AP VALVES & STRUCTURAL HEART 2022

새로 시작하는 센터를 위한 AMC 타비 가이드

타비 전후 심초음파, 무엇을 봐야하나요?

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Disclosure

- I have no financial relationships to disclose

Contents

- Preprocedural planning: Role of stress echocardiography and TEE
- Intra-TAVR monitoring: Transthoracic or Transesophageal?
- Post-TAVR: assessment of valve function

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Candidates for TAVR

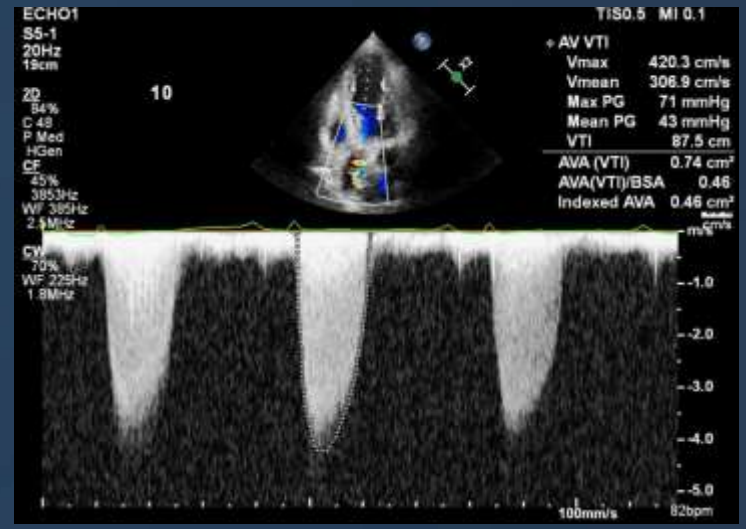
2020 ACC/AHA Guideline for the Management of Valvular Heart Disease

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C: Asymptomatic severe AS					
C2	Asymptomatic severe AS with LV systolic dysfunction	Severe leaflet calcification/ fibrosis or congenital stenosis with severely reduced leaflet opening	Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg AVA typically ≤1.0 cm^2 (or AVAi 0.6 cm^2/m^2) but not required to define severe AS	LVEF <50%	None
D: Symptomatic severe AS					
D1	Symptomatic severe high-gradient AS	Severe leaflet calcification/ fibrosis or congenital stenosis with severely reduced leaflet opening	Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg AVA typically ≤1.0 cm^2 (or AVAi ≤0.6 cm^2/m^2) but may be larger with mixed AS/AR	LV diastolic dysfunction LV hypertrophy Pulmonary hypertension may be present	Exertional dyspnea, decreased exercise tolerance, or HF Exertional angina Exertional syncope or presyncope
D2	Symptomatic severe low-flow, low-gradient AS with reduced LVEF	Severe leaflet calcification/ fibrosis with severely reduced leaflet motion	AVA ≤1.0 cm^2 with resting aortic V_{max} <4 m/s or mean ΔP <40 mm Hg Dobutamine stress echocardiography shows AVA <1.0 cm^2 with V_{max} ≥4 m/s at any flow rate	LV diastolic dysfunction LV hypertrophy LVEF <50%	HF Angina Syncope or presyncope
D3	Symptomatic severe low-gradient AS with normal LVEF or paradoxical low-flow severe AS	Severe leaflet calcification/ fibrosis with severely reduced leaflet motion	AVA ≤1.0 cm^2 (indexed AVA ≤0.6 cm^2/m^2) with an aortic V_{max} <4 m/s or mean ΔP <40 mm Hg AND Stroke volume index <35 mL/m^2 Measured when patient is normotensive (systolic blood pressure <140 mm Hg)	Increased LV relative wall thickness Small LV chamber with low stroke volume Restrictive diastolic filling LVEF ≥50%	HF Angina Syncope or presyncope

- **High-gradient AS**
  - **Symptom? C1 vs. D1**
  - **LVEF<50%? C2**
- **Low-gradient AS**
  - **Definition: AVA<1.0cm^2 And V max <4.0m/s or PG <40mmHg**
  - **LVEF <50%? Low-flow (D2)**
  - **SVI <35 mL/m^2? Paradoxical low-flow (D3)**

