

Percutaneous VSD closure

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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

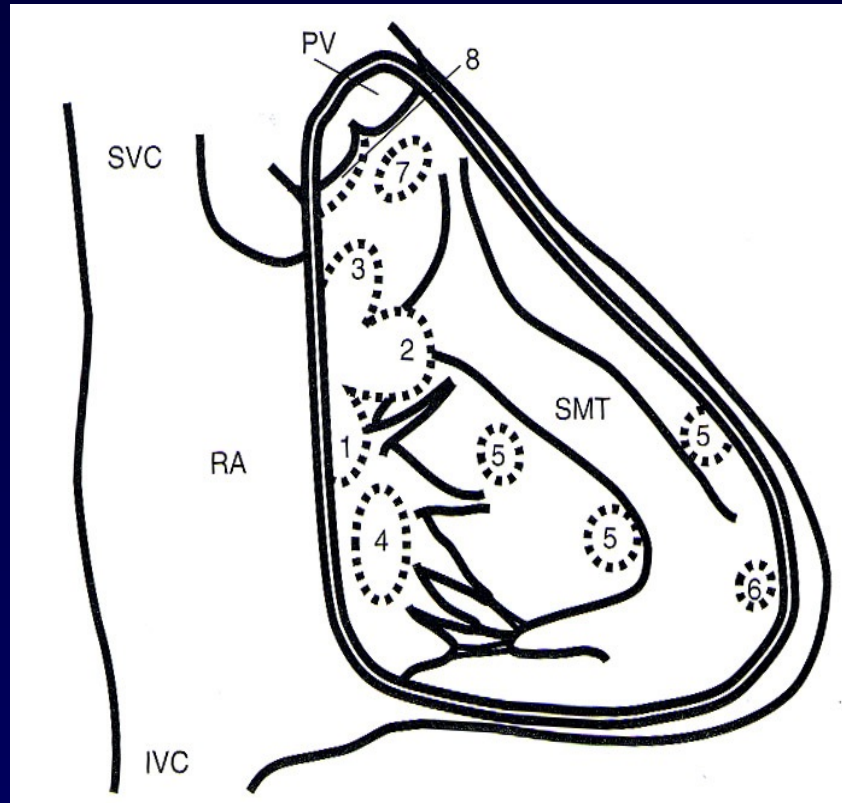
Sub-aortic stenosis

Sub-pulmonary stenosis (RV mid ventricular stenosis)

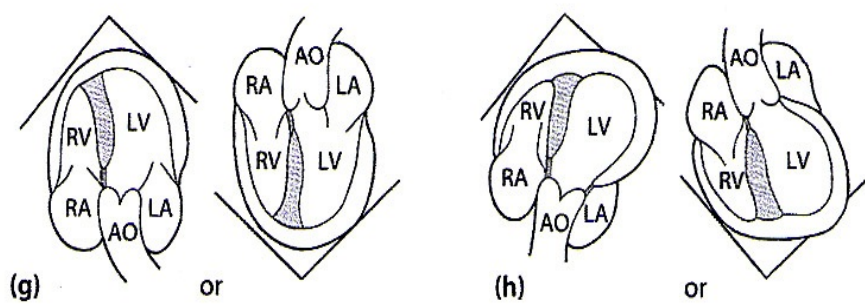
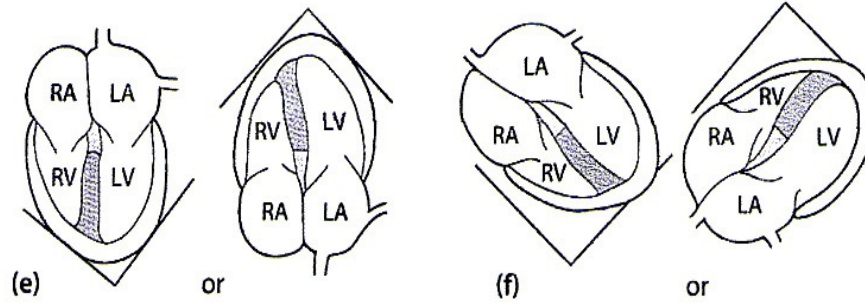
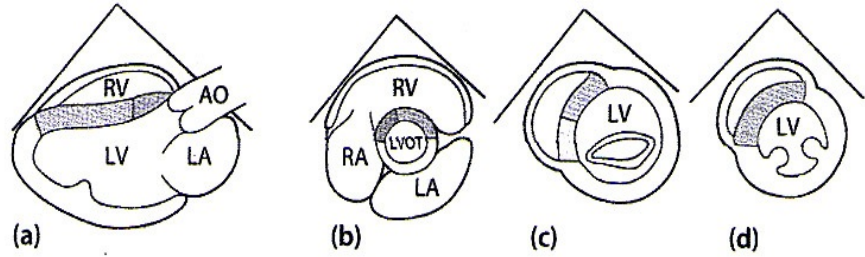
Eisenmenger syndrome

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

VSD



VSD



Membranous
 Trabecular
 Inlet
 Infundibular

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

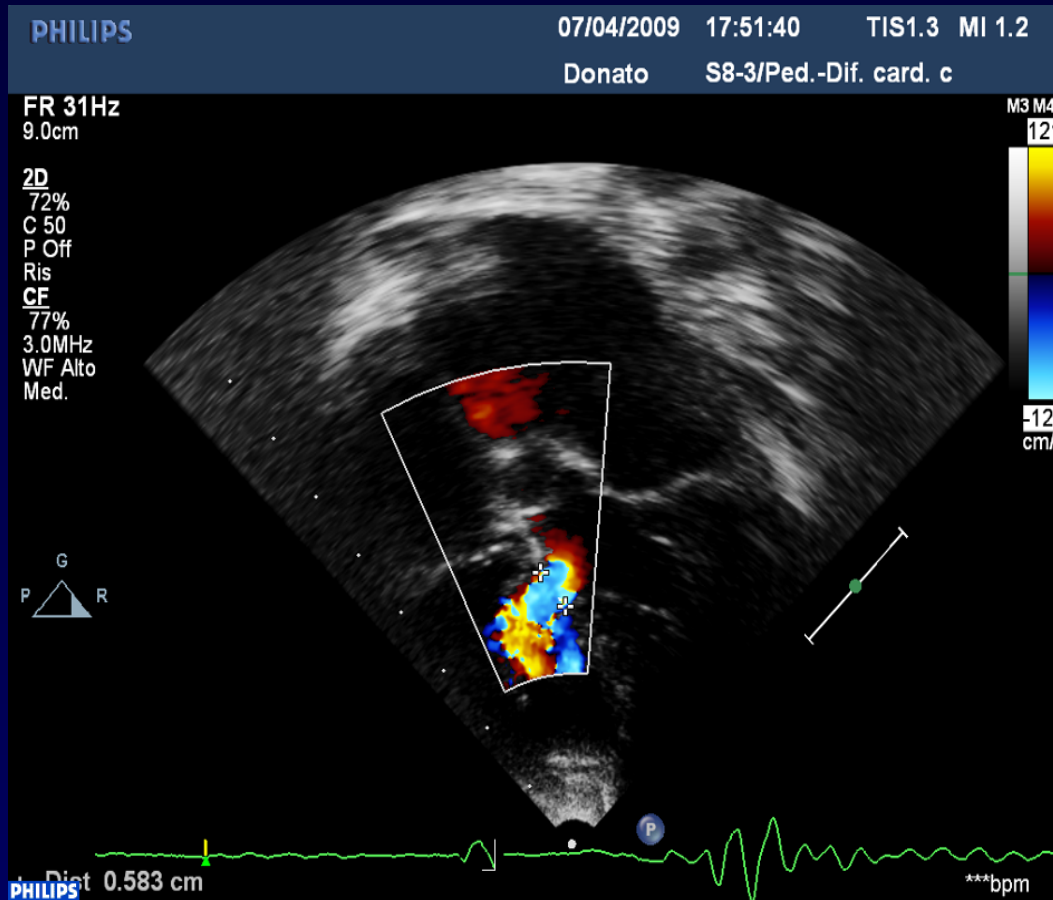
Usually it is quite easy to analyse the margins
and measure the size of the defect

Margins are usually well seen

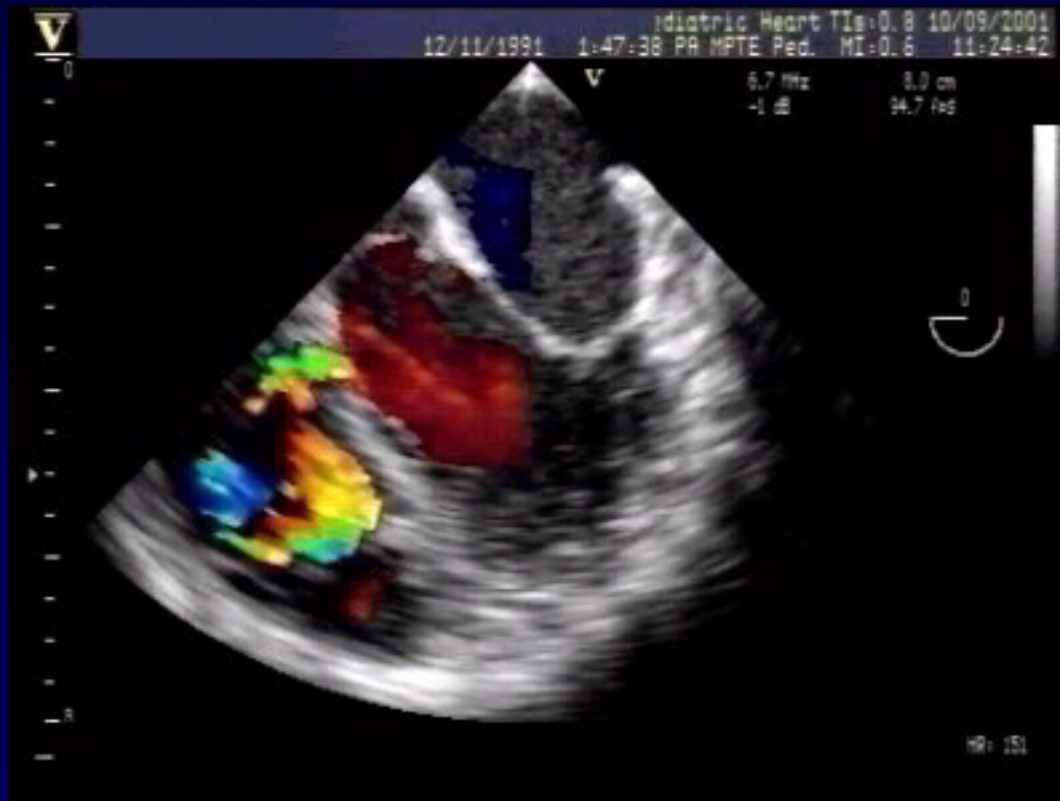
Measure of the defect in 2D
and with color (measure at the “PISA”)



Muscular VSD



Muscular VSD



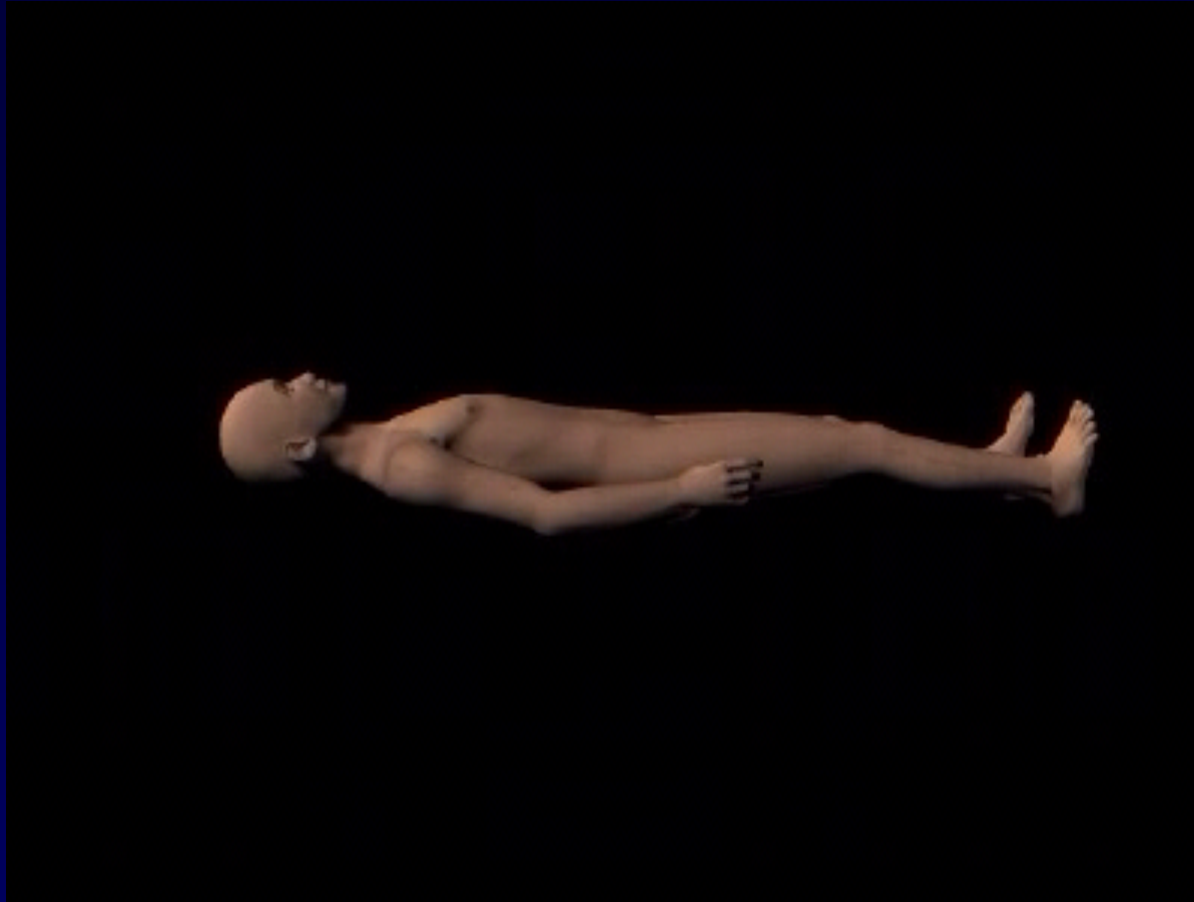
Procedure protocol

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

Amplatzer muscular VSD occluder



Amplatzer muscular VSD occluder



Amplatz muscular VSD occluder



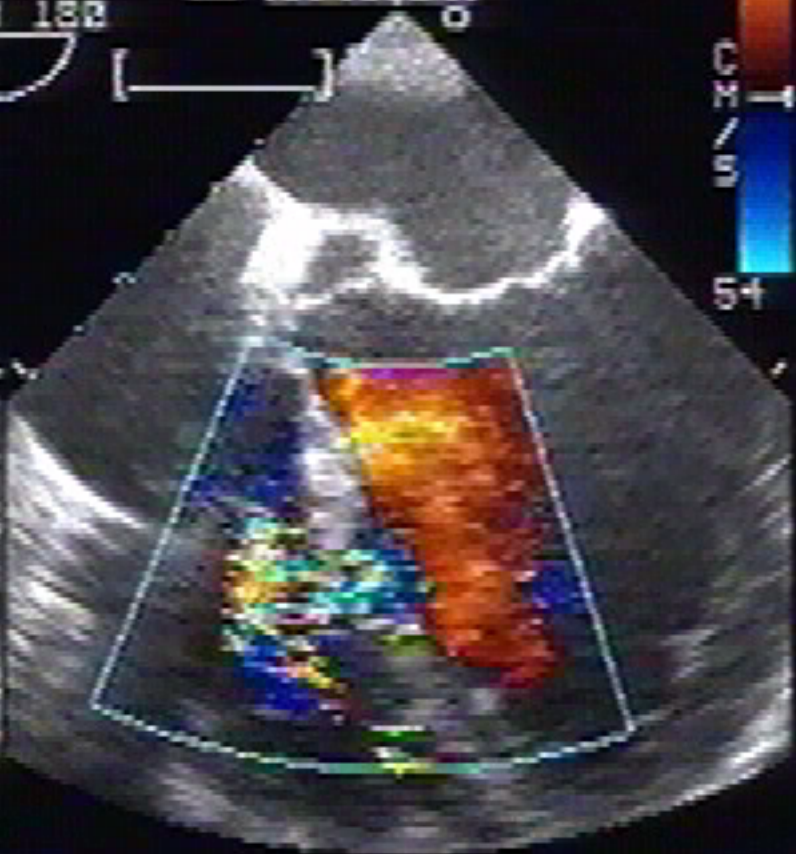
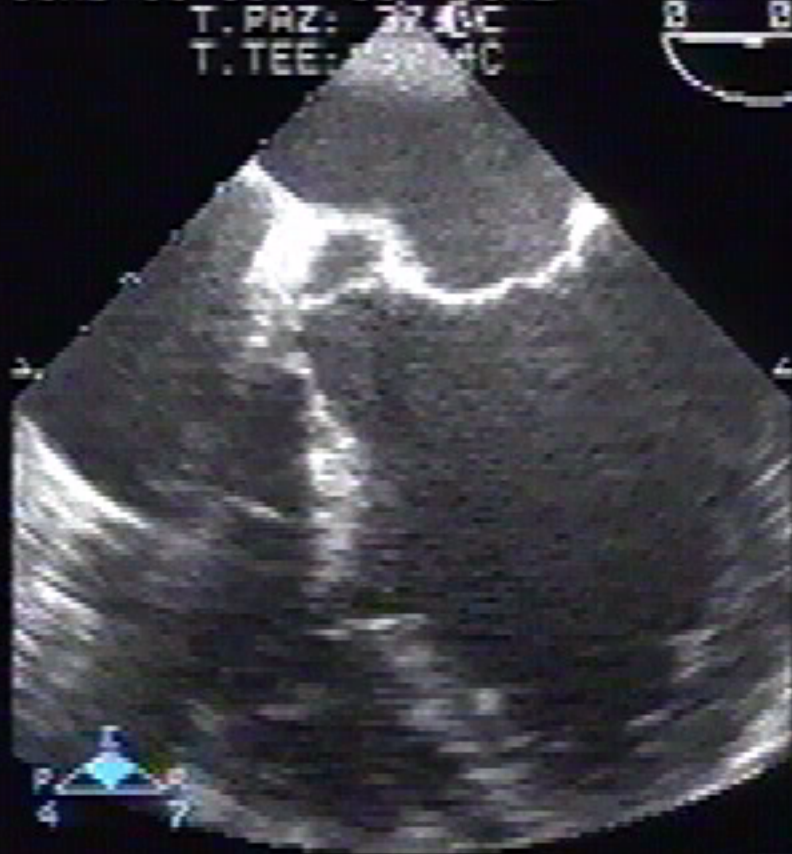
TIS: B. S T621B
16 OTT 06 08:31:19
B/B/E/VE/R13CM
GUAD 58 COMP 65 16HZ
T. PAZ: 32.0C
T. TEE: 36.4C

