Dysfonction de prothèse valvulaire

Février 2025

Dr Manon Canevet
Anesthésiste Réanimateur – CTCV CHU Nantes

CHU NANTES

Prothèses valvulaires ?

chirurgicales

percutanées

Fémoral

Carotidien

Apical

biologiques

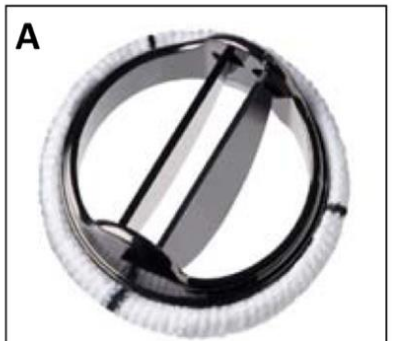
Edwards

Medtronic

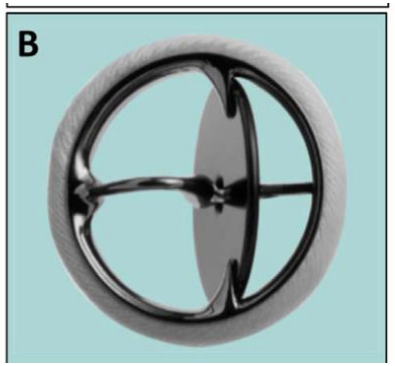
Prothèses valvulaires ?

chirurgicales

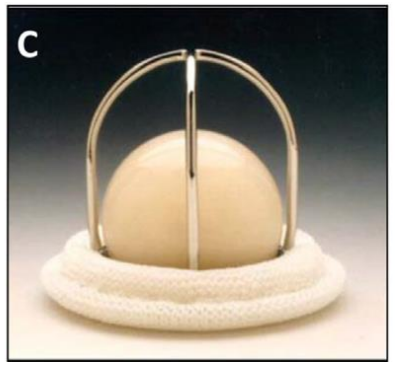
mécaniques



Double ailette



Simple ailette



« cage ball »

St Jude Medical, Carbomedics, On-X …

percutanées

Fémoral

Carotidien

Apical

biologiques

Edwards

Medtronic

Prothèses valvulaires ?

chirurgicales

Biologiques

Stentées

Avalus

trifecta

Magna Ease

non stentées

freestyle

Perceval

percutanées

Fémoral

Carotidien

Apical

biologiques

SAPIEN 3

Edwards

CoreValve

Medtronic

Comment choisir ?

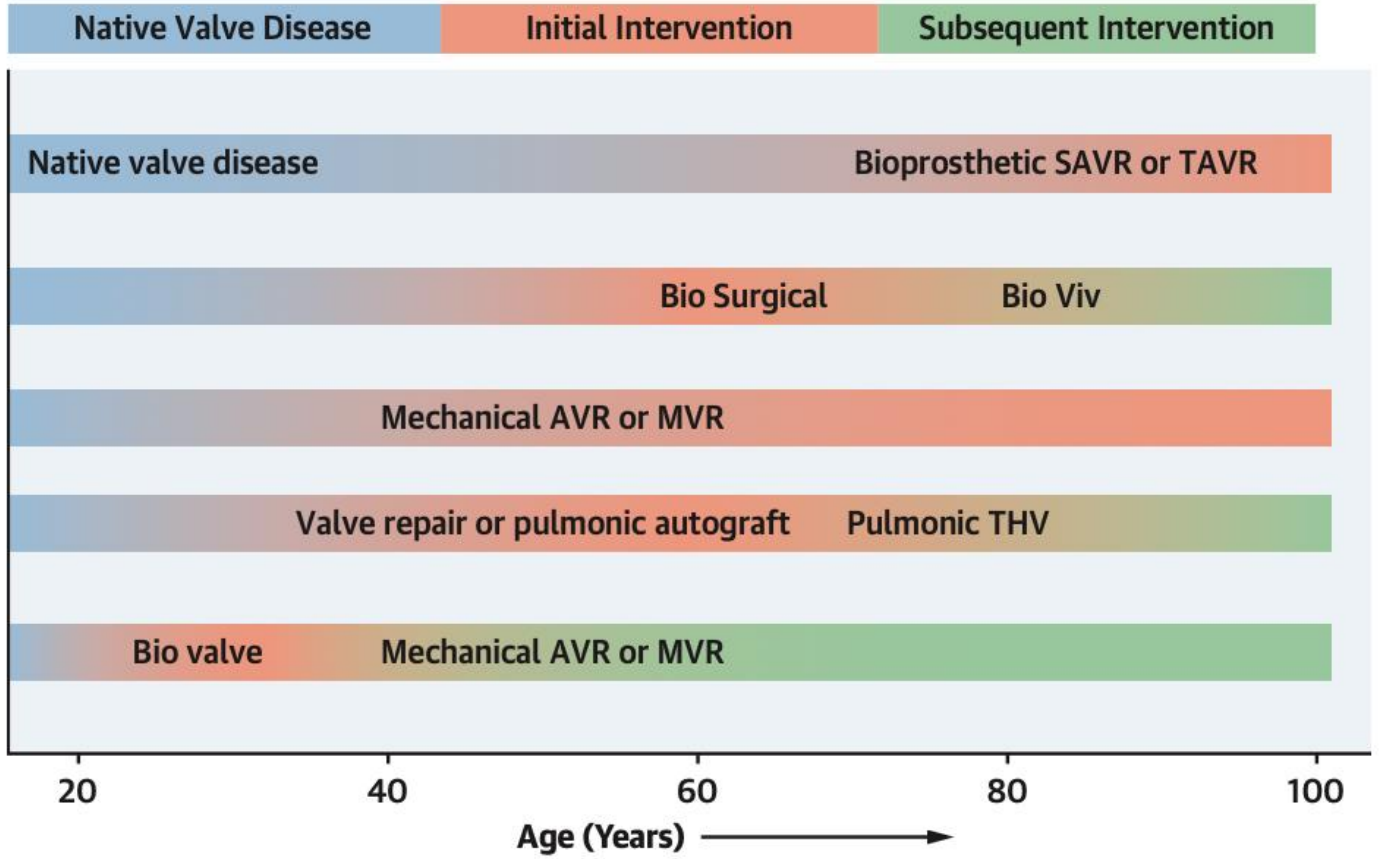
Anticoagulation

Age

Antécédents du patient

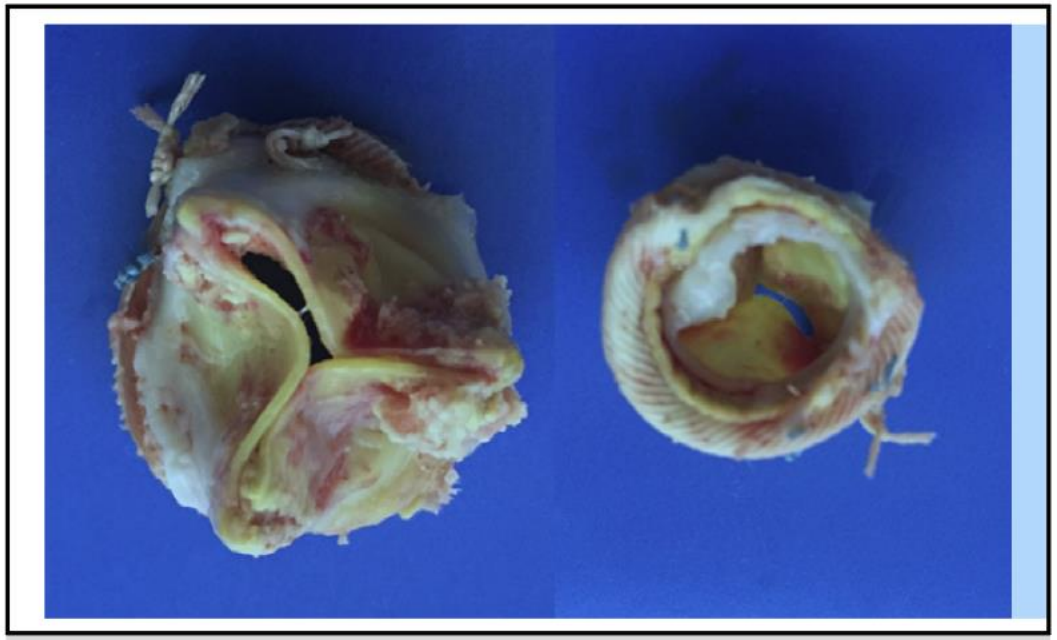
Morphologie (SC)

Caractéristiques de la valve



Standardized definitions for bioprosthetic Valve dysfunction following aortic or mitral valve replacement, JACC, state of art review, Pibarot et al 2022

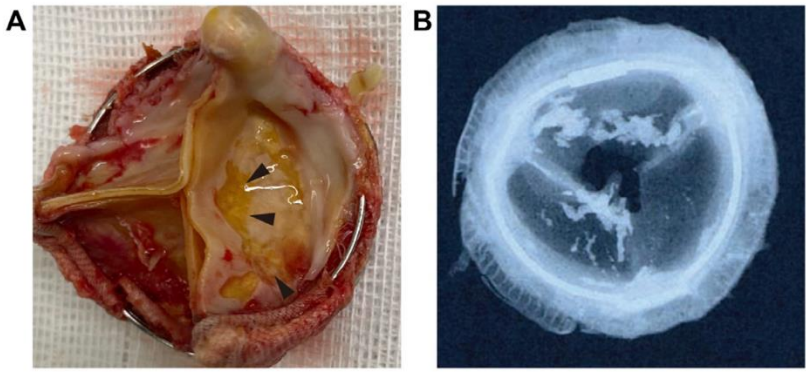
Comment choisir ?

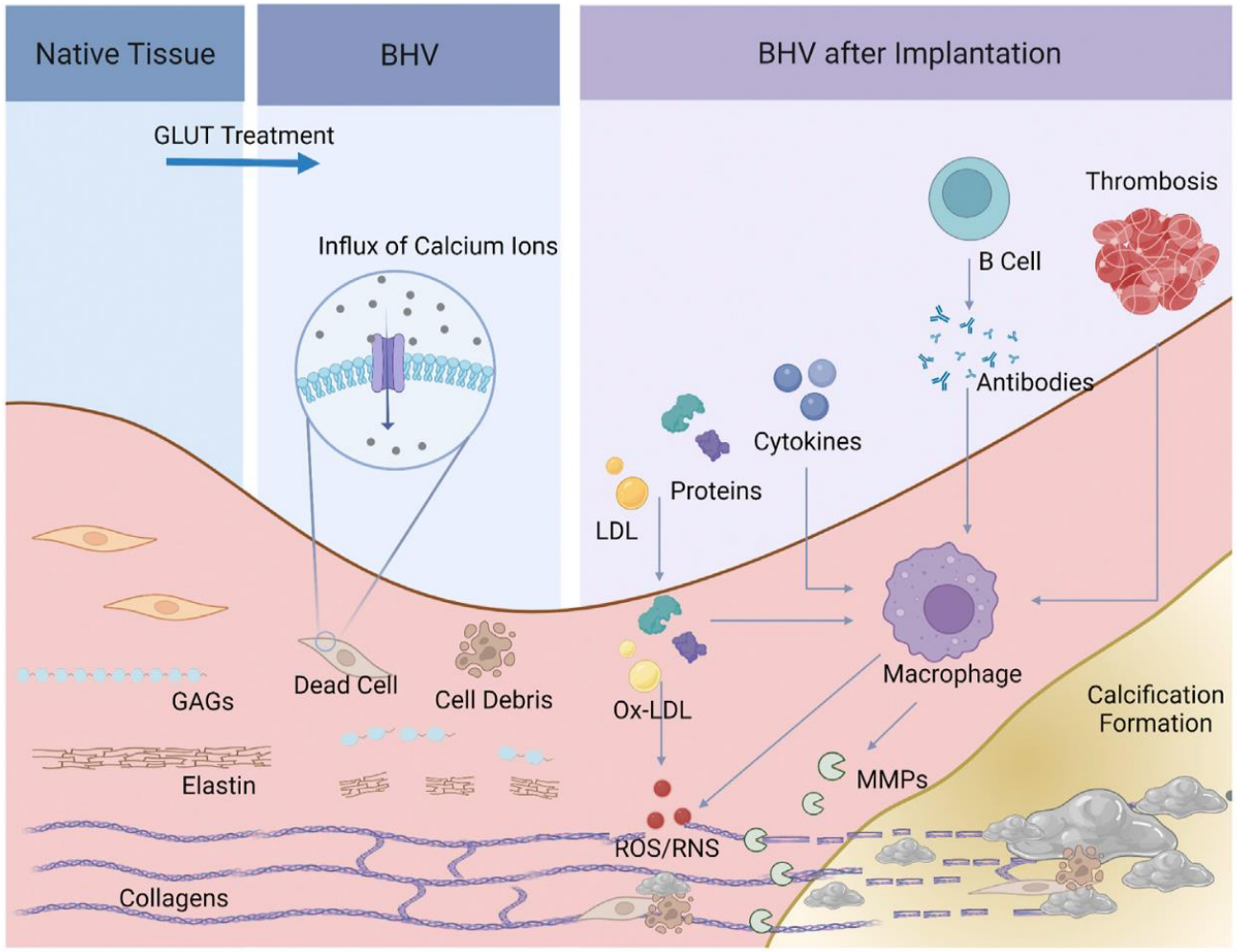


Explanted Trifecta valve with structural degeneration in inflow and outflow portions.

Early Trifecta valve failure: Report of a cluster of cases from a tertiary care referral center Kalra et al 2017 by The American Association for Thoracic Surgery

Comment choisir ?

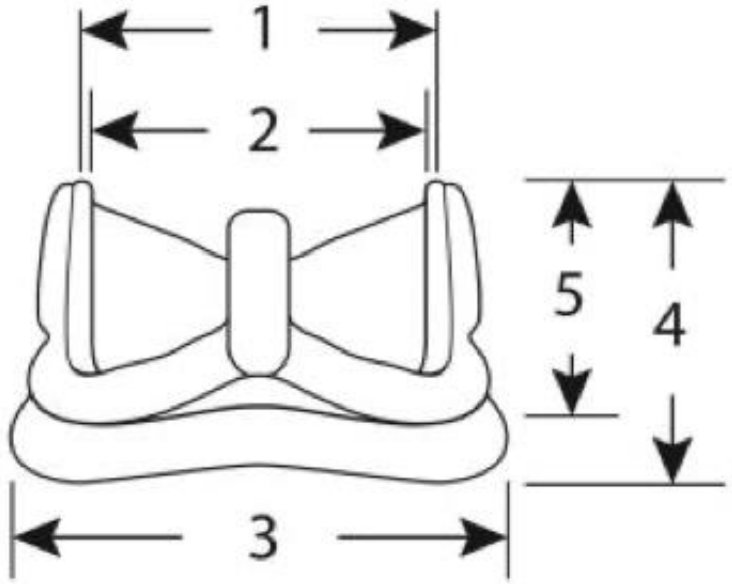




Mechanisms and Drug Therapies of Bioprosthetic Heart Valve Calcification, Frontiers in pharmacology, Wen et al, 2022

The role of antibody responses against glycans in bioprosthetic heart valve calcification and deterioration, T senage et al Fev 2022 Nature medicine

Comment choisir ?



