

# Anomalies de la valve tricuspidé

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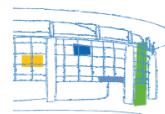
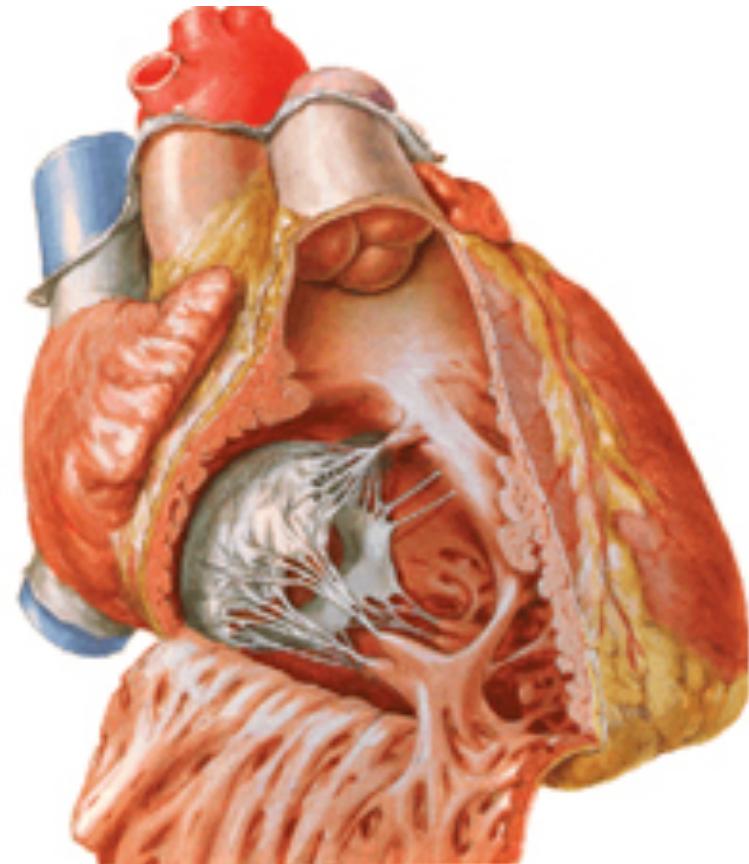
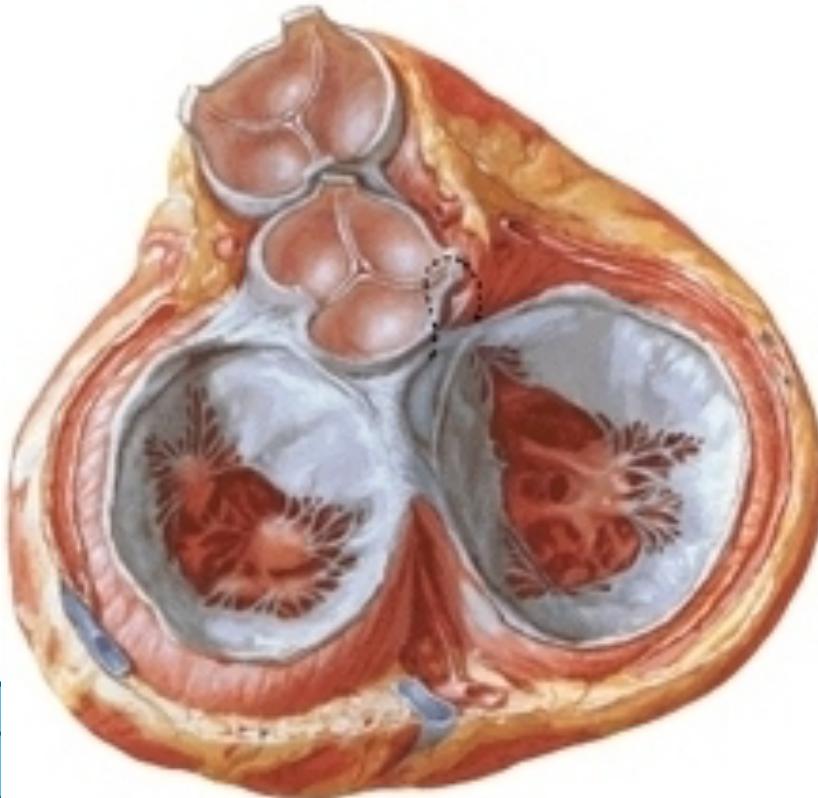
Bordeaux FRANCE



No disclosures

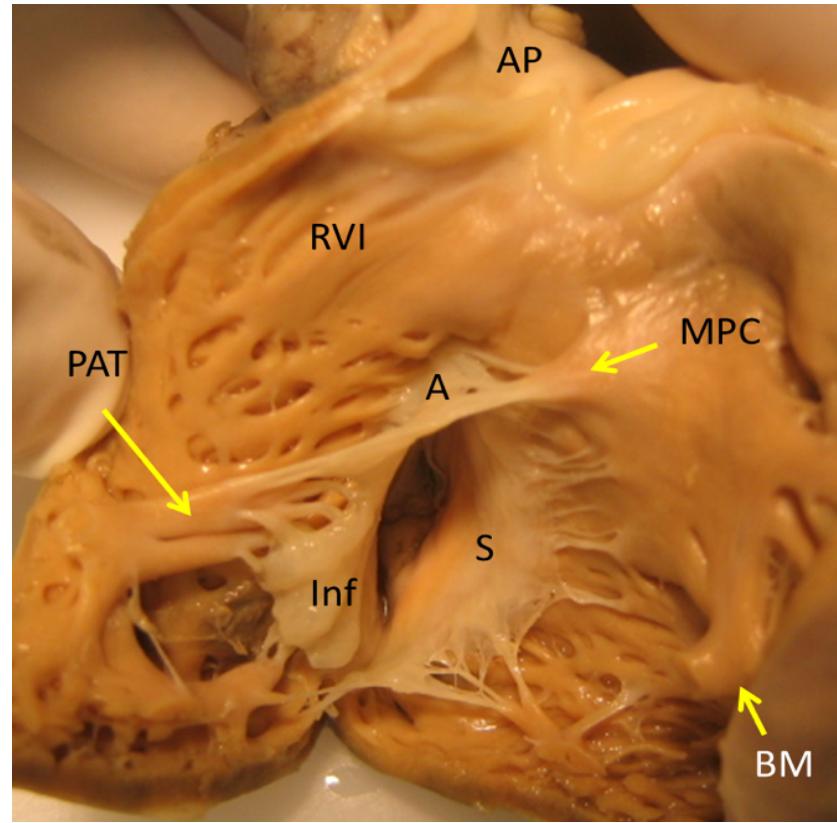
# Anatomy

- Large morphological variability
- Very thin leaflets
- Difficult to identify the scallops
- Leaflets and hing points often displaced from anatomic annulus



# Anatomie tricuspidé

- Anatomie des piliers variable
- 2 piliers constants:
  - le muscle papillaire du conus
  - pilier antérieur.
- Le feuillet septal: attache multiples sur le SIV directement ou par l'intermédiaire de petits piliers.



# classification

- Ebstein anomaly
- TV dysplasia (PA IVS, critical PS)
- Miscellaneous (cleft, prolapse,.....)
- Secondary TR (post VSD closure, PM lead, endocarditis)

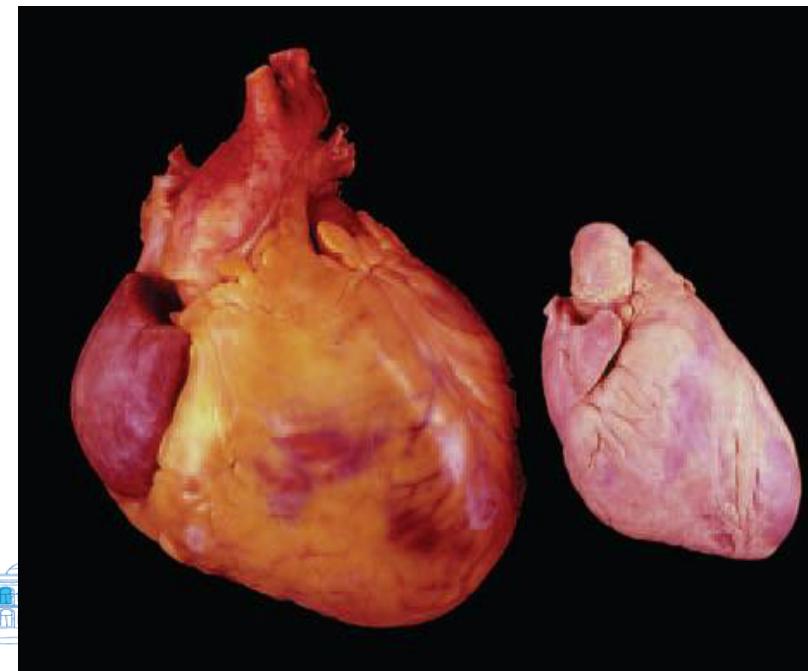


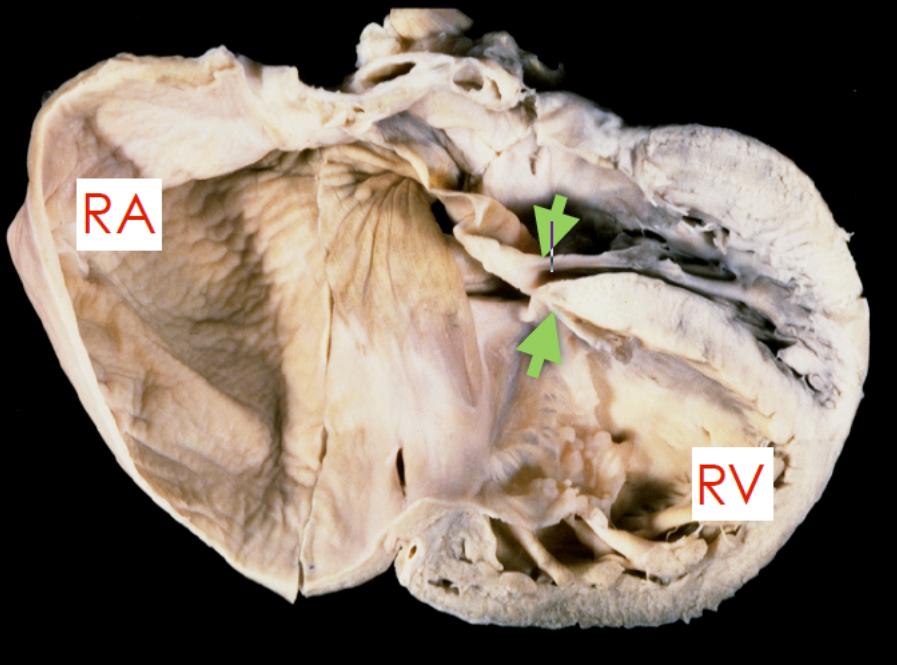
# Anomalie d'Ebstein

- décrite par Willem Ebstein en 1866
- patient de 19 ans
  - insuffisance tricuspidale
  - Cyanose
  - Dyspnée
  - Palpitations
  - turgescence jugulaire
  - cardiomégalie



Wilhelm Ebstein,  
1866,  
Professor of Medicine  
Gettingen, Germany

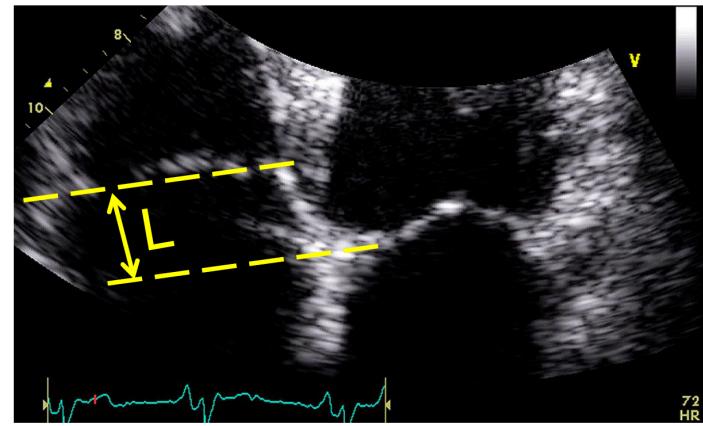




## Displacement index

$$\text{Index} = \frac{L}{\text{BSA}}$$

> 8 mm/m<sup>2</sup>  
Ebstein anomaly



Shiina A et al. J Am Coll Cardiol. 1984 ;3:356-70.



## Description autopsique initiale



feuillet tricuspidé antérieur élargi et fenestré



feuillets inférieur et septal hypoplasiques, épaisse et adhérente à la paroi du ventricule droit



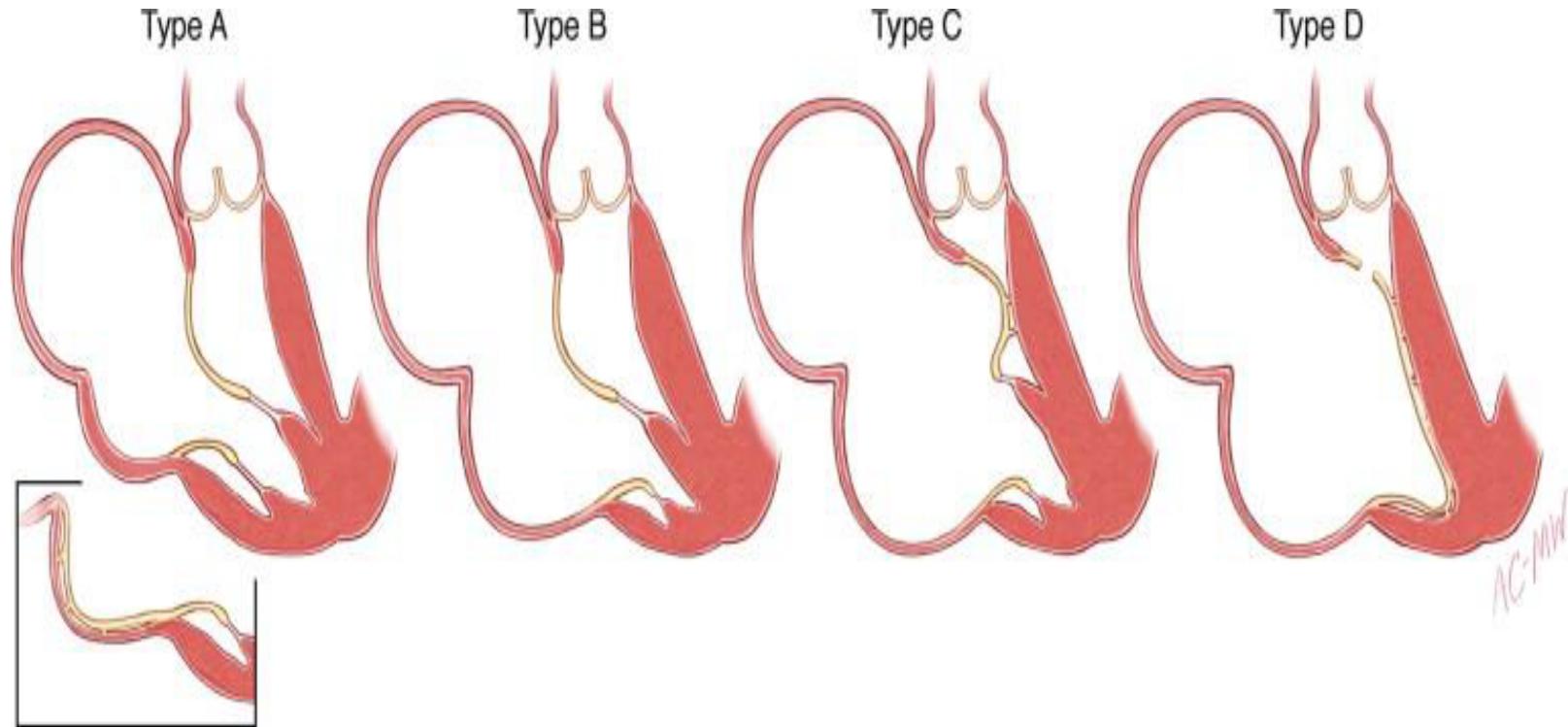
Atrialisation, dilatation, amincissement de la paroi VD



