

CHAPTER 5

The Elbow, Forearm, Wrist, and Hand

LEARNING OBJECTIVES

After working through the material in this chapter, you should be able to:

- Identify the main structures of the elbow, forearm, wrist, and hand, including bones, joints, special structures, and deep and superficial muscles.
- Label and palpate the major surface landmarks of the elbow, forearm, wrist, and hand.
- Locate the attachments and nerve supply of the muscles of the elbow, forearm, wrist, and hand.
- Identify and demonstrate all actions of the muscles of the elbow, forearm, wrist, and hand.
- Demonstrate passive and resisted range of motion of the elbow, forearm, wrist, and hand.
- Draw, label, palpate, and fire the superficial and deep muscles of the elbow, forearm, wrist, and hand.
- Describe the unique functional anatomy and relationships between each muscle of the elbow, forearm, wrist, and hand.
- Identify both the synergists and the antagonists involved in each movement of the elbow, forearm, wrist, and hand (flexion, extension, etc.).
- Identify muscles used in performing four coordinated movements of the elbow, forearm, wrist, and hand: lifting, twisting, shooting, and grasping.

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OVERVIEW OF THE REGION

The elbow, forearm, wrist, and hand move in a variety of ways and serve many important functions. Some of these, such as grasping and lifting, are very powerful. Others, such as twisting and plucking, are more precise and even delicate. Many are complex, revealing the multifunctionality of the main joints of this region. For example, the elbow is capable of hinging as well as rotating. Two distinct joints at the elbow and one at the wrist work together to make this versatility possible. The wrist and hand are also multifunctional as a result of their multiple joints and many small muscles. Finally, joints from the elbow to the fingers work together to accomplish some of the tasks most characteristic of the human species—those of the human hand.

Long tendons connect muscle bellies in the elbow and forearm to bones in the wrist and hand. This pulley system requires a complex network of ligaments, connective tissue, and nerves to maintain optimal function and blood and lymphatic vessels to keep the region nourished. Bursae and tendon sheaths reduce friction between the structures within the joints.

Given its structural complexity, you can readily appreciate why improper alignment and use patterns could easily disrupt this region's function. An understanding of the information in this chapter will help you promote healthy functioning for yourself and your clients.

