Fetal Cardiac Handbook

Everylittleheartmatters.org

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Introduction

This 28-page handbook has been designed as a practical guide for obstetricians, gynecologists, maternal–fetal medicine subspecialists and trainees, radiologists, sonographers, and midwives who are learning to image the fetal heart at all stages of pregnancy. Screening for and diagnosing cardiac abnormalities in utero presents considerable challenges, often requiring many years of training before one can reliably recognise the most effective approaches to detection and management. Although numerous resources exist in textbooks and online modules, these are often extensive and, while comprehensive, can be overwhelming for those at the beginning of their learning journey. This creates a gap between the needs of trainees and the vast technical resources available.

This handbook aims to bridge that gap by providing a simplified, systematic framework for fetal cardiac screening and diagnosis. It aligns with ISUOG's Global Initiative: Every Little Heart Matters (ELHM), launched in 2025, which seeks to improve the prenatal detection of congenital heart defects worldwide. By distilling the complexity of the fetal heart into a clear, step-by-step approach, ELHM aspires to empower every probe handler to recognise when a heart appears abnormal and ensure timely referral.

Through diagrams, high-quality ultrasound images, and concise explanatory text, the handbook highlights the key normal anatomical landmarks encountered in a systematic cardiac examination. It begins with guidance on preparing and optimally configuring the ultrasound machine before scanning, then moves through a section-by-section analysis of the fetal heart based on ISUOG guidelines. Each of the five standard ISUOG screening views is described in detail, along with the anomalies that may be detected within them. The content is presented in an accessible style, supported by tables and illustrations designed to simplify complex concepts, and concludes with a curated collection of ultrasound images illustrating both common and rare cardiac abnormalities.

Acknowledgements

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Abbreviations:

- **AA** — Aortic Arch
- **ADV** — Absent Ductus Venosus
- **Ao** — Aorta
- **AoA** — Aortic Atresia
- **ARSA** — Aberrant Right Subclavian Artery
- **ARLA** — Aberrant Left Subclavian Artery
- **AS** — Aortic Stenosis
- **ASD** — Atrial Septal Defect
- **AVSD** — Atrio-Ventricular Septal Defect
- **APVS** — Absent Pulmonary Valve Syndrome
- **CAS** — Critical Aortic Stenosis
- **cCTGA** — Congenital Corrected Transposition of the Great Arteries
- **CTR** — Cardio-Thoracic Ratio
- **DA** — Ductus Arteriosus
- **DAA** — Double Aortic Arch
- **DAo** — Descending Aorta
- **DILV** — Double Inlet Left Ventricle
- **FGR** — Fetal Growth Restriction
- **FO** — Foramen Ovale
- **FOA** — Foramen Ovale Aneurysm
- **HLHS** — Hypoplastic Left Heart Syndrome
- **IAA** — Interrupted Aortic Arch
- **IEF** — Intracardiac Echogenic Focus
- **IVS** — Interventricular Septum
- **Int-IVC + Az-Cont** — Interrupted IVC with Azygous Continuation
- **LA** — Left Atrium
- **LAI** — Left Atrial Isomerism
- **LBCV** — Left Brachiocephalic Vein
- **LCC** — Left Common Carotid
- **LSA** — Left Subclavian Artery
- **LV** — Left Ventricle
- **MA with VSD** — Mitral Atresia with Ventricular Septal Defect
- **PA with IVS** — Pulmonary Atresia with Intact Ventricular Septum
- **PLSVC** — Persistent Left Superior Vena Cava
- **PRUV** — Persistent Right Umbilical Vein
- **PV** — Pulmonary Valves
- **RA** — Right Atrium
- **RAI** — Right Atrial Isomerism
- **RAA & RAD** — Right Aortic Arch & Right Arterial Duct
- **RAD** — Right Arterial Duct
- **RV** — Right Ventricle
- **TAPVR** — Total Anomalous Pulmonary Venus Return
- **T1** — First Trimester
- **T2** — Second Trimester
- **T3** — Third Trimester
- **TAo** — Transverse Aortic Arch
- **TGA** — Transposition of the Great Arteries
- **TOF** — Tetralogy of Fallot
- **TR & MR** — Tricuspid / Mitral Regurgitation
- **SCT** — Sacrococcygeal Teratoma
- **TTTS** — Twin-Twin Transfusion Syndrome
- **TV Dysplasia** — Tricuspid Valve Dysplasia
- **UV** — Umbilical Vein
- **VOG** — Vein of Galen
- **VS** — Vessel

Machines Settings

Setup

- Highest frequency transducer possible
- Harmonics on (especially with high BMI)
- Compound resolution (all angles acquired → 1 image)
- Speckle reduction (smoothing effect)
- Narrow sector width (this increases frame rate aim >25 Hz)
- Magnification
- Increase dynamic range (contrast)
- Low persistence and single focal zone
- CINE loop review
- Transvaginal examination (up to 14 weeks)

Colour Doppler Settings

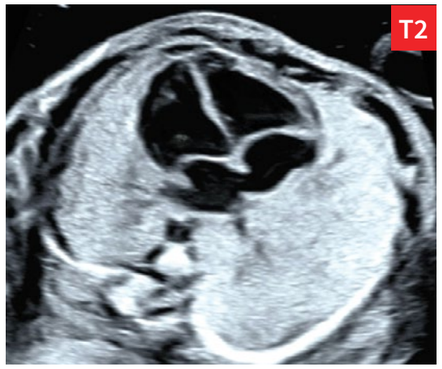
- Optimize grey scale first
- Colour Doppler second trimester
- Power Doppler first trimester
- PRF – (T1) **25-35 cm/sec** and (T2) **55-65 cm/sec**
  (T3) **65-75 cm/sec**
- Lower PRF for pulmonary & systemic veins (DV) and neck vessels, e.g., RT subclavian artery
- Smallest Colour Doppler box possible
- Set Balance and colour gain correctly
- To obtain good colour 'fill' of any chamber or vessel follow this setup order:

  1) **Always** set PRF first, then

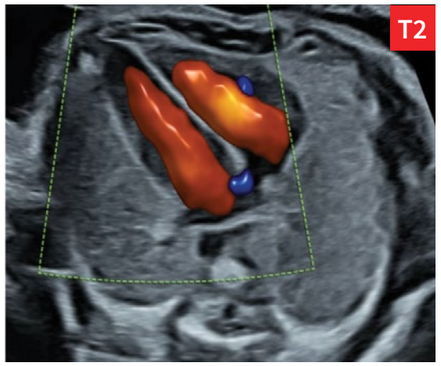
  2) Power output (increase / reduce)

  3) Colour gain and balance (increase / reduce) Adjust wall motion filter (low in T1, mid in T2)

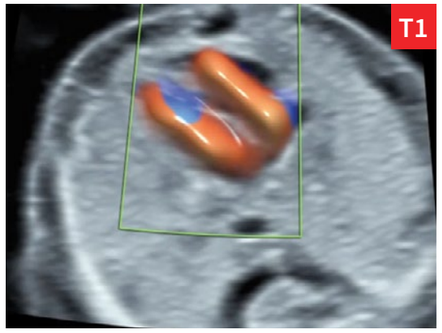
2D



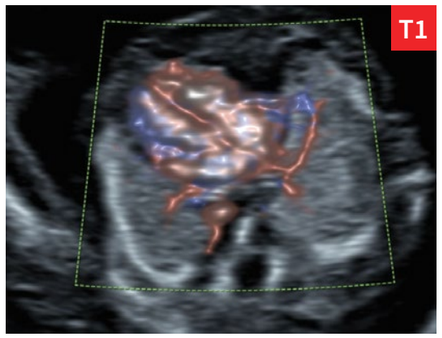
Colour Doppler



Power Doppler



Slow*flow*

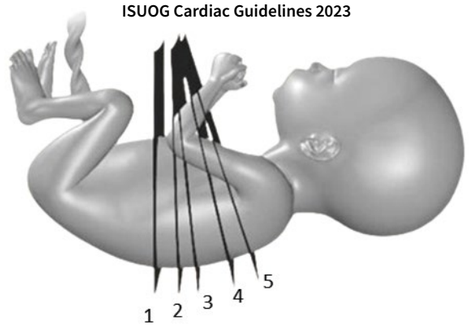


How to Image the Heart

Image Technique

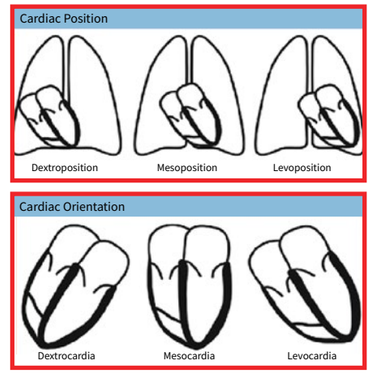
- Commence at the abdominal circumference plane
- Slide up cephalad to a transverse section through fetal thorax
- Aim to have the spine in a posterior position (~ 6 o'clock)
- Obtain only one complete rib on each side to get the 'perfect' transverse section
- NB: **Avoid** oblique section through thorax (i.e. multiple ribs in view on either side)
- Ideally cardiac apex at ~ 11 o'clock (when cephalic) or at ~ 2 o'clock (when breech) – especially for Colour Doppler assessment of IVS
- Narrow sector width
- Reduce depth
- Magnify the image so it occupies most of the screen using high definition zoom if possible

Cardiac sections 1 – 5
ISUOG Cardiac Guidelines 2023



General (SARRS: Size. Axis. Rate. Rhythm. Situs.)

