National Education Curriculum
Specialty Curricula

OB-GYN
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Section I: First Trimester

Rationale: Accurate assessment and performance of obstetrical sonograms require sonographers to assemble a comprehensive knowledge of the development and sonographic appearance of the fetal and extra-fetal anatomy throughout the gestational period. An understanding of the fertilization process, clinical indications for obstetrical sonograms, and sonographic characteristics of normal and abnormal gravid uterine anatomy specific to each trimester is essential for the performance of high quality examinations.

1. Define terminology related to obstetrics
2. Explain fertilization process
3. Distinguish between layers of decidualized endometrium
4. Identify normal anatomic features of developing embryo
5. Describe first trimester measurement techniques for determination of gestational age
6. Discuss normal findings of adnexa in first trimester
7. Correlate clinical presentation with sonographic findings
8. Differentiate the normal and abnormal appearances of a first trimester pregnancy
9. Discuss first trimester complications
10. Describe sonographic findings associated with ectopic pregnancy
11. Describe the types and sonographic appearances of abortion
12. List the clinical and sonographic findings associated with gestational trophoblastic neoplasia

I. Clinical Assessment of Obstetrical Patient

A. Terminology
   1. Gravidity
   2. Parity
   3. Abortion
   4. Fundal height
   5. Gestational age (GA)
   6. Menstrual age (MA)
   7. Embryologic age

B. Laboratory Tests for Pregnancy Determination
   1. Qualitative
   2. Quantitative
   3. Rising pattern
   4. Quantitative references
   5. Second International Reference (2nd S)
   6. International Reference Preparation (IRP)

C. Gestational Age Calculation
   1. Obstetric wheel
   2. Naegle’s rule
D. Indications for Sonographic Evaluation
   1. Numerous indications
   2. Often trimester specific
   3. Controversy surrounding scanning without clinical indication
   4. Pros and cons of routine scanning
   5. Point of care

II. Normal First Trimester
A. Fertilization
   1. Zygote - fertilized egg
   2. Cleavage
   3. Morula
   4. Blastocyst
   5. Development of germ layers
B. Decidualization
   1. Three layers
      a. Decidua capsularis
      b. Decidua parietalis
      c. Decidua basalis
   2. Chorionic villi
      a. Chorion frondosum
C. Gestational Sac
   1. Implantation location
   2. Sonographic appearance
      a. Echogenic ring surrounding fluid-filled space
      b. Double decidual sac sign
      c. Correlation with β-hCG values
      d. Mean sac diameter (MSD)
         i) An average measurement of three dimensions of gestational sac
D. Embryonic/Fetal Membranes
   1. Chorion
   2. Amnion
   3. Vitelline stalk
   4. Allantois
E. Yolk Sac
   1. Primary or primitive yolk sac
   2. Secondary yolk sac
      a. First structure to be visualized within gestational sac
      b. Location
3. Functions
   a. Hemopoiesis
   b. Development of sex glands
   c. Formation of digestive tract
   d. Transfer of nutrients
4. Sonographic technique
   a. Endovaginal
      i) Optimal for earliest visualization
   b. Transabdominal
   c. Measurements

F. Embryonic Period
   1. Organogenesis
   2. Embryonic trilaminar disc
   3. Limb buds
   4. Spine
   5. Head and trunk differentiation
   6. Cranial structures
      a. Rhombencephalon - primitive hindbrain seen as anechoic cystic structure in posterior aspect of head
      b. Cerebral hemispheres - differentiated at week 9
   7. Physiologic umbilical herniation
   8. Sonographic appearance
      a. Mean sac size consideration
      b. Cardiac motion
      c. Crown rump length (CRL)
      d. Nuchal translucency

III. Uterine Assessment
   A. Congenital Development Anomalies
   B. Leiomyoma(s)

IV. Extrauterine Assessment
   A. Ovaries
      1. Corpus luteum cyst
         a. Most common ovarian mass seen in first trimester
         b. Function
         c. Resolution
   B. Posterior cul-de-sac
      1. Evaluation for fluid

V. First Trimester Complications
A. Subchorionic Hemorrhage
   1. Spontaneous bleed/hematoma between chorion and endometrium
   2. Consequences and pregnancy outcome

B. Ectopic Pregnancy
   1. Definition
   2. Risk factors
      a. Endometriosis
      b. Pelvic inflammatory disease (PID)
      c. Congenital abnormalities of fallopian tubes or uterus
      d. Tubal scarring
      e. Use of intrauterine contraceptive device (IUD)
      f. Artificial reproductive techniques
      g. Previous history of ectopic pregnancy
      h. Previous history of C-section
   3. Clinical Presentation
      a. Positive β-hCG
      b. Clinical triad
         i) Vaginal bleeding
         ii) Adnexal mass
         iii) Pelvic pain
      c. Symptoms outside clinical triad
      d. Adnexal tenderness
         i) Cervical tenderness
         ii) Shock
            • Hypotension
            • Hemoperitoneum
            • Life-threatening
   4. Potential sites for ectopic pregnancy
      a. Fallopian tube
      b. Ovarian
      c. Interstitial/corneal
      d. Cervical
      e. Abdominal
   5. Sonographic Assessment
      a. Endometrium
         i) Absence of gestational sac
         ii) Thickened prominent endometrium
            • Decidual reaction
6. Treatment
   a. Surgical
   b. Pharmacologic

C. Heterotopic Pregnancy
   1. Definition
      a. Simultaneous intrauterine pregnancy and ectopic pregnancy
   2. Risk with assisted reproductive technology

D. Anembryonic Gestation
   1. Definition
      a. Presence of gestational sac without presence of embryo
      b. Formerly termed blighted ovum
   2. Clinical associations
      a. β-hCG values
      b. Brownish vaginal discharge
      c. Lack of emesis
      d. Small uterine size
   3. Gestational sac considerations
      a. Shape of sac
      b. Size of sac
      c. Yolk sac

E. Spontaneous Abortion
   1. Threatened abortion
      a. Definition
         i) Clinical symptoms with normal sonographic findings
      b. Clinical presentation
         i) Cramping
         ii) Vaginal spotting
      c. Sonographic appearance
   2. Inevitable abortion
      a. Definition
         i) Ruptured fetal membranes or open cervical os
b. Clinical presentation  
   i) Vaginal bleeding  
   ii) Cramping  
   iii) β-hCG correlation  
c. Sonographic appearance  
   i) Position of sac in lower uterine segment  

3. Incomplete abortion  
   a. Definition  
   i) Partial retained products of conception without viable fetus  
   b. Clinical presentation  
   i) Vaginal bleeding  
   ii) Cramping  
   iii) β-hCG correlation  
c. Sonographic appearance  

4. Missed abortion  
   a. Definition  
   i) Fetal demise  
   b. Clinical presentation  
   i) Variable  
c. Sonographic appearance  

5. Complete abortion  
   a. Definition  
   i) Expulsion of all products of conception  
   b. Clinical presentation  
   i) Vaginal bleeding  
   ii) Cramping  
   iii) β-hCG correlation  
c. Sonographic appearance  

6. Recurrent spontaneous abortion  
   a. Previously referred to as habitual abortion  
   b. Definition  
   i) Two consecutive or three total spontaneous abortions  

F. Embryonic Oligohydramnios  
   1. Definition  
      a. Gestational sac is small in comparison to crown-rump length  
   2. Sonographic appearance  

G. Gestational Trophoblastic Neoplasia (GTN)  
   1. Classifications
a. Hydatidiform mole
   i) Most common form
   ii) Types
       • Complete
       • Partial
b. Choriocarcinoma
   i) Malignant invasive form

2. Clinical assessment
   a. Excessively elevated $\beta$-hCG
   b. Hyperemesis
   c. Large uterine size

3. Sonographic appearance
   a. Complete mole
      i) Enlarged uterus with vesicular appearance
   b. Partial mole
      i) Large placenta
      ii) Gestational sac with or without fetus
   c. Choriocarcinoma
      i) Uterine enlargement
      ii) Focal, echogenic myometrial nodules
   d. Ovarian association
      i) Theca lutein cysts

4. Treatment and follow-up
   a. Uterine evacuation
   b. Serial $\beta$-hCG
   c. Computed tomography (CT)
   d. Magnetic resonance
Section II: Fetal Assessment in the Normal Second and Third Trimesters

1. Describe the scan planes utilized in fetal sonography
2. Illustrate the various fetal positions
3. Identify normal fetal anatomy
4. Describe anatomical relationship to surrounding structures
5. Describe sonographic appearance of fetal anatomical structures
6. Indicate measurement techniques utilized in fetal gestational age and growth assessment

II. Fetal Assessment in the Normal Second and Third Trimesters

A. Scan Planes
   1. Maternal scan planes
   2. Sagittal
   3. Transverse (axial)
   4. Coronal
   5. Fetal planes
   6. Sagittal or longitudinal axis
   7. Transverse or axial axis
   8. Coronal axis

B. Fetal Positions
   1. Vertex
   2. Breech
   3. Complete
   4. Incomplete breech
   5. Frank breech
   6. Transverse
   7. Oblique

C. Assessment of Fetal Anatomy
   1. Cranial
      a. Identification, sonographic appearance and anatomical relationship
         i) Choroid plexus
         ii) Lateral ventricles
         iii) Cavum septum pellucidum and vergae
         iv) Corpus callosum
         v) Interhemispheric fissure or falx
         vi) Thalami
vii) Third ventricle
viii) Cerebral peduncles
ix) Circle of Willis
x) Posterior fossa
  • Cerebellum
  • Fourth ventricle
  • Cisterna magna

b. Calvarium
i) Frontal bone
ii) Parietal bone
iii) Occipital bone
c. Head shape variations
i) Dolichocephaly
ii) Brachycephaly
iii) Oxencephaly
d. Measurements of fetal head
i) Biparietal diameter (BPD)
  • Fetal axial or thalamic plane
  • Level of midline echo complex
  • Reliability with increasing gestational age
ii) Cephalic index (CI)
  • Evaluates head shape for reliability of BPD
  • Calculation formula
  • Normal values
  • Cephalic indices
    o Dolichocephaly
    o Brachycephaly
iii) Head circumference (HC)
  • Measurement obtained at same level as BPD
  • Reliability for age determination
iv) Lateral ventricle
  • Measurement obtained in fetal axial plane
  • Measurement criteria
v) Cerebellum
  • Shape
  • Measurement obtained in fetal axial oblique plane
  • Correlation to gestational age
vi) Cisterna magna
   • Measurement criteria

vii) Nuchal Fold
   • 18-22 weeks
   • Measurement criteria

2. Facial anatomy
   a. Identification, sonographic appearance and anatomical relationship
      i) Sagittal or profile view
         • Frontal bone shape
         • Nose/nasal bone
         • Chin
      ii) Coronal view
         • Upper lip
         • Orbits
         • Lens
         • Nostrils
         • Palate

b. Measurements
   i) Outer to outer orbital diameter (OOD)
   ii) Inner orbital diameter (IOD)
   iii) Correlation to gestational age
   iv) Qualitative assessment

3. Spine
   a. Vertebral development
      i) Three ossification centers
         • Centrum
         • Right and left neural processes (Lateral ossification center)
   b. Sonographic assessment
      i) Sagittal plane
         • Vertebral body
         • Lateral ossification center
         • Caudal end tapering (Conus medularis)
         • Skin integrity
         • Curvature of spine
      ii) Coronal plane
         • Lateral ossification centers
      iii) Transverse
• Most important view for evaluation of spinal defects
• Angulation of posterior centers

4. Thorax
   a. Identification, sonographic appearance, and anatomical relationship
      i) Lung
      ii) Diaphragm
      iii) Larynx
      iv) Thymus
      v) Fetal position and situs
      vi) Heart
         • Cardiac axis
         • Heart/thorax ratio
         • M-Mode to determine fetal heart rate
            o Optimal for practice of as low as reasonably achievable (ALARA)
            o Cardiac rhythm
         • Identification of normal four heart chambers
            o Left atrium lies closest to fetal spine
            o Right ventricular apex may appear thicker due to moderator band
            o Four chambers should be nearly equal in size
         • Anatomy demonstrated with 4-chamber view
            o Atria
            o Foramen ovale/septum primum
            o Ventricles
            o Atrioventricular valves
            o Papillary muscles
            o Intercardiac septae
         • Great vessels arising off ventricle
            o Aorta
            o Pulmonary artery
         • Anatomy demonstrated in a fetal sagittal view
            o Aortic arch and great vessel branching
               ~ Sonographic appearance resembles a candy cane shape
            o Ductal arch
               ~ Communication between main pulmonary artery and descending aorta
               ~ Sonographic appearance resembles a hockey stick shape
         • Additional anatomy to be evaluated
            o Subcostal view can demonstrate continuity of interventricular septum to aortic
root
o Entrance of inferior vena cava and superior vena cava into right atrium
o Entrance of pulmonary veins into left atrium

