Echo evaluation of valve prostheses

- **stenosis / obstruction**
- **regurgitation**
- **endocarditis**
- **embolism / thrombosis without obstruction**

Recommendations for Evaluation of Prosthetic Valves With Echocardiography and Doppler Ultrasound

A Report From the American Society of Echocardiography's Guidelines and Standards Committee and the Task Force on Prosthetic Valves, Developed in Conjunction With the American College of Cardiology Cardiovascular Imaging Committee, Cardiac Imaging Committee of the American Heart Association, the European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography and the Canadian Society of Echocardiography, Endorsed by the American College of Cardiology Foundation, American Heart Association, European Association of Echocardiography, a registered branch of the European Society of Cardiology, the Japanese Society of Echocardiography, and Canadian Society of Echocardiography

2009

Primary parameters of obstruction to flow:

- max. (AVR) and mean gradients (AVR, MVR, TVR);

see normal values table

Additional parameters (especially in AVR if gradients ↑):

- AVR: ratio VTI_{LVOT} / VTI_{prosth} (velocity index)

ASE/EAE 2009

- „effective orifice area “

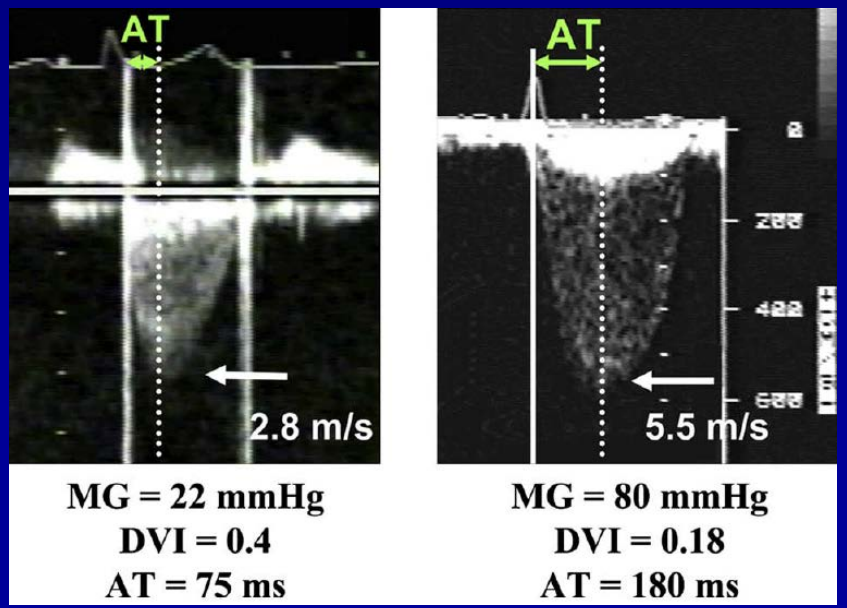
= stroke volume/ VTI_{prosth}

= $\pi \bullet r^2 \bullet VTI_{LVOT}$ / VTI_{prosth}

(not from ring size !)

- AVR:

acceleration time (> 100 ms ?)



MG = 22 mmHg
DVI = 0.4
AT = 75 ms

MG = 80 mmHg
DVI = 0.18
AT = 180 ms

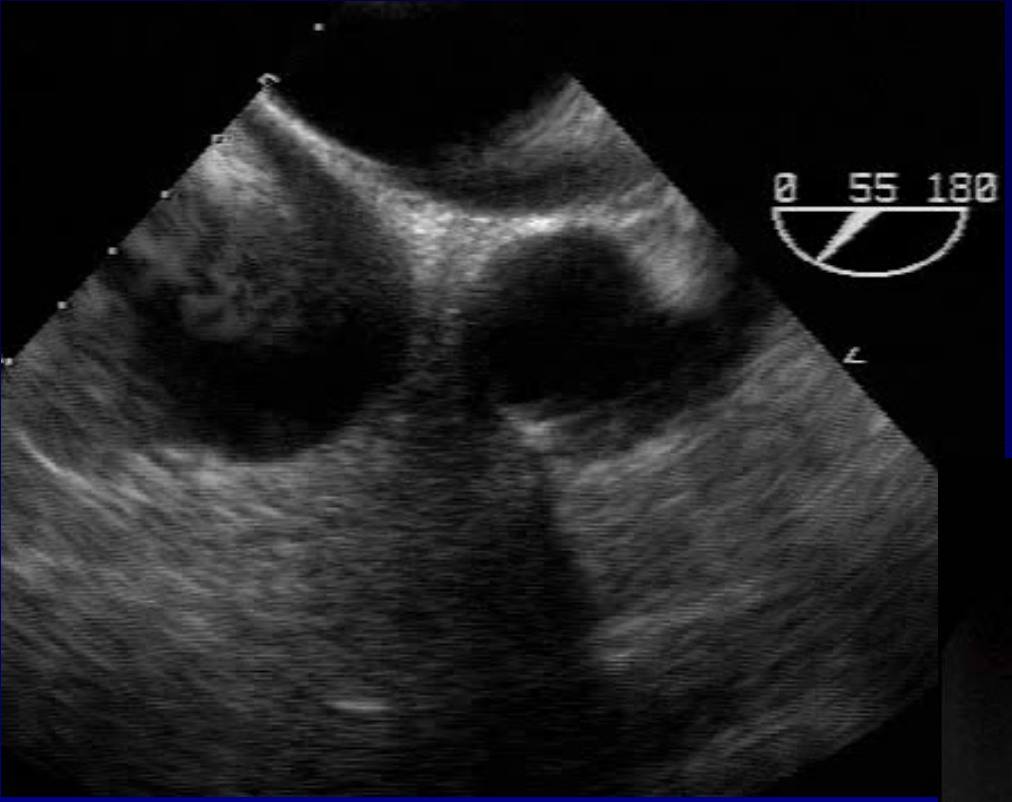
Aortic prostheses:

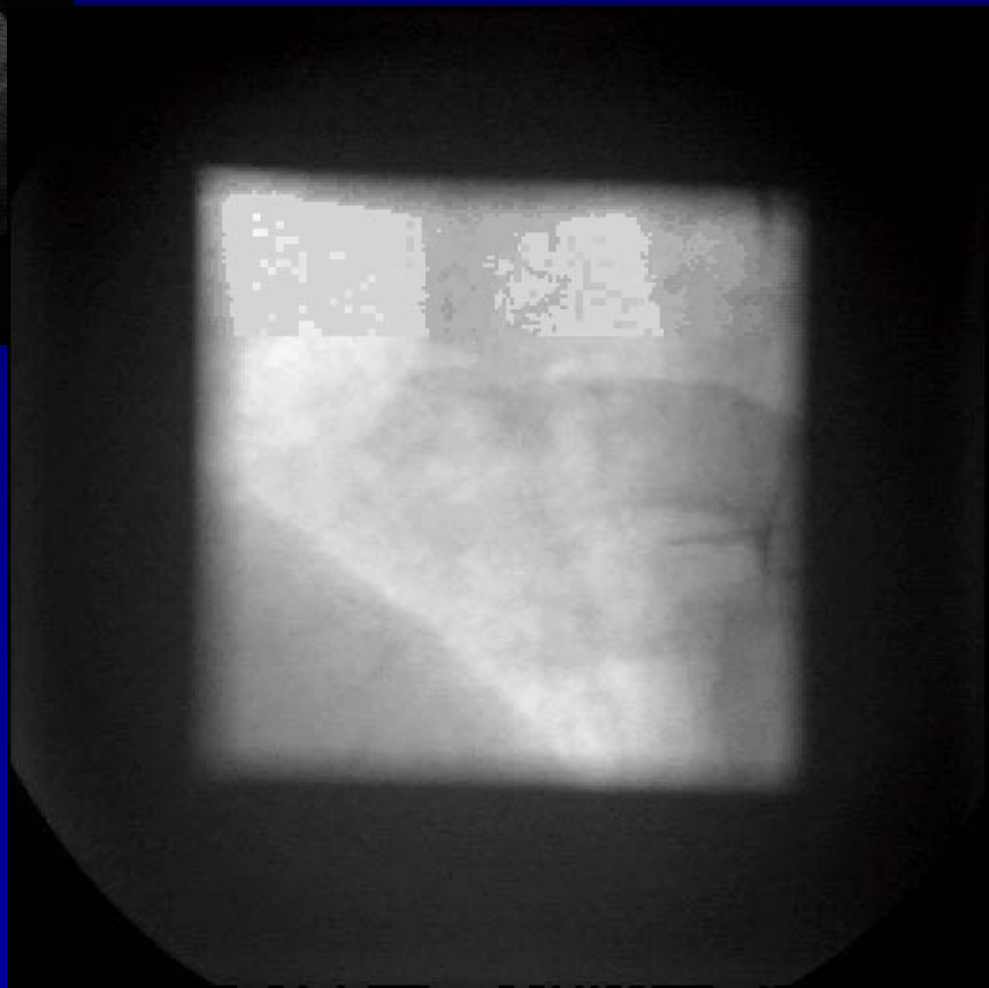
assessment of obstruction is often difficult

