

Κλινικό Περιστατικό: Στένωση Αορτικής Βαλβίδας

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2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease



Stages of AS

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D: Symptomatic severe AS					
D1	Symptomatic severe high-gradient AS	<ul style="list-style-type: none"> Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening 	<ul style="list-style-type: none"> Aortic $V_{max} \geq 4$ m/s or mean $\Delta P \geq 40$ mm Hg AVA typically ≤ 1.0 cm² (or AVAi < 0.6 cm²/m²) but may be larger with mixed AS/AR 	<ul style="list-style-type: none"> LV diastolic dysfunction LV hypertrophy Pulmonary hypertension may be present 	<ul style="list-style-type: none"> Exertional dyspnea or decreased exercise tolerance Exertional angina Exertional syncope or presyncope
D2	Symptomatic severe low-flow/low-gradient AS with reduced LVEF	<ul style="list-style-type: none"> Severe leaflet calcification with severely reduced leaflet motion 	<ul style="list-style-type: none"> AVA ≤ 1.0 cm² with resting aortic $V_{max} < 4$ m/s or mean $\Delta P < 40$ mm Hg Dobutamine stress echocardiography shows AVA ≤ 1.0 cm² with $V_{max} > 4$ m/s at any flow rate 	<ul style="list-style-type: none"> LV diastolic dysfunction LV hypertrophy LVEF $< 50\%$ 	<ul style="list-style-type: none"> HF Angina Syncope or presyncope
D3	Symptomatic severe low-gradient AS with normal LVEF or paradoxical low-flow severe AS	<ul style="list-style-type: none"> Severe leaflet calcification with severely reduced leaflet motion 	<ul style="list-style-type: none"> AVA ≤ 1.0 cm² with aortic $V_{max} < 4$ m/s or mean $\Delta P < 40$ mm Hg Indexed AVA ≤ 0.6 cm²/m² and Stroke volume index < 35 mL/m² Measured when patient is normotensive (systolic BP < 140 mm Hg) 	<ul style="list-style-type: none"> Increased LV relative wall thickness Small LV chamber with low stroke volume Restrictive diastolic filling LVEF $\geq 50\%$ 	<ul style="list-style-type: none"> HF Angina Syncope or presyncope

Case Report

Male, 68 years old

BSA: 2.02m², BMI: 23.6Kg/m²

BP: 130/85mmHg, HR: 55bpm

- Hypertension
- Diabetes Mellitus
- Hypercholesterolemia
- Coronary Artery Disease - CABG
- Creatinine: 106μmol/L (1.20mg/dl)
eGFR: 48mL/min/1.73 m²
- Chronic Obstructive Pulmonary Disease
- Peripheral Vascular Disease

➤ Heart Failure: (NYHA class III)

➤ Angina: no

Log Euroscore I: 25%

✓ B-blockers

✓ ACEi

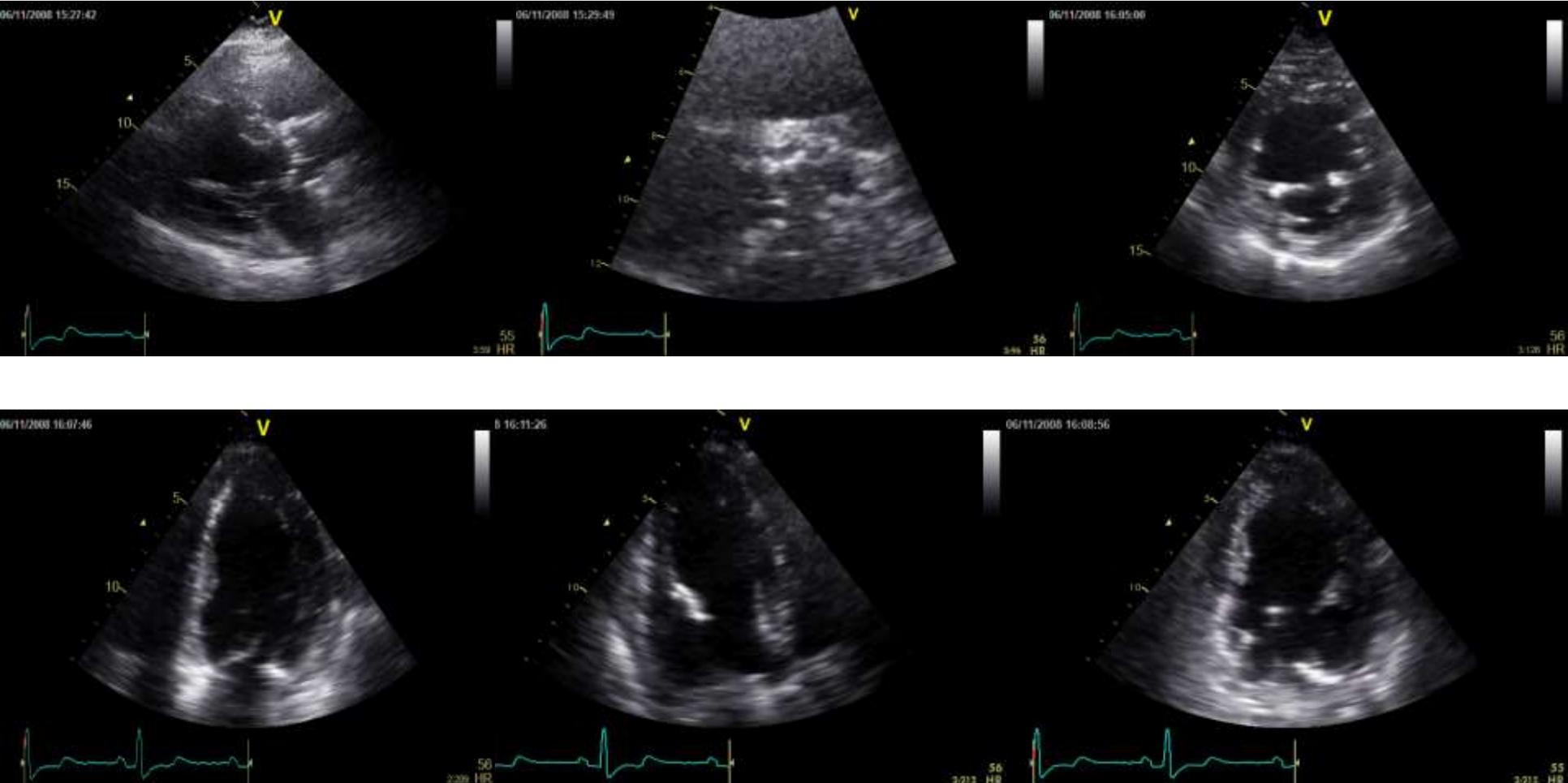
✓ Diuretic

✓ Statin

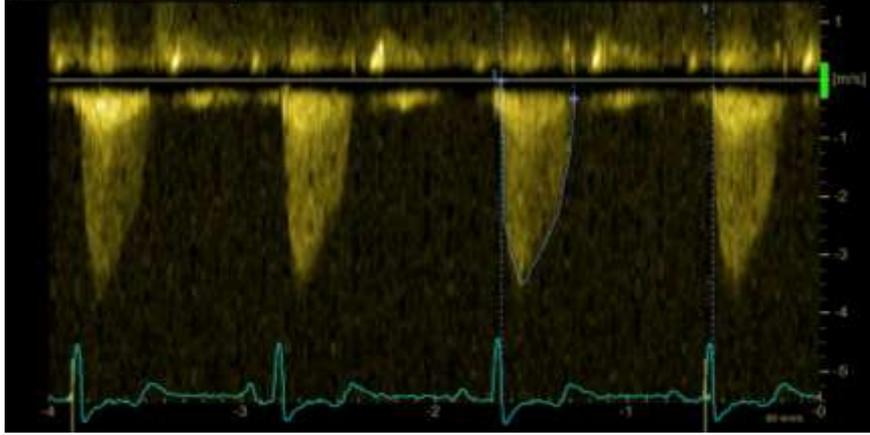
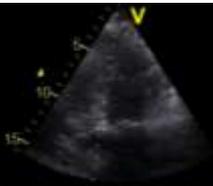
✓ Antiplatelet

✓ Insulin

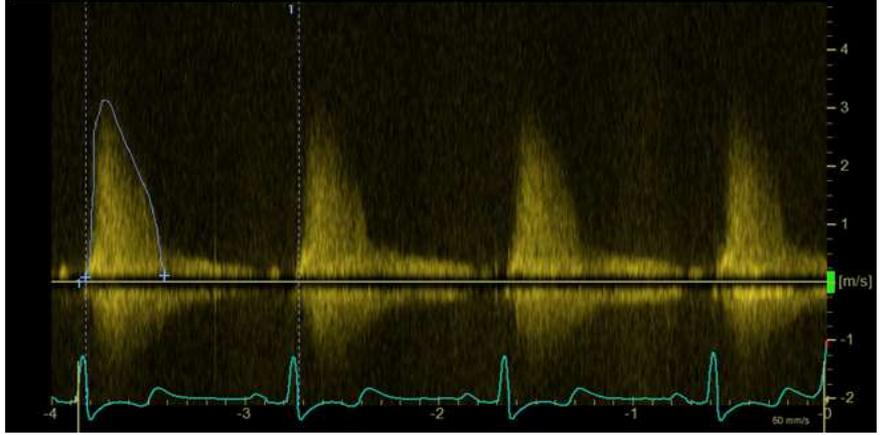
Aortic Stenosis: Severe?



