Imaging of 2nd Trimester Pregnancy

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Objectives

- List and identify sonographic images of normal anatomic structures identified during a routine second trimester fetal ultrasound examination
- Demonstrate some common fetal conditions that can be diagnosed during a routine second trimester fetal ultrasound
- Illustrate sonographic markers for aneuploidy
Outline

- Imaging Standards and Techniques
  - Ultrasound
  - MRI
- Maternal Anatomy and Pathology
- Fetal Anatomy
  - Abnormal screening US findings
  - Markers of Aneuploidy
  - Chromosomal Anomalies
Second Trimester Ultrasound

- Typically obtained at 18-22 weeks
- 3-5 MHz abdominal transducer
- +/- ≥5-10 MHz endovaginal transducer
- Real time sonography to confirm:
  - Cardiac activity
  - Fetal movement
Second Trimester Ultrasound

- Maternal Anatomy
  - Uterus and adnexa
    - When technically feasible
  - Placenta
  - Cervix
  - Amniotic fluid

- Fetal Anatomy
  - Sonographic predictors of gestational age
  - Head, face, and neck
  - Chest
  - Abdomen
  - Spine
  - Extremities
  - Gender
    - Multiple gestations

Fetal MRI

- Not a first line screening modality
- Problem solving
  - Indeterminate US findings
  - Abnormal US findings
Fetal MRI

- **Risks**
  - Heat deposition
  - Acoustic noise
- **Gadolinium contrast not recommended**
  - Gadolinium crosses the placenta
- “Pregnant patients can be accepted to undergo MR scans at any stage of pregnancy if, in the determination of a level 2 MR personnel-designated attending radiologist, the risk-benefit ratio to the patient warrants that the study be performed.”

Fetal MRI

- Limitations
  - Motion
    - Fetal
    - Maternal
  - Small size of fetal structures
  - Distance between fetus and receiver coil
Fetal MRI

- Technique
  - Depends on indication for exam
  - Supine or left lateral decubitus position
  - Surface phased array coil
  - 3 plane (to the fetus) single shot fast spin echo T2 images
  - T1 images helpful in assessment of fetal bowel, fat, hemorrhage
  - No IV gadolinium contrast
Cervix

- 3-4 cm in length
- Most accurate when bladder is empty
- Cervical Incompetence
  - Variable definitions
  - Less than 2.5 cm in length
Funneling

- Greater than 50% funneling before 25 weeks is associated with preterm delivery
- Measure using endovaginal probe
- U shaped funneling has higher risk than V shaped funneling

V shaped funneling
Placenta Previa

- Marginal Placenta Previa
  - Placental edge within 2 cm of internal cervical os
- Partial Placenta Previa
  - Placenta partially covers the internal cervical os
- Complete Placenta Previa
  - Placenta completely covers internal cervical os
Placenta Previa

- Often resolves with pregnancy
  - 5% at 15-16 weeks
  - 0.5% at term
- Imaging with an empty bladder
  - Imaging with a full bladder can mimic placenta previa
Placenta Accreta Spectrum

- Abnormal penetration of placental tissue beyond endometrial lining of uterus
- Risk factors
  - Placenta Previa
  - Prior C-section
Placenta Accreta Spectrum

- Placenta Accreta Vera 80%
  - Placenta attaches to myometrium but without invasion
- Placenta Increta 15%
  - Placenta invades the myometrium
- Placenta Percreta 5%
  - Placenta penetrates through uterus and may invade other organs
    - Bladder
    - Rectum
Ultrasound findings
- Turbulent flow within placental lacunae
- Irregular bladder wall
- Thinned (< 1 mm) or loss of myometrium
- Multiple hypoechoic vascular lacunae

Poor predictive value
- 33% sensitivity
Placenta Accreta Spectrum

- MRI Findings
  - Heterogeneous placental T2 signal
  - Dark intraplacental bands on T2 images
  - Loss of normal myometrium
  - Bladder tenting
  - Loss of fat plane between uterus and pelvic organs
  - Placental invasion of pelvic structures
- Poor sensitivity 38%
Placental Masses

- Chorangioma
- Teratoma
  - Rare
- Metastases
  - Maternal
    - Malignant melanoma
      - Most common
Chorangioma

