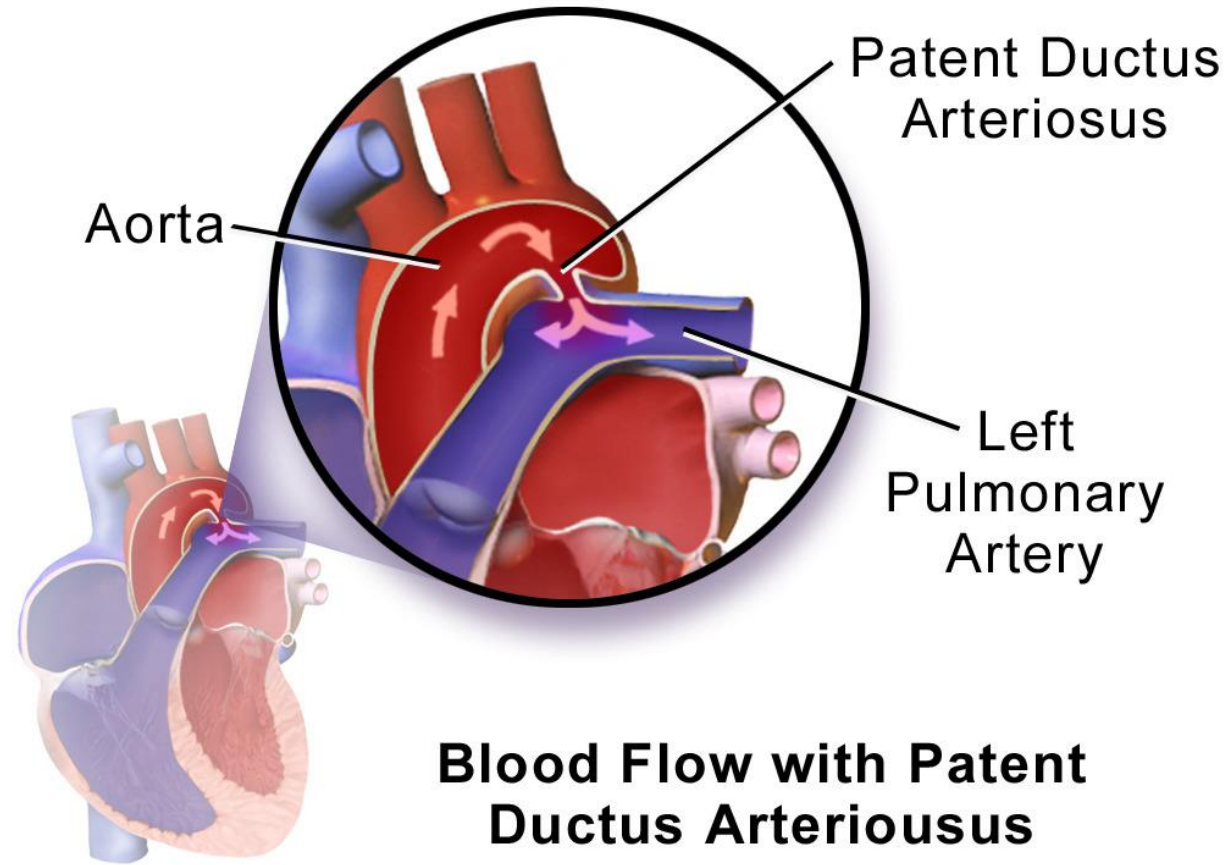
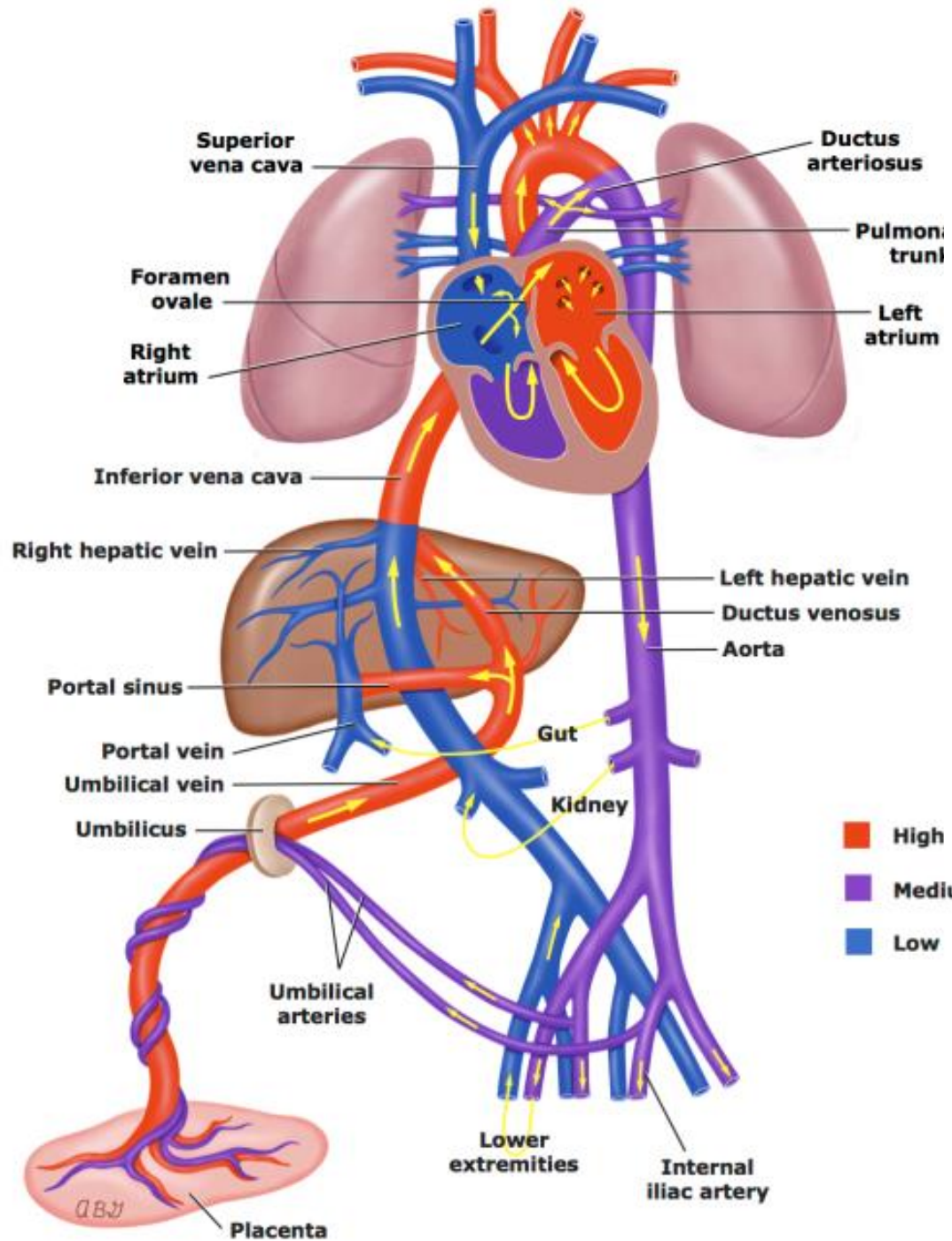


# DIAGNOSIS OF PDA



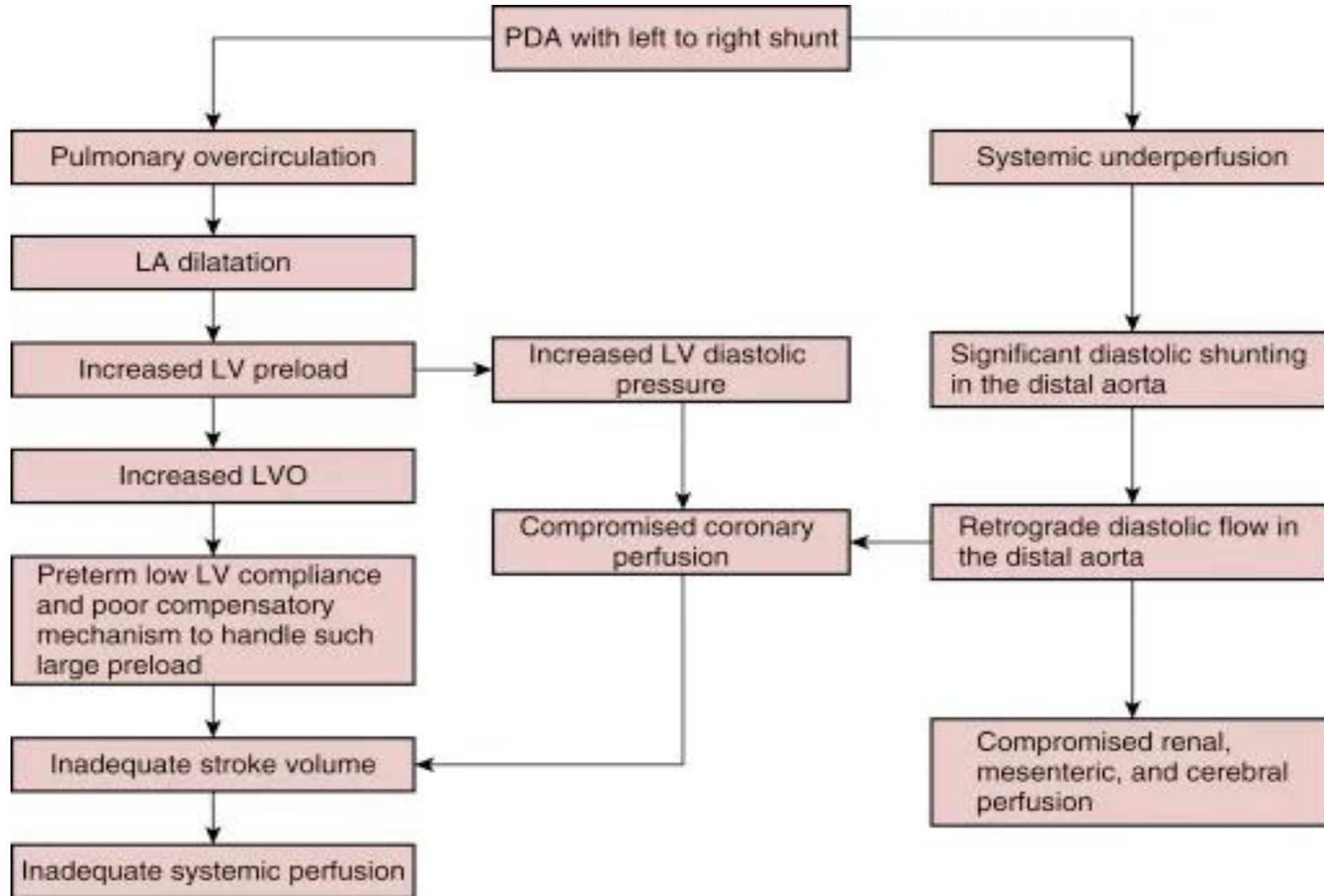
**Blood Flow with Patent Ductus Arteriosus**

■ High  
■ Medium  
■ Low

# Dynamics of PDA

- During pregnancy – Shunts → Pulmonary circulation towards the Systemic circulation (right-to-left shunt).
- Postnatal transition → Fall in Pulmonary vascular resistance + rise in systemic vascular resistance → reversal of the shunt (left-to-right)
- The effect of the PDA on preterm circulation → volume of the shunt through the duct.
- Ductal flow depends on → pressures at both ends of the shunt.
- Early hours of life → high pulmonary pressures → balanced pulmonary to systemic circulation.
- Signs of a shunt → develop when the shunt volume increases secondary to an increased pressure gradient

# PDA – Pathophysiology



**TABLE  
48.1**

**Incidence of Patent Ductus Arteriosus Among Infants Less Than 30 Weeks' Gestation**

PRESENCE OF PDA (ANY SIZE) (%)

Gestation (wk)	Day 4	Day 7	Day 20	Day 40	Day 60	Day 80
28–29	55	33	20	10	8	
26–27	84	68	48	38	27	27
24–25	96	87	75	72	56	38

PRESENCE OF HEMODYNAMICALLY SIGNIFICANT PDA (%)\*

Gestation (wk)	Day 4	Day 7	Day 20	Day 40	Day 60	Day 80
27–28		21	13	5	1	0
25–26		64	50	22	3	0
23–24		93	88	58	33	14

# What is a significant Duct?

## ❖ Clinical Examination

- Inability to wean from ventilator
  - Ventilated for at least 7 days
  - Worsening respiratory parameters
- Symptoms or signs of large PDA
  - Systolic murmur
  - Hyperdynamic circulation
  - Wide Pulse pressure
  - Bounding Pulses
  - Cardiomegaly
  - Hypotension and Acidosis
  - Pulmonary haemorrhage
  - Increased pulmonary arterial marking

## ❖ Echocardiography

# Application Of NPE In The Evaluation Of PDA

European consensus statement on NPE.

1. Important to ensure the patients' comfort.
2. The initial scan should be a comprehensive appraisal of cardiac anatomy, sufficient to confirm structural normality of the heart and avoid inadvertent PDA treatment in the presence of a duct-dependent lesion.
3. The clinician must be aware that echocardiographic indices of hemodynamic significance have variable reproducibility between observers.