AV Vmax	3.48 m/s
AV Vmean	2.56 m/s
AV maxPG	48.57 mmHg
AV meanPG	28.85 mmHg
AV VTI	97.1 cm
AV Env.Ti	379 ms
HR	55 BPM



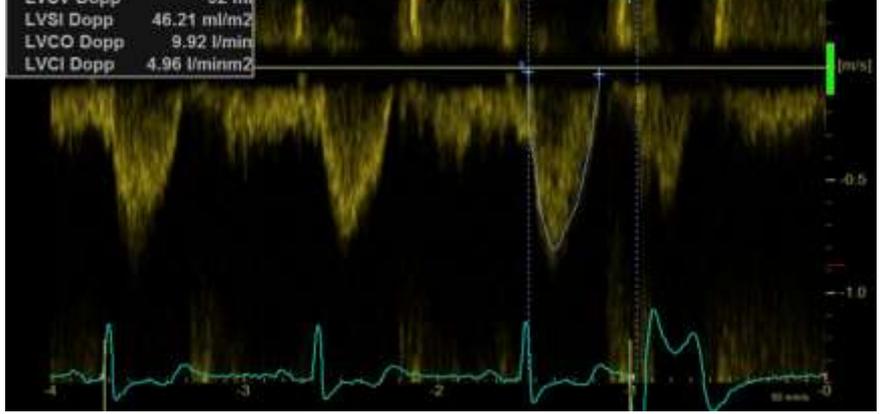
AV Vmax	3.14 m/s
AV Vmean	1.97 m/s
AV maxPG	39.53 mmHg
AV meanPG	18.95 mmHg
AV VTI	80.2 cm
AV Env.Ti	406 ms
HR	55 BPM



LVOT Diam 1.9 cm



LVOT Vmax	0.81 m/s
LVOT Vmean	0.56 m/s
LVOT maxPG	2.60 mmHg
LVOT meanPG	1.41 mmHg
LVOT VTI	20.4 cm
LVOT Env.Ti	365 ms
HR	107 BPM
LVSV Dopp	92 ml
LVSI Dopp	46.21 ml/m ²
LVCO Dopp	9.92 l/min
LVCI Dopp	4.96 l/min/m ²



2D TTE

LVOT CSA= $0.785 \times \text{diameter LVOT}^2$

SV= LVOT CSA x LVOT VTI

SV index= SV/BSA

Zva= (systolic BP + mean pressure gradient) / SV index

AVA= SV / Ao VTI (continuity equation)

AVA index= AVA/BSA

SV: 68ml

SVi: 34ml/m²

Zva: 5.90mmHg/ml/m²

AVA: 0.74cm²

AVAi: 0.37cm²/m²

Low flow - low gradient severe AS with preserved LVEF

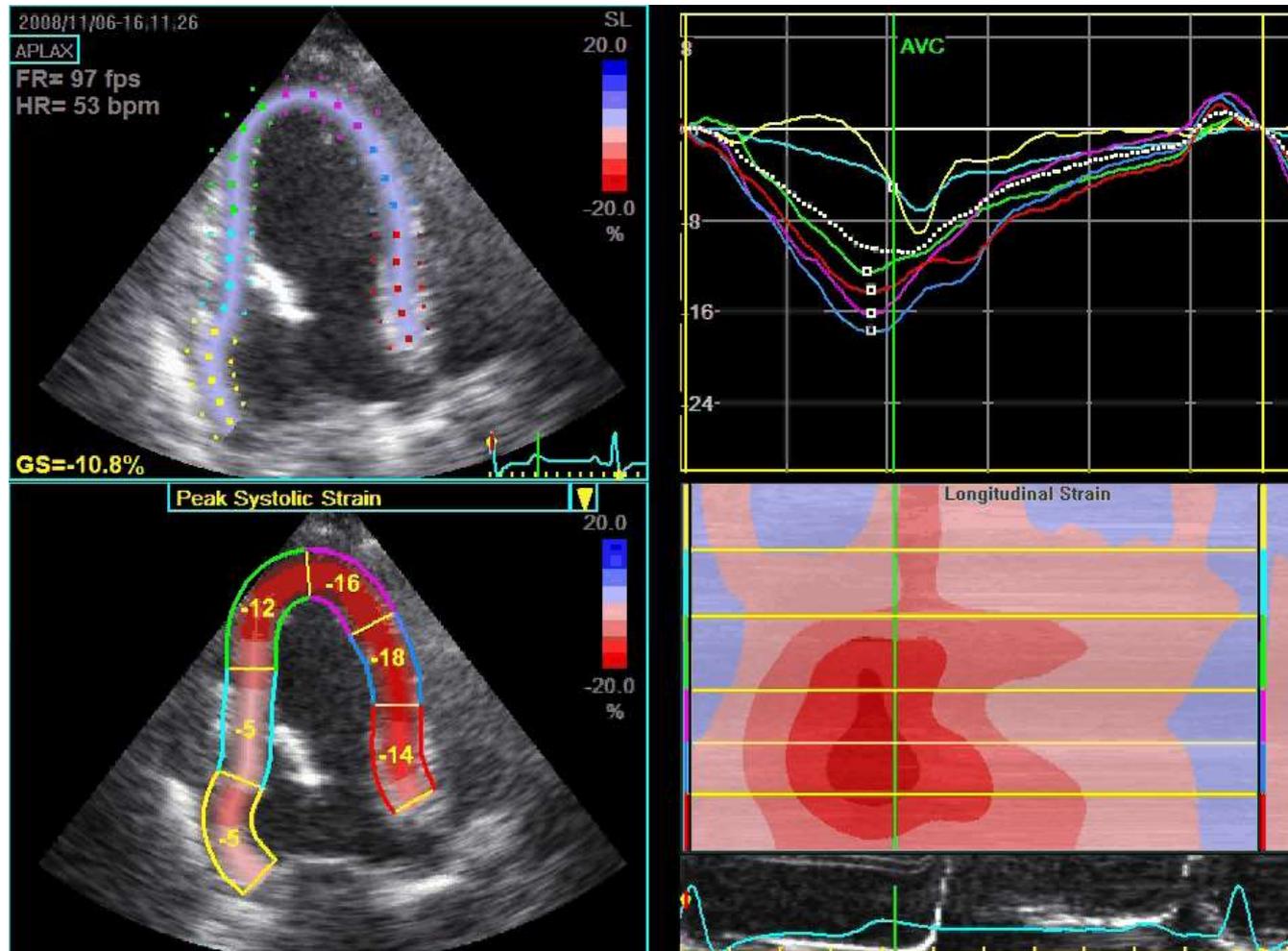
- $SV_i \leq 35 \text{ ml/m}^2$
- $MPG \leq 40 \text{ mmHg}$
- $AVA_i < 0.6 \text{ cm}^2/\text{m}^2$
- $LVEF \geq 50\%$

