Use of Ultrasound on Labor and Delivery

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Conflict of Interest

- Dr. Hobbins has voluntarily disclosed that he does not have a financial affiliation with a commercial organization
- He does not intend to discuss or describe any off-label or investigational use of a medical device or pharmaceutical during this presentation

Learning Objectives

- Learn how to precisely perform cervical length measurements using ultrasound
- Describe how ultrasound can be used to evaluate the uterine scar, placental location, amniotic fluid volume, preterm or premature rupture of membranes
- Understand how ultrasound can be used to assess fetal head station
Cervical Length

A key to preterm labor

Most patients presenting with contractions in late pregnancy prior to 36 weeks are NOT in preterm labor.

Our job is to pick out the ones that are in PTL and leave the others alone.
**Cervical Length**

Cervical length in threatened PTL in singletons with intact membranes

<table>
<thead>
<tr>
<th>CL</th>
<th>Delivery within 48 hrs</th>
<th>Delivery within 7 days</th>
<th>Delivery &lt; 35 wks</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 m</td>
<td>9/ 20 (45%)</td>
<td>16/ 20 (80%)</td>
<td>17/ 20 (85%)</td>
</tr>
<tr>
<td>6-10 mm</td>
<td>8/ 28 (28.6%)</td>
<td>12/ 28 (42%)</td>
<td>16/ 28 (57%)</td>
</tr>
<tr>
<td>11-15 mm</td>
<td>4/47 (8.5%)</td>
<td>14/47 (30%)</td>
<td>21/47 (44.7%)</td>
</tr>
<tr>
<td>16-20 mm</td>
<td>0/ 76 (0%)</td>
<td>0/ 76 (0%)</td>
<td>5/ 76 (6.6%)</td>
</tr>
<tr>
<td>&gt; 20 mm</td>
<td>0/339 (0%)</td>
<td>1/339 (0.3%)</td>
<td>17/339 (5.0%)</td>
</tr>
</tbody>
</table>


**Conclusion**

Very compelling evidence for the worth of CL in PTL!
Cervical Length in Preterm Labor

- 253 women with preterm labor
  - 21 delivered preterm (8.3%)

- If CL ≥ 1.5 cm, 1.8% delivered < 7 days
- If CL < 1.5 cm, 47.2% delivered < 7 days


Cervical Length in Preterm Labor: Rate of delivery within 7 days according to cervical length


The Length of the Cervix and the Risk of Spontaneous Premature Delivery

Iams JD, Goldenberg RL, et al and the MCHD MFM Unit Network
Funneling and Membranes

The Role of Cervical Length in PROM

1. To determine whether or not membranes are actually ruptured

2. To estimate the length of the latent period

Are membranes actually ruptured?

1. Assess the integrity of the amnion coursing over the cervix
Fluid in the vagina

Flow of fluid in real time

Intact Membranes
Ruptured Membranes

PROM

Latency Period
- 100 pts pPROM:
  - if CL < 2 cm, average latency period 59 hrs
  - if CL ≥ 2 cm, average latency period 10 days

Cervical Length and pPROM: Revisited
- 101 women with pPROM
  - 58 delivered within 7 days
- Highly correlated with:
  - cervical length
  - presence or absence of contractions
  - gestational age

Cervical Length and pPROM: Revisited

Relationship between cervical length and incidence of delivery within 7 days of ROM


Third Trimester Bleeding

Ultrasound:
- Rules out placenta previa
- May help to rule out placenta abruptions
- Will not rule out cervical bleeding

Placenta Previa

Use transabdominal ultrasound
- first, with some urine in bladder
- then if placenta is in proximity of cervix, empty bladder
- use transabdominal ultrasound (TAU) and transvaginal ultrasound (TVU) together to complete diagnosis
Placenta Previa

<table>
<thead>
<tr>
<th></th>
<th>CSR</th>
<th>Bleeding before delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>If placenta 10 - 22 mm away</td>
<td>31%</td>
<td>3%</td>
</tr>
<tr>
<td>If placenta 1 - 10 mm away</td>
<td>75%</td>
<td>29%</td>
</tr>
</tbody>
</table>

No difference in blood loss at delivery or postpartum hemorrhage

Placenta Abruption

- Look for extra membranous clot
- Do not expect to visualize site of separation
- Not visualizing clot does not rule out abruption
Vasa Previa

- Incidence – 1 : 2500
- Risk Factors
  - Multiple pregnancies
  - 2nd trimester low-lying placenta
  - I VF
  - Bleeding
  - Bi-lobed / Succenturiate lobed placenta
  - I VF 1 in 290
- Types
  - (1) Velamentous cord insertion
  - (2) Succenturiate placenta
- Mortality – 70-90%

Gray-scale: echolucent structure over cervix

Vasa previa

Color Doppler: confirms vessels

Vasa Previa
Pulsed Doppler: UA flow. Confirms Dx = Vasa Previa

145 bpm

Reactive NST prior to AROM

Sinusoidal pattern after ROM
Color Doppler Findings Associated with Placenta Accreta