PHILIPS

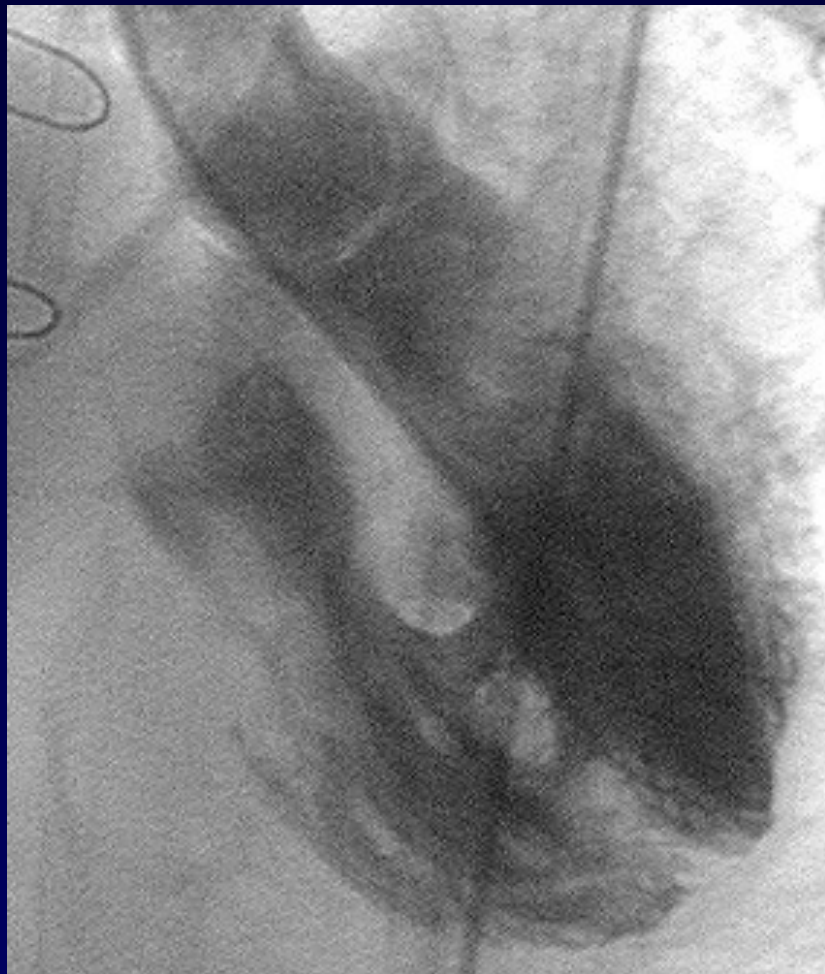
4.4MHZ

TEE

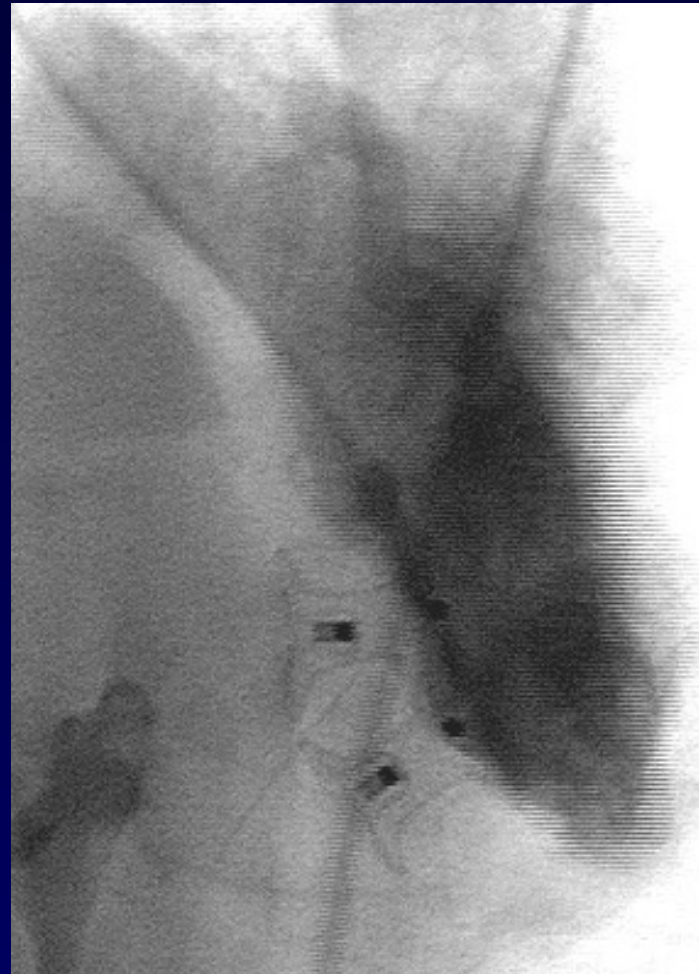
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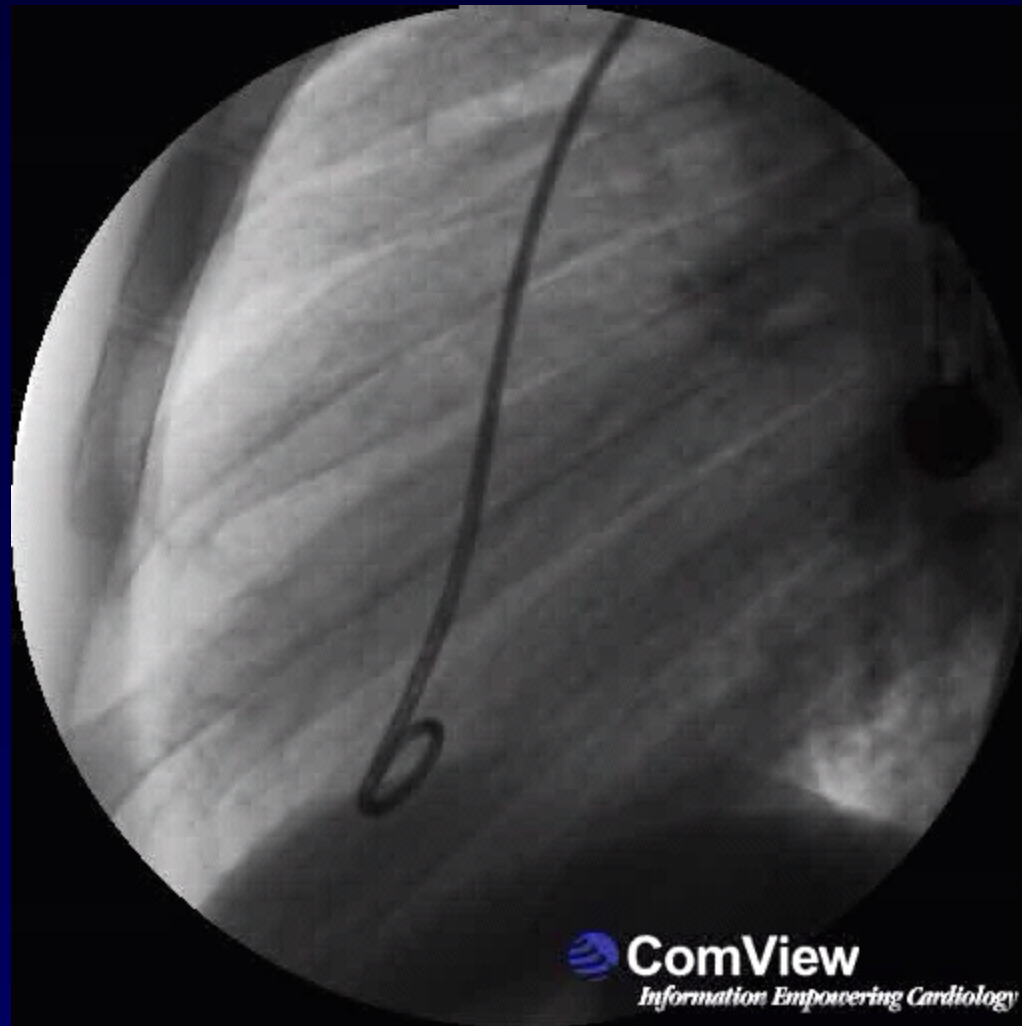
Multiple Muscular VSD's



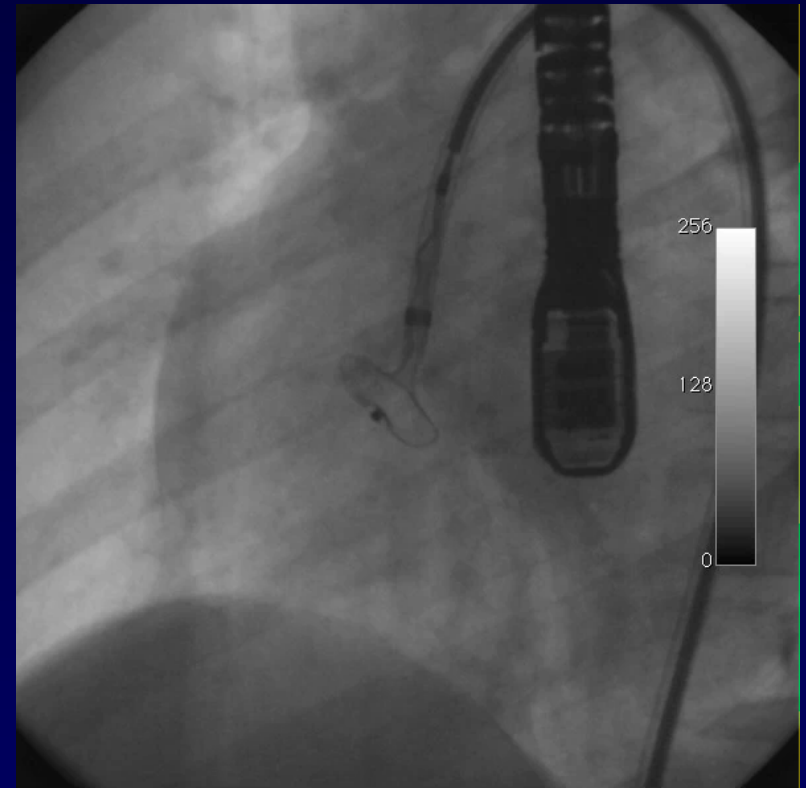
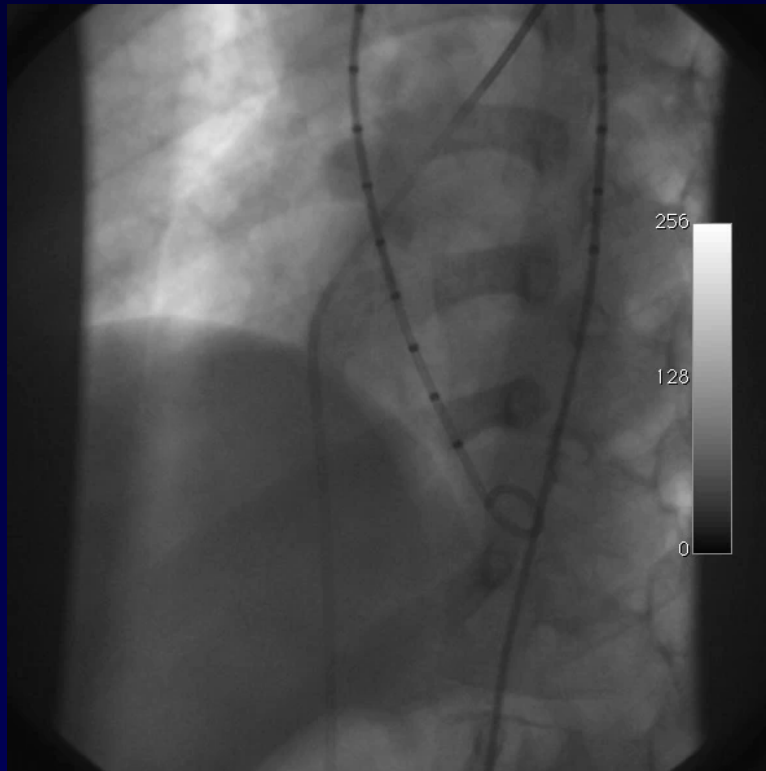
Implantation of 2 devices



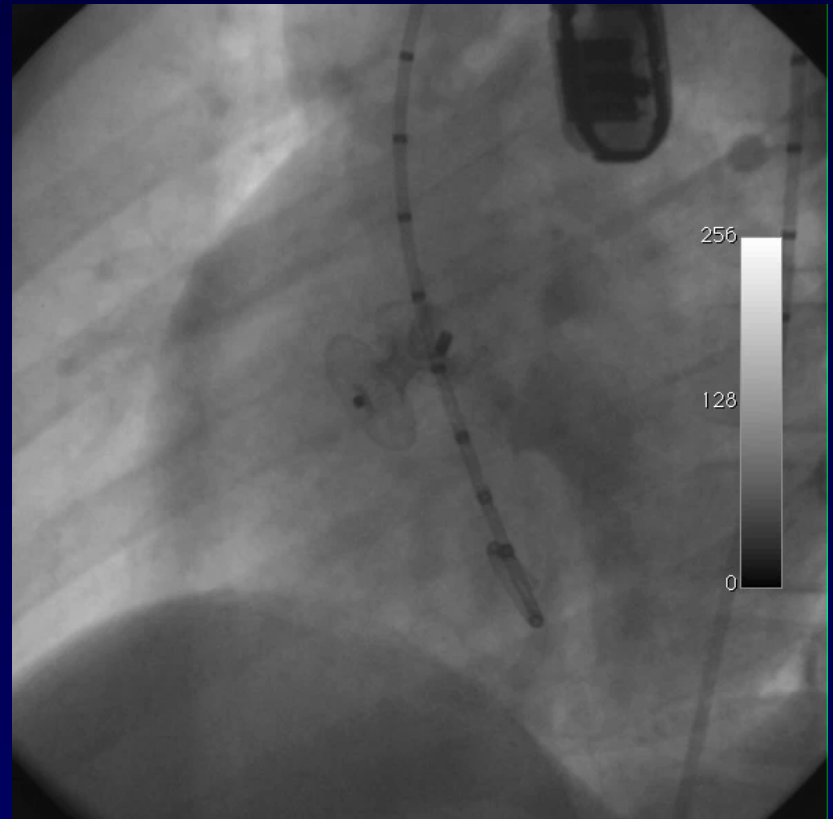
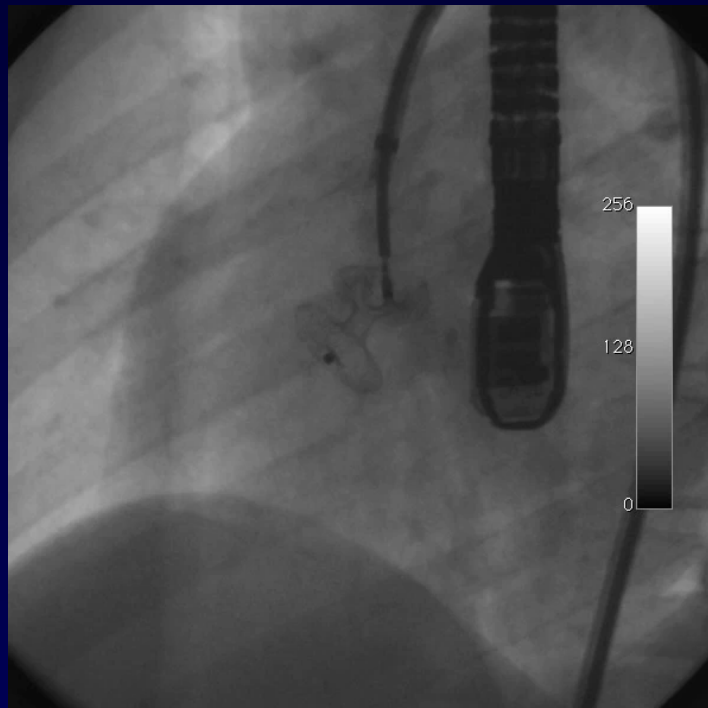
Retrograde closure of high muscular VSD



