Introduction to Normal and Abnormal Fetal Anatomy

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Introduction to Normal and Abnormal Fetal Anatomy

Brian Loe, MD FRCP(C)
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Adapted from ISUOG Basic training lecture
Learning Objective

At the end of the lecture you will be able to:

• Compare the differences between the ultrasound appearances of normal fetal anatomy and of the more common structural fetal abnormalities.
Key Questions

- Which abnormalities can be excluded by obtaining normal HC and AC sections in the 2nd or 3rd trimester fetus?

- What are principal differences in ultrasound appearances between a structurally normal fetus and a fetus with open spina bifida?

- How can the AC section be used to exclude the most common abdominal wall and gastrointestinal defects?

- What are the typical ultrasound features of lower urinary tract obstruction?
Key Anatomic Planes
Scanning Planes
Scanning Planes

SAGITTAL
Scanning Planes
Image Orientation

Orientation of the probe

Medical imaging

ANTERIOR

RIGHT

POSTERIOR

LEFT
Image Orientation

Orientation of the probe

ANTERIOR
Cephalad
POSTERIOR
Caudal
Determining Fetal Lie

Ant

Maternal R

Maternal L

Post
Key Features of HC Section
Key Features of HC Section

1. Midline (falx cerebri)
2. Cavum septum pellucidum
3. Rugby football shape, rounded back, more pointed at front
4. Skull contour regular
5. Posterior horn <10.0mm
6. Anterior horn(s) slit-like
Measure BPD & HC
Posterior Fossa

- Cisterna Magna
- Cerebellum
- Falx
- NF
Posterior Fossa
Optimal Imaging Plane

Cerebellum
Nuchal fold
Cisterna magna
Key Features of AC Section
Key Features of AC Section

1. Short length of **umbilical vein**, spine

2. Single **stomach** ‘bubble’, on left side

3. Remaining echotexture homogeneous

4. (Gall bladder to right of UV)

5. No fetal kidneys seen in this plane
Measure AC

- Stomach
- Umbilical Vein
- True cross section of spine – 3 ossification centers
Establishing Situs
Establishing Situs
First Establish Fetal Position
4 Chamber View

- **Easy** view to obtain
- **No specialized skill** needed
- Obtainable in **all fetal positions**
- Rules **out 60% CHD**
- Easy **slide up from AC** with full rib
- **Starting point** for the sweep
4 Chamber View – Normal Appearance

- **Right ventricle** is the most anterior, below the sternum
- **Left atrium** is closest to the spine and the most central structure in the chest
- **Tricuspid valve** is more apical than the mitral valve
- Flap of the **foramen ovale** is in the left atrium
- ** Moderator band** is in the right ventricle
- **Crux** seen
Kidneys – Normal Appearance
Kidneys – Normal Appearance

- **Lateral to spine**
- Posterior to stomach
- Normal renal tissue similar echogenicity to bowel, liver etc
- (Coronal view allows easier comparison)
- Cortex homogenous echopattern
- **Renal pelvis**, centrally positioned, <5.0mm AP
Cord Insertion – Normal Appearance

1. Slide inferiorly from AC to sacrum
2. Maintain cross sectional approach
3. Cord inserts superior to bladder
Bladder – Normal Appearance

- **Central** position in fetal pelvis
- **Anterior to rectum**
- Thin walled
- No internal content

- Size varies (~30 minute cycle)

- **Umbilical artery** on each side
Key Features to Measure FL
Key Features of Amniotic Fluid

AFI: 5 – 25 cm
SDVP: 2 – 8 cm

Do not include fetal parts or umbilical cord (check with Color Doppler if unsure)
Axial Anatomic Planes
Normal or Abnormal Appearances?

