Muscles of the Upper Limb

Muscles of the upper limb (extremity) are amazingly diverse in form and function. Some span large areas while others are quite small. The actions of these muscles are complex because many muscles cross more than one joint and therefore contraction can move one bone or the other or perhaps both bones at once. Therefore many muscles may work together to stabilize one bone to provide a large variety of individual movements or combined movements. The shoulder is flexible, being attached by a bony girdle and supported mainly by muscle. This allows the arm and hand a huge range of motion required for activities such as throwing a baseball. This to some degree compromises the strength of the shoulder (versus other joints such as the hip). However, the shoulder is still quite strong and provides the stability required for lifting heavy objects while moving at the same time.

EXHIBIT 13.1 Muscles of the Thorax (Chest) That Move the Pectoral Girdle (Clavicle and Scapula)

**OBJECTIVE**

- Describe the origin, insertion, action, and innervation of the muscles that move the pectoral girdle.

Muscles of the upper limb are arranged in diverse groups: muscles are superficial, deep, or very deep. Four muscles, the pectoralis major, deltoid, trapezius, and latissimus dorsi muscles, are not only superficial but also have a large surface area and dominate the superficial musculature of the shoulder region. The concept of reverse muscle action (RMA), described previously in Section XX.X, is well illustrated in particular muscles of the upper limb and will be described in this chapter.

The main action of the muscles that move the pectoral girdle is to stabilize the scapula so it can function as a steady origin for most of the muscles that move the humerus. Because scapular movements usually accompany humeral movements in the same direction, the muscles also move the scapula to increase the range of motion of the humerus. For example, it would not be possible to raise the arm above the head if the scapula did not move with the humerus. During abduction, the scapula follows the humerus by rotating upward.

Muscles that move the pectoral girdle can be classified into two groups based on their location in the thorax: anterior and posterior thoracic muscles (Figure 13.1). The anterior thoracic muscles are the subclavius, pectoralis minor, and serratus anterior. The subclavius is a small, cylindrical muscle under the clavicle that extends from the clavicle to the first rib. It steadies the clavicle during movements of the pectoral girdle. It also helps hold the only bony articulation of the upper limb with the axial skeleton (the sternoclavicular joint) when, for example, hanging from a bar.

The pectoralis minor is a thin, flat, triangular muscle that is deep to ribs 1–8. Vertebral border and Abducts scapula and rotates it Dorsal scapular nerve.

**MUSCLE ORIGIN INSERTION ACTION INNERNATION**

| Subclavius | First rib. | Clavicle | Depresses and moves clavicle anteriorly (protraction) and helps stabilize pectoral girdle. | Subclavian nerve. |
| Pectoralis major | Usually ribs 3–5. | Convoluted process of scapula. | Abduces scapula and rotates it downward. RMA: Elevates third through fifth ribs during forced inhalation when scapula is fixed. | Medial pectoral nerve. |
| Serratus anterior | Usually ribs 1–8. | Ventral border and inferior angle of anterior surface of scapula. | Abduces scapula and rotates it upward. RMA: Elevates ribs when scapula is stabilized; known as “boxer’s muscle” because it is important in horizontal arm movements such as punching and pushing. | Long thoracic nerve. |

### POSTERIOR THORACIC MUSCLES

| Rhomboid major | Superior nuchal line of occipital bone, ligamentum nuchae, and spines of C7–T12. | Clavicle and acromion and spine of scapula. | Superior fibers elevate scapula; middle fibers adduct scapula; inferior fibers depress scapula; superior and inferior fibers together rotate scapula upward; stabilizes scapula. RMA. Superior fibers can help extend head. | Accessory (XI) nerve and cervical spinal nerves C5–C6. |

### ANTERIOR THORACIC MUSCLES

| Serratus anterior | | | | |
| Rhomboids | | | | |
| Rhomboid major | Superior nuchal line of occipital bone, ligamentum nuchae, and spines of C7–T12. | Clavicle and acromion and spine of scapula. | Superior fibers elevate scapula; middle fibers adduct scapula; inferior fibers depress scapula; superior and inferior fibers together rotate scapula upward; stabilizes scapula. RMA. Superior fibers can help extend head. | Accessory (XI) nerve and cervical spinal nerves C5–C6. |

CONTENTS AT A GLANCE

- Muscles of the upper limb (extremity) are amazingly diverse in form and function.
- Some muscles span large areas while others are quite small.
- The actions of these muscles are complex because many muscles cross more than one joint and therefore contraction can move one bone or the other or perhaps both bones at once.
- Therefore, many muscles may work together to stabilize one bone to provide a large variety of individual movements.
- The shoulder is flexible, being attached by a bony girdle and supported mainly by muscle. This allows the arm and hand a huge range of motion.
- The main action of the muscles that move the pectoral girdle is to stabilize the scapula so it can function as a steady origin for most of the muscles that move the humerus.
- The subclavius is a small, cylindrical muscle that extends from the clavicle to the first rib.
- The pectoralis minor is a thin, flat, triangular muscle that is deep to ribs 1–8.
- The EXHIBITS (13.1–13.5) illustrate the origin, insertion, action, and innervation of the muscles that move the pectoral girdle.

EXHIBIT 13.1

Muscles of the upper limb are arranged in diverse groups: muscles are superficial, deep, or very deep. Four muscles, the pectoralis major, deltoid, trapezius, and latissimus dorsi muscles, are not only superficial but also have a large surface area and dominate the superficial musculature of the shoulder region. The concept of reverse muscle action (RMA), described previously in Section XX.X, is well illustrated in particular muscles of the upper limb and will be described in this chapter.

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The pectoralis minor is a thin, flat, triangular muscle that is deep to ribs 1–8. Vertebral border and Abducts scapula and rotates it Medial pectoral nerve. Long thoracic nerve.

### POSTERIOR THORACIC MUSCLES

- Rhomboid major: Superior nuchal line of occipital bone, ligamentum nuchae, and spines of C7–T12.
- Rhomboid minor: Spines of T7–T11.

### ANTERIOR THORACIC MUSCLES

- Serratus anterior: Spine of T2–T5.
- Rhomboids: Spine of T7–T11.

CONTENTS AT A GLANCE

- Muscles of the upper limb (extremity) are amazingly diverse in form and function.
- Some muscles span large areas while others are quite small.
- The actions of these muscles are complex because many muscles cross more than one joint and therefore contraction can move one bone or the other or perhaps both bones at once.
- Therefore, many muscles may work together to stabilize one bone to provide a large variety of individual movements.
- The shoulder is flexible, being attached by a bony girdle and supported mainly by muscle. This allows the arm and hand a huge range of motion.
- The main action of the muscles that move the pectoral girdle is to stabilize the scapula so it can function as a steady origin for most of the muscles that move the humerus. Because scapular movements usually accompany humeral movements in the same direction, the muscles also move the scapula to increase the range of motion of the humerus. For example, it would not be possible to raise the arm above the head if the scapula did not move with the humerus. During abduction, the scapula follows the humerus by rotating upward.

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### POSTERIOR THORACIC MUSCLES

- Rhomboid major: Superior nuchal line of occipital bone, ligamentum nuchae, and spines of C7–T12.
- Rhomboid minor: Spines of T7–T11.