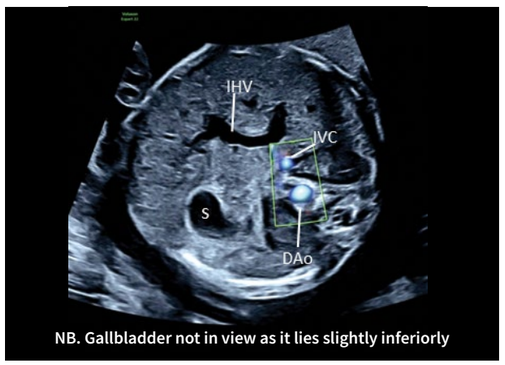
- Start by establishing fetal situs. Confirm stomach on left side
- Save / store a split image showing stomach and heart on the same side
- Heart occupies 1/3-1/2 of thorax. Usually can fit 3 hearts in the chest
- 2/3 of the heart in the LT hemithorax and 1/3 in the RT hemithorax
- Cardiac axis should be 45 ±20˚
- A vertical line from the fetal spine to the anterior chest wall should roughly pass through the tricuspid valve
- Change in position is usually due to a problem extrinsic to the heart
- Change in Axis is usually due to a cardiac abnormality
- Rate 120 – 160 bpm and rhythm should be regular
- CTR<60%
- Occasional ectopic beats are a normal variant and seen most commonly at the mid trimester



Section 1: Abdomen

- Check stomach in normal position on LT side
- Note intra-hepatic vein sweeps away from stomach to the right i.e., 'J-Hook' configuration
- Gallbladder to the right of the umbilical vein and lies slightly inferiorly
- Descending aorta to the left of the spine
- IVC anterior and to the right of the spine

Observe the following in order:
1) Stomach 2) IHV 3) Gallbladder



NB. Gallbladder not in view as it lies slightly inferiorly

4-Chamber View

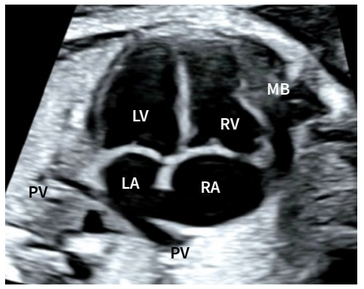
Section 2

Left Ventricle (LV)

- LV is posterior
- Forms the apex
- LV smooth septum
- Longer than RV

Mitral Valve

- Two valve leaflets, best visualised on short axis view
- Leaflets have no attachment to the IVS NB Mitral valve leaflet
- NB Mitral valve leaflet closer to base of heart



Interventricular Septum

- Separate RV and LV
- Wide at apex and thin at AV valves. Proximal portion adjacent to AV valve is membranous
- The IVS is 1/3 membranous and 2/3 muscular
- Muscular and inlet VSD's can be seen on 4-chamber view: Best assessed with apex at 2, 5, 7, 11 o'clock, i.e., 30° to the beam on 4-chamber view

Right Ventricle (RV)

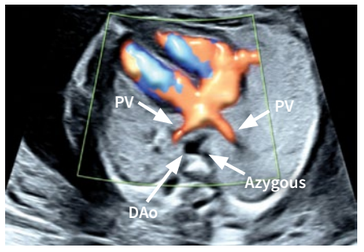
- RV is anterior
- Lies behind the sternum
- Triangular
- Trabeculated
- Irregular cavity
- Moderator band is a distinguishing feature from LV

Tricuspid Valve

- Three valve leaflets, but cannot count on 4-chamber view (but can count leaflets on short axis view). Septal valve attached to IVS.
- NB septal leaflet of the tricuspid valve inserts more apically, i.e., 'offset'

Left Atrium

- Central chamber in the chest
- Most posterior cardiac chamber
- Closest to the aorta and spine
- Identify pulmonary veins (while there are four PV's, generally only the two seen at a time on 2D)
- At 4CV, it is the 2 inferior PV seen
- Foramen ovale should bulge into LA (i.e. Right → Left shunt)



Area Behind the Heart

- Lower PRF 10-15 cm/sec to see PV's. If you see at least one PV entering LA, this excludes TAPVR
- To confirm it is the PV use pulsewave Doppler
- Azygous lies to RT of DAo and is smaller and frequently not visible (1/3 size of DAo)
- Oesophagus lies anterior to DAo

Right Atrium

- Receives the SVC and IVC. May see eustachian valve
- Foramen ovale (size highly variable and thus diagnosis of Secundum ASD is very challenging!
- Right atrial appendage is pyramidal in shape with a broad base

4-Chamber View – Anomalies

Defects seen on 4-Chamber View

- Hypoplastic Left Heart Syndrome (MA+AoA)
- Hypoplastic Right Heart Syndrome (PA &IVS)

Small Left Ventricle:

- Coarctation / Interruption
- Mitral atresia with VSD
- Critical aortic stenosis (LV maybe also be dilated)
- TAPVR
- FOA
- Epstein's Anomaly

Small Right Ventricle:

- PA with IVS
- Tricuspid atresia with VSD
- Critical pulmonary stenosis

Atrioventricular Septum / AV Valves:

- Ventricular Septal Defect (VSD)
- Atrial Septal Defect (ASD)
- AVSD
- Ebstein's Anomaly
- Tricuspid / Mitral valve dysplasia
- Tricuspid / Mitral atresia

Others:

- Right Aortic Arch (DAo to RT of spine)
- Dilated Coronary Sinus – commonly secondary to PLSVC or rarely TAPVR
- Absent Ductus Venosus
- Systemic Venous drainage directly to right atrium
- 2 vessels – same size – Int-IVC + Az-Cont
- Cardiomegaly / Cardiomyopathy: most commonly CMV and Parvovirus

Rare Anomalies:

- TAPVR (RV>LV)
- APVS with intact interventricular septum (Dilated RV)
- Ectopia Cordis
- Restrictive FO
- Cardiac tumours, e.g., Rhabdomyomas
- Ventricular Aneurysm – LT sided more common
- Ventriculo-coronary arterial circulation

Cardiac Anomalies with a Normal 4-Chamber View

- Tetralogy of Fallot
- Common arterial trunk
- Transposition of great vessels
- Aortic coarctation / interruption
- Aortic stenosis (when not critical)
- Pulmonary stenosis

4–Chamber Soft Signs / Minor Anomalies

- Intracardiac echogenic focus
- Cardiac axis deviation
- Mesocardia
- Pericardial effusion
- Dilated coronary sinus
- Discordant ventricles: especially third trimester T3, i.e., **LV<RV** (check for coarctation and TAPVR)
- Discordant great arteries: especially third trimester, i.e., most often **MPA>Ao** (need to exclude pulmonary stenosis)

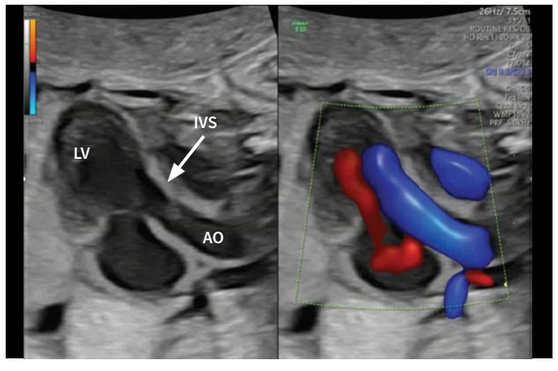
LVOT / 5-Chamber View

Section 3

Imaging

- From 4-chamber, rotate probe until aortic outflow tract (5th chamber) comes into view
- Anterior wall of Ao should be continuous with the IVS
- Check calibre of aorta (calculate Z-score of Ao valve annulus if it subjectively looks abnormal)
- Check central location of the Ao valve leaflets when closed
- Check aortic valve leaflets disappear completely when valves open during ventricular systole
- Check aorta and MPA are not parallel, i.e., MPA crosses the Ao during caudal to cephalic sweep
- To confirm the identity of the outflow tracts, make sure that the PA exiting from the anterior morphologic RV bifurcates
- Exclude straight course of ascending Aorta, i.e., anterior Ao wall parallel with the IVS e.g. TOF IAA
- Check for laminar flow across the Ao Valve on colour Doppler

Observe the following:
1) Continuity of the anterior wall of the Ao with IVS 2) Normal Aortic valve 3) check calibre of ascending aorta 4) check curvature of Aorta 5) check Laminar flow



LVOT. Note Mitral valve and superior pulmonary veins also come into view in this section

Abnormalities Seen in the LVOT (5-Chamber View):

Tetralogy of Fallot Double outright right ventricle Common arterial Trunk	Dilated Aorta. High volume flow (sometimes seen on B-Mode) Dextroposition of the Ao
Coarctation Aortic interruption	Narrow Ao. Ao valve eccentric (bicuspid)
Aortic Stenosis	Dilated Ao. Turbulent flow on colour doppler
Perimembraneous VSD (anterior malaligned) Perimembraneous VSD (posterior malaligned)	1. Dropout 2. Edge enhancement 3. Wash of color across the defect
Transposition of the great arteries	Vessel arising from the LV (MPA) Bifurcates and may be dilated

RVOT (3-Vessel View)

Section 4

Imaging

From 4-chamber, 'Fan' the probe cephalad and three possible views are seen to arise:

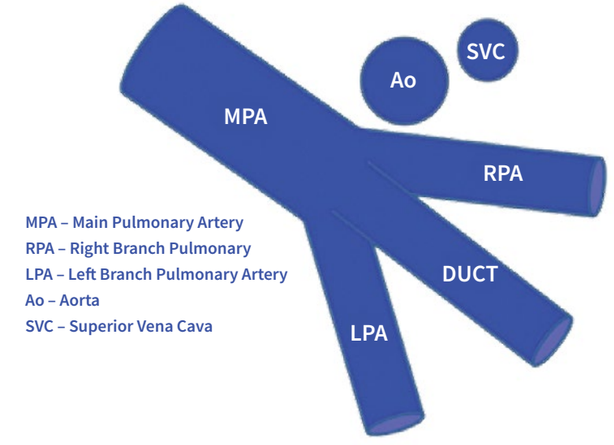
1. (MPA + RPA) + Ao & SVC
2. (MPA + RPA + LPA) + Ao & SVC
3. (MPA + Duct) + Ao & SVC

This section must demonstrate:
MPA > Ao > SVC

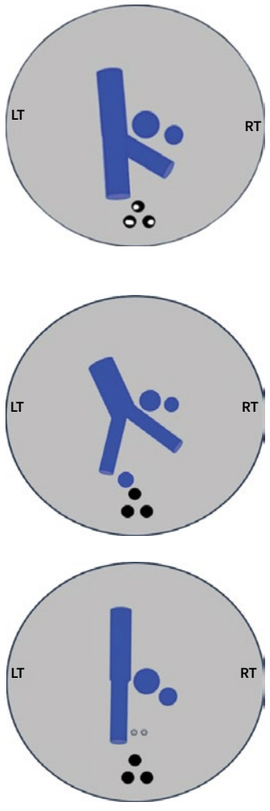
At this level, MPA is larger than the Ao which is larger than the SVC. The caliber of these vessels and flow pattern disturbance, including increased peak systolic velocities (PSV's) are key clues to outflow tract anomaly detection. Ensure PV disappears completely when valve opens during ventricular systole. Check for Laminar flow across the pulmonary valve. At this level the RPA should always be smaller than the Ao.

