CDC 4R051O

Diagnostic Medical Sonography Journeyman

Change Supplement for Volume: 2

IMPORTANT: Make the corrections shown in this supplement before beginning your study of the volume(s) it affects. This supplement has both pen-and-ink changes and replacement pages. Tear out the replacement pages and insert them in your volumes

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1-1	Unit menu	9	Delete LO 206, Applying ergonomics
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4-1 – 4-20	4-1 – 4-28

Unit 4. Other Sonography Imaging

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MOST OF THE facilities you will be working in will have a mammography staff as part of the diagnostic imaging team. You will be called upon to assist the mammographic section in their diagnosis of a host of breast problems. Where you fit in will be to clarify a problem for the radiologist to make a proper diagnosis. In addition, sonography is increasingly being used for purposes beyond traditional body imaging of structures such as the breast and abdomen. Because of improvements in resolution, minute detail is more readily visible than was possible even five years ago. In this unit, we will cover breast imaging and briefly describe some of the uses of sonography in specialized roles—most of which have been with us for a long time, but are being used more frequently.

4–1. Breast Imaging

To be an effective member of this diagnostic team requires familiarity with breast anatomy and physiology. An understanding of the sonographic appearance of breast structures will help you to correlate your findings with those of your mammography partners. Finally, your knowledge of the various breast abnormalities and their sonographic characteristics will enable you to recognize a range of masses efficiently; both benign and malignant. In this section, we will focus on the sonographic approach to breast imaging, and by doing so you will better assist the radiologist as he or she combines mammographic reporting in his or her diagnosis.

221. Breast anatomy and physiology

Most of the female breast is functional or glandular tissue (parenchymal) with stromal or supporting tissue providing a frame. The anatomy of the breast is laid out in such a way as to point to its primary focus for providing milk to a nursing infant. Thus, glands and ducts throughout the breast all point toward the nipple.

Breast anatomy

The female has two collections of breast tissue situated anterior to and covering the chest muscles on the left and right. Size and shapes of breasts vary from woman to woman and frequently within the same woman, depending on age, genetic factors, and individual hormone influence.

From the outer skin down deep to the chest wall, all ducts of the breast are arranged in a concentric circle, like spokes in a wheel, pointing to the central axis of the nipple. It is helpful to think of the breast as being divided into three layers or zones, each going deeper toward the chest wall:

1. Premammary zone (subcutaneous layer).
2. Mammary zone (mammary layer).
3. Retromammary zone (retromammary layer).

The subcutaneous layer, or premammary zone, is composed of skin, connective tissue, and fat, all being subcutaneous tissue similar to that elsewhere in the body. In menstruating women, this region is thin relative to the mammary layer beneath, and in older women, it is relatively thick. The outer skin displays the nipple in the anatomical center of the breast surrounded by a circular region of varying sizes and pigments called the areola of breast. The areola surface has numerous tiny projections that serve as outlets for the areolar glands (sometimes called Montgomery glands) beneath. Below the skin are fat lobules separated by suspensory ligaments of breast, fibrous connective tissue commonly referred to as Cooper ligaments (you'll often hear the possessive, *Cooper's*). The Cooper ligaments hold up the breast tissue, giving it much of its shape and stretch from the skin down through the subcutaneous layer with its fat lobules to the anterior surface of the mammary zone. Cooper ligaments also frequently form a network all the way through the layers to the chest wall.

The anterior surface below the premammary zone is actually thick connective fascia and separates the premammary zone from the mammary zone. The second layer, the mammary zone, is the thickest layer and contains the functional or glandular tissue of the breast. This layer is divided into at least 15 lobes, each with ducts and hundreds of lobules, and separated by dense fibrous tissue. Inside each lobule is less dense fibrous tissue that surrounds the ducts and, along with varying amounts of fat, is interspersed throughout. Also inside each of the lobules are the functional units of the breast called terminal ductolobular units (TDLU), composed of tiny sac-like glands called acini or alveoli, as well as intralobular stroma or connective tissue. Branching from the TDLU are tiny ducts called secondary tubules, pointing toward the center of breast and the nipple. Each secondary tubule departs their respective lobule and eventually merges with other secondary tubules to form one of at least 15 lactiferous ducts (also called mammary ducts) that drain the main lobes. Lactiferous ducts widen slightly into lactiferous sinuses or ampulla just before ascending up into the nipple.

Below the functional mammary layer is the posterior mammary fascia or deep fascia. Beneath the fascia is a thin layer of fat lobules called the retromammary zone. Deep into this layer lies the pectoralis major muscle of the chest.

A triangular shape sliver of breast tissue sometimes extends into the armpit in some women. This area, the axilla, has many lymph nodes, which sometimes factor into mammographic problems requiring sonographic clarification.

Breast physiology

The function of the breast (specifically, the mammary glands) is to produce and secrete milk (lactation) for the nourishment of infants after childbirth. To accomplish this, the glandular tissue is strongly influenced by hormonal forces in producing milk as well as moving milk through and out of the breast. Continuous development of the tissue varies with age and monthly menstrual cycles, all of which correspond with levels of hormone production. The important hormones are estrogen and progesterone, which increase significantly during pregnancy due to their major source, the placenta. Estrogen causes an increase in the development of the acinar and ducts in preparation for delivery. The increase in glandular tissue and activity causes the breast to swell in size. Progesterone completes the processes begun by estrogen.

At the time of birth, the placental production of estrogen and progesterone ceases and the presence in the blood of those hormones drops dramatically. The hypothalamus gland in the brain senses this reduction in estrogen and progesterone, and ceases to produce a factor that prevents the anterior pituitary gland from producing prolactin. Prolactin is a hormone that stimulates the acini to produce milk.

The milk is secreted from the TDLU into the lactiferous ducts and stored within lactiferous sinuses. When a child sucks on the nipple and draws the stored milk from the sinus, the posterior pituitary gland is stimulated to produce a hormone called oxytocin. This hormone causes the lactiferous ducts to contract and squeeze secreted milk forward and continuous lactation begins.

To prevent damage and infection to the nipple area while breastfeeding, the areolar glands (which enlarge during pregnancy) secrete a lubricant that seems to reduce chapping also.

222. Breast pathology

Clinical symptoms of patients with palpable but benign breast masses are likely limited to pain or bilateral nipple discharge. Palpable benign causes are frequently due to glandular changes of normal breast tissue, which may be tied to the menstrual cycle and its fluctuating hormone levels. These changes, such as fibrocystic changes and duct ectasia, can produce hardened lumps (sonographically echogenic glandular ridges along the anterior of the mammary layer) and are sometimes called aberrations of normal development (ANDI).

Conversely, patients with malignant breast masses tend to have symptoms of painless skin dimpling, ulcerations, nipple retraction, palpable masses that are extremely hard, and unilateral spontaneous or bloody nipple discharge.

Benign disease

Non-malignant diseases of the breast can be focal or diffuse. We will look at some of the more common occurrences.

Benign cystic disease

Simple cysts of the breast are common in middle-aged women. However, they occur less frequently in menopausal women who do not receive hormone (estrogen) therapy. They can be singular or multiple, unilaterally or bilaterally. They are asymptomatic unless very large, causing pain. In nearly all cases, simple cysts of the breast are benign.

Various conditions can cause benign complex cysts. One of the more common benign conditions is fibrocystic change or disease. Occurring mostly in young women after 20, fibrocystic change is a condition that involves the increase of fibrous stroma or connective tissue and varying degrees of cystic dilation of the terminal ducts of the breast. The terminal ducts are connected to the mammary glands or acini, located within the TDLUs. Most fibrocystic change patients complain of pain in the breast and lumpiness.

