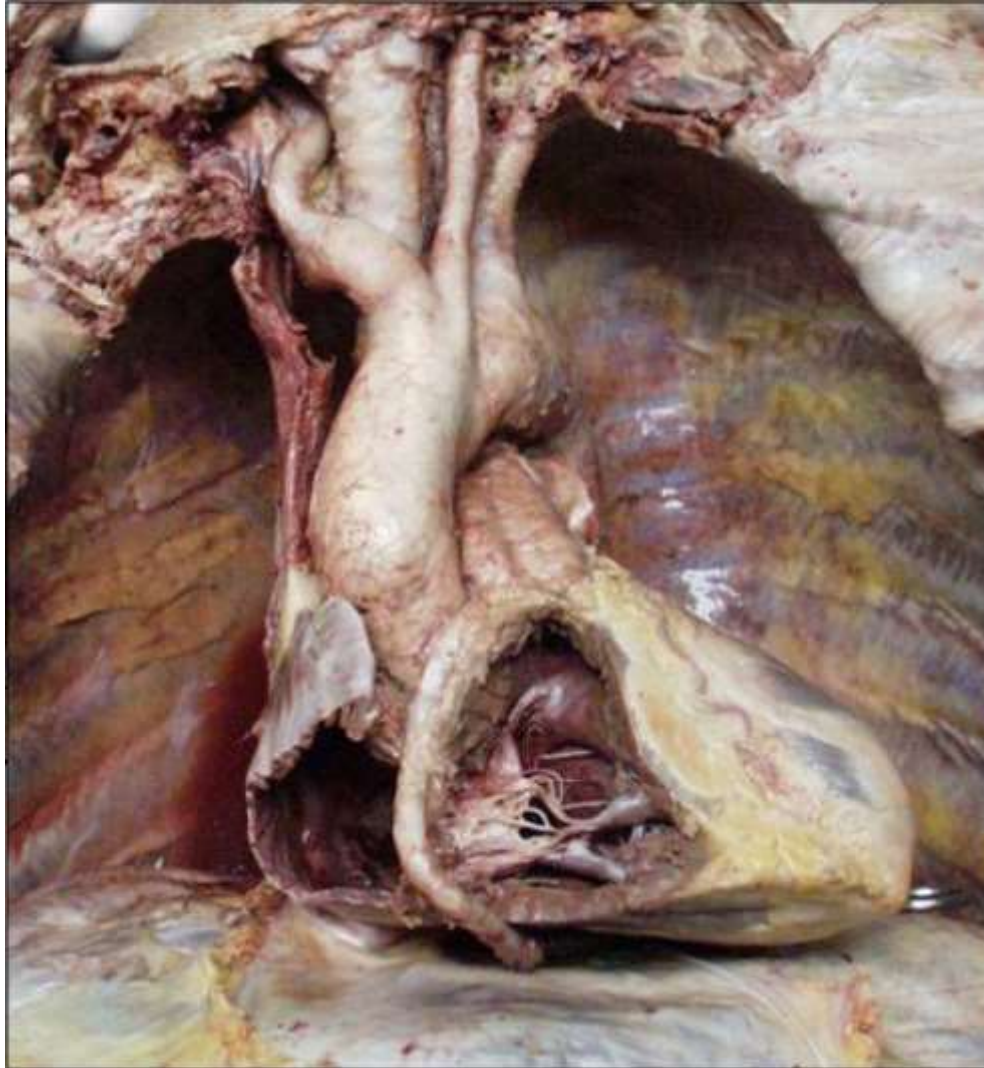
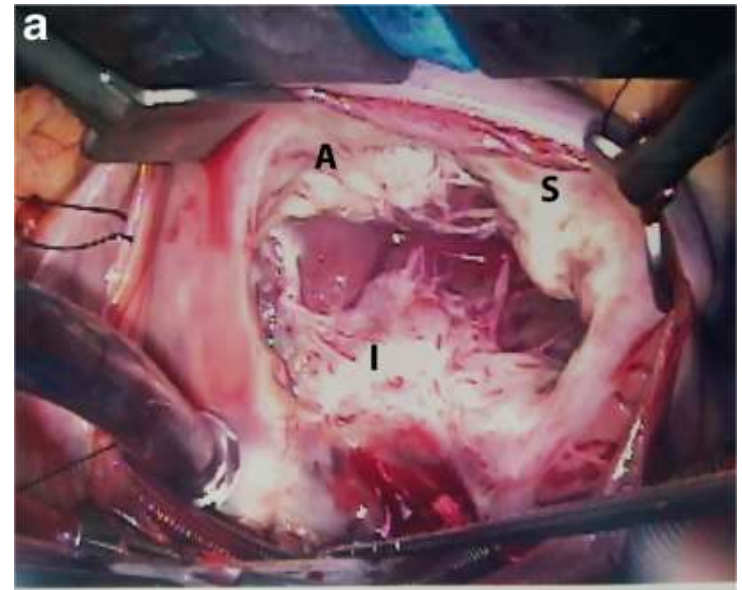
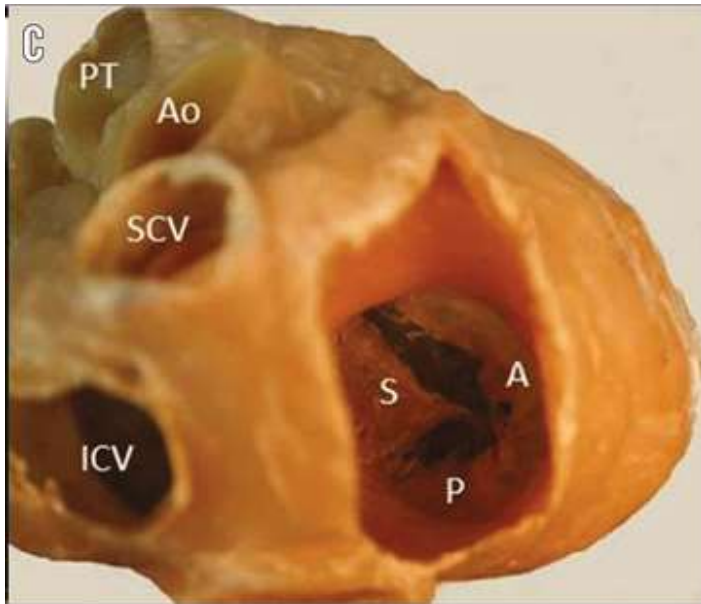


# Echocardiographie des valvulopathies tricuspides

A. Darif

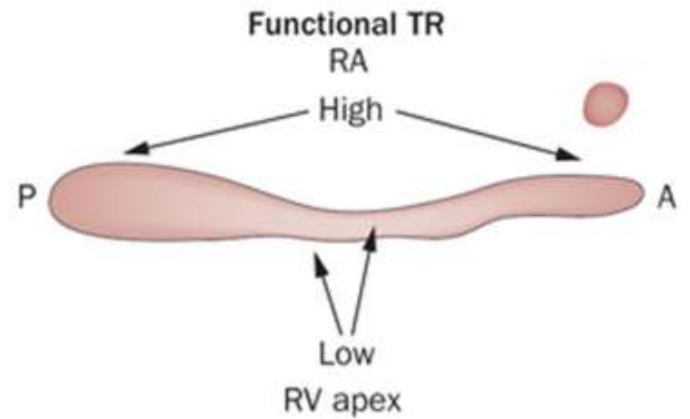
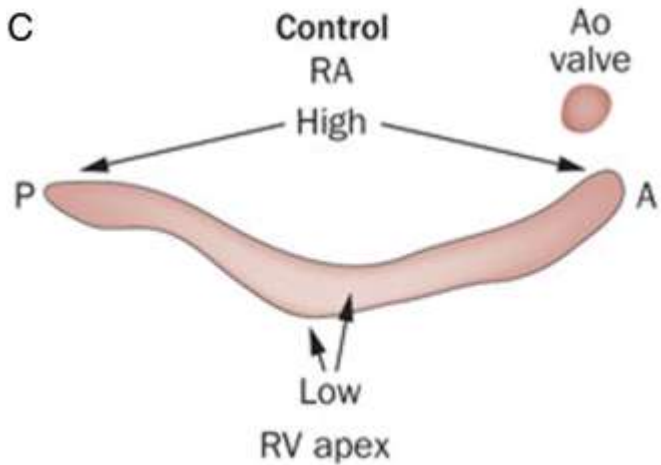
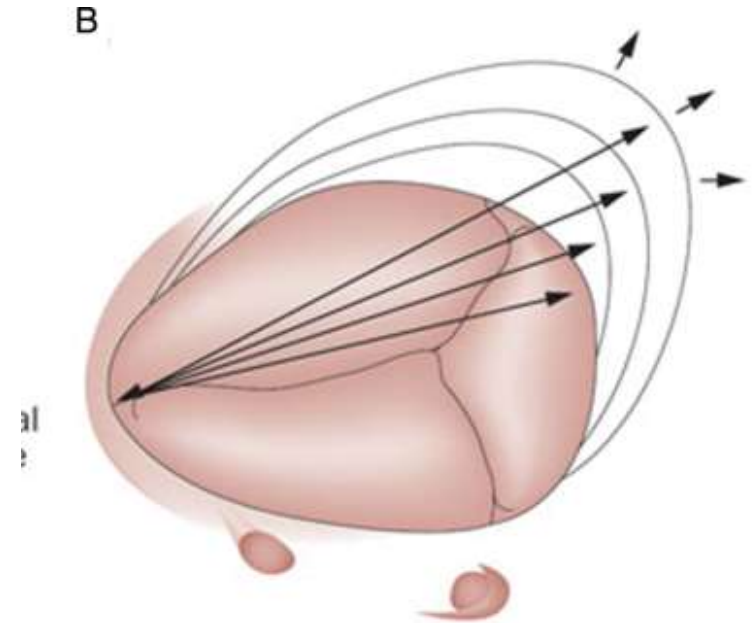
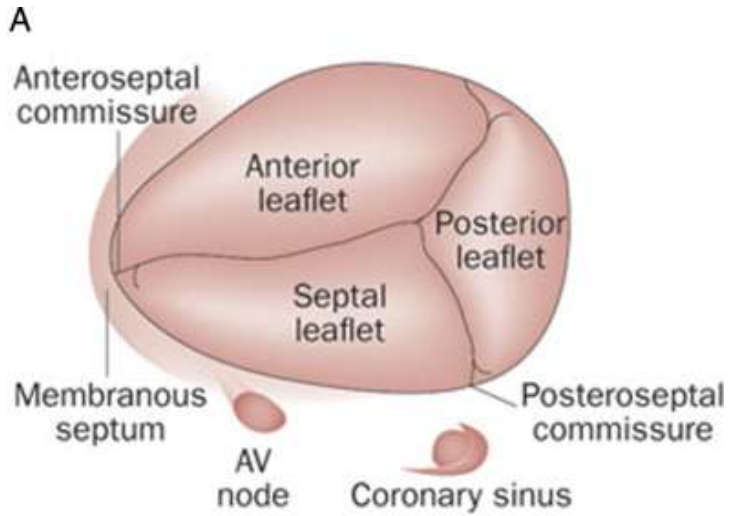


# Rappels anatomiques



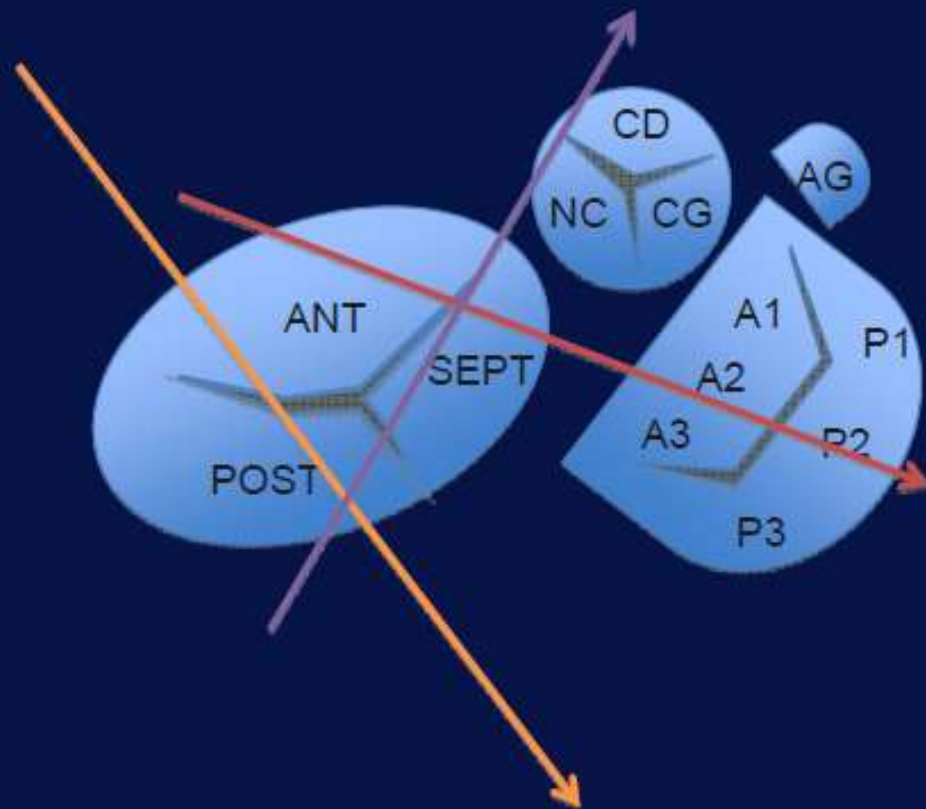
*EuroIntervention* 2015;11:W123-W127

*Insights Imaging* (2016) 7:649-667

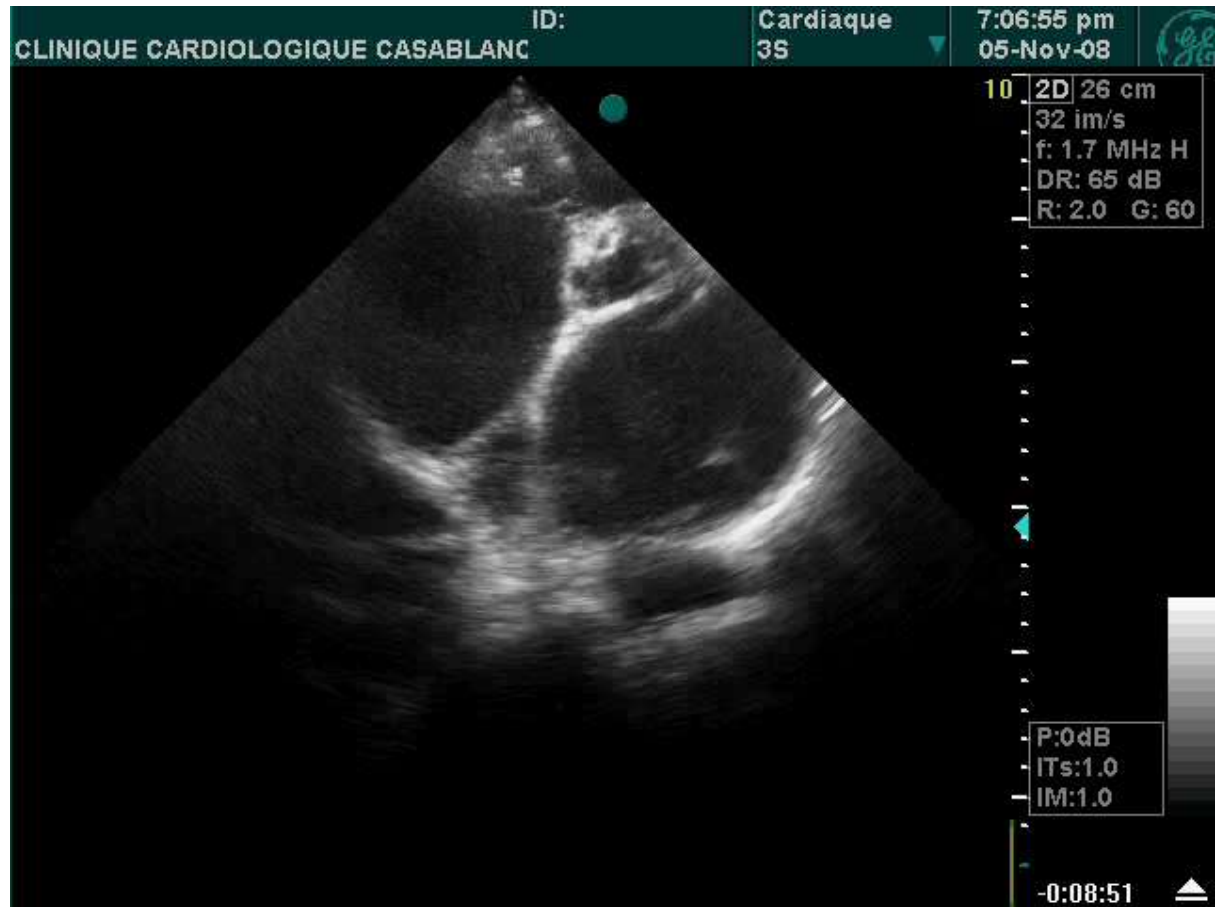
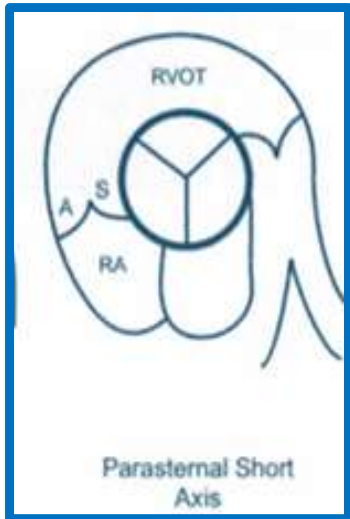


PSG cavités droites	Valve ANT et POST
Apicale 4C	Valve SEPT et ANT
Sous costale 4C	Valve SEPT et POST

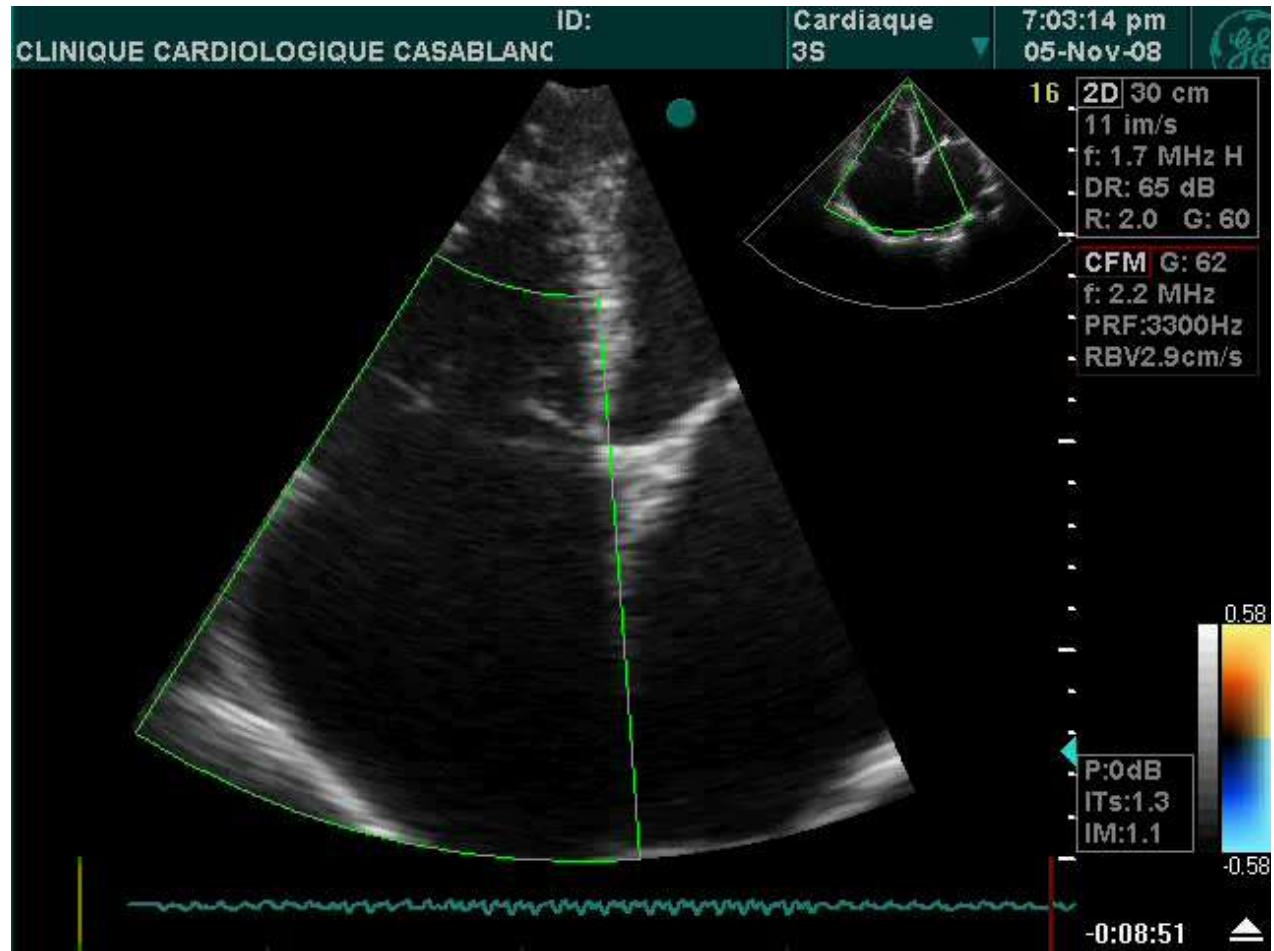
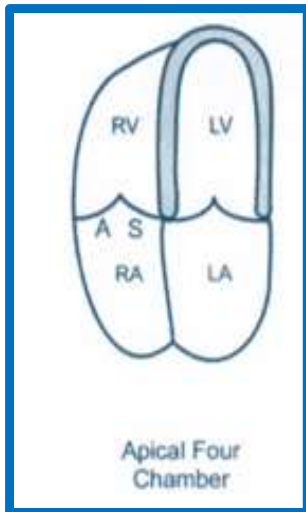
Coupes ETT