- **small valve**
- **in mechanical valves disc motion is often impossible to assess**
- **pressure recovery**
- **„patient-prosthesis mismatch“**

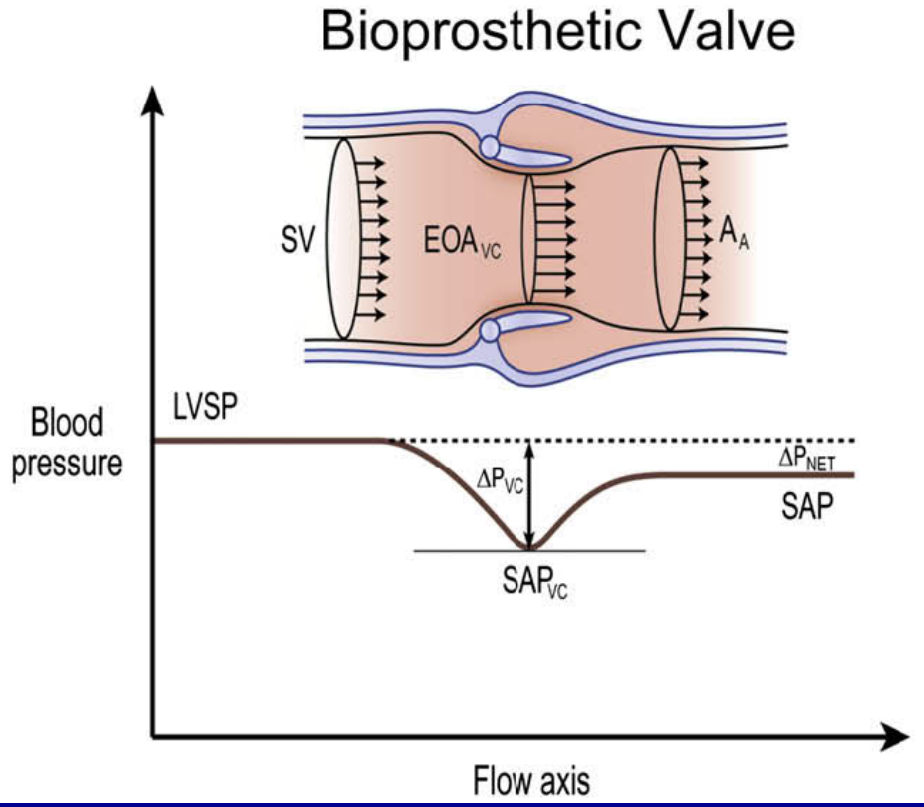
60yr old patient w bileaflet AVR max./mean 68 / 38 mmHg

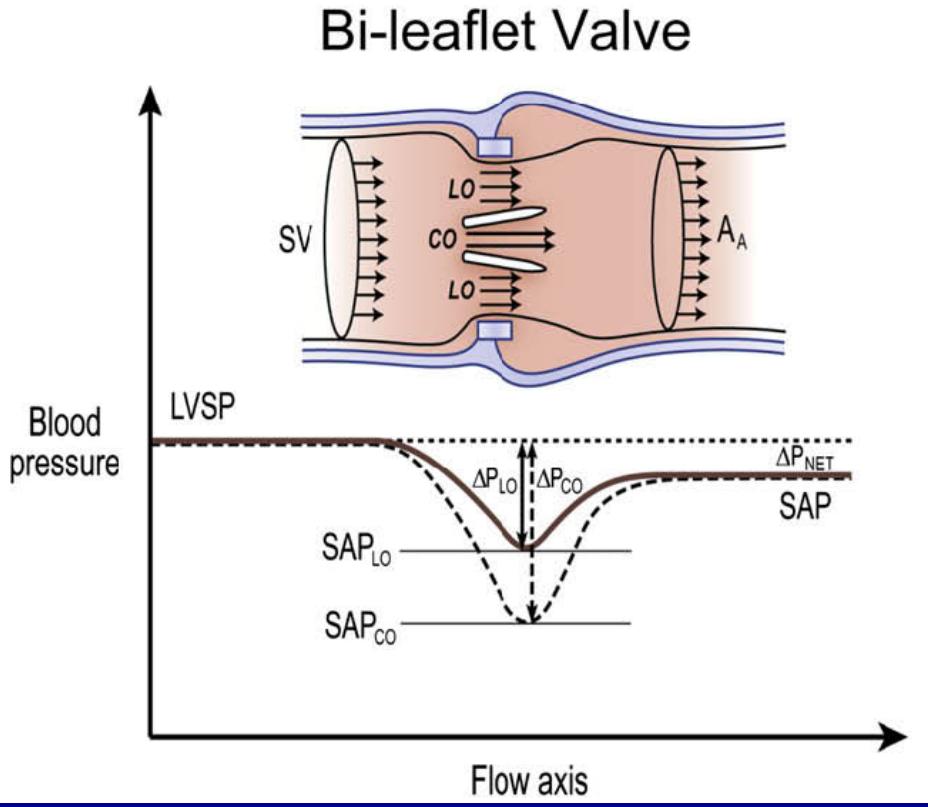
Valve	Size	Peak gradient (mm Hg)	Mean gradient (mmHg)	Effective orifice area (cm^2)
St Jude Medical Standard *Bileaflet*	19	42.0± 10.0	24.5± 5.8	1.5± 0.1
	21	25.7± 9.5	15.2± 5.0	1.4± 0.4
	23	21.8± 7.5	13.4± 5.6	1.6± 0.4
	25	18.9± 7.3	11.0± 5.3	1.9± 0.5
	27	13.7± 4.2	8.4± 3.4	2.5± 0.4
	29	13.5± 5.8	7.0± 1.7	2.8± 0.5


