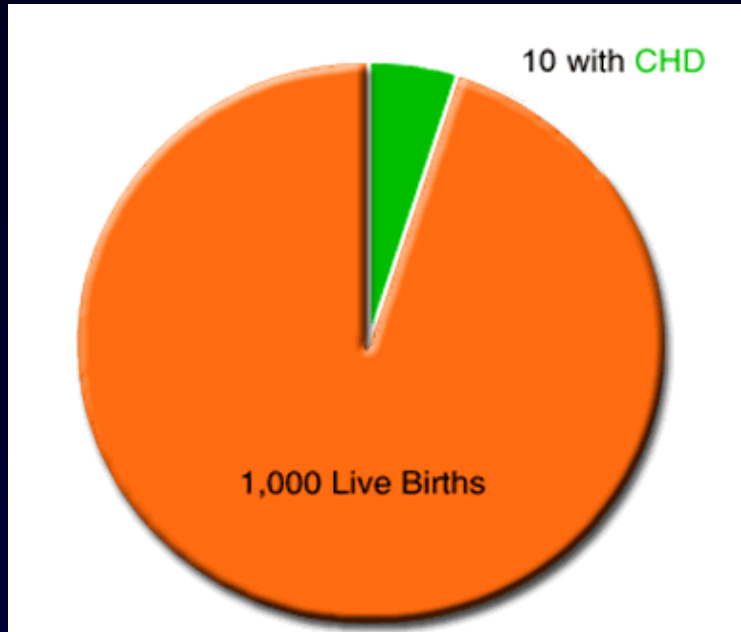


TEE in Adult Congenital Heart Disease: Indication and Guideline

Geu-Ru Hong

Yonsei University College of Medicine,
Severance Cardiovascular Hospital

Adult Congenital Heart Disease



- Most common birth defect
- Most (over 85%) now living to adulthood

Table 1. Survival Rate from Year of Birth (1940–2000) by Complexity of Congenital Heart Disease

Year of birth	Simple	Moderate	Complex
1940–1959	90%	55%	10%
1960–1979	95%	65%	50%
1980–1989	95%	90%	80%

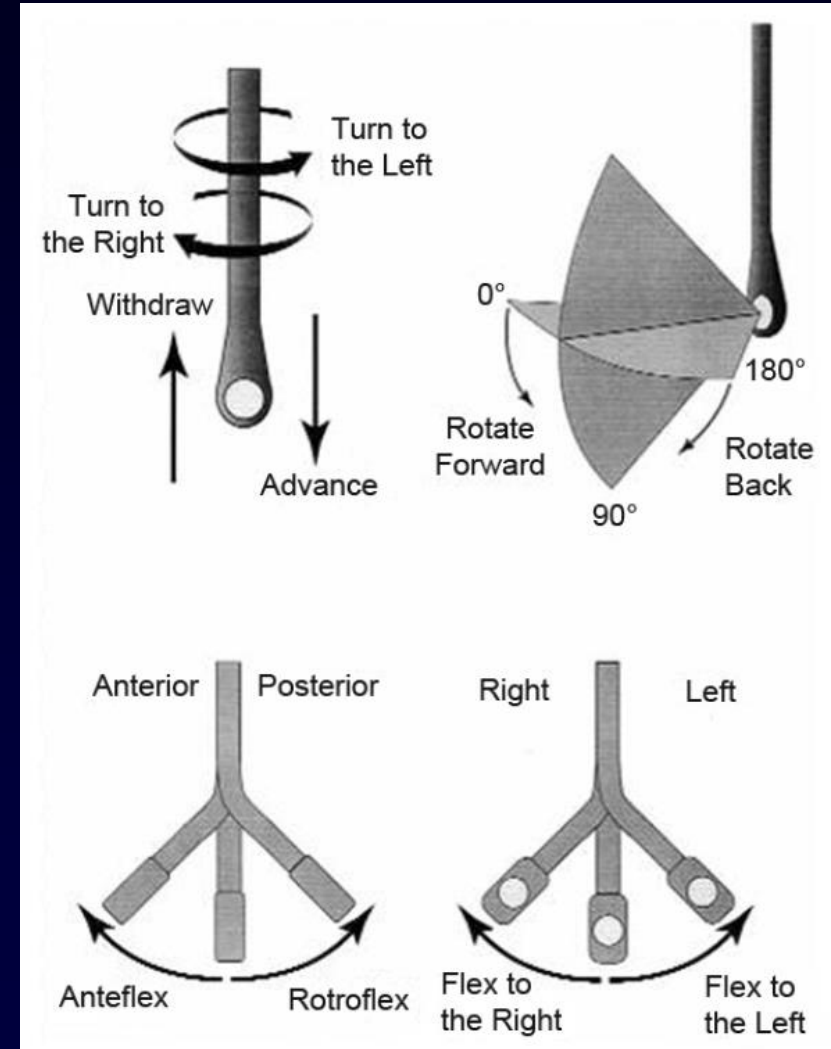
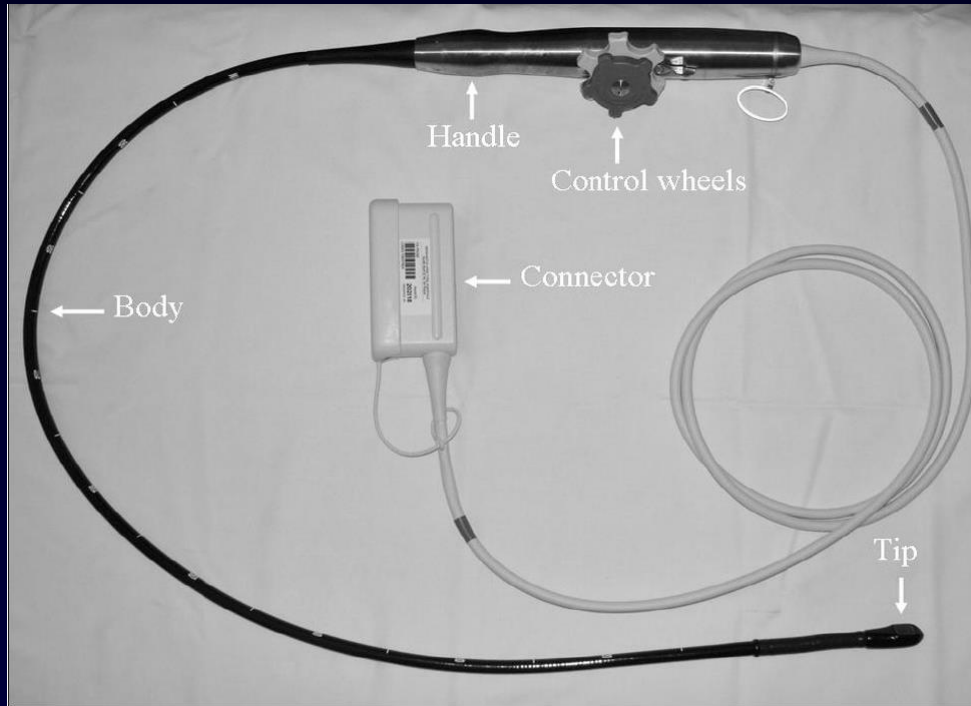
Common CHD in Adults

- Bicuspid aortic valve
- Atrial septal defect
- Ventricular septal defect
- Patent ductus arteriosus
- Coarctation of aorta
- ToF
- Miscellaneous
 - Ebstein's anomaly, corrected TGA,
 - Congenital coronary anomalies

Echocardiography in ACHD

- Preferred method for initial assessment of congenital heart disease
- Comprehensive assessment of LV function, valvular abnormalities
- Limitations
 - Poor image quality
 - Chest wall deformities
 - Extracardiac structures
 - Post-surgical assessment
 - poor assessment of RV size and function

Transesophageal Echocardiography



Transesophageal Echocardiography

- First introduced in Mayo clinic (1987)
- Better image quality
- Relatively easy to perform
- Few complication
- 5-10% of patients with TTE require TEE

Seward JB et al, Mayo Clinic Proceedings, 1988;63:649-680

Transesophageal Echocardiography

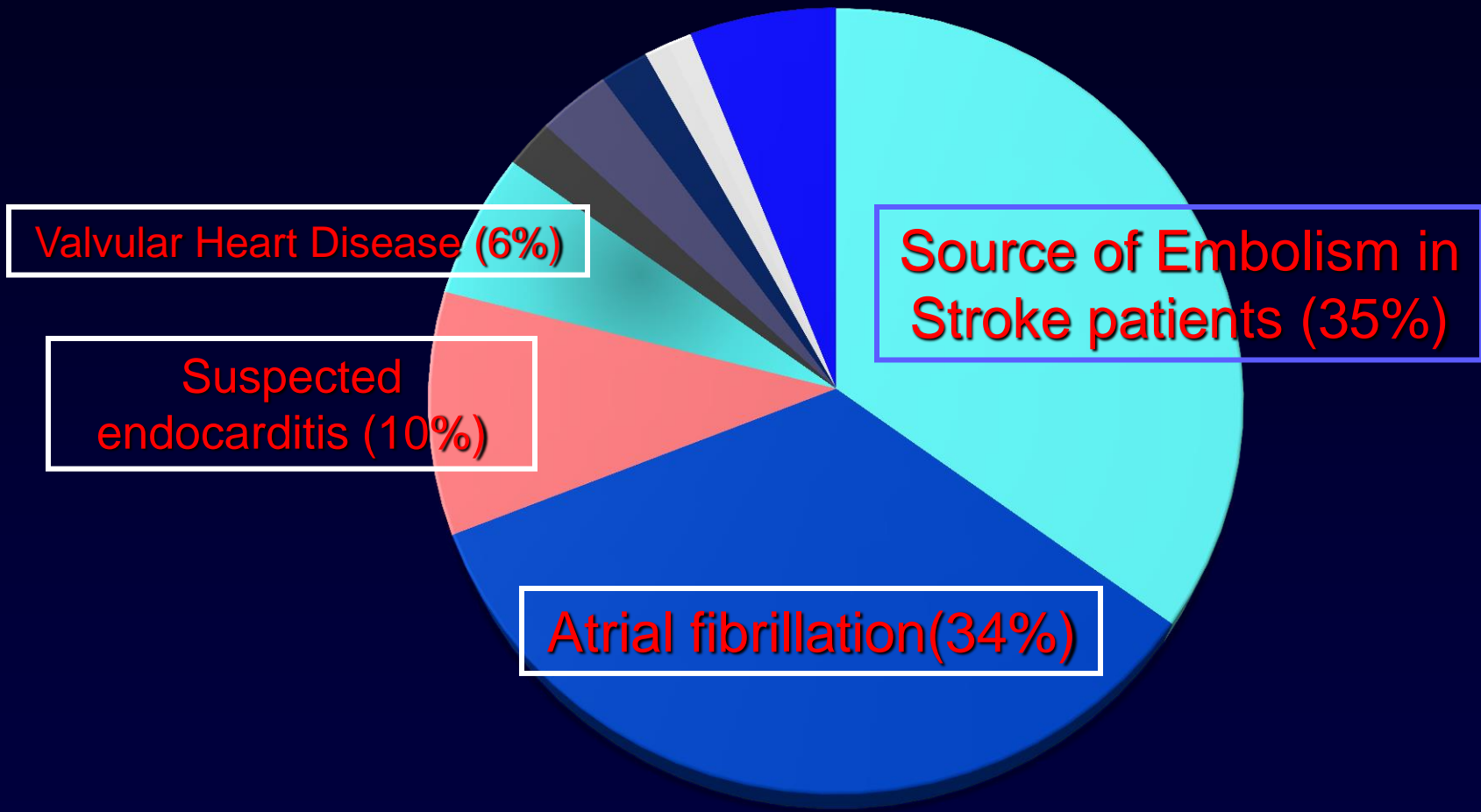
TTE for Adult Congenital Heart Disease		
92.	• Initial evaluation of known or suspected adult congenital heart disease	A (9)
93.	• Known adult congenital heart disease with a change in clinical status or cardiac exam	A (9)
94.	• Re-evaluation to guide therapy in known adult congenital heart disease	A (9)
98.	• Routine surveillance (≥ 1 y) of adult congenital heart disease following incomplete or palliative repair <ul style="list-style-type: none"> ◦ with residual structural or hemodynamic abnormality ◦ without a change in clinical status or cardiac exam 	A (8)
TEE as Initial or Supplemental Test—General Uses		
99.	• Use of TEE when there is a high likelihood of a nondiagnostic TTE due to patient characteristics or inadequate visualization of relevant structures	A (8)
101.	• Re-evaluation of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated	A (8)
103.	• Guidance during percutaneous noncoronary cardiac interventions including but not limited to closure device placement, radiofrequency ablation, and percutaneous valve procedures	A (9)
104.	• Suspected acute aortic pathology including but not limited to dissection/transsection	A (9)
TEE as Initial or Supplemental Test—Valvular Disease		
106.	• Evaluation of valvular structure and function to assess suitability for, and assist in planning of, an intervention	A (9)
108.	• To diagnose infective endocarditis with a moderate or high pretest probability (e.g., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device)	A (9)
TEE as Initial or Supplemental Test—Embolic Event		
109.	• Evaluation for cardiovascular source of embolus with no identified noncardiac source	A (7)
TEE as Initial Test—Atrial Fibrillation/Flutter		
112.	• Evaluation to facilitate clinical decision making with regards to anticoagulation, cardioversion, and/or radiofrequency ablation	A (9)

Indications

- TTE is inconclusive
- Potential new information obtained by TEE is important
- Cardiovascular structures not seen well on TTE:
LAA, Pulmonary veins, atrial septum, thoracic aorta
- Best available image quality is of crucial importance: infective endocarditis, assessment of prosthetic valves

Flachskampf FA et al., Eur J Echocardiogr 2010;11,557-576

Indications for TEE



Oh JK et al. *The Echo Manual*. 3rd edition

Indications

- Cardiac source of embolism evaluation
- Infective endocarditis
- Aortic dissection, aortic aneurysm
- Atrial fibrillation

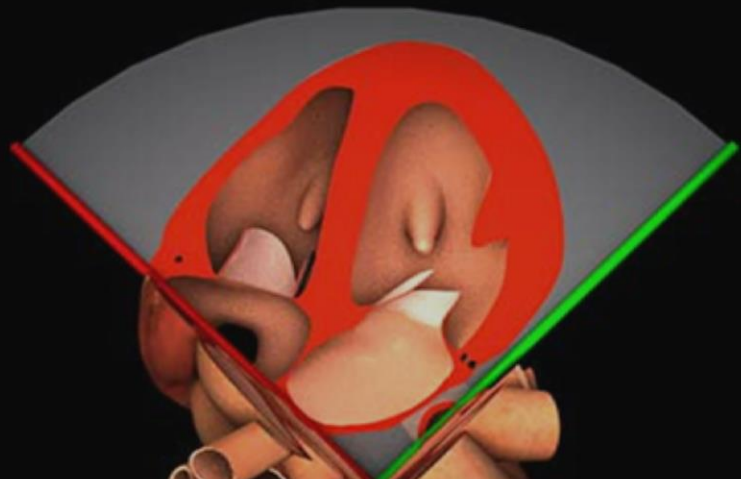
Increasing number of patients with A fib, TEE guided cardioversion, ablation procedure

- Valvular disease, Prosthetic valve evaluation
- Cardiac mass

Flachskampf FA et al., Eur J Echocardiogr 2010;11,557-576

Routine TEE Views

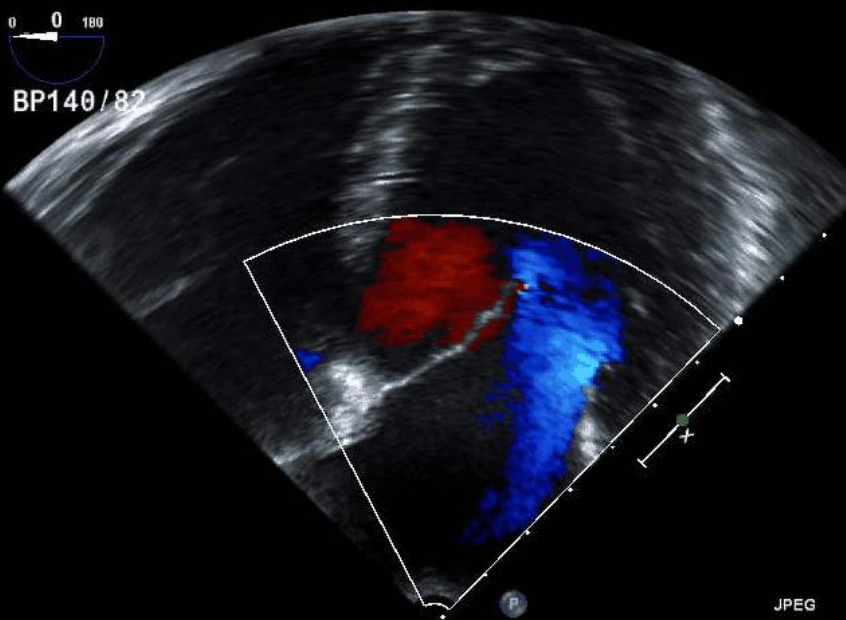
1. Transesophageal (TE) Views



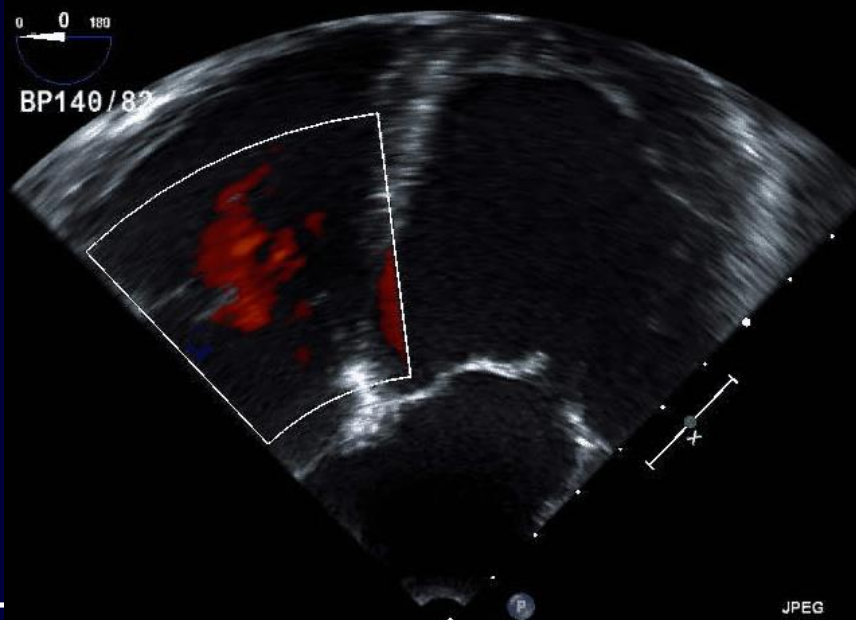
- 2D : LV, LA, RV, RA size
- Wall motion
- Color Doppler : TV, MV



T: 37.0C
T< 37.0C

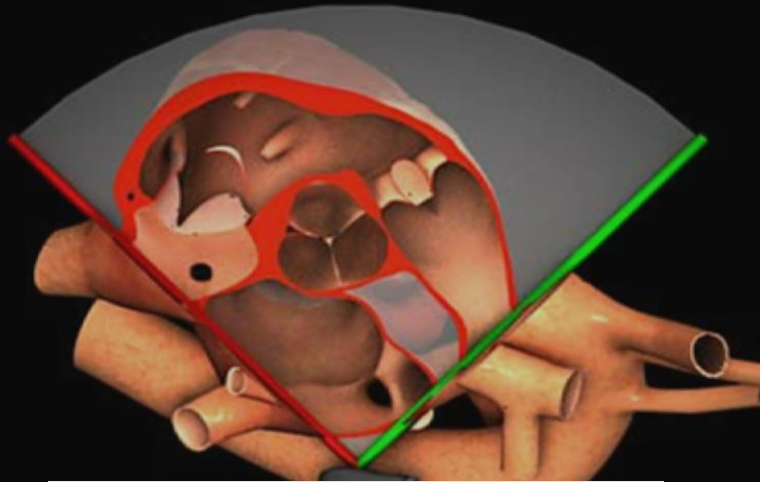


T: 37.0C
T: 37.3C



T: 37.0C
T: 37.5C

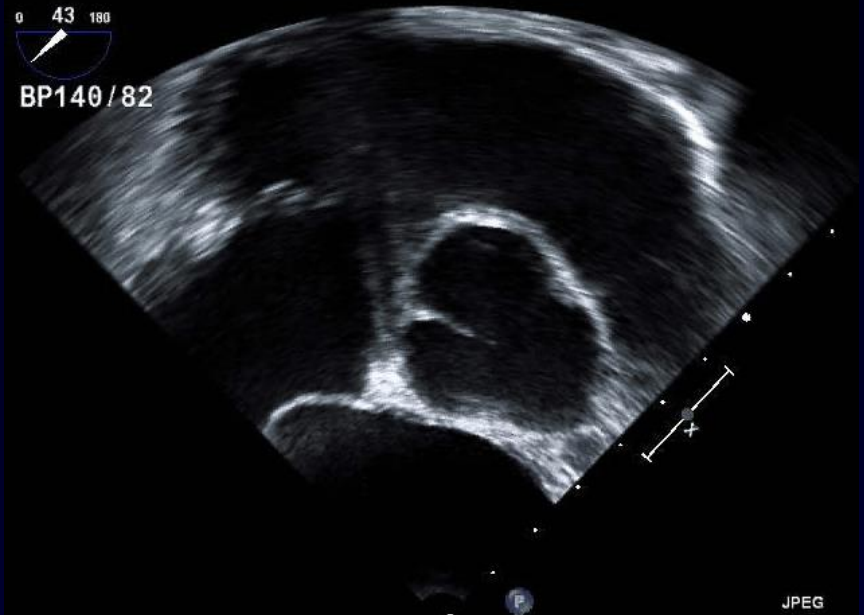




- Morphologic evaluation of AV (Vegetation, 2D planimetry...)
- LA and LAA for thrombi swirling