Fibroadenoma

The most common benign solid tumor of the breast in women under 35 is the fibroadenoma. Arising from the TDLU, fibroadenomas are composed of a mixture of fibrous connective tissue, epithelial or glandular tissue (acini), and ducts. The tumors are generally 2 to 4 cm and are typically singular but may be multiple. Most are asymptomatic. In adolescents, a fibroadenoma may occur that is 5 cm or more in size called a giant “juvenile” fibroadenoma, which tend to rapidly grow and cause pain. They are otherwise indistinguishable from typical fibroadenoma.

Papilloma

A papilloma is a benign epithelial tumor that projects from surrounding tissue. In breasts, the intraductal papilloma arises from the lactiferous duct, mostly in the subareolar region. Common in middle-aged women, they cause nipple discharge of either serous or bloody fluid. The carcinoma form of papilloma is rare and normally seen only in postmenopausal women.

Another benign form of papilloma is the intracystic papilloma, which arise from the TDLUs. The cysts can cause pain if they become inflamed.

Mastitis

Although other benign focal abnormalities occur within the breast, such as milk of calcium cysts, lipomas in the subcutaneous layer, and cystic collections of necrotic fat (fat necrosis), these are extremely rare. Another more common breast abnormality is mastitis, inflammation of diffuse breast tissue. The typical breast mastitis case is caused by infection. Rarely, it may be the result of prior irradiation. The infectious organism typically responsible is *Staphylococcus*. Patients commonly complain of extremely painful and tender breast either bilaterally or in a single area. Nipple discharge is also seen with mastitis cases.

Mastitis is divided up into two types: breast inflammation occurring after childbirth (puerperal) and inflammation at all other times (non-puerperal). During pregnancy, the lactiferous duct will sometimes become blocked or occluded, causing the duct to expand into a retention cyst called a galactocele. This structure, in combination with the introduction of infectious inflammation, sometimes erupts into a massive abscess (a collection of pus) within a few months of delivery. Puerperal mastitis is located close to the periphery of the breast. Occasionally certain types of mastitis will cause periductal inflammation in the subareolar region, prompting the lactiferous ducts to expand with debris. This condition is called *ductal ectasia*.

Conversely, centrally located abscesses can be both puerperal and non-puerperal. These large collections tend to possess an elongated shape, coursing roughly parallel to the duct of origin. Because mastitis can cause an inflamed duct to rupture, fluid is spilled into the breast tissue.

Malignant disease

Of the various breast cancers that can occur, by far the most common is carcinoma. Carcinomas arise from epithelial cells, which are structural cells that cover nearly every surface and organ in the body. Women who are at risk for breast carcinoma are generally provided with diagnostic mammograms coupled with sonography annually. One percent of breast cancers occur in men.

Risk Factors for Breast Cancer	
Age	Rare in women younger than 35. Mostly occur in women over 50.
Family history/ Genetics	History of breast cancer in mother, sister, daughter. Autosomal dominant.
Hormone levels and status	Early or late menopause. Women who have never given birth (nulliparous) or who become pregnant after reaching 35 years of age.
Alcohol/ chemicals/ radiation	Excessive exposure.

Two types of carcinoma occur in the breast: carcinoma *in situ* (non-invasive or non-infiltrating) and invasive (infiltrating) carcinoma.

Carcinoma in situ

Of the *non-invasive* carcinomas, the most common is intraductal carcinoma or ductal carcinoma in situ (DCIS). Arising from the TDLUs, DCIS fills and expands the mammary ducts but does not break through. Because this malignancy can develop into invasive carcinoma, biopsy is used when expanded ducts filled with hypoechoic material are seen on sonography. DCIS frequently appears as a mass extending throughout a duct.

Invasive carcinoma

Invasive ductal or infiltrating ductal carcinoma is the most common breast cancer in women. Usually, the invasive carcinoma presents clinically as a hard fixed mass in the breast. Invasive carcinoma does precisely what its name implies and spreads into the breast tissue beyond the duct of origin. Other types of invasive carcinoma are lobular carcinoma, medullary carcinoma (which resembles a cyst because of its sharp round border and homogeneously hypoechoic center), and colloid (mucinous) carcinoma. All of these types are determined after laboratory analysis of a biopsy tissue sample.

Invasive carcinoma spreads primarily through the lymphatics of the breast. The lymph channels all rise toward the nipple and converge before coursing toward the axillary lymph nodes.

223. Imaging normal and abnormal breasts

Breast sonography seems to be a simple thing to do because of the superficial nature of the tissue. However, because glandular tissue changes with age and hormonal levels, the sonographic appearance of the breast will also change. The three major layers of the breast vary in size and echogenicity to such a degree that a sonographer must have knowledge of other factors such as patient history, clinical information, and prior mammogram information. Considering these factors, along with practical experience examining normal breast tissue, will help you to locate and document masked and subtle abnormalities.

Indications

The major reason for performing breast sonography is to determine the characteristics of either palpable abnormalities or focal abnormalities seen on mammography. Frequently, sonography can prove to be useful for other reasons.

Indications for Breast Sonography	
Locate and Characterize Masses	Palpable masses felt through either clinical or self-examination and in conjunction with mammography. Nonpalpable masses seen on mammography. Initial step for women under 30 and pregnant or lactating women.
Localization and Guidance	Useful for needle biopsy and cyst aspiration of abnormal tissue, decreasing the need for surgery.
Evaluation	Breast implant problems such as leakage and rupture.
Planning	Used to help map out plans for radiation therapy of prior breast cancer patients

The main concern is breast cancer, and some women at risk will often have breast masses evaluated with both mammography and sonography. Certain symptoms are common for breast cancer and may prompt sonographic evaluation, such as advanced age, family history of breast cancer, and personal history of breast cancer. On mammography, suspicions of cancer are raised when irregular borders are seen in masses (often referred to as "spiculated") or focal clusters of microcalcifications are discovered. Patients may also have inflammation (mastitis) or trauma.

Sonographic approach

To properly evaluate breast tissue, you will need at least a 7 MHz linear-array transducer or higher with multiple focal zones in the near-field. Most transducers with frequencies above 7 MHz have near field focusing capable of superior imaging as close as 1.5 to 2.0 cm beneath the skin surface. Breast masses are typically seen no deeper than 3 or 4 cm, and higher frequency transducers are able to render these structures with outstanding resolution. For patients with large breasts having deep breast abnormalities, either reposition patient (to flatten breast out as much as possible) or switch to a lower frequency for adequate beam penetration.

It is critical that you work closely with the radiologist to determine the best way to evaluate mammographic findings or the referring physician's concerns. The patient's medical history and prior sonographic or mammographic studies must be reviewed (preferably before you scan). Unless you are scanning a patient younger than 30 or pregnant/lactating, you should have mammograms available for review. If not, proceed with the radiologist's instructions. Requests should be specific on what breast abnormality is to be evaluated and the general location.

Patients should be dressed in such a manner where only the breast to be examined is exposed. For abnormalities located in the medial portion of the breast, a supine position for the patient is appropriate. If the abnormality is laterally situated to the nipple, roll the patient up slightly on the contralateral side (the side opposite the breast of interest) to flatten the breast out against the body. This will bring any potential masses closer to your transducer. For large breasts, roll them up into a near decubitus position. For all positions, have the patient raise the arm of the side examined above their head and resting on a support.

Sonographic appearance and standard views

In general, young women will have more dense breasts in the glandular tissue, while older women (particularly post-menopausal) will have mostly fat within the breast tissue. The three zones of the breast have distinct appearances on sonography.