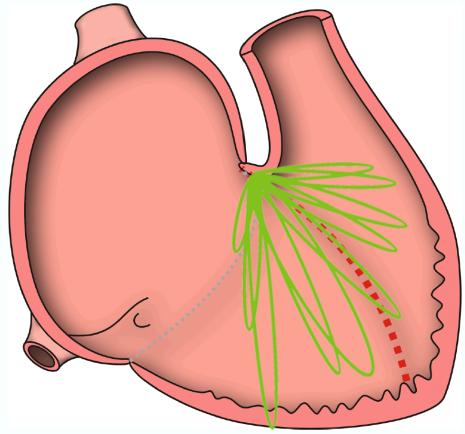
OD très dilatée + FOP

# Spectre anatomique et clinique

- Dépend du stade auquel s'arrête le développement normal de la tricuspidé

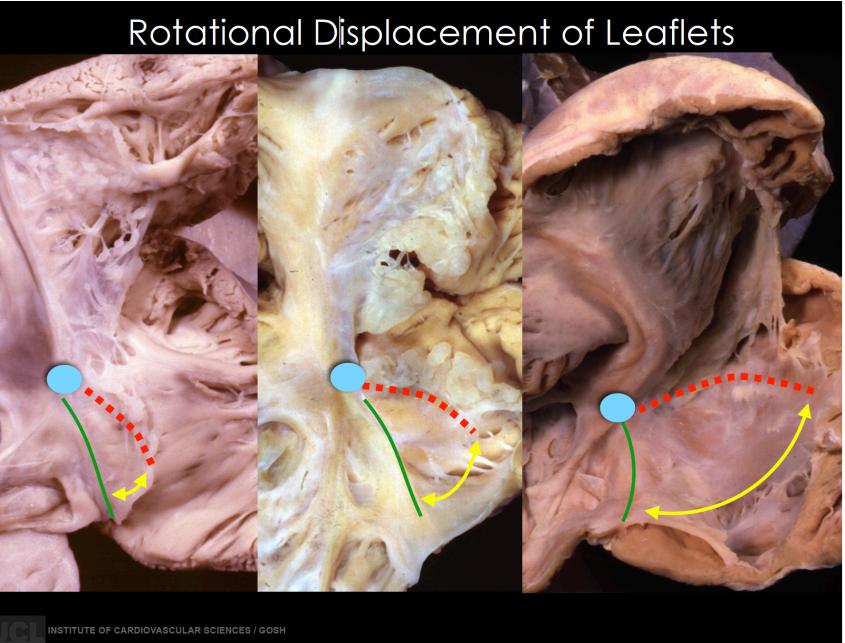


## Rotational Displacement in Ebstein's Malformation



Adapted from Schreiber C, Cook A et al J Thorac Cardiovasc Surg. 1999

 INSTITUTE OF CARDIOVASCULAR SCIENCES / GOSH

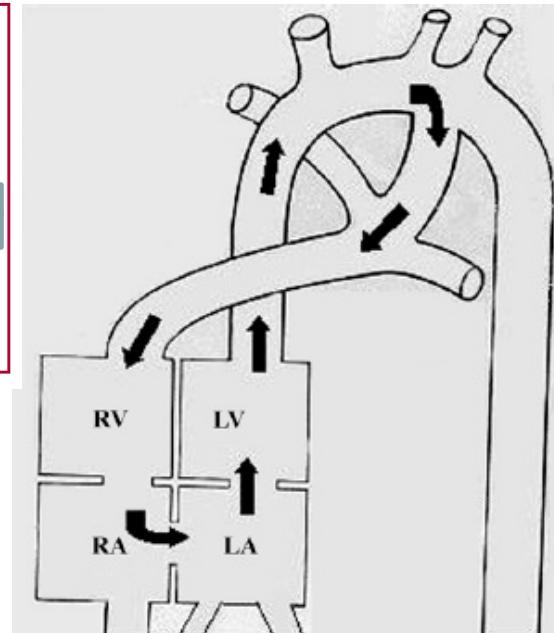


# Congenital Heart Disease

## Outcomes and Predictors of Perinatal Mortality in Fetuses With Ebstein Anomaly or Tricuspid Valve Dysplasia in the Current Era A Multicenter Study

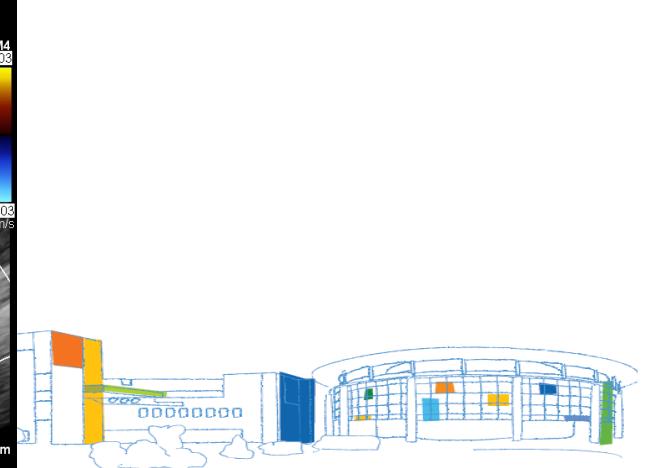
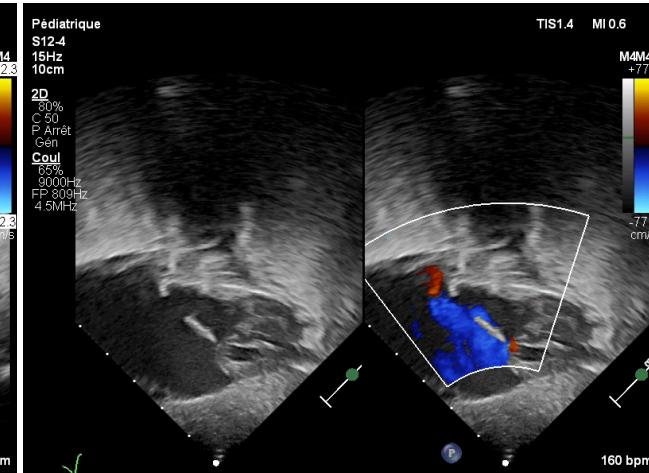
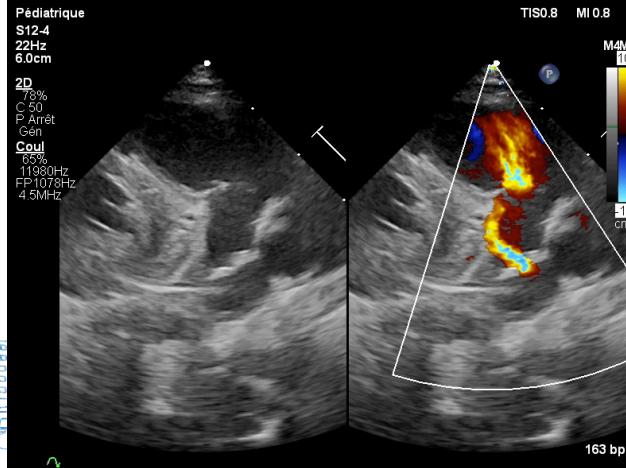
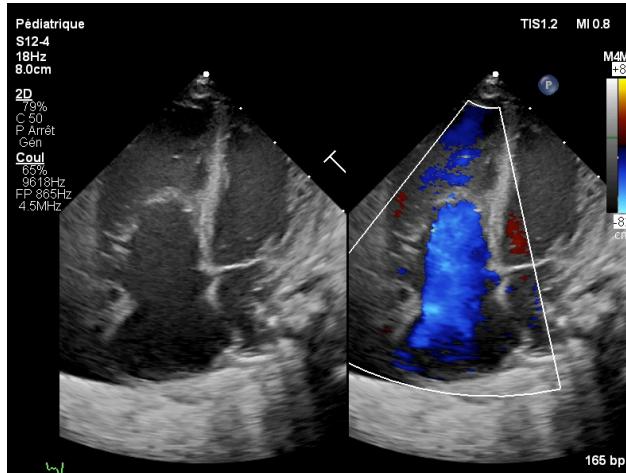
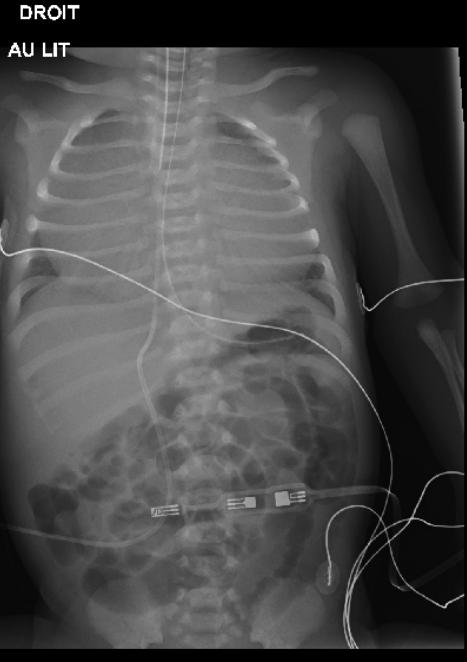
### CLINICAL PERSPECTIVE

Ebstein anomaly and tricuspid valve dysplasia are rare congenital tricuspid valve malformations associated with high perinatal mortality. Previous literature has consisted of single-center series, often spanning several decades. We report a series of 243 fetuses with Ebstein anomaly or tricuspid valve dysplasia from 23 centers across North America in the recent era. Unfortunately, perinatal mortality remained high at 45%, with one-third of patients not surviving to neonatal hospital discharge. Independent risk factors for mortality included gestational age at diagnosis of <32 weeks, larger tricuspid valve annulus z-score, the presence of pulmonary regurgitation, and a pericardial effusion. The presence of pulmonary regurgitation, in particular, signifies circular shunt physiology, which often culminated in mortality. An understanding of this unique physiology in utero may help clinicians better counsel expectant parents, develop and pursue novel treatment and perinatal management strategies, and ultimately improve mortality for fetuses with this rare and complex disease.



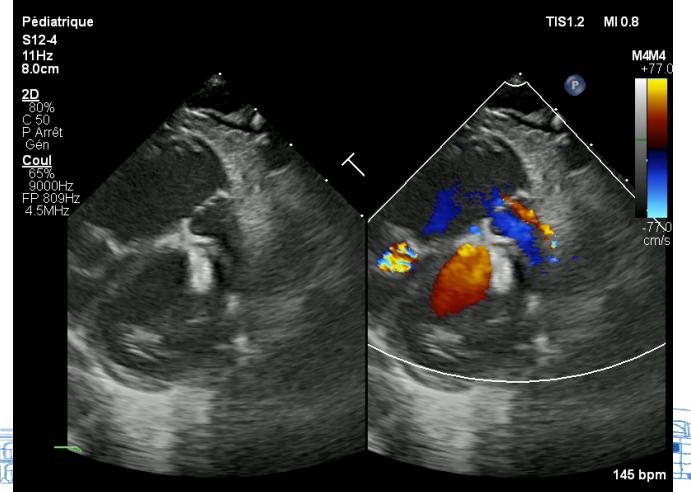
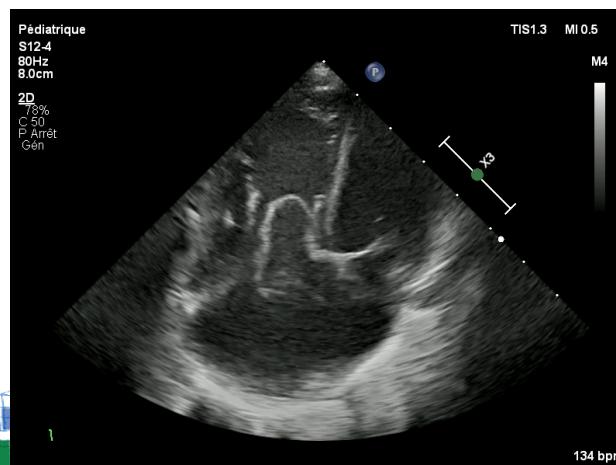
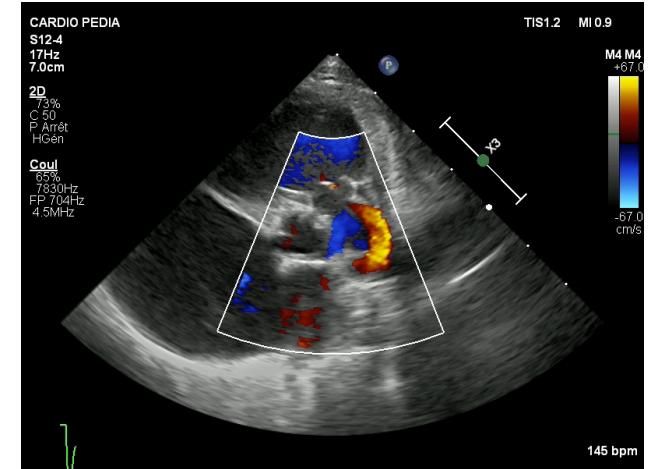
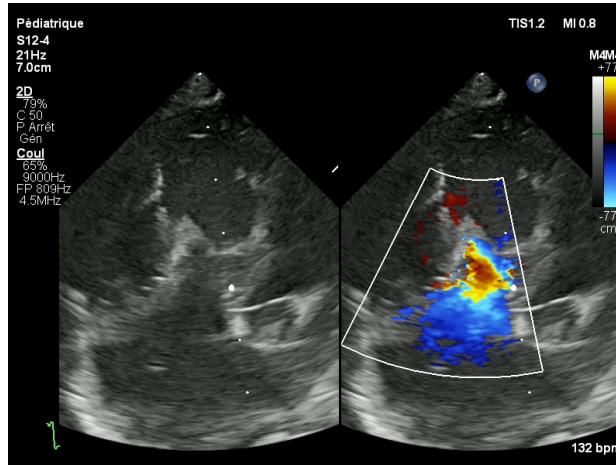
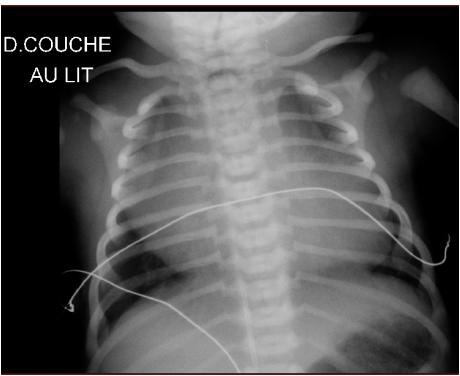
# Neo natal assessment

