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Don't Fear the Fetus: A Second/Third Trimester Ultrasound Blueprint for the General Radiologist

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After participating in this activity, the radiologist should be better able to perform and interpret basic but comprehensive ultrasound evaluation of the fetus in the second and third trimesters.

CME Category: Women's Imaging
Subcategory: Genitourinary
Modality: Ultrasound

Key Words: Fetal Ultrasound, Second/Third Trimester

Ultrasound imaging of the fetus is not performed by many general radiologists for various reasons. One of the reasons is the increasing demand for more radiologic studies that are less time consuming than comprehensive fetal sonography. At a time when an increase in individual productivity is expected despite no additional personnel, time-intensive studies are discouraged. A study of the recent U.S. recession (2007–2009) found that even with fewer workers, output increased, an effect deemed “making do with less.”^{1,2} In radiology, an increase in productivity was partially achieved by subspecialists broadening their scope of practice. A recent study conducted by the American College of Radiology found that approximately three fourths of practicing radiologists consider themselves subspecialists, but only half of their professional time is spent in their subspecialty. Thus, today, most imagers are already part-time generalists.³ It is, therefore, likely that all diagnostic radiologists will be expected to interpret studies that are outside of their subspecialty or comfort zone.

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The second/third trimester ultrasound can be an intimidating study, because of fear of litigation. To help overcome this concern, practice guidelines for the performance of obstetrical ultrasound have been established, and recently revised in 2013, by the American College of Radiology (ACR), the American Institute of Ultrasound in Medicine (AIUM), in conjunction with the American College of Obstetricians and Gynecologists (ACOG), and the Society of Radiologists in Ultrasound (SRU).⁴ The purpose of the guidelines is to provide the interpreting radiologist with a basic blueprint to follow in every comprehensive fetal ultrasound evaluation. As radiologists face the changes that future health care policies will impose on them, it is best to realize that primary care physicians and allied health providers will likely be better served by radiologists willing and able to provide a wide spectrum of radiologic services.⁵

The following parameters are components of a basic comprehensive fetal ultrasound evaluation. In high-risk pregnancies with suspected chromosomal anomalies, a targeted examination may be performed, in which additional views of specific fetal anatomic structures are obtained (i.e., fetal heart by echocardiography, hands and feet, and hard palate).

Imaging Parameters

Fetal ultrasound is performed primarily to evaluate fetal growth and anatomy. Fetal ultrasound also guides management of complicated pregnancies and multiple gestations.⁶ The standard second/third trimester obstetrical ultrasound examination serves as an important baseline against which subsequent ultrasound scans may be compared.⁷ The standard second/third trimester obstetrical ultrasound examination

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usually is performed after 18 weeks' gestational (menstrual) age, and optimally between 18 and 20 weeks' gestational age. When technical limitations are encountered and any of the fetal anatomic structures, listed later, are not visualized adequately, these omissions should be noted in the final ultrasound report. A limited follow-up examination may be recommended to reexamine those structures that were evaluated incompletely. A targeted anatomic examination of the fetus may be necessary in some cases, such as when an abnormality is found or suspected in high-risk pregnancies.⁵

Fetal ultrasound is performed primarily to evaluate fetal growth and anatomy.

The following is a list of the basic required elements of the standard second/third trimester obstetrical ultrasound.

Maternal Anatomy

Uterus:

- The cervix should be visualized through the transabdominal approach (Figure 1). Additional transvaginal or transperineal views may be considered if the cervix appears shortened or cannot be adequately visualized transabdominally. The normal cervix should measure at least 3 cm in length. A short cervix (technically <2.5 cm) increases the possibility of pregnancy loss or premature labor.
- The presence of any uterine masses or congenital uterine malformations should be documented.

Adnexa:

- The adnexa may be difficult to visualize especially in the third trimester but should be documented to exclude the presence of adnexal masses.

Fetal Evaluation

Fetal Number:

- Multiple gestations require documentation of chorionicity and amnionicity, comparison of fetal sizes, estimation of amniotic fluid volume in each amniotic cavity, and fetal genitalia (when visualized).