Sonographic Appearance of Normal Breasts	
Premammary (subcutaneous)	Skin layer is echogenic and few millimeters thick.
	Fat lobules beneath are hypoechoic and this area is very thin in young women and thick in older women (fig. 4–1).
	Interspersed throughout the fat lobules are the highly echogenic linear bands (Cooper ligaments) stretching (on sonography) from the mammary layer to the skin surface.
Mammary	Echogenic layer.
	Young women: thick and contains some areas of hypoechoic fat; occasionally, hypoechoic linear structures (ducts) are seen; may be echogenic and dense from fibrous tissue.
	Pregnant or lactating women: Extremely thickened and echogenic with a homogeneous echotexture.
	Older and post-menopausal women: Thin or almost entirely replaced with hypoechoic fat; Cooper ligaments remain highly echogenic and give a polyhedral shapes to the fat lobules.
Retromammary	Hypoechoic fat lobules similar to premammary in echogenicity.
	Very thin layer (a few centimeters) made of fat lobules.

	Sits atop the linear bands of hypoechoic muscle representing the pectoralis major muscle of the chest.

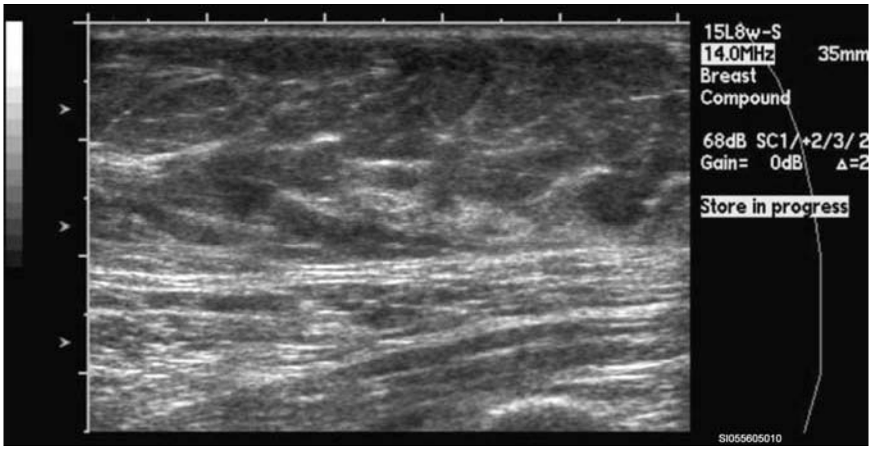

Figure 4–1. Breast layers.

The retromammary layer appears thicker on mammography because breast tissue is pulled away from the chest wall during the procedure. Conversely on sonography, the retromammary layer is compressed during the supine examination beneath the sonographer's transducer. Thus, masses that seem further out from the retromammary layer on mammography may actually appear closer to the layer with sonography. Therefore, careful scanning and correlation with mammographic location is critical.

Most sonography departments will require you to use either a quadrant method or a clock method to label location for your images. For the quadrant-method, the right and left breasts are split into four sections through the nipple.

1. Upper Outer Quadrant – RUOQ and LUOQ.
2. Lower Outer Quadrant – RLOQ and LLOQ.
3. Upper Inner Quadrant – RUIQ and LUIQ.
4. Lower Inner Quadrant – RLIQ and LLIQ.

For the clock method, you should imagine the breast as similar to the face of a clock with the center being the nipple. Directly cephalic to the nipple is the 12:00 position and it increases clockwise from 1:00 to 11:00 in even intervals around.

Frequently, you will be asked to label the orientation of a mass in relation to its location. For example, you've located a right breast mass at the 3:00 position. You would label its orientation either as longitudinal (sagittal) or transverse to the body. Some radiologists may have you label the long axis of a mass according to its orientation to the nipple. That is, the nipple has imaginary lines radiating out like wheel spokes (radial). Our 3:00 mass will be imaged and labeled as radial and, with a 90-degree rotation, antiradial. Further methods of labeling will even have you label the depth of a mass in relation to the three mammary layers (A, B, and C).

Mammographic imaging of masses is generally performed through a cranial-caudal (CC) approach through the breast (under compression) or a medial lateral oblique (MLO) with the breast pulled away from the chest wall (also under compression). Although sonography can approach breast masses from nearly all directions, it may prove helpful to try to use the same mammographic view. A transverse view anteriorly corresponds to the CC mammographic projection. Although difficult with a transducer, you may be able to come close to MLO view (remember the breast is pulled away during the mammogram) by doing a longitudinal view along the lateral edge of the breast, coronal with the body. Again, use the quadrant or clock method to annotate your findings.

Imaging breast abnormalities

A host of breast masses may be present but your main job is to determine if the masses are cystic or solid and their locations. Once a solid mass is identified, you must attempt to characterize its features. This is important because the radiologist is responsible for positively ruling out or confirming the presence of a malignancy.

Benign versus malignant masses

Benign masses of the breast tend to be cystic. Solid benign masses have borders that are mostly smooth and sharply defined on sonography. Sonographic findings characteristic of malignancy can be seen in the borders, shapes, and internal appearances of breast masses.

General Sonographic Characteristics of Malignant Breast Masses		
Border (Surface)	***Shape***	***Internal Appearance***
Irregular Spicular (spiked) /hypo- or hyperechoic Thick echogenic rim Angular (infiltration) Microlobulation	Taller than wide (1 cm or less) Extension or branches into a visible duct	Acoustic posterior shadowing beginning from within the mass Clusters of microcalcifications within mass Hypoechogenicity

Benign disease

We will look at typical sonographic approaches.

Benign cystic disease

Simple cysts of the breast can appear singular or multiple unilaterally or bilaterally. To be considered simple cyst, many radiologists require you to demonstrate specific criteria:

- Smooth, solid, and thin border or margin.
- Anechoic lumen.
- Posterior acoustic transmission or enhancement.
- Round or oval shape.
- Thin posterior shadowing off lateral edges of the cyst (fig. 4–2).

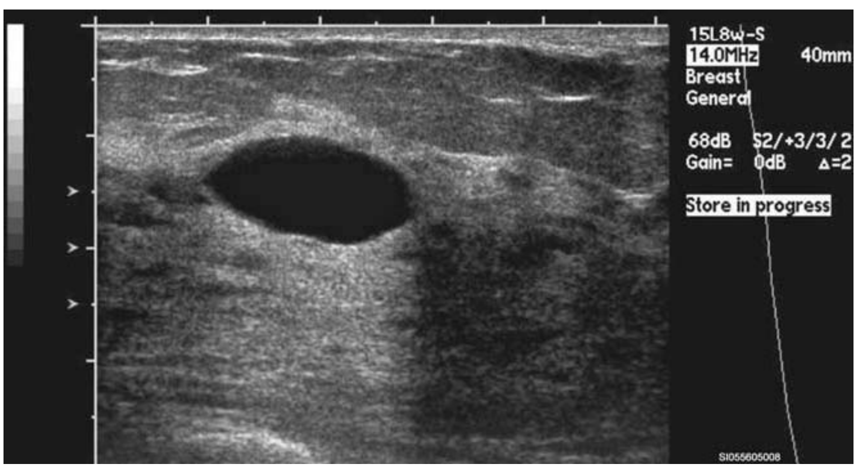

Figure 4–2. Classic breast cyst.

Without these criteria being met, the cysts should be considered complex. The range of appearances for complex cysts runs from internal low-level echoes within the cyst to mural nodules and thick septations.

On sonography, fibrocystic change typically will display multiple cysts within the glandular layer of the breast. Some cysts may have thin septations. Mild cases of fibrocystic change will have cysts appearing throughout the breast of varying sizes but normally only a few centimeters in size, corresponding to the mottled appearance of breast tissue on mammography.

