CHAPTER 2

THE UPPER LIMB

The function of the upper limb is to place the hand in position to be effective as a grasping tool. As such, the upper limb has adapted into a body part with great freedom of motion. Muscles that control this motion extend across the back and thorax. If the back has previously been dissected, the superficial group of back muscles has been studied. If the thorax has previously been dissected, the pectoral region has been studied. If the upper limb is your first dissection unit, you will be instructed to dissect the superficial group of back muscles and the pectoral region at the appropriate time.

SURFACE ANATOMY [G 465, 475; N 401; C 26]

The upper limb is divided into four regions: **shoulder**, **arm (brachium)**, **forearm (antebrachium)**, and **hand (manus)**. The surface anatomy of the upper limb can be studied on a living subject or on the cadaver. Place the cadaver in the supine position (face up) and palpate the following superficial structures (Fig. 2.01):

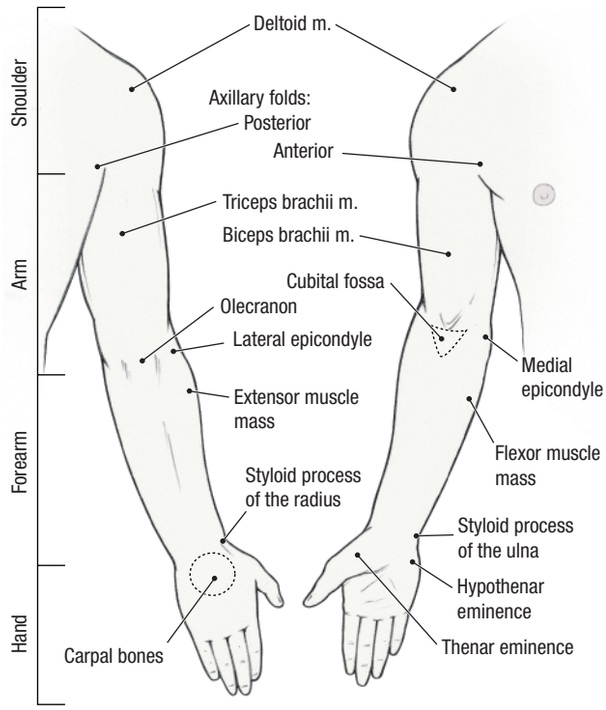

Figure 2.01. Surface anatomy of the upper limb.

KEY TO REFERENCES
G = Grant's Atlas, 11th ed., page number
N = Netter's Atlas, 3rd ed., plate number
R = Rohen's Color Atlas of Anatomy, 5th ed., page number
C = Clemente's Atlas, 4th ed., page number

- **Anterior axillary fold**
- **Posterior axillary fold**
- **Deltoid muscle**
- **Biceps brachii muscle**
- **Triceps brachii muscle**
- **Cubital fossa**
- **Medial epicondyle**
- **Lateral epicondyle**
- **Olecranon**
- **Flexor muscle mass (in the forearm)**
- **Extensor muscle mass (in the forearm)**
- **Carpal bones (on the dorsum of the wrist)**
- **Styloid process of the radius**
- **Styloid process of the ulna**
- **Thenar eminence**
- **Hypothenar eminence**

SUPERFICIAL VEINS AND CUTANEOUS NERVES

Before you dissect . . .

The **superficial fascia** of the upper limb contains fat, **superficial veins,** and **cutaneous nerves**. In the living body, the superficial veins may be conspicuous through the skin. They are frequently used for drawing blood and injecting medications. In the cadaver, the superficial veins are not conspicuous through the skin. The cutaneous nerves of the upper limb pierce the deep fascia to reach the superficial fascia and skin.

The order of dissection will be as follows: the entire upper limb will be skinned. The objective is to remove only the skin, leaving the superficial fascia undisturbed. The superficial veins and selected cutaneous nerves will be dissected. The fat will then be removed so that the deep fascia may be observed. **[G 462, 464; N 462, 463; R 388, 394; C 25]**

Dissection Instructions

SKIN INCISIONS

1. If the back has not been dissected previously, go to page 7, follow the skinning instructions that are provided there, and return to this page.
2. If the thorax has not been dissected previously, go to page 43, follow the skinning instructions that are provided there, and return to this page.
3. Place the cadaver in the supine position (face up).
4. Refer to Figure 2.02. Before cutting, realize that the skin is thin on the anterior surface of the upper limb. *Be careful not to cut too deeply.*

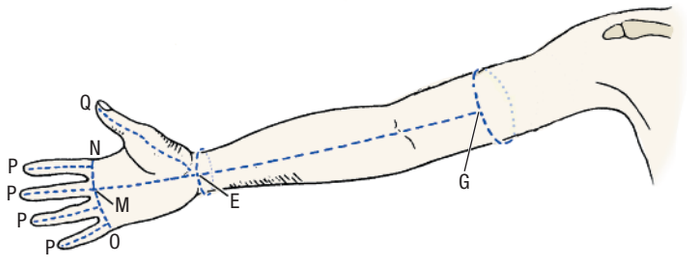

Figure 2.02. Skin incisions.

5. Use a scalpel to make an incision that encircles the arm midway between the shoulder and the elbow (G). If the back has been skinned, this incision has been made previously.
6. Make an incision that encircles the wrist (E). The skin is very thin (2 mm) on the anterior surface of the wrist.
7. Join the two circular incisions with a longitudinal incision on the anterior aspect of the upper limb (E to G).
8. Remove the skin from the arm and forearm and place it in the tissue container. Do not damage the superficial veins and cutaneous nerves in the superficial fascia.
9. Force open the clenched hand and let your dissection partner hold it open.
10. Make a longitudinal incision across the palm (E to M).
11. Make a transverse incision at the level of the webs of the fingers (N to O).
12. Make a longitudinal incision on the anterior surface of digits 2 to 5 (from incision N/O to P).
13. Make a longitudinal incision along the palmar surface of digit 1 (E to Q).
14. Remove the skin from the palmar and dorsal surfaces of the hand and digits 1 to 5. *When skinning the digits, proceed with caution*. Note that the subcutaneous tissue on the palmar surface of the digits is very thin, especially at the skin creases. There are digital nerves, vessels, and fibrous digital sheaths immediately deep to the skin.

SUPERFICIAL VEINS [G 464; N 462, 463; R 386; C 25]

1. Use blunt dissection to demonstrate the superficial veins (Fig. 2.03).
2. On the dorsum of the hand, identify the **dorsal venous arch**. Note that the dorsal venous arch collects venous drainage from the posterior surface of the hand and digits.
3. In the posterior forearm, demonstrate the **basilic vein** and **cephalic vein**, which arise from the dorsal venous arch.
4. Abduct the upper limb and have your dissection partner hold it in the abducted position.
5. Use a probe to follow the cephalic and basilic veins proximally, freeing them from the surrounding fat and connective tissue.
6. Demonstrate that the cephalic and basilic veins are joined across the cubital fossa by the **median cubital vein**. This pattern can be quite variable and should be observed on other cadavers.
7. Follow the cephalic vein proximally into the pectoral region where it courses in the **deltopectoral groove** between the deltoid muscle and the pectoralis major muscle. Near the clavicle, the cephalic vein passes deeply into the **deltopectoral triangle** to join the axillary vein.
8. Follow the basilic vein proximally. Before reaching the axilla, it pierces the deep fascia to join the brachial vein.
9. Use a probe to elevate the superficial veins (Fig. 2.03). Note that **perforating veins** penetrate the deep fascia and connect the superficial veins to deep veins.

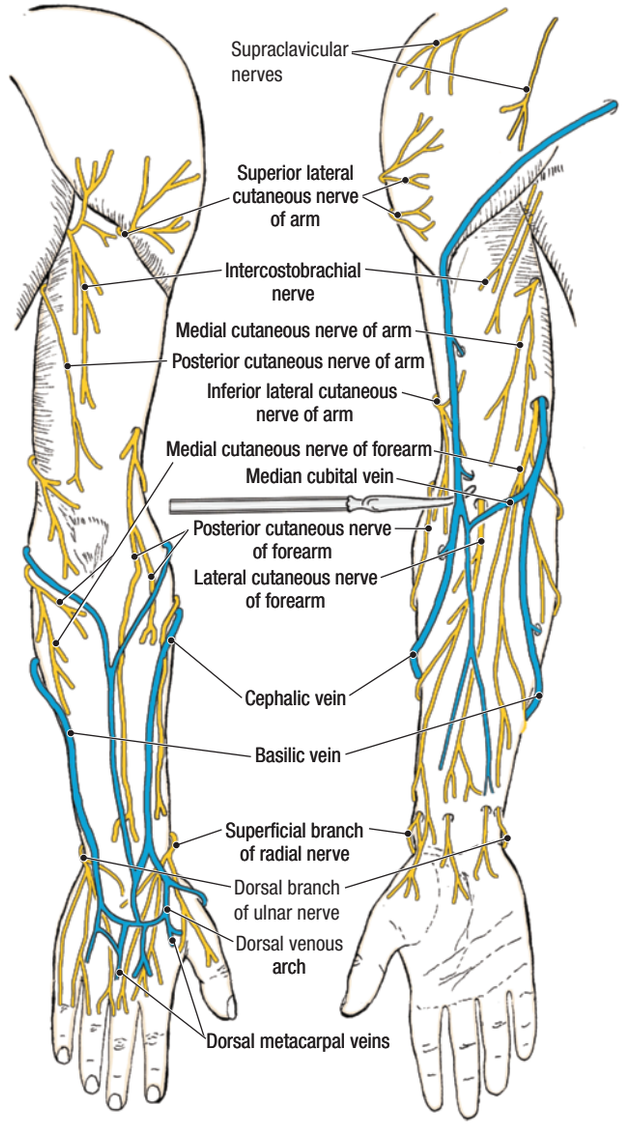

Figure 2.03. Cutaneous nerves and superficial veins.

CUTANEOUS NERVES [G 462; N 462, 463; R 388; C 25]

1. Do not dissect all of the cutaneous nerves of the upper limb. A few (described later in greater detail) are clinically relevant and should be demonstrated by blunt

dissection. Before dissecting, use an illustration to familiarize yourself with the course and distribution of all of the **cutaneous nerves of the upper limb** (Fig. 2.03):

- **Superior lateral cutaneous nerve of the arm**
- **Inferior lateral cutaneous nerve of the arm**
- **Posterior cutaneous nerve of the arm**
- **Intercostobrachial nerve**
- **Medial cutaneous nerve of the arm**
- **Medial cutaneous nerve of the forearm**
- **Lateral cutaneous nerve of the forearm**
- **Posterior cutaneous nerve of the forearm**

2. At the level of the elbow, identify the **lateral cutaneous nerve of the forearm**. It is located in the superficial fascia lateral to the biceps brachii tendon and in close relationship to the cephalic vein or the median cubital vein.
3. At the level of the elbow, identify the **medial cutaneous nerve of the forearm**. It is located on the medial side of the biceps brachii tendon and is in close relationship to the basilic vein.
4. At the lateral side of the wrist, use a probe to dissect the **superficial branch of the radial nerve**. The superficial branch of the radial nerve may be found in the superficial fascia near the styloid process of the radius. Expose only 2 or 3 cm of this nerve.
5. At the medial side of the wrist, identify the **dorsal branch of the ulnar nerve.** The dorsal branch of the ulnar nerve may be found in the superficial fascia near the styloid process of the ulna. Expose only 2 or 3 cm of this nerve.
6. The cutaneous nerves to the digits will be studied with the hand.
7. Remove all remaining superficial fascia, preserving the superficial veins and nerves that you have dissected. Do not disturb the deep fascia. Place the superficial fascia in the tissue container.
8. Examine the **deep fascia** of the upper limb. Note that the deep fascia of the upper limb extends from the shoulder to the fingertips. It attaches to the bones of the upper limb and forms compartments that contain groups of muscles. The deep fascia of the upper limb is regionally named: **brachial fascia** in the arm, **antebrachial fascia** in the forearm, and **palmar fascia** and **dorsal fascia of the hand** in the hand.

After you dissect . . .

Review the superficial fascia of the upper limb. Use the dissected specimen to trace the course of the superficial veins from distal to proximal. Review the location of the cephalic vein, basilic vein, and median cubital vein in the cubital fossa and recall that these are important for venipuncture. Use the dissected specimen to review the four cutaneous nerves that you have dissected. Use an illustration to review the pattern of distribution of the cutaneous nerves that you did not dissect. Compare this pattern of cutaneous nerve distribution to a dermatome chart. Review the deep fascia of the upper limb and name its parts. **[G 462, 463; N 464, 465; C 24]**

SUPERFICIAL GROUP OF BACK MUSCLES

Instructions for dissection of the superficial group of back muscles are found in Chapter 1, *The Back*. If you are dissecting the upper limb before the back, the superficial group of back muscles must be dissected now. Turn to pages 7–9, complete that dissection, and return to this page.

SCAPULAR REGION

Before you dissect . . .

There are six shoulder (scapulohumeral) muscles: **Deltoid**, **supraspinatus**, **infraspinatus**, **teres minor**, **teres major**, and **subscapularis**. The order of dissection will be as follows: the deltoid muscle will be studied, then it will be detached from its proximal attachment and the course of its nerve and artery will be studied. Subsequently, the four muscles arising from the dorsal surface of the scapula (supraspinatus, infraspinatus, teres major, teres minor) will be dissected and their nerves and blood vessels will be demonstrated. The subscapularis muscle will be dissected with the axilla.

SKELETON OF THE SCAPULAR REGION [G 498; N 404; R 359, 361; C 70, 76]

Refer to a skeleton. On the **scapula**, identify (Fig. 2.04):

- **Acromion**
- **Spine**
- **Supraspinous fossa**
- **Suprascapular notch**
- **Infraspinous fossa**
- **Supraglenoid tubercle**
- **Glenoid cavity**
- **Infraglenoid tubercle**
- **Coracoid process**

On the **humerus**, identify (Fig. 2.04):

- **Head**
- **Anatomical neck**
- **Greater tubercle**
- **Lesser tubercle**
- **Intertubercular sulcus (bicipital groove)**
- **Surgical neck**
- **Deltoid tuberosity**
- **Radial groove**

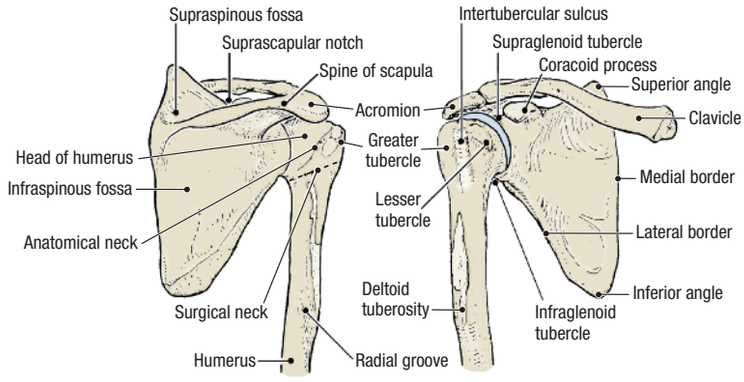

Figure 2.04. Skeleton of the scapular region.

Dissection Instructions

1. Place the cadaver in the prone position (face down). Abduct the upper limb to 45 degrees. If a block is available, place it under the chest.
2. Use blunt dissection to define the borders of the **deltoid muscle**. The proximal attachments of the deltoid muscle are the spine of the scapula, the acromion of the scapula, and the lateral one-third of the clavicle. The distal attachment of the deltoid muscle is the deltoid tuberosity of the humerus. The deltoid muscle abducts the humerus. **[G 497; N 407; R 370; C 407]**
3. Use a scalpel to detach the deltoid muscle from its proximal attachments. Make your cuts close to the bone. Leave the muscle attached to the humerus. Reflect the deltoid muscle laterally, taking care not to tear the vessels and nerve that course along its deep surface.
4. Observe the **axillary nerve** and the **posterior circumflex humeral artery and vein** on the deep surface of the deltoid muscle near its attachment to the humerus. Use a probe to clean the nerve and vessels and trace them around the surgical neck of the humerus (Fig. 2.05). **[G 506; N 409; R 371; C 41]**
5. Note that the axillary nerve innervates the deltoid muscle and the **teres minor muscle**.
6. Follow the axillary nerve and the posterior circumflex humeral artery and vein proximally. Push your finger parallel to the nerve and vessels to open the **quadrangular space** (Fig. 2.05). Define the **borders of the quadrangular space**:
   - **Superior border—**inferior border of the teres minor muscle
   - **Lateral border –** surgical neck of the humerus
   - **Medial border –** long head of the triceps brachii muscle
   - **Inferior border –** superior border of the teres major muscle
7. Identify the **long head of the triceps brachii muscle**. Observe that the long head of the triceps brachii muscle passes anterior to the teres minor muscle and posterior to the teres major muscle.
8. Use a probe to clean and define the borders of the **teres minor muscle**. The proximal attachment of the teres minor muscle is the lateral border of the scapula. The distal attachment of the teres minor muscle is the inferior facet of the greater tubercle of the humerus. The teres minor muscle laterally rotates the humerus.
9. Clean and define the borders of the **teres major muscle**. The proximal attachment of the teres major muscle is the inferior angle of the scapula. The distal attachment of the teres major muscle is the medial lip of the intertubercular sulcus of the humerus. The teres major muscle adducts and medially rotates the humerus.
10. Reflect the trapezius muscle superiorly, leaving it attached along the "hinge" of cervical fascia that was created during the back dissection.
11. Clean and define the borders of the **supraspinatus muscle**. The proximal attachment of the supraspinatus muscle is the supraspinous fossa of the scapula. The distal attachment of the supraspinatus muscle is the highest facet of the greater tubercle of the humerus. The supraspinatus muscle initiates abduction of the humerus.

