Chapter 16

Bony Thorax, Chest, and Abdomen

Learning Objectives

At the conclusion of this chapter, you will be able to:

- Name the bones that make up the bony thorax and identify each on an anatomic diagram and on a radiograph
- Name and identify on an anatomic diagram the principal organs located within the thoracic cavity
- Name and identify on an anatomic diagram the principal organs located within the abdominal cavity
- Identify significant positioning landmarks in the thoracic and abdominal areas by palpation
- Demonstrate correct body and part positioning for routine projections and common special projections of the bony thorax, chest, and abdomen
- Correctly evaluate radiographs of the bony thorax, chest, and abdomen for positioning accuracy
- Describe and recognize on radiographs pathology that is common to the bony thorax, chest, and abdomen

Key Terms

aorta
atelectasis
bronchus (pl. bronchi)
cardiophrenic angles
carina
colon
costophrenic angles
diaphragm
duodenum
emphysema
esophagus
ileum
jejunum
KUB
mediastinum
peritoneum
pleura
pleural effusion
pneumoconiosis
pneumonia
pneumothorax
sphincter
sternum
thorax
trachea
vena cava

Anatomy and positioning of the thoracic and abdominal cavities are covered in this chapter. Chest radiography is within the scope of practice for most limited x-ray machine operators (LXMOs) with the exception of those holding licenses that restrict practice to specific body parts. Radiography of the ribs and of the abdomen is less commonly within the LXMO scope of practice but is included in this chapter for educators and students in those states where imaging of these body parts is allowed.

Radiography of skeletal anatomy requires an approach that is quite different from that used for visualization of the soft tissues and organs. Examinations of the bony **thorax** and chest involve the same general part of the body, but they differ from each other considerably. This chapter details the positioning and techniques required to best demonstrate both types of thoracic tissue.

Although chest and abdominal radiography both involve soft tissue and organs, they are quite different. As explained in Chapter 7, subject contrast reflects tissue density differences within the body part. Differences in subject contrast require variations in exposure factors, primarily kilovoltage peak (kVp) and milliampere seconds (mAs), to obtain optimal visualization on the radiograph. The subject contrast of the chest differs greatly from that of the abdomen. Subject contrast within the chest is provided by the radiolucency of the air in the lungs. The abdomen has tissues with very similar densities and therefore has relatively little subject contrast.

Chest radiographs provide diagnostic information about the heart, lungs, and other organs that lie in the area around the heart. Although chest radiography may seem to be the simplest and most familiar of all radiographic examinations, it is also the most likely to provide lifesaving information for the patient's care. For this reason, the ability to take high-quality chest radiographs is an essential skill for limited operators.

Radiography of the abdomen, on the other hand, is less likely to be required of the limited operator. In some states, abdominal radiography is beyond the scope of limited practice. Even when there is no restriction on abdominal radiography, these examinations are not often performed in an outpatient setting. If you are using this book as a text in a formal course, the abdomen may not be included in the curriculum. Basic information on the anatomy, positioning, and pathology of the abdomen is included here so that the content will be comprehensive for those who need this information.

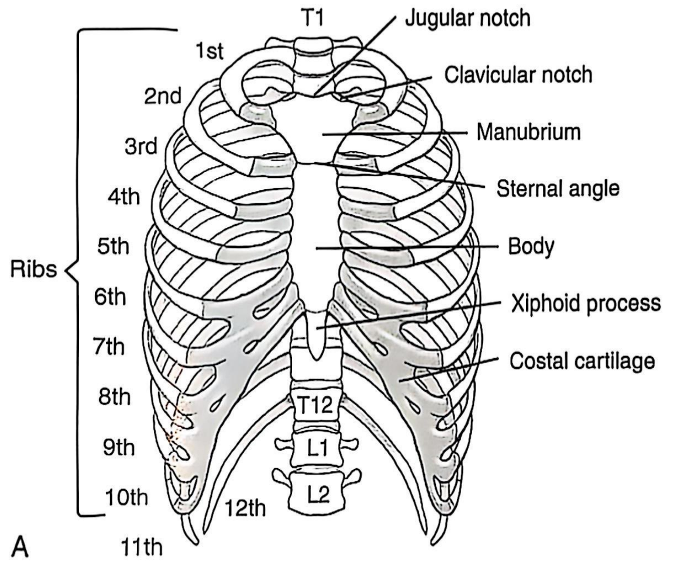
ANATOMY

Bony Thorax

The term *thorax* refers to the upper portion of the trunk, the chest. The thoracic cage (Fig. 16.1) is the bony structure that surrounds the organs of the chest and upper abdomen. It consists of the 12 thoracic vertebrae, 12 pairs of ribs, and the breastbone, which is called the **sternum.**

The sternum is a slender, flat bone located in the midline of the anterior thorax. It has three parts: the manubrium, the body or gladiolus, and the xiphoid process. The manubrium is the superior portion. Its upper margin is indented to form the jugular notch, also called the *manubrial notch* or *suprasternal notch*, which is a useful positioning landmark. The body is the long, middle portion of the sternum. The junction of the manubrium and the body forms a palpable bony ridge called the *sternal angle*. The xiphoid process is the distal tip and is also a useful positioning landmark. In childhood the xiphoid process is formed only of cartilage; it ossifies in adulthood.

The ribs are numbered 1 through 12, from the top down. They are attached posteriorly to the thoracic



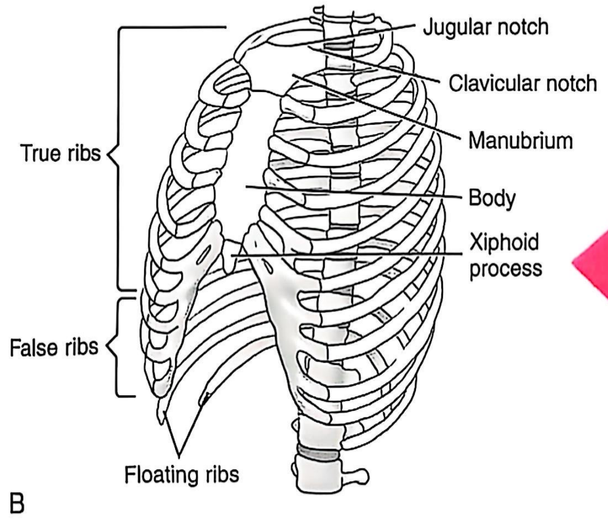


Fig. 16.1 Bony thorax. (A) Anterior aspect. (B) Anterolateral oblique aspect.

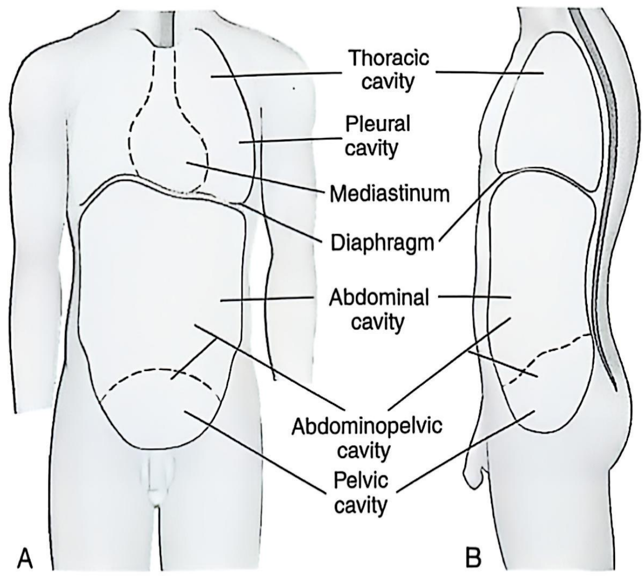


Fig. 16.2 Body cavities. (A) Anterior aspect. (B) Lateral aspect.

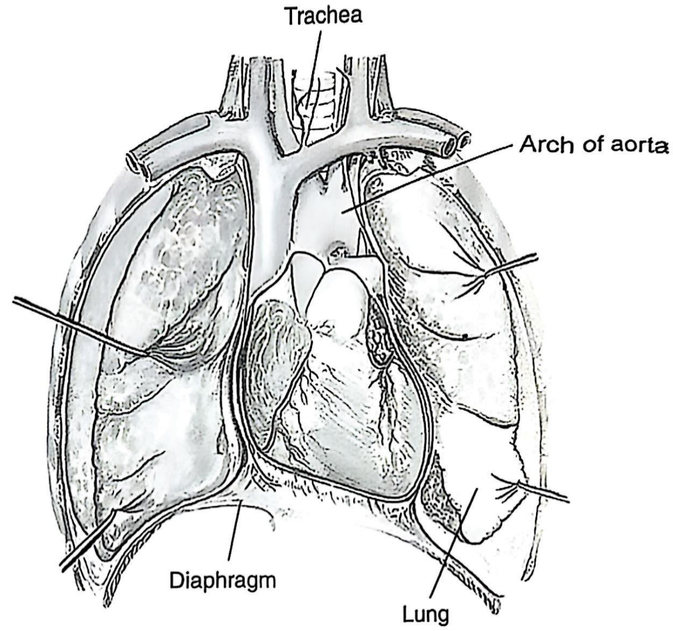


Fig. 16.3 The thoracic cavity is divided into three sections: the right and left pleural cavities and the mediastinum.

vertebrae, forming the costovertebral articulations. Ribs are long flat slender curved bones, and most have costal cartilage at their anterior ends. The connection between the rib and its associated cartilage is called the *costochondral articulation.* The anterior end of each rib is approximately 3 to 4 inches inferior to its posterior end. When one is breathing, the rib articulations move gently, which allows the thorax to expand with inspiration and to contract with expiration.

The first seven pairs of ribs are called *true ribs.* They attach anteriorly to the sternum, forming cartilaginous amphiarthrodial joints. The lower five pairs of ribs are called *false ribs* because they do not completely surround the thorax. Ribs 8, 9, and 10 are attached to bands of costal cartilage attached to the sternum. Ribs 11 and 12 are also called *floating ribs.* They have no cartilage and are not attached anteriorly.

Cavities of the Trunk

The interior of the trunk of the body is divided into two main cavities, the thoracic cavity and the abdominopelvic cavity (Fig. 16.2). The two cavities are separated beneath the lungs by the **diaphragm.** The diaphragm is a large sheath of muscle that expands and contracts with breathing. It forms an arching curve from front to back.

Chest

The thoracic cavity (Fig. 16.3) is divided into three parts: two pleural cavities that contain the lungs and the space between the lungs, which is called the **mediastinum.** The principal structures within the mediastinum are the heart, with its associated great vessels; the trachea or "windpipe"; and the **esophagus.** The trachea is a part of the respiratory system and connects the throat to the lungs. The esophagus is a part of the digestive system and connects the throat to the stomach. Portions of the lymphatic system (the thymus gland and many lymph nodes) are also located within the mediastinum.

The heart (Fig. 16.4) is the principal organ of the circulatory system, which is introduced in Chapter 12. It occupies the inferior portion of the mediastinum in a sac of serous membrane called the *pericardium.* It is about the size of a fist and consists mainly of heart muscle tissue called the *myocardium.* The heart is divided into four hollow chambers: the right and left atria, which are receiving chambers, and the right and left ventricles, which are discharging chambers. Blood enters the atria through veins and is pumped out into arteries via the ventricles. Valves between the chambers regulate blood flow.

The term *great vessels* refers to the veins and arteries that carry blood to and from the heart. The **vena cava** is the large vein that brings oxygen-depleted blood from the body to the right atrium. Venous blood contains carbon dioxide (CO_2), a gas, which is a waste product of oxygen use. The blood then flows into the right ventricle and is pumped into the pulmonary arteries, which carry it to the lungs. In the capillaries of the lungs, CO_2 is exchanged for oxygen and the CO_2 is exhaled. Oxygenated blood returns from the lungs to the left atrium via the pulmonary veins. From the left atrium it flows into the left ventricle, which pumps it back out to the body via the **aorta.** The aorta is the largest artery of the body. It leaves the heart in a superior direction and makes a "U turn" through what is called the *aortic arch.* Arteries branching from the aortic arch supply blood to the head and upper body. The descending aorta passes in an inferior direction posterior to the heart, through the diaphragm, and through the abdomen. Its many branches supply oxygenated blood to the remainder of the body.

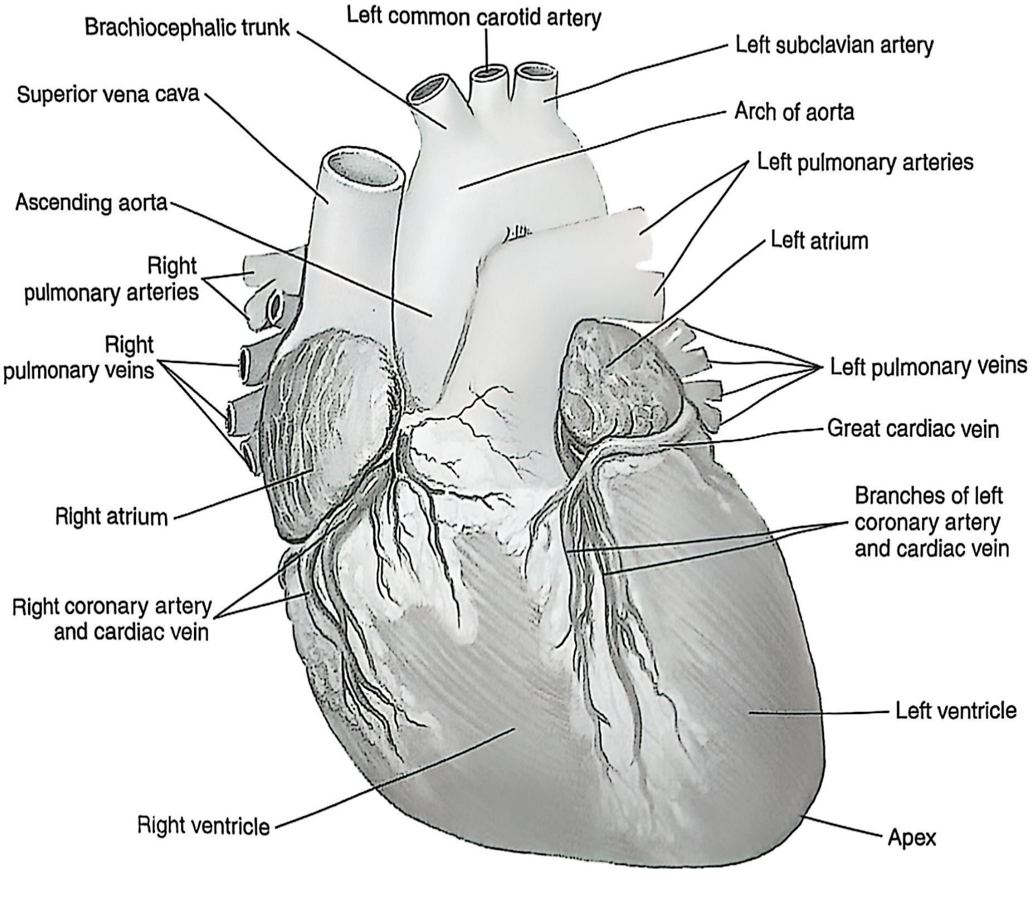


Fig. 16.4 Anterior aspect of the heart.

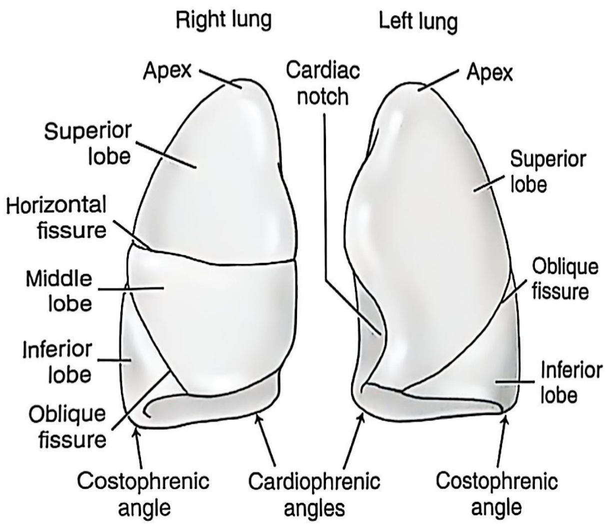


Fig. 16.5 Anterior aspect of the lungs.

