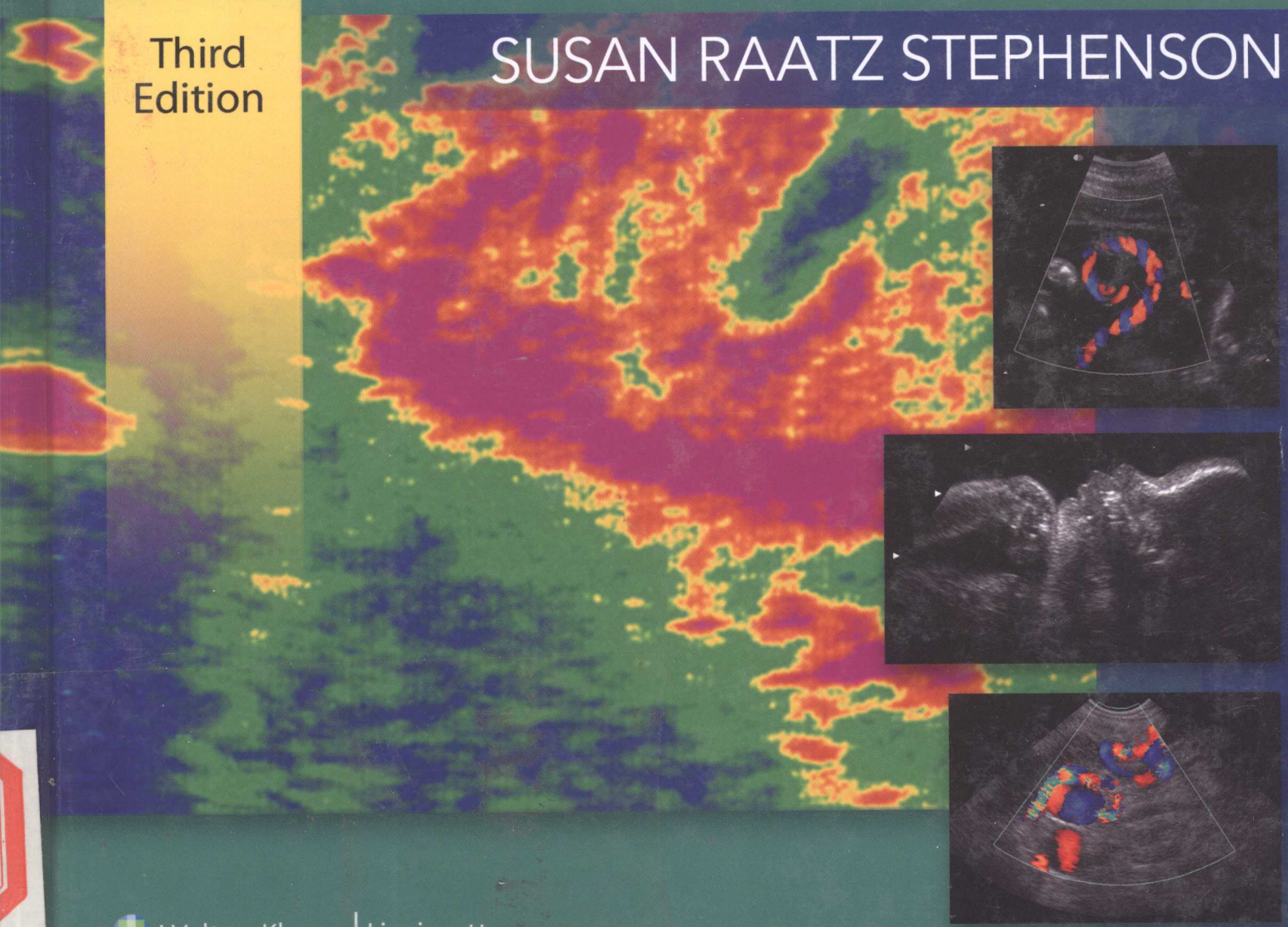
DIAGNOSTIC MEDICAL SONOGRAPHY

OBSTETRICS AND GYNECOLOGY

Third Edition

SUSAN RAATZ STEPHENSON



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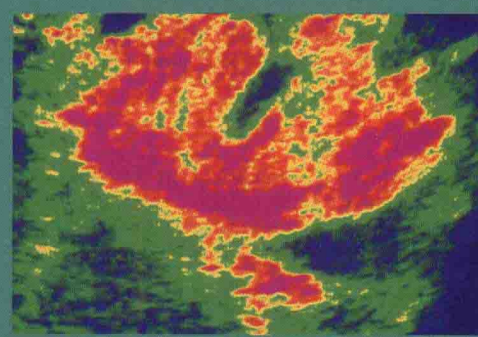

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To the men in my life, none of whom wanted this dedication. Beginning with my father who nurtured the personality, to my brother with whom I compete, the son who has become a great person, the man I chose to spend my life with and has to put up with me, and finally, to my nephew who I look forward to getting to know better.

