The American College of Obstetricians and Gynecologists
WOMEN'S HEALTH CARE PHYSICIANS

The association for medical ultrasound
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AMERICAN INSTITUTE OF ULTRASOUND IN MEDICINE

PRACTICE BULLETIN

CLINICAL MANAGEMENT GUIDELINES FOR OBSTETRICIAN–GYNECOLOGISTS

NUMBER 175, DECEMBER 2016

(Replaces Practice Bulletin 101, February 2009, and Committee Opinion 297, August 2004)

Ultrasound in Pregnancy

Obstetric ultrasonography is an important and common part of obstetric care in the United States. The purpose of this document is to present information and evidence regarding the methodology of, indications for, benefits of, and risks associated with obstetric ultrasonography in specific clinical situations. Portions of this Practice Bulletin were developed from collaborative documents with the American College of Radiology and the American Institute of Ultrasound in Medicine (1, 2).

Background

Instrumentation

Obstetric ultrasound examinations are performed with a transabdominal, transvaginal, or transperineal approach. Real-time ultrasonography is necessary to confirm fetal viability through observation of cardiac activity and active fetal movement. The choice of transducer frequency is a trade-off between beam penetration and resolution. Lower frequencies provide better penetration but at the expense of resolution. Selection of the proper transducer is based on the clinical situation; however, with modern equipment, abdominal transducers generally allow sufficient penetration in most patients while providing adequate resolution. During early pregnancy, an abdominal transducer with a frequency of 5 MHz or a transvaginal transducer with a frequency of 5–10 MHz or higher generally provides very good resolution while allowing adequate penetration. A lower-frequency transducer may be needed to provide adequate penetration for abdominal imaging later in pregnancy or in an obese patient. Images should be archived and easily accessible for later review. To ensure that the ultrasound equipment is operating at a safe and optimal level, regular service should be performed as recommended by the manufacturer.

Types of Examinations

The American College of Obstetricians and Gynecologists, the American College of Radiology, the American Institute of Ultrasound in Medicine, the National Institute of Child Health and Human Development, the Society for Maternal–Fetal Medicine, and the Society of Radiologists in Ultrasound have adopted the following uniform terminology for the performance of ultrasonography in the second trimester and the third trimester: standard, limited, and specialized (1–3).

Standard Examination

A standard obstetric ultrasound examination includes an evaluation of fetal presentation and number, amniotic fluid volume, cardiac activity, placental position, fetal biometry, and an anatomic survey. The maternal cervix and adnexa should be examined as clinically appropriate and when technically feasible.

Committee on Practice Bulletins—Obstetrics and American Institute of Ultrasound in Medicine. This Practice Bulletin was developed by the American College of Obstetricians and Gynecologists' Committee on Practice Bulletins–Obstetrics and the American Institute of Ultrasound in Medicine in collaboration with Lynn L. Simpson, MD.

The information is designed to aid practitioners in making decisions about appropriate obstetric and gynecologic care. These guidelines should not be construed as dictating an exclusive course of treatment or procedure. Variations in practice may be warranted based on the needs of the individual patient, resources, and limitations unique to the institution or type of practice.

The necessary components of fetal anatomy in a standard examination are listed in Box 1 and commonly can be obtained after approximately 18 weeks of gestation, although it may be possible to document normal structures before this time. Sometimes structures can be difficult to visualize because of fetal size, position, and movement; maternal abdominal scars; increased maternal abdominal wall thickness; and reduced amniotic fluid volume. When technical limitations result in suboptimal images, the nature of the limitations should be documented in the report; a follow-up examination should be considered.

Box 1. Essential Elements of Standard Examination of Fetal Anatomy ⇦

Head, Face, and Neck*
- Lateral cerebral ventricles
- Choroid plexus
- Midline falx
- Cavum septum pellucidi
- Cerebellum
- Cisterna magna
- Upper lip

Chest
- Heart
  - Four-chamber view
  - Left and right ventricular outflow tracts

Abdomen
- Stomach (presence, size, and situs)
- Kidneys
- Urinary bladder
- Umbilical cord insertion site into the fetal abdomen
- Umbilical cord vessel number

Spine
- Cervical, thoracic, lumbar, and sacral spine

Extremities
- Legs and arms

Fetal Sex
- In multiple gestations and when medically indicated

*A measurement of the nuchal fold may be helpful during a specific gestational age interval to assess the risk of aneuploidy.

Data from the American College of Radiology. ACR-ACOG-AIUM-SRU Practice parameter for the performance of obstetrical ultrasound. ACR, Diagnostic Radiology: Ultrasonography Practice Parameters and Technical Standards, 2013. Amended 2014.

Limited Examination

A limited examination is performed when a specific question requires investigation. It does not replace a standard examination. For example, a limited examination in the second trimester or the third trimester could be performed to confirm fetal heart activity in a patient experiencing vaginal bleeding or confirm placental location or to establish fetal presentation in a laboring patient. A limited examination also may be performed in any trimester to estimate amniotic fluid volume, evaluate the cervix, or assess embryonic or fetal viability.

Specialized Examination

The components of the specialized examination are more extensive than for a standard ultrasound examination and are determined on a case-by-case basis. Also referred to as a "detailed," "targeted," or "76811" ultrasound examination, the specialized anatomic examination is performed when there is an increased risk of an anomaly based on the history, laboratory abnormalities, or the results of the limited examination or the standard examination (4). Other specialized examinations include fetal Doppler ultrasonography, biophysical profile, fetal echocardiography, or additional biometric measurements. Specialized examinations are performed by an operator with formal training in this area (4). Indications for specialized examinations also include the possibility of fetal growth restriction and multifetal gestation (5, 6).

First-Trimester Ultrasound Examination

Indications. A first-trimester ultrasound examination is performed before 14 0/7 weeks of gestation. Some indications for performing first-trimester ultrasound examinations are listed in Box 2.