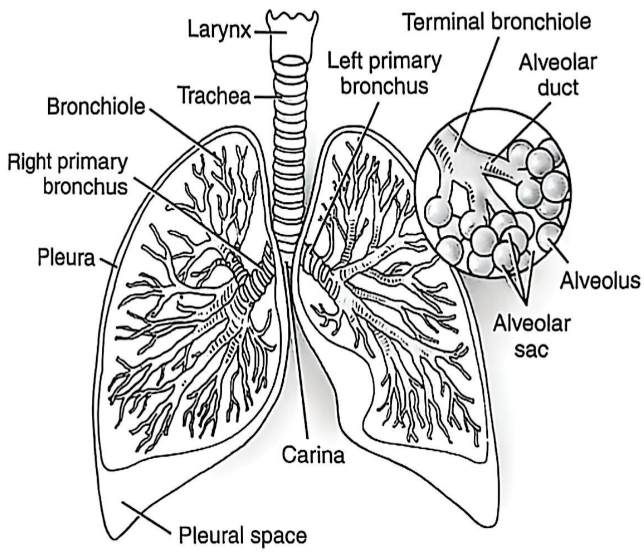


Fig. 16.6 Organs of the respiratory system within the thoracic cavity.

Respiratory System

The respiratory system is introduced in Chapter 12. The principal organs of the respiratory system are the lungs (Fig. 16.5), which are divided into sections called *lobes*. The right lung has three lobes: superior, middle, and inferior. The left lung has only two lobes: superior and inferior. Each lung is shaped somewhat like a tall pyramid. The broad lower surface is called the *base* and the angle at the top is called the *apex*. The inferolateral corners are called the **costophrenic angles.** The inferomedial corners are called the **cardiophrenic angles.** The left lung is slightly smaller and is narrower at the base than the right lung.

The other organs of the respiratory system include the mouth and nasal passages, pharynx (throat), larynx, trachea, and **bronchi** (singular, *bronchus*) (Fig. 16.6).

A small valve between the pharynx and the trachea, the epiglottis, closes off the trachea when one swallows, so that food passes into the esophagus rather than the trachea. The trachea divides into right and left primary branches at the **carina** (tracheal bifurcation), found at about the level of the sternal angle and the T4-T5 interspace. Each primary branch enters one lung and then divides into secondary branches, one for each lobe of the lung.

The membranes that line the pleural cavities and cover the lungs are called **pleura.** They secrete serous fluid, which moistens and lubricates the surfaces so that the lungs can move smoothly against the walls of the pleural cavity with breathing motion. The space between the lungs and the walls of the pleural cavity is called the *pleural space.*

Abdomen

The abdominopelvic cavity is divided into two sections: the abdominal and pelvic cavities. The abdominal cavity is the larger section, extending from the diaphragm into the upper portion of the bony pelvis. It contains the principal organs of the digestive tract: the stomach, small and large intestines, liver, gallbladder, and pancreas. The spleen, which is part of the lymphatic system, is also located within the abdominal cavity. Its location is immediately beneath the diaphragm on the far left and behind the stomach.

The abdominal organs are contained in a double-walled serous membrane sac called the **peritoneum.** Parietal peritoneum lines the walls of the cavity and visceral peritoneum is positioned over and around the organs in folds. The folds between the organs, the mesentery, hold the organs in position. The anterior fold of the visceral peritoneum is called the *omentum.*

The abdominopelvic cavity also contains the urinary system. The kidneys and ureters are located in the retroperitoneal space, posterior to the visceral peritoneum, against the posterior wall of the abdominal cavity.

The pelvic cavity is inferior to the abdominal cavity and situated within the bones of the pelvis. It contains the urinary bladder, the distal portion of the large intestine, and the internal parts of the reproductive system.

There are two systems for dividing the abdominopelvic cavity into parts so that locations within it can be readily identified. The simplest system is that which divides the area into four quadrants (Fig. 16.7). More specific localization is provided by a system that divides the abdomen into nine regions (Fig. 16.8). The limited operator must learn the names of the quadrants and regions and the principal structures that lie within each. This knowledge will facilitate clear communication regarding the site of a patient's pain or wound or make it easier to locate the area of clinical interest on a radiograph.

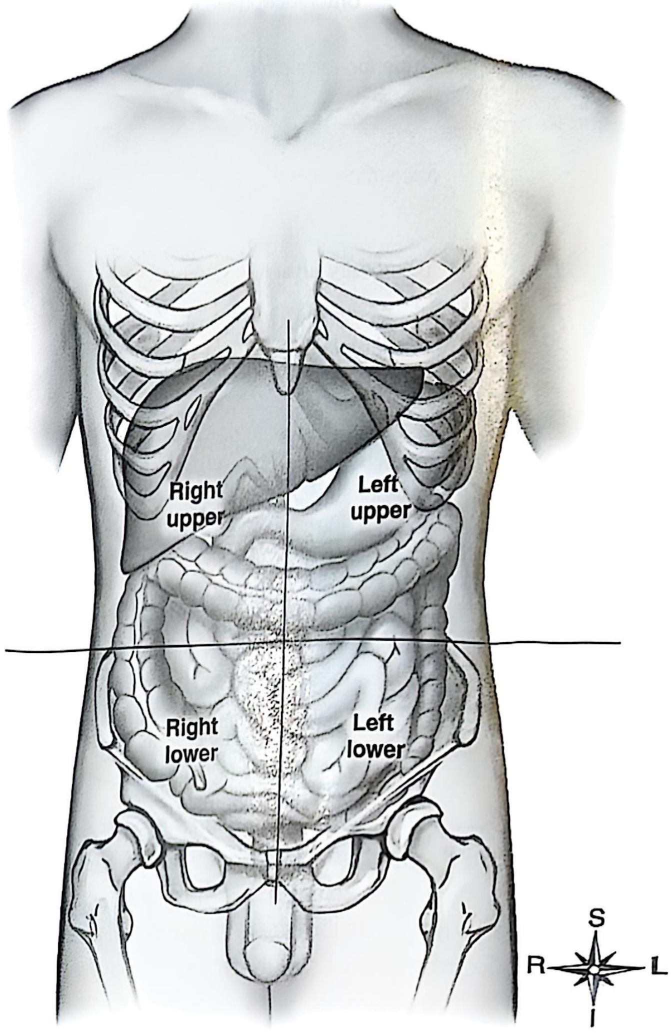


Fig. 16.7 Abdominopelvic cavity divided into quadrants: *I*, Inferior; *L*, left; *R*, right; *S*, superior.

Alimentary Canal

The digestive system is introduced in Chapter 12. The portions of the alimentary canal that are within the abdominopelvic cavity are the distal end of the **esophagus,** the stomach, the small intestine, and the large intestine, also called the **colon** (Fig. 16.9).

From the mouth, food passes through the pharynx and into the esophagus at the epiglottis. The esophagus passes through the mediastinum and the diaphragm and into the abdominal cavity. Between the esophagus and the stomach is a round muscle called a **sphincter,** which opens and closes the opening to the stomach.

The stomach is in the left upper quadrant of the abdomen. Its rounded upper portion is called the *fundus.* The large central curved portion is called the *body.* The lateral surface of the body is called the *greater curvature,* and the medial portion is called the *lesser curvature.* The narrow distal portion of the stomach is called the *pylorus.* Another sphincter, the pyloric sphincter, joins the pylorus to the first portion of the small intestine.

Digestion and absorption of food occur in the small intestine. The adult small intestine is 20 to 22 feet in

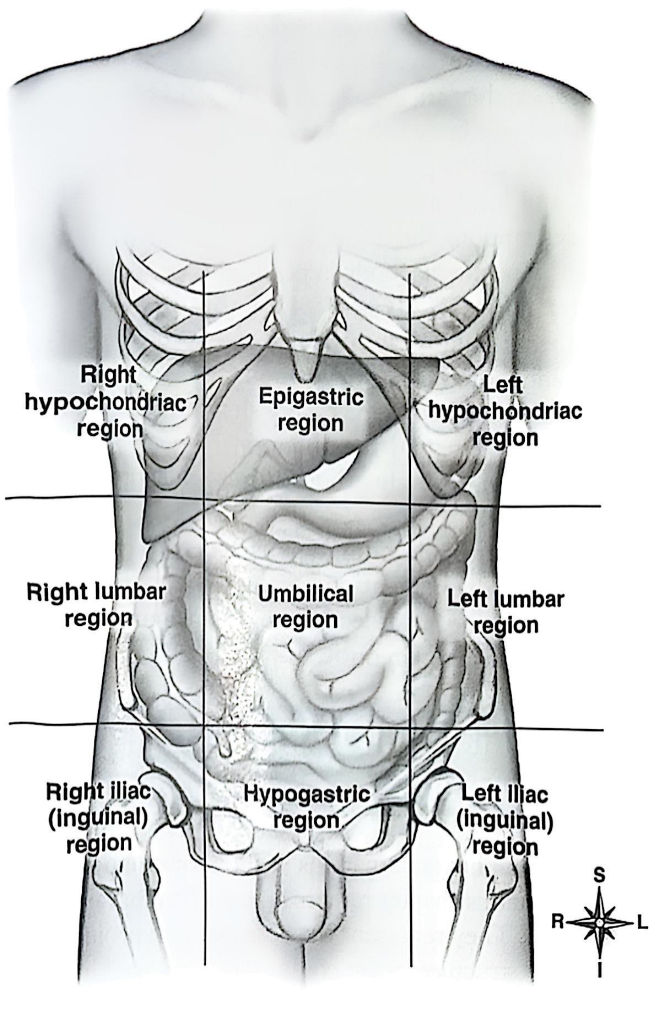


Fig. 16.8 Nine abdominal regions: *I*, Inferior; *L*, left; *R*, right; *S*, superior.

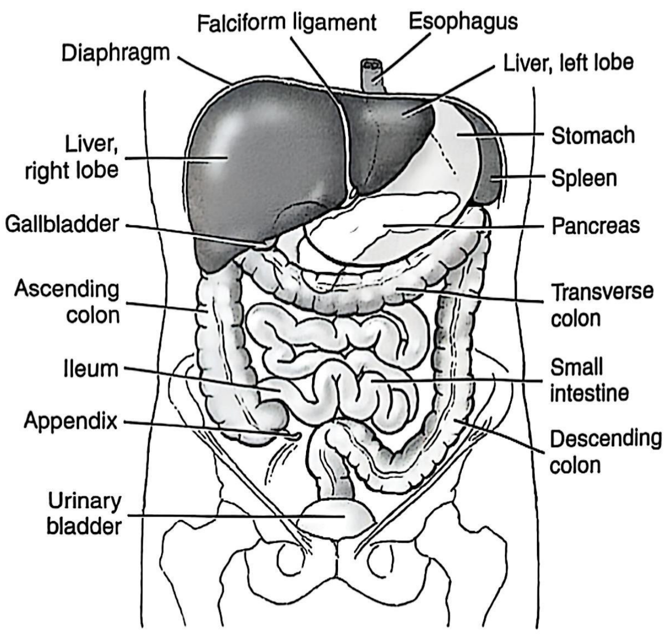


Fig. 16.9 Abdominal organs of the digestive system.

length. Its diameter ranges from 1.5 inches at the proximal end to about 1 inch at the distal end.

The small intestine has three parts. The proximal portion is the **duodenum.** It is about 8 to 10 inches long and forms the shape of the letter C. The rounded segment just distal to the pyloric sphincter is called the *duodenal bulb.* There is no obvious division between the second and third portions of the small intestine. The first 8 feet or so of the small intestine past the duodenum is called the **jejunum,** and the remainder is called the **ileum.** The distal portion of the ileum is called the *terminal ileum.* The ileum and jejunum loop back and forth across the central and lower part of the abdominal cavity and are framed by the colon.

The principal functions of the large intestine or colon are to reclaim water from the intestinal contents and to eliminate solid food waste from the body. The first portion, the cecum, is located in the right lower quadrant. The terminal ileum attaches to the cecum at the ileocecal valve. The appendix is a small pouch attached to the cecum. From the cecum, the ascending colon extends superiorly to the right upper quadrant, where it makes a right-angle turn in the medial direction. This turn is called the *right colic flexure.* The transverse colon extends across the upper abdomen and turns inferiorly on the left side at the left colic flexure. From this flexure it extends inferiorly and is called the *descending colon.* In the left lower quadrant, the colon forms an S-shaped curve. This portion is called the *sigmoid colon*, for the Greek letter sigma (σ). The sigmoid colon extends toward the midline, where it turns inferiorly again and is called the *rectum.* The terminal portion of the rectum is called the *anal canal.* Food waste exits the body at the anal sphincter.

Other Digestive System Organs

The other organs of the digestive system that lie within the abdominal cavity are the liver, gallbladder, and pancreas (Fig. 16.10). The liver and gallbladder and their associated ducts are called the *biliary system.*

The liver is a large organ in the right upper quadrant. It fills the right hypochondriac region and part of the epigastric region. It is wedge-shaped, with its apex to the left of the midline. The liver has several important functions. It is a storehouse for energy, and it removes toxins from the blood. Its most important function from a radiographic standpoint is the production of bile. The liver manufactures and secretes bile, which the body uses to digest fats. The hepatic ducts of the liver collect the bile and come together to form the common hepatic duct.

The gallbladder is a storage sac for bile and is located on the undersurface of the liver. The cystic duct is the passage for bile between the gallbladder and the common hepatic duct. The common hepatic and cystic ducts come together to form the common bile duct. Following a meal that contains fats, the gallbladder contracts, releasing bile. The bile flows through the common bile duct and into the

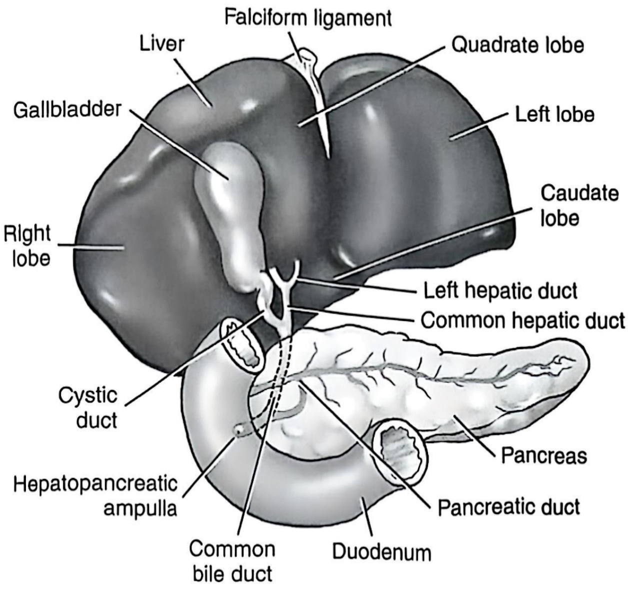


Fig. 16.10 Liver, gallbladder, and pancreas in relation to the duodenum.

duodenum at the hepatopancreatic ampulla, also called the *ampulla of Vater*.

The pancreas is an elongated gland that lies transversely in the upper abdomen. It is attached to the posterior abdominal wall. The wide end, which is called the *head*, lies in the curve of the duodenum. The tail lies adjacent to the spleen. The midportion is called the *body*. The pancreas manufactures insulin and glucagon, enzymes that are essential to sugar metabolism. The pancreas also secretes pancreatic juices that aid digestion. The pancreatic juices flow through the pancreatic duct and empty into the duodenum at the hepatopancreatic ampulla.

BODY HABITUS

Accurate radiography of the chest and abdomen requires an awareness of body habitus—that is, the general shape of the patient's body. Organs vary greatly in size, shape, and location according to body types. The four basic types of body habitus are called *sthenic*, *hyposthenic*, *asthenic*, and *hypersthenic*; they are illustrated in Fig. 16.11.

The sthenic body habitus is considered to be "average." About 50% of the population has this body type. The size, shape, and location of organs correspond to classic textbook descriptions and illustrations.

The hyposthenic body type might be thought of as "slender normal." About 35% of the population has a hyposthenic build. The organs tend to be longer, narrower, and more vertical in position.

The asthenic body type is very slender. The organs are long and narrow, and the abdominal organs are located much lower in the body. About 10% of the population has this body type.

The hypersthenic body type is a massive and stocky. About 5% of the population has this body type. The thorax is short, broad, and deep. The organs tend to be high and more horizontal in position.

POSITIONING AND RADIOGRAPHIC EXAMINATIONS

The radiographic examinations of the thorax and abdomen presented in this chapter require no use of radiographic contrast media. They represent the positions and projections of those body structures most commonly employed in limited practice. They generally require use of large 14 × 17 inch (35 × 43 cm) image receptors (IRs). Variations in orientation and centering of the IR for thoracic and abdominal imaging are related to the location of the diaphragm and influenced by both body habitus and respiratory phase. Although the thorax and abdomen may have a similar thickness, imaging requires the application of different technical factors: high kVp for the large variations in tissue densities in the chest, moderate kVp to demonstrate the small differences in tissue densities in the abdomen, and low kVp for the thin bones of the thoracic cage.