		1	2	3	4	5
Modèle	**Référence**	**Taille valve**	**Diamètre de l'orifice interne**	**Diamètre extérieur de l'anneau de suture**	**Hauteur du profil de la valve**	**Saillie aortique**
AVALUS (modèle 400)	40019	19 mm	17,5 mm	27,0 mm	13,0 mm	11,0 mm
	40021	21 mm	19,5 mm	29,0 mm	14,0 mm	12,0 mm
	40023	23 mm	21,5 mm	31,0 mm	15,0 mm	13,0 mm
	40025	25 mm	23,5 mm	33,0 mm	16,0 mm	14,0 mm
	40027	27 mm	25,5 mm	36,0 mm	17,0 mm	15,0 mm

Effective orifice area = EOA

Valve aortique

Table 7 **Normal reference values of effective orifice areas for the prosthetic aortic valves**

Prosthetic valve size (mm)	19	21	23	25	27	29
Stented bioprosthetic valves						
Mosaic	1.1 ± 0.2	1.2 ± 0.3	1.4 ± 0.3	1.7 ± 0.4	1.8 ± 0.4	2.0 ± 0.4
Hancock II	–	1.2 ± 0.2	1.3 ± 0.2	1.5 ± 0.2	1.6 ± 0.2	1.6 ± 0.2
Carpentier-Edwards Perimount	1.1 ± 0.3	1.3 ± 0.4	1.5 ± 0.4	1.8 ± 0.4	2.1 ± 0.4	2.2 ± 0.4
Carpentier-Edwards Magna	1.3 ± 0.3	1.5 ± 0.3	1.8 ± 0.4	2.1 ± 0.5	–	–
Biocor (Epic)	1.0 ± 0.3	1.3 ± 0.5	1.4 ± 0.5	1.9 ± 0.7	–	–
Mitroflow	1.1 ± 0.2	1.2 ± 0.3	1.4 ± 0.3	1.6 ± 0.3	1.8 ± 0.3	–
Trifecta	1.4	1.6	1.8	2.0	2.2	2.4
Stentless bioprosthetic valves						
Medtronic Freestyle	1.2 ± 0.2	1.4 ± 0.2	1.5 ± 0.3	2.0 ± 0.4	2.3 ± 0.5	–
St Jude Medical Toronto SPV	–	1.3 ± 0.3	1.5 ± 0.5	1.7 ± 0.8	2.1 ± 0.7	2.7 ± 1.0
Prima Edwards	–	1.3 ± 0.3	1.6 ± 0.3	1.9 ± 0.4	–	–
Mechanical valves						
Medtronic-Hall	1.2 ± 0.2	1.3 ± 0.2	–	–	–	–
St Jude Medical Standard	1.0 ± 0.2	1.4 ± 0.2	1.5 ± 0.5	2.1 ± 0.4	2.7 ± 0.6	3.2 ± 0.3
St Jude Medical Regent	1.6 ± 0.4	2.0 ± 0.7	2.2 ± 0.9	2.5 ± 0.9	3.6 ± 1.3	4.4 ± 0.6
MCRI On-X	1.5 ± 0.2	1.7 ± 0.4	2.0 ± 0.6	2.4 ± 0.8	3.2 ± 0.6	3.2 ± 0.6
Carbomedics Standard and Top Hat	1.0 ± 0.4	1.5 ± 0.3	1.7 ± 0.3	2.0 ± 0.4	2.5 ± 0.4	2.6 ± 0.4
ATS Medical[a]	1.1 ± 0.3	1.6 ± 0.4	1.8 ± 0.5	1.9 ± 0.3	2.3 ± 0.8	–

Effective orifice area is expressed as mean values available in the literature. Further studies are needed to validate these reference values.
[a]For the ATS medical valve, the label valve sizes are 18, 20, 22, 24, and 26 mm. High velocities are common in size 19 or 21 prostheses. Adapted with permission from Ref. 7.

Effective orifice area = EOA

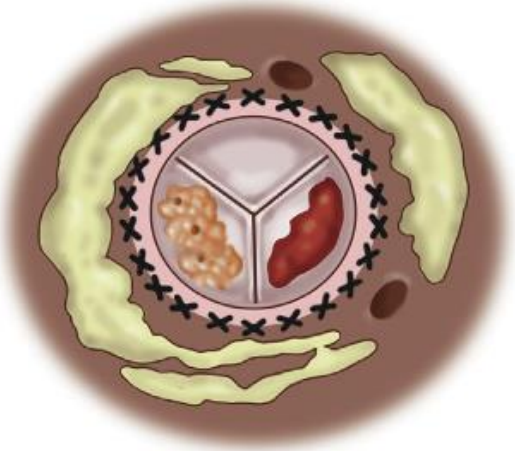
Valve mitrale

Table 8 **Normal reference values of effective orifice areas for the prosthetic mitral valves**

Prosthetic valve size (mm)	25	27	29	31	33
Stented bioprosthetic valves					
Medtronic Mosaic	1.5 ± 0.4	1.7 ± 0.5	1.9 ± 0.5	1.9 ± 0.5	–
Hancock II	1.5 ± 0.4	1.8 ± 0.5	1.9 ± 0.5	2.6 ± 0.5	2.6 ± 0.7
Carpentier-Edwards Perimount	1.6 ± 0.4	1.8 ± 0.4	2.1 ± 0.5	–	–
Mechanical valves					
St Jude Medical Standard	1.5 ± 0.3	1.7 ± 0.4	1.8 ± 0.4	2.0 ± 0.5	2.0 ± 0.5
MCRI On-X[a]	2.2 ± 0.9	2.2 ± 0.9	2.2 ± 0.9	2.2 ± 0.9	2.2 ± 0.9

Effective orifice area is expressed as mean values available in the literature. Further studies are needed to validate these reference values.
[a]The On-X valve has just 1 size for 27 to 29 and 31 to 33 mm prostheses. In addition, the strut and leaflets are identical for all sizes (25 to 33 mm); only the size of the sewing cuff is different. Adapted with permission from Ref. 7.

Dysfonction de prothèses



Structurelles

- Concerne les bioprothèses +++

Non structurelles

- Mismatch de prothèse (PPM)
- Fuite périprothétiques
- Autres
  - Feuillet attaché
  - Pannus
  - Malposition
  - Dilatation secondaire des cavités cardiaques

endocardite

thrombus

- Concerne les valves mécaniques +++

Paramètres échographiques

= évaluation d'une valve native !

Analyse structurelle

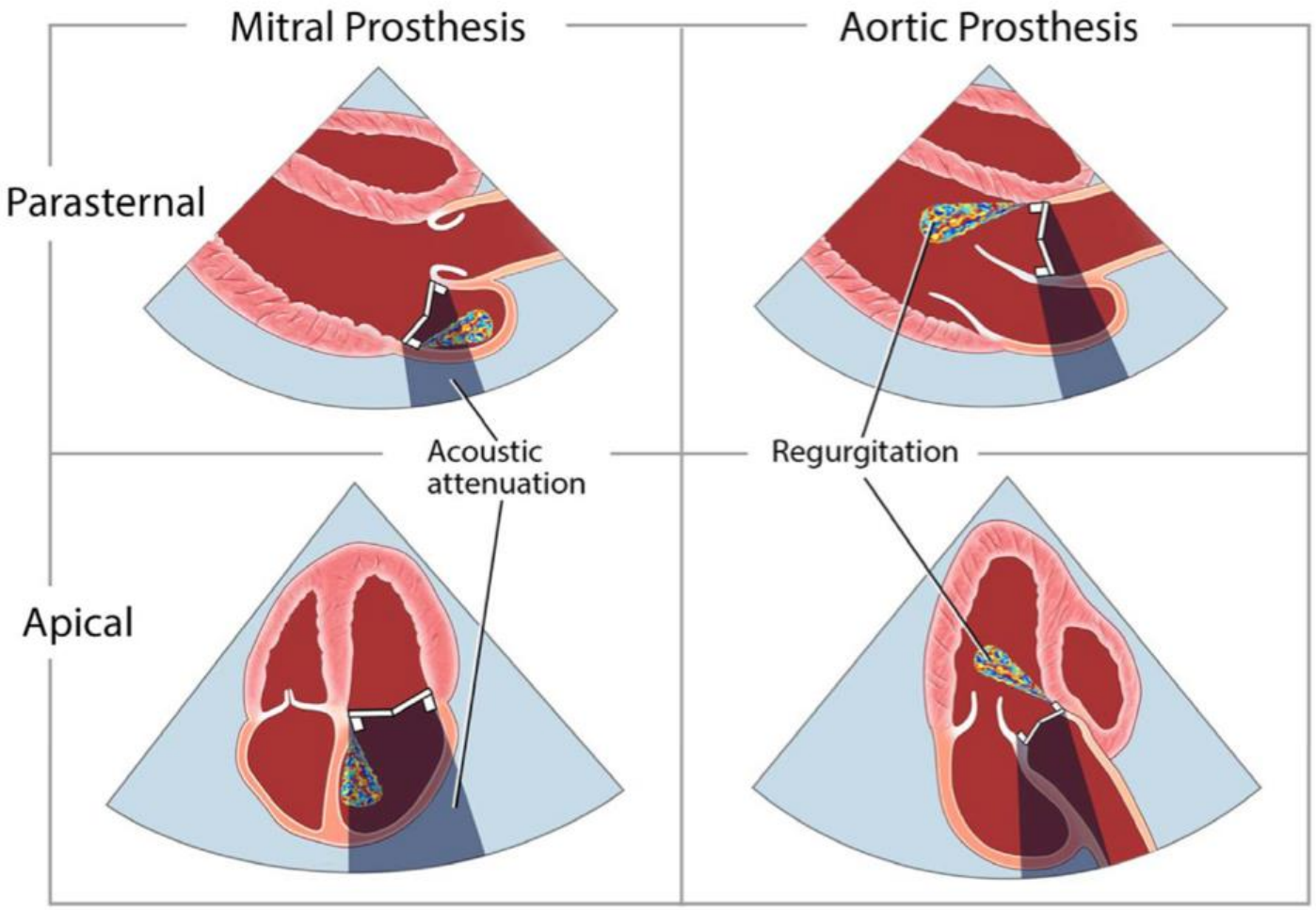
- Mobilité des feuillets / ailettes
- Images d'addition

Analyse hémodynamique

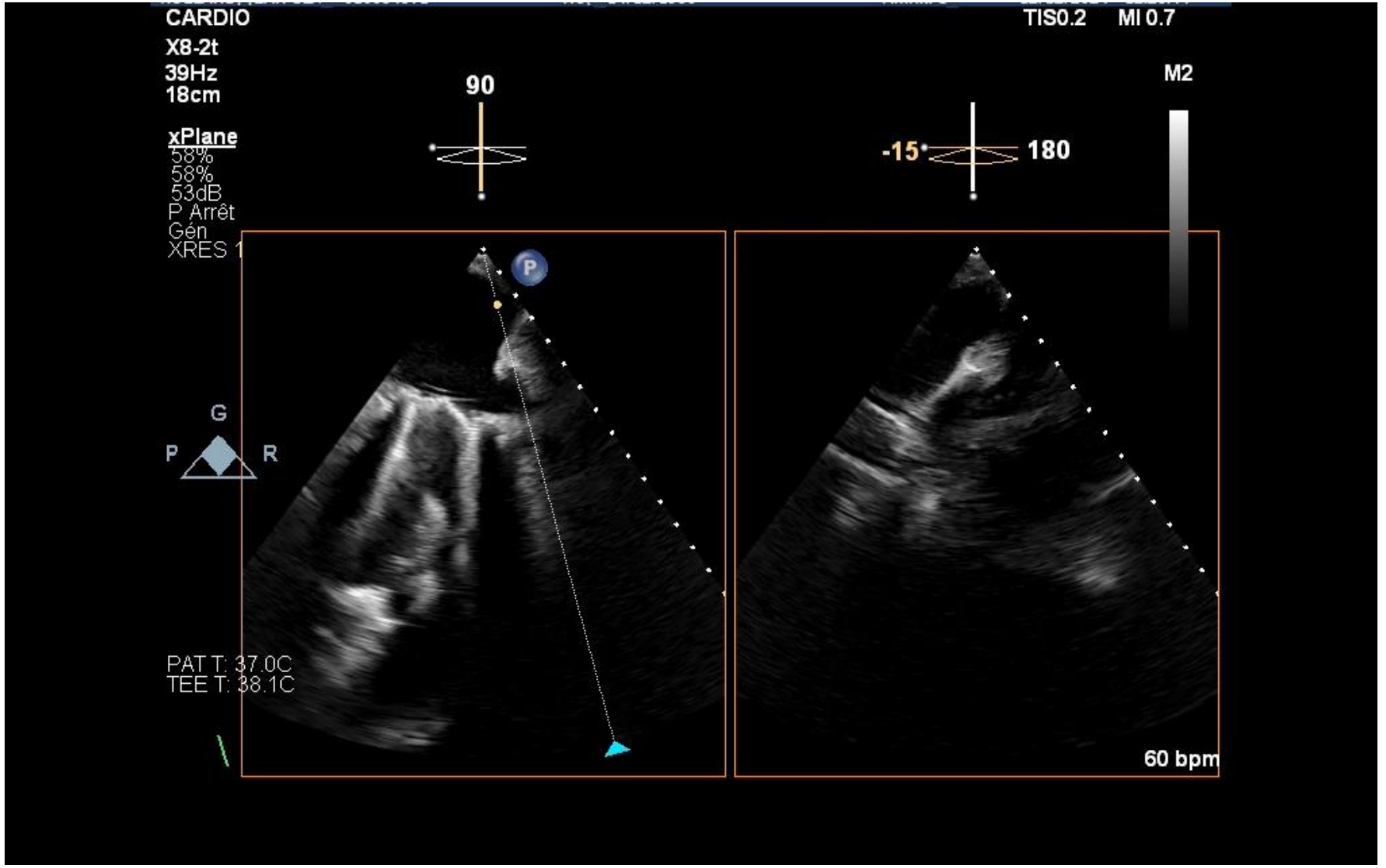
- Aspect du CW
- Temps accélération, Vmax
- gradient moyen
- Calculer EOA par équation de continuité
- Index de perméabilité (DVI)