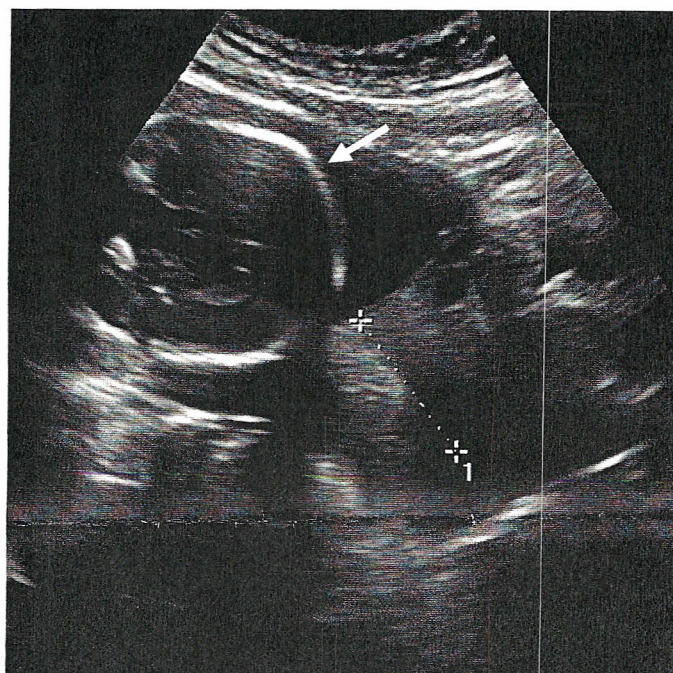


Figure 1. Cervix. Longitudinal view of the cervix shows a normal cervical length of more than 3 cm (cursors). The placenta is not visualized covering the cervix ruling out placenta previa. The fetal head is presenting (arrow).

Presentation:

- Cephalic, breech, or transverse presentation should be determined.

Amniotic Fluid:

- Experienced examiners may give a qualitative estimate on the basis of the relative balance between fetal versus amniotic fluid volume, which achieves subjective equilibrium at 20 to 24 weeks.
- Semiquantitative methods such as amniotic fluid index (AFI) and single deepest pocket (SDP) also have been developed (Figure 2). The AFI measures the amniotic fluid in all 4 quadrants of the uterus; and when the sum of the 4 measurements exceeds 20 cm, polyhydramnios should be considered. The SDP is a measurement of the deepest pocket of amniotic fluid in 1 of the 4 quadrants, and a measurement greater than 8 cm also suggests the presence of polyhydramnios.

The continuing education activity in *Contemporary Diagnostic Radiology* is intended for radiologists.

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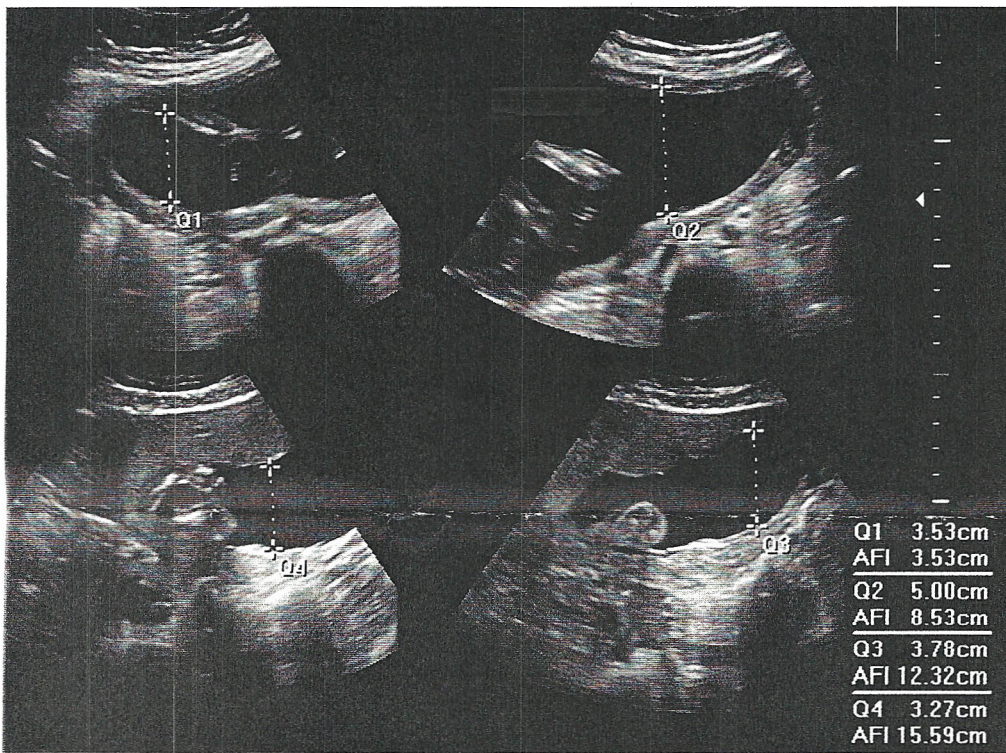


Figure 2. Amniotic fluid index (AFI). The amniotic fluid index is measured by adding the depths of amniotic fluid pockets in all 4 quadrants of the uterus. A value of 5 to 20 cm is considered normal with the upper limits usually encountered in the second trimester and the lower limits in the third trimester. The amniotic fluid index in this patient is 15.59 cm.