### ANTERIOR THORACIC MUSCLES

- Serratus anterior: Spine of T2–T5.
Muscles of the Thorax (Chest) That Move the Pectoral Girdle (Clavicle and Scapula) CONTINUED

XX.XX, contracted muscles become shorter and wider. Moreover, the brachial plexus runs between the pectoralis minor and the rib cage. Chronic contraction of this muscle can thus compress nerves and emulate the symptoms of carpal tunnel syndrome (see Exhibit 13.3). Besides its role in movements of the scapula, the pectoralis minor muscle assists in forced inhalation.

The serratus anterior is a large, flat, fan-shaped muscle between the ribs and scapula. It is so named because of the saw-toothed appearance of its origins on the ribs. This muscle can be highly developed in body builders and athletes (Figure 13.1a–d). It is an antagonist of the rhomboids and is responsible for abduction of the scapula. A large portion of the belly is deep to the anterior scapula. The muscle is thus riding over the rib cage. The production of hydrogen bonds during the aging process, as discussed in Section XX.X, often causes the serratus anterior of elderly persons to become “cemented” between the rib cage and the scapula. Range of motion of the scapula is thus often greatly reduced as the aging process continues. The lateral and inferior portion of the breast lies superficial to the serratus anterior muscle.

The posterior thoracic muscles are the trapezius, levator scapulae, rhomboid major, and rhomboid minor. The trapezius is a large, flat, triangular sheet of muscle extending from the skull and vertebral column medially to the pectoral girdle laterally. It is the most superficial back muscle and covers the posterior neck region and superior portion of the trunk. The two trapezius muscles form a trapezoid (diamond-shaped quadrangle), hence its name. Discounting body builders and professional athletes, the trapezius muscle of most persons is less than 0.25 in. thick. The three sets of fibers (superior, middle, and inferior) enable this muscle to cause multiple actions.

The levator scapulae is a narrow, elongated muscle in the posterior portion of the neck. It is deep to the sternocleidomastoid and trapezoid muscles. This muscle contains a twist in the belly (Figure 13.1d). The twist inverts the superior and inferior fibers as they approach the insertion and increases the leverage of each fiber. The fibers become un-twisted and stretched as a bone is moved away from the anatomical or neutral position. A muscle that is twisted has the ability to contract with greater force. The insertion is on and near the superior angle of the scapula and pain of the muscle is usually perceived here. The origin, however, goes as high as the atlas, and therefore the belly is longer than one might think. As its name suggests, one of its actions is to elevate the scapula. Its reverse muscle action (RMA), when the origin and insertion are switched, is to pull posteriorly on (extend) the neck, particularly when the person has a head-forward posture, as demonstrated in Figure 13.2. Normal alignment of the body includes positioning of the external auditory meatus directly superior to the acromion process of the scapula. As discussed in Chapter 10, chronic shortening of any muscle can reset the tone of the muscle spindles, and the muscle can therefore develop a compromised blood supply and become painful.

What is the main action of the muscles that move the pectoral girdle?
EXHIBIT 13.1
Muscles of the Thorax (Chest) That Move the Pectoral Girdle (Clavicle and Scapula) CONTINUED

Person who wish to have both hands free and hold a telephone cradle by elevating the shoulder are also likely to develop a chronically short- ened levator scapulae muscle and thus experience pain near the super ior angle of the scapula and an inability to fully turn their neck when checking the blind spot while driving.

The rhomboid major and rhomboid minor lie deep to the trapezius and are not always distinct from each other (Figure 13.1). They appear as parallel bands that pass inferiorly and laterally from the verte brae to the scapula. Their names are based on their shape, that is, a rhomboid (an oblique parallelogram). The rhomboid major is about two times wider than the rhomboid minor. The two muscles are often iden tified by their attachments. The muscles lie deep to the trapezius and functionally are the only muscles holding the upper limb to the posterior axial skeleton. The rhomboids are usually very thin and are easily over worked by lifting or repetitive movements of the upper limbs; thus pain and a burning sensation between the shoulder blades is common for many people. Both muscles are used when forcibly lowering the raised upper limbs, as in driving a stake with a sledgehammer. Emotional stresses can also cause spasm of the rhomboids in many people. Manual therapists who develop pain in the rhomboids sometimes back up to a corner of a refrigerator or a wall and lean themselves backward such that the corner presses into the rhomboids and helps to relieve the pain.

 Movements of the Scapula
To understand the actions of muscles that move the scapula, it is first helpful to review the various movements of the scapula:

• Elevation: Superior movement of the scapula, such as shrugging the shoulders or lifting a weight over the head.
• Depression: Inferior movement of the scapula, as in pulling down on a rope attached to a pulley.
• Abduction (protraction): Movement of the scapula laterally and anteriorly, as in doing a push-up or punching.
• Adduction (retraction): Movement of the scapula medially and posteriorly, as in pulling the arm in a rowboat.
• Upward rotation: Movement of the inferior angle of the scapula laterally so that the glenoid cavity is moved upward. This movement is required to move the humerus past the horizontal as in raising the arms in a jumping jack.
• Downward rotation: Movement of the inferior angle of the scapula medially so that the glenoid cavity is moved downward. This movement is seen when a gymnast on parallel bars supports the weight of the body on the hands.

Relating Muscles to Movements
Arrange the muscles in this exhibit according to the following actions on the scapula: (1) depression, (2) elevation, (3) abduction, (4) adduction, (5) upward rotation, and (6) downward rotation. The same muscle may be mentioned more than once.

MANUAL THERAPY APPLICATION
Structural and Functional Analysis
Structural analysis includes visual and palpatory assessment of a patient while he is sitting, standing, or lying without movement. For example, a manual therapist might position herself behind the patient who is standing and observe the heights of the two scapulae. If the heights are different, the therapist would attempt to determine what would contribute to a height discrepancy. Pain in the shoulder region or the back may result from such misalignments of the skeleton.

Functional analysis includes palpating the structure during motion to assess the functioning of the involved musculature and joints. For example, a manual therapist might stand behind the patient who is standing and ask her to place her hands (palms out) on her lower back. The manual therapist would observe the movement of the scapulae as symmetry of motion. If one scapula is “winged out,” meaning that the medial edge of the scapula has moved posteriorly and is no longer near the rib cage, the therapist might conclude that the action may have been the result of a whiplash injury in the past. The serratus anterior muscle helps hold the scapula against the rib cage and is innervated by the long thoracic nerve that arises from spinal nerves C5-C7. A whiplash injury involving this part of the cervical region may compromise this nerve and reduce the strength of the serratus anterior muscle, thus causing the winged appearance of the scapula. Such an injury would be confirmed by, or added to, the written history of the patient. It should be noted that during the intake history, many patients inadvertently forget to mention such injuries, which could have occurred years ago.

CHECKPOINT
What muscles in this exhibit are used to raise your shoulders, lower your shoulders, join your hands behind your back, and join your hands in front of your chest?

EXHIBIT 13.2
Muscles of the Thorax (Chest) and Shoulder That Move the Humerus (Arm Bone)

OBJECTIVE
• Describe the origin, insertion, action, and innervation of the muscles that move the humerus.

Of the nine muscles that cross the shoulder joint, all except the pectoralis major and latissimus dorsi originate on the scapula. The pectoral muscles and latissimus dorsi will be discussed in the next section. The deltoid (which arises from the scapula) is innervated by the axillary nerves because they originate on the axilla skeleton. The remaining seven muscles, the scapular muscles, arise from the scapula (see Exhibit 13.1). Of the two axillary muscles that move the humerus, the pectoralis major is a large, thick, fan-shaped muscle that covers the superior part of the thorax and forms the anterior fold of the axilla. When this muscle and the latissimus dorsi are well developed, the axilla is deeper. By placing the thumb in the axilla of the patient, manual therapists are able to place the fingers on the belly of the muscle and thus massage both surfaces simultaneously. The pectoralis major has a twist in it that improves its contraction strength; the clavicular head inserts more distally and the sternocostal head inserts more proximally.