0 43 180

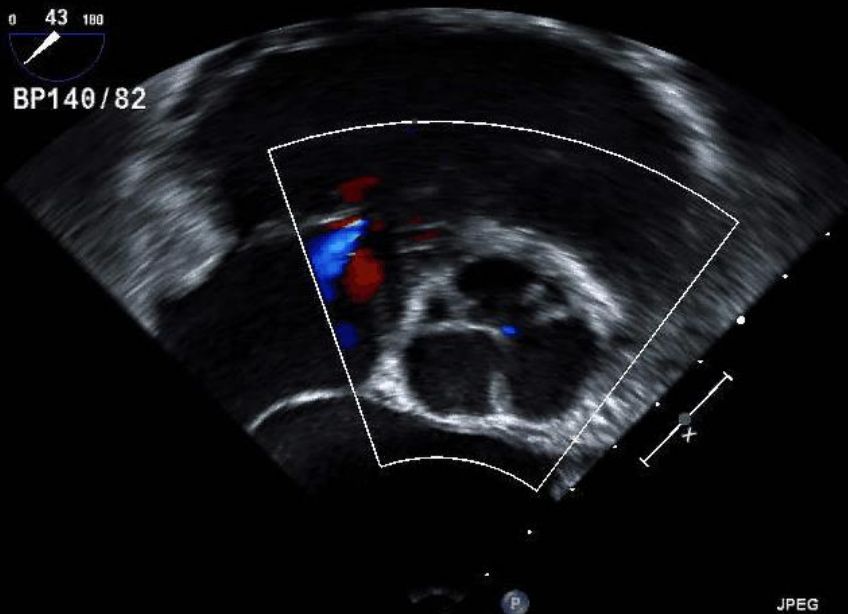
BP140/82



T: 37.0C
T: 37.7C

0 43 180

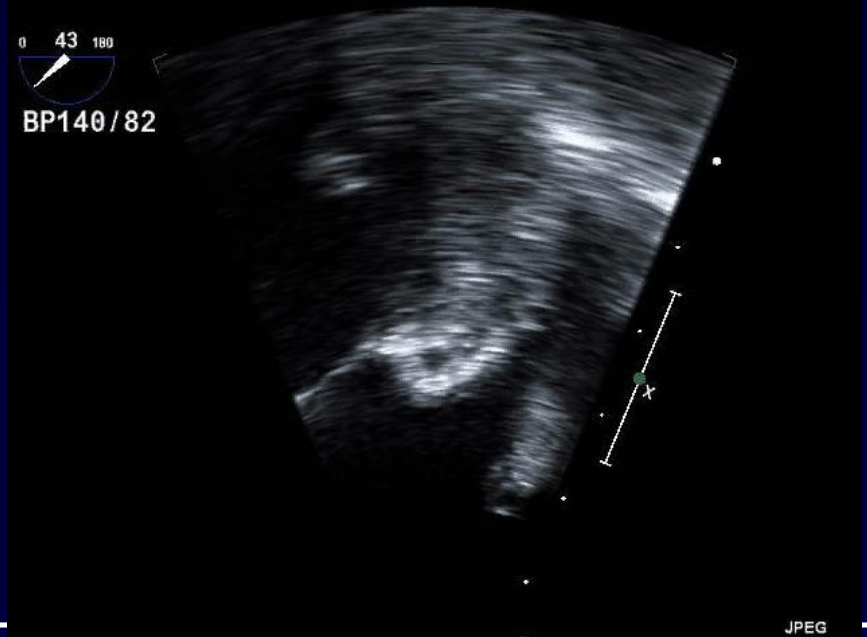
BP140/82



T: 37.0C
T: 38.1C

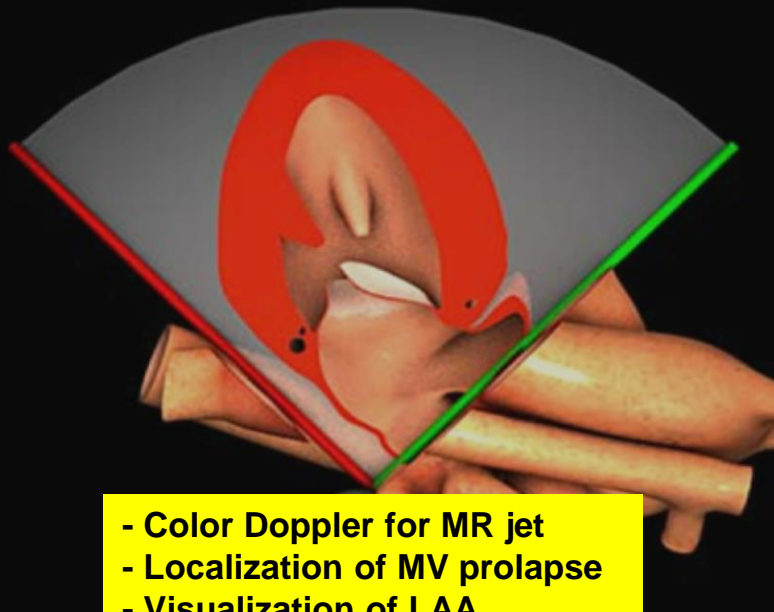
0 43 180

BP140/82



T: 37.0C
T: 38.7C





- Color Doppler for MR jet
- Localization of MV prolapse
- Visualization of LAA

0 60 180
BP127/79

T: 37.0C
T: 39.5C

JPEG

0 93 180
BP140/82

T: 37.0C
T: 39.5C

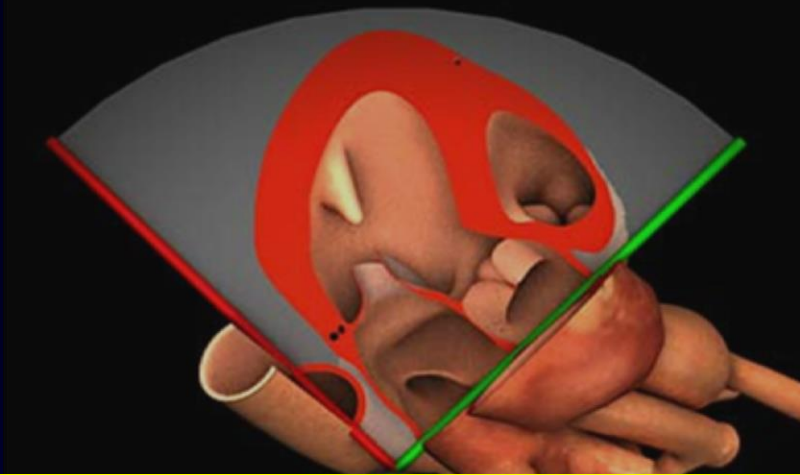
JPEG

0 93 180
BP140/82

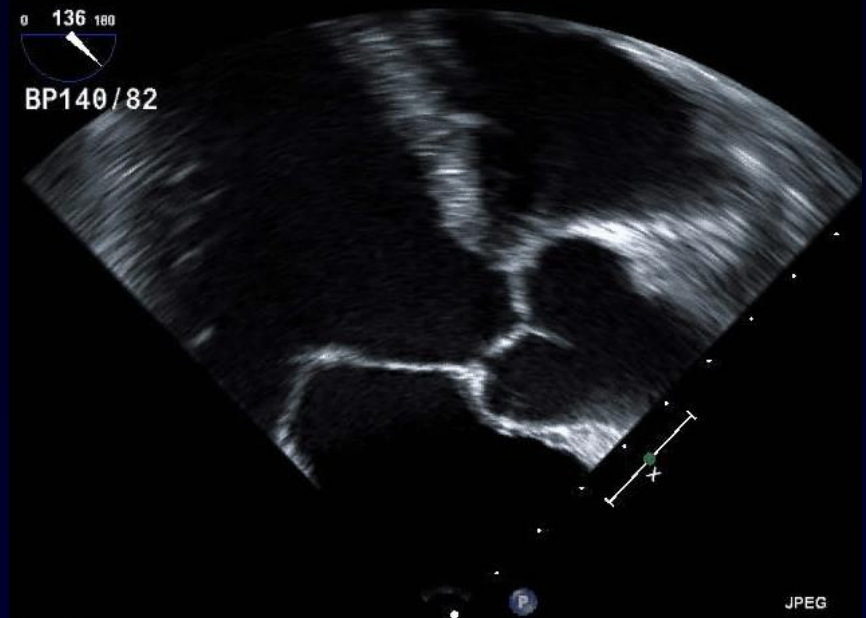
T: 37.0C
T: 38.9C

JPEG

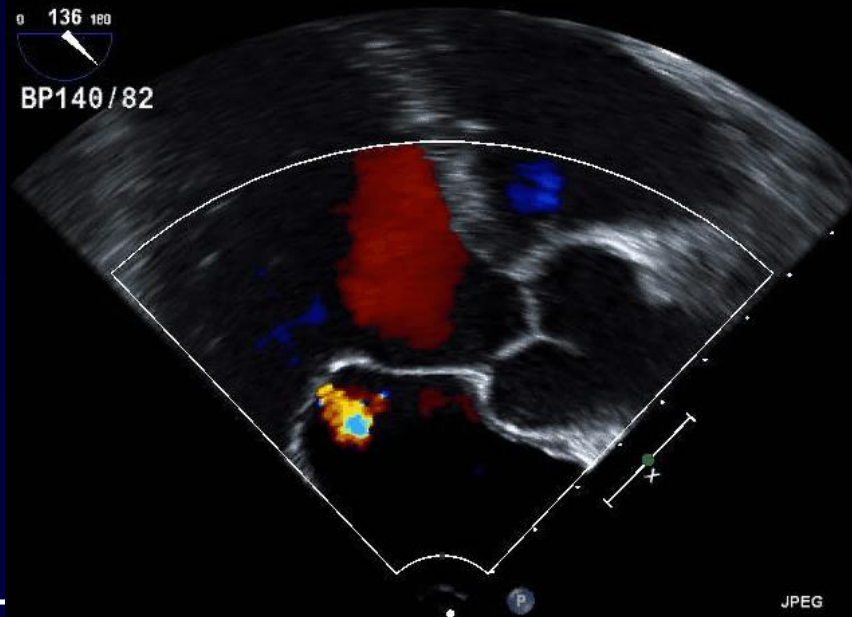




- Analogous to the parasternal long-axis view
- 2D and Color Doppler evaluation of MV and AV



T: 37.0C
T: 38.7C

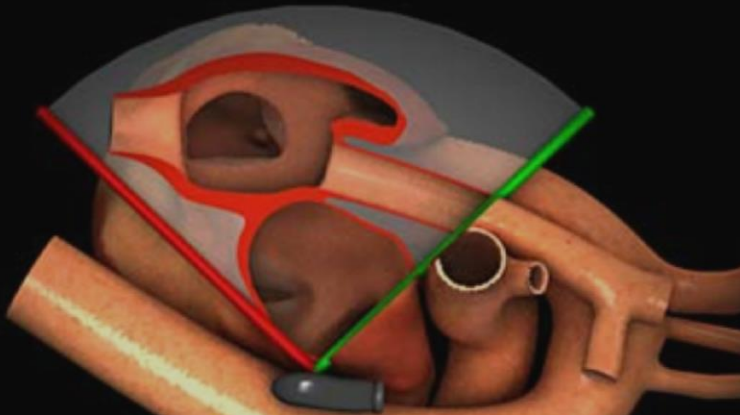


T: 37.0C
T: 38.9C



T: 37.0C
T: 39.5C





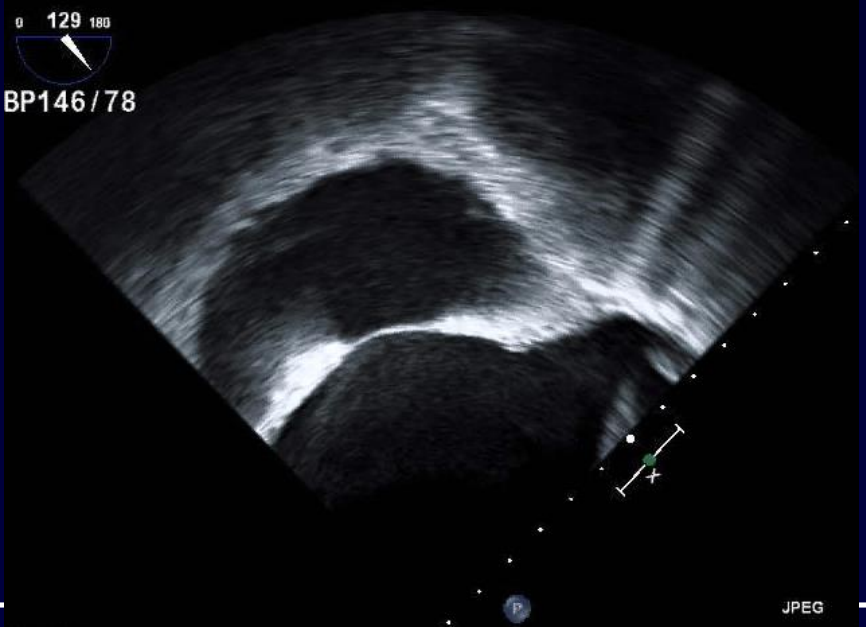
- Best view to evaluate the PFO, ASD, SEC
- Evaluate PFO with agitated saline test

0 90 180
BP140/82



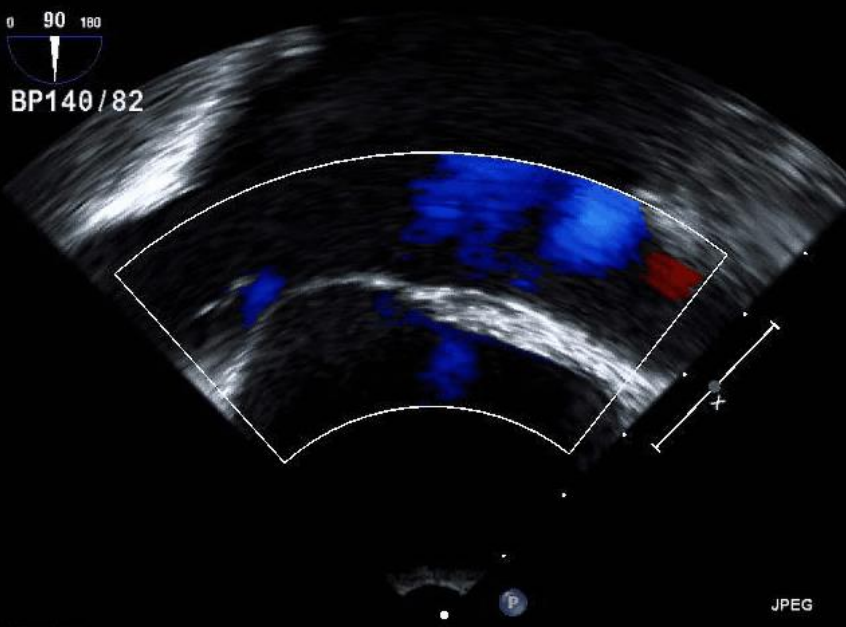
T: 37.0C
T: 38.7C

0 129 180
BP146/78



T: 37.0C
T: 39.3C

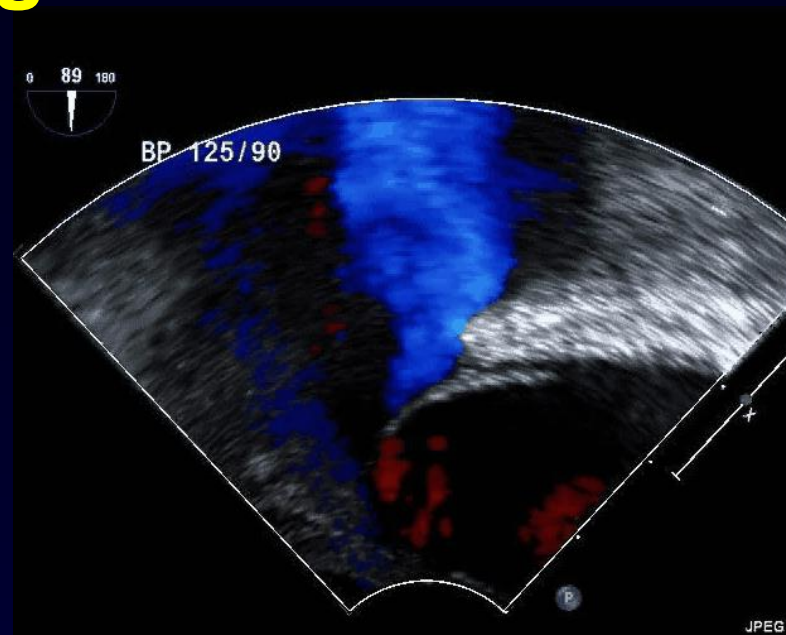
0 90 180
BP140/82



T: 37.0C
T: 38.7C

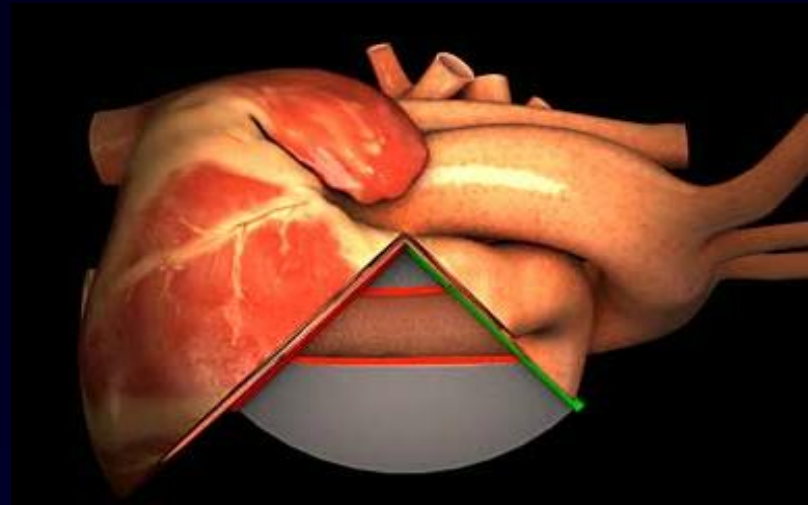
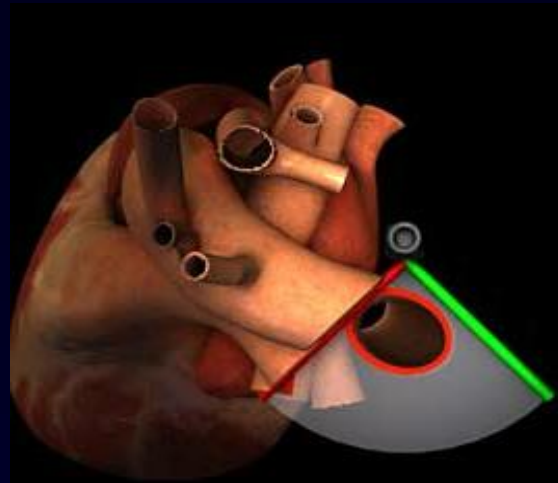


Shunt evaluation: Agitated saline test



Routine TEE Views

2. Examination of the aorta



- Presence and characteristic of aortic plaque
 - Size, thickness of plaque

FR 36Hz
 5.0cm

xPlane
 52%
 52%
 50dB
 P Off
 Gen

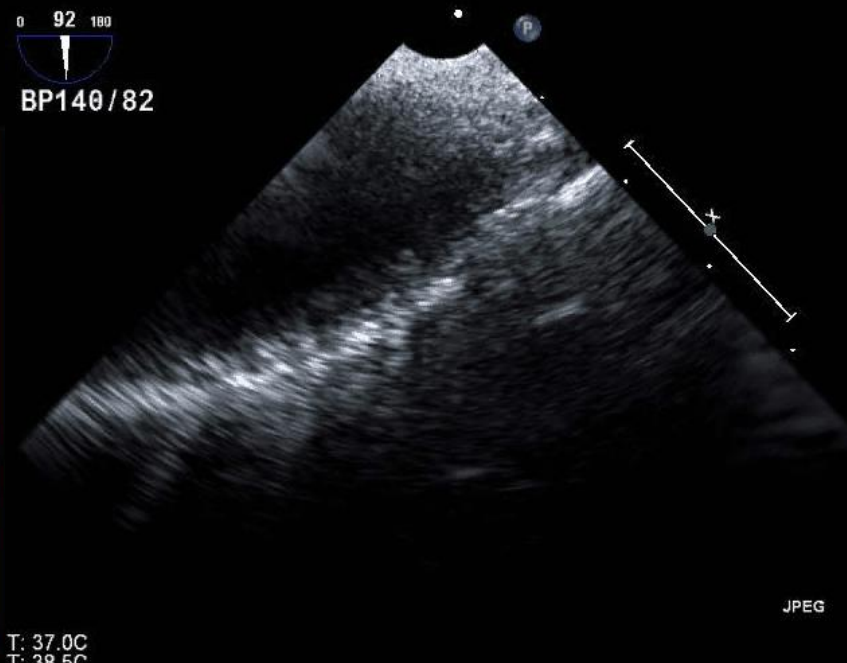


M4



BP140/82

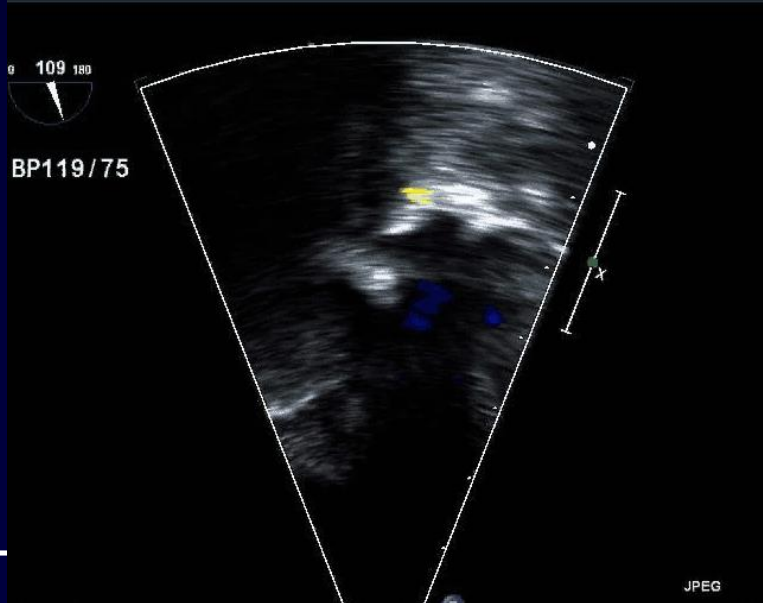
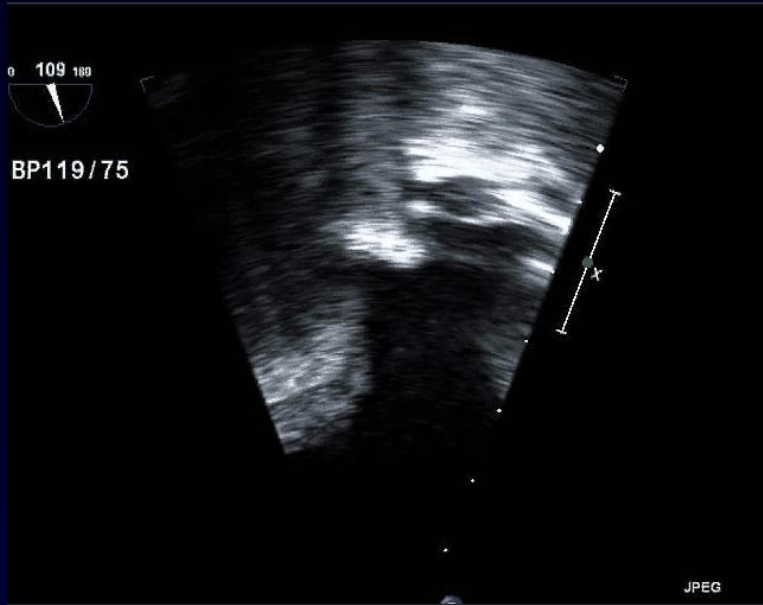
BP140/82



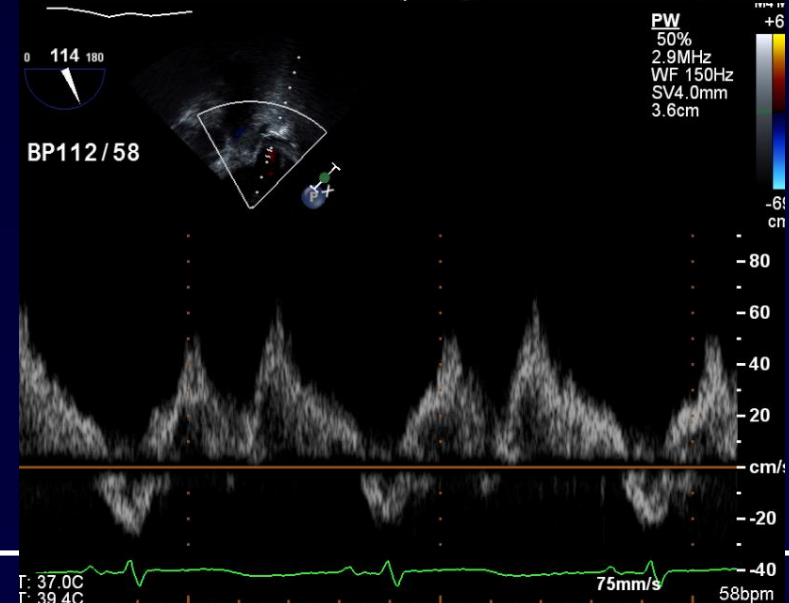
Alternative Views

Pulmonary veins

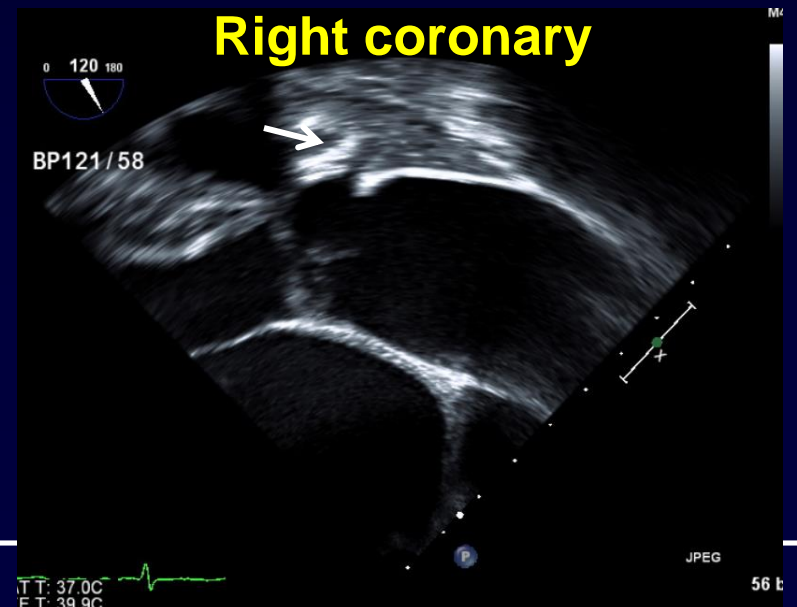
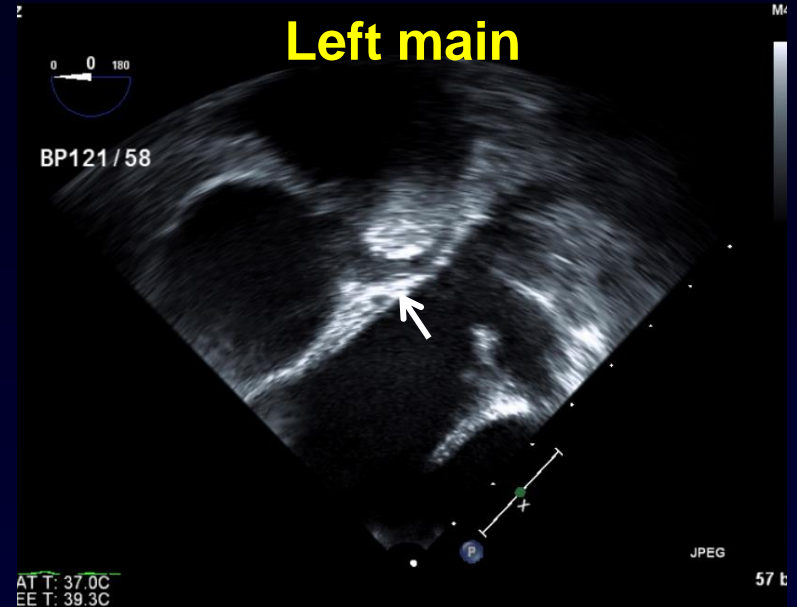
Lt. pulmonary veins