5. Abdomen/pelvis
   a. Identification, sonographic appearance, and anatomical relationship
      i) Abdominal wall
         • Umbilical cord insertion
         • Anterior muscles
            o Pseudoascites
      ii) Gastrointestinal
         • Liver
         • Stomach
         • Intestines
            o Small intestine
            o Colon
            o Meconium
         • Gallbladder
      iii) Genitourinary system
         • Kidneys
            o Location
            o Sonographic assessment
               ~ Number of kidneys
               ~ Size
               ~ Echogenicity pattern
               ~ Renal pelvis
               ~ Color Doppler to verify two kidneys if necessary
            o Renal function association to amniotic fluid
         • Bladder
            o Sonographic assessment
               ~ Fill/empty cycle
         • Ureters
         • Adrenals
            o Sonographic appearance
      iv) Genitalia
         • Documentation of fetal gender
            o Genitourinary anomalies
            o Multiple gestation
v) Measurements of abdomen
  • Abdominal circumference
    o Transverse axis at level of umbilical vein and portal sinus junction
    o Correlation to gestational age and fetal weight
  • Renal length
    o Indications for measurement inclusion
    o Length measure in fetal sagittal plane
    o Circumference
    o Renal pelvis

6. Skeleton
   a. Osteogenesis
   b. Appendicular skeleton
      i) Sonographic identification of bones
         • Femur
         • Humerus
         • Radius/Ulna
         • Tibia/Fibula
         • Hands
         • Feet
         • Digits
   c. Pelvis
      i) Iliac wings
   d. Measurements
      i) Femur
         • Humerus
         • Correlation to gestational age
         • Femur/foot ration in circumstances of a short femur
      ii) Long bone measurements
         • Indications for long bones assessment

7. Estimation of fetal weight
   a. Formulas used
   b. Generated through biometry
   c. Standard errors
   d. Gestational age dependent
   e. Variances
III. Extra-Fetal Assessment of the Second and Third Trimesters

A. Cervix

1. Role of sonography in assessment of cervix
   a. Related to risk for premature birth and morbidity
   b. Evaluation for determination of cervical length, funneling, or beaking

2. Indications for cervical evaluation
   a. History of premature birth
   b. History of premature labor
   c. Multiple gestation
   d. Premature rupture of membranes
   e. Uterine anomaly
   f. Low lying placenta
   g. Other

3. Sonographic technique
   a. Patient position
   b. Application of fundal pressure
   c. Transabdominal
      i) Length may vary with bladder filling decreasing reliability
   d. Translabial
      i) May be referred to as transperineal
      ii) Used when endovaginal approach is contraindicated
      iii) Empty bladder
      iv) Cervix is oriented horizontally on the image
   e. Endovaginal
      i) Considered gold-standard approach
      ii) Higher frequency transducer
iii) Too much pressure on cervix shortens length

f. Measurement from external os to internal os
   i) Linear technique
   ii) Trace technique

4. Incompetent cervix
   a. Clinical diagnosis
   b. Treatment options
      i) Bedrest
      ii) Cerclage
      iii) Progesterone therapy

B. Placenta

1. Development of placenta
   a. Decidual changes
      i) Decidua basalis
         • Develops to become maternal surface of placenta
   b. Decidua capsularis
      i) Lies closest to endometrium
   c. Decidua vera
      i) Also known as decidua parietalis
      ii) Endometrial changes in side opposite site of implantation

2. Functional unit
   a. Chorionic villi
   b. Chorion frondosum
      i) Referred to as chorionic plate

3. Circulation
   a. Role of uterine spiral arteries
   b. Intervillous spaces
   c. Maternal blood returns via network of veins
      i) Basilar veins
      ii) Subchorionic veins
      iii) Interlobar veins
      iv) Marginal veins

4. Physiology
   a. Respiration
   b. Nutrition
   c. Excretion
   d. Protection
   e. Storage
f. Hormone production
   i) Human chorionic gonadotropin
   ii) Estrogen
   iii) Progesterone

5. Positions
   a. Anterior
   b. Posterior
   c. Lateral - left or right
   d. Fundal
   e. Combination
   f. Relationship to internal os

6. Maturity and grading criteria
   a. Grading scale of 0-3
   b. Maturity
      i) Causes for premature maturation
         • Maternal hypertension
         • Maternal cigarette smoking
         • Intrauterine growth restriction
         • Multiple gestation
      ii) Causes for delayed maturation
         • Maternal diabetes
   c. Placental lakes

7. Size considerations
   a. Weight
   b. Overall size hard to measure
   c. Anteroposterior dimension
   d. Associations with large placenta
      i) Maternal diabetes
      ii) Isoimmunization
      iii) Feto-maternal hemorrhage
      iv) Intrauterine infection
      v) Non-immune hydrops
      vi) Chromosomal anomaly
      vii) Uterine anomaly
      viii) Twin-to-twin transfusion syndrome
      ix) Congenital neoplasm
      x) Other
   e. Associations with small placenta
8. Placenta abnormalities
   a. Placenta previa
      i) Placenta completely or partially covering internal os
      ii) Risk factors
          • Multigravida and multiparous women
          • Prior cesarean section
          • History of therapeutic abortion
          • Advanced maternal age
          • Closely-spaced pregnancies
          • Abnormal fetal position
          • Maternal anemia
          • History of uterine leiomyomata
          • History of uterine infections
      iii) Classifications of previa
          • Complete
          • Partial
          • Marginal
          • Low-lying
      iv) Clinical symptoms
          • Painless vaginal bleeding
          • Presents in second and third trimesters
   v) Sonographic considerations
      • Transabdominal approach
        o Over distention of bladder may cause false-positive appearance
        o Partial void technique assists in determining most accurate assessment
        o Limited visualization in third trimester with cephalic presentations and a posterior placenta
          ~ Reverse Trendelenburg position may assist visualization of internal os
      • Endovaginal
        o Most accurate approach
      • Relationship of placental edge to internal os
        o Measurement of distance of edge of placenta to center of internal os
   b. Abnormal placental attachment
      i) Abnormal adherence of all or part of placenta to myometrium
ii) Classifications

- Accreta
- Increta
- Percreta

iii) Risk factors

- Placenta previa
- Previous cesarean section
- Advanced maternal age
- Prior uterine surgery

iv) Sonographic evaluation

- Most common insertion site is lower uterine segment in patients with placenta previa
- Absent or thin hypoechoic interface between placenta and myometrium
- Color Doppler can identify increased vascularity at abnormal insertion site
- Translabial approach may be useful for evaluation of lower uterine segment in third trimester
- MRI frequently used as an imaging adjunct

v) Maternal consequences

- Placenta may not expel causing excessive hemorrhage
- High maternal mortality rate with increta and percreta without pre-natal diagnosis

9. Developmental variants and abnormalities

a. Succenturiate placenta

i) Presence of one or more accessory lobes connected to placenta by blood vessels

ii) Sonographic considerations

- Connection with placenta by vascular band
- Color Doppler

iii) Associated with vasa previa

b. Circumvallate/circummarginate placenta

i) Abnormal attachment of placental membranes to fetal placental surface

ii) Sonographic considerations

- Elevated and thickened placental margin

iii) Clinical risks

- Premature rupture of membranes
- Premature labor
- Placental abruption
- Intrauterine growth restriction
- Fetal anomalies
- Retained placenta
c. Abnormal chordal attachments
   i) Battledore placenta
      - Umbilical cord attaches to placental margin
      - Clinical consequences
   ii) Velamentous placenta
      - Umbilical cord inserts at margin of placenta beneath membranes
      - Area of cord closest to placenta is not covered by Wharton’s jelly
      - Association with fetal intrauterine growth restriction (IUGR)
      - Risk of vasa previa

d. Masses and lesions
   i) Chorioangioma
      - Most common benign tumor of placenta
      - Sonographic presentation
         o Located just beneath chorionic plate
         o Small in size
         o Well-circumscribed solid mass
         o Variable echogenicity
      - Fetal consequences
         o IUGR
         o Polyhydramnios
         o Cardiomegaly
         o Hydrops
         o Demise
   ii) Less common masses
      - Hemangioma
      - Teratoma
      - Thrombosis
      - Hematoma

10. Placental abruption
    a. Premature separation of placenta from endometrial surface
       i) Clinical symptoms
          - Vaginal bleeding
          - Pain
          - Tense uterine wall
          - Shock
          - Preterm labor
    b. Risk factors
i) Previous history of abruption
ii) Trauma
iii) History of placenta previa
iv) Maternal hypertension
v) Uterine leiomyoma
vi) Short umbilical cord
vii) Methamphetamine use
viii) Uterine anomalies

c. Types
   i) Retroplacental
      • Results from rupture of spiral arteries
      • High-pressure bleed
      • Sonographic presentation
         o Thickened placenta
         o Retroplacental clot may be visualized
   ii) Marginal
      • Rupture of marginal vein
      • Low-pressure bleed
      • Sonographic presentation
         o Anechoic or hypoechoic subchorionic area
   iii) Fetal consequences
      • Premature labor or delivery
      • Fetal demise
   iv) OB emergency

11. Fetal membrane abnormalities
   a. Amniotic band syndrome
      i) Malformations caused by fibrous strands entangling or trapping fetal parts
      ii) Fetal anomalies associations
         • Craniofacial defects
         • Limb defects
         • Visceral defects
   b. Amniotic sheets
      i) Associated with intrauterine synechiae
      ii) Clinical significance is unclear

C. Umbilical Cord
   1. Embryology
   2. Wharton’s jelly
   3. Anatomy
a. One umbilical vein
   i) Function
b. Two umbilical arteries
   i) Derived from fetal internal iliac arteries
   ii) Function
c. Sonographic assessment
   i) Transverse section of umbilical cord
   ii) Arteries adjacent to fetal bladder
   iii) Cord insertion into fetal abdomen
   iv) Cord insertion into placenta
   v) Coiling

4. Abnormalities
a. Single umbilical artery
   i) Sonographic presentation
      • Transverse view demonstrates two vessels
      • One umbilical artery lateral to fetal bladder
   ii) Associations
      • Congenital anomalies
      • Chromosomal anomalies
      • Intrauterine growth restriction
      • Premature delivery
      • Perinatal death

b. Short umbilical cord
   i) Cord length less than 35 centimeters (cm)
   ii) Associated with:
      • Oligohydramnios
      • Restricted amniotic space
      • Intrinsic fetal anomaly
      • Cord compression
      • Fetal compression

c. Long umbilical cord
   i) Cord length greater than 80 cm
   ii) Associations
      • Polyhydramnios
      • Nuchal cord
      • True cord knots
      • Fetal distress
      • Cord stricture of torsion due to excessive fetal motion
d. Cord masses
i) Omphalomesenteric cyst
ii) Allantoic cyst
iii) Hemangioma
iv) Thrombosis
v) Herniation
e. Cord knots
   i) True
   ii) False
f. Nuchal cord
g. Vasa previa
   i) Presence of umbilical cord vessels across internal os
   ii) Risk factors
      - Abnormal fetal position
      - Long umbilical cord
      - Polyhydramnios
      - Velamentous insertion of cord
      - Marginal insertion of cord into low-lying placenta
      - Succenturiate lobe
   iii) Sonographic presentation
      - Presence of vessels in lower uterine segment
      - Color Doppler
   iv) Fetal consequences
      - Fetal exsanguination with vaginal delivery
      - Premature rupture of membranes
5. Umbilical artery Doppler
   a. Indications
      i) Intrauterine growth restriction
      ii) Abnormal biophysical profile
      iii) Abnormal amniotic fluid index
      iv) Multiple gestation
   b. Sonographic technique
      i) Color Doppler useful adjunct
      ii) Pulsed wave Doppler/sample gate placement
      iii) Waveform analysis
         - Diastolic component
            o Low resistant
            o Abnormal characteristics
               ~ Decreased
               ~ Absent
               ~ Reversed
c. Calculations
   i) Systolic /diastolic ratio
   ii) Pulsatility index
   iii) Resistive index

D. Amniotic Fluid
1. Structures responsible for production
   a. Amniotic membrane
   b. Umbilical cord
   c. Lungs
   d. Skin
   e. Kidneys

2. Functions
   a. Cushion to protect fetus
   b. Allows for activity and movement
   c. Prevents adherence of amnion to embryo
   d. Promotes lung growth
   e. Regulates temperature
   f. Reservoir for fetal metabolites

3. Fluid regulation
   a. First trimester
      i) Membranes
      ii) Lungs
      iii) Skin
      iv) Non-keratinization
   b. Second and third trimesters
      i) Urine
      ii) Fetal swallowing

4. Fluid volume
   a. Correlation to gestational age
   b. Qualitative assessment
      i) Subjective evaluation by sonographer
         - Excessive fluid
         - Decreased fluid
   c. Quantitative methods
      i) Amniotic fluid index (AFI)
         - Sonographic technique
           o Parallel to maternal sagittal plane
           o Vertical fluid pocket
Four quadrants

- Calculation
- Criteria for oligohydramnios and polyhydramnios
- Reproducibility
- Gestational age related

ii) Single pocket assessment

- Maximum vertical pocket (MVP)
- Sonographic technique
  - Parallel to maternal sagittal plane
- Criteria for oligohydramnios and polyhydramnios

