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Ultrasound in Obstetrics and Gynecology

A Practitioner's Guide

KATHRYN A. GILL

Ultrasound in Obstetrics and Gynecology

A Practitioner's Guide

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DAVIES

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CHAPTER

1

Introduction to Diagnostic Ultrasound

Kathryn A. Gill, MS, RT, RDMS, FSDMS

OBJECTIVES

After completing this chapter you should be able to:

1. Explain the advantages and limitations of B-mode ultrasound imaging.
2. Describe how the body is imaged in two dimensions.
3. List the sonographic criteria necessary to characterize a mass as cystic, solid, or complex.
4. Identify sonographic artifacts and describe their appearance.
5. Explain the relative advantages and disadvantages of the sector, linear, and curved (convex) linear transducers.
6. Demonstrate the various maneuvers used to manipulate the ultrasound transducer.
7. Describe the correct way to hold the transducer while scanning a patient.

B-mode (brightness mode) diagnostic ultrasound imaging provides a dynamic means of evaluating soft-tissue structures of the pelvis and pregnant uterus in cross section. Although the technique of performing diagnostic ultrasound procedures appears effortless, diagnostic ultrasound is one of the most difficult imaging modalities to perform and interpret. Because the inexperienced practitioner can make normal anatomy look abnormal, practitioners must be able to recognize normal patterns before they can appreciate pathology. To help simplify the learning process, this chapter introduces some of the basic concepts and terms used among sonographers, focusing on two-dimensional B-mode imaging. Doppler concepts and applications are addressed elsewhere, including Chapter 12.

THE ADVANTAGES AND DISADVANTAGES OF DIAGNOSTIC ULTRASONOGRAPHY

Advantages

Diagnostic ultrasonography has several advantages over other imaging modalities. In most cases, the sonographic exam is easily tolerated by patients. For evaluating the pelvic area transabdominally, the only required preparation is that the patient has a full urinary bladder. There is usually no need for elaborate bowel preparation, nor is it necessary to introduce contrast agents in order to image soft-tissue organs, as is required for other radiologic procedures. Since the images are produced by using high-frequency sound waves, the patient is not exposed to radiation. To date, no adverse human biologic effects

have been demonstrated at the frequency levels used in diagnostic ultrasound. Cross-sectional imaging allows us to easily identify anatomic relationships among organs and other structures and to appreciate depth relationships. Most diagnostic ultrasound systems are portable, and so imaging is not restricted to one department or room. Finally, diagnostic ultrasound procedures are cost- and time-efficient compared to other imaging modalities (Box 1-1).

Box 1-1.	Advantages of B-mode diagnostic ultrasonography.
	Patient tolerates it well
	No bowel preparation is necessary
	Relatively noninvasive
	No radiation to patient
	Anatomic relationships are clearly shown
	Depth relationships are shown
	Time-efficient
	Cost-effective
	Portable

Disadvantages

There are only a few disadvantages to diagnostic ultrasound imaging (Box 1-2). The physics of sound propagation limits the usefulness of ultrasound somewhat in evaluating dense, calcified structures (Figure 1-1) and air-filled organs such as the gastrointestinal tract (Figure 1-2). These structures cause total reflection of the ultrasound and inhibit the sound from penetrating the anterior surface of the structure. In addition, B-mode diagnostic imaging—as distinct from Doppler ultrasonography—does not provide adequate information about function, because the organ, if present, is imaged whether it functions or not. Although efforts are being made through research to improve tissue characterization with ultrasound, the modality is not sensitive enough to distinguish **benign** from **malignant** tissue.

Box 1-2.	Disadvantages of B-mode diagnostic ultrasonography.
	Limited applications
	Inability to determine function
	Inability to distinguish benign from malignant

Nevertheless, sonographic characteristics can suggest that a mass is benign or has a high-risk potential for being malignant.

INFORMATION PROVIDED

Diagnostic ultrasound provides information about the size, shape, echo pattern, and position of organs and other structures. The sonographer knows the normal patterns of all the pelvic organs, including shape, contour,

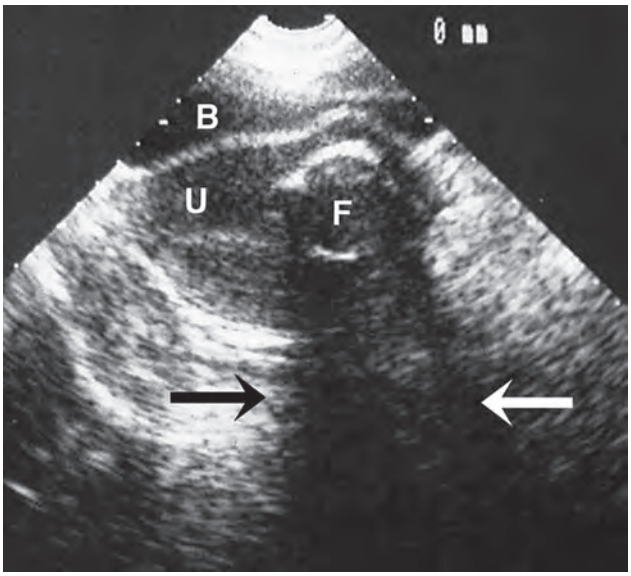


Figure 1-1. *Transverse image through a uterus with a calcified fibroid demonstrating a shadow (arrows) produced from the fibroid. U = uterus, B = bladder, F = fibroid.*

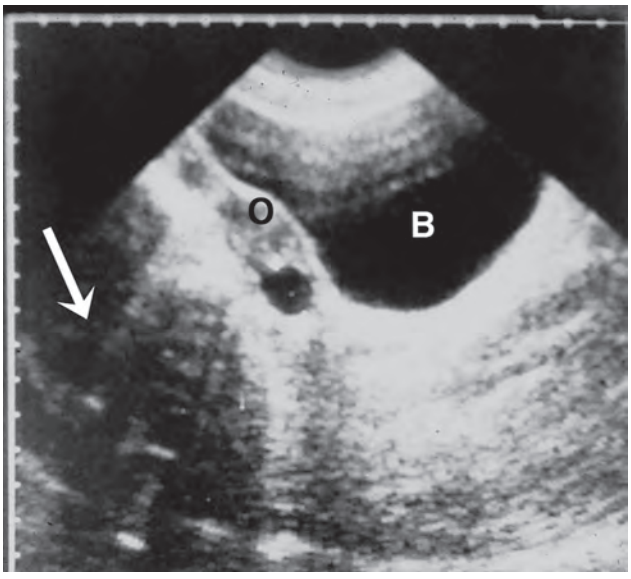


Figure 1-2. *Longitudinal image of an ovary with some shadowing posterior to it from intestinal gas (arrow). B = bladder, O = ovary.*

texture, and internal architecture and relative position. Any disruption of the normal patterns suggests an **anomaly**, or abnormality. When a mass is discovered within or adjacent to an organ, the practitioner should attempt to characterize the mass and determine its origin. To ascertain the size of pelvic organs so they can be compared to normal, measurements are taken in three dimensions. The three measurements include longitudinal, transverse, and anterior/posterior (AP) dimensions (Figure 1-3).

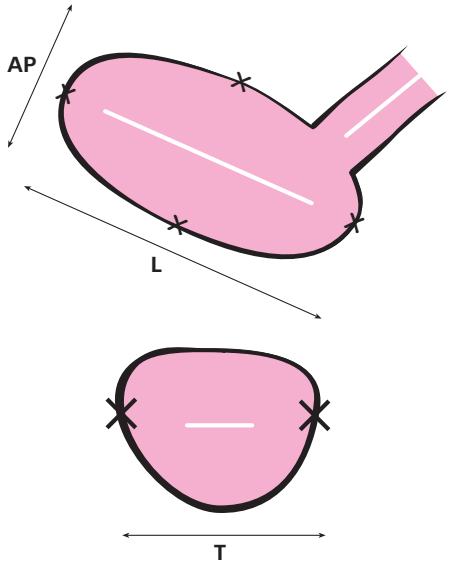


Figure 1-3. *Anatomic drawing demonstrating how to measure an organ or mass in the longitudinal (L), transverse (T), and anterior/posterior (AP) dimensions.*

SCAN PLANES, BODY ORIENTATIONS, AND LABELING

There are two basic scan planes used in diagnostic ultrasound imaging. They are longitudinal (or sagittal) and transverse.

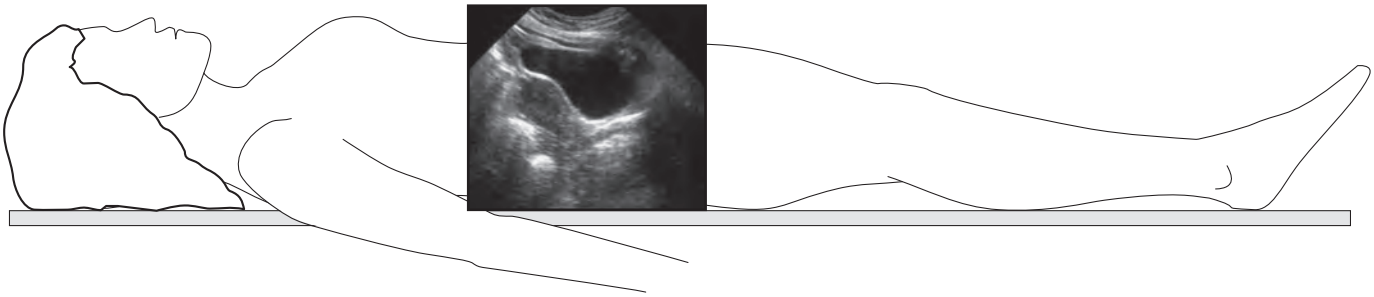
Scan Planes

In **longitudinal** (**sagittal**) imaging, the patient's supine body is divided into right and left sections. An imaginary line down the midline is referred to as **mid-sagittal** (see Box 1-3). The longitudinal (sagittal) image is viewed as though the practitioner were looking at the patient from her right side. On the ultrasound monitor, the patient's head (**cephalic**) is on the left side of the screen and her feet (**caudal**) on the right. The top of the screen is the **anterior** aspect and the bottom of the screen is **posterior** (Figures 1-4 A and B).

Box 1-3. Longitudinal/sagittal landmarks and their abbreviations.

M or ML—midline (mid-sagittal)
R—to the right
L—to the left

A



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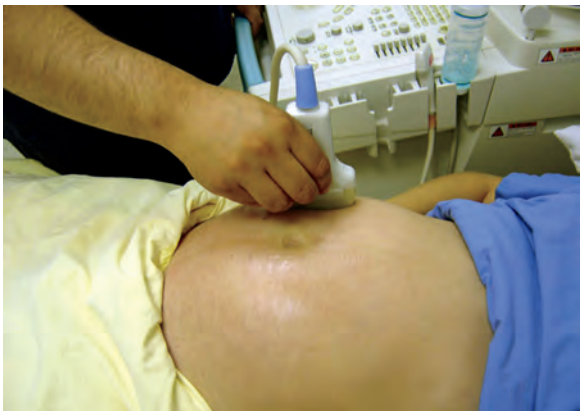


Figure 1-4. A *Drawing showing how the body is viewed in the longitudinal plane.* **B** *Image showing transducer placement on abdomen of a pregnant patient for longitudinal imaging. (Figure continues . . .)*

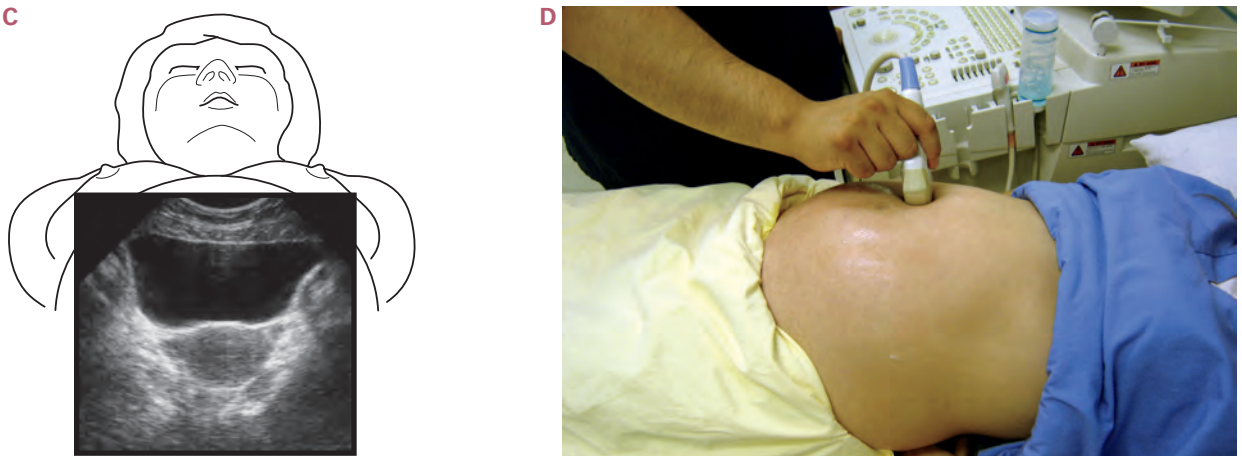


Figure 1-4, continued. C *Drawing showing how the body is viewed from the transverse plane.* **D** *Image showing transducer placement on the abdomen of a pregnant patient demonstrating the transverse orientation. Compression maneuver is also demonstrated.*

Transverse plane imaging visualizes the patient as though she were bisected by an imaginary horizontal line across the waistline into superior and inferior sections (see Box 1-4). The image is viewed as though you were looking at your patient from her feet. On the ultrasound monitor, the patient's right side is on the left side of the screen and her left side on the right. The anterior and posterior aspects are unchanged from that of the longitudinal plane (Figures 1-4 C and D). The **symphysis pubis** describes the line of the union of the bodies of the pelvic bones in the median plane, and the iliac crest or **transcrestal plane** describes the transverse plane at the level of the top of the pelvic bones.

The **coronal plane** divides the patient's body into front and back portions. When scanning in this plane in the long axis, the top of the image would be the lateral aspect, the bottom of the screen would be medial, the right side of the screen would be inferior (caudal), and the left would be superior (cephalic). The sonographer has to indicate whether he or she is scanning from the right lateral approach or the left lateral approach.

Box 1-4. Transverse landmarks and their abbreviations.

S or SP—symphysis pubis
IC/TCP—iliac crest/transcrestal plane
U—umbilicus
+ = superior movement
− = inferior movement

Finally, an **oblique** scan plane is any plane that is not longitudinal (sagittal), coronal (A/P), or transverse. Ultrasound has the unique ability to create any type of oblique plane, as the transducer is in the operator's hand. This also makes it imperative to have good knowledge of sonographic anatomy in all planes.

Body Orientations

Other useful terms related to scan planes and body orientations include:

Medial: Toward the center line of the body.

Lateral: Away from the center line of the body.

Proximal: Closer to the point of reference, the origin, etc.

Distal: Farther away from the point of reference, the origin, etc.

Superior: Above; toward the head; generally interchangeable with "cephalad."

Inferior: Below; toward the feet or "caudal."

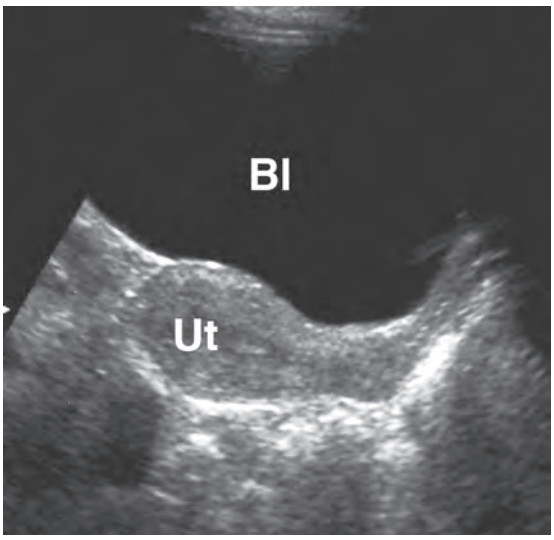
Superficial: Closer to the surface/skin.

Deep: Farther down from the surface/skin.

Labeling and Documentation

Images should be labeled accurately for documentation purposes. Labeling of scans may vary according to departmental protocols. Some departments choose simply to label images by organ, as demonstrated in Figures 1-5 A and B. Others may label by plane (Figure 1-5C). Guidelines suggested by the American Institute of Ultrasound in Medicine (AIUM) and other laboratory accrediting

A



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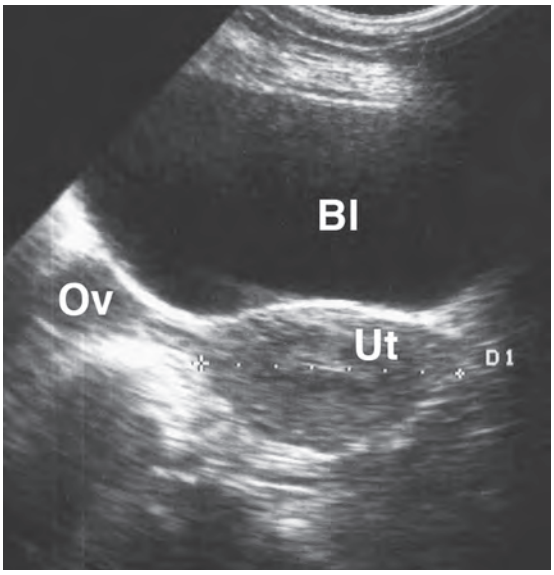

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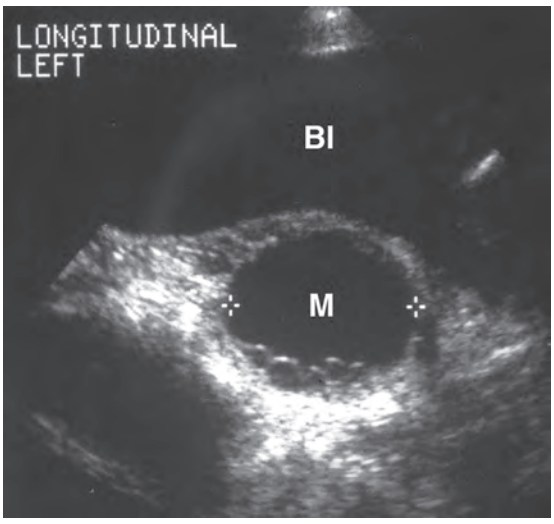


Figure 1-5. A *Longitudinal scan through a normal uterus (Ut = uterus, Bl = bladder).* **B** *Transverse scan through a normal uterus (Ut = uterus, Bl = bladder, Ov = ovary).* **C** *Longitudinal scan through a complex left adnexal mass (calipers; Bl = bladder, M = mass).*

Table 1-1. Ultrasound labeling guidelines and examples.