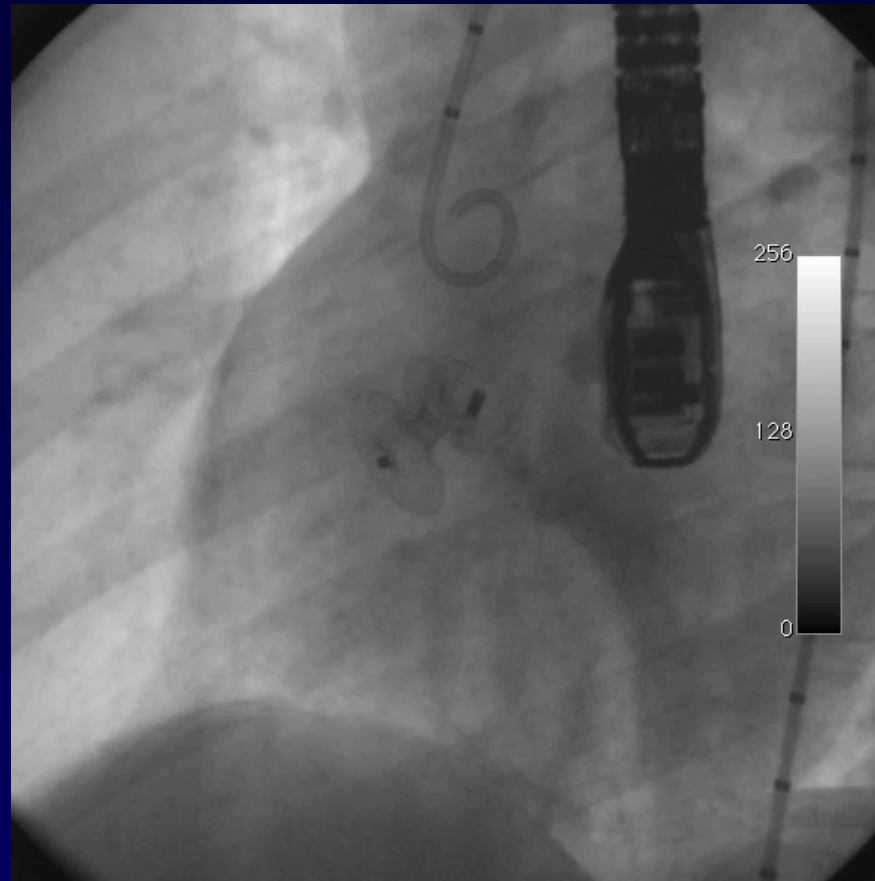
Retrograde closure of high muscular VSD



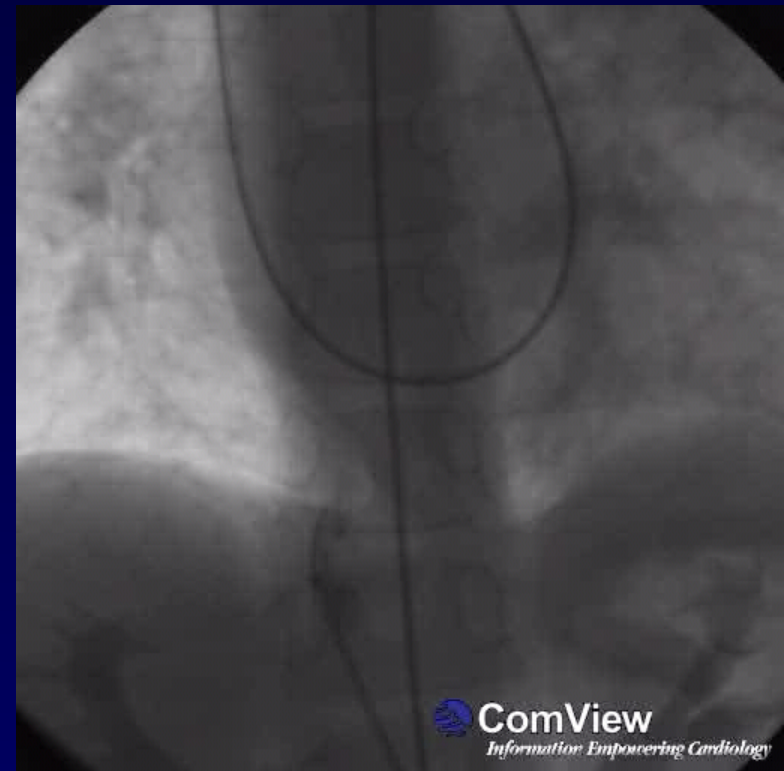
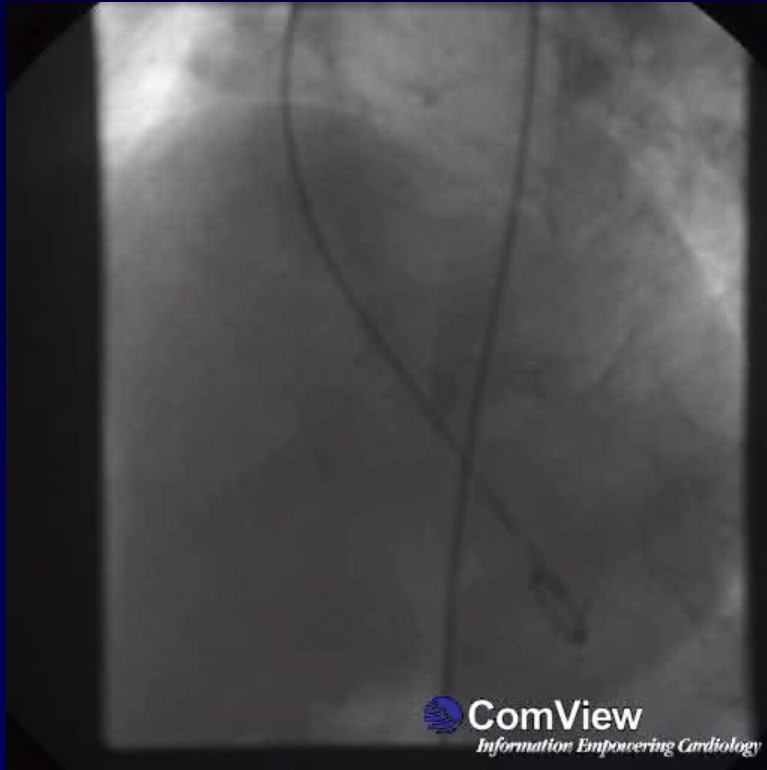
Retrograde closure of high muscular VSD



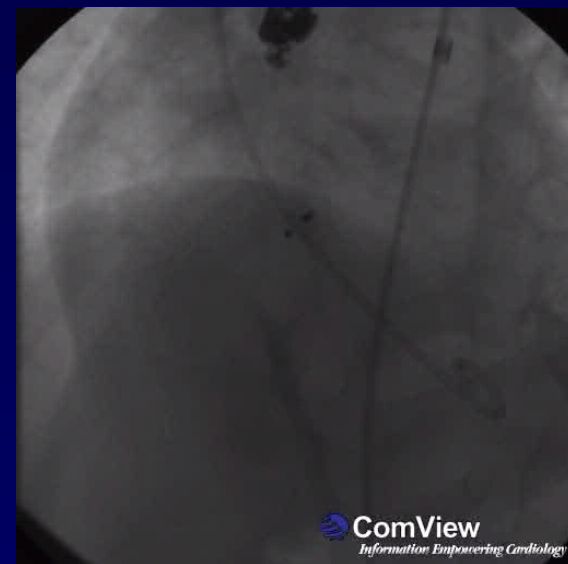
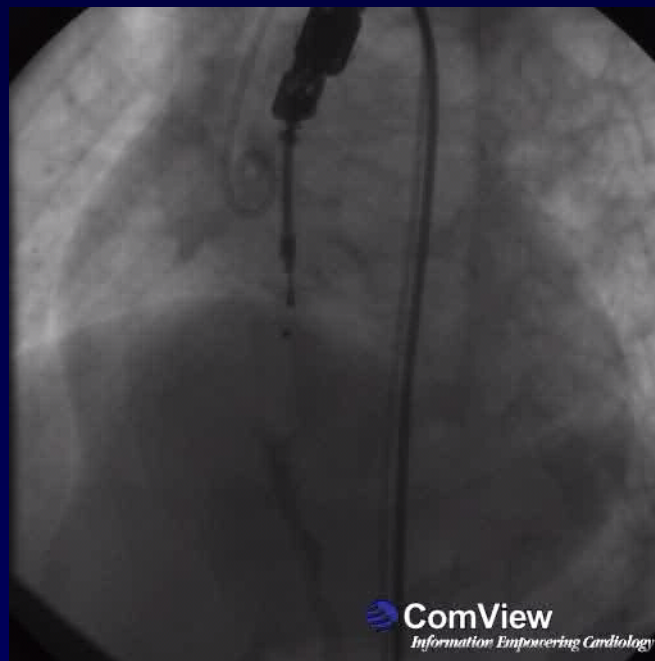
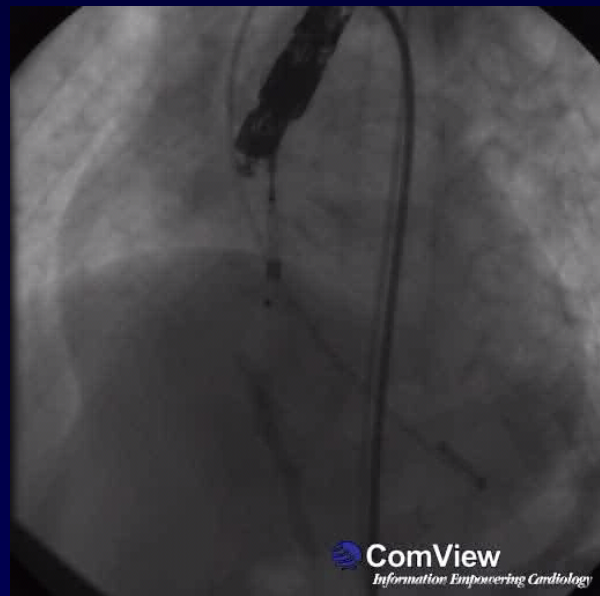
Retrograde closure of high muscular VSD



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



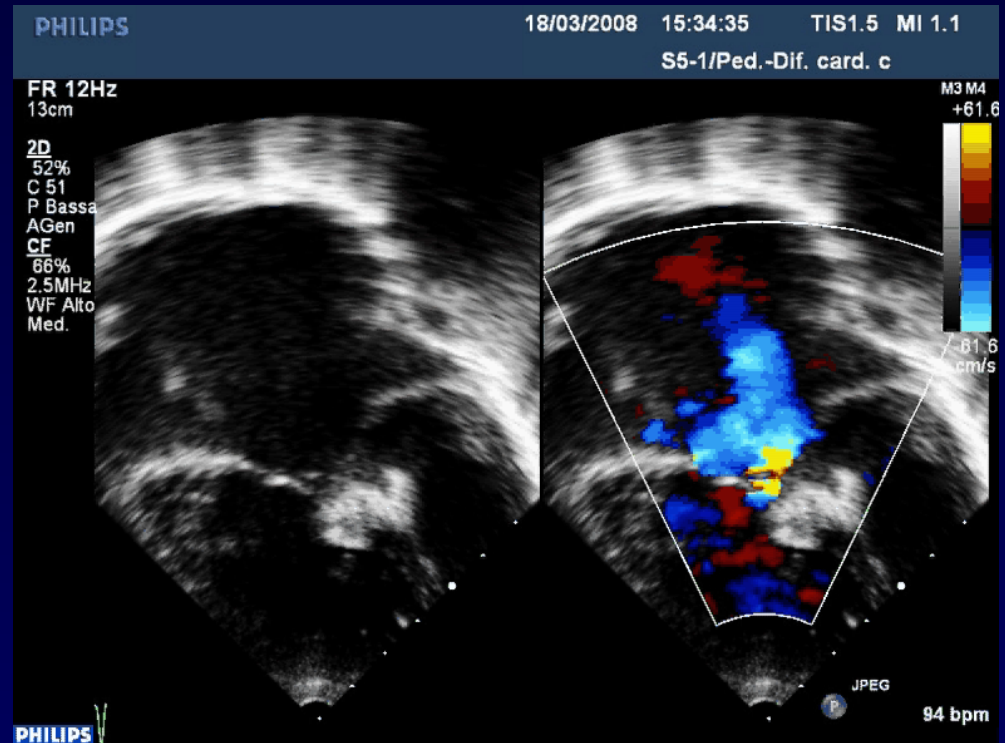
Retrograde closure of high muscular VSD (interrupted IVC and azygos continuation)



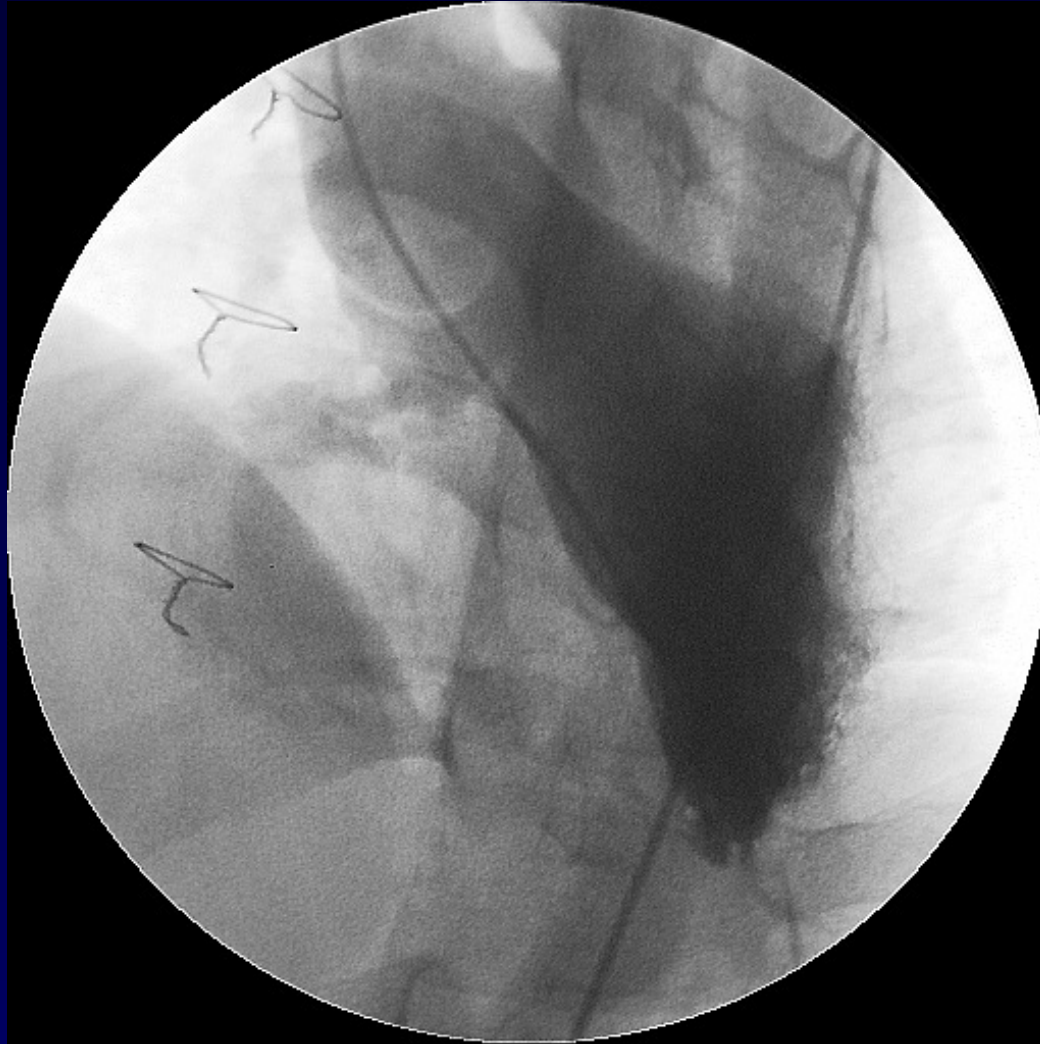
Complications

Device entangled
in the tricuspid valve

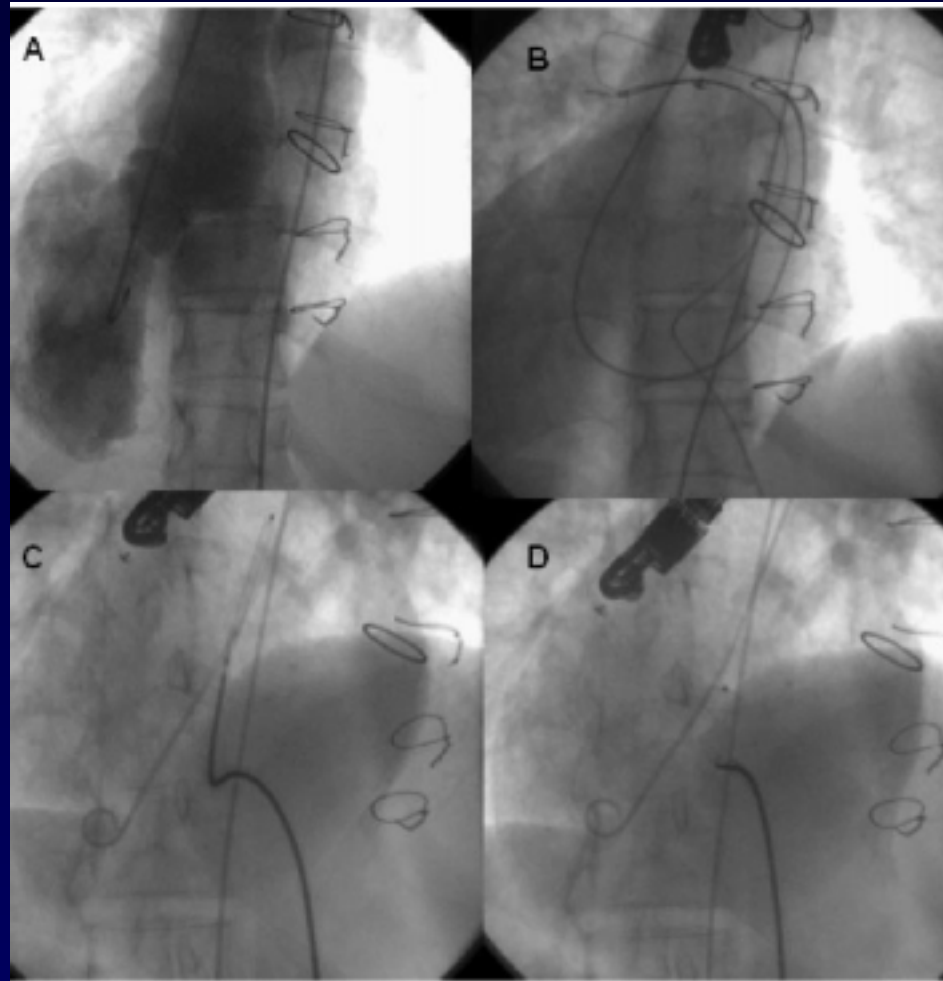
Sometimes worsening
of TR during f-up



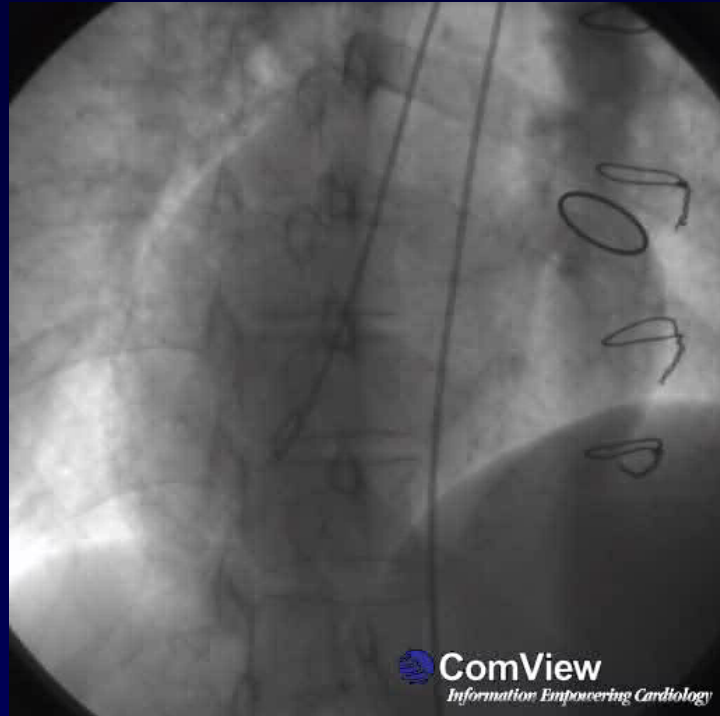
Residual post-surgery VSD



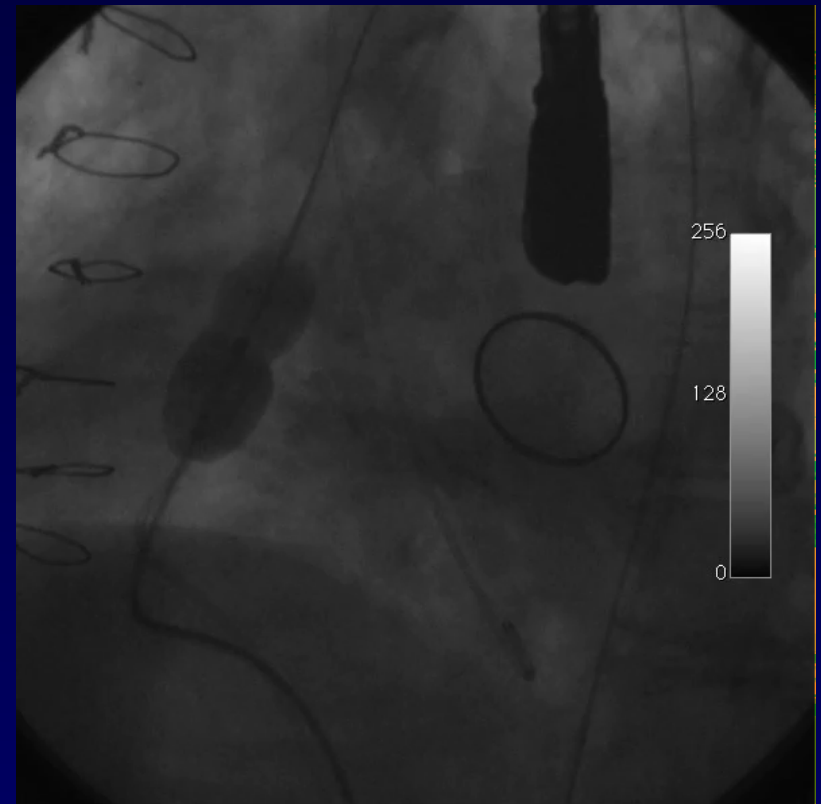
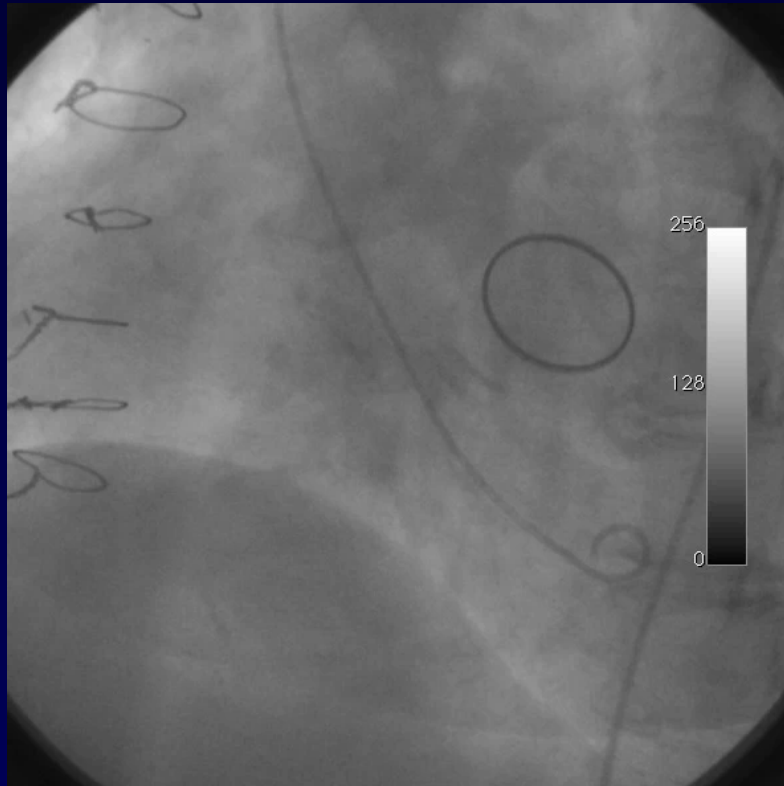
Residual post-surgical VSD