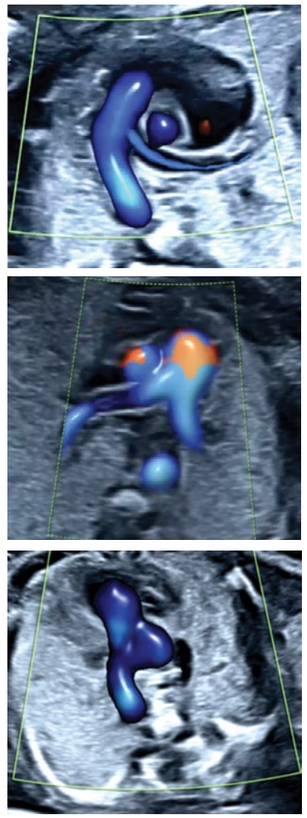
MPA crosses Ao and is anterior and superior to the Ao (NB. Reversed in TGA) and MPA must be followed to ensure it bifurcates.

Branches of main pulmonary artery
NB: When obtaining the RVOT keep the RV wall in view → facilitates visualisation of the PV



MPA – Main Pulmonary Artery
RPA – Right Branch Pulmonary
LPA – Left Branch Pulmonary Artery
Ao – Aorta
SVC – Superior Vena Cava





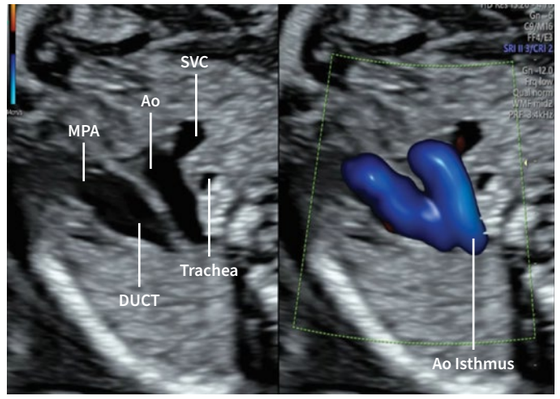
Three Vessel & Tracheal View (3VST)

Section 5

Imaging

- Sweep from the 3VV cephalad to get the3VST view. Duct is just slightly larger than the Ao which is larger than the SVC
- Duct and Ao should be to the left of the trachea and SVC to the RT. Other vessels and structures seen in this view, or slightly more cephalad, include:
  - Left brachiocephalic vein (LT → RT flow), Internal thoracic (or internal mammary) vessels, subclavian vessels, azygous vein (PRF 10-25 cm/sec) and thymus gland
- Reversal of flow in either of the great arteries appreciated in this section
- Aorta is continuous with the duct. If there is loss of continuity then suspect Aortic interruption

NOTE: The vessel closest to the trachea is almost always the aorta



Abnormalities seen on 3VST view:

In cases of suspected vessel discordance, Z-scores assist in determining whether a vessel is diminutive or prominent relative to gestational age.

Narrow / Absent TAo
HLHS
Coarctation
Aortic Interruption
Mitral Stenosis with VSD
Critical AS

Reversal of Flow Along Aorta
Hypoplastic Left Heart Syndrome
Critical Aortic Stenosis
Hypoplastic Left Heart,
e.g., Severe Coarctation

Other causes
Polyvalvular Dysplasia, etc.
Fetal Breathing (intermittent)

Dilated TAo
Aortic Stenosis with Post Stenotic Dilatation
TOF
DORV (Sub-Aortic VSD)

Narrow or Absent Duct
Pulmonary Atresia with IVS
Critical Pulmonary Stenosis
Absent Pulmonary Valve Syndrome
Tetralogy of Fallot
Ebstein Anomaly
Tricuspid Valve Dysplasia
Double Outlet Right Ventricle
Tricuspid Atresia with VSD
TTTS
FGR

Reversal of Flow in the Duct
Pulmonary Atresia with Conotruncal anomalies Ebstein Anomaly
Tricuspid Valve Dysplasia
Polyvalvular Dysplasia

Dilated Duct
Pulmonary stenosis + Post Stenotic Dilatation
Ductal Aneurysm
Tortuous Duct – Normal Variant in T3

Single Vessel (Not Dilated)
TGA
TOF with PA .DORV
IAA

Single Vessel (Dilated)
CAT

Rearrangement Anomalies
RAA / DAA
RAD with RAA
Absent RT SVC + PLSVC (3 Vessel)
'Y' Configuration (Tetralogy of Fallot)

4 Vessels
Persistent LT SVC / Bilateral SVC
Ascending Vein in Supra-Cardiac
TAPVR

Dilated SVC and or Dilated LBCV
Vein of Galen Aneurysm
Severe FGR
Supra-Cardiac TAPVR

Absent / Abnormal Course LBCV
Absent LBCV (Frequently Seen in PLSVC)
Intra-Thymic Left Brachiocephalic Vein

Aortic and Ductal Arches

(Targeted Fetal Echocardiogram)

Section 6 – Sagittal Imaging

Imaging Aortic Arch

Technique No. 1

- Ideally with spine posterior
- Go to AC bring one full rib into view on both sides. Rotate on the descending aorta. Angle probe so descending aorta angulated, i.e., at 45°

Technique No. 2

- Go to 3VST view and rotate the probe 90°, keeping the aortic isthmus in view
- Left parasagittal AA is seen as a candy cane shaped
- Arises from the centre of the chest
- AA gives three branches: Innominate, LCC and LSA
- 15% of cases Bovine Arch (Innominate and LCC have a common origin). So, normal arch branching 74 – 89%
- Above Desc Ao lies LA and RPA side by side and RA more anteriorly
- Aortic Isthmus lies between the left subclavian artery and the Ductus arteriosus

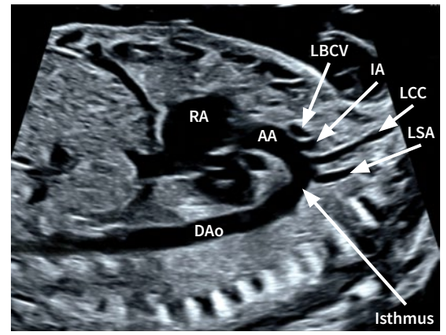
Importance of Aortic Arch View:

- Coarctation / Interruption
- TGA (anterior arch gives off neck vessels)
- Reversal of flow in the Duct (PA with IVS and Co-truncal anomalies)
- Identification of collaterals (Pulmonary atresia)

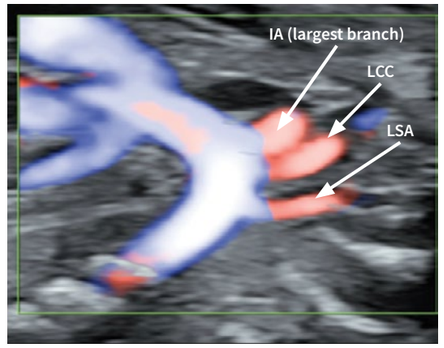
Imaging of the Ductal Arch

- Located to the left of AA
- Exits from the anterior chamber behind the sternum
- Sagittal imaging shows point of Y-configuration of ductus arteriosus joining the aortic arch
- Parasagittal imaging shows RA RV TV MPA wrapping around transverse aortic valve
- DA higher velocities than Ao and thus aliasing in this vessel may represent a normal variant

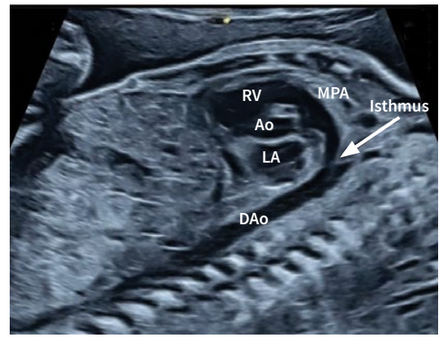
Aorta characteristics:
1) Circular 2) Central superior & 3) Branches



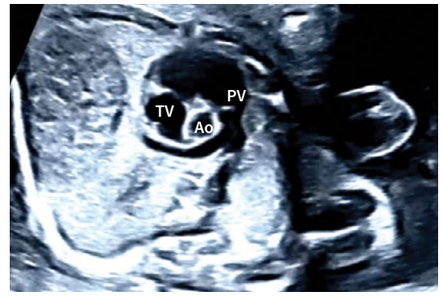
Colour Doppler aortic arch



Sagittal ductal arch



Outlet septum view → parasagittal arch



IVC, SVC & Ductus Venosus

(Targeted Fetal Echocardiogram / Detailed Scan)

Section 7 – Sagittal Imaging

Imaging the SVC and IVC

- Obtain a 4-chamber heart
- Identify right atrium
- Rotate 90 degrees to bring IVC and SVC into view
- Referred to as ‘Bull’s Horns’ view / or ‘seagull view’

On sagittal image, note IVC ‘dives’ anteriorly through the liver to join DV and LHV whereas aorta continues strictly posteriorly along spine superiorly to enter the thorax.

Aorta and IVC lie side by side in the pelvis but IVC lies anterior and to the RT of the Ao in the upper abdomen.

If there are 2 side by side vessels, then it is most likely interrupted IVC with azygous continuation.

IVC DV and LHV join below the diaphragm to form the subdiaphragmatic vestibulum which then crosses the diaphragm and enters the right atrium.

Eustachian valve may be seen in this plane (EV).

Imaging DV

Either axial or parasagittal plane.

Axial: go to AC and angle the probe slightly cephalad.

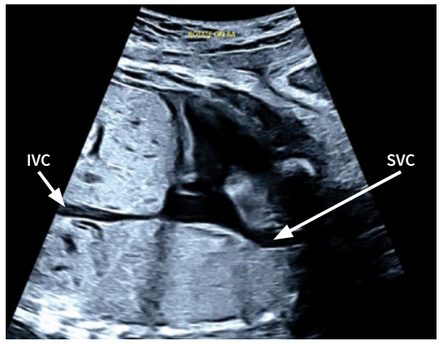
Sagittal imaging of the DV is more reliable (because it avoids accidental sampling of the hepatic veins [i.e., reverse A-wave; false positive], and also avoids accidental sampling of the IHV [gate too wide], which may mask reduced / absent / reversed DV ‘A-wave’ – false negative).

In the first trimester, sagittal imaging of the DV is always preferable. Place the sample gate over the point of aliasing.

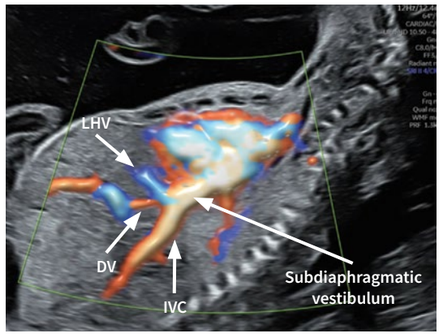
On the spectral Doppler trace, take note of the proximity of the ‘A-wave’ to the baseline.

For the first trimester, in identifying the DV, use Power Doppler and Slow*flow* Doppler in preference to Colour Doppler.

