



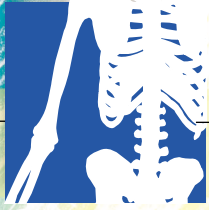
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# 13

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## Skeletal Muscles

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## Chapter Outline

<b>General Clinical Features Concerning Muscles</b>	<b>189</b>	<b>Rupture of the Supraspinatus Tendon</b>	<b>195</b>
Muscle Tone	189	Axillary Nerve and the Quadrangular Space	196
Muscle Attachments	189	Carpal Tunnel Syndrome	196
Muscle Shape and Form	189	Tenosynovitis of the Synovial Sheaths of the Flexor Tendons	196
Segmental Innervation of Muscle	189	Trigger Finger	198
<b>Muscles of the Head</b>	<b>189</b>	Mallet Finger	198
Lacerations of the Scalp	189	Boutonniere Deformity	198
Facial Muscle Paralysis	189	Dupuytren's Contracture	198
<b>Muscles of the Neck</b>	<b>191</b>	<b>Muscles of the Lower Limb</b>	<b>199</b>
Sternocleidomastoid Muscle and Protection from Trauma	191	Gluteus Maximus and Intramuscular Injections	199
Congenital Torticollis	191	Gluteus Maximus and Bursitis	199
Spasmodic Torticollis	191	Gluteus Medius and Minimus and Poliomyelitis	199
Clinical Significance of the Deep Fascia of the Neck	191	Quadriceps Femoris as a Knee-Joint Stabilizer	200
Fascial Spaces	191	Rupture of the Rectus Femoris	200
<i>Acute Infections of the Fascial Spaces of the Neck</i>	191	Rupture of the Ligamentum Patellae	200
<i>Chronic Infection of the Fascial Spaces of the Neck</i>	191	Femoral Sheath and Femoral Hernia	200
Clinical Significance of the Triangles of the Neck	191	Adductor Muscles and Cerebral Palsy	201
<b>Muscles of the Abdominal Wall</b>	<b>192</b>	The Adductor Magnus and Popliteal Aneurysms	202
Hematoma of the Rectus Sheath	192	Semimembranosus Bursa Swelling	202
Abdominal Muscles, Abdominothoracic Rhythm, and Visceroptosis	192	Anterior Compartment of the Leg Syndrome	202
Muscle Rigidity and Referred Pain	193	Tenosynovitis and Dislocation of the Peroneus Longus and Brevis Tendons	202
Surgery and the Tendinous Intersections of the Rectus Abdominis Muscle	193	Gastrocnemius and Soleus Muscle Tears	202
Psoas Abscess	193	Ruptured Tendo Calcaneus	202
<b>Muscles of the Pelvis</b>	<b>193</b>	Rupture of the Plantaris Tendon	202
Pelvic Floor	193	Plantaris Tendon and Autografts	202
Functional Significance of the Pelvic Floor in the Female	193	Plantar Fasciitis	202
Injury to the Pelvic Floor	194	Clinical Problems Associated with the Arches of the Foot	203
<b>Muscles of the Upper Limb</b>	<b>194</b>	Bursae and Bursitis in the Lower Limb	203
Rotator Cuff Tendinitis	194	<b>Clinical Problem Solving Questions</b>	<b>203</b>
		<b>Answers and Explanations</b>	<b>206</b>



## GENERAL CLINICAL FEATURES CONCERNING MUSCLES

### Muscle Tone

Determination of the **tone** of a muscle is an important clinical examination. If a muscle is **flaccid**, then either the afferent, the efferent, or both neurons involved in the reflex arc necessary for the production of muscle tone have been interrupted. For example, if the nerve trunk to a muscle is severed, both neurons will have been interrupted. If poliomyelitis has involved the motor anterior horn cells at a level in the spinal cord that innervates the muscle, the efferent motor neurons will not function. If, conversely, the muscle is found to be hypertonic, the possibility exists of a lesion involving higher motor neurons in the spinal cord or brain.

### Muscle Attachments

The importance of knowing the main attachments of all the major muscles of the body need not be emphasized. Only with such knowledge is it possible to understand the normal and abnormal actions of individual muscles or muscle groups. How can one even attempt to analyze, for example, the abnormal gait of a patient without this information?

### Muscle Shape and Form

The general shape and form of muscles should also be noted, since a paralyzed muscle or one that is not used (such as occurs when a limb is immobilized in a cast) quickly atrophies and changes shape. In the case of the limbs, it is always worth remembering that a muscle on the opposite side of the body can be used for comparison.

### Segmental Innervation of Muscle

Skeletal muscle receives a segmental innervation. Most of these muscles are innervated by two, three, or four spinal nerves and therefore by the same number of segments of the spinal cord. To paralyze a muscle completely, it is thus necessary to section several spinal nerves or to destroy several segments of the spinal cord.

Learning the segmental innervation of all the muscles of the body is an impossible task. Nevertheless, the segmen-

tal innervation of the following muscles should be known because they can be tested by eliciting simple muscle reflexes in the patient (CD Fig. 13-1).

- **Biceps brachii tendon reflex:** C5 and 6 (flexion of the elbow joint by tapping the biceps tendon)
- **Triceps tendon reflex:** C6, 7, and 8 (extension of the elbow joint by tapping the triceps tendon)
- **Brachioradialis tendon reflex:** C5, 6, and 7 (supination of the radioulnar joints by tapping the insertion of the brachioradialis tendon)
- **Abdominal superficial reflexes (contraction of underlying abdominal muscles by stroking the skin):** Upper abdominal skin T6–7, middle abdominal skin T8–9, and lower abdominal skin T10–12
- **Patellar tendon reflex (knee jerk):** L2, 3, and 4 (extension of the knee joint on tapping the patellar tendon)
- **Achilles tendon reflex (ankle jerk):** S1 and S2 (plantar flexion of the ankle joint on tapping the Achilles tendon)



## MUSCLES OF THE HEAD

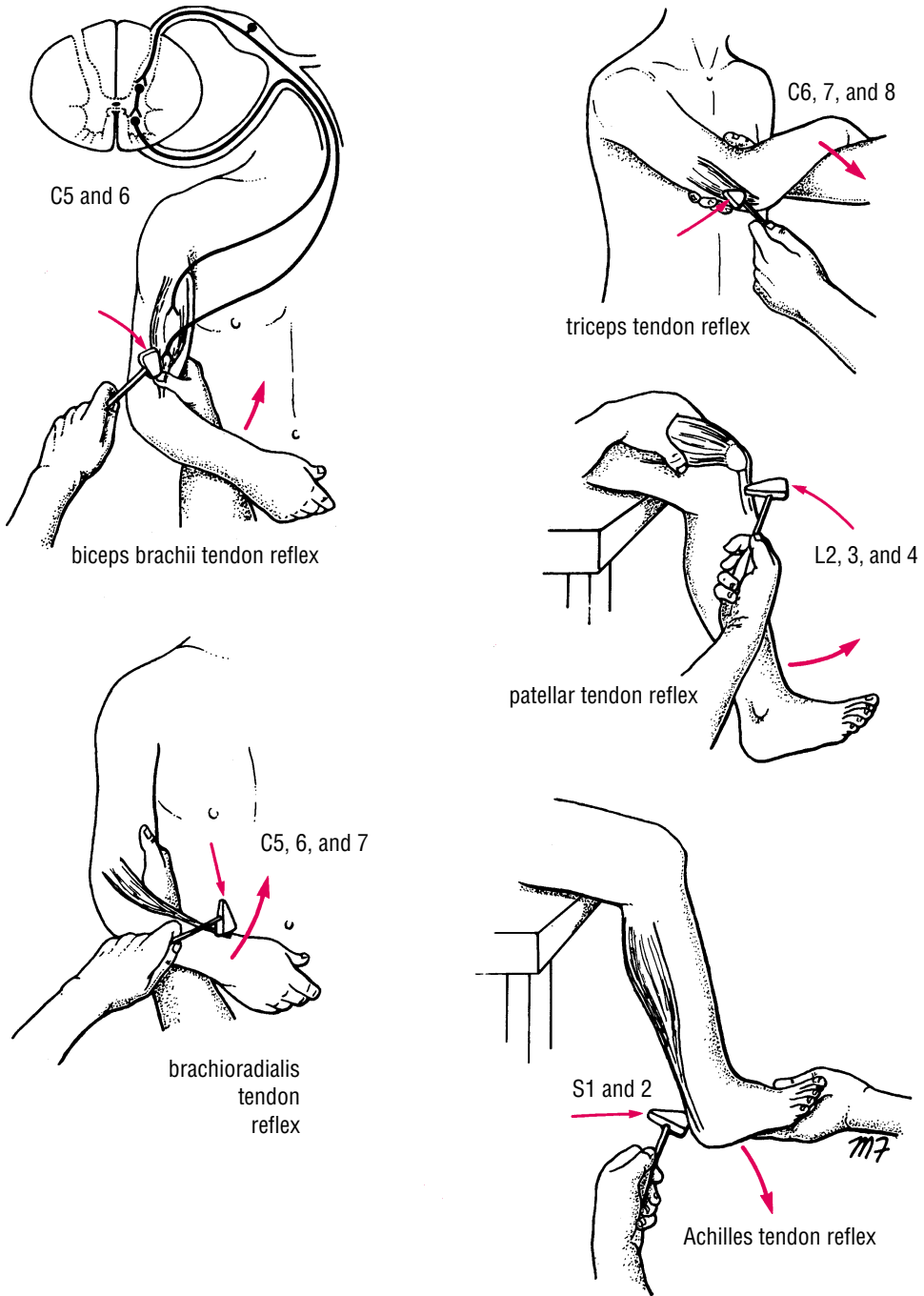
### Lacerations of the Scalp

The tension of the **epicranial aponeurosis** (see text Fig. 13-6), produced by the tone of the occipitofrontalis muscles, is important in all deep wounds of the scalp. If the aponeurosis has been divided, the wound will gape open. For satisfactory healing to take place, the opening in the aponeurosis must be closed with sutures.

Often a wound caused by a blunt object such as a baseball bat closely resembles an incised wound. This is because the scalp is split against the unyielding skull, and the pull of the occipitofrontalis muscles causes a gaping wound. This anatomic fact may be of considerable forensic importance.