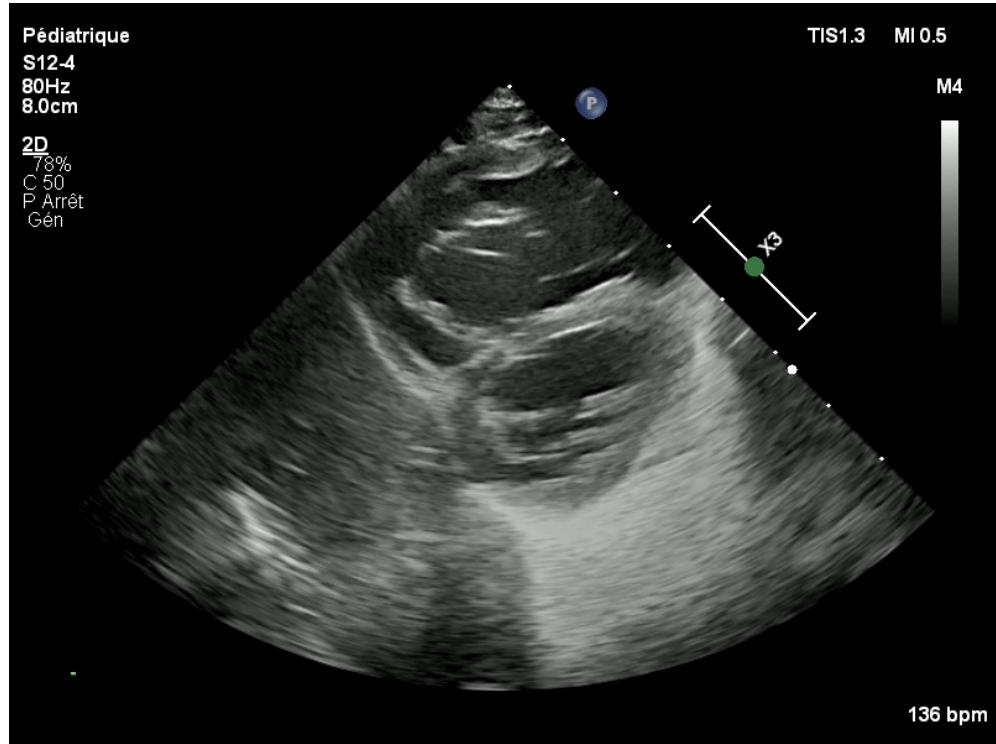
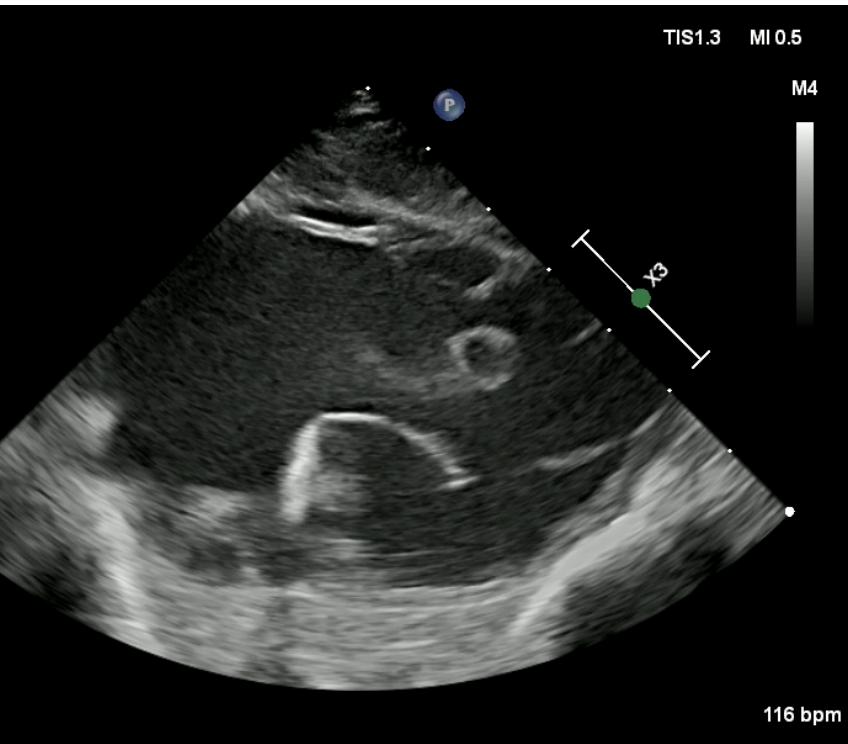
- Ebstein anomaly with circulatory shunt



# Neo natal assessment

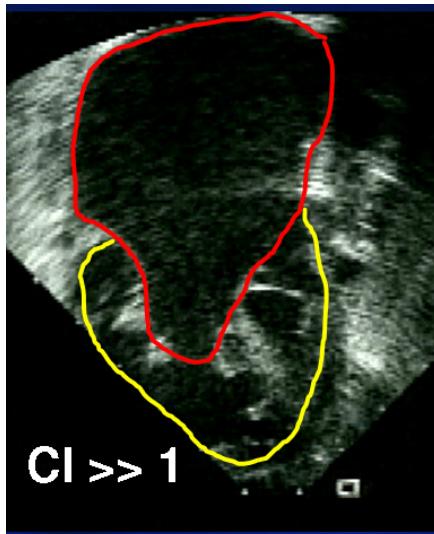
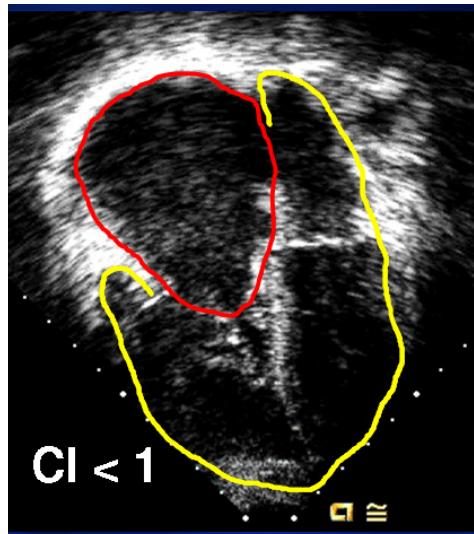
- Ebstein anomaly with no circulatory shunt





# Celermajer index

- Pour les nouveau-nés



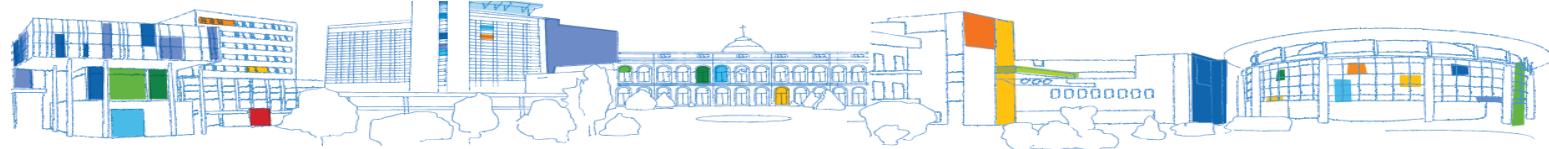
RA area + aRV area	
fRV area+ LA area + LV area	
Grade	ratio
1	< 0.5
2	0.5 ~ 0.99
3	1 ~ 1.49
4	> 1.5

GOSE score	ratio	Mortality (%)
1-2	< 1.0	8
3 (acyanotic)	1.1 ~ 1.4	10 (early) 45 (late)
3 (cyanotic)	1.1 ~ 1.4	100
4	> 1.5	100

# ETT



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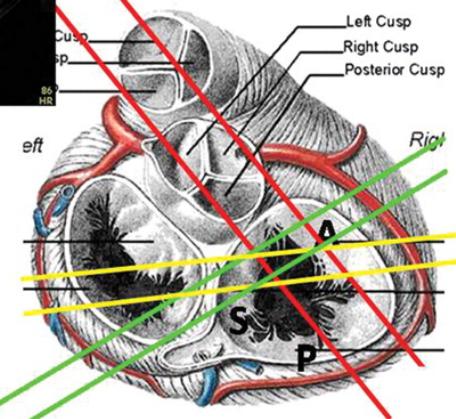


# Visualization of the tricuspid valve leaflets by two-dimensional echocardiography

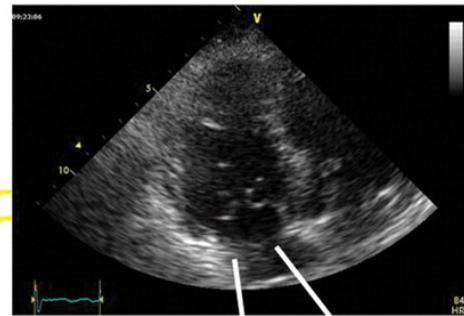
Parasternal SAX VIEW



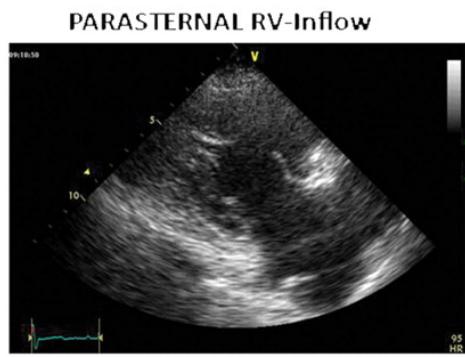
Septal	0%	48%
Anterior	0%	52%
Posterior	92%	0%



APICAL 4CH VIEW



Septal	0%	100%
Anterior	100%	0%
Posterior	0%	0%



Septal	100%	0%
Anterior	0%	100%
Posterior	0%	0%

Badano L P et al. Eur J Echocardiogr 2009;10:477-484



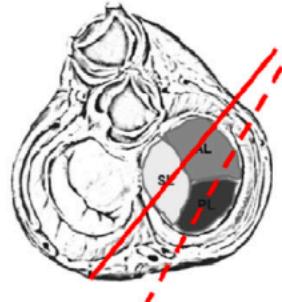
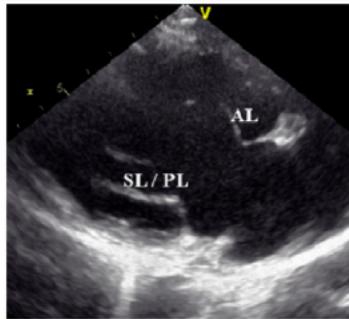
CHU



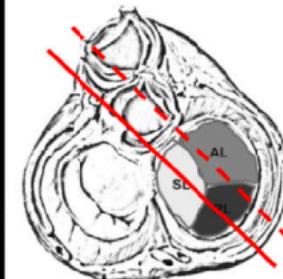
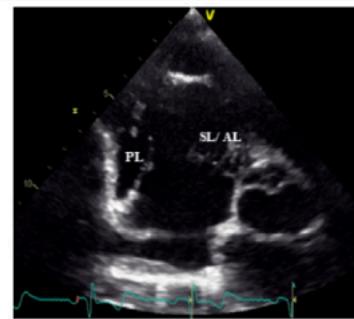
European Journal of  
Echocardiography

## 2D TRANSTHORACIC ECHOCARDIOGRAPHY

### PARASTERNAL LONG AXIS VIEW OF THE RV INFLOW



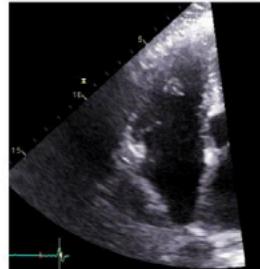
### PARASTERNAL SHORT AXIS VIEW AT THE AORTIC LEVEL



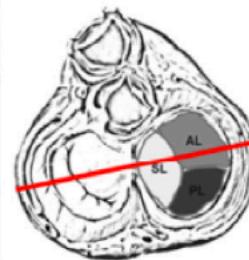
- obtained from the parasternal long axis view by tilting the probe downwards
- displays the anterior leaflet and either the septal or posterior leaflet (tilt vertically the probe 15° or more from the initial position)

- displays the posterior leaflet and either (more often) the septal leaflet attached near the RCA trajet or the anterior leaflet

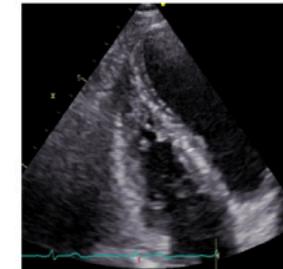
### RV FOCUSED (MEDIAL) APICAL 4 CHAMBER VIEW



### APICAL 4 CHAMBER VIEW



### RV MODIFIED (LATERAL) APICAL 4 CHAMBER VIEW

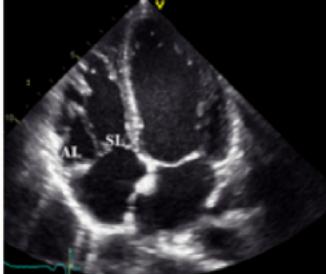
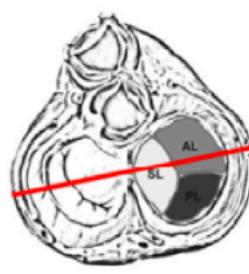
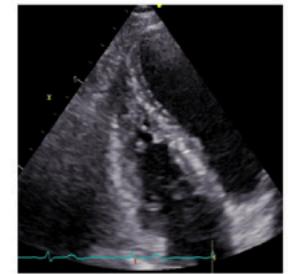
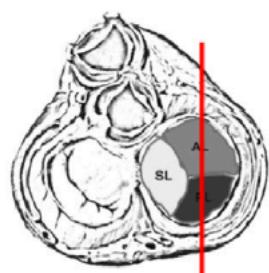
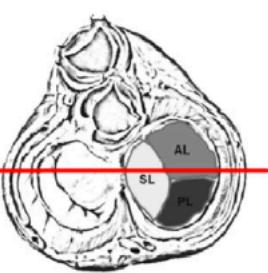


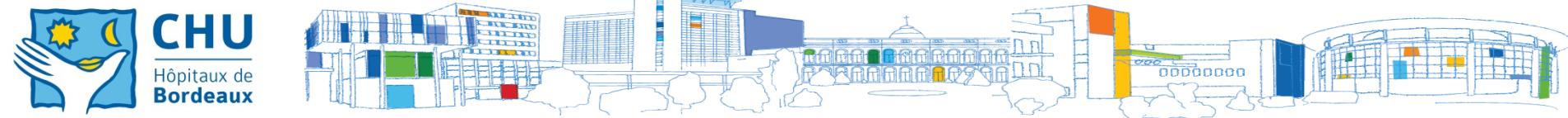
- obtained from the apical 4C view by tilting the probe to the right toward the sternum

- displays anterior and septal leaflet
- recommended view for TA diameter measure

- obtained from the apical 4C view by moving the transducer Laterally

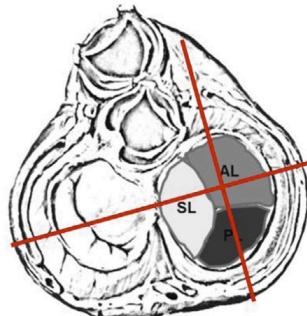
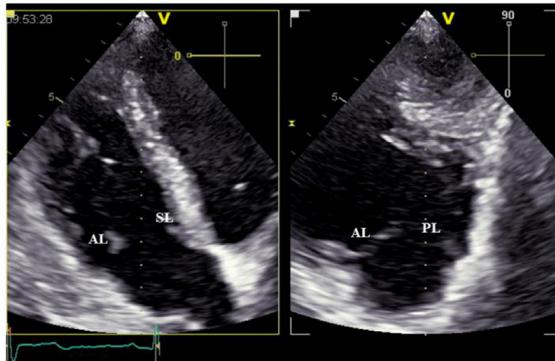


RV FOCUSED (MEDIAL) APICAL 4 CHAMBER VIEW	APICAL 4 CHAMBER VIEW	RV MODIFIED (LATERAL) APICAL 4 CHAMBER VIEW
	 	
<ul style="list-style-type: none"> <li>- obtained from the apical 4C view by tilting the probe to the right toward the sternum</li> </ul>		<ul style="list-style-type: none"> <li>- displays anterior and septal leaflet</li> <li>- recommended view for TA diameter measure</li> </ul>
<b>APICAL 2 CHAMBER VIEW FOCUSED ON THE RV</b>		<b>RV SUBCOSTAL 4 CHAMBER VIEW</b>
 	 	
<ul style="list-style-type: none"> <li>- obtained by rotating the probe 90° counter-clockwise from the 4C view centered on RV</li> <li>- displays posterior and anterior leaflets</li> </ul>		<ul style="list-style-type: none"> <li>- displays anterior and septal leaflets</li> </ul>



# 3D TRANSTHORACIC ECHOCARDIOGRAPHY (REALTIME 3D ECHOCARDIOGRAPHY or FULL-VOLUME)

## BIPLANE 2D VIEWS



- 4-chamber view of the RV displays the RV free wall and septum with anterior and septal leaflets

- Coronal cut plane displays the right atrium, anterior and posterior leaflets

## REAL TIME OR FULL-VOLUME ACQUISITIONS

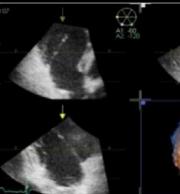
- Obtained from the parasternal right ventricular inflow view or the apical 4C view centred on the RV or the subcostal view
- Centre the TV in the 3D volume, manually adjust the transducer to optimize the image to simultaneously view all three leaflets
- TV can be displayed from both the right atrial and right ventricular perspectives

### 3D-RTE PARASTERNAL INFLOW VIEW



- Best results are usually obtained using the parasternal inflow view

### 3D-RTE AND MULTIPLANE TRICUSPID VIEW



- A cropping plane can be used to obtain the following views of the RV: sagittal right ventricular inflow (top left and right), coronal (middle left and right)

### EN FACE VIEW OF THE TV FROM THE RV SIDE



- Cropping from the apex towards the base will display the en face view of the TV from the RV

