Transcatheter Closure of VSDs : the first results at Hue Central Hospital

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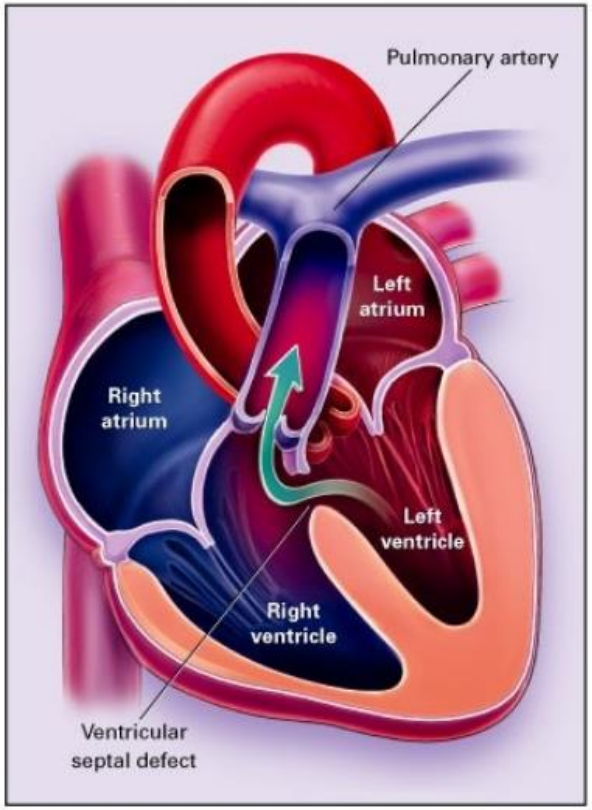
Introduction

- Most common CHD in children (25%)
- 75-80% of small VSD's close spontaneously by late childhood
- 10-15% of large VSD's close spontaneously
- 60% of defects close before age 3, and 90% before age 8
- Risk factors for decreased survival for unoperated patients include:
  - Cardiomegaly on CXR, Elevated PASP (>50 mmHg), and CV symptoms.



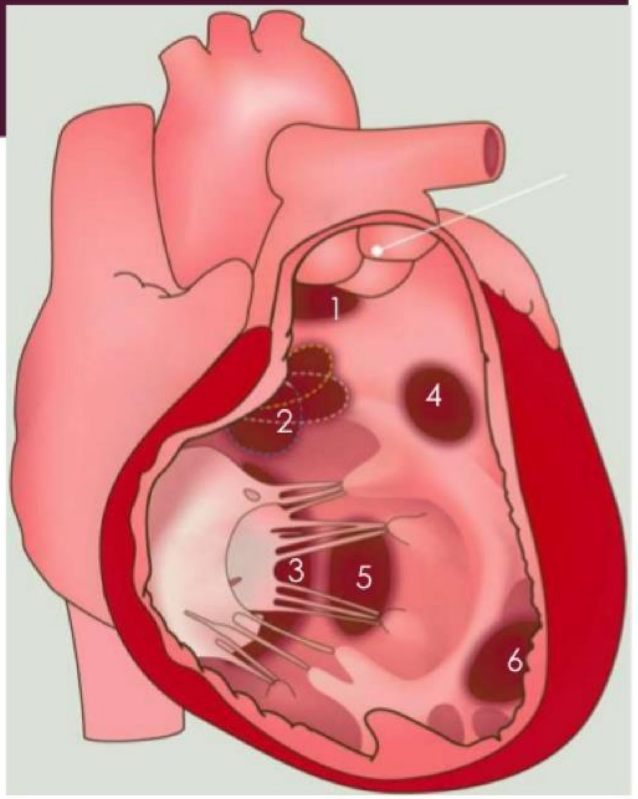
Prevalence, etiology

- Chromosomal disorders associated with an increased incidence of VSD , (Down syndrome), (Di George syndrome), (Turner syndrome).
- Familial forms , TBX5, GATA4, and NKX2.5 mutations .
- Children from an adult with a VSD that is not associated with a genetic disorder may have a risk of VSD as high as 3 % if the father is affected and a 6 % risk if the mother is affected

Classifications

TYPES OF VENTRICULAR SEPTAL DEFECTS

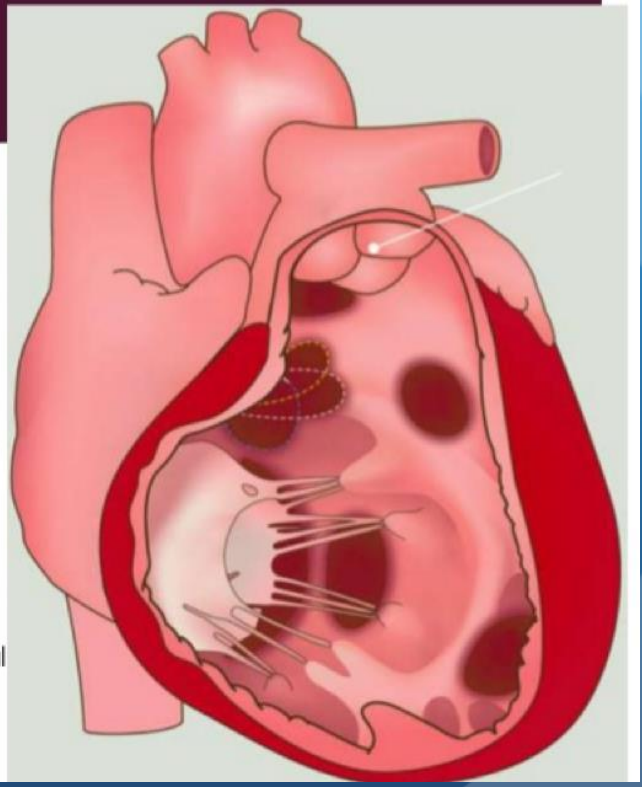
TYPE 1 :(1) subarterial valve; defect: in the left ventricular outflow tract just below the aortic valve (conal,subpul, infundibular, supracristal, doubly commited) (4) outlet
TYPE 2 :(2) perimembranous defect, membranous septum (yellow , white , and blue dashed circumference for outlet, trabecular and inlet subtype,)
TYPE3 :(3) inlet or atrioventricular defect, which lies inferior to the septal leaflet of the tricuspid valve; and (5) inlet and apical
TYPE 4 : (6) muscular defects, which are entirely bounded by the muscular septum and are often multiple



