Imaging of Abnormal Placental Implantation: A Patient with Placenta Percreta

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Agenda

• Patient L.S.
• Menu of Tests
• Anatomy of Female Pelvis and Placenta
• Abnormal Placental Implantation
• Film interpretation
• Differential Diagnosis
• Conclusions
Agenda: Patient L.S.

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Patient L.S.: History of Present Illness

CC: Placenta previa with vaginal bleeding

HPI:
• 32 year old female G3P2 at 18 weeks GA
• Presents with episode of bright red vaginal blood
  • Bleeding has subsided
  • Denies contractions, cramping, pain
  • Bleeding episode at 5 weeks GA
  • Diagnosed with placenta previa by US
  • No bleeding since first episode
Patient L.S.: Past Obstetrical History

Past Obstetrical History:
- Cesarean section
  - Arrest of descent
- Cesarean section
  - Repeat, twin intrauterine pregnancy

Reason for Imaging:
Narrow differential diagnosis
- Placenta accreta
- Placenta increta
- Placenta percreta
Agenda: Menu of Tests

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Menu of Tests:
Obstetrical Imaging in 2nd and 3rd Trimester

Preferred imaging modalities:
• Ultrasound (US)
• Magnetic Resonance Imaging (MRI)
  – Abdominal MRI, -contrast

Lesser used studies:
• Radiograph
• Computed Tomography (CT)
  – Abdominal CT, -contrast
Effects of Ionizing Radiation

**Increased risk:**
- Miscarriage
- Congenital anomalies
- Genetic disease
- Growth restriction
- Developmental disorders

**When imaging modality necessary:**
- **Radiograph**
  - Wear lead apron to minimize fetal exposure
  - Fast film/screen combination or digital radiography
- **Computed Tomography**
  - Narrow collimation and wide pitch
  - Patient moves through scanner at faster rate

Brent, 2009
Menu of Tests: Ultrasound

Description:
- Transducer emits and receives sound waves
- Spatial distribution determined by time for sound waves to return

Advantages:
- No biologic effects documented
- No contraindications

Limitations:
- Difficult to image fetus in obese patients
- Operator dependent
  - Image quality depends on sonographer skill

Menu of Tests: Magnetic Resonance Imaging

Description:
• Magnets and radiowaves causes alignment of hydrogen protons
• Different electronic environments lead to different signals

Advantages:
• No ionizing radiation
• No reported harmful effects
• Excellent images of soft tissue

Limitations:
• Avoid in first trimester
  – No experience with safety during organogenesis
• Potential safety concerns
  – Induce local electric fields and currents
  – Radiofrequency radiation heats tissue
  – Projection of metal objects
• Gadolinium contrast not recommended
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Anatomy of Female Pelvis and Placenta

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Anatomy of Female Pelvis: Sagittal View

Fetus in Utero

- Placenta
- Umbilical Cord
- Amniotic Sac
- Fetus
- Uterus
- Uterine Wall
- Cervix
- Vagina
- Anus

Anterior

Posterior

http://www.rush.edu/rumc/page-1098987343902.html
Anatomy of the Placenta: Close-Up

http://utdol.com/online/content/image.do;jsessionid=F77F02EF28252E1638A20B402D73CB4E.1103?imageKey=obst_pix/placen4.htm&title=Placental%20vasculature
http://www.rush.edu/rumc/page-1098987343902.html
Anatomy of the Placenta: Maternal Surface

- Myometrium
- Endometrium
- Decidua

Myometrium

Endometrium

Decidua
  • Acts as barrier to invasion by fetal chorionic villi
Anatomy of the Placenta: Fetal Surface

Chorionic villi
• Can invade past decidua into maternal surface

Umbilical cord
Anatomy of the Placenta: Maternal and Fetal Surface

Myometrium
Endometrium
Decidua
Chorionic villi
Umbilical cord
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Placenta Previa: Definition and Types

Definition:
- Placenta overlies or lies proximal to internal cervical os

Types:
- A. Marginal
- B. Partial
- C. Complete
Placenta Previa: Clinical Facts

Risk factors:
• Endometrial scarring
• Cesarean delivery
• Increasing parity
• Increasing maternal age
• Prior curettage for abortion

Clinical presentation:
• Painless vaginal bleeding after 20 weeks
• Can present with uterine contractions