Susan Raatz Stephenson

And to students and professionals who will use this book:
In my own journey to this point, there were many times when I wished the technology changes would slow down. Through the years, it became evident that the development and use of modes, such as Doppler and now Volume Imaging, require lifelong learning. My advice to you is to endeavor to understand the why and when we use the facets of sonography. Remember, "Curiosity is the very basis of education and if you tell me that curiosity killed the cat, I say only the cat died nobly."

—Arnold Edinborough

A final note from B.B. King,
"The beautiful thing about learning is nobody can take it away from you."

Acknowledgments

Three years ago when Diane Kawamura contacted me about this project, I had no idea how much I would learn in the process. Contributing authors provided an amazing amount of information, some formatted content in a manner adopted for subsequent chapters. All provided some aspect of women's health imaging that was new to this editor. The support of fellow editors, Anne Marie Kupinski (vascular) and Diane M. Kawamura (abdomen), in creating the three volumes of *Diagnostic Medical Sonography* were invaluable. Their input and ideas were a significant contribution to the project.

The image contributions became just as valuable. We thank the many sonographers and physicians for their assistance. A special thank you and recognition for ongoing support in image acquisition includes Philips Medical Systems, Bothell, WA; GE Healthcare, Wauwatosa, WI; Joe Antony, MD, Cochin, India; Robin Davies, Ann Smith, and Denise Raney, Derry Imaging Center, Derry, NH; Barbara Hall-Terracciano; the sonographers at the Intermountain Medical Center, Murray, UT; Darla Matthew, Doña Ana Community College; and Pamela M. Foy at The Ohio State University Medical Center.

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To our colleagues, students, friends, and family, who provide continued sources of encouragement, enthusiasm, and inspiration, thank you.

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Preface

The third edition of *Diagnostic Medical Sonography: Obstetrics and Gynecology* is a major revision. Educators and colleagues encouraged us to produce a third edition to incorporate the new advances used to image, to refresh the foundational content, and to continue to provide information that recognizes readers have diverse backgrounds and experiences. The result is a textbook that can be used as either an introduction to the profession or as a reference for the profession. The content lays the foundation for a better understanding of anatomy, physiology, pathophysiology, and complementary imaging expanding the sonographer practitioner, sonographer, sonologist, or student when caring for the patient.

The first chapter "Principles of Scanning Technique in Obstetric and Gynecologic Ultrasound" contains information on patient care and the process of beginning the imaging exam. Technology in the form of the picture archiving and communication systems (PACS) and interconnected computer systems within a clinic or hospital have revolutionized our profession.

The remainder of the textbook arrangement groups the gynecologic and obstetric chapters together. Throughout the chapters, we have tried to incorporate instrumentation and complementary imaging modalities when appropriate. This allows for integration of sonographic physics as well as other imaging modality findings that sonographers often follow.

We made every attempt to produce an up-to-date and factual textbook, at the same time presenting the material in an interesting and enjoyable format to capture the reader's attention. To do this, we provided detailed descriptions of anatomy, physiology, pathology, and the normal and abnormal sonographic representation of these anatomical and pathologic entities with illustrations, summary tables, and images, many of which include valuable case study information.

Our goal is to present as complete a text as possible, and recognizing that by tomorrow, the textbook must be supplemented by current journal readings. With every technological advance made in equipment, the sonographer's imagination must stretch to create new applications. With the comprehensive foundation available in this text, the sonographer can meet that challenge.

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Using This Series

The books in the *Diagnostic Medical Sonography* Series will help you develop an understanding of specialty sonography topics. Key learning resources and tools throughout the textbook aim to increase your understanding of the topics provided and better prepare you for your professional career. This User's Guide will help you familiarize yourself with these exciting features designed to enhance your learning experience.

18 Abnormalities of the Placenta and Umbilical Cord

Lisa M. Allen

OBJECTIVES

- Recognize the sonographic appearance of placental and umbilical cord anomalies
- Discuss developmental variations in placental size, shape, and configuration
- Identify placenta previa classifications
- Explain placental abruption and the associated risk factors
- List placenta accreta classifications and known risk factors
- Name the various abnormalities of umbilical cord insertion into the placenta
- Describe cystic and solid masses of the umbilical cord

KEY TERMS

succenturiate lobe | circummarginate placenta | circumvallate placenta | placenta previa | placental abruption | placenta accreta spectrum | chorioangioma | amniotic band syndrome | uterine synechiae | marginal insertion | battledore placenta | velamentous insertion | true knot | false knot | nuchal cord | cord prolapse | vasa previa | single umbilical artery | cord entanglement | umbilical cord hemangioma | umbilical cord coiling | umbilical coiling index

GLOSSARY

Aneurysm Focal dilatation of an artery

Bilobed placenta Placenta where the lobes are nearly equal in size and the cord inserts into the chorionic bridge of tissue that connects the two lobes

Body stalk anomaly Fatal condition associated with multiple congenital anomalies and absence of the umbilical cord

Breus' mole Very rare condition where there is massive subchorionic thrombosis of the placenta secondary to extreme venous obstruction

