

# Percutaneous VSD closure

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San Donato Milanese - Italy



# Patients selection

- Pts having hemodynamically significant VSD
- Left ventricular enlargement (left ventricular overload), defined as a LVEDD  $> +2$  SD above the mean for the patient's age.
- History of bacterial endocarditis
- Clinical evaluation, EKG, Chest-x-ray, echo
- Exclusion criteria:
  - *Body weight  $< 5-6$  Kg for mVSD and  $< 8-10$  kg for pmVSD*



# Which patients with congenital VSD are not suitable to percutaneous closure?

## Exclusion criteria:

*Supracrystal VSD*

*Malalignment VSD*

*Associated significant aortic regurgitation*

*Prolapse of aortic cusp*

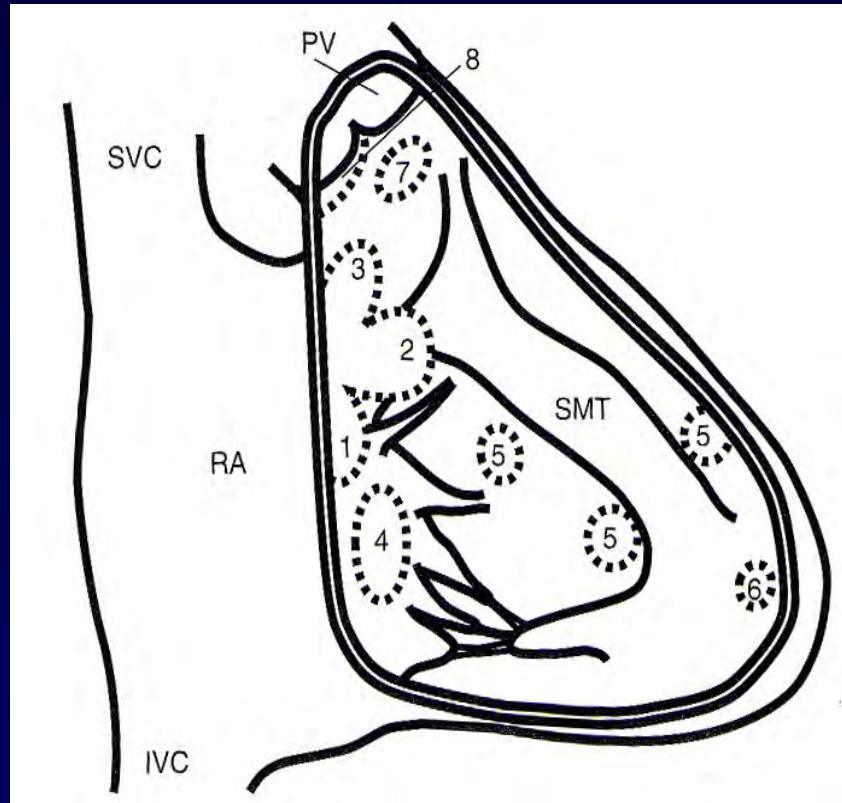
*Sub-aortic stenosis*

*Sub-pulmonary stenosis (RV mid ventricular stenosis)*

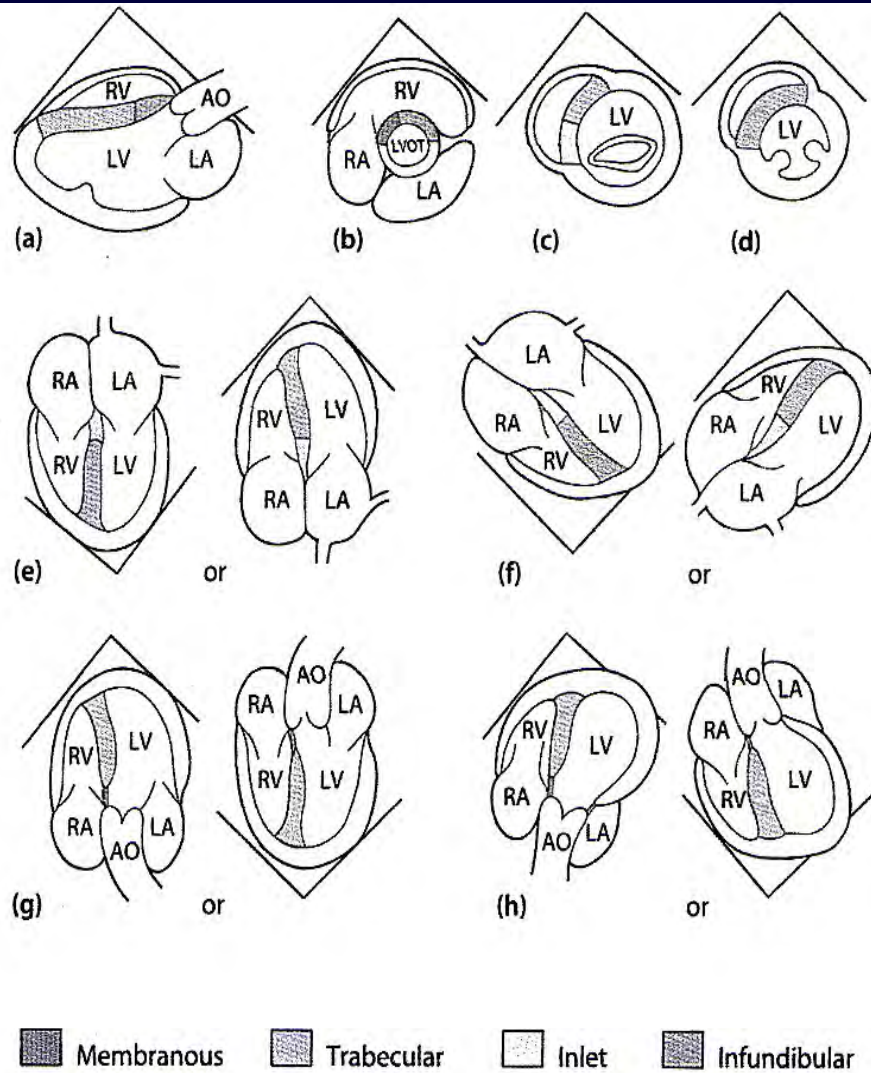
*Eisenmenger syndrome*

*High pulmonary pressures ( $PAR \geq 2/3 SAR$ )*

# VSD



# VSD



# *Muscular VSD*

Pre-procedural Echocardiographic evaluation (TTE/TEE)

Size (measure in different views)

Number (single/multiple)

Location (apical/mid muscular/high muscular)

Associated defects (ASD/pulmonary stenosis/aortic coarctation/others)

Contra-indication to percutaneous closure

# *Muscular VSD*

## Procedural Echocardiographic evaluation (TEE)

Integrate data from fluoroscopy and EKG

Analysis of VSD (Size/Number/Location/Associated defects  
Contra-indication to percutaneous closure)

Check position of :

Guide wire (TV, AoV)

Ventricular function during manoeuvres

Long-sheath (MV, free LV wall, AoV, TV)

# *Muscular VSD*

Usually it is quite easy to analyse the margins  
and measure the size of the defect

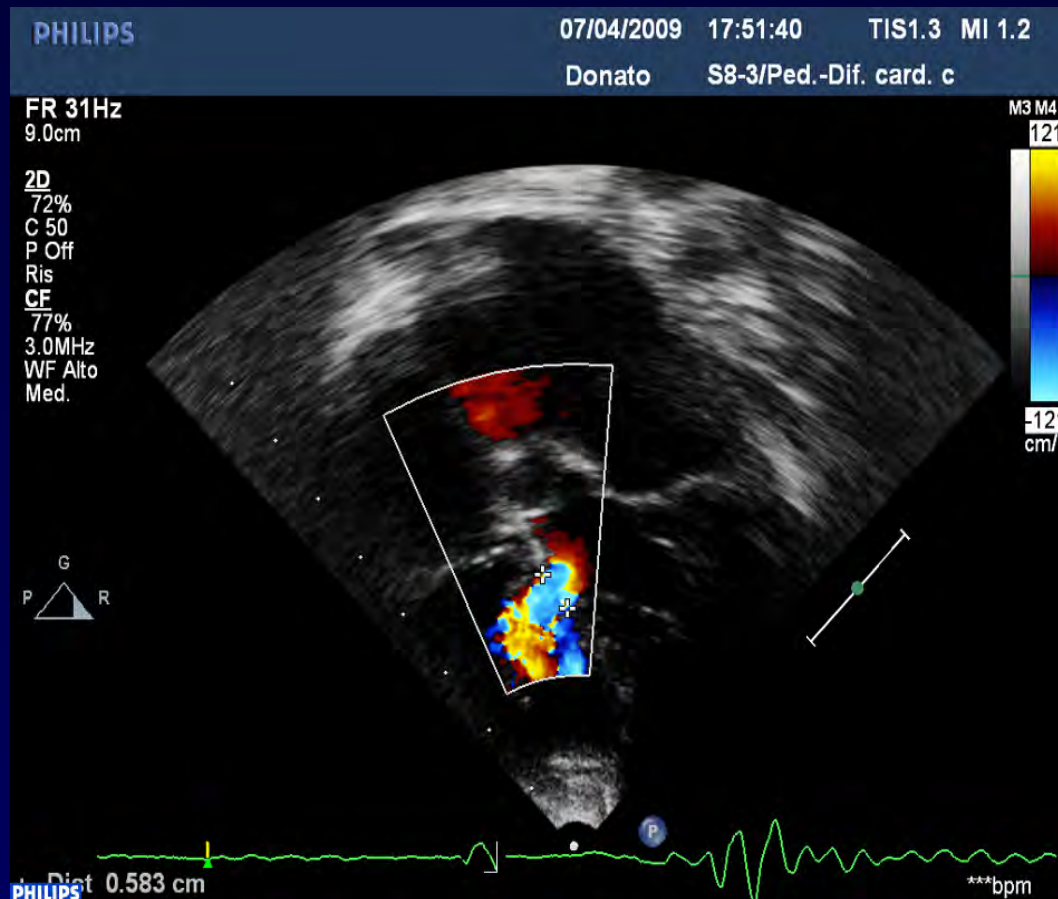
Margins are usually well seen

Measure of the defect in 2D  
and with color (measure at the “PISA”)





# Muscular VSD



# *Muscular VSD*



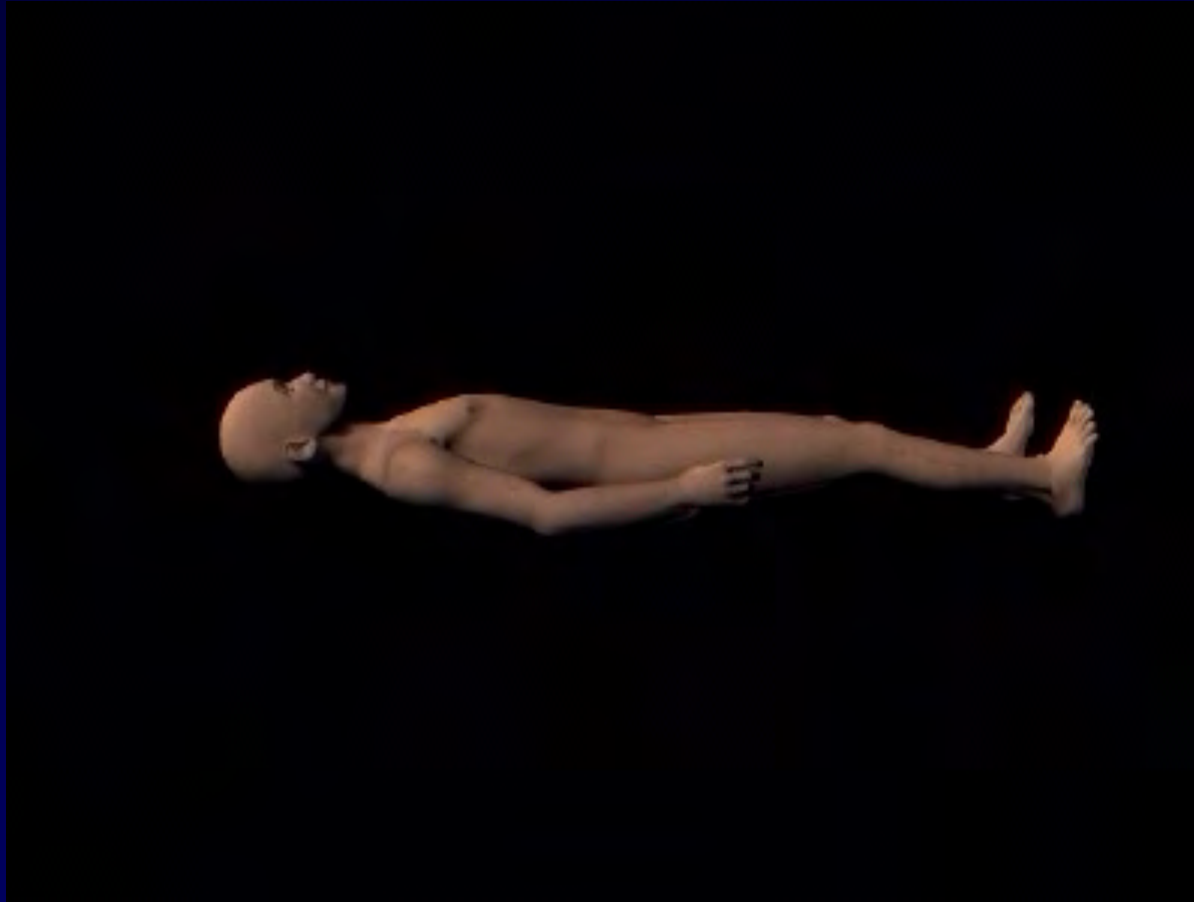
# Procedure protocol

- General anesthesia
- Full heparinization
- Arterial and venous access
- Basal hemodynamics
- Assessment of VSD size and location
- Fluoro and TEE monitoring

