

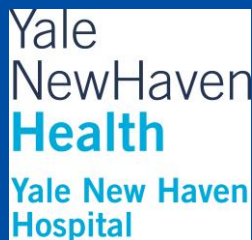
Basic Fetal Cardiac Evaluation

Mert Ozan Bahtiyar, MD

Director, Fetal Care Center

Division of Maternal Fetal Medicine

Department of Obstetrics, Gynecology and Reproductive Sciences



Background

- CHD is a leading cause of infant mortality
- Prenatal detection may improve outcomes
 - TGA, HLHS, coarctation
- Society guidelines
- Screening exam vs. echocardiogram

AIUM Practice Guideline for the Performance of

Fetal Echocardiography

Guideline developed in conjunction with the American College of Obstetricians and Gynecologists (ACOG), the Society for Maternal-Fetal Medicine (SMFM), and the American Society of Echocardiography (ASE), and endorsed by the American College of Radiology (ACR).



The association for medical ultrasound
aium
AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE

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Consensus Report on the Detailed Fetal Anatomic Ultrasound Examination

Indications, Components, and Qualifications

76811 Task Force

Ultrasound Obstet Gynecol 2013; 41: 348–359
Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/uog.12403



 **isuog**.org

GUIDELINES

ISUOG Practice Guidelines (updated): sonographic screening examination of the fetal heart

Examination “Levels”

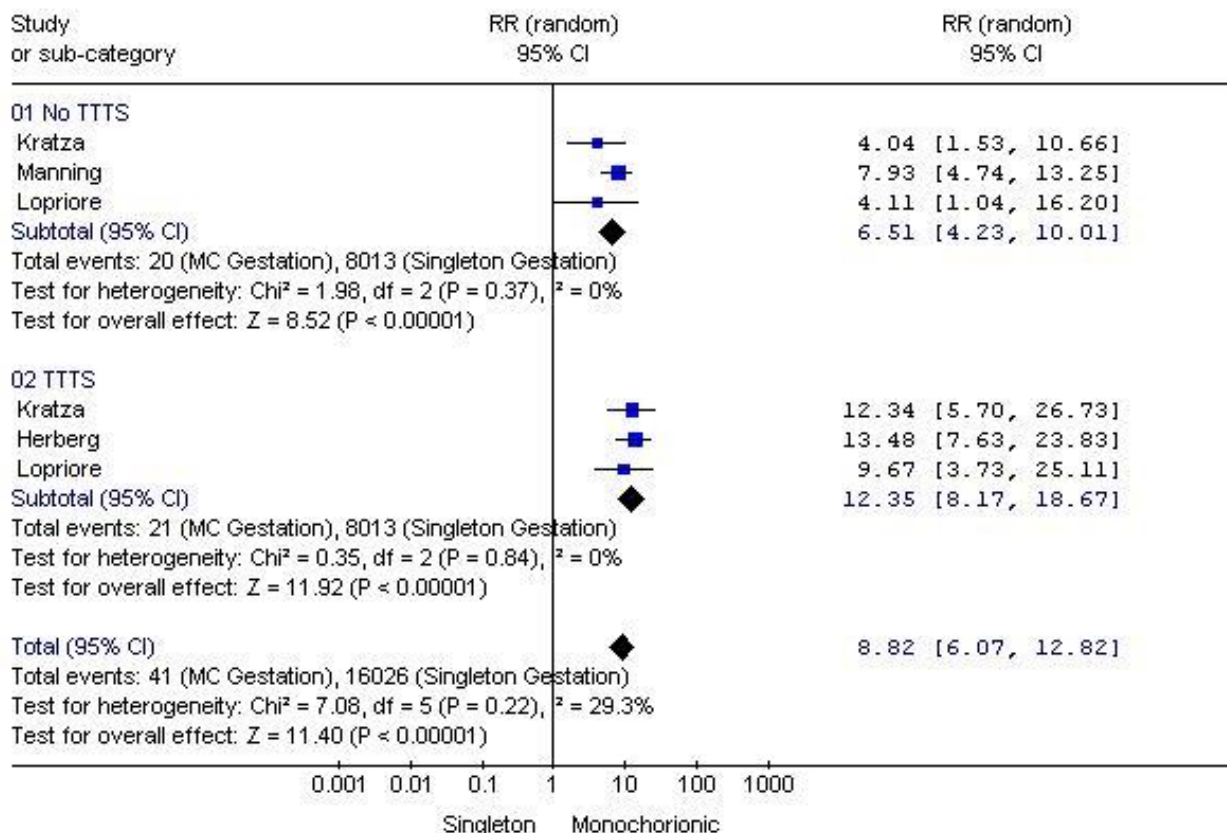
- **Basic Ultrasound (76805)**
 - 4 chamber view
 - RVOT
 - LVOT
- **Detailed Ultrasound (76811)**
 - Basic +
 - Aortic arch
 - SVC/IVC
 - 3VV
 - 3V&T
- **Fetal echocardiogram**

Fetal Echo - Some Fetal Indications

- Abnormal cardiac screening exam
- First degree relative of fetus with CHD
- Abnormal heart rate or rhythm
- Fetal chromosomal anomaly
- Extracardiac anomaly
- Hydrops
- Increased NT
- Monochorionic twins

Congenital Heart Defects in Monochorionic Twin Gestation

Review: Congenital Heart Disease in Monochorionic Twin Gestations: A Systematic Review
 Comparison: 02 CHD Prevalence in Monochorionic Twin Gestation
 Outcome: 01 CHD Prevalence in MC/DA Twin Gestations



Bahtiyar et al. JUM 26(11):1491-98. 2007

Fetal Echo - Some Maternal Indications

- Autoimmune antibodies (SSA/Ro, SSB/La)
- Familial inherited disorders (e.g. 22q11.2 del)
- Metabolic disease (e.g. DM, PKU)
- Teratogen exposure (e.g. retinoids, lithium)
- IVF

Table 5. Frequency of CHDs Compared to Historical Data

Order	CHDs		OR Against Historical Data ^b		
	n/N	Frequency ^a	Fyler ¹⁴	Ferencz et al ¹⁵	Wren et al ¹⁶
Total					
Per pregnancy	8/749	10.7 (3.3–18.0)	7.3 (3.6–14.7) ^c	2.9 (1.4–5.9) ^c	1.9 (1.0–3.9)
Per fetus	8/1001	8.0 (2.4–13.5)	5.5 (2.7–11.0) ^c	2.2 (1.1–4.4) ^c	1.4 (0.7–2.8)
Singleton	4/512	7.8 (0–15.4)	5.3 (2.0–14.3) ^c	2.1 (0.8–5.7)	1.4 (0.5–3.8)
Twins					
Per pregnancy	4/222	18.0 (0.5–35.5)	12.5 (4.6–33.5) ^c	4.9 (1.8–13.3) ^c	3.3 (1.2–8.8) ^c
Per fetus	4/444	9.0 (0.2–17.8)	6.2 (2.3–16.5) ^c	2.45 (0.9–6.6)	1.6 (0.6–4.3)
Triplets					
Per pregnancy	0/15	ND	ND	ND	ND
Per fetus	0/45	ND	ND	ND	ND

n indicates number of patients with CHDs; N, total number of patients in the study; and ND, not determined.

^aPer 1000 pregnancies or fetuses as appropriate.

^bOdds ratio with 95% CI compared with historical data.

^c $P < .05$.

Bahtiyar MO. J Ultrasound Med 2010; 917-922

Timing/Technique

- Usually 18-22 weeks
- Technical limitations (obesity, position, late gestation)
- Optimization of equipment (zoom, frequency, harmonics, narrow field, high frame rate, etc)

AIUM: Because the heart is a dynamic structure, a complete evaluation can only be made if real-time imaging with acquisition of analog recordings or digital video clips is used a standard part of every fetal echocardiogram.

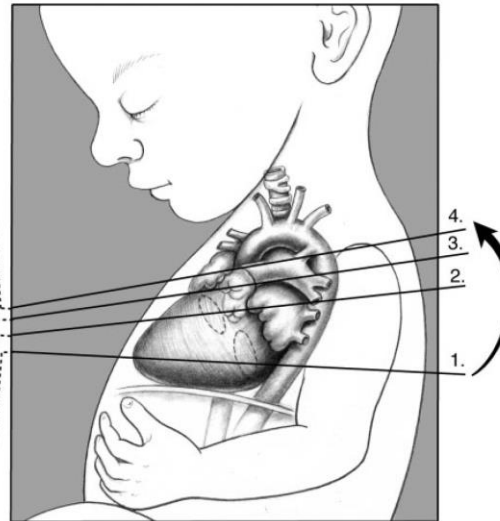
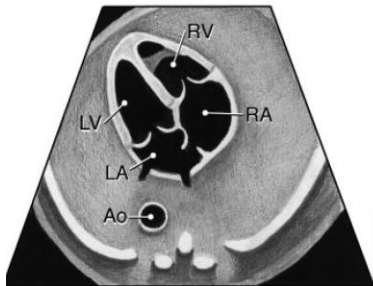
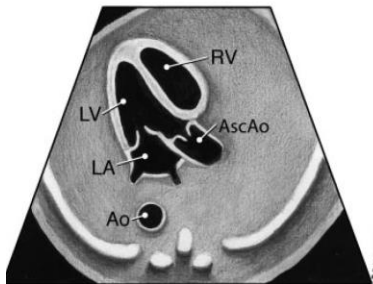
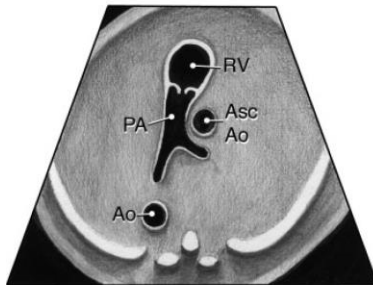
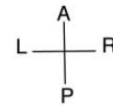
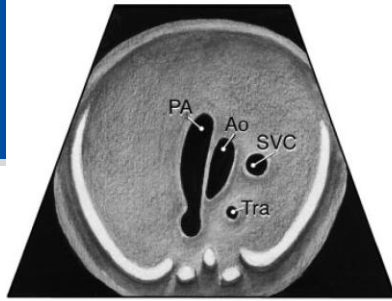
- Clips of (at least): 4 chamber, LVOT, RVOT, 3VTV, sag AA/DA with and without Color

Parameters

- Visceral/abdominal situs
- Atria
- Ventricles
- Great arteries
- Atrioventricular junction
- Ventriculoarterial junction
- Heart rate/rhythm
- Cardiac biometry (optional)
- Cardiac function assessment (optional)

Specific Views

- Grayscale
 - 4 chamber view
 - LVOT
 - RVOT
 - 3 vessel and trachea view
 - Short-axis – low for ventricles, high for outflow
 - Long-axis view
 - Aortic arch view
 - Ductal arch view
 - SVC/IVC