Classifications

TYPE 1

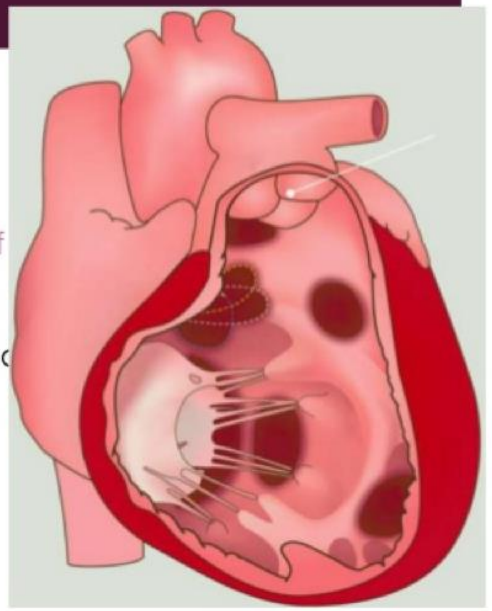
- Conal,subpul, infundibular, supracristal, doubly commited
- Aortic regurgitation (87% IN 20Y)
- Prolapse of the anterior aortic valve leaflet. (LCC,RCC
- 6 % of defects 30% in Asian
- Spontaneous closure of this type of defect is uncommon
- Doubly committed subarterial :
  - More common in Asian patients,
  - In the outlet septum,
  - Bordered by fibrous continuity of the aortic and pulmonary val



Classifications

TYPE 2

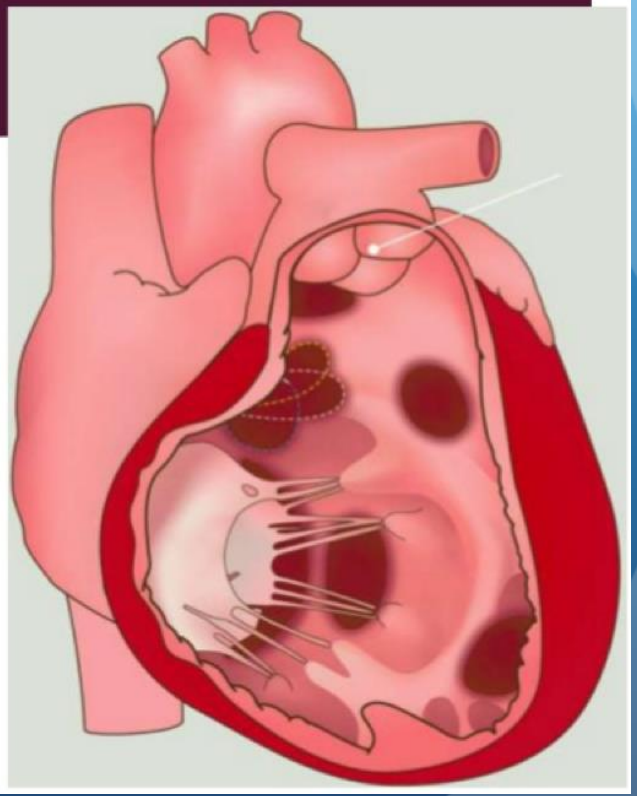
- Synonyms: perimembranous, paramembranous,conoventricular
- SUBTYPES : Inlet, trabecular, outlet, and confluent. (multiple areas of
- Most common VSD, (80 % of defects)
- Bordered by fibrous continuity between the leaflets of an AV valve
an arterial valve.
- AI (Prolapse of,RCC,NCC)



Classifications

TYPE 3

- Synonyms: inlet, AV canal type, endocardial cushion
- May be associated with AV canal defect.
- Trisomy 21 syndrome.
- 5–8 % of VSDs .



Classifications

TYPE 4(MUSCULAR)

- Rim totally composed of septal muscle
- Subclassified as inlet, trabecular outlet, or confluent .
- 20 % of VSDs in infants
- Spontaneous closure is common,.
- Frequently multiple.
- "Swiss-cheese" septum

Classifications

GERBODE-TYPE VSD

- Left ventricle to right atrium.
- Extremely rare

Classifications

- According to borders of VSD.

TYPE	FEATURES
PERIMEMBRANOUS	Bordered directly by fibrous continuity between leaflets of AV valves and arterial valves
DOUBLY COMMITTED	Bordered by fibrous continuity between leaflets of aortic and pulmonary valves
MUSCULAR	Completely embedded in muscular septum

Pathophysiology

- **A restrictive VSD**
  1. Produces a significant pressure gradient between the left ventricle and the right ventricle
  2. Pulmonary-to-aortic systolic pressure ratio < 0.3
  3. Small (≤1.4 : 1) shunt.
  4. Less than 5mm, or defect size <=25% of annulus diameter
  5. Normal PA and branches
  6. Normal LV, LA size

Pathophysiology

- **A moderately restrictive VSD**
  1. Qp/Qs of 1.4 to 2.2 :
  2. pulmonary-to-aortic systolic pressure ratio less than 0.66.
  3. Diameter of defect >25% <75% of annulus size or 5-10 mm
  4. RVP,PAP normal or near normal
  5. Mild to moderate PA,LA,LV dilation

Pathophysiology

- **A large or non-restrictive VSD**
  1. Qp/Qs > 2.2
  2. pulmonary-to-aortic systolic pressure ratio greater than 0.66.
  3. Defect diameter >75% of aortic diameter
  4. PH in less than 2years

Natural history

1. A restrictive VSD may close spontaneously during childhood and sometimes in adult life.
2. A perimembranous defect ,doubly committed VSD,
    1. Progressive AR.
    2. Subaortic and subpulmonary stenosis
    3. Left ventricular to right atrial shunt
3. A moderately restrictive VSD
    1. Left atrial and ventricular dilation and dysfunction
    2. Variable increase in pulmonary vascular resistance.
4. A large or nonrestrictive VSD
    1. Ventricular volume overload early in life
    2. Progressive rise in pulmonary artery pressure
    3. A fall in left-to-right shunting.