LFLG severe AS

Resting

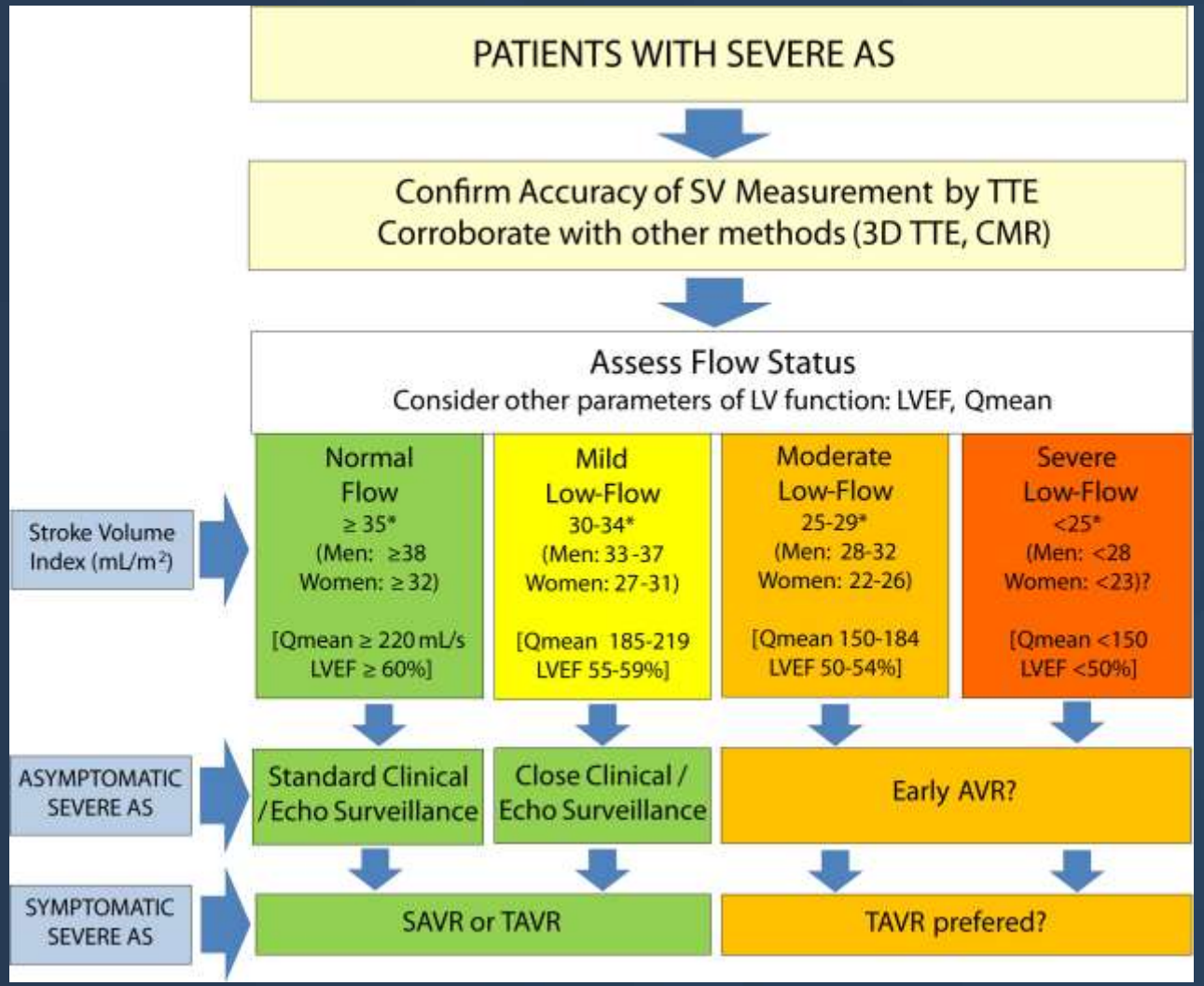


10mcg/kg/min

	BP	PR	AV Vmax	AV TVI	LVOT TVI	AVA	ESV	EDV	EF	SpO_2
Basal	129/75	82	3.4	83.9	13.8	0.6	106	139	23%	96%
2.5 mcg	88/40	78	3.6	84.9	14.5	0.58	106	135	22%	96%
5 mcg	95/44	76	3.7	87.2	15.3	0.56	105	134	22%	97%
7.5 mcg	100/55	84	3.9	93.8	15.7	0.54	87.6	124	29%	98%
10 mcg	107/54	80	4.2	87.5	14.4	0.53	92.5	130	29%	98%
Recovery	109/56	80	3.5	75.8	15.8	0.67	110	165	33%	98%

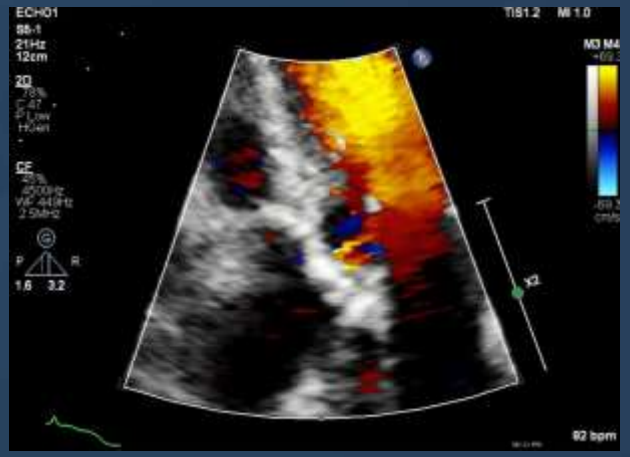
Dobutamine infusion을 10 mg/kg/min까지 시행함.
Aortic valve는 4.2 m/sec까지 증가하였으며, AVA는 0.5~0.6 ㎠으로 유지되어
truly stenotic severe AS에 합당함.