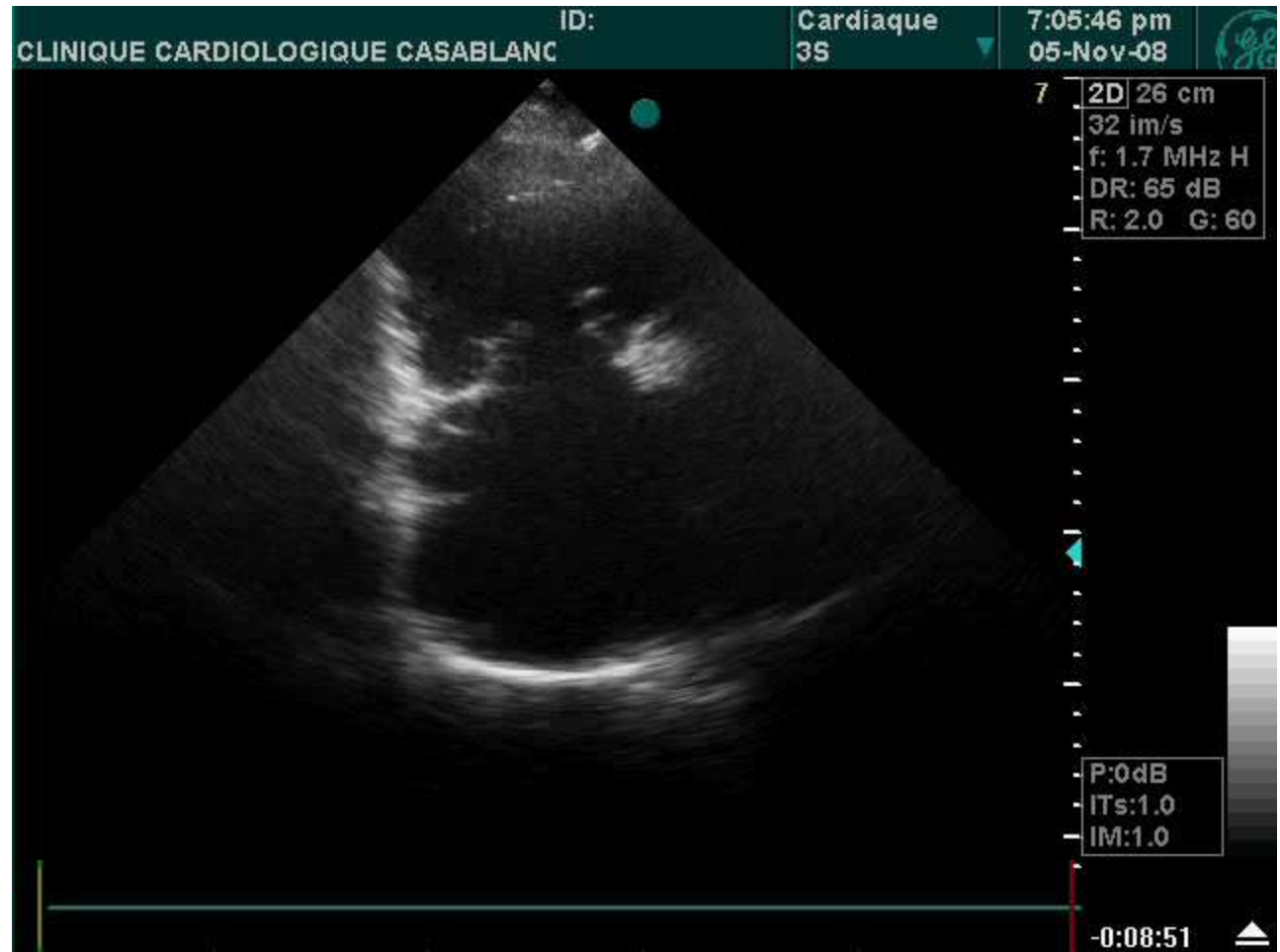
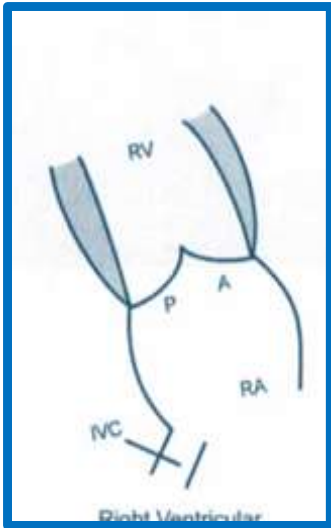
# Echocardiographie transthoracique



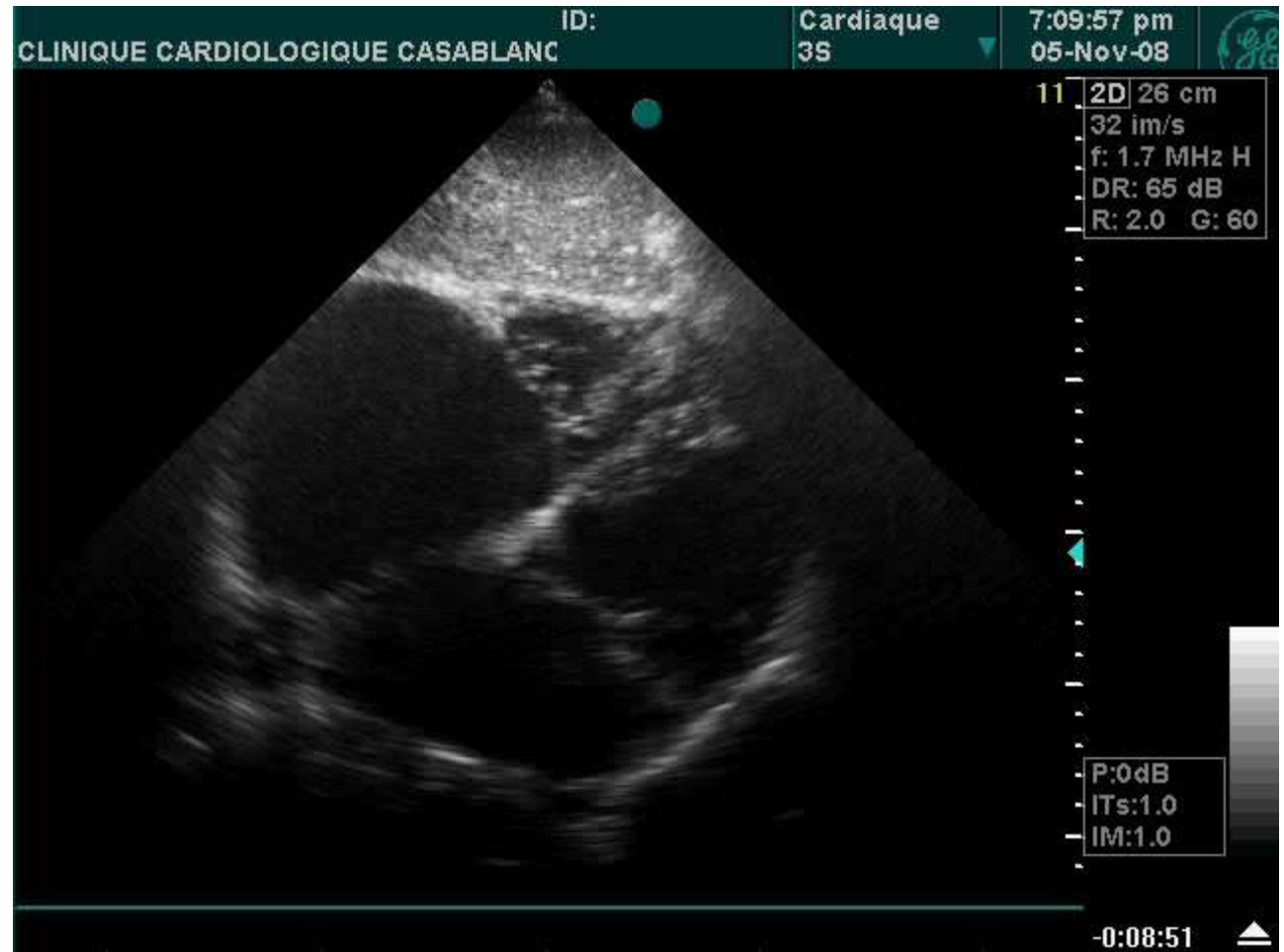
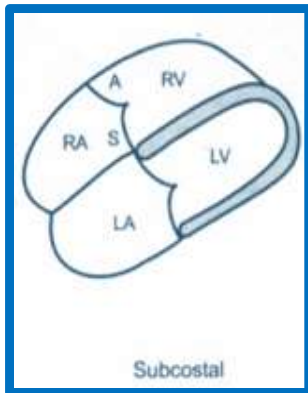
# Echocardiographie transthoracique



# Echocardiographie transthoracique

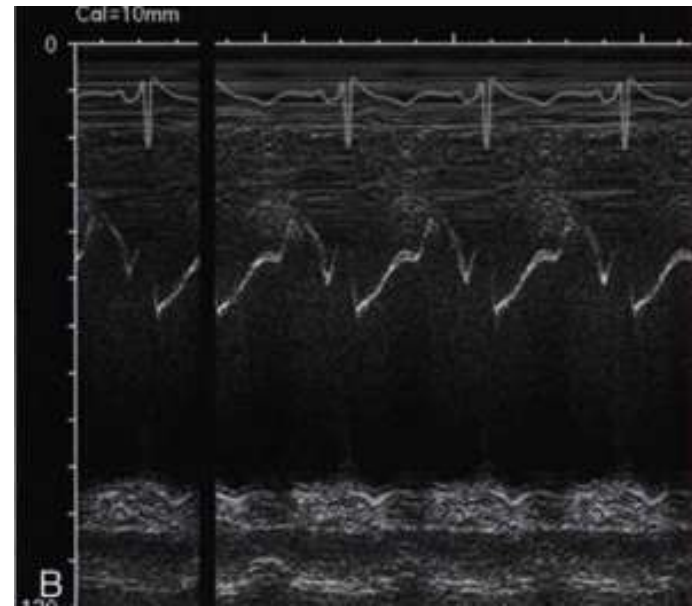
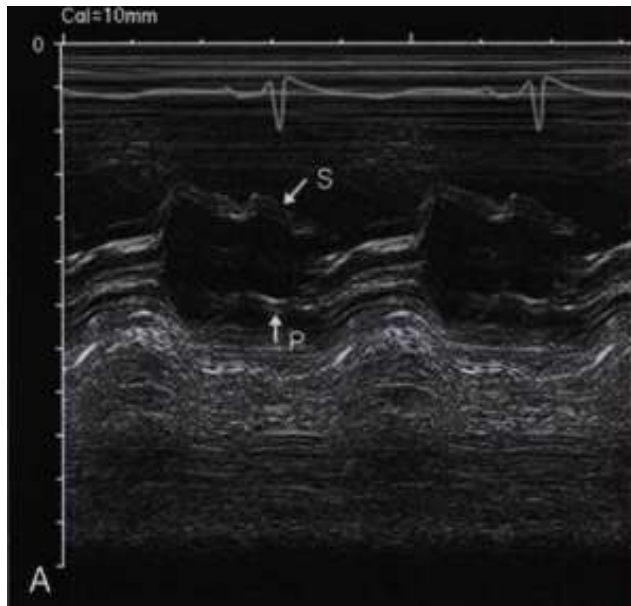


# Echocardiographie transthoracique



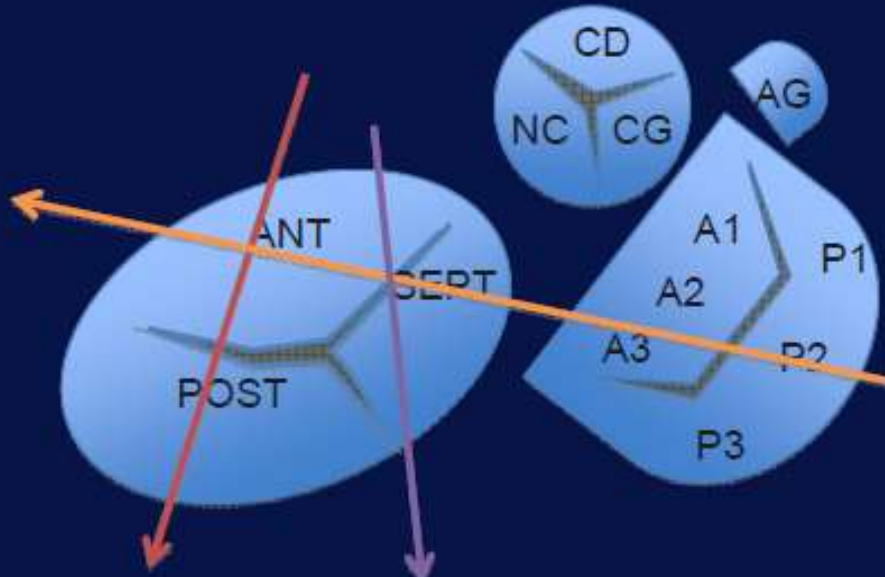


# Mode TM

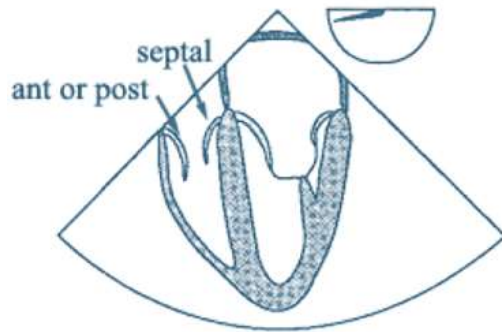


4C 0° + rétro flexion	Valve ANT et SEPT
4C 90° + rotation horaire	Valve POST et ANT
Base du cœur 60 70°	Valve SEPT et ANT

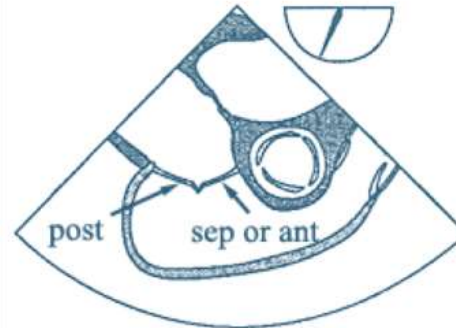
# Coupes ETO



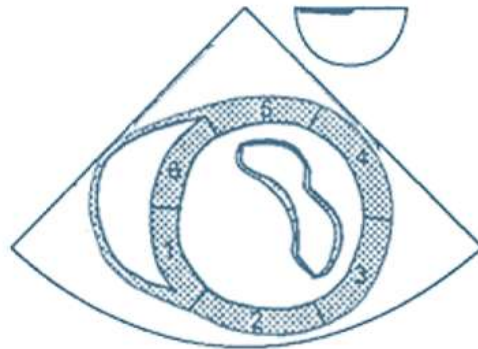
# ETO



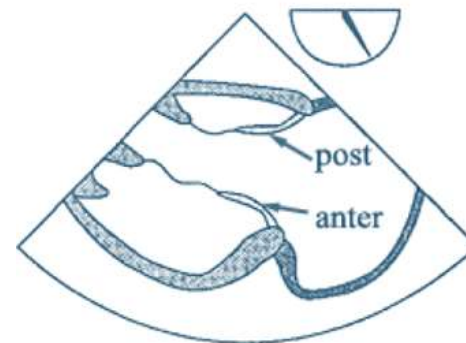
ME four chamber



ME RV inflow-outflow

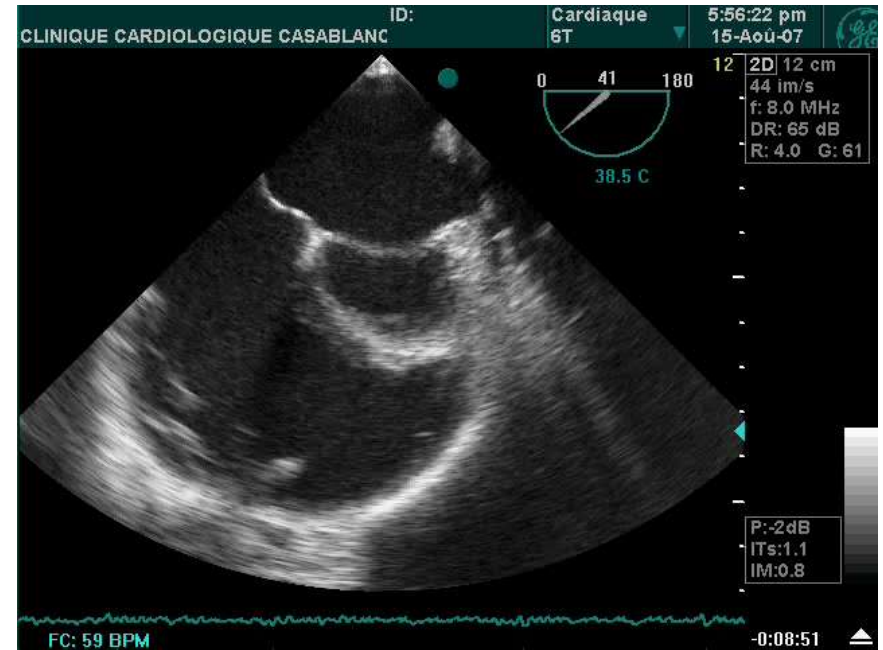
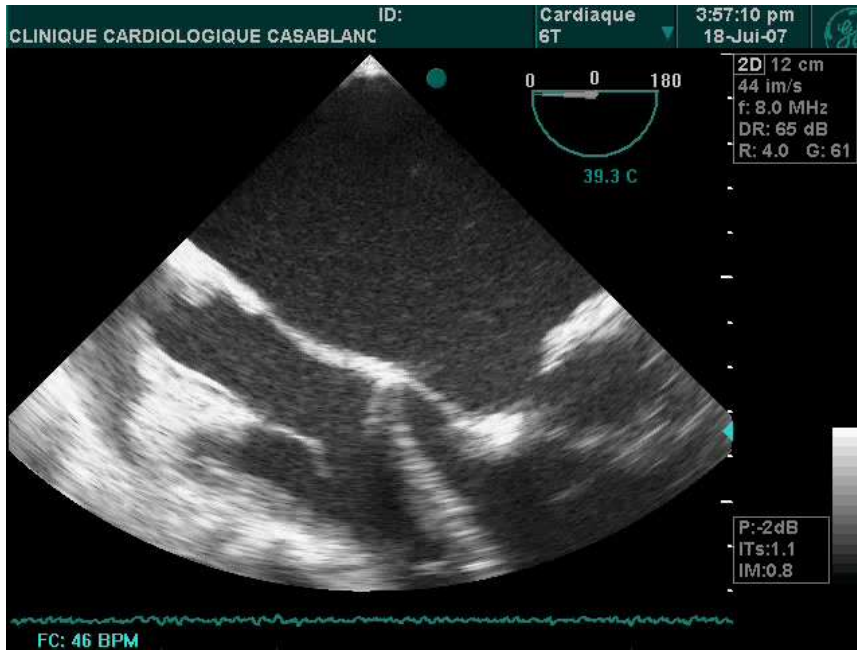


TG basal SAX



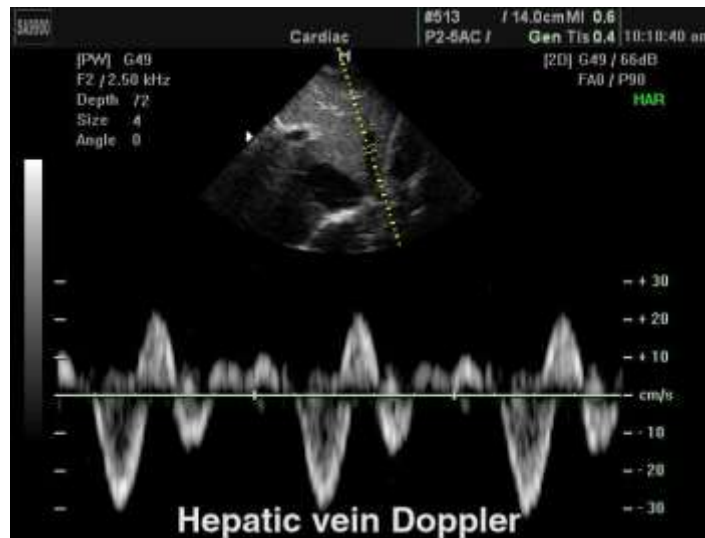
TG RV inflow

# ETO

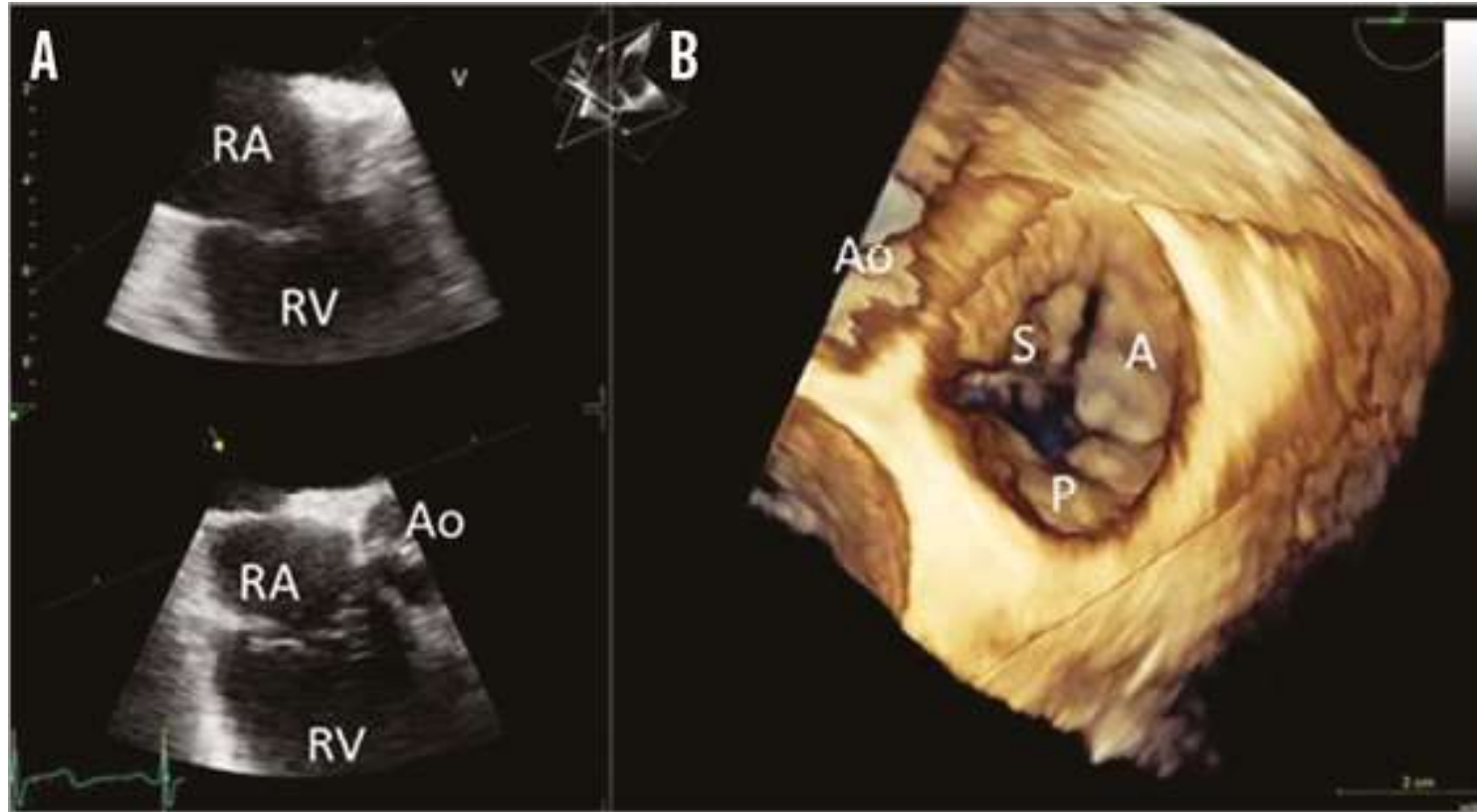


# Valve tricuspide normale

- valves souples mobiles
- Gradient antérograde moyen < 2 mmHg
- Diamètre diastolique maximal de l'anneau 30-35 mm
- IT minime présente chez 60 % des sujet normaux (*dont 15 % moyenne*)
- Flux veineux sus-hépatiques :