### Facial Muscle Paralysis

The facial muscles are innervated by the facial nerve. Damage to the facial nerve in the internal acoustic meatus (by a tumor), in the middle ear (by infection or operation), in the facial nerve canal (perineuritis, **Bell's palsy**), or in the parotid gland (by a tumor) or caused by lacerations of the face will cause distortion of the face, with drooping of the lower eyelid, and the angle of the mouth will sag on the affected side. This is essentially a lower motor neuron lesion. An upper motor neuron lesion (involvement of the pyramidal tracts) will leave the upper part of the face normal because the neurons supplying this part of the face receive corticobulbar fibers from both cerebral cortices.



**CD Figure 13-1** Some important tendon reflexes used in medical practice.



## MUSCLES OF THE NECK

### Sternocleidomastoid Muscle and Protection from Trauma

The sternocleidomastoid, a strong, thick muscle crossing the side of the neck (see text Fig. 13-9), protects the underlying soft structures from blunt trauma. Suicide attempts by cutting one's throat often fail because the individual first extends the neck before making several horizontal cuts with a knife. Extension of the cervical part of the vertebral column and extension of the head at the atlantooccipital joint cause the carotid sheath with its contained large blood vessels to slide posteriorly beneath the sternocleidomastoid muscle. To achieve the desired result with the head and neck fully extended, some individuals have to make several attempts and only succeed when the larynx and the greater part of the sternocleidomastoid muscles have been severed. The common sites for the wounds are immediately above and below the hyoid bone.

### Congenital Torticollis

Most cases of congenital torticollis are a result of excessive stretching of the sternocleidomastoid muscle during a difficult labor. Hemorrhage occurs into the muscle and may be detected as a small, rounded "tumor" during the early weeks after birth. Later, this becomes invaded by fibrous tissue, which contracts and shortens the muscle. The mastoid process is thus pulled down toward the sternoclavicular joint of the same side, the cervical spine is flexed, and the face looks upward to the opposite side. If left untreated, asymmetrical growth changes occur in the face, and the cervical vertebrae may become wedge shaped.

### Spasmodic Torticollis

Spasmodic torticollis, which results from repeated chronic contractions of the sternocleidomastoid and trapezius muscles, is usually psychogenic in origin. Section of the spinal part of the accessory nerve may be necessary in severe cases.

### Clinical Significance of the Deep Fascia of the Neck

The deep fascia in certain areas of the neck forms distinct sheets called the investing, pretracheal, and prevertebral

layers (see text Fig. 13-11). These fascial layers are easily recognizable to the surgeon at operation.

### Fascial Spaces

Between the more dense layers of deep fascia in the neck is loose connective tissue that forms potential spaces that are clinically important. Among the more important spaces are the visceral, retropharyngeal, submandibular, and masticatory spaces (CD Fig. 13-2).

The deep fascia and the fascial spaces are important because organisms originating in the mouth, teeth, pharynx, and esophagus can spread among the fascial planes and spaces, and the tough fascia can determine the direction of spread of infection and the path taken by pus. It is possible for blood, pus, or air in the retropharyngeal space to spread downward into the superior mediastinum of the thorax.

### Acute Infections of the Fascial Spaces of the Neck

**Dental infections** most commonly involve the lower molar teeth. The infection spreads medially from the mandible into the submandibular and masticatory spaces and pushes the tongue forward and upward. Further spread downward may involve the visceral space and lead to edema of the vocal cords and airway obstruction.

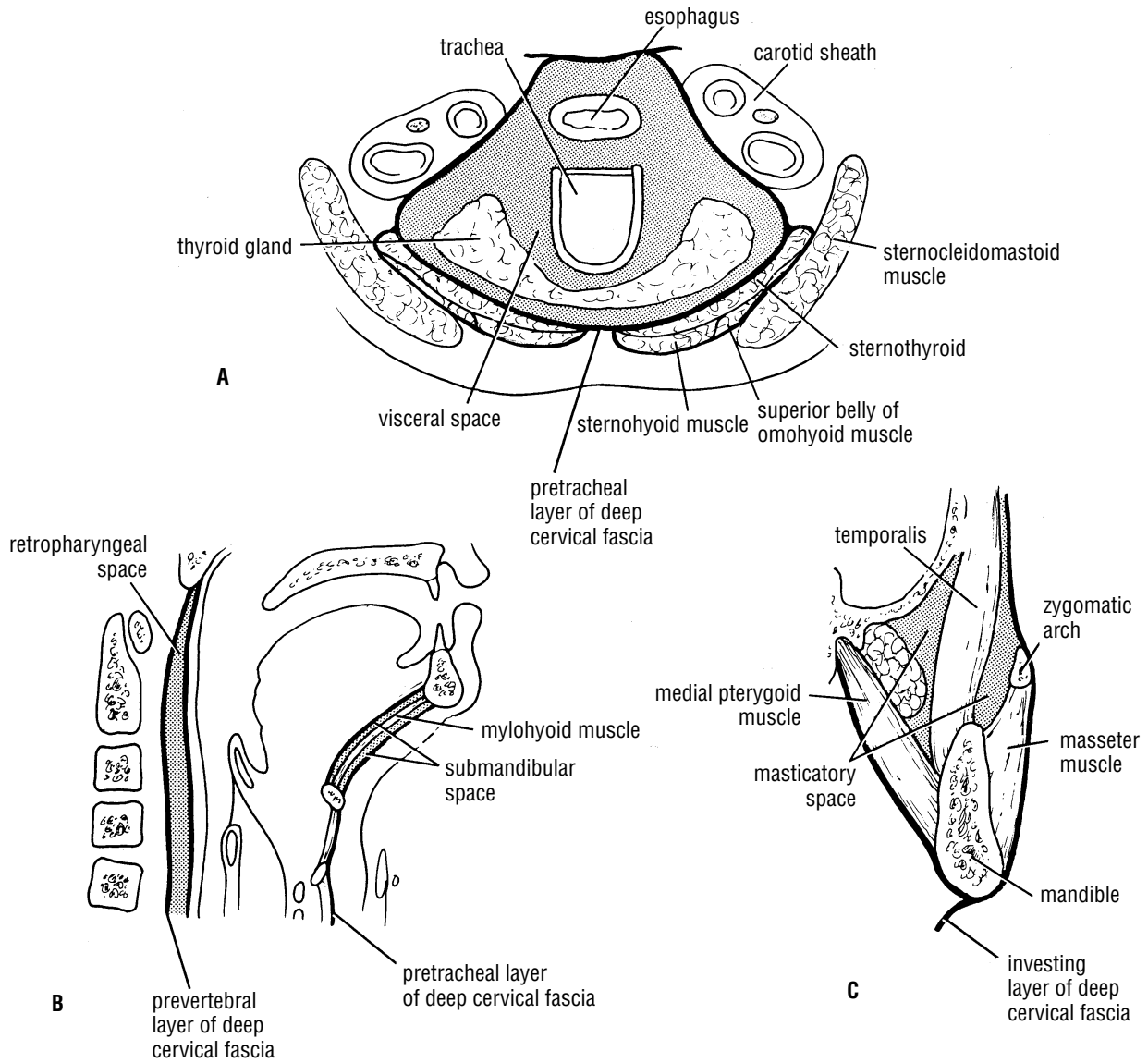
**Ludwig's angina** is an acute infection of the submandibular fascial space and is commonly secondary to dental infection.

### Chronic Infection of the Fascial Spaces of the Neck

**Tuberculous infection of the deep cervical lymph nodes** can result in liquefaction and destruction of one or more of the nodes. The pus is at first limited by the investing layer of the deep fascia. Later, this becomes eroded at one point, and the pus passes into the less restricted superficial fascia. A dumbbell-shaped abscess is now present. The clinician is aware of the superficial abscess but must not forget the existence of the deeply placed abscess.

### Clinical Significance of the Triangles of the Neck

The triangles of the neck (see text Fig. 13-12) assist the medical examiner in accurately localizing a wound, tumor, or swelling. Commit to memory the boundaries and make a list of the important contents of each triangle.



**CD Figure 13-2** **A.** Cross section of the neck showing the visceral space. **B.** Sagittal section of the neck showing the positions of the retropharyngeal and submandibular spaces. **C.** Vertical section of the body of the mandible close to the angle showing the masticatory space.



## MUSCLES OF THE ABDOMINAL WALL

### Hematoma of the Rectus Sheath

Hematoma of the rectus sheath is uncommon but important, since it is often overlooked. It occurs most often on the right side below the level of the umbilicus. The source of the bleeding is the inferior epigastric vein or, more rarely, the inferior epigastric artery (see text Fig. 19-7). These

vessels may be stretched during a severe bout of coughing or in the later months of pregnancy, which may predispose to the condition. The cause is usually blunt trauma to the abdominal wall, such as a fall or a kick. The symptoms that follow the trauma include midline abdominal pain. An acutely tender mass confined to one rectus sheath is diagnostic.

### Abdominal Muscles, Abdominothoracic Rhythm, and Visceroptosis

The abdominal muscles contract and relax with respiration, and the abdominal wall conforms to the volume of the abdominal viscera. There is an **abdominothoracic rhythm**.

Normally, during inspiration, when the sternum moves forward and the chest expands, the anterior abdominal wall also moves forward. If, when the chest expands the anterior abdominal wall remains stationary or contracts inward, it is highly probable that the parietal peritoneum is inflamed and has caused a reflex contraction of the abdominal muscles.

The shape of the anterior abdominal wall depends on the tone of its muscles. A middle-aged woman with poor abdominal muscles who has had multiple pregnancies is often incapable of supporting her abdominal viscera. The lower part of the anterior abdominal wall protrudes forward, a condition known as **visceroptosis**. This should not be confused with an abdominal tumor such as an ovarian cyst or with the excessive accumulation of fat in the fatty layer of the superficial fascia.

## Muscle Rigidity and Referred Pain

Sometimes it is difficult for a physician to decide whether the muscles of the anterior abdominal wall of a patient are rigid because of underlying inflammation of the parietal peritoneum or whether the patient is voluntarily contracting the muscles because he or she resents being examined or because the physician's hand is cold. This problem is usually easily solved by asking the patient, who is lying supine on the examination table, to rest the arms by the sides and draw up the knees to flex the hip joints. It is practically impossible for a patient to keep the abdominal musculature tensed when the thighs are flexed. Needless to say, the examiner's hand should be warm.

A pleurisy involving the lower costal parietal pleura causes pain in the overlying skin that may radiate down into the abdomen. Although it is unlikely to cause rigidity of the abdominal muscles, it may cause confusion in making a diagnosis unless these anatomic facts are remembered:

- The xiphoid process—T7
- The umbilicus—T10
- The pubis—L1

## Surgery and the Tendinous Intersections of the Rectus Abdominis Muscle

Note that the anterior wall of the rectus sheath is firmly attached to the tendinous intersections of the rectus abdominis muscle. The posterior wall of the sheath, however, has no attachment to the muscle.