- Diffuse and focal placental lacunar flow
- Bladder and uterine serosal hypervascularity
- Prominent subplacental venous complex


Color Doppler Findings Associated with Placenta Accreta

- Study of Doppler evaluation of 80 women with previa and high risk of accreta
  - Dx suspected in 16 pts
  - Confirmed in 14/16 by pathology
  - 82% sensitivity, 97% specificity
Intraplacental sonolucent spaces or “venous lakes” are observed adjacent to involved uterine wall – “Swiss cheese appearance”

Normal interface between placenta and myometrium: Characterized by a hypoechoic boundary representing the myometrium & normal retroplacental vasculature

Placenta Accreta: Hypoechoic boundary between placenta & bladder is lost Placenta appears contiguous with the bladder wall
Use of Ultrasound Prior to VBAC

Which patients should not have a trial of labor?

Study from Japan

- No uterine ruptures when thinnest myometrial diameter was more than 2.9 mm
- 30% uterine rupture when diameter less than 2.0 mm
- Consider routine evaluation of lower uterine segment in VBACs


Uterine Wall Scars

Lancet 1996; 347: 281-284

- Ultrasound and uterine wall scars
- 642 patients with previous C-sections
- All had TA ultrasound evaluation of lower uterine segment (one investigator in all)
  - Vaginal delivery 60.1%
  - CSx (1/2 emergency) 39.9%
  - Uterine rupture 2.5%
  - Dehiscence 1.5%
**Uterine Wall Scars**  
*Lancet* 1996; 347: 281-284

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 4.5 mm</td>
<td>100%</td>
<td>45.0%</td>
<td>6.9%</td>
</tr>
<tr>
<td>≥ 3.5 mm</td>
<td>88.0%</td>
<td>73.2%</td>
<td>11.8%</td>
</tr>
<tr>
<td>≥ 2.5 mm</td>
<td>32.0%</td>
<td>93.0%</td>
<td>15.7%</td>
</tr>
</tbody>
</table>

**Conclusion**

- If thinnest uterine wall diameter is > 3.5 mm, negative predictive value was 99.3%
- 16% of those with 1.6 - 2.5 mm had scar defect

∴ Safe to do VBAC if uterine wall is adequate thickness

**Technique for Evaluation of Uterine Scar**
Uterine Scar

Uterine Scar

Uterine Scar

Uterine Scar
**Uterine Scar Thickness**  
Latest Paper from Montreal

- 236 patients - half had TOL
- 9 uterine scar defects
- 3 through-and-through ruptures
- Scans 36-37 weeks (TA)
- ROC = 2.3 mm


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**Logistic regression analysis for factors that were associated with uterine scar defect**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Before Adjustment</th>
<th>After Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full lower uterine segment thickness &lt; 2.3 mm</td>
<td>5.09 (1.24 - 20.98)</td>
<td>4.6 (1.04 - 20.91)</td>
</tr>
<tr>
<td>Single-layer closure</td>
<td>5.79 (1.48 - 22.65)</td>
<td>6.54 (1.39 - 30.82)</td>
</tr>
<tr>
<td>Interdelivery interval, mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 18</td>
<td>0.79 (1.49 - 31.01)</td>
<td>0.74 (1.37 - 60.57)</td>
</tr>
<tr>
<td>18 - 24</td>
<td>1.11 (0.14 - 10.89)</td>
<td>1.42 (0.14 - 12.86)</td>
</tr>
<tr>
<td>≥ 24</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

CI, confidence interval

Preoperative Evaluation Prior to Cesarean Section

- Check placental location
- Confirm fetal position
- Type of uterine incision if transverse lie
- Whether placenta accreta
- Shortest way in (obesity)
- Knowing where the cord inserts

Low Lying Placenta & Uterine Incision

External Version and Amniotic Fluid Index

- The relationship of amniotic fluid volume to success
- 1,361 pts for version

<table>
<thead>
<tr>
<th>AFI (cm)</th>
<th>Success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>41.9%</td>
</tr>
<tr>
<td>10-15</td>
<td>51.9%</td>
</tr>
<tr>
<td>&gt; 15</td>
<td>64.5%</td>
</tr>
<tr>
<td>However, in patients with AFI &lt; 5 cm, success in 40%</td>
<td></td>
</tr>
</tbody>
</table>

Umbilical Vein

- Another U/S parameter to assess fetal condition in labor – the umbilical vein
- 26 patients with “pathological” FHR patterns
- 26 patients with normal FHR tracings
- Presence or absence of umbilical vein pulsations inside the liver
- Providers were blinded to results of umbilical vein Dopplers

Umbilical Vein (continued)

- 8 of the pathological group had pulsations and 75% had operative delivery for fetal distress. The remaining 18 did not have operative delivery.
- None of those in the normal group had pulsations and none had an operative delivery.


