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Ultrasonography in Pregnancy

This Practice Bulletin was developed by the ACOG Committee on Practice Bulletins—Obstetrics with the assistance of Alfred Z. Abuhamad, 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.

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THE AMERICAN COLLEGE OF
OBSTETRICIANS AND
GYNECOLOGISTS
WOMEN'S HEALTH CARE PHYSICIANS

Most women have at least one ultrasound examination during pregnancy. The purpose of this document is to present evidence regarding the methodology of, indications for, benefits of, and risks associated with obstetric ultrasonography in specific clinical situations. Portions of this document were developed collaboratively with the American College of Radiology and the American Institute of Ultrasound in Medicine. The sections that address physician qualifications and responsibilities, documentation, quality control, infection control, and patient safety contain recommendations from the American College of Obstetricians and Gynecologists.

Background

Instrumentation

Ultrasound examination should be conducted with real-time scanners, using a transabdominal or a transvaginal approach or both. Real-time ultrasonography is necessary to confirm the presence of fetal life through observation of cardiac activity and active movement. The choice of transducer frequency is a trade-off between beam penetration and resolution. With modern equipment, abdominal transducers with frequencies ranging from 3 MHz to 5 MHz allow sufficient penetration in most patients while providing adequate resolution. A lower-frequency transducer (2–2.25 MHz) may be needed to provide adequate penetration for abdominal imaging in an obese patient. 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 may provide superior resolution while still allowing adequate penetration. A method for storing the images also is required. The equipment should be serviced at regular intervals according to the manufacturer's recommendations.

Types of Examinations

The American College of Obstetricians and Gynecologists uses the terms “standard” (also called basic), “limited,” and “specialized” (also called detailed) to describe various types of ultrasound examinations performed during the second or third trimesters. First-trimester ultrasound examination is distinct and is discussed separately.

Standard Examination

Ultrasonography is an accurate method of determining gestational age, fetal number, viability, and placental location. A standard obstetric ultrasound examination in the second or third trimester includes an evaluation of fetal presentation, amniotic fluid volume, cardiac activity, placental position, fetal biometry, and fetal number, plus an anatomic survey. The maternal cervix and adnexa should be examined as clinically appropriate when technically feasible.

Fetal anatomy, as described in this document, may be assessed adequately by ultrasonography after approximately 18 weeks of gestation. It may be possible to document normal structures before this time, although some structures can be difficult to visualize because of fetal size, position, and movement; maternal abdominal scars; and increased maternal abdominal wall thickness. A second- or third-trimester ultrasound examination may pose technical limitations for an anatomic evaluation because of suboptimal imaging. When this occurs, the report of the ultrasound examination should document the nature of this technical limitation. A follow-up examination may be helpful. The essential elements of a standard examination of fetal anatomy are listed in the box.

Limited Examination

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

Specialized Examination

A detailed or targeted anatomic examination is performed when an anomaly is suspected on the basis of history, laboratory abnormalities, or the results of either the limited or standard examination. Other specialized examinations might include fetal Doppler ultrasonography, biophysical profile, amniotic fluid assessment, fetal echocardiography, or additional biometric measure-

Essential Elements of Standard Examination of Fetal Anatomy

- Head, Face and Neck*
 - Cerebellum
 - Choroid plexus
 - Cisterna magna
 - Lateral cerebral ventricles
 - Midline falx
 - Cavum septi pellucidi
 - Upper lip
- Chest—Heart (The basic cardiac examination includes a four-chamber view of the fetal heart. As part of the cardiac screening examination, an attempt should be made, if technically feasible, to view the outflow tracts.)
- Abdomen
 - Stomach (presence, size, and situs)
 - Kidneys
 - Bladder
 - Umbilical cord insertion site into the fetal abdomen
 - Umbilical cord vessel number
- Spine—Cervical, thoracic, lumbar, and sacral spine
- Extremities—Legs and arms (presence or absence)
- Sex—Medically indicated in low-risk pregnancies only for the evaluation of multiple gestations

*A measurement of the nuchal fold may be helpful during a specific age interval to suggest an increased risk of aneuploidy.

American College of Radiology. ACR practice guideline for the performance of obstetrical ultrasound. In: ACR practice guidelines and technical standards, 2007. Reston (VA): ACR; 2007. p. 1025–1033.

ments. Specialized examinations are performed by an operator with experience and expertise in such ultrasonography who determines the components of the examination on a case-by-case basis.