## Psoas Abscess

The psoas fascia covers the anterior surface of the psoas muscle and can influence the direction taken by a tuber-

culous abscess. Tuberculous disease of the thoracolumbar region of the vertebral column results in the destruction of the vertebral bodies, with possible extension of pus laterally under the psoas fascia (CD Fig. 13-3). From there, the pus tracks downward, following the course of the psoas muscle, and appears as a swelling in the upper part of the thigh below the inguinal ligament. It may be mistaken for a femoral hernia.



## MUSCLES OF THE PELVIS

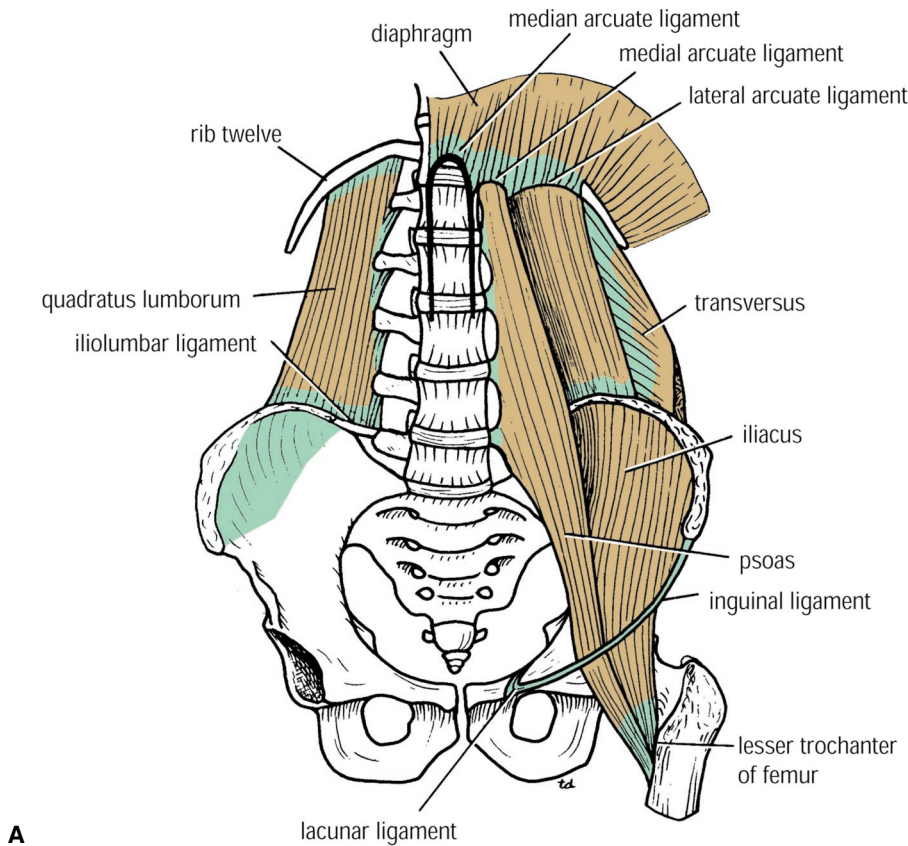
### Pelvic Floor

The pelvic diaphragm is a gutter-shaped sheet of muscle formed by the levatores ani and coccygeus muscles and their covering fasciae (see text Figs. 13-19 and 13-20). From their origin, the muscle fibers on the two sides slope downward and backward to the midline, producing a gutter that slopes downward and forward.

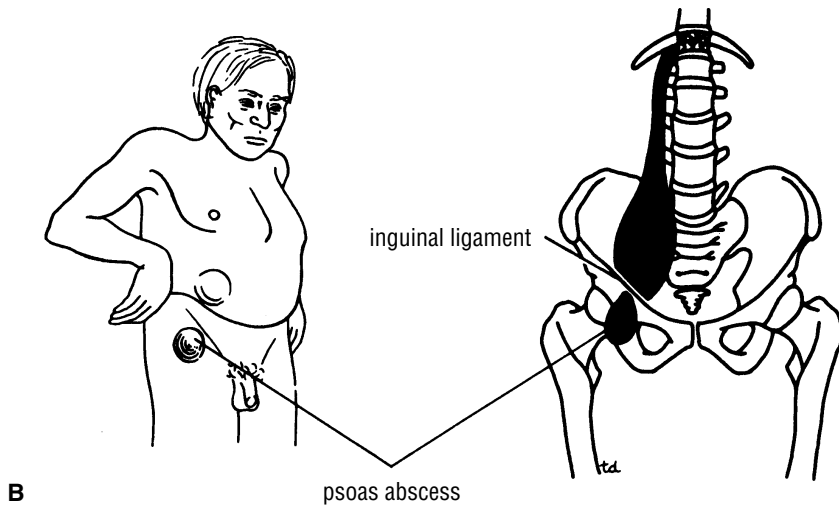
A rise in the intraabdominal pressure, caused by the contraction of the diaphragm and the muscles of the anterior and lateral abdominal walls, is counteracted by the contraction of the muscles forming the pelvic floor. By this means, the pelvic viscera are supported and do not “drop out” through the pelvic outlet. Contraction of the puborectalis fibers greatly assists the anal sphincters in maintaining continence under these conditions by pulling the anorectal junction upward and forward. During the act of defecation, however, the levator ani continues to support the pelvic viscera but the puborectalis fibers relax with the anal sphincters.

### Functional Significance of the Pelvic Floor in the Female

The female pelvic floor serves an important function during the second stage of labor (CD Fig. 13-4). At the pelvic inlet, the widest diameter is transverse so that the longest axis of the baby's head (anteroposterior) takes up the transverse position. When the head reaches the pelvic floor, the gutter shape of the floor tends to cause the baby's head to rotate so that its long axis comes to lie in the anteroposterior position. The occipital part of the head now moves downward and forward along the gutter until it lies under the pubic arch. As the baby's head passes through the lower part of the birth canal, the small gap that exists in the anterior part of the pelvic diaphragm becomes enormously enlarged so that the head may slip through into the perineum. Once the baby has passed through the perineum, the levatores ani muscles recoil and take up their previous position.



A



B

**CD Figure 13-3** A. Muscles and bones forming the posterior abdominal wall. B. Case of advanced tuberculous disease of the thoracolumbar region of the vertebral column. A psoas abscess is present, and swellings occur in the right groin above and below the right inguinal ligament.

### Injury to the Pelvic Floor

Injury to the pelvic floor during a difficult childbirth can result in the loss of support for the pelvic viscera leading to **uterine** and **vaginal prolapse**, herniation of the bladder (**cystocele**), and alteration in the position of the bladder neck and urethra, leading to **stress incontinence**. In the latter condition, the patient dribbles urine whenever the intraabdominal pressure is raised, as in coughing. **Prolapse of the rectum** may also occur.

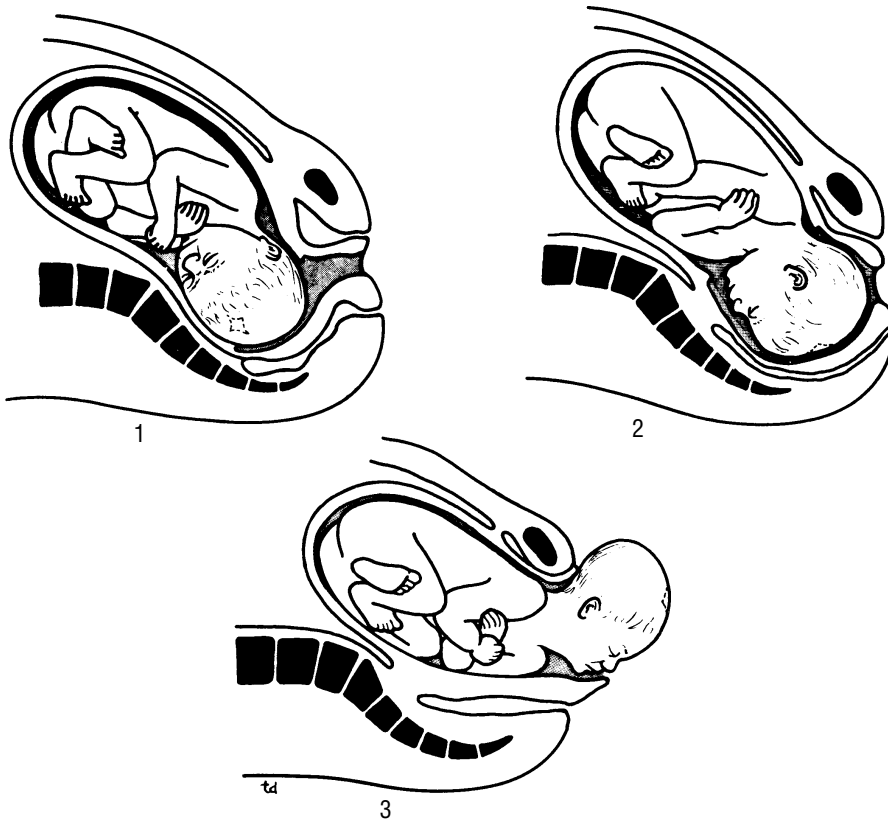


## MUSCLES OF THE UPPER LIMB

### Rotator Cuff Tendinitis

The rotator cuff, consisting of the tendons of the subscapularis, supraspinatus, infraspinatus, and teres minor muscles,



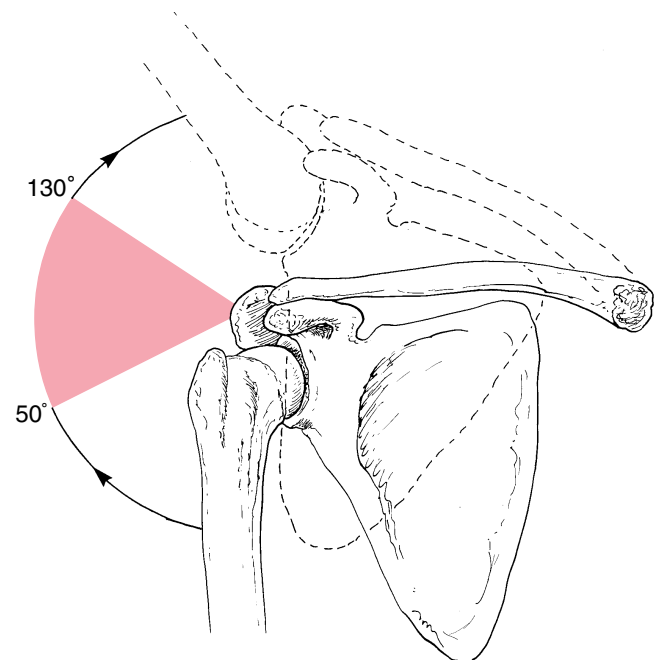


**CD Figure 13-4** Stages in rotation of the baby's head during the second stage of labor. The shape of the pelvic floor plays an important part in this process.

which are fused to the underlying capsule of the shoulder joint, plays an important role in stabilizing the shoulder joint. Lesions of the cuff are a common cause of pain in the shoulder region. Excessive overhead activity of the upper limb may be the cause of tendinitis, although many cases appear spontaneously. During abduction of the shoulder joint, the supraspinatus tendon is exposed to friction against the acromion (CD Fig. 13-5). Under normal conditions, the amount of friction is reduced to a minimum by the large subacromial bursa, which extends laterally beneath the deltoid. Degenerative changes in the bursa are followed by degenerative changes in the underlying supraspinatus tendon, and these may extend into the other tendons of the rotator cuff. Clinically, the condition is known as **subacromial bursitis**, **supraspinatus tendinitis**, or **pericapsulitis**. It is characterized by the presence of a spasm of pain in the middle range of abduction (CD Fig. 13-5), when the diseased area impinges on the acromion.