The latissimus dorsi is a broad, triangular muscle located on the inferior part of the back (Figure 13.2a–c). The muscle forms most of the posterior wall of the axilla. The reverse muscle action (RMA) of the latissimus dorsi enables the spine and torso to be elevated. It is commonly called the “swimmer’s muscle” because its many actions are used while swimming; consequently, many competitive swimmers have well-developed “lats.” These movements are seen in a paraplegic when transferring from a wheelchair. Similarly, if the arm is stabilized, as when hanging from a bar, latissimus dorsi will assist in extension of the spine. Like the pectorals major and levator scapulae muscles, latissimus dorsi has a twist in it near the insertion that increases its contraction effectiveness.

Among the scapular muscles, the deltoid is a thick, powerful shoul der muscle that covers the shoulder joint and forms the rounded con tour of the shoulder. This muscle is a frequent site of intramuscular inj ections. As you study the deltoid, note that its fascicles originate from three different points and that each group of fascicles moves the humerus differently. These points of insertion are the clavicular, acromial, and spinous of the scapula (Figure 13.2a–b); they are the same three points as the insertions of the trapezius. The muscle has three sets of fibers (anterior, middle, and posterior) that enable it to function as three distinct muscles that are used in flexion, abduction, rotation, or extension of the humerus; see the photo of the arm that shows the deltoid in Figure 13.2a.

The subscapularis is a large triangular muscle that fills the sub scapular fossa of the scapula and forms a small part in the apex of the posterior wall of the axilla (see Figure 13.2b). The subscapularis, a rounded muscle named for its location in the supraspinous fossa of the scapula, lies deep to the trapezius and has a belly that is about the size of your thumb (Figure 13.2c–e). The tendon of insertion slides back over the supraglenoid tubercle of the greater tuberosity of the humerus, just anterior to the glenohumeral joint. The fibers are arranged so that they hold the head of the humerus in the glenoid fossa and stabilize the shoulder joint. The subscapularis is innervated by the thoracodorsal nerve, which supplies the latissimus dorsi muscle. The subscapularis is an important muscle for preventing glenohumeral joint instability. When the subscapularis is weak or paralyzed, the shoulder joint is at risk for dislocation.
The infraspinatus is a triangular muscle, also named for its location in the infraspinous fossa of the scapula. A portion of the muscle is superficial and other portions are deep to the trapezius and to the deltoid (see Figure 13.4c). Thick fascial layers cause the infraspinatus to feel more dense than surrounding muscles on palpation. This muscle often develops trigger points (knots) in the muscle or adheres to the glenohumeral joint capsule and results in a condition called adhesive capsulitis, which limits movement of the arm dramatically.

The teres major is a thick, flattened muscle inferior to the teres minor that also helps form part of the posterior wall of the axilla. It is also a synergist of the latissimus dorsi (Figure 13.4a). The two muscles have been called the “handcuff muscles” since their combined actions are to bring the arms into position behind the back. The teres major rotates the arm medially and the teres minor rotates it laterally.

The teres minor is a small, cylindrical, elongated muscle, located between the teres major and the infraspinatus muscles (Figure 13.4c). Its belly lies parallel to the inferior edge of the infraspinatus and is sometimes indistinguishable from the infraspinatus.

The coracobrachialis is an elongated, narrow muscle in the arm, located in the lateral wall of the axilla along with the biceps brachii (Figure 13.4c). Its point of origin, the coracoid process of the scapula, in many people is tender on palpation. Since three muscles are attached here, tenderness at the site implies a problem with one or more of these muscles: the coracobrachialis, pectoralis minor, or biceps brachii muscles.

Four deep muscles of the shoulder—supraspinatus, infraspinatus, teres minor, and subscapularis—strengthens and stabilizes the shoulder joint. These muscles join the scapula to the humerus. Their flat tendons fuse to—

EXHIBIT 13.2

Muscles of the Thorax (Chest) and Shoulder That Move the Humerus (Arm Bone) CONTINUED

The strength and stability of the shoulder joint are provided by the tendons that form the rotator cuff.

Which of the rotator cuff muscles inserts on the anterior humerus?
gather to form the rotator (musculotendinous) cuff, a nearly complete circle of tendons around the shoulder joint, like the cuff on a shirt sleeve. The four rotator cuff muscles are often described as the “SITS” muscles and this could serve as a mnemonic for remembering the names.

The supraspinatus muscle is especially subject to wear and tear because of its location between the head of the humerus and acromion of the scapula, which compresses its tendon during shoulder movements, especially abduction of the arm. This is further aggravated by poor posture with slouched shoulders and medially rotated shoulders that also increase compression of the supraspinatus tendon.

The subscapularis is the only rotator cuff muscle that attaches to the lesser tubercle of the humerus, the other three attach to the greater tubercle. Sandwiched between the supraspinatus anterior and subscapular fossa (on the anterior scapula), the subscapularis is difficult to access in many patients (Figure 13.4a-d). When the therapist places the fingers of one hand on the inferior vertebral border of the scapula, the other hand can pull the patient’s shoulder over the fingers. This technique can be used to stretch some of the fibers of the trapezius, the rhomboids, the serratus anterior, and the subscapularis simultaneously. As described in Section 10.X, hydrogen bonds within connective tissues commonly increase in number during the aging process and, with the lack of aerobic exercise, reduce the flexibility of the scapula.

Inferior angle of scapula. Medial lip of Extends arm at shoulder joint and Lower subscapular

### MUSCLE ORIGIN INSERTION ACTION INNERVATION

**AXIAL MUSCLES THAT MOVE THE HUMERUS**

- Pectineus major (part of internal oblique; pectineus = pectinate major = larger) (see also Figure 13.7-1)
- Latissimus dorsi (lata = wide; dorso = back)

**SCAPULAR MUSCLES THAT MOVE THE HUMERUS**

- Deltoideus (DEL-toy-dee-us) ( deltoid = triangular shaped)
- Subscapularis (sub-scap = under; scap = scapula)
- Supraspinatus (supra = above; spin = spine; supraspin = superior to spine of the scapula)
- Infraspinatus (infra = below; spin = spine; infraspin = inferior to spine of the scapula)
- Teres major (Tere = Teres; major = larger)
- Teres minor (Tere = Teres; minor = smaller)
- Coracobrachialis (kor = coraco-brachialis; coraco = coracoid process of the scapula; brachio = arm)

**EXHIBIT 13.2**

**EXHIBIT 13.2**

Muscles of the Thorax (Chest) and Shoulder That Move the Humerus (Arm Bone) CONTINUED

**Surface Features of the Back**

In addition to the muscles that we’ve discussed in detail, there are several other superficial bones and muscles that form the feature of the back (Figure 13.5).

- **Vertebral spines.** The spinous processes of vertebrae, especially the thoracic and lumbar vertebrae, are quite prominent when the vertebral column is flexed.
- **Scapulae.** These easily identifiable surface landmarks on the back

**Figure 13.5** Surface anatomy of the back. (G) The posterior boundary of the axilla, the posterior axillary fold, is formed mainly by the latissimus dorsi and teres major muscles.
lie between ribs 2 and 7. In fact, it is also possible to palpate some ribs on the back. Depending on how lean a person is, it might be possible to palpate various parts of the scapula, such as the vertebral border, axillary border, inferior angle, spine, and acromion. The spinous process of T3 is at about the same level as the spine of the scapula, and the spinous process of T7 is approximately opposite the inferior angle of the scapula.

