Basic Athletic Training
Course Pack C

CHAPTER

23

Throat, Thorax, and Visceral Conditions

STUDENT OUTCOMES

1. Identify the important bony and soft-tissue structures of the throat, thorax, and viscera.
2. List the primary and accessory organs in the female and male reproductive systems.
3. Identify the primary organs located in each quadrant of the abdominopelvic region.
4. Explain the effects of hormones on the human body.
5. Describe measures to prevent injuries to the throat, thorax, and viscera.
6. Describe the assessment of the throat, thorax, and visceral regions.

7. Analyze and interpret urinalyses findings.
8. Describe the signs and symptoms of superficial injuries of the throat, chest wall, and abdominal wall and explain the management of these injuries.
9. Describe internal complications of the thoracic area, occurring spontaneously or as a result of direct trauma, that can lead to a life-threatening situation.
10. Describe the signs and symptoms of sternal and rib fractures and explain the management of these injuries.
11. Describe the signs and symptoms of intra-abdominal injuries and explain the management of these injuries.
12. Identify injuries and conditions of the genitalia related to participation in sports and physical activity.
13. Describe the management procedures for acute injury of the throat, thorax, and viscera.

INTRODUCTION

Torso injuries occur in nearly every sport, particularly those involving sudden deceleration and impact. Injuries to the reproductive organs, however, are rare, particularly in females. Although protective equipment and padding are available to protect the anterior throat, thorax, and viscera, only football, men's lacrosse, ice hockey, fencing, catchers in baseball and softball, and goalies in lacrosse and field hockey require specific safety equipment for this vital region. Approximately 2% of all athletic injuries affect the abdomen, with the most commonly injured abdominal organs being the spleen, liver, and kidney.[1] Most injuries are superficial and are easily recognized and managed. Some injuries, however, may involve the respiratory and circulatory system, leading to a life-threatening situation.

This chapter begins with a review of the anatomy of the anterior throat, thorax, and viscera, followed by a brief discussion on the prevention of injuries. A step-by-step assessment is presented to help determine the extent

and seriousness of the injury. Common injuries are then presented, followed by internal complications that result from trauma or spontaneous rupture. Because rehabilitation of the region usually is included with other body regions, specific exercises for the thorax and visceral region are not discussed.

ANATOMY OF THE THROAT

The throat includes the pharynx, larynx, trachea, esophagus, a number of glands, and several major blood vessels (Fig. 23.1). Injuries to the throat are of particular concern because of the life-sustaining functions of the trachea and carotid arteries.

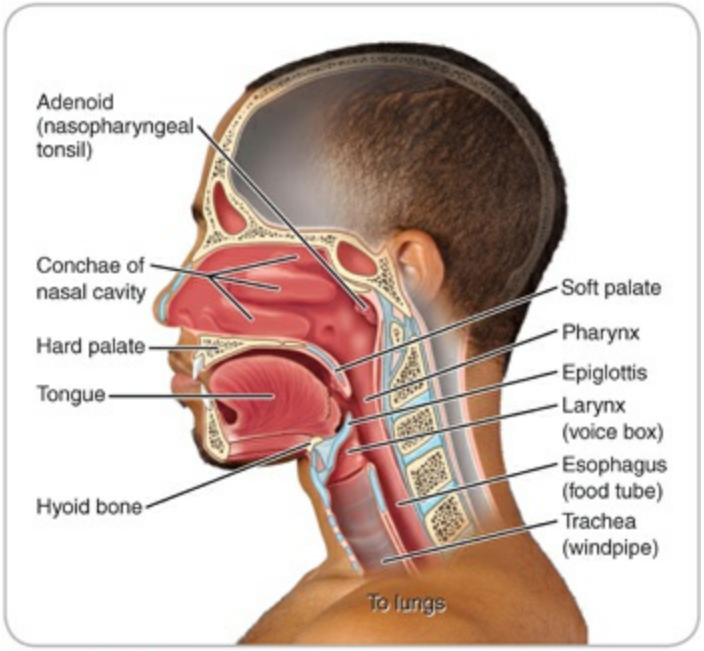

Figure 23.1. The throat region. A lateral cross-sectional view.

Pharynx, Larynx, and Esophagus

The pharynx, commonly known as the throat, connects the nasal cavity and mouth to the larynx and esophagus. The pharynx lies between the base of the skull and the 6th cervical vertebra. The laryngeal prominence on the thyroid cartilage that shields the front of the larynx is known as the Adam's apple. A specialized, spoon-shaped cartilage, called the epiglottis, covers the superior

opening of the larynx during swallowing to prevent food and liquids from entering. If a foreign body does slip past the epiglottis, the cough reflex is initiated, and the foreign body normally is ejected back into the pharynx. The larynx also contains the vocal cords, which are two bands of elastic connective tissue surrounded by mucosal folds. When expired air from the lungs passes over the vocal cords, sound is able to be produced.

The hyoid bone, the only bone of the body that does not articulate directly with any other bone, lies just inferior to the mandible in the anterior neck. It is anchored by the narrow stylohyoid ligaments to the styloid processes of the temporal bones, and it serves as an attachment point for neck muscles that raise and lower the larynx during swallowing and speech.

The esophagus carries food and liquids from the throat to the stomach. It is a muscle-walled tube that originates from the pharynx in the midneck and follows the anterior side of the spine. The body of the esophagus is divided into cervical, thoracic, and abdominal regions. The esophagus is pinched together at both the upper and lower ends by muscles referred to as sphincters. The coordinated action of the esophageal walls propels food into the stomach. The esophageal sphincters maintain a barrier against reverse movement of the esophageal contents into the pharynx and gastric fluids into the esophagus. When the esophagus is empty, the tube is collapsed.

Trachea

The trachea extends inferiorly from the larynx through the neck into the midthorax, where it divides into the two right and left bronchial tubes. The tracheal tube is formed by C-shaped rings of hyaline cartilage that are joined by fibroelastic connective tissue. Smooth muscle fibers of the trachealis muscle form the open side of the “C” and allow the expansion of the posteriorly adjacent esophagus as swallowed food passes. Contraction of the trachealis muscle during coughing can dramatically reduce the size of the airway and, in doing so, increases the pressure inside the trachea to promote the expulsion of mucus.

Blood Vessels of the Throat

The largest blood vessels coursing through the neck are the common carotid arteries (Fig. 23.2). The common carotid arteries, which provide the major blood supply to the brain, head, and face, divide into external and internal carotid arteries at the level of the Adam's apple. Branches from the carotid arteries include the superior thyroid arteries, the facial artery, and the lingual artery; these arteries supply the thyroid and larynx, the face and sinuses, and the mouth and tongue, respectively. Several arteries branch from the left and right subclavian arteries and course upward through the posterior side of the neck, including the costocervical trunk, the thyrocervical trunk, and the vertebral artery.

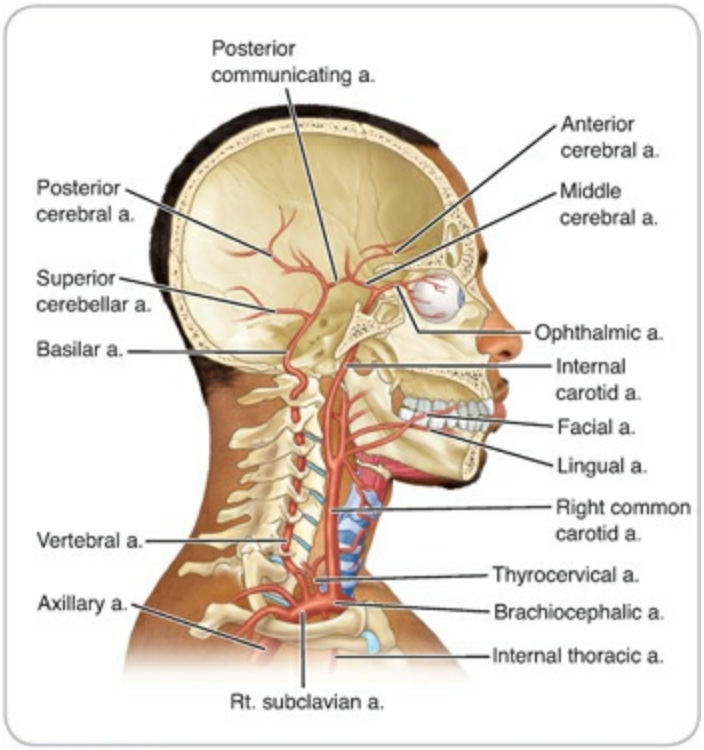

Figure 23.2. The arterial supply to the neck and throat region.

ANATOMY OF THE THORAX

The thoracic cavity, or chest cavity, lies anterior to the spinal column and extends from the level of the clavicle down to the diaphragm. The major

organs of the thorax are the heart and lungs. These organs are not commonly injured. However, internal complications caused by direct trauma or spontaneous damage can necessitate emergency action.

Thoracic Cage and Pleura

The thorax includes the sternum, ribs, costal cartilages, and thoracic vertebrae. These structures form a protective cage around the heart and lungs (**Fig. 23.3**). The sternum consists of the manubrium, which articulates with the 1st and 2nd ribs; the body, which articulates with the 2nd through 7th ribs; and the xiphoid process, a trapezoidal projection composed of hyaline cartilage that ossifies around 40 years of age. The costal cartilages of the first seven pairs of ribs attach directly to the sternum. The costal cartilages of ribs 8 through 10 attach to the costal cartilages of the immediately superior ribs. The last two rib pairs are known as floating ribs, because they do not attach anteriorly to any other structure.

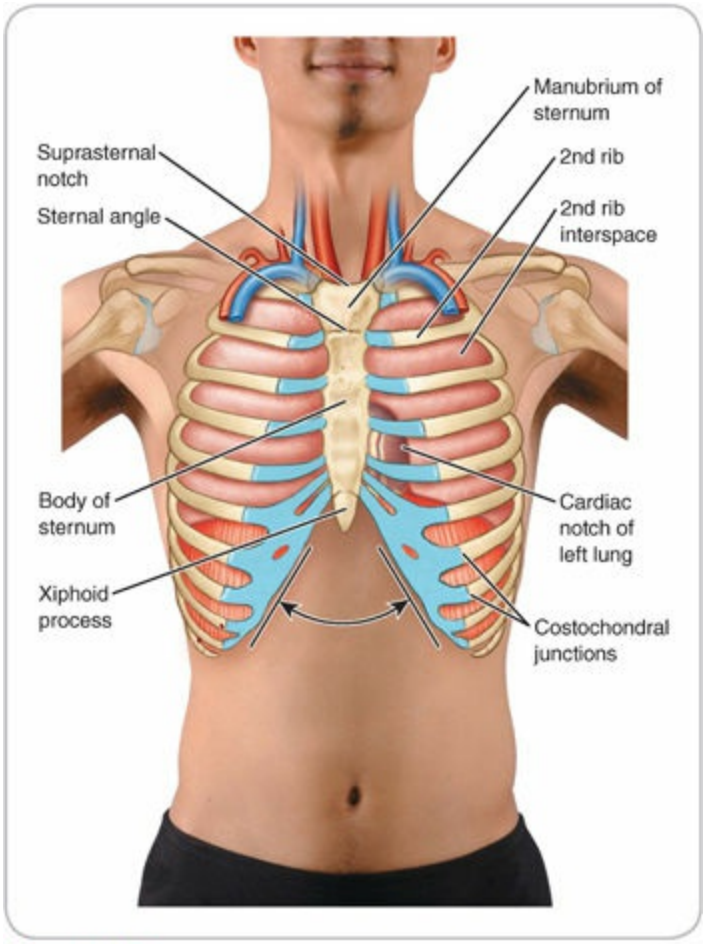

Figure 23.3. The thoracic cage. Note that only the first seven pairs of ribs articulate anteriorly with the sternum through the costal cartilages.

The thoracic cavity is lined with a thin, double-layered membrane called the pleura. The pleural cavity is a narrow space between the pleural membranes that is filled with pleural fluid secreted by the membranes, which enables the lungs to move against the thoracic wall with minimal friction during breathing. A further discussion on the anatomy of the lungs is provided in Chapter 26.

Muscles of the Thorax

The muscles of the thoracic region and the muscles of respiration are shown in **Figures 23.4** and **23.5**. The major respiratory muscle is the diaphragm, a powerful sheet of muscle that completely separates the thoracic and abdominal cavities. During relaxation, the diaphragm is dome-shaped. During contraction,

it flattens, increasing the size of the thoracic cavity. In turn, this increase in cavity volume causes a decrease in intrathoracic pressure, resulting in inhalation of air into the lungs.