Régurgitations

Cônes d’ombre



Valve mécanique double ailettes

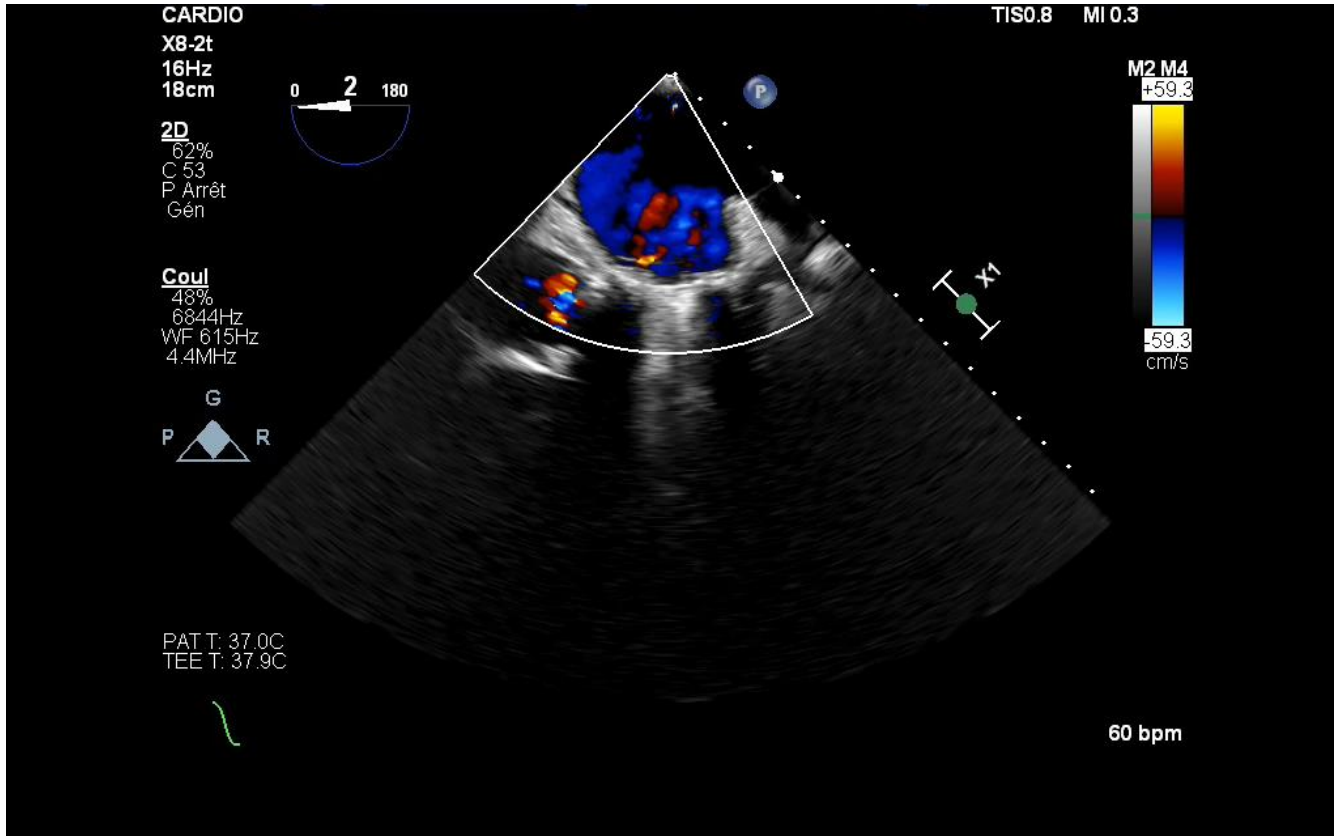


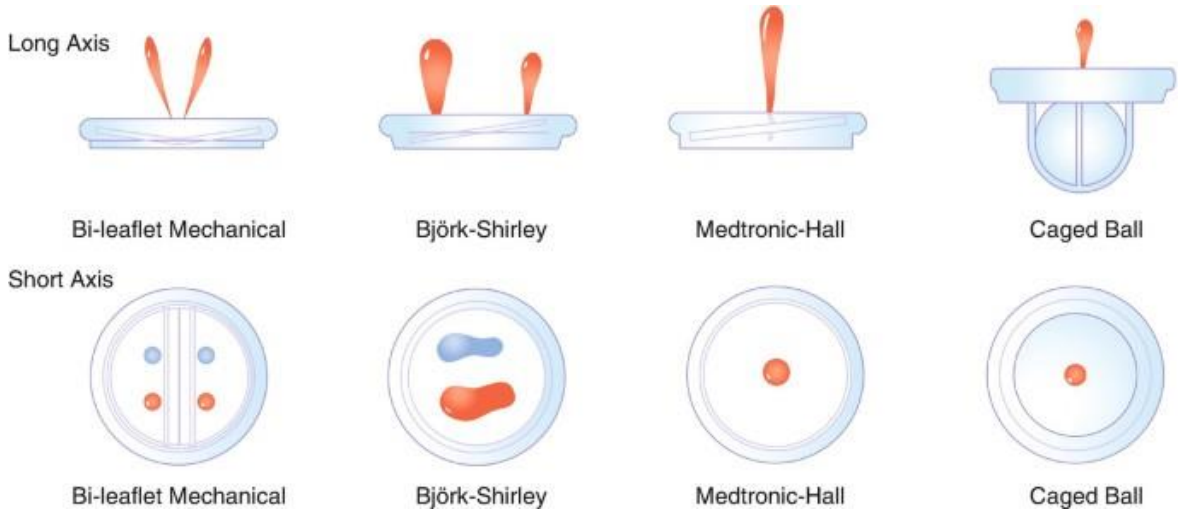
Mouvement des ailettes

Valve mécanique double ailettes

Valve mécanique double ailettes

Fuite de
« lavage »

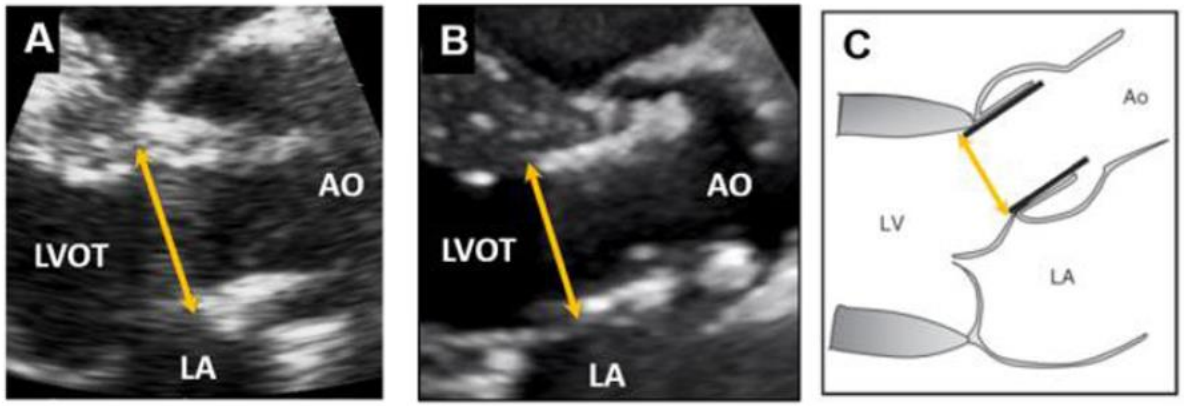




Analyse hémodynamique

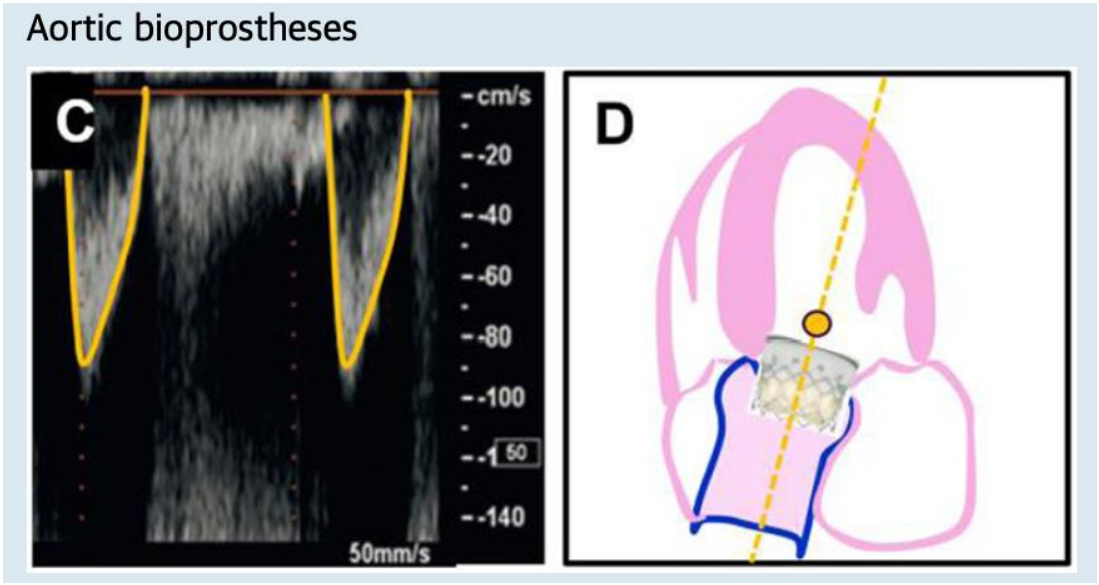
Mesure de la CCVG

Aortic bioprostheses



Externe !

Placer le curseur PW



En amont de la valve

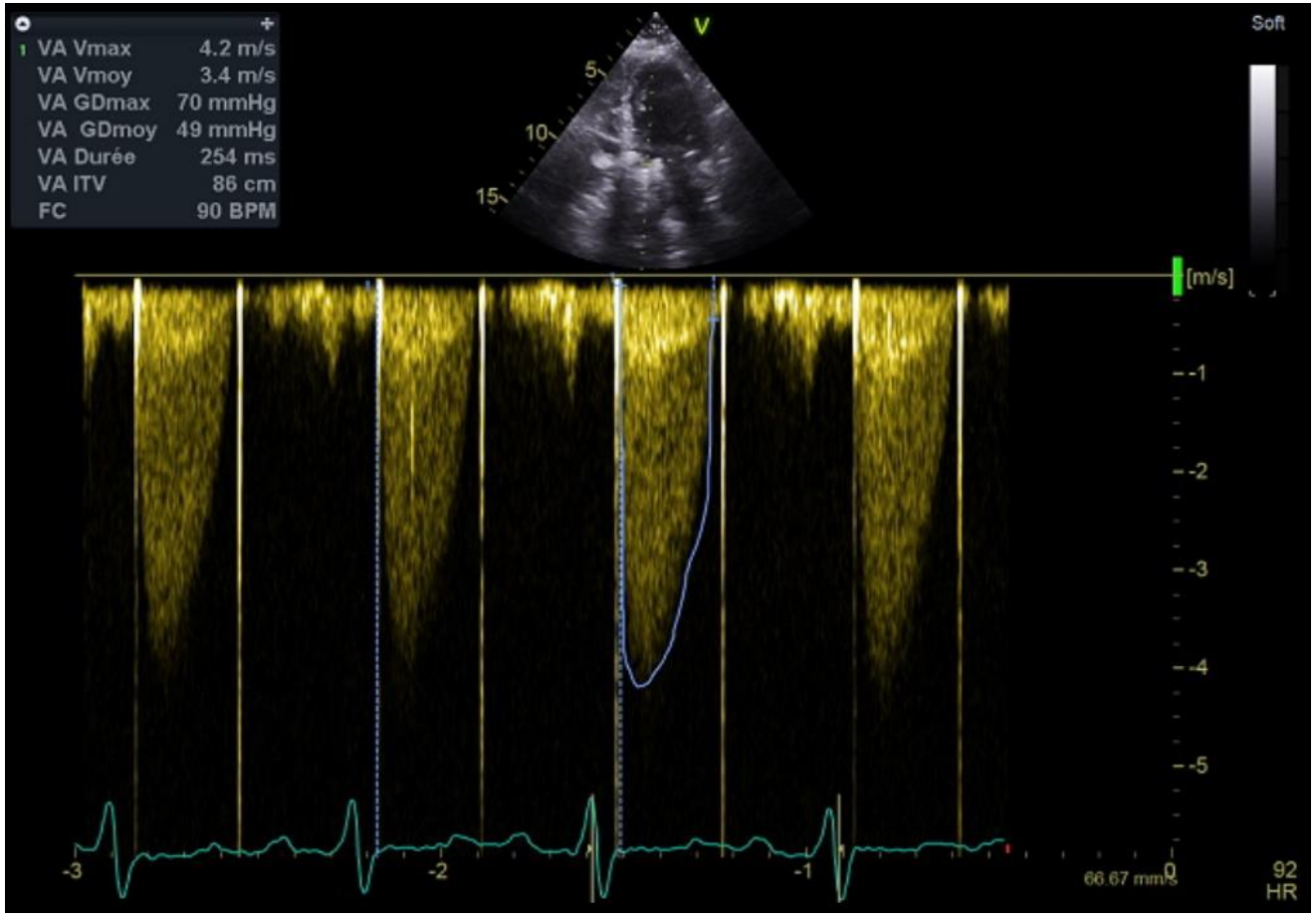
Analyse hémodynamique

Mesure du gradient moyen par doppler continu

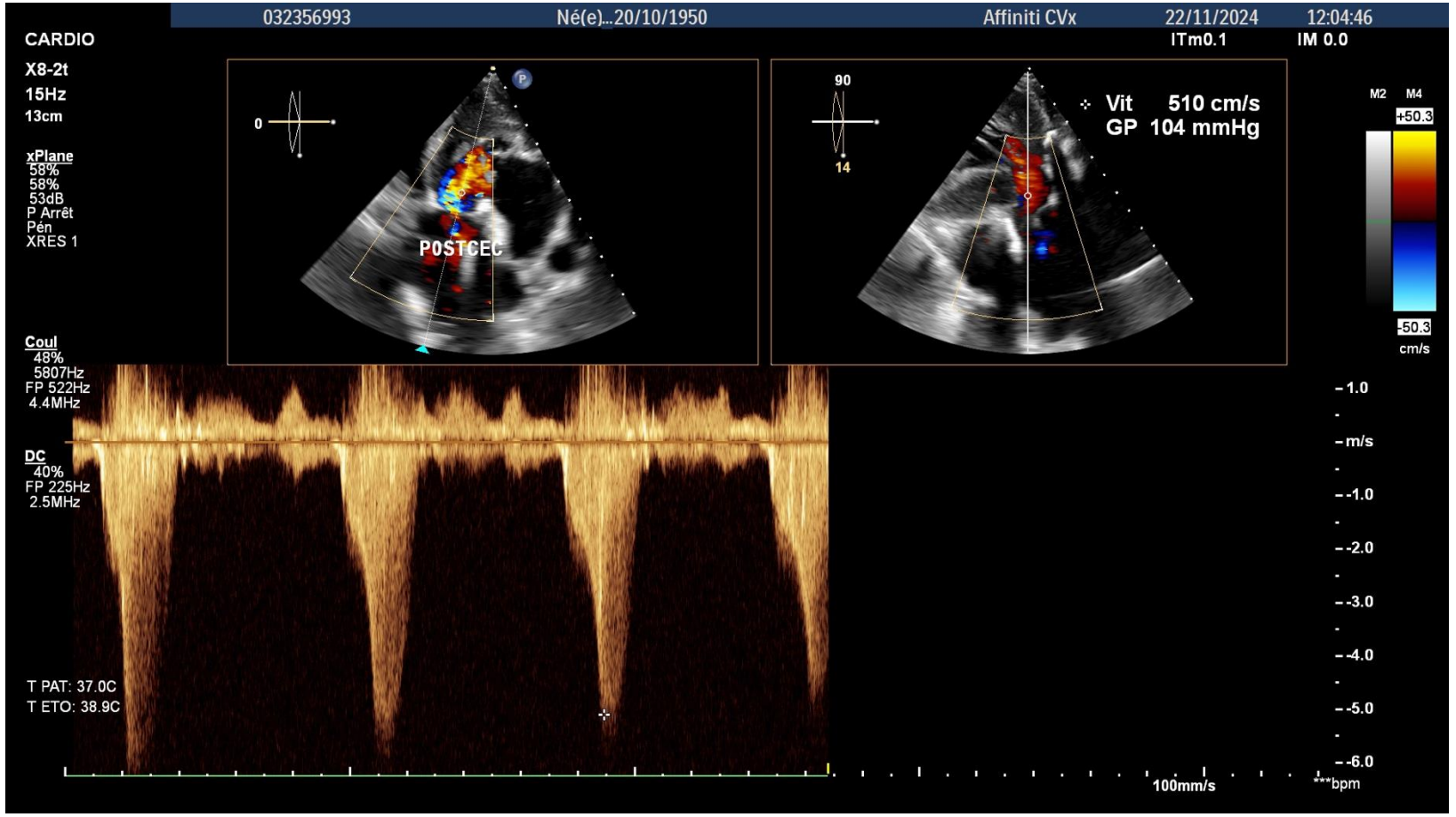
Valeurs normales

Gm < 20mmHg (Vao)

Gm < 5mmHg (VM)