- **Erector spinae (sacrospinalis) muscle.** Located on either side of the vertebral column between the skull and iliac crests.

- **Posterior axillary fold.** Formed by the latissimus dorsi and teres major muscles, the posterior axillary fold can be palpated between the fingers and thumb at the posterior aspect of the axilla (armpit region); forms the posterior wall of the axilla.

- **Triangle of auscultation** (au-skul-TAH-shun; listen-ing). A triangular region of the back just medial to the inferior part of the scapula, where the rib cage is not covered by superficial muscles. It is bounded by the latissimus dorsi and trapezius muscles and vertebral border of the scapula. The triangle of auscultation is a landmark of clinical significance because in this area respiratory sounds can be heard clearly through a stethoscope pressed against the skin. If a patient folds the arms across the chest and bends forward, the lung sounds can be heard clearly in the intercostals space between ribs 6 and 7.

### Relating Muscles to Movements

Arrange the muscles in this exhibit according to the following actions on the humerus at the shoulder joint: (1) flexion, (2) extension, (3) abduction, (4) adduction, (5) medial rotation, and (6) lateral rotation. The same muscle may be mentioned more than once.

### CHECKPOINT

Why are the two muscles that cross the shoulder joint called axial muscles, and the seven others called scapular muscles?

Most of the muscles that move the radius and ulna (forearm bones) cause flexion and extension at the elbow, which is a hinge joint. The biceps brachii, brachialis, and brachioradialis muscles are the flexor muscles. The extensor muscles are the triceps brachii and the anconeus (Figure 13.6b).

The **biceps brachii** is the large muscle located on the anterior surface of the arm. As indicated by its name, it has two heads of origin (long and short), both from the scapula. The muscle spans both the shoulder and elbow joints. In addition to its role in flexing the forearm at the elbow joint, it also supinates the forearm at the radioulnar joints and flexes the arm at the shoulder joint. The tendon of the distal muscle attaches to the radius and also becomes aponeurotic (meaning that the cross-sectional view changes from round to a flat, sheetlike aponeurosis) on the surface of the muscles of the forearm. The bicipital aponeurosis covers and helps protect the median nerve and the brachial artery. This aponeurotic sheet of fascia also tends to support a vein (see Chapter 23) by forming a sturdy platform, and the connective tissue fibers of the aponeurosis keep the vein from rolling. This site is thus a favorite of health-care professionals who wish to insert a needle into a vein for either withdrawal of blood or injection of medication.

- **CHECKPOINT**

Why are the two muscles that cross the shoulder joint called axial muscles, and the seven others called scapular muscles?

- **OBJECTIVE**

Describe the origin, insertion, action, and innervation of the muscles that move the radius and ulna.

Figure 13.6 Muscles of the arm that move the radius and ulna (forearm bones).

- **(a) Anterior view**

  - Clavicle
  - Acromion of scapula
  - Coracoid process of scapula
  - Humerus
  - Tendon of latissimus dorsi (cut)
  - Tendon of pectoralis major (cut)
  - Deltoid (cut)
  - **BICEPS BRACHII:**
    - SHORT HEAD
    - LONG HEAD
  - **TRICEPS**: BRACHII
  - **LATERAL HEAD**
  - **MEDIAL HEAD**
  - **BRACHIALIS**
  - **ANCONUS**
  - **Radius**
  - **Bicipital aponeurosis**
  - **Scapula**
  - **Humerus**
  - **Ribs**
  - **Teres major**

- **(b) Posterior view**

  - **Clavicle**
  - **Coracoid process of scapula**
  - **Humerus**
  - **Tendon of latissimus dorsi (cut)**
  - **Tendon of pectoralis major (cut)**
  - **Deltoid (cut)**
  - **BICEPS BRACHII:**
    - **LONG HEAD**
    - **SHORT HEAD**
  - **TRICEPS**: BRACHII
  - **LATERAL HEAD**
  - **MEDIAL HEAD**
  - **BRACHIALIS**
  - **ANCONUS**
  - **Radius**
  - **Bicipital aponeurosis**
  - **Scapula**
  - **Humerus**
  - **Ribs**
  - **Teres major**

Most of the muscles that move the radius and ulna (forearm bones) cause flexion and extension at the elbow, which is a hinge joint. The biceps brachii, brachialis, and brachioradialis muscles are the flexor muscles. The extensor muscles are the triceps brachii and the anconeus (Figure 13.6b). The biceps brachii is the large muscle located on the anterior surface of the arm. As indicated by its name, it has two heads of origin (long and short), both from the scapula. The muscle spans both the shoulder and elbow joints. In addition to its role in flexing the forearm at the elbow joint, it also supinates the forearm at the radioulnar joints and flexes the arm at the shoulder joint. The tendon of the distal muscle attaches to the radius and also becomes aponeurotic (meaning that the cross-sectional view changes from round to a flat, sheetlike aponeurosis) on the surface of the muscles of the forearm. The bicipital aponeurosis covers and helps protect the median nerve and the brachial artery. This aponeurotic sheet of fascia also tends to support a vein (see Chapter 23) by forming a sturdy platform, and the connective tissue fibers of the aponeurosis keep the vein from rolling. This site is thus a favorite of health-care professionals who wish to insert a needle into a vein for either withdrawal of blood or injection of medication. Since the biceps brachii is the primary supinator of the forearm, the belly is shorter and thicker when the forearm is supinated. Even children, when showing off their muscles, usually use this pose. Look at your biceps brachii muscle when the shoulder and elbow joints are flexed and when the forearm is pronated and then supinated. The brachialis is deep to the biceps brachii muscle. It is the most powerful flexor of the forearm at the elbow joint. For this reason, it is called the “workhorse” of the elbow flexors. Its thick belly is wider than that of biceps brachii (Figure 13.6a). Sandwiched between the biceps brachii and triceps brachii, the lateral edge of the brachialis is usually distinguishable on palpation of the lateral arm.
The brachioradialis muscle is located in the proximal half of the forearm (Figure 13.6g, 13.8a,h). It is deep to the forearm extensor muscles. The long head crosses the shoulder joint between the teres major and teres minor, the other heads do not. The anconeus is a small muscle located in the posterior compartment of the forearm that assists the triceps brachii in extending the forearm at the elbow joint (Figure 13.6h).

Some muscles that move the radius and ulna are involved in pronation and supination at the radioulnar joints. The pronators, as suggested by their names, are the pronator teres and pronator quadratus muscles. Pronator teres (Figure 13.6i, 13.8a) is located in the proximal forearm between the brachioradialis and the forearm flexor muscles. In this region of the upper limb, it is the only muscle with obliquely running fibers. If this muscle impinges on the median nerve that runs deep to it, the patient may experience pronator teres syndrome. When these patients are asked to make a fist, they are able to flex only the fourth and fifth digits.

The pronator quadratus is flat and four-sided (quadratus); its fibers run transversely, at right angles to the radius and ulna. It is located in the distal forearm and is synergistic to the pronator teres. Both of the pronator muscles cause the radius to cross the ulna in the act of pronation of the forearm.