Skull
1. Brain, level of ventricles
2. Brain, post fossa
3. Chest – 4 chamber view
4. Abdomen – stomach
5. Cord insertion/abdominal wall
6. Kidneys and bladder
7. Amniotic fluid
8. Size and relative size
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
Finding the HC - Shape

1. Dolichocephaly
2. Brachycephaly
3. Anencephaly
4. Encephalocele
5. Lemon sign
6. Cystic hygroma
7. Craniocynostosis
Dolichocephaly

Schematic adapted from: http://breechbirth.org.uk/2014/04/dolichocephaly-understanding-breech-head-molding/
Brachycephaly
Anencephaly
Anencephaly

Sagittal

Coronal
Encephalocele
Cystic Hygroma
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
Finding the HC – Intracranial Structures

1. Ventriculomegaly
2. Holoprosencephaly
Ventriculomegaly
Holoprosencephaly
Finding the Posterior Fossa – Intracranial Structures

1. Banana sign
2. Vermian agenesis
Banana Sign
Vermian Agenesis
The Spine
Open Spina Bifida Typical Appearances

Normal appearances

Abnormal appearances
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. **Chest – 4 chamber view**
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
Finding the 4 Chamber View

1. Situs abnormalities
2. Ectopia cordis
3. Univentricle
4. AV canal
5. CDH
Abnormal Situs
Ectopia Cordis
Univentricle
Atrioventricular Septal Defect

Loss of Off-Set
Congenital Diaphragmatic Hernia
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
Finding the AC

1. Establishing situs
2. Absent stomach: esophageal atresia
3. Double bubble: duodenal atresia
Establishing Situs
Absent Stomach

15 Mins Later
Absent Stomach
Double Bubble Sign
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
1. Normal gut herniation
2. Omphalocele
3. Gastroschisis
Normal Gut Herniation

Fetuses have exompholos at 9-10 weeks that resolves by 12 weeks
Omphalocele

Abnormal cord insertion
- Cord inserts into apex of defect
- Contains liver +/- bowel etc
- Membrane covered
Gastroschisis

Normal cord insertion

- Defect below and to right of cord insertion
- Contains bowel only
- Free floating – no covering membrane
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
Kidneys and Bladder
Kidneys and Bladder

1. Renal agenesis
2. Hydronephrosis
3. Bladder outlet obstruction
Urinary Tract Obstruction

1. Appearances dependent on
   • Site of obstruction
   • Unilateral or bilateral

2. Amniotic fluid volume
   • Oligo/anhydramnios – bilateral and/or low (bladder outlet)
   • Normal fluid - unilateral
Renal Agenesis
Hydronephrosis
Bladder Outlet Obstruction
Bladder Outlet Obstruction
Normal or Abnormal Appearances?

1. Skull
2. Brain, level of ventricles
3. Brain, post fossa
4. Chest – 4 chamber view
5. Abdomen – stomach
6. Cord insertion/abdominal wall
7. Kidneys and bladder
8. Amniotic fluid
### Oligohydramnios: Causes

*From Ultrasound in Obstetrics & Gynecology: A Practical Approach. Abuhamad et al 2014*

**TABLE 9.1** Common Causes of Oligohydramnios

- Premature rupture of membranes
- Genitourinary abnormalities
- Uteroplacental insufficiency
- Postdates pregnancies
## Polyhydramnions: Causes

<table>
<thead>
<tr>
<th>TABLE 9.2</th>
<th>Common Causes of Polyhydramnios</th>
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<tbody>
<tr>
<td>-</td>
<td>Gestational and pregestational diabetes</td>
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<tr>
<td>-</td>
<td>Isoimmunization</td>
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<td>-</td>
<td>Fetal structural and chromosomal abnormalities</td>
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<td>Fetal infections</td>
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<td>Multiple pregnancies with Twin-Twin Transfusion Syndrome</td>
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<td>-</td>
<td>Idiopathic</td>
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Relative Sizes
Key points

1. The key to identifying abnormalities is understanding the range of normal appearances at differing gestations

2. It is important to develop a consistent approach to each scan, rather than scanning randomly

3. Find the long axis of the fetus first and assess the appearances
Key points

4. Then assess the fetal anatomy in cross section starting with the head, assess skull and intracranial anatomy, measure the HC

5. Slide through the chest to the abdomen, assess situs, chest contents and upper abdomen, measure AC

6. Find FL by continuing to slide through lower abdomen and pelvis, assess abdominal wall, cord insertion, kidneys, bladder, spine and skin covering
Conclusions

Distinguishing between normal and abnormal ultrasound appearances requires:

- The development of a consistent scanning technique
- Paying rigorous attention to the quality of sections obtained
- Understanding how to manipulate the probe to improve poor sections
- Appreciating how the range of normal appearances, and therefore potentially abnormal appearances, changes with gestation
Questions?

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