Placenta:

- Document location, appearance, and relation of the placenta to the internal cervical os.
- Transvaginal or transperineal views may be helpful in visualizing the internal cervical os and its relation to the placenta.
- When placenta previa is suspected early in pregnancy, a repeat evaluation in the late third trimester is necessary because the majority of cases of early placenta previa resolve because of uterine growth during pregnancy.

The majority of cases of early determined placenta previa resolve because of uterine growth during pregnancy.

Fetal Biometry

The first trimester crown-rump length is the most accurate means for sonographic dating of pregnancy. Beyond the first trimester, various sonographic parameters can be used to estimate gestational age based on size and compare this to menstrual dates. Significant discrepancies may suggest fetal growth abnormality (intrauterine growth restriction, or macrosomia). The best estimate of gestational age usually is based on a first trimester ultrasound or an early second trimester ultrasound. When not available, the menstrual dates are used for baseline reference and correlated with serial fetal measurements.

The first trimester crown-rump length is the most accurate means for sonographic dating of pregnancy.

Biparietal Diameter:

- The biparietal diameter (BPD) is measured at the level of the thalami and cavum septi pellucidi.
- The cerebellum should not be visualized when in the correct plane for BPD measurement.
- The BPD measurement should be taken from the outer edge of the nondependent skull to the inner edge of the dependent skull.
- When there is suspicion of brachycephaly or dolichocephaly, the BPD measurement may be inaccurate and the head circumference (HC) is used instead as the dating parameter.
- Based on a menstrual age of 18 to 20 weeks, the normal BPD should be 4.0 to 4.6 cm.

Head Circumference:

- HC is measured at the same level as BPD, around the outer perimeter of the calvarium (Figure 3).
- The measurement of HC is less affected by skull shape than the measurement of BPD.
- Based on a menstrual age of 18 to 20 weeks, the normal HC should be 15 to 17 cm.

Abdominal Circumference:

- The abdominal circumference (AC) is measured at the skin line on a true transverse view of the fetal abdomen.
- The AC is obtained at the level of the portal sinus, and fetal stomach, when visible (Figure 4).
- If the AC measurement is determined at the level of the umbilical cord insertion into the fetal abdomen, it could underestimate the gestational age.
- Based on a menstrual age of 18 to 20 weeks, the normal AC is 13 to 14.5 cm.

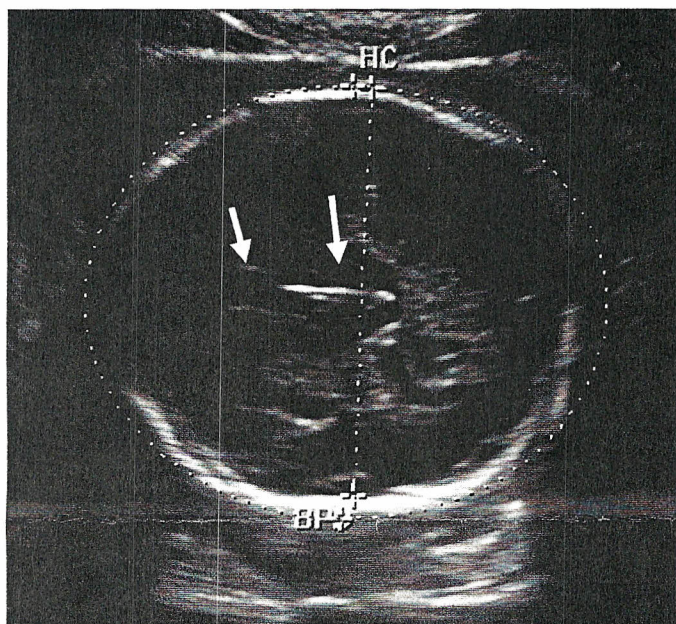


Figure 3. Head measurements. The biparietal diameter (BPD) and head circumference (HC) are measured at the same plane where the image includes the thalami (*long arrow*), and the cavum septi pellucidum (*short arrow*). The cerebellum and falx should not be in the field of view when the image is obtained correctly.

