NEWER MODALITIES OF DIAGNOSIS IN PREGNANCY

By: J.Lissa, Asst. professor, JSS CON, Mysore.

Cardiotocography

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 (EFM).

Simultaneous recordings are performed by two separate transducers, one for the measurement of the fetal heart rate and a second one for the uterine contractions. Each of the transducers may be either external or internal.

PROCEDURE

External measurement means taping or strapping the two sensors to the abdominal wall. The heart ultrasonic sensor, similar to a Doppler fetal monitor, detects motion of the fetal heart. The pressure-sensitive contraction transducer, called a tocodynamometer (toco), measures the tension of the maternal abdominal wall - an indirect measure of the intrauterine pressure.

Internal measurement requires a certain degree of cervical dilatation, as it involves inserting a pressure catheter into the uterine cavity, as well as attaching a scalp electrode to the fetal head to adequately measure the electric activity of the fetal heart. Internal measurement is more precise, and might be preferable when a complicated childbirth is expected.

Interpretation of a CTG tracing

- Uterine activity (contractions)
- Baseline fetal heart rate (FHR)
- Baseline FHR variability
- Presence of accelerations
- Periodic or episodic decelerations
- Changes or trends of FHR patterns over time

Normal - less than or equal to 5 contractions in 10 minutes, averaged over a 30-minute window

Tachysystole - more than 5 contractions in 10 minutes, averaged over a 30-minute window

To be called an acceleration, the peak must be greater than or equal to 15 bpm, and the acceleration must last greater than or equal to 15 seconds from the onset to return.
Non stress test (NST)

How is a NST Performed?

The test involves attaching one belt to the mother’s abdomen to measure fetal heart rate and another belt to measure contractions.

Movement, heart rate and “reactivity” of heart rate to movement is measured for 20-30 minutes. If the baby does not move, it does not necessarily indicate that there is a problem; the baby could just be asleep. A nurse may use a small “buzzer” to wake the baby for the remainder of the test.

INDICATION

- A NST may be performed if:
  - baby is not moving as frequently as usual
  - overdue
  - There is any reason to suspect that the placenta is not functioning adequately
  - high risk for any other reason
  - The test can indicate if the baby is not receiving enough oxygen because of placental or umbilical cord problems; it can also indicate other types of fetal distress.

NST results

A reactive non-stress result indicates that blood flow (and oxygen) to the fetus is adequate. A nonreactive non-stress result requires additional testing to determine whether the result is truly due to poor oxygenation, or whether there are other reasons for fetal non reactivity (i.e. sleep patterns, certain maternal prescription or nonprescription drugs).

A typical CTG output for a woman not in labour. A: Fetal heartbeat; B: Indicator showing movements felt by mother (caused by pressing a button); C: Fetal movement; D: Uterine contractions

Risks and side effects to the mother or baby

A NST is a noninvasive test that poses no known risks or side effects to mother or baby.

When is a NST performed?

NSTs are generally performed after 28 weeks of gestation. Before 28 weeks, the fetus is not developed enough to respond to the test protocol.
Contraction Stress Test

A contraction stress test checks to see if your unborn baby (fetus) will stay healthy during the reduced oxygen levels that normally occur during contractions when you are in labor. This test includes external fetal heart monitoring. The test is done when you are 34 or more weeks pregnant.

During a uterine contraction, the blood and oxygen supply to your baby drops for a short time. This is not a problem for most babies. But the heart rate of some babies gets slower. This change in heart rate can be seen on the external fetal monitoring device.

Procedure

For a contraction stress test, the hormone oxytocin is given to you in a vein (intravenously, or IV) to cause labor contractions.

Massage your nipples. This tells your body to release oxytocin. If baby's heart rate slows down (decelerates) in a certain pattern after a contraction instead of speeding up (accelerating), baby may have problems with the stress of normal labor.

A contraction stress test is usually done if the mother have an abnormal nonstress test or biophysical profile. A biophysical profile uses ultrasound during a nonstress test to measure a series of physical characteristics of baby.

Some doctors may do a biophysical profile or a Doppler ultrasound test instead of a contraction stress test

How It Is Done

A contraction stress test may be done in your doctor's office or hospital by a family medicine doctor or an obstetrician and a trained laboratory technician or nurse. usually do not need to stay overnight.