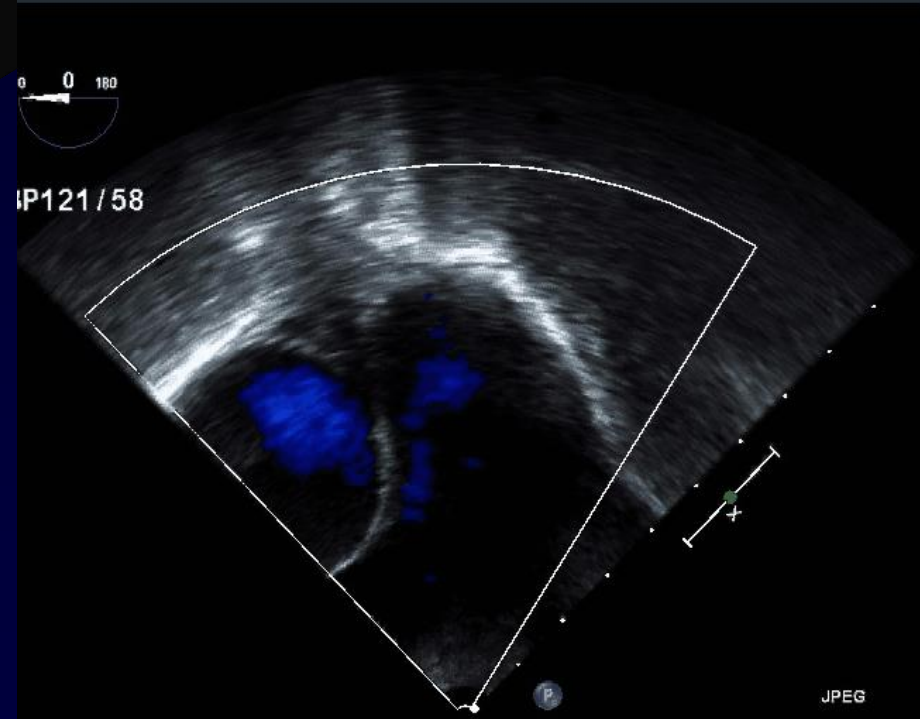
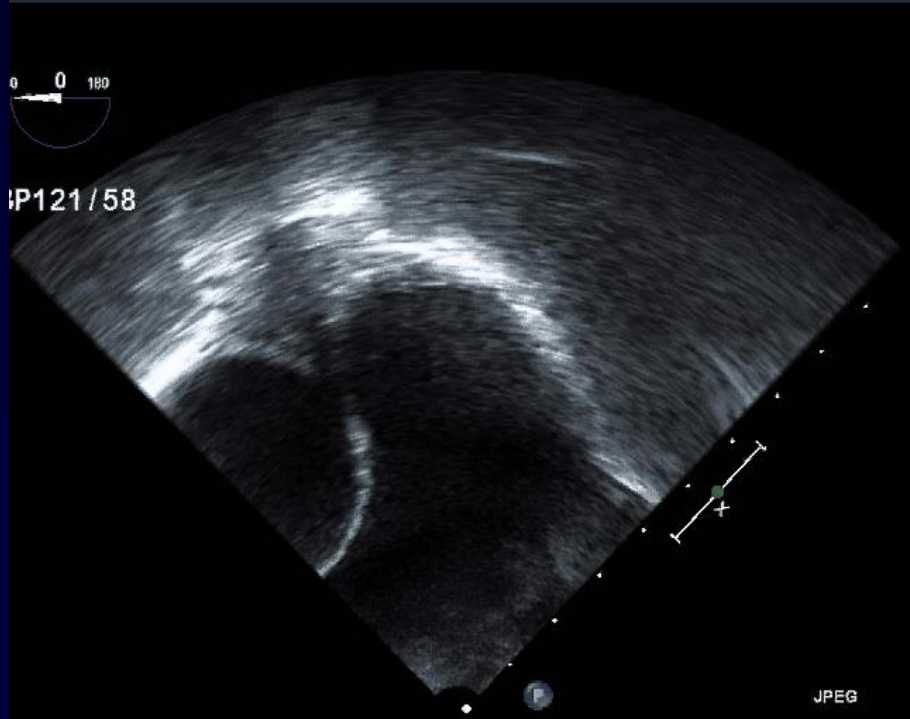
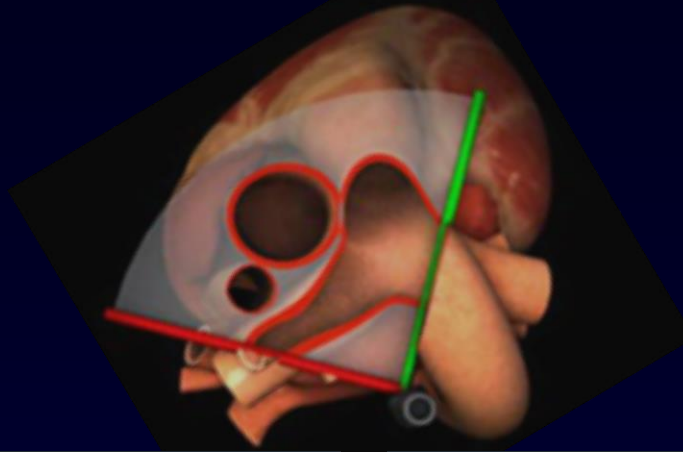
Rt. pulmonary veins



Coronary arteries



Pulmonary artery bifurcation



0 85 180

BP112/51



T: 37.0C
T: 39.6C

JPEG

0 135 180

BP112/51



T: 37.0C
T: 39.6C

JPEG

0 0 180

BP112/51



T: 37.0C
T: 39.5C

JPEG

0 50 180

BP112/51



PAT T: 37.0C
TEE T: 39.4C



JPEG

79 bpm

TEE in ACHD

- Good for evaluation of venous return, atria, AV valves, and the left ventricular outflow tract
- Mid-esophageal (ME) four-chamber and bicaval views good for atrial septum by 2D
- ME 4-chamber and transgastric mid-short axis to assess for VSDs
- Essential in intra-operative repair
- Imaging assistance during device intervention

TEE in ACHD

- Preferred method in the following cases:
 - ASD, PFO
 - Bicuspid AV
 - Mitral valve regurgitation
 - Ebstein's anomaly
 - Fontan – assessing for right atrial thrombus, obstruction
- Device intervention
 - ASD, VSD, PFO closure

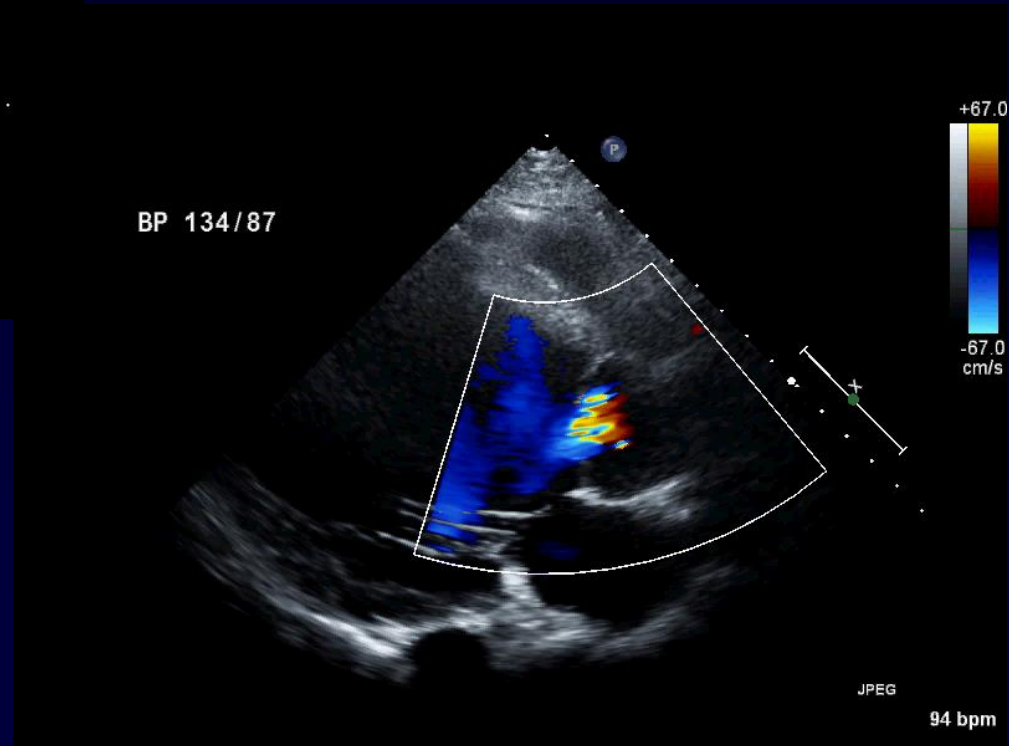
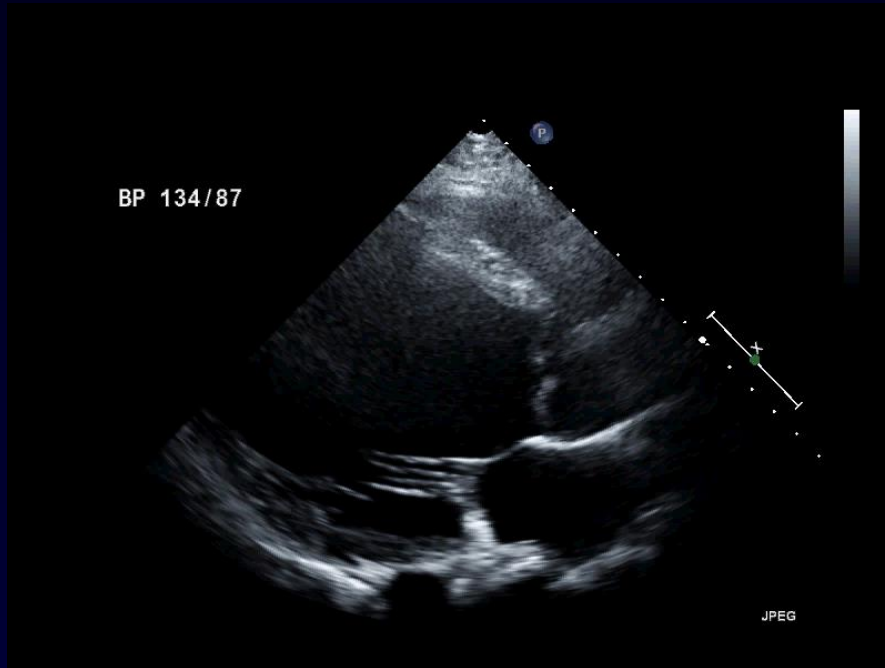
TEE in ACHD

- Confirm definitive congenital anomaly
- Find other associated congenital anomaly
- Decision of treatment strategy
- Assistance of intervention or operation

TEE in ACHD

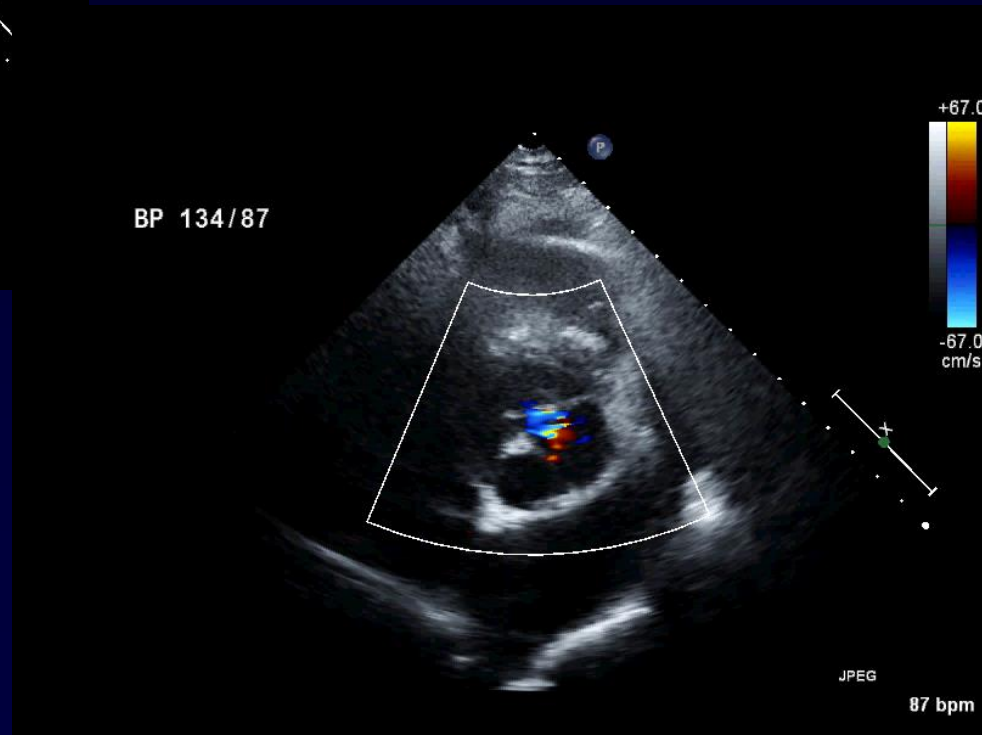
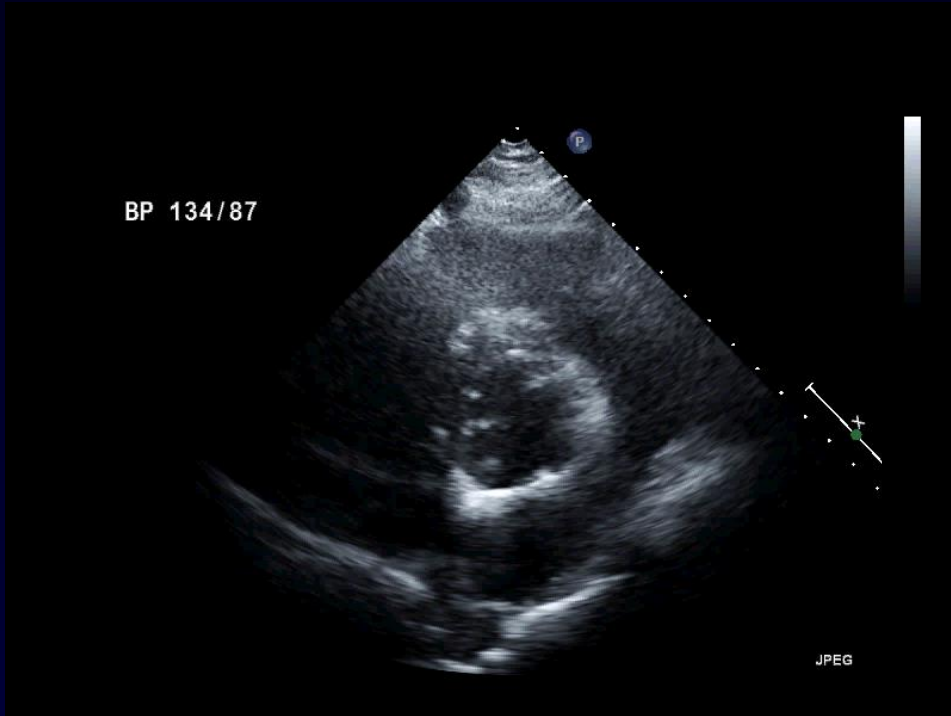
- **Confirm definitive congenital anomaly**
- Find other associated congenital anomaly
- Decision of treatment strategy
- Assistance of intervention or operation

27 year-old man with DOE

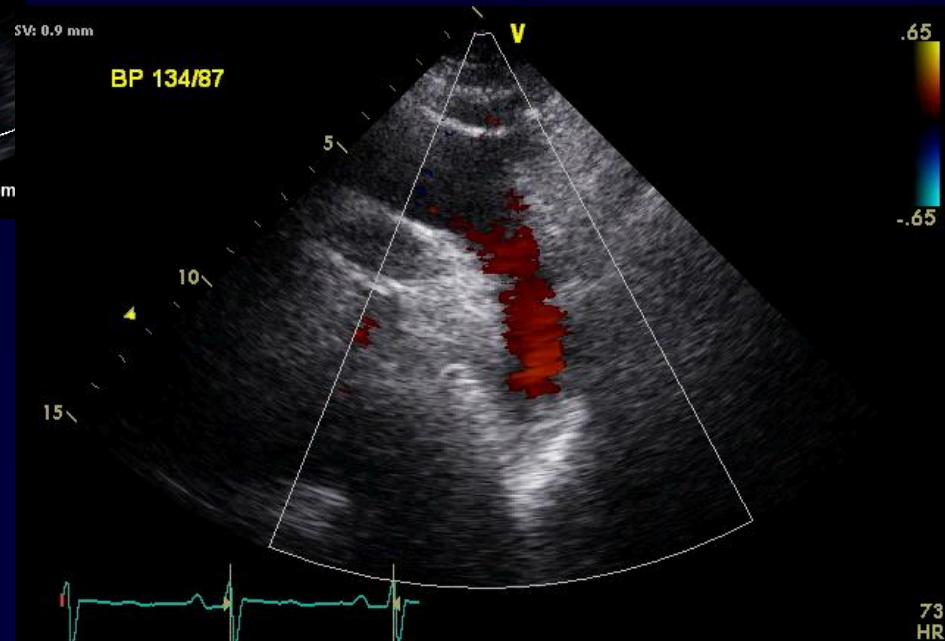
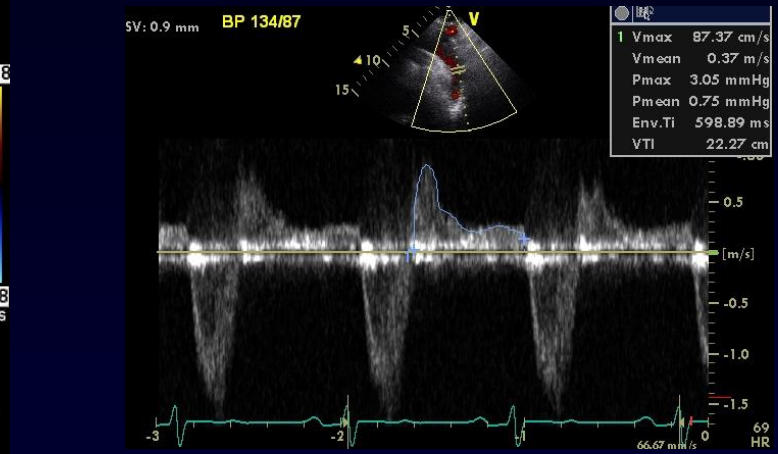
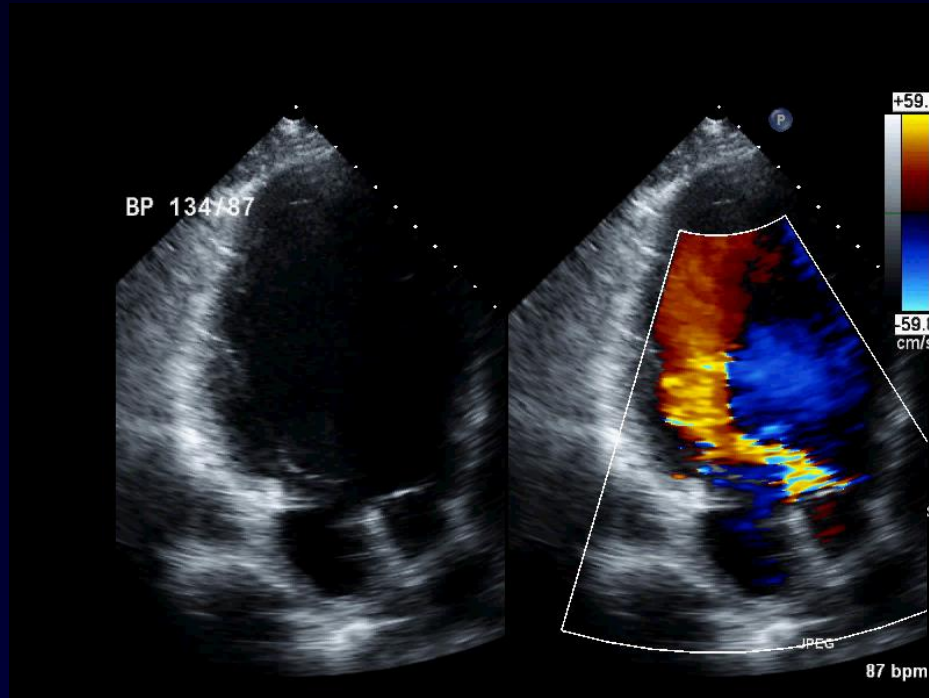


LVEDD = 96mm
LVEF = 32% by biplane

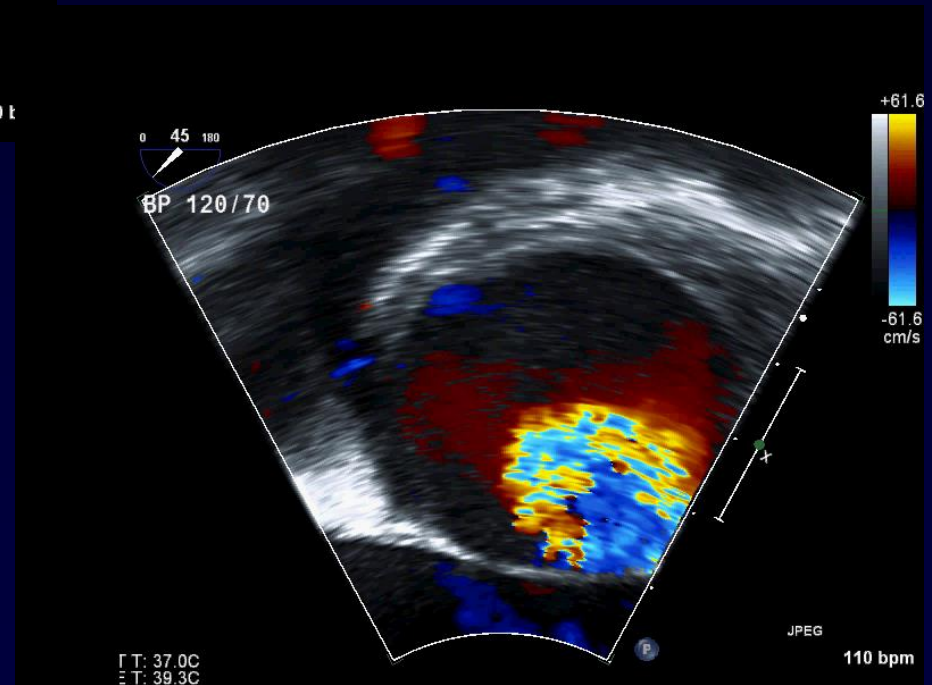
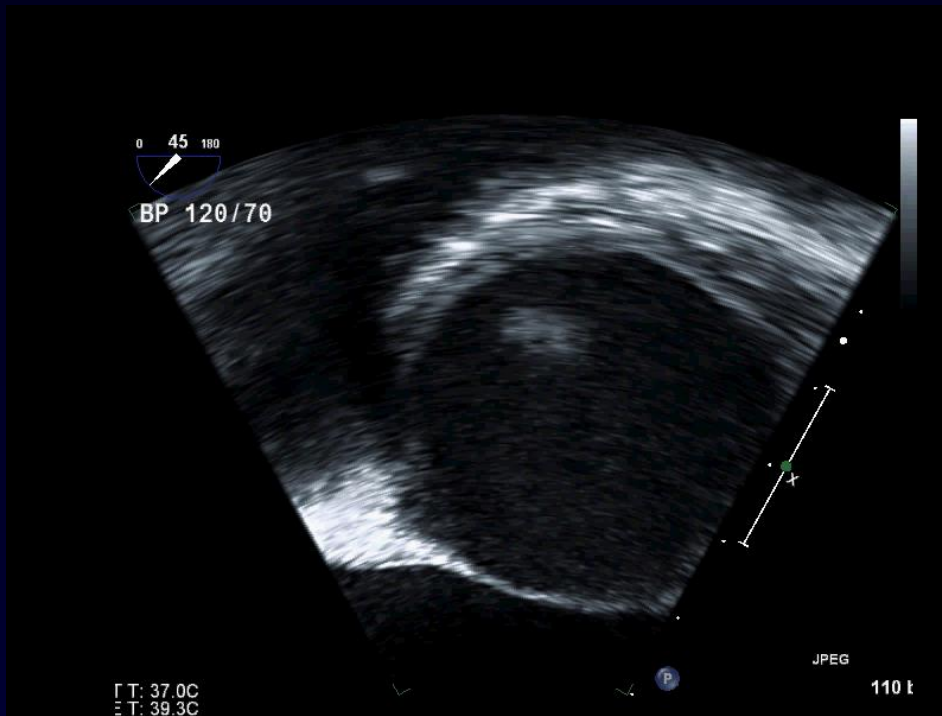
27 year-old man with DOE