Extrachorial placenta Attachment of the placental membranes to the fetal surface of the placenta rather than to the underlying villous placental margin

False knot Bending, twisting, and bulging of the umbilical cord vessels mimicking a knot in the umbilical cord

Gastroschisis Periumbilical abdominal wall defect, typically to the right of normal cord insertion, that allows for free-floating bowel in the amniotic fluid

Limb–body wall complex Condition characterized by multiple complex fetal anomalies and a short umbilical cord

Marginal insertion (a.k.a. battledore placenta) Occurs when the umbilical cord inserts at the placental margin instead of centrally

Mickey Mouse sign Term used to describe the cross-section of the three-vessel umbilical cord or the portal triad (portal vein, hepatic artery, common bile duct)

Omphalocele Central anterior abdominal wall defect of the umbilicus where abdominal organs are contained by a covering membrane consisting of peritoneum, Wharton's jelly, and amnion

Placentomegaly Term that refers to a thickened placenta

Synechia (Asherman's syndrome) Linear, extra amniotic tissue that projects into the amniotic cavity with no restriction of fetal movement

Thrombosis Intraplacental area of hemorrhage and clot

True knot Result of the fetus actually passing through a loop or loops of umbilical cord creating one or more knots in the cord

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CHAPTER OBJECTIVES

Measurable objectives listed at the beginning of each chapter help you understand the intended outcomes for the chapter, as well as recognize and study important concept within each chapter.

GLOSSARY

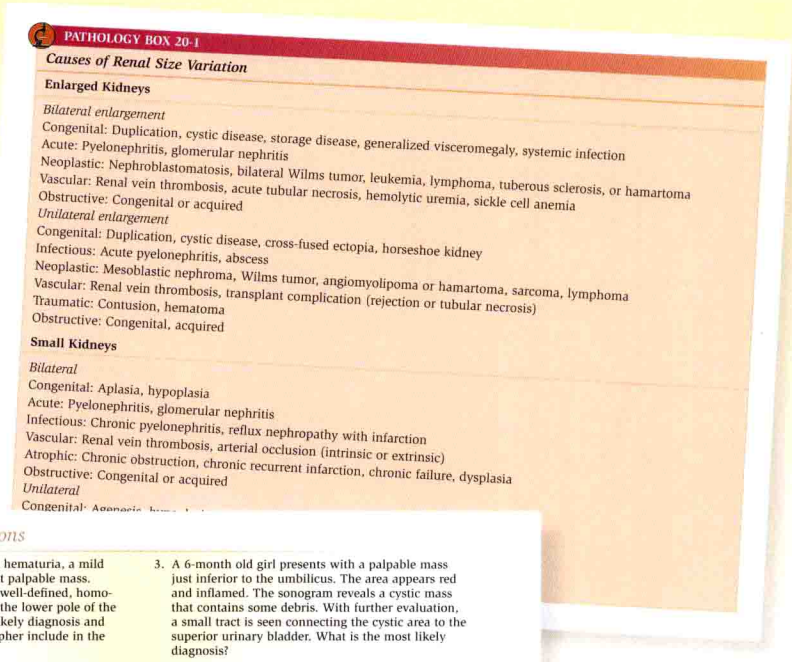
Key terms are listed at the beginning of each chapter and clearly defined, then highlighted in bold type throughout the chapter to help you to learn and recall important terminology.

PATHOLOGY BOXES

Each chapter includes tables of relevant pathologies, which you can use as a quick reference for reviewing the material.

CRITICAL THINKING QUESTIONS

Throughout the chapter are critical thinking questions to test your knowledge and help you develop analytical skills that you will need in your profession.



PATHOLOGY BOX 20-1

Causes of Renal Size Variation

Enlarged Kidneys

Bilateral enlargement

Congenital: Duplication, cystic disease, storage disease, generalized visceromegaly, systemic infection
Acute: Pyelonephritis, glomerular nephritis
Neoplastic: Nephroblastomatosis, bilateral Wilms tumor, leukemia, lymphoma, tuberous sclerosis, or hamartoma
Vascular: Renal vein thrombosis, acute tubular necrosis, hemolytic uremia, sickle cell anemia
Obstructive: Congenital or acquired

Unilateral enlargement

Congenital: Duplication, cystic disease, cross-fused ectopia, horseshoe kidney
Infectious: Acute pyelonephritis, abscess
Neoplastic: Mesoblastic nephroma, Wilms tumor, angiomyolipoma or hamartoma, sarcoma, lymphoma
Vascular: Renal vein thrombosis, transplant complication (rejection or tubular necrosis)
Traumatic: Contusion, hematoma
Obstructive: Congenital, acquired

Small Kidneys

Bilateral

Congenital: Aplasia, hypoplasia
Acute: Pyelonephritis, glomerular nephritis
Infectious: Chronic pyelonephritis, reflux nephropathy with infarction
Vascular: Renal vein thrombosis, arterial occlusion (intrinsic or extrinsic)
Atrophic: Chronic obstruction, chronic recurrent infarction, chronic failure, dysplasia
Obstructive: Congenital or acquired

