Imaging of coarctation and interrupted aortic arches

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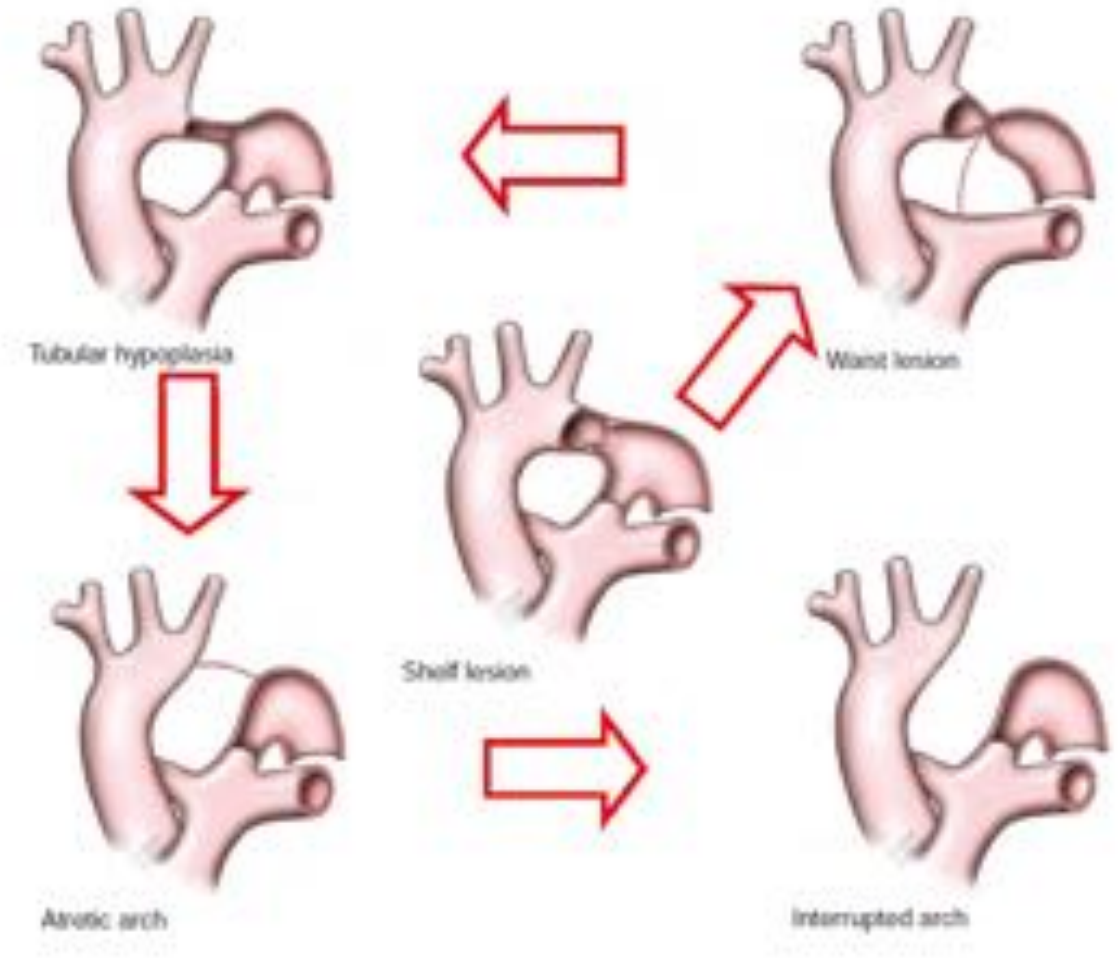
CHU Hôpitaux de Bordeaux

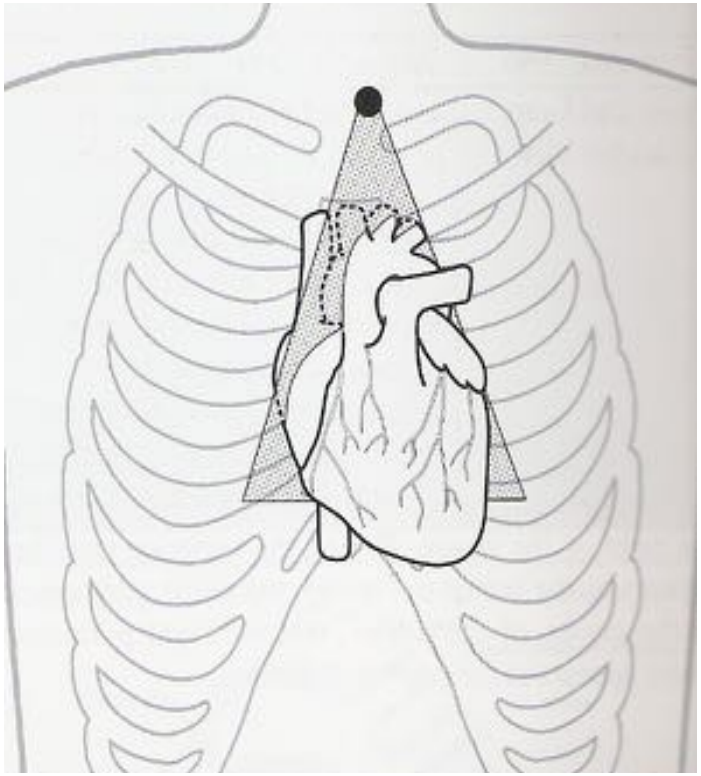
Coarctation of Aorta: Morphology

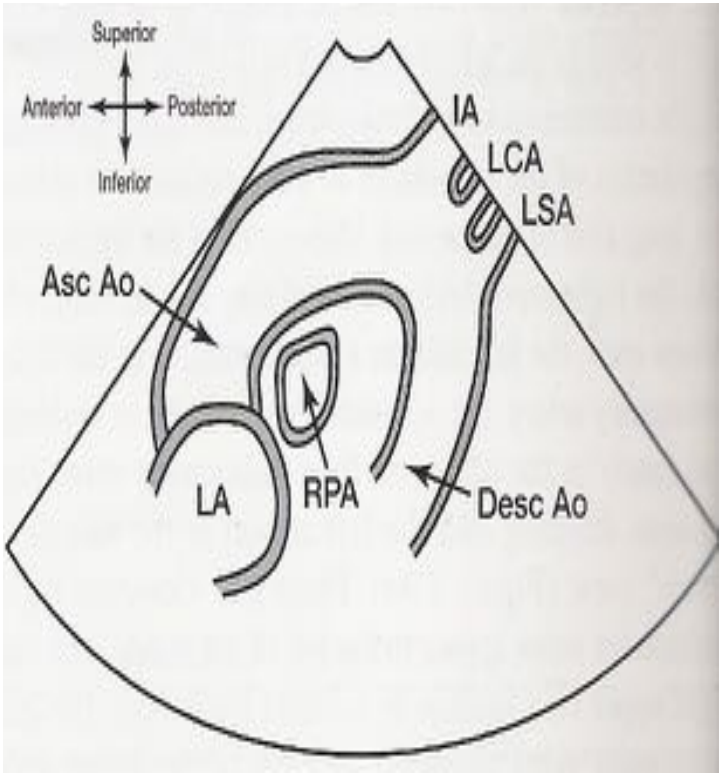
Different morphologic patterns based on age at diagnosis



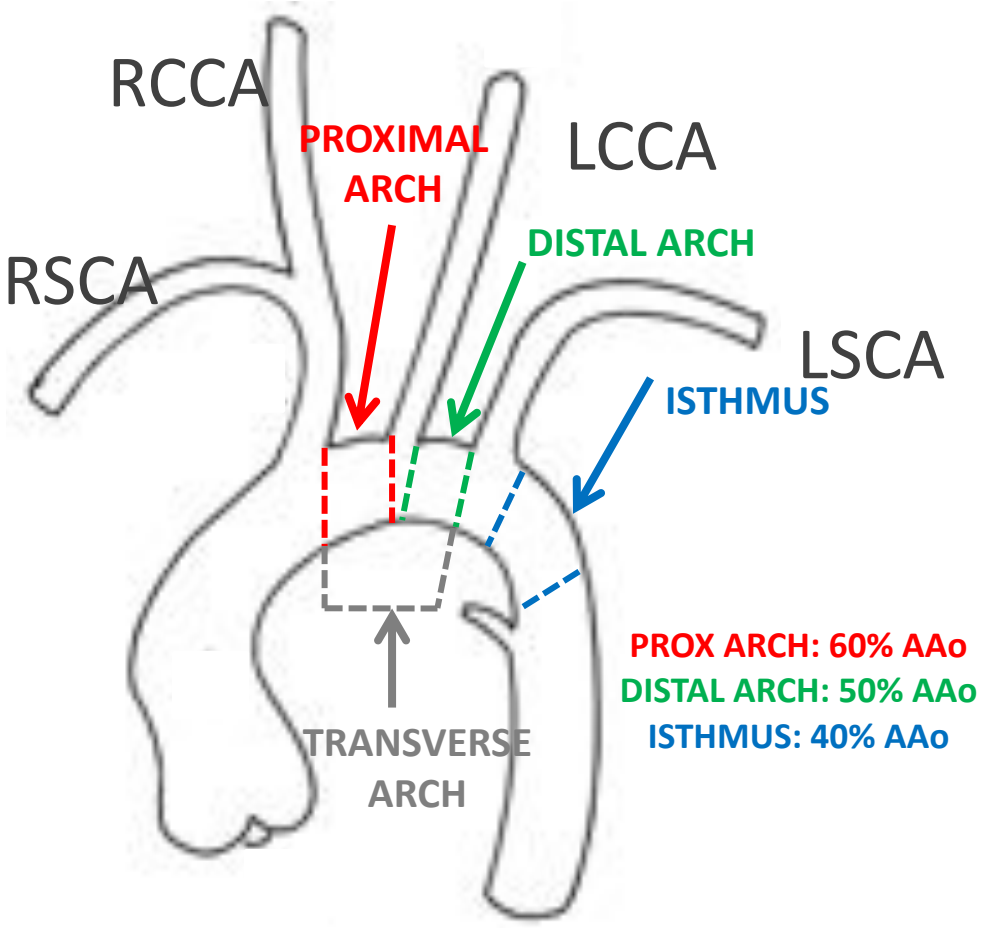
Suprasternal Long Axis

Comprehensive assessment of aortic arch



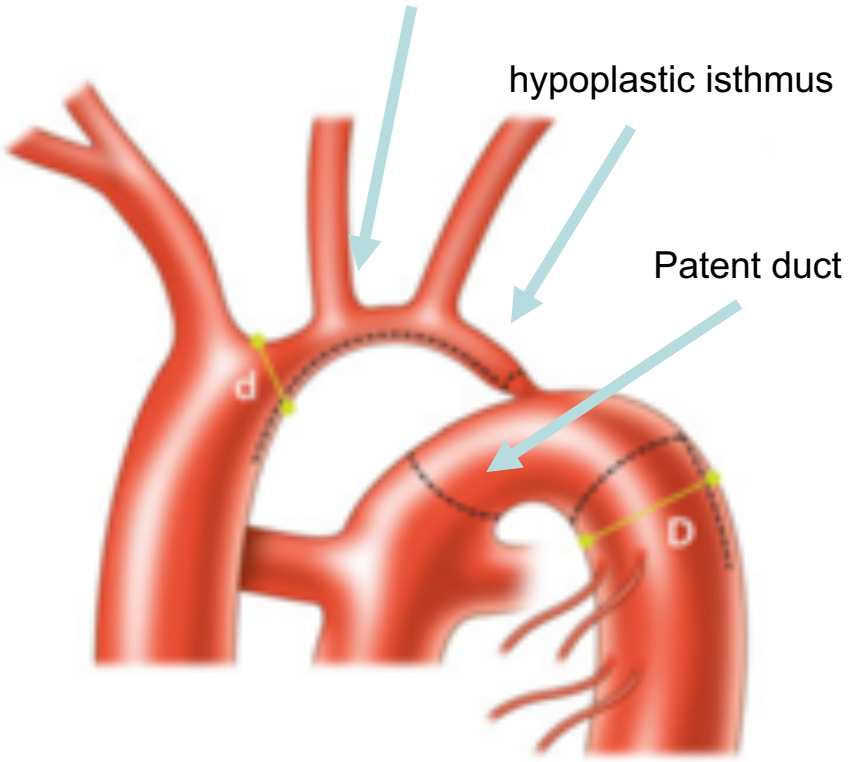


Neonatal coarctation



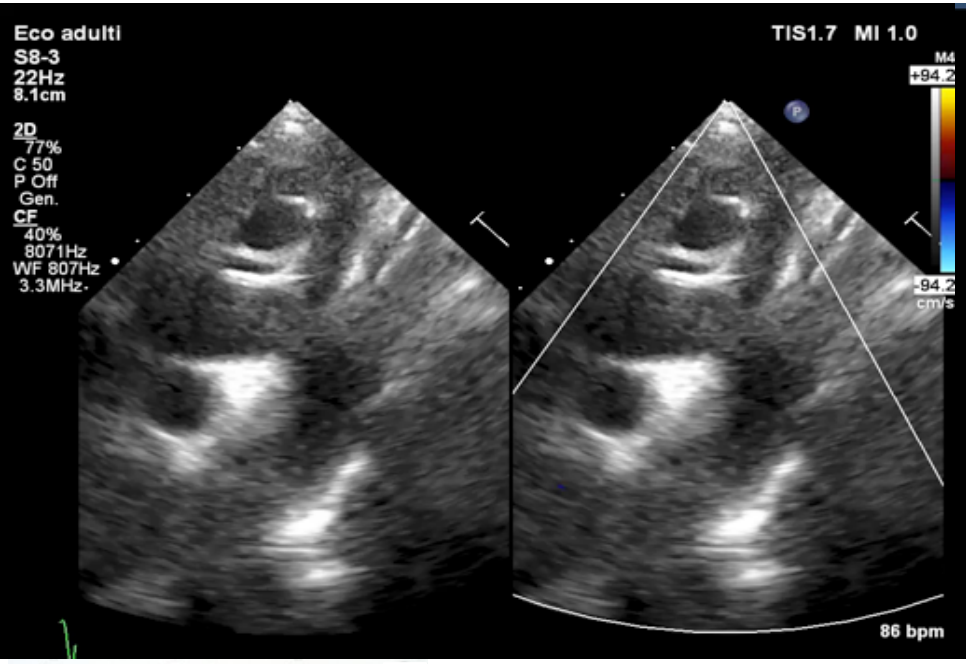
Normal arch

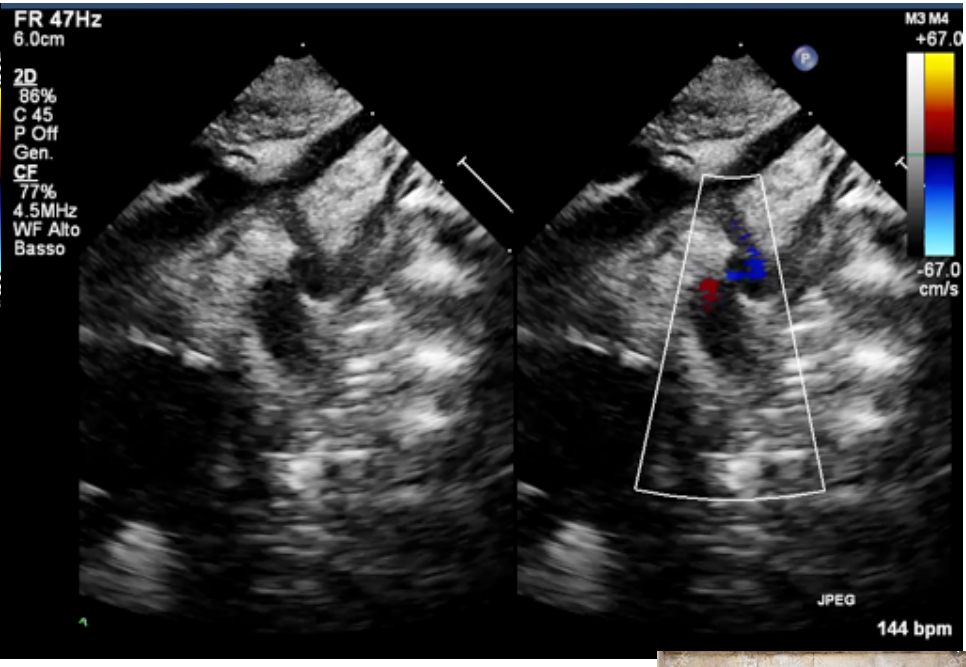
Hypoplastic (elongated) distal transverse arch between the LCA and the LSCA



Neonatal coarctation

Aortic arch view: oblique sagittal plane

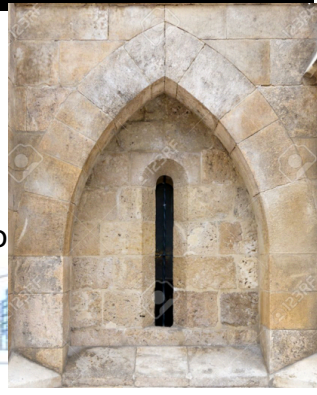




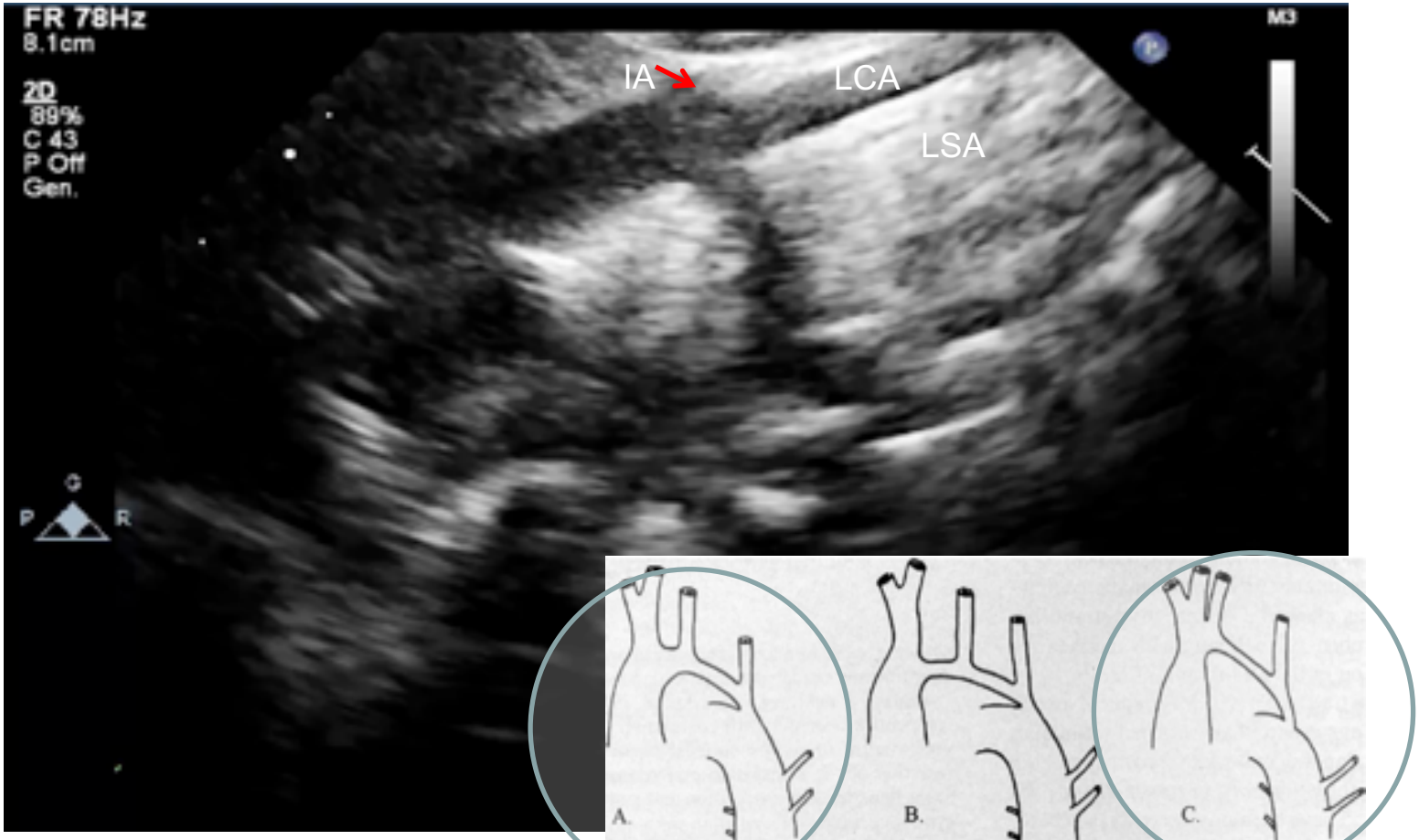
Normal arch

Coarctation

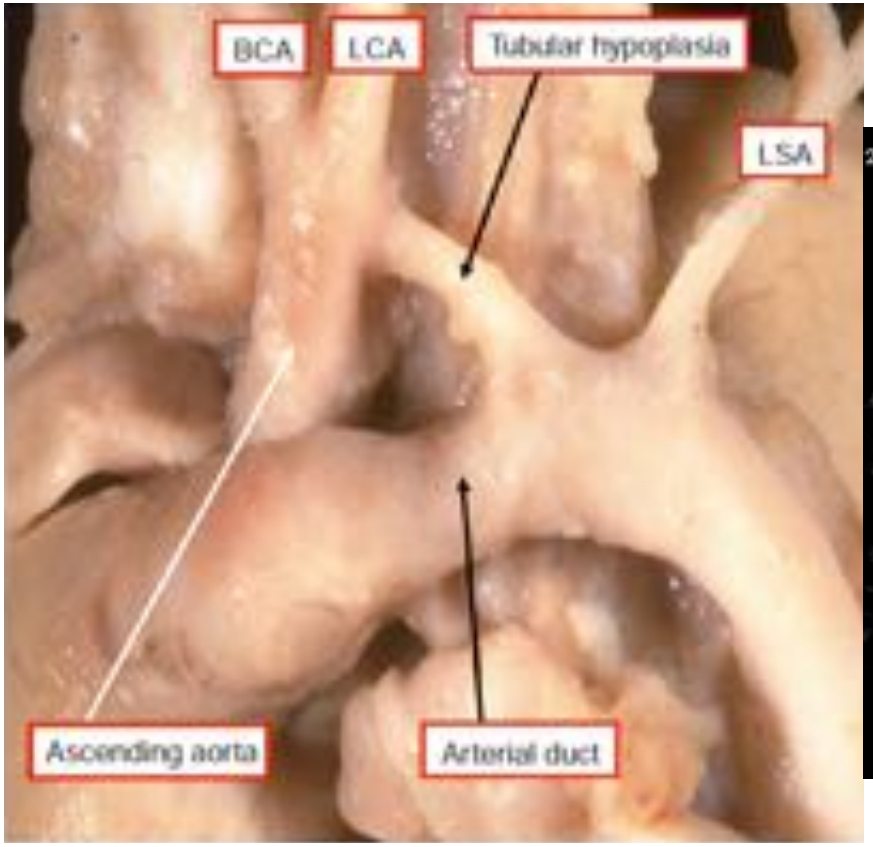
-various degree of arch hypoplasia and tortuosity
-acute angle between AAo and Desc Ao