If the fetal abdominal circumference measurement is determined at the level of the umbilical cord into the fetal abdomen, it could underestimate the gestational age.

Femur Length:

- Femur length (FL) measures the ossified portion of the femoral shaft.
- Care should be taken not to include the cartilaginous parts of the femur that extend beyond the limits of the ossified portion (Figure 5).
- Based on a menstrual age of 18 to 20 weeks, the normal FL is 2.8 to 3.3 cm.

Fetal Weight Estimate:

- Fetal weight can be estimated via the measurements obtained previously, using published nomograms.^{4,6,7}
- If previous fetal ultrasound studies are available for comparison, appropriate interval growth also should be documented.

Anatomic Survey

Head:

- All images are obtained in the axial plane, approximately 15 to 20 degrees from the canthomeatal line.
- The atria of the lateral cerebral ventricles are measured at their greatest transverse diameter posterior to the choroid plexus. The transverse diameter of each atrium should not be greater than 10 mm in a normal fetus. Borderline measurements should be followed to exclude early ventriculomegaly.
- Ventricular choroid plexus should be identified to exclude the presence of choroid plexus cysts.

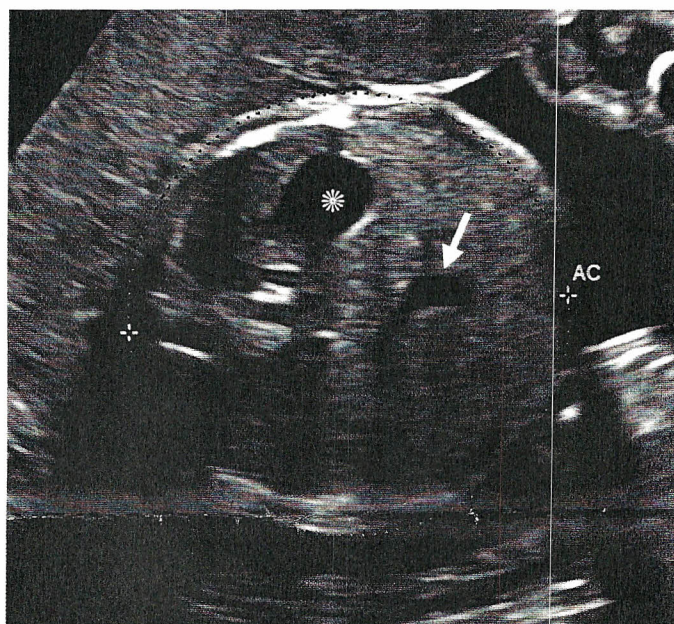


Figure 4. Abdominal circumference (AC). The abdominal circumference is measured at the level of the umbilical vein (*arrow*) after it enters the fetal abdomen and becomes intrahepatic in its course. The stomach (*) usually is seen at this level in the left upper quadrant.

- The falx should be midline.
- The cavum septi pellucidum also should be midline, anterior to the thalamus and third ventricle.
- The transverse cerebellar diameter may be measured in cases of intracranial anomalies when BPD or HC is unreliable. Then the transverse diameter of the cerebellum is compared to published criteria for gestational age. These criteria are available in any obstetrical ultrasound textbook.
- Based on a menstrual age of 18 to 20 weeks, the normal transverse cerebellar diameter is 18.0 to 19.3 mm.
- The cisterna magna is measured in its deepest AP dimension posterior to the vermis of the cerebellum (Figure 6). Its maximum AP diameter should be less than 10 mm.

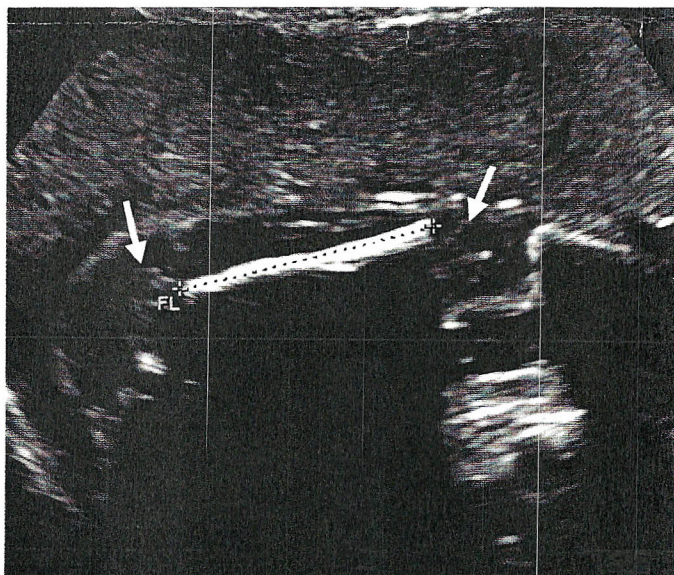


Figure 5. Femur length (FL). The femur length measures the ossified portion of the bone (*cursors*). The cartilaginous portions in the proximal and distal epiphyses (*arrows*) are not well seen.