Imaging Parameters. An ultrasound examination may be performed either transabdominally or transvaginally. If a transabdominal examination is inconclusive, a transvaginal scan or transperineal scan is recommended. The following factors should be considered during the examination.

The uterus, including the cervix, and the adnexa should be evaluated for the presence of a gestational sac and any adnexal pathology. If a gestational sac is seen, its location should be documented. The gestational sac should be evaluated for the presence or absence of a yolk sac or embryo, and the crown–rump length of the embryo should be documented. The crown–rump length is a more accurate indicator of gestational (menstrual) age than the mean gestational sac diameter. Mean sac diameter measurements are not recommended for estimating the due date (7). However, the mean gestational

sac diameter may be recorded when an embryo is not identified. Caution should be used in presumptively diagnosing a gestational sac in the absence of a definite embryo or yolk sac. Without these findings, an intrauterine fluid collection could represent a pseudogestational sac associated with an ectopic pregnancy.

Presence or absence of cardiac activity should be reported. The criteria for diagnosing nonviability in early pregnancy have been revised to reduce false positive results (8). An embryo should be visible by transvaginal ultrasonography with a mean gestational sac diameter of 25 mm or greater. With transvaginal ultrasound examinations, cardiac motion should be observed when the embryo is 7 mm or greater in length. If an embryo less than 7 mm in length is seen without cardiac activity, a subsequent ultrasound examination at a later time may be needed to assess the presence or absence of cardiac activity. Fetal number should be reported. Amnionicity and chorionicity should be documented, to the extent possible, for all multiple gestations. Embryonic or fetal anatomy should be assessed as appropriate for the gestational age.

Box 2. Indications for First-Trimester Ultrasonography ⇦

Indications for first-trimester ultrasonography include, but are not limited to the following:

- To confirm the presence of an intrauterine pregnancy
- To evaluate a suspected ectopic pregnancy
- To evaluate vaginal bleeding
- To evaluate pelvic pain
- To estimate gestational age
- To diagnose or evaluate multiple gestations
- To confirm cardiac activity
- As adjunct to chorionic villus sampling, embryo transfer, or localization and removal of an intrauterine device
- To assess for certain fetal anomalies, such as anencephaly, in patients at high risk
- To evaluate maternal pelvic or adnexal masses or uterine abnormalities
- To screen for fetal aneuploidy
- To evaluate suspected hydatidiform mole

Data from the American College of Radiology. ACR-ACOG-AIUM-SRU Practice parameter for the performance of obstetrical ultrasound. ACR, Diagnostic Radiology: Ultrasonography Practice Parameters and Technical Standards, 2013. Amended 2014.

Second- and Third-Trimester Ultrasound Examination

Indications. Ultrasonography can be beneficial in many situations in the second and third trimesters. Indications for second- and third-trimester ultrasonography are listed in Box 3.

Imaging Parameters for a Standard Fetal Examination. Transabdominal ultrasonography generally is used to assess the second- and third-trimester pregnancy, with transvaginal ultrasonography added as needed. If a transabdominal examination is inconclusive, a transvaginal scan or transperineal scan is recommended. This may be especially useful in imaging the fetal brain structures when the head lies deep within the maternal pelvis or when a low-lying placenta is obscured by shadowing. Fetal cardiac activity, fetal number, and fetal presentation should be reported. Any abnormal heart rates or rhythms should be reported. An abnormal finding on second-trimester ultrasonography that identifies a major congenital anomaly significantly increases the risk of genetic abnormality and warrants further counseling, including the discussion of various prenatal testing strategies. Multiple gestations require the documentation of this additional information: chorionicity, amnionicity, comparison of fetal sizes, fetal sex (when possible to visualize), estimation of amniotic fluid volume (increased, decreased, or normal) in each sac, and, if monochorionic or of uncertain chorionicity, findings that may suggest twin–twin transfusion syndrome.

Ultrasonography can detect abnormalities in amniotic fluid volume. An estimate of amniotic fluid volume should be reported. Although it is acceptable for experienced examiners to qualitatively estimate amniotic fluid volume, semiquantitative methods also have been described for this purpose (eg, amniotic fluid index [AFI] and single deepest pocket) and are preferred because of their reproducibility.

The placental location, appearance, and relationship to the internal cervical os should be recorded. It is recognized that apparent placental position early in pregnancy may not correlate with its location at the time of delivery. Therefore, if a low-lying placenta or placenta previa is suspected early in gestation, verification in the third trimester by repeat ultrasonography is indicated. If an anterior placenta previa or low-lying placenta is found in a patient with a prior cesarean delivery, the possibility of abnormal implantation, including placenta accreta, should be considered.

Transabdominal, transvaginal, or transperineal views may be helpful in assessing cervical length or visualizing the internal cervical os and its relationship

to the placenta. Transvaginal or transperineal ultrasonography should be considered if the cervix appears shortened.

Box 3. Indications for Second- and Third-Trimester Ultrasonography ⇦

Indications for second- and third-trimester ultrasonography include, but are not limited to the following:

- Screening for fetal anomalies
- Evaluation of fetal anatomy
- Estimation of gestational age
- Evaluation of fetal growth
- Evaluation of vaginal bleeding
- Evaluation of abdominal or pelvic pain
- Evaluation of cervical insufficiency
- Determination of fetal presentation
- Evaluation of suspected multiple gestation
- Adjunct to amniocentesis or other procedure
- Evaluation of a significant discrepancy between uterine size and clinical dates
- Evaluation of a pelvic mass
- Evaluation of a suspected hydatidiform mole
- Adjunct to cervical cerclage placement
- Suspected ectopic pregnancy
- Suspected fetal death
- Suspected uterine abnormalities
- Evaluation of fetal well-being
- Suspected amniotic fluid abnormalities
- Suspected placental abruption
- Adjunct to external cephalic version
- Evaluation of prelabor rupture of membranes or premature labor
- Evaluation of abnormal biochemical markers
- Follow-up evaluation of a fetal anomaly
- Follow-up evaluation of placental location for suspected placenta previa
- History of previous congenital anomaly
- Evaluation of the fetal condition in late registrants for prenatal care
- Assessment for findings that may increase the risk of aneuploidy

Data from the American College of Radiology. ACR-ACOG-AIUM-SRU Practice parameter for the performance of obstetrical ultrasound. ACR, Diagnostic Radiology: Ultrasonography Practice Parameters and Technical Standards, 2013. Amended 2014.

