Sonographic Abnormalities of the Placenta and Umbilical Cord

Ivana M Vettraino, MD, MBA
Maternal Fetal Medicine
Associate Professor, Michigan State University
Here, There and Everywhere
Objectives

• Understand development of the placenta and umbilical cord

• Recognize the prenatal sonographic appearance of common and uncommon placental abnormalities

• Recognize the prenatal sonographic appearance of common and uncommon umbilical cord abnormalities

• Understand which additional specific sonographic images to obtain following identification of a suspected placental or umbilical cord abnormality during prenatal sonogram

• Identify those patients at risk for placental abnormalities
Introduction

**Placenta**
- Transfer site for oxygen, carbon dioxide, and building blocks for the fetus
- Synthesizes many proteins and other substances

**Umbilical cord**
- Conduit for oxygenated and non-oxygenated fetal blood to the placenta
Placental Development

- **Begins at implantation (Day 5 to 6 post fertilization)**
  - Embryonic pole of blastocyst contacts uterine epithelium
    - Outer cell layer (Trophoblast) becomes the placenta
    - Inner cell layer (Extraembryonic (EE) mesodermal cells)

- **Day 13 post fertilization**
  - Formation of placental villi begins
    - Outgrowths of trophoblast proliferate laterally into the IVS
    - Trophoblast shell gradually breaks open allowing maternal blood to enter the placental lacunae
  - Known as “homochorial placentation”
Placental Development

**Summary**

- Villi form over the entire chorionic sac
- By end of the first trimester
  - Villi regress from all except the deep pole
    - Chorion levae
  - Remain as the definitive discoid placenta
    - Chorion frondsum
    - The decidua
- Abnormalities in this process result in persistence of villi at abnormal sites on the chorionic sac
  - Accessory or succenturiate lobes
Ultrasound

- **As early as 10 weeks’ gestation**
  - Placenta visible
    - Thickening of the hyperechoic rim around gestational sac
- **12 to 13 weeks’ gestation**
  - Intervillous blood flow can be seen by color Doppler
- **14 to 15 week’s gestation**
  - Placenta seen as hypoechoic area
  - Retroplacental complex
    - Decidua
    - Myometrium
    - Uterine vessels
The Early Sonogram
The Early Sonogram
The Early Sonogram
The Early Sonogram

The exocoelomic cavity (ECC)
- The space between the trophoblast/chorion and the amnion/yolk sac
- Large fluid-filled space

Ultrasound
- Visible using a transvaginal probe toward end of third week post fertilization (fifth week of menstrual age)
- Between 5 and 9 weeks of pregnancy represents largest anatomic space within the chorionic sac
- By the end of 3rd month
  - Amnion abuts the inner surface of the chorion
  - ECC is obliterated
The Early Sonogram
The Early Sonogram
The Early Sonogram

Non-fusion of the amnion/chorion
The Placenta

Term placenta

- Discoid - 15 to 20 cm in diameter
- Ovoid at high altitude
- 3 cm at the center
  - Should not be thicker than 4 cm at term
  - (Thickness in mm = to gestational age in weeks)
- 500 grams in weight

Size is a reflection of the health and size of the fetus
Placental Disc

Thin placenta (placentomalacia)

Associations

- Small for gestational age fetus
- Intrauterine infection
- Chromosomal abnormalities
- Severe polyhydramnios
Placental Disc

Thick placenta (Placentomegaly)
- Technical artifact
- Small area of attachment to the uterine wall
- Heterogenous
  - Molar pregnancy
  - Triploidy
  - Placental hemorrhage
- Homogenous
  - Maternal diabetes
  - Fetal Anemia
  - Hydrops
  - Infection
  - Chromosomal abnormalities
Normal Placenta
Placental Disc
Placental Disc

- **Circumvallate placenta**
  - Abnormality of placental shape
  - Membranes insert toward the center of the placenta
    - Rolled, thickened membranes
  - Complications
    - Hemorrhage
    - Infarction
    - Abruption
    - Fetal growth restriction
    - Preterm labor/delivery
  - May be partial or complete

- Complications
Circumvallate Placenta
Circumvallate Placenta

Uterine Synechiae
Circumvallate Placenta

Uterine Synechiae
Circumvallate Placenta
Circumvallate Placenta
Circumvallate Placenta
Decision Tree

- Shelf-like structure in multiple planes
  - YES
    - Associated with placental edge
      - NO
        - Placental edge is raised and curled circumferentially around the placenta
          - NO
            - Synechia
          - YES
            - Circumvallate Placenta
    - NO
      - Any of the following:
        - Web-like avascular bands
        - Bands attaching to fetus
        - Bands restricting motion
        - Constriction rings
        - Amputation defects
        - Multiple severe anomalies
      - YES
        - Amniotic Band Syndrome
      - NO
        - Other?
Placental Disc

**Circumvallate placenta**

- Sonographic appearance
  - Irregular rolled up edge of placenta
  - Appears like a shelf or band
  - Can be confused with a uterine synechiae
  - Upturned edge may contain hypoechoic or cystic spaces
Placental Disc