The supinator of the forearm is aptly named the supinator muscle (Figure 13.6f, 13.8b,c). Its thin muscle belly lies lateral to the elbow joint and is deep to the forearm extensor muscles. The supinator is antagonistic to both of the pronator muscles and pulls the radius into the anatomical position from pronation. You use the powerful action of the supinator when you twist a corkscrew or turn a screw with a screwdriver.

**Surface Features of the Arm Pit**

The armpit region, or axilla, is a pyramid-shaped area at the junction of the arm and the chest that enables blood vessels and nerves to pass between the neck and the free upper limbs (Figure 13.7a). In the limbs, functionally related skeletal muscles and their associated blood vessels and nerves are grouped together by fascia into regions called compartments (Figure 13.6c). In the arm, the biceps brachii, brachialis, and coracobrachialis muscles make up the anterior (flexor) compartment. The triceps brachii muscle forms the posterior (extensor) compartment.

**EXHIBIT 13.3**

**Muscles of the Arm That Move the Radius and Ulna (Forearm Bones) CONTINUED**

The triceps brachii muscle forms the is a pyramid-shaped area at the junction of muscle The anterior axillary fold. is flat and four-sided (continued) EXHIBIT 13.3
Which muscles are the most powerful flexor and the most powerful extensor of the forearm?
The median cubital vein is frequently used to withdraw blood from a vein for diagnostic purposes or to introduce substances into blood, such as medications, contrast media for radiographic procedures, nutrients, and blood cells and/or plasma for transfusion.

• Brachial artery. Continuation of the axillary artery that passes posterior to the coracobrachialis muscle and then medial to the biceps brachii muscle. It enters the middle of the cubital fossa and passes deep to the bicipital aponeurosis, which separates it from the median cubital vein. Blood pressure is usually measured in the brachial artery, when the cuff of a sphygmomanometer (blood pressure instrument) is wrapped around the arm and a stethoscope is placed over the brachial artery in the cubital fossa. Pulse can also be detected in the artery in the cubital fossa. However, blood pressure can be measured at any artery where you can obstruct blood flow. This becomes important in case the brachial artery cannot be utilized. In such situations, the radial or popliteal arteries might be used to obtain a blood pressure reading.

• Bicipital aponeurosis. An aponeurosis that inserts the biceps brachii muscle into the deep fascia in the medial aspect of the forearm. It also helps to protect the median nerve and brachial artery.

The location of the muscles that form the walls of the axilla are shown in figure 13.4.

**MANUAL THERAPY APPLICATION**

Tenosynovitis

Tenosynovitis (ten-o-sin-oh-vi-tis) is an inflammation of the tendons, tendon sheaths, and synovial membranes surrounding certain joints. The tendons most often affected are at the wrists, shoulders, elbows, finger joints, ankles, and feet. The affected tendons sometimes become visibly swollen because of fluid accumulation. Tenderness and pain are frequently associated with movement of the body part. The condition often follows trauma, strain, excessive exercise, or other stressors. For example, tenosynovitis of the dorsum of the foot may also be caused by tying shoes too tightly. Gymnasts are prone to developing the condition as a result of chronic, repetitive, and maximum hyperextension at the wrist. Other repetitive movements involving activities such as typing, haircutting, carpentry, and assembly line work can also result in tenosynovitis. Manual therapy procedures can reduce swelling by moving various blood through the affected area and can also enhance arterial blood flow that will facilitate healing.

Relating Muscles to Movements

Arrange the muscles in this exhibit according to the following actions on the elbow joint: (1) flexion and (2) extension; the following actions on the forearm at the radioulnar joints: (1) supination and (2) pronation; and the following actions on the humerus at the shoulder joint: (1) flexion and (2) extension. The same muscle may be mentioned more than once.
MUSCLE ORIGIN INSERTION ACTION INNERVATION

SUPERFICIAL ANTERIOR (FLEXOR) COMPARTMENT OF THE FOREARM

Flexor carpi radialis (MED-sup-rect-base of ulna; flexor = ex- = muscles of the hand (ex = outside))
- Medial epicondyle of humerus
- Second and third metacarpals
- Flexes and abducts hand (radial deviation) at wrist joint
- Median nerve

Palmaris longus
- Medial epicondyle of humerus
- Palmar aponeurosis (fascia in center of palm)
- Weakly flexes hand at wrist joint
- Median nerve

Flexor carpi ulnaris (ul-nar-is = ulna)
- Medical epicondyle of humerus and superior posterior border of ulna
- Flexes and adducts hand (ulnar deviation) at wrist joint
- Ulnar nerve

Deep posterior (extensor) compartment

Abductor pollicis longus
- Base of distal phalanx of thumb
- Flexes distal phalanx of thumb at interphalangeal joint
- First metacarpal

Extensor pollicis brevis
- Base of proximal phalanx of thumb
- Extended proximal phalanx of thumb at interphalangeal joint

Extensor pollicis longus
- Base of distal phalanx of thumb
- Extended distal phalanx of thumb at interphalangeal joint

Extensor indicis
- Posterolateral surface of ulna and interosseous membrane
- Extended proximal phalanx of index finger at interphalangeal joint

*Reminder: The thumb or pollex is the first digit and has two phalanges: proximal and distal. The remaining digits, the fingers, are numbered II–V (2–5), and each has three phalanges: proximal, middle, and distal.

EXHIBIT 13.4

MUSCLES OF THE FOREARM THAT MOVE THE WRIST, HAND, THUMB AND DIGITS

MUSCLE ORIGIN INSERTION ACTION INNERVATION

SUPERFICIAL POSTERIOR (EXTENSOR) COMPARTMENT OF THE FOREARM (CONTINUED)

Extensor digitorum
- Lateral epicondyle of humerus
- Dorsal and middle phalanges of each finger
- Extends distal and middle phalanges of each finger at interphalangeal joints, proximal phalanx of each finger at metacarpophalangeal joint, and hand at wrist joint
- Radial nerve

Extensor digiti minimi
- Lateral epicondyle of humerus
- Tendons of extensor digitorum on fifth phalanges
- Extends proximal phalanx of little finger at metacarpophalangeal joint and hand at wrist joint
- Deep radial nerve

Extensor carpi ulnaris
- Lateral epicondyle of humerus and posterior border of ulna
- Fifth metacarpal
- Extends and abducts hand at wrist joint (ulnar deviation)
- Deep radial nerve

DEEP POSTERIOR (EXTENSOR) COMPARTMENT OF THE FOREARM

Abductor pollicis longus (ab- = away; polli- = hand; longus = long)
- Posterolateral surface of ulna and interosseous membrane
- First metacarpal
- Extends and abducts thumb at carpometacarpal joint and abducts hand at wrist joint
- Deep radial nerve

Extensor pollicis brevis
- Posterolateral surface of ulna and interosseous membrane
- Base of proximal phalanx of thumb
- Extended proximal phalanx of thumb at interphalangeal joint
- Deep radial nerve

Extensor pollicis longus
- Posterolateral surface of ulna and interosseous membrane
- Base of distal phalanx of thumb
- Extended distal phalanx of thumb at interphalangeal joint
- Deep radial nerve

Extensor indicis
- Posterolateral surface of ulna and interosseous membrane
- Tendon of extensor digitorum of index finger
- Deep radial nerve

*Reminder: The thumb or pollex is the first digit and has two phalanges: proximal and distal. The remaining digits, the fingers, are numbered II–V (2–5), and each has three phalanges: proximal, middle, and distal.

EXHIBIT 13.4
tendons that insert into the middle and distal phalanges of the fingers), extensor digiti minimi (a slender muscle usually connected to the extensor digiti minimi), and the extensor carpi ulnaris.