Labeling Guideline	Examples
Organ/area of interest	Ovary (ov)
Plane/axis	Longitudinal (lg-long-ln-sag)
Patient position	Left lateral decubitus (LLD)

organizations recommend at the very least that images indicate (1) the organ or area of interest, (2) the plane or axis, and (3) the patient's position if it is other than **supine** (Table 1-1). Whichever labeling protocol you choose, be consistent and as specific as possible.

CHARACTERIZING TISSUE

The descriptive terms used in diagnostic ultrasound help us to characterize the texture and density of tissues. If a structure has many echoes within it, we call it **echogenic**. Echoes that are exaggerated and extremely bright are referred to as being **hyperechoic** (Figure 1-6A), which usually suggests either a very solid, dense structure or the phenomenon of echo enhancement due to the sound beam passing through a fluid component (Figure 1-6B), as described below. **Hypoechoic** describes a structure that is solid but has low-level echoes within it, while **anechoic** denotes a structure without echoes (Figure 1-7). **Echopenic** describes a mass that has a few low-level echoes but is

A

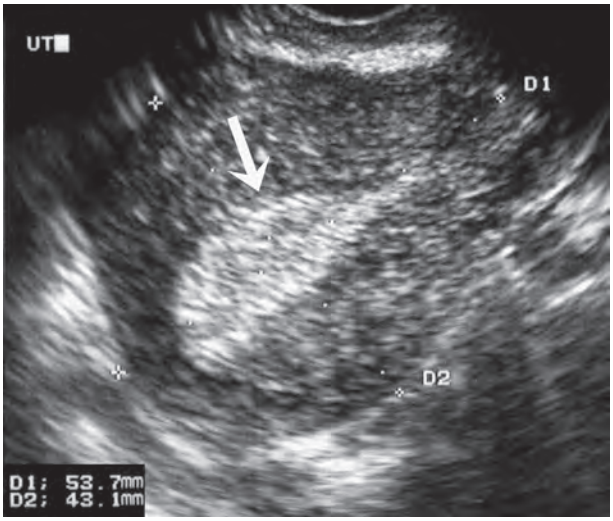


Figure 1-6. A *Longitudinal transvaginal image demonstrating a hyperechoic endometrium (arrow). (Figure continues . . .)*

TRANSDUCER MANIPULATION

Taming the transducer is one of the sonographer's greatest challenges. Good scanning technique requires eye-hand coordination and a lot of practice.

Terms used in describing transducer manipulation include *sliding*, *rocking*, *tilting* or *angling*, *rotating*, and *compression*:

- **Sliding** refers to gross movement of the transducer from one location to another and can be done in any direction (Figure 1-19).
- **Rocking** the transducer toward or away from an indicator makes it possible to center the point of interest or actually to extend the field of view in one direction. Another term for this is **in-plane motion**, as it allows for visualization of more anatomy in the original plane slice (Figure 1-20).

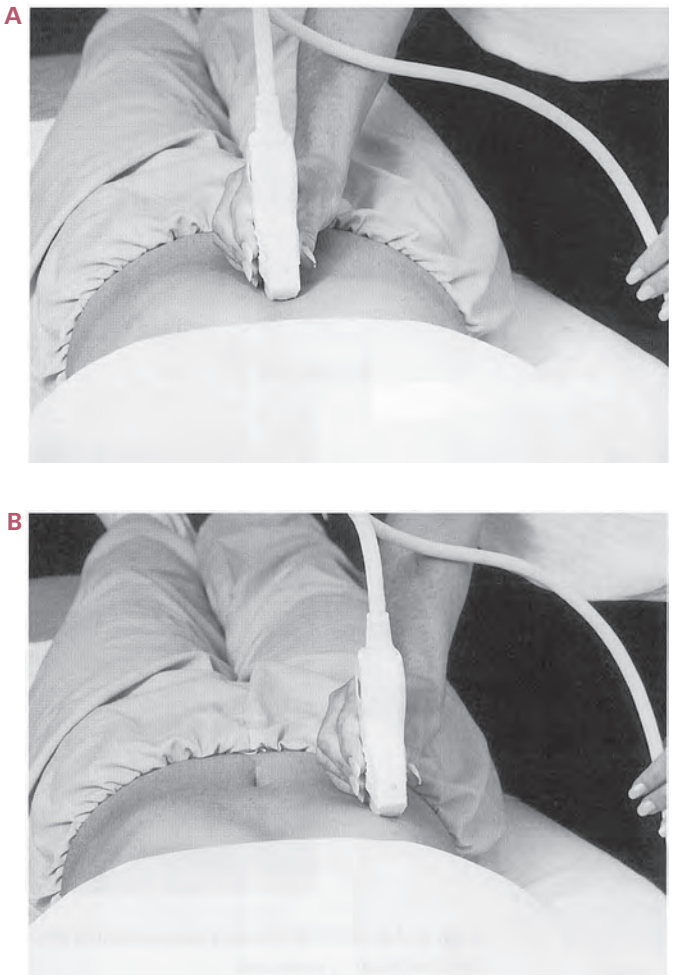


Figure 1-19. A, B *Sliding the transducer from midline to the middle of the right costal. Reprinted with permission from Gill KA:* Abdominal Ultrasound: A Practitioner's Guide. *Philadelphia, Saunders, 2001.*

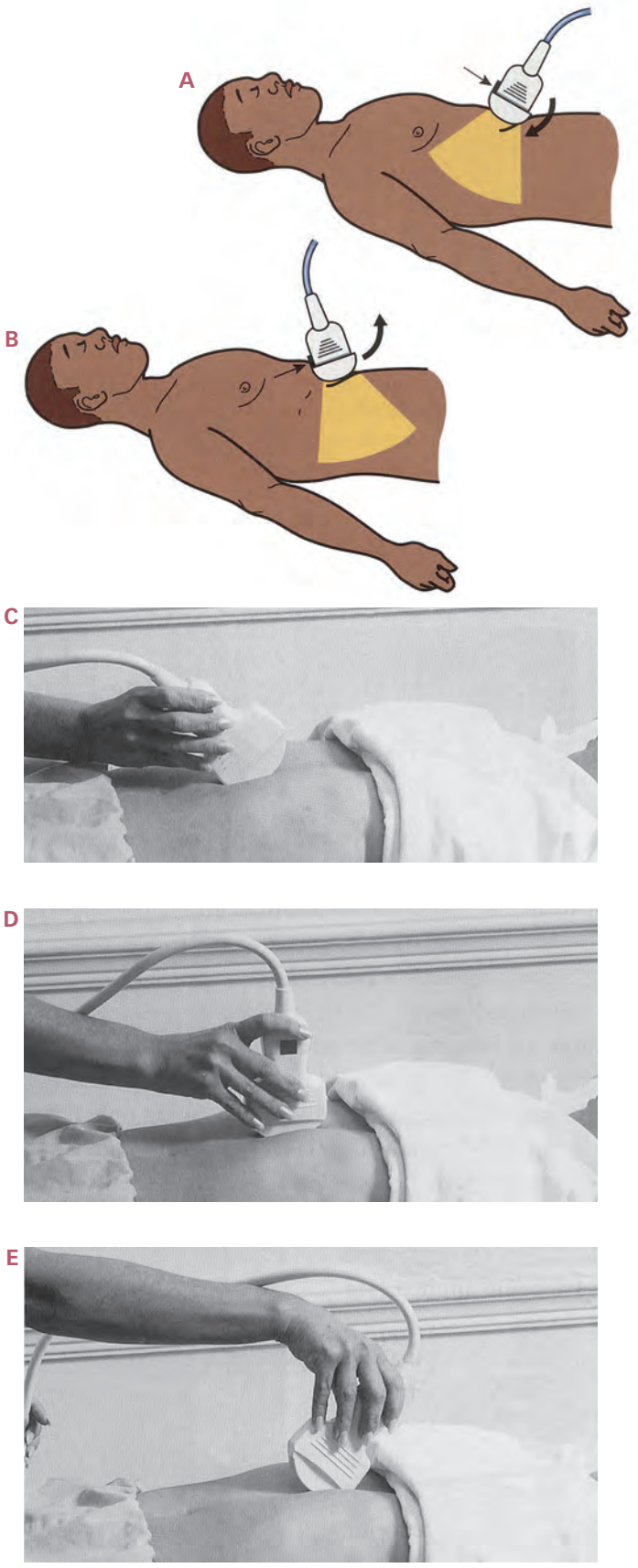
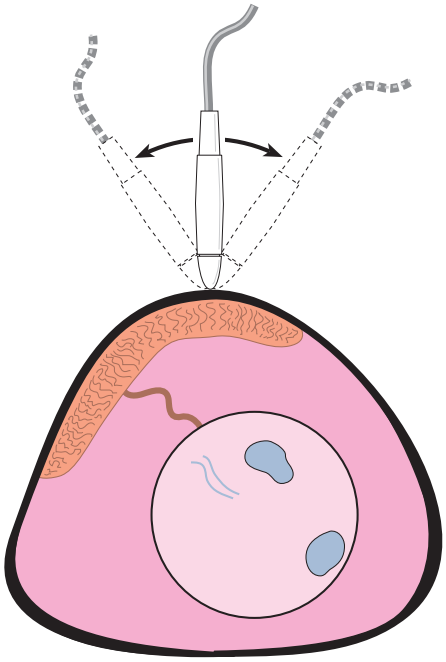


Figure 1-20. A, B *Rocking the transducer.* **C–E** *Images demonstrating the in-plane rocking motion. Reprinted with permission from Gill KA:* Abdominal Ultrasound: A Practitioner's Guide. *Philadelphia, Saunders, 2001.*

- **Tilting** or **angling** the transducer from side to side (also known as **cross-plane motion**) makes it possible to visualize other planes in the same axis. One can evaluate an entire organ by sweeping through it from side to side and from top to bottom because the sweep is perpendicular to the visualized plane (Figure 1-21).
- **Rotating** the transducer from the 12 o'clock to the 9 o'clock position while holding the transducer in the proper longitudinal plane results in an image of the transverse plane. Rotation of the transducer off of the true longitudinal or transverse plane results in an *oblique view* (Figure 1-22).
- **The compression maneuver**—gently pressing down with the transducer—may be used to displace bowel gas, compress adipose tissue, separate structures, or determine tissue response. When compression is utilized, it should be done gradually and always with consideration of the patient's comfort (Figure 1-23).

A



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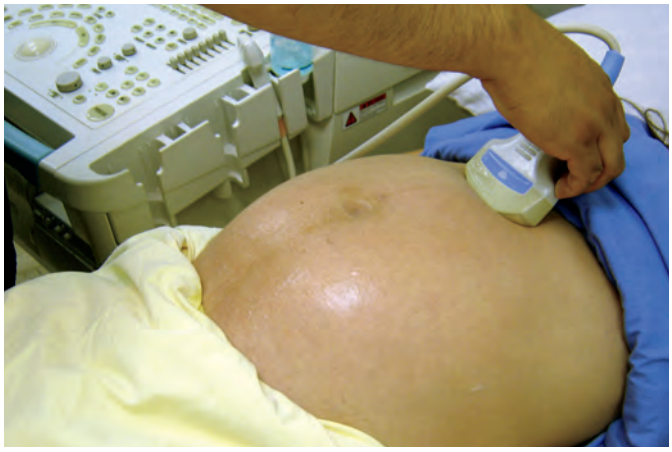
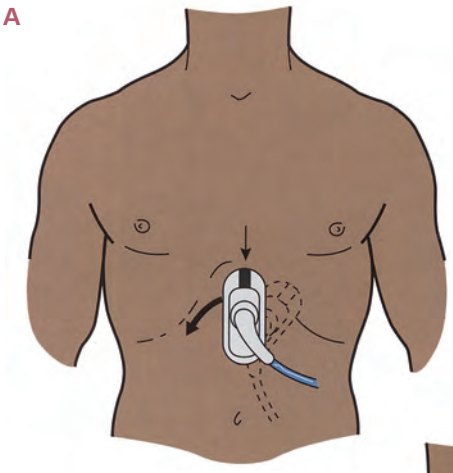


Figure 1-21. A *Tilting the transducer.* **B** *Demonstration of the transducer being tilted cross plane down toward the patient's feet.*

A



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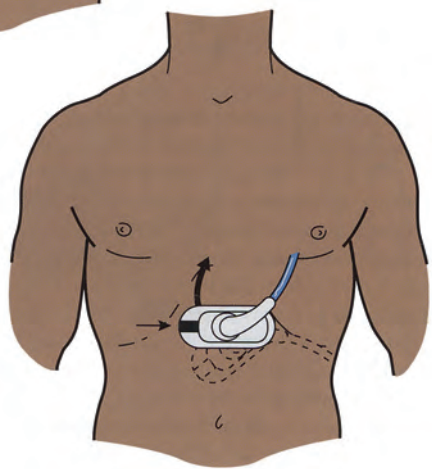

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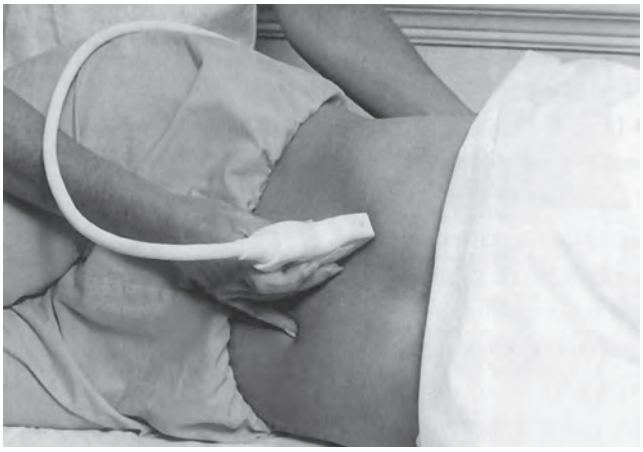


Figure 1-22. A, B *Rotating the transducer.* **C** *Image of a patient in the left lateral decubitus position with the transducer rotated counterclockwise from the longitudinal into the right costal margin. Reprinted with permission from Gill KA:* Abdominal Ultrasound: A Practitioner's Guide. *Philadelphia, Saunders, 2001.*

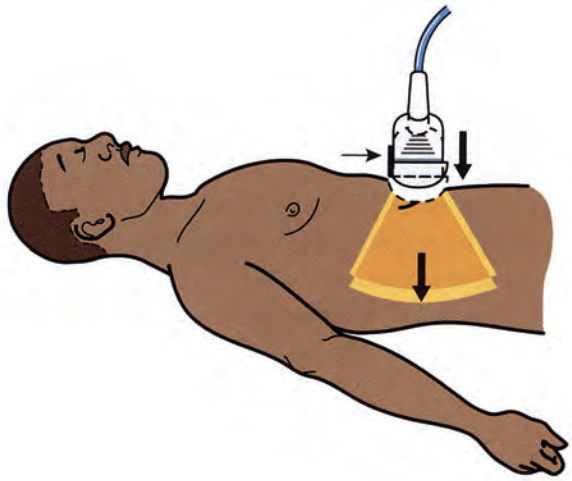


Figure 1-23. *Compression is applied by gently pushing down on the transducer and applying pressure evenly across the entire length of the transducer. Reprinted with permission from Gill KA:* Abdominal Ultrasound: A Practitioner's Guide. *Philadelphia, Saunders, 2001.*

See "Transducer Insertion and Manipulation" in the following introduction to transvaginal technique for additional techniques of probe manipulation used in transvaginal studies.

INTRODUCTION TO TRANSVAGINAL TECHNIQUE

First a note on terminology. The terms ***transvaginal*** and ***endovaginal*** are commonly used interchangeably. So too are the terms ***transabdominal*** (through the abdominal wall) and ***transvesical*** (through the urinary bladder). For instance, one might say, "A transvesical ultrasound examination is performed before an endovaginal examination in order to evaluate the entire pelvis." One might also use the equivalent statement, "A transabdominal ultrasound examination is performed before a transvaginal examination in order to evaluate the entire pelvis." Transabdominal and transvesical examinations both use the anterior approach, while the transvesical examination specifically utilizes the full urinary bladder as an **acoustic window**. Sometimes we do perform transabdominal examinations when the urinary bladder is empty. Nevertheless, it is common for ultrasound practitioners to use these terms interchangeably.

Advantages

Transvaginal sonography is an excellent complement to the transabdominal pelvic evaluation because it can provide additional information that in many cases cannot be obtained with the traditional transvesical approach. Because transvaginal sonography relies on higher-frequency transducers (5–7.5 MHz), tissue resolution is improved. The transducer is placed immediately adjacent to the pelvic structures, and therefore there is no need for great depth penetration to image through abdominal wall, fat, and bowel. Large obese patients and those with thick scarring from previous operations are no longer the challenge they once were. The endometrium and fundal region of the retroflexed uterus can be better imaged as the sound beam can be angled so that it is more perpendicular to the anatomy (Figure 1-24). Products of conception can be

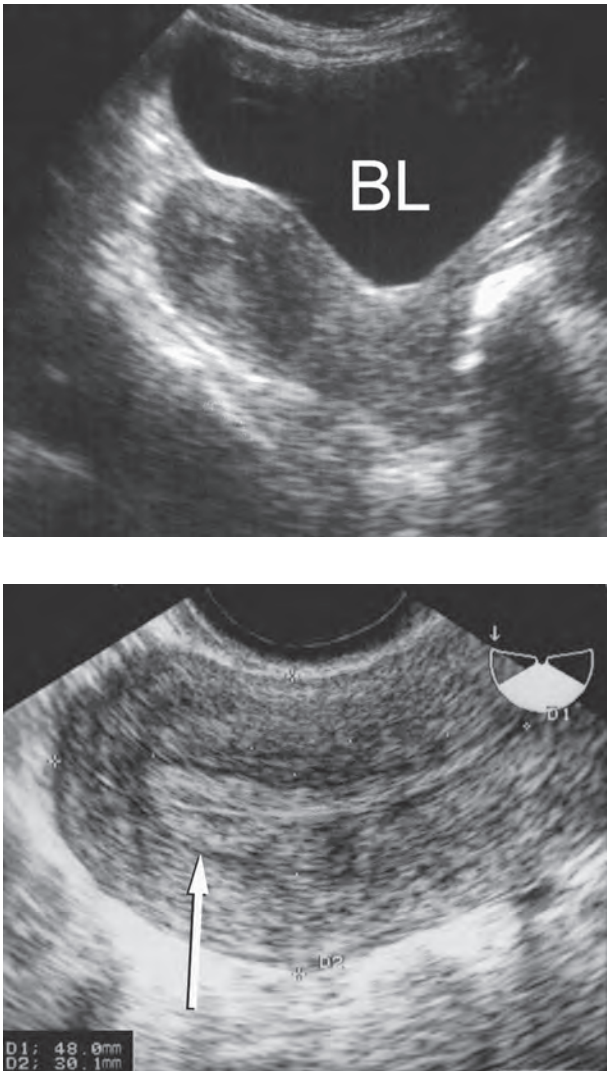


Figure 1-24. A *Transabdominal image through the uterus using the bladder (BL) as an acoustic window. The endometrial stripe cannot be well-defined.* **B** *Transvaginal image showing improved resolution of the endometrium (arrow). Following page:* **C** *Transabdominal image of the right ovary (calipers) revealing little detail of the ovarian architecture (BL = bladder).* **D** *Transvaginal technique allows for visualization of the ovarian parenchyma and individual follicles (arrows).*

imaged 1–2 weeks earlier, and there is no need for bladder filling prior to the examination. The vaginal transducer can also be used to locate areas of tenderness and to help rule out adhesions by checking for organ mobility. See Box 1-6.