***Echocardiography precedes clinical signs by mean of 2 days!!***

# Assessment of PDA

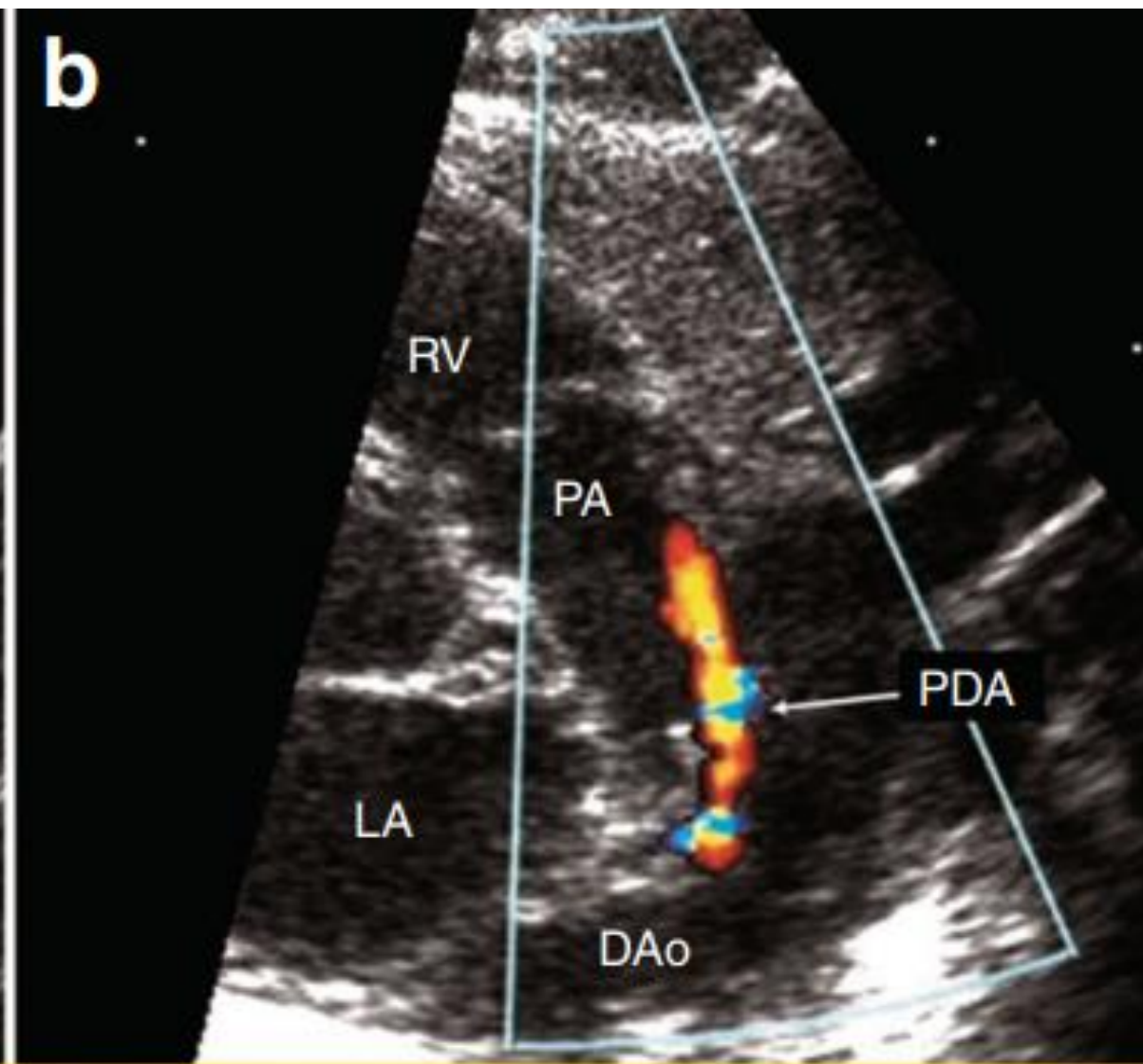
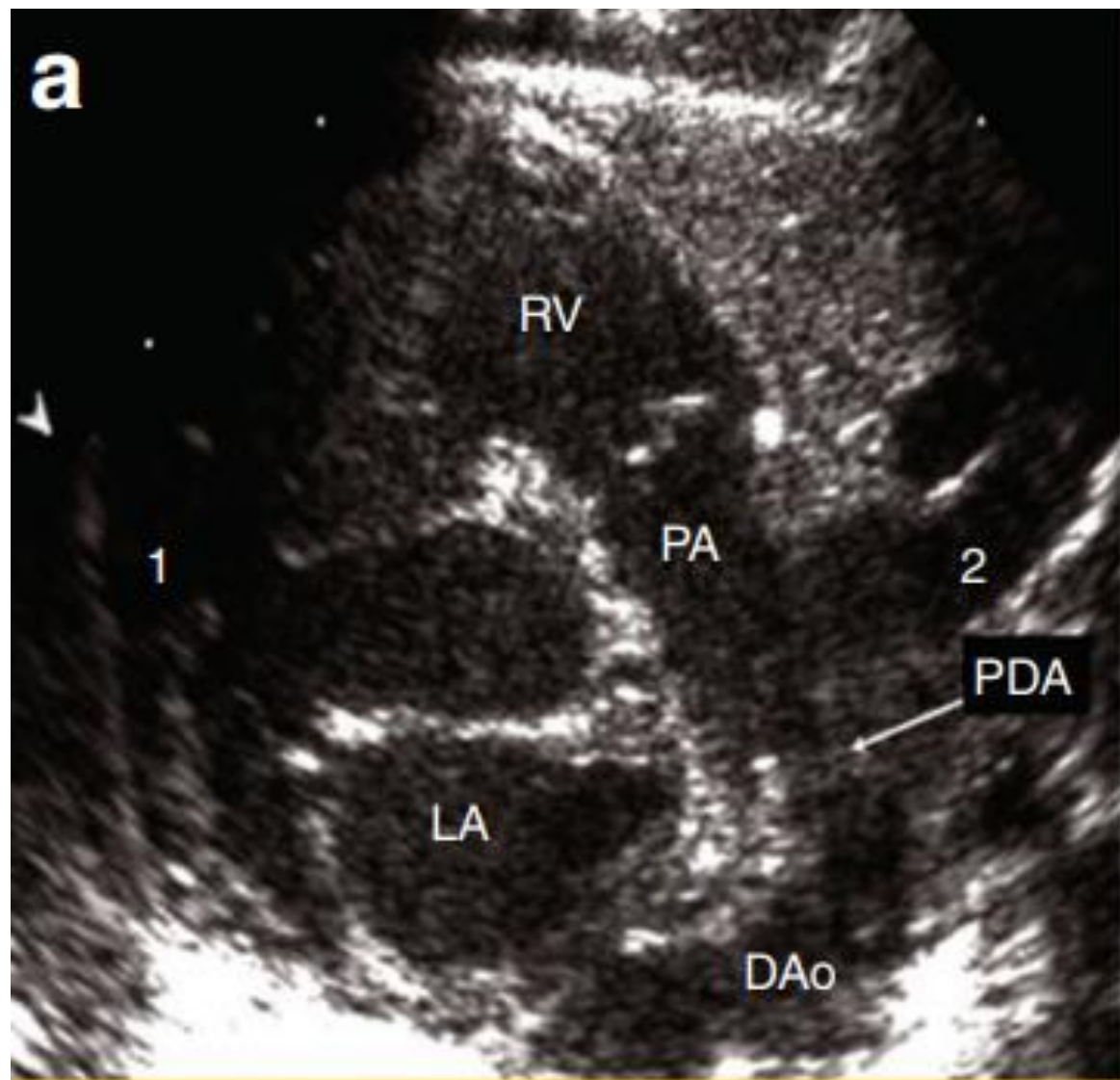
1. **PDA characteristics**—diameter, flow direction, (ratio of) systolic and diastolic flow velocities
2. **Indices of pulmonary over circulation**—left ventricular output + one parameter of left-sided volume loading OR left heart pressure loading
3. **Systemic Hypoperfusion-** Doppler flow patterns in the systemic circulation



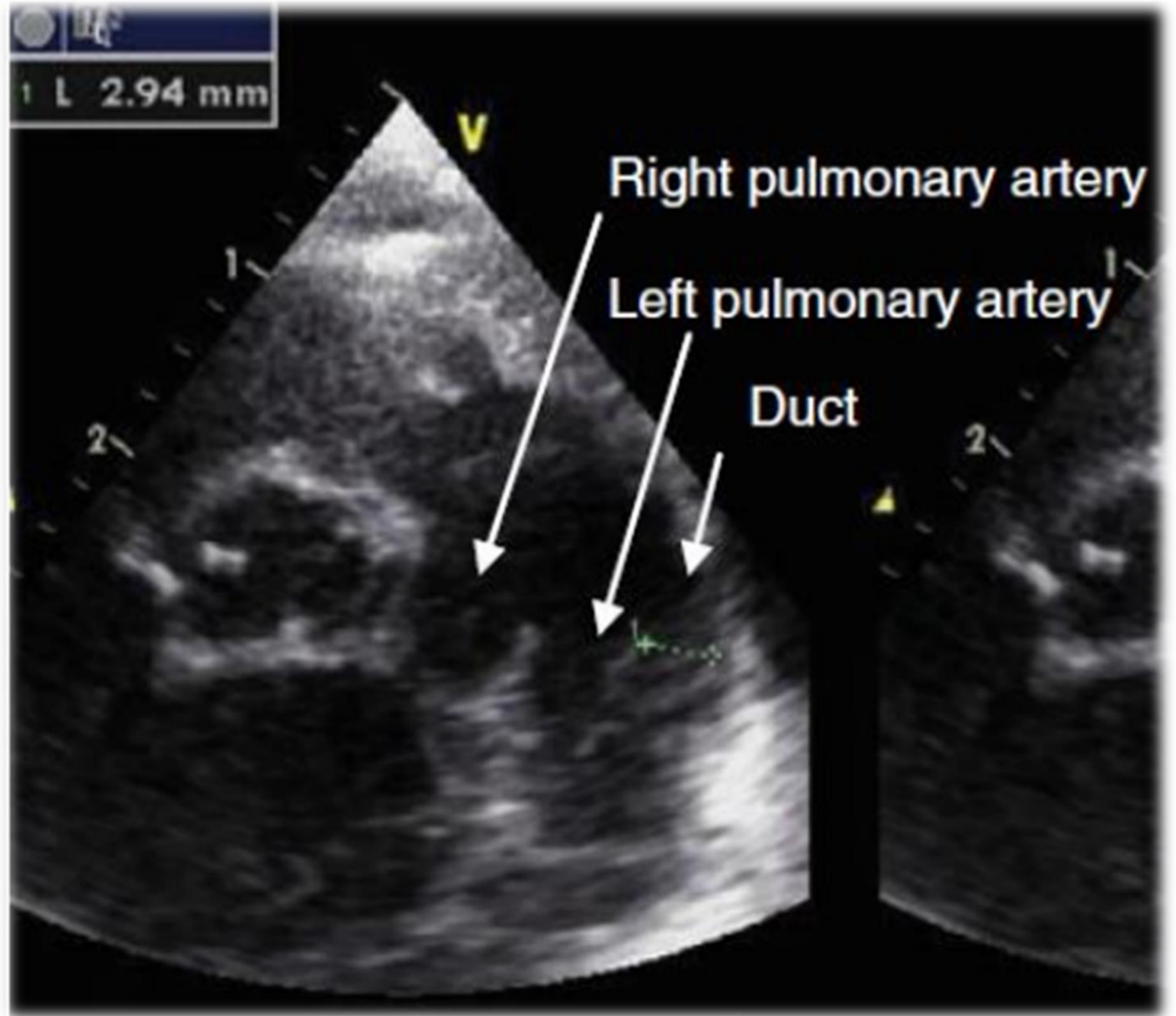
# PDA characteristics

- **View:** High left Parasternal short axis window- ductal view
- **Probe position:** sagittal plane to the left of the sternum with the marker pointing toward the head
- The PDA is visualized as a structure leaving the left side of the junction of the MPA and the LPA toward the descending aorta.
- Sweep Side to side to bring duct in view
- **Color Doppler:** Direction of transductal blood flow