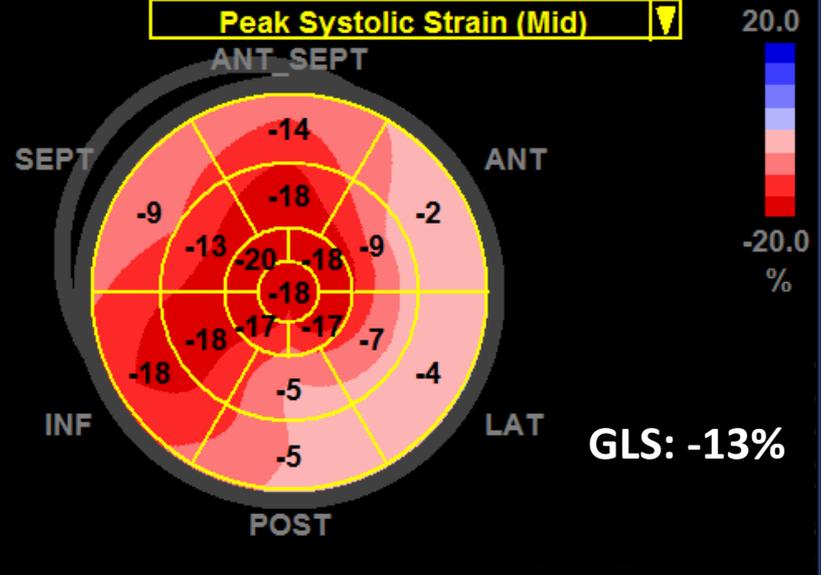
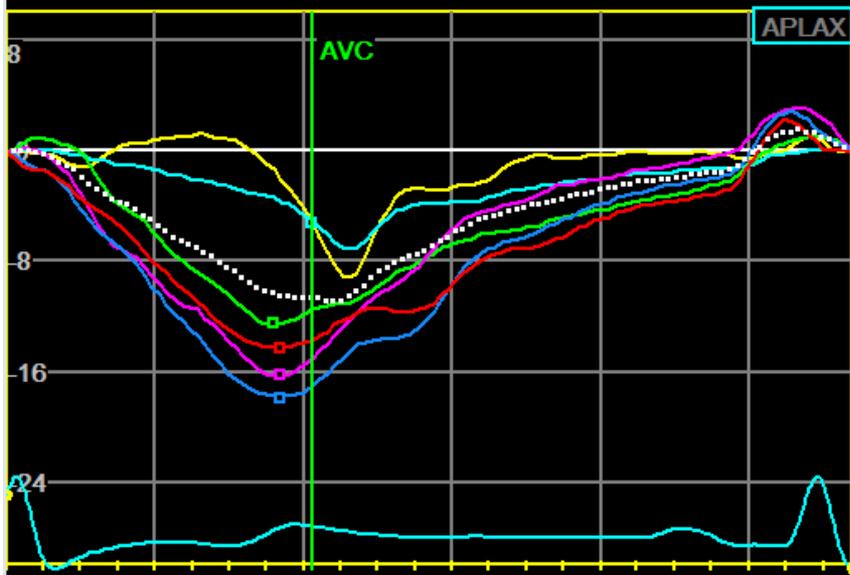
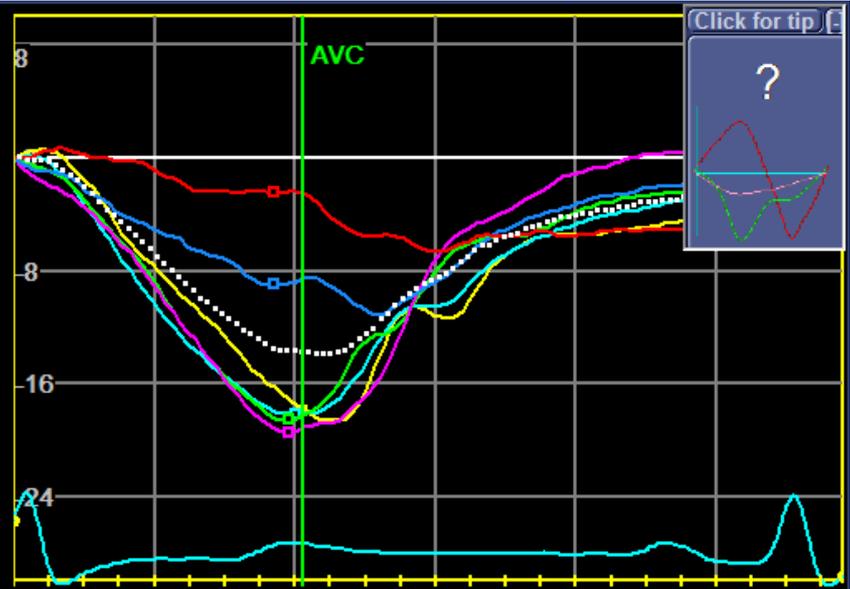
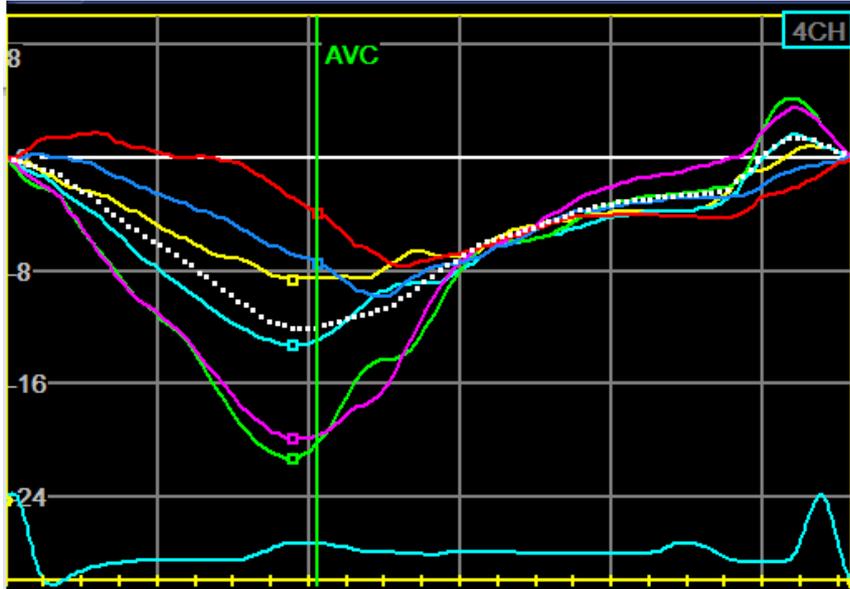
Low-Flow, Low-Gradient Severe Aortic Stenosis Despite Normal Ejection Fraction Is Associated With Severe Left Ventricular Dysfunction as Assessed by Speckle-Tracking Echocardiography