## Rupture of the Supraspinatus Tendon

In advanced cases of rotator cuff tendinitis, the necrotic supraspinatus tendon can become calcified or rupture. Rupture of the tendon seriously interferes with the normal



**CD Figure 13-5** Subacromial bursitis, supraspinatus tendinitis, or pericapsulitis showing the painful arc in the middle range of abduction, when the diseased area impinges on the lateral edge of the acromion.

abduction movement of the shoulder joint. It will be remembered that the main function of the supraspinatus muscle is to hold the head of the humerus in the glenoid fossa at the commencement of abduction. The patient with a ruptured supraspinatus tendon is unable to initiate abduction of the arm. However, if the arm is passively assisted for the first 15° of abduction, the deltoid can then take over and complete the movement to a right angle.

## Axillary Nerve and the Quadrangular Space

A subglenoid dislocation of the head of the humerus into the quadrangular space (see text Fig. 13-24) can cause damage to the axillary nerve, as indicated by paralysis of the deltoid muscle and loss of skin sensation over the lower half of the deltoid muscle.

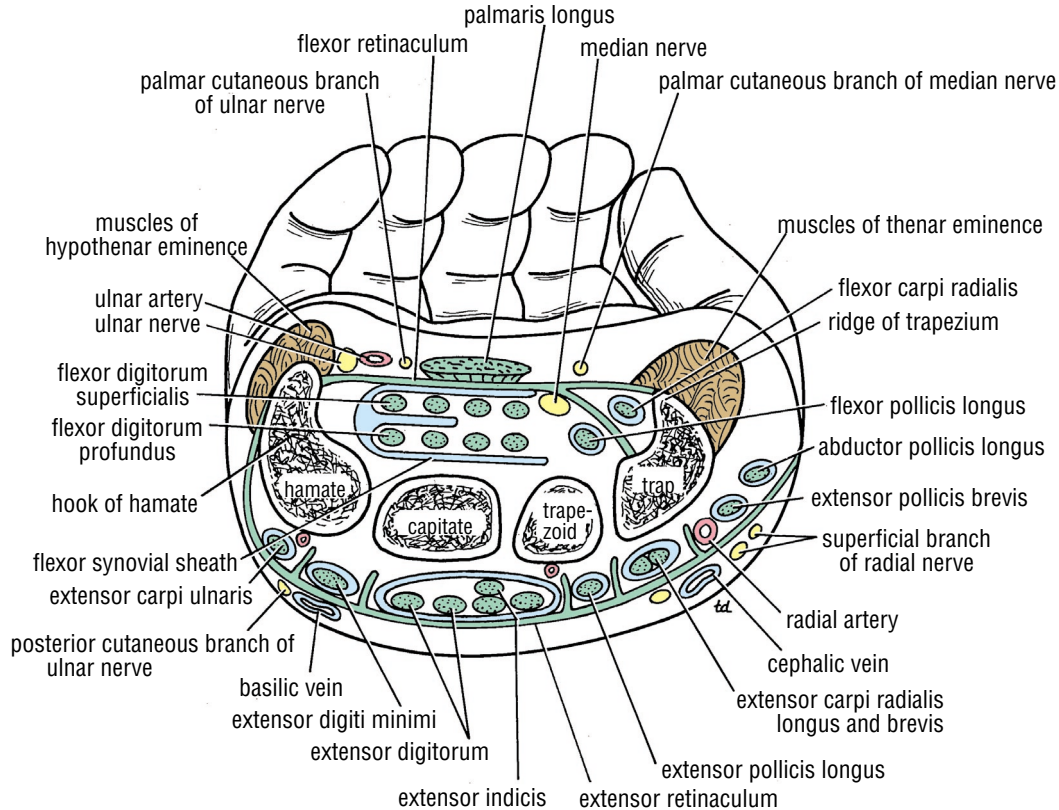
## Carpal Tunnel Syndrome

The carpal tunnel, formed by the concave anterior surface of the carpal bones and closed by the flexor retinaculum, is tightly packed with the long flexor tendons of the fingers, their surrounding synovial sheaths, and the median nerve

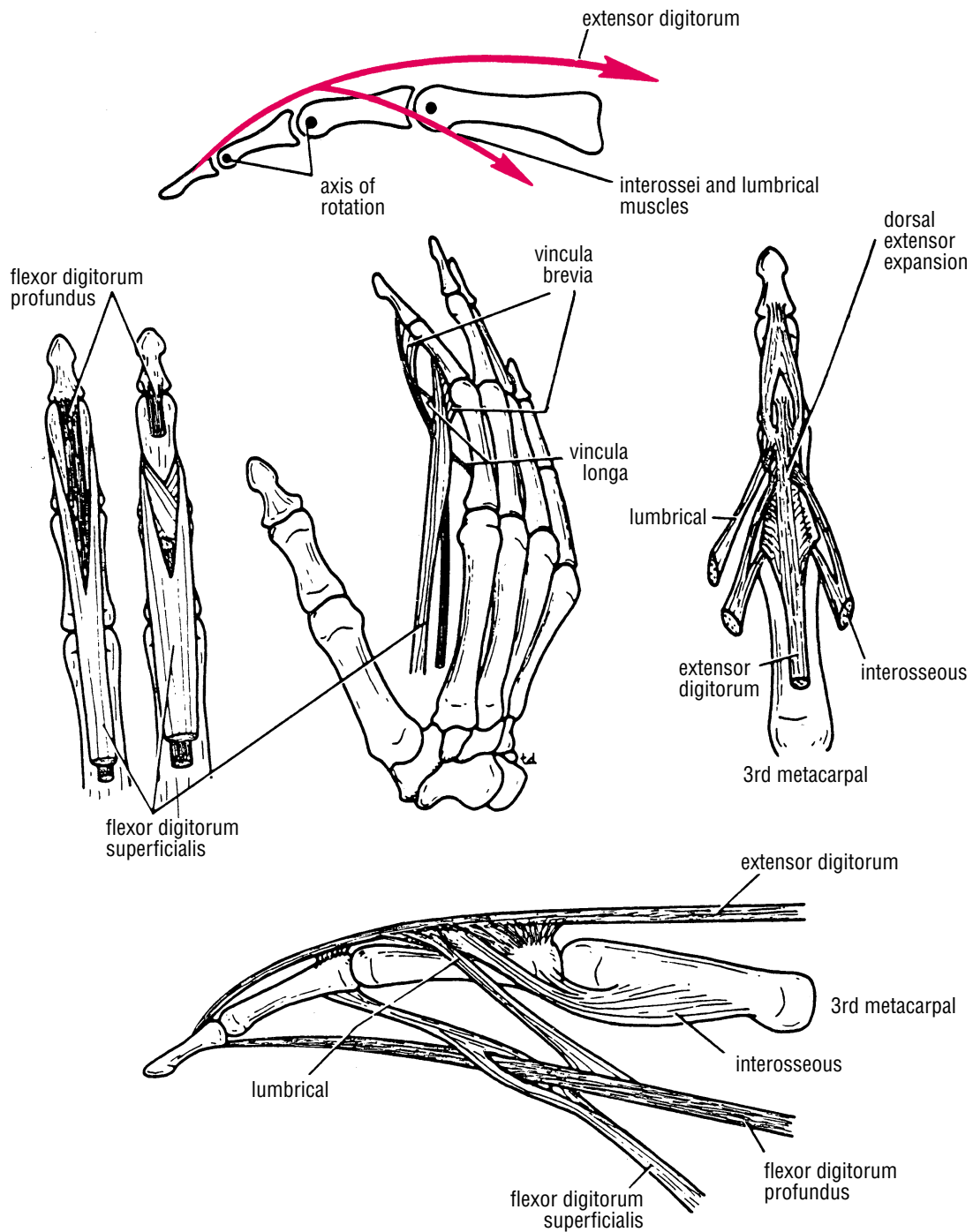
(CD Fig. 13-6). Clinically, the syndrome consists of a burning pain or “pins and needles” along the distribution of the median nerve to the lateral three and a half fingers and weakness of the thenar muscles. It is produced by compression of the median nerve within the tunnel. The exact cause of the compression is difficult to determine, but thickening of the synovial sheaths of the flexor tendons or arthritic changes in the carpal bones are thought to be responsible in many cases. As you would expect, no paresthesia occurs over the thenar eminence because this area of skin is supplied by the palmar cutaneous branch of the median nerve, which passes superficially to the flexor retinaculum. The condition is dramatically relieved by decompressing the tunnel by making a longitudinal incision through the flexor retinaculum.

## Tenosynovitis of the Synovial Sheaths of the Flexor Tendons

Tenosynovitis is an infection of a synovial sheath. It most commonly results from the introduction of bacteria into a sheath through a small penetrating wound, such as that made by the point of a needle or thorn. Rarely, the sheath may become infected by extension of a pulp-space infection.



**CD Figure 13-6** Cross section of the hand showing the relation of the tendons, nerves, and arteries to the flexor and extensor retinacula.



**CD Figure 13-7** Insertions of long flexor and extensor tendons in the fingers. Insertions of the lumbrical and interossei muscles are also shown. The uppermost figure illustrates the action of the lumbrical and interossei muscles in flexing the metacarpophalangeal joints and extending the interphalangeal joints.