Disadvantages

Although transvaginal sonography can provide valuable, additional information, it is not the recommendation of this author to use the technique solely. Due to the lack of penetration provided by higher frequencies, the depth of penetration is only about 6 cm; therefore, anatomy positioned higher in the pelvis will not be imaged. An enlarged uterus filled with fibroids cannot be adequately evaluated, nor can vaginal masses such as Gartner's duct cysts. As the bladder begins to fill, pelvic anatomy is displaced out of the field of view, and artifactual refractive shadows from the bladder edge interfere with imaging. Because the vagina limits transducer movement somewhat, the field of view is also limited. Finally, the transvaginal image gives us a more magnified view of the anatomy, and many times we are not able to appreciate surrounding structures for orientation purposes or to view a mass or structure in its entirety on one image. See Box 1-7.

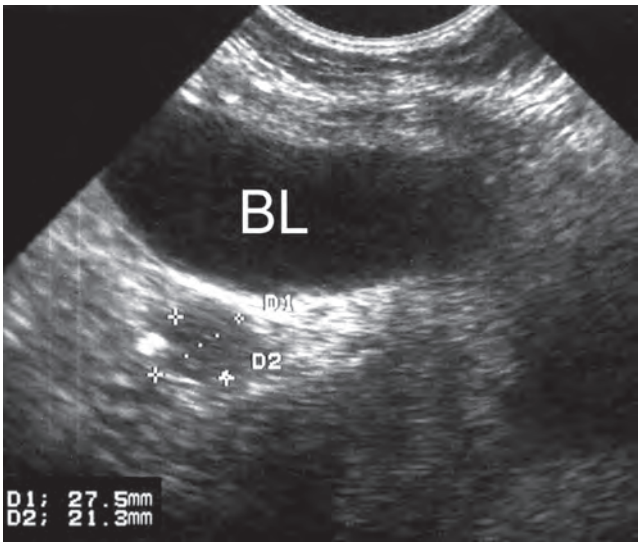
Box 1-6. Advantages of transvaginal sonography.

- Provides information that cannot be obtained transabdominally.
- Tissue resolution is improved because of the high-frequency transvaginal transducers.
- Large obese patients and those with surgical scarring are more easily imaged.
- Endometrium and fundus of a retroflexed uterus are better imaged.
- Products of conception can be imaged 1–2 weeks earlier.
- Bladder filling is not required.
- Areas of tenderness can be localized and evaluated.
- Adhesions can be ruled out by confirming organ mobility.

Box 1-7. Disadvantages of transvaginal sonography.

- Depth of penetration is only about 6 cm, so anatomy higher in the pelvis cannot be imaged.
- An enlarged, fibroid-filled uterus cannot be adequately evaluated.
- Vaginal masses (e.g., Gartner's duct cysts) cannot be adequately evaluated.
- Bladder filling can displace pelvic anatomy from the field of view and can create artifactual refractive shadows.
- Field of view is somewhat limited by the limitations of probe manipulation.
- The magnified transvaginal image can interfere with orientation and make it difficult to view a mass or structure in its entirety.

C



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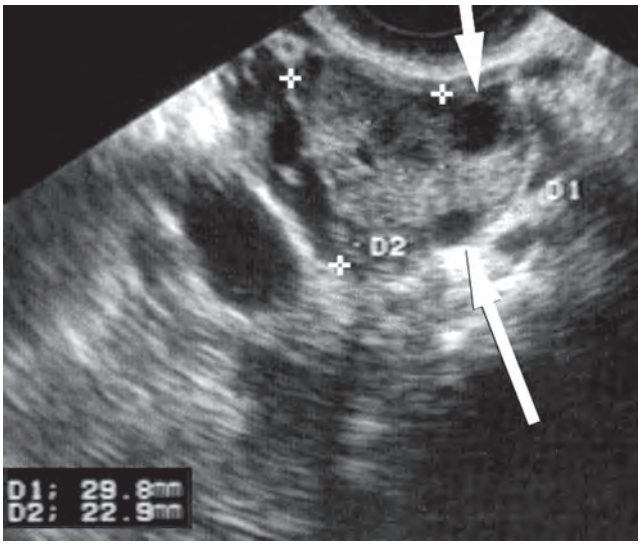

Figure 1-24, continued.

One still needs a global view of the pelvis in order to perform a thorough and complete pelvic examination. A transvaginal study without benefit of the transabdominal perspective will eventually result in missed anatomy and pathology. Limited studies performed for embryonic/fetal viability, follicular monitoring, confirmation of an **intrauterine pregnancy** (**IUP**) (any pregnancy that takes place within the womb), and the like are acceptable but should be documented as limited exams.

Contraindications

Sonographers often make judgment calls concerning images taken during an examination or the technique to be utilized. In some circumstances, transvaginal studies should not be performed, such as in virginal patients, young or old. It is imperative to inquire if the patient is or has been sexually active before performing a vaginal study. This type of questioning should be done in private, away from attending friends or relatives, since the patient may not want them to be privy to this information.

Vaginal atrophy or stenosis is not uncommon among elderly patients and may be seen in patients who have had radiation treatment as well. A transvaginal study would be quite uncomfortable for these patients and may even tear delicate membranes.

Transvaginal studies are also contraindicated in obstetric patients who present with bleeding and a dilated cervix. With cervical dilatation, the risks of introducing infection are increased, as are spontaneous abortion and premature rupture of membranes (PROM).

Others who should not be scanned transvaginally include those with cervical incompetence and a bleeding placenta previa. If the vaginal perspective is needed in these cases, translabial or transperineal scanning can be performed with the transabdominal transducer. See Box 1-8.

Box 1-8. Contraindications for transvaginal sonography.

- Virginal patients
- Vaginal atrophy or stenosis
- Obstetric patients with bleeding and dilated cervix
- Cervical incompetence
- Bleeding placenta previa

Instrumentation

As noted above, several types and formats of transducers are commercially available, including sector, linear, curved linear, and phased array. Fields of view range from 85 degree angles to 240 degrees. When evaluating equipment, bear in mind that your choice of transducer may significantly limit your ability to see well if the angle of your field of view is less than 90 degrees. Additional options available include varying the degree of angle, variable focuses, variable frequencies, and a steerable beam.

Transducer housings may have straight handles or bent ("broken") handles (Figures 1-25 A and B). Straight handles are easier to aim, but the bent handles are easier to manipulate if you do not have a gynecologic table. Both are handled similarly in the sagittal plane, but coronal viewing requires more thought with the bent handle because the transducer must be rotated 180 degrees to view the opposite sides of the pelvis. Coronal viewing with the straight handle is accomplished by simply rotating counterclockwise 90 degrees toward you as you would for transverse imaging transabdominally.

Patient Preparation

The vaginal study is a very intimate examination and patients may be somewhat reluctant at first. It is important to take the time to explain the procedure in detail and to answer any questions she may have. Let her know that additional information can be obtained transvaginally, and reassure her that the transducer will be inserted only an inch or two. It might be helpful to use a comparison, such as how far one inserts a tampon or suppository. Additionally, explain that the procedure should not be uncomfortable but, if it becomes so, she should let you know. Once she agrees to have the examination performed, she should be instructed to empty her bladder completely and disrobe from the waist down.

Transducer Preparation

Some recommend preparing the transducer in front of the patient so they can see that the transducer is cleansed, disinfected, and protected by a sheath. Nevertheless, many practitioners prefer to do this while the patient is dressing to save valuable time. The transducer should be cleansed well between patients. Guidelines for cleaning and preparing endocavitary ultrasound transducers published by the American Institute of Ultrasound in Medicine appear in Appendix B.

Once the transducer is cleaned a small dollop of gel is applied to the tip. It is then covered by a protective sheath. If the patient has a known infection, it may be an indication to double sheath the probe. One may choose to use condoms, surgical gloves, or commercially available probe covers. Condoms have been shown to have fewer leakage problems than some commercial probe covers (see Appendix B). Another consideration in choosing probe covers is whether they contain latex or not. Latex allergies are not uncommon, and symptoms can vary from mild welting to severe systemic anaphylaxis. It has been reported that 18%–40% of spina bifida patients are latex-sensitive. Patients should be questioned about latex sensitivity. Ask them if they have ever experienced a rash, itching, or wheezing after inflating a toy balloon or wearing latex gloves. Latex sensitivities should be reported, and patients should be advised on how to inform others of their allergy. Gloves that are labeled "hypoallergenic" may not always prevent adverse reactions.

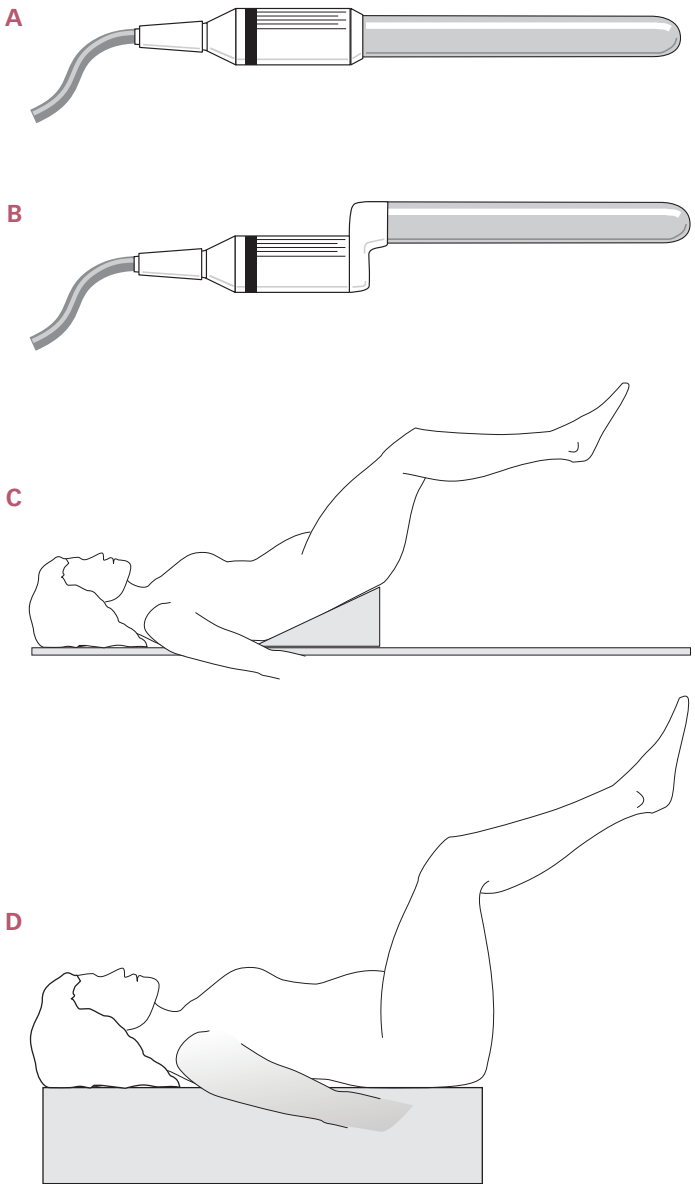

Figure 1-25. A, B *The architecture of the straight and bent-handle endovaginal transducers.* **C** *A wedge sponge elevating the patient's hips but not the upper body.* **D** *Elevation of upper and lower body. (Figure continues . . .)*

Patient Positioning

The patient is positioned on the exam table in the supine lithotomy position. Make sure that she is properly draped and that she is not unnecessarily exposed. A chaperone policy needs to be established when male sonographers are responsible for performing transvaginal studies.

Ideally, a gynecologic table with stirrups and a break-away feature allows for easy performance of the vaginal exam. If such a table is not available, elevate the patient's hips so that the transducer can be manipulated properly for adequate visualization of the uterus and ovaries. This can be accomplished by using sponges or a stack of sheets placed under the hips. Care should be taken to elevate the upper body as well so any free fluid in the pelvis will remain in the pelvis (Figures 1-25 C and D).

Transducer Insertion and Manipulation

The sheathed transducer can be inserted by the sonographer or the patient. Lubricate the end of the transducer with KY jelly or other coupling agent (about 5 cc) for easy insertion. Beware, however, that KY jelly can be spermicidal and should not be used during a fertility-assisted procedure such as ovarian follicular monitoring or artificial insemination. These studies are usually performed during mid-cycle, when the cervical mucus is sufficient for comfortable insertion of the transducer.

Once the transducer is inserted, there are four scanning motions that will be employed. They are angling/tilting, push/pull, rotating, and anterior abdominal pressure (Figures 1-25 E–G). **Angling/tilting** is performed from side to side and up and down in a sweeping motion. **Rotating** the transducer allows you to go from the sagittal to the coronal plane. The transducer should always be rotated in counterclockwise direction so that the orientation of the right and left side of the patient remains consistent. Because you cannot image the entire uterus in one picture, the transducer will have to be pushed in deep for imaging the uterine fundus and must be pulled out slowly for imaging the cervix. Sometimes, anatomy is superiorly located or

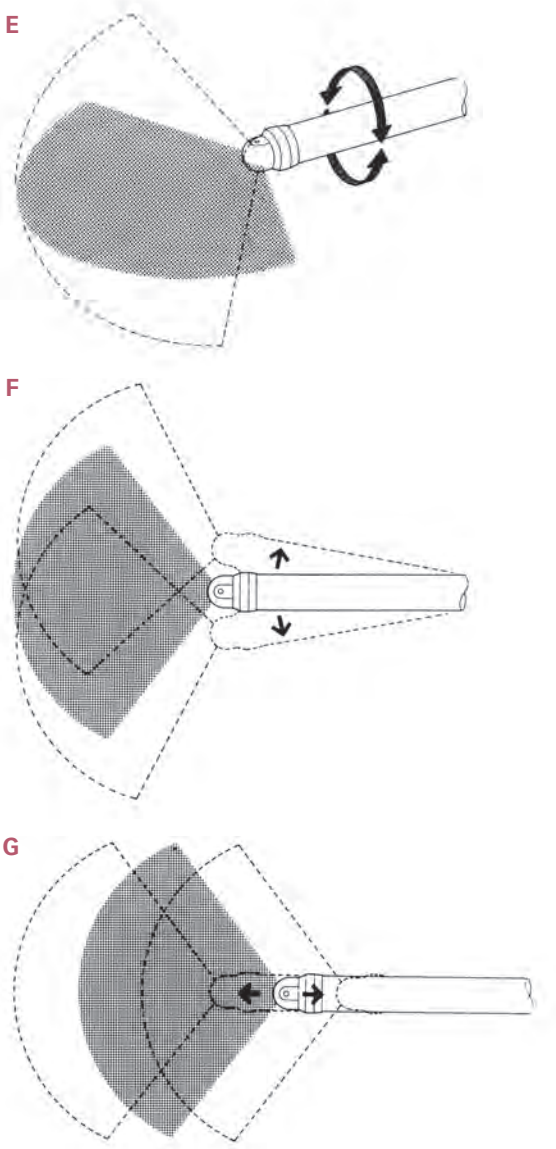

Figure 1-25, continued. E–G *Scanning motions used with transvaginal technique. Reprinted with permission of the Department of Obstetrics and Gynecology, New York University Medical Center.*

just beyond the field of view. In these cases, pressing on the anterior abdomen may help reposition the structure of interest closer to the transducer for better visualization.

Image Orientation

The most difficult part of transvaginal scanning is understanding the image orientation. Organ shapes, echogenicities, and pathologies are the same transvaginally as they are transabdominally. This is true for measurements as well. Other than initial disorientation, nothing about sonographic characteristics is changed. Once you understand how we are looking at the anatomy, image orientation will make sense.

Let's start with what we are most comfortable with, the transabdominal view. Using the full urinary bladder as a window, the practitioner places the transducer on the anterior abdomen and the **long-axis** or longitudinal view of the uterus is demonstrated (Figure 1-26A). A full-bladder technique is required for transabdominal scanning. The filled urinary bladder serves as an acoustic window through which the sound beam can be transmitted. It also displaces the uterus so it lies more perpendicularly to the scan plane, and it helps move the air-filled bowel out of the field of view (Figure 1-26B). Finally, the urinary bladder can serve as an internal cystic reference. (Because vaginal studies are performed with an empty urinary bladder, the patient is instructed to void completely [Figure 1-26C].)