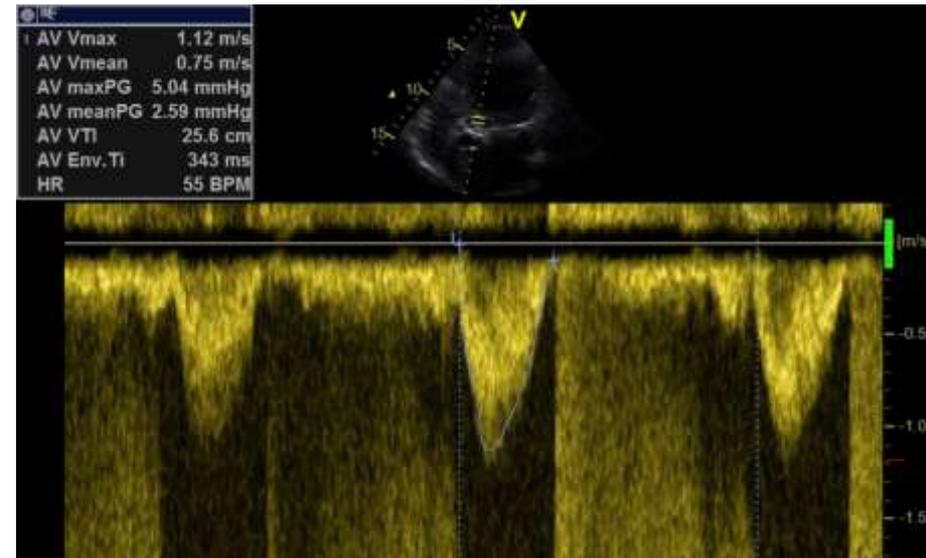
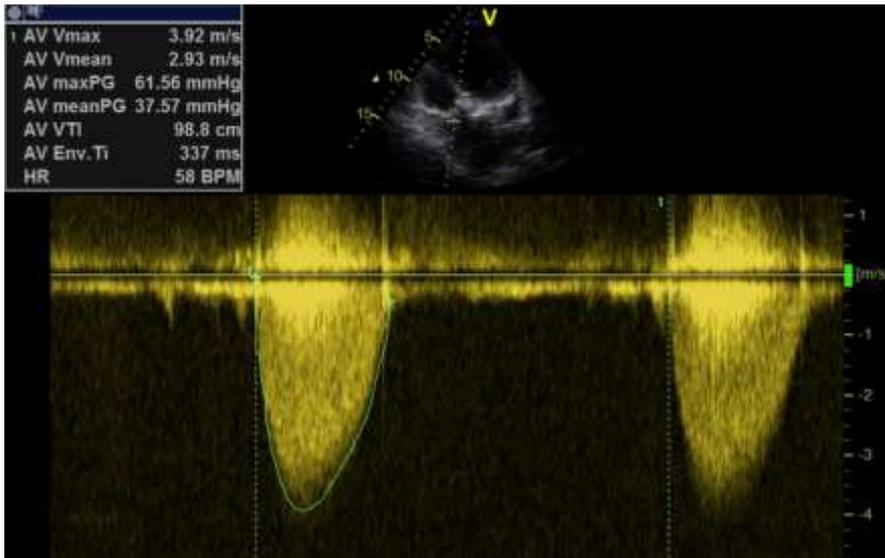
$AVA \leq 0.6 \text{ cm}^2/\text{m}^2$	Normal Flow $SVI > 35 \text{ mL}/\text{m}^2$	Low Flow $SVI \leq 35 \text{ mL}/\text{m}^2$	
High gradient $MG > 40 \text{ mm Hg}$	Group 1	Group 2	
	Normal flow, high gradient	Low flow, high gradient	
	$n = 213$ (62.7%)	$n = 45$ (13.2%)	
	LVEF: $66.8 \pm 8 \%$	LVEF: $63.7 \pm 8.2 \%$	
	MG: $57 \pm 13.5 \text{ mm Hg}$	MG: $64.4 \pm 16.3 \text{ mm Hg}$	$n = 258$
	AVA: $0.79 \pm 0.17 \text{ cm}^2$	AVA: $0.46 \pm 0.11 \text{ cm}^2$	(75.9%)
	AVAi: $0.44 \pm 0.08 \text{ cm}^2/\text{m}^2$	AVAi: $0.26 \pm 0.05 \text{ cm}^2/\text{m}^2$	
	Z_{va} : $4.1 \pm 0.8 \text{ mm Hg}/\text{ml}/\text{m}^2$	Z_{va} : $6.7 \pm 1.3 \text{ mm Hg}/\text{ml}/\text{m}^2$	
	GLS: $-16.5 \pm 3.4 \%$	GLS: $-14.1 \pm 3.5 \%$	
Low gradient $MG \leq 40 \text{ mm Hg}$	Group 3	Group 4	
	Normal flow, low gradient	Low flow, low gradient	
	$n = 52$ (15.3%)	$n = 30$ (8.8%)	
	LVEF: $64.6 \pm 7.3 \%$	LVEF: $63 \pm 9.3 \%$	
	MG: $34.4 \pm 4.6 \text{ mm Hg}$	MG: $32.7 \pm 5.7 \text{ mm Hg}$	$n = 82$
	AVA: $0.86 \pm 0.14 \text{ cm}^2$	AVA: $0.7 \pm 0.12 \text{ cm}^2$	(24.1%)
	AVAi: $0.49 \pm 0.07 \text{ cm}^2/\text{m}^2$	AVAi: $0.38 \pm 0.08 \text{ cm}^2/\text{m}^2$	
	Z_{va} : $4 \pm 0.8 \text{ mm Hg}/\text{ml}/\text{m}^2$	Z_{va} : $5.5 \pm 1.1 \text{ mm Hg}/\text{ml}/\text{m}^2$	
	GLS: $-16.5 \pm 3.5 \%$	GLS: $-15.5 \pm 4.1 \%$	
	$n = 265$ (78%)	$n = 75$ (22%)	$n = 340$
			(100%)

AVA indicates aortic valve area; AVAi, aortic valve area index; GLS, global longitudinal strain; LVEF, left ventricular ejection fraction; MG, mean gradient; SVI, stroke volume index; Z_{va} , valvulo-arterial impedance.

Global Longitudinal Strain







At Stress

AVA peak: 0.81cm²
 SV peak: 80ml
 Ejection time peak: 0.330sec
 Q peak: 242ml/sec

At rest

AVA rest: 0.74cm²
 SV rest: 68ml
 Ejection time rest: 0.370sec
 Q rest: 183.78ml/sec

$$AVA_{proj} = \frac{AVA_{peak} - AVA_{rest}}{Q_{peak} - Q_{rest}} \times (250 - Q_{rest}) + AVA_{rest}$$

AVA proj: 0.89cm²

AVA proj index: 0.44cm²/m²

Stress Echocardiography to Assess Stenosis Severity and Predict Outcome in Patients With Paradoxical Low-Flow, Low-Gradient Aortic Stenosis and Preserved LVEF

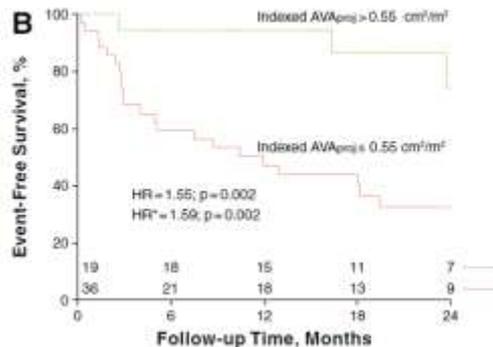
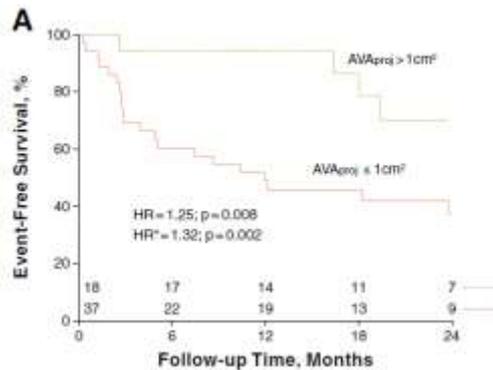
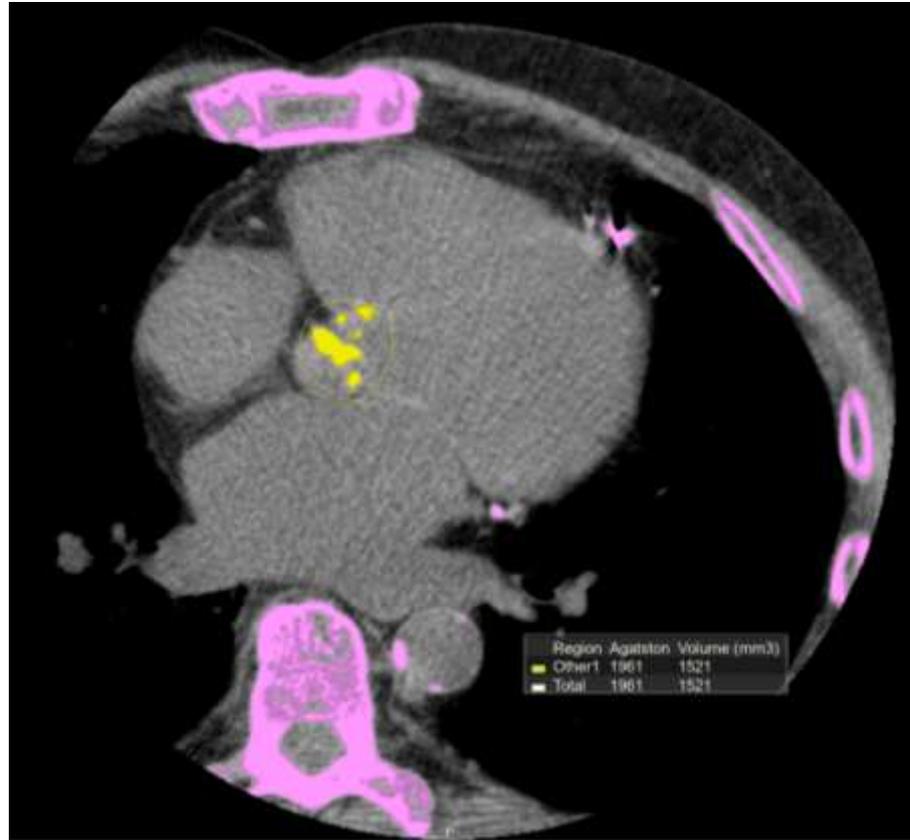