1. Four Chamber View
2. Left Ventricular Outflow Tract
3. Right Ventricular Outflow Tract
4. Three Vessels Trachea View

Specific Views

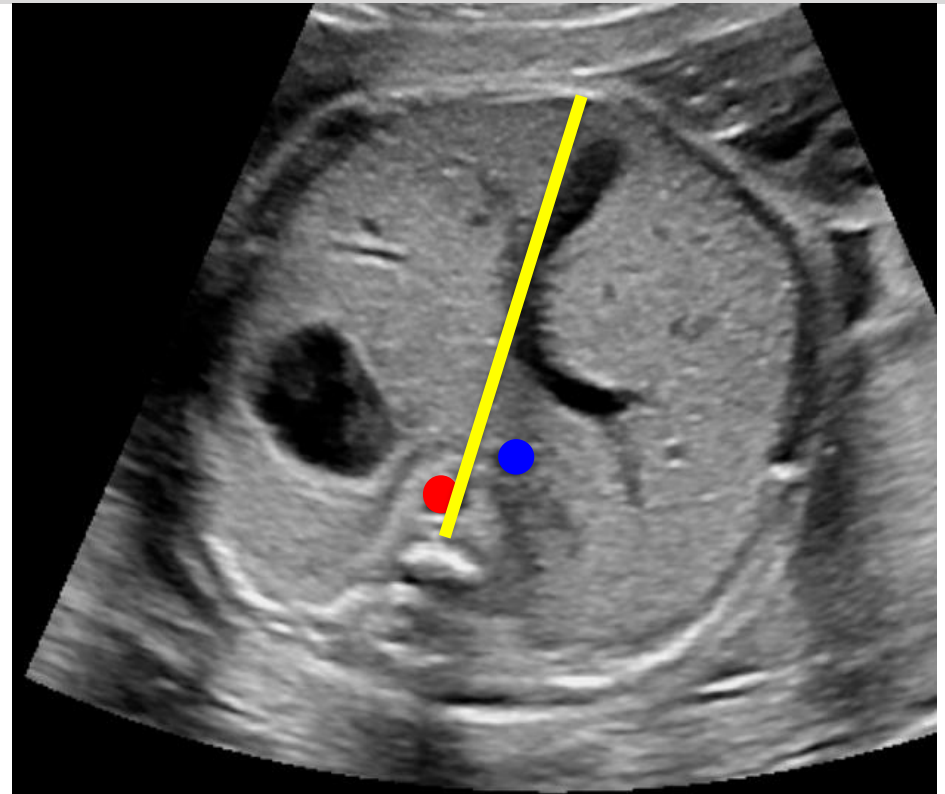
- Color
 - Systemic veins – SVC/IVC, DV
 - Pulmonary veins
 - Foramen ovale
 - AV valves
 - Atrial and ventricular septa
 - Semilunar valves
 - Ductal arch
 - Aortic arch
 - Umb vein/artery (optional)

Specific Views

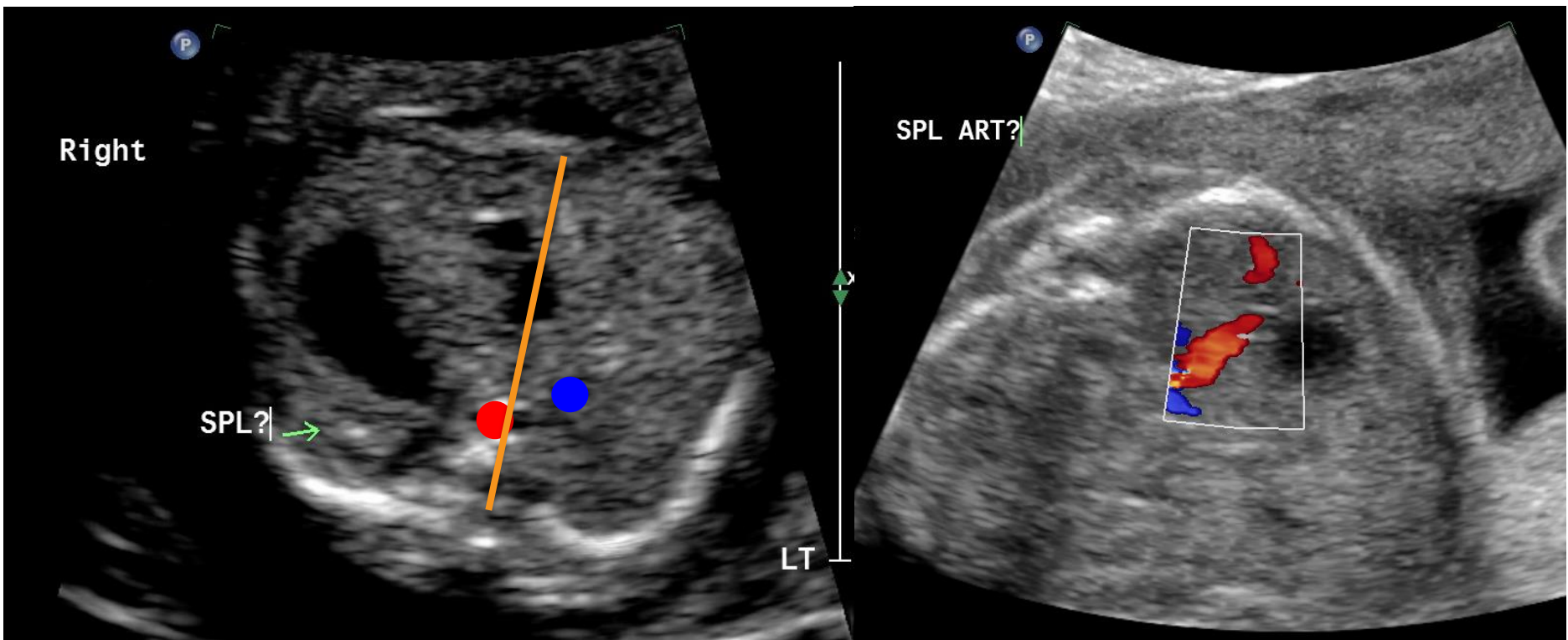
- Pulsed Doppler
 - AV valves
 - Semilunar valves
 - DV
 - Umb vein/artery (optional)
 - Cardiac rhythm disturbance
 - Any structure in which an abnormality on Color Doppler is detected

Upper Abdomen

- Stomach
- Aorta on left
- IVC on the right and more ventral
- Umbilical vein to the left portal sinus



Abdominal Situs Inversus

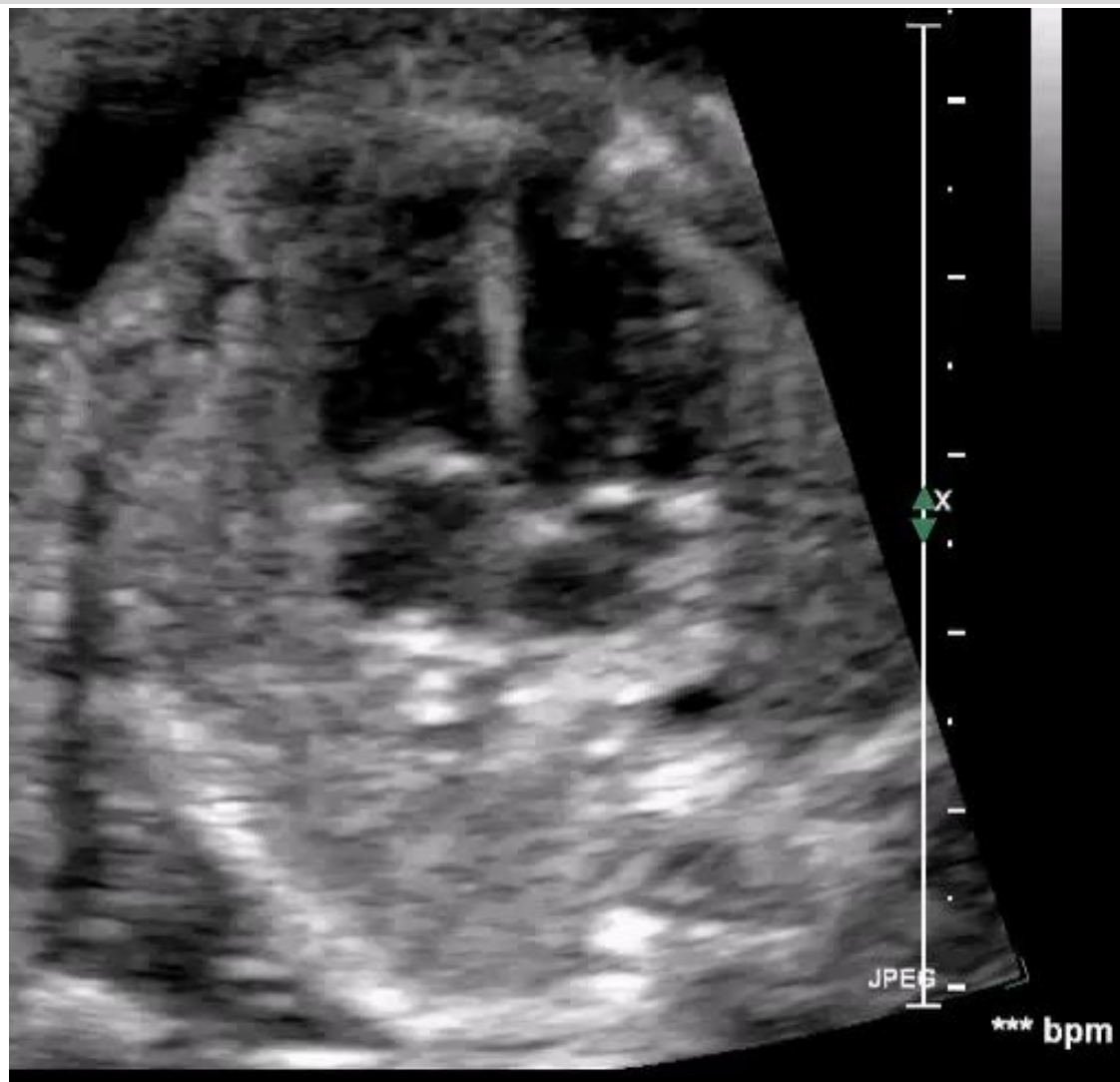




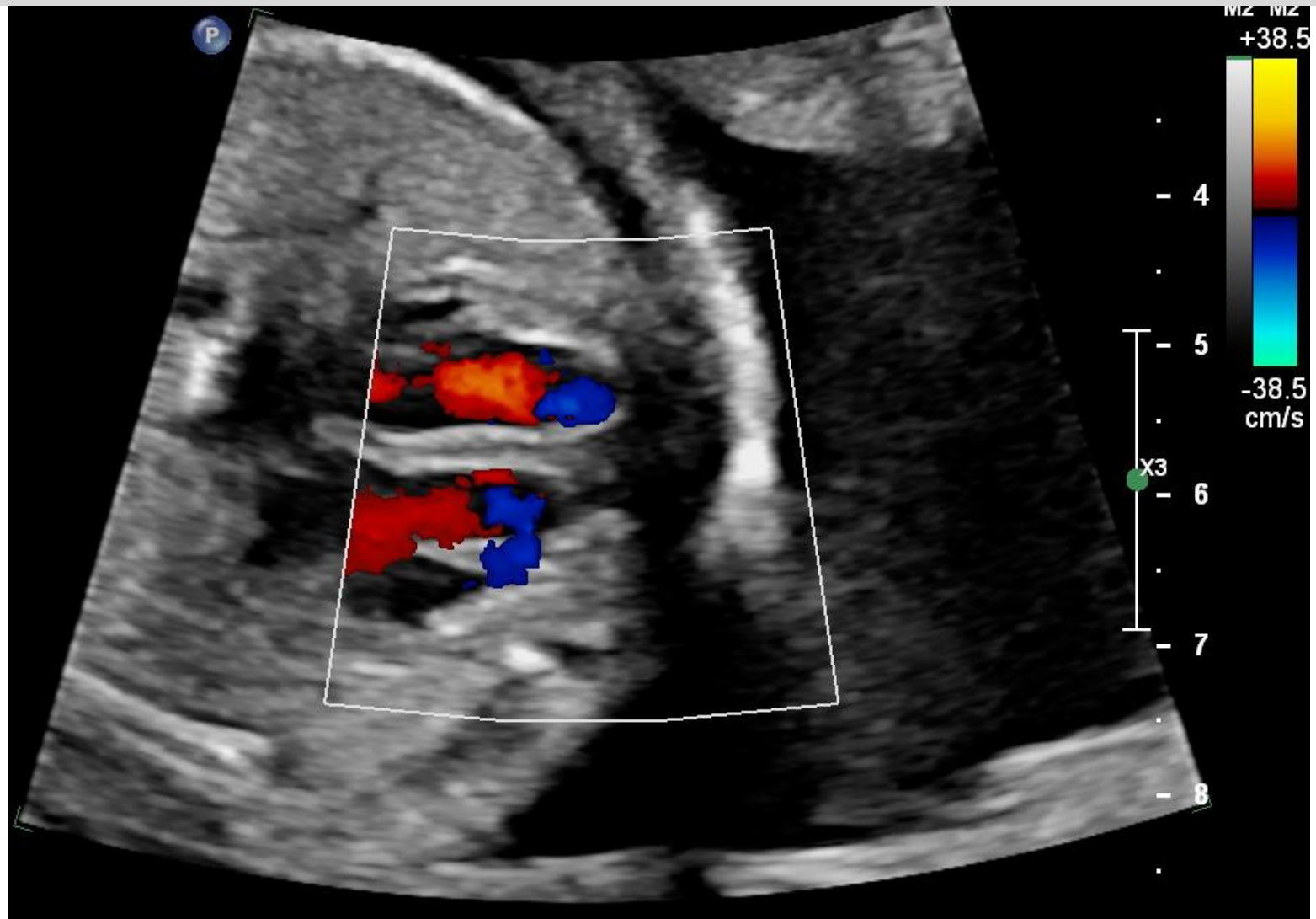
Four Chamber View

- Heart area $\sim 1/3$ of chest area
- Hypoechogenic rim
- Long axis to the left, $45^\circ \pm 20^\circ$
 - Abnormal axis a/w CHD, esp outflow tract anomalies
 - Abnormal axis a/w chromosomal anomaly
 - Left deviation with gastroschisis/omphalocele
- Position
 - Displacement with CDH, space-occupying lesions (CPAM, etc), lung hypoplasia/agenesis
- $RV \approx LV, RA \approx LA$
- Visualize the crux of the heart
- Examine the interventricular septum