Unilateral

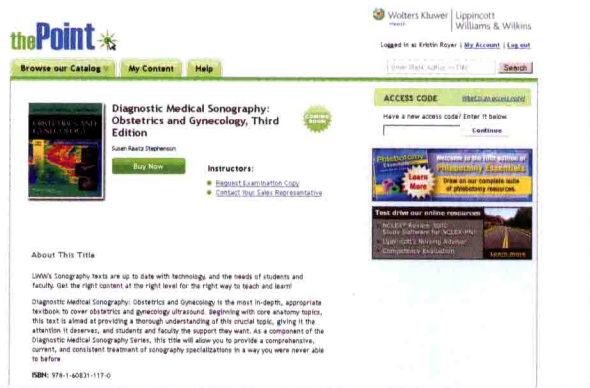
Congenital: Agenesis, hypo-

Critical Thinking Questions

1. A 3-year-old boy presents with hematuria, a mild fever, and a left upper quadrant palpable mass. The sonogram demonstrates a well-defined, homogeneously solid, 3-cm mass in the lower pole of the left kidney. What is the most likely diagnosis and where else should the sonographer include in the examination?
2. The sonographer receives a requisition to perform an abdominal sonogram on a 2-day-old infant with a right upper quadrant abdominal mass following a difficult delivery. The examination reveals a large echogenic mass superior to the right kidney and appears separate from the right kidney. What is the most likely diagnosis and what would help to confirm the diagnosis?
3. A 6-month old girl presents with a palpable mass just inferior to the umbilicus. The area appears red and inflamed. The sonogram reveals a cystic mass that contains some debris. With further evaluation, a small tract is seen connecting the cystic area to the superior urinary bladder. What is the most likely diagnosis?
4. What is the most common cause of hydronephrosis in infants?
5. While scanning a newborn patient for a renal examination, the sonographer notices both kidneys are enlarged and echogenic with hyperechoic foci scattered throughout both kidneys. What is the most likely diagnosis?

RESOURCES

You will also find additional resources and exercises online, including a glossary with pronunciations, quiz bank, sonographic video clips, and weblinks. Use these interactive resources to test your knowledge, assess your progress, and review for quizzes and tests.



Contents

1 Principles of Scanning Technique in Obstetric and Gynecologic Ultrasound

Susan Raatz Stephenson

OBJECTIVES

- Describe preparation of the patient for an obstetric or gynecologic sonogram
- Identify the appropriate transducer for an examination
- Explain ultrasound safety and the basic premise of as low as reasonably possible (ALARA)
- Discuss the safety of 2D, 3D, and Doppler imaging
- List the certification options available to a practicing sonographer
- Explain the need for laboratory accreditation

KEY TERMS

patient preparation | transabdominal | endovaginal | exam protocol | ALARA | certification | registry

GLOSSARY

Adnexa Area around an organ

Aortocaval compression syndrome (supine hypotensive syndrome) Compression of the aorta and inferior vena cava (IVC) by the gravid uterus resulting in symptoms of nausea, hypotension, lightheadedness, and syncope

Ascites Fluid within the abdominal or pelvic cavity

Bioeffects Biophysical results of the interaction of sound waves and tissue

Ectopic pregnancy Pregnancy outside of the uterus

Electronic medical record (EMR) Electronic database containing all the patient information

Endocavity Inside a cavity such as the abdomen or pelvis

Fundus Top portion of the uterus

Hospital information system (HIS) Paper-based or computerized system designed to manage hospital data, such as billing and patient records

Lithotomy position Position of the patient with the feet in stirrups often used during delivery

Modality worklist (MWL) Electronic list of patients entered into a modality, such as ultrasound,which helps reduce data entry errors

Nongravid Nonpregnant

Perivascular Around the vessels

Picture archiving and communication system (PACS) Database that stores radiologic images

Placenta previa Condition where the placenta implantation is low in the uterus and will deliver before the fetus

Radiology information system (RIS) Physical or electronic system designed to manage radiology data, such as billing, reports, and images

Scanning protocol List of images required for a complete examination

Transabdominal Imaging through the abdomen

Transducer footprint Area of the transducer that comes in contact with the patient and emits ultrasound

Transvaginal/endovaginal Within the vagina

Vasa previa Condition where the umbilical cord becomes trapped between the presenting fetal part and the cervix

The goal of any sonographic examination is to produce a diagnostic study through the use of proper technique and patient preparation. Optimization of the examination reduces costs, adheres to the ALARA[1] principle of reducing exposure to ultrasound energy, and decreases patient discomfort. A protocol-driven approach help ensure complete imaging of the pelvic organs or fetus. This systematic imaging includes two-dimensional (2D) real-time, spectral, color or power Doppler, and increasingly, three-dimensional (3D) and four-dimensional (4D) imaging.

Manipulation of the technical factors such as overall gain, persistence, and output power has increasingly become linked to automated image adjustment. Obtaining the required images for a study requires knowledge of not only the physics of ultrasound but also a thorough knowledge of normal and abnormal anatomy, and the disease processes being imaged.