Table 2. Predictors of Combined Endpoint Aortic Valve Replacement or Death

Variables	Increment Category	Univariate Analysis		Multivariate Analysis			
		HR (95% CI)	p Value	Model 1		Model 2	
				HR (95% CI)	p Value	HR (95% CI)	p Value
Age	+1 yr	1.02 (0.99–1.05)	0.18	1.03 (1.00–1.06)	0.08	1.02 (0.99–1.05)	0.15
Sex	Male	1.36 (0.64–3.07)	0.542	—	0.48	—	0.96
Diabetes mellitus	Yes	1.62 (0.46–4.40)	0.41	—	—	—	—
Chronic kidney failure	Yes	2.35 (0.79–5.72)	0.12	—	—	—	—
Rest LVEF	+5%	0.99 (0.77–1.23)	0.92	—	—	—	—
Peak SE LVEF	+5%	1.02 (0.86–1.22)	0.82	—	—	—	—
Δ LVEF	+5%	1.03 (0.84–1.29)	0.73	—	—	—	—
Rest SV Index	+1 ml/m ²	1.03 (0.94–1.15)	0.54	—	—	—	—
Peak SE SV Index	+1 ml/m ²	1.02 (0.97–1.07)	0.45	—	—	—	—
Δ SV Index	+1 ml/m ²	1.02 (0.96–1.07)	0.57	—	—	—	—
Rest mean gradient	+5 mm Hg	1.13 (0.99–1.28)	0.08	—	—	—	—
Peak SE mean gradient	+5 mm Hg	1.13 (1.03–1.25)	0.02	—	—	—	—
Rest AVA	−0.1 cm ²	1.12 (0.95–1.34)	0.16	—	—	—	—
Peak SE AVA	−0.1 cm ²	1.08 (0.96–1.23)	0.22	—	—	—	—
AVA _{proy}	−0.1 cm ²	1.25 (1.06–1.48)	0.008	1.32 (1.10–1.60)	0.002	—	—
Indexed AVA _{proy}	−0.1 cm ² /m ²	1.55 (1.16–2.12)	0.002	—	—	1.59 (1.18–2.22)	0.002

Aortic Valve Calcium



AVC: 1961 AU

AVC index: 763 AU/m²

AVC density: 405 AU/cm²

The Complex Nature of Discordant Severe Calcified Aortic Valve Disease Grading

New Insights From Combined Doppler Echocardiographic and Computed Tomographic Study

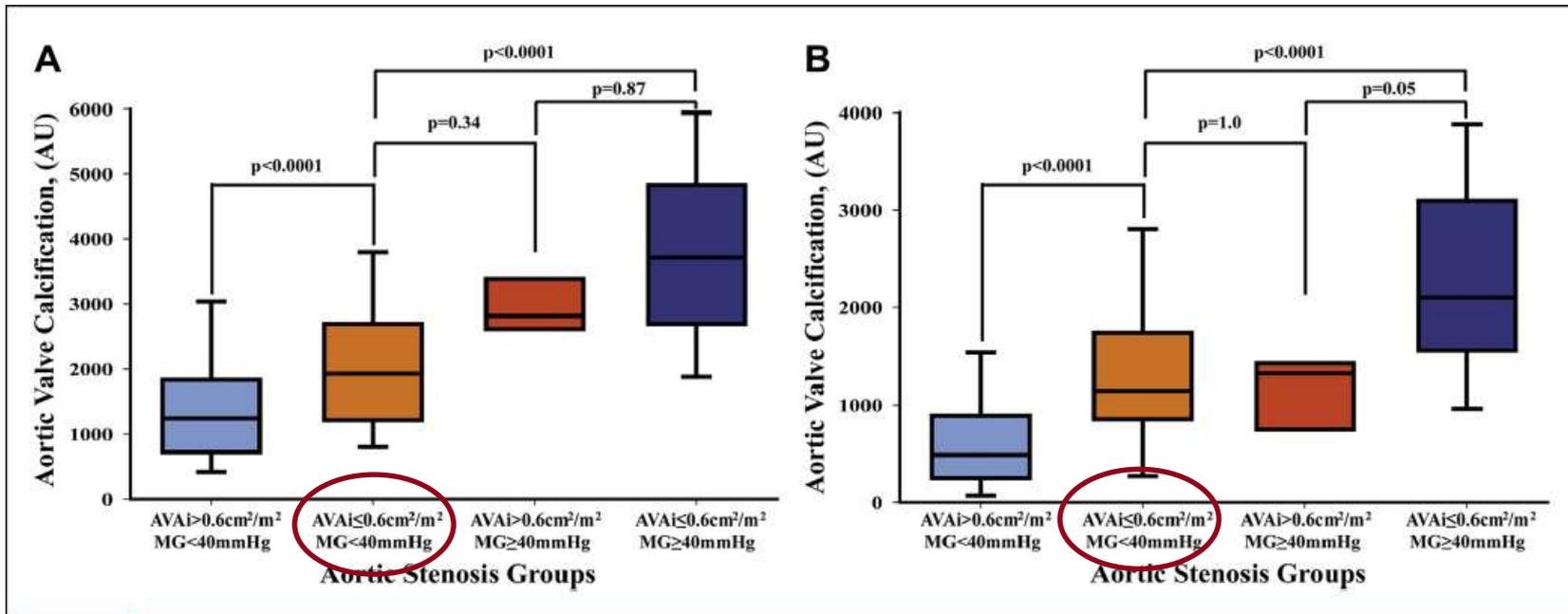
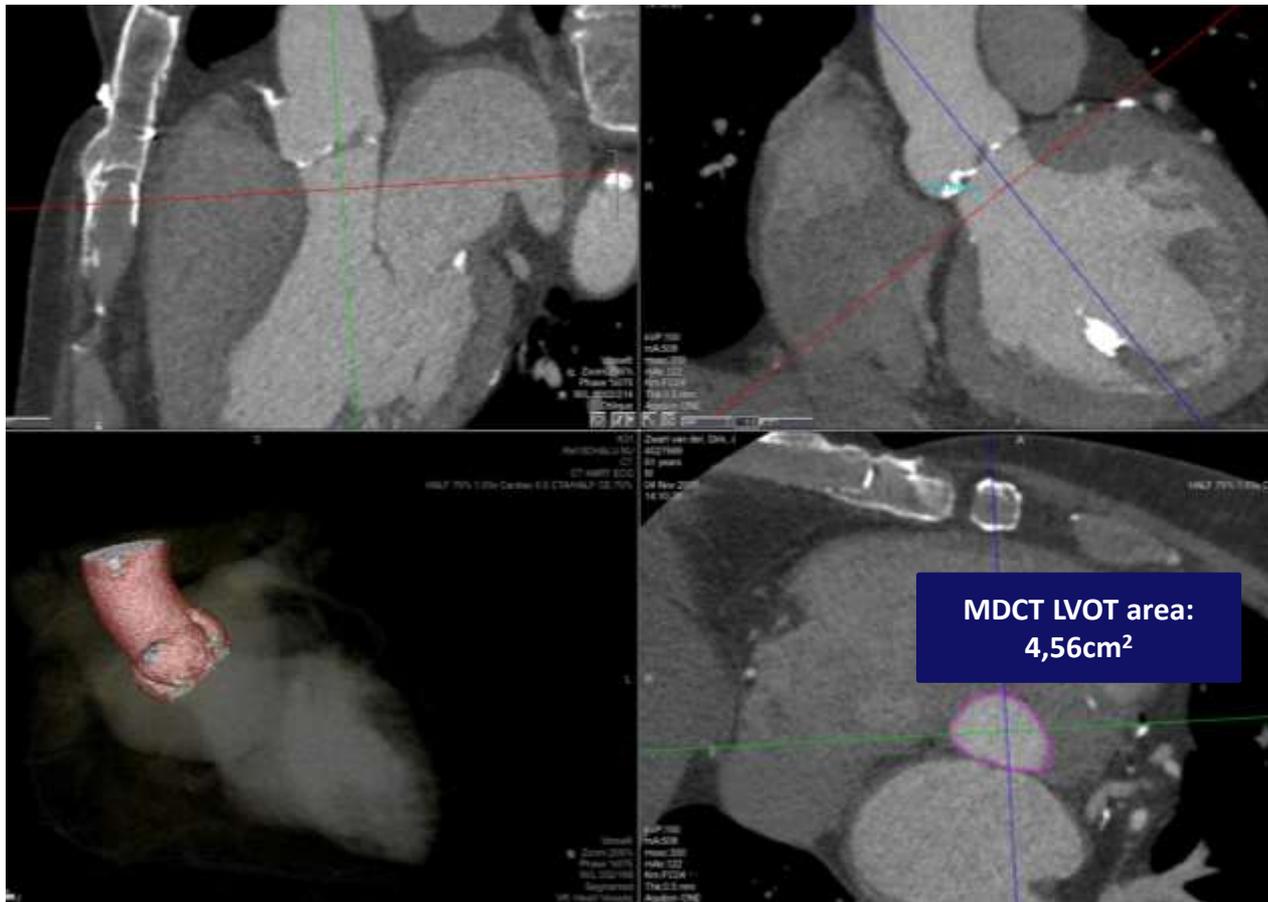


Figure 1 Distribution of Aortic Valve Calcification by Sex in the Various AS Groups

Concordant grading-moderate aortic stenosis (AS), discordant grading with low mean gradient (MG), discordant grading with high MG, and concordant grading-severe AS; x-axis in box-plot format, whereby the box indicates the 25th to 75th percentiles, the line within the box indicates the median, and the vertical bar indicates the 95% range. The y-axis indicates the aortic valve calcification load. **(A)** Data in men; **(B)** data in women. Of note, among patients with low MG, the overlap of aortic valve calcification between patients with severe AS (small AVA) and moderate AS (larger AVA) is more prominent in men than in women. AU = arbitrary units; AVAi = aortic valve area indexed to body surface area.