Echocardiography

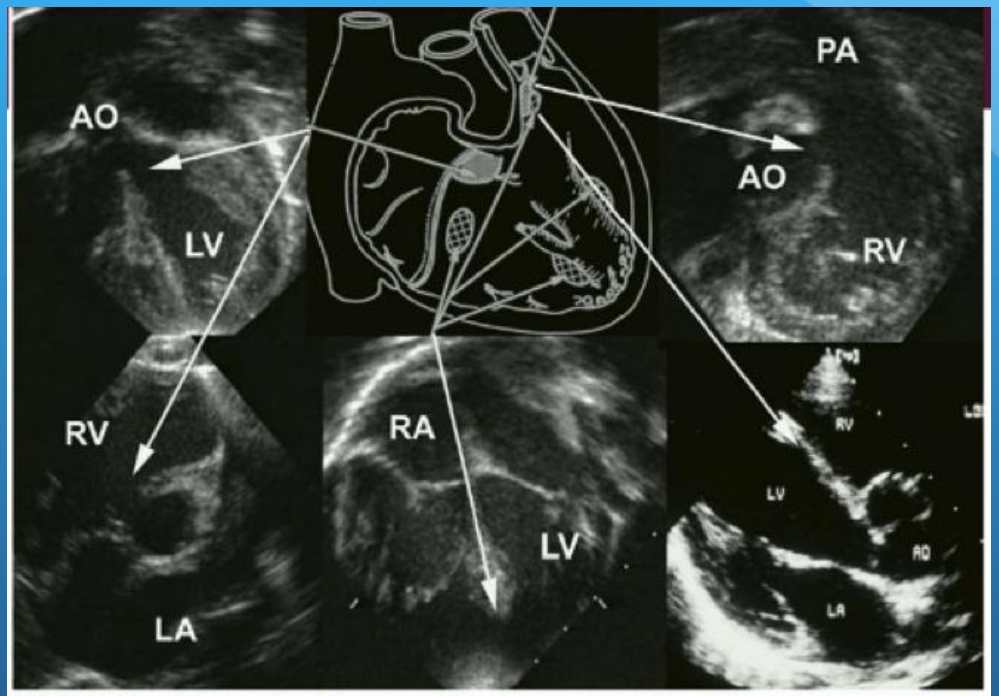
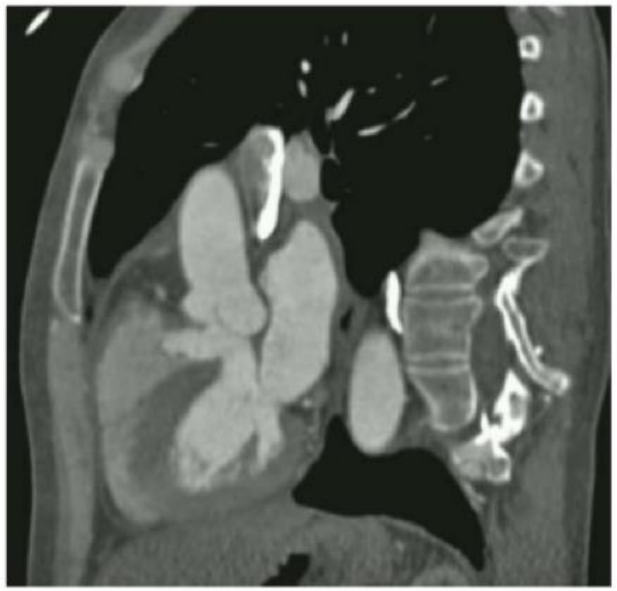


FIGURE 65-8 Montage of the different types of ventricular septal defects. The central diagram outlines th location of the various types of defects as seen from the right ventricle. The two left images show a perimembra nous ventricular septal defect as seen in the five-chamber and short-axis views. Note that the defect is roofed b the aorta and is next to the tricuspid valve. The bottom middle echocardiogram is a muscular apical defect. Th upper right image is a right anterior oblique view in a doubly committed ventricular septal defect. The lower righ image is a short-axis view showing an outlet ventricular septal defect with prolapse of the right coronary cusp AO = aorta; LA = left atrium; LV = left ventricle; PA = pulmonary artery; RA = right atrium; RV = right ventricle.

CT scanner



Indications for intervention

1. The presence of a significantVSD
   1. The symptomatic patient shows a Qp/Qs > 1.5 : 1,
   2. Pulmonary artery systolic pressure > 50 mm Hg,
   3. Increased left ventricular and left atrial size, or deteriorating left ventricular function

   in the absence of irreversible pulmonary hypertension.
2. Presence of a perimembranous or outlet VSD with more than mild aortic regurgitation
3. History of recurrent endocarditis.
4. In children, a nonrestrictive VSD and a smaller VSD with significant symptoms failing to respond to medication.

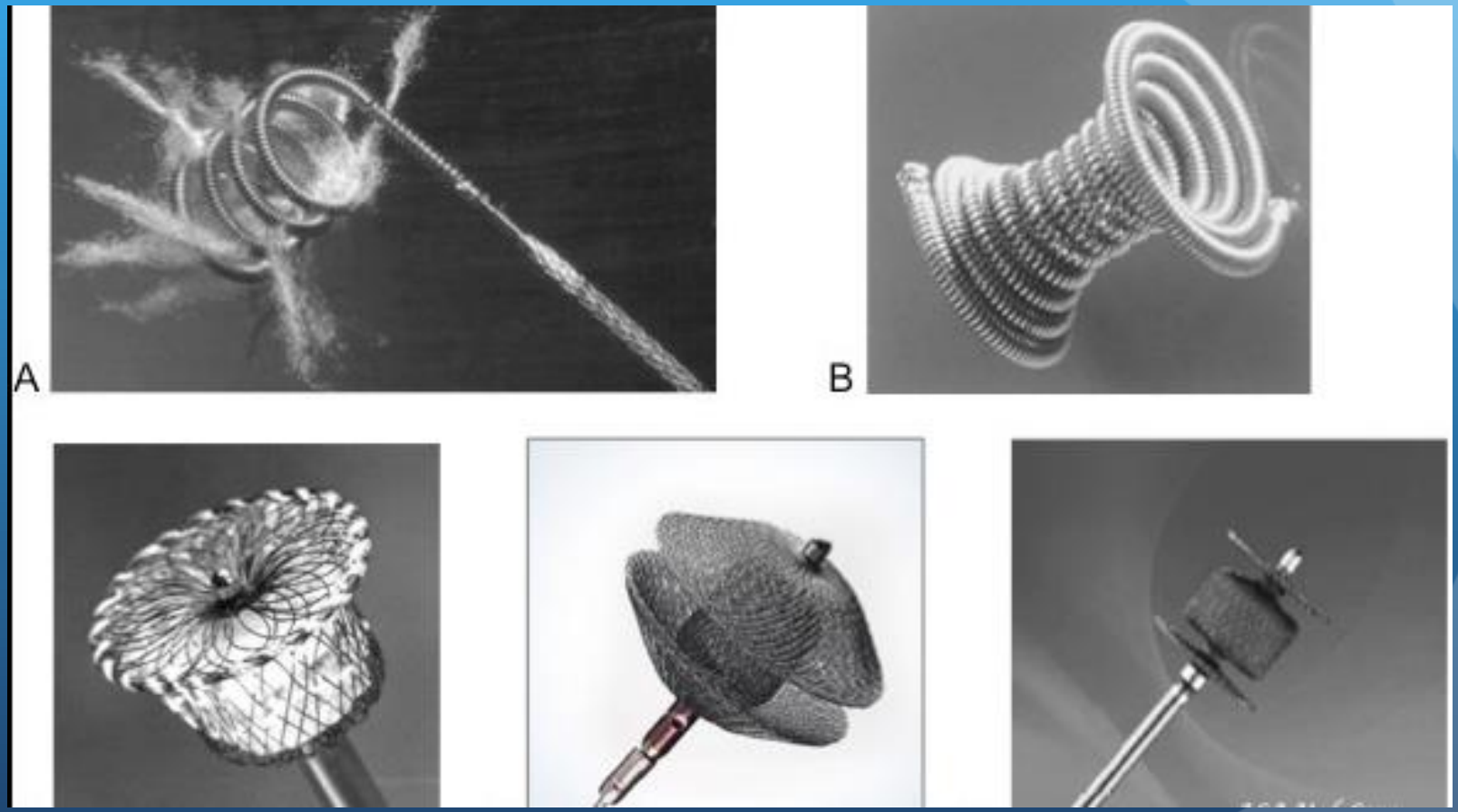
Complications

- AV Dissociation, RBBB
- Ventricular arrhythmias
- Heart block
- Poor hemodynamic state
- Residual shunting 2%
- AR/TR
- Cardiac dysfunction
- Pulmonary hypertension
- Early hospital death < 1%