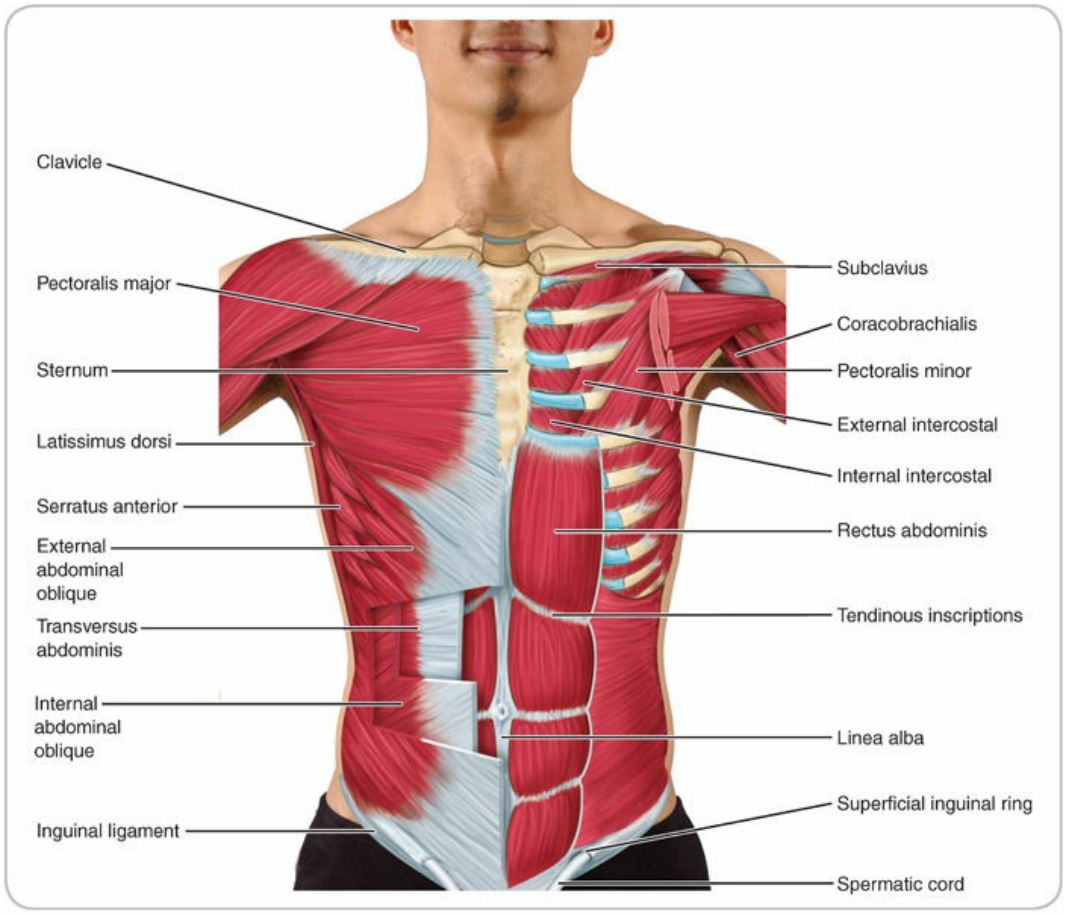

Figure 23.4. The anterior muscles of the trunk.

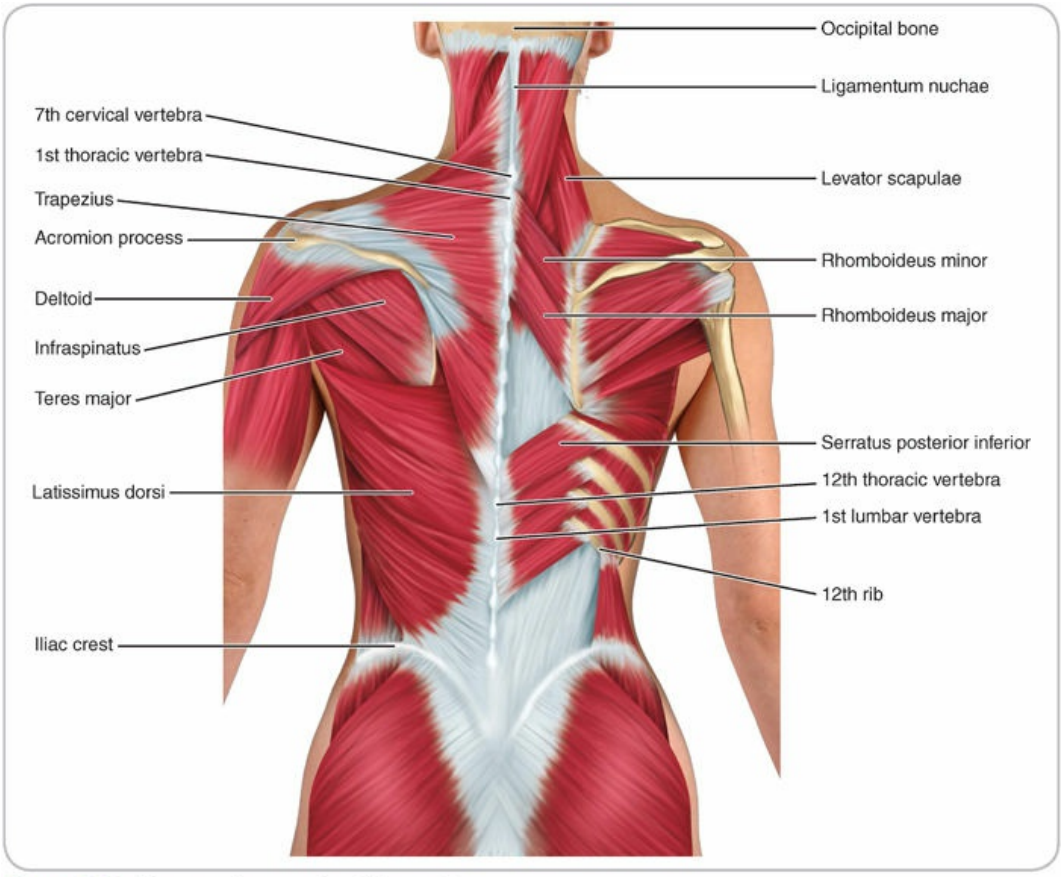

Figure 23.5. The posterior muscles of the trunk.

See **Muscles of the Thorax**, found on the companion Web site at thePoint, for a summary of the muscles of the thoracic region and the muscles of respiration, including their attachments, primary actions, and nerve innervation.

ANATOMY OF THE VISCERAL REGION

The visceral region includes the organs and vessels between the diaphragm and the pelvic floor and can be divided into four quadrants: right upper quadrant, left upper quadrant, left lower quadrant, and right lower quadrant (Fig. 23.6). Specific structures are located within each quadrant and are presented in Table 23.1 and Figure 23.7. The peritoneal space includes the diaphragm, liver, spleen, stomach, and transverse colon. A portion of the cavity is covered by the bony thorax. The retroperitoneal space, which is the region behind the peritoneum and pelvis, includes the aorta, vena cava,

pancreas, kidneys, ureters, and portions of the duodenum and colon. The pelvic organs and vessels include the rectum, bladder, uterus, and iliac vessels. The abdomen contains both solid and hollow organs. The solid organs include the spleen, liver, pancreas, kidneys, and adrenal glands. The hollow organs include the stomach, gallbladder, small and large intestines, bladder, and ureters. The pelvic girdle protects the lower abdominal organs.

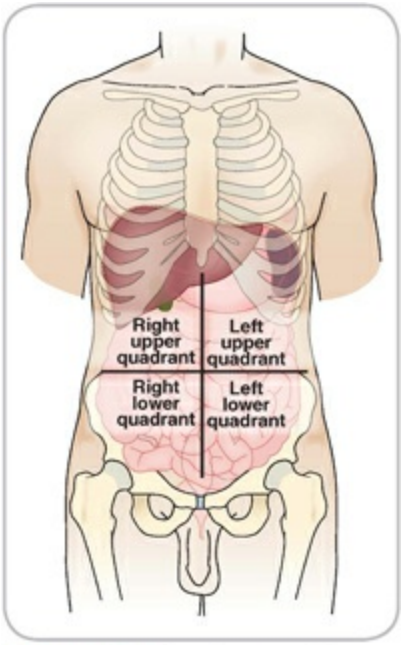

Figure 23.6. Quadrants of the abdominopelvic region.

TABLE 23.1 Abdominopelvic Quadrants: Important Organs

QUADRANT	ORGANS
Lower left quadrant (LLQ)	Descending colon, sigmoid colon, left ovary, left fallopian tube, left ureter
Left upper quadrant (LUQ)	Stomach, spleen, left lobe of liver, body of pancreas, left kidney, left adrenal gland, parts of transverse and descending colon
Right upper quadrant (RUQ)	Liver, gall bladder, duodenum, pancreas, right kidney
Right lower quadrant (RLQ)	Cecum, appendix, ascending colon, right ovary and fallopian tube, right ureter

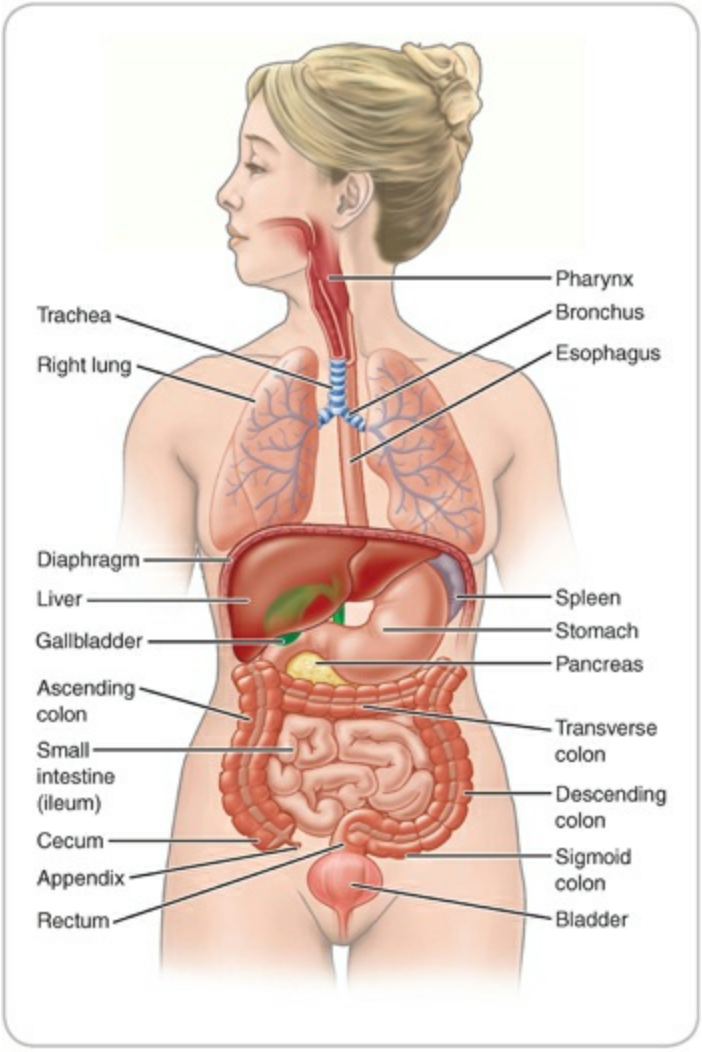

Figure 23.7. The anterior view of the visceral organs.

Pelvic Girdle and Abdominal Cavity

The pelvic girdle, or pelvis, consists of the sacrum, ilium, ischium, and pubis. The joints between these bones are fused in adults, and as such, no movement is allowed. The pelvis forms a protective basin around the internal organs of the abdomen, and it transfers loads between the spine and lower extremity through the hip joint. The pelvis also provides a mechanical link between the upper and lower extremities. Its primary role is to stabilize the lower trunk while motion occurs in the extremities.

Visceral Organs

The stomach is a J-shaped bag positioned between the esophagus and small intestine. Food is stored in the stomach for approximately 4 hours, during which time hydrochloric acid secreted in the stomach breaks it down into a paste-like substance known as **chyme**. The chyme then moves into the small intestine, where it is progressively absorbed. A few substances, including water, electrolytes, aspirin, and alcohol, are absorbed into the bloodstream across the stomach lining without full digestion.

The small intestine is approximately 2 m (6 ft) in length and is responsible for most of the digestion and absorption of food as it is propelled through the organ by waves of alternate circular contraction and relaxation by a process called **peristalsis**. This process takes approximately 3 to 6 hours. During the next 12 to 24 hours, water and electrolytes are further absorbed from the stored material in the large intestine, or colon. Mass peristaltic movements pass through the intestines several times per day to move the feces to the rectum.

The vermiform appendix protrudes from the large intestine in the right lower quadrant of the abdomen. It can become a protected environment for the accumulation of bacteria, leading to inflammation of the appendix, or appendicitis.

The liver, which is located in the upper right quadrant under the diaphragm, produces bile, a greenish liquid that helps break down fat in the small intestine. The liver also absorbs excess glucose from the bloodstream and stores it, in the form of glycogen, for later use. Additional functions of the liver include processing fats and amino acids, manufacturing blood proteins, and detoxifying certain poisons and drugs. These functions can be severely impaired by alcohol abuse, which can result in cirrhosis of the liver. **Hepatitis** is inflammation of the liver caused by a viral infection, which also can reduce the liver's efficiency. The gallbladder functions as an accessory to the liver by storing concentrated bile on its way to the small intestine.

The spleen, which is the largest of the lymphoid organs, performs four vital functions:

1. Cleansing the blood of foreign matter, bacteria, viruses, and toxins
2. Storing excess red blood cells for later reuse, and releasing others into the

blood for processing by the liver

3. Producing red blood cells in the fetus
4. Storing blood platelets

The pancreas secretes most of the digestive enzymes that break down food in the small intestine. It also secretes the hormones insulin and glucagon, which lower and elevate blood sugar levels, respectively.

The kidneys filter and cleanse the blood. They are vital for filtering out toxins, metabolic wastes, drugs, and excess ions and excreting them from the body in urine. The kidneys also return needed substances, such as water and electrolytes, to the blood. The ureters connect the kidneys to the urinary bladder, which is an expandable sac that stores urine.

Blood Vessels of the Trunk

The major blood vessel of the trunk is the aorta, with its numerous branches (Fig. 23.8). The left and right coronary arteries branch from the ascending aorta to supply the heart muscle. The first arterial branch from the aortic arch is the brachiocephalic artery, which splits into the right common carotid artery and right subclavian artery. The second and third branches from the aortic arch are the left common carotid artery and the left subclavian artery, respectively. The thoracic aorta yields 10 pairs of intercostal arteries to supply the muscles of the thorax, the bronchial arteries to the lungs, the esophageal artery to the esophagus, and the phrenic arteries to the diaphragm. The distal portion of the descending aorta becomes the abdominal aorta. The first branch of the abdominal aorta is the celiac trunk, which forms the left gastric artery to the stomach, the splenic artery to the spleen, and the common hepatic artery to the liver. Other branches of the abdominal aorta include the superior and inferior mesenteric arteries to the small intestine and the first half of the large intestine, the renal arteries to the kidneys, the ovarian arteries in females, and the testicular arteries in males. The distal portion of the abdominal aorta divides into the common iliac arteries, which further divide into the internal iliac artery to supply the organs of the pelvis, and the external iliac artery, which

enters the thigh to become the femoral artery.