First-Trimester Ultrasound Examination

Indications. A first-trimester ultrasound examination is an ultrasound examination performed before 13 weeks and 6 days of gestation. Indications for performing first-trimester ultrasound examinations are listed in the box.

Imaging Parameters. Scanning in the first trimester may be performed either transabdominally or transvaginally. If a transabdominal examination is not definitive, a transvaginal scan or transperineal scan should be per-

Indications for First-Trimester Ultrasonography

- 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 diagnosis 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

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formed whenever possible. The following factors should be considered during the examination.

The uterus, including the cervix, and adnexa should be evaluated for the presence of a gestational sac. 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 should be recorded, when possible. The crown–rump length is a more accurate indicator of gestational (menstrual) age than is mean gestational sac diameter. 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, intrauterine fluid collection could represent a pseudogestational sac associated with an ectopic pregnancy.

Presence or absence of cardiac activity should be reported. With transvaginal scans, cardiac motion should be observed when the embryo is 5 mm or greater in length. An embryo should be visible by transvaginal ultrasonography with a mean gestational sac diameter of 20 mm or greater. If an embryo less than 5 mm in length is seen without cardiac activity, a subsequent scan 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 for all multiple gestations when possible. Embryonic or fetal anatomy should be assessed according to gestational age.

The uterus, including adnexal structures, should be evaluated. The presence, location, and size of adnexal masses should be recorded. The presence of leiomyomas should be recorded, and measurements of the largest or any potentially clinically significant leiomyomas may be recorded. The cul-de-sac should be evaluated for the presence or absence of fluid.

For patients who desire an assessment of their individual risk of fetal aneuploidy, a standardized measurement of the nuchal translucency during a specific age interval is necessary. Nuchal translucency measurements should be used (in conjunction with serum biochemistry) to determine the risk of Down syndrome, trisomy 13, trisomy 18, or other anatomic abnormalities, such as heart defects. In this setting, it is important that the practitioner measure the nuchal translucency according to established guidelines for measurement. In addition, a quality assessment program is recommended to ensure accurate results. Organizations currently providing guidelines and ongoing quality assessment include the Nuchal Translucency Quality Review program of the Maternal–Fetal Medicine Foundation and the program sponsored by the Fetal Medicine Foundation.

Second- and Third-Trimester Ultrasound Examination

Indications. Ultrasonography can be of benefit in many situations in the second and third trimesters. Indications for second- and third-trimester ultrasonography are listed in the box.

Imaging Parameters for a Standard Fetal Examination. Fetal cardiac activity, fetal number, and fetal presentation should be reported. Any abnormal heart rates or rhythms should be reported. Multiple gestations require the documentation of additional information: chorionicity, amnionicity, comparison of fetal sizes, estimation of amniotic fluid volume (increased, decreased, or normal) on each side of the membrane, and fetal genitalia (when visualized).

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, single deepest pocket, two-diameter pocket).

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 well with its location at the time

Indications for Second- and Third-Trimester Ultrasonography

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

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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. Transabdominal, transperineal, or transvaginal views may be helpful in assessing cervical length or visualizing the internal cervical os and its relationship to the placenta. Transvaginal or transperineal ultrasonography may be considered if the cervix appears shortened.

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. Beyond this period, 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 estimations increases with advancing pregnancy. Significant discrepancies between gestational age and fetal measurements may suggest the possibility of a fetal growth abnormality, intrauterine growth restriction, or macrosomia. The pregnancy should not be redated 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 thalami 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 (dolichocephaly) or rounded (brachycephaly) 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 calvaria. This measurement is not affected by head shape.

Femoral diaphysis length can be reliably used after 14 weeks of gestation. The long axis of the femoral shaft is most accurately measured with the beam of insonation being 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 junction 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 studies have been performed, appropriateness of growth also should be reported. Scans for growth evaluation are typically performed at least 2–4 weeks apart. A shorter scan interval may result in confusion as to whether anatomic changes 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 15%. 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 appropriate. The presence, location, and size of adnexal masses and the presence of at least the largest and potentially clinically significant leiomyomas may be recorded. It may not be possible to image the normal maternal ovaries during the second and third trimesters.

Three-Dimensional Ultrasonography

Three-dimensional ultrasonography provides an advance in imaging technology. With three-dimensional ultrasonography, the volume of a target anatomic region can be acquired. The acquired 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 acquired volume. The technical advantages of three-dimensional ultrasonography include its ability to acquire and manipulate an infinite 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 is still lacking. Potential areas of promise include fetal facial anomalies, neural tube defects, and skeletal malformations where three-dimensional ultrasonography may be helpful in diagnosis as an adjunct to, but not a replacement for, two-dimensional ultrasonography (1). Until clinical evidence shows a clear advantage to conventional two-dimensional ultrasonography, three-dimensional ultrasonography is not considered a required modality at this time.