Table 4 Accuracy of AVC, AVCi, and AVCd to Identify Severe AS

Sex	AUC	Threshold	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
AVC						
Women	0.91					
	Specific threshold	1,681*	69	95	95	65
	Best threshold	1,274*	86	89	93	79
	Sensitive threshold	791*	95	63	81	88
Men	0.90					
	Specific threshold	3,381*	59	95	95	59
	Best threshold	2,065*	89	80	88	82
	Sensitive threshold	1,661*	95	70	84	90
AVCi						
Women	0.91					
	Specific threshold	1,071†	59	95	96	59
	Best threshold	637†	91	85	91	85
	Sensitive threshold	476†	95	69	84	89
Men	0.89					
	Specific threshold	1,733†	55	95	95	57
	Best threshold	1,067†	86	79	87	77
	Sensitive threshold	776†	95	61	80	88
AVCd						
Women	0.93					
	Specific threshold	580‡	73	95	96	68
	Best threshold	292‡	92	81	87	86
	Sensitive threshold	228‡	95	68	83	89
Men	0.92					
	Specific threshold	727‡	65	95	95	63
	Best threshold	476‡	90	80	88	82
	Sensitive threshold	402‡	95	70	84	90

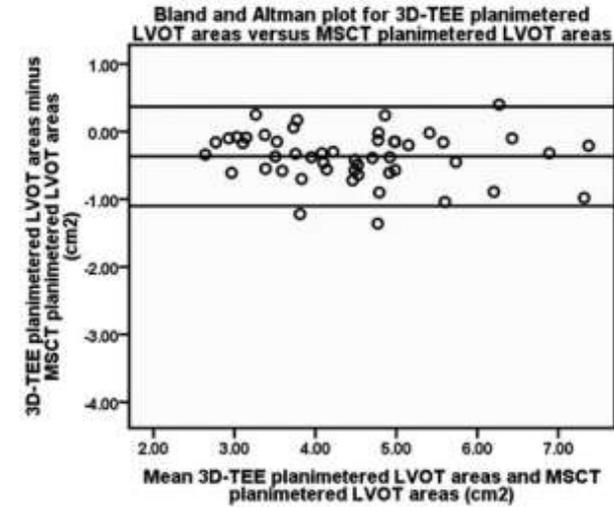
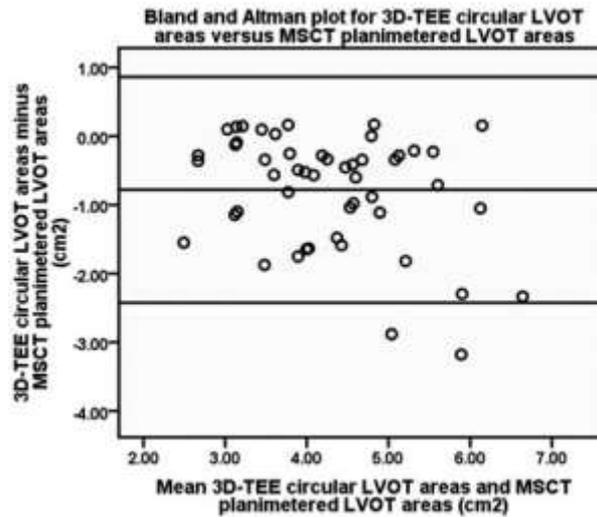
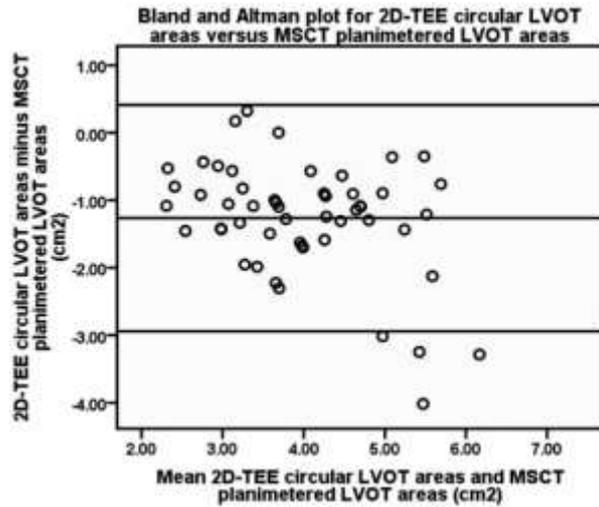


$$Fusion\ AVAi = \left(\frac{MDCT\ LVOT\ area \times Echo\ VTI\ PW\ LVOT}{Echo\ VTI\ CW\ Aortic\ Valve} \right) / Body\ Surface\ Area$$

$$Fusion\ AVAi = \left(\frac{4.56 \times 21.4}{92} \right) / 2.02$$

$$Fusion\ AVAi = 0.52\text{cm}^2/\text{m}^2$$

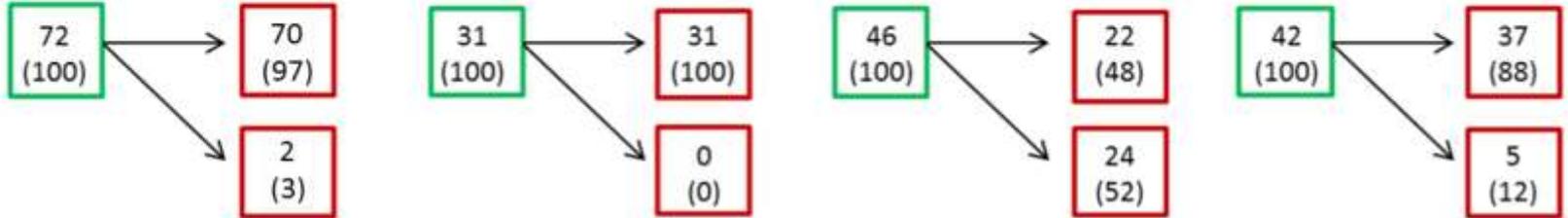
Comparison of Aortic Root Dimensions and Geometries Before and After Transcatheter Aortic Valve Implantation by 2- and 3-Dimensional Transesophageal Echocardiography and Multislice Computed Tomography



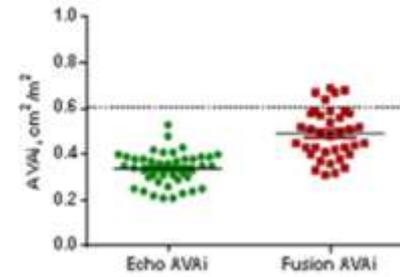
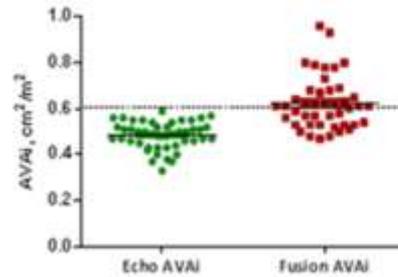
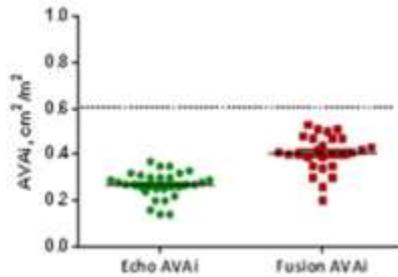
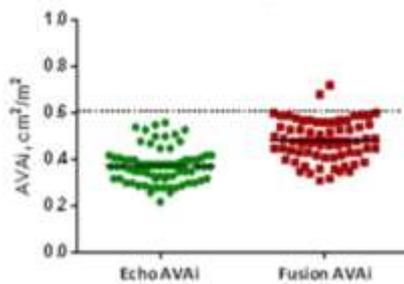
Aortic Stenosis