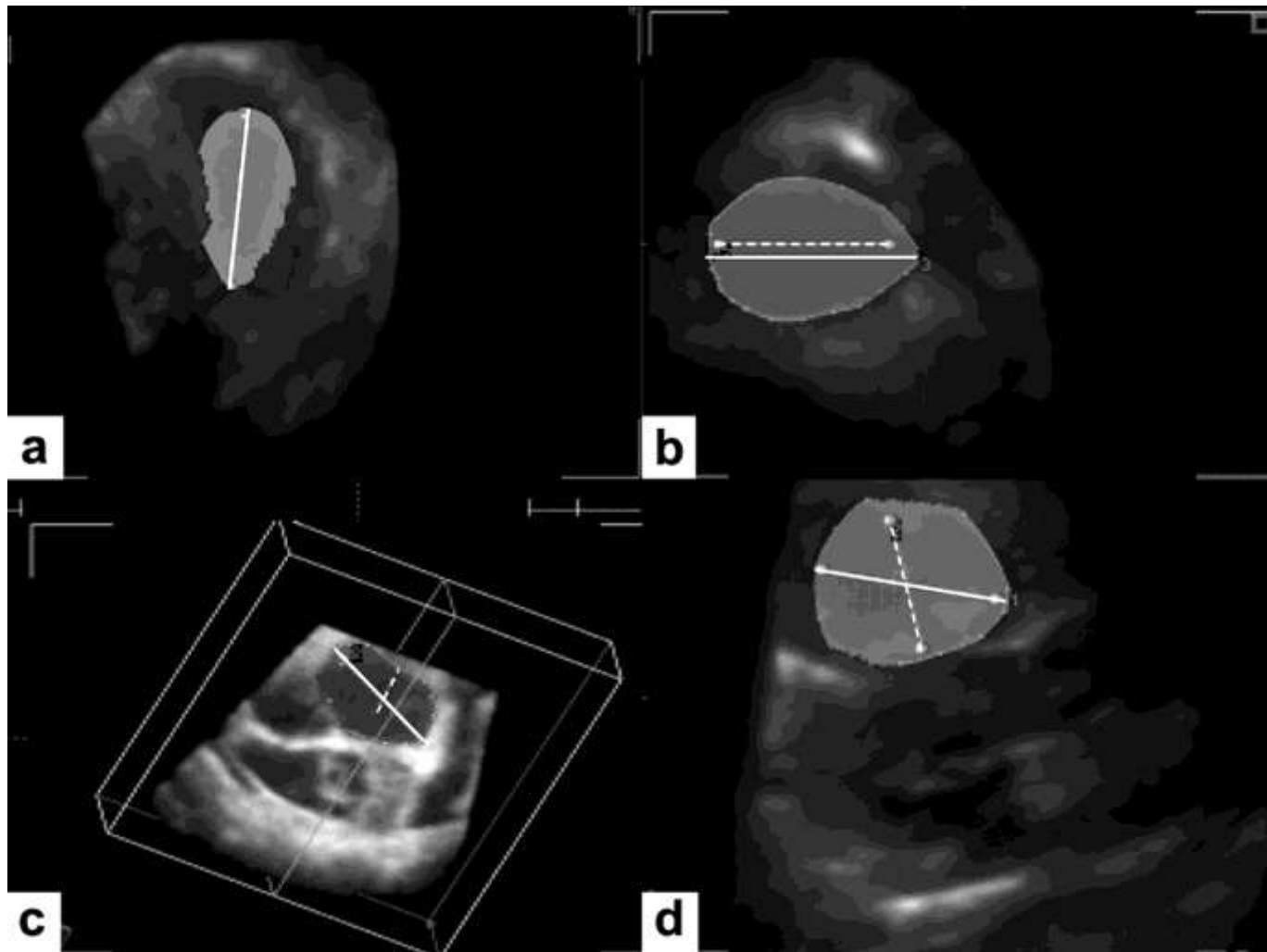


# Echocardiographie 3D



*EuroIntervention 2015;11:W123-W127*

# Echocardiographie 3D



# Insuffisance Tricuspidienne

## Atteintes primitives

- RAA
- Endocardite
- Carcinoïde
- Toxique
- Tumeur
- Iatrogène (Pacemaker)
- Traumatique
- Dégénérative (prolapsus)
- Congénitales :
  - CAV
  - Ebstein
  - Sténose
  - Atrésie

## Atteintes secondaires

- Cardiopathies gauches +++
- HTAP
- Dilatation du VD
- Dysfonction VD
- Infarctus



# Evaluation de l'Insuffisance Tricuspidienne

## 1- Diagnostic étiologique

- Diamètre de l'anneau > 40 mm + valves normales

↳ IT fonctionnelle ++

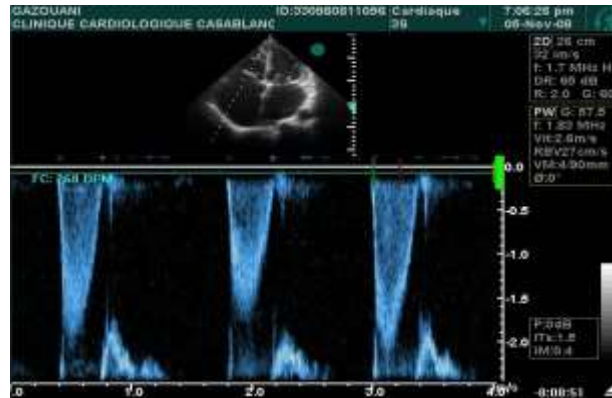


<b>Etiology</b>	<b>Pathologic Changes</b>
Functional regurgitation	1. Asymmetric annular dilatation universally involving the anterior and posterior leaflets
Rheumatic	1. Leaflet thickening and fibrosis 2. Commissural fusion (commonly the anteroseptal commissural) 3. Chordal fusion and shortening
Endocarditis	1. Vegetations usually on the atrial side of the valves
Carcinoid	1. Endocardial fibrous thickening on the ventricular surface of the valve

# Evaluation de l'Insuffisance Tricuspidienne

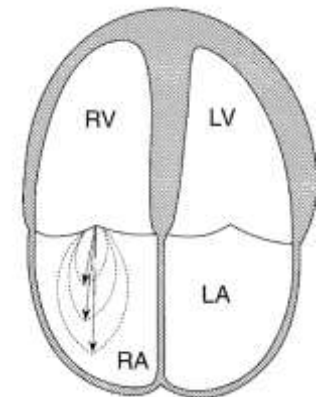
## 2- Diagnostic de sévérité

- Doppler pulsé: flux laminaire \*



- Vitesse antérograde  $> 1\text{m/s}$  (en dehors d'une sténose)

-Extension du jet \*\*: longueur du jet  $> 45\text{ mm}$   
surface du jet  $> 10\text{ cm}^2$   
surface du jet /surface de l'OD  $> 40\%$

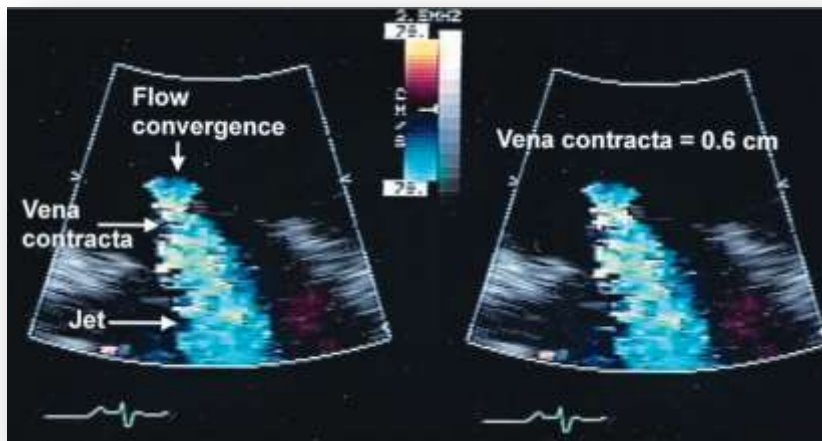


\* Minogoe *Am Heart J* 1990;**119:627-35**.

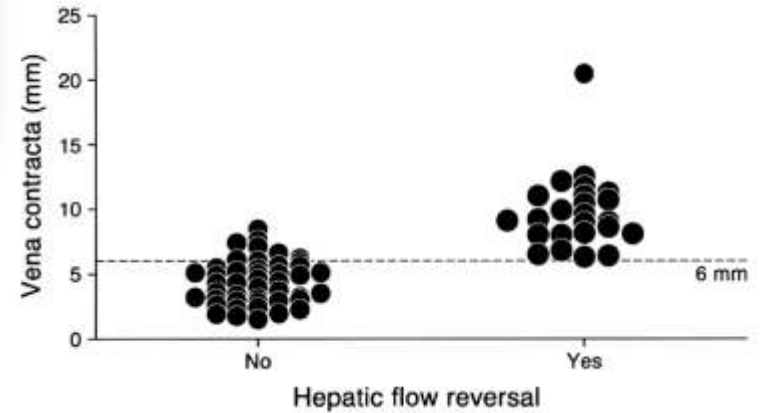
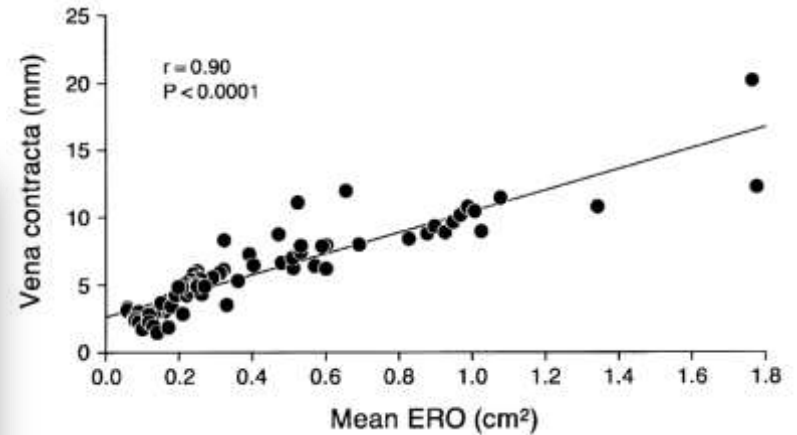
\*\* Pravin *Curr Probl Cardiol* 2008;**33:47-84**.

# Evaluation de l'Insuffisance Tricuspidienne

## 2- Diagnostic de sévérité

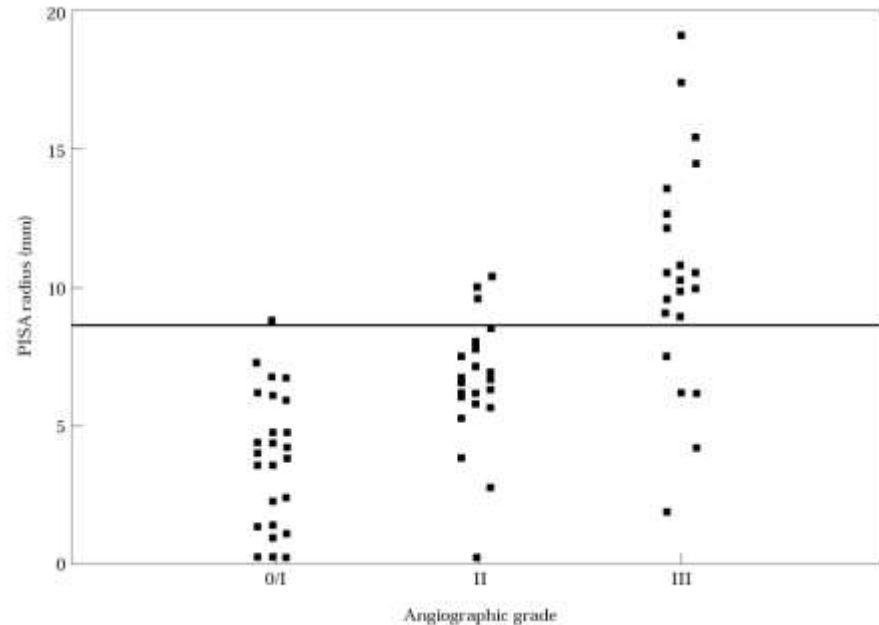
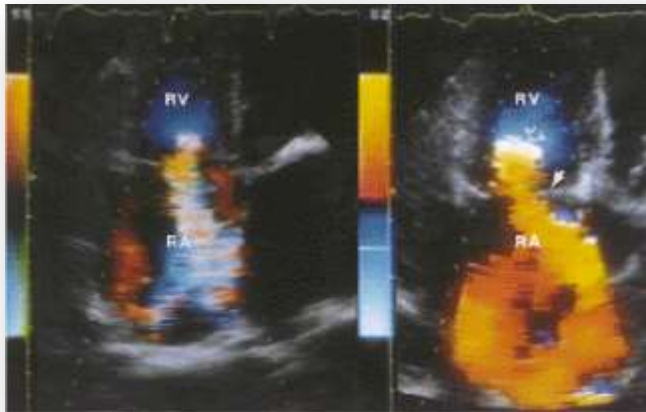


- Vena contracta > 6mm

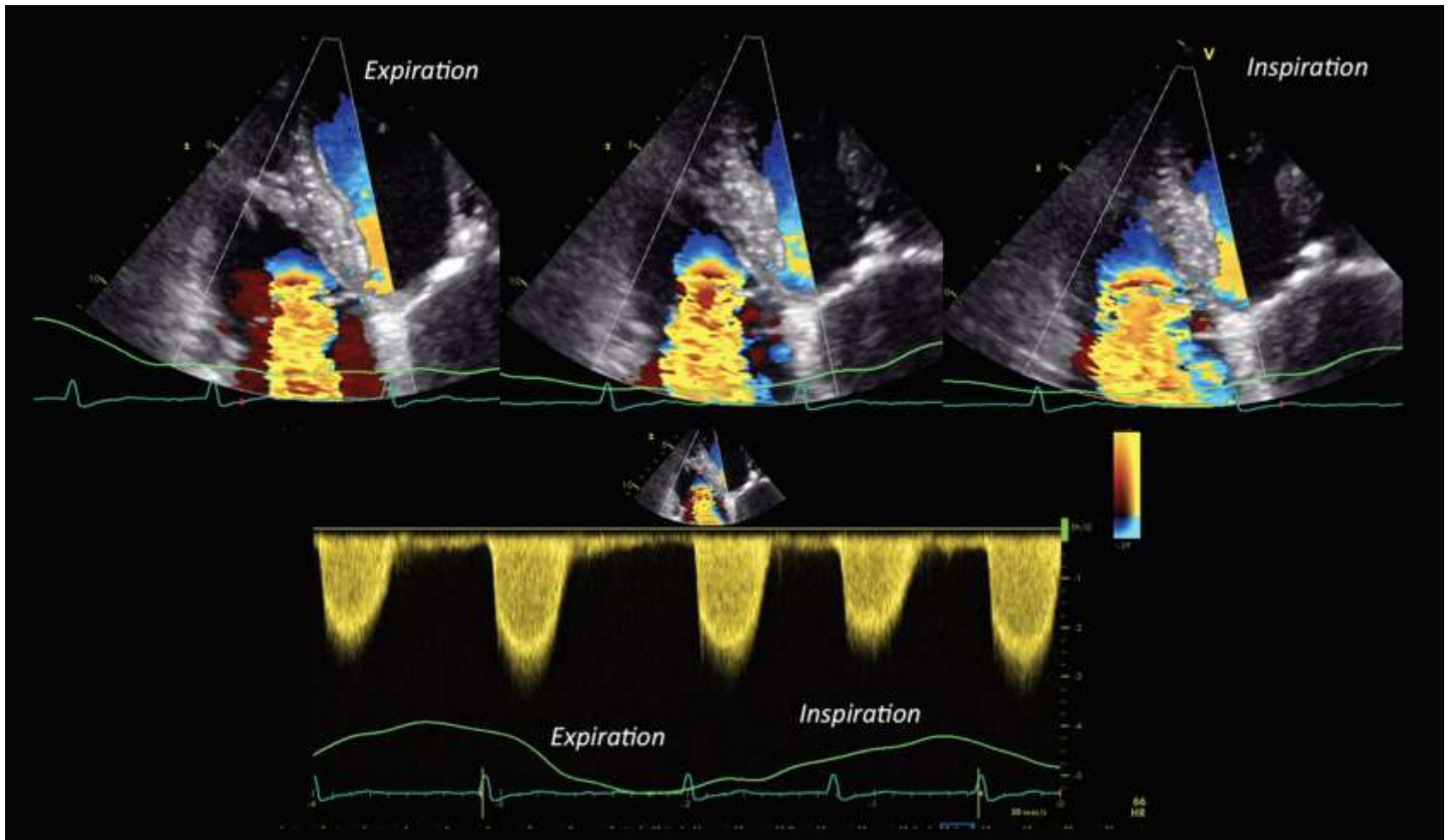


# Evaluation de l'Insuffisance Tricuspidienne

## 2- Diagnostic de sévérité



- Rayon de PISA > 8mm (Nyquist 28 cm/s)

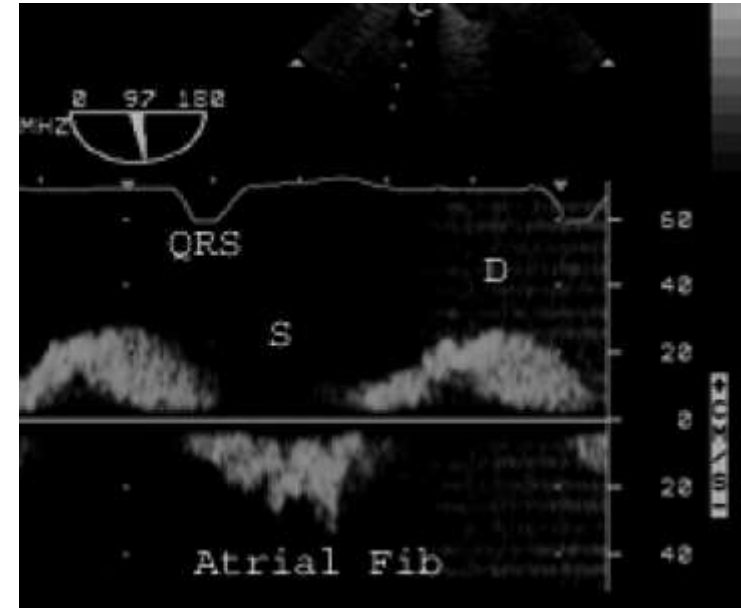
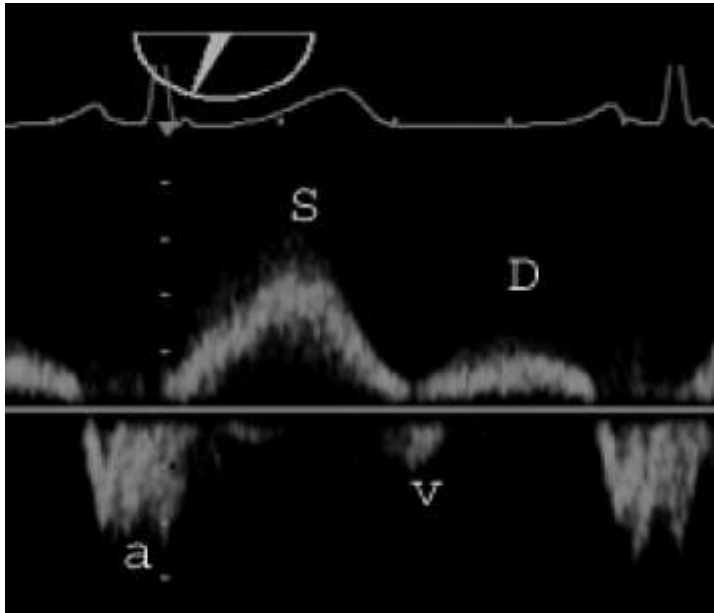