27 year-old man with DOE

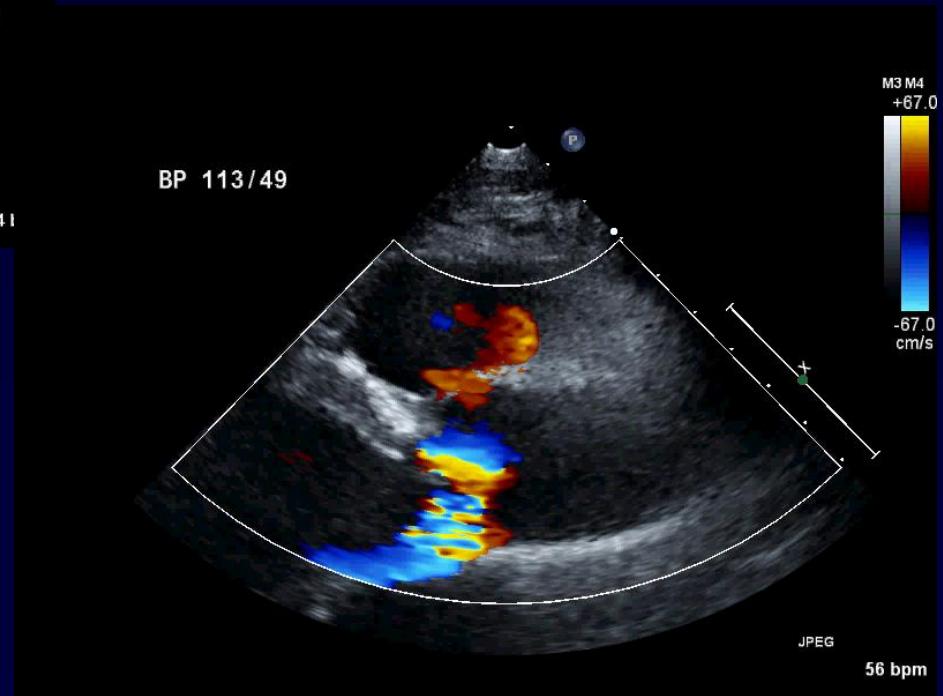
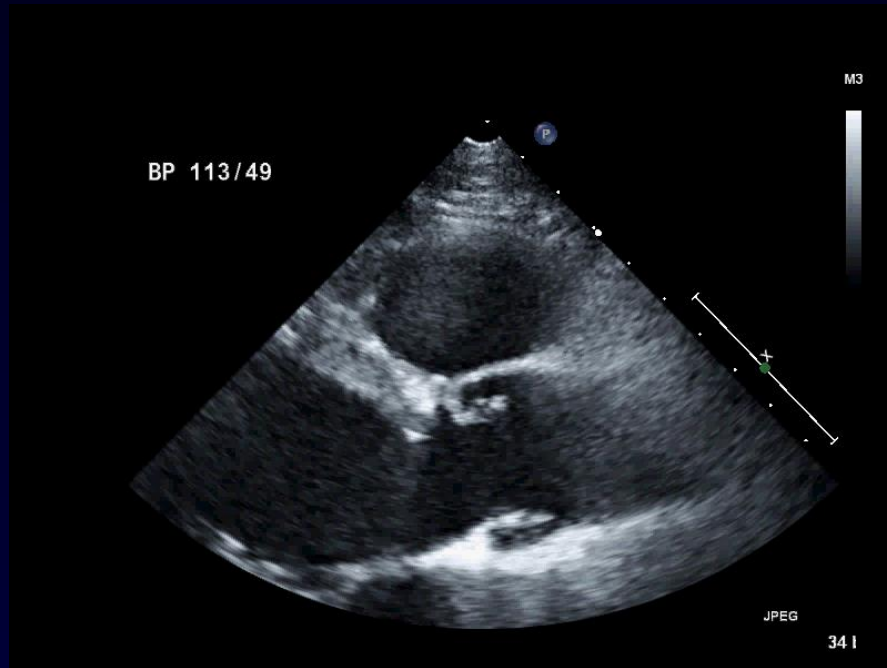


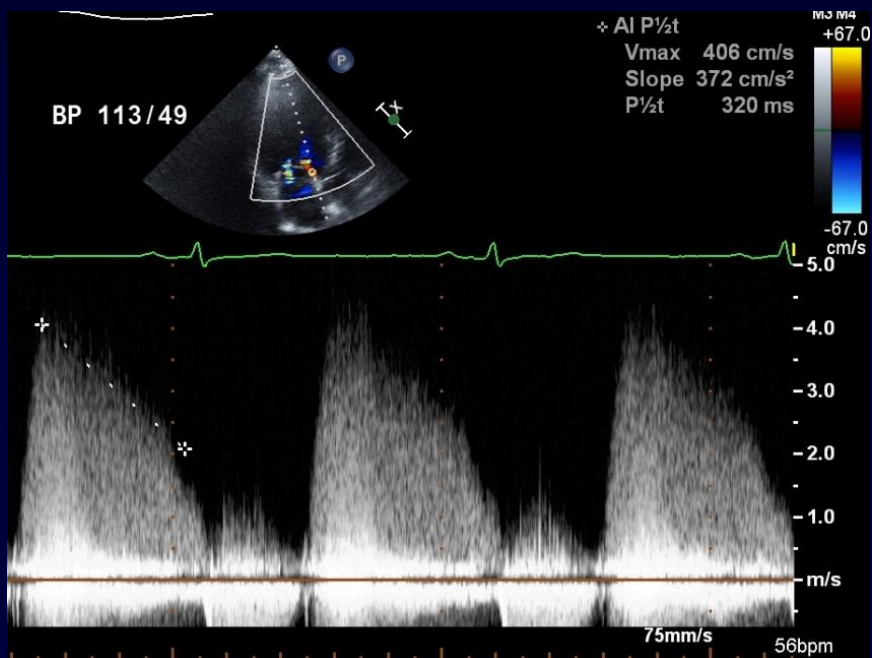
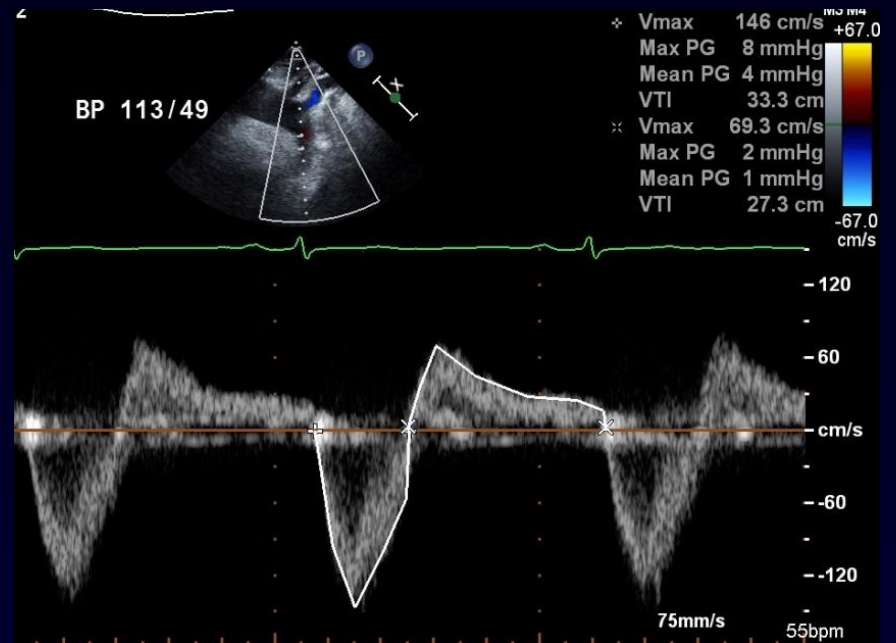
TEE



Congenital
quadracuspid AV
with sever AR

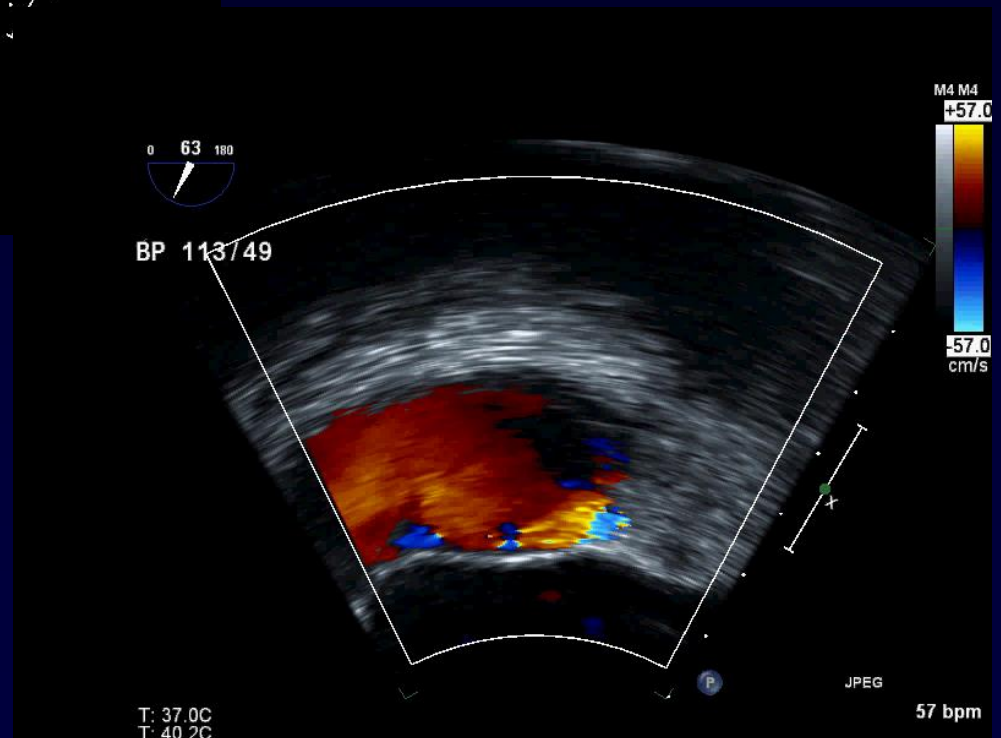
55 year-old man with dyspnea

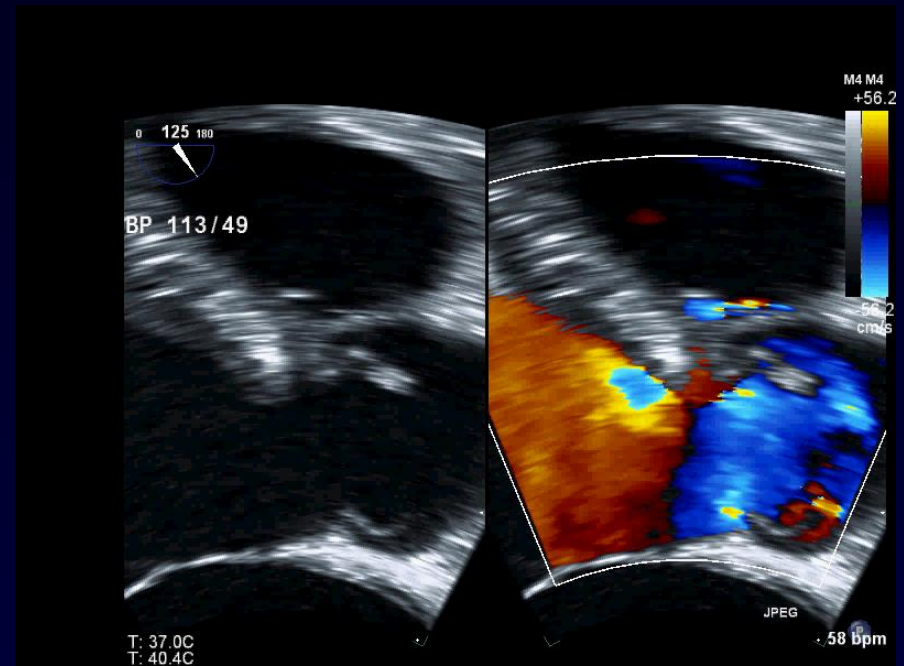
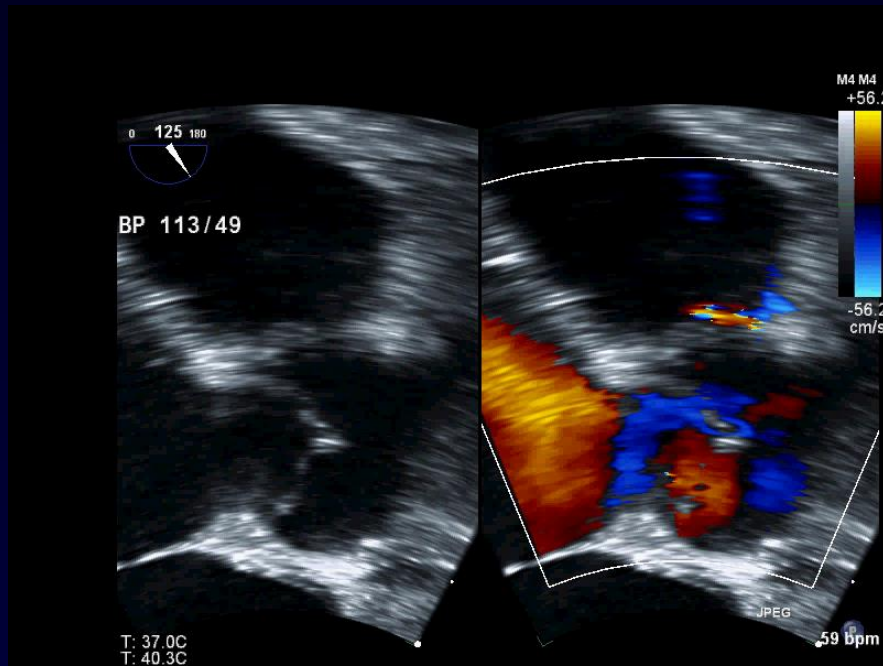




LVEDD = 76mm
LVEF = 61%

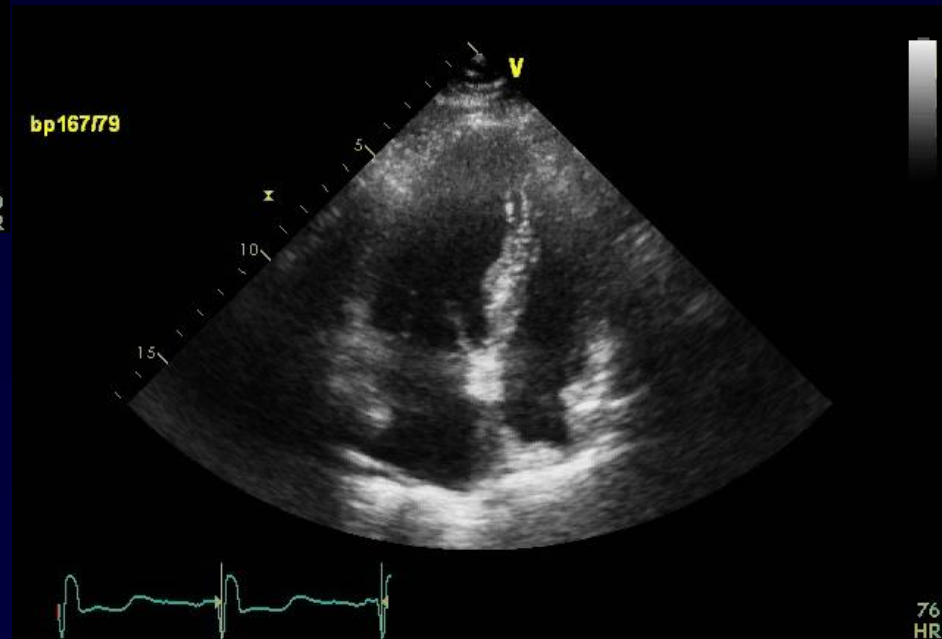
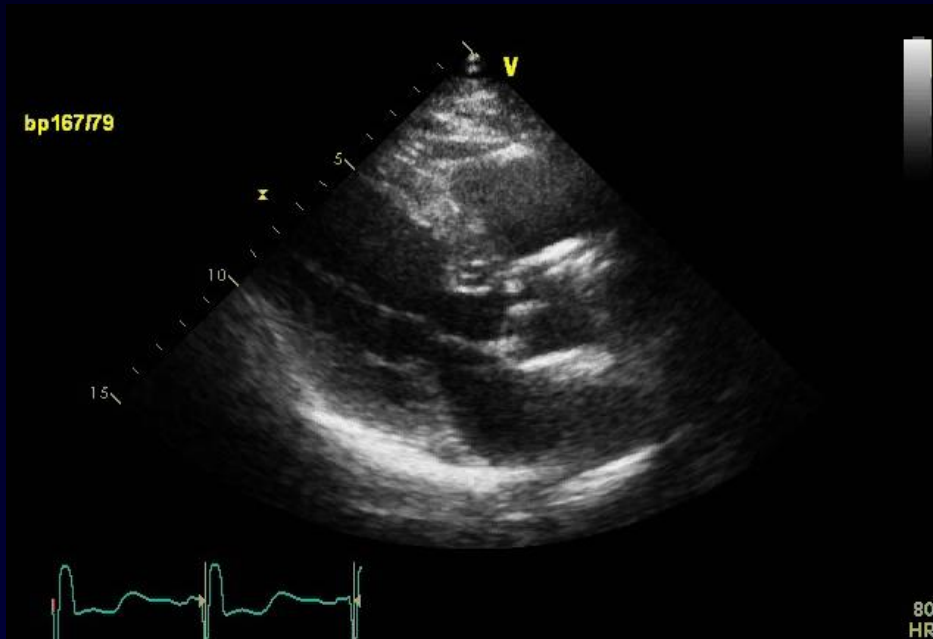
TEE





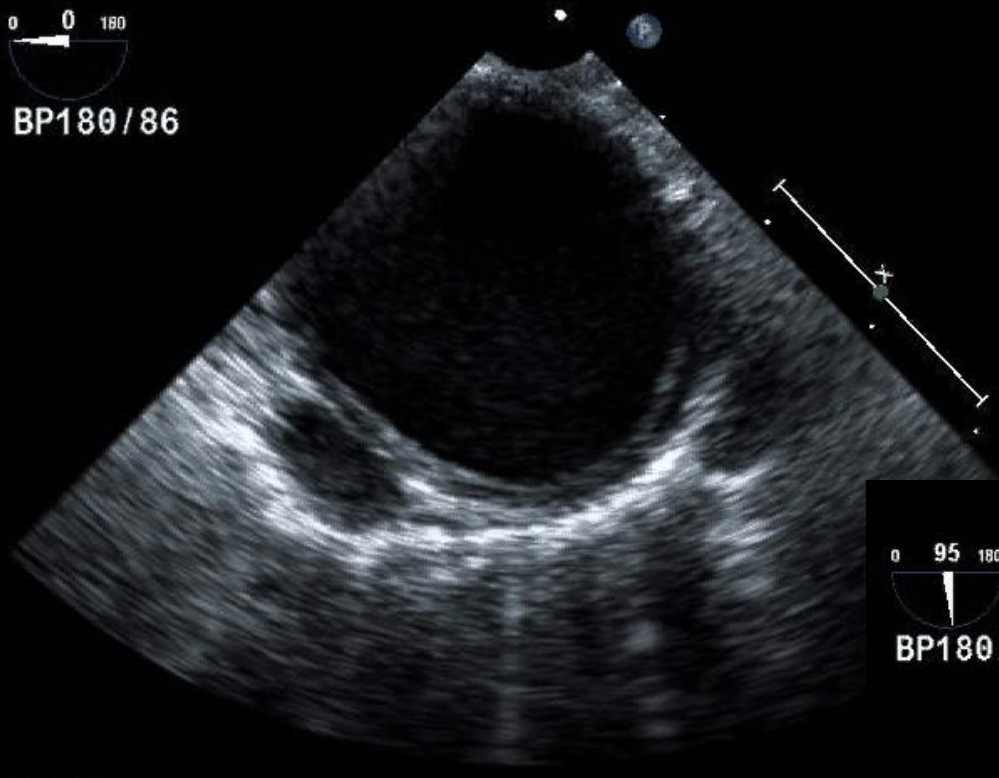
Subarterial VSD with Severe AR due to prolapse of RCC