During the test, you will lie on a bed with your back raised. You will be tilted a little to your left side so you will not have pressure on the blood vessels in your belly. Two belts with sensors will be placed around your belly. One belt holds the sensor that records your baby's heart rate; the other sensor measures your uterine contractions. Gel may be used on your skin with the heart rate sensors.

The sensors are hooked to a recording unit. The heart rate monitor may be moved if your baby changes position. Your baby's heart rate and your contractions are recorded for 10 minutes. Your blood pressure and other vital signs are also recorded.

Amniocentesis

Amniocentesis (also referred to as amniotic fluid test or AFT) is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fetal infections, in which a small amount of amniotic fluid, which contains fetal tissues, is sampled from the amnion or amniotic sac surrounding a developing fetus.

The fetal DNA is examined for genetic abnormalities. Using this process the sex of the fetus can also be determined and hence this procedure has legal restrictions in some gender-biased countries.
Indications and results

Early in pregnancy, used for diagnosis of chromosomal and other fetal problems such as:

- Down syndrome (trisomy 21)
- Trisomy 13
- Trisomy 18
- Fragile X
- Rare, inherited metabolic disorders
- Neural tube defects (anencephaly and spina bifida) by alpha-fetoprotein levels.

Later on, it also can be used to detect problems such as:

- Infection
- Rh incompatibility
- Prediction of lung maturity
- Decompression of polyhydramnios
- An emerging indication for amniocentesis is in the management of preterm rupture of membranes where measurement of certain amniotic fluid inflammatory markers may be helpful.

Risks and drawbacks

Amniocentesis is performed between the 15th and 20th week of pregnancy; performing this test earlier may result in fetal injury. The term "early amniocentesis" is sometimes used to describe use of the process between weeks 11 and 13

Complications of amniocentesis include

- preterm labor and delivery,
- respiratory distress,
- postural deformities,
- fetal trauma and
- alloimmunisation of the mother (rhesus disease).
Chorionic villous sampling (CVS),

"chorionic villous sampling", is a form of prenatal diagnosis to determine chromosomal or genetic disorders in the fetus.

It entails sampling of the chorionic villus (placental tissue) and testing it for chromosomal abnormalities. CVS usually takes place at 10–12 weeks' gestation, earlier than amniocentesis (14–16 weeks). It is the preferred technique before 15 weeks.

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It can be performed in a transcervical or transabdominal manner.

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- Indications

- Possible reasons for having a CVS can include:
  - Abnormal first trimester screen results
  - Increased nuchal translucency or other abnormal ultrasound findings
  - Family history of a chromosomal abnormality or other genetic disorder
  - Parents are known carriers for a genetic disorder
  - Advanced maternal age (maternal age above 35). AMA is associated with increase risk of Down's syndrome and at age 35, risk is 1:400.[6] Screening test are usually carried out first before deciding if CVS should be done.

Risks
Risk of miscarriage in CVS in about 0.5 - 1%. Apart from a risk of miscarriage, there is a risk of infection and amniotic fluid leakage. The resulting amniotic fluid leak can develop into a condition known as oligohydramnios, which is low amniotic fluid level. If the resulting oligohydramnios is not treated and the amniotic fluid continues to leak it can result in the baby developing hypo plastic lungs (underdeveloped lungs).

Additionally, there is also mild risk of Limb Reduction Defects associated with CVS, especially if the procedure is carried out in earlier terms (before 12th week of pregnancy).

It is important after having CVS that the obstetrician follow the patient closely to ensure the patient does not develop infection.

It can be performed in a transcervical or transabdominal manner

Percutaneous umbilical cord blood sampling

**Percutaneous umbilical cord blood sampling (cordocentesis)**

**Percutaneous umbilical cord blood sampling** (PUBS), also called *cordocentesis*, is a diagnostic genetic test that examines blood from the fetal umbilical cord\(^1\) to detect fetal abnormalities.

PUBS provides a means of rapid chromosome analysis and is useful when information cannot be obtained through amniocentesis, CVS, or ultrasound (or if the results of these tests were inconclusive). This test carries a significant risk of complication and is typically reserved for pregnancies determined to be at high risk for genetic defect.