Methods

- 27 VSD patients
- Patient selection for VSD closure: Heart team including cardiologists, cardiac surgeons, cardiac interventionists
- The patients are evaluated with history, physical examination, ECG, Xray, and echocardiography.
- Exclusion criteria include:
  - weight less than 3.0 kg;
  - distance of less than 4 mm between the VSD and the aortic; pulmonic; mitral or tricuspid valves;
  - pulmonary vascular resistance greater than 7 Woods units;
  - Sepsis / active bacterial infections
  - contraindication to anti-platelet

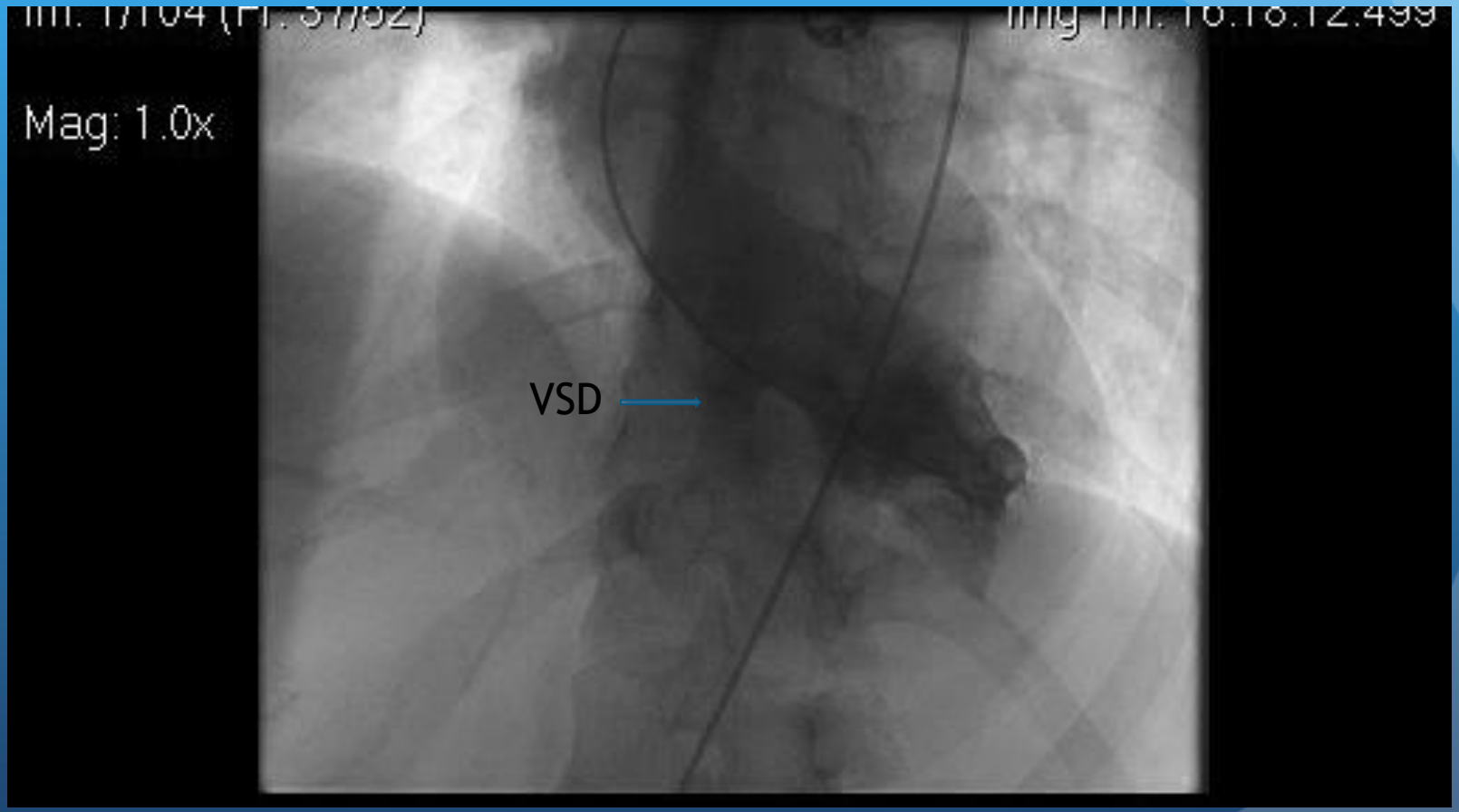
Devices



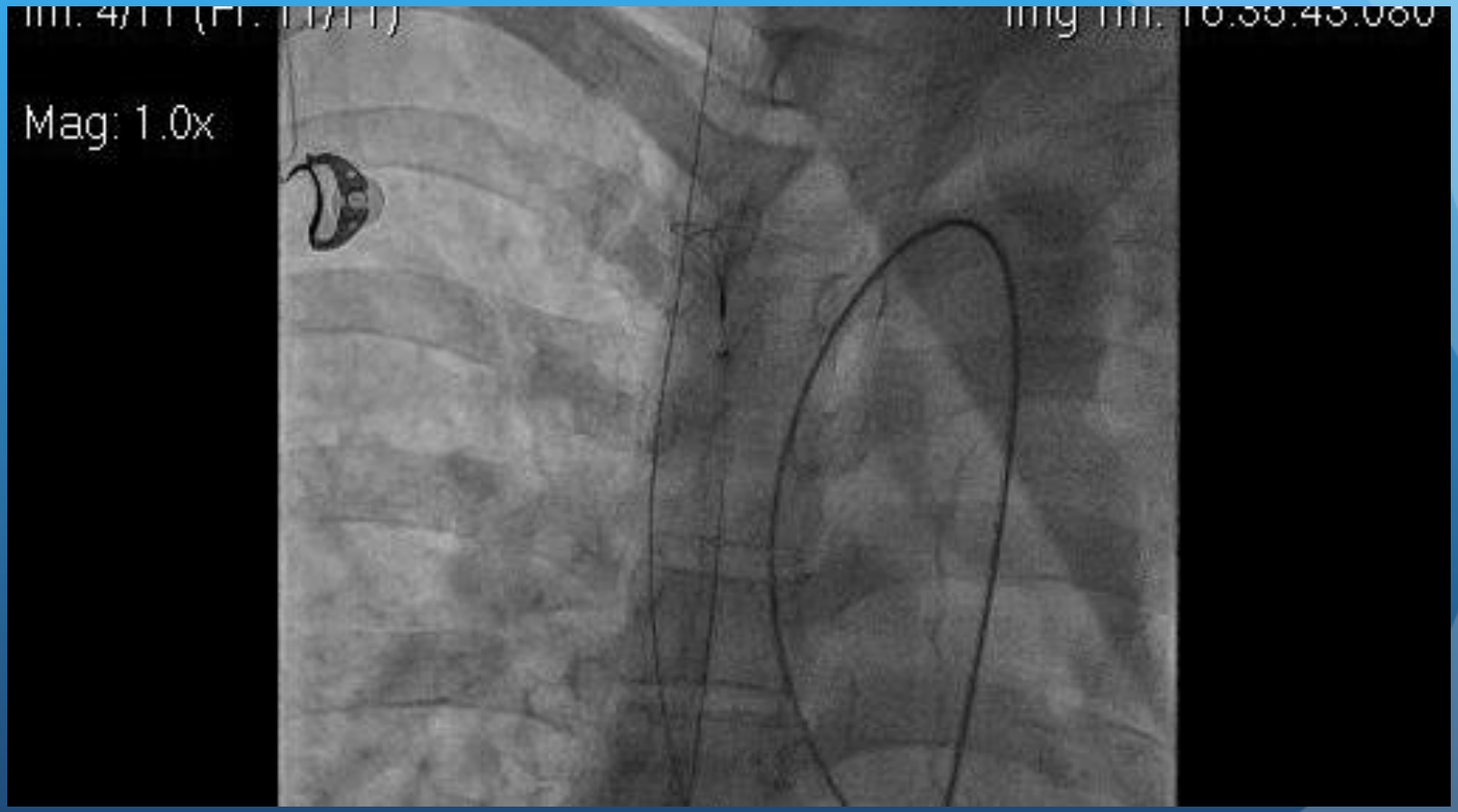
DEVICE IMPLANTATION TECHNIQUE

- General endotracheal anesthesia in small children and local anesthesia in adults
- Access : the femoral vein, the femoral artery
- Heparin : ACT > 200s
- Right and left heart catheterization
- Left ventriculography is performed to define the location, size and number of VSDs