- Also chorioangioma or placental hemangioma
- Benign placental neoplasm
  - Hemangioma of placenta
- Most common placental tumor
  - Approximately 1% of placentas
- Usually less than 5 cm
- Uncommon to grow after ~20 weeks
Chorangioma Pathology

- Composed of fetal capillary channels surrounded by a variably cellular stroma

Amer HZM and Heller DS. Chorangioma and related vascular lesions of the placenta-- a review. Fetal and Pediatric Pathology; 2010; 29:199-206.
Chorangioma

- Ultrasound imaging findings
  - Hypoechoic
  - Vascular
  - Well circumscribed
- Completely intraplacental
- Typically near umbilical cord insertion
Amniotic Fluid

- Subjective assessment
  - 2nd trimester
    - Fluid:fetus ratio 1:1
Amniotic Fluid

Semiquantitative Measurements

- **Maximum vertical pocket (MVP)**
  - Identify largest fluid pocket
  - Measure depth of fluid
  - Avoid fetal parts and cord
  - 2-8 cm normal

- **Amniotic Fluid Index (AFI)**
  - Maximum vertical pocket in each quadrant of uterus
  - Sum the 4 quadrants for AFI
  - 5-24 cm normal
Oligohydramnios

- Deficiency of amniotic fluid
- Amniotic fluid measurements
  - Subjective 2nd trimester
    - Fetus takes up more than half of uterus
  - MVP
    - Less than 2 cm
  - AFI
    - Less than 5 cm
Causes of Oligohydramnios

- Premature rupture of membranes
  - Most common
- Renal abnormalities
- Utero-placental insufficiency
- Fetal demise
- Post dates

- Chromosomal abnormalities
  - Trisomy 18
  - Trisomy 13
- Indomethacin
  - Prostaglandin inhibitor
- Urethral atresia
- Intrauterine growth retardation
Potter Sequence

- Typical appearance of fetus with oligohydramnios
  - No normal kidneys
  - No fluid-filled bladder
  - Clubfoot
  - Hip dysplasia
  - Pulmonary hypoplasia
  - Potter facies
Polyhydramnios

- Excessive amniotic fluid
- Amniotic fluid measurements
  - Subjective 2^{nd} trimester
    - Fluid:fetus ratio over 1:1
  - MVP
    - Over 8cm
  - AFI
    - Over 24 cm
Causes of Polyhydramnios

- Idiopathic 60%
- Maternal 25%
  - Diabetes mellitus
  - Hypertension
    - Pre-eclampsia
  - Maternal congestive heart failure
- Fetal 10%
  - CNS lesions
    - Most common fetal cause
  - GI tract obstruction
  - Abdominal wall defects
  - Cervical masses
  - Thoracic masses
  - Cardiovascular abnormalities
  - Twin-Twin transfusion
  - Hydrops
  - Reduced fetal movement
# Twin Gestations

<table>
<thead>
<tr>
<th>Type of gestation</th>
<th>Chorion</th>
<th>Amnion</th>
<th>Yolk Sac</th>
<th>Fetus</th>
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<tbody>
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<td>Singleton</td>
<td>1</td>
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Twin Gestations

- Dichorionic Diamniotic
- Monochorionic Diamniotic
- Monochorionic Monoamniotic
- Conjoined twins

Easiest to determine type of pregnancy in first trimester
Dichorionic Diamniotic

- 1st trimester
  - Thick echogenic chorion completely surrounds each sac
  - Two yolk sacs
  - Indicates diamniotic gestation
Dichorionic Diamniotic

- 2nd trimester
  - “Twin peak” or lambda sign
    - Wedge of chorionic tissue extending into the base of the inter-twin membrane
Monochorionic Diamniotic

- 1\textsuperscript{st} trimester
  - Two yolks sacs
  - Single chorionic sac
- 2\textsuperscript{nd} trimester
  - Same gender
  - Thin inter-twin membrane
Monochorionic Monoamniotic

- **Diagnosis**
  - 1\textsuperscript{st} trimester
    - Single yolk sac
  - 2\textsuperscript{nd} trimester
    - No inter-twin membrane
    - Same gender
Monochorionic Monoamniotic

- Umbilical cord entanglement
  - As early as 10 wks
- High perinatal mortality 28-68%
Monochorionic Gestations

