

OBSTETRICS AND GYNECOLOGY

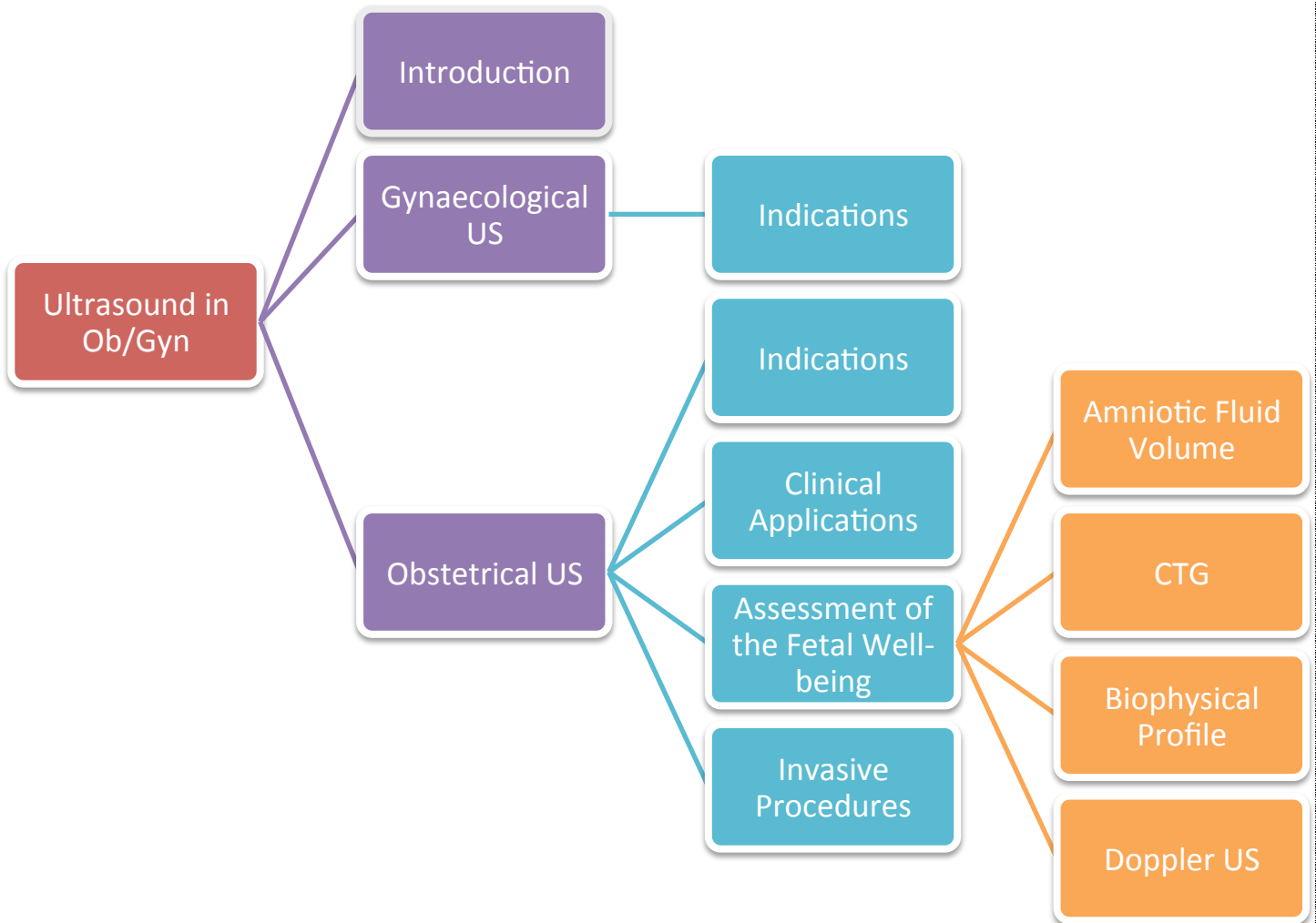
(Tutorial 11) Ultrasound in Obstetrics and Gynaecology

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Introduction

The Definition of Ultrasound (1):

The term "ultrasound" refers to sound waves of a frequency greater than that which the human ear can appreciate, namely frequencies greater than 20,000 cycles per second or Hertz (Hz). To obtain images of the pregnant or nonpregnant pelvis, frequencies of 2 to 10 million Hertz (2 to 10 megahertz [MHz]) are typically required.