Gestational age is most accurately determined in the first half of pregnancy. First-trimester crown–rump measurement is the most accurate means for ultrasound dating of pregnancy. Beginning at 14 weeks, a variety of ultrasound parameters, such as biparietal diameter, abdominal circumference, and femoral diaphysis length, can be used to estimate gestational age. However, the variability of gestational age estimation increases with advancing pregnancy. Standards for acceptable variation in ultrasonographic gestational age have been previously published (7). Significant discrepancies between gestational age and fetal measurements, especially later in pregnancy, may suggest a fetal growth abnormality such as intrauterine growth restriction or macrosomia. The gestational age should not be revised after a date has been calculated from an accurate earlier scan that is available for comparison.

Biparietal diameter is measured at the level of the thalamus and cavum septi pellucidi. The cerebellar hemispheres should not be visible in this scanning plane. The measurement is taken from the outer edge of the proximal skull to the inner edge of the distal skull. The head shape may be flattened (dolichocephalic) or rounded (brachycephalic) as a normal variant. Under these circumstances, measurement of the head circumference may be more reliable than measurement of the biparietal diameter for estimating gestational age. Head circumference is measured at the same level as the biparietal diameter, around the outer perimeter of the calvarium. The accuracy of head circumference measurement is not affected by head shape.

Femoral diaphysis length can be used for dating after 14 weeks of gestation. The long axis of the femoral shaft is most accurately measured with the beam of insonation perpendicular to the shaft, excluding the distal femoral epiphysis.

Abdominal circumference or average abdominal diameter should be determined at the skin line on a true transverse view at the level of the umbilical vein, portal sinus, and fetal stomach when visible. Abdominal circumference or average abdominal diameter measurement is used with other biometric parameters to estimate fetal weight and may allow detection of intrauterine growth restriction or macrosomia.

Fetal weight can be estimated by obtaining measurements such as the biparietal diameter, head circumference, abdominal circumference or average abdominal diameter, and femoral diaphysis length. Results from various prediction models can be compared with fetal weight percentiles from published nomograms. If previous ultrasound studies have been performed during the pregnancy, appropriateness of growth also should be reported. Scans for growth evaluation typically are

performed at least 3–4 weeks apart. In rare cases, a 2-week interval may be chosen, but a shorter scan interval may result in confusion as to whether size differences are caused by growth or by variations in the measurement technique itself. Currently, even the best fetal weight prediction methods can yield errors as high as plus or minus 20%. This variability can be influenced by factors such as the nature of the patient population, the number and types of anatomic parameters being measured, technical factors that affect the resolution of ultrasound images, and the weight range being studied.

Evaluation of the uterus, adnexal structures, and cervix should be performed when feasible. The presence, location, size, and characteristics of adnexal masses should be documented, as well as the presence of any leiomyomas with potential clinical significance. It may not be possible to image normal maternal ovaries during the second and third trimesters.

Three-Dimensional Ultrasonography

Three-dimensional ultrasonography represents an advance in imaging technology. With three-dimensional ultrasonography, the volume of a target anatomic region can be calculated. The defined volume then can be displayed in three orthogonal two-dimensional planes representing the sagittal, transverse, and coronal planes of a reference two-dimensional image within the volume. The volume also can be displayed in its rendered format, which depicts the topographic anatomy of the volume. The technical advantages of three-dimensional ultrasonography include its ability to acquire and manipulate a large number of planes and to display ultrasound planes traditionally inaccessible by two-dimensional ultrasonography. Despite these technical advantages, proof of a clinical advantage of three-dimensional ultrasonography in prenatal diagnosis in general still is lacking. Potential areas of promise include fetal facial anomalies, neural tube defects, fetal tumors, and skeletal malformations for which three-dimensional ultrasonography may be helpful in diagnosis as an adjunct to but not a replacement for two-dimensional ultrasonography (9).

Ultrasound Facility Accreditation

The American Institute of Ultrasound in Medicine and the American College of Radiology offer ultrasound facility accreditation. This process involves a review of ultrasound case studies, equipment use and maintenance, report generation, image storage, and ultrasonographer and physician qualifications. Practices, not individuals, may be accredited in ultrasonography for obstetrics, gynecology, or both. Practices that receive ultrasound accreditation have been shown to improve compliance with published standards and guidelines for the performance of obstetric ultrasound examinations (10).

Physicians who perform, evaluate, and interpret diagnostic obstetric ultrasound examinations should be licensed medical practitioners with an understanding of the indications for such imaging studies, the expected content of a complete obstetric ultrasound examination, and a familiarity with the limitations of ultrasound imaging. They should be familiar with ultrasound safety and the anatomy, physiology, and pathophysiology of the pelvis, pregnant uterus, and fetus. All physicians who perform or supervise the performance of obstetric ultrasonography should have received specific training in obstetric ultrasonography; this is especially necessary in performing specialized obstetric ultrasound examinations (4).

Physicians are responsible for the quality and accuracy of ultrasound examinations performed in their names, regardless of whether they personally produced the images. Physicians also are responsible for the quality of the documentation of examinations and the quality control and safety of the environments, the ultrasonography, and the procedures performed.