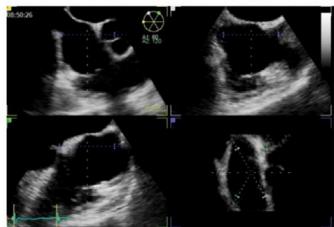
### EN FACE VIEW OF THE TV FROM THE ATRIAL SIDE



- Cropping from the atrial roof towards the apex will display the right atrial view  
- 'Surgical view' is obtained through a rotation of around 45° so that the septal leaflet is located at 6 o'clock

## 3D TRANSESOPHAGEAL ECHOCARDIOGRAPHY

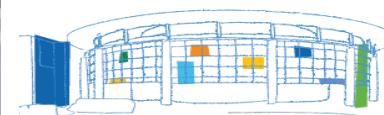
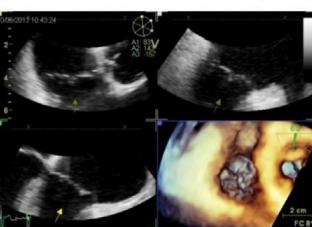
### TEE DERIVED TRIPANE VIEWS

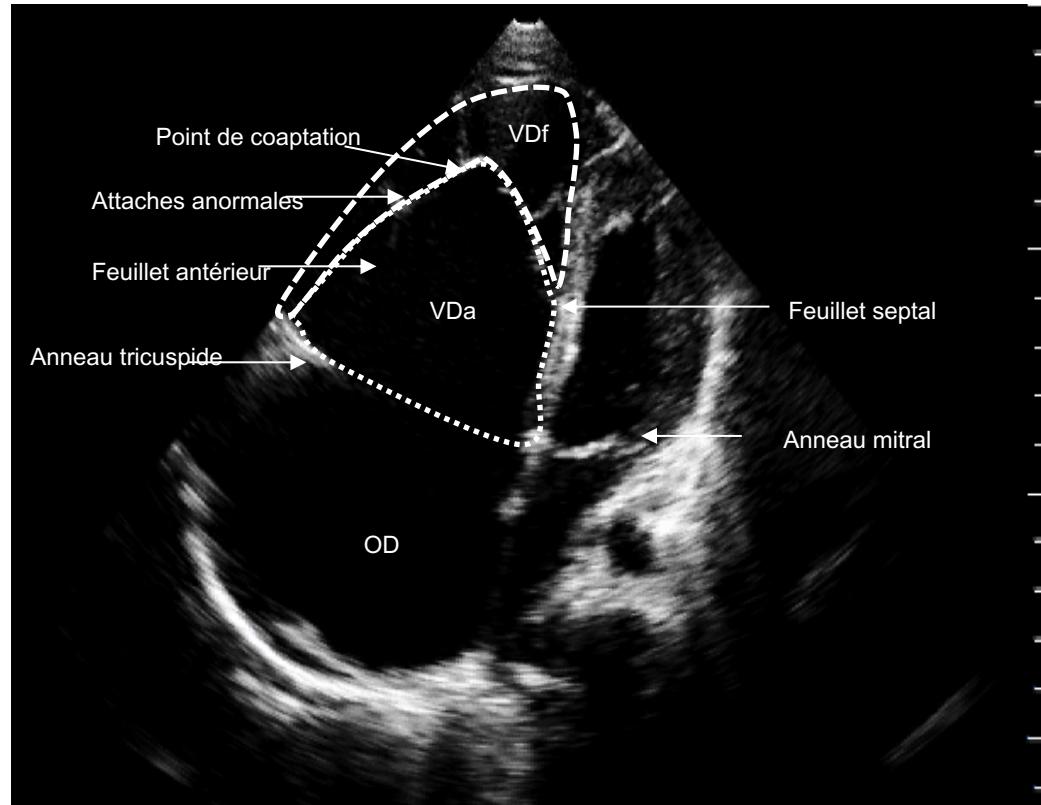
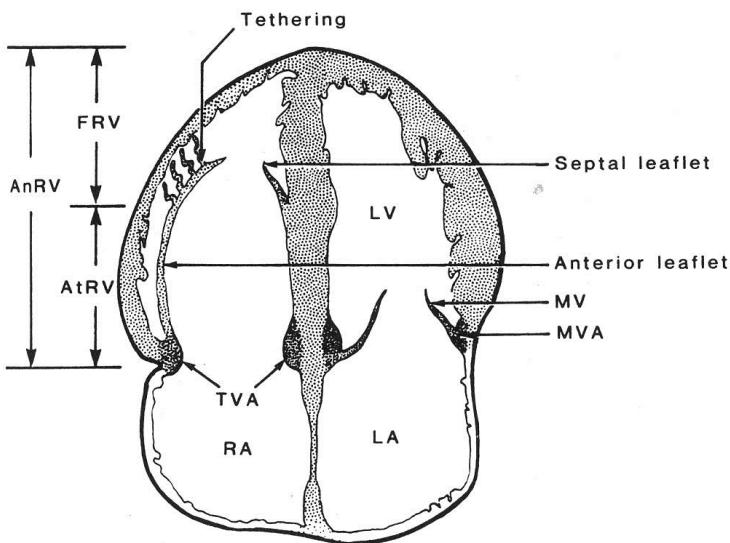


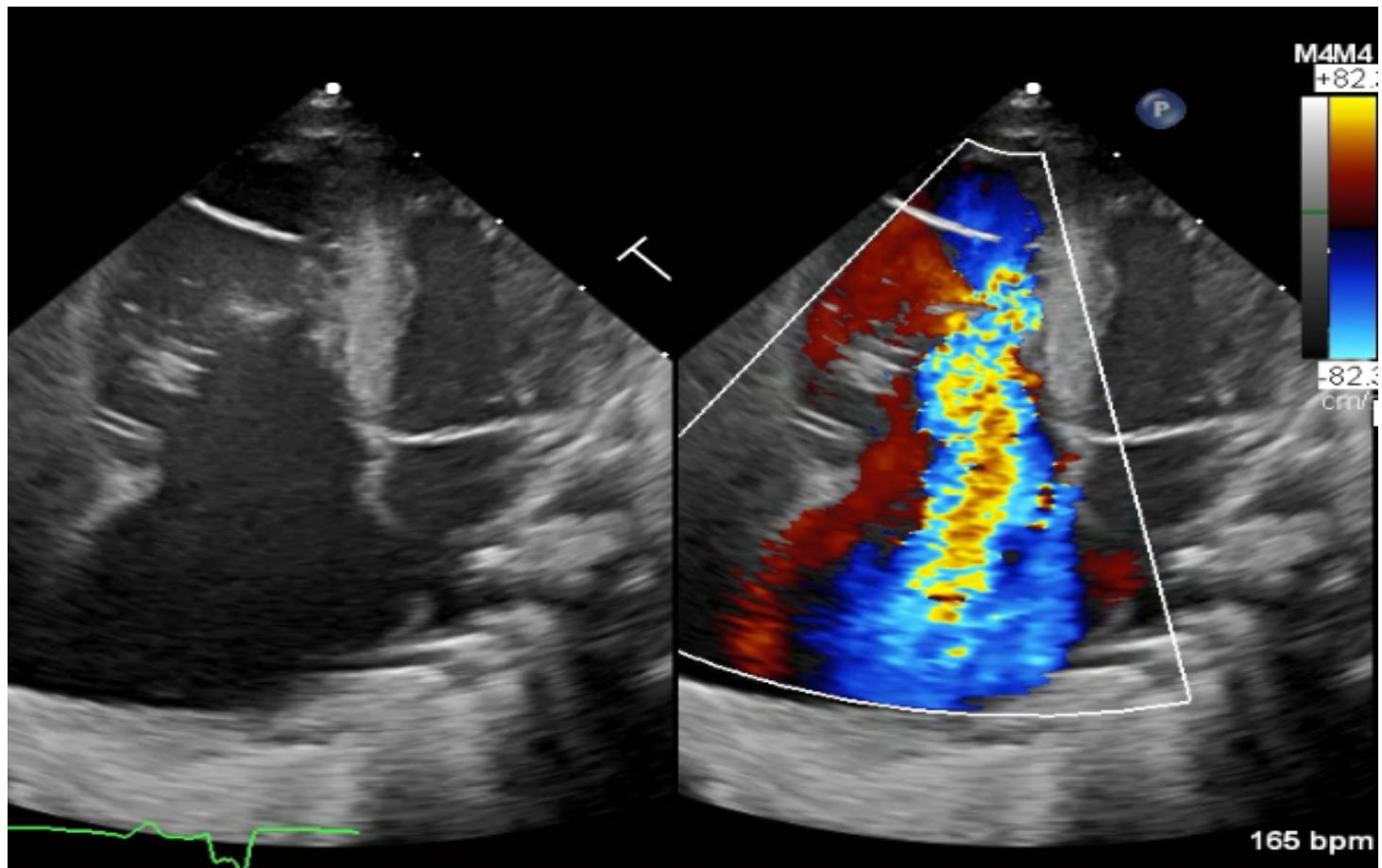
### RT3DE 60° MID-ESOPHAGEAL EQUIVALENT OF SHORT-AXIS VIEW

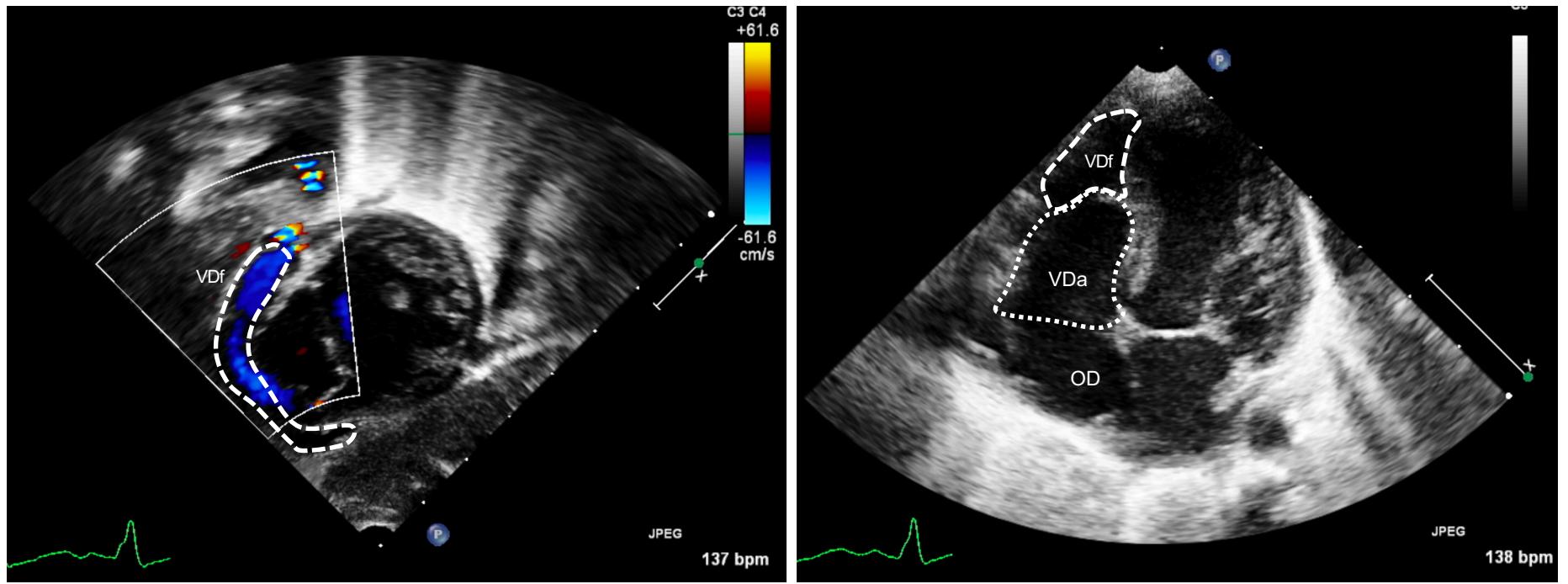


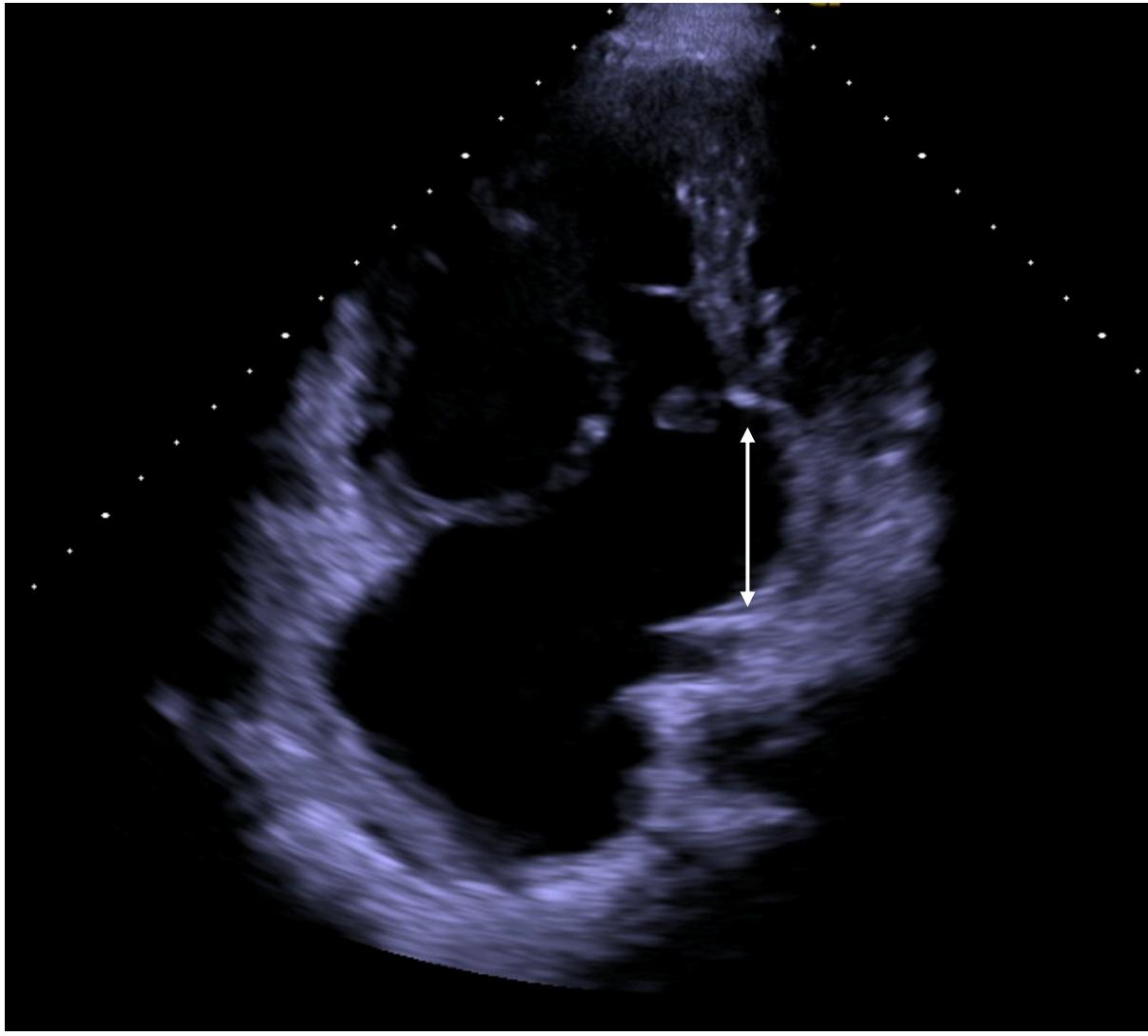
### FULL VOLUME EN FACE VIEW OF THE TV FROM THE RV SIDE