5. Abnormal fluid volume

a. Polyhydramnios

i) Defined as an amniotic fluid volume greater than 2000 ml

ii) Associated anomalies

- Gastrointestinal
- Central nervous system
- Cardiovascular system
- Twin-to-twin transfusion
- Skeletal system
- Respiratory system
- Maternal diabetes
- Chromosomal abnormalities
- Other

b. Oligohydramnios

i) Reduction in amount of amniotic fluid

ii) Associated conditions

- Abnormalities
- Genitourinary
  - Most common
- Chromosomal anomalies
- Intrauterine growth restriction (IUGR)
- Ruptured membranes
- Post-term pregnancy
- Hypertension

iii) Fetal risks

- Dependent on timing and severity of onset of oligohydramnios
- Consequences may include:
Skeletal and facial deformities
- Pulmonary hypoplasia
  - Associated with fetal demise

**Section IV: Assess Abnormal Fetal Growth**

1. Discuss clinical indications and manifestations of intrauterine growth restriction
2. Identify etiologies of intrauterine growth restriction
3. Differentiate sonographic findings of symmetric intrauterine growth restriction and asymmetric intrauterine growth restriction
4. Explain parameters evaluated during performance of a biophysical profile
5. Discuss role of Doppler in fetal well-being assessment

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**IV. Assess Abnormal Fetal Growth**

A. Intrauterine Growth Restriction

1. Defined as a fetal weight at or below 10th percentile for a given gestational age
2. Clinical associations
   a. Small for gestation age (SGA)
      i) Discrepant fundal height
   b. Maternal hypertension
   c. Decreased fetal movement
3. Types
   a. Symmetric
      i) Physical parameters are decreased in size
      ii) Associated with severe insult in first trimester
      iii) Etiology
         • Chromosomal abnormality
         • Fetal alcohol syndrome
         • Intrauterine infection
         • Severe maternal malnutrition
         • Intrauterine infection
         • Genetic defects
         • Chromosomal aberrations
         • Microcephaly
         • Skeletal dysplasias
         • Uncontrolled diabetes
   b. Asymmetric
      i) Etiologies and risk factors
• Maternal
  o Poor nutrition
  o Adverse social-economic conditions
  o Tobacco
  o Drug use
  o Alcoholism
  o Heart condition
  o Anemia
  o Diabetes (Type I)
  o History of small for gestational age (SGA)
  o Post-maturity
  o Irradiation
  o High altitude
  o Under age 17 and over age 35
  o Chronic renal disease

• Placenta
  o Placental insufficiency
  o Abruption
  o Infarcts
  o Placental neoplasm(s)

• Fetal
  o Isoimmunization
  o Multiple gestation
  o Congenital anomalies
  o Other

c. Clinical associations
  i) Small for uterine size (also known as size smaller than dates)
  ii) Maternal hypertension
  iii) Pre-eclampsia

d. Sonographic assessment
  i) Abdominal circumference small for gestational age
  ii) Head circumference/ abdominal circumference ratio
    • Brain-sparing effect
  iii) Doppler middle cerebral artery
    • Increased diastolic flow, lower resistive index and S/D ratio
  iv) Fetal weight
  v) Possible progression to symmetric IUGR
  vi) Placenta
• May be associated with thin placenta
• Advanced grade of placenta may be seen prematurely
• Amniotic fluid volume may be decreased

vii) Serial examinations are required for accurate assessment with prior dating
e. Postpartum risks and complications of fetus and neonate
i) Asphyxia
ii) Meconium aspiration
iii) Low birth weight
iv) Decreased Apgar score
v) Stillbirth

B. Macrosomia

1. Definitions
   a. Estimated fetal weight greater than 4500 grams
   b. Fetal weight calculation above 90th percentile for gestational age

2. Risk factors
   a. Gestational diabetes mellitus
   b. Type 1 or type 2 diabetes
   c. Multiparity
   d. Advanced maternal age
   e. Excessive maternal weight gain and/or obesity
   f. Post-term delivery
   g. History of large for gestational age (LGA) fetus

3. Sonographic assessment
   a. Abdominal circumference
      i) Most reliable
   b. BPD
      i) Non-reliable predictor
   c. Chest circumference
   d. Overall sonographic prediction is poor

4. Complications
   a. Fetal shoulder dystocia
   b. Increased mortality and morbidity

C. Assessment of Fetal Well-Being

1. Biophysical profile
   a. Assessment of fetal well-being or fetal distress
   b. Performance criteria
      i) Gross body movement
      ii) Fetal tone
iii) Maximum vertical pocket (MVP) or AFI
iv) Breathing (hiccups)
v) Nonstress test
c. Scoring method
d. Time limit

2. Doppler flow studies
   a. Umbilical artery
      i) Systolic-to-diastolic ratio
      ii) Resistive index
      iii) Waveform analysis
   b. Middle cerebral artery (MCA)
      i) Indications
         • Fetal anemia
         • IUGR
         • Hydrops
         • Isoimmunization
      ii) Sonographic technique
         • Axial plane
         • Color Doppler
         • Spectral Doppler
            o Output power considerations
            o Direction and waveform characteristics
            o Spectral Doppler indices
            o Pulsatility index
            o Resistive index
            o S/D ratio
            o Peak systolic velocity
   c. Ductus venosus
      i) Indications
         • Abnormal MCA Doppler
         • Venous pulsation in second and third trimester
      ii) Sonographic technique
         • Color Doppler for identification
         • Spectral Doppler
            o Venous pulsations
               ~ First trimester
               • Pulsations seen
            o Second and third trimester
               ~ Waveform transitions from pulsations to continuous
iii) Venous pulsations associations

- IUGR
- Congenital heart disease
- Congestive heart failure
- Increased mortality
Section V: High Risk Obstetrics

1. Define terminology associated with multifetal fertilization and development
2. Discuss sonographic approach in assessment of multifetal gestations
3. Describe risks associated with individual classifications of zygocity
4. List risks to fetuses of mothers with maternal illnesses or diseases
5. Differentiate fetal risks between maternal diabetes mellitus and gestational diabetes

V. High Risk Obstetrics

A. Multifetal Gestation

1. Incidence of multiple gestation
   a. Age
   b. Race
   c. Heredity
   d. Assisted reproductive technology
   e. Ovulation induction agents

2. Clinical associations
   a. Size greater than dates
   b. Elevation of maternal serum alpha-fetoprotein (MSAFP)

3. Terminology (twins)
   a. Zygocity - number of ovum fertilized
      i) Monozygotic
      ii) Dizygotic
   b. Chorionicity - number of placentas
      i) Monochorinic
      ii) Dichorionic
   c. Amnionicity - number of amniotic sacs
      i) Monoamniotic
      ii) Diamniotic

4. Classifications
   a. Monozygotic
      i) Frequency of occurrence
      ii) Development combinations
         - Diamniotic, dichorionic
            o Division of zygote within first three days after conception
            o Division of zygote between day 4 and day 8 after conception
• Monoamniotic, monochorionic
  o Division of zygote after day 8 from conception
• Conjoined
  o Division of zygote after day 13 may result in conjoined twins

b. Dizygotic gestations
  i) Frequency of occurrence
  ii) Non-identical fetuses
  iii) Diamniotic, dichorionic development

5. Sonographic assessment for classification
  a. First trimester
    i) Number of gestational sacs and placenta(s)
    ii) Twin-peak sign
      • Thick membranes
  b. Second and third trimester
    i) Membrane
    ii) Number of placenta(s)
    iii) Gender

6. Sonographic growth assessment of multifetal gestation
  a. Number of fetuses
  b. Fetal lie
  c. Number of placentas
  d. Presence or absence of membrane
  e. Measurements obtained are same as with singletons
  f. Evaluation of normal fetal growth parameters
  g. Documentation of fetal heart rates
  h. Qualitative assessment of amniotic fluid or MVP
  i. Identification of bulging membrane
  j. Discordance
    i) Definition
    ii) Calculation
    iii) Significance
  k. Principally similar for higher order multiple pregnancies

7. Risks and complications
  a. Pregnancy induced hypertension
  b. Premature rupture of membranes
  c. Intrauterine growth restriction
  d. Fetal papyraceous
  e. Vanishing twin
f. Monochorionic twin syndromes
   i) Increased risk for fetal anomalies
   ii) Increased risk for fetal demise
   iii) Twin-to-twin transfusion syndrome (TTTS)
       - Abnormal arteriovenous shunt
       - Discordant growth
         o Donor twin
         o Recipient twin
       - Treatment
         o Amniotic fluid reduction
         o Laser ablation of arterial venous communication
   iv) Twin reverses arterial profusion (TRAP)
       - Acardiac twin

g. Monoamniotic risks
   i) Conjoined twins
      - Classifications
        o Thoracopagus
        o Omphalopagus
        o Thoraco-omphalopagus
        o Craniopagus
        o Pygopagus
        o Ischiopagus
   ii) Cord Entanglement
       - High risk of fetal demise

B. Maternal Illnesses
   1. Diabetes mellitus
      a. Type 1
      b. Type 2
      c. Associated fetal effects
         i) Macrosomia
         ii) Spontaneous abortion
         iii) Polyhydramnios
         iv) Placentamegaly
         v) Congenital malformations
            - Cardiovascular
            - Caudal regression syndrome
            - Renal
            - Gastrointestinal
2. Gestational diabetes
   a. Onset with pregnancy
   b. Diagnosis
   c. Sonographic associations
      i) Macrosomia
      ii) Polyhydramnios
      iii) Placentomegaly
3. Hypertension
   a. Elevated blood pressure
      i) Types
         • Chronic hypertension
         • Pregnancy induced
            o Preeclampsia
               ~ Edema
               ~ Rapid weight gain
               ~ Proteinuria
               ~ Hypertension
            o Eclampsia
               ~ Seizures
               ~ Headaches
               ~ Blurred vision
               ~ Coma
               ~ Death
      b. Fetal associations
         i) Oligohydramnios
         ii) IUGR
         iii) Premature labor
         iv) Increased incidence of abruptio placenta
         v) Placental infarcts
         vi) Small or thin placenta
         vii) Stillbirth
   c. Treatment
      i) Bedrest
      ii) Medication for hypertension
4. TORCH
   a. Acronym for a group of maternal infections
i) Toxoplasmosis  
ii) Others  
iii) Rubella  
iv) Cytomegalovirus  
v) Herpes simplex virus  

b. Role of sonography  
i) Fetal growth assessment  
ii) Amniotic fluid assessment  
iii) Fetal well-being  
iv) Calcifications  
v) Hydrops  

5. Isoimmunization  
a. Etiology  
i) Rh isoimmunization  
ii) Rh- patient carrying an Rh+ fetus  
iii) Fetal hemolysis  
iv) First pregnancy versus subsequent pregnancies  
   • RhoGAM  

b. Fetal consequences  
i) Fetal anemia  
ii) Congestive heart failure  
iii) Hydrops fetalis  

c. Sonographic assessment  
i) Percutaneous umbilical blood sampling (PUBS)  
ii) Fetal hydrops  
iii) Guidance for intrauterine transfusions  
iv) MCA velocity  
v) Amniocentesis  

d. Treatment  
i) Intra-uterine blood transfusion  

6. Thrombophilias  
a. Consequences  
i) DVT  
ii) Fetal loss  
iii) Placental abruption  
iv) IUGR  

7. Other maternal infections
Section VI: Fetal Structural Abnormalities

1. Discuss various fetal abnormalities and their sonographic appearances
2. Define terminology and associations of fetal face abnormalities
3. Define terminology and associations of skeletal anomalies
4. Correlate clinical assessments with fetal abnormalities

VI. Fetal Structural Abnormalities

A. Fetal Face
   1. Terminology and associations
      a. Hypotelorism
         i) Associated with holoprosencephaly
      b. Hypertelorism
         i) Associations
            • Cephaloceles
            • Craniosynostosis
            • Median cleft syndrome
            • Trisomy 18
      c. Anophthalmia
      d. Macroglossia
         i) Associated with Trisomy 21
         ii) Beckwith Wiedemann syndrome
      e. Micronagthia
         i) Associations
            • Pierre Robin syndrome
            • Trisomy 13
            • Trisomy 18
            • Musculoskeletal syndromes
   2. Cleft lip and palate
      a. Most common facial abnormality
      b. Two major groups
         i) Upper lip and anterior maxilla with or without involvement of soft and/or hard palate
         ii) Cleft involving hard and soft without cleft lip
         iii) Bilateral versus unilateral
      c. Association with other anomalies
         i) Trisomy 13
         ii) Anencephaly
iii) Holoprosencephaly
iv) Autosomal dominant syndromes
v) Autosomal recessive syndromes
d. Sonographic assessment
   i) Cleft lip
   ii) Cleft palate
   iii) Role of 3-D

B. Fetal Neck
   1. Cystic hygroma
      a. Etiology
         i) Lymphatic system
      b. Locations
      c. Associations
         i) Chromosomal
            • Turner’s syndrome
            • Down’s syndrome
         ii) Fetal
            • Congenital heart defects
            • Hydrops fetalis
            • Edema
d. Sonographic presentation
   i) Cystic structure posterior neck
   ii) Septations
   iii) Size
   iv) Potential regression
   v) Oligohydramnios
   vi) Presents at <20 weeks GA