Documentation and Quality Assurance

Adequate documentation is essential for high-quality patient care and communication of medical information. There should be a report of each ultrasound examination, which includes all findings and an interpretation. Quality control should be accomplished through careful documentation of obstetric ultrasound examination results, organized and reliable archiving of reports and images and, ideally, correlation with clinical outcomes. Quality review and education regarding nuchal translucency measurement, first-trimester nasal bone assessment, and cervical length measurement are available from organizations such as the Perinatal Quality Foundation and the Fetal Medicine Foundation. Quality assurance is an integral part of clinical care and obstetric ultrasonography is no exception. Practices that perform obstetric imaging as part of their clinical services should continually correlate their imaging results to clinical outcomes.

Patient Safety

Ultrasonography is safe for the fetus when used appropriately and should be used when medical information about a pregnancy is needed; however, ultrasound energy delivered to the fetus cannot be assumed to be completely innocuous, and the possibility exists that such biological effects may be identified in the future (11). Thus, ultrasonography should be performed only when there is a valid medical indication and, in all cases, the lowest possible ultrasound exposure settings that

obtain adequate image quality and gain the necessary diagnostic information should be used, following the as-low-as-reasonably-achievable (ALARA) principle (12). Aligned with the ALARA principle, spectral or "flow" Doppler should not routinely be used to "auscultate" the fetal heart rate in the first trimester because of its higher energy delivery; instead, adequate documentation of viability can be obtained with use of M-mode scanning or conventional two-dimensional real-time ultrasonography with video archiving (1).

Cleaning and Sterilization

Use of ultrasound transducers, like any instrument used on a patient, presents the possibility of microbial transmission if not properly cleaned after each use. Transabdominal ultrasonography is not completely free of this risk, although the risk is substantially lower than it is for transvaginal and transperineal ultrasonography. Transabdominal ultrasound transducers may be adequately cleansed between patients with soap and water or a disposable disinfectant spray or wipe. Transvaginal ultrasound transducers always should be covered with a single-use disposable cover when used. However, disposable protective covers are not without risk of rupture or defect, and it is recommended that transvaginal ultrasound transducers undergo high-level disinfection between each use. Steps involved in cleaning transvaginal ultrasound transducers include using running water followed by a damp soft cloth with mild soap, and a small brush if needed, to thoroughly cleanse the probe, followed by high-level disinfection with chemical agents (13, 14). The U.S. Food and Drug Administration has published a list of approved high-level disinfectants for use in processing reusable medical devices (15). For all chemical disinfectants, precautions must be taken to protect workers and patients from the toxicity of the disinfectant. Practitioners should consult the labels of proprietary products for specific instructions as well as instrument manufacturers regarding the compatibility of these agents with probes.

Clinical Considerations and Recommendations

▶ *Should all patients be offered ultrasonography?*

At various gestational ages, an ultrasound examination is an accurate method of determining gestational age, fetal number, viability, and placental location, and it is recommended for all pregnant patients (16, 17) An ultrasound examination in the second trimester also should include screening for structural abnormalities. It appears that tertiary-level centers have higher detection rates for detecting fetal anomalies, but when an ultrasound examination is performed, patients should be counseled about the limitations of ultrasonography regardless of the site, skill of the examiner, or the sophistication of the equipment.

▶ *What is the sensitivity of ultrasonography for detecting fetal anomalies?*

Ultrasonography can be used to diagnose many major fetal anomalies. However, significant variability in the sensitivity of routine ultrasonography for detection of fetal anomalies has been reported (18–20). In a review of 36 studies that included more than 900,000 fetuses, an overall sensitivity of approximately 40% for detecting fetal anomalies was noted, with a range from less than 15% to higher than 80% (21). In general, studies performed at tertiary centers showed a higher detection rate for fetal anomalies (19, 22). Also, studies on this subject have varied with regard to the definition of major versus minor fetal anomalies, the level of background risk of anomalies in the study population, the level of training and expertise of the operators, and the completeness of anomaly confirmation. The detection rate tends to be higher for defects of the central nervous system and urinary tract than for the heart and great vessels (23). Obesity also lowers detection rates of fetal anomalies during prenatal ultrasonography (24, 25).

Although detection of some anomalies is possible as early as 11–14 weeks, the use of ultrasonography to screen for major fetal anomalies in the first trimester should not replace the more appropriate screening of fetal anatomy in the second trimester (26). The benefits and limitations of ultrasonography should be discussed with all patients.

▶ *What is the role of nonmedical use of ultrasonography in pregnancy?*

Although there is no reliable evidence of physical harm to human fetuses from diagnostic ultrasound imaging using current technology, casual use of ultrasonography, especially during pregnancy, should be avoided. The use of two-dimensional or three-dimensional ultrasonography without a medical indication and only to view the fetus, obtain a "keepsake" picture, or determine the fetal sex is inappropriate and contrary to responsible medical practice. Viewed in this light, exposing the fetus to ultrasound energy with no anticipation of medical benefit is not justified (27–29). The U.S. Food and Drug Administration views the promotion, sale, or lease of ultrasound equipment for making "keepsake" fetal videos as an unapproved use of a medical device. Use

of ultrasonography without a physician's order may be a violation of state or local laws or regulations regarding the use of a prescription medical device (30).

In addition, nonmedical ultrasonography may falsely reassure pregnant women who may incorrectly believe that the ultrasound imaging is diagnostic. If abnormalities are detected in this setting, patients may not receive the necessary support, information, and follow-up. Obstetric ultrasonography is most appropriately obtained as part of delivery of prenatal care and should be performed only with the intention of providing medical benefit to the patient (31).

▶ *What is the optimal gestational age at which to perform an obstetric ultrasound examination?*

The best gestational age for obstetric ultrasonography will depend on the clinical indication for the examination. For patients with uncertain or unreliable menstrual dating or with an indication to confirm viability, first-trimester ultrasonography is most accurate (7). In these instances, a dating ultrasound examination should be obtained at the first prenatal visit.