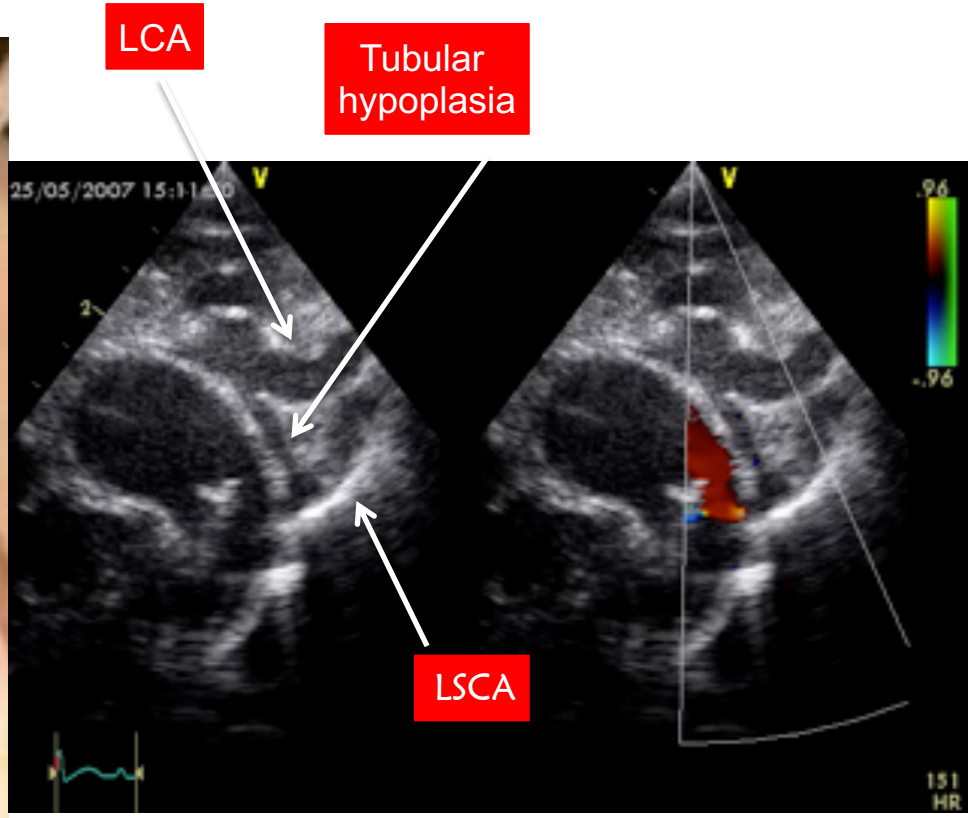
Tubular coarctation



Neonatal coarctation

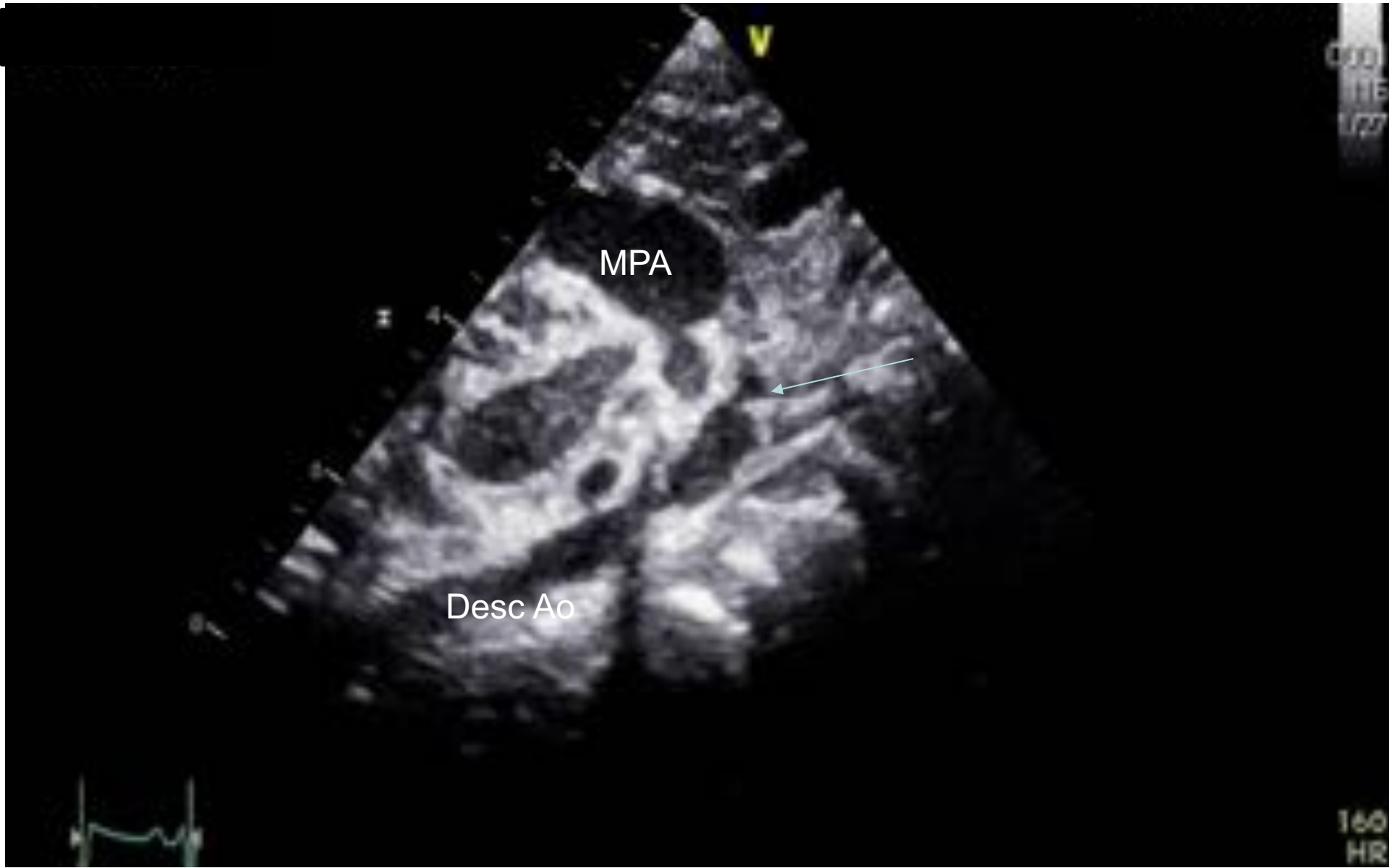


Paediatric Cardiology-3rd Edition;
Robert-Anderson-Edward-Baker-Andrew-Redington

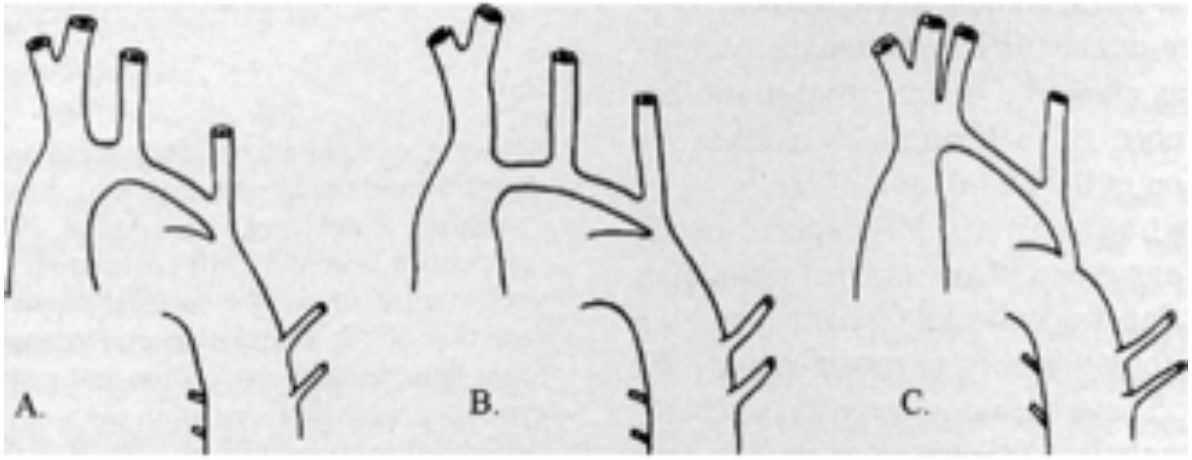


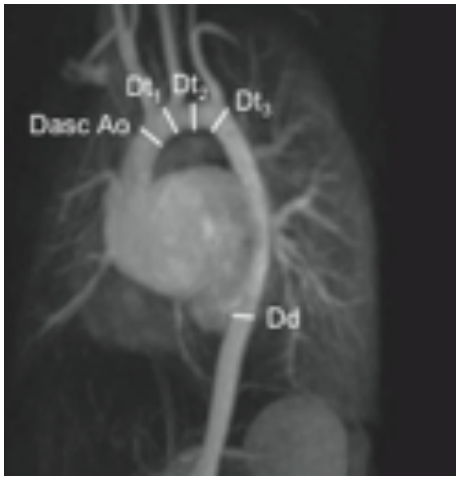
Zscore <2 = hypoplastic arch

Alternative approach: left subclavian view



Neonatal coarctation: surgical planning





- Degree of aortic arch and isthmus hypoplasia varies in both length and diameter
- Different potential head and neck vessels distribution
- Consider cross sectional imaging +++

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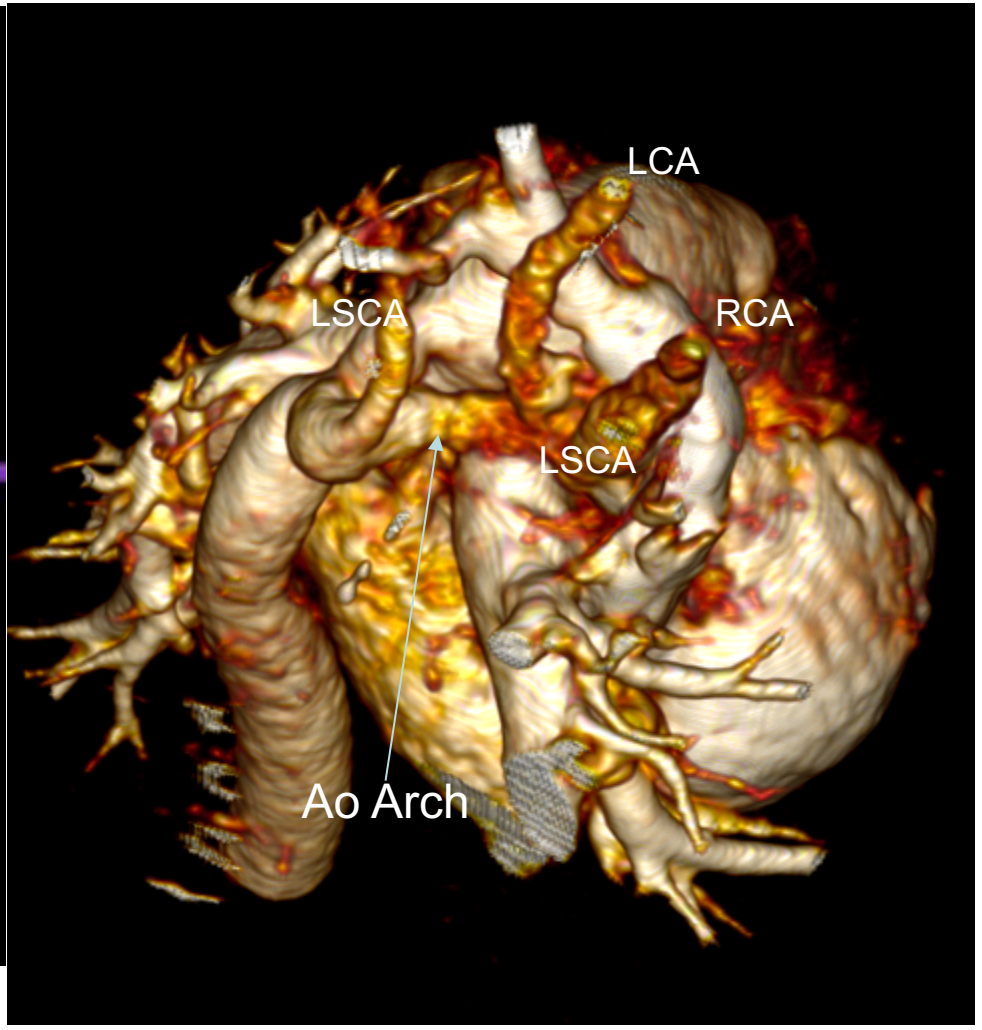
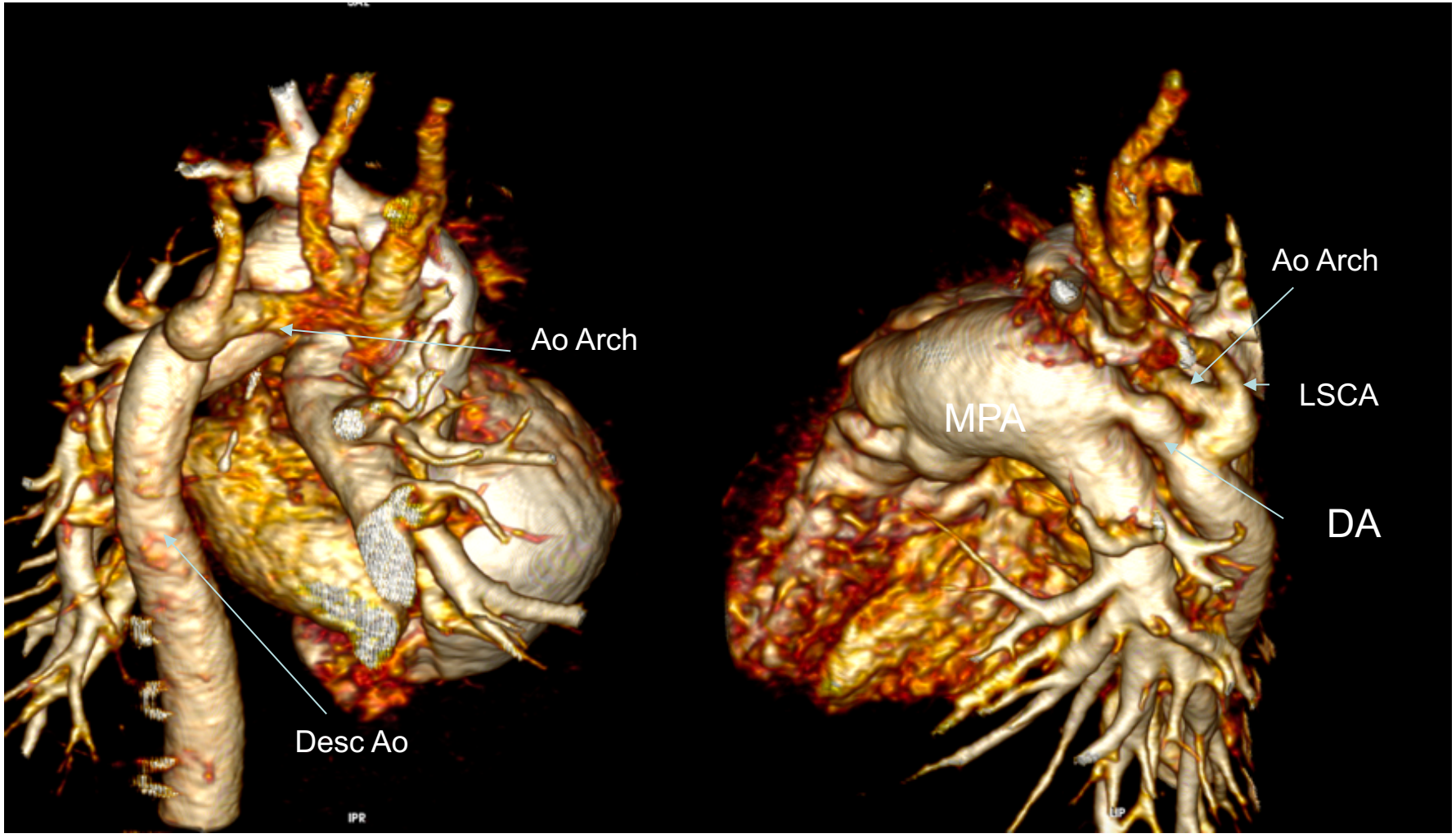
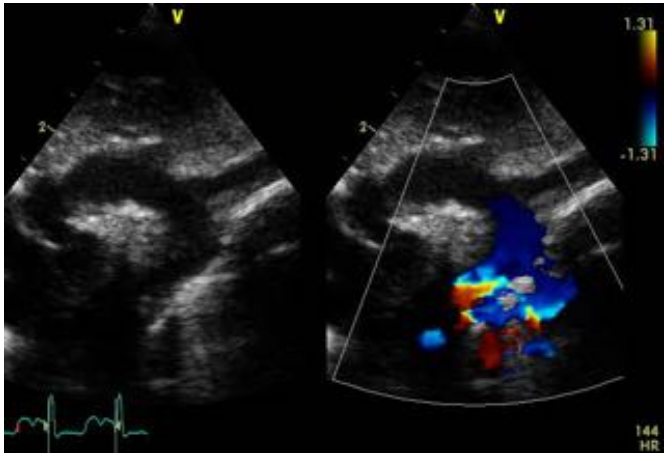
Computed tomography