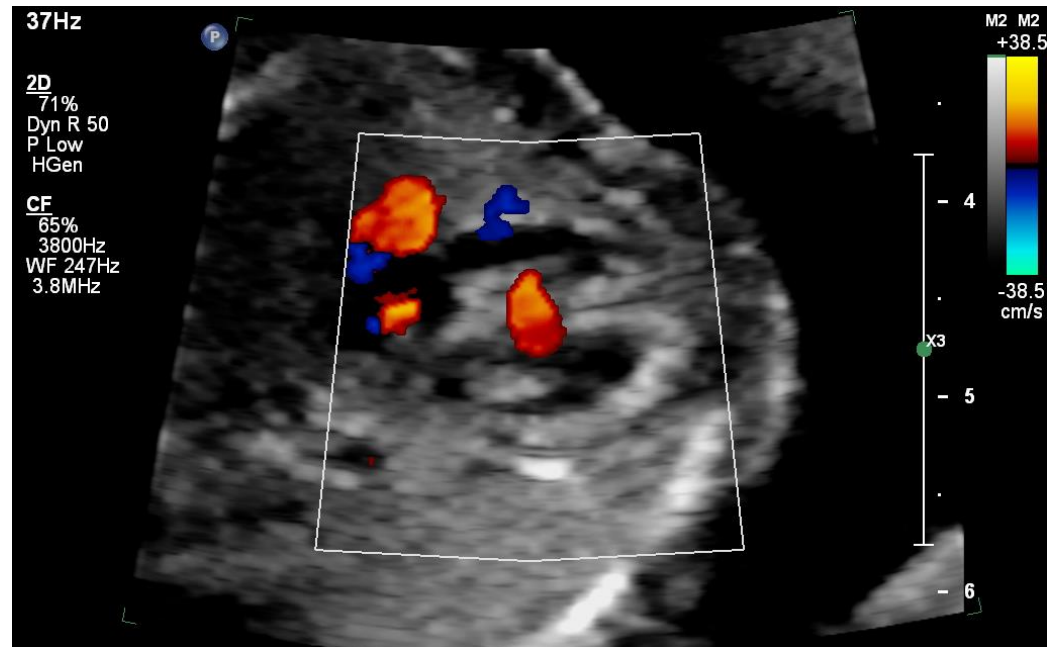
Four Chamber View



Interventricular Septum



Interventricular septum



Differentiating the Ventricles

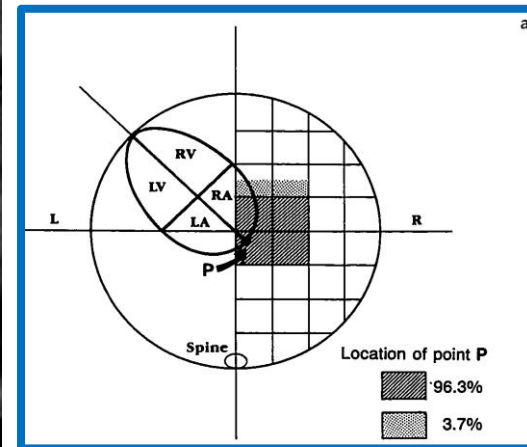
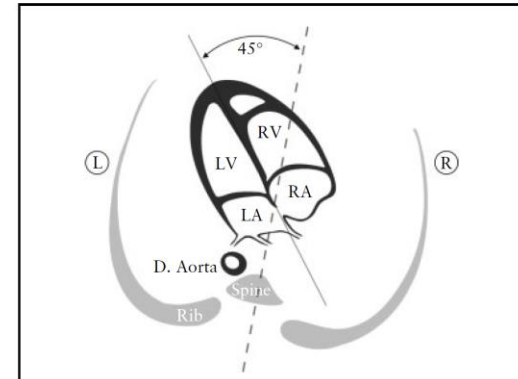
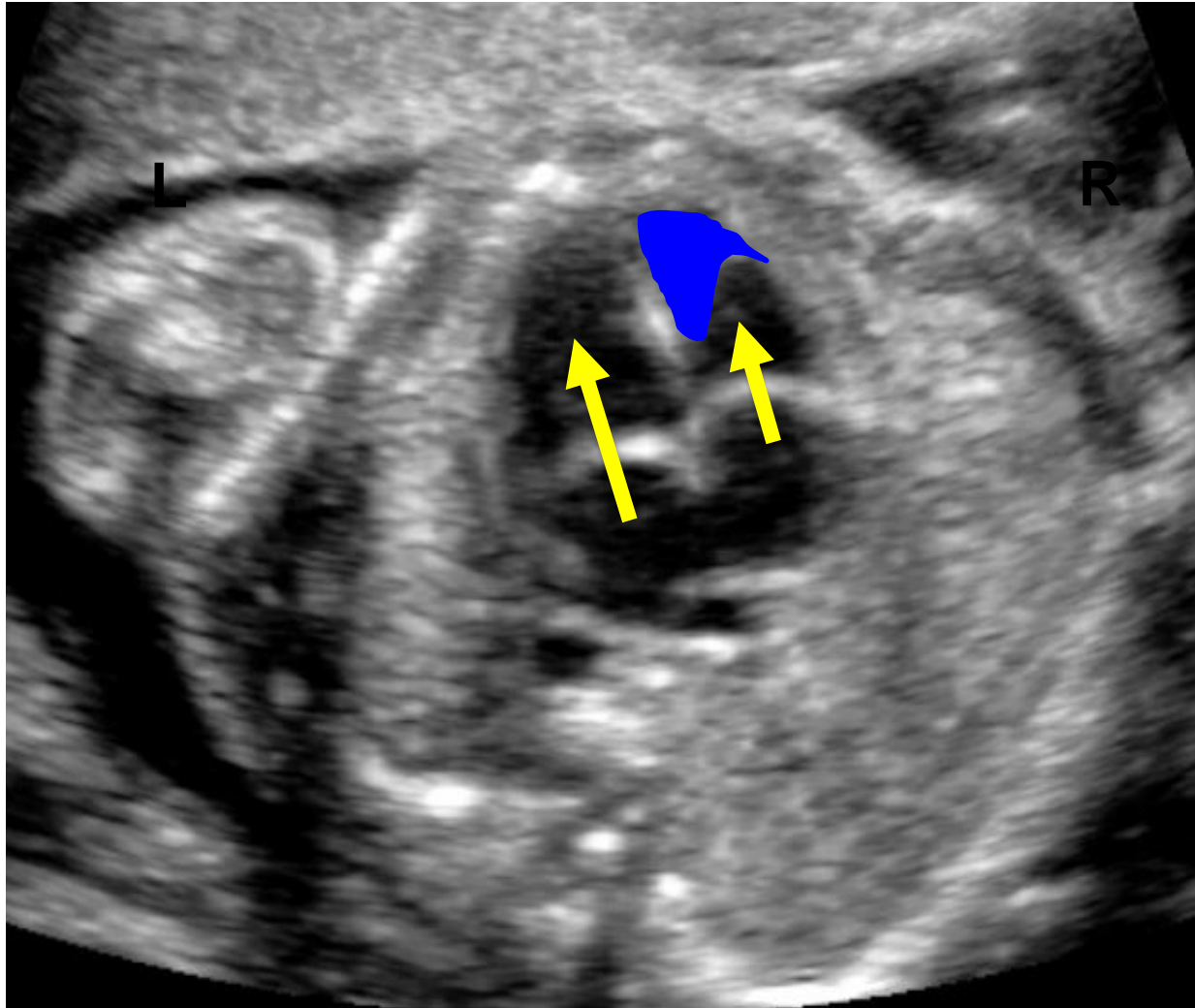
Right

- Shape – “square”
- Trabeculated
- Moderator band apical
- Papillary muscles attach to interventricular septum
- Tricuspid valve belongs to RV

Left

- Shape – “oval”
- Smooth
- LV forms apex of heart
- Papillary muscles attach to free wall
- Mitral valve belongs to LV

