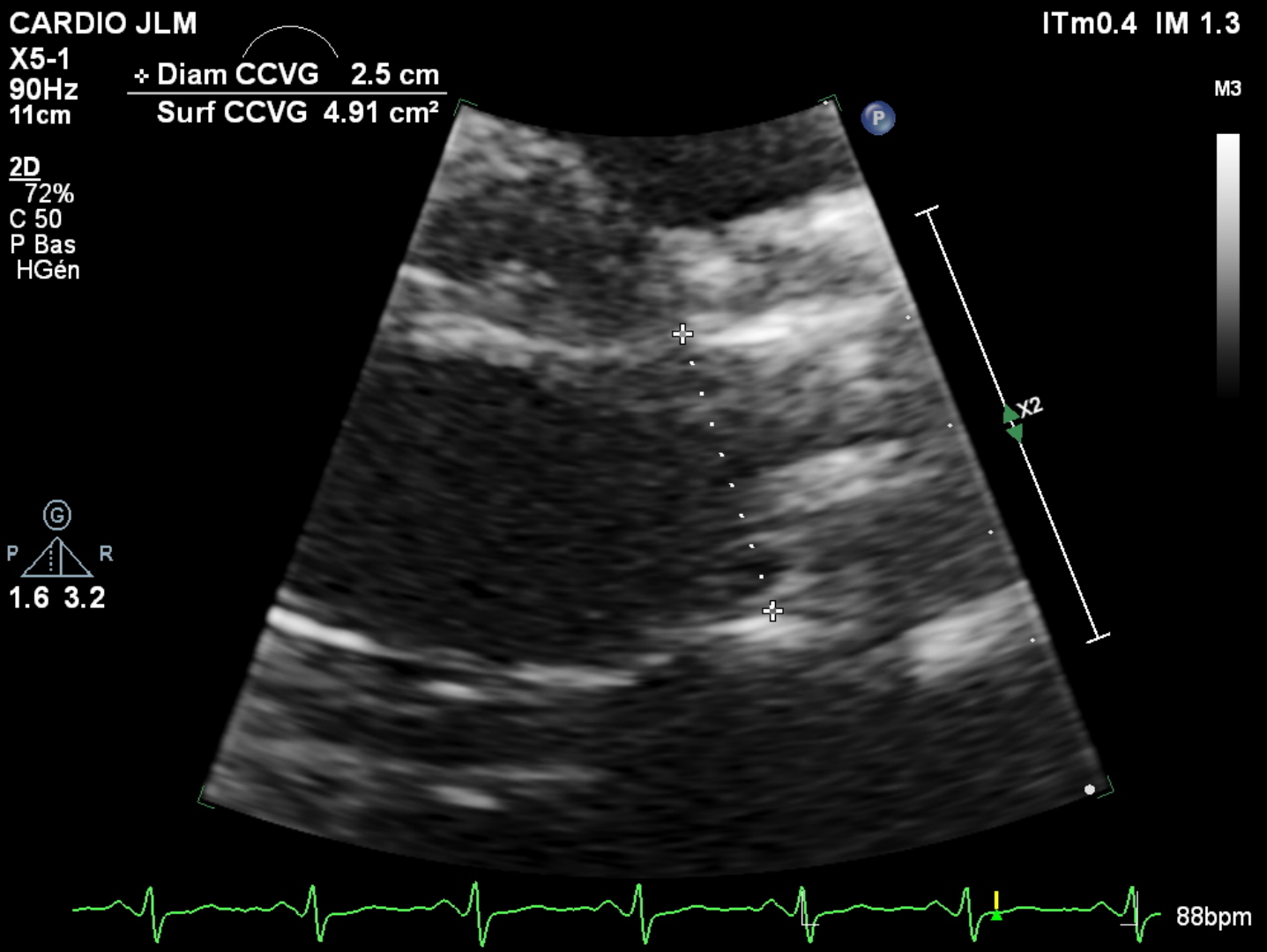
Anneau aortique large



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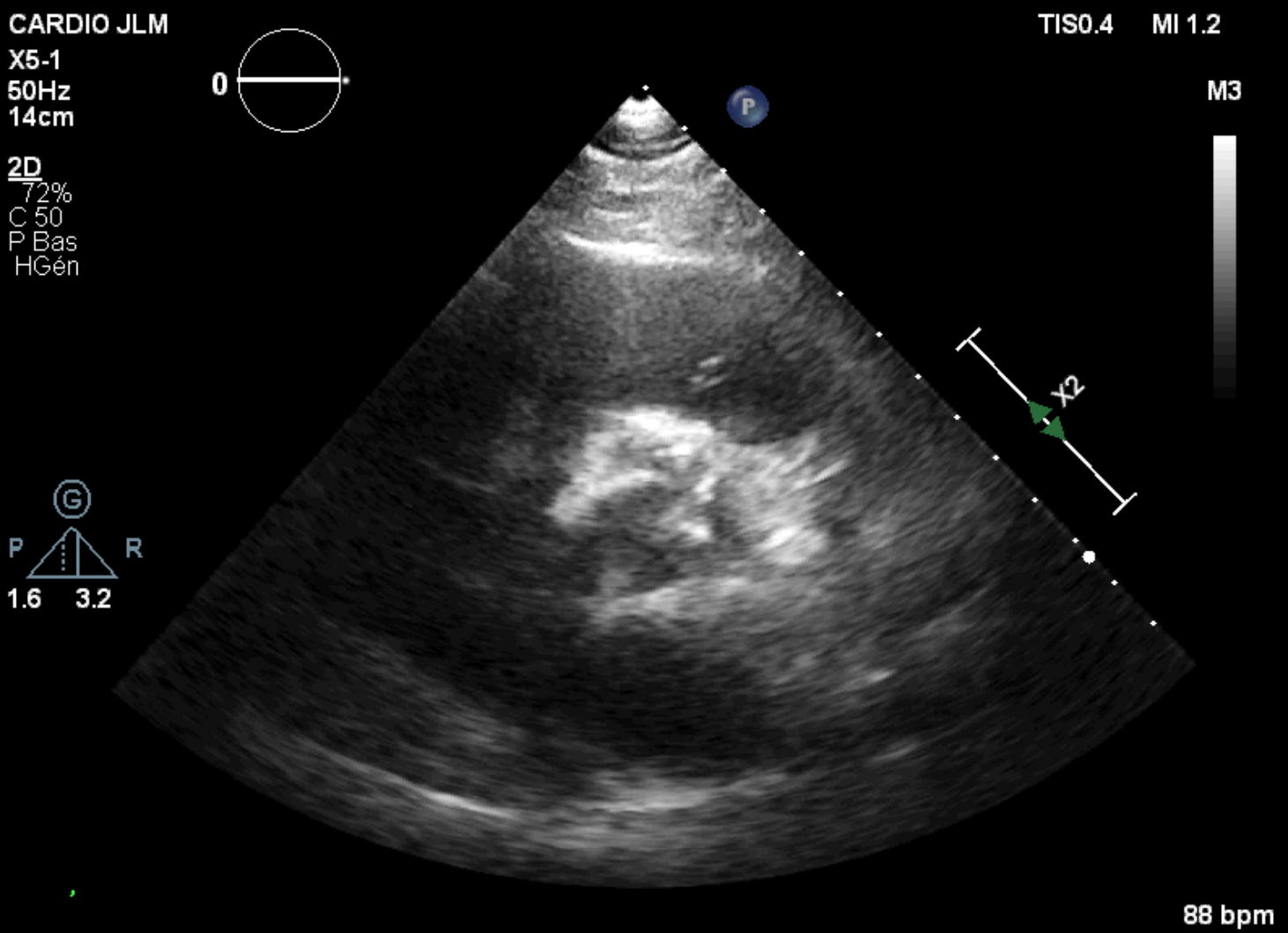
Probable bicuspidie (forme rare)



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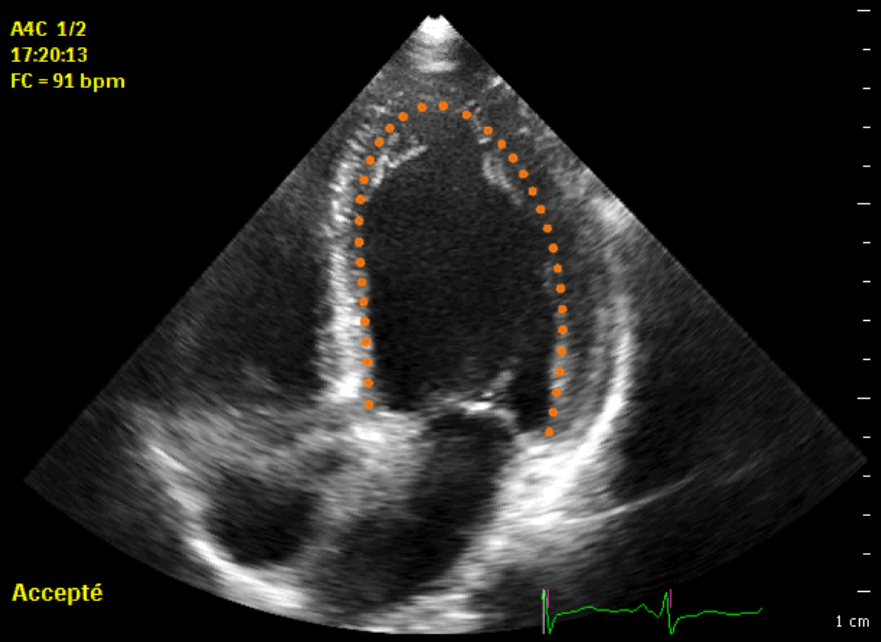
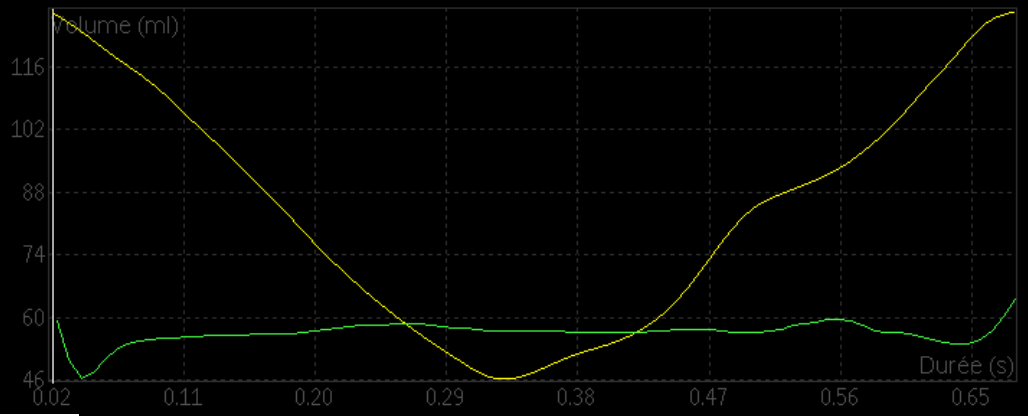
Simpson biplan (Semi)-Auto





Mesures	
VTD	128.0 ml
VTS	46.7 ml
FE	63.6 %
Cycles cardiaques	
R-R VA	659 ms
R-R VM	659 ms

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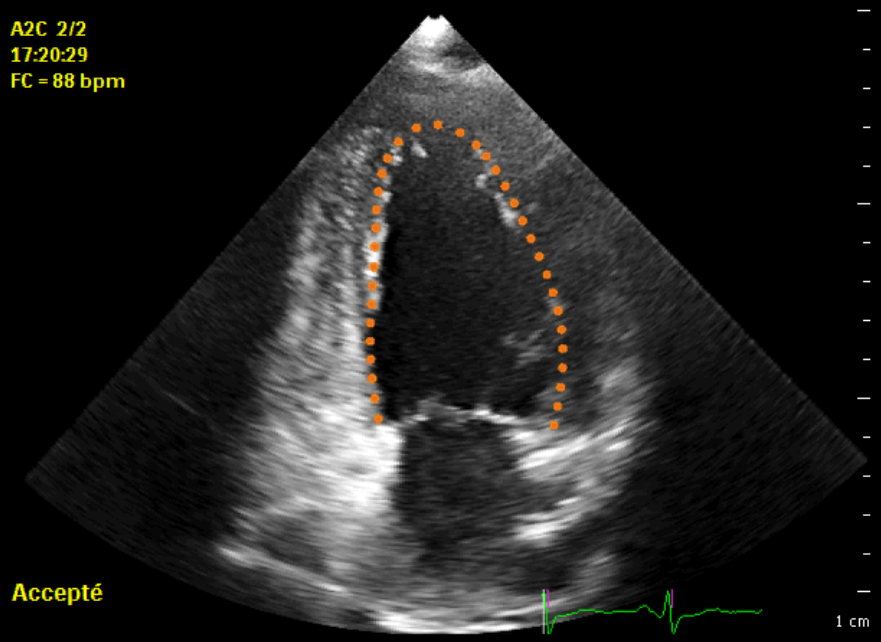
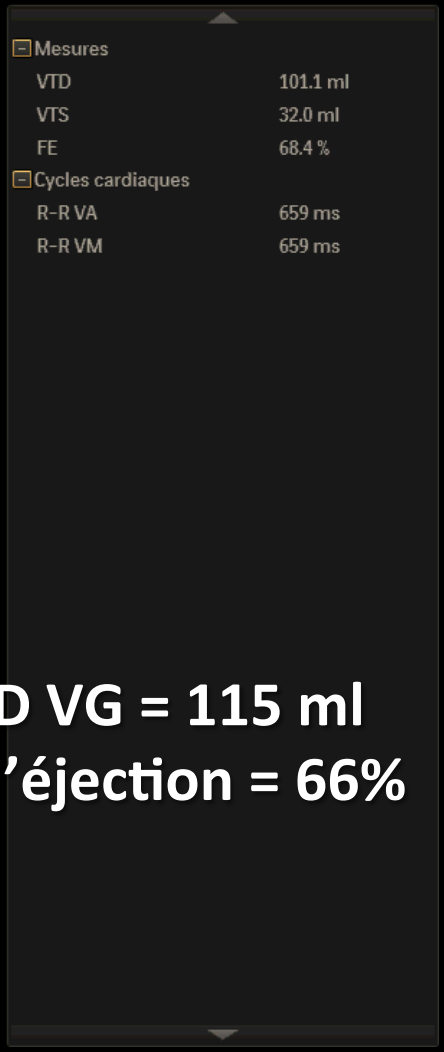
Volume TD-VG indexé = 71 ml/m²





Volume TD VG = 115 ml

Fraction d'éjection = 66%

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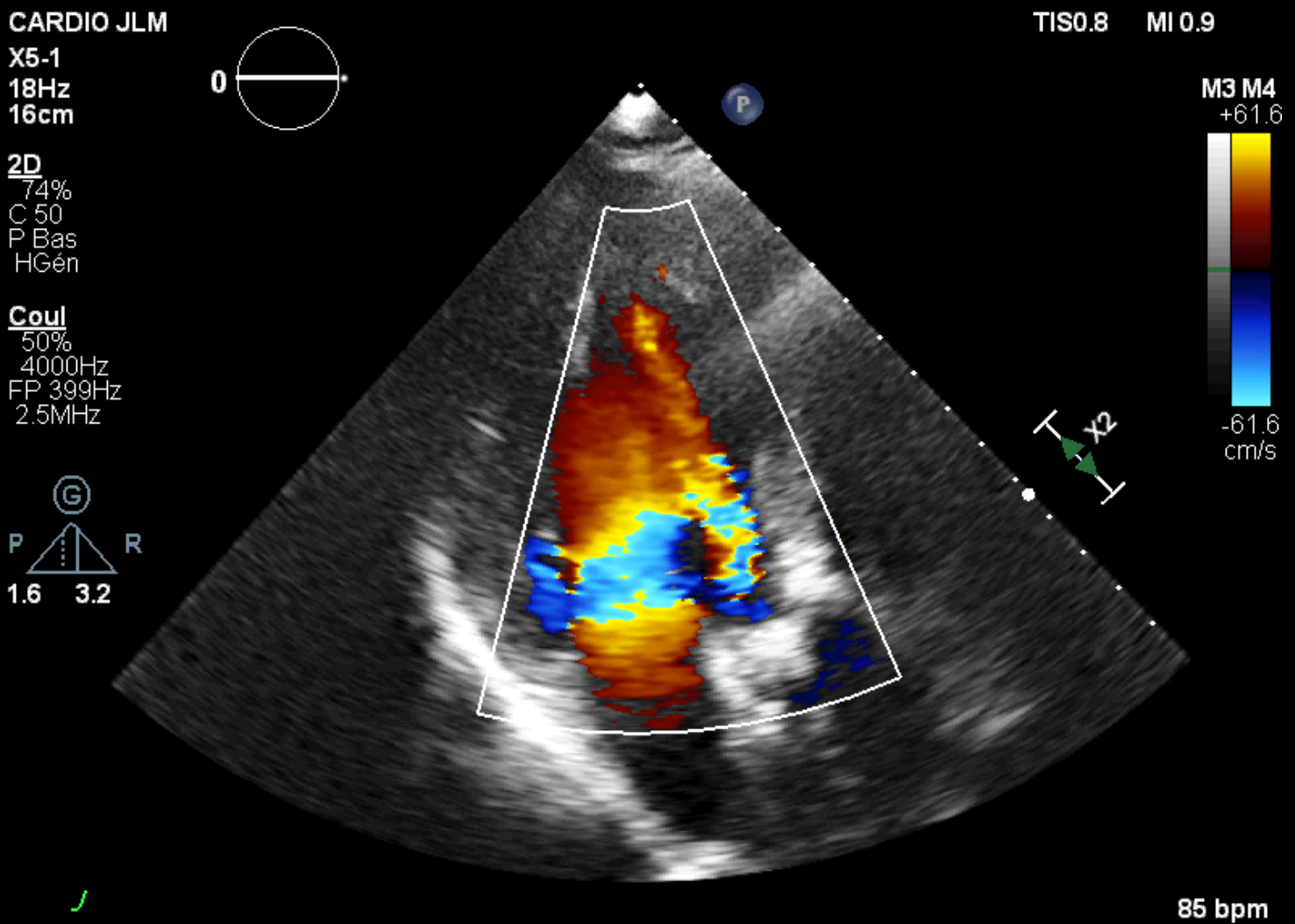
IAo: Incidence apicale 3C



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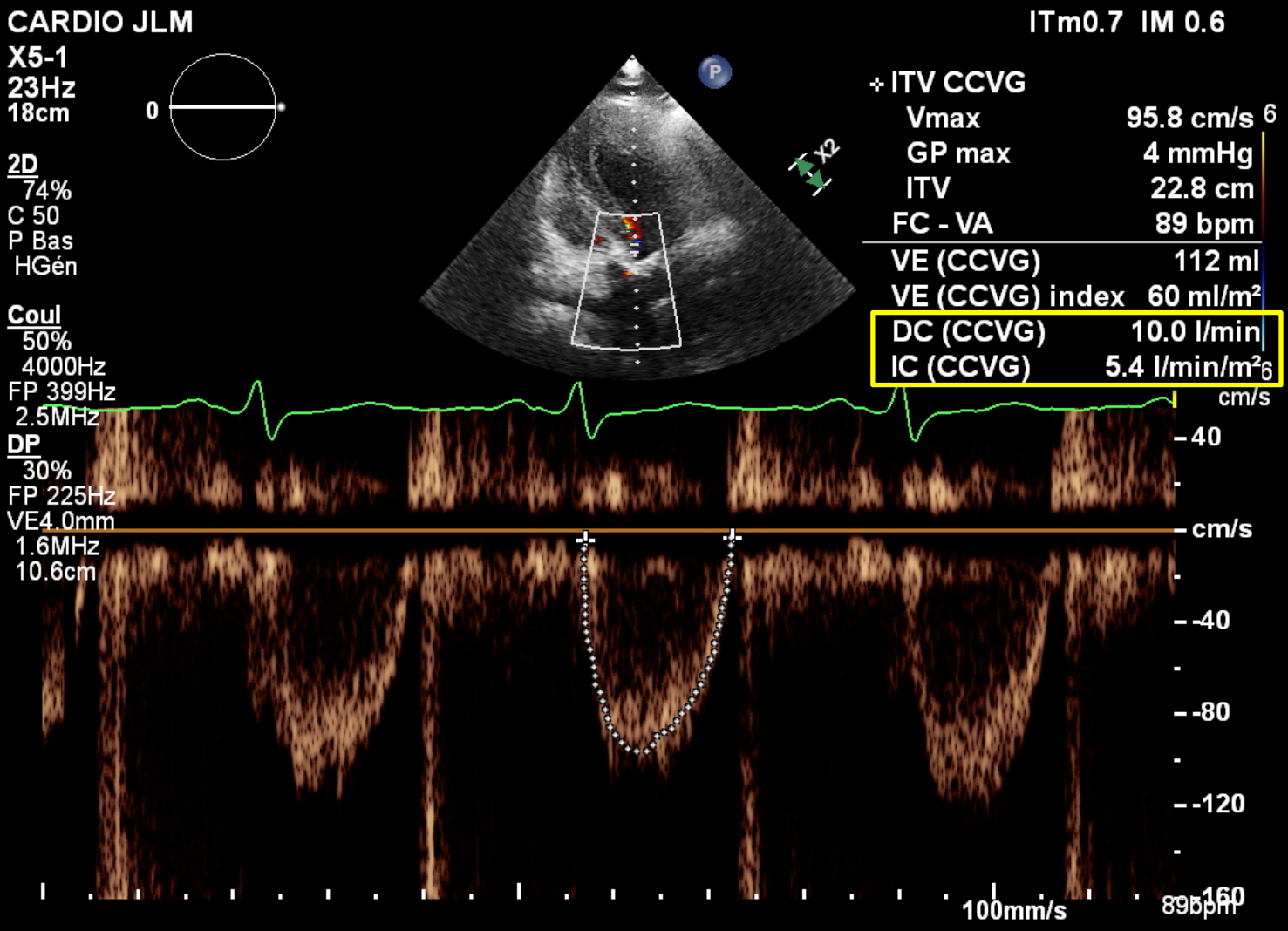
Débit cardiaque augmenté



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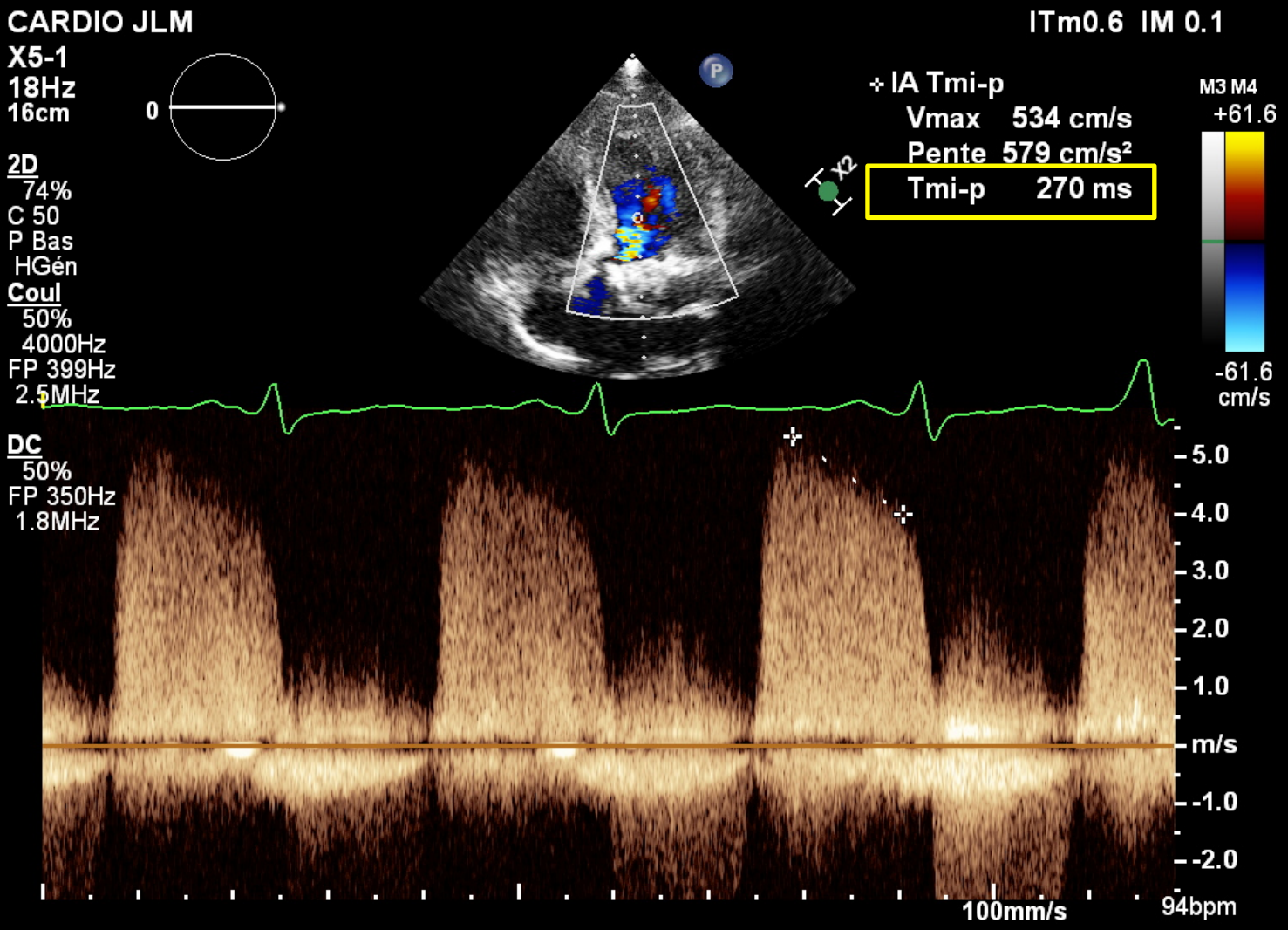
PHT (relativement) court



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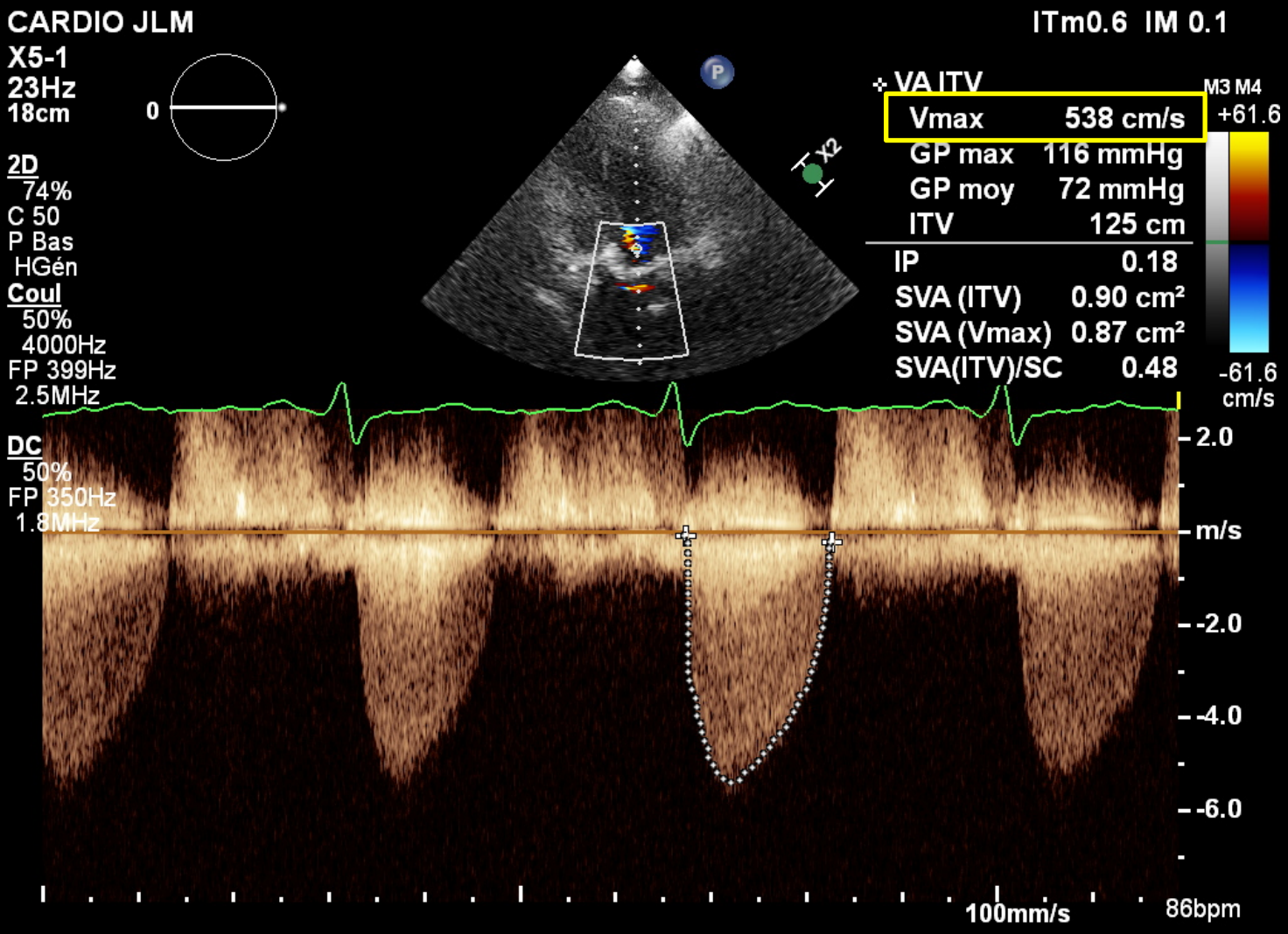
Vmax = 5,4 m/s



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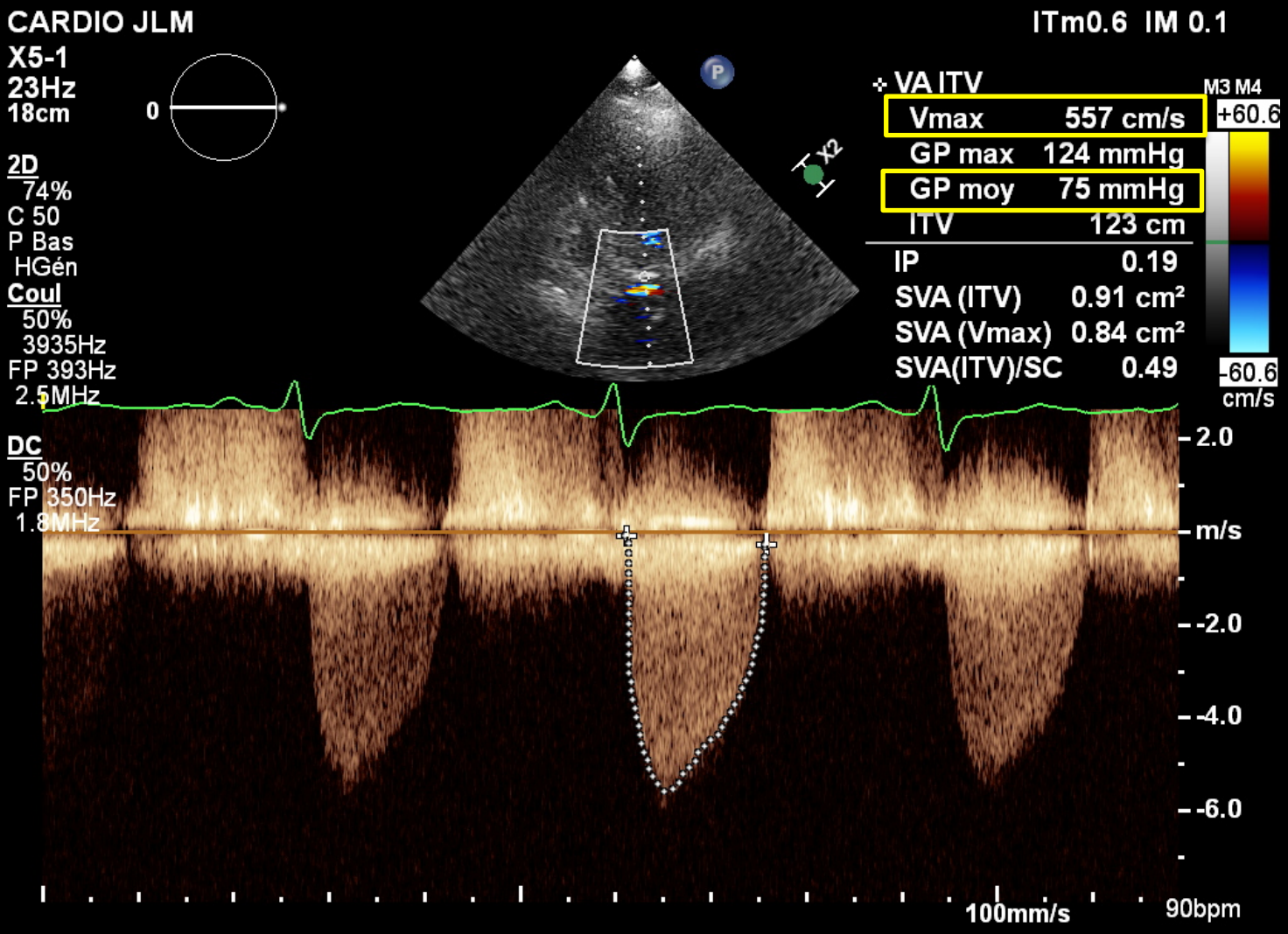
Vmax = 5,6 m/s



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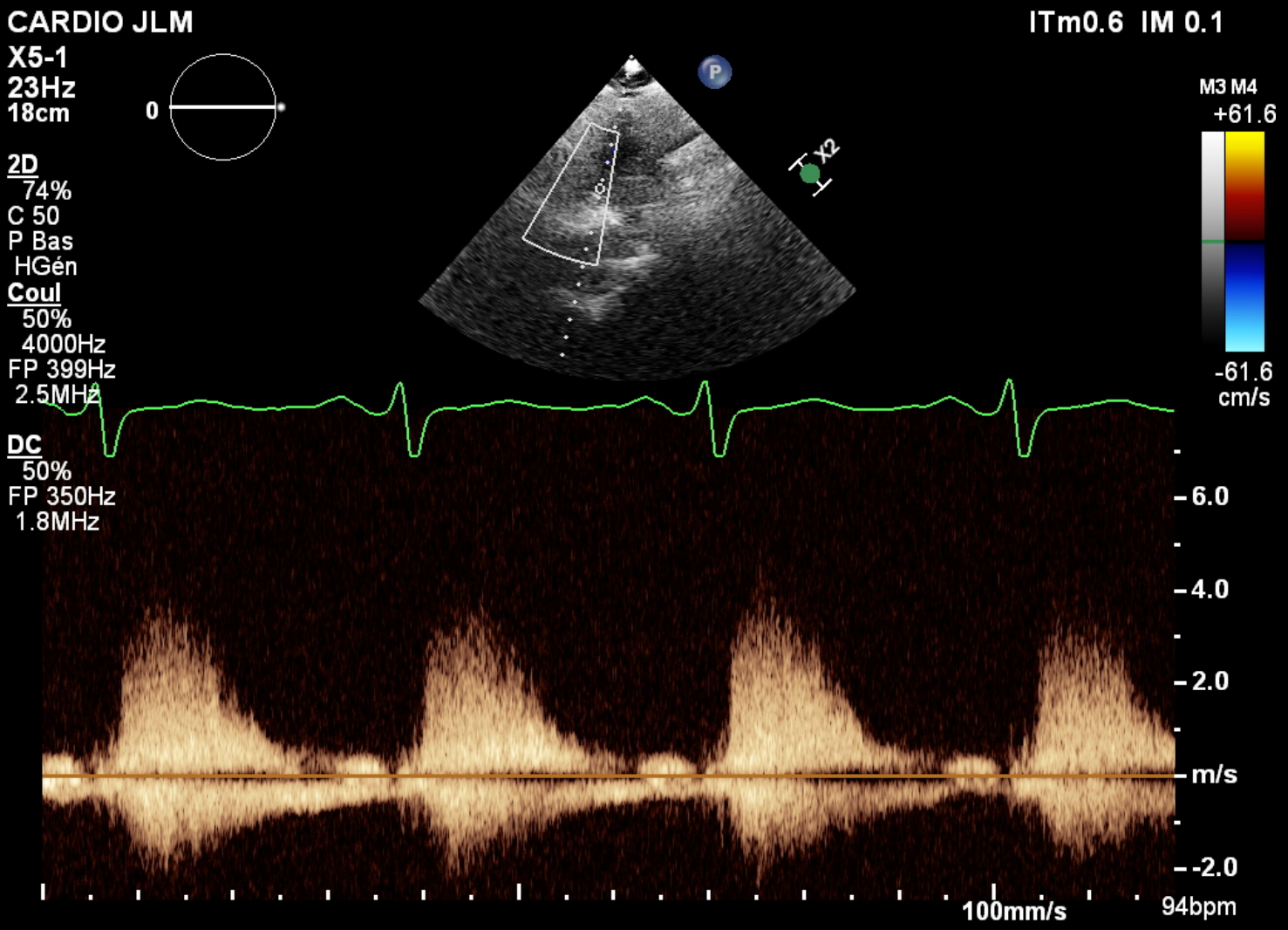
Parasternale droite: pas mieux



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Homme, 73 ans asymptomatique

- Valve aortique sévèrement calcifiée
- HVG concentrique, Fraction d'éjection VG = 66%
- IAo: QC = 10 l/min, PHT = 270 ms
- RAC: Vmax = 5,6 m/s, GM = 75 mmHg, SVA: 0,9 cm^2

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Valvulopathie aortique

A. Rétrécissement aortique sévère

B. Insuffisance aortique sévère

C. Maladie aortique sévère

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Valvulopathie aortique

A. Rétrécissement aortique sévère

B. Insuffisance aortique sévère

C. Maladie aortique sévère

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Quel examen complémentaire ?

A. ECG d'effort

B. Echographie d'effort

C. Scanner cardiaque

D. Coronarographie

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Quel examen complémentaire ?

A. ECG d'effort

B. Echographie d'effort

C. Scanner cardiaque

D. Coronarographie

Exercise testing (ECG) is recommended in physically active patients for unmasking symptoms and for risk stratification of asymptomatic patients with severe AS

2017 ESC/EACTS Guidelines for the management of valvular heart disease
European Heart Journal. 2017; 38: 2739-91

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Protocole : LDR Cycloergomètre

Motif d'arrêt : Fatigue musculaire du patient

Tableau des données d'effort

Phase	Palier	Durée pal.	Charge (W)	tours (tpm)	FC (/min)	TA (mmHg)	Commentaire
PRE-TEST		00:38	0	0	78		
EFFORT	PALIER 1	00:04	0	0	80		
	PALIER 2	02:00	88	57	122	189/89	
	PALIER 3	00:17	93	57	126	219/94	
RECUP.		06:15	0	0	90	163/82	

Fc repos : 78 /min
FC max : 126 /min soit **85 %** de la FMT calculée à **147 /min** Réserve FC utilisée: 69 %
FC fin de récup : 90 /min

TA repos : --/-- mmHg
TA max : **219/94 mmHg**
TA fin de récup : --/-- mmHg

ST max : -0.80 mm, 0.00 mV/s en II; EFFORT PALIER 2 02:00

Durée de l'effort : 2:20 min Charge maximale: 93 Watt = 5.0 METS
PWC 130 1.25 W/kg **PWC 150** -- W/kg

CONCLUSION :

TEST D EFFORT MENE A 86 % DE LA FMT POUR UNE CHARGE DE 93 WATTS NEGATIF
CLINIQUEMENT ET ELECTRIQUEMENT
HTA DE REPOS CONTEXTE ANXIETE
TROULBE DE REPOLARISATION EN RECUPERATION AVEC st SOUS DECLAE A -0,8 MM

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Quelle prise en charge ?

A. Surveillance CLIN + Echo à 6 mois

B. TAVI

C. RVA chirurgical

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Important: The previous additive [1] and logistic [2] EuroSCORE models are out of date. A new model has been prepared from fresh data and is launched at the 2011 EACTS meeting in Lisbon. The model is called EuroSCORE II [3] - this online calculator has been updated to use this new model. If you need to calculate the older "additive" or "logistic" EuroSCORE please visit the old calculator by clicking here.

Patient related factors			Cardiac related factors		
Age [1] (years)	75	0.46	**NYHA**	I	0
Gender	male	0	**CCS class 4 angina [8]**	no	0
Renal impairment [2] *See calculator below for creatinine clearance*	normal (CC >85ml/min)	0	**LV function**	good (LVEF > 50%)	0
Extracardiac arteriopathy [3]	yes	.5360268	**Recent MI [9]**	no	0
Poor mobility [4]	no	0	**Pulmonary hypertension [10]**	no	0
Previous cardiac surgery	no	0	**Operation related factors**		
Chronic lung disease [5]	no	0	**Urgency [11]**	elective	0
Active endocarditis [6]	no	0	**Weight of the intervention [12]**	single non CABG	.0062118
Critical preoperative state [7]	no	0	**Surgery on thoracic aorta**	no	0
Diabetes on insulin	no	0			
EuroSCORE II	1.30 %				
EuroSCORE II					
Note: This is the 2011 EuroSCORE II	Calculate	Clear			

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Quelle prise en charge ?

A. Surveillance CLIN + Echo à 6 mois

B. TAVI

C. RVA chirurgical

- Vmax > 5,5 m/s
- Age <75 ans, faible risque opératoire
- Probable bicuspidie (confirmée à l'intervention)
- Longévité des prothèses « TAVI » après 5 ans ?

2017 ESC/EACTS Guidelines for the management of valvular heart disease
European Heart Journal. 2017; 38: 2739-91

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Early surgery :
- Risk of sudden death ++
- Myocardial fibrosis
- Postop. LV dysfunction
- Death on the waiting list
- Cardiologist's anxiety (!)
Watchful waiting :
- Operative risk ++
- Valve related morbidity:
2-3%/ year
- Endocarditis, thrombosis, bleeding
Rosenhek et al. Eur Heart J. 2002;23:1417-21

www.imm.fr

The patient with asymptomatic AS

1. The risk of sudden death
2. The risk of myocardial fibrosis
3. Relevant cutoffs for Vmax/ LVEF ?
4. Exercise testing
5. Role for 2D-strain imaging?
6. What do the Guidelines tell us?

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The patient with asymptomatic AS

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Sudden death vs Operative risk

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Asymptomatic AS: Risk of sudden death Without preceding symptom ?