Paradoxical LFLG severe AS



By biplane method

LVEDD/ESD 31/17mm
LVEDV/ESV 40/15 cc
SVI = 19.8 cc/m²



By continuity equation

LVOT diameter 18 mm
LVOT TVI 24.6cm²
SVI = 49.2 cc/m²

Exercise echo (for symptom), CT calcium score

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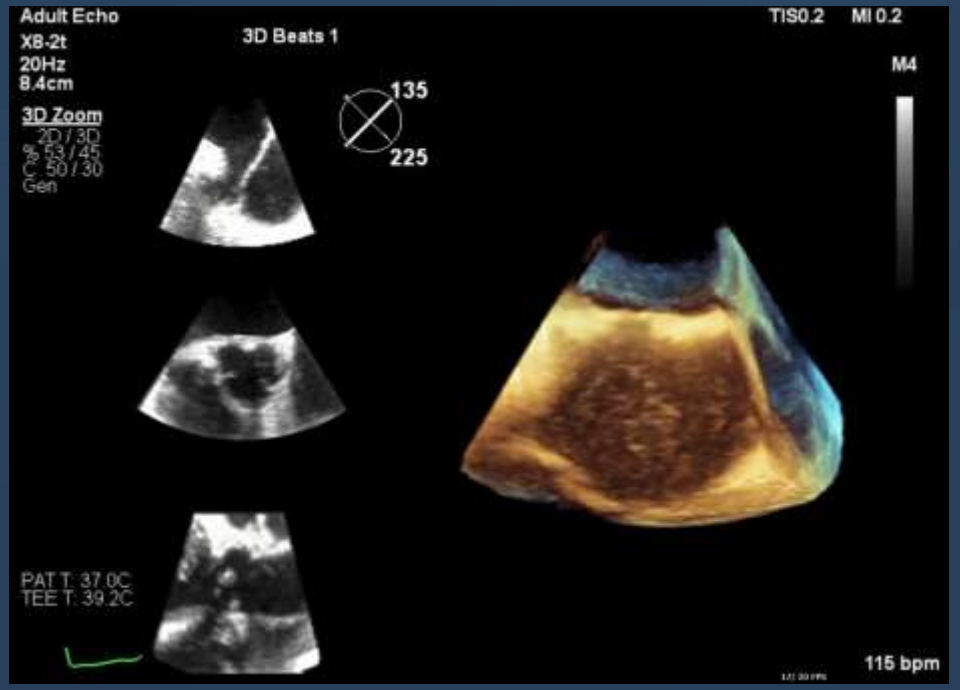
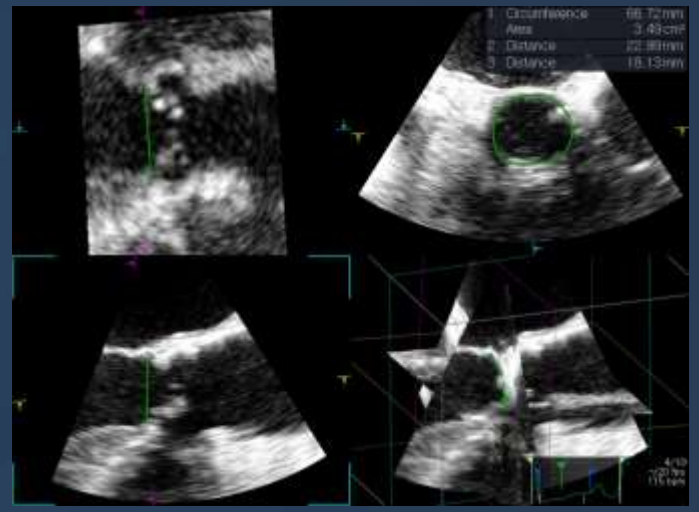
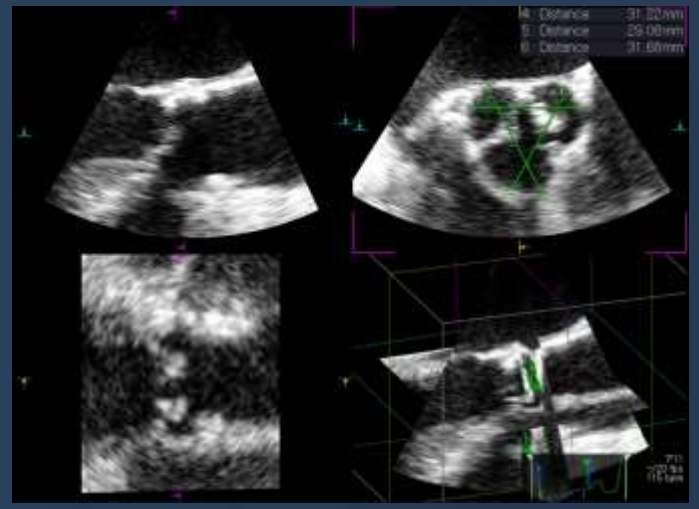
TEE for sizing of TAVR valve







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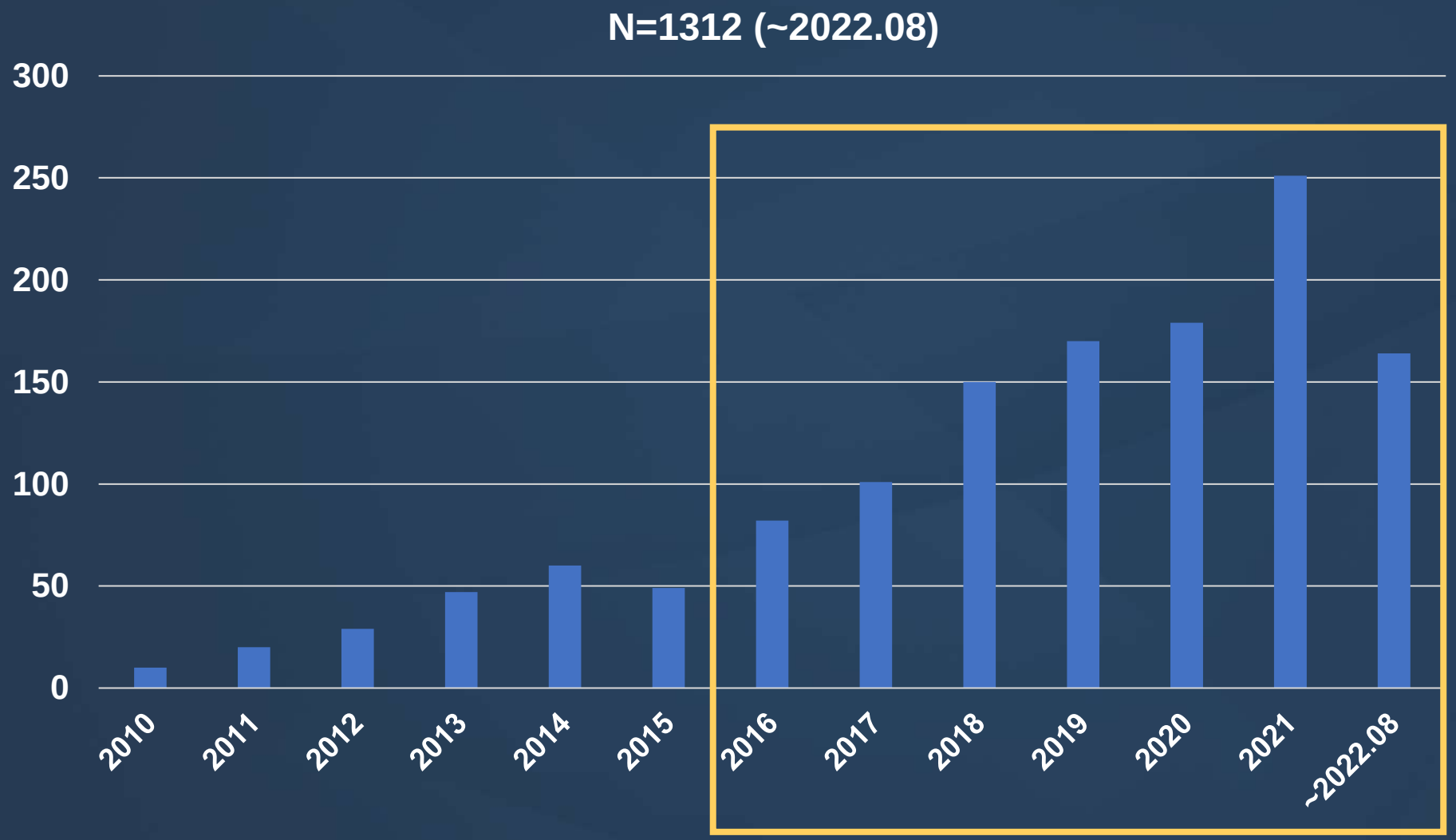
AMC TAVR volume