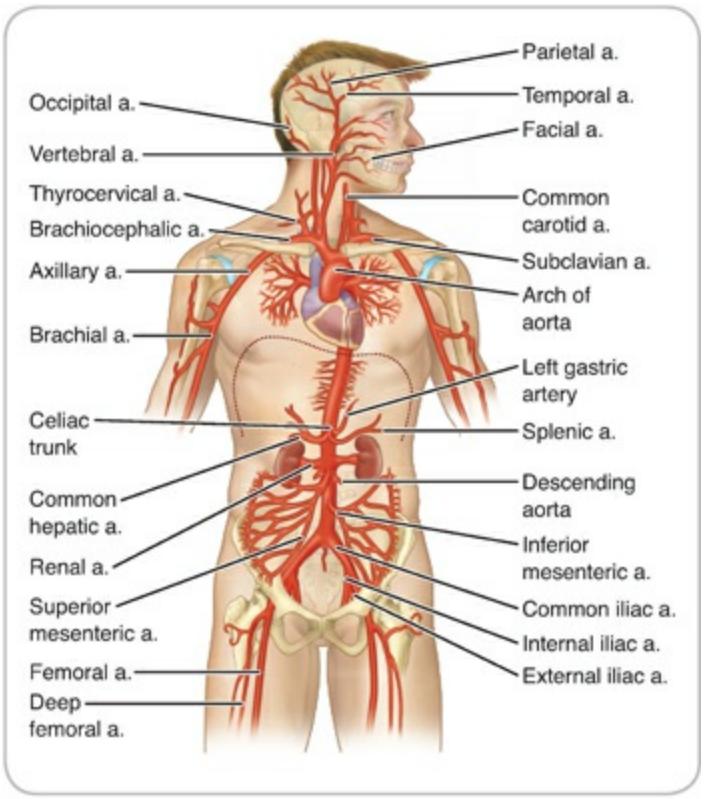

Figure 23.8. The arterial system of the trunk.

See **Muscles of the Pelvic Girdle**, found on the companion Web site at thePoint, for a summary of the locations, primary functions, and innervations of the major muscles of the pelvic girdle.

Muscles of the Pelvic Girdle

As is the case throughout the neck and trunk, muscles in the pelvic region are named in pairs, with one located on the left and the other on the right side of the body. These muscles cause lateral flexion or rotation when they contract unilaterally, but they contribute to spinal flexion or extension when bilateral contractions occur.

ANATOMY OF THE GENITALIA

The reproductive organs of the female and male include the primary and

accessory sex organs. The primary sex organs—the ovaries and testes—produce gametes (specifically, ovum and sperm, respectively) that, when joined together, develop into a fetus. Important sex hormones influence sexual differentiation and development of secondary sex characteristics and, in the female, regulate the reproductive cycle. The sex hormones predominantly are produced by the primary sex organs and belong to the general family known as **steroids**. In the female, estrogen and progesterone are produced by the ovaries. In the male, the adrenal cortex and testes produce hormones collectively known as **androgens**, the most active being testosterone. The accessory sex organs transport, protect, and nourish the gametes after they leave the ovaries and testes. In females, the accessory sex organs include the fallopian tubes, uterus, vagina, and vulva. In males, the accessory sex organs include the epididymis, ductus deferens, seminal vesicles, prostate gland, bulbourethral glands, scrotum, and penis.

Female Reproductive System

The female reproductive system includes the ovaries, which produce ova (female eggs); the fallopian tubes, which transport, protect, and nourish the ova; the uterus, which provides an environment for development of the fertilized embryo; and the vagina, which serves as the receptacle for sperm (Fig. 23.9). These structures are protected by the pelvic girdle and seldom are injured during participation in sport and physical activity.

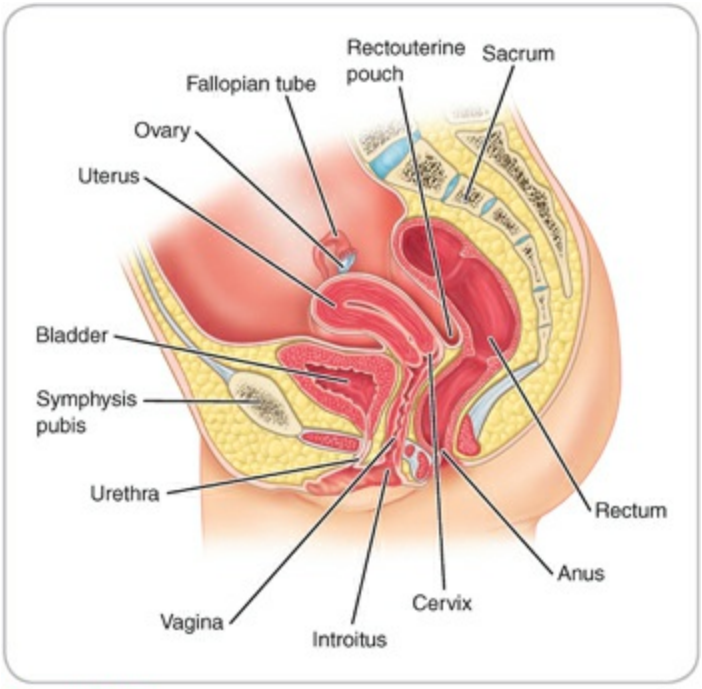

Figure 23.9. A median section of the female pelvis.

The ovarian cycle begins at puberty with the release of an ovum, or egg, from the ovary. The ovum, which is released at ovulation, travels through a fallopian tube to the uterus, where it embeds itself in the uterine wall. The menstrual cycle lasts anywhere from 28 to 40 days, involves a repeated series of changes within the lining of the uterus, and is controlled by the ovarian cycle. Menses, or menstrual flow, is a phase in the menstrual cycle that lasts 3 to 6 days; during this time, the thickened vascular walls of the uterus, the unfertilized ovum, and blood from the damaged vessels of the endometrium are discharged.

The hormones estrogen and progesterone are produced by the ovaries. **Estrogens** help to regulate the menstrual cycle and influence the development of female physical sex characteristics, such as the appearance of breasts, pubic and axillary hair, increased subcutaneous fat (particularly in the hips and breasts), and widening of the pelvis. Estrogens also are responsible for the rapid growth spurt seen in girls between the ages of 10 and 13 years. This growth is short-lived, however, because increased levels of estrogen cause early closure of the epiphyses of long bones, in turn causing females to reach their full height between the ages of 15 to 18 years. In contrast, males may

continue to grow until the age of 19 to 21 years. **Progesterones** are responsible for regulating the menstrual cycle and stimulating the development of the uterine lining in preparation for pregnancy.

The external genital organs of the female are known as the vulva, or pudendum. The outer rounded folds, referred to as the labia majora, protect the vestibule into which the vagina and urethra open.

Male Reproductive System

The male reproductive system includes the testes, which produce spermatozoa; a number of ducts that store, transport, and nourish the spermatozoa; several accessory glands that contribute to the formation of semen; and the penis, through which urine and semen pass (Fig. 23.10). **Testosterone**, which is the primary androgen produced by the testes, stimulates the growth and maturation of the internal and external genitalia at puberty and is responsible for sexual motivation. Secondary sex characteristics that are testosterone-dependent include the appearance of pubic, axillary, and facial hair; enhanced hair growth on the chest or back; and a deepening of the voice as the larynx enlarges. Androgens also increase bone growth, bone density, and skeletal muscle size and mass.

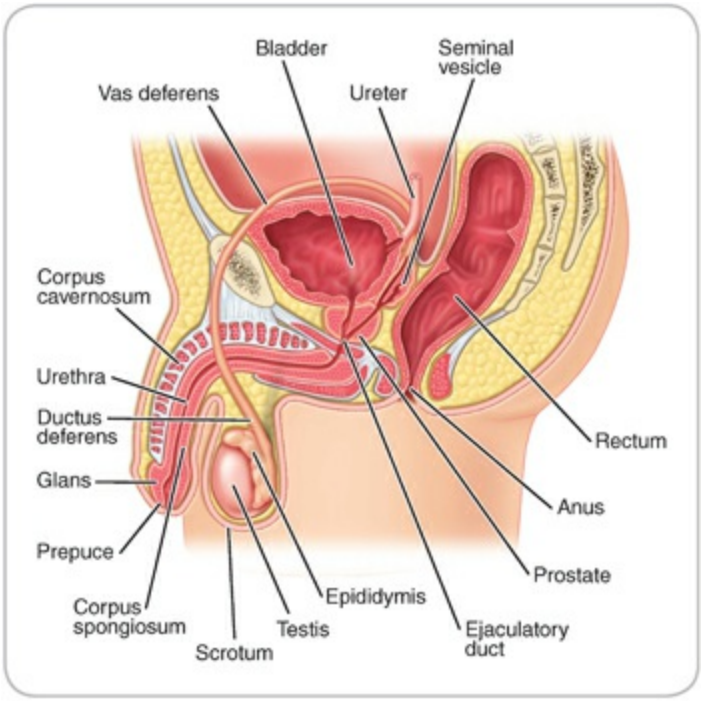

Figure 23.10. **A median section of the male pelvis.**

PREVENTION OF INJURIES TO THE THROAT, THORAX, AND VISCERA

? The throat, thorax, and viscera are vulnerable to direct impact injuries. This region is such a critical area that injuries can be life threatening. What measures can be taken to prevent injuries to this region?

Injuries to the throat, thorax, and abdomen occur in nearly every sport, yet few sports require protective equipment for all players. In sports where high-velocity projectiles are present, throat and chest protectors are required only for specific player positions (e.g., catcher or goalie). As with other body regions, protective equipment, in combination with a well-rounded physical conditioning program, can reduce the risk of injury. Although proper skill techniques can prevent some injuries, this is not a major factor in this region.

Protective Equipment

Face masks with throat protectors are required for fencing participants, baseball/softball catchers, and field hockey, ice hockey, and lacrosse goalies. Many of these athletes wear an extended pad attached to the mask to protect the throat region.

Many participants in collision and contact sports wear full chest and abdominal protection. In young baseball and softball players (younger than 12 years of age), it has been suggested that all infield players wear chest protectors. Adolescent rib cages are less rigid, placing the heart at greater risk from a direct impact. Although there are many commercially made wall protectors for use by youth lacrosse and baseball athletes, it is important to remember that no chest wall protectors have yet been found to be effective in preventing commotio cordis.[2] In this age group, more baseball and softball deaths occur from impacts to the chest than to the head.

Shoulder pads can protect the upper thoracic region, and rib protectors can provide protection against rib, upper abdominal, or low back contusions. Body suits made of mesh with pockets can hold rib and hip pads to protect the sides and back.

The male genitalia are more susceptible to injury than the female genitalia. Protective cups can protect the penis and scrotum from injury. Sport bras can provide added support to reduce excessive vertical and horizontal breast motion during exercise. Protective equipment is illustrated and discussed in Chapter 3.

Physical Conditioning

Flexibility and strengthening of the torso muscles should not be an isolated program; rather, it should include a well-rounded conditioning program for the back, shoulder, abdomen, and hip regions. Range of motion (ROM) and strengthening exercises should include both open and closed kinetic chain activities. Exercises for the thorax and abdominal region are included in the chapters on Pelvic, Hip, and Thigh Conditions, Shoulder Conditions, Cervical and Thoracic Spinal Conditions, and Lumbar Spinal Conditions.

Injuries to the throat, thorax, and viscera can be prevented by wearing appropriate protective equipment. Physical conditioning should include a well-rounded flexibility and strengthening program for the shoulder, back, abdominal, and hip regions.

ASSESSMENT OF THROAT, THORAX, AND VISCERAL CONDITIONS

During practice, a 20-year-old football player was struck in the abdomen with a helmet and experienced a sudden onset of abdominal pain in the upper left quadrant. How should the assessment of this injury progress to determine the extent and severity of injury?

The injury assessment for thoracic and visceral injuries should focus on vital signs and the history of the injury. Chest or abdominal trauma, although initially appearing to be superficial and minor, can mask an internal hemorrhage and swelling that can seriously compromise the function of vital organs. An individual's condition can slowly deteriorate and become a life-threatening condition. Although general observation and palpation can confirm the possibility of a serious underlying condition, an understanding of the history of the injury and constant monitoring of vital signs strengthen the assessment.

The clinician should assess consciousness, respiration, and circulation. If the individual is having difficulty breathing, anxiety and panic may make the task more difficult. If a spinal injury has been ruled out, the individual should be placed in a supine position, with the knees flexed, to facilitate breathing. The airway should be open and clear of any blood or vomitus. The trachea should be in the middle of the throat and should not move during respirations. If breathing does not return to normal within a minute or two, the emergency medical plan, including summoning emergency medical services (EMS), should be activated. It is always better to have EMS en route during the assessment than to wait and see if the condition gets better. Several conditions

can intensify in severity with time, thereby seriously compromising the health of the injured party. The clinician should record vital signs so that a baseline of information is established. Methods for assessing level of consciousness, airway, breathing, vital sign assessment, and clearing the patient of potential cervical spine injury were presented in Chapter 7.

As is the case with an acute abdominal injury, water and food should not be given to the individual. Not only can the condition be aggravated, any food or fluid in the gastrointestinal tract will make the surgery, if necessary, more dangerous. While waiting for EMS to arrive, the vital signs should be monitored frequently and the individual should be treated for shock.

See **Application Strategy: Thorax and Visceral Region Evaluation**, available on the companion Web site at thePoint, for a summary of the assessment of the thorax and visceral regions.

HISTORY

The assessment of the football player's injury should begin with a history. The mechanism of injury and the site of the trauma have already been identified. What additional questions need to be asked as part of the on-field assessment of this injury?

Because few special tests are available for the region, the clinician must rely heavily on information provided in the history. Injuries to the ribs, costal cartilage, or abdominal muscles usually produce tenderness at the site of injury. Abdominal pain may indicate a serious abdominal injury, but it also can be a symptom in conditions as minor as precompetition anxiety. The issue is not to draw a distinction between acute and nonacute pain but, rather, to draw one between possible surgical and nonsurgical conditions. Because pain tolerance can vary, every complaint of thoracic or abdominal pain must be assessed.

