Antenatal Assessment of Fetal Wellbeing – Dr. Sundus

The concept of antenatal fetal monitoring aims at

- Assuring satisfactory growth and well-being of the fetus as well as the mother all throughout the pregnancy.
- Screening out the high risk cases and the adverse maternal and/or intrauterine factors which may affect the healthy growth of the fetus. Extra care is to be taken in these cases to achieve an ultimate perinatal fetal outcome.
- Detecting early in pregnancy those congenital abnormalities or inborn metabolic disorders which are not compatible with life or may lead to chronic ill health of the offspring. These maybe eliminated by early termination of pregnancy.

Fetal physiology

Uteroplacental development:

- The absence of resistance to blood flow in the uteroplacental arteries allows increasing volume flow through the intervillous space as the fetus, placenta and the uterus increase in size.
- Thus of major importance with regards to fetal supply of oxygen and nutrients, is the adequacy of the uteroplacental circulation.
- Trophoblast invades the decidual lining of the uterus and reaches maternal blood vessels (spiral arteries) within the decidua and inner myometrium.
- These trophoplastic cells will destroy the endothelium and the elastic and muscular component of the vessel wall.
- These vessels will subsequently termed uteroplacental arteries and consequently offers no resistance to the flow of blood through them.
- These changes are called the physiological adaptation of the placenta.
- This loss of auto regulation means that perfusion of the intervillous space is dependent on maternal blood pressure.

Methods for antepartum fetal assessment

- Fetal movement counting
- Assessment of uterine growth
- Antepartum fetal heart rate testing” CTG”
- Biophysical profile
- Doppler velocimetry

When to begin testing

- Single factors with minimal to moderate increased risk for antepartum fetal death: 32 weeks.
- Highest maternal risk factors: 26 weeks.
- When estimated fetal maturity is sufficient to expect a reasonable chance of survival should intervention be necessary.
Conditions placing the fetus at risk for UPI “HIGH RISK PREGNANCIES”

1. Preeclampsia, chronic hypertension,
2. Collagen vascular disease, diabetes mellitus, renal disease,
3. Fetal or maternal anemia, blood group sensitization,
4. Hyperthyroidism, thrombophilia, cyanotic heart disease,
5. Postdate pregnancy,
6. Fetal growth restriction,
7. Previous history of stillbirth or neonatal death,
8. History of recurrent miscarriage or preterm birth,
9. History of previous fetus with congenital abnormality,

FETAL MOVEMENTS

• Passive unstimulated fetal activity commences as early as 7 weeks and becomes more sophisticated and coordinated by the end of pregnancy.
• Between 20 and 30 weeks, general body movements become organized, and the fetus starts to show rest-activity cycles.
• Although several fetal movement counting protocols have been used, neither the optimal number of movements nor the ideal duration for counting them has been defined. For example, in one method, perception of 10 fetal movements in up to 2 hours is considered normal.

Assessment of uterine growth “symphsis fundal height measurement”

• General rule: fundal height in centimeters will equal the weeks of gestation.
• Exceptions: maternal obesity, multiple gestation, polyhydramnios, abnormal fetal lie, oligohydramnios, low fetal station, and fetal growth restriction.
• Abnormalities of fundal height should lead to further investigation.
• Accuracy: poor “Need more than 4 weeks to show difference”

NONSTRESS TESTS

• Freeman (1975) and Lee and colleagues (1975) introduced the nonstress test to describe fetal heart rate acceleration in response to fetal movement as a sign of fetal health.
• This test involved the use of Doppler-detected fetal heart rate acceleration coincident with fetal movements perceived by the mother.
• By the end of the 1970s, the nonstress test had become the primary method of testing fetal health.

Cardiotocography

• In medicine (obstetrics), cardiotocography (CTG) is a technical means of recording (-graphy) the fetal heartbeat (cardio-) and the uterine contractions (-toco-) during pregnancy, typically in the third trimester. The machine used to perform the monitoring is called a cardiotocograph, more commonly known as an electronic fetal monitor or external fetal monitor (EFM). CTG can be used to identify signs of fetal distress.

Interpretation

Cardiotocography is used to monitor several different measures: uterine contractions and four fetal heart rate features –

1 – Baseline heart rate, 2 – variability, 3 – accelerations, 4 – decelerations,
5 – Response to stimuli: *Contractions, *Fetal movements, *Other
Fetal heart variability:

- Under normal physiological conditions, the interval between successive heart beats varies (beat-to-beat variability). This is called short-term variability and it increases with increasing gestational age. This is not visible on standard CTG; it can be obtained from fetal electrocardiograms (ECG).
- There are longer term fluctuations in heart rate occurring between 2-6 times per minute. This is called baseline variability and it is responsible for the snow-teeth appearance of the heart rate on the CTG paper.
- Normal baseline variability reflects a normal fetal autonomic nervous system.