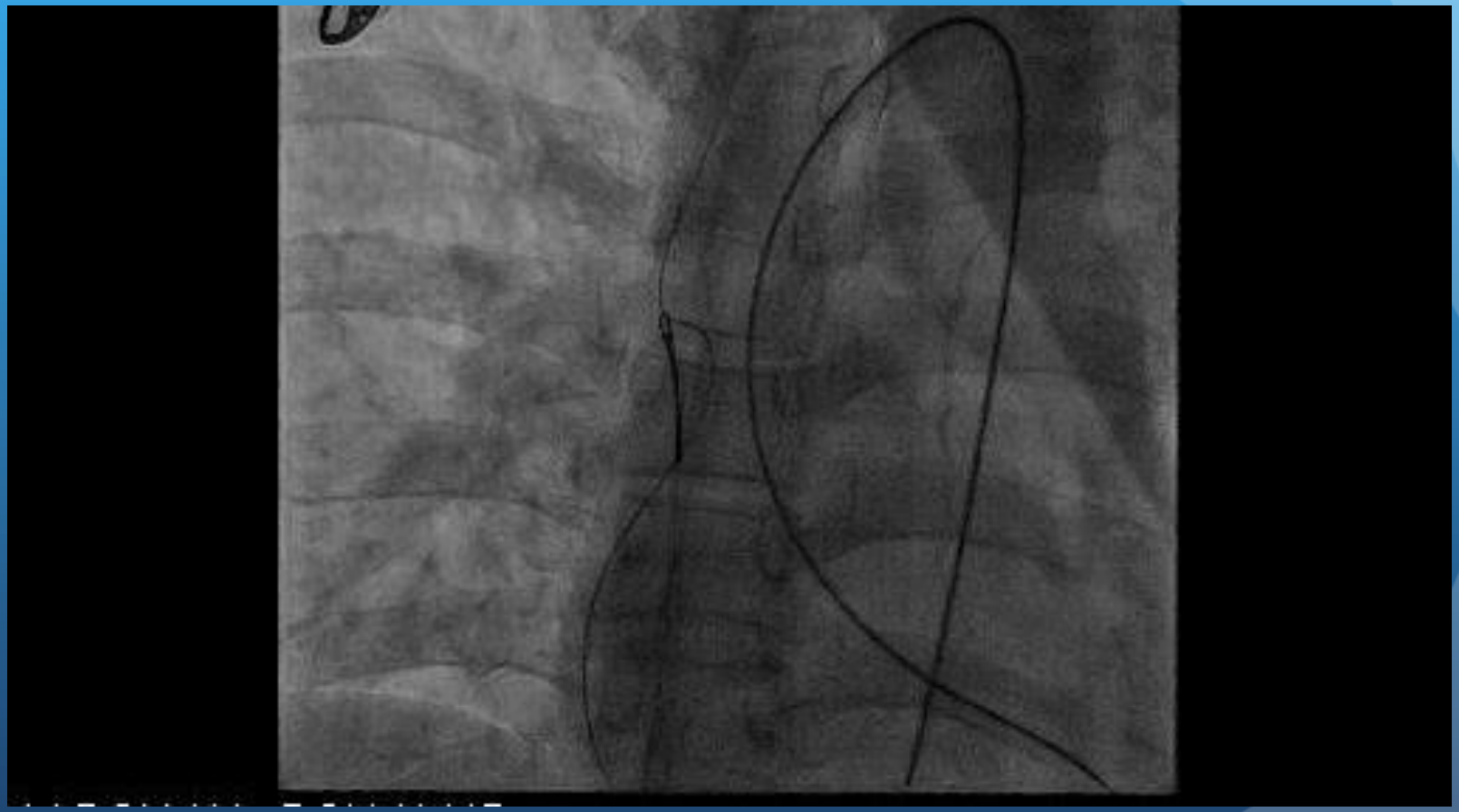
Left ventriculography



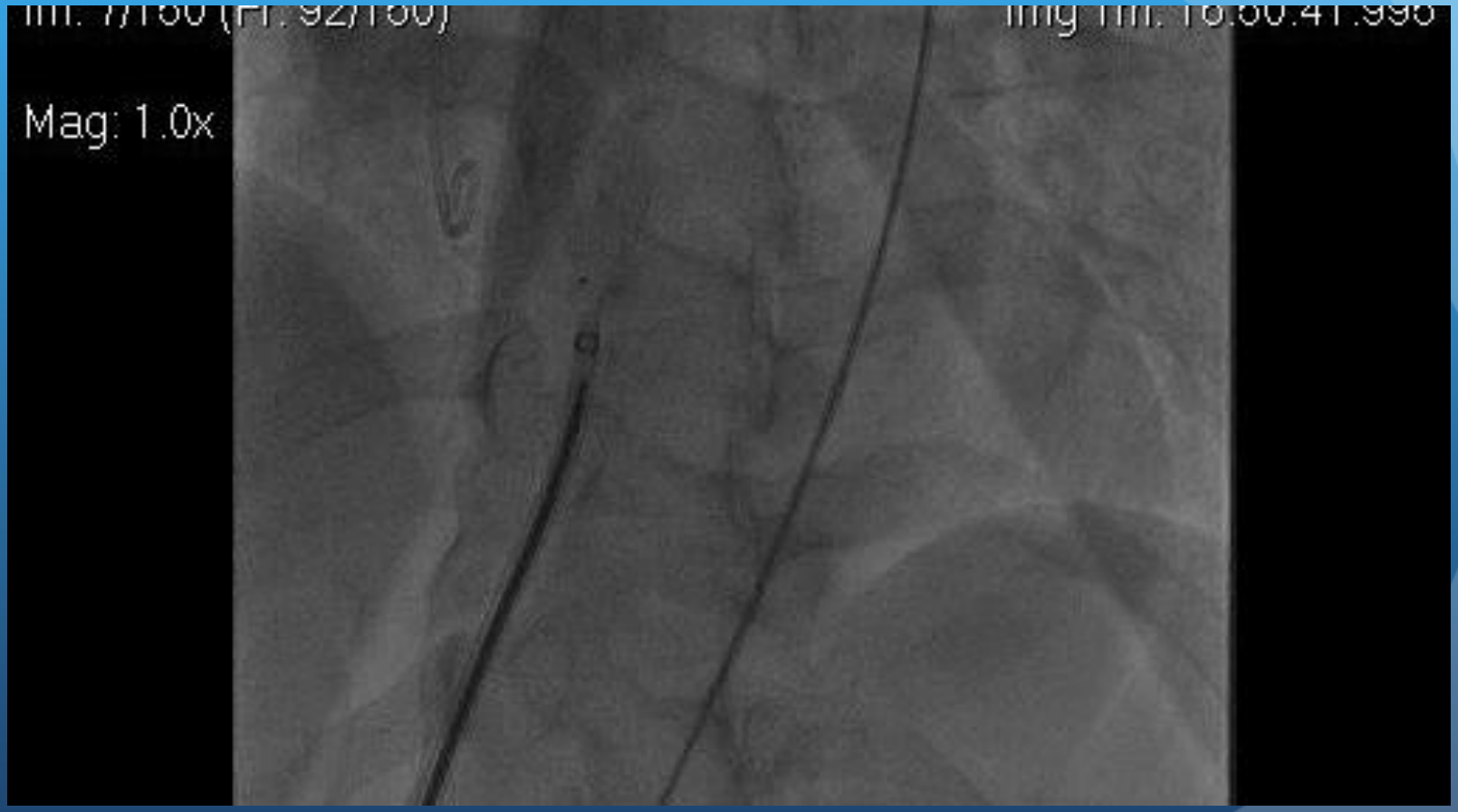
