Fetal Heart

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Senior Sonographer

Image Optimization

- Highest possible frequency transducer
- Optimise
  - Spatial resolution
  - Temporal resolution
  - Contrast resolution
- Fetal heart set-up
- Frame rate
- Tint
- Dynamic Range
- Persistence
- Harmonics
- Cross beam imaging
- Speckle reduction imaging

Image Optimization

- HD Zoom!

Overview

- Image optimization
- Anatomy
- Routine views/scan planes
- Abnormal Appearances
- Pathologies

Image Optimization

- System
- Your scanning

Image Optimization

- Cine-loop
  - Assists real-time evaluation of cardiac structures
  - Confirm movement of heart valve leaflets throughout cardiac cycle.
Image Optimization

BMI

The very active fetus

- Lift abdominal apron (suprapubic)
- Further optimize settings – Machines are getting better and better!
- Cine
- Colour

Next few slides: Routine B-mode / Colour Cardiac Assessment

1. Situs / size/ rhythm
2. 4-Chamber view
   - Atrial Chambers
   - Ventricular Chambers
   - Atrioventricular Junction and valves
   - Atrioventricular and Septum
   - Pulmonary Vessels
3. Long axis
   - LVOT / Aortic Valve
4. Short axis
   - RVOT / Pulmonary Valve
5. 3VV
6. 3VTV/Arrow
7. Ao Arch
8. Du Arch

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Anatomy & Scan Planes

Routine Cardiac Assessment in B-Mode and Colour

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Abnormal Axis & Situs

- 1 risk of cardiac malformation
  - Outflow tracts
- Associations:
  - Chromosomal abnormality
  - CDH
  - Space occupying lesion (CPAM)
- Secondary to:
  - Lung hypoplasia
  - Gastroschisis
  - Omphalocele
- Isomerism
- Dextrocardia

4-chamber View: HD Zoomed assessment

- Symmetry
- Atrial Chambers
  - Septum Primum & Foramen Ovale
- Ventricular Chambers
  - Intra-ventricular septum
- Myocardium/Pericardium
- Atrioventricular junction & valves
- Pulmonary veins

4-chamber View: Situs & general aspects

- Stomach & heart on left
- Heart = 1/3 thoracic area
- Majority in left chest
- Apex to left by 45° ± 20°
- 4 chambers present
- Regular cardiac rhythm
- No pericardial effusion

4-chamber View: Atrial Chambers

HD Zoomed assessment
**4-chamber View: Atrial Chambers**
- 2 Atria, approx = size
- Foramen ovale flap in left atrium
- Septum Primum present
- Pulmonary veins entering LA

**Abnormal Atria**
- Size/Symmetry
- ASD
  - Septum secundum defects
  - Septum primum defects
  - Sinus venous ASD (rare)
  - Coronary sinus ASD (rare)
- TAPVR
  - No veins entering the LA

**4-chamber View: Ventricles**
- 2 ventricles, approx = size
- No ventricular wall hypertrophy
- Moderator band RV apex
- LV rounder apex
- IVS intact
  - apex to crux

**Abnormal Ventricles**
- Asymmetry
  - Spectrum
  - Mild - Very important for detection of developing lesions
- Cardiomyopathy
- VSD
  - Muscular
  - Perimembranous
  - Infundibular
  - Outlet

**4-chamber View:**
- **Ventricular Chambers**
  - HD Zoomed assessment
- **AV Junction & Valves**
  - HD Zoomed assessment
4-chamber View: AV Junction & Valves
- Intact cardiac crux
- 2 AV valves open and move freely
- Atrial to ventricular flow
- Offset:
  - TV leaflet closer to apex than MV

Abnormal AV Valves
- Regurgitation
  - Mitral (rare in isolation)
  - Tricuspid (common):
    - AHS: normal
    - Marker for:
      - Ebstein’s
      - Tricuspid Dysplasia
      - Pulm Atresia
- Atresia
  - Thinned
  - Tethered
- Double inlet
- AVSD
  - Highest risk of chromosomal abnormality (46-73%)
  - Poor detection rates antenatally
  - Abnormal alignment of AV valves
    - Complete, Partial, Balanced or Unbalanced

Abnormal LVOT:
- Aortic Stenosis
  - Aortic Valve hypoplasia
    - Not formed or very small
    - HLHS
  - Aortic Valve Dysplasia
    - Thickened
    - Echogenic
    - Incomplete opening
- Alasing
- Regurgitation

LVOT View
- Arising from LV
- Continuous with IVS

RVOT
**RVOT View:**
- Arising from RV
- Crosses LVOT
- Just below 3VV
- Branch pulmonary arteries
- Pulmonary valve
  - Opening and closing
  - Cine!