Diagnosis:
• Straightforward by US

http://www.aafp.org/afp/AFPprinter/20070415/1199.html
Faiz et al., 2003
Cotton et al., 1980
Placenta Accreta: Definition and Types

**Definition:**
- Chorionic villi attach to myometrium
- Villi invade past maternal decidua layer

**Types**
- **Accreta**  
  - Attach to myometrium
- **Increta**  
  - Invade into myometrium
- **Percreta**  
  - Invade past uterine serosa into organs

http://embryology.med.unsw.edu.au/Notes/images/placenta/anchoring-villi2.jpg
http://embryology.med.unsw.edu.au/Notes/placenta2.htm
Miller et al., 1997
Placenta Accreta: Clinical Facts

Risk Factors:
- Previous uterine surgery
- Prior cesarean delivery

Clinical Manifestations:
- Profuse hemorrhage after delivery
- Inability to separate placenta from uterus
- Life-threatening

Diagnosis:
- US and MRI
- No imaging modality determines diagnosis with absolute accuracy
  - US=Sensitivity 0.8, Specificity 0.95
  - MRI=Sensitivity 0.88, Specificity 1.00

http://embryology.med.unsw.edu.au/Notes/images/placenta/anchoring-villi2.jpg
http://embryology.med.unsw.edu.au/Notes/placenta2.htm
Miller et al., 1997
Warshak et al., 2006
Agenda: Approach to OB US

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• Film interpretation
  – Approach to Obstetrical Ultrasound
• Differential Diagnosis
• Conclusions
Approach to Obstetrical Ultrasound Evaluation

Check relevant structures:
- Anterior abdominal wall
- Uterus
  - Myometrium
- Placenta
- Amniotic Fluid
- Fetus
- Cervix
- Ovaries
- Bladder

Placenta Location:
- Anterior vs. Posterior uterine wall
- Cervical status
  Placenta previa?

Placenta texture:
- Homogeneous vs. heterogeneous
- Distinct myometrial surface?
Analyzing ultrasound images can be difficult, especially when the orientation of the images are not apparent.

Now that we have learned an approach to obstetrical ultrasound evaluation, let’s practice on Companion Patient 1 who has normal pelvic anatomy during pregnancy.

Refer back to these normal images and the color coding of the anatomical structures when examining the US images for our patient L.S.
Companion Patient 1: Orientation of Sagittal View on US

In these ultrasound images:

• The transducer was placed on anterior abdominal wall

• For sagittal views, patient’s legs are always to the right

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Location of Cross-Sectional Views

For these sagittal views, the transducer was placed in the following locations:

- Mid-uterus (MU)
- Cervix (CX)

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Anterior Abdominal Wall

Anterior abdominal wall

Hyperechoic structure with striations

Most anterior

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Uterus

Uterus, Myometrium

Hypoechoic structure under anterior abdominal wall

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Placenta

Placenta

Homogeneous hypoechoic structure lining uterine wall

Usually located on anterior uterine wall

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Amniotic Fluid

Amniotic Fluid
Anechoic area in uterine cavity, surrounding fetus

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Fetus

Fetus
In uterine cavity, surrounded by anechoic amniotic fluid

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Cervix

Cervix
Anechoic
Linear
Posterior to bladder

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Bladder

Bladder
Anechoic
Inferior to uterus

http://www.rush.edu/rumc/page-1098987343902.html
Companion Patient 1: Normal Pelvic Anatomy Summary

Anterior abdominal wall
Uterus, Myometrium
Placenta
Amniotic fluid
Fetus
Cervix
Bladder

http://www.rush.edu/rumc/page-1098987343902.html
Now that we have reviewed the normal female pelvic anatomy on US, let’s make some impressions:

**Placenta Location:**
- On anterior *uterine wall*
- Placenta does not extend to *internal cervical os*
- No evidence of previa

**Placental texture:**
- Homogeneous
- Distinct interface between *uterus* and *placenta*
Approach to Ultrasound Evaluation: Fetus

Number of gestations
• Single or multiple

Position
• Cephalic or breech

Fetal Heart Rate
• Normal is >100 bpm

Dating by fetal measurements
• Head size
  – Biparietal diameter (BPD)
  – Head circumference (HC)
• Abdominal circumference (AC)
• Femur length (FL)