Snare capture



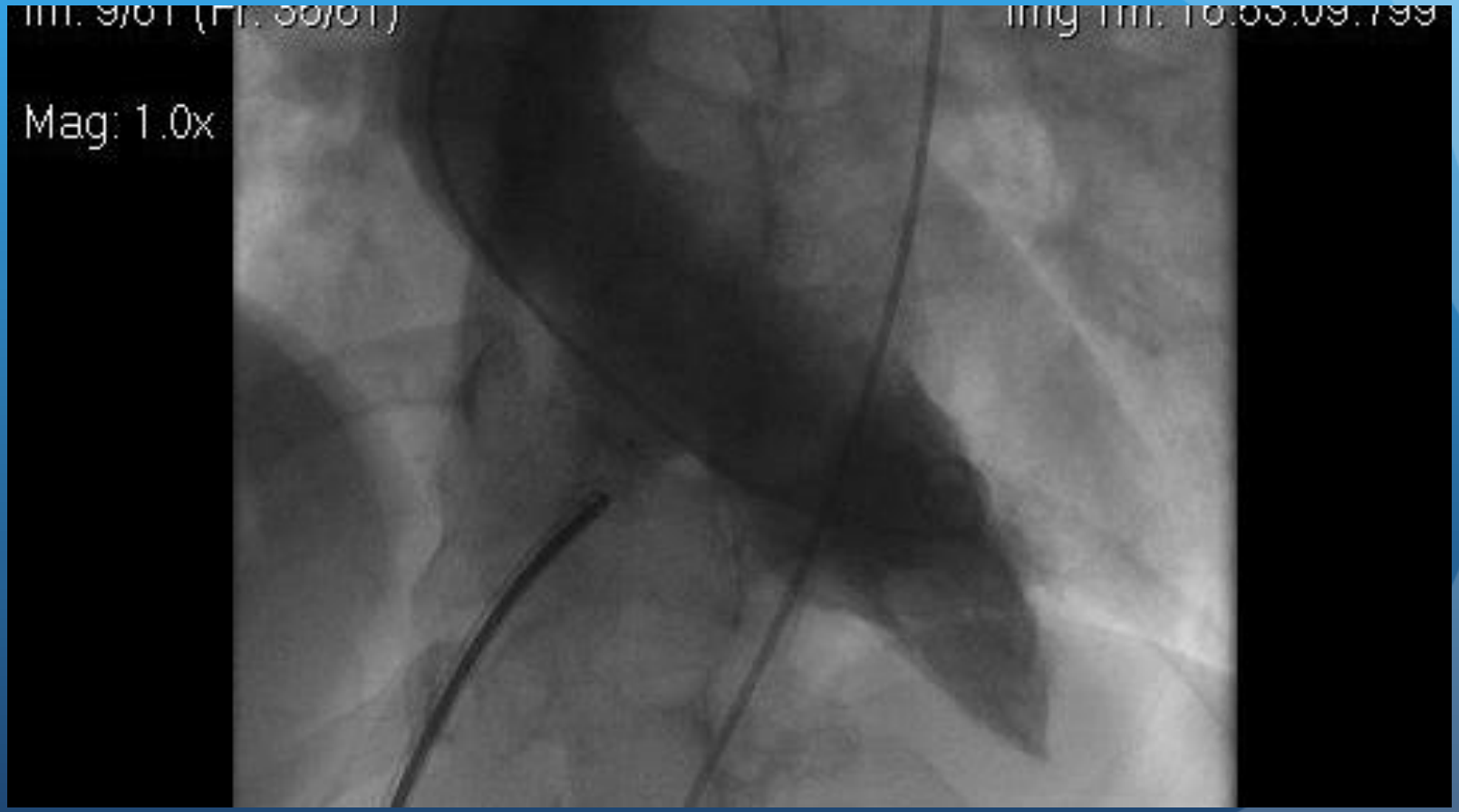
Snare capture



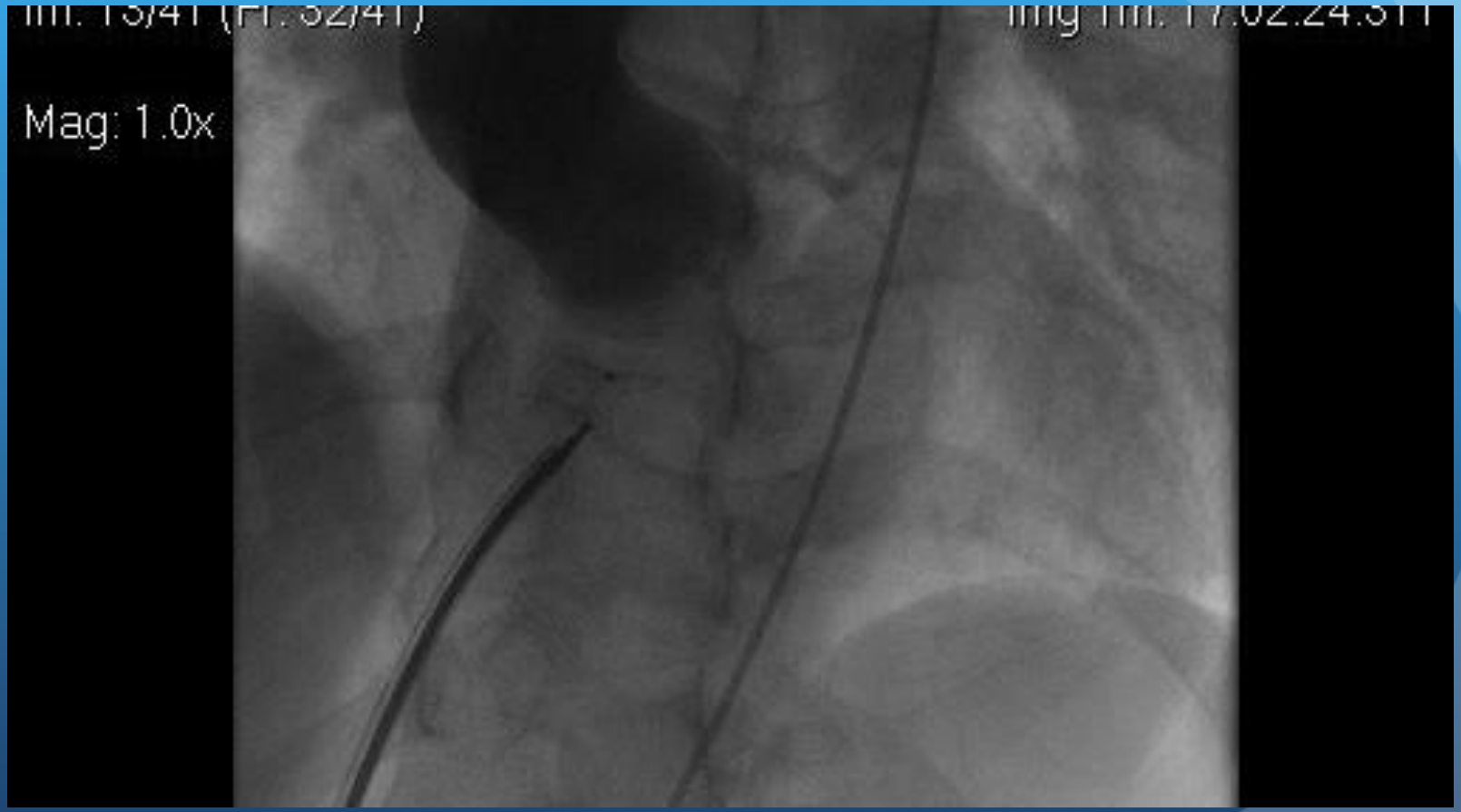