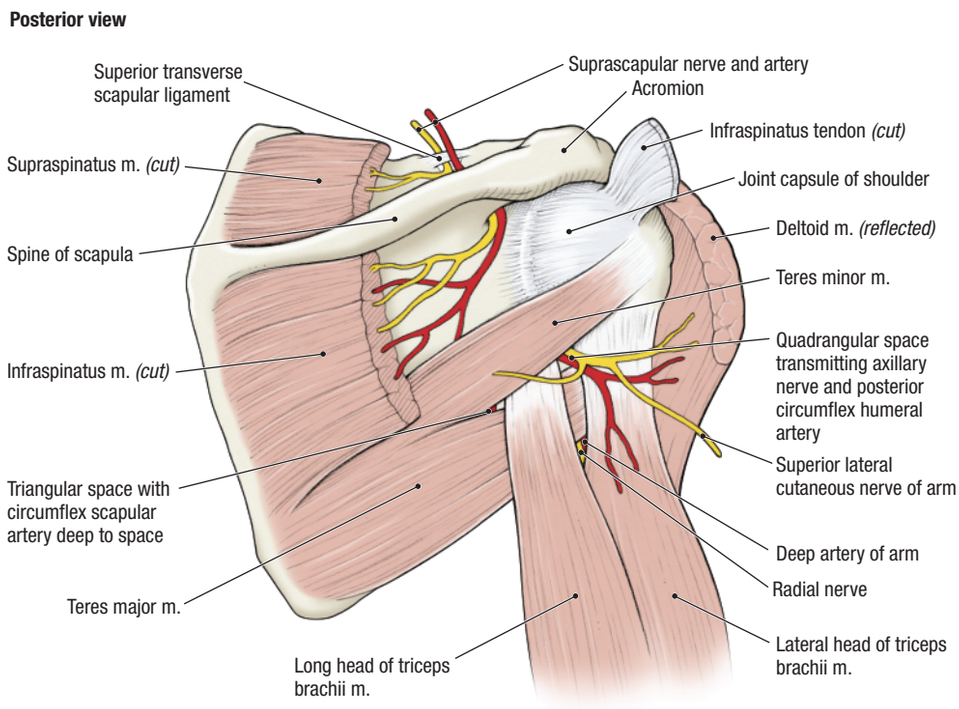

Figure 2.05. Blood and nerve supply to the posterior aspect of the shoulder.

12. Use a probe to define the borders of the **infraspinatus muscle**. The proximal attachment of the infraspinatus muscle is the infraspinous fossa of the scapula. The distal attachment of the infraspinatus muscle is the middle facet of the greater tubercle of the humerus. The infraspinatus muscle laterally rotates the humerus.
13. The **suprascapular artery** and the **suprascapular nerve** are found deep to the supraspinatus muscle (Fig. 2.05). The supraspinatus muscle must be reflected to see them. **[G 506; N 409; R 392; C 23]**
14. Use a scalpel to transect the supraspinatus muscle approximately 5 cm lateral to the superior angle of the scapula but medial to the suprascapular notch. Hold a disarticulated scapula over the scapula of the cadaver to help locate the proper level of the cut.
15. Use blunt dissection to free the distal portion of the supraspinatus muscle from the supraspinous fossa. Reflect the distal part of the supraspinatus muscle laterally. Leave it attached to the humerus.
16. Clean the **suprascapular artery and nerve**. Follow the artery and nerve superiorly. Observe that the suprascapular artery passes superior to the **superior transverse scapular ligament** and the suprascapular nerve passes inferior to it (Fig. 2.05). This relationship can be remembered by use of a mnemonic device: "*A*rmy (*a*rtery) goes over the bridge, *N*avy (*n*erve) goes under the bridge."
17. Transect the **infraspinatus muscle** approximately 5 cm lateral to the vertebral border of the scapula (Fig. 2.05).
18. Use blunt dissection to loosen the distal portion of the infraspinatus muscle from the scapula and reflect it laterally.
19. Follow the **suprascapular artery** and the **suprascapular nerve** inferiorly. Note that they reach the infraspinatus muscle by coursing deep (anterior) to the spine of the scapula (Fig. 2.05).
20. The suprascapular artery contributes to the collateral circulation of the scapular region. Use an illustration to study the **scapular anastomosis**. **[G 471; N 410; R 392]**
21. The four muscles of the **rotator cuff** are: **supraspinatus, infraspinatus, teres minor, and subscapularis**. The subscapularis muscle will be dissected with the axilla. Use an illustration to study the distal attachments of the rotator cuff muscles. **[G 498, 514; N 403, 404; R 371; C 37]**

After you dissect . . .

Replace the muscles of the scapular region in their correct anatomical positions. Use an illustration and the dissected specimen to review the proximal attachment and distal attachment of each muscle of the scapular region. List the action of each muscle and the combined action of the rotator cuff group of muscles. Review the origin, course, and distribution of the transverse cervical artery, dorsal scapular artery, and suprascapular artery. Review the scapular anastomosis. Review the relationship of the suprascapular artery and the suprascapular nerve to the superior transverse scapular ligament. Review the innervation of each muscle dissected today.

PECTORAL REGION

Instructions for dissection of the pectoral region are found in Chapter 3, *The Thorax*. If you are dissecting the upper limb before the thorax, the pectoral region must be dissected now. Turn to pages 43–46, complete that dissection, and return to this page.

AXILLA

Before you dissect . . .

The **axilla** is the region between the pectoral muscles, the scapula, the arm, and the thoracic wall (Fig. 2.06). It is a transitional region through which vessels and nerves pass from the root of the neck into the upper limb. The **contents of the axilla** are: **axillary sheath**, **brachial plexus**, **axillary vessels and their branches**, **lymph nodes and lymphatic vessels**, **portions of three muscles,** and a considerable amount of fat and connective tissue.

Study a diagram and note the following **boundaries of the axilla**: **[G 482; N 411]**

- **Apex of the axilla –** bounded by the clavicle anteriorly, the upper border of the scapula posteriorly and the first rib medially
- **Base of the axilla –** skin and fascia of the armpit
- **Anterior wall –** pectoralis major muscle, pectoralis minor muscle, and the clavipectoral fascia
- **Posterior wall –** posterior axillary fold (teres major and latissimus dorsi muscles) and the subscapularis muscle that covers the anterior surface of the scapula
- **Medial wall –** upper portion of the thoracic wall and the serratus anterior muscle, which overlies this wall
- **Lateral wall –** intertubercular sulcus of the humerus

The order of dissection will be as follows: the pectoralis major and pectoralis minor muscles will be reflected to expose the contents of the axilla. The axillary vein and its tributaries will be removed. The branches of the axillary artery will be dissected. The brachial plexus will be studied.

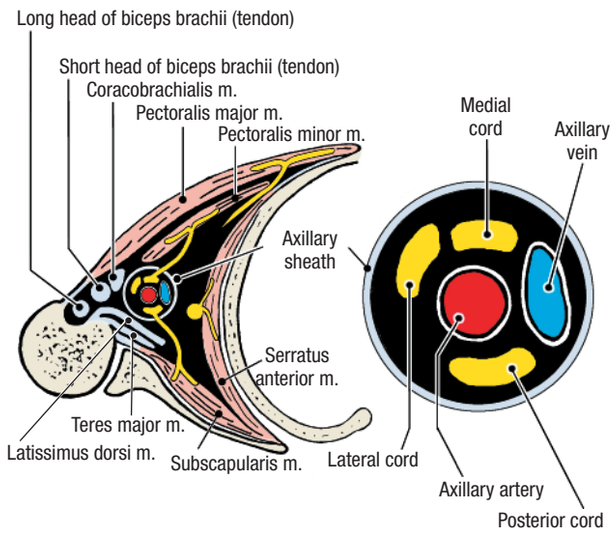

Figure 2.06. Walls and contents of the axilla (transverse section).

Dissection Instructions

1. Review the pectoralis major muscle, the pectoralis minor muscle, and the clavipectoral fascia.
2. Reflect the pectoralis major muscle laterally.
3. Reflect the pectoralis minor muscle superiorly.
4. Abduct the arm to approximately 45 degrees.
5. Identify the **axillary sheath** (Fig. 2.06). The axillary sheath is a connective tissue structure that surrounds the axillary vessels and brachial plexus. The axillary sheath extends from the lateral border of the first rib to the inferior border of the teres major muscle.
6. Use scissors to open the anterior surface of the axillary sheath.
7. Identify the **axillary vein** within the axillary sheath. Cut the cephalic vein where it joins the axillary vein and preserve it. Use a probe to dissect the axillary vein from the structures that lie posterior to it (axillary artery and brachial plexus). Cut the axillary vein at the lateral border of the first rib and bluntly dissect it distally as far as possible. Remove it completely. **[G 481; N 412; R 397; C 15]**
8. As the dissection proceeds, remove veins that are tributary to the axillary vein. Retain the accompanying arteries. Note the presence of lymph nodes that are associated with the veins.

AXILLARY ARTERY [G 488, 489; N 410; R 398; C 14]

The **axillary artery** begins at the lateral border of the first rib, where it is the continuation of the **subclavian artery** (Fig. 2.07). The axillary artery ends at the inferior border of the teres major muscle, where its name changes to **brachial artery**. The axillary artery is surrounded by the brachial plexus (Fig. 2.06, inset). *The brachial plexus must be retracted and preserved during dissection of the axillary artery and its branches.*

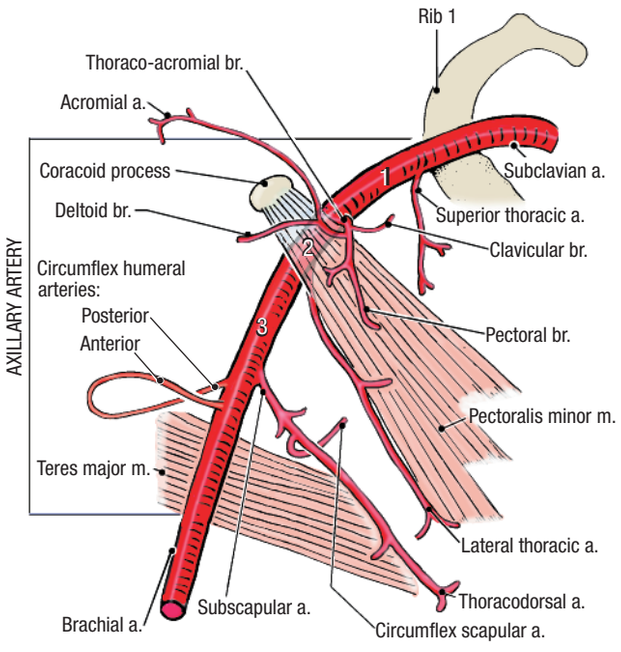

Figure 2.07. Branches arising from the axillary artery.

1. Identify the **three parts of the axillary artery** (Fig. 2.07):
   - **First part** extends from the lateral border of the first rib to the medial border of the pectoralis minor muscle.
   - **Second part** lies posterior to the pectoralis minor muscle.
   - **Third part** extends from the lateral border of the pectoralis minor muscle to the inferior border of the teres major muscle.

Dissection note: The branching pattern of the axillary artery may vary from that which is commonly illustrated. If the pattern is different in your specimen, note that the branches are named according to their distribution rather than by their origin.

2. The first part of the axillary artery has one branch, the **superior thoracic artery**. Follow the superior thoracic artery to its area of distribution in the first and second intercostal spaces.
3. The second part of the axillary artery has two branches (Fig. 2.07): **thoraco-acromial artery** and **lateral thoracic artery**.
4. Use blunt dissection to open the clavipectoral fascia and identify the thoraco-acromial artery on the medial side of the pectoralis minor muscle.
5. Identify the branches of the thoraco-acromial artery:
   - **Acromial branch –** passes laterally across the coracoid process to the acromion.
   - **Deltoid branch –** courses laterally in the deltopectoral groove. It accompanies the cephalic vein.
   - **Pectoral branch –** passes between the pectoralis major and pectoralis minor muscles and supplies both.
   - **Clavicular branch –** courses superior and medial to supply the subclavius muscle.
6. Identify the **lateral thoracic artery** and follow it along the lateral border of the pectoralis minor muscle (Fig. 2.07). The lateral thoracic artery may have an alternate origin from the subscapular artery, but it consistently courses along the lateral border of the pectoralis minor muscle. The lateral thoracic artery supplies the pectoral muscles and the lateral thoracic wall. In females, the lateral thoracic artery also supplies the lateral portion of the mammary gland.
7. The third part of the axillary artery has three branches: **subscapular artery**, **posterior circumflex humeral artery**, and **anterior circumflex humeral artery**.
8. Identify the **subscapular artery**. It is the largest branch of the axillary artery. The subscapular artery courses inferiorly for a short distance before dividing into the **circumflex scapular artery** (to muscles on the posterior surface of the scapula) and the **thoracodorsal artery** (to the latissimus dorsi muscle). The subscapular artery gives off several unnamed muscular branches.
9. Find the **anterior and posterior circumflex humeral arteries**, which arise from the axillary artery distal to the origin of the subscapular artery. Occasionally,

these two arteries may arise from a short common trunk. They supply the deltoid muscle.

10. Observe that the **posterior circumflex humeral artery** is the larger of the two circumflex humeral arteries. Follow it as it passes posterior to the surgical neck of the humerus with the axillary nerve. Demonstrate that the posterior circumflex humeral artery and the axillary nerve pass through the quadrangular space.
11. The **anterior circumflex humeral artery** courses around the anterior surface of the humerus at the surgical neck. It passes deep to the tendon of the long head of the biceps brachii muscle.

BRACHIAL PLEXUS [G 488; N 412; R 399; C 15]

The brachial plexus begins in the root of the neck superior to the clavicle. It passes distally toward the base of the axilla, where its **terminal branches** arise. Only the **infraclavicular part of the brachial plexus** will be dissected at this time. The **supraclavicular part** will be dissected with the neck.

The **three cords of the brachial plexus** (lateral, medial, and posterior) are named according to their relationship to the second part of the axillary artery (posterior to the pectoralis minor muscle) (Fig. 2.08).

1. Identify the **musculocutaneous nerve**. It is the most lateral terminal branch of the brachial plexus and enters the coracobrachialis muscle.
2. To find the **lateral cord**, use your fingers to follow the musculocutaneous nerve proximally.
3. Observe that the lateral cord gives rise to one other large branch, the **lateral root of the median nerve**. Follow the lateral root distally and identify the **median nerve.**
4. To find the **medial cord**, trace the **medial root of the median nerve** proximally.
5. The medial cord continues distally as the **ulnar nerve**.
6. Note that the three **terminal branches** that you have just identified (musculocutaneous nerve, median nerve, and ulnar nerve) form the letter M anterior to the third part of the axillary artery (Fig. 2.08).
7. Trace the **medial** and **lateral pectoral nerves** from the reflected pectoral muscles to their origins from the medial and lateral cords, respectively.
8. Identify two branches of the medial cord. They are the **medial cutaneous nerve of the forearm** and the **medial cutaneous nerve of the arm**. Use your fingers to trace these nerves a short distance (7.5 cm) into the arm.
9. Use a piece of string to retract the axillary artery, the lateral cord, and the medial cord in the superior direction. This procedure exposes the **posterior cord** of the brachial plexus. The branches of the posterior cord are the **axillary nerve**, **radial nerve**, and three **subscapular nerves** (upper, middle and lower).
10. Use blunt dissection to clean the **axillary nerve**. Observe that the axillary nerve passes posterior to the humerus and courses through the quadrangular space with the posterior circumflex humeral artery (Fig. 2.09).
11. Use blunt dissection to clean the **radial nerve** and confirm that it leaves the axilla by passing posterior to the humerus. The radial nerve is the motor and sensory nerve to the posterior portion of the upper limb.
12. Identify the subscapular nerves that arise from the posterior cord (Fig. 2.09). The **upper subscapular nerve** innervates the subscapularis muscle. The **middle subscapular nerve (thoracodorsal nerve**) innervates the latissimus dorsi muscle. The **lower subscapular nerve** innervates the subscapularis muscle and the teres major muscle. Verify that these nerves run in the loose connective tissue on the anterior surface of the subscapularis muscle.

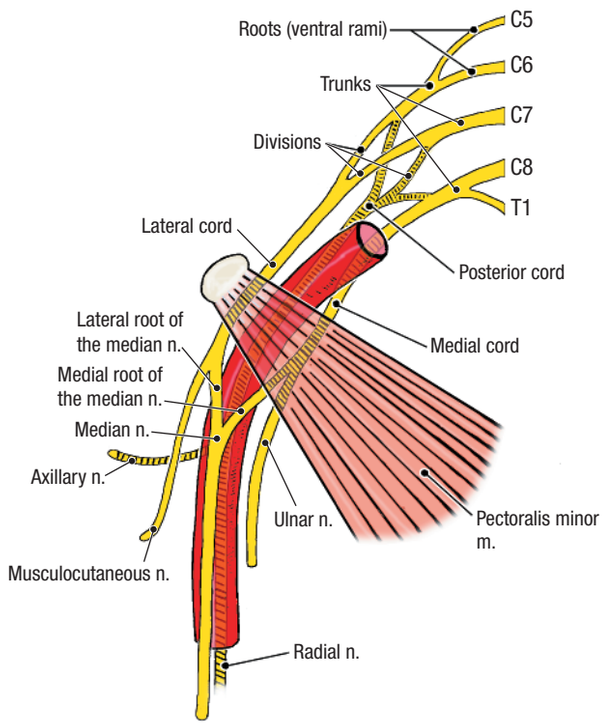

Figure 2.08. Relationship of the brachial plexus to the axillary artery.