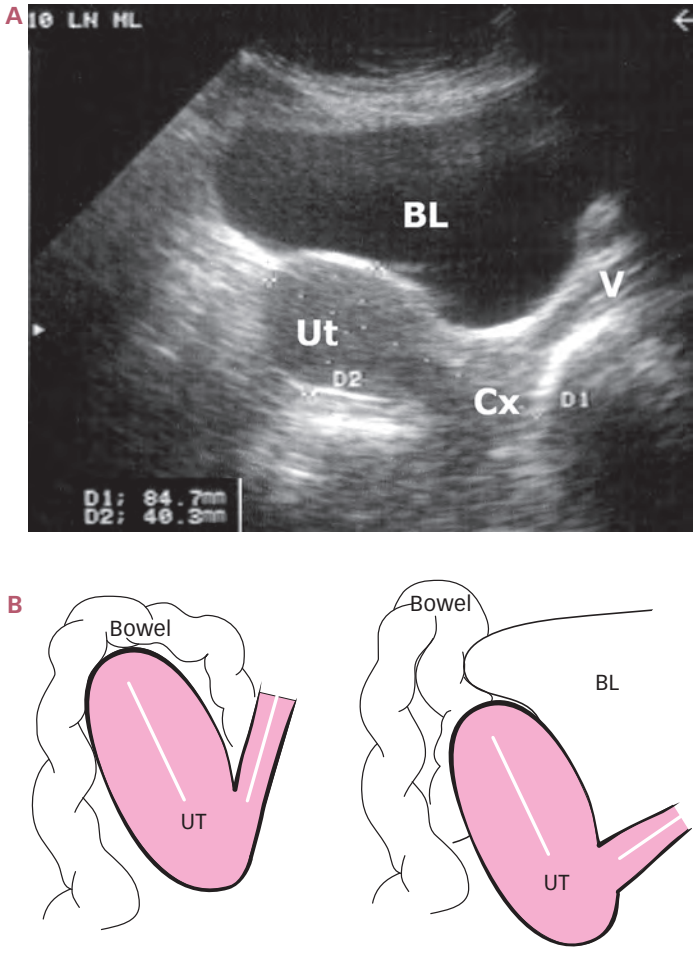

Figure 1-26. A *Longitudinal image of the uterus performed transabdominally through the filled urinary bladder. BL = bladder, Ut = uterus, Cx = cervix, V = vagina.* **B** *Drawing demonstrating how the full bladder affects the pelvic anatomy. UT = uterus, BL = bladder. Following page:* **C** *Transabdominal image through the longitudinal uterus after bladder has been emptied. Bladder residual (arrow). Ut = uterus, Cx = cervix, V = vagina.* **D** *Same Image as C rotated 90 degrees counterclockwise.*

Now rotate this transabdominal image counterclockwise 90 degrees to see the image as if it were performed transvaginally (Figure 1-26D). In the sagittal plane, the bladder will appear in the upper left corner of the image, while the cervix will be seen in the upper right corner (Figure 1-27). As you look at the image, the patient's head would be at the bottom of the image and her feet toward the top of the image. Her anterior abdomen would be toward the left side of the image and her posterior aspect toward the right. We are viewing her anatomy as if she were standing on her head facing the left side of the screen (Figure 1-28). When viewing an **anteflexed**

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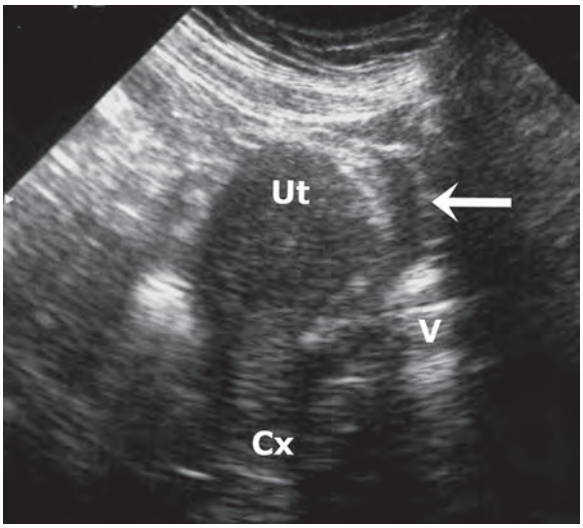

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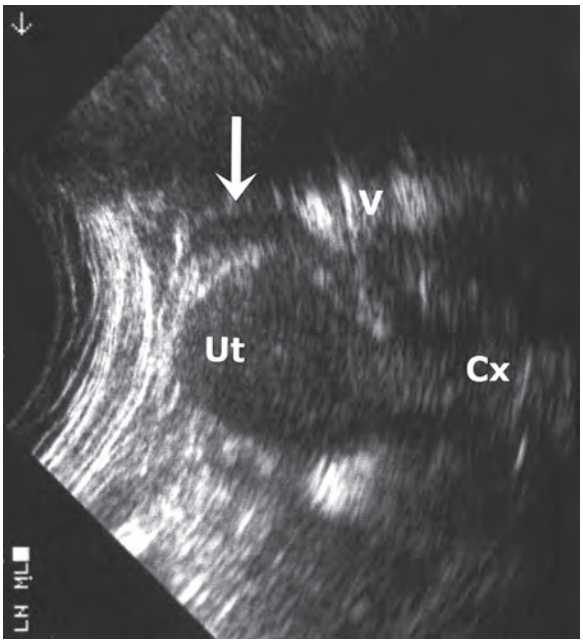

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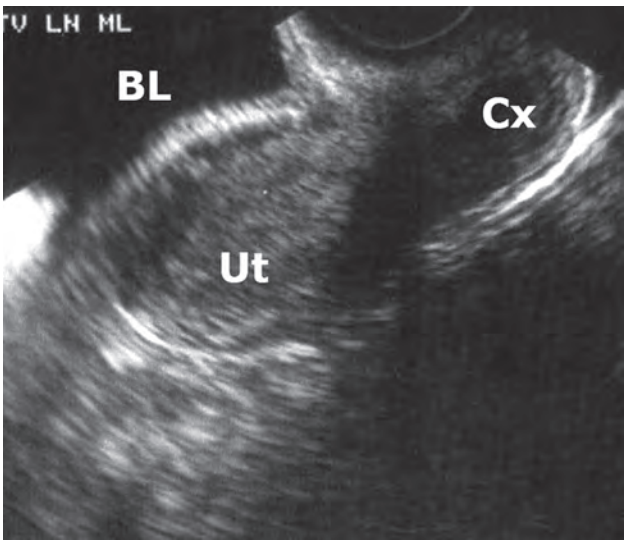

Figure 1-27. *Transvaginal image through the uterus in the longitudinal plane. BL = bladder, Ut = uterus, Cx = cervix.*

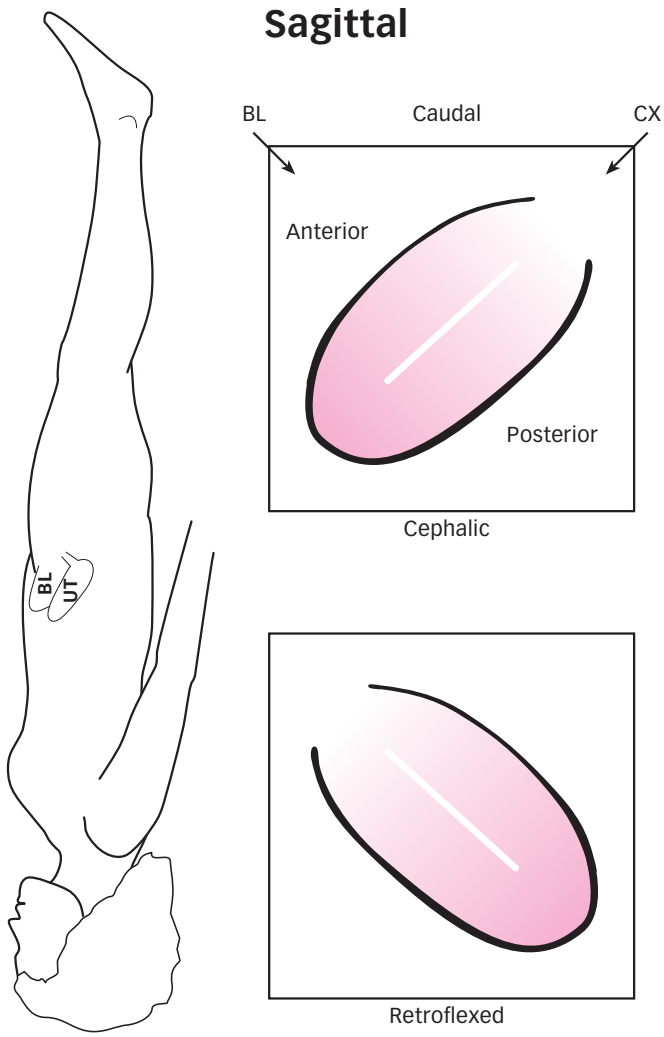

Figure 1-28. *How we view the pelvic anatomy (longitudinally) transvaginally.*

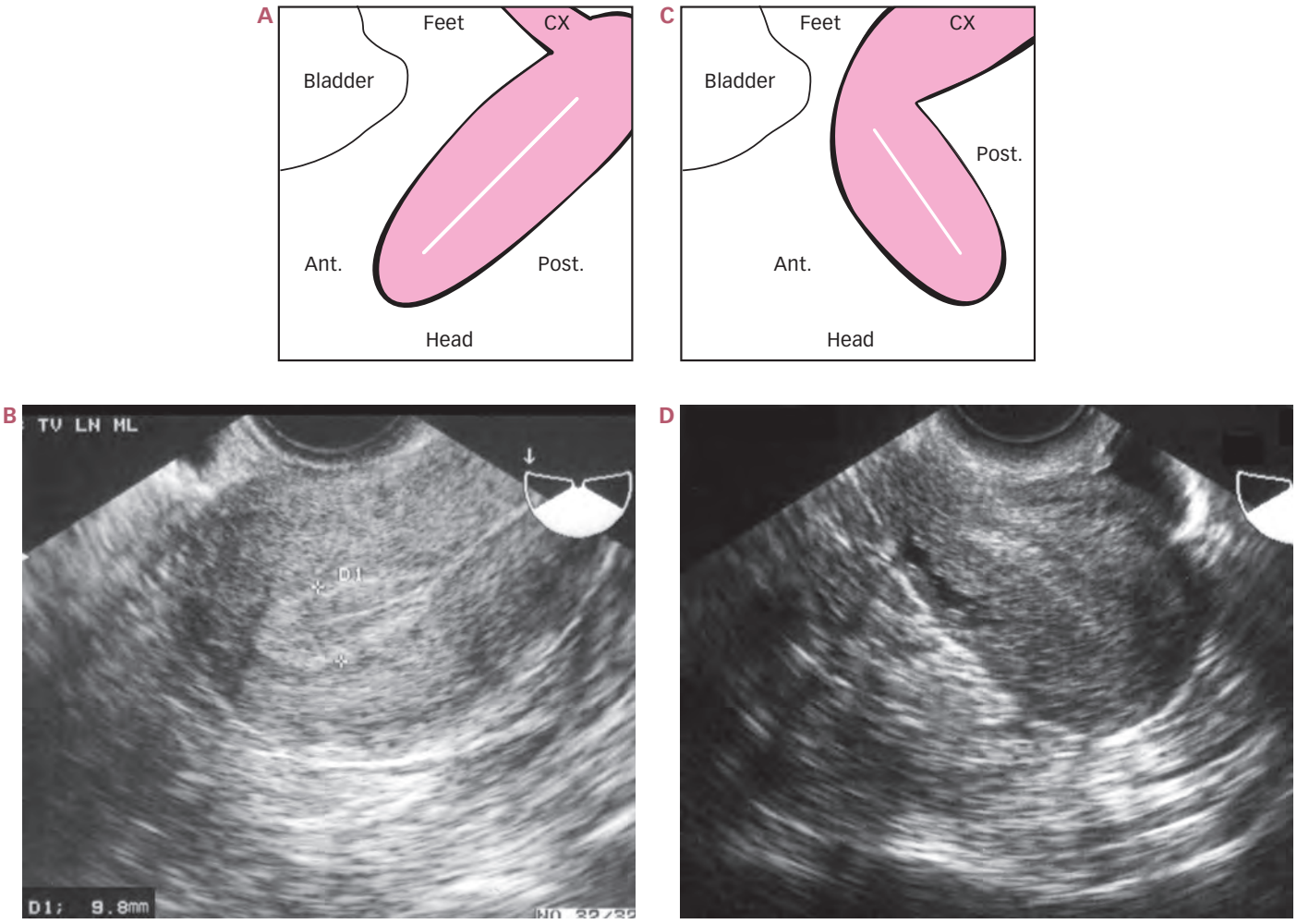

Figure 1-29. A *The longitudinal anteflexed uterus viewed transvaginally.* **B** *Transvaginal image of an anteflexed uterus in the longitudinal plane.* **C** *The longitudinal retroflexed uterus viewed transvaginally.* **D** *Transvaginal image of a retroflexed uterus in the longitudinal plane.*

uterus, the endometrial stripe points toward the left lower corner of the image (Figures 1-29 A and B). If the uterus is **retroflexed**, the endometrial stripe points in the opposite direction, toward the right lower corner of the image (Figures 1-29 C and D).

Coronal imaging maintains the standard right/left orientation used in transabdominal scanning. The only thing different is that the patient's caudal end is toward the top of the image and her cephalic end is at the bottom. We are viewing her as if she were standing on her head with her back side facing us (Figure 1-30).

Pitfalls

The bowel can still be a problem when performing transvaginal studies, especially if the patient has forced fluids in order to fill her bladder for the transabdominal study. Still, active peristalsis should be apparent. Avoid imaging bowel patterns unless, of course, one sees bowel-related pathology. Static images of bowel can be mistaken for complex adnexal pathology (Figure 1-31).

Engorged pelvic vasculature can be mistaken for dilated fallopian tubes or appear as follicles in an ovary when scanned transversely (Figure 1-32). If one's imaging equipment has color Doppler capability, applying color will provide the answer. Dilated veins caused by pelvic congestion can be identified by slightly increasing the overall gain and watching for the swirling motion of the blood flow within the vessel. This is a helpful technique if color Doppler is not available. Arcuate vessels of the uterus are easily seen with transvaginal technique and should not be mistaken for myometrial cysts (Figure 1-33).

Free pelvic fluid is a common transvaginal finding, especially if a patient is in the middle of her menstrual cycle. One almost always sees a little free fluid in patients during

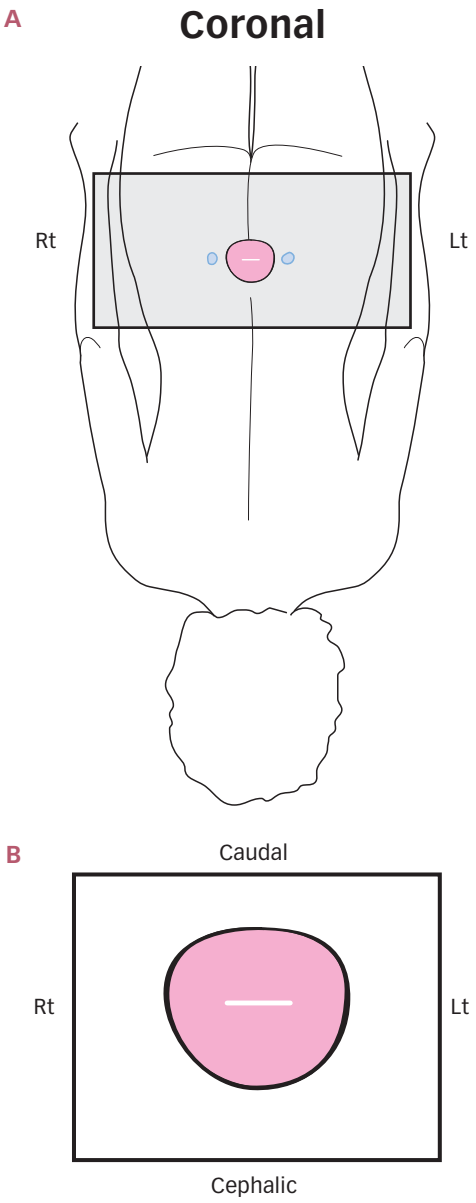

Figure 1-30. A, B *How we view the pelvic anatomy (coronal) transvaginally.* **C** *Coronal transvaginal image through the uterus.*

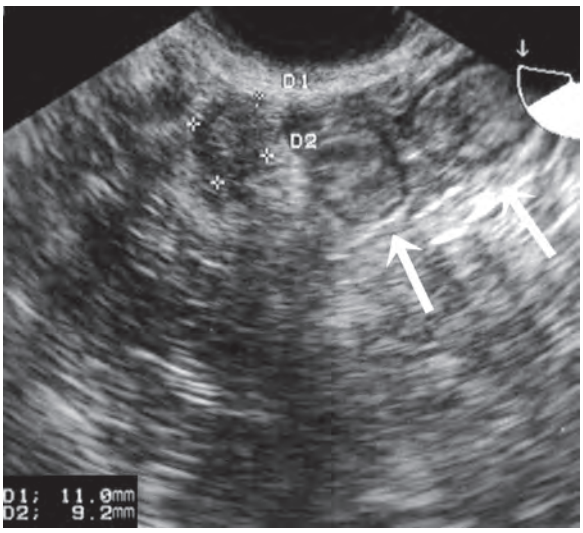

Figure 1-31. *Transvaginal image showing fecal-filled bowel (arrows). A small postmenopausal ovary is being measured between the calipers.*

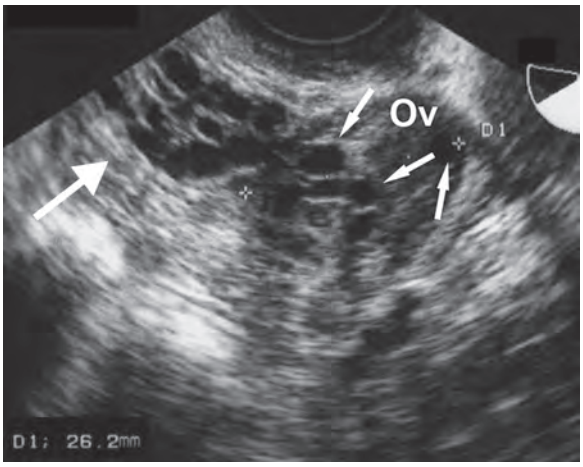

Figure 1-32. *Transvaginal image of a follicle-containing ovary (small arrows) with engorged vessels (large arrow) adjacent to it. Ov = ovary.*

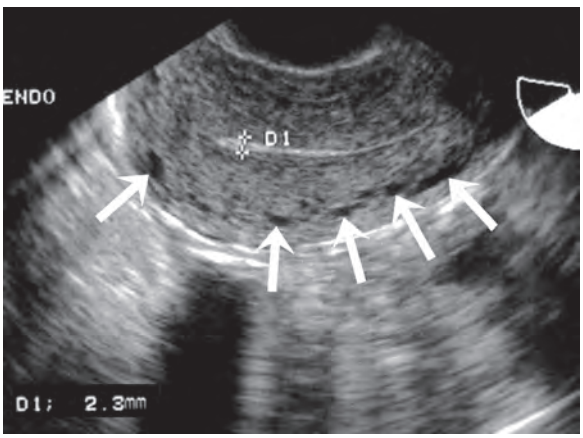

Figure 1-33. *Longitudinal transvaginal image of the uterus showing prominent arcuate vessels (arrows). The endometrium is being measured (calipers).*

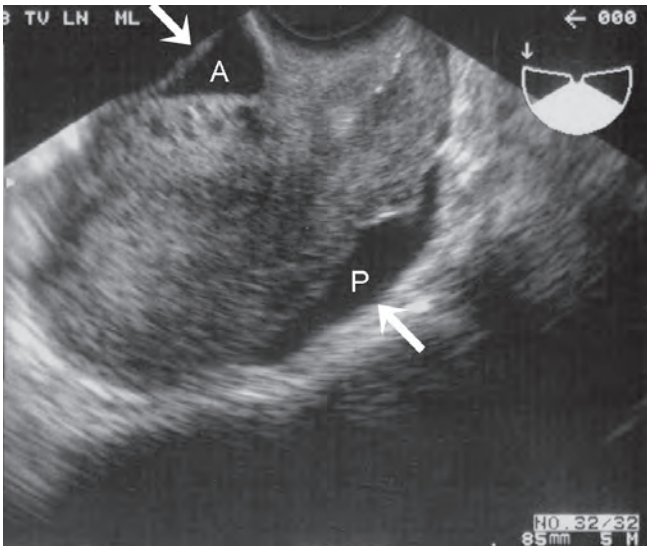

Figure 1-34. *Longitudinal transvaginal image showing free fluid (arrows) in the anterior and posterior cul-de-sacs. A = anterior, P = posterior.*

their reproductive years; it should not be mistaken for pathologic fluid. Moderate free fluid from a ruptured cyst or bleeding will appear, transvaginally, to be quite obvious (Figure 1-34).