Ultrasound Facility Accreditation

The American Institute of Ultrasound in Medicine and the American College of Radiology offer ultrasound facility accreditation. This process involves review of

submitted ultrasound case studies, equipment use and maintenance, report generation, storage of images, 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 (2).

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 the anatomy, physiology, and pathophysiology of the pelvis, the pregnant uterus, and the fetus. These physicians should have undergone specific training in obstetric ultrasonography either during or since their residency training and should be able to document this training. Completion of an approved residency in obstetrics and gynecology with documentation of obstetric ultrasound experience and training with certification by the American Board of Obstetrics and Gynecology is evidence of the necessary and appropriate training.

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 and the procedures.

Documentation and Quality Assurance

Adequate documentation is essential for high-quality patient care. There should be a record of the ultrasound examination and its interpretation. Ideally, quality control is accomplished through careful record keeping of obstetric ultrasound examination results, reliable archiving of reports and images, and clinical correlation with clinical outcomes. The ultimate quality standard of any imaging study is to correlate the study findings with clinical outcomes. Any practice active in obstetric ultrasonography should maintain such records and make every effort to correlate imaging results with ultimate clinical outcome data.

Patient Safety

Ultrasonography is safe for the fetus when used appropriately and 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 (3). Ultrasonography should be performed only when there is a valid medical indication, and the lowest possible ultrasound exposure setting should be used to gain the necessary diagnostic information under the as-low-as-reasonably achievable principle (4). Diagnostic levels of ultrasonography can produce physical effects, such as mechanical vibrations (referred to as cavitation) or an increase in tissue temperature under laboratory conditions.

Although there is no reliable evidence of physical harm to human fetuses from diagnostic ultrasound imaging using current technology, public health experts, clinicians, and industry representatives agree that casual use of ultrasonography, especially during pregnancy, should be avoided. The use of either two-dimensional or three-dimensional ultrasonography only to view the fetus, obtain a picture of the fetus, or determine the fetal sex without a medical indication is inappropriate and contrary to responsible medical practice. Viewed in this light, exposing the fetus to ultrasonography with no anticipation of medical benefit is not justified (5–7). 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 (8). Thus, ultrasonography should be used in a prudent manner to provide medical benefit to the patient.

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 patient’s use. Transabdominal ultrasonography is not completely free of this risk, although the risk is substantially lower than it is for transvaginal ultrasonography. Transabdominal ultrasound transducers may be adequately cleansed between patients simply by wiping with a disposable antiseptic paper towelette. Transvaginal ultrasound transducers should always be covered with a single-use disposable latex or nonlatex cover. 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 or a damp soft cloth to remove any residual gel or debris from the probe, followed by high-level disinfection with chemical agents (9, 10). The U.S. Food and Drug Administration has published a list of approved high-level disinfectants for use in processing reusable medical

devices (11). 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, and what is the sensitivity of ultrasound for detecting fetal anomalies?*

Ultrasonography can be used to diagnose many major fetal anomalies. It has been suggested that all patients be offered routine ultrasound screening, given that 90% of infants with congenital anomalies are born to women with no risk factors (12). Significant controversy exists with regard to the sensitivity of routine ultrasonography in detecting fetal anomalies (13–15). In a review of 36 studies involving more than 900,000 fetuses, an overall sensitivity of 40.4% for detecting fetal anomalies was noted, with a range of 13.3–82.4% (16). Studies on this subject vary with regard to the definition of major versus minor fetal anomalies, the level of risk in the study population (high risk versus low risk), the expertise of the operators (tertiary versus nontertiary centers) and the ascertainment of anomalies. In general, studies performed at tertiary centers showed a higher detection rate for fetal anomalies (15, 17). Sensitivity tends to be higher for defects of the central nervous system and urinary tract than for the heart and great vessels (18). When an ultrasound examination is performed, patients should be counseled about the limitations of ultrasonography. This should include a discussion of the sensitivity of the examination for the detection of abnormalities and potential false-positive findings.