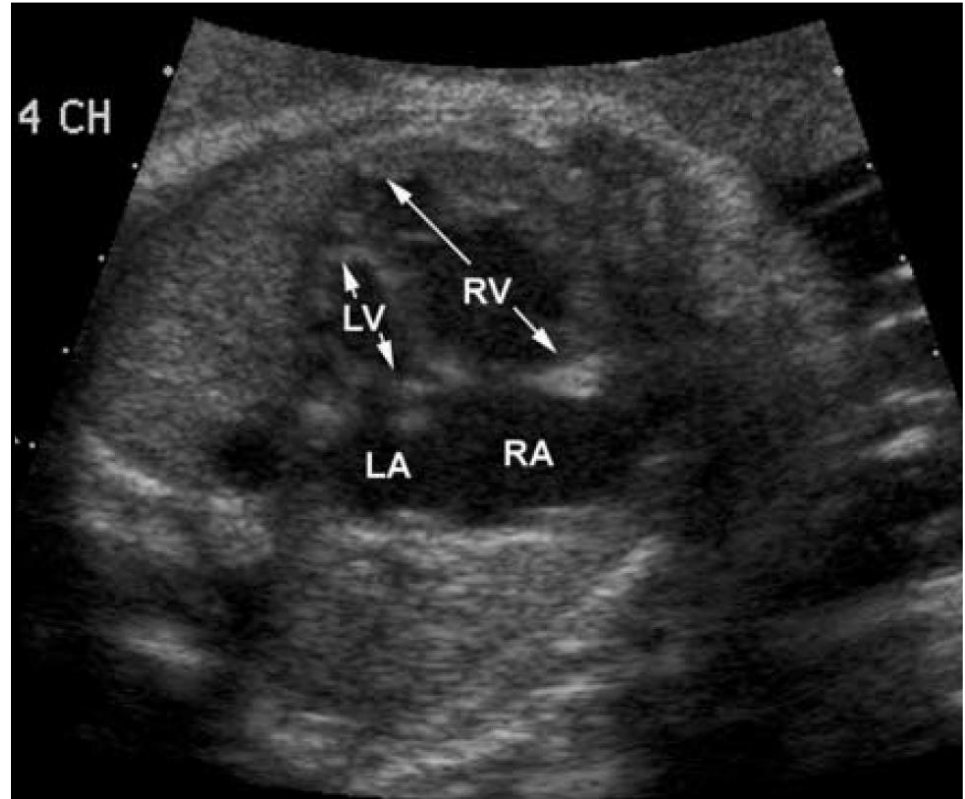
Four Chamber View



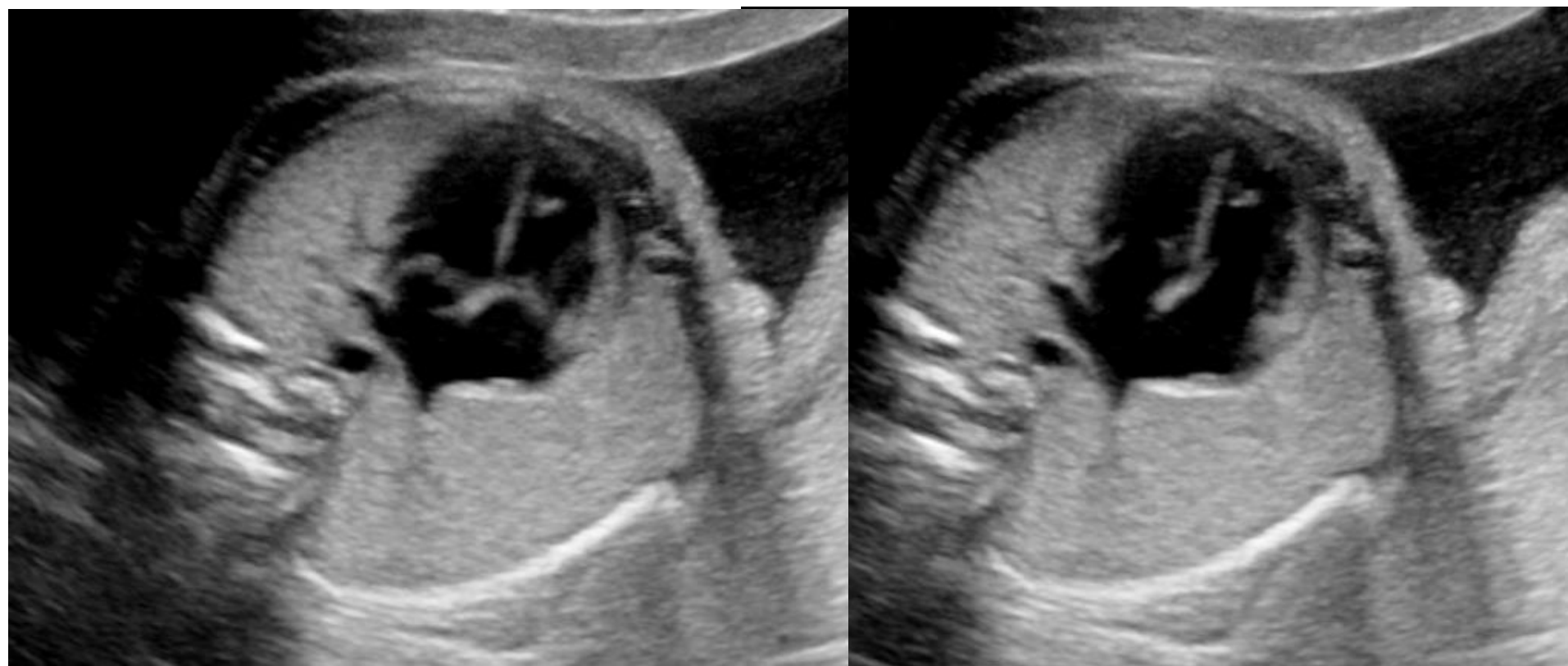
Comstock CH. Obstet Gynecol 1987

Ventricles

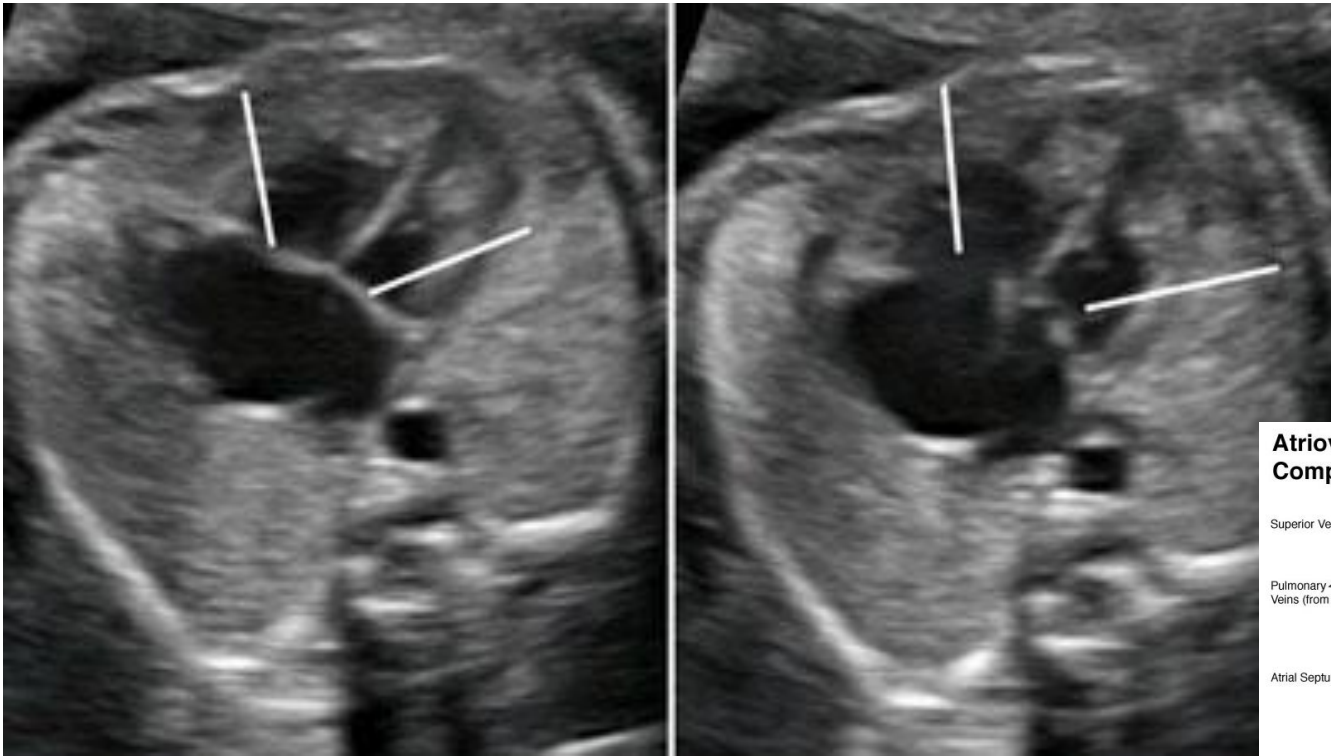
- Single ventricle
 - HLHS
 - Pulmonary atresia
 - Double inlet
- AV valve attachment
- AV discordance
- Dextrocardia
- Heterotaxy



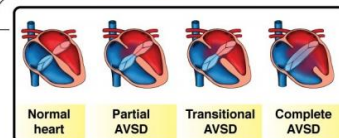
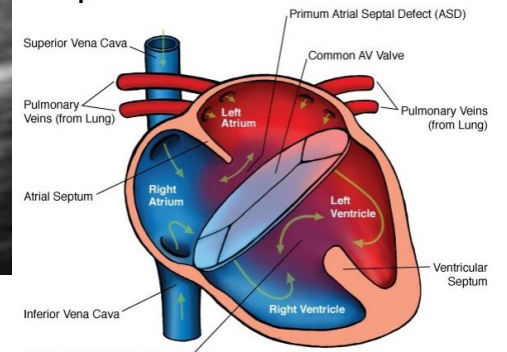
AV valves



AV valve attachment



Atrioventricular Septal Defect (AVSD) Complete



Differentiating the Atria

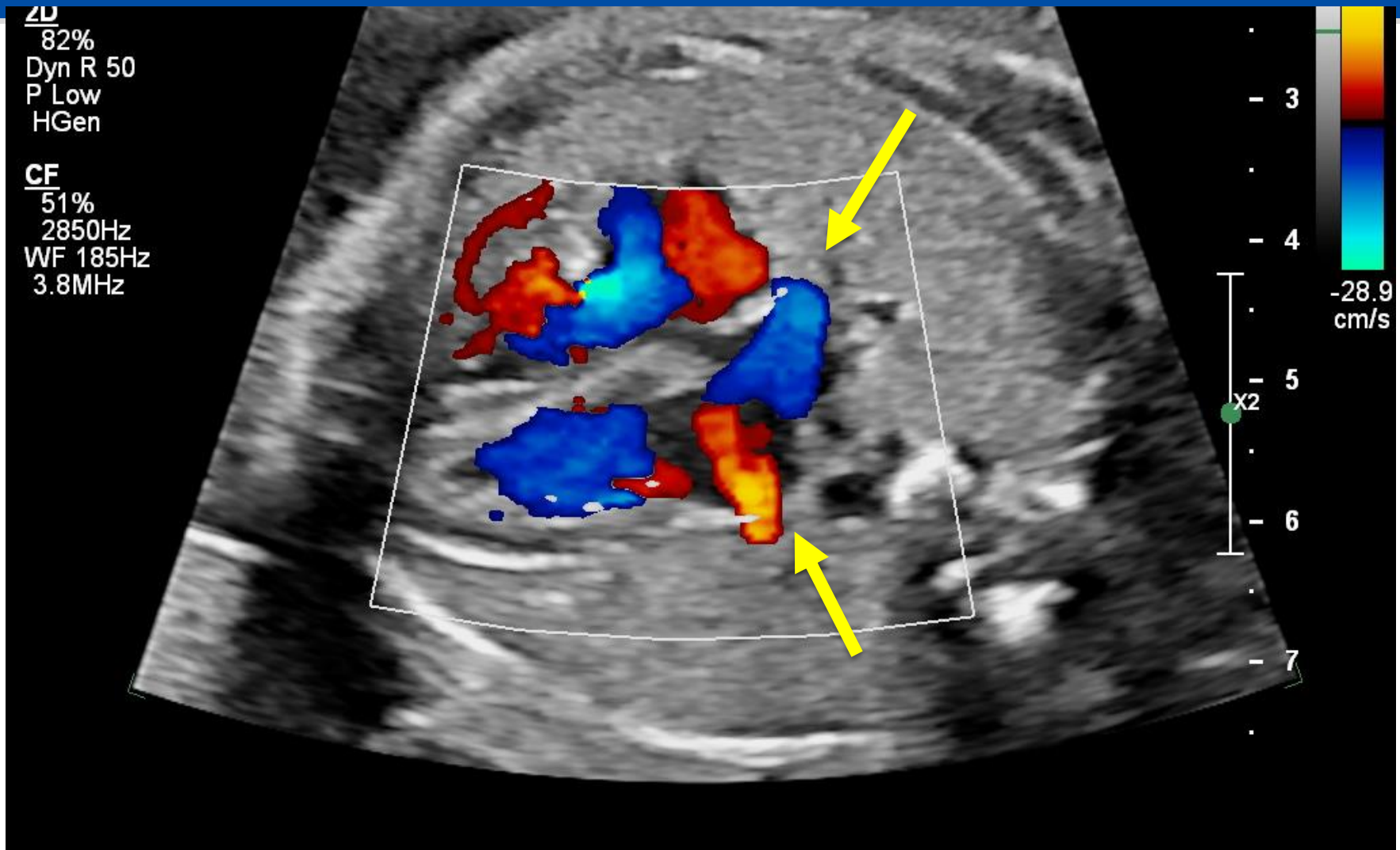
Right

- Anteriorly located
- Receives IVC, SVC, coronary sinus
- Appendage is pyramidal in shape with broad base
- *Posterior portion is smooth, anterior portion is trabeculated*