65 year-old woman with stroke



0 0 180

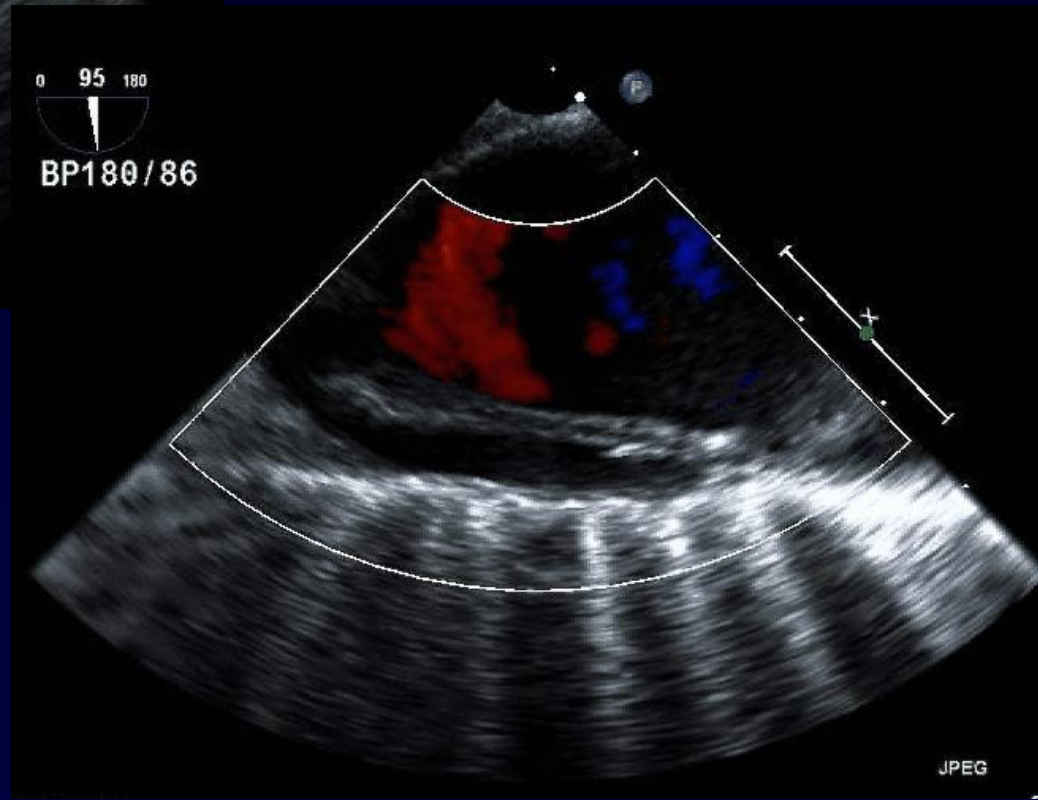
BP180/86



TEE

0 95 180

BP180/86



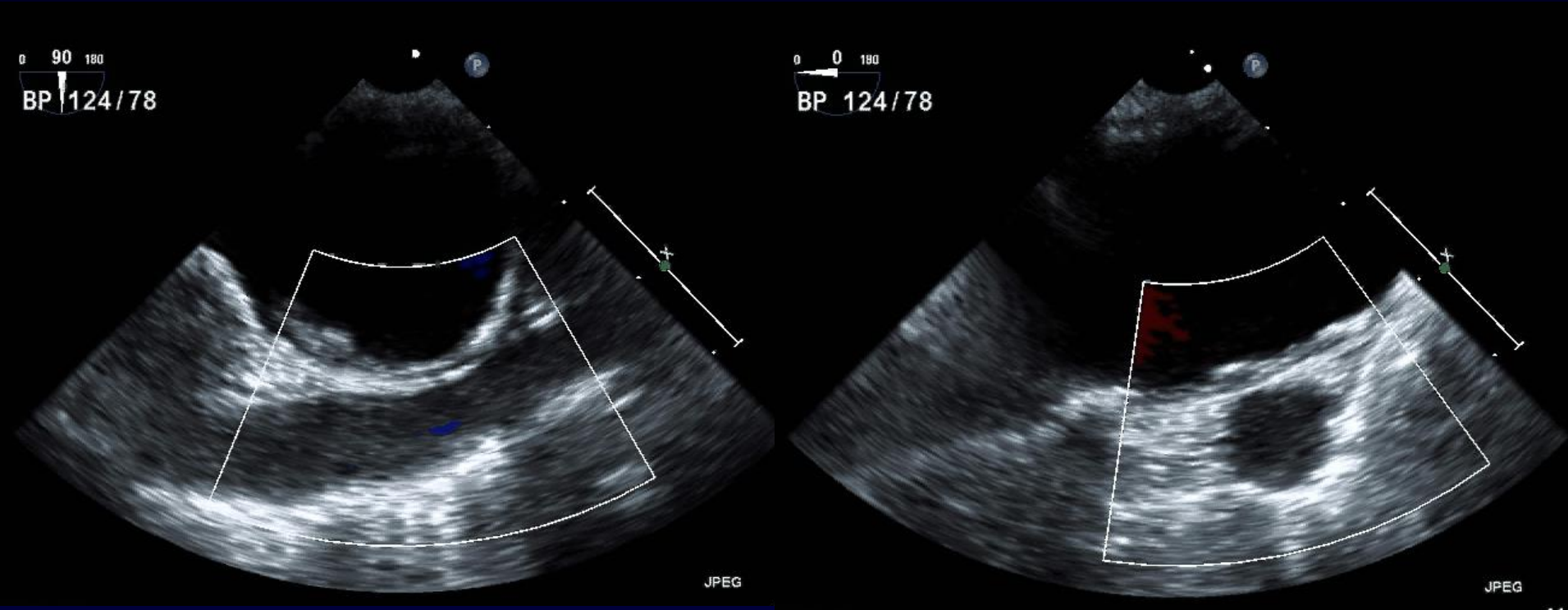
JPEG

Angiography



Kommerell's diverticulum

TEE

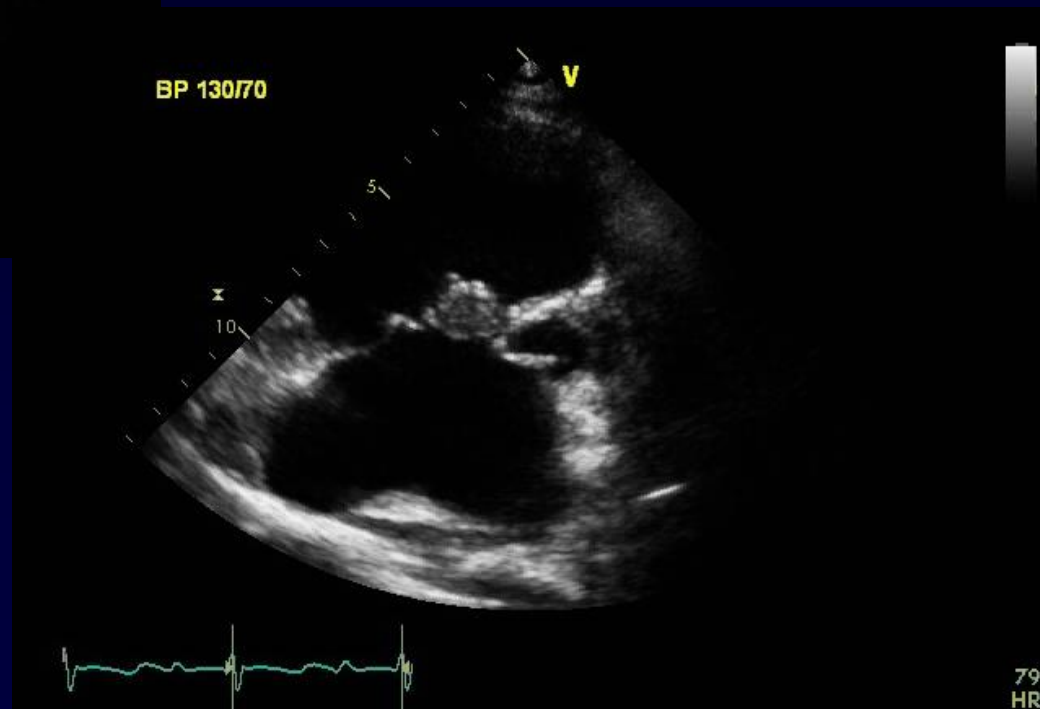
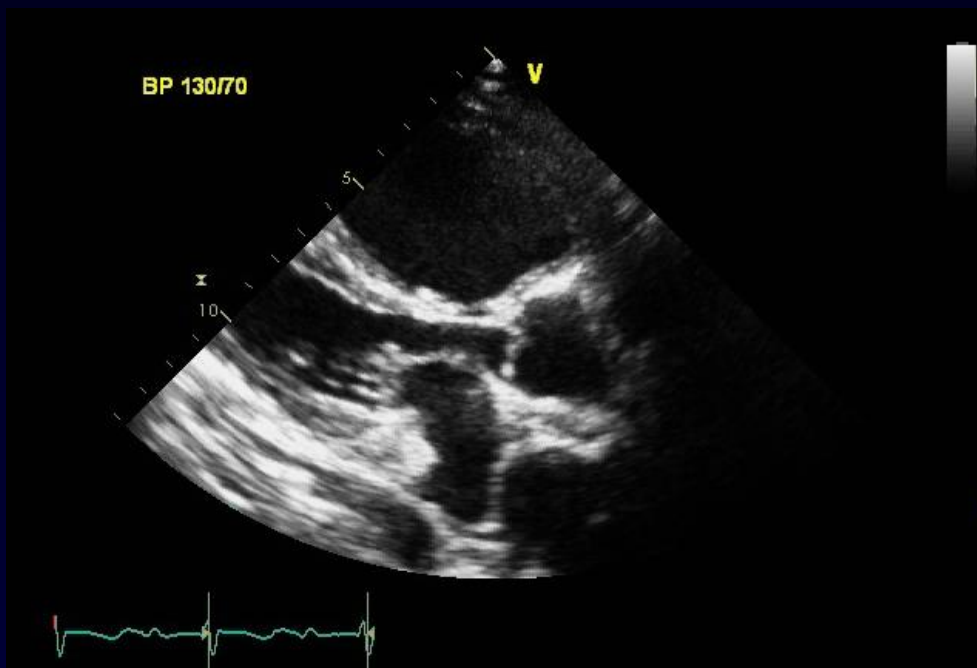


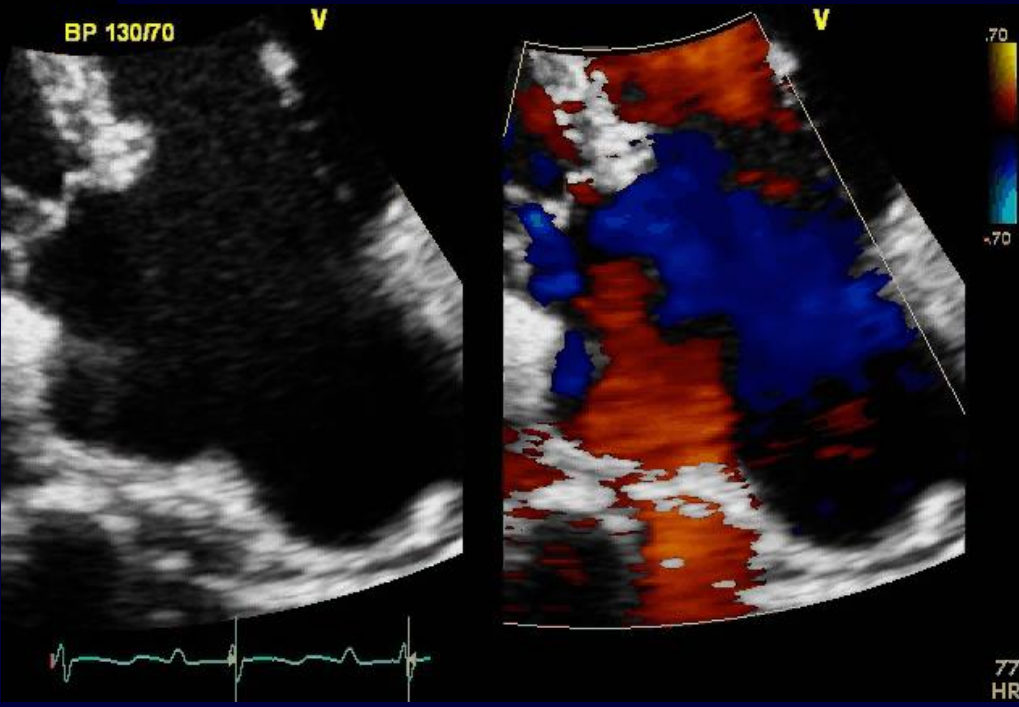
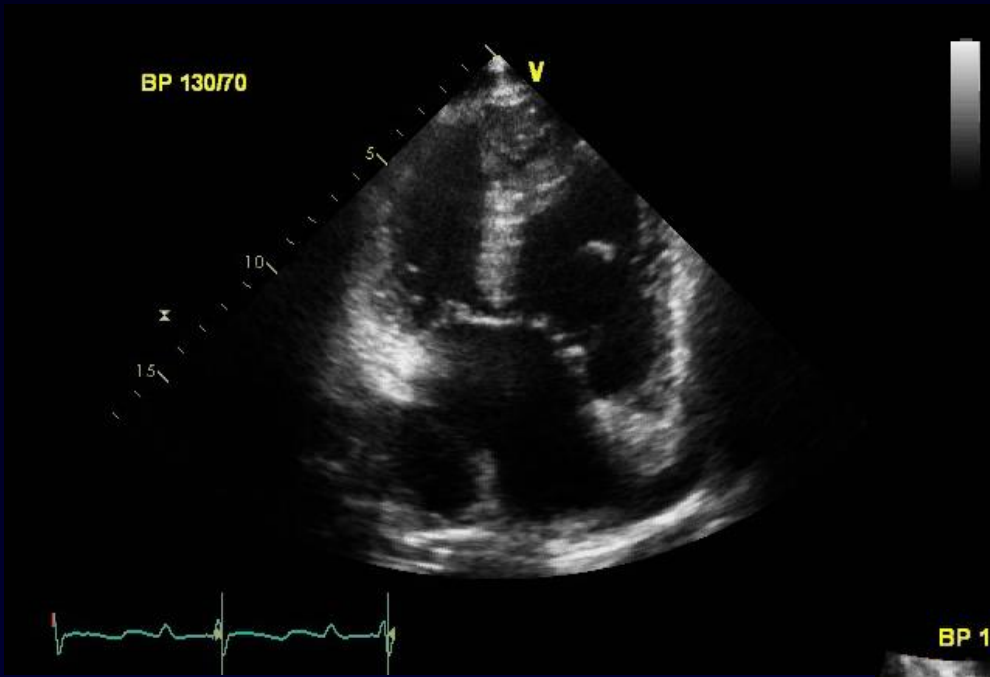
Lt side SVC

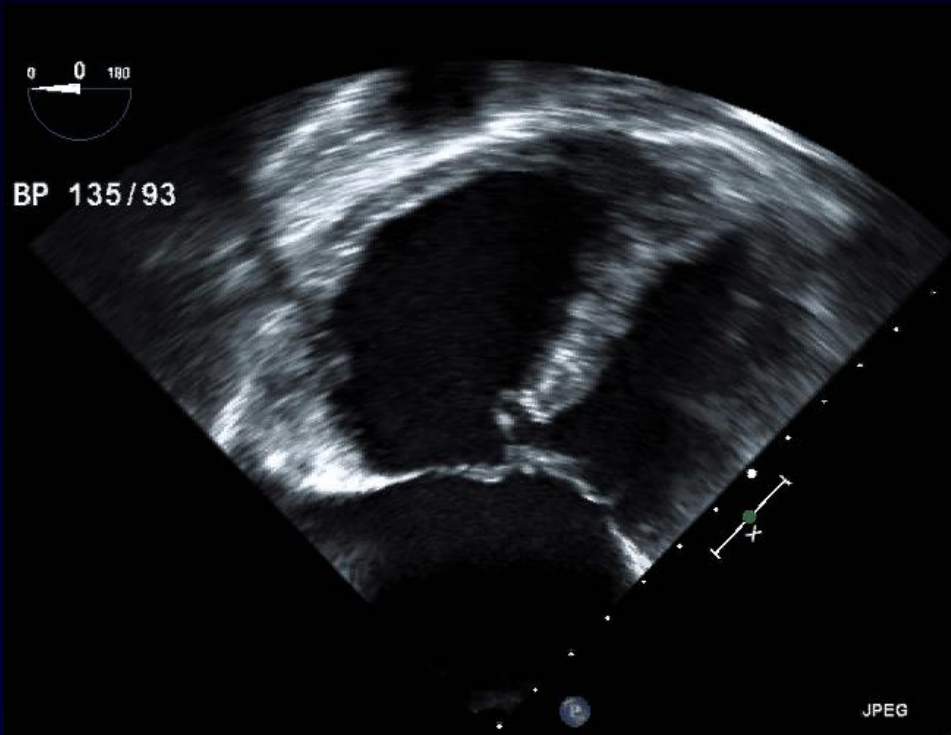
TEE in ACHD

- Confirm definitive congenital anomaly
- **Find other associated congenital anomaly**
- **Decision of treatment strategy**
- Assistance of intervention or operation