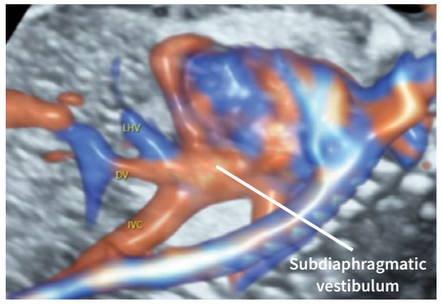
Sagittal SVC & IVC ‘Bull’s Horns’ View Eustachian Valve



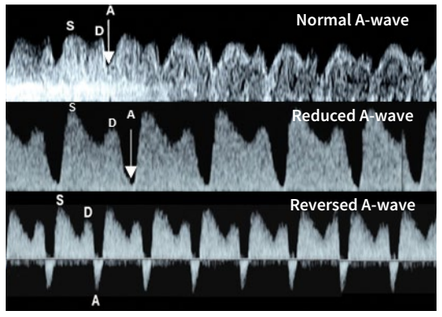
Confluence of the ductus venosus left hepatic vein and inferior vena cava



4D facilitates visualisation of IVC and Ao in the same image



Different A-wave appearances



Cardiac Malformations Made Easy

Left Heart and Aorta

- Hypoplastic Left Heart syndrome (MA+AA)
- Critical Aortic Stenosis
- Mitral Atresia with VSD
- Coarctation of the Aorta
- Interrupted Aortic Arch
- Aortic Stenosis / Bicuspid Aortic Valve
- Right Aortic Arch / Double Aortic Arch
- Aberrant Right Subclavian Artery
- Interrupted IVC and azygous continuation

Right Heart and Pulmonary Artery

- Pulmonary Atresia with intact IVS (HRHS)
- Tricuspid Atresia with VSD
- Ebstein’s Anomaly
- Tricuspid Valve dysplasia
- Pulmonary Stenosis
- Unguarded Tricuspid Valve
- Absent Pulmonary Valve syndrome
- Aberrant Arterial Duct / Constriction
- Right Arterial Duct

Override Anomalies

- Tetralogy of Fallot / APVS
- Double Outlet Right Ventricle
- Common Arterial Trunk

Venous Anomalies

- Persistent RT umbilical Vein
- Absent Ductus Venosus
- Interrupted IVC
- Umbilical Vein Varix
- Persistent left SVC
- Absent right SVC
- Anomalous Pulmonary Venous Return
- Scimitar Syndrome
- Portosystemic Shunt
- Umbilical Vein into the RA

Septal Defects

- Atrial Septal Defect
- Ventricular Septal Defect
- Atrio-Ventricular Septal Defect

Spatial Arrangement Anomalies

- Transposition Great Arteries
- Congenitally Corrected TGA

Rare

- Cardiac Tumours / cardiomyopathy
- Aneurysm / Diverticulum / Uhls
- Exstrophy (Pentalogy of Cantrell)
- Univentricular heart: DILV / DIRV
- Cor-Triatriatum

Heterotaxy Syndromes

- Left Atrial Isomerism
- Right Atrial Isomerism
- Situs Inversus Totalis

Soft Markers of Aneuploidy

- Intra-Cardiac Echogenic Focus
- Tricuspid Regurgitation
- DV-Abnormal Waveform
- Pericardial Effusion
- Two Vessel Cord

Borderline Findings & Variations

- Ventricular Asymmetry
- Great Vessel Asymmetry
- Cardiomegaly
- Axis Deviation
- Tricuspid regurgitation
- Mesocardia
- Prominent Eustachian Valve
- Intra-Thymic Left BCV
- Foramen Ovale Aneurysm
- Redundant Foramen Ovale

Possible Scan Findings Section by Section

Abdomen – Section 1

- Heterotaxy:
  - Stomach on RT (LAI or RAI)
  - Stomach Posterior (RAI)
  - Stomach Anterior / Central (LAI)
- Interrupted IVC:
  1) Dilated Azygous (side-by-side with Ao)
  2) Dilated Hemiazygous (LT posterior to Ao)
- PRUV, ADV
- UV Varix (intrahepatic or extrahepatic)
- Absent DV
- Hepatic Vein to RA

4-Chamber SARRS – Section 2

- Mesocardia, Dextrocardia, Dextroposition
- TR. MR. FO
- VSD. ASD. AVSD. IEF
- 2 or 3VS Behind the Heart
- **LV Small** → HLHS, CAS, CoA, IAA
  MS with VSD, TAPVR, FOA
- **LV Large** → CAS
- **RV Small** → PA with IVS, T Atresia with VSD, PS
- **RV Large** → Coarctation, TAPVR, Duct constriction, PA / IVS, Aneurysm, Uhls
- **RA-Large** → Ebsteins / TV dysplasia, Aneuyrsm
- **LA-Large** → CAS. Cor triatriatum
- Cardiac Tumours e.g. Rhabdomyomas
- Cardiac Diverticulum. Ventricular Aneurysm
  Moderator band in Sonographic LV (cCTGA)
  Pericardial Effusion
- Ectopia Cordis
- Cardiomegaly → VOG, SCT, Placental Chorioangioma
- Cardiomyopathy

5-Chamber – Section 3

- TOF DORV CAT
- AS, CAS, Coart, IAA VSD
- TGA → LVOT Divides

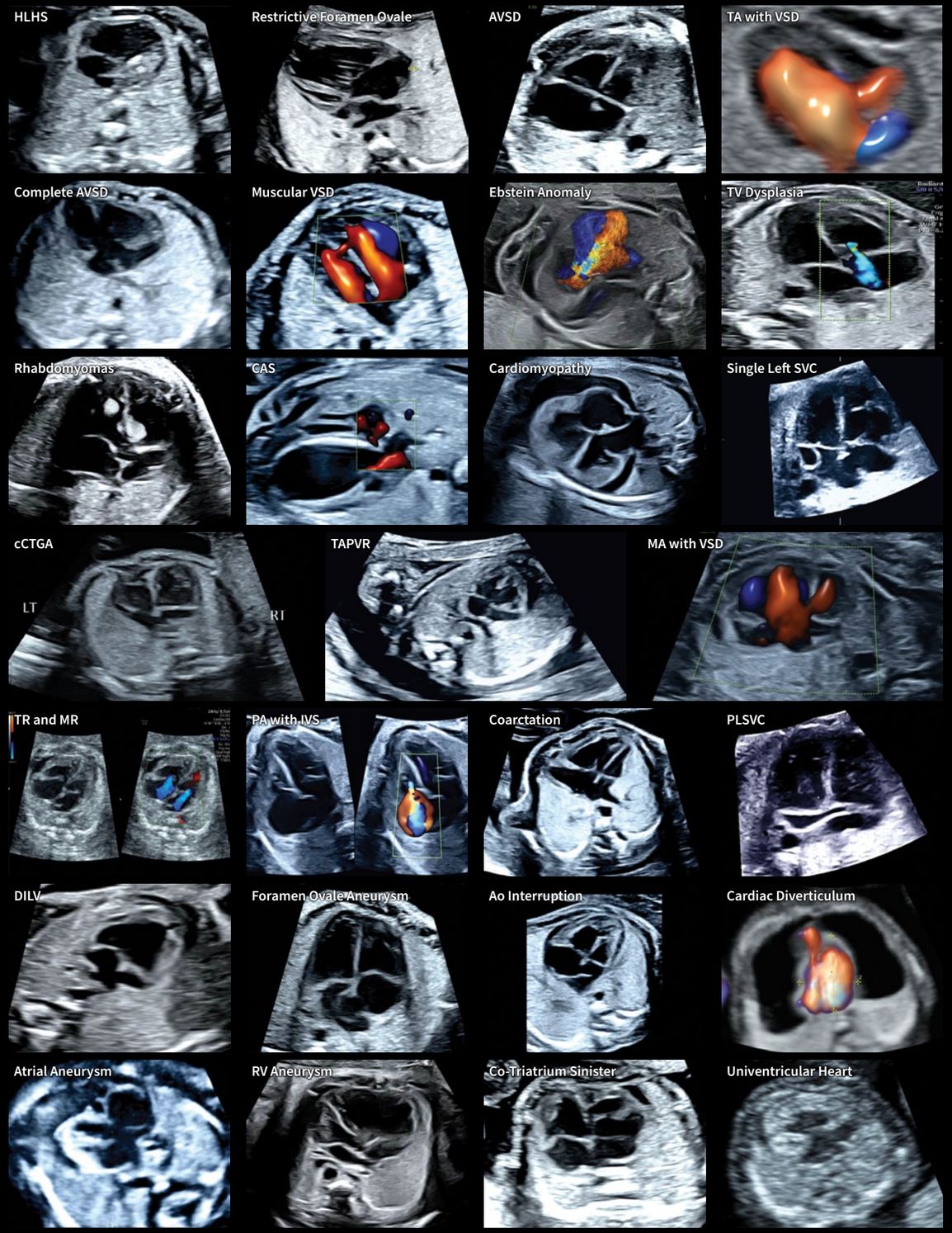
3 Vessel – Section 4

- Small PA TOF, PS, PA + IVS
- Big PA – PS, APVS
- Small Ao – HLHS, Coarctation
- IAA, CAS, MA + VSD
- Big Ao – TOF, CAT, DORV, AS
- 2 Vessels – HLHS / Pa with IVS / TGA
- 4VS – BLSVC. TAPVR

3VST View – Section 5

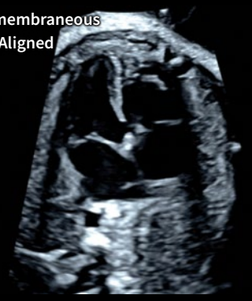
- RAA / DAA / ARSA / ALSA
- Reversal of Flow – Duct
- Reversal of Flow – TAo
- **Only 2 Vessels:**
  - Pulmonary Atresia / Aortic Atresia
  - Absent / Tiny Ao = LT heart obstruction
  - Absent / Small Duct = RT heart obstruction
  - Absent Duct Arteriosus
  - TGA, cCTGA
- **4 Vessels:**
  - BLSVC
  - TAPVR (supra-cardiac)
- Intrathymic LBCV
- Absent Thymus
- Absent RT SVC with Persistent LT SVC