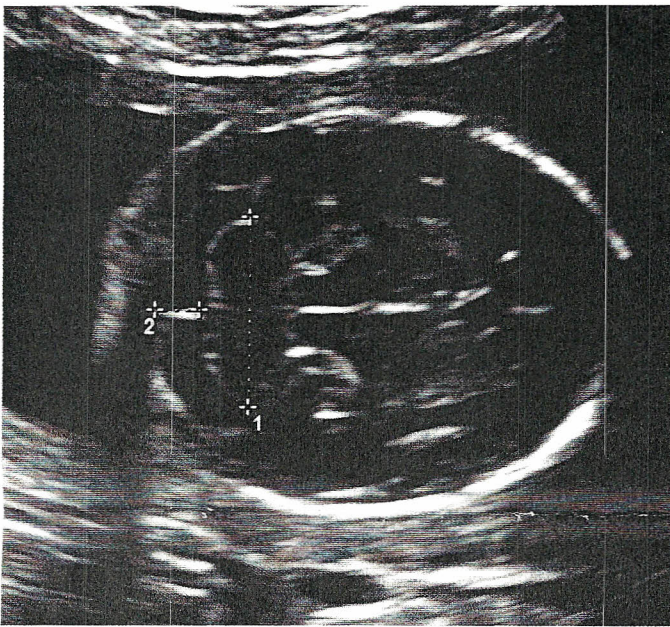


Figure 6. Cerebellum. The cerebellum is demonstrated at a lower and more inferiorly oriented plane of the head. At this level, the transverse cerebellar diameter (*cursor 1*) and the depth of the cisterna magna (*cursor 2*) are measured.

An isolated cisterna magna >10 mm may be a normal variant in cases of mega cisterna magna, but can be seen in fetuses with an abnormal karyotype, especially in the presence of additional structural abnormalities. It is also a finding in Dandy Walker variants where the only finding may be a large cisterna magna due to dysgenesis or hypoplasia of the cerebellar vermis.

Fetal ventricular choroid plexus should be identified to exclude the presence of choroid plexus cysts.

Face:

- The upper lip should be identified in a coronal plane. In a targeted examination, the palate also may be imaged in the axial plane to exclude a cleft palate.
- A profile of the face should be performed for documentation of the nasal bone.

Chest:

- Cardiac activity and heart rate are documented. The normal fetal heart rate during the second/third trimester is 100 to 180 beats per minute (bpm).
- Four-chamber cardiac view (Figure 7) should be performed.
- Left and right ventricular outflow tracts should be visualized if technically feasible; follow-up studies may be performed if the outflow tracts are not seen initially.

Abdomen:

- The stomach usually is seen after 16 weeks. Document presence, size (relative to gestational age), and situs.

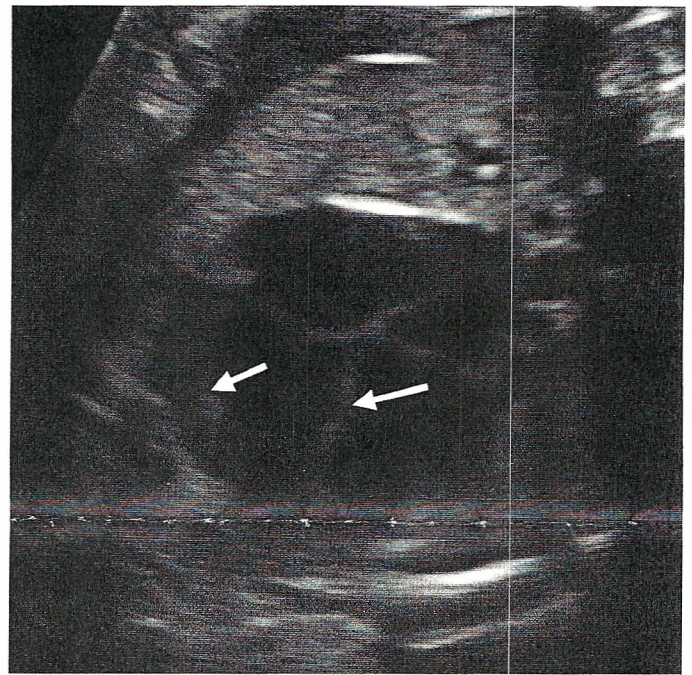


Figure 7. Heart. A 4-chamber view of the heart is shown with the right ventricle showing the characteristic moderator band (*short arrow*) within the ventricular cavity. The interventricular septum (*long arrow*) intersects the atrioventricular valves as it continues as the interatrial septum.

