How to Perform Optimal Umbilical Artery Doppler

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Doppler Analysis

- Qualitative
  - The visual or acoustic evaluation of Doppler wave form

- Quantitative
  - Indirect method to evaluate blood perfusion
  - Calculation of volume flow
  - Calculation of indices

Umbilical Artery Doppler

- Pregnancy complications such as FGR and preeclampsia, which are characterized by rising impedance in the fetoplacental vascular bed, show a decline in the end-diastolic velocity and an increase in Doppler indices

- Absent or reversed EDF
  - 80X increase in perinatal mortality

Thornton & Lilford, 1993
**Doppler Analysis**

- Waveform is commonly described by pulsatility which can be measured
  - Peak Systolic velocity – PSV
  - Resistance Index – RI
  - Pulsatility Index – PI
  - Systolic/Diastolic Ratio – S/D
  - Acceleration Index – AI
  - Acceleration Time – AT

**When is Umbilical Artery Doppler Abnormal?**

- If diastolic flow is absent or reversed after 18 to 20 weeks
- If the S/D ratio is greater than 3.0 after 30 weeks gestation

**Factors Affecting the Waveform**

1. Gestational age
2. Fetal heart rate
3. Fetal breathing
4. Fetal motion
5. Maternal breathing
6. Sample site
7. Technical factors
8. Pregnancy complications

**Factors that Affect UA Doppler Assessment**

- Gestational age
  - The end-diastolic velocity increases with advancing gestation, which is consistent with the progressive decline in fetoplacental blood flow impedance from fetal and placental vascular and hemodynamic changes

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Factors that Affect UA Doppler Assessment

• Fetal heart rate
  – The fetal heart rate can affect Doppler indices. However, within the normal limits of the fetal heart rate (120 to 160 bpm), the changes in the Doppler indices are not significant.

Factors that Affect UA Doppler Assessment

• Cardiac factors
  – There is an inverse relation between fetal heart rate and length of cardiac cycle
    • Effects acceleration of blood in systole
    • Contractility of the heart effects peak velocity
    • Heart rate

Factors that Affect UA Doppler Assessment

Effect of bradycardia
• When the heart rate drops, the diastolic phase of the cardiac cycle is prolonged and the end-diastolic frequency shift declines

Factors Affecting the Waveform

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Factors that Affect UA Doppler Assessment

• Fetal breathing
  – Effects systolic & diastolic velocity and pulse rate
Factors that Affect UA Doppler Assessment

Fetal motion
- Irregular cardiac cycle length

Factors Affecting the Waveform
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Factors that Affect UA Doppler Assessment

Maternal Breathing Movement
Factors that Affect UA Doppler Assessment

Sample site may affect cord indices
- Highest resistance, near the fetal abdomen
- Lowest resistance, near the placental end

Factors Affecting the Waveform
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Why some recommend sampling the cord near the fetus?
- The impedance is found to be highest at the fetal end of the umbilical cord and therefore the absence of end diastolic flow is seen first in this region.

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Umbilical Artery Doppler
**Frame Rate**

- Rate at which images are updated on the display; dependent on frequency of the transducer and depth selection.

**CD Box vs. Resolution**

- Long box… spreads out gates.
**CD Box vs. Resolution**

- Short box... consolidate gates

**Umbilical Artery Doppler**

- Where & how was signal obtained?
  - What is the angle of insonation
  - Where is the sample volume
  - What is the sample volume size

**Spectral Doppler**

- **Cursor**
  - Is used for optimal alignment between vessel axis & Doppler scan line
  - "Angle of insonation"

- **Angle correction**
  - Only used to measure velocity

**Sample Volume**

- Determines the location and area that the pulsed wave Doppler listens for a returning signal
Spectral Doppler

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is used for optimal alignment between vessel axis & Doppler scan line

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**Umbilical Artery Doppler**

**What is the angle of insonation?**

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**Umbilical Artery Doppler**

“Angle to Flow”

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**Umbilical Artery Doppler**

“Angle to Flow”

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**Umbilical Artery Doppler**

“Angle to Flow”
Where is the sample volume?

What is the sample volume size?

- Size ranges from 0.7 to 15mm
- Larger gate to search for flow
- Smaller gate for precise information
• Where & how was signal obtained?
  – What is the angle of insonation
  – Where is the sample volume
  – What is the sample volume size

• Technical considerations
  – Doppler gain
  – Velocity scale
  – Wall filter
  – Sweep speed

Spectral Doppler – Gain

• Controls the amplification of the returning Doppler signals
• The Doppler gain should be adjusted to a level that fills in the gray scale of the spectral analysis waveform without creating noise

Caution

Spectral Display effect of “Doppler Gain”

Color Doppler – Gain

Spectral Doppler - Velocity Scale

Controls “PRF” (the rate at which the transducer is pulsed per second)

• Increasing the scale
  – smaller waveform size
• Decreasing the scale
  – bigger waveform size
**Spectral Doppler - Velocity Scale**
- Controls the range of velocities displayed.
- Higher settings can increase the range but may introduce artifacts.
- Lower settings reduce the range but can lose diagnostic information.

**Spectral Doppler - Wall Filter**
- Suppresses velocities associated with tissue or wall motion.
- Higher settings reduce artifacts, but can eliminate diagnostic information.

**Spectral Doppler - Sweep Speed**
- Controls how quickly the spectral information is updated.
- Three speeds: Slow, Moderate, Fast.
A Doppler index is calculated as a ratio and is, therefore, virtually independent of the angle of insonation, thus obviating the need for measuring the angle.
Cord Abnormalities
- Cord entanglement
- True knot in cord
- Cord stricture
- Velamentous insertion
- Tight nuchal cords

Thank You