C. Fetal Head and Brain
   1. Clinical associations
      a. Elevated maternal alpha-fetoprotein (MSAFP)
      b. Increased fundal height
   2. Head shape abnormalities
      a. Lemon shape
      b. Strawberry shape
      c. Brachycephaly
d. Dolichocephaly
e. Cloverleaf shape
   3. Ventriculomegaly
a. Measurement criteria
b. Hydrocephalus
c. Pathogenesis
   i) Stenosis of aqueduct of Sylvius
   ii) Excess cerebrospinal fluid production
   iii) Decreased cerebrospinal absorption
   iv) Cerebral atrophy
   v) Primary failure of brain growth
   vi) Communicating hydrocephalus
   vii) Abnormal karyotypes
   viii) Dandy-Walker syndrome
   ix) Spinal abnormalities
d. Sonographic criteria and findings
   i) Presence of excess fluid in lateral and 3rd ventricles
   ii) Evaluate brain texture
   iii) Atria of lateral ventricle exceeds 10mm
   iv) Associated findings may include:
      • Polyhydramnios
      • Abnormal fetal lie
      • Fetal hydrops
      • Meningomyelocele
      • Other cranial or spinal anomalies

4. Anencephaly and acrania
   a. Description
      i) Anencephaly is absence of skull and cerebral hemispheres
      ii) Acrania is absence of skull
   b. Sonographic considerations
      i) Acrania
         • Absence of skull
         • Presence of brain
            ○ Atrophic changes
      ii) Anencephaly
         • Rudimentary brain tissue
         • Bulging fetal orbits giving a frog-like appearance
         • Presence of facial bones
      iii) Polyhydramnios
      iv) Increased fetal activity

5. Cephalocele
a. Description
   i) Herniation of intracranial structures through a defect in cranium

b. Terminology
   i) Cranial meningocele
   ii) Encephalocele

c. Locations of defect
   i) Posterior aspect of skull
      • Most common
   ii) Parietal suture
   iii) Frontal suture

d. Anomaly associations

e. Sonographic presentation
   i) Bony defect in skull
   ii) Extracranial mass
   iii) Ventriculomegaly
   iv) Microcephaly

6. Holoprosencephaly
   a. Abnormality in development of forebrain
   b. Chromosomal associations
      i) Trisomy 13
   c. Classifications
      i) Alobar
      ii) Semilobar
      iii) Lobar holoprosencephaly
   d. Sonographic appearance and associations
      i) Large, midline, cystic space with peripheral cerebral tissue
      ii) Absence of falx and corpus callosum
      iii) Facial anomalies
         • Hypotelorism
         • Cyclopia
         • Midline facial clefts
      iv) Hydrocephalus
      v) Microcephaly
   e. Prognosis
      i) Dependent on classification and severity

7. Dandy-Walker Complex
   a. Etiology
      i) Dysgenesis of cerebellar vermis
ii) Cisterna magna enlargement

iii) Fourth ventricle is continuous with a cystic space

b. Sonographic appearance

i) Large, cystic structure in posterior fossa
   • Continuous with enlarged fourth ventricle

ii) Enlargement of posterior fossa

iii) Cerebellar hemispheres may be separated and flattened

iv) Ventriculomegaly

v) Polyhydramnios

8. Arnold Chiari Type II malformation

a. Displacement of posterior fossa structures into cervical canal

i) Anatomic involvement
   • Pons
   • Fourth ventricle
   • Medulla
   • Cerebellum

b. Sonographic findings

i) Cerebellum and 4th ventricle displacement

ii) Cisterna magna obliteration

iii) Frontal horns of lateral ventricles

c. Associated with spinal dysraphia

9. Hydranencephaly

a. Etiology

i) Destructive insult to brain

b. Sonographic appearance

i) Macrocephaly

ii) Large anechoic area in cranial vault surrounding midbrain and basal ganglia

iii) Occasionally absent falx

iv) Variable presence of 3rd ventricle

v) Tentorium separating normal posterior fossa from anterior and middle cranial fossae

vi) Polyhydramnios

vii) Occasionally small portions of occipital lobes

viii) Differential diagnosis

10. Microcephaly

a. Definition

i) Small head with more than 3 standard deviations below normal

b. Associations

i) Intrauterine infections
ii) Aneuploidy

iii) Central nervous system anomalies

c. Sonographic criteria
   i) Small BPD (other parameters are normal)
   ii) Increased or decreased HC/AC ratio
   iii) Poor cranial growth on serial sonograms
   iv) Abnormal intracranial architecture
   v) High false positive rate

11. Agenesis of corpus callosum
   a. Description
      i) Failure of development of part or all of corpus callosum
   b. Associated with:
      i) Trisomy 13
      ii) Trisomy 18
      iii) Holoprosencephaly
      iv) Median facial clefts
      v) Dandy-Walker syndrome
   c. Sonographic appearance
      i) Absence of all or part of corpus callosum
      ii) Absence of cavum septum pellucidum
      iii) Elevation and dilation of 3rd ventricle
      iv) Widely separated lateral ventricular frontal horns
      v) Colpocephaly
      vi) Ventricles may demonstrate teardrop shape

12. Vein of Galen aneurysm
   a. Rare arteriovenous malformation
   b. Sonographic assessment
      i) Cystic space in midline of brain
      ii) May be irregular in shape
      iii) Color Doppler confirms vascular and turbulent nature
   c. Associations
      i) Cardiomegaly
      ii) Nonimmune hydrops
      iii) Ventriculomegaly

13. Schizencephaly
   a. Characterized by clefts in cerebral cortex
   b. Sonographic assessment
      i) Fluid filled-cleft(s) in cerebral cortex
ii) Unilateral or bilateral

iii) Associated with
   • Absence of cavum septum pellucidum
   • Absence of corpus callosum

14. Lissencephaly
   a. Brain surface is smooth without normal sulci and gyri
   b. Sonographic assessment
      i) Difficult to diagnose until third trimester when sulci and gyri may be seen
      ii) Ventriculomegaly
   c. Associated with:
      i) Agenesis of corpus callosum
      ii) Dandy-Walker malformation
      iii) Colpocephaly
      iv) Other syndromes

15. Porencephalic cysts
   a. Cysts filled with cerebrospinal fluid that communicate with ventricular system
   b. Sonographic assessment
      i) Cyst in brain parenchyma
      ii) Cyst communicates with ventricular system or subarachnoid space
      iii) May be asymptomatic

D. Spinal Abnormalities

1. Spina bifida
   a. Terminology
      i) Spina bifida
      ii) Spina bifida occulta
      iii) Meningocele
      iv) Myelomeningocele
      v) Rachischisis
   b. Pathogenesis
      i) Multifactorial genetic
      ii) Folic acid deficiency
      iii) Maternal diabetes
      iv) Trisomy 18
   c. Clinical associations
      i) Elevated MSAFP
      ii) Elevated acetyl cholinesterase (ACHE)
      iii) May be large for gestational age if polyhydramnios is present
   d. Sonographic assessment
i) Lumbar region is most common
ii) Posterior transaxial scan
iii) Position of laminae and pedicles
iv) Level of defect
v) Cleft in skin
vi) Mass extending of spine
vii) Upper and lower limb movement
viii) Evaluate fetal head for shape anomalies
   • Lemon sign
   • Banana sign
ix) Evaluate skeletal system for talipas, leg movement

e. Associated cranial anomalies
   i) Hydrocephalus
   ii) Encephalocele
   iii) Arnold Chiari II malformation

f. Fetal surgery may be an option

2. Scoliosis and kyphosis
   a. Scoliosis
   b. Kyphosis
   c. Anomaly associations
      i) Spina bifida
      ii) Abdominal wall defects
      iii) Skeletal dysplasia
   d. Sonographic assessment
      i) Scoliosis
         • Lateral longitudinal view
      ii) Kyphosis
         • Coronal plane
         • Posterior longitudinal

3. Caudal regression
   a. Sequence of anomalies
      i) Femoral hypoplasia
      ii) Leg anomalies
      iii) Sacral agenesis
      iv) Lumbar spine abnormalities
   b. Associated with diabetes mellitus
   c. Sonographic appearance
      i) Short femurs
ii) Sacral agenesis
iii) Legs may be flexed and abducted at hips

4. Sirenomelia
   a. Pathogenesis
      i) Arterial insufficiency to lower limbs
   b. Fusion of legs with deformed or absent feet
      i) Sonographic findings
      ii) Oligohydramnios
      iii) Fusion of legs
      iv) Single foot or absence of feet
   c. Prognosis
      i) Usually fatal due to pulmonary hypoplasia sequential to oligohydramnios

5. Sacrococcygeal teratoma
   a. Incidence
   b. Gender tendency
   c. Etiology
      i) Contains all three germ layers
   d. Sonographic assessment
      i) Mass in buttocks area adjacent to spine
      ii) Solid or complex appearance
      iii) Calcifications frequently present
      iv) External mass is most common presentation
      v) Functional AV fistula
         • Hydrops
         • High flow
      vi) Fetal surgery may be an option

E. Fetal Thorax
   1. Congenital diaphragmatic hernia
      a. Protrusion of abdominal contents into thorax through a defect in diaphragm
      b. Pathophysiology
         i) Results from failure of pleuropertitoneal membrane
         ii) Usually occurs on left
         iii) Loops of bowel or most of abdominal contents may herniate
         iv) Compression of lung may cause pulmonary ipsilateral hypoplasia and respiratory
            distress
      c. Sonographic appearance
         i) Displaced heart
         ii) Cystic mass (stomach) in thorax
         iii) Absence of intraabdominal stomach
         iv) Bowel in chest
2. Fetal hydrothorax
   a. Pleural effusion
   b. Common associations
      i) Hydrops fetalis
      ii) Congestive heart failure
      iii) Chromosomal anomalies
   c. Sonographic appearance
      i) Anechoic area in one or both sides of chest
      ii) Depending on size of effusion, compression of lung can result in pulmonary hypoplasia and displace heart
   d. Fetal shunting

3. Cystic adenomatoid malformation (CAM)
   a. Benign tumor of lung
   b. Usually a unilateral finding involving a single lobe
   c. Types and sonographic appearances
      i) Type I
         • Single or multiple large cysts measuring 2 cms or greater
      ii) Type II
         • Multiple small cysts less than 1 cm in diameter
      iii) Type III
         • Multiple tiny cysts giving a bulky hyperechoic appearance
      iv) May be spontaneous
   d. Associated findings
      i) Polyhydramnios
      ii) Mediastinal shift
      iii) Hydrops fetalis

4. Bronchopulmonary sequestration
   a. Pulmonary mass separate from normal tracheobronchial tree
   b. Sonographic appearance
      i) Well-defined echogenic mass
      ii) Usually triangular in shape
   c. Differentials
      i) CAM
      ii) Mediastinal teratoma

5. Pulmonary hypoplasia
   a. Underdevelopment of fetal lungs
b. Factors associated with normal lung growth
   i) Adequate amniotic fluid
   ii) Adequate thoracic space
   iii) Lung fluid
   iv) Fetal breathing movements

c. Manifestations of abnormal lung growth
   i) Oligohydramnios
   ii) Skeletal dysplasias
   iii) Decreased chest circumferences
   iv) Congenital diaphragmatic hernia
   v) Pulmonary mass

F. Cardiac Anomalies
   1. Most common major fetal anomaly
   2. Can be an isolated finding or associated with other anomalies, particularly abnormal karyotypes
   3. Congenital defects
      a. Valvular
         i) Epstein’s anomaly
         ii) Valvular atresia
      b. Septal
         i) Ventricular septal defect
         ii) Atrial septal defect
         iii) Atrioventricular septal defect
      c. Great vessel
         i) Transposition of great vessels
            • Great vessels may give a parallel appearance
         ii) Truncus arteriosus
            • Single common arterial trunk
         iii) Double outlet right ventricle
      d. Tetralogy of Fallot
         i) Most common form of cyanotic heart disease
         ii) Criteria
            • Perimembranous ventricular septal defect
            • Outlet of conal ventricular defect
            • Pulmonic stenosis
            • Pulmonary artery hypoplasia
            • Right ventricular hypertrophy
      e. Hypoplastic ventricle
         i) Hypoplasia
ii) Underdevelopment of either right or left ventricle
iii) Results in a non-functional ventricle

4. Cardiac masses
   a. Rhabdomyoma
      i) Echogenic mass(es) within fetal heart
      ii) May be associated with hydrops
      iii) Etiology may be tuberous sclerosis

5. Arrhythmias
   a. Types
      i) Tachycardia
      ii) Bradycardia
      iii) Irregular
   b. Sonographic assessment
      i) M-Mode placement though atria and ventricle simultaneously
      ii) Hydrops