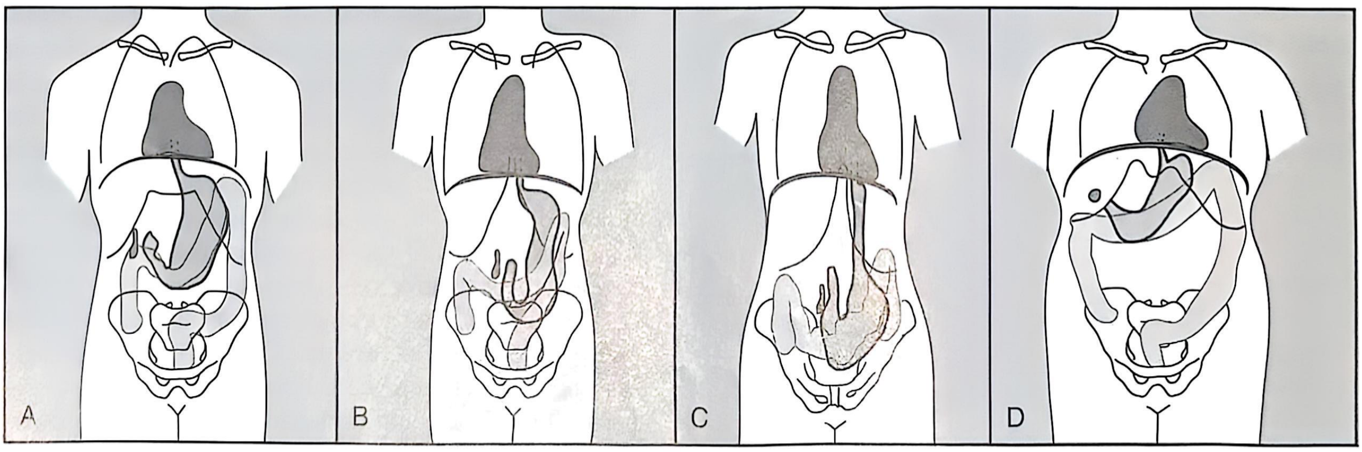


Fig. 16.11 Organ shape and location in relation to body habitus. (A) Sthenic. (B) Hyposthenic. (C) Asthenic. (D) Hypersthenic.

Chest

When physicians read chest radiographs, the diameter of the heart shadow is compared with the size of the thoracic cage. This is an important diagnostic measurement. Chest radiography is done at 72 inches (183 cm) source–image receptor distance (SID) to minimize magnification of the image of the heart. For the same reason, posteroanterior (PA) and left lateral projections are preferred to anteroposterior (AP) and right lateral projections. Keeping the heart as close to the IR as possible and using a 72-inch SID increases the accuracy of heart size measurements.

Exposures of the chest are most commonly made on inspiration to expand the lung fields. This expansion also results in separation of the pulmonary vasculature (the small vessels of the lungs), allowing a more complete evaluation of the lung. It is good practice to have the patient take two deep inspirations, holding the breath in on the second inspiration. This often produces a deeper inspiration for the exposure. In addition, if deep inspiration causes a cough reflex, the radiographer will be less likely to expose the IR during a cough. The act of inspiration causes the diaphragm to move caudad (Fig. 16.12). The greater the inspiration, the greater the depression of the diaphragm. Evidence of a full inspiration is seen on a chest radiograph when 10 ribs can be counted superior to the diaphragm.

The upright position is important, both for maximum lung expansion (gravity aids in caudal movement of the diaphragm) and for the visualization of air-fluid levels or pleural effusions. The decubitus position is also used to evaluate the presence of excess fluid in the pleural cavity. Air-fluid levels and **pleural effusion** are discussed in the pathology section of this chapter.

The chest has a high degree of subject contrast because the lungs are filled with air and easily penetrated, whereas the mediastinum is a very dense structure. For this reason, chest radiography requires a high-kVp technique to create images with low radiographic contrast and prevent the appearance of black lungs and white mediastinum, with little detail visible in either area. In addition, this high-kVp technique causes the ribs to appear less visible, so that the soft tissues are more easily evaluated. A grid is used to reduce fog from the high-energy scatter radiation that is produced with high kVp. Short exposure times are important because the heartbeat causes motion within the chest, which blurs the image when the exposure is longer than 0.05 second.

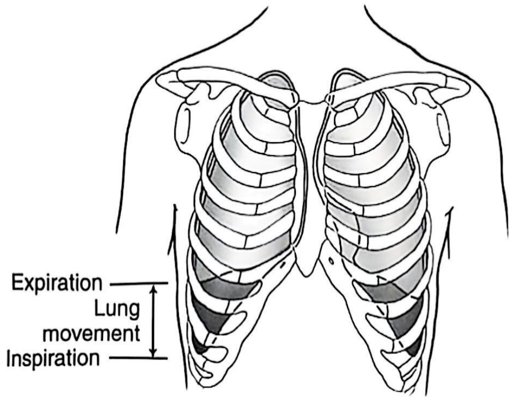


Fig. 16.12 Lung movement during respiration. Lungs expand during inspiration as the diaphragm moves caudad. Lungs contract on expiration as the diaphragm moves cephalad.

A lead half apron that wraps around the pelvis, front and back, is the ideal gonad shield for chest radiography. Collimation and beam attenuation by posterior body structures provide gonad shielding from lower-energy primary radiation and collimator scatter. The quantity of collimator scatter reaching the patient at 72 inches SID is minimal. However, for maximal protection, a lead shield should be used for all chest radiographs.

In preparation for chest examinations, the patient is instructed to remove all clothing and jewelry from the area between the neck and the waist and to don a gown that opens in the back.

ROUTINE EXAMINATION

The routine examination of the chest includes the PA and left lateral projections. When a patient is unable to stand for the PA projection, the AP projection can be substituted.

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 72 inches (183 cm) if possible

Body position: Standing, facing IR holder.

Part position:

PA: Anterior surface of chest is against upright Bucky with coronal plane parallel to IR. Backs of hands are placed on hips, and shoulders are rotated anteriorly (Fig. 16.13A). The purpose of arm position is to rotate scapulae out of the way so that they will not be superimposed on lungs. As an alternative, patients who are unsteady may wrap their arms around the Bucky to prevent movement and decrease the potential for a fall. IR is aligned so that upper margin is 1.5 to 2 inches (3.8 to 5 cm) above level of spinous process of C7.

> NOTE: Crosswise IR placement may be needed for patients with hypersthenic body habitus.

AP: Patient supine with arms at side (Fig. 16.13B). IR is aligned so that upper margin is 1.5 to 2 inches (3.6 to 5 cm) above level of shoulders.

Lateral: Both arms are raised overhead, with the patient grasping opposite elbows. As an alternative, patients who are unsteady can grasp an overhead bar, if incorporated into the upright Bucky, or an intravenous pole to prevent movement and decrease the potential for a fall. Left side of body is in contact with upright Bucky, and midcoronal plane of thorax is perpendicular to center of IR (Fig. 16.15). IR placement is unchanged from PA projection.

Central ray:

PA: Perpendicular to center of IR. Center point should be at the level of T7, which corresponds to the level of the inferior angle of the scapulae.

AP: Perpendicular to center of IR. Center point should be on the midsagittal plane at a level 3 inches below the jugular notch.

Lateral: Perpendicular to center of IR. Center point should be on the midcoronal plane at the level of T7.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on second deep inspiration.

Structures seen: Heart, lungs, and mediastinum. No rotation of the sternoclavicular joints on the PA projection (Fig. 16.14). Superimposition of the posterior ribs, indicating no rotation, on the lateral projection (Fig. 16.16).

Fig. 16.13 Chest. (A) Position for PA projection, patient upright. (B) Position for AP projection, patient supine.

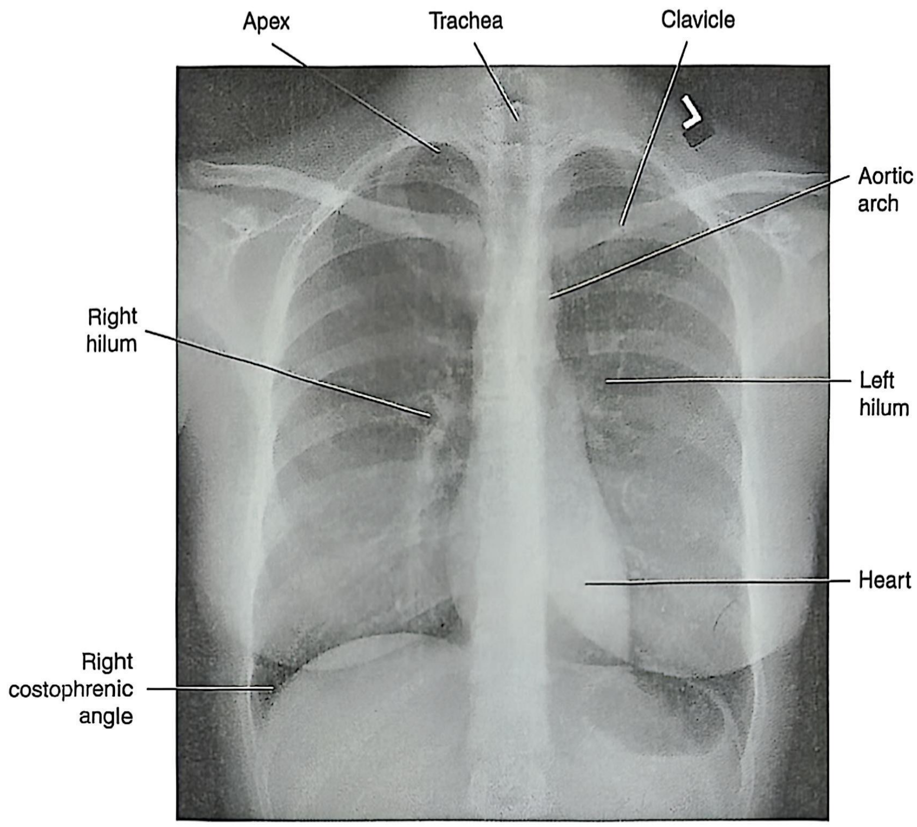


Fig. 16.14 Chest. PA projection.

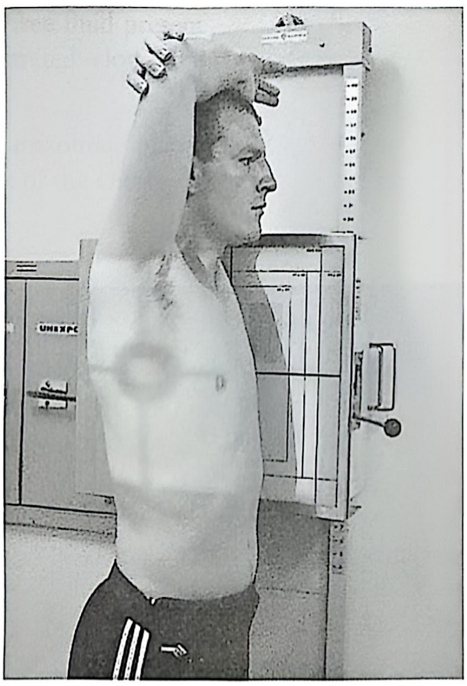


Fig. 16.15 Chest. Position for lateral projection, patient upright.

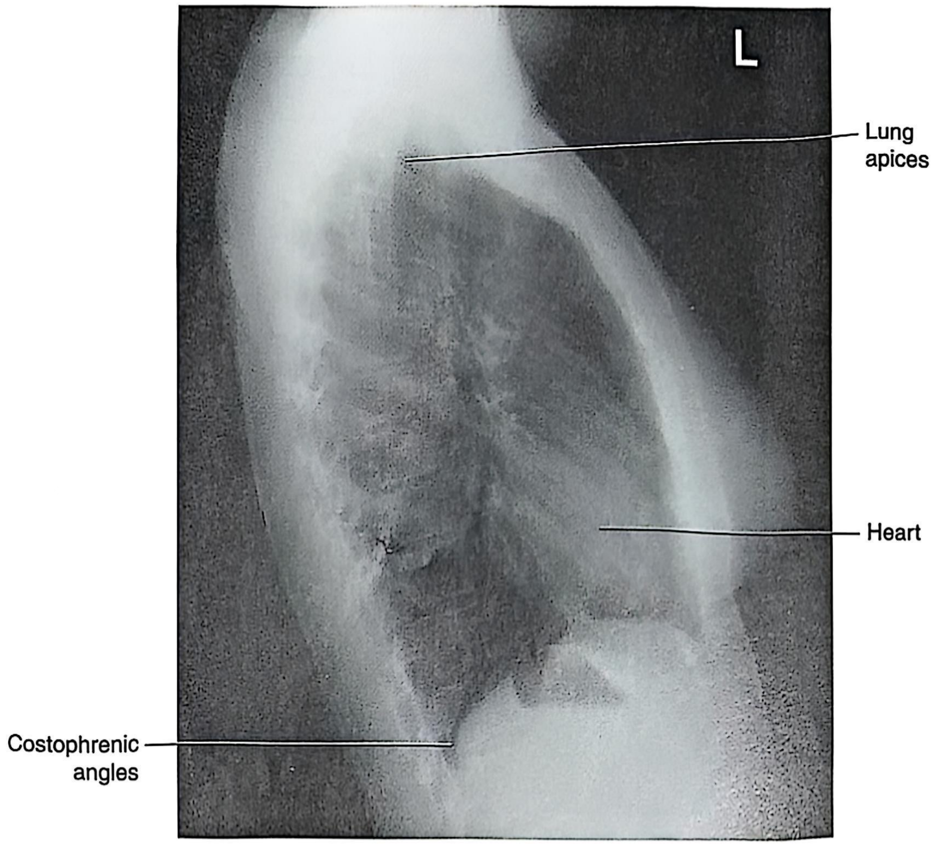


Fig. 16.16 Chest. Lateral projection.

SUPPLEMENTAL PROJECTIONS

AP OR PA PROJECTION (LATERAL DECUBITUS POSITION)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 72 inches (183 cm)

Body position: Recumbent, lying on side of interest.

Part position: Midsagittal plane of chest horizontal. Chest elevated 2 to 3 inches (5 to 8 cm) on radiolucent pad. Anterior or posterior surface of chest against a vertical grid device (Fig. 16.17).

Central ray: Horizontal and perpendicular to center of IR. Center point should be midsagittal and at the level of T7.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on second deep inspiration.

Structures seen: Heart, lungs, and mediastinum. Sternoclavicular joints equidistant from spine, which indicates no rotation (Fig. 16.18). Any free fluid present in the pleural space will be demonstrated along the dependent chest wall.

NOTE: Long axis of the IR is horizontal, placed lengthwise in relation to the long axis of the chest.

Fig. 16.17 Chest. Position for AP projection (right lateral decubitus position).

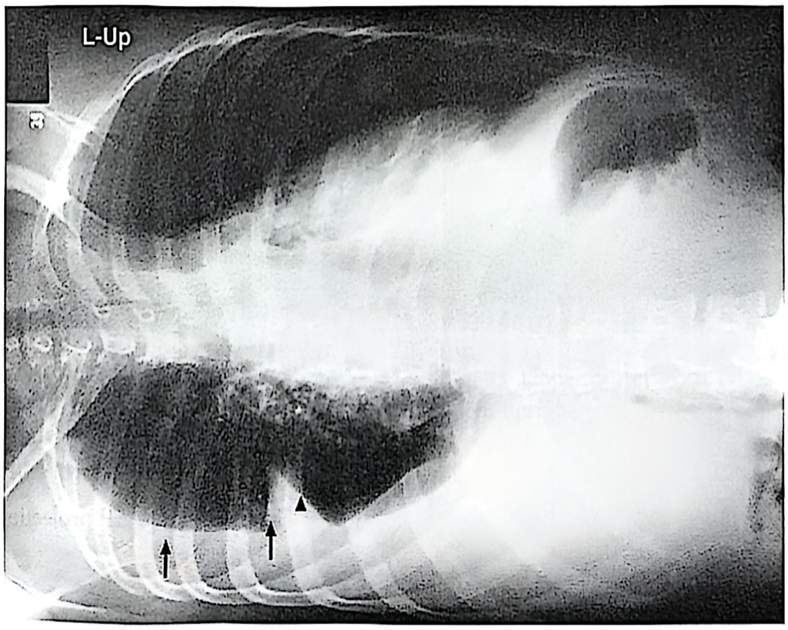


Fig. 16.18 Chest. AP projection, right lateral decubitus position. Fluid is visible in the right pleural cavity *(arrows)*. Note fluid in the fissure between lobes of the lung *(arrowhead)*. Note correct side marker placement, with the "up" side of the chest indicated.