4-Chamber Abnormalities

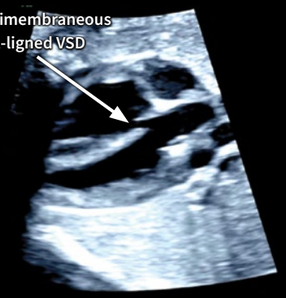


5-Chamber View Anomalies

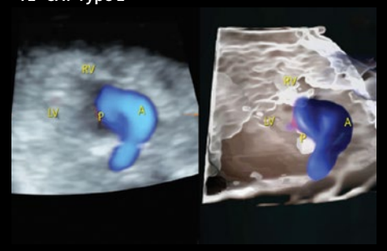
Perimembraneous VSD-Aligned



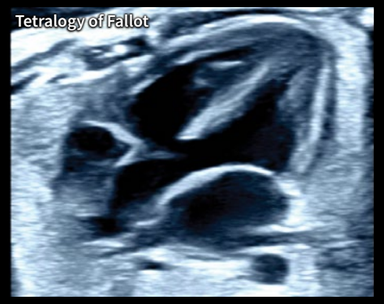
Perimembraneous Mal-ligned VSD



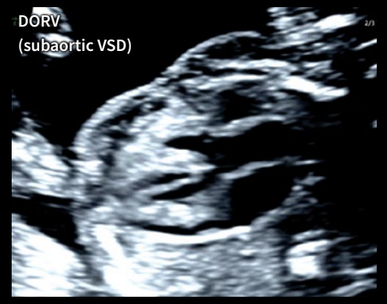
T1- CAT Type 1



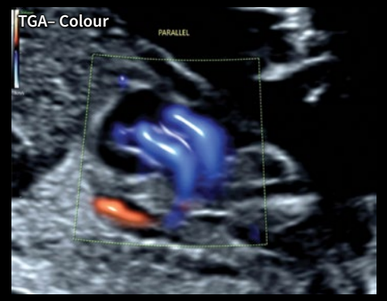
Tetralogy of Fallot



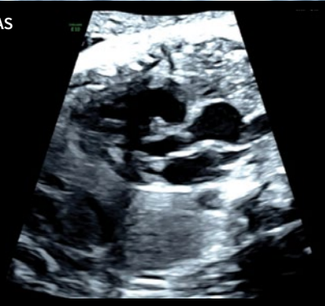
DORV (subaortic VSD)



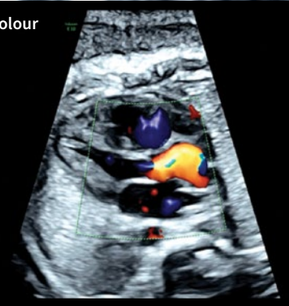
TGA– Colour



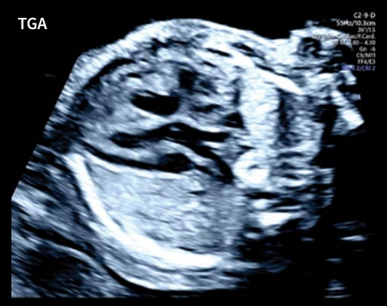
AS



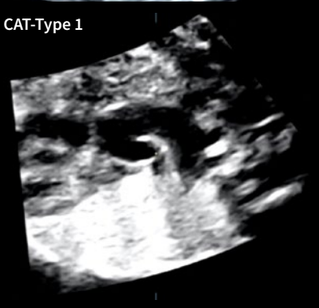
AS Colour



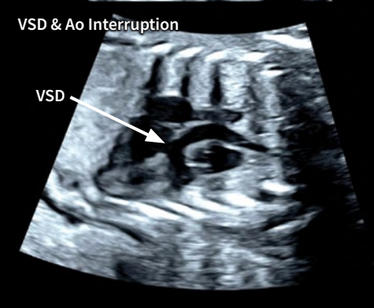
TGA



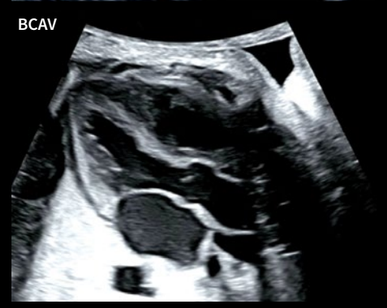
T2- CAT-Type 1



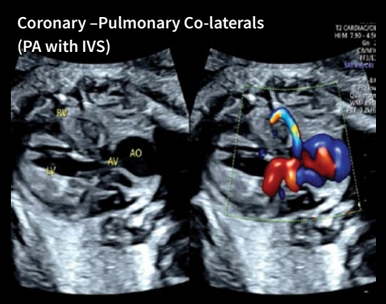
VSD & Ao Interruption



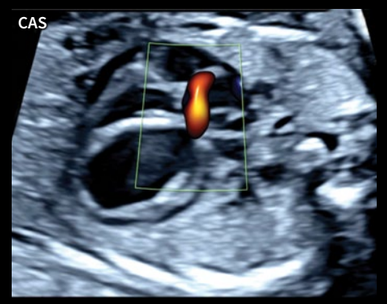
BCAV



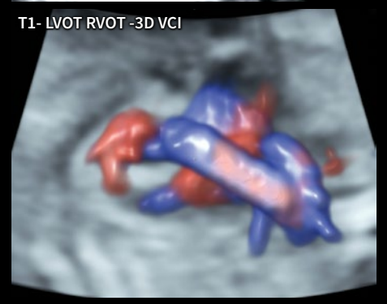
Coronary –Pulmonary Co-laterals (PA with IVS)