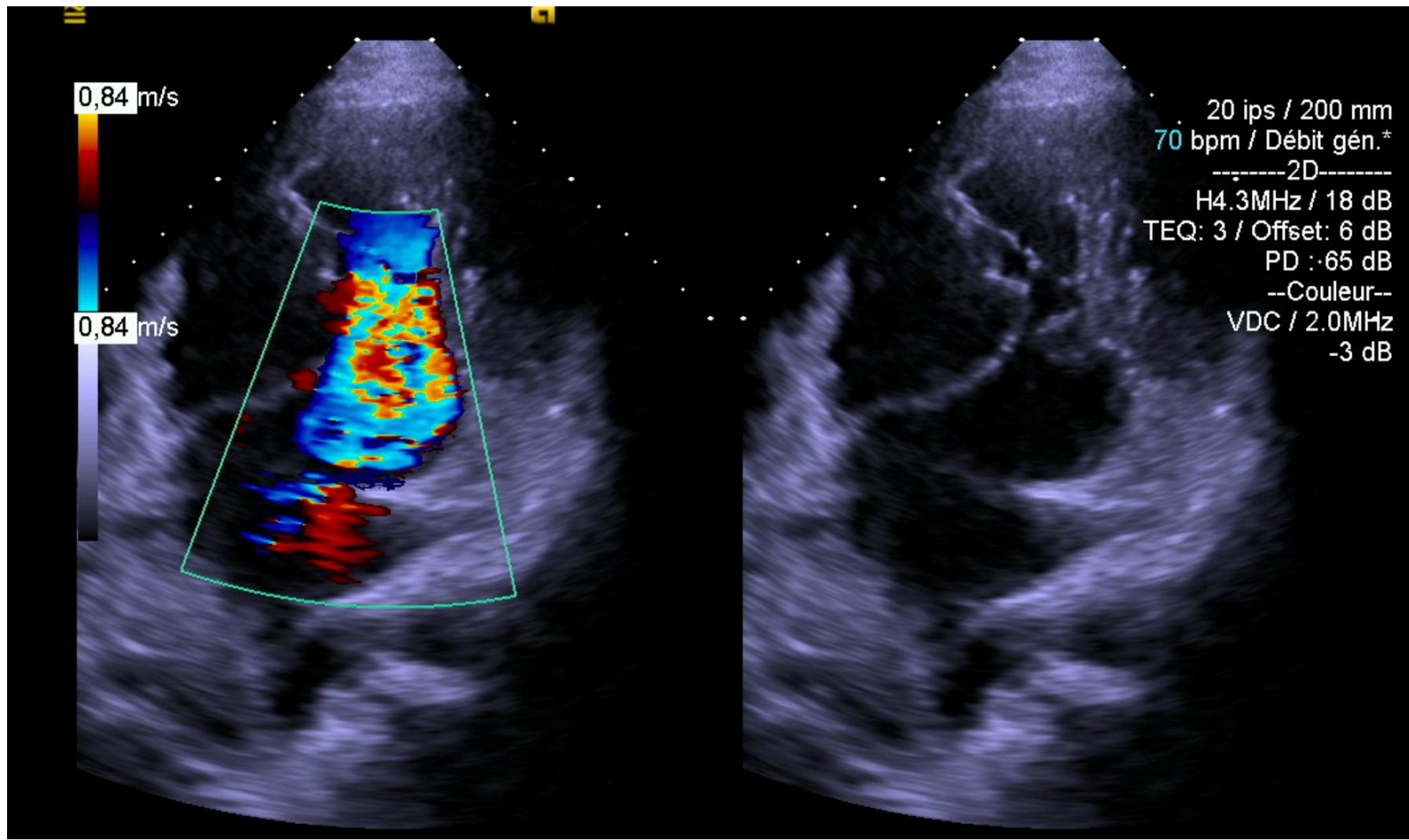


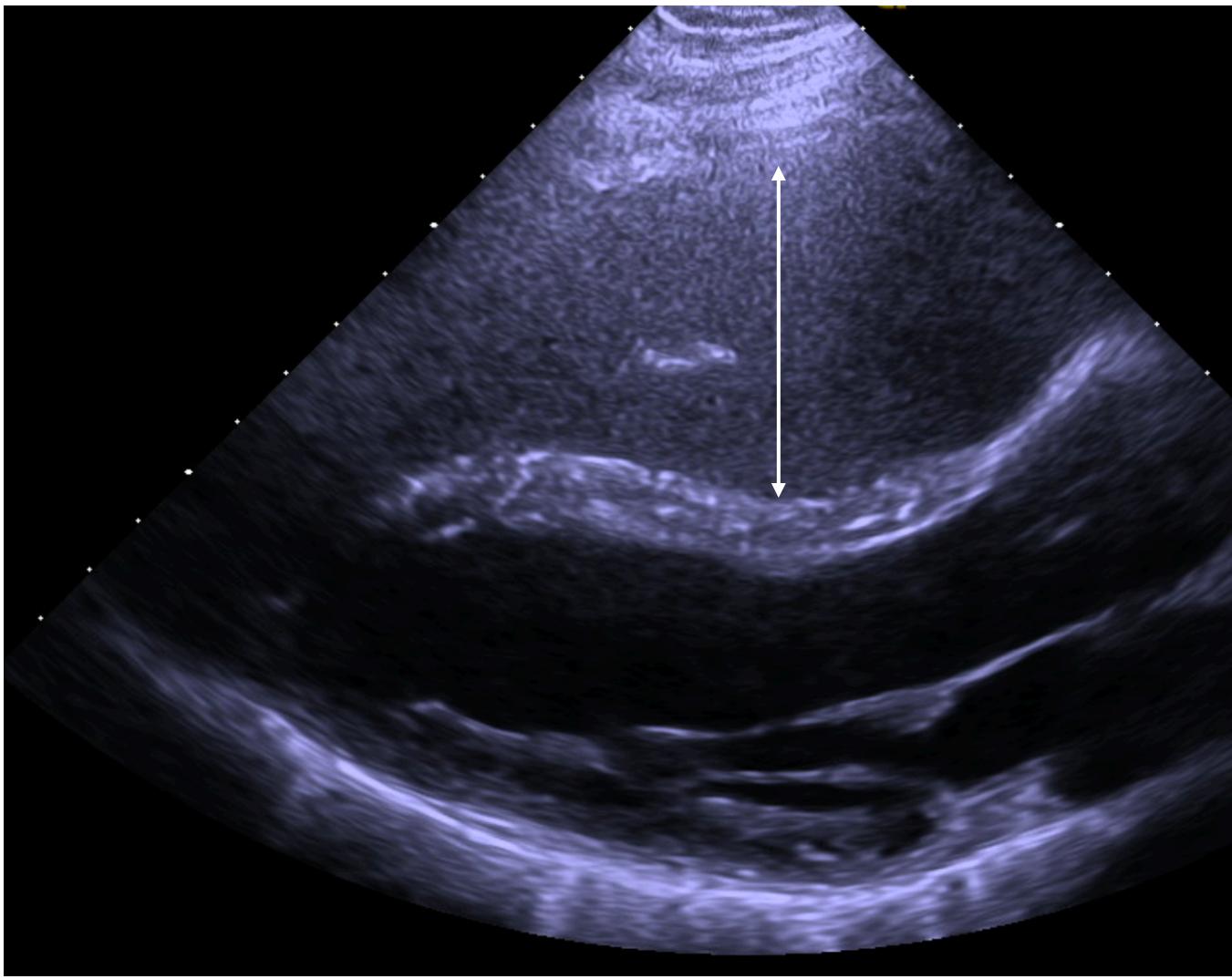










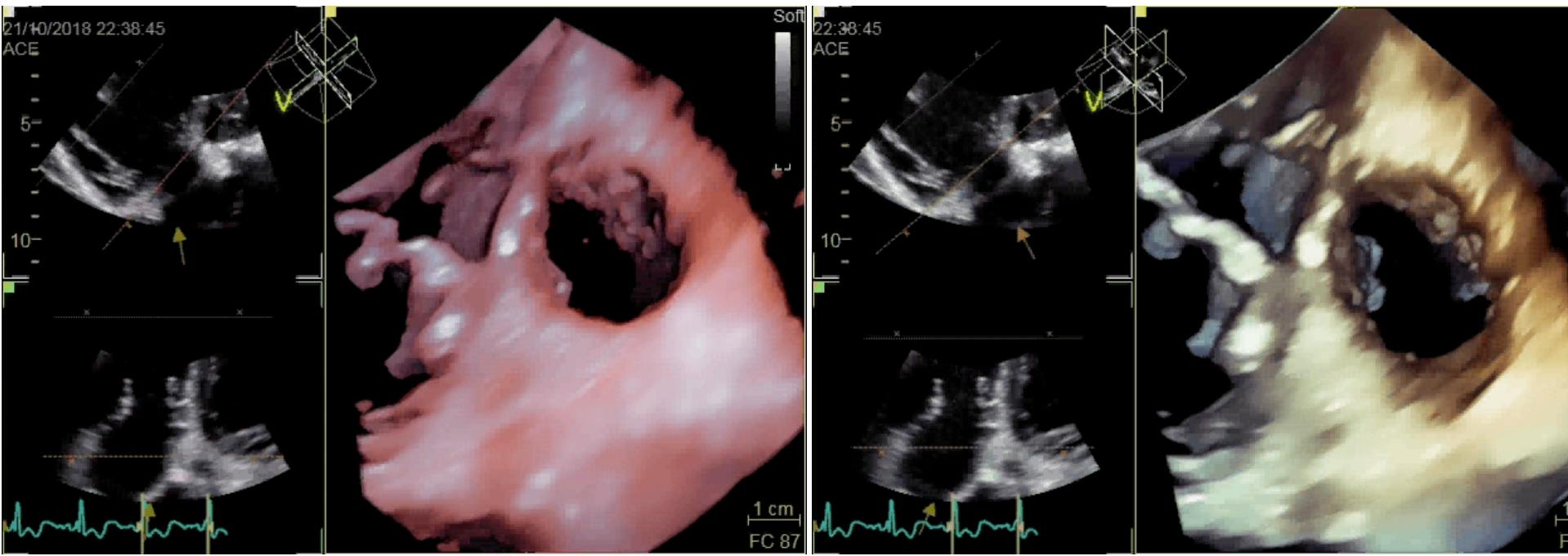


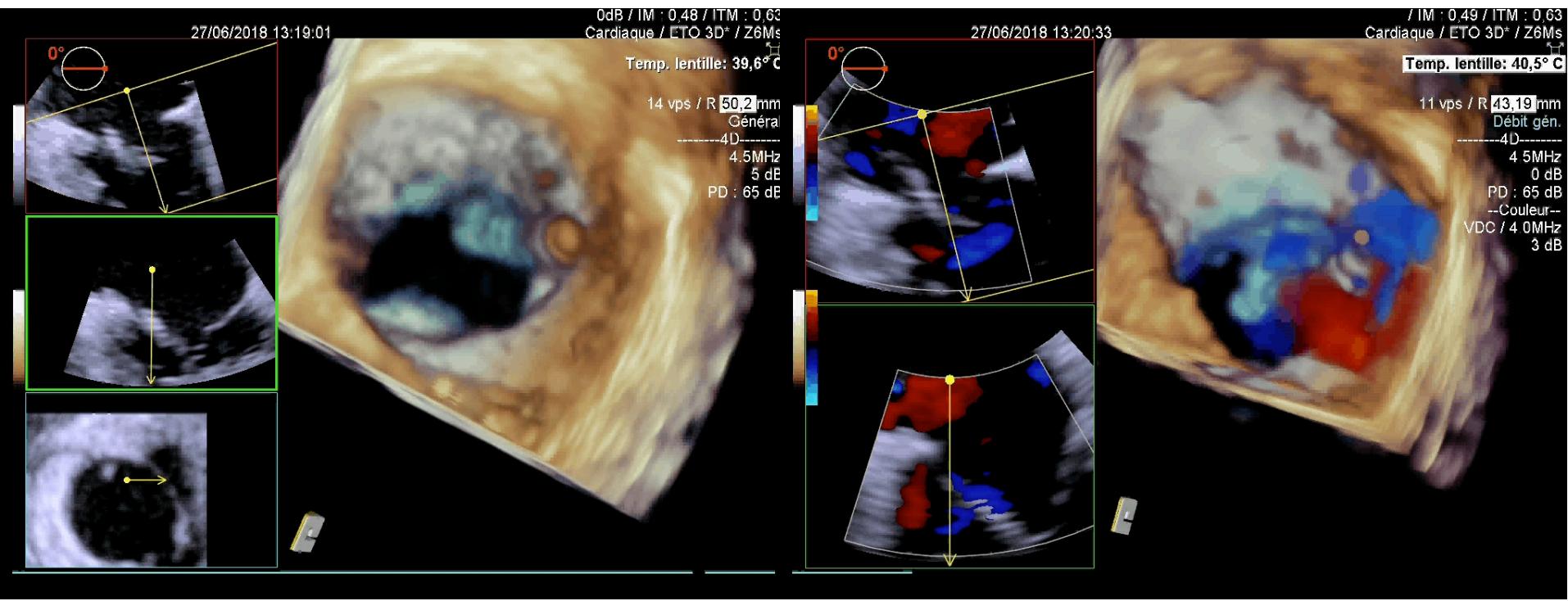
# ETO

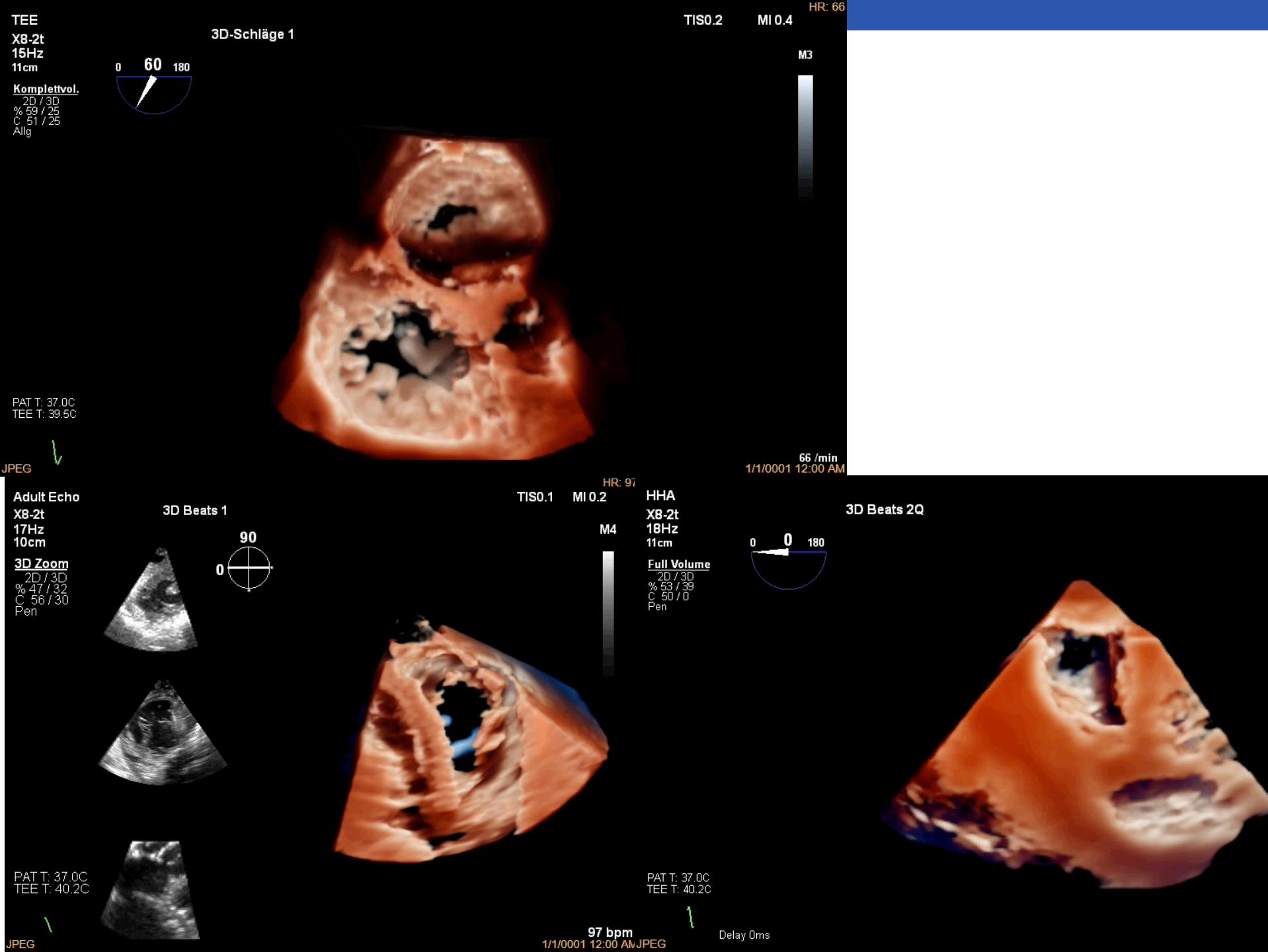


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Bordeaux









## 2D TRANSESOPHAGEAL ECHOCARDIOGRAPHY

### MID-ESOPHAGEAL 4 CHAMBER (0- 30°)



- probe is turned to the right until the TV is seen
- displays anterior and septal leaflets
- recommended view for TA diameter measure