0 55 180



pressure recovery

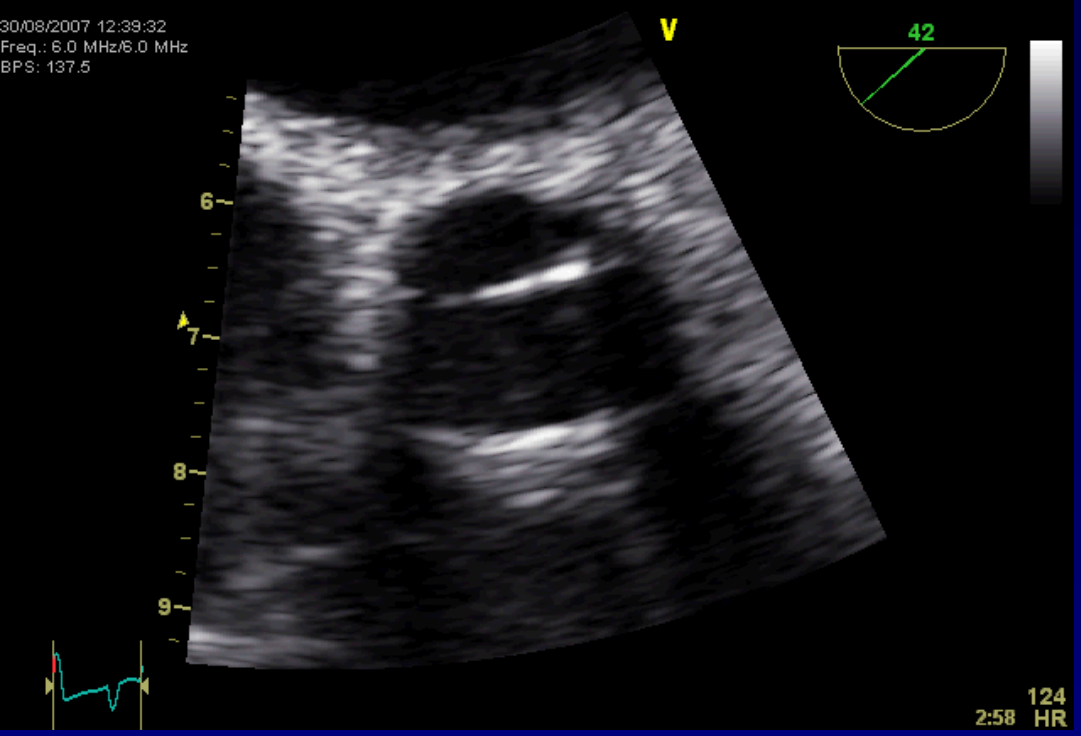


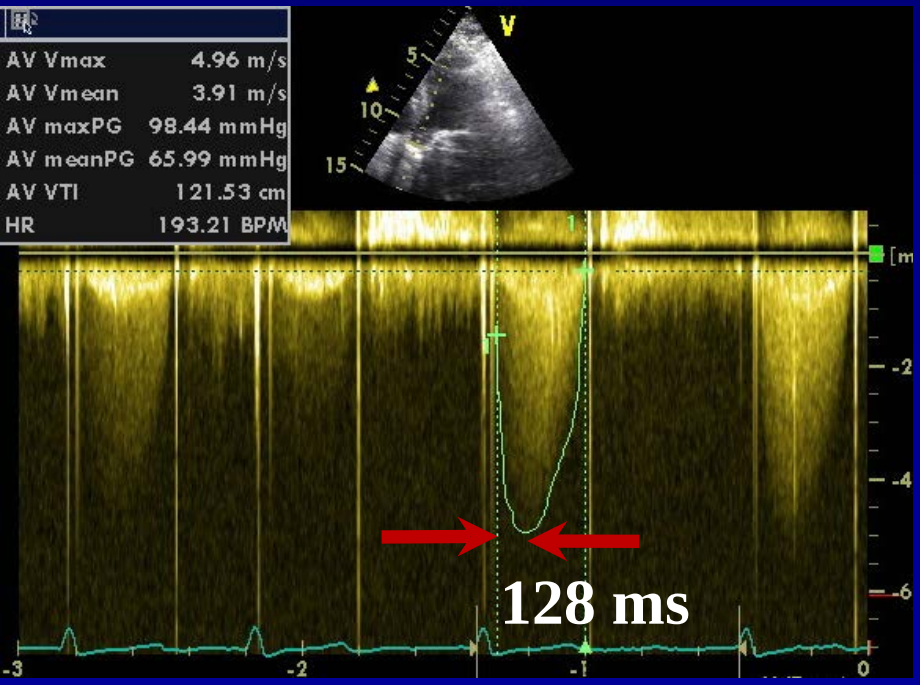


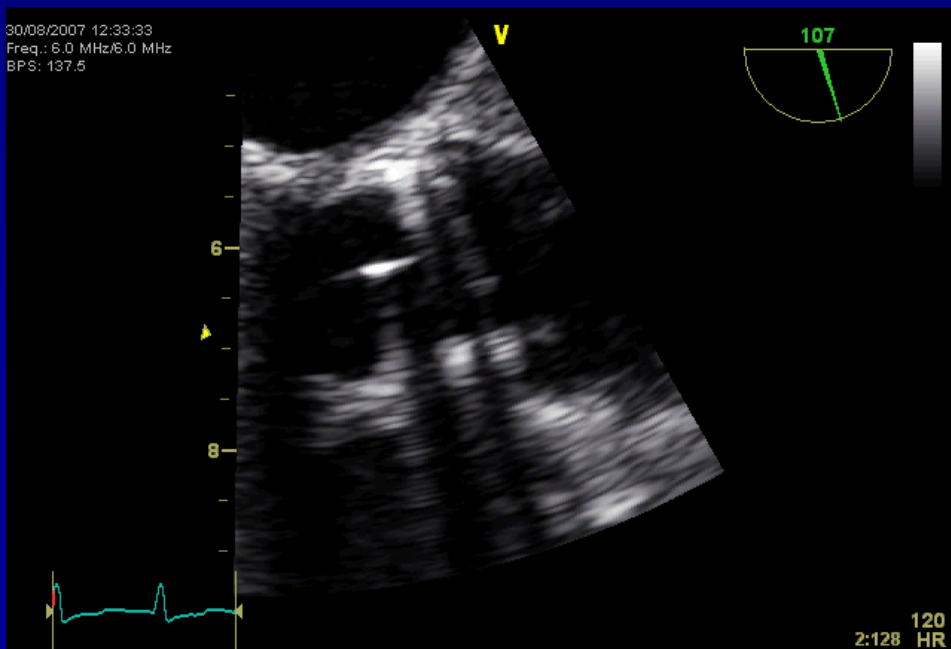
ASE/EAE recommendations 2009

most pronounced in small bileaflet aortic prostheses and with narrow aorta

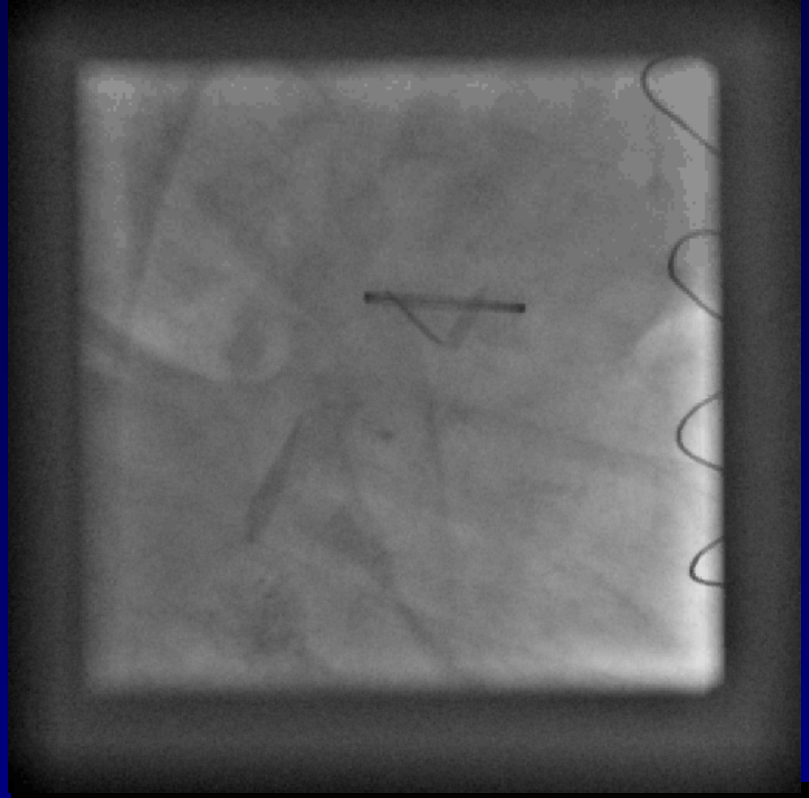
55yr old woman with double valve replacement due to rheumatic disease