STARTING OUT

Now you are ready to begin scanning. Practice makes perfect, and your technique and scan speed will improve over time. In the beginning stages, scan slowly so that you have time to recognize the anatomy as it appears on the display, and how the sonographic image interrelates with the actual anatomy as it is being insonated. If you have to change your transducer position, you should utilize one motion at a time. For example, you should not rock and tilt at the same time. During the learning process, you have to be able to see which motion gives you the desired effects. So tilt or angle first, and then rock to center. Another rule of thumb is to get your patient to help you whenever possible. Give the patient instructions such as changing her position on the table or emptying her bladder. Consider your patient at all times, and tell her to inform you if anything you do becomes uncomfortable.

Establish an exam system and follow it with each and every patient you examine. Following a specific protocol guarantees that each patient receives a complete and thorough examination. Additional images and views may be necessary when pathology or variants are observed. The additional information collected allows for tailoring exams to each patient's needs. Scanning guidelines recommended by the American Institute of Ultrasound in Medicine can be found in Appendix B. These guidelines provide an excellent basis for establishing your own scanning protocols. Moreover, adherence to the AIUM guidelines represents a minimum standard of care.

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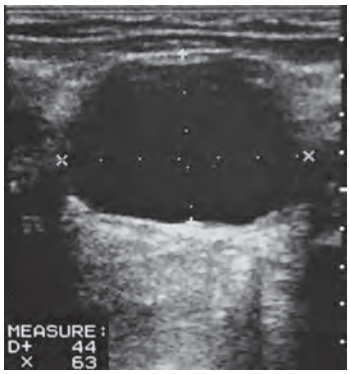
SELF-ASSESSMENT EXERCISES

Questions

1. What type of transducer produced this image of an ovarian cyst?



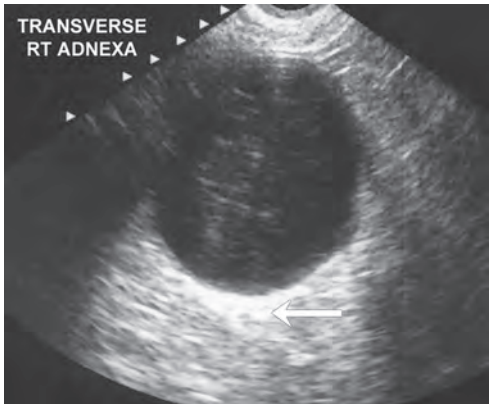
A. Sector
B. Linear
C. Curved linear
D. Phased array
E. Mechanical

2. Which of the following statements about diagnostic ultrasound imaging is correct?
   A. Sonography is an excellent method for imaging the bowel.
   B. Diagnostic ultrasound can differentiate benign from malignant tissue.
   C. Ultrasound imaging can determine organ function and size.
   D. A cystic mass can be readily identified with sonography.
   E. Contrast agents must be used to image soft tissues.

3. Of the following, which is not a criterion for diagnosing a simple cyst?
   A. Well-defined outline
   B. No internal echoes
   C. Poor through-transmission
   D. Refractive edge shadows
   E. Posterior enhancement

4. Why do blood-filled masses show less posterior enhancement than those containing pus?
   A. Red blood cells refract sound.
   B. Blood is thicker than pus.
   C. Blood contains protein and absorbs more sound.
   D. A and B
   E. A and C

5. Which of the following best describes this mass?



A. Cystic
B. Solid
C. Complex cystic
D. Complex solid
E. Homogeneous

6. In the image from question 5, to what is the arrow pointing?
   A. Reverberation echoes
   B. Posterior enhancement
   C. Refractive shadowing
   D. Slice-thickness artifact
   E. Ring-down artifact

CHAPTER

5

The Placenta and Umbilical Cord

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OBJECTIVES

After completing this chapter you should be able to:

1. Describe placental circulation and hemodynamics as they relate to the mother and fetus.
2. List and define the placental variants and explain how they might adversely affect the pregnancy.
3. Identify the sonographic characteristics of placental aging and explain the grading system.
4. Discuss the pitfalls of diagnosing placenta previa.
5. Explain how cord length can affect the fetus and outcome of pregnancy.

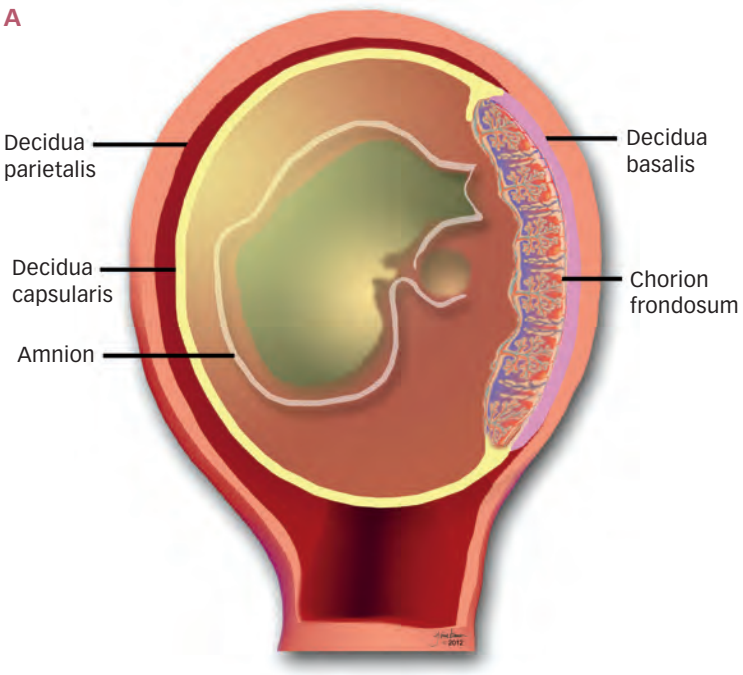
THROUGHOUT HISTORY MAN HAS BEEN CURIOUS about the placenta and has believed its value included supernatural and medicinal properties. In 3400 BC, Egyptians thought the placenta represented the eternal soul, and the Chinese are just one of many cultures believing that ingestion of placenta can cure ailments such as delirium, weakness, loss of willpower, and pinkeye. Even today's alternative medicine options promote this practice. Several websites offer recipes for preparing placenta, including placenta lasagna, pizza, stew, and pâté.

The placenta plays a critical role in the growth, development, and maturation of a normal, healthy pregnancy, and sonography plays an important role in evaluating the placenta. As part of a comprehensive sonographic examination of a second or third trimester pregnancy, the placenta should be evaluated for the following:

1. Size and shape
2. Number
3. Texture
4. Location relative to the internal cervical os

EARLY PLACENTAL DEVELOPMENT

The endometrium responds to hormone stimulation in preparation for receiving a fertilized egg. Upon ovulation, the corpus luteum produces progesterone, which induces the secretory changes in the endometrium. **Decidua**—the term for the uterine lining following conception—is the functional layer of the endometrium that "falls away" after delivery. Changes in the endometrium may be seen in both intrauterine and ectopic pregnancies.



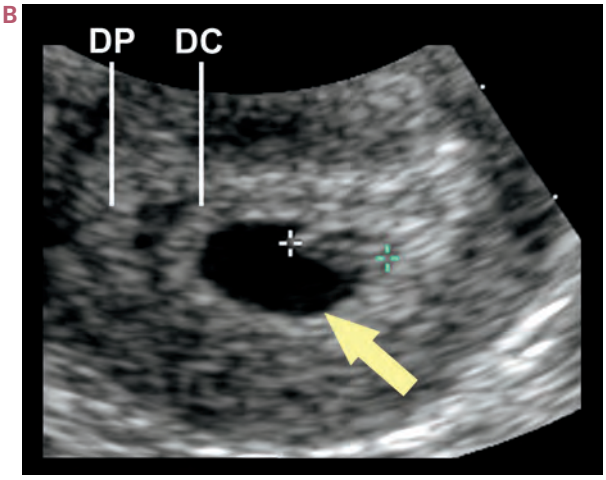


Figure 5-1. A *Parts of the decidual lining of the endometrial cavity and fetal membranes.* **B** *Early intrauterine gestational sac demonstrating the deciduas and double decidual ring. The arrow is pointing to the intrauterine gestational sac. DC = decidua capsularis, DP = decidua parietalis.*

The site where the blastocyst implants in the endometrium is called the **decidua basalis**, which ultimately develops into the maternal portion of the placenta. The layer of decidua that is stretched out into the uterine cavity and closes over and surrounds the blastocyst and chorionic sac is called the **decidua capsularis**. An avascular area of the decidua capsularis develops into the **smooth chorion**, or chorionic membrane. As the pregnancy grows, the chorionic membrane surrounds the nonplacental portion of the uterine cavity and fuses with the amniotic membrane. The decidua lining the remaining part of the uterine cavity is called the **decidua parietalis**, or **decidua vera** (Figure 5-1).

At the site of implantation, chorionic villi surround the entire gestational sac. The **syncytiotrophoblast** erodes endometrial tissues (capillaries, glands, and connective tissue), allowing maternal blood to seep out and surround implanted villi, establishing a primitive uteroplacental circulation. This bushy part of the chorion that interweaves with the decidua basalis is the **chorion frondosum**, or **villous chorion** or **chorionic villus** (Figure 5-2A). Sonographically, the chorion frondosum appears as a thickened, echogenic area adjacent to the gestational sac at the site of implantation (Figure 5-2B). As the decidua capsularis balloons out into the uterine cavity, it comes to lie directly adjacent to the decidua parietalis. This **apposition** of the two layers of decidua gives rise to the **double decidual sac sign**—a useful and accurate sonographic finding for identifying a normal intrauterine gestation and excluding ectopic pregnancies (Figures 5-2 C and D).

The smooth chorion arises from the decidua capsularis. Each blastocyst develops one chorion. As the uterine lining is stretched out into the uterine cavity, the decidua capsularis loses its vascularity and becomes greatly thinned and attenuated. It eventually contacts and fuses with the decidua parietalis, obliterating the uterine cavity. The cellular decidual components degenerate and eventually disappear, leaving only the membrane-like chorion. Occasionally, the chorion does not fuse completely with the decidua parietalis, leaving small, focal detached areas that fill with blood. These structures, called **subchorionic hematomas**, are frequently imaged sonographically during the first trimester (Figure 5-3A). The chorion is divided into the ***smooth chorion*** and the ***villous chorion***. The villous chorion forms the fetal portions of the placenta. The portion of the chorionic wall related to the placenta is called the **chorionic plate** (Figure 5-3B). It typically contains the chorionic vascular structures that can be seen on the fetal surface of the placenta.

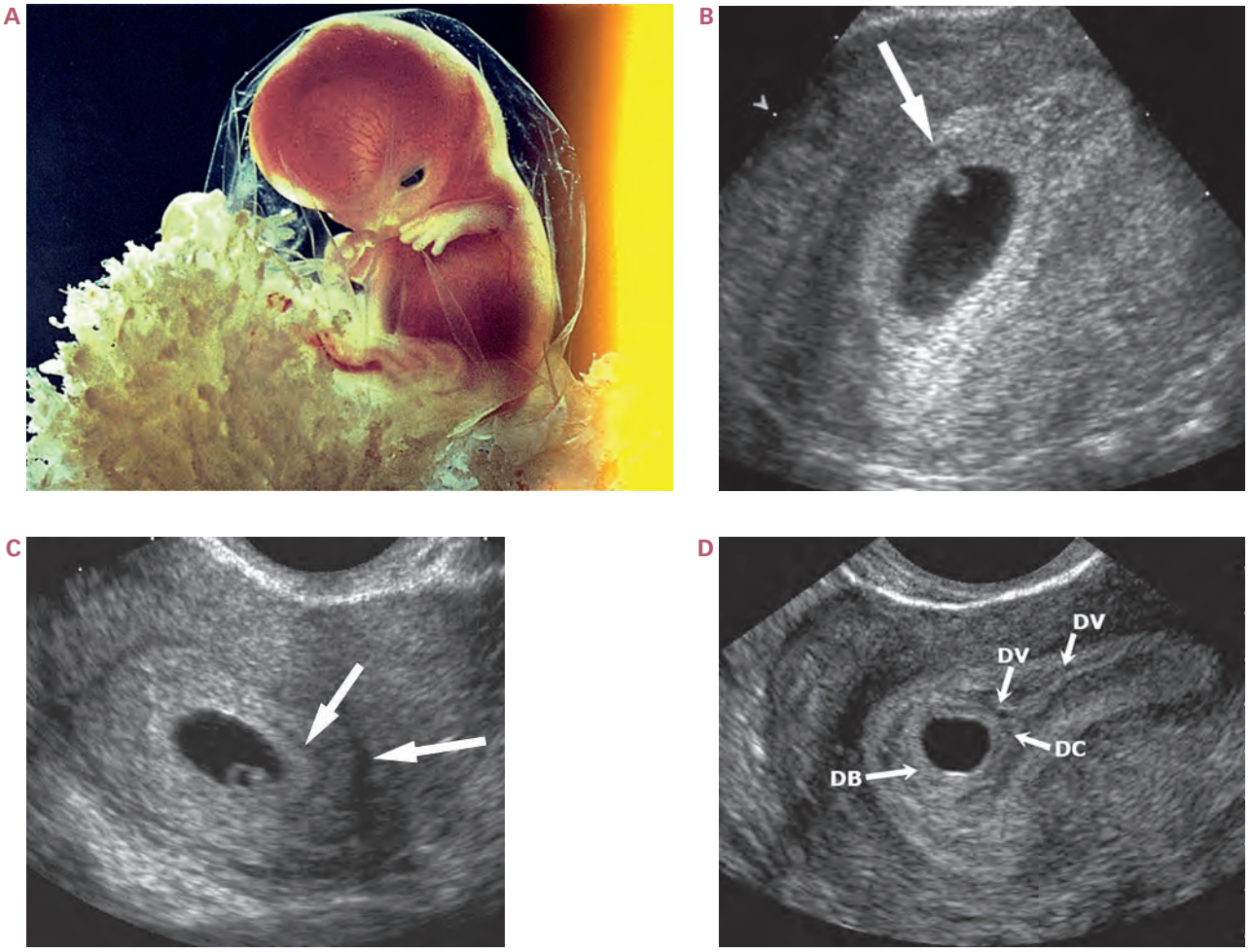


Figure 5-2. A *Chorionic villus.* **B** *Arrow shows thickened ridge of chorion where the early placenta is developing.* **C** *Double sac sign (arrows).* **D** *Longitudinal image of an early intrauterine gestational sac. DB = decidua basalis, DC = decidua capsularis, DV = decidua vera.*

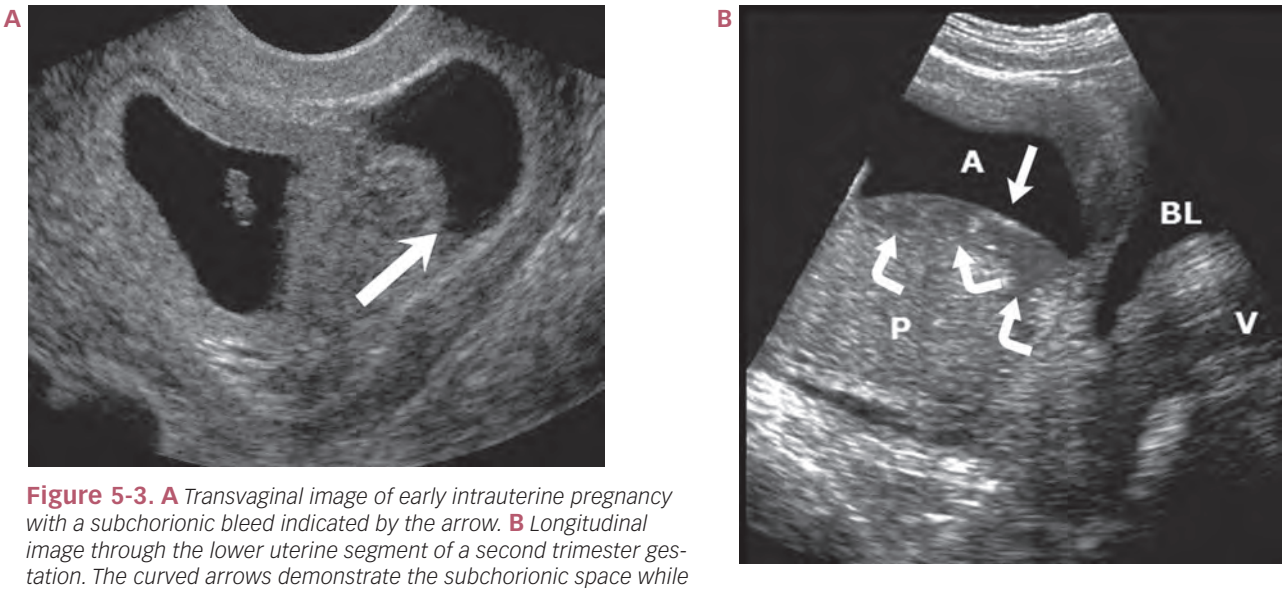


Figure 5-3. A *Transvaginal image of early intrauterine pregnancy with a subchorionic bleed indicated by the arrow.* **B** *Longitudinal image through the lower uterine segment of a second trimester gestation. The curved arrows demonstrate the subchorionic space while the straight arrow shows the chorionic plate. BL = maternal bladder, A = amniotic fluid, P = placenta, V = vagina.*