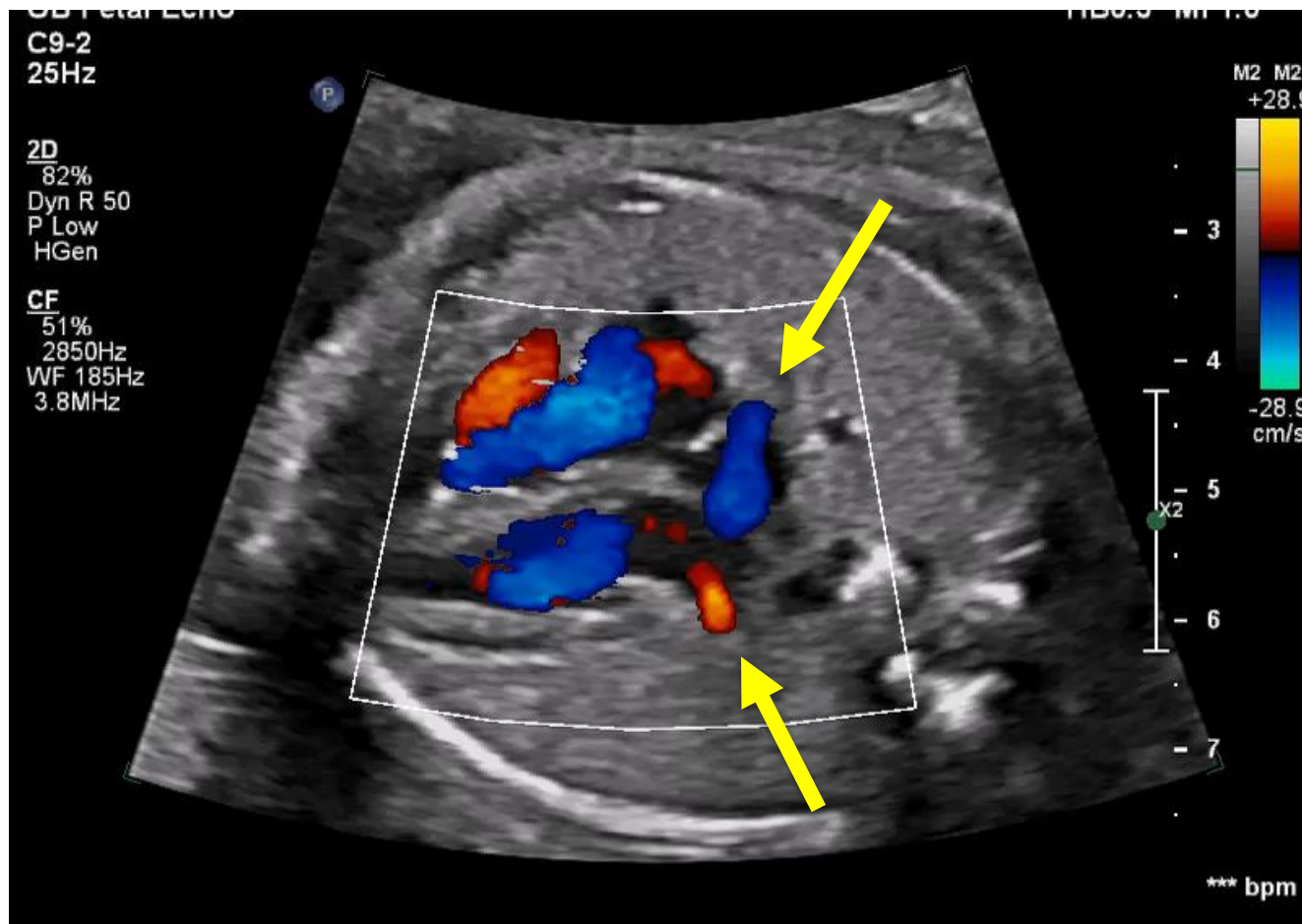
Left

- Posteriorly located, over the spine
- Receives 4 pulmonary veins
- Appendage is narrow, fingerlike with coarse walls
- Foramen ovale flap into LA
- *Anterior and posterior portions are smooth*

Left atrium



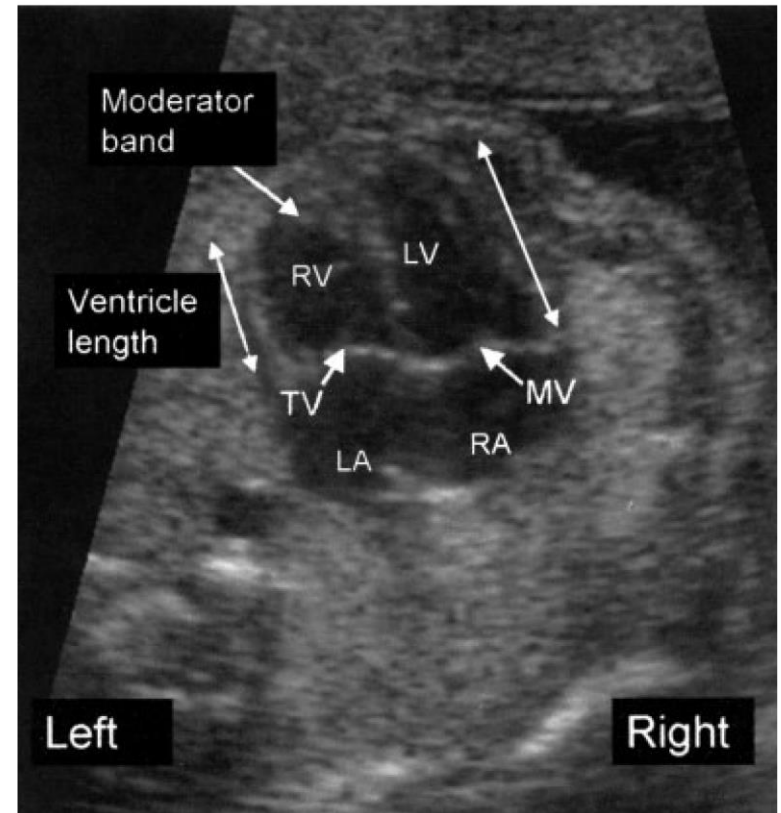
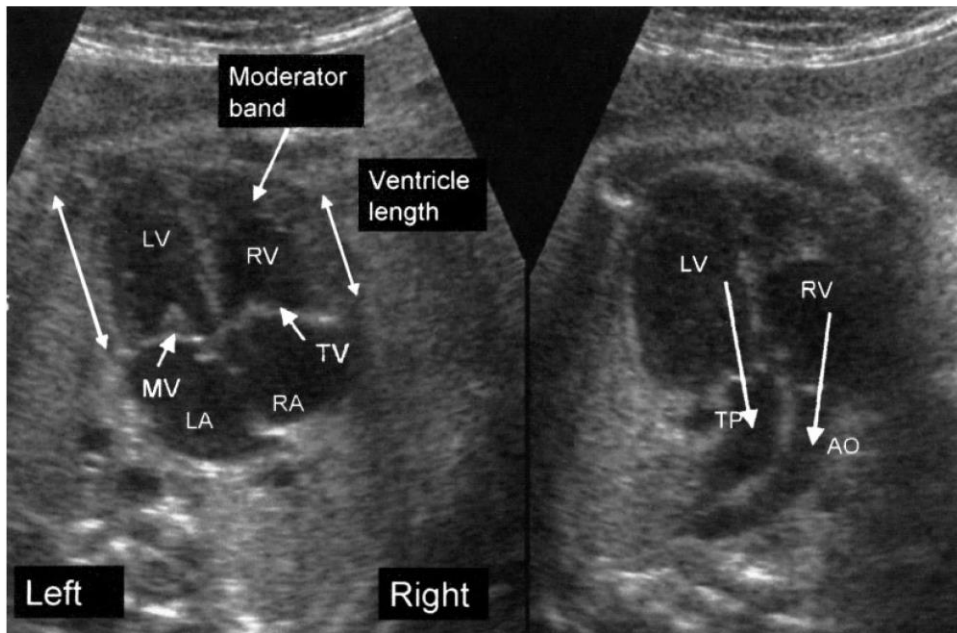
Left atrium Pulmonary Veins



Right atrium



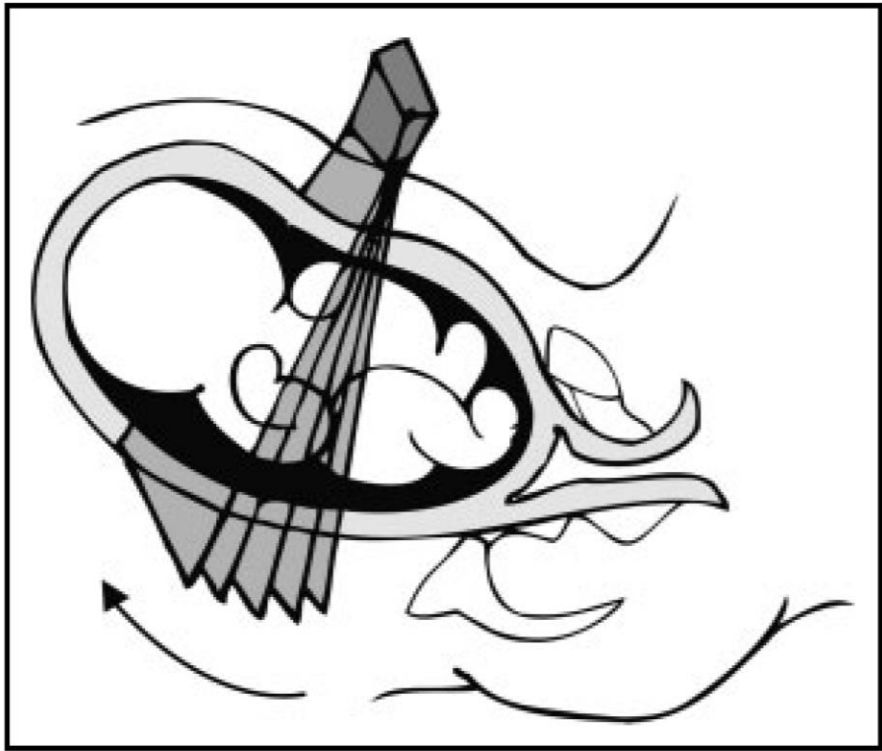
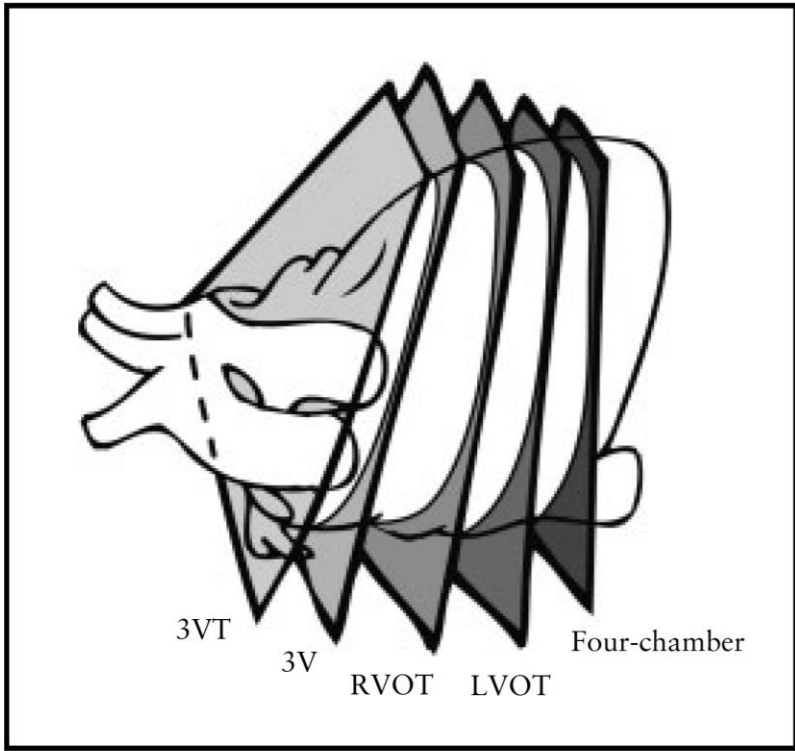
AV discordance



McEwing & Chaoui, UOG 2004

4 chamber view

- Normal
 - TOF
 - DORV
 - dTGA
 - Truncus arteriosus
 - VSD (malalign, outlet)
 - AV, PV stenosis
 - AV, PV atresia
 - Hypoplast or interrup AA
- Abnormal
 - Single ventricle variants
 - Complete AVCD
 - ccTGA
 - HLHS
 - VSD (membr)
 - TV, MV atresia
 - Ebsteins
 - RV disproportion (TAPVR, coarct)