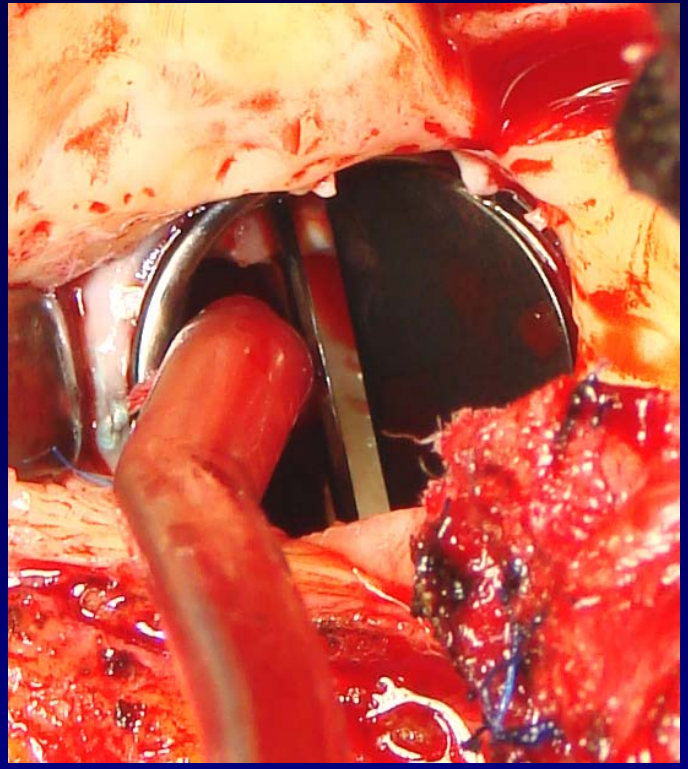




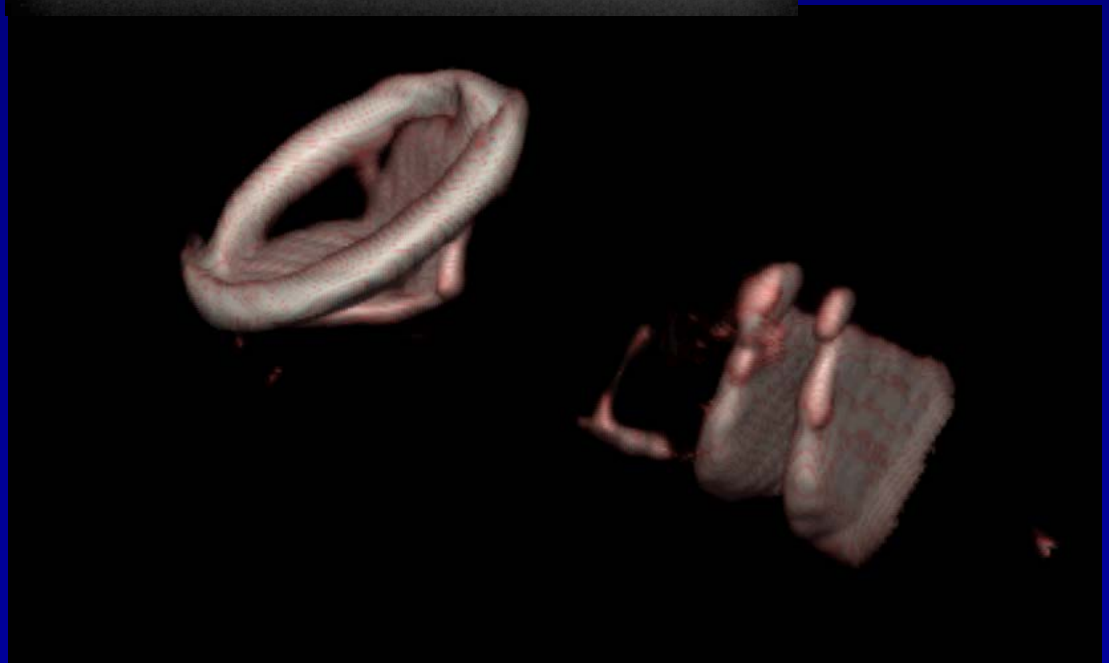


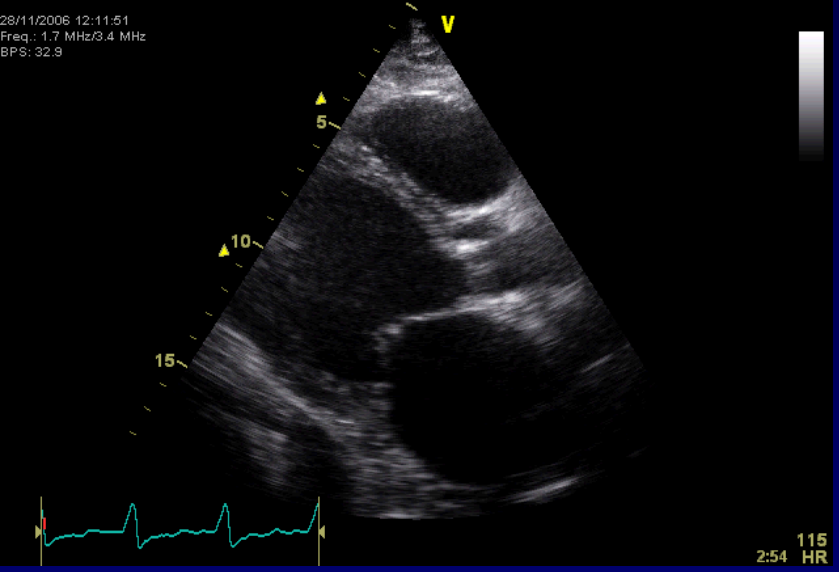
AVR

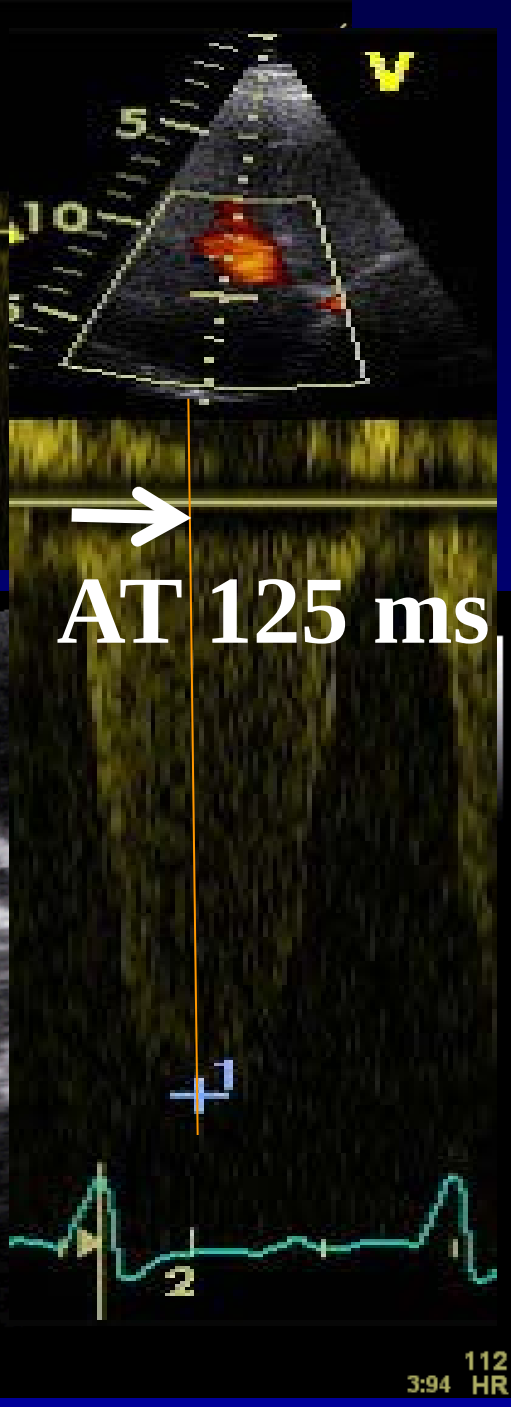




AVR

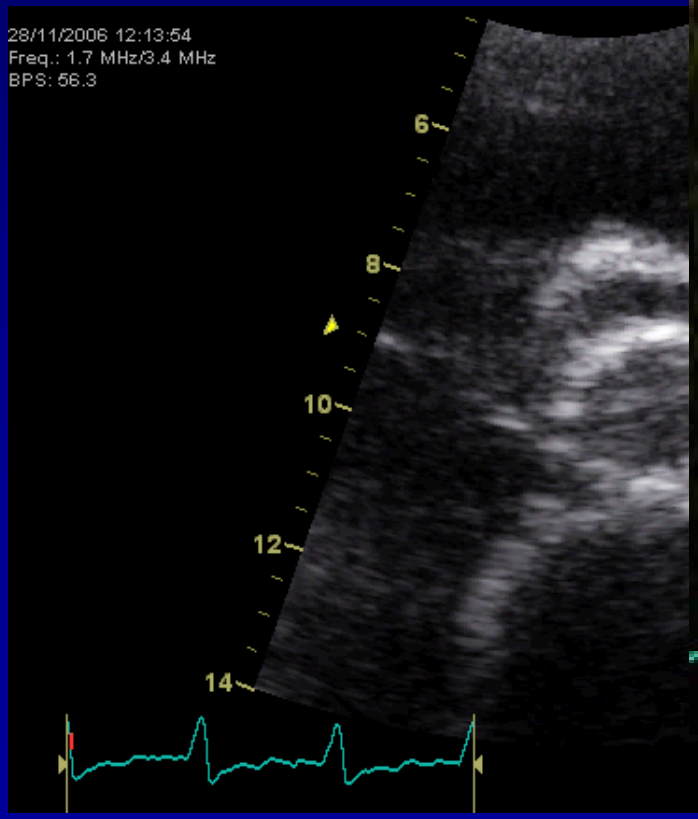






50 yr old pt 4 years after AVR with stentless pericardial valve

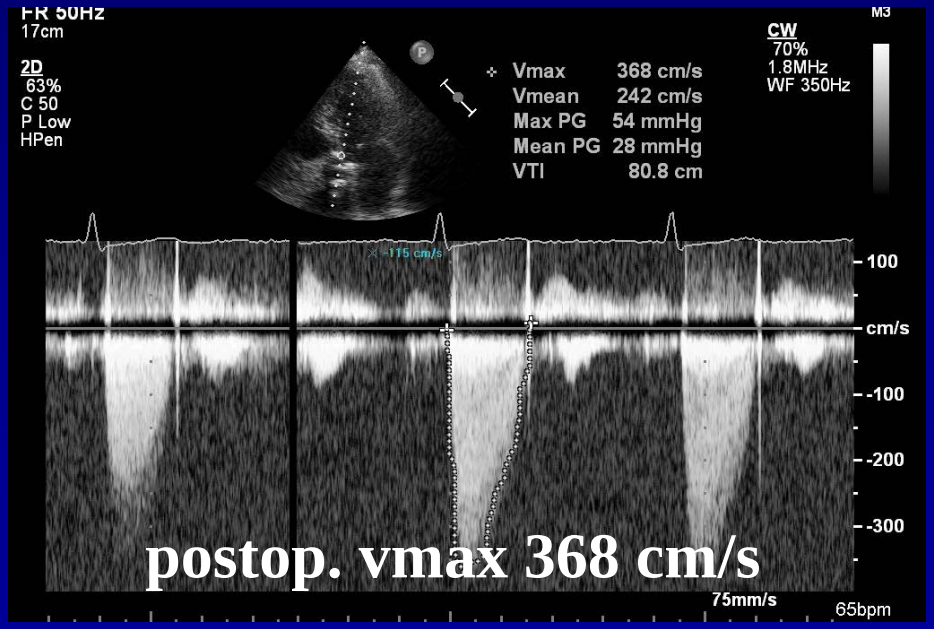
now new LV dysfunction (EF 10%), severe MR, max.gradient 40 mmHg, cardiogenic shock