Author (Year)	N patients	FU (months)	AS severity	Sudden death (annual rate, %)
Otto (1997)	123	30	V_{max} > 2.5 m/s	0
Amato (2001)	66	15	AVA < 1.0 cm^2	4.8
Monin (2009)	211	22	V_{max} > 3.0 m/s	0.4
Rosenhek (2010)	116	41	V_{max} > 5.0 m/s	0.3
Lancellotti (2010)	126	20	AVA < 1.2 cm^2	0.1
Maréchaux (2010)	135	20	AVA < 1.5 cm^2	0

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Risk of sudden death ≈ 0.8% /year *vs.* Operative risk ≥ 2-3%

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Sudden death in patients with severe AS: Data from the CURRENT AS Registry

- Retrospective analysis (2003-2011) of 3815 consecutive patients (Vmax> 4.0 m/s, MPG >40 mmHg, or AVA < 1.0 cm^2) Mean age =78 years, 38% of males
- Median follow-up duration = 3.6 years (>2 years in 93%)

Variables	Whole Cohort N=3815	Symptomatic N=2005	Asymptomatic N=1808	*P* Value
Echocardiographic variables				
V_{max}, m/s	4.1±0.9	4.3±0.9	3.9±0.8	<0.001
V_{max} ≥5 m/s*	698 (18%)	490 (24%)	207 (11%)	<0.001
V_{max} ≥4 m/s	2185 (57%)	1320 (66%)	864 (48%)	<0.001
Peak aortic PG, mm Hg	72±32	78±33	65±28	<0.001
Mean aortic PG, mm Hg	41±20	45±21	36±17	<0.001
AVA (equation of continuity), cm^2	0.72±0.18	0.67±0.19	0.77±0.17	<0.001

RESULTS: Among 82 asymptomatic patients experiencing sudden death:

- 66% of patients (n=54) died abruptly without any preceding symptoms
- 65% of these sudden deaths occurred within 3 months of the last clinical follow-up visit

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Taniguchi et al. *J Am Heart Assoc.* 2018; 7:e008397.

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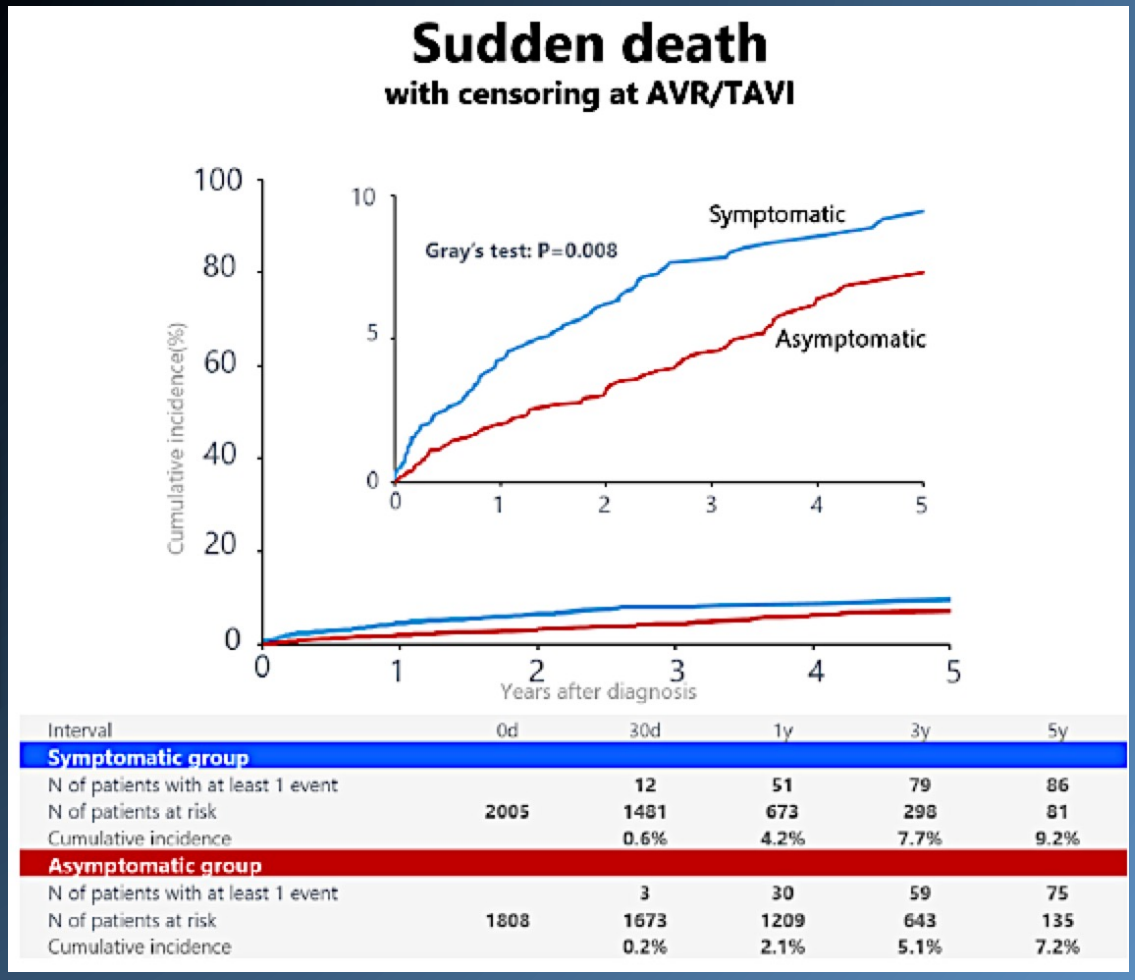
Sudden death in patients with severe AS: Data from the CURRENT AS Registry

Asymptomatic patients : cumulative 5-year incidence of sudden death (censored at AVR) = 7.2% (1.4%/year)

Independent risk factors for sudden death:

- Hemodialysis (HR 3.63; 95% CI 2.42-5.43)
- Prior myocardial infarction (HR 2.11; 95% CI 1.28-3.50)
- Peak aortic jet velocity ≥ 5 m/s (HR 1.76; 95% CI 1.12-2.78)
- LV ejection fraction < 60% (HR 1.52; 95% CI1.08-2.14).
- Body mass index < 22 (HR 1.51; 95% CI 1.03-2.21)



Interval	0d	30d	1y	3y	5y
Symptomatic group					
N of patients with at least 1 event		12	51	79	86
N of patients at risk	2005	1481	673	298	81
Cumulative incidence		0.6%	4.2%	7.7%	9.2%
Asymptomatic group					
N of patients with at least 1 event		3	30	59	75
N of patients at risk	1808	1673	1209	643	135
Cumulative incidence		0.2%	2.1%	5.1%	7.2%

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Taniguchi et al. *J Am Heart Assoc.* 2018; 7:e008397.

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The Society of Thoracic Surgeons National Database 2018 Annual Report

Table 1. STS National Database Participation

Variable	STS Adult Cardiac Surgery Database[a]
Participants[c] in United States	1,079
Hospitals[d] in United States	1,120
Surgeons in United States	2,966
Operations[e] in United States	6,610,348
States in United States	50 states and Washington, DC
Estimated penetration at the hospital level in United States	>90%–95% of hospitals that perform adult heart operations in the United States[f]
Percentage of programs in United States and Canada that consented to voluntarily publicly report (as of October 1, 2018)	65.4
Total countries (including United States)[i]	11
Participants[c] outside United States	32
Hospitals[d] outside United States	32
Surgeons outside United States	171
Operations[e] outside United States	62,291
Total participants[c]	1,111
Total hospitals[d]	1,152
Total surgeons	3,137
Total operations[e]	6,672,639

Jacobs et al.
Ann Thorac Surg.
2018; 106: 1603–11

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The Society of Thoracic Surgeons National Database 2018 Annual Report

Selected Outcomes of the More Commonly Performed Adult Cardiac Surgical Procedures in Calendar Year 2016

Variable	AVR	AVR + CABG
No. of operations	28,037	17,196
Mortality, %		
In-hospital mortality	1.6	2.7
Operative mortality[b]	2.2	3.3
Major morbidity, %		
Reoperation[c]	4.8	6.2
DSWI/mediastinitis	0.1	0.3
Permanent stroke	1.4	2.2
Prolonged ventilation >24 hours	6.6	11.9
Renal failure	1.9	3.6
New-onset atrial fibrillation	31.3	39.1
Readmission ≤ 30 days of discharge	9.8	12.2
Postoperative hospital LOS, days		
Mean	7.0	8.4
Median	6.0	7.0

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Jacobs et al. *Ann Thorac Surg.* 2018; 106: 1603–11

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The patient with asymptomatic AS

Myocardial fibrosis ?

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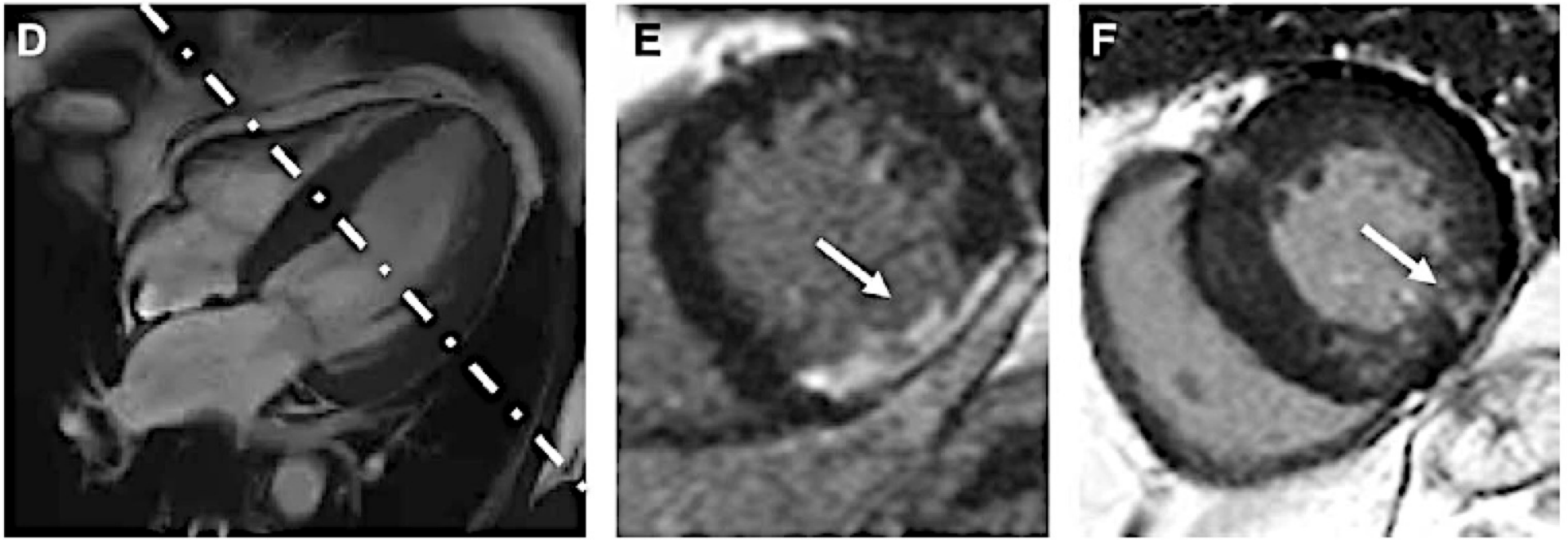
Myocardial Scar and Mortality in Severe Aortic Stenosis (BSCMR Valve Consortium)

Observational study (6 UK cardiothoracic centers, January 2003 to May 2015) :

- 674 patients with severe AS (aged 75±14 years; 63% male; MPG: 46±18 mmHg; LVEF: 61±17%) listed for AVR or TAVI.
- Patients underwent CMR for LV volumes, EF and scar quantification. Myocardial scar was categorized into 3 patterns: none, infarct, or non-infarct patterns



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Musa et al. *Circulation.* 2018; 138: 1935-47

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Myocardial Scar and Mortality in Severe Aortic Stenosis (BSCMR Valve Consortium)

- Management: surgical AVR (n=399) or TAVI (n=275).

- 145 patients died (21.5%) during follow-up (median, 3.6 years)

Independent factors for all-cause mortality:

- Age

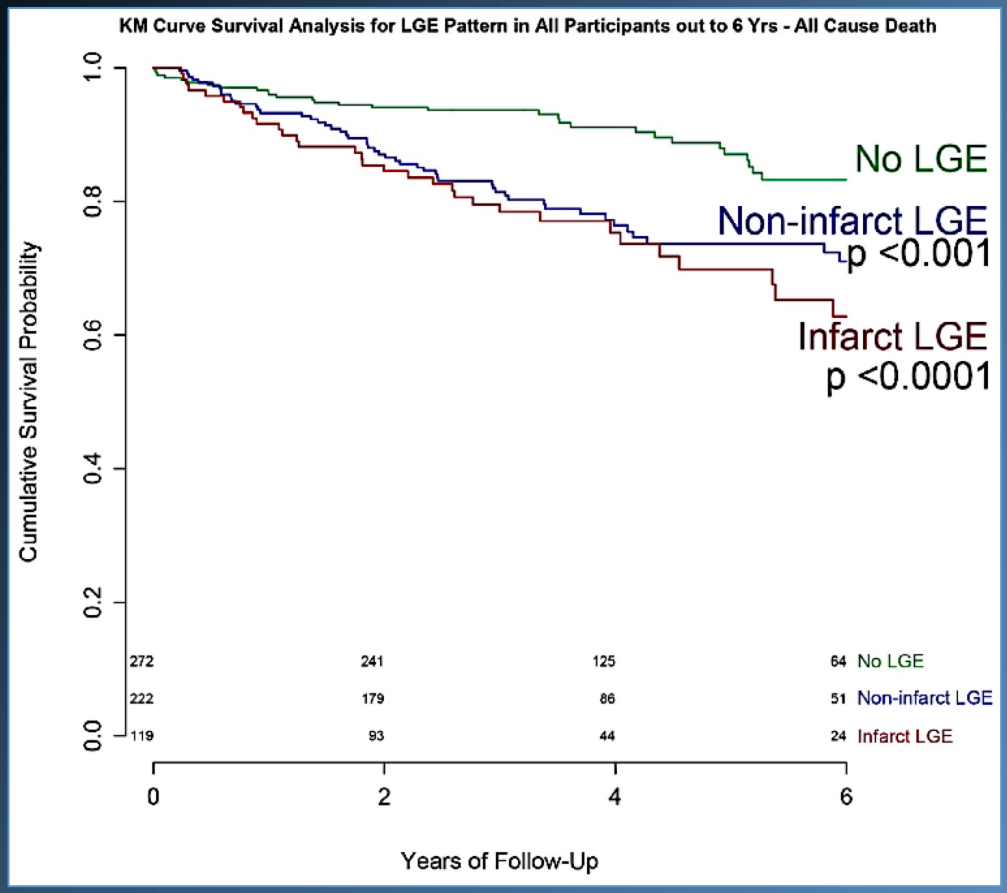
(HR,1.50; 95% CI, 1.11–2.04; P =0.009, scaled by epochs of 10 years)

- STS score

(HR, 1.12; 95% CI, 1.03–1.22; P =0.007)

- Scar presence assessed by CMR

(HR, 2.39; 95% CI, 1.40–4.05; P =0.001)



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Musa et al. *Circulation.* 2018; 138: 1935-47

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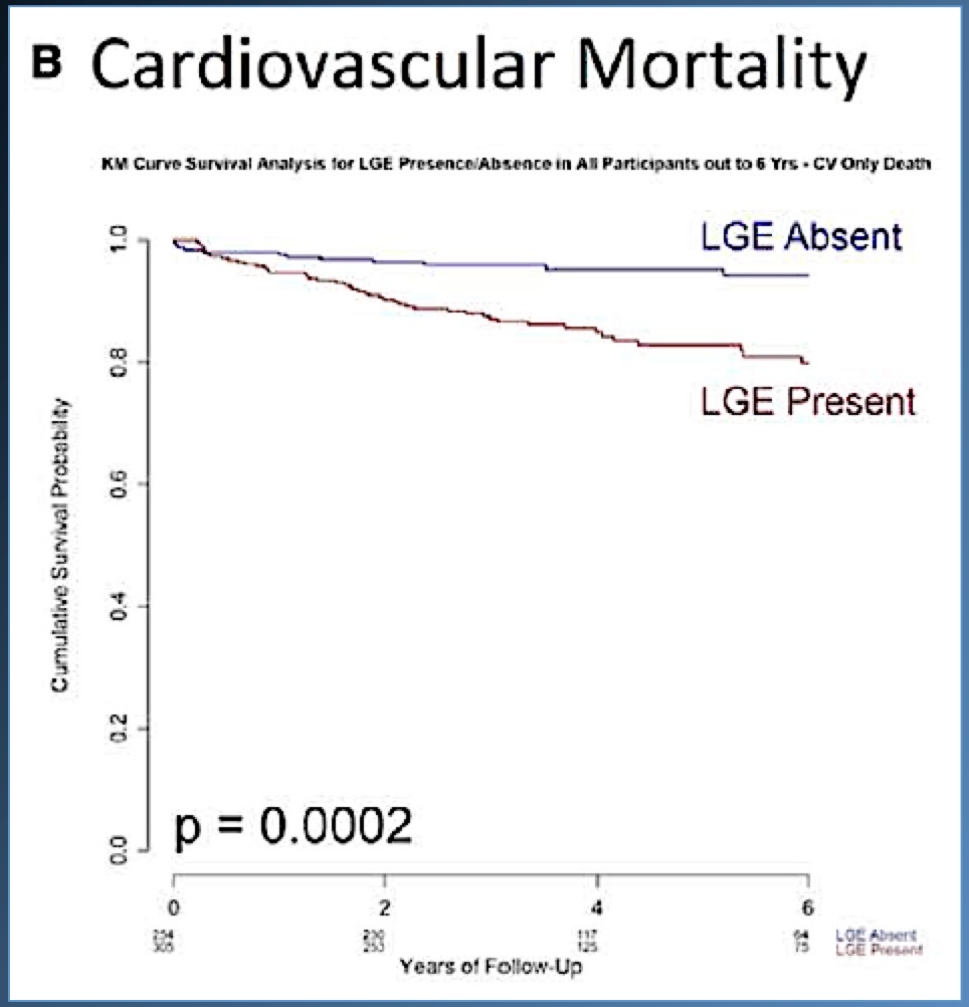
Myocardial Scar and Mortality in Severe Aortic Stenosis (BSCMR Valve Consortium)

Myocardial scar independently predicted:

- All-cause mortality
(26.4% versus 12.9%; P <0.001)

- Cardiovascular mortality
(15.0% versus 4.8%; P <0.001)

- Every 1% increase in LV myocardial scar burden was associated with 8% higher cardiovascular mortality
(HR, 1.08; 95% CI, 1.01–1.17; P <0.001)



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Musa et al. *Circulation.* 2018; 138: 1935-47

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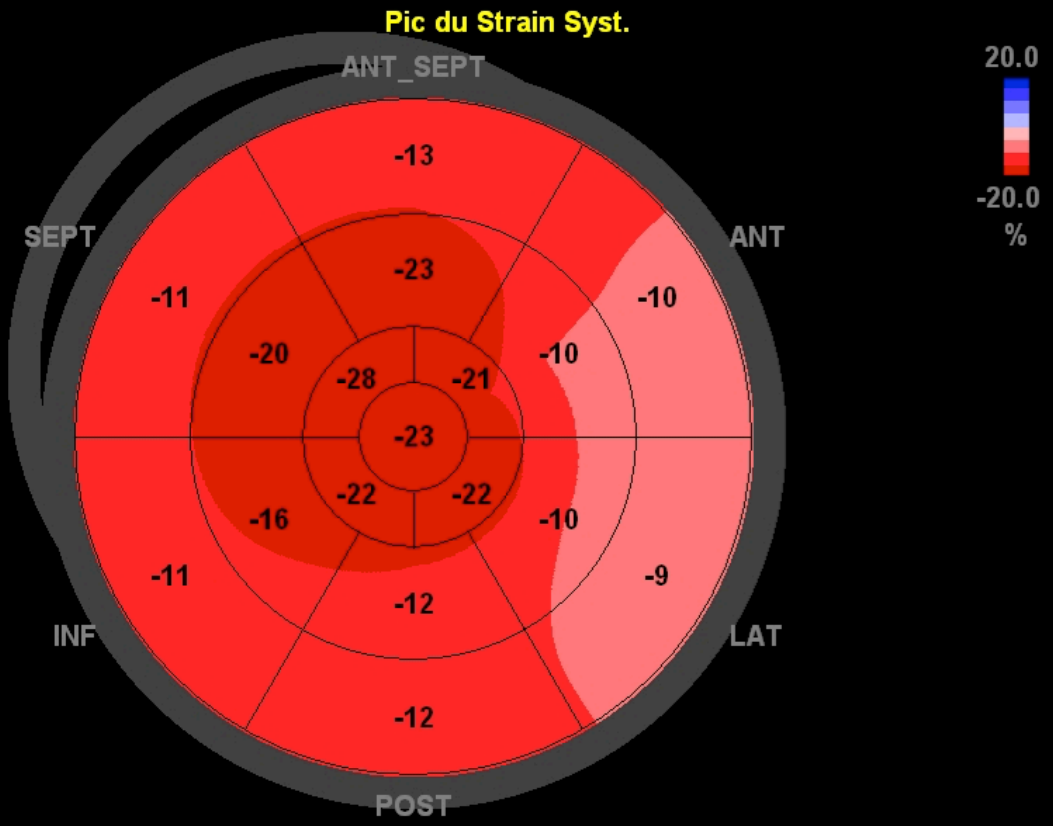
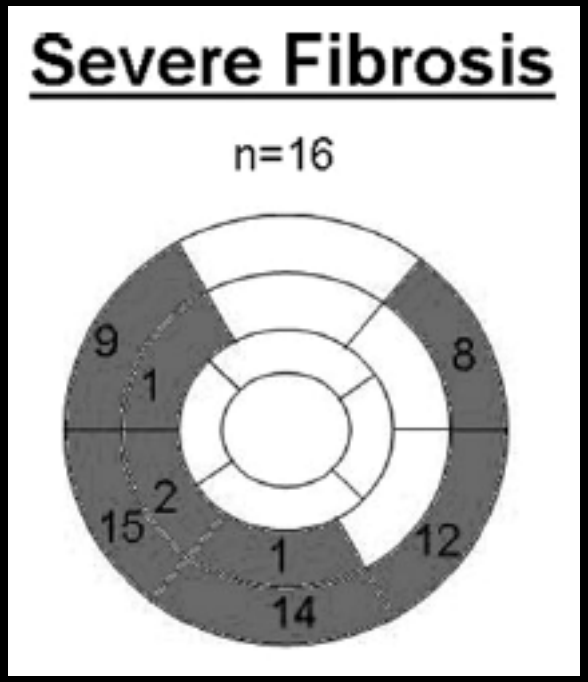
Preserved LVEF vs. Impaired longitudinal *strain*, linked to myocardial fibrosis





Weidemann et al.
Circulation. 2009; 120: 577-84

Global Longitudinal *strain* : -16%

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The patient with asymptomatic AS

Cutoffs for Vmax : What is critical AS ?

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Risk stratification of severe AS with preserved LVEF: Peak aortic jet velocity

Background: **The definition of critical AS remains unclear: Vmax> 5-m/s (USA) vs. 5.5 m/s (Europe). NB: ≈20% of patients with severe AS are in this range.**

Methods: **1140 patients with preserved LVEF, AVA ≤ 1 cm² and Vmax ≥ 4 m/s were divided into 4 groups:**

Variable	Vmax 4–4.49 m/s (n=460)	Vmax 4.5–4.99 m/s (n=328)	Vmax 5–5.49 m/s (n=220)	Vmax ≥5.5 m/s (n=132)	*P* Value
Demographics, baseline data, and symptoms					
Age, y	75±11	74±11	74±12	74±12	0.538
Male sex, n (%)	231 (51.2%)	188 (57.7%)	109 (49.8%)	64 (48.9%)	0.162
Body surface area, m²	1.88±0.2	1.89±0.2	1.87±0.2	1.87±0.2	0.464
Hemoglobin, g/dL*	12.8±2.4	12.8±1.9	12.9±1.8	12.7±1.8	0.746
Creatinine, μmol/L†	100±58	103±60	103±62	102±46	0.873
NYHA, n (%)					
1–2	353 (76.7%)	237 (72.3%)	162 (73.6%)	103 (78%)	
					0.404
3–4	107 (23.3%)	91 (27.7%)	58 (26.4%)	29 (22%)	

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Bohbot et al. *Circ Cardiovasc Imaging.* 2017;10:e006760.

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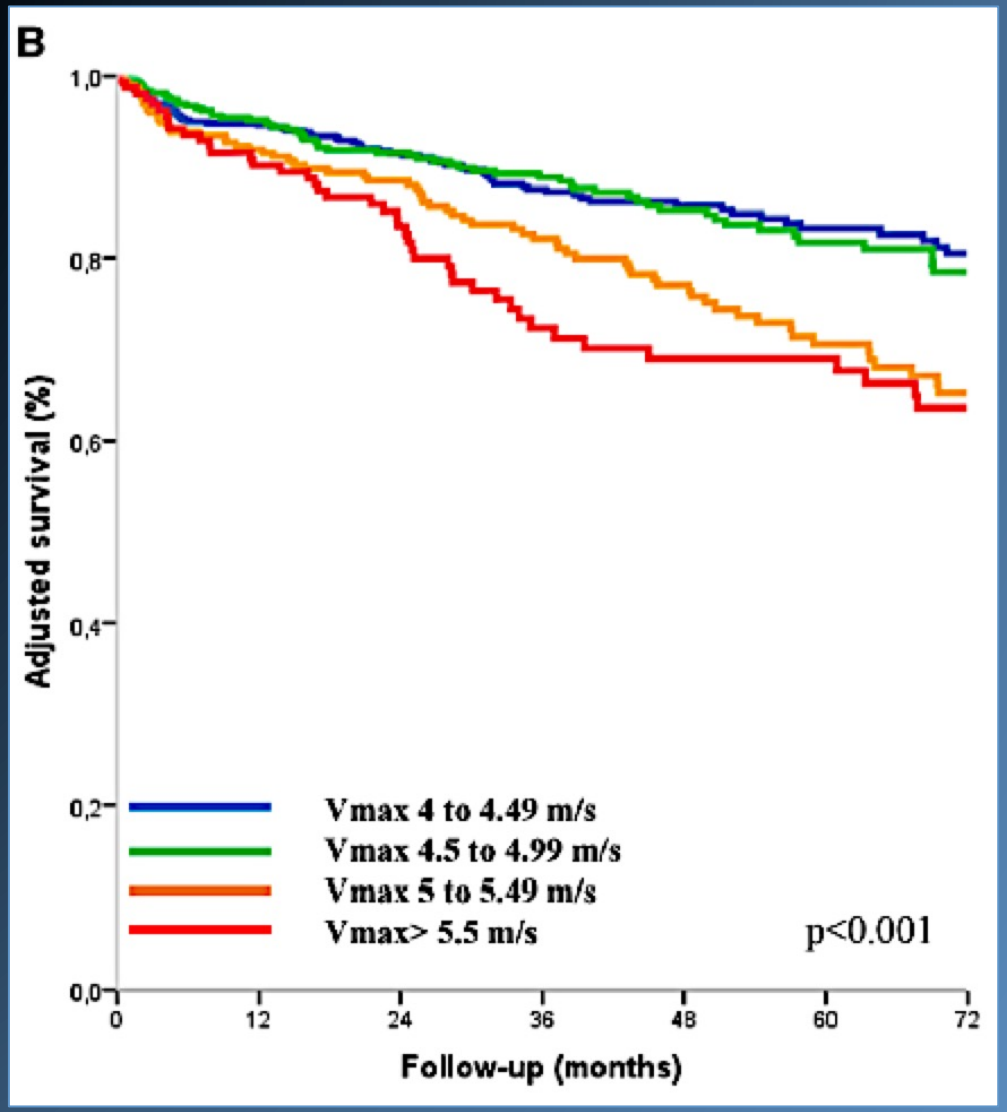
Risk stratification of severe AS with preserved LVEF: Peak aortic jet velocity

After adjustment for covariates (including surgery):

- No difference in mortality between Vmax 4-4.49 m/s vs. Vmax 4.5-4.99 m/s (P =0.64).

- Both Vmax 5-5.49 m/s and Vmax ≥ 5.5 m/s exhibited significant excess mortality vs. Vmax < 5 m/s



Bohbot et al. *Circ Cardiovasc Imaging.* 2017;10:e006760.

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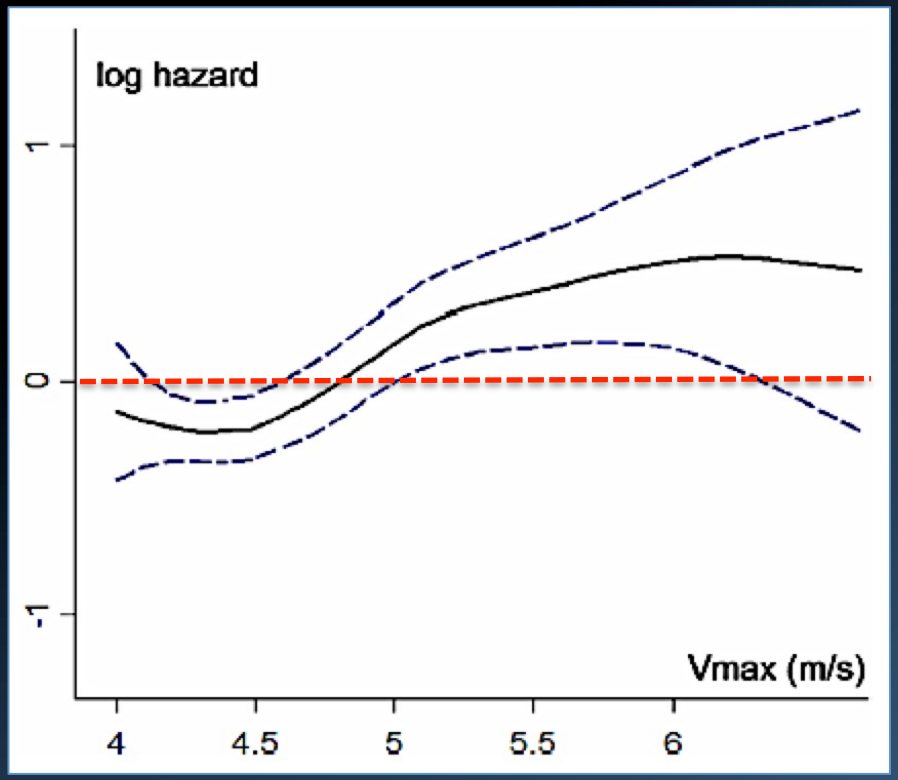
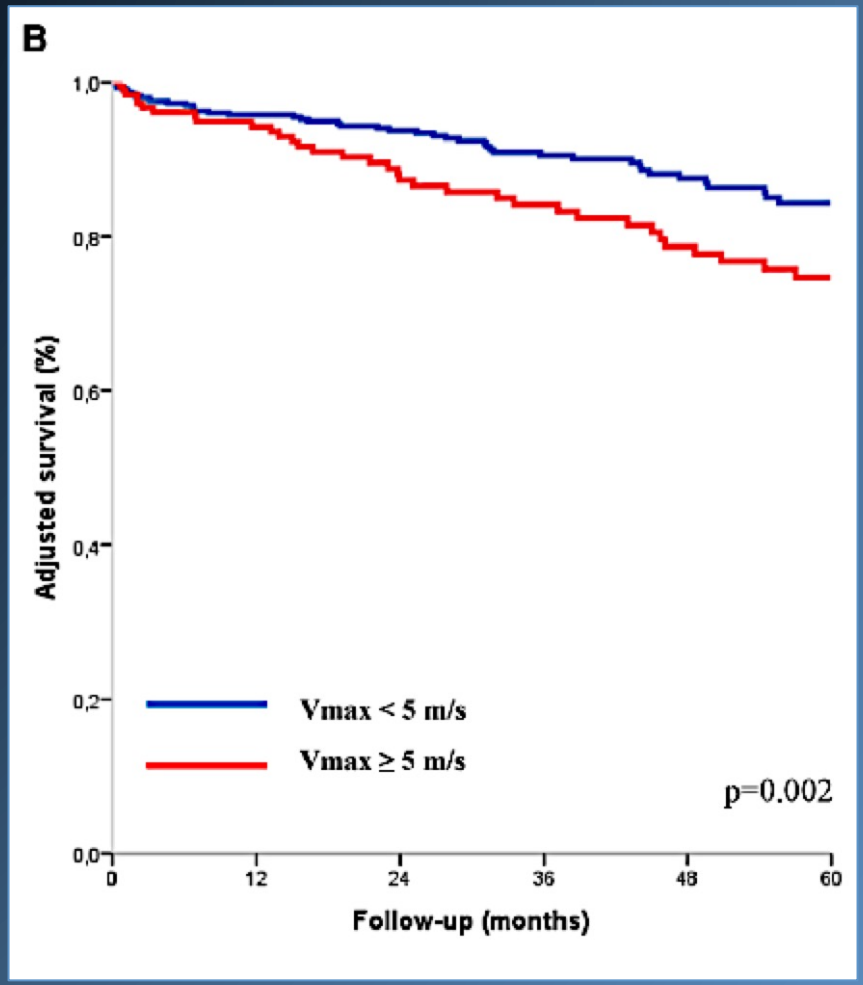
Risk stratification of severe AS with preserved LVEF: Peak aortic jet velocity

Asymptomatic/minimally symptomatic patients with severe AS : Survival curves adjusted for age, sex, BSA, hypertension, NYHA class, CAD, atrial fibrillation, comorbidity index, LVEF





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Bohbot et al. *Circ Cardiovasc Imaging.* 2017;10:e006760.

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Risk stratification of severe AS with preserved LVEF: Peak aortic jet velocity

Multi variable analysis: Asymptomatic patients with Vmax ≥ 5 m/s have a 2-fold increase in mortality risk after adjustment for AV surgery

Vmax	HR	CI	P value
Model 1: Adjusted: for age, sex, BSA, hypertension, CAD, atrial fibrillation, comorbidity index, LVEF			
Vmax <5 m/s	Reference		
Vmax >5 m/s	1.85	1.25-2.71	0.002
Model 2: Adjusted for all variables in Model 1 + AV surgery (time dependent)			
Vmax <5 m/s	Reference		
Vmax >5 m/s	1.98	1.47-2.68	<0.001

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Bohbot et al. *Circ Cardiovasc Imaging.* 2017;10:e006760.

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The patient with asymptomatic AS

Cutoffs for LVEF : LV systolic dysfunction in AS?

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Relationship between LVEF and mortality in Asymptomatic patients with Severe AS

- Multicenter study: Amiens, Lille, Brussels
- 1 678 patients with severe AS, LVEF ≥50% No or minimal symptoms
- Population divided into 3 groups:
  LVEF ≥60%, LVEF 55%-59% and LVEF<55%

TABLE 1 Baseline Demographic, Clinical, and Echocardiographic Characteristics of the Study Population With Asymptomatic and Minimally Symptomatic Severe Aortic Stenosis According to LVEF

	LVEF ≥60% (n = 1,108)	LVEF 55%-59% (n = 331)	LVEF <55% (n = 239)	p Value
Demographic data and symptoms				
Age, yrs	75.8 ± 10.3	75.8 ± 10.7	76.3 ± 10.3	0.709
Males	517 (46.7)	181 (54.7)*	138 (57.7)*	**0.001**
Aortic valve				
Aortic valve area, cm^2	0.74 (0.60, 0.89)	0.73 (0.58, 0.86)	0.75 (0.61, 0.90)	0.387
Peak aortic jet velocity, m/s	4.3 (3.8, 4.8)	4.2 (3.7, 4.7)	4 (3.4, 4.7)†	**0.008**
Transaortic mean pressure gradient, mm Hg	46 (34, 57)	44 (34, 57)	41 (30, 54)*	**0.001**
Indexed stroke volume, ml/m^2	40 (32, 46)	38 (33, 44)	36 (29, 43)*	**0.011**
Left ventricular function				
LV end-diastolic diameter, mm	46 (41, 51)	47 (42, 53)*	49 (43, 53)†	**<0.001**
LV end-systolic diameter, mm	27 (23, 31)	30 (26, 35)†	33 (28, 38)†	**<0.001**
LV end-diastolic volume, ml	100 (79, 135)	117 (91, 154)†	123 (95, 157)†	**0.001**
LV end-systolic volume, ml	33 (23, 44)	48 (37, 62)†	57 (45, 72)†	**<0.001**
Ejection fraction	68 (65, 73)	58 (57, 59)†	53 (51, 54)†	**<0.001**
sPAP, mm Hg	30 (25, 37)	30 (25, 38)	32 (25, 40)	0.066
GLS‡	−17 ± 2	−16 ± 3	−15 ± 4*	**0.007**

Bohbot et al. *J Am Coll Cardiol Img.* 2019; 12: 38-48.

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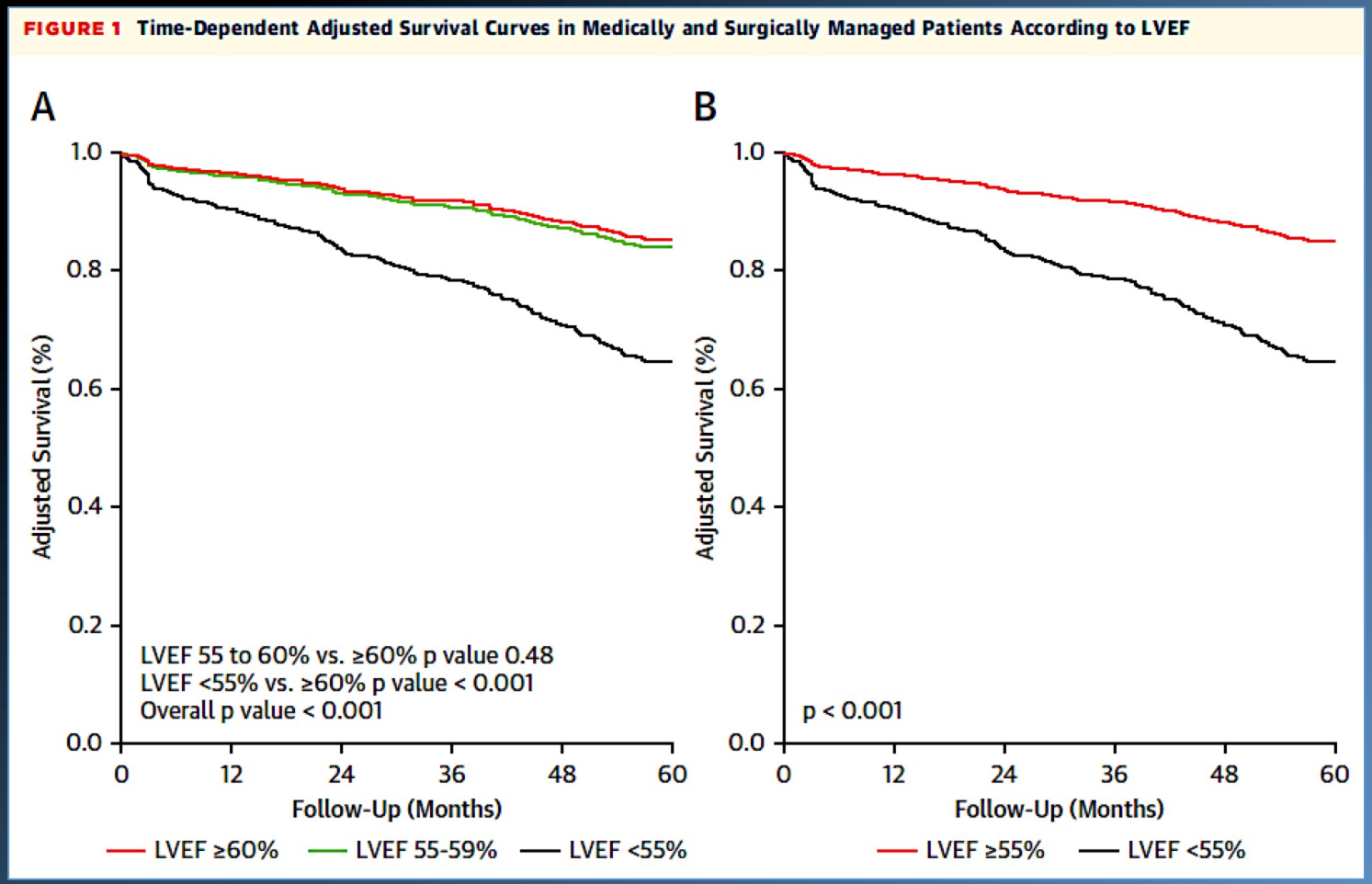
Relationship between LVEF and mortality in Asymptomatic patients with Severe AS

RESULTS: LVEF <55% (14% of study population) was associated with a >2-fold increase in the risk of all-cause mortality

FIGURE 1 Time-Dependent Adjusted Survival Curves in Medically and Surgically Managed Patients According to LVEF



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Bohbot et al. *J Am Coll Cardiol Img.* 2019; 12: 38-48.