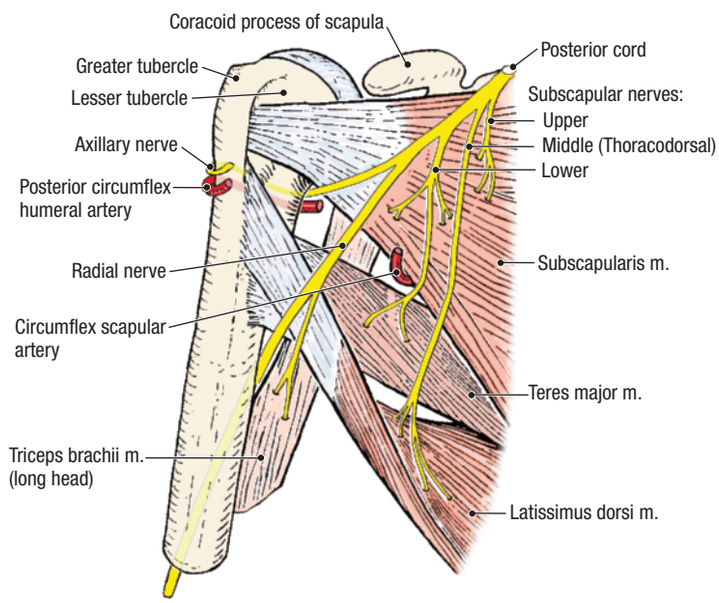

Figure 2.09. Posterior wall of the axilla and posterior cord of the brachial plexus.

13. Identify the three muscles that form the posterior wall of the axilla: **latissimus dorsi**, **teres major,** and **subscapularis** (Fig. 2.09).
14. Examine the **subscapularis muscle**. The proximal attachment of the subscapularis muscle is the subscapular fossa of the scapula. The distal attachment of the subscapularis muscle is the lesser tubercle of the humerus. The subscapularis muscle medially rotates the humerus. The subscapularis muscle is a member of the **rotator cuff group of muscles**.
15. Verify that the medial wall of the axilla is formed by the **serratus anterior muscle** (Fig. 2.06). Use an illustration to study the attachments of the serratus anterior muscle. The proximal attachments of the serratus anterior muscle are the external surfaces of ribs 1 to 8. Its distal attachment is the anterior surface of the medial border of the scapula. The serratus anterior muscle protracts the scapula. The serratus anterior muscle also rotates the scapula, especially when the arm is abducted above the horizontal plane. **[G 491; N 412; R 398; C 12]**
16. Use your fingers to follow the serratus anterior muscle posteriorly toward the medial margin of the scapula. On the superficial surface of this muscle, use a probe to free the **long thoracic nerve**. Note the vertical course of this nerve. Observe its branches to the serratus anterior muscle. Follow the nerve superiorly as far as possible toward the apex of the axilla.

CLINICAL CORRELATION

Nerve Injuries

The **long thoracic nerve** is vulnerable to stab wounds and to surgical injury during radical mastectomy. Injury of the long thoracic nerve affects the serratus anterior muscle. When a patient with paralysis of the serratus anterior muscle is asked to push with both hands against a wall, the medial border of the scapula protrudes on the affected side, a condition known as "winged scapula."

The **thoracodorsal nerve** is vulnerable to compression injuries and surgical trauma during mastectomy. Injury of the thoracodorsal nerve affects the latissimus dorsi muscle, resulting in a weakened ability to extend, adduct, and medially rotate the humerus.

The **axillary nerve** courses around the surgical neck of the humerus and may be injured during a fracture or during an inferior dislocation of the shoulder joint. Injury of the axillary nerve affects the deltoid muscle and teres minor muscle, resulting in a weakened ability to abduct and laterally rotate the humerus.

After you dissect . . .

Replace the pectoralis major muscle and the pectoralis minor muscle into their correct anatomical positions and review their attachments. Review the boundaries of the axilla. Use the dissected specimen to observe the relationship of the three parts of the axillary artery to the pectoralis minor muscle. Name all of the branches of the axillary artery and identify each branch on your dissected specimen. Test your understanding of the brachial plexus by drawing a picture that shows its structure and branches. Extend this exercise to the cadaver by demonstrating the divisions, cords, and terminal branches of the infraclavicular portion of the brachial plexus. Review the motor nerve supply to the muscles of the scapular region. Name each muscle and the nerve that supplies it. Realize that some of these nerves arise from the supraclavicular portion of the brachial plexus and that they have not yet been dissected completely. Review the movements of the scapula. Examine other cadavers to gain an appreciation of variations in the branching patterns of arteries and nerves. Use an illustration to review the lymphatic drainage of the axilla.

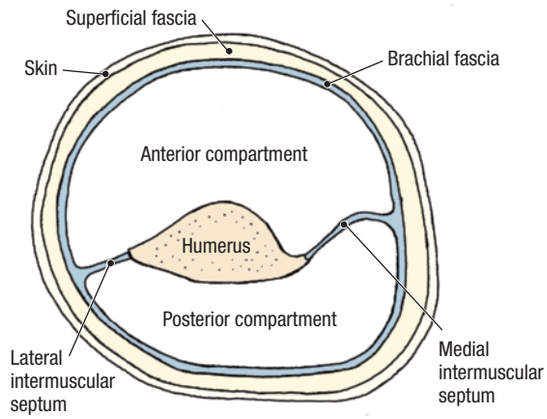

Figure 2.10. Compartments of the right arm.

ARM AND CUBITAL FOSSA

Before you dissect . . .

The **brachial fascia (deep fascia of the arm)** is a sleeve of tough connective tissue that is continuous at its proximal end with the **pectoral fascia**, the **axillary fascia**, and the deep fascia that covers the deltoid and latissimus dorsi muscles. Distally, the brachial fascia is continuous with the **antebrachial fascia (deep fascia of the forearm)**. The brachial fascia is connected to the medial and lateral sides of the humerus by intermuscular septa (Fig. 2.10), creating an **anterior (flexor) compartment** and a **posterior (extensor) compartment** for the muscles of the arm. The anterior compartment contains three muscles (biceps brachii, brachialis, and coracobrachialis) and the musculocutaneous nerve. The posterior compartment contains two muscles (triceps brachii and anconeus), the radial nerve, and the deep artery and vein of the arm.

The order of dissection will be as follows: the anterior compartment of the arm will be opened and its contents will be studied. Nerves and blood vessels will then be traced distally through the arm to the elbow region. The cadaver will be turned to the prone position to complete the dissection of the posterior compartment of the arm.

SKELETON OF THE ARM AND CUBITAL REGION [G 524; N 419; R 361, 362; C 76, 77]

Refer to a skeleton. On the **humerus** identify (Fig. 2.11):

- **Medial epicondyle**
- **Lateral epicondyle**
- **Olecranon fossa**

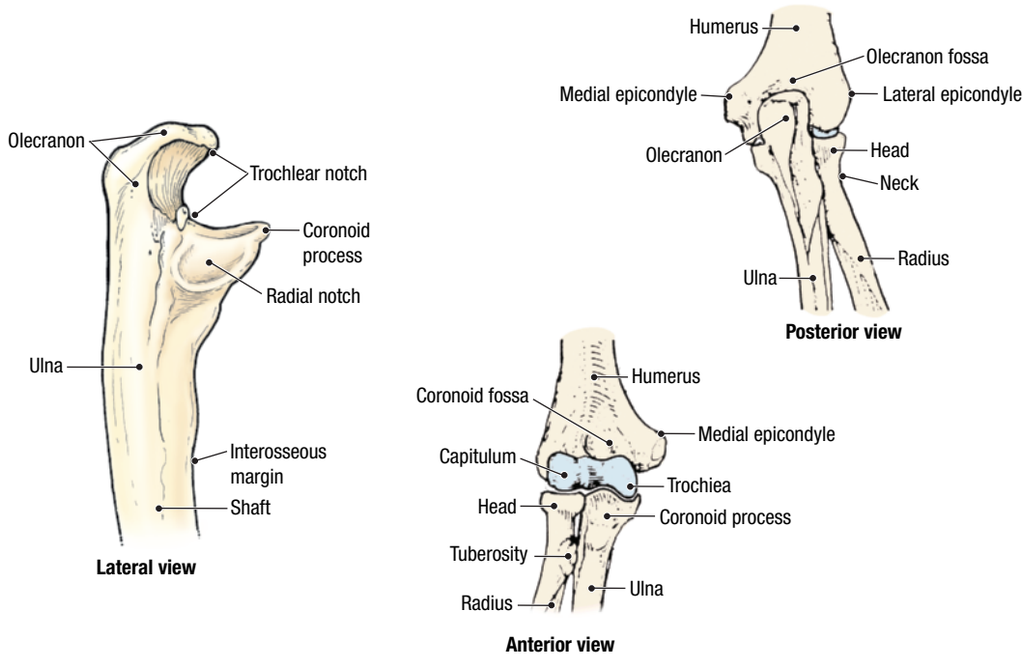

Figure 2.11. Skeleton of the elbow region.

On the **radius** identify:

- **Head**
- **Neck**
- **Tuberosity**

On the **ulna** identify:

- **Olecranon**

Dissection Instructions

ANTERIOR COMPARTMENT OF THE ARM [G 501, 502; N 414; R 401; C 32, 33]

1. Place the cadaver in the supine position.
2. Use scissors to make a longitudinal incision in the anterior surface of the brachial fascia from the level of the pectoralis major tendon to the elbow.
3. Use your fingers to separate the brachial fascia from the underlying muscles. Work laterally and medially from the incision and note the presence of the **lateral intermuscular septum** and the **medial intermuscular septum**.
4. Use your fingers to separate the three muscles in the anterior compartment of the arm: **coracobrachialis**, **brachialis**, and **biceps brachii** (Fig. 2.12).
5. The **biceps brachii muscle** has two proximal attachments on the scapula:
   - **Short head of the biceps brachii muscle** attaches to the coracoid process of the scapula.
   - **Long head of the biceps brachii muscle** attaches to the supraglenoid tubercle of the scapula. The tendon of the **long head of the biceps brachii**

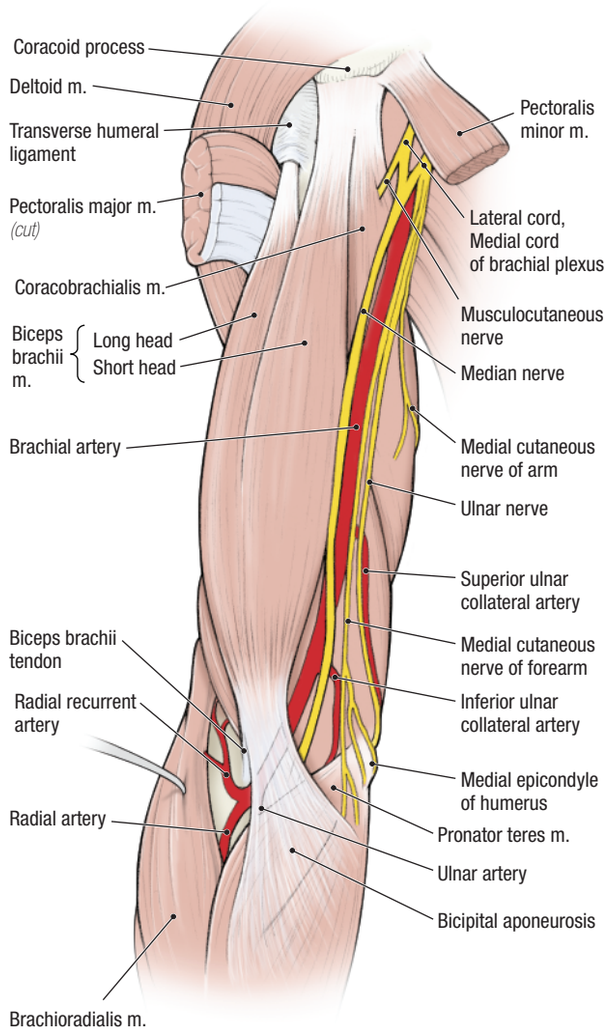

Figure 2.12. Contents of the anterior compartment of the arm.

muscle courses through the intertubercular sulcus of the humerus posterior to the **transverse humeral ligament**, and then enters the shoulder joint. Do not follow the tendon of the long head to its attachment on the scapula.

6. Identify the **biceps brachii tendon** at the level of the elbow. The distal attachment of the biceps brachii muscle is on the tuberosity of the radius. The biceps brachii muscle supinates and flexes the forearm.
7. Identify the **bicipital aponeurosis** (Fig. 2.12). The bicipital aponeurosis is a broad extension of the biceps tendon that attaches to the antebrachial fascia. The bicipital aponeurosis is located on the medial side of the biceps brachii tendon.
8. Find the **musculocutaneous nerve** in the axilla (Fig. 2.12). Follow the musculocutaneous nerve distally until it enters **coracobrachialis muscle**. Note that the musculocutaneous nerve innervates the three muscles of the anterior compartment of the arm.
9. Use your fingers to confirm that the proximal attachment of the coracobrachialis muscle is the coracoid process and that its distal attachment is on the medial side of the shaft of the humerus. The coracobrachialis muscle adducts and flexes the humerus.
10. Use scissors to transect the biceps brachii muscle approximately 5 cm proximal to the elbow. Preserve the musculocutaneous nerve. Reflect the two portions of the biceps brachii muscle proximally and distally, respectively.
11. Observe the **brachialis muscle**, which is deep to the biceps brachii muscle. The proximal attachment of the brachialis muscle is the anterior surface of the distal one-half of the humerus and its distal attachment is on the coronoid process of the ulna. The brachialis muscle flexes the forearm.
12. Follow the **musculocutaneous nerve** through the plane of loose connective tissue between the biceps brachii muscle and brachialis muscle.
13. After the musculocutaneous nerve gives off its muscular branches, it continues distally as the **lateral cutaneous nerve of the forearm**. Follow the lateral cutaneous nerve of the forearm to the cubital fossa, where it emerges near the lateral side of the biceps brachii tendon. Review the relationship of the lateral cutaneous nerve of the forearm to the cephalic vein.
14. Follow the **medial cutaneous nerve of the forearm** from the brachial plexus to the level of the elbow (Fig. 2.12). Note its relationship to the basilic vein at the level of the elbow.
15. Find the **median nerve** where it arises from the brachial plexus (Fig. 2.12). Use blunt dissection to follow the median nerve from the axilla to the cubital fossa. The median nerve courses distally within the **medial intermuscular septum** with the **brachial artery**.
16. Use blunt dissection to follow the **ulnar nerve** from the medial cord of the brachial plexus to the medial epicondyle of the humerus (Fig. 2.12). Note that the ulnar nerve is in contact with the posterior surface of the medial epicondyle of the humerus. Palpate the ulnar nerve on yourself where it passes posterior to the medial epicondyle.
17. Identify the **brachial artery**. The brachial artery is the continuation of the axillary artery. The brachial artery begins at the inferior border of the teres major muscle and ends at the level of the elbow by branching into the **ulnar artery** and **radial artery** (Fig. 2.12). Verify that the brachial artery courses with the median nerve within the medial intermuscular septum, and that the median nerve is the only large structure to cross the brachial artery. **[G 503; N 416; R 401; C 34, 35]**
18. The brachial artery has three named branches in the arm: **deep artery of the arm**, **superior ulnar collateral artery**, and **inferior ulnar collateral artery**. Several unnamed muscular branches also arise along the length of the brachial artery.
19. Remove the brachial veins and their tributaries to clear the dissection field. Preserve the branches of the brachial artery.
20. Find the **deep artery of the arm** (**deep brachial artery**, **profunda brachii artery**) where it arises from the brachial artery. The deep artery of the arm courses around the posterior surface of the humerus, where it accompanies the radial nerve in the radial groove. The course of the deep artery of the arm will be seen when the posterior compartment of the arm is dissected.
21. Identify the **superior ulnar collateral artery** (Fig. 2.12). It arises from the brachial artery near the middle of the arm. It courses distally with the ulnar nerve and passes posterior to the medial epicondyle of the humerus.
22. Find the **inferior ulnar collateral artery** (Fig. 2.12). It arises from the brachial artery approximately 3 cm above the medial epicondyle of the humerus and passes anterior to the medial epicondyle between the **brachialis muscle** and the **pronator teres muscle.**

CLINICAL CORRELATION

Brachial Artery [G 530; N 417; R 385; C 27]

Use an illustration to study the collateral circulation around the elbow joint (Fig. 2.13). The brachial artery may become blocked at any level distal to the deep artery of the arm without completely blocking blood flow to the forearm and hand.

In the arm, the brachial artery lies medial to the biceps brachii muscle and close to the shaft of the humerus. The brachial artery is compressed at this location when taking a blood pressure reading.

CUBITAL FOSSA [G 518-520; N 416; R 405-407; C 44, 48]

The **cubital fossa** (L. *cubitus*, elbow) is the depression on the anterior aspect of the elbow. The cubital fossa is clinically important because it contains superficial veins that are used for venipuncture. Large nerves and vessels pass through this region to enter the forearm.