„Patient-prosthesis mismatch“

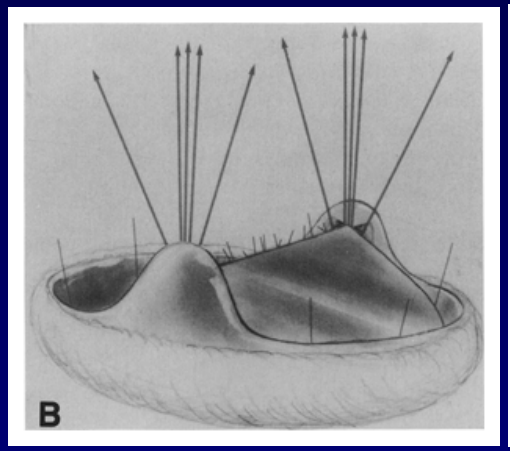
- prosthesis functions normally but is too small for patient
- effective orifice area < 0.85 cm^2/m^2
- relevant only in AVR
- unclear prognostic significance

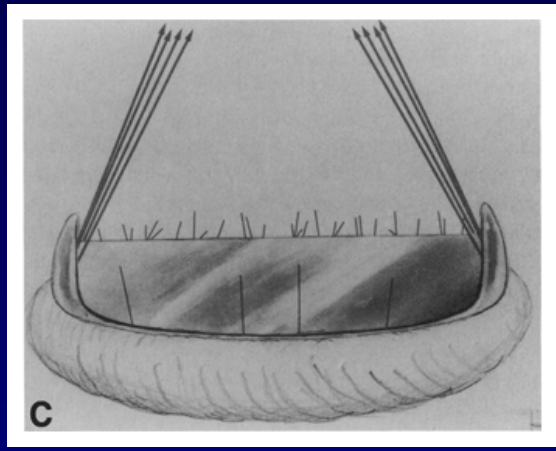
AS → AVR (Nr.21 bioprosthesis) morphologically good function



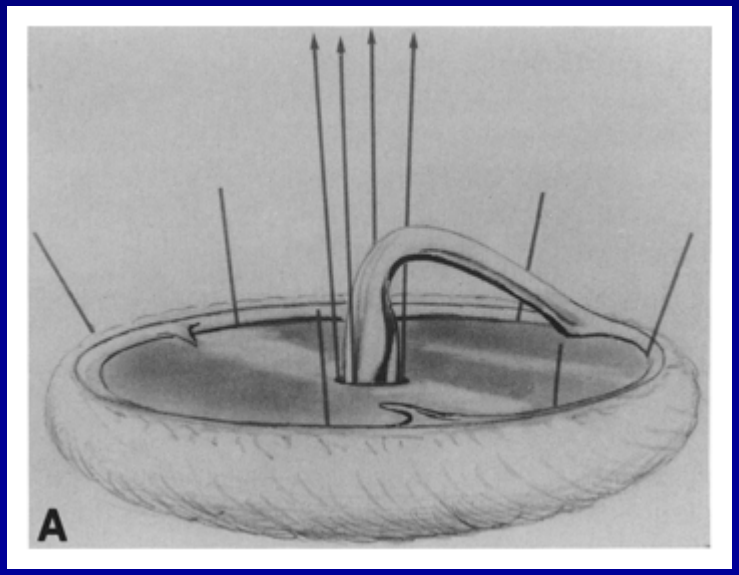
eff.orifice area = 3,14•35 /81 = 1.4 cm^2; → EOI = 0.67 cm^2/m^2

Normal prosthetic regurgitation





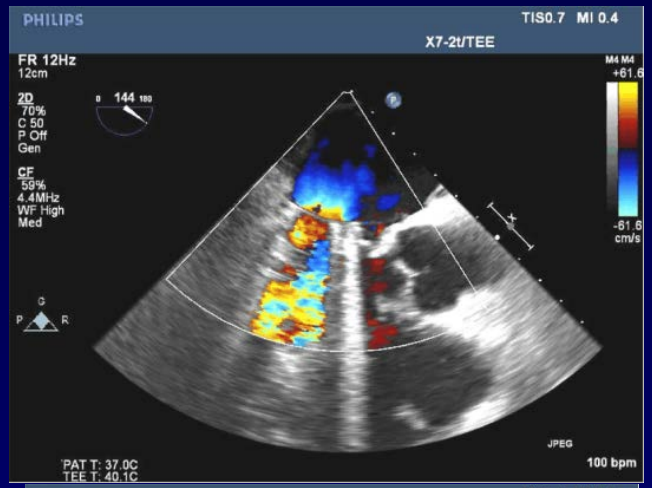
bileaflet



Medtronic-Hall

Flachskampf JACC 91; 18:1493


PHILIPS
TIS0.7 MI 0.4
X7-2t/TEE
FR 12Hz
12cm
2D
70%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
TEE T: 39.9C
97 bpm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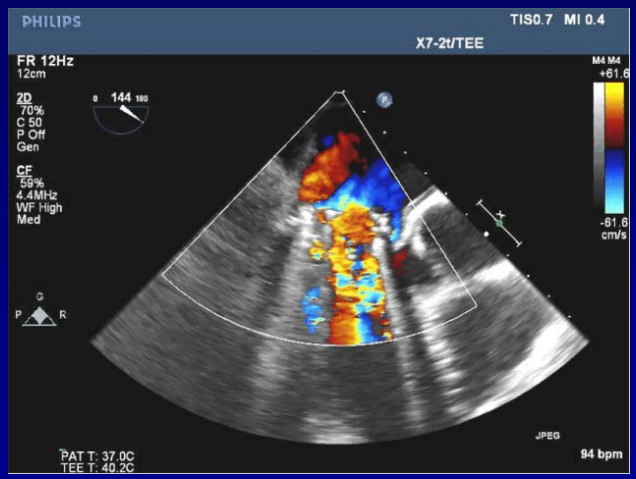
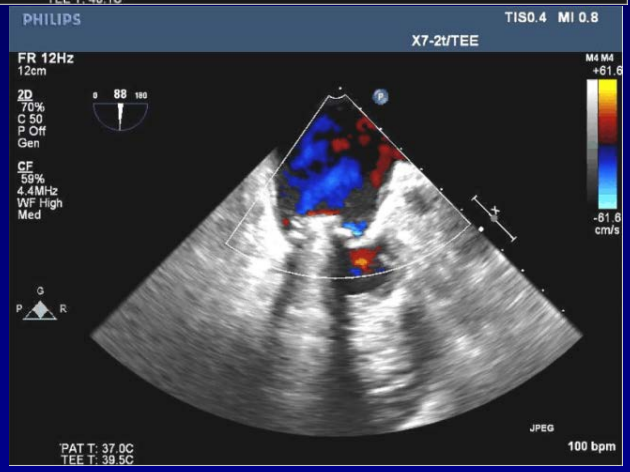
TIS0.7 MI 0.4
X7-2t/TEE
FR 12Hz
12cm
2D
70%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
TEE T: 40.1C
100 bpm


PHILIPS
TIS0.7 MI 0.4
X7-2t/TEE
FR 12Hz
12cm
2D
70%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
TEE T: 40.2C
94 bpm


PHILIPS
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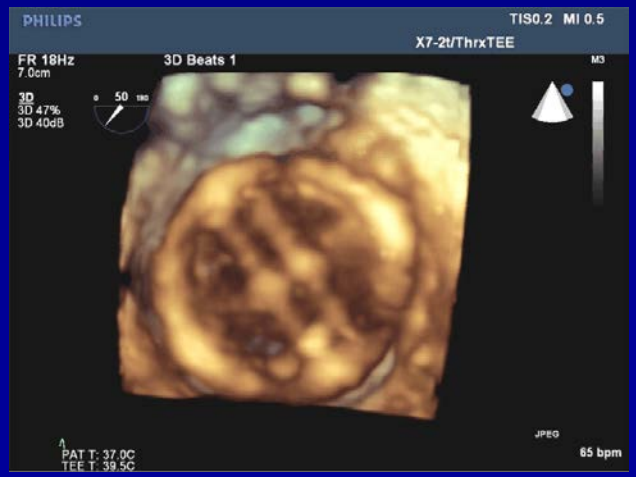
X7-2t/TEE
FR 12Hz
12cm
2D
70%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+61.6
-61.6
cm/s
JPEG
PAT T: 37.0C
TEE T: 39.5C
100 bpm