Minimalist approach

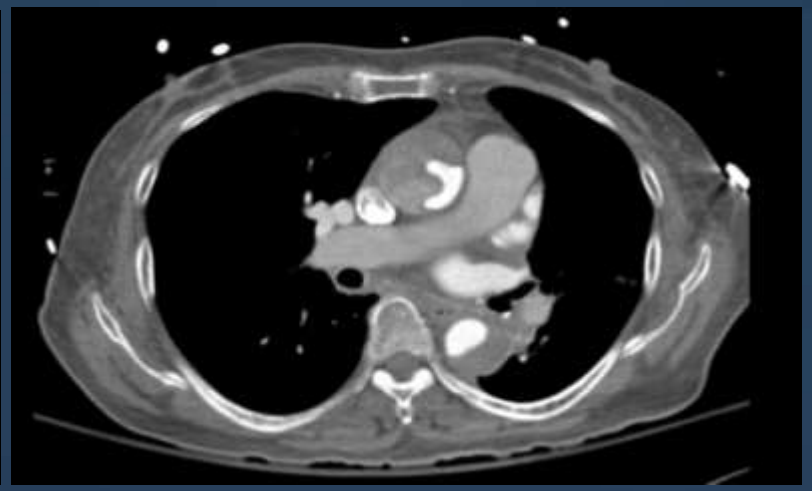
When the TEE is needed?

- Initial learning period
- Trans-apical approach
- Emergent or urgent TAVR
- Valve-in-valve procedure

Routine Transthoracic echocardiography with backup transesophageal probe

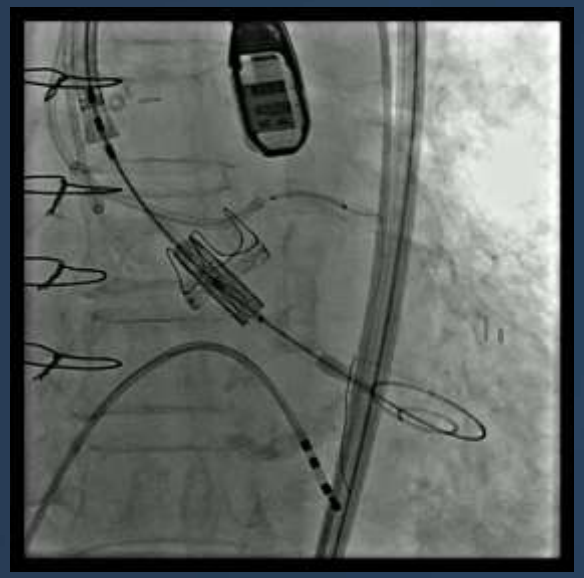
- **Pericardial effusion – cardiac tamponade**
  - Aortic root injury
  - RV rupture due to pacing lead
- **RWMA due to coronary obstruction during ViV procedure**
- **LVOT or leaflet calcium fracture**

Aortic root injury

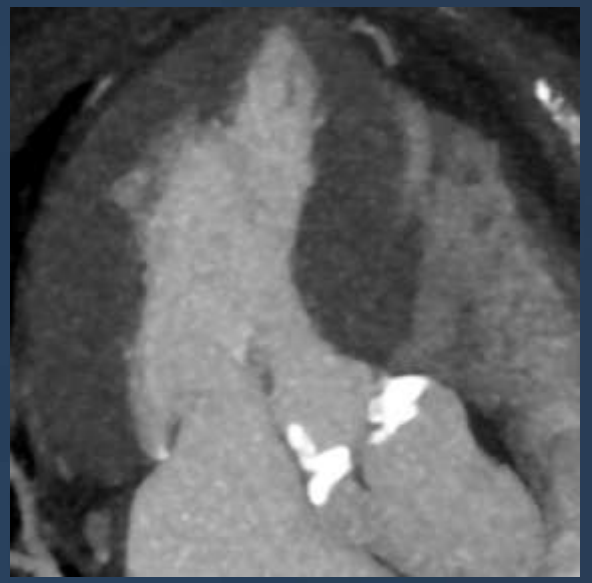


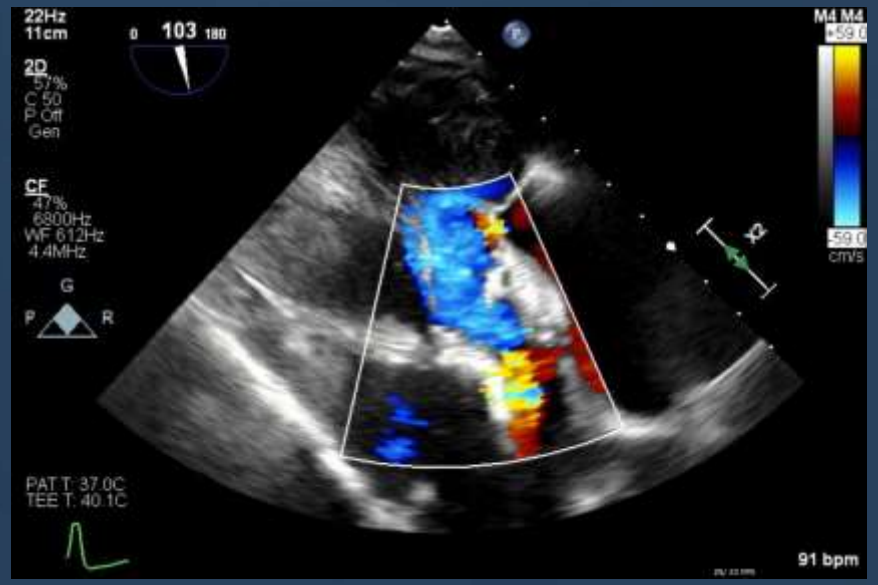
J Am Coll Cardiol Case Rep. 2022 Apr, 4 (8) 464–469