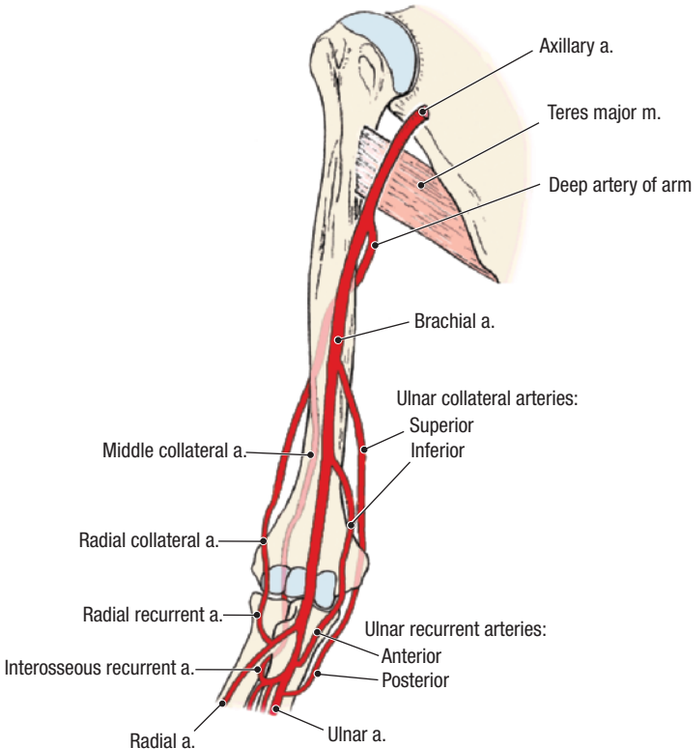

Figure 2.13. Brachial artery and its branches.

1. Note the **boundaries of the cubital fossa**:
   - **Lateral boundary –** brachioradialis muscle
   - **Medial boundary –** pronator teres muscle
   - **Superior boundary –** an imaginary line connecting the medial and lateral epicondyles of the humerus
   - **Superficial boundary (roof of the cubital fossa) –** antebrachial fascia reinforced by the bicipital aponeurosis
   - **Deep boundary (floor of the cubital fossa) –** brachialis and supinator muscles
2. Review the positions of the cephalic vein, basilic vein, and median cubital vein in the cubital fossa. To gain access to deeper structures, it may be necessary to cut the median cubital vein and retract its halves medially and laterally, respectively.
3. Find the **tendon of the biceps brachii muscle** in the cubital fossa.
4. Cut the **bicipital aponeurosis** near the biceps brachii tendon and reflect the aponeurosis medially. Do not cut the brachial artery, which lies deep to the bicipital aponeurosis.
5. Follow the **median nerve** and the **brachial artery** from the arm into the cubital fossa. Remove any fat that may be obstructing your view of these structures.
6. Observe the relative positions of the structures in the cubital fossa (Fig. 2.12): the biceps brachii tendon is lateral, the brachial artery is intermediate, and median nerve is medial. Note that the bicipital aponeurosis passes superficial to the brachial artery and median nerve, but it lies deep to the superficial veins. The bicipital aponeurosis protects the brachial artery and median nerve from injury during venipuncture.

POSTERIOR COMPARTMENT OF THE ARM [G 505, 506; N 415; R389, 390; C 36]

1. Place the cadaver in the prone position.
2. To gain better access to the posterior compartment, rotate the arm medially.
3. Use scissors to open the posterior compartment of the arm by making a longitudinal incision through the brachial fascia from the level of the olecranon of the ulna to the teres minor muscle.
4. Use your fingers to clean and define the borders of the **triceps brachii muscle**. The triceps brachii muscle has three proximal attachments:
   - **Long head of the triceps brachii muscle** attaches to the infraglenoid tubercle of the scapula.
   - **Lateral head of the triceps brachii muscle** attaches to the posterior surface of the humerus superior to the radial groove.
   - **Medial head of the triceps brachii muscle** attaches to the posterior surface of the humerus inferior to the radial groove.
5. Observe the distal attachment of the triceps brachii tendon on the olecranon of the ulna. The triceps brachii muscle extends the forearm.
6. Use your fingers to separate the **long head of the triceps brachii** from the **lateral head**. Observe that the teres major muscle crosses the anterior surface of the long head.
7. Inferior to the teres major muscle is an opening between the long head of the triceps brachii muscle and lateral head of the triceps brachii muscle (Fig. 2.14). Use a probe to widen this opening and identify the **radial nerve** and the **deep artery of the arm.**
8. Push a probe distally along the course of the radial nerve. The probe should be positioned between the lateral head of the triceps brachii muscle and the humerus (Fig. 2.14).
9. Use a scalpel to transect the lateral head of the triceps brachii muscle over the probe. This cut will separate the lateral head of the triceps brachii muscle from the medial head.
10. Use a probe to clean the radial nerve and the deep artery of the arm. Observe that the radial nerve and deep artery of the arm lie directly on the posterior surface of the humerus in the **radial groove**.
11. Confirm the course of the radial nerve through the posterior compartment to the elbow. To do this, return to the cubital fossa. On the lateral aspect of the forearm, identify the **brachioradialis muscle**. Use your fingers to open the connective tissue plane between the brachioradialis muscle and the brachialis muscle. Deep in this plane of connective tissue, find the radial nerve.
12. Follow the radial nerve proximally. Note that the radial nerve passes on the flexor side of the elbow joint and that it is accompanied by the radial recurrent artery (Fig. 2.12).
13. Identify the **anconeus muscle** (Fig. 2.14). The proximal attachment of the anconeus muscle is the lateral epicondyle of the humerus. The distal attachment is the lateral surface of the olecranon and superior part of the posterior surface of the ulna. The anconeus muscle assists the triceps brachii muscle in extension of the forearm.

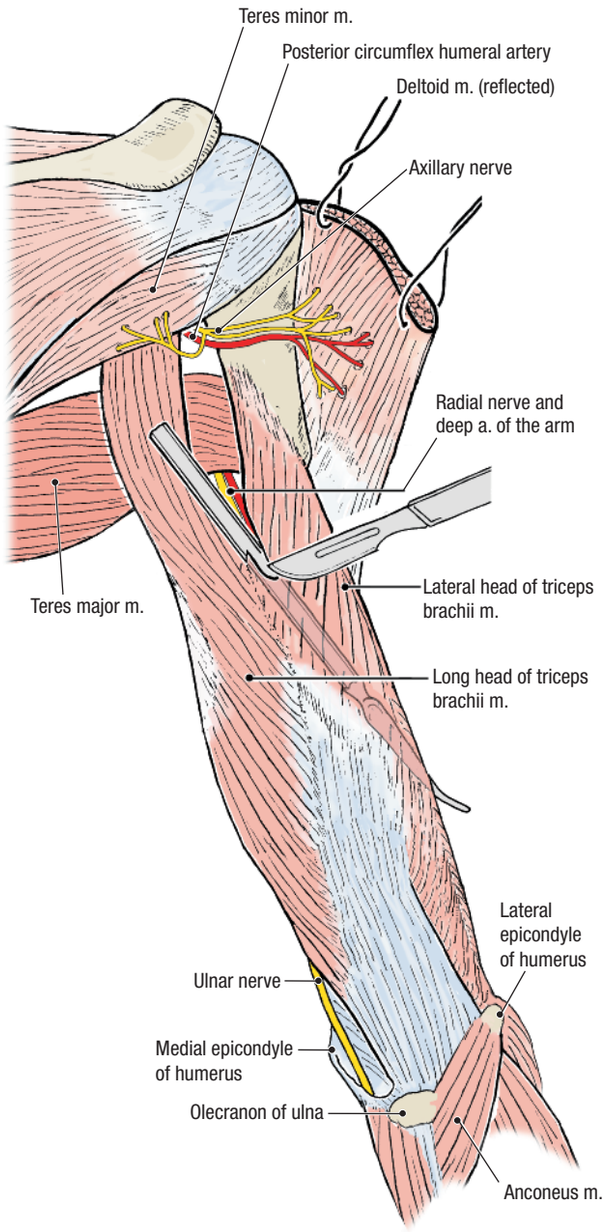

Figure 2.14. How to transect the lateral head of the triceps brachii muscle.

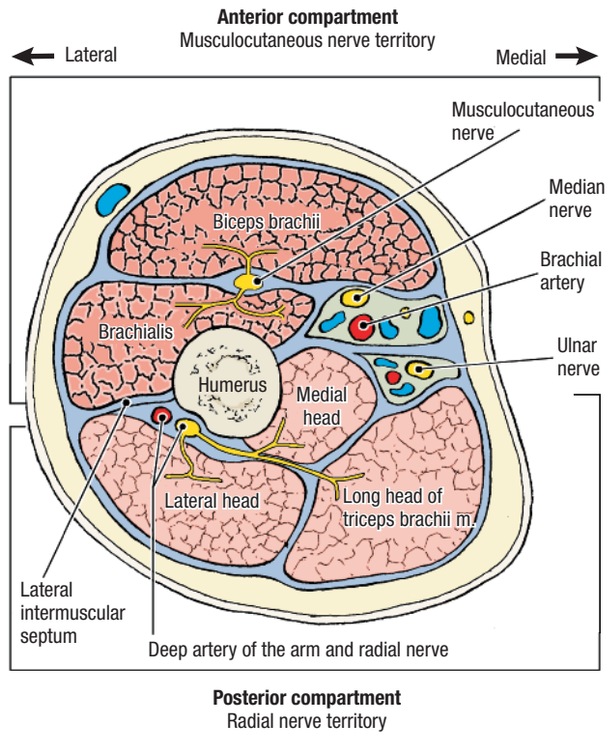

Figure 2.15. Compartments of the right arm with contents.

FLEXOR REGION OF THE FOREARM

Before you dissect . . .

The antebrachial fascia is a sleeve of connective tissue that invests the forearm. Intermuscular septa project inward from it and attach the antebrachial fascia to the radius and ulna (Fig. 2.16). The intermuscular septa, the interosseous membrane, the radius, and the ulna combine to divide the forearm into an **anterior (flexor) compartment** and a **posterior (extensor) compartment**. At the level of the wrist, the antebrachial fascia is thickened posteriorly to create a strong transverse band called the **extensor retinaculum**.

The muscles in the anterior compartment of the forearm can be divided into a **superficial group of flexor muscles** and a

After you dissect . . .

Replace the muscles of the anterior and posterior compartments of the arm in their correct anatomical positions. Review the proximal attachment, distal attachment, nerve, and action of each muscle. Use the dissected specimen to review the origin, course, termination, and branches of the brachial artery. Trace each nerve that you have dissected from the brachial plexus to the elbow, reviewing relationships. Review a drawing of a cross-section of the arm and notice the position of the brachial fascia and the intermuscular septa relative to the structures that you have dissected. Review the nerve territories of the brachial region (Fig. 2.15). Recall the rules of innervation of the muscles of the arm: **all muscles in the anterior compartment of the arm are innervated by the musculocutaneous nerve. All muscles in the posterior compartment of the arm are innervated by the radial nerve.** ***The median nerve and the ulnar nerve do not innervate muscles in the arm.***

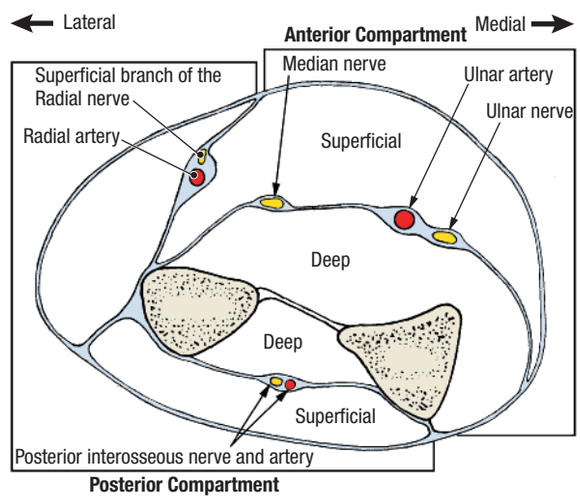

Figure 2.16. Compartments of the right forearm.

deep group of flexor muscles. Muscles of the superficial flexor group arise primarily from the medial epicondyle of the humerus and its supracondylar ridge. Muscles of the deep flexor group arise from the anterior surfaces of the radius, ulna, and interosseous membrane. Study a transverse section through the mid-level of the forearm (Fig. 2.16). Note that the ulnar artery, ulnar nerve, and median nerve are in a connective tissue plane that separates the superficial flexor group from the deep flexor group.

SKELETON OF THE FOREARM [G 524, 532, 554; N 419, 422; R 361, 362; C 76, 77]

Refer to a skeleton. On the **humerus**, identify (Fig. 2.17):

- **Medial epicondyle**
- **Medial supracondylar ridge**
- **Lateral epicondyle**
- **Lateral supracondylar ridge**
- **Capitulum**
- **Trochlea**
- **Olecranon fossa**

On the **radius** identify (Fig. 2.17):

- **Head**
- **Neck**
- **Tuberosity**
- **Anterior oblique line**
- **Ulnar notch**
- **Styloid process**
- **Interosseous border** for attachment of the **interosseous membrane**

On the **ulna** identify (Fig. 2.17):

- **Olecranon**
- **Trochlear notch**
- **Radial notch**
- **Head**
- **Interosseous border** for attachment of the interosseous membrane

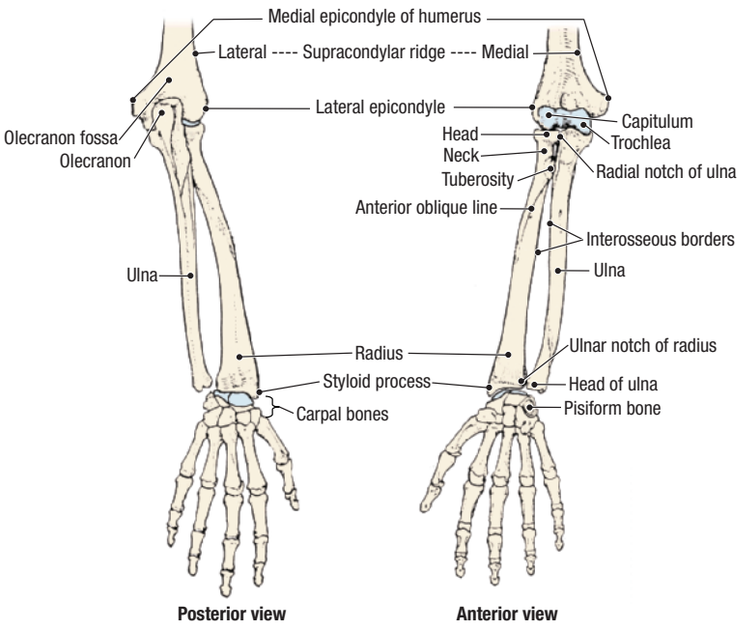

Figure 2.17. Skeleton of the forearm.

On the palmar surface of the articulated hand, identify the **pisiform bone** (Fig. 2.17).

On the skeleton, examine the **elbow joint**. The elbow joint is the articulation between the trochlear notch of the ulna and the trochlea of the humerus, and the articulation between the head of the radius and the capitulum of the humerus. These two articulations account for the hinge action of the elbow joint.

Observe the **proximal radioulnar joint** between the head of the radius and the radial notch of the ulna. Observe the **distal radioulnar joint** between the head of the ulna and the ulnar notch of the radius. Pronate and supinate the hand and notice the rotational movements that occur in the proximal and distal radioulnar joints. In the position of supination (anatomical position), the radius and the ulna are parallel. In the position of pronation, the radius crosses the ulna.

The order of dissection will be as follows: the structures in the superficial fascia will be reviewed and the antebrachial fascia will be removed. At the level of the wrist, the relative positions of tendons, vessels, and nerves will be studied. The superficial group of flexor muscles will be studied and then reflected. Vessels and nerves that lie between the superficial and deep groups of flexor muscles will be studied. The deep group of flexor muscles will be dissected.

Dissection Instructions

SUPERFICIAL GROUP OF FLEXOR MUSCLES [G 534, 535; N 429; R 408; C 44]

1. Place the cadaver in the supine position and abduct the upper limb. Forcefully supinate the hand and have your dissection partner hold it in this position.
2. Use blunt dissection to remove the remnants of the superficial fascia, taking care to preserve the cephalic and basilic veins.
3. Use scissors to incise the anterior surface of the antebrachial fascia from the cubital fossa to the wrist. Use your fingers or a probe to separate the antebrachial fascia from the muscles that lie deep to it. Detach the antebrachial fascia from its attachments to the radius and ulna and place it in the tissue container.
4. Use blunt dissection to clean the **superficial group of flexor muscles**. There are five muscles in this group: **Pronator teres**, **flexor carpi radialis**, **palmaris longus**, **flexor carpi ulnaris**, and **flexor digitorum superficialis**. Note that part of the proximal attachment of these muscles is from a **common flexor tendon**. The common flexor tendon is attached to the medial epicondyle of the humerus.
5. Note the distal attachment and action of each muscle of the superficial group of flexors:
   - **Pronator teres muscle** attaches to the middle of the lateral surface of the radius. The pronator teres muscle pronates the hand and flexes the forearm.
   - **Flexor carpi radialis tendon** attaches to the base of the second metacarpal bone. The flexor carpi radialis muscle flexes and abducts the hand.
   - **Palmaris longus tendon** attaches to the palmar aponeurosis. The palmaris longus muscle flexes the hand.

- **Flexor carpi ulnaris tendon** attaches to the pisiform bone, hamate bone, and the base of the fifth metacarpal bone. The flexor carpi ulnaris muscle flexes and adducts the hand.
- **Flexor digitorum superficialis tendon** attaches to the middle phalanx of digits 2 to 5. The flexor digitorum superficialis muscle flexes the middle phalanx of digits 2 to 5.