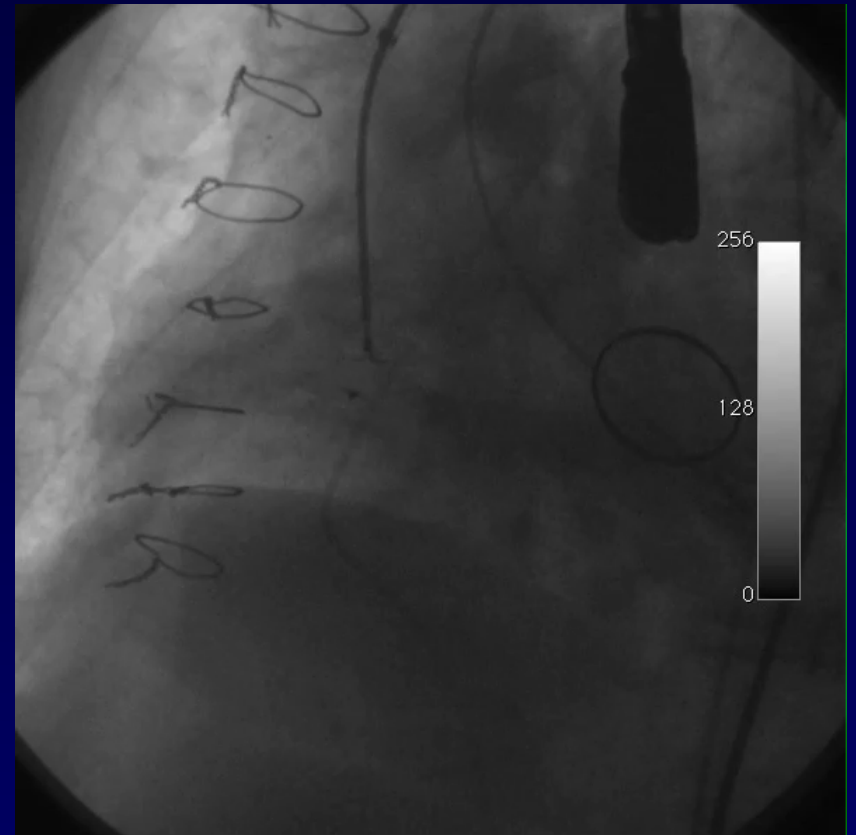
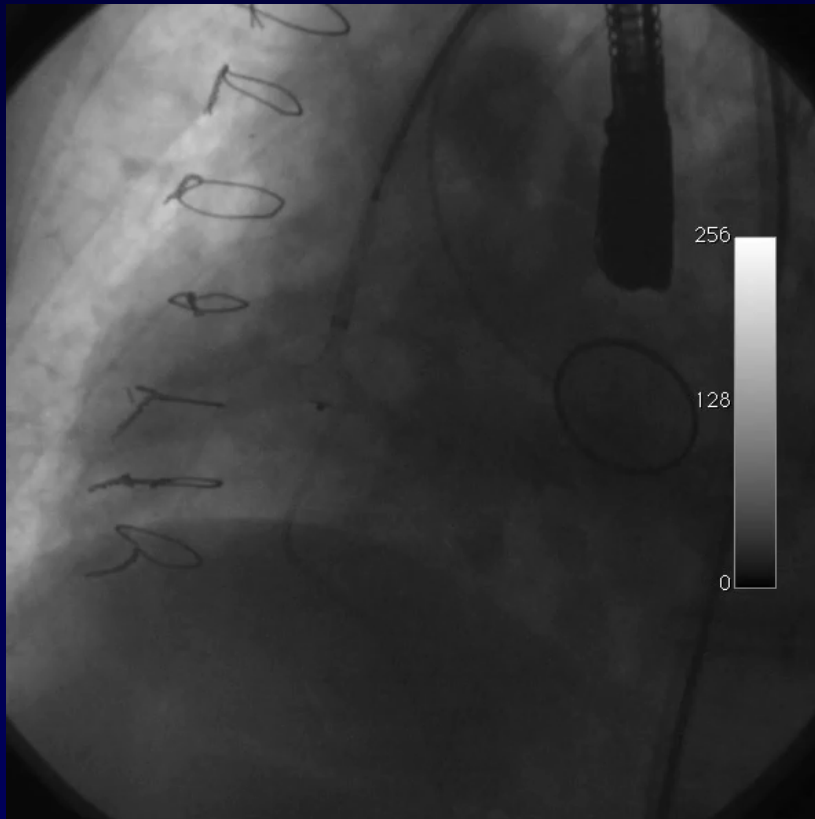
Residual post-surgical VSD



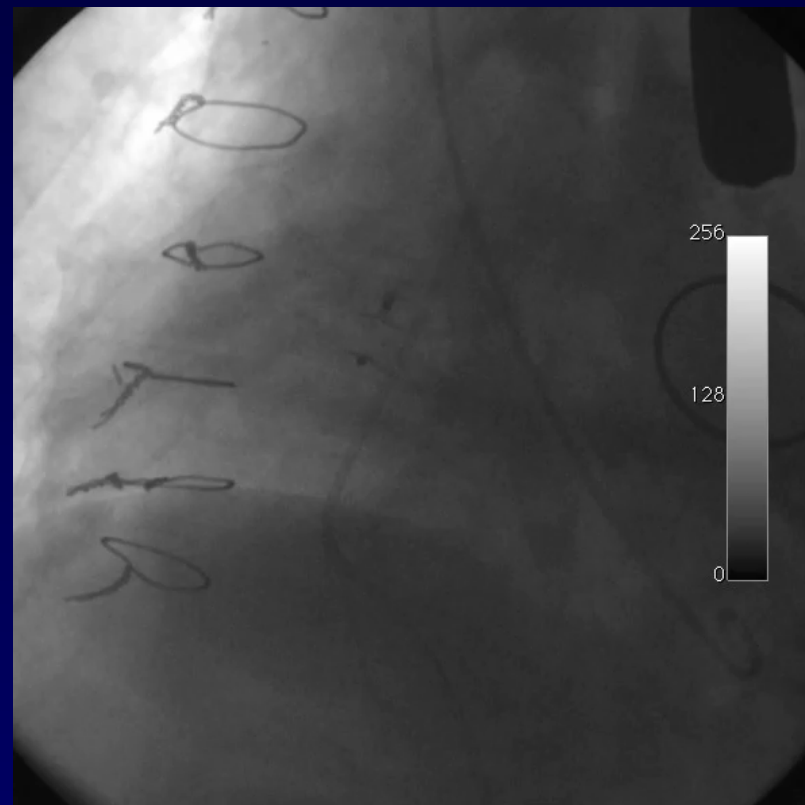
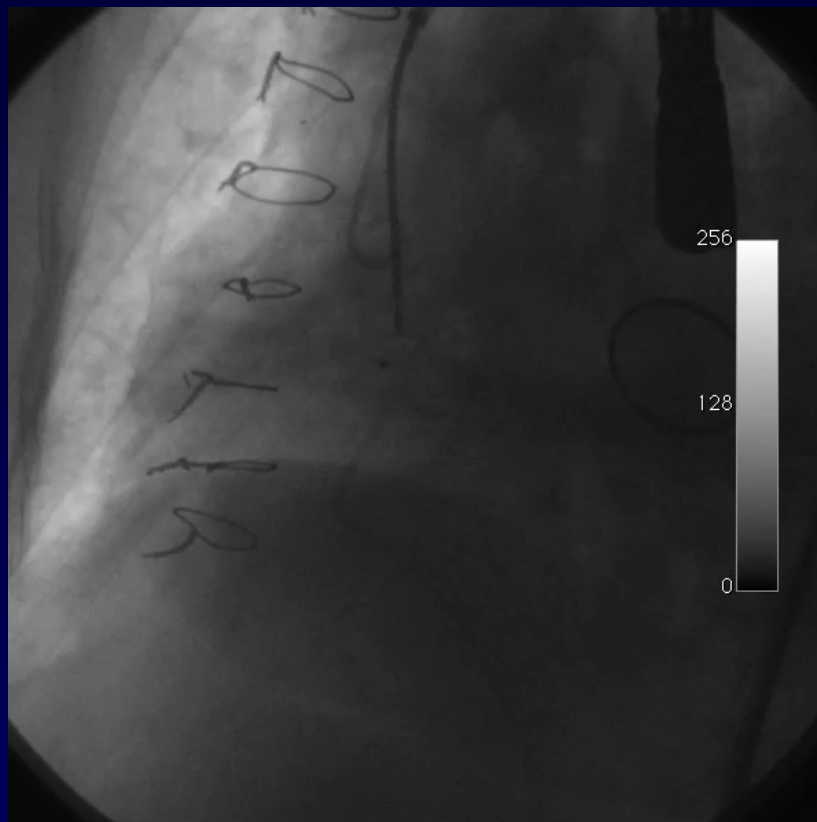
Residual post-surgical VSD



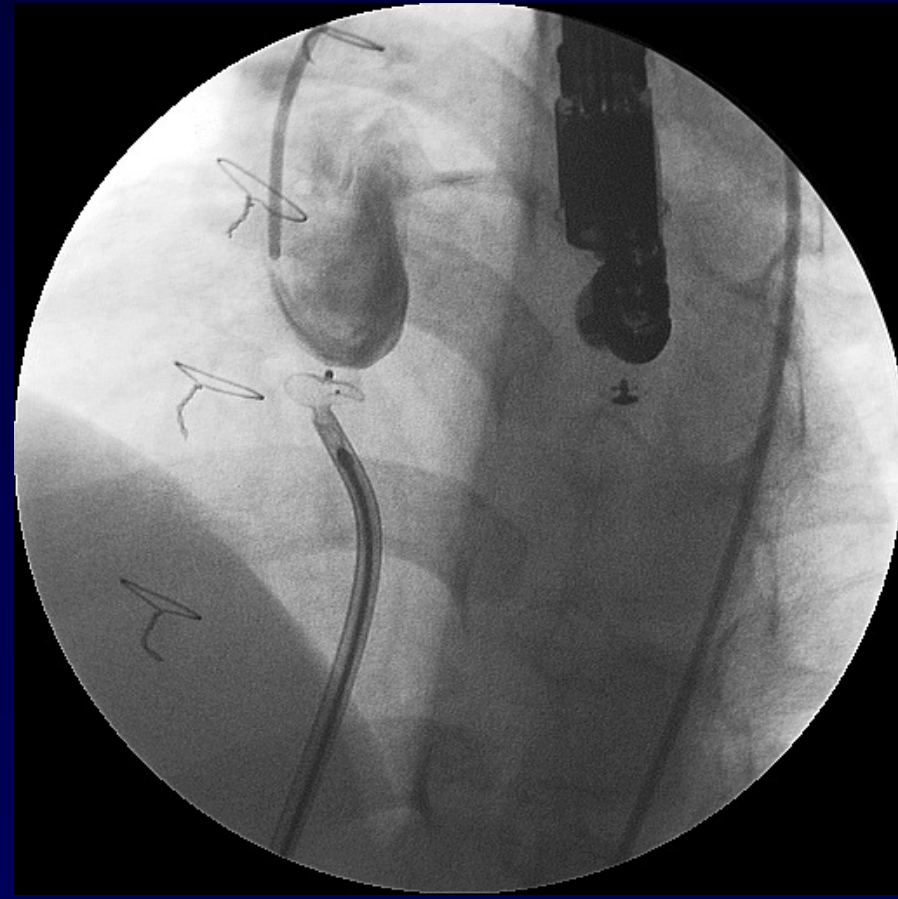
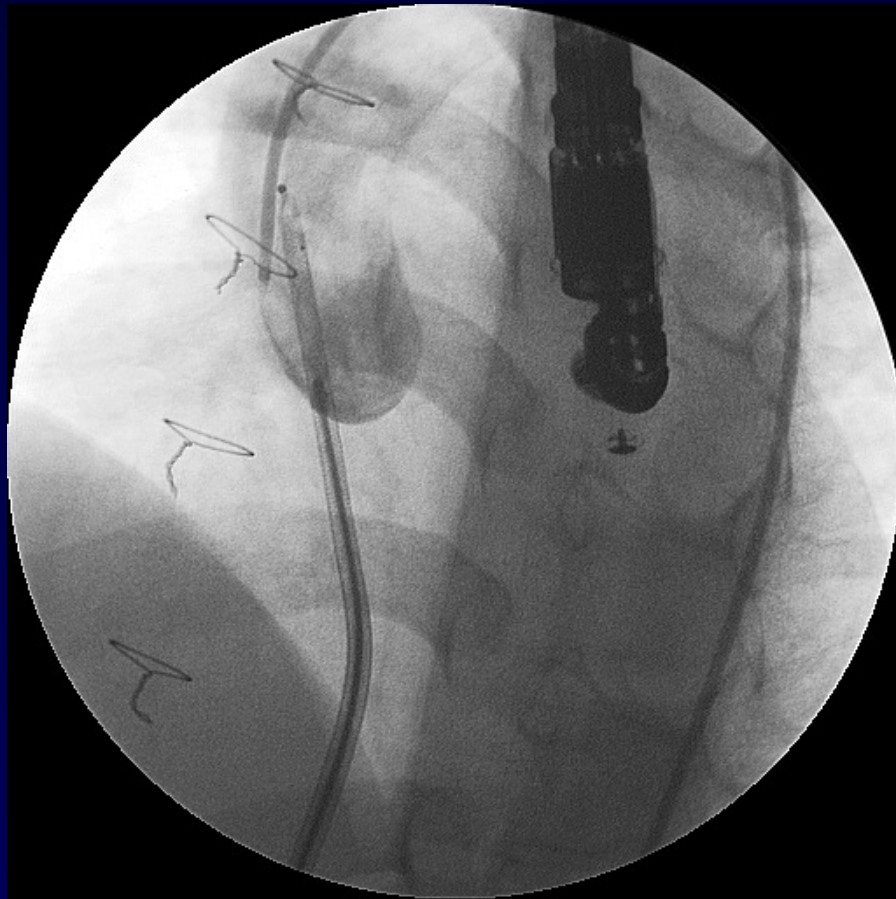
Residual post-surgical VSD



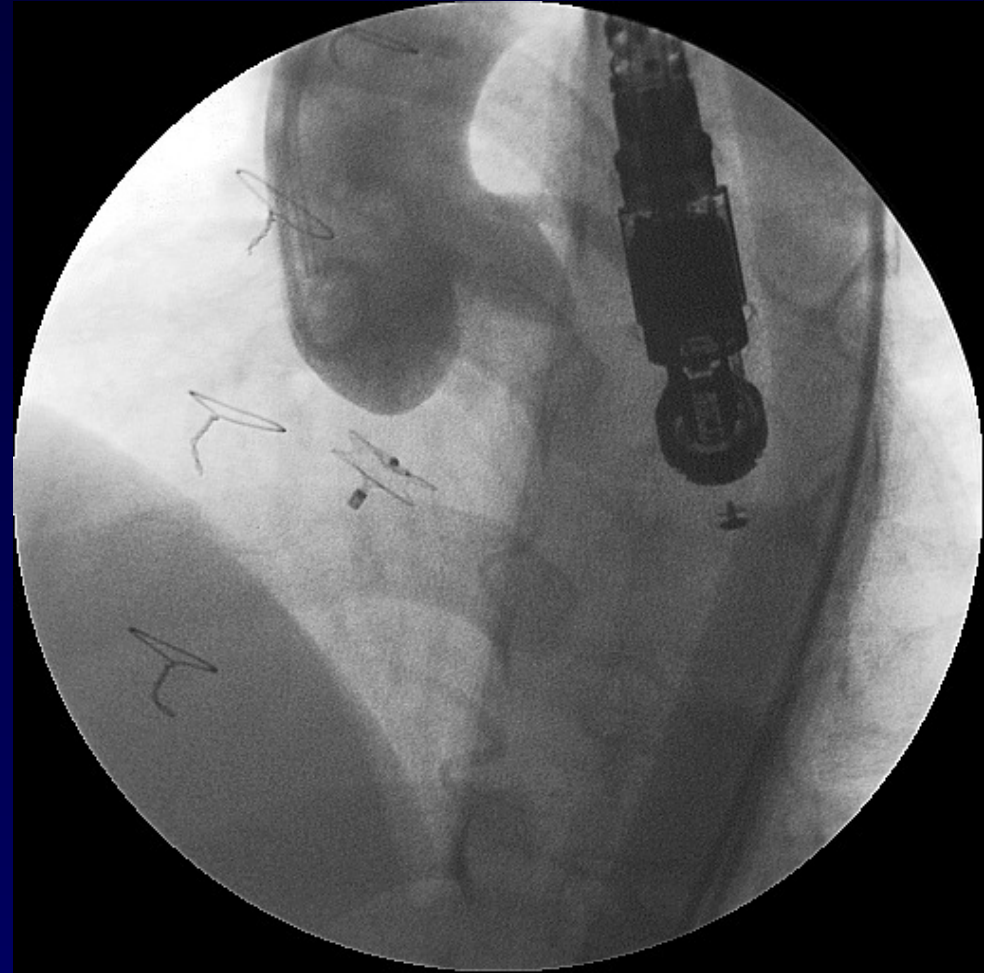
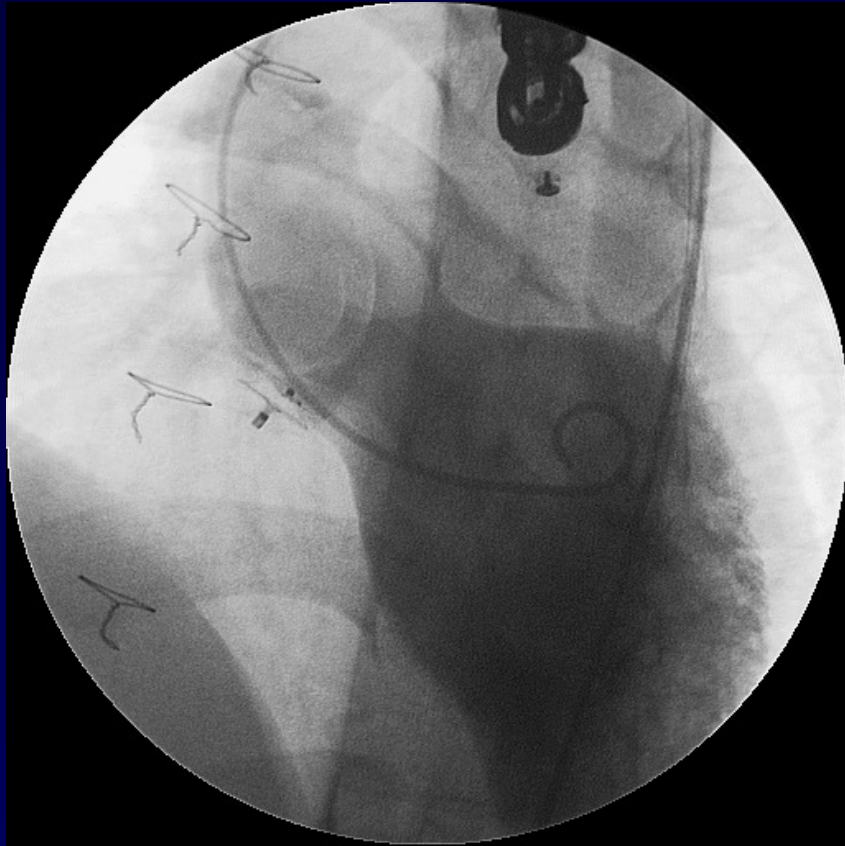
Residual post-surgical VSD