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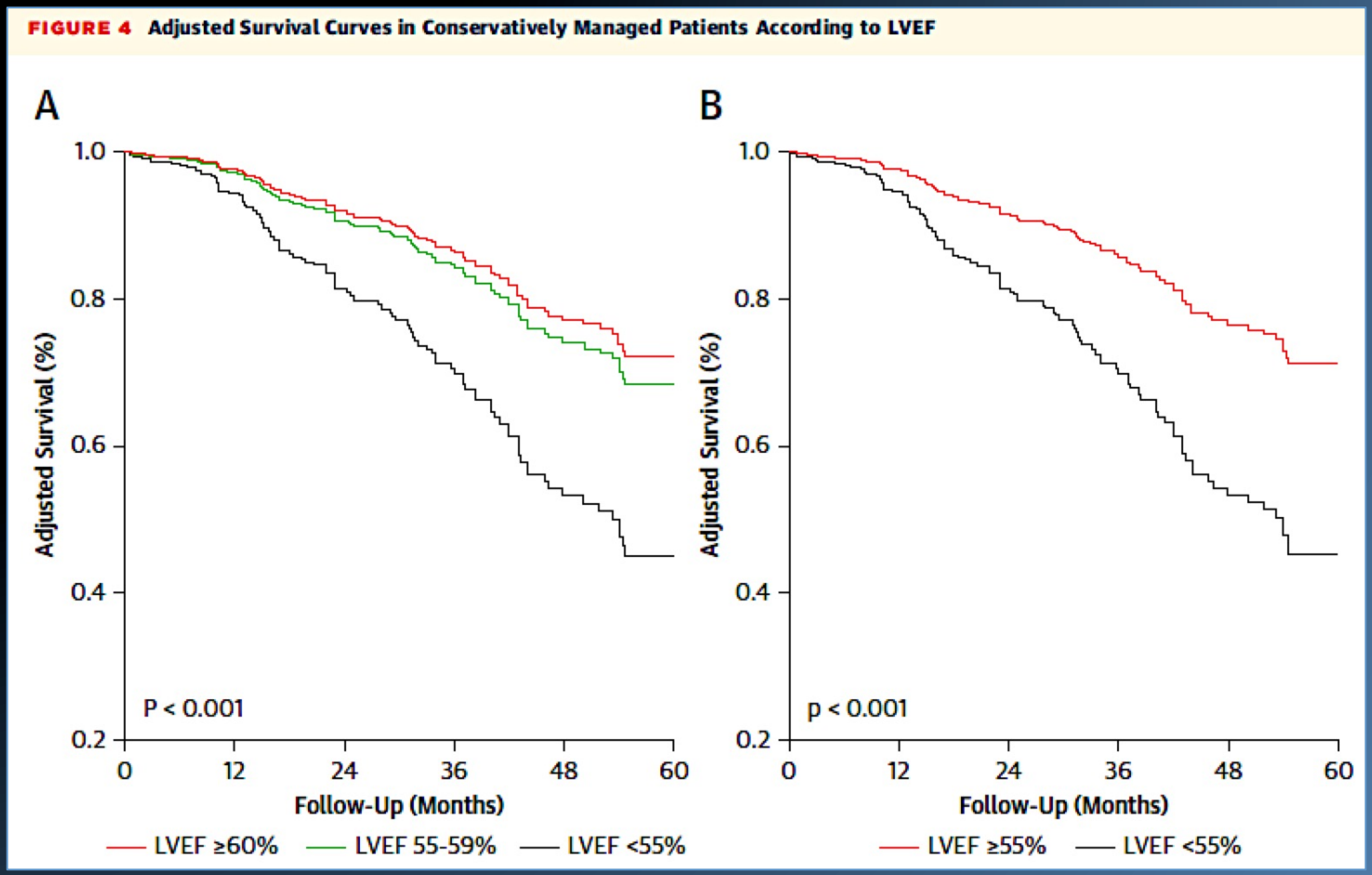
Relationship between LVEF and mortality in Asymptomatic patients with Severe AS

FIGURE 4 Adjusted Survival Curves in Conservatively Managed Patients According to LVEF



Patients with LVEF <55% managed conservatively displayed significant excess mortality, even after covariate adjustment (adjusted HR: 2.44 [1.51 to 3.94]; p < 0.001)

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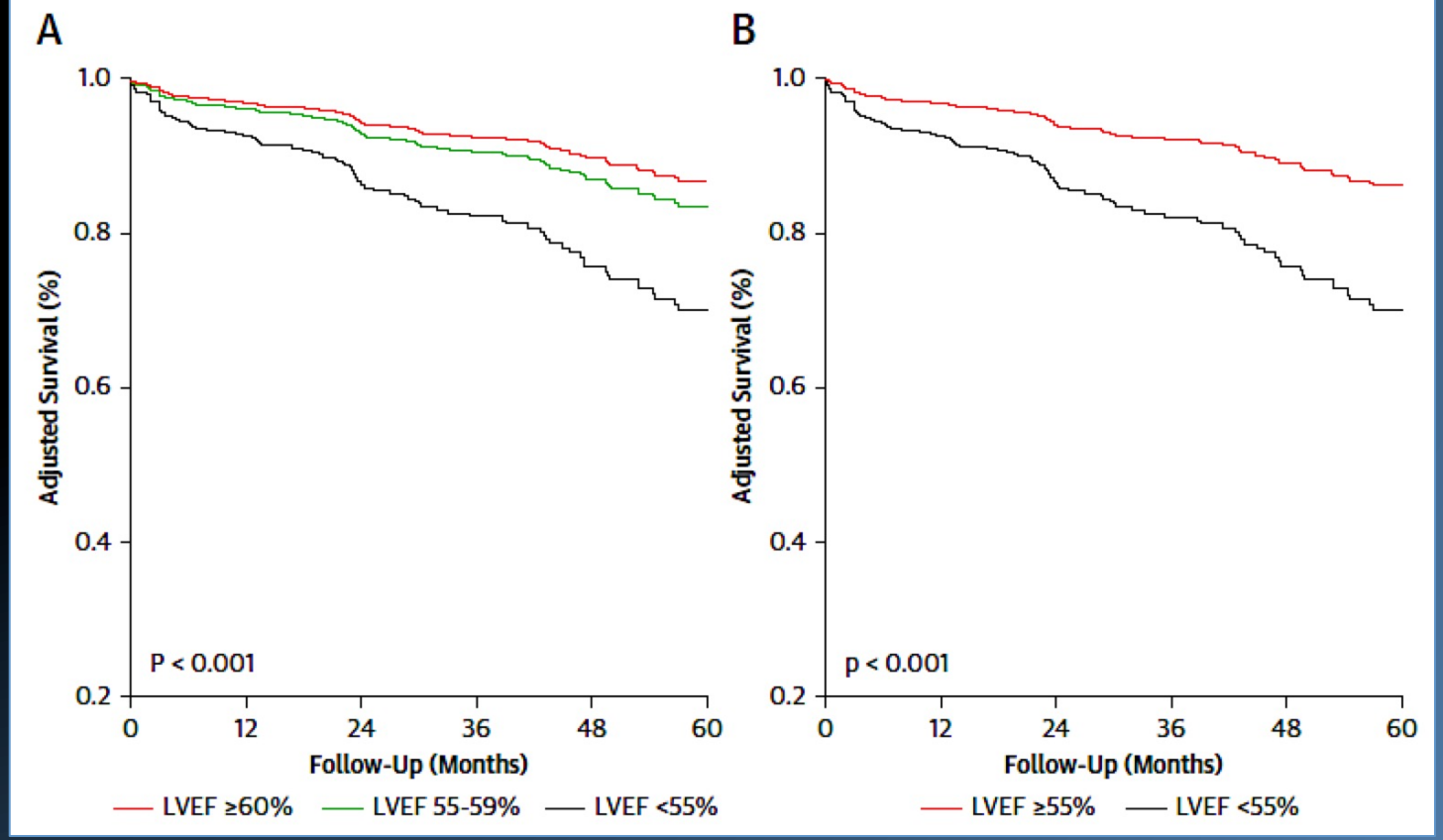
Relationship between LVEF and mortality in Asymptomatic patients with Severe AS

FIGURE 5 Adjusted Survival Curves in Surgically Managed Patients According to LVEF



Patients with preoperative LVEF <55% who underwent SAVR within 3 months also displayed significant excess mortality (adjusted HR: 2.51 [1.58 to 4.00]; p < 0.001)

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Bohbot et al. *J Am Coll Cardiol Img.* 2019; 12: 38-48.

The patient with asymptomatic AS

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Exercise testing: What is really useful ?

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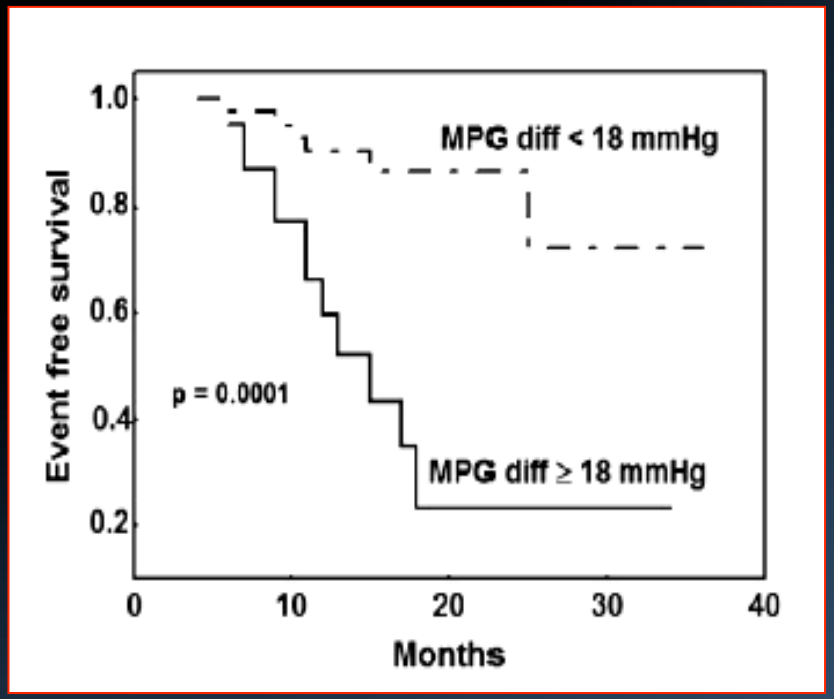
Exercise-Echo in asymptomatic (moderate-severe) aortic stenosis

N= 69 patients. After 15±7 months of FU: 2 patients developed symptoms, 2 were hospitalized for CHF, 12 underwent AVR (combined with CABG in 4) and 3 died (2 from sudden death and 1 in the postoperative period)



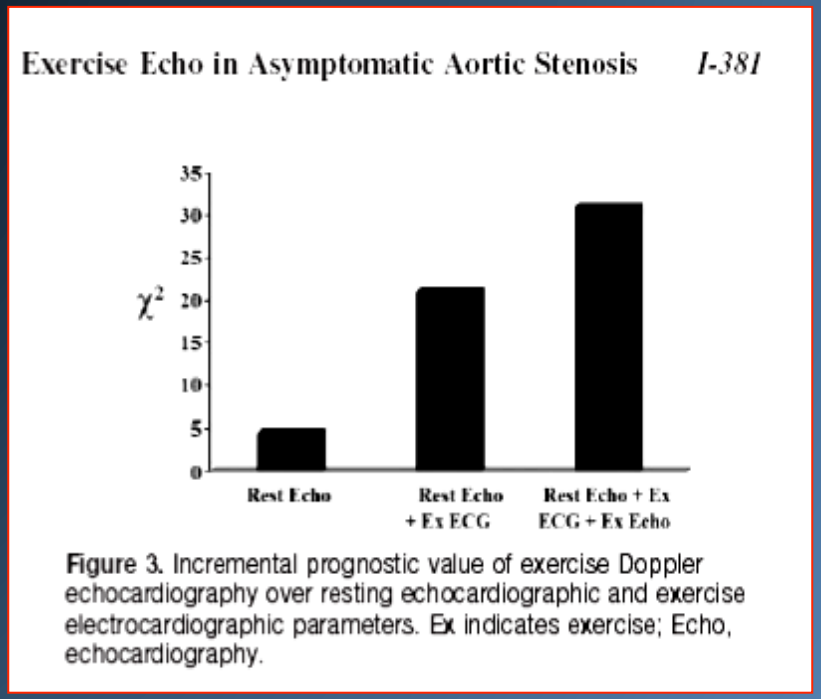


Figure 3. Incremental prognostic value of exercise Doppler echocardiography over resting echocardiographic and exercise electrocardiographic parameters. Ex indicates exercise; Echo, echocardiography.

Incremental prognostic value of Exercise Echo over Rest/ Exercise test: OK

Concerns: mainly moderate AS at baseline; events mostly driven by AVR +++

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Lancellotti et al. *Circulation.* 2005;112[Suppl I]: I-337

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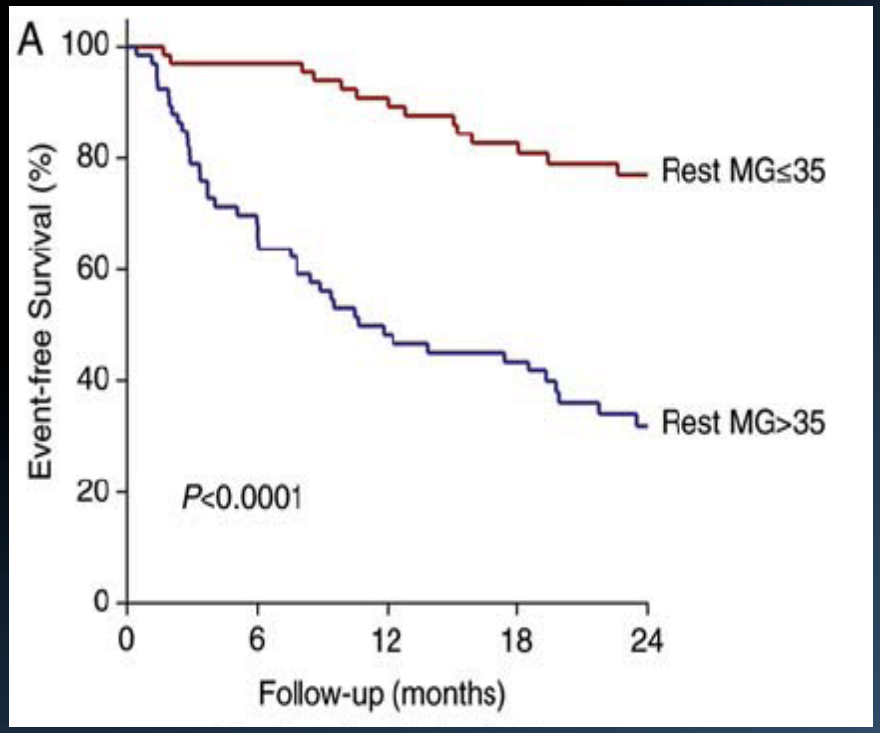
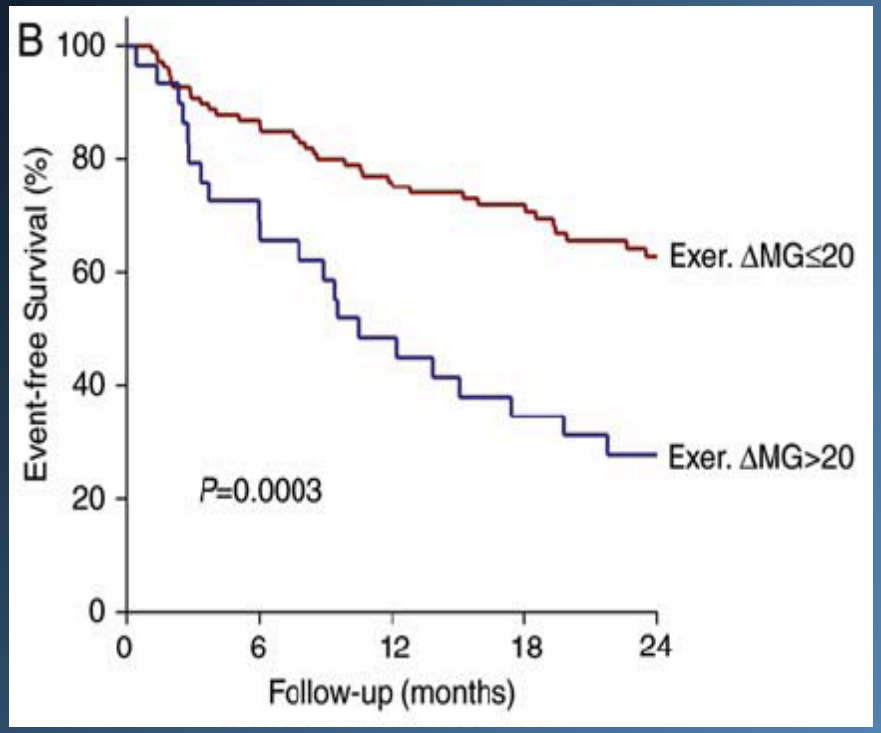
Usefulness of *Exercise Echocardiography* in asymptomatic aortic stenosis

135 asymptomatic patients with moderate/ severe AS and normal standard exercise test





The technical challenge of Doppler measurements at peak exercise may limit their widespread use +++

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Maréchaux et al. *Eur Heart J.* 2010; 31: 1390-7

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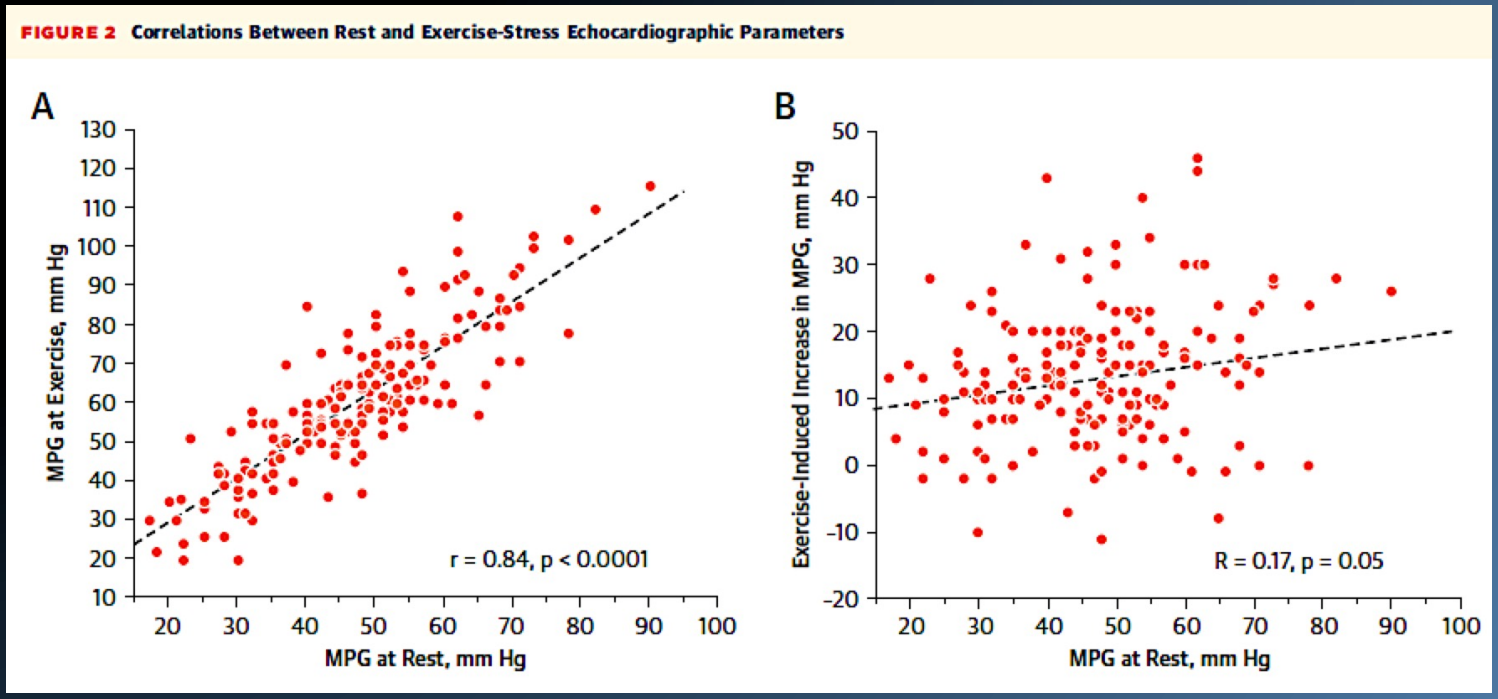
Prognostic value of Exercise-Echo in asymptomatic patients with AS

148 consecutive patients (66±15 years; 74% males) with pure, isolated, asymptomatic AS, LVEF ≥50% and SPAP <50 mm Hg underwent symptom-limited exercise echocardiography

FIGURE 2 Correlations Between Rest and Exercise-Stress Echocardiographic Parameters



(A) Strong correlation between MPG at rest and MPG at peak exercise

(B) No correlation between MPG at rest and changes in MPG during exercise

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Goublaire et al. *J Am Coll Cardiol Img.* 2018; 11:787–95

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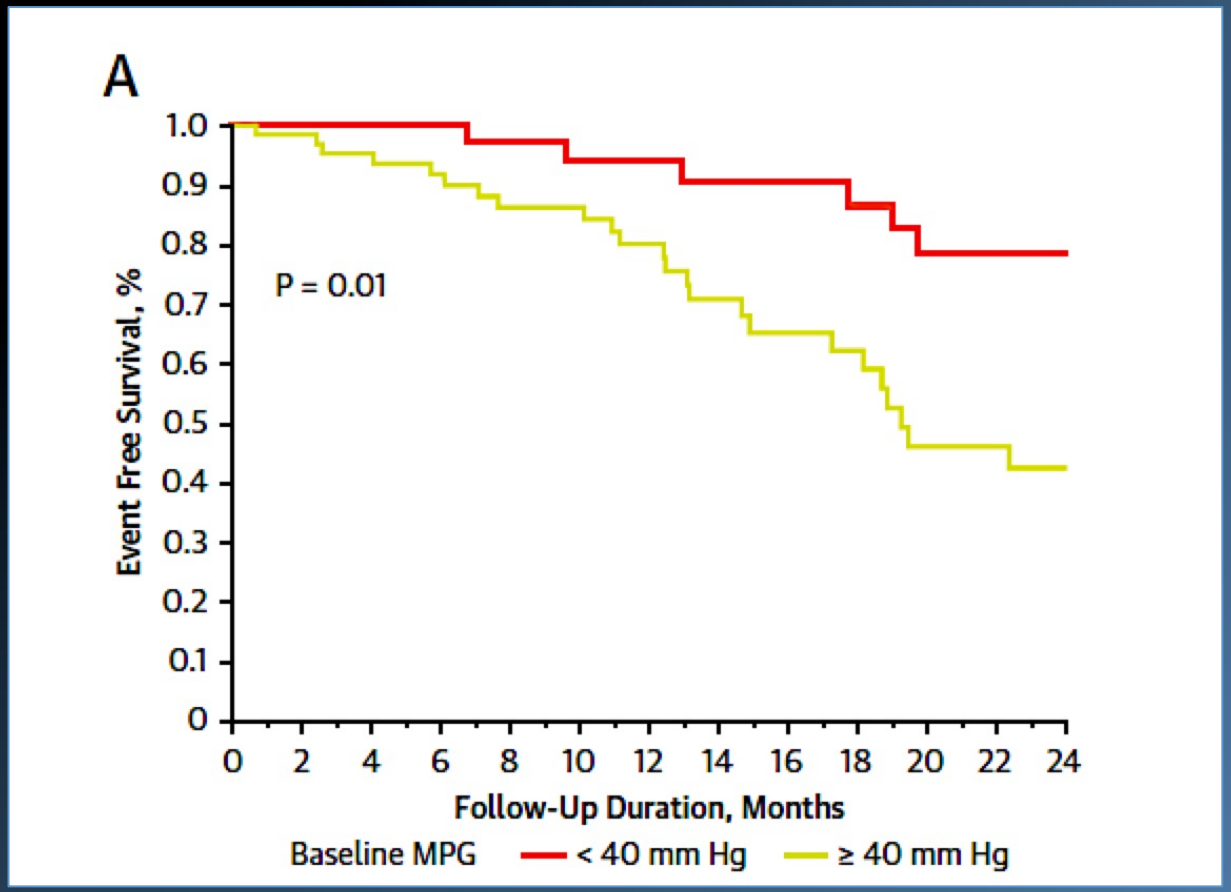
Prognostic value of Exercise-Echo in asymptomatic patients with AS

After adjustment for age, sex, and LVEF, MPG at rest was predictive of outcome (HR: 1.07; 95% CI: 1.04 to 1.10; p < 0.0001)



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Goublaire et al. *J Am Coll Cardiol Img.* 2018; 11:787–95

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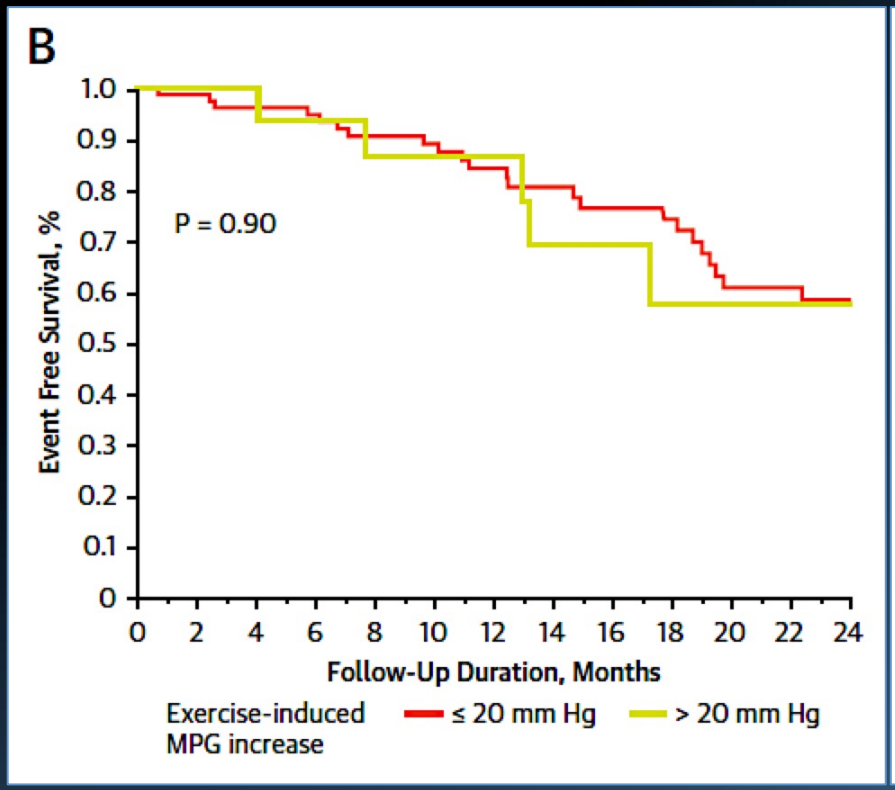
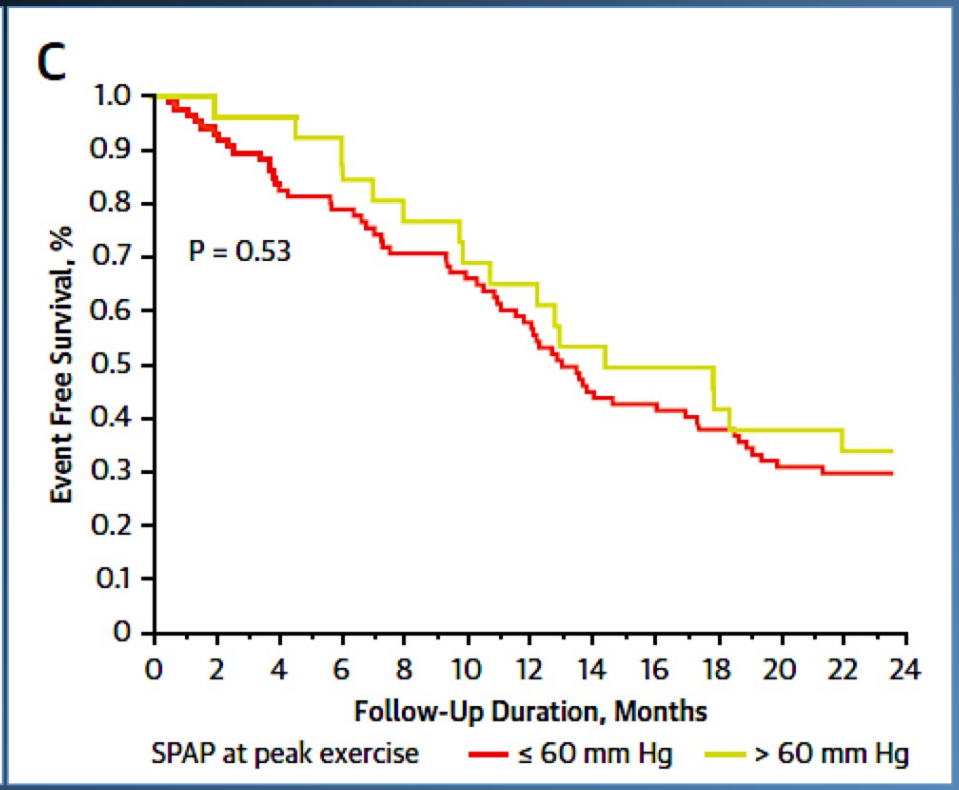
Prognostic value of Exercise-Echo in asymptomatic patients with AS

Neither MPG increase >20 mm Hg nor peak SPAP >60 mm Hg was predictive of the occurrence of AS-related events or aortic valve replacement (all p >0.20)





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Goublaire et al. *J Am Coll Cardiol Img.* 2018; 11:787–95

The patient with asymptomatic AS

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What's the role of BNP ?

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Plasma Brain Natriuretic Peptide Concentration: Impact of Age and Gender

- In 2 042 randomly selected residents of Olmsted County (Minnesota) >44 years old, BNP (Shionogi and Biosite assays), Doppler echocardiography, and medical record review were performed.
- A normal subset of subjects (n =767) in sinus rhythm, without cardiovascular, renal or pulmonary disease or diabetes; without cardiovascular medications and with normal systolic, diastolic, and valvular function was identified.

Table 1. Plasma BNP (Biosite [BNP-B] and Shionogi [BNP-S] Assays) by Age and Gender in Normal Subjects

	Age 45–54		Age 55–64		Age 65–74		Age 75–83	
Gender BNP	n	Median (25th, 75th)	n	Median (25th, 75th)	n	Median (25th, 75th)	n	Median (25th, 75th)
Women								
Biosite	180	18 (10, 32)	135	27 (15, 43)	56	29 (19, 52)	17	67 (28, 89)
Shionogi	194	28 (13, 55)	141	32 (18, 68)	59	45 (20, 111)	18	58 (26, 172)
Men								
Biosite	181	7 (3, 13)	111	11 (5, 20)	40	18 (7, 37)	2	21 (17, 24)
Shionogi	193	17 (9, 34)	118	31 (14, 49)	42	28 (10, 58)	2	38 (31, 44)

The median 25th and 75th percentiles are shown.
BNP = brain natriuretic peptide.

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Redfield et al. *J Am Coll Cardiol.* 2002;40:976–82

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BNP clinical activation in aortic stenosis: Impact on long-term survival

- Definition: BNP Ratio = measured BNP/maximal normal BNP value specific to age and sex; BNP Ratio >1 defined BNP clinical activation
- Hypothesis: Link between BNP Ratio and mortality in 1 953 consecutive patients with at least moderate AS

	Whole cohort (n= 1 953)	Asymptomatic isolated AS (n= 565)
Age (years)	76±12	74±13
Male (%)	55	55
Symptoms, n (%)	1 165 (60)	0
BNP (pg/ml)	252 (98-592)	138 (58-324)
BNP ratio	2,5 (1,0-5,7)	1,4 (0,6-3,1)
Vmax (m/s)	3,8±1,0	3,9±1,0
LVEF (%)	57±15	65±7

Clavel et al. *J Am Coll Cardiol.* 2014;63:2016–25

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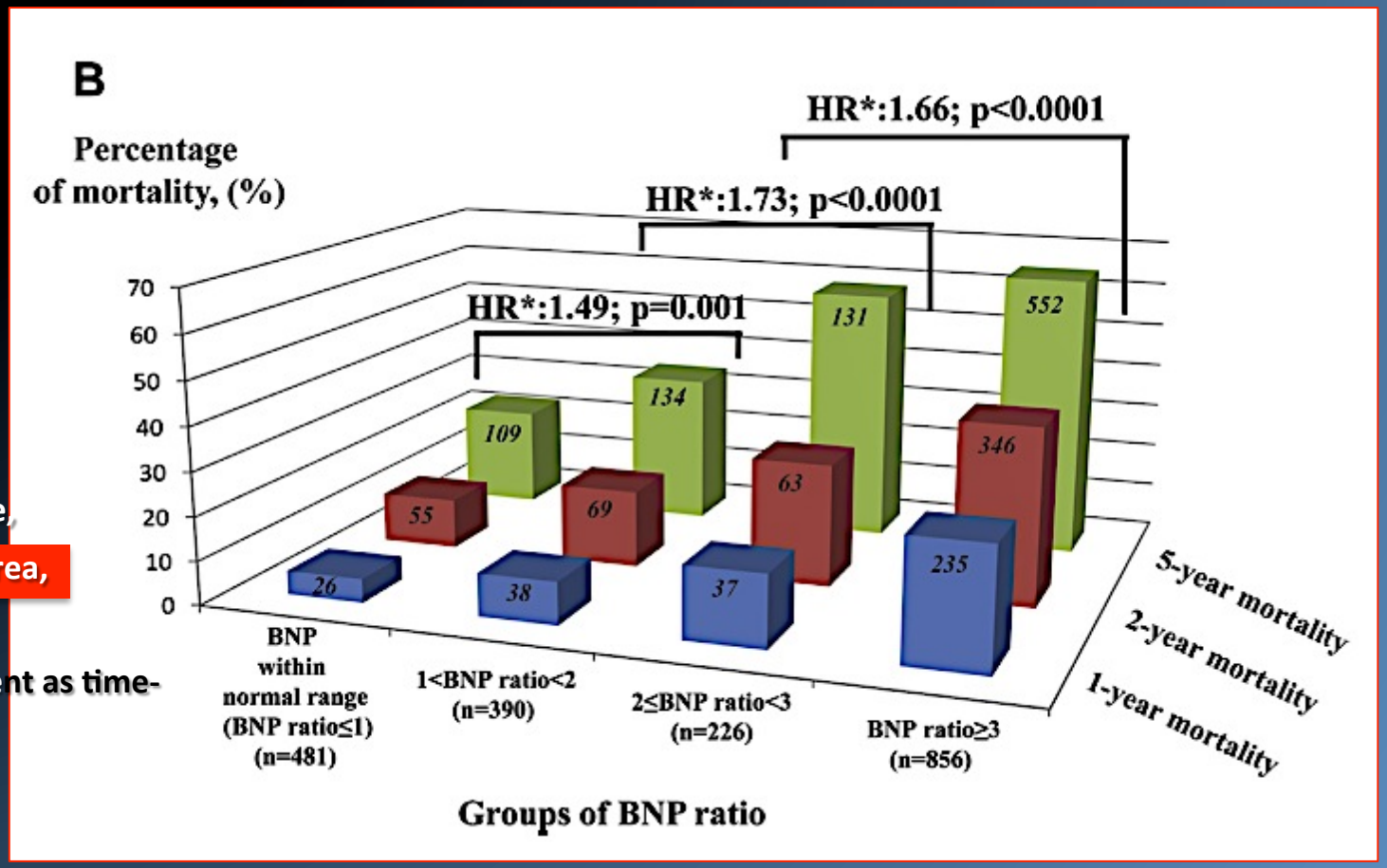
BNP clinical activation in aortic stenosis: Impact on long-term survival

- Link between BNP Ratio and mortality in 1 953 consecutive patients with at least moderate aortic stenosis

*HR Adjusted for:

- age, sex,
- body surface area,
- atrial fibrillation,
- Charlson score index,
- symptoms,
- creatinine level,
- hemoglobin level,
- systolic blood pressure,
- indexed aortic valve area,
- LV ejection fraction,
- aortic valve replacement as time-dependent variable



Clavel et al. *J Am Coll Cardiol.* 2014;63:2016–25

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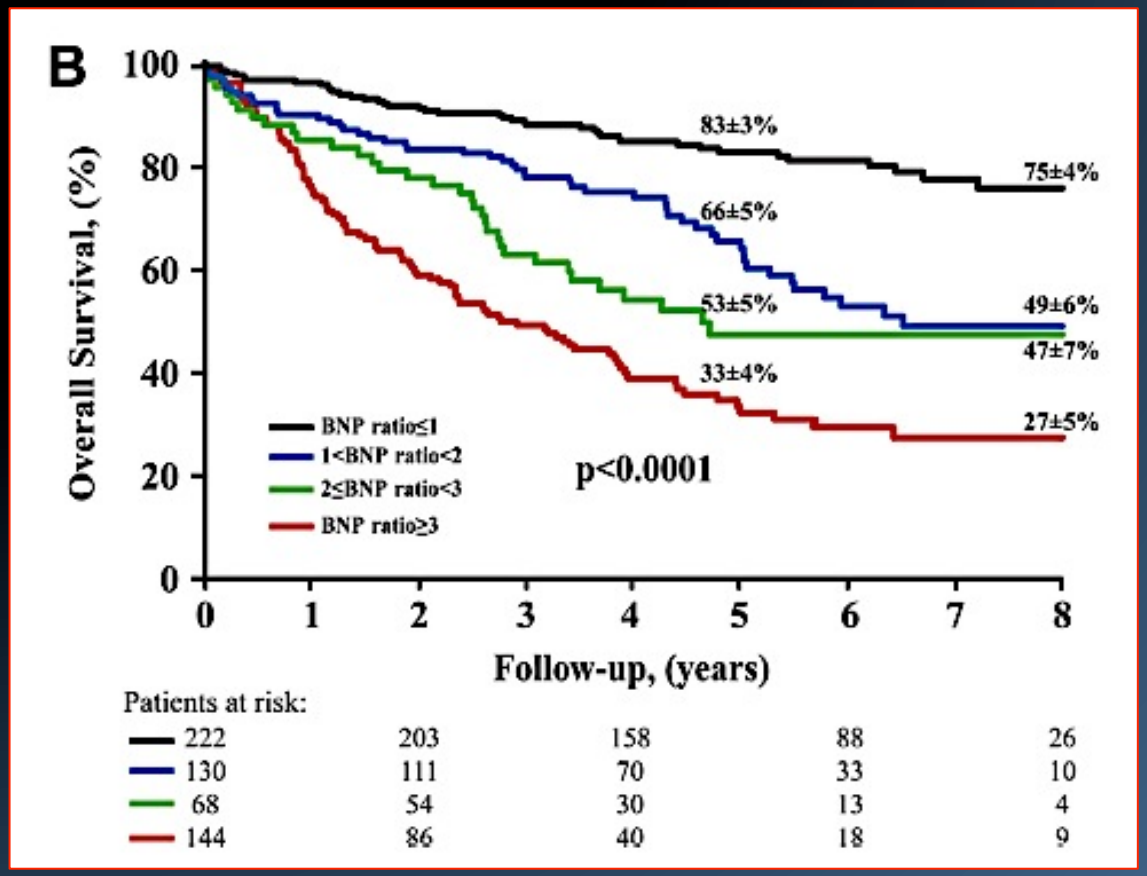
BNP clinical activation in aortic stenosis: Impact on long-term survival

- Link between BNP Ratio and overall survival in 565 asymptomatic patients with at least moderate aortic stenosis, normal LV ejection fraction and no previous AMI



- BNP clinical activation is associated with excess long-term mortality incrementally and independently of all baseline characteristics, even in asymptomatic patients
- Higher mortality with higher BNP clinical activation emphasizes the need of appropriate clinical interpretation of BNP levels according to age/ gender

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Clavel et al. *J Am Coll Cardiol.* 2014;63:2016–25

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Risk score for predicting outcome in patients with asymptomatic aortic stenosis

- Prospective observational study, single center (FR): 107 patients with asymptomatic AS (72 years [63-77]; 35 women; Vmax: 4.1 m/s [3.5-4.4]).
- Predefined end points for assessing outcome: occurrence within 24 months of death or AV replacement necessitated by symptoms.

Variable at baseline	Whole population (n= 104)	Remained asymptomatic (n= 42)	Endpoint ≤ 24 months (n=62)	p value
Valve area, cm^2	0.9 [0.8-1.1]	1.1 [1.0-1.3]	0.8 [0.7-1.0]	0.0001
Indexed area, cm^2	0.5 [0.4-0.6]	0.6 [0.5-0.7]	0.5 [0.4-0.5]	0.0001
Baseline BNP, pg/ml	58 [30-111]	30 [14-64]	83 [43-165]	0.0001
BNP (2), pg/ml	66 [32-173]	36 [16-71]	161 [64-242]	0.0001

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Monin et al. *Circulation*. 2009; 120: 69-75

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Risk score for predicting outcome in patients with asymptomatic aortic stenosis

Variables independently associated with outcome were used to build a score that was validated in an independent cohort of 107 patients from Belgium

Variable at baseline	Odds ratio	95% confidence interval	p value
Baseline serum BNP	3.9	1.8 - 8.1	0.0001
Baseline Peak aortic -jet velocity	6.2	2.1 - 17.9	0.001
Female gender	5.2	1.5 - 18.6	0.012

Score = [Vmax (m/s) x 2] + [Nat. Log BNP x 1.5] + 1.5 (female gender)

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Monin et al. *Circulation*. 2009; 120: 69-75

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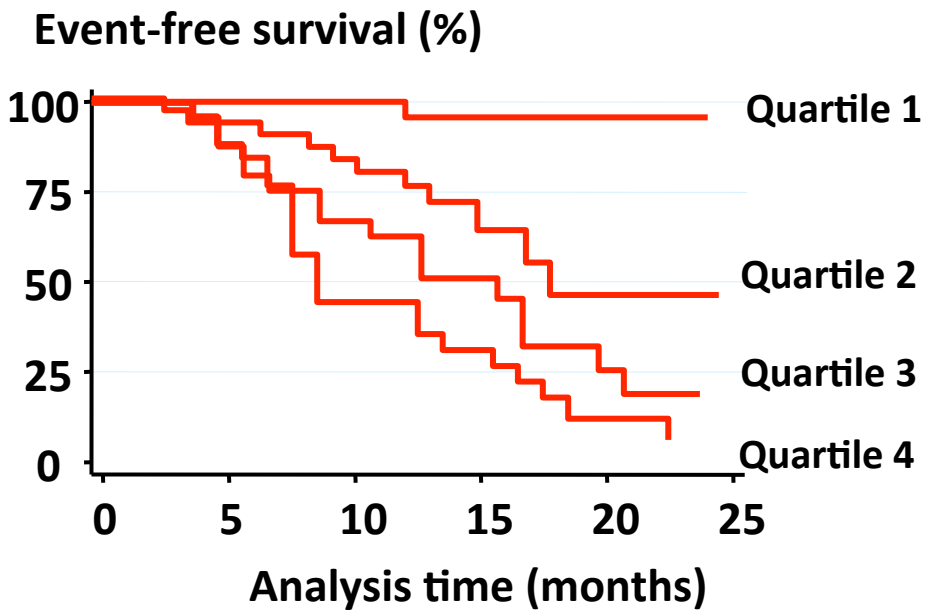
Risk score for predicting outcome in patients with asymptomatic aortic stenosis

Event-free survival after 20 months: 80% for patients within the 1st score quartile vs. 7% for the 4th quartile

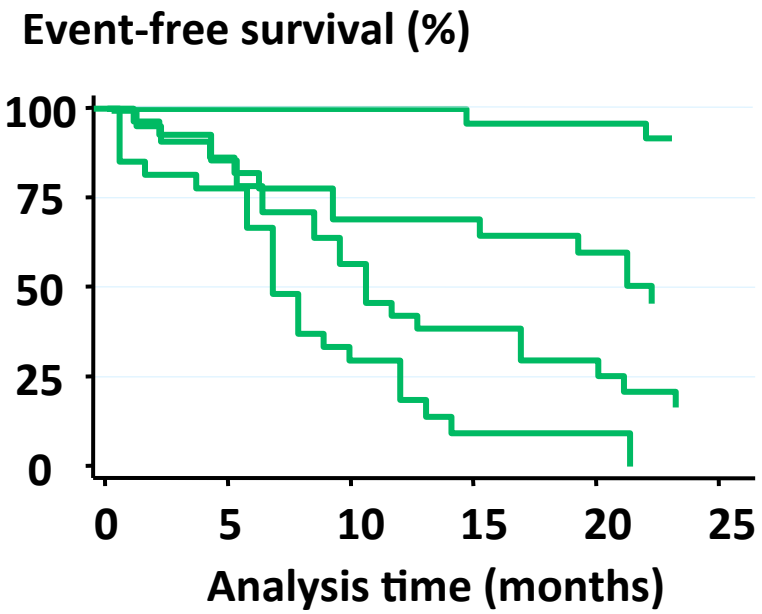
Development Cohort
Créteil, N= 104



80%

7%

Validation Cohort
Lièges, N= 107



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Monin et al. *Circulation*. 2009; 120: 69-75

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The patient with asymptomatic AS

What's the role of 2D-strain?