Korean Circ J 2016;46(4):443-455

# Evaluation de l'Insuffisance Tricuspidienne

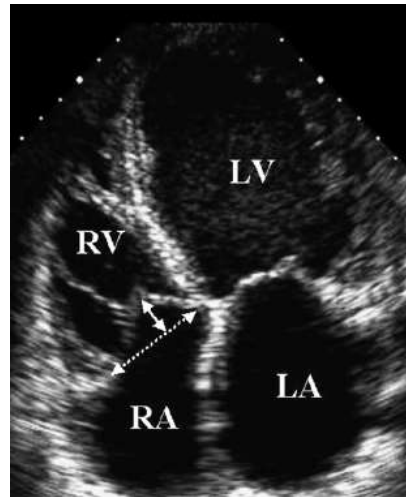
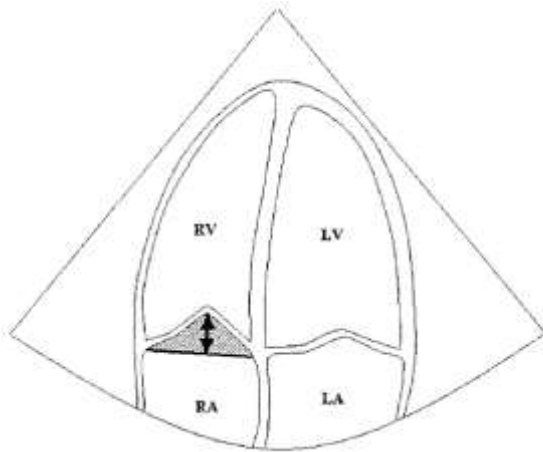
## 2- Diagnostic de sévérité

- Inversion du flux systolique veineux sus-hépatique



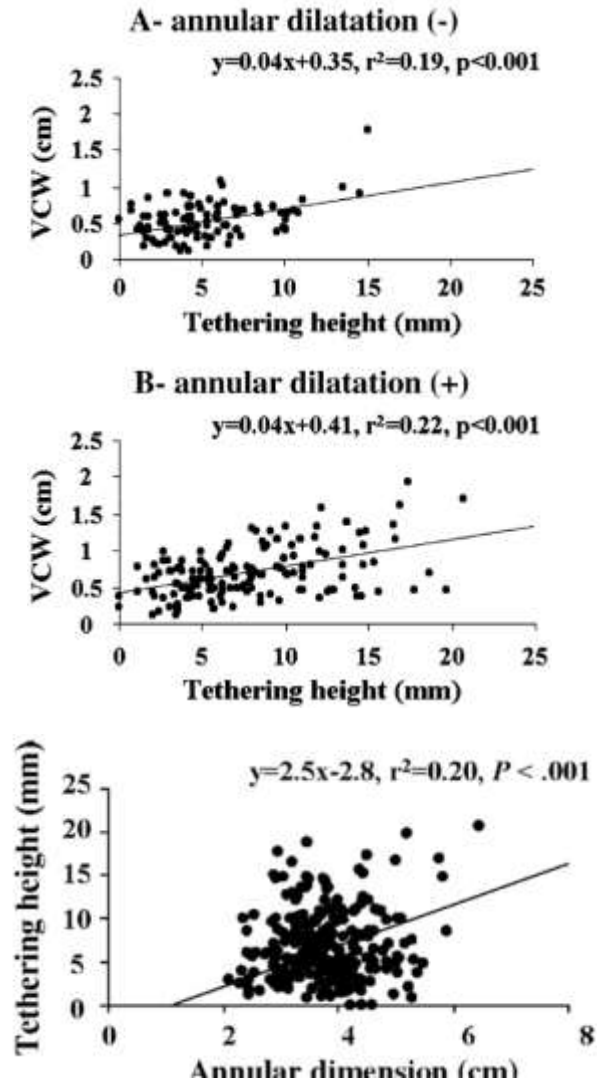
# Nouveaux indices

## Tethering



Hauteur > 3,6mm

Fukuda Am Heart J 2006;152:1208214.)



# Evaluation de l'Insuffisance Tricuspidienne

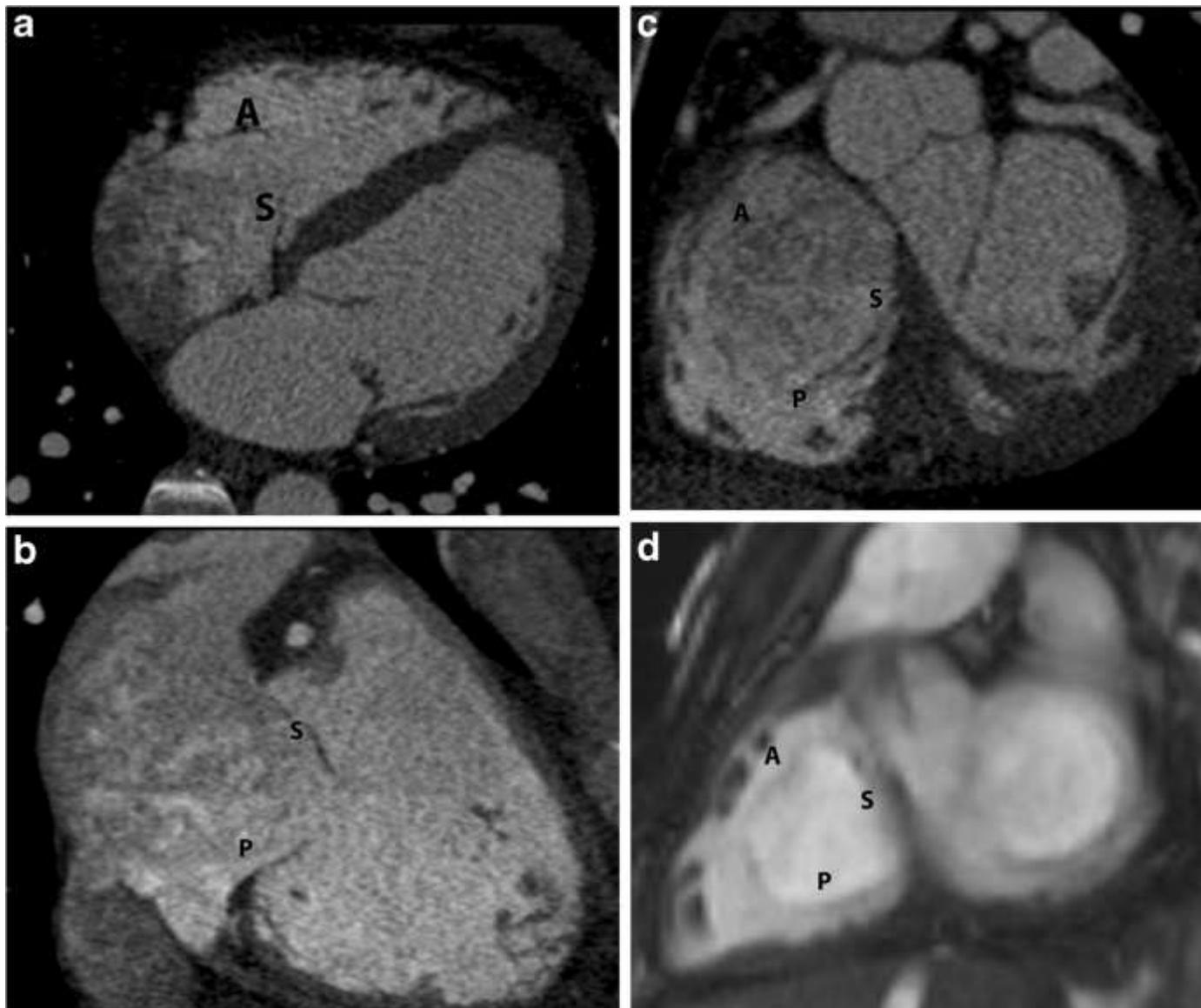
Parameter	Tricuspid valve regurgitation		
	Mild	Moderate	Severe
Valve morphology	Normal	Normal/abnormal	Abnormal
RV, RA, IVC size	Normal	Normal or dilated	Dilated unless acute TR; TV annulus $\geq 4$ cm
CW jet	Less intense than inflow	Almost as dense as inflow	As dense as inflow with late delay
Jet area	$< 5 \text{ cm}^{2a}$	5–10 $\text{cm}^2$	$> 10 \text{ cm}^2$
Jet/RA area	$< 20\%$	20–40%	$> 40\%$
Vena contracta width	Small <sup>a</sup>	Probably $< 7$ mm	$\geq 7$ mm
Proximal isovelocity surface area radius	$\leq 5$ mm	0.6–0.9 mm	$> 10$ mm for a Nyquist limit of 30 cm/sec; $\geq 7$ mm for a Nyquist limit of 40 cm/sec Other feature: jet length $> 5.3 \text{ cm}^a$
Hepatic vein flow	Systolic dominance	Systolic blunting	Systolic reversal



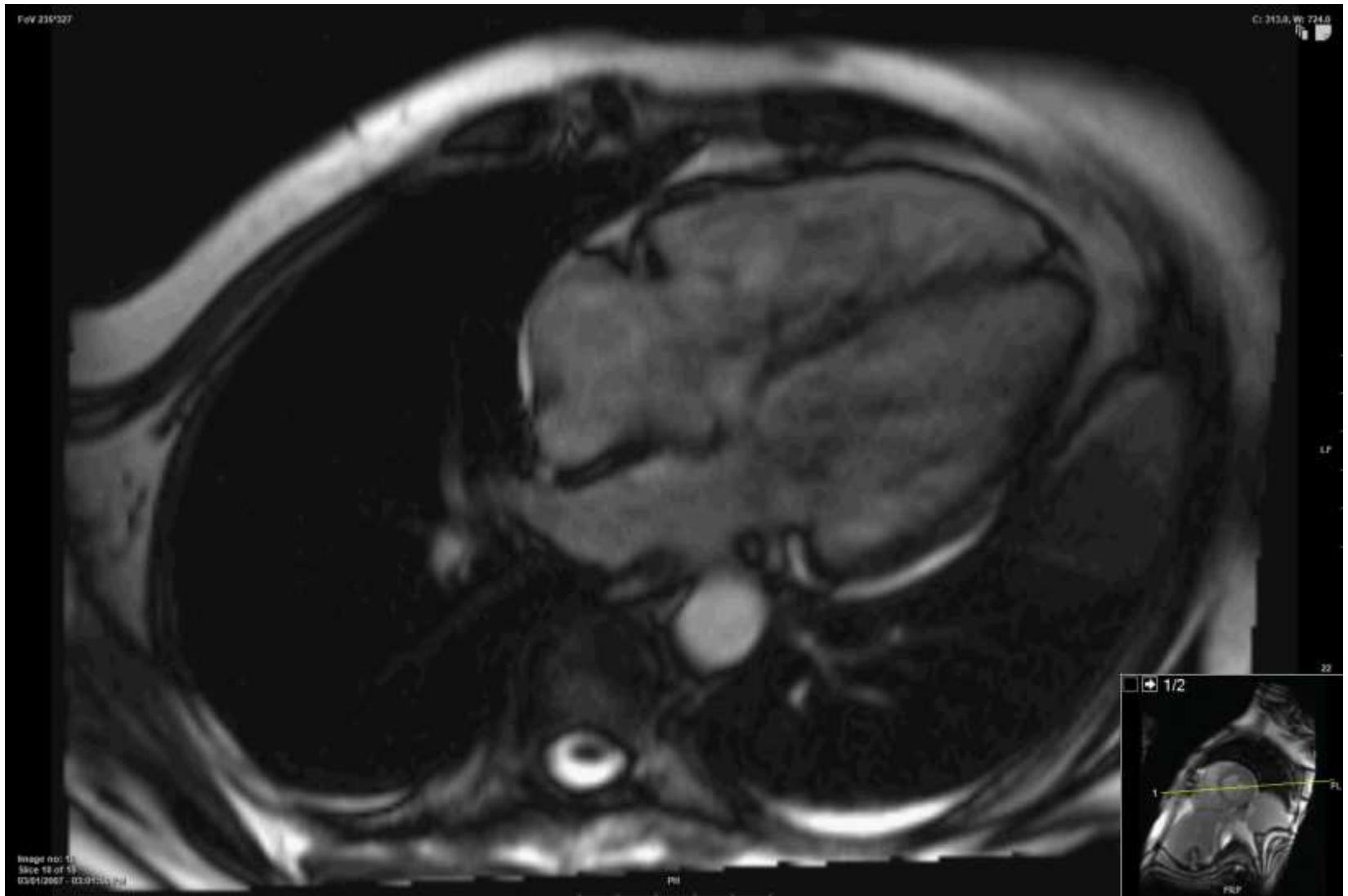
# Exemple



## Autres modalités : Scann



## Autres modalités : IRM



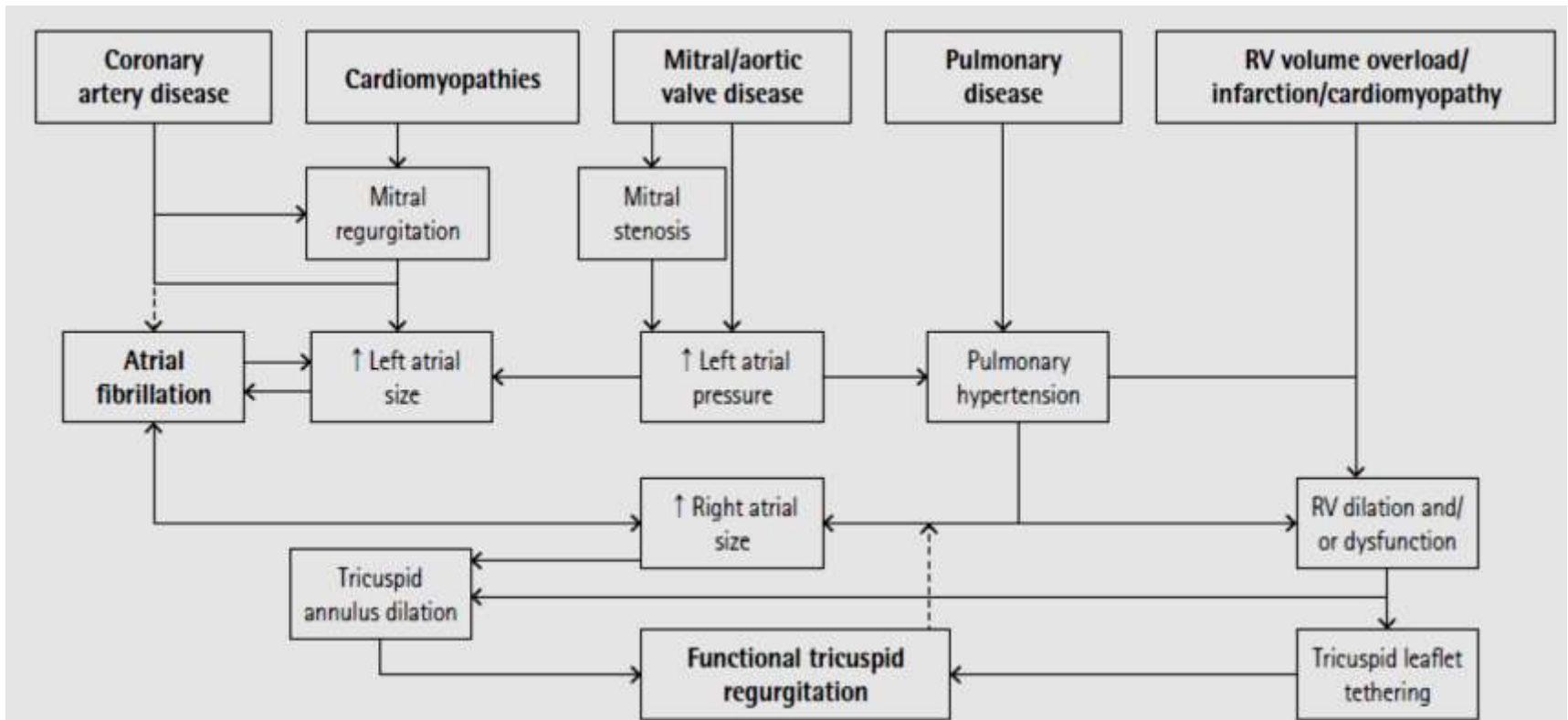
*Insights Imaging (2016) 7:649–667*

**Table 1** Comparison of different imaging modalities used in the evaluation of the tricuspid valve

	Echocardiography	CT	MRI
Modes/sequences	<ul style="list-style-type: none"> <li>• Gray scale</li> <li>• 2D</li> <li>• 3D</li> <li>• Doppler</li> </ul>	<ul style="list-style-type: none"> <li>• Non-contrast</li> <li>• Contrast</li> <li>• Static/dynamic</li> </ul>	<ul style="list-style-type: none"> <li>• Cine SSFP</li> <li>• RV long-axis, RV horizontal long-axis, axial, short-axis, 4-chamber</li> <li>• Velocity-encoded phase contrast</li> <li>• Black-blood T1W, T2W, fat-saturated</li> <li>• Early contrast enhancement</li> <li>• Delayed contrast enhancement</li> </ul>
Advantages	<ul style="list-style-type: none"> <li>• Widely available</li> <li>• Low cost</li> <li>• Safe</li> <li>• Can be performed at bedside</li> <li>• Can be performed even in hemodynamically unstable patients</li> <li>• Morphological and functional evaluation</li> </ul>	<ul style="list-style-type: none"> <li>• Good spatial resolution</li> <li>• Good temporal resolution</li> <li>• Multiplanar reconstruction capabilities</li> <li>• Calcification</li> <li>• Evaluation of associated extracardiac disorders</li> <li>• Pre-surgical planning</li> </ul>	<ul style="list-style-type: none"> <li>• Good spatial resolution</li> <li>• Good temporal resolution</li> <li>• Multiplanar imaging capabilities</li> <li>• Morphological information</li> <li>• Tissue characterization</li> <li>• Accurate functional quantification of valve and ventricles</li> </ul>
Disadvantages	<ul style="list-style-type: none"> <li>• Operator-dependent</li> <li>• Limited windows, especially for right heart</li> <li>• More limited in obesity, COPD, immediately post-surgery</li> <li>• Limited tissue characterization</li> </ul>	<ul style="list-style-type: none"> <li>• Ionizing radiation</li> <li>• Potentially nephrotoxic contrast media</li> <li>• Dynamic evaluation/ventricular functional evaluation possible only in retrospective ECG-gated scans which is associated with higher radiation dose</li> <li>• Valve function cannot be evaluated</li> <li>• Limited in patients with high/irregular heart rates</li> <li>• Limited tissue characterization</li> <li>• Only in hemodynamically stable patients</li> </ul>	<ul style="list-style-type: none"> <li>• Not widely available</li> <li>• Higher cost</li> <li>• Time-consuming</li> <li>• Contraindicated in some devices, claustrophobia</li> <li>• Calcifications not well seen</li> <li>• Risk of nephrogenic systemic fibrosis in patients with severe renal dysfunction.</li> <li>• Cannot be performed in hemodynamically unstable patients.</li> <li>• Requires breath-hold and steady heart rates</li> </ul>

SSFP steady-state free precession, RV right ventricle, T1W T1-weighted, T2W T2-weighted

# IT fonctionnelle



# IT fonctionnelle

**Table 2.** Predictors of late functional tricuspid regurgitation

Age

Female

Atrial fibrillation

Tricuspid annulus dilation >40 mm (>21 mm/m<sup>2</sup>)