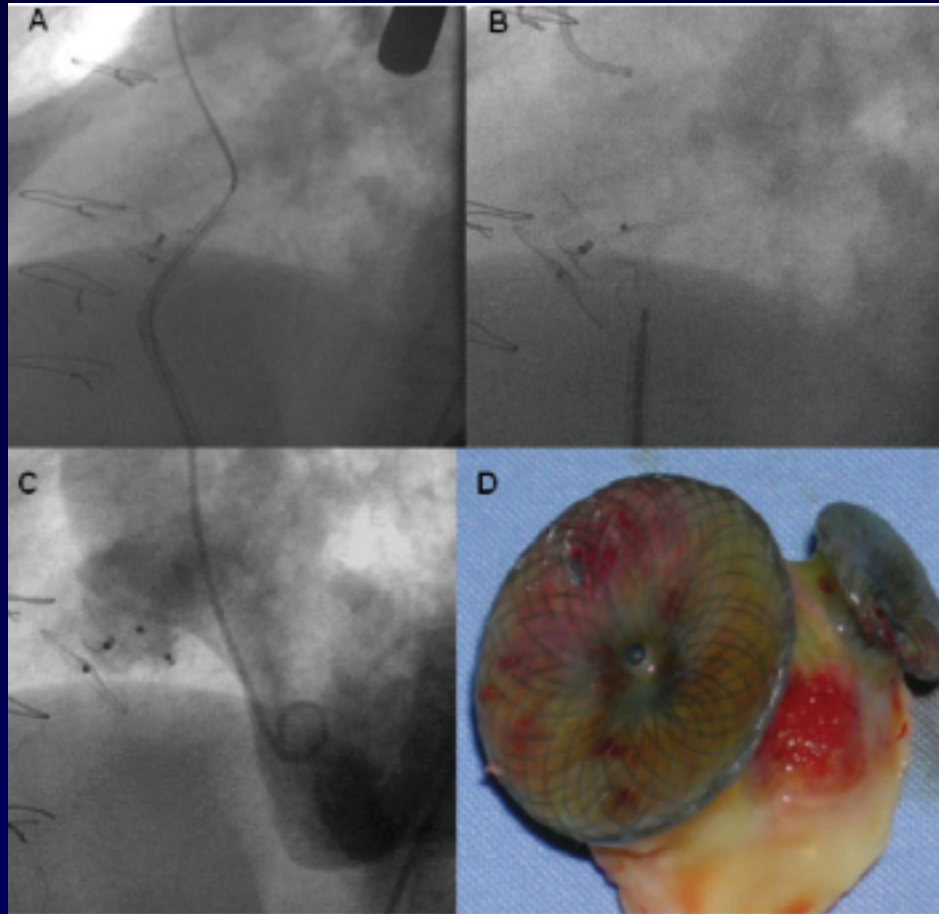
Non standard procedure (aortic approach)



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.

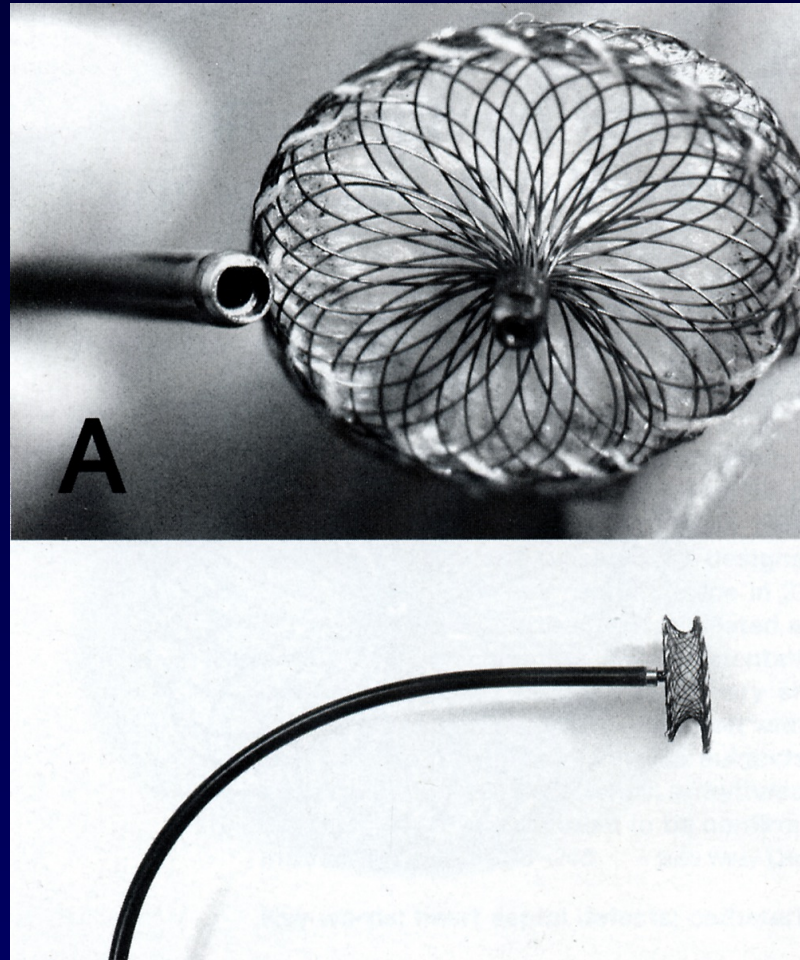
Limitation

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)

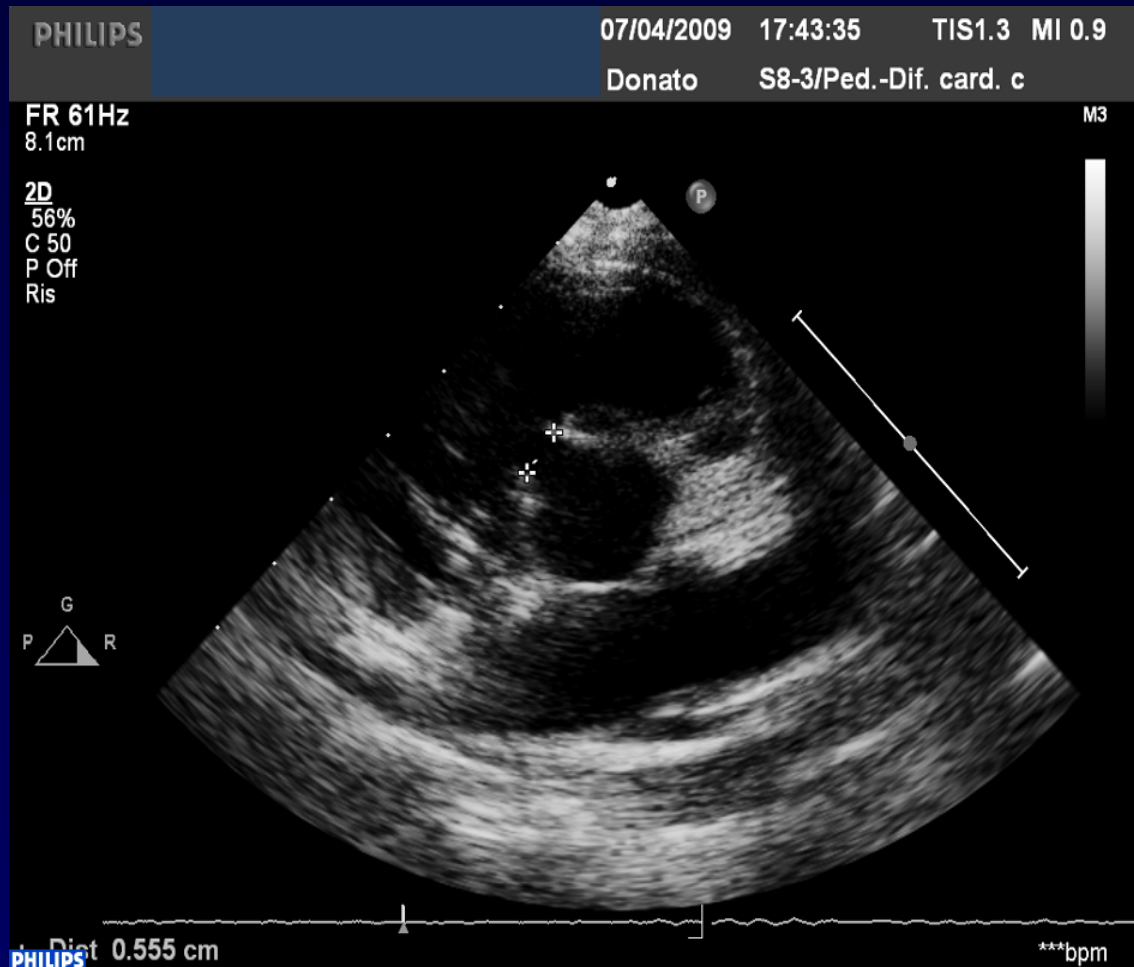
Ventricular function during manoeuvres

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



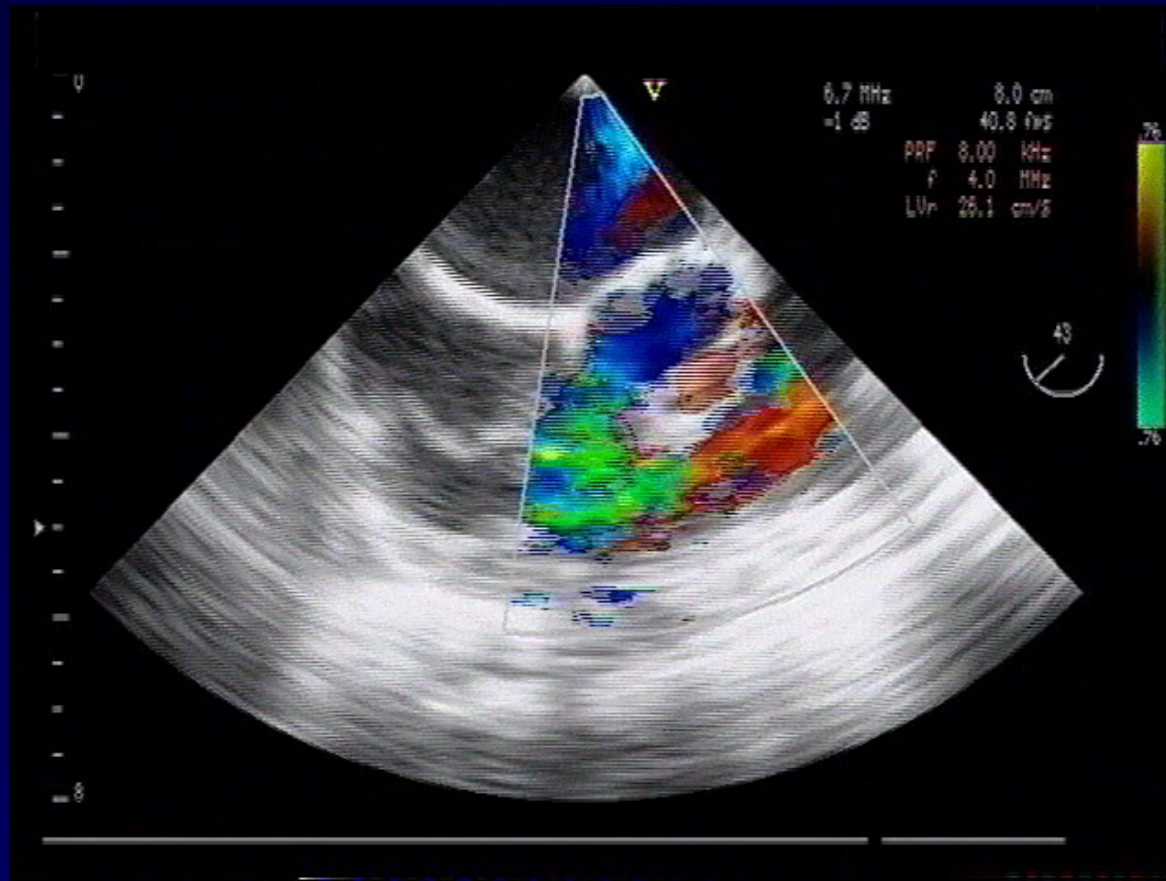
Perimembranous VSD

Echocardiographic evaluation



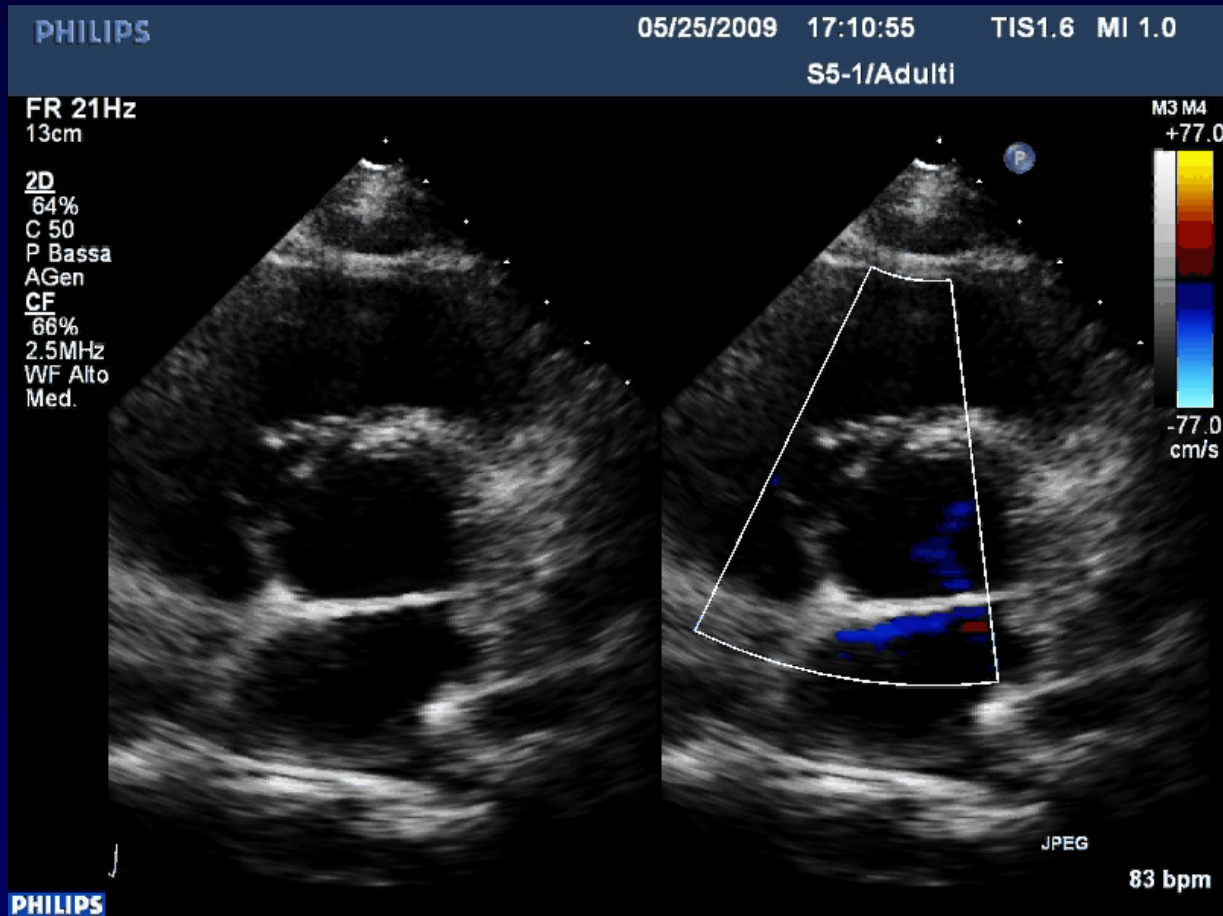
Perimembranous VSD

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?