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SURFACE ANATOMY OF THE ELBOW, FOREARM, WRIST, AND HAND

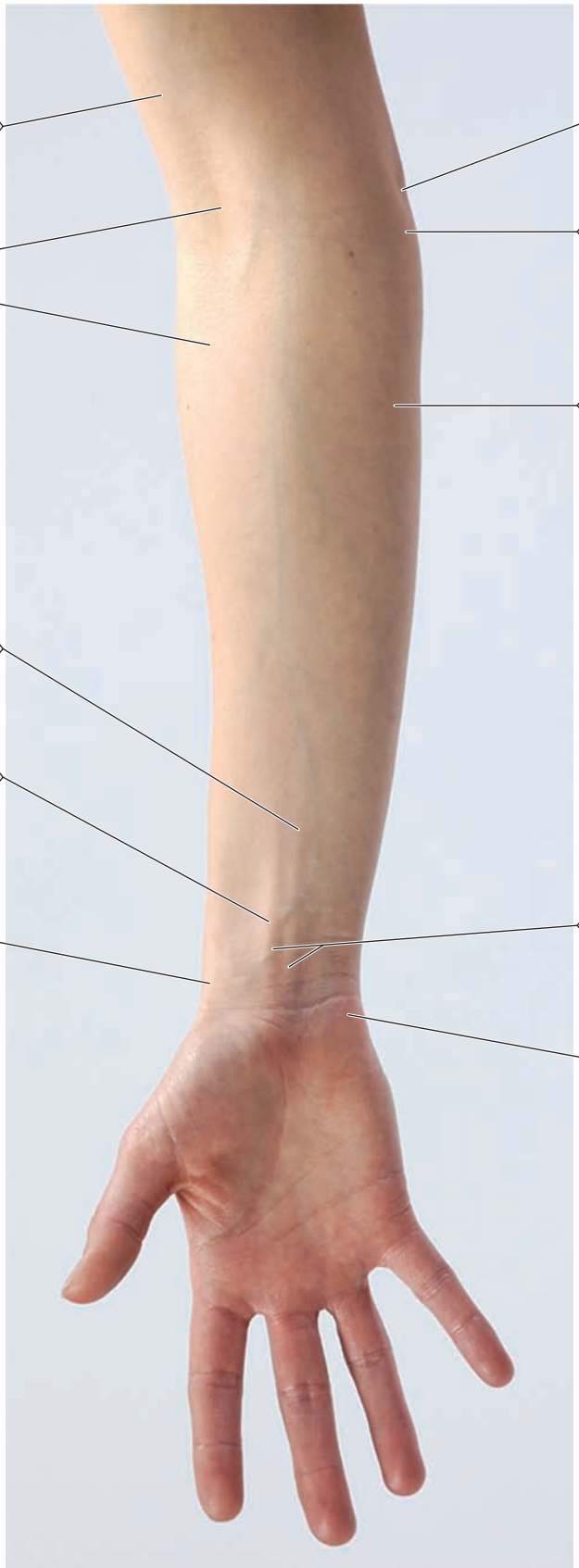


FIGURE 5.1A Anterior view of the forearm.

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SURFACE ANATOMY OF THE ELBOW, FOREARM, WRIST, AND HAND



FIGURE 5.1B Posterior view of the forearm.