Fibroadenoma

On sonography, the tumor is mostly hypoechoic compared to surrounding glandular layer or isoechoic if surrounded by hypoechoic fat. The borders are clearly defined and smooth. However, some fibroadenomas may have rounded lobulations. The tumor is mostly oval with the long axis parallel to the skin surface (wider-than-tall) (fig. 4–3). Because a fibroadenoma is not really a part of the parenchyma and displaces surrounding tissue, you may see what appears to be a thin echogenic capsule around it—particularly with the superior resolutions of modern equipment. This false capsule (pseudocapsule) represents compressed glandular tissue. The fibroadenoma is slightly mobile and moves independently of surrounding tissue. Upon palpation, they are felt to be firm but rubbery. You will occasionally see posterior shadowing; however, most will show no effect below the tumor. Measure these tumors in all three dimensions (sagittal/transverse or radial/antiradial), and note the location using the clock or quadrant methods.

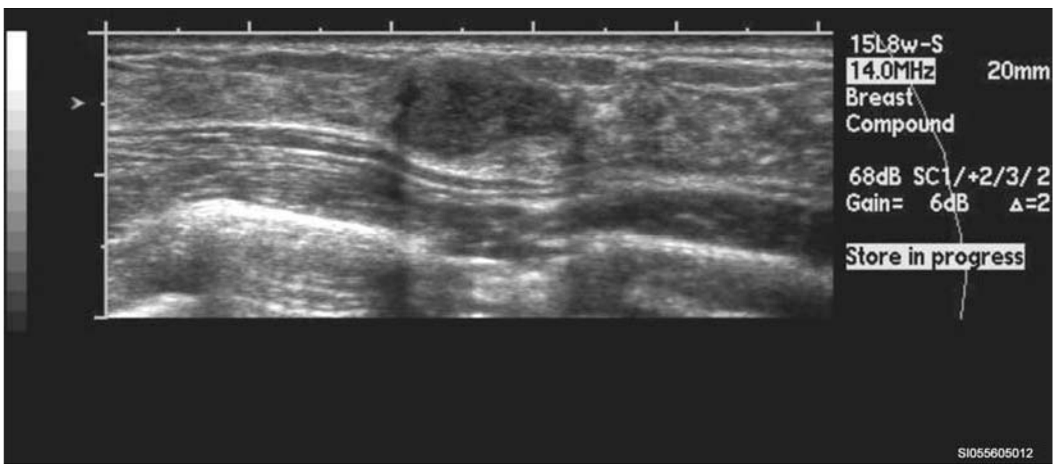

Figure 4–3. Fibroadenoma.

Papilloma

They appear on sonography as isoechoic to duct walls and will usually cause the affected duct to distend with fluid. Intraductal papillomas are solitary and measure only a few millimeters, so you likely will be able to locate it only within a distended duct.

The intracystic papilloma appears on sonography as a projection from cyst walls into the lumen. These mural nodules are the key sonographic feature of intracystic papillomas. The cysts may have thick walls and septations.

Mastitis

On sonography, peripheral or central abscess are complex but largely cystic, sometimes with enhanced acoustic transmission. The tenderness of the skin directly over the area and the large, disorganized appearance of the collection on sonography is nearly confirmation for abscess. Generally, abscesses are analyzed by tissue sample (aspiration) and then clinically drained.

Malignant disease

Of the various carcinomas within invasive and noninvasive breast cancers, each generally shares malignant features and their appearances overlap on sonography. However, certain distinguishing sonographic features lend themselves to suggesting a type of carcinoma present.

Carcinoma in situ

Although contained in the duct, DCIS occasionally displays the typical sonographic signs of malignancy; that is, a mass taller-than-wide, hypoechoic, with extreme shadowing, lobulations, angled margins, and calcifications. However, visualization of DCIS can be difficult because these lesions can be quite small. If they contain a small single calcification, you may be able to detect it within the center of the duct in cross-section, almost as a target sign. If occurring in the subareolar region, DCIS can be confused on sonography with ductal ectasia, which can fill ducts with debris in this area.

Invasive carcinoma

This carcinoma shares the typical sonographic features of breast malignancy, especially with branches of ducts extending from a mass. Therefore, the mass requires biopsy for confirmation (figs. 4–4 and fig. 4–5).

By the time the mammogram and sonogram occurs in about half of breast cancer patients, the cancer will have spread to nodes in the axilla. A normal lymph node is hypoechoic and oval shaped. Inside it is an echogenic line representing a hilum, through which nerves and blood vessels pass. If infected or metastasized, it will typically enlarge into rounded shaped and will become hypervascular. If you notice a mass displaying the hallmarks of malignancy, your radiologist may require you to search the axillary with the transducer for enlarged and rounded lymph nodes.

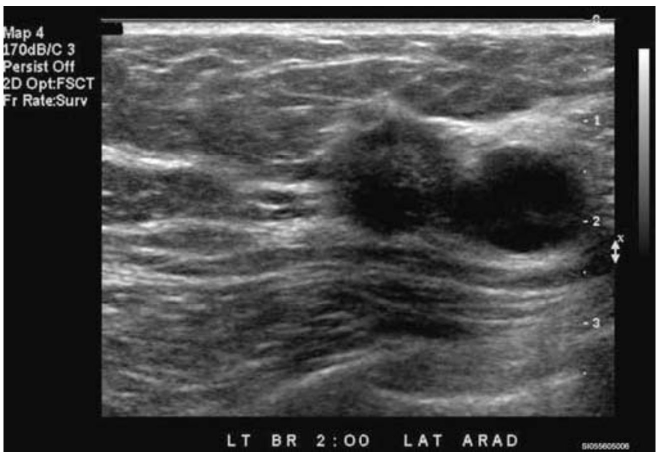

Figure 4–4. Shadowing breast mass exhibiting a malignant character beside a cystic mass.

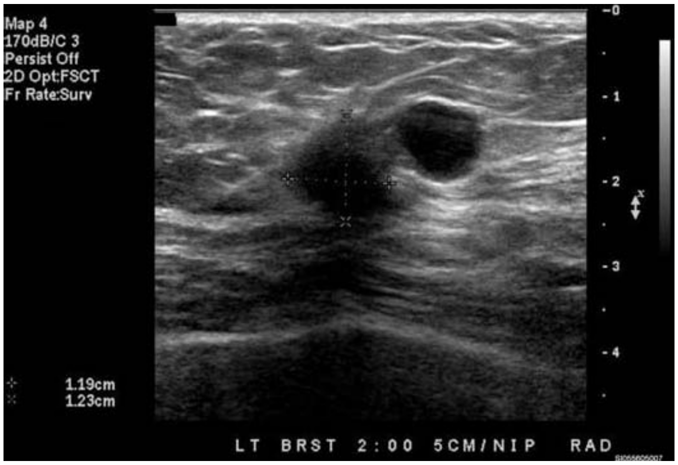

Figure 4–5. Measuring shadowing breast mass.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

221. Breast anatomy and physiology

1. What influences the size and shape of breasts?

2. List the three layers of the breast.

3. What separates the fat lobules below the breast skin?

4. What constitutes the mammary layer?

5. What is the relationship between TDLUs and breast milk?

222. Breast pathology

1. Clinical symptoms of pain are likely found in which type of breast mass?

2. What is the difference between a typical fibroadenoma and a giant fibroadenoma?

3. Describe a centrally located abscess of the breast.

4. Match the risk factor for breast cancer in column B with its more specific description in column A. Each item in column B may be used only once.

Column A	***Column B***
____ (1) Excessive exposure.	a. Hormone levels and status.
____ (2) Women who become pregnant after reaching 35 years of age.	b. Age.
____ (3) Rare in women younger than 35.	c. Alcohol/chemicals/radiation.
____ (4) History of breast cancer in mother, sister, daughter.	d. Family history/genetics.