# Amplatz muscular VSD occluder



# Amplatz muscular VSD occluder



# Amplatz muscular VSD occluder





TIS: 8.8 T6218  
16 OTT 06 08:31:19  
B/B/E/12/R13CM  
GUAD 58 COMP 65 16HZ  
T.PAZ: 32.6C  
T.TEE: 38.4C

PHILIPS

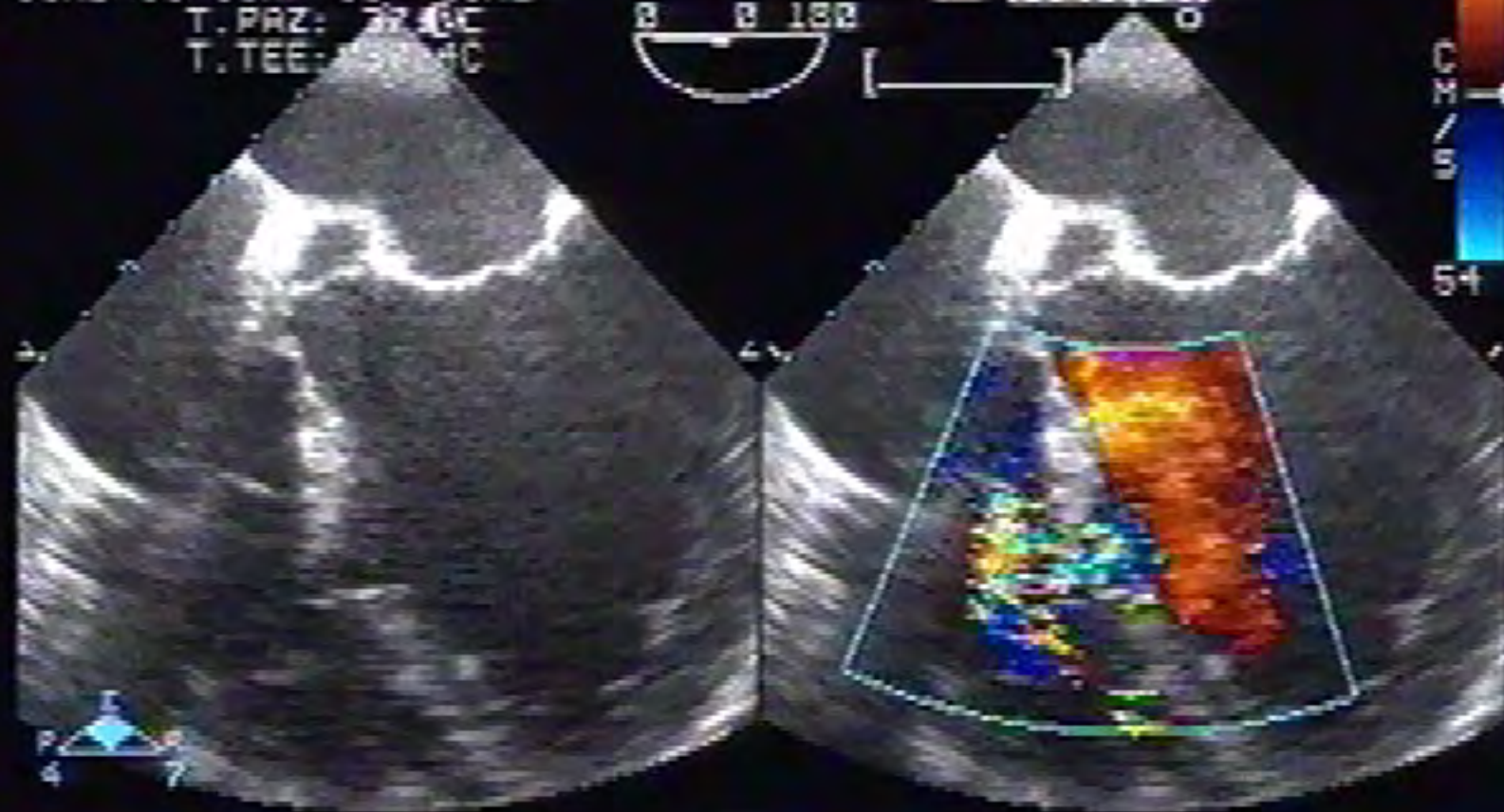
4.4MHZ

TEE

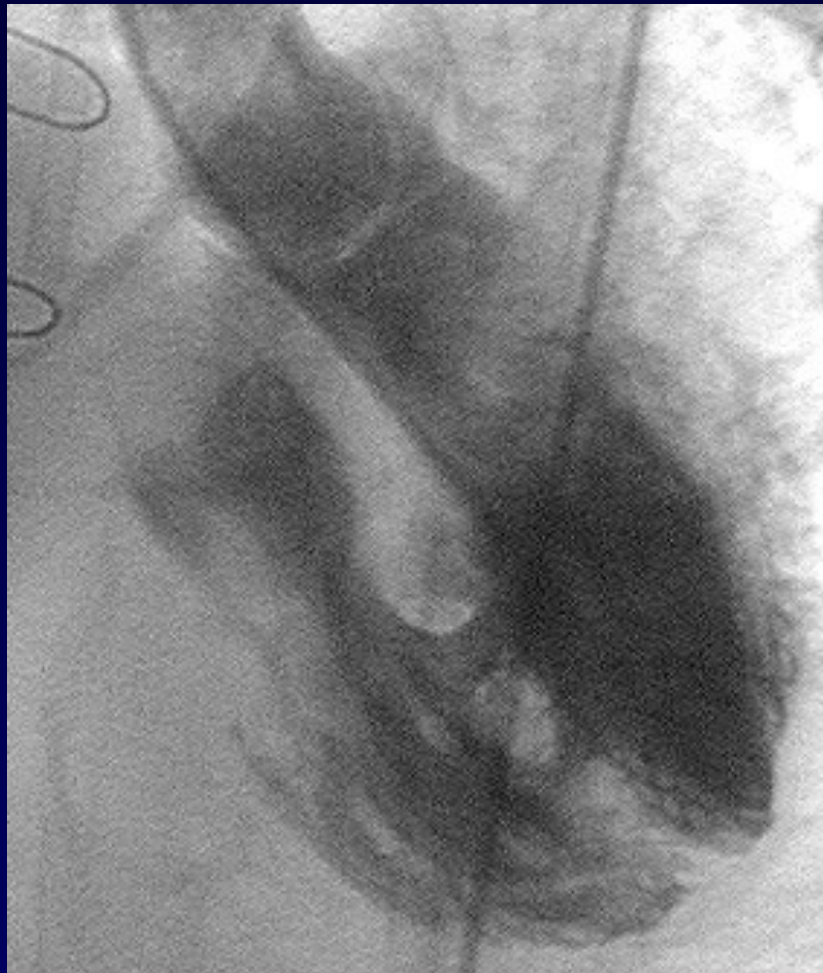
88236, 18

B B 182

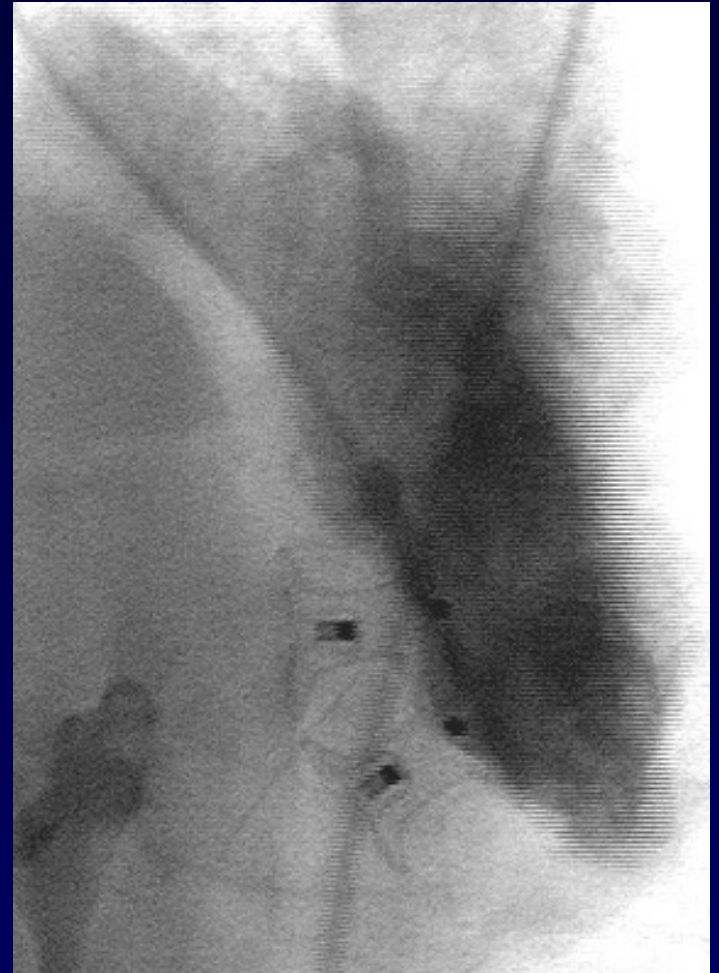
CM  
54  
54



Multiple Muscular VSD's

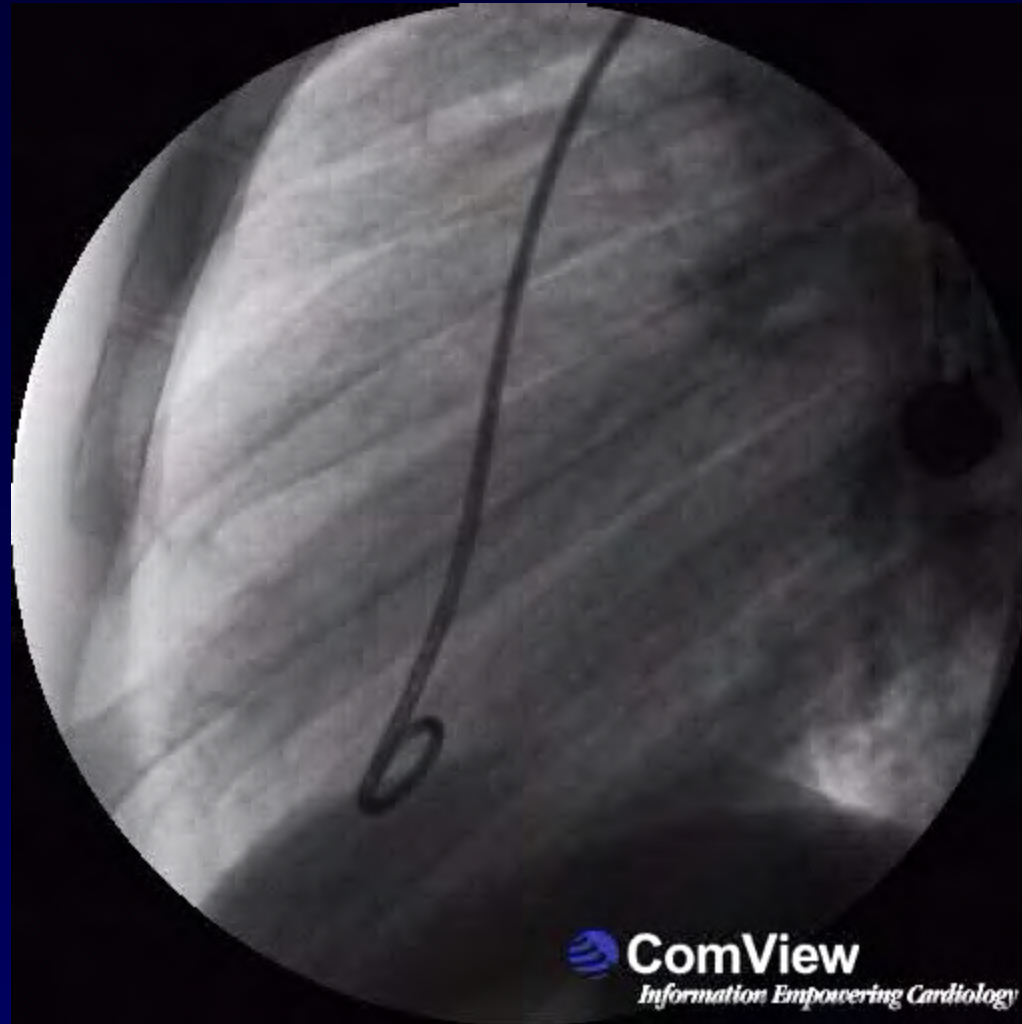


Implantation of 2 devices



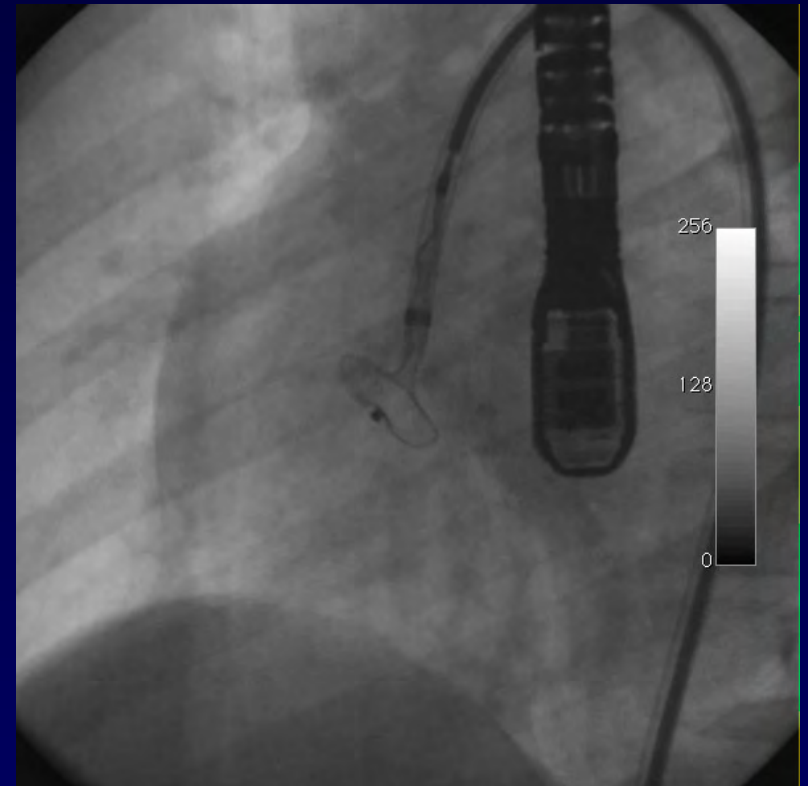
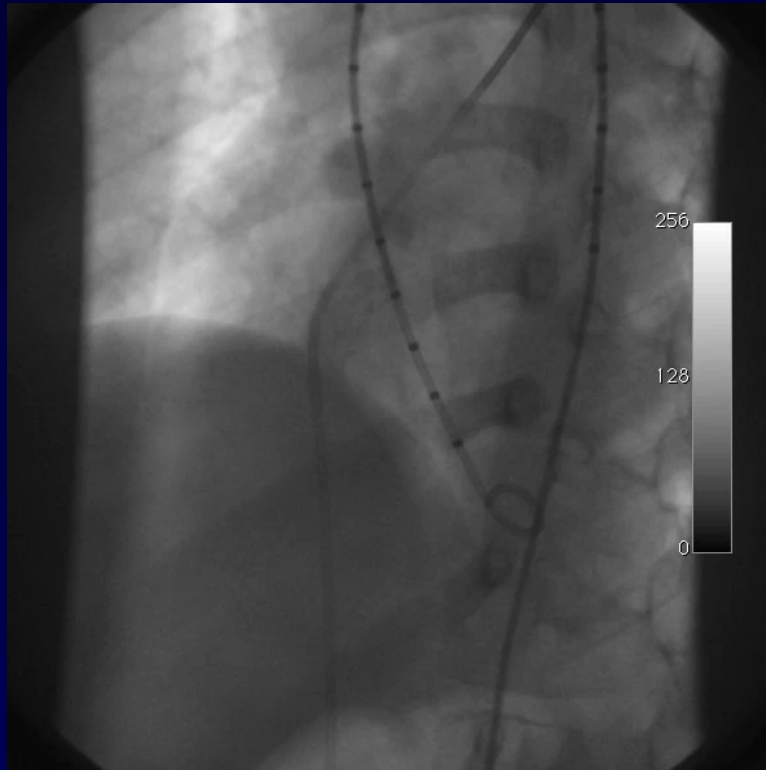


## Retrograde closure of high muscular VSD

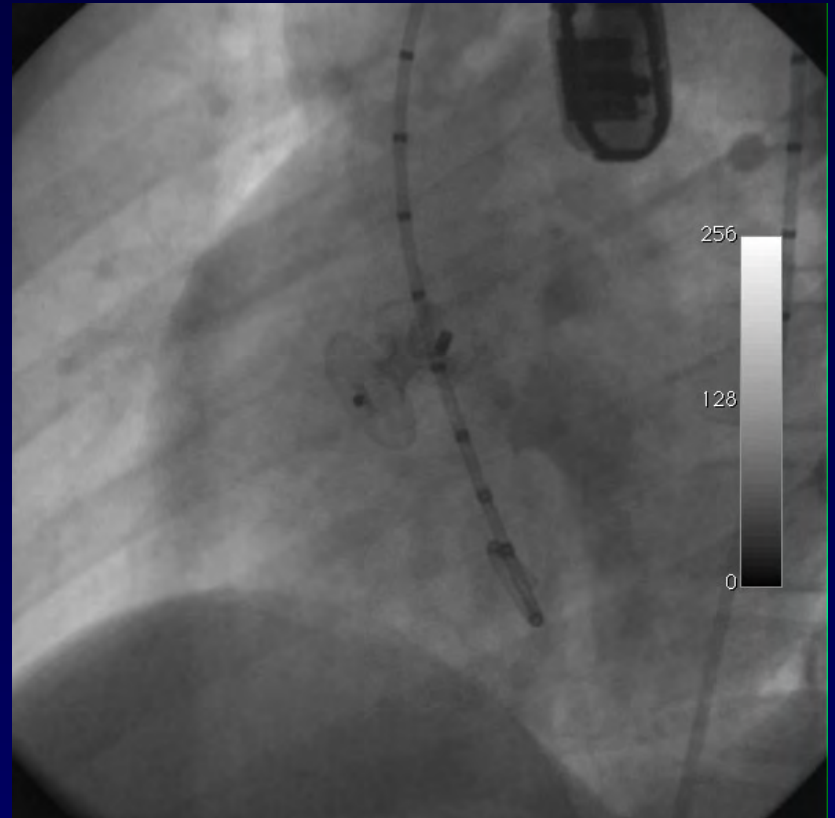
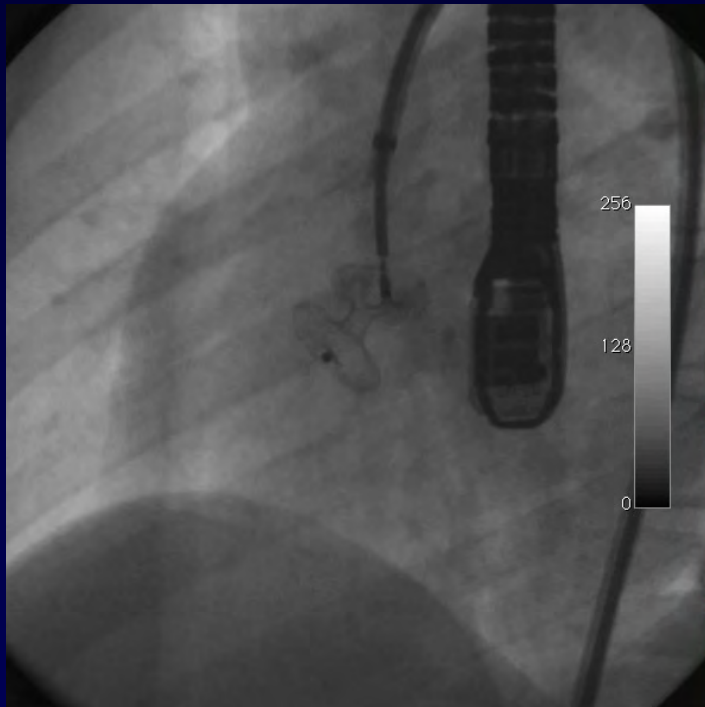


IRCCS Policlinico San Donato

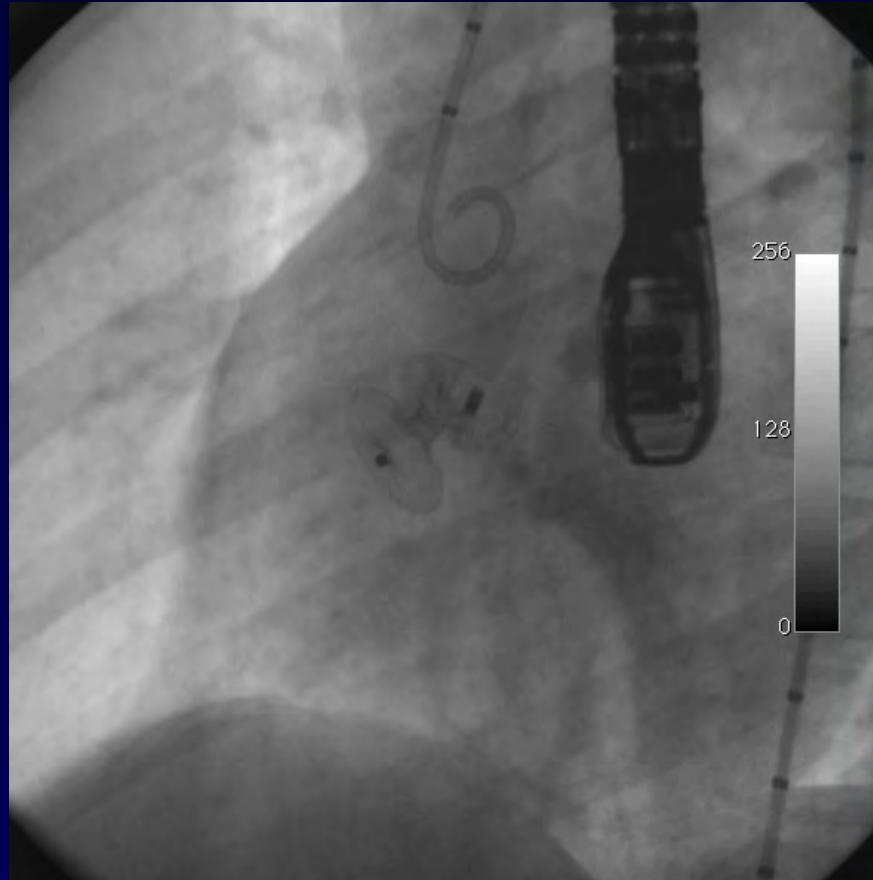
## Retrograde closure of high muscular VSD