Outflow tract views

- RVOT \approx LVOT
- Cross at right angles
- Connection to appropriate vessels
- Opening of valves
- Relationship of great arteries
 - dTGA: Ao ant/rt of PA
 - ccTGA: Ao ant/lt of PA
 - DORV: side by side (or other)

LVOT

- Vessel arising from the LV → Aorta
- Continuity of ventricular septum and aorta
- Post wall of AAO contiguous with ant cusp of MV
- Valve moves freely, not thickened
- 3 head vessels
- Outlet VSDs, conotruncal anomalies





- MV/AV share fibrous continuity
- LV is bullet shaped
- PV/AV not seen in same plane



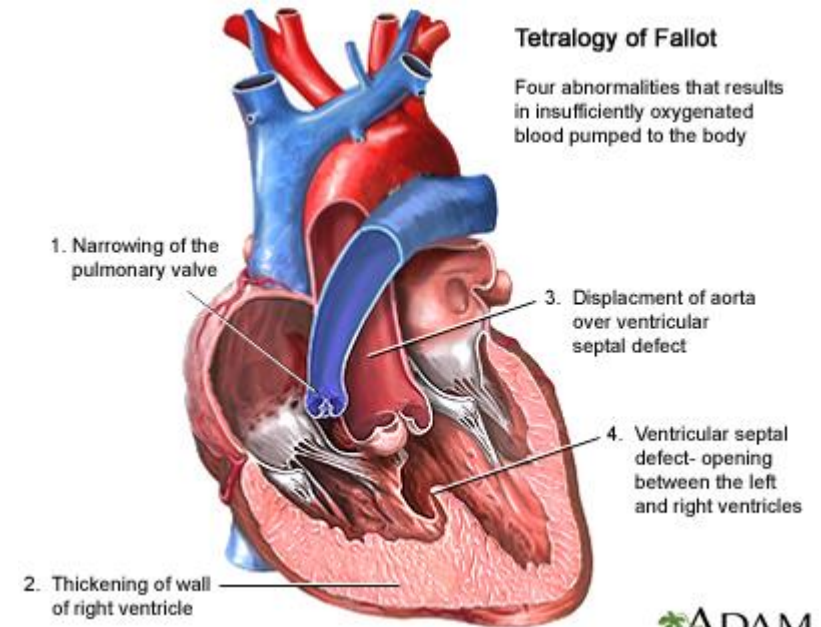
RVOT

- Vessel arising from the RV → Pulmonary artery
- PA is slightly larger than Ao
- Crosses ascending Ao at ~right angle just above origin
- Branches into RPA (1st), then LPA

Valve integrity



Overriding aorta



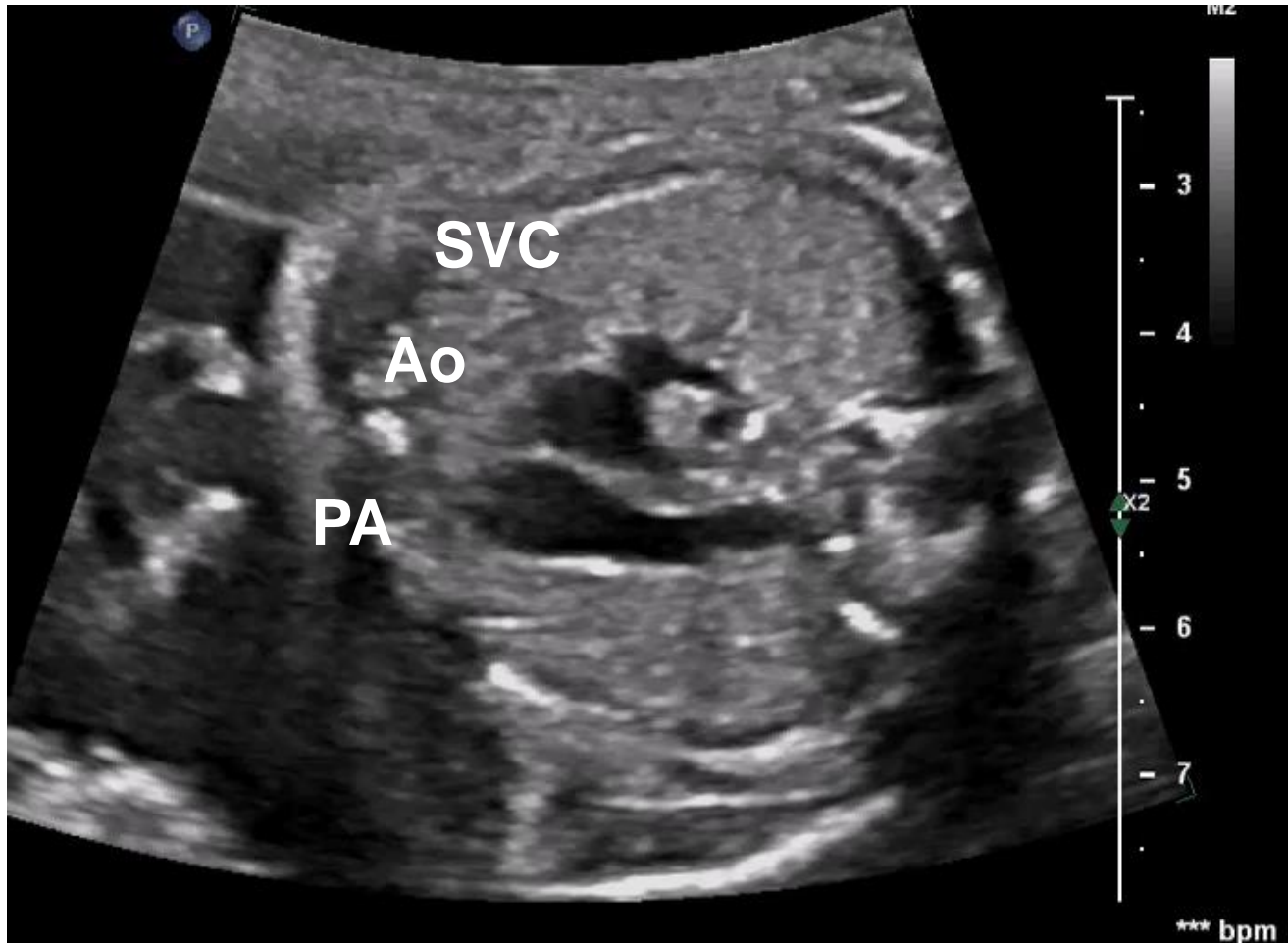
DDx VSD with great vessel override

	Diagnostic clue	Additional signs
TOF	Patent, narrow PA Antegrade flow in PA	Antegrade or retrograde flow in DA
Pulm atresia w VSD	Very narrow PA No antegrade flow in PA	DA tortuous with retrograde flow
Absent pulm valve	Very large PA To-and-fro blood flow in PA	No DA generally Aortic root is more narrow than PA
Truncus arteriosus	PA arises from the overriding aorta	Valve of the overriding vessel may show regurg
DORV	PA is overriding and aorta courses in parallel	Mimics TGA with VSD Aorta or PA may be of normal size or narrow

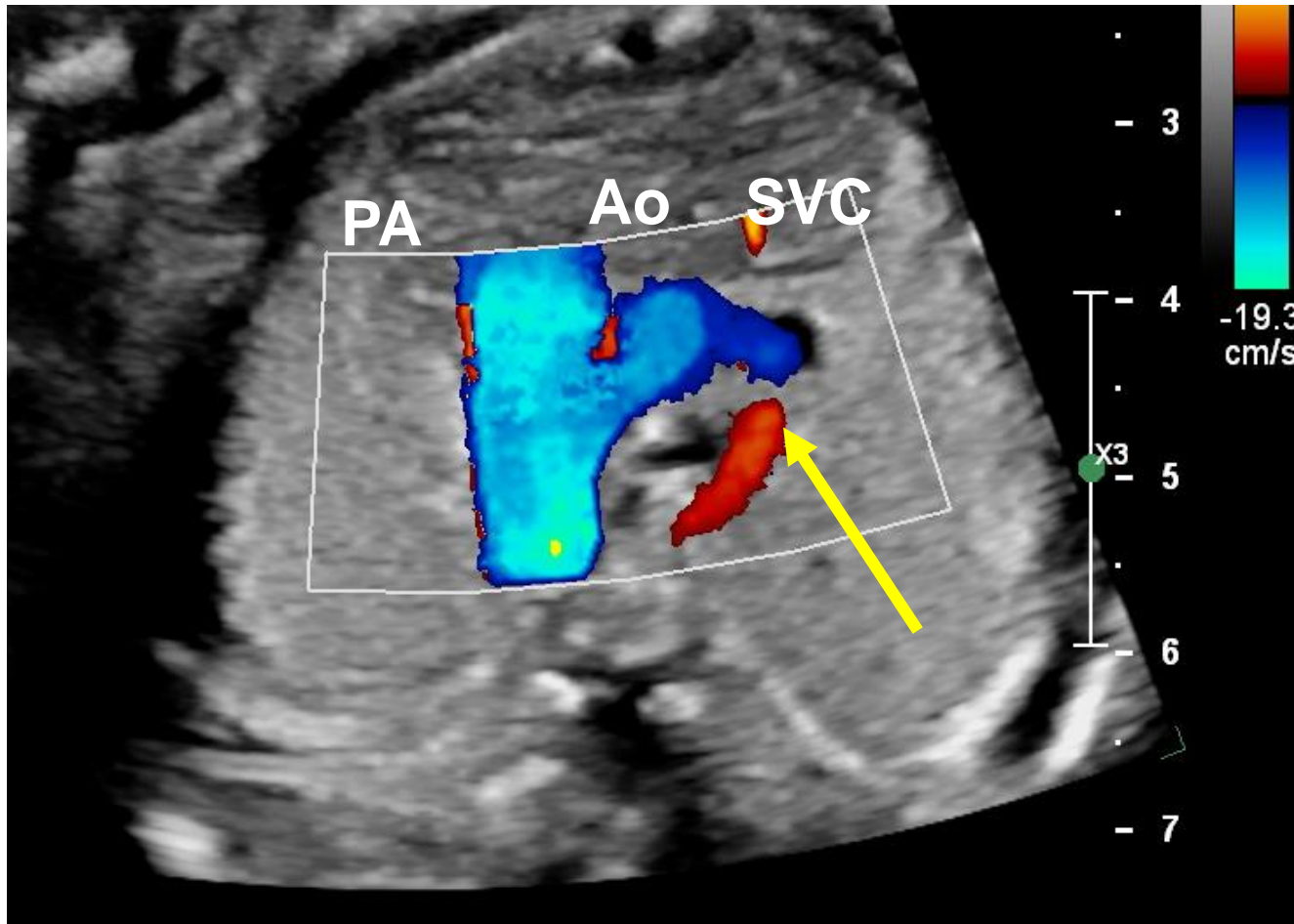
Abuhamad & Chaoui, 2010

3 Vessel View

- Number of vessels = 3
- Vessel arrangement (relative position)
 - Left → Right = PA, Ao, SVC
- Vessel size
 - PA > Ao > SVC
- Vessel alignment
 - Anterior → Posterior = PA, Ao, SVC