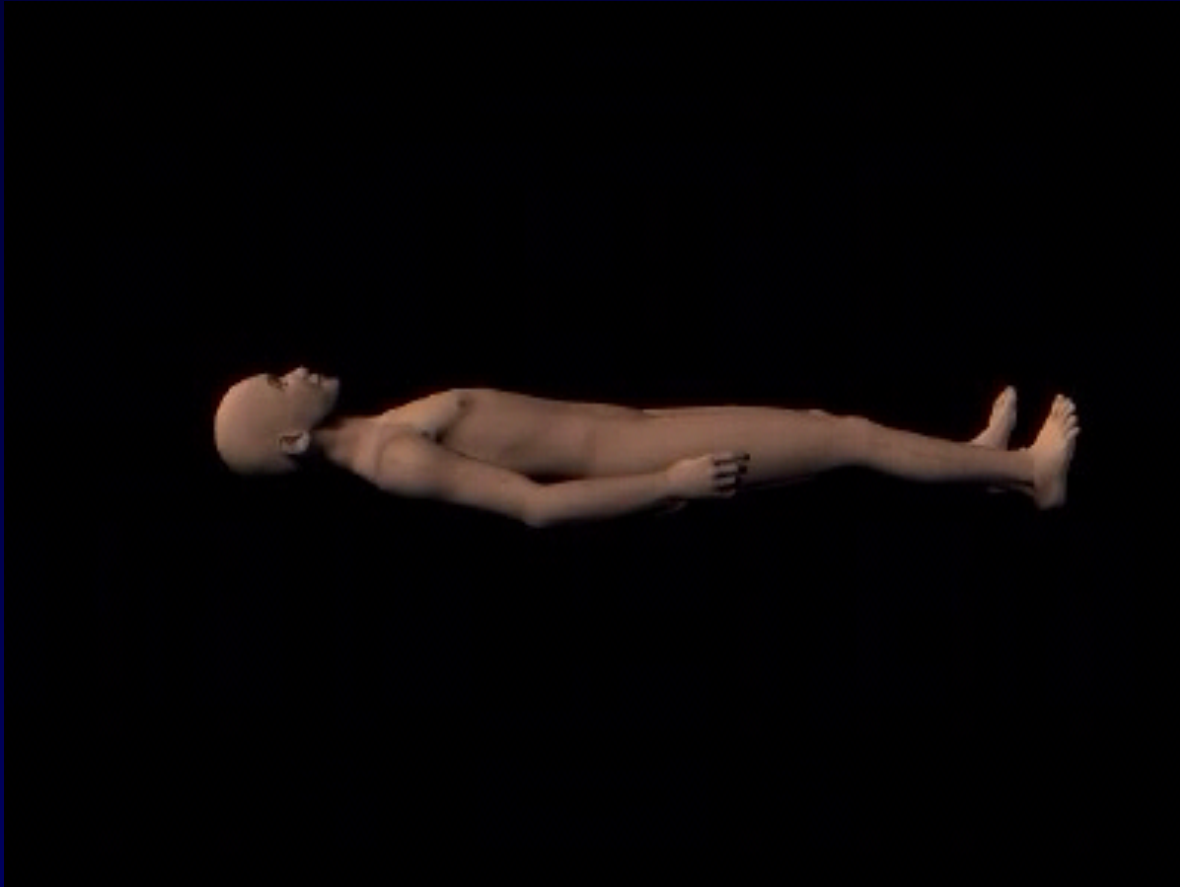
embolization?

Pericardial effusion?

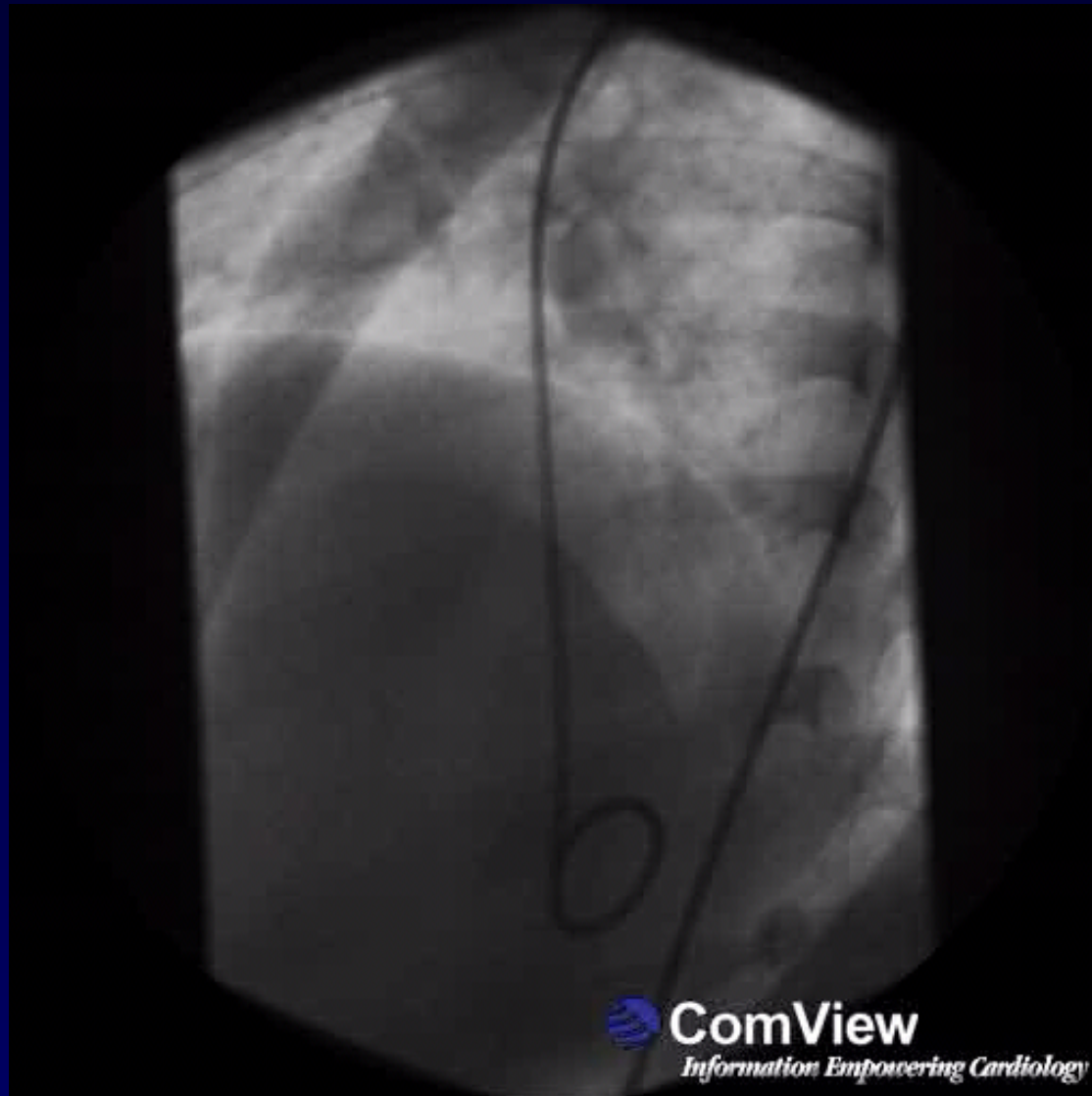
Regurgitation of AoV,MV,TV?



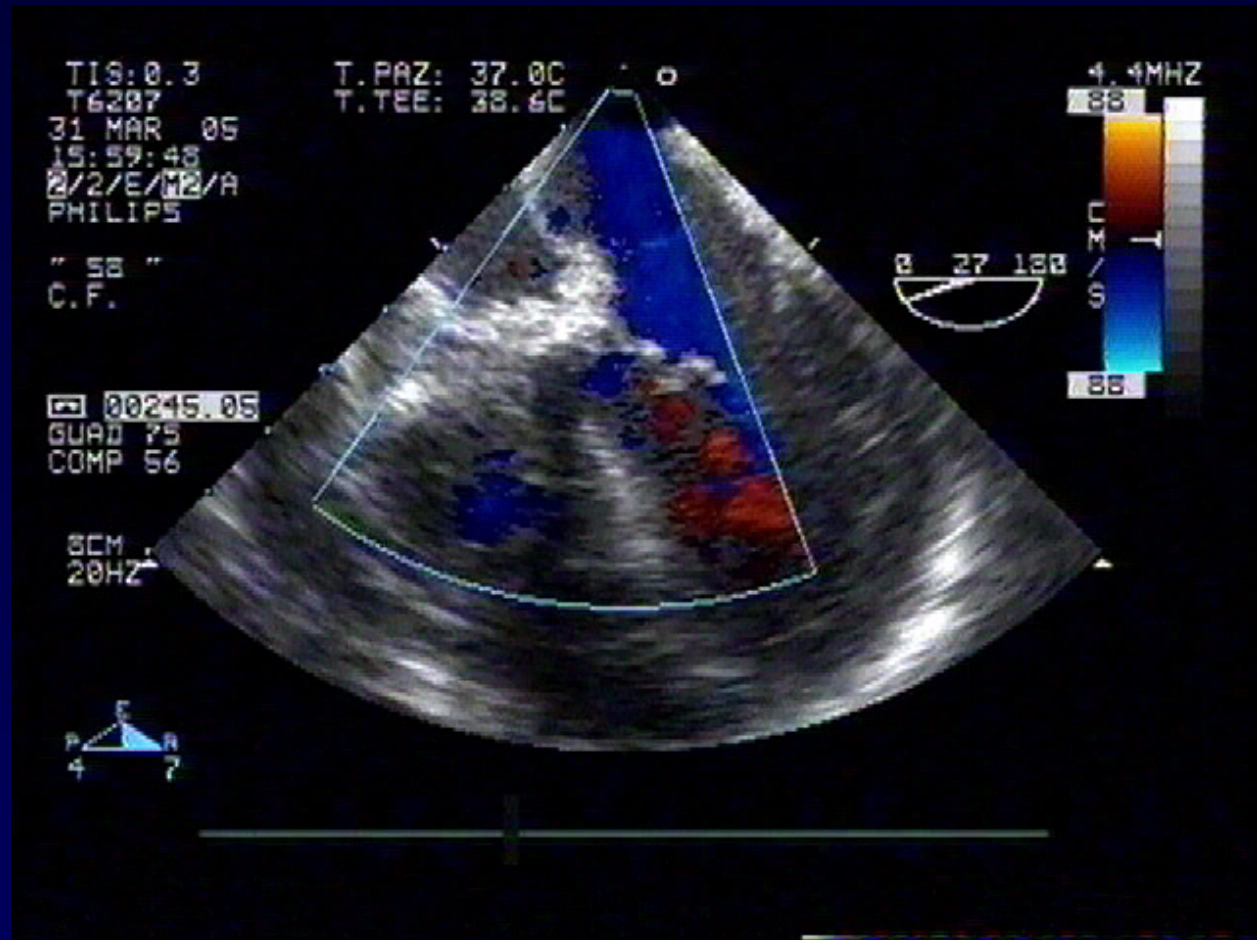
Perimembranous VSD Closure with “eccentric device”



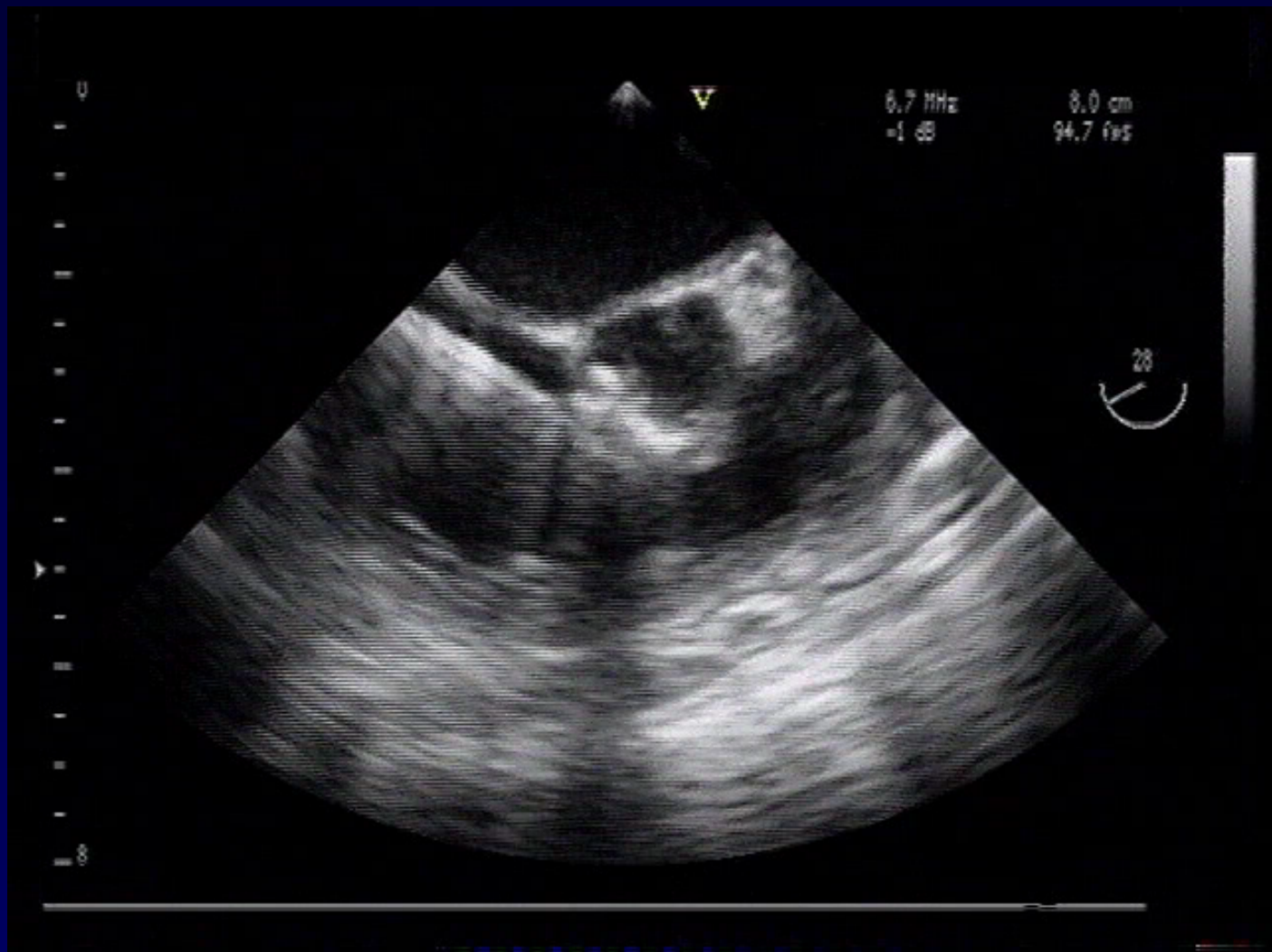
Perimembranous VSD



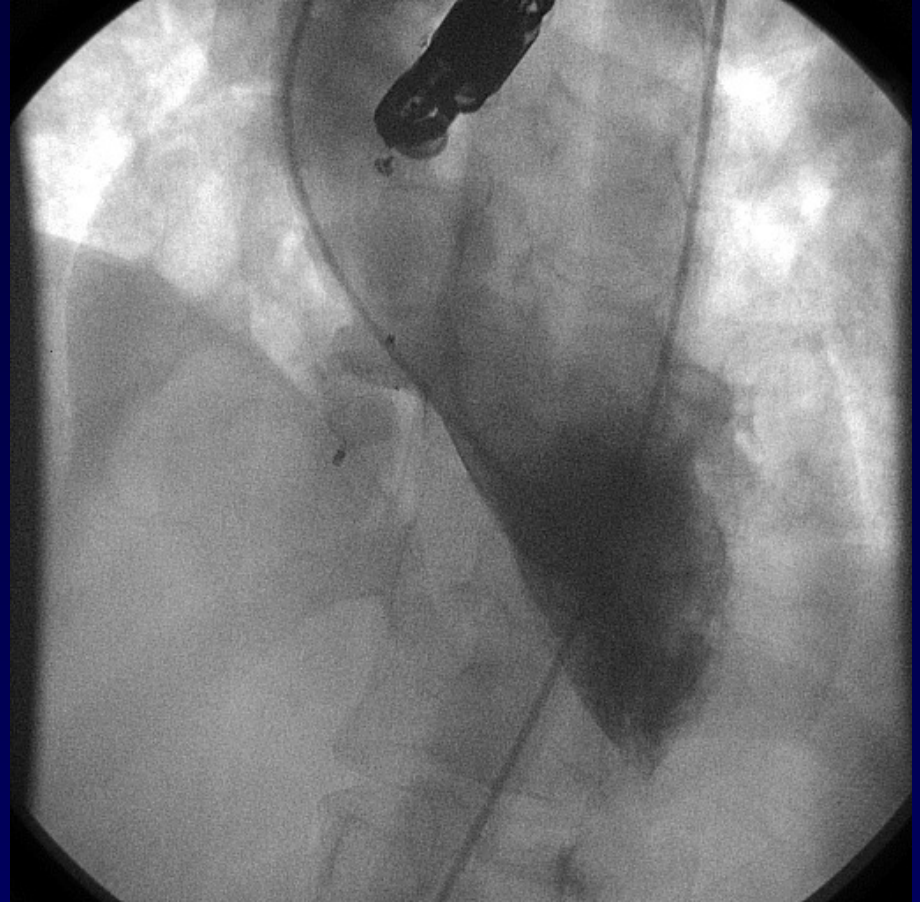
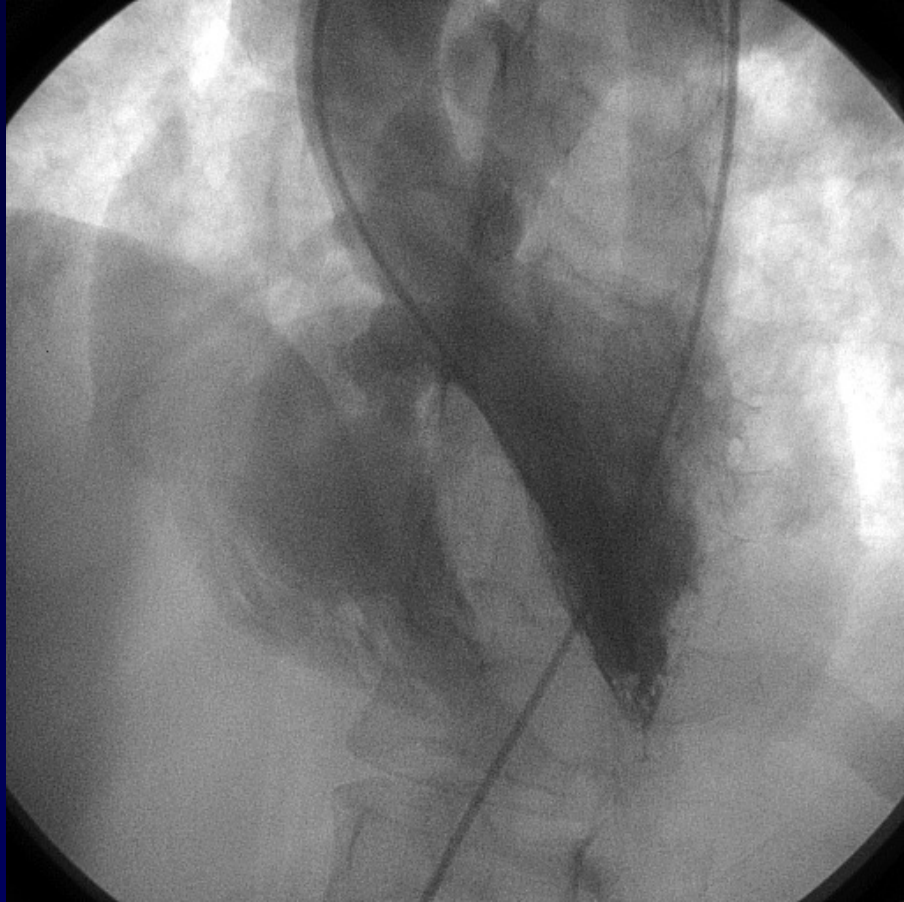
Perimembranous VSD