Severe leaflet tethering

Right chamber dilation

Right ventricular dysfunction

Pulmonary hypertension

Longer time between mitral valve disease onset and corrective surgery

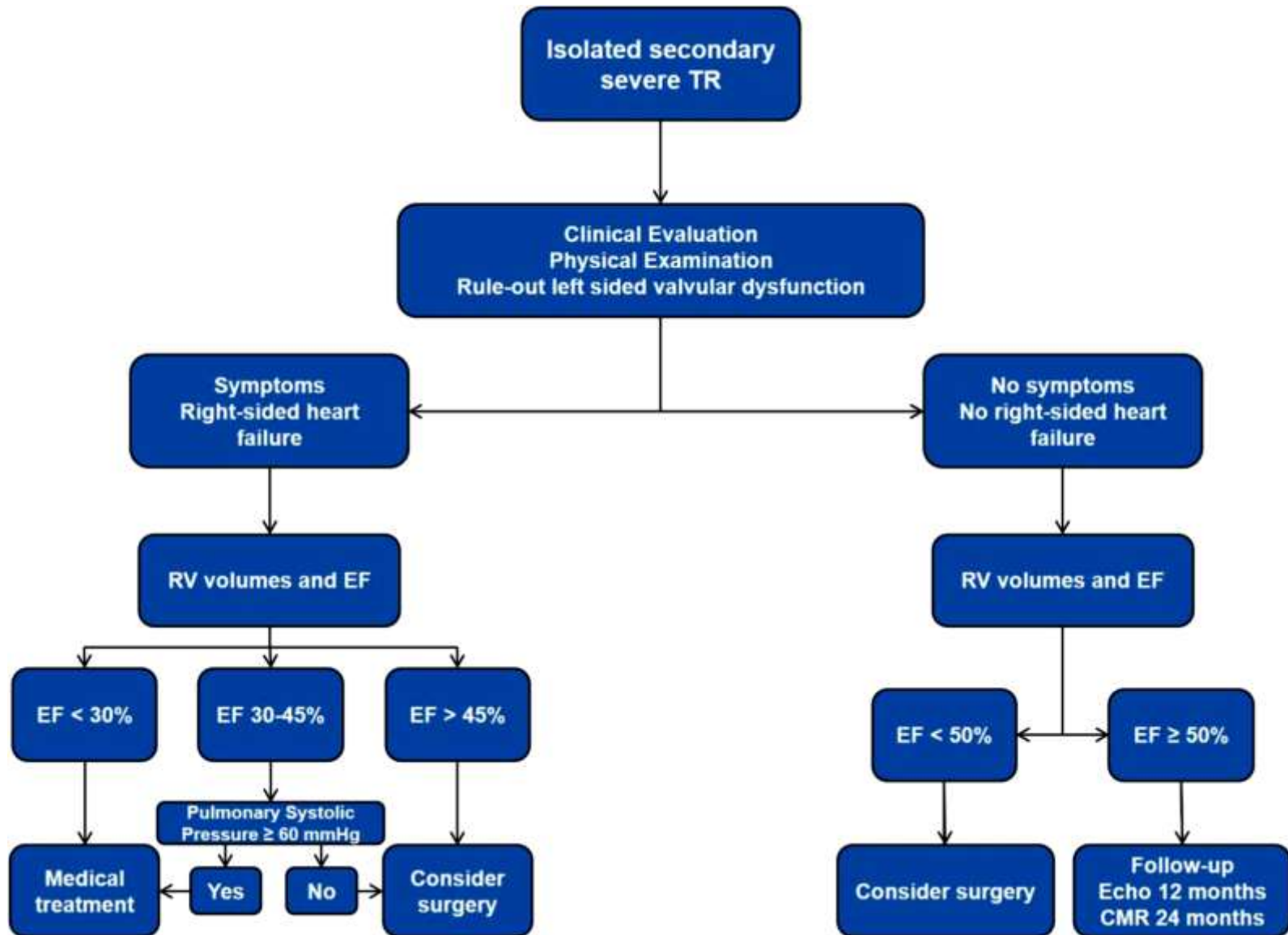
Left atrial dilation

Rheumatic valve disease

Ischemic heart disease

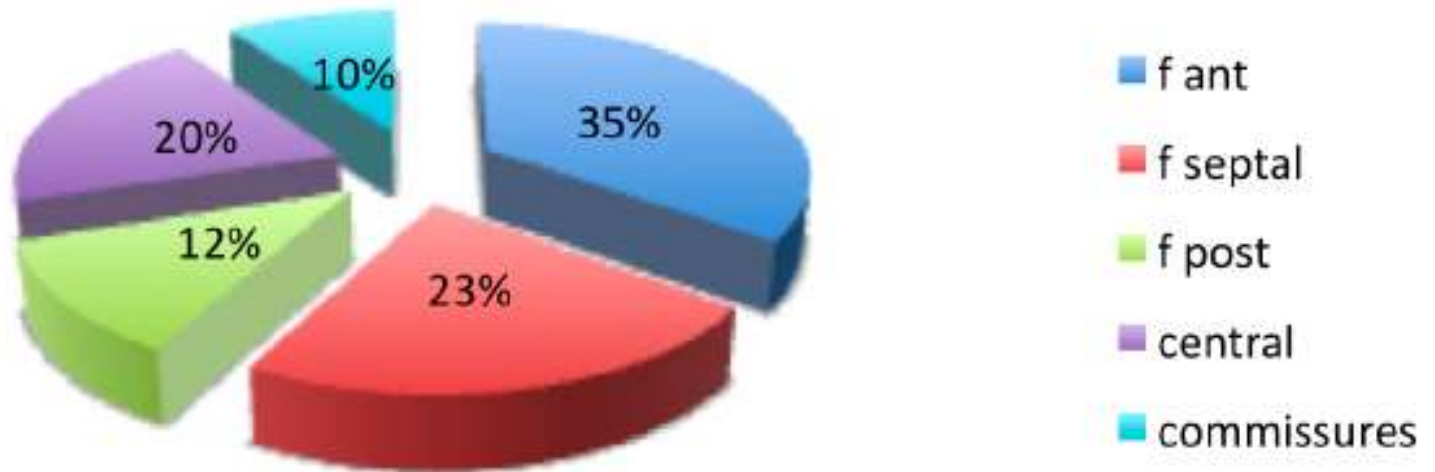
Left-sided prosthetic valve dysfunction

# IT sévère + Dysfonction Ventriculaire



# *Fuites tricuspides post Pace-Maker*

## fréquence de localisation des sondes





# *Fuites tricuspides post Pace-Maker*

- Fréquence estimée 24.2% aggravent une IT pré existante, dont 5% IT modérée à sévère
- Plus fréquemment après pose DAI
  - Volume de sonde
  - Pathologie sous jacente?
- Augmentation du risque de fuite parallèlement au nombre de sondes en place
- Indications opératoires pour IT sévère augmente avec le temps

# *Fuites tricuspides post Pace-Maker*

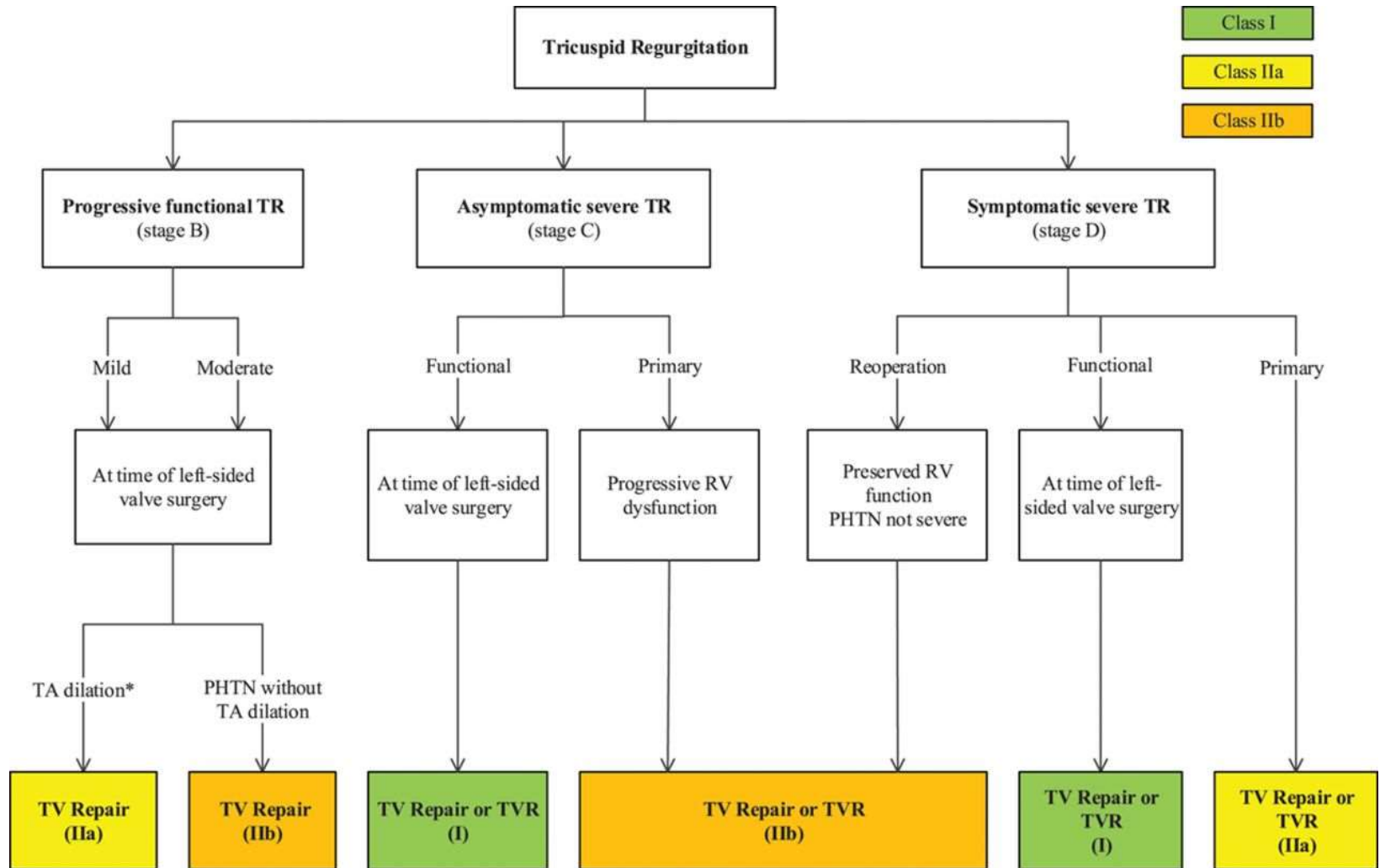
## Lésions observées

- Fibrose
- Épaississement des feuillets valvulaires
- Limitation de la mobilité

## • Mécanismes évoqués

- Adhérence
- Perforation feuillet septal ou postérieur
- Enchevêtrement
- Gène à la mobilité des feuillets

# Indications opératoires



Rick A. Nishimura et al. *Circulation*. 2014;129:2440-2492

# Rétrécissement tricuspide

## - *Signes de sévérité*

-Surface tricuspide  $< 1 \text{ cm}^2$  en planimétrie (ETO)

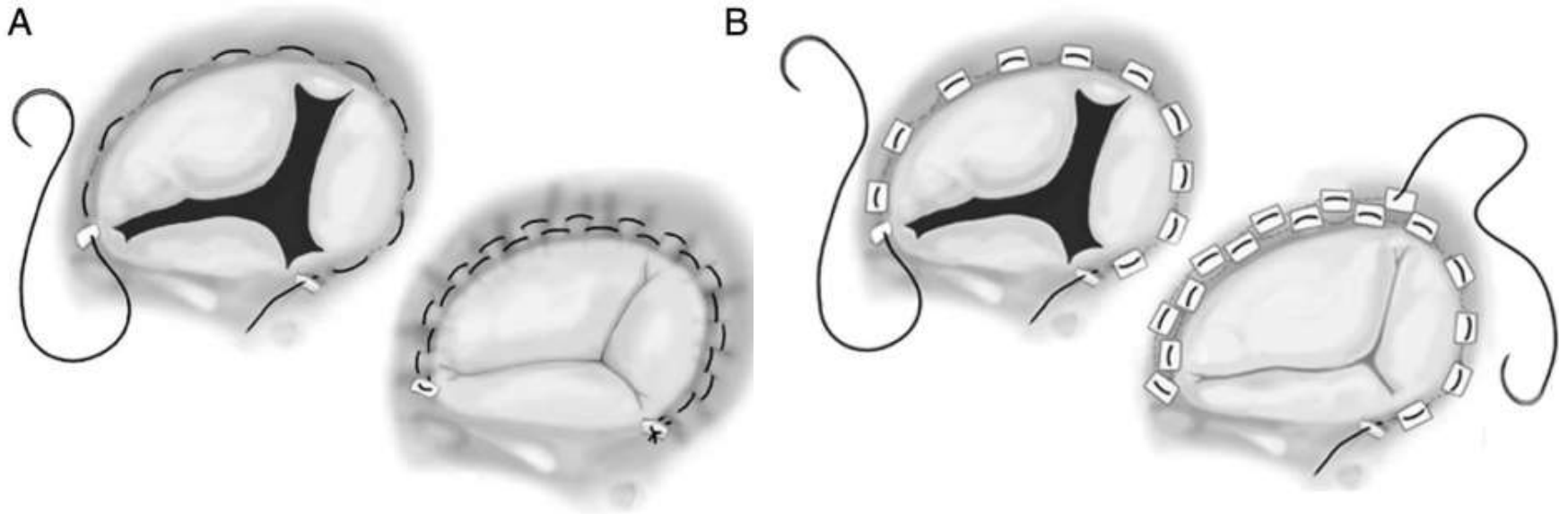
ou par formule de Hatle:  $190/\text{PHT}$  ( au lieu de 220)

équation de continuité:  $\text{volume d'éjection}/\text{ITV tricuspide}$

-Gradient moyen  $> 7 \text{ mmHg}$  RT sévère

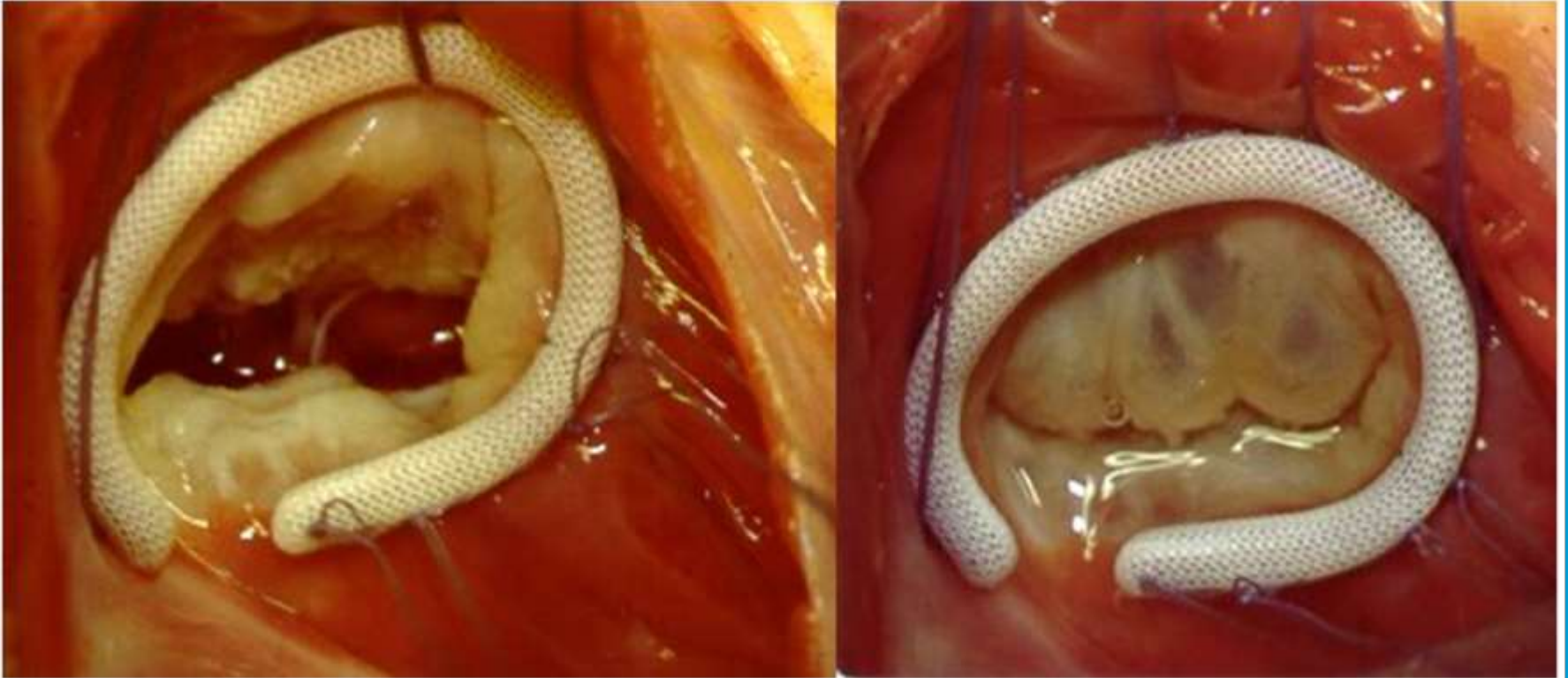
2-5 mmHg RT modérée

# Techniques opératoires



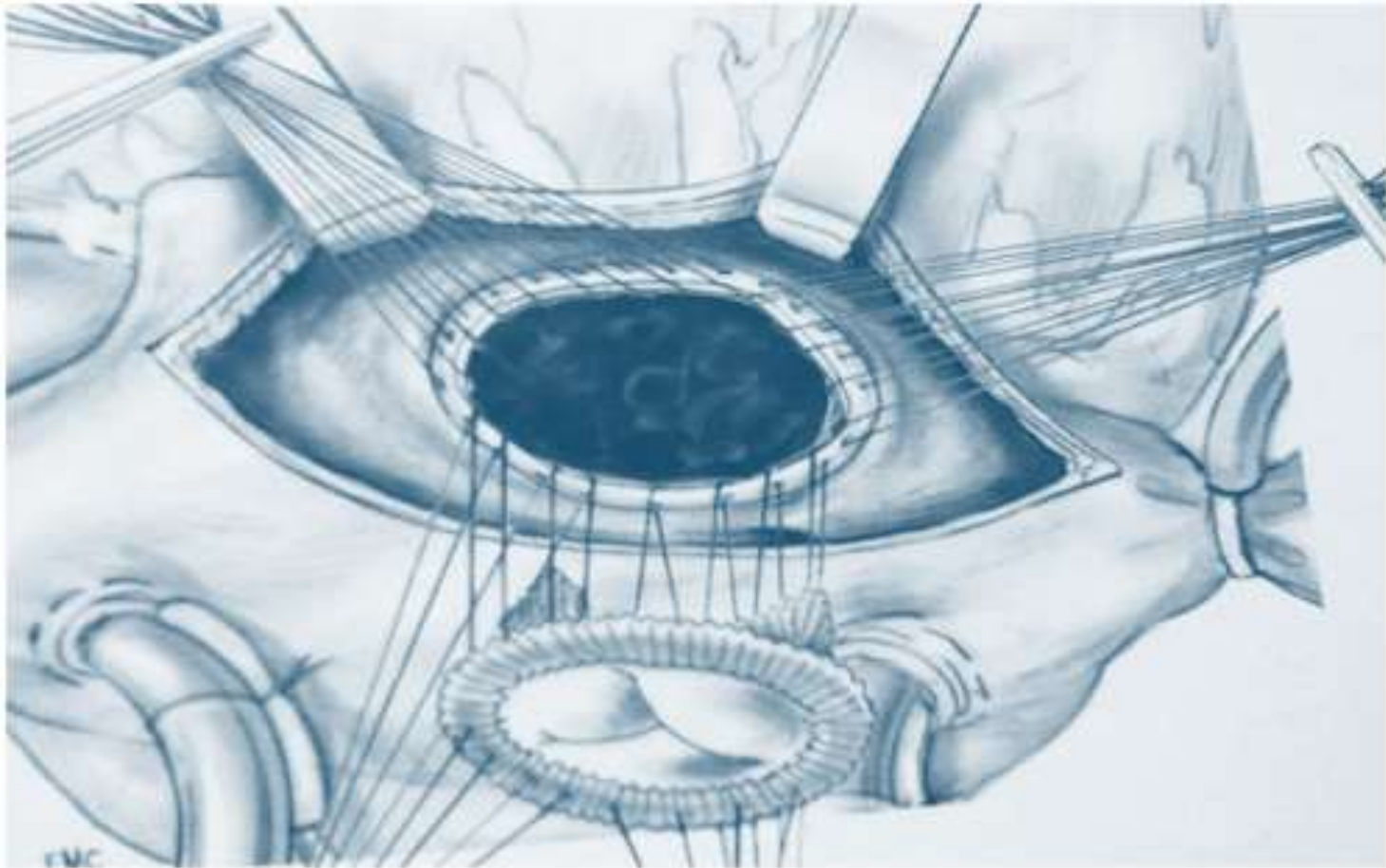
Suture annuloplasty: De Vega (A) and modified De Vega annuloplasty (B).