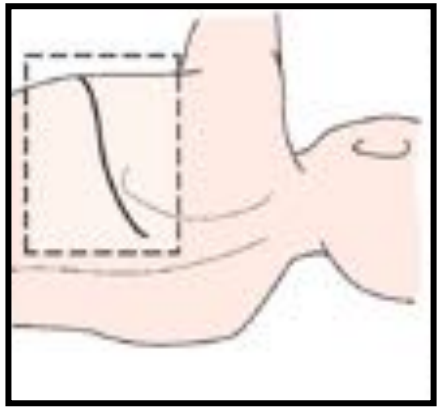


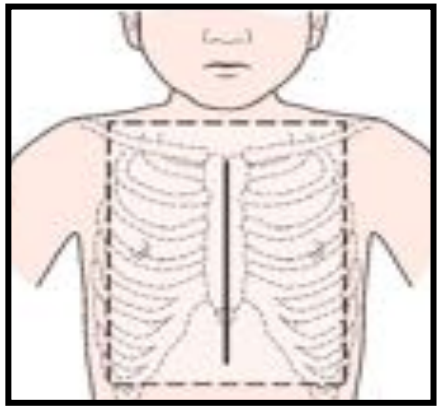
Computed tomography

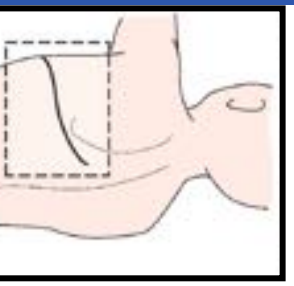


What the surgeon wants to know

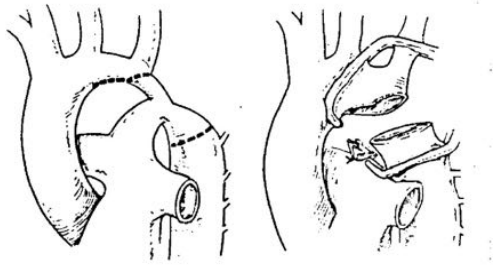


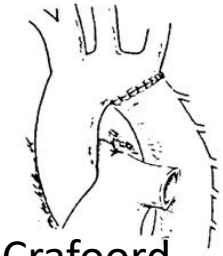




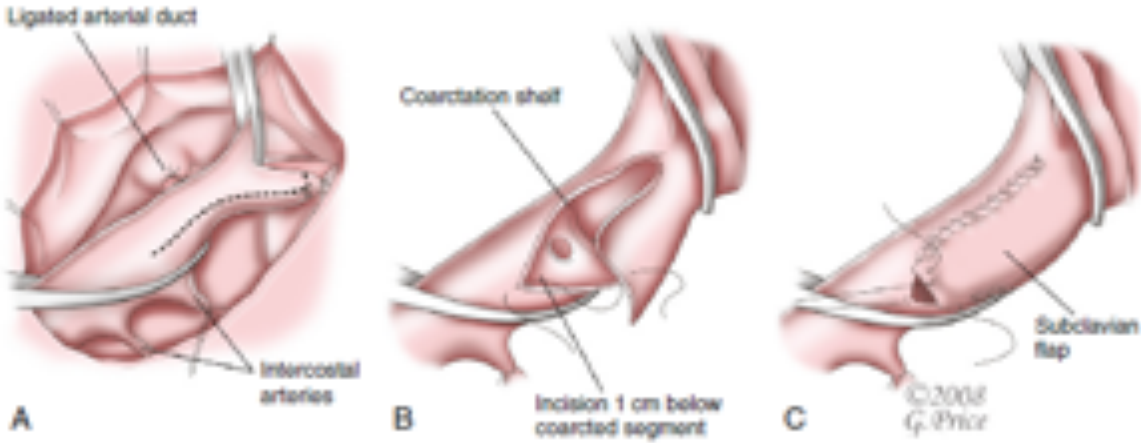


CoA repair from left thoracotomy

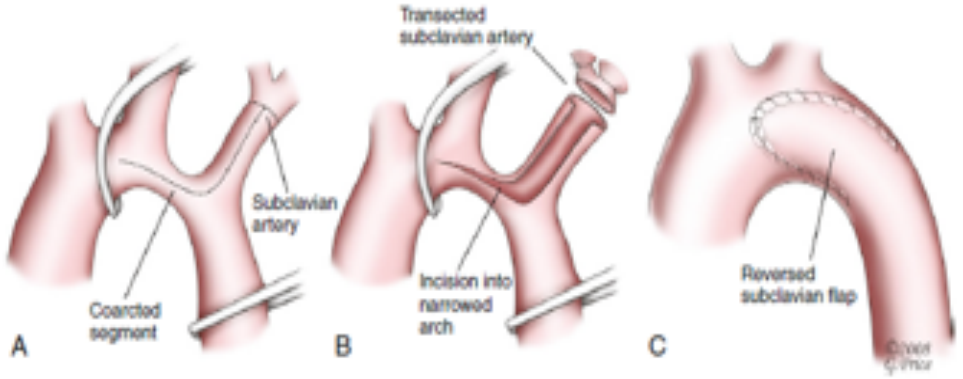




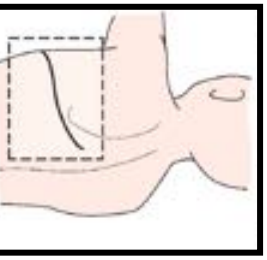
Crafoord



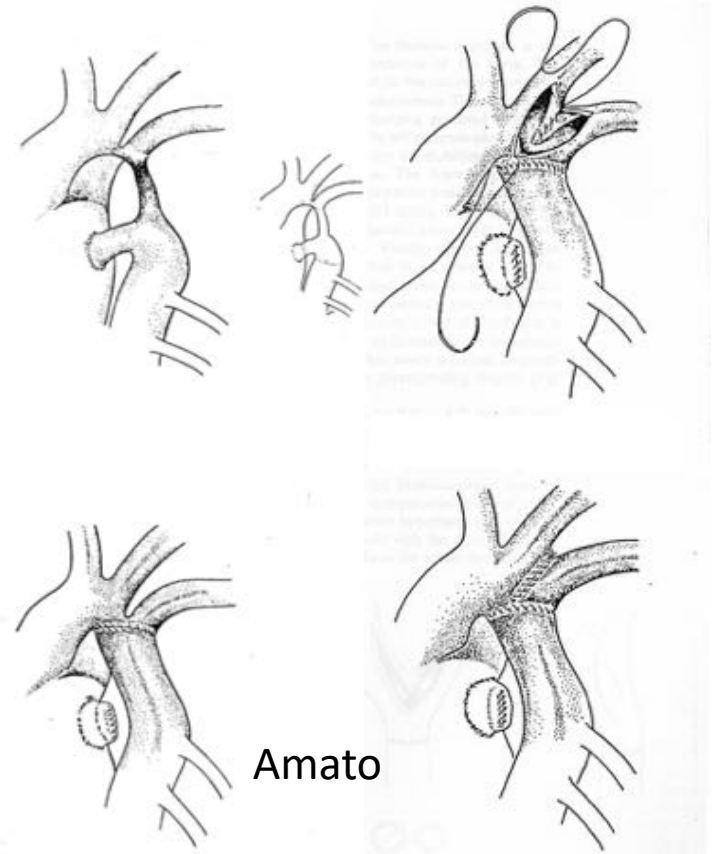
Waldhausen



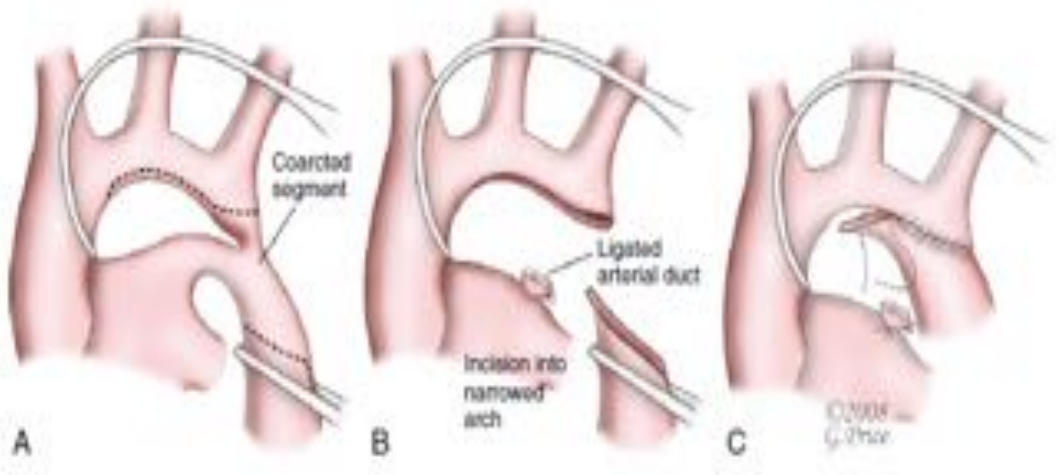
Tiraboshi



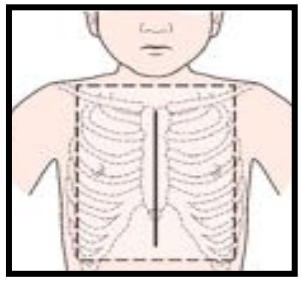
CoA repair from left thoracotomy



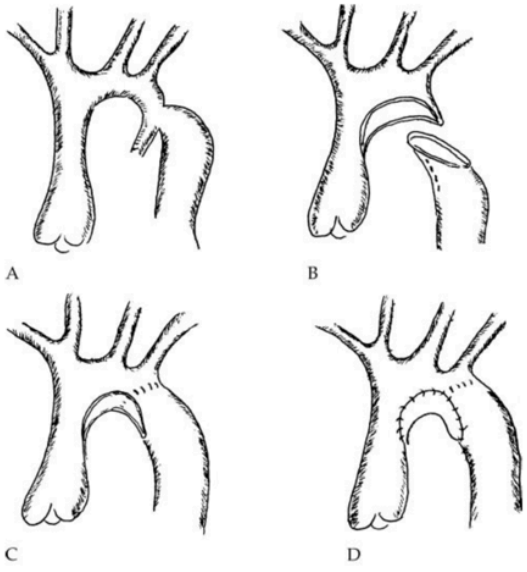
Amato

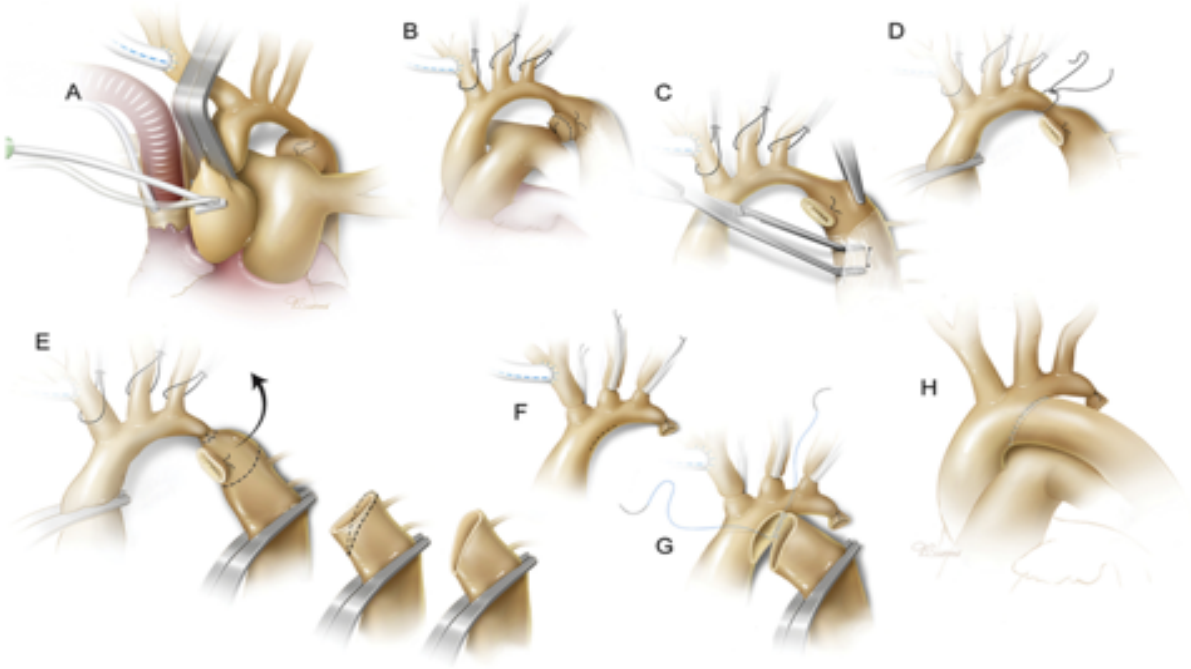


Extended Crafoord



Aortoplasty from the front





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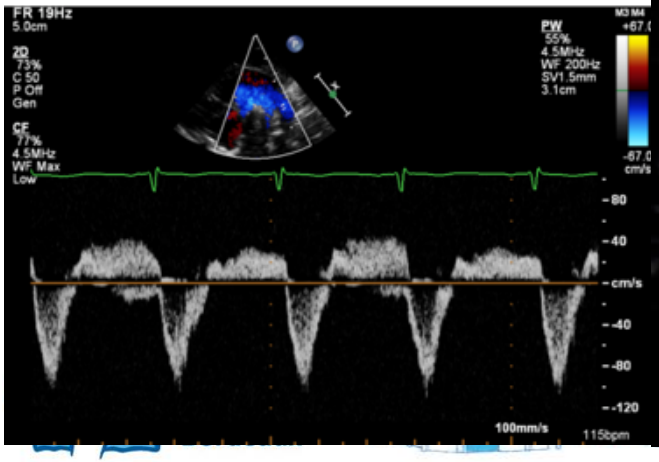
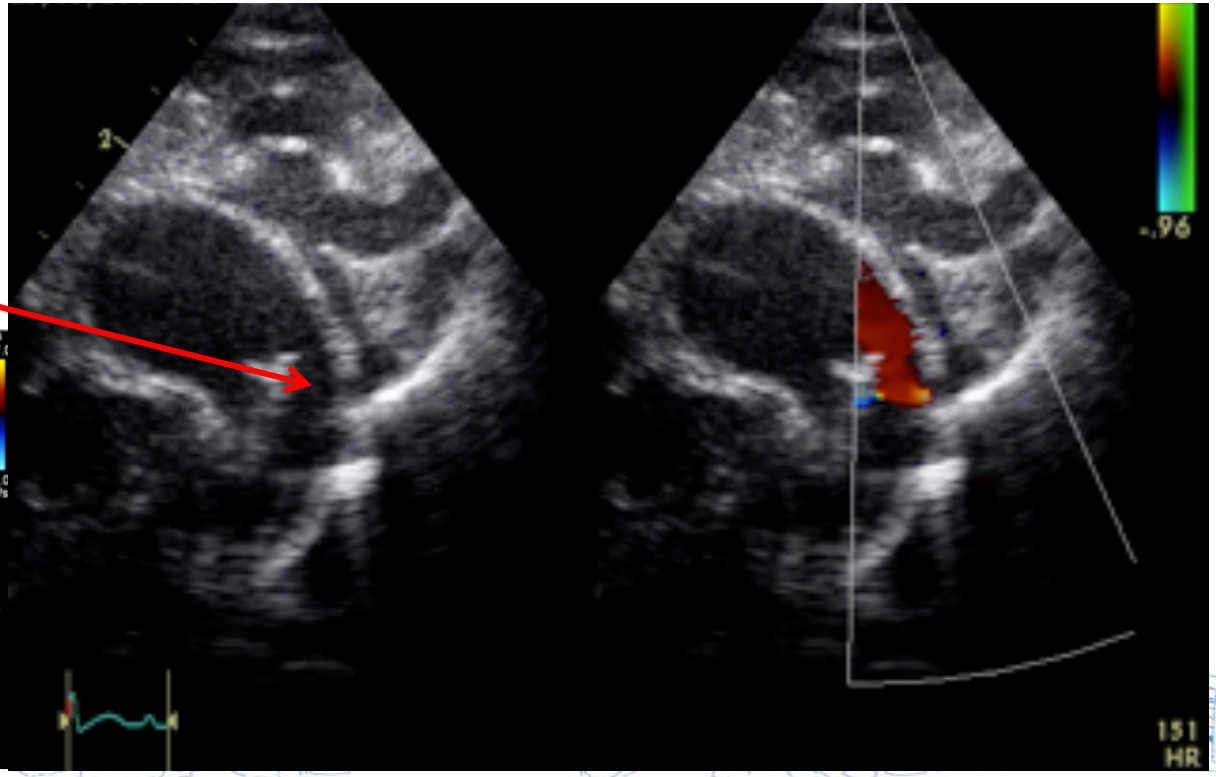
Neonatal CoA: change in spectral doppler pattern

- Arterial duct widely open after birth
- Severe coarctation + PH : bidirectionnal flow
  - R to L shunt during systole
  - L to R shunt during diastole

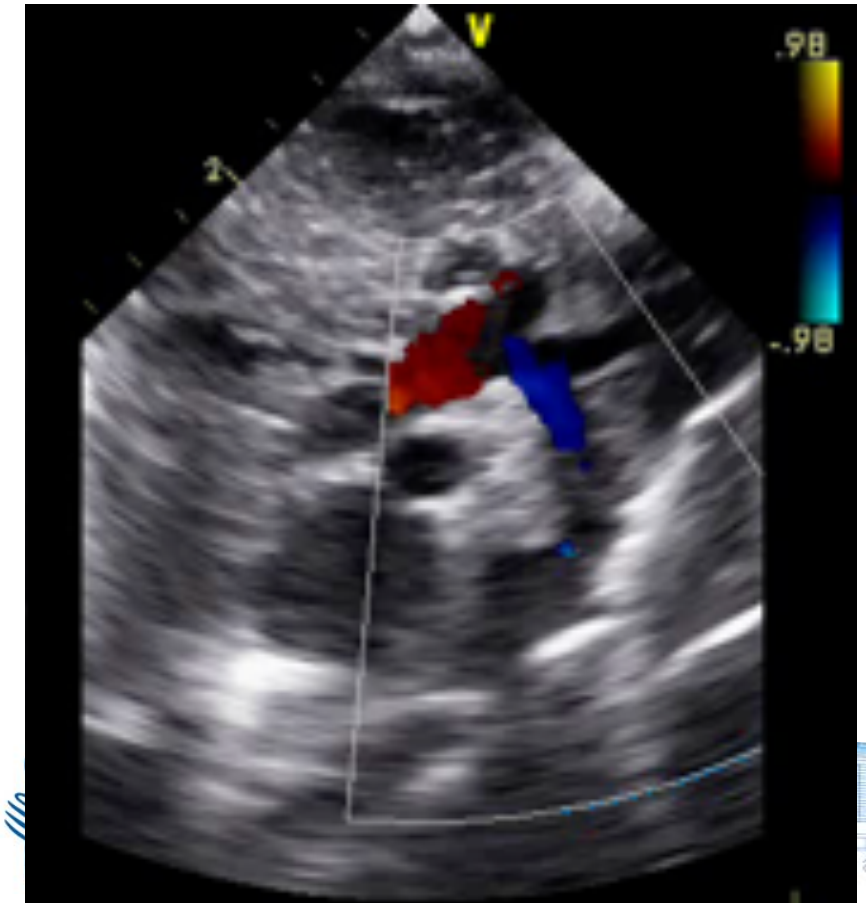
Bidirectional PDA shunt

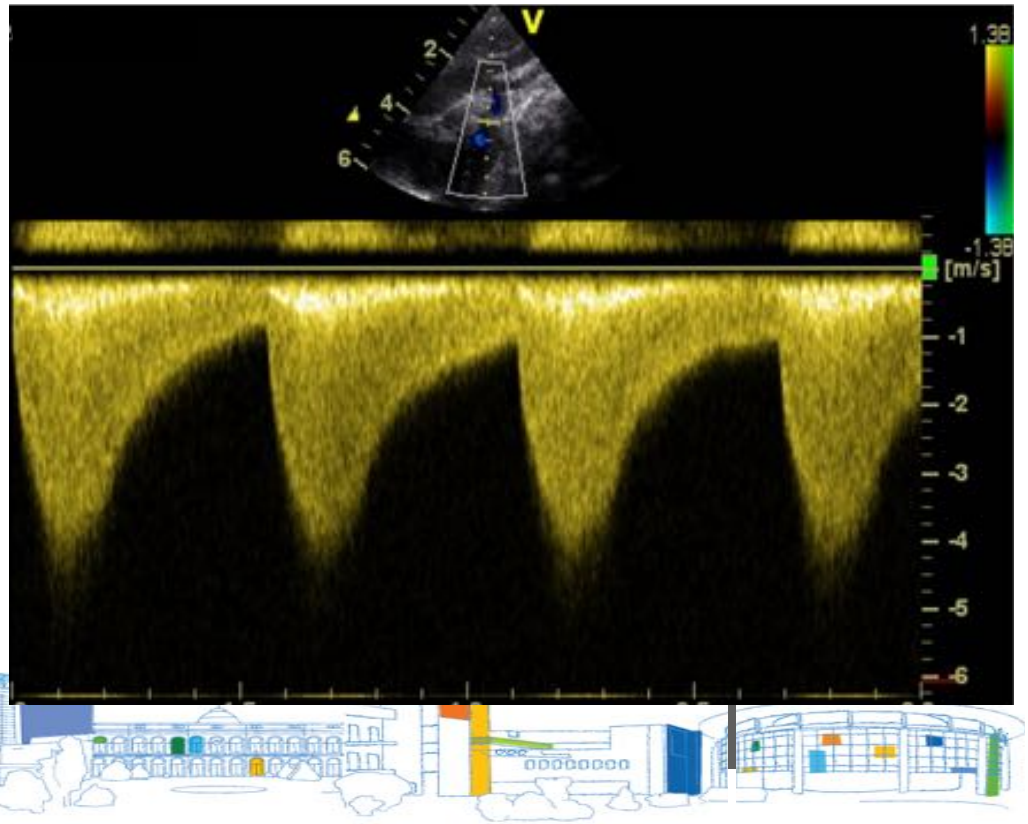




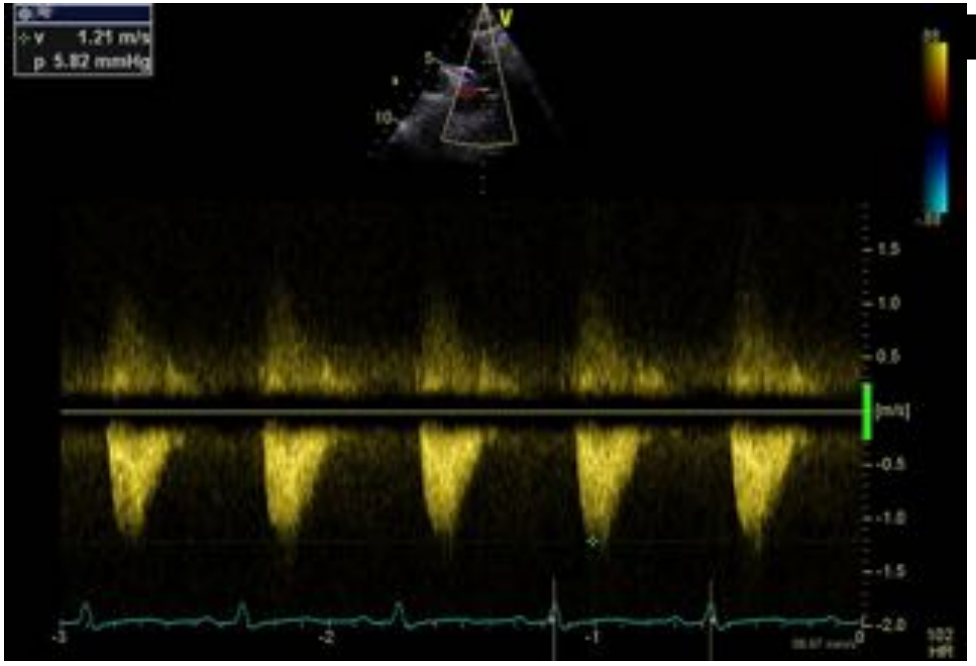
Neonatal CoA: change in spectral doppler pattern

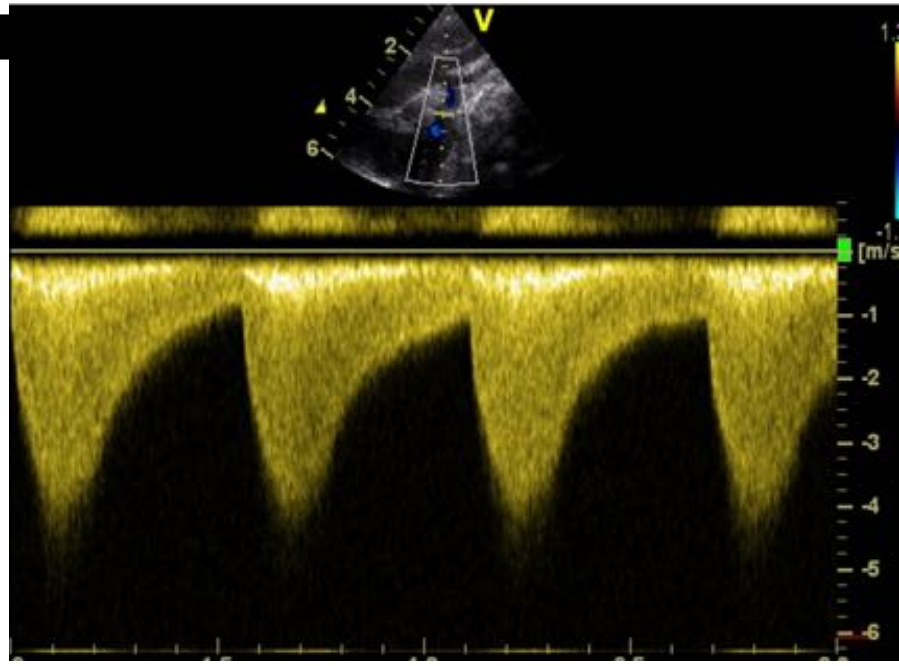
- Restrictive arterial or closed duct and preserved LV function
- High pressure gradient accross the CoA:
  - high velocity systolic peak
  - diastolic tail