**3VV/3VTV/Arrow:**
- 3VV - Assessment of vessel:
  - Number: 3
  - Size: L to R = biggest to smallest
  - Alignment: L to R = PAS
  - Arrangement: L to R = ant to post

- 3VTV and Arrow
  - More cephalad
  - Level of DA & transverse ao arch
  - Relationship with trachea emphasized

**Abnormal RVOT:**
- Ebsteins Anomaly
- TOF
- Pulmonary Stenosis
  - Narrow
  - Thickened pulmonary valve
    - Does not disappear in systole
- Pulmonary Atresia
  - Reversed flow through PA
  - TR

**Abnormal 3VV/3VTV/Arrow:**
- Size / flow discrepancy:
  - Left sided lesions
  - Right sided lesions
- Only 2 vessels seen:
  - TGA
  - Interrupted Aortic Arch
  - truncus arteriosis
- 4 vessels
  - Persistent left SVC
- Spatial
  - Right sided aortic arch

**3VV / 3VTV / Arrow**

**Arches**
Aortic and Ductal Arch:

- Sagittal
  - Anterior or Posterior
- Ao Arch more cranial – candy cane
- Du Arch – hockey stick

Abnormal Aortic Arch:

- Aortic Coarctation
  - Lowest prenatal diagnosis rate of any CHD
  - 40% isolated
  - 60% additional cardiac abnormalities
  - Associated with
    - Turner Syndrome
    - Di George Syndrome (22q.11 deletion) (Buyens et al. 2012)
- Interrupted Ao Arch
- Truncus Arteriosis
- Conotruncal lesions
- Parallel arches (TGA)

Abnormal Ductal Arch:

- Rt sided lesions
  - Ebstein
  - TOF
  - Pulmonary stenosis/atresia
    - Small Ductus
    - Low forward flow
    - Reverse flow

Cardiac Cases:

Case 1

TGA

- Transposition of the Great Arteries

- 5-7% of all CHD
- ¼ to 1/3 missed diagnosis antenatally
- D-Transposition most common:
  - Concordant atrial – ventricular connections
  - Discordant ventricular – arterial connections
- L-Transposition rare
  - Discordant atrial – ventricular connections
  - LV on the Rt and RV on the Lt
TGA: 4-chamber
- Usually normal 4 chamber view
  - Except if associated with VSD
    - 50%
    - Usually perimembranous

TGA: Outflow Tracts
- Outflow tracts NOT crossing
  - Parallel outflow tracts and arches
  - Usually Ao is to the Rt and anterior of PA
  - Pulm branches arising from LVOT

TGA: Arches
- Parallel

TGA: 3VV / Arrow
- Abnormal 3VV
  - 2 vessels instead of 3
  - Transverse arch & SVC
  - No arrow

Case 2:
TOF
- Tetralogy of Fallot

TOF
- Most common form of cyanotic heart disease
- Associations:
  - Trisomies 13, 18 and 21
  - 22q.11 deletion (up to 34%)
  - Extracardiac pathology
- Anterior / leftward deviation of outlet septum
  - Impingement of flow through pulmonary outflow tract
  - Over-riding Ao
  - Hypoplastic PA
  - VSD (subaortic)
TOF: 4-chamber view

- Often appears normal (~95%)
- Leftward cardiac axis may be present

TOF: RVOT / Pulmonary Outflow

- Thickened dysplastic Pulm. valve
- Hypoplastic MPA and branch PA
  - Progressive
    - Assoc. with progressive pulmonary outflow tract obstruction
- Pulmonary stenosis
  - Turbulent, reversed or absent flow
- Severity of outflow obstruction determines outcome
  - Patent
  - Direction of flow (MPA & DA)
    - Critical for planning postnatal management
  - Reversed flow (DA) – severe pulmonary outflow obstruction