	Normal Flow – High Gradient	Low Flow – High Gradient	Normal Flow – Low Gradient	Low Flow – Low Gradient
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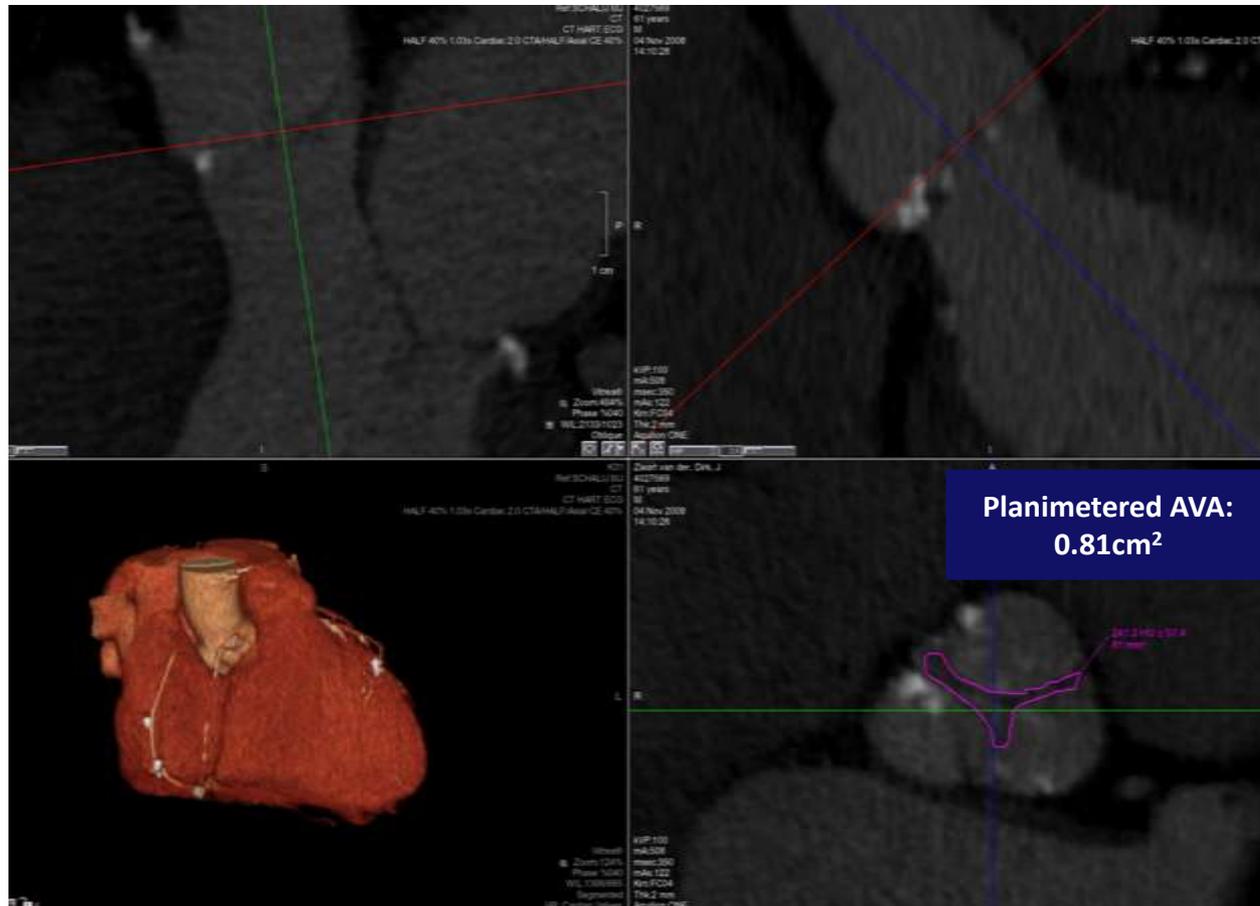
Severe, n (%)



Moderate, n (%)



MDCT AVA planimetered



Anatomic Aortic Valve Area

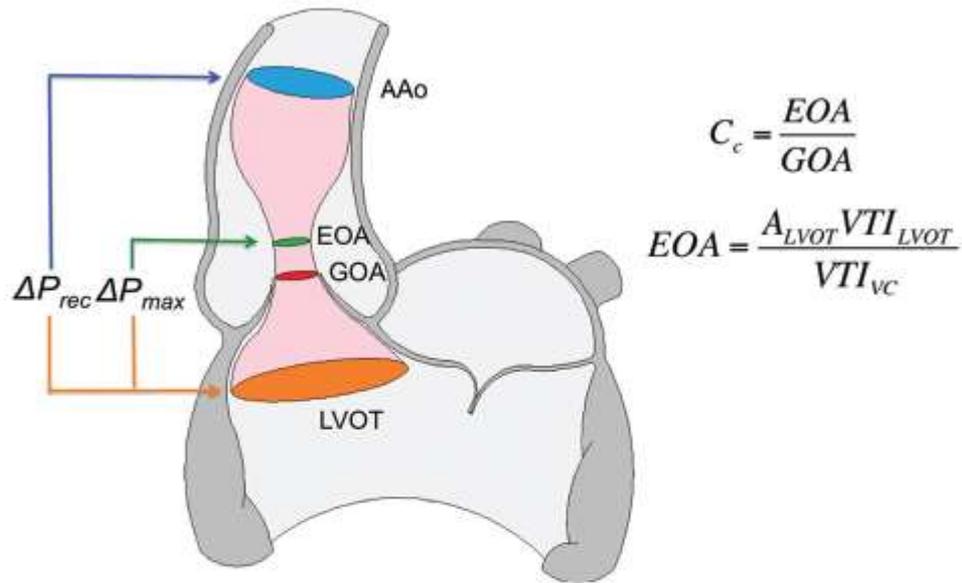
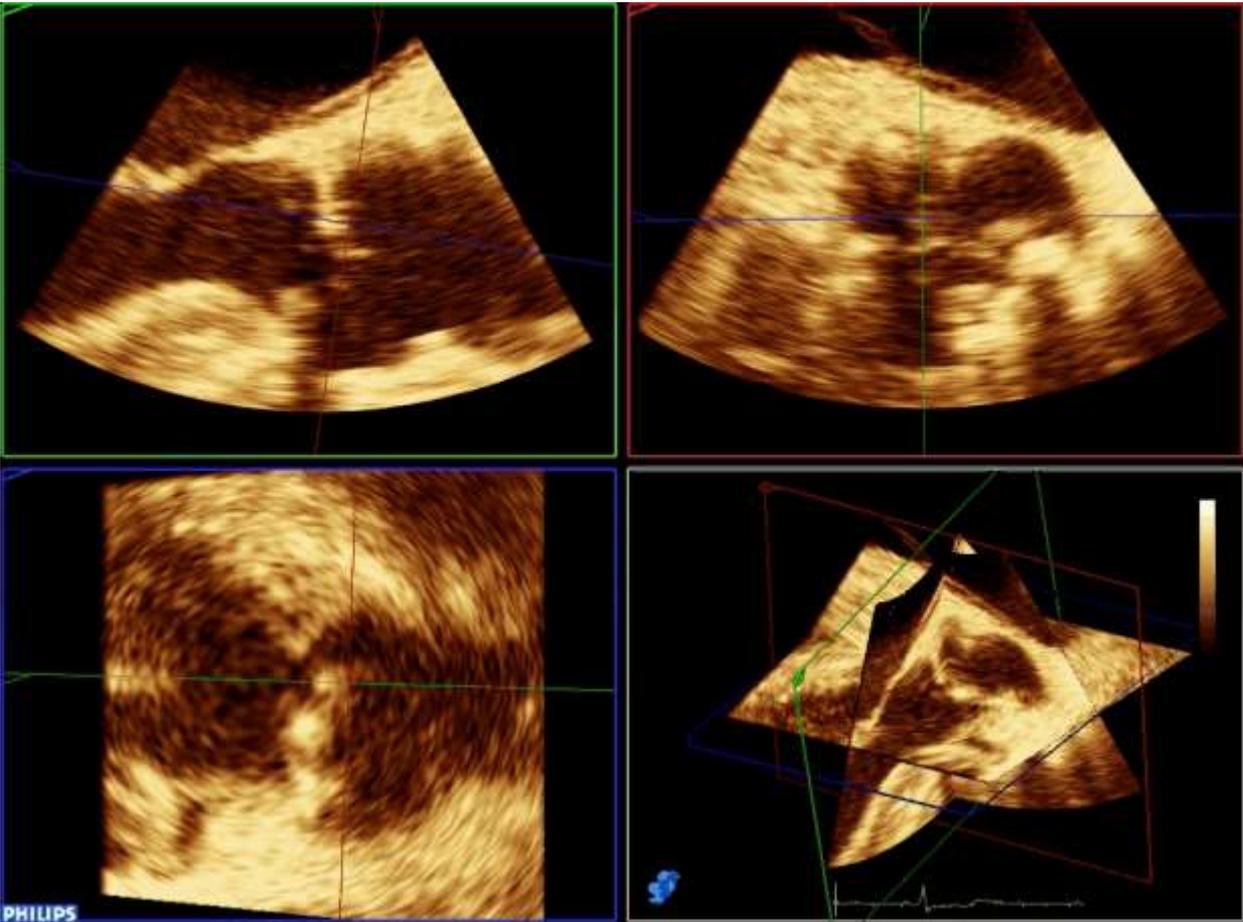
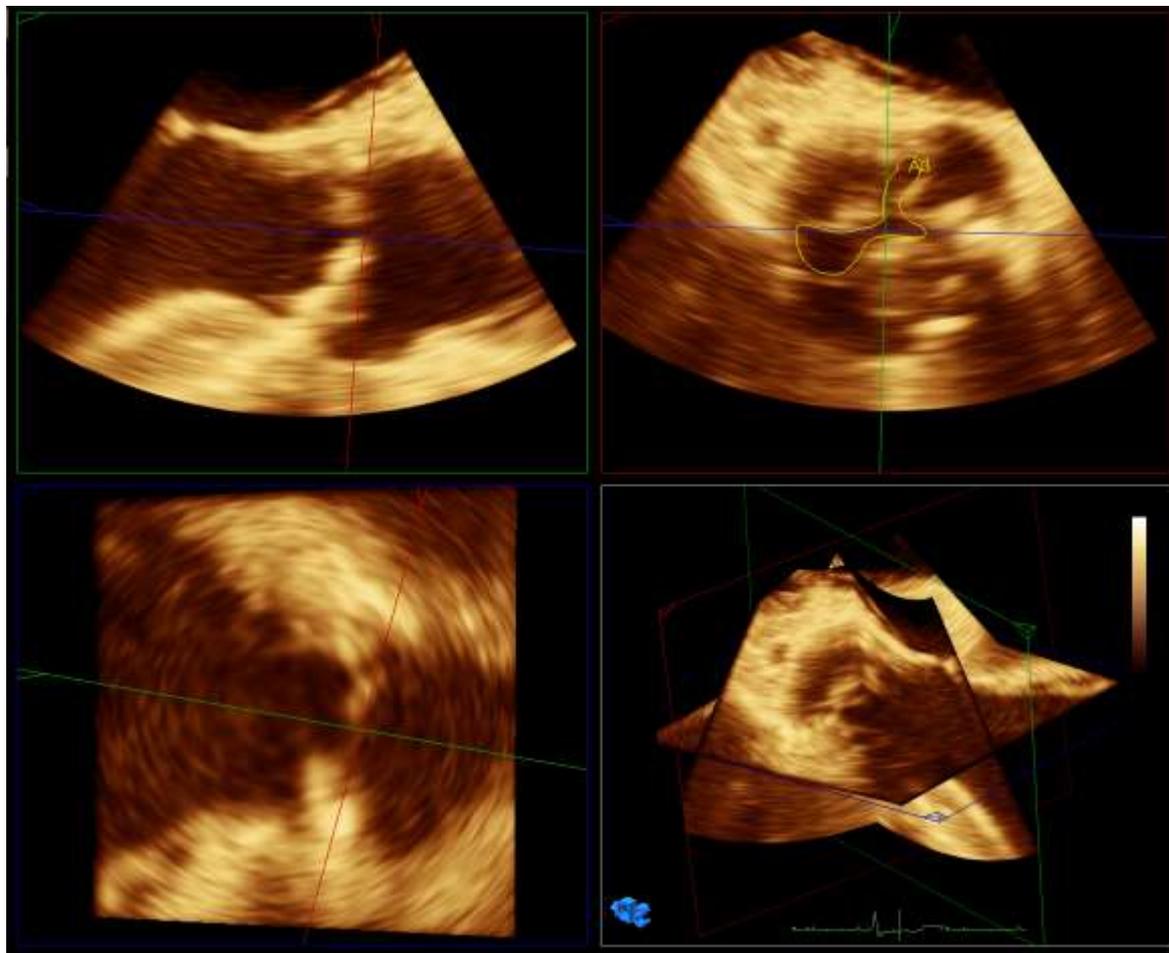