Preprocedure Issues (1):

The sonographer should know the reason for the ultrasound examination and results of other evaluations related to the patient's problem. All of this information is critical for targeting specific structures, choosing whether to use a transvaginal and/or transabdominal technique, and deciding whether additional studies may be helpful (e.g., saline infusion sonohysterography, Doppler velocimetry).

There is little benefit to having a full bladder for obstetrical exams and it is often very uncomfortable for the patient. Furthermore, a full bladder can distort anatomy (e.g., false diagnosis of placenta previa or falsely elongated cervix). The cervix can usually be seen transabdominally without a full bladder. If it cannot be seen transabdominally, transvaginal sonography almost always provides satisfactory images.

Similarly, if transabdominal visualization of the pregnancy is inadequate in the first trimester, transvaginal sonography will almost always show more detail and is optimally performed with an empty bladder.

In gynecologic patients, not allowing the patient to empty whatever urine is in her bladder just prior to a transabdominal ultrasound examination generally permits sufficient initial visualization of the pelvis. As discussed above, transvaginal sonography should be performed with an empty bladder.

- The bladder should be empty before doing transvaginal ultrasound.
- If we suspect placenta previa, we do transvaginal ultrasound and visualize the edge between the placenta and the cervix.
- When doing a standard gynecological transabdominal ultrasound, the bladder should be full for easy waves transmission.

Gynaecological Ultrasound

Indications (1):

- Evaluation of the menstrual cycle (endometrial thickness, follicular development).
- Monitoring natural or stimulated follicular development during infertility therapy.
- Localization of an intrauterine device.
- Evaluation of abnormal uterine bleeding.
- Assessment of a pelvic mass (e.g., adenomyosis, fibroid, cancer, cysts).
- Evaluation for sequelae of pelvic infection (e.g., abscess, hydrosalpinx).
- Evaluation of congenital uterine anomalies.
- Screening for malignancy.

Components (1): The components of a typical gynecologic sonographic examination include:

- Uterine size, shape, and orientation.
- Evaluation of endometrium, myometrium, and cervix.
- Identification and morphology of ovaries, if possible.
- Assessment of the uterus and adnexa for masses, cysts, hydrosalpinges, fluid collections.
- Evaluation of the cul-de-sac for free fluid or masses.

Obstetrical Ultrasound

Indications (1):

- ✓ Estimating the location of pregnancy and the gestational age.
- ✓ Assess the fetal well-being.
- ✓ Diagnose multiple gestation and determine chorionicity.
- ✓ Evaluate fetal anomalies.
- ✓ Evaluate the cervix for risk of preterm loss of birth.
- ✓ Part of fetal aneuploidy screening.
- ✓ Evaluate suspected abnormalities of amniotic fluid volume or abruptio placenta.
- ✓ Determine fetal presentation.

Clinical Application of Ultrasound (2):

1. Diagnosis and Confirmation of Viability in Early Pregnancy

The gestational sac can be visualized from as early as 4–5 weeks of gestation and the yolk sac at about 5 weeks. The embryo can be observed and measured at 5–6 weeks gestation. A visible heartbeat can be visualized by about 6 weeks.

Transvaginal ultrasound plays a key role in diagnosing incomplete or missed abortion, when the fetus can be identified, but with an absent fetal heart and in a blighted ovum.