The deep posterior compartment muscles are arranged in the following order from lateral to medial: abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus, and extensor indicis.

The tendons of the muscles of the forearm that attach to the wrist or continue into the hand, along with blood vessels and nerves, are held close to bones by strong fasciae. The tendons are also surrounded by tendon sheaths. At the wrist, the deep fascia is thickened into fibrous bands called retinacula (retinaculum = a holdfast). The flexor retinaculum is located over the palmar surface of the carpal bones. The long flexor tendons of the digits and wrist and the median nerve pass deep to the flexor retinaculum (Figure 13.9). The extensor retinaculum is located over the dorsal surface of the carpal bones. The extensor tendons of the wrist and digits pass deep to it.

**Figure 13.8** Muscles of the forearm that move the wrist, hand, thumb and digits.

(a) Anterior superficial view  
(b) Anterior intermediate view  
(c) Anterior deep view  
(d) Posterior superficial view  
(e) Posterior deep view

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**Figure 13.9** (Continued) The anterior compartment muscles function as flexors, adductors, and abductors. The posterior compartment muscles function as extensors, adductors, and abductors.
Which of the flexor muscles does not pass deep to the flexor retinaculum?
REpetitive Strain Injuries

Repetitive strain or motion injuries (RSIs) include a large number of conditions resulting from overuse of equipment, poor posture, poor body mechanics, or activity that requires repeated movements; for example, various conditions of assembly line workers. Examples of overuse of equipment include overuse of a computer, hammer, guitar, or piano, to name a few.

Tennis elbow can be caused by strain of the extensor muscles of the forearm. It is so named because a series of forceful backhand strokes in tennis can cause pain of the lateral elbow joint (lateral epicondylitis). The extensor muscles strain or sprain, resulting in pain. Tennis elbow can be caused by a sudden trauma or repetitive actions in many types of daily activities.

Little-league elbow typically develops as a result of a heavy pitching schedule and/or a schedule that involves throwing curve balls, especially among youngsters. In this disorder, the elbow may enlarge, fragment, or separate.

Golfer’s elbow can be caused by strain of the flexor muscles, especially flexor carpi radialis, as a result of repetitive movements such as swinging a golf club. Pain can occur, however, be caused by many actions. Pianists, violinists, movers, weight lifters, bikers, and those who use computers are among those who may develop pain near the medial epicondyle (medial epicondylitis).

Carpal tunnel pain is caused by compression of the median nerve. The carpal tunnel is a narrow passageway formed anteriorly by the flexor retinaculum and posteriorly by the carpal bones. Through this tunnel pass the median nerve, the most superficial structure, and the long flexor tendons for the digits (Figure 13.9). Structures within the carpal tunnel, especially the median nerve, are vulnerable to compression, and the resulting condition is known as carpal tunnel syndrome. The person may experience numbness, tingling, or pain of the wrist and hand. Compression within the tunnel usually results from inflamed and thickened tendon sheaths of flexor tendons, fluid retention, excessive exercise, infection, trauma, and/or repetitive activities that involve flexion of the wrist such as keyboarding, cutting hair, and playing a piano.

Treatment may be progressive if the problem worsens. Initial treatment may include aspirin or ibuprofen (both are anti-inflammatory drugs). Treatment may progress to an injection of cortisone into the carpal tunnel. Persons may be asked to keep the wrist straight to minimize movement of the inflamed tendon sheaths; some type of splint or brace may be prescribed. Continued pain may necessitate surgery to cut (release) the transverse carpal ligament and thus relieve the compression of the nerve. It should be noted that “carpal tunnel pain” can also be caused by compression of the median nerve in two areas of the shoulder. When this occurs, carpal tunnel surgery will not alleviate the pain. Furthermore, scar tissue formed after the surgery may exacerbate the problem. Nerve compression in the shoulder area is discussed in Chapter 16.

Compression of the median nerve can also occur between the anterior and middle scalenes (see Figure 13.3) or deep to the pectoralis minor (see Figure 12.X). Pain in the wrist or hand is perceived by the patient that is identical to the pain of true carpal tunnel syndrome. Compression of the scalene and pectoralis minor can usually lengthen these muscles and thereby reduce impingement on the median nerve. By lengthening these muscles, a manual therapist can usually determine within minutes whether the pain of the wrist and hand may be a function of the thoracic outlet.

| Exhibit 13.4 | Muscles of the Forearm That Move the Wrist, Hand, and Digits | CONTINUED | 360 |

What nerve may become compressed within the carpal tunnel?

| Exhibit 13.4 | Muscles of the Forearm That Move the Wrist, Hand, and Digits | CONTINUED | 361 |

What tendons form the boundaries of the “anatomical snuffbox?”

Relating Muscles to Movements

Arrange the muscles in this exhibit according to the following actions on the wrist joint: (1) flexion, (2) extension, (3) abduction, and (4) adduction; the following actions on the fingers at the metacarpophalangeal joints: (1) flexion and (2) extension; the following actions on the fingers at the interphalangeal joints: (1) flexion and (2) extension, the following actions on the thumb at the carpometacarpal, metacarpophalangeal, and interphalangeal joints: (1) extension and (2) abduction, and the following action on the thumb at the interphalangeal joint: flexion. The same muscle may be mentioned more than once.

CHECKPOINT

Which muscles and actions of the wrist, hand, and digits are used when writing?

Figure 13.10 Surface anatomy of the forearm and wrist.

Muscles of the forearm are most easily identified by locating their tendons near the wrist and tracing them proximally.
Muscles of the Palm That Move the Digits—Intrinsic Muscles of the Hand

OBJECTIVE
• Describe the origin, insertion, action, and innervation of the intrinsic muscles of the hand.

Several of the muscles discussed in Exhibit 13.4 move the digits in various ways and are known as extrinsic muscles of the hand. They produce the powerful but crude movements of the digits. The intrinsic muscles of the hand (Figure 13.11) in the palm produce the weak but intricate and precise movements of the digits that characterize the human hand. The muscles in this group are so named because their origins and insertions are within the hand. The intrinsic muscles of the hand are divided into three groups: (1) thenar, (2) hypothenar, and (3) intermediate. The thenar muscles include the abductor pollicis brevis, opponens pollicis, and flexor pollicis brevis. The abductor pollicis brevis is a thin, short, relatively broad superficial muscle on the lateral side of the thenar eminence. The opponens pollicis is a small, triangular muscle that is deep to the abductor pollicis brevis muscle. The flexor pollicis brevis is a short, flat muscle below the first metacarpal bone that inserts on the base of the proximal phalanx of the thumb. It flexes the thumb and opposes it to the fingers and the trunk.

Intrinsic Muscles of the Hand

The intrinsic muscles of the hand produce the intricate and precise movements of the digits that characterize the human hand. The intrinsic muscles of the hand are divided into three groups: (1) thenar, (2) hypothenar, and (3) intermediate. The thenar muscles include the abductor pollicis brevis, opponens pollicis, and flexor pollicis brevis. The abductor pollicis brevis is a thin, short, relatively broad superficial muscle on the lateral side of the thenar eminence. The opponens pollicis is a small, triangular muscle that is deep to the abductor pollicis brevis muscle. The flexor pollicis brevis is a short, flat muscle below the first metacarpal bone that inserts on the base of the proximal phalanx of the thumb. It flexes the thumb and opposes it to the fingers and the trunk.