Infection of a digital sheath results in distension of the sheath with pus; the finger is held semiflexed and is swollen. Any attempt to extend the finger is accompanied by extreme pain because the distended sheath is stretched. As the inflammatory process continues, the pressure within the sheath rises

and may compress the blood supply to the tendons that travel in the vincula longa and brevia (CD Fig. 13-7). Rupture or later severe scarring of the tendons may follow.

A further increase in pressure can cause the sheath to rupture at its proximal end. Anatomically, the digital sheath

of the index finger is related to the thenar space, whereas that of the ring finger is related to the midpalmar space. The sheath for the middle finger is related to both the thenar and midpalmar spaces. These relationships explain how infection can extend from the digital synovial sheaths and involve the palmar fascial spaces.

In the case of infection of the digital sheaths of the little finger and thumb, the ulnar and radial bursae are quickly involved. Should such an infection be neglected, pus may burst through the proximal ends of these bursae and enter the fascial space of the forearm between the flexor digitorum profundus anteriorly and the pronator quadratus and the interosseous membrane posteriorly. This fascial space in the forearm is commonly referred to clinically as the **space of Parona**.

## Trigger Finger

In trigger finger, there is a palpable and even audible snapping when a patient is asked to flex and extend the fingers. It is caused by the presence of a localized swelling of one of the long flexor tendons that catches on a narrowing of the fibrous flexor sheath anterior to the metacarpophalangeal joint. It may take place either in flexion or in extension. A similar condition occurring in the thumb is called trigger thumb. The situation can be relieved surgically by incising the fibrous flexor sheath.

## Mallet Finger

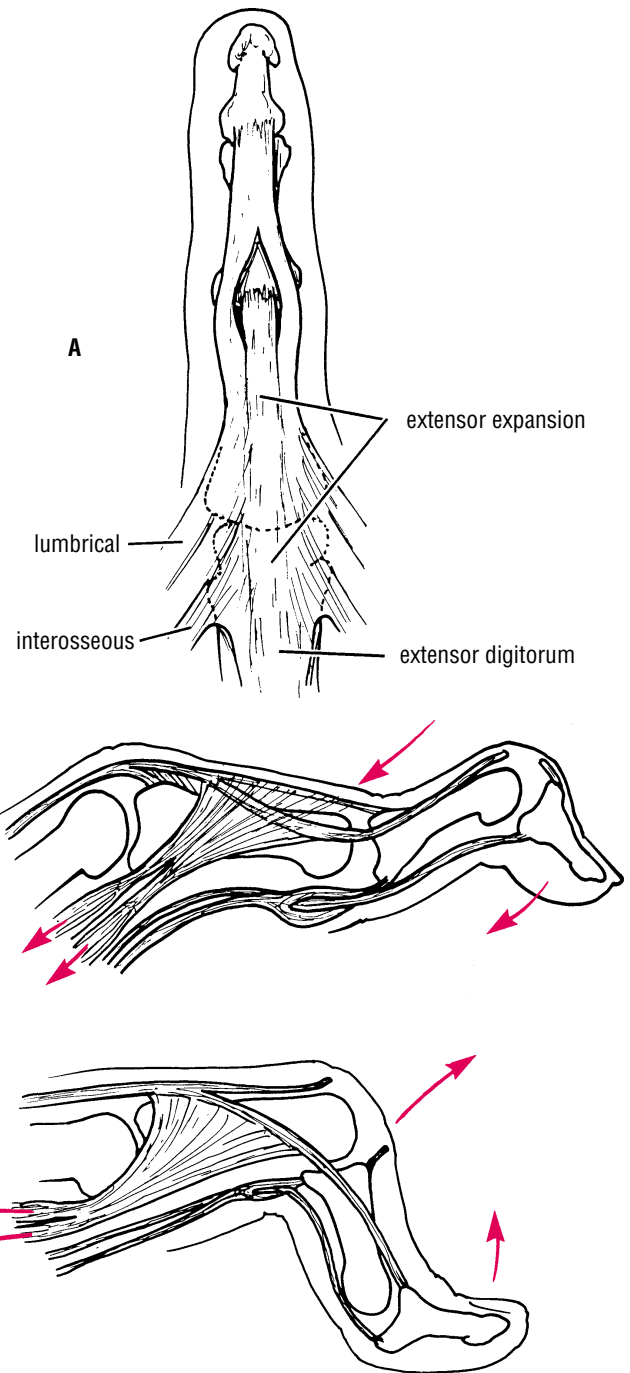
Avulsion of the insertion of one of the extensor tendons into the distal phalanges can occur if the distal phalanx is forcibly flexed when the extensor tendon is taut. The last 20° of active extension is lost, resulting in a condition known as mallet finger (CD Fig. 13-8).

## Boutonnière Deformity

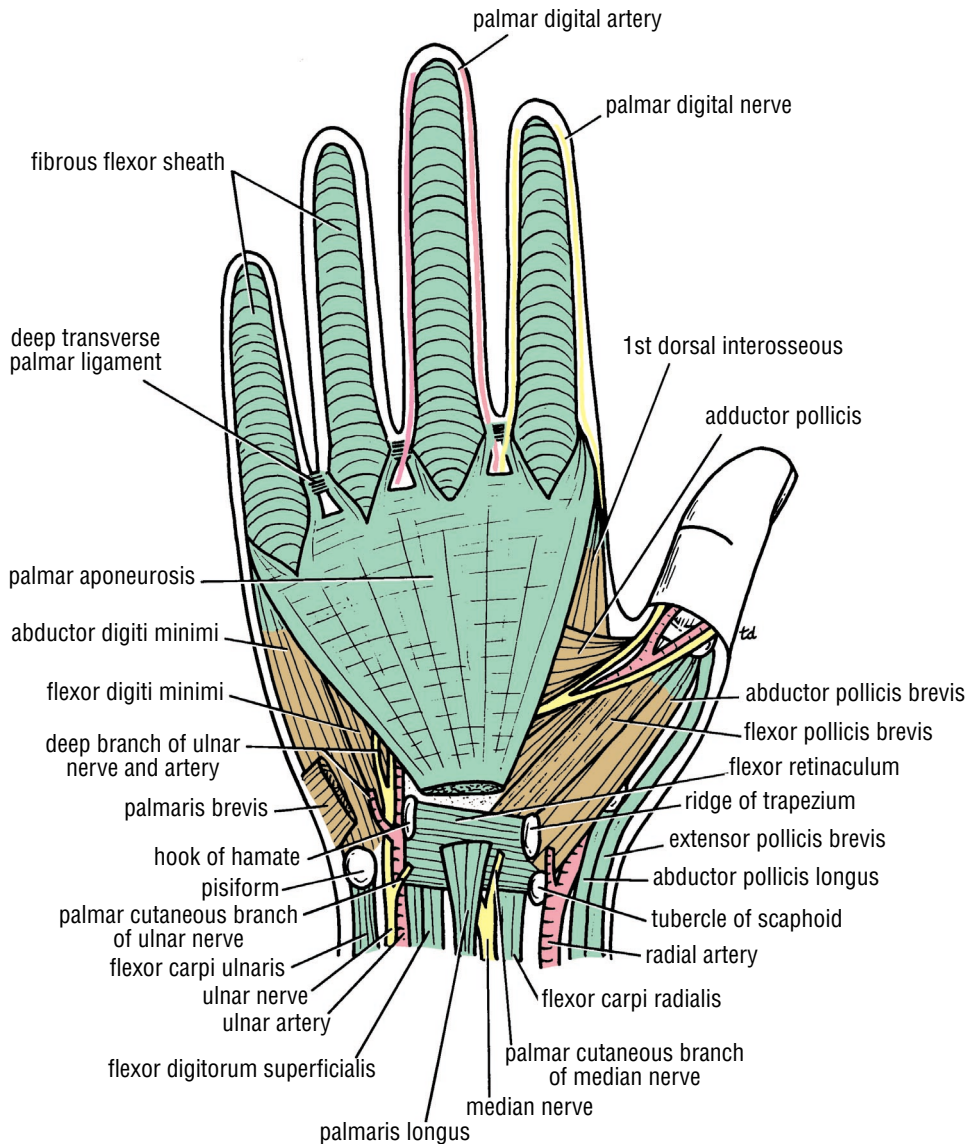
Avulsion of the central slip of the extensor tendon proximal to its insertion into the base of the middle phalanx results in a characteristic deformity (CD Fig. 13-8C). The deformity results from flexing of the proximal interphalangeal joint and hyperextension of the distal interphalangeal joint. This injury can result from direct end-on trauma to the finger, direct trauma over the back of the proximal interphalangeal joint, or laceration of the dorsum of the finger.

## Dupuytren's Contracture

Dupuytren's contracture is a localized thickening and contracture of the palmar aponeurosis (CD Fig. 13-9). It commonly starts near the root of the ring finger and draws that finger into the palm, flexing it at the metacarpophalangeal joint. Later, the condition involves the little finger in the same manner. In long-standing cases, the pull on the fibrous sheaths of these fingers results in flexion of the proximal



**CD Figure 13-8** **A.** Posterior view of normal dorsal extensor expansion. The extensor expansion near the proximal interphalangeal joint splits into three parts: a central part, which is inserted into the base of the middle phalanx, and two lateral parts, which converge to be inserted into the base of the distal phalanx. **B.** Mallet or baseball finger. The insertion of the extensor expansion into the base of the distal phalanx ruptured; sometimes a flake of bone on the base of the phalanx is pulled off. **C.** Boutonnière deformity. The insertion of the extensor expansion into the base of the middle phalanx is ruptured. The *arrows* indicate the direction of the pull of the muscles and the deformity.



**CD Figure 13-9** Anterior view of the palm of the hand. The palmar aponeurosis has been left in position.

interphalangeal joints. The distal interphalangeal joints are not involved and are actually extended by the pressure of the fingers against the palm.



## MUSCLES OF THE LOWER LIMB

### Gluteus Maximus and Intramuscular Injections

The gluteus maximus is a large, thick muscle with coarse fasciculi that can be easily separated without damage. The great thickness of this muscle makes it ideal for intramuscu-

lar injections. To avoid injury to the underlying sciatic nerve, the injection should be given well forward on the **upper outer quadrant of the buttock**.

Bursitis, or inflammation of a bursa, can be caused by acute or chronic trauma.