In this chapter, you will find descriptions of basic techniques and protocols of scanning in obstetrics and gynecology along with emerging imaging technologies. Routines specific to the topics discussed are explained in greater detail in subsequent chapters.

PATIENT PREPARATION

GETTING SET UP

When the patient arrives for her sonographic examination, she first must be entered into the hospital information system (HIS). A patient number assignment identifies the patient's electronic medical record (EMR), to which all laboratory, pathology, and imaging studies are attached. Each visit generates a separate number to help identify procedures. Upon entry into the radiology information system (RIS), the sonographer is able to search the modality worklist (MWL), and the patient study information automatically populates on the ultrasound machine. Although this sounds quite complicated, the connected hospital makes our lives much easier through the elimination of errors and the use of film.[2]

The sonographer should introduce himself or herself when meeting the patient. To confirm the patient's identification, use two identifiers such as the name and the date of birth. Some facilities attach an arm band to the patient that can be used for identification purposes. At this time, ask the patient what she is scheduled for to confirm the correct order and her perception of the upcoming examination (Table 1-1). Upon completion of patient identity and exam confirmation, explain the procedure, the length of the examination, what she may expect to feel, and where and how the transducer will be moved.

All pertinent clinical information should be included on the ultrasound report. This includes patient age, date of the last menstrual period (LMP; also whether it is normal), gravidity, parity, symptoms such as pain or bleeding, history of pelvic procedures, and any other pertinent medical or surgical history. This information

TABLE 1-1

Patient Identifiers[a]

- Ask patient his or her name
- Have the patient state his or her date of birth (DOB)
- Exam type
- Ordering clinician
- Armband

[a]To ensure the proper patient, use two different identifiers.[40]

should be obtained from the patient if it is not on the examination request. This information can be entered into the equipment in an introductory screen *which in many cases can* calculate gestational age and due dates. This information then transfers to the electronic report (Fig. 1-1). It is desirable to obtain this information before beginning the examination to minimize the chance that the patient will conclude the questions are related to something the sonographer is seeing on the screen.

Knowing the patient's reproductive history gives the sonographer information with which to design and interpret the sonographic examination. For example, if the patient is small for gestational age (SGA), the exam might reveal growth problems or low fluid levels. Although variations of the obstetric coding system may be used, the following is the most common: *Gravidity* (G) refers to the number of previous pregnancies and includes the current gestation. A pregnant woman who had a nonviable ectopic pregnancy and later gave birth to twins would be G3. If the patient is currently nongravid but has had four previous pregnancies, she is said to be G4. *Parity* (P) refers to the number of pregnancies the patient has carried to term; thus, an ectopic pregnancy would be recorded as P0 and a twin gestation would be P1. The numbers used after P refer, in order, to the number of term pregnancies, abortions (spontaneous or induced), and living children. Thus, the currently pregnant patient would be classified as a G3P1A1T2, which would mean the woman has had three pregnancies, one full-term pregnancy, one abortion (the ectopic pregnancy in this case), and two full-term births, (in this case, a set of twins).[3] If the patient is not currently pregnant, she would be a G2P1A1T2 (Table 1-2).

It is generally accepted that the first day of the LMP is used to date pregnancies. The LMP usually occurs about 2 weeks before conception. The LMP is chosen because women can document this date. Still, 20% to 40% of pregnant women are uncertain of their LMP, making dating of a pregnancy unreliable. Ultrasound can narrow the estimated date of delivery (EDD), also referred to as estimated date of confinement (EDC), to as little as ±2.7 days by using the average of at least three first-trimester crown-rump length (CRL) measurements.[4]