When used as part of combined first-trimester screening or integrated screening for aneuploidy, an ultrasound examination with nuchal translucency measurement before 14 0/7 weeks of gestation provides accurate dating of pregnancy and an effective screening test for trisomy 13, trisomy 18, and trisomy 21 when combined with maternal age and serum markers (32, 33). However, a complete anatomic assessment is not possible before at least 14 weeks of gestation.

In the absence of other specific indications, the optimal time for a single ultrasound examination is at 18–22 weeks of gestation. This timing allows for a survey of fetal anatomy in most women and an accurate estimation of gestational age. At 18–22 weeks of gestation, anatomically complex organs such as the fetal heart and brain can be imaged with sufficient clarity to allow detection of many major malformations, compared with visualization earlier in pregnancy when the anatomy is not as well developed. This timing also allows for management options to be available, including fetal monitoring and treatment and, for those who desire it, pregnancy termination. In the obese patient, expectations regarding visualization of fetal anatomy should be tempered.

▶ *How and when is ultrasonography used to adjust gestational age?*

In clinical situations for which first-trimester ultrasonography is not performed for other indications (such as fetal aneuploidy screening), use of dating by a reliable last menstrual period is acceptable. When performed, ultrasound measurement of the embryo or fetus in the first trimester is the most precise method to confirm or establish gestational age. Measurements of the crown–rump length are more precise the earlier in the first trimester that ultrasonography is performed and are more precise than mean sac diameter measurements (7). Before 14 0/7 weeks of gestation, gestational age assessment based on measurement of the crown–rump length has a precision of 5–7 days (7, 34, 35). If the embryonic morphology is normal and if ultrasound dating before 9 0/7 weeks of gestation differs by more than 5 days from menstrual dating, or if ultrasound dating between 9 0/7 weeks of gestation and 13 6/7 weeks of gestation differs by more than 7 days from menstrual dating, the estimated due date should be changed to correspond with the ultrasound dating. Dating changes for smaller discrepancies may be appropriate depending on how early in the first trimester the ultrasound examination was performed, the reliability of the last menstrual period date, and other relevant information (Table 1).

At measurements greater than 84 mm (corresponding to 14 0/7 weeks of gestation), the precision of the crown–rump length to estimate gestational age decreases, and in these cases, multiple second-trimester biometric parameters should be used for dating. Ultrasound dating in the second trimester typically is based on calculations that incorporate the biparietal diameter, head circumference, femur length, and abdominal circumference. Of the different measurements, the head circumference is the single most-predictive parameter of gestational age between 14–22 weeks of gestation, although combining various parameters improves the precision of gestational age over the use of head circumference measurement alone (16, 36). Formulas derived from singleton data can be used to determine gestational age in twins and triplets (37).

The third trimester (28 0/7 weeks of gestation and beyond) is the least accurate period for gestational age assessment by ultrasonography, with a precision range of plus or minus 21–30 days (7). As in the second trimester, measurement of the four biometric parameters usually is used to calculate a mean ultrasonographic gestational age in the third trimester. Among the four, the best single measurement of gestational age in the third trimester is the femur length. However, reported precision of femur length ranges from 3–4 weeks at term (38, 39). Reassigning gestational age in the third trimester should be done with caution because of this wide margin of precision and, therefore, early ultrasound dating is preferred. Repeat ultrasound examinations to ensure appropriate interval growth may be necessary to guide

management decisions late in pregnancy but should not be used to change a gestational age or estimated date of delivery established by an earlier reliable ultrasound examination. In general, gestational age established by ultrasound examination should take preference over estimates based on the last menstrual period when the discrepancy between the estimated ages is greater than the precision of ultrasonography as noted in Table 1 (7).

▶ *How is amniotic fluid volume evaluated using ultrasonography?*

Several techniques have been proposed for the estimation of amniotic fluid during the ultrasound examination, including a subjective assessment, measurement of the single deepest vertical pocket, and the AFI. Objective measurement to detect amniotic fluid abnormalities has many advantages over subjective assessment, including reproducibility, easily communicated levels of fluid volume, and the ability to follow trends in amniotic fluid measurement. It is recommended that objective, rather than subjective, measurements of amniotic fluid volume be used, especially in the third trimester.

The single deepest pocket technique involves finding the deepest pocket of amniotic fluid that is free of cord and fetal parts with the ultrasound transducer oriented perpendicular to the floor, then measuring the pocket's greatest vertical dimension (40). The AFI technique is based on the division of the uterus into four quadrants and measuring the deepest vertical pocket of fluid in each quadrant and then adding the four measurements together (41). To qualify as a measurable amniotic fluid pocket with either method, the width of the pocket must be at least 1 cm.

The term oligohydramnios refers to decreased amniotic fluid volume relative to gestational age. Oligohydramnios is associated with genitourinary abnormalities in the fetus, premature rupture of membranes, uteroplacental insufficiency, and postterm pregnancy. Oligohydramnios has been linked to increased rates of perinatal morbidity and mortality (42). Oligohydramnios is described in various ways, including absence of a vertical pocket of at least 2 cm and an AFI of less than 5 cm. However, best available evidence supports using the deepest vertical pocket method of measurement because it leads to fewer interventions with no increase in poor perinatal outcomes compared with use of the AFI (3, 43, 44). Only the deepest vertical pocket method should be used with multiple pregnancies.

The term polyhydramnios refers to increased amniotic fluid volume relative to gestational age. Polyhydramnios most often is idiopathic but can be associated with gestational and pregestational diabetes, fetal structural abnormalities and chromosomal abnormalities, fetal infections, multiple gestations with twin–twin transfusion syndrome, or fetal anemia due to isoimmunization or fetal–maternal hemorrhage. Idiopathic polyhydramnios, which represents 50–60% of cases of polyhydramnios, has been linked to fetal macrosomia and an increase in adverse pregnancy outcome (45), including stillbirth (46). Polyhydramnios commonly is described by an AFI greater than or equal to 24 cm or a maximum deepest vertical pocket of equal to or greater than 8 cm.