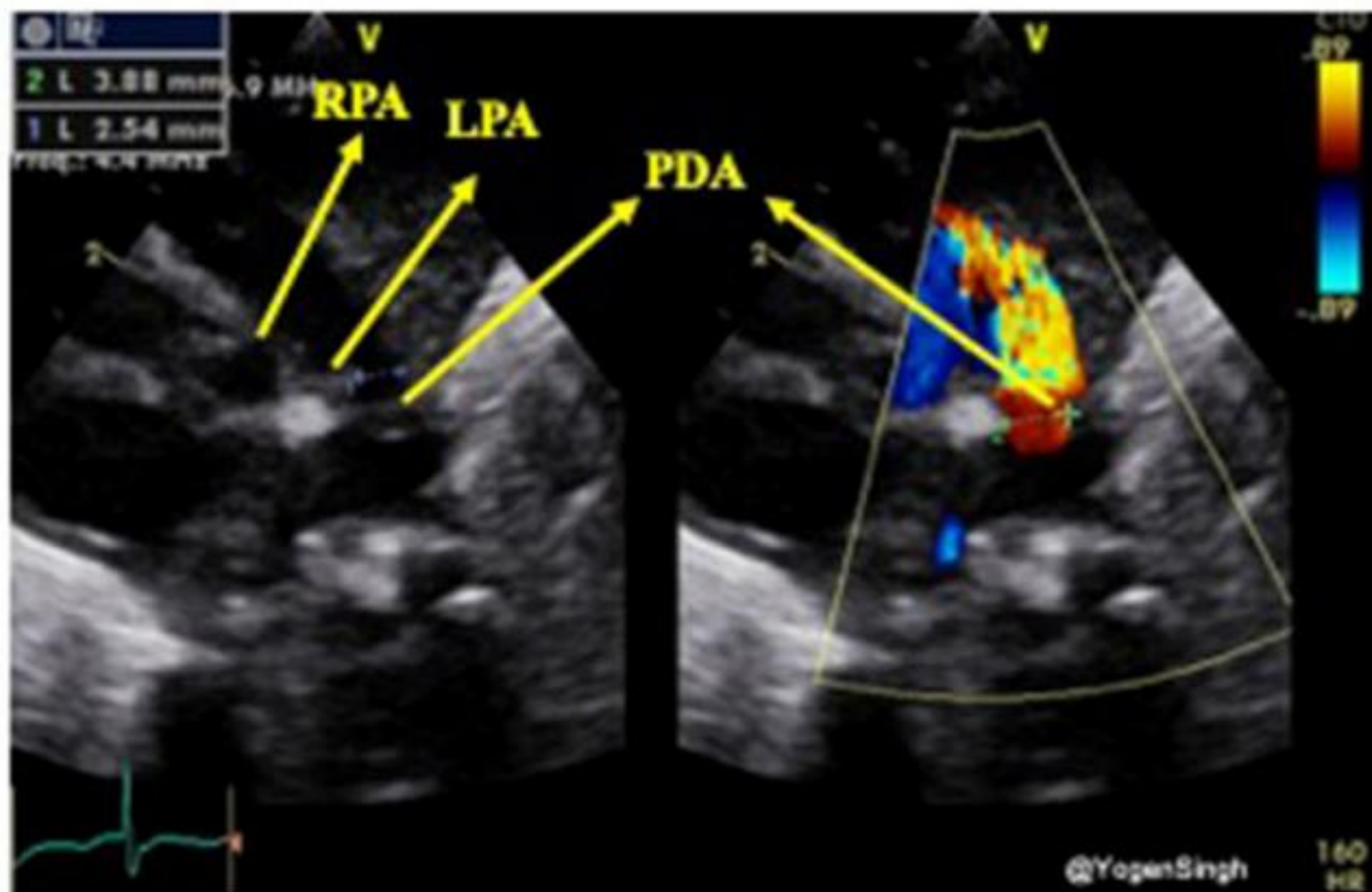
# Three legged view



- Measure the PDA at the smallest dimension (site of maximum constriction) by a frame by frame analysis- at the pulmonary end.
- The diameter can be expressed as an absolute value (smallest cut-off 1.5 mm) or indexed either to the dimension of the LPA (smallest cut-off 0.5) or to the patient's weight (cut-off 1.4 mm/kg).

Duct characteristic	Size	PDA: LPA
Small shunt	<1.5 mm	< 0.5
Moderate shunt	1.5 – 2mm	0.5 – 1
Large shunt	>2 mm	>1

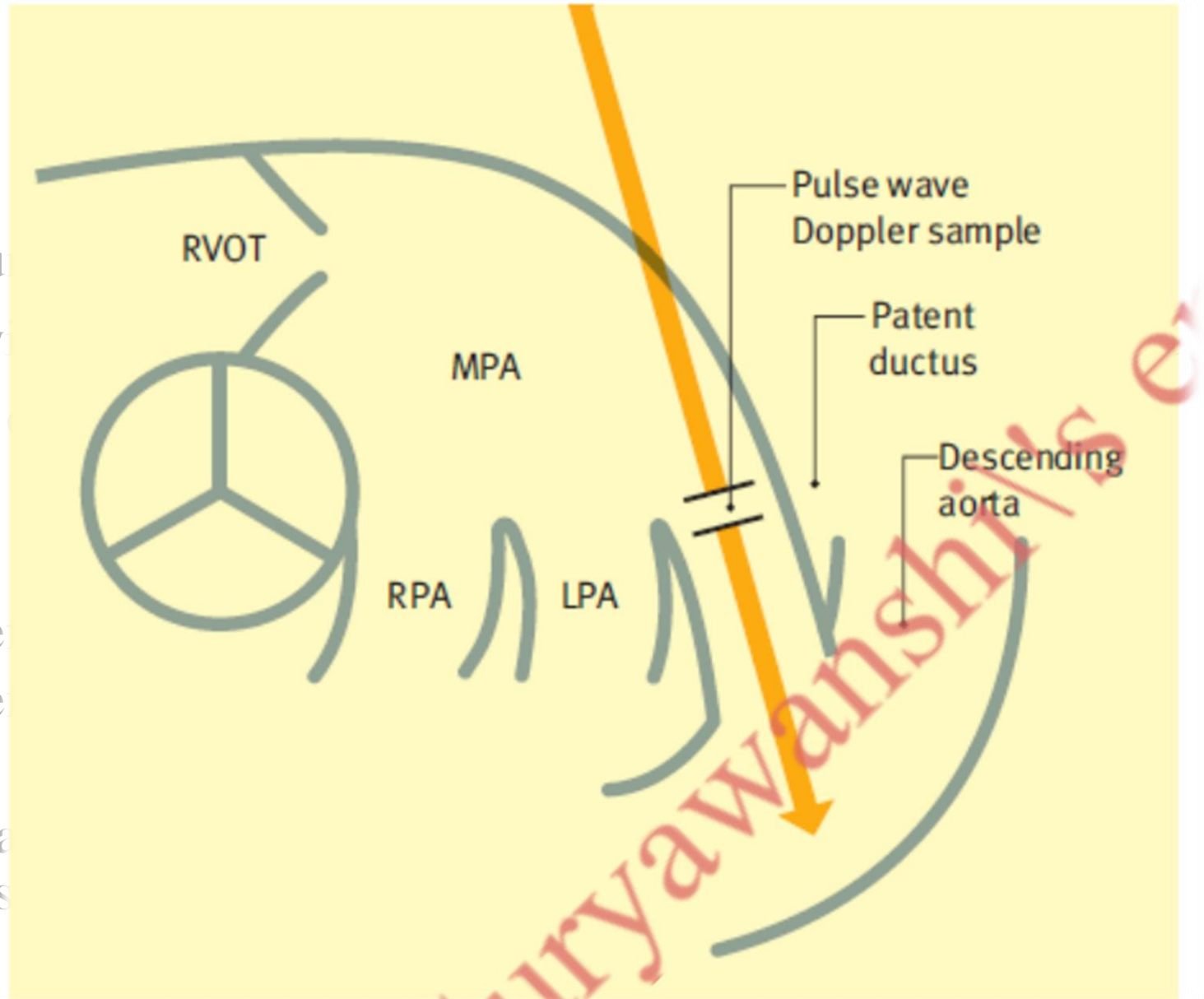
- 95% limit of agreement between two observers for PDA diameter - 48%



# Duct – Velocity and

- Depend on dimension of the shunt
- Similar size duct can have a vary
- Velocity and direction → Pulsed
- Direction →
  - Left to right
  - Bidirectional with Right to le
  - Bidirectional with Right to le
  - Pure Right to left.

The last two patterns may be pa  
and/or elevated pulmonary pres  
ductal closure

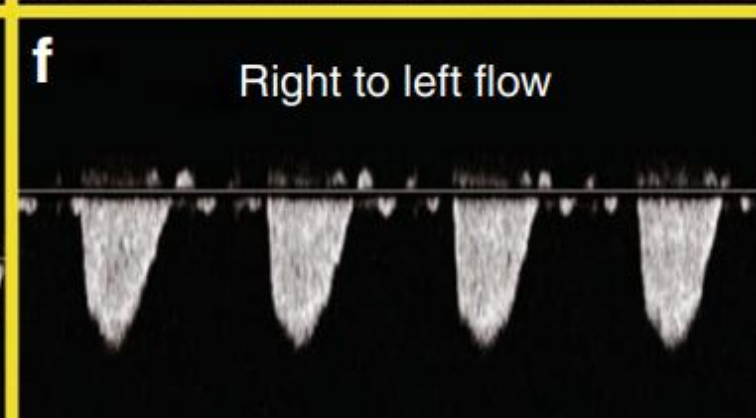
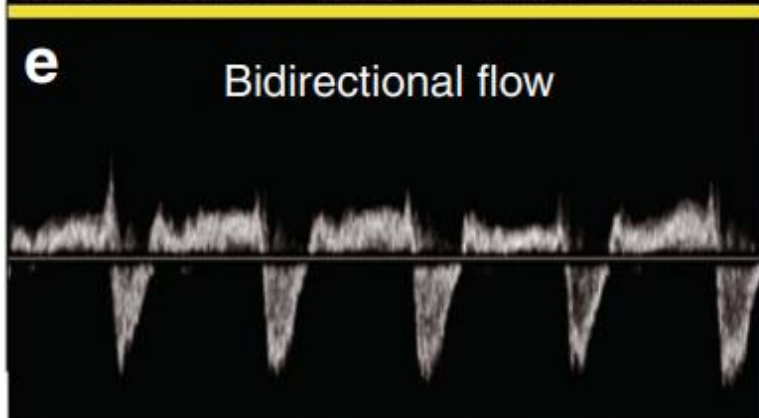
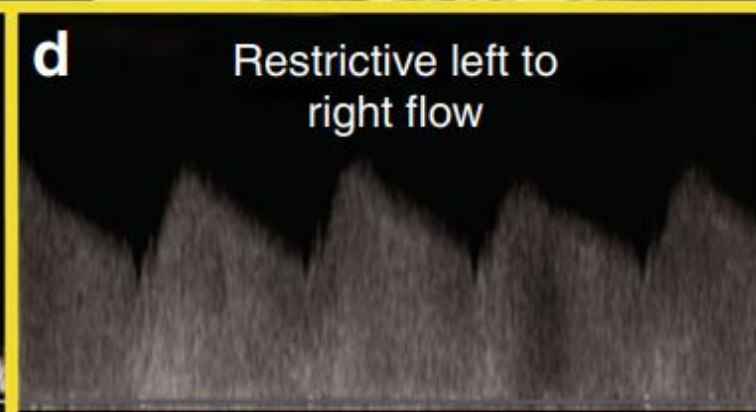
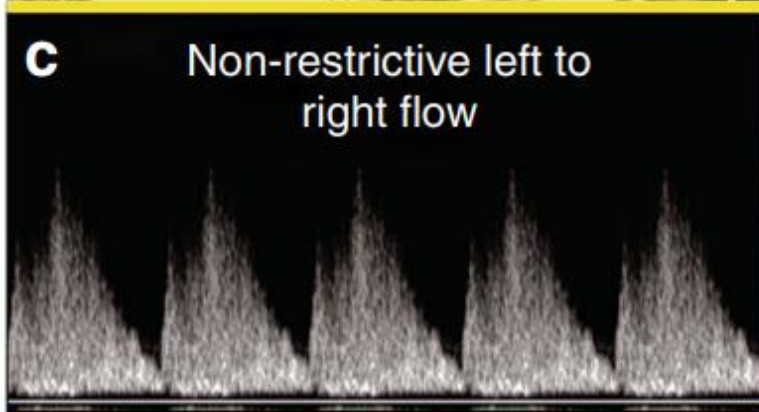
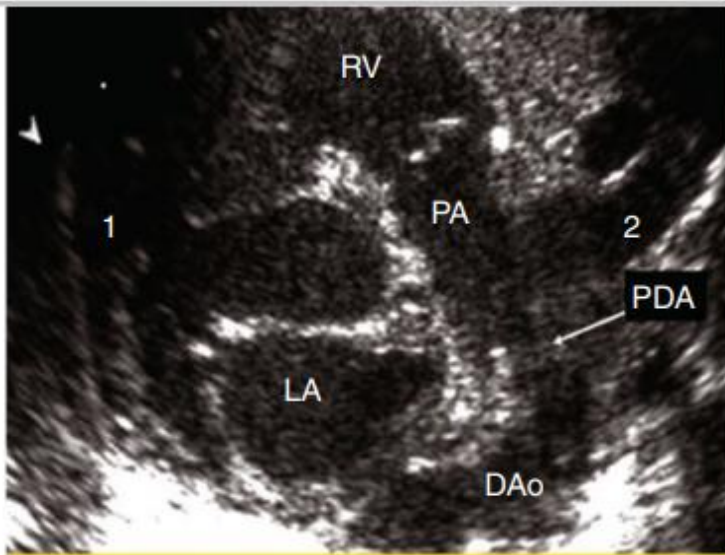


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**Left to Right Shunt**

160  
HR



**C: Pulsatile or non-restrictive** pattern: characterized by a left to right shunt with an arterial waveform and high peak systolic velocity: end-diastolic velocity ratio.

**D: Restrictive pattern:** High systolic and diastolic velocity, and low peak systolic velocity: end-diastolic velocity ratio.