### Gluteus Maximus and Bursitis

An inflamed bursa becomes distended with excessive amounts of fluid and can be extremely painful. The bursae associated with the gluteus maximus are prone to inflammation.

### Gluteus Medius and Minimus and Poliomyelitis

The gluteus medius and minimus muscles may be paralyzed when poliomyelitis involves the lower lumbar and

sacral segments of the spinal cord. They are supplied by the superior gluteal nerve (L4 and 5 and S1). Paralysis of these muscles seriously interferes with the ability of the patient to tilt the pelvis when walking.

## Quadriceps Femoris as a Knee-Joint Stabilizer

The quadriceps femoris is an important extensor muscle for the knee joint. Its tone greatly strengthens the joint; therefore, this muscle mass must be carefully examined when disease of the knee joint is suspected. Both thighs should be examined, and the size, consistency, and strength of the quadriceps muscles should be tested. Reduction in size caused by muscle atrophy can be tested by measuring the circumference of each thigh a fixed distance above the superior border of the patella.

The vastus medialis muscle extends farther distally than the vastus lateralis. Remember that the vastus medialis is the first part of the quadriceps muscle to atrophy in knee-joint disease and the last to recover.

## Rupture of the Rectus Femoris

The rectus femoris muscle can rupture in sudden violent extension movements of the knee joint. The muscle belly retracts proximally, leaving a gap that may be palpable on the anterior surface of the thigh. In complete rupture of the muscle, surgical repair is indicated.

## Rupture of the Ligamentum Patellae

This can occur when a sudden flexing force is applied to the knee joint when the quadriceps femoris muscle is actively contracting.

## Femoral Sheath and Femoral Hernia

The hernial sac descends through the femoral canal within the femoral sheath.

The femoral sheath is a prolongation downward into the thigh of the fascial lining of the abdomen. It surrounds the femoral vessels and lymphatic vessels for about 1 in. (2.5 cm) below the inguinal ligament (CD Fig. 13-10). The **femoral artery**, as it enters the thigh below the inguinal ligament, occupies the lateral compartment of the sheath. The **femoral vein**, which lies on its medial side and is separated from it by a fibrous septum, occupies the intermediate compartment. The **lymphatics**, which are separated from the vein by a fibrous septum, occupy the most medial compartment.

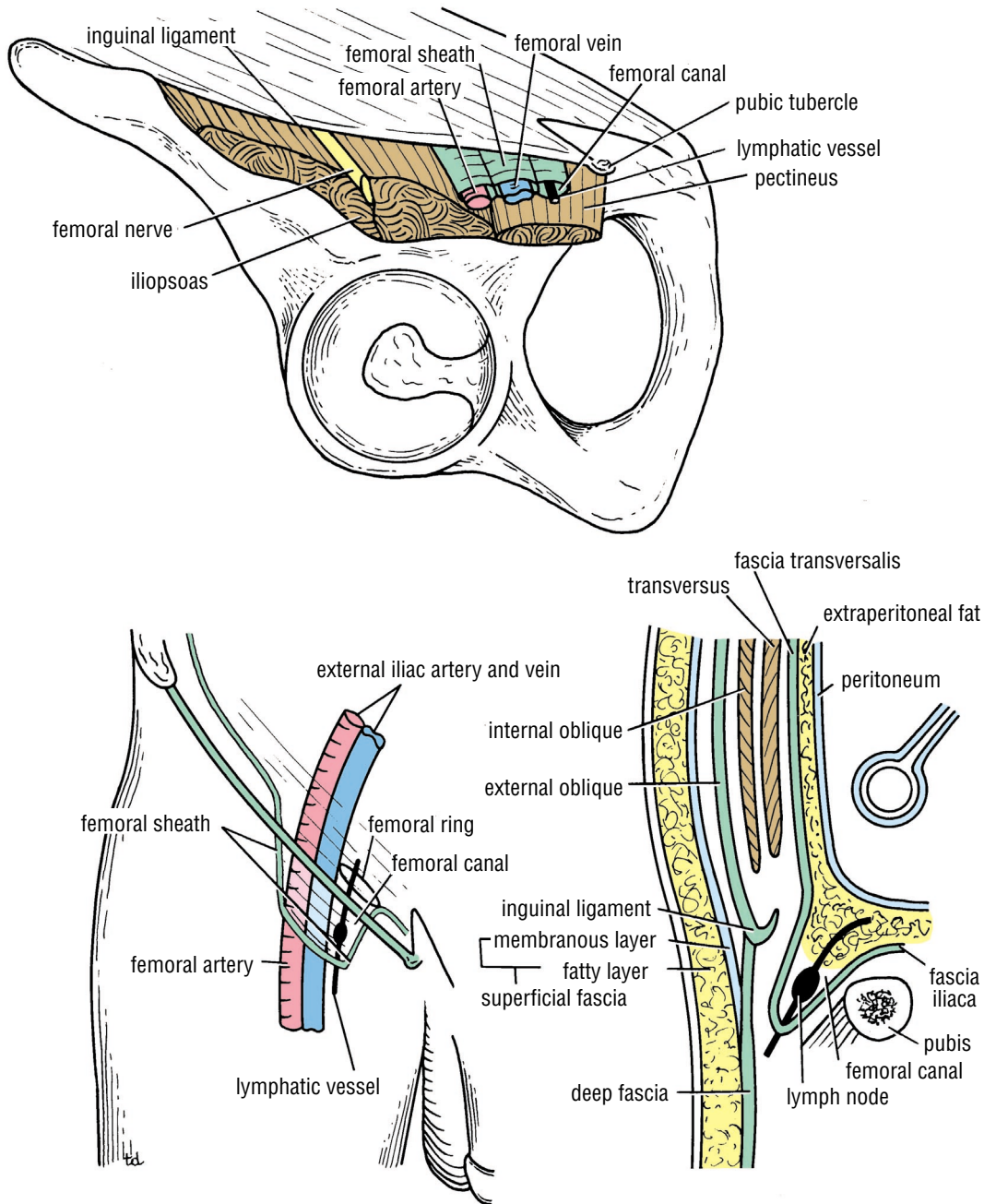
The **femoral canal**, the compartment for the lymphatic vessels, occupies the medial part of the sheath. It is about 0.5 in. (1.3 cm) long, and its upper opening is referred to as the **femoral ring**. The **femoral septum**, which is a condensation of extraperitoneal tissue, plugs the opening of the femoral ring.

A **femoral hernia** is more common in women than in men (possibly because of their wider pelvis and femoral canal). The hernial sac passes down the femoral canal, pushing the femoral septum before it. On escaping through the lower end of the femoral canal, it expands to form a swelling in the upper part of the thigh deep to the deep fascia. With further expansion, the hernial sac may turn upward to cross the anterior surface of the inguinal ligament.

The neck of the sac always lies **below and lateral to the pubic tubercle**. This serves to distinguish it from an inguinal hernia, which lies above and medial to the pubic tubercle. The neck of the sac is narrow and lies at the femoral ring. The ring is related anteriorly to the inguinal ligament, posteriorly to the pectineal ligament and the superior ramus of the pubis, medially to the sharp free edge of the lacunar ligament, and laterally to the femoral vein. Because of these anatomic structures, the neck of the sac is unable to expand. Once an abdominal viscus has passed through the neck into the body of the sac, it may be difficult to push it up and return it to the abdominal cavity (**irreducible hernia**). Furthermore, after the patient strains or coughs, a piece of bowel may be forced through the neck, and its blood vessels may be compressed by the femoral ring, seriously impairing its blood supply (**strangulated hernia**). A femoral hernia is a dangerous condition and should always be treated surgically.

When considering the differential diagnosis of a femoral hernia, it is important to consider diseases that may involve other anatomic structures close to the inguinal ligament. For example:

- **Inguinal canal:** The swelling of an inguinal hernia lies above the medial end of the inguinal ligament. Should the hernial sac emerge through the superficial inguinal ring to start its descent into the scrotum, the swelling will lie above and medial to the pubic tubercle. The sac of a femoral hernia lies below and lateral to the pubic tubercle.
- **Superficial inguinal lymph nodes:** Usually, more than one lymph node is enlarged. In patients with inflammation of the nodes (**lymphadenitis**), carefully examine the entire area of the body that drains its lymph into these nodes. A small, unnoticed skin abrasion may be found. Never forget the mucous membrane of the lower half of the anal canal—it may have an undiscovered carcinoma.
- **Great saphenous vein:** A localized dilatation of the terminal part of the great saphenous vein, a **saphenous varix**, can cause confusion, especially because a hernia



CD Figure 13-10 Right femoral sheath and its contents.

and a varix increase in size when the patient is asked to cough. (Elevated intraabdominal pressure drives the blood downward.) The presence of varicose veins elsewhere in the leg should help in the diagnosis.

- **Psoas sheath:** Tuberculous infection of a lumbar vertebra can result in the extravasation of pus down the psoas sheath into the thigh (CD Fig. 13-3). The presence of a swelling above and below the inguinal ligament, together with clinical signs and symptoms referred to the vertebral column, should make the diagnosis obvious.

- **Femoral artery:** An expansile swelling lying along the course of the femoral artery that fluctuates in time with the pulse rate should make the diagnosis of **aneurysm of the femoral artery** certain.

## Adductor Muscles and Cerebral Palsy

In patients with cerebral palsy who have marked spasticity of the adductor group of muscles, it is common practice to

perform a tenotomy of the adductor longus tendon and to divide the anterior division of the obturator nerve. In addition, in some severe cases the posterior division of the obturator nerve is crushed. This operation overcomes the spasm of the adductor group of muscles and permits slow recovery of the muscles supplied by the posterior division of the obturator nerve.

## The Adductor Magnus and Popliteal Aneurysms

The pulsations of the wall of the femoral artery against the tendon of adductor magnus at the opening of the adductor magnus is thought to contribute to the cause of popliteal aneurysms.

## Semimembranosus Bursa Swelling

Semimembranosus bursa swelling is the most common swelling found in the popliteal space. It is made tense by extending the knee joint and becomes flaccid when the joint is flexed. It should be distinguished from a Baker's cyst, which is centrally located and arises as a pathologic (osteoarthritis) diverticulum of the synovial membrane through a hole in the back of the capsule of the knee joint.