Baseline variability is modified (reduced) by:

- Fetal sleep states and activity.
- Hypoxia.
- Fetal infection.
- Drugs suppressing the fetal CNS, such as opioids and hypnotics.
- Base line variability is considered abnormal when it is less than 10 beats per minute (normal 10-25 bpm).
- As the fetus display deep sleep cycles of 20-40 minutes at a time, baseline variability will be normally reduced for this length of time, but will be preceded and followed by a more normal period of trace if the CTG is continued for a sufficient duration.

Reduced Fetal Heart Rate Variability

Baseline fetal heart rate:

- Fetal heart rate falls with advancing gestational age as a result of maturing fetal parasympathetic (vagal) tone. It is best determined over a period of 5-10 minutes.
- At term the normal fetal heart rate is 110-150 beats per minutes (bpm).
- Prior to term 160 bpm is taken as the upper limit of normal.
- A rate lower than 110 bpm is termed fetal bradycardia. If all other features of the CTG are normal, this is unlikely to represent fetal hypoxia unless the rate is less than 100 bpm.
- Fetal heart rate between 150-170bpm is termed fetal tachycardia and it is again unlikely to represent fetal compromise if the trace is otherwise normal and there are no antenatal risk factors.
Causes of fetal tachycardia:

2. Maternal or fetal infection.
3. Acute fetal hypoxia.
4. Fetal anemia.
5. Drugs such as adrenoceptor agonists e.g. ritodrine.

Fetal Heart Rate Acceleration

- The fetal heart rate normally is increased or decreased by autonomic influences mediated by sympathetic or parasympathetic impulses from brainstem centers. Beat-to-beat variability is also under the control of the autonomic nervous system.

**The nonstress test is based on the hypothesis that the heart rate of a fetus who is not acidotic as a result of hypoxia or neurological depression will temporarily accelerate in response to fetal Movement.**

**The National Institute of Child Health and Human Development Fetal Monitoring Workshop (1997) has defined normal acceleration based on gestational age.**

**The acceleration of 15 bpm or more above the baseline rate, and the acceleration lasts 15 seconds or longer but less than 2 minutes in fetuses at or beyond 32 weeks.**

**Before 32 weeks, accelerations are defined as having an acme 10 bpm or more above baseline for 10 seconds or longer.**

Normal Nonstress Tests “Two or more accelerations that peak at 15 bpm or more above baseline, each lasting 15 seconds or more, and all occurring within 20 minutes of beginning the test”.

It was also recommended that accelerations with or without fetal movements be accepted, and that a 40-minute or longer tracing—to account for fetal sleep cycles—should be performed before concluding that there was insufficient fetal reactivity.

Fetal heart rate decelerations:

- These are transient reductions in fetal heart rate of 15 bpm or more, lasting for more than 15 seconds.
- When occurring in relation to isolated uterine contractions or fetal movement they do not appear to be associated with a poor fetal outcome.
- Decelerations that occur in the presence of other abnormal features such as reduced variability or baseline tachycardia are more likely to reflect fetal hypoxia.
Types of decelerations:

1. Early decelerations:
   - Uniform, repetitive, periodic slowing of FHR with onset early in the contraction and return to baseline at the end of the contraction.

2. Late decelerations:
   - Uniform, repetitive, periodic slowing of FHR with onset mid to end of the contraction and nadir more than 20 seconds after the peak of the contraction and ending after the contraction.

3. Variable decelerations:
   - Variable, intermittent periodic slowing of FHR with rapid onset and recovery.
   - Time relationships with contraction cycle are variable and they may occur in isolation.


From the above descriptions a normal ante-partum fetal CTG can be defined as:

1. A baseline of 110-150 bpm.
3. Two accelerations in 20 min.
4. No decelerations.

Suspicious CTG when there is:

1. Absence of accelerations.
2. Abnormal baseline rate (< 110 or > 150 bpm).
3. Reduced variability (<10bpm).
4. Variable decelerations.
Abnormal CTG:

- No accelerations and two or more of the following:
  - Abnormal baseline rate.
  - Abnormal variability.
  - Repetitive late decelerations.
  - Variable decelerations with ominous features:
    - Duration > 60s.
    - Late recovery baseline.
    - Late deceleration component.
    - Poor variability between/during decelerations.

ACOUSTIC STIMULATION TESTS

- Loud external sounds have been used to startle the fetus and thereby provoke heart rate acceleration—an acoustic stimulation nonstress test.
- A commercially available acoustic stimulator is positioned on the maternal abdomen, and a stimulus of 1 to 2 seconds is applied. This may be repeated up to three times for up to 3 seconds. A positive response is defined as the rapid appearance of a qualifying acceleration following stimulation.

CONTRACTION STRESS TESTING

- Brief periods of impaired oxygen exchange result, and if uteroplacental pathology is present, these elicit late fetal heart rate decelerations. Contractions also may produce a pattern of variable decelerations as a result of cord compression, suggesting oligohydramnios, which is often a concomitant of placental insufficiency.
- Contractions were induced using intravenous oxytocin” at least three spontaneous contractions of 40 seconds or longer are present in 10 minutes”, and the fetal heart rate response was recorded using standard monitoring. The criterion for a positive (abnormal) test was uniform repetitive late fetal heart rate decelerations.