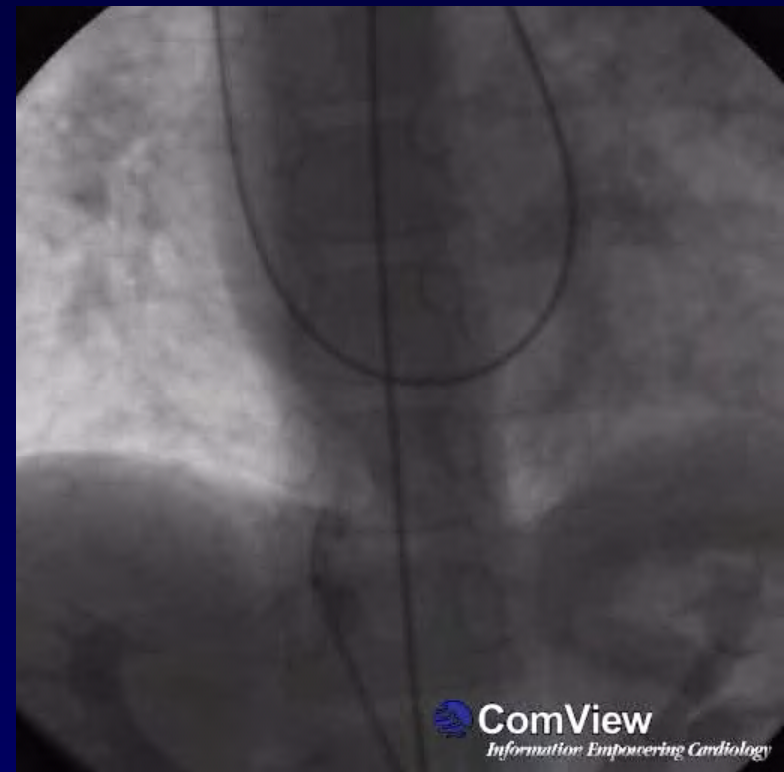
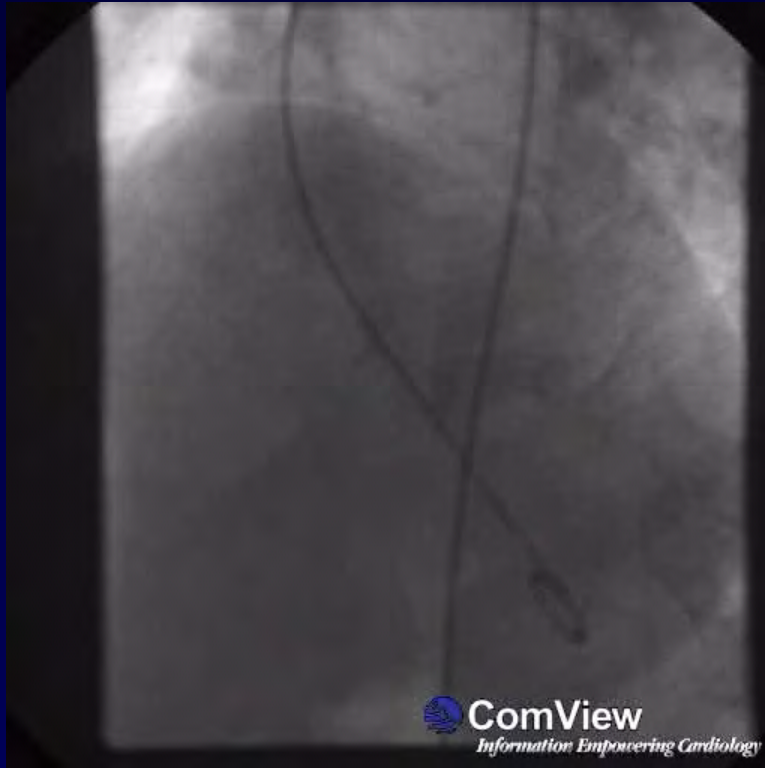
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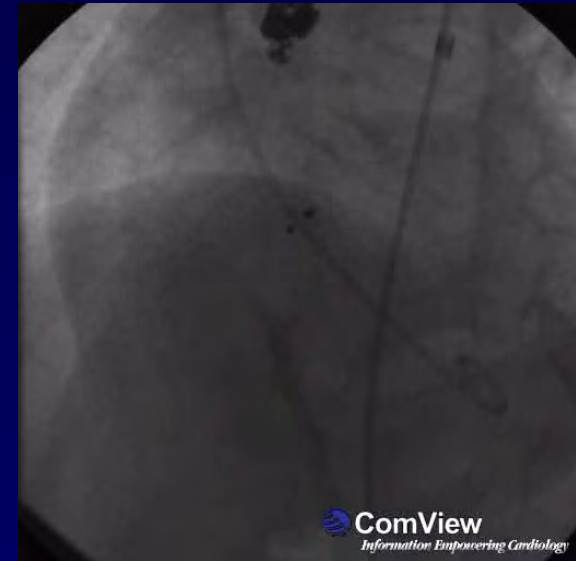
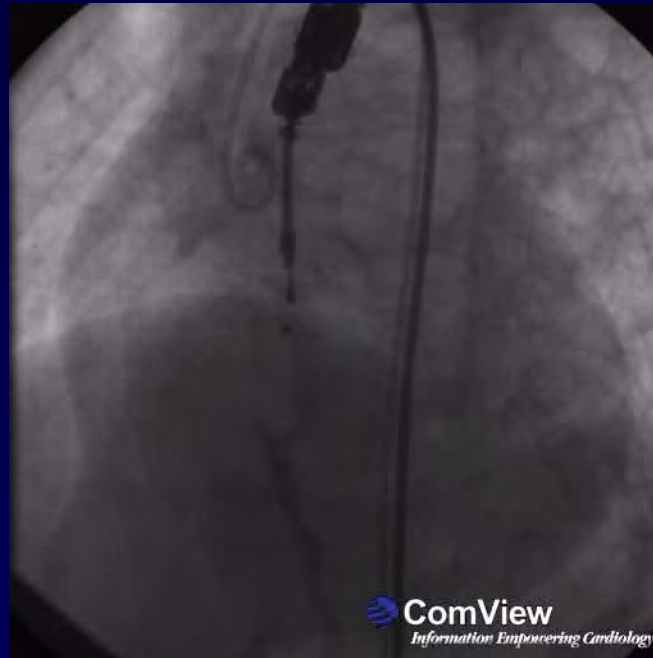
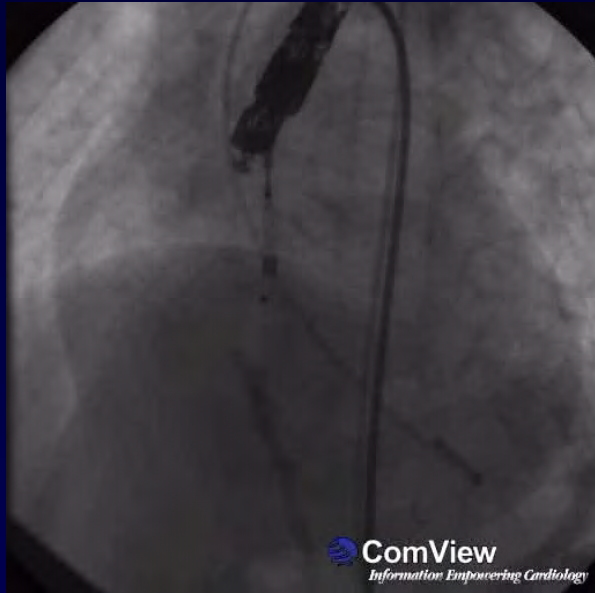


## Retrograde closure of high muscular VSD (interrupted IVC and azygos continuation)





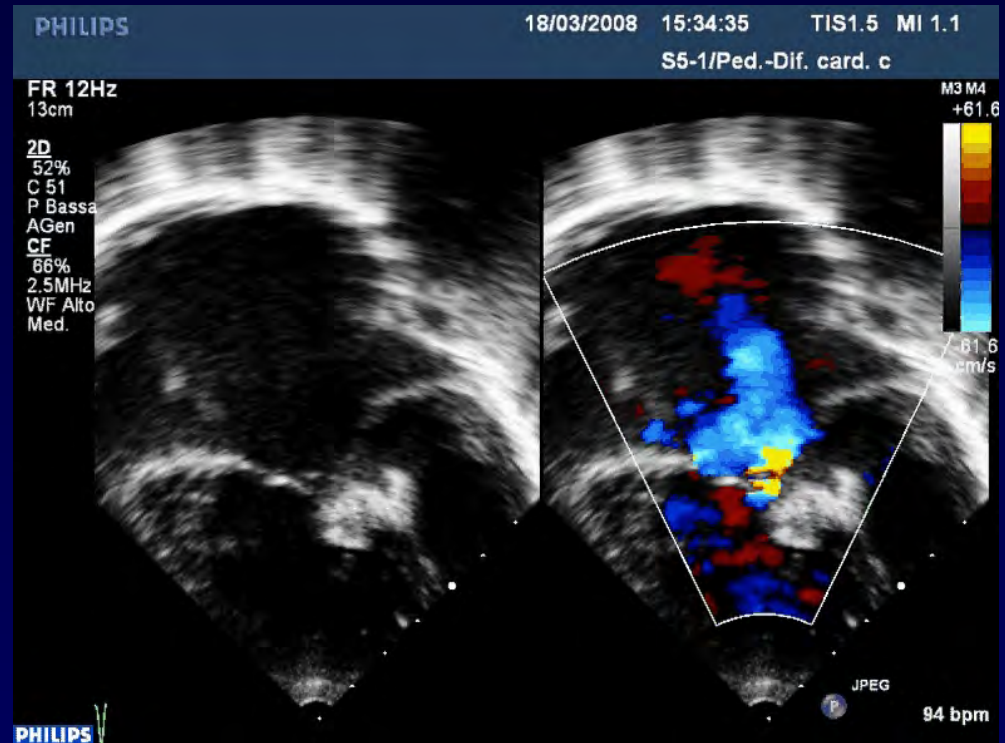
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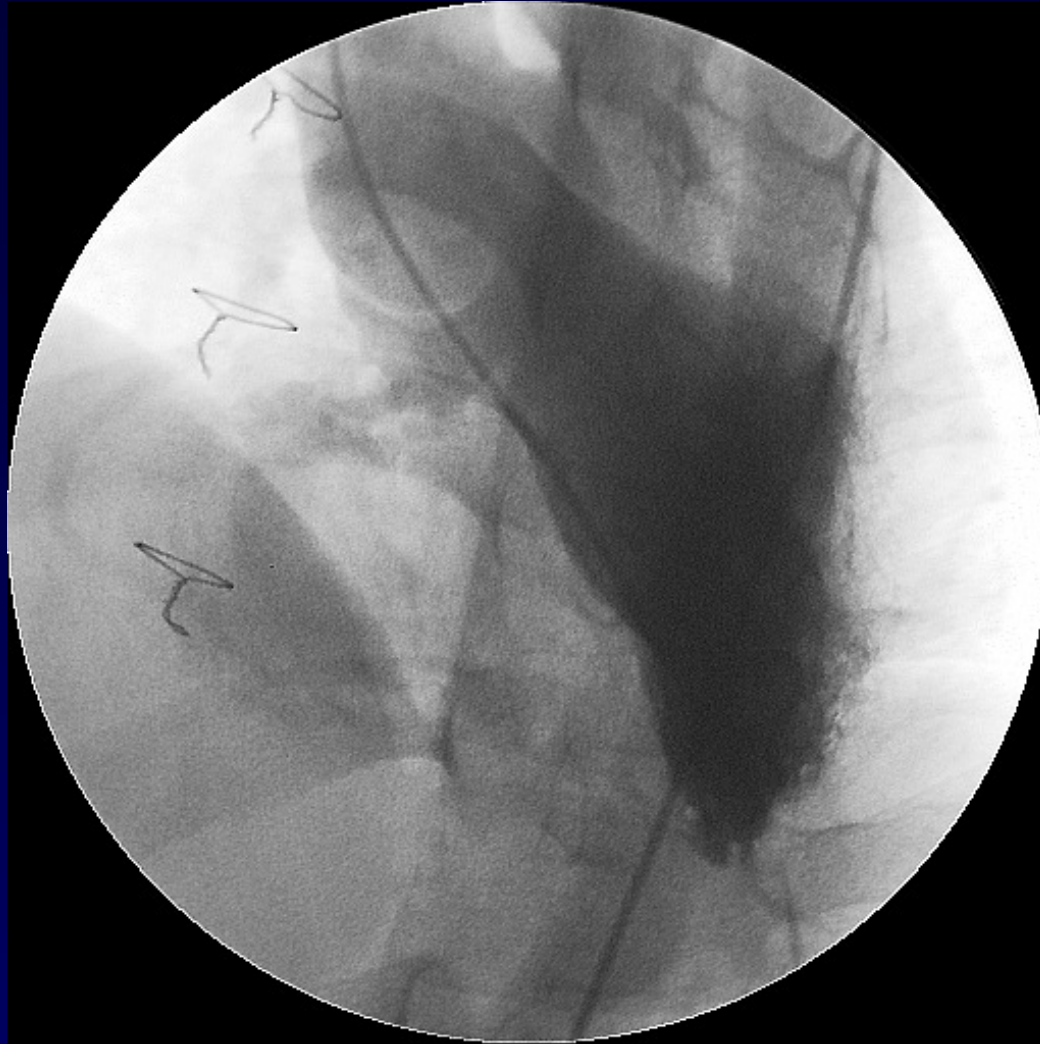
# Complications