Figure 6.3 Ultrasound sac showing yolk sac (ys) and embryo (e) with the vitelline duct (vd)

2. Determination of the Gestational Age and Assessment of Fetal Size and Growth

Up to approximately 20 weeks gestation the range of values around the mean for measurements of fetal length, head size and long bone length is narrow and hence assessment of gestation based on these measures is accurate.

The biparietal diameter (BPD) and femur length (FL) can be used to determine the gestational age. Measuring the fetal abdominal circumference (AC) and head circumference (HC) will allow assessment of the size and growth of the fetus, and will assist in the diagnosis and management of fetal growth restriction. The combination of these parameters can provide more accurate estimation of fetal weight than any of the parameters taken singly. Gestational age cannot be accurately calculated by ultrasound after 20 weeks gestation because of the wider range of normal values of AC and HC around the mean.

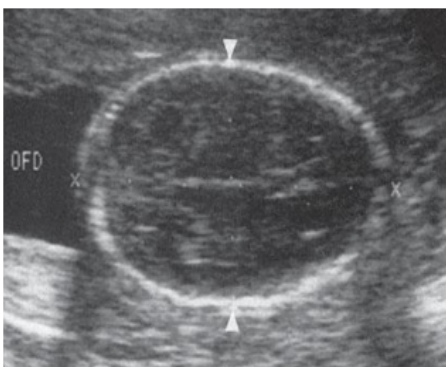


Figure 6.5 Biparietal diameter (BPD)



Figure 6.6 Femur length (FL)

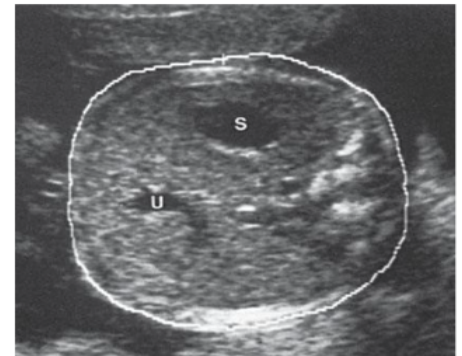


Figure 6.7 Abdominal circumference (AC) measurement demonstrating the correct section showing the stomach (S) and the umbilical vein (U)

- In IUGR: if it is symmetrical, there will be low total growth rate. If it is asymmetrical, there will be asymmetry between head measures (BPD and HC) and AC “the head is bigger than the abdomen” ⁽²⁾.
- In diabetic pregnancies, the abdomen is disproportionately bigger due to the effects of the insulin on the fetal liver and fat stores ⁽²⁾.

3. Multiple Pregnancy

The dividing membrane in **monochorionic twins** (i.e. those who 'share' a placenta) is formed by **two layers of amnion** and in **dichorionic twins** by **two layers of chorion and two of amnion**. Dichorionic twins therefore have thicker membranes than monochorionic twins and this can be perceived qualitatively on ultrasound.

Ultrasonically, dichorionic twin pregnancies in the first trimester of pregnancy have a **thick inter-twin separating membrane (septum)**, flanked on either side by a very thin amnion. This is in contrast to a monochorionic twin pregnancy, which on two-dimensional ultrasound has **a very thin inter-twin septum**.

4. Diagnosis of Fetal Anomalies

Major structural anomalies can be diagnosed by ultrasound around or before 20 weeks gestation, like spina bifida, hydrocephalus, skeletal anomalies, abdominal wall defects and cleft lip and palate.

First trimester ultrasonic 'soft' markers for chromosomal abnormalities such as the absence of fetal nasal bone, an increased fetal nuchal translucency (the area at the back of the neck) are now in common use to enable detection of fetuses at risk of chromosomal anomalies such as Down's syndrome.

5. Placental Localization

At the 20 weeks scan, it is customary to identify women who have a low-lying placenta. At this stage, the lower uterine segment has not yet formed and most low-lying placentas will appear to 'migrate' upwards as the lower segment stretches in the late second and third trimesters. About 5 per cent of women have a low-lying placenta at 20 weeks will eventually be shown to have a placenta previa. The transvaginal approach is taken with caution.