Piège = Obstruction sous aortique

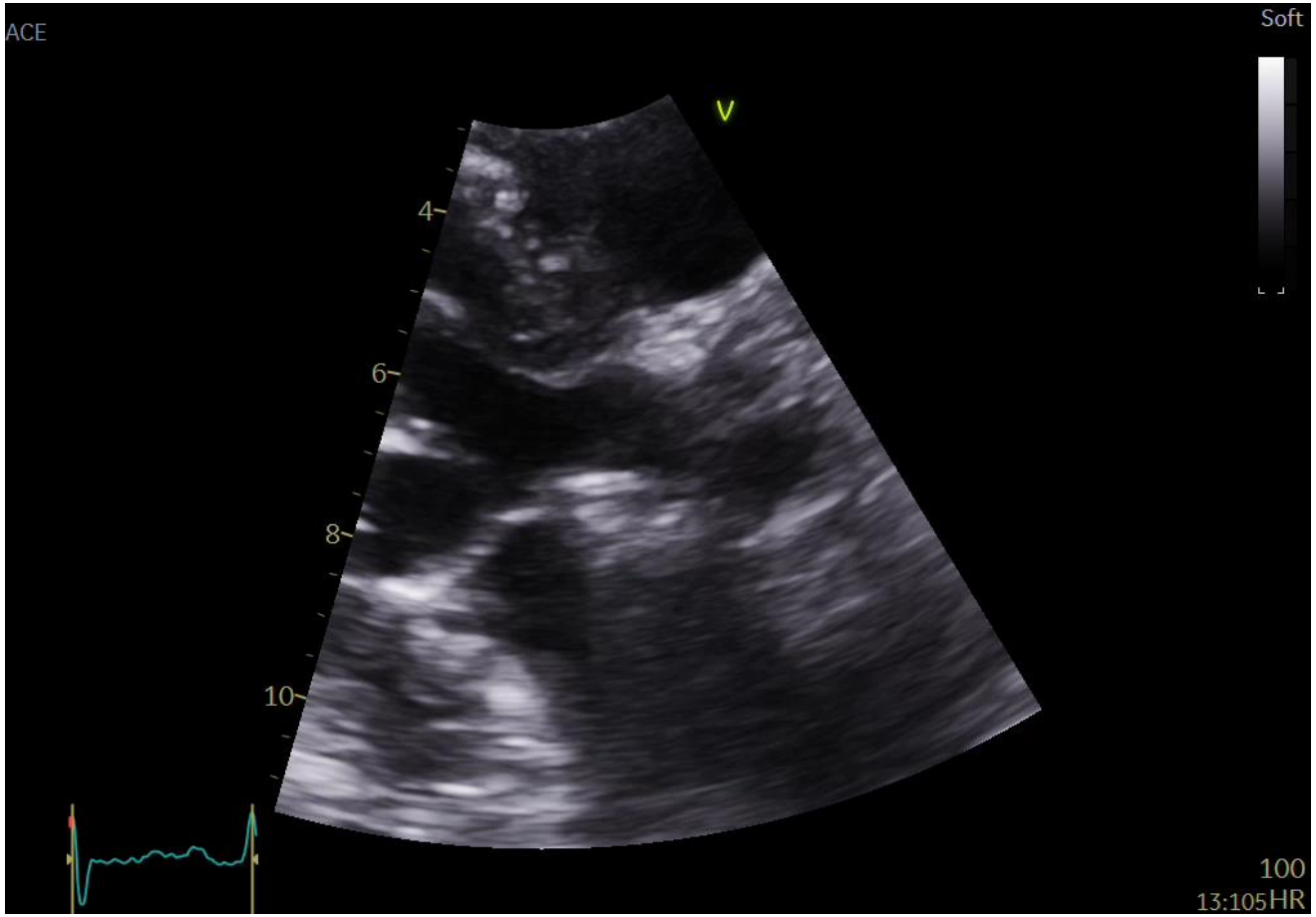


Aspect en lame de sabre

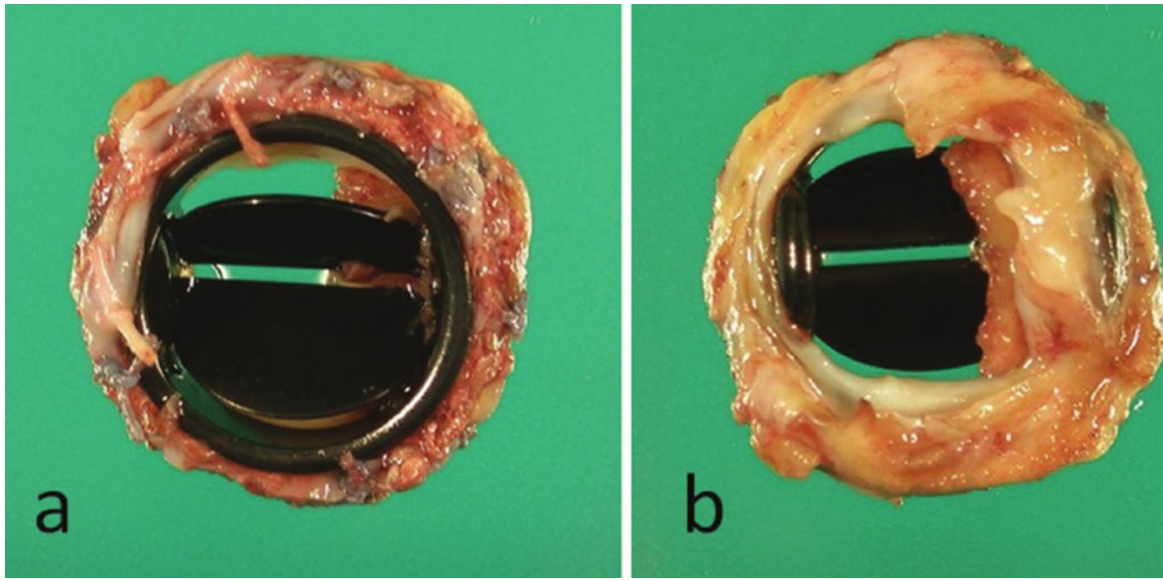
postRVAo biologique

HVG

Obstruction sous aortique



Pannus



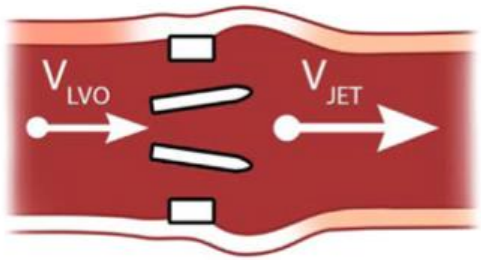
Analyse hémodynamique

Sténose ?

DVI (doppler velocity index) = index de perméabilité

Valeurs normales

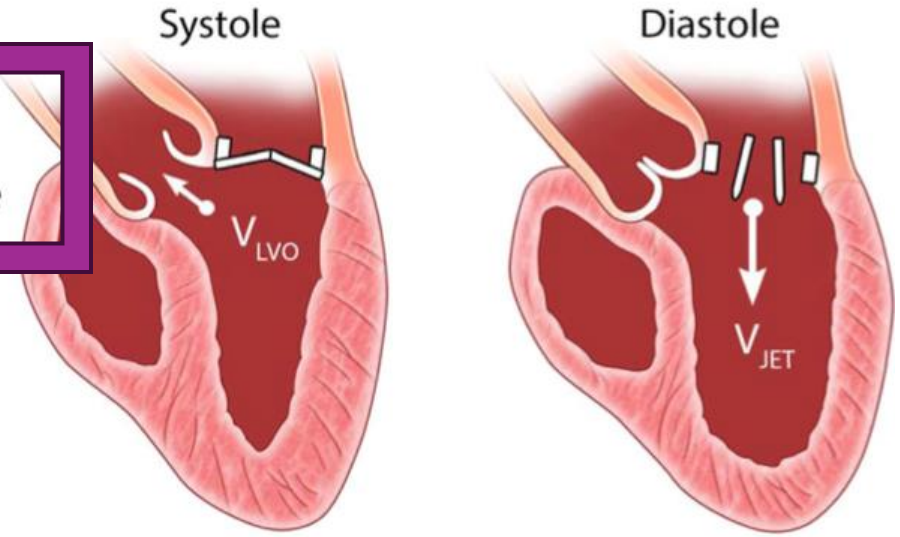
Prosthetic Aortic Valve



IP = ITVssAo (PW) / ITV Vao (CW)

N >= 0,35

Prosthetic Mitral Valve



IP = ITVMitral(CW) / ITVssAo (PW)

N<2,2

Indépendant

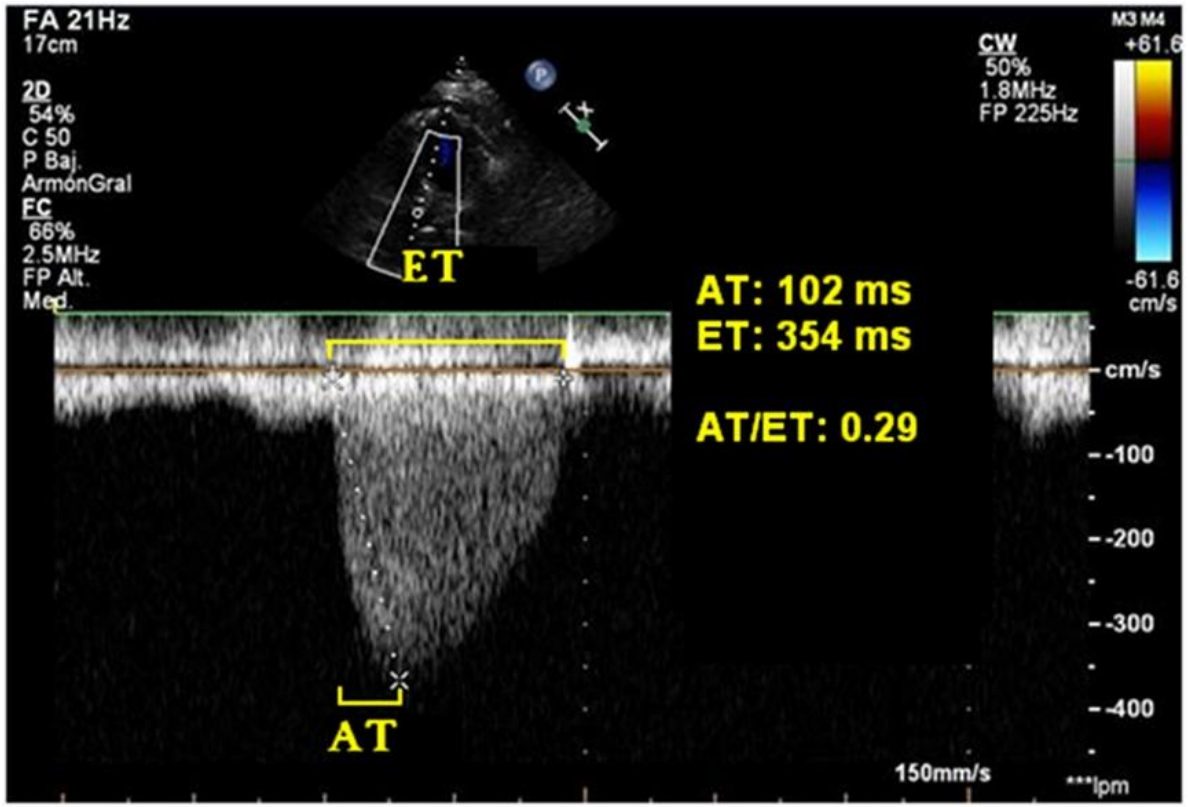
- **De la FC**
- **Du Qc**
- **Mesure CCVG**

Analyse hémodynamique

Sténose ?

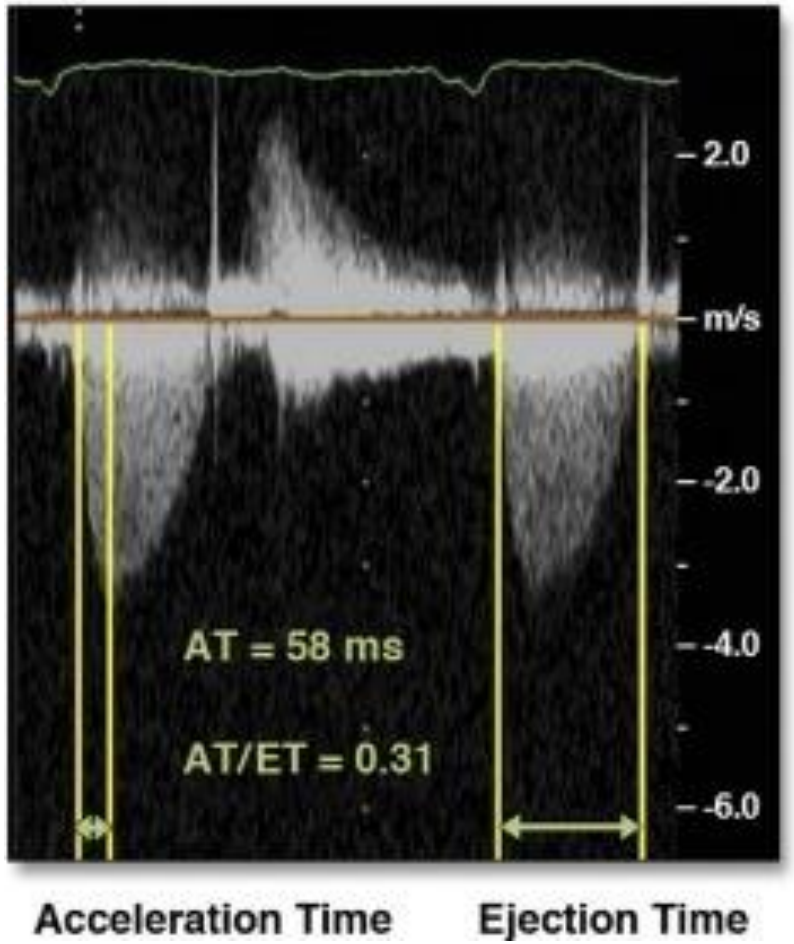
Temps d'accélération

Arrondi contours
symétriques
temps accélération long



vs

Triangulaire
Pic précoce
Temps accélération court

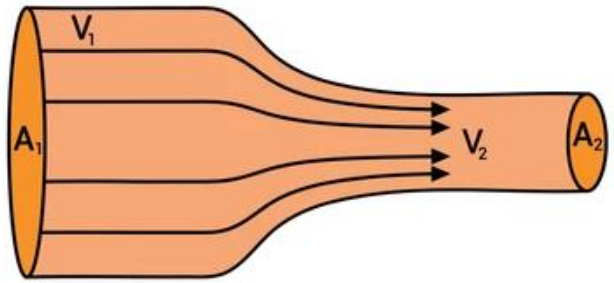


Analyse hémodynamique

Sténose ?

EOA = effective orifice area

➔ Équation de continuité



$$A_1V_1 = V_2A_2$$

EOAaortique = ITVssAo (PW) x diamètre CCVGx Pi x 0,785
ITV VAo (CW)

N>1,1cm2

EOAmitrale = ITVssAo (PW) x D CCVG xPi x 0,785
ITV mitral (CW)

N>ou= 2,2cm2

!!peu fiable Si FA ou IAo associée

Analyse hémodynamique

Sténose ?