The clinician should gather information regarding the primary complaint, the mechanism of injury, and the characteristics of the symptoms. Pain that is

sudden in onset, severe or explosive, progressive, continuous, and lasts more than 6 hours generally indicates a serious internal problem that necessitates surgical intervention. Persistent pain that awakens the person or that occurs during relative inactivity also is a red flag. Pain that is gradual, mild-to-moderate, intermittent, recurrent, occurs after exercise or eating, or resolves partially or completely in less than 6 hours indicates a less serious condition that favors a nonsurgical diagnosis.[3] **Table 23.2** identifies some common nonmusculoskeletal sources of abdominal pain and the typical signs and symptoms that are associated with each condition. The patient should be referred for additional examination if any of the conditions listed in **Table 23.2** are suspected.

TABLE 23.2 Common Nonmusculoskeletal Sources of Abdominal Pain

CONDITION	SIGNS AND SYMPTOMS
Appendicitis (acute)	Inflammation of the appendix resulting in constant pain; progresses in severity; begins in the outer umbilical region; moves to the right lower quadrant; nausea, vomiting, and loss of appetite; low-grade fever
Cholecystitis (acute)	Inflammation of the gallbladder, resulting in constant pain in the right upper quadrant; onset often follows a meal; nausea and vomiting; tenderness in the right upper quadrant and right shoulder; splinting on the right side
Perforated peptic ulcer	Perforated stomach ulcer resulting in a sudden onset of pain in the midepigastric region that spreads and is aggravated by movement; individual is reluctant to move and appears acutely ill; rigid abdomen; grunting respiration; absent bowel sounds
Ectopic pregnancy	Pregnancy in the fallopian tube, which results in a tubal rupture causing a sudden, severe, and persistent pain, generally following a missed or abnormal period; typically epigastric; often associated with hypotension and tachycardia
Ovarian cyst	An abnormal cystic tumor of the ovary that usually is benign; constant pain with a sharp, sudden onset; usually in the ipsilateral lower area of the abdomen below the umbilicus; may have nausea and vomiting following the pain
Pelvic inflammatory disease	Chronic inflammation of the pelvis caused by multiple infections, including chlamydia and gonorrhea, resulting in pain at the end of or shortly after a normal menstrual period; bilateral lower quadrant pain aggravated by manipulation of the cervix; rarely, nausea and vomiting; possible cervical discharge; fever
Urinary calculus	Pain location changes with the movement of the urinary stone and may radiate to the testicle or groin of the involved side; pain is very severe; individual cannot get comfortable

The clinician should ask questions about previous injuries to the area that may have some bearing on this specific condition. It is important to remember that some conditions, such as a ruptured spleen, can delay hemorrhage for hours, days, or even weeks after the initial trauma. Other injuries with an acute onset may have signs and symptoms that subside only to recur later. Questions should be asked about activities that aggravate the pain. Coughing, sneezing, rapid movements, and walking, especially down stairs, can cause peritoneal irritation. Musculoskeletal pain often is relieved by changing position.

In younger athletes who are sexually active, females experience abdominal

pain twice as often as males of the same age. Males, however, tend to have a higher incidence of conditions necessitating surgical intervention. Pain that is sudden in onset and follows an abnormal menstrual period might stem from an ectopic pregnancy, which would constitute a medical emergency. Pain that occurs shortly after a normal menstrual period, is bilateral, and is accompanied by fever and abdominal pain but not nausea and vomiting suggests pelvic inflammatory disease.

See **Application Strategy: Developing a History for a Thoracic or Abdominal Injury**, found on the companion Web site at thePoint, for specific questions that can be asked for chest and abdominal injuries.

During the on-field assessment of the football player, the mechanism of injury and the location of trauma have been identified. The clinician should ask questions related to the location and type of pain (including pain in areas other than the injured site) and the presence of any dizziness, nausea, weakness, numbness, or other unusual feelings.

OBSERVATION AND INSPECTION

During the history, the individual reports pain in his upper chest and left shoulder. He also complains of feeling weak and light-headed. What factors should be observed and inspected as part of the ongoing on-field assessment of this injury?

An observation of body position can give an indication regarding the site, nature, and severity of injury. For example, in an acute thoracic injury, the individual may lean toward the injured side, using an arm or a hand to stabilize the region. In an acute abdominal injury, the individual typically lies on the injured side and brings the knees toward the chest to relax the abdominal muscles. Facial expressions can confirm the individual's hesitation to perform any movement because of severe pain. A chest expansion can reveal the rate and depth of respirations.

Inspection

The individual should be sufficiently undressed so that the site of injury can be observed. An inspection should include the neck, back, chest, abdomen, and groin, with any deformity, edema, bruising, ecchymosis, and skin color being noted. A deformity may indicate a sternal or rib fracture, costochondral separation, or muscle rupture. An abrasion or localized bruising on the chest wall could suggest a possible rib fracture or internal complication. Diffuse bruising in the axilla and chest wall may indicate a ruptured pectoralis major. A bruise or ecchymosis in the umbilical area (i.e., **Cullen sign**) indicates intraperitoneal bleeding. A distention in the abdomen may indicate an internal hemorrhage. Pale, cold, and clammy skin is associated with shock. Cyanosis, or a bluish tinge to the skin, indicates a lack of oxygen resulting from internal pulmonary or cardiac problems. Coughing up bright red or frothy blood indicates a severe lung injury. Vomitus containing blood that looks like used coffee grounds indicates that blood has been swallowed and partially digested.

The rate and depth of respirations should be noted, particularly if the individual has any difficulty catching his or her breath. If the condition is only transitory (e.g., the "wind has been knocked out"), breathing and color should quickly return to normal. An individual with an internal injury tends to use rapid and shallow breaths, because deep breathing increases pain. The clinician should observe the symmetric rise and fall of the chest; any abnormal motion may indicate a fractured rib or pneumothorax. If breathing does not quickly return to normal or the individual's condition rapidly deteriorates, the injury should be considered significant, and the emergency medical plan, including summoning EMS, should be activated.

See **Application Strategy: Observation and Inspection of the Thorax and Viscera**, found on the companion Web site at thePoint, for specific observations that can help to determine the extent and severity of thoracic or abdominal injuries.

Auscultation and Percussion

If auscultation or percussion is used in the assessment, both should be completed before palpation. Because the visceral organs are interconnected by

connective tissue, any palpation in the abdomen moves the internal organs and, as such, can produce inaccurate or false sounds.

Auscultation is used to listen for the presence or absence of sounds in the body and should precede any physical contact with the individual to prevent the alteration of peristalsis by physical stimulation. A stethoscope usually has two heads: the bell and the diaphragm. The bell is used to detect low-pitched sounds, whereas the diaphragm is better at detecting higher pitched sounds. When using the bell of the stethoscope, light pressure should be applied to maintain contact with the skin surface. Firm pressure is applied when using the diaphragm to keep it pressed tightly to the skin. Because the bell or diaphragm must always be in contact with the skin, listening through clothing is never acceptable. It may take 2 to 3 minutes in each area to adequately evaluate the nature and character of the underlying conditions, particularly with bowel sounds.

Auscultation of the Lungs

In the thorax, the flow of air should be heard throughout the various regions of each lung (**Fig. 23.11**). Because most breath sounds are high-pitched, the diaphragm is used to evaluate lung sounds. Individuals who should be evaluated include those with the following signs and symptoms (**Box 23.1**)[3]:

- Shortness of breath or dyspnea
- Cough with or without a bloody sputum
- Pleuritic pain
- A resting respiratory rate greater than 22 breaths per minute
- Cyanosis or finger clubbing

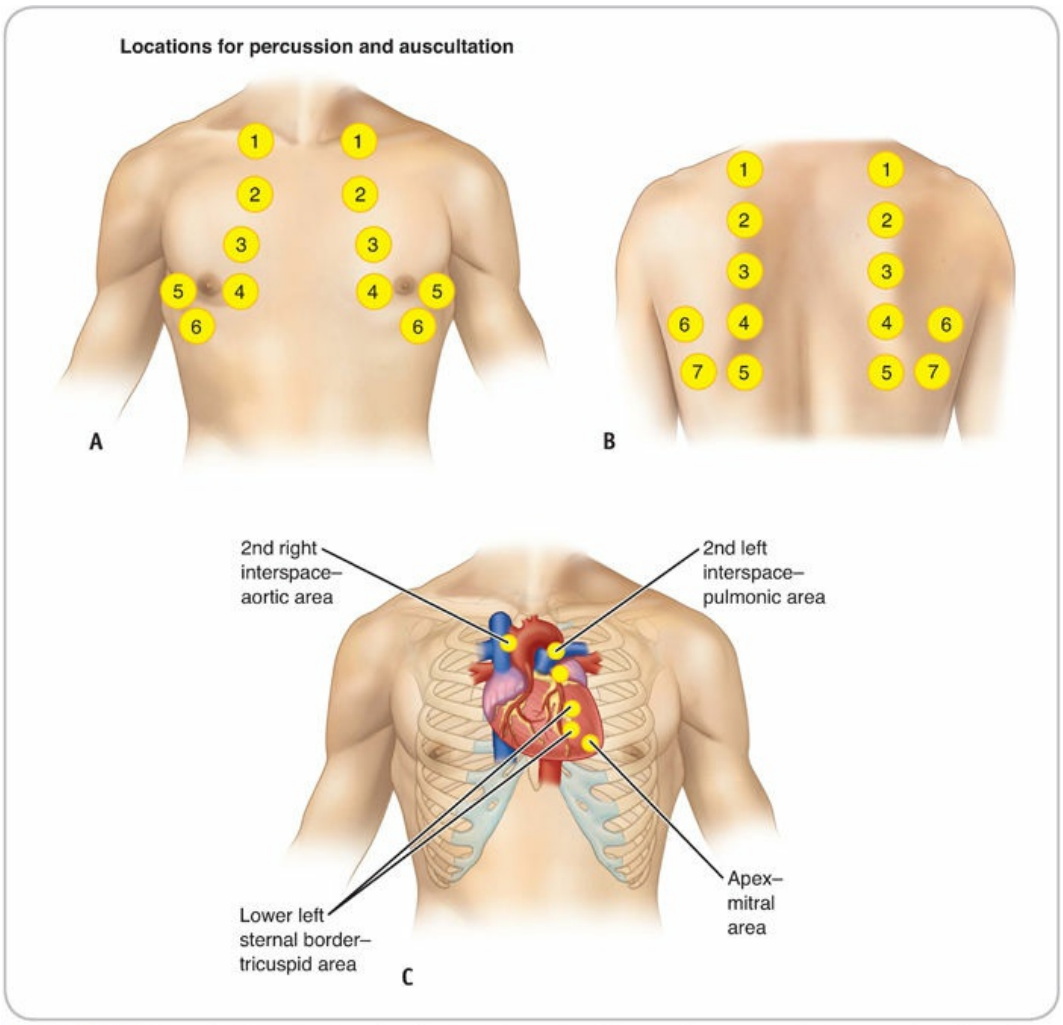

Figure 23.11. Auscultation. An auscultation is performed with a stethoscope to listen at various sites for air exchange in the lobes of the lungs. **A,** Anterior view. **B,** Posterior view. **C,** Cardiac sounds also can be auscultated over four specific sites.

BOX 23.1 Signs and Symptoms Indicating the Need for Lung Auscultation

- Shortness of breath or dyspnea (could indicate conditions such as pneumonia, pneumothorax, asthma, or heart failure)
- Cough with or without a bloody sputum (could indicate pneumonitis, bronchitis, fibrotic lung disease, or bronchial carcinoma)
- Pleuritic pain (could indicate acute inflammation of the pleural surface, herpes zoster involving the intercostal nerves, or rib fracture)
- A resting respiratory rate of greater than 22 breaths per minute

- Cyanosis or finger clubbing (could indicate several pulmonary diseases, including chronic suppurative disease or pulmonary carcinoma)

The patient should be instructed to breathe deeply through an open mouth. The clinician should listen for at least one full breath at each site, moving from one side to the other and comparing symmetric areas of the lungs. The intensity of breath sounds should be noted. Breath sounds usually are louder in the lower posterior lung fields and may vary from area to area. Characteristics of normal breath sounds are summarized in Table 23.3. Abnormal sounds are summarized in Table 23.4.[4]

TABLE 23.3 Characteristics of Normal Breath Sounds

	DURATION OF SOUNDS	INTENSITY OF EXPIRATORY SOUND	PITCH OF EXPIRATORY SOUND	LOCATIONS WHERE NORMALLY HEARD
Vesicular	Inspiratory sounds last longer than expiratory ones	Soft	Relatively low-pitched	Over most of both lungs
Bronchovesicular	Inspiratory and expiratory sounds are about equal	Intermediate	Intermediate-pitched	Often in the 1st and 2nd interspaces anteriorly and between the scapulae
Bronchial	Expiratory sounds last longer than inspiratory ones	Loud	Relatively high-pitched	Over the manubrium, if heard at all
Tracheal	Inspiratory and expiratory sounds are about equal	Very loud	Relatively high-pitched	Over the trachea in the neck

From Bickley LS, Szilagyi PG. *Bates' Guide to Physical Examination and History Taking*. Philadelphia, PA: Lippincott Williams & Wilkins; 2003:227; with permission.

TABLE 23.4 Abnormal Breath Sounds

SOUND	CHARACTERISTICS
Crackles	May result from abnormalities of the lungs (e.g., pneumonia, fibrosis, or early congestive heart failure) or the airways (e.g., bronchitis or bronchiectasis)
Fine crackles	Soft, high-pitched, and very brief (5–10 msec). They sometimes are compared to rubbing dry strands of hair together between the thumb and finger close to the ear.
Coarse crackles	Somewhat louder than fine crackles, lower in pitch, and not quite so brief (20–30 msec)
Wheezes	Relatively high-pitched (~400 MHz or higher) and has a hissing or shrill quality. Wheezing suggests narrowed airways, as in asthma, bronchitis, chronic obstructive pulmonary disease, and congestive heart failure.
Rhonchi	Relatively low-pitched (~200 MHz or lower) and have a rumbling or snoring quality. They usually are caused by the passage of air through bronchi obstructed by thick mucus.
Stridor	A wheeze that is entirely or predominantly inspiratory. It often is louder in the neck than over the chest wall, and it indicates partial obstruction of the larynx or trachea.
Pleural rub	Inflamed or roughened pleural surfaces momentarily grate against each other and are delayed by friction, producing creaking sounds known as a pleural rub or pleural friction rub. Pleural rubs resemble crackles acoustically but usually are confined to a relatively small area of the chest wall and typically are heard in both phases of respiration.
Mediastinal crunch	A series of precordial crackles synchronous with heartbeat, not with respiration. They are best heard in the left lateral position (Hamman sign) and are caused by mediastinal emphysema.
Absence of sounds	May be caused by pleural effusion, pneumothorax, tension pneumothorax, hemothorax, or traumatic asphyxia

Auscultation of the Heart

A normal cardiac cycle consists of two sounds, often called "lub-dub," which is caused by the blood flowing against the valves as they close. Individuals who should have the heart evaluated include those listed in Box 23.2.