- The kidneys are visualized in the coronal or axial planes (Figure 8).
- The urinary bladder is visualized after 16 weeks.
- The umbilical cord insertion site into the fetal abdomen (Figure 9) is important to identify.

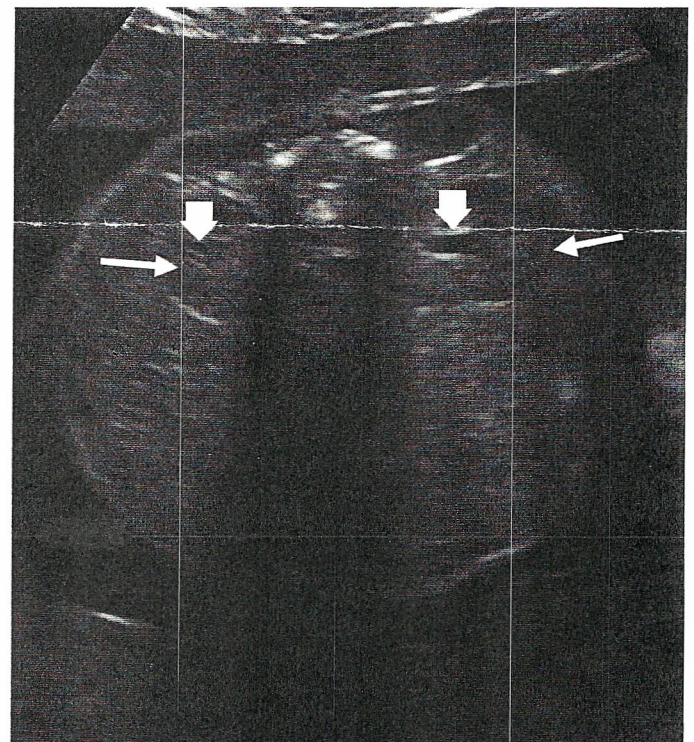


Figure 8. Kidneys. Fetal kidneys (*thin arrows*) are ovoid structures that abut the fetal spine in the axial view. In the late second and third trimesters, the renal pelvises (*thick arrows*) can be seen, making identification of the kidneys easier.

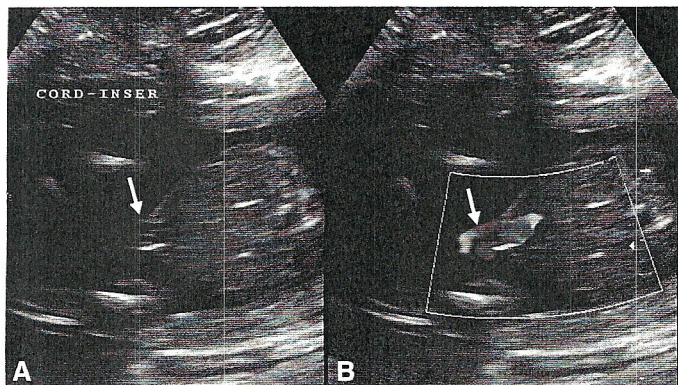


Figure 9. Umbilical cord insertion. *A*: Transverse view of the fetal abdomen shows the cord (arrow) inserting into the anterior abdomen without evidence of ventral abdominal wall defects. *B*: Color Doppler transverse view helps to localize the cord insertion (arrow), especially in cases where other fetal anatomy interferes with adequate visualization.

- Color Doppler at the level of the urinary bladder demonstrates umbilical cord vessel number; demonstration of both umbilical arteries confirms the presence of the normal 3-vessel umbilical cord (Figure 10). Although a 2-vessel umbilical cord is found in many normal fetuses, its presence warrants further investigation with more detailed ultrasound to exclude other fetal anomalies.

The stomach and urinary bladder usually are visualized after 16 weeks' gestational age.

Spine:

- Identification of the cervical, thoracic, lumbar, and sacral spine in sagittal (Figure 11) and axial planes should be undertaken.