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SURFACE ANATOMY OF THE ELBOW, FOREARM, WRIST, AND HAND

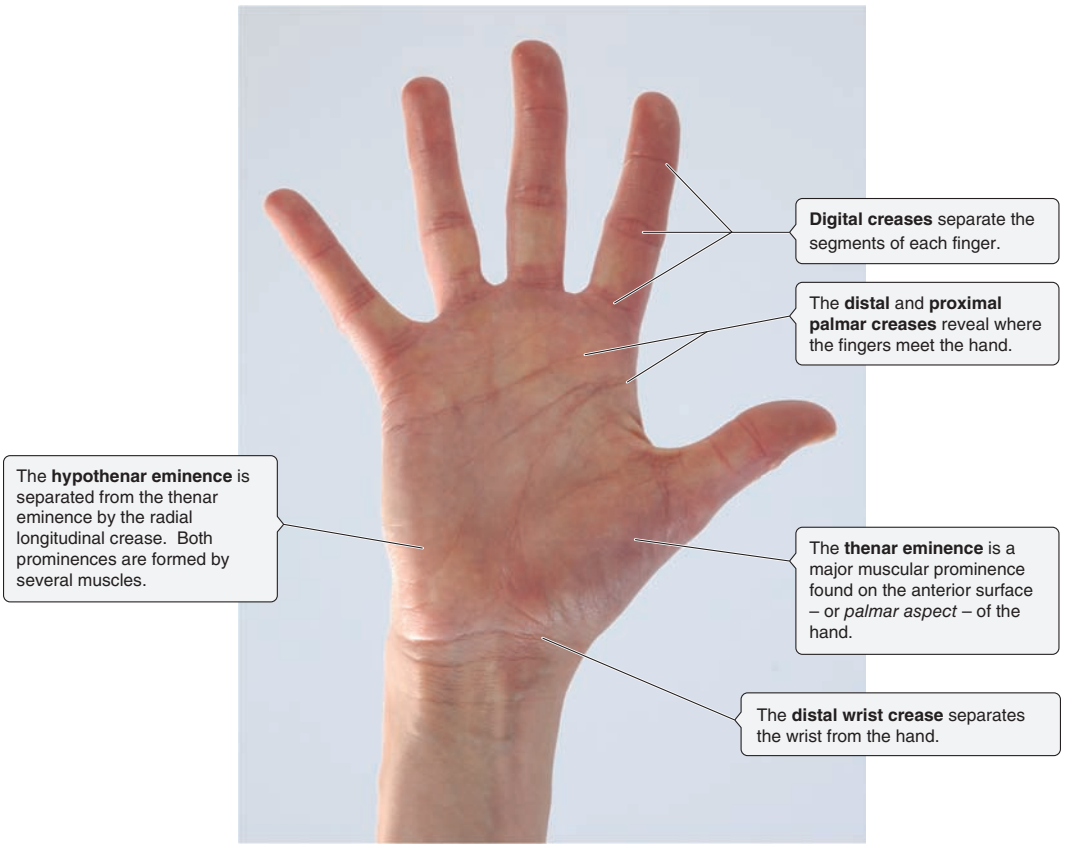


FIGURE 5.1C Anterior view of the hand.

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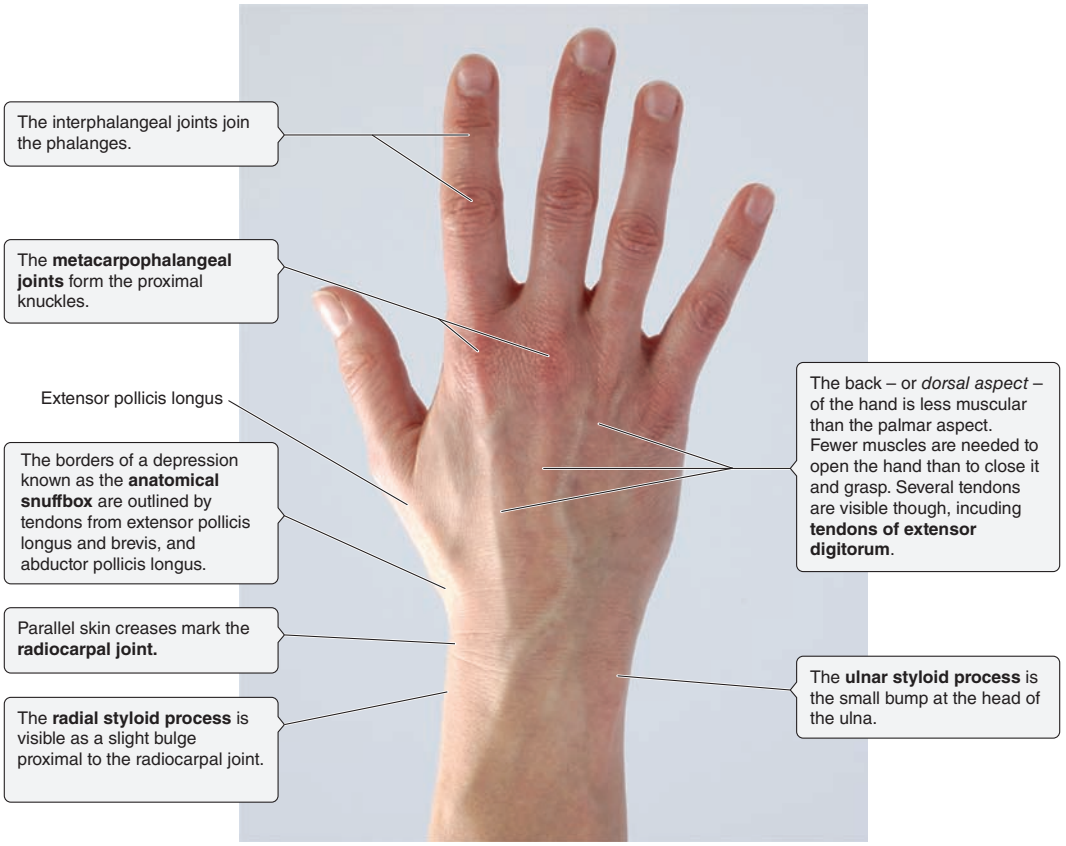


FIGURE 5.1D Posterior view of the hand.