BOX 23.2 Signs and Symptoms Indicating the Need for Heart Auscultation

- Cyanosis of the skin and mucous membranes accompanied by clubbing of the nails (indicates congenital heart disease)
- Any signs of Marfan syndrome
- Palpitations or a history of syncope, angina, and fatigue
- Rapid pulse (tachycardia) of more than 100 beats per minute at rest
- Slow pulse (bradycardia) of less than 40 beats per minute at rest
- Unusual and severe dyspnea after routine exercise
- Sustained arterial hypertension
- Retrosternal pain brought on by exertion but relieved with rest
- Traumatic chest injuries that could cause cardiac injury

An abnormal sound is called a murmur and is produced by turbulent energy in the walls of the heart and blood vessels. Obstruction to flow, or flow from a narrow to a larger diameter vessel, produces the turbulence, which sets up motion currents that strike the walls and produce vibrations that can be heard with a stethoscope. Murmurs also can be produced when a large volume of blood is flowing through a normal opening. Murmurs may be described as "blowing," "rumbling," or "harsh." If abnormal sounds such as a click, snap, or a murmur are present, the individual should be referred to a physician.

The diaphragm of the stethoscope is more effective in detecting the relatively high-pitched sounds of S_1 (i.e., first sound) and S_2 (i.e., second sound), the murmurs of aortic and mitral regurgitation, and pericardial friction rubs. The bell of the stethoscope is more sensitive to the low-pitched sounds of

S_3 and S_4 and the murmur of mitral stenosis.

The clinician should be on the right side of the patient with the individual recumbent and the head and chest elevated to 45°. This position allows the clinician to observe chest movements associated with cardiac function as well as to place the stethoscope head correctly during auscultation. Some clinicians begin at the apex; others prefer to start at the base (i.e., upper margins of the heart). Either pattern is satisfactory.

Four classic sites are used to determine cardiac sounds (see **Fig. 23.11**):

1. Aortic (second intercostal space, right sternal border)
2. Pulmonic (second intercostal space, left sternal border)
3. Tricuspid (left lower sternal border)
4. Mitral (cardiac apex)

After listening to each site, the clinician should instruct the patient to roll partly onto the left side, which positions the left ventricle closer to the chest wall. In this position, the clinician should place the bell lightly on the apical impulse. Finally, the patient should be instructed to sit up, lean forward, exhale completely, and stop breathing in expiration; this position accentuates aortic murmurs that otherwise might go undetected.

Auscultation of the Abdomen

In the abdomen, auscultation can determine bowel motility. It is important to listen to the abdomen before performing percussion or palpation, because these maneuvers may alter the frequency of bowel sounds.

The diaphragm of the stethoscope should be placed gently on the abdomen, assessing each of the four quadrants shown in **Figure 23.6**. Bowel sounds should be noted relative to their frequency and character. Normal bowel sounds consist of clicks and gurgles, occurring at an estimated frequency of 5 to 34 per minute.[5] Hyperperistalsis with rushes, cramps, and diarrhea suggests gastroenteritis.

Percussion

Percussion typically is used over a bony structure to determine a possible fracture, but it also can be used in the chest and abdominal region to indicate internal complications. The clinician should place their nondominant hand on the patient's abdomen over the various internal organs. This is followed by the clinician using the second and third finger of the dominant hand to tap on the distal interphalangeal joint of the middle finger of the nondominant hand. The tapping should be performed as a quick rapid motion (Fig. 23.12). The tone indicates if the organ is hollow (tympanic) or solid (full).

Figure 23.12. Percussion. Percussion is used in the abdominal region to indicate internal complications and should be performed before palpation.

In the chest, the same sites used during auscultation are percussed and bilaterally compared. Dullness replaces resonance when fluid or solid tissue replaces air-containing lung tissue. Because pleural fluid usually sinks to the inferior pleural space (i.e., posteriorly in a supine patient), only a very large effusion can be detected anteriorly. The heart normally produces an area of dullness to the left of the sternum from the 3rd to 5th interspace.

In the abdomen, the four quadrants are tested to assess the distribution of tympany and dullness. Tympany usually predominates because of gas in the gastrointestinal tract, but fluid and feces may produce normal, scattered areas of dullness. It is important to note any large, dull areas that may indicate an enlarged organ and any facial expressions to indicate any discomfort.

Hypoperistalsis, or a silent abdomen, could indicate a serious underlying problem, such as an

obstruction or an internal hemorrhage. Immediate referral to the nearest medical facility is warranted. Activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

Note the football player's willingness or ability to move, ease in motion, and general attitude. The inspection should include viewing the chest and abdomen, with any deformity, edema, bruising, ecchymosis, and skin color being noted.

PALPATION

The general attitude of the football player indicates that he is uncomfortable and in pain. No abnormal findings are apparent by inspection. As part of the ongoing on-field assessment of this injury, what areas should be palpated?

It is important to begin palpation away from the painful area so that pain will not be carried over into other areas. Palpation begins with gentle circular motions, feeling for deformity, crepitus, swelling, rigidity, muscle guarding, or tenderness. The patient should be in a supine position with the knees flexed for more comfort.

The trachea should be palpated during breathing to ensure that it does not move, because movement may indicate a tension pneumothorax. The clinician should palpate the clavicle, sternum, costochondral cartilage, and ribs, moving in an anterior-to-posterior direction and noting any pain, deformity, or crepitus. The left anterior rib cage should be palpated for an enlarged spleen. The spleen may be more prominent if the patient raises his or her arms above the head. While palpating the posterior rib cage, the clinician should locate the approximate position of the kidneys. The left kidney is well protected by the posterolateral rib cage; the right kidney rests more inferior.

Possible rib fractures and costochondral separations are assessed with gentle pressure applied to the sternum and vertebrae in an anteroposterior

direction (Fig. 23.13A). This action causes the rib cage to bow out laterally. Lateral compression on the sides of the rib cage causes strain on the costochondral junctions (Fig. 23.13B). Compression should begin superiorly and move down, in an inferior direction, until the entire area is covered. Pain at a specific site indicates a positive sign.

Figure 23.13. Compression of the rib cage in a supine position. A, Anteroposterior compression for rib fracture. **B,** Lateral compression for costochondral separation.

The fingernails can be blanched to determine normal capillary refill. Certain cardiac or pulmonary conditions may result in cyanosis of the nail beds, fingers, and toes.

An examination of the abdomen begins by gently stroking the area. An underlying peritoneal irritation causes a light touch to be perceived as a disagreeable sensation, referred to as **dysesthesia**, and suggests a serious underlying condition. Palpation should be performed using the flat part of several fingers, with both hands moving in small, circular motions (Fig. 23.14). It is important to avoid poking or making sudden moves, because this may cause the individual to jerk and tighten the muscles. Palpation should begin away from the injured site and should move across the abdomen in a straight line. Any muscle guarding or rigidity should be noted. Muscle guarding that cannot be voluntarily relaxed may indicate internal peritoneal hemorrhage. It is important to palpate for tenderness, muscle resistance, and superficial masses or deficits in the continuity of the abdominal wall. Deeper palpation can detect rigidity, swelling, or masses. Rebound tenderness at the **McBurney point** is indicative of appendicitis (Fig. 23.15). The rebounding pain is caused when the inflamed appendix is impacted by the viscera returning to the normal position. This phenomenon, however, also can occur with peritonitis.

Figure 23.14. Palpation of the abdomen. The clinician should use the flat part of several fingers and move both hands in small, circular motions.

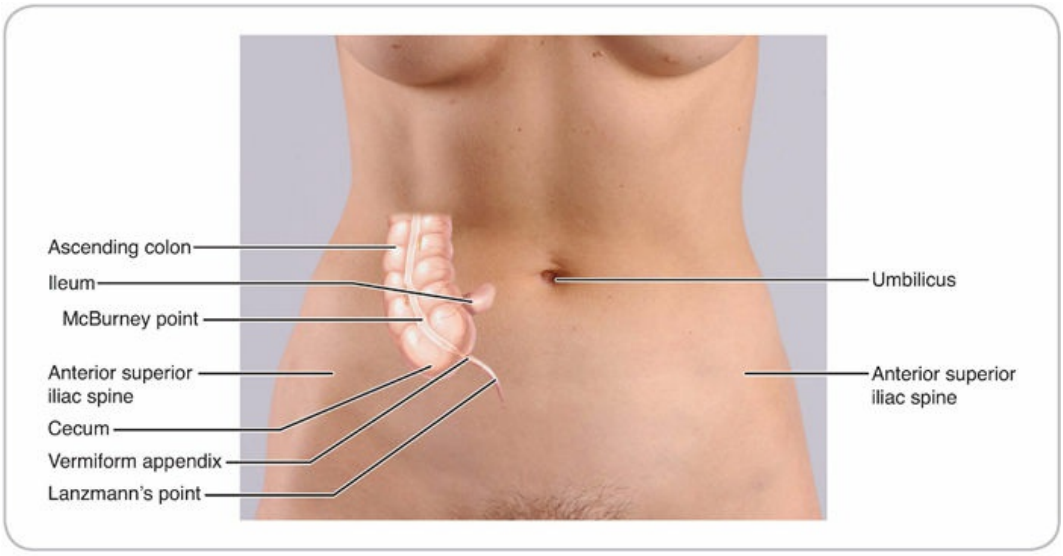

Figure 23.15. McBurney point. This point is the location where the base of the appendix is most commonly found. It is in the right lower quadrant about one-third of the distance from the anterior superior iliac spine to the umbilicus. Rebound tenderness over McBurney point suggests the presence of appendicitis. Another cause of appendicitis can be an interruption of the blood supply to the appendix. Lanzmann point is a tender point in appendicitis that is situated on a line between the two anterior superior iliac spines, 5 to 6 cm from the right spine and 2 cm below McBurney point.

The focus of the palpation of the injury to the football player should be the upper left quadrant, but it is important to palpate the entire abdomen. The palpation should assess point tenderness, swelling, deformity, rebound pain, spasms, and rigidity.

PHYSICAL EXAMINATION TESTS

? The palpation reveals rigidity over the upper left quadrant. An assessment of vital signs indicates the following: blood pressure is 96/70 mm Hg, pulse is weak at 96 beats per minute, and the skin is cool and clammy. What injury should be suspected, and how should this condition be managed?

Very few special tests are available for the thorax and visceral area. Most of the information must be gathered during the history, observation, and palpation phase of the assessment. If the condition is not serious and a muscular strain is suspected, active, passive, and resisted muscle testing can be performed. Neck and trunk motion include flexion, extension, lateral flexion, and rotation. The clinician should note the individual's willingness to perform the motion, ease of motion, and bilateral comparison of motions when applicable.

Vital Signs

It is important to note pulse rate and rhythm, blood pressure, temperature, and respiratory rate and characteristics. The pulse usually is taken at the carotid artery; however, a pulse also can be taken at the radial, femoral, or brachial arteries. A normal pulse rate for a physically active individual ranges between 60 and 100 beats per minute, depending on when the pulse is taken. The pulse rate is higher, for example, if taken immediately after exercise. Highly conditioned individuals tend to have lower pulse rates.

Respirations should range between 12 and 20 breaths per minute, with highly conditioned individuals falling into the lower range. Rapid, shallow breaths may indicate internal injury or shock. Deep, quick breaths may indicate asthma or pulmonary obstruction. Noisy, raspy breaths may indicate a partial airway obstruction.

Any sputum should be checked for the presence of blood. Pink or bloody sputum indicates internal bleeding and should be treated as a serious condition.

Painful abdominal conditions frequently are reflected in the vital signs as tachycardia, tachypnea, and elevated temperature. With conditions that involve the upper abdomen or lower lobes of the lung, respiration may be rapid,

shallow, painful (grunting), or splinted. Hypotension may result from gastrointestinal bleeding, dehydration, or vagal stimulation.

Urinalysis

Urinalysis is a common test that uses chemically treated dipsticks to provide fast, general results for such information as specific gravity, pH, and levels of leukocytes, nitrate, protein, glucose, ketones, urobilinogen, bilirubin, and blood in the urine (**Fig. 23.16**). In conducting a urinalysis, the patient should be instructed to clean and rinse the external urethra. In collecting the specimen, the patient should be told to direct the initial flow of urine into the toilet bowl before directing it into a clean specimen cup. One to 2 oz of urine should be collected. The clinician should insert the dipstick into the fluid following the manufacturer's recommended immersion times, and the color produced on the dipstick is then matched to the values provided by the manufacturer. Normal and abnormal urinalysis findings are presented in **Table 23.5**.