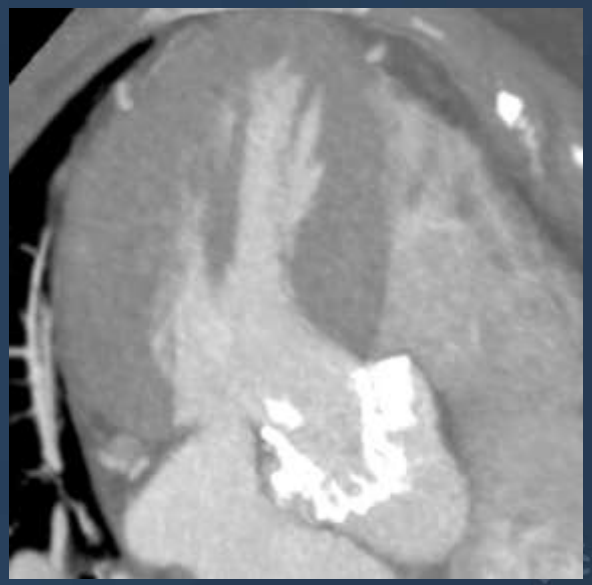
Coronary Obstruction during ViV procedure



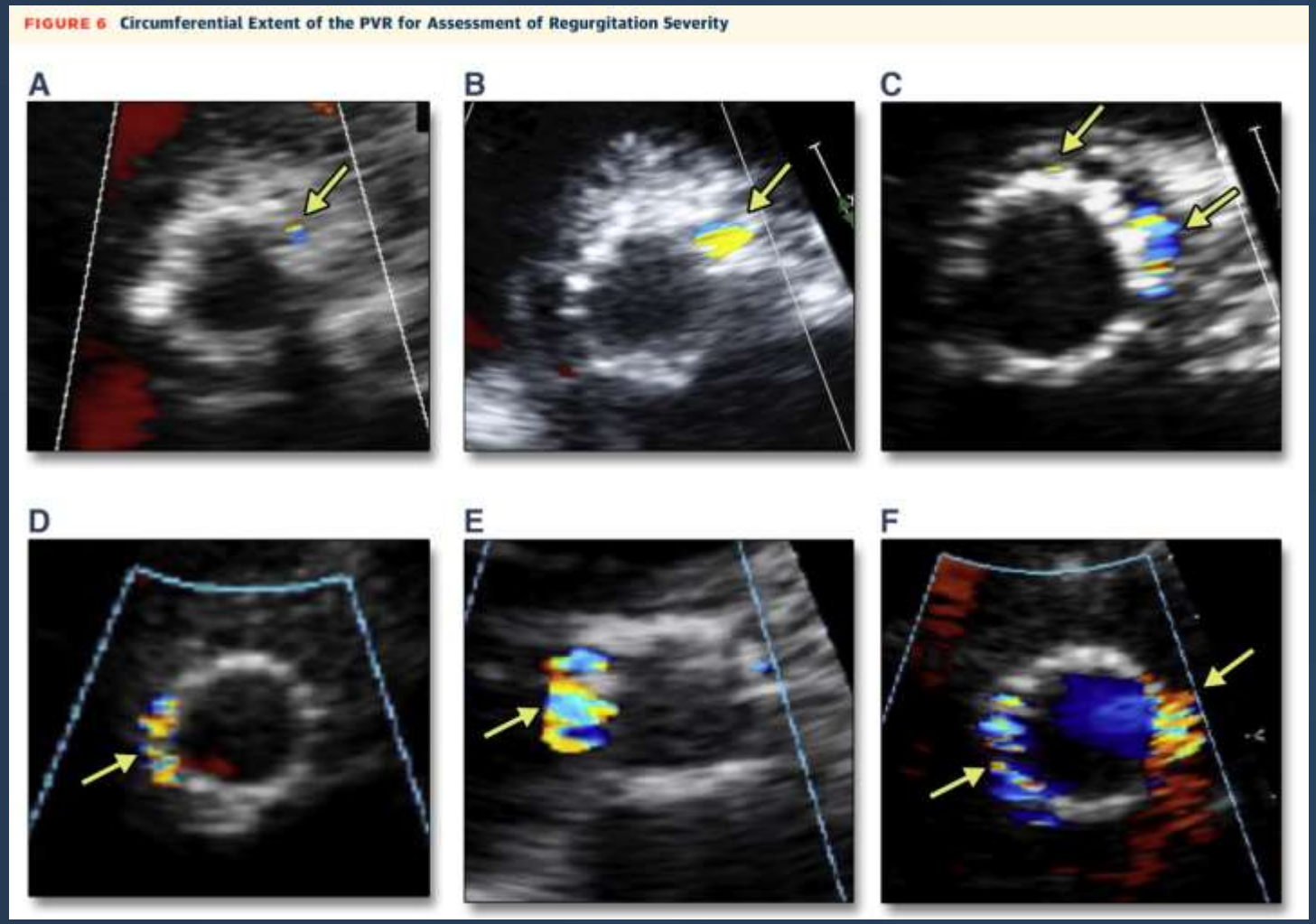
Leaflet Calcium Fracture

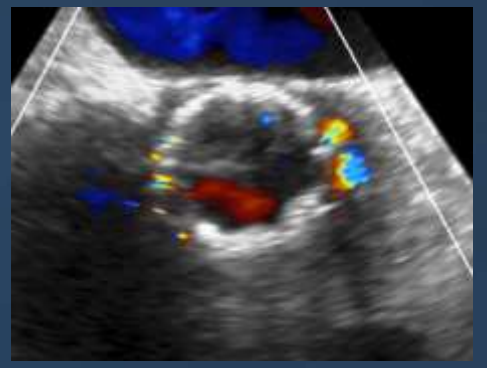


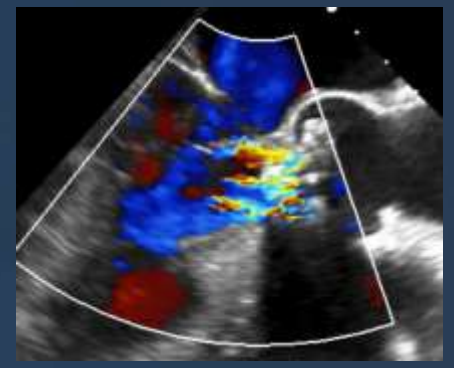




