Novel Approaches to Managing Umbilical Cord and Placental Issues

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Causes of fetal death after 20 weeks' gestation

God-given safeties in umbilical cord

- Amniotic fluid
- Wharton's jelly
- Coiling
- Two arteries

When these favorable mechanisms are broken down, fetus might be at risk!
Umbilical cord abnormalities

- Abnormal cord insertion
- Hyper- or Hypo-coiled cord
- Cord entanglement
- Single umbilical artery
- Umbilical cord prolapse

Abnormal Cord Insertion

Normal placenta and umbilical cord
Abnormal Cord Insertions

- Marginal: 5%
- Velamentous: 2%
- Vasa previa: 1/2000

Pathophysiology of velamentous insertion

- Lack of Wharton's jelly
- Vessels are easily compressed!
- Normal cord
- Velamentous

Vasa Previa
FHR at 34 weeks

Emergency CS was determined!

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Frequencies of VD・NRFS・eC/S

<table>
<thead>
<tr>
<th></th>
<th>Normal CS (2037)</th>
<th>Upper-middle (91)</th>
<th>Lower (10)</th>
<th>Upper-middle NRFS (70)</th>
<th>Lower NRFS (10)</th>
<th>Velamentous NRFS (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal Velamentous (30)</td>
<td>p &lt; 0.05</td>
<td></td>
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</tr>
</tbody>
</table>

Ultrasound diagnosis of velamentous insertion

(1) Umbilical vessels enter the placental margin parallel to the uterine wall and connect to superficial placental vessels.
(2) The umbilical vessels diverge as they traverse the membrane.
(3) The cord insertion is immobile, even when the uterus is shaken.

Hasagawa Ultrasound Obstet. Gynecol. 2006;4

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Transvaginal ultrasound pictures of vasa previa

Cord insertion on the lower uterine segment is strongly associated with vasa previa.

Hasegawa Fetal diagnosis and Ther. 2007

Diagnosis of vasa previa should be made during early second trimester!

Vasa previa is not infrequent

1/500
by ultrasound diagnosis

1/2000 (retrospective estimation)

### Screening of vasa previa

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adjusted OR (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberrant vessels on membrane</td>
<td>65.1 (5.8-733)</td>
<td>0.001</td>
</tr>
<tr>
<td>Cord insertion on the lower uterus</td>
<td>344.7 (31-3838)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Hasegawa et al. Prenatal Diagnosis, 2010

Confirmation of normal placental location with normal insertion is recommended for safe delivery!
Summary (abnormal insertion)

- Velamentous vessels on the lower uterus is high risk.
- In vasa previa, fetal death is avoidable only with antepartum diagnosis and elective CS.
- In cases with vasa previa, CS should be performed before rupture of membrane before 36 weeks gestation.

Hyper-coiled Cord

Coiling Index = \( \frac{1}{\text{one cycle of coil (cm)}} \)

Degani et al. Obstet Gynecol, 1995
### Antenatal and postnatal Coiling Index

<table>
<thead>
<tr>
<th>Measurement at (n)</th>
<th>10% tile</th>
<th>50% tile</th>
<th>90% tile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hyper-</td>
<td>Normo-</td>
<td>Hyper-</td>
</tr>
<tr>
<td>18-22wks (258)</td>
<td>0.23</td>
<td>0.37</td>
<td>*0.58</td>
</tr>
<tr>
<td>28-32wks (196)</td>
<td>0.21</td>
<td>0.34</td>
<td>*0.49</td>
</tr>
<tr>
<td>At delivery (1969)</td>
<td>0.10</td>
<td>0.17</td>
<td>*0.27</td>
</tr>
</tbody>
</table>

*: p<0.05 ANOVA, post-hoc test

Abnormal antenatal Coiling Index > 0.5 (2.0 cm/cycle)

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### Pathophysiology of hyper-coiled cord

**Complicated narrow cord (umbilical ring)**

Easy to obstruct

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### Hyper-coiled cord and fetal death

Pregnant parturient visited to our hospital due to lack of fetal movement at 22 weeks +5. Diagnosis of fetal death caused by umbilical ring constriction was made.
Summary (Hyper-coiled cord)

- Strict FHR monitoring during labor is required in cases with hyper-coiled cord.
- Precise observations are required in FGR or abnormal Doppler findings associated with hyper-coiled cord.
- However, fetal death often occurs during early-mid gestation. It is not avoidable nor predictable.