Figure 2. Schematic of flow through a stenotic aortic valve. Formulas for the contraction coefficient and EOA using the continuity equation are also shown. AAo indicates ascending aorta; EOA, effective orifice area; GOA, geometric orifice area; LVOT, left ventricular outflow tract; VC, vena contracta; and VTI velocity time integral.

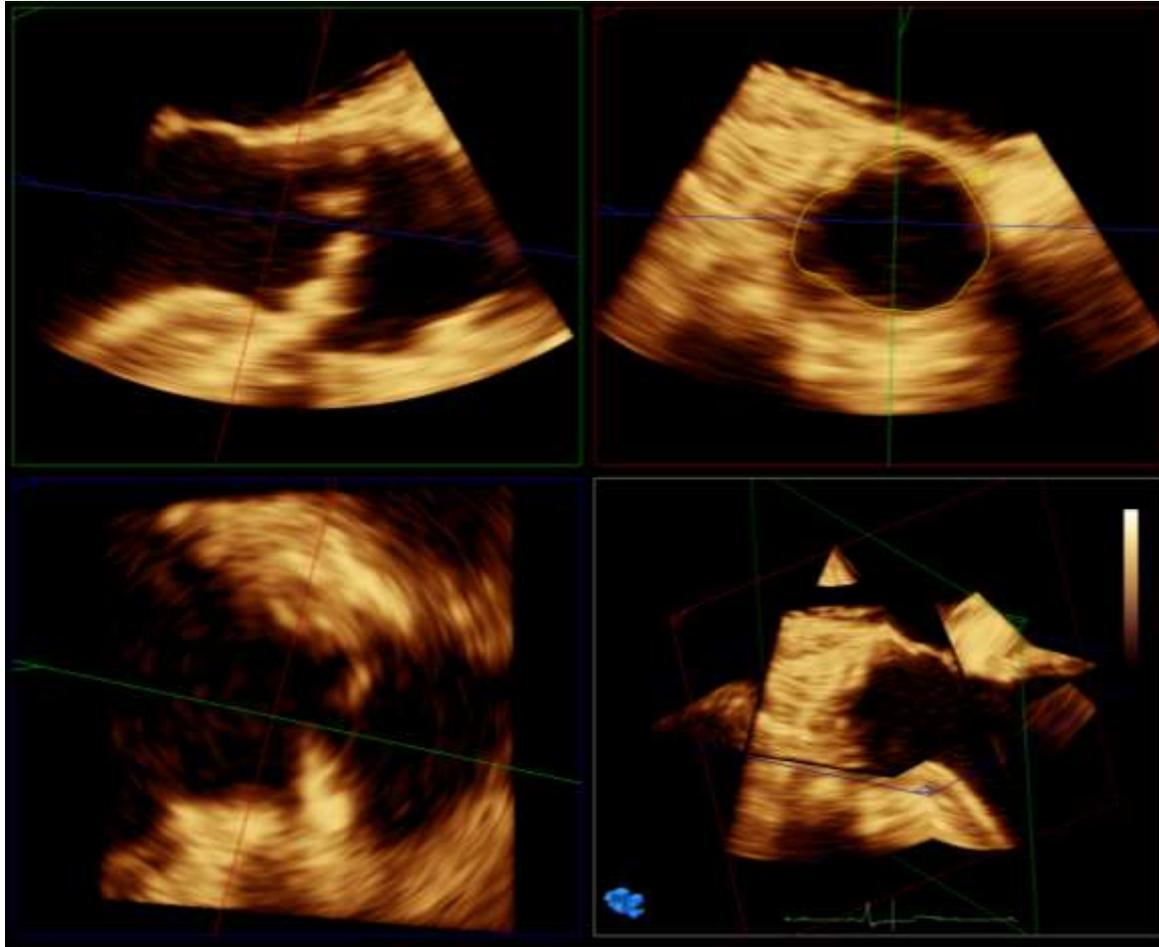


3D TEE AVA planimetered



AVA: 0.86cm²

3D TEE LVOT planimetered area



LVOT area: 4.38cm²

Diagnostic Algorithm

Severe AS low-flow low-gradient with preserved LVEF

1. Symptoms
2. Hypertension
 - Should be treated. Echo after normalization of BP
3. Stenosis Severity
 - Look at the left ventricle (size, remodelling, function-GLS)
 - Look at the global afterload (Zva)
 - Low-dose Dobutamine stress echo (AVA projected)
 - MDCT : Aortic valve calcium load (Agatston)
 - 3-Dimensional LVOT area (Fusion AVAi)
 - AVA planimetry on 3D Imaging

Ευχαριστώ