6. Use your fingers to separate the tendons of the superficial group of flexor muscles. Note that the muscle bellies cannot be easily separated from each other. From lateral to medial, identify the superficial structures at the wrist (Fig. 2.18): **[G 539; N 429; R 408; C 44]**
   - Tendon of the **abductor pollicis longus muscle**
   - **Radial artery**
   - Tendon of the **flexor carpi radialis muscle**
   - **Median nerve**
   - Tendon of the **palmaris longus muscle** (absent in 13% of limbs)
   - Four tendons of the **flexor digitorum superficialis muscle**
   - **Ulnar artery** and **ulnar nerve**
   - Tendon of the **flexor carpi ulnaris muscle**
7. Palpate the tendons listed above in your own wrist. Feel the pulse of the radial artery between the tendons of the abductor pollicis longus and flexor carpi radialis muscles. The median nerve is superficial at the wrist and can be easily injured. Palpate the distal attachment of the flexor carpi ulnaris tendon on the pisiform bone. Palpate the ulnar nerve and artery, which lie immediately lateral to the pisiform bone.

VESSELS AND NERVES [G 536; N 430; R 408; C 48]

1. On the lateral side of the proximal forearm, identify the **brachioradialis muscle**. At the point where the pronator teres muscle passes deep to the brachioradialis muscle, use your fingers to open the connective tissue plane that is medial to the brachioradialis muscle. In this intermuscular plane, identify the **superficial branch of the radial nerve**, which courses distally on the deep surface of the brachioradialis muscle. Trace the superficial branch of the radial nerve distally and confirm that it becomes subcutaneous near the wrist.
2. Once again, identify the **brachial artery** in the cubital fossa**.** Use blunt dissection to trace the brachial artery distally until it bifurcates into the **radial artery** and the **ulnar artery**.

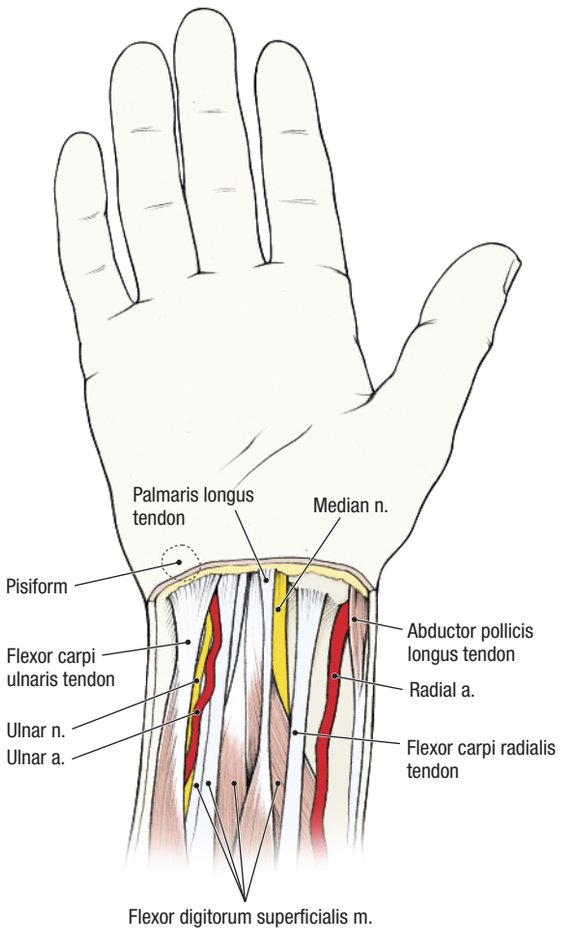

Figure 2.18. Structures of the anterior aspect of the wrist.

CLINICAL CORRELATION

High Bifurcation of the Brachial Artery

In approximately 3% of upper limbs, the brachial artery bifurcates in the arm. When it does, the ulnar artery may course superficial to the superficial group of flexor muscles. When this happens, the ulnar artery may be mistaken for a vein. When certain drugs are injected into an artery, the capillary bed is damaged, followed by gangrene. In the example of the ulnar artery, the hand could be severely injured.

3. Use a probe to clean the radial artery and follow it distally to the level of the wrist. The radial vein and its tributaries may be removed to clear the dissection field. The radial artery gives rise to several unnamed muscular branches in the forearm.
4. Find the **radial recurrent artery**, which arises from the radial artery near its origin from the brachial artery. The radial recurrent artery courses proximally in the connective tissue plane between the brachioradialis muscle and the brachialis muscle. The radial recurrent artery anastomoses with the radial collateral branch of the deep artery of the arm. The radial recurrent artery is part of the anastomotic network around the elbow (Fig. 2.13).
5. Identify the **median nerve** in the cubital fossa. It is medial to the brachial artery. The median nerve innervates most of the muscles of the flexor compartment of the forearm.

6. Follow the median nerve distally. The median nerve courses deep to the superficial group of flexor muscles. To expose the median nerve, use scissors to cut the tendon of the palmaris longus muscle approximately 3 cm proximal to the wrist and reflect the muscle belly proximally. Cut the tendon of the flexor carpi radialis muscle approximately 5 cm proximal to the wrist and reflect it proximally.
7. Insert a probe through the pronator teres muscle along the anterior surface of the median nerve. Use scissors to cut the portion of the pronator teres muscle that lies anterior to the median nerve. Use a probe to release the median nerve and follow it distally.
8. Observe that the median nerve passes deep to the flexor digitorum superficialis muscle. Use scissors to detach the flexor digitorum superficialis muscle from its proximal attachment to the radius. Retract the muscle medially, leaving its ulnar and humeral attachments undisturbed.
9. Use a probe to free the median nerve from the loose connective tissue that lies between the superficial and deep groups of forearm flexor muscles (Fig. 2.16). Observe that the median nerve innervates the palmaris longus, flexor carpi radialis, flexor digitorum superficialis, and pronator teres muscles.
10. Find the **ulnar artery** in the cubital fossa. The ulnar artery passes posterior to the deep part of the pronator teres muscle. To follow the ulnar artery distally, release it from the pronator teres muscle. Insert a probe through the pronator teres muscle along the anterior surface of the ulnar artery (posterior to the deep part of the pronator teres muscle). Use scissors to cut the deep part of the pronator teres muscle. The pronator teres muscle is now completely transected and it may be reflected to broaden the dissection field.
11. Use a probe to clean the ulnar artery and follow it from the cubital fossa to the wrist. The ulnar vein and its tributaries may be removed to clear the dissection field. Observe that the median nerve crosses anterior to the ulnar artery in the cubital fossa. Note that the ulnar artery passes between the flexor digitorum superficialis and the flexor digitorum profundus muscles to reach the ulnar (medial) side of the forearm.
12. Find the **common interosseous artery**. It arises approximately 3 cm distal to the origin of the ulnar artery from the brachial artery. The common interosseous artery is usually quite short. It passes posterolaterally toward the interosseous membrane before dividing into the **anterior interosseous artery** and the **posterior interosseous artery**.
13. Identify the **anterior interosseous artery** on the anterior surface of the interosseous membrane. The anterior interosseous artery supplies the deep group of flexor muscles.
14. The **posterior interosseous artery** passes over the proximal end of the interosseous membrane to reach the posterior compartment of the forearm. The posterior interosseous artery supplies the extensor group of forearm muscles. Identify it, but do not attempt to follow it into the posterior compartment at this time.
15. Two other named vessels arise from the ulnar artery in the proximal forearm: **anterior ulnar recurrent artery** and **posterior ulnar recurrent artery**. They anastomose with the superior and inferior ulnar collateral branches of the brachial artery, respectively (Fig. 2.13). Do not attempt to find these vessels. Note that unnamed muscular branches arise from the ulnar artery in the forearm.
16. Observe that the ulnar artery joins the **ulnar nerve** approximately one-third of the way down the forearm.
17. Follow the ulnar nerve proximally and observe that it passes between the two heads of the flexor carpi ulnaris muscle. The ulnar nerve innervates the flexor carpi ulnaris muscle and the medial one-half of the flexor digitorum profundus muscle.

DEEP GROUP OF FLEXOR MUSCLES [G 537; N 431; R 409; C 50]

1. Three muscles comprise the **deep group of flexor muscles**: **flexor digitorum profundus**, **flexor pollicis longus**, and **pronator quadratus**.
2. The proximal attachment of the **flexor digitorum profundus muscle** is the anterior surface of the ulna and interosseous membrane. Distally, the flexor digitorum profundus tendons attach to the distal phalanx of digits 2 to 5. The flexor digitorum profundus muscle flexes the distal phalanx of digits 2 to 5. The lateral one-half of the flexor digitorum profundus muscle is innervated by the median nerve. The medial one-half of the flexor digitorum profundus muscle is innervated by the ulnar nerve.
3. The proximal attachment of the **flexor pollicis longus muscle** is the anterior surface of the radius and interosseous membrane. The distal attachment of the flexor pollicis longus tendon is the distal phalanx of digit 1 (thumb). The flexor pollicis longus muscle flexes digit 1.
4. The **pronator quadratus muscle** lies posterior to the tendons of the superficial and deep flexor muscles. Its fibers run transversely from the ulna to the radius in the distal one-fourth of the forearm. Retract the tendons of the superficial and deep groups of flexor muscles and find the pronator quadratus muscle. The pronator quadratus muscle pronates the hand.
5. Observe that the **anterior interosseous artery and nerve** pass posterior to the pronator quadratus muscle.

After you dissect . . .

Replace the flexor muscles in their correct anatomical positions. Use the dissected specimen to review the proximal attachment, distal attachment, and action of each muscle dissected. Organize these muscles into a superficial group and a deep group and recall that the nerves and vessels that course through the forearm are found between the two groups. Follow the brachial artery from its origin in the proximal arm to its bifurcation in the cubital fossa. Review all of the branches of the radial and ulnar arteries. Trace the course of these two arteries from the elbow to the wrist. Review the course of the median nerve from the

brachial plexus to the wrist. Review the course of the ulnar nerve from the brachial plexus to the wrist. Recall the rule for innervation of the muscles in the anterior compartment of the forearm: **all muscles of the anterior compartment of the forearm are innervated by the median nerve** ***except the flexor carpi ulnaris muscle and the medial one-half of the flexor digitorum profundus muscle, which are innervated by the ulnar nerve.***

PALM OF THE HAND

Before you dissect . . .

The **intrinsic hand muscles** have their proximal and distal attachments within the hand. There are two superficial groups of intrinsic hand muscles: the **thenar group of muscles** forms the **thenar eminence**, and the **hypothenar group of muscles** forms the **hypothenar eminence**. Deep in the hand is a third group of intrinsic hand muscles: the interosseous muscles and the adductor pollicis muscle.

In the middle of the palm, the palmar fascia is thickened to form the palmar aponeurosis. The palmar fascia over the thenar and hypothenar eminences is much thinner. Deep to the palmar aponeurosis are the tendons of the superficial and deep digital flexor muscles. These tendons reach the palm through the carpal tunnel and are responsible for flexing the digits. In the deepest part of the palm are small muscles that abduct and adduct the digits.

The palm is supplied with blood by two arterial arches. The superficial arch is mainly derived from the ulnar artery and the deep arch from the radial artery. The nerve supply of the palmar aspect of the hand is derived from the median and ulnar nerves.

The order of dissection will be as follows: the palmar aponeurosis will be studied and removed. The superficial palmar arch will be dissected, followed by the tendons of the muscles of the anterior compartment of the forearm. The flexor retinaculum will be cut and the flexor tendons will be released from the palm. The muscles of the thenar group will be dissected, followed by the muscles of the hypothenar group. The deep palmar arch will be dissected along with the deep branch of the ulnar nerve. The interosseous muscles will be studied.

SKELETON OF THE HAND [G 532, 554; N 439; R 364, 365; C 78, 79]

Refer to an articulated skeleton of the hand and identify (Fig. 2.19):

- **Eight carpal bones** (Gr. *karpos*, wrist)
- **Five metacarpal bones**
- **14 phalanges**

Be able to identify the eight carpal bones in an articulated skeleton. Digit 1 (thumb) has two phalanges: proximal and distal. Digits 2 to 5 (fingers) have three phalanges: proximal, middle, and distal.

Identify the **pisiform bone** and the **hook of the hamate** on the medial side of the wrist. On the lateral side of the wrist, identify the **tubercle of the scaphoid** and the **tubercle of the trapezium**. The **flexor retinaculum** bridges these four bones (Fig. 2.20). The space between the carpal bones and the flexor retinaculum is the **carpal tunnel**, which allows passage of the flexor tendons and the median nerve into the hand.

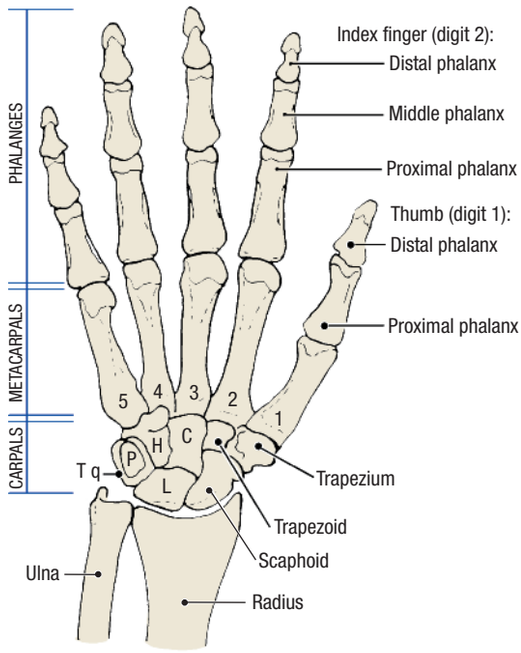

Figure 2.19. Skeleton of the hand. The eight carpal bones include a proximal row of four bones (scaphoid; lunate, *L*; triquetrum, *Tq*; pisiform, *P*) and a distal row of four bones (trapezium; trapezoid; capitate, C; hamate, *H*).

Dissection Instructions

SUPERFICIAL PALM [G 541; N 442, 443; R 412; C 62, 68]

1. Use scraping motions with a dull scalpel blade to clean the fat from the **palmar aponeurosis**. Observe that the palmar aponeurosis has four bands of **longitudinal fibers**, one band to each of digits 2 to 5. These longitudinal fibers end by attaching to the fibrous digital sheath near the base of the proximal phalanx of each digit.
2. Identify the fascia of the **thenar muscles** lateral to the palmar aponeurosis.
3. Identify the fascia of the hypothenar muscles medial to the palmar aponeurosis. The **palmaris brevis muscle** is found superficial to the hypothenar muscles. It is a thin, fragile muscle. The proximal attachment of the

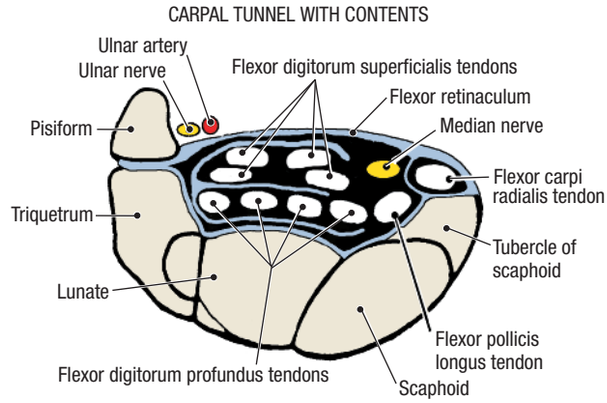

Figure 2.20. Transverse section through the left carpal tunnel.

palmaris brevis muscle is the medial aspect of the palmar aponeurosis. Its distal attachment is the skin over the hypothenar eminence.

4. Detach the palmaris brevis muscle from the palmar aponeurosis and reflect it medially.
5. Find the tendon of the **palmaris longus muscle** where you transected it in the forearm. Follow the palmaris longus tendon distally into the palm, where it is attached to the palmar aponeurosis. Although the palmaris longus muscle may be absent, the palmar aponeurosis is always present.
6. Remove the palmar aponeurosis. Use a scalpel and skinning motions to detach the palmar aponeurosis from the underlying deep structures. Begin at its proximal end and proceed distally. Use the palmaris longus tendon to apply traction to the palmar aponeurosis during its removal. Do not cut too deeply, because the superficial palmar arch is in contact with the deep surface of the palmar aponeurosis.
7. Near the proximal end of digits 2 to 5, remove the band of longitudinal fibers of the palmar aponeurosis. Use blunt dissection to clean the **fibrous digital sheath** on the flexor surface of digit 3 (Fig. 2.21).
8. Find the **ulnar artery** in the forearm. Use a probe to dissect the ulnar artery and follow it into the palm. The ulnar artery passes lateral to the pisiform bone with the ulnar nerve, and then divides into a **superficial branch** and a **deep palmar branch.** The superficial branch of the ulnar artery crosses the palm to form the **superficial palmar arch**. The superficial palmar arch is completed by a smaller contribution from the **superficial palmar branch of the radial artery** (Fig. 2.22). **[G 546; N 443; R 414; C 68]**
9. Use a probe to clean the superficial palmar arch and the three **common palmar digital arteries** arising from it. Trace one common palmar digital artery distally and note that it divides into two **proper palmar digital arteries** that supply the adjacent sides of two digits.
10. Find the **ulnar nerve** lateral to the pisiform bone. Use a probe to dissect the **superficial branch of the ulnar nerve**, which supplies cutaneous innervation to digit 5 and the medial side of digit 4. The **deep branch of the ulnar nerve** disappears into the hypothenar muscles. Identify the initial portion of the deep branch of the ulnar nerve but do not follow it at this time.