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Dahl JS et al. JACC Cardiovasc Imaging. (2016)

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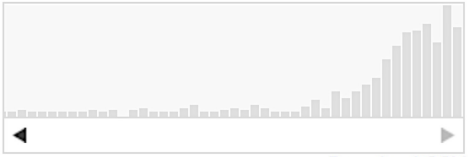

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CLINICAL RESEARCH
Valvular heart disease

Alterations in multidirectional myocardial functions in patients with aortic stenosis and preserved ejection fraction: a two-dimensional speckle tracking analysis

Arnold C.T. Ng[1,2†], Victoria Delgado[1†], Matteo Bertini[1], Marie Louisa Antoni[1], Rutger J. van Bommel[1], Eva P.M. van Rijnsoever[1], Frank van der Kley[1], See Hooi Ewe[1], Tomasz Witkowski[1], Dominique Auger[1], Gaetano Nucifora[1], Joanne D. Schuijf[1], Don Poldermans[3], Dominic Y. Leung[4], Martin J. Schalij[1], and Jeroen J. Bax[1*]

[1]Department of Cardiology, Leiden University Medical Center, Albinusdreef 2, 2333 ZA Leiden, The Netherlands; [2]Department of Cardiology, Princess Alexandra Hospital, University of Queensland, Brisbane, Queensland, Australia; [3]Department of Anaesthesiology, Erasmus Medical Center, Rotterdam, The Netherlands; and [4]Department of Cardiology, Liverpool Hospital, Sydney, New South Wales, Australia

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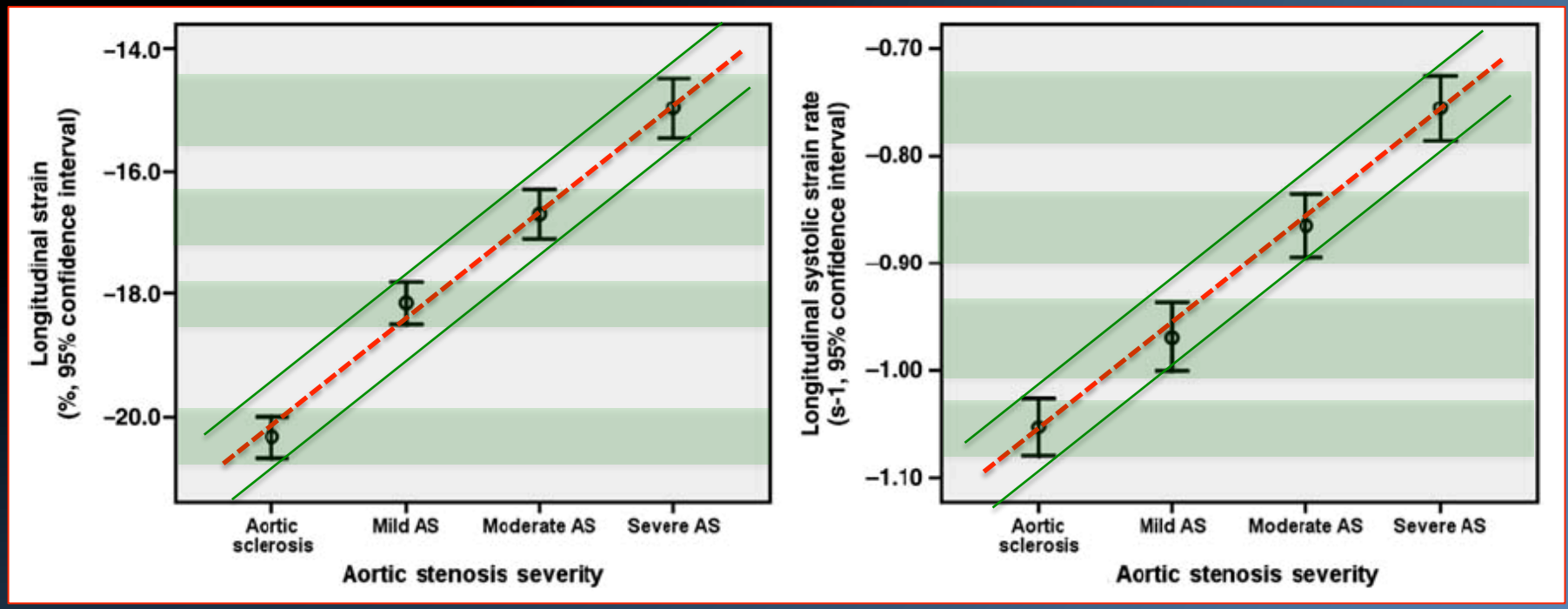
Alterations in multidirectional strain in AS with preserved ejection fraction (???)

420 patients (age 66±15 years) with aortic sclerosis, mild, moderate, and severe AS with LVEF ≥50%. Multidirectional strain / SR imaging.



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Ng et al. *Eur Heart J.* 2011; 32: 1542

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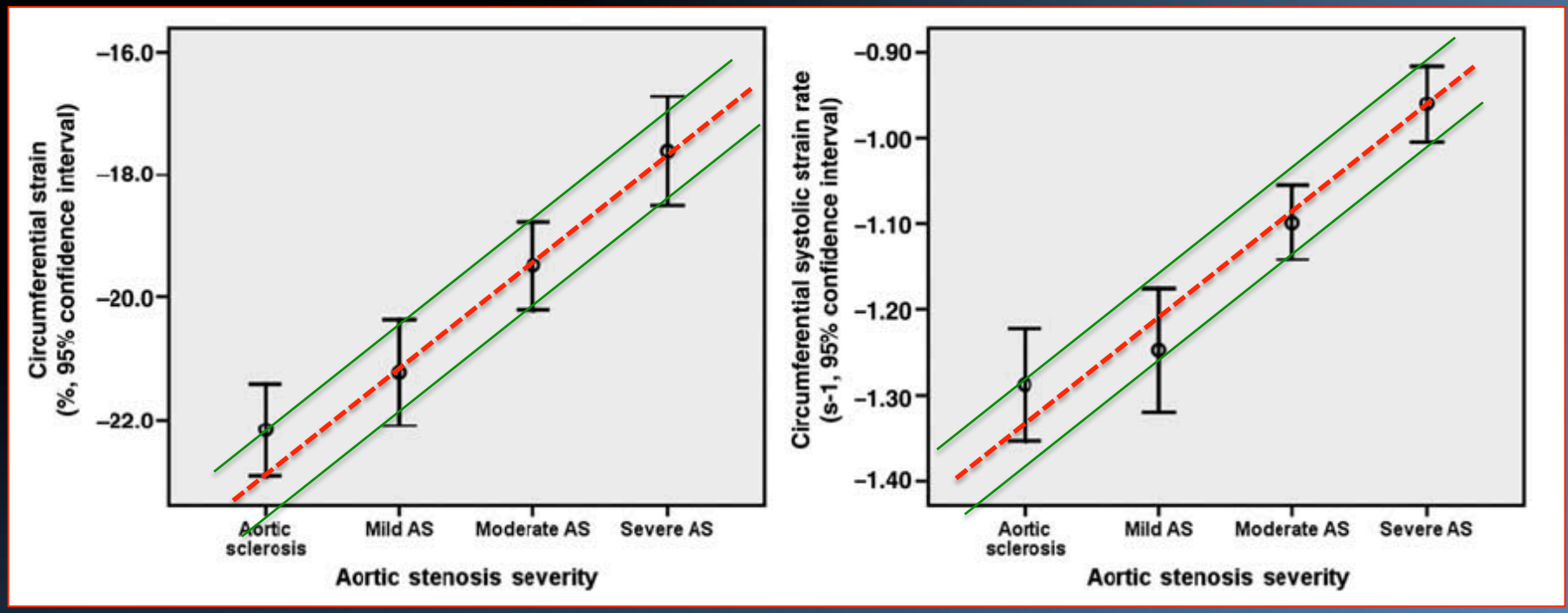
Alterations in multidirectional strain in AS with preserved ejection fraction (???)

Myocardial dysfunction starts in the sub-endocardium (mild AS) to mid-wall (moderate AS) and eventually to transmural dysfunction (severe AS)



Aortic valve area (AS severity) was an independent determinant of multidirectional strain and SR on multiple linear regressions

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Ng et al. *Eur Heart J.* 2011; 32: 1542

Impact of impaired myocardial deformations on exercise tolerance and prognosis in patients with asymptomatic aortic stenosis

Stéphane Lafitte[1]*, Matthieu Perlant[1], Patricia Reant[1], Karim Serri[2], Herve Douard[1], Anthony DeMaria[3], and Raymond Roudaut[1]

[1]*Cardiologic Hospital, Pessac and Bordeaux 2 University, France*; [2]*Sacre Coeur Hospital, University of Montreal, Montreal, Canada*; *and* [3]*Division of Cardiology, University of California at San Diego, USA*

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Lafitte et al. *Eur J Echocardiogr.* 2008;10:414-9

KEYWORDS
Aortic valvular stenosis;
Myocardial contractility;
Strain echocardiography;
Prognosis

Aims As assessed by tissue Doppler velocities, longitudinal contraction is commonly altered at an earlier stage than radial contraction in patients with severe aortic stenosis (AS). However, its relationship to exercise tolerance or to prognosis has not been clearly established. By using two-dimensional (2D) echocardiographic strain, we sought to evaluate values of deformation components in the setting of severe AS and to correlate these values with exercise tolerance and with patients' outcome.

Methods and results Sixty-five asymptomatic patients with severe AS (aortic valve area $<1\ cm^2$) were studied by echocardiography and exercise treadmill and were compared with controls. Conventional echographic parameters as well as longitudinal, radial, and circumferential deformations by 2D strain were measured at rest. During exercise treadmill, maximum tolerated workload, maximum heart rate, blood pressure, and EKG ST variations were recorded. Patients were then followed during 12 months. Compared with controls, despite similar ejection fractions, AS patients presented with a significantly lower global longitudinal strain (GLS) (-17.8 ± 3.5 vs. $-21.1 \pm 1.8\%$, $P < 0.05$) more pronounced in the basal segments (BLS) (-12.4 ± 2.9 vs. $-18.4 \pm 2.5\%$, $P < 0.05$). No difference was observed in terms of radial or circumferential strains. In a subgroup of AS patients with abnormal response to exercise, GLS and BLS were significantly lower (-14.7 ± 5.1 vs. $-19.3 \pm 4.0\%$ and -10.7 ± 2.5 vs. $-14.4 \pm 2.1\%$, $P < 0.05$). With cut-offs of -18 and -13%, GLS and BLS were able to determine an inadequate exercise response with a sensitivity and specificity of 68 and 75% (AUC 0.77), and 77 and 83% (AUC 0.81), respectively. Finally, patients with a basal strain below -13% presented with more cardiac events in the follow-up.

Conclusion In asymptomatic patients with severe AS, impaired longitudinal contraction assessed by 2D strain is associated with abnormal exercise response and with an increased risk of cardiac events during follow-up.

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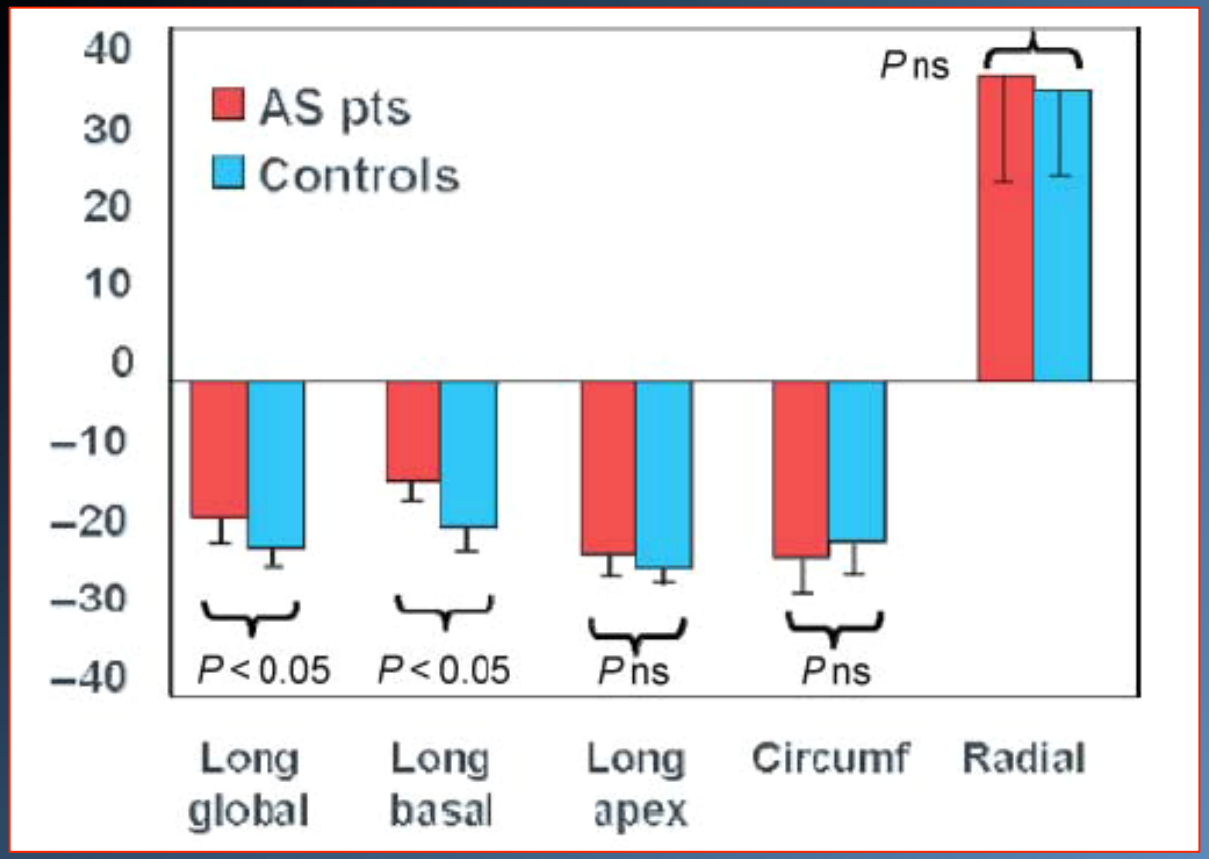
Impaired myocardial strain and prognosis in asymptomatic AS

In 65 Pts with asymptomatic AS (*strain*: GE Medical systems):

- Lower longitudinal strain (- 18 vs. -21%, P < 0.05) vs. Controls despite similar LVEF
- NB: lowest strain-values in basal segments

NB: Circumferential or Radial strain: NS



Lafitte et al. *Eur J Echocardiogr.* 2008;10:414-9

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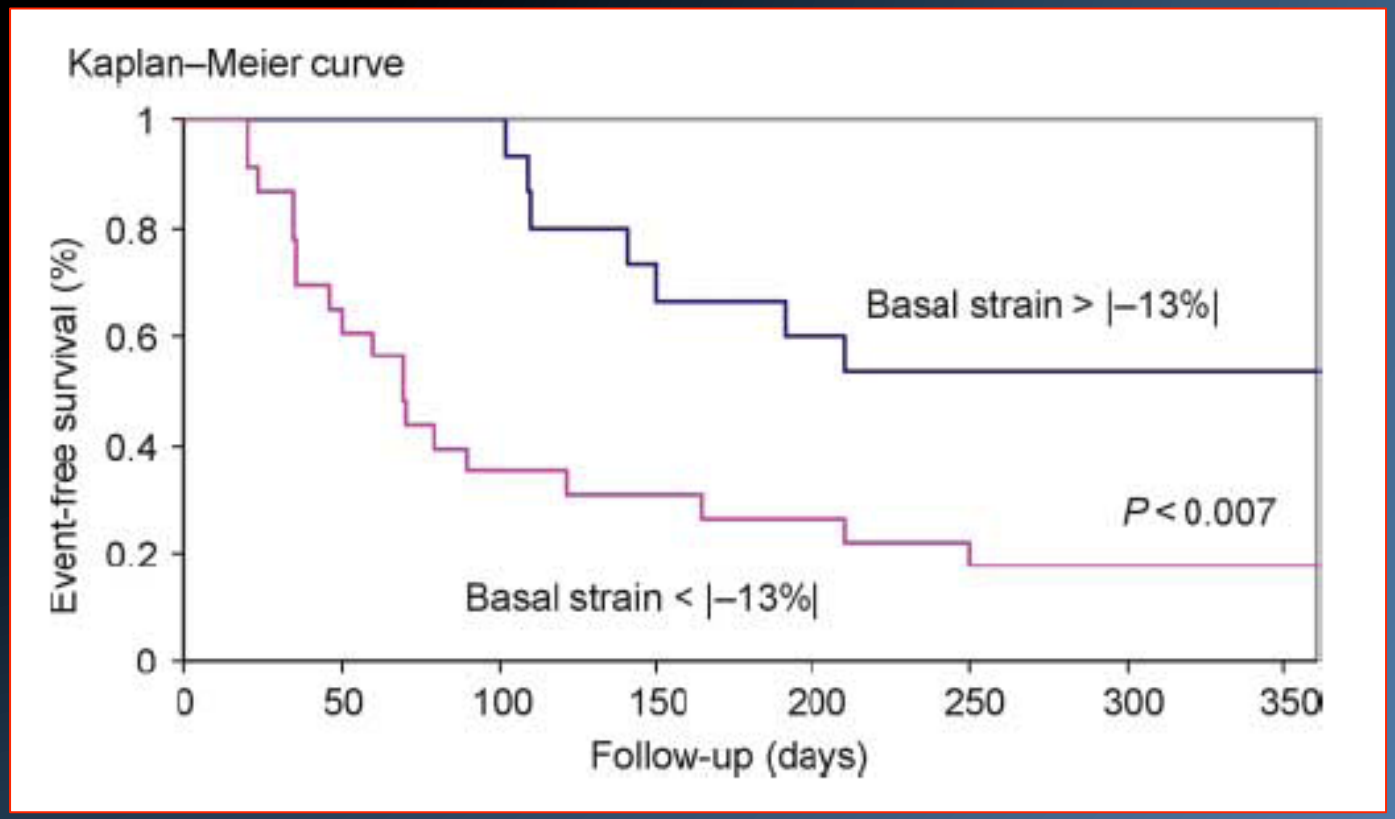
Impaired myocardial strain and prognosis in asymptomatic AS

Endpoint: hospitalization for cardiac cause, AV replacement or cardiovascular death within 12 months



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Lafitte et al. *Eur J Echocardiogr.* 2008;10:414-9

Myocardial deformation in aortic valve stenosis: relation to left ventricular geometry

Dana Cramariuc,[1,2] Eva Gerdts,[1,2] Einar Skulstad Davidsen,[2] Leidulf Segadal,[3] Knut Matre[1]

Cramariuc et al. *Heart*. 2010; 96: 106-12

► See Editorial p 95

[1]Institute of Medicine, University of Bergen, Bergen, Norway
[2]Department of Heart Disease, Haukeland University Hospital, Bergen, Norway [3]Department of Surgical Sciences, University of Bergen, Bergen, Norway

Correspondence to
Dana Cramariuc, Department of Heart Disease, Haukeland University Hospital, NO-5021, Bergen, Norway; dana.cramariuc@helse-bergen.no

Disclosures: Eva Gerdts has received honoraria for occasional lectures at scientific symposia sponsored by Merck/Schering-Plough Pharmaceuticals and as member of the Scientific Steering Committee in the SEAS study.

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ABSTRACT

Objective To assess left ventricular (LV) strain and displacement and their relations to LV geometry in patients with aortic stenosis (AS).

Design Cross-sectional echocardiographic study in patients with AS. Peak circumferential, radial and longitudinal strain, and radial, longitudinal and transverse displacement were measured by 2D speckle tracking. Severity of AS was assessed from energy loss index (ELI). LV hypertrophy was present if LV mass/height$^{2.7}$ $\geq$46.7/49.2 g/m$^{2.7}$ in women/men and concentric LV geometry if relative wall thickness $\geq$0.43. LV geometry was assessed from LV mass/height$^{2.7}$ and relative wall thickness in combination.

Setting Department of Heart Disease, Haukeland University Hospital, Bergen, Norway.

Patients 70 patients with AS (mean age 73$\pm$10 years, 54% women).

Interventions None.

Main outcome measures Association of regional and average LV myocardial strain and displacement with LV geometric pattern and degree of AS.

Results Average longitudinal strain was lower in the hypertrophy groups and correlated with higher LV mass index and relative wall thickness, lower stress-corrected

myocardial deformation (ie, thickening and thinning in the radial plane, and shortening and lengthening in the longitudinal and circumferential planes) and thus enabling assessment of regional or global myocardial function.[6–9] Myocardial deformation can be assessed both by tissue Doppler imaging and 2D speckle tracking echocardiography,[10–12]. For this study we chose 2D speckle tracking which is angle-independent and allows faster post-processing and analysis of multiple segments simultaneously.[11 13]

The aim of this study was to assess the impact of LV geometry on LV strain and displacement in patients with degenerative AS.

METHODS

Study population

This study was prospectively planned for all patients with degenerative AS who had conventional and 2D speckle tracking echocardiography undertaken at the echocardiography laboratory, Haukeland University Hospital, Bergen, Norway as part of prospective clinical trial protocols in the time period April 2006–October 2007. A total of 70 patients were identified, and all agreed to participate

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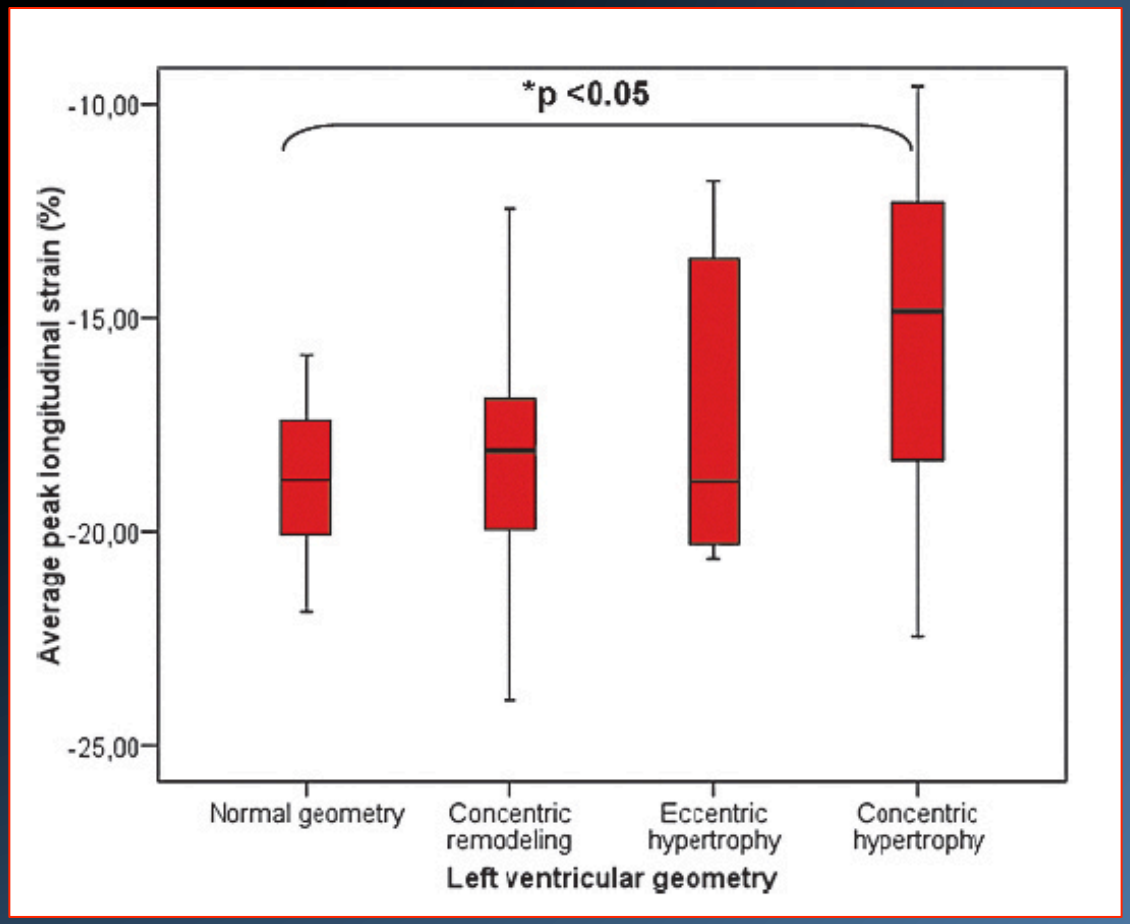
Myocardial deformation in AS : Relation to LV geometry

2D-Strain assessed by Speckle Tracking (*GE Healthcare*) in 70 patients with AS and various degrees of LV remodeling



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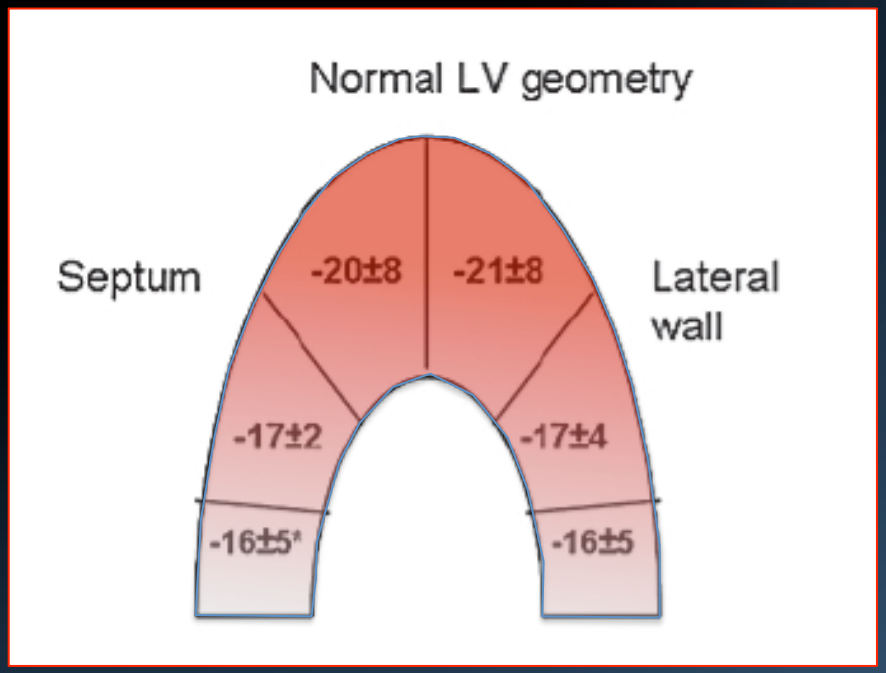
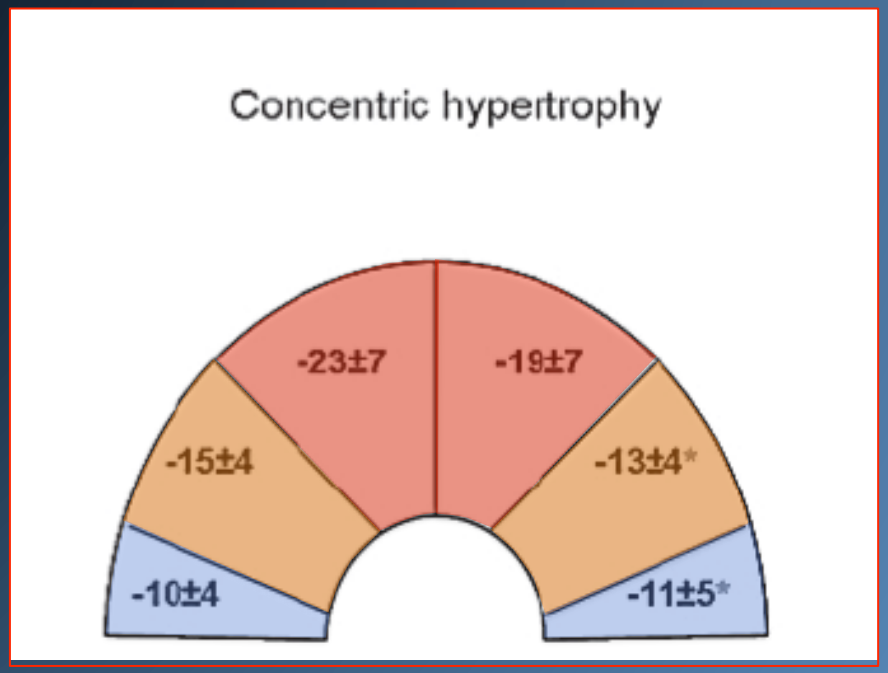
Myocardial deformation in AS : Relation to LV geometry

Longitudinal Strain was significantly lower in the basal segments in all LV remodeling patterns compared with patients with normal geometry





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Cramariuc et al. *Heart.* 2010; 96: 106-12

Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Normal Ejection Fraction Is Associated With Severe Left Ventricular Dysfunction as Assessed by Speckle-Tracking Echocardiography

A Multicenter Study

Jérôme Adda, MD; Christopher Mielot, MD; Roch Giorgi, MD, PhD; Frédéric Cransac, MD; Xavier Zirphile, MD; Erwan Donal, MD; Catherine Sportouch-Dukhan, MD; Patricia Réant, MD; Stéphane Laffitte, MD; Stéphane Cade, MD; Yvan Le Dolley, MD; Franck Thuny, MD; Nathalie Touboul, PhD; Cécile Lavoute, PhD; Jean-François Avierinos, MD; Patrizio Lancellotti, MD; Gilbert Habib, MD

Background—Low-flow low-gradient (LFLG) is sometimes observed in severe aortic stenosis (AS) despite normal ejection fraction, but its frequency and mechanisms are still debated. We aimed to describe the characteristics of patients with LFLG AS and assess the presence of longitudinal left ventricular dysfunction in these patients.

Methods and Results—In a multicenter prospective study, 340 consecutive patients with severe AS and normal ejection fraction were studied. Longitudinal left ventricular function was assessed by 2D-strain and global afterload by valvulo-arterial impedance. Patients were classified according to flow and gradient: low flow was defined as a stroke volume index $\leq$35 mL/m^2, low gradient as a mean gradient $\leq$40 mm Hg. Most patients (n=258, 75.9%) presented with high-gradient AS, and 82 patients (24.1%) with low-gradient AS. Among the latter, 52 (15.3%) presented with normal flow and low gradient and 30 (8.8%) with LFLG. As compared with normal flow and low gradient, patients with LFLG had more severe AS (aortic valve area=0.7$\pm$0.12 cm^2 versus 0.86$\pm$0.14 cm^2), higher valvulo-arterial impedance (5.5$\pm$1.1 versus 4$\pm$0.8 mm Hg/mL/m^2), and worse longitudinal left ventricular function (basal longitudinal strain=$-$11.6$\pm$3.4 versus $-$14.8$\pm$3%; $P<0.001$ for all).

Conclusions—LFLG AS is observed in 9% of patients with severe AS and normal ejection fraction and is associated with high global afterload and reduced longitudinal systolic function. Patients with normal-flow low-gradient AS are more frequent and present with less severe AS, normal afterload, and less severe longitudinal dysfunction. Severe left ventricular longitudinal dysfunction is a new explanation to the concept of LFLG AS. (***Circ Cardiovasc Imaging*. 2012;5:27-35.**)

Key Words: aorta ■ stenosis ■ echocardiography ■ valves

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Bas débit/ bas gradient paradoxal : Altération de la fonction longitudinale

Etude multicentrique, N= 340 Pts, SAo < 0.6 cm^2/m^2 avec FEVG >50%

Strain (2D) Longitudinal	Débit normal/ Haut Gradient N= 213, 63%	Bas débit/ Haut Gradient N= 45, 13%	Débit normal/ Bas Gradient N= 52, 15%	Bas débit/ Bas Gradient N= 30, 9%
Strain global (%)	-17±3	-14±4 ***	-17±4	-16±4
Strain apical (%)	-22±6	-20±5 *	-21±6	-20±7
Strain médian(%)	-16±3	-14±3 ***	-17±3	-14±3 §
Strain basal (%)	-14±3	-11±3 ***	-15±3	-12±3 *§§

* p<.05 and *** p<.001 vs. Débit normal/ Haut gradient
§ p<.05 and §§ p<.001 vs. Débit normal/ Bas gradient

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Adda et al. *Circ Cardiovasc Imaging.* 2012; 5:27-35

Relationship between Longitudinal Strain and Symptomatic Status in Aortic Stenosis

David Attias, MD, Laurent Macron, MD, Julien Dreyfus, MD, Jean-Luc Monin, MD, PhD, Eric Brochet, MD, Laurent Lepage, MD, Guillaume Hekimian, MD, Bernard Iung, MD, Alec Vahanian, MD, and David Messika-Zeitoun, MD, PhD, *Paris, France*

Background: Global longitudinal strain (GLS) and basal longitudinal strain (BLS) assessed using two-dimensional speckle-tracking imaging have been proposed as subtle markers of left ventricular (LV) systolic dysfunction with potential prognostic value in patients with aortic stenosis (AS). The aim of this study was to evaluate the relationship between longitudinal strain and symptomatic status in patients with AS.

Methods: GLS and BLS were measured in 171 patients with pure, isolated, at least mild AS prospectively enrolled at two institutions. The population was divided into four groups: asymptomatic nonsevere AS ($n = 55$), asymptomatic severe AS with preserved LV ejection fraction (LVEF; ≥50%) ($n = 37$), symptomatic severe AS with preserved LVEF ($n = 60$), and severe AS with reduced LVEF (<50%) ($n = 19$).

Results: GLS was significantly different among the four groups ($P < .0001$), but the difference was due mainly to patients with reduced LVEFs. In addition, there was an important overlap among the groups, and in multivariate analysis, after adjustment for age, gender, AS severity, and LVEF, GLS was not an independent predictor of symptomatic status ($P = .07$). BLS was also significantly different among the four groups ($P < .0001$) but in contrast was independently associated with symptomatic status ($P < .0001$). However, as for GLS, there was an important overlap between groups and differences were close to intraobserver or interobserver variability (1.3 ± 1.1% and 2.0 ± 1.6%, respectively).

Attias et al. *J Am Soc Echocardiogr.* 2013; 8: 868-74

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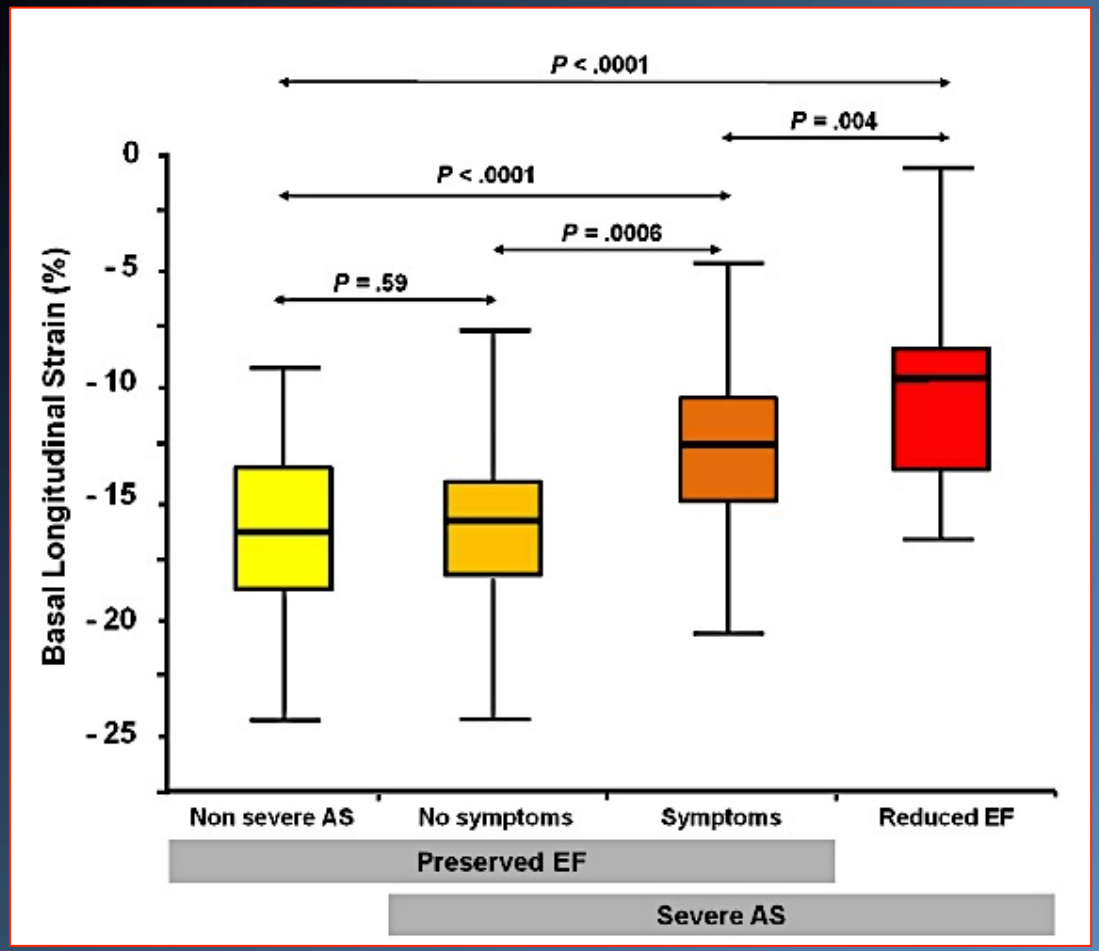
Relationship between longitudinal strain and symptomatic status in AS

GLS and BLS measured in 171 patients with pure, at least mild AS prospectively enrolled at two institutions

- BLS was independently associated with symptomatic status in contrast to GLS.

- However: important overlap between groups; differences close to measurements' reproducibility

- Longitudinal strain, at least as a single criterion, should be interpreted with caution in the decision-making process in asymptomatic/ severe AS



Attias et al. *J Am Soc Echocardiogr.* 2013; 26: 868-74

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European Heart Journal – Cardiovascular Imaging (2016) **17**, 283–292
doi:10.1093/ehjci/jev143

Basal longitudinal strain predicts future aortic valve replacement in asymptomatic patients with aortic stenosis

Helle Gervig Carstensen[1]*, Linnea Hornbech Larsen[2], Christian Hassager[2], Klaus Fuglsang Kofoed[2,3], Jan Skov Jensen[1], and Rasmus Mogelvang[2]

[1]Department of Cardiology, Gentofte Hospital, University of Copenhagen, Niels Andersens Vej 65, DK-2900 Copenhagen, Denmark; [2]Department of Cardiology, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark; and [3]Department of Radiology, Rigshospitalet, University of Copenhagen, Copenhagen, Denmark

Received 22 October 2014; accepted after revision 11 May 2015; online publish-ahead-of-print 14 June 2015

Aims To evaluate the prognostic value of global longitudinal strain (GLS) and basal longitudinal strain (BLS) with the knowledge of coexisting coronary pathology evaluated by multi-detector computed tomography (MDCT) coronary angiography.

Background GLS and BLS are both sensitive markers of myocardial dysfunction and predictors of outcome in asymptomatic aortic stenosis. Aortic stenosis and ischaemic heart disease share risk factors and longitudinal function can be severely reduced in both conditions, why some of the previous findings of impaired regional longitudinal function in asymptomatic aortic stenosis could in fact be explained by silent ischaemic heart disease.