**E: Bidirectional pattern:** Elevated pulmonary pressures equal to or near systemic.

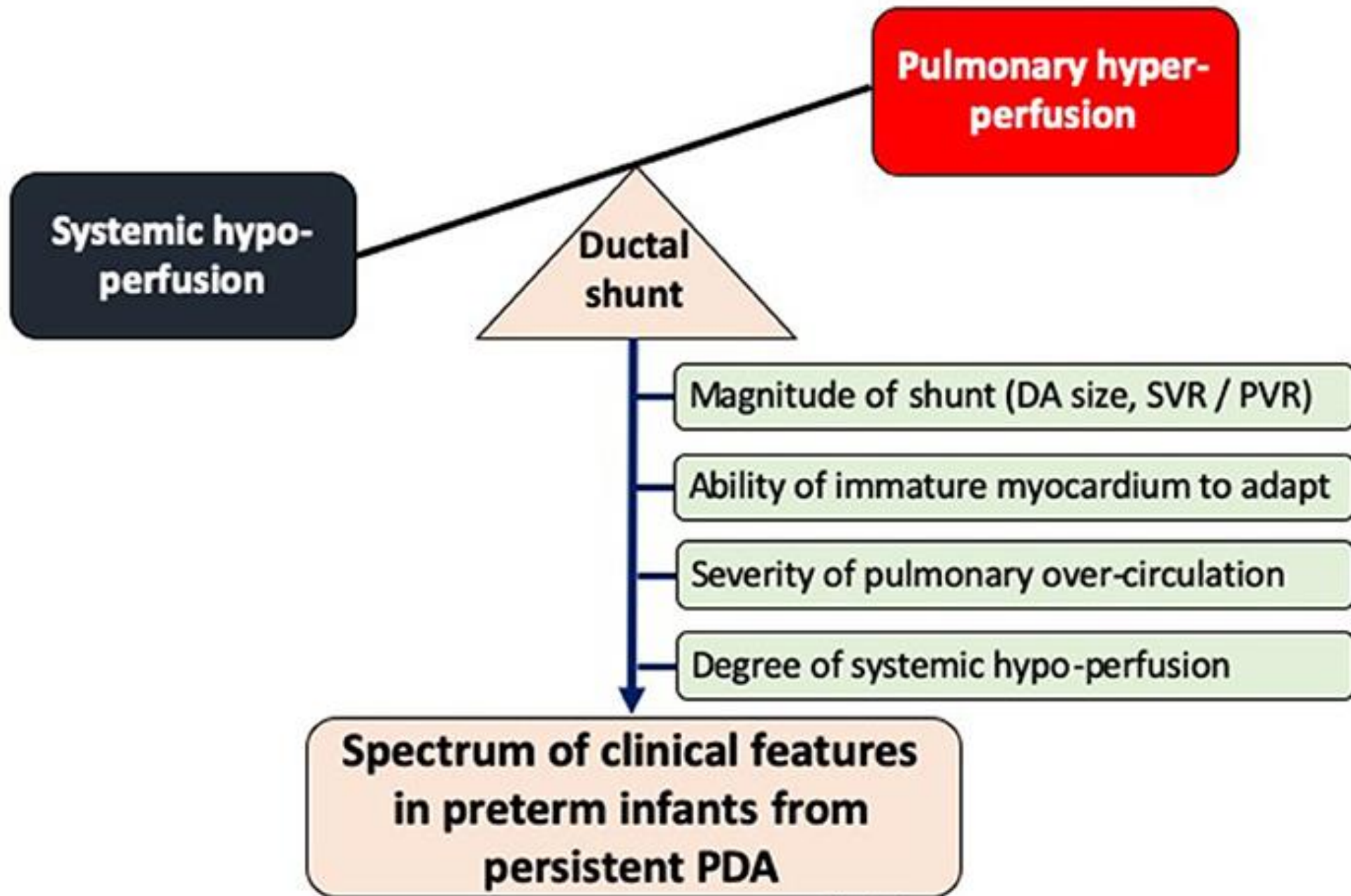
**F: Pure Right to left flow:** supra-systemic pulmonary pressures



# To remember..

Duct Characteristic	Duct Velocity (V max)	Systolic:Diastolic ratio
Small shunt	>2 m/s	<2 (closing duct)
Moderate shunt	2- 4 m/s	2-4 (pulsatile)
Large shunt	<2 m/s	>4

I



# Echocardiographic parameters associated with pulmonary over circulation

A] LVO (mL/kg/min)

B] Left heart volume loading: [ surrogate markers for inc Pulm venous return]

- La:Ao
- LVEDD (mm)
- LPA diastolic velocity (m/s)

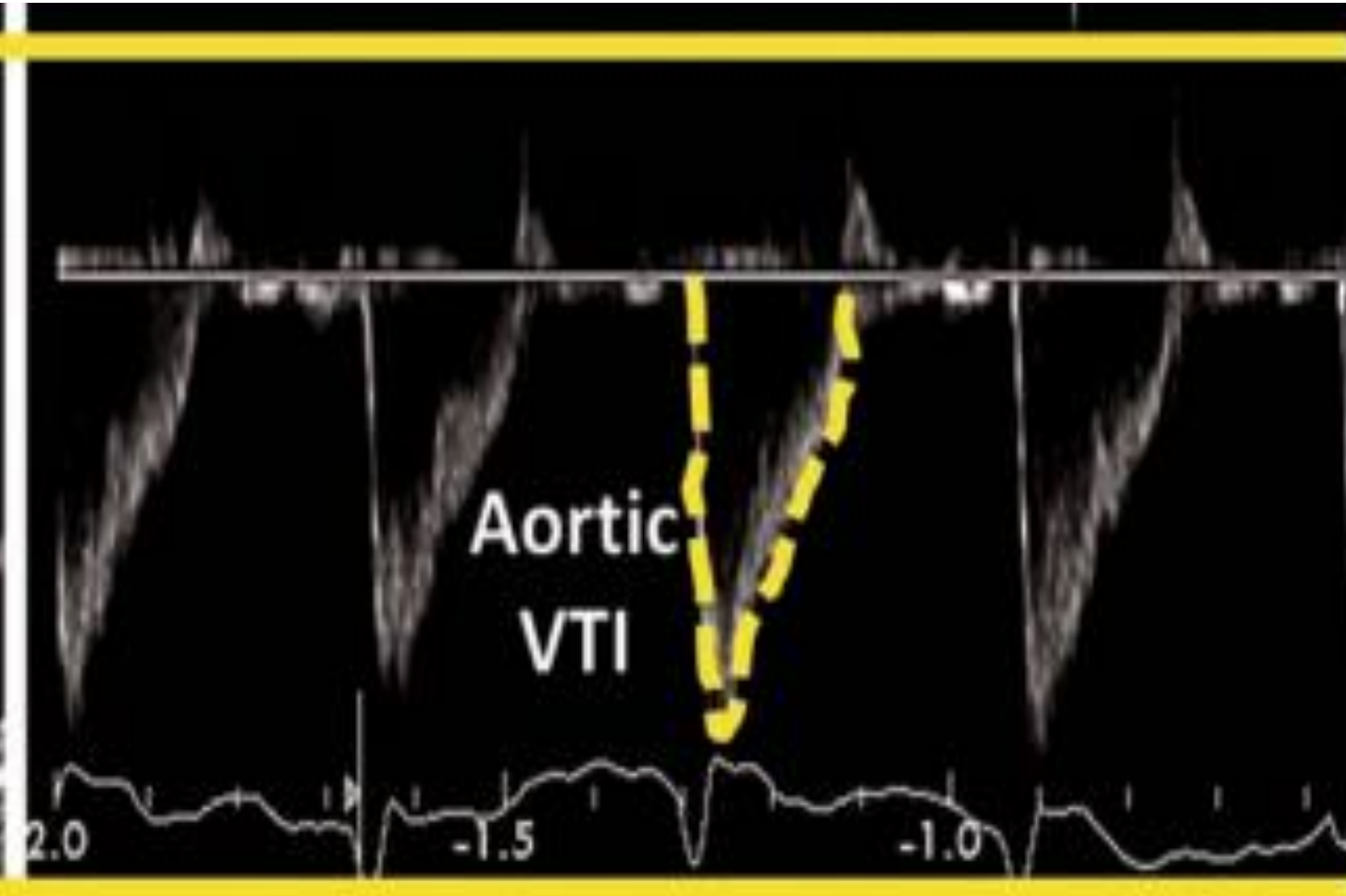
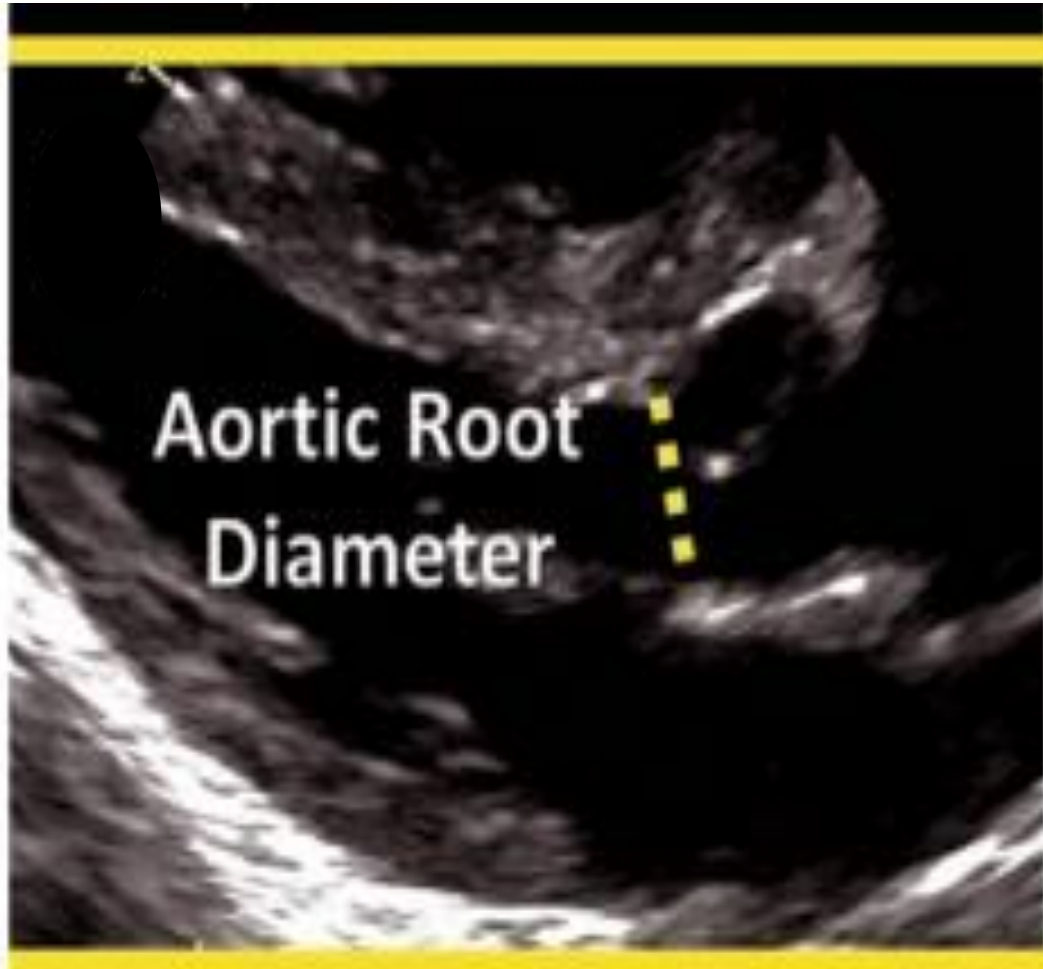
C] Left side pressure loading: -

- Mitral valve E:A
- IVRT (ms)

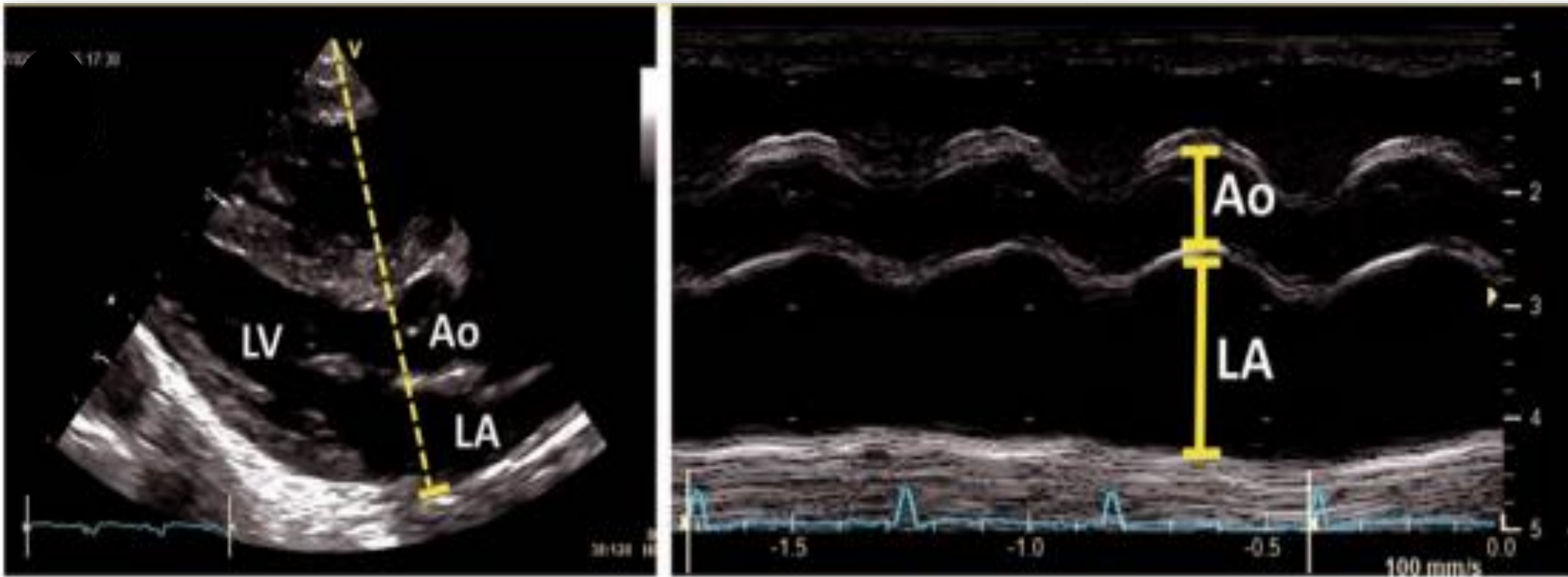
Parasternal long axis view  
M – Mode; Perpendicular



