Fetal Doppler
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Objectives
- Review Fetal Circulation
- Provide Indications for Umbilical Artery, Middle Cerebral Artery, and Ductus Venosus Doppler studies.
- Demonstrate normal and abnormal Doppler findings, and changes in fetal circulation.

Fetal Circulation
- Three vessel cord
  - One vein carries oxygenated blood from placenta to baby.
  - Two arteries carry deoxygenated blood away from baby back to placenta.
**Placenta and Umbilical Cord Vessels**

**When To Do Umbilical Artery Doppler**
- Monochorionic-Diamniotic Twins
- Discordant Twin Growth (>15%)
- Intrauterine Growth Restriction
  - EFW <10% and/or AC <5%
- Oligohydramnios
- Umbilical Cord Abnormalities
- Umbilical Vein Varix
- Child With A Known Chromosomal Anomaly

**Pointers for Umbilical Artery**
- Sample Free Floating Areas of the Cord
- Use Color Doppler to Locate the Umbilical Artery
- Zoom Image of the Umbilical Artery
- Doppler at an Angle of 0 Degrees when Possible
- Fetal Breathing will Make Doppler Inaccurate
Systole

Diastole

S/D ratio should decrease as pregnancy progresses

- The villi within the placenta increase in size and number during pregnancy.
- Resistance to flow in the umbilical artery decreases during pregnancy.

The placenta is like a large body of water. A normal umbilical artery should have low resistance and low S/D ratio!
Umbilical Artery Doppler

- Umbilical Artery Doppler only shows vascular function of the placenta.
- Abnormal Doppler
  - Increase in Resistance with decreased diastolic flow
  - Absent End diastolic Flow
  - Reversal of flow in diastolic component
- When absent or reversal of flow is seen, >70% of the vascular bed is obliterated.
- Could have normal Doppler of the umbilical artery and still have placental dysfunction!!!
Decrease in Arteriole Villi in placenta

Increase in Placenta Resistance

Decrease in Diastolic flow in the Umbilical Artery

Decrease in Nutrients Delivered to Fetus through Umbilical Vein

Absent or Reversed Diastolic flow

IUGR/Brain Sparing

FETAL HYPOXIA: Decrease in the amount of oxygen reaching the fetus

Redistribution of blood flow

Increased

Brain Heart Adrenal Glands

Decreased

Kidneys Gut Musculoskeletal System Lungs

With the decrease of oxygen and nutrients provided to the fetal kidneys, urine production goes down and Oligohydramnios may be present.

With the increase in fetal flow to the brain, the RESISTANCE in flow to the brain decreases. Doppler the Middle Cerebral Artery!
Why obtain MCA Doppler

- Abnormal Umbilical Artery Doppler
  - S/D ratio >95%, or absent or reversal of end diastolic flow
- At Risk for Fetal Anemia
- Hydrops Present
- Positive Kleihauer-Betke
- Abdominal Vein Varix
- Severe Polyhydramnios >30 cm

Pointers for Middle Cerebral Artery Doppler

- Spectral Doppler angle at 0 degrees. Best angle for accurate Doppler velocities
- Spectral Doppler should be obtained at the origin of the MCA not as it courses away from the Circle of Willis.
- Measurements of the Peak Systolic Velocity and S/D ratio are obtained.
- Doppler velocities obtained when fetus is breathing are inaccurate.
The middle cerebral artery arises from the trifurcation of the Internal Carotid Artery. It is one of the 3 paired arteries supplying blood to the brain.

- Anterior Cerebral
- Middle Cerebral
- Posterior Cerebral

It is connected to the Anterior Cerebral Artery and the Posterior Communicating Artery.

The vascular system branches into smaller vessels. The smaller the vessel, the greater the resistance.
The Normal MCA exhibits a high resistance waveform.

Brain Sparing

The Umbilical Artery has high resistance and the Middle Cerebral Artery has low resistance, which is the opposite of normal flow. This is an example of brain sparing.
One of the intrauterine fetal shunts
- Branches from Umbilical Vein connects to the fetal IVC, delivering oxygenated blood.
- 2 mm in diameter, 2 cm length

Normal flow in the Ductus venosus is forward flow from the Umbilical Vein towards the Inferior Vena Cava of the fetus.

Triphasic Waveform
- S=Systole Ventricle
- D=Early Diastole
- A=Atrial Contraction

We want only forward flow!
When Doppler Ductus Venosus?

- Absence or reversal of flow in the Umbilical Artery
- Abdominal Vein Varix
- During a fetal echocardiogram

Ductus Venosus

- Reversed Flow in DV
- Diminished cardiac contractility
  - Placenta insufficiency, anemia, hypoxia
  - Extrinsic compression pericardial fluid
  - Increased afterload
  - Abnormal placenta resistance
  - Obstruction to cardiac outflow
  - Increased preload (increase venous return)
  - Shunt Lesions
  - Recipient twin in TTTS

Ductus Venosus

<table>
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<tr>
<th>Normal</th>
<th>Abnormal</th>
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![Ductus Venosus Images]
Outcomes

- When SGA fetuses deliver at term with and without brain sparing are compared there are no differences in perinatal outcome.
- Brain sparing is a protective mechanism at birth preventing brain damage.
- When the same children are examined at 2 yrs of age, those with brain sparing perform significantly lower in communication and problem solving.

Long Term Neurodevelopment Outcome

- Those with reversed end diastolic flow in the Umbilical Artery have the most severe perinatal outcomes and long standing neurological outcomes.
- Increased risk for
  - Mental impairment
  - Impaired motor function
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Fetal Anemia

- Fetal Anemia is an inadequate number or quality of red blood cells within the fetal circulation. The fetal red blood cells are responsible for delivering oxygen to the fetal organs and cells.
- RBC are not being produced by the fetus
- RBC are being destroyed within the fetus
- When severe fetal anemia is present, the fetal heart pumps harder to try and provide more oxygen to the cells and organs. This may result in fetal heart failure or Hydrops.
- Due to the decrease in the number of red blood cell the blood is less viscous and flows faster.

Viscosity
When checking for fetal anemia, the Peak Systolic Velocity (PSV) is measured.

- **Median (1.0)**
- **Mild Elevation (1.29 MoM)**
- **Moderate Elevation (1.50 MoM)**
- **Severe Elevation (1.55 MoM)**

The PSV in the MCA is correlated with gestational age and graphed on the following chart.

**MCA-PSV to Predict Moderate to Severe Anemia (1.5 MoM)**

- Peak systolic velocity >1.5 MoM in fetuses a risk for anemia
  - 100% sensitivity to detect anemia
  - 65% positive predictive value
  - 100% Negative predictive value
  - 12% false-positive rate
Timing of MCA Doppler

- If the PSV is at >1.5 MoM, intervention is considered
  - Transfusion
  - Delivery
- Serial scans are used to monitor the trending of the velocities. After 35 weeks, there is an increase in false positives. Additional testing may be required if MCA PSV is >1.5 MoM after 35 weeks gestation.

QUESTIONS????