Basal longitudinal strain predicts valve replacement in asymptomatic patients with AS

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- Prospective follow-up of 104 asymptomatic patients with moderate–severe AS (aortic valve area <1.5 cm^2). Longitudinal strain (GE Vingmed, Horten, Norway)
- Combined endpoint: indication for AVR and sudden cardiac death

	All patients (n = 104)	Patients with event-free survival (n = 61)	Patients with event (n = 43)	P-value
Demography, risk profile, and comorbidity				
Age (years)	72 (±9)	72 (±9)	73 (±8)	0.49
Male gender	68% (71)	67% (41)	70% (30)	0.83
LVEF (%)	59 (55–66)	59 (56–67)	56 (54–61)	0.041[a]
SVIndex (mL/m^2)	42 (36–49)	41 (36–49)	42 (37–49)	0.68
LVMI (g/m^2)	83 (72–98)	80 (70–99)	90 (73–99)	0.11
Peak gradient (mmHg)	43 (32–65)	38 (30–54)	52 (36–73)	<0.001[a]
Peak velocity (m/s)	3.3 (2.8–4.0)	3.1 (2.7–3.7)	3.6 (3.0–4.3)	<0.001[a]
Mean gradient (mmHg)	24 (18–40)	22 (16–34)	32 (23–47)	<0.001[a]
AVA (cm^2)	0.90 (0.75–1.14)	0.98 (0.84–1.26)	0.80 (0.70–0.95)	<0.001[a]
AVAI (cm^2/m^2)	0.47 (0.39–0.60)	0.55 (0.41–0.63)	0.42 (0.36–0.49)	0.001[a]
Moderate—AVA 1.0–1.5 cm^2	36% (38)	49% (30)	19% (8)	0.001[a]
Severe—AVA < 1.0 cm^2	64% (66)	51% (31)	81% (35)	

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Gervig Carstensen et al. *Eur Heart J Cardiovasc Imaging*. 2016; 17: 283–92

Basal longitudinal strain predicts valve replacement in asymptomatic patients with AS

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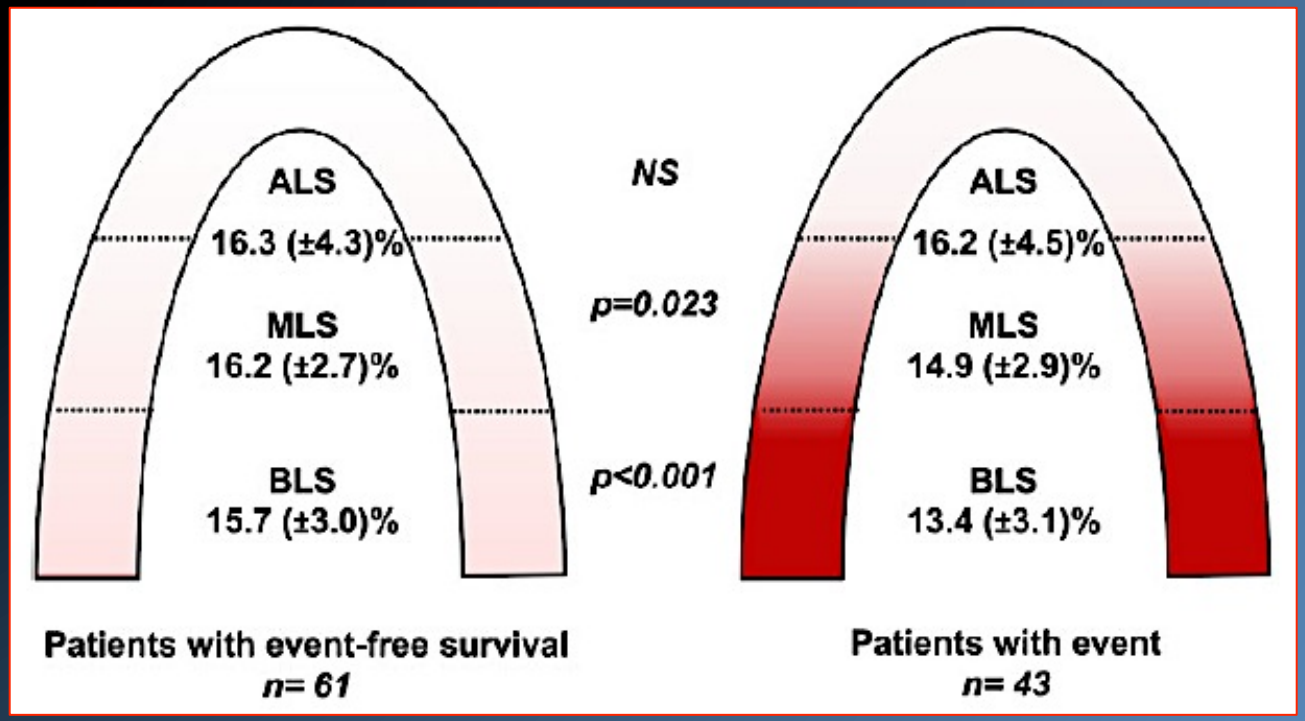
- 104 asymptomatic patients with moderate–severe AS (aortic valve area <1.5 cm^2)
- Combined endpoint: indication for AVR and sudden cardiac death

RESULTS:

- Median follow-up: 2.3 years (1.7–3.6)
- No sudden cardiac death
- 43 patients (41%) met the endpoint of indication for AVR:
  - Symptoms (n=42)
  - LVEF <50% (n=1)



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Gervig Carstensen et al. *Eur Heart J Cardiovasc Imaging.* 2016; 17: 283–92

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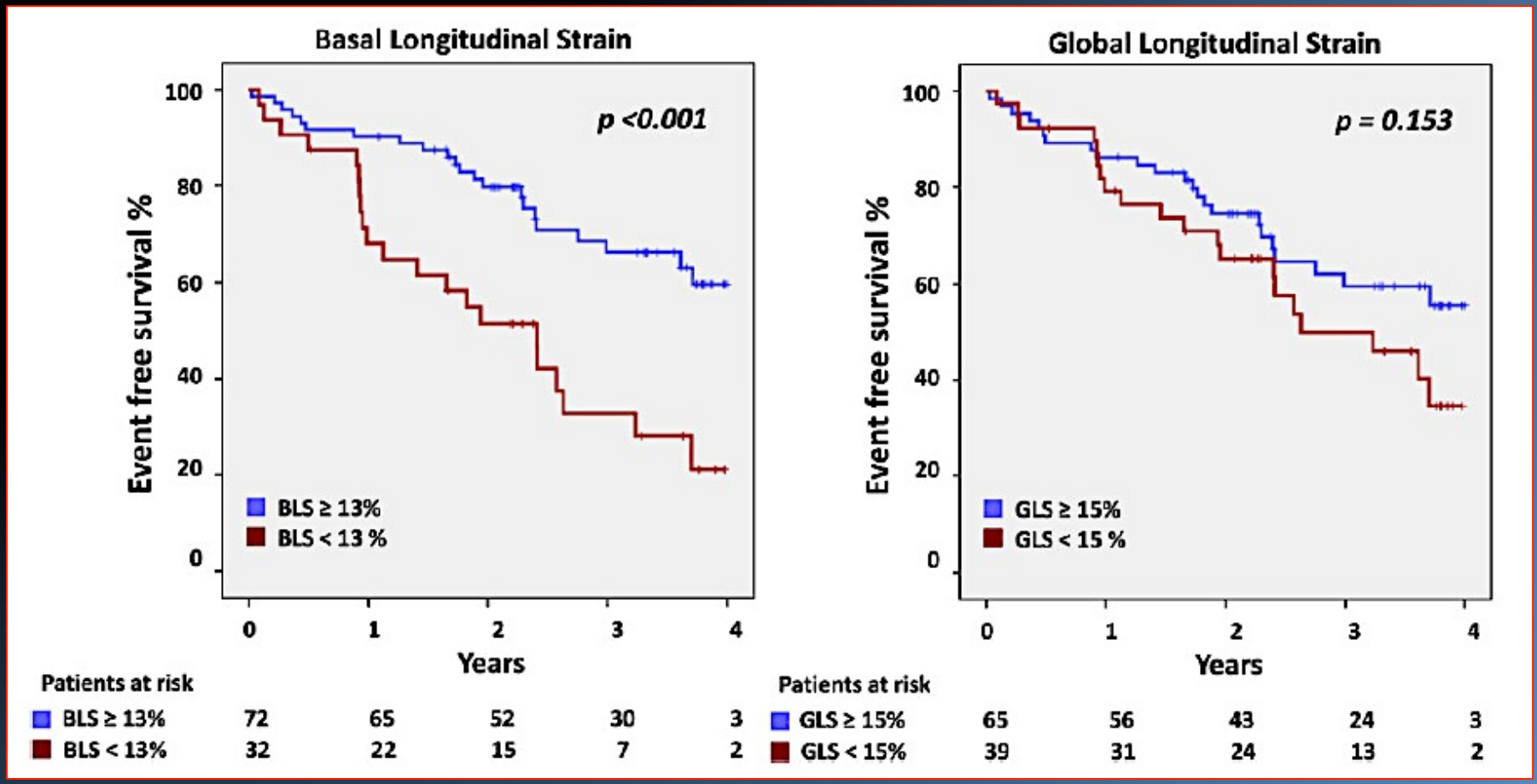
Basal longitudinal strain predicts valve replacement in asymptomatic patients with AS

In contrast to GLS, BLS is a significant predictor of AVR in asymptomatic patients with AS



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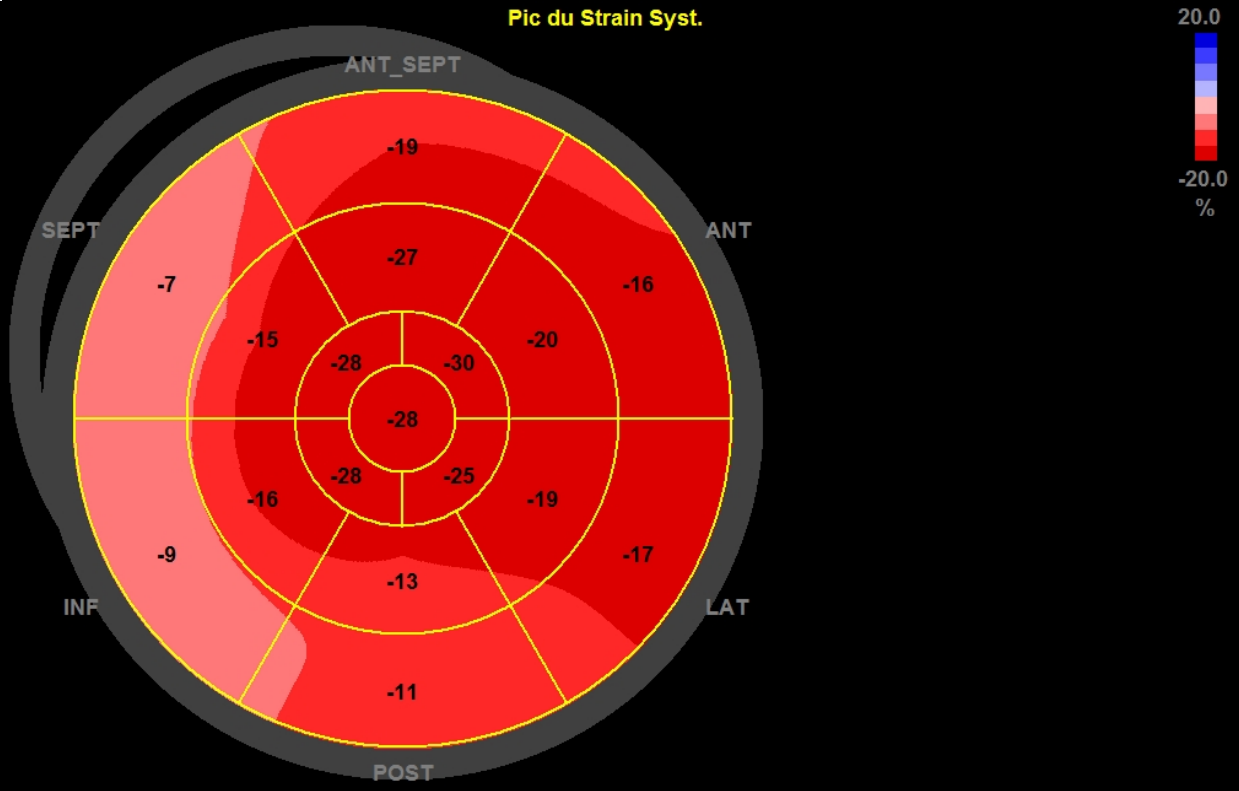
Basal longitudinal *strain* <-13%



29/11/2018-20:43:15

GLPS_LAX	-21.1 %	HR_ApLAX	53 bpm
GLPS_A4C	-17.8 %	FR_min	58 fps
GLPS_A2C	-19.8 %	PSD	65 msec
GLPS_Avg	-19.5 %		
AVC_MAN	432 msec		

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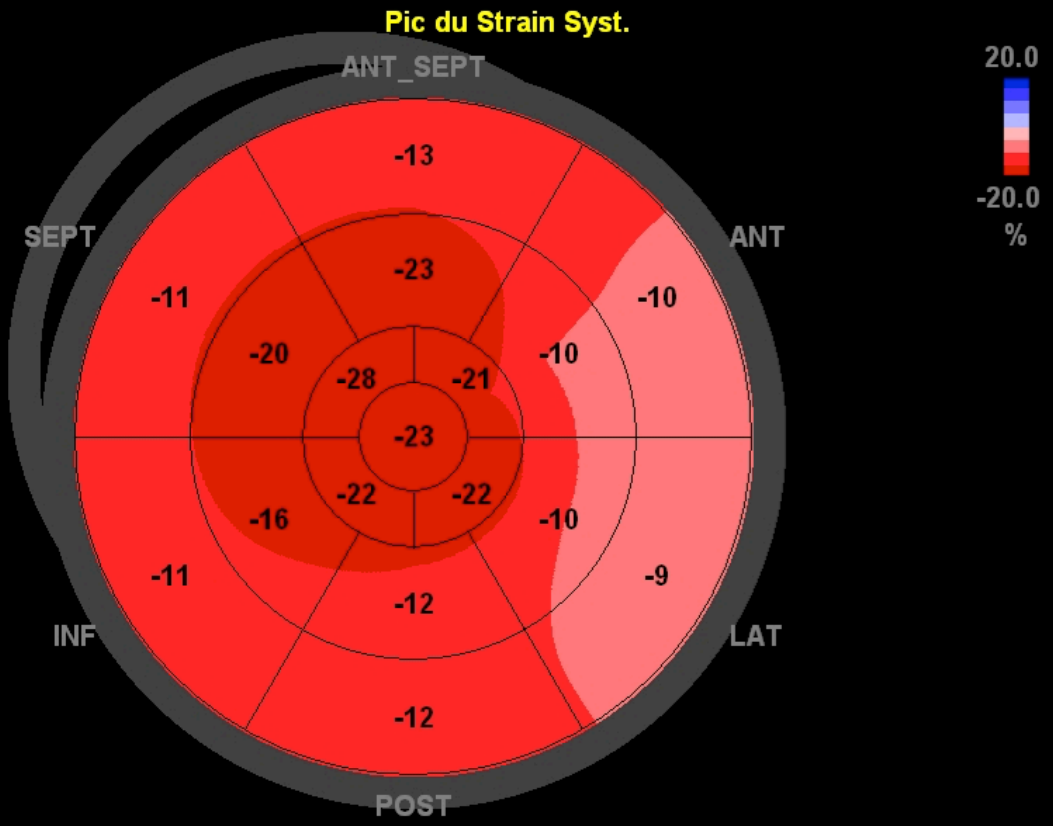
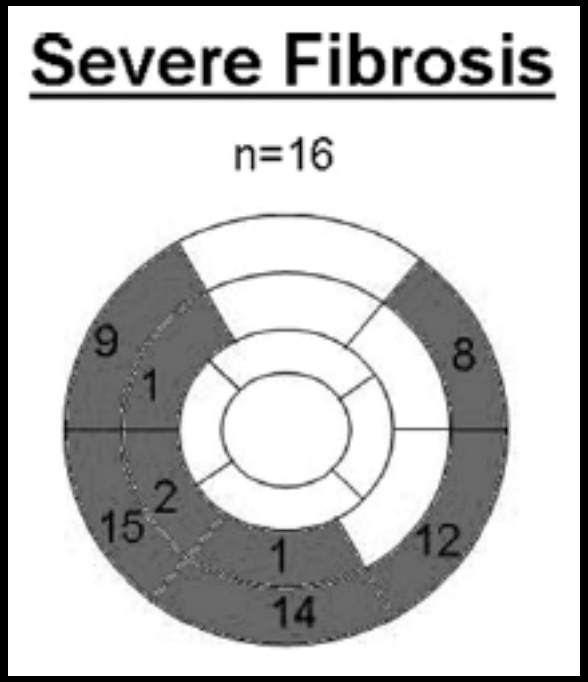
Preserved LVEF vs. Impaired longitudinal *strain*, linked to myocardial fibrosis





Weidemann et al.
Circulation. 2009; 120: 577-84

Global Longitudinal *strain* : -16%

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The patient with asymptomatic AS

What about current Guidelines?

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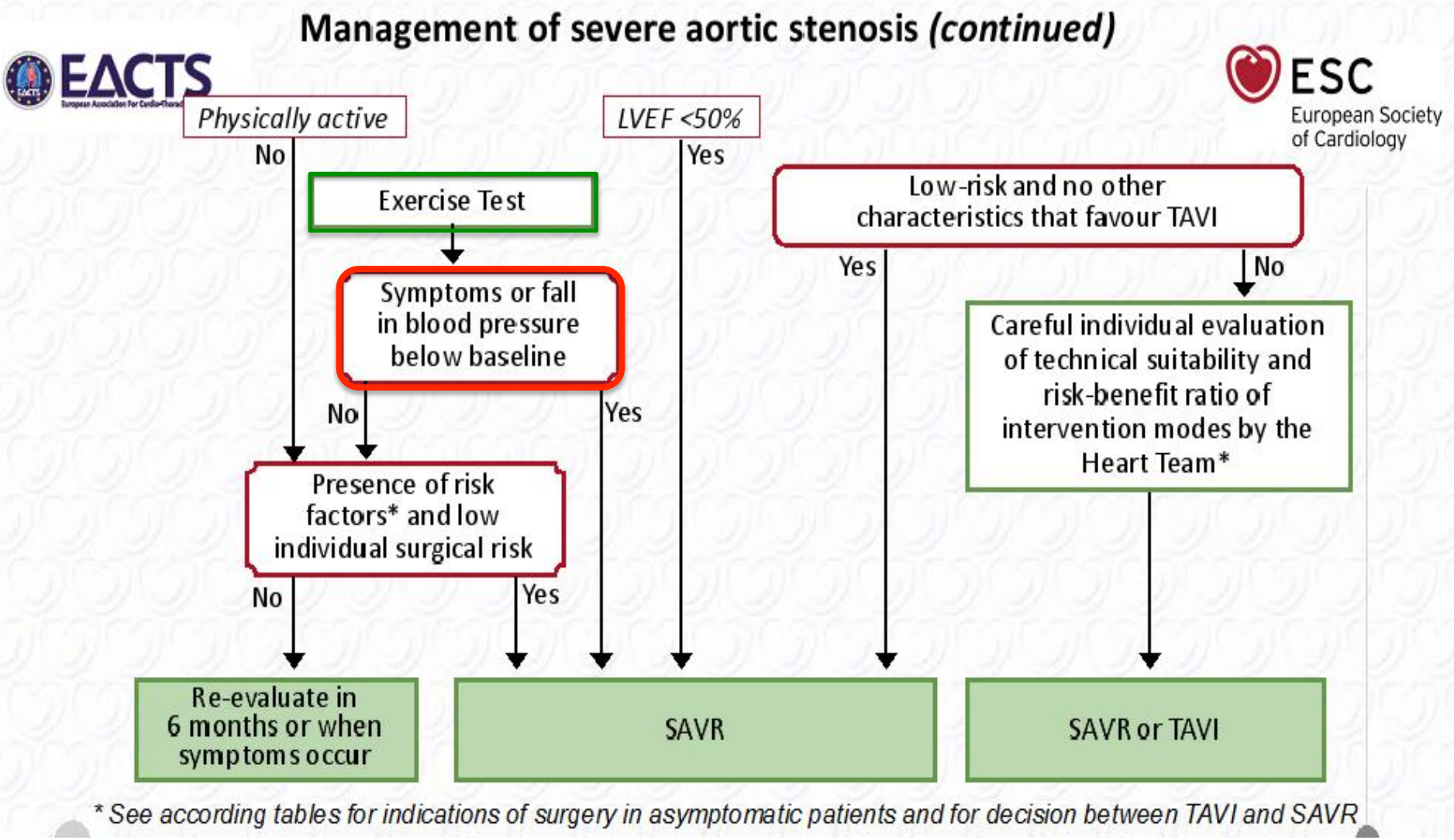

2017 ESC/EACTS Guidelines for the management of valvular heart disease

European Heart Journal. **2017; 38: 2739-91**

What is new in the 2017 Valvular Heart Disease Guidelines?

Changes in recommendations	
2012	**2017**
Indications for surgery in asymptomatic aortic stenosis	
IIb C Markedly elevated BNP levels.	**IIa C** Markedly elevated BNP levels (>threefold age- and sex-corrected normal range) confirmed by repeated measurements without other explanations.
IIb C Increase of mean pressure gradient with exercise by >20 mmHg.	Taken out
IIb C Excessive LV hypertrophy in the absence of hypertension.	Taken out

2017 ESC/EACTS Guidelines for the management of valvular heart disease
European Heart Journal. **2017; 38: 2739-91**

Indications for intervention in aortic stenosis and recommendations for the choice of intervention mode *(continued)*

Recommendations	Class	Level
c) Asymptomatic patients with severe aortic stenosis (refers only to patients eligible for surgical valve replacement)		
SAVR is indicated in asymptomatic patients with severe aortic stenosis and systolic LV dysfunction (LVEF <50%) not due to another cause.	I	C
SAVR is indicated in asymptomatic patients with severe aortic stenosis and abnormal exercise test showing symptoms on exercise clearly related to aortic stenosis.	I	C

2017 ESC/EACTS Guidelines for the management of valvular heart disease
European Heart Journal. **2017; 38: 2739-91**

www.escardio.org/guidelines

Indications for intervention in aortic stenosis and recommendations for the choice of intervention mode *(continued)*

Recommendations	Class	Level
SAVR should be considered in asymptomatic patients with severe aortic stenosis and abnormal exercise test showing fall in blood pressure below baseline.	IIa	C
SAVR should be considered in asymptomatic patients with normal ejection fraction and none of the above-mentioned exercise test abnormalities if the surgical risk is low and one of the following findings is present: – very severe aortic stenosis defined by a V_{max}>5.5 m/s, – severe valve calcification and a rate of V_{max} progression ≥0.3m/s/year, – markedly elevated BNP levels (>threefold age- and sex-corrected normalrange) confirmed by repeated measurements without other explanations, – severe pulmonary hypertension (systolic pulmonary artery pressure at rest >60 mmHg confirmed by invasive measurement) without other explanation.	IIa	C

2017 ESC/EACTS Guidelines for the management of valvular heart disease
***European Heart Journal.* 2017; 38: 2739-91**

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RAC sévère asymptomatique

1. ECG d'effort largement indiqué : faux asymptomatiques, Charge atteinte, %FMT, élévation de la PA systolique+++
2. Echographie d'effort : pas d'indication en pratique clinique (ESC-EACTS 2017): peu validé, études contradictoires, difficultés techniques
3. Risque de mort subite: 1,4% annuel, dans les 3 mois suivant la dernière consultation (2/3 des cas), aucun signe prémonitoire
4. Valeurs seuil à reconsidérer: RAC critique: Vmax > 5 m/s et dysfonction systolique VG: FEVG <55%
5. RVA CHIRURGICAL seul envisageable (ESC-EACTS 2017): durabilité >5 ans des prothèses TAVI inconnue (modèles ≈ 2015)

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AR: Clinical case #2

- Young man, 34 years old, strictly asymptomatic
- Height: 185 cm; weight: 70 kg
- Known BAV since infancy
- Referred for severe aortic regurgitation

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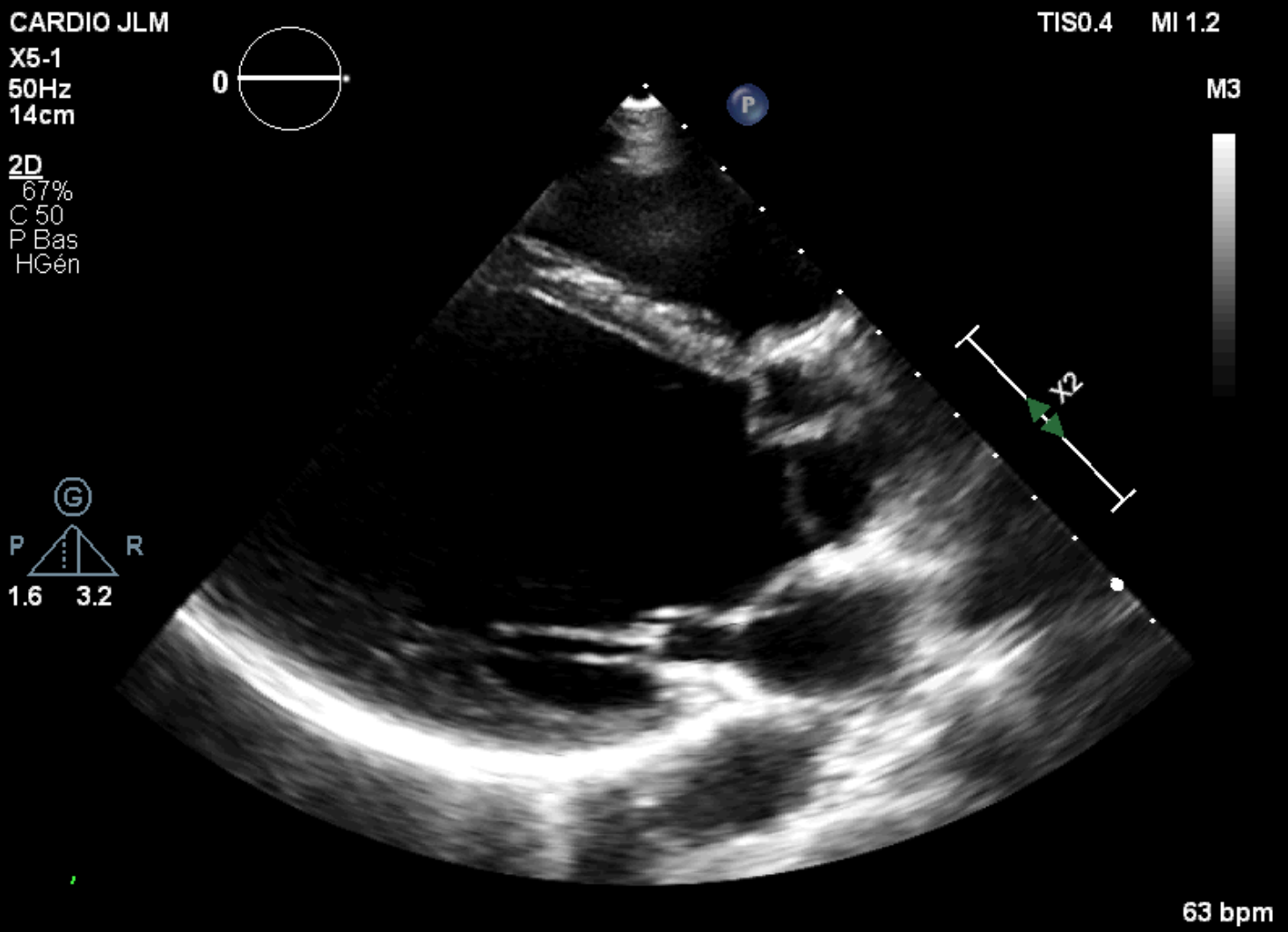
Anterior cusp prolapse



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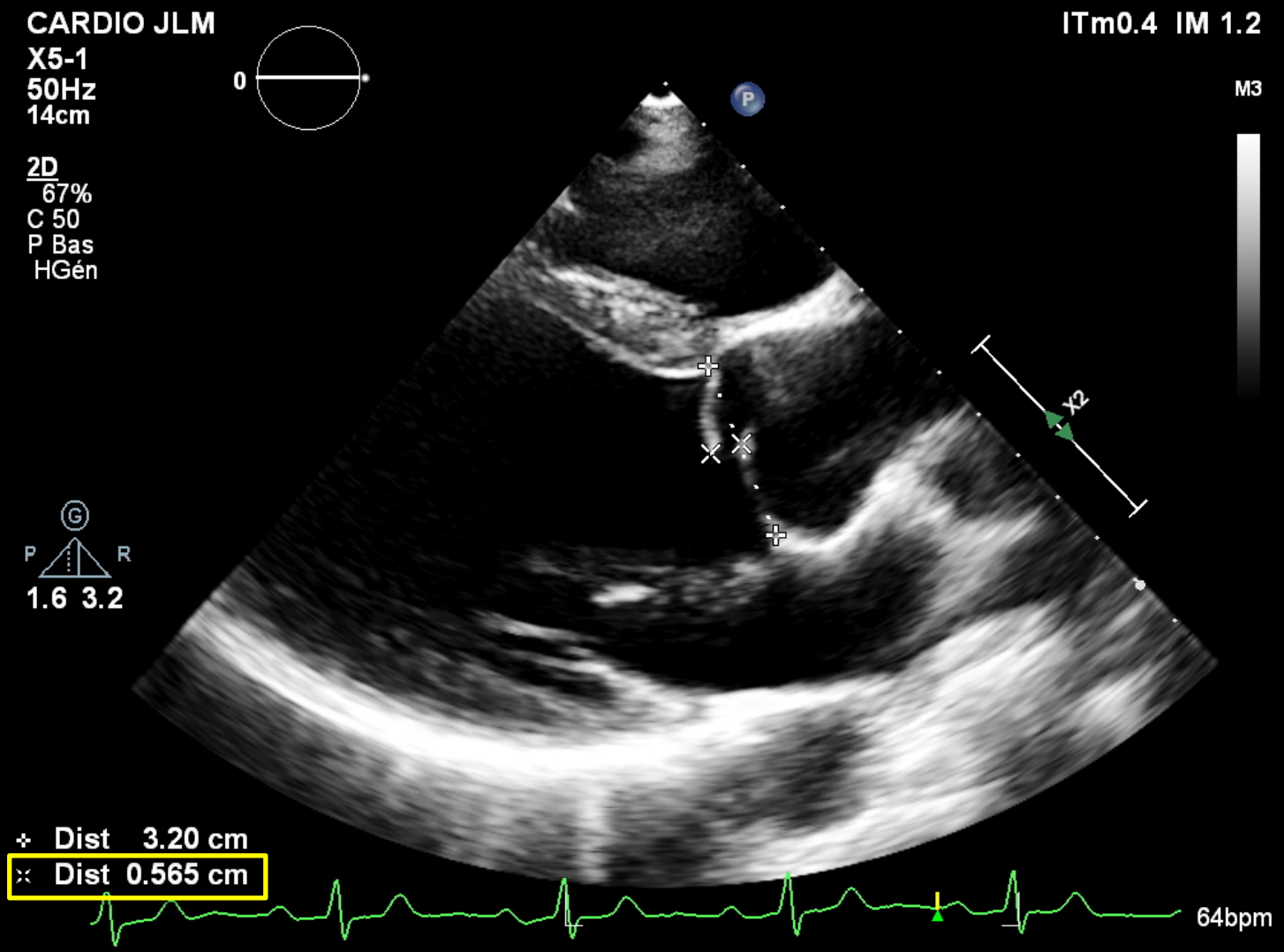
Complete prolapse (Negative eH)



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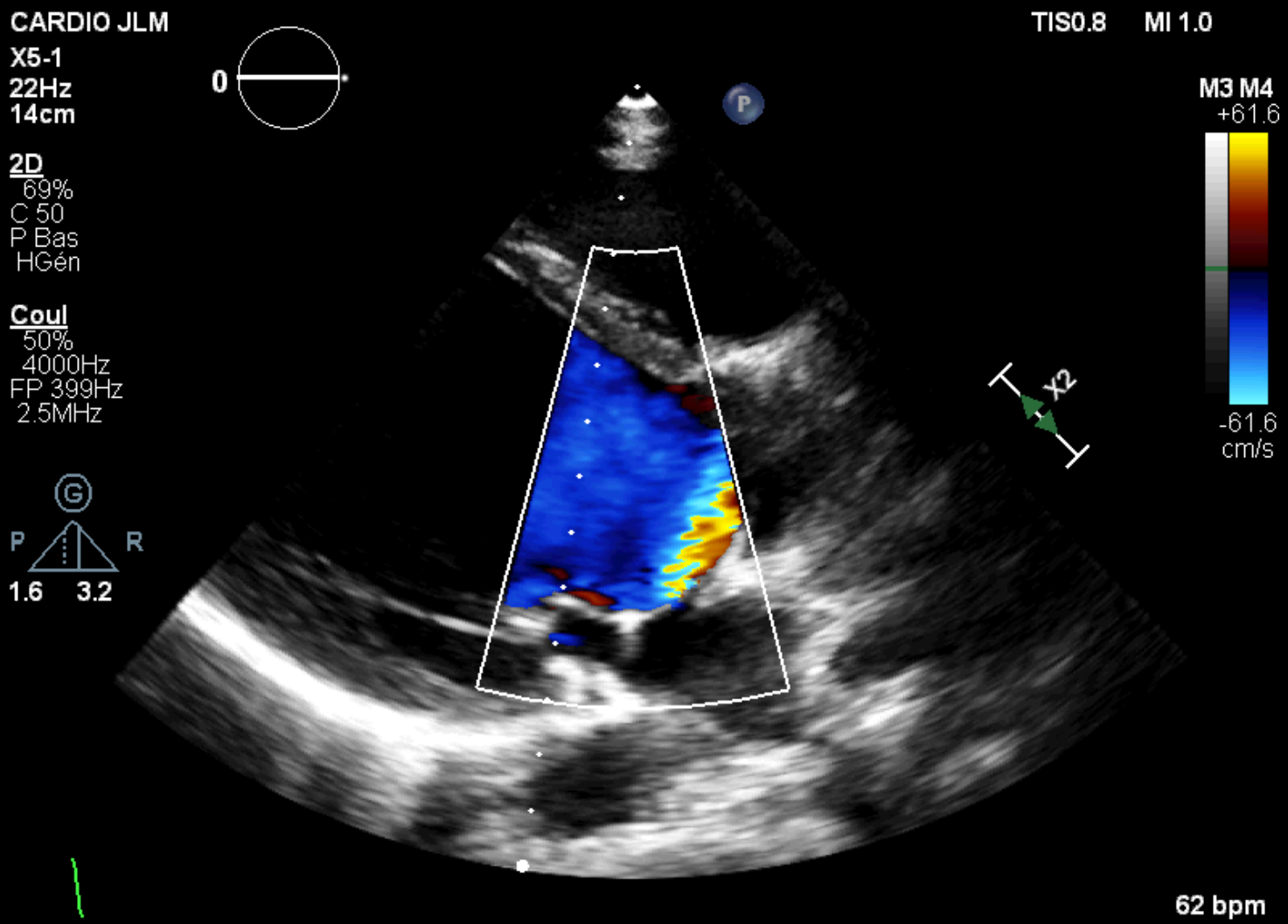
Vertical jet → anterior mitral leaflet



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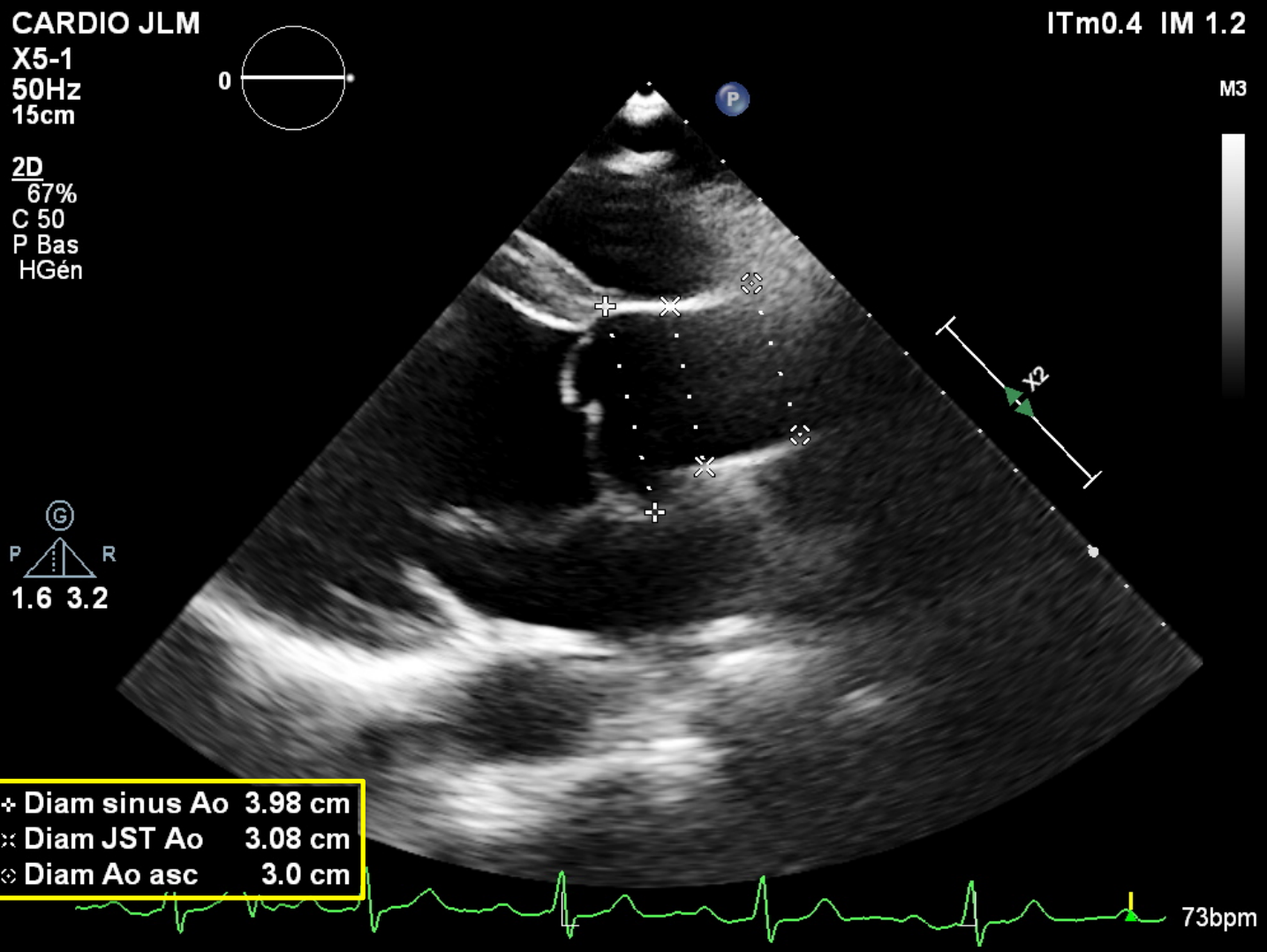
Proximal aorta: not dilated



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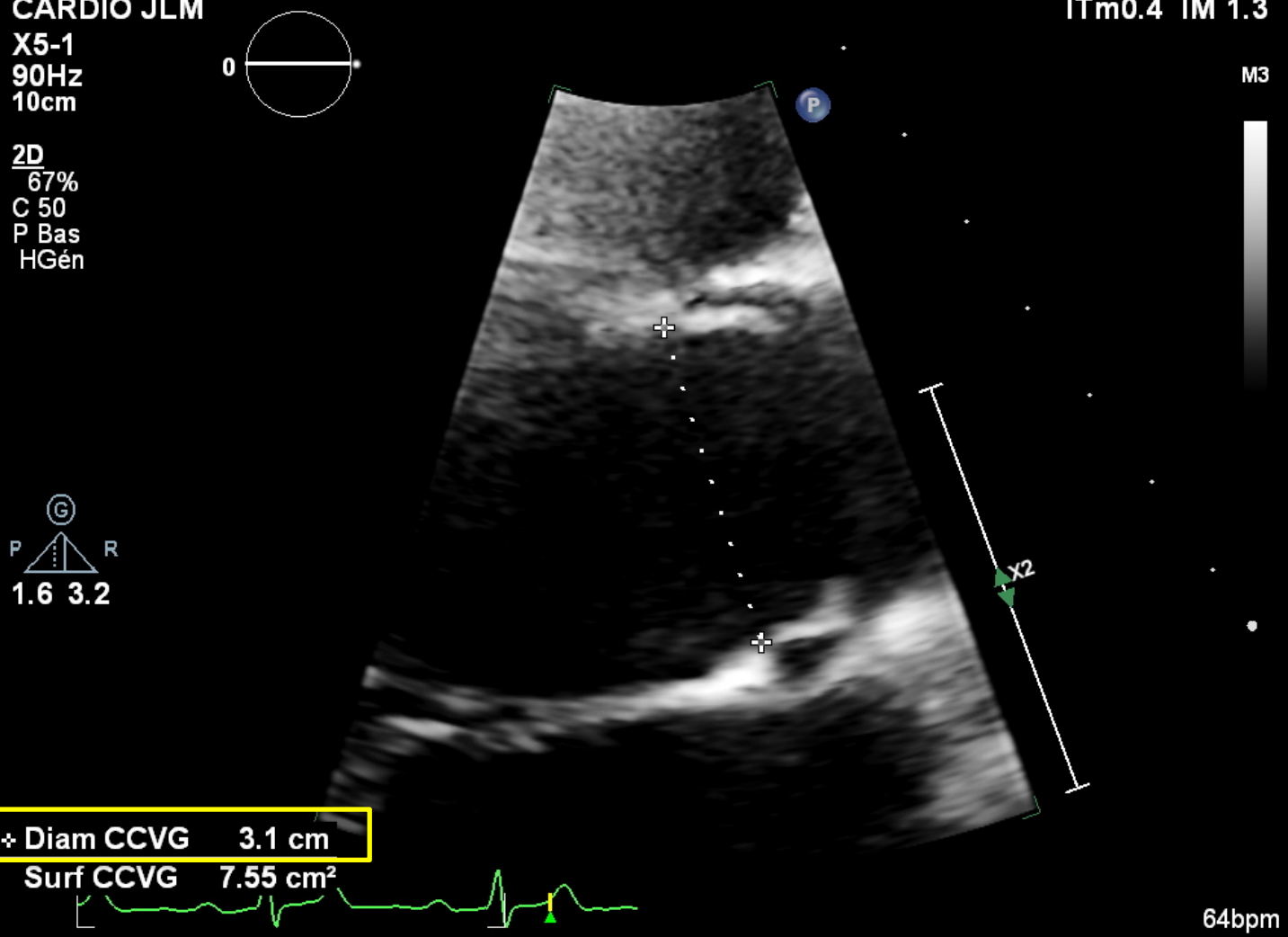
Large aortic ring



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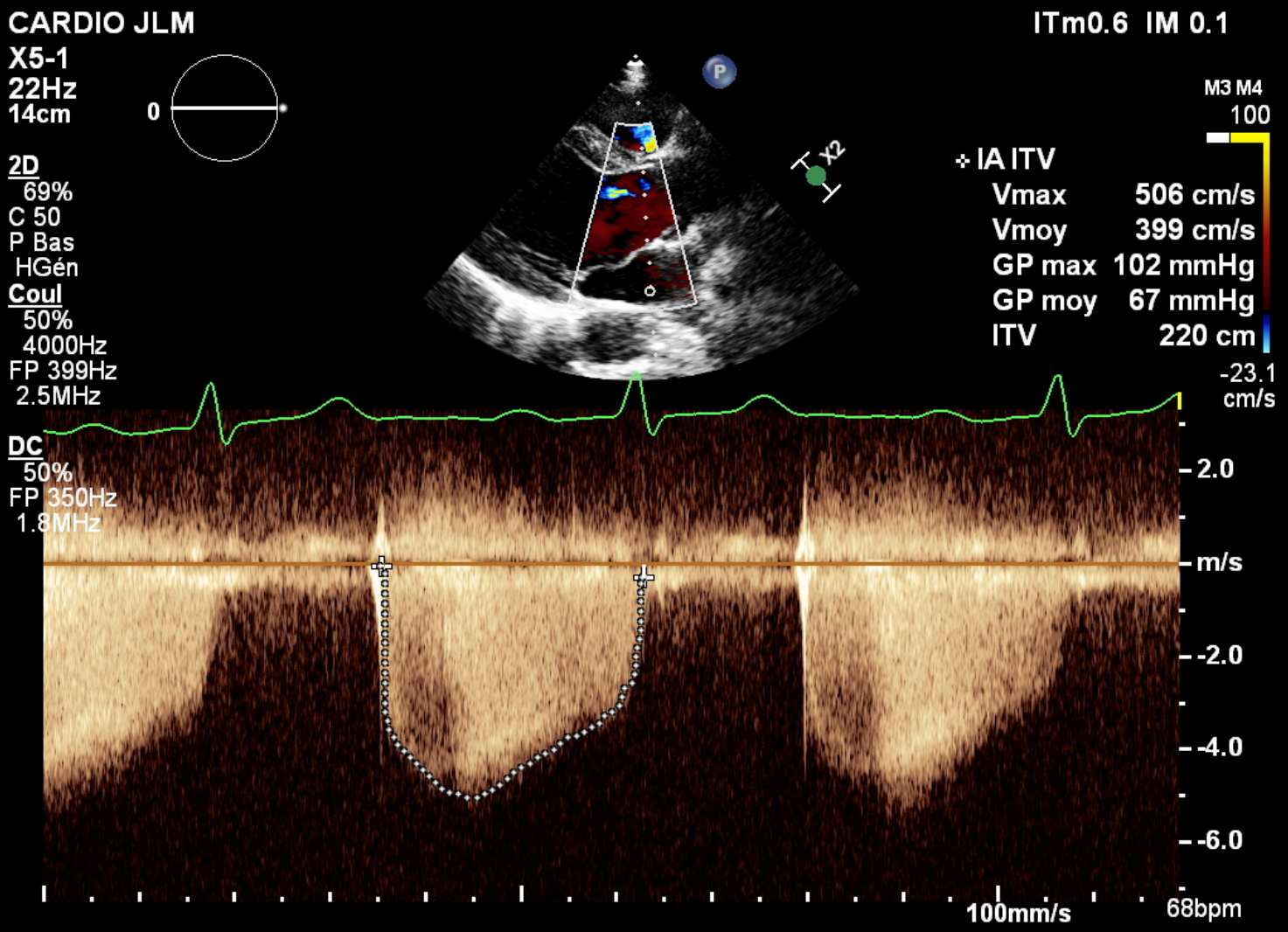
CW Doppler: Regurgitant jet