Extremities:

- Document both sides of the extremities with demonstration of the bones of the upper (Figure 12) and lower

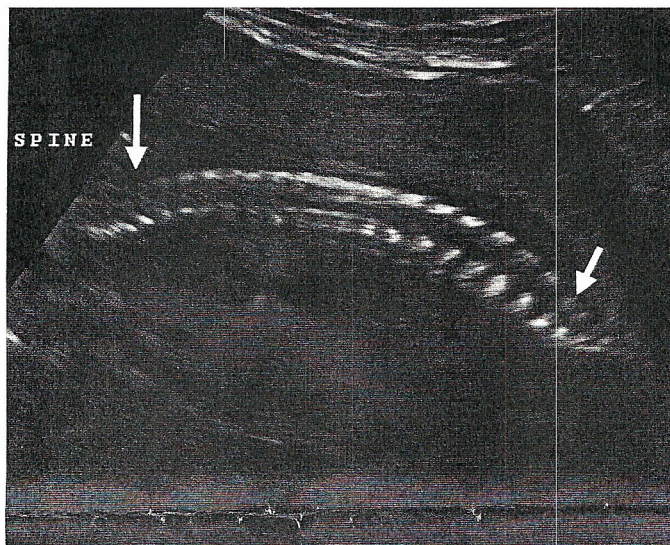


Figure 11. Spine. The fetal spine should be demonstrated in both the longitudinal and transverse planes. It should be demonstrated in its entirety in single or multiple images from the occipitocervical junction (long arrow) to the coccyx. The short arrow is at the lumbosacral junction.

extremities. In a targeted examination, signs of aneuploidy such as persistent clenched fists, clubbed feet, or supernumerary digits may be needed.

Genitalia:

- Evaluation of the genitalia is required in multiple gestations and when medically indicated for genetic counseling.

Conclusion

Most subspecialty-trained radiologists today spend a considerable amount of their professional time interpreting imaging studies outside of their realm of fellowship training.³ This CME activity emphasizes that future health care models

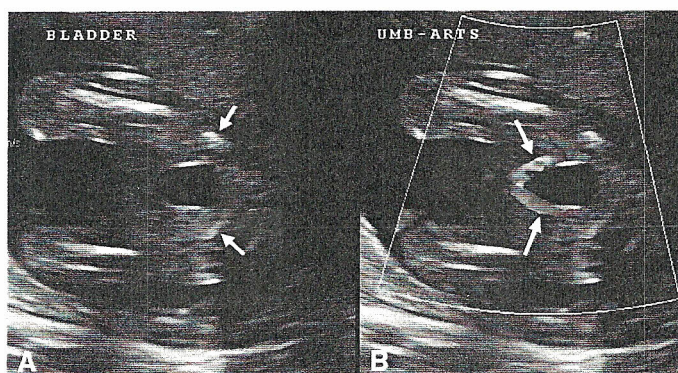


Figure 10. Urinary bladder. *A*: The fetal urinary bladder usually is imaged after 16 weeks at the level of the iliac ossification centers (arrows). *B*: Color Doppler allows identification of 2 umbilical arteries (arrows) as they course on either side of the urinary bladder to the cord insertion. Visualization of these two arteries ensures the presence of a 3-vessel umbilical cord.

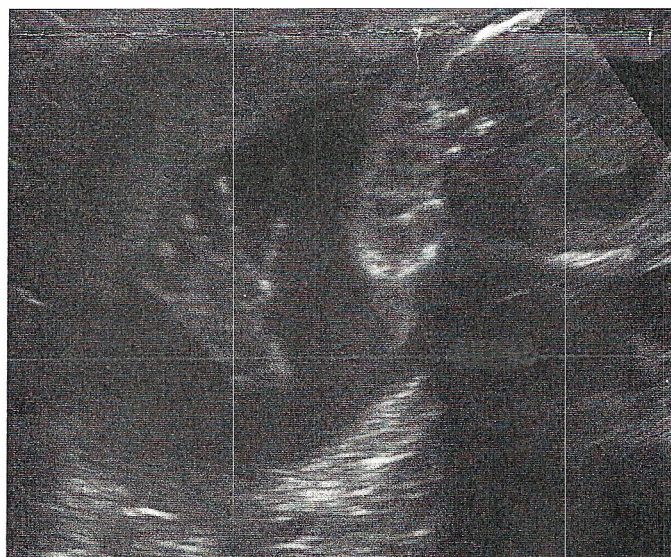


Figure 12. Fetal hands. Legs and arms are stipulated requirements in the guidelines. Although it is not necessary to document fingers and toes, the demonstration of an open hand is a reassuring sign in cases where aneuploidy is suspected.

ensure that this trend will continue, and radiologists will be increasingly called upon to interpret studies that may be outside of their comfort zone, such as the standard second/third trimester obstetrical ultrasound.