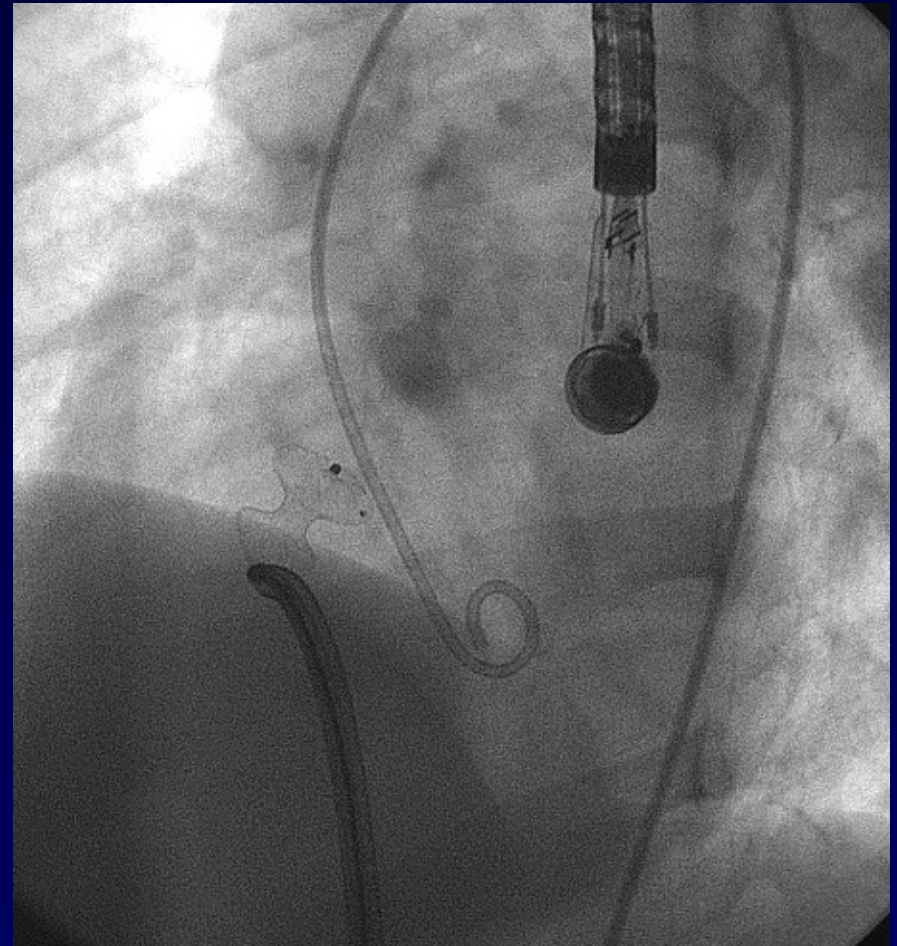
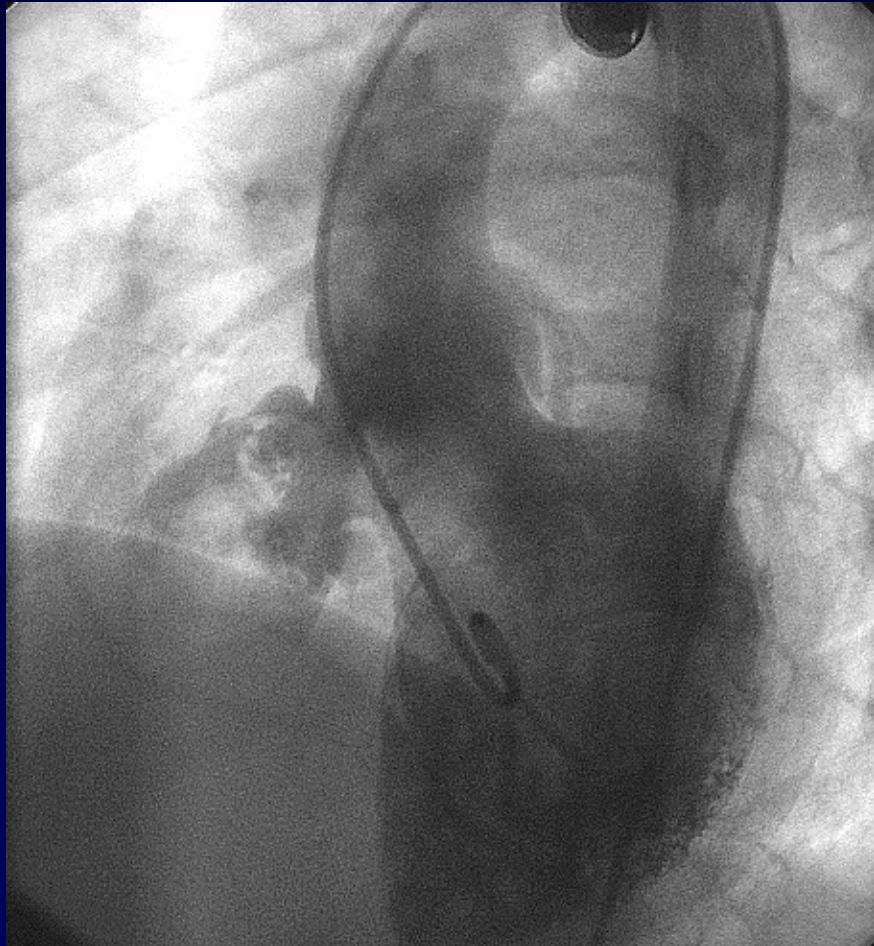
Perimembranous VSD



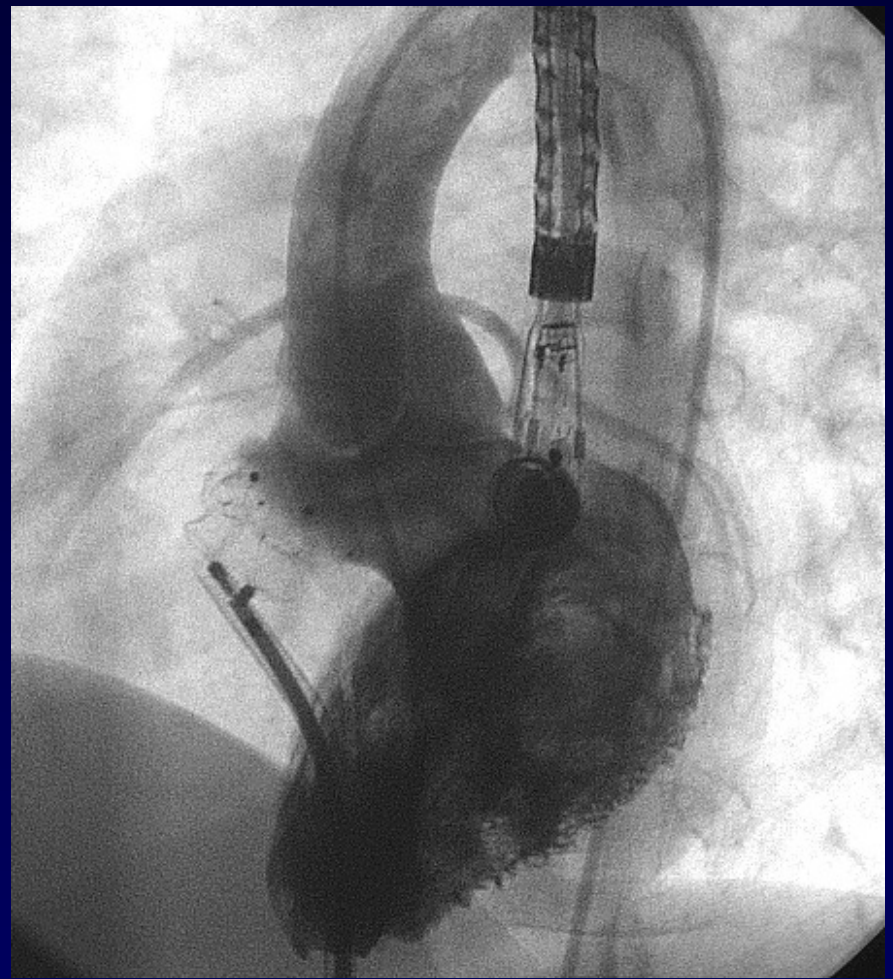
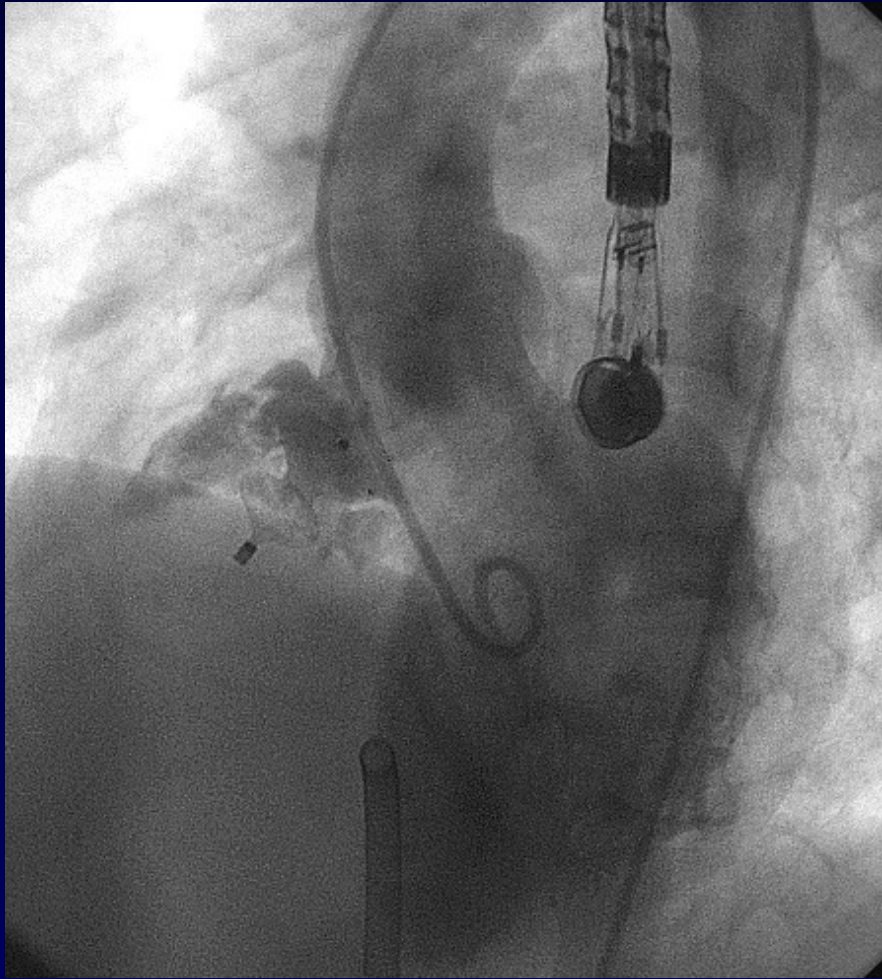
Perimembranous VSD with “septal aneurysm”



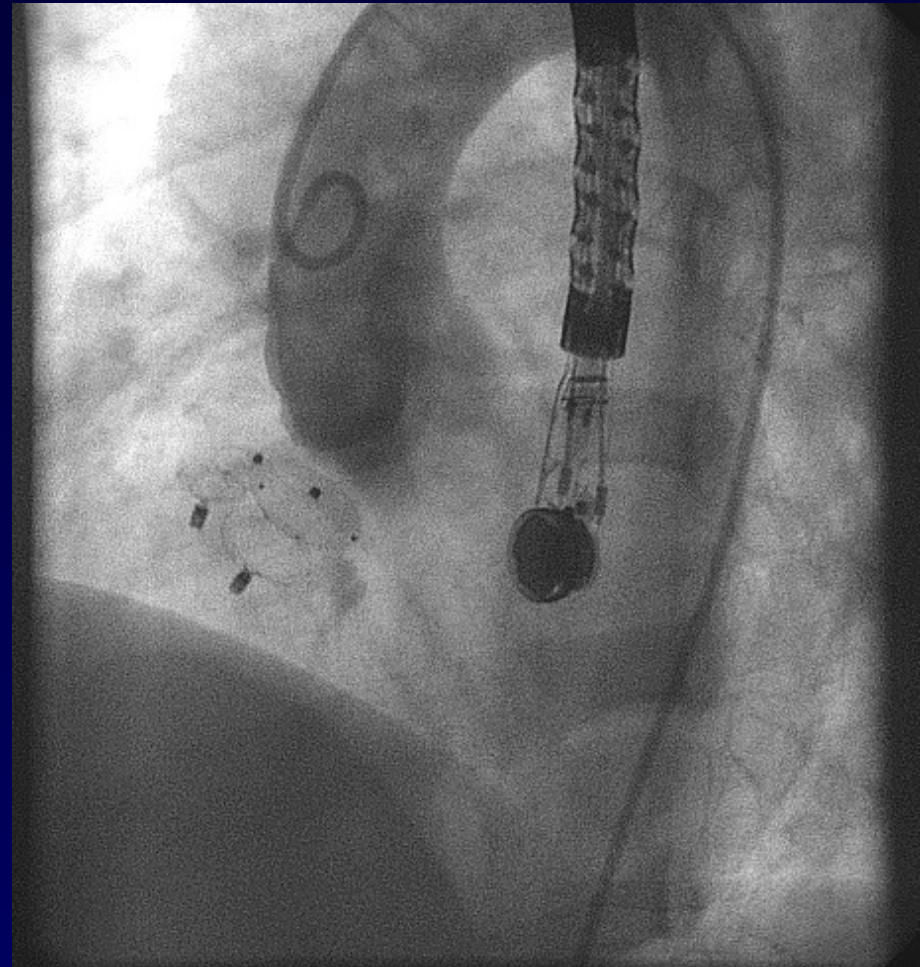
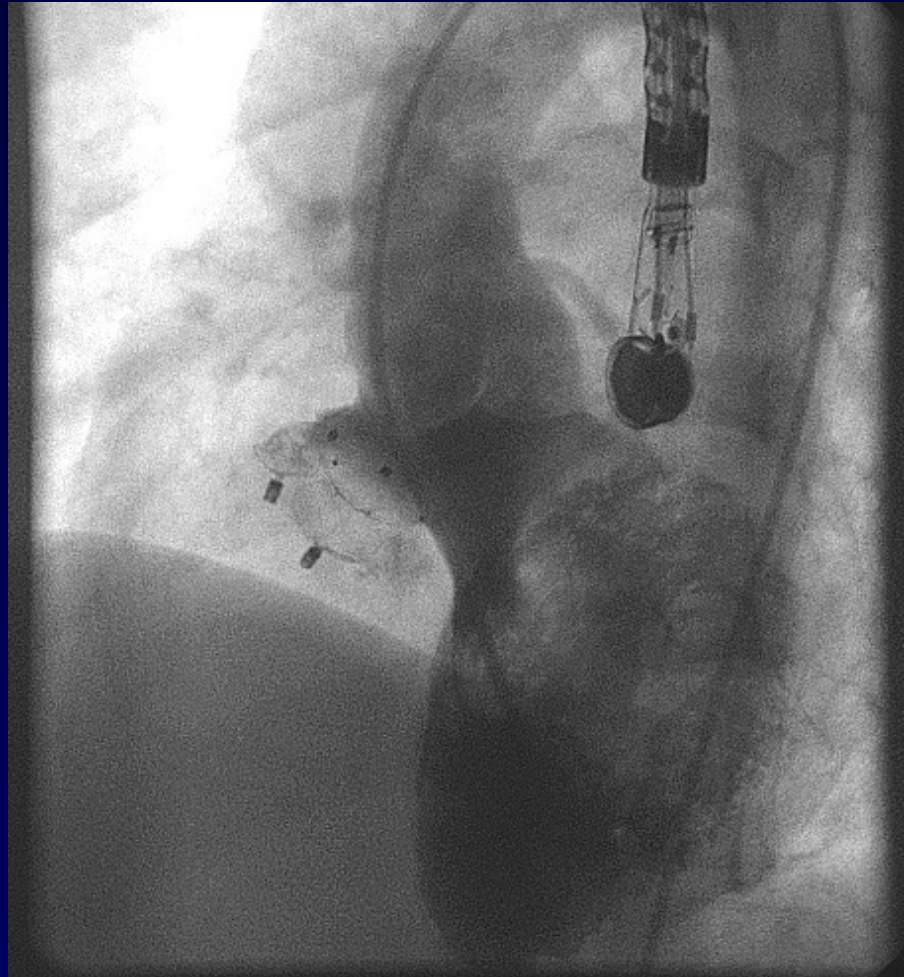
Multiple Perimembranous VSD with “septal aneurysm”



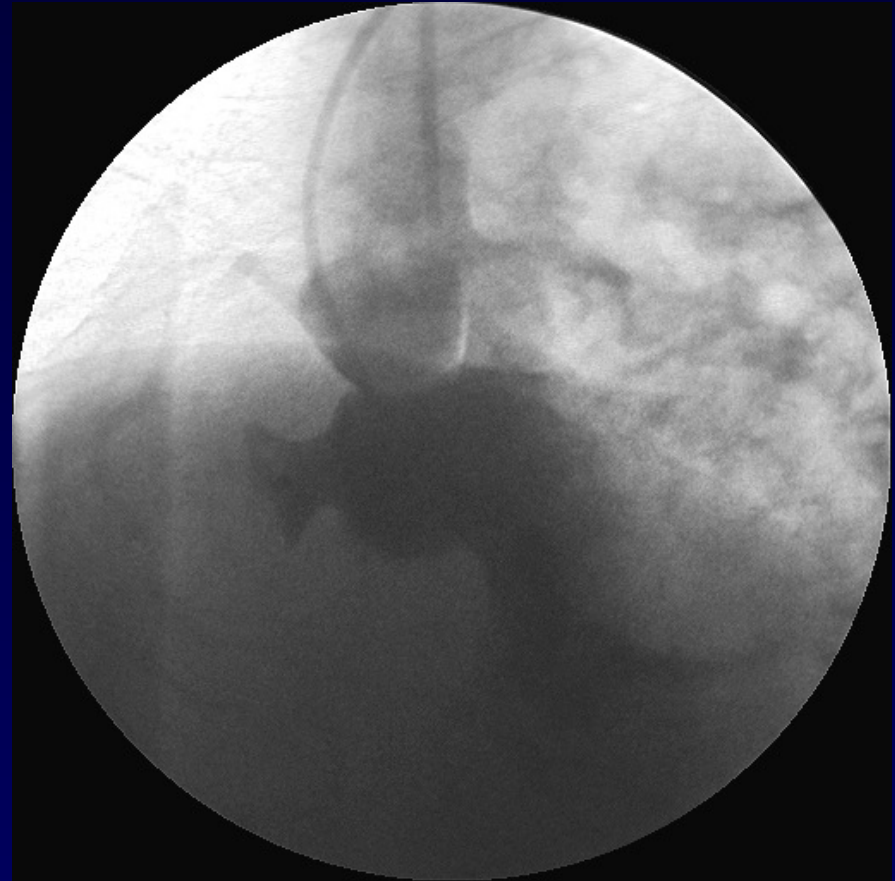
Multiple Perimembranous VSD with septal aneurysm