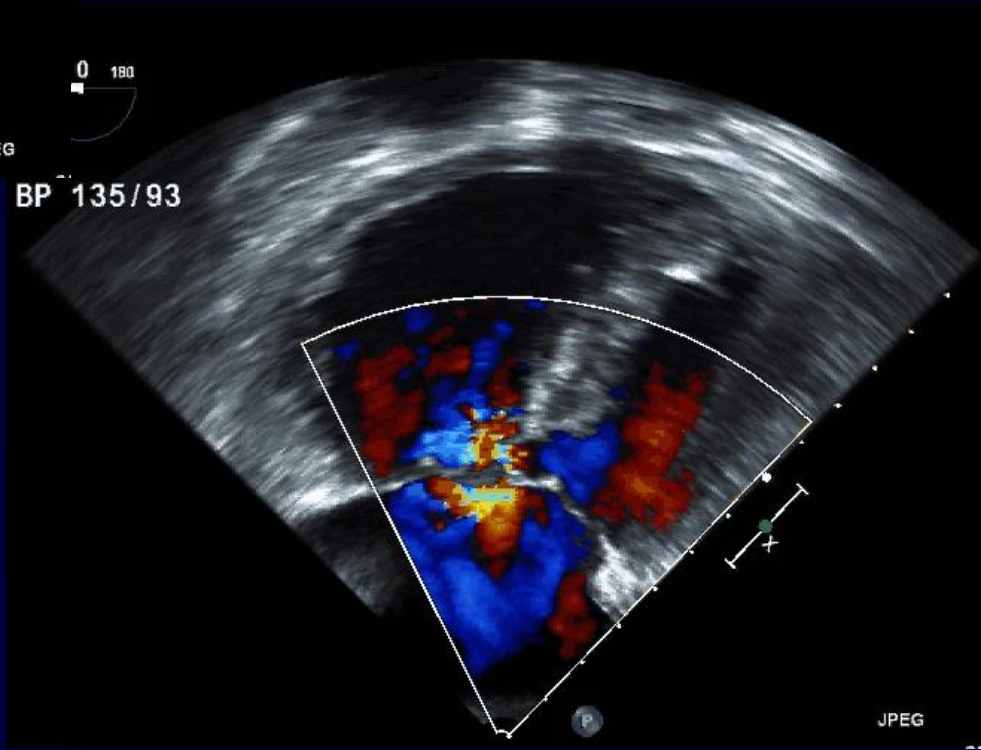
48 year-old woman with DOE



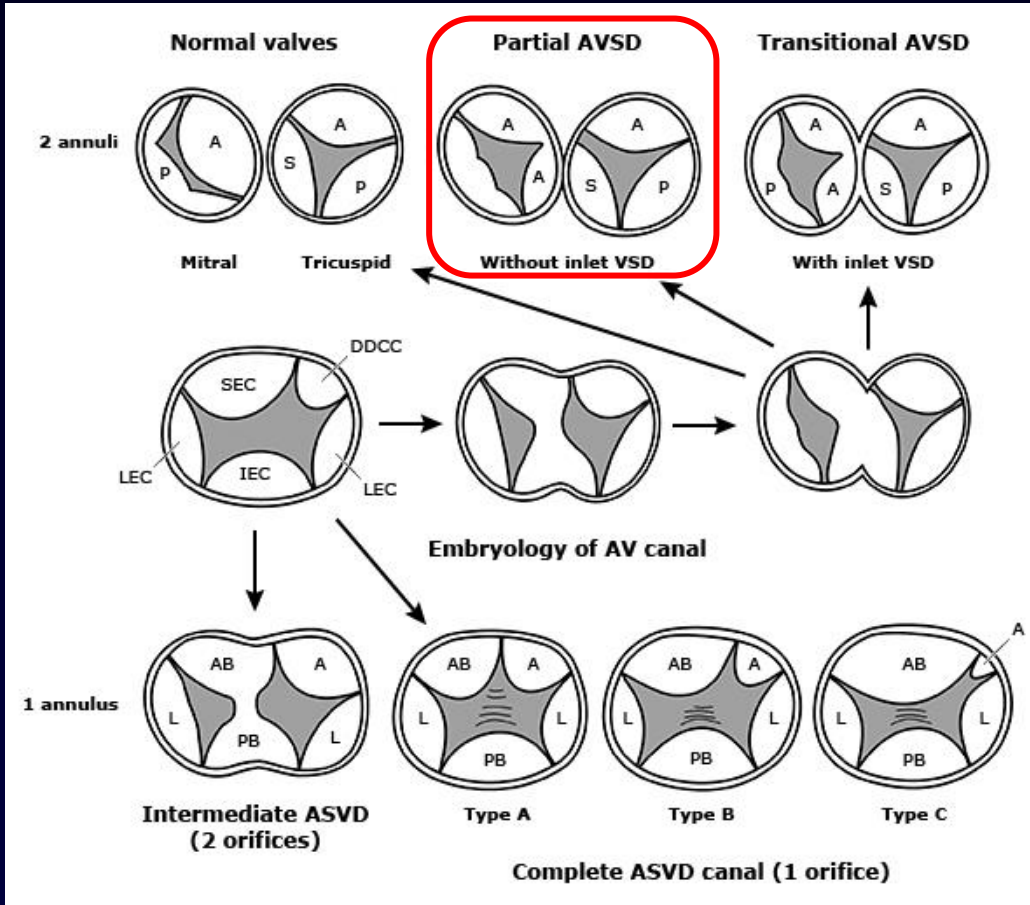




TEE



Endocardial cushion defect

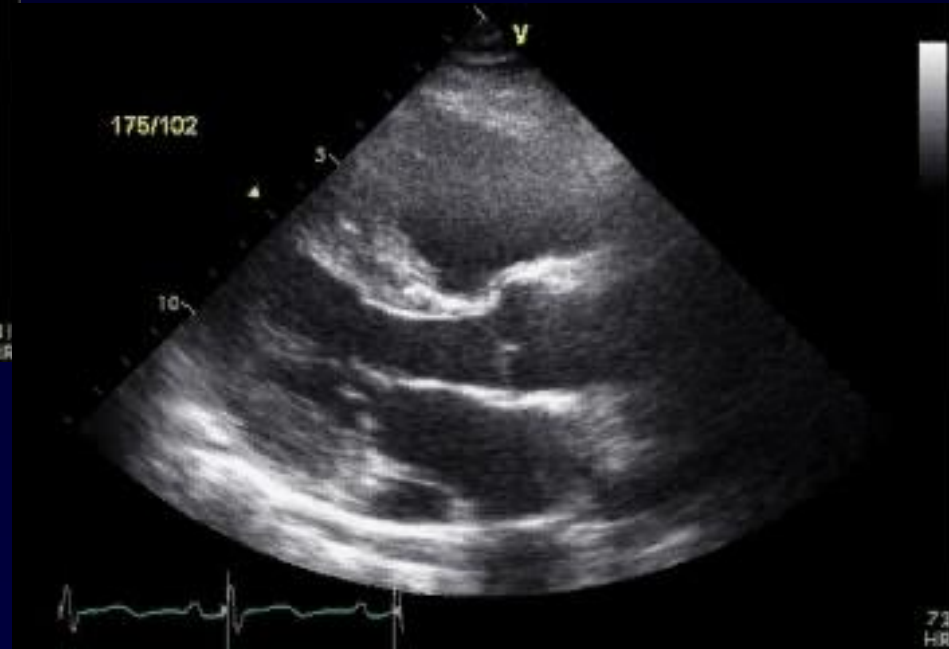


Partial AVSD with cleft mitral valve

52-year-old woman with DOE

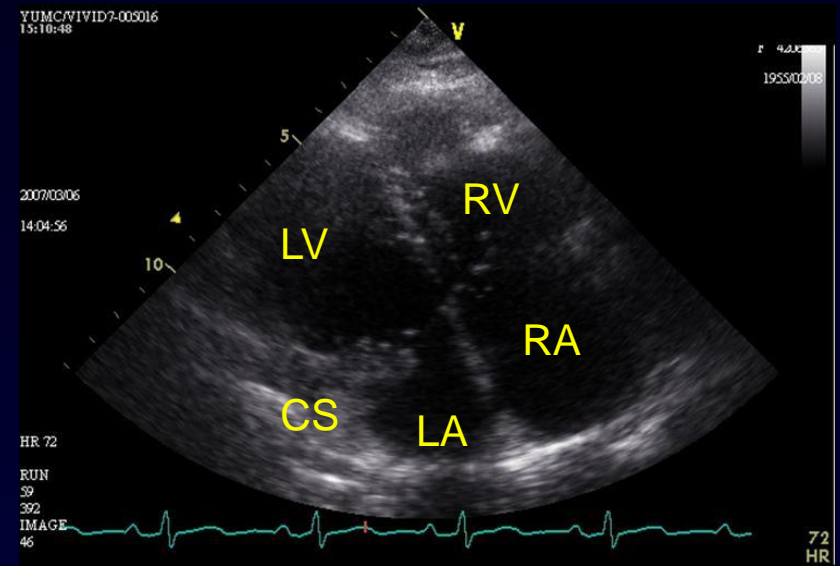


1 year ago

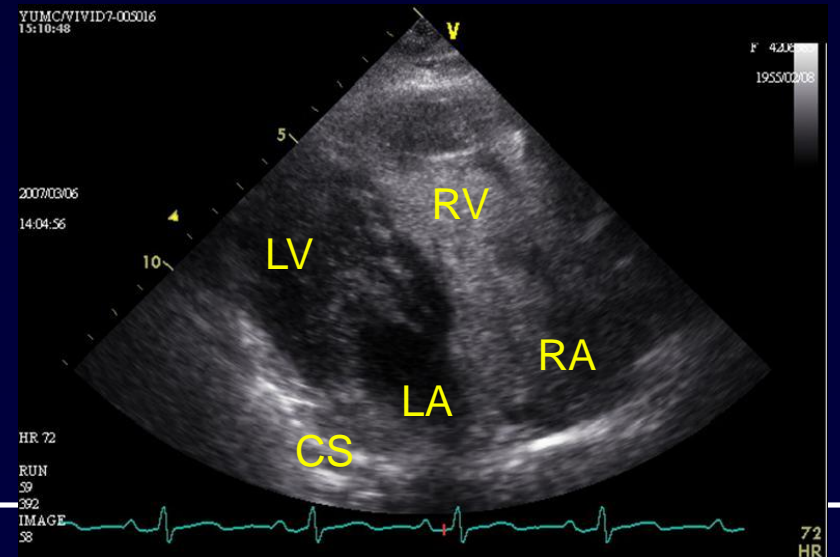


Present

Agitated Saline Injection



Saline bubble test



12 Mar 07

10:04:15 am

TE-V5M 58Hz
7.0MHz 90mm
TEE-1
General
Lens Temp=38.0°C

65dB S1/ 0/1/4
Gain= 14dB Δ=1

Store in progress
0:57:50
HR= 88bpm



TEE

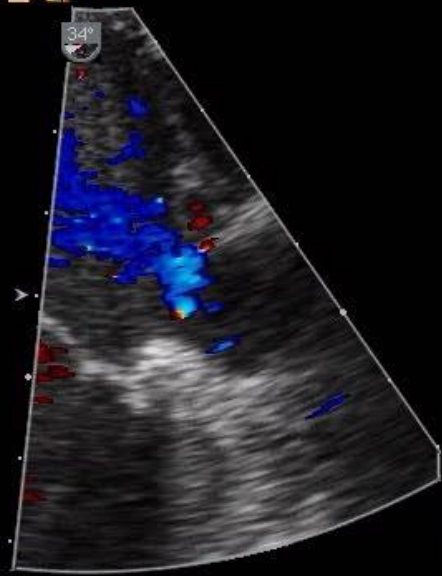
12 Mar 07

10:04:55 am

Lens Temp=38.0°C

HR= 81bpm

YONSEI MEDICAL CENTER



AN MI JA: Copying to ECHO, capture 55...
Text 1

Home Set

Home

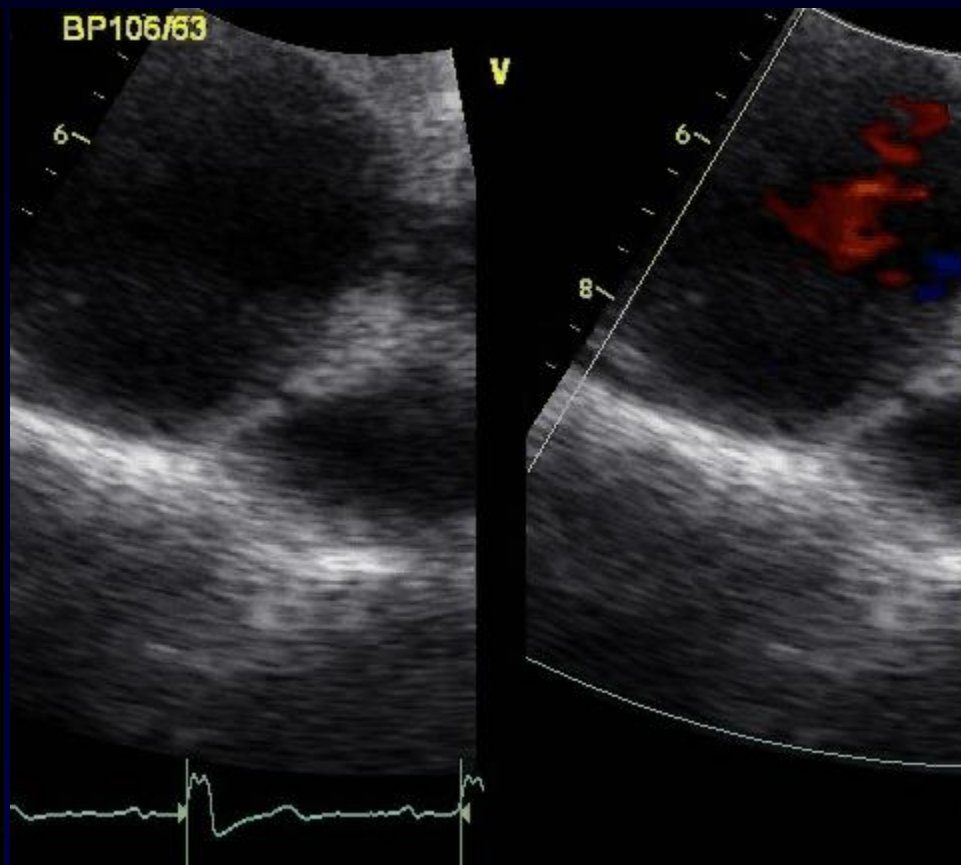
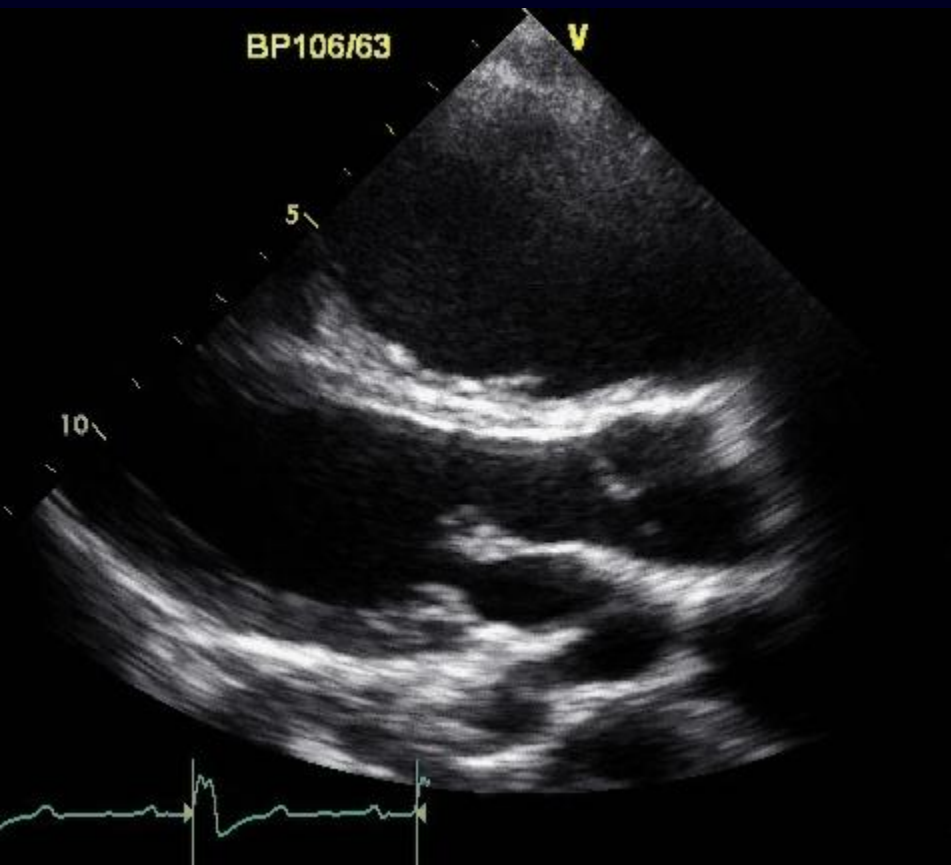


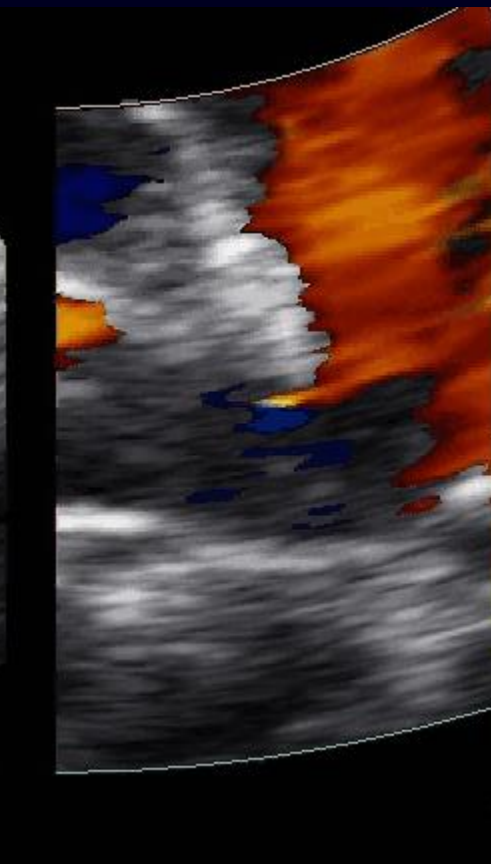
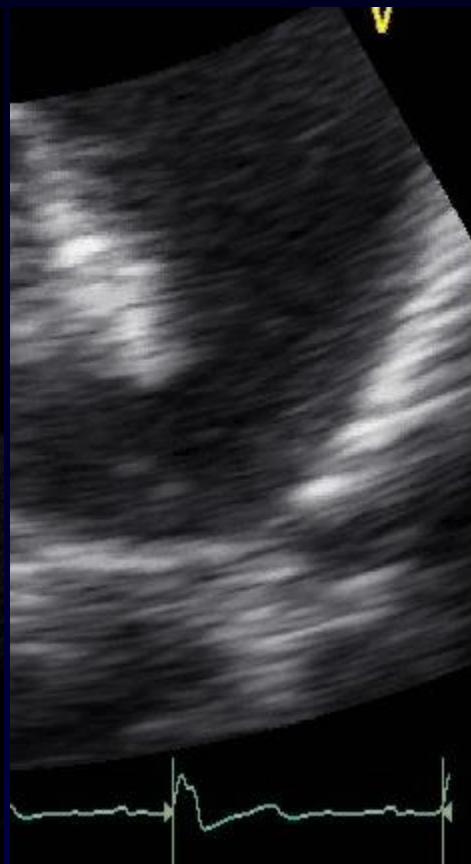
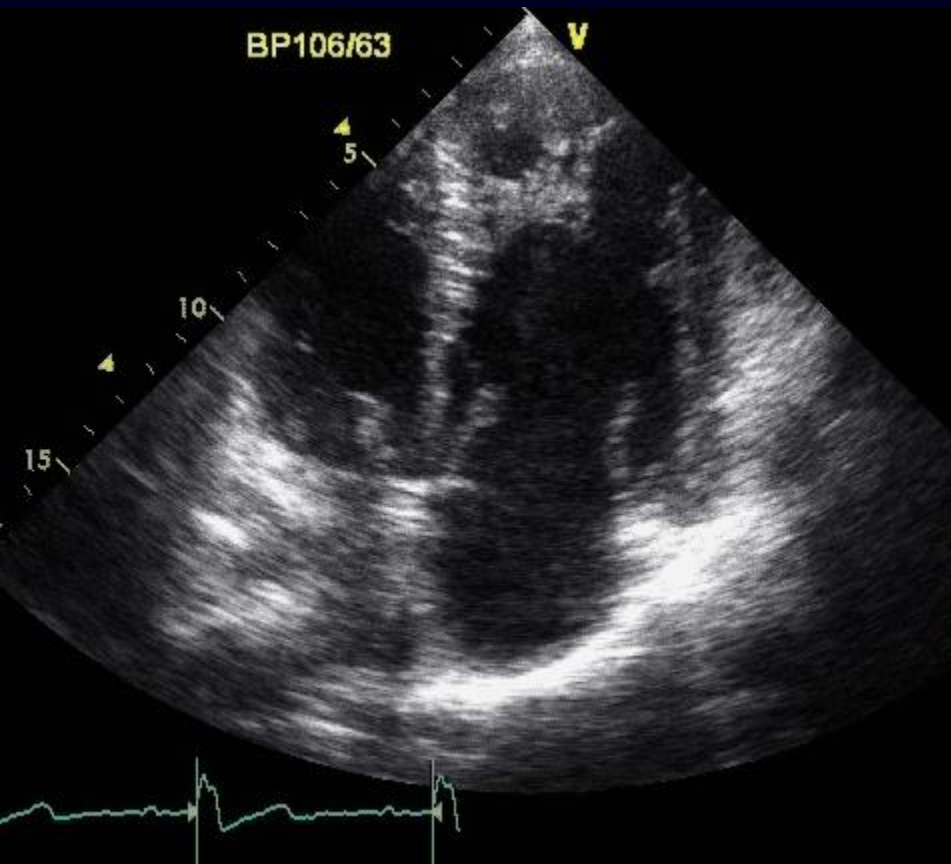
Dilated Coronary Sinus with Significant Lt to Rt shunt

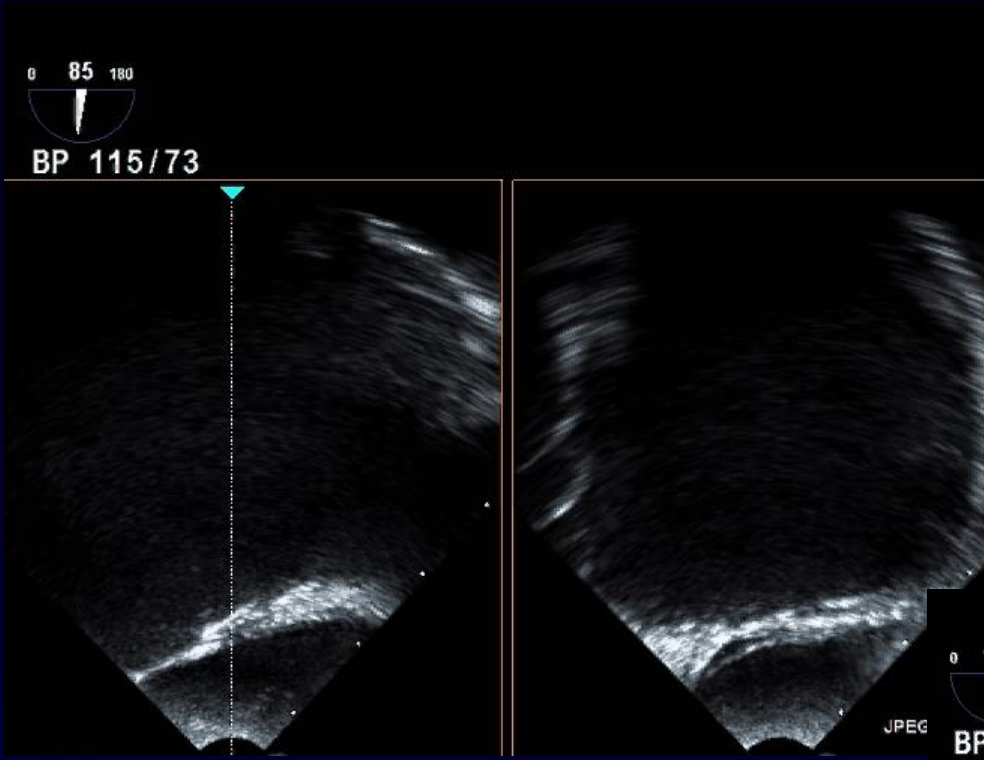
Unroofed coronary sinus

20-year-old man with DOE

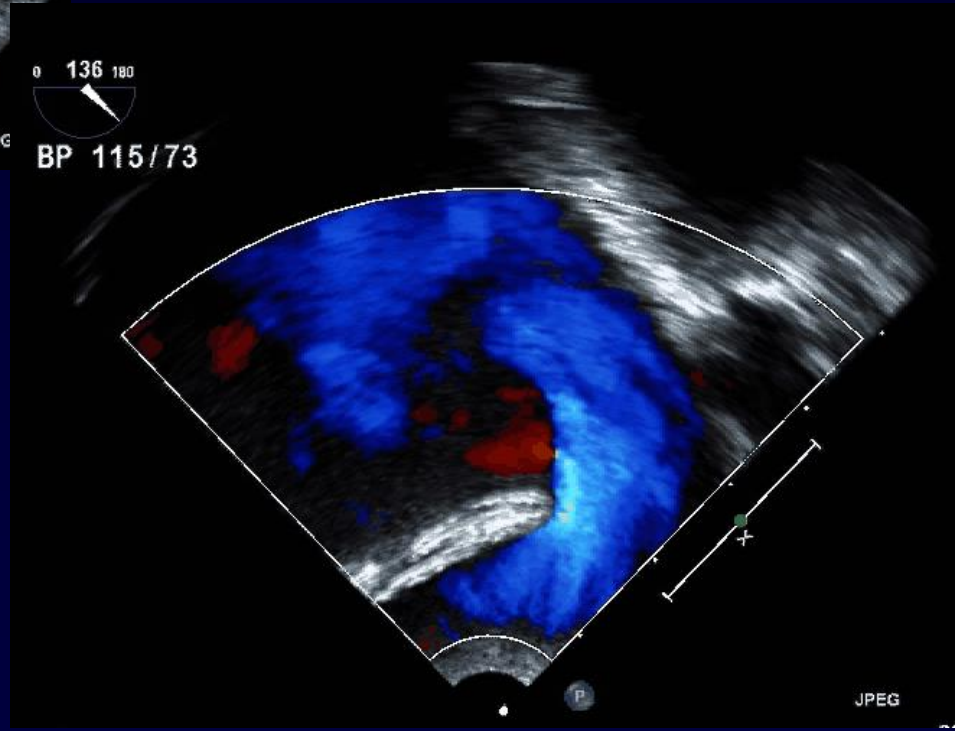
- Phx
 - Congenital pulmonary artery malformation (출생시)
 - Pulmonary hypertension (군 입대전)
 - Pulmonary valvular stenosis
- PI
 - 출생시 폐동맥 기형 진단 받고 7세까지 추적관찰했던 과거력 있었으며, 군 입대전 폐고혈압, 폐동맥 판막 협착증 진단 받은 과거력 있는 분임
 - 군 입대후 숨찬 증상으로 훈련 수행에 제약 있어 다시 검사위해 본원 방문



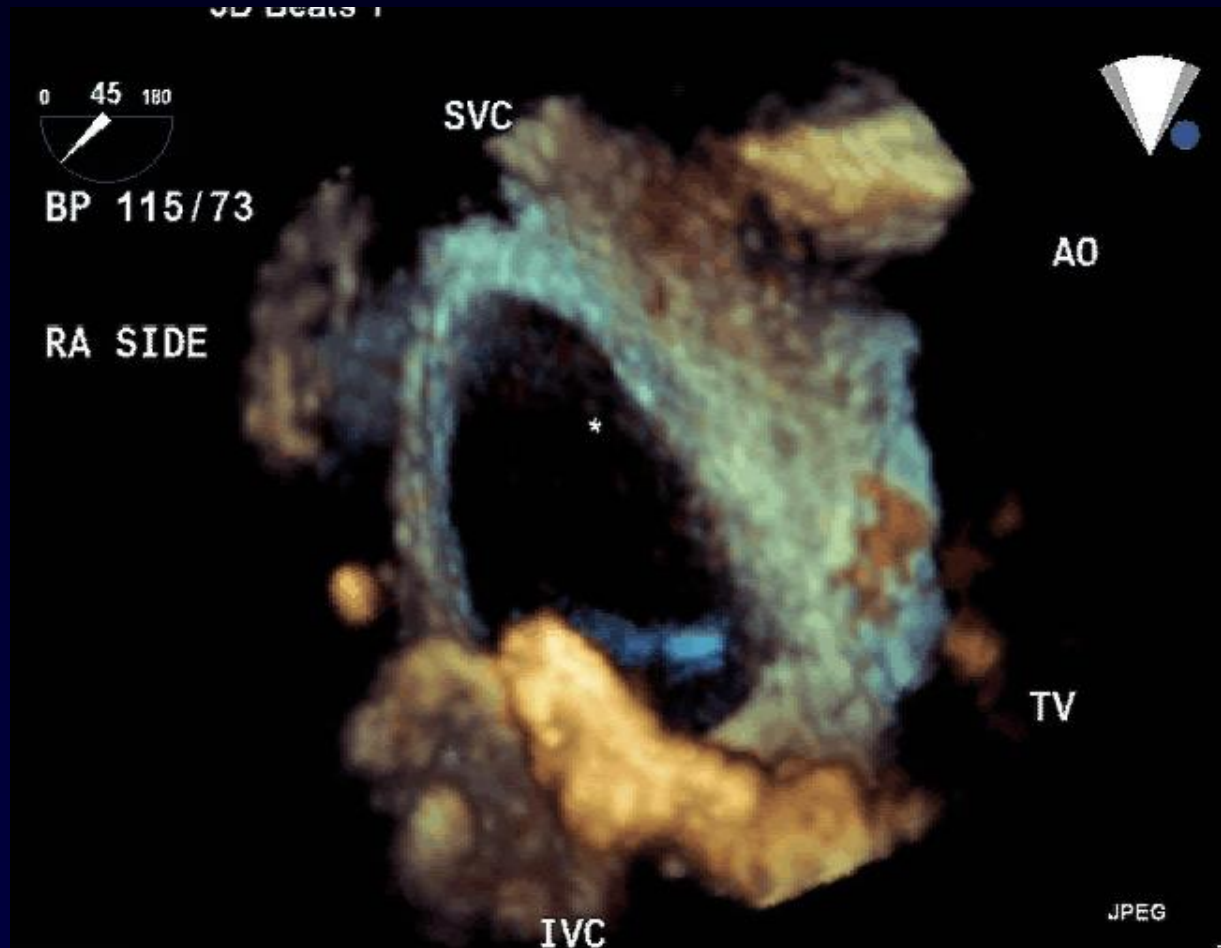




TEE



3D - TEE



Sinus venosus ASD

TEE in ACHD

- Confirm definitive congenital anomaly
- Find other associated congenital anomaly
- Decision of treatment strategy
- **Assistance of intervention or operation**

Echocardiography and cardiac interventions

Cardiac interventions

Technology/costs

Choosing procedure and technical requirements

Image quality / temporal and spacial resolution

Experience / Learning curve



2D

Doppler

3D

Transthoracic

Intra-cardiac

Transesophageal

Portable/mobile

High-end



Echocardiography and cardiac interventions (procedures with 2D/3D TEE guidance)

Anesthetic approach

Anesthesia with Intubation	49%
Sedation	45%
No sedation	6%

<i>Intervention procedure with TEE</i>	Total
PFO Closure	29
ASD Closure	28
LAA Closure	17
Periprosthetic leak closure	10
TAVI	6
Balloon valvuloplasty	4
Biopsy intracardiac mass	3
Alcohol Septal Ablation in HOC	2
Aortic endoprosthesis	2
	101



Intervent.

Image 3D TEE

Anesthesia



Echocardiography and cardiac interventions

Guiding interventional procedures

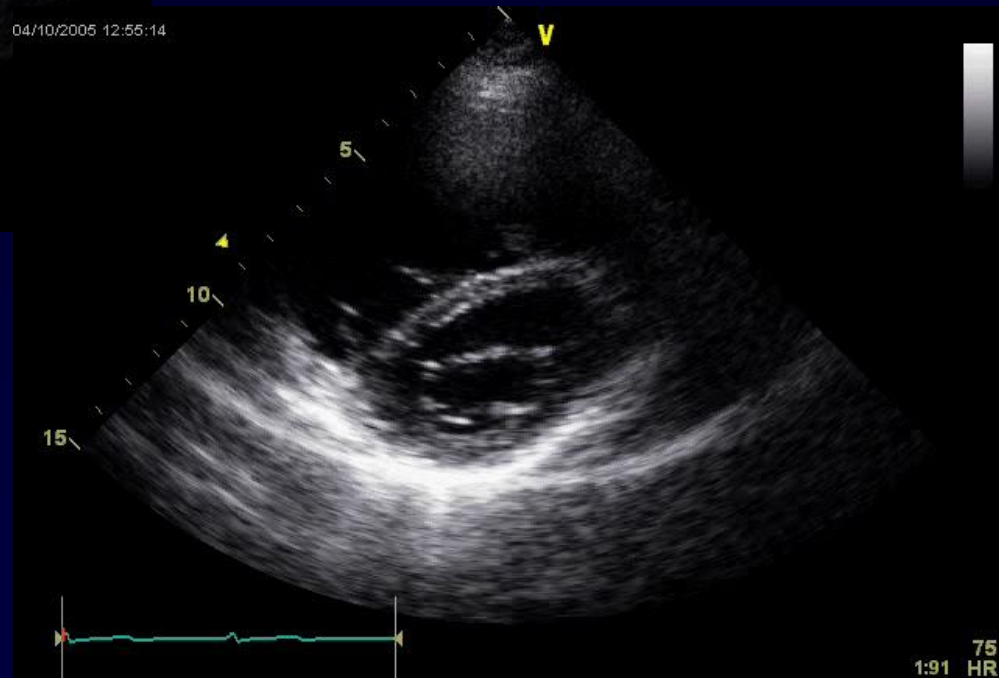
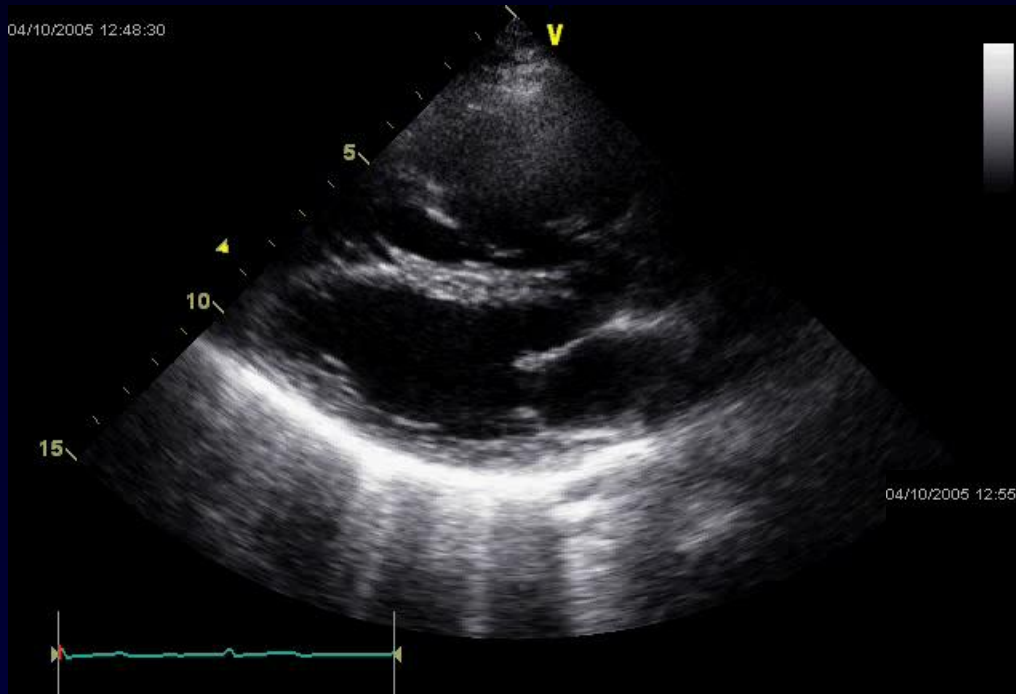
Table 1 Interventional procedures: use of echocardiography for guidance