Amniotic fluid volume

Umbilical cord structure

Morphologic Abnormalities
Agenda: Film Interpretation

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- Abnormal Placental Implantation
- Film interpretation
  - Patient MV
- Differential Diagnosis
- Conclusions
Our Patient L.S.: Placenta Previa on US

Film Findings:
1. Placenta located on anterior uterine wall
2. Placenta extends over internal cervical os

Impression 1:
Placenta previa
Our Patient L.S.: Placenta Previa on US, Labeled

**Film Findings:**
1. Placenta located on anterior uterine wall
2. Placenta extends over internal cervical os

**Impression 1:**
Placenta previa
Our Patient L.S.: Placenta Previa on US, Labeled

Film Findings:
1. Placenta located on anterior uterine wall
2. Placenta extends over internal cervical os

Impression 1:
Placenta previa

Our Patient L.S.: 
Increased Vascularity in Myometrium with Linear-Array US

Linear-array transducer
- Fine image resolution
- Sound waves cannot penetrate as deep
Our Patient L.S.:  
Increased Vascularity in Myometrium on Linear-Array US, Findings

Film Findings:  
1. Loss of the myometrial and placental interface anteriorly  
2. Increased vascularity extending into myometrium
Our Patient L.S.:
Increased Vascularity in Myometrium on Linear-Array US, Labeled

Film Findings:
1. Loss of the myometrial and placental interface anteriorly
2. Increased vascularity extending into myometrium
Our Patient L.S.:
Increased Vascularity in Bladder Wall on US, Labeled

Film Findings:
1. Hypoechoic tubular structure representing placental vein extending into myometrium
2. Increased vascularity in bladder wall
Our Patient L.S.: Increased Vascularity in in Bladder Wall on US, Labeled

Film Findings:

1. Hypoechoic tubular structure representing *placental vein* extending into myometrium

2. *Increased vascularity* in bladder wall
Our Patient L.S.:
Increased Vascularity in Bladder Wall on US, Labeled

Impression 2: Differential Diagnosis
Placenta accreta
Placenta increta
Placenta percreta

http://embryology.med.unsw.edu.au/Notes/placenta2.htm
Our Patient L.S.: Fetal Examination on US

Number of gestations
- Single

Position
- Breech

Fetal Heart Rate
- Normal 154 bpm

Dating by fetal measurements
- BPD=3.45 cm
- HC=13.63 cm
- Age by US=17 weeks

Amniotic fluid volume
- Normal

Umbilical cord structure
- Normal

Morphologic Abnormalities
- None
Our Patient L.S.: Follow-Up

**Impression:**
1. Placenta previa
2. Placenta accreta, possible placenta percreta
3. Normal survey of fetus

**Recommendations:**
- Follow-up with US and MRI closer to delivery
Our Patient L.S.: Loss of Placental Myometrial Interface on F/U US

Film Findings:
1. Loss of normal placental myometrial interface anteriorly
2. Increased vascularity extending to bladder wall

Impression:
• Suggestive of Placenta Percreta
Our Patient L.S.: Loss of Placental Myometrial Interface on F/U US, Labeled

Film Findings:
1. Loss of normal placental myometrial interface anteriorly
2. Increased vascularity extending to bladder wall

Impression:
• Suggestive of Placenta Percreta
Our Patient L.S.:  
Increased Vascularity in Bladder Wall on F/U US

Film Findings:
1. Irregular superior bladder wall
2. Increased vascularity in bladder wall

Impression:
• Suggestive of Placenta Percreta

Transvaginal US, Low Uterus, Transverse View
Transvaginal US Color Doppler, Low Uterus, Transverse View

PACS, BIDMC
Our Patient L.S.:
Increased Vascularity in Bladder Wall on F/U US, Labeled

Film Findings:
1. Irregular superior bladder wall
2. Increased vascularity in bladder wall

Impression:
• Suggestive of Placenta Percreta
Our Patient L.S.: F/U Fetal US Examination

Film Findings:

- **Fetal Heart Rate**
  - Normal 158 bpm

- **Normal growth**
  - BPD=7.01 cm
  - HC=9.08 cm
  - Age by US=28 weeks, 1 day
Approach to Obstetrical MRI Evaluation

• **Check relevant structures:**
  – Anterior abdominal wall
  – Uterus
    • Myometrium
  – Placenta
  – Amniotic Fluid
  – Fetus
  – Cervix
  – Ovaries
  – Bladder

• **Placenta Location:**
  – Anterior vs. Posterior uterine wall
  – Cervical status
    • Placenta previa?