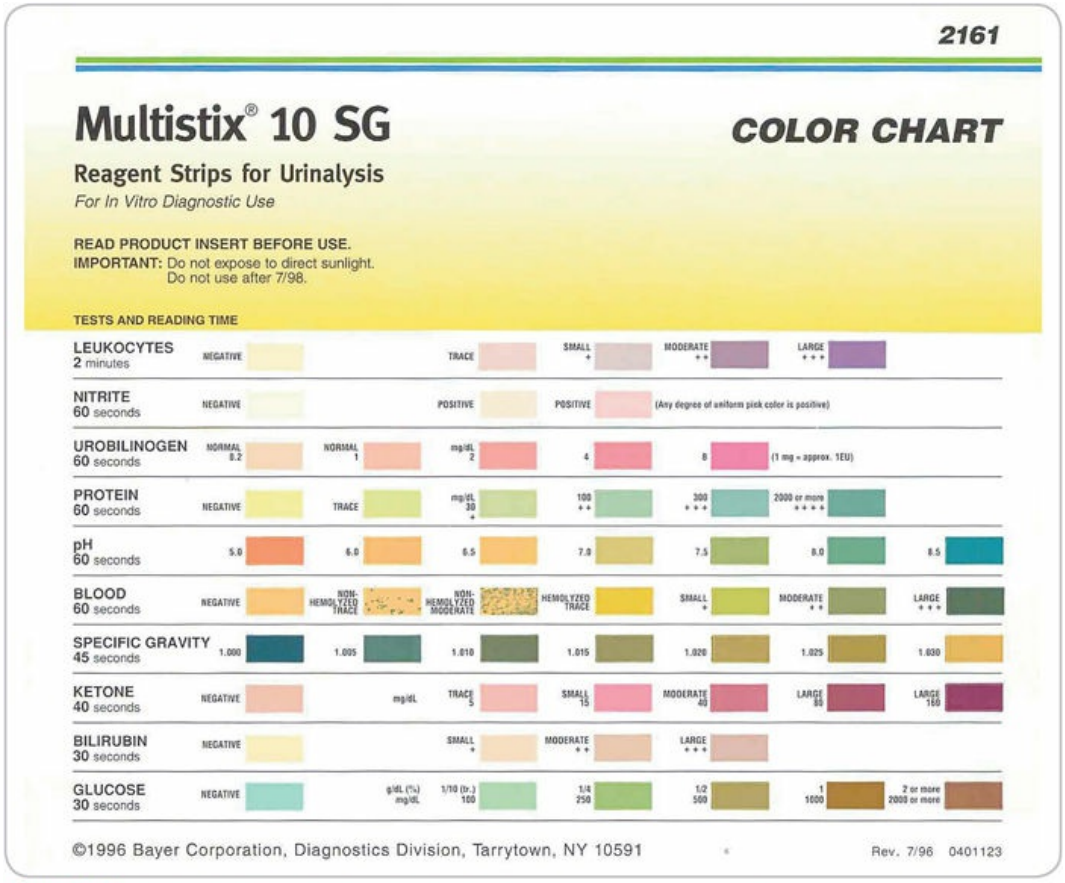

Figure 23.16. Urinalysis chart for chemical dipstick testing. After dipping the stick into the urine in accordance with manufacturer's protocol, the color produced on the dipstick is then matched to the values provided by the manufacturer.

TABLE 23.5 Normal and Abnormal Urinalysis Results

COMPONENT	NORMAL FINDINGS	ABNORMAL FINDINGS AND POTENTIAL CAUSES
Appearance	Color is a light yellow to a dark amber color.	Cloudy urine may indicate infection.
Odor	Odorless	Fruity odor may indicate presence of ketone bodies.
Leukocytes (WBC)	Normal is 0.	Elevated levels suggest possible infection in urinary tract or kidneys.
Nitrates	Normal is 0.	Elevated levels suggest possible UTI.
Urobilinogen	Normal range is 3.2–16.0.	Greater levels suggest liver disease. Lower levels may suggest jaundice.
Protein	Normal is 0 to trace.	Greater than trace indicates possible rhabdomyolysis, pregnancy, renal disease, and congestive heart failure.
Ph	Normal range is 4.5–7.2, with 6.0 average.	*Lower levels* indicate possible acidosis, dehydration, or diabetic ketoacidosis; creates an environment conducive to developing kidney stones. *Higher levels* indicate possible UTI, pyloric obstruction, or kidney dysfunction.
Blood (hemoglobin)	Normal is 0.	Elevated levels can occur due to diseases of the kidney and urinary tract, trauma, medications, or strenuous exercise.
Specific gravity	Normal values: 1.005–1.025	*Low specific gravity (< 1.005)* is characteristic of diabetes or kidney infection. *High specific gravity (> 1.035)* suggests possible dehydration, liver failure, or shock.
Ketones	Normal is 0 to trace.	Greater than trace ketones is also associated with diabetes but may occur with starvation and after bouts of vomiting and diarrhea.
Bilirubin	Normal is 0.	Presence of any amount of bilirubin is early indicator of liver disease.
Glucose	Normal is 0 to trace.	Greater than trace glucose may be the result of ingesting large glucose-rich foods that "spill" glucose into the urine but is also associated with diabetes.

WBC, white blood cell; *UTI*, urinary tract infection.

Neurological Test

Neurological tests in the thorax and abdomen are somewhat limited. Dermatomes vary and often overlap. Although the dermatomes tend to follow the ribs, the absence of only one dermatome may not lead to a loss in sensation. Sites for referred pain can indicate the origin of injury and are illustrated in Figure 6.1. Myotome testing includes finger abduction and adduction (T1) and hip flexion (L1–L2). No other myotome testing exists for the axial region. In addition, no deep tendon reflexes exist for the region, although it always is appropriate to test the deep tendon lumbar and sacral reflexes (i.e., patellar reflex and Achilles reflex).

Based on the on-field assessment of the football player, a splenic injury should be suspected. As such, activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to

arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

THROAT CONDITIONS

During a rebound attempt, a basketball player is struck in the anterior neck with an elbow. The player is coughing and having difficulty swallowing. What injury should be suspected? How should the situation be managed?

Neck Lacerations

Etiology

Although uncommon, lacerations to the neck can occur. In ice hockey, for example, a skater may attempt to leap over another player who is down on the ice. The edge of the skate blade may slice the down player. Bicycle accidents (neck striking the handlebars) and falls (neck striking an object) are more likely to occur in children, whereas motor vehicle, minibike, snowmobile, water jet ski, or all-terrain vehicle accidents occur in adolescents and adults.

Activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to arrive, the clinician should apply firm, direct pressure over the wound. The clinician also should maintain the airway, assess vital signs, and treat for shock as necessary.

Signs and Symptoms

If the trauma is sufficiently deep, it can damage the jugular vein or carotid artery on the lateral side of the neck.

Management

Immediate control of the hemorrhage is imperative. In addition to blood loss, air may be sucked into the vein and carried to the heart as an air embolism. Such an embolism can be fatal.

Contusions and Fractures

Etiology

Contusions and fractures to the trachea, larynx, and hyoid bone can occur during hyperextension of the neck. In this position, the thyroid cartilage (Adam's apple) becomes prominent and vulnerable to direct impact forces. In rare instances, these injuries can be fatal as a result of the extravasation of blood into the laryngeal tissues, leading to airway edema and asphyxia resulting from obstruction.

Signs and Symptoms

Immediate symptoms include hoarseness, dyspnea (difficulty breathing), coughing, difficulty swallowing (dysphagia), laryngeal tenderness, and an inability to make high-pitched "e" sounds. Significant trauma to the region can result in severe pain, laryngospasm, and acute respiratory distress (**Box 23.3**). Laryngospasm occurs when the adductor muscles of the vocal cords pull together in a shutter-like fashion and the upper surface of the vocal cords closes over the top, causing complete obstruction. The individual may recover on site, leave the area, and return home, only to have increasing respiratory problems en route. As the internal hemorrhage and swelling increases, the occlusion becomes more complete, and the individual's breathing becomes more difficult. Panic and anxiety can increase respiration and, in doing so, compound the problem. Swelling usually is maximal within 6 hours but may occur as late as 24 to 48 hours after injury. Cyanosis and a loss of consciousness may occur with a complete occlusion.

BOX 23.3 Signs and Symptoms Indicating Tracheal and Laryngeal Injuries

- Mild bruising and redness
- Shortness of breath
- Pain and point tenderness
- Subcutaneous crepitation

- Difficulty swallowing or coughing
- Spasmodic coughing
- Hoarseness or loss of voice[a]
- Laryngospasm[a]
- Presence of hemorrhage with blood-tinged sputum[a]
- Loss of contour of the Adam's apple (thyroid cartilage)[a]
- Cyanosis or respiratory distress

[a]A "red flag" that necessitates activation of EMS.

With significant trauma, activation of the emergency plan, including summoning EMS, is warranted. In these cases, it is important to consider an associated injury to the cervical spine. The clinician also should maintain the airway, assess vital signs, and treat for shock as necessary.

If the patient recovers on-site, observation should continue throughout the day to note the presence of any delayed respiratory problems. Application Strategy 23.1 explains the management of tracheal and laryngeal injuries.

APPLICATION STRATEGY 23.1

Management Algorithm for Tracheal and Laryngeal Injuries

If severe anterior throat trauma has occurred:

Assume a possible spinal injury and treat accordingly.

Ensure an open airway:

- If needed, use the jaw-thrust maneuver to achieve a chin-up position.
- Apply ice to control swelling, if appropriate.

If an obvious deformity is present in the pharynx:

Manually straighten the airway.

If a major laceration is present:

- Control hemorrhage with firm, manual pressure.
- Maintain pressure during assessment.
- Loosen any restrictive clothing.
- To reduce panic or anxiety, talk calmly to the patient, providing assurance that you are there to help.
- Treat for shock and monitor vital signs until EMS arrives.

Management

In an effort to diminish panic and anxiety resulting from the sudden inability to breathe, the clinician should immediately reassure the patient. The clinician should help the patient to focus on his or her breathing rate.

Activate the emergency medical plan, including summoning EMS.

The basketball player struck in the anterior neck could have a contusion or fracture to the trachea, larynx, or hyoid bone. In an effort to diminish panic and anxiety because of the sudden inability to breathe, the clinician should immediately reassure the patient. An open airway should be maintained, and the patient should be asked to focus on the breathing rate. In cases involving severe anterior neck trauma or spasm, it is important to consider an associated injury to the cervical spine. If breathing does not return to normal in a few minutes, activation of the emergency medical plan, including summoning EMS, is warranted.

THORACIC CONDITIONS

In an effort to improve his cardiovascular fitness, a healthy, 35-year-old man began a supervised running program. He has been running for 3

weeks and occasionally experiences a stitch in the side while running. A physician has advised him that the condition is not serious and has suggested that he attempt to run through the pain. What techniques can be used to alleviate the pain while running?

Thoracic injuries frequently are caused by sudden deceleration and impact, which can lead to compression and a subsequent deformation of the rib cage. The extent of damage depends on the direction, the magnitude of force, and the point of impact. For example, a glancing blow may bruise the chest wall, whereas a baseball that strikes the ribs directly may fracture a rib and drive the bony fragments internally, causing subsequent lung or cardiac damage. Box 23.4 identifies signs and symptoms that indicate a serious thoracic condition.

BOX 23.4 Red Flags Indicating a Serious Thoracic Condition

- Shortness of breath or difficulty breathing
- Deviated trachea or trachea that moves during breathing
- Anxiety, fear, confusion, or restlessness
- Distended neck veins
- Bulging or bloodshot eyes
- Suspected rib or sternal fracture
- Severe chest pain aggravated by deep inspiration
- Abnormal chest movement on affected side
- Coughing up bright red or frothy blood
- Abnormal or absent breath sounds
- Rapid, weak pulse
- Low blood pressure
- Cyanosis

Stitch in the Side

Etiology

Potential causes include trapped colonic gas bubbles, localized diaphragmatic hypoxia with spasm, liver congestion with stretching of the liver capsule, and poor conditioning.

Signs and Symptoms

A stitch in the side refers to a sharp pain or spasm in the chest wall, usually on the lower right side, during exertion.

Management

The frequency of a stitch usually diminishes as an individual's level of aerobic conditioning improves. Attempts can be made to run through the pain by the following:

- Forcibly exhaling through pursed lips
- Breathing deeply and regularly
- Leaning away from the affected side
- Stretching the arm on the affected side over the head as high as possible

Breast Conditions

Excessive breast motion during activity can lead to soreness, contusions, and nipple irritation. Although breast conditions usually are associated with women, men also may have conditions of the breast and nipples inducting contusion, gynecomastia, and nipple irritation.

Contusions

- **Etiology**

Excessive breast motion or direct trauma can lead to hemorrhage and edema formation in the breast tissue. Moderate-to-severe contusions to the breast may produce fat necrosis or a hematoma formation, both of which are painful and

may result in the formation of a localized breast mass. The appearance of these lesions on a mammogram may be indistinguishable from that of a malignant tumor. Direct trauma should be recorded on a woman's permanent medical record to avoid any erroneous conclusions when reading a future mammogram.

Signs and Symptoms

In mild contusion, hemorrhage and edema may be present in the soft tissue of the breast. In moderate contusion, a painful hematoma may be present.

Management

Immediate management of a breast contusion includes the application of ice and external support to the area.

Nipple Irritation

Etiology

Nipple irritation commonly is seen in distance runners. Two commonly seen conditions are called runner's nipples and cyclist's nipples. **Runner's nipples** are associated with friction over the nipple area. **Cyclist's nipples** are caused by the combined effects of perspiration and wind chill.

Signs and Symptoms

With runner's nipples, the shirt rubs over the nipples causing friction, which can lead to abrasions, blisters, or bleeding. In cyclist's nipples, the nipples become cold and painful. Each condition can persist for several days.

Management

The initial treatment of runner's nipples involves cleansing the wound, applying an antibiotic ointment, and covering the wound with a nonadhering, sterile gauze pad. Infection secondary to the injury may involve the entire nipple region or may extend into the breast tissue and necessitate referral to a physician. This condition can be prevented by applying petroleum-based products and adhesive bandages over the nipples. The initial treatment for cyclist's nipples is to warm the nipples after completion of the event to prevent irritation. This condition can be prevented by wearing a windproof jacket.

Gynecomastia

Etiology

Gynecomastia is an excessive development of the male breast tissue, often accompanied by pain or sensitivity. The condition usually is bilateral and is more prevalent in adolescent males, particularly those taking anabolic steroids. Other causes include testicular, pituitary, and adrenal pathologies.

Sign and Symptoms

Symptoms associated with the condition include nipple soreness, tenderness to pressure, and increased susceptibility to irritation through friction from a shirt.

Management

Typically, the condition is physiological and resolves spontaneously in 6 to 12 months. Occasionally, surgical removal of extra breast tissue may be indicated for cosmetic reasons or for a biopsy specimen to rule out malignancy.