Chest (Lung Apices)

AP AXIAL PROJECTION (LORDOTIC POSITION)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise

Grid: Yes

SID: 72 inches (183 cm)

Body position: Standing

Part position: Patient stands facing tube, 8 to 12 inches (20 to 30 cm) in front of upright Bucky. Patient then arches back and places shoulders against Bucky. Sagittal plane is perpendicular to IR. Backs of hands are placed on hips and shoulders rotated anteriorly (Fig. 16.19). The purpose of the arm position is to rotate the scapulae out of the way anteriorly so that they will not be superimposed on lungs. IR is aligned so that upper margin is 3 inches above upper border of shoulder.

Central ray: Perpendicular to center of IR. Center point should be at the level of the midsternum.

> NOTE: If the patient is unable to assume the lordotic position, the central ray can be angled 15 degrees cephalad with the patient standing erect. A 30-degree angle may be needed for patients with a shallow chest (small AP diameter).

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on second deep inspiration.

Structures seen: Apices of both lungs, free of superimposition by the clavicles (Fig. 16.20).

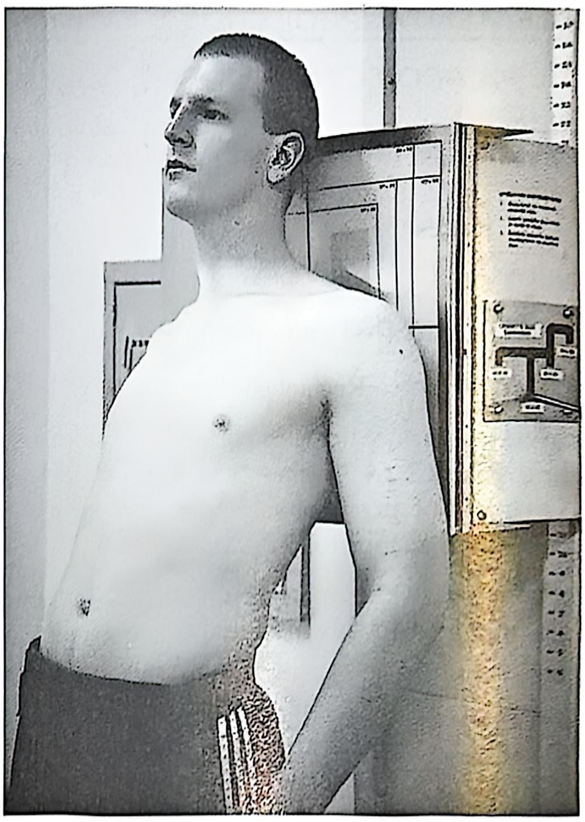


Fig. 16.19 Chest. Position for AP axial projection (lordotic position).

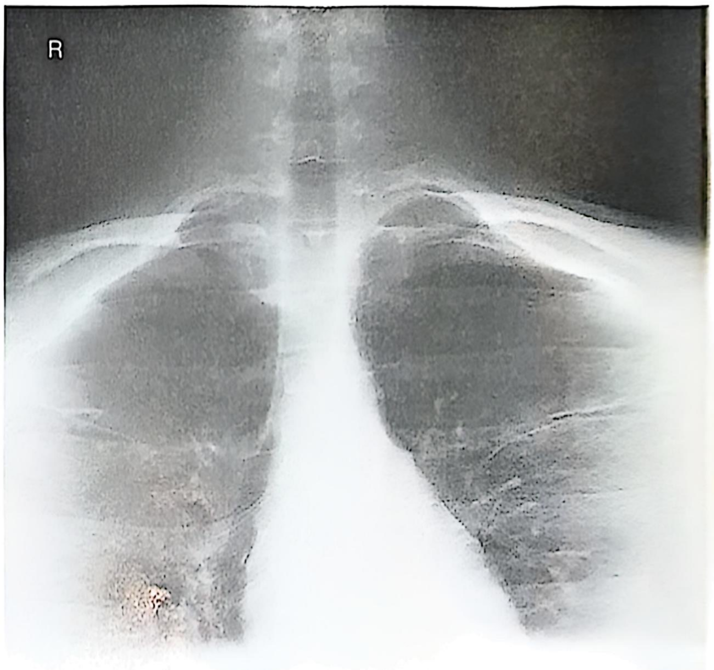


Fig. 16.20 Chest. AP projection (lordotic position).

Ribs

Rib studies may be done with the patient recumbent or upright. Upright positions are usually most comfortable for patients with painful rib injuries. Upright positions may also be safer, decreasing the possibility that pressure on rib fragments will cause puncture of the lung during positioning.

For purposes of radiography, ribs are named both by anatomic location and in relation to the diaphragm. Upper ribs are cephalad to the diaphragm, whereas lower ribs are below the diaphragm. The anterior aspects of the ribs are called the *anterior ribs*, whereas the posterior aspects are called the *posterior ribs*. The lateral aspects are referred to as the *axillary ribs* or *axillary portions*, because they are located within or near the axillary region.

A rib examination usually consists of AP or PA and oblique projections. Some physicians prefer to include chest radiographs because rib fractures may cause significant soft tissue injury that must be evaluated for proper patient care and treatment.

Both anterior and posterior ribs that are within the radiation field are seen on either AP or PA rib projections. However, the ribs nearest the IR are visualized with better detail. It is usual to take AP projections when the area of clinical interest is primarily posterior and to take PA projections for greater detail of the anterior ribs. Variations are acceptable when the preferred position would be too painful for the patient.

AP or PA projections demonstrate the anterior and posterior portions of the ribs, which are in the coronal plane. The axillary (lateral) portions of the ribs are oriented more or less in the sagittal plane and are seen "on end" on the AP or PA projection. For this reason, oblique projections are used to demonstrate the axillary portions of the ribs. Lateral projections are not useful because they result in the superimposition of right and left ribs.

For posterior ribs, the AP oblique projection is taken in the "same side" oblique position, with the side of clinical interest placed nearest the IR. That is, the right posterior oblique (RPO) position is used for right ribs and the left posterior oblique (LPO) position is used for left ribs. For anterior ribs, the correct PA oblique projection is that in which the side of interest is farthest from the IR. The right anterior oblique (RAO) position demonstrates the left ribs, and the left anterior oblique (LAO) position demonstrates the right ribs.

The ribs below the diaphragm require more exposure than the ribs above the diaphragm. This is because the air-containing lung tissues above the diaphragm are much more radiolucent than the dense abdominal tissues below the diaphragm. Separate exposure charts are used for the two areas. The lower ribs are radiographed on expiration to raise the diaphragm, ensuring a uniform tissue density.

ROUTINE EXAMINATION

UPPER POSTERIOR RIBS: AP AND AP OBLIQUE PROJECTIONS

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Standing or recumbent.

Part position:

AP: Supine on table or upright with posterior surface of chest against upright Bucky or grid holder (Fig. 16.21). Coronal plane is parallel to IR. Upper margin of IR is 1.5 to 2 inches (3.8 to 5 cm) above level of spinous process of C7.

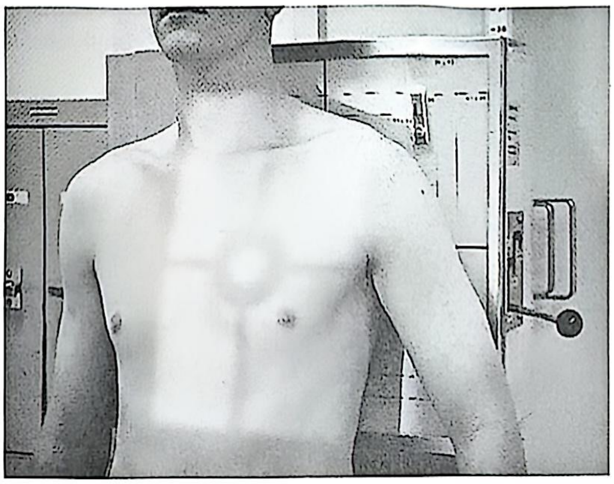


Fig. 16.21 Upper posterior ribs. Position for AP projection, patient upright.

AP oblique: RPO position for right ribs or LPO position for left ribs. Coronal plane forms an angle of 45 degrees with IR plane (Fig. 16.22). Upper margin of IR is 1.5 to 2 inches (3.8 to 5 cm) above level of spinous process of C7.

Central ray:

AP: Perpendicular to center of IR. Center point should be in midclavicular line at approximate level of axillary fold.

AP oblique: Perpendicular to center of IR. Central ray enters at a point on midline of anterior surface at approximate level of axillary fold.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on inspiration.

Structures seen: Ribs 1 through 10. Posterior portions are best seen on AP projection (Fig. 16.23); axillary portions are best seen on oblique projection (Fig. 16.24).

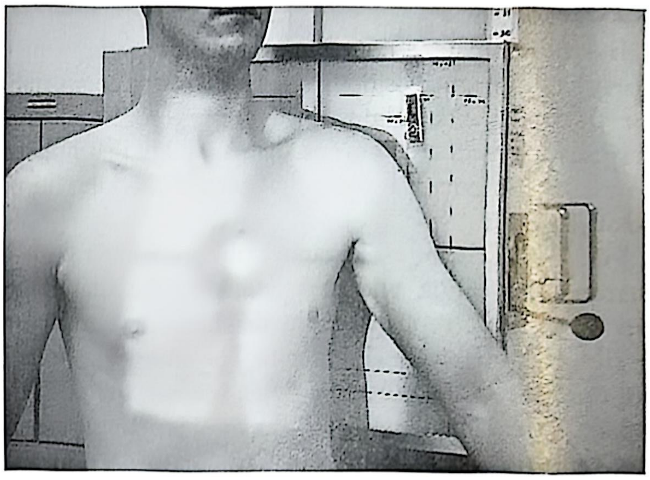


Fig. 16.22 Upper posterior ribs. Position for AP oblique projection, patient upright.

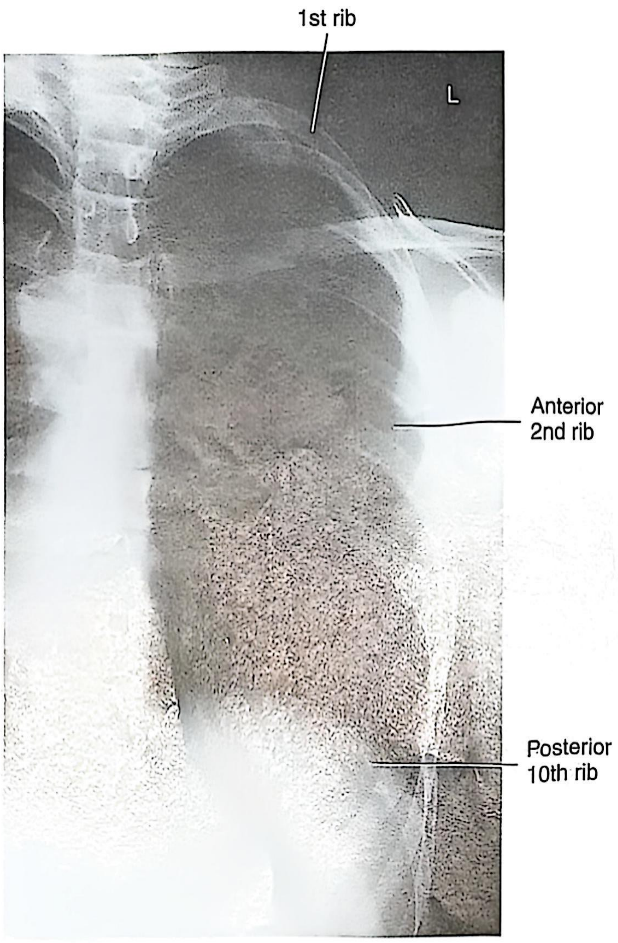


Fig. 16.23 Upper posterior ribs. AP projection.

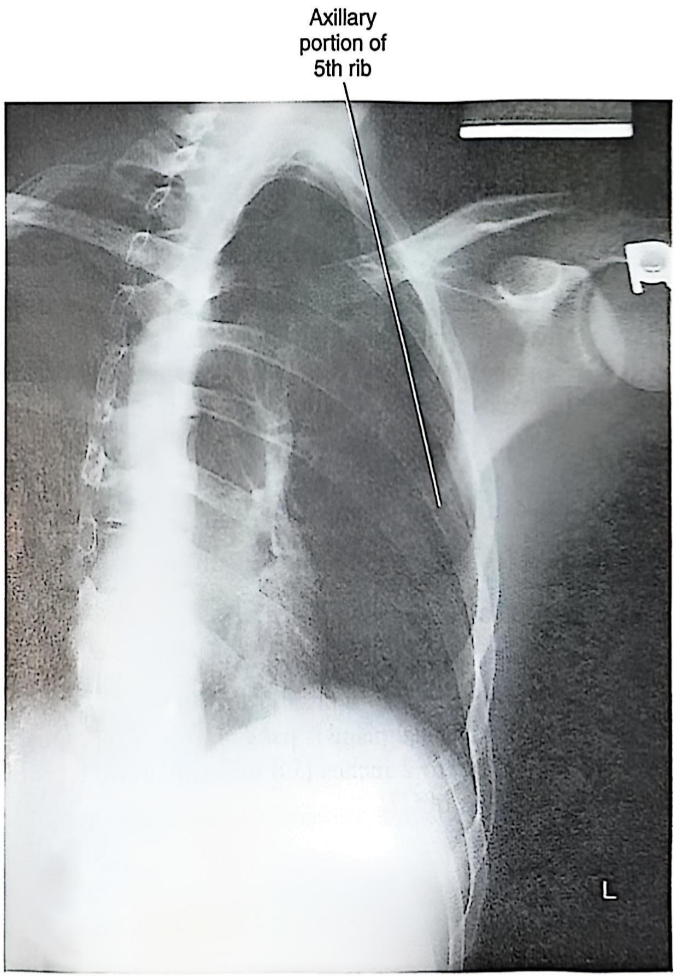


Fig. 16.24 Upper posterior ribs. AP oblique projection.

UPPER ANTERIOR RIBS: PA AND PA OBLIQUE PROJECTIONS

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum.

Body position: Standing or recumbent.

Part position:

PA: Prone on table or upright with anterior surface of chest against upright grid cabinet (Fig. 16.25). Coronal plane is parallel to IR. Upper margin of IR is 1.5 to 2 inches (3.8 to 5 cm) above level of spinous process of C7.

PA oblique: RAO position for left ribs or LAO position for right ribs. Coronal plane forms angle of 45 degrees with IR plane (Fig. 16.27). Upper margin of IR is 1.5 to 2 inches (3.8 to 5 cm) above level of spinous process of C7.

Central ray:

PA: Perpendicular to center of IR. Center point should be in midclavicular line at approximate level of axillary fold.

PA oblique: Perpendicular to center of IR. Central ray enters at point on posterior surface midway between spine and midaxillary line of affected side at approximate level of axillary fold.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on inspiration.

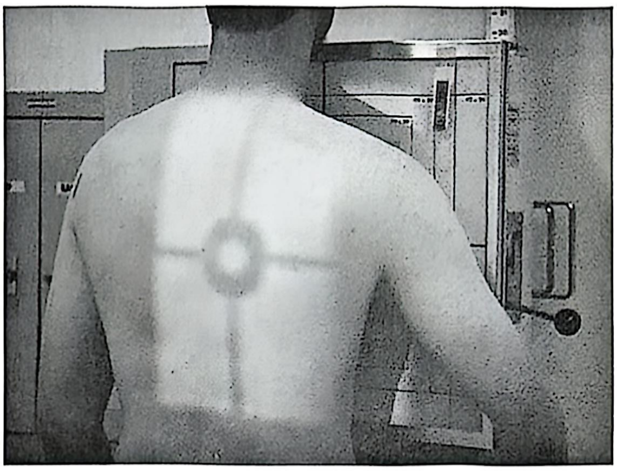


Fig. 16.25 Upper anterior ribs. Position for PA projection, patient upright.

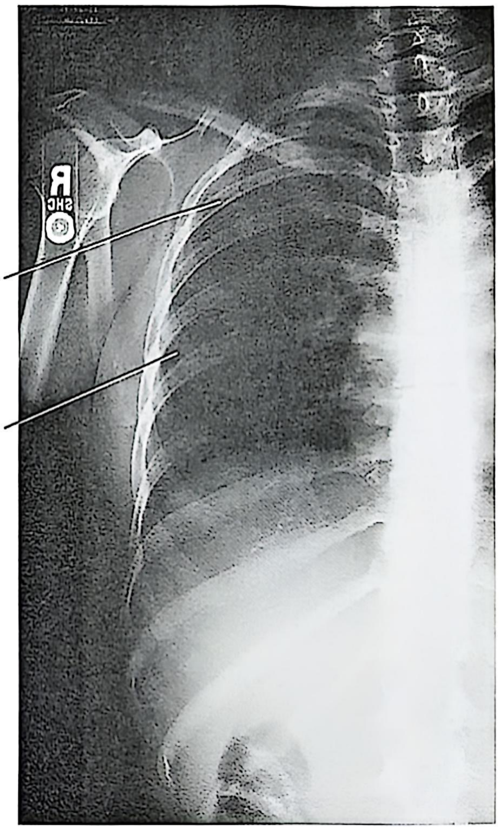


Fig. 16.26 Upper anterior ribs. PA projection.