- Vascular connection between fetuses
- Increased risk of fetal morbidity and mortality
  - Prematurity
  - Congenital malformations
    - Conjoined twins
  - Intrauterine growth retardation
  - Twin to twin transfusion syndrome
  - Twin reversed arterial perfusion (TRAP) sequence
  - Twin embolization syndrome
Outline

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- Maternal Anatomy and Pathology
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  - Abnormal screening ultrasound findings
  - Markers of Aneuploidy
  - Chromosomal Anomalies
Diffuse Abnormalities

- Intrauterine Growth Restriction (IUGR)
- Hydrops Fetalis
Intrauterine Growth Restriction

- All fetal biometric parameters < 10\textsuperscript{th} percentile
- Causes
  - Normal
    - Wrong dates and/or constitutional
  - Maternal conditions
  - Placental insufficiency
    - Most common
  - Fetal conditions
    - Multiple fetuses
    - Infection
    - Aneuplody
    - Structural anomalies
Hydrops Fetalis

- Fluid in 2 or more compartments
  - Ascites
  - Pleural effusion
  - Anasarca
  - Placentomegaly

Scalp edema

Ascites
Outline

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  - Chromosomal Anomalies
Focal Abnormalities

- Intracranial
- Pulmonary
- Abdominal
- Lumbosacral
- Skeletal
Intracranial Findings

- Ventriculomegaly
  - Aqueductal stenosis
  - Hydranencephaly
  - Holoporsencephaly
- Anencephaly
- Intracranial cysts
- Posterior fossa
Anencephaly

- Most severe form of cranial nerve tube defect
- Lack of brain
- Nothing superior to orbits
- Frog’s eye appearance
Intracranial Cysts

- Choroid plexus cyst
- Arachnoid cyst
- Porencephalic cyst
- Cystic Teratoma
- Galenic malformation
Choroid Plexus Cyst

- Usually resolves by 32 weeks
- 1% of 2nd trimester exams
  - Not a marker if isolated
- When any other anomaly seen:
  - 20x risk of aneuploidy
- 50% of trisomy 18
  - Other anomalies detectable
Choroid Plexus Cyst

- Usually resolves by 32 weeks
- 1% of 2nd trimester exams
  - Not a marker if isolated
- 50% of trisomy 18
  - Other anomalies detectable
- When any other anomaly seen
  - 20x risk of aneuploidy
Posterior Fossa

- Chiari malformation
  - Small posterior fossa
- Dandy Walker spectrum
  - Large posterior fossa
    - Posterior fossa cyst
Chiari II

- Brain/skull
  - Banana cerebellum
  - Absent cisterna magna
  - Lemon head
  - Ventriculomegaly
Chiari II

- Spine
  - Dysraphism
  - Myelomeningocele
Dandy Walker Malformation

- Posterior Fossa Cyst
Fetal Lung Mass

- May be isoechoic to lung
  - Look for displacement or deviation of the axis of the heart
Fetal Lung Mass

- Differential diagnosis
  - Congenital pulmonary airway malformation
  - Congenital lobar overinflation
  - Sequestration
  - Congenital diaphragmatic hernia
  - Duplication cyst
  - Fetal lung interstitial tumor
Abdomen

- Abdominal wall defects
- Bowel
- Hepatobiliary
- Adrenal
- Kidney
- Bladder
- Genitalia
Abdominal Wall Defects

Omphalocele

- Covering membrane
  - Peritoneum
  - Wharton’s jelly
  - Amnion
- Umbilical cord inserts into hernia sac
Abdominal Wall Defects

Gastroschisis

- No covering membrane
  - Free floating bowel
  - Thickened wall
- Umbilical cord inserts into abdomen
  - Paraumbilical defect – to right of cord
- Low association with other abnormalities
<table>
<thead>
<tr>
<th>Omphalocele</th>
<th>Gastroschisis</th>
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</thead>
<tbody>
<tr>
<td>▪ Covering membrane</td>
<td>▪ No covering membrane</td>
</tr>
<tr>
<td>▪ Umbilical cord inserts into hernia sac</td>
<td>▪ Free floating bowel</td>
</tr>
<tr>
<td>▪ 70% associated with other anomalies</td>
<td>▪ Umbilical cord inserts into abdomen</td>
</tr>
<tr>
<td>▪ May contain liver</td>
<td>▪ Low association with other abnormalities but may have malrotation/short gut</td>
</tr>
<tr>
<td></td>
<td>▪ Does not include liver</td>
</tr>
</tbody>
</table>
Kidney