Severity of PVL after TAVR





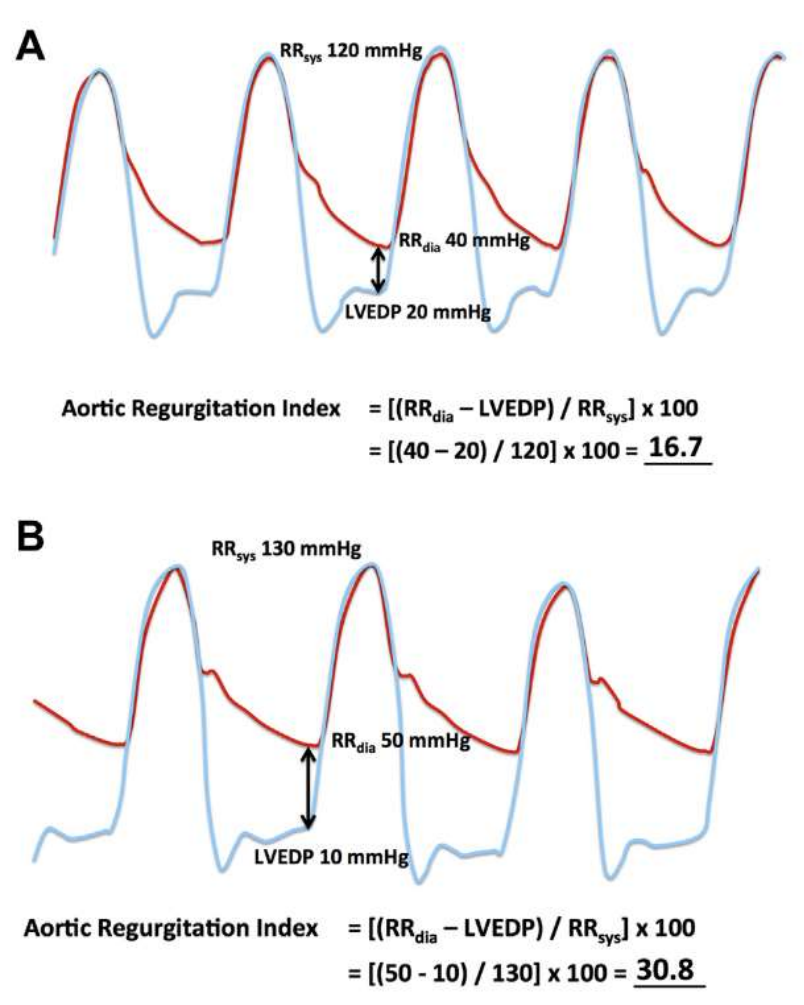


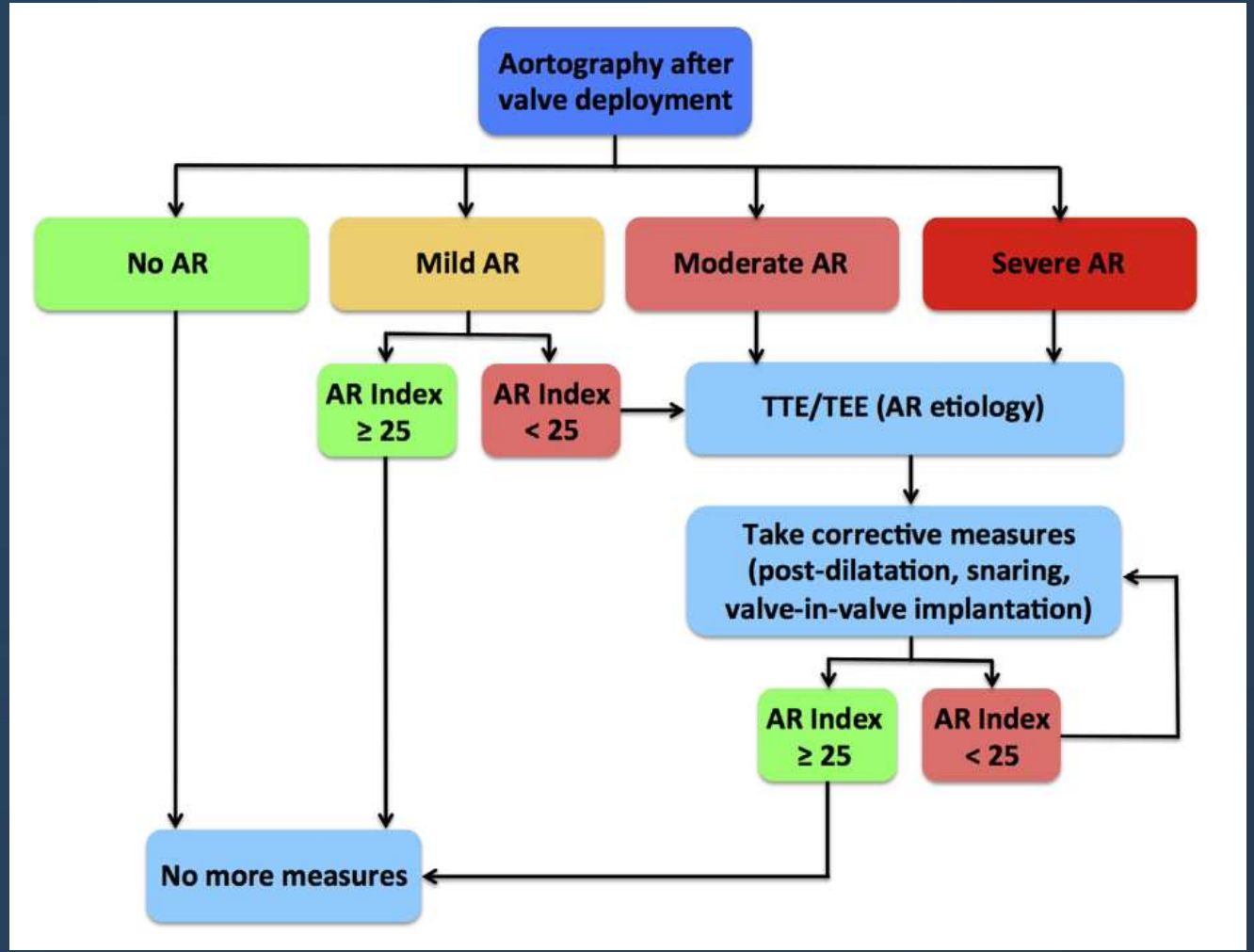
Circumferential extent

- Trace <5%
- Mild 5-15%
- Mild to moderate 15-25%
- Moderate 15-25% + large VC
- Moderate to severe >30%