Structures seen: Ribs 1 through 10. Anterior portions are best seen on PA projection (Fig. 16.26); axillary portions are best seen on oblique projection (Fig. 16.28).

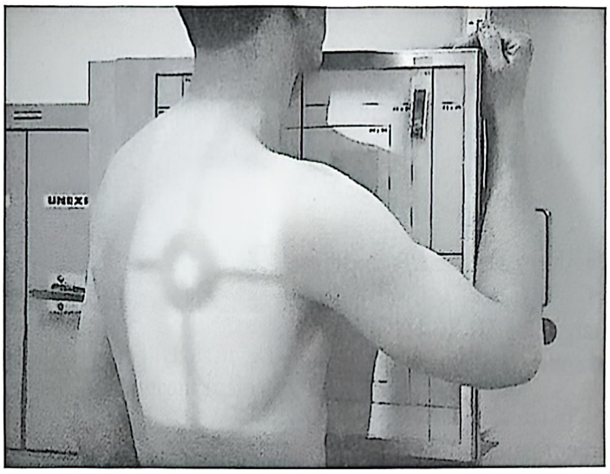


Fig. 16.27 Upper anterior ribs. Position for PA oblique projection, patient upright.

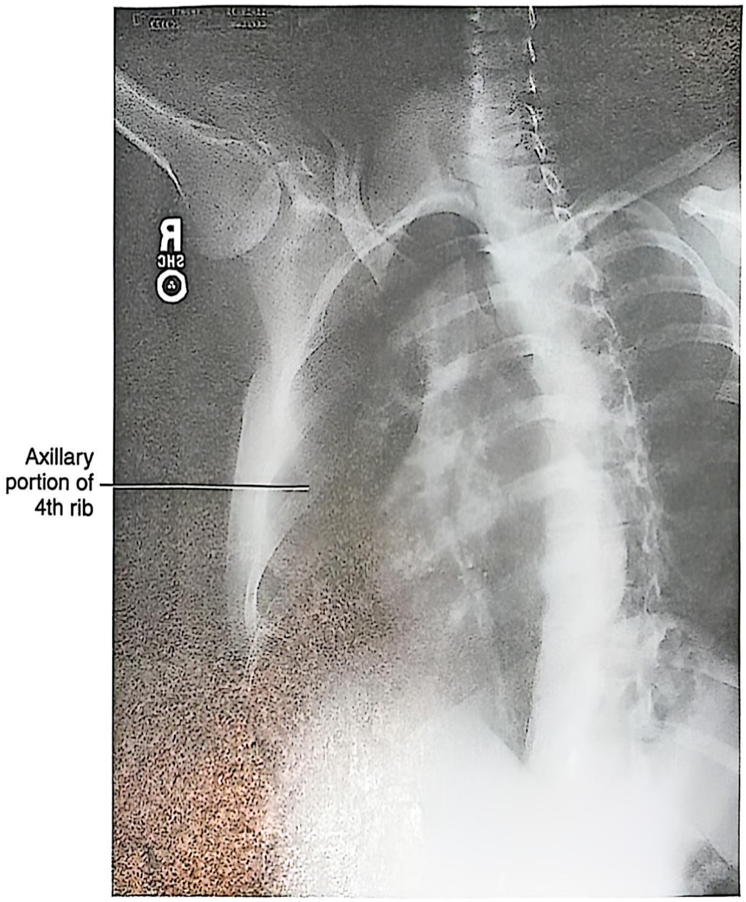


Fig. 16.28 Upper anterior ribs. PA oblique projection.

LOWER POSTERIOR RIBS: AP AND AP OBLIQUE PROJECTIONS

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Standing or recumbent.

Part position:

AP: Supine on table (Fig. 16.29) or upright with posterior surface of chest against upright grid cabinet. Coronal plane is parallel to IR. Lower margin of IR is at level of iliac crest.

AP oblique: RPO position for right ribs or LPO position for left ribs. Coronal plane forms angle of 45 degrees with IR plane (Fig. 16.30). Lower margin of IR is at level of iliac crest.

Central ray:

AP: Perpendicular to center of IR. Center point should be in midclavicular line at approximate level of tip of xiphoid process.

AP oblique: Perpendicular to center of IR. Central ray enters at point on midline of anterior surface at approximate level of tip of xiphoid process.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. If smaller IR is used, collimate to the smaller size. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on expiration.

Structures seen: Ribs 8 through 12. Posterior portions of ribs are best seen on AP projection (Fig. 16.31); axillary portions are best seen on oblique projection (Fig. 16.32).

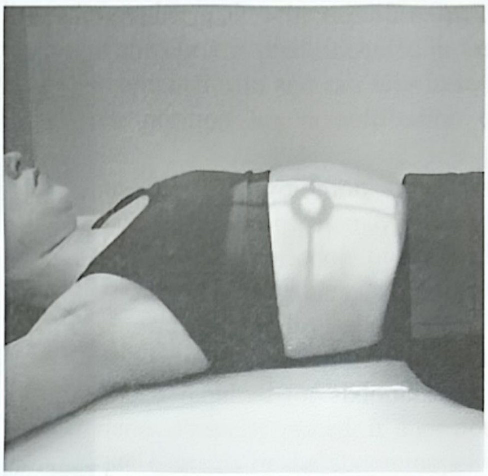


Fig. 16.29 Lower posterior ribs. Position for AP projection, patient recumbent.

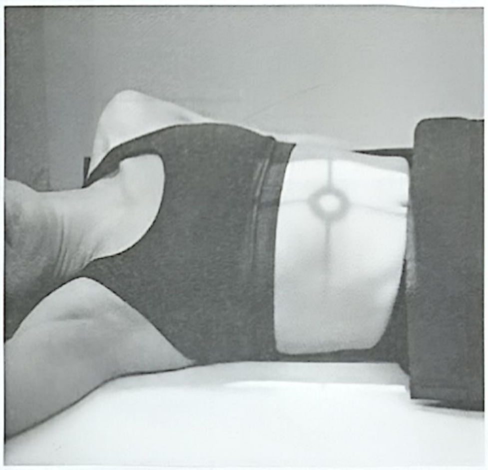


Fig. 16.30 Lower posterior ribs. Position for AP oblique projection, patient recumbent.

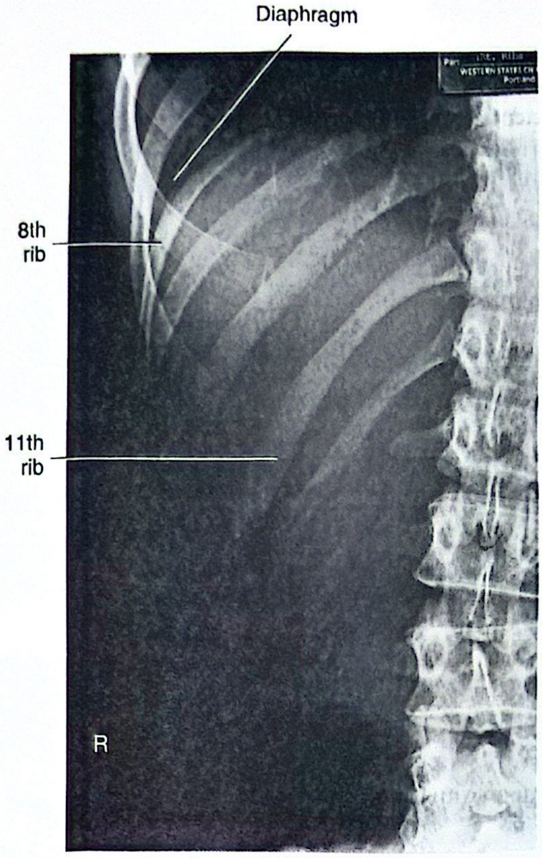


Fig. 16.31 Lower posterior ribs. AP projection.

Fig. 16.32 Lower posterior ribs. AP oblique projection.

Abdomen

Radiographic examinations of the abdomen may consist of one or more projections, depending on the purpose of the examination. The basic projection, which is a part of any abdomen study, is the AP projection in the supine position, also called a "kidneys, ureters, and bladder" (KUB) projection. This projection is also used in many cases in which the urinary tract is not of primary clinical interest.

A radiographic examination for patients with acute abdominal pain will likely include an AP projection in both the supine and upright positions. If the patient is unable to stand for the upright radiograph, the AP projection in the left lateral decubitus position is substituted. The purpose of including upright or decubitus positions is to demonstrate air-fluid levels in the intestines and to visualize free intraperitoneal air, if present. The significance of these findings is discussed in the pathology section of this chapter. For these findings to be most effectively demonstrated, the patient must maintain the upright or decubitus position for several minutes before the radiographer makes the exposure. An upright PA projection of the chest is often included in examinations for acute abdominal pain and can substitute for the upright abdomen position for demonstration of free intraperitoneal air.

In addition to the AP projection in the supine, upright, and decubitus positions, it may sometimes be desirable to take a lateral projection of the abdomen. The lateral projection is necessary to evaluate the abdominal aorta and to localize abdominal foreign bodies that are not within the gastrointestinal tract.

Gonad shielding is required for abdominal radiography of male patients. Properly placed, it does not affect visualization of the contents of the abdominopelvic cavity. Ovarian shields, on the other hand, obscure the pelvic cavity on females and should not be used for abdominal studies. Shielding may be used for females for upright radiographs when the suspected pathology is in the upper and middle portions of the abdomen and the pelvic portion is well demonstrated on the KUB.

ROUTINE EXAMINATION

The routine examination of the abdomen includes the AP projection in the supine position. Supplemental radiographs are produced in the upright and left lateral decubitus positions.

AP PROJECTION (SUPINE POSITION)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Supine.

Part position: Sagittal plane is perpendicular to IR (Fig. 16.33) and knees may be flexed moderately and supported by a bolster. The IR is centered at the level of the iliac crests. Check that inferior margin of IR is at the level of the greater trochanter to ensure inclusion of pelvic floor.

Central ray: Perpendicular to center of IR through a point in midline at level of iliac crest.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Stop breathing on expiration.

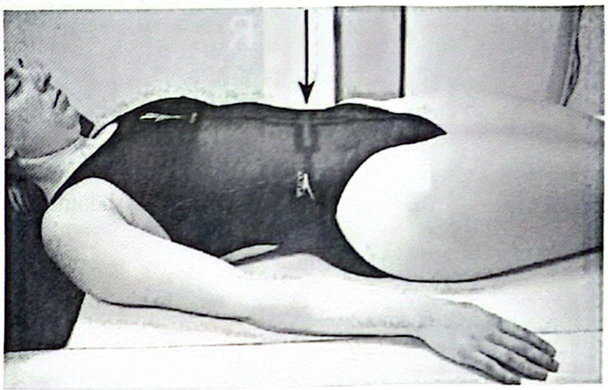


Fig. 16.33 Abdomen. Position for AP projection, patient recumbent.

Structures seen: Abdominal contents between diaphragm and pelvic floor (Fig. 16.34). When exposure is correct, psoas muscles, liver margin, and kidney shadows should be visible.

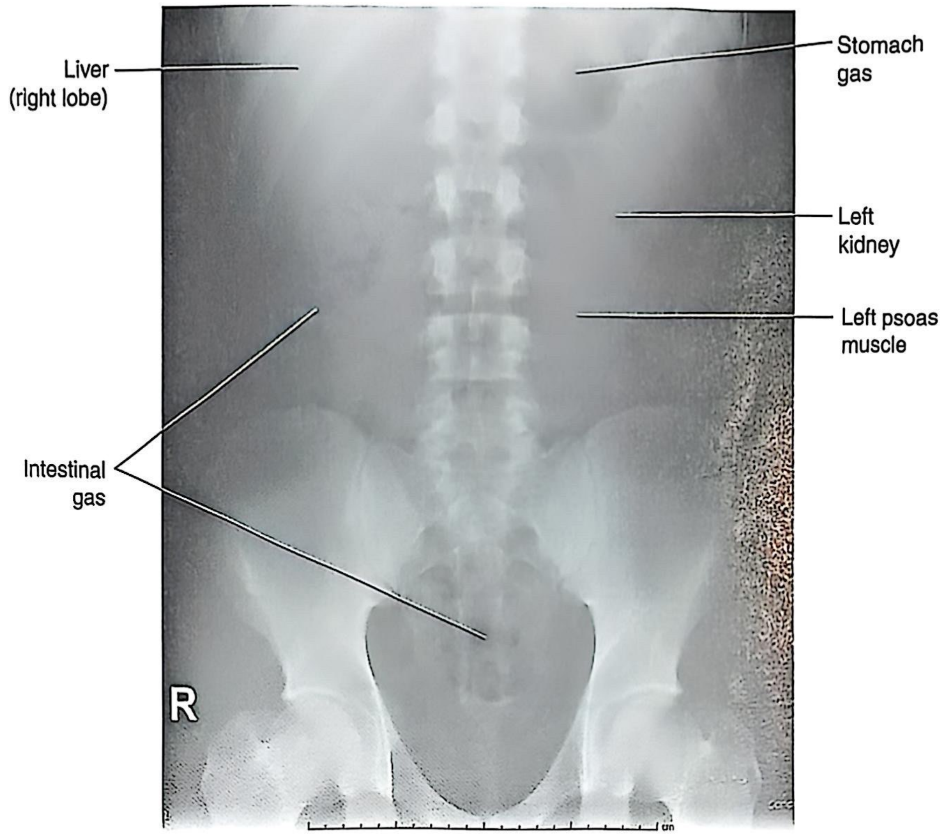


Fig. 16.34 Abdomen. AP projection, patient recumbent.

SUPPLEMENTAL PROJECTIONS

AP PROJECTION (UPRIGHT POSITION)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Standing, facing tube.

Part position: Midsagittal plane centered to IR and perpendicular to it (Fig. 16.35).

Central ray: Perpendicular to center of IR through a point in midline approximately 2 inches superior to level of iliac crest.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Suspend breathing on inspiration.

Structures seen: Abdominal contents between diaphragm and pelvic floor if included. Diaphragm must be seen at top of IR (Fig. 16.36). Air-fluid levels will be visible in intestines, if present. Free intraperitoneal air, if present, may be seen beneath diaphragm. See pathology section for discussion of air-fluid levels and free intraperitoneal air.

Fig. 16.35 Abdomen. Position for AP projection, patient upright.

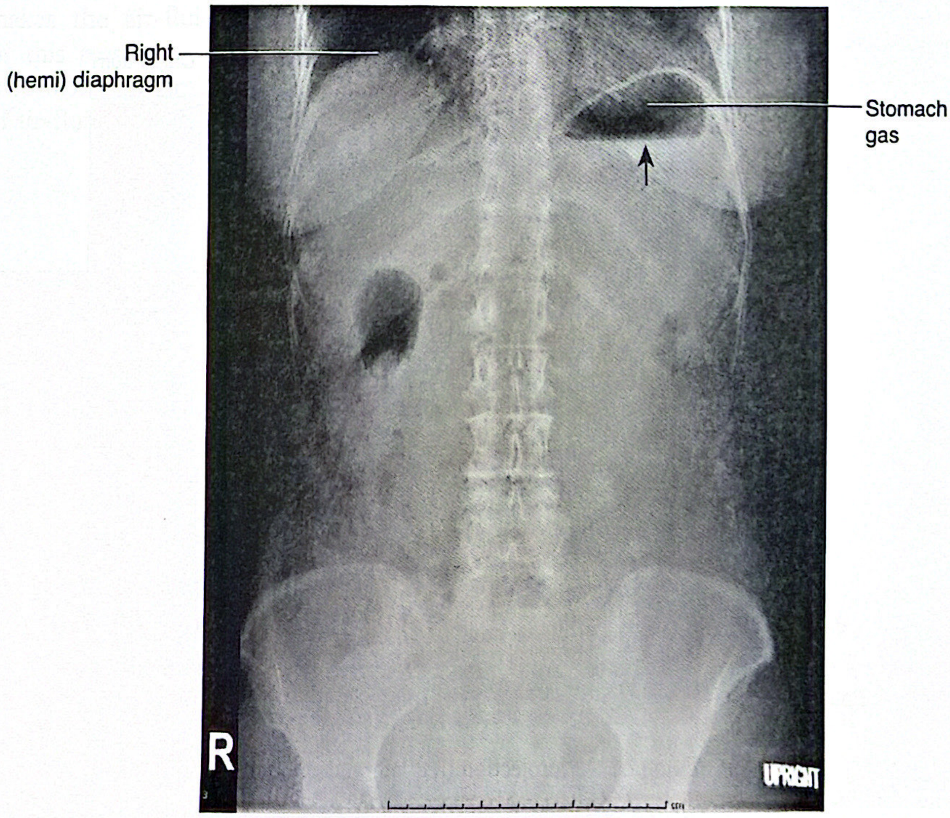


Fig. 16.36 Abdomen. AP projection, patient upright. Note fluid in the stomach, visible as a horizontal light line just below the stomach gas *(arrow)*.