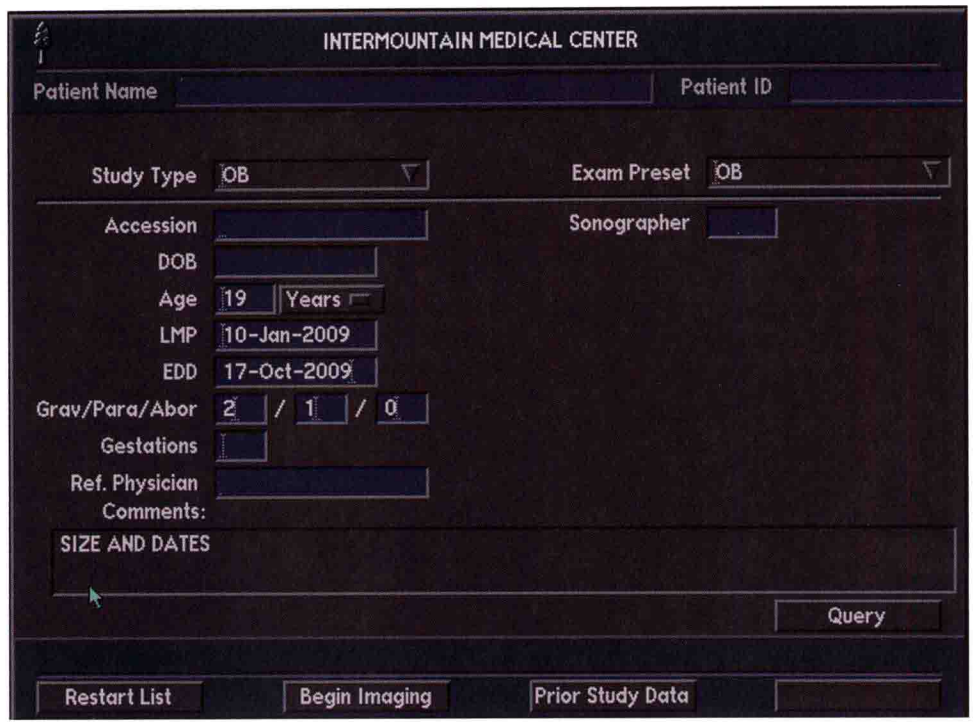


Figure 1-1 The patient data entry (PDE) screen allows entry of the accession number or the patient visit number, LMP, and patient pregnancy information. If you work in a facility that does not have a connected workflow, the patient information may be manually entered on this screen.

After obtaining all pertinent clinical information, assist the patient onto the examination table, making her as comfortable as possible. A pillow or two under the patient's knees relieves back strain. For a transabdominal examination, apply gel liberally to the lower abdomen to provide an effective medium for sound transmission. To minimize patient discomfort, warm the gel to body temperature. If a laboratory is not equipped with a gel warmer, the gel may be warmed in a sink of warm water. Do not use a microwave, as the gel heats unevenly and may explode. If an endovaginal examination is to be performed, give the patient privacy while she undresses from the waist down and drapes herself with a sheet.

Every laboratory should develop scanning protocols for each type of examination and include these in a printed reference manual. Suggested protocols have been developed for obstetric and gynecologic scanning by the American Institute of Ultrasound in Medicine (AIUM; Displays 1-1 and 1-2).[5,6] The Society of

TABLE 1-2
Gravida/Parity Definitions

Term/Abbreviation	Definition
Gravida (G)	Number of pregnancies
Para (P)	Number of pregnancies over 36 weeks (term)
Abortion (A)	Number of failed pregnancies
Term (T)	Number of live births

DISPLAY 1-1

Guidelines for the Performance of the Antepartum Obstetrical Ultrasound Examination

Guidelines for First-Trimester Sonography

Indications: Confirm intrauterine pregnancy; evaluate for suspected ectopic pregnancy; determine the cause of vaginal bleeding or pelvic pain; estimate gestational age; diagnose or evaluate multiple pregnancies; confirm viability, adjunct to chorionic villus sampling (CVS), embryo transfer, and localization and removal of an intrauterine device (IUD); assess for fetal anomalies such as anencephaly; evaluate maternal uterine anomalies and/or pelvic masses; measure the nuchal translucency (NT); and evaluate for suspected hydatidiform mole.

Overall Comment. Scanning in the first trimester may be performed abdominally, vaginally, or using both methods. If an abdominal examination fails to provide diagnostic information, perform a vaginal or transperioneal examination. Similarly, if a vaginal scan fails to image all areas needed for diagnosis, an abdominal scan should be performed.

1. Evaluate the uterus and adnexa for the presence of a gestational sac. Document any visualized gestational sac and determine the location. Note the presence or absence of an embryo and record the CRL.

   Comment. (1) CRL is a more accurate indicator of gestational age than gestational sac diameter. If the embryo is not identified, evaluate the gestational sac for the presence of a yolk sac. The estimate of gestational age would be based on either the mean diameter of the gestational sac or on the morphology and contents of the gestational sac. (2) Identification of a yolk sac or an embryo is definitive evidence of a gestational sac. Use caution in making a definitive diagnosis of a gestational sac prior to the development of these structures. The lack of a yolk

sac and embryo raises suspicion of an intrauterine fluid collection, which often coexists with the pseudogestational sac associated with an ectopic pregnancy. (3) During the late first trimester, biparietal diameter (BPD) and other fetal measurements also may be used to establish fetal age.

2. Record the presence or absence of cardiac activity with M-Mode or Cineloop.

Comment. (1) Real-time observation is critical for this diagnosis. (2) With vaginal scans, an embryo with a CRL of 5 mm or greater should demonstrate cardiac motion. If an embryo less than 5 mm in length is seen with no cardiac activity, a follow-up scan may be needed to evaluate for fetal life.

3. Document fetal number.

Comment. Report multiple pregnancies only when imaging multiple embryos. Incomplete amnion and chorion fusion, or elevation of the chorionic membrane by intrauterine hemorrhage, often mimic a second sac in the first trimester, leading to an incorrect diagnosis of a multiple pregnancy.

4. Evaluate the uterus, adnexal structures, and cul-de-sac.

Comment. (1) This allows recognition of incidental findings of potential clinical significance. Record the presence, location, and size of myomas and adnexal masses. Scan the cul-de-sac for presence or absence of fluid. If there is fluid in the cul-de-sac, image the flanks and subhepatic space for intra-abdominal fluid. (2) Correlate serum hormonal levels with ultrasound findings to help in differentiation of a normal, abnormal, or ectopic pregnancy.