6. Measurement of Cervical Length

Evidence suggests that approximately 50 per cent of women who deliver before 34 weeks gestation will have a short cervix. The length of the cervix can be assessed using transvaginal scanning.

Ultrasound in Assessment of Fetal Well-being (2):

1. Amniotic Fluid Volume

A reduction in amniotic fluid volume is referred to as **'oligohydramnios'** and an excess is referred to as **'polyhydramnios'**.

The fetus has a role in the control of the volume of amniotic fluid. It swallows amniotic fluid, absorbs it in the gut and later excretes urine into the amniotic sac. Congenital abnormalities that impair the fetus's ability to swallow, for example anencephaly or oesophageal atresia, **will result in an increase in amniotic fluid**. Congenital abnormalities that result in a failure of urine production or passage, for example renal agenesis and posterior urethral valves, **will result in reduced or absent amniotic fluid**. Fetal growth restriction can be associated with reduced amniotic fluid because of reduced renal perfusion and hence urine output. Two ultrasound measurement approaches give an indication of amniotic fluid volume:

- ✓ Maximum vertical pool: **less than 2 cm = oligohydramnios, greater than 8 cm = polyhydramnios.**
- ✓ Amniotic fluid index: in the third trimester, it should be between 10 and 25 cm; **values below 10 cm indicate a reduced volume and those below 5 cm indicate oligohydramnios, while values above 25 cm indicate polyhydramnios.**

2. Cardiotocograph (CTG)

The cardiotocograph (CTG) is a continuous tracing of the fetal heart rate used to assess fetal well-being. **Features which are reported from a CTG to define normality and identify abnormality and potential concern for fetal well-being include the: baseline rate, baseline variability, accelerations and decelerations.**

The recording is obtained with the pregnant woman positioned comfortably in a left lateral or semi-recumbent position to avoid compression of the maternal vena cava. An external ultrasound transducer for monitoring the fetal heart and a tocodynamometer (stretch gauge) for recording uterine activity are secured overlying the uterus. Recordings are then made for at least 30 minutes with the output from the CTG machine producing two 'lines', one a tracing of fetal heart rate and a second a tracing of uterine activity.

3. Biophysical Profile

A biophysical profile is a long (30 minute) ultrasound scan which observes fetal behavior, measures amniotic fluid volume and includes a CTG. By assigning each of the active variables, and also amniotic fluid volume and the CTG scores of either 2 (normal) or 0 (suboptimal), **it is possible to**

assign an individual fetus score of between 0 and 10. A score of 0, 2 or 4 is considered abnormal and a score of 8 or 10 normal. A score of 6 is equivocal and requires repeat within a reasonable timescale (hours) to exclude a period of fetal sleep as a cause. This is the basis of fetal biophysical profiling.

Parameter	Score 2	Score 0
Non-stress CTG	Reactive	Fewer than two accelerations in 40 minutes
Fetal breathing movements	≥30 seconds in 30 minutes	Less than 30 seconds of fetal breathing in 30 minutes
Fetal body movements	≥3 movements in 30 minutes	Two or fewer gross body movements in 30 minutes
Fetal tone	One episode of limb flexion	No evidence of fetal movement or flexion
Amniotic fluid volume*	Largest cord-free pocket of fluid over 1 cm	Less than 1 cm pocket of fluid

Figure 6.13 Biophysical profile scoring system

4. Doppler Investigation

The use of Doppler ultrasound allows the assessment of the velocity of blood within fetal and placental vessels and provides indirect assessment of fetal and placental condition. Waveforms can be obtained from both the umbilical and fetal vessels.