Table 1. Guidelines for Redating Based on Ultrasonography ⇦

Gestational Age Range*	Method of Measurement	Discrepancy Between Ultrasound Dating and LMP Dating That Supports Redating
8 6/7 wk or less	CRL	More than 5 d
9 0/7 wk to 13 6/7 wk	CRL	More than 7 d
14 0/7 wk to 15 6/7 wk	BPD, HC, AC, FL	More than 7 d
16 0/7 wk to 21 6/7 wk	BPD, HC, AC, FL	More than 10 d
22 0/7 wk to 27 6/7 wk	BPD, HC, AC, FL	More than 14 d
28 0/7 wk and beyond†	BPD, HC, AC, FL	More than 21 d

Abbreviations: AC, abdominal circumference; BPD, biparietal diameter; CRL, crown–rump length; FL, femur length; HC, head circumference; LMP, last menstrual period.

*Based on LMP.

†Because of the risk of redating a small fetus that may be growth restricted, management decisions based on third-trimester ultrasonography alone are especially problematic and need to be guided by careful consideration of the entire clinical picture and close surveillance.

Method for estimating due date. Committee Opinion No. 611. American College of Obstetricians and Gynecologists. Obstet Gynecol 2014;124:863–6.

▶ *Can ultrasonography alone be used to modify the risk of fetal chromosome abnormalities in the first and second trimesters?*

Although ultrasonography cannot be used to confirm or exclude a diagnosis of chromosomal anomalies such as aneuploidy, ultrasonography can be used to further modify the risk that already exists by age or serum screening. In the first trimester, an increased nuchal translucency is an early presenting feature of a broad range of fetal chromosomal, genetic, and structural abnormalities. When nuchal translucency measurements are used to modify the maternal age-related trisomy 21 risk, the detection rate for trisomy 21 is approximately 70% in a high-risk population (47). Nuchal translucency measurements may be particularly useful in the evaluation of multifetal gestations, for which serum screening is not as accurate (twins) or is unavailable (triplets or higher), compared with a singleton gestation. Nuchal translucency screening during the first trimester for trisomy 21 is feasible in twin or triplet gestation but has lower sensitivity than first-trimester integrated screening in singleton pregnancies. However, measurement of nuchal translucency alone is less effective for first-trimester screening of the singleton pregnancy than is combined testing (nuchal translucency measurement and biochemical markers) (33). Among first-trimester fetuses with increased nuchal translucency measurement, approximately one third will have chromosome defects, and trisomy 21 accounts for approximately 50% of these chromosomal disorders (47). Other first-trimester ultrasonographic markers such as nonvisualization of the nasal bone, tricuspid regurgitation, and abnormal ductus venosus waveforms have been associated with trisomy 21, but their clinical usefulness in the general population remains uncertain.

A second-trimester specialized ultrasound examination may be targeted to detect fetal aneuploidy. Individual second-trimester ultrasound markers for aneuploidy, such as echogenic bowel, short femur or humerus, and dilated renal pelvis, have a low sensitivity and specificity for trisomy 21, particularly when used to screen a low-risk population (48), and a meta-analysis of 48 studies confirms that most isolated ultrasound markers have only a small effect on modifying the pretest risk of trisomy 21 (49). Isolated markers that have little significance in the absence of an elevated pretest risk of fetal aneuploidy are choroid plexus cyst and echogenic intracardiac foci (3). Studies indicate that the highest detection rate for aneuploidy is achieved with the use of a systematic combination of markers and gross anomalies, such as thickened nuchal fold, absent or hypoplastic nasal bone, or cardiac defects (50, 51). Studies done in high-risk populations have reported detection rates of approximately 50–75% in the second trimester, albeit with high false-positive rates ranging from 5% to greater than 15% (52).

The significance of ultrasonographic markers identified by a second-trimester ultrasound examination in a patient who has had a negative first-trimester screening test result is unknown (33). Subtle second-trimester ultrasound markers should be interpreted in the context of a background risk based on the patient's age, history, genetic screening, and serum screening results. In women who have undergone invasive fetal genetic testing or who have had cell-free DNA testing, the association between isolated soft markers and aneuploidy risk generally is not relevant (3).

If no abnormal markers are identified after carefully performed ultrasonography, the pretest risk of trisomy 21 in a patient at high risk may be reduced (49, 53). This approach is not reliable in women at low risk. At this time, risk adjustment based on second-trimester ultrasound markers should be limited to individuals with expertise in this area. Although ultrasonography can help identify fetuses with trisomy 21, it is most effective in detecting trisomy 21 and other aneuploidies when combined with other modalities.

▶ *How and when is ultrasonography used to assess for fetal anemia?*

Doppler ultrasonography is a noninvasive method that can be used to assess the degree of fetal anemia associated with a variety of conditions such as red cell alloimmunization, fetal infection, and fetal hydrops. A peak systolic velocity in the fetal middle cerebral artery greater than 1.5 multiples of the median for gestational age is a good predictor of severe anemia in the second trimester and early third trimester, with an overall sensitivity of approximately 75% (54, 55). Also, there is good correlation between the peak systolic velocity in the fetal middle cerebral artery and hemoglobin in fetuses that have undergone multiple transfusions, expanding the clinical use of this Doppler test (56). However, its accuracy in monitoring fetuses at risk of anemia after 34–35 weeks of gestation is less clear because of a higher false-positive rate (57). Correct technique is a critical factor when determining peak systolic velocity in the fetal middle cerebral artery and should be performed only at an appropriate gestational age by those with adequate training and clinical experience (58–60). In a center with trained personnel, Doppler measurement of peak systolic velocity in the fetal middle cerebral artery is an appropriate noninvasive means to monitor pregnancies at risk of fetal anemia.