Left ventricular Output-  $[(\pi D^2)/4 * VTI * HR] / BW$  ml/kg/min



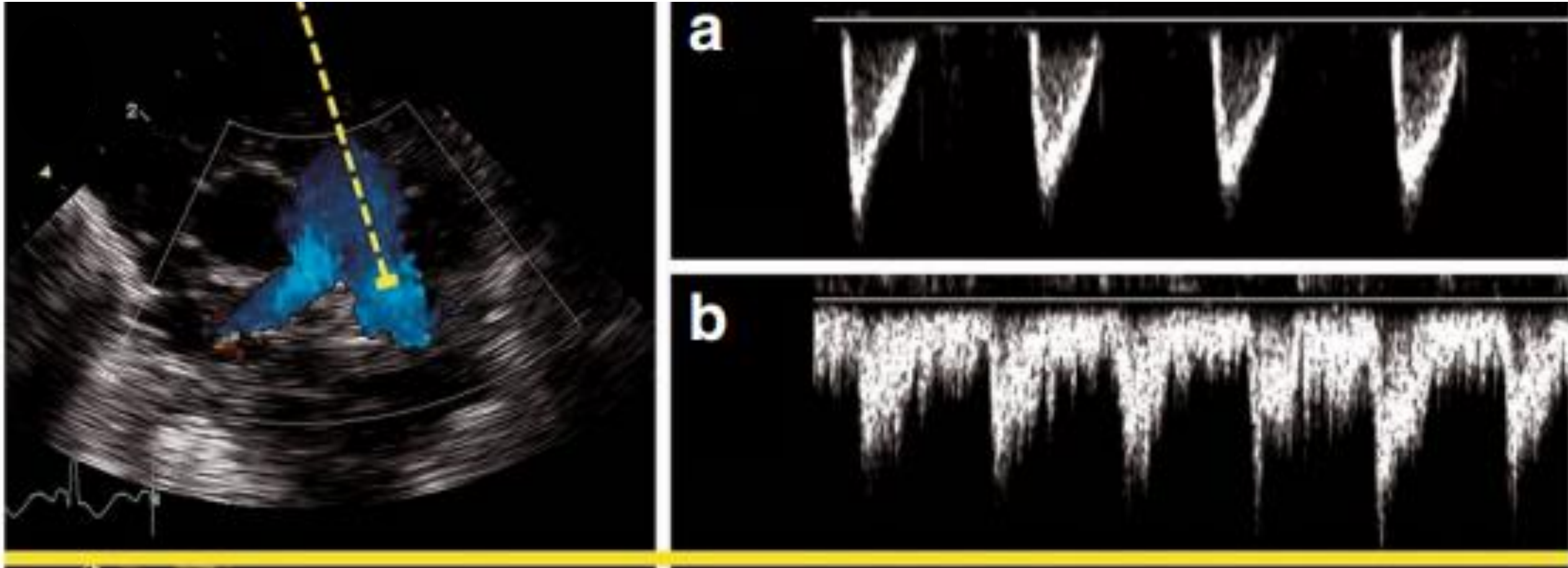
# LA/Aortic ratio



A large left-to-right shunt through the foramen ovale → “offload” the left side of the heart even in the presence of a significant shunt → Artificially low/normal LA:Ao ratio.

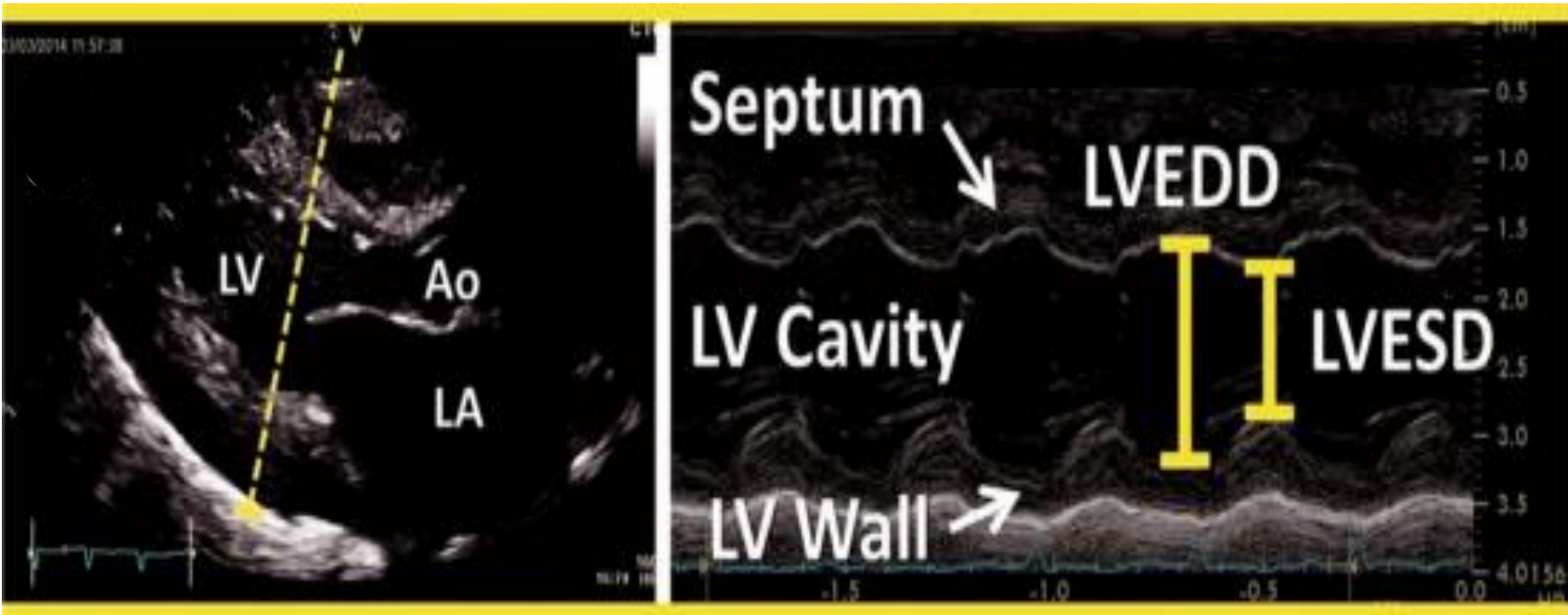
This measurement is also prone to a high degree of interobserver variability

# Left Pulmonary artery flow – Short Axis view – PW doppler



Forward diastolic flow in the presence of significant left-to-right ductal flow

# Left ventricular end diastolic dimension





# To Remember

Ductal Characteristics	LA/Ao ratio	LV output (ml/kg/min)	End Diastolic LPA flow velocity (m/s)
Small Shunt	<1.5	<200	<0.2
Moderate Shunt	1.5 - 2	200- 300	0.2 - 0.5
Large Shunt	>2	>300	>0.5

**A] LVO (mL/kg/min)**

**B] Left heart volume loading: [ surrogate markers for inc Pulm venous return]**

- La:Ao

- LVEDD (mm)

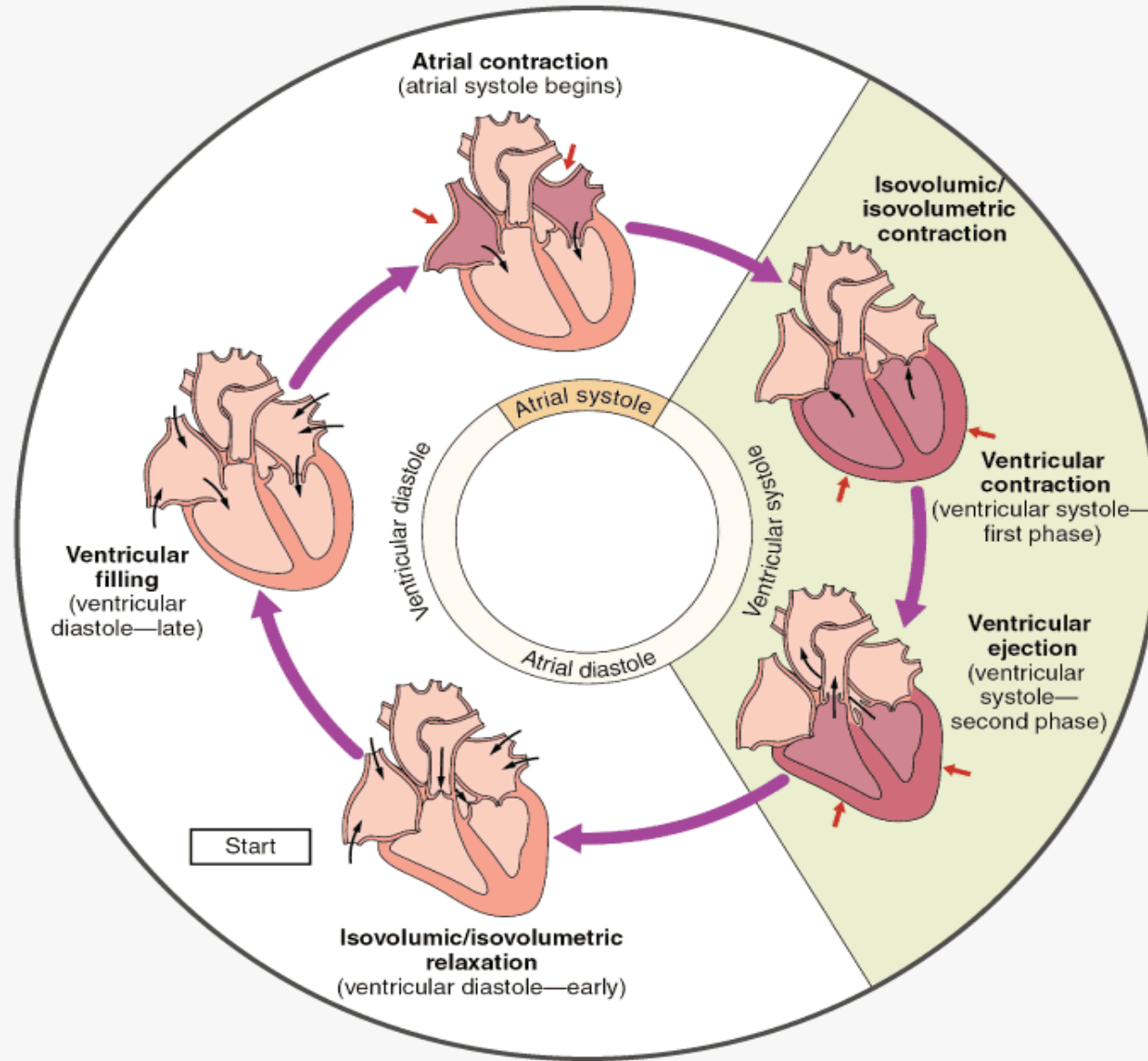
- LPA diastolic velocity (m/s)

**C] Left side pressure loading: -**

- Mitral valve E:A

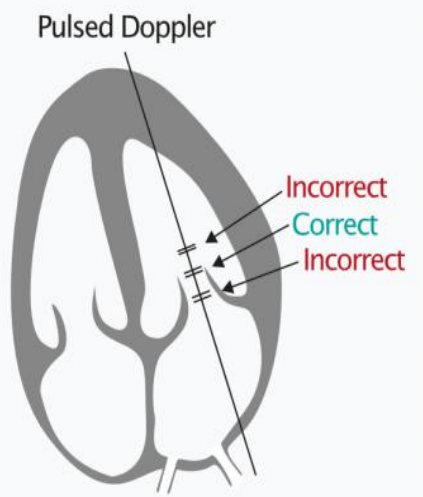
- IVRT (ms)