Device entangled  
in the tricuspid valve

Sometimes worsening  
of TR during f-up

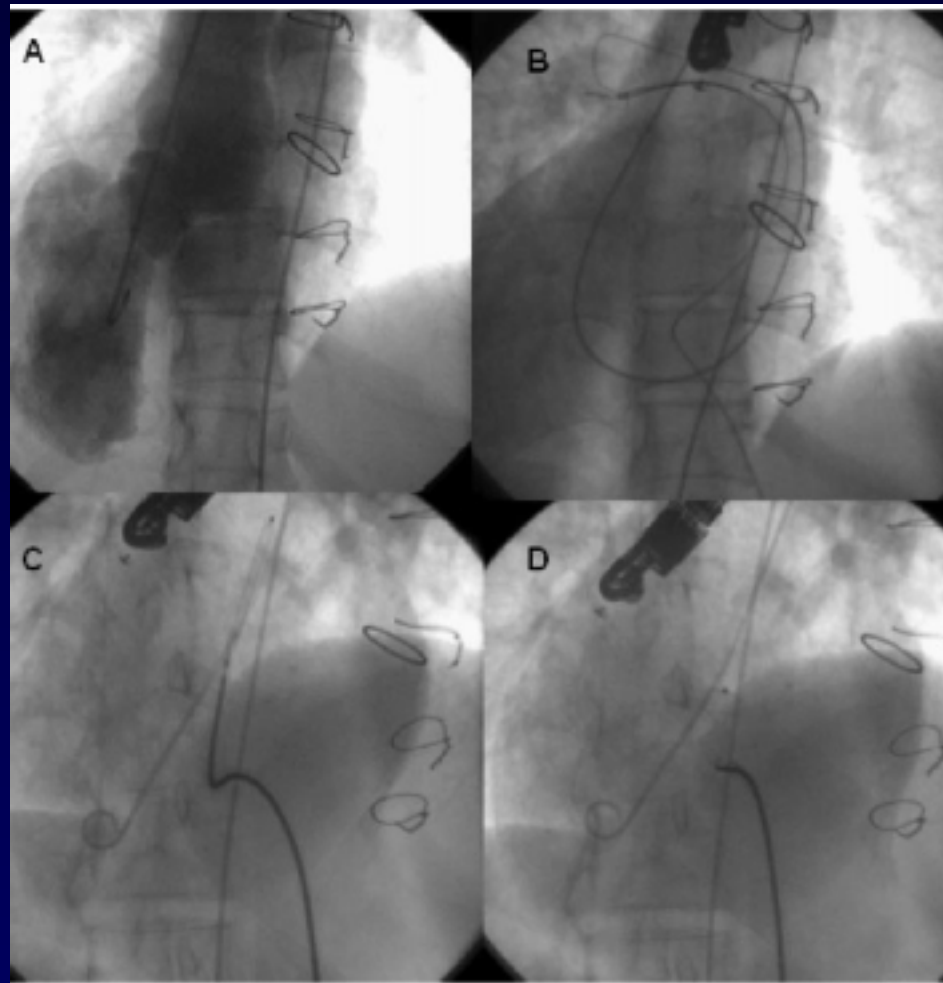


# Residual post-surgery VSD

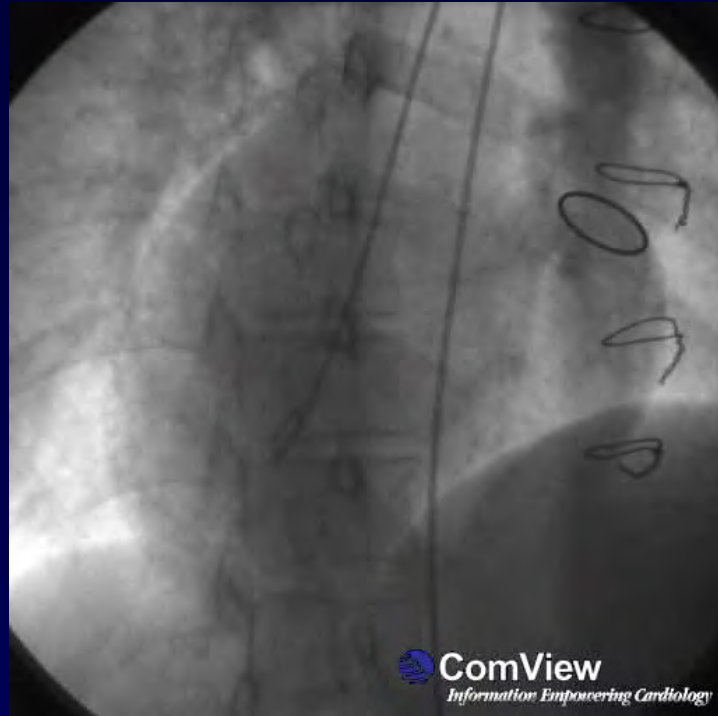




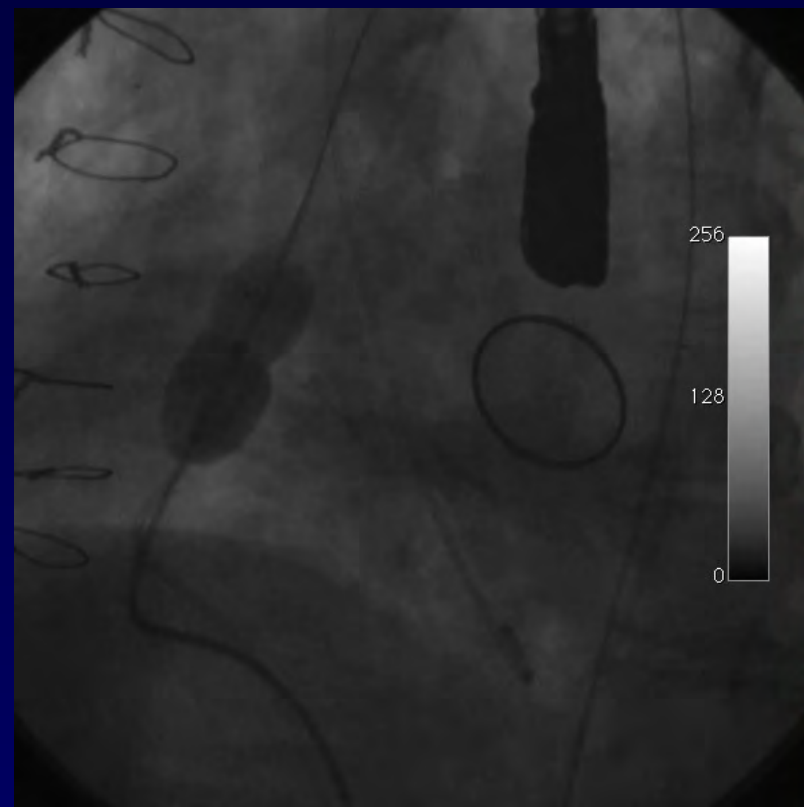
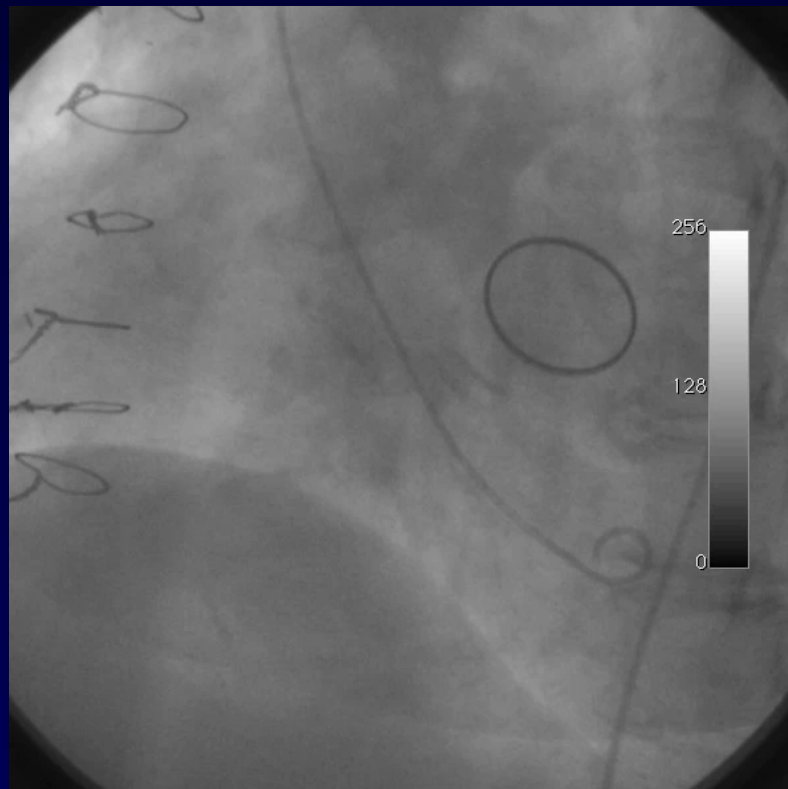
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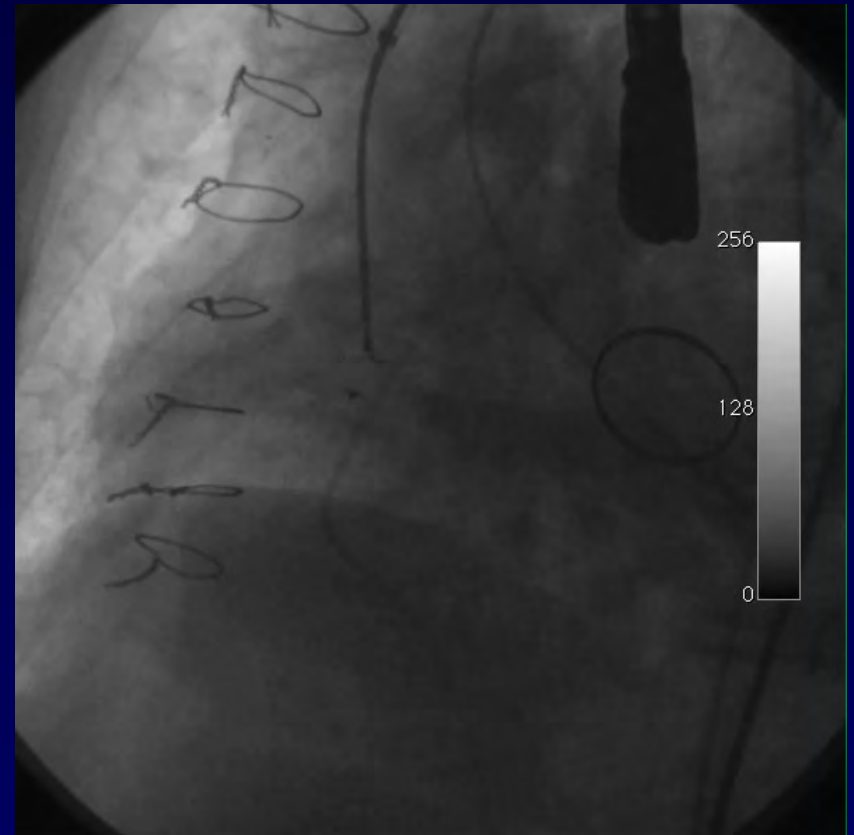
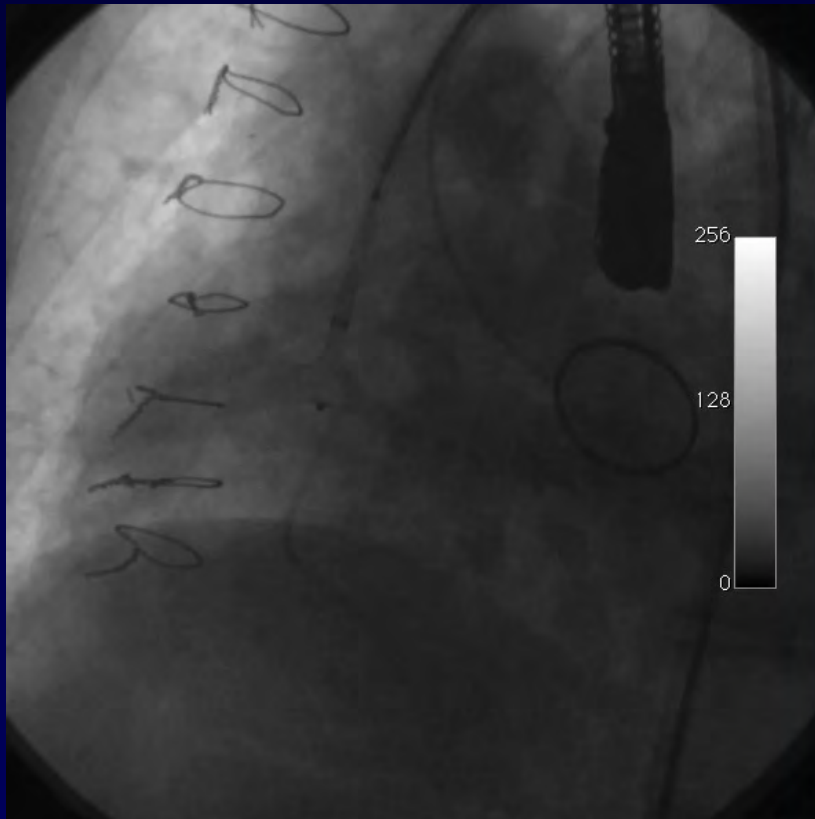
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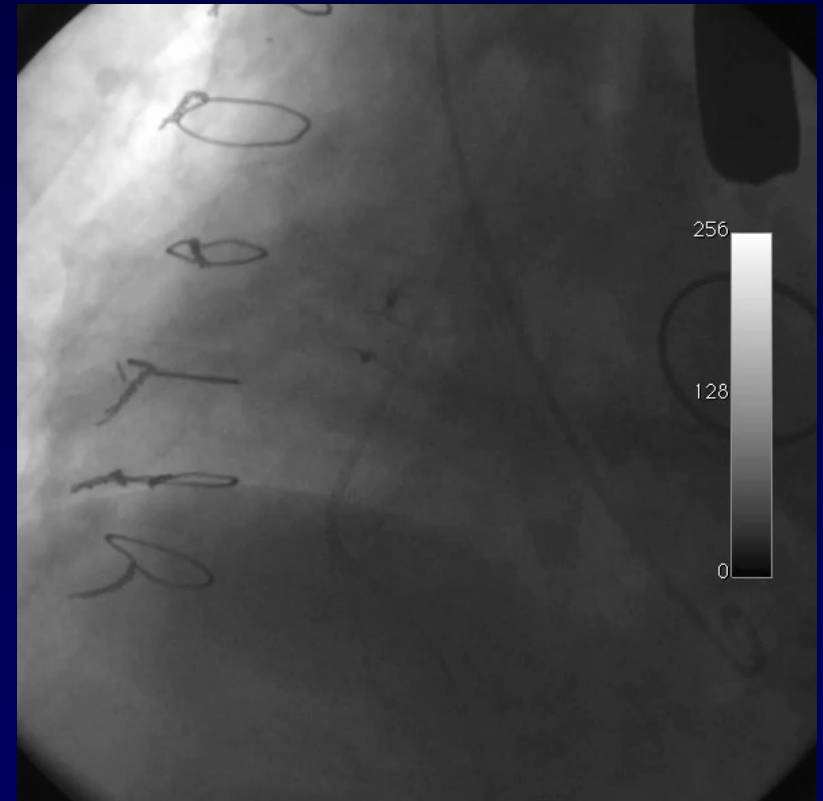
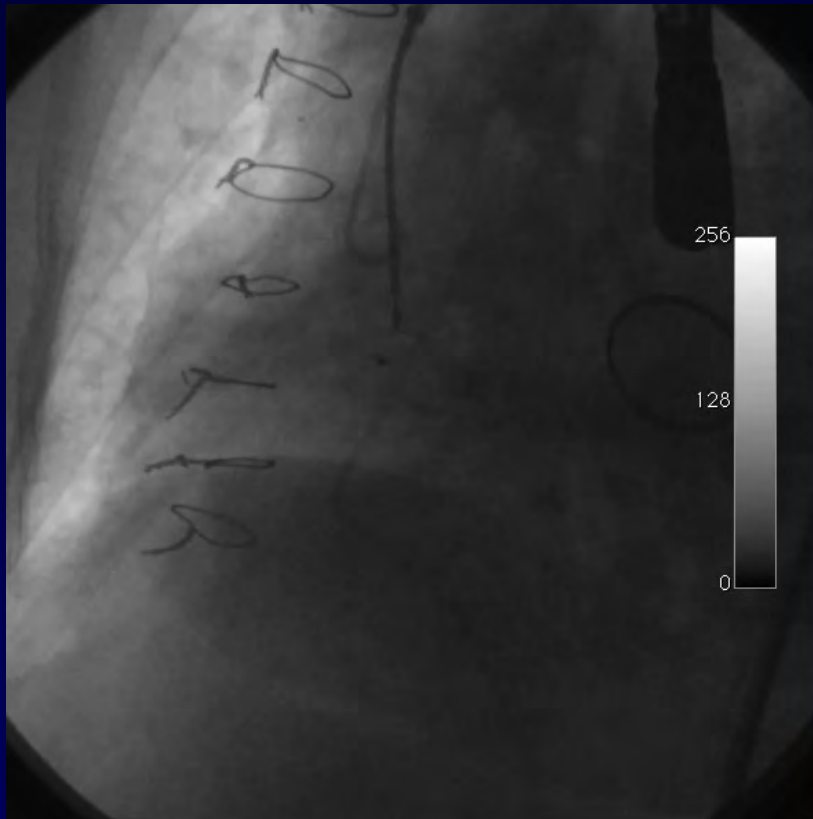
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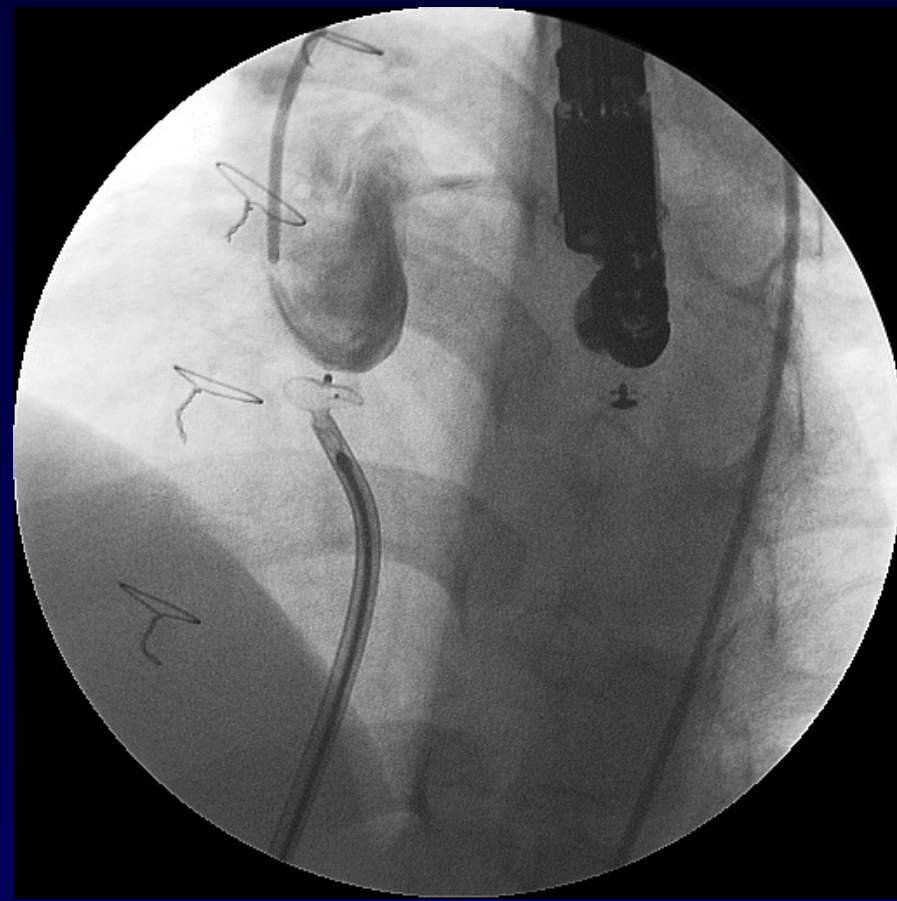
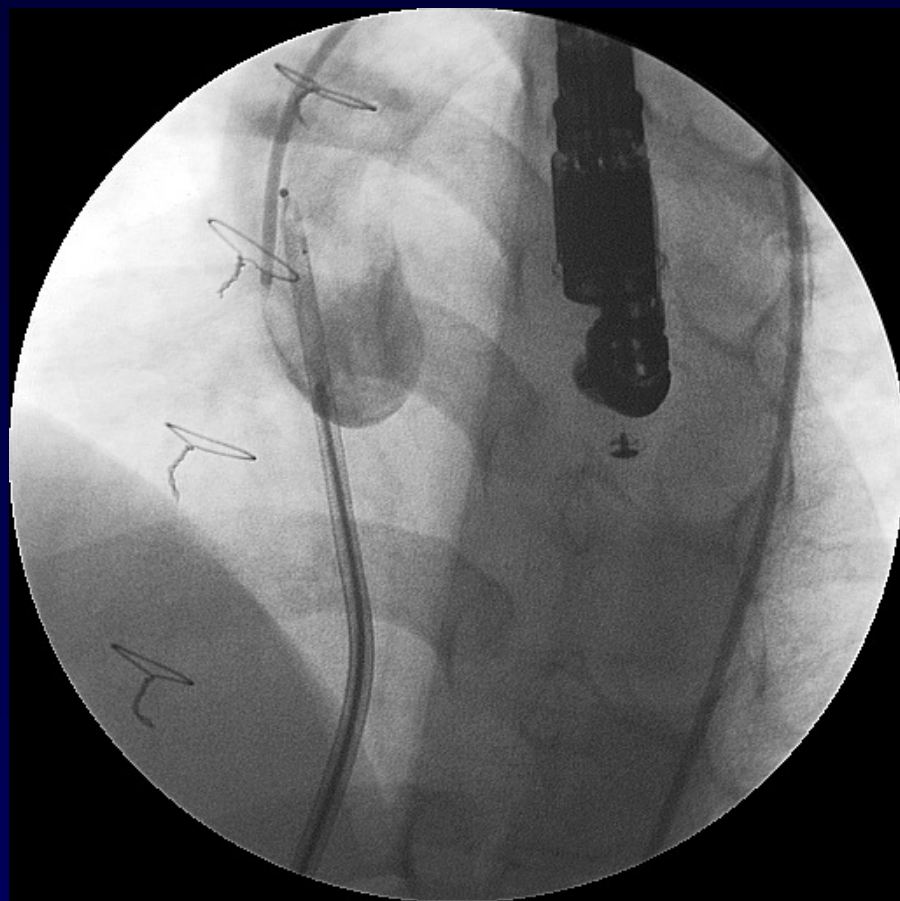
# Residual post-surgical VSD