Prenatal ultrasonography may reduce the rate of perinatal mortality, primarily through pregnancy termination for prenatally diagnosed congenital malformations, but does not appear to reduce the rate of perinatal morbidity. Ultrasonography provides more accurate estimation of gestational age, which prevents unnecessary labor inductions for postterm pregnancy (19). Screening detects multiple gestations, congenital anomalies, and intrauterine growth restriction, but direct health benefits from having this knowledge currently are unproven (20). Despite the limitations of the evidence, given the detection rate of more than 80% for fetal anomalies in some experienced centers, the benefits and limitations of ultrasonography should be discussed with all patients.

However, if a patient requests ultrasonography, it is reasonable to honor the request. The decision ultimately rests with the physician and patient jointly.

► ***What gestational age represents the optimal time for an obstetric ultrasound examination?***

Ideally, all women should be offered aneuploidy screening before 20 weeks of gestation, regardless of maternal age (21). For women presenting before 14 weeks of gestation, the option for first-trimester screening is available, which may include ultrasonography for nuchal translucency measurement. Ultrasonography in the context of a nuchal translucency measurement provides accurate dating of pregnancy and a very effective screening test for Down syndrome and trisomy 18 when combined with maternal age and serum markers (pregnancy-associated plasma protein A and free or total β -hCG) (22). However, a complete anatomic assessment is not possible before 14 weeks of gestation.

In the absence of specific indications, ultrasound examination between 18–20 weeks of gestation allows for a reasonable survey of fetal anatomy and an accurate estimation of gestational age. At 18–20 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 at a time when termination of pregnancy may still be an option. Therefore, the optimal timing for a single ultrasound examination in the absence of specific indications for a first-trimester examination is at 18–20 weeks of gestation.

► ***Should routine measurement of cervical length be included in ultrasonography?***

The value of routine cervical length measurement in low-risk pregnancies has not been established; therefore, this practice currently is not recommended. Although there is an association between short cervix and preterm delivery, there are no data to support routine screening for all women. An effective screening protocol for assessing risk of preterm birth that combines cervical measurements and other risk factors has not been developed (23–25). For certain pregnant women at high risk, serial evaluation of the cervical length may identify those at increased risk of primary or recurrent preterm birth.

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

In general, ultrasound-established dates should take preference over menstrual dates when the discrepancy is greater than 7 days in the first trimester and greater than 10 days in the second trimester. Ultrasonography may be

considered to confirm menstrual dates if there is a gestational age agreement within 1 week by crown–rump measurements obtained in the first trimester or within 10 days by an average of multiple fetal biometric measurements obtained in the second trimester (up to 20 weeks of gestation). Reassigning gestational age in the third trimester should be done with caution because the accuracy of ultrasonography is within 3–4 weeks. Before 6 weeks of gestation, dating can be done by measurement of the gestational sac, which is visible as early as 4 weeks of gestation and certainly by the fifth week of gestation. The mean sac diameter, which is the average of three measurements of the gestational sac, can accurately estimate gestational age (mean sac diameter [mm] + 30 = gestational age [days]) (26). Maximum embryo length at 6–10 weeks of gestation and crown–rump length, which represents the maximum length of the fetus from the top of the head to the rump region, are the most accurate at determining gestational age (27). When the crown–rump length exceeds 60 mm, dating of pregnancy can be accomplished by other biometric parameters, such as measurement of the biparietal diameter, head circumference, femur length, and abdominal circumference. The head circumference is the most predictive parameter of gestational age between 14–22 weeks of gestation because it predicts gestational age by 3.4 days (28). Combining various parameters improves the prediction of gestational age slightly over the use of head circumference measurement alone (28). Formulas derived from singleton data can be used to determine gestational age in twins and triplets (28). In the third trimester, the best single measurement of gestational age based on fetal biometry is the femur length. However, reported accuracy of femur length ranges from 1 week in the second trimester to 3–4 weeks at term (29, 30). Guidelines for assignment of gestational age when a discrepancy exists between menstrual and ultrasound-established dates vary in different ultrasound units.

► ***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, single deepest pocket, and amniotic fluid index (AFI). The technique of subjective assessment includes comparing the echo-free areas in the uterus with the areas occupied by the fetus and placenta. This technique showed good intraobserver and interobserver agreements among experienced examiners (31) but does not allow for dissemination of criteria for use by less experienced operators. Furthermore, this technique does not allow for a longitudinal assessment of trends in amniotic fluid estimation. The single deepest pocket

technique involves finding the single largest pocket of amniotic fluid on ultrasonography, free of cord and fetal parts, and then measuring either the greatest vertical dimension or the greatest vertical and horizontal dimensions with the ultrasound transducer perpendicular to the floor. 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. Most ultrasonographers measure pockets of fluid that are free of cord and fetal parts.