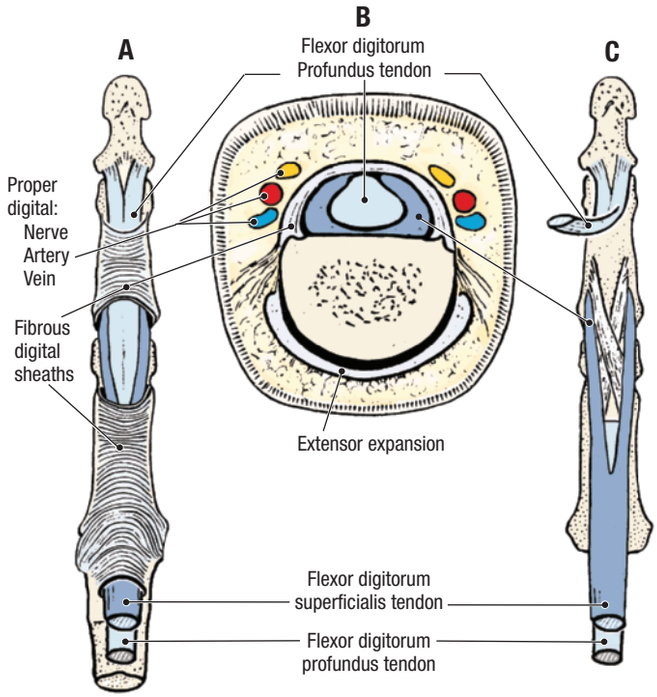

Figure 2.21. Flexor tendons in the finger. **A.** Fibrous digital sheath showing the two osseofibrous tunnels. **B.** Transverse section of a finger showing the fibrous digital sheath surrounding the flexor tendons. **C.** Distal attachment of the flexor tendons.

CARPAL TUNNEL [G 547; N 444; R 415; C 65]

1. Identify the **flexor retinaculum** between the thenar and hypothenar eminences. Use an illustration to review the flexor retinaculum and its role in the formation of the **carpal tunnel** (Fig. 2.21).
2. Insert a probe from proximal to distal, deep to the flexor retinaculum (Fig. 2.23). Use a scalpel to cut through the flexor retinaculum to the probe. Open the carpal tunnel.
3. Examine the **contents of the carpal tunnel**: **median nerve**, **four tendons of the flexor digitorum superficialis muscle**, **four tendons of the flexor digitorum profundus muscle**, and the **tendon of the flexor pollicis longus muscle**.
4. Find the median nerve at the level of the wrist and follow it through the carpal tunnel. Identify the **recurrent branch of the median nerve**, which innervates the three thenar muscles (Fig. 2.23). The median nerve also innervates **lumbrical muscles 1 and 2**.
5. Follow the **common palmar digital branches** of the median nerve to the lateral 3 1/2: digits (Fig. 2.22). Note that the common palmar digital nerves typically divide to give rise to two **proper palmar digital nerves**, which accompany the proper palmar digital arteries. Use an illustration to study the cutaneous distribution of the median nerve in the hand. **[G 559; N 455; R 409; C 24]**
6. Identify the flexor tendons that pass through the carpal tunnel. Observe that these tendons pass through the palm of the hand posterior to the superficial palmar arch and digital nerves. The flexor tendons enter the **fibrous digital sheaths** on the anterior surfaces of the digits (Fig. 2.21).
7. Use an illustration to study the extent of the synovial tendon sheaths deep to the flexor retinaculum and extending into the palm. There are two sets of synovial sheaths: one **common flexor sheath (ulnar bursa)** and three **digital synovial sheaths**. The tendon of the flexor pollicis longus muscle has it own synovial sheath (**radial bursa**). **[G 548; N 445, 446; R 378, 379; C 63]**

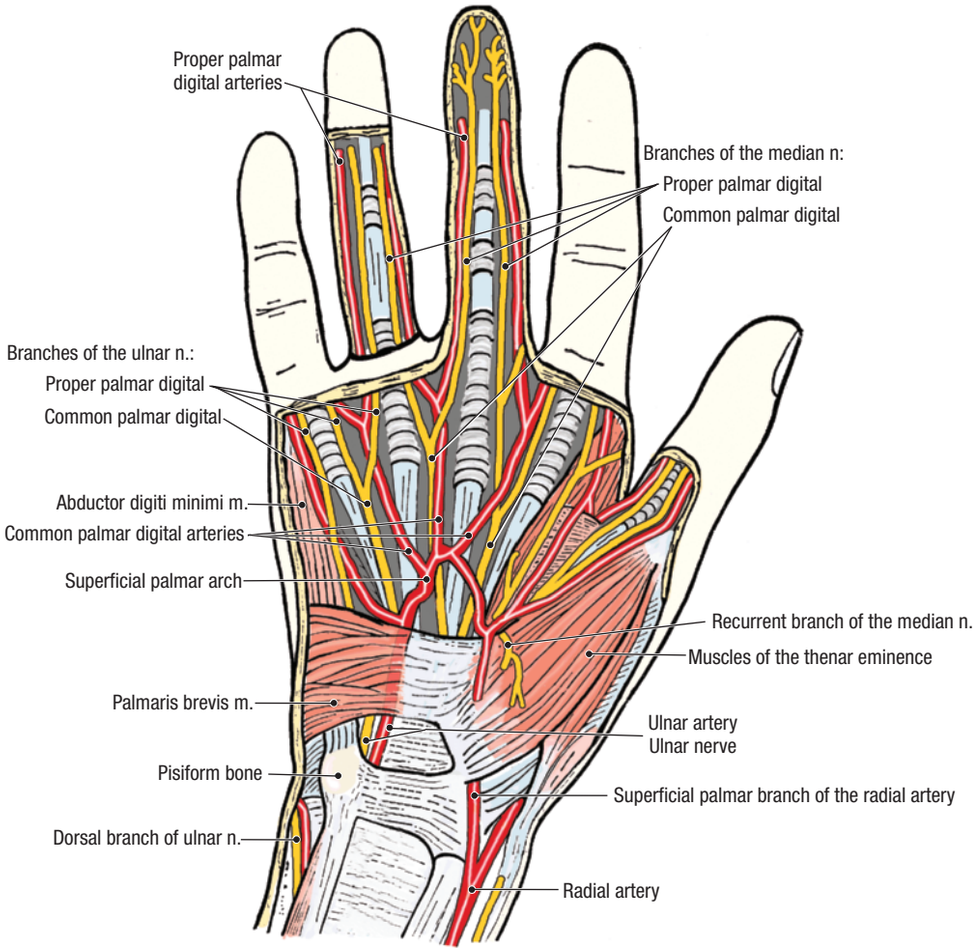

Figure 2.22. Superficial dissection of the palm.

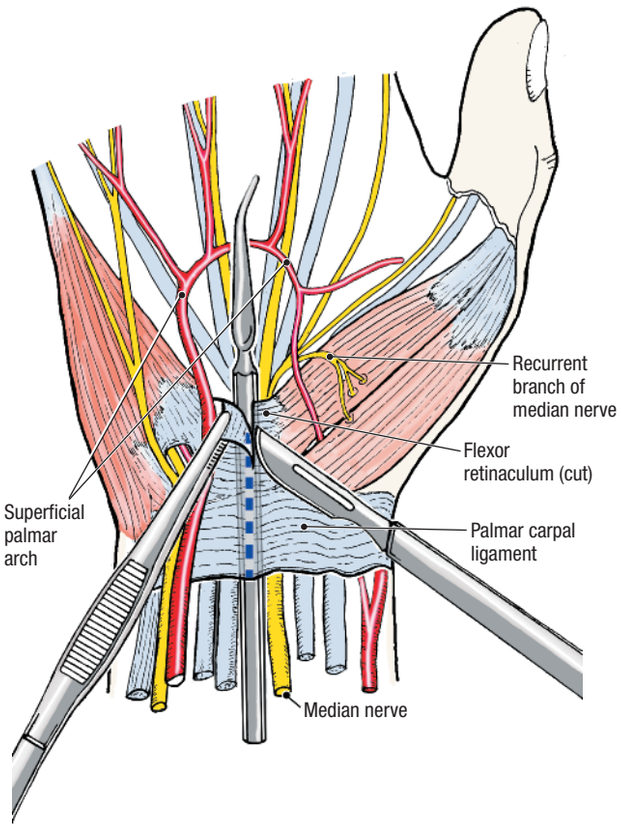

Figure 2.23. How to open the carpal tunnel.

CLINICAL CORRELATION

Carpal Tunnel Syndrome

A swelling of the common flexor sheath may encroach on the available space in the carpal tunnel. As a result, the median nerve may be compressed resulting in pain and paresthesia of the thumb, index finger, and middle finger, and weakness of the thenar muscles.

8. In the distal forearm, use your fingers to separate the tendons of the **flexor digitorum superficialis** muscle from the tendons of the **flexor digitorum profundus muscle**. Approximately 5 cm proximal to the wrist, use scissors to transect the tendons of the flexor digitorum superficialis muscle. Reflect the tendons distally, pulling them through the carpal tunnel. During this procedure, the common flexor sheath will be destroyed. To reflect the tendons even further, cut the superficial palmar arch in the midline of the palm, retract the common digital branches of the median and ulnar nerves, and make a longitudinal slit in the fibrous digital sheaths of digits 2 to 5.

9. In the palm, observe the tendons of the **flexor digitorum profundus muscle**. Identify four **lumbrical muscles** that are attached to the four tendons of the flexor digitorum profundus muscle. The distal attachment of the lumbrical muscles is the radial side of the **extensor expansions** of digits 2 to 5 (Fig. 2.24). The lumbrical muscles flex the metacarpophalangeal joints and extend the interphalangeal joints.
10. In digit 3, study the **relationship of the tendons of the flexor digitorum superficialis** and **flexor digitorum profundus muscles** (Fig. 2.24). Note that the tendon of the flexor digitorum profundus splits the tendon of the flexor digitorum superficialis. Verify that the flexor digitorum superficialis tendon attaches to the middle phalanx, whereas the flexor digitorum profundus tendon attaches to the distal phalanx. This pattern is true of digits 2 to 5.
11. Identify the **flexor pollicis longus muscle** in the forearm. Follow its tendon distally through the carpal tunnel into the palm. Pull on the tendon to confirm that the flexor pollicis longus muscle attaches to the distal phalanx of the thumb.

THENAR MUSCLES [G 548, 550; N 448; R 412; C 64]

1. Use blunt dissection to clean the palmar surface of the thenar muscles.
2. The thenar group contains three muscles: **abductor pollicis brevis**, **flexor pollicis brevis**, and **opponens pollicis** (L. *pollex*, thumb; genitive, *pollicis*). The proximal attachments of the thenar muscles are the scaphoid, trapezium, and flexor retinaculum.
   - **Abductor pollicis brevis muscle** attaches to the lateral side of the proximal phalanx of the thumb and it abducts the thumb.
   - **Flexor pollicis brevis muscle** attaches to the lateral side of the proximal phalanx of the thumb and it flexes the thumb.
   - **Opponens pollicis muscle** attaches to the lateral side of the shaft of the first metacarpal bone and it opposes the thumb.
3. Observe the **recurrent branch of the median nerve**. The recurrent branch of the median nerve crosses the superficial surface of the flexor pollicis brevis muscle, and then disappears deep to the abductor pollicis brevis muscle.
4. Use a probe to separate the abductor pollicis brevis muscle from the flexor pollicis brevis muscle. Use the recurrent branch of the median nerve to help locate the correct plane of separation.
5. Use a probe to elevate the abductor pollicis brevis muscle and transect it with scissors.
6. Observe the **opponens pollicis muscle** deep to the abductor pollicis brevis muscle. Note that the opponens pollicis muscle attaches to the lateral side of the entire length of the shaft of the first metacarpal bone.

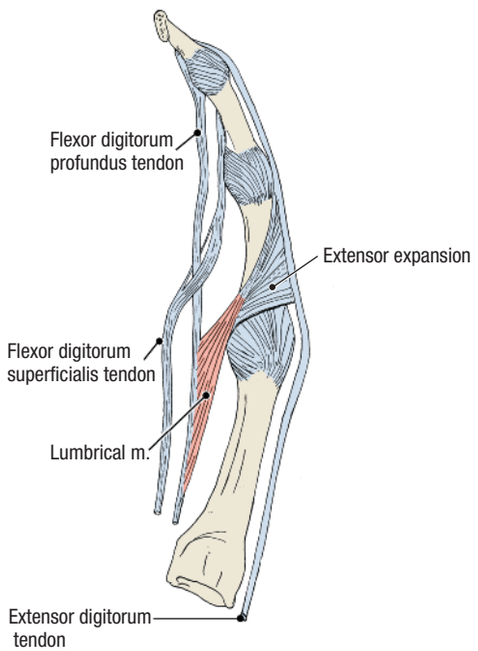

Figure 2.24. Extensor expansion.

CLINICAL CORRELATION

Recurrent Branch of the Median Nerve

The recurrent branch of the median nerve is superficial and it can easily be severed by "minor" cuts over the thenar eminence. If the recurrent branch of the median nerve is injured, the thenar muscles are paralyzed and the thumb cannot be opposed.

HYPOTHENAR MUSCLES [G 548, 550; N 448; R 412; C 64]

1. Use blunt dissection to clean the palmar surface of the hypothenar muscles. The hypothenar group contains three muscles: **abductor digiti minimi**, **flexor digiti minimi brevis**, and **opponens digiti minimi**. The proximal attachments of the hypothenar muscles are the pisiform, hamate, and flexor retinaculum.
   - **Abductor digiti minimi muscle** attaches to the medial side of the base of the proximal phalanx of digit 5 and it abducts digit 5.
   - **Flexor digiti minimi brevis muscle** attaches to the medial side of the base of the proximal phalanx of digit 5and it flexes digit 5.
   - **Opponens digiti minimi muscle** attaches to the medial border of the fifth metacarpal bone and it opposes digit 5.
2. Use a probe to define the borders of the abductor digiti minimi muscle and the flexor digiti minimi brevis muscle. Use the tendons at the distal attachment to aid in this separation.
3. Use a probe to elevate the abductor digiti minimi brevis muscle and detach it from its proximal attachment on the flexor retinaculum. Preserve the deep branches of the ulnar artery and ulnar nerve.

4. Observe the **opponens digiti minimi muscle**. Note that the opponens digiti minimi muscle attaches to the entire length of the shaft of the fifth metacarpal bone.

DEEP PALM [G 550, 551; N 448, 449; R 412; C 69]

1. Transect the flexor digitorum profundus muscle in the distal one-third of the forearm. Reflect its tendons and the associated lumbrical muscles distally as far as possible. The deep palm is now exposed.
2. Find the ulnar nerve and the ulnar artery on the lateral side of the pisiform bone.
3. The **deep branch of the ulnar nerve** and the **deep palmar branch of the ulnar artery** pass between the proximal attachments of the flexor digiti minimi brevis and abductor digiti minimi muscles.
4. Push a probe parallel to the deep branch of the ulnar nerve where it pierces the opponens digiti minimi muscle. Use a scalpel to cut down to the probe. Use blunt dissection to follow the deep branch of the ulnar nerve into the palm.
5. Observe that the deep branch of the ulnar nerve lies on the anterior surface of the interosseous muscles (Fig. 2.25A).
6. Observe the **deep palmar arch.** The deep palmar arch courses with the deep branch of the ulnar nerve. The deep palmar arch arises from the **radial artery**. The deep palmar arch is completed by the deep branch of the ulnar artery. Use an illustration to study the branches of the deep palmar arch.
7. Identify the **adductor pollicis muscle** (Fig. 2.25A). Use blunt dissection to define its borders. The adductor pollicis muscle has two heads: **oblique** and **transverse**. The proximal attachments of the oblique head are the bases of metacarpal bones 2 and 3 and the adjacent carpal bones. The proximal attachment of the transverse head is the anterior surface of the shaft of metacarpal bone 3. Both heads attach to the medial side of the base of the proximal phalanx of the thumb. The adductor pollicis muscle draws the thumb toward digit 3 (adduction).
8. Use an illustration to study the three **palmar interosseous muscles** (Fig. 2.25A). The palmar interosseous muscles are unipennate muscles that attach to the metacarpal bones of digits 2, 4, and 5. Distally, the palmar interosseous muscles attach to the bases of the proximal phalanges and the extensor expansions. Do not dissect these muscles. **[G 545; N 448; R 416; C 66]**
9. Use an illustration to study the four **dorsal interosseous muscles** (Fig. 2.25B). The dorsal interosseous muscles are bipennate muscles that attach to metacarpal bones 1 to 5. Distally, the dorsal interosseous muscles attach to the bases of the proximal phalanges and the extensor expansions of digits 2 to 4. Look at the dorsum of the dissected hand and note that the dorsal interosseous muscles occupy the intervals between the metacarpal bones. Do not dissect these muscles.
10. Study the actions of the interosseous muscles (Fig. 2.25). The three **P**almar interosseous muscles are **AD**ductors (**PAD**). They adduct digits 2, 4, and 5 toward an imaginary axial line drawn through the long axis of digit 3. The four **D**orsal interosseous muscles are **AB**ductors (**DAB**). They move digits 2 to 4 away from the imaginary axial line. The two dorsal interosseous muscles that attach to digit 3 move it to either side of the imaginary axial line. The interosseous muscles are innervated by the deep branch of the ulnar nerve.