# Residual post-surgical VSD

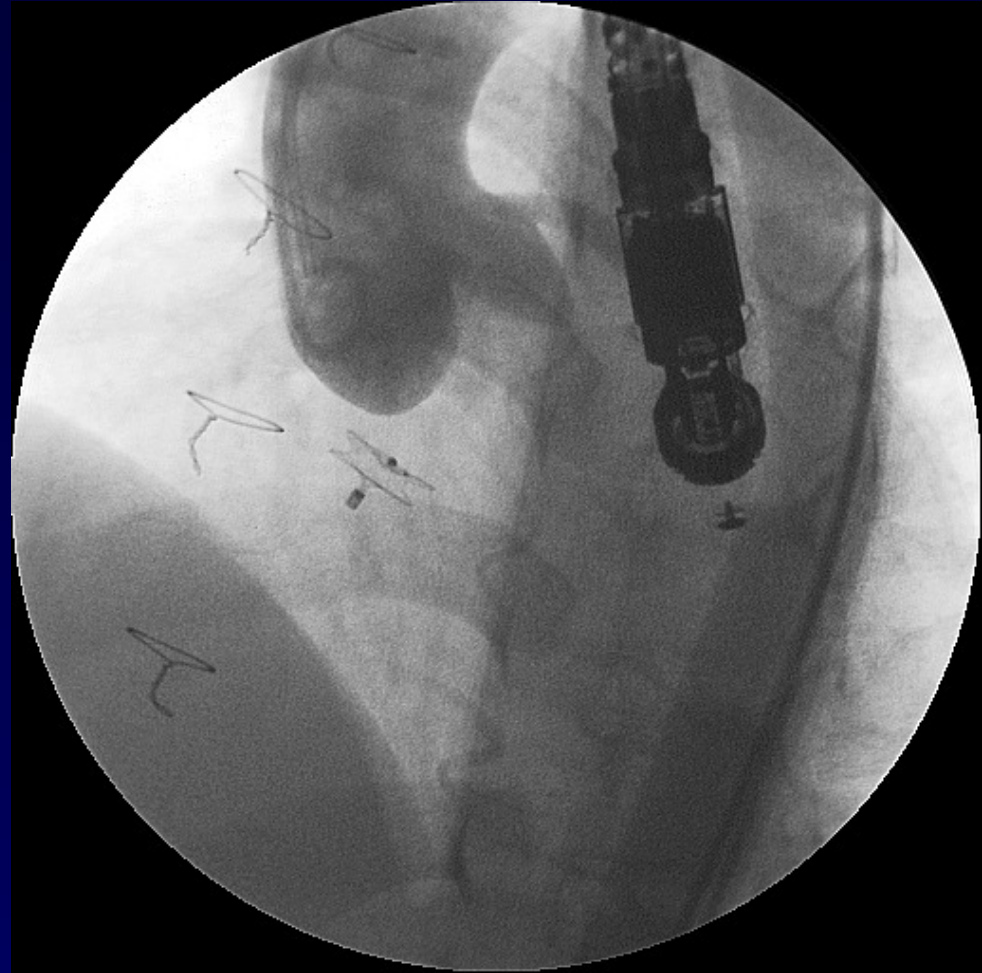
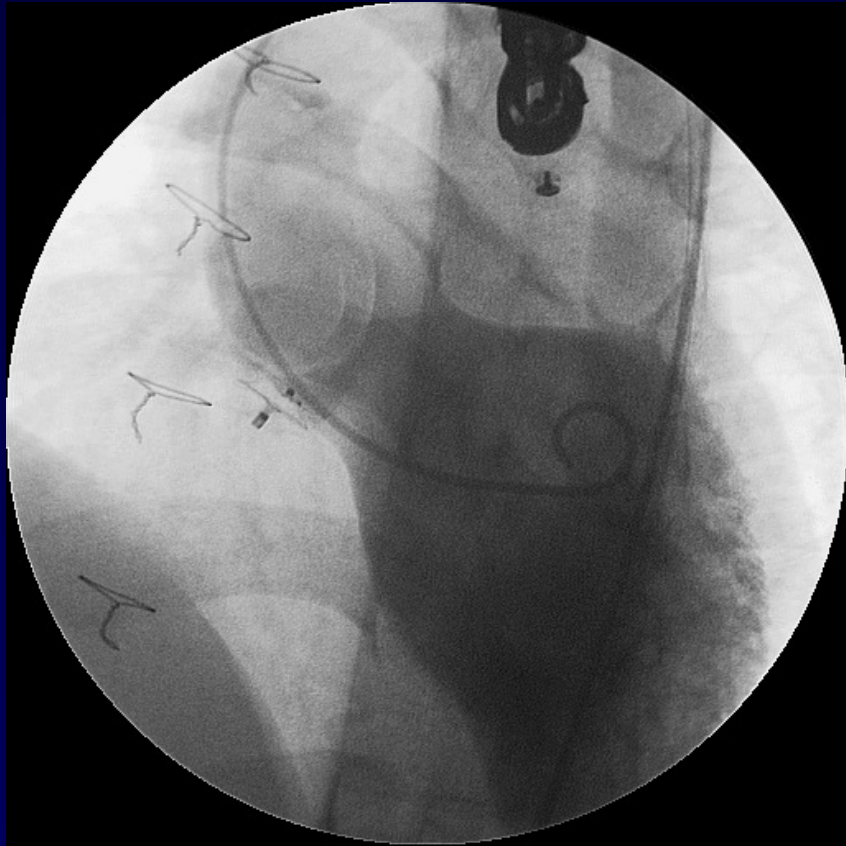


## Non standard procedure (aortic approach)

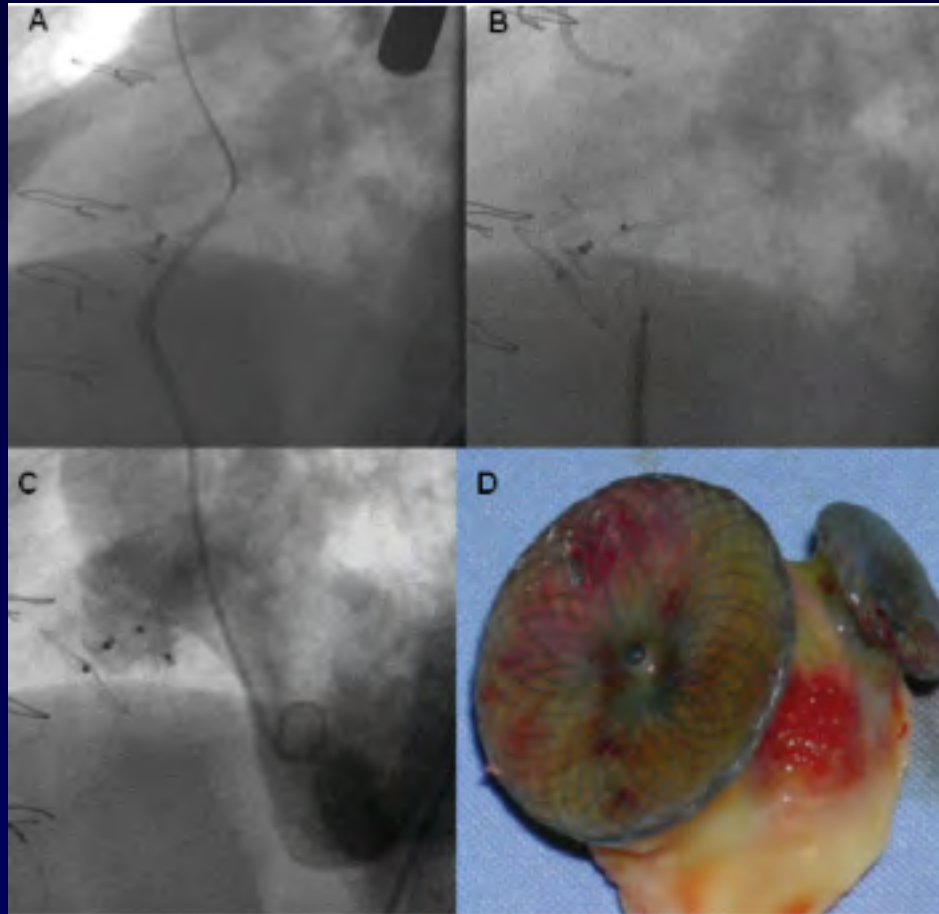




## Non standard procedure (aortic approach)



# Residual post-surgical VSD





# Residual post-surgical VSD

## Balloon sizing of the defect

- exact site, size, and position of the residual shunt
- not 'stop-flow' in most of the cases but a 'pull-through'

## TEE and angiography

It is essential to have expert TEE guidance

## Aortic retrograde approach

- easier in these cases.
- anterograde approach: it can be difficult to advance the sheath tip to the LV apex (surgical patches?)
- there is less space in the sub-aortic region to deploy the LV disc and increased risk of complications.
- if the LV disc is deployed in the ascending aorta, it is more difficult to retrieve it back in the sheath, if required, with increased risk of damaging the aortic valve.

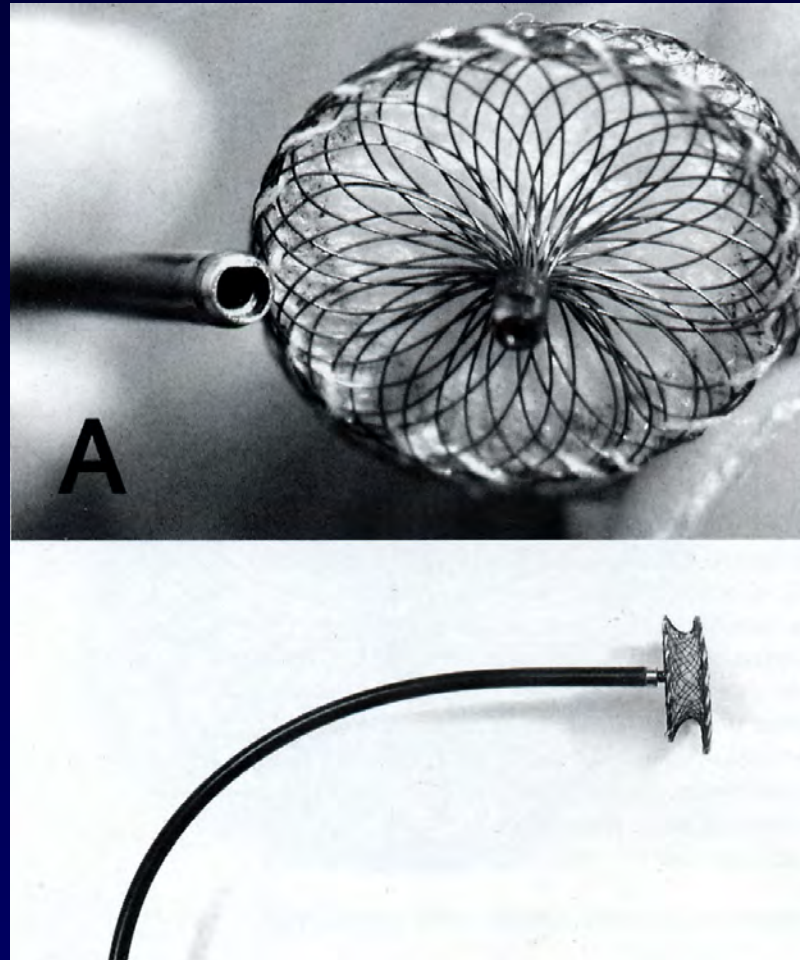
## Limitation

subjects who may accommodate the use of a 8Fr long-sheath in the femoral artery.

Amplatzer membranous VSD occluder  
“eccentric device”



## Amplatzer membranous VSD occluder “eccentric device”



## Amplatzer membranous VSD occluder “eccentric device”



# *Perimembranous VSD*

Pre-procedural Echocardiographic evaluation (TTE)

Size (measure in different views)

Number (single/multiple)

Extension (inlet/trabecular/outlet)

Aneurysm/Pouches from the TV/ septal L of the TV

Associated defects (ASD/pulmonary stenosis/aortic coarctation/others)

Contra-indication to percutaneous closure

# *Perimembranous VSD*

Procedural Echocardiographic evaluation (TEE)

Integrate data from fluoroscopy, EKG

Analysis of VSD (Size/Number/Location/Aneurysm/Associated defects  
Contra-indication to percutaneous closure)

Check position of :

Guide wire (TV, AoV)

Ventricular function during manoeuvres

Long-sheath (MV, free LV wall, AoV,TV)





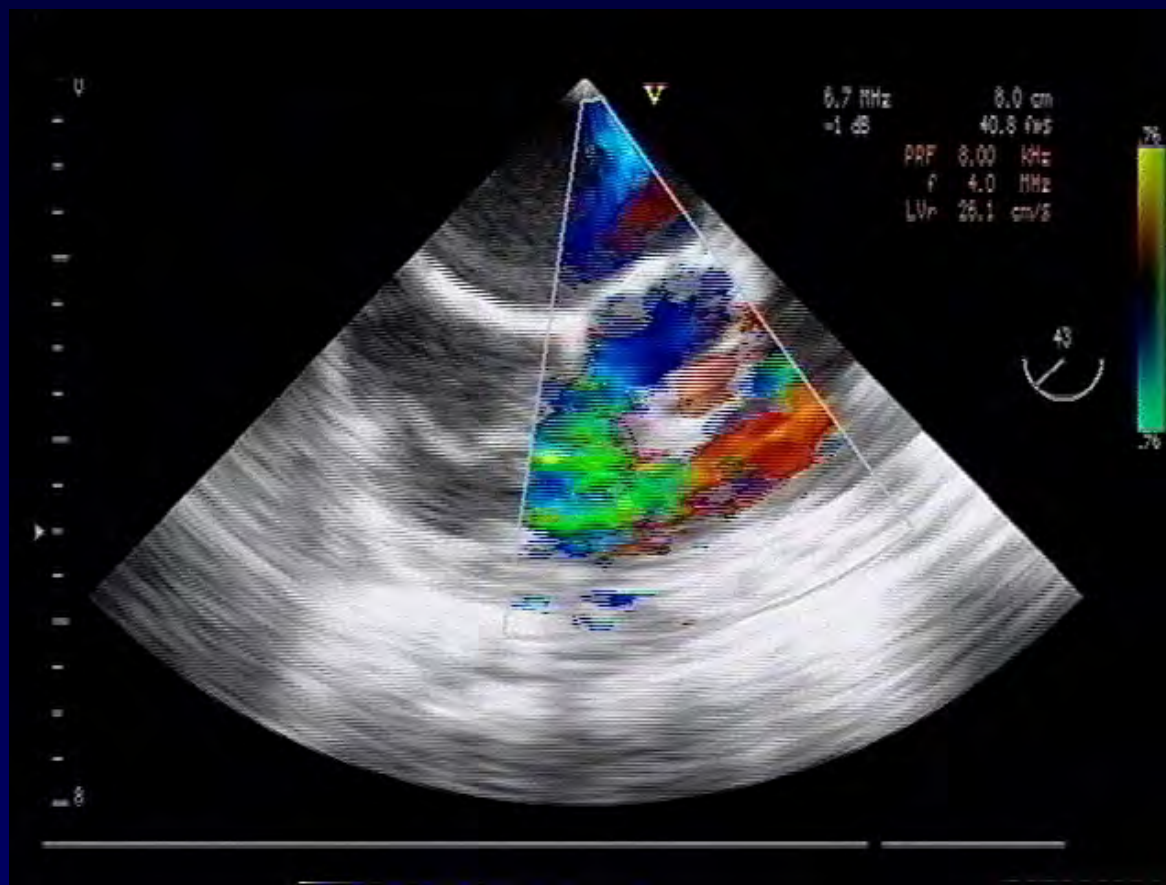
# *Perimembranous VSD*

## Echocardiographic evaluation



# *Perimembranous VSD*

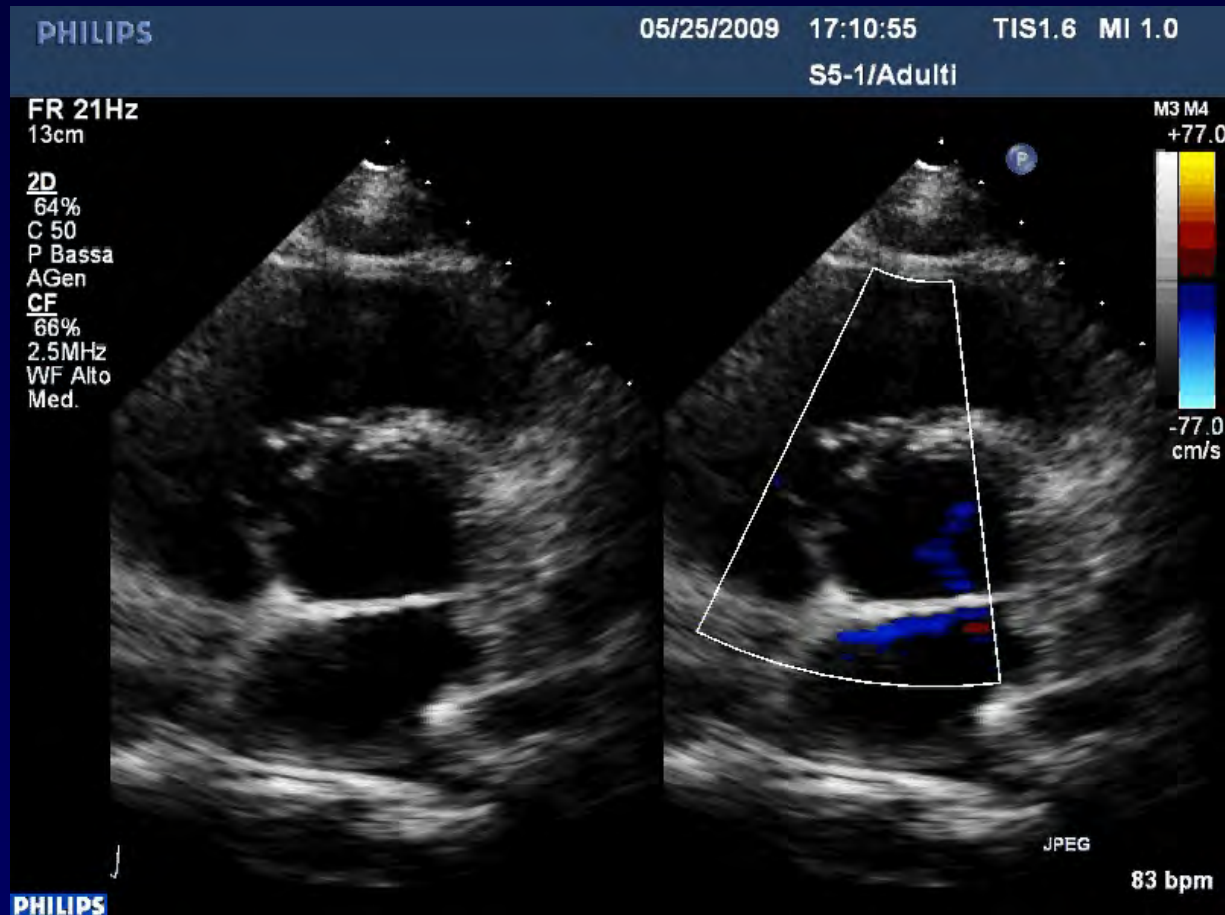
Echocardiographic evaluation





# *Perimembranous VSD*

## Echocardiographic evaluation



# *Perimembranous VSD*

Procedural Echocardiographic evaluation (TEE)

Check interatrial septum, direction of shunting on PFO/ASD

Check tricuspid valve

Check device deployment:

LV disk (MV, free LV wall, IVS, Ao valve)

Connecting waist

RV disk (IVS, TV)



# *Perimembranous VSD*

Procedural Echocardiographic evaluation (TEE)

Check device position:

malposition?

embolization?