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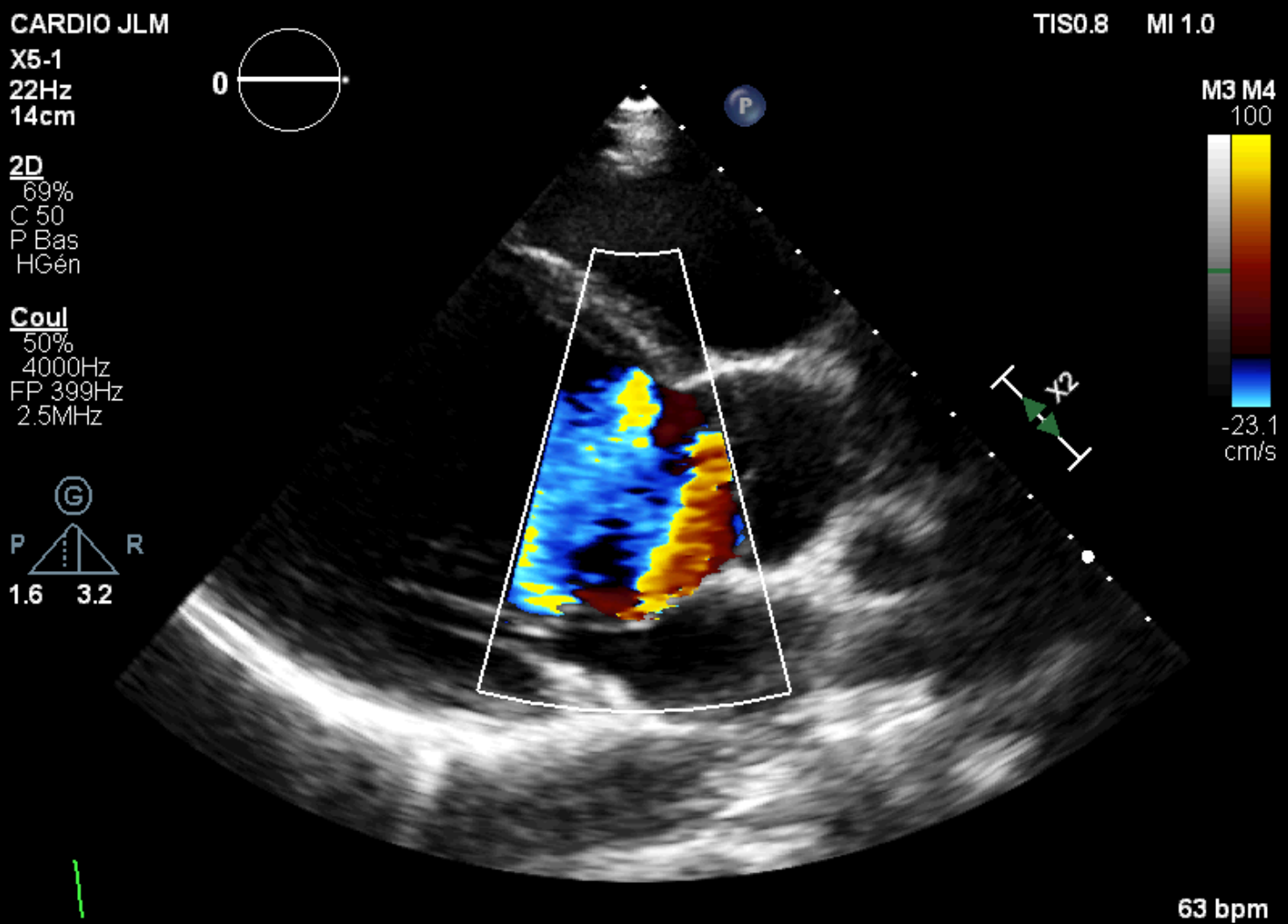
PISA / Long-axis view



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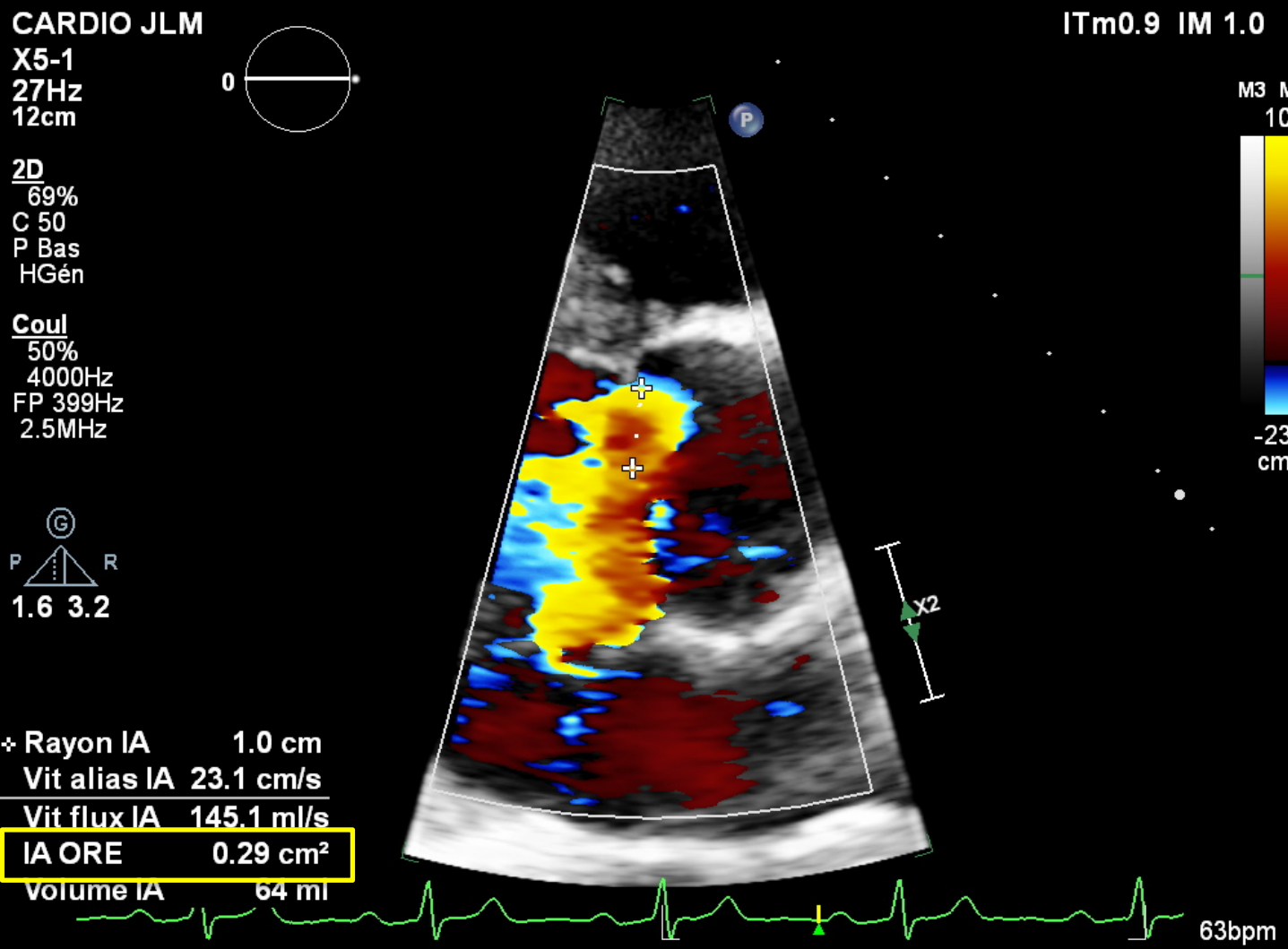
ERO close to 30 mm²



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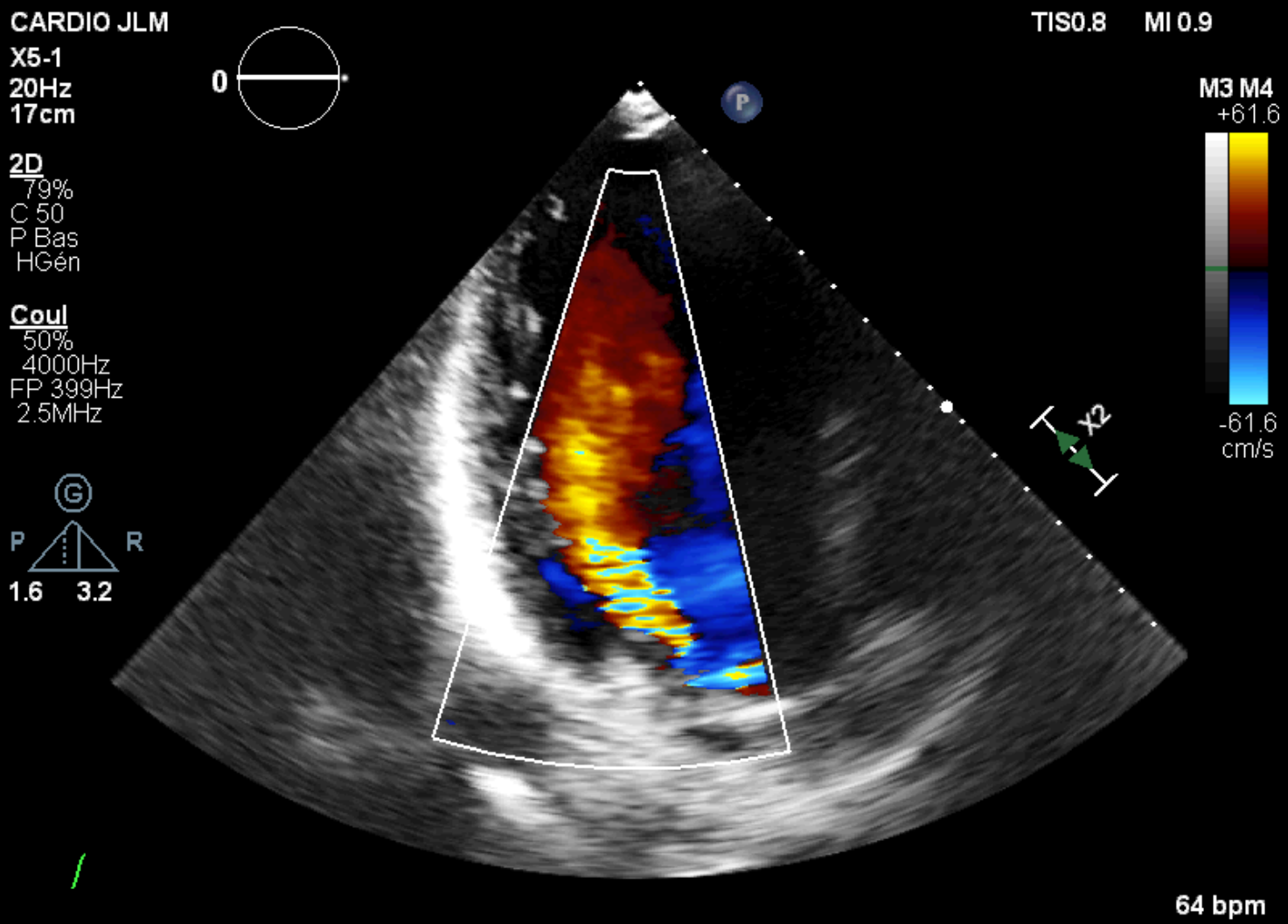
Very large extension of AR jet



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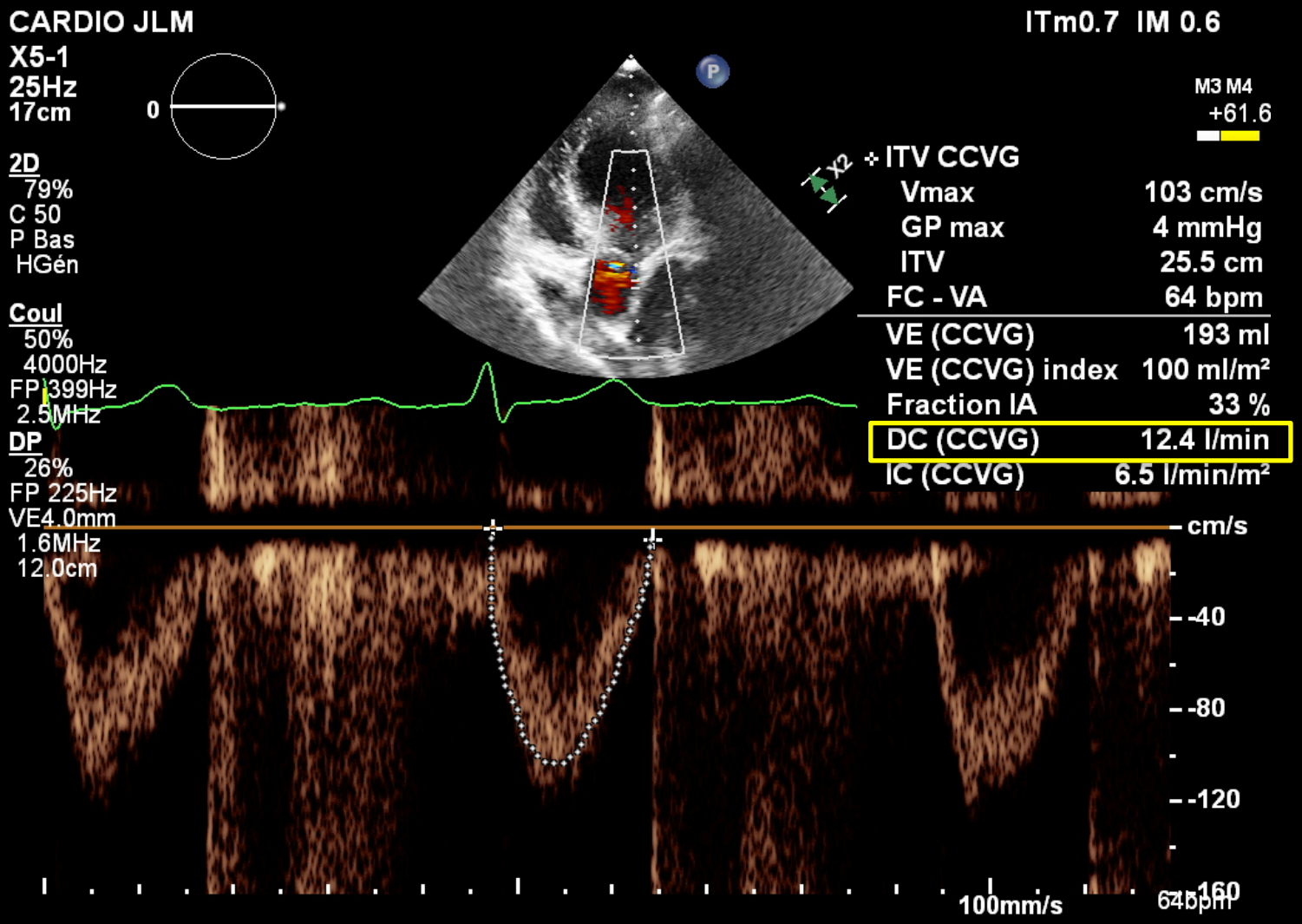
Cardiac output > 12 l/min



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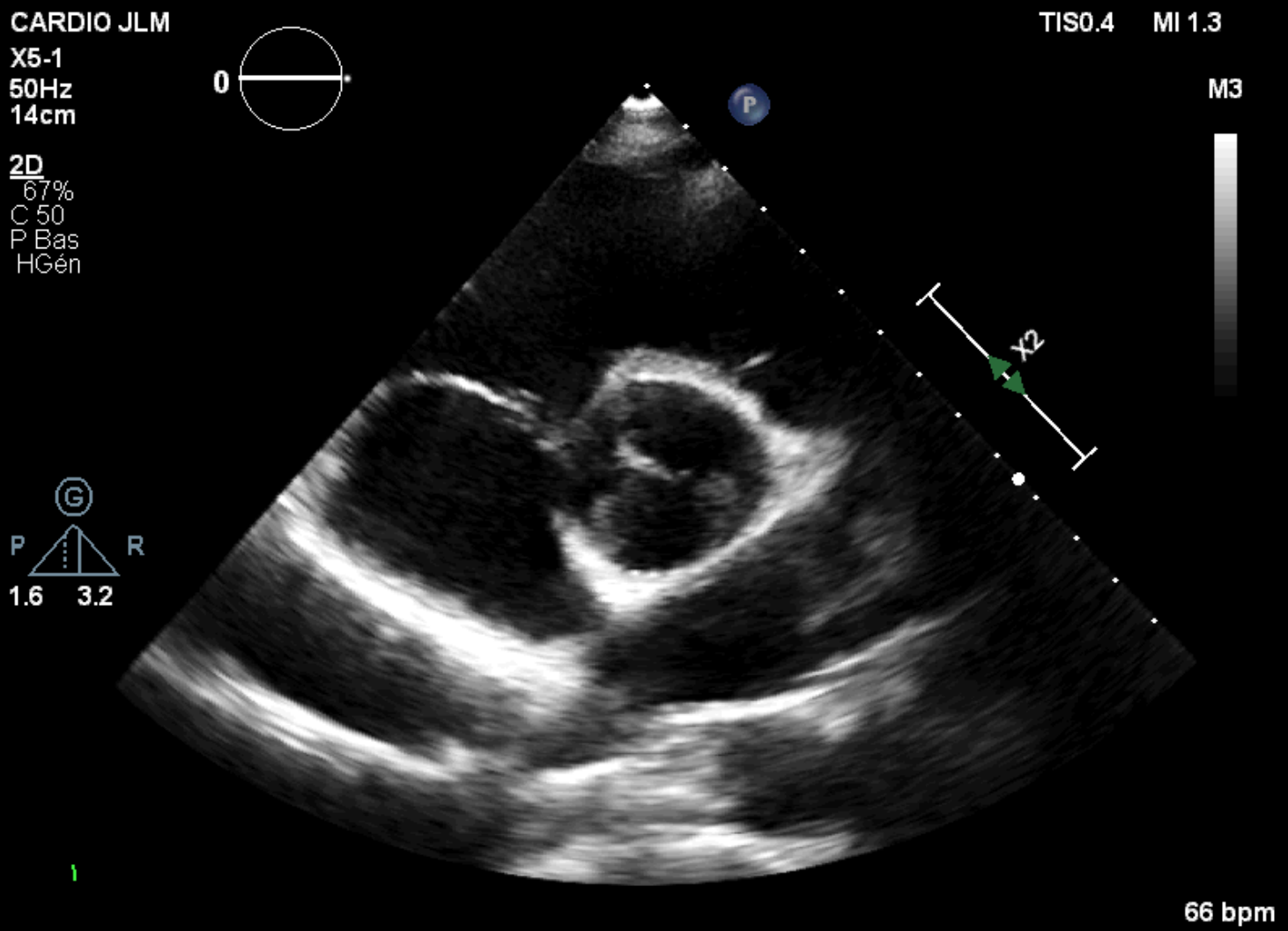
Typical form of BAV (L-R)



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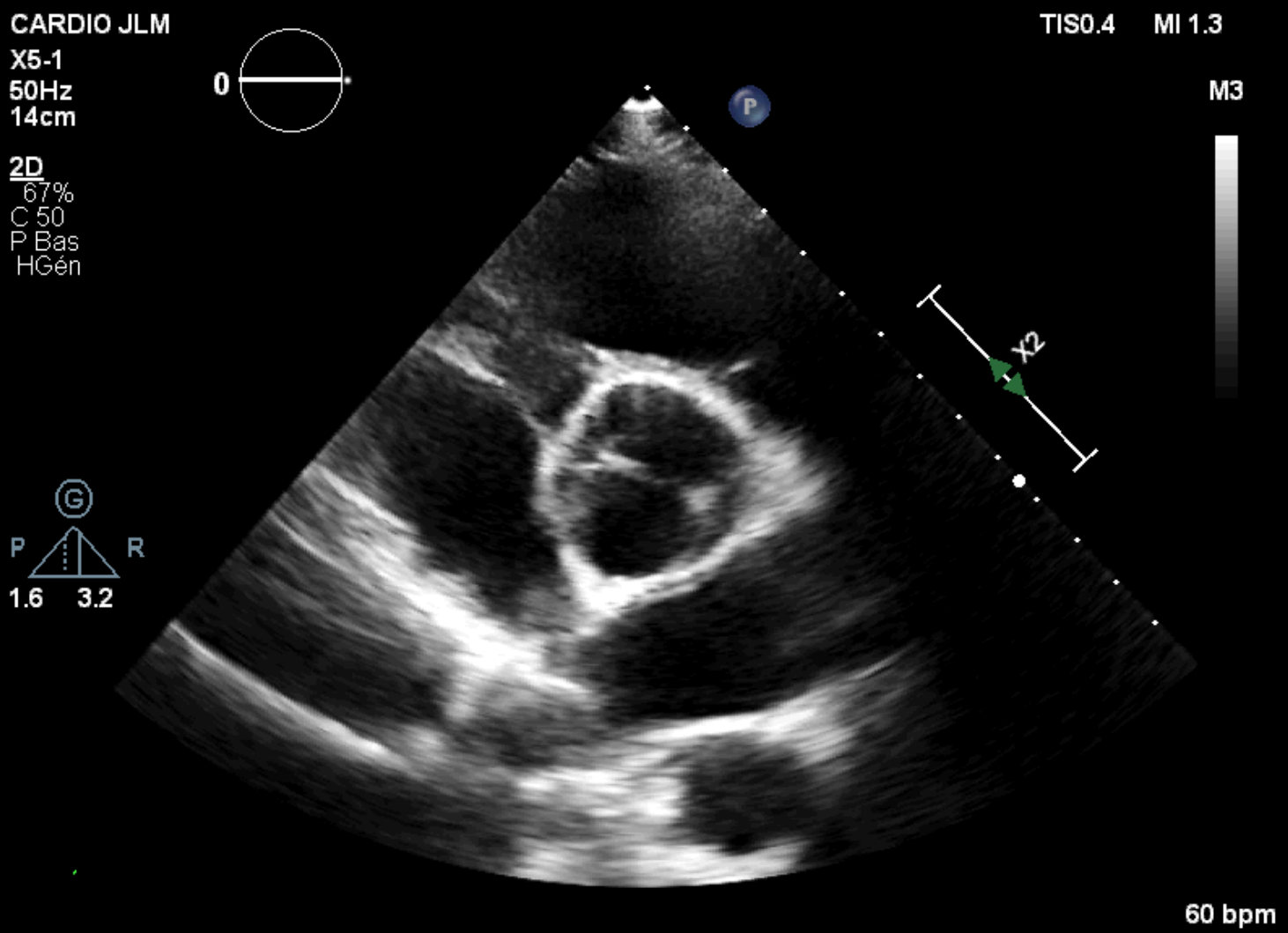
Prolapse of the conjoined cusp



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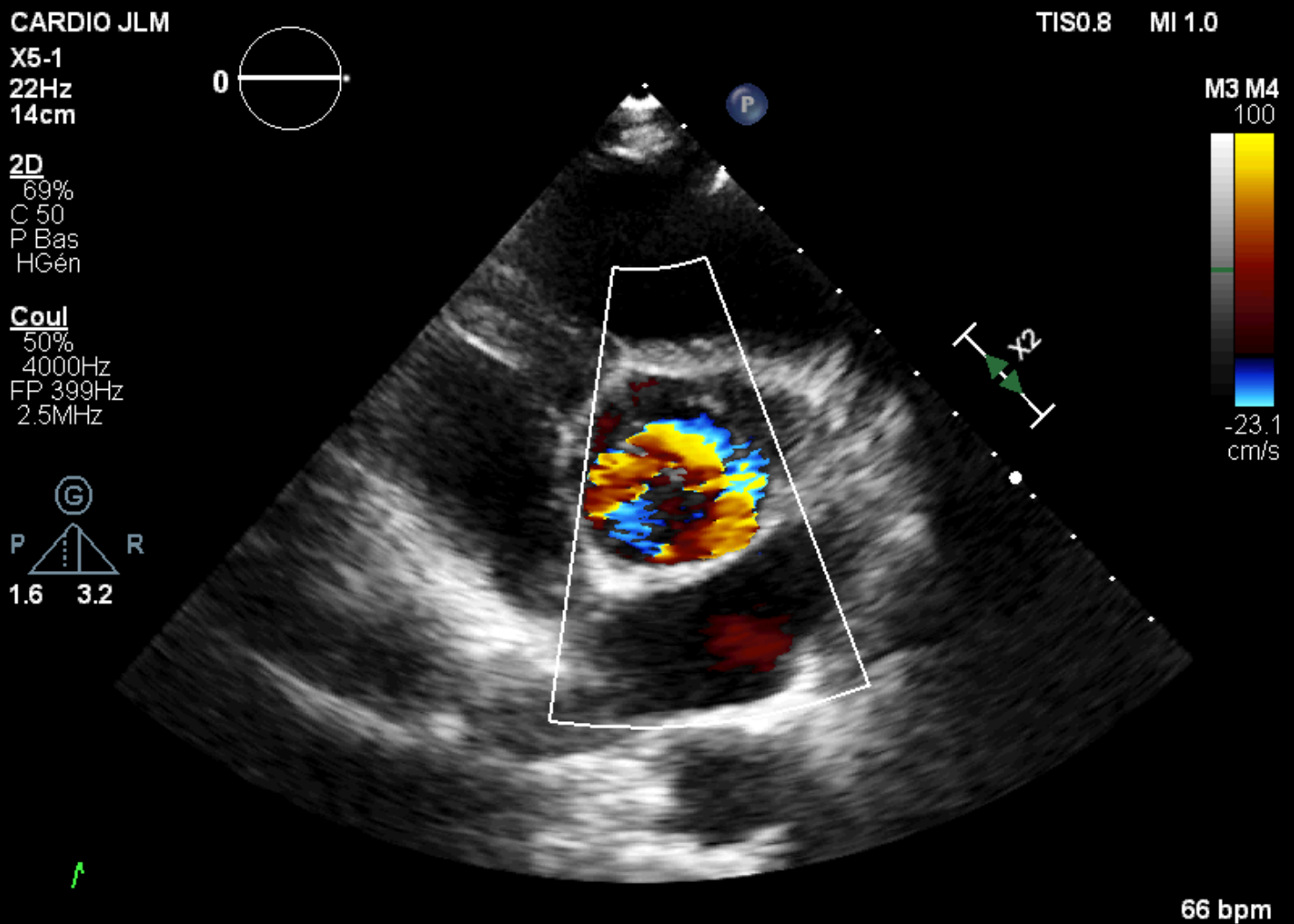

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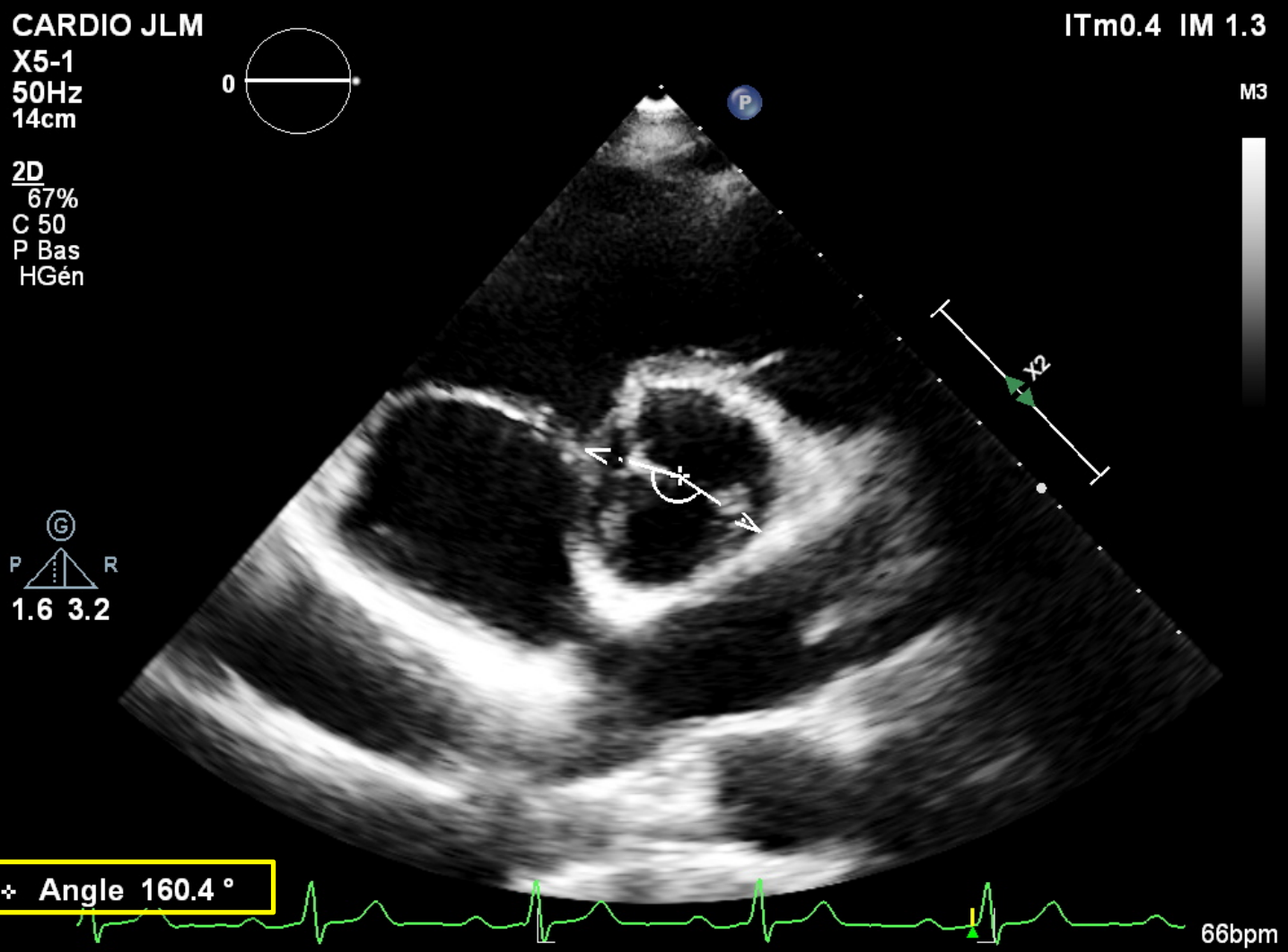
Commissural orientation = 160°



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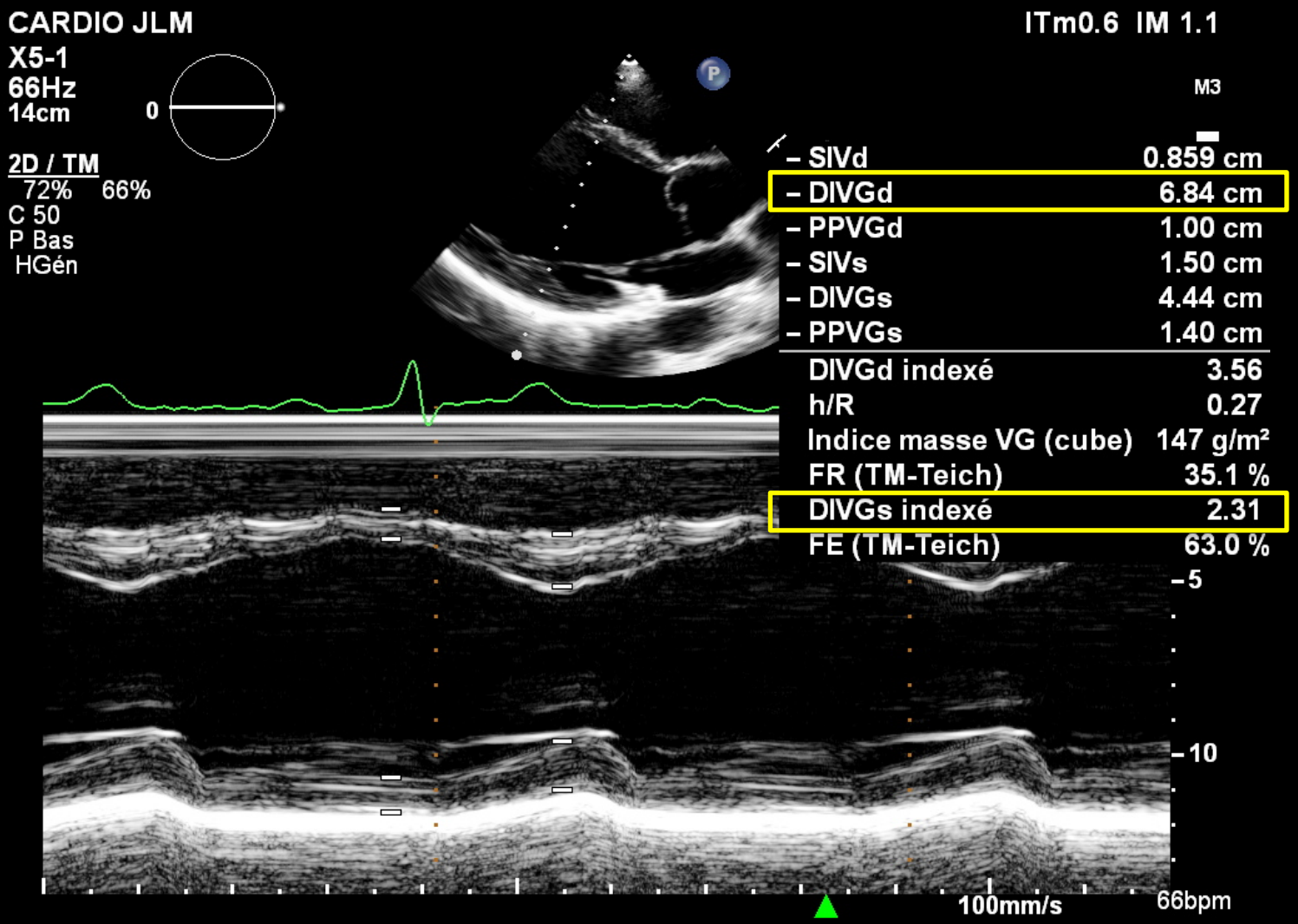
LV End-diastolic diameter <70 mm



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LV End-systolic diameter <25 mm/m²

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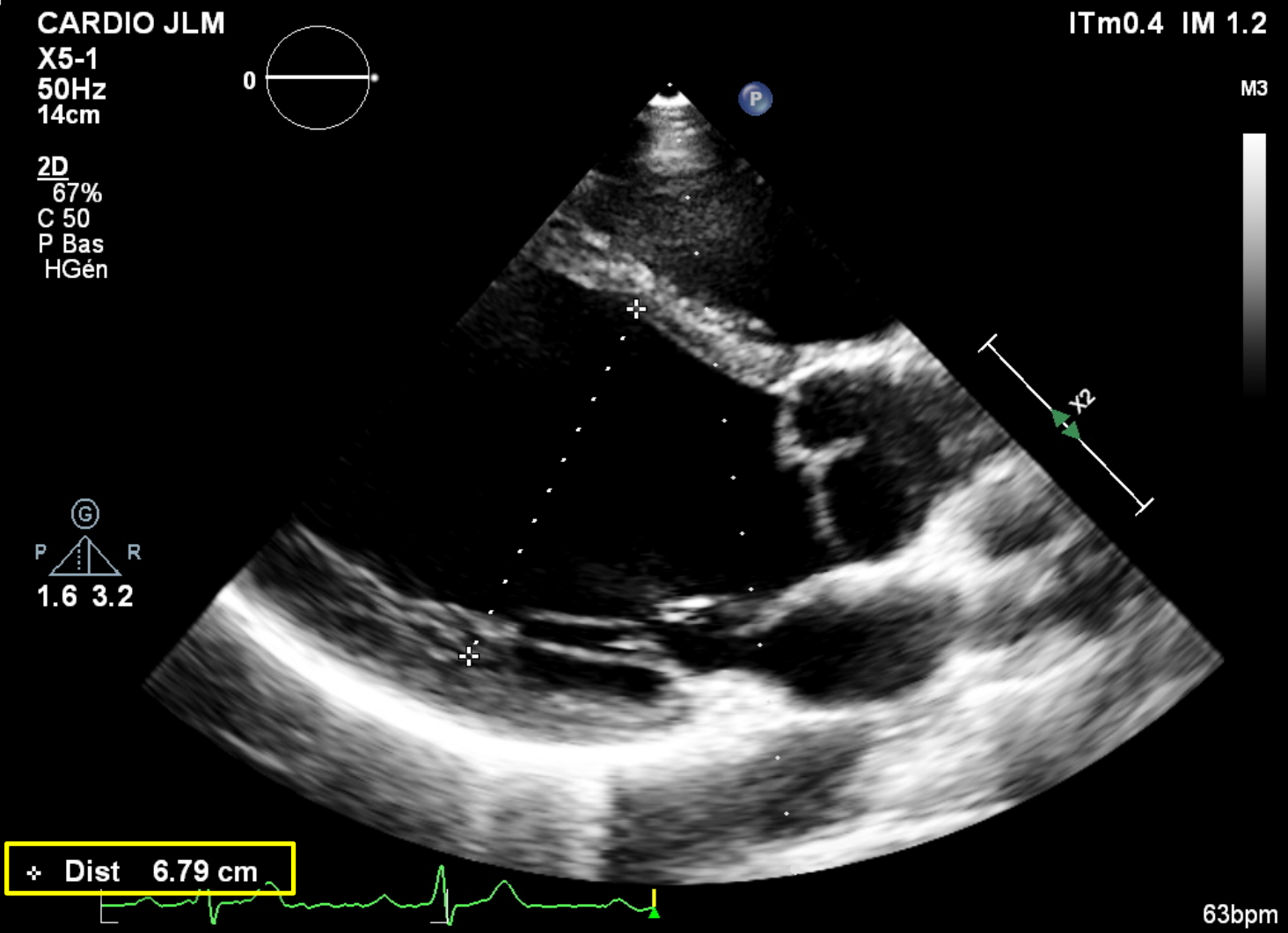
LV End-diastolic diameter <70 mm



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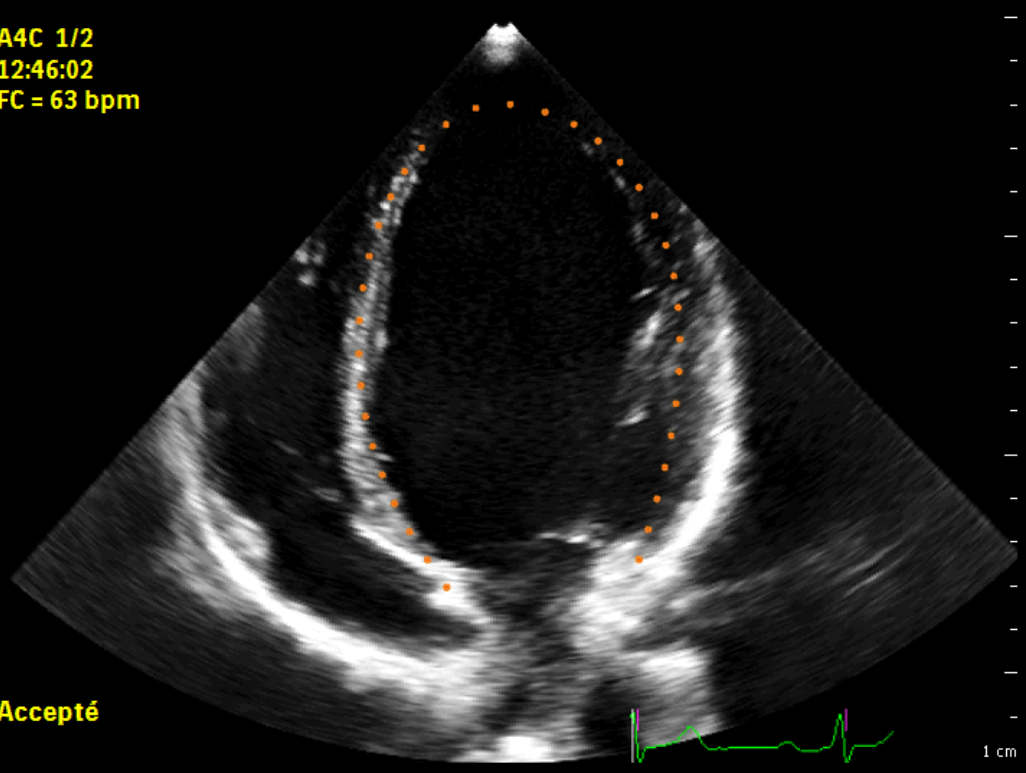

Mesures

VTD	327.4 ml
VTS	147.9 ml
FE	54.8 %

Cycles cardiaques

R-R VA	959 ms
R-R VM	959 ms

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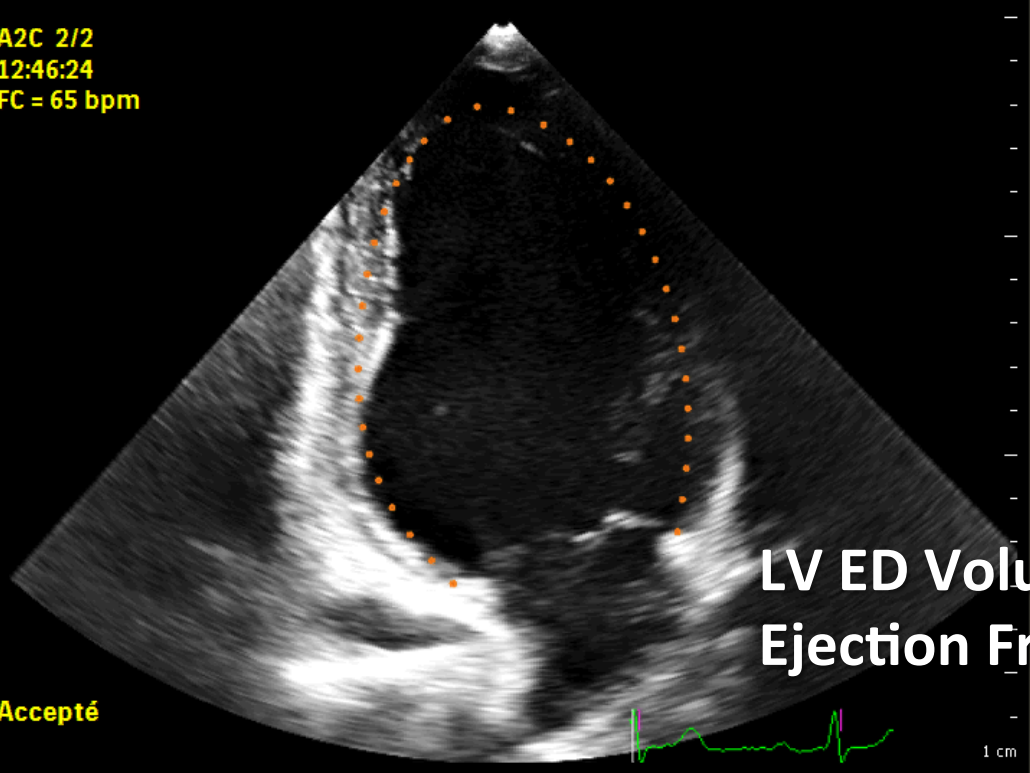

Mesures
VTD 325.6 ml
VTS 149.4 ml
FE 54.1 %
Cycles cardiaques
R-R VA 959 ms
R-R VM 959 ms

LV ED Volume = 325 ml
Ejection Fraction = 55%

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Clinical case : summary

- 34-year old man, strictly asymptomatic
- Typical form of bicuspid valve/ no calcification
- Prolapse of conjoined cusp/ No root dilatation
- Severe aortic regurgitation
- Severe LV dilatation
- Should this patient be operated on?