Strain of the Pectoralis Major Muscle

Etiology

Strains of the pectoralis major muscle can occur in a variety of activities, including power lifting (particularly while bench pressing), boxing, and wrestling. The mechanism of injury usually is indirect, resulting from extreme eccentric muscle tension. A rupture results when the actively contracting muscle is overburdened by a load or an extrinsic force that exceeds tissue tolerance. A strain of the pectoralis major also can result from direct trauma involving a sudden deceleration maneuver, such as when punching in boxing or blocking with an extended arm in football.

Ruptures are seen almost exclusively in men between 20 and 40 years of age.[6] A higher incidence of this injury is seen with anabolic steroid abuse.[7,8] Steroid use causes muscle hypertrophy and an increase in power secondary to rapid strength gain not accompanied by a concomitant increase in tendon size.

Signs and Symptoms

An audible pop, snap, or tearing sensation usually is accompanied by immediate, marked pain and weakness. The pain often is described as an aching or fatigue-like pain rather than a sharp pain. If the proximal attachment ruptures, the muscle retracts toward the axillary fold, causing it to appear enlarged. Swelling and ecchymosis are limited to the anterior chest wall. If the distal attachment is ruptured, the muscle bulges medially into the chest region, causing the axillary fold to appear thin. Swelling and ecchymosis occur on the anterior chest wall and upper arm. Shoulder motion is limited by pain. Horizontal adduction and internal rotation of the shoulder are weak and accentuate the deformity.

Management

Treatment depends on the extent of damage and follows the standard protocol for muscle strains. If the strain is mild or moderate, the subsequent treatment should focus on control of the inflammation, protected ROM exercises, and gradual strengthening. When ROM has been achieved, the individual's strength, endurance, and power can be restored.

Rupture of the muscle can require surgical intervention. Surgical treatment has been performed successfully following delays as long as 5 years after the injury; however, the best results are achieved with prompt recognition and surgery.[7,9]

Costochondral Injury

Etiology

Costochondritis and costochondral sprains may occur during a collision with another object or as a result of a severe twisting motion of the thorax, such as during the sweep motion in rowing.[10] This action can sprain or separate the costal cartilage where it attaches to the sternum or where the anterior margin of the rib attaches to the anterior end of the costal cartilage, thus putting pressure on the intercostal nerve lying between it and the rib above (**Fig. 23.17**). Slipping rib syndrome, as it sometimes is called, more frequently involves the 10th rib, followed by the 9th or 8th rib. The onset of symptoms may be

insidious, occurring long after the initial trauma.[11]

Figure 23.17. An undisplaced costochondral separation. The costal cartilage separates from the site at which the anterior margin of the rib attaches to the anterior end of the costal cartilage.

Signs and Symptoms

The individual may hear or feel a pop. The initial localized sharp pain may be followed by intermittent stabbing pain for several days. Pain may slowly decrease in intensity, but sharp clicks may occur during bending maneuvers as the displaced cartilage overrides the bone. A visible deformity and localized pain can be palpated at the involved joint. The pain can be reproduced either by hooking the fingers under the anterior costal margin and by pulling the rib cage anteriorly or by adducting the arm on the affected side coupled with rotation of the head toward the affected side.[10] More severe sprains produce pain during deep inhalation and can refer the pain to the epigastric region or the spine.

Management

The standard acute protocol should be followed to reduce pain and inflammation. The individual should be referred to a physician for further assessment. The discomfort usually resolves itself with 3 or 4 weeks of rest and anti-inflammatory medication, but it may persist for 9 to 12 weeks.

Occasionally, a physician may choose to inject the site with steroid medication to relieve chronic pain.

Sternal Fractures

Etiology

The sternum rarely is fractured in sports, but such an injury may occur as a result of rapid deceleration and high impact into an object or acute flexion that causes the upper fragment to displace anteriorly over the lower fragment. The fracture itself is not significant; however, the incidence of an associated intrathoracic injury is high. The most common site of fracture is the body of the sternum, with most fractures transverse.[12]

If a sternal fracture is suspected, the emergency plan, including summoning EMS, should be activated. Observation in the hospital with a cardiac monitor often is necessary because of the high incidence of associated intrathoracic trauma. While waiting for EMS to arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

Signs and Symptoms

A sternal fracture causes an immediate loss of breath. Localized pain is present, with pressure over the sternum, and is aggravated by deep inspiration if the fracture is incomplete. If the fracture is complete, a palpable defect is present, and pain occurs during normal respiration. Because of the anatomical location, any suspected fracture should be assessed for underlying injury, such as cardiac contusion, injury of internal mammary vessels, retrosternal and mediastinal hematoma, and pulmonary laceration or contusion.[8]

Management

The treatment of an undisplaced sternal fracture is nonoperative. Rest and pain control with analgesics is recommended. Surgical repair utilizing wiring, plates, and screws is used for unstable injuries, displaced factures, and uncontrollable pain and associated injuries that complicate pulmonary or cardiac function. Other cases involving persistent pain, nonunion, or malunion with deformity may also require surgical intervention.[12]

Rib Fractures

Etiology

Stress fractures to the ribs can result from an indirect force, such as a violent muscle contraction. They typically occur at the rib's weakest point (i.e., where it changes direction or has the smallest diameter). Opposing contractions of the scalene muscles and upper digitations of the serratus anterior muscle may fracture the 1st rib at its thinnest segment where the subclavian artery crosses, as is seen in weight lifting or baseball pitching. Anterolateral stress fractures of the 4th and 5th ribs have been reported in golfers and rowers because of excessive action of the serratus anterior muscle.[8,9] Violent muscle contractions also are known to cause fractures to the floating ribs or avulsion fractures to the lower three ribs. In particular, the external oblique muscles often are involved.

Rib fractures are the most common thoracic injury as a result of blunt trauma.[13] The force usually is applied in the anteroposterior plane, leading to fractures at the posterior angles of the 5th through 9th ribs. Nondisplaced fractures are more common than displaced. If the fracture is displaced, the clinician should conduct an internal injury assessment. If a fracture occurs to the lower two ribs, there may be associated damage to the kidneys, liver, or spleen. Splenic trauma has been reported in up to 20% of left lower rib fractures, and liver trauma has been reported in up to 10% of right lower rib fractures.[10]

Signs and Symptoms

Intense localized pain over the fracture site is aggravated by deep inspiration, coughing, or chest movement (**Fig. 23.18**). In many cases, the individual takes shallow breaths and leans toward the fracture site, stabilizing the area with a hand to prevent excessive movement of the chest to ease the pain. A visible contusion and palpable crepitus may be present at the impact site. If the fracture has displaced and punctured a lung, the patient may cough up blood, especially bright red or frothy blood. A stethoscope should be used to listen for abnormal or absent breath sounds in the lungs. The rate and depth of

respirations should be recorded. Manual compression of the rib cage in an anteroposterior direction and in a lateral compression produces pain over the fracture site (see Fig. 23.13). If any signs of respiratory distress, cyanosis, or shock appear, a thorough assessment for an underlying visceral injury should be conducted. Box 23.5 identifies other signs and symptoms indicating a possible sternal or rib fracture.

BOX 23.5 Signs and Symptoms Indicating a Possible Sternal or Rib Fracture

- History of direct blow, compression of the chest, or violent muscle contraction
- Individual may lean toward the fractured side, stabilizing the area with a hand to prevent movement of the chest
- Localized discoloration or swelling over the fracture site
- Visible, slight step deformity
- Palpable pain and crepitus at the fracture site
- Increased pain on deep inspiration
- Increased pain on trunk rotation and lateral flexion away from the fracture site
- Increased pain on manual compression of the rib cage in an anteroposterior direction or with lateral compression
- Shallow breathing
- Cyanosis
- Rapid, weak pulse and low blood pressure with multiple fractures; with a fracture that has damaged intercostals, vessels, and nerves; or if the lung or pleural sac has been penetrated

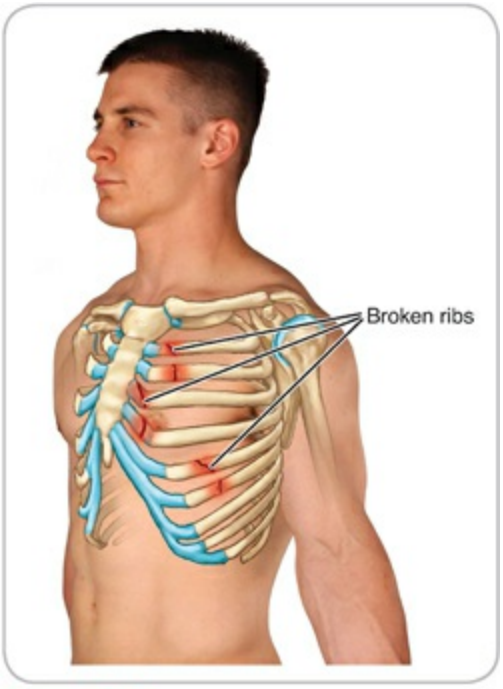

Figure 23.18. An undisplaced fractured rib.

Management

Treatment involves standard acute protocol. A 6-in elastic bandage can be wrapped around the thorax with circular motions distal to the injury site, or a sling and swathe may be used to immobilize the chest if pain is intense or multiple fractures are suspected. If one or two ribs are fractured, the individual should be referred to a physician immediately.

Pain tends to be most severe during the first 3 to 5 days following injury and ultimately disappears after 3 to 6 weeks. Depending on the fracture site, the presence of a displaced or nondisplaced fracture, and the number of ribs involved, it may be necessary to refrain from participation in sports and physical activities until healing is complete. Strapping or taping to reduce chest movement is not recommended, because it may aggravate the condition. With a simple fracture, a flak jacket or rib vest can be worn to protect the area from reinjury.

If three or more ribs are fractured indicating presence of a flail chest, or signs and symptoms suggesting internal injury are present, the emergency plan, including summoning EMS, should be activated. While waiting for EMS to arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

The male runner could attempt the following: exhaling forcibly through pursed lips, breathing deeply and regularly, leaning away from the affected side, or stretching the arm on the affected side over the head as high as possible.

INTERNAL COMPLICATIONS

During preseason volleyball practice, a player experiences hyperventilation while sprinting. What is the management of this condition?

Several conditions may alter breathing and cardiac function. Hyperventilation is associated with an inability to catch one's breath and, in most instances, is not a serious problem. Direct trauma to the thorax can lead to serious underlying problems, although these conditions are rare in sport participation. Among the more serious complications are pulmonary contusion, pneumothorax, tension pneumothorax, hemothorax, and heart contusions.

Hyperventilation

Etiology

Hyperventilation often is linked to pain, stress, or trauma in sport participation. Other causes may include altitude, asthma, pulmonary embolus, left ventricular failure, aspirin, alcohol withdrawal, anxiety or panic, or central nervous system lesions.[14] The respiratory rate increases during activity. Rapid, deep inhalations draw more oxygen into the lungs. Conversely, long exhalations result in too much carbon dioxide being exhaled.

Signs and Symptoms

Signs and symptoms include an inability to catch one's breath, numbness in the lips and hands, spasm of the hands, chest pain, dry mouth, dizziness, and occasionally, fainting. Inspiratory difficulty or frequent sighing may also be

present.

Management

It is important to calm the individual because panic and anxiety can complicate the condition. Treatment involves concentrating on slow inhalations through the nose and exhalations through the mouth until the symptoms have stopped. Although breathing into a paper bag has proved to be quite successful in restoring the oxygen–carbon dioxide balance, many individuals find it to be embarrassing. Breathing into a paper bag is not needed except in severe cases.

Lung Injuries

Etiology

Injury to the lungs can range from a contusion to a life-threatening situation. Nonpenetrating chest trauma is rare in sport participation. Forces transmitted through the thorax, as in landing on a football or a body slam onto the hard ground, cause blood and protein to leak into the alveoli and interstitial spaces, leading to pulmonary collapse. Penetrating chest trauma, due to a fractured rib or a penetrating wound to the chest (e.g., a stab wound), can result in a laceration of lung tissue.

Signs and Symptoms

Common signs and symptoms of pulmonary **contusions** include chest pain, rapid breathing, shortness of breath, rales, and coughing. Breathing may be compromised, and hypoxia may appear 2 to 4 hours after trauma. The condition may go undetected until the individual coughs up blood or has other problems, such as a pneumothorax, rib fracture, or subcutaneous emphysema.

A **pneumothorax** is a condition whereby air is trapped in the pleural space, causing a portion of a lung to collapse. Although the etiology of a pneumothorax can vary, the two most common types are spontaneous and nonspontaneous. Spontaneous pneumothorax occurs unexpectedly, with or without an underlying disease. Risk factors include male gender, cigarette smoking, and an asthenic physiognomy.[15] In particular, 20- to 30-year-old

males who are tall, lean, and have a long and narrow chest appear to be at increased risk. Other pulmonary conditions that may lead to a spontaneous pneumothorax include asthma, cystic fibrosis, emphysema, and pneumonia.[16] In a spontaneous pneumothorax, pain can stop abruptly after onset, leading to a delay in treatment. Dyspnea and chest discomfort gradually increase until the individual finally seeks medical care. In some cases, symptoms may flare up suddenly, producing acute pain localized to the side of the pneumothorax and difficulty in breathing.

Nonspontaneous, or traumatic, pneumothorax ranks second only to rib fractures as the most common sign of chest injury and can be seen in 40% to 50% of patients with chest trauma.[15] Air is allowed to escape into the pleural cavity with each inhalation, thus preventing the lung from expanding fully (**Fig. 23.19A**). The most common symptoms of a traumatic pneumothorax are dyspnea, cyanosis, severe chest pain on the affected side, deviation of the trachea, and decreased or absent breath sounds over the affected area with hyperresonance to percussion (**Box 23.6**).[17] Other symptoms may include asymmetric chest expansion, confusion, fatigue, anxiety, restlessness, and a decrease in blood pressure. Pain may be referred to the shoulder tip, across the chest, or over the abdomen. If not recognized and treated promptly, the condition can develop into tension pneumothorax.