Hypo-coiled cord

Cord entanglement
Cord entanglement

- 30% of all deliveries
- Nuchal cord is most frequently observed

Incidence of acute delivery stratified by number of nuchal cord

<table>
<thead>
<tr>
<th>Number of Nuchal Cord</th>
<th>Multiparous n=1770</th>
<th>Nulliparous n=2382</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.0%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Once</td>
<td>13.3%</td>
<td>13.3%</td>
</tr>
<tr>
<td>Twice</td>
<td>20.9%</td>
<td>6.6%</td>
</tr>
<tr>
<td>Three</td>
<td>30.8%*</td>
<td>25.0%*</td>
</tr>
</tbody>
</table>

* p<0.05

Summary (nuchal cord)

- Although it appears to increase over gestation in the presence of cord entanglement, nuchal cord keeps appearing and disappearing over time.
- Thus, number of the nuchal cord is determined near term.
Fore-lying cord and Umbilical cord prolapse

Transvaginal ultrasound picture of fore-lying cord
Clinical risk factors for poor neonatal outcomes in umbilical cord prolapse from nation wide survey in Japan

- Purpose: To clarify the clinical risk factors associated with poor neonatal outcomes due to umbilical cord prolapse.
- Methods: A postal questionnaire survey was attempted in Japan. The clinical risk factors and management associated with poor neonatal outcomes were analyzed in cases of umbilical cord prolapse treated in Japan.

2007-2011
- Delivery institution: 942
- Deliveries: 2,037,460
- Umbilical cord prolapse: 369 (174 institutions)
- Incidence: 0.018%, 1:5521
### Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Fore-lying (85)</th>
<th>Prolapse (284)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact survival</td>
<td>88.2 % (75)</td>
<td>78.9 % (224)</td>
</tr>
<tr>
<td>Survival with disability</td>
<td>7.6 % (6)</td>
<td>6.7 % (19)</td>
</tr>
<tr>
<td>Neonatal death</td>
<td>12 % (1)</td>
<td>5.3 % (15)</td>
</tr>
<tr>
<td>Fetal death</td>
<td>0 % (0)</td>
<td>3.2 % (9)</td>
</tr>
<tr>
<td>Unknown</td>
<td>3.5 % (3)</td>
<td>6.0 % (17)</td>
</tr>
</tbody>
</table>


### Outcomes (after 36 weeks)

<table>
<thead>
<tr>
<th></th>
<th>Fore-lying (40)</th>
<th>Prolapse (168)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intact survival</td>
<td>97.5 % (39)</td>
<td>87.5 % (147)</td>
</tr>
<tr>
<td>Survival with disability</td>
<td>2.5 % (1)</td>
<td>7.1 % (12)</td>
</tr>
<tr>
<td>Neonatal death</td>
<td>0 % (0)</td>
<td>1.8 % (3)</td>
</tr>
<tr>
<td>Fetal death</td>
<td>0 % (0)</td>
<td>2.4 % (4)</td>
</tr>
<tr>
<td>Unknown</td>
<td>0 % (0)</td>
<td>0.6 % (1)</td>
</tr>
</tbody>
</table>


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**Occurrence of cord prolapse**

- **Distribution over gestational weeks**
- **Number of cases**

Hasegawa, Arch Gynecol Obstet 2015

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**Outcomes**

- **Incidence of cord prolapse**
- **Number of cases**


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The results of the multivariate regression analysis for poor outcomes

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Adjusted odds ratio (95% confidence interval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prolapsed amniotic sac</td>
<td>4.49 (1.31, 15.42)</td>
</tr>
<tr>
<td>Preterm labor</td>
<td>2.99 (1.25, 7.17)</td>
</tr>
<tr>
<td>Replacement of cord into the uterus</td>
<td>2.87 (1.03, 7.95)</td>
</tr>
<tr>
<td>Intrapartum diagnosis</td>
<td>0.28 (0.11, 0.75)</td>
</tr>
<tr>
<td>Emergency cesarean section</td>
<td>0.11 (0.04, 0.28)</td>
</tr>
</tbody>
</table>

The cumulative survival curves regarding the interval between the diagnosis and the delivery for the intact survival and poor outcome infants

- Intact survival (n=138)
- Not intact survival, neonatal or intrapartum death (n=27)

After prolapse before CS

Relieve pressure on the cord  or  Knee-chest position
Umbilical cord prolapse after onset of labor