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Quelle prise en charge ?

A. Surveillance CLIN + Echo à 6 mois

B. RVA chirurgical

C. Chirurgie conservatrice
(plastie valvulaire aortique)

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Quelle prise en charge ?

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Indications for surgery in severe aortic regurgitation

Recommendations	Class	Level
A. Severe aortic regurgitation		
Surgery is indicated in symptomatic patients.	I	B
Surgery is indicated in asymptomatic patients with resting LVEF ≤50%.	I	B
Surgery is indicated in patients undergoing CABG or surgery of the ascending aorta or of another valve.	I	C
Heart Team discussion is recommended in selected patients* in whom aortic valve repair may be a feasible alternative to valve replacement.	I	C
Surgery should be considered in asymptomatic patients with resting ejection fraction >50% with severe LV dilatation: LVEDD >70 mm, or LVESD>50 mm (or LVESD >25 mm/m^2 BSA in patients with small body size).	IIa	B

** Patients with pliable non-calcified tricuspid or bicuspid valves who have a type I (enlargement of the aortic root with normal cusp motion) or type II (cusp prolapse) mechanism of AR.*

2017 ESC/EACTS Guidelines for the management of valvular heart disease

European Heart Journal. **2017; 38: 2739-91**

www.escardio.org/guidelines

www.imm.fr

According to current Guidelines:
No indication for surgery in this patient
But where do these cutoff come from?

During the battle, Rebel spies managed to steal secret plans to the Empire's ultimate weapon, the DEATH STAR, an armored space station with enough power to destroy an entire planet.

Pursued by the Empire's sinister agents, Princess Leia races home aboard her starship, custodian of the stolen plans that can save her people and restore freedom to the galaxy....

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Star Wars. *Episode IV*. 1977; October 19th

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Natural history of asymptomatic patients with chronic AR and normal LVEF

104 consecutive asymptomatic patients with severe chronic AR

Inclusion : January 1973 to March 1988

TABLE 2. Risk Stratification Based on Kaplan-Meier Life Table Analysis of Measurements at Initial Study

Variable	Value	Likelihood of death, symptoms, or LV dysfunction
LV end-systolic dimension	>50 mm	19% per year
	40–49 mm	6% per year
	<40 mm	0% per year
LV end-diastolic dimension	≥70 mm	10% per year
	<70 mm	2% per year
LV ejection fraction response to exercise	Decrease >5%	12% per year
	Decrease 0–5%	4% per year
	Increase >0%	1% per year

LV, left ventricular.

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Bonow et al. *Circulation*. 1991; 84: 1625-35

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Do we have more recent data ?

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Star Wars. *Episode VIII.* 2017; December 17th

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Long-term outcomes in patients with aortic regurgitation and preserved LVEF

Cleveland Clinic (January 2003 - December 2010)

- 1,417 patients (aged 54±16 years, 75% men)
- Patients were asymptomatic (87%) or mildly symptomatic
- Grade ≥ 3/4 AR and preserved LVEF (>50%)
- 933 patients (66%) underwent AV surgery at 55 days (19 -435)
- Operative mortality: 2%

TABLE 2 Echocardiographic Variables

LV ejection fraction, %	57 ± 4
LV end-diastolic diameter	
Nonindexed, cm	5.4 ± 0.9
Indexed, cm/m^2	2.7 ± 0.6
LV end-diastolic diameter	
≥6.5 cm	154 (11)
≥7.5 cm	18 (1.3)
LV end-systolic diameter	
Nonindexed, cm	3.6 ± 0.8
Indexed, cm/m^2	1.8 ± 0.4
LV end-systolic diameter ≥5 cm	50 (3.5)
iLVSD ≥2.5 cm/m^2	93 (7)
Indexed left atrial area, cm^2/m^2	10.6 ± 3
Aortic valve morphology	
Trileaflet	877 (62)
Bicuspid	523 (37)
Unicuspid/quadricuspid	17 (1)

Mentias et al. *J Am Coll Cardiol.* 2016; 68: 2144–53.

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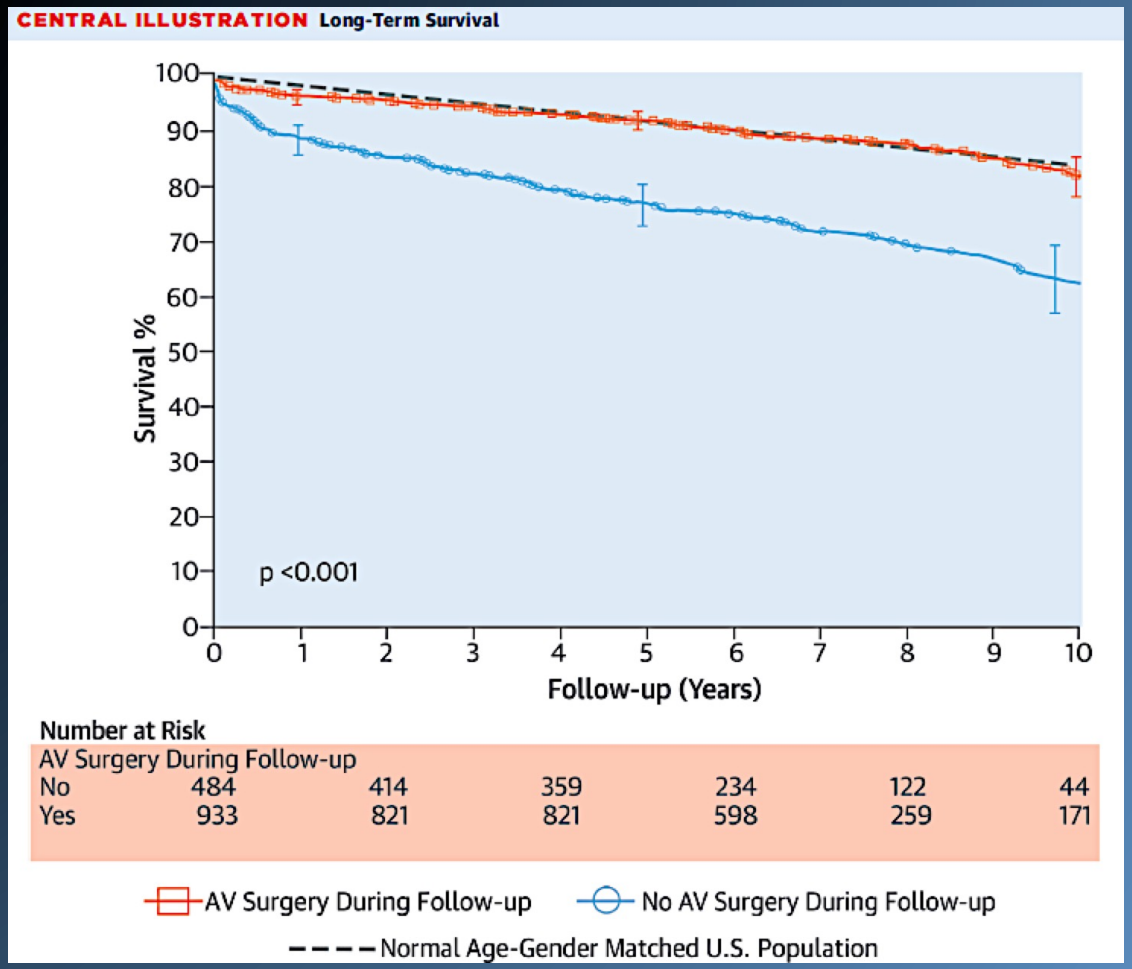
Long-term outcomes in patients with aortic regurgitation and preserved LVEF

- AV surgery was associated with improved survival

- Survival of patients who underwent AV surgery : similar to age/ sex-matched U.S. population

- Follow-up: 96% of deaths occurred in patients with indexed-LV-ESD <25 mm/m²



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Mentias et al. *J Am Coll Cardiol.* 2016; 68: 2144–53.

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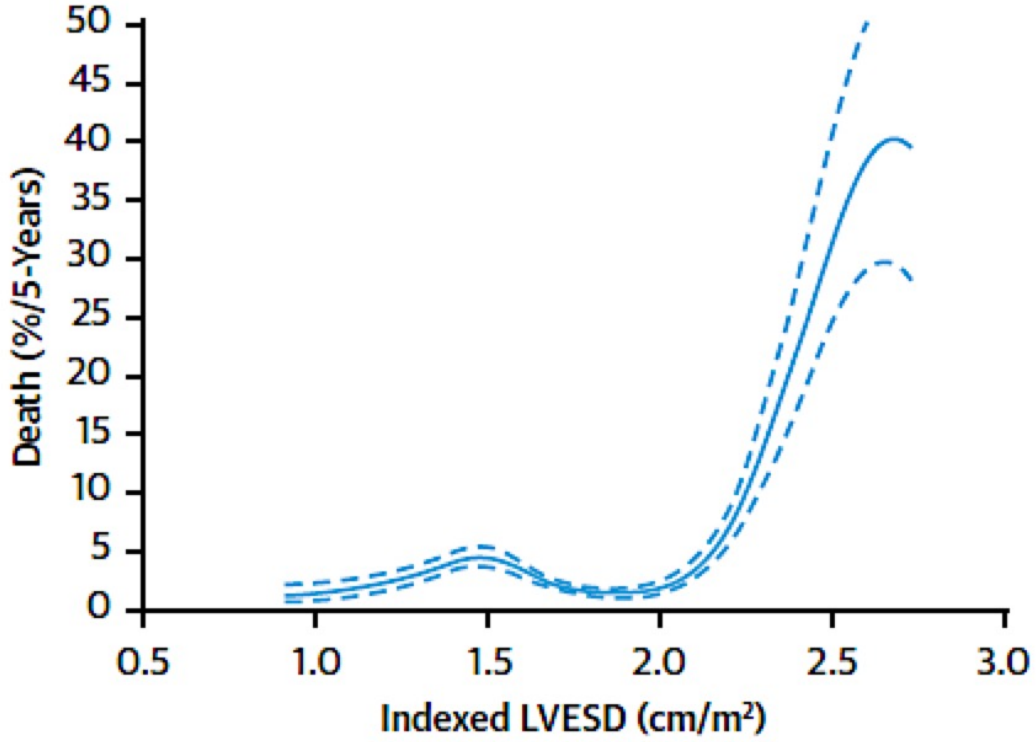
Long-term outcomes in patients with aortic regurgitation and preserved LVEF

In the subgroup that did not undergo AV surgery :

- Patients with index-LV-ESD <20 mm/m² had excellent 5-year survival

- The risk of death significantly and continuously rose as index-LV-ESD increased beyond 20 mm/m²

FIGURE 1 Mortality Risk



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Mentias et al. *J Am Coll Cardiol.* 2016; 68: 2144–53.

www.imm.fr

Outcomes in hemodynamically significant AR and limitations of current guidelines

Mayo Clinic (2006-2017) :

- 748 consecutive patients with Grade ≥3/4 chronic AR without prior heart surgery, AMI or overt CAD

- 387 patients (52%) were medically treated

- 361 patients (48%) underwent AVR

TABLE 1 Baseline Characteristics and Echocardiographic Parameters in All Patients (N = 748)

Age, yrs*	58 ± 17
Women	137 (18)
Echo parameters	
LVEF, %	59 ± 8
LVEF <50%	72 (10)
LVESD	
Nonindexed, mm‡	40 ± 7
>50 mm	49 (7)
>55 mm	16 (2)
LVESDi, mm/m^2‡	20 ± 4
LVESDi >25 mm/m^2*	74 (10)
LVEDD	
Nonindexed, mm‡	60 ± 7
>65 mm	151 (20)
>75 mm	15 (2)
Indexed, mm/m^2	30 ± 4

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Yang et al. *J Am Coll Cardiol.* 2019; 73: 1741-52

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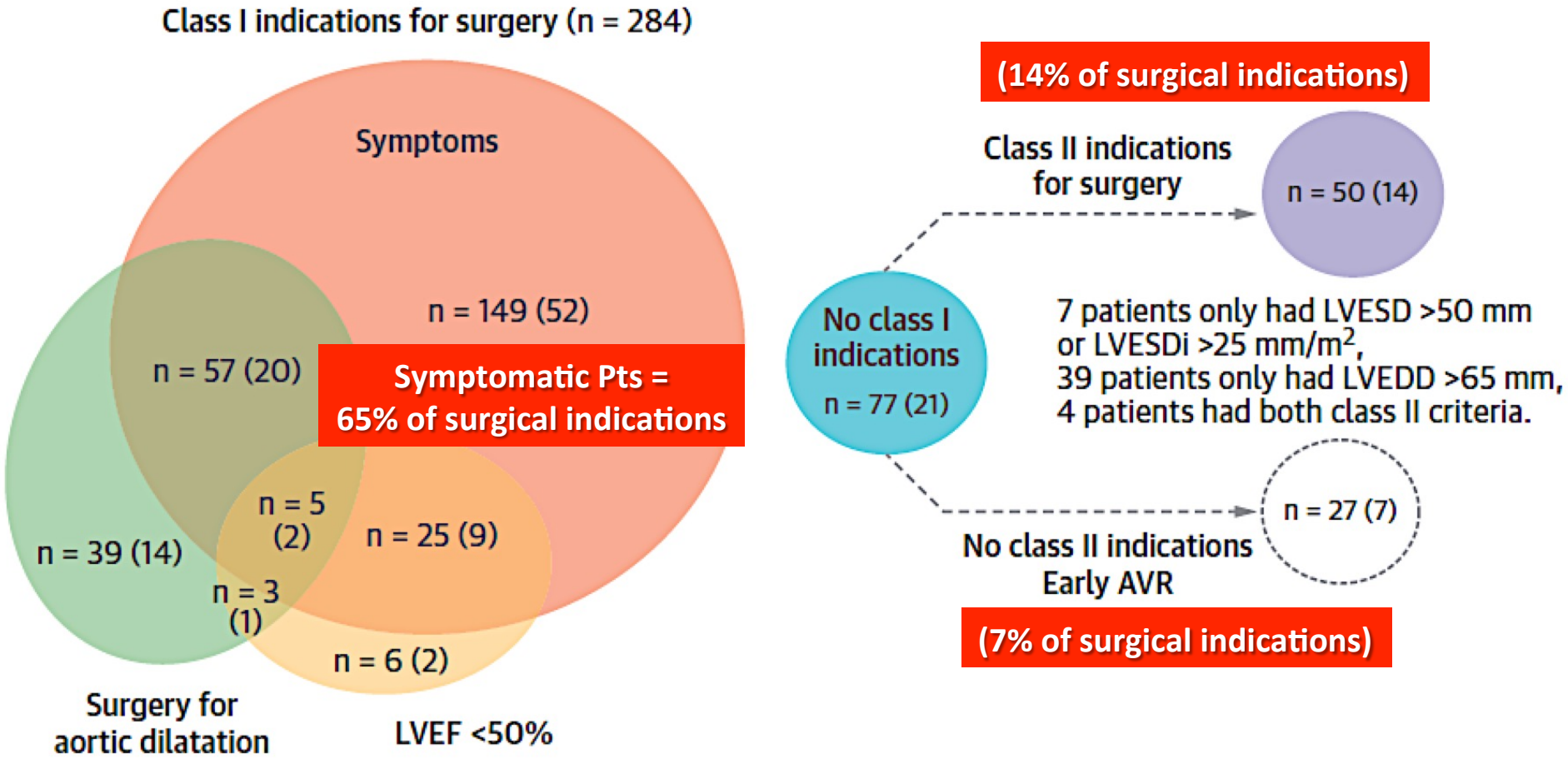
Outcomes in hemodynamically significant AR and limitations of current guidelines

FIGURE 2 Surgical Indications for 361 Patients With Aortic Valve Surgery



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Yang et al. *J Am Coll Cardiol.* 2019; 73: 1741-52

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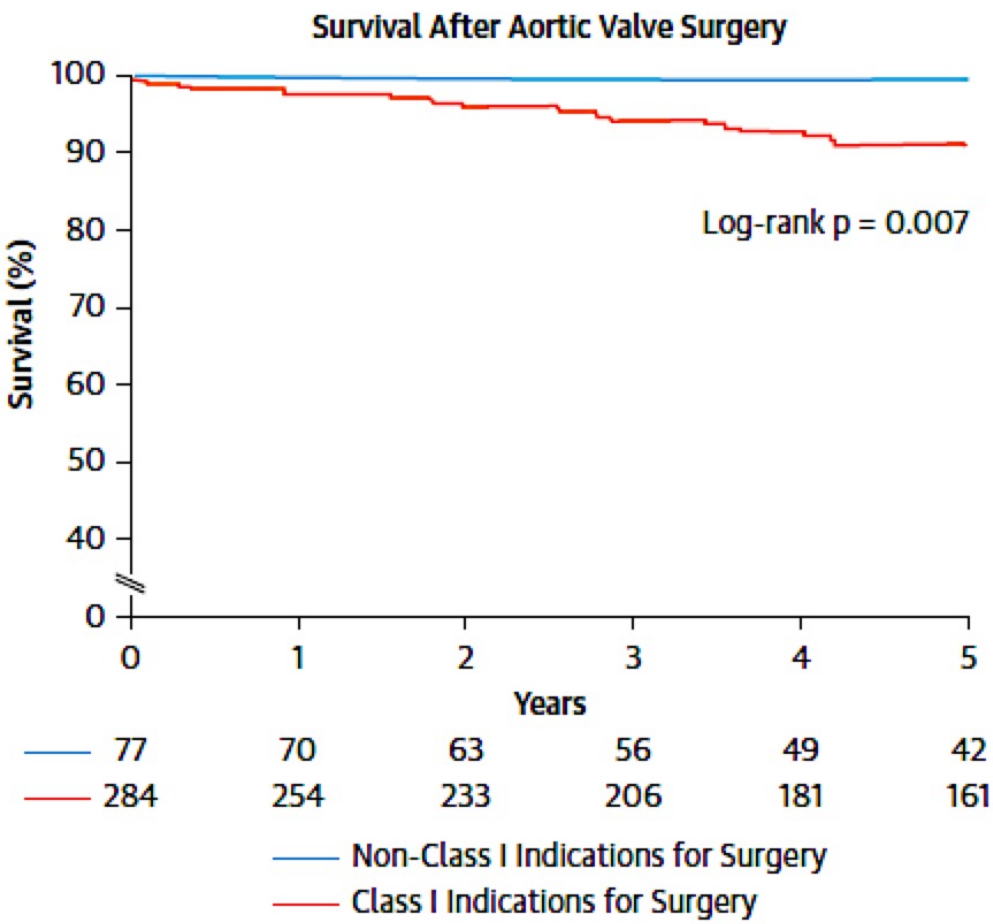
Outcomes in hemodynamically significant AR and limitations of current guidelines

Surgery in 361 patients :

- AV replaced (73%) or repaired (27%)
- Thoracic aorta procedures: 31%
- Mortality (30-day): 1%
- Patients with non–Class I indications for surgery had better post-operative survival

FIGURE 4 Kaplan-Meier Curves in Survival After Aortic Valve Surgery (n = 361): Separated on the Basis of Class I Indications for Surgery



Yang et al. *J Am Coll Cardiol.* 2019; 73: 1741-52

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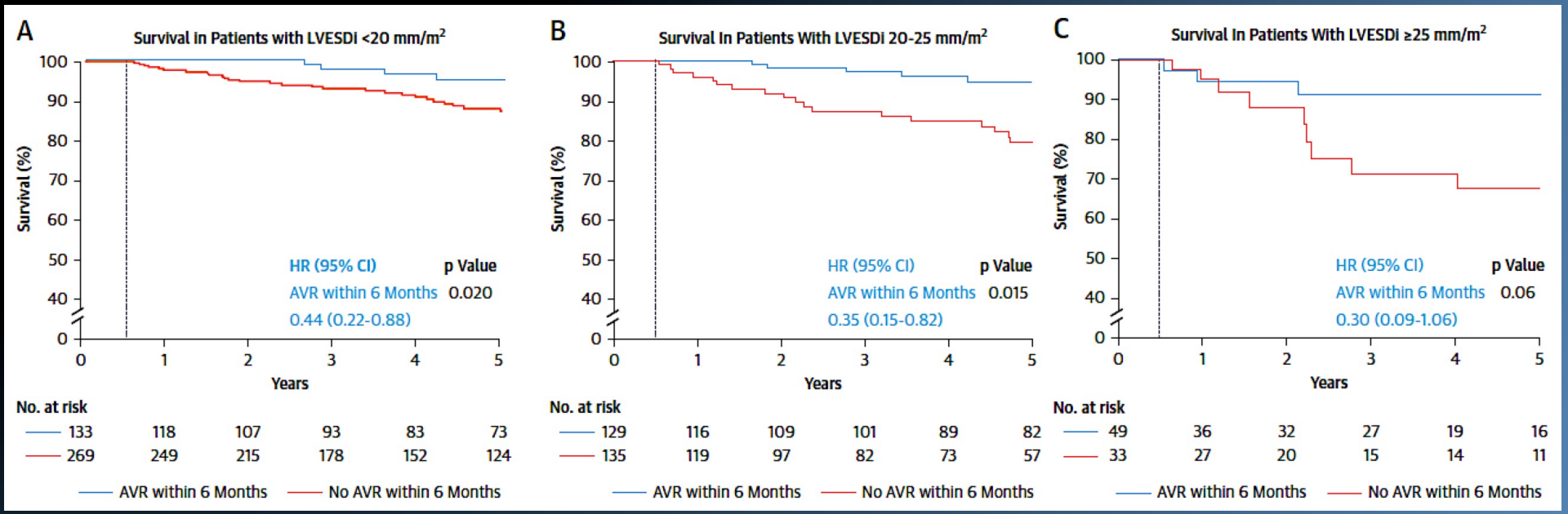
Outcomes in hemodynamically significant AR and limitations of current guidelines

FIGURE 3 Kaplan-Meier Survival Curves Adjusted for Age, Sex, Charlson Comorbidity Index, and Symptoms in 3 Strata of LVESDi



AVR was associated with better survival in all patients :
(A) LVESDi <20 mm/m², (B) 20-25 mm/m² and (C) >25 mm/m²

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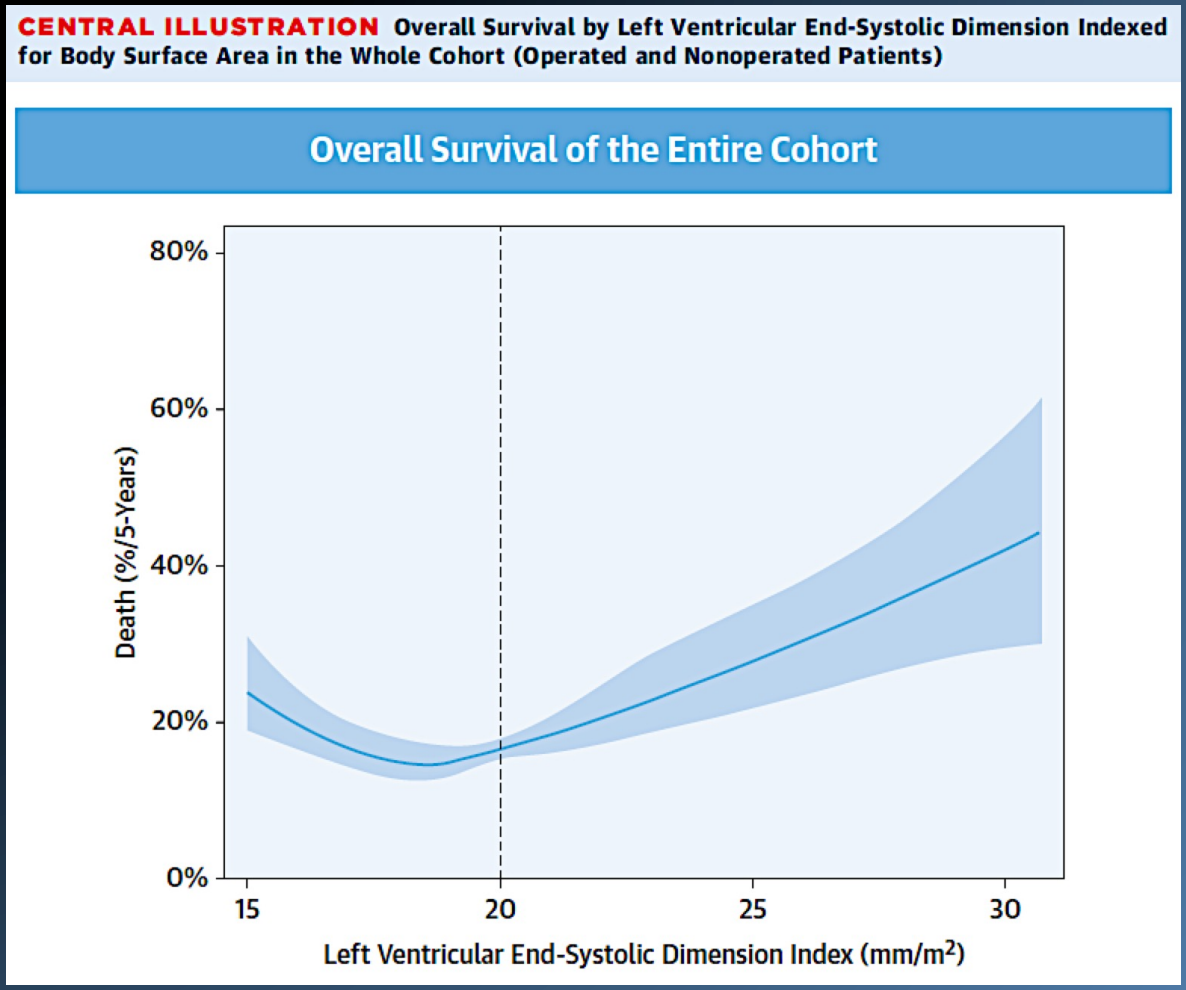
Outcomes in hemodynamically significant AR and limitations of current guidelines

5-year survival started to decrease in patients with LV index ESD >20 mm/m²

CENTRAL ILLUSTRATION Overall Survival by Left Ventricular End-Systolic Dimension Indexed for Body Surface Area in the Whole Cohort (Operated and Nonoperated Patients)



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Yang et al. *J Am Coll Cardiol.* 2019; 73: 1741-52

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Do guidelines-based indications result in an outcome penalty in patients with severe AR ?

356 consecutive patients with pure, isolated ≥ grade-3 chronic AR operated on at the Clinique Universitaire St-Luc (Brussels, BE), between 1995 and 2014

Operative procedures:

- AV repair (80%)
- Ross procedure (7%)
- Bioprosthetic AVR (9%)
- Mechanical AVR (4%)

Operative mortality = 1,1% (4 patients)

Table 1: Baseline demographic and clinical characteristics

Characteristics	Overall population			
	Class I n=204	Class II n=73	No trigger n=79	P-Value
Demographics				
Age (years)	55 ± 15	43 ± 15	49 ± 14	<0.001
Male gender (n, %)	160 (78%)	69 (95%)	67 (85%)	0.006
Weight (kg)	80 ± 17	84 ± 17	82 ± 17	0.25
Height (m)	1.72 ± 0.10	1.78 ± 0.09	1.76 ± 0.08	<0.001
Aortic pathology				
Bicuspid valve (%)	32	60	56	<0.001
Type I dysfunction (%)	31	23	32	0.43
Type II dysfunction (%)	40	60	49	0.008
Type III dysfunction (%)	29	16	19	0.038
Risk scores				
STS PROM (%)	1.22 ± 1.03	0.72 ± 0.51	0.78 ± 0.59	<0.001
Associated procedures				
CABG (%)	10	5	8	0.50
	(57%)	(21%)	(22%)	

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De Meester et al. *J Am Coll Cardiol.* 2019; 12: DOI: 10.1016

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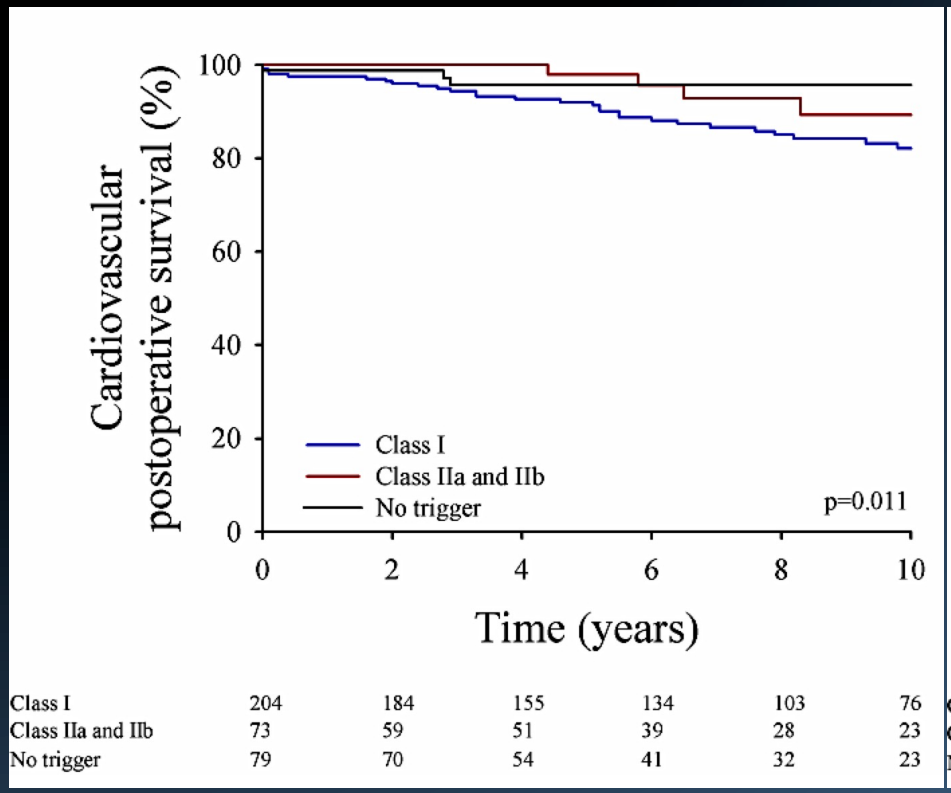
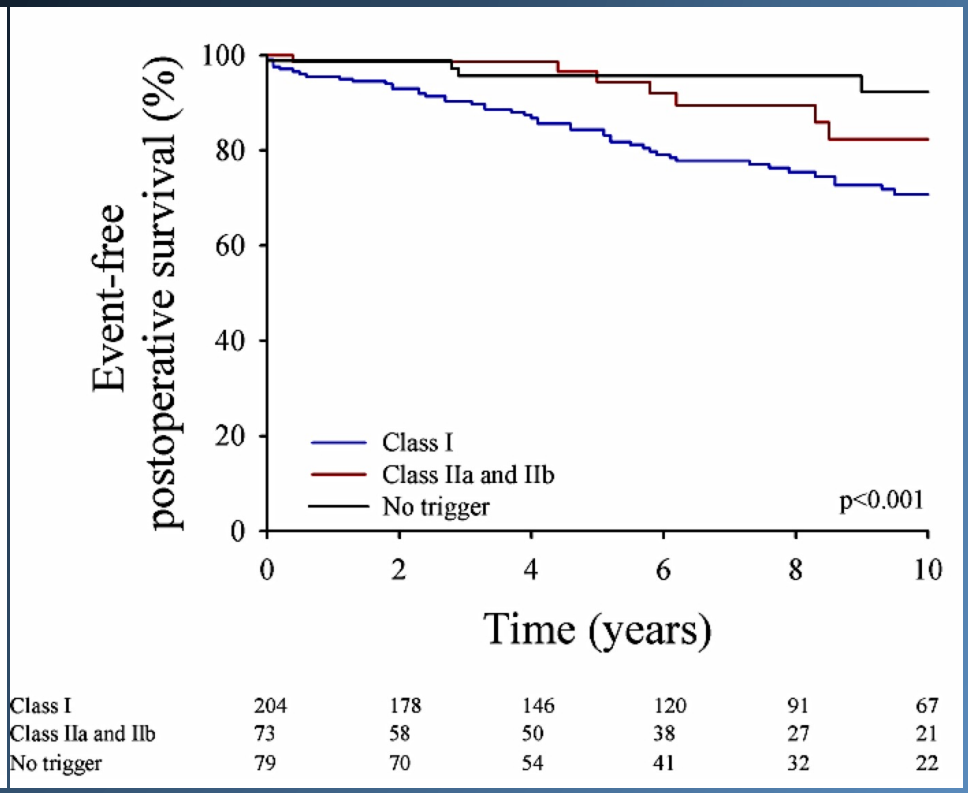
Do guidelines-based indications result in an outcome penalty in patients with severe AR ?

Class-I (symptoms/reduced LVEF) and Class-IIa triggers (end-systolic LV diameters) are associated with an increased risk of CV death or CHF



Class I	204	184	155	134	103	76
Class IIa and IIb	73	59	51	39	28	23
No trigger	79	70	54	41	32	23



Class I	204	178	146	120	91	67
Class IIa and IIb	73	58	50	38	27	21
No trigger	79	70	54	41	32	22

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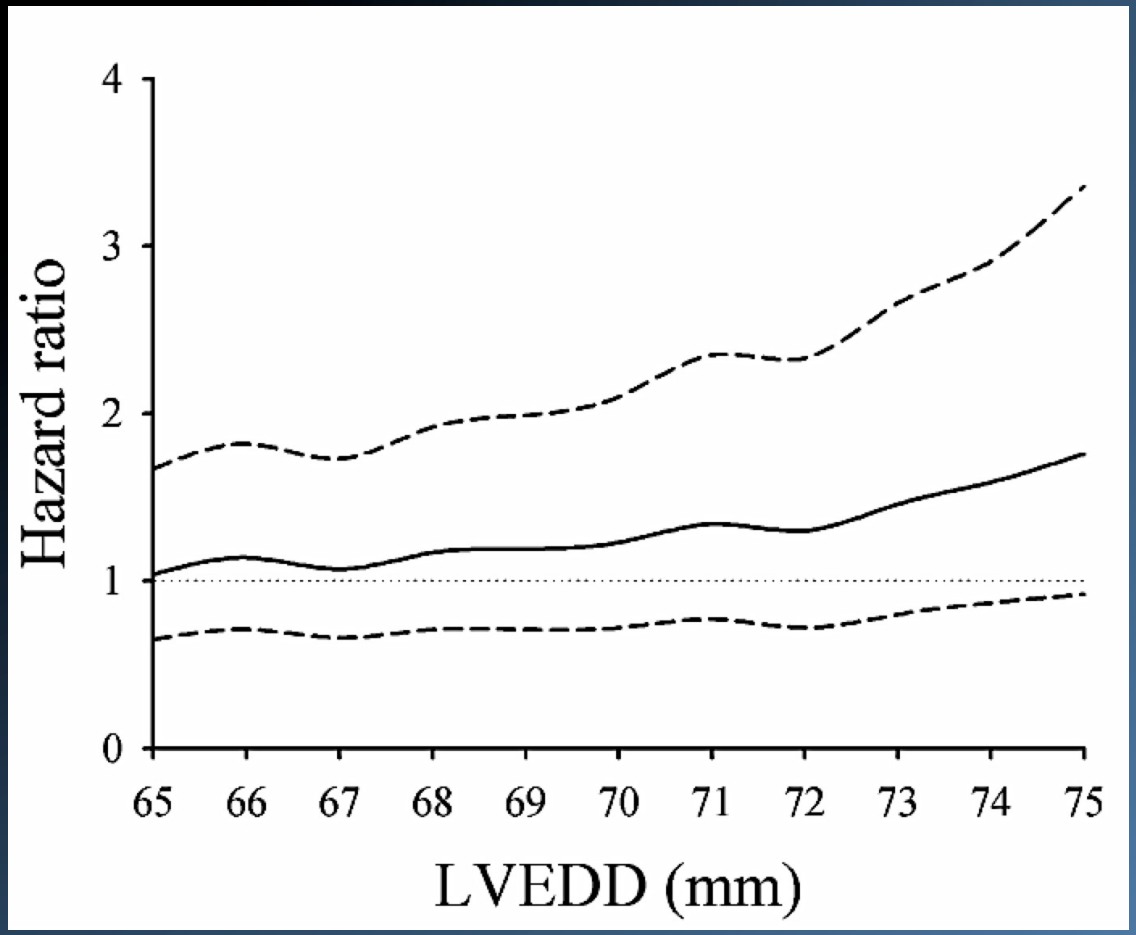
Do guidelines-based indications result in an outcome penalty in patients with severe AR ?

Class-IIb triggers (LV dilatation at end-diastole) do not result in an increased risk of mortality or an increased incidence of hospitalization for CHF



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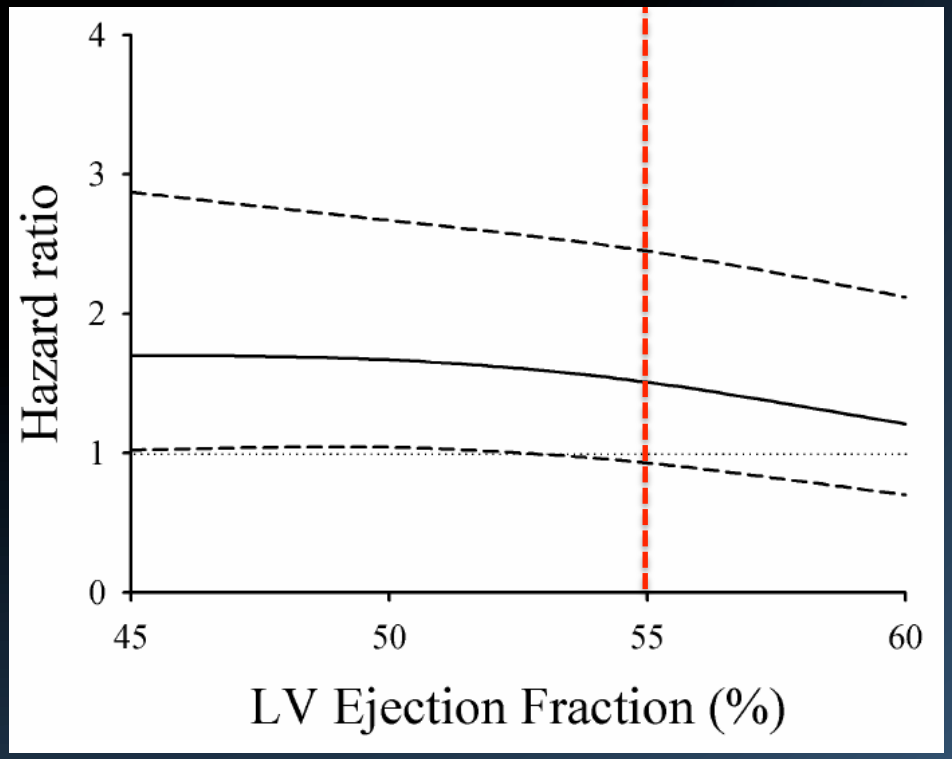
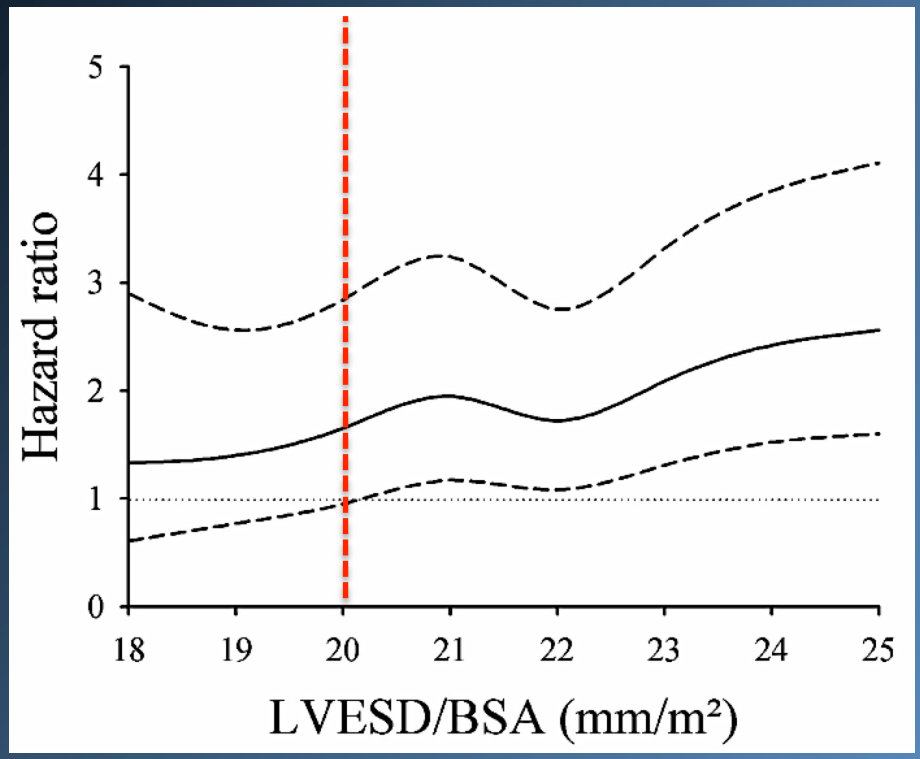
Do guidelines-based indications result in an outcome penalty in patients with severe AR ?