G. Fetal Abdominal Wall Defects
1. Gastroschisis
   a. Description
      i) Defect of abdominal wall adjacent to insertion of umbilical cord
   b. Pathogenesis
   c. Sonographic appearance
      i) Free-floating loops of bowel in amniotic fluid
      ii) Defect adjacent to umbilical cord
         • Defect to right of umbilical cord most common
      iii) Associated with IUGR and oligohydramnios
   d. Prognosis
      i) Usually good
      ii) Isolated defect
2. Omphalocele
   a. Definition
      i) Pathologic herniation of abdominal contents into umbilical cord
   b. Pathogenesis
   c. Association with chromosomal abnormalities or complexes
      i) Trisomies
      ii) Pentology of Cantrell
      iii) Beckwith-Weidemann syndrome
   d. Sonographic appearance
i) Herniated mass is contiguous with umbilical cord
ii) Herniated contents are covered by membrane
iii) Herniated abdominal contents may include:
   • Bowel
   • Liver
   • Mesentary
   • Omentum
   • Pancreas
   • Spleen

e. Prognosis
   i) Organ involvement
      • Bowel containing omphaloceles carry increased risk for chromosomal anomalies
      • Good when isolated

3. Pentalogy of Cantrell
   a. Five abnormalities
      i) Anterior diaphragmatic hernia
      ii) Omphalocele
      iii) Cardiac anomalies
      iv) Defect of diaphragmatic pericardium
      v) Lower sternal defect
         • Ectopia cordis

   b. Prognosis
      i) Universally fatal

4. Limb-body wall complex
   a. Structures involved
      i) Limb defects
      ii) Anterior body defects
      iii) Encephalocele
      iv) Internal organ malformations
      v) Very short or absent umbilical cord

   b. Prognosis
      i) Universally fatal

5. Bladder and cloacal exstrophy
   a. Midline defects of infraumbilical anterior abdominal wall
   b. Bladder exstrophy
      i) Inappropriate eversion of bladder mucosa
      ii) Usually isolated
      iii) Sonographic findings
• Inability to identify fetal bladder
• Lower anterior abdominal soft-tissue mass

c. Cloacal exstrophy
   i) More complex due to lack of separation of urogenital septum from rectum
   ii) May result in two hemibladders
   iii) Frequently associated with other anomalies

H. Gastrointestinal Abnormalities

1. Esophageal atresia
   a. Congenital atresia of esophagus
   b. Usually associated with a tracheo-esophageal fistula (TEF)
   c. Types
      i) Type A
         • Esophageal atresia without TEF
      ii) Type B
         • Esophageal atresia with TEF at proximal esophageal segment
      iii) Type C
         • Esophageal atresia with TEF to distal esophageal segment
         • Most common presentation
      iv) Type D
         • Esophageal atresia with TEF to both proximal and distal esophageal segments
      v) Type E
         • Tracheoesophageal fistula without esophageal atresia

d. Sonographic assessment
   i) Visualization and size of stomach depends on presence of TEF
   ii) Polyhydramnios
   iii) Difficult diagnosis to make

2. Duodenal atresia
   a. Obstruction of duodenum of varied etiology
   b. Sonographic appearance
      i) Classic double-bubble sign representing stomach and proximal portion of duodenum
      ii) Polyhydramnios
   c. Association with Trisomy 21

3. Meconium ileus
   a. Obstruction due to impaction of meconium
   b. Association with cystic fibrosis
   c. Sonographic findings
      i) Dilatation of small bowel
      ii) Large bowel is decreased in size
iii) Echogenic bowel

4. Hirschsprung’s disease
   a. Rare disorder of functional bowel obstruction
   b. Sonographic findings
      i) Multiple dilated loops of bowel
      ii) Polyhydramnios

I. Genitourinary Abnormalities
   1. Sonographic approach to evaluation of genitourinary abnormalities
      a. Kidneys
         i) Presence and number of kidneys
         ii) Shape
         iii) Size
         iv) Echogenicity
         v) Renal pelvis
            • Dilatation
      b. Ureter
         i) Non-visualized
         ii) Dilated
      c. Bladder
         i) Presence or absence
         ii) Size
      d. Amniotic fluid volume
         i) Normal versus oligohydramnios
      e. Identification of fetal gender
   2. Renal agenesis
      a. Bilateral
         i) Associations
            • Oligohydramnios
            • Pulmonary hypoplasia
            • Facial anomalies
            • Mortality
      b. Sonographic presentation
         i) Severe oligohydramnios after mid-second trimester
         ii) Absent kidneys and bladder
         iii) Fetal adrenals may mimic kidneys
         iv) Color Doppler used to confirm absence of renal arteries
      c. Unilateral
         i) Sonographic findings
• Presence of one kidney
• Normal bladder appearance
• Normal amniotic fluid volume

3. Potter’s classifications
   a. Type I: Infantile Polycystic Kidney Disease (ARPKD)
      i) Autosomal recessive
      ii) Sonographic presentation
         • Enlarged kidneys bilaterally
         • Increased echogenicity of kidneys with loss of corticomedullary differentiation
         • Bladder may be small or absent
         • Oligohydramnios
   
   b. Type II: Multicystic Dysplastic Kidney (MCDK)
      i) Incidence
         • Most common form of renal cystic disease in infants and neonates
      ii) Sonographic appearance
         • Enlarged kidney with multiple cysts of varying size
         • If unilateral
            o Normal bladder
            o Normal amniotic fluid volume
         • If bilateral
            o Non-functioning bladder
            o Oligohydramnios
   
   c. Type III: Adult Polycystic Kidney Disease (ADPKD)
      i) Autosomal dominant
      ii) Family history
      iii) Sonographic findings
         • May have normal appearing kidneys
         • Can appear echogenic or enlarged
         • Bladder will be present
         • Normal amniotic fluid volume
   
   d. Type IV: Obstructive Cystic Dysplasia
      i) Etiology
         • Onset in first or early second trimester
         • Bladder obstruction

4. Obstructive urinary tract abnormalities
   a. Terminology
      i) Hydronephrosis
ii) Pyelectasis

b. Ureteral obstruction
   • Ureteropelvic junction (UPJ)
   ii) Renal pelvis will be dilated
   iii) Ureterovesical junction (UVJ)
     • Renal pelvis and ureter will be dilated

c. Bladder outlet obstruction
   i) Bilateral hydronephrosis and dilated ureters
   ii) Posterior urethral valve (PUV)
     • Most common male fetus
   iii) Bladder dilatation with a keyhole resembling appearance
   iv) Oligohydramnios

d. Sonographic assessment
   i) Amniotic fluid volume
     • Indirect assessment of renal function
     • Pulmonary hypoplasia
   ii) Renal pelvis measurements
   iii) Level of obstruction
   iv) Fetal gender
   v) Bladder appearance
   vi) Renal parenchyma
   vii) Fetal therapy proposed

5. Prune Belly syndrome
   a. Complex malformation
      i) Anterior abdominal wall distension
      ii) Urinary tract obstruction
      iii) Cryptorchidism
   b. Pathophysiology
   c. Sonographic appearance

6. Testicular hydrocele
   a. Description
      i) Accumulation of fluid in tunica vaginalis
   b. Sonographic criteria
      i) Fluid surrounds entire testicle

7. Ovarian cyst
   a. Functional
   b. Sonographic appearance

J. Musculoskeletal Abnormalities
1. Abnormalities of cartilage and/or bone growth and development

2. Most common types
   a. Achondrogenesis
   b. Thanatophoric dysplasia
   c. Camptomelic dysplasia
   d. Osteogenesis imperfecta
   e. Achondroplasia
   f. Talipes
   g. Many others
      i) Isolated to bone
      ii) Associated anomalies
   h. Many genetic
      i) Dominant
      ii) Recessive

3. Terminology
   a. Rhizomelia
   b. Mesomelia
   c. Micromelia
   d. Acromelia
   e. Talipes equinovarus
   f. Syndactyly
   g. Polydactyly

4. Clinical management
   a. Family history
   b. Serial sonograms for growth

5. Sonographic assessment
   a. Amniotic fluid volume
   b. Limb length
      i) Proximal segments
      ii) Distal bone segments
   c. Bone mineralization
   d. Bone appearance
      i) Fractures
      ii) Curvature
      iii) Bowing
   e. Skull shape
      i) Kleeblattschädel
      ii) Craniosynostosis
iii) Frontal bossing

iv) Facial features

f. Thorax
   i) Size
      • Pulmonary hypoplasia
   ii) Rib length

6. Skeletal dysplasias
   a. Thanatophoric dysplasia (two types)
      i) Key features
         • Rhizomelia
         • Bowed long bones
         • Narrow thorax
         • Normal trunk length
         • Large head size
         • Severely flattened vertebral bodies
         • Association with pathologic anomalies
            o Horseshoe kidney
            o Atrial septal defects
            o Imperforate anus
            o Cloverleaf skull
      ii) Sonographic appearance
         • Short-limbed dwarfism
         • Cloverleaf skull
         • Hypoplastic thorax
         • Polyhydramnios
      iii) Prognosis
         • Lethal
         • Dominant
   b. Achondrogenesis
      i) Failure of ossification process
      ii) Two types
         • Type I (Parenti-Fraccaro)
            o Key features
               ~ Incomplete ossification of skull
               ~ Rib fractures
               ~ Extreme dwarfism
               ~ Arms extremely short and stubby
~ Head proportional to trunk

- Type II (Langer-Saldino)
  - Key features
    - Head large compared to body
    - Prominent skin folds over a short neck
    - Small chest
    - Distended abdomen
    - Short limbs held away from body

iii) Sonographic appearance
- Severely shortened limbs
- Lack of vertebral ossification
- Large head with normal to slightly decreased ossification of cranium

iv) Prognosis
- Lethal
- Recessive type I; type II dominant

c. Achondroplasia
i) Types

ii) Sonographic appearance
- Rhizomelia
- Macrocephaly
- Trident hands
- Depressed nasal bridge
- Frontal bossing
- Presents in mid-to-late second trimester

iii) Prognosis
- Non-lethal
- Dominant

d. Osteogenesis Imperfecta
i) Pathophysiology
- Disorder of production, secretion or function of collagen
- Hypomineralization

ii) Multiple types exist
- Type I
  - Autosomal dominant
  - Normal to decreased bone echogenicity
  - Innumerable fractures
  - Severe bone shortening
• Type IIB
  o Autosomal recessive
  o Normal bone echogenicity
  o Numerous fractures
  o Moderate femur shortening

• Type IIC
  o Autosomal recessive
  o Normal bone echogenicity
  o Numerous fractures
  o Moderate shortening of all extremity bones

• Type III
  o Autosomal recessive
  o Decreased bone echogenicity
  o Numerous fractures
  o Moderate femur bone shortening
  o Severe handicaps

• Type IV
  o Autosomal dominant
  o Normal bone echogenicity
  o Isolated fractures
  o Absence of bone shortening

iii) Prognosis
  • Lethal
    o Types IIB, IIC

e. Camptomelic dysplasia
  i) Characterized by bent or bowed limbs
  ii) Associated anomalies
    • Congenital heart disease
    • Hydronephrosis
    • Hydrocephalus

iii) Sonographic appearance
    • Bowing of long bones
      o Lower limb most commonly affected
    • IUGR
    • Female genitalia with XY karyotype

f. Dysostosis
  i) Absence or malformation of individual bones
  ii) Prenatal diagnosis is difficult except in cases of cloverleaf skull
g. Talipes (equinovarus)
   i) Inversion of foot and flexion of sole
   ii) Causes
      • Oligohydramnios
      • Amniotic band syndrome
      • Uterine tumors
      • Spina bifida
      • Chromosomal abnormalities
      • Isolated
      • Other
   iii) Sonographic appearance
      • Orientation of foot and leg bones

7. Postural/movement abnormalities

K. Other
1. Fetal hydrops
   a. Definition
      i) Condition characterized by excessive fluid accumulation in fetal extravascular compartments, body cavities, and subcutaneous tissues
   b. Other findings
      i) Polyhydramnios
      ii) Enlarged fetal liver and/or spleen
      iii) Subcutaneous edema and thickening
      iv) Enlarged cord
   c. Types
      i) Nonimmune hydrops fetalis pathology associations
         • Fetal anomalies
            o Cystic hygromas
            o Diaphragmatic hernia
            o Neoplasms
            o Fetal anemia
            o Chromosomal anomalies
            o Cardiovascular malformations
            o Infections
            o Cardiac failure
            o Arrythmias
         • Placental abnormalities
            o Chorioangioma
            o Twin to twin transfusion
• Other

ii) Immune hydrops fetalis

• Erythroblastosis fetalis
• Caused by immunologic response
• Isoimmunization
  o Rhesus (Rh)
  o Other
Section VII: Genetic Abnormalities and Syndromes

1. List maternal serum markers associated with chromosomal anomalies
2. Characterize sonographic findings with genetic syndromes

VII. Genetic Abnormalities and Syndromes

A. Maternal Serum Markers for Screening
   1. Alpha fetoprotein (AFP)
   2. Triple screen
   3. Quad screen
   4. First trimester

B. Genetics
   1. Terminology
      a. Karyotype
      b. Autosomal recessive
      c. Autosomal dominant
      d. Mosaicism
      e. Translocation
      f. Multifactorial