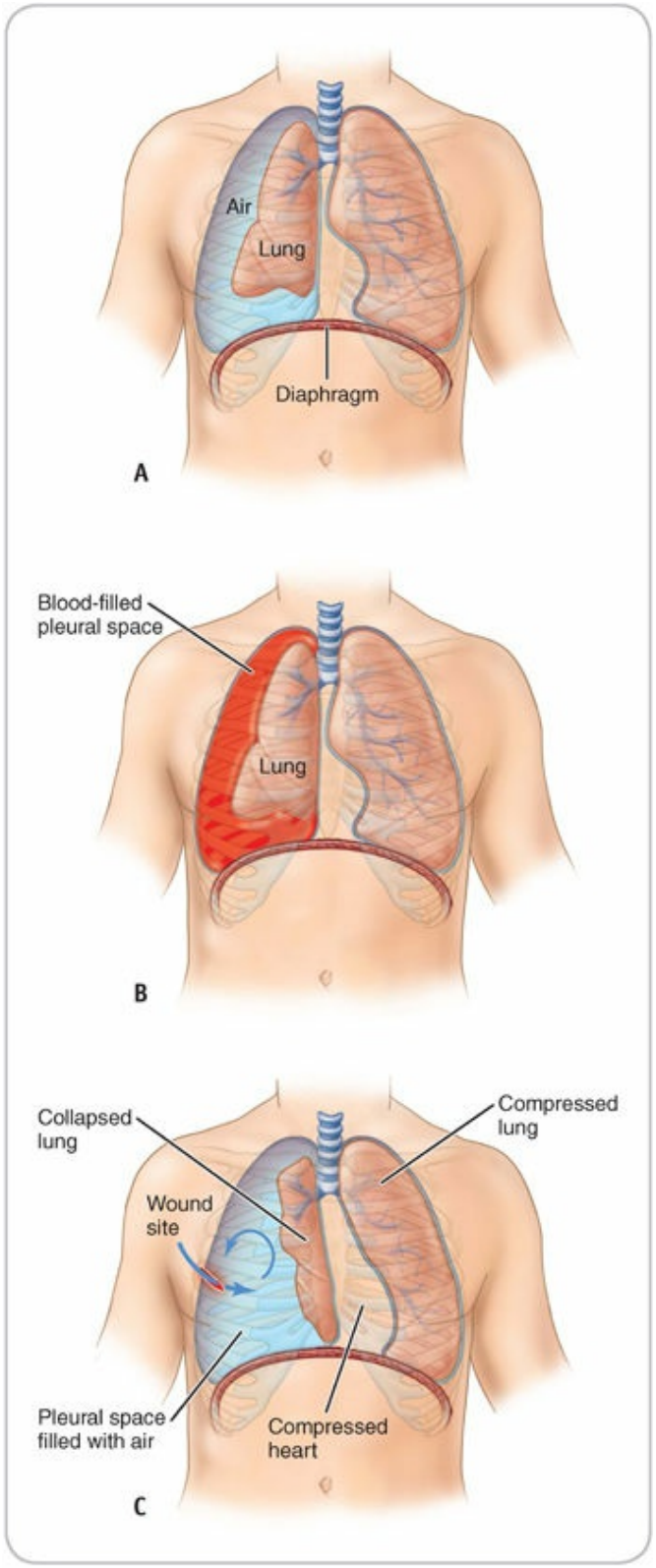

Figure 23.19. The internal complication to the lungs. **A,** Pneumothorax. **B,** Hemothorax. **C,** Tension pneumothorax. Each condition can become life threatening if the lung collapses.

BOX 23.6 Signs and Symptoms Indicating Possible Pneumothorax

- Sudden onset or sharp chest pain
- Shortness of breath
- Difficulty breathing
- Referred pain to the tip of the shoulder, across the chest, or over the abdomen
- Light-headedness
- Tightness in the chest

- Decreased or absent breath sounds over the collapsed lung
- Asymmetric chest movements on the affected side
- Decrease in blood pressure
- Tachycardia

A **hemothorax** involves the loss of blood, rather than air, into the pleural cavity (Fig. 23.19B). Fractured ribs may tear lung tissue and blood vessels in the chest or chest cavity. The individual usually presents with severe pain, hypoxia, decreased breath sounds unilaterally or bilaterally, dyspnea, tachypnea, and dullness to percussion over the affected side.[17] The individual may cough up frothy blood. As the condition deteriorates, the signs and symptoms of shock appear, including hypotension, decreased venous return, and cyanosis. The neck veins may be flat, secondary to hypovolemia, or distended because of the mechanical effects of intrathoracic pressure. Tracheal deviation and/or a mediastinal shift are classic signs caused by the contents of the thoracic cavity shifting away from the accumulation of blood as a result of the increased intrathoracic pressure.[17]

A **tension pneumothorax** occurs when air or blood progressively accumulates in the pleural space during inspiration and cannot escape on expiration. The pleural space expands with each breath, displacing the

mediastinum to the opposite side. This displacement compresses the heart, the uninjured lung, the thoracic aorta, and the vena cava, causing a decrease in blood return to the right side of the heart, thereby decreasing cardiac output (Fig. 23.19C). Signs and symptoms include chest pain, tracheal deviation away from the tension pneumothorax, respiratory distress, unilateral absence of breath sounds on the affected side, hypotension, and circulatory compromise leading to cyanosis and possibly death.[13,17] Asymmetric chest wall movement may be visible, as may be distended neck veins.

Traumatic asphyxia results from direct, massive trauma to the thorax. Classic symptoms include a bluish tinge over the neck and facial regions, subconjunctival hemorrhage, ecchymosis, and minute hemorrhagic spots on the face. A loss of vision also has been reported as a result of retinal edema, but such a loss may improve within hours or days.

Management

Each of these conditions is considered a medical emergency, and the patient should be transported to the nearest hospital as quickly as possible. The individual should be kept calm, quiet, and seated while focusing on controlled breathing until the ambulance arrives.

Activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

Cardiac Injuries

Direct trauma to the upper left chest can compress the heart between the sternum and spine. Blunt trauma may lead to **cardiac tamponade** or cause **commotio cordis**. Other more insidious heart conditions that impact sport participants are heart murmurs and athletic heart syndrome.

Sudden death due to cardiac anomalies is defined as an event that is nontraumatic and unexpected and occurs either instantaneously or within minutes of an abrupt change in an individual's previous clinical state. For individuals younger than 35 years of age, the most common cause is

hypertrophic cardiomyopathy, with a higher frequency seen in male athletes as compared with females.[16] Other causes of sudden death include abnormalities in the coronary arteries, aortic rupture associated with Marfan syndrome, and mitral valve prolapse. In individuals older than 35 years of age, the most common cause is ischemic coronary artery disease. Because of the complexity of sudden death, it is discussed in greater detail in Chapter 25.

Heart Contusion and Cardiac Tamponade

Etiology

Blunt chest trauma can compress the heart between the sternum and spine, leading to blunt cardiac injury or **heart contusion** (formally called myocardial contusion). The symptoms associated with heart contusions range from moderate to severe. Because it lies directly posterior to the sternum, the right ventricle often is injured. Red blood cells and fluid leak into the surrounding tissues and, in doing so, decreases circulation to the heart muscle. This action leads to localized cellular damage and necrosis of the heart tissue.[18] Cardiac tamponade is caused by the same mechanism. Cardiac tamponade occurs when massive blunt trauma ruptures the myocardium or lacerates a coronary artery, which leads to an increased volume of blood or edematous exudate into the pericardial sac. As blood and fluid fill the pericardial sac, the tension limits venous inflow and diastolic filling, and cardiac output is diminished. The heart is unable to fill and/or pump effectively, and without early recognition and treatment, cardiac arrest occurs.[18]

Signs and Symptoms

Heart contusion will result in shortness of breath, chest and heart pain, weakness, and fatigue. Symptoms will range in severity. Decreased cardiac output secondary to arrhythmias, or irregular heartbeats, are of major concern. Shock may be present. In serious cases, the Beck triad may be present to signify possible cardiac tamponade (i.e., venous pressure elevation is apparent through distended neck veins, decreased arterial pressure [hypotension], muffled heart tones). Although heart contusion may be slow to present all symptoms, with cardiac tamponade, the individual collapses within seconds

and goes into respiratory arrest.

Management

An ambulance should be summoned immediately for transport to the nearest hospital. The athletic trainer should treat the individual for shock and be prepared to do cardiopulmonary resuscitation (CPR) if vital signs are absent. In many cases, resuscitation is unsuccessful even if given immediately after the injury. This may result from structural cardiac disruption caused by the trauma.

Activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to arrive, the clinician should maintain the airway and, if necessary, initiate breathing and chest compressions.

Commotio Cordis

Commotio cordis results when the heart is struck at the beginning of the T wave in the cardiac cycle and disrupts the electrical impulses that control normal heart rhythm.[18] The leading mechanism of injury was from a projectile striking the chest, including baseballs, softballs, hockey pucks, and lacrosse balls. Commotio cordis is described in detail in Chapter 24. Unlike cardiac tamponade, the patient collapses almost instantaneously upon impact due to ventricular tachycardia. The most effective treatment is immediate application of an automatic external defibrillator, although commotio cordis usually is a fatal event.

Heart Murmur

Etiology

Heart murmurs are distinguished from normal heart sounds by their longer duration. They are attributed to turbulent blood flow and may be benign or diagnostic of valvular heart disease. Murmurs are most often caused by defective heart valves. A stenotic heart valve has an abnormally narrowed valvular orifice that cannot open completely and obstructs blood flow, as in *aortic stenosis*. A valve may also be unable to close completely, as in *aortic regurgitation*, which is blood leaking backward through the valve when it

should be closed. Murmurs also can be caused by conditions such as pregnancy, fever, thyrotoxicosis (a diseased condition resulting from an overactive thyroid gland), or anemia.

Signs and Symptoms

A diastolic murmur occurs when the heart muscle relaxes between beats. A systolic murmur occurs when the heart muscle contracts. Continuous murmurs are heard through the cardiac cycle and may present as a clicking, whooshing, or swishing noise heard through auscultation with a stethoscope. Systolic murmurs are graded by intensity (loudness) from 1 to 6. A grade 1 is very faint, heard only with a special effort. A grade 6 is extremely loud and can be heard with a stethoscope slightly removed from the chest.

Management

All heart murmurs should be assessed by a physician for a medical diagnosis to determine the source of the murmur and any underlying pathology. This is done through auscultation, chest X-rays, and echocardiograms. If the murmur does not indicate heart disease, sports participation is allowed with no restrictions.

Because hyperventilation can produce panic and anxiety, the clinician should initially attempt to calm the volleyball player. Next, the clinician should encourage the patient to concentrate on his or her breathing. Specifically, the patient should be instructed to inhale slowly through the nose and exhale through the mouth until breathing returns to normal. Breathing into a paper bag has proven to be quite successful in restoring the oxygen–carbon dioxide balance associated with hyperventilation, but this technique can be embarrassing for the patient and is not necessary except in severe cases.

ABDOMINAL WALL CONDITIONS

Following a blow to the abdomen, a high school ice hockey player

experiences dyspnea. A solar plexus contusion is suspected. How should the condition be managed?

The muscles of the abdominal wall are strong and powerful yet also flexible enough to absorb impact. Consequently, injuries to the abdominal wall usually are minor; however, some conditions, such as a contusion to the solar plexus and hernias, can affect sports participation.

Skin Contusions

Etiology

Blunt trauma can result in a minor contusion or damage to internal organs.

Signs and Symptoms

Simple contusions to the abdominal wall are evident by tenderness over the area of impact, pain during active contraction of the abdominal muscles, and the absence of referred pain. Any case involving blunt trauma requires an assessment to rule out internal injury. Information specific to intra-abdominal conditions is provided later in this chapter.

Management

The management of a simple contusion includes the application of ice and compression to limit the hemorrhage. A pressure dressing may be applied if a large hematoma forms.

Muscle Strains

Etiology

Muscle strains are caused by direct trauma, sudden twisting, or a sudden hyperextension of the spine. The rectus abdominis is the most commonly injured muscle. Complications arise when the epigastric artery or intramuscular vessels are damaged, leading to a rectus sheath hematoma. Nearly 80% of hematomas occur below the umbilicus.

Signs and Symptoms

Sudden abdominal pain, nausea, vomiting, marked tenderness, swelling, and muscle guarding may be present. Straight leg raising or hyperextension of the back increases the pain. A palpable mass may or may not be present; if a mass is present, it becomes fixed with contraction of the muscle. Other signs include a bluish discoloration around the periumbilical region 72 hours after injury (Cullen sign) and pain with resisted trunk or hip flexion.[8]

If internal injury is suspected, activation of the emergency plan, including summoning EMS, is warranted. While waiting for EMS to arrive, the clinician should maintain the airway, assess vital signs, and treat for shock as necessary.

Management

Treatment consists of ice, rest, and the use of nonsteroidal anti-inflammatory drugs for the first 36 to 48 hours. Local heat and whirlpools can be used after 48 to 72 hours with activity modification until the hematoma and soreness resolve. Activities such as twisting, turning, trunk flexion, or sudden stretching should be avoided until painful symptoms subside.

Solar Plexus Contusion ("Wind Knocked Out")

Etiology

A blow to the abdomen with the muscles relaxed is referred to as a solar plexus punch. Although the true cause of the breathing difficulty is unknown, it is thought to be caused by diaphragmatic spasm and a transient contusion to the sympathetic **celiac plexus**.

Signs and Symptoms

The blow results in an immediate inability to catch one's breath (dyspnea). Fear and anxiety may complicate the condition.

Management

The assessment should include a thorough airway analysis. Any mouth guard or partial dental plates should be removed. Any restrictive equipment and

clothing around the abdomen should be loosened, and the individual should be instructed to flex his or her knees toward the chest. Although it may seem paradoxic, the individual should be instructed to take a deep breath and hold it. This action should be repeated until normal breathing is restored. Another method for restoring normal breathing is to instruct the individual to whistle. This action forces the diaphragm to relax. Because a severe blow may lead to an intra-abdominal injury, an assessment should be performed to rule out an internal injury.

Hernias

Etiology

A **hernia**, which is a protrusion of the abdominal viscera through a weakened portion of the abdominal wall, can be either congenital or acquired. Congenital hernias are present at birth and may be related to family history. Acquired hernias occur after birth and may be aggravated by a direct blow, strain, or abnormal intra-abdominal pressure, such as that exerted during heavy weight lifting. The three most common hernias are indirect, direct, and femoral (**Fig. 23.20**).