▶ *How is ultrasonography used to detect disturbances in fetal growth?*

Serial assessment of fetal size by clinical methods such as fundal height is a low-cost, relatively reliable, and easy way to screen for fetal growth disturbances in most pregnant women (5, 61). However, when a growth disturbance is suspected clinically or there is a medical or obstetric condition that increases the risk of a growth disturbance, ultrasonography is the modality of choice to identify abnormal fetal growth.

Four standard fetal measurements generally are obtained as part of a complete obstetric ultrasound examination after the first trimester: 1) fetal abdominal circumference, 2) head circumference, 3) biparietal diameter, and 4) femur length (62). Fetal morphologic parameters can be converted to fetal weight estimates using published formulas and tables (63). Contemporary ultrasound equipment calculates and displays an estimate of fetal weight on the basis of these formulas. Although all of the published formulas for estimating fetal weight show a good correlation with birth weight, the variability of the estimate is up to 20% with most of the formulas (62).

Because calculations of estimated fetal weight in the past have not been based on prospective ultrasound data, and because multiple reports have shown customization of fetal weight standards for maternal race and weight can improve the accuracy of ultrasound-estimated fetal growth, the National Institute of Child Health and Human Development performed a prospective study to determine new standards for fetal growth (63–65). This study showed that maternal race or ethnicity significantly affects fetal growth, and adjusting for this maternal factor likely decreases the misdiagnosis of intrauterine growth restriction and macrosomia by ultrasonography. Regardless, it is unclear whether use of customized growth calculations improves outcomes, and their use is not yet widely accepted. Standard growth tables continue to be acceptable for clinical use.

If the estimated fetal weight is below the 10th percentile, further evaluation for intrauterine growth restriction should be considered (5). Similarly, if the estimated fetal weight is more than the 90th percentile, evaluation should be considered for fetal macrosomia (66). For multifetal pregnancies, a 20% discordance in estimated fetal weight between the larger fetus and the smaller fetus warrants further evaluation for discordant growth (6). Monochorionic multiple pregnancies are at increased risk of complications such as unequal placental sharing with discordant growth or intrauterine growth restriction and for twin–twin transfusion syndrome with resultant fetal growth restriction, and they require increased surveillance. Serial ultrasound measurements are of considerable clinical value in confirming or excluding disturbances in fetal growth. These cases are complex and should be managed in consultation with a specialist, especially when growth restriction is detected before 34 weeks (5).

If the ultrasonographically determined estimated fetal weight is below the 10th percentile for gestational age, further evaluation should be considered, such as amniotic fluid assessment and Doppler blood flow studies of the umbilical artery. Because growth-restricted fetuses have a high incidence of structural abnormalities and genetic abnormalities, a specialized ultrasound examination of fetal anatomy also is recommended if not performed previously.

▶ *How should the fetus with intrauterine growth restriction be assessed?*

Monitoring the growth-restricted fetus should involve serial ultrasound measurements of fetal biometry and amniotic fluid volume, antenatal surveillance with fetal heart rate or biophysical heart rate testing, and Doppler flow assessment of the umbilical artery. Antenatal surveillance of the growth-restricted fetus should not begin before a gestational age when delivery would be considered for perinatal benefit (5).

The optimal interval to assess growth in the fetus with growth restriction has not been established (67). In most cases, growth can be routinely evaluated with serial ultrasound examinations every 3–4 weeks. Although interval growth in the growth-restricted fetus is sometimes done as frequently as every 2 weeks, ultrasound assessment of growth should not be performed more frequently because of the inherent error associated with ultrasound measurements (68, 69).

Umbilical artery Doppler velocimetry used in conjunction with standard fetal surveillance, such as nonstress tests, biophysical profiles, or both, is associated with improved outcomes in fetuses with fetal growth restriction. Absent or reversed end-diastolic flow in the umbilical artery is associated with an increased risk of perinatal mortality (70–73). The rate of perinatal death is reduced by as much as 29% when umbilical artery Doppler velocimetry is added to standard antepartum testing in the setting of fetal growth restriction (74, 75). Other Doppler studies have been investigated to determine whether normal physiologic adaptation is failing and fetal death is imminent, including the evaluation of flow in the middle cerebral artery, aortic isthmus, and ductus venosus, but it is unclear, at this time, if addition of these tests to standard clinical surveillance improves neonatal outcomes (76–79). Currently, there is a lack of

data to support the use of Doppler studies of fetal vessels other than the umbilical artery in monitoring the growth-restricted fetus (5, 80).

There are no large clinical trials to guide the frequency of antepartum testing; thus, the optimal frequency remains unknown (44). Antepartum testing of the growth-restricted fetus should be repeated periodically to monitor for continued fetal well-being until delivery; tests of fetal well-being (eg, nonstress tests, biophysical profiles, umbilical artery Doppler velocimetry) are typically repeated once or twice weekly. An abnormal test result requires further evaluation, which may include more frequent testing or delivery (44).

▶ *How should twin gestations be monitored with ultrasonography?*

Because clinical criteria alone are unreliable to diagnose and assess multifetal gestations, the use of ultrasound assessment is recommended (6). Ultrasonography can be used to determine fetal number, estimated gestational age, chorionicity, and amnionicity. Assessment of chorionicity is most accurate early in pregnancy and, because of the increased rate of complications associated with monochorionicity, determination of chorionicity by the late first trimester or early second trimester is important for counseling and caring for women with multifetal pregnancies. The determination of chorionicity guides pregnancy management, including decisions and technical considerations for multifetal reduction or selective fetal termination, the initiation and frequency of fetal surveillance, and the timing and route of delivery (6).