AMNIOTIC BANDS AND SHEETS

Usually by 12 weeks but certainly by 16 weeks, the chorion and amnion fuse (Figure 5-4). Episodes of bleeding during pregnancy or invasive procedures such as amniocentesis may force the amnion and chorion apart (chorio-amnio separation; Figure 5-5). If rupture occurs, the result is **amniotic band syndrome**. **Amniotic**

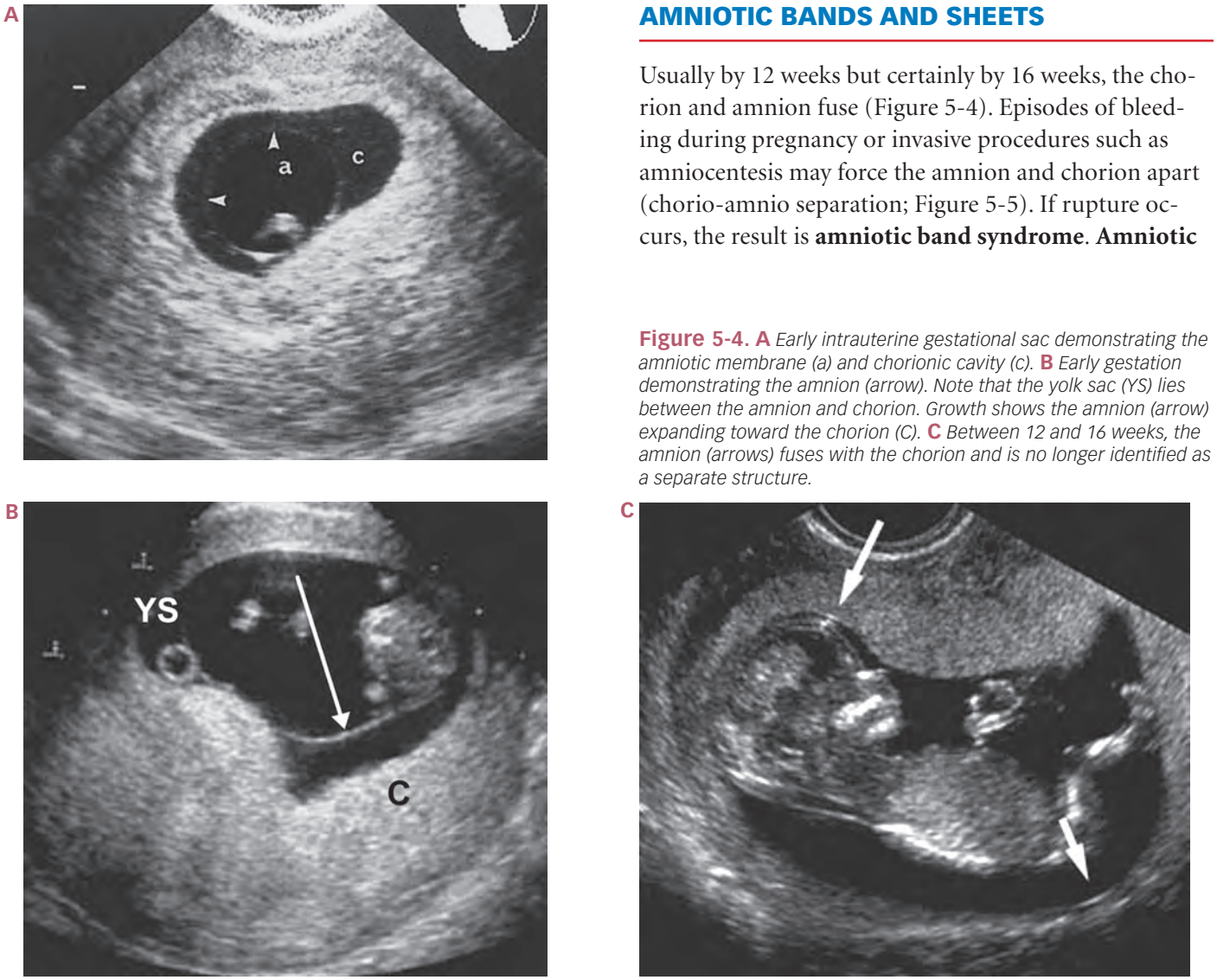


Figure 5-4. A *Early intrauterine gestational sac demonstrating the amniotic membrane (a) and chorionic cavity (c).* **B** *Early gestation demonstrating the amnion (arrow). Note that the yolk sac (YS) lies between the amnion and chorion. Growth shows the amnion (arrow) expanding toward the chorion (C).* **C** *Between 12 and 16 weeks, the amnion (arrows) fuses with the chorion and is no longer identified as a separate structure.*

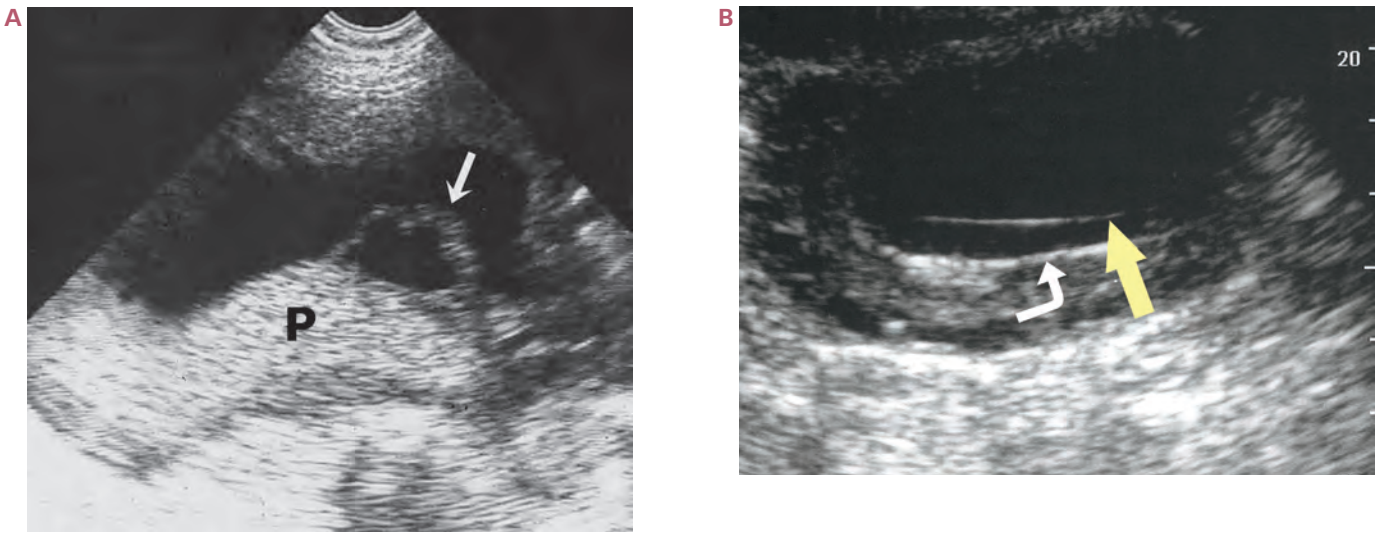


Figure 5-5. A *Membrane (arrow) seen anterior to placenta (P) represents separation of the amnion from the chorion.* **B** *Bleeding during pregnancy can force the amnion (arrow) and chorion (curved arrow) to separate, resulting in an amniotic band.*

bands are thin strands of tissue that can attach to and wrap around fetal parts, causing constrictures, deformities such as clefts, and amputations (Figure 5-6).

Amniotic sheets are thought to relate to folds of amnion and chorion across a uterine synechia (Figure 5-7A). They look different from amniotic bands because they are thicker and have a free edge that is often globular. Unlike amniotic bands, amniotic sheets are considered benign (Figures 5-7 B and C). Nevertheless, care should still be taken to confirm that fetal movement is not restricted.

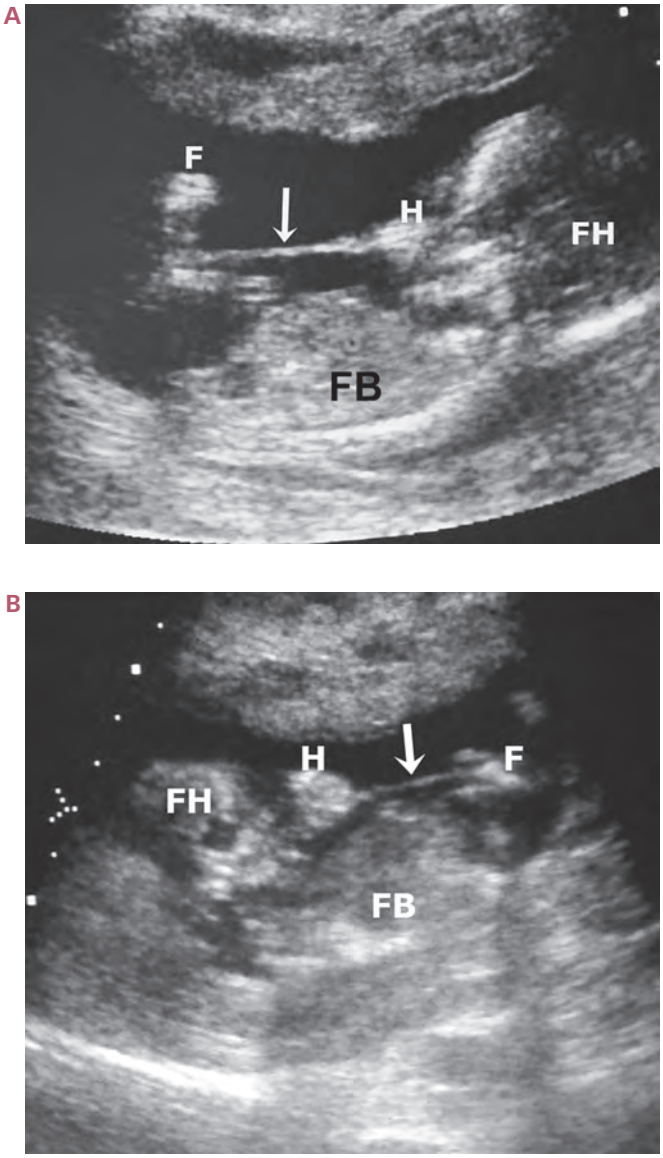


Figure 5-6. A *and* **B** *The amniotic band (arrow) can attach to fetal parts and cause structural anomalies and restrict fetal movement. FH = fetal head, FB = fetal body, F = foot, H = hand.*

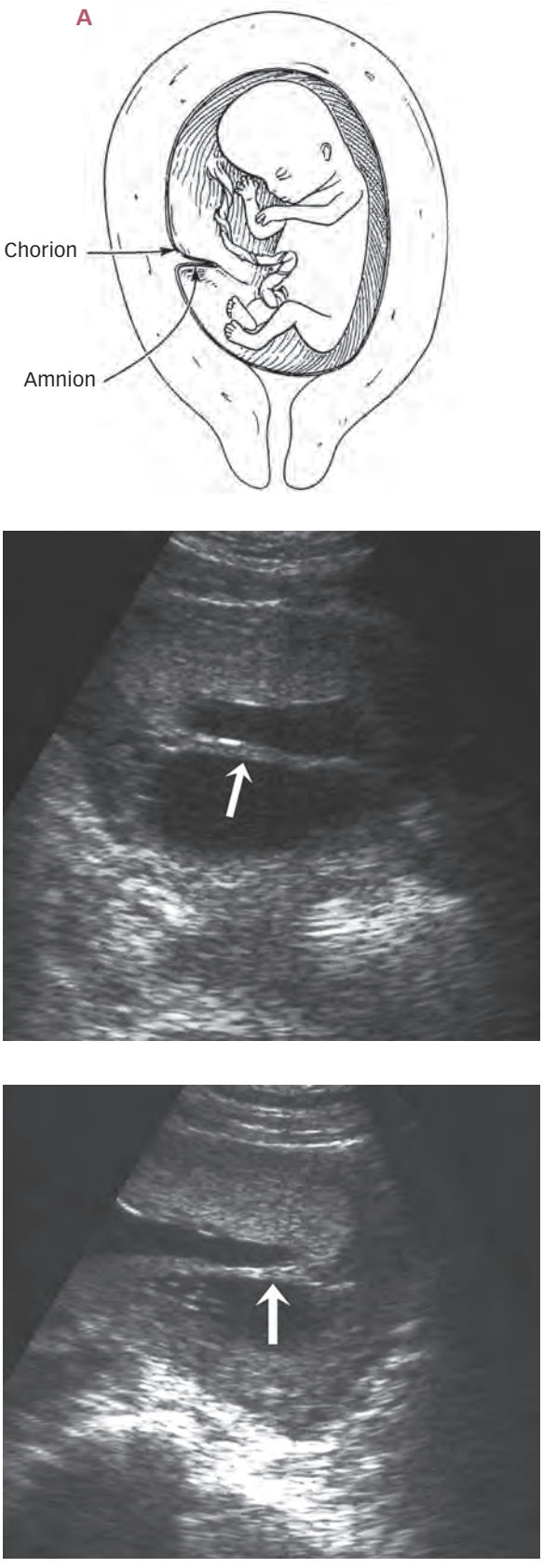


Figure 5-7. A *Amniotic sheets are thought to be amnion and chorion folded over a uterine synechia. Reprinted with permission from Nelson LH:* Ultrasonography of the Placenta—A Review. *Laurel, MD, AIUM, 1994, p 42.* **B** *and* **C** *Thick strands represent amniotic sheets (arrow) resulting from scarring of the uterine cavity.*

PLACENTAL ANATOMY AND PHYSIOLOGY

The placenta is a highly vascular, discoid organ critical to the developing fetus (Figure 5-8A). It possesses three main functions (Box 5-1):

1. It metabolizes substances that serve as sources of nutrients and energy for the embryo/fetus.
2. It transports gases, nutrients, hormones, electrolytes, antibodies, and waste products to and from the fetus.
3. It secretes endocrine proteins such as human chorionic gonadotropin (hCG) and **human chorionic somatomammotropin** (**hCS**), both of which are essential for the maintenance and growth of the pregnancy.

The placenta can lose as much as 30% of its surface area and still maintain adequate function.

Box 5-1. Placental functions.

Nutrients to fetus*
Exchange of gases*
Hormones
Antibodies
Waste excretion*

*Three main functions of the placenta.

Table 5-1 correlates the thickness of the placenta with gestational age. Typically, the placenta measures 2–4 cm in thickness (anteroposterior diameter) and weighs about 600 grams at birth. Nevertheless, there is enormous variability in the actual size and shape of a placenta, and

A

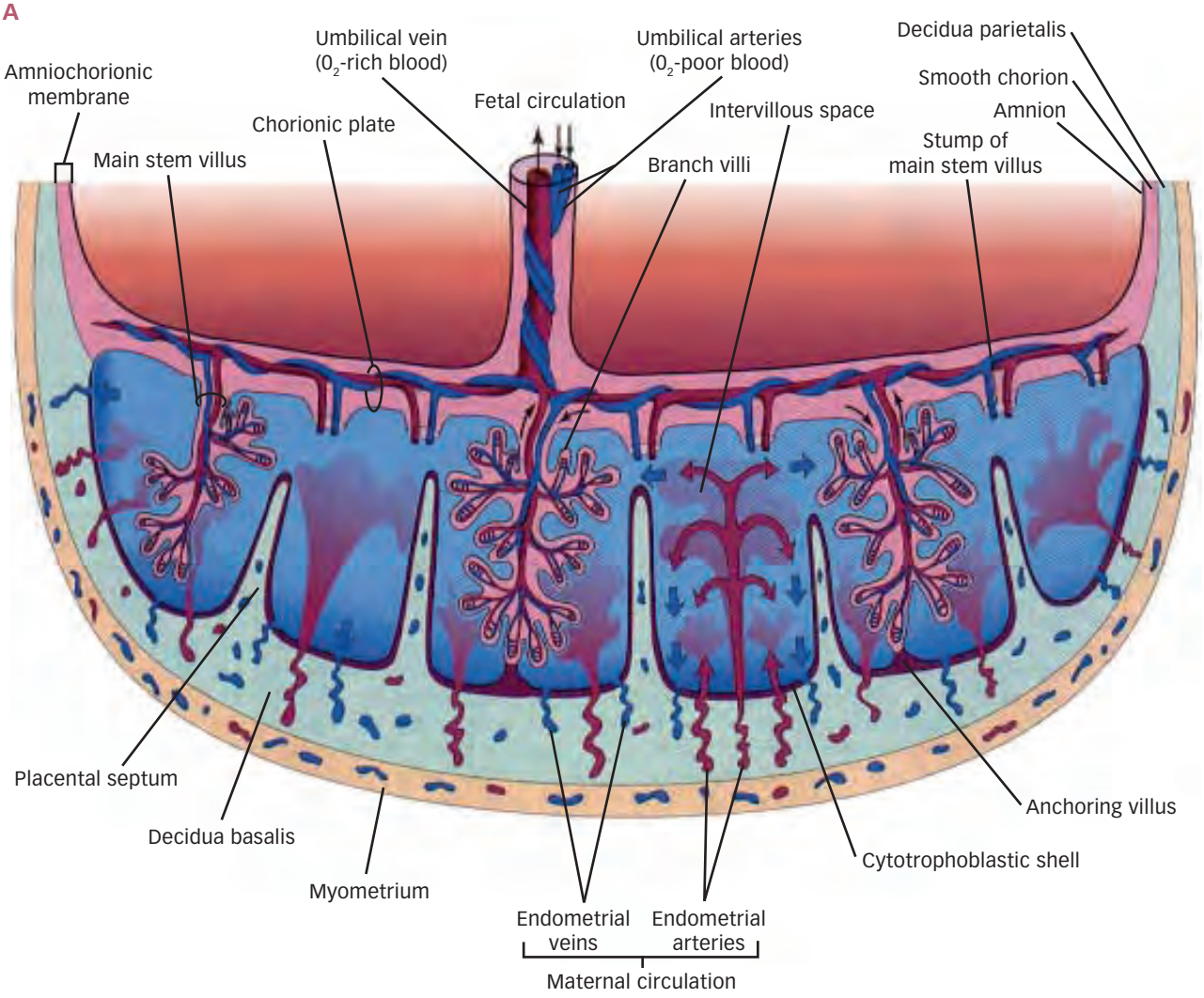


Figure 5-8. A *Drawing of the placenta. Used with permission from Moore KL, Persaud TVN:* The Developing Human: Clinically Oriented Embryology, *8th Edition. Philadelphia, Saunders Elsevier, 2008, p 116. (Figure continues . . .)*

Table 5-1. Placental thickness correlated with gestational age.