Pericardial effusion?

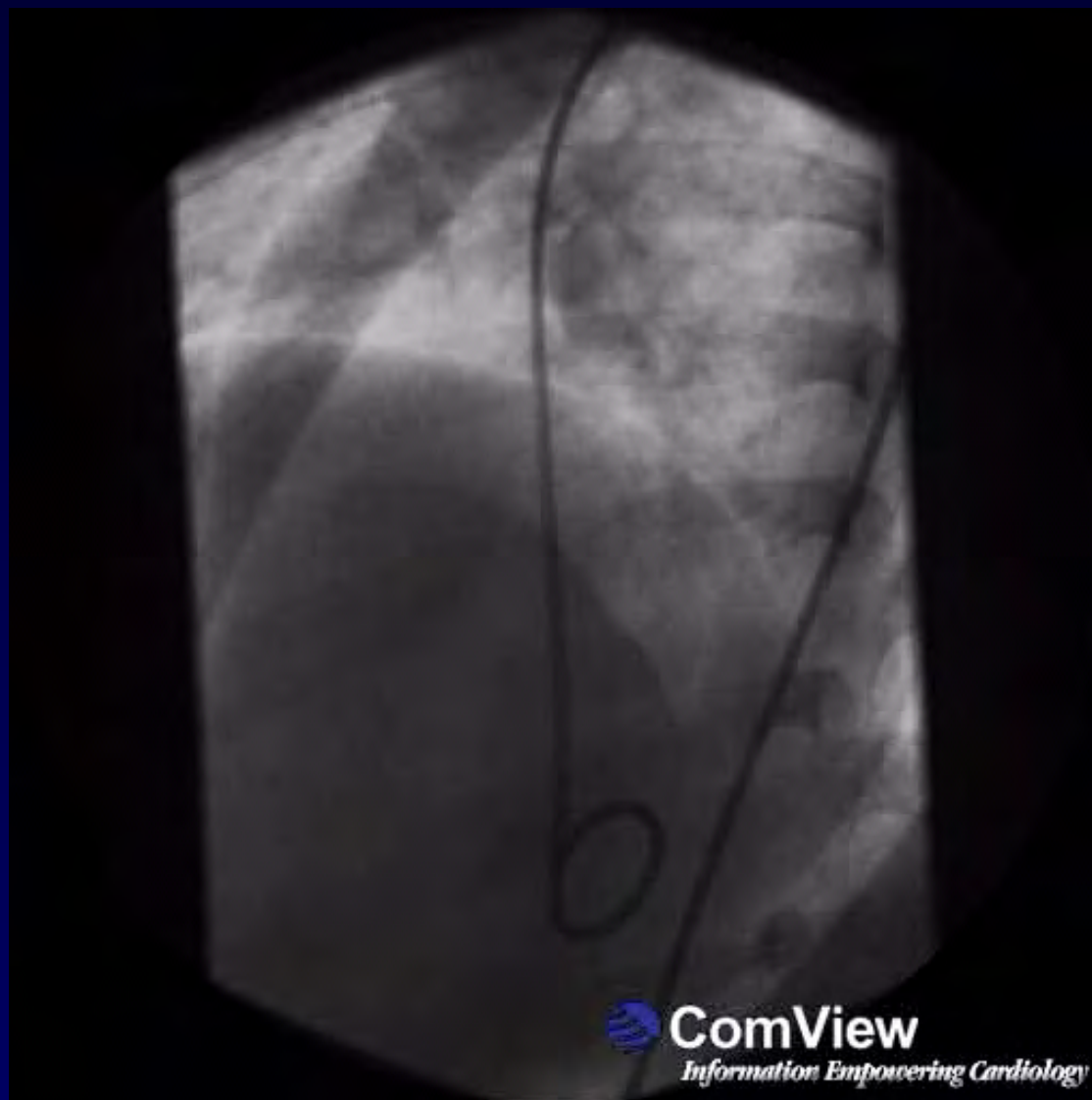
Regurgitation of AoV,MV,TV?



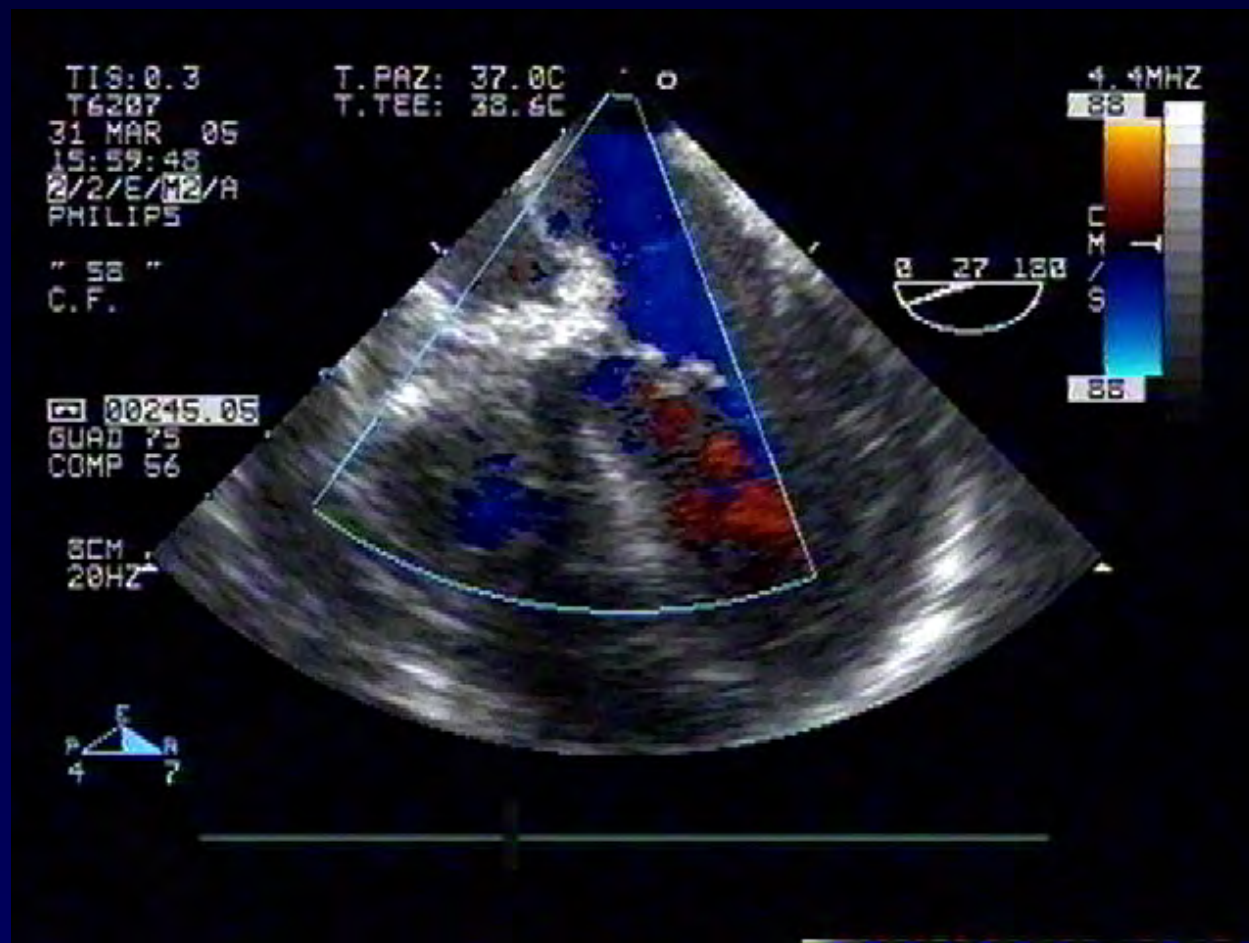
## Perimembranous VSD Closure with “eccentric device”



## Perimembranous VSD

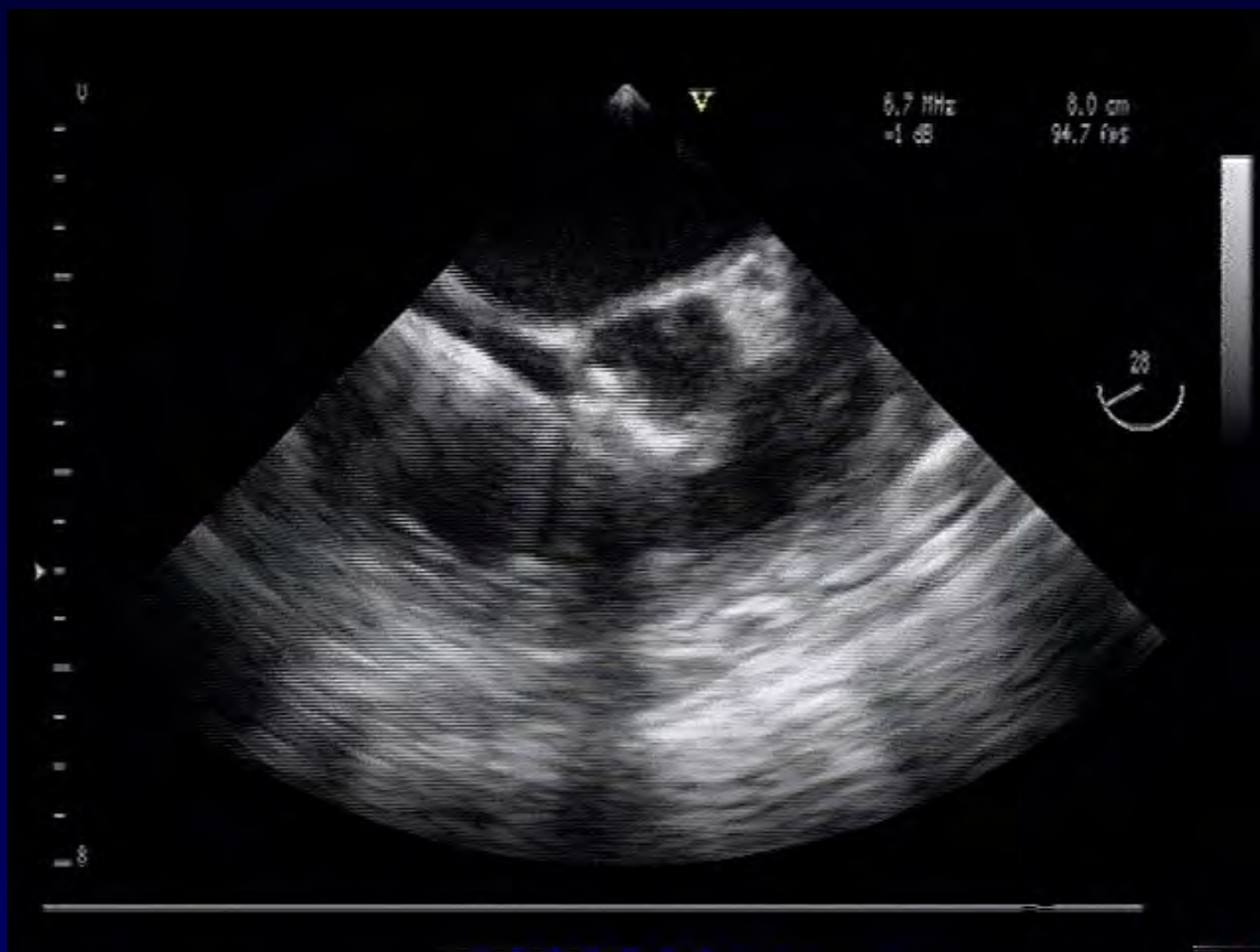


## Perimembranous VSD

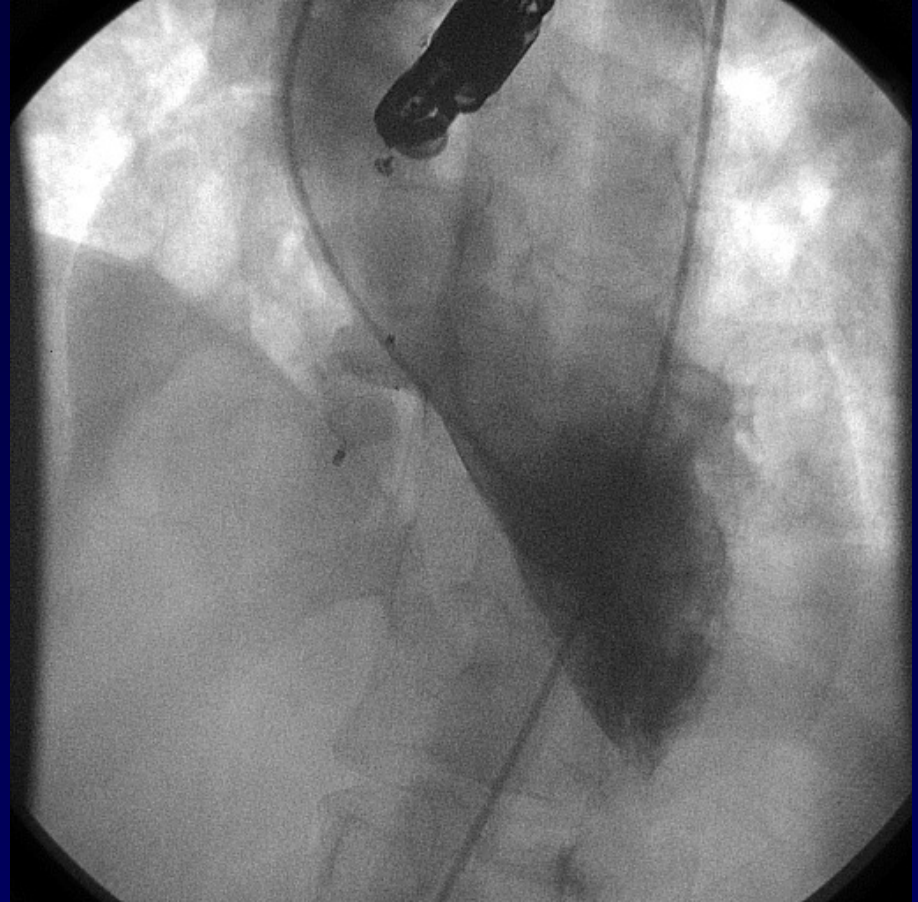
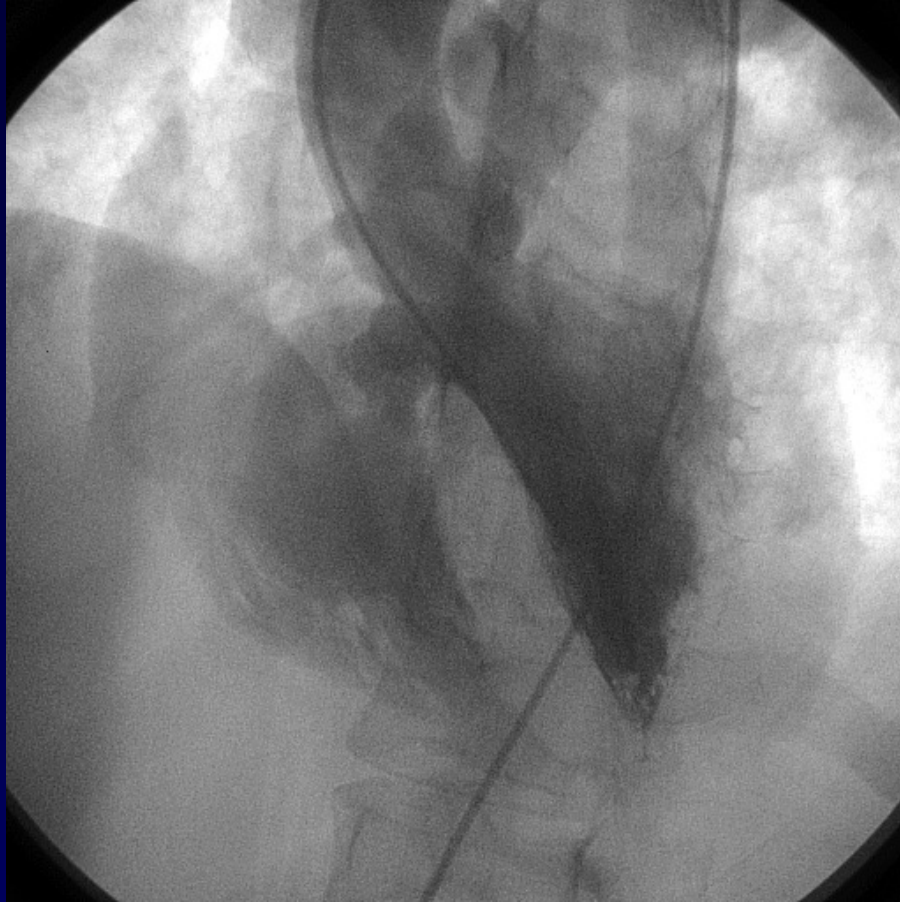