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 (32). Oligohydramnios is described in various ways. Two acceptable definitions are 1) an AFI less than 5 cm or 2) a maximum deepest vertical pocket of less than 2 cm. In a randomized clinical trial, the use of amniotic fluid index compared with single deepest pocket technique during antepartum surveillance was associated with significantly higher rates of suspected oligohydramnios, which led to increased interventions without a demonstrable benefit (33). Recent studies suggest that AFI is a weaker predictor of perinatal outcome than has been classically suggested (34).

The term polyhydramnios or hydramnios refers to increased amniotic fluid volume relative to gestational age. Hydramnios often is idiopathic but can be associated with gestational and pregestational diabetes, isoimmunization, fetal structural and chromosomal abnormalities, fetal infections, multiple gestations with twin-twin transfusion syndrome, or fetal-maternal hemorrhage. Idiopathic hydramnios, which represents 50–60% of cases of hydramnios, has been linked to fetal macrosomia and an increase in adverse pregnancy outcome (35). Hydramnios 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.

► ***How may ultrasonography be used to detect fetal chromosome abnormalities in the second trimester?***

A second-trimester specialized ultrasound examination, often called a genetic ultrasound examination, may be targeted to detect fetal aneuploidy. Individual second-trimester ultrasound markers, such as echogenic bowel, intracardiac echogenic focus, short femur or humerus, and dilated renal pelvis, have a low sensitivity and specificity for Down syndrome, particularly when used to screen a low-risk population (36). Studies indicate that the highest

detection rate is achieved with a systematic combination of markers and gross anomalies, such as thickened nuchal fold or cardiac defects (37, 38). Studies done in high-risk populations have reported detection rates of approximately 50–75% in the second trimester, albeit with a high false-positive rate (39). If no abnormal ultrasound markers are identified after carefully performed ultrasonography, the a priori risk of Down syndrome in a patient at high risk may be reduced (40). This approach has not been adequately studied in women at low risk.

With the current limitations of ultrasonography, ultrasound evaluation is not recommended as a primary screening modality for Down syndrome and other chromosomal abnormalities. A major limitation of the use of second-trimester ultrasound markers has been the lack of standardization in measurements and definitions of what constitutes abnormal findings. Identification of an echogenic intracardiac focus or echogenic bowel in a fetus is based on a subjective assessment of the operator. Furthermore, studies that defined the lower limits of fetal long bone measurements for ultrasonography in screening for Down syndrome have primarily relied on a high-risk referral population. At this time, risk adjustment based on second-trimester ultrasound markers should be limited to individuals with expertise in this area.

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

Ultrasonography is helpful in detecting fetal growth disturbances. Four standard fetal measurements generally are obtained as part of any complete obstetric ultrasound examination after the first trimester: 1) fetal abdominal circumference, 2) head circumference, 3) biparietal diameter, and 4) femur length (41). Fetal morphologic parameters can be converted to fetal weight estimates using published formulas and tables (42). 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 generally is plus or minus 16–20% (2 standard deviations) (41). If the estimated fetal weight is below the 10th percentile, further evaluation should be considered for intrauterine growth restriction (43). Similarly, if the estimated fetal weight is more than 4,000 g or 4,500 g, evaluation should be considered for fetal macrosomia (44).

Serial ultrasound measurements are of considerable clinical value in confirming or excluding the diagnosis and assessing the progression and severity of growth disturbances. Serial ultrasonography to determine the rate of growth should be obtained approximately every 2–4

weeks. Measurements at shorter intervals (less than 2 weeks) may overlap and cause interpretation errors.

Summary of Recommendations and Conclusions

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

- ▶ Ultrasound examination is an accurate method of determining gestational age, fetal number, viability, and placental location.
- ▶ Gestational age is most accurately determined in the first half of pregnancy.
- ▶ Ultrasonography can be used in the diagnosis of many major fetal anomalies.
- ▶ Ultrasonography is safe for the fetus when used appropriately.

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

- ▶ Ultrasonography is helpful in detecting fetal growth disturbances.
- ▶ Ultrasonography can detect abnormalities in amniotic fluid volume.

The following conclusion and recommendation are based primarily on consensus and expert opinion (Level C):

- ▶ The optimal timing for a single ultrasound examination in the absence of specific indications for a first-trimester examination is at 18–20 weeks of gestation.
- ▶ The benefits and limitations of ultrasonography should be discussed with all patients.

Proposed Performance Measure

Documentation of the discussion of the benefits and limitations of ultrasonography

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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 April 2008. 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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