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SKELETAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

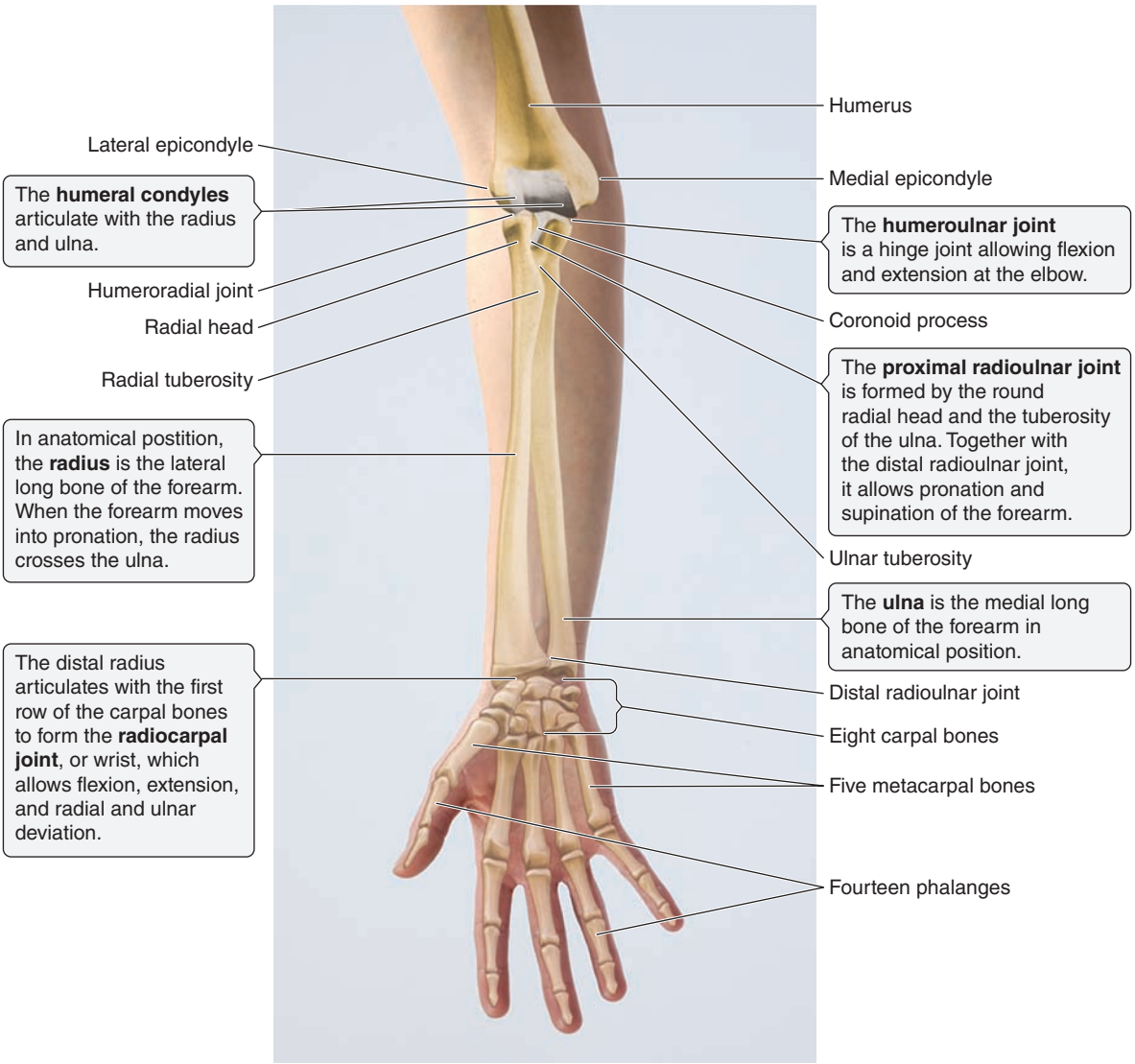


FIGURE 5.2A Skeletal structures of the forearm: Anterior view.