PHILIPS
TIS1.0 MI 0.5
X7-2t/ThrxTEE
FR 2Hz
7.0cm
3D Beats 1
3D
3D 47%
3D 40dB
CF
50%
4.4MHz
M3 M4
JPEG
PAT T: 37.0C
TEE T: 40.4C
85 bpm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X7-2t/ThrxTEE
FR 18Hz
7.0cm
3D Beats 1
3D
3D 47%
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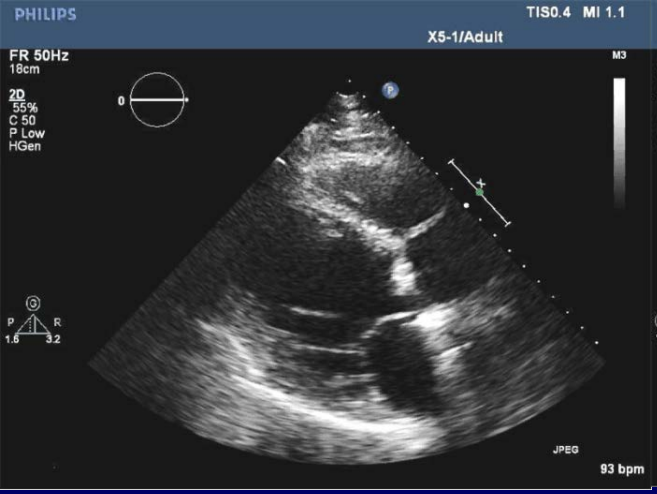
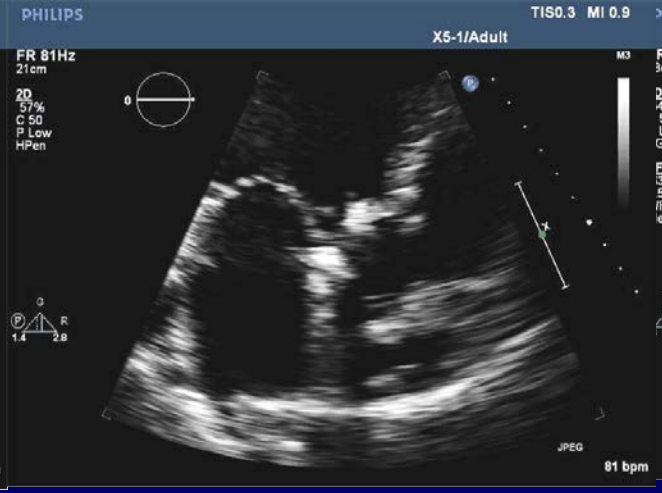
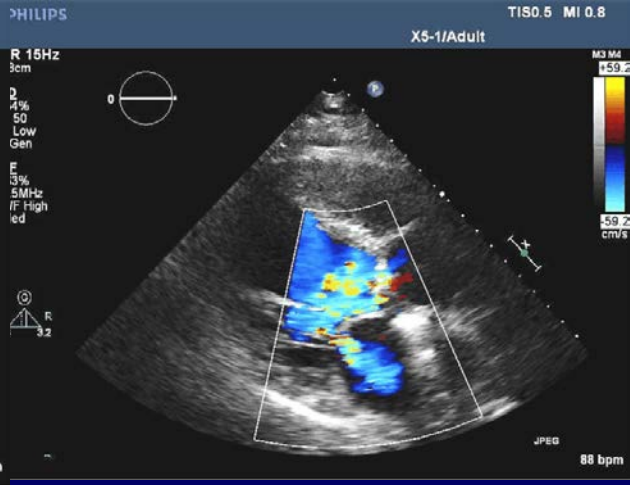
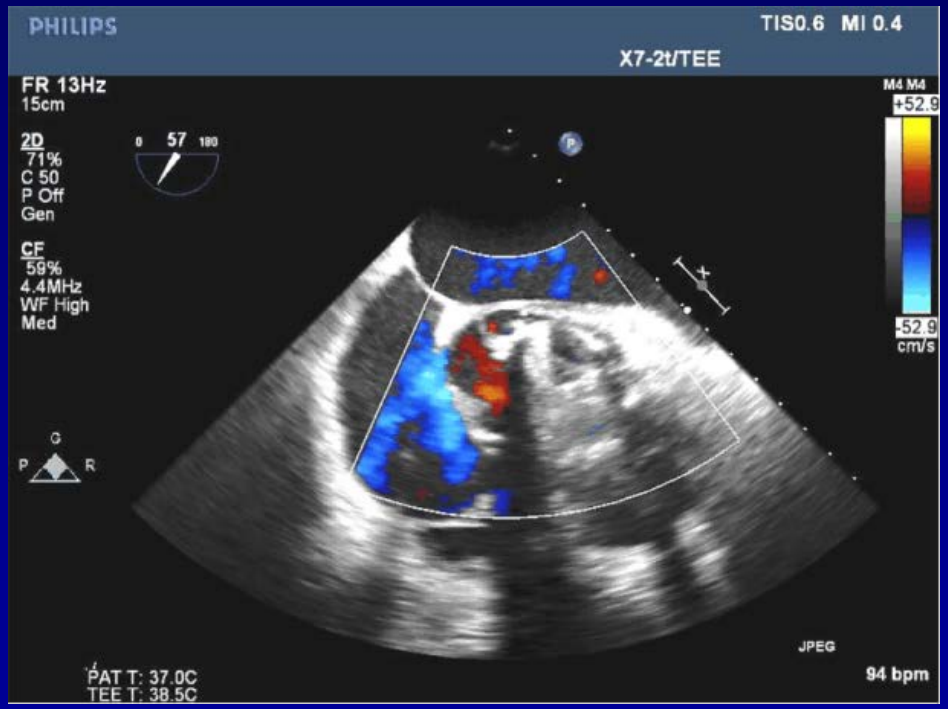
M3
JPEG
PAT T: 37.0C
TEE T: 39.5C
85 bpm