CAS

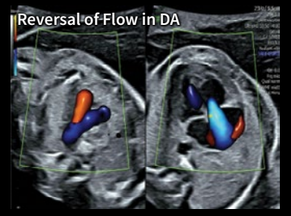


T1- LVOT RVOT -3D VCI

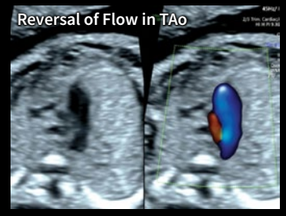


Abnormalities Seen on the 3VST View

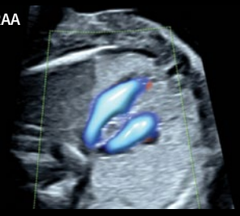
Reversal of Flow in DA



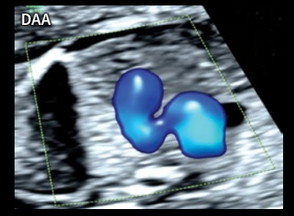
Reversal of Flow in TAo



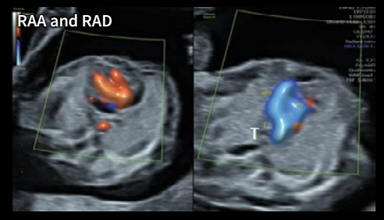
RAA



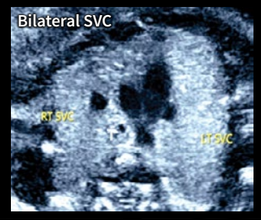
DAA



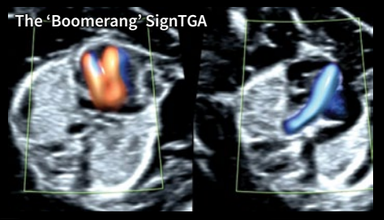
RAA and RAD



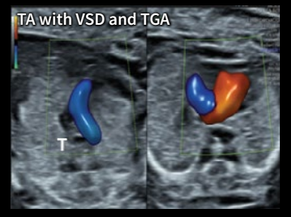
Bilateral SVC



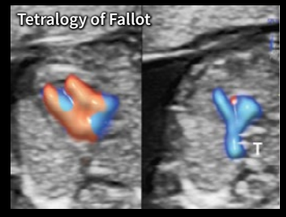
"The 'Boomerang' SignTGA



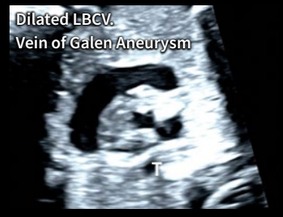
TA with VSD and TGA



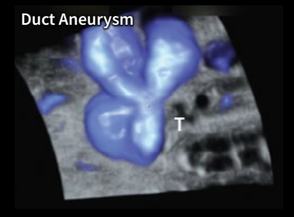
Tetralogy of Fallot



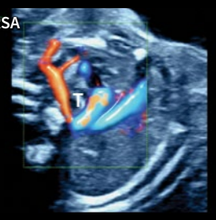
Dilated LBCV. Vein of Galen Aneurysm



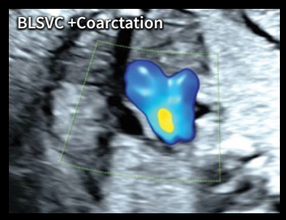
Duct Aneurysm



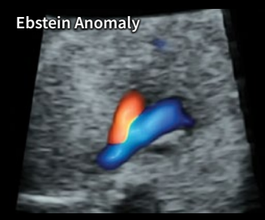
ARSA



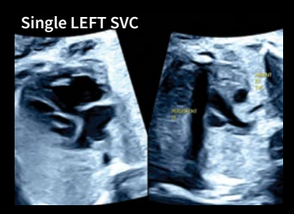
BLSVC +Coarctation



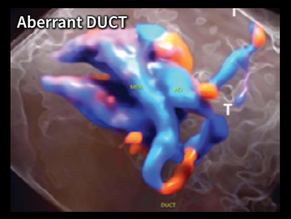
Ebstein Anomaly



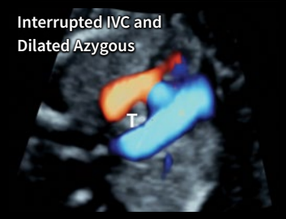
Single LEFT SVC



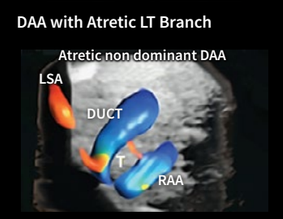
Aberrant DUCT



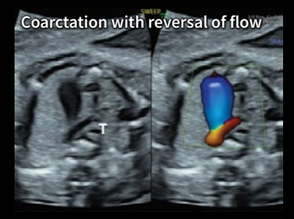
Interrupted IVC and Dilated Azygous



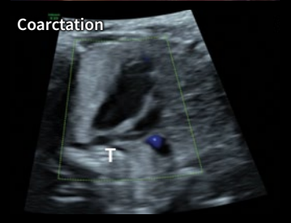
DAA with Atretic LT Branch



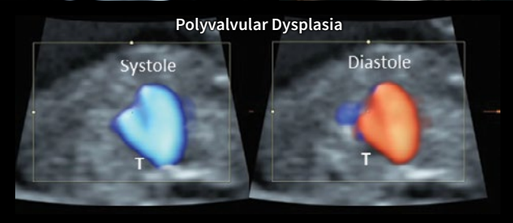
Coarctation with reversal of flow



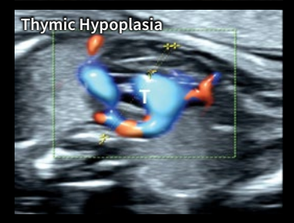
Coarctation



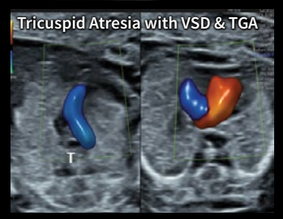
Polyvalvular Dysplasia



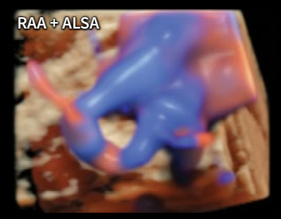
Thymic Hypoplasia



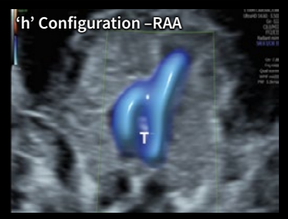
Tricuspid Atresia with VSD & TGA



RAA + ALSA



'h' Configuration –RAA



T1 - TGA

Summary

ISUOG Checklist For Cardiac Screening

ISUOG Cardiac Guidelines 2023

Upper abdomen			
	Stomach on left	☐ Yes	☐ No
Four-chamber view			
General	Heart on left, axis -45°	☐ Yes	☐ No
	Heart area ≤ ⅓ chest area	☐ Yes	☐ No
	Regular rhythm, rate 120–160 bpm	☐ Yes	☐ No
Atria	Approximately equal in size	☐ Yes	☐ No
	Patent foramen ovale; foramen ovale flap valve in left atrium	☐ Yes	☐ No
	At least one pulmonary vein entering left atrium	☐ Yes	☐ No
Atrioventricular junction	Two separate valves that open and close freely	☐ Yes	☐ No
	Tricuspid valve more apical than mitral valve (normal valve offset)	☐ Yes	☐ No
Ventricles	Approximately equal in size	☐ Yes	☐ No
	Moderator band at apex of right ventricle	☐ Yes	☐ No
	Septum appears intact	☐ Yes	☐ No
Left ventricular outflow-tract view			
	Vessel in continuity with ventricular septum and does not bifurcate	☐ Yes	☐ No
	Aortic valve leaflets not thickened, open and close freely	☐ Yes	☐ No
Right ventricular outflow-tract view / three-vessel view			
	Vessel arising from right ventricle is anterior to aorta and bifurcates	☐ Yes	☐ No
	Great arteries crossover	☐ Yes	☐ No
	Pulmonary valve leaflets are not thickened, open and close freely	☐ Yes	☐ No
Three-vessel and trachea view			
	V-sign (ductal and aortic arches to left of trachea)	☐ Yes	☐ No
	Ductal and aortic arches similar in size	☐ Yes	☐ No

Fetal Cardiac Imaging — 20 Golden Rules

▶ Golden Rule 1

Three key controls determine optimal colour Doppler demonstration of flow in the cardiac chambers and connecting vessels:

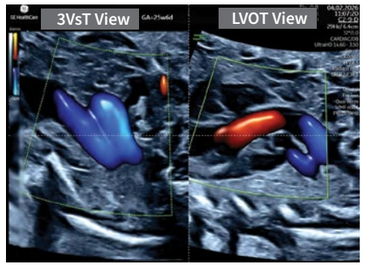
- **Pulse repetition frequency (PRF)**
- **Colour output**
- **Colour gain**

Order of priority:

1. Set PRF first
2. Then adjust **colour output** (while maintaining MI and TI <1)
3. Finally, fine-tune **colour gain** to achieve adequate chamber/vessel fill

Correct adjustment of these three controls ensures accurate colour "fill" and flow representation, allowing colour to map anatomy precisely to the endocardial border or vessel wall without masking abnormal flow patterns.

Correct settings yield correct demonstration of flow though the great



25W6D. PRF 65 cms/sec.
Power Output 95%. TI and MI <1

▶ Golden Rule 2

Use gestation-based PRF settings as your starting guide before colour or pulsed Doppler assessment — and remember that flow velocities in the 4-chamber, great arteries and veins change throughout gestation.

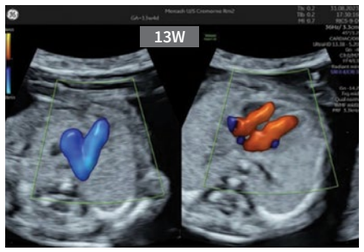
Default PRF settings are often inappropriate for fetal cardiac assessment. Using gestation-based starting PRF improves flow display and reduces misleading Doppler findings. This is especially important because **normal fetal cardiovascular flow is not static: velocities in the great arteries and veins seen in/around the 4-chamber differ and increase with advancing gestational age**, so PRF must be selected in context rather than using a one-size-fits-all approach.

Broad starting PRF guide:

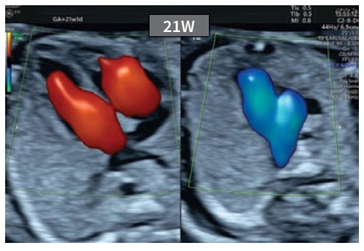
- **First trimester:** 25–35 cm/s
- **Second trimester:** 45–65 cm/s
- **Third trimester:** 65–80 cm/s

Use a gestation-appropriate PRF and adjust dynamically: avoid starting too high which can miss low-velocity flow or too low which can create excess aliasing/noise. Re-tune PRF whenever **depth, zoom, or imaging view** changes.

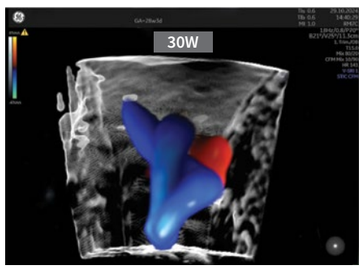
T1 (28 cms/sec)



T2 (48 cms/sec)



T3 (67 cms/sec)



Fetal Cardiac Imaging — 20 Golden Rules *(Continued)*

Golden Rule 3

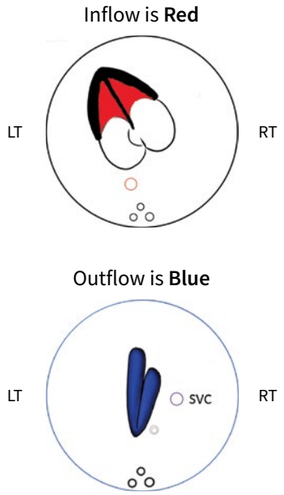
Prioritise a consistent colour Doppler display convention.

When the apex is up, set the colour scale so that:

- **Red** = flow moving towards the transducer
- **Blue** = flow moving away from the transducer

The aim is to ingrain a reflex understanding of blood-flow direction. With repeated use of the same colour convention, normal flow patterns become immediately recognisable, and abnormalities in flow direction are detected more quickly and intuitively.

In practical terms, with this orientation and scale, cardiac inflow will appear red, and the outflow tracts appear blue.



Golden Rule 4

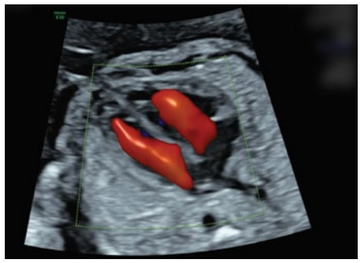
The importance of cine loop review.

Deliberately slowing cardiac motion during cine review is essential for accurate interpretation. Careful cine loop control improves detection of both common and uncommon abnormalities, including findings that may be subtle or only briefly visible in motion.

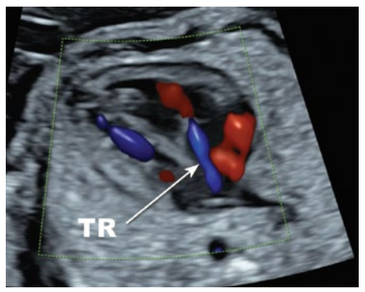
This applies across a wide spectrum of pathology — from mild valvular stenosis to rarer hemodynamic findings. In many cases, key abnormalities are not fully appreciated on still frames and only become evident only during dynamic review.

In this case of tricuspid valve regurgitation, a jet of blood flow arising from the right atrio-ventricular valve crosses the foramen ovale and enters the left atrium. This was recognised only on cine review while assessing atrio-ventricular valve motion, underscoring the importance of meticulous playback and focused evaluation of flow dynamics across the cardiac cycle.

Systole – Normal Inflow



Cine loop ‘rewind’ reveals regurgitant jet crosses the foramen ovale

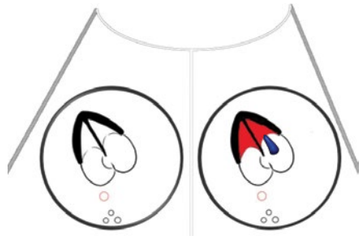


Golden Rule 5

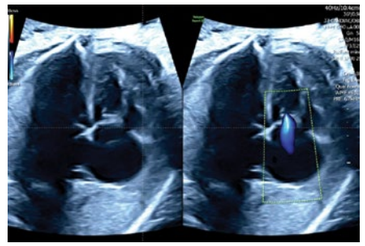
Compare 2D and colour doppler side-by-side split screen imaging.

During routine prenatal cardiac screening, reviewing 2D and colour doppler simultaneously can be a powerful approach. A side-by-side display — typically 2D on the left and colour on the right — allows assessment of cardiac and vessel motion alongside evaluation of flow dynamics through the inflow tracts, chambers, ventricular walls, valves, and great arteries. This combined view can strengthen understanding of the relationship between blood flow and tissue motion, and helps localise the exact site of flow disturbance — a step that can be critical when distinguishing entities with similar appearances, such as tricuspid valve dysplasia versus Ebstein anomaly. For beginner and intermediate learners building pattern recognition, this combined view can be particularly valuable.

Diagrammatic representation of split imaging (2D grayscale, left; color Doppler, right) demonstrating the vena contracta



Split imaging allows identification of the vena contracta with precision

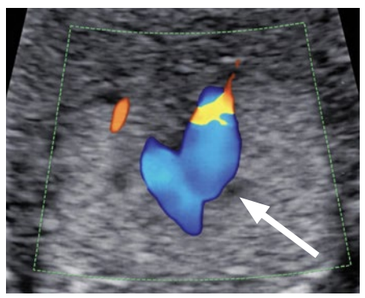


Golden Rule 6

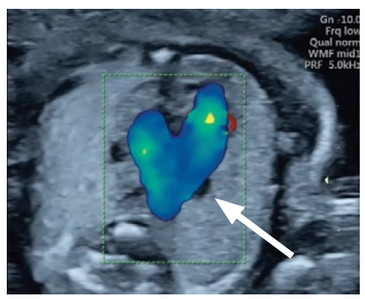
Do not rely on a single transducer.