5. Evaluate the nuchal region in the presence of a live fetus.

Comment. (1) The NT measurement is a very specific measurement obtained at laboratory-determined intervals. (2) Use the NT measurement in conjunction with serum biochemistry to determine the patient risk for trisomy 13 or 18, or other defects such as heart or spine malformations. (3) NT certification ensures consistent quality and examination performance between sonographers.

Guidelines for Second- and Third-Trimester Sonography

Indications: Evaluation of gestational age and fetal growth; determination of the cause of vaginal bleeding, pelvic pain, or cervical insufficiency; determination of fetal presentation; diagnosis or evaluation of multiple pregnancies; confirmation of viability, adjunct to amniocentesis; determination of cause of uterine size and clinical date discrepancies; assessment for fetal anomalies; evaluation of maternal uterine anomalies, pelvic masses, or suspected ectopic pregnancy; evaluation of fetal well-being; determination of amniotic fluid levels, suspected placental abruption, placement of cervical cerclage, adjunct to external cephalic version, premature rupture of membranes (PROM), abnormal biochemical markers; follow up to a fetal anomaly and placental location, history of a congenital anomaly; evaluation of fetal condition in patients with late prenatal care; assessment of findings that increase the risk of aneuploidy; and evaluation for suspected hydatidiform mole.

1. Document fetal life, number, presentation, and activity.

Comment. (1) Report an abnormal heart rate and/or rhythm. (2) Multiple pregnancies require the documentation of additional information: number of gestational sacs, number of placentas, presence or absence of a dividing membrane, fetal genitalia (if visible), comparison of fetal sizes, and comparison of amniotic fluid volume (AFV) on each side of the membrane.

2. Report an estimate of AFV (increased, decreased, normal).

Comment. When determining the appropriateness of AFV, consider the physiologic variation that occurs with each stage of pregnancy.

3. Record the placental location and appearance, as well as its relationship to the internal cervical os. Document the umbilical cord insertion sites into both the placenta and fetus. Include a cross-section of the free floating cord for three vessel confirmation as well as color Doppler images of the umbilical vessels coursing lateral to the fetal bladder.

Comment. (1) It is recognized that apparent placental position early in pregnancy may not correlate well with its location at the time of delivery. (2) An overdistended maternal urinary bladder or a lower uterine contraction can give the examiner a false impression of placenta previa. (3) Abdominal, transperineal, or vaginal views may be helpful in visualizing the internal cervical os and its relationship to the placenta.

4. Obtain fetal measurements to assess gestational age using a combination of cranial measurement such as the BPD or head circumference (HC), and limb measurement such as the femur length (FL).

Comment. (1) Third-trimester measurements may not accurately reflect gestational age due to morphologic differences in individuals (i.e., short, tall). Base the current exam dates on the earliest examination as the CRL, BPD, HC, and FL have a greater accuracy earlier in the pregnancy. To determine the current fetal age, use an OB wheel, enter data into the equipment or use the following calculation: CRL, BPD, HC, and/or the FL by the equation: current fetal age = estimated age at time of initial study + number of weeks elapsed since first study.

4A. The standard reference level for measurement of the BPD is an axial image that includes the thalamus.

Comment. If the fetal head is dolichocephalic or brachycephalic, the BPD measurement may be misleading. Occasionally, computation of the cephalic index (CI), a ratio of the BPD to the fronto-occipital diameter, is needed to make this determination. In such situations, other measurements of head size, such as the HC, may be necessary.

4B. Measure the HC at the same level as the PBD, around the outer perimeter of the calvarium at the level of the thalamus.

4C. Routinely measure and record the FL after the 14th week of gestation.

Comment. As with head measurements, there is considerable biologic variation in normal FLs late in pregnancy.

5. Obtain a fetal weight estimate in the late second and in the third trimesters. This measurement requires an abdominal diameter or circumference.

Comment. (1) Check appropriateness of growth from previous studies at least 2 to 4 weeks previous. (2) Fetal weight estimations may be as much as ±15% from actual delivery weights. This may be due to the patient population, sonographer measuring techniques, and technical factors.

5A. Measure the abdominal circumference (AC) on a true transverse view, preferably at the level of the junction of the left and right portal veins and fetal stomach.

Comment. An AC measurement helps estimate fetal weight and may allow detection of growth retardation and macrosomia.

5B. Estimate interval growth from previous fetal biometric studies.

6. Evaluate the uterus (including the cervix) and adnexal structures.

Comment. This allows recognition of incidental findings of potential clinical significance. Record the presence, location, and size of myomas and adnexal masses. It is frequently not possible to image the maternal ovaries during the second and third trimesters. Vaginal or transperineal scanning may be helpful in evaluating the cervix when the fetal head prevents visualization of the cervix from transabdominal scanning.