PROTHESE AORTIQUE

- Vmax > 3m/s
- Gm >ou= 20mmHg
- EOA < 1,1cm2
- DVI<0,25
- AT > 100ms
- AT/LVET > 0,32

« RED FLAG »

PROTHESE MITRALE

- Vmax onde E > 1,9m/s
- Gm >ou = 5mmHg
- EOA < 2,0cm2
- DVI > ou = 2,2
- PHT> 130ms

Analyse hémodynamique

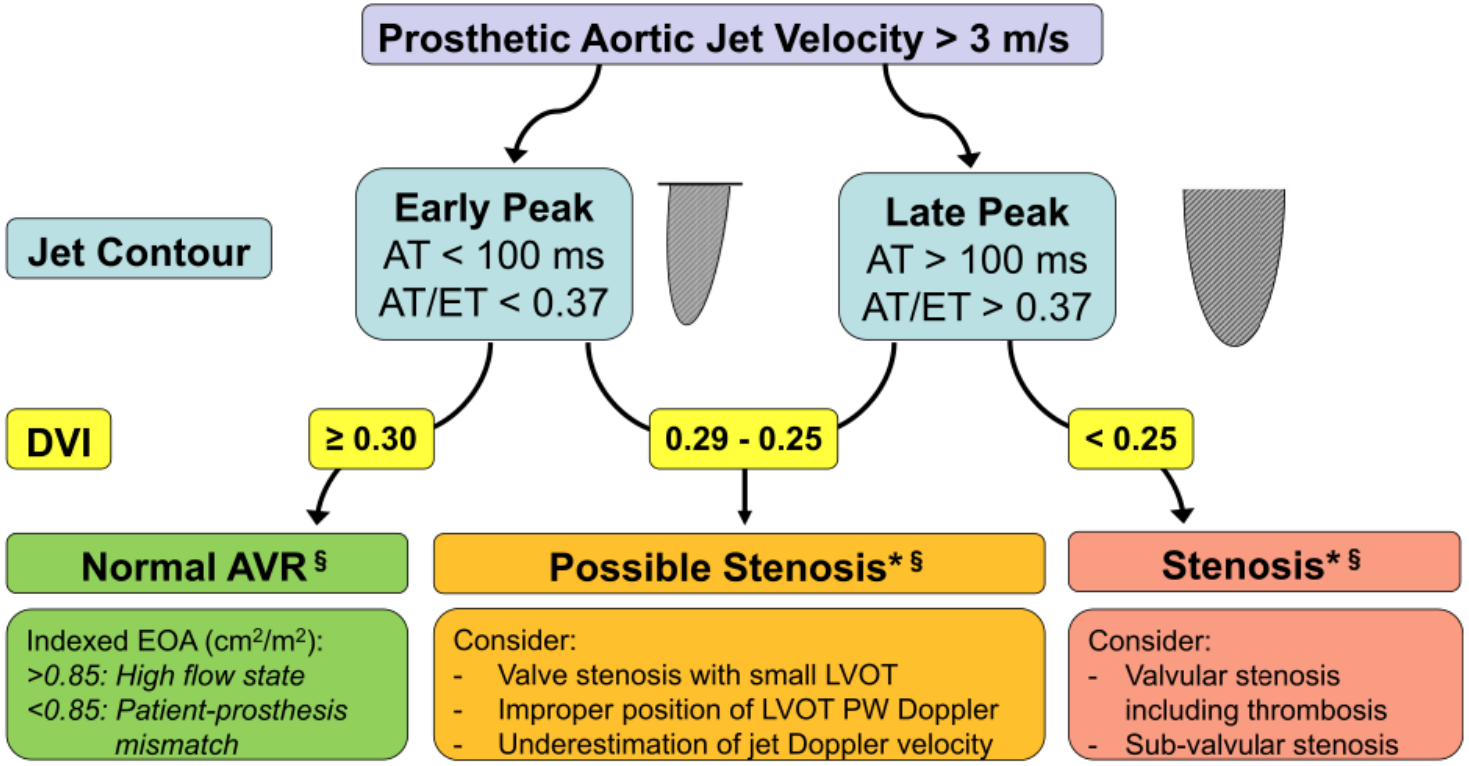
PROTHESE AORTIQUE

Table 5 Doppler parameters of prosthetic valves in the aortic valve position

	Normal	Possible stenosis	Suggests significant stenosis
Appropriate for all prosthetic aortic valves			
Jet velocity contour*	Triangular, early peaking	Triangular to intermediate	Rounded, symmetric
Acceleration time, msec*	<80	80-100	>100
Acceleration time/LV ejection time ratio	<0.32	0.32-0.37	>0.37
Peak velocity, m/sec†‡	<3	3-4	≥4
Specific AVR considerations			
SAVR			
Mean gradient, mm Hg†	<20	20-34	≥35
DVI§¶	>0.35	0.25-0.35	<0.25
EOA§	Reference EOA ± 1 SD	1 SD smaller than reference EOA	2 SDs smaller than reference EOA
TAVI (change from baseline)			
Mean gradient†	Change <10 mm Hg from baseline†	Increase of 10-19 mm Hg from baseline	Increase ≥20 mm Hg from baseline
DVI§¶	Change <0.1 or 20% from baseline‖	Decrease 0.1-0.19 or 20%-39% from baseline‖	Decrease ≥0.2 or ≥40% from baseline‖
EOA§	Change <0.3 cm^2 or 25% from baseline‖	Decrease of 0.3-0.59 cm^2 or 25%-49% from baseline‖	Decrease ≥0.6 cm^2 or ≥50% from baseline‖

Analyse hémodynamique

PROTHESE AORTIQUE



*	Valve stenosis is further substantiated by EOA compared to respective reference values of similar valve type and size.
§	Assessment of mechanical valve motion: fluroscopy & CT > TEE; Etiology of Valve stenosis: CT angiography & TEE > CMR.

Analyse hémodynamique

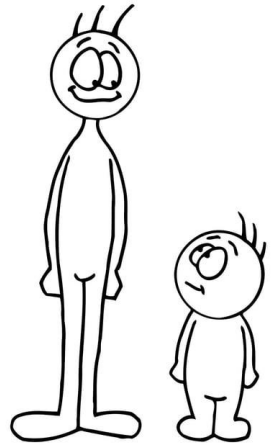
PROTHESE MITRALE

Table 11 Doppler findings suggestive of prosthetic mitral valve stenosis

	Normal*	Possible stenosis†	Suggests significant stenosis*†
Peak velocity, m/sec‡§	<1.9	1.9-2.5	≥2.5
Mean gradient, mm Hg‡§	≤5	6-10	>10
VTI_{PrMv}/VTI_{LVOT}‡§	<2.2	2.2-2.5	>2.5
EOA, cm^2	≥2.0	1-2	<1
PHT, msec	<130	130-200	>200
	fuite		*Obstruction*

!! Aussi présent en cas de fuite

PPM = mismatch patient/prothèse



- Étape 1 : SC du patient

- Etape 2 **: x 0,85cm2/m2** (aortique) **x1,2cm2/m2** (mitrale)

aortique

AORTIQUE

If BMI <30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	>0.85
Moderate	0.85-0.66
Severe	≤0.65

If BMI ≥30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	>0.70
Moderate	0.70-0.56
Severe	≤0.55

MITRALE

If BMI <30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	>1.2
Moderate	0.91-1.2
Severe	≤0.90

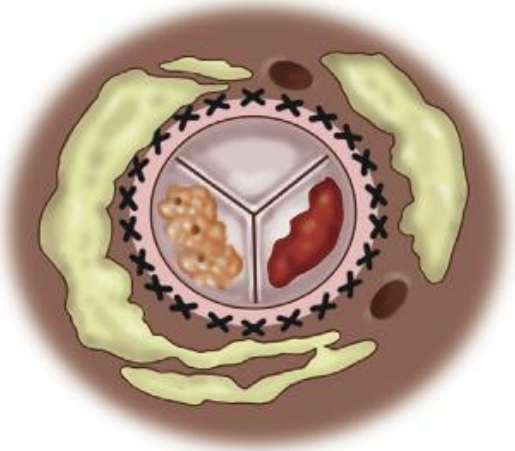
If BMI ≥30 kg/m²

Severity	Indexed EOA (cm²/m²)
Insignificant	>1.0
Moderate	0.76-1.0
Severe	≤0.75

!!! Attention différent chez le patient obèse

	EOAi by Prosthesis size (mm)					
Prosthesis size (mm)	**19**	**21**	**23**	**25**	**27**	**29**
Average EOA (cm²)	1.1	1.3	1.5	1.8	2.3	2.7
BSA (m²)						
0.6	1.83	2.17	2.50	3.00	3.83	4.50
0.7	1.57	1.86	2.14	2.57	3.29	3.86
0.8	1.38	1.63	1.88	2.25	2.88	3.38
0.9	1.22	1.44	1.67	2.00	2.56	3.00
1	1.10	1.30	1.50	1.80	2.30	2.70
1.1	1.00	1.18	1.36	1.64	2.09	2.45
1.2	0.92	1.08	1.25	1.50	1.92	2.25
1.3	0.85	1.00	1.15	1.38	1.77	2.08
1.4	0.79	0.93	1.07	1.29	1.64	1.93
1.5	0.73	0.87	1.00	1.20	1.53	1.80
1.6	0.49	0.88	0.88	0.88	0.88	1.69
1.7	0.65	0.76	0.88	1.06	1.35	1.59
1.8	0.61	0.72	0.83	1.00	1.28	1.50
1.9	0.58	0.68	0.79	0.95	1.21	1.42
2	0.55	0.65	0.75	0.90	1.15	1.35
2.1	0.52	0.62	0.71	0.86	1.10	1.29
2.2	0.50	0.59	0.68	0.82	1.05	1.23
2.3	0.48	0.57	0.65	0.78	1.00	1.17
2.4	0.46	0.54	0.63	0.75	0.96	1.13
2.5	0.44	0.52	0.60	0.72	0.92	1.08

Dysfonction de prothèses



Structurelles

- Concerne les bioprothèses +++

Non structurelles

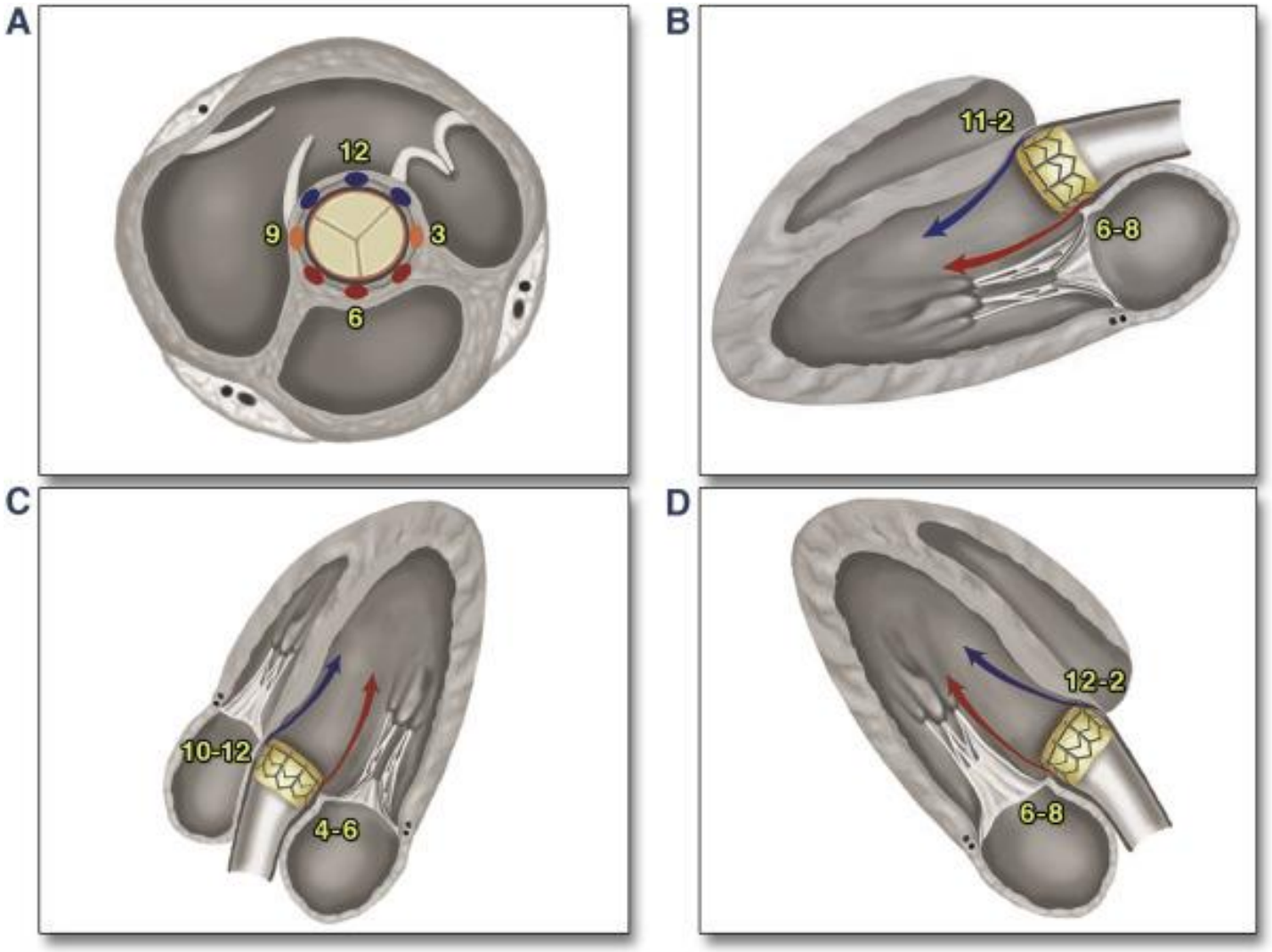
- Mismatch de prothèse (PPM)
- Fuite périprothétiques
- Autres
  - Feuillet attaché
  - Pannus
  - Malposition
  - Dilatation secondaire des cavités cardiaques