Gestational Age (Weeks)	Mean Thickness (cm)	± 2 SD
10	1.15	0.8–1.55
15	1.8	1.15–2.3
20	2.05	1.2–2.8
25	2.5	1.8–3.2
30	3.0	1.8–3.6
35	3.25	2.5–4.0
40	3.35	2.5–4.2

the size relates directly to uteroplacental circulation. However, a placenta should not measure more than 4–5 cm at term. Factors that may contribute to placental morphologic variations include race, altitude, pathologic circumstances of implantation, underlying maternal comorbidity, and maternal habits such as smoking. A large, fluffy placenta is usually the result of villous edema and hyperplasia. Placental enlargement is associated with fetal hemolytic disease, maternal diabetes, and severe maternal anemia (Figure 5-8B and Box 5-2). Abnormally small placentas are associated with intrauterine growth restriction (IUGR), pre-eclampsia, severe insulin-dependent diabetes, chronic infection, and chromosomal abnormalities (Box 5-3).

B

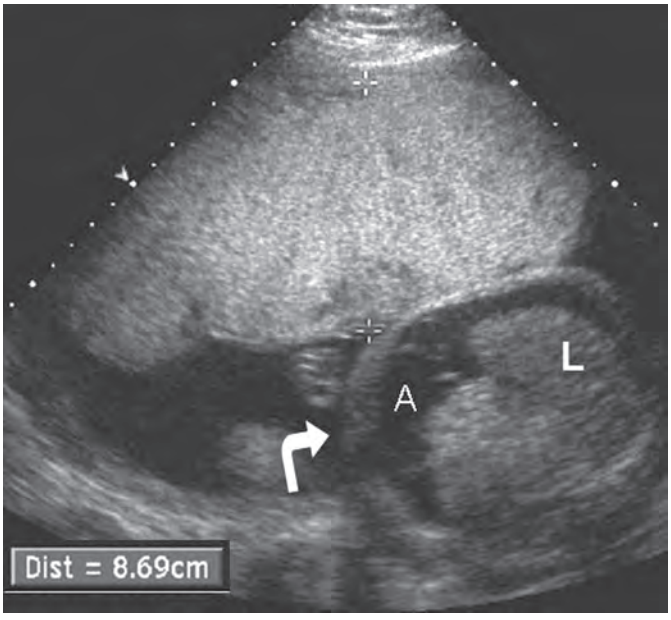


Figure 5-8, continued. B *Thickened anterior placenta (calipers) at 8.6 cm. Note that the fetal abdomen also shows evidence of hydrops, demonstrating skin edema (arrow) and abdominal ascites (A). L = liver. (Figure continues . . .)*

Box 5-2. Conditions associated with large placenta.

- Diabetes
- Rh sensitization
- TORCH infections
- Syphilis
- Triploidy

Box 5-3. Conditions associated with small placenta.

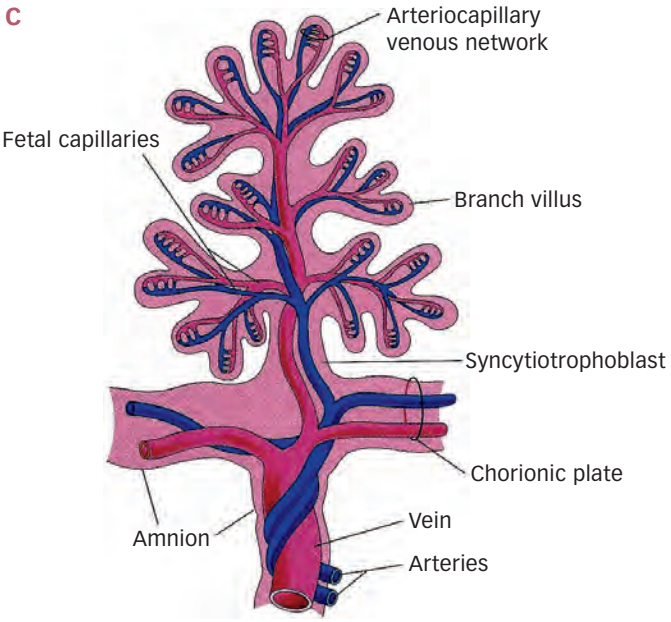
- Intrauterine growth restriction
- Abnormal placentation (membranous)
- Pre-eclampsia
- Severe insulin-dependent diabetes
- Chronic infection
- Chromosomal abnormalities

The placenta is considered a maternal-fetal structure because of the apposition or fusion of fetal organs to maternal tissue for the purpose of physiologic exchange. Functionally and anatomically, the placenta is divided into two portions, maternal and fetal.

Maternal Portion

The maternal portion of the placenta constitutes less than 20% of placental weight. It is composed of compressed sheets of decidua basalis (placental septa) that project into pools of maternal blood and divide the placental body into the lobular **cotyledons**. Into each of these cotyledons project one or two stem villi and their many branch villi. The intervillous space is a large, blood-filled space that surrounds the chorionic villus. It is derived from the coalescence of lacunar networks that are found in the embryonic chorion frondosum. Maternal blood enters the intervillous space from the endometrial spiral arteries and is drained by the endometrial veins, which are found over the entire surface of the decidua basalis. The branch villi are continuously bathed with the maternal blood that is circulating in the intervillous space. It is at this level that the essential transfer of oxygen, nutrients, hormones, waste products, and other substances takes place (Figure 5-8C).

C



D

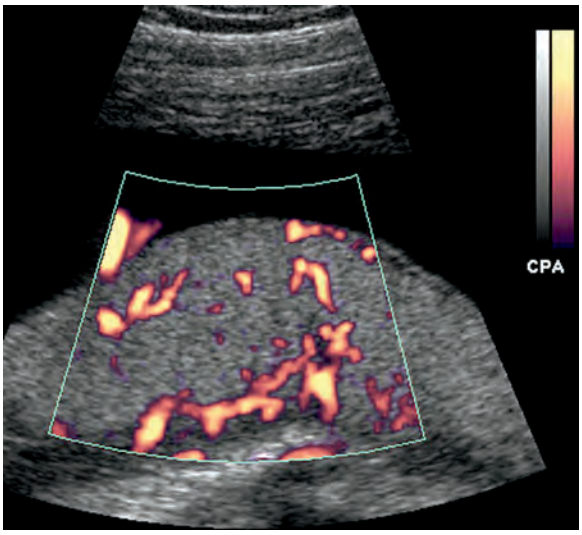


Figure 5-8, continued. C *Drawing of a stem chorionic villus and its arterio-capillary-venous system. The arteries carry poorly oxygenated fetal blood and waste products from the fetus, whereas the vein carries oxygenated blood and nutrients to the fetus. Used with permission from Moore KL, Persaud TVN:* The Developing Human: Clinically Oriented Embryology, *8th Edition. Philadelphia, Saunders Elsevier, 2008, p 117.* **D** *Normal posterior placenta showing vascularization.*

Fetal Portion

The primary functional units of the placenta are fetal structures called villi. The large surface area created by the multiple convolutions of each villus provides the blood/cellular membrane contact necessary for the transfer of metabolic products between fetus and mother (see Figure 5-8C). The placental membrane is a two- to three-cell-thick covering over the small branches of the villus that regulates the transfer of some substances from the maternal serum into the fetal bloodstream. The placental membrane acts as a true barrier only to molecules of a certain size, configuration, and charge. Some metabolites, toxins, and hormones, though present in the maternal circulation, do not pass through the placental membrane in sufficient concentrations to affect the embryo or fetus. However, most drugs and other substances in the maternal plasma pass through the placental membrane and enter the fetal plasma, including heparin and certain types of bacteria.

PLACENTAL CIRCULATION AND HEMODYNAMICS

A large volume of maternal arterial blood flow into the placenta is required to adequately perfuse the rapidly growing fetus. Therefore, in an average pregnancy, maternal blood volume increases by 45%–50% by term. Uterine arterial flow increases to accommodate this increased volume, and at about 14 weeks' gestation the appearance of end-diastolic flow velocities in an umbilical arterial Doppler spectral waveform indicates the establishment of continuous intervillous circulation. Blood flowing into the low-pressure intervillous spaces via the spiral arteries demonstrates pulsatile but low-resistance flow patterns throughout gestation using Doppler ultrasound techniques. (See Chapter 12.)

Maternal Placental Circulation

The blood in the intervillous space is temporarily outside the maternal circulatory system. It enters the intervillous space through 80 to 100 spiral endometrial arteries in the decidua basalis. These vessels discharge into the intervillous space through gaps in the cytotrophoblastic shell. The blood flow from the spiral arteries is pulsatile and propelled in jet-like fountains by the maternal blood pressure (Figure 5-8D). The welfare of the embryo and fetus depends on the adequate bathing of the branch villi with maternal blood more than on any other factor. Significant reductions of uteroplacental circulation may result in fetal hypoxia and intrauterine growth restriction.

Fetal Placental Circulation

Poorly oxygenated blood leaves the fetus and passes through the umbilical arteries to the placenta. At the site of attachment of the cord to the placenta, these arteries divide into a number of radially disposed chorionic

arteries that branch freely in the chorionic plate before entering the chorionic villi. The blood vessels form an extensive arterio-capillary-venous system within the chorionic villi, which brings the fetal blood extremely close to the maternal blood. This system provides a very large area for the exchange of metabolic and gaseous products between the maternal and fetal bloodstreams.

The well-oxygenated fetal blood in the fetal capillaries passes into thin-walled veins that follow the chorionic arteries to the site of attachment of the umbilical cord, where they converge to form the umbilical vein. This large vessel carries oxygen-rich blood to the fetus (Figure 5-9).

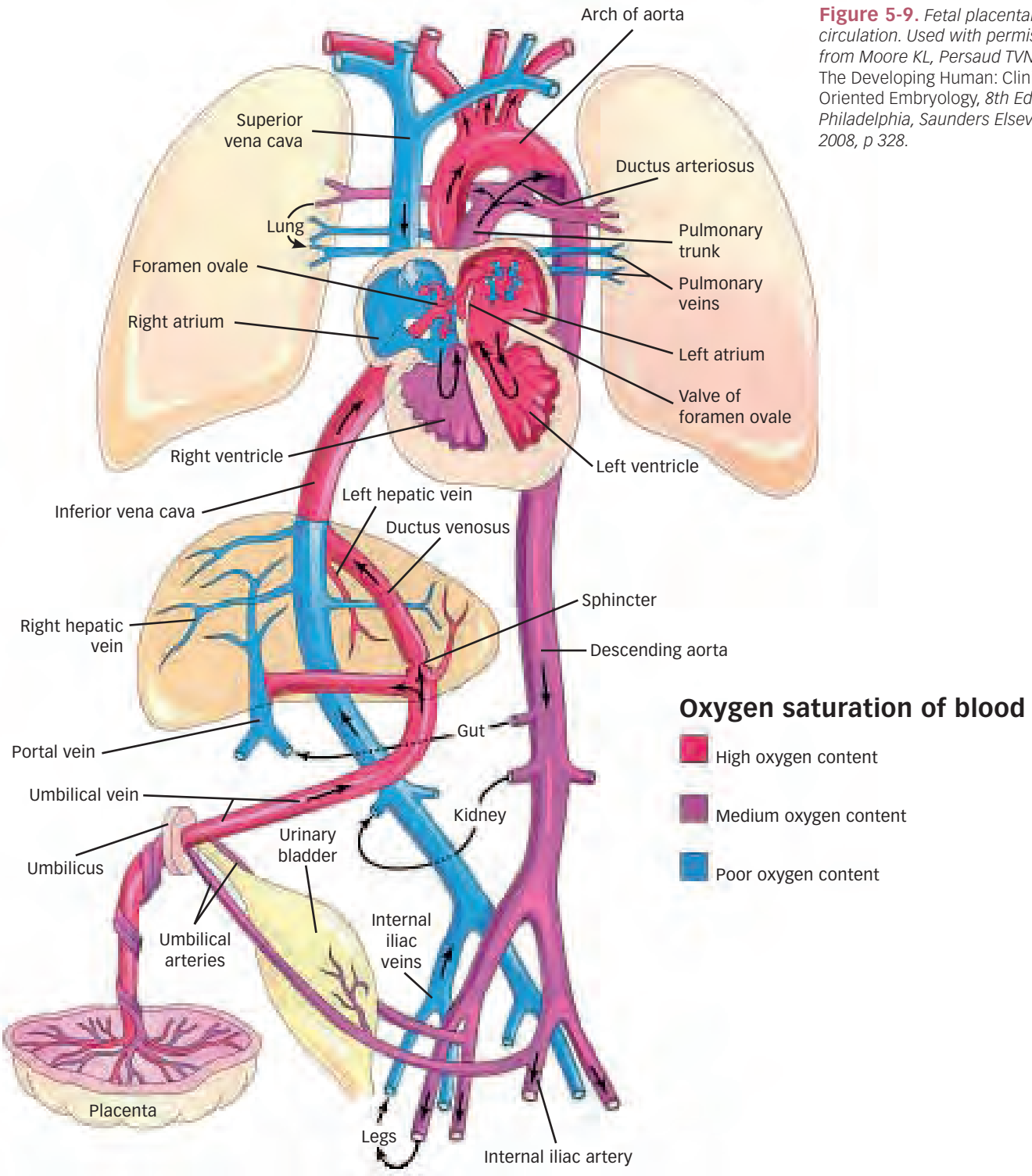


Figure 5-9. *Fetal placental circulation. Used with permission from Moore KL, Persaud TVN:* The Developing Human: Clinically Oriented Embryology, *8th Edition. Philadelphia, Saunders Elsevier, 2008, p 328.*

PLACENTAL LOCATION

The placenta can attach itself anywhere within the uterine cavity and this position should be reported with some degree of detail. For example, a placenta that wraps around the lateral aspect of the uterus can appear to be both anterior and posterior when scanning the uterus in the long axis (Figures 5-10 A and B). One should also be aware that uterine growth can cause a previously reported low placenta to appear to have moved or changed position. This is referred to as **placental retraction** (Figure 5-10C). With uterine growth, the placenta is pulled and stretched, which causes some thinning at the edges and gives the appearance that it moves away from its original low position. Another explanation is trophotropism: The placenta may grow in areas of optimal myometrial perfusion and atrophy in areas that are not well vascularized. For these reasons, a **low-lying** or **marginal placenta** should be checked later in the pregnancy to confirm its position.

PLACENTAL GRADING

Structural, or maturational, changes occur within the placenta as it ages. A method of **placental grading** based on sonographically observable changes was devised to help assess fetal lung maturity. Paramount among the changes that can be observed with sonography is the development of small areas of calcific degeneration in the basal plate or within the placental cotyledons. While subsequent studies have demonstrated that statistical correlation between placental grade and lung maturity is generally poor, the identification of a mature placenta in the second or early third trimester may indicate impending placental insufficiency or may predict other postnatal morbidity such as respiratory distress syndrome, especially in the presence of underlying maternal medical complications.

The sonographic criteria used to grade a placenta appear in Figure 5-11A. In cases where different areas of the placenta exhibit different degrees of maturity, the area that appears most mature is graded and reported (Figures 5-11 B–F).