**Procedure**

PUBS is similar to amniocentesis, but instead of sampling the amniotic fluid which surrounds the fetus, PUBS examines fetal blood.

An advanced imaging ultrasound determines the location for needle insertion into the placenta, and the needle is guided through the mother's abdomen and uterine wall into the fetal vein of the umbilical cord, where a fetal blood sample is removed.

The sample can then be sent for chromosomal analysis. The entire process lasts 45 minutes to an hour. Because the fetal vein is fragile early in pregnancy, PUBS is performed no earlier than 17 weeks into pregnancy.

PUBS testing has a turnaround time of about 72 hours and can detect chromosomal abnormalities, blood disorder, some metabolic disorders, infections, and some causes of structural problems.\(^2\) PUBS has largely replaced fetoscopy, which has a much higher rate of miscarriage.

It has been used with mothers with immune thrombocytopenic purpura.\(^3\)

**Risks**
Miscarriage is the primary risk associated with PUBS and occurs in 1-2% of procedures. Additional possible complications are similar to those for amniocentesis and include:

- blood loss at the puncture site,
- infection, and
- premature rupture of membranes. During the procedure, the mother may feel discomfort similar to a menstrual cramp.

**Triple test**

The **triple test**, also called **triple screen**, the Kettering test or the Bart's test, is an investigation performed during pregnancy in the second trimester.

### Values measured

The triple test measures the following three levels in the maternal serum:

- **Alpha-fetoprotein** (AFP)
- **human chorionic gonadotropin** (hCG)
- **unconjugated estriol** (UE₃)

The Triple test measures:

- serum levels of AFP,
- estriol, and
- beta-hCG,

with a 70% sensitivity and 5% false-positive rate.

**Down syndrome** and other **prenatal diagnosis**. A positive test means having a high risk of chromosomal abnormalities and neural tube defects, and such patients are then referred for more sensitive and specific procedures to receive a definitive diagnosis, mostly invasive procedures like **amniocentesis**.
Interpretation

The levels may indicate increased risk for certain conditions:

- **AFP**
- **UE₃**
- **hCG**

Associated conditions

- low
- low
- high

**Down Syndrome**

- low
- low
- low

**Trisomy 18 (Edward's syndrome)**

High

Neural tube defects like spina bifida associated with increase levels of acetylcholinesterase in aminonic fluid, or omphalocele, or gasteroschisis, or multiple gestation like twins or triplets

**Ultrasound**

An ultrasound scan is a diagnostic technique which uses high-frequency sound waves to create an image of the internal organs.

A screening ultrasound is sometimes done during the course of a pregnancy to check normal fetal growth and verify the due date. Ultrasounds may be performed at various times throughout pregnancy for different reasons:

In the first trimester:

- to confirm pregnancy dates
- to establish the dates of a pregnancy
- to determine the number of fetuses and identify placental structures
• to diagnose an ectopic pregnancy or miscarriage
• to examine the uterus and other pelvic anatomy
• in some cases to detect fetal abnormalities

Mid-trimester

- to confirm pregnancy dates
- to determine the number of fetuses and examine the placental structures
- to assist in prenatal tests such as an amniocentesis
- to examine the fetal anatomy for presence of abnormalities
- to check the amount of amniotic fluid
- to examine blood flow patterns
- to observe fetal behavior and activity
- to examine the placenta
- to measure the length of the cervix
- to monitor fetal growth

Third trimester:

• to monitor fetal growth
• to check the amount of amniotic fluid
• as part of other testing such as the biophysical profile
• to determine the position of a fetus
• to assess the placenta

types

- **abdominal ultrasound**
  In an abdominal ultrasound, gel is applied to the abdomen and the ultrasound transducer glides over the gel on the abdomen to create the image.