Umbilical Vein in Labor

- Conclusion:
  - Addition of umbilical vein Doppler may further sort out true fetal distress in those patients with worrisome fetal heart rate patterns.

Umbilical Vein

Normal

Abnormal

Cord Around the Neck

Nuchal Cords and Outcome of Delivery

- Nuchal cords - *What is the meaning of this finding?*
- 118 consecutive cases in which a nuchal cord was identified between 17-36 wks
- 233 randomized matched controls

Nuchal Cords and Outcome of Delivery

Comparison of Intrapartum and Neonatal Complications in the Study Population

<table>
<thead>
<tr>
<th>Complication</th>
<th>Nuchal cord (n=118)</th>
<th>No Nuchal cord (n=115)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA at del &lt;37 wk, %</td>
<td>21</td>
<td>11</td>
<td>.040</td>
</tr>
<tr>
<td>Cesarean del, %</td>
<td>27</td>
<td>25</td>
<td>.741</td>
</tr>
<tr>
<td>Non-reassuring fetal heart tracing as indication for Cesarean delivery, %</td>
<td>26</td>
<td>21</td>
<td>.378</td>
</tr>
<tr>
<td>Fetal heart rate abnormalities as described in “Materials &amp; Methods”, %</td>
<td>36</td>
<td>32</td>
<td>.487</td>
</tr>
<tr>
<td>Meconium-stained amniotic fluid present, %</td>
<td>17</td>
<td>14</td>
<td>.655</td>
</tr>
<tr>
<td>5-min Apgar score &lt;7, %</td>
<td>5.2</td>
<td>5</td>
<td>.963</td>
</tr>
<tr>
<td>NICU admission ≥ 24 h, %</td>
<td>3</td>
<td>4</td>
<td>.487</td>
</tr>
</tbody>
</table>


U/S detection of nuchal cord prior to labor induction and the risk of Cesarean delivery

- 189 patients had U/S prior to induction of labor
- At delivery, 18% had nuchal cords
- Bad news: only 37.5% were detected
- Good news: nuchal cord did not affect need for Cesarean delivery or neonatal outcome

Are there ultrasound clues for shoulder dystocia?

Macrosomia: Chances of Shoulder Dystocia

- TD - BPD > 1.4 cm (Elliott)
- AD - BPD ≥ 2.6 cm (Cohen, et al)
- TC vs. HC in percentile (Winn)

AD = abdominal diameter = AC divided by 3.14
TC = thoracic circumference at level of 4-chamber heart
TD = thoracic diameter at level of fetal liver just below heart


Latest Shoulder Dystocia Study from Columbia University

- Re-evaluated AAD - BPD in 5,200 patients
- Incidence of SD (> 1 min, maneuvers in addition to McRoberts maneuver) was 6.9%
- Using 2.6 cm as threshold - 25% had SD in unselected patients
  - In diabetes, the risk of SD was 38.5%
- If <2.6 cm, 3.8% had SD in unselected patients, and 8% in diabetics

No Prenatal Care

- What are her dates?
- Preterm labor versus term SGA?
- Are there other markers of fetal maturity?
- Do I have to do an amniocentesis to prove pulmonic maturity?

Epiphyseal Ossification Centers


- Distal femoral epiphysis (DFE)
  - dimension in axial plane
  - mean appearance beginning at 32-33 weeks
  - can be seen as early as 29 weeks
  - absence of DFE most likely <34 weeks
  - size increases linearly with age
- DFE > 3 mm plus presence of proximal tibial epiphysis >2 mm correlated with L/S ratio > 2
  (sensitivity 100%, FNR 0%, NPV 96%)
- Does not include diabetics
Epiphyseal Ossification Centers
Mahoney, et al. Radiology 1986; 159: 521

- Proximal humeral epiphysis (PHE)
  - only 15% viable on CXR in neonates at 38 wks
  - 40% at 40-41 wks
  - 82% at 42 wks
- Proximal tibial epiphysis (PTE)
  - < 34 wks absent
  - 35 wks 35%
  - 37 wks 79%
  - 39 wks 100%
- Presence or absence of PHE/ PTE
Postpartum Bleeding

Revolutionizes management by avoiding unnecessary anesthesia and instrumentation.

Postpartum Hemorrhage (PPH)

- Lee et al (1981) evaluated 56 patients with ultrasound in evaluation of PPH
- 56 patients with PPH
- 9 patients retained products
- 5 patients abundant intrauterine clot
- 42 with empty cavity - responded well to pharmacologic intervention

Retained Products of Conception

Key Points

- Determining which pts are truly in PTL
- Determining if pts have rupture membranes
- Estimating latency period in PROM
- Assessing a pt’s candidacy for a trial of labor
- Looking for placenta previa, abruption and accreta
- Monitoring progress in the second stage of labor
- Quickly determining the cause of postpartum hemorrhage