J Am Coll Cardiol Img 2015;8:340–60

AR index and Treatment Algorithm





J Am Coll Cardiol Img 2015;8:340–60

Complications of TAVR

TABLE 5 Complications of TAVR

	Transesophageal Echo Assessment
Hemodynamic instability	
Severe transvalvular or paravalvular aortic regurgitation	• Assess location of regurgitation (central vs. paravalvular). • Assess position of the transcatheter valve. • Assess severity of aortic regurgitation.
Severe mitral regurgitation	• Evaluate severity of mitral regurgitation and anatomy of the mitral apparatus: valvular perforation, rupture chordae, tethering of the leaflets.
Pericardial effusion	• Assess for tamponade physiology and possible etiology (i.e., chamber perforation, aortic dissection).
Ventricular dysfunction	• Evaluate for regional or global wall motion abnormalities of the LV or RV. • Identify the coronary ostium; use color flow Doppler to assess blood flow.
Aortic rupture or dissection	• Examine the aortic root/ascending aorta for periaortic hematoma, aortic dissection, or rupture. • Assess for pericardial effusion/tamponade.
Major bleeding	• Assess ventricular size and function (wall collapse due to hypovolemia).
Other procedural complications	
Balloon aortic valvuloplasty complication	• Assess severity of aortic regurgitation. • Examine the aortic root/ascending aorta for periaortic hematoma, aortic dissection, or rupture. • Identify the left main ostium; use color flow Doppler to assess blood flow.
Mal-positioning of the transcatheter heart valve	• Too high or too low within the annulus with resulting hemodynamic instability: rapid deployment of a second valve can be performed. • Embolization of the valve (into the LV or into the aorta) may require surgical intervention.
Fistula	• Ventricular septal defect. • Aortocameral fistula (typically into the RVOT or right atrium).

LV = left ventricle; RV = right ventricle; RVOT = right ventricular outflow tract; TAVR = transcatheter aortic valve replacement.

J Am CollCardiol Img 2015;8:261–87

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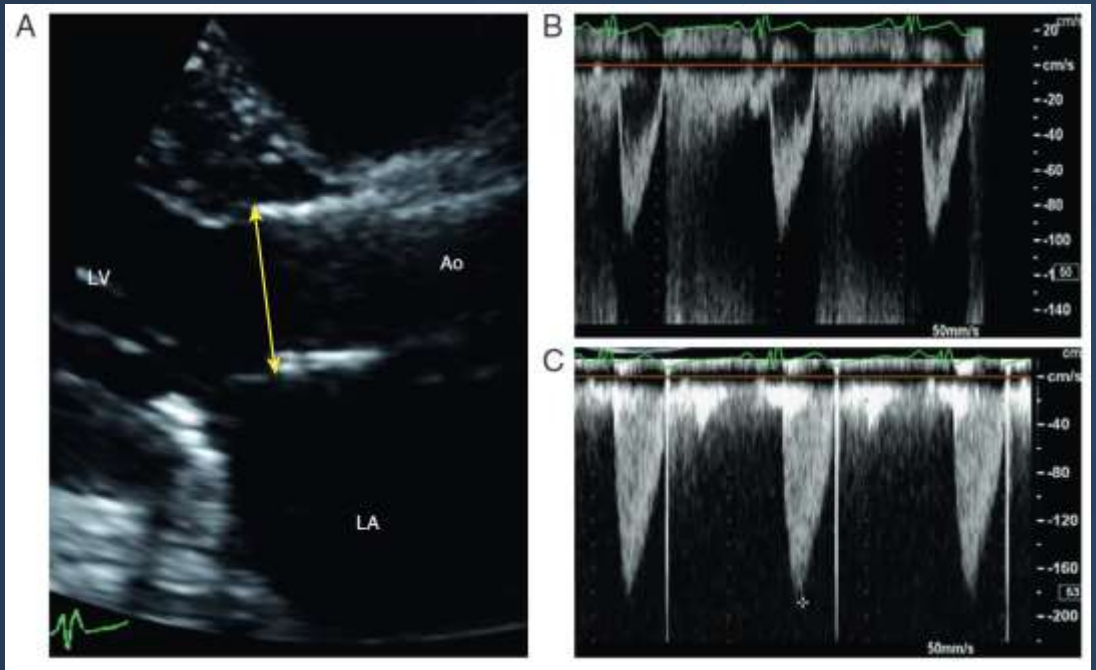
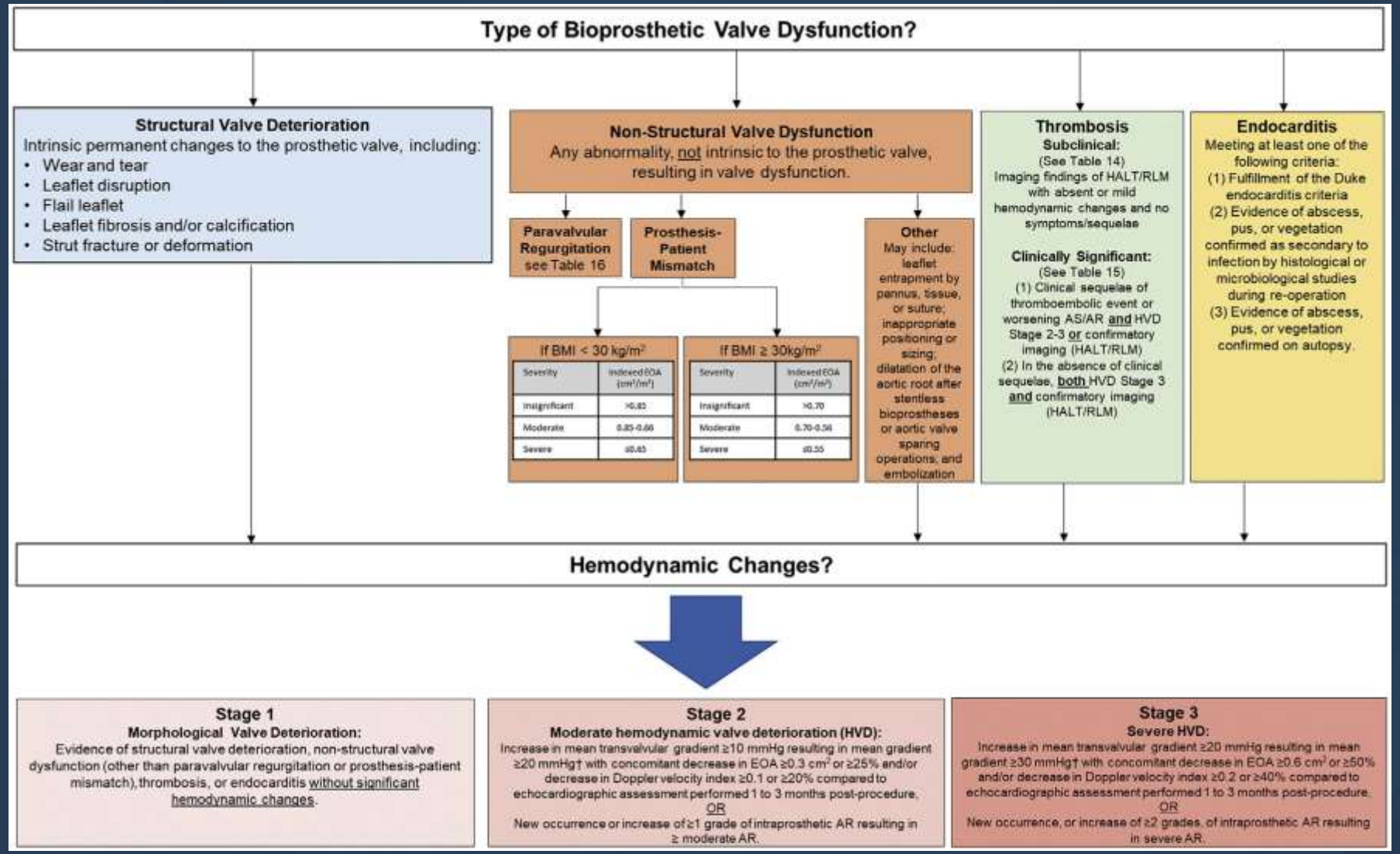
Expected EOA