- **transvaginal ultrasound**
  In a transvaginal ultrasound, a smaller ultrasound transducer is inserted into the vagina and rests against the back of the vagina to create an image. A transvaginal ultrasound produces a sharper image and is often used in early pregnancy.
several types of ultrasound imaging techniques

- The most common is two dimensional, or 2D. This gives a flat picture of one aspect of the image.
- The 3D image allows the physician to see width, height, and depth of images, which can be helpful in diagnosis. The 3D images can also be captured and saved for later review.
- The latest technology is 4D ultrasound, which allows the physician to visualize the unborn baby moving in real-time. With 4D imaging, a three-dimensional image is continuously updated, providing a "live action" view. These images often have a golden color, which helps show shadows and highlights.
- Ultrasound images may be captured in still photographs or on video to document findings.

Fetoscopy

Fetoscopy is definitely an endoscopic procedure during pregnancy to permit use of the fetus, the amniotic cavity, the umbilical cord, and also the fetal side from the placenta. A little (3-4 mm) incision is created in the abdomen, as well as an endoscope is inserted through the abdominal wall and uterus into the amniotic cavity.

Fetoscopy allows medical interventions such as a biopsy or perhaps a laser occlusion of abnormal arteries. Fetoscopy is really a process that employs a guitar known as a fetoscope to judge or treat the fetus while pregnant.

There are two various kinds of fetoscopy:

- endoscopic and
- external.

A few of the fetal irregularities which may be treated by endoscopic fetoscopy are:

- Twin/twin transfusion syndrome (TTTS).
- Congenital diaphragmatic hernia (CDH).
- Acardiac twin.
- Urinary tract obstruction.

Risks

The only real potential problem with external fetoscopy may be the chance of missing an abnormal heartbeat or rhythm. Its effectiveness and accuracy rely on the ability of the practitioner.

Endoscopic fetoscopy has got the possibility of causing infection within the fetus and/or mother; premature rupture from the amniotic membranes; premature labor; and fetal death. When endoscopic fetal
surgery is performed rather than open-uterus fetal surgery, the potential risks towards the mother and fetus are reduced. The potential risks are since the incision is considerably smaller, with less potential loss of blood, decreased uterine irritability, and reduced risk of early miscarriage.

**Amniotic fluid index**

Amniotic fluid index (AFI) is a rough estimate of the amount of amniotic fluid and is an index for the fetal well-being. It is a part of the biophysical profile.

AFI is the score (expressed in cm) given to the amount of amniotic fluid seen on pregnant uterus and calculated by a ultrasonograph (aka ultrasound). To determine the AFI, doctors may use a four-quadrant technique, when the deepest, unobstructed, vertical length of each pocket of fluid is measured in each quadrant and then added up to the others, or the so called "Single Deepest Pocket" technique.

An AFI between 8-18 is considered normal Median AFI level is approximately 14 from week 20 to week 35, when the amniotic fluid begins to reduce in preparation for birth.

An AFI < 5-6 is considered as Oligohydramnios The exact number can vary by gestational age. The fifth percentile for gestational age is sometimes used as a cutoff value.

An AFI > 20-24 is considered as Polyhydramnios.

**Vibroacoustic stimulation**

Vibroacoustic stimulation is the application of a vibratory sound stimulus to the abdomen of a pregnant woman to induce FHR accelerations. The presence of FHR accelerations reliably predicts the absence of fetal metabolic acidemia. Vibroacoustic stimulation is typically used during a nonstress test (NST)

**Biophysical profile**

A biophysical profile is a prenatal ultrasound evaluation of fetal well-being, involving a scoring system. It is often done when a non-stress test is non reactive, or for other obstetrical indications.

**Test**

The biophysical profile (BPP) has 5 components: 4 ultrasound (US) assessments and a nonstress test (NST). The nonstress test (NST)(CTG) evaluates fetal heart rate and response to fetal movement. The five discrete biophysical variables:

- Fetal movement
- Fetal tone
- Fetal breathing
- Amniotic fluid volume
Fetal Heart Rate

Scoring

Each assessment is graded either 0 or 2 points, and then added up to yield a number between 0 and 10. A BPP of 8 or 10 is generally considered reassuring. A BPP normally is not performed before the second half of a pregnancy, since fetal breathing movements do not occur in the first half.

The presence of these biophysical variables implies absence of significant central nervous system hypoxemia/acidemia at the time of testing. By comparison, a compromised fetus typically exhibits loss of accelerations of the fetal heart rate (FHR), decreased body movement and breathing, hypotonia, and, less acutely, decreased amniotic fluid volume.