### RV-FOCUSED MID-ESOPHAGEAL 4 CHAMBER (0- 30°)



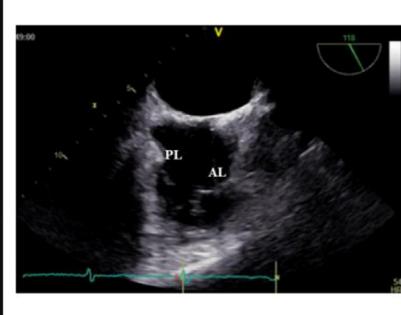
- Flex right the transducer to place the right ventricle in the center of the image
- displays anterior and septal leaflets

### MID-ESOPHAGEAL RV INFLOW-OUTFLOW VIEW (60-90°)



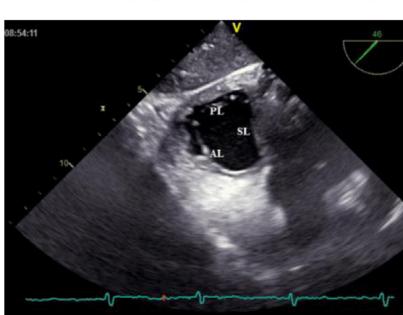
- multiplane angle is then rotated forward to 60-90° to develop the aortic short axis view
- displays posterior and either anterior (more frequently) or septal leaflets

### LOW-ESOPHAGEAL RV VIEW (90- 150°)



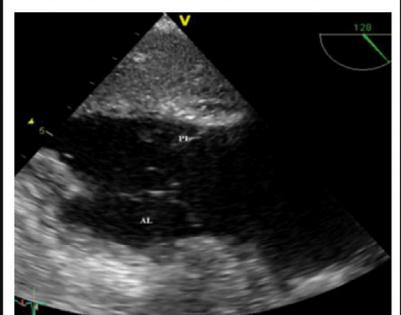
- obtained from the bicaval view by pushing slightly the probe
- displays anterior and posterior leaflets

### TRANSGASTRIC RV BASAL SHORT AXIS (0°-30°)

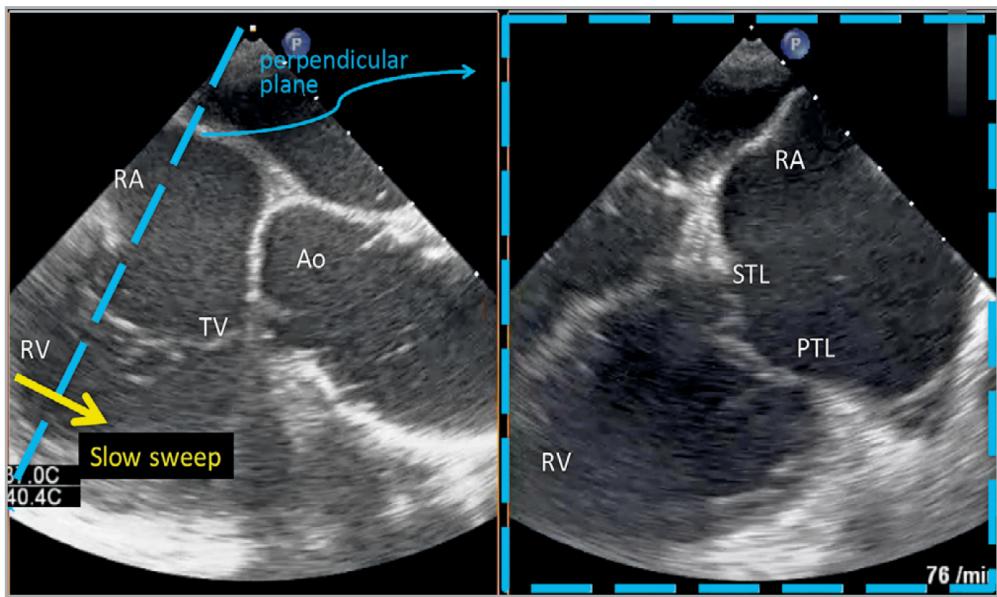
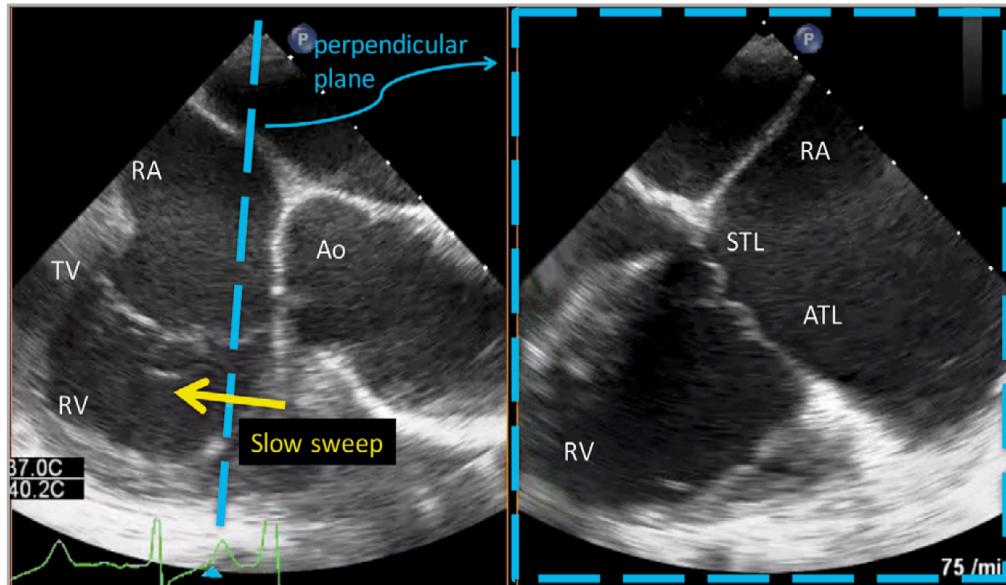


- probe is slightly withdrawn toward the base of the heart until the TV is in the center and multiplane angle is rotated to around 30°
- displays en face view with the 3 TV leaflets

### TRANSGASTRIC RV INFLOW (100-120°)



- multiplane angle is rotated to 100° until the apex of the RV appears on the left
- displays posterior and anterior leaflets
- provides the best images of the subvalvular apparatus



PHILIPS

19/02/2006

CI 52Hz  
9.0cm

2D  
77%  
C 50  
P Arrêt  
Rés

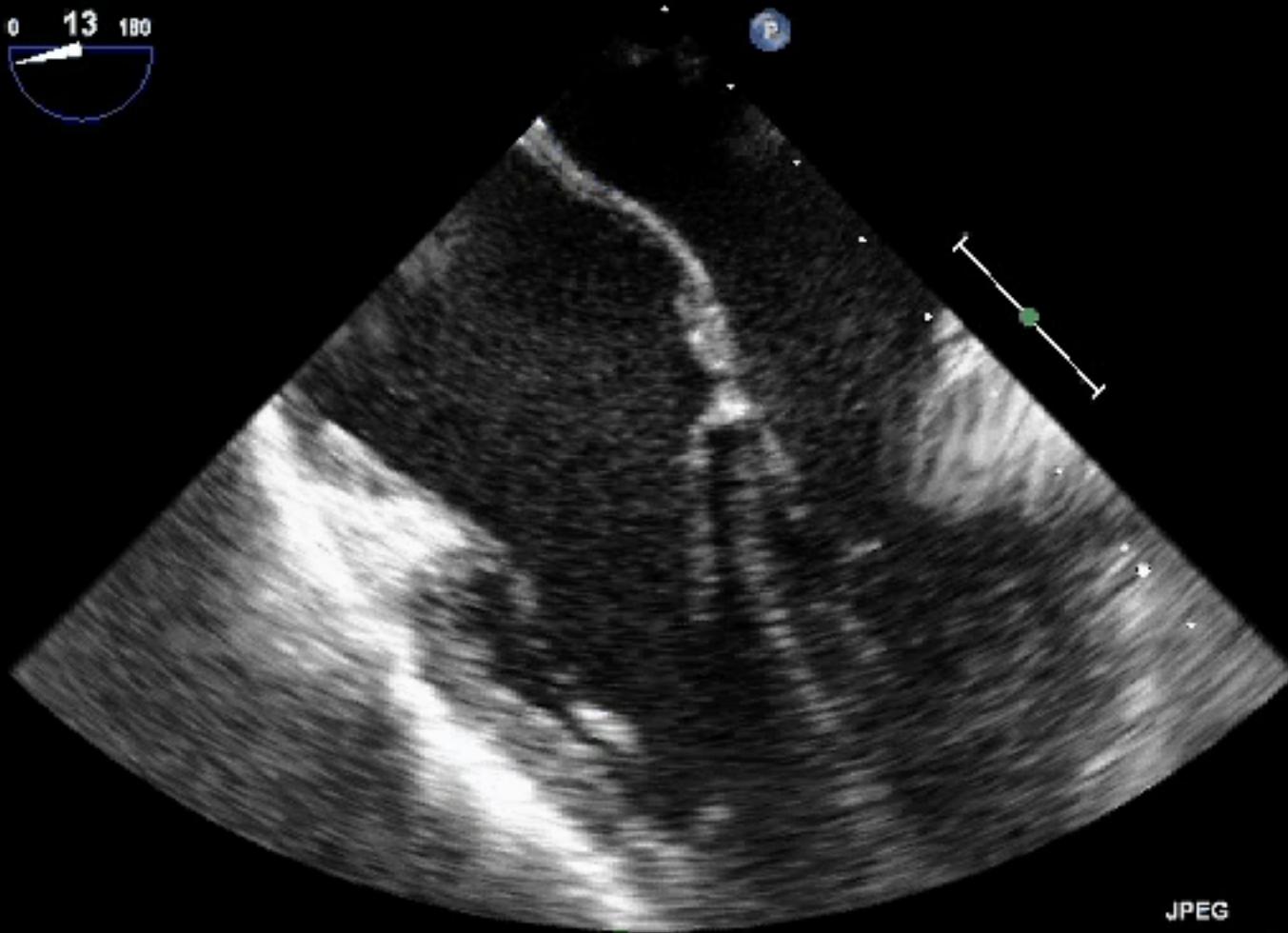
28/04/2014 18:01:39 ITm0.1 IM 0.5

CX7-2t/Adulte

C4



G  
P ▲ R



JPEG

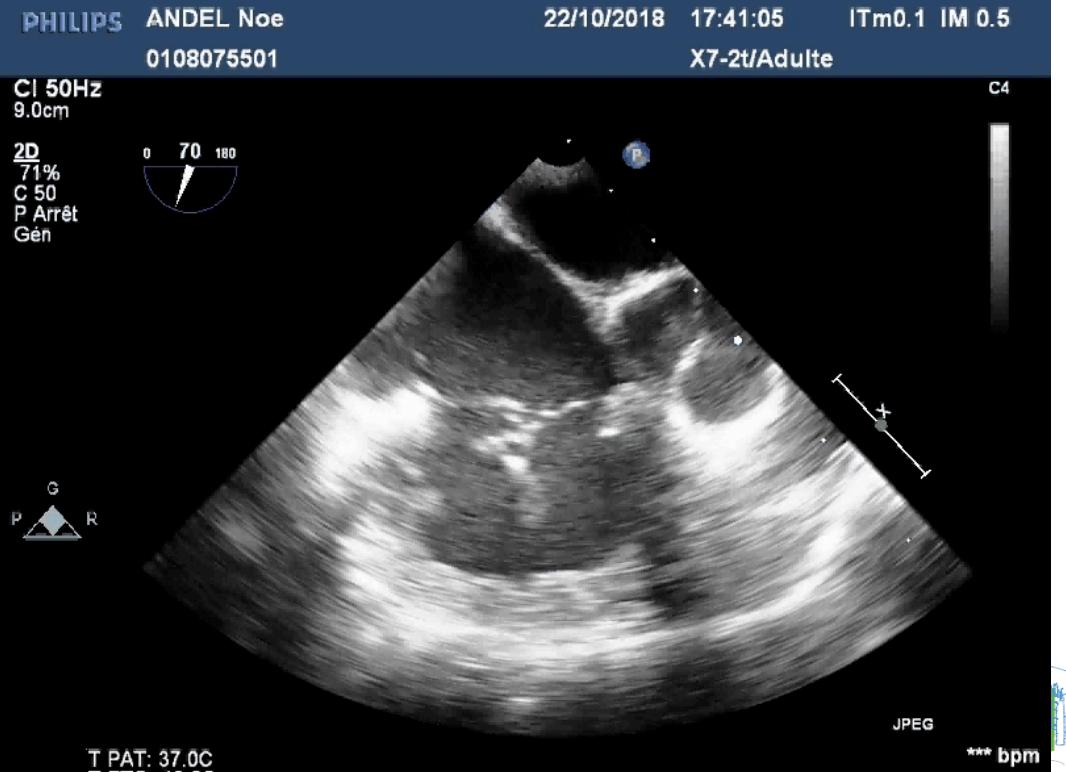
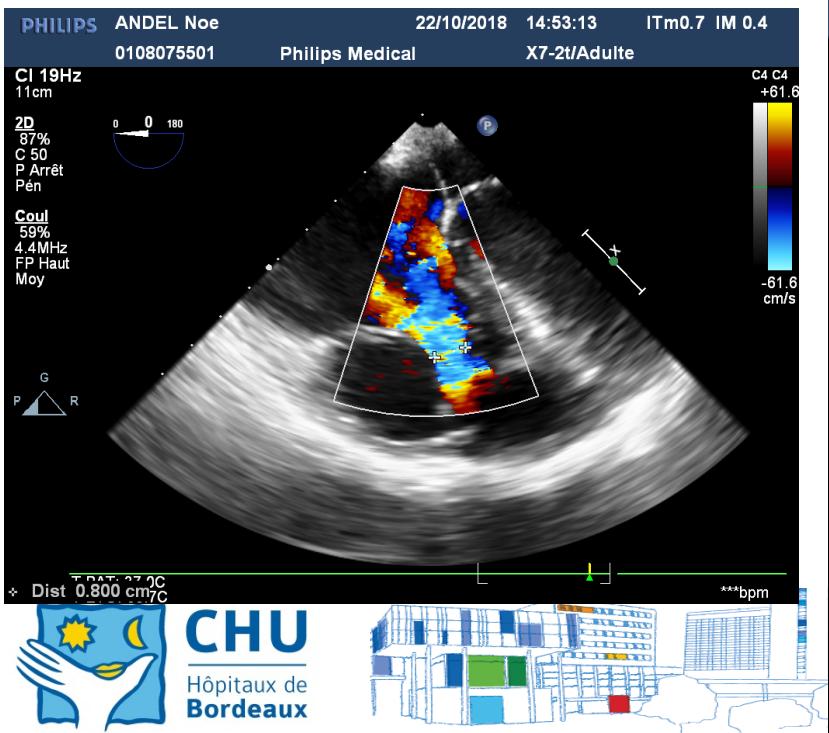
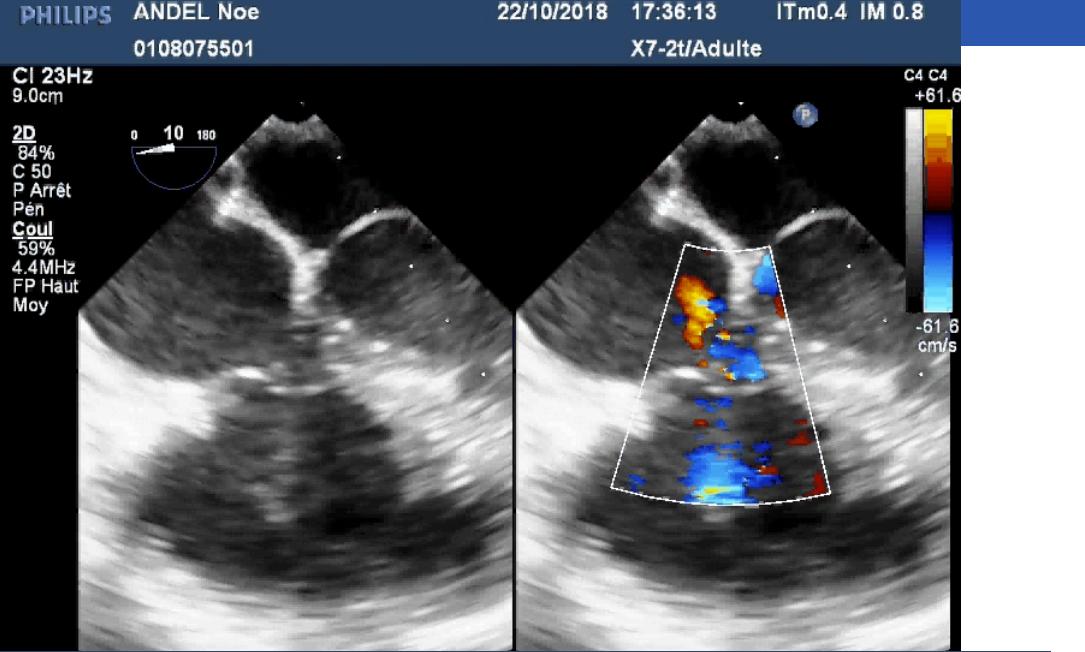
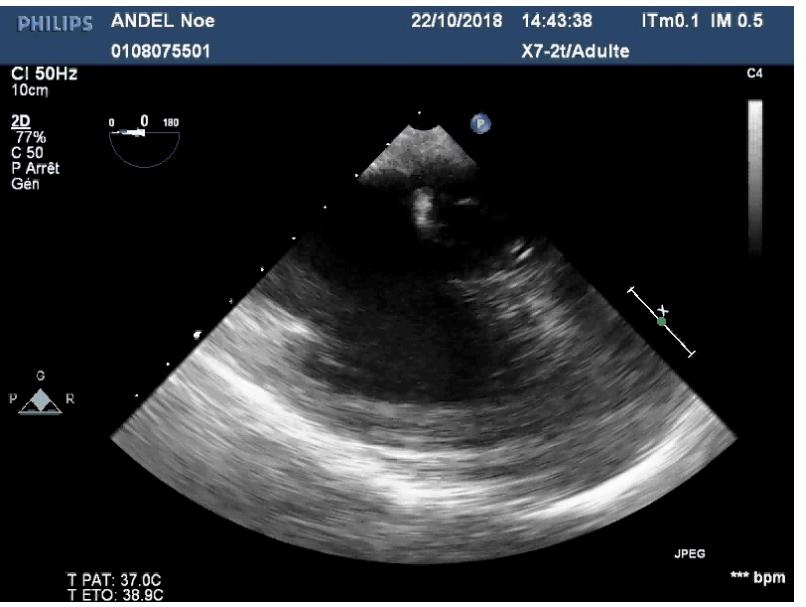
TPAT: 37.0C  
ETO: 39.0C