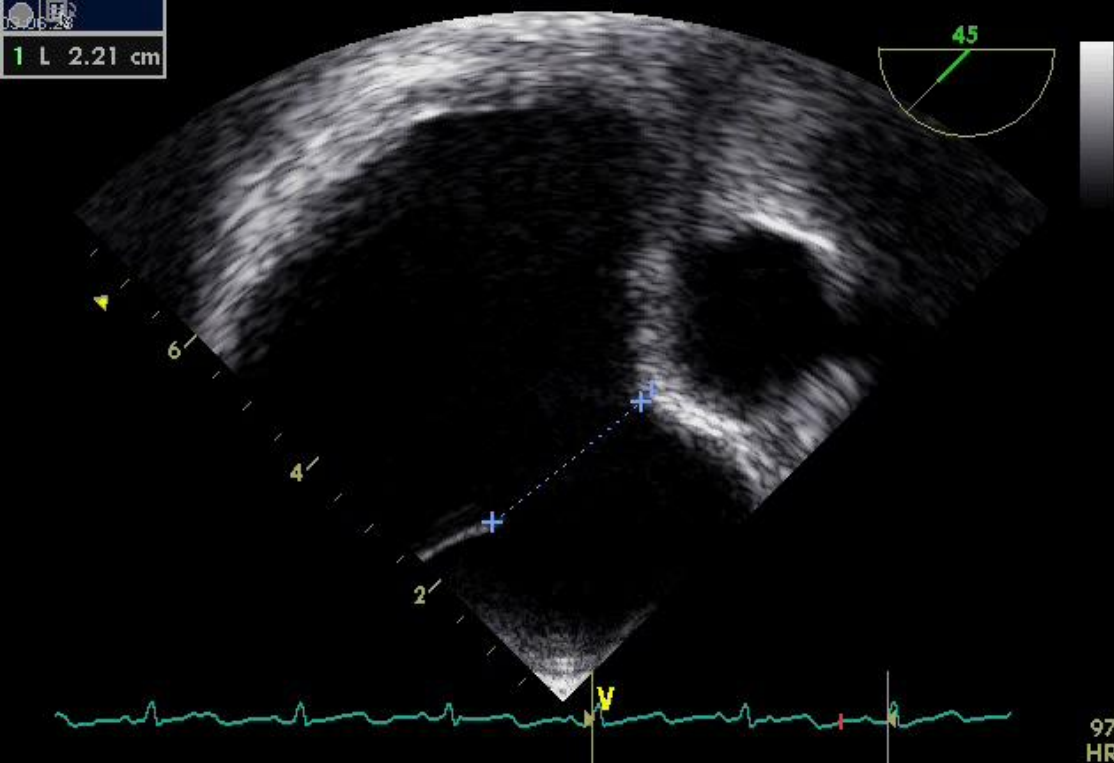
Interventional Procedure	TTE	TEE	ICE
Transseptal catheterization	+	++	++ (radial or phased array)
PMBV	++	+++	++
Transcatheter closure of ASD, ventricular septal defect, and PFO	+	++	++ (phased array)
Alcohol septal ablation in HOCM	++	++	-
Percutaneous mitral valve repair	+	+++	+
Percutaneous left ventricular assist device placement	-	++	++
Percutaneous stented aortic valve prosthetic placement	-	+	+
Balloon or blade atrial septostomy	++	++	++
Placement of LAA occlusion devices	-	++	++
Myocardial and intravascular biopsy	++	++	++ (phased array)
Congenital heart disease applications (completion of Fontan procedure, coarctation repair)	+	+	+
Placement of aortic endograft	-	-	+ (radial or phased array)

-, No documented role or benefit in the literature; +, anecdotal reports of use and benefit exist, but further study is needed to delineate; ++, advantages favor use when available; +++, clearly documented benefit or role.

ASE RECOMMENDATIONS FOR CLINICAL PRACTICE
Echocardiography-Guided Interventions; *Silvestry, JASE, Mar 2009*

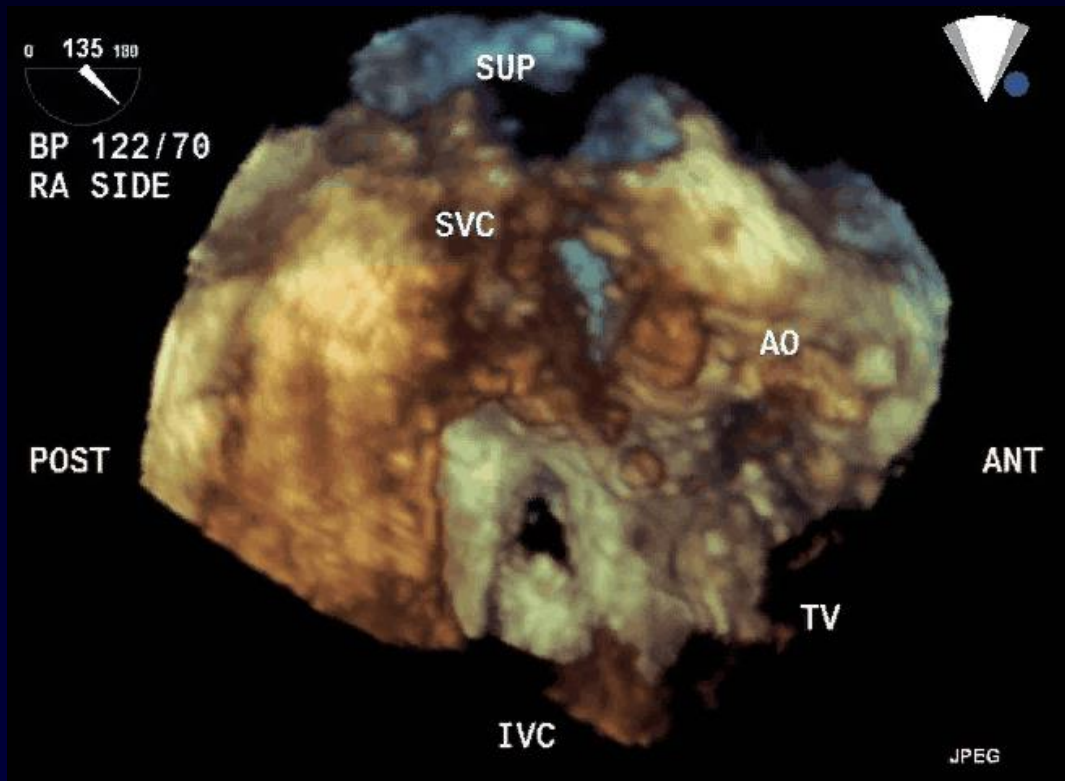
F/25 with DOE



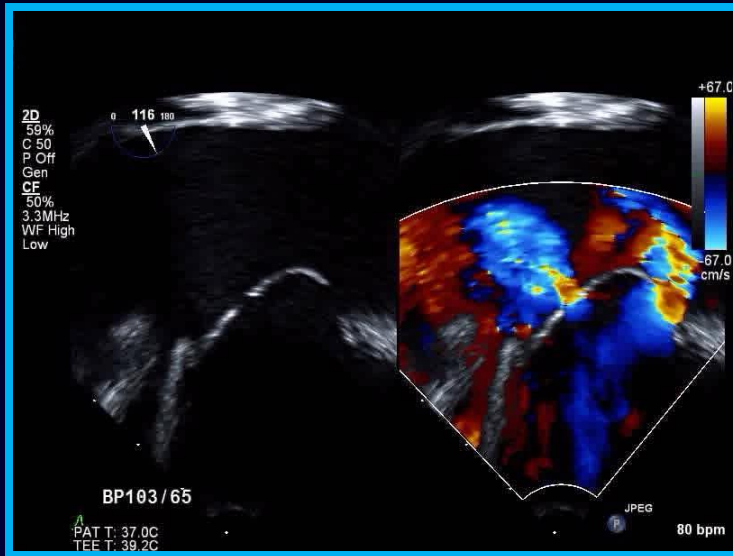


TEE

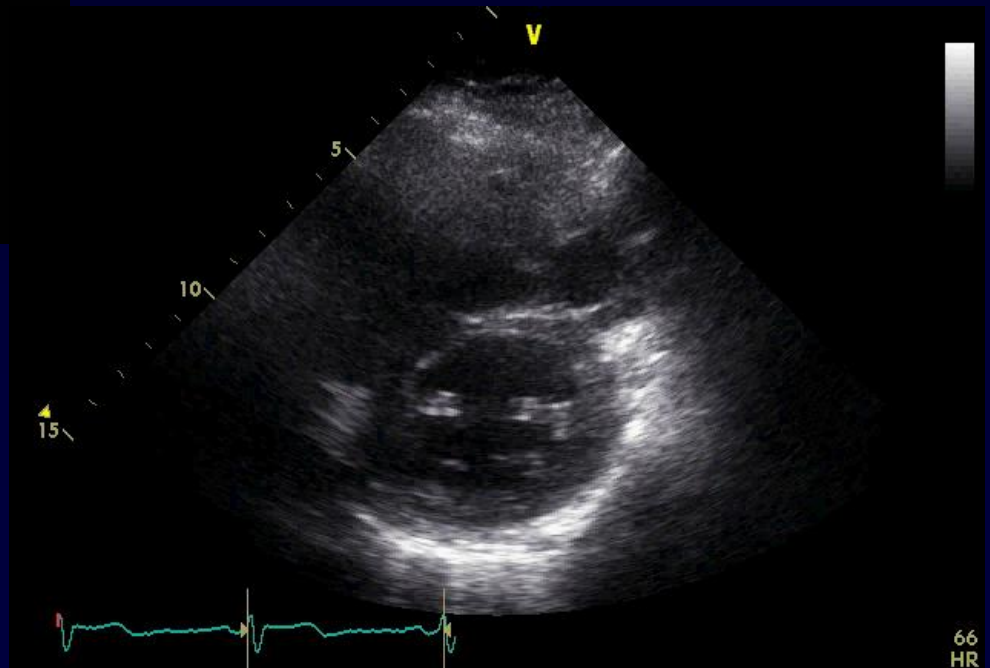
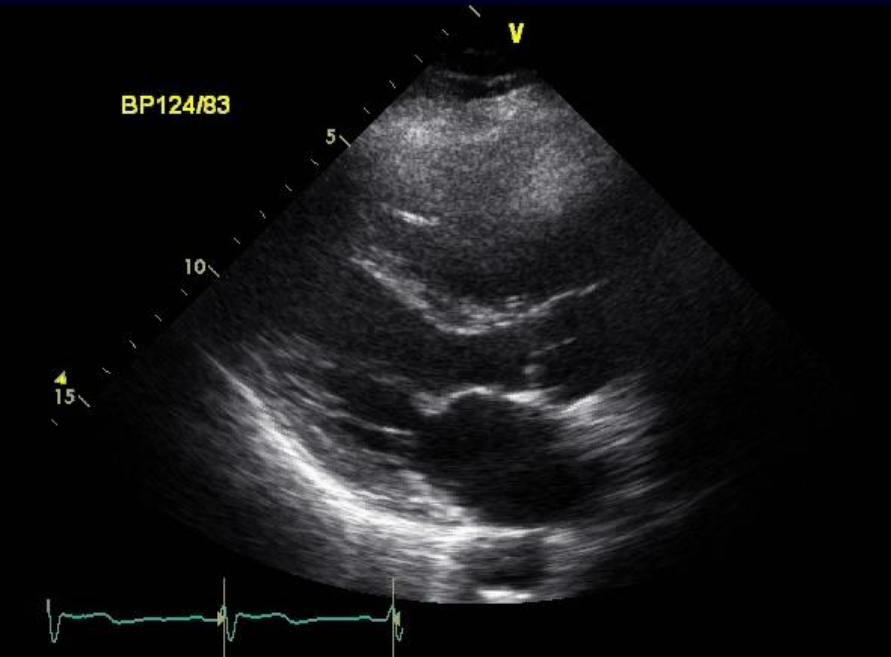


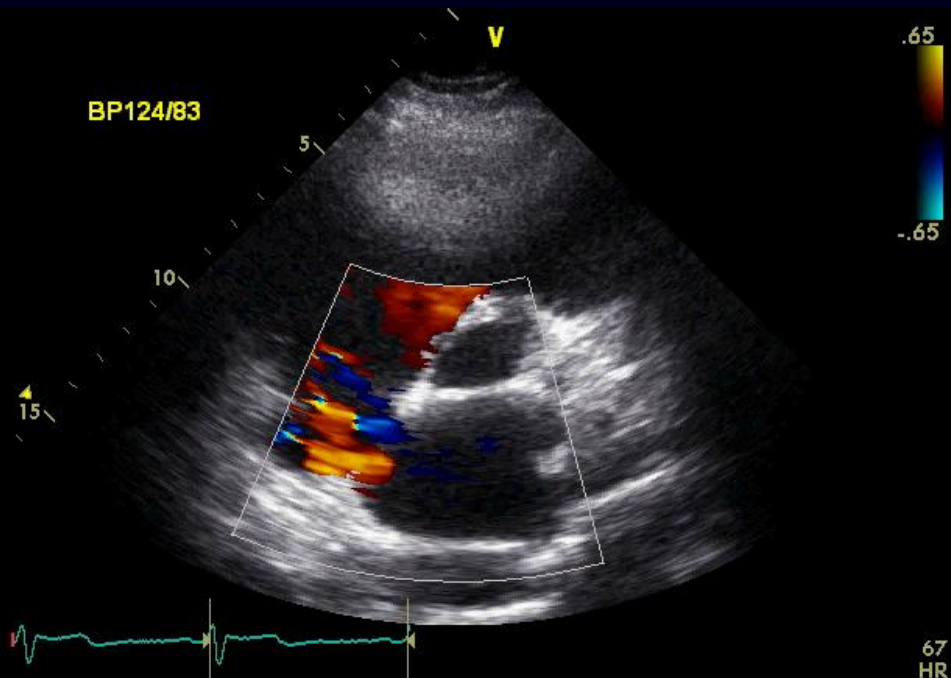


3D TEE - Multiple ASD

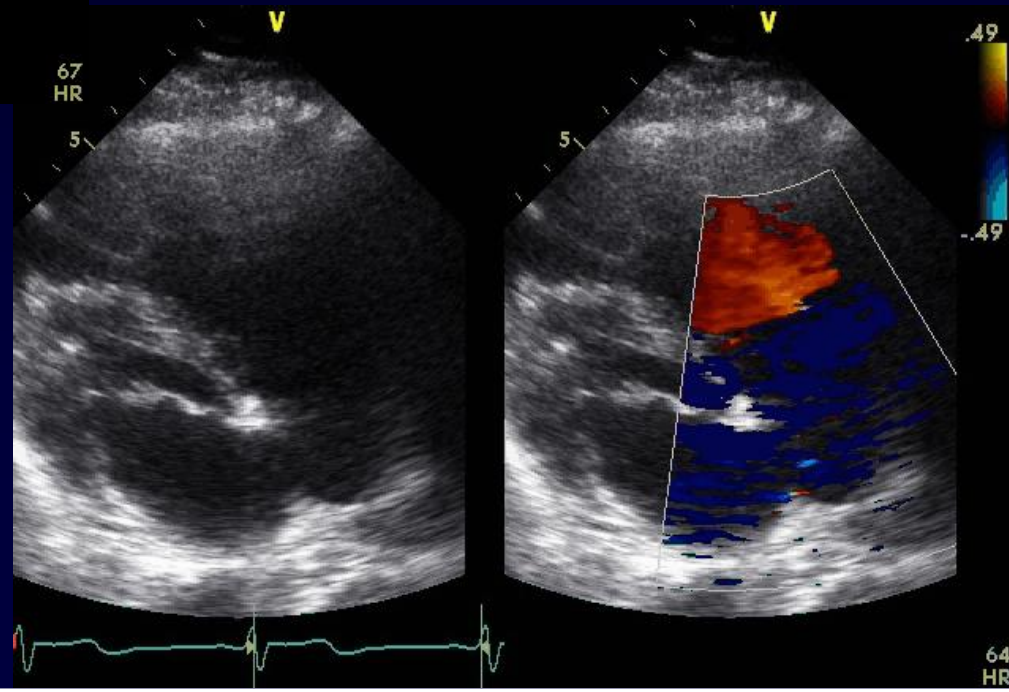


40-year-old woman with DOE





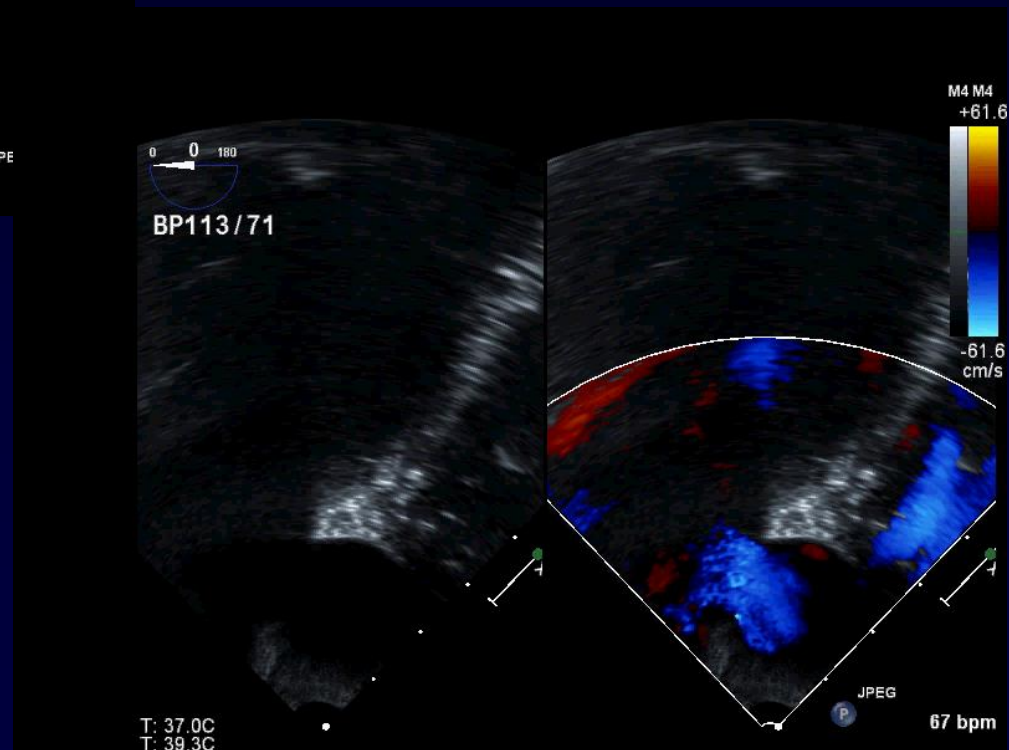
ASD secundum : 1.6cm
 Qp:Qs = 1.98

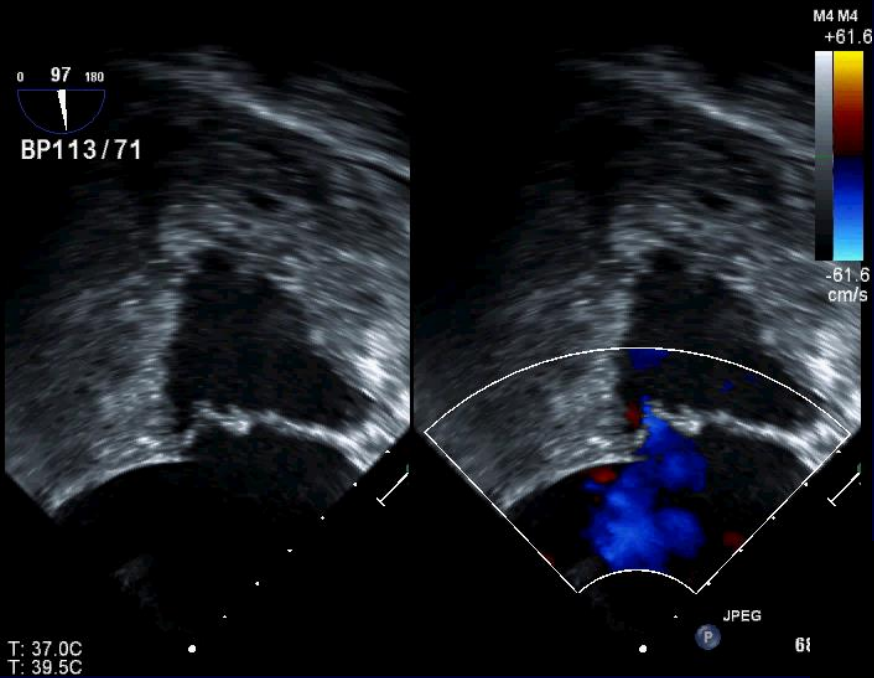


TEE

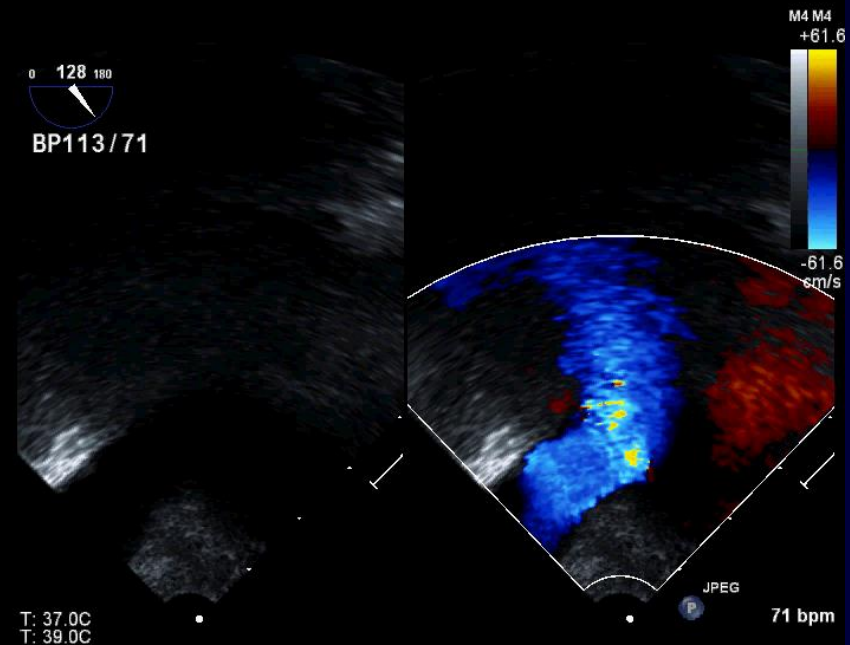


Secundum ASD : 1.9cm





Secundum ASD : 1.9cm
Unroofed coronary sinus



43-year-old man with sudden aphasia

✓ **Past History:** Hypertension (–), DM (–), Smoking (–)

✓ **Family History:** None

✓ **Review of System:**

Aphasia (+), Transient right side weakness (+)

✓ **Physical Examination:**

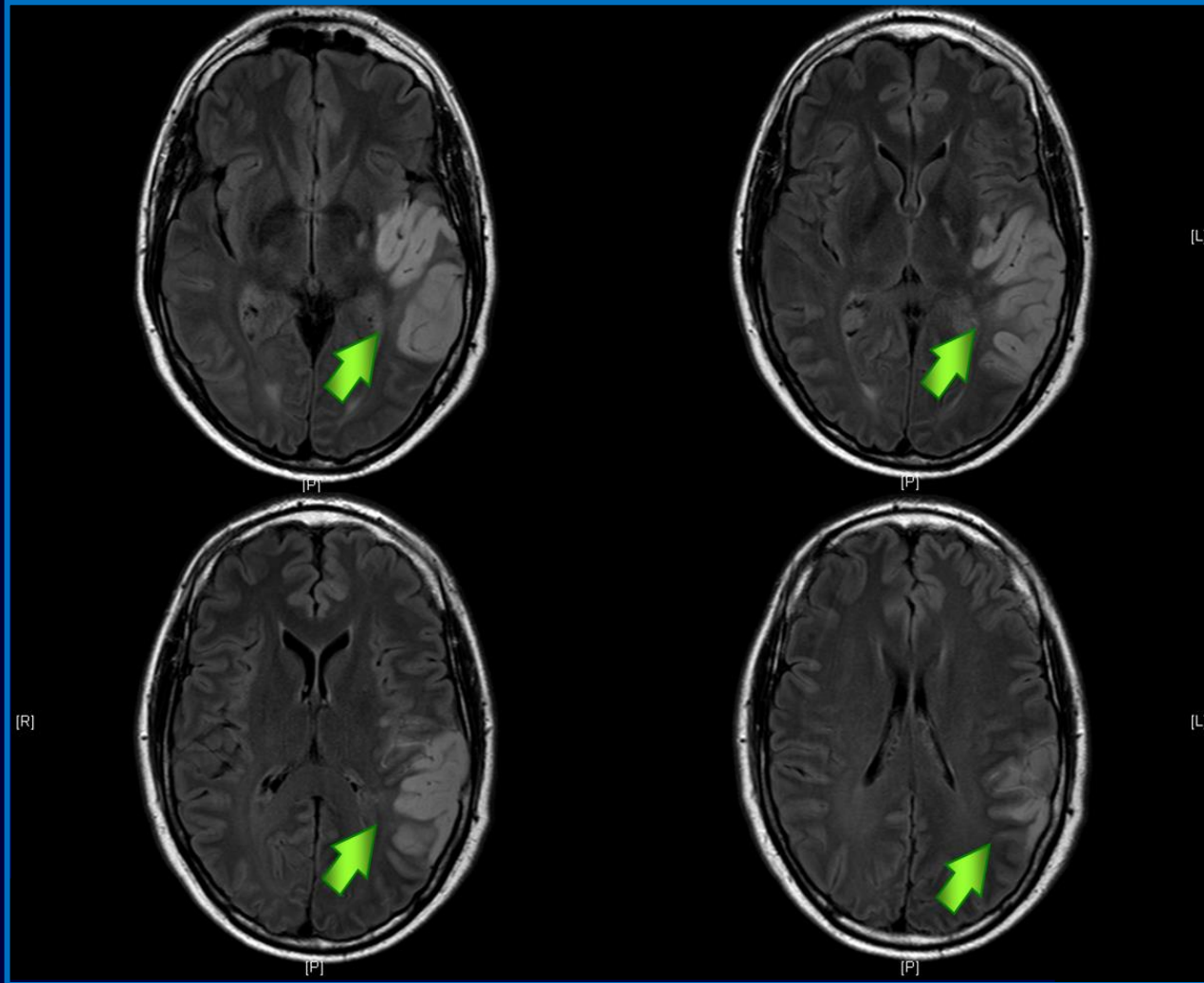
BP 152 / 92 mmHg, PR 118 bpm, RR 17 / min