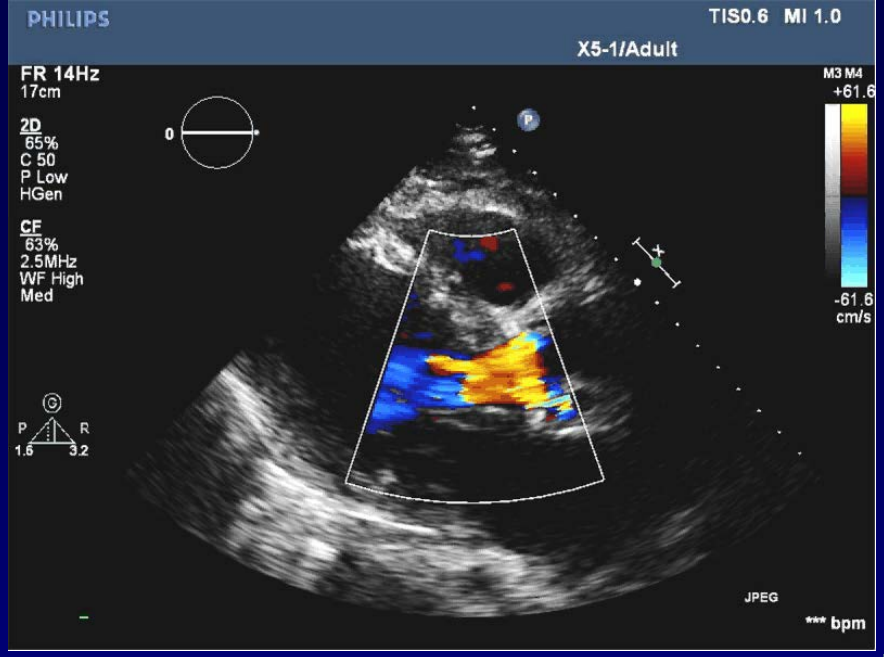


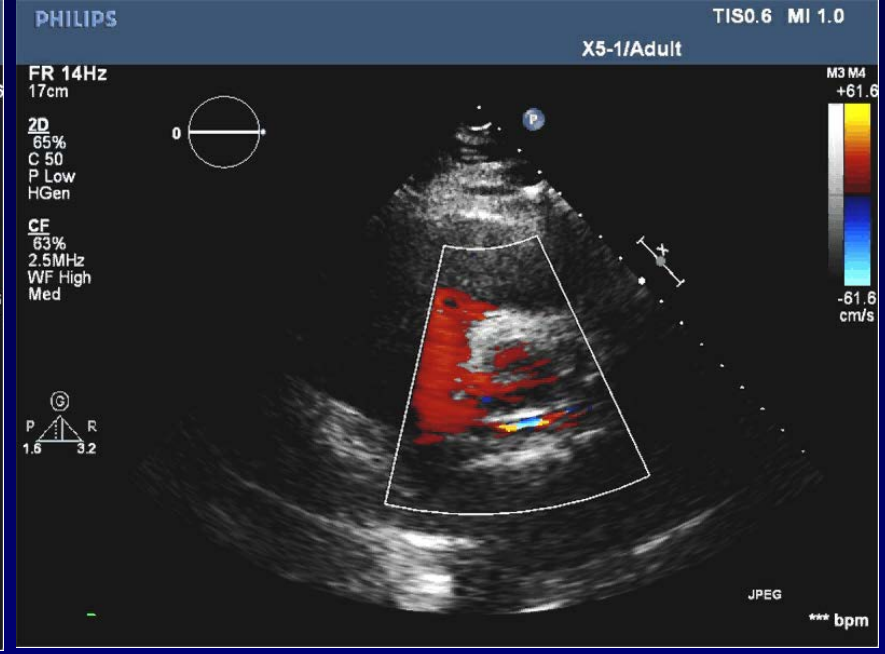


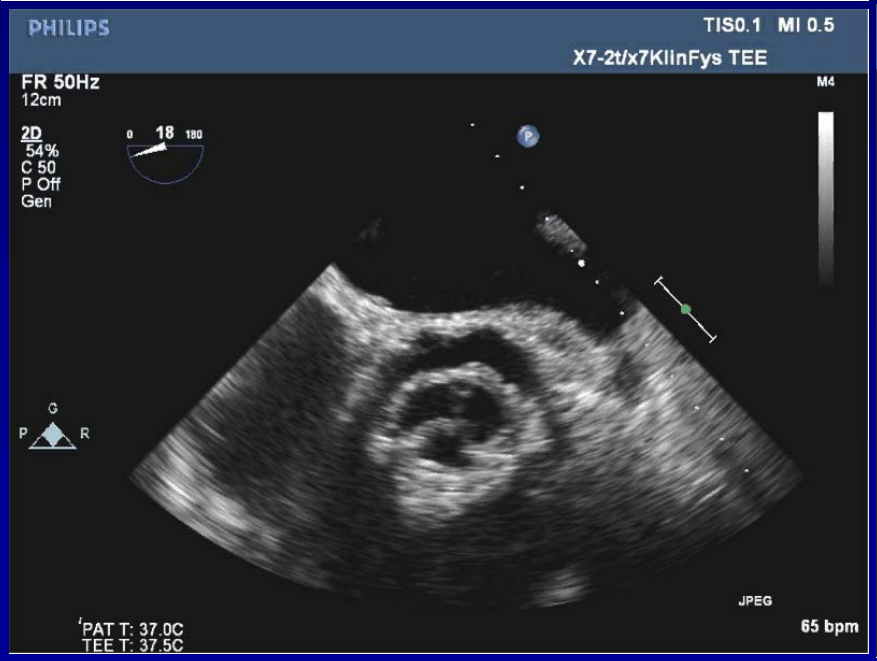


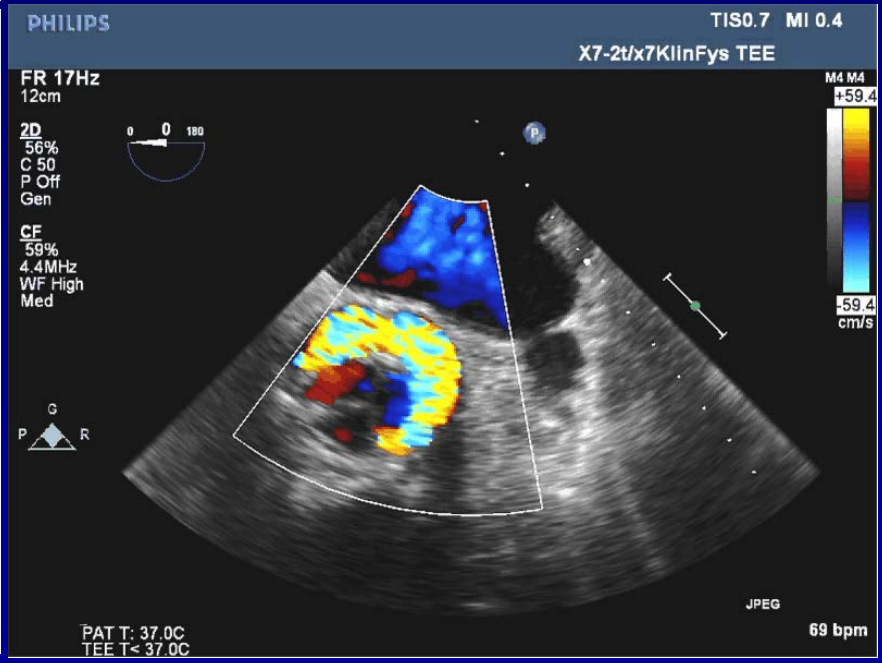
Rule of thumb:

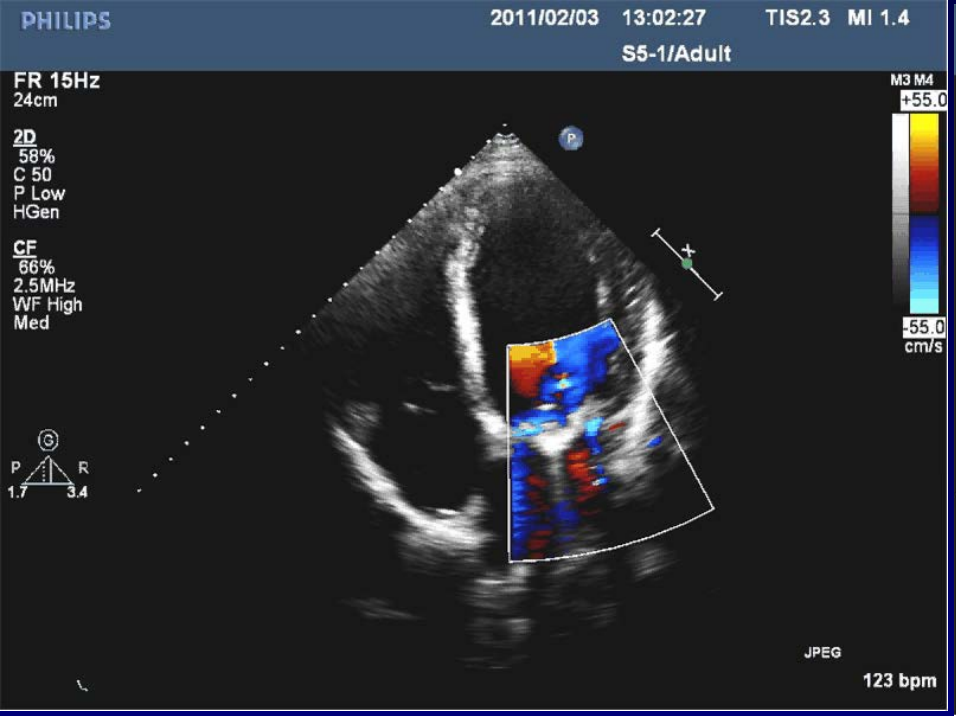
leakage > 20% of circumference (> 72°) → severe