Umbilical artery: Waveforms obtained from the umbilical artery **provide information on placental resistance to blood flow** and hence indirectly placenta 'health' and function. An infarcted placenta secondary to maternal hypertension, for example, will have increased resistance to flow.

Fetal vessels: Falling oxygen levels in the fetus result in a redistribution of blood flow to protect the brain, heart and adrenal glands, and vasoconstriction in all other vessels. **The middle cerebral artery will show increasing diastolic flow as hypoxia increases**, while a rising resistance in the fetal aorta reflects compensatory vasoconstriction in the fetal body.

Absent diastolic flow in the fetal aorta implies fetal acidaemia. When late diastolic flow is absent in the ductus venosus delivery should be considered as fetal death is imminent.

Measurement of velocity of blood in the middle cerebral artery also gives an indicator of the presence of fetal anaemia. The peak systolic velocity increases in this situation. This technique is particularly useful in the assessment of the severity of Rhesus disease and twin-to-twin transfusion syndrome which results in anaemia in the donor twin.

Ultrasound and Invasive Procedures (2):

Ultrasound is used to guide invasive diagnostic procedures such as amniocentesis, chorion villus sampling and cordocentesis, and therapeutic procedures such as the insertion of fetal bladder shunts or chest drains. If fetoscopy is performed, the endoscope is inserted under ultrasound guidance.

- Fetal ECHO can be done as early as 20 weeks.
- Nose and lips view is done at 18 weeks to rule out cleft lip and palate.

Summary of the aims of obstetric ultrasound (2)

The early pregnancy scan (11–14 weeks): The principal aims of this scan are:

- To confirm fetal viability.
- To diagnose multiple gestation, and in particular.
- To provide an accurate estimation of gestational age.
- To determine chorionicity.
- To identify markers which would indicate an increased risk of fetal chromosome abnormality such as Down's syndrome.
- To identify fetuses with gross structural abnormalities.

The 20 week scan (18–22 weeks): The principal aims of this scan are:

- To provide an accurate estimation of gestational age if an early scan has not been performed.
- To carry out a detailed fetal anatomical survey to detect any fetal structural abnormalities or markers for chromosome abnormality.
- To locate the placenta and identify the 5% of women who have a low-lying placenta for a repeat scan at 34 weeks to exclude placenta previa.
- To estimate the amniotic fluid volume.

Also, in Some centers:

- To perform Doppler ultrasound examination of maternal arteries to screen for adverse pregnancy outcome, for example pre-eclampsia.
- To measure cervical length to assess the risk of preterm delivery.

Ultrasound in the third trimester: The principle aims of ultrasound in the third trimester are:

- To assess fetal growth.

References

1. Ultrasound Examination in Obstetrics and Gynecology:
<http://www.uptodate.com/contents/ultrasound-examination-in-obstetrics-and-gynecology#H20>
2. Obstetrics by Ten Teachers 19th Edition.

MCQs:

Q1. A 26-year-old G1P0 patient at 34 weeks gestation is being evaluated with Doppler ultrasound studies of the fetal umbilical arteries. The patient is a healthy smoker. Her fetus shown evidence of intrauterine growth restriction (IUGR) on previous ultrasound examination. The Doppler studies currently show that the systolic to diastolic ratio (S/D) in the umbilical arteries is much higher than it was on her last ultrasound 3 weeks ago and there is now reverse diastolic flow. Which of the following is correct information to share with the patient?

- a. The Doppler studies indicate that the fetus is doing well
- b. With advancing gestational age the S/D ration is supposed to be one
- c. These Doppler findings are normal in someone who smokes
- d. Reverse diastolic flow is normal as a patient approaches full term
- e. The Doppler studies are worrisome and indicate that the fetus is deteriorating

Q2. A 17-year-old primipara presents to your office at 41 weeks. Her pregnancy has been uncomplicated. Because her cervix is unfavorable for induction of labor, she is being followed with biophysical profile (BPP) testing. Which of the following is correct information to share with the patient regarding BPPs?