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>INNERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>THENAR (LATERAL ASPECT OF PALM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abductor pollicis brevis</td>
<td>ab-DUK-ter POL-li-sis BREVS; ab-DUK-ter = moves part away from middle; pollic = the thumb; brevis = short</td>
<td>Flexor retinaculum, scaphoid, and trapezium. Lateral side of proximal phalanges of thumb</td>
<td>Abducts thumb at carpometacarpal joint.</td>
<td>Median nerve.</td>
</tr>
<tr>
<td>Flexor pollicis brevis</td>
<td>FLEKS-ar = decreases angle at joint</td>
<td>Flexor retinaculum, trapezium, capitatum, and trapezoid. Lateral side of proximal phalanges of thumb.</td>
<td>Flexes thumb at carpometacarpal and metacarpophalangeal joints.</td>
<td>Median and ulnar nerves.</td>
</tr>
</tbody>
</table>

HYPOTHENAR (MEDIAL ASPECT OF PALM)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>INNERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abductor digiti minimi (DIJ-ı¯-te)</td>
<td>MIN-i-mi; digit = finger or toe; minimi = little</td>
<td>Palmaris and tendon of flexor carpi ulnaris. Medial side of proximal phalanges of little finger</td>
<td>Abducts and flexes little finger at metacarpophalangeal joint.</td>
<td>Ulnar nerve.</td>
</tr>
<tr>
<td>Opponens digiti minimi</td>
<td></td>
<td>Flexor retinaculum and humate. Medial side of proximal phalanges of little finger</td>
<td>Flexes little finger at carpometacarpal and metacarpophalangeal joints.</td>
<td>Ulnar nerve.</td>
</tr>
</tbody>
</table>

INTERMEDIATE (MIDPALMAR)

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>ORIGIN</th>
<th>INSERTION</th>
<th>ACTION</th>
<th>INNERVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbricals</td>
<td>LÜM-br-ik-sal; lumbricus = earthworm (four muscles)</td>
<td>Lateral sides of tendons and flexor digitorum profundus of each finger.</td>
<td>Flex each finger at metacarpophalangeal joints and extend each finger at interphalangeal joints.</td>
<td>Median and ulnar nerves.</td>
</tr>
<tr>
<td>Palmar interossei</td>
<td>PAL-mar in’-ter-os-ë-i; palmar = palm, inter = between-um; -ossei = group (three muscles)</td>
<td>Sides of shafts of metacarpals of all digits (except the middle one).</td>
<td>Flex each finger at metacarpophalangeal joints. Flex fingers 2–4 at metacarpophalangeal joints, and extend each finger at interphalangeal joints.</td>
<td>Ulnar nerve.</td>
</tr>
<tr>
<td>Dorsal interossei</td>
<td>DOR-sal in’-ter-os-ë-i; dorsal = back surface (four muscles)</td>
<td>Adjacent sides of metacarpals. Proximal phalanges of each finger.</td>
<td>Flex each finger at metacarpophalangeal joints and extend each finger at interphalangeal joints.</td>
<td>Ulnar nerve.</td>
</tr>
</tbody>
</table>
wide muscle that is medial to the abductor pollicis brevis muscle. The three thenar muscles plus the adductor pollicis from the thenar emi-

cence, the lateral rounded contour on the palm that is also called the

call of the thumb. The adductor pollicis also acts on the thumb. The

muscle is fan-shaped and has two heads (oblique and transverse) sepa-

rated by a gap through which the radial artery passes.

The three hypothenar muscles act on the little finger and form the

hypothenar eminence, the medial rounded contour on the palm that is

also called the ball of the little finger. The hypothenar muscles are the

abductor digiti minimi, flexor digiti minimi brevis, and opponens digiti

minimi. The abductor digiti minimi is a short, wide muscle and is the

most superficial of the hypothenar muscles. It is a powerful muscle that

plays an important role in grasping an object with outspread fingers. The

flexor digiti minimi brevis muscle is also short and wide and is lateral to

the abductor digiti minimi muscle. The opponens digiti minimi

muscle is triangular and deep to the other two hypothenar muscles.

The 11 intermediate (midpalmar) muscles act on all the digits. The

intermediate muscles include the lumbricals, palmar interossei, and
dorsal interossei. The lumbricals (worm-shaped), as their name in-
dicates, are squiggly. They originate from and insert into the tendons

of other muscles (flexor digitorum profundus and extensor digitorum).

The palmar interossei are the smaller and more anterior of the in-

terossei muscles. The dorsal interossei are the posterior interossei

muscles. Both sets of interossei muscles are located between the

metacarpals and are important in abduction, adduction, flexion, and

extension of the fingers, and in movements in skilled activities such as

writing, typing, and playing a piano.

The functional importance of the hand is readily apparent when

you consider that certain hand injuries can result in permanent disabil-

ity. Most of the dexterity of the hand depends on movements of the

thumb. The general activities of the hand are free motion, power grip

(forcible movement of the fingers and thumb against the palm, as in

squeezing), precision handling (a change in position of a handled ob-

ject that requires exact control of finger and thumb positions, as in

winding a watch or threading a needle), and pinch (compression be-

 tween the thumb and index finger or between the thumb and first two

fingers).

Movements of the thumb are very important in the precise activities

of the hand, and they are defined in different planes from comparable

movements of other digits because the thumb is positioned at a right

angle to the other digits. The five principal movements of the thumb

are illustrated in Figure 13.11c and include flexion (movement of the

thumb medially across the palm), extension (movement of the thumb

laterally away from the palm), abduction (movement of the thumb in

an anteroposterior plane away from the palm), adduction (movement

of the thumb in an anteroposterior plane toward the palm), and oppo-

sition (movement of the thumb across the palm so that the tip of the

thumb meets the tip of a finger). Opposition is the single most distinc-

tive digital movement that gives humans and other primates the ability
to grasp and manipulate objects precisely.

CONTINUES
Surface Features of the Hand

The hand, or manus, is the region from the wrist to the termination of the upper limb; it has several distinguishable features (Figure 13.12).

- **Knuckles.** Commonly refers to the dorsal aspect of the heads of metacarpals 2-5 (or II-V), but also includes the dorsal aspects of the metacarpophalangeal and interphalangeal joints.
- **Dorsal venous network of the hand (dorsal venous arch).** Superficial veins on the dorsum of the hand that drain blood into the cephalic vein. It can be displayed by compressing the blood vessels at the wrist for a few moments as the hand is opened and closed.
- **Tendon of extensor digit minimi muscle.** This can be seen on the dorsum of the hand in line with the phalanges of the little finger.
- **Tendons of extensor digitorum muscle.** These can be seen on the dorsum of the hand in line with the phalanges of the ring, middle, and index fingers.

Relating Muscles to movements

**Arrange the muscles in the exhibit according to the following actions on the thumb at the carpometacarpal and metacarpophalangeal joints:**
1. Abduction.
2. Adduction.
3. Flexion.
4. Extension.

**Arrange the muscles in the exhibit according to the following actions on the fingers at the metacarpophalangeal and interphalangeal joints:**
1. Abduction.
2. Adduction.
3. Flexion.
4. Extension.

The same muscle may be moved more than once.