bpm

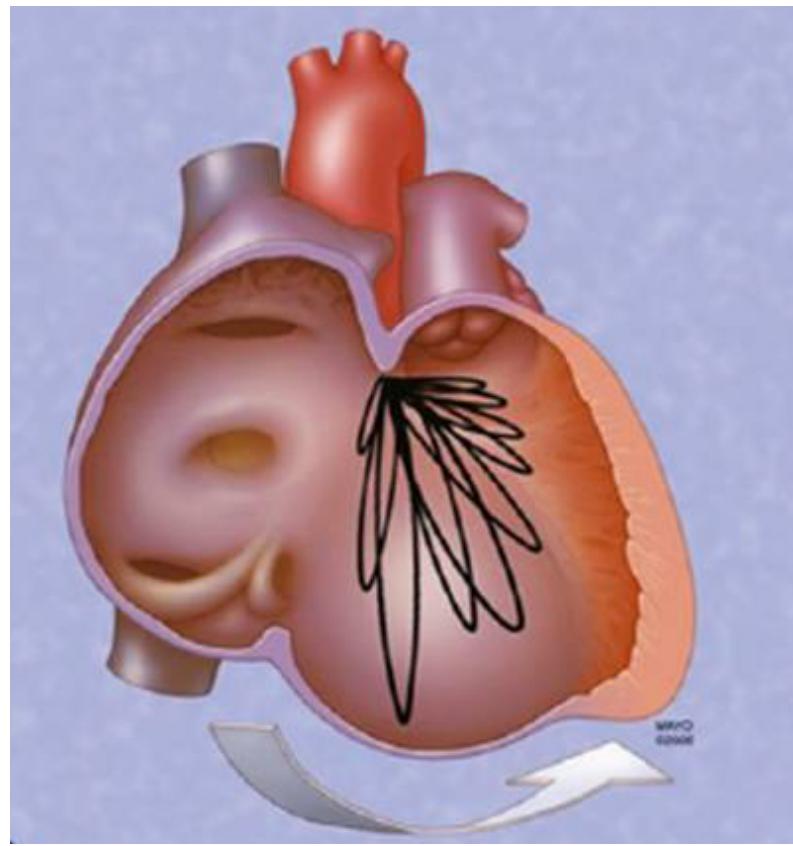


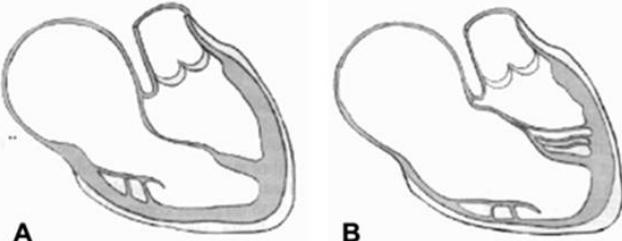
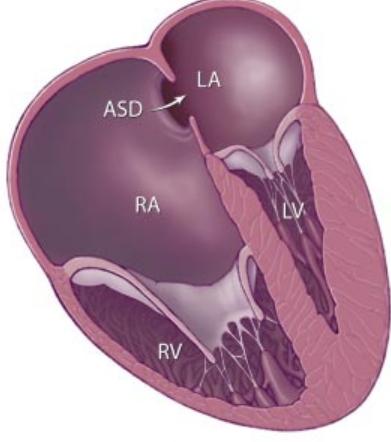
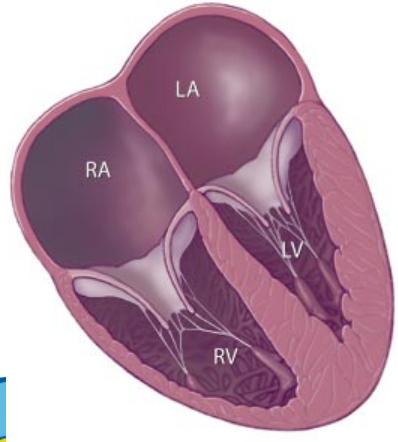
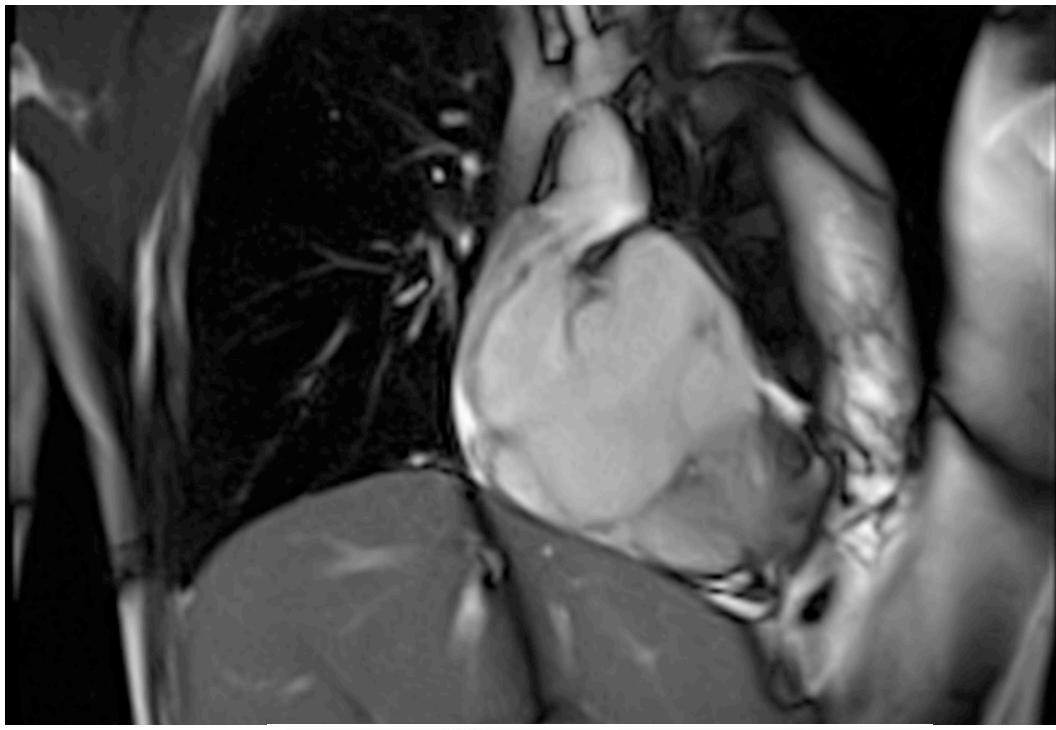
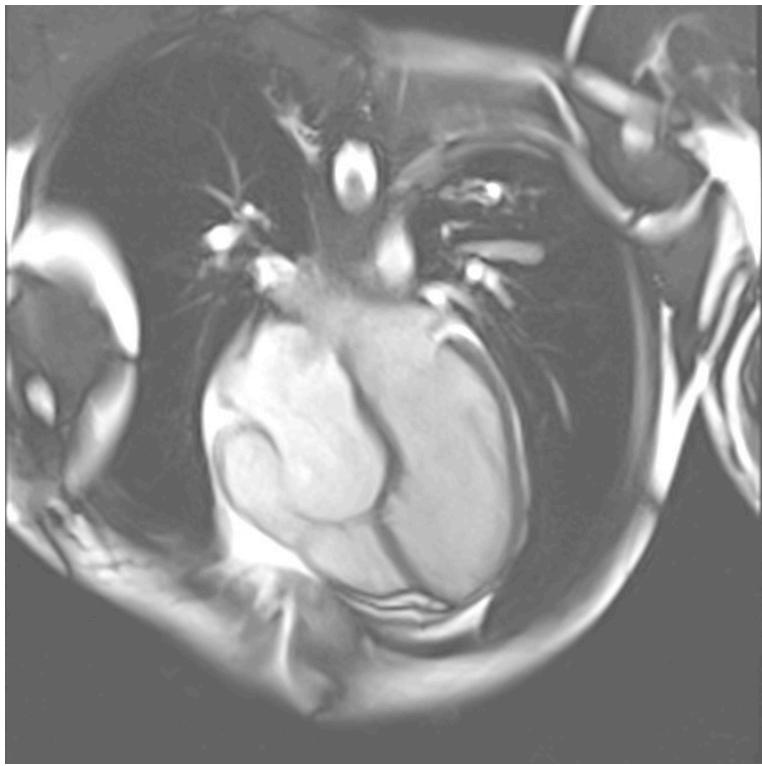
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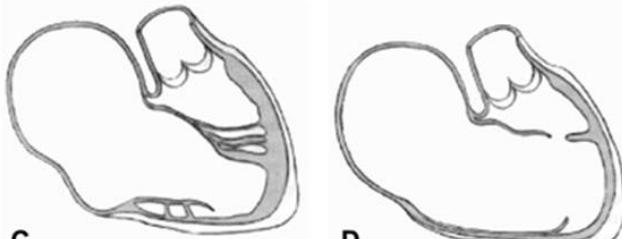