## Anterior Compartment of the Leg Syndrome

The anterior compartment syndrome is produced by an increase in the intracompartmental pressure that results from an increased production of tissue fluid. Soft tissue injury associated with bone fractures is a common cause, and early diagnosis is critical. The deep, aching pain in the anterior compartment of the leg that is characteristic of this syndrome can become severe. Dorsiflexion of the foot at the ankle joint increases the severity of the pain. Stretching of the muscles that pass through the compartment by passive plantar flexion of the ankle also increases the pain. As the pressure rises, the venous return is diminished, thus producing a further rise in pressure. In severe cases, the arterial supply is eventually cut off by compression, and the dorsalis pedis arterial pulse disappears. The tibialis anterior, the extensor digitorum longus, and the extensor hallucis longus muscles are paralyzed. Loss of sensation is limited to the area supplied by the deep peroneal nerve—that is, the skin cleft between the first and second toes. The surgeon can open the anterior compartment of the leg by making a longitudinal incision through the deep fascia and thus decompress the area and prevent anoxic necrosis of the muscles.

## Tenosynovitis and Dislocation of the Peroneus Longus and Brevis Tendons

Tenosynovitis (inflammation of the synovial sheaths) can affect the tendon sheaths of the peroneus longus and brevis muscles as they pass posterior to the lateral malleolus. Treatment consists of immobilization, heat, and physiotherapy. Tendon dislocation can occur when the tendons of peroneus longus and brevis dislocate forward from behind the lateral malleolus. For this condition to occur, the superior peroneal retinaculum must be torn. It usually occurs in older children and is caused by trauma.

## Gastrocnemius and Soleus Muscle Tears

Tearing of the gastrocnemius or soleus muscles will produce severe localized pain over the damaged muscle. Swelling may be present.

## Ruptured Tendo Calcaneus

Rupture of the tendo calcaneus is common in middle-aged men and frequently occurs in tennis players. The rupture occurs at its narrowest part, about 2 in. (5 cm) above its insertion. A sudden, sharp pain is felt, with immediate disability. The gastrocnemius and soleus muscles retract proximally, leaving a palpable gap in the tendon. It is impossible for the patient to actively plantar flex the foot. The tendon should be sutured as soon as possible and the leg immobilized with the ankle joint plantar flexed and the knee joint flexed.

## Rupture of the Plantaris Tendon

Rupture of the plantaris tendon is rare, although tearing of the fibers of the soleus or partial tearing of the tendo calcaneus is frequently diagnosed as such a rupture.

## Plantaris Tendon and Autografts

The plantaris muscle, which is often missing, can be used for tendon autografts in repairing severed flexor tendons to the fingers; the tendon of the palmaris longus muscle can also be used for this purpose.

## Plantar Fasciitis

Plantar fasciitis, which occurs in individuals who do a great deal of standing or walking, causes pain and tenderness of the sole of the foot. It is believed to be caused by repeated



minor trauma. Repeated attacks of this condition induce ossification in the posterior attachment of the aponeurosis, forming a **calcaneal spur**.

## Clinical Problems Associated with the Arches of the Foot

See CD Chapter 12.

## Bursae and Bursitis in the Lower Limb

A variety of bursae are found in the lower limb where skin, tendons, ligaments, or muscles repeatedly rub against bony points or ridges.

Bursitis, or inflammation of a bursa, can be caused by acute or chronic trauma, crystal disease, infection, or disease of a neighboring joint that communicates with the bursa. An inflamed bursa becomes distended with excessive amounts of fluid. The following bursae are prone to

inflammation: the bursa over the ischial tuberosity; the greater trochanter bursa; the prepatellar and superficial infrapatellar bursae; the bursa between the tendons of insertion of the sartorius, gracilis, and semitendinosus muscles on the medial proximal aspect of the tibia; and the bursa between the tendo calcaneus and the upper part of the calcaneum (long-distance runner's ankle).

Two important bursae communicate with the knee joint, and they can become distended if excessive amounts of synovial fluid accumulate within the joint. The suprapatellar bursa extends proximally about three fingerbreadths above the patella beneath the quadriceps femoris muscle. The bursa, which is associated with the insertion of the semimembranosus muscle, may enlarge in patients with osteoarthritis of the knee joint.

The anatomic bursae described should not be confused with **adventitious bursae**, which develop in response to abnormal and excessive friction. For example, a subcutaneous bursa sometimes develops over the tendo calcaneus in response to badly fitting shoes. A **bunion** is an adventitious bursa located over the medial side of the head of the first metatarsal bone.

## Clinical Problem Solving Questions

Read the following case histories/questions and give the best answer for each.

### General Muscle Information

In a 63-year-old man, a magnetic resonance imaging scan of the lower thoracic region of the vertebral column reveals the presence of a tumor pressing on the lumbar segments of the spinal cord. He has a loss of sensation in the skin over the anterior surface of the left thigh and is unable to extend his left knee joint. Examination reveals that the muscles of the front of the left thigh have atrophied and have no tone and that the left knee jerk is absent.

- The following statements concerning this patient are correct **except** which?
  - The tumor is interrupting the normal function of the efferent motor fibers of the spinal cord on the left side.
  - The quadriceps femoris muscles on the front of the left thigh are atrophied.
  - The loss of skin sensation is confined to the dermatomes L1, 2, 3, and 4.
  - The absence of the left knee jerk is because of involvement of the first lumbar spinal segment.

- The loss of muscle tone is caused by interruption of a nervous reflex arc.

A woman recently took up employment in a factory. She is a machinist, and for 6 hours a day she has to move a lever repeatedly, which requires that she extend and flex her right wrist joint. At the end of the second week of her employment, she began to experience pain over the posterior surface of her wrist and noticed a swelling in the area.

- The following statements concerning this patient are correct **except** which?
  - Extension of the wrist joint is brought about by several muscles that include the extensor digitorum muscle.
  - The wrist joint is diseased.
  - Repeated unaccustomed movements of tendons through their synovial sheaths can produce traumatic inflammation of the sheaths.
  - The diagnosis is traumatic tenosynovitis of the long tendons of the extensor digitorum muscle.

### Head and Neck Muscles

A 43-year-old woman was seen in the emergency department with a large abscess in the middle of the right

posterior triangle of the neck. The abscess was red, hot, and fluctuant. The abscess showed evidence that it was pointing and about to rupture. The physician decided to incise the abscess and insert a drain. The patient returned to the department for the dressings to be changed 5 days later. She stated that she felt much better and that her neck was no longer painful. However, there was one thing that she could not understand. She could no longer raise her right hand above her head to brush her hair.

3. The following statements explain the signs and symptoms in this case, suggesting that the spinal part of the accessory nerve had been incised, **except** which?
  - A. To raise the hand above the head, it is necessary for the trapezius muscle, assisted by the serratus anterior, to contract and rotate the scapula so that the glenoid cavity faces upward.
  - B. The trapezius muscle is innervated by the spinal part of the accessory nerve.
  - C. As the spinal part of the accessory nerve crosses the posterior triangle of the neck, it is deeply placed, being covered by the skin, the superficial fascia, the investing layer of deep cervical fascia, and the levator scapulae muscle.
  - D. The surface marking of the spinal part of the accessory nerve is as follows: Bisect at right angles a line joining the angle of the jaw to the tip of the mastoid process. Continue the second line downward and backward across the posterior triangle.
  - E. The knife opening the abscess had cut the accessory nerve.

A 46-year-old man was seen in the emergency department after being knocked down in a street brawl. He had received a blow on the head with an empty bottle. On examination, the patient was conscious and had a large gaping wound on the top of the head.

4. Why did the wound in this patient gape wide open when he was hit with a blunt object and not a knife?
  - A. The skin on the top of the head was excessively tight.
  - B. The blow of the bottle had split the epicranial aponeurosis against the underlying skull and the tone of the occipitofrontalis muscle had pulled the skin wound open.
  - C. The subcutaneous tissue of the scalp contains smooth muscle, which pulled the wound open.
  - D. A hematoma was formed beneath the scalp and forced the wound open.
  - E. The underlying parietal bone of the skull was fractured and forced the wound open.

## Muscles of the Back

A 75-year-old woman was dusting the top of a high closet while balanced on a chair. She lost her balance

and fell to the floor, catching her right lumbar region on the edge of the chair.

5. The following statements about this patient are correct **except** which?
  - A. A lumbar puncture (spinal tap) should always be performed in back injuries to exclude damage to the spinal cord.
  - B. Anteroposterior and lateral radiographs exclude the presence of a fracture, especially of a transverse process.
  - C. A 24-hour specimen of urine should be examined for blood to exclude or confirm injury to the right kidney.
  - D. Careful examination of the erector spinae muscles or quadratus lumborum muscle may reveal extreme tenderness and therefore injury to these muscles.
  - E. Examination of the back revealed a large bruised area in the right lumbar region, which was extremely tender to touch.

## Muscles of the Thoracic Wall

A resident obtained a sample of pleural fluid from a patient's right pleural cavity. He inserted the needle close to the upper border of the sixth rib in the anterior axillary line.

6. Name the muscles that the needle pierced in order to enter the pleural cavity.
  - A. Trapezius and latissimus dorsi
  - B. Trapezius and serratus anterior
  - C. Serratus anterior, external intercostal, internal intercostal, and innermost intercostal
  - D. External intercostal and internal intercostal
  - E. Latissimus dorsi, serratus anterior, and external intercostal

## Abdominal Muscles

A 75-year-old man with chronic bronchitis noticed that a bulge was developing in his left groin. On examination, an elongated swelling was seen above the medial end of the left inguinal ligament. When the patient coughed, the swelling enlarged but did not descend into the scrotum. The patient had weak abdominal muscles.

7. The symptoms and signs displayed by this patient can be explained by the following statements **except** which?
  - A. The inguinal swelling was a direct inguinal hernia.
  - B. The cause of the hernia was weak abdominal muscles.
  - C. The hernial sac was wide and in direct communication with the peritoneal cavity.
  - D. A rise in intraabdominal pressure on coughing caused the hernial swelling to expand.
  - E. The swelling did not involve the conjoint tendon.

A 40-year-old woman noticed a painful swelling in her right groin after helping her husband move some heavy furniture. On examination, a small tender swelling was noted in the right groin.