TOF: VSD

- Sweep towards outflow tracts
- VSD & overriding Ao

TOF: LVOT View / Over-riding Aorta

- May be enlarged
  - Late in gestation
- More anterior than in normal heart
- “Y” view (flow into the aorta from both ventricles)

3 types TOF

1. Pulmonary Stenosis (75%)
   - Most common
   - Narrow
   - Thickened pulmonary valve

2. Pulmonary Atresia (20%)
   - More severe variant
   - Large subaortic VSD & one great artery
   - Reversed flow through PA
   - Hypoplastic branch PA’s
   - TR

3. Absent Pulmonary Valve Syndrome (5%)
   - Large MPA and branch PA’s
   - Significant regurgitation

TOF: 3VV/Arrow view

- Pulmonary Hypoplasia
- Reversed flow in DA
Case 3:

**HLHS**

- Hypoplastic Left Heart Syndrome

- Associated with:
  - Turner Syndrome
  - Trisomy 13 and 18

- Progressive lesion
  - Aortic stenosis (mild – mod – severe)
  - Mitral / Aortic Atresia
  - Hypertrophic LV
  - Mitral Insufficiency
  - Progressively hypoplastic LV

- The term HLHS = severely hypoplastic LV

**HLHS Ultrasound Findings:**

- Severely hypoplastic LV
- Threadlike LVOT & ascending aorta
- Distal arch larger, more normal diameter
- Retrograde flow in distal aortic arch
- Left to right atrial flow

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Case 4:

**RAA**

- Right sided Aortic Arch
- Associated cardiac
- Isolated
- Vascular ring
Case 5:
HLHS
- Hypoplastic Left Heart Syndrome

Case 6:
VSD
Aortic Coarctation

Case 7:
HRHS
- Hypoplastic Right Heart Syndrome
- Pulmonary Atresia

Case 8:
New position – Apex up
AVSD
- Atrial-Ventricular Septal Defect
- Absent Offset Cross
- Can be missed
  - positional
  - Common
  - T21

Case 9:
Case 9:
- Look behind the heart
- Interrupted IVC

Case 10:
DORV
- Double Outlet Right Ventricle

Case 11:
TR
- Normal
- Marker for:
  - Ebsteins
  - Pulm Aresia
  - Cardiomegaly

Case 12:
Ebsteins
- TR
- Dilated RA [due to TR]
- Thickened TV
- Displaced TV / greater offset of AV valves
- RVOT obstruction 20%
- Reversed ductal flow in severe forms
- Cardiomegaly (severe forms)
- High mortality (severe TR impacts function of LV as well as RV, therefore poor outcomes).

Case 13:
- Muscular VSD

4 types of VSD
1. Muscular
2. Perimembranous (into LVOT)
3. Inlet (near AV valves and can be assoc. with AVSD)
4. Outlet (prenatal diagnosis prenatally)
Case 15

TAPVR
- Total Anomalous Pulmonary Venous Return

4-chamber View: Normal Pulmonary Veins
- Proximity to the pulmonary arteries can cause confusion
- Check direction of flow on colour

4-chamber View: Normal Pulmonary Veins
- 4 veins (2 Rt 2 Lt)
  - Visualise 1 from each side
- Posterior Left atrium
- Low flow
  - Scale <25cm/s

TAPVR
- No PV’s to LA
  - PV’s to systemic veins or directly to RA
- 5th most common cause of critical heart disease (Ganesan, 2014)
- One of the most common cardiac disease missed prenatally (Laux et al 2013)
- Varying range of cyanosis at birth
  - Depends on amount of deoxygenated blood reaching the circulatory system
- May be life threatening
  - Right to left atrial shunt required for survival
- Isolated or associated with other CHD
- Associated Syndromes:
  - Turner syndrome, Noonan syndrome, heterotaxy (asplenia and polysplenia syndromes)

Ultrasound Appearances: TAPVR
- Pulmonary veins not entering LA
- Smooth posterior LA surface
- Asymmetrical ventricles
  - RV/L
  - May not be apparent until 3rd trimester
- Abnormally wide space between the LA and the descending aorta
- Abnormal vein behind the heart “Twig Sign” (posterior venous confluence)
- TAPVR can be excluded when at least 1 PV is seen entering the LA (PAPVR not excluded)
Ultrasound Appearances: TAPVR

- Pulmonary veins not entering LA
- Smooth posterior LA surface

Conclusion

Enjoy! 😊