# CARDIAC CYCLE

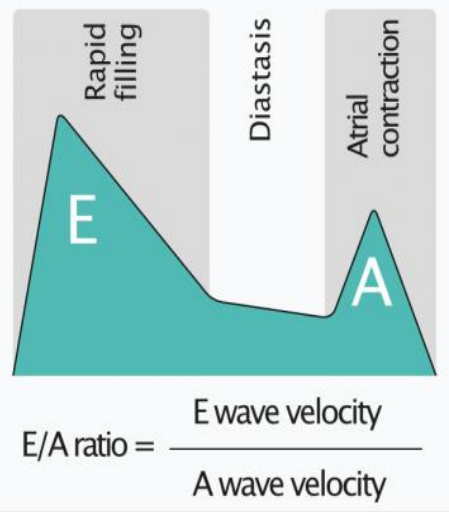


# Mitral inflow - E/A ratio

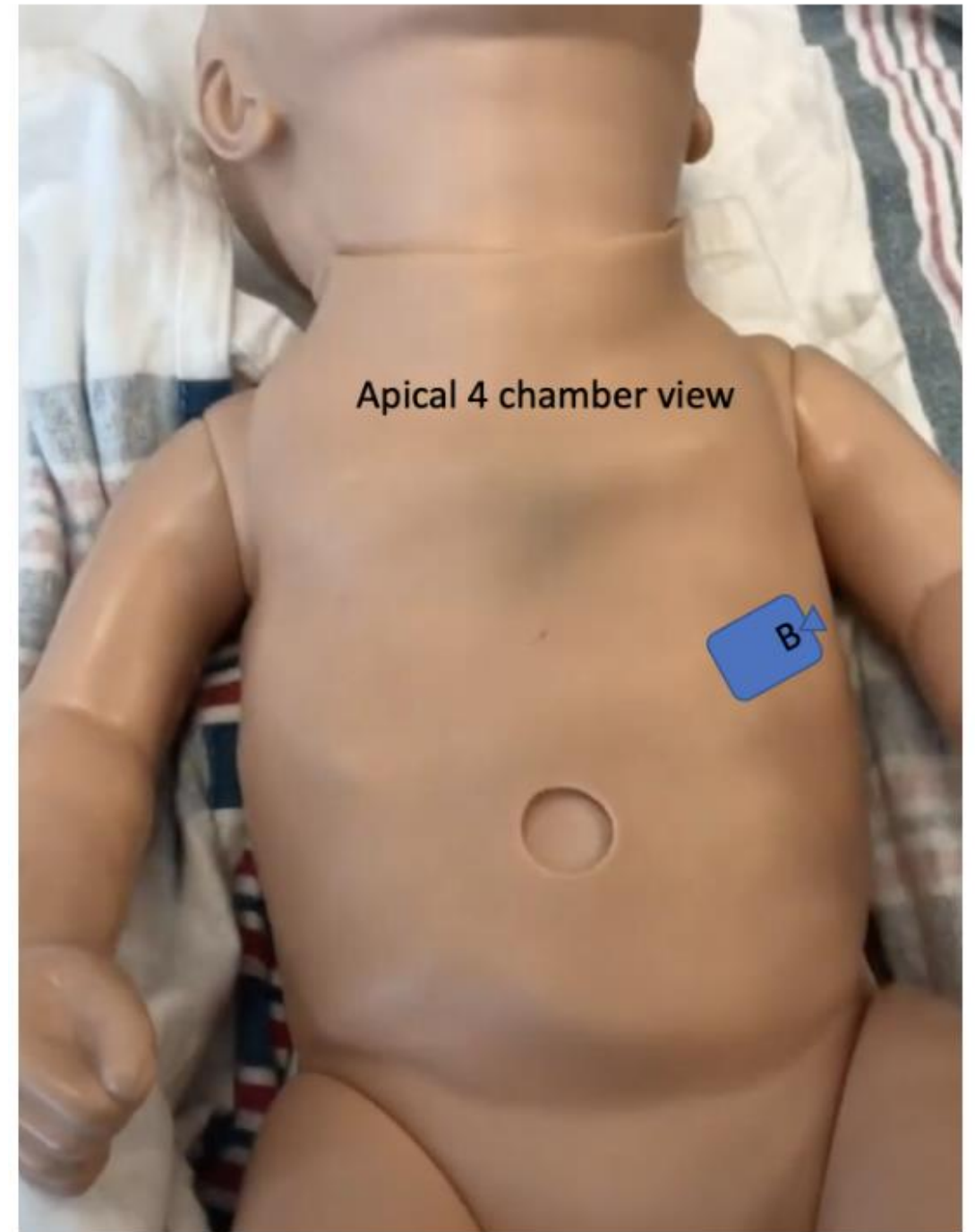
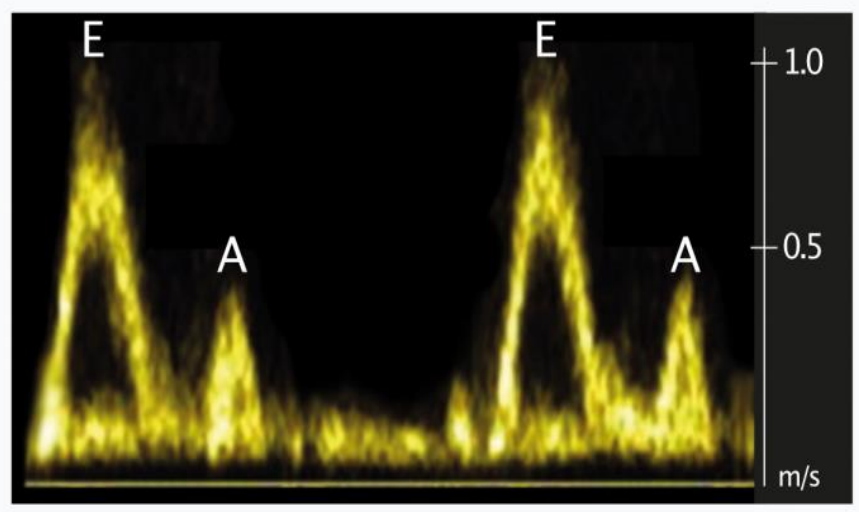
A