Placental calcifications

- No proven correlation with pregnancy outcome

Etiologies

- Maturation
  - Grading of the placental no longer in vogue
- Maternal tobacco use
- Maternal thrombotic disorders on anti-coagulation therapy
Placental Calcifications
Placental Calcifications
Placental Infarcts
Placental Disc

**Succenturiate (accessory) lobe**

- Associations
  - Infarction
  - Velamentous cord insertion
  - Vasa previa
- Must assess where fetal vessels connect to the main body of the placenta
- Color Doppler can be useful
Placental Disc

Succenturiate/Accessory Lobes
Placental Disc

Succenturiate/Accessory Lobes
Caution
Placental Masses

**Placenta tumors**

- **Chorioangioma**
  - Most common benign tumor
  - Vascular mass arising from chorionic tissue
  - Small tumors found in 1% of examined placentas
  - Most clinically relevant mass (greater than 5cm)
    - 1 in 500 to 1 in 16,000 live births

**Complications**

- None
- Fetal hydrops from high output cardiac failure due to “steal” phenomena
Placental Masses

Placenta tumors

Chorioangioma

Sonography

Well-circumscribed round mass near chorionic surface

Often near umbilical cord insertion

Sonographic measures

MCA Doppler

Evaluation for fetal hydrops

Serial sonograms every 2 to 3 weeks to assess the fetus if mass around 5 cm

More often if larger
Placental Masses
Placental Masses
Placental Masses
Placental Masses

Placental infarct 21 ½ weeks’ gestation
Placental Masses
**Abdominal Circumference**

- **AC (mm)**
- **EGA (wks)**

**Biparietal Diameter**

- **BPD (mm)**
- **EGA (wks)**

**Head Circumference**

- **HC (mm)**
- **EGA (wks)**

**Femur Length**

- **FL (mm)**
- **EGA (wks)**

---

Placental Mass
Placental Mass
Placental Masses

- **Lakes**
  - Enlarged spaces filled with maternal blood
  - Appear nearly black
  - Slow swirling blood seen within the spaces
  - Considered a normal finding
  - Can be associated with IUGR
  - Can mimic molar pregnancy
  - Caution with history of previous uterine surgery
Placental Cysts

- Most surface cysts associated with normal pregnancy outcome
- Related to cystic change in an area of subchorionic fibrin
- Cysts larger than 4.5 cm or more than 3 in number are associated with intrauterine growth restriction
Placental Cyst
Placental Abruption

- A clinical diagnosis - not an ultrasound diagnosis
- Premature separation normally implanted placenta

Associations
- Maternal hypertension
- Preeclampsia
- Abdominal trauma
- Cocaine abuse
- Tobacco use
- Advanced maternal age
Placental Abruption

**Sonography**
- **Hemorrhage**
  - Acute - hyperechoic
  - 3 to 7 days - isoechoic
  - 1 to 2 weeks - hypoechoic
  - Greater than 2 weeks - complex appearance
- **Retroplacental hypoechoic area**
  - Must distinguish from complex of uteroplacental vessels
    - Should be less than 1 to 2 cm in thickness
  - Can be confused with a myoma or uterine contraction
  - Color Doppler interrogation useful
Placental Abruption
Subchorionic Bleed
Placental Hemorrhages

AJR 2001; 176:607-615
Sub-Amniotic Bleed
Placenta Previa

*Placenta over the internal cervical os*

*Primary cause of third trimester bleeding*

*0.5 to 1 percent of term pregnancies*

*Risk factors*

- Advanced maternal age
- Multiparous patients
- History of cesarean section
- History of uterine curettage

*Low-lying placenta*

- Placental edge within 2 cm from the internal cervical os
Placenta Previa

Sonography

- Transabdominal scanning
  - Artifact from distended bladder
  - Artifact from localized uterine cramp
  - 25 percent of placental location incorrectly noted
- Translabial scanning
  - Reliable for placenta $\geq 2$ cm from internal cervical os
  - Less reliable for placenta $\geq 1$ cm from internal cervical os
- Transvaginal scanning
  - No contraindication
  - Probable gold-standard
Artifact Of Full Bladder
Placenta Previa
Low-lying Placenta

**Sonography**
- Second trimester
  - Very common
  - Only 1 to 5 percent persist into 3\textsuperscript{rd} trimester
- Translabial scanning
- Transvaginal scanning
Low-lying Placenta
Placenta Accreta

- Abnormal adherence of placenta to uterus resulting in failure to separate following delivery
- Three categories:
  - Accreta
  - Increta
  - Percreta
- Prevalence:
  - 1 in 2500 pregnancies
  - 1 in 10 with placenta previa
- Risk factors:
  - Prior cesarean section
  - Advanced maternal age
Placenta Accreta

**Sonography**

**Findings**
- Retroplacental hypoechoic area is absent
- Prominent multiple lacunae within the placenta
  - “Swiss cheese” appearance
- Marked periplacental vascularity on color Doppler interrogation