AP PROJECTION (LEFT LATERAL DECUBITUS POSITION)

IR: Positioned by manufacturer or department protocol for proper anatomy display orientation; CR plate: 14 × 17 inches (35 × 43 cm) lengthwise.

Grid: Yes

SID: 40 inches minimum

Body position: Recumbent on left side on radiographic table or stretcher (Fig. 16.37). If stretcher is used, it is placed in front of upright Bucky. Patient is facing tube.

Part position: Midsagittal plane of abdomen is horizontal and is centered to vertically oriented IR and perpendicular to it.

Central ray: Horizontal and perpendicular to center of IR through a point in midline approximately 2 inches superior to level of iliac crest.

Collimation: Adjust light field to 14 × 17 inches (35 × 43 cm) on the collimator. Place side marker in the collimated light field.

Patient instruction: Do not move. Suspend breathing on inspiration.

Structures seen: Abdominal contents between diaphragm and pelvic floor, if included. Diaphragm must be seen (Fig. 16.38). Air-fluid levels, if present, will be visible in intestines. Free intraperitoneal air, if present, will be seen near top of IR, along right abdominal wall adjacent to liver. See pathology section for discussion of air-fluid levels and free intraperitoneal air.

NOTE: Long axis of IR is horizontal, placed lengthwise in relation to the long axis of the abdomen.

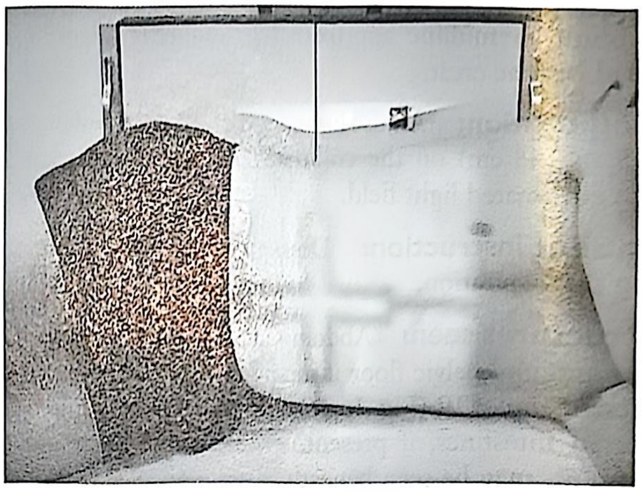


Fig. 16.37 Abdomen. Position for AP projection (left lateral decubitus position).

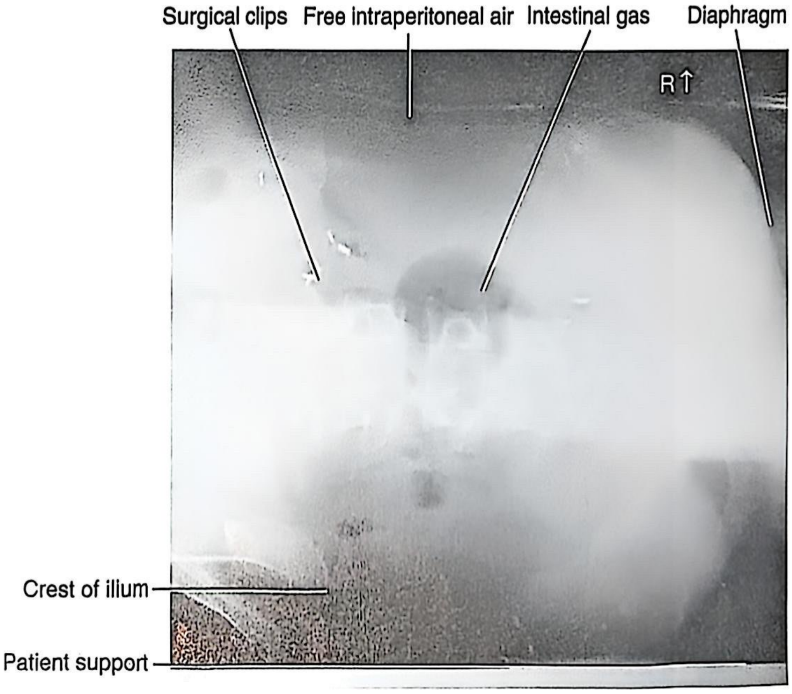


Fig. 16.38 Abdomen. AP projection (left lateral decubitus position).

PATHOLOGY

Bony Thorax

The most common reason for radiography of the bony thorax is trauma. The young boy in Fig. 16.39 was injured in a car accident. Trauma to the sternum is demonstrated in Fig. 16.40.

Nontraumatic pathology of the bony thorax includes malignant bone disease. Primary neoplastic lesions may occur in the bony thorax. Multiple myeloma is a fairly common example. Metastatic bone lesions also occur in the ribs, often secondary to lung tumors. Osteochondroma (exostosis), a benign bone tumor, is also seen in the ribs.

Air-Fluid Levels

When fluid is present in a space normally occupied by air, it is an important diagnostic sign of pathology. The interface between air and fluid is usually clearly visible radiographically. The possibility of abnormal air-fluid levels exists in the chest, the abdomen, and the paranasal sinuses (see Chapter 17).

Because fluid is heavier than air, the air will always be above the fluid, and the interface between the air and the fluid will be a horizontal line. *A horizontal x-ray beam is necessary to demonstrate air-fluid levels.* This is easily understood when you look at a glass that contains water. Seen from the top, it is not possible to tell how much water the glass holds. Seen from the side, however, the horizontal line of sight makes the air-fluid level clearly visible (Fig. 16.41). For this reason, upright and/or decubitus positions using a horizontal central ray are *necessary* for the demonstration of air-fluid levels.

Fig. 16.39 Fracture of the left first rib *(arrow)* posteriorly.

Chest

Many acute and chronic conditions may affect the organs of the chest, and most can be evaluated radiographically. The scope of this text permits only a very limited introduction to this subject; examples of some of the common types are offered.

Trauma to the chest may result in lung collapse, called **atelectasis.** Air escaping from the collapsing lung may occupy space in the pleural cavity formerly occupied by the lung. The presence of air in the pleural cavity is called **pneumothorax.** This intrapleural air may also result from penetration of the chest wall. Atelectasis is always present when there is pneumothorax. The lung markings (bronchioles and blood vessels that create the threadlike lines of decreased radiographic density in the lungs) are compressed with atelectasis. The radiographic appearance is such that the lung appears lighter in the collapsed area because the lung markings are very close together. Pneumothorax appears as an absence of lung markings in an area where lung is normally present. Pneumothorax is seen in Fig. 16.42.

Atelectasis may affect a portion of a lung without pneumothorax (Fig. 16.43). The cause may be bronchial obstruction from a foreign body or neoplasm. Abscess

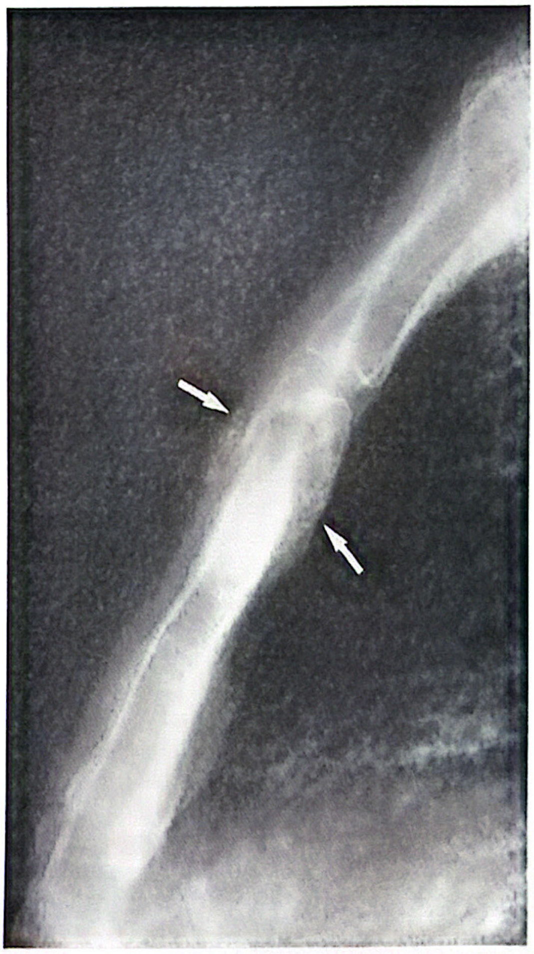


Fig. 16.40 Fracture of the sternum *(arrows)* from striking the steering wheel in a car accident.

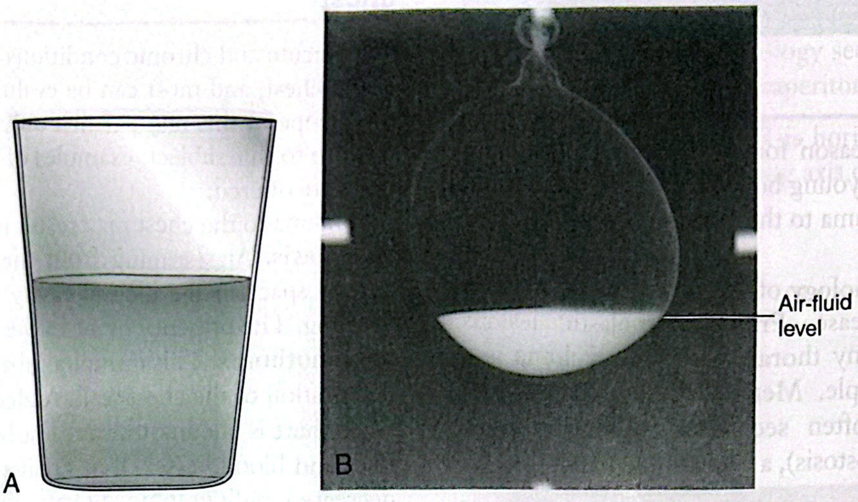


Fig. 16.41 Air-fluid levels are visualized with a horizontal line of view. (A) Liquid in a glass. (B) Radiograph of balloon showing air-fluid level.

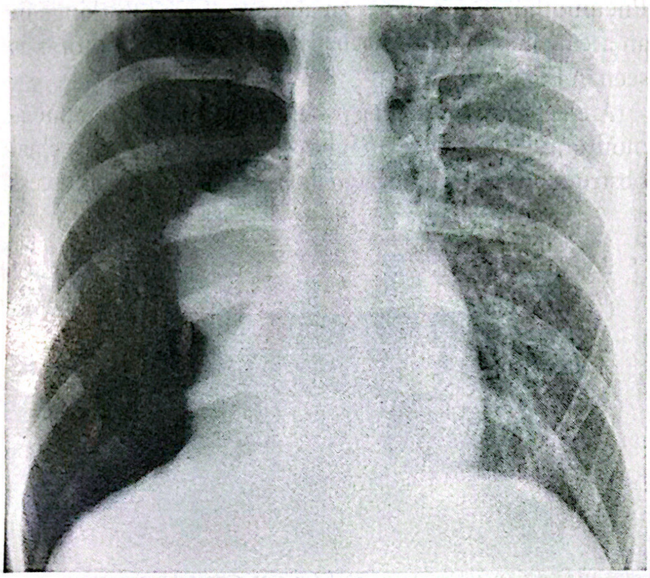


Fig. 16.42 Spontaneous pneumothorax. Complete collapse of right lung.

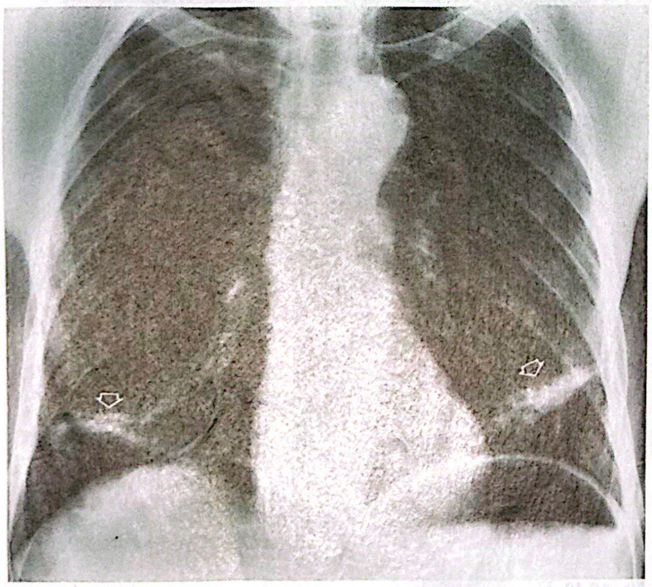


Fig. 16.43 Platelike atelectasis *(arrows)* in both lung bases associated with chronic bronchitis.

(localized infection), **emphysema**, and **chronic bronchitis** may also cause atelectasis.

Pneumonia is an inflammation of the lung that is usually caused by bacterial or viral infection. It may also be caused by the inhalation of chemical agents or the aspiration of vomitus. Acute pneumonia causes consolidation of the lung tissue, increased tissue density because of engorgement of the blood vessels, and fluid within spaces that are normally filled with air. Several types of pneumonia are illustrated in Fig. 16.44.

Emphysema, a chronic lung condition, is a type of chronic obstructive pulmonary disease. It is characterized by obstruction and destruction of the small airways and alveoli of the lungs, which results in overinflation of the lungs and the inability to exhale stale air effectively. Chronic overinflation of the lungs increases the AP diameter of the chest and causes depression and flattening of the diaphragm (Fig. 16.45). It is important for radiographers to recognize the outward physical signs of emphysema before performing radiography so that the exposures for chest radiographs may be adjusted appropriately. Patients with emphysema are often described as "barrel chested." The difference between the PA and lateral chest measurements will be only 8 cm or less. There may be retraction of the costal muscles near the neck with prominence of the clavicles. Patients may practice positive pressure breathing, pursing their lips as they exhale. The large chest measurement does not require a large exposure because the chest volume consists predominantly of air. The mAs for chest radiographs must be reduced by 30% to 60% from the usual mAs for patients of similar measurement. The actual percentage of mAs reduction necessary depends on the severity of the disease.

Tuberculosis (TB) is an infectious lung disease (Fig. 16.46). Most persons exposed to the TB organism do not develop active disease. The body's immune system walls off the infection so that it becomes dormant. In this inactive stage, the individual has no symptoms and cannot

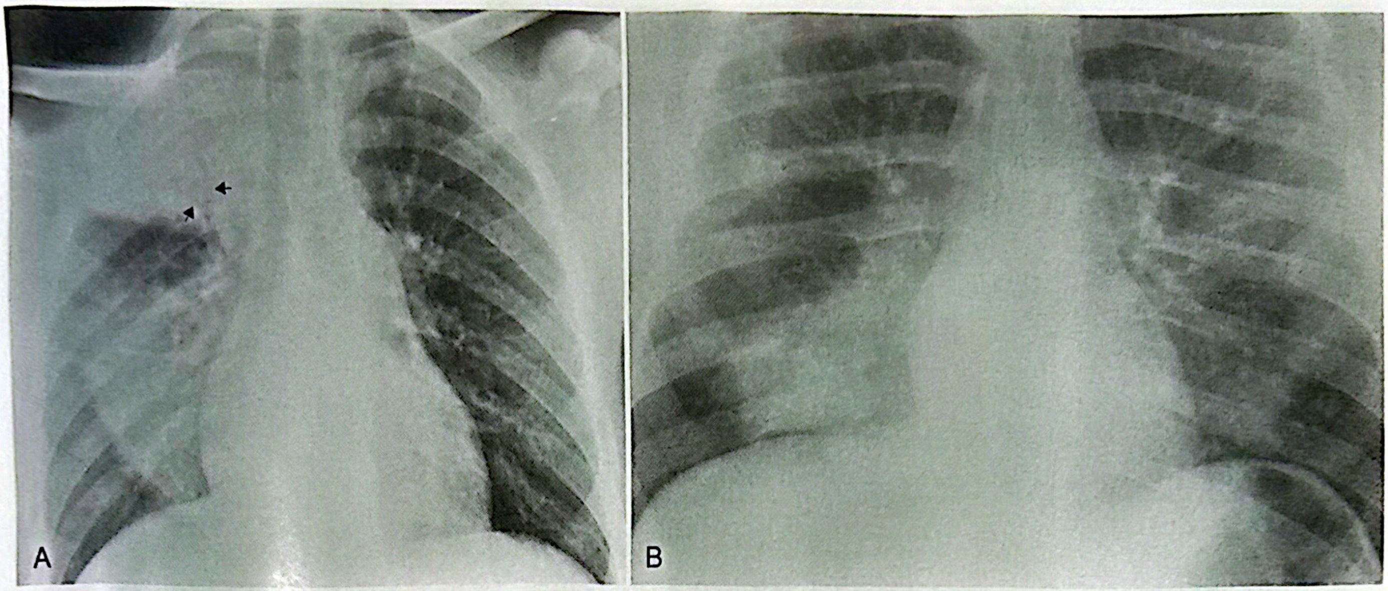


Fig. 16.44 There is great variation in the radiographic appearance of pneumonia. (A) Bacterial pneumonia with consolidation of the right upper lobe and medial and posterior segments of the right lower lobe. The air bronchogram *(arrows)* is the air contrast of the upper lobe bronchus seen through the consolidated lung, a diagnostic sign. (B) Bacterial bronchopneumonia producing ill-defined consolidation in right lung base.