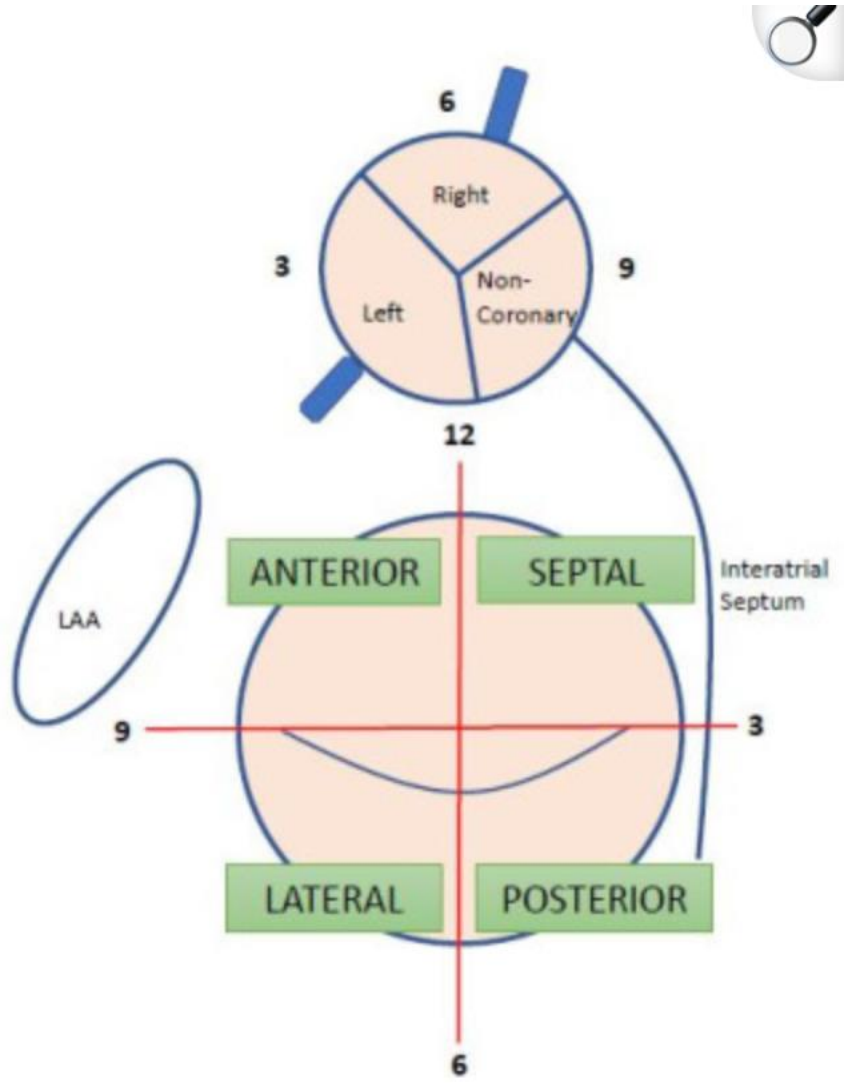
endocardite

thrombus

- Concerne les valves mécaniques +++

Régurgitations



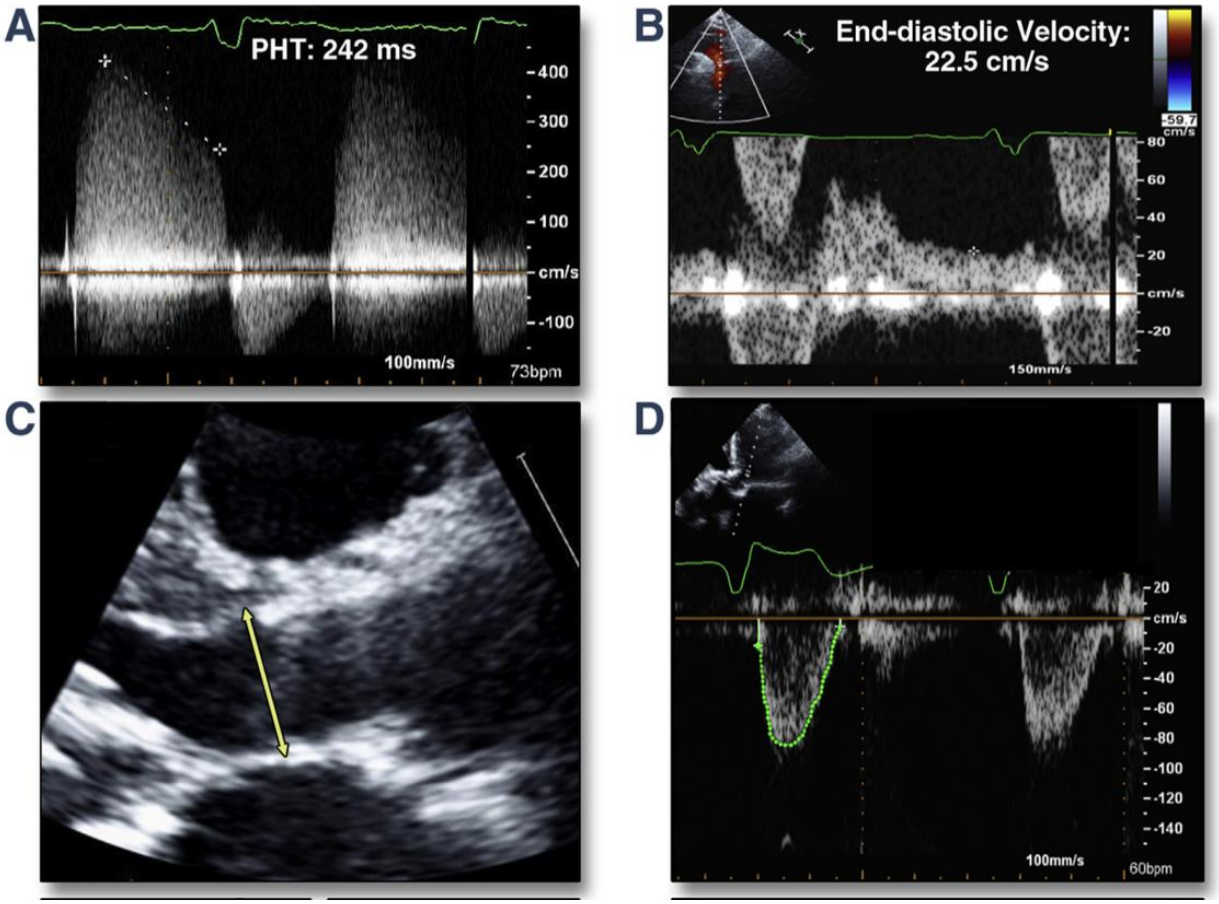


Assessment of Paravalvular Regurgitation Following TAVR, JACC 2015

Régurgitations

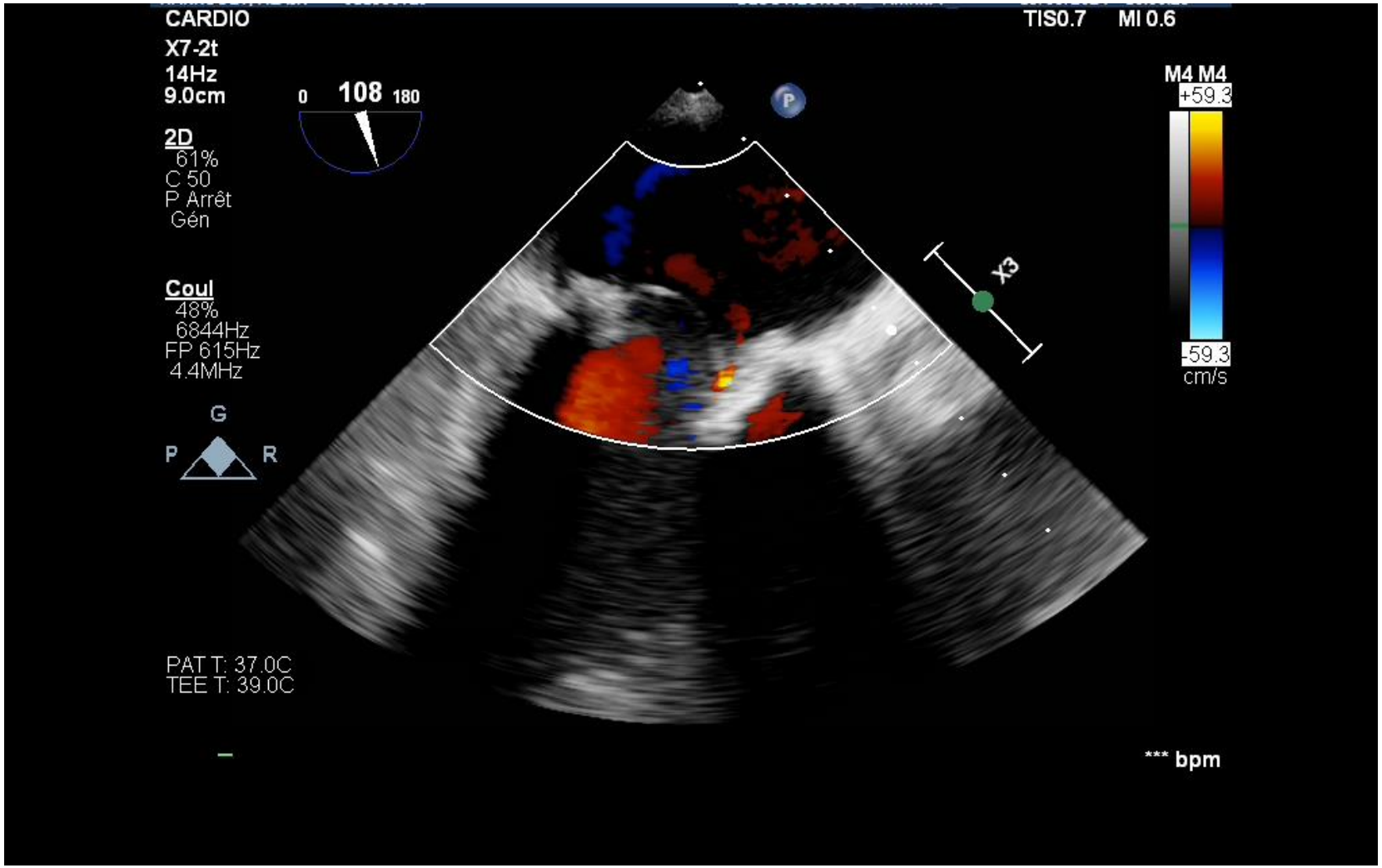
Prothèse valvulaire aortique

PHT < 200ms



Vitesse télédiastolique aorte descendante > 20cm/s

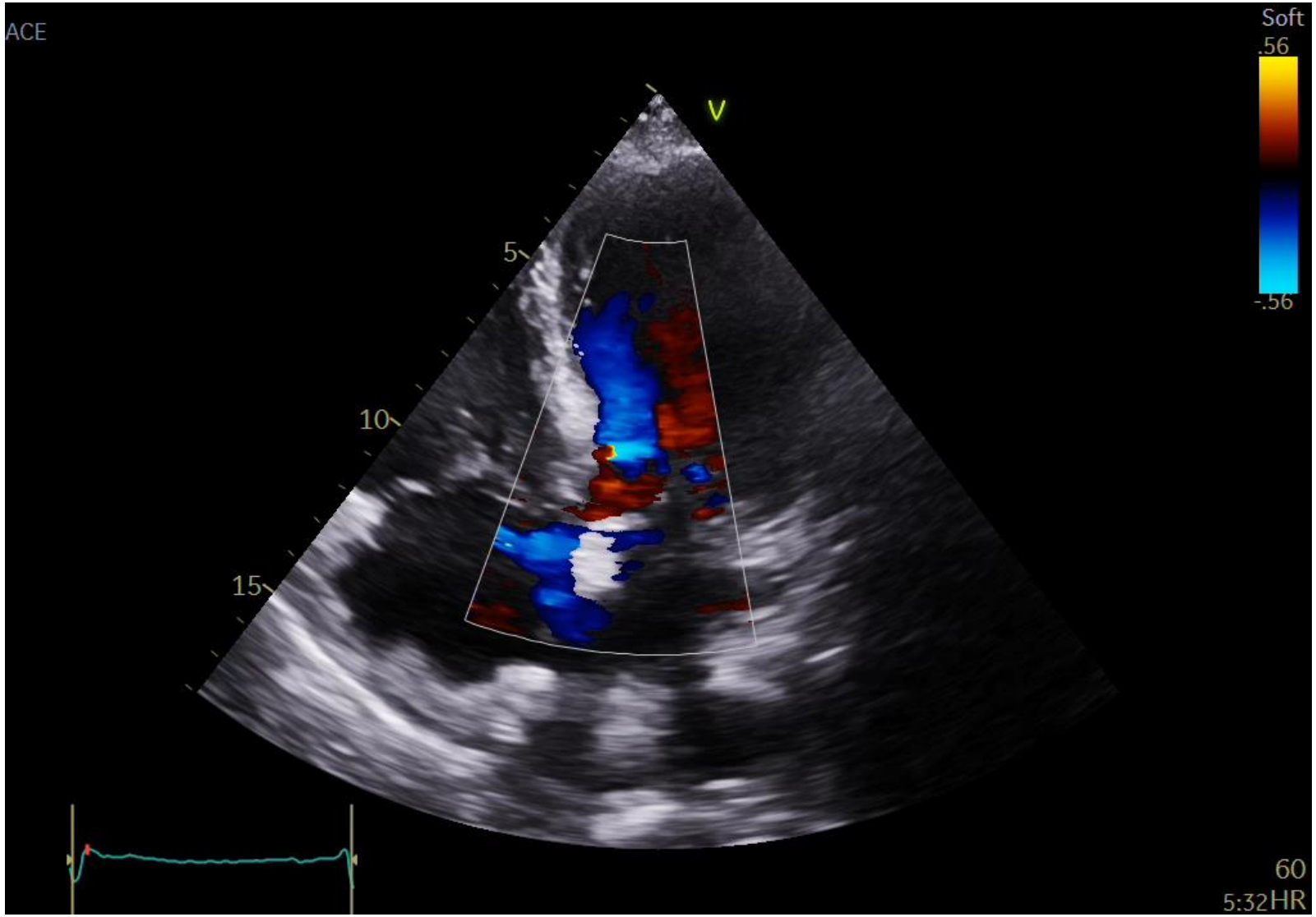
Fuite intraprothétique



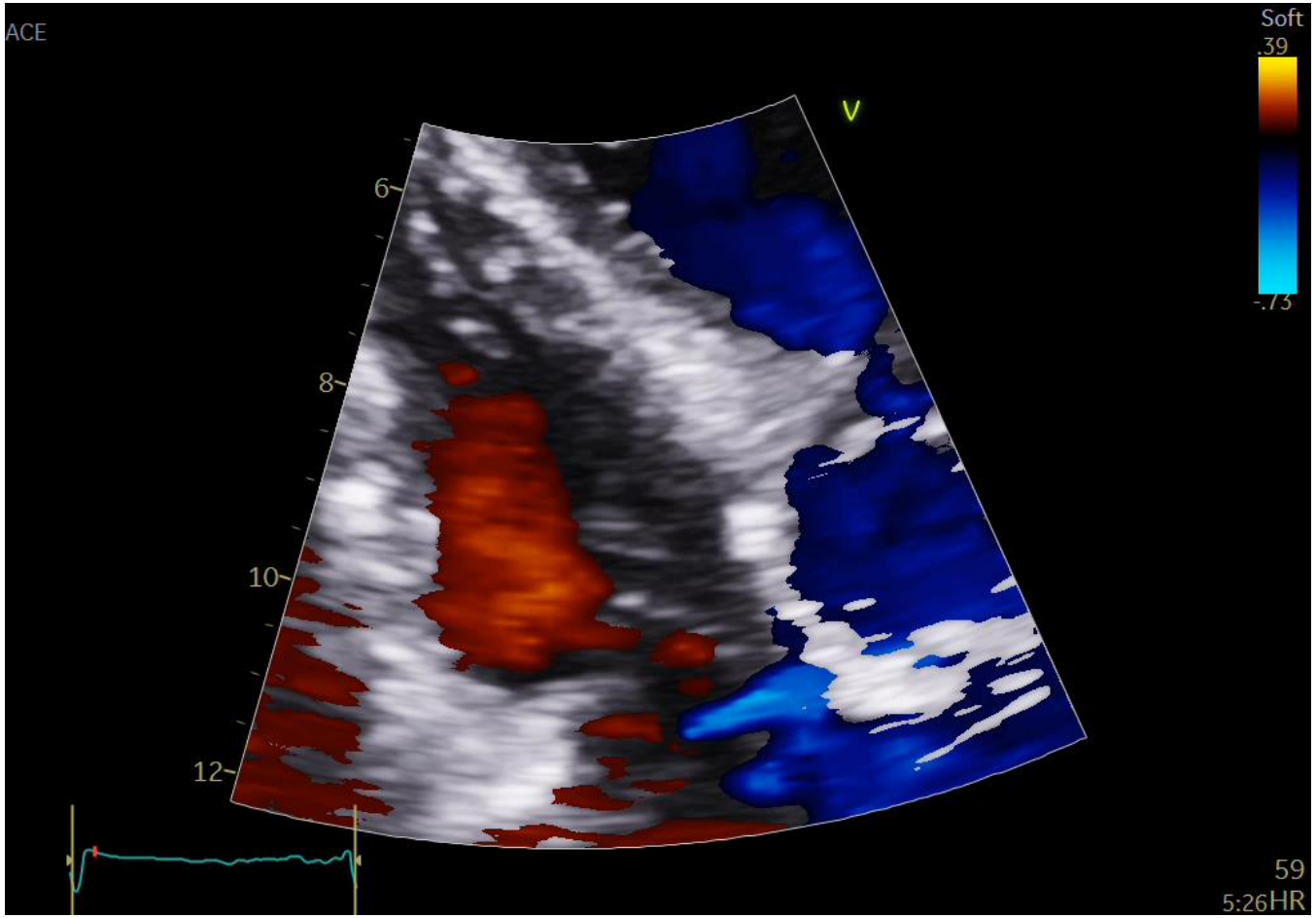
Petite taille
Vmax < 1,5m/s

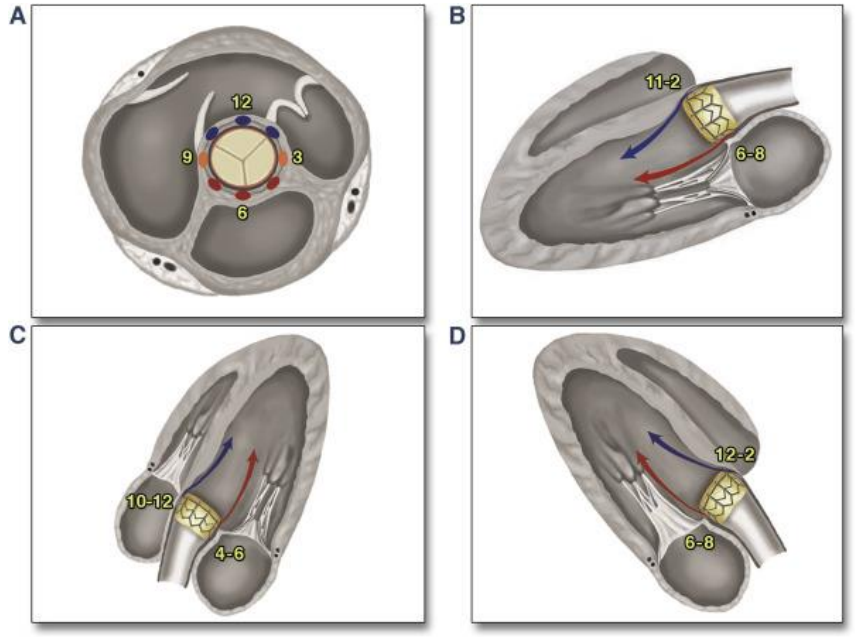
Plutôt central

Fuite périprothétique

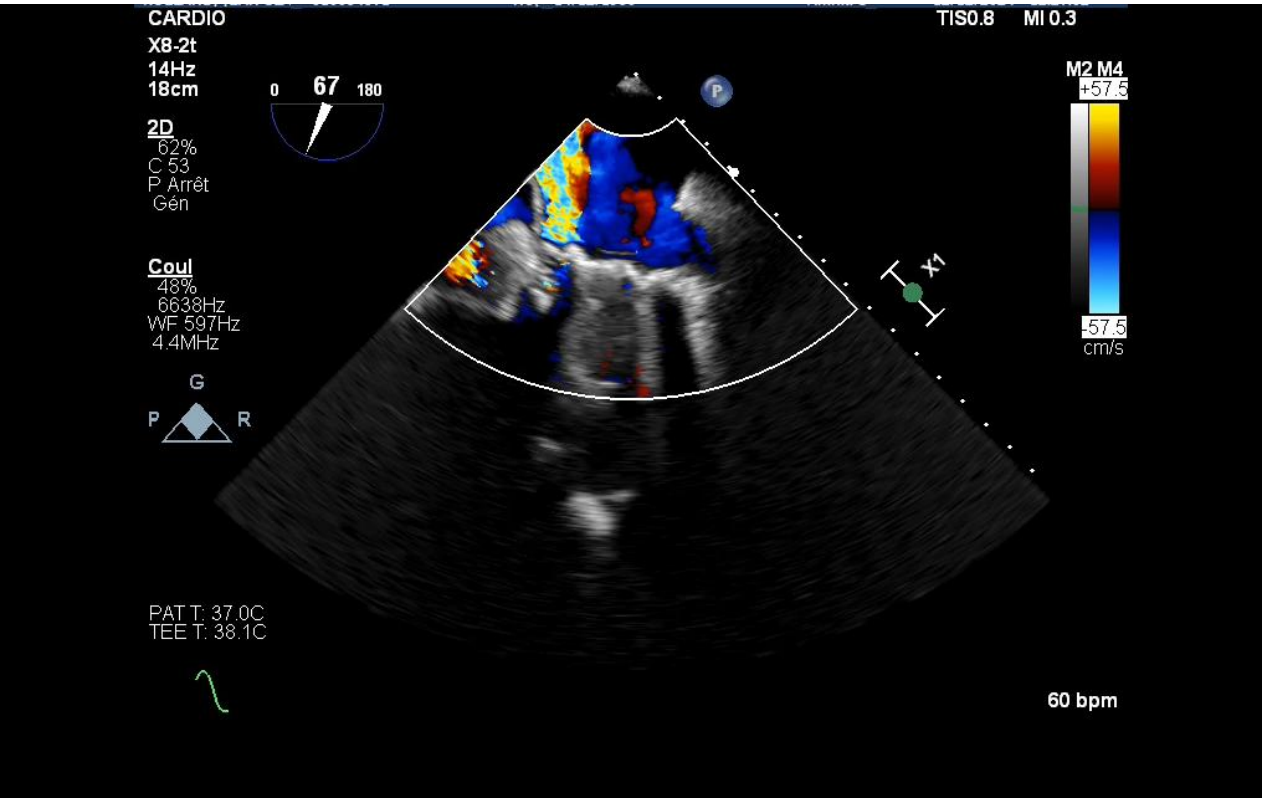


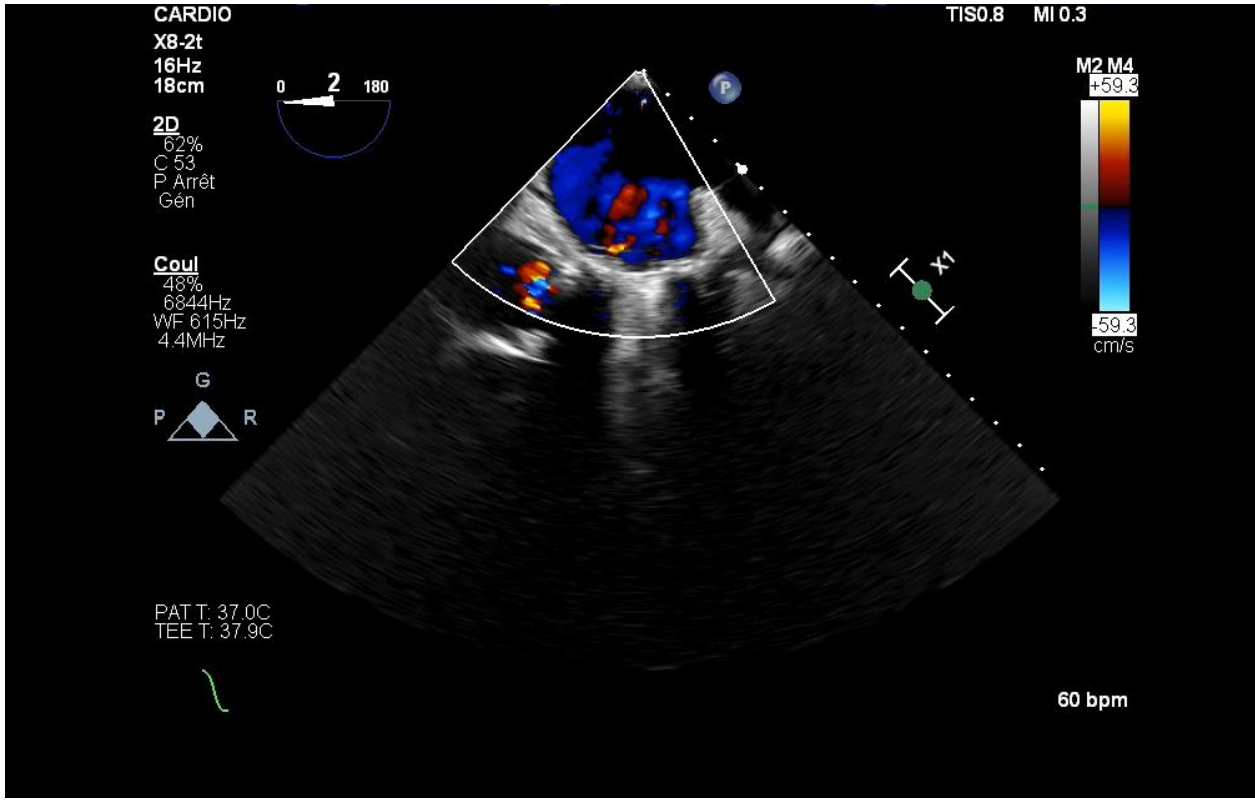
Fuite périprothétique





Fuite périprothétique





Régurgitations

PROTHESE AORTIQUE

Table 8 Parameters for evaluation of the severity of prosthetic aortic valve regurgitation

Parameters	Mild	Moderate	Severe
Valve structure and motion			
Mechanical or bioprosthetic	Usually normal	Abnormal*	Abnormal*
Structural parameters			
LV size	Normal†	Normal or mildly dilated†	Dilated†
Doppler parameters (qualitative or semiquantitative)			
Jet width in central jets, % LVOT diameter, (CD)‡	Narrow (≤25%)	Intermediate (26%-64%)	Large (≥65%)
VC width, cm (CD)	<0.3	0.3-0.6	>0.6
VC area, cm^2 (2D/3D CD)§	<0.10	0.10-0.29	≥0.30
Circumferential extent of PVL, % (CD)¶‖	<10	10-29	≥30
Jet density (CW)	Incomplete or faint	Dense	Dense
Jet deceleration rate (PHT), msec (CW)#	Slow (>500)	Variable (200-500)	Steep (<200)
Diastolic flow reversal in the descending aorta (PW)	Absent or brief early diastolic	Intermediate	Prominent, holodiastolic
Doppler parameters (quantitative)			