ADO 1 implanted



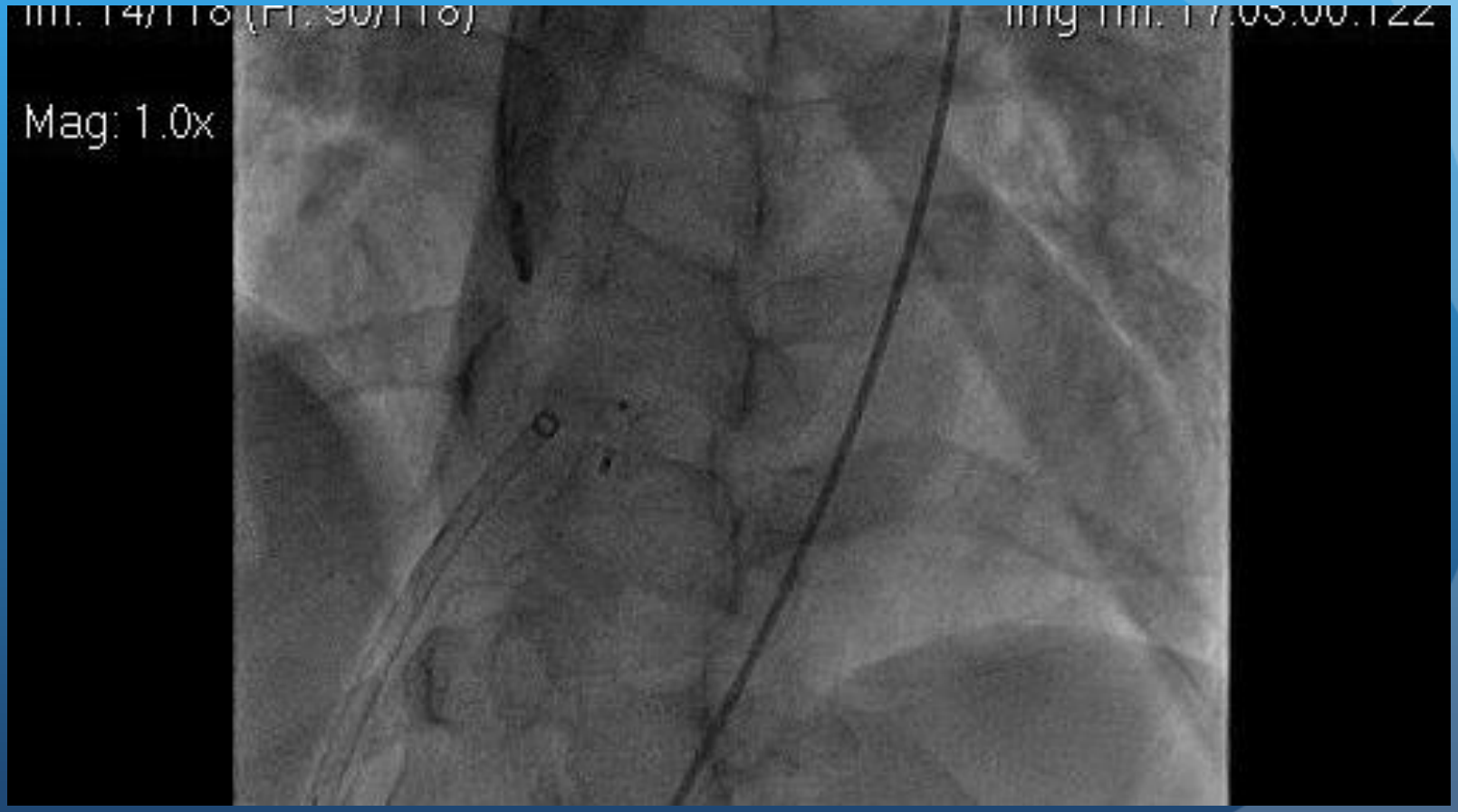
Left ventriculography after ADO1 implanted