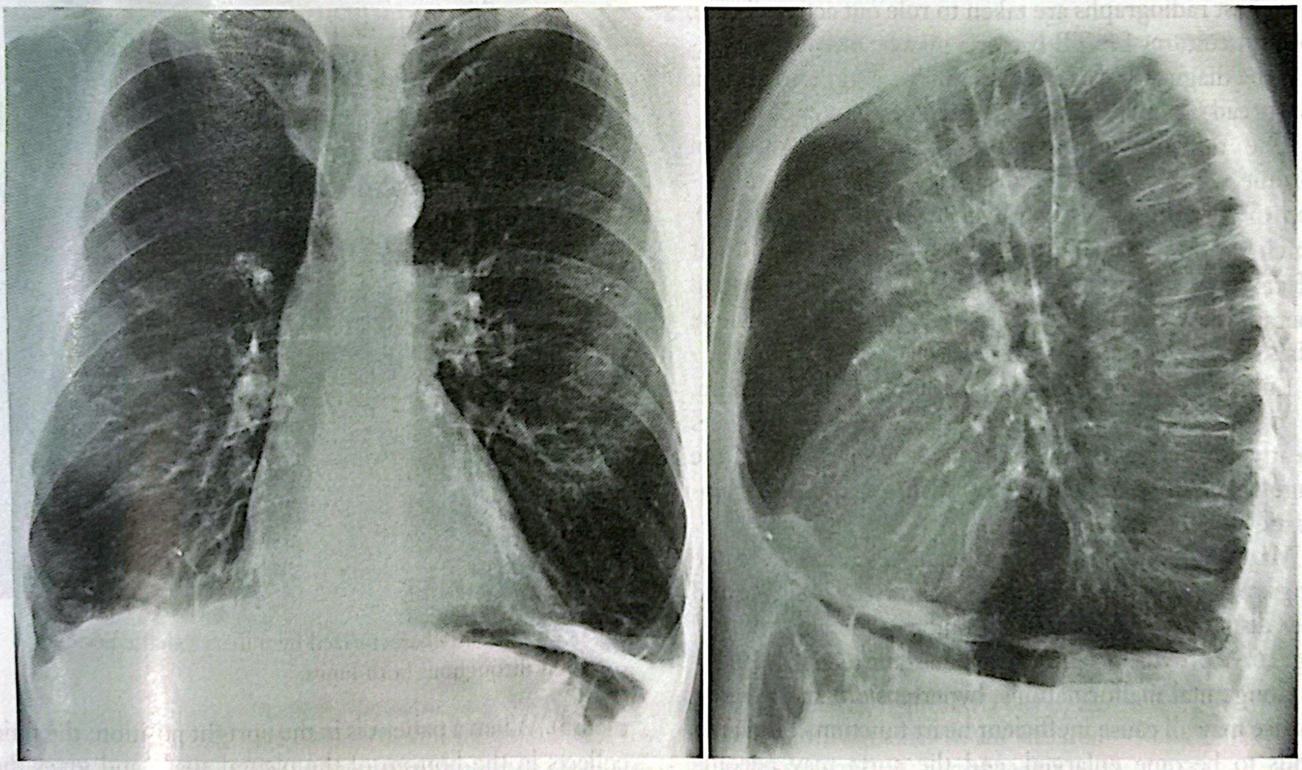


Fig. 16.45 Emphysema, a form of chronic obstructive pulmonary disease characterized radiographically by dark, overinflated lungs and a flattened diaphragm.

transmit the disease to others. TB may become active, however, when the immune system is depressed. Malnutrition, human immunodeficiency virus (HIV) infection, other disease processes, or advanced age may allow TB to become active. When dormant TB becomes reactivated, it is called *secondary tuberculosis.* It often affects the apices of the lungs. A chest radiograph in the lordotic position may be ordered to better visualize this area of the lungs. The primary screening test for TB is the tuberculin skin test. Anyone who has ever contracted the disease will

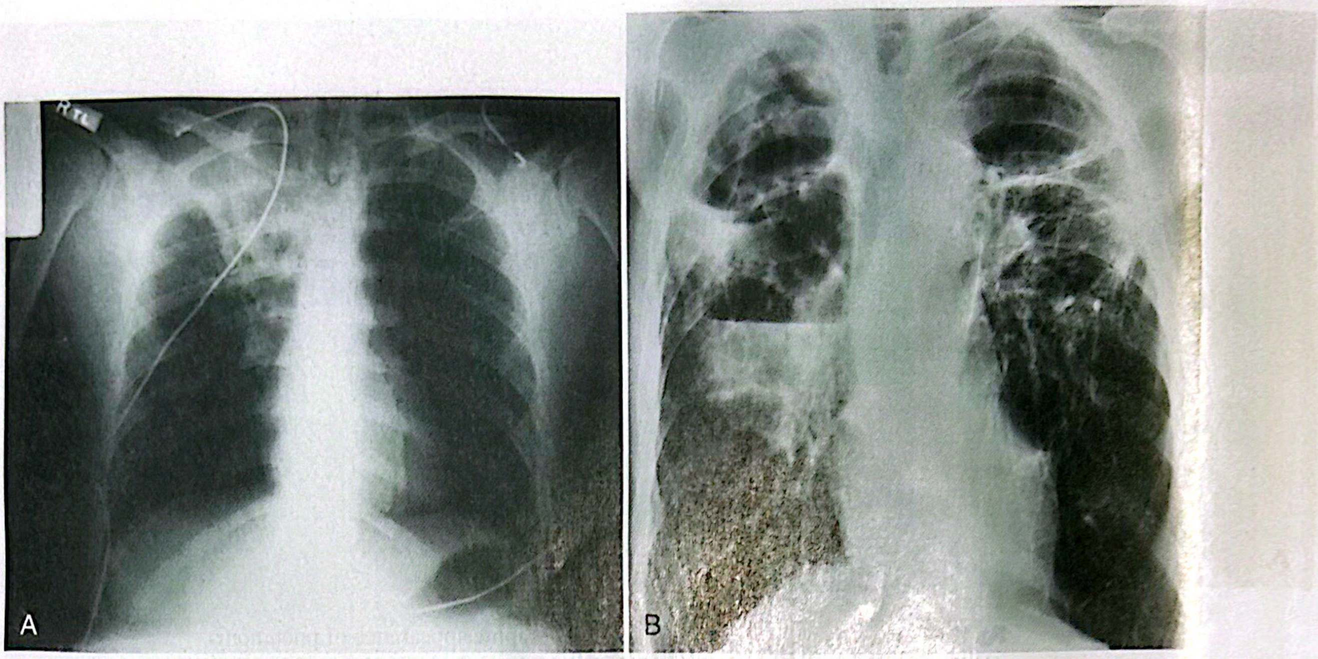


Fig. 16.46 Tuberculosis has different radiographic appearances. (A) Active, primary tuberculosis in the right upper lobe. (B) Secondary tuberculosis with fibrocalcific changes in both apices.

have developed antibodies to the TB organism and will have positive test results. When the skin test result is positive, chest radiographs are taken to rule out active disease. Sputum cultures for TB bacteria may be *necessary* to confirm the diagnosis of active disease. Precautions to prevent the spread of active TB are discussed in Chapter 21.

The term **pneumoconiosis** refers to a group of chronic occupational lung diseases caused by the inhalation of irritating dust. One type is silicosis (Fig. 16.47), which results from the inhalation of silicone dioxide. It affects workers in mines, foundries, and sandblasting operations. Other examples of pneumoconiosis include asbestosis and coal miner's disease (black lung).

Lung cancer may arise from the lung tissue, the pleura, or a bronchus. The radiographic appearance differs greatly, depending on the type of tissue involved and the stage of the disease. Fig. 16.48 provides examples of neoplastic lung disease.

Many different malignant diseases metastasize to the lungs. Metastatic lesions may be solitary or multiple and may display a wide variety of radiographic appearances. Fig. 16.49 provides examples of metastatic lung disease.

Congenital malformations, hypertension, and valvular disease may all cause inefficient heart function. The heart tends to become enlarged, and the aorta may become elongated and tortuous. Cardiac insufficiency causes pulmonary edema, the collection of fluid in the tiny spaces within the lung. Advanced cardiac insufficiency with pulmonary edema is called *congestive heart failure* (Fig. 16.50).

Pleural effusion is a collection of fluid in the pleural space (Fig. 16.51). This is a nonspecific radiographic finding with many possible causes. The most common causes are neoplastic disease, congestive heart failure, pulmonary embolism, infection, and pleurisy (inflammation of the pleura). When a patient is in the upright position, the fluid collects in the bottom of the pleural space and gives the appearance of blunting or rounding of the normally sharp costophrenic angles. This is an important reason why both costophrenic angles must always be included on PA chest radiographs.

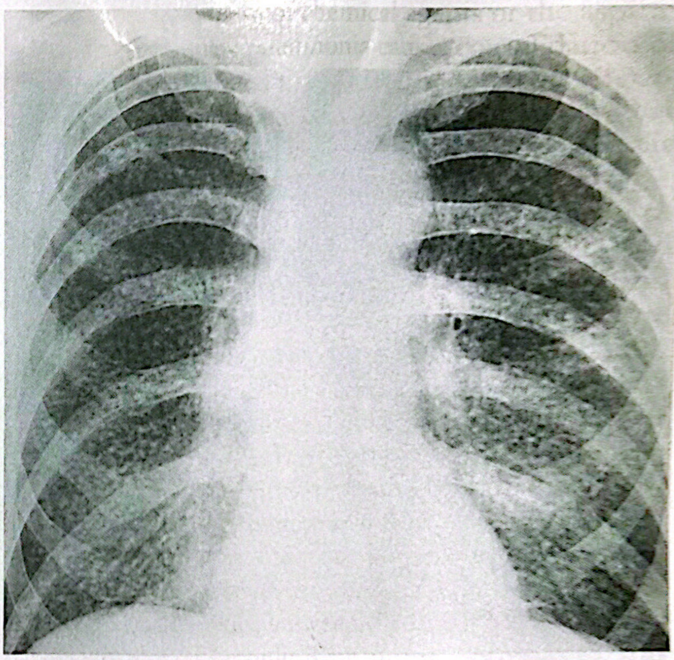


Fig. 16.47 Silicosis, characterized by miliary calcific nodules scattered throughout both lungs.

Abdomen

Many abdominal structures, and particularly the internal contours of abdominal organs, cannot be seen radiographically

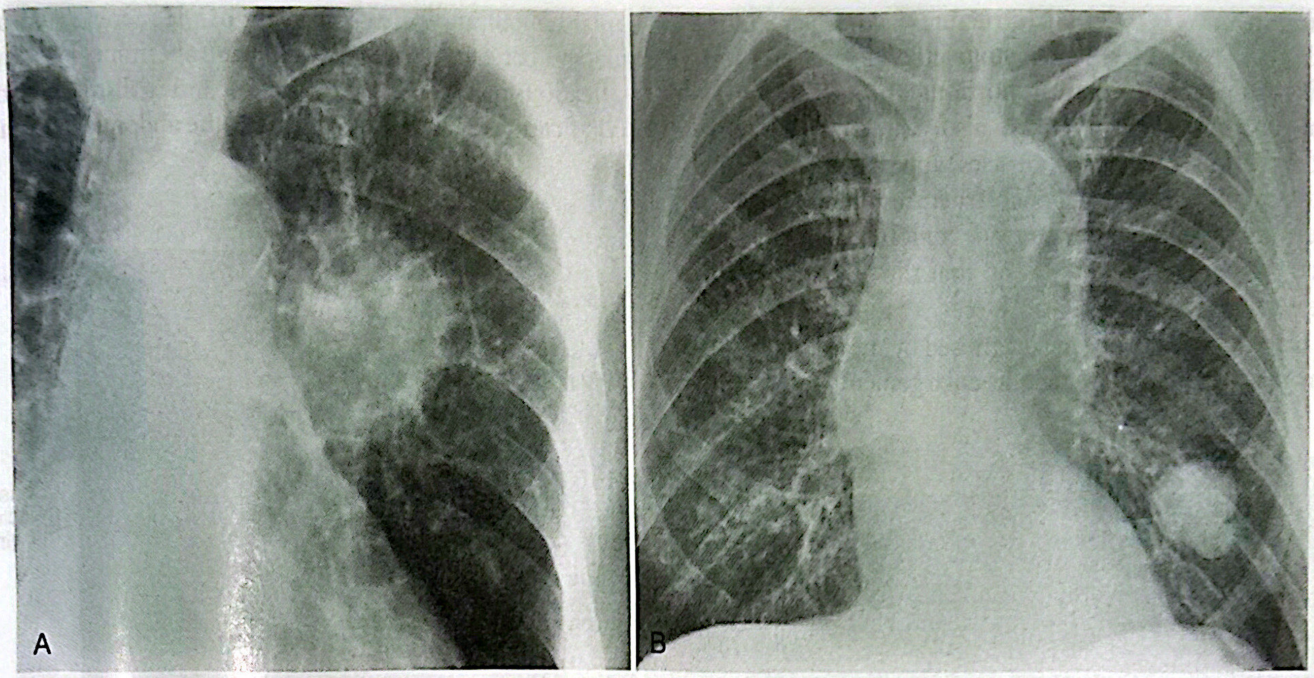


Fig. 16.48 Examples of neoplastic lung disease. (A) Bronchogenic carcinoma, a highly malignant tumor. Its fuzzy, ill-defined margins are indicative of invasive growth into surrounding tissue. (B) Peripheral bronchial adenoma in the left lower lobe. This tumor has a low level of malignancy, which is typical of neoplasms with smooth, rounded margins.

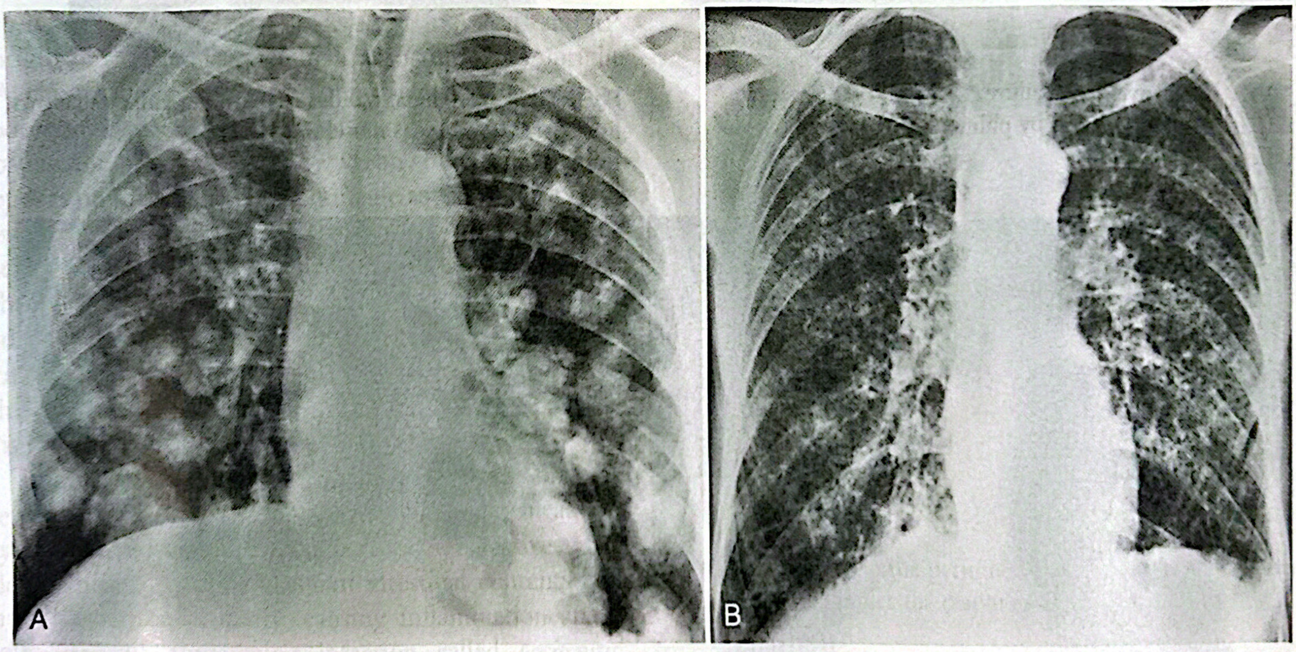


Fig. 16.49 Metastatic lung disease. (A) Hematogenous metastases (spread via blood) are well-defined lesions scattered throughout the lungs. The lesions may be any size from tiny to very large, depending on the site of the primary cancer. (B) Lymphangitic metastases spread via the lymphatic system. In this case, the disease arises from primary cancer of the stomach.

without the use of contrast media. A contrast medium is a special compound that absorbs radiation to a greater extent than tissue. A liquid suspension of barium sulfate is either swallowed or administered rectally to outline the internal structures of the gastrointestinal tract. Special contrast media tablets are available to provide contrast for examinations of the gallbladder. Intravenous injections, or injections directly into the organs of interest, are used to provide contrast in the urinary tract and the biliary system. Procedures using contrast media are beyond the scope of this text.