5. Of the two types of breast carcinoma, which is the most common?

223. Imaging normal and abnormal breasts

1. What type of transducer will you need to evaluate breast tissue properly?

2. Describe the sonographic appearance of the mammary layer of the breast.

3. List the four sections of the four-quadrant method and their sonographic labels.

4. Describe general sonographic characteristics of malignant breast masses.

5. What are the key sonographic features of intracystic papillomas?

4–2. Neonatal Brain Imaging

Although sonography of the neonatal brain is not new, it is being performed in more institutions because of the excellent images obtained compared with the past. Relatively simple to perform, the notorious complexity behind neonatal imaging is largely due to a need for understanding neonatal brain anatomy. For our purposes, only a basic description is needed. As you advance in sonography, you will be able to build on this foundation with more in-depth studies of brain anatomy.

224. Neonatal brain fundamentals

Recall from your diagnostic imaging training that the sutures of the skull are formed by the incomplete fusions of bone plates. At many of the angles and intersections of these sutures are spaces called fontanelles. Of particularly interest to sonographers is the anterior or frontal fontanelle primarily, and the posterior or occipital fontanelle secondarily. The fontanelles may remain open anywhere from six months up to over a year after birth. The anterior fontanelle is a space formed by the junction of the frontal bone at the front of the skull above the orbits with the two parietal bones on either side of the head. The posterior fontanelle is a space formed by a similar arrangement of the posterior parietal bones with the occipital bone at the back of the skull.

Typical reasons for physicians to request a sonogram of the neonatal head are development abnormalities, brain lesions, hemorrhage, and inflammation.

Anatomy and physiology

The brain housed within the skull is divided into two hemispheres superiorly sitting atop a midbrain section and brain stem, from which the spinal cord courses through the foramen magnum and becomes the spinal cord. Three layers of membranes, called meninges, cover the brain.

1. Dura mater (tough outer covering).
2. Arachnoid (middle membrane).
3. Pia mater (inner layer).

The surface of each brain hemisphere is convoluted with twists and turns of raised tissue called gyri. Fissures or spaces called sulci separate every couple of gyri. Each sulcus may be thought of as a groove or depression. Prominent sulci or fissures separate the brain into four separate regions or lobes, the frontal (anterior and superior), parietal (on either side posteriorly), temporal (on either side inferior to both frontal and parietal lobes), and occipital lobe (posteriorly).

A space exists between two hemispheres of the brain (right and left) called the interhemispheric fissure or falx cerebri. These two hemispheres represent the largest lobe (frontal lobe), called the cerebrum, the area attributed to thought, consciousness, memory, emotion, and language. Within the either half of the cerebrum are two spaces called lateral ventricles. Each ventricle produces and is filled with cerebral spinal fluid (CSF), which coats the subarachnoid (beneath the arachnoid membrane) cavities of the brain and spinal cord. CSF fluid helps maintain and balance the internal pressure of the brain and spinal cord within their bone casings (skull and vertebrae), as well as bathes these structures with proteins and glucose.

The two ventricles form channels that slip through tiny openings in the brain called interventricular foramina (foramen of Monro) and join together into a deep midline third ventricle. A narrow tube called the cerebral aqueduct (aqueduct of Sylvius) drains CSF inferiorly into a fourth ventricle, located between the cerebellum in the posterior cavity (fossa) of the skull and a portion of the brain stem.

Neonatal head pathology

One developmental abnormality is of the cerebellum and brain stem pulled down into and through the foramen magnum (Arnold-Chiari malformation, type II, clamping off CSF flow at the fourth ventricle and causing hydrocephalus or expansion of the ventricular system).

Other neonatal developmental abnormalities of the head referred for sonography are large cysts in the area where cerebellum should be, Dandy-Walker malformations, and hydrocephalus caused by congenital (from birth) obstruction of the aqueduct of Sylvius (aqueductal stenosis).

Prominent reasons for sonography of the neonatal head are to rule out hemorrhage within the brain, above the dura mater (epidural), or below the dura mater (subdural). Inflammation of the meninges and ventricles are also reasons for prompt scanning of the neonatal brain. Finally, brain masses are obvious reasons for using sonography as a way to characterize a lesion in the brain as solid or cystic.

225. Imaging the neonatal head

Using at least a 7.5 MHz sector array transducer with a small footprint allows sonographers to obtain the complex images of the neonatal brain. Many radiologists establish neonatal head protocol based on certain structures that they want to see on the image. The structures and the order in which they are imaged vary with the radiologists and institutions. The following images are basic protocol typical of most departments:

1. Coronal images of the interhemispheric fissure.
2. Sagittal and coronal (or transverse) views of the corpus callosum (the tissue that connects the hemispheres).
3. Lateral ventricles.
4. The third ventricle.
5. Contents of the posterior fossa.

To obtain these images, most sonographers use the open anterior fontanelle as a window through the bone of the skull. Nearly all of the images can be obtained by manipulating transducer at this fontanelle. Common coronal scan planes are generally based on acquiring certain landmarks.

Common Coronal Scan Planes and Landmarks	
Anterior	Anterior frontal horns of the lateral ventricles
Middle	Lateral ventricles, third ventricle, corpus callosum
Posterior (A)	Cisterna magna
Posterior (B)	Choroid within the atria of the lateral ventricles
Posterior (C)	Posterior brain matter

The sagittal scan planes found in many departments are based on three major scan planes: a central midline scan and an approximately 10-degree angulation of the transducer to either side for lateral plane views. To obtain images of the cerebellum and posterior fossa that are not well seen with coronal views, some radiologists will ask for axial views obtained from a fontanelle located on the posterior and side of the head behind the ear (mastoid fontanelle).

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

224. Neonatal brain fundamentals

1. Which fontanelles of the neonatal skull are of particular interest to sonographers?

2. List the three layers of the brain meninges.

3. What is the narrow tube that drains CSF into the fourth ventricle?

4. What are the typical reasons for physicians to request a sonogram of the neonatal head?

5. List some neonatal developmental abnormalities of the head.

225. Imaging the neonatal head

1. Describe basic neonatal head protocol typical of most departments.

2. Match the scan plane in column B with the landmark in column A. Each item in column B may be used only once.

Column A	*Column B*
____ (1) Anterior frontal horns of the lateral ventricles.	a. Middle.
____ (2) Lateral ventricles, third ventricle, and corpus callosum.	b. Anterior.
____ (3) Choroid within the atria of the lateral ventricles.	c. Posterior.
____ (4) Posterior brain matter.	d. Posterior.
____ (5) Cisterna magna.	e. Posterior.

4–3. Invasive Procedures

The usefulness of sonography for assisting surgical procedures cannot be understated. The ability to see where a needle or catheter is going through successive layers of tissue, real-time, and cheaply compared to the costs of surgical instruments, is invaluable. In this section, we will briefly look at some of the interesting ways sonography can enhance interventional procedures.

226. Performing invasive ultrasound

Without sonography, physicians who perform invasive procedures (those that enter the body through piercing the skin) are technically doing so blind. Such a method relies on the physician's knowledge of typical anatomical and pathological structures, with varying degrees of extensiveness. However, with sonography, the accuracy of performance increases to a near standard, and physicians are able to see where they are scanning and what they are doing in real-time.

Ultrasound guidance

Whatever invasive procedure used, one of three guidance methods will typically be employed:

1. Indirect needle guidance.
2. Free hand technique.
3. Needle guidance.

The indirect guidance is nothing more than marking the skin over the site where sonographic images were taken to demonstrate the target. The free-hand technique involves the operator seeing the needle being placed into the target from virtually any angle with a free hand while watching the image real-time via sonography. In the needle guidance method, the needle is attached to the transducer and is visualized inserting into the target along a pre-determined path.