7. The study should include, but not necessarily be limited to, assessment of the following fetal anatomy: cerebral ventricles, posterior fossa (including cerebellar hemispheres and cisterna magna), choroid plexus, lateral cerebral ventricles, midline falx, cavum septi pellucid, upper lip, views of the heart to include the four-chambers (including its position within the thorax), left ventricular outflow, and right ventricular outflow along with aortic arch and ductal arch images, spine, stomach, kidneys, urinary bladder, color Doppler or Color Power Angio images of the umbilical vessels lateral to the bladder, fetal umbilical cord insertion site, and intactness of the anterior abdominal wall and placenta. Also include images of the limbs, along with the presence or absence of the long bone and the fetal sex determination. Although not considered part of the minimum required examination, when fetal position permits, it is desirable to examine all areas of the anatomy.

Comment. (1) It is recognized that not all malformations of the previously mentioned organ systems can be detected using ultrasonography. (2) Consider these recommendations as a minimum guideline for the fetal anatomic survey. Occasionally, some of these structures may not be well visualized, as occurs when fetal position, low amniotic volume, or maternal body habitus limit the sonographic examination. When this occurs, the report of the ultrasound examination should include a notation delineating structures that were not well seen. (3) Suspected abnormalities may require a targeted evaluation of the area(s) of concern. (4) In the patient with an increased risk of aneuploidy, perform a nuchal fold measurement.

(American Institute of Ultrasound in Medicine. *Guidelines for Performance of the Antepartum Obstetrical Ultrasound Examination*. Laurel, MD: AIUM; 2007.)

DISPLAY 1-2

Guidelines for Performance of the Ultrasound Examination of the Female Pelvis

Indications: Pain; painful menses (dysmenorrhea); lack of menses (amenorrhea); excessive menstrual bleeding (menorrhagia); irregular uterine bleeding (metrorrhagia); excessive irregular bleeding (menometrorrhagia); follow-up of previous detected abnormality; evaluation, monitoring, and/or treatment of infertility patients; delayed menses, precocious puberty, or vaginal bleeding in a prepubertal child; postmenopausal bleeding; abnormal or technically limited manual examination; signs and symptoms of a pelvic infection; further imaging of an anomaly found during another imaging study; congenital anomaly evaluation; excessive bleeding; pain or signs of infection after pelvis surgery; delivery or abortion; localization of an intrauterine device (IUD), malignancy screening for high-risk patients; urinary incontinence or pelvic organ prolapse; and guidance for interventional or surgical procedures.

The following guidelines describe the examination to be performed for each organ and anatomic region in the female pelvis. All relevant structures should be identified by the abdominal and/or vaginal approach. If an abdominal examination is performed and fails to provide the necessary diagnostic information, a vaginal scan should be done when possible. Similarly, if a vaginal scan is performed and fails to image all areas needed for diagnosis, an abdominal scan should be performed. In some cases, both an abdominal and a vaginal scan may be needed.

GENERAL PELVIC PREPARATION

For a pelvic sonogram performed through the abdominal wall, the patient's urinary bladder should, in general, be distended adequately to displace the small bowel and its contained gas from the field of view. Occasionally, overdistention of the bladder may compromise evaluation. When this occurs, imaging should be repeated after the patient partially empties the bladder.

For a vaginal sonogram, the urinary bladder is preferably empty. The vaginal transducer may be introduced by the patient, the sonographer, or the physician. A female member of the physician's or hospital's staff should be present, when possible, as a chaperone in the examining room during vaginal sonography.

UTERUS

The vagina and uterus provide anatomic landmarks that can be used as reference points when evaluating the pelvic structures. In evaluating the uterus, document the following: (1) uterine size, shape, and orientation; (2) the endometrium; (3) the myometrium; and (4) the cervix.

Evaluate the uterine length on a long-axis view as the distance from the fundus to the cervix. The depth of the uterus (anteroposterior dimension) is measured on the same long-axis view from its anterior to posterior walls, perpendicular to its long axis. Measure the width on the axial or coronal view. Exclude the cervix when performing volume measurements of the uterus.

Document abnormalities of the uterus to include of contour changes, echogenicity, masses, and cysts. Measure findings on at least two dimensions, acknowledging that it is not necessary to measure all fibroids.

Analyze the endometrium for thickness, focal abnormality, and the presence of any fluid or masses in the endometrial cavity. Measure the endometrium on a midline sagittal image, including anterior and posterior portions of the basal endometrium and excluding the adjacent hypoechoic myometrium and any endometrial fluid. Assessment of the endometrium should allow for normal variations in the appearance of the endometrium expected with phases of the menstrual cycle and with hormonal supplementation. Sonohysterography helps evaluate the patient with abnormal dysfunctional uterine bleeding or with an abnormally thickened endometerium. Document an IUD and the location within the uterus. When available, obtain a 3D volume for coronal reconstruction of the uterus.

ADNEXA (OVARIES AND FALLOPIAN TUBES)

When evaluating the adnexa, an attempt should be made to identify the ovaries first since they can serve as a major point of reference for assessing the presence of adnexal