Fetal position at prolapse

Dilatation of os at prolapse
Timing of prolapse

Singleton, head presentation
n=181

- Unruptured (fore-laying) 13%
- Spontaneous rupture 35%
- During amniotomy 24%
- Independent of rupture 28%

Hasegawa, Arch Gynecol Obstet 2015

Summary (umbilical cord prolapse)

- Cord prolapse is associated with
  - abnormal fetal position
  - polyhydramnios
  - use of dilatation balloon
  - prolapsed amniotic bag in the early gestation
  - placental cord insertion on the lower uterus

- Do not touch the umbilical cord, even when prolapse occurs.
- Emergency CS is required. Fetal presenting part should be pushed back into the uterus until delivery.

Management of delivery in cases with umbilical cord abnormalities

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Aspects of FHR in abnormal umbilical cord

Ultrasound diagnosis is not GOAL!

Purpose of screening is to obtain healthy babies!

The only way to know the state of baby inside the uterus is by continuous FHR tracing!!!

Continuous FHR monitoring!

Frequency of decelerations in cord abnormalities

| Variable decelerations even with weak or no uterine contraction. |
| FHR monitoring is most important before onset and during first stage of labor. |
| Atypical variable decelerations might be showing compression of weak point of the umbilical cord. |

Krebs AJOG 1983
Hasegawa JOGR 2009
Hasegawa J Obstetrics and Gynaecology Res. 2009
Screening (first trimester)

- Location of cord insertion
  Cases whose umbilical cord insertion located in lower uterine segment frequently have cord and placental abnormalities later in pregnancy.

- Two umbilical arteries
  Agenesis type of single umbilical artery is associated with fetal congenital anomalies.


Screening (second trimester)

- Placenta previa
- Velamentous insertion or vasa previa
- Umbilical cord coiling

Screening (third trimester)

- Fore-lying cord
- Nuchal cord
- Obstructive type of single umbilical artery
- Reconfirmation of umbilical cord abnormalities, risk assessment, and determination of management at delivery.
**Risk classifications**

<table>
<thead>
<tr>
<th>Risks</th>
<th>Ultrasonographic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>High risk</td>
<td>High possibility of NRFS does not necessarily indicate an elective CS, but the risk of emergency CS is high (estimated emergency CS &gt; 10%)</td>
</tr>
<tr>
<td></td>
<td>Velamentous cord insertion</td>
</tr>
<tr>
<td></td>
<td>Marginal insertion on the low uterus</td>
</tr>
<tr>
<td></td>
<td>Hyper-coiled cord</td>
</tr>
<tr>
<td></td>
<td>Three or more nuchal cords</td>
</tr>
<tr>
<td></td>
<td>Obstructed single umbilical artery</td>
</tr>
<tr>
<td></td>
<td>Low-lying placenta</td>
</tr>
<tr>
<td>FGR (≤ -2 SD)</td>
<td></td>
</tr>
<tr>
<td>Middle risk</td>
<td>Slight high possibility of NRFS means the risk of emergency CS is not so high (estimated emergency CS &lt;10%)</td>
</tr>
<tr>
<td></td>
<td>Twice nuchal cords</td>
</tr>
<tr>
<td></td>
<td>Aplastic type of single umbilical artery</td>
</tr>
<tr>
<td></td>
<td>FGR (-2 &lt; FW ≤ -1.5SD)</td>
</tr>
<tr>
<td>Low risk</td>
<td>Without any abnormalities</td>
</tr>
</tbody>
</table>

**Management of delivery**

- **Extreme high risk**
  - Intensive FHR monitoring during pregnancy
  - Elective CS
- **High risk**
  - Induction of labor
- **Middle risk**
  - Continuous FHR monitoring during labor
- **Low risk**

**Frequencies of NRFS and emergency CS stratified by risk classifications**

- NRFS
  - Low risk: 6.2%
  - Middle risk: 11.1%
  - High risk: 17.6%
- Emergency CS
  - Low risk: 1.0%
  - Middle risk: 4.4%
  - High risk: 8.8%

* p<0.05 compared with Low risk
Detection of placental and umbilical cord abnormalities are also required in antenatal ultrasound screening.

According to ultrasound diagnosis, risk classification before onset of labor is strongly recommended for safe deliveries.

Continuous FHR tracing shows fetal condition, but only during tracing.

The use of FHR monitoring with familiarization of the umbilical cord abnormalities is the best way to avoid fetal complications.

Conclusions

Thank you for your attention!