Aspiration/localization

Aspiration is technically a form of biopsy in that fluid rather than solid tissue is extracted from the body using a needle under ultrasound guidance. Fluid is then examined by laboratory analysis. Most aspiration procedures call for thin diameter needles, such as the 22 or 20 gauge needles to aspirate or drain various fluids from cysts to abscesses. This is why it is sometimes referred to as fine-needle aspiration (FNA). Various types of needles having removable parts that allow catheters to be inserted are available, as well as needles that accommodate equipment such as guide-wires and three-way stopcocks for drainage procedures. Renal cysts, breast cysts, or abscesses throughout the body are some of the areas of interest for FNA. Breast masses typically call for the use of the free-hand guidance method, whereas a more direct approach is used for other procedures. FNA using larger bore 18 gauge needles are sometimes used to extract cells from solid nodules in the thyroid. Thoracentesis (the passage into the chest with a hollow needle, trocar, and cannula for draining fluid from the pleural space), or simply marking on the skin a location before thoracentesis, is significantly enhanced when guided by sonography. Intervention procedures (i.e., thoracentesis) for thorax fluid collections are accomplished through curvilinear transducers that can view the chest tissue through the rib cage. FNA is also used for thoracentesis.

Sonographic localization procedures are largely used to augment mammography. Ultrasound guidance for the placement of a guide wire before a surgical procedure is the extent of the sonographer's involvement. Normally localization using sonography is for masses already known. Sonography is used in the event a patient will be unable or unwilling to undergo mammographic localization.

Ultrasound-guided needle biopsy

Ultrasound-guided needle biopsy is strictly used for solid tissue extraction of cells. Large needles are typically required beginning with 16-gauge or larger. Most needle-biopsies (also called *core* biopsies) use spring-loaded biopsy guns, in which the needle is loaded into a handheld mechanism and inserted into the body percutaneously (through the skin) and guided under sonography to the edge of a target. A button is pressed and the needle is thrust forward into a target lesion and then manually withdrawn with a sample amount of target tissue (the core) within the needle. This is quite useful for hard, tough tumors or masses. The entire procedure, before, during, and immediately after the firing of the biopsy gun, is recorded. Most biopsy guns are held separately from the ultrasound transducer. You may work in a department where the radiologist fires the biopsy gun while you hold the transducer directly over the site of interest.

Because of the possibility for uncontrolled internal hemorrhaging, sonography helps to see the post-biopsy effects on any vascular structures in the path of the needle. Patients with blood-clotting problems should be identified before attempting ultrasound-guided needle biopsy.

Interoperative portable sonography

Frequently referred to as *intra*operative sonography, the procedure is simply the use of sonography during operating room surgery. Thus, the procedure is an invasive one. Normally, this involves moving sonographic units (thus, making them portable) from the ultrasound section to the operating room.

Interoperative portable sonography is used to provide real-time benefit of direct visualization of disease during the surgical procedure. Surgeons find interoperative sonography particularly useful for locating and characterizing masses and fluid collections during operations of such structures as the liver, the kidneys, pancreas, and the biliary system. Frequently, new characterization of disease is discovered that may have been masked during routine pre-operation sonography. Compared to other surgical imaging devices, such as bulky C-arm equipment, sonography in the operating room is quicker, uses no ionizing radiation, and provides easier direct organ imaging.

Sonographers always should use sterile techniques and personal protective equipment when in the surgical environment. Each facility has their own protective procedures, but certain precautions are universal. For example, surgical gloves, mask, and gown are basic items needed. Also, most sonographers will have sterile probe covers, usually made of latex with coupling gel inside for sound transmission through the material. Various designs of surgical probe covers are available for the interoperative procedure. Also manufactured are sterile plastic covers or barriers for the ultrasound unit itself. Many surgeons will have everyone in the surgical suite scrub (surgical handwashing before donning surgical clothing), with no exceptions. If you do have to scrub, always remember to consider every surface non-sterile, and do not touch anything unless clearly told you can touch it. The reverse is also true; if unscrubbed, assume everything in the room to have an invisible sterile field and ask where you are permitted to work. This latter distinction still involves the complete sterilization of your equipment and at least semi-sterilization of the hand that holds the probe.

227. Thorax sonography

Because previous units have covered most of the anatomy concerning parts requiring invasive sonography, such as the liver or kidneys, and because sonographers are sometimes called upon to perform ultrasound guidance for an invasive procedure of the thorax (thoracentesis), we will briefly cover the anatomy and physiology of the chest or thorax.

Anatomy and physiology

The ribcage surrounds the thoracic cavity posteriorly and laterally, with a cartilaginous attachment to the ends of the ribs anteriorly meeting up with the sternum or breastbone centrally. In between individual ribs are intercostal muscles, which allow the rib cage to expand and contract. Sonographers use the intercostal space as windows for thoracic imaging. Inferiorly, the diaphragm separates the thoracic cavity from the abdominal cavity.

Beneath the ribs is the parietal pleura, a membrane that covers the entire inner wall of the thoracic cavity to include the superior surface of the diaphragm. On the inferior surface of the diaphragm, the portion that faces the abdomen, there is a peritoneum covering. The layer beneath the parietal pleura is the visceral pleura, which is separated from the parietal by a space called the pleural space. A small amount of pleural fluid is present in the space to lubricate the movement of the lungs against the thoracic wall during respiration. The visceral pleura separate and completely encase the lungs, partitioning those structures from the mediastinum, which contains esophagus, trachea, and heart. Thus, right and left pleural cavities are distinctly closed off from each other.

Of course, two air-filled lungs take up most of the thoracic cavity. The sole purpose of the lungs is to intake oxygen and to expel carbon dioxide. This gaseous exchange (respiration) takes place within thousands of individual lung sacs called alveoli. The ability to inhale and exhale air is largely a result of the rib cage, intercostal muscles, and the pleural membranes sliding past each other without friction. The lack of friction is, again, due to the presence of fluid in the pleural space. The capability of the lungs to expand and contract is largely due to the motion of the diaphragm.

Thorax pathology

Abnormalities of the chest can be characterized into three major areas:

1. Pleural.
2. Lung.
3. Mediastinal.

An increase in the normal amount of fluid within the pleural space is called a *pleural effusion*. Typically, sonographic involvement is concerned with locating a pleural effusion collection. Two types of pleural effusion are transudative (caused by heart failure or uremia, which is excessive urea and nitrogen wastes in the blood) and exudative (caused by infectious inflammation or malignancy). Infectious inflammation can cause pleural fluid to become prurulent, a condition called *empyema*, or pus in the pleural space. The pleura itself may thicken with both effusion and empyema, restricting the expansion of the lung and interfering with respiration.

Other pleural abnormalities can occur. For instance, *pleural plaques*, dense collagenous or calcified tissue caused by pneumonia, trauma, and exposure to certain chemicals and toxins. Tumors may occur from the lung tissue and can be found in the pleural space or as a part of the pleura itself.

The lung itself can be infiltrated with fluid and inflammatory cells within the air spaces caused by disease processes such as pneumonia. The affected lung tends to harden into a dense mass. This condition is called *consolidation*. Other lung abnormalities are atelectasis (absence of air in the lung with collapsed alveoli) and solid lung masses.

Cysts and masses typically collect within the mediastinum. Common types are *bronchogenic cysts* and *teratomas*. Usually sonographers are called on only to determine if a mass is solid or cystic.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

226. Performing invasive ultrasound

1. List three ultrasound guidance methods.

2. Most aspiration procedures call for which type of needles?

3. How are sonographic localization procedures related to mammography?

4. What is the strict use of ultrasound-guided needle biopsy?

5. What is the purpose for interoperative portable sonography?

227. Thorax sonography

1. What is the significance of the intercostal space to sonographers?

2. What is the sole purpose of the lungs?

3. List the three major abnormalities of the chest area.

4. What causes pleural plaques?

4–4. Three-and Four-Dimensional Ultrasound Imaging

Three-dimensional (3D) ultrasound is the acquisition, reconstruction, and evaluation of volume data in multiple scanning planes and is a recent ultrasound innovation. In this lesson, we will briefly introduce the sonographer to the methods and new technologies of 3D ultrasound imaging.