Probe selection should never be assumed — always trial a higher- and/or lower-frequency transducer to determine which performs best for the examination at hand. In fetal cardiac imaging, image quality is influenced by multiple variables, and no single transducer suits every case.

Low Frequency Transducer:
Persistent left SVC (PLSVC) is barely visible



Higher Frequency Transducer:
Persistent left SVC (PLSVC) is more clearly visible



Fetal Cardiac Imaging — 20 Golden Rules *(Continued)*

Golden Rule 7

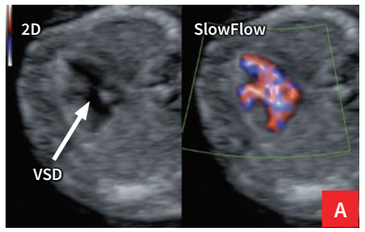
Colour doppler balance / priority optimisation.

Optimise the colour doppler **balance** or **priority** setting so there is an appropriate trade-off between grayscale 2D anatomy and colour flow display. Correct balance preserves structural detail while allowing abnormal flow patterns and anatomic defects to be seen more clearly.

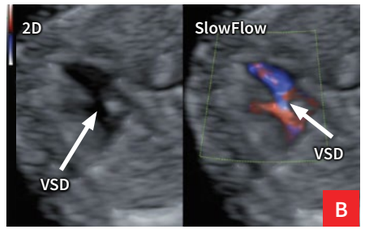
For example, in **(Image A)**, 2D raised the suspicion of a ventricular septal defect, but with the default balance/priority settings, colour doppler did not support its presence.

The defect only became apparent after the balance/priority setting was adjusted appropriately, allowing the VSD to come clearly into view on both 2D and colour Doppler **(Image B)**.

Default balance setting – VSD not appreciated



Optimised balance setting –
VSD clearly demonstrated



Golden Rule 8

SITUS and position safeguard check.

For every examination, save one still image showing the stomach and four-chamber view together after confirming fetal orientation.

The purpose of this image is not to prove situs from a single frame. The purpose is to **prove that a deliberate situs and position check was performed**.

By making yourself save one image that includes both the stomach and the **heart**, you create a simple **discipline check** that helps prevent this step from being skipped. It shows that a conscious effort was made to establish **fetal orientation, situs, and cardiac position**, rather than assuming normality during a routine scan.

This rule works as a practical safeguard: it does not replace the full assessment, but it helps **enforce** it.

Before saving the image, confirm:

1. Head position

2. Spine position

3. Cardiac position

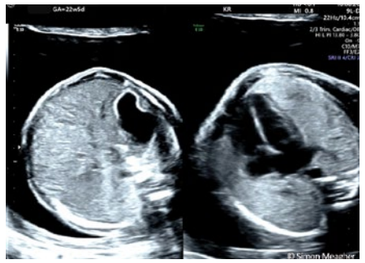
4. Stomach position

Then save **one still image** that includes:

(i) **Stomach**

(ii) **Four-chamber view of the heart** (in the same image)

Stomach on the left. Heart on the same side with 2/3 of the Heart in left hemithorax



Golden Rule 9

The cardiac chamber closest to the descending aorta is almost always the left atrium.

This is one of the most reliable spatial orientation clues in routine cardiac imaging. For trainees, identifying the chamber adjacent to the descending aorta helps confirm laterality and reduces confusion when assessing the 4-chamber view.

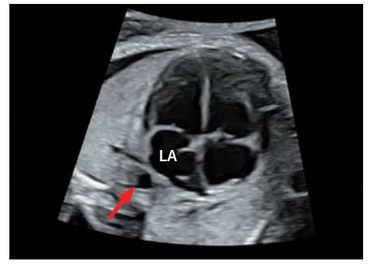
What to do in practice.

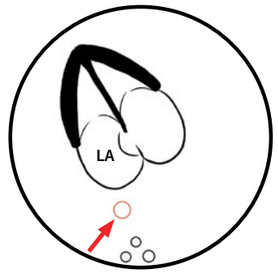
- In the four-chamber plane, identify the **descending aorta (red arrow)** posterior to the heart
- Determine which atrial chamber lies closest to it
- Use this relationship as an **anatomic anchor** before making further chamber-based assessments

Common pitfall(s).

- Losing orientation in an oblique plane and mislabeling the atria
- Relying on a single feature without confirming situs and cardiac axis

*If you are disoriented, find the descending aorta first — the nearest chamber is usually the left atrium





Chamber closest to the descending Aorta is the Left Atrium

Golden Rule 10

How to obtain the short axis views of the fetal heart.

To obtain the fetal cardiac short-axis view:

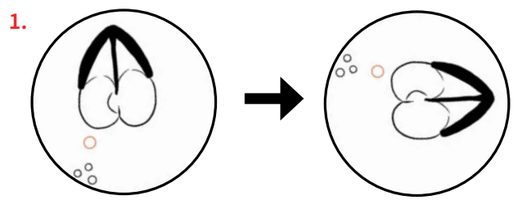
1. Bring the apex from the starting position of 12 o'clock to 9 o'clock, then
2. Rotate the transducer 90 degrees to bring the short axis into view.

This is especially important when assessing:

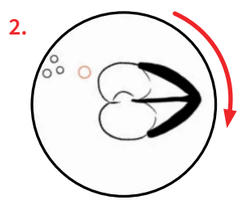
1. Ventricular septal defects
2. Atrioventricular valve abnormalities
3. Partial and complete atrioventricular septal defects

Note: if the apex remains at 12 o'clock, the short-axis view is generally not obtainable.

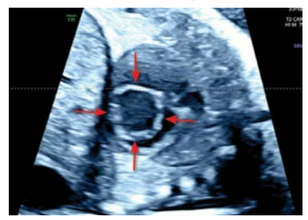
A wide "arc maneuver of the transabdominal transducer will bring the apex from 12 o'clock to 9 o'clock



Once apex is at 3 o'clock → rotate the transducer 90°



In this case short axis permits visualisation of a complete AVSD



Fetal Cardiac Imaging — 20 Golden Rules *(Continued)*

Golden Rule 11

Best orientation to visualise integrity of the ventricular septum.

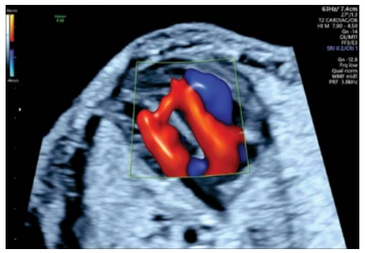
When assessing the interventricular septum for VSDs, defects are often best seen with the cardiac apex at approximately 11 o'clock or 1 o'clock.

This helps reduce septal dropout artefact. **Septal dropout alone is frequently a false-positive finding**.

To support a true septal defect, look for all three features together:

- Dropout in the septum
- Edge enhancement (well-defined defect margins)
- Colour **wash** across the defect (true trans-septal flow)

Colour Doppler with the apex at 11 o'clock demonstrates a mid-muscular VSD



Golden Rule 12

How to best examine the AV valves.

Assessment of AV valve offset is a critical component of routine cardiac evaluation. Normally, the septal leaflet of the tricuspid valve inserts closer to the apex, while the mitral valve inserts closer to the base, creating the normal AV valve offset. **This relationship is best appreciated when the cardiac apex is oriented superiorly, ideally at the 12 o'clock position**. If the heart is assessed only in a transverse orientation, with the apex at 3 o'clock or 9 o'clock, partial or complete atrioventricular septal defects may be overlooked.

What to look for:

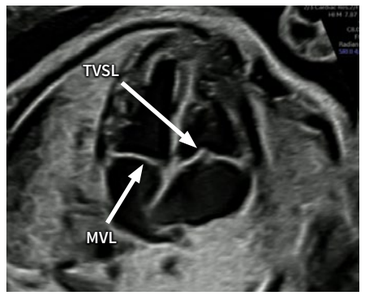
1. Normal AV valve offset with the tricuspid septal leaflet more apical than mitral valve
2. Inlet septal continuity
3. Atrial primum septal continuity
4. Subtle abnormalities on cine loop playback

Teaching pearl.

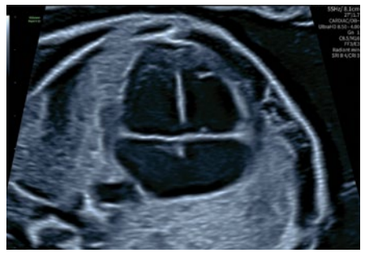
If you want to judge AV valve offset, rotate to apex-up first. Apex-up (12 o'clock) is not just a nicer view — it is often the more diagnostic view for AV canal spectrum defects and subtle inlet/primum septal abnormalities.

When assessing the AV valves, care must be taken not to confuse the coronary sinus with the valve plane, as this may create the false impression of loss of offset.

Normal AV valves –
TVSL – Tricuspid valve septal leaflet
MVL – Mital valve leaflet



Abnormal AV valves – loss of offset along with ASD and VSD in a case of partial AVSD



Golden Rule 13

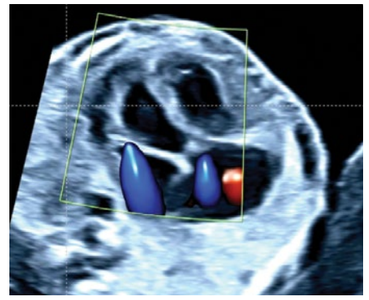
Mitral regurgitation is rare.

Tricuspid valve regurgitation may be present in up to **~5% of pregnancies** (gestation dependent), whereas mitral regurgitation is rare and should promptly raise suspicion of an underlying cardiac anomaly.

So exclude the following:

- Mitral atresia
- Mitral stenosis
- Critical aortic stenosis
- Cardiomyopathy
- Rhythm disturbance

4-chamber showing both mitral and tricuspid valve regurgitation



Golden Rule 14

Do not miss including the pulmonary valve when looking at the RVOT!

For RVOT / 3-vessel assessment, sweep from the RV free wall to the pulmonary artery, keeping the RV free wall in view if possible.

This ensures the **pulmonary valve is seen, not assumed**. Failure to see it is a common cause of **false-negative pulmonary valve lesions**, especially in the **third trimester**.

What to do.

Start at the **RV free wall** → sweep through the **RVOT** to bring the **main pulmonary artery** into view → keep the **RV free wall visible** → confirm the **pulmonary valve level** before calling the RVOT normal.

Common pitfall.