**CHECKPOINT**

**How do the actions of the extrinsic and intrinsic muscles of the hand differ?**

**STUDY OUTLINE**

Muscles that move the pectoral girdle (Exhibit 13.1)

1. Muscles that move the pectoral girdle stabilize the scapula so it can function as a stable point of origin for most of the muscles that move the humerus.
2. Anterior thoracic muscles that move the pectoral girdle are the subclavius, pectoralis minor, and serratus anterior.
3. Posterior thoracic muscles that move the pectoral girdle are the trapezius, levator scapulae, rhomboid major, and rhomboid minor.
4. The serratus anterior is an antagonist of the rhomboids and is responsible for abduction of the scapula.
5. The trapezius is the most superficial muscle of the back with three sets of fibers (superior, middle, and inferior) that enable this muscle to cause multiple actions.

**Muscles that move the humerus (Exhibit 13.2)**

1. Muscles that move the humerus originate for the most part on the scapula; the remaining muscles originate on the axilary skeleton.
2. The two axial muscles that move the humerus, the pectoralis major and the latissimus dorsi, form the anterior and posterior axillary folds, respectively, and a twist in each muscle near the insertion increases the contraction strength.
3. The prominence of the shoulder is formed by the deltoid muscle, a frequent site of intramuscular injection.
4. The rotator (musculotendinous) cuff muscles, which include the supraspinatus, infraspinatus, teres minor, and subscapularis, strengthen and stabilize the shoulder joint.

**Muscles that move the radius and ulna (Exhibit 13.3)**

1. Muscles that move the radius and ulna are involved in flexion and extension at the elbow joint and are organized into flexor and extensor compartments.
2. The biceps brachii muscle spans both the shoulder and elbow joints with two heads of origin (long and short), both from the scapula, and an insertion on the radius and bicipital aponeurosis.
3. The triceps brachii, the only muscle belly located in the posterior compartment of the arm, is an antagonist to the biceps brachii.

**SELF-QUIZ QUESTIONS**

1. Impingement syndrome, common among athletes, is usually caused by the frequent pinching of:
   a. coracobrachialis
   b. deltoid
   c. subscapularis
d. supraspinatus.
2. Pronator quadratus originates on the and inserts on the:
   a. radius; radius
   b. radius; ulna
c. ulna; ulna
   d. ulna; radius
3. Which of the following muscles is NOT innervated by the median nerve?
   a. flexor carpi radialis
   b. flexor digitorum superficialis
c. flexor carpi ulnaris
d. palmaris longus.
4. Which muscle is commonly called the “swimmer’s muscle”? 
   a. deltid 
   b. latissimus dorsi
c. pectoralis major
d. supraspinatus.
5. Which of the following muscles does not adduct the scapula?
   a. rhomboid major 
   b. rhomboid minor
c. serratus anterior
   d. trapezius
6. The anterior fibers of the deltoid and rotate the arm at the shoulder:
   a. extend; laterally
   b. extend; medially
c. flex; laterally
   d. flex; medially.
7. The muscle that originates on the medial epicondyle of the humerus and inserts on second and third metacarpals is the:
   a. flexor carpi radialis
   b. flexor digitorum superficialis
c. flexor carpi ulnaris
d. palmaris longus.

Intrinsic muscles of the hand (Exhibit 13.5)

1. The intrinsic muscles of the hand are important in skilled activities and provide humans with the ability to grasp and manipulate objects precisely.
2. The thenar muscles act on the thumb and form the lateral aspect of the palm (thenar eminence).
3. The hypothenar muscles act on the little finger and form the medial aspect of the palm (hypotheminal eminence).
4. The hand contains the extensor tendons on the dorsum, and the thenar and hypothenar eminences on the palm.
5. The intermediate (midpalmar) muscles act on the digits and include the lumbricals, palmar interossei, and dorsal interossei.
8. The origin of the levator scapulae is
9. Which muscle is NOT innervated, at least partially, by the musculocutaneous nerve?
   a. brachialis b. biceps brachii c. brachioradialis d. coracobrachialis
10. Which of the following is not an innervation of the trapezius?
    a. accessory (cranial nerve XI) b. C2 c. C3 d. C4
11. The innervation of the triceps brachii is the ________ nerve.
    a. median b. radial c. musculocutaneous d. two of the above
12. Which muscle is NOT part of the rotator cuff?
    a. infraspinatus b. subscapularis c. teres major d. teres minor
13. Which of the following muscles does NOT originate on the scapula?
    a. infraspinatus b. subscapularis c. pectoralis major d. supraspinatus
14. Which of the following muscles inserts on the radial tuberosity and bicipital aponeurosis?
    a. biceps brachii b. brachioradialis c. brachialis d. coracobrachialis
15. The origin of the rhomboid minor is
16. Which muscle inserts on the middle of the medial surface of the shaft of the humerus?
    a. coracobrachialis b. latissimus dorsi c. supraspinatus d. teres minor
17. Which muscle usually originates on the third, fourth, and fifth ribs and inserts on the coracoid process?
    a. coracobrachialis b. pectoralis minor c. serratus anterior d. subclavius
18. Carpai tunnel syndrome may be caused by compression of the ________ nerve.
    a. median b. radial c. musculocutaneous d. ulnar
19. The brachialis inserts on the
    a. humerus b. radius c. ulna d. two of the above.
20. The tendon of palmaris longus lies
    a. deep to extensor retinaculum b. superficial to extensor retinaculum
c. deep to flexor retinaculum d. superficial to flexor retinaculum.

José was confused because he thought his cuffs were only found on shirtsleeves, not inside his shoulder. Explain to José what the doctor means and how the injury could affect his arm movement.

Minor league pitcher José has been throwing a hundred pitches a day in order to perfect his curve ball. Lately he has experienced pain in his pitching arm. The doctor diagnosed a torn rotator cuff.

José was confused because he thought his cuffs were only found on shirtsleeves, not inside his shoulder. Explain to José what the doctor means and how the injury could affect his arm movement.

The origin of the levator scapulae is a. C1–C4 b. C4–C8 c. T1–T4 d. superior vertebral border of the scapula.

Which muscle is NOT innervated, at least partially, by the musculocutaneous nerve? a. brachialis b. biceps brachii c. brachioradialis d. coracobrachialis

Which of the following is not an innervation of the trapezius? a. accessory (cranial nerve XI) b. C2 c. C3 d. C4

The innervation of the triceps brachii is the ________ nerve. a. median b. radial c. musculocutaneous d. two of the above

Which muscle is NOT part of the rotator cuff? a. infraspinatus b. subscapularis c. teres major d. teres minor

Which of the following muscles does NOT originate on the scapula? a. infraspinatus b. subscapularis c. pectoralis major d. supraspinatus

Which of the following muscles inserts on the radial tuberosity and bicipital aponeurosis? a. biceps brachii b. brachioradialis c. brachialis d. coracobrachialis

The origin of the rhomboid minor is a. C7–T1 b. T2–T5 c. C7–T5 d. C6–T6

Which muscle inserts on the middle of the medial surface of the shaft of the humerus? a. coracobrachialis b. latissimus dorsi c. supraspinatus d. teres minor

Which muscle usually originates on the third, fourth, and fifth ribs and inserts on the coracoid process? a. coracobrachialis b. pectoralis minor c. serratus anterior d. subclavius

Carpal tunnel syndrome may be caused by compression of the ________ nerve. a. median b. radial c. musculocutaneous d. ulnar

The brachialis inserts on the a. humerus b. radius c. ulna d. two of the above.

The tendon of palmaris longus lies a. deep to extensor retinaculum b. superficial to extensor retinaculum c. deep to flexor retinaculum d. superficial to flexor retinaculum.

José was confused because he thought his cuffs were only found on shirtsleeves, not inside his shoulder. Explain to José what the doctor means and how the injury could affect his arm movement.

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