228. Three-dimensional imaging technology methods

Recent advances include real-time 3D, sometimes called four-dimensional (4D) ultrasound (time is the fourth dimension) . Although 3D ultrasound has been commercially available since the 1990s, many sonographers and physicians still perceive 3D as being a new technology. To broaden diagnostic awareness, it is necessary to understand the basic clinical and technical concepts of 3D ultrasound.

The technologies behind 3D ultrasound are diverse. Most new ultrasound scanners can be purchased with a 3D option. This simply means that the 3D hardware and software are integrated into the system while other companies have designed offline computers that connect to existing ultrasound systems that can convert ultrasound data into 3D. More precise offline 3D systems use electromagnetic positioning systems, which attach to the ultrasound transducer, and offer more accurate data acquisition. Still others have dedicated 3D ultrasound transducers that provide the easiest, most accurate, and reproducible 3D images at this time.

When a sonographer performs 3D ultrasound, the patient's anatomy is acquired as a volume data set . This volume data set must be displayed on a flat screen . This is typically achieved in the multiplanar format, which means that the original acquisition plane plus the two orthogonal planes are displayed on the screen. This will be further discussed later in the lesson.

3D ultrasound can be divided into three basic steps as follows:

1. Volume acquisition.
2. Multiplanar display.
3. Rendering.

Volume acquisition

Acquisition is the method of collecting patient anatomy as a series of slices, which are then processed and stored for display as 3D volume data. The data acquisition is the most important step. Without an accurate volume data set, the 3D reconstruction and rendering will not be accurate and thereby, not useful. The two primary methods of acquiring volumes are manual acquisition and automatic acquisition.

Manual acquisition

Manual acquisition is the original 3D method of collecting anatomy. This method required the sonographer to move the transducer physically along the patient's skin to collect anatomy as a series of slices ; the quality of the data set was very operator dependent. The two-dimensional (2D) slices are stored in a cineloop and compressed into a 3D volume data set.

Unfortunately, manually sliding the transducer at a constant speed over a given distance proved to be difficult, which often resulted in non-uniform data sets.

Automatic acquisition

The majority of manufactures have replaced manual acquisition transducer technology with specialized 3D transducers, in which the elements within the transducer move while the sonographer holds the transducer stationary; this method essentially removes the element of human error during acquisition. These transducers are often slightly larger than conventional transducers, but they provide a more accurate and reproducible volume data set.

Multiplanar display

After acquisition, patient anatomy may be reviewed, but it must be displayed on a flat screen. This is typically achieved by using the multiplanar display, which demonstrates anatomy as three simultaneous orthogonal scan planes: longitudinal, transverse, and the coronal planes.

It is important to understand that planar images display an orthogonal relationship. That is to say, images display 90 degrees to each other. These planes can be rotated and manipulated to create the optimal scan plane and is accomplished by rotating each plane on the X, Y, or Z axis. The sonographer may also rotate the planar images to provide a more comprehensive review of complex anatomy or pathology. The multiplanar display, in conjunction with the 3D rendered image, provides the most clinical benefit.

Rendering

Renderings display a 3D representation of the anatomy of interest. The sonographer can use several types of rendering algorithms to view varying anatomy. Images rendered in 3D are usually classified into two groups: *surface* or *transparent renderings*.

Surface mode

Surface rendering is used to generate a surface detail of the desired anatomy (fig. 4–6). This is the most common rendering mode .

Figure 4–6. Fetal Face.

Transparent mode

Transparent renderings look beyond the surface of the anatomy to reveal structures located within, and are usually composed of, one of the following rendering modes: *maximum* or *minimum*.

Maximum mode

When viewing the volume date set, the sonographer can instruct the computer to display only the brightest intensity echoes within the volumes (instead of looking at the surface anatomy). This is called the maximum mode. It is used to assess the fetal skeletal anatomy (fig. 4–7).

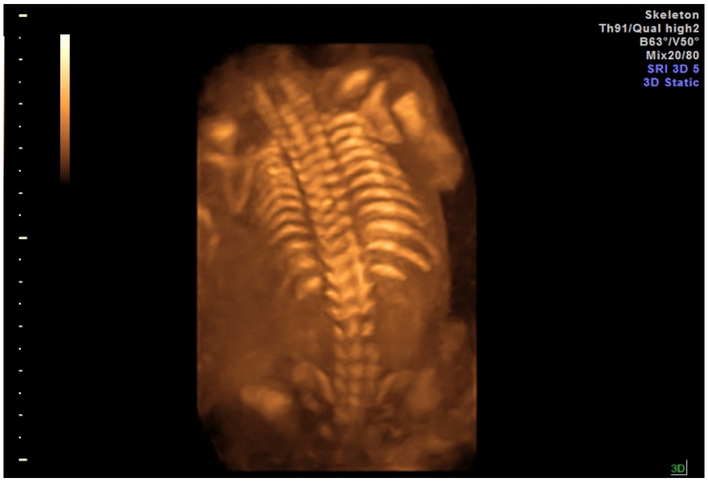

Figure 4–7. Fetal Skeleton.

Minimum mode

In contrast to the maximum mode, the minimum mode emphasizes the lowest intensity echoes within the volume. This is used for visualizing fluid-filled structures such as vasculature, cystic areas, fetal bladder, stomach, and amniotic fluid.

229. New three-dimensional imaging technologies

Three-dimensional/four-dimensional volumetric ultrasound continues to evolve. The latest advances have centered on ultrasound automation. There are certain structures that can be automatically identified and manipulated by the ultrasound systems themselves.

Ultrasound automation

One example of an automation tool is sonographic volume computer-aided display (SonoVCAD), which is designed to show the fetal's heart outflow tracts and great vessels from a single, four-chamber acquisition . Another tool, sonography based automatic volume count (SonoAVC) is intended to automatically count and measure follicles in a stimulated ovary.

Volumetric transducer

New volume transducers are also being introduced. These developments are in the form of matrix array transducers. These transducers contain thousands of elements that can be fired in ways to capture true real-time volumes and create live displays of multiple planes and 4D rendering simultaneously. Currently, the clinical application for these transducers are limited to echocardiography.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

228. Three-dimensional imaging technology methods

1. What represents the fourth dimension in 4D ultrasound?

2. When performing a three-dimensional ultrasound, how is the patient's anatomy acquired and what is it displayed on?

3. What are the three basic steps 3D ultrasound is divided into?

4. Match the description in Column A with the appropriate step of three-dimensional ultrasound in Column B. Each item in column B may be used only once.

Column A	Column B
___(1) Removes the element of human error when acquiring scan data.	a. Manual acquisition.
___(2) Displays a three-dimensional representation of anatomy of interest.	b. Automatic acquisition.
___(3) Requires physical movement of transducer along patient to collect anatomy.	c. Multiplanar display.
___(4) Demonstrates anatomy as three simultaneous orthogonal scan planes.	d. Rendering.

5. What is the *most* common rendering mode?

229. New three-dimensional imaging technologies

1. What does SonoVCAD stand for and what is it designed to do?

2. What is SonoAVC intended to do?

Answers to Self-Test Questions

221

1. Age, genetic factors, and individual hormone influence.
2. (1) Premammary zone (subcutaneous layer).
   (2) Mammary zone (mammary layer).
   (3) Retromammary zone (retromammary layer).
3. Suspensory ligaments of breast, fibrous connective tissue commonly referred to as Cooper ligaments.
4. Functional or glandular tissue of the breast. This layer is divided into at least 15 lobes, each with ducts and hundreds of lobules, and separated by dense fibrous tissue. Inside each lobule is less dense fibrous tissue that surrounds the ducts and, along with varying amounts of fat, is interspersed throughout. Also, inside each of the lobules are the functional units of the breast called TDLU, composed of tiny sac-like glands called acini or alveoli as well as intralobular stroma or connective tissue.
5. Milk is secreted from the TDLU into the lactiferous ducts.