- Hydronephrosis
- Ureteropelvic Junction Obstruction
- Renal Agenesis
- Multicystic Dysplastic Kidney
- Autosomal Recessive Polycystic Kidney Disease (ARPKD)
- Mesoblastic Nephroma
Hydronephrosis

- Gestational Age Dependent
  - Less than 22 weeks
    - Over 4mm
  - 33 weeks – term
    - Over 7mm
Lumbosacral Masses

- Myelomeningocele
- Sacrococcygeal teratoma
- Lipoma
- Hemangioma
- Lymphatic malformation
Sacrococcygeal Teratoma

- Mature cystic teratoma
  - Derived from all 3 germ cell layers
- Extends from sacrum
- No spinal dysraphism
- Prognosis depends on:
  - Amount of solid component
  - Degree of arteriovenous shunting
Sacrococcygeal Teratoma

- Imaging Findings
  - Solid and cystic
    - Often echogenic on ultrasound
  - Can contain calcifications
  - May have hydrops fetalis
  - Vascularity
    - Solid tumors with increased AV shunting
Skeletal

- Deformities
  - Clubfoot
  - Radial club hand
- Short proximal long bones
  - Skeletal dysplasia
  - Aneuploidy
- Polydactyly
  - Skeletal dysplasia
  - Syndromes
Clubfoot

- Sagittal lower leg and AP foot in same image
- 60% bilateral
  - 75% with other anomalies
- 40% unilateral
  - 60% with other anomalies
Clubfoot

- Associations
  - Spina bifida
  - Neuromuscular disorder
  - Restricted in utero environment
    - Oligohydramnios
  - Chromosomal anomalies
Outline

- Imaging Standards and Techniques
  - Ultrasound
  - MRI
- Maternal Anatomy and Pathology
- Fetal Anatomy
  - Abnormal screening US findings
  - **Markers of Aneuploidy**
  - Chromosomal Anomalies
2nd Trimester Soft Markers

- Not abnormalities
- Indicate an increased risk of abnormality

- Nuchal fold
- Ventriculomegaly
- Short proximal long bones
- Echogenic intracardiac focus
- Hypoplastic nasal bone
- Echogenic bowel
- Choroid plexus cyst
- Two-vessel cord
- Aberrant right subclavian artery
- Enlarged cisterna magna
- Fetal pyelectasis
# Nuchal Fold

<table>
<thead>
<tr>
<th>Age Performed</th>
<th>Nuchal Fold Translucency</th>
<th>Nuchal Fold Thickness</th>
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</thead>
<tbody>
<tr>
<td>11-14 weeks</td>
<td></td>
<td>18-22 weeks</td>
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</table>

<table>
<thead>
<tr>
<th>Where measured</th>
<th>Nuchal Fold Translucency</th>
<th>Nuchal Fold Thickness</th>
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</thead>
<tbody>
<tr>
<td>Mid-sagittal plane</td>
<td></td>
<td>Axial section at level of posterior fossa</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What measured</th>
<th>Nuchal Fold Translucency</th>
<th>Nuchal Fold Thickness</th>
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</thead>
<tbody>
<tr>
<td>Only the lucency</td>
<td></td>
<td>Outer edge of skull to skin/amniotic fluid interface</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal value</th>
<th>Nuchal Fold Translucency</th>
<th>Nuchal Fold Thickness</th>
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<tbody>
<tr>
<td>2.5-3.0 mm</td>
<td></td>
<td>Less than 6mm</td>
</tr>
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<table>
<thead>
<tr>
<th>% with aneuploidy</th>
<th>Nuchal Fold Translucency</th>
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<tbody>
<tr>
<td>80-90%</td>
<td></td>
<td>Varies with gestational age and thickness 50-80%</td>
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</table>
Nuchal Fold