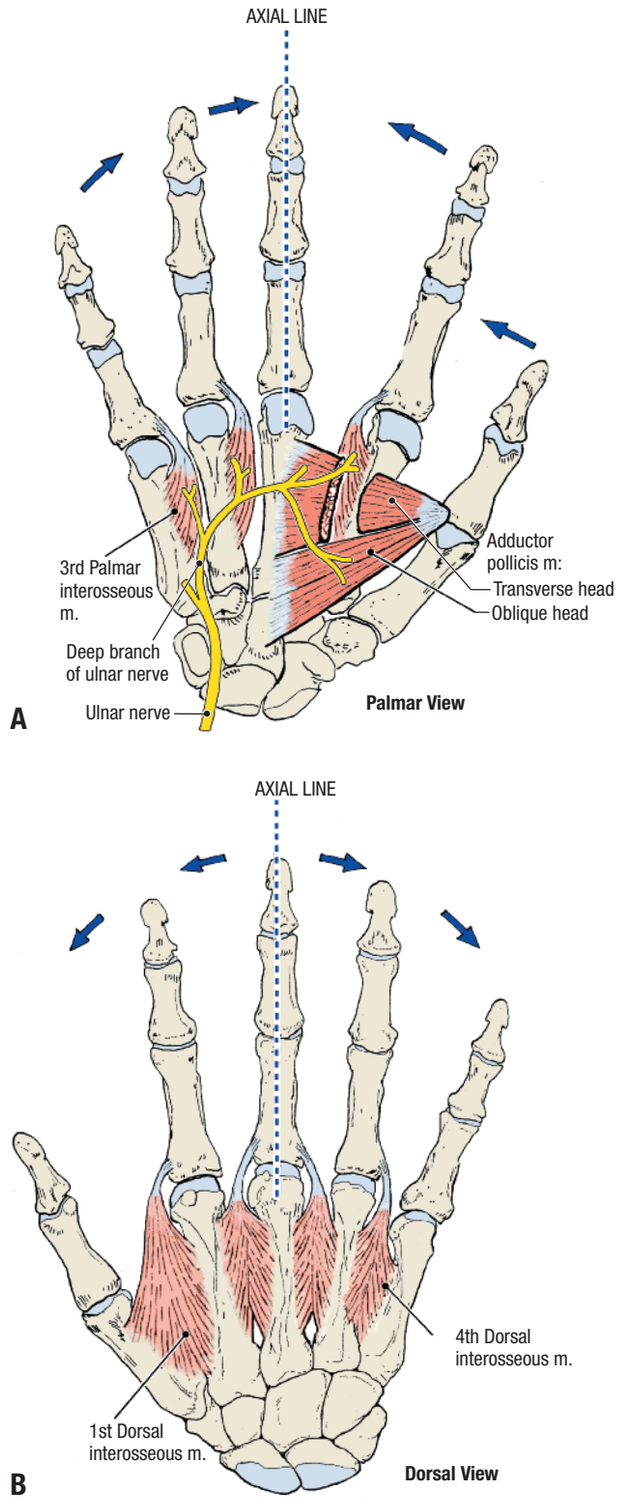

Figure 2.25. A. The three unipennate **P**almar interosseous muscles **AD**duct (**PAD**) the fingers (arrows) in relation to the axial line. **B.** The four bipennate **D**orsal interosseous muscles **AB**duct (**DAB**) the fingers (arrows).

After you dissect . . .

Place the muscles, tendons, and nerves that you have dissected back into their correct anatomical positions. Review the movements of the fingers and thumb. Define flexion, extension, abduction, and adduction. Review the muscles that are responsible for each action. Use the dissected specimen to follow the median nerve from the forearm into the hand. Follow the ulnar artery from the elbow to the hand. In the hand, trace the superficial branch and deep palmar branch of the ulnar artery. Follow the ulnar nerve from the medial epicondyle of the humerus to the hand. In the hand, trace the superficial and deep branches of the ulnar nerve. Review an illustration that demonstrates the cutaneous distribution of the ulnar and median nerves in the hand. Recall the rule for innervation of the muscles in the hand: **all intrinsic muscles of the hand are innervated by the ulnar nerve** ***except the muscles of the thenar group and the first two lumbrical muscles, which are innervated by the median nerve.*** **[G 462; N 455; R 388]**

EXTENSOR REGION OF THE FOREARM AND DORSUM OF THE HAND

Before you dissect . . .

The posterior compartment of the forearm contains the extensor muscles of the forearm. They can be divided into a superficial group and a deep group (Fig. 2.16). The muscles of the superficial group extend the wrist and the proximal phalanges. The muscles of the deep group of extensors cause supination of the hand, extension of digit 2, and abduction and extension of the thumb. The deep branch of the radial nerve innervates the extensor muscles of the forearm. Nerves and vessels of the posterior compartment run in the connective tissue plane that divides the superficial group of extensor muscles from the deep group of extensor muscles.

In the dorsum of the hand, the bones are superficial. There are no intrinsic muscles in the dorsum of the hand, so no motor innervation is required. The radial, ulnar, and median nerves share the cutaneous innervation of the dorsum of the hand.

The order of dissection will be as follows: the antebrachial fascia will be removed from the elbow to the wrist. The muscles of the superficial extensor group will be identified and followed to their distal attachments in the hand. The tendons of the superficial extensor muscles will be released from the extensor retinaculum and retracted to permit the muscles of the deep extensor group to be studied. The contents of the anatomical snuffbox will be identified.

Dissection Instructions

SUPERFICIAL GROUP OF EXTENSOR MUSCLES [G 556; N 427; R 403; C 52]

1. Place the cadaver in the supine position.
2. Use blunt dissection to remove the remnants of the superficial fascia from the posterior forearm and dorsum of the hand, taking care to preserve the dorsal venous arch.
3. Identify the **extensor retinaculum**, which is located on the posterior surface of the distal forearm.
4. Use scissors to incise the posterior surface of the antebrachial fascia from the olecranon to the extensor retinaculum. Preserve the extensor retinaculum. Use your fingers or a probe to separate the antebrachial fascia from the muscles that lie deep to it. Detach the antebrachial fascia from its attachments to the radius and ulna and place it in the tissue container.
5. Six muscles comprise the **superficial extensor group**: **brachioradialis**, **extensor carpi radialis longus**, **extensor carpi radialis brevis**, **extensor digitorum**, **extensor digiti minimi**, and **extensor carpi ulnaris**. Note that four of the muscles in the superficial extensor group (extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, and extensor carpi ulnaris) attach to the lateral epicondyle of the humerus by way of a **common extensor tendon**.
6. Use tendon patterns at the wrist and distal attachments to positively identify the muscles of the superficial extensor group:
   - **Brachioradialis tendon** attaches to the lateral surface of the distal radius.
   - **Extensor carpi radialis longus tendon** attaches to the base of metacarpal bone 2.
   - **Extensor carpi radialis brevis tendon** attaches to the base of metacarpal bone 3.
   - **Extensor digitorum tendons** attach to the extensor expansions of digits 2 to 5.
   - **Extensor digiti minimi tendon** attaches to the extensor expansion of digit 5.
   - **Extensor carpi ulnaris tendon** attaches to the base of metacarpal bone 5.
7. Note that the tendons of the extensor digitorum longus muscle are tied together by **intertendinous connections** on the posterior surface of the hand. **[G 562; N 453; R 404; C 60]**
8. Observe the **extensor expansion** of digit 3 (Fig. 2.24). The extensor expansion is wrapped around the dorsum and the sides of the proximal phalanx and the distal end of the metacarpal bone. The hood-like expansion retains the extensor tendon in the midline of the digit. The tendons of the lumbrical and interosseous muscles attach to the extensor expansion. **[G 563; N 447; R 404; C 65]**
9. Cut through the **extensor retinaculum** to release the tendons of the extensor digitorum muscle. Retract the tendons medially. Note that the other extensor tendons are also contained within individual osseofibrous tunnels. Synovial sheaths line these tunnels.

DEEP GROUP OF EXTENSOR MUSCLES [G 557; N 428; R 403; C 54]

1. Five muscles comprise the **deep extensor group**: **abductor pollicis longus**, **extensor pollicis brevis**, **extensor pollicis longus**, **extensor indicis**, and **supinator**.
2. The proximal attachments of four muscles of the deep extensor group (abductor pollicis longus, extensor

pollicis brevis, extensor pollicis longus, and extensor indicis) are the posterior surfaces of the radius, ulna, and interosseous membrane. These four muscles emerge from the interval between the extensor digitorum muscle and the extensor carpi radialis brevis muscle.

3. Observe the tendon of each of the following muscles and follow it to its distal attachment:
   - **Abductor pollicis longus tendon** attaches to the base of metacarpal bone 1.
   - **Extensor pollicis brevis tendon** attaches to the base of the proximal phalanx of digit 1.
   - **Extensor pollicis longus tendon** attaches to the base of the distal phalanx of digit 1.
   - **Extensor indicis tendon** attaches to the extensor expansion of digit 2.
4. Identify the **anatomical snuffbox** (Fig. 2.26). The anatomical snuffbox is the depression on the posterior surface of the wrist that is bounded anteriorly by the **abductor pollicis longus tendon** and the **extensor pollicis brevis tendon**. The posterior boundary of the anatomical snuffbox is the **extensor pollicis longus tendon**. [G 564, 565; N 452; R 404; C 59]
5. Within the anatomical snuffbox, find the **radial artery**. Use a probe to clean the radial artery and follow it distally until it disappears between the two heads of the **first dorsal interosseous muscle**. Note that the **dorsal carpal arch** supplies arterial blood to the dorsum of the hand (Fig. 2.26), but do not dissect its branches.
6. Near the elbow, use your fingers to retract the brachioradialis muscle and observe the **supinator muscle**. The proximal attachments of the supinator muscle are the lateral epicondyle of the humerus, the radial collateral ligament, the anular ligament, and the lateral surface of the ulna. The distal attachment of the supinator muscle is the proximal one-third of the radius. The supinator muscle supinates the hand.
7. On the lateral aspect of the elbow, once again find the radial nerve in the connective tissue plane between the brachioradialis muscle and the brachialis muscle. Observe that the radial nerve divides into a superficial branch and a deep branch. The **deep branch of the radial nerve** enters the supinator muscle.
8. Turn the upper limb and look for the deep branch of the radial nerve where it emerges from the distal border of the supinator muscle.
9. When the deep branch of the radial nerve emerges from the supinator muscle, its name changes to **posterior interosseous nerve**. The posterior interosseous nerve provides motor branches to the extensor muscles.
10. Observe that the posterior interosseous nerve is accompanied by the **posterior interosseous artery**, which is a branch of the common interosseous artery.

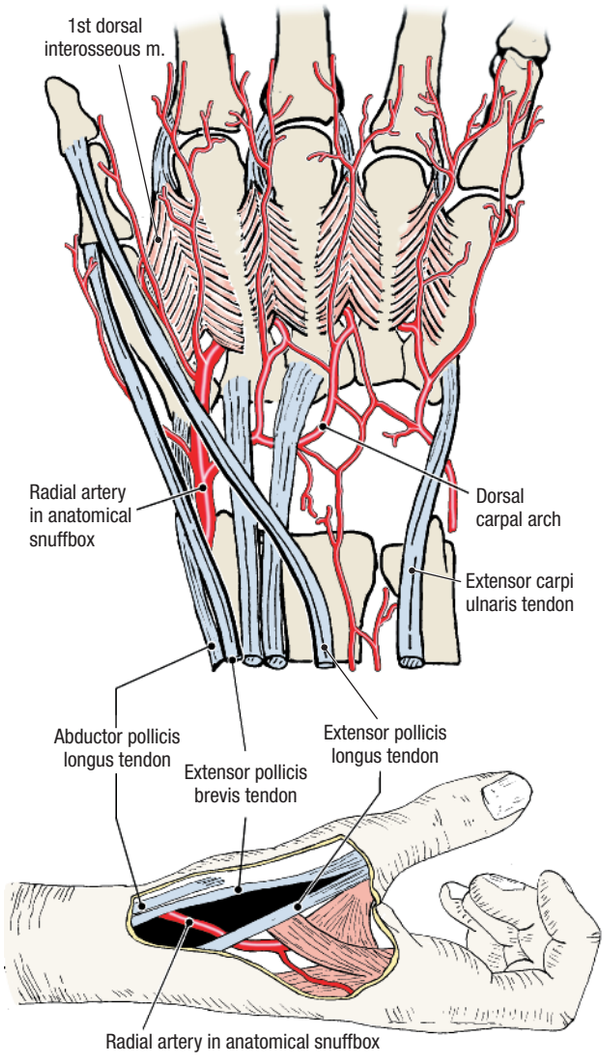

Figure 2.26. Radial artery in the anatomical snuffbox.

After you dissect . . .

Replace the muscles of the posterior compartment of the forearm into their correct anatomical positions. Use the dissected specimen to review the attachments of the extensor tendons. Note that the tendons of three strong extensor muscles (extensor carpi radialis longus, extensor carpi radialis brevis, and extensor carpi ulnaris) attach to the proximal ends of metacarpal bones. These three extensors of the wrist work synergistically with the flexors of the digits: a firm grasp requires an extended wrist. Review the extensor expansion of digit 3. Review the course of the common interosseous branch of the ulnar artery and observe how the posterior interosseous artery enters the posterior compartment of the forearm. Review the course of the radial artery from the cubital fossa to the deep palmar arch. Palpate the anatomical snuffbox on yourself. Feel the pulsations of the radial artery within its boundaries. Recall the rule for innervation of the posterior compartment of the forearm: **The radial nerve innervates all of the muscles in the posterior compartment of the forearm.** ***Note that there are no intrinsic muscles in the dorsum of the hand.***

JOINTS OF THE UPPER LIMB

Before you dissect . . .

Dissect joints in one upper limb. Keep the soft tissue structures of the other limb intact for review purposes.

The order of dissection will be as follows: the sternoclavicular and acromioclavicular joints will be dissected. The glenohumeral joint will be dissected. The elbow joint and radioulnar joints will be studied. The wrist joint will be dissected. Finally, the joints of the digits will be studied. During this dissection, the muscles of one limb will be removed. Take advantage of this opportunity to review the proximal attachment, distal attachment, innervation, and action of each muscle as it is removed.

Dissection Instructions

STERNOCLAVICULAR JOINT [G 486; N 402; C 93]

1. Use an articulated skeleton to observe the relationships between the sternum and clavicle. Identify the **clavicular notch of the manubrium**. The medial end of the clavicle articulates with the clavicular notch and the adjacent part of the first costal cartilage (Fig. 2.27).
2. Place the cadaver in the supine position. The tendon of the sternocleidomastoid muscle is attached to the anterior surface of the sternoclavicular joint. Detach the tendon and reflect the sternocleidomastoid muscle superiorly.
3. Identify the **anterior sternoclavicular ligament**, which connects the sternum to the clavicle.
4. Use blunt dissection to clean the **costoclavicular ligament**, which runs obliquely from the first costal cartilage to the inferior surface of the clavicle near its medial end.
5. Use a scalpel to remove the anterior sternoclavicular ligament. Within the joint cavity, observe the **articular disc**. Inferiorly, the articular disc is attached to the first costal cartilage. Superiorly, the articular disc is attached to the clavicle. Observe that the articular disc is attached in such a manner that it resists medial displacement of the clavicle.
6. Palpate the movements of the sternoclavicular joint on yourself. Place your left hand on your right sternoclavicular joint and circumduct your right upper limb through a large circle. Observe that the sternoclavicular joint allows a limited amount of movement in every direction.

ACROMIOCLAVICULAR JOINT [G 510, 512; N 406; R 366; C 72]

1. Review the bony features that are relevant to the **acromioclavicular joint**: **acromion**, **coracoid process of the scapula**, and **lateral end of the clavicle** (Fig. 2.28).
2. Detach the trapezius muscle from the lateral end of the clavicle. Detach the coracobrachialis and pectoralis minor muscles from the coracoid process. The acromioclavicular joint is now exposed. The acromioclavicular joint is a plane synovial joint between the acromion and the distal end of the clavicle.
3. Identify the **coracoclavicular ligament**, which supports the acromioclavicular joint. Use a probe to clean the ligament. Identify its two parts: **conoid ligament** and **trapezoid ligament**.
4. Open the acromioclavicular joint by completely removing the joint capsule. Separate the acromion from the lateral end of the clavicle.
5. Note the shape of the articulating surfaces. The angle of the articulating surfaces causes the acromion to move inferior to the distal end of the clavicle when the acromion is forced medially. The conoid and trapezoid ligaments prevent the acromion from moving inferiorly relative to the clavicle, strengthening the joint.

GLENOHUMERAL JOINT [G 510, 511; N 406; R 366; C 71-73]

The **glenohumeral joint** (**shoulder joint**) is a ball-and-socket synovial joint with a wide range of motion. The shoulder joint has a greater degree of movement than any other joint in the body. This is because of the small area of contact between the head of the humerus and the glenoid fossa of the scapula and the loose joint capsule. Stability of

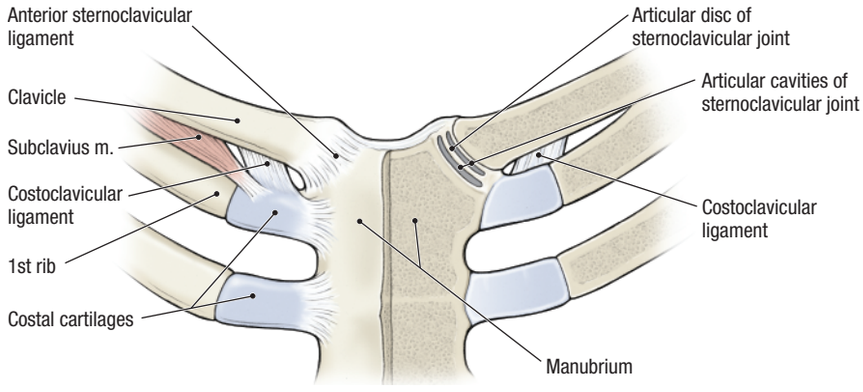

Figure 2.27. Sternoclavicular joint.