Neonatal CoA: change in spectral doppler pattern



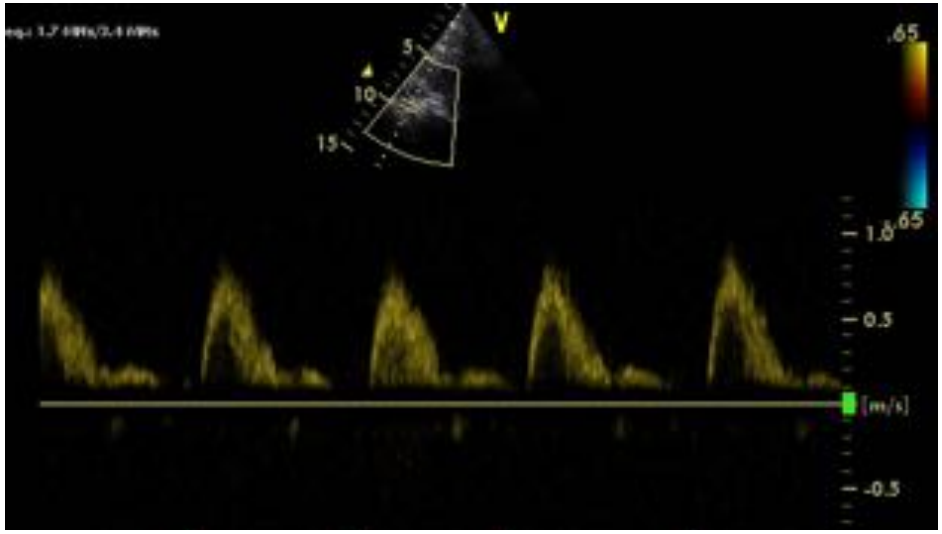


!! Pitfalls: typical flow can be missing

- PDA
- Multiple left heart obstructive lesions
- Low cardiac output
- Collaterals (older chidren)

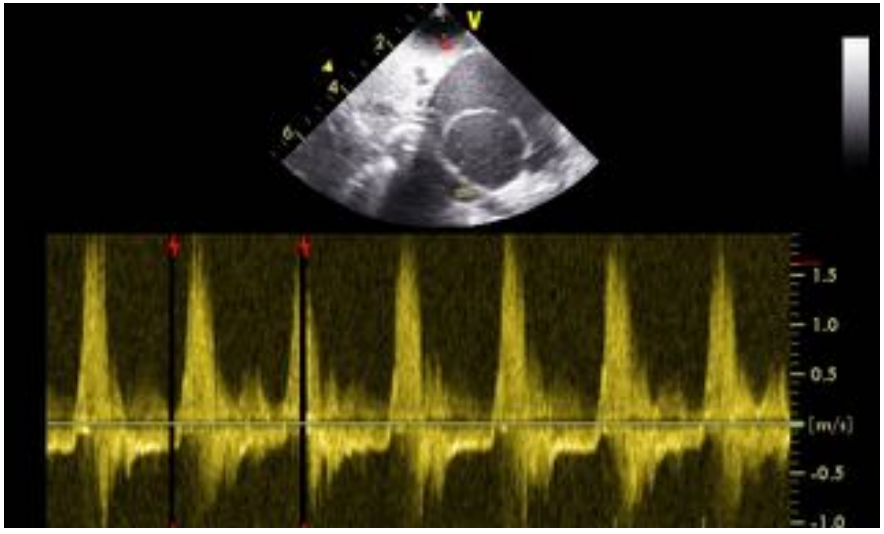
Abdominal aorta Doppler evaluation

Normal



- Systolic wave
- No diastolic tail
- No reversed diastolic flow

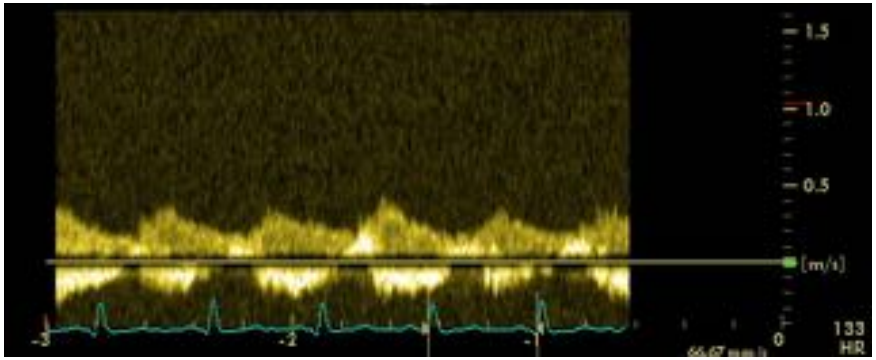
Coarctation+ PDA + PH



- Near normal systolic flow
- Absent diastolic tail
- Slighly reversed diastolic flow

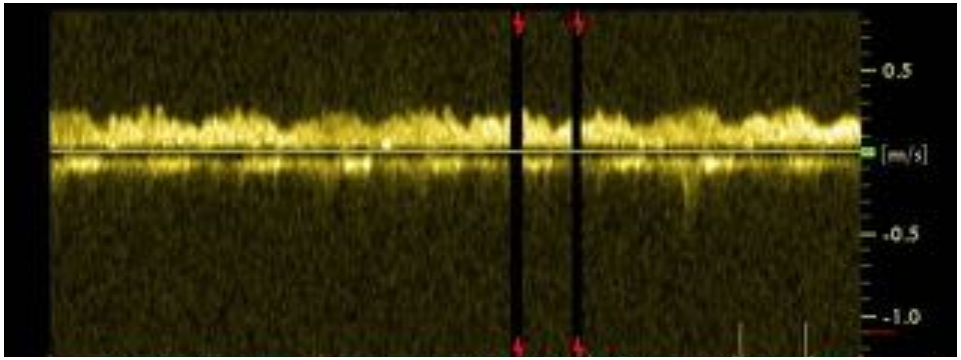
Abdominal aorta Doppler evaluation

CoA and restrictive arterial duct with preserved LV function



- Low systolic wave form amplitude
- Antegrade diastolic flow
- Phasic variations depending on LV function

CoA with closed duct and impaired LV function

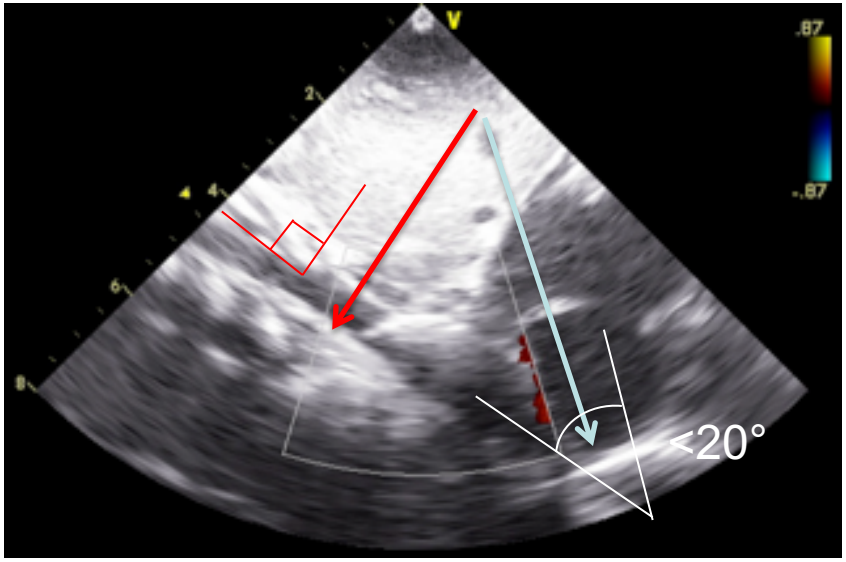


- Extremely low velocity flow
- Minimal phasic variations

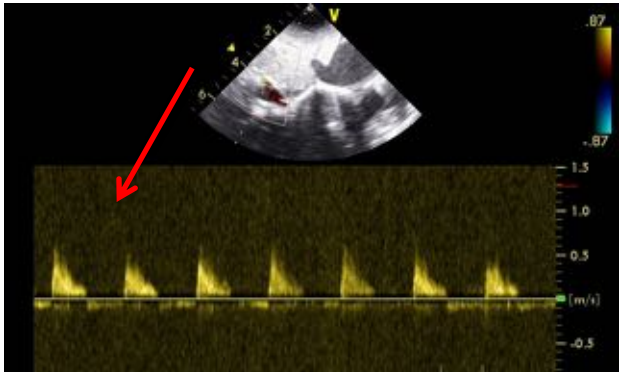
Pitfalls

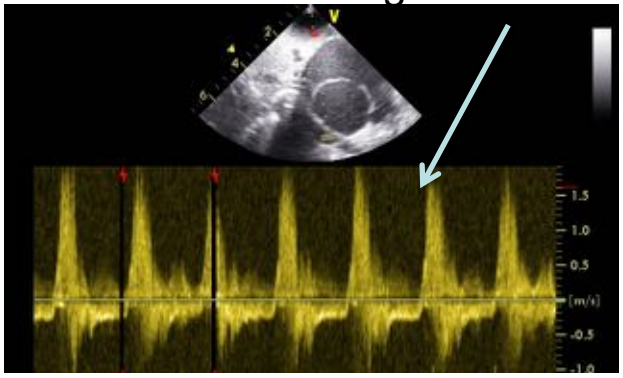
$$\Delta F = 2.Ft.v.\cos\theta / c$$

ΔF : doppler shift
V : blood velocity
F_t : transmit frenquency
C : celerity (velocity of sound in soft tissue
θ : angle between direction of US wave propagation and blood motion

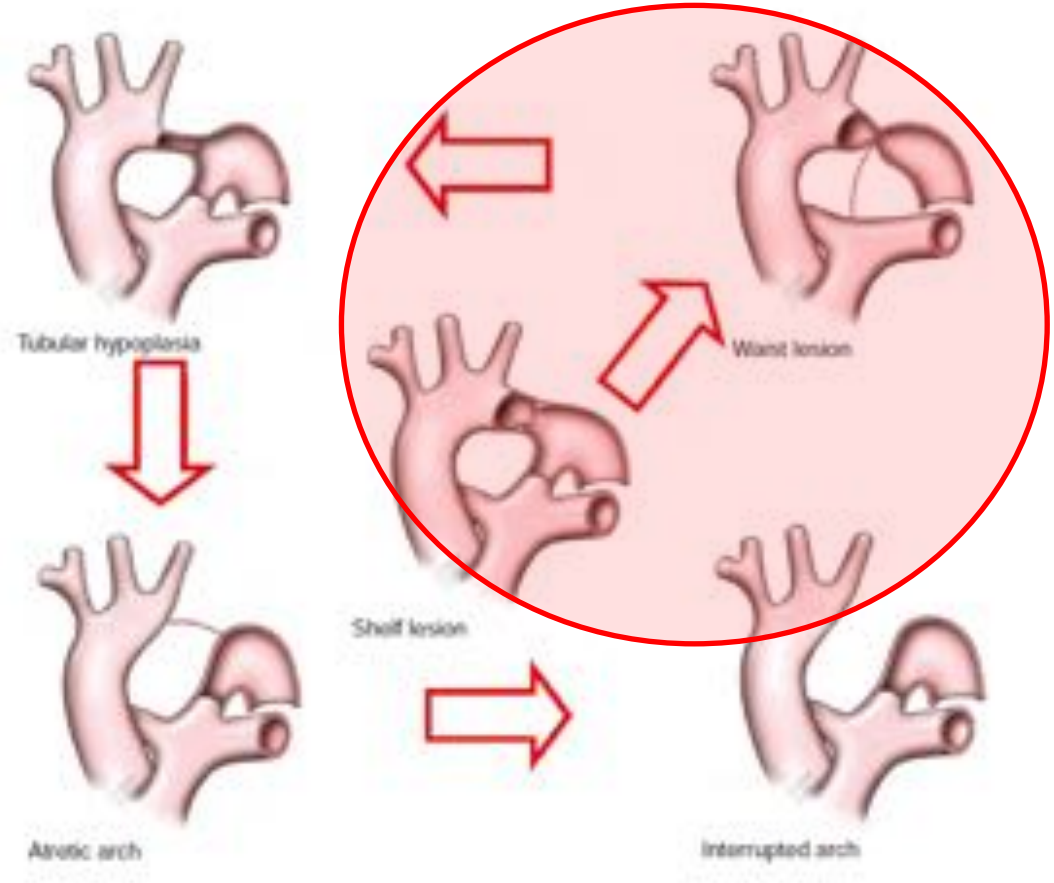


Cosinus of 90° = 0 = no signal
Angle < 20° acceptable in practice





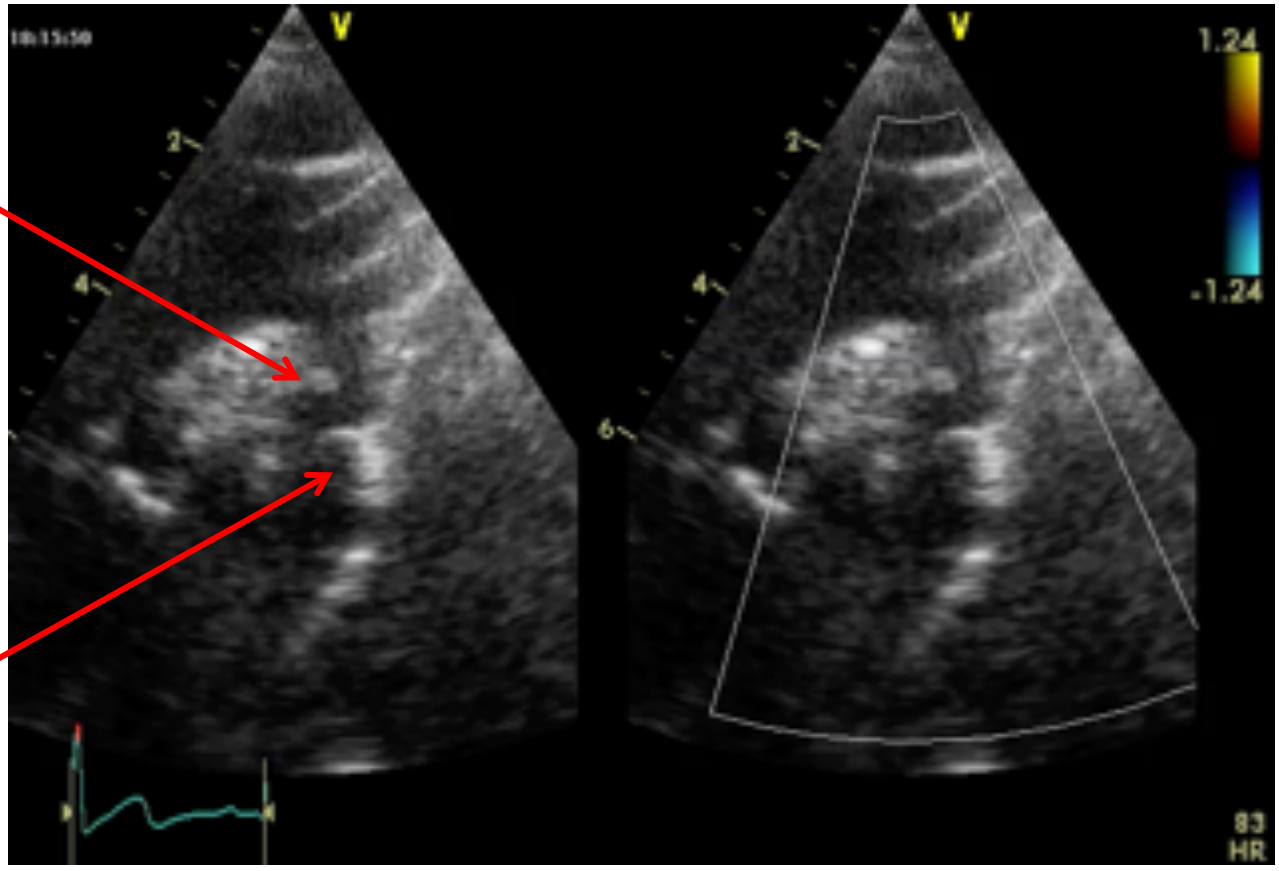
Coarctation of Aorta: Morphology



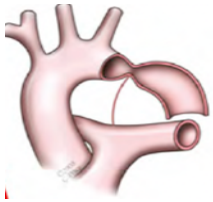
CoA of the aorta: shelf lesion

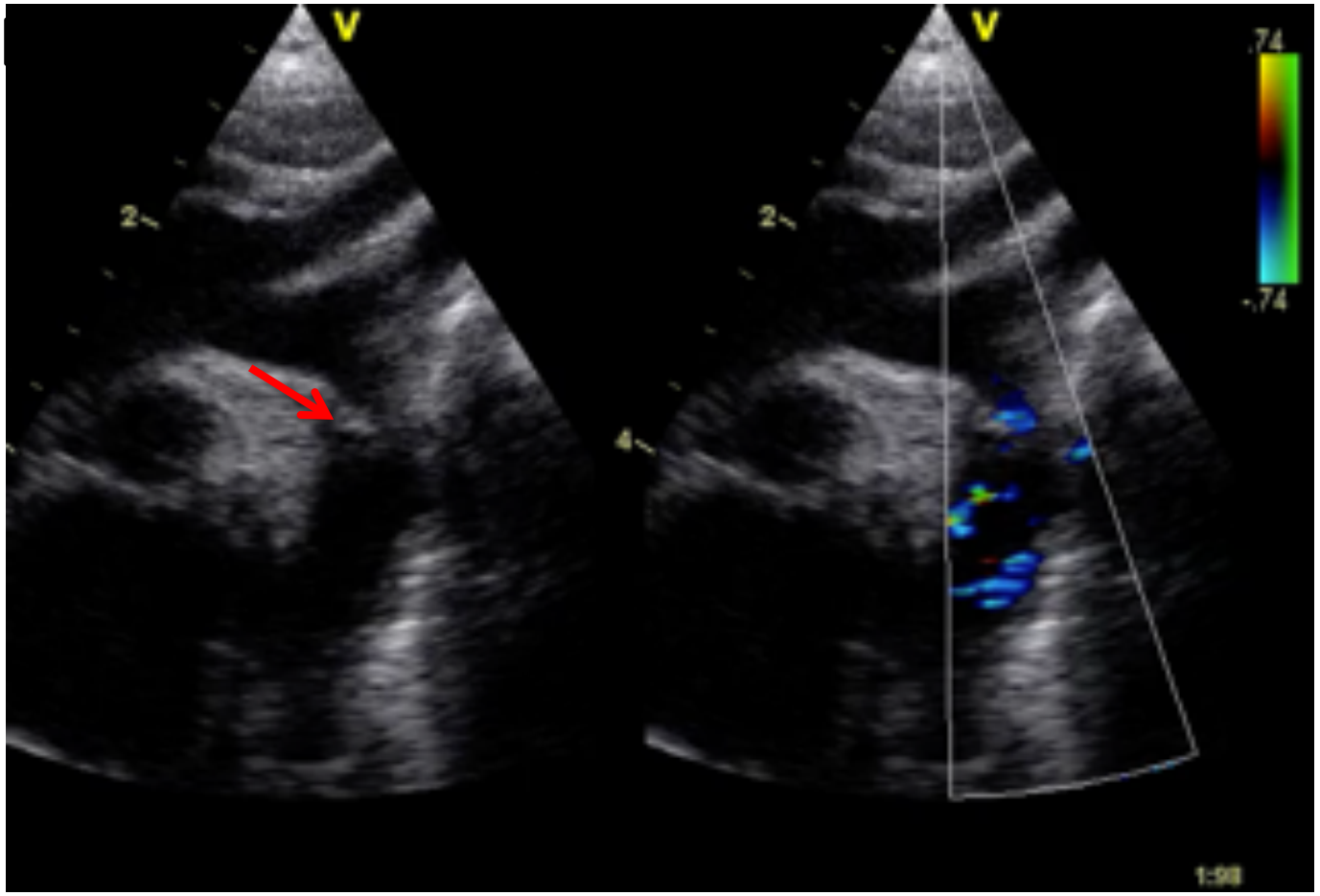
Obstruction at the site of the aortic ampulla

Coarctation ridge



CoA of the aorta: waist lesion





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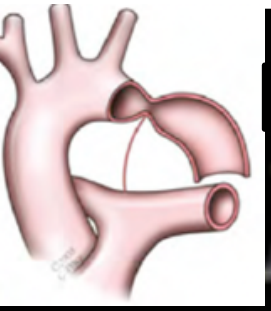
CoA of the aorta: waist lesion



Alternative approach:

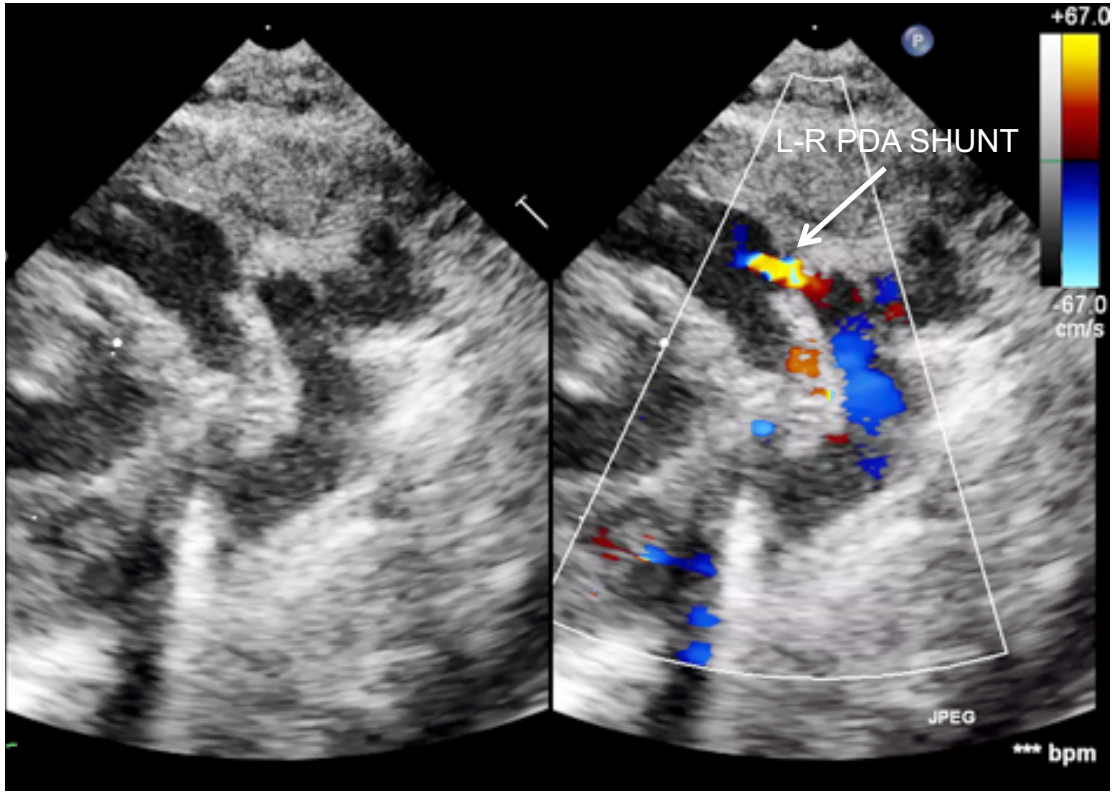
High left parasternal view

MPA

Desc Ao

Kinking

- Elongation and tortuosity of the terminal arch and prox Desc Ao
- Figure « 3 »
- Acute angle at the level of the duct
- No/mild pressure gradient

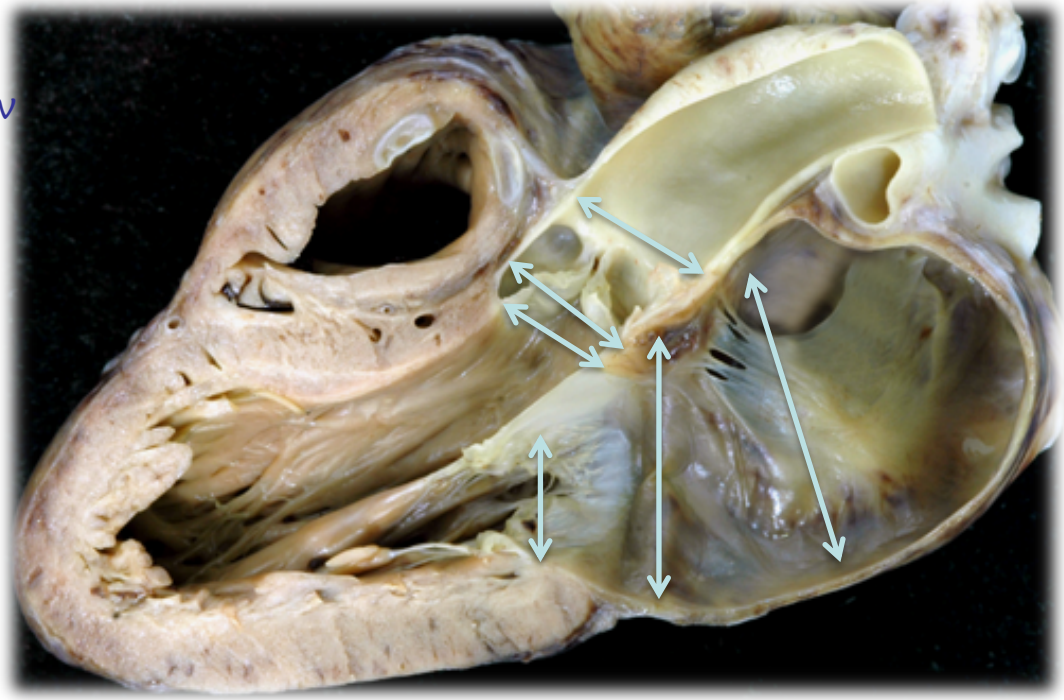


Kinking

- Elongation and tortuosity of the terminal arch and prox Desc Ao
- Figure « 3 »
- Acute angle at the level of the duct
- No/mild pressure gradient

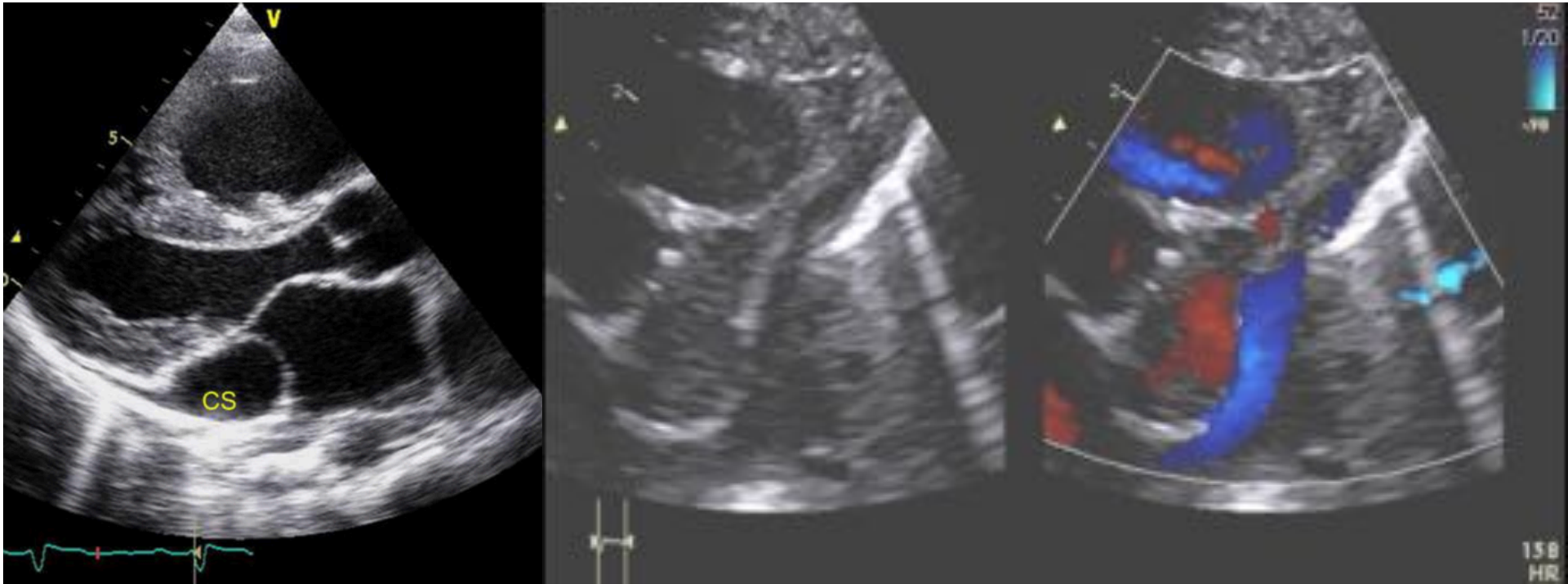
DIFFERENT LEVELS OF OBSTRUCTION

- Extremely frequent >50%
- Bicuspid aortic valve
- Obstruction of LV inflow and outflow
  - Congenital **stenotic** lesions of the **mitral valve**
  - Valvar and subvalvar **aortic stenosis**
- Increased pulmonary rather than systemic pathway
  - **VSD** (PM/Posterior malalignment)
  - **AVSD**
- Complex CHD
  - **TA** and **VA discordance**
  - **DORV/TGA**

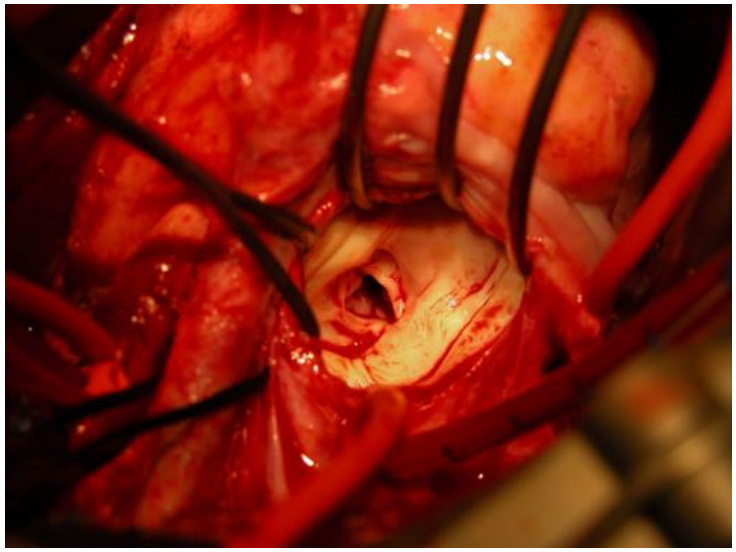


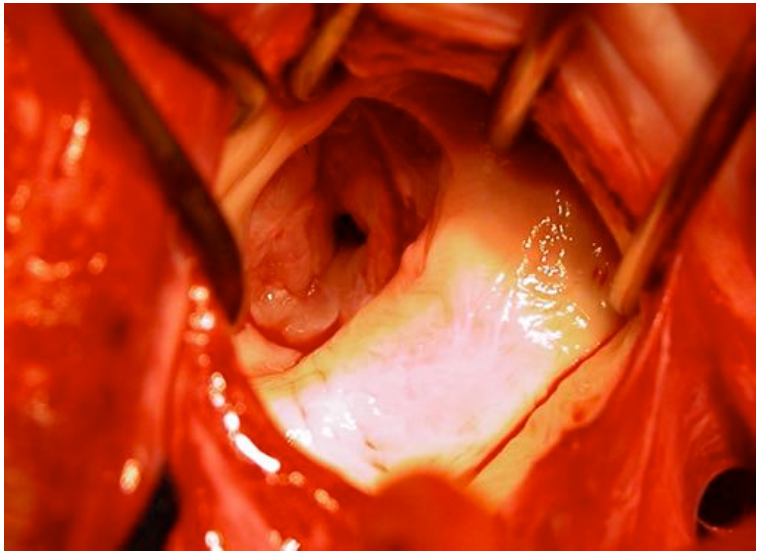
courtesy Beatrice Bonello

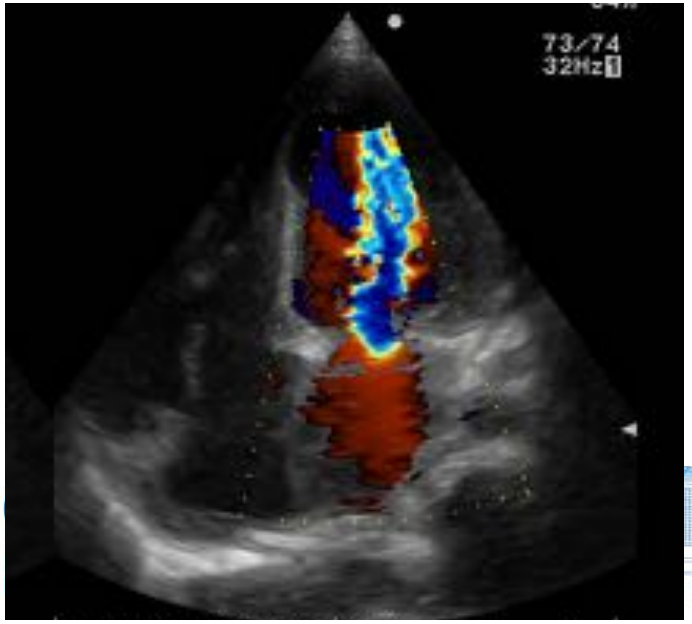
Left SVC



Supra mitral ring

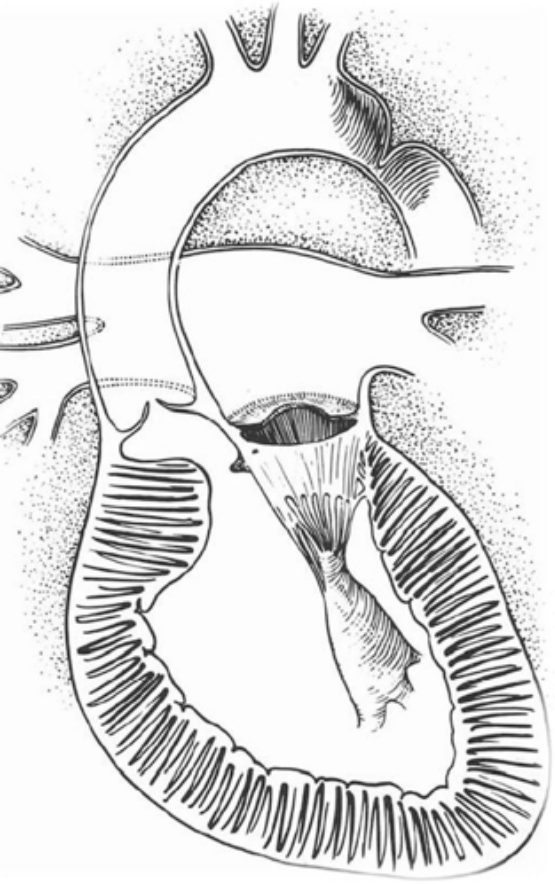


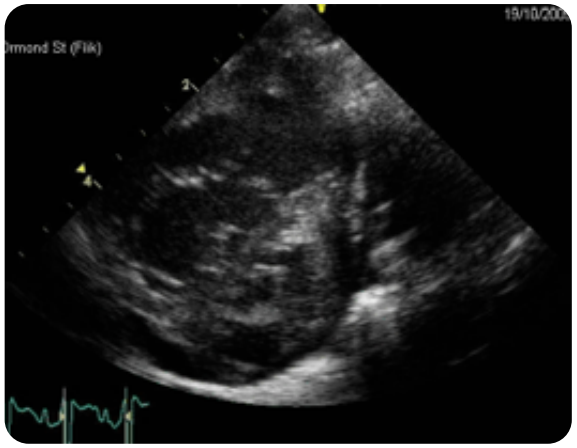


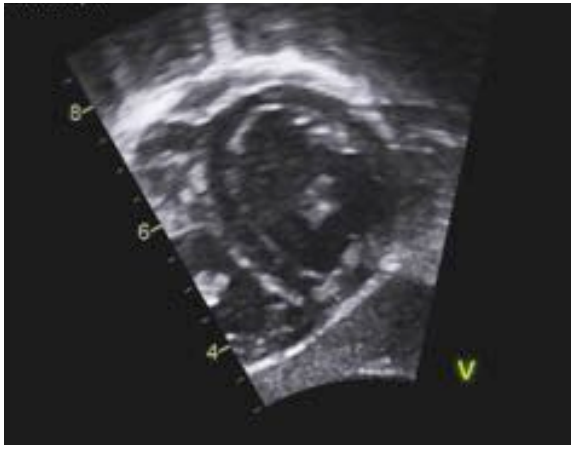


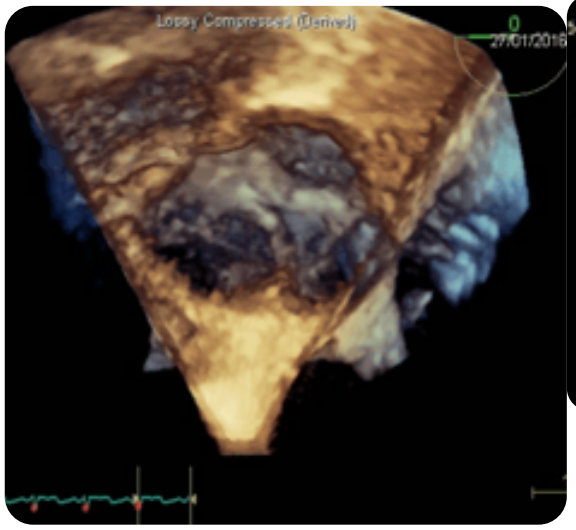
Courtesy Bernard Kreitmann

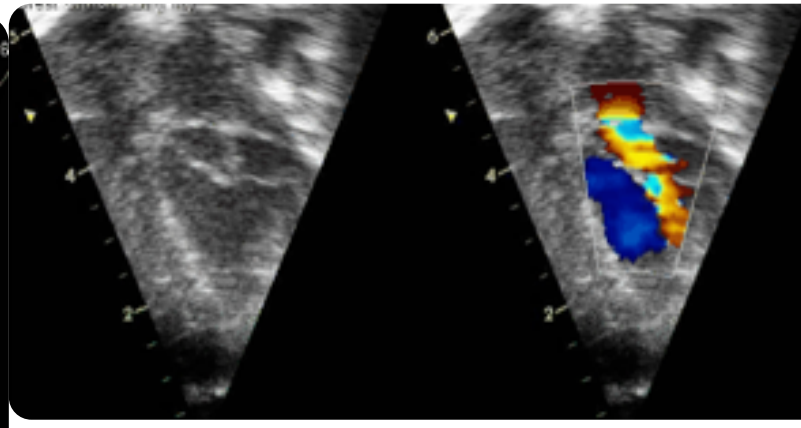
Shone complex







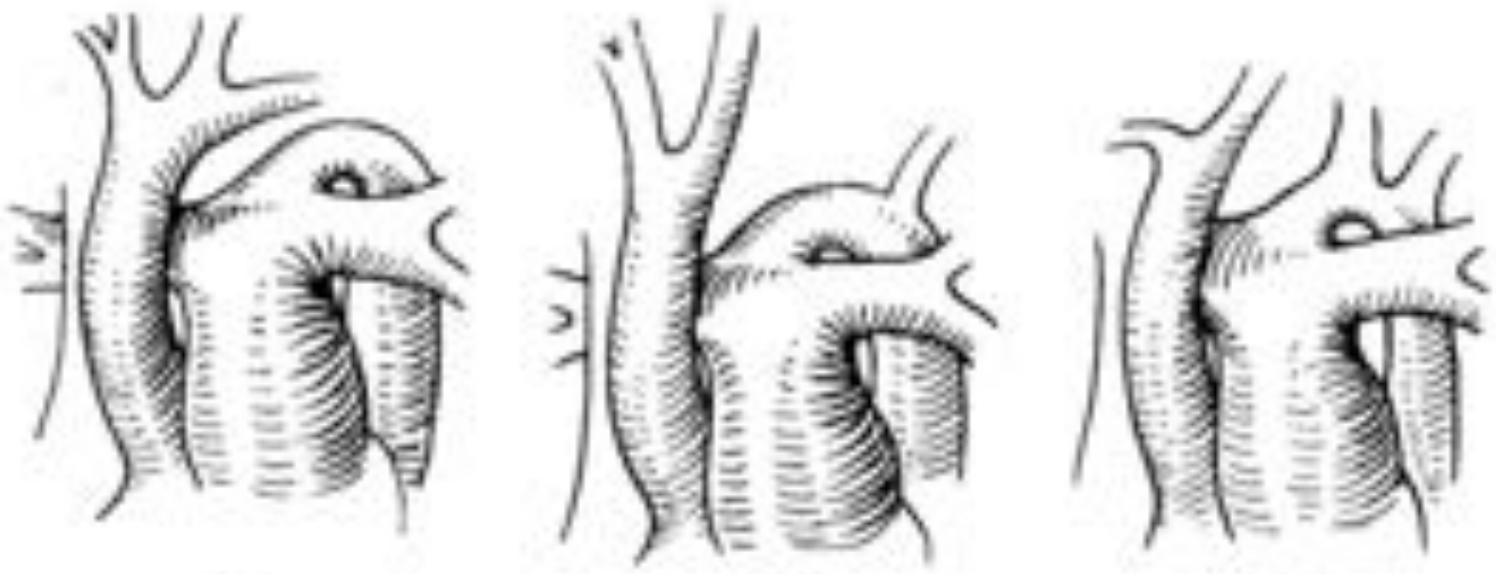




Imaging of coarctation and interrupted aortic arch

- Introduction and pathophysiology
- imaging of coarctation
- Imaging of interrupted aortic arch