# MRI

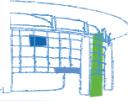




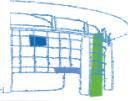
A



C



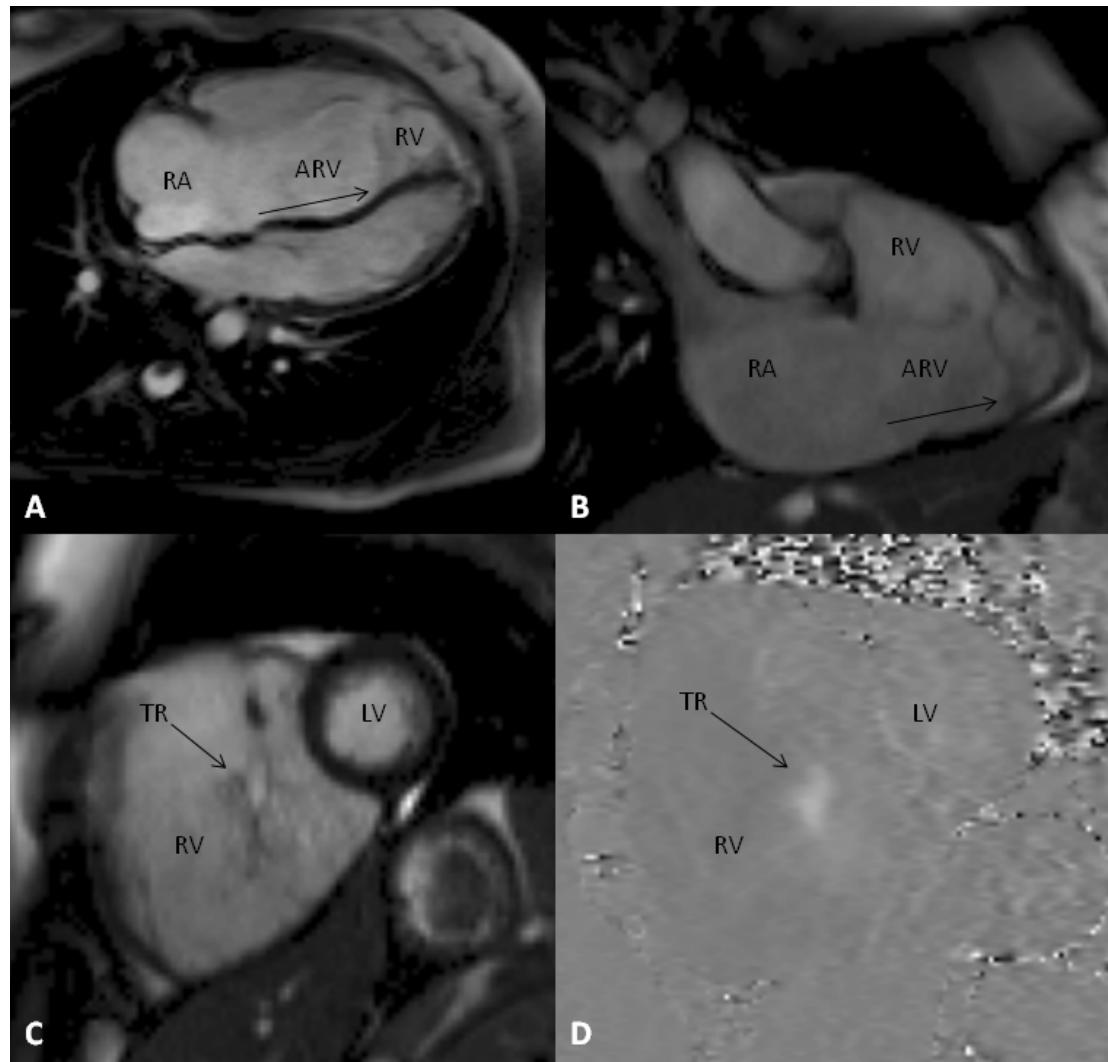
B

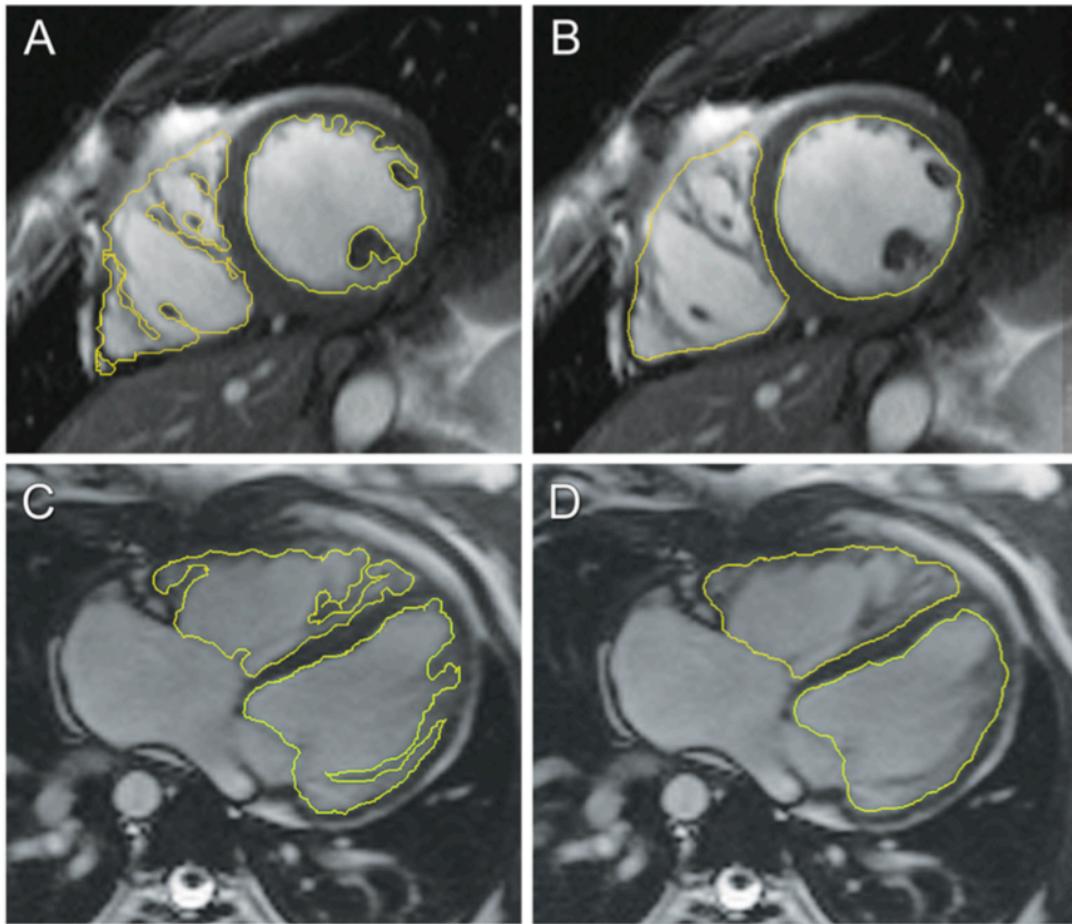


D

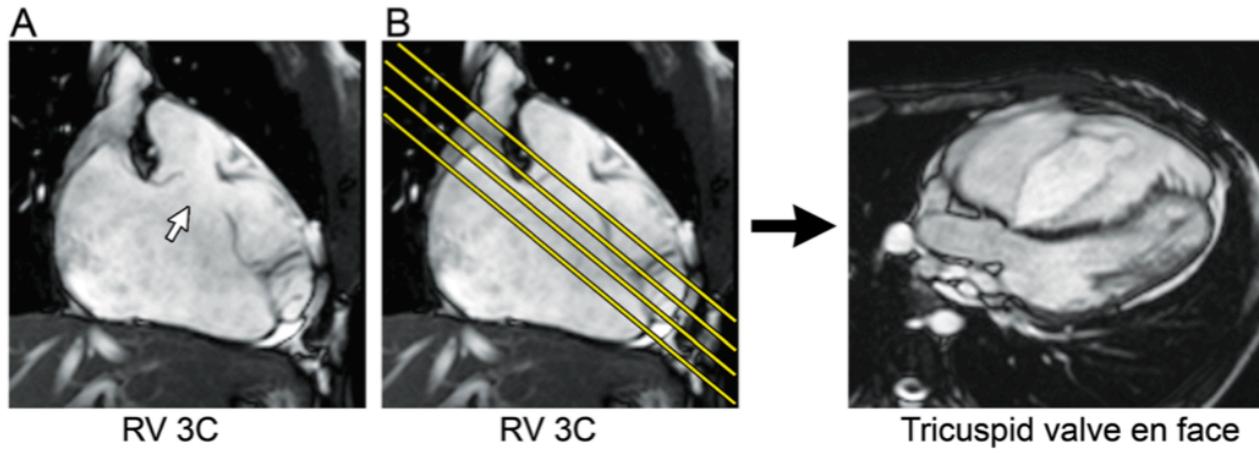


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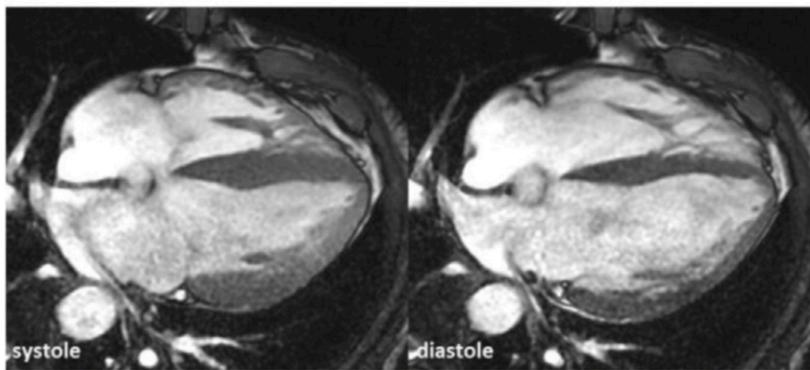
**Figure 8 Tracing ventricular borders.** Diagram demonstrating the drawing of left and right ventricular endocardial contours in end-diastole. Images may be acquired in a ventricular short-axis orientation (**A** and **B**) or in an axial orientation (**C** and **D**). There is practice variation regarding whether to trace the papillary muscles and right ventricular trabeculations to exclude them from (**A** and **C**) versus include them in (**B** and **D**) the blood pool.



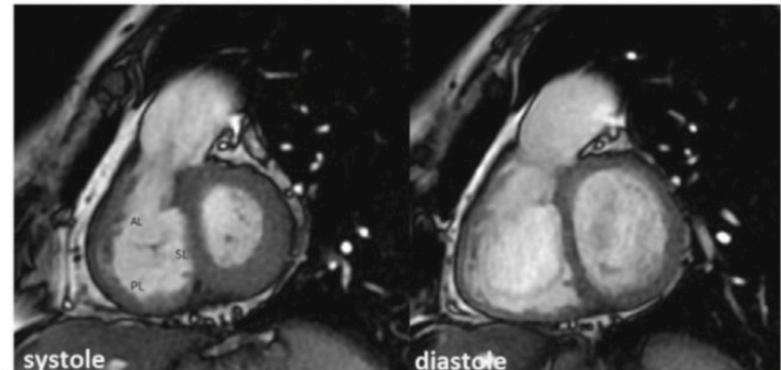
**Figure 19 Ebstein anomaly imaging protocol.** **A.** Right ventricular 3-chamber view (RV 3C) steady-state free precession cine image in a 22-year-old with Ebstein anomaly. In this example, the functional tricuspid valve plane is displaced and inflow is directed into the right ventricular outflow tract (white arrow). **B.** The RV 3C image is used to plan a stack of cine images to visualize the displaced tricuspid valve orifice *en face* for anatomic assessment or flow quantification.

# CARDIAC MAGNETIC RESONANCE IMAGING

## CINE IRM (SSFP) HORIZONTAL LONG AXIS



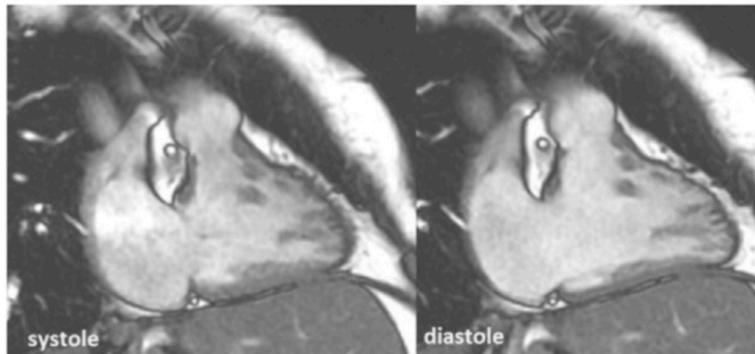
## CINE IRM (SSFP) SHORT AXIS



- recommended view for TA diameter measurement (diastole)

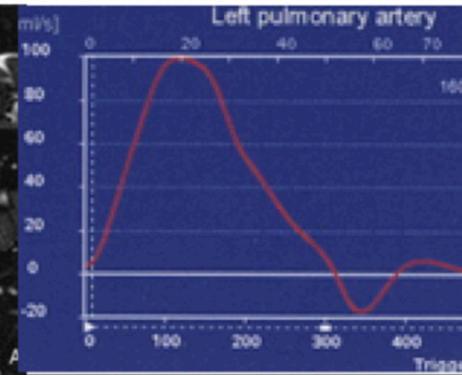
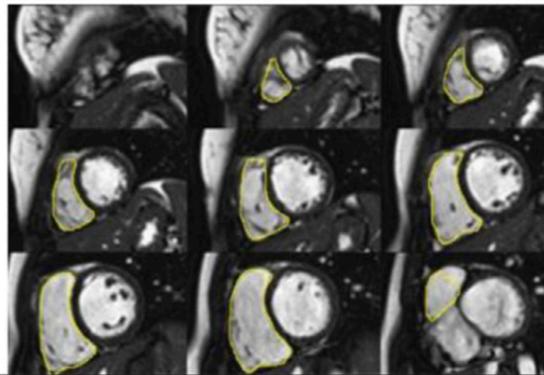
- Short axis systolic view positioned at the level of TV tips
- TR vena contracta shown by cine MRI

## CINE IRM (SSFP) RIGHT HEART 2-CHAMBER



- displays anterior and posterior leaflets
- allows the diagnosis of TV prolapse

## STROKE VOLUME METHOD FOR TR QUANTIFICATION

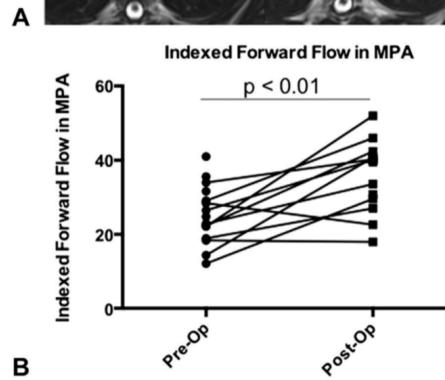
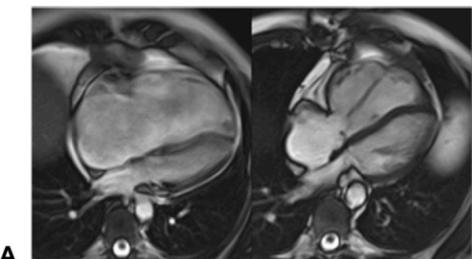


- Total RV SV is calculated from the SSFP images (left)
- Forward stroke volume is measured in the pulmonary artery with phase contrast (right) and the difference represents TV regurgitant volume

**TABLE 2. Cardiac magnetic resonance imaging analysis of effect of cone reconstruction on right ventricle (RV) and left ventricle (LV) volumes**

	Preoperative	Postoperative	P value
RV end-systolic volume	$112.1 \pm 80.6$	$91.0 \pm 45.3$	.54
RV end-diastolic volume	$166 \pm 66.3$	$145.9 \pm 56.1$	.24
LV end-systolic volume	$19.8 \pm 8.9$	$22.4 \pm 10.4$	.25
LV end-diastolic volume	$49.4 \pm 14.4$	$60.14 \pm 14.5$	<b>.006</b>

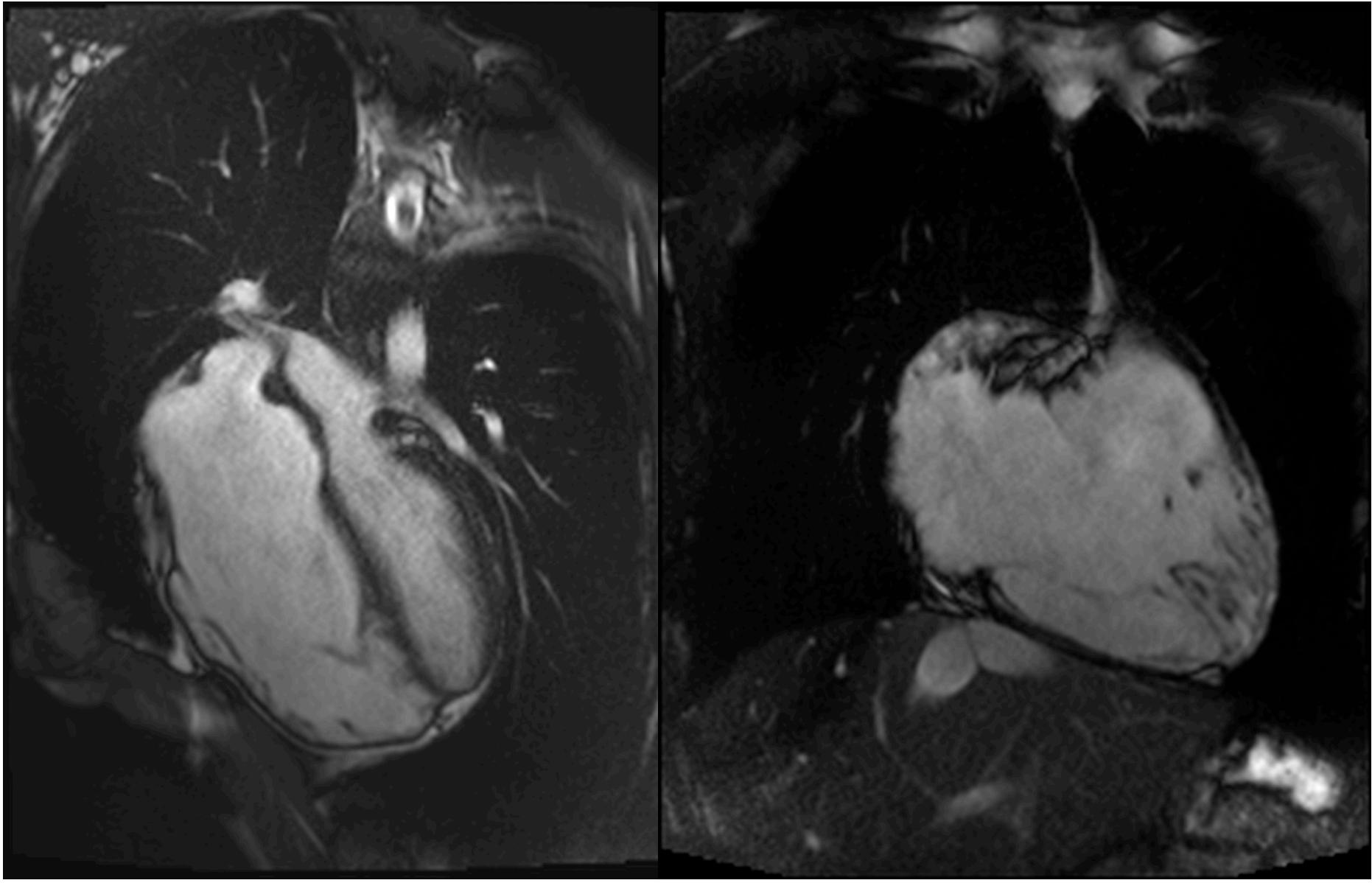
All values are indexed for body surface area. Boldface type indicates statistical significance. *RV*, Right ventricle; *LV*, left ventricle.



**FIGURE 1.** Effect of cone reconstruction on right ventricle forward flow, measured with cardiac magnetic resonance (CMR) imaging. A, Pre- and postoperative CMR images of Ebstein's anomaly, showing that the cone operation reduces right atrium size and enhances left ventricle size. B, The right ventricle achieves improved forward flow volume into the main pulmonary artery (MPA), as measured by CMR imaging phase-contrast flow mapping. *preop*, Preoperative; *postop*, postoperative.

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