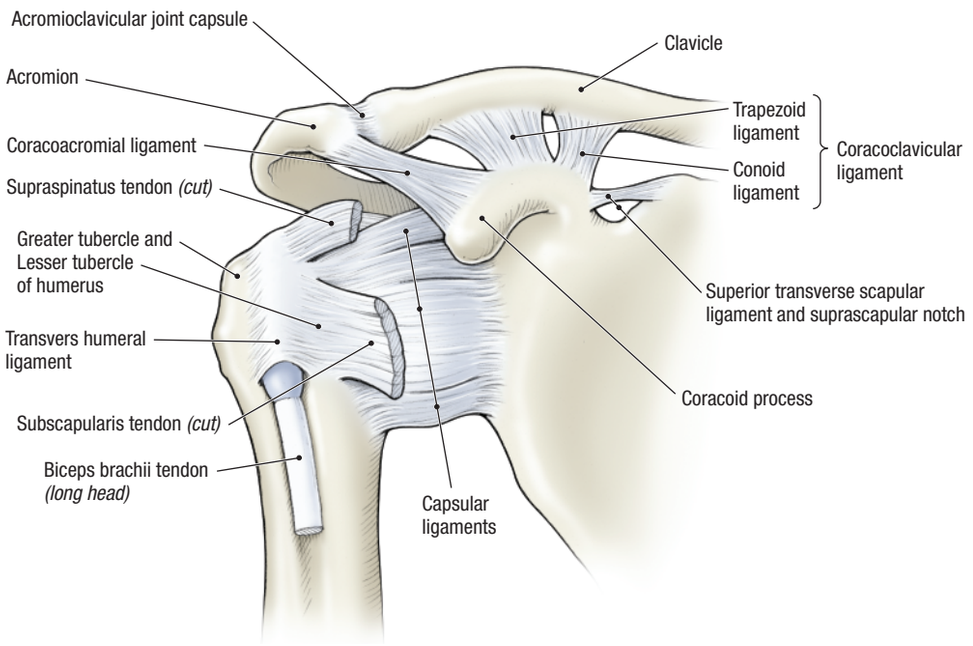

Figure 2.28. Acromioclavicular joint and anterior aspect of glenohumeral joint.

the shoulder joint depends on the function of the muscles of the rotator cuff.

1. Place the cadaver in the supine position.
2. Review the bony features pertinent to dissection of the **glenohumeral joint** (Fig. 2.29):
   - **Glenoid fossa of the scapula**
   - **Head of the humerus**
   - **Anatomical neck of the humerus**
3. To expose the **capsule of the glenohumeral joint**, the muscles and tendons that span the joint must be removed. Review the proximal attachment and distal attachment of each muscle as you remove it.
4. Remove the coracobrachialis muscle and the short head of the biceps brachii muscle. Leave the subscapularis muscle intact.
5. Place the cadaver in the prone position. Observe that the tendons of the supraspinatus, infraspinatus, and teres minor muscles blend with the joint capsule. Remove these tendons.
6. Remove the long head of the triceps brachii muscle
7. The posterior surface of the **joint capsule** is now exposed. Verify that the joint capsule is attached to the anatomical neck of the humerus.
8. Use a scalpel to open the posterior surface of the joint capsule (Fig. 2.29).
9. Use a saw or a chisel to remove the head of the humerus at the anatomical neck.
10. Use a probe to explore the **glenoid cavity**. Identify the **glenoid labrum** and attempt to demonstrate the three **glenohumeral ligaments**, which strengthen the anterior wall of the fibrous capsule (Fig. 2.29).
11. Observe that the **tendon of the long head of the biceps brachii muscle** passes through the glenoid cavity and is attached to the supraglenoid tubercle.
12. Place the cadaver into the supine position. Define and clean the **coracoacromial ligament**, which spans from the coracoid process to the acromion. The coracoacromial ligament, the acromion, and the coracoid process prevent superior displacement of the head of the humerus.

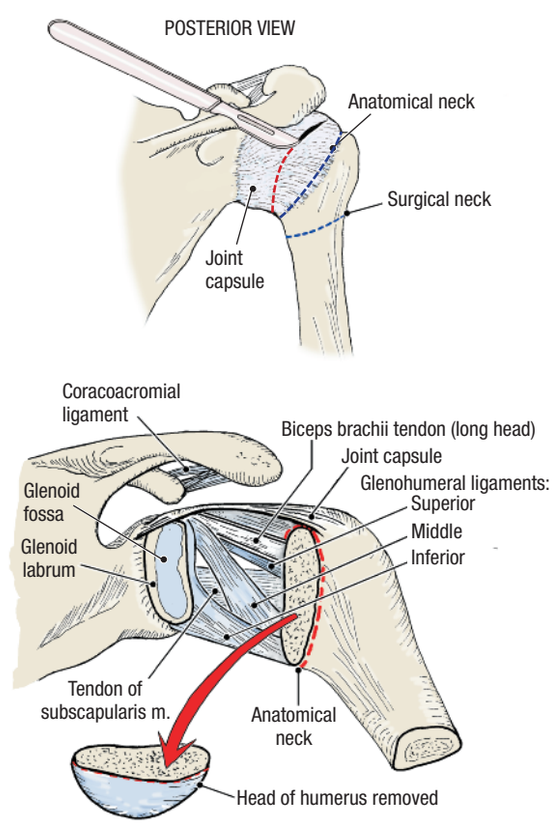

Figure 2.29. How to open the glenohumeral joint capsule and remove the head of the humerus.

13. Use the dissected specimen to perform the movements of the glenohumeral joint: Flexion, extension, abduction, adduction, and circumduction. Note that this freedom of motion is obtained at the loss of joint stability.

ELBOW JOINT AND PROXIMAL RADIOULNAR JOINT [G 526, 527; N 419, 421; R 367; C 80, 81]

1. Review the bony features of the elbow region (Fig. 2.30).
2. Use an articulated skeleton to verify that the elbow joint consists of two parts:
   - A **hinge joint** between the trochlea of the humerus and the trochlear notch of the ulna.
   - A **gliding joint** between the capitulum of the humerus and the head of the radius.
3. Remove the brachialis muscle from the anterior surface of the joint capsule.
4. Detach the triceps brachii tendon from the olecranon and the posterior surface of the joint capsule.
5. Remove the superficial flexor muscles of the forearm from their attachment to the medial epicondyle. Review the common flexor tendon and the five muscles that attach to it.
6. Identify the **ulnar collateral ligament** on the medial side of the elbow joint (Fig. 2.30). Observe that it consists of a strong anterior cord and a fan-like posterior portion.
7. Remove the superficial extensor muscles of the forearm from their attachment to the lateral epicondyle of the humerus. Review the common extensor tendon and the muscles that attach to it.
8. Remove the supinator muscle.
9. Identify the **radial collateral ligament**. It fans out from the lateral epicondyle of the humerus to the radius and anular ligament.
10. The **proximal radioulnar joint** is a pivot joint that occurs between the head of the radius and the radial notch of the ulna. The **anular ligament** and the radial notch of the ulna completely encircle the head of the radius (Fig. 2.30). Note that the radius can freely rotate in the anular ligament. Place the hand of the cadaver specimen into the pronated position. Now, pull on the biceps brachii tendon. Note the strong supinating action of the biceps brachii muscle.
11. Open the elbow joint by making a transverse cut through the anterior surface of the joint capsule between the ulnar collateral ligament and the radial collateral ligament.
12. Use a probe to explore the extent of the **synovial cavity**. Observe the smooth articular surfaces of the humerus, ulna, and radius.
13. Use the dissected specimen to perform the movements of the elbow joint: flexion and extension. Observe the joint surfaces and the collateral ligaments during these movements.

INTERMEDIATE RADIOULNAR JOINT [G 531; N 422; R 368; C 85]

1. The radius and ulna are joined throughout their length by the **interosseous membrane**. Use an illustration to study this joint.

DISTAL RADIOULNAR JOINT [G 570, 571; N 438; C 85]

1. The distal radioulnar joint is the pivot joint that occurs between the head of the ulna and the ulnar notch of the radius (Fig. 2.31).
2. Remove all tendons and soft tissue structures that cross the wrist. Review the distal attachment of each tendon and the action of each muscle.
3. Note that the anterior and posterior surfaces of the wrist joint are reinforced by **radiocarpal ligaments**.

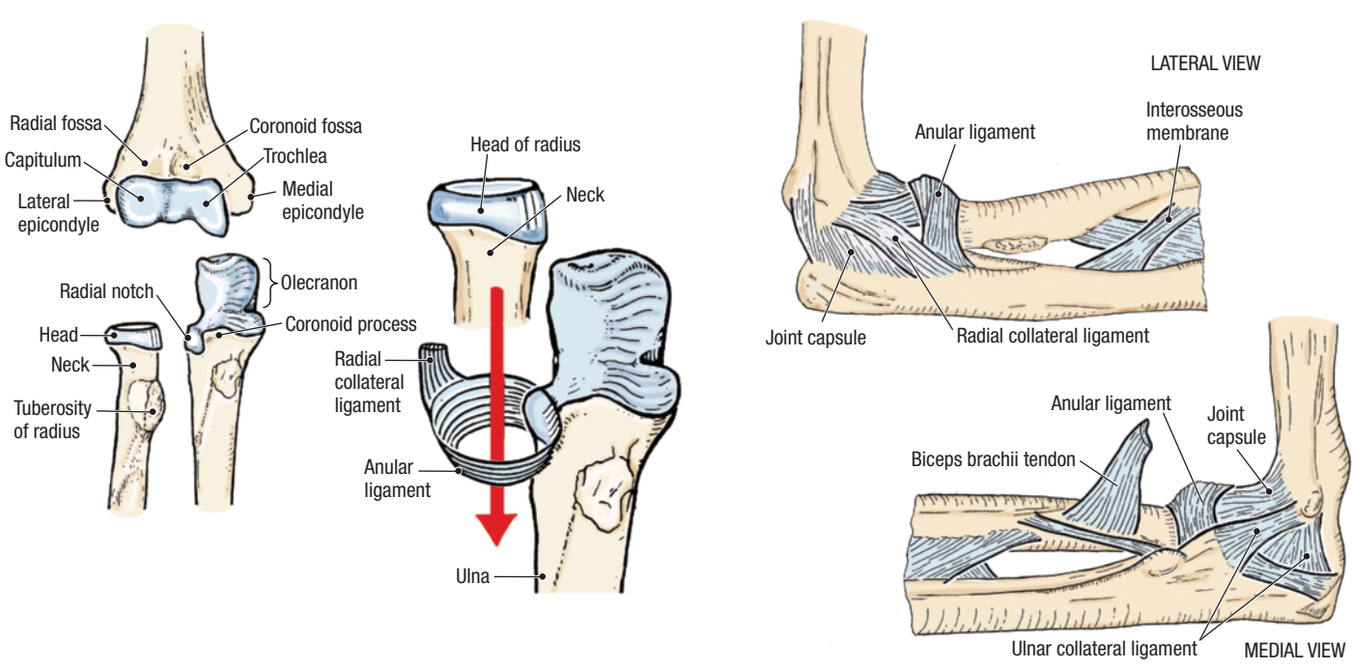

Figure 2.30. Elbow joint.

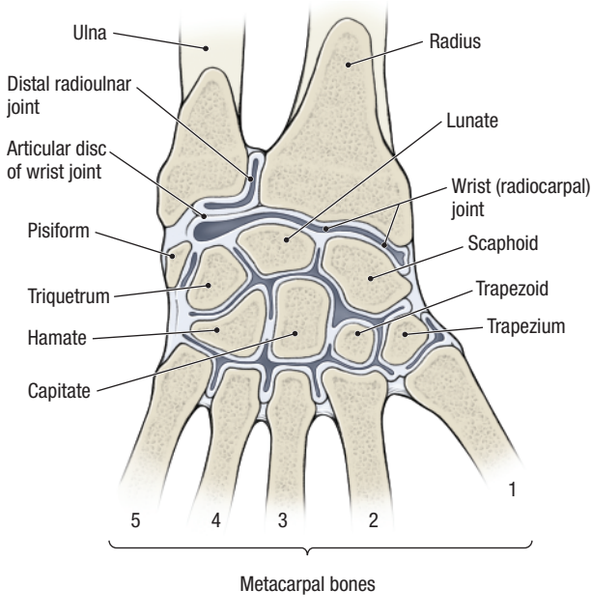

Figure 2.31. Distal radioulnar and wrist joints.

4. To open the distal radioulnar joint, extend the hand. On the anterior surface of the joint capsule, cut transversely through the radiocarpal ligaments. This cut should be made proximal to the flexor retinaculum and carpal tunnel. Leave the hand attached to the forearm by the posterior part of the joint capsule.
5. Use a probe to explore the articulation between the radius and the ulna. Note that the distal radioulnar joint contains an **articular disc**. Verify that the articular disc holds the distal ends of the radius and the ulna together.

WRIST JOINT [G 570, 572; N 437, 438; R 368, 369; C 84]

1. The **wrist joint (radiocarpal joint)** is the articulation between the distal end of the **radius** and the proximal **carpal bones** (Fig. 2.31). Note that the distal end of the radius articulates with only two carpal bones: **scaphoid** and **lunate**.
2. Identify the smooth proximal surfaces of the **scaphoid**, **lunate**, and **triquetrum**. Study the corresponding **articular surface of the radius.** Notice that the **scaphoid** and **lunate** bones must transmit forces from the hand to the forearm. Therefore, these carpal bones are the ones most commonly fractured in a fall on the outstretched hand.
3. Once again, identify the articular disc. The articular disc articulates with the triquetrum when the hand is adducted.
4. Use the dissected specimen to perform the movements of the wrist joint: flexion, extension, adduction, abduction, and circumduction. Observe the articular surfaces during these movements.

METACARPOPHALANGEAL JOINTS [G 575; N 441; R 369; C 85]

1. Dissect digit 3 as a representative example.
2. Remove the tendons of the flexor digitorum superficialis and flexor digitorum profundus muscles. Note their attachments on the phalanges.
3. Remove the interosseous muscles and the extensor expansion to expose the metacarpophalangeal joint capsule.
4. Clean the collateral ligaments (Fig. 2.32). Move the digit to confirm that the ligaments are slack during extension and taut during flexion. Therefore, the digits cannot be spread (abducted) unless they are extended.
5. Use the dissected specimen to perform the movements of the digit at the metacarpophalangeal joint: flexion, extension, abduction, and adduction. Confirm that the metacarpophalangeal joints are condyloid joints.

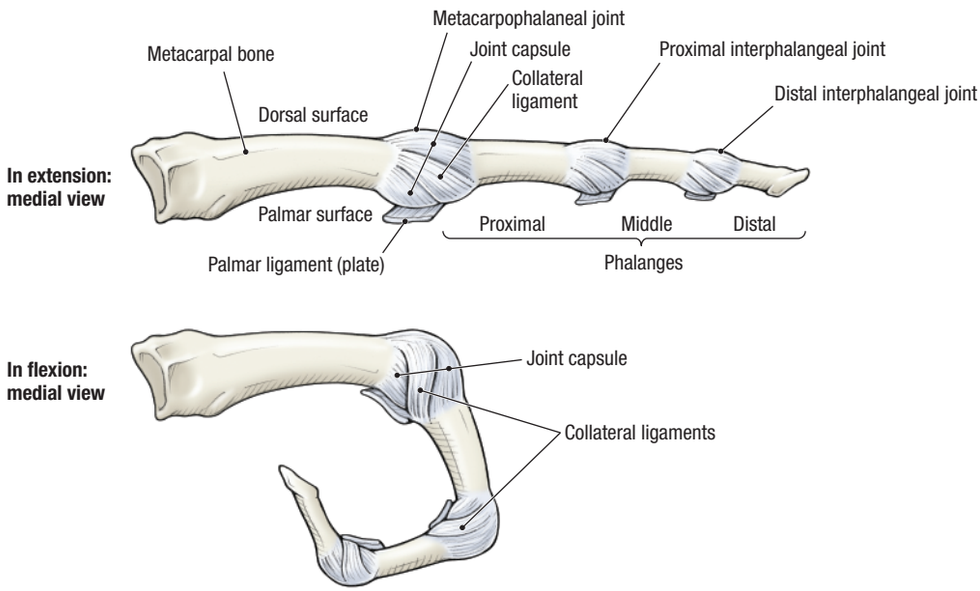

Figure 2.32. Metacarpophalangeal and interphalangeal joints.

INTERPHALANGEAL JOINTS [G 575; N 441; R 369; C 85]

1. Clean the collateral ligaments of the interphalangeal joints of digit 3 (Fig. 2.32).
2. Use a probe to explore the synovial cavity of one interphalangeal joint. Inspect the articular surfaces that are covered with smooth cartilage.
3. Use the dissected specimen to perform flexion and extension of the interphalangeal joint and confirm that the collateral ligaments limit the range of motion. Confirm that the interphalangeal joints are hinge joints.