L



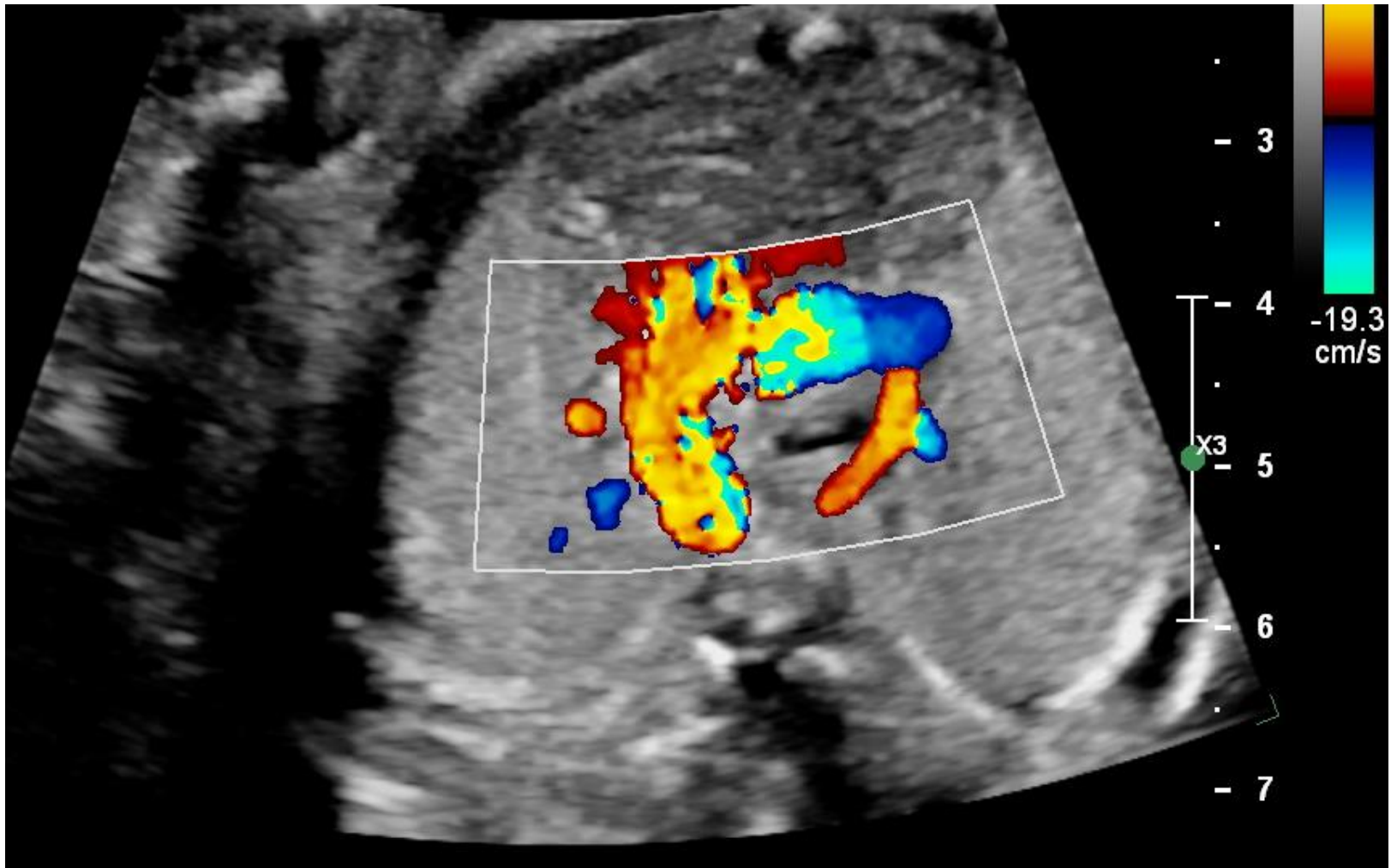
R

3 Vessel Trachea View

- Ductal & aortic arches :
 - are to the LEFT of the trachea
 - form a V as they join the descending aorta
- Nl 4 chamber/Abnl 3V
 - cTGA
 - TOF
 - Pulmonary atresia w VSD
- Abnormal 3VT
 - Coarctation
 - Right aortic arch
 - Double aortic arch
 - Vascular rings



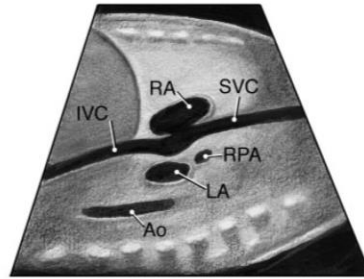
Azygous vein



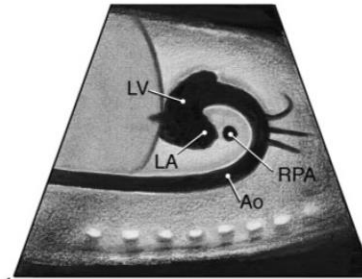
Thymus



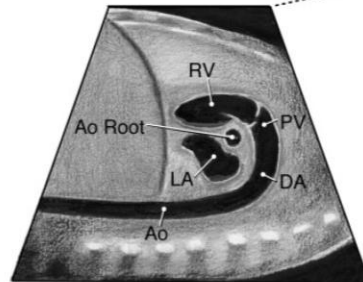
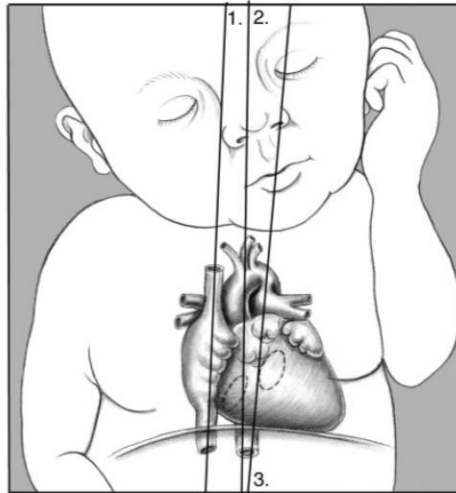
Li L. Ultrasound Obstet Gynecol 2011;37:404409