B



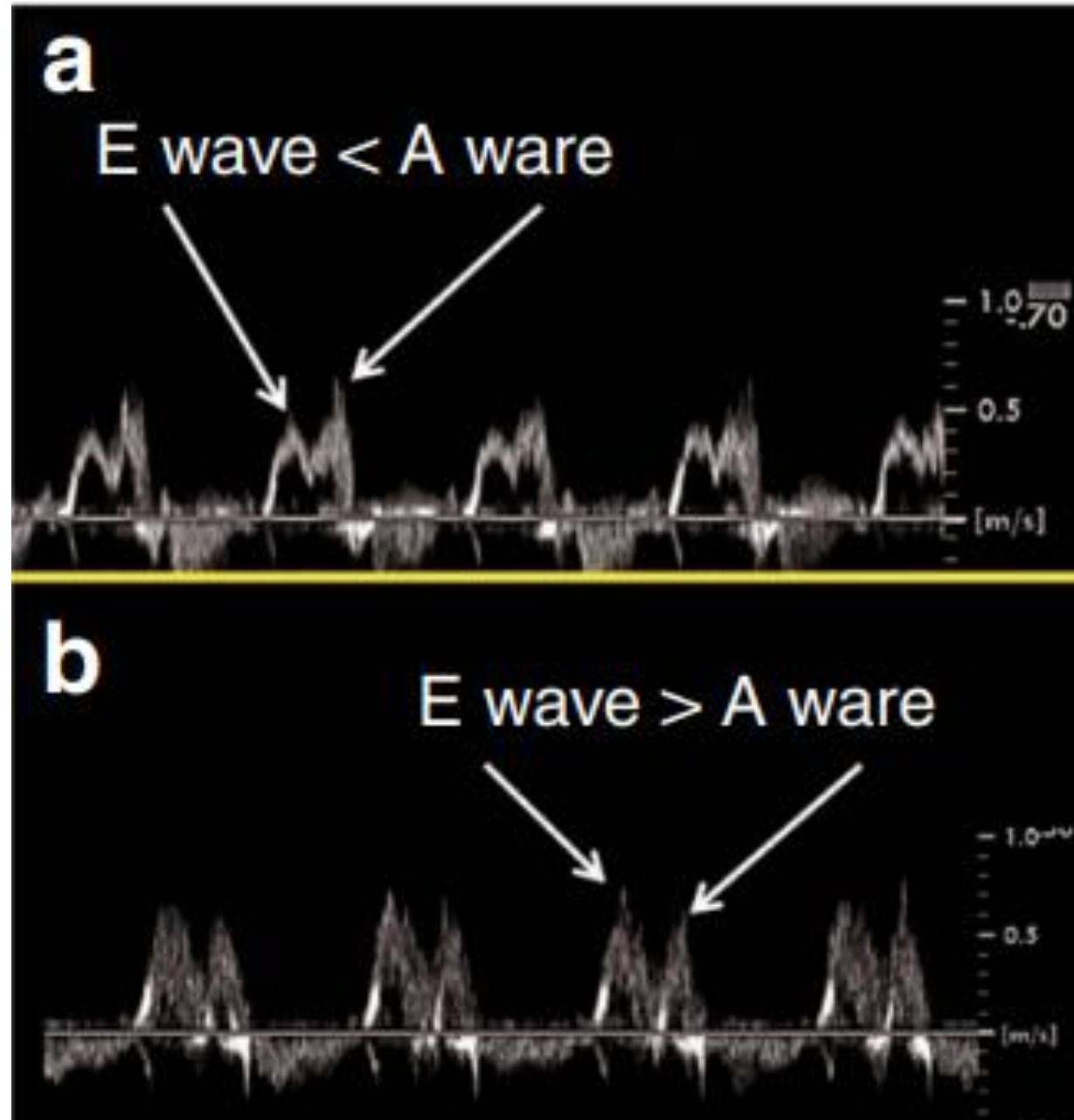
C



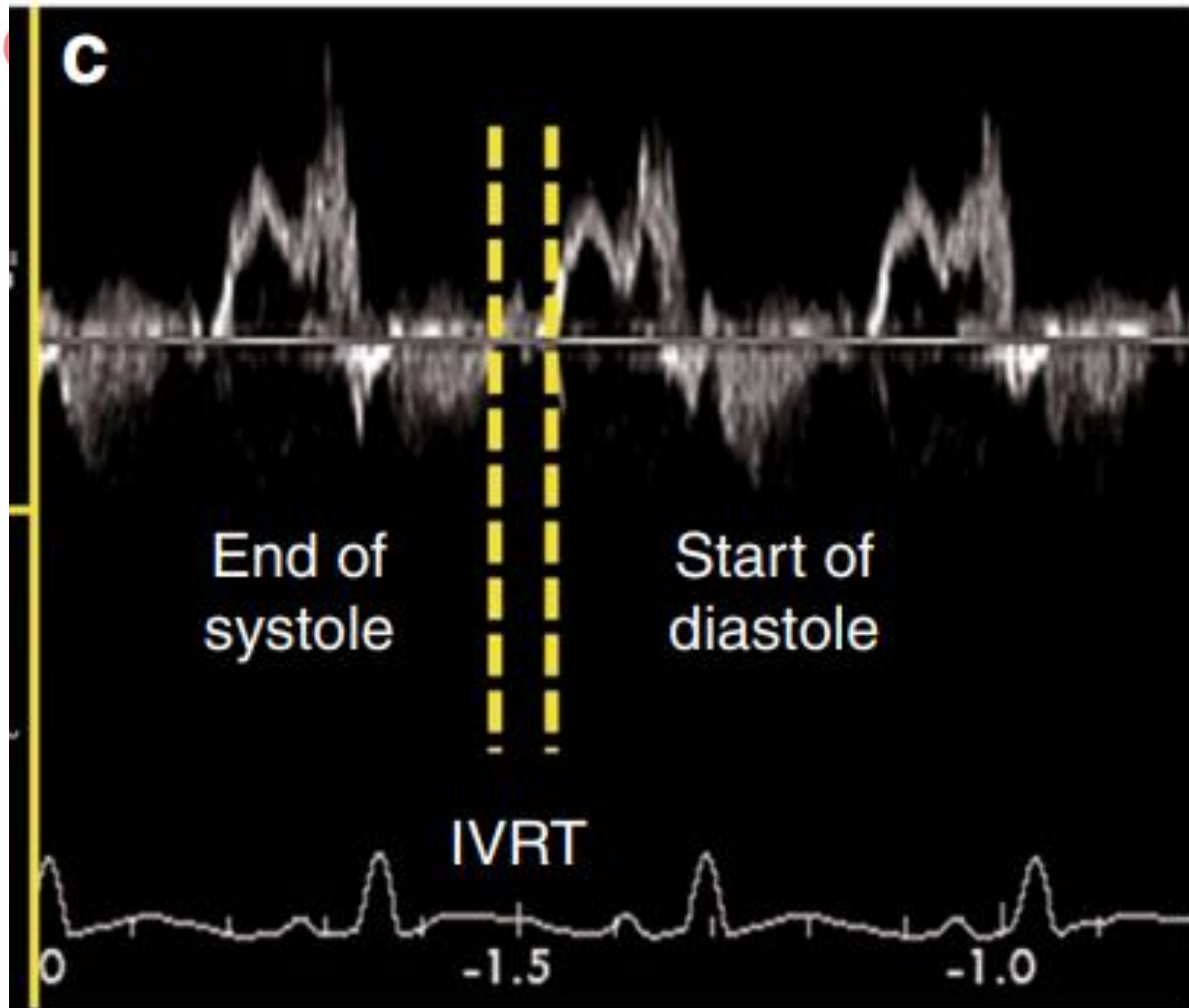
# In PDA

In Healthy  
preterm  
neonates d/t  
diastolic  
dysfunction

In Preterm  
neonates with  
PDA due to  
overfilled left  
atrium



# LV IVRT



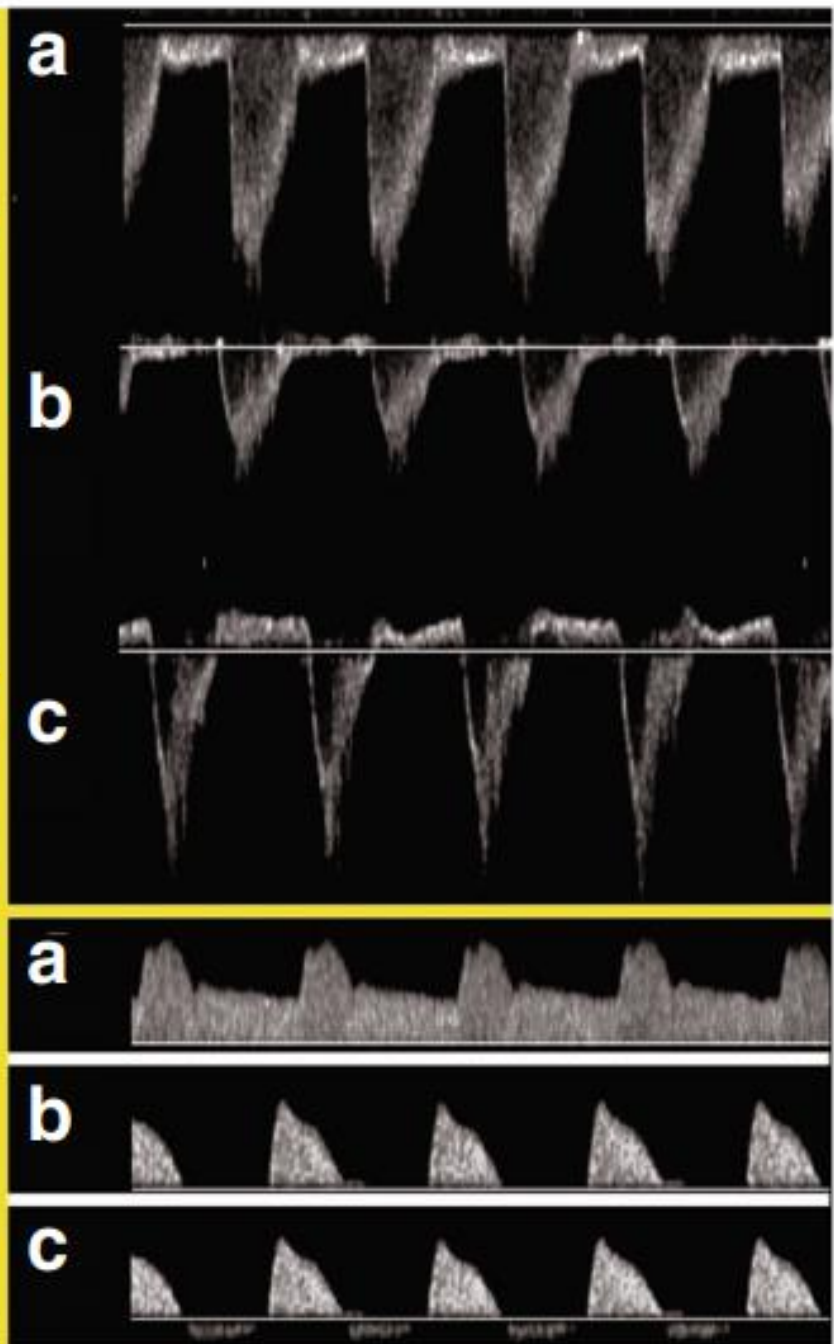
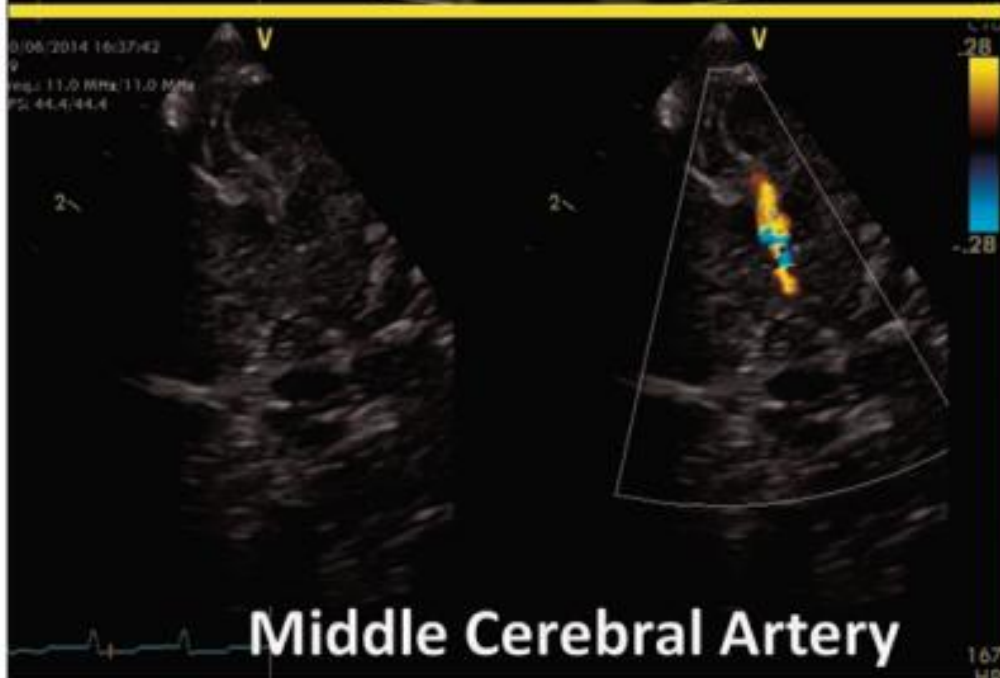
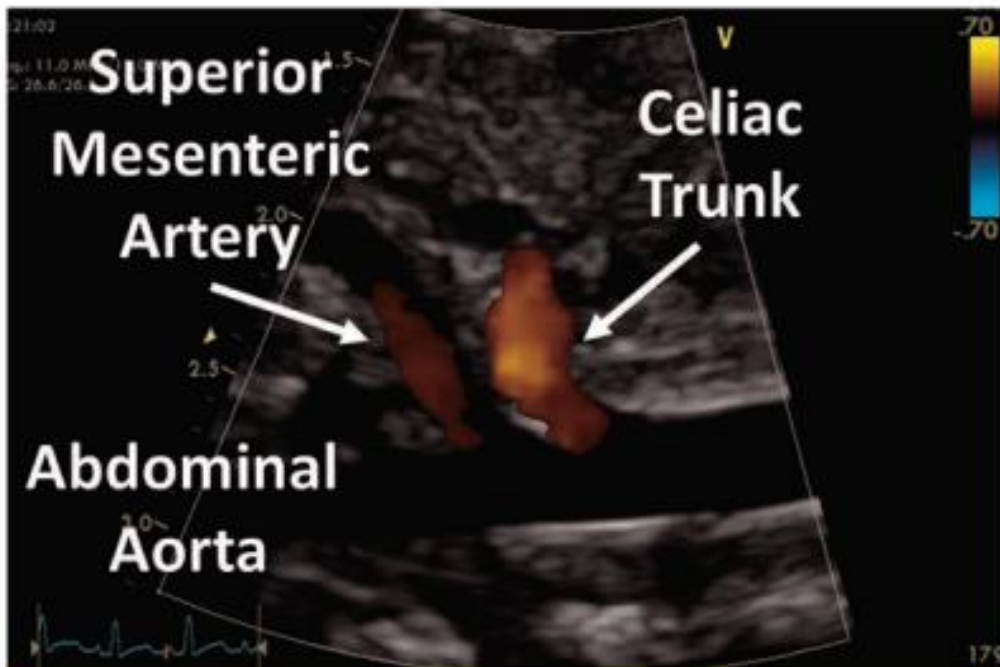
# To Remember

Duct Characteristic	Mitral Valve E:A ratio	IVRT
Small shunt	<1	>40
Moderate shunt	1	30-40
Large shunt	>1	<30

# Indices of Systemic shunt effect

- ❖ Flow direction in one of the following post-ductal artery –
  - Descending aorta
  - Celiac trunk
  - Middle cerebral artery (forward, absent, reversed)





# When Is a PDA Hemodynamically Significant?

- **AAP 2020:** *There is no consensus on clinical or sonographic criteria that define the need for PDA closure*

- The  
vari

***Existing sonographic criteria cannot  
clearly define the need for PDA  
closure***

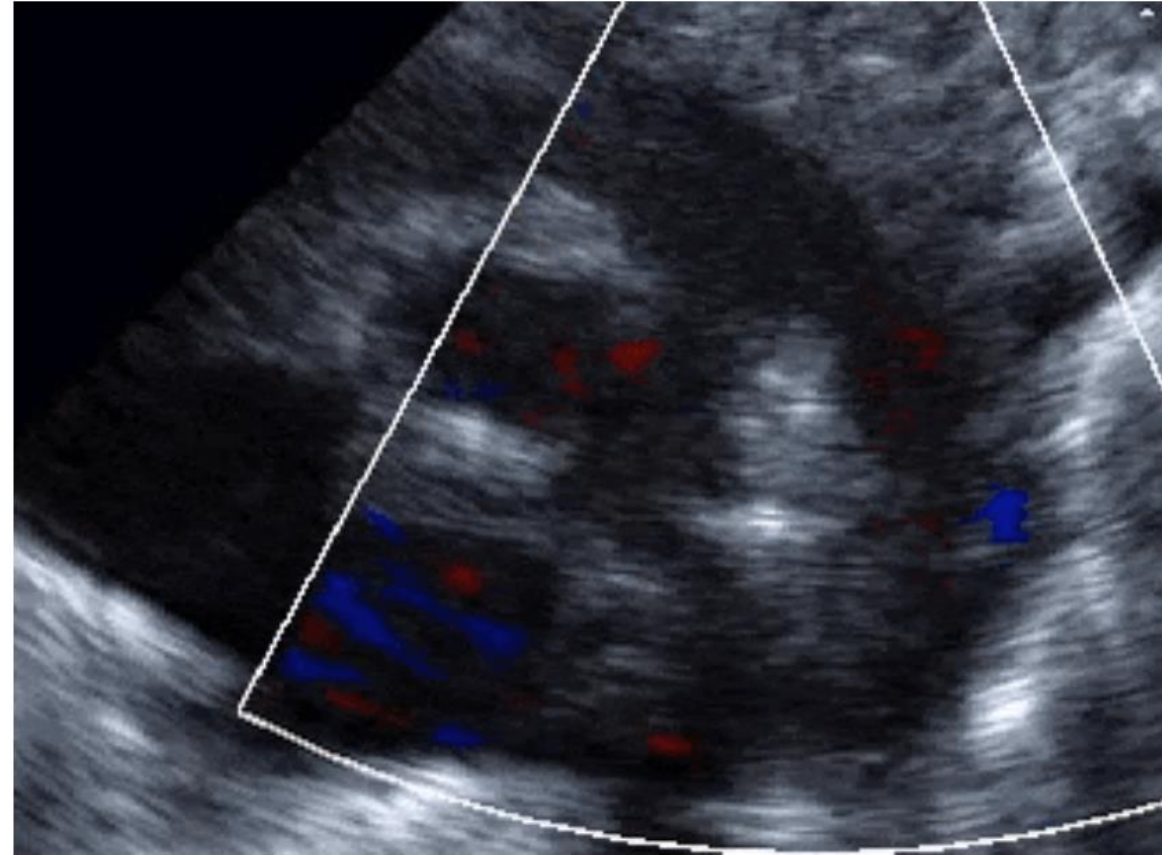
- Ass  
pati

- **Can**  
use  
(*strong recommendation*).