C. Sonographic Markers
   1. Nuchal translucency
      a. Measurement technique
         i) Gestational age
      b. Abnormal criteria
      c. Associations
         i) Aneuploidy
         ii) Fetal cardiac anomalies
         iii) Cystic hygroma
   2. Second trimester Trisomy 21 markers
      a. Nuchal fold
      b. Absent or hypoplastic nasal bone
      c. Echogenic bowel
      d. Pylectasis
      e. Shortened long bones
      f. Echogenic intra-cardiac focus
      g. Absent or hypoplastic middle phalanx of 5th digit
   3. Second trimester neural tube defect (NTD) findings
      a. Elevated MSAFP if open defect
b. Ventral wall defect
c. Absent or reduced fetal extremity movements

D. Chromosomal anomalies

1. Trisomy 21
   a. Down’s syndrome
   b. Sonographic associations
      i) Sonographic markers as listed above
      ii) Duodenal atresia (third trimester)
      iii) Heart defects
         * Ventricular septal defect
         * Atrioventricular canal defect
      iv) Mild ventriculomegaly

2. Trisomy 18
   a. Edward’s syndrome
   b. Sonographic associations
      i) Heart defects
      ii) Clenched hands
      iii) Omphalocele
      iv) Micrognathia
      v) Talipes
      vi) Choroid plexus cysts
      vii) Renal anomalies
      viii) Cleft lip and palate
      ix) Congenital diaphragmatic hernia
      x) Cerebellar hypoplasia
      xi) Meningomyelocele
      xii) SUA
   c. IUGR and hydramnios

3. Trisomy 13
   a. Patau’s syndrome
   b. Sonographic associations
      i) Heart defects
      ii) Omphalocele
      iii) Polydactyly
      iv) Talipes
      v) Cleft lip and palate
      vi) Renal anomalies
      vii) Meningomyelocele
viii) Micrognathia
ix) Holoprosencephaly

4. Turner’s syndrome
   a. XO syndrome
   b. Occurs in females only
   c. Sonographic associations
      i) Cystic hygroma
      ii) Heart defects
         • Coarctation of aorta
      iii) Hydrops
      iv) Renal anomalies
   d. Prognosis
      i) High risk for in utero demise
      ii) Survivors have ovarian dysgenesis and short stature

5. Triploidy
   a. Complete extra set of chromosomes
   b. Vast majority spontaneously abort prior to 20 weeks
   c. Sonographic associations
      i) Heart defects
      ii) Omphalocele
      iii) Renal anomalies
      iv) Cranial defects
      v) Facial defects

6. VACTERL
   a. Grouping of complex anomalies
      i) Vertebral defects
      ii) Anal atresia
      iii) Cardiac anomalies
      iv) Tracheoesophageal fistula
      v) Renal anomalies
      vi) Limb dysplasia
Section VIII: Interventional Procedures

1. List invasive and interventional techniques utilized in obstetrics
2. Discuss indications for invasive diagnostic procedures utilized in obstetrics
3. Discuss role of sonography with interventional procedures

VIII. Interventional Procedures

A. Chorionic Villus Sampling (CVS)
   1. Biopsy of chorionic villi or placenta
   2. Indications
      a. Increased risk of diagnosable genetic disorders
      b. Advanced maternal age
   3. Risk associations
      a. Transcervical approach increases risk of infection
      b. Slightly higher fetal loss as compared to amniocentesis
      c. Possible limb reduction if performed earlier than 8-10 weeks
   4. Sonographic assessment
      a. Gestational age criteria
      b. Transabdominal approach
      c. Transcervical approach
      d. Placental localization

B. Amniocentesis
   1. Indications
      a. Genetic assessment
         i) Performed after 14 weeks gestation
         ii) Advanced maternal age
         iii) History of fetal karyotype abnormality
         iv) Abnormal prenatal genetic screening
         v) Either parent with known balanced rearrangement
      b. Lung maturity
         i) Performed in mid to late third trimester
         ii) Indicated when premature delivery is contemplated
      c. Fetal infections
      d. Isoimmunization
   2. Risk associations
   3. Technique
      a. Sonography is performed before amniocentesis to confirm
         i) Gestational age
ii) Fetal viability
iii) Position of placenta
iv) Localize amniotic fluid pocket to avoid placenta, fetus and cord

b. Sonography during procedure
   i) Localize pocket of fluid with sonography under sterile technique
   ii) Visualize needle for insertion and placement into amniotic fluid
   iii) For genetic testing 20-30 cc of fluid is removed and sent for cell culture, karyotyping and biochemical analysis

c. Sonography after procedure
   i) Fetal heart-rate

C. Percutaneous Umbilical Blood Cord Sampling (PUBS)
   1. Cordocentesis
      a. Sonography-guided sampling of umbilical cord blood in utero
   2. Indications
      a. Diagnostic
         i) Evaluation of fetal hematocrit
         ii) Genetic testing
         iii) Fetal blood analysis
      b. Therapeutic
         i) Blood transfusion
         ii) Administration of fetal drugs in utero
      c. Risks
         i) Risks greater than with CVS or amniocentesis
         ii) Fetal maternal hemorrhage
         iii) Trauma
         iv) Infection
         v) Premature rupture of membranes
         vi) Premature labor
         vii) Fetal distress
      d. Technique
         i) Sterile technique
         ii) Localization for needle insertion site
         iii) Post-procedure monitoring

D. Advanced in utero treatments can be performed for
   1. Bladder obstruction
   2. Fetal thoracentesis
   3. Laser ablation for twin-to-twin transfusion syndrome (TTTS)
   4. Shunt placement
   5. Open neural tube defects
   6. Congenital diaphragmatic hernia
   7. Other
Section IX: Post-Partum Complications

1. Discuss role of sonography in post-partum period
2. Discuss role of sonography in post-partum infection
3. List causes for post-partum hemorrhage

IX. Post-Partum Complications

A. Hemorrhage
   1. Causes
      a. Abnormal attachment of placenta to myometrium
         i) Placental accreta
         ii) Placental increta
         iii) Placental percreta
      b. Lacerations of vagina and cervix
      c. Retained products of conception
         i) Sonographic appearance
      d. Uterine atony
      e. Coagulopathy
   2. Risks
      a. Decreased hematocrit
      b. Hypotension
      c. Hysterectomy
      d. Renal failure
      e. Shock
      f. Death

B. Infection
   1. Increased risk with Cesarean section delivery
   2. Endometritis
      a. Description
         i) Infection of endometrium with potential extension into myometrium and parametrial tissues
      b. Clinical associations
         i) Fever
         ii) Uterine tenderness
         iii) Abnormal bleeding
         iv) Odorous lochia
      c. Sonographic appearance
Section X: Prudent Use

1. Discuss mechanisms to use sonography prudently in obstetrics
2. Describe emerging technologies used in obstetrics

X. Prudent Use

A. Prudent Use and Bioeffects
   1. Equipment presets
      a. Output power
         i) Relative intensities of 2-D versus Doppler
         ii) Mechanical index (MI)
         iii) Thermal index (TI)
      b. Fetal heart rate and documentation
         i) Relative intensities of M-Mode versus Doppler
         ii) Spectral and color Doppler
            • Not recommended for first trimester
            • Indications for performance in 2nd and 3rd trimesters
            • Benefits outweighs risk
      c. As low as reasonably achievable (ALARA)
         i) Time efficiency
         ii) Diagnostic indications only
   2. Professional organization position statements

B. Emergent Technologies
   1. 3-D
      a. Multi-planar concepts
      b. Advantages
      c. Diagnostic role
   2. 4-D
      a. Surface rendering techniques
      b. Skeletal (amplitude)
      c. Image manipulation
   3. Extended field of view
      a. Placental location
      b. Fetal presentation
Section XI: Performance Standards and Documentation

1. Discuss minimum requirements in performance of obstetrical sonograms specific to first trimester, second and third trimesters

2. A clinical history and indications for examination should be documented for all examinations

XI. Performance Standards and Documentation

A. First Trimester

1. Sonograms can be performed either transabdominal approach, endovaginal approach, or use of both techniques

   a. Anatomy should be evaluated and documented

      i) Visualization and location of gestation sac

      ii) Presence or absence of yolk sac

      iii) Identification of embryo

      iv) Presence or absence of cardiac activity

         • M-Mode for heart rate

         • Color Doppler to confirm absent cardiac activity

      v) Gestational age determination

         • Mean sac diameter if no embryo present

         • Crown-rump length

      vi) In multiple gestation: fetal number, chorionicity and amnionicity

      vii) Uterine, adnexal, and cul-de-sac assessment

B. Second and Third Trimester

1. Fetal number

2. Fetal position

3. Fetal viability and M-Mode for heart rate

4. Fetal measurements for size and growth

   a. Biparietal diameter

   b. Head circumference

   c. Abdominal circumference

   d. Femur length

   e. Estimated fetal weight (EFW)

5. Fetal anatomy

   a. Lateral ventricle

   b. Choroid plexus

   c. Cisterna magna

   d. Cerebellum

   e. Nuchal fold (up to 25 wks)
f. Upper lip
g. Face profile
h. Midline falx
i. Cavum septum pellucidum
j. Spine
k. Heart
   i) 4-chamber
   ii) outflow tracts
l. Stomach
m. Kidneys
n. Bladder
o. Umbilical cord insertion
   i) Number of vessels
p. All extremities
q. Lower leg/foot position
6. Gender, if medically indicated
7. Placenta
   a. Position
   b. Appearance
   c. Relationship to internal os
   d. Cord insertion to placenta
8. Amniotic fluid
   a. Subjective <24 weeks
   b. Quantitative AFI or MVP >24 weeks
9. Maternal anatomy
   a. Uterus
   b. Adnexa
   c. Cervix
      i) Color Doppler if low placenta (r/o vasa previa)
Section XII: Gynecology – Anatomy, Physiology, and Pathology

Rationale: Accurate assessment and performance of gynecologic/female pelvis sonograms requires sonographers to assemble a comprehensive knowledge of the anatomy, physiology, pathophysiology, and sonographic appearances of the female reproductive system. An understanding of the embryologic development, pre-menarchal, menarchal, and postmenopausal female reproductive system is essential for the performance of high quality examinations.

1. Describe the embryology, anatomy, function and normal sonographic appearances of the female pelvis
2. Discuss the sonographic techniques, including emerging technologies, used to evaluate the female pelvis
3. Identify the clinical indications and laboratory values associated with abnormalities and diseases of the female reproductive system
4. Describe congenital abnormalities and pathology in terms of sonographic appearance, sequelae, and associated pathologies

XII. Anatomy, Physiology, and Pathology

A. Normal Pelvic Anatomy

1. Embryology
   a. Uterus, fallopian tubes and vagina formed by fusion of Mullerian ducts
   b. Ovaries develop from external cortex of gonadal ridge

2. Uterus
   a. Hollow, pear-shaped muscular organ with a network of arteries and veins
      i) Cervix
      • Proximal portion of uterus
      ii) Isthmus
      • Narrow portion connecting body/corpus with cervix
      iii) Corpus
      • Largest portion of the uterus
      iv) Fundus
      • Distal portion containing cornua housing interstitial portion of fallopian tubes
   b. Tissue layers
      i) Serosa
      • Surrounds uterus
      • Not sonographically distinct
      ii) Myometrium
      • Muscular middle layer
      • Junctional zone
      iii) Endometrium
      • Innermost layer; highly vascular
      • Consists of basal and functional layers
• Endometrial canal contiguous with vagina and fallopian tubes

c. Location
  i) In true pelvis posterior to urinary bladder and anterior to rectum
  ii) Aligned with mid-sagittal plane
  iii) Body and fundus are loosely held in place by broad and round ligaments
  iv) Uterosacral ligaments hold cervix in place

d. Size
  i) Related to age, menstrual status, and parity status
  ii) Measure length, width, height

e. Positions of the uterus
  i) Most common axis is anterverted/anteflexed with non-distended bladder
  ii) Variations in uterine position
    • Retroverted
    • Retroflexed
    • Dextroposition
    • Levoposition
    • Dextroflexed
    • Levoflexed

f. Sonographic appearance
  i) Myometrium
    • Typically homogeneous
    • Mid-level gray echogenicity
    • Peripheral anechoic structures (vessels)
  ii) Endometrium
    • Varies in echogenicity and thickness cyclically
    • Varies in thickness with menopausal status and hormone replacement therapy
    • Measurement of thickness

3. Vagina
   a. Vagina extends from vulva to the uterus
   b. Consists of muscular layers and inner mucosa
   c. Relational anatomy
   d. Sonographic appearance
      i) Highly reflective

4. Ovaries
   a. Location
      i) Lateral to uterus
      ii) Posterior and distal to fallopian tubes
      iii) Posterior to broad ligament
iv) Not covered by peritoneum  
v) Anterior/medial to internal iliac vessels  

b. Connections  
i) Mesovarium ligament to broad ligament  
ii) Inferior to uterus by utero-ovarian ligament  
iii) To fallopian tube by fimbriae ovarica  
iv) Lateral pelvis by suspensory ligaments  
v) Medial, lateral, and posterior borders of each ovary are free  

c. Description  
i) Oval/almond-shaped structures  
ii) May assume more elongated or rounded shape  
iii) Outer cortex and inner medulla  
iv) Surface smooth early in life, becoming markedly pitted or puckered with years of ovulatory activity  
v) Atrophy following menopause  

d. Size  
i) Length, width, depth  
ii) Volume  
   • Premenarchal  
   • Menarchal  
   • Postmenopausal  

e. Sonographic appearance  
i) Solid structure with peripheral anechoic follicles  
ii) Low to medium-level echogenicity  
iii) Dominant follicle (graafian follicle) identified prior to ovulation  