BIOPHYSICAL PROFILE

Manning and colleagues (1980) proposed the combined use of five fetal biophysical variables as a more accurate means of assessing fetal health than a single element. Required equipment includes a sonography machine and Doppler ultrasound to record fetal heart rate. Typically, these tests require 30 to 60 minutes of examiner time.

The five biophysical components assessed, which include:

1. fetal heart rate acceleration,
2. fetal breathing,
3. fetal movements,
4. fetal tone, and
5. amnionic fluid volume.

**Normal variables were assigned a score of 2 each and abnormal variables, a score of 0. Thus, the highest score possible for a normal fetus is 10.

Modified Biophysical Profile

- An abbreviated biophysical profile, specifically, a vibroacoustic nonstress test and combined with amnionic fluid index determination. This abbreviated biophysical profile required approximately 10 minutes to perform.
Components and their Scores for the Biophysical Profile

<table>
<thead>
<tr>
<th>Component</th>
<th>Score 2</th>
<th>Score 0</th>
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<tbody>
<tr>
<td>Nonstress test</td>
<td>&gt;= 2 accelerations of 15 beats/min for 15 sec within 20–40 min</td>
<td>0 or 1 acceleration within 20–40 min</td>
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<tr>
<td>Fetal breathing</td>
<td>&gt;= episode of rhythmic breathing lasting 30 sec within 30 min</td>
<td>&lt;30 sec of breathing within 30 min</td>
</tr>
<tr>
<td>Fetal movement</td>
<td>&gt;=3 discrete body or limb movements within 30 min</td>
<td>&lt; 3 discrete movements</td>
</tr>
<tr>
<td>Fetal tone</td>
<td>&gt;=1 episode of extremity extension and subsequent return to flexion</td>
<td>0 extension/flexion events</td>
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<tr>
<td>Amnionic fluid volume</td>
<td>A pocket of amnionic fluid that measures at least 2 cm in two planes perpendicular to each other (2 * 2 cm pocket)</td>
<td>Largest single vertical pocket &lt;=2 cm</td>
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Amnionic Fluid Volume

- Amnionic fluid volume is commonly evaluated in women with complaints of decreased fetal movement. Moreover, amnionic fluid has become an integral component in the antepartum assessment of pregnancies at risk of fetal death.
- This is based on the rationale that decreased uteroplacental perfusion may lead to diminished fetal renal blood flow, decreased urine production, and ultimately, oligohydramnios.

DOPPLER VELOCIMETRY

- Doppler ultrasound is a noninvasive technique to assess blood flow by characterizing downstream impedance. Three fetal vascular circuits, which include the umbilical artery, middle cerebral artery, and ductus venosus, are currently being assessed using Doppler technology to determine fetal health and help time delivery for growth-restricted fetuses.
- Maternal uterine artery Doppler velocimetry has also been evaluated in efforts to predict placental dysfunction. The goal of such testing is to optimize the time of delivery—late enough to avoid complications of preterm delivery and early enough to avoid stillbirth.
- Placental vascular dysfunction results in increased umbilical artery blood flow resistance, which progresses to decreased middle cerebral artery impedance followed ultimately by abnormal flow in the ductus venosus.

Umbilical Artery Velocimetry

- Absent or reversed end-diastolic flow signifies increased impedance to umbilical artery blood flow. It is reported to result from poorly vascularized placental villi and is seen in extreme cases of fetal growth restriction.

Middle Cerebral Artery

- Doppler velocimetry interrogation of the middle cerebral artery (MCA) has received particular attention because of observations that the hypoxic fetus attempts brain sparing by reducing cerebrovascular impedance and thus increasing blood flow.

Ductus Venosus

- The use of Doppler ultrasound to assess the fetal venous circulation is the most recent application of this technology. They concluded that ductus venosus Doppler velocimetry was the best predictor of perinatal outcome. Importantly, however, negative or reversed flow in the ductus venosus was a late finding because these fetuses had already sustained irreversible multiorgan damage due to hypoxemia.
*More recently fetal aorta is used to assess the fetal wellbeing as a rising resistance in the fetal aorta reflects compensatory vasoconstriction in the fetal body.

*When diastolic flow is absent in the fetal aorta, this implies fetal acideamia.

Uterine Artery

- Uterine artery Doppler may be most helpful in assessing pregnancies at high risk of complications related to uteroplacental insufficiency.
- Persistence or development of high-resistance patterns have been linked to a variety of pregnancy complications like pre-eclampsia “Uterine arteries – usually done at 24/40 week of pregnancy”

**The most precise method of detecting fetal growth is by ultrasound biometry:**

These includes measurement of

1. Biparietal diameter.
2. Head circumference.
3. Abdominal circumference.
4. Femur length.

The above measurements are used to estimate the fetal weight by U/S.

**And by serial U/S assessment we can detect impairment of fetal growth usually at 2 week interval.**