# *Techniques opératoires*



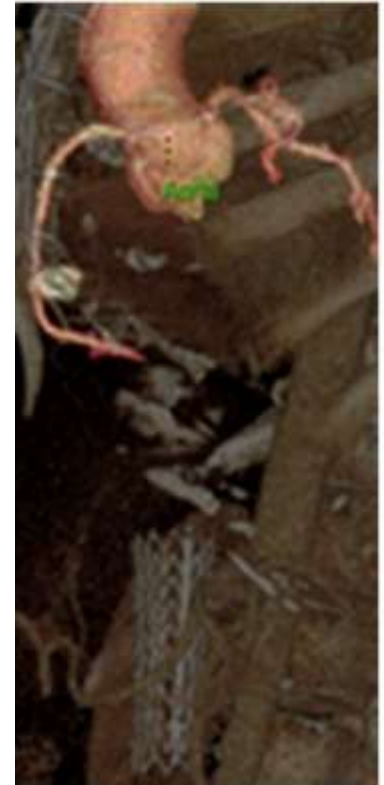
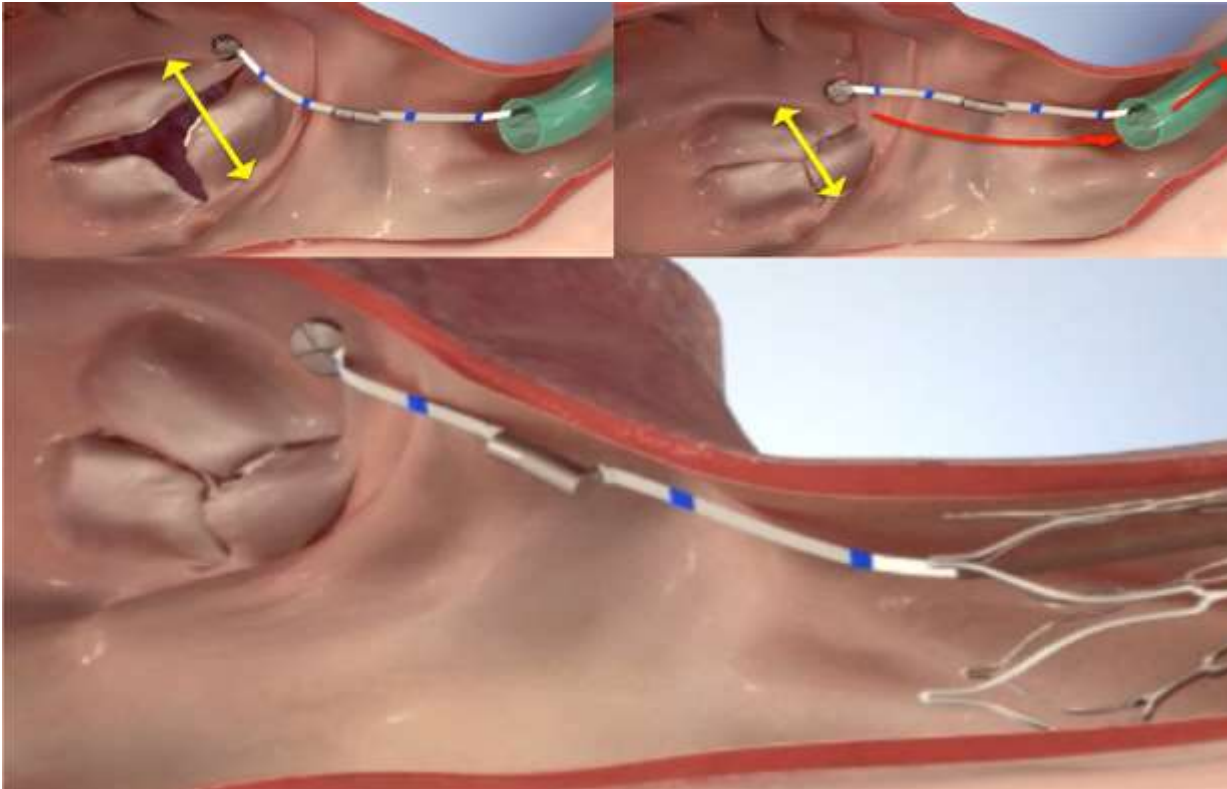
Annuloplastie : possible réalisation a Cœur battant

## *Techniques opératoires*



Remplacement valvulaire

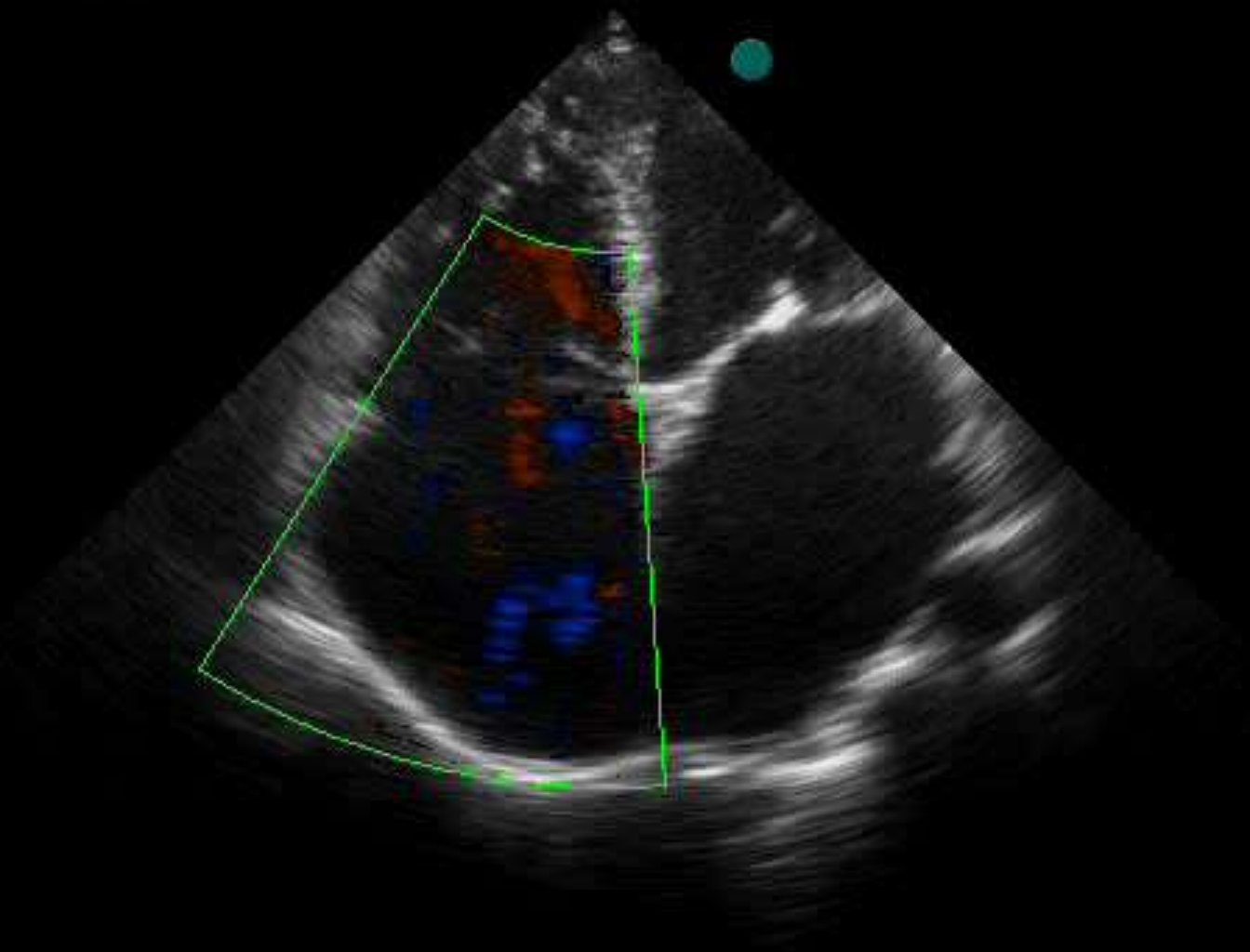
# Techniques Per-cutannées





# Conclusion

- La valve oubliée du cœur
- Co morbidité importante
- Clinique peu spécifique: Intérêt de l'échocardiographie
- Développements en cours : 3D ++++
- Imageries alternatives: IRM ++
- Horizons: Approche percutanée

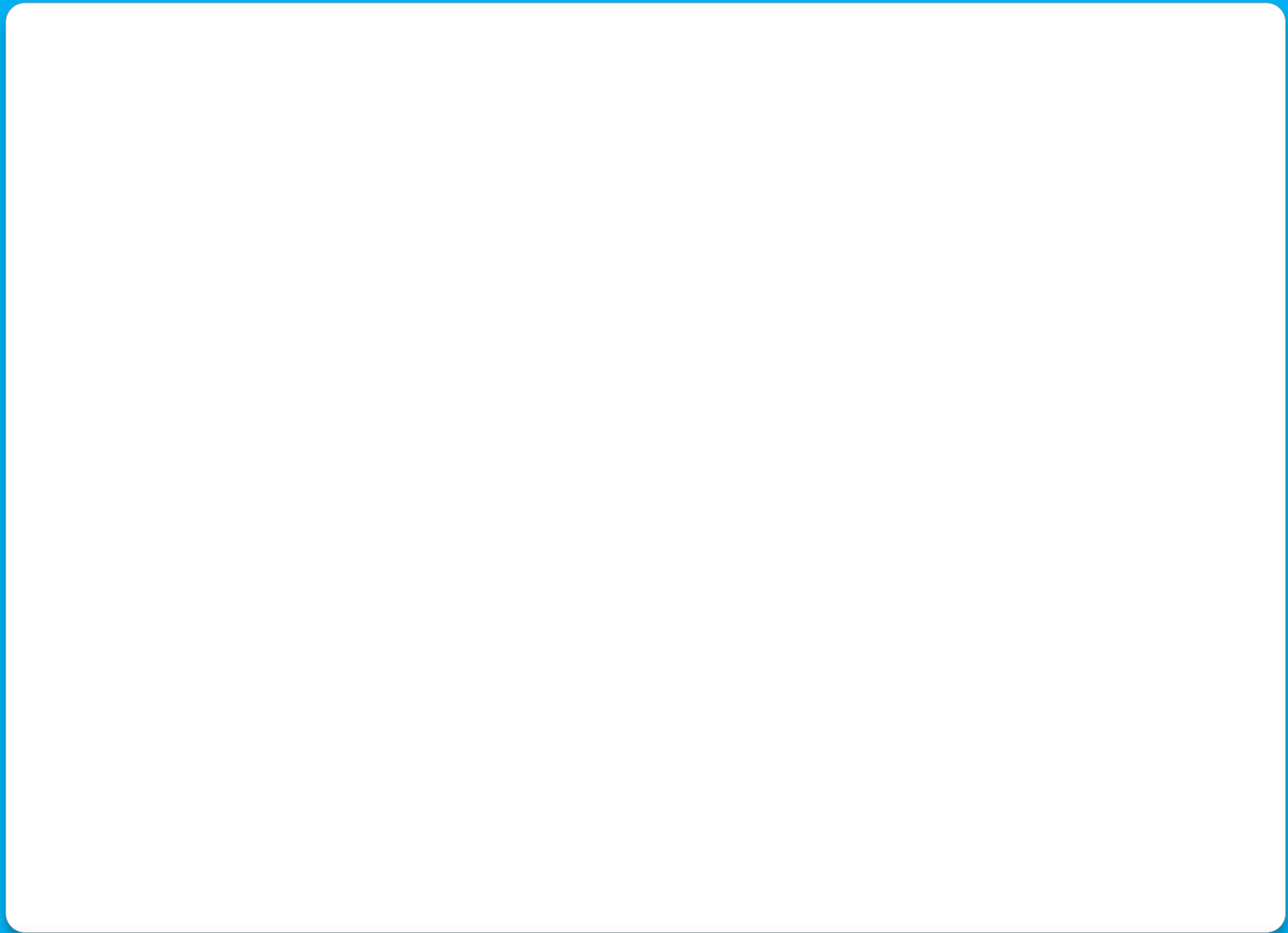


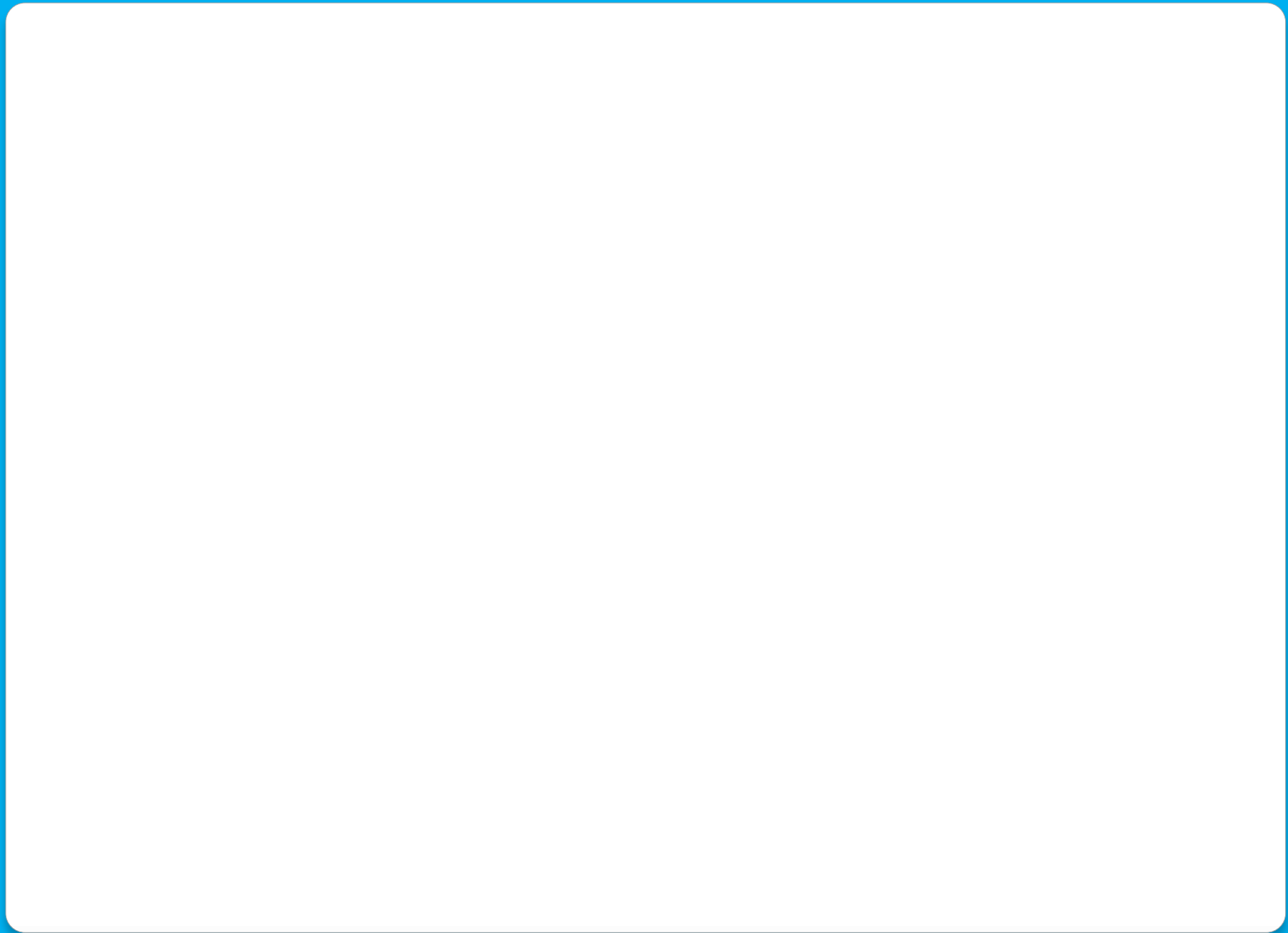
3 2D 30 cm  
11 im/s  
f: 1.7 MHz H  
DR: 65 dB  
R: 2.0 G: 60

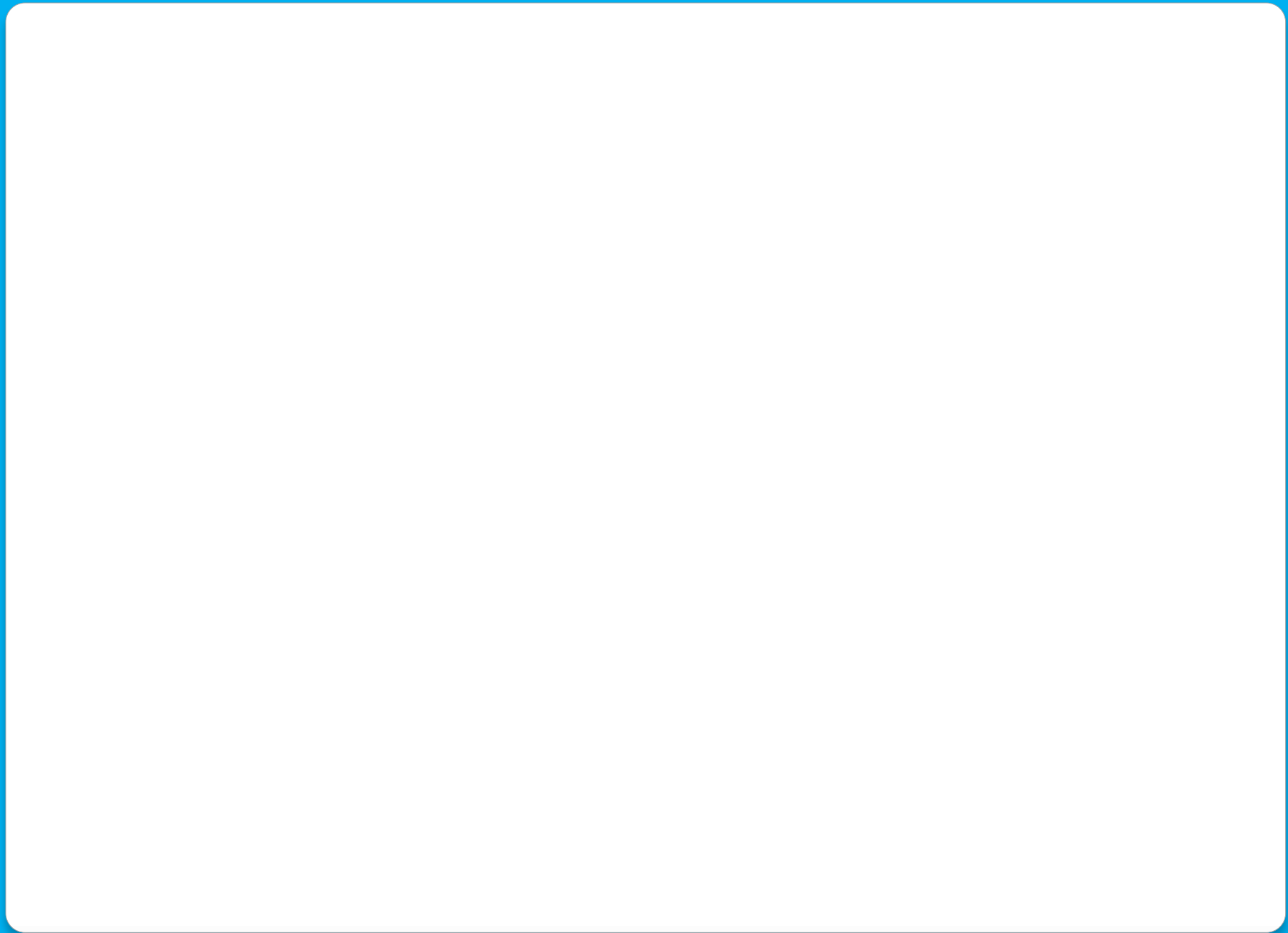
CFM G: 62  
f: 2.2 MHz  
PRF:3300Hz  
RBV2.9cm/s

P:0dB  
ITs:1.3  
IM:1.1









# Indication opératoires

**TABLE 7.** 2006 ACC/AHA guidelines for management of patients with valvular heart disease<sup>35</sup>: Tricuspid valve disease

## Management

### Class I

TV repair is beneficial for severe TR in patients with MV disease requiring MV surgery  
(*Level of Evidence: B*)

### Class IIa

1. TV replacement or annuloplasty is reasonable for severe primary tricuspid regurgitation when symptomatic (*Level of Evidence: C*)
2. TV replacement is reasonable for severe TR secondary to diseased/abnormal tricuspid valve leaflets not amenable to annuloplasty or repair (*Level of Evidence: C*)

### Class IIb

Tricuspid annuloplasty may be considered for less than severe TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation (*Level of Evidence: C*)

### Class III

1. TV replacement or annuloplasty is not indicated in asymptomatic patients with TR whose pulmonary artery systolic pressure is less than 60 mm Hg in the presence of a normal MV (*Level of Evidence: C*)
2. TV replacement or annuloplasty is not indicated in patients with mild primary TR (*Level of Evidence: C*)

## Tricuspid Valve Surgery

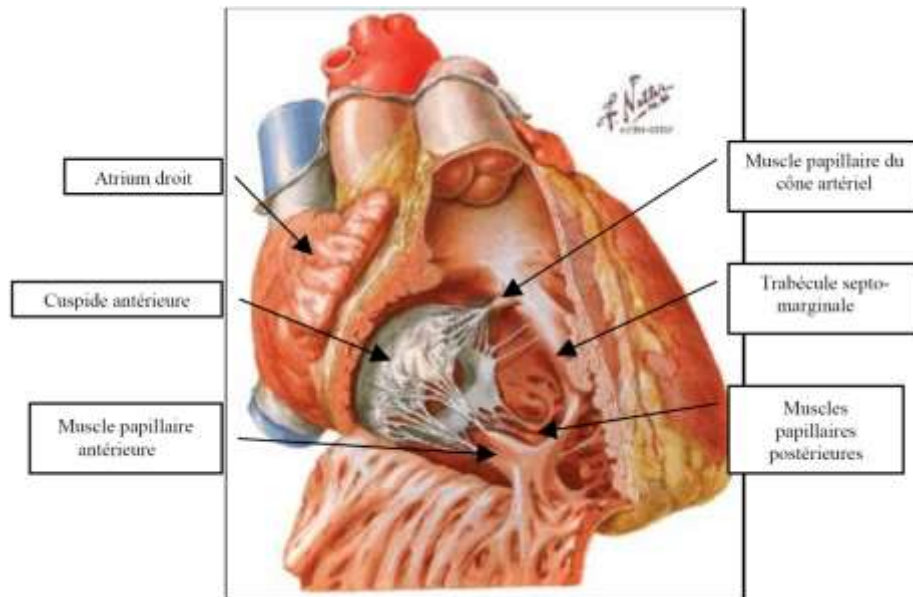
### Class I

Severe TR in the setting of surgery for multivalvular disease should be corrected. (*Level of Evidence: C*)

