Biophysical Profile & Color Doppler Ultrasound in the High Risk Pregnancy

Biophysical Profile and Color Doppler Ultrasound in the High Risk Pregnancy Presented by: Dr. Farzad Afzali Kasra Ultrasound Clinic

- BPP is applying to detect prenatal asphyxia
- Doppler ultrasound is a modality for detecting fetal hypoxia and acidosis
- Doppler can also predict later pre-eclampsia at the 24-26 gestational weeks.

- Hypoxia: Low oxygen tension
- Asphyxia: Low oxygen and high CO2
- Ischemia: Drop in blood flow

Comment: So, Doppler ultrasound can predict fetal distress sooner than BPP

- Prediction of the effect of an asphyxial insult on the fetus requires a measure of:
BPP is applying to detect prenatal asphyxia

Doppler ultrasound is a modality for detecting fetal hypoxia and acidosis

Doppler can also predict later pre-eclampsia at the 24-26 gestational weeks.

• BPP is applying to detect prenatal asphyxia
• Doppler ultrasound is a modality for detecting fetal hypoxia and acidosis
• **Hypoxia**: Low oxygen tension
• **Asphyxia**: Low oxygen and high CO2
• **Ischemia**: Drop in blood flow

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**Severity** of the asphyxia.

**Duration** of the asphyxia.

- Prediction of the effect of an asphyxial insult on the fetus requires a measure of:

  **Severity** of the asphyxia

  **Duration** of the asphyxia
• 18-48 hours (Neuronal necrosis) 48-72 hours of white matter macroph. & Astrocy.)
> 4 days cavitation visible on head U/S
Comment

- Fetal asphyxia may or may not be concomitant with clinical presentation (based on severity, duration & location of insult)

  Dr. farzad. atzali
## Component & Definition

<table>
<thead>
<tr>
<th>Component</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Fetal movements</td>
<td>3 body or limb movements</td>
</tr>
<tr>
<td>Fetal tone</td>
<td>One episode of active extension and flexion of the limbs; opening and closing of hand</td>
</tr>
<tr>
<td>Fetal breathing movement</td>
<td>episode of $\geq$ 30 seconds in 30 minutes. Hiccups are considered breathing activity.</td>
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<tr>
<td>Amniotic fluid volume</td>
<td>single 2 cm x 2 cm pocket is considered adequate.</td>
</tr>
<tr>
<td>Non-stress test</td>
<td>2 accelerations $&gt; 15$ beats per minute of at least 15 seconds duration.</td>
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### Comment

As you know, oligohydramnios may be:
- **Mild**  \( AFI = 5-8 \text{cm} \)
- **Moderate**  \( AFI = 2-5 \text{cm} \)
- **Severe**  \( AFI < 2 \text{cm} \)

Only severe oligohydramnios is considered as an abnormal score.
• Fetal movement and fetal tone develop between 7.5 and 9 weeks’ menstrual age
• Fetal breathing movements are detectable by, at least 17-18 weeks’ gestation
• The non-stress test is most reliable between 32 weeks and term (Ware, 1994).
Comment
So, BPP has a limited role for assessing fetal well being before 32 gestational weeks.

- The non-stress test and fetal breathing movements are suppressed when the pH falls below 7.2.
- If the fetal pH falls below 7.10, fetal tone and fetal movements are abolished (Vintzileos, 1987).

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The biophysical profile score is continued for a maximum of 30 minutes.

Oligohydramnios is now defined as a pocket of amniotic fluid < 2.0 x 2.0 cm (Manning, 1995).
### Perinatal Mortality and the Biophysical Profile Score

<table>
<thead>
<tr>
<th>Score</th>
<th>Perinatal Mortality/1000</th>
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<tbody>
<tr>
<td>8-10</td>
<td>1.86</td>
</tr>
<tr>
<td>6</td>
<td>9.76</td>
</tr>
<tr>
<td>4</td>
<td>26.3</td>
</tr>
<tr>
<td>2</td>
<td>94.0</td>
</tr>
<tr>
<td>0</td>
<td>285.7</td>
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</table>
I think, if you are working in a center that perinatal mortality is 50/1000 for preterm delivered fetus (otherwise normal), if you visit a fetus with BPP= 4, you can wait until 35-37 gestational weeks cautiously. (perinatal mortality for BPP = 4 is 26/1000)

Dr. farzad.afzali
Color Doppler Ultrasound in the High Risk Pregnancy

- Doppler ultrasound has three view of applying in the OB& GYN field.
- 1 – direct view for example in ovarian torsion or detecting vascularity of a fibroma.
- 2 – easy conceptional view for example to differentiating a benign ovarian mass from malignant one.
- 3- deep conceptional view for example in detecting fetal hypoxia & acidosis in pregnancy

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Maximum Frequency Shift

\[ S \] = systolic peak (max. velocity)
\[ D \] = end diastolic flow
\[ V_m \] = mean velocity
\[ A \] = Temporal average frequency over 1 cardiac cycle

Doppler Indices

\[ RI = \frac{(S - D)}{S} \] (Pourcelot, 1974)
\[ PI = \frac{(S - D)}{A} \] (Gosling, 1976)
\[ S/D \text{ Ratio} = \frac{S}{D} \] (Stuart & Drumm, 1980)
Uterine Artery
An early stage in fetal adaptation to hypoxemia

- central redistribution of blood flow (brain-sparing reflex)

- increased blood flow to protect the brain, heart, and adrenals

- reduced flow to the peripheral and placental circulations
Doppler wave form of early stage of fetal hypoxemia