222

1. Benign.
2. Unlike typical fibroadenomas, giant fibroadenomas occur in adolescents, tending to rapidly grow and cause pain.
3. Can be both puerperal and non-puerperal; large collections with an elongated shape, coursing roughly parallel to the duct of origin. Because mastitis can cause an inflamed duct to rupture, fluid is spilled into the breast tissue.
4. (1) c.
   (2) a.
   (3) b.
   (4) d.
5. Invasive ductal or infiltrating ductal carcinoma.

223

1. At least a 7 MHz linear-array transducer or higher with multiple focal zones in the near-field.
2. Echogenic layer; Young women: thick and contains some areas of hypoechoic fat; occasionally, hypoechoic linear structures (ducts) are seen; May be echogenic and dense from fibrous tissue; Pregnant or lactating women: Extremely thickened and echogenic with a homogeneous echotexture; Older and post-menopausal women: Thin or almost entirely replaced with hypoechoic fat; Cooper ligaments remain highly echogenic and give a polyhedral shapes to the fat lobules.
3. (1) Upper Outer Quadrant: RUOQ and LUOQ.
   (2) Lower Outer Quadrant: RLOQ and LLOQ.

(3) Upper Inner Quadrant: RUIQ and LUIQ.

(4) Lower Inner Quadrant: RLIQ and LLIQ.

4. Border (surface) is irregular (spiculated, thick, or hypo/hyper echoic), angular, with microlubualtions; the shape is taller-than-wide, with extension or branches into a visible duct; and an internal appearance of hypoechogenicity, clusters of microcalcifications within mass, and acoustic posterior shadowing beginning from within the mass..
5. Mural nodules, projections from cyst walls into the lumen.

224

1. The anterior or frontal fontanelle primarily, and the posterior or occipital fontanelle secondarily.
2. (1) Dura mater (tough outer covering).
   (2) Arachnoid (middle membrane).
   (3) Pia mater (inner layer).
3. Cerebral aqueduct (aqueduct of Sylvius).
4. Development abnormalities, brain lesions, hemorrhage, and inflammation.
5. Large cysts in the area where cerebellum should be, Dandy-Walker malformations, and hydrocephalus caused by congenital (from birth) obstruction of the aqueduct of Sylvius (aqueductal stenosis).

225

1. Coronal images of the interhemispheric fissure, sagittal and coronal (or transverse) views of the corpus callosum (the tissue that connects the hemispheres), the lateral ventricles, the third ventricle, and the contents of the posterior fossa.
2. (1) b.
   (2) a.
   (3) d.
   (4) e.
   (5) c.

226

1. (1) Indirect needle guidance.
   (2) Free hand technique.
   (3) Needle guidance.
2. Thin diameter needles, such as the 22 or 20 gauge needles.
3. Augment.
4. Solid tissue extraction of cells.
5. To provide real-time benefit of direct visualization of disease during surgical procedures. Surgeons find interoperative sonography particularly useful for locating and characterizing masses and fluid collections during operations of such structures as the liver, the kidneys, pancreas, and the biliary system. Frequently, new characterization of disease is discovered that may have been masked during routine pre-operation sonography.

227

1. Sonographers use the intercostal space as windows for thoracic imaging.
2. To intake oxygen and to expel carbon dioxide.
3. (1) Pleural.
   (2) Lung.
   (3) Mediastinal.
4. Pneumonia, trauma, and exposure to certain chemicals and toxins.

228

1. Time.

2. Using volume data sets and must be displayed on a flat screen.
3. Volume acquisition, multiplanr display, and rendering.
4. (1) b.
   (2) d.
   (3) a.
   (4) c.
5. Surface.

229

1. Sonogrphic volume computer-aided display that shows the fetal's heart outflow tracts and great vessels from a single, four-chamber acquisition.
2. Automatically count and measure follicles in a stimulated ovary.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy.

82. (221) What is the relationship of the subcutaneous layer and the premammary zone in the breast?
    a. Premammary zone is the subcutaneous layer.
    b. Premammary zone is inside the subcutaneous layer.
    c. Subcutaneous layer is below the premammary zone.
    d. Subcutaneous layer is above the premammary zone.

83. (221) Where inside the mammary layer of the breast are terminal ductolobular units (TDLU) located?
    a. Lobules.
    b. Nipples.
    c. Lobes.
    d. Ducts.

84. (222) What is the *common* factor of both puerperal and non-puerperal mastitis?
    a. Inflammation of the breast.
    b. Formation of a galactocele.
    c. Occurs after delivering child.
    d. Peripheral abscess formation.

85. (222) What characteristic makes ductal carcinoma in situ (DCIS) different from invasive carcinoma?
    a. Ductal.
    b. Metastatic.
    c. Noninvasive.
    d. Hyperechoic.

86. (223) What is the *main* reason for performing breast sonography?
    a. Analyze breast implants.
    b. Locate the lactiferous ducts.
    c. Ascertain the size of breasts.
    d. Characterize palpable masses.

87. (223) Of the following, which sonographic characteristic will a radiologist require you to demonstrate as a criterion for a simple cyst?
    a. Mural nodule.
    b. Thin septations.
    c. Irregular border.
    d. Anechoic lumen.

88. (223) What is the sonographic appearance of a fibroadenoma compared to fat?
    a. Hyperechoic.
    b. Hypoechoic.
    c. Isoechoic.
    d. Anechoic.

89. (224) What helps maintain internal pressure of the spinal cord?
    a. Pia mater.
    b. Falx cerebri.
    c. Cerebral spinal fluid.
    d. Fine-needle aspiration.

90. (224) Which of the following developmental abnormalities involves the cerebellum being pulled down into the foramen magnum?
    a. Brain hemorrhage.
    b. Aqueductal stenosis.
    c. Dandy Walker malformation.
    d. Arnold-Chiari malformation, type II.

91. (224) What is a reason for requesting sonography of the neonatal head?
    a. Stenosis.
    b. Dysphagia.
    c. Inflammation.
    d. Hypertension.

92. (225) Through which skull structure will some radiologist ask for axial views of the cerebellum?
    a. Mastoid fontanelle.
    b. Anterior fontanelle.
    c. Posterior fontanelle.
    d. Occipital fontanelle.

93. (226) What ultrasound guidance method involves attaching a needle to the transducer and visualizing the needle along a pre-determined path?
    a. Needle guidance.
    b. Indirect needle guidance.
    c. Free-hand needle technique.
    d. Three-way stopcock guidance.

94. (226) Of the following techniques, which extracts fluid from the body rather than solid tissue?
    a. Free hand.
    b. Aspiration.
    c. Core biopsy.
    d. Localization.

95. (226) Breast masses typically call for which guidance method?
    a. Needle guidance.
    b. Free-hand technique.
    c. Indirect needle guidance.
    d. Three-way stopcock guidance.

96. (226) What is interoperative sonography?
    a. Sonography replacing surgery.
    b. Sonography during surgery.
    c. Sonography before surgery.
    d. Sonography after surgery.

97. (226) What surrounds the thoracic cavity posteriorly and laterally?
    a. Ribs.
    b. Pleura.
    c. Sternum.
    d. Diaphragm.

98. (226) What structure covers the entire inner wall of the thoracic cavity?
    a. Parietal pleura.
    b. Visceral pleura.
    c. Tunica albuginea.
    d. Tunica vaginalis.

99. (227) An increase in the normal amount of fluid within the pleural space is called pleural
    a. plaque.
    b. empyma.
    c. effusion.
    d. consolidation.

100. (227) What is absence of air in the lungs?
a. Atelectasis.
b. Pleural effusion.
c. Bronchogenic cyst.
d. Pleural consolidation.

Student Notes

Student Notes

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