Regurgitant volume, mL/beat	<30	30-59	≥60
Regurgitant fraction, %	<30	30-50	≥50

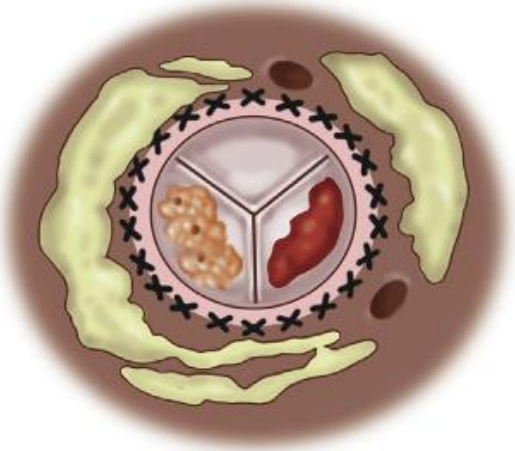
Régurgitations

PROTHESE MITRALE

Table 13 Echocardiographic criteria for severity of prosthetic mitral valve regurgitation using findings from TTE and TEE

	Mild	Moderate	Severe
Structural parameters			
LV size	Normal*	Normal or dilated	Usually dilated†
Prosthetic valve‡	Usually normal	Abnormal§	Abnormal§
Doppler parameters			
Color flow jet area‡¶	Small, central jet (usually <4 cm^2 or <20% of LA area)	Variable	Large central jet (usually >8 cm^2 or >50% of LA area) or variable size wall-impinging jet swirling in left atrium
Flow convergence‖	None or minimal	Intermediate	Large
Jet density (CW)‡	Incomplete or faint	Dense	Dense
Jet contour (CW)‡	Parabolic	Usually parabolic	Early peaking: triangular
Pulmonary venous flow‡	Systolic dominance#	Systolic blunting#	Systolic flow reversal**
Quantitative parameters††			
VC width (cm)‡	<0.3	0.3-0.69	≥0.7
RVol, mL/beat	<30	30-59‡‡	≥60‡‡
RF, %	<30	30-49	≥50
EROA, cm^2	<0.20	0.20-0.39	≥0.40

Dysfonction de prothèses



Structurelles

- Concerne les bioprothèses +++

Non structurelles

- Mismatch de prothèse (PPM)
- Fuite périprothétiques
- Autres
  - Feuillet attaché
  - Pannus
  - Malposition
  - Dilatation secondaire des cavités cardiaques

endocardite

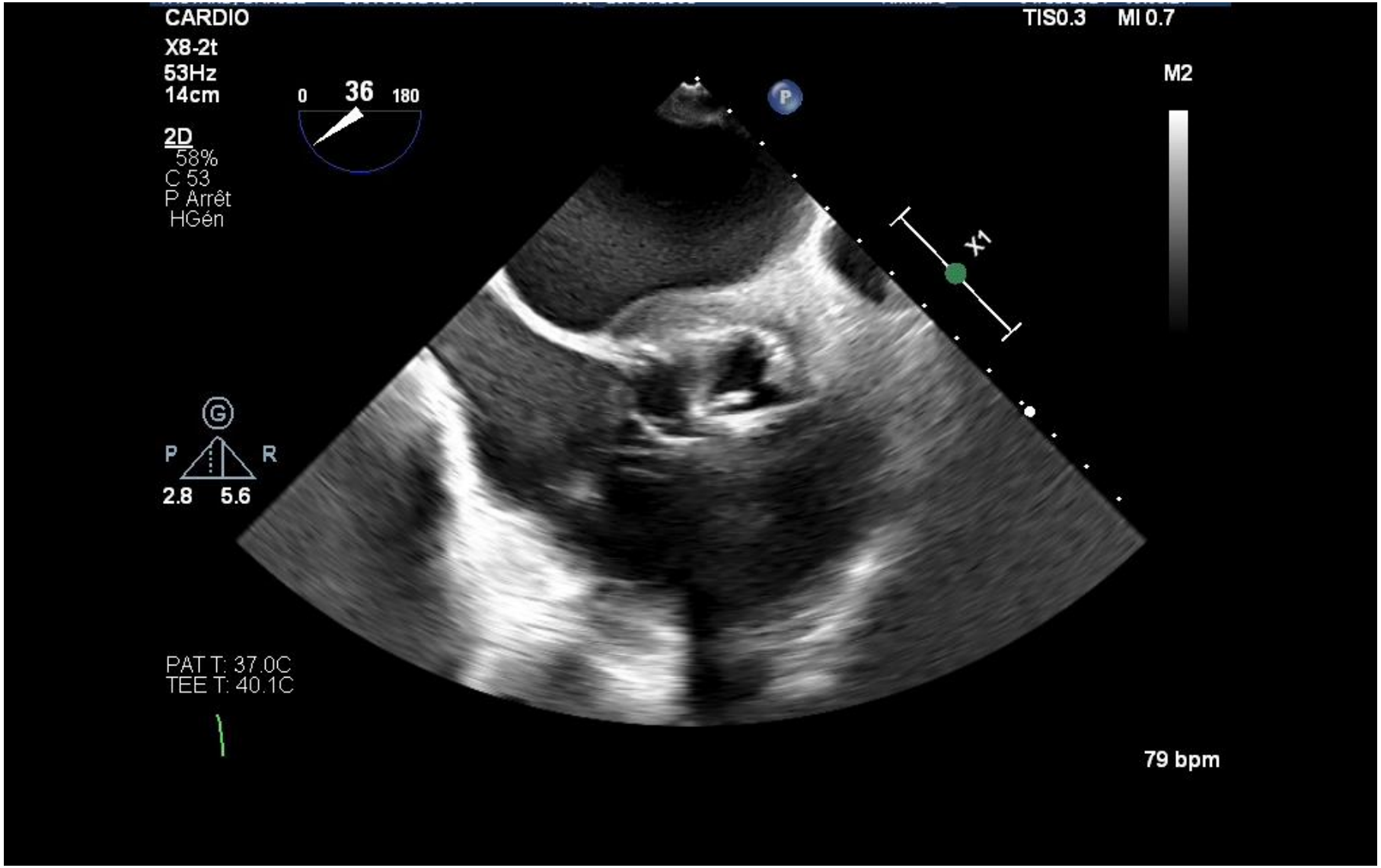
thrombus

- Concerne les valves mécaniques +++

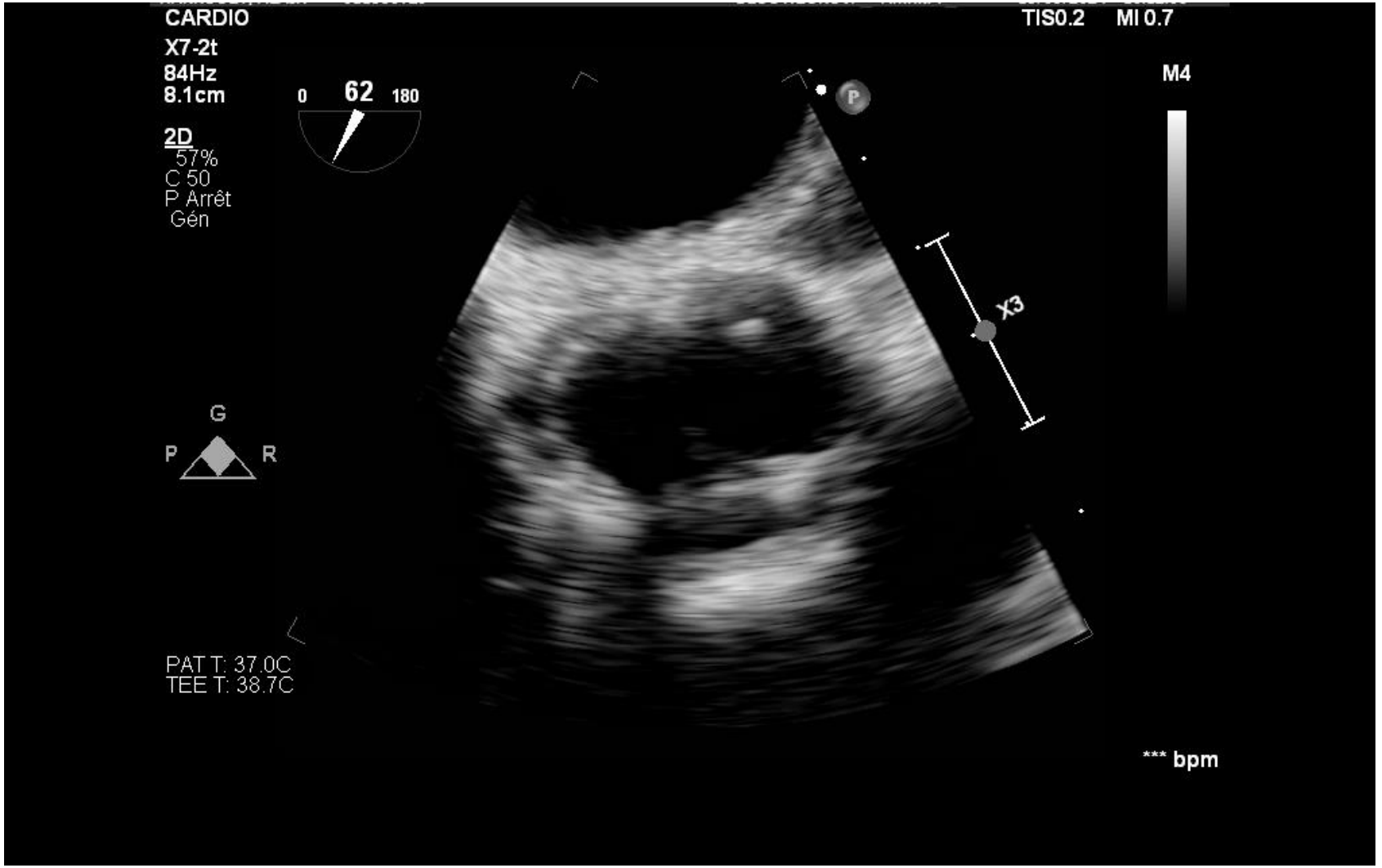
Endocardite

- Prévalence 1 à 6%
- 70% d abcès periprothtétique (plus rare pour une valve native)
- Abcès / Pseudoanévrisme (7 à 25% des cas) / Fistule
- Plus rarement végétations seule appendue