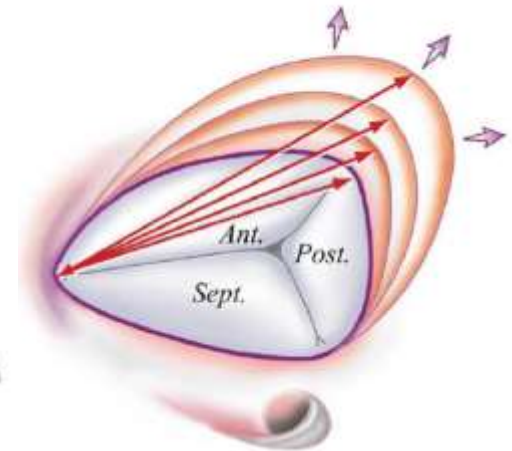
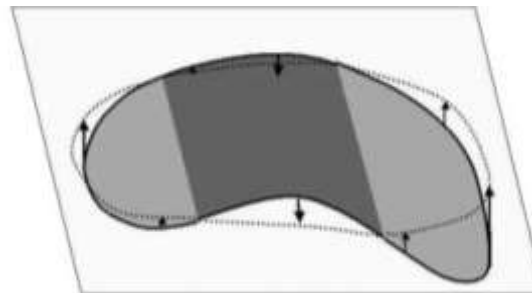
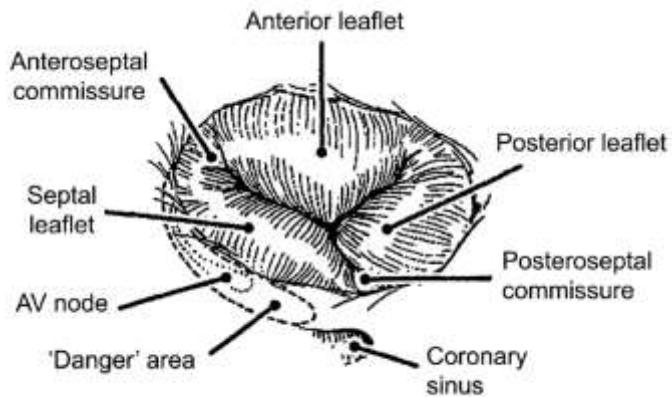
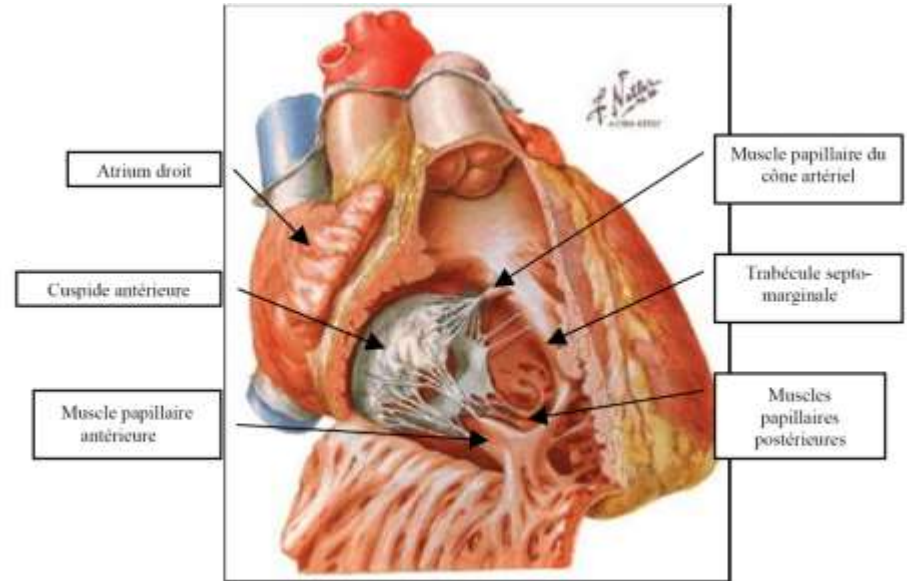
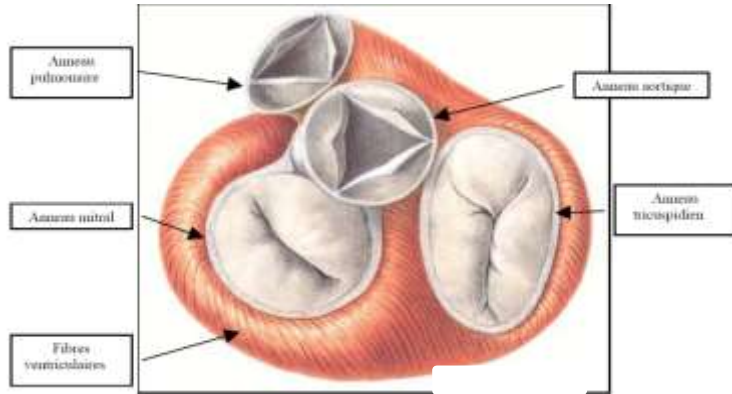
### Class IIa

Tricuspid annuloplasty is reasonable for mild TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation. (*Level of Evidence: C*)

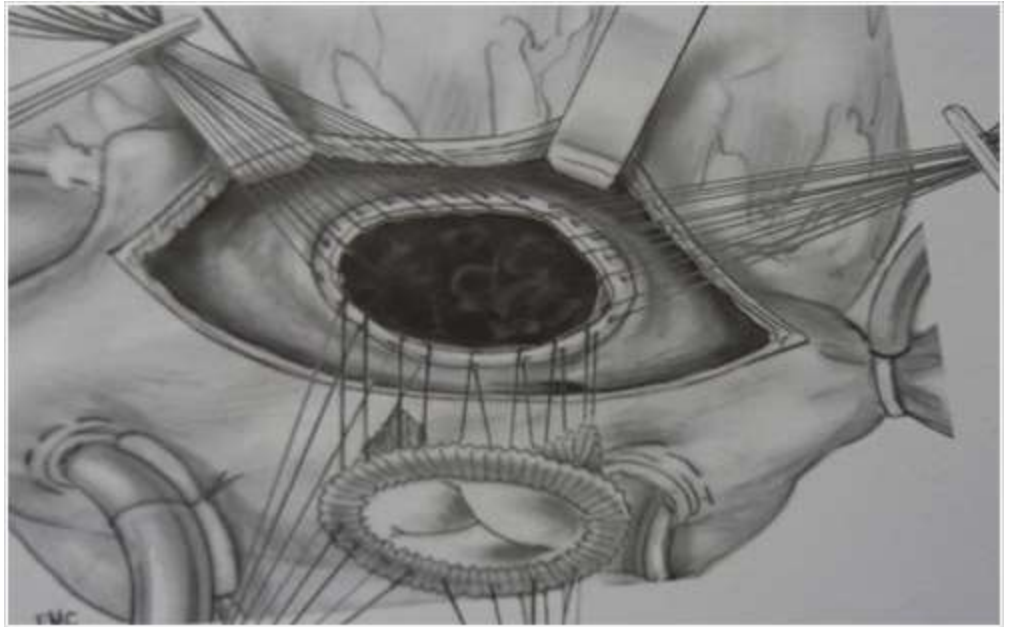
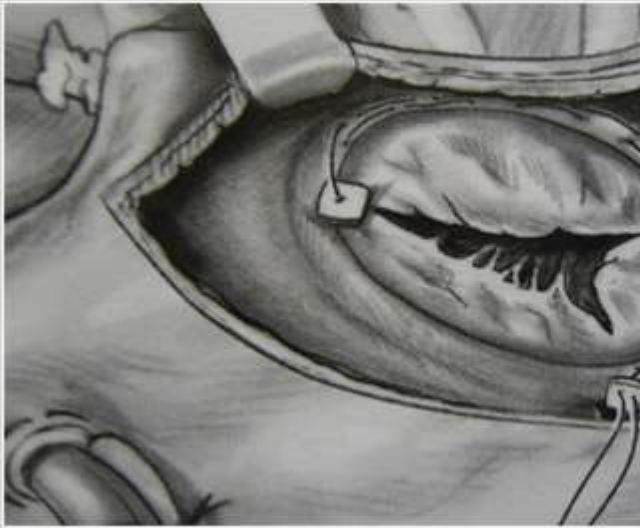
# Rappels anatomiques



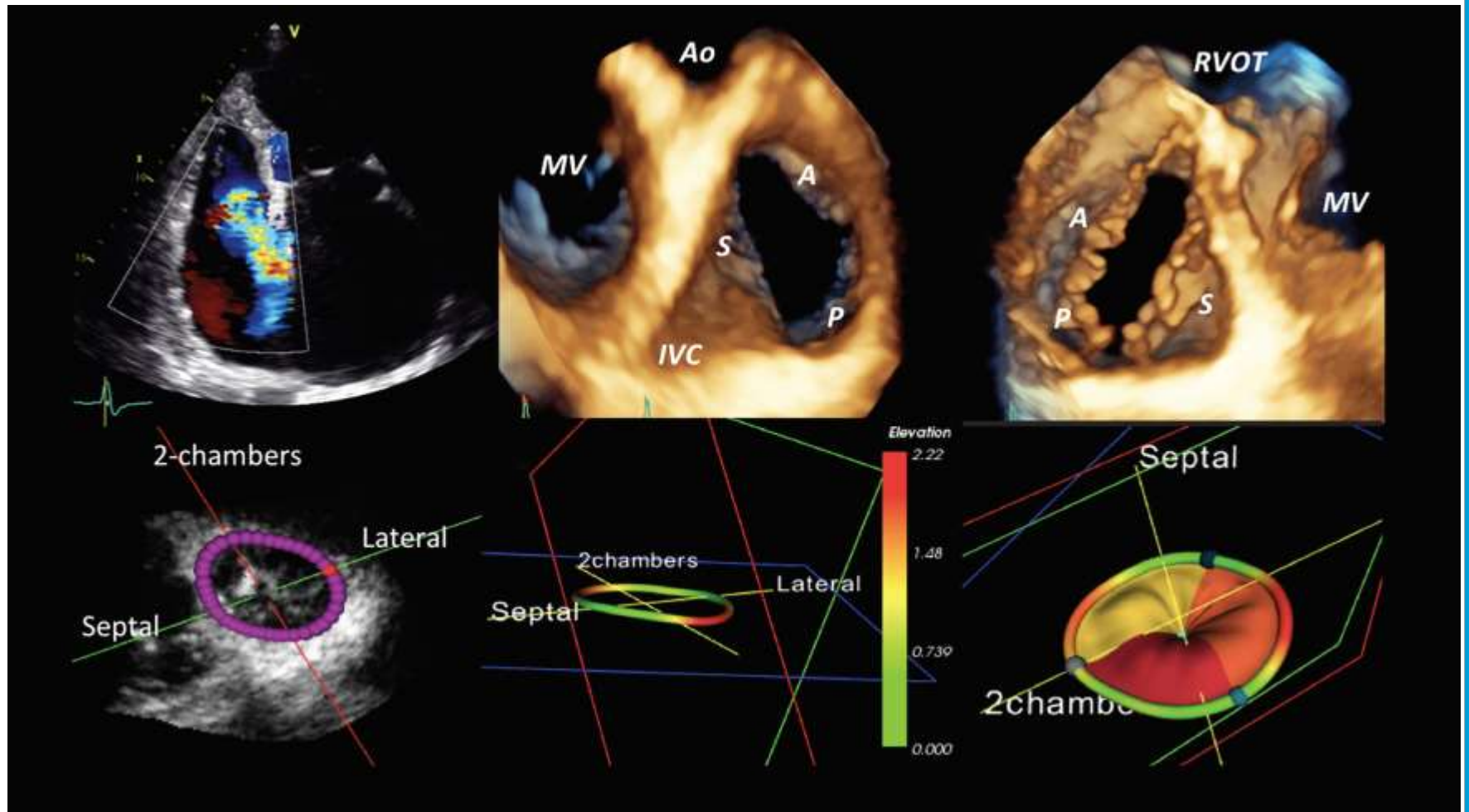
# Rappels anatomiques



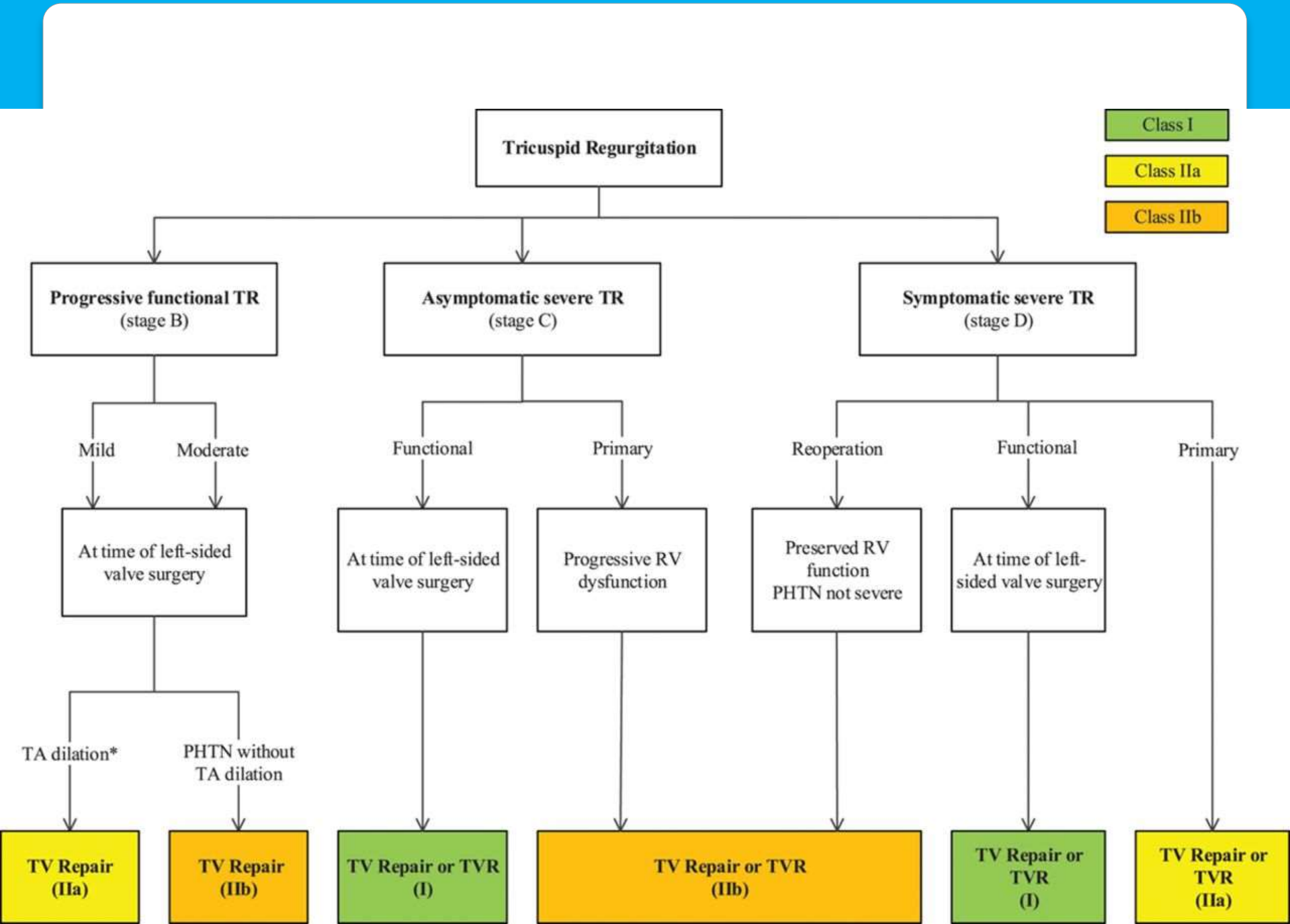


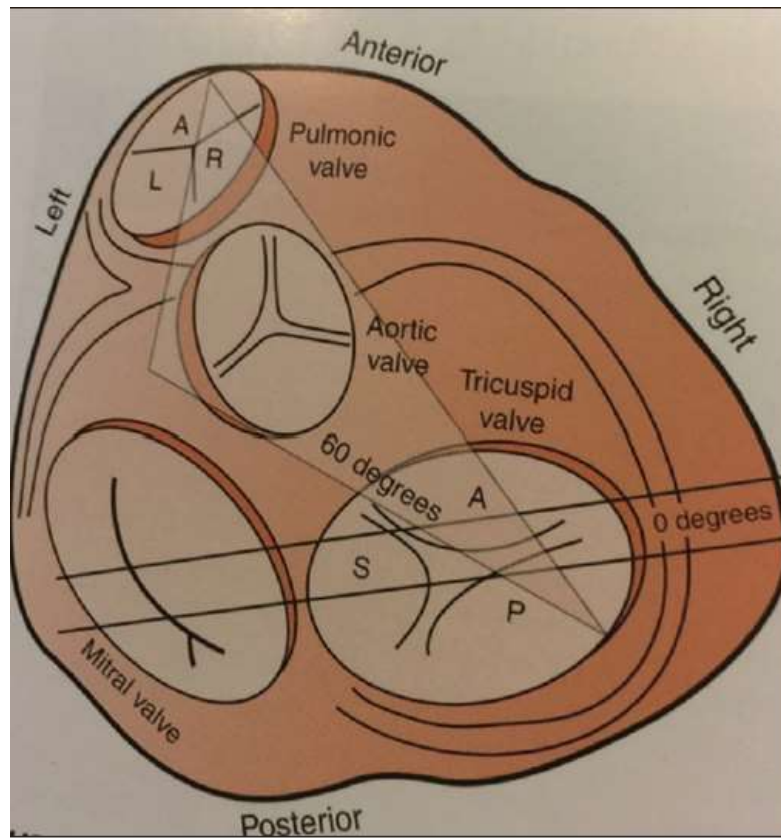


# Echocardiographie 3D



*Korean Circ J 2016;46(4):443-455*



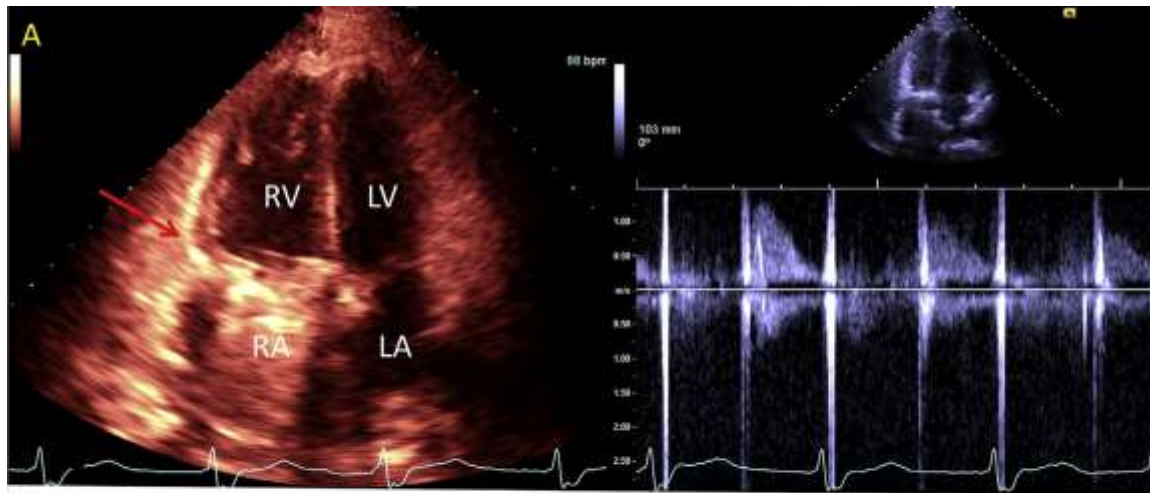


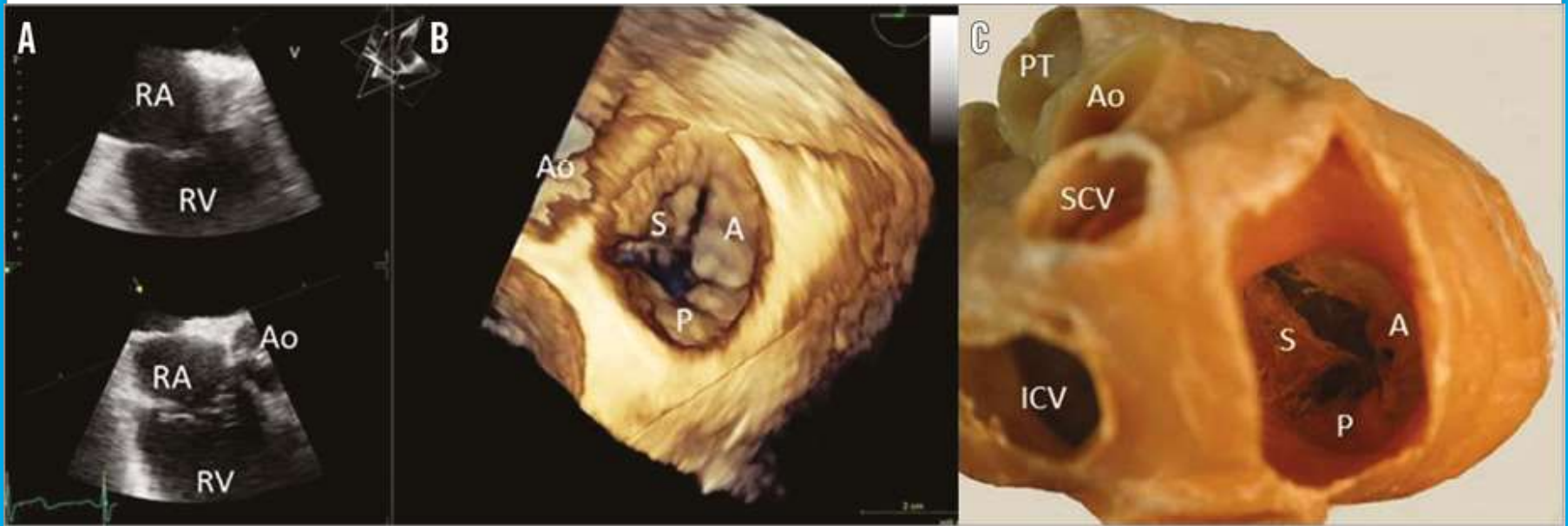
*Bhatia A. Ann Card Anaesth 2016;19:S21-5.*

**Table 1.** Management-oriented classification of functional tricuspid regurgitation

	<b>Stage 1</b>	<b>Stage 2</b>	<b>Stage 3</b>
TR severity	None or mild	Mild or moderate	Severe
Annular diameter, mm	<40	>40	>40
Leaflet coaptation mode	Normal*	Edge-to-edge*	Absent <sup>†</sup>
Treatment	Medical treatment	Tricuspid annuloplasty	Tricuspid annuloplasty+leaflet augmentation <sup>†</sup>