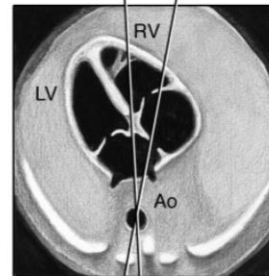
1. Bicaaval View



2. Aortic Arch View



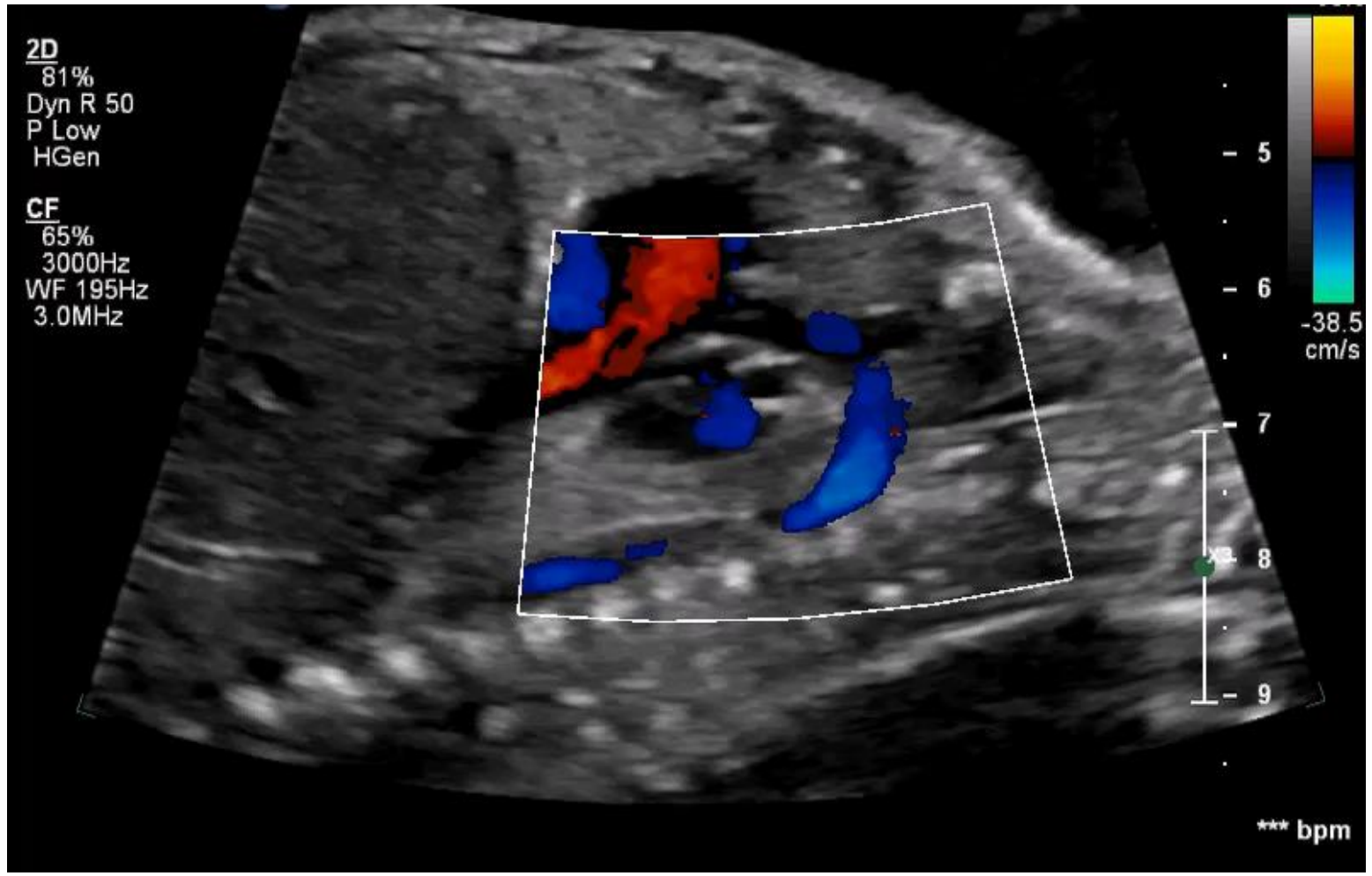
3. Ductal Arch View



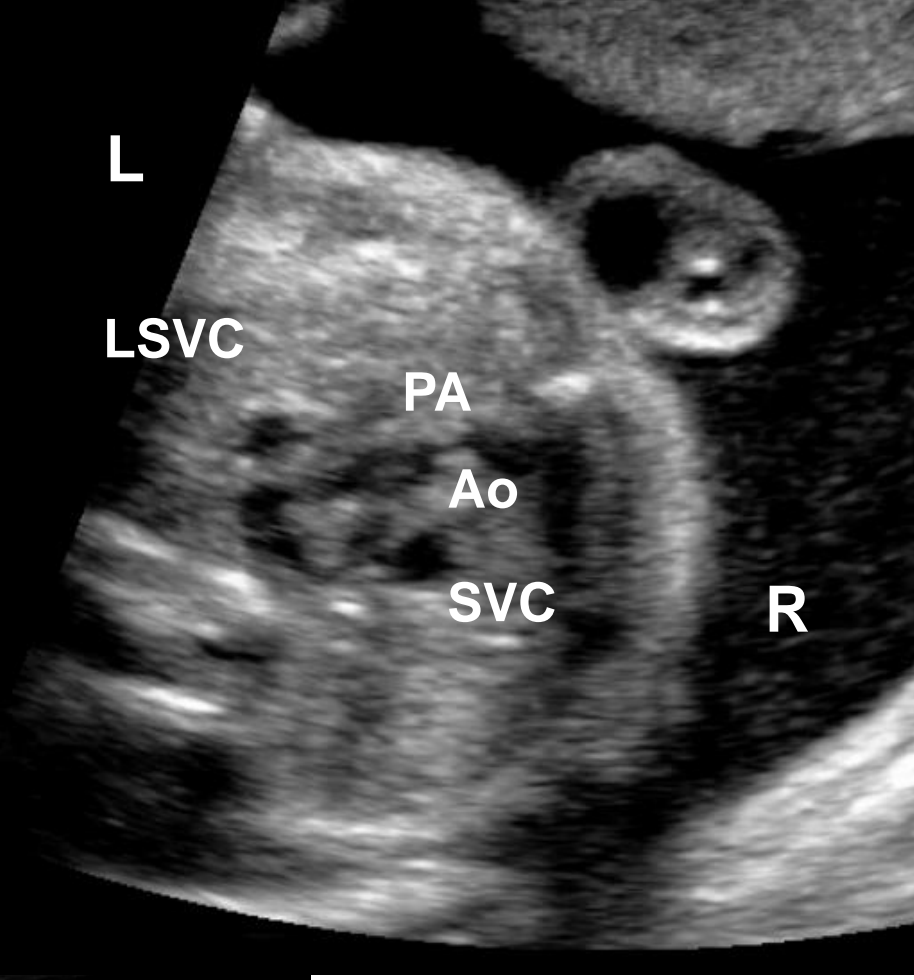
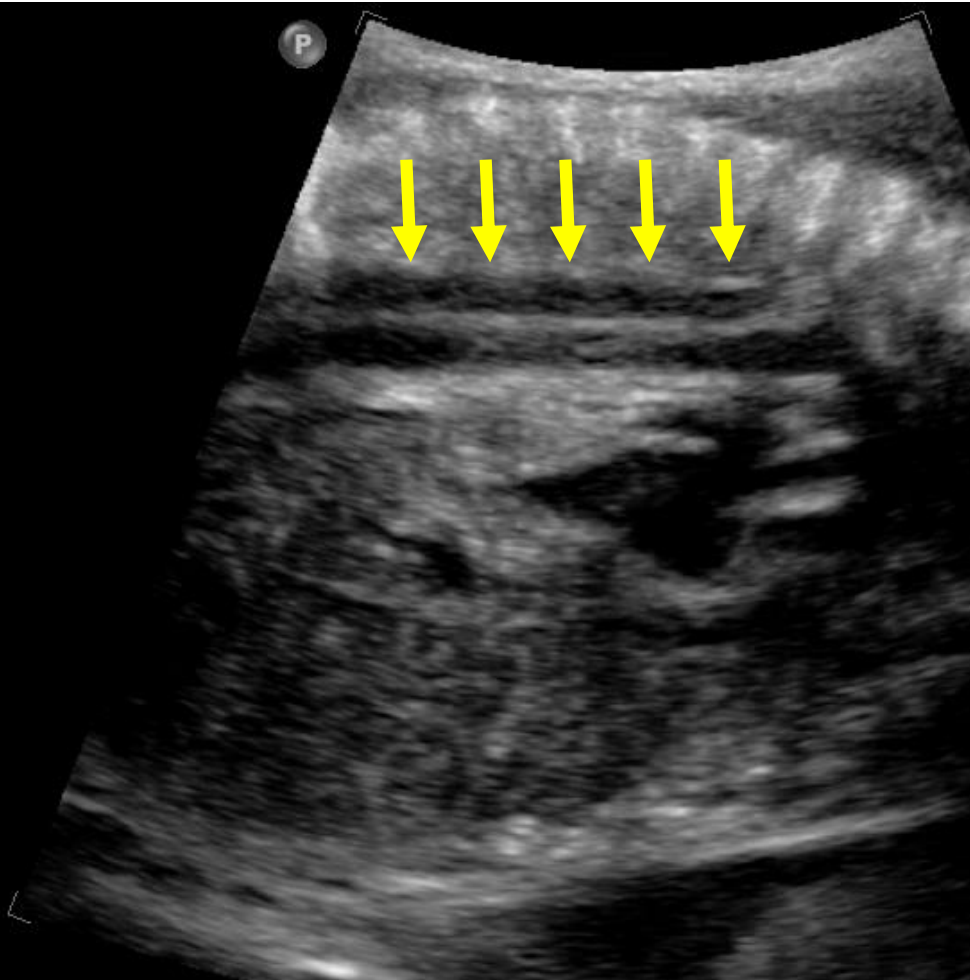
Four Chamber View

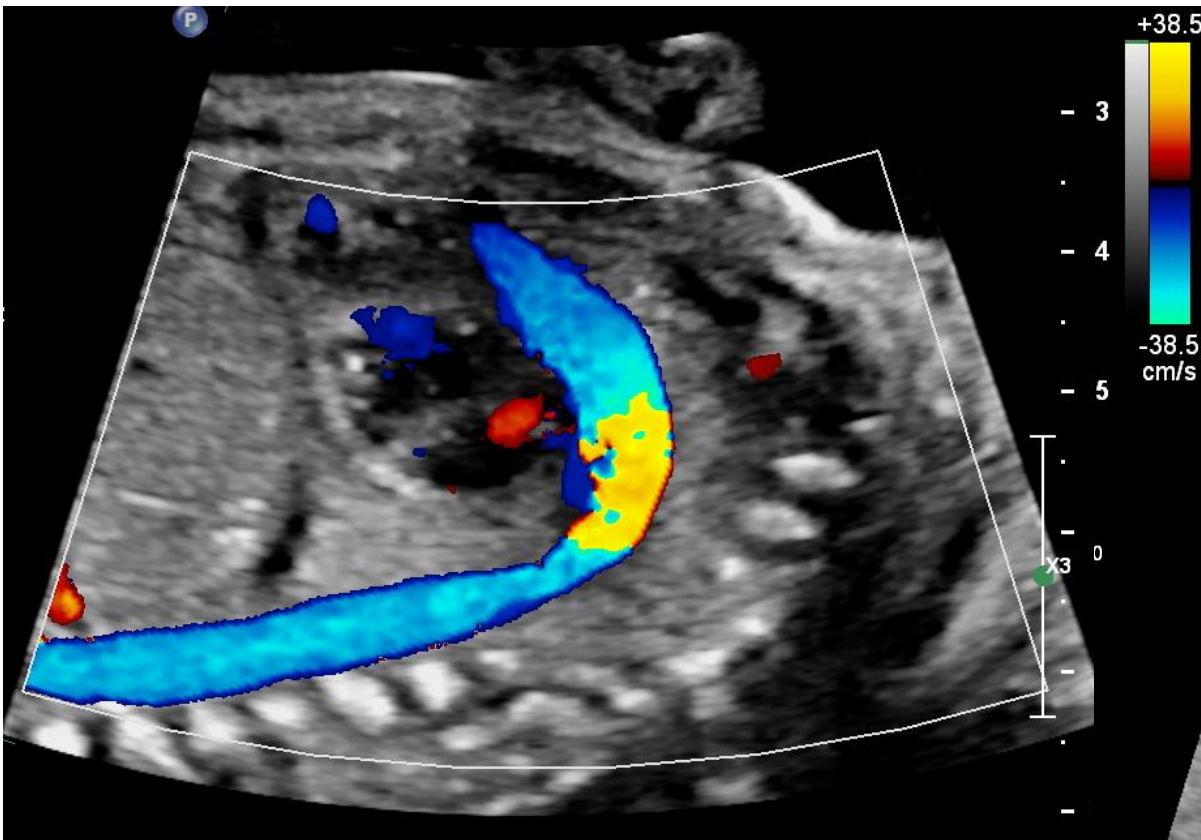
Ductal Arch Plane Aortic Arch Plane

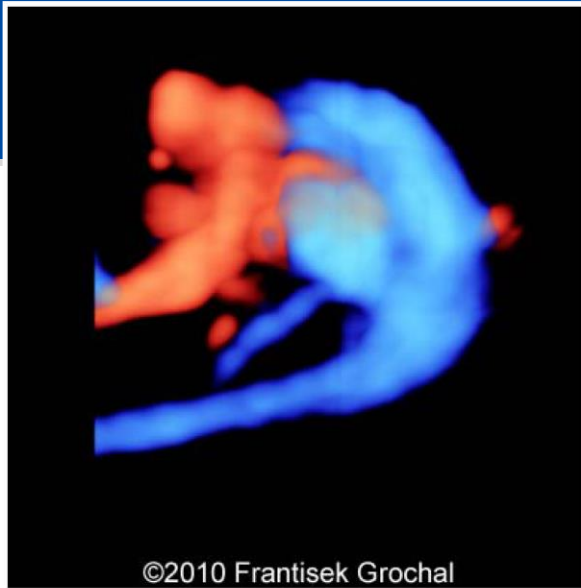




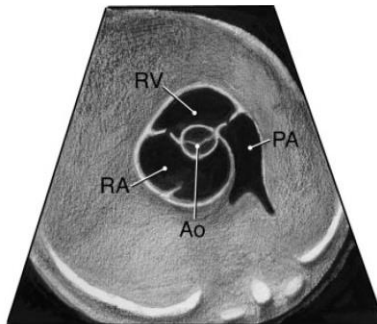
Persistent LSVC with interr IVC



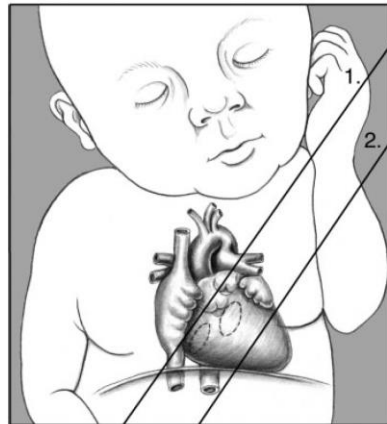




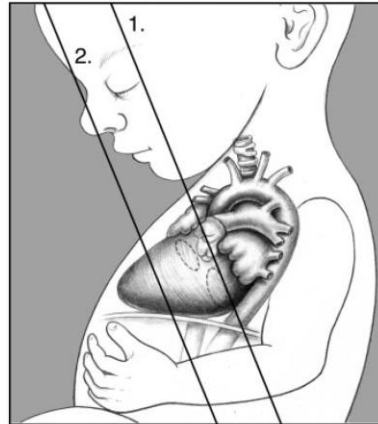
d-TGA



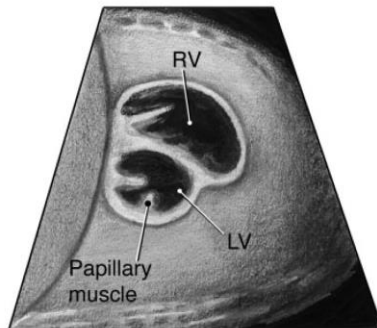
1. High Short Axis View - Great Arteries



Fetal Heart - Coronal View



Fetal Heart - Sagittal View



2. Low Short Axis View - Ventricles

Short axis view



The 4 second echo



Box 1

Cardiac examination check list

Situs

Size

Location

Axis

Heart rate and rhythm

Four chamber

LA = RA

LV = RV

RV has moderator band, anterior

AV valves

Two distinct AV valves

Tricuspid slightly apically displaced

Interventricular septum intact

Foramen ovale present

Foraminal flap opens in to LA

LVOT

RVOT

3-VV/3-VTV

Abbreviations: AV, atrioventricular; LA, left atrium; LV, left ventricle; LVOT, left ventricular outflow tract; RA, right atrium; RV, right ventricle; RVOT, right ventricular outflow tract; 3-VTV, 3-vessel trachea view; 3-VV, 3-vessel view.

Box 2

Anomalies can be identified due to concerns during initial fetal heart assessment

1. Situs inversus
2. Abnormal location (shift of the heart with or without axis change)
 - a. CDH
 - b. Agenesis of fetal lung
 - c. Congenital lung abnormalities
3. Axis deviation (extreme left or right axis deviation)
 - a. CDH
 - b. Outflow abnormalities
4. Cardiomegaly
5. Rate and rhythm
 - a. Bradycardia
 - b. Tachycardia
 - c. Irregular rhythm

Bahtiyar MO. Obstet Gynecol Clin N Am 42 (2015) 209–223

Box 3

Anomalies can be identified through basic cardiac examination

Four-chamber view

1. AVSD
2. Hypoplastic left heart syndrome
3. Mitral stenosis
4. Tricuspid atresia
5. Epstein anomaly
6. Hypertrophy
7. Pericardial effusion
8. Intracardiac masses

LVOT

1. Overriding aorta
2. Double outlet RV
3. Aortic valve stenosis
4. Transposition of great arteries
5. Truncus
6. Ventricular septal defect

RVOT

1. Pulmonary valve stenosis
2. Transposition of great arteries
3. Truncus arteriosus

3-VV

1. Vascular ring
2. Right-sided aortic arch

Conclusions

- Levels of examination
- Systematic approach
- Color Doppler
- Referral as indicated

- A systematic approach to fetal heart examination, regular feedback, and implementation of training programs could improve detection rates and in turn neonatal outcome.
- In utero detection of congenital heart disease (CHD) allows possible prenatal interventions.
- In utero detection of CHD improves postnatal outcome.

Thank you