5. Fallopian tubes  

a. Description  
i) Paired muscular tubular structures  
ii) Extends from cornua of uterus laterally  

b. Size  
i) Length  
ii) Diameter  

c. Divisions  
i) Interstitial  
ii) Isthmus  
iii) Ampulla  
iv) Infundibulum  
   • Contains fimbriae (includes fimbriae ovarica)
d. Layers
   i) Serosa
   ii) Middle muscular layer
   iii) Internal circular layer of muscular fibers

e. Sonographic appearance
   i) Normal fallopian tube not visualized

6. Supporting pelvic structure
   a. Bones
      i) Sacrum
      ii) Coccyx
      iii) Two innominate bones
         • Ilium
         • Pubis
         • Ischium
   b. Regions
      i) Greater or false pelvis
      ii) Lesser or true pelvis
   c. Ligaments
      i) Broad ligament
      ii) Round ligament
      iii) Cardinal ligament
      iv) Uterosacral ligament

7. Pelvic musculature
   a. Psoas major muscle
   b. Iliopsoas muscle
   c. Obturator internus
   d. Piriformis
   e. Levator ani
   f. Rectus abdominis muscle

8. Potential spaces
   a. Posterior cul-de-sac/rectouterine pouch
   b. Anterior cul-de-sac/vesicouterine pouch

9. Pelvic vasculature
   a. Abdominal aorta bifurcates into right and left common iliac arteries
      i) Bifurcate into external and internal iliac arteries
   b. External iliac artery is in the false pelvis
      i) Becomes femoral artery
   c. Internal iliac artery
d. Uterine vasculature
   i) Venous drainage of uterus is analogous with arterial supply
   ii) Uterine arteries
      • Arises from internal iliac artery
   iii) Arcuate arteries
   iv) Radial arteries
      • Penetrate myometrium
   v) Straight arteries
      • Basal layer of endometrium
   vi) Spiral arteries

e. Ovarian arterial supply comes from abdominal aorta
   i) Ovarian/gonadal arteries
   ii) Branch of uterine artery
   iii) Ovary has dual blood supply

f. Ovarian venous drainage
   i) Right ovarian vein drains into IVC
   ii) Left ovarian vein drains into left renal vein


g. Vaginal blood supply
   i) Vaginal branches of uterine artery
   ii) Venous drainage is analogous to arterial supply

h. Fallopian tubes are supplied by anastomosed ovarian and uterine branches

10. Doppler evaluation
a. Endovaginal imaging
b. Angle independent waveform analyses
   i) S/D ratio (also referred to as A/B ratio)
   ii) Resistive index (RI)
   iii) Pulsatility index (PI)
c. Normal uterine Doppler
   i) Demonstrates high resistance flow
d. Reproductive age female
   i) Ovarian arterial flow varies with menstrual cycle

11. Related imaging studies
a. Abdominal sonography
b. Computed tomography (CT)
c. Magnetic resonance imaging (MRI)
d. Radiographic procedures
B. Physiology

1. Endocrine cycle

   a. Menstrual cycle, ovarian cycle, and endometrial changes
      i) Controlled by hormones

   b. Menstrual cycle depends on functional integrity of three endocrine sources
      i) Hypothalamus
         • Produces follicle stimulating hormone releasing factor (FSHRF) and luteinizing hormone releasing factor (LHRF)
      ii) Pituitary gland
         • Produces follicle stimulating hormone (FSH) and luteinizing hormone (LH)
            o FSH responsible for ripening of graafian follicle
            o LH induces ovulation
      iii) Ovarian axis
         • Secretes estrogen and progesterone
         • Contributes to the amount of FSH and LH produced and secreted by pituitary

   c. Estrogen
      i) Principle modulator of hypothalamus-pituitary activity
      ii) Stimulates endometrial growth
      iii) Sensitizes the muscle to induce rhythmic contractions of fallopian tubes
      iv) Stimulates cervical mucous secretion
      v) Induces proliferation of vaginal epithelium
      vi) Stimulates growth of breast duct system
      vii) Responsible for development of female body contours

   d. Progesterone
      i) Increases rapidly after ovulation
      ii) Peaks about seven days post ovulation
      iii) Is secreted by the corpus luteum during second half of cycle
         • Corpus luteum regresses without fertilization
         • Progesterone level decreases
            o Decreased estrogen and progesterone leads to disintegration of endometrial lining and menstruation occurs
      iv) Functions
         • Induction of secretory activity in endometrial glands
         • Desensitizes myometrium to oxytocic activity
• Modifies histological appearance of vaginal epithelium
• Inhibits secretory activity of cervical glands
• Increases basal body temperature
• Stimulates development of alveolar system
• Inhibits secretion of LH, thus inhibiting ovulation

2. Ovarian cycle
   a. At birth, each ovary contains approximately 200,000 primary follicles
   b. Around first day of menstrual cycle four or five primary follicles begin to grow
      i) Follicle growth produces low levels of estrogen and minute amounts of progesterone
   c. At approximately fourth to fifth day, one follicle develops into secondary follicle
   d. Preovulatory phase
      i) Day six to thirteen
      ii) Secondary follicle matures into graafian follicle
      iii) Other maturing follicles undergo atresia
   e. Ovulation occurs approximately on day 14
      i) Mature ovum is expelled
      ii) Ruptured graafian follicle is healed by capillary bleeding and is absorbed
   f. Luteal phase
      i) Day 15 to day 28
      ii) Follicular cells transform into a golden-colored body called corpus luteum
         • Corpus luteum grows for seven to eight days
         • Secretes estrogen and increasing amount of progesterone
         • Prepares endometrium to receive fertilized ovum
         • Without fertilization corpus luteum regresses
            o Menstruation occurs
            o Cycle is repeated

3. Menstrual and/or endometrial cycle
   a. Periodic discharge of blood, mucous, tissue, fluid and epithelial cells
   b. Rhythmic cycle based on approximately 28 days
      i) Menses
         • Days 1 to 5
      ii) Postmenstrual phase
         • Days 6 to 9
         • Thin endometrium
      iii) Proliferative phase
         • Days 6 to 13
         • Increased thickness of the mucosa
iv) Secretory phase
   • Days 13 to 28
   • Thickening of endometrium

4. Pregnancy test
   a. Beta human chorionic gonadotropin (β-hCG)
   b. Derived from trophoblast
   c. Urine pregnancy test
      i) False negatives
      ii) False positives
   d. Serum pregnancy test
      i) More sensitive than urine
      ii) Use when considering ectopic pregnancy
      iii) Standards for reporting β-hCG Milli-international units (mIU)
         • International reference preparation (IRP)
         • Second international standard (2nd IS)
      iv) Sonographic correlation with β-hCG levels

5. Human chorionic gonadotropin (hCG)
   a. Produced by trophoblast
   b. Forms basis of most pregnancy tests
   c. Rises rapidly after 6th week of gestation
   d. Peaks at 10th to 12th week
   e. Decreases and plateaus at 8-10 weeks
   f. Levels diminish following parturition

6. Fertilization
   a. Sperm motility
   b. Sperm dissolves portion of ovum membrane
   c. Fertilization usually occurs in distal portion of the fallopian tube
   d. Fertilized ovum develops zona pellucida
      i) The fertilized ovum is called a zygote
   e. Zygote
   f. Cleavage
   g. Morula
   h. Blastocyst
      i) Differentiation
      i) Implantation

C. Infertility/Endocrinology
   1. Methods of contraception
a. Hormonal
   i) Oral contraceptives
   ii) Depo-medroxyprogesterone acetate
   iii) Levonorgestrel implants
   iv) Post-coital hormonal contraception

b. Barrier method
   i) Diaphragm
   ii) Cervical cap
   iii) Condoms

c. Intrauterine contraceptive device (IUD)
   i) Foreign body (usually T-shaped) placed in fundal portion of endometrial cavity
   ii) Ovulation and corpus luteum formation are not impaired
   iii) Risks
   iv) Sonographic appearance
       - Highly reflective structure
       - Entrance-exit reflections
       - Posterior shadowing
       - Radiograph may be performed when not identified sonographically

d. Vaginal ring

2. Surgical fertility control
   a. Bilateral tubal ligation
   b. Hysterectomy
   c. Elective abortion
   d. Micro-inserts into fallopian tubes

3. Infertility
   a. Definition
      i) Pregnancy does not result after one year of normal sexual activity without contraception
   b. Incidence
   c. Causes
   d. Patient management
   e. Medications
   f. Assisted reproductive technology (ART) and sonographic guidance
      i) Techniques
         - Gamete Intrafallopian Transfer (GIFT)
         - Zygote Intrafallopian Tube Transfer (ZIFT)
         - In Vitro Fertilization (IVF)
      ii) Patient physiologic changes
      iii) Sonographic role of monitoring of ART
D. Postmenopausal

1. Appearance
   a. Uterus decreases in size
   b. Ovaries decrease in size

2. Hormonal changes due to estrogen deficiency
   a. Vagina loses rugosity
   b. Endocervical cells produce less cervical mucus
   c. Hormone replacement therapy
      i) Estrogen
      ii) Progesterone

E. Pelvic Pathology

1. Uterus
   a. Pediatric pelvis
      i) Precocious puberty
         • Abnormal early development of sexual maturity
         • Sonographic appearance
            o Adult shape uterus
            o Ovarian volume greater than 1 cm³
      ii) Abnormal fluid collections due to obstruction of genital tract
         • Hydrometra
            o Abnormal collection of fluid within uterine cavity
            o Occurs most commonly in premenarchal patients
            o Etiology
               ~ Imperforate vaginal hymen
               ~ Congenital vaginal atresia
         • Pyometra
            o Fluid collection that is mucinous and infectious
         • Hydrometrocolpos
            o Fluid accumulation in vagina and uterus
         • Hematometrocolpos
            o After menarche, the menses accumulate within vagina and uterine cavity
            o Older women may experience fluid and/or menses accumulation within uterine cavity secondary to cervical obstruction due to malignancy or cervical stenosis
   • Symptoms
      o Vague pelvic discomfort
      o Pain with defecation and/or urination
      o May be asymptomatic
• Sonographic appearance
  o Anechoic and distended uterine cavity and cervical canal
  o With hematometra or pyometra, cavity may contain echogenic fluid-debris levels

iii) Sexual ambiguity
  • Etiology
    o Male pseudohermaphroditism (46, XY)
    o Female pseudohermaphroditism (46, XX)
    o True hermaphroditism (46, XX or 46, XY)
    o Chromosomal abnormalities
      o Ambiguous genitalia
  • Treatment
  • Congenital uterine anomalies (may have associated renal anomalies)

iv) Uterus didelphys
v) Bicornuate uterus
  • Uterus bicornuate bicollis
  • Uterus bicornuate unicollis
vi) Uterus septus
  • Subsubseptus
vii) Uterus unicorne
viii) Uterine aplasia

b. Endometrial hyperplasia
i) Abnormal thickening of endometrium due to estrogen over-stimulation
ii) Associated with tamoxifen
iii) Clinical symptoms
  • Uterine bleeding
iv) Sonographic appearance
  • Thickened endometrium with or without cystic changes

c. Endometrial polyps
i) Overgrowth of endometrial tissue
ii) Clinical symptoms
  • Abnormal vaginal bleeding
iii) Sonographic appearance
  • Diffuse or focal endometrial thickening

d. Endometrial carcinoma
i) Associated with estrogen stimulation
ii) Clinical symptoms
  • Postmenopausal vaginal bleeding
iii) Sonographic appearance
   - Normal endometrium (rare)
   - Thickened endometrium with or without focal irregularity
   - Enlarged uterus with endometrium demonstrating a mixed echogenicity in later stages
   - Endometrial adhesions
     - Synechiae/Asherman syndrome
     - Bands of endometrial tissue associated with trauma or surgery

Leiomyoma
i) Most common benign gynecological tumor
   - Single or multiple
   - Degeneration
   - May enlarge over time

ii) Signs and symptoms
   - Asymptomatic
   - Pelvic pain
   - Menorrhagia
   - Enlarged uterine size
   - Menstrual irregularity

iii) Classifications
   - Intramural
   - Subserosal
   - Submucosal
   - Pedunculated

iv) Sonographic appearance
   - Variable echogenicity
     - Hypoechoic
     - Homogeneous
     - Heterogeneous
   - Shadowing
   - Well-defined borders
   - Solid
   - Doppler
     - Stalk flow