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SKELETAL STRUCTURES OF THE ELBOW, FORE ARM, WRIST, AND HAND

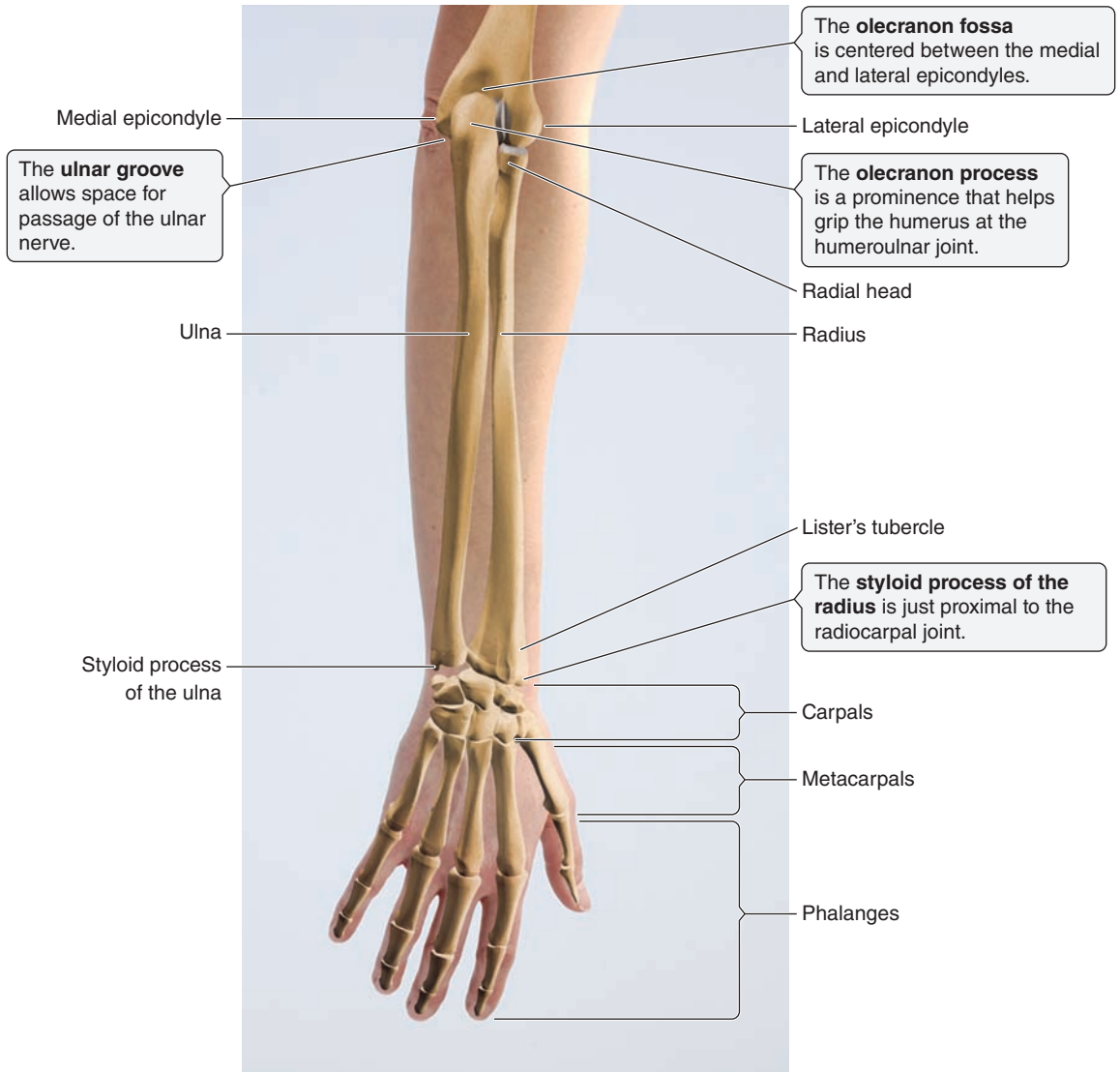


FIGURE 5.2B Skeletal structures of the forearm: Posterior view.