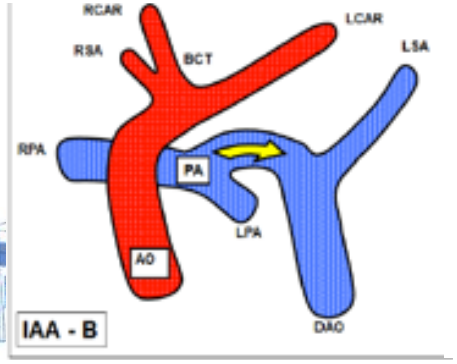
Celoria and Patton classification

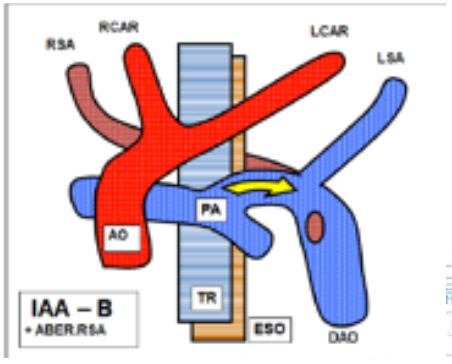


33%

66%

1%





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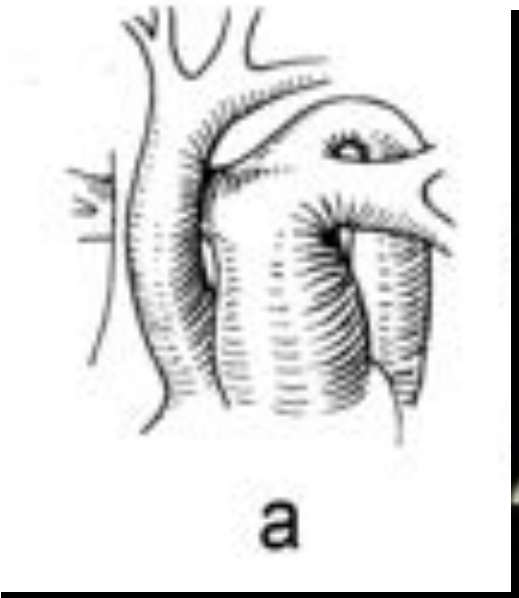
Type A IAA



-site of interruption
-Ao arch diameter
-Distance IAA-DescAo

BCA
LCA
LSCA
Short atretic segment
Desc Ao

Type A IAA

a

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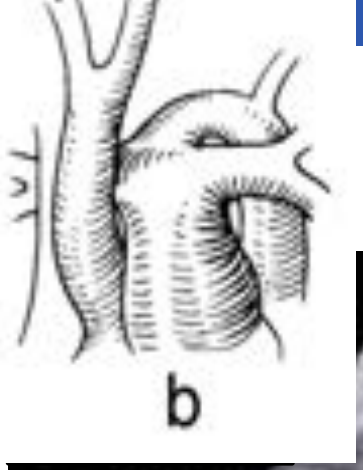
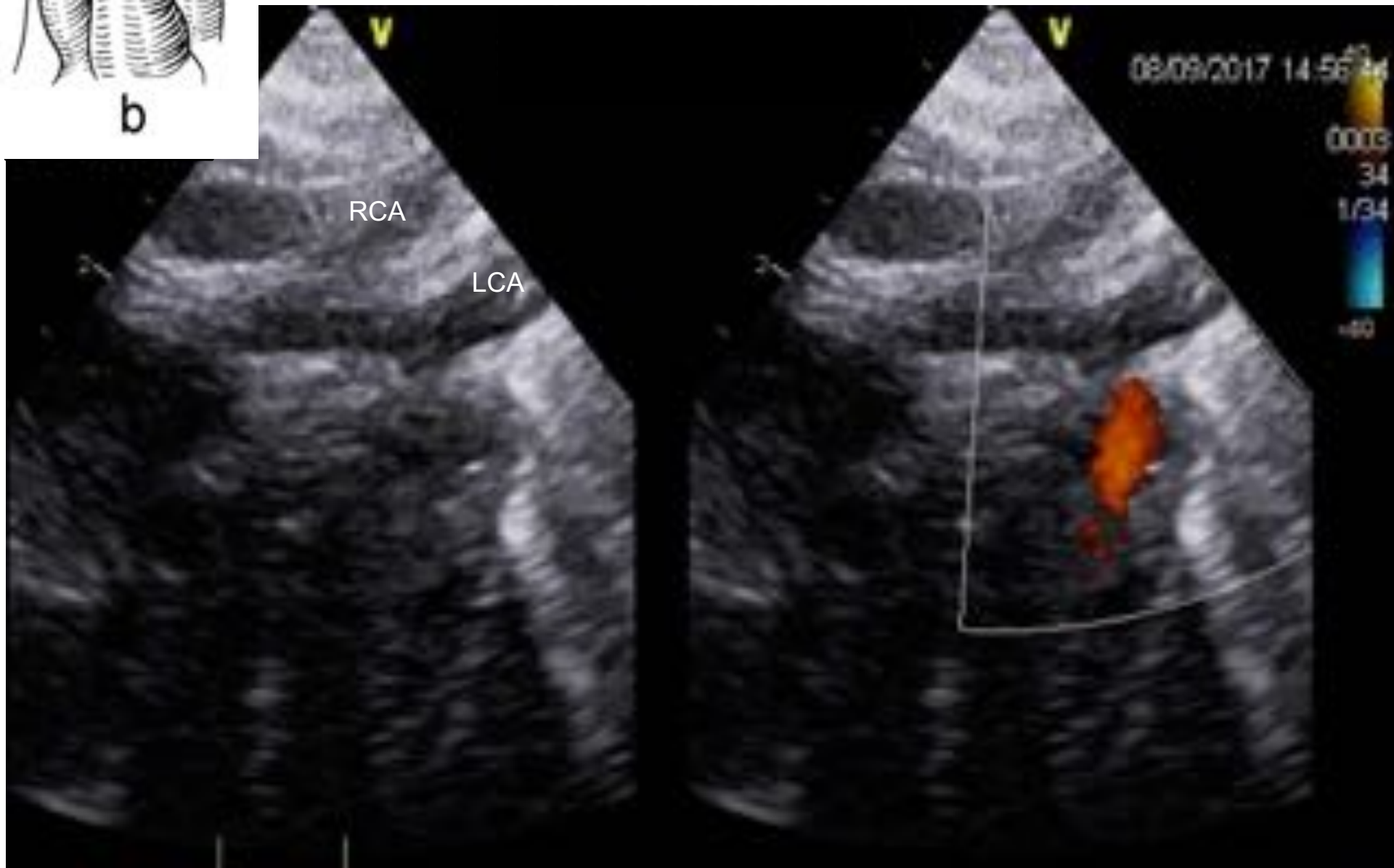
Type B IAA





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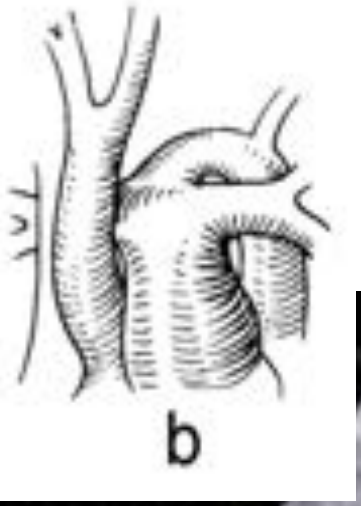
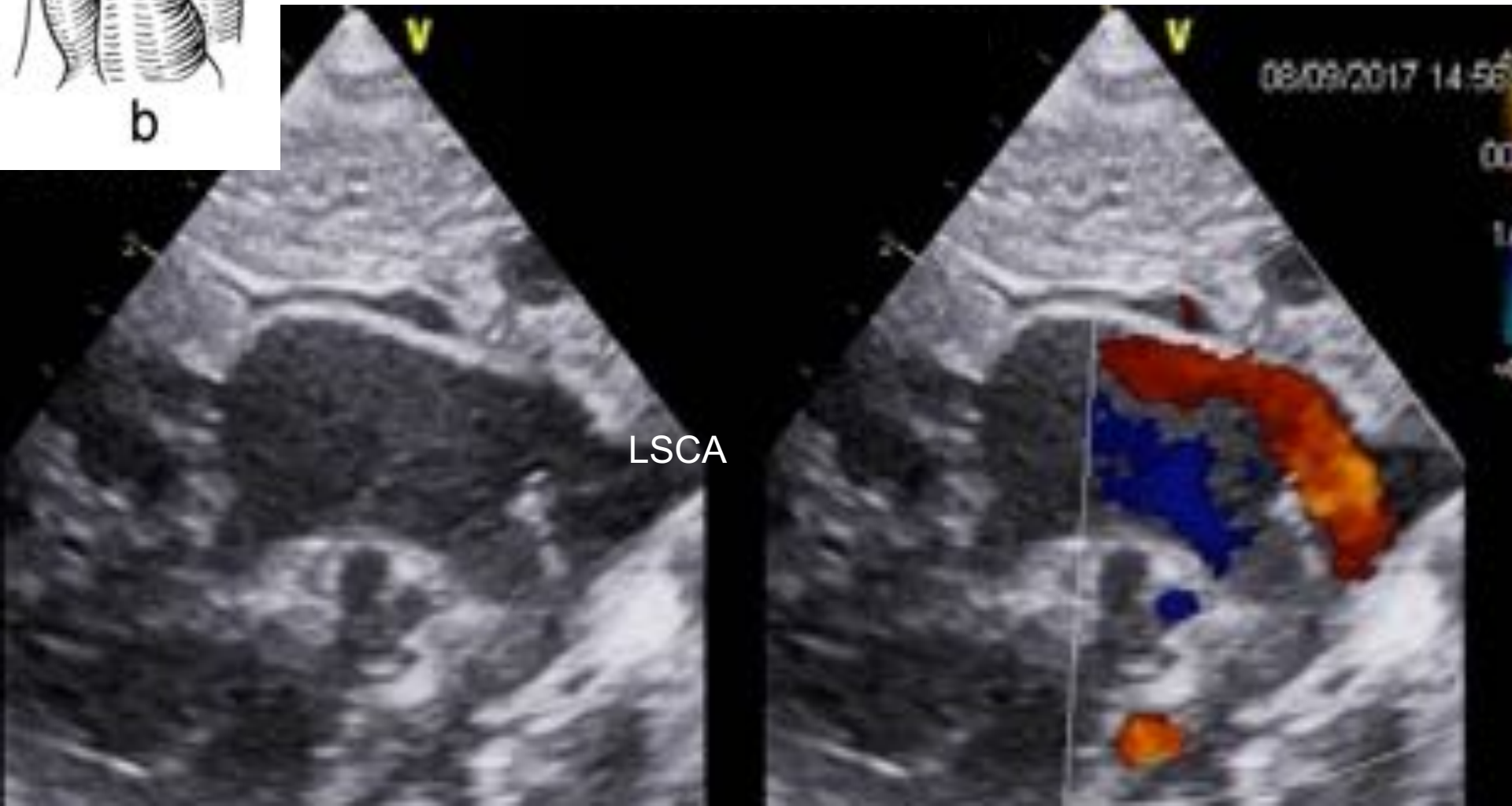
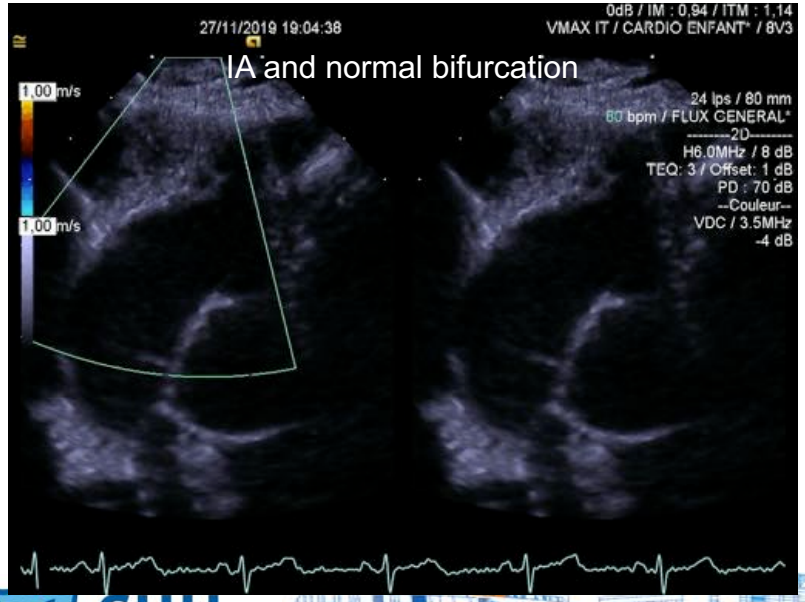
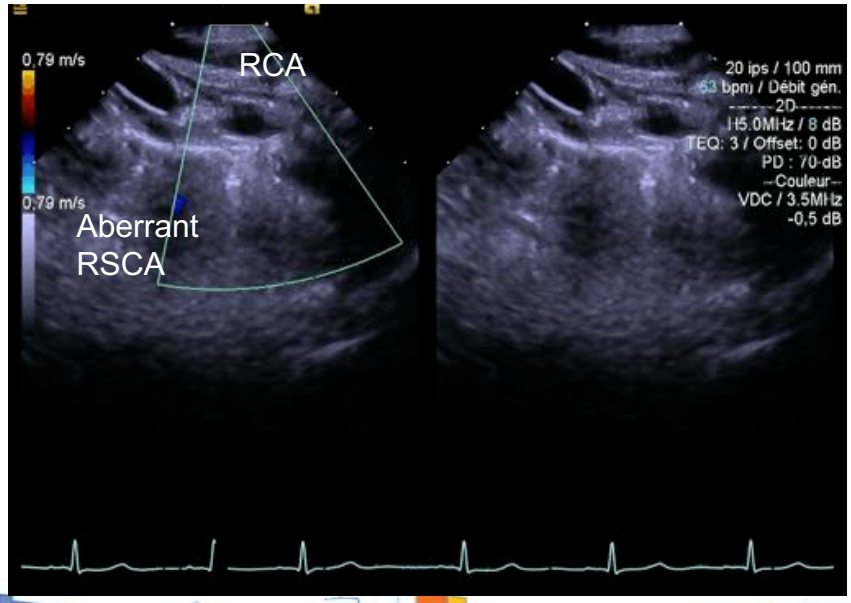




Aberrant origin of the subclavian artery

- Identify the 1st brachiocephalic vessel (opposite to the arch side) and IA bifurcation (RCA +RSCA)
- Lower and posterior course of aberrant RSCA relative to RCA
- Can aslo be identified arising from Desc Ao (suprasternal coronal view/ subcostal view)





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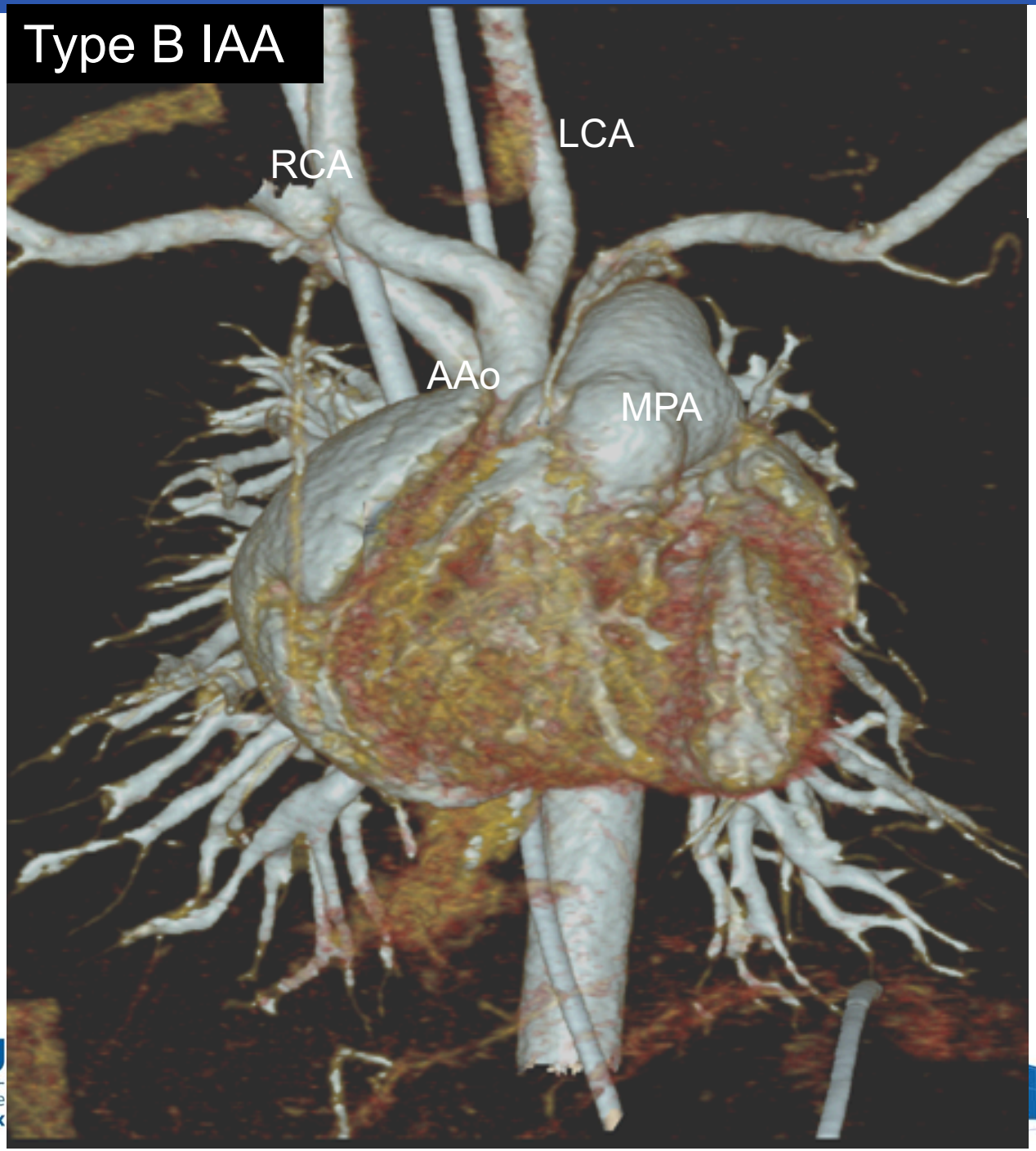

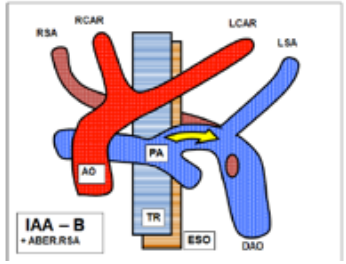

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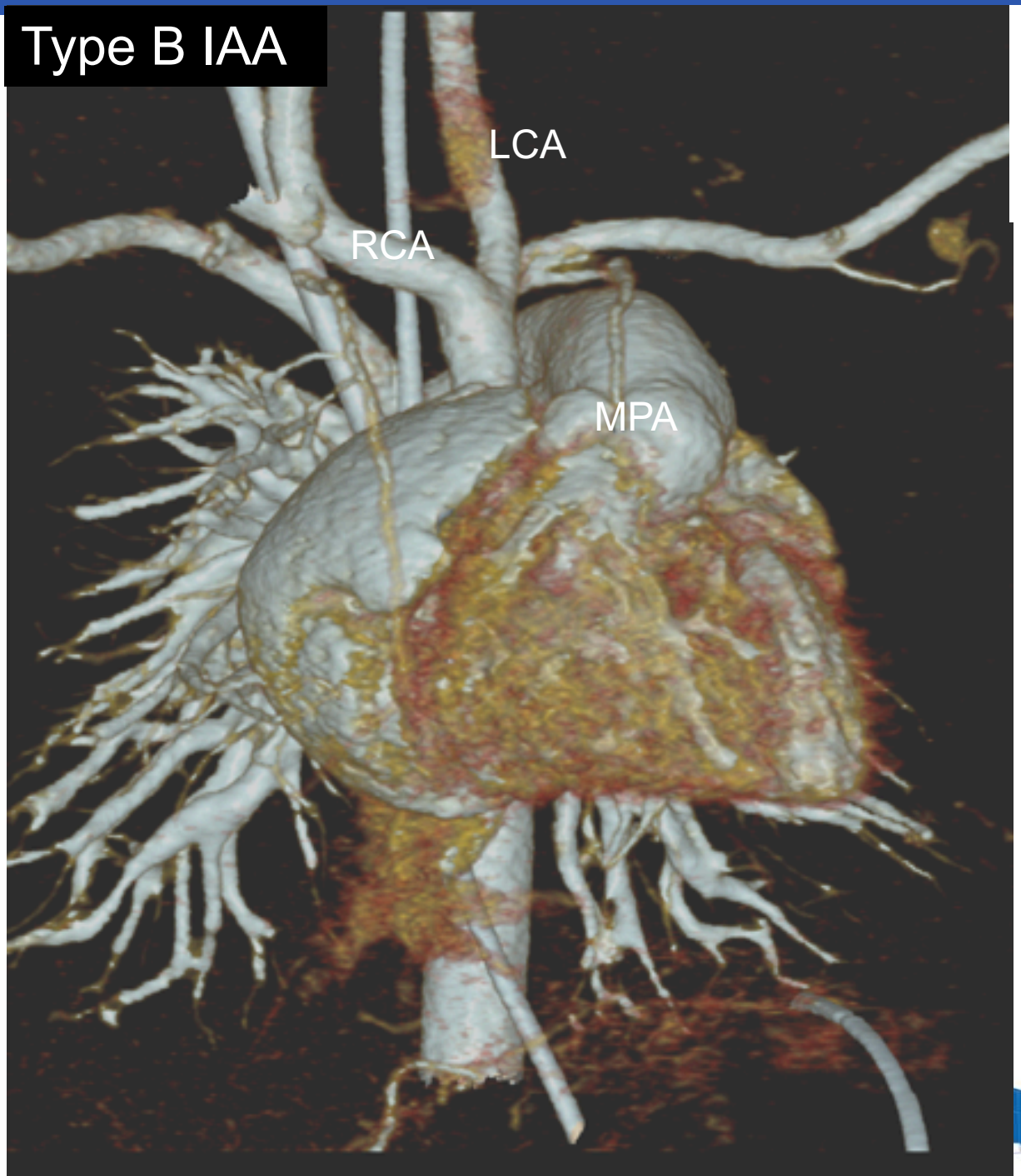
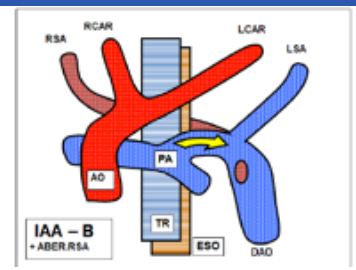
Type B IAA