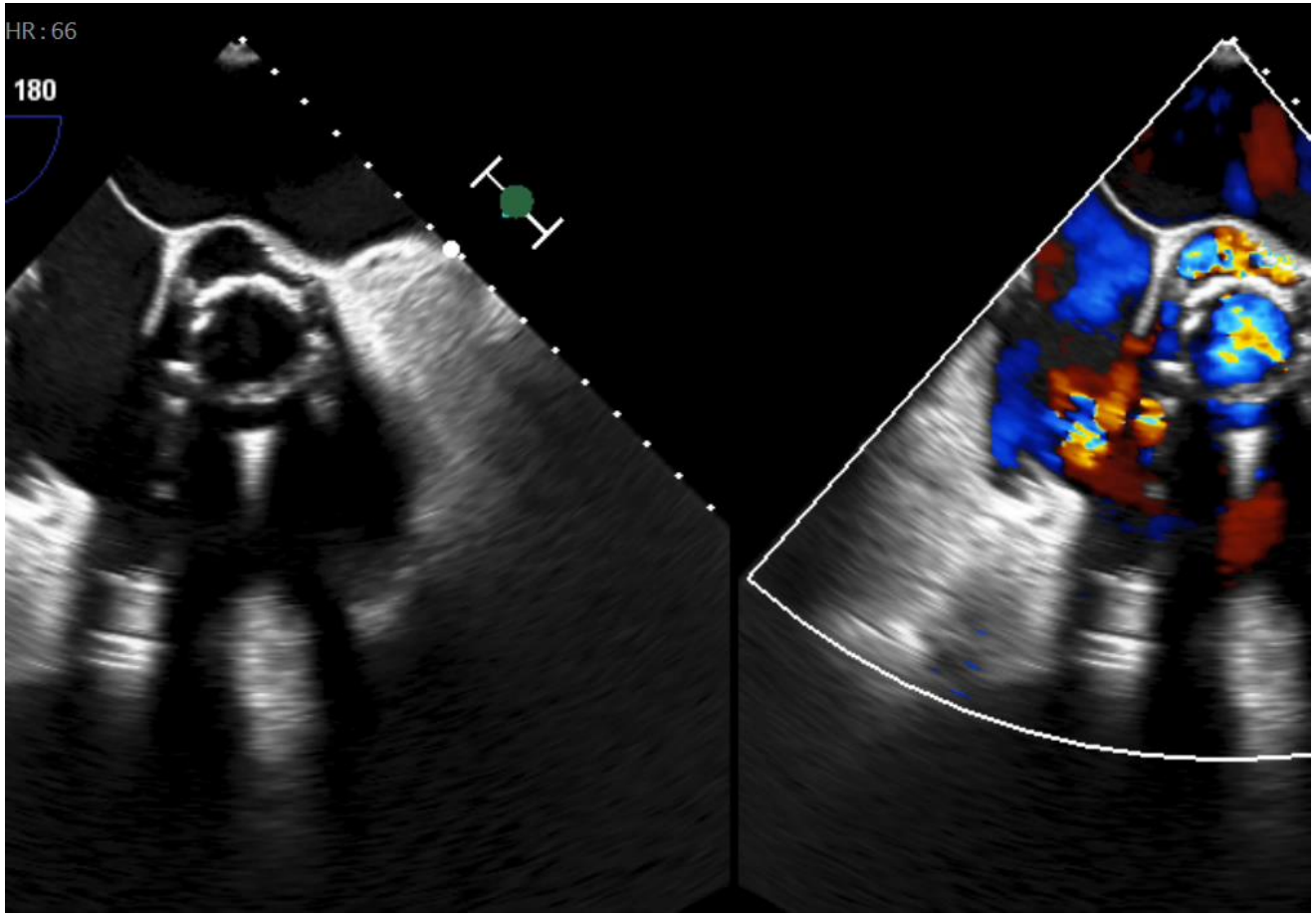
Abcès


CARDIO
X8-2t
53Hz
14cm
2D
58%
C 53
P Arrêt
HGén
0
36
180
TIS0.3
MI 0.7
M2
X1
G
P
R
2.8
5.6
PAT T: 37.0C
TEE T: 40.1C
79 bpm

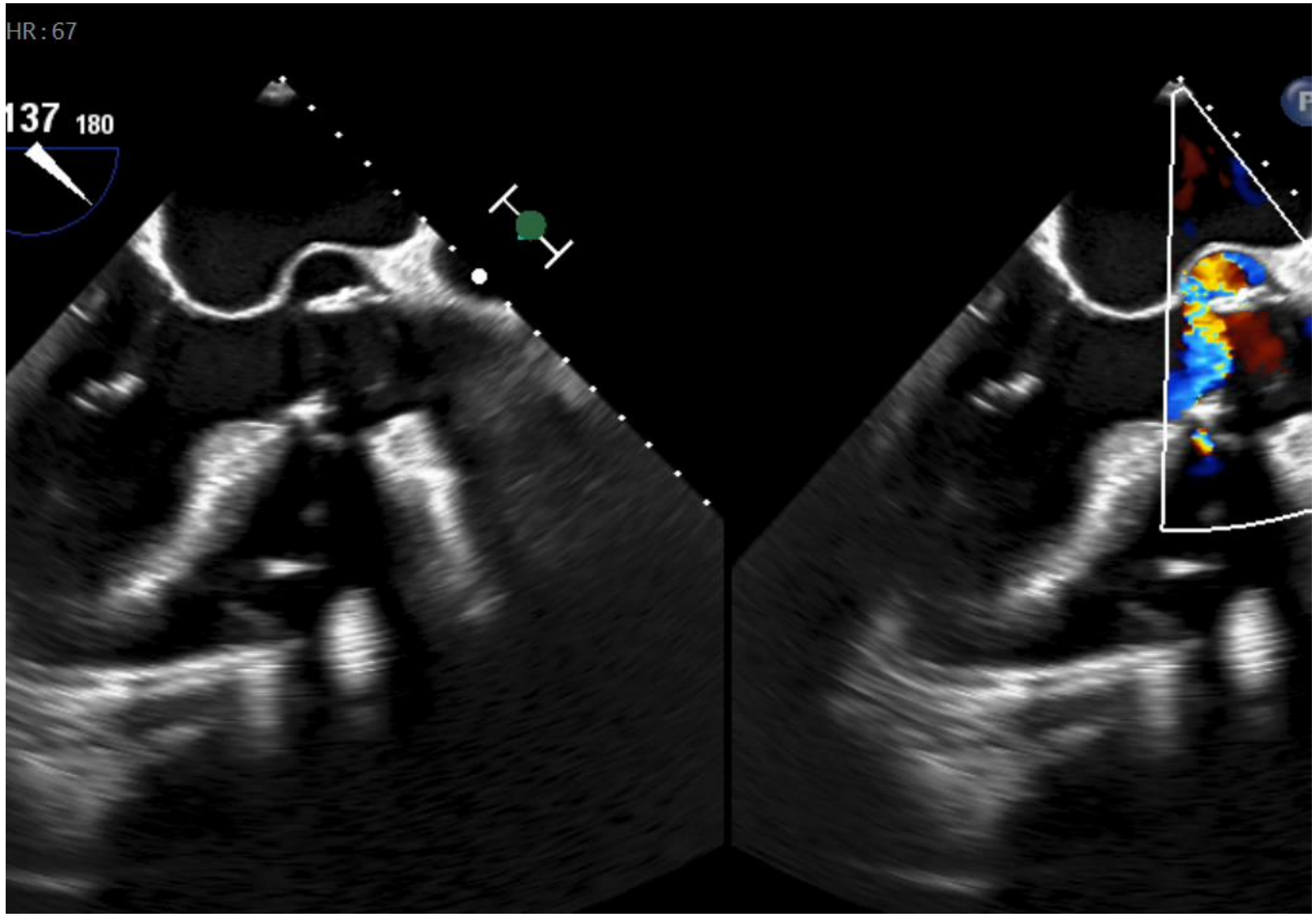
Abcès


CARDIO
X7-2t
84Hz
8.1cm
2D
57%
C 50
P Arrêt
Gén
0
62
180
TIS0.2
MI 0.7
M4
X3
G
P
R
PAT T: 37.0C
TEE T: 38.7C
*** bpm

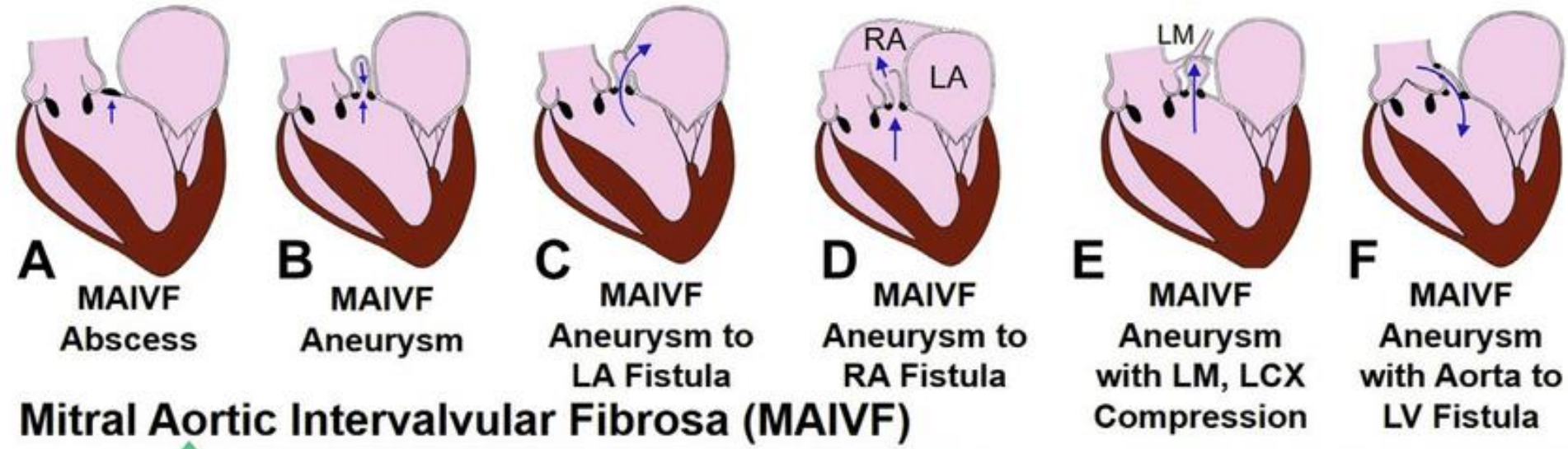
Fistule ou pseudoanévrisme ?



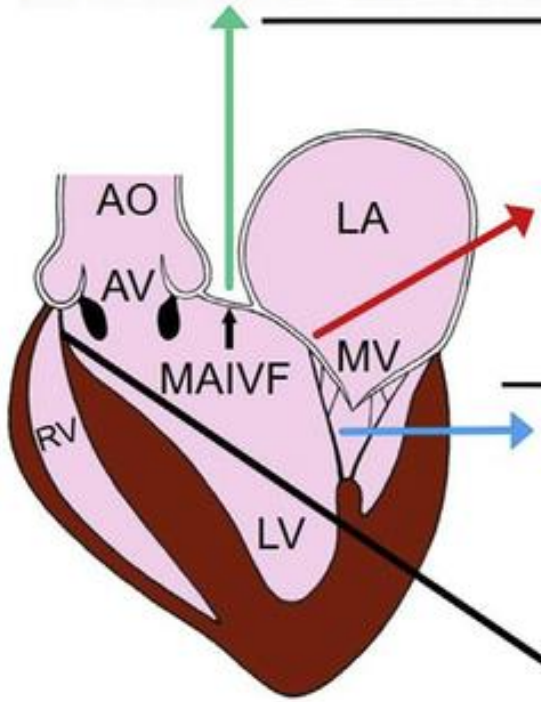
Fistule



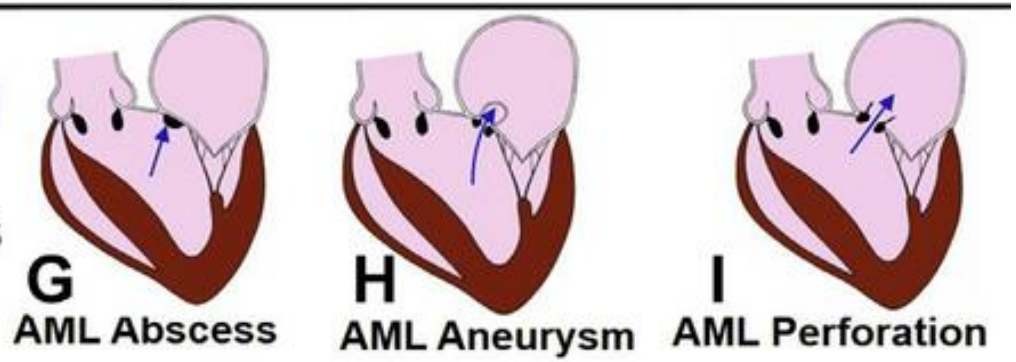
AV Endocarditis: Sub-aortic Complications



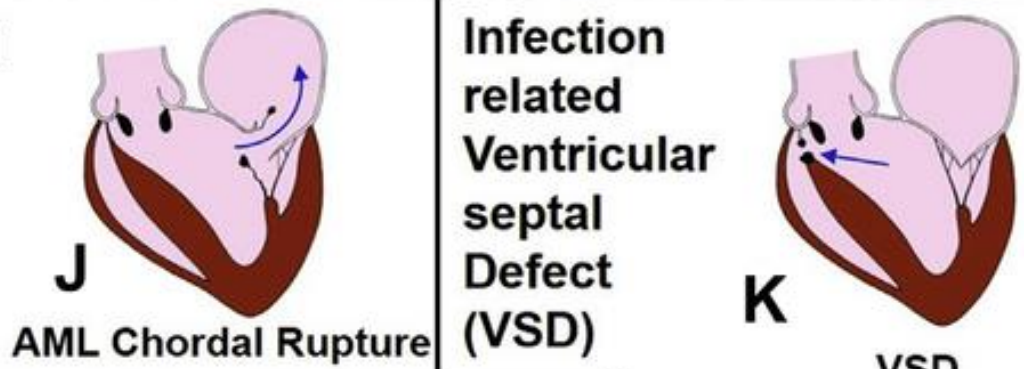
Mitral Aortic Intervalvular Fibrosa (MAIVF)



Anterior Mitral Leaflet (AML) Complications



AML Chordal Rupture



Infection related Ventricular septal Defect (VSD)

Conclusions

- Bien connaitre les types de prothèses (littérature+++)
- Plusieurs types « dysfonctions » associées
- Endocardite +++
- Diagnostic parfois difficile, en cas de doute ➔ AVIS cardiologue++