Nuchal Fold Translucency

Nuchal Fold Thickness
Echogenic Intracardiac focus

- Mineralized papillary muscle
- Echogenic as bone
- In a normal pregnancy
  - If isolated, benign variant
- In a high risk pregnancy
  - Increased risk of Trisomy 21 and Trisomy 13
Echogenic Bowel

- Echogenic as bone
- Often focal
- Adverse outcome:
  - 6% isolated
  - 50% with other anomalies
- Associated abnormalities
  - Trisomy 21
  - In utero infection
  - Bowel obstruction
  - IUGR
Two-Vessel Cord

- Single umbilical artery
- Secondary to atresia or atrophy of one of the umbilical arteries
- 30-40% increased risk of anomalies
Trisomy 21

- Also Down’s Syndrome
- 20 fold increase for acute leukemia
- Average lifespan 20 years
- Mental impairment 100%
- Hearing loss 90%
- Major anomalies
  - Cardiac 25%
  - Gastrointestinal 8%
  - Central Nervous System 4%

“Double bubble” sign of duodenal atresia
Trisomy 21

- **1st Trimester Markers**
  - Increased nuchal fold translucency
  - Absent nasal bone

- **2nd Trimester Markers**
  - 1 or more markers seen in 50-70% of T21 fetuses
    - Nuchal fold thickening
    - Short proximal long bones
    - Echogenic bowel
    - Echogenic intracardiac focus
    - Renal pelviectasis
    - Absent or hypoplastic nasal bone
    - Fifth finger clinodactyly
      - “Curved” finger
    - Sandal gap foot
Trisomy 13

- Also Patau Syndrome
- 75% live born die within 6 months
- Major anomalies
  - Central nervous system 70%
  - Facial 50%
  - Musculoskeletal 50%
  - Cardiac 80%
  - Renal 50%
Trisomy 13

1\textsuperscript{st} Trimester markers
- Increased nuchal fold translucency

2\textsuperscript{nd} Trimester markers
- Echogenic intracardiac focus
- Single umbilical artery
- Increased nuchal fold thickness
- Echogenic bowel
Trisomy 18

- Also Edward Syndrome
- 2/3 of fetuses alive at 16 weeks die before term
- 90% of live born die in first year of life
- Major anomalies
  - Intrauterine growth restriction 50%
  - Cardiac 90%
  - Musculoskeletal 75%
  - Central nervous system 42%
  - Urinary 35%

Rocker bottom feet

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Trisomy 18

- 1\textsuperscript{st} trimester markers
  - Increased nuchal fold translucency
- 2\textsuperscript{nd} trimester markers
  - Choroid plexus cysts
  - Strawberry shaped calvarium
  - Mega cisterna magna
  - Single umbilical artery
  - Umbilical cord cyst
XO

- Also Turner’s syndrome, Ullrich-Turner syndrome, Monosomy X
- 100% female
- 1% live born
- Major anomalies
  - Nuchal lymphatic malformation
  - Hydrops fetalis
  - Cardiovascular 60%
    - Coarctation of the aorta

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**1st trimester markers**
- Increased nuchal fold translucency
- Hydrops fetalis
- Tachycardia

**2nd trimester markers**
- Hydrops fetalis
- Nuchal lymphatic malformation
Lymphatic Malformation

- Also called cystic hygroma
- Develop secondary to congenital blockage of the lymphatic drainage
- Associated with:
  - Turner Syndrome (XO)
  - Trisomy 13
  - Trisomy 18
  - Trisomy 21
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Maternal Anatomy

- Cervix
  - Incompetence
    - Use transvaginal probe
- Placenta
  - Placenta previa
    - Often resolves with pregnancy
    - Measure with empty bladder
- Amniotic fluid volume
  - Polyhydramnios
  - Olgiohydramnios
- Twin gestations
  - Easiest to determine type of pregnancy in 1st trimester
## Twin Gestations

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  - All fetal biometric parameters < 10\textsuperscript{th} percentile
- Hydrops Fetalis
  - Fluid in 2 or more compartments
Focal Abnormalities

- Intracranial
  - Choroid plexus cyst
- Pulmonary
  - Deviation of axis of heart
- Abdominal
  - Omphalocele
  - Gastroschisis
- Lumbosacral
  - Sacrococcygeal teratoma
- Skeletal
  - Clubfoot
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THANK YOU!