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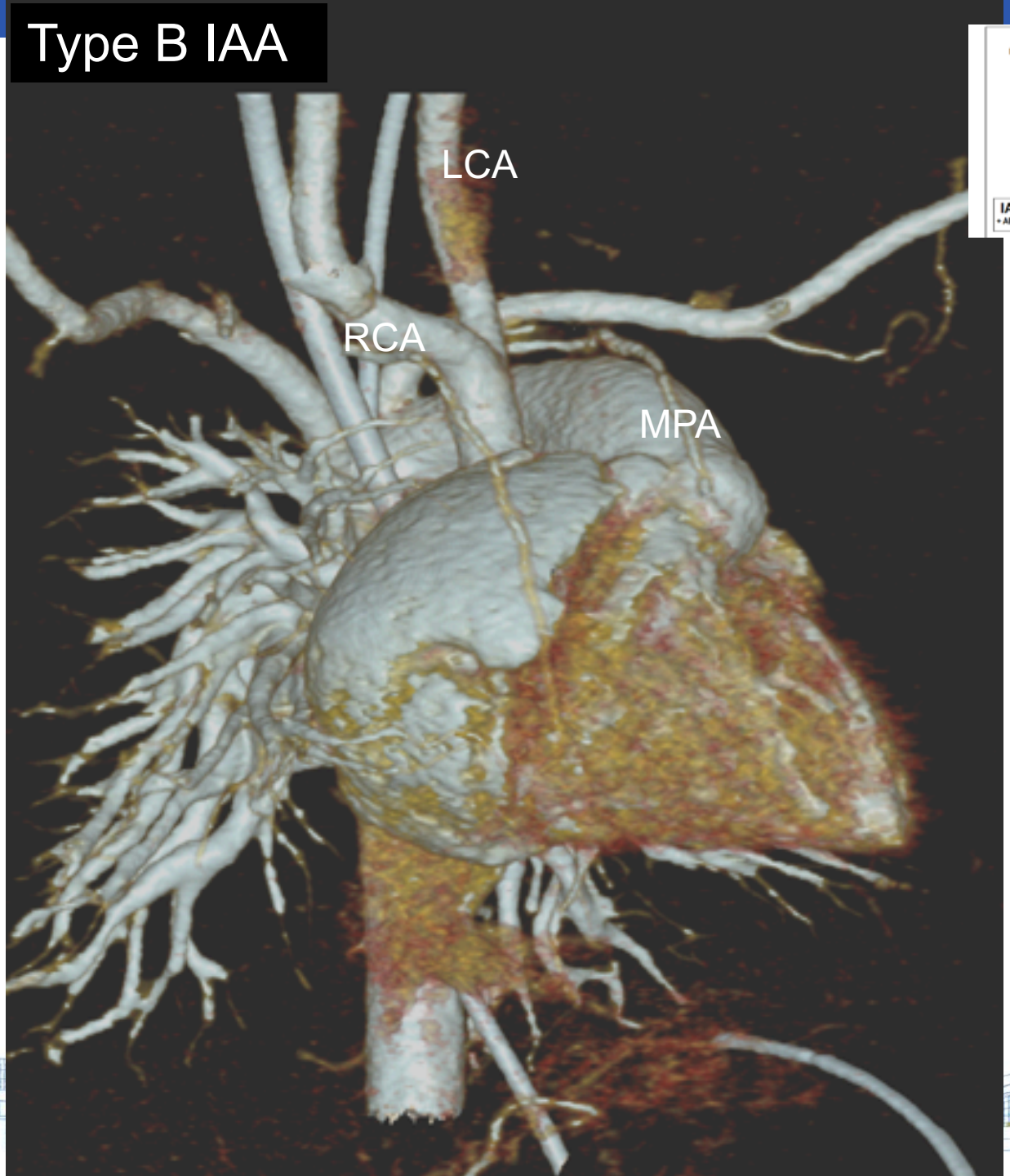

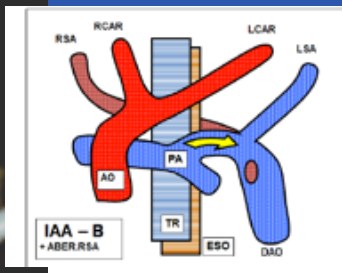

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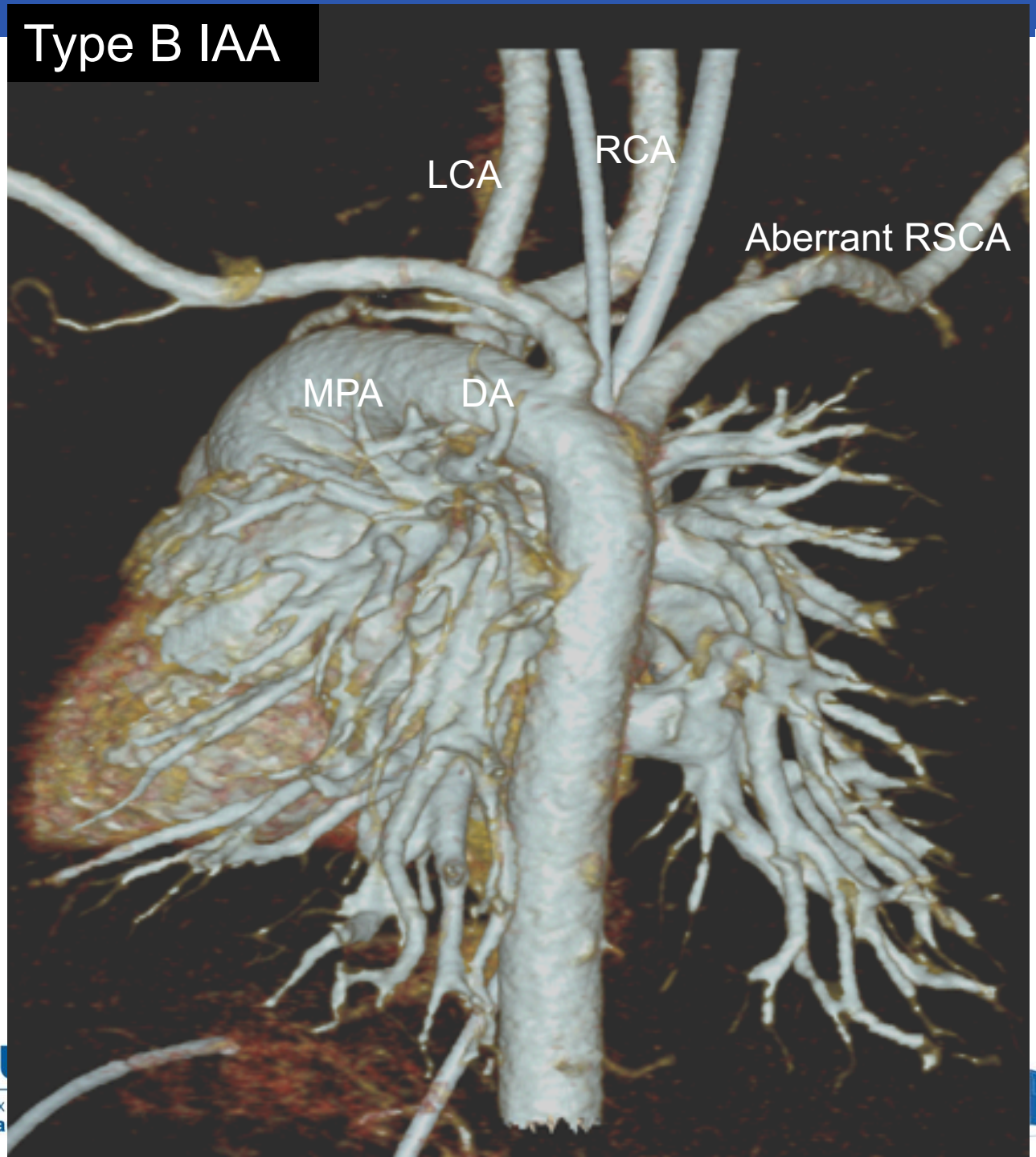
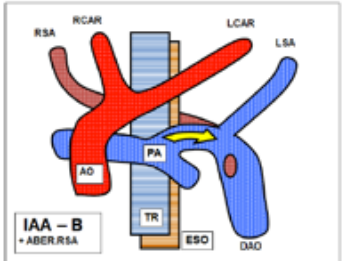
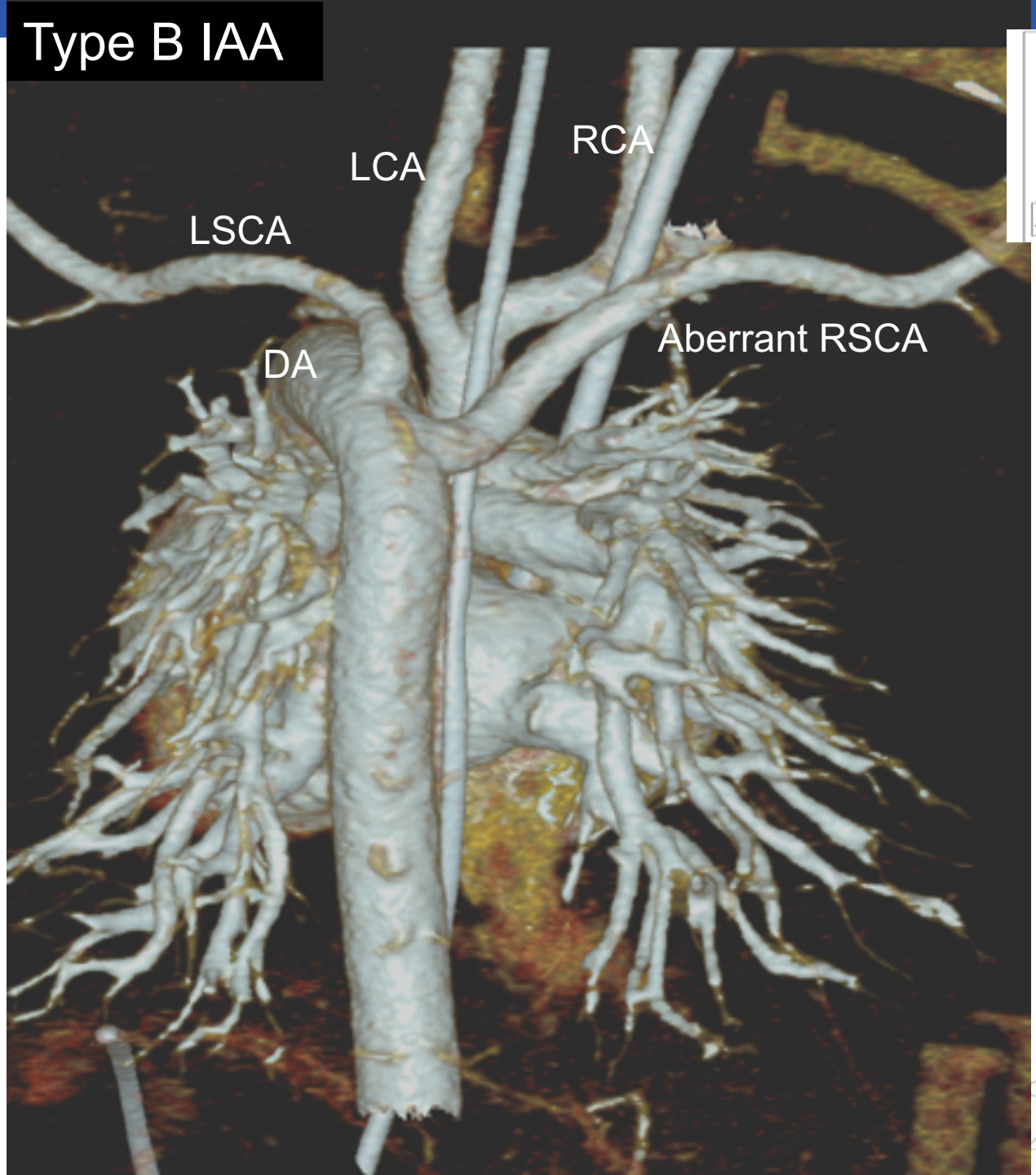
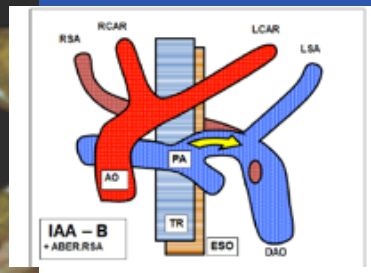
Type B IAA


LCA
RCA
Aberrant RSCA
MPA
DA


RSA
RCAR
LCAR
LSA
PA
AO
TR
ESO
DAO
IAA – B
+ ABER.RSA

Type B IAA





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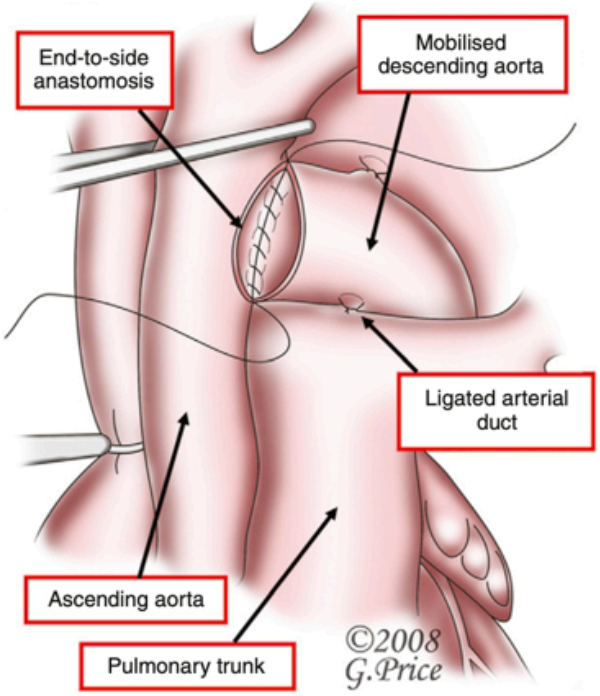
Associated lesions: Conoventricular VSD

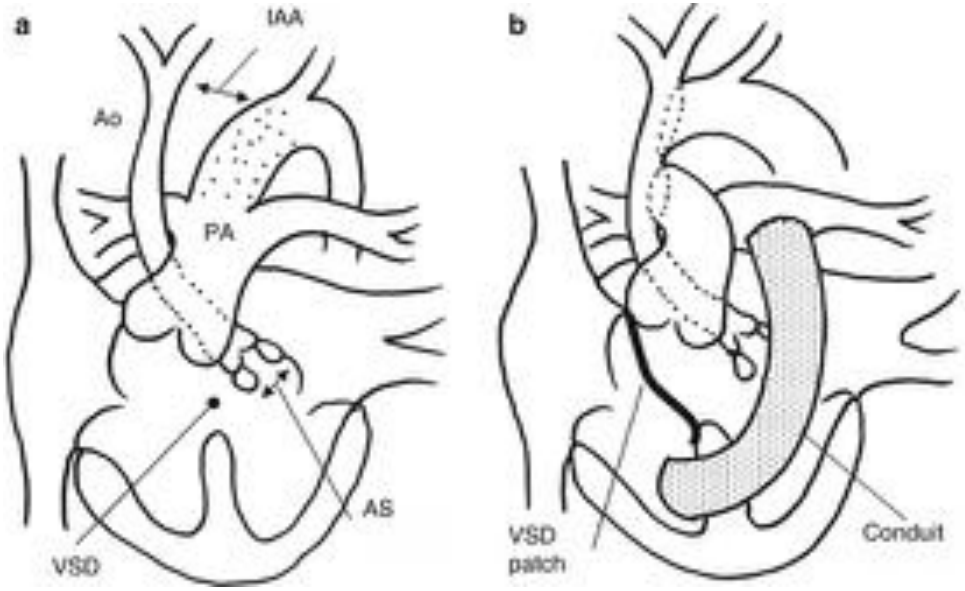
- Integral part of the type B IAA
- Posterior malalignment of conal septum
- Various degree of Subaortic stenosis
  - LVOT area < 0,7vm²/m²: predictive factor of post-op LVOTO

Surgical repair

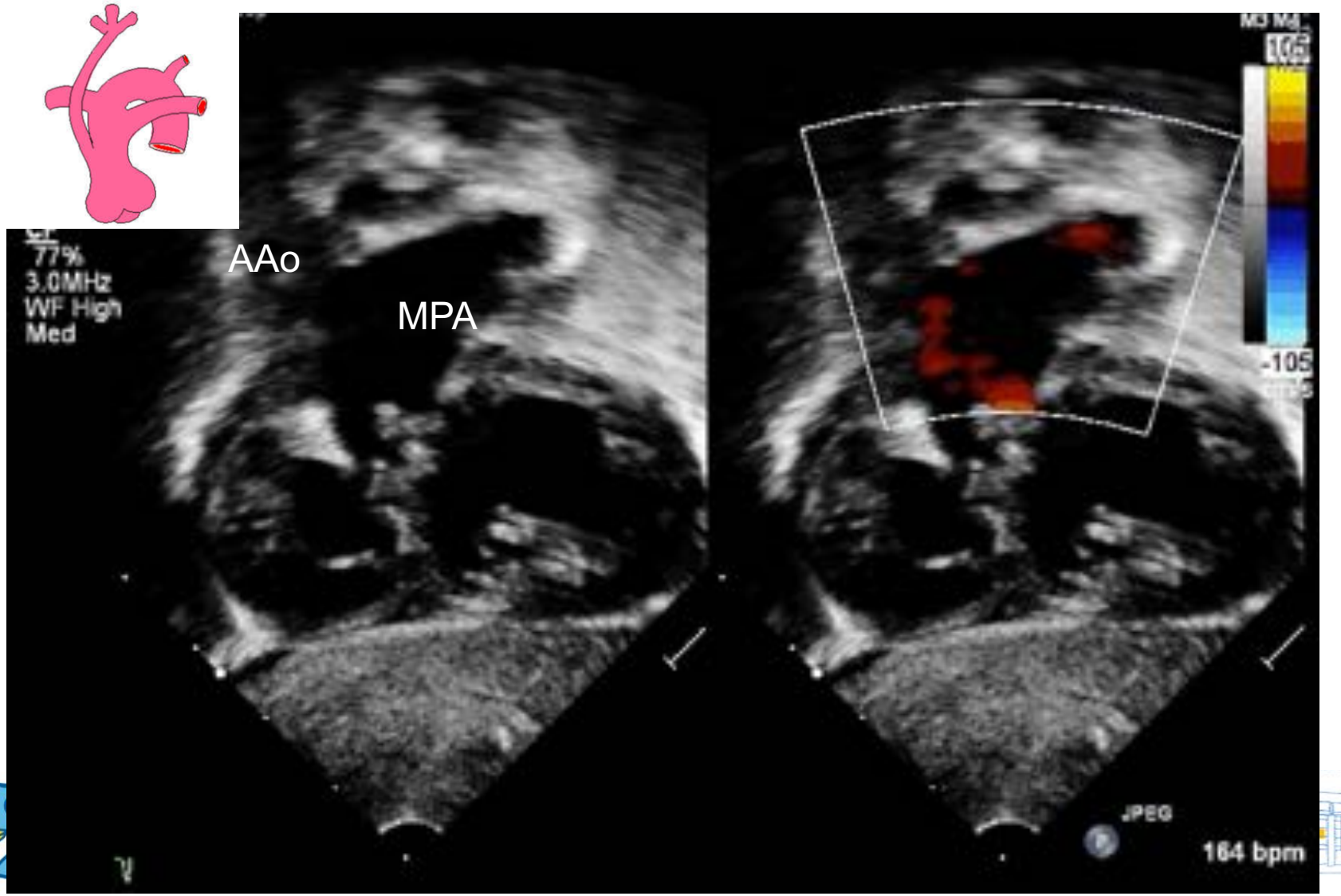
- Conventional technique includes
  - VSD closure
  - End to side anastomosis



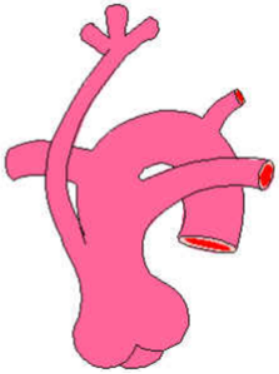
- The Yasui procedure includes:
  - modified DKS procedure to bypass the LVOTO (connecting the aortic and pulmonary roots)
  - Rastelli operation (RV to PA conduit)