Ht. 187 cm, Wt. 115 kg, BMI: 33 kg/m²

Motor grade V/V on upper/ lower extremities

Sensory: Intact

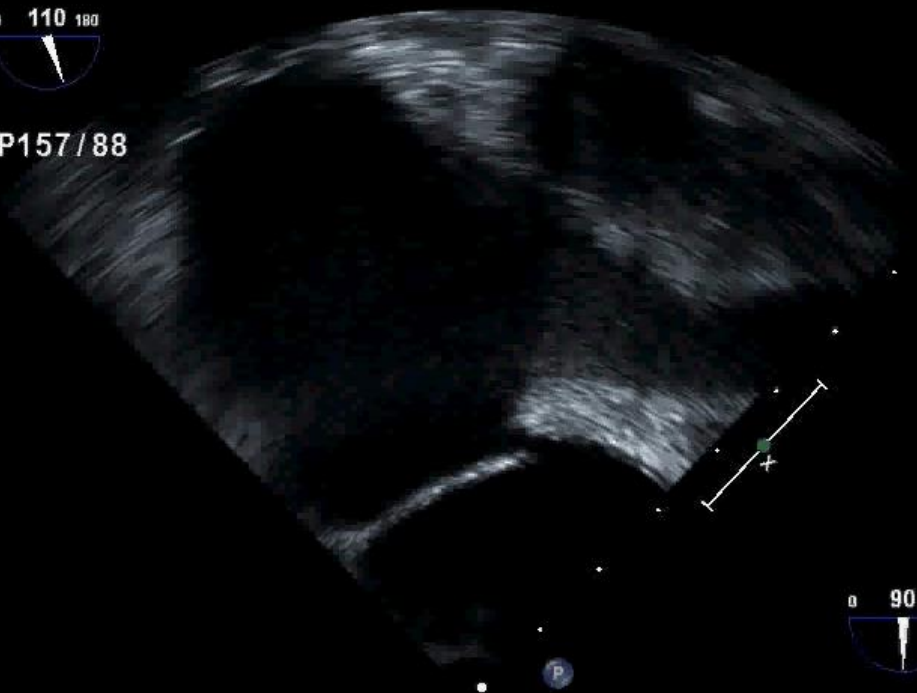
Brain MRI



Acute infarct, left MCA
territory
Intraluminal thrombus at
left distal MCA area

0 110 180

BP157/88



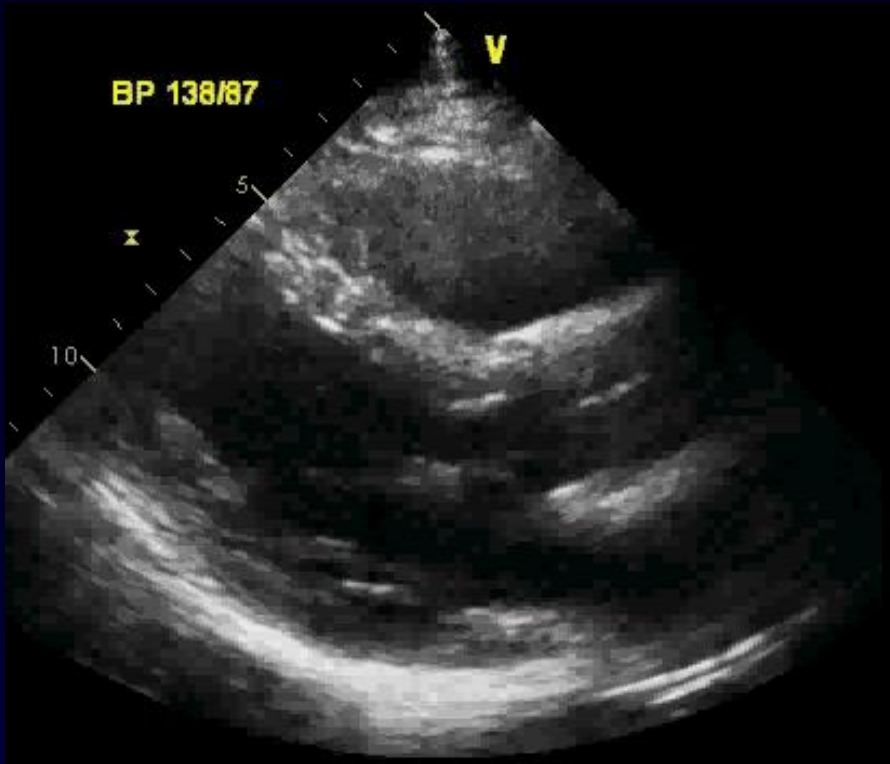
TEE

0 90 180

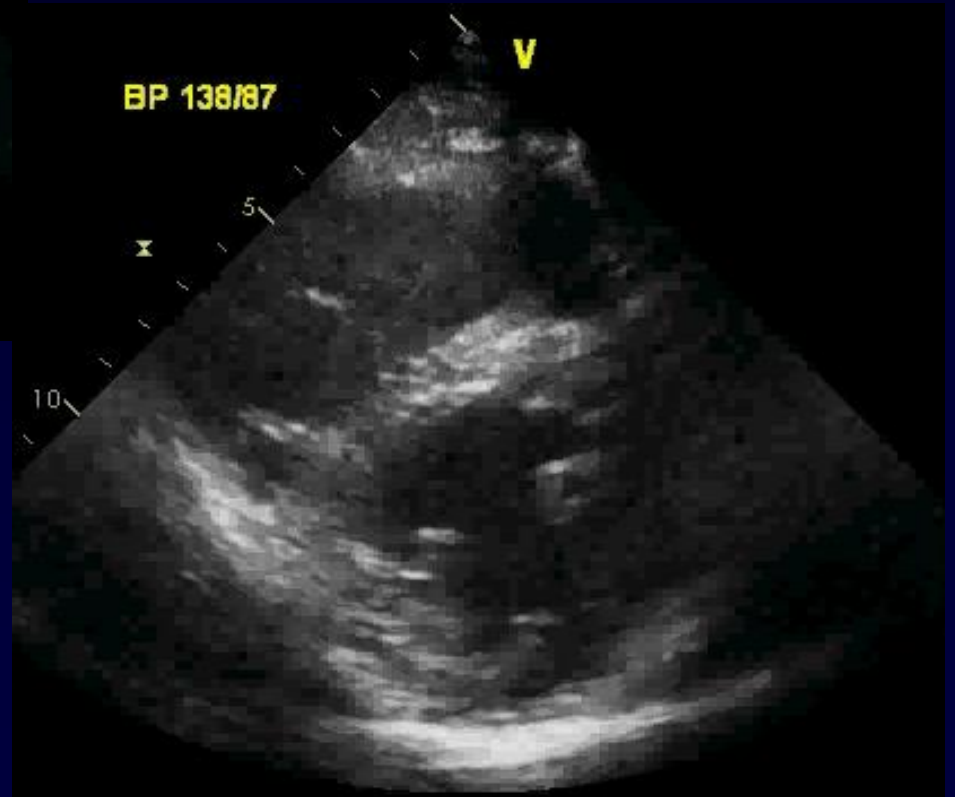
BP157/88
RESTING

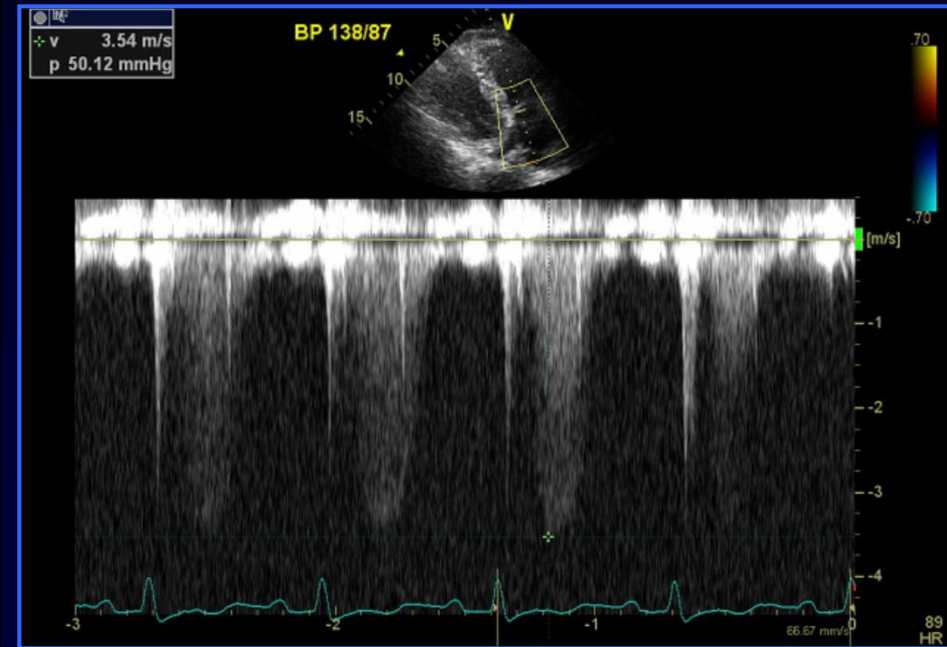
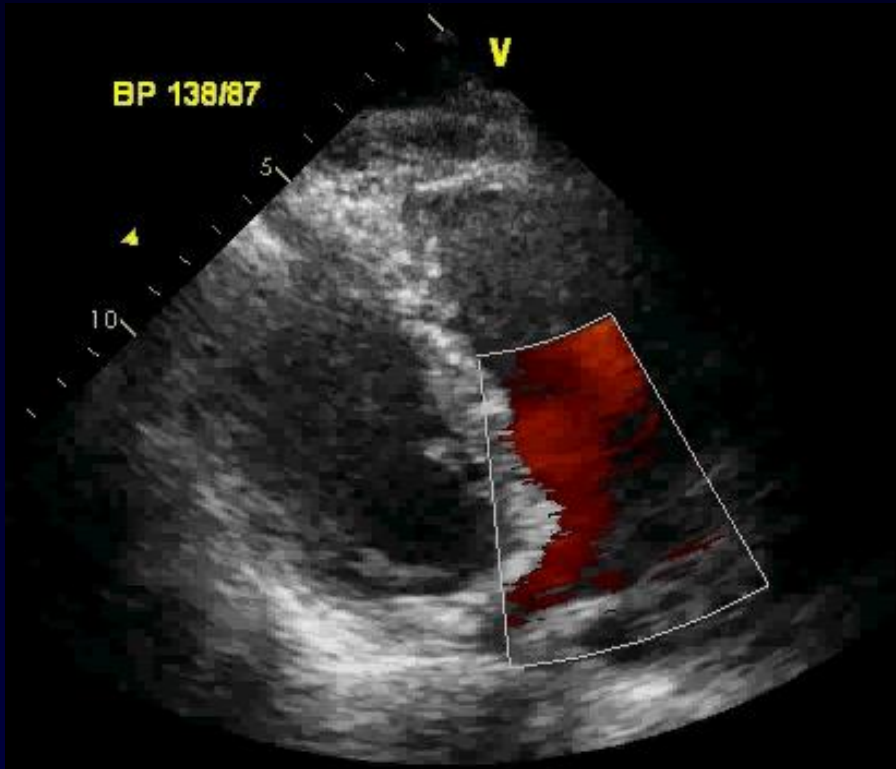


JPEG



TTE

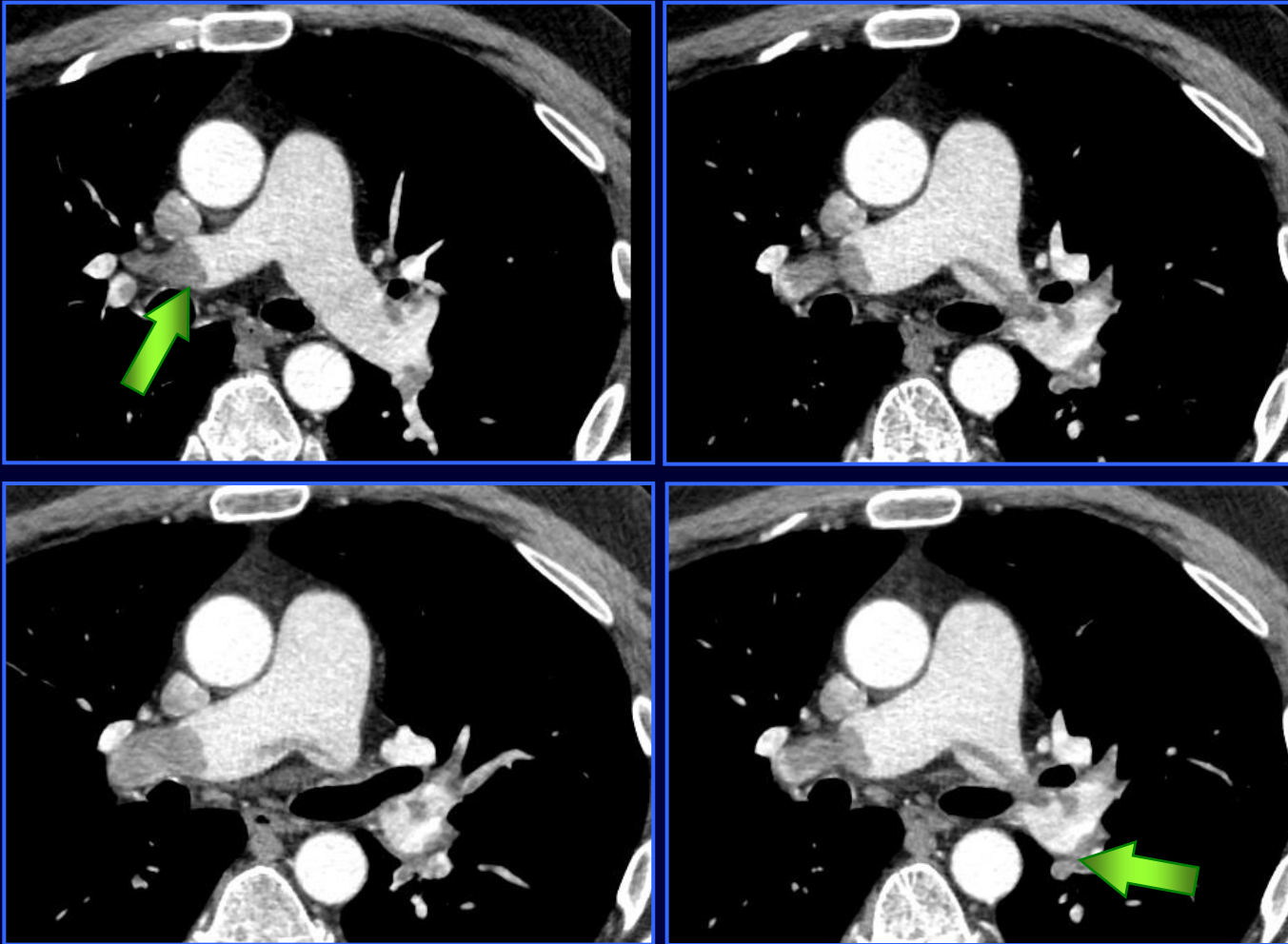




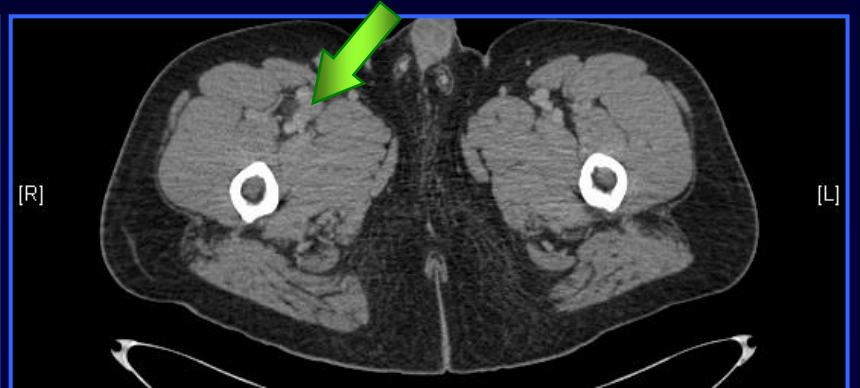
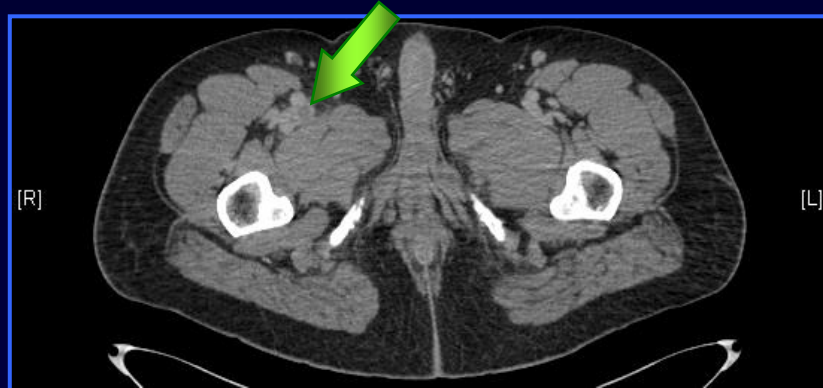
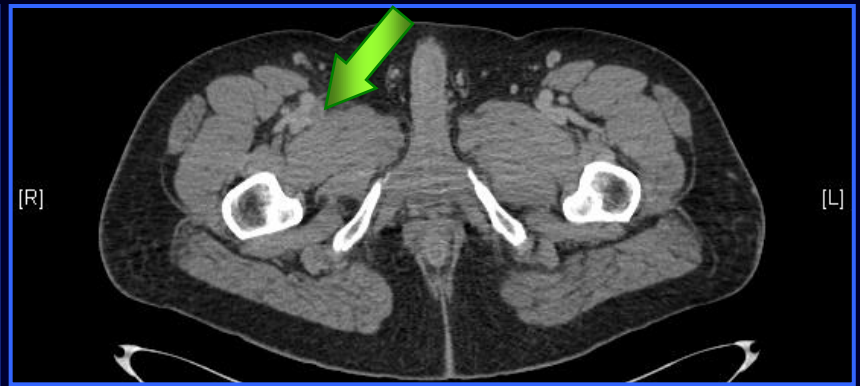
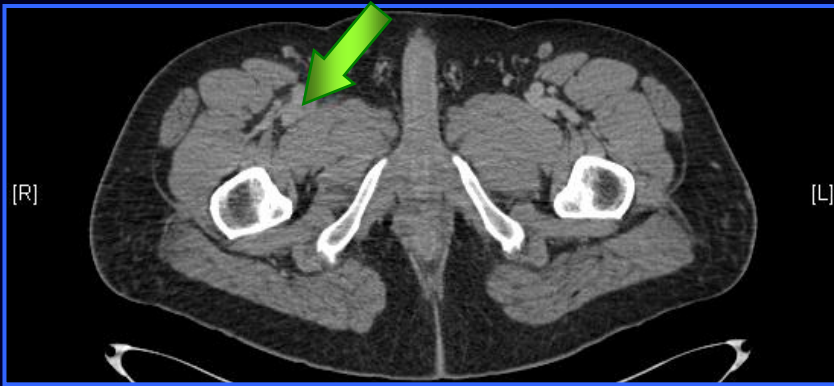
TR Vmax = 3.5 m/s

Estimated RVSP = 60 mmHg

CHEST CT



Low Extremities CT

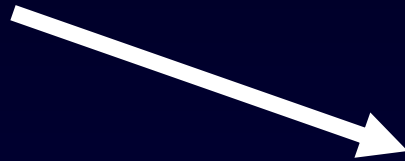
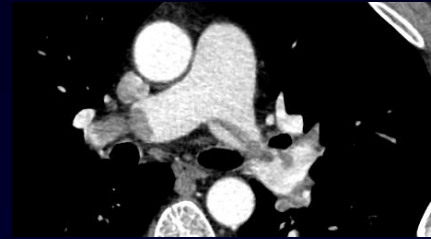


Source of embolism in this man..

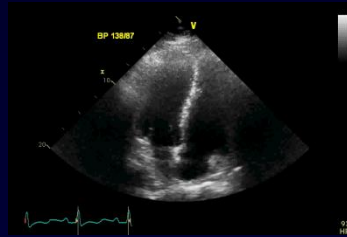
Deep vein thrombosis



Pulmonary embolism



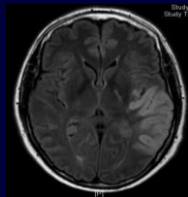
Pressure overload to the right heart



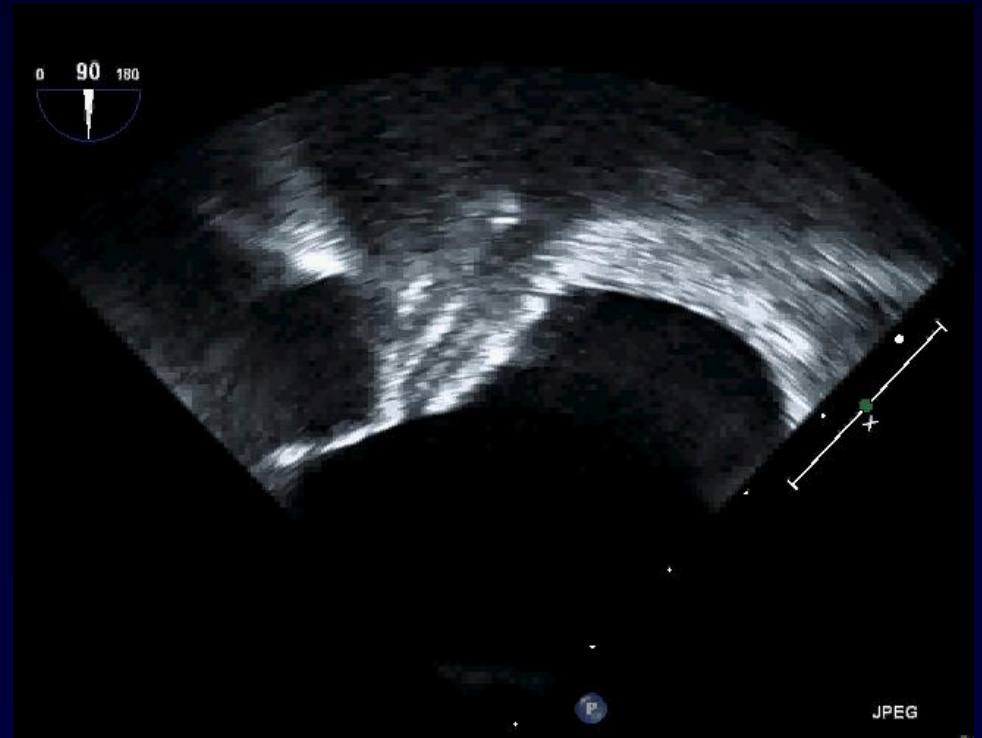
Thrombus pass through the PFO to LA



Acute stroke



PFO device closure



Take home message

- TEE is useful when TTE is inconclusive
- Can visualize cardiovascular structures not seen well on TTE: (LAA, Pulmonary veins, atrial septum, thoracic aorta)
- TEE can provide imaging assistance for intervention



**SEVERANCE
HOSPITAL**



**CARDIOVASCULAR
HOSPITAL**

Thank You For Your Attention !