- increased end-diastolic flow in the middle cerebral artery (lower MCA pulsatility index or resistance index)
- decreased end-diastolic flow in the umbilical artery (higher umbilical artery RI or systole-to-diastole [S/D] ratio)

Doppler Wave Form of Early Stage of Fetal Hypoxemia
- increased end-diastolic flow in the middle cerebral artery (lower MCA pulsatility index or resistance index)
- decreased end-diastolic flow in the umbilical artery (higher umbilical artery RI or systole-to-diastole [S/D] ratio)
Long term outcomes need to be examined:

- Middle cerebral artery
- Aorta
- Umbilical artery
- Uterine artery
- IVC
- Ductus venosus
Comment

- The first Doppler change is rising peak velocity in ductus venosum.
- It can not be measured by Doppler precisely because it is an angle related index.
The middle cerebral artery (MCA) in the fetal brain:
- normally high-impedance
- most accessible to U/S imaging
- more than 80% of cerebral blood
Comment

- Average of both MCAs must be calculated for more precise result.

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Fetal Aorta
Comment

• PI of thoracic aorta is sum of all branches PI below it, specially both umbilical & femoral arteries.
• It means that increased impedance against umbilical artery causes increasing PI of thoracic aorta.
• Placental insufficiency inhibits acid extraction from fetal body and causes acidosis.
Comment

- Acidosis causes peripheral arterial spasm & rises PI of femoral arteries, consequently increases thoracic aorta PI.
- If fetal acidosis has an intrinsic cause, it will be expected that femoral artery PI will be effected more than umbilical PI.

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The damage that obliterate small muscular arteries in placental tertiary stem villi

- flow or even reversed flow

- commonly associated with severe IUGR and oligohydramnios
Umbilical Artery
• The best predictor of PIH is notch in the uterine artery and RI >58 % after 24 w of gestation.
• A/C ratio > 2.5 is considered pathologic.
Comment

- I think that RI of uterine artery more than 75% (2 standard deviation above mean) must be considered as a limit for prediction of preeclampsia.

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Uterine Artery
Pathological Changes in Venous Flows with FGR

Venous indices reflect:
- Ventricular function
- Fetal hypoxia
- Myocardial lactic acidosis

Decrease cardiac output secondary to myocardial dysfunction:
- Rise in CVP
- Increase in reverse flow in atrial systole
- Transmitted down venous system - the further from the heart the greater degree of cardiac dysfunction.
Pattern continued

• DV ‘a’ wave decrease
• Reverse EDF UA -- Reverse ‘a’ wave DV
• Pulsatile UV
• Constriction of cerebral circulation
• Death within 96 hours
S = Ventricular systole
D = early diastole
a = atrial contraction
**Ductus Venosus - Normal**

- Normal progression through pregnancy is for a decrease in proportion of blood flow from umbilical vein - 40 to 15% of total volume 2nd to 3rd trimester
- Leads to more flow to liver
- Increase in blood flow velocity with gestational age
Comment

- We can find ductus venosum by rising color scale to 50 cm/sec at level of umbilical artery.
- It causes other vessels except aorta ductus venosum to disappear.
Ductus Venosum
Umbilical Vein

- Umbilical vein displays pulsatility in first trimester but this disappears with advancing gestation in the pregnancy unaffected by FGR.
The data on MCA PI on 5 year follow up is very worrying as the brain sparing effect commonly occurs before venous Doppler disturbances.
In clinical practice, it is necessary to carry out serial Doppler investigations to estimate the duration of fetal blood flow redistribution.

The onset of abnormal venous Doppler results indicates deterioration in the fetal condition and iatrogenic delivery should be considered.
FIGURE 8. Timeline for fetal hypoxemia

- Abnormal fetal growth
- Abnormal arterial Doppler (~ 2 weeks)
- Abnormal venous Doppler (~1-2 days??)
- Abnormal cardiotocograph/BPP score

BPP—Biophysical profile
Comment

- It seems that arterial changes can lead directly to non-reactive NST, asphyxia and death because of brain damage.
- Venous changes are signs of fetal heart failure, so fetal death is due to heart damage.
- Therefore, fetal hypoxia and acidosis can end to fetal death, either by cardiac or brain failure.

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Conclusion

- The best predictor for fetal acidemia is PI of thoracic aorta.
- The best predictor of fetal hypoxia is PI of MCA.
• PI of MCA/PI of TA must be more than 0.9 before 30, less than 0.8 before the 34 and less than 0.75 before the 36 weeks of pregnancy.

• PI of MCA/PI of UA must be >1.08 during pregnancy.

• The larger values are abnormal and termination may be considered after 35-37 weeks of pregnancy.
Comment

- I think PI MCA/PI umbilical artery is more reliable than PI MCA/PI Aorta
Reverse flow in the umbilical artery, along with pathologic waveform in the venous system are the best predictor of severe fetal distress, so termination of pregnancy must be considered as soon as possible.
Comment

It must be stressed that:

Delivered fetus with mild fetal hypoxia (only PI of MCA is lower than 1.5) has normal condition and apgar in the labor room, but in future it has higher risk for mean IQ be lower than non hypoxemic fetuses.

Dr. Farzad Aftali
- Fetal biometry and arterial Doppler
  - the early compensatory phase of IUGR

- Venous Doppler, FHR analysis, and the biophysical profile
  - data on the later stages (commonly associated with fetal acidosis and impending cardiovascular collapse)

- When used in conjunction with other diagnostic tools, Doppler U/S improve outcomes in growth-restricted fetuses.

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