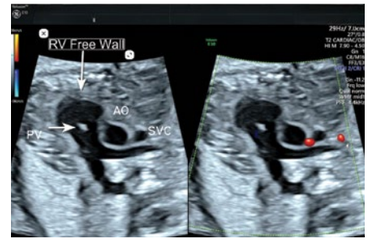
Jumping straight to the **3-vessel view** and assuming that seeing the **pulmonary artery means the pulmonary valve has been assessed**.

Teaching pearl.

Pulmonary artery seen on 3-vessel view ≠ pulmonary valve seen.

NB. Note: it's important to see the valve in systole to make sure that the leaflets completely disappear.

Main pulmonary artery in view along with RV wall brings the pulmonary valve leaflets into view



Fetal Cardiac Imaging — 20 Golden Rules *(Continued)*

Golden Rule 15

Ensure correct curvature of the RVOT i.e. convex to the left.

Learn to appreciate the curvature of the pulmonary artery arising from the right ventricle i.e. it should be convex to the left!

This is best demonstrated using a split image:

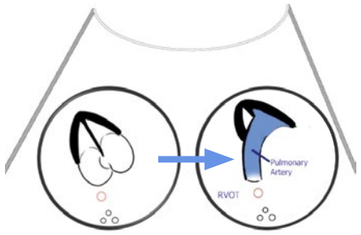
- **Left Pane:** 4-chamber view
- **Right Pane:** Right Ventricular Outflow Tract (RVOT)

Over time, this builds spatial understanding of how the pulmonary artery arises from the right ventricle and arches over the LVOT, and more importantly, develops recognition of its **normal curvature and course**.

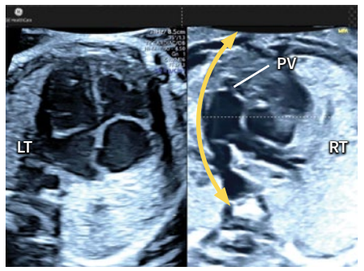
When abnormal, this framework helps trigger recognition of **transposition of the great arteries (TGA)**, where the curvature/convexity is reversed.

Note: In simple TGA (and in complex anomalies with transposed great arteries), the convexity is directed to the **right** "The **boomerang** sign."

Split image demonstrates how the RVOT arises from the RV i.e. Convex to the left



Split image demonstrates how the RVOT arises from the RV i.e. Convex to the left



Golden Rule 16

How to obtain the outlet septum.

For outflow tract VSD visualisation, use a sequential sweep and rotation technique.

How to obtain the view:

Start with a four-chamber view → sweep right ventricular outflow tract (RVOT) view → rotate to bring the tricuspid valve, right pulmonary artery and arterial duct into view.

Key imaging goal:

This maneuver brings key structures into the same imaging plane, allowing assessment of:

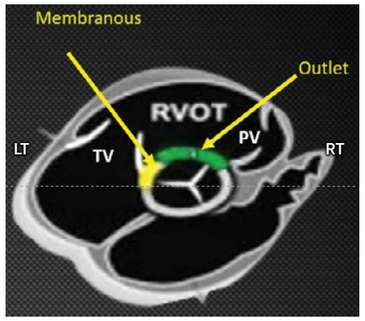
1. Tricuspid valve

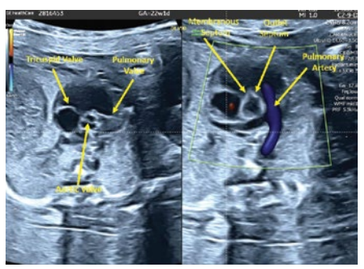
2. Right ventricle

3. Pulmonary valve

When these structures **are seen together**, you can usually visualise: the membranous septum (adjacent to the tricuspid valve septal leaflet), and the outlet septum (adjacent to the pulmonary valve leaflet).

This combined view improves detection of **perimembranous and outlet septal defects**, which may be difficult to appreciate on standard ISUOG screening planes alone.



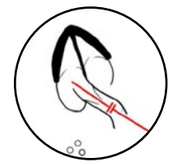


Golden Rule 17

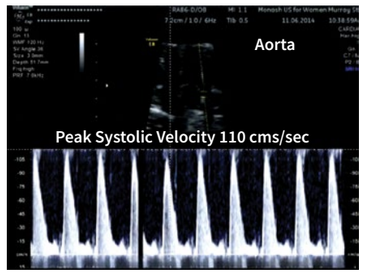
Remember to compare the great arteries.

When semilunar valve stenosis is suspected, compare Doppler velocities in both great arteries. If aliasing or turbulent flow is present, place the pulsed Doppler gate just distal to the aortic or pulmonary valve. Because fetal velocities in the two great arteries are usually similar, **a clear discordance supports true valvular stenosis** and reduces false-positive diagnosis.

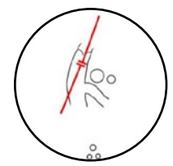
LVOT



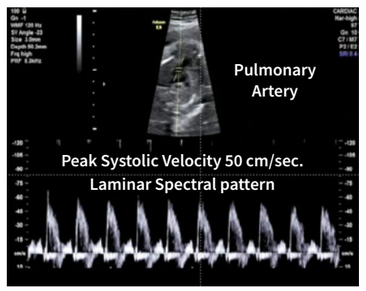
Elevated peak systolic velocity in the aorta



RVOT



For comparison: normal peak systolic velocity in the pulmonary artery



Golden Rule 18

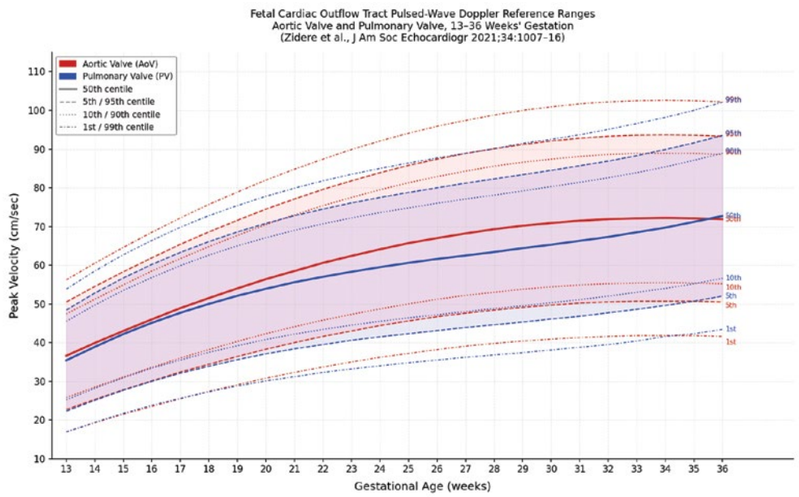
The Rule of 100.

When pulsed doppler assessment of any fetal cardiac chamber or vessel shows **a peak systolic velocity (PSV) >100 cm/s**, this should raise suspicion of a pathological flow disturbance. Although this practical heuristic can be applied up to approximately **36 weeks' gestation**, most structural cardiac screening is performed earlier (typically at **12–13 weeks** and **18–21 weeks**). At these gestations, **100 cm/s** is a practical, safe, and clinically useful **alert threshold** for identifying unexpectedly elevated flow velocities.

The key advantage in routine practice is that this rule provides a **quick screening trigger without needing to refer to detailed velocity charts** for individual chambers or vessels.

Teaching pearl.

When the **PSV >100 cm/s in any fetal cardiac chamber or vessel on pulsed Doppler → stop, verify, and explain**.



Fetal Cardiac Imaging — 20 Golden Rules *(Continued)*

Golden Rule 19

Teaching rule: in the 3VST view, the great vessel closest to the trachea is almost always the transverse aortic arch.

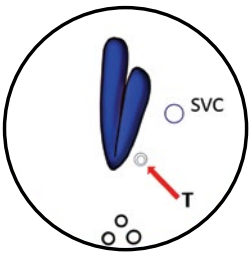
This is a key orientation rule in the upper mediastinum. It helps the examiner quickly distinguish the **aortic arch** from the **ductal arch**, avoid misidentification, and assess arch laterality.

Its main practical value is that it tells you **exactly where to look for reversed flow:**

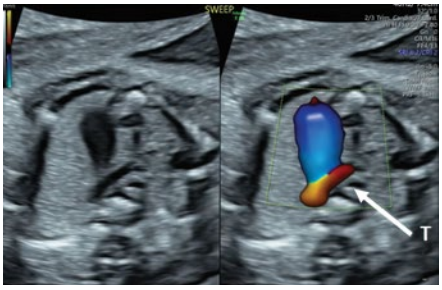
1. In **left heart lesions**, assess the vessel **closest to the trachea** for reverse flow in the **aortic arch**
2. In **right heart lesions**, assess the vessel **farther from the trachea** for reverse flow in the **arterial duct**
3. It also helps target assessment for **vascular variants**, particularly **aberrant right or left subclavian arteries**, and
4. **Bottom line**: in the 3VT view, use the trachea as your landmark — the vessel nearest it is usually the aortic arch, and that relationship helps you rapidly interpret both **vascular pathology and vascular variants**.

There is an important exception to this rule. i.e. when a right aortic arch exists in combination with a right arterial duct, which is rare!

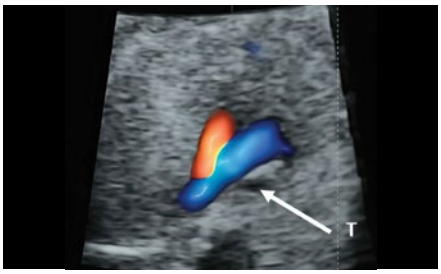
Diagram showing forward flow in both great arteries



Reversal of flow in the TAo.
LT outflow tract obstruction suspected



Reversal of flow in the aorta.
LT outflow tract obstruction suspected



Golden Rule 20

Optimisation when imaging the subclavian arteries.

For assessment of an aberrant subclavian artery or the left brachiocephalic vein, optimal imaging is usually achieved with the spine close to 3 o'clock or 9 o'clock.

Diagram showing ideal position to visualise the subclavian arteries

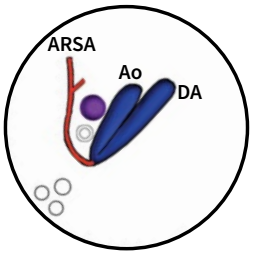
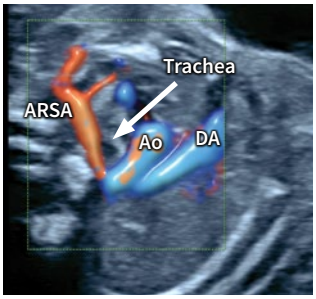


Image showing ideal position to visualise the subclavian arteries



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