Valve Iteration	Prosthetic Valve Size, mm 20	23	26	29	All Sizes	p Value
SAPIEN						
EOA, cm^2	NA	1.56 ± 0.43 (1,212)	1.84 ± 0.52 (1,130)	NA	1.70 ± 0.49 (2,342)	<0.001
Mean gradient, mm Hg	NA	9.92 ± 4.27 (1,212)	8.76 ± 3.89 (1,130)	NA	9.36 ± 4.13 (2,342)	<0.001
DVI	NA	0.53 ± 0.13 (1,212)	0.53 ± 0.13 (1,130)	NA	0.53 ± 0.13 (2,342)	0.64
SAPIEN XT						
EOA, cm^2	NA	1.41 ± 0.30 (545)	1.74 ± 0.42 (675)	2.06 ± 0.52 (251)	1.67 ± 0.46 (1471)	<0.001
Mean gradient, mm Hg	NA	10.41 ± 3.74 (545)	9.24 ± 3.57 (675)	8.36 ± 3.14 (251)	9.52 ± 3.64 (1,471)	<0.001
DVI	NA	0.52 ± 0.10 (545)	0.54 ± 0.11 (675)	0.53 ± 0.11 (251)	0.53 ± 0.11 (1,471)	0.004
SAPIEN 3						
EOA, cm^2	1.22 ± 0.22 (47)	1.45 ± 0.26 (471)	1.74 ± 0.35 (626)	1.89 ± 0.37 (326)	1.66 ± 0.38 (1,470)	<0.001
Mean gradient, mm Hg	16.23 ± 5.01 (47)	12.79 ± 4.65 (471)	10.59 ± 3.88 (626)	9.28 ± 3.16 (326)	11.18 ± 4.35 (1,470)	<0.001
DVI	0.42 ± 0.07 (47)	0.43 ± 0.08 (471)	0.43 ± 0.09 (626)	0.40 ± 0.09 (326)	0.43 ± 0.09 (1,470)	<0.001
CoreValve						
EOA, cm^2	1.12 ± 0.36 (19)	1.74 ± 0.49 (289)	1.97 ± 0.53 (446)	2.15 ± 0.72 (81)	1.88 ± 0.56 (835)	<0.001
Mean gradient, mm Hg	14.43 ± 5.72 (22)	8.27 ± 3.82 (307)	8.85 ± 4.17 (478)	9.55 ± 3.44 (83)	8.85 ± 4.14 (890)	<0.001
DVI	0.44 ± 0.09 (20)	0.59 ± 0.15 (300)	0.54 ± 0.12 (463)	0.49 ± 0.12 (83)	0.55 ± 0.13 (866)	<0.001
Evolut R						
EOA, cm^2	1.09 ± 0.26 (3)	1.69 ± 0.40 (71)	1.97 ± 0.54 (129)	2.60 ± 0.75 (52)	2.01 ± 0.65 (255)	<0.001
Mean gradient, mm Hg	14.97 ± 7.15 (3)	7.53 ± 2.65 (77)	7.85 ± 3.08 (141)	6.30 ± 3.23 (57)	7.52 ± 3.19 (278)	<0.001
DVI	0.42 ± 0.04 (3)	0.61 ± 0.13 (75)	0.59 ± 0.14 (135)	0.58 ± 0.15 (55)	0.59 ± 0.14 (268)	0.09

J Am Coll Cardiol Img 2019;12:25–34

Bioprosthetic Valve Dysfunction



Généreux, P. et al. J Am Coll Cardiol. 2021;77(21):2717–46.

Conclusion

- TTE and TEE play a critical role in the diagnosis of aortic valve stenosis
  - Dobutamine stress echo and Exercise echo

- When a patient becomes hemodynamically unstable, TTE or TEE can be an essential diagnostic tool, and we can get clues from it

- Regular TTE follow-up after TAVR is required