Because of the increased rate of complications associated with monochorionicity, a specialized examination, if available, is recommended (81). Importantly, monochorionic twins have a higher frequency of fetal and neonatal death compared with dichorionic twins, as well as morbidities such as fetal anomalies and congenital anomalies, twin–twin transfusion syndrome, prematurity, and fetal growth restriction (82, 83). This trend also is seen in higher-order multifetal pregnancies with monochorionic placentation; for example, a triplet gestation that is fully monochorionic or has a monochorionic pair is at higher risk of complications than a triplet gestation that is trichorionic (84, 85). Recent reports suggest an increased risk of congenital heart defects in fetuses of monochorionic pregnancies, and a fetal echocardiogram should be considered, especially if cardiac anatomy is not clearly seen and normal on a specialized ultrasound examination.

Because of the increased incidence of growth disturbance and the difficulty in assessing fetal growth with clinical criteria, serial ultrasound examinations usually are employed to assess fetal growth. For dichorionic twin gestations, there are no evidence-based recommendations on the frequency of fetal growth scans after 20 weeks of gestation; however, it seems reasonable to perform serial ultrasound surveillance every 4–6 weeks in the absence of evidence of fetal growth restriction or other pregnancy complications (6). For monochorionic twins, who carry a risk of twin–twin transfusion beginning in the second trimester, serial ultrasound evaluation approximately every 2 weeks beginning at around 16 weeks of gestation should be considered (6).

Summary of Conclusions and Recommendations

The following conclusions are based on good and consistent evidence (Level A):

- At various gestational ages, ultrasound examination is an accurate method of determining gestational age, fetal number, viability, and placental location, and it is recommended for all pregnant patients.
- Gestational age is most accurately determined in the first half of pregnancy.
- Measurement of nuchal translucency alone is less effective for first-trimester screening of the singleton pregnancy than is combined testing (nuchal translucency measurement and biochemical markers).
- In a center with trained personnel, Doppler measurement of peak systolic velocity in the fetal middle cerebral artery is an appropriate noninvasive means to monitor pregnancies at risk of fetal anemia.
- Umbilical artery Doppler velocimetry used in conjunction with standard fetal surveillance, such as nonstress tests, biophysical profiles, or both, is associated with improved outcomes in fetuses with fetal growth restriction.

The following conclusions are based on limited or inconsistent evidence (Level B):

- Nuchal translucency screening during the first trimester for trisomy 21 is feasible in twin or triplet gestation but has lower sensitivity than first-trimester integrated screening in singleton pregnancies.
- Assessment of chorionicity is most accurate early in pregnancy and, because of the increased rate of complications associated with monochorionicity, determination of chorionicity by the late first

trimester or early second trimester is important for counseling and caring for women with multifetal pregnancies.

- An abnormal finding on second-trimester ultrasonography that identifies a major congenital anomaly significantly increases the risk of genetic abnormality and warrants further counseling, including the discussion of various prenatal testing strategies.
- When a growth disturbance is suspected clinically or there is a medical or obstetric condition that increases the risk of a growth disturbance, ultrasonography is the modality of choice to identify abnormal fetal growth.
- Objective measurement to detect amniotic fluid abnormalities has many advantages over subjective assessment, including reproducibility, easily communicated levels of fluid volume, and the ability to follow trends in amniotic fluid measurement. It is recommended that objective, rather than subjective, measurements of amniotic fluid volume be used, especially in the third trimester.

The following conclusions and recommendations are based primarily on consensus and expert opinion (Level C):

- In the absence of other specific indications, the optimal time for a single ultrasound examination is at 18–22 weeks of gestation.
- In the obese patient, expectations regarding visualization of fetal anatomy should be tempered.
- Subtle second-trimester ultrasound markers should be interpreted in the context of a background risk based on the patient's age, history, genetic screening, and serum screening results.
- The benefits and limitations of ultrasonography should be discussed with all patients.

For More Information

The American College of Obstetricians and Gynecologists has identified additional resources on topics related to this document that may be helpful for obgyns, other health care providers, and patients. You may view these resources at www.acog.org/More-Info/UltrasoundinPregnancy.

These resources are for information only and are not meant to be comprehensive. Referral to these resources does not imply the American College of Obstetricians and Gynecologists' endorsement of the organization, the organization's website, or the content of the resource. These resources may change without notice.

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The MEDLINE database, the Cochrane Library, and ACOG's own internal resources and documents were used to conduct a literature search to locate relevant articles published between January 1985 and November 2014. The search was restricted to articles published in the English language. Priority was given to articles reporting results of original research, although review articles and commentaries also were consulted. Abstracts of research presented at symposia and scientific conferences were not considered adequate for inclusion in this document. Guidelines published by organizations or institutions such as the National Institutes of Health and the American College of Obstetricians and Gynecologists were reviewed, and additional studies were located by reviewing bibliographies of identified articles. When reliable research was not available, expert opinions from obstetrician–gynecologists were used.

Studies were reviewed and evaluated for quality according to the method outlined by the U.S. Preventive Services Task Force:

- I Evidence obtained from at least one properly designed randomized controlled trial.
- II-1 Evidence obtained from well-designed controlled trials without randomization.
- II-2 Evidence obtained from well-designed cohort or case–control analytic studies, preferably from more than one center or research group.
- II-3 Evidence obtained from multiple time series with or without the intervention. Dramatic results in uncontrolled experiments also could be regarded as this type of evidence.
- III Opinions of respected authorities, based on clinical experience, descriptive studies, or reports of expert committees.

Based on the highest level of evidence found in the data, recommendations are provided and graded according to the following categories:

Level A—Recommendations are based on good and consistent scientific evidence.

Level B—Recommendations are based on limited or inconsistent scientific evidence.

Level C—Recommendations are based primarily on consensus and expert opinion.

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Ultrasound in pregnancy. Practice Bulletin No. 175. American College of Obstetricians and Gynecologists. Obstet Gynecol 2016;128: e241–56.