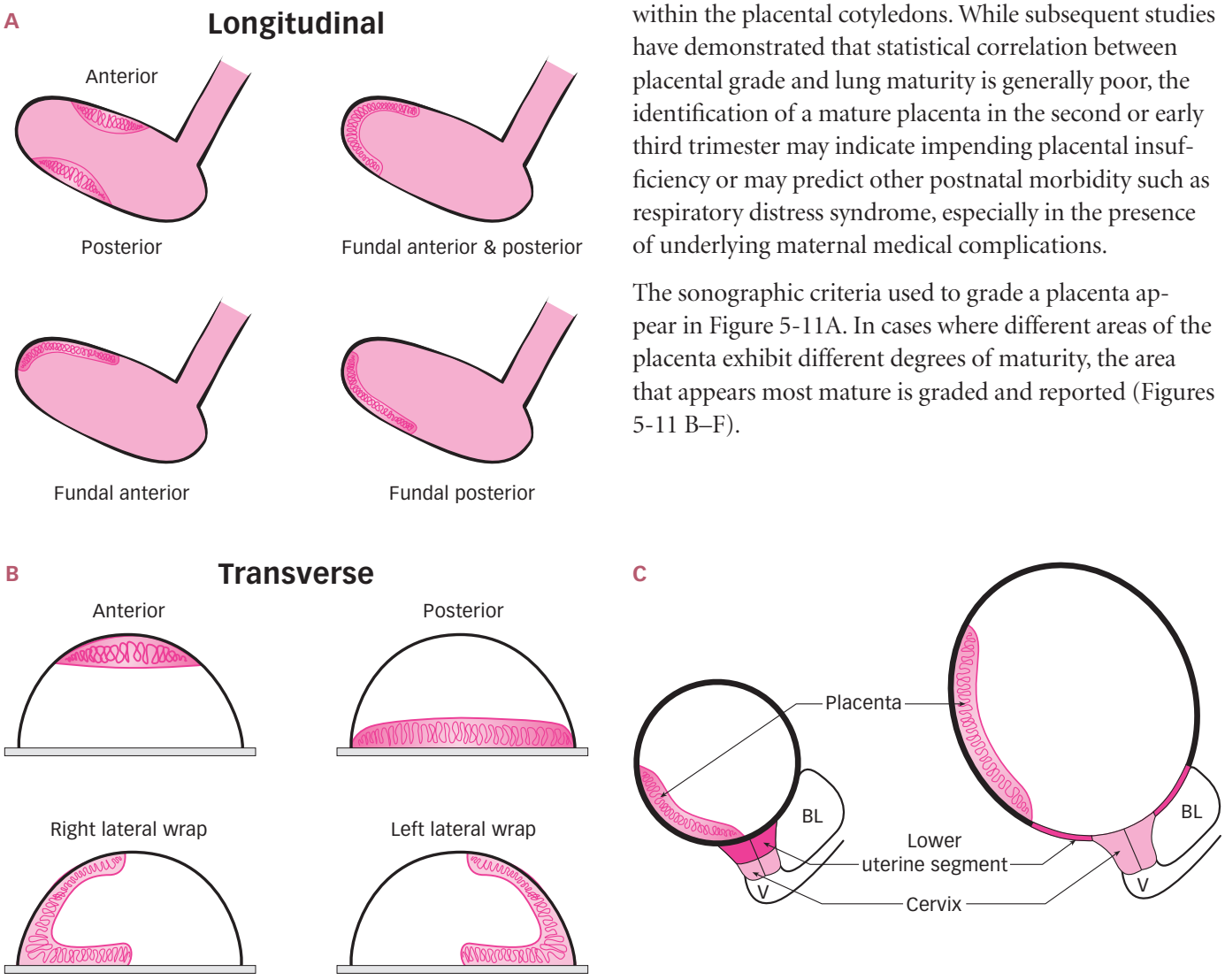
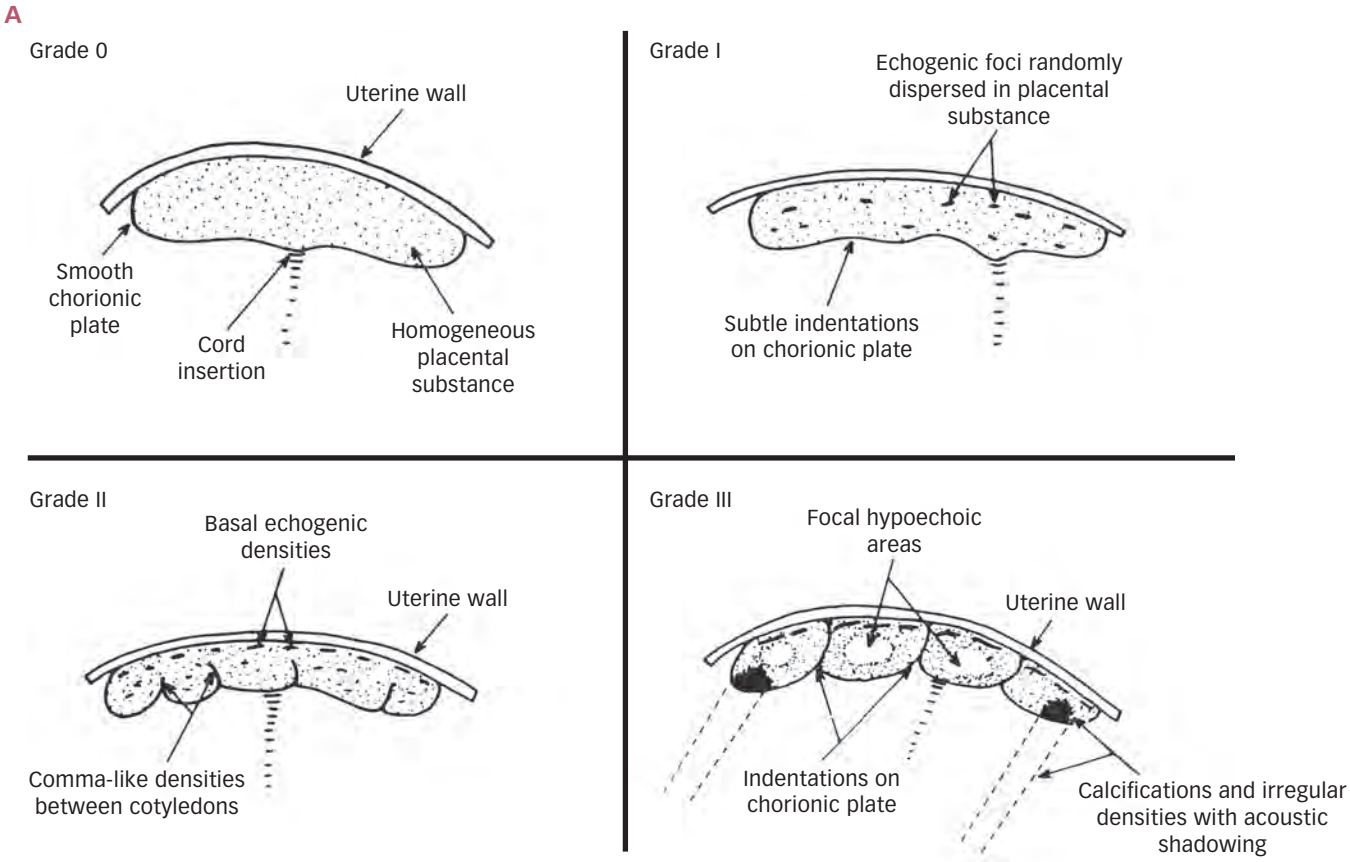
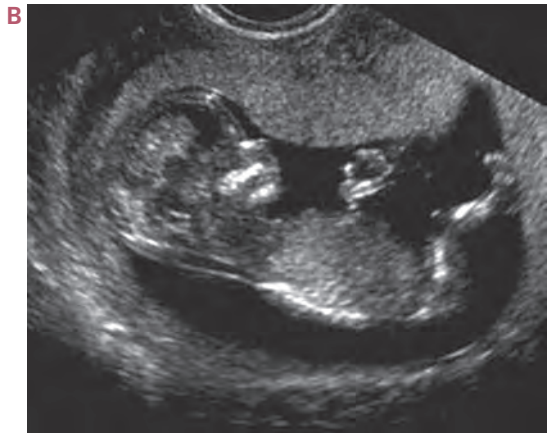
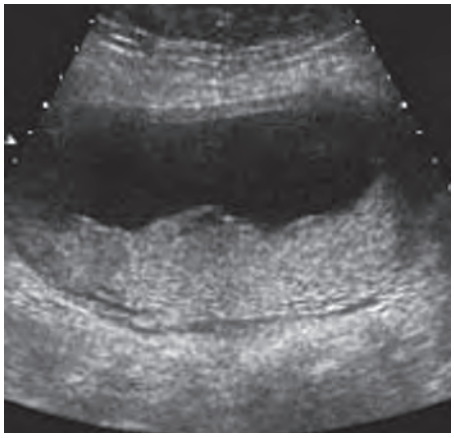


Figure 5-10. A *Placental locations as seen in the longitudinal plane.* **B** *Placental locations as seen in the transverse plane.* **C** *Due to the differential growth rate of the uterus during pregnancy, an early low-lying placenta can appear to change position by the third trimester. BL = maternal bladder, V = vagina.*







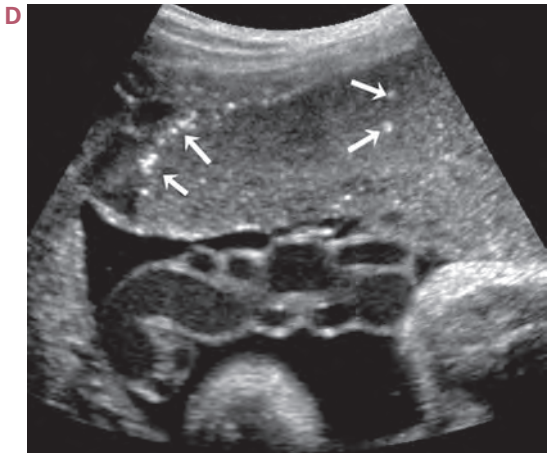


Figure 5-11. A *Grannum's placental grading starts with grade 0 (late first to early second trimester), with a smooth echo pattern of the parenchyma, no calcifications of the chorionic/basal plate, and no indentations of the chorionic plate. Grade I (mid-second to early third trimester) displays diffuse, randomly distributed calcifications (2–4 mm) and subtle indentations of the chorionic plate. Grade II (late third trimester to delivery) is characterized by dot-dash calcifications parallel to the basal plate and larger indentations of the chorionic plate. Finally, grade III (39 weeks to postdelivery) displays larger calcifications and indentations of the basal plate. Reprinted with permission from Grannum PA, Berkowitz RL, Hobbins JC: The ultrasonic changes in the maturing placenta and their relation to fetal pulmonic maturity. Am J Obstet Gynecol 133:915, 1979.* **B** *Anterior grade 0 placenta showing smooth homogeneous echo pattern and smooth chorionic plate.* **C** *This posterior grade I placenta demonstrates undulation of the chorionic plate, making it appear broken, and there is mild heterogenicity of the placenta.* **D** *This anterior placenta shows bright echogenic foci scattered throughout the placenta and especially along the basal area (arrows), typical of grade II. (Figure continues . . .)*

E

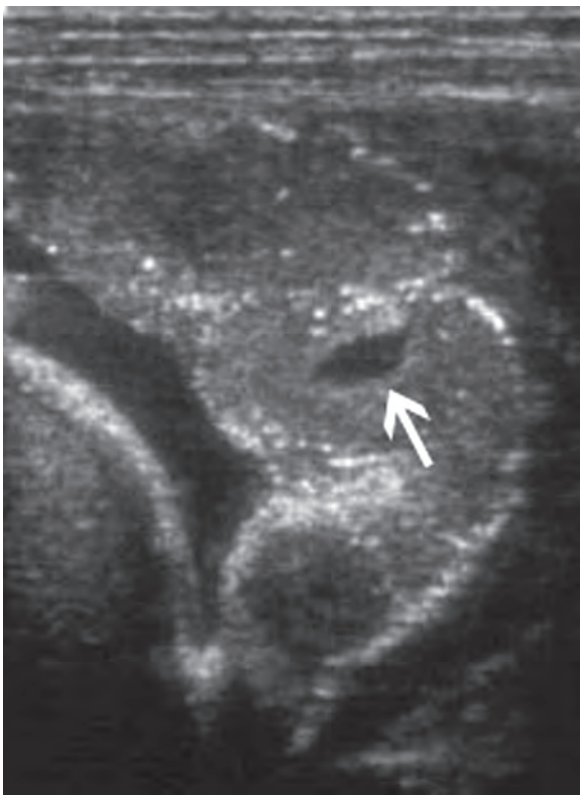
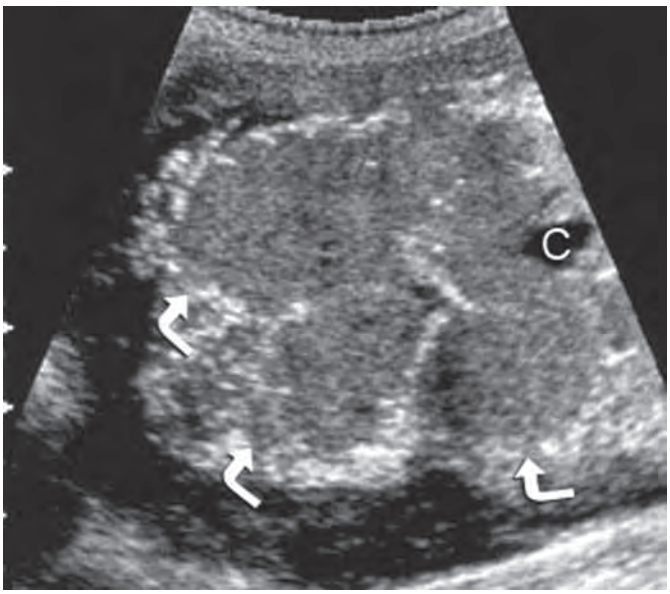


Figure 5-11, continued. E *This grade III placenta shows distinct lobulations with areas of calcification and cystic degeneration (arrow).* **F** *A grade III placenta showing areas of cystic degeneration (C) and distinct lobulations (curved arrows) outlined by hyperechoic calcific changes.*

F



Early placental aging, as demonstrated by the presence of calcifications within the placenta, may be related to many factors, including cigarette smoking, maternal age, parity, and other maternal morbidity. Women who demonstrate placental calcification on sonography at 34–36 weeks have an increased risk of delivering infants of low birth weight, in poor condition at birth, and at risk for perinatal death. In patients with underlying medical conditions such as diabetes or **hypertension** (essential or pregnancy-induced hypertensive disorder [PIHD]) and in patients at increased risk for intrauterine growth restriction, placental grading can provide important information about the status and potential outcome of the pregnancy.

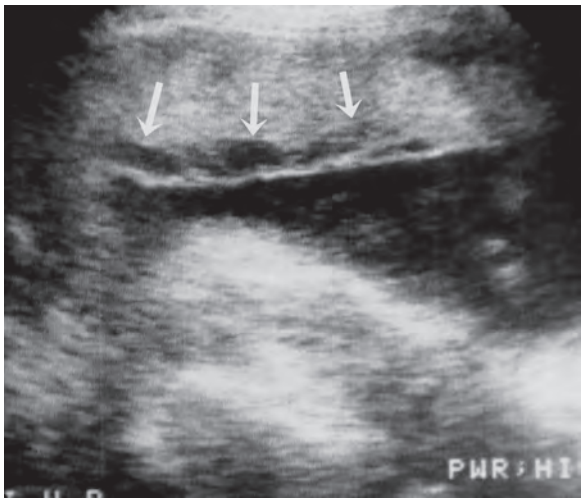
FIBRIN DEPOSITION

Maternal blood pooling in the subchorionic and perivillous spaces is normal. Examination with high-frequency transducers will reveal slow flow. Over time, fibrin deposits develop. These appear sonographically beneath the chorionic plate (subchorionic; Figure 5-12A) or within the placenta around individual villi (perivillous). (A large subchorionic hematoma is referred to as a **Breus mole**.) Intervillous thromboses contain both fetal and maternal blood and range in size from just a few millimeters to several centimeters. Thromboses usually develop in the mid-placental region and may be described as *maternal lakes* (Figure 5-12 B and C). They are associated with an enlarged placenta, and there is an increased incidence with Rh incompatibility, suggesting that sensitization might result.

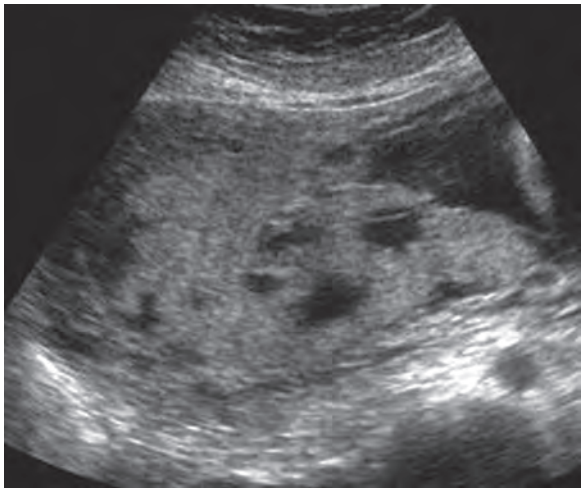
Decidual septal cysts are rare but occur in the same general vicinity between the cotyledons of the placenta. Cysts and thromboses can look similar sonographically (Figure 5-13). Thrombus, however, changes with time, including the development of fibrinous strands and plaque formation. These lesions may sometimes be responsible for elevation of **maternal serum alpha-fetoprotein** (**MSAFP**).

Placental infarctions are the result of ischemic necrosis of placental villi caused by interference with maternal blood flow to the intervillous space. Often part of the normal aging process, placental infarctions are usually peripheral in location. If uteroplacental circulation is

A



B



C

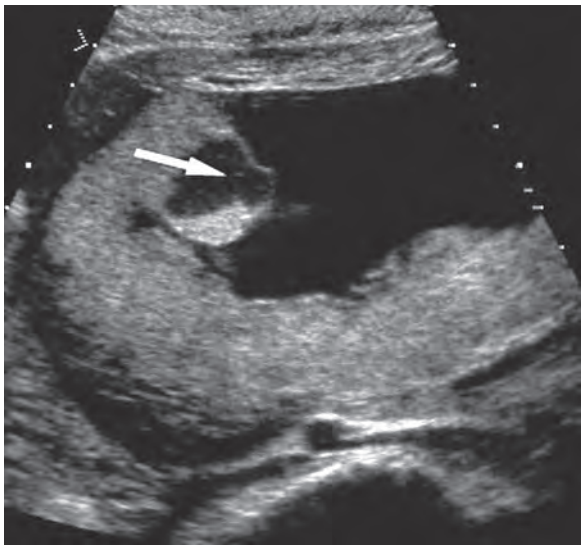
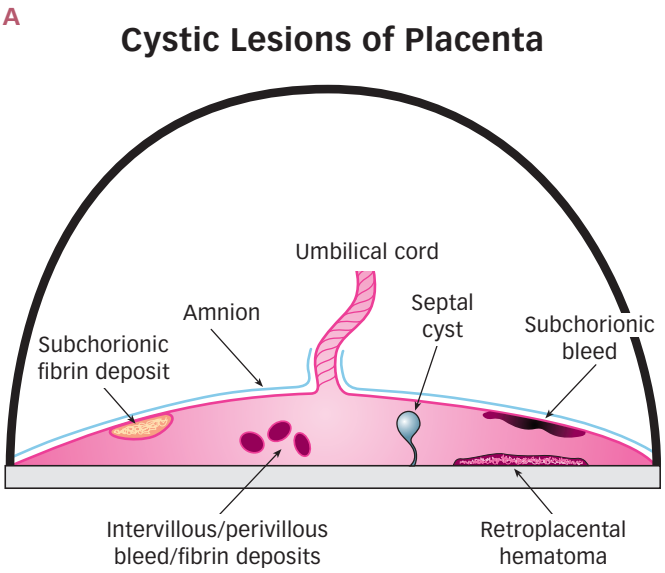


Figure 5-12. A *Along the edge of this anterior placenta are multiple subchorionic fibrin deposits (arrows).* **B** *Intervillous thromboses or maternal lakes are usually located more centrally in the placenta.* **C** *A placental venous lake showing some debris and a septation (arrow) within.*

A



B

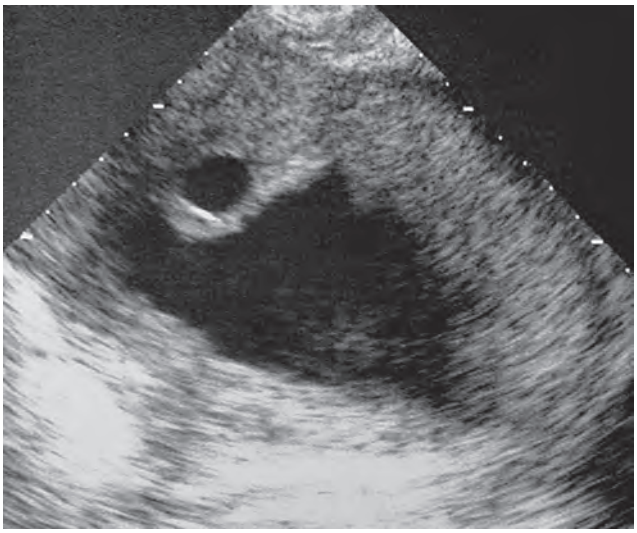


Figure 5-13. A *Various locations for cystic lesions of the placenta.* **B** *Placental cyst is well-defined and shows no internal fibrinous strands that would suggest thrombosis.*

otherwise normal, there are rarely any fetal complications. Placental infarctions occur more commonly with eclampsia/pre-eclampsia. When this condition is severe, placental insufficiency may occur. Infarctions are often difficult to image with ultrasound as they appear more echogenic rather than hypoechoic unless there is associated active hemorrhage.

Intraplacental lesions are frequently encountered during sonographic examination. Most are associated with collections of blood or clots. There is some overlap in describing these blood formations, and their sonographic appearances can be very similar.