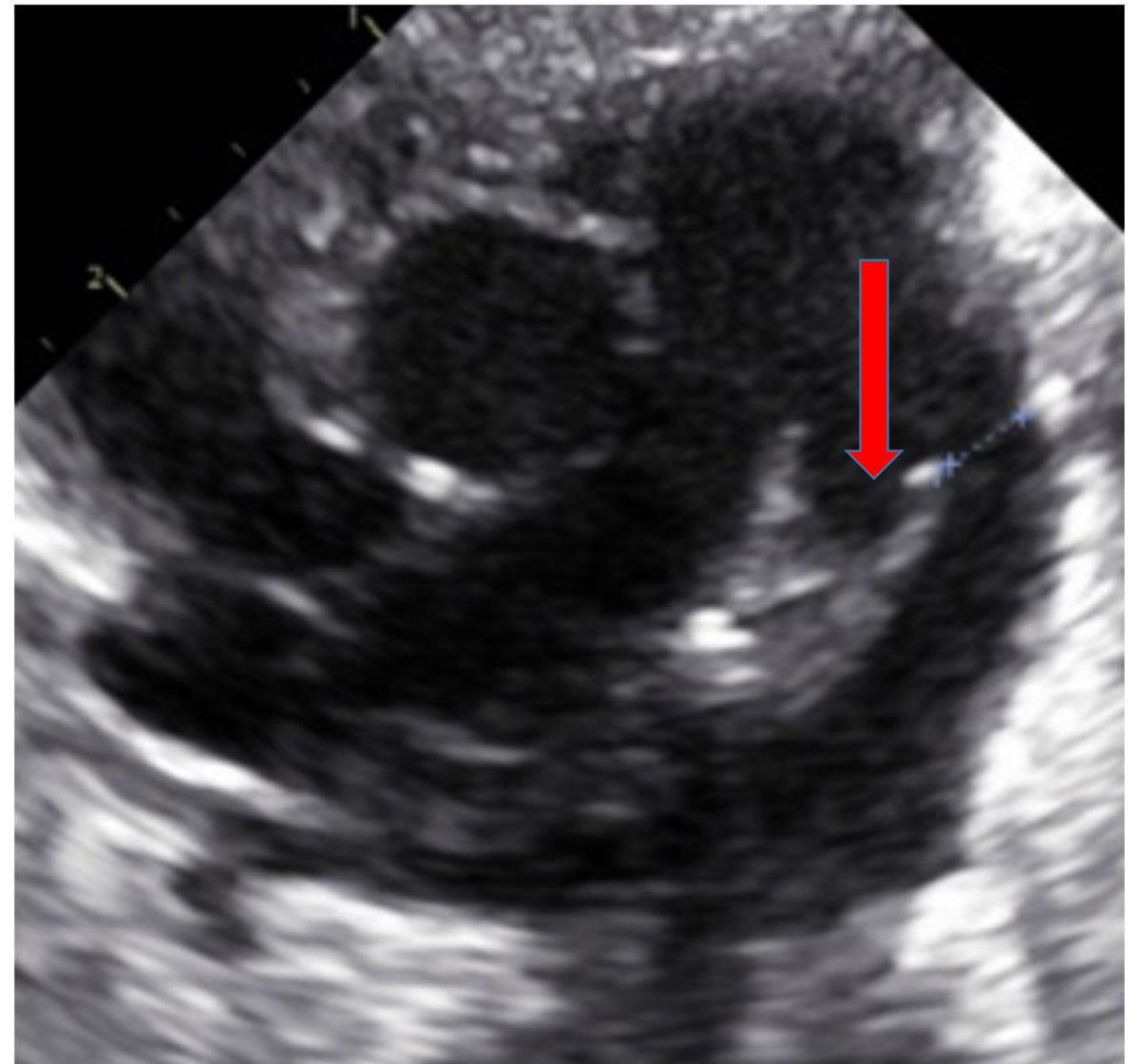
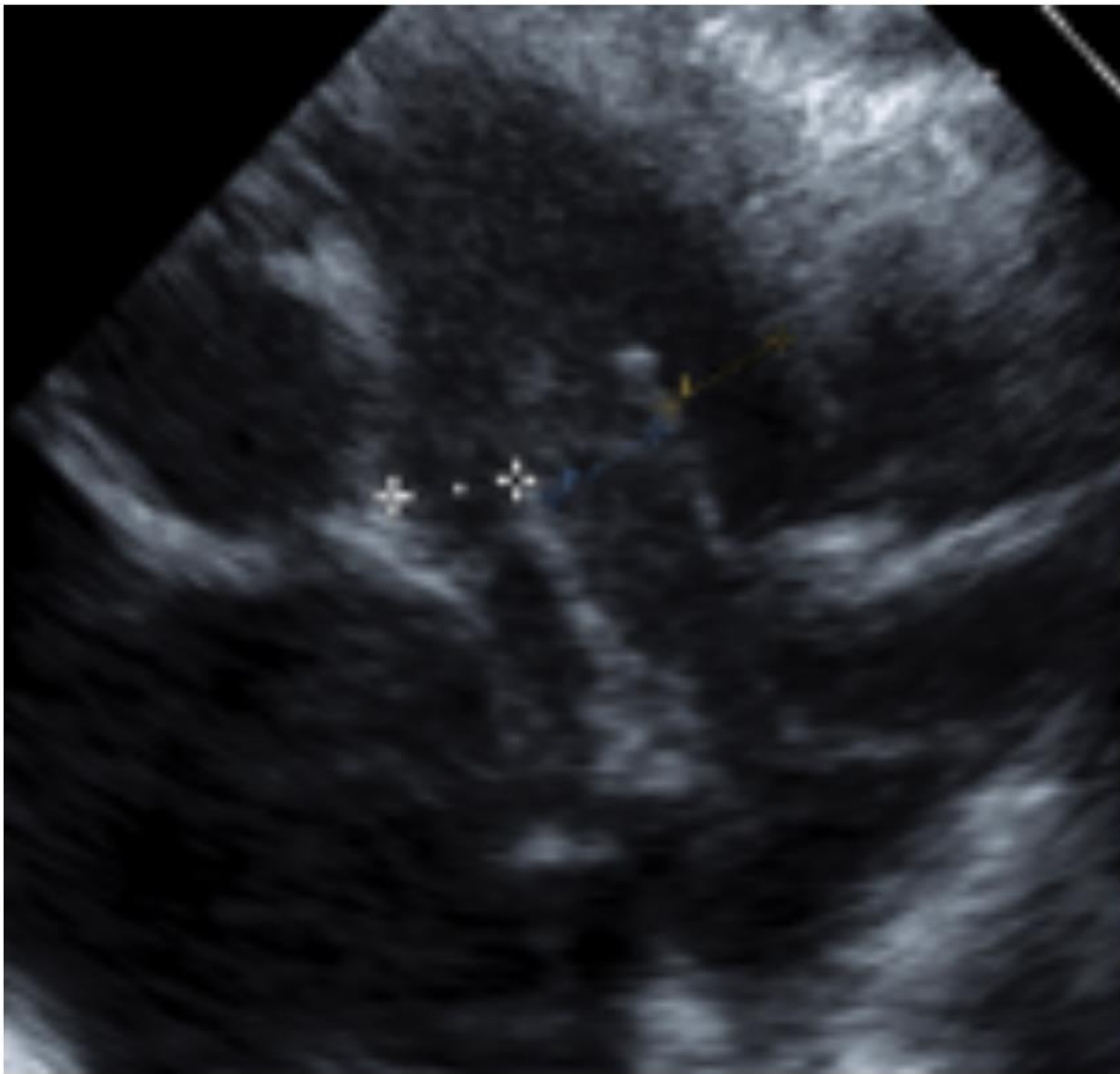
- Insufficient evidence : To suggest a set of echocardiographic criteria to define hs PDA. A PDA with a diameter of  $<1.5$  mm is unlikely to result in a hemodynamically significant shunt, and therefore may be conservatively managed without pharmacotherapy (*conditional recommendation*).

Lower Risk	Determinants of Risk (hsPDA)	Higher Risk
No	Tachycardia	Yes
No	Tachypnea	Yes
No need for respiratory support or oxygen, stable SpO <sub>2</sub> and Pao <sub>2</sub>	Respiratory support	Need for invasive or noninvasive respiratory support Worsening respiratory situation (eg, increasing flow and Fio <sub>2</sub> on HFNC; increasing PEEP, PIP, and Fio <sub>2</sub> on CPAP; NIV; MV) and frequent desaturations
Abdomen soft, not distended	Abdominal signs and symptoms	Abdominal distension, residual feeding volume (other pre-NEC signs)
Not present	Signs of organ dysfunction	Renal failure, NEC, impaired NIRS variables
<ul style="list-style-type: none"> <li>• LA only mildly dilated LA/Ao ≤ 1.2 (PLAX)</li> <li>• Normal LV size</li> <li>• Normal systolic LV function (LVEF ≥ 55%)</li> <li>• Ductal diameter ≤ 1 mm (at narrowest ID)</li> <li>• PDA Vmax ≥ 3 m/s (CW Doppler)</li> <li>• Ductal systolic and diastolic left-to-right flow ≥ 2 m/s (continuous) usually indicates narrowing (closing) PDA</li> <li>• Normal mean and diastolic PA flow</li> <li>• ACA RI ≤ 0.75</li> <li>• No (or only early) diastolic retrograde DAO flow</li> </ul>	Echocardiography, Doppler sonography (cerebral, abdominal)	<ul style="list-style-type: none"> <li>• Severe LA dilation LA/Ao ≥ 1.4 (PLAX)</li> <li>• Severe LV dilation (4C view, PSAX)</li> <li>• Systolic LV dysfunction (LVEF &lt; 50%)</li> <li>• Ductal diameter ≥ 2 to 3 mm (at narrowest ID) or ductal diameter greater than or equal to MPA diameter</li> <li>• PDA Vmax ≤ 2 m/s (CW, unrestrictive)</li> <li>• Ductal left-to-right diastolic flow ≥ 0.5 m/s</li> <li>• Highly elevated mean + diastolic PA flow</li> <li>• Severe PA dilation (eg, LPA &gt; AAO)</li> <li>• ACA RI ≥ 0.9</li> <li>• Holodiastolic retrograde DAO flow (steal)</li> </ul>

OSCE

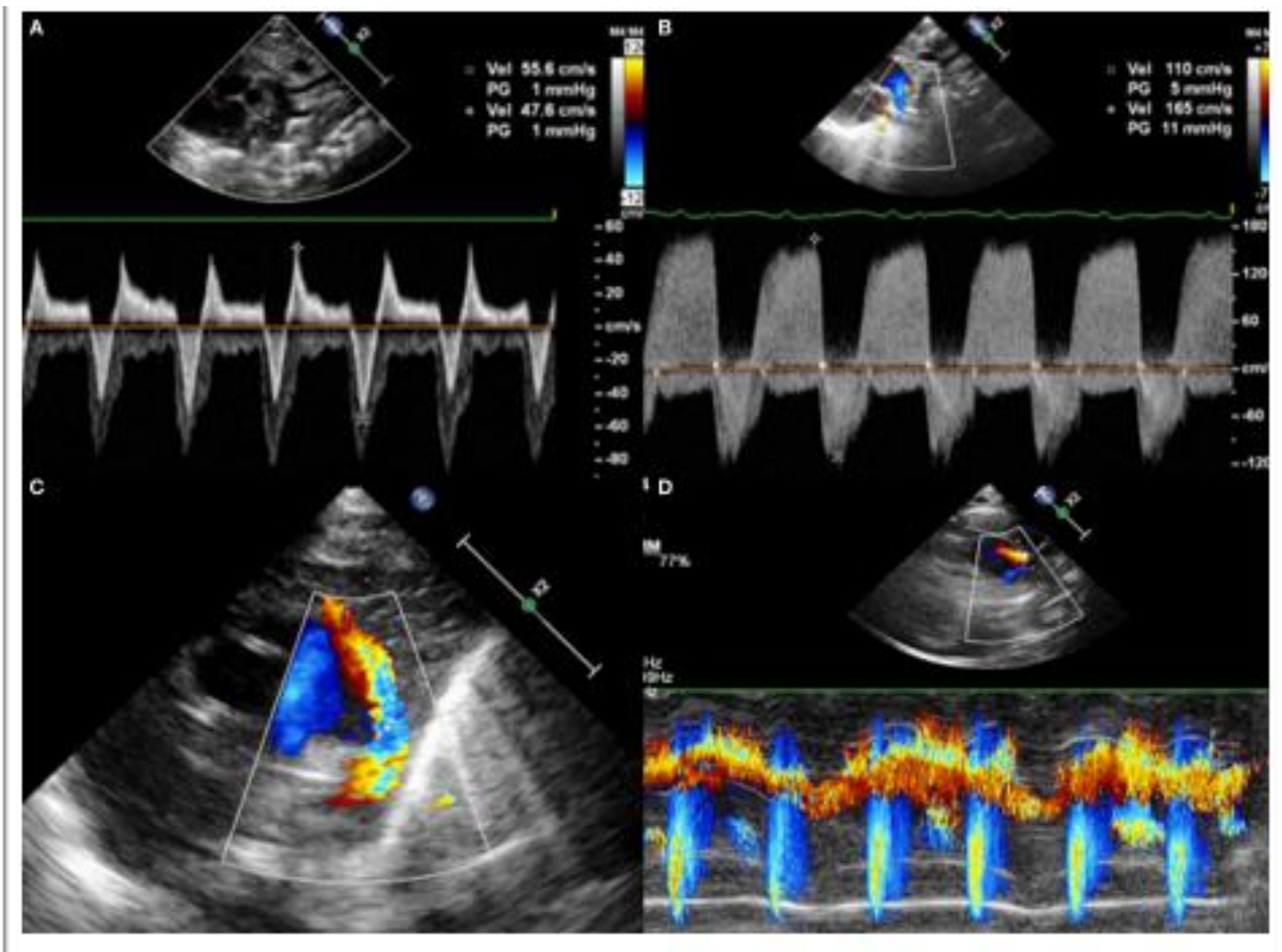


Identify the view?



- Identify the structure?
- Two parameters which can be measured on this for PDA

# Identify the direction of shunt flow in the 2 graphs







*Coming soon.....*



*To Treat or Not to treat...*