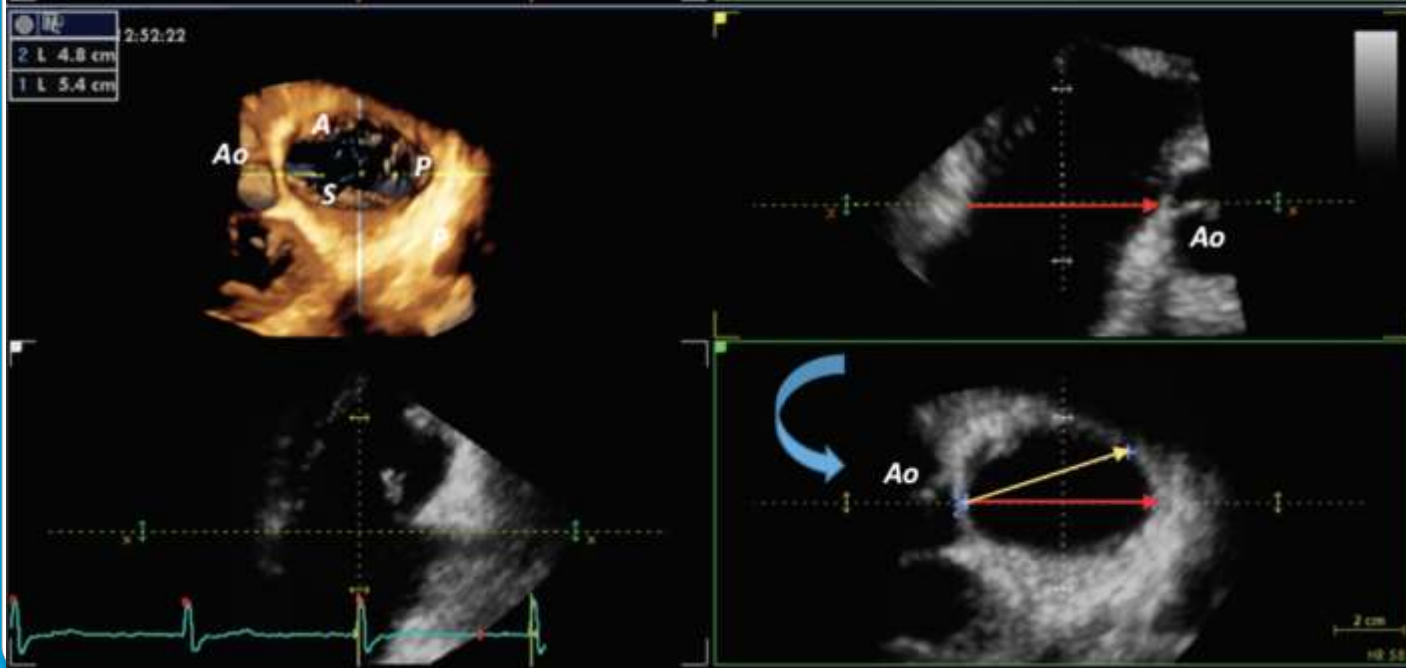
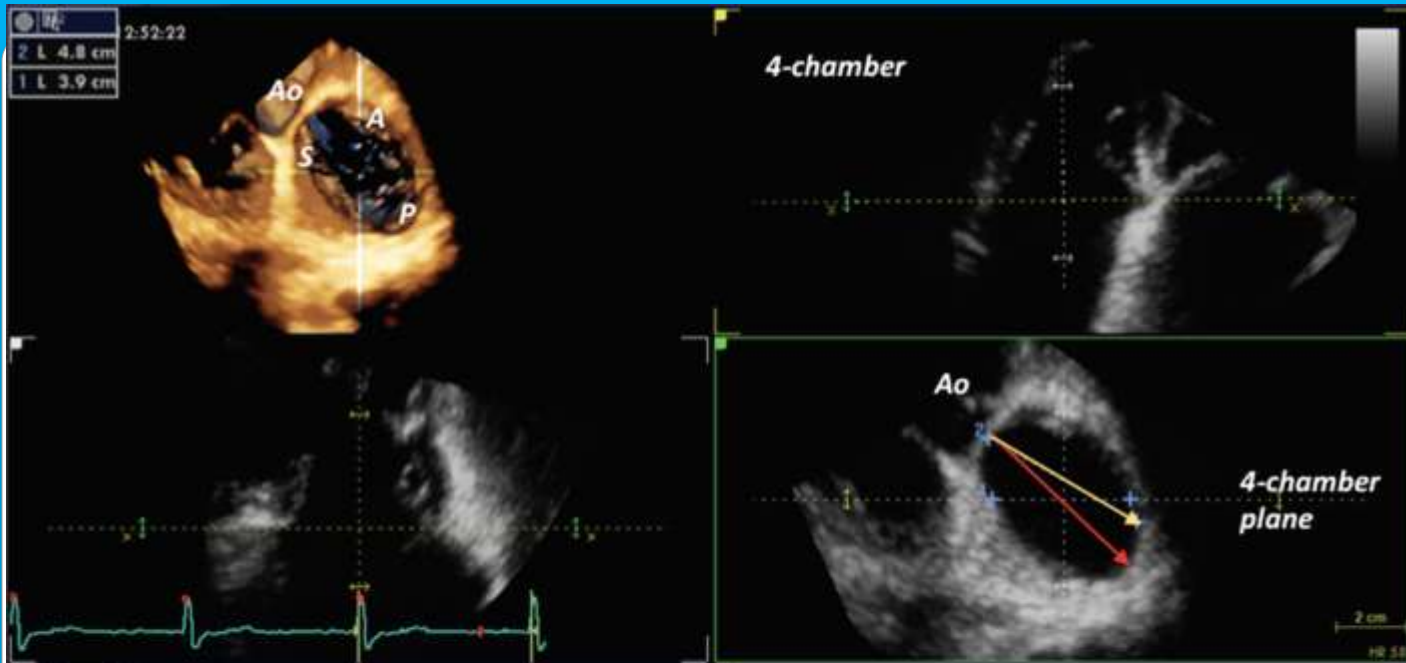
\*No leaflet tethering (<8 mm). <sup>†</sup>Leaflet tethering may be present (≥8 mm). <sup>†</sup>If leaflet tethering is present. TR: tricuspid regurgitation. Modified from Dreyfus et al.<sup>17)</sup>



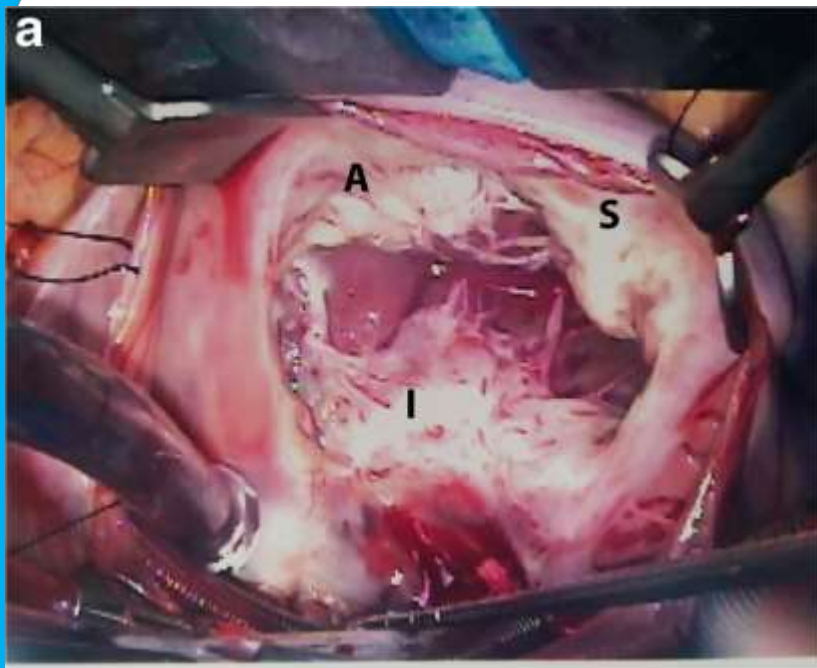


EuroIntervention 2015;11:W123-W127

**The tricuspid valve and the right heart: anatomical, pathological and imaging specifications**

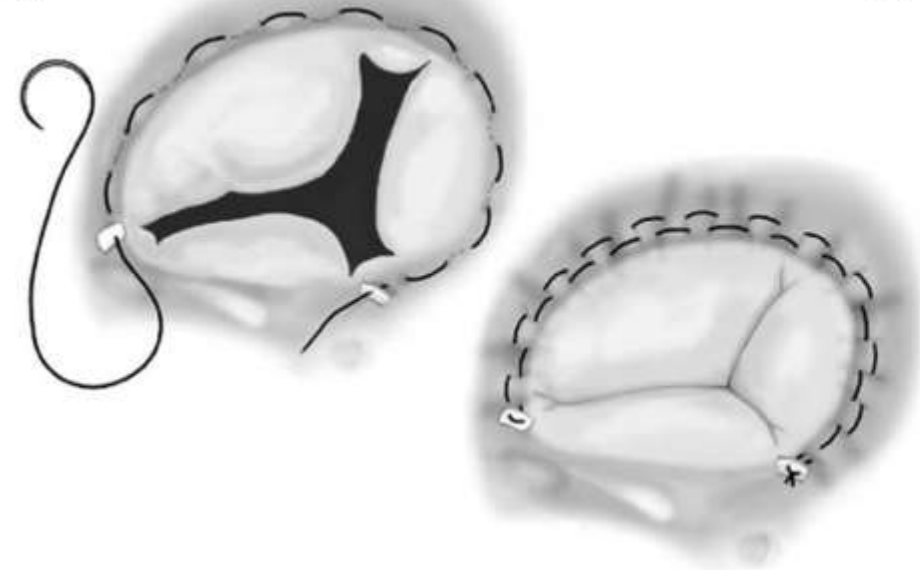




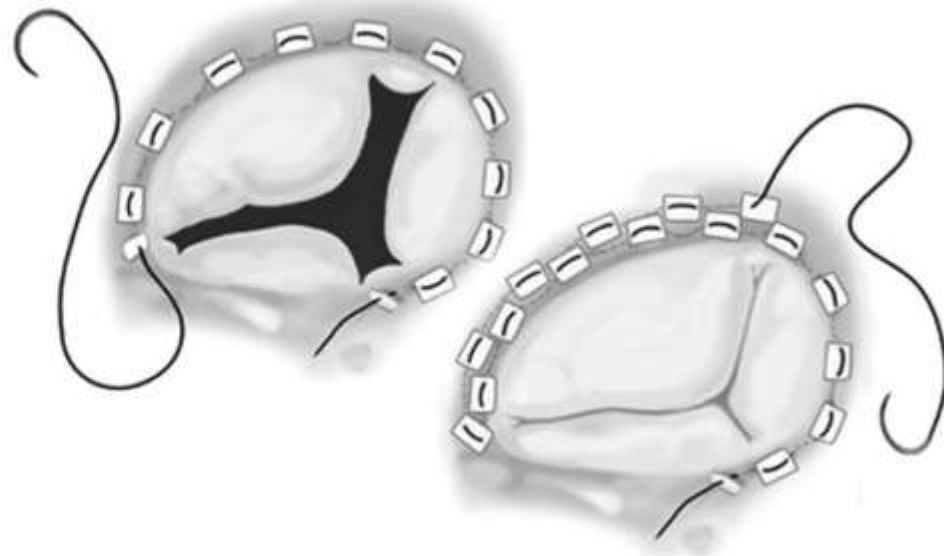


Insights Imaging (2016) 7:649–667

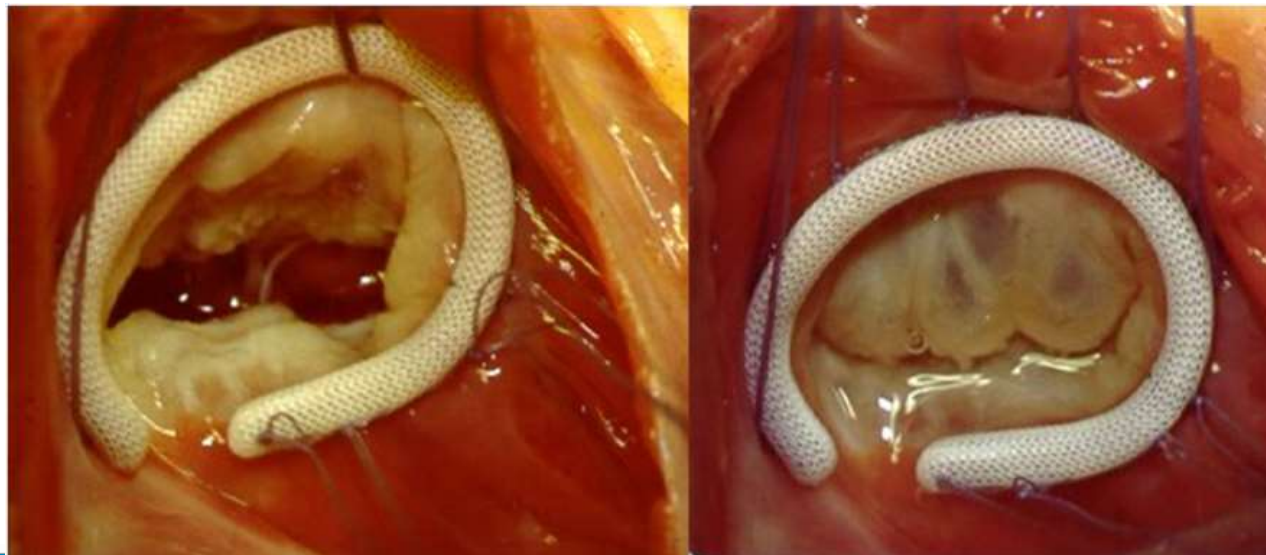
A



B



Suture annuloplasty: De Vega (A) and modified De Vega annuloplasty (B).



## Fuites tricuspides post PMK

- Fréquence estimée 24.2% aggravent une IT pré existante, dont 5% IT modérée à sévère
- Plus fréquemment après pose DAI
  - Volume de sonde
  - Pathologie sous jacente?
- Augmentation du risque de fuite parallèlement au nombre de sondes en place
- Indications opératoires pour IT sévère augmente avec le temps

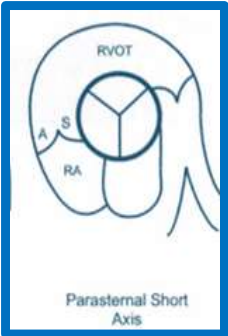
# Fuites tricuspides post PMK

- Lésions observées
  - Fibrose
  - Épaississement des feuillets valvulaires
  - Limitation de la mobilité
- Mécanismes évoqués
  - Adhérence
  - Perforation feuillet septal ou postérieur
  - Enchevêtrement
  - Gène à la mobilité des feuillets

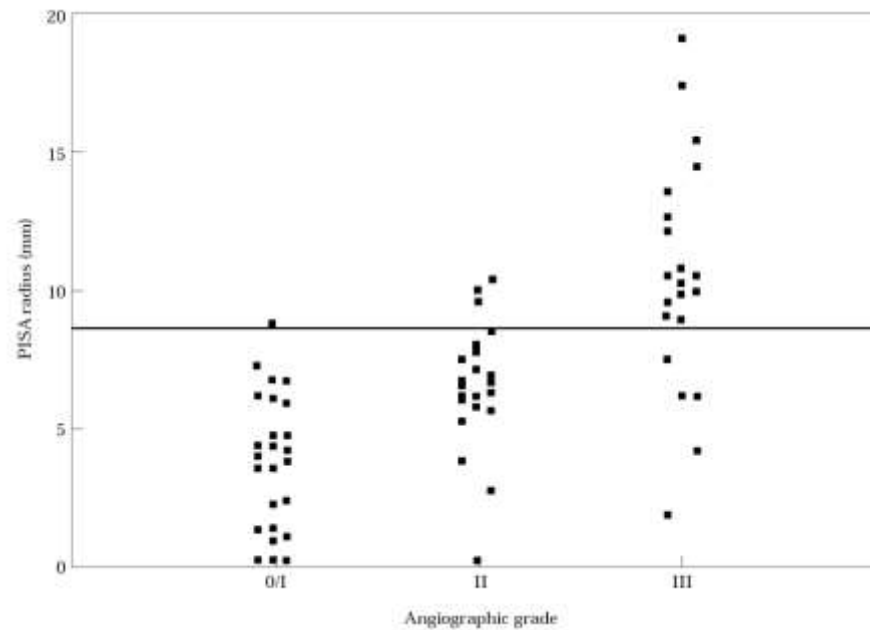
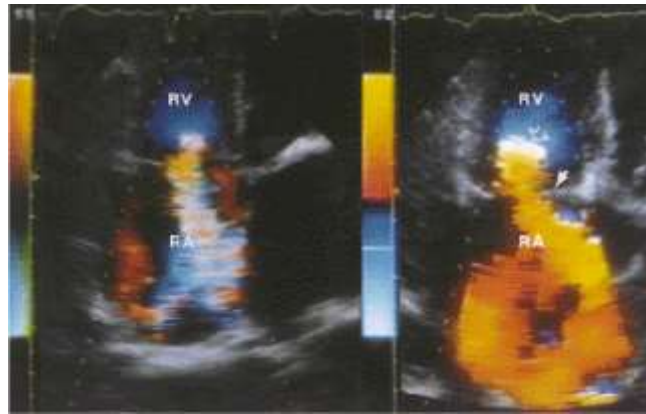
# Rappels anatomiques

## Fuites tricuspides post PMK

- Pas de relation entre position de sonde et intensification IT
- Diagnostic de gravité délicat en raison de « l'ombre portée » de la sonde
- Influence non connue sur le devenir des patients

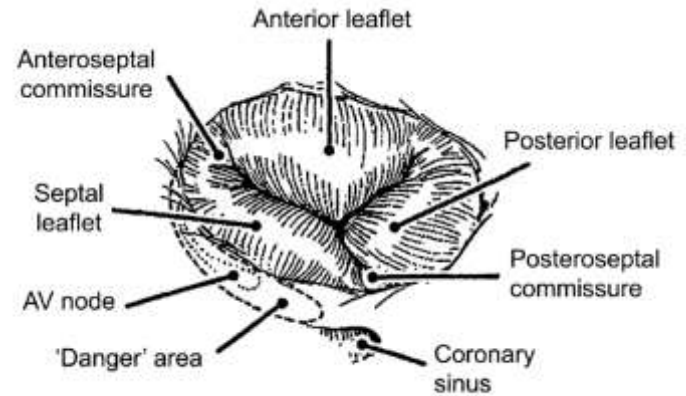
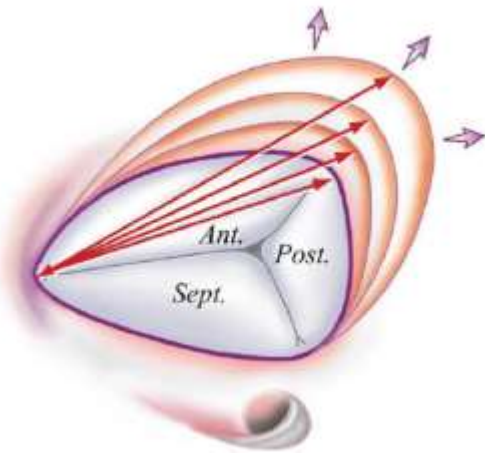
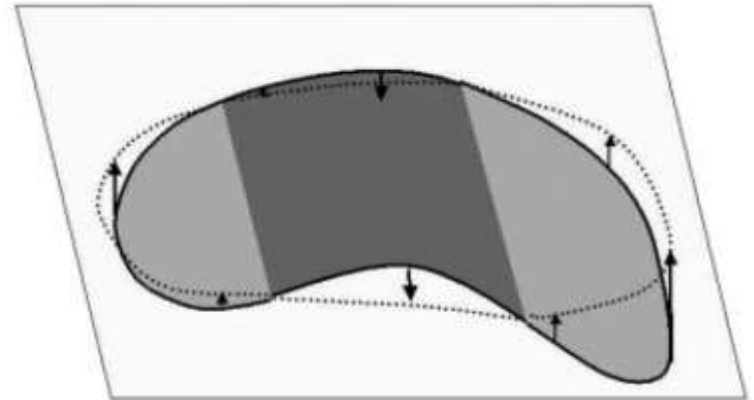
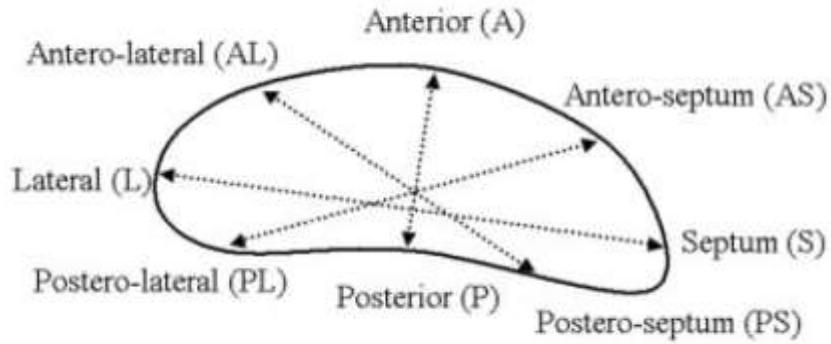


Parasternal Short  
Axis



**Grossmann Eur Heart J 1998; 19: 652–659**

# Rappels anatomiques





# Rappels anatomiques

# Echocardiographie de contraste



<b>Parameters for tricuspid severity</b>	<b>Mild</b>	<b>Moderate</b>	<b>Severe</b>
Anatomy of leaflets	Normal	Normal or abnormal	Abnormal, flail, noncoaptation
HV/RA/RV size	Normal	Normal or dilated	Dilated
Jet area (cm <sup>2</sup> )	<0.5	>0.5	>10 or >30% of right atrial area
Vena contracta width (cm)	<0.2	<0.7	>0.7
Pisa radius (cm)	0.5	0.6-0.9	>0.9
TR jet by CWD	Soft parabolic	Dense, variable contour	Dense, triangular, early peak
HV flow profile	S>D systolic dominance	S<D	S<0 systolic reversal
Tricuspid inflow (cm <sup>2</sup> )			E>1
EROA (ml)			>45
Effective regurgitant volume (ml)			>45

HV: Hepatic vein, RA: Right atrium, RV: Right ventricle, TR: Tricuspid regurgitation, CWD: Continuous wave Doppler, EROA: Effective regurgitant orifice area

# ***Fuites tricuspides post Pace-Maker***

*JASE 2008;21:284*  
*JACC 2005;15:1672*

# *Fuites tricuspides post Pace-Maker*

- Fréquence estimée 24.2% aggravent une IT pré existante, dont 5% IT modérée à sévère
- Plus fréquemment après pose DAI
  - Volume de sonde
  - Pathologie sous jacente?
- Augmentation du risque de fuite parallèlement au nombre de sondes en place
- Indications opératoires pour IT sévère augmente avec le temps