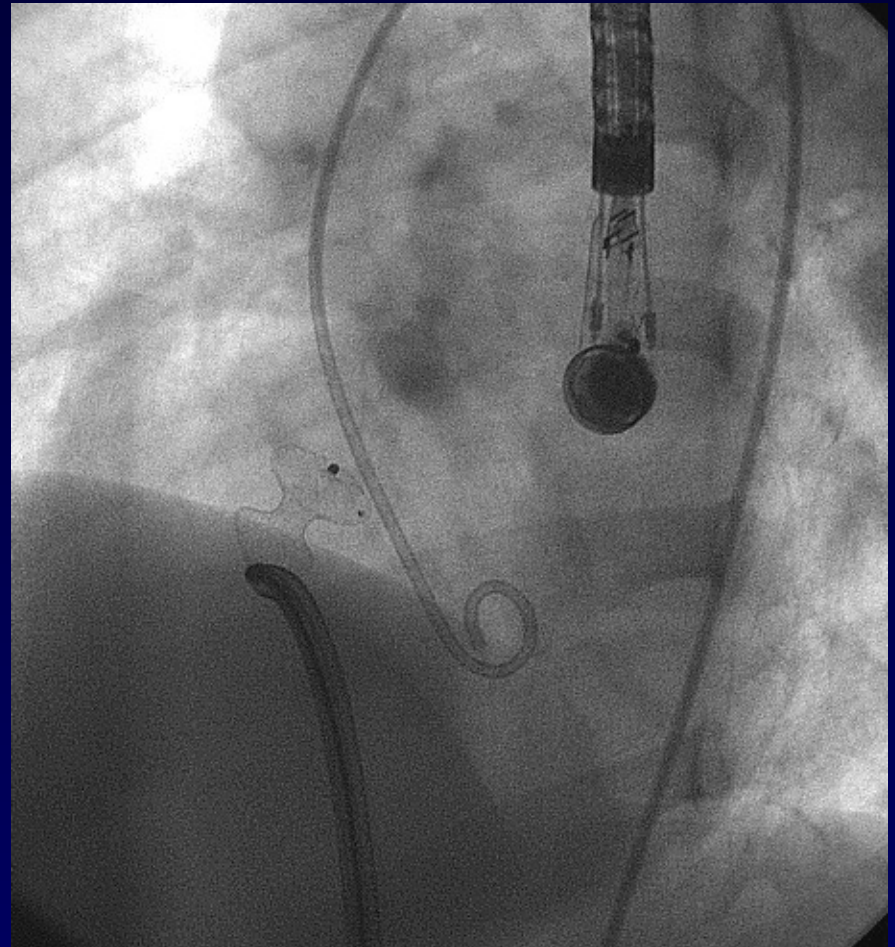
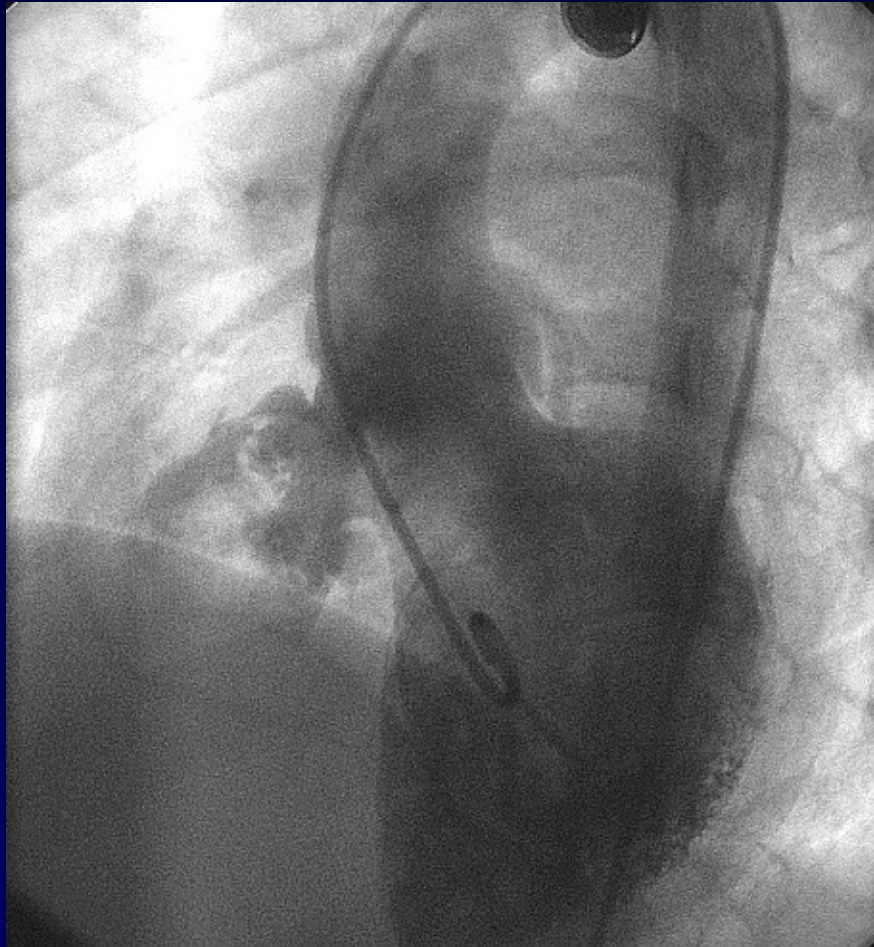
## Perimembranous VSD



## Perimembranous VSD with “septal aneurysm”

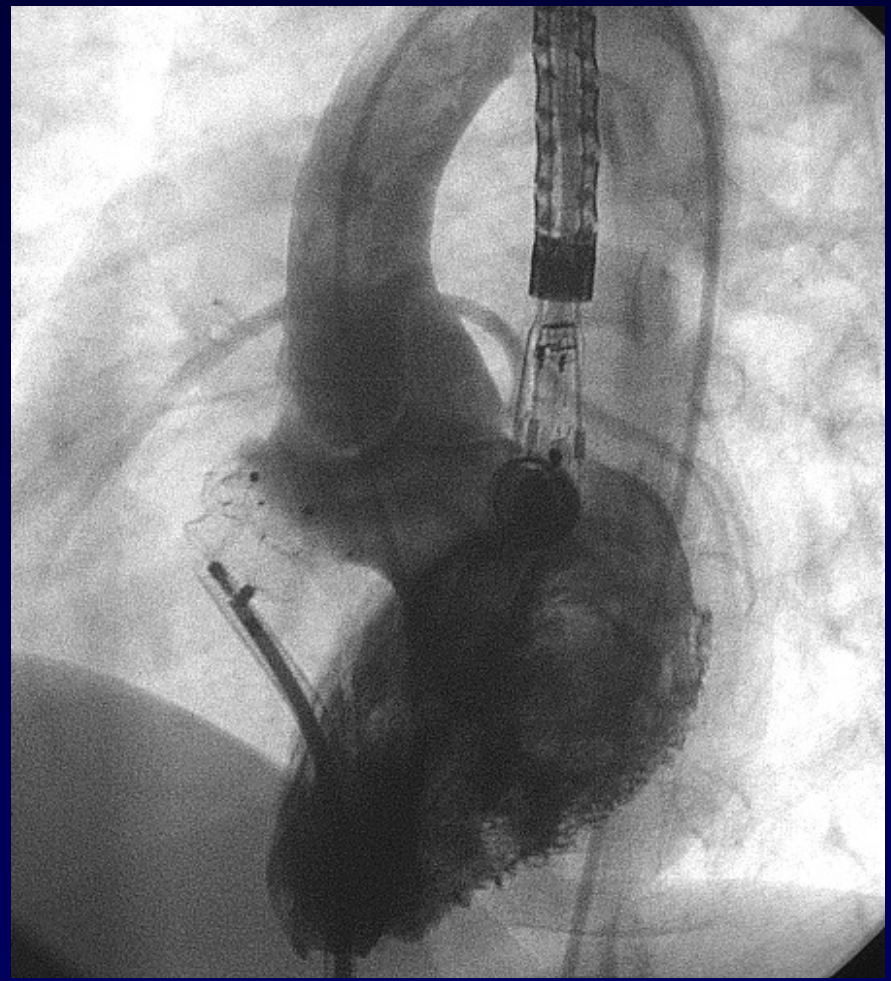
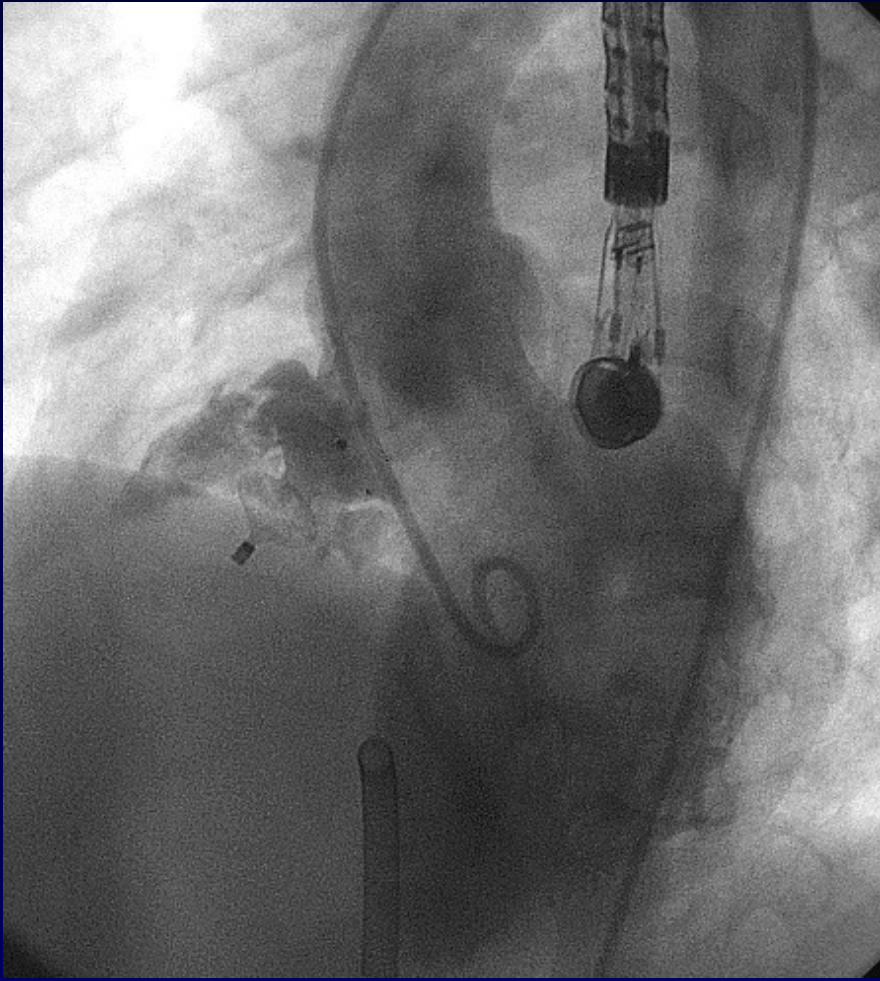


## Multiple Perimembranous VSD with “septal aneurysm”

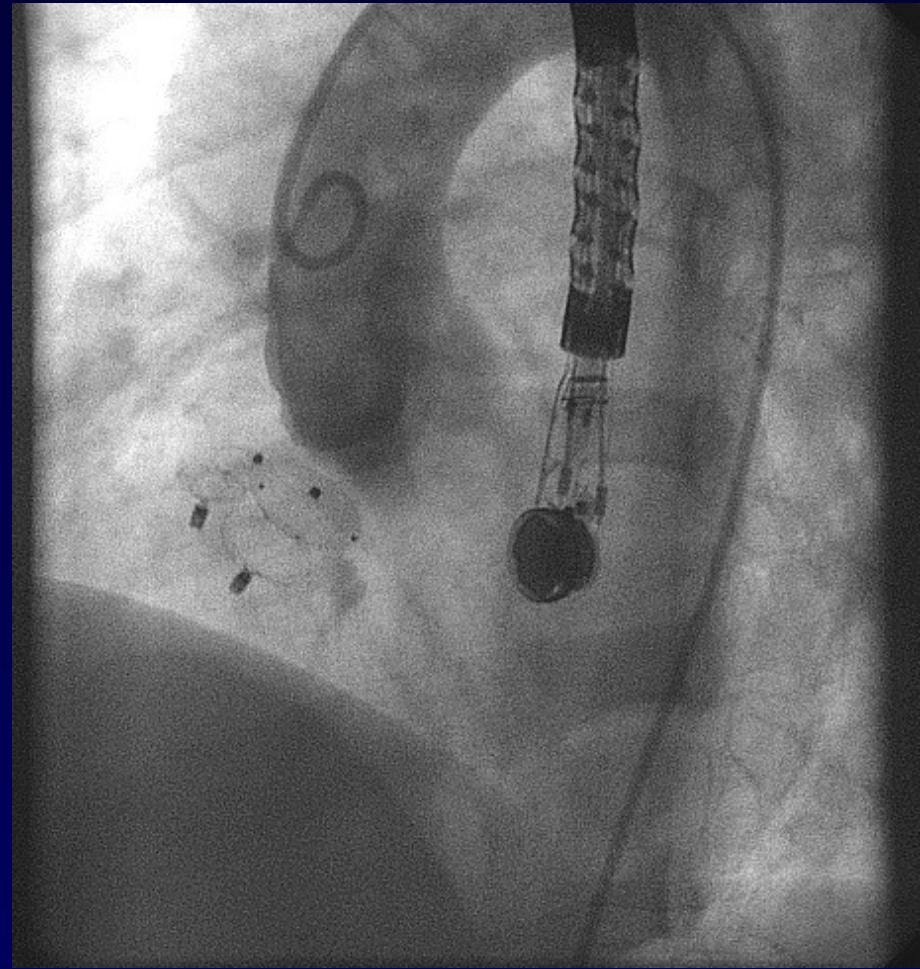
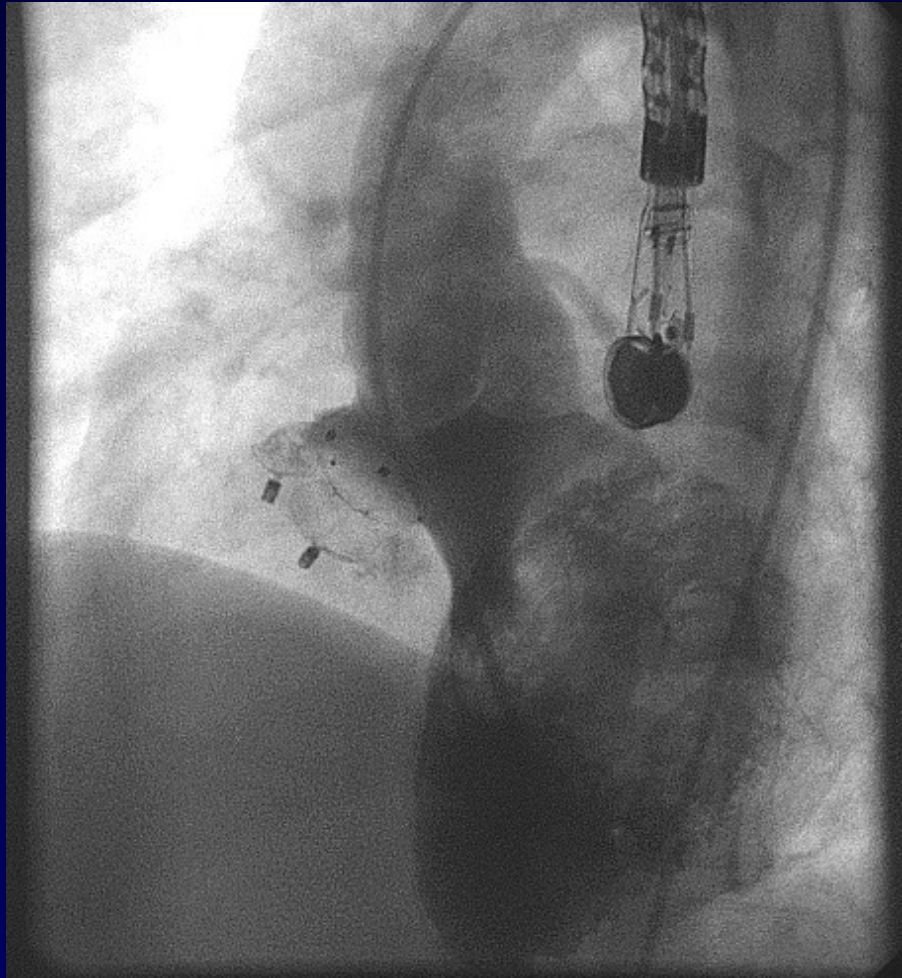




## Multiple Perimembranous VSD with septal aneurysm



## Multiple Perimembranous VSD with septal aneurysm





Perimembranous VSD with “septal aneurysm”  
Closure with Muscular VSD occluder





## Perim.VSD + ASD + PDA



# Amplatzer perimembranous VSD occluder

## *Tips, Tricks, Hints and Pitfalls*

- *Difficulties in advancing the sheath over the AV circuit: start all over again*
- *Desaturation when the sheath is in place: R-to-L shunt through the PFO/ASD due to “functional” tricuspid stenosis*
- *Retrograde closure from the the aortic side*
- *Difficulties in placing the sheath towards the LV apex: open the device from the aorta*



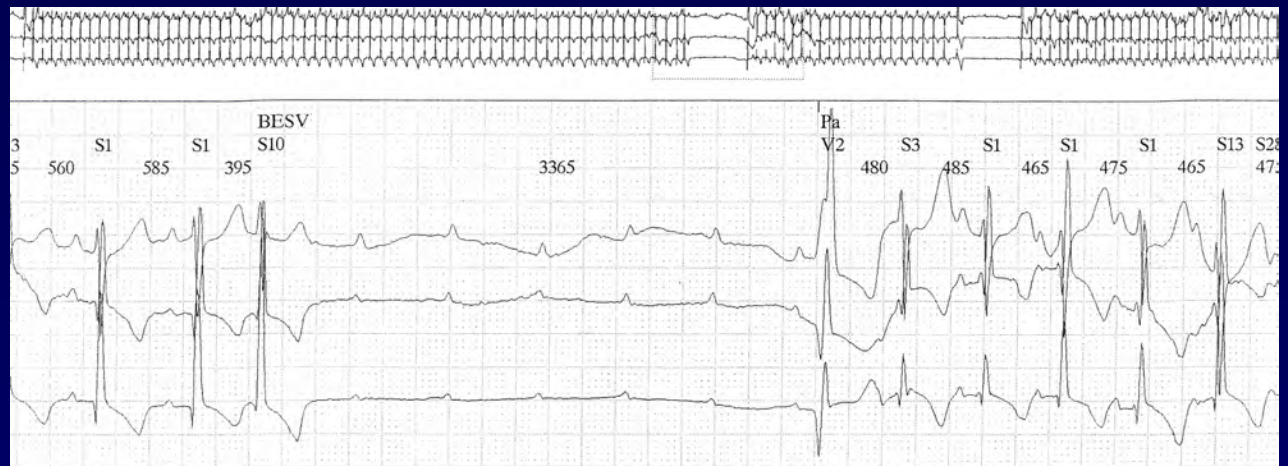
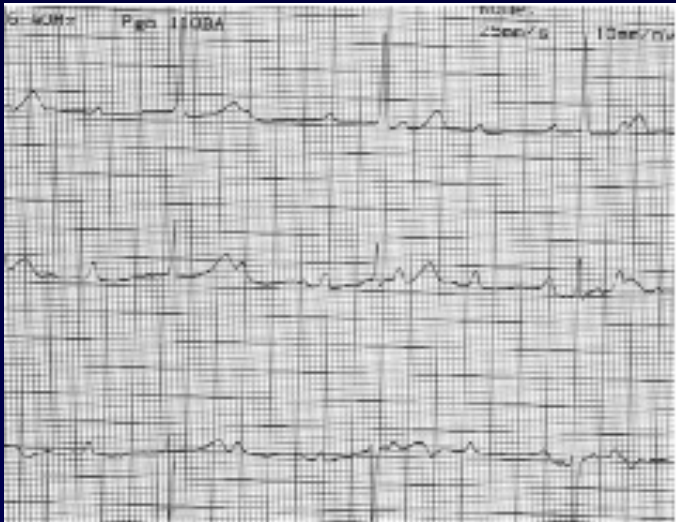
# Complete -AVB