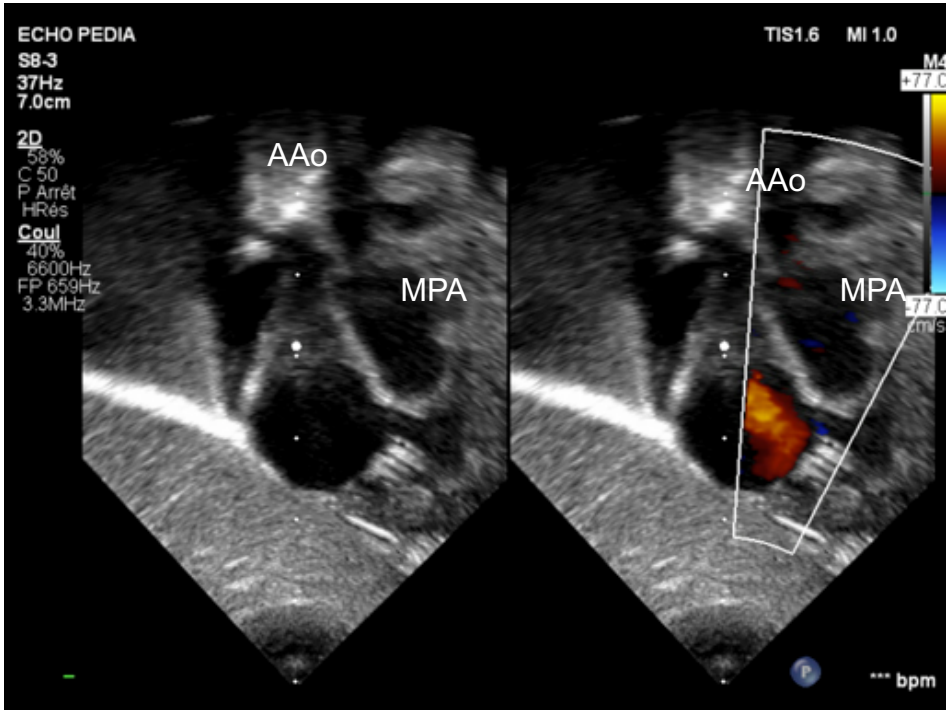


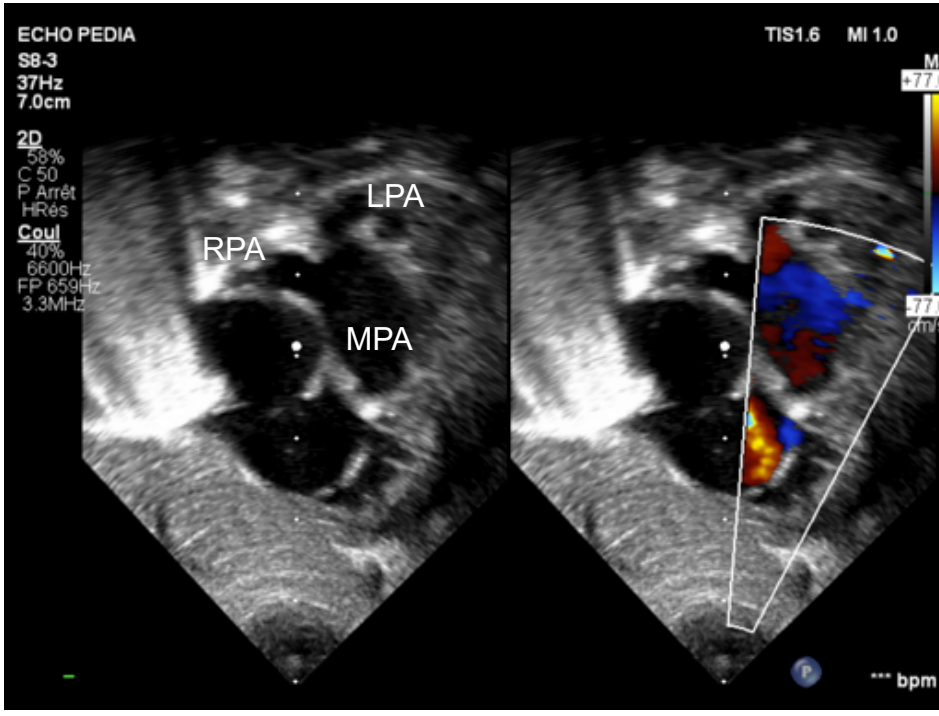
Type A4 TAC (Van Praagh classification)



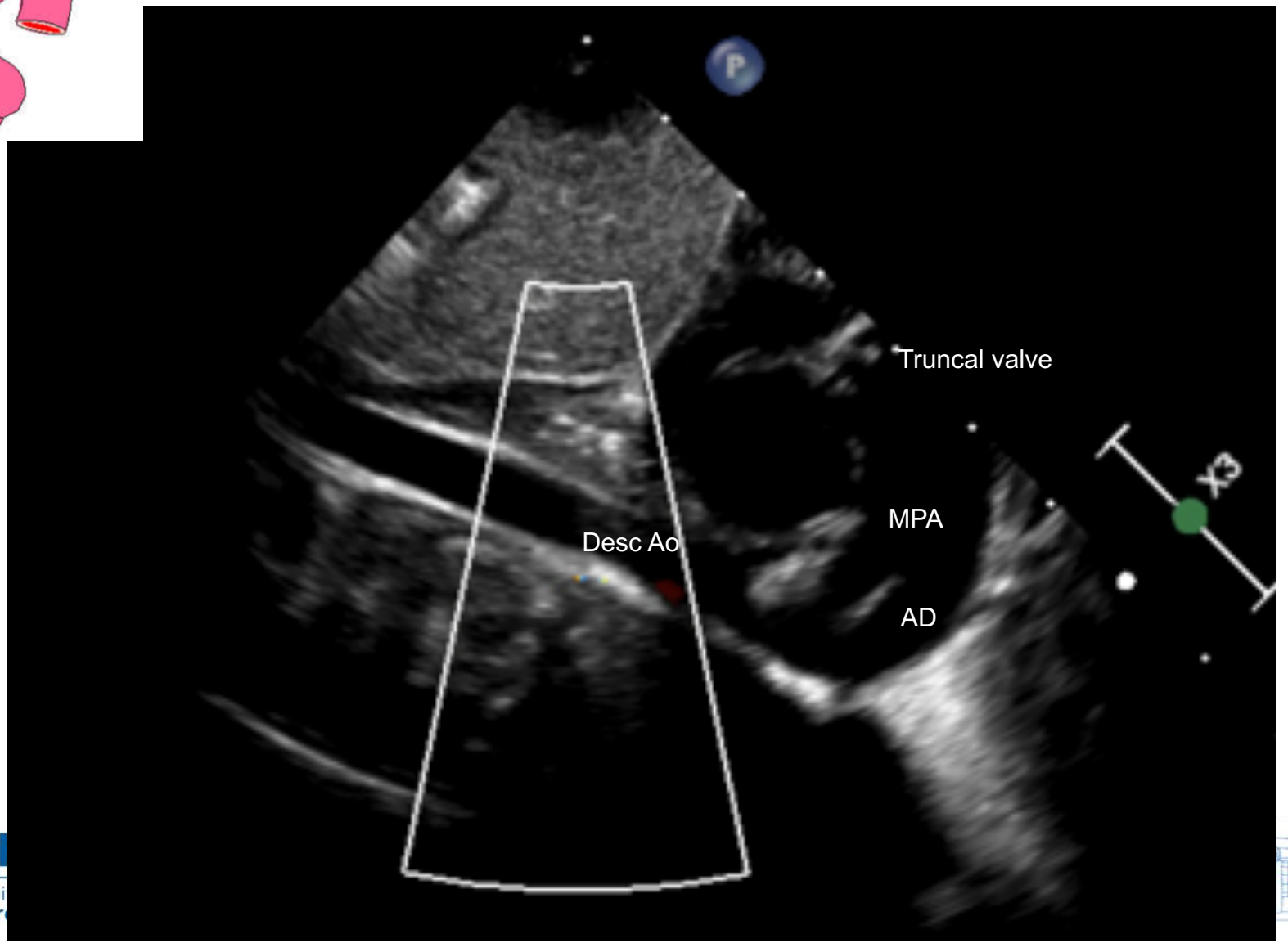
Subcostal view



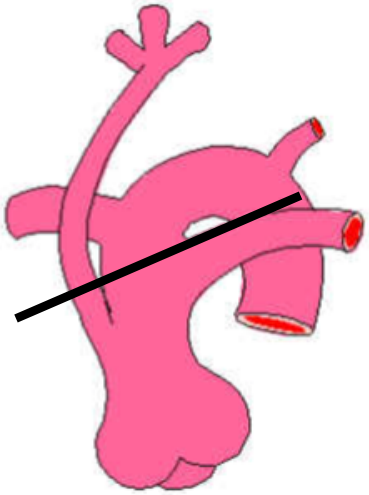


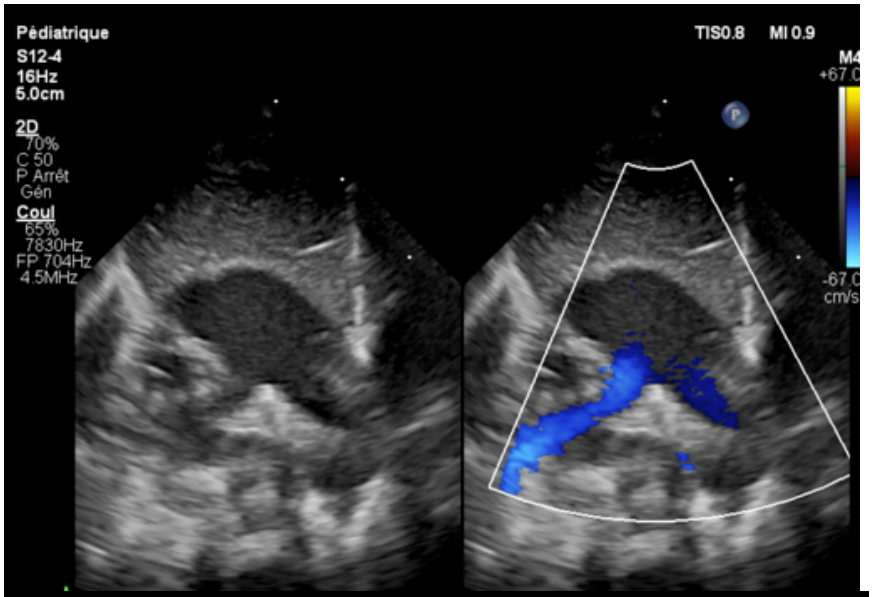


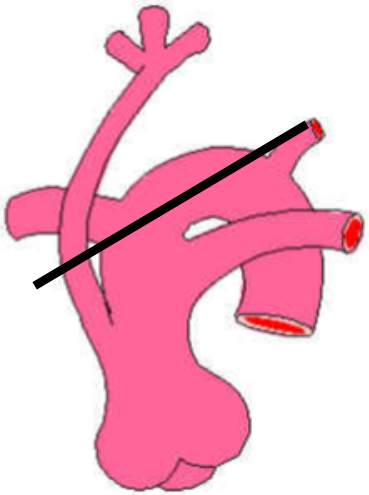
Subcostal view

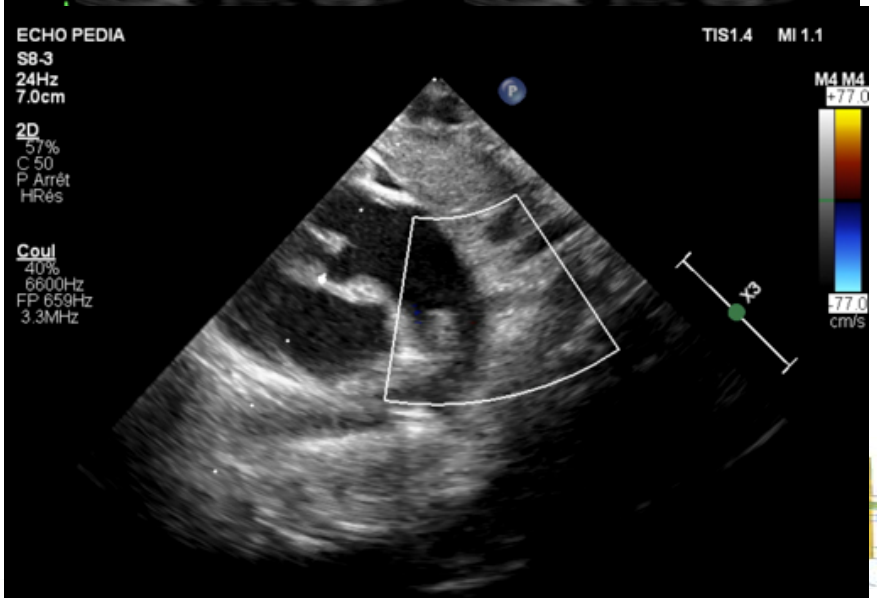


Parasternal short axis view

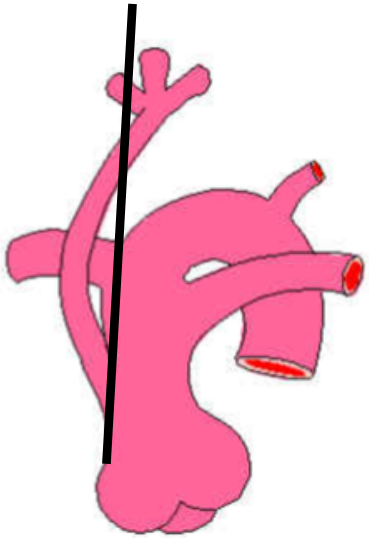


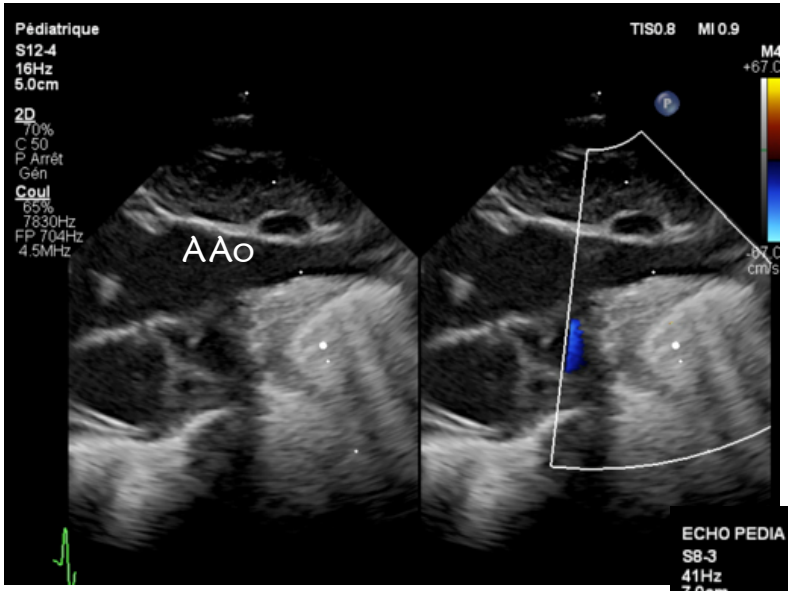


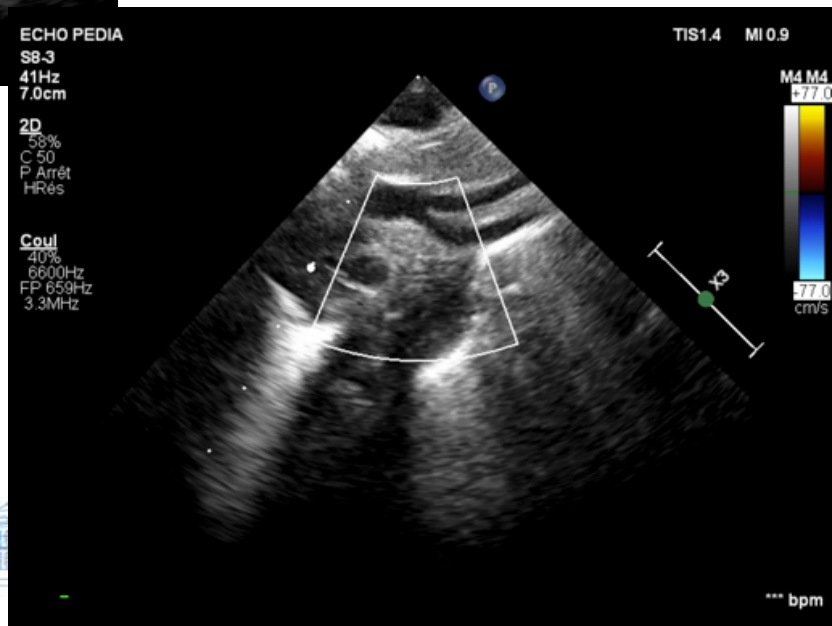




Supra sternal/ Right subclavian view







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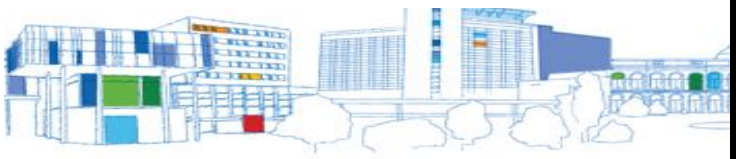
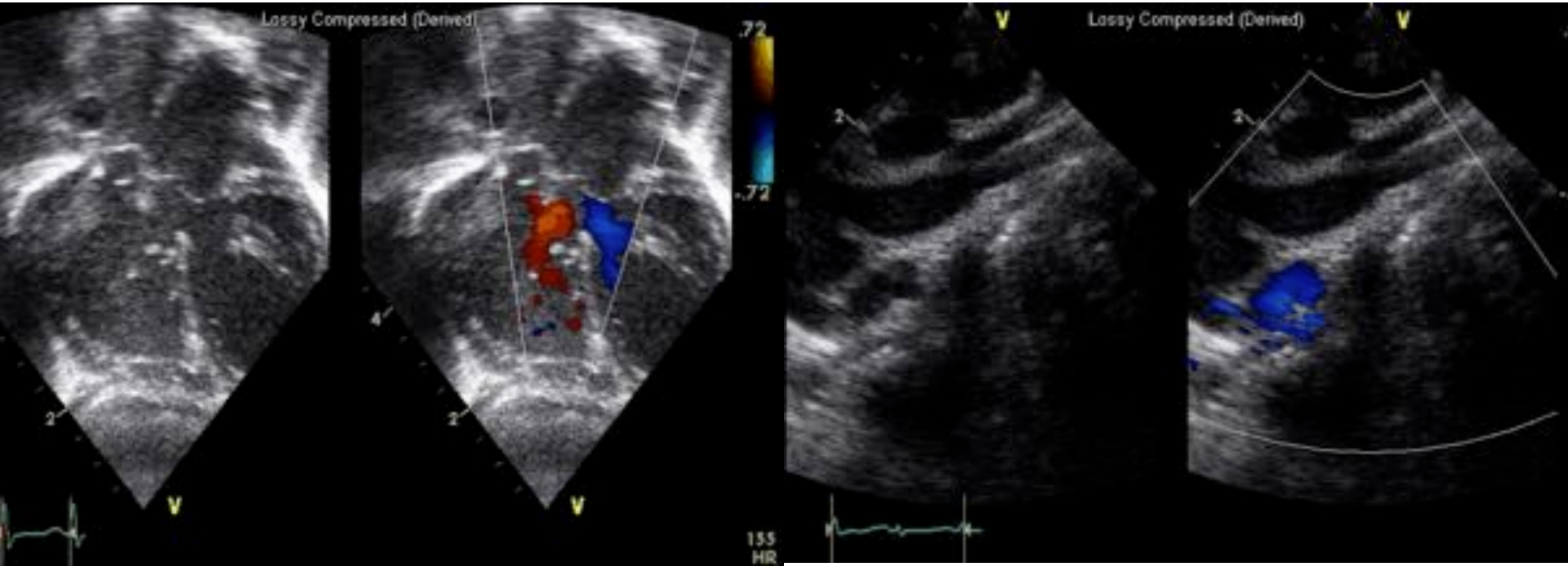
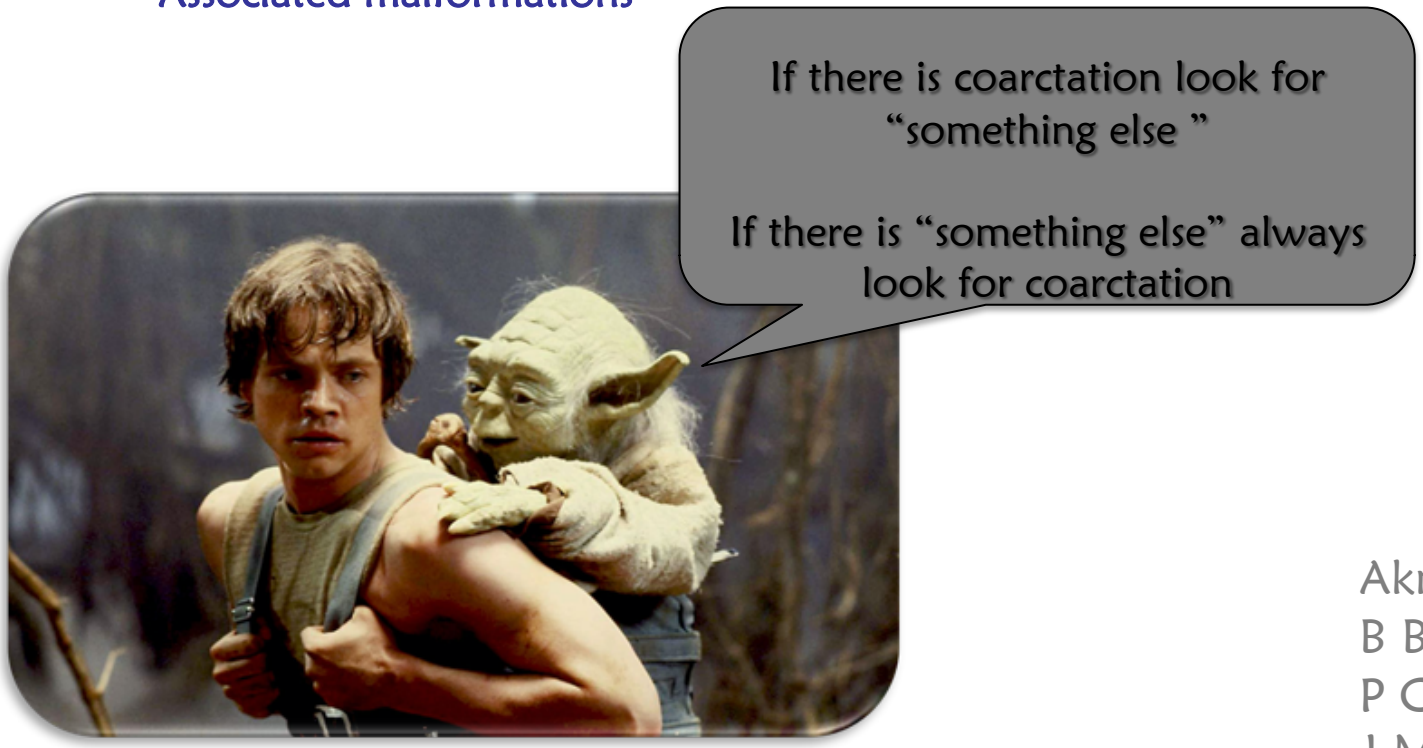


TGA+ malaligned VSD+ IAA



Conclusion

- Comprehensive assessment of Ao arch anatomy, origins of brachiocephalic vessels, isthmus, and prox desc Ao
- Assessment of flow gradients in transverse arch, arterial duct and at the coarctation site
- LV size and function
- **Associated malformations**



Aknowledgements
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P Ciliberti
J Marek

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Bordeaux