- a. BPP testing includes assessment of amniotic fluid volume, fetal breathing, fetal body tone, and contraction stress testing
- b. The false-negative rate of the BPPs is 10% so a reassuring BPP should be repeated in 48 hours
- c. False-positive results of BPP are rare even if the amniotic fluid level is low
- d. Spontaneous decelerations during BPP testing are associated with significant fetal morbidity
- e. A normal BPP should be repeated in 1 week to 10 days in a post-term pregnancy

Q3. A pregnant woman who is 7 weeks from her LMP comes to your office for her first visit. Her previous pregnancy ended in a missed abortion in the first trimester. The patient therefore is very anxious about the well-being of this pregnancy. Which of the following modalities will allow you to best document fetal heart action?

- a. Regular stethoscope
- b. Fetoscope
- c. Fetal Doppler stethoscope
- d. Transvaginal sonogram
- e. Transabdominal pelvic sonogram

Q4: Your patient complains of decreased fetal movement at term. You recommend a modified BPP test. Nonstress test (NST) in your office was reactive. The next part of the modified BPP is which of the following?

- a. Contraction stress test
- b. Amniotic fluid index evaluation
- c. Ultrasound assessment of fetal movement
- d. Ultrasound assessment of fetal breathing movements
- e. Ultrasound assessment of fetal tone

Answers

Q1: E

Q2: D

Q3: D

Q4: B

Explanation

Q1: Simple continuous-wave Doppler ultrasound can be used to display flow velocity waveforms as a function of time. With increased gestational age, in normal pregnancy there is an increase in end-diastolic flow velocity relative to peak systolic velocity, which causes the S/D ratio to decrease with advancing gestation. An increase in S/D ratio is associated with increased resistance in the placenta vascular bed as can be noted in preeclampsia or fetal growth retardation. Nicotine and maternal smoking have also been reported to increase S/D ratio. Many studies document the value of umbilical Doppler flow studies in recognition of fetal compromise. It seems that the S/D ratio increases as the fetal condition deteriorates; this is the most severe in cases of absent or reversed end diastolic flow. In normal twins, the S/D ratio falls within the normal range of singletons. Doppler studies have been used for invasive surveillance in cases of twin-to-twin transfusion.

Q2: The BPP is based on FHR monitoring (generally NST) in addition to four parameters observed on real-time ultrasonography: amniotic fluid volume, fetal breathing, fetal body movements, and fetal body tone. Each parameter gets a score of 0 to 2. A score of 8 or 10 is considered normal, a score of 6 is equivocal, and a score of 4 or less is abnormal and prompts delivery. The false-negative rate for the BPP is less than 0.1%, but false-positive results are relatively frequent, with poor specificity. Oligohydramnios is an ominous sign, as are spontaneous decelerations. In patients with profile scores of 8 but with spontaneous decelerations, the rate of cesarean delivery indicated for fetal distress has been 25%. Testing more frequently than every 7 days is recommended in patients with post-term pregnancies, connective tissue disease, chronic hypertension, and suspected fetal growth retardation, as well as in patients with previous fetal death.

Q3: Vaginal ultrasound can detect fetal heart action as early as 5 weeks of amenorrhea. With a traditional, nonelectronic fetal stethoscope, heart tones can be heard after 19 to 20 weeks gestational age. With a Doppler stethoscope, fetal heart tones can be usually be detected by 10 weeks gestational age.

Q4: The BPP consists of five components:

1. Nonstress test
2. Fetal breathing movements – one or more episodes of fetal breathing movements of 30 seconds or more within 30 minutes.
3. Fetal movement – three or more discrete body or limb movements within 30 minutes.
4. Fetal tone - one or more episodes of extension of a fetal extremity with return to flexion, or opening or closing of a hand.
5. Determination of amniotic fluid volume – a single vertical pocket of amniotic fluid exceeding 2 cm.