Adenomyosis
i) Endometrial implants lie within myometrium

ii) Signs and symptoms
   - Pelvic cramping
• Dysmenorrhea
• Uterine enlargement

iii) Sonographic appearance
• Hypoechoic uterus
• Heterogeneous myometrium
• Diffusely enlarged
• Myometrial cysts

g. Nabothian cyst
i) Benign cervical cyst

h. Cervical carcinoma
i) Etiology
• Mostly related to HPV infection

ii) Risk factors
• Early sexual encounters
• Multiple sexual partners
• Sexually transmitted infection
• Exposure to human papilloma virus (HPV)

iii) Peak incidence post-pubescent women
iv) Squamous cell carcinoma most common
v) Signs and symptoms
• Vaginal discharge
• Bleeding
• Malodorous discharge
• Palpable pelvic mass

vi) Sonographic appearance
• Normal
• Enlarged, bulky cervix
• Solid mass in cervix
• Hematometra or pyometra with cervical stenosis
• Extension of disease to pelvic sidewalls, bladder, and rectum

i. Leiomyosarcoma
i) Rare malignant tumor

ii) Signs and symptoms
• Asymptomatic
• Uterine bleeding

iii) Sonographic appearance
• Similar to leiomyoma
• Cystic degeneration
• Inhomogeneous uterine mass
• Local invasion or distant metastases

2. Ovarian
   a. Functional masses
      i) Follicular cyst
         • Occurs when dominant follicle fails to ovulate
         • May lead to menstrual irregularities
         • Sonographic appearance
            o Anechoic
            o Thin wall
            o Posterior enhancement
      ii) Corpus luteum cyst
          • Forms after the dominant follicle ruptures and ova is expelled
            o Hemorrhage occurs at rupture site
          • Signs and symptoms
            o Pelvic pain
            o Nausea and vomiting
            o Enlarged, tender ovary
          • Sonographic appearance
            o Complex cyst
          • Corpus luteum cyst of pregnancy
            o Supports early pregnancy
            o Sonographic appearance
              ~ Thin-walled
              ~ Unilateral
              ~ Fluid in posterior cul-de-sac with rupture
      iii) Theca lutein cysts
           • Develop with high levels of human chorionic gonadotropin (hCG)
           • Associations
             o Gestational trophoblastic neoplasia
             o Ovarian hyperstimulation syndrome
             o Multiple pregnancy and singleton gestations
           • Sonographic appearance
             o Bilateral
             o Large, multilocular cysts
   b. Benign
      i) Paraovarian cysts
• Arise from Gartner’s duct remnants or from hydatid of Morgagni
• Found within broad ligament
• Sonographic appearance
  • Thin-walled
  • Anechoic
  • Variable size

ii) Serous cystadenoma ree
• Common, benign epithelial tumor
• Sonographic appearance
  o Unilateral
  o Cystic structure with low-level debris
  o Smooth walls
  o May contain septae

iii) Mucinous cystadenoma
• Benign epithelial tumor
• Sonographic appearance
  o Multi-septate tumor
  o Large
  o Mid-level echoes

iv) Mature cystic teratoma
• Commonly termed dermoid
• Germ cell tumor
• Usually seen in young women of reproductive age
• Signs and symptoms
  o Mild to acute pain
  o Adnexal fullness
  o Pressure symptoms
• Sonographic appearance
  o Cystic to complex
  o Calcification with shadowing

v) Fibroma
• Stromal tumor
• Associated with Meigs’ syndrome
  o Pelvic mass
  o Hydrothorax
  o Ascites
• Signs and symptoms
OB-GYN

o Local pelvic pain
o Pressure symptoms when large
o Asymptomatic when small

• Sonographic appearance
  o Solid
  o Hyperechoic

vi) Theca cell tumor

• Benign, solid, unilateral mass most commonly found in menopausal or postmenopausal women
• Signs and symptoms
  o Pelvic pain
  o Pressure
• Sonographic appearance
  o Ovarian enlargement
  o Solid
  o Attenuating
  o Calcifications may be seen
  o Cystic degeneration may occur

vii) Brenner tumor

• Uncommon, solid mass
• May be associated with Meigs’ syndrome
• Rarely malignant

viii) Endometrioma

• Large cysts filled with dark brown fluid
• Occurs with endometriosis
  o Ectopic endometrial tissue found on structures within abdominal-pelvic cavity
• Signs and symptoms
  o Dyspareunia
  o Metromenorrhagia
  o Dysmenorrhea
• Sonographic appearance
  o Well defined
  o Low-level echogenicity
  o Cystic mass filled with low-level echoes
  o Punctate calcifications

c. Malignant

i) Epithelial ovarian cancer

• Most common type of ovarian cancer
• More common in postmenopausal women

• Risk factors
  o Age
  o Family history of ovarian or breast cancer
  o Nulliparity
  o Infertility
  o Late menopause
  o Prolonged ovulatory activity

• Clinical signs and symptoms
  o Abdominal pain
  o GI symptoms
  o Pressure
  o Vaginal bleeding
  o Weight change
  o Endocrine imbalance
  o Elevated CA 125

• Sonographic appearance
  o Ovarian mass
  o Cystic components
  o Thick septations
  o Mural nodules
  o Calcifications with or without shadowing
  o Low-level echoes within cystic component
  o Decreased vascular impedance
  o Extra-ovarian findings

ii) Germ cell

• Dysgerminoma
  ~ Frequency of occurrence
    · Rare, malignant epithelial tumor
  o Sonographic appearance
    ~ Solid
    ~ Homogeneous
    ~ Irregularly defined
    ~ May see cystic degeneration

• Immature/malignant teratoma
  o Frequency of occurrence
    ~ Rare malignant tumor
    ~ Occurring more frequently in children and young adults
iii) Sex cord stromal tumors

iv) Metastasis
   - Krukenburg’s tumor
     o Secondary ovarian carcinoma from primary neoplasm of gastrointestinal tract

d. Ovarian torsion
   i) Partial or complete rotation of pedicle secondary to ovarian mass or cyst
      - Occlusion or decrease of blood inflow and outflow
   ii) Signs and symptoms
      - Sudden onset of severe pelvic pain
      - Nausea, vomiting
      - Palpable adnexal mass
   iii) Sonographic appearance
      - Ovarian enlargement
      - Hyperechoic ovary
      - Heterogeneous
      - Dilated vessels on periphery of ovary
      - Doppler may demonstrate absent or decreased blood flow

e. Polycystic ovarian disease
   i) Identified in young women
   ii) Stein-Leventhal syndrome
      - Polycystic ovaries
      - Hirsutism
      - Amenorrhea
      - Enlarged ovaries
      - Obesity
      - Impaired fertility
   iii) Sonographic appearance
      - Bilaterally, mildly enlarged ovaries
      - Multiple peripheral small cysts

3. Pelvic inflammatory disease (PID)
   a. Inflammatory condition of uterus, cervix, ovaries, fallopian tubes and peritoneal surfaces
b. Etiology
   i) Sexually-transmitted infection (STI)
   ii) Intrauterine device (IUD) use
   iii) Extension of lower abdominal and/or pelvic abscesses
   iv) Complication of postabortion or childbirth

c. Classifications
   i) Acute
   ii) Chronic

d. Signs and symptoms
   i) Severe pelvic pain
   ii) Fever
   iii) Shaking/chills
   iv) Leukocytosis
   v) Vaginal discharge
   vi) Irregular vaginal bleeding
   vii) Rebound tenderness
   viii) Pain with cervical manipulation
   ix) Dyspareunia

e. Complications
   i) Endometritis
      • Sonographic appearance
         o Normal
         o Thickened endometrium
         o Air or fluid in endometrial cavity
         o Increased vascularity
   ii) Salpingitis
      • Sonographic appearance
         o Distended fallopian tubes with thickened walls and pyosalpinx in acute phase
         o Hydrosalpinx in chronic phase
   iii) Tubo-ovarian abscess (TOA)
      • Result of very severe pelvic infection
      • Signs and symptoms
         o High fever
         o Elevated WBC
         o High erythrocyte sedimentation (ESR)
         o Severe lower abdominal pain
         o Nausea and vomiting
         o RUQ pain
iv) Doppler flow studies
   • Uterine artery Doppler
     o Uterine neoplasms
   • Ovarian Doppler
     o Ovarian neoplasms
   • Endometrial

v) Correlative and/or prior imaging
   • Radiographic procedures
     o Fluoroscopic studies
     o Intravenous urogram (IVU) or Intravenous pyelography (IVP)
     o Voiding cystourethrogram (VCUG)
   • Computed tomography (CT)
   • Magnetic resonance (MRI)
Section XIII: Gynecology – Patient Care and Imaging Techniques

1. List pertinent information derived from the patient interview and/or review of medical chart that is obtained prior to the sonogram
2. Describe the sonographic techniques, including emerging technologies, used to evaluate the female pelvis
3. Describe the protocol and procedure for transabdominal and endovaginal female pelvis sonograms

XIII. Patient Care and Imaging Techniques

A. Patient Assessment
   1. Patient history
      a. Menstrual history
         i) Implantation break-through bleeding
      b. History of pain/fever
      c. Pregnancy test and type of test
      d. History of vaginal bleeding
      e. Abdominal and pelvic surgeries
      f. IUD usage
      g. Reason for referral
      h. History of smoking and alcohol use
      i. Medications
      j. Pertinent laboratory tests
      k. Palpable pelvic mass
      l. Obstetrical history
      m. History of disease and/or anomaly
      n. History of assisted reproduction
         i) Pertinent family history

B. Scanning Techniques
   1. Transperineal scanning
   2. Transabdominal imaging
      a. Adequate filling of urinary bladder
      b. Patient supine
      c. Transducer selection
   3. Endovaginal imaging
      a. Empty urinary bladder
      b. Lithotomy position
      c. Transducer selection and disinfection
      d. Transducer covers
         i) Latex
         ii) Non-latex
      e. Lubricants
4. Anatomical evaluation and documentation
   a. Gynecologic examination
      i) Bladder
         • Anechoic
         • Size, shape
         • Bladder wall
         • Distention
      ii) Uterus
         • Endometrium
         • Myometrium
         • Borders
         • Position
         • Echogenicity
         • Measurements
           o Length
           o Width
           o Height
         • Cervix
      iii) Ovaries
         • Echogenicity
         • Location
         • Size
         • Measurements (length, width, depth)
         • Adjacent adnexa
      iv) Potential spaces
      v) Evaluation of anomalies
         • Location
         • Size
         • Borders
         • Contents
         • Presence of ascites
         • Evaluate kidneys if needed

C. Procedures
   1. Sonohysterography
   2. Follicular aspiration
   3. Abscess drainage

D. Adjunctive Technologies
   1. 3-D imaging
   2. Volume rendering
   3. Focused ultrasonic ablation of tumors
4. Guidance for cryoablation

**Abbreviations**

<table>
<thead>
<tr>
<th>A</th>
<th>Abdominal Circumference</th>
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<tbody>
<tr>
<td>AC</td>
<td>Amniotic Fluid Index</td>
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<td>AFI</td>
<td>Alpha Feto Protein</td>
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<td>ALARA</td>
<td>As Low As Reasonably Achievable</td>
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<tr>
<td>ADPKD</td>
<td>Adult Dominant Polycystic Kidney Disease</td>
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<td>ART</td>
<td>Assisted Reproductive Technology</td>
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<tr>
<td>B</td>
<td>Beta-Human Chorionic Gonadotropin</td>
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<td>β-hCG</td>
<td>Biparietal Diameter</td>
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<td>BPD</td>
<td>Cystic Adenomatoid Malformation</td>
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<td>Crown Rump Length</td>
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<td>Computerized Tomography</td>
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<td>Human Papilloma Virus</td>
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<td>Inner Orbital Diameter</td>
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<td>IOD</td>
<td>International Reference Preparation</td>
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<td>Infantile Recessive Polycystic Kidney Disease</td>
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<td>Intrauterine Growth Restriction</td>
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<td>Large for Gestation Age</td>
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<td>LGA</td>
<td>Luteinizing Hormone</td>
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<td>Luteinizing Hormone Releasing Factor</td>
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<tr>
<td>LHRF</td>
<td>Last Menstrual Period</td>
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</table>
| LMP | Return to Table of Contents »
MA Menstrual Age
MCDK Multicystic Dysplastic Kidney
MHz Megahertz
MI Mechanical Index
MIU Milli-International Units
MRI Magnetic Resonance Imaging
MSAFP Maternal Serum Alpha-Feto Protein
MSD Mean Sac Diameter
MVP Maximum Vertical Pocket

OFD Occipital Frontal Diameter
OOD Outer Orbital Diameter

P1 Pulsatility Index
PID Pelvic Inflammatory Disease
PUBS Percutaneous Umbilical Blood Sampling
PUV Posterior Urethral Valve

RI Resistive Index

S
2ndIS Second International Standard
SGA Small for Gestation Age
S/D ratio Systolic/Diastolic Ratio
SHG Sonohysterography
STI Sexually Transmitted Infection
SUA Single Umbilical Artery
SVC Superior Vena Cava

TI Thermal Index
TOA Tubo-Ovarian Abscess
TRAP Twin Reversed Arterial Perfusion
TTTS Twin-to-Twin Transfusion Syndrome

UPJ Ureteropelvic Junction
UVJ Ureterovesical Junction

VCUG Voiding Cystourethrogram

ZIFT Zygote Intrafallopian Tube Transfer
Utilized References