8. The symptoms and signs displayed by this patient can be explained by the following statements **except** which?
  - A. The neck of a femoral hernial sac is situated below and medial to the pubic tubercle.
  - B. A hernial sac formed of parietal peritoneum was forced downward.
  - C. The peritoneum was forced through the right femoral canal.
  - D. The patient had a right-sided femoral hernia.
  - E. The excessive exertion caused a rise in intraabdominal pressure.
9. Following a sudden severe blow on the anterior abdominal wall from the hind leg of a horse, a patient complained of pain and swelling below the umbilicus. On examination, extensive bruising of the skin was observed over the lower part of the right rectus muscle. On gentle palpation, a deep swelling confined to the right rectus sheath was felt. Given that the deep swelling was due to a collection of blood (hematoma), which blood vessels were likely to have been ruptured?
10. In a patient with a history of tuberculosis, an angular kyphosis of the lumbar vertebral column suddenly developed. On examination, a swelling was found in the groin, just below the right inguinal ligament. On deep palpation of the anterior abdominal wall above the right inguinal ligament, a further swelling could be felt. Digital pressure on the first swelling caused expansion of the second swelling and vice versa. What is the diagnosis? Explain the swelling in anatomical terms.
11. The following statements concerning this patient are correct **except** which?
  - A. Altered skin sensation was felt in the skin areas supplied by the digital branches of the median nerve.
  - B. The muscles of the thenar eminence showed some evidence of wasting as seen by flattening of the thenar eminence.
  - C. The muscles of the thenar eminence are supplied by the recurrent muscular branch of the median nerve.
  - D. The median nerve enters the palm through the carpal tunnel.
  - E. The median nerve occupies a large space between the tendons behind the flexor retinaculum.
  - F. This patient has carpal tunnel syndrome.
12. The following statements concerning this patient are correct **except** which?
  - A. Altered skin sensation was felt in the skin areas supplied by the digital branches of the median nerve.
  - B. The muscles of the thenar eminence showed some evidence of wasting as seen by flattening of the thenar eminence.
  - C. The muscles of the thenar eminence are supplied by the recurrent muscular branch of the median nerve.
  - D. The median nerve enters the palm through the carpal tunnel.
  - E. The median nerve occupies a large space between the tendons behind the flexor retinaculum.
  - F. This patient has carpal tunnel syndrome.
13. Following a radical mastectomy operation a woman noticed that her right shoulder blade projected backwards. Can you explain this deformity?
14. A 40-year-old man visited his physician complaining of pain of 3 weeks' duration in his right shoulder. On examination, the patient could actively abduct his right shoulder to 50°; thereafter, he experienced severe pain that prevented further movement. If the arm was then passively raised above a right angle, it could be held actively without pain in that position. If the patient attempted to lower the arm, he again experienced severe pain in the middle range of abduction. What is your diagnosis?

A 64-year-old man consulted his physician because he had noticed during the past 6 months a thickening of the skin at the base of his left ring finger. As he described it: "There appears to be a band of tissue that is pulling my ring finger into the palm." On examination of the palms of both hands, a localized thickening of subcutaneous tissue could be felt at the base of the left ring and little fingers. The metacarpophalangeal joint of the ring finger could not be fully extended, either actively or passively.

15. The following statements concerning this patient are correct **except** which?
  - A. The deep fascia beneath the skin of the palm is thickened to form the palmar aponeurosis.
  - B. The distal end of the aponeurosis gives rise to five slips to the five fingers.
  - C. Each slip is attached to the base of the proximal phalanx and to the fibrous flexor sheath of each finger.
  - D. Fibrous contraction of the slip to the ring finger resulted in permanent flexion of the metacarpophalangeal joint.
  - E. The patient had Dupuytren's contracture.

## Pelvic Muscles

11. A multiparous 57-year-old woman visited her gynecologist complaining of a "bearing-down" feeling in the pelvis and of low backache, both of which were worse when she was tired. On vaginal examination, the external os of the cervix was found to be located just within the vaginal orifice. A diagnosis of uterine prolapse was made. What are the main supports of the uterus?

## Muscles of the Upper Limb

A 50-year-old woman complaining of severe "pins and needles" in her right hand and lateral fingers visited her physician. She said that she had experienced difficulty in buttoning up her clothes when dressing. On physical examination the patient pointed to her thumb and index, middle, and ring fingers as the areas where she felt discomfort. No objective impairment of sensation was found in these areas. The muscles of the thenar

## Muscles of the Lower Limb

A 54-year-old man was told by his physician to reduce his weight. He was prescribed a diet and was advised to exercise more. One morning while jogging, he heard a sharp snap and felt a sudden pain in his right lower calf. On examination in the emergency department, the physician noted that the upper part of the right calf was swollen and a gap was apparent between the swelling and the heel. A diagnosis of rupture of the right Achilles tendon was made.

16. The following statements concerning this patient are correct **except** which?
- With the patient supine, gentle squeezing of the upper part of the right calf did not produce plantar flexion of the ankle joint.
  - The Achilles tendon is the tendon of insertion of the gastrocnemius and soleus muscles.
  - The Achilles tendon is inserted into the posterior surface of the talus.
  - Rupture of the Achilles tendon results in the bellies of the gastrocnemius and soleus muscles retracting upward, leaving a gap between the divided ends of the tendon.
  - Normally, the gastrocnemius and soleus muscles are the main muscles responsible for plantar flexion of the ankle joint.

A 25-year-old man was admitted to the emergency department after an automobile accident. Apart from other superficial injuries, he was found to have a fracture of the middle third of the right femur.

17. The following statements concerning this patient are possible **except** which?
- The soleus muscle was responsible for the backward rotation of the distal fragment.
  - A lateral radiograph showed overlap of the fragments, with the distal fragment rotated backward.

- A large amount of force would be necessary to restore the leg to its original length.
- The hamstrings and quadriceps femoris muscles were responsible for the leg shortening.
- The right leg was 2 in. (5 cm) shorter than the left leg.

18. A 42-year-old woman was seen in the emergency department after slipping on some ice on the way to work. She complained of pain on movement of her right ankle joint. The physician asked the patient to evert her right foot. Which of the following muscles everts the foot?
- The tibialis anterior muscle
  - The flexor hallucis longus muscle
  - The peroneus longus muscle
  - The tibialis anterior muscle
  - The flexor digitorum longus muscle
19. A 61-year-old woman was being examined for osteoarthritis of the left hip joint by an orthopedic surgeon. He flexed the left hip joint with the knee flexed. What structure normally limits the flexion of this joint with the knee flexed?
- The hamstring muscles
  - The iliofemoral ligament
  - The adductor magnus muscle
  - The anterior abdominal wall
  - The ischiofemoral ligament
20. A physician's assistant asked a patient to walk up and down the examining room so that she might study his gait. Which of the following muscles plays an important role in lifting the left foot off the ground while walking?
- The left gluteus medius muscle
  - The left gluteus maximus muscle
  - The right adductor longus muscle
  - The right gluteus medius muscle
  - None of the above

## Answers and Explanations

- D** is the correct answer. The patellar tendon reflex (knee jerk) involves L2, 3, and 4 segments of the spinal cord.
- B** is the correct answer. The wrist joint is not diseased. This patient has traumatic tenosynovitis of the long tendons of the extensor digitorum muscle.
- C** is the correct answer. The spinal part of the accessory nerve, which supplies the sternocleidomastoid and the trapezius muscles, lies superficial to the levator

scapulae muscle as it crosses the posterior triangle of the neck (see text Fig. 13-9).

- B** is the correct answer. A blunt object forcibly striking the head often splits the epicranial aponeurosis against the underlying skull, causing the skin wound to gape open as if incised by a knife.
- A** is the correct answer. A lumbar puncture (spinal tap) is not required in cases of simple trauma to the back.

6. **C** is the correct answer. On the anterior axillary line (a line extending vertically downward from the lower border of the pectoralis major muscle) at the level of the upper border of the sixth rib, the needle would pierce the skin, fascia, the serratus anterior muscle, the external intercostal muscle, the internal intercostal muscle, the innermost intercostal muscle, and the parietal pleura (see text Fig. 3-4).
7. **E** is the correct answer. The conjoint tendon, formed by the fusion of the tendons of the internal oblique and transversus abdominis muscles, greatly strengthens the posterior wall of the inguinal canal. A weakness of the conjoint tendon and the lower abdominal musculature was responsible for the bulge, which constitutes a direct inguinal hernia.
8. **A** is the correct answer. The neck of the femoral hernial sac is situated below and lateral to the pubic tubercle (see CD Fig. 13-10).
9. A sudden unexpected blow on the anterior abdominal wall causes excessive stretching of this structure. In this case the right inferior epigastric artery, which lies within the rectus sheath, was ruptured and the bleeding occurred into the sheath. If a person is expecting a blow, he or she automatically contracts his abdominal muscles and protects the underlying structures.
10. The patient had a tuberculous infection of the lumbar vertebral column with destruction of the bodies of the vertebrae, hence the kyphosis. The tuberculous pus extended laterally and to the right and entered the right psoas fascial sheath. From there, it extended downward into the thigh, producing a swelling above and below the inguinal ligament. Since the pus in each swelling was continuous, pressure could be transmitted from one swelling to the other (see CD Fig. 13-3).
11. The uterus is mainly supported by the tone of the levatores ani muscles. In addition, the ligaments of the visceral layer of pelvic fascia, namely, the transverse cervical, sacrocervical, and pubocervical ligaments, play an important role.
12. **E** is the correct answer. The median nerve occupies a small restricted space in the carpal (see CD Fig. 13-6).
13. This patient has a winged scapula caused by the paralysis of the serratus anterior muscle. The nerve supply to the serratus anterior muscle is the thoracodorsal nerve, a branch of the posterior cord of the brachial plexus. Sometimes during a radical mastectomy operation, which involves the clearing out of the lymph nodes and fat in the axilla, the nerve is sacrificed since it may be involved in malignant disease (see text Fig. 13-23).
14. This patient had supraspinatus tendinitis. During the middle range of abduction, the tendon of the supraspinatus impinges against the outer border of the acromion. Normally, the larger subacromial bursa intervenes and ensures that the movement is relatively free of friction and is painless. In this condition, the bursa has degenerated and the supraspinatus tendon exhibits a localized area of collagen degeneration (see CD Fig. 13-5).
15. **B** is the correct answer. The distal end of the palmar aponeurosis gives rise to four slips, which pass to the four medial fingers (see CD Fig. 13-9).
16. **C** is the correct answer. The Achilles tendon is inserted into the posterior surface of the calcaneum (see text Fig. 13-55).
17. **A** is the correct answer. The gastrocnemius muscle is responsible for the backward rotation of the distal fragment of the fractured femur.
18. **C** is the correct answer. The peroneus longus everts the foot.
19. **D** is the correct answer. Flexion of the hip joint (with the knee flexed) is limited by the thigh coming in contact with the anterior abdominal wall.
20. **D** is the correct answer. The right gluteus medius and the right gluteus minimus tilt the pelvis so that the left lower limb is raised, thus permitting the left foot to be advanced forward clear of the ground.