Large variability in

Clinical presentation  
(asymptomatic-mild symptoms-  
syncope-sudden death)

Timing (up to 2 years after procedure)

Answer to steroids



# Perimembranous VSD and cAV block: possible mechanisms and risk factors

## Early Heart block

*Trauma/edema from catheter manipulation  
and/or device*

*Inflammatory reaction to device*

*Down's Syndrome*

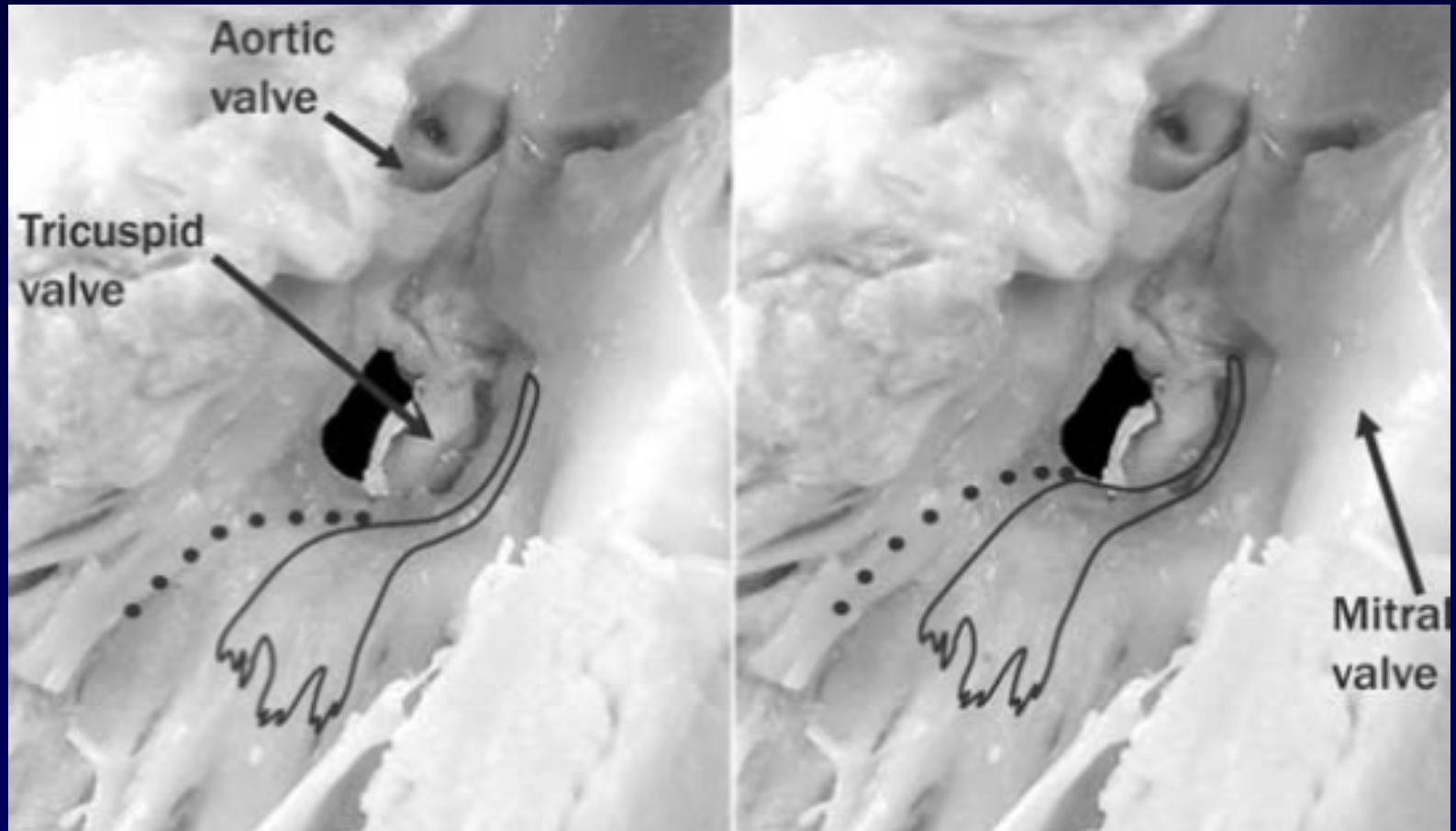
## Late Heart block

*Trauma from continuing expansion of an  
oversized device*

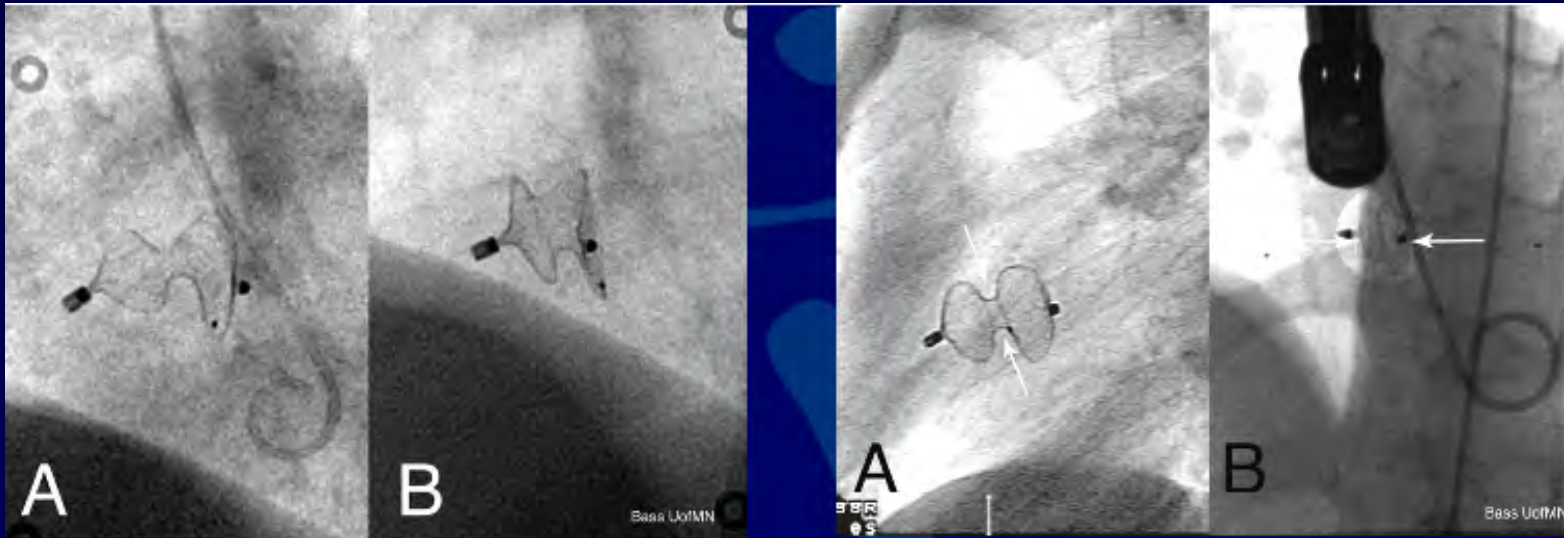
*fibrosis*

*Down's Syndrome*

# Perimembranous VSD



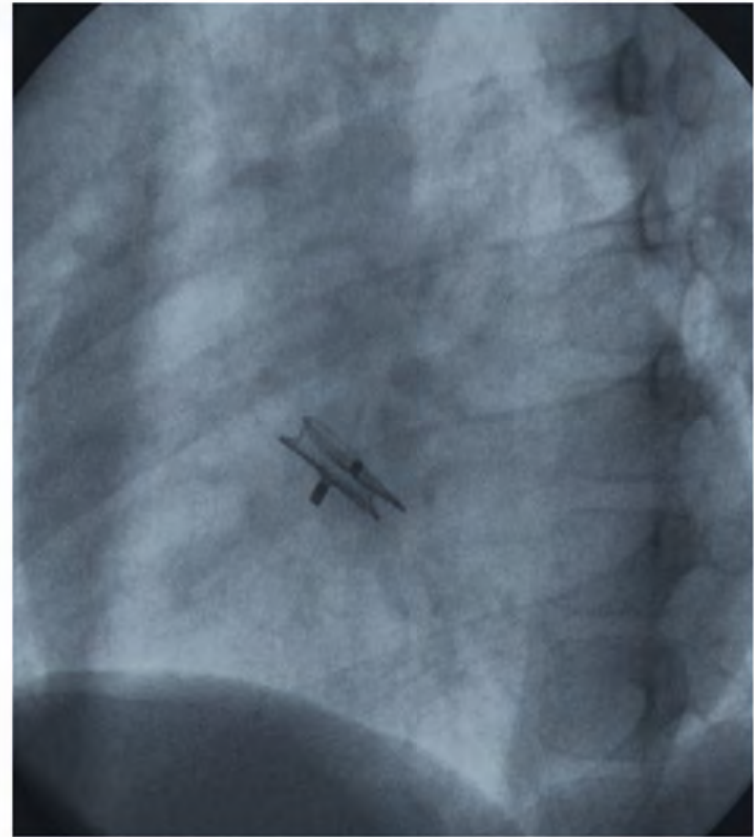
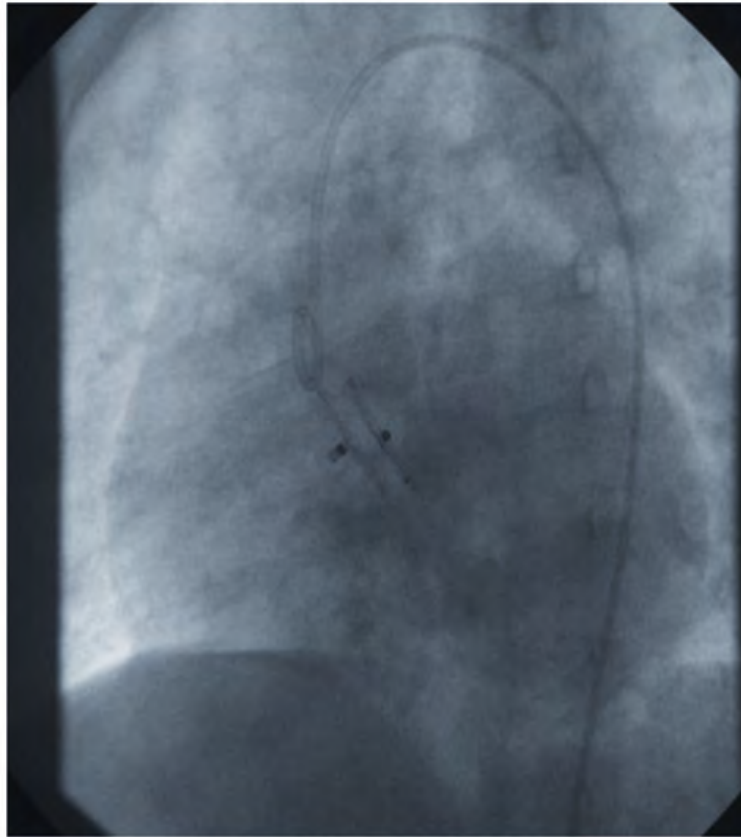
# *“Oversizing”*



**Courtesy J. Bass**



# *“Oversizing”*



# Perimembranous VSD



European Heart Journal (2007) 28, 2361–2368  
doi:10.1093/eurheartj/ehm314

Clinical research  
Congenital heart disease

## Transcatheter closure of congenital ventricular septal defects: results of the European Registry

Table 3 Characteristics of patients with complete atrio-ventricular block

Patient	Age (years)	Defect type	Post-surgical defect (yes/no)	Device type	Measure (mm)	Transient (Yes/No)	Therapy	Timing of occurrence post-procedure
1	4	pmVSD	No	A-ASD	4	No	Stop kt—surgery	
2	2	pmVSD	No	A-pmVSD	12	No	PM	1 day
3	11	pmVSD	No	A-pmVSD	8	No	PM	5 days
4	55	mVSD	Yes	A-mVSD	10	Yes		
5	3.4	pmVSD	No	A-pmVSD	8	Yes		
6	4.2	pmVSD	No	A-pmVSD	8	No	PM	5 days
7	8.1	pmVSD	No	A-pmVSD	6	No	PM	4 days
8	11.6	mVSD	Yes	A-pmVSD	10	Yes		
9	5.2	pmVSD	No	A-pmVSD	10	No	PM	3 days
10	1.5	mVSD	Yes	A-PDA	5/4	No	PM	5 days
11	1.2	mVSD	No	A-PDA	8/6	Yes		
12	1	pmVSD	no	A-pmVSD	8	Yes	Stop kt—surgery	
13	36	pmVSD	no	A-pmVSD	16	No	PM	7 months
14	1.2	pmVSD	No	A-pmVSD	8	No	PM	18 months
15	2.7	pmVSD	No	A-pmVSD	12	No	PM	12 months
16	2.6	pmVSD	No	A-pmVSD	8	No	PM	4 months

A-mVSD, Amplatzer muscular VSD occluder; A-pmVSD, Amplatzer perimembranous VSD occluder; A-ASD, Amplatzer atrial septal defect occluder; A-PDA, Amplatzer PDA occluder; PM, pace-maker implantation.

# Perimembranous VSD

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## **Permanent Pacemaker for Atrioventricular Conduction Block After Operative Repair of Perimembranous Ventricular Septal Defect**

Elliot M. Tucker, MD, Lee A. Pyles, MD, FACC, John L. Bass, MD, James H. Moller, MD, FACC  
*Minneapolis, Minnesota*

Of 4,432 patients with PMVSD repair, 48 (1.1%) underwent PPM placement for AV block. The PPM group was more likely to have Down syndrome (41% vs. 18%;  $p < 0.001$ ), was younger (mean age 14 vs. 26 months;  $p < 0.001$ ), and had longer mean length of postoperative hospital stays (20 vs. 8 days;  $p < 0.001$ ). The most significant risk factor for AV block was Down syndrome (odds ratio 3.62, 95% confidence interval 2.02 to 6.39;  $p < 0.005$ ). Modal time to PPM placement was 7 days (range 0 to 4,078 days). Out of 1,877 patients comparable to those currently considered for device closure, 13 (0.8%) underwent PPM placement after PMVSD repair.

# Perimembranous VSD

Transcatheter closure of congenital ventricular septal defects in adults:  
Mid-term results and complications.



Int J Cardiol 2008 Jan 28

M . Chessa, G. Butera, M. Carminati.

0% occurrence of cAVB

# Perimembranous VSD

0% occurrence of cAVB in children > 5 years old



# Perimembranous VSD



European Heart Journal (2007) 28, 2361–2368  
doi:10.1093/eurheartj/ehm314

Clinical research  
Congenital heart disease

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5	3.4	pmVSD	No	A-pmVSD	8	Yes		
6	4.2	pmVSD	No	A-pmVSD	8	No	PM	5 days
7	8.1	pmVSD	No	A-pmVSD	6	No	PM	4 days
8	11.6	mVSD	Yes	A-pmVSD	10	Yes		
9	5.2	pmVSD	No	A-pmVSD	10	No	PM	3 days
10	1.5	mVSD	Yes	A-PDA	5/4	No	PM	5 days
11	1.2	mVSD	No	A-PDA	8/6	Yes		
12	1	pmVSD	no	A-pmVSD	8	Yes	Stop kt—surgery	
13	36	pmVSD	no	A-pmVSD	16	No	PM	7 months
14	1.2	pmVSD	No	A-pmVSD	8	No	PM	18 months
15	2.7	pmVSD	No	A-pmVSD	12	No	PM	12 months
16	2.6	pmVSD	No	A-pmVSD	8	No	PM	4 months

A-mVSD, Amplatzer muscular VSD occluder; A-pmVSD, Amplatzer perimembranous VSD occluder; A-ASD, Amplatzer atrial septal defect occluder; A-PDA, Amplatzer PDA occluder; PM, pace-maker implantation.



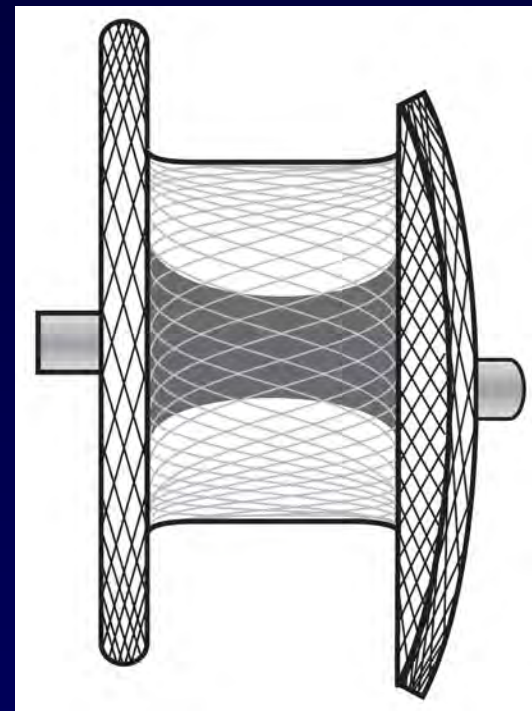
# Closure of PMVSDs

## Tomorrow



# AMPLATZER® Membranous VSD Occluder 2

- Minimizes Pressure on the Septal Tissue
  - The dual-layer waist is engineered to impart minimal radial pressure against the defect while providing stability
  - 3mm waist length reduces clamp force on the ventricular septum



Gianfranco Butera · Massimo Chessa  
Andreas Eicken · John Thomson *Editors*



# **Cardiac Catheterization for Congenital Heart Disease**

From Fetal Life to  
Adulthood

*Forewords by*  
Shakeel Qureshi and Mario Carminati

 Springer

Thank you for your attention