• **Placenta texture:**
  – Homogeneous vs. heterogeneous
  – Distinct myometrial surface?
Approach to MRI Evaluation: Fetus

Number of gestations
• Single or multiple

Position
• Cephalic or breech

Morphologic Abnormalities
• Better soft tissue contrast
  • Head, face, heart, outflow tracts, stomach, kidneys, cord insertion site, bladder, spine, extremities
• Congenital abnormalities
Our Patient L.S.: Marginal Placenta on MRI

Film Findings:
1. Placenta location
   • Low anterior position
   • Extends more posterior on left
2. Placenta extension
   • Margin of the internal cervical os
   • But does NOT cover os

Impression 1:
Marginal Placenta
Our Patient L.S.: Marginal Placenta on MRI, Labeled

Filmed Findings:

1. Placenta location
   • Low anterior position
   • Extends more posterior on left

2. Placenta extension
   • Margin of the internal cervical os
   • But does NOT cover os

Impression 1:
Marginal Placenta

Abdominal T2 Weighted MRI, Coronal View
Before examining the placenta on MRI in our patient L.S., let’s first examine the placenta in a normal pregnancy.

When examining a normal pregnancy on MRI, there is a distinct interface between the placenta and uterus.
Our Patient L.S.:
Loss of Interface between Myometrium and Placenta on MRI

Film Findings:
1. Anterior loss of normal myometrium overlying the placenta
2. Prominent intramural vessels in anterior wall of uterus
Our Patient L.S.:
Loss of Interface between Myometrium and Placenta on MRI, Labeled

Film Findings:
1. Anterior *loss of normal myometrium* overlying the placenta
2. Prominent *intramural vessels* in anterior wall of uterus
Film Findings:
1. Loss of normal myometrial signal at lower uterine segment
2. Placental tissue extends to roof of the bladder
3. Vessels contiguous with placenta extend into bladder roof
Film Findings:
1. **Loss of normal myometrial** signal at lower uterine segment
2. Placental tissue extends to roof of the bladder
3. **Vessels contiguous** with placenta extend into bladder roof
Impression 2:
Placenta percreta involving inferior aspect of lower uterine segment, tissue extends into roof of bladder
Before examining the fetus in our Patient L.S. on MRI, let’s first examine the fetus in a normal pregnancy.

In a normal pregnancy, the fetus is usually in a cephalic position, with the head pointing towards the cervix.
Our Patient L.S.: Fetal Examination on MRI

Film Findings:
1. No gross fetal abnormality
2. Footling breech

PACS, BIDMC
Our Patient L.S.: Fetal Examination on MRI, Labeled

Film Findings:
1. No gross fetal abnormality
2. Footling breech
Use of Imaging in Abnormal Placental Implantation

Impression:
1. Marginal Placenta
2. Placenta Percreta

Recommendations:
• Prevention of life-threatening delivery
• Prepare Urology, Gyn/Onc, Interventional Radiologist Consult
• Prepare for Cesarean Hysterectomy, Partial Cystectomy
• Prepare fluids, RBC, FFP availability at delivery
At 29 weeks GA, presented with progressive bleeding and contractions
  Proceeded with delivery
  Cesarean delivery, supracervical hysterectomy, partial cystectomy

Estimated blood loss: 4500cc
  Received 5 liters IV fluids, 6 units of packed RBC, 2 units of FFP

Cystogram after partial cystectomy
  Irregular contour consistent with partial cystectomy
  No evidence of bladder leak
Our Patient L.S.: Epilogue

• Baby girl was born at 31.1 weeks
  – Liveborn female weighing 1550 grams
  – APGARs of 2 and 8
  – Admitted to NICU

• Last progress report indicates:
  – The baby was still in NICU at 37 weeks
  – She would go home at 39 weeks
  – She has been successfully breastfeeding
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Conclusions

• US and MRI are preferred imaging modalities during pregnancy to avoid fetal exposure to ionizing radiation

• Abnormal placental invasion can lead to life-threatening hemorrhage

• No imaging modality diagnoses abnormal placental invasion with absolute accuracy

• US and MRI can help make pre-operative plans to prevent life-threatening emergencies
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References