The abdominal features that are visible on "plain films" (radiographs made without contrast media) are the outer contours of such abdominal structures as the liver and the kidneys. Because gas in the stomach and intestines provides radiographic contrast, portions of the gastrointestinal tract that contain gas are also visible on abdominal radiographs. The psoas muscles appear on abdominal radiographs as dense diagonal structures on either side of the lumbar spine. They are not abdominal organs, but their visibility is one indication that the exposure factors are correct (Fig. 16.52).

Conditions that may be diagnosed by means of abdominal plain radiographs include enlargement of the liver, enlargement and/or displacement of the kidneys, abnormal gas patterns in the bowel, free intraperitoneal air, calcifications such as kidney stones and gallstones, and calcifications in arteries, particularly the abdominal aorta.

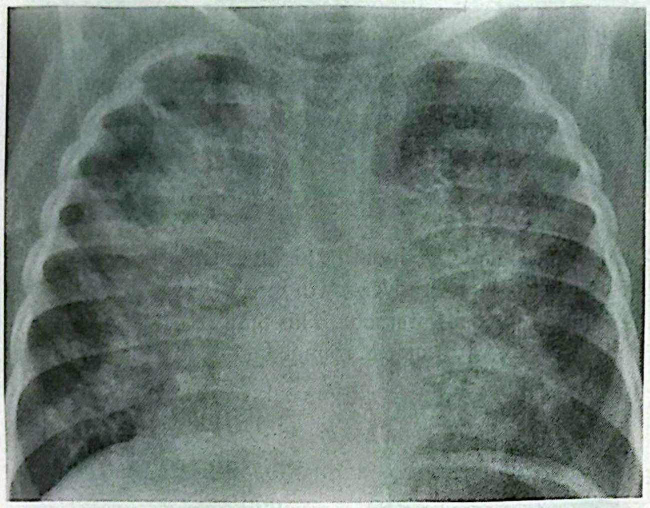


Fig. 16.50 Congestive heart failure. Decreased radiographic density in the lungs caused by pulmonary edema.

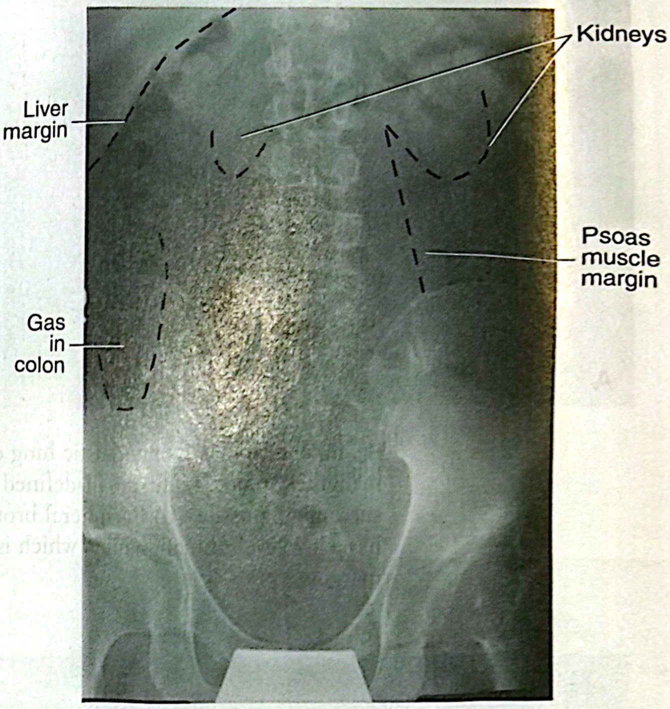


Fig. 16.52 AP abdominal radiograph showing kidney shadows, liver margin, and psoas muscles.

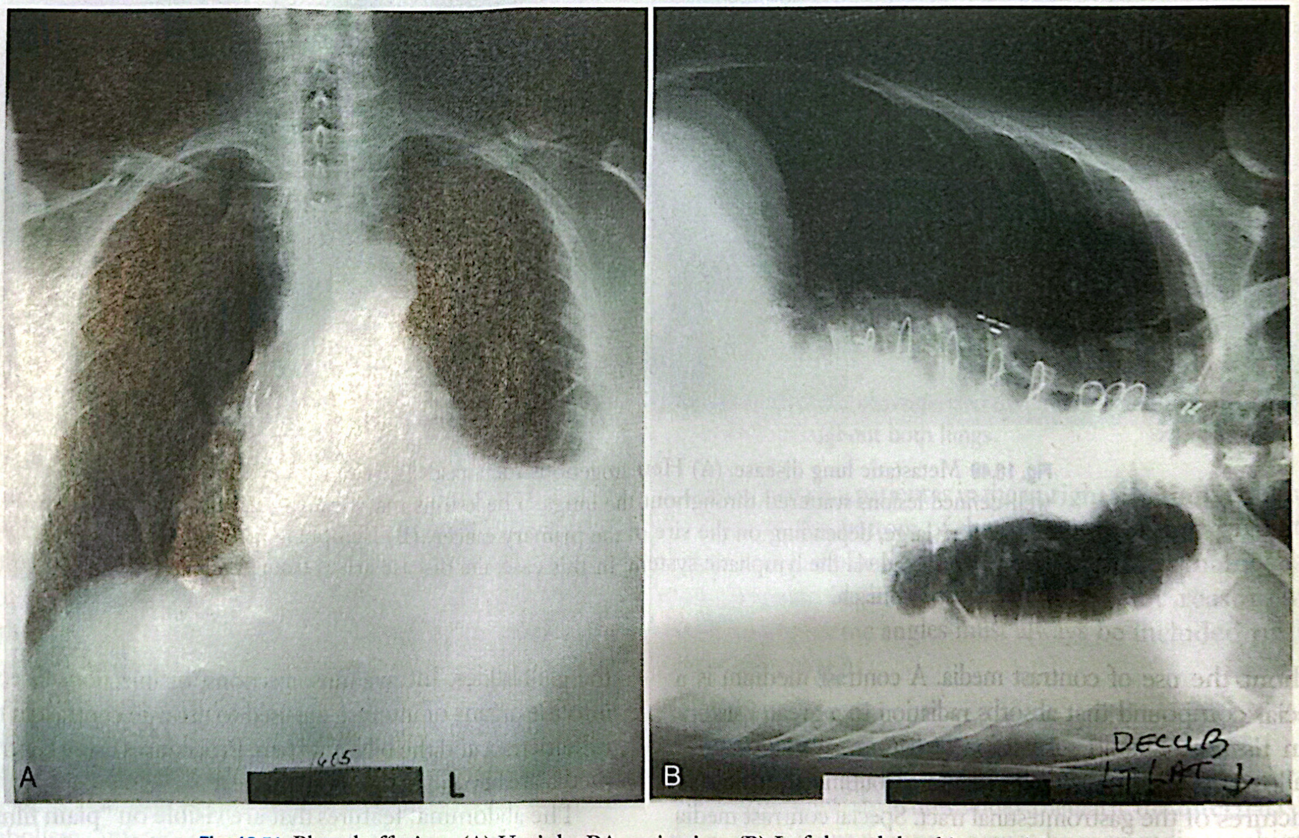


Fig. 16.51 Pleural effusion. (A) Upright PA projection. (B) Left lateral decubitus position.

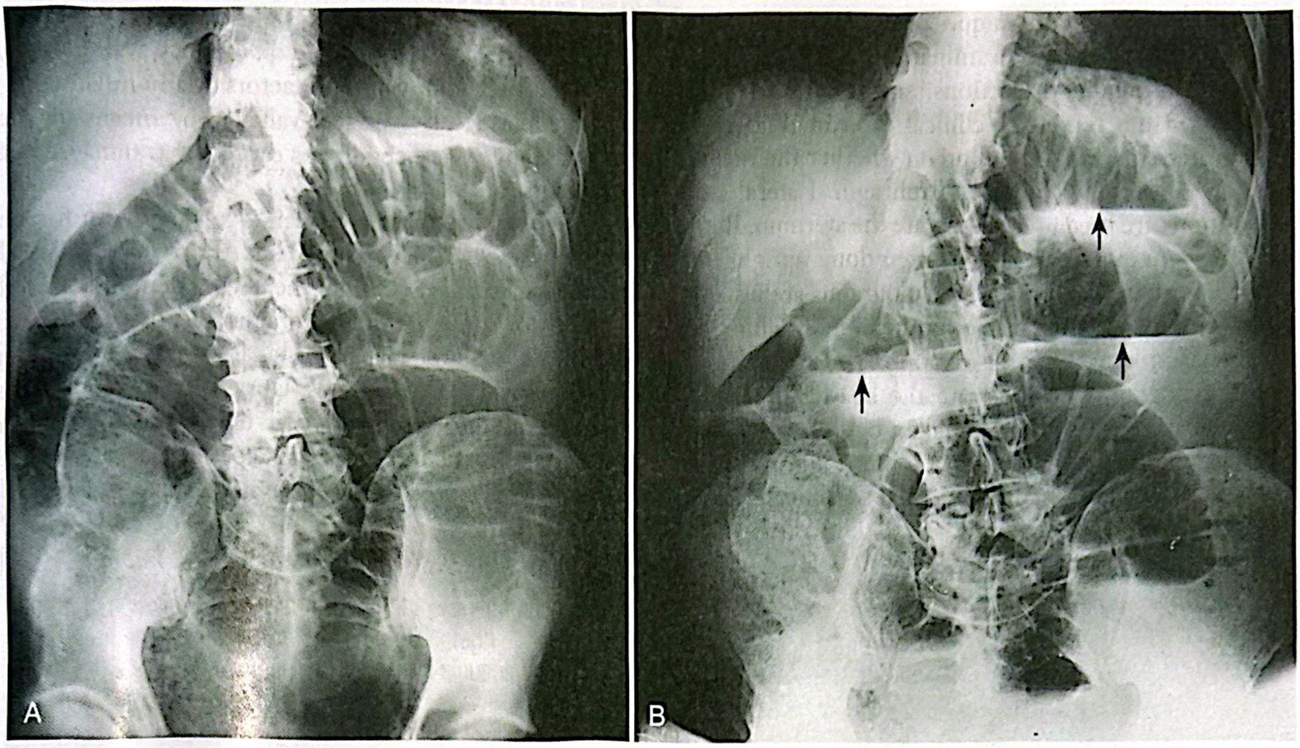


Fig. 16.53 Bowel obstruction. (A) Supine position shows distended loops of small intestine. (B) Upright position on the same patient shows air-fluid levels *(arrows)* within small intestine.

An acute abdomen series consists of AP supine and AP upright or decubitus abdominal radiographs. An upright PA chest radiograph is also often included. The acute abdomen series is used in cases of suspected bowel obstruction or ruptured hollow viscus. Bowel obstruction appears on the supine position image as multiple loops of distended, gas-filled small intestine. On the upright abdomen radiograph, air-fluid levels are present (Fig. 16.53). The presence of large quantities of gas results in increased radiographic density if routine exposure factors are used. For this reason, it is desirable to decrease the mAs somewhat for abdominal radiography in cases of bowel obstruction.

The term *ruptured hollow viscus* refers to an opening between the gastrointestinal tract and the peritoneal cavity. A ruptured appendix and a perforated ulcer are examples. When this occurs, gas and intestinal contents leak into the peritoneal cavity, causing inflammation and a potentially life-threatening infection called *peritonitis.* Ruptured hollow viscus is diagnosed radiographically by the appearance of gas, or "free air," in the peritoneal cavity outside the gastrointestinal tract. Because gas rises, it is seen on upright position images just beneath the diaphragm (Fig. 16.54). In the left lateral decubitus position, free air rises to the right abdominal wall and is visible along the flank.

The accumulation of fluid in the peritoneal cavity is called *ascites.* When ascites is present, the abdomen tends to be distended and rigid. Ascites is a nonspecific finding that is indicative of serious disease. Examples of conditions that may be associated with ascites include cirrhosis of the liver, neoplastic disease of the intestine, and pelvic inflammatory disease, which is an infection involving the female reproductive organs. Ascites increases the tissue density of the abdomen, which requires an increase in mAs to obtain adequate radiographic density.

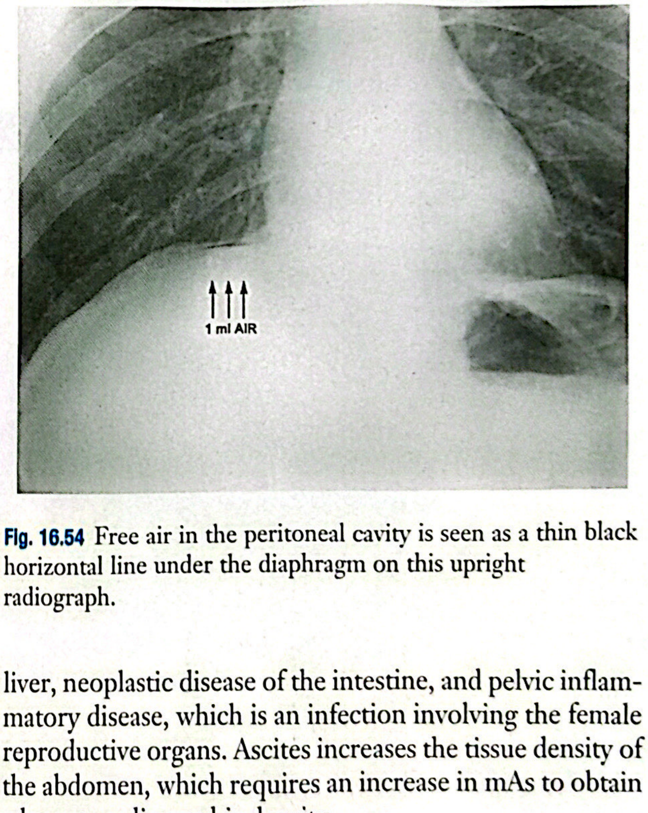


Fig. 16.54 Free air in the peritoneal cavity is seen as a thin black horizontal line under the diaphragm on this upright radiograph.

SUMMARY

The bony thorax consists of the ribs, the sternum, and the thoracic spine. The ribs and sternum are radiographed using relatively low kVp techniques to avoid overpenetrating these small bones. Rib examinations consist of both AP or PA and oblique projections, and procedures vary depending on the region of clinical interest. Different exposures are required, depending on whether the ribs of interest are above or below the diaphragm. Lateral and RAO positions are used to demonstrate the sternum. Both rib and sternum examinations are often done upright for patient comfort and safety. These radiographs are usually taken to demonstrate fractures, but other abnormalities of these skeletal structures may be demonstrated as well.

Chest radiographs demonstrate the heart, lungs, and mediastinum and are commonly taken by limited operators. These radiographs may provide lifesaving information about the condition of vital organs. Routine chest radiography consists of PA and left lateral projections taken upright at 72-inches SID to minimize magnification of the heart. They are exposed on deep inspiration using a grid and high kVp exposure factors. Many inflammatory and neoplastic diseases are evaluated by means of chest radiography, as are conditions caused by trauma or heart problems.

Radiography of the abdomen is less common for limited operators to perform. The AP projection in the supine position, also called the KUB, demonstrates the outlines of some abdominal organs and may also reveal calcifications in the urinary or biliary system or abnormal gas patterns in the intestines. Upright or decubitus positions are used to demonstrate air-fluid levels that indicate intestinal obstruction or free intraperitoneal air, which is diagnostic of ruptured hollow viscus.