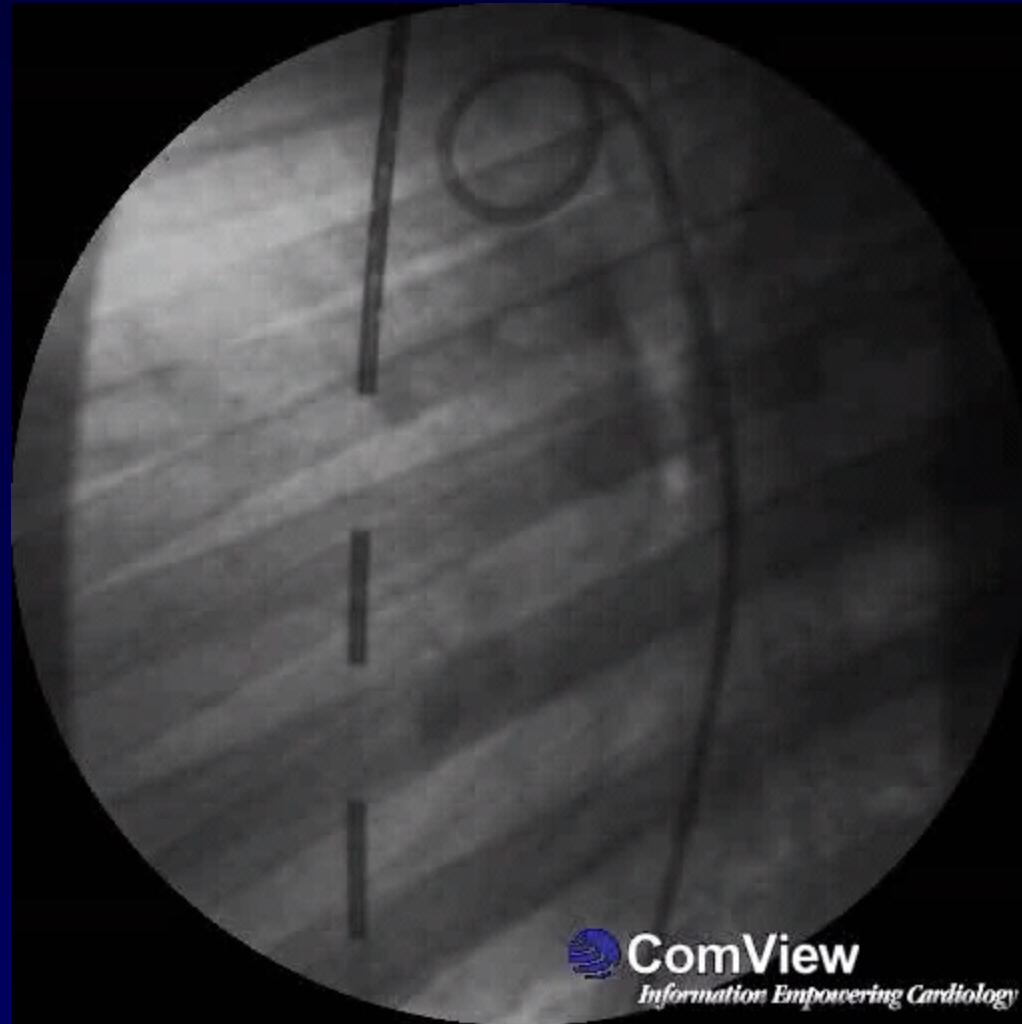
Multiple Perimembranous VSD with septal aneurysm



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*



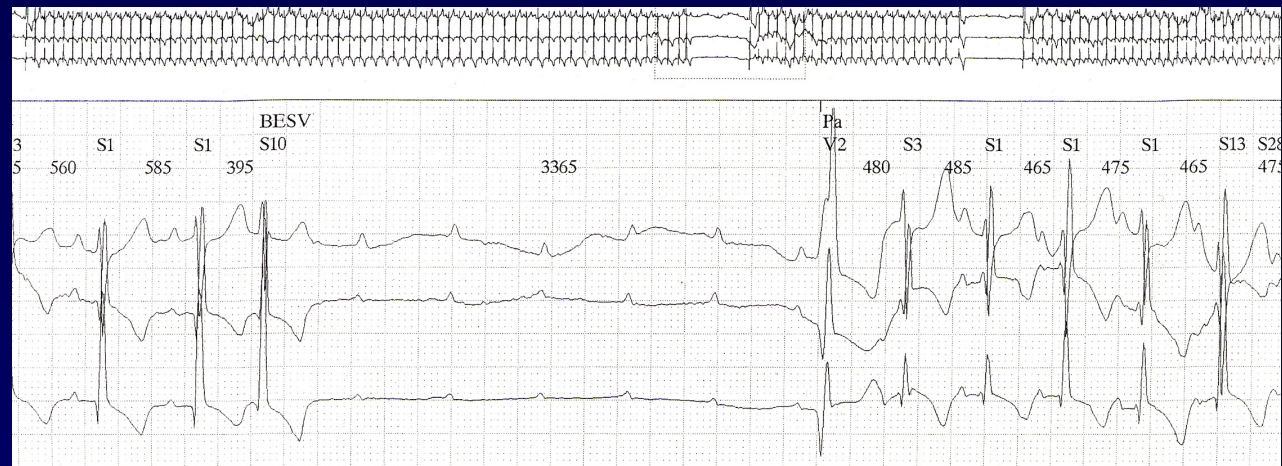
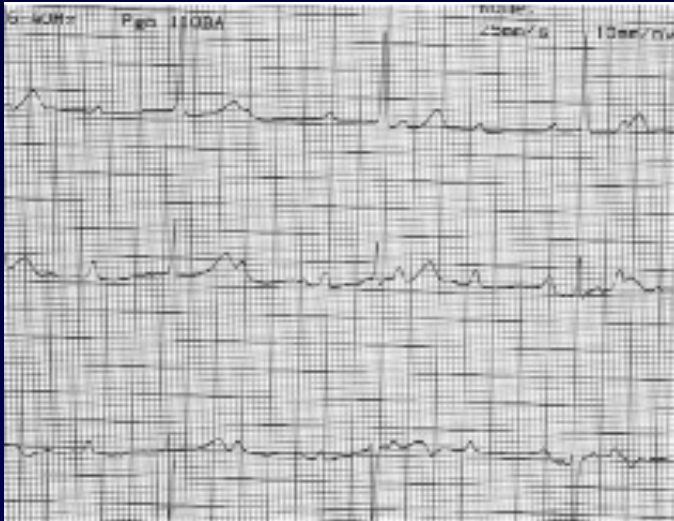
Complete -AVB

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

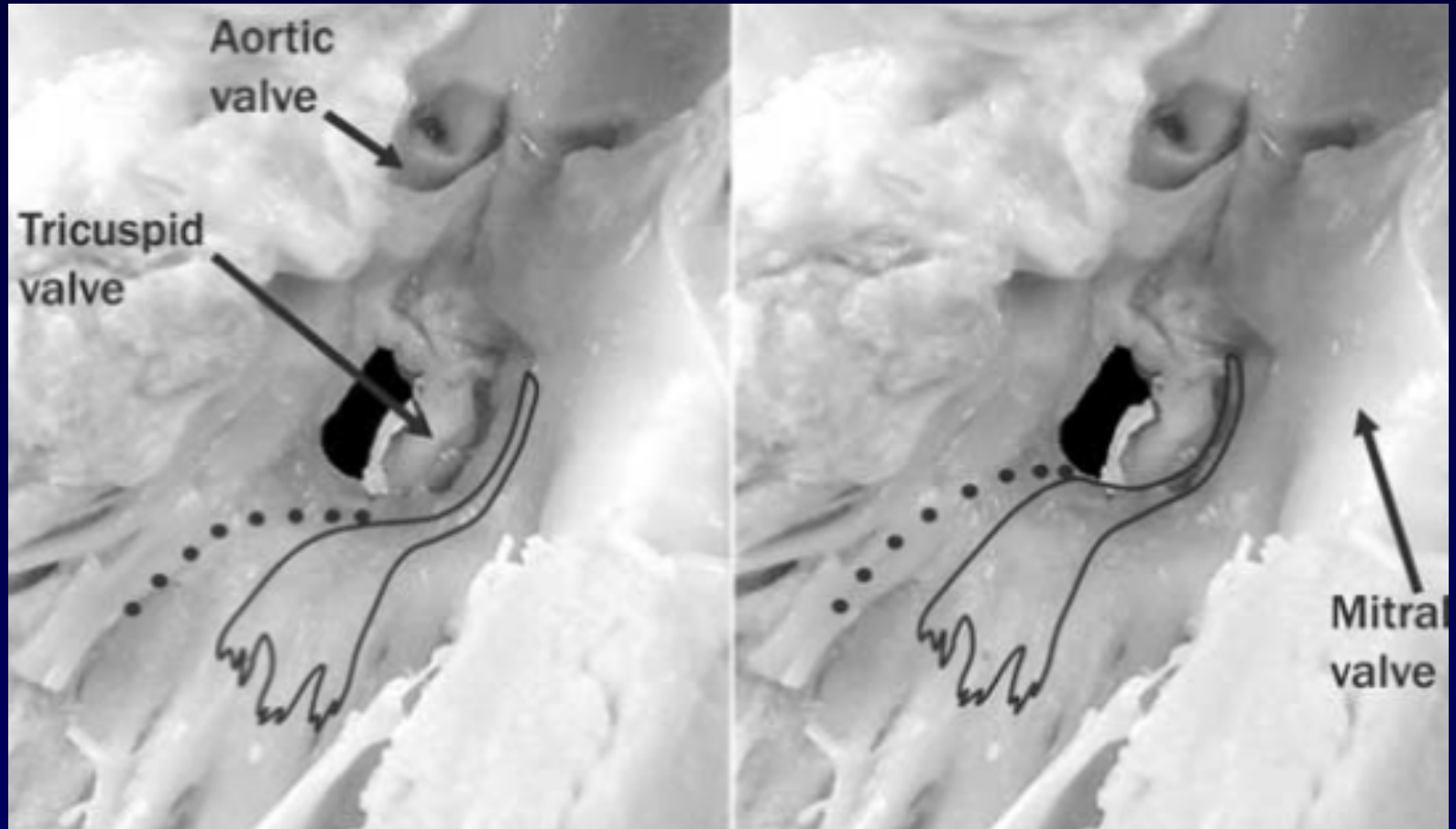
Late Heart block

*Trauma from continuing expansion of an
oversized device*

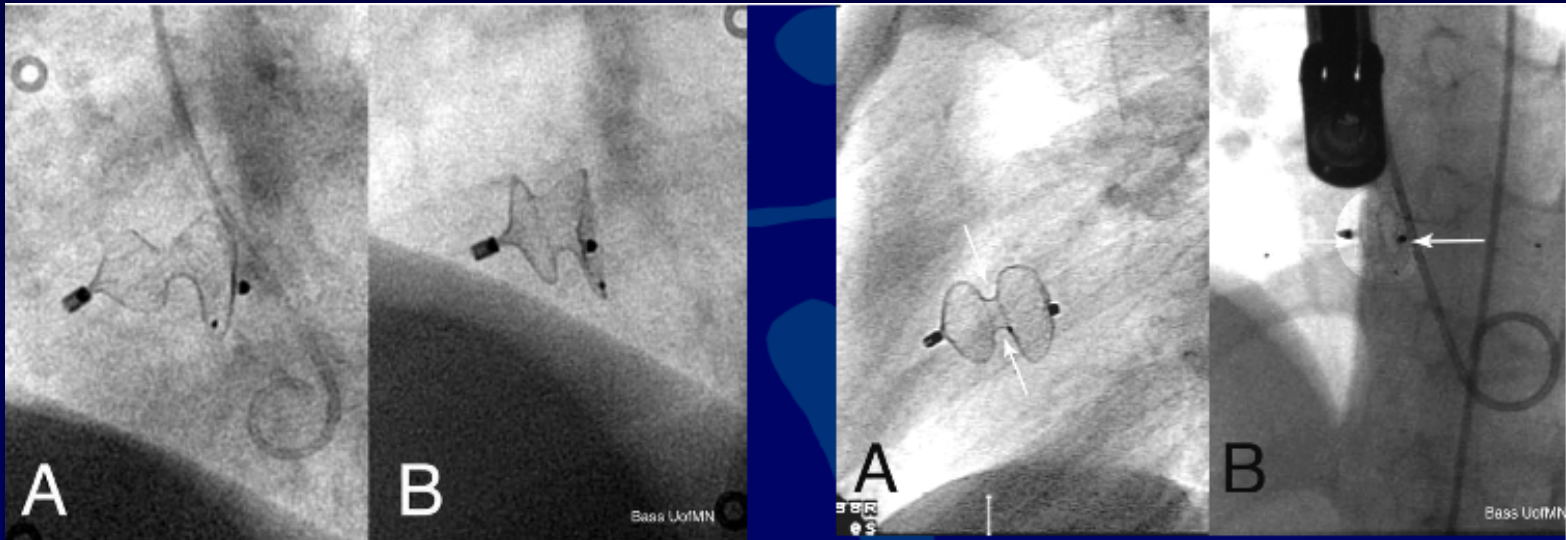
fibrosis

Down's Syndrome

Perimembranous VSD

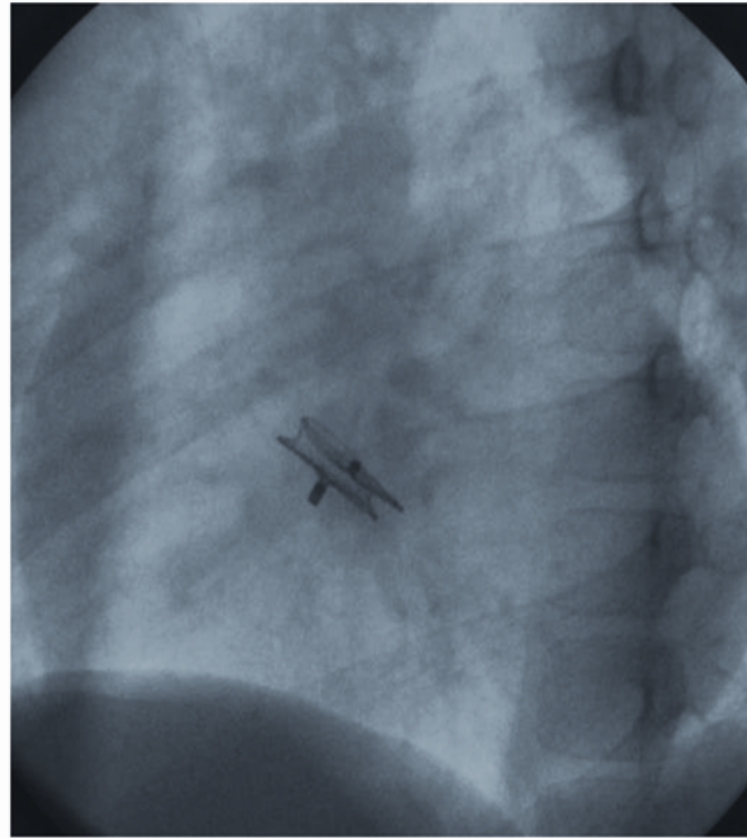
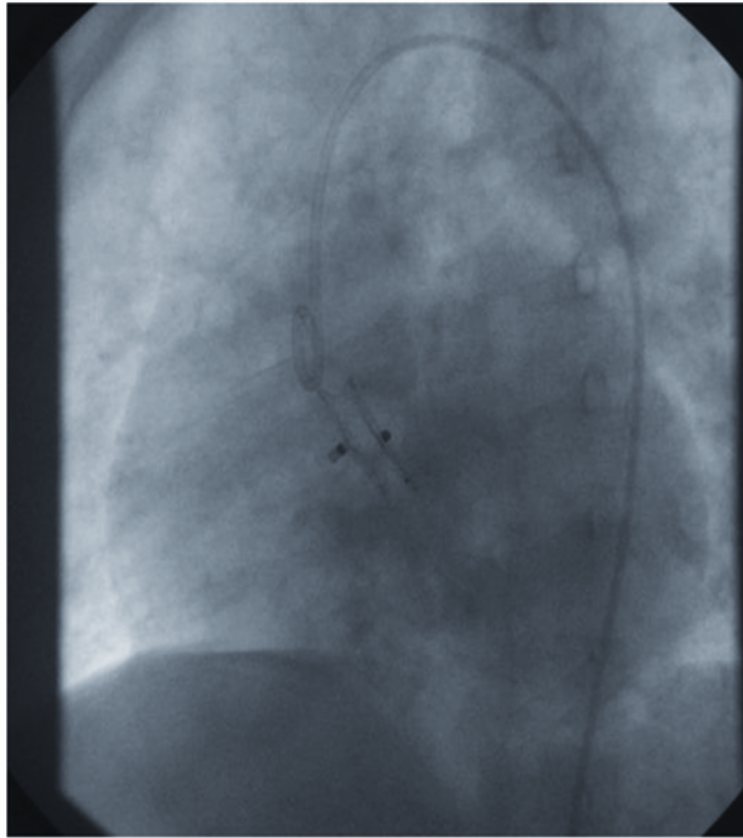


“Oversizing”



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.



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0% occurrence of cAVB

Perimembranous VSD

0% occurrence of cAVB in children > 5 years old

Perimembranous VSD



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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.

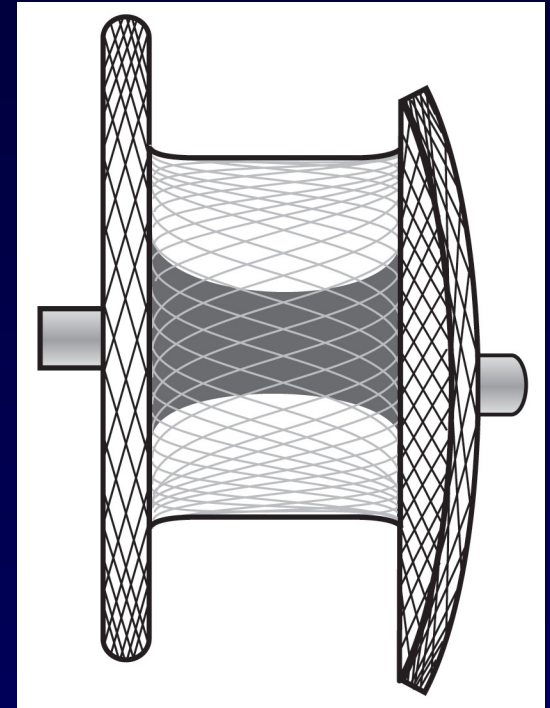
Closure of PMVSDs

Tomorrow

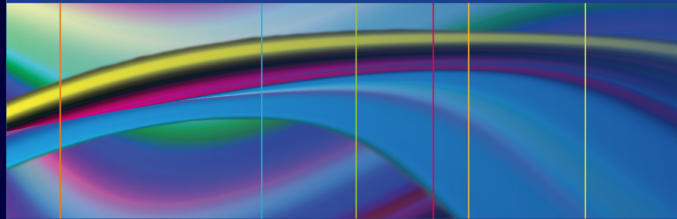


AMPLATZER® Membranous VSD Occluder 2

- 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