In the basic blueprint of the Practice Guidelines set forth by the AIUM, ACR, ACOG, and SRU, required images are described to document normal fetal anatomy. This blueprint outlines a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care.⁵ When an imaging finding becomes problematic, consultation or referral to a colleague with expertise in obstetrical ultrasound or a high-risk pregnancy clinic should be made without hesitancy. By adhering to these simple rules, diagnostic radiologists will never have to *fear the fetus* again!⁸

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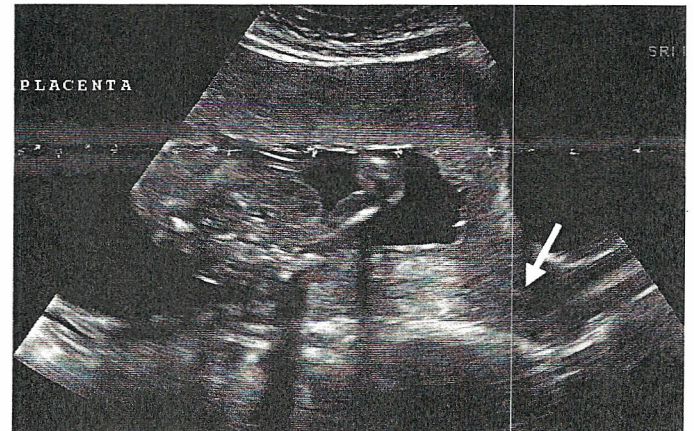


Figure 13. See quiz question 4.

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1. On fetal obstetrical ultrasound, the maximum cisterna magna measurement (in mm) should be less than
 - A. 10
 - B. 11
 - C. 12
 - D. 13
 - E. 14
2. Which one of the following is the *best* method to document the presence/absence of a 3-vessel umbilical cord on fetal obstetrical ultrasound?
 - A. Color Doppler at the site of the umbilical cord insertion
 - B. Direct visualization of the vessels within the umbilical cord
 - C. Color Doppler at the level of the intrahepatic portion of the umbilical vein
 - D. Color Doppler at the level of the urinary bladder
 - E. Direct visualization of the vessels coursing through the abdomen
3. Which one of the following is the *most* accurate means for sonographic dating of pregnancy?
 - A. Second trimester abdominal circumference
 - B. First trimester crown-rump length
 - C. Second trimester biparietal diameter
 - D. Second trimester head circumference
 - E. Second trimester femur length
4. Figure 13 on page 7 is a longitudinal fetal ultrasound image of the cervix (*arrow*) and the lower uterus. Which one of the following statements regarding this image is *true*?
 - A. The fetus is in the cephalic presentation.
 - B. A short cervix is present.
 - C. The placenta is posterior in location.
 - D. A myoma is present in the anterior uterine wall.
 - E. Placenta previa is absent.
5. The *usual* gestational time for the appearance of the fetal stomach and urinary bladder on fetal obstetrical ultrasound is
 - A. 12 weeks
 - B. 13 weeks
 - C. 14 weeks
 - D. 15 weeks
 - E. after 16 weeks
6. The length of a normal cervix on fetal obstetrical ultrasound should be at *least*
 - A. 1.5 cm
 - B. 2.0 cm
 - C. 2.5 cm
 - D. 3.0 cm
 - E. none of the above
7. The normal number of vessels in the umbilical cord is
 - A. 2
 - B. 3
 - C. 4
 - D. 5
 - E. 6
8. The optimal time (in gestational weeks) to obtain the standard second/third trimester fetal obstetrical ultrasound to check for fetal anomalies is
 - A. 13 to 14
 - B. 14 to 16
 - C. 16 to 18
 - D. 18 to 20
 - E. 20 to 22
9. The fetal abdominal circumference should be measured on fetal obstetrical ultrasound at the level of which one of the following fetal anatomic sites?
 - A. Portal sinus
 - B. Dome of the urinary bladder
 - C. Esophagogastric junction
 - D. Anus
 - E. Diaphragm
10. Which one of the following statements regarding the fetal biparietal diameter in fetal obstetrical ultrasound is *false*?
 - A. It is the measurement that extends from the outer edge of the nondependent skull to the inner edge of the dependent skull.
 - B. The cerebellum should not be visualized when in the correct plane for its measurement.
 - C. It is independent of head shape.
 - D. It is measured at the level of the thalami and cavum septi pellucidi.