Transvaginal sonogram with power Doppler should be considered in cases of an anterior placenta in patients at risk

MRI can be helpful in suspicious cases or in cases with a posterior placenta
Placenta Accreta
Placenta Accreta

Placenta Accreta

Gestational sac with low implantation

J Ultrasound Med 22:19-23 • 0278-4297
The Umbilical Cord

1. Ductus omphalo-entericus
2. Allantois
3. Umbilical Vein
4. Umbilical arteries
5. Amnion
The Umbilical Cord

- Lifeline between the fetus and placenta
- Formed by the fifth week of development
- Protects the vessels that travel between the fetus and the placenta
By end of 3rd week of development embryo attached to placenta by a connecting stalk comprised of 5 structures.

By the end of 1st trimester structures disappear:
- Omphalo-enteric duct (Meckel’s diverticulum)
- Umbilical vesicle of the allantois (Umbilical ligament)
- Vitelline circulation system in the extra-embryonic region
- Umbilical coelom, which clumps and disappears

Resulting in 2 arteries and 1 vein surrounded by an amniotic epithelial layer.

Warton jelly forms as connective tissue of the body stalk and the amnion.
The Umbilical Cord

- Normally contains two umbilical arteries and one umbilical vein
- Approximately 1% of all umbilical cords contain only one artery—rather than the normal two

**Associations**
- Variation of normal
- Cardiovascular anomalies in 15-20%
- Renal anomalies
- SGA baby
- Maternal smoking during pregnancy
Single Umbilical Artery
3 versus 2 vessel Umbilical Cord
The Umbilical Cord

**Other pathologies**

- Mid-gut herniation
  - Loops of bowel found within the proximal portion of the cord between 10 to 13 weeks’
  - Meckel’s diverticulum
- Intrinsic processes
  - Inflammation, knots and torsion
- Extrinsic damage
  - Following invasive, diagnostic procedures
The Umbilical Cord
The Umbilical Cord

Placental insertion variations

Central insertion
  Most common
Marginal insertion (Very edge of placenta)
  Approximately 7% of single births
  “Battledore”
Velamentous insertion
  Fetal vessels course through membranes before entering placenta
  Approximately 1% of pregnancies
  Associated with fetal growth restriction
Vasa previa
  Vessels course near or over the internal cervical os
The Umbilical Cord

Pathologies of the umbilical cord

Length
- Normal length - 50 and 60 cm with a diameter of 1.5 cm
- Can be too short (seldom) or too long (more prevalent)

Placental cord insertion
- Velamentous, marginal or eccentric

Number of vessels
- Normally contains two arteries and a vein
- Single umbilical artery
  - One newborn per 200 births
  - Associated with cardiac and renal anomalies as well as fetal growth restriction
Images

Velamentous cord insertion
The Umbilical Cord

Pathologies of the umbilical cord

Length

Short cord
- Increase risk of congenital anomalies, trisomy 21, oligohydramnios, breech presentation

Abnormally long cords
- Knots
  - True
  - False
- Nuchal cords
  - 25 percent of pregnancies
  - Two or more are worrysome
- Cord prolapse
Umbilical Cord
Pathologies of the umbilical cord

Coiling

Absence

4 % of fetuses

Associated with increase perinatal morbidity and mortality

Increase risk of trisomy 21, velamentous cord insertion, coarctation of the aorta, intrauterine death, preterm birth
The Umbilical Cord

Pathologies of the umbilical cord

- **Cysts**
  - 3.4 percent of 1st trimester fetuses
  - Associated with fetal anomalies and aneuploidy
    - 50 percent of cases

- **Sonographically**
  - **True cysts**
    - Encircled by color Doppler blood flow
  - **Pseudocysts**
    - Due to areas of focal edema within the Warton’s jelly
    - Do not have peripheral blood flow
Umbilical Cord Varix

http://www.fetalultrasound.com/online/text/34-023.htm
Umbilical Cord Varix

Vasa Previa

- Rare but life threatening to the fetus
- Fetal vessels cross over or near the internal cervical os
- High index of suspicion necessary
  - Velamentous cord insertion
  - Accessory/succenturiate lobe
  - Resolution of a placenta crossing the internal cervical os
Vasa Previa

- **Sonography**
  - Index of suspicion
  - Color Doppler
  - Must distinguish from free loops of umbilical cord over the cervix

  - Re-examine patient at a later time
  - Note that the cord is free floating and moves away from the cervix with change in maternal position
Images

Vasa Previa
Vasa Previa
The Umbilical Cord

• Diagnostic utility of the umbilical cord
  • Noninvasive methods to assess fetal well-being
  • Assessment of fetal blood flow through umbilical cord
  • Doppler interrogation of the umbilical artery
    • Measuring amount of forward blood flow through the umbilical artery during fetal systole and diastole
    • More forward blood flow from the fetus to the placenta through the umbilical artery, the healthier the fetus
Miscellaneous
Amniotic band