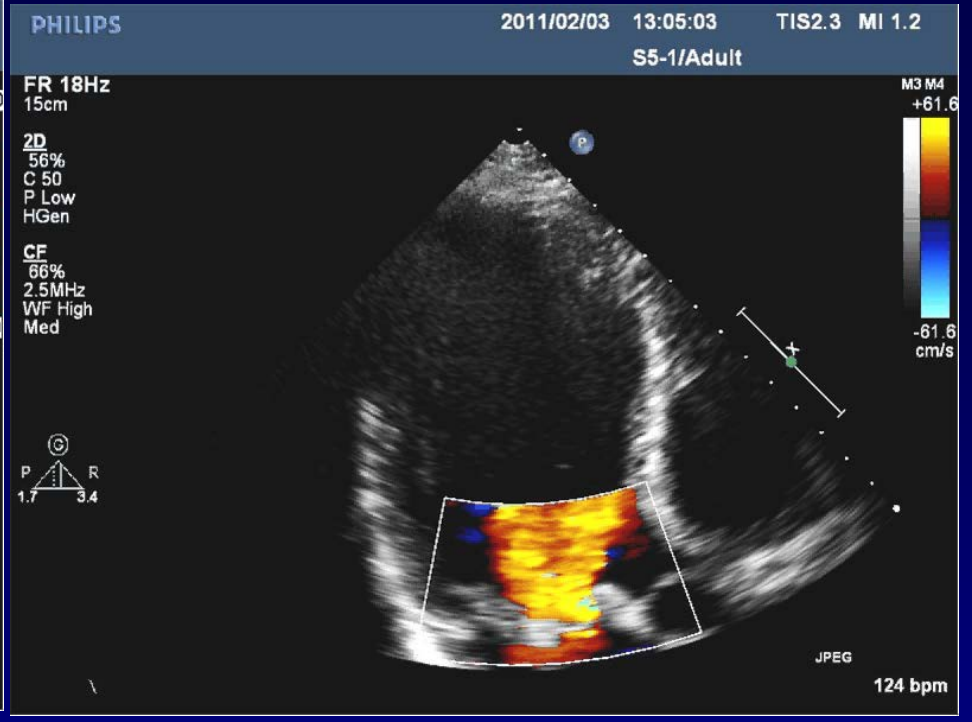

PHILIPS
TIS0.6 MI 1.0
X5-1/Adult
FR 14Hz
17cm
2D
65%
C 50
P Low
HGen
CF
63%
2.5MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
JPEG
*** bpm

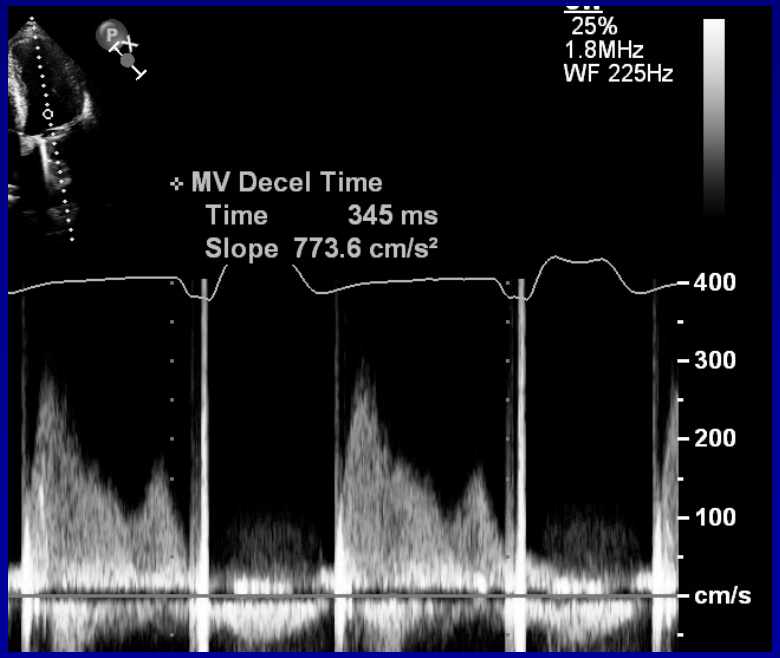

PHILIPS
TIS0.6 MI 1.0
X5-1/Adult
FR 14Hz
17cm
2D
65%
C 50
P Low
HGen
CF
63%
2.5MHz
WF High
Med
M3 M4
+61.6
-61.6
cm/s
JPEG
*** bpm


PHILIPS
TIS0.1 MI 0.5
X7-2t/x7KlinFys TEE
FR 50Hz
12cm
2D
54%
C 50
P Off
Gen
M4
JPEG
PAT T: 37.0C
TEE T: 37.5C
65 bpm


PHILIPS
TIS0.7 MI 0.4
X7-2t/x7KlinFys TEE
FR 17Hz
12cm
2D
56%
C 50
P Off
Gen
CF
59%
4.4MHz
WF High
Med
M4 M4
+59.4
-59.4
cm/s
JPEG
PAT T: 37.0C
TEE T< 37.0C
69 bpm







mean gradient 9 mmHg, PHT ca. 90 ms

Practical summary

- **low threshold for TEE**
- **document postoperative gradients for comparison**
- **use fluoroscopy if obstruction of mechanical AVR is suspected; look at acceleration time (> 100 ms ?)**
- **regurgitation: get best possible pictures (TEE); compare forward VTI / stroke volume with earlier exams; in paravalvular leakage, assess circumferential extent (>20 % ?)**

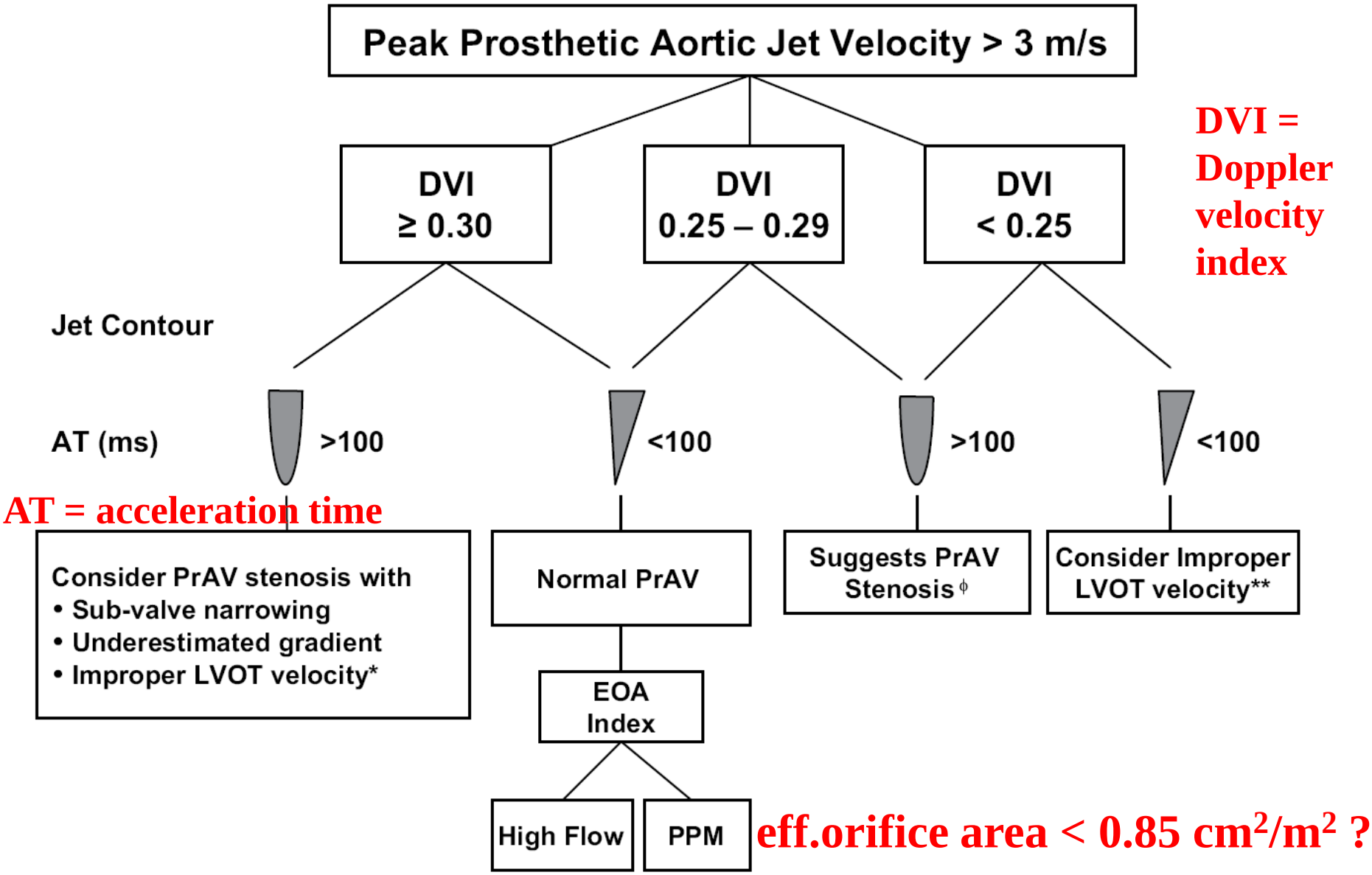


Figure 10 Algorithm for evaluation of elevated peak prosthetic aortic jet velocity incorporating DVI, jet contour, and AT. *PW Doppler sample too close to the valve (particularly when jet velocity by CW Doppler is ≥4 m/s). **PW Doppler sample too far (apical) from the valve (particularly when jet velocity is 3-3.9 m/s). φStenosis further substantiated by EOA derivation compared with reference values if valve type and size are known. Fluoroscopy and TEE are helpful for further assessment, particularly in bileaflet valves. *AVR*, Aortic valve replacement.