Increased risk of CV death or CHF as soon as LVEF falls below 55% or indexed LV end-systolic diameter >20 mm/m² (22 mm/m² in asymptomatic patients)





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Word of caution

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Survival implications of LV end-systolic diameter in MR due to flail leaflets (MIDA)

- 739 patients with MR due to flail leaflets (65±12 years, LVEF: 65± 10%)
- LVESD > 40 mm (22 mm/m²) : Mortality risk increased linearly
- HR: 1.15, 95% CI: 1.04 to 1.27 per 1-mm increment

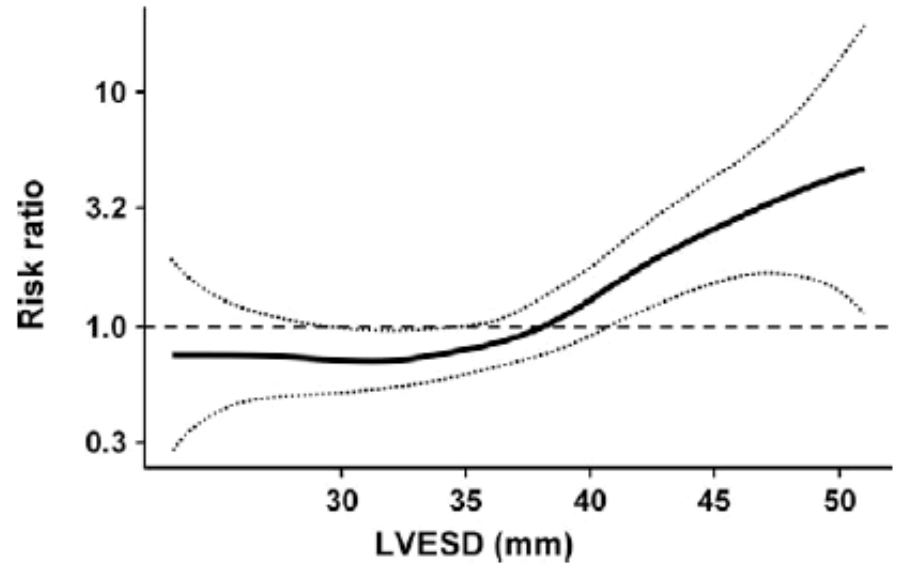

Figure 2 Association Between LVESD and the Risk of Overall Mortality Under Conservative Management

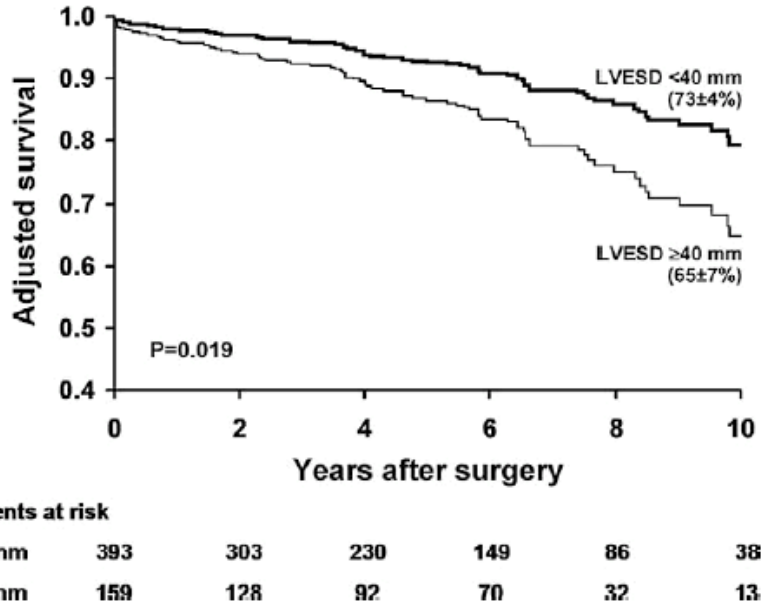

Figure 4 Adjusted Post-Operative Overall Survival According to LVESD in Operated Patients With Organic MR

Tribouilloy et al. *J Am Coll Cardiol.* 2009; 54: 1961-8

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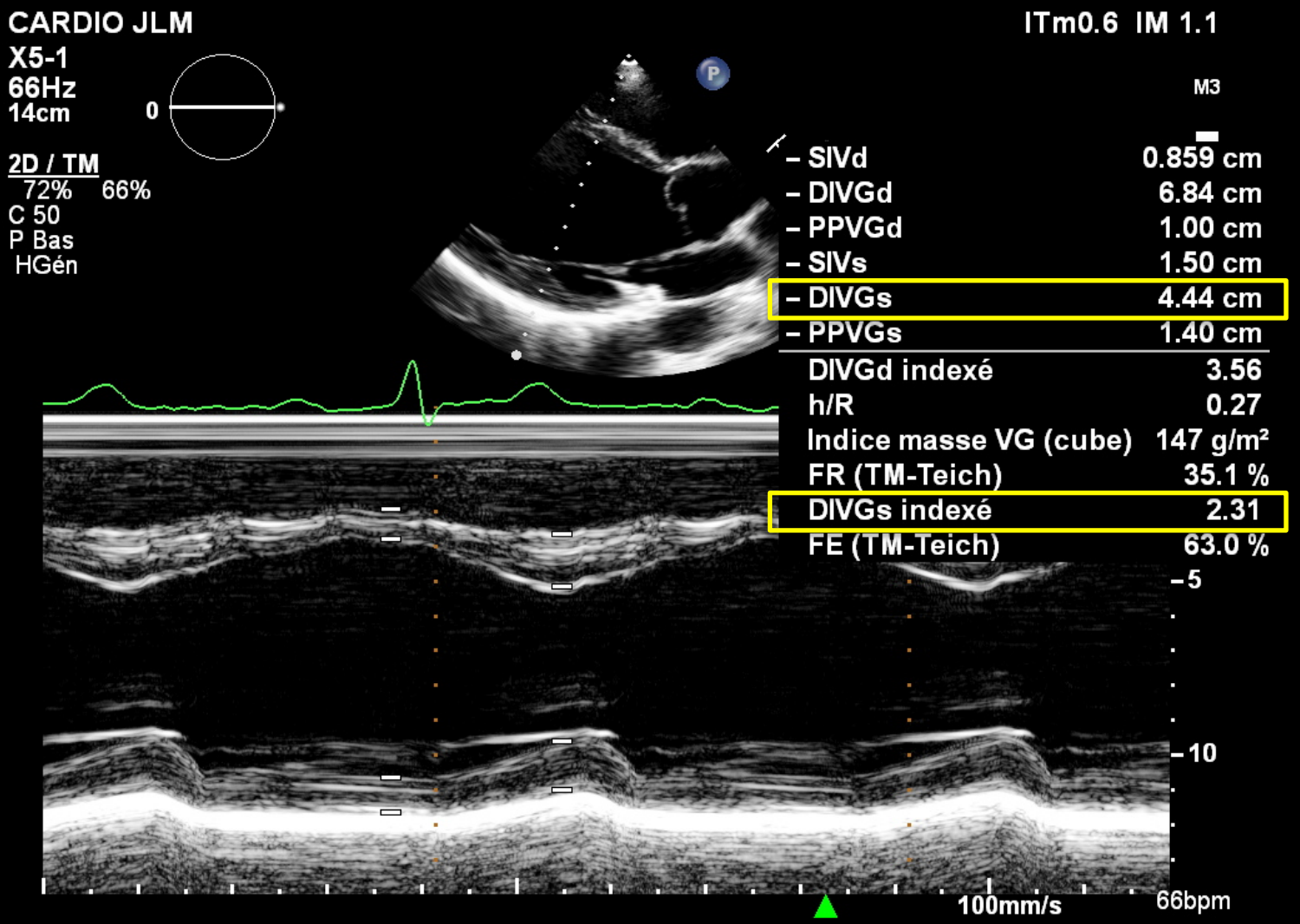
LV End-systolic diameter = 44 mm



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LV End-systolic diameter = 23 mm/m²

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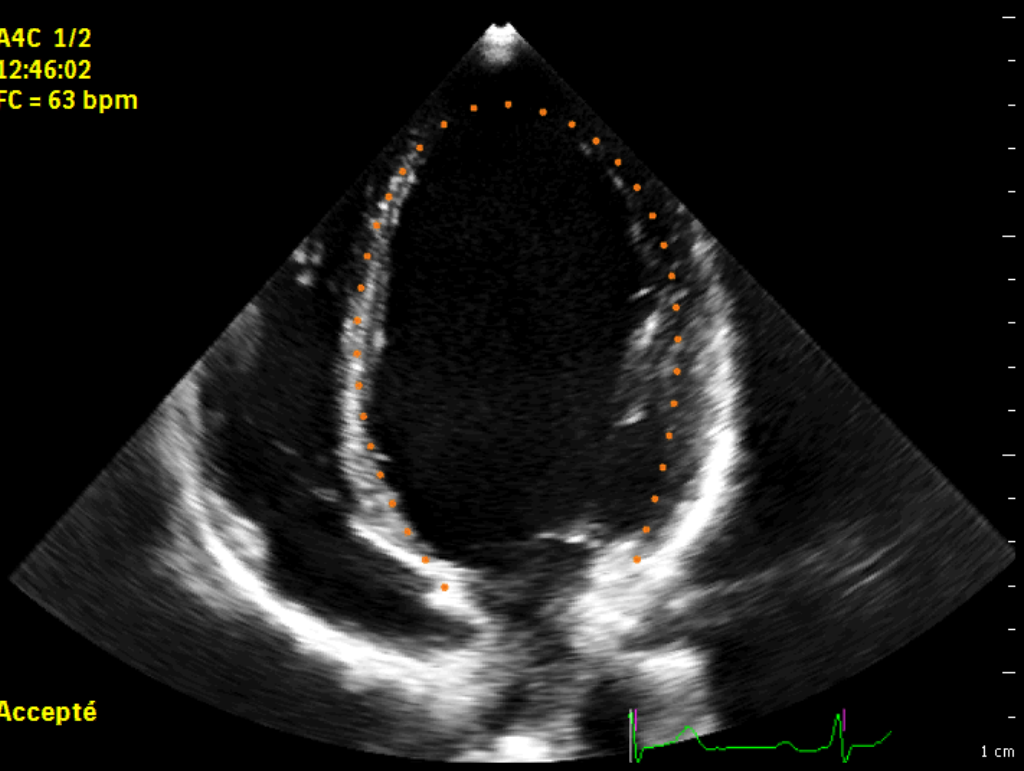

Mesures

VTD	327.4 ml
VTS	147.9 ml
FE	54.8 %

Cycles cardiaques

R-R VA	959 ms
R-R VM	959 ms

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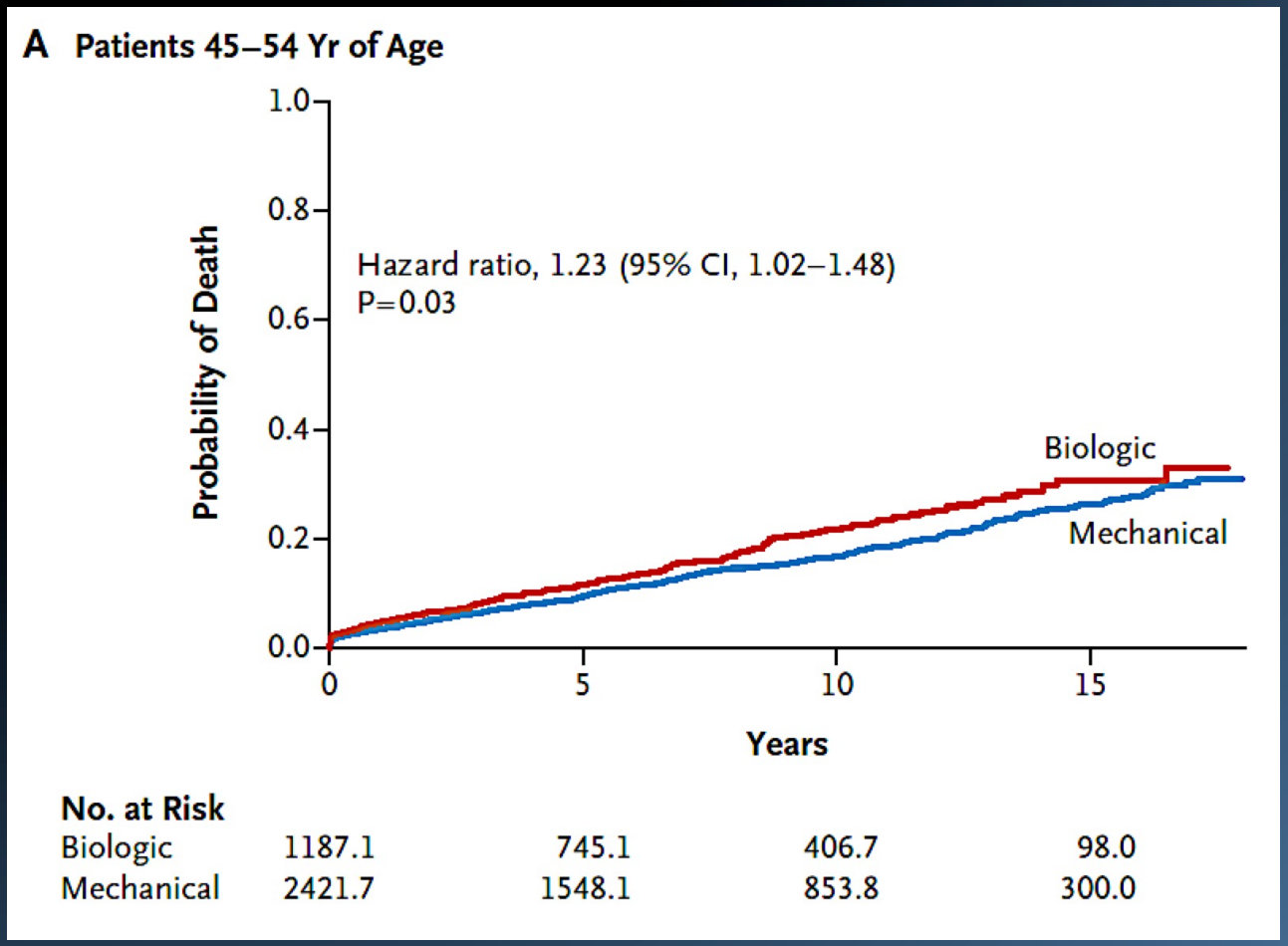
Mechanical or Biologic Prostheses for Aortic and Mitral-Valve Replacement

AVR: 15-year mortality (45-54 years): 31% (Biologic) vs. 26% (Mechanical)



Significantly lower incidence of STROKE with Bioprosthetic vs. Mechanical AV in the 45-54 years group

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Goldstone et al. *N Engl J Med.* 2017; 377: 1847-57

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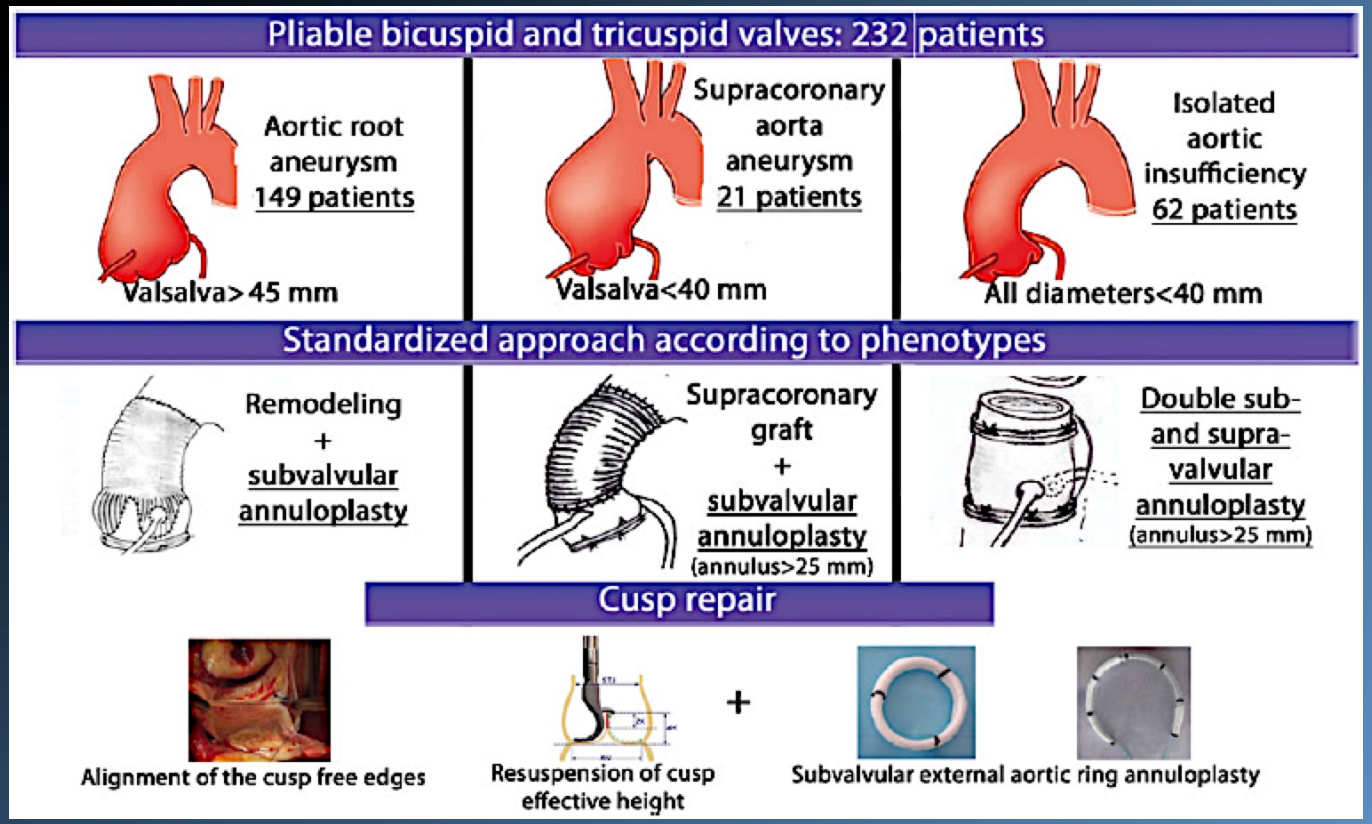
Long-term results of external aortic ring annuloplasty for aortic valve repair

Long-term results of 232 consecutive patients (aged 50± 15 years) from the *Aortic Valve repair International Registry* (AVIATOR)

- Cusp repair in 75% of patients; 30-day operative mortality rate = 1.4%
- Mean FU: 40±38 months (0–146); actuarial survival rate at 7 years = 89.9%.



Lansac et al. *Eur J Cardiothorac Surg.* 2016; 50: 350–60

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Indications for surgery in severe aortic regurgitation

Recommendations	Class	Level
A. Severe aortic regurgitation		
Surgery is indicated in symptomatic patients.	I	B
Surgery is indicated in asymptomatic patients with resting LVEF ≤50%.	I	B
Surgery is indicated in patients undergoing CABG or surgery of the ascending aorta or of another valve.	I	C
Heart Team discussion is recommended in selected patients* in whom aortic valve repair may be a feasible alternative to valve replacement.	I	C
Surgery should be considered in asymptomatic patients with resting ejection fraction >50% with severe LV dilatation: LVEDD >70 mm, or LVESD>50 mm (or LVESD >25 mm/m^2 BSA in patients with small body size).	IIa	B

** Patients with pliable non-calcified tricuspid or bicuspid valves who have a type I (enlargement of the aortic root with normal cusp motion) or type II (cusp prolapse) mechanism of AR.*

2017 ESC/EACTS Guidelines for the management of valvular heart disease

European Heart Journal. **2017; 38: 2739-91**

www.escardio.org/guidelines

Indications for surgery in (A) severe aortic regurgitation and (B) aortic root disease (irrespective of aortic regurgitation severity) (continued)

Recommendations	Class	Level
B. Aortic root or tubular ascending aorta aneurysm (irrespective of the severity of aortic regurgitation)		
Aortic valve repair, using the reimplantation or remodelling with aortic annuloplasty technique, is recommended in young patients with aortic root dilation and tricuspid aortic valves, when performed by experienced surgeons.	I	C
Surgery is indicated in patients with Marfan syndrome, who have aortic root disease with a maximal ascending aortic diameter ≥50 mm.	I	C

2017 ESC/EACTS Guidelines for the management of valvular heart disease

European Heart Journal. **2017; 38: 2739-91**

www.escardio.org/guidelines

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Summary-1: Are we operating patients with chronic AR too late?

Three large recent series (Total N>2 500) demonstrate that:

- Most patients with severe AR currently undergo surgery for class-I indications (2017 ESC-EACTS)

- Class-I and Class-IIa triggers are associated with an increased long-term risk of cardiovascular death or congestive heart failure

- Long-term survival (including postoperative) starts to decline a soon as:
  - LVEF is < 55%
  - Indexed LV end-systolic diameter is > 20-22 mm/m^2

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Summary-2: Are we operating patients with chronic AR too late ?

Caution: Retrospective studies

- None of the previous (recent) studies was randomized
- 25-30% mortality 15 years after AV replacement, in patients aged 45-55 years
- AV repair might have better long-term results in these patients
- Current cutoffs might probably be revised, especially for young patients eligible for AV repair (as for primary MR)
- More robust data are certainly needed

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Incremental Prognostic Utility of Left Ventricular Global Longitudinal Strain in Asymptomatic Patients With Significant Chronic Aortic Regurgitation and Preserved Left Ventricular Ejection Fraction

Alaa Alashi, MD, Amgad Mentias, MD, Amjad Abdallah, MD, Ke Feng, MD, A. Marc Gillinov, MD, L. Leonardo Rodriguez, MD, Douglas R. Johnston, MD, Lars G. Svensson, MD, PhD, Zoran B. Popovic, MD, PhD, Brian P. Griffin, MD, Milind Y. Desai, MD

ABSTRACT

OBJECTIVES This study sought to examine the prognostic utility of left ventricular (LV) global longitudinal strain (GLS) in asymptomatic patients with ≥III+ aortic regurgitation (AR), an indexed LV end-systolic dimension of <2.5 cm/m^2, and preserved left ventricular ejection fraction (LVEF).

BACKGROUND Management of asymptomatic patients with severe chronic AR and preserved LVEF is challenging and is typically based on LV dimensions.

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Incremental prognostic value of GLS in asymptomatic patients with chronic AR and preserved LVEF

TABLE 1 Baseline Characteristics of the Study Population (N = 1,063)

Age, yrs	53 ± 16
Male	813 (77)
Race	
White	922 (87)
African-American	64 (6)
Asian	15 (1.4)
Hispanic	18 (1.7)
Other	43 (4)
Body surface area, m^2	2.0 ± 0.2
Hypertension	589 (55)
Diabetes mellitus	57 (5)
Hyperlipidemia	387 (36)
Smoker	279 (26)
Stroke	47 (4)
Peripheral arterial disease	16 (2)
Chronic renal failure	11 (1)
Connective tissue disorder	37 (4)
Society of Thoracic Surgeons score, %	4.4 ± 5.0

TABLE 3 Multivariate Cox Proportional Hazard Analysis for Predictors of Longer Term Mortality in the Entire Study Population (Number of Deaths = 146)

	HR (95% CI)	p Value
STS score (for 1% increase)	1.51 (1.28–1.77)	<0.001
Indexed left ventricular end-systolic dimension (for every cm/m^2 increase)	0.50 (0.33–0.83)	<0.001
Left ventricular global longitudinal strain (for every unit worsening)	1.11 (1.04–1.19)	0.003
Right ventricular systolic pressure (for every 10 mm Hg increase)	1.33 (1.20–1.49)	<0.001
Aortic valve surgery	0.35 (0.25–0.50)	<0.001
Interaction between aortic valve surgery and indexed left ventricular end-systolic dimension	1.27 (1.14–3.15)	<0.01

Higher iLV-ESD was paradoxically associated with lower long-term mortality, likely because patients with a higher iLV-ESD were more likely to be referred for AV surgery, which was associated with improved long-term survival.

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Alashi et al. *J Am Coll Cardiol Img.* 2018; 11: 673-82

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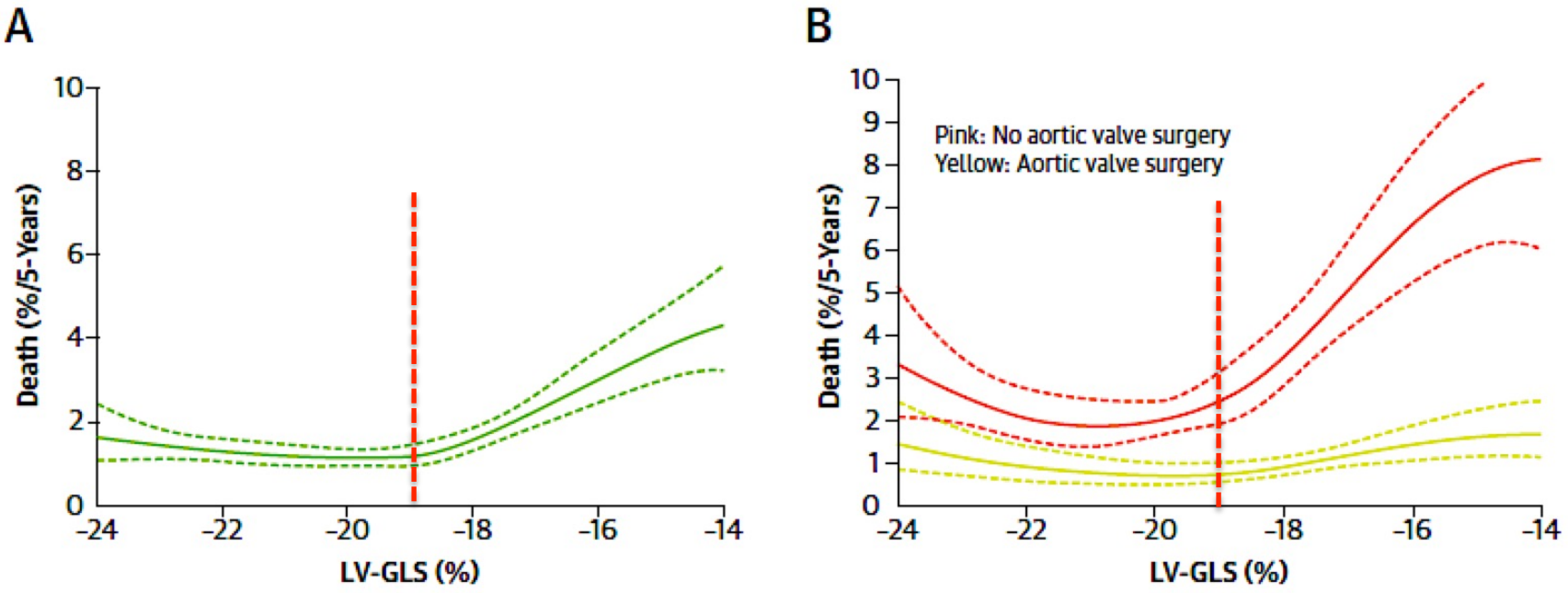
Incremental prognostic value of GLS in asymptomatic patients with chronic AR and preserved LVEF

FIGURE 5 Risk of Death, Based on LV-GLS in the Study Population as a Whole and in the Study Population Separated on the Basis of Undergoing Aortic Valve Surgery Versus Not



Progressive increase in mortality at GLS worse than ≈ 19%, in the entire study population and the non-surgical group. These findings need further validation.

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Alashi et al. *J Am Coll Cardiol Img.* 2018; 11: 673-82

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RAC sévère: indications opératoires de Classe II

RECOMMANDATIONS	Classe	NP
Un RVA est raisonnable en cas de RAC asymptomatique très sévère (Vmax ≥ 5.0 m/s) avec faible risque opératoire	IIa	B
Un RVA est raisonnable en cas de RAC asymptomatique sévère avec diminution de la tolérance à l'effort ou chute tensionnelle lors du test d'effort	IIa	B
Un RVA est raisonnable en cas de RAC modéré (Vmax = 3,0–3,9 m/s) si une chirurgie cardiaque est indiquée par ailleurs	IIa	C

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AHA/ACC Guidelines on VHD. *Circulation*. 2014; 129: e521-e643

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Durability of transcatheter vs. surgical bioprosthetic aortic valves in patients at lower surgical risk

NOTION (Nordic Aortic Valve Intervention):

- All-comer patients with severe AS and lower surgical risk randomized 1:1 to TAVR (n = 139) or SAVR (n = 135)

1/ Moderate/severe structural valve deterioration (SVD) :

- mean gradient ≥20 mm Hg
- increase in mean gradient ≥10 mm Hg
- more than mild intraprosthetic AR

2/ Bioprosthetic valve failure (BVF):
valve related death, AV reintervention, or severe hemodynamic SVD

TABLE 1 Baseline Characteristics of the Implanted Cohort of the NOTION Trial

	TAVR (n = 139)	SAVR (n = 135)	p Value
Age, yrs	79.4 ± 4.9	78.8 ± 4.6	0.326
BMI, kg/m^2	26.6 ± 4.3	26.6 ± 4.1	0.983
Male	52.5	53.3	0.893
NYHA functional class III/IV	46.4	46.3	0.986
STS score	3.0 ± 1.7	3.0 ± 1.6	0.882
STS score			0.832
<4%	82.7	81.5	
4%–10%	15.8	18.5	
>10%	1.4	0.0	
Logistics EuroSCORE II	2.0 ± 1.3	2.0 ± 1.2	0.906
Diabetes mellitus	17.3	20.7	0.463
Creatinine >2 mg/dl	1.4	0.7	>0.999
Peripheral vascular disease	4.3	6.7	0.393
Prior stroke	5.8	9.6	0.228
Chronic lung disease	12.2	11.9	0.923
Permanent pacemaker	3.6	4.4	0.721
Atrial fibrillation/flutter	29.0	24.8	0.439

Values are mean ± SD or %

BMI = body mass index; NOTION = Nordic Aortic Valve Intervention; NYHA = New York Heart Association; SAVR = surgical aortic valve replacement; STS = Society of Thoracic Surgeons; TAVR = transcatheter aortic valve replacement.

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Søndergaard et al. *J Am Coll Cardiol.* 2019;73: 546–53.

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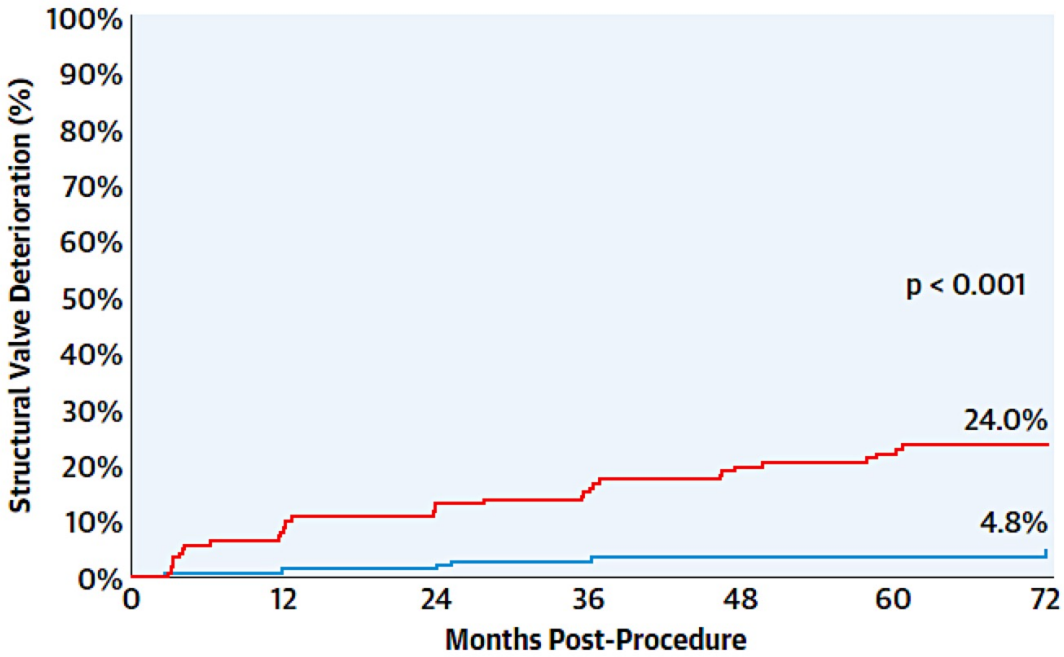
Durability of transcatheter vs. surgical bioprosthetic aortic valves in patients at lower surgical risk

Patients randomized to SAVR (27% Mosaic, 29% Epic, 24% Trifecta, 10% Perimount, and 10% Sorin Mitroflow) or TAVR (100% first-generation CoreValve) and followed annually

CENTRAL ILLUSTRATION Cumulative Incidence of Structural Valve Deterioration Through 6 Years



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Søndergaard et al. *J Am Coll Cardiol.* 2019;73: 546–53.

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Durability of transcatheter vs. surgical bioprosthetic aortic valves in patients at lower surgical risk

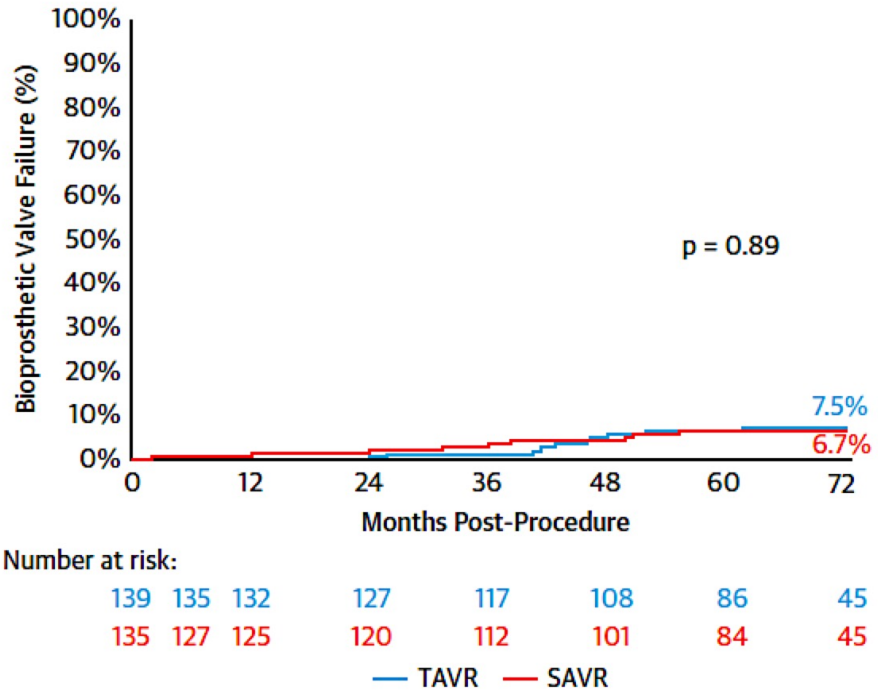
At 6 years, the rates of all-cause mortality were similar for TAVR (42.5%) and SAVR (37.7%) patients (p . 0.58).

TABLE 3 Bioprosthetic Valve Dysfunction and Its Components Through 5 Years

	TAVR (n = 139)	SAVR (n = 135)	p Value
Bioprosthetic valve dysfunction	56.1	66.7	0.073
Components			
Structural valve deterioration	4.8	24.0	<0.0001
Nonstructural valve deterioration	54.0	57.8	0.52
Thrombosis	0.0	0.0	NA
Endocarditis	5.8	5.9	0.95

Values are %.
Abbreviations as in Table 1.

FIGURE 3 Cumulative Incidence of Bioprosthetic Valve Failure Through 6 Years



There was no significant difference in bioprosthetic valve failure (BVF) between transcatheter aortic valve replacement (TAVR) and surgical aortic valve replacement (SAVR) through 6 years.

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Søndergaard et al. *J Am Coll Cardiol.* 2019;73: 546–53.

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Durability after AVR with the Mitroflow vs. the Perimount bioprosthesis

We compared 440 AVR with Mitroflow valves with 1953 AVR with CE pericardial valves implanted from 1999 to 2014 with regard to reoperation, reoperation for structural valve deterioration (SVD) and all-cause mortality.

		All valve sizes		
	All	CE Perimount	Mitroflow	
N	2393	1953	440	
Age	74.7 ± 6.8	74.4 ± 7.1	76.2 ± 5.5	0.00
Women	947 (39.6%)	622 (31.9%)	325 (73.9%)	0.00
Renal insufficiency	73 (3.1%)	63 (3.9%)	10 (3.2%)	NS
Diabetes	342 (14.3%)	285 (14.6%)	57 (12.9%)	NS
COPD	399 (16.7%)	334 (17.1%)	65 (14.8%)	NS
Previous surgery	73 (3.1%)	53 (2.7%)	20 (4.6%)	0.04
AVR + concomitant	1187 (49.6%)	968 (49.6%)	219 (49.8%)	NS
Endocarditis	70 (2.9%)	62 (3.2%)	8 (1.8%)	NS
Previous stroke	211 (8.8%)	165 (8.5%)	46 (10.5%)	NS
Peripheral artery disease	177 (7.4%)	149 (7.6)	28 (6.4%)	NS
Eject. Fract. 30–50%	769 (32.8%)	591 (30.3%)	177 (40.3%)	0.00
Eject. Fract. <30%	147 (6.5%)	130 (6.7%)	17 (3.9%)	0.03
Emergency	74(3.1%)	64 (3.3%)	10 (2.3%)	NS
EuroSCORE logistic	11.7 ± 12.5	11.4 ± 12.5	12.9 ± 12.3	0.01

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Nielsen et al. *Eur J Cardiothorac Surg.* 2016; 46: 1705–10

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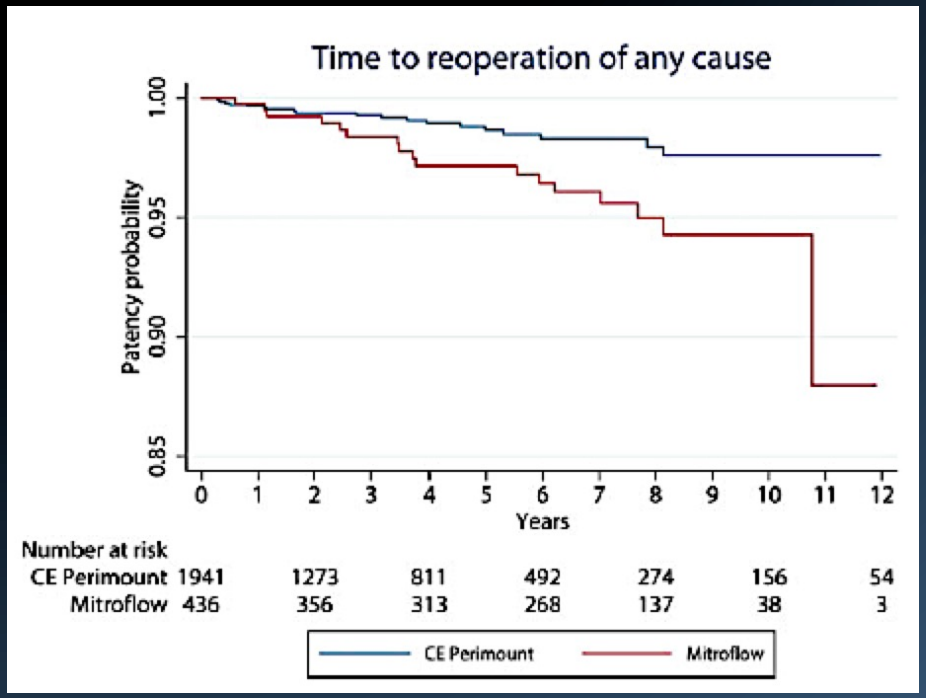
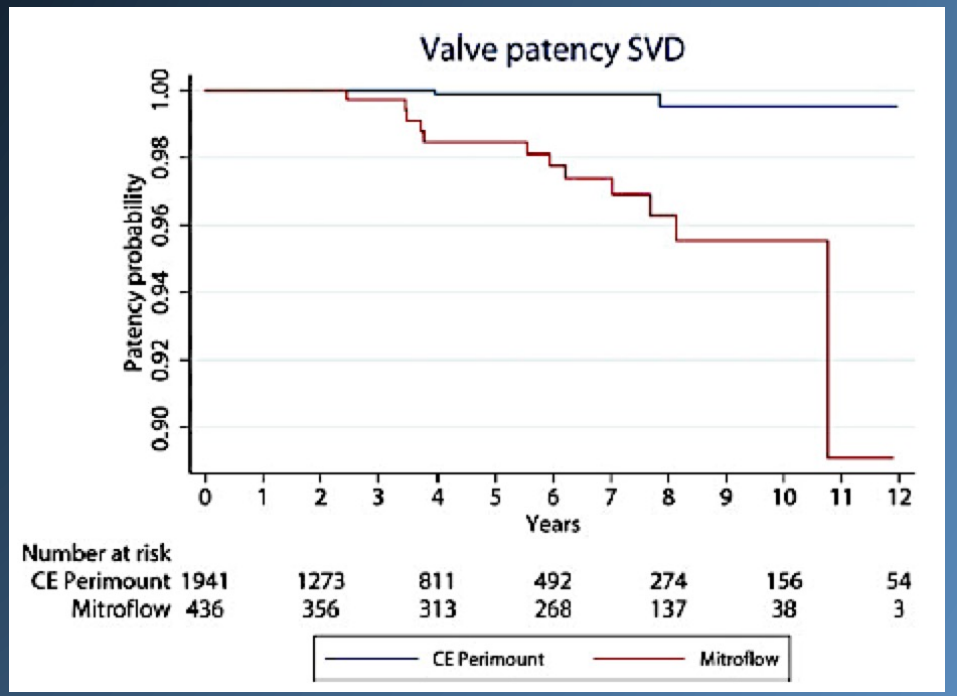
Durability after AVR with the Mitroflow vs. the Perimount bioprosthesis

- 10-year freedom from explant (for any cause) was higher for CE Perimount (98 ± 0.7%) than for Mitroflow (95 ± 1.4%, P < 0.01).

- 10-year freedom from explant due to SVD was higher for CE Perimount (100%) than for Mitroflow (96%) (P < 0.01).





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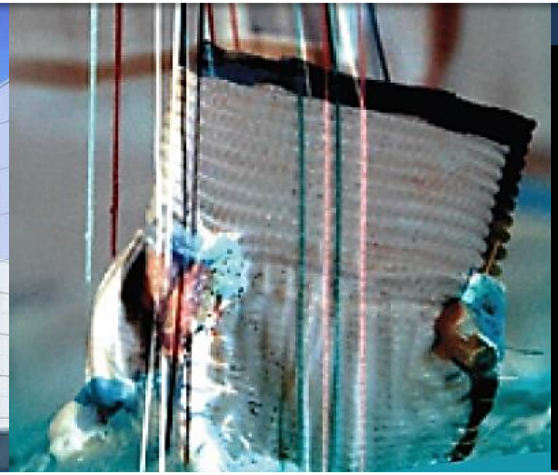
Nielsen et al. *Eur J Cardiothorac Surg.* 2016; 46: 1705–10

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