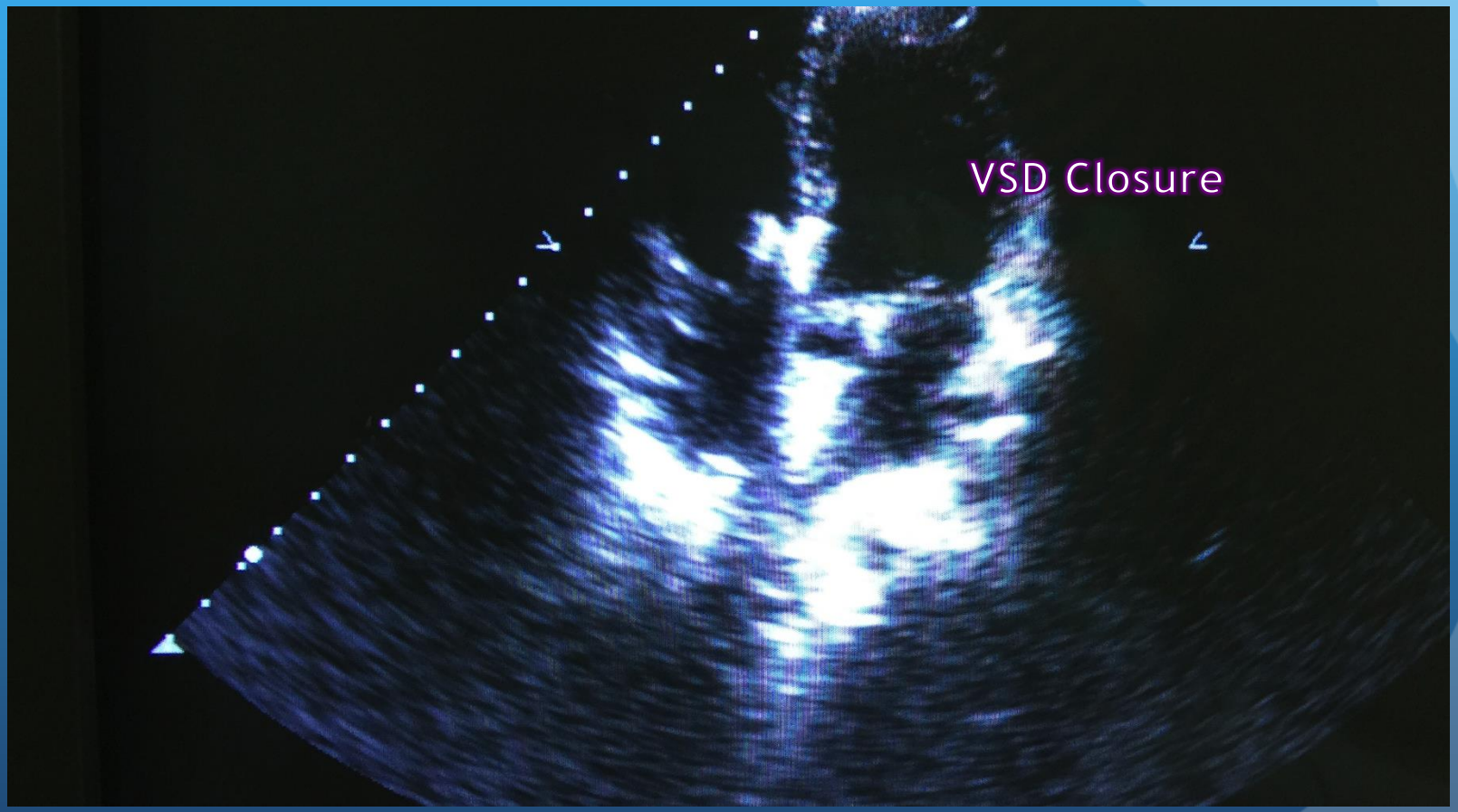
Aortography



The final result



After VSD closure



Results: patient characteristics

patient	male	female	total
n	12 (44.44%)	15 (55.56%)	27 (100%)
Mean age	19.82±14.74	30.4± 15.52	
Youngest	1 year old		
Oldest	59 year old		
< 6 year old			4 (14.81%)

Results: VSD characteristics

VSD characteristics		
Position	**Perimembranous**	**23 (85.19%)**
	Muscular	**4 (14.81%)**
Aneurysm		**9 (33.33%)**
Distance to AV (mm)	**6.11 ± 5.87**	
PAPs (mmHg)	**29.04 ± 3.17**	
Gradient (LV/RV) mmHg	**82.9 ± 9.94**	
EF (%)	**63.69 ± 1.26**	

Results: VSD characteristics (2)

VSD diameter	Echo	catheterization	P
LV side (mm)	6.52 ± 2.29	7.89 ± 3.69	> 0.05
RV side (mm)	4.5 ± 2.12	3.2 ± 0.49	> 0.05

Procedure

	mean	minimum	maximum
Time of procedure (min.)	**56.28 ± 27.5**	**30**	**150**
Time of exposure (min.)	**15.74 ± 7.01**	**6.5**	**31.8**
Contrast (ml)	**123.92 ± 38.52**	**60**	**200**

Devices

Devices	mean	minimum	maximum
Size of Amplatzer (mm)	10.38 ± 2.59	6	16
Size of Deli (F)	7.37 ± 0.68	6	12

27 procedures: 1 ADO II implanted;
1 Muscular VSD implanted
25 ADO I implanted

Complications

	In Cath lab	24h	1 month	3 month	> 6 month
Death	**0**	**0**	**0**	**0**	**0**
Residual shunting	**3**	**2**	**2**	**1**	**0**
Hematuria	**0**	**1**	**1**	**0**	**0**
arrhythmia	**1**	**1**	**0**	**0**	**0**
AR/TR	**0**	**0**	**0**	**0**	**0**
Cardiac dysfunction	**0**	**0**	**1**	**0**	**0**

- **Complete VSD clossure procedures: 100%**
- **Success rate : 96.3%**
- **Follow- up (month): 11.92 ± 8.36 (3-38)**

- **1 male patient with muscular VSD, 10.17 mm in diameter, 1st attempt with ADO1 unsuccessfully; 2nd attempt with muscular VSD 16 successfully but residual shunting and RBBB, ventricular arrhythmias (stable with lidocain)**
- **1 day later: hematuria lasting within 1 month**
- **Residual shunting more → cardiac dysfuntion**
- **The patient was sent to open heart operation**

Authors	year	n	age	Success rate (%)	Adverse events (%)	Description	Follow-up month	C-AVB/PM implantation (%)
NL Hieu	2013	267	0.7-54	94.76	0.79	AVB	15.25	0.36
HA Binh	2015	27	1-59	96.3	3.7	Shunt	11.92	0
Thanopoulos	2003	10	1.5-12	100	0	0	3	0
Hijazi	2002	6	3.5-19	100				0
Bass	2003	27	1.25-32	93	3.7	Acute AR		0
Pedra	2004	10	5-32	100	2.2		3	0
Arora	2003	91	3-33	95	2.2	C-AVB		2.2
Butera	2007	104	0.6-63	96	1.9	C-BAV	38.5	5.7
Zuo	2010	301	1.2-50	97.6	1	C-BAV	36.7	1
Predescu	2008	20	0.5-16	100	0	0	23.1	22

Conclusions

- Transcatheter closure of VSDs is safe and feasible
- Transcatheter closure of PDA devices can be used to VSD closure with encouraging results
- Cardiac surgeons back-up incase of adverse events