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SKELETAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

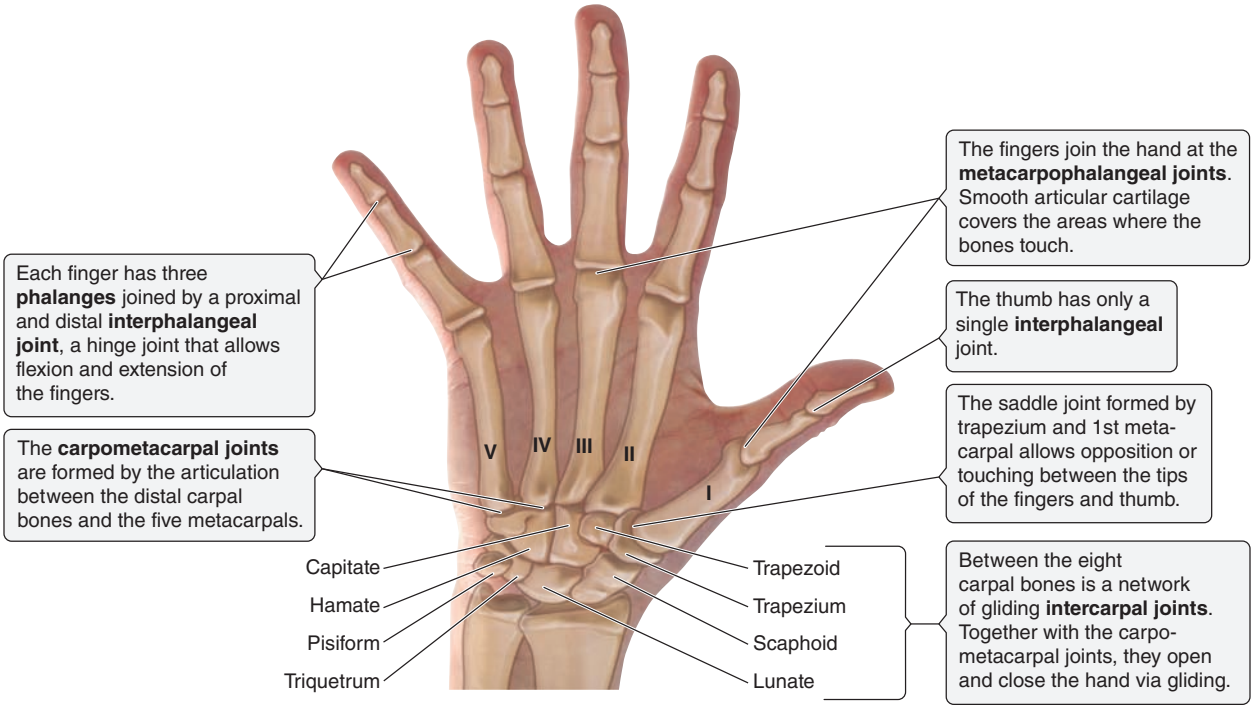


FIGURE 5.2C Skeletal structures of the hand: Anterior view.

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BONY LANDMARKS OF THE ELBOW, FOREARM, WRIST, AND HAND

Palpating the Olecranon Process

Positioning: client supine with elbow flexed and forearm neutral

1. Locate the posterior surface of the elbow.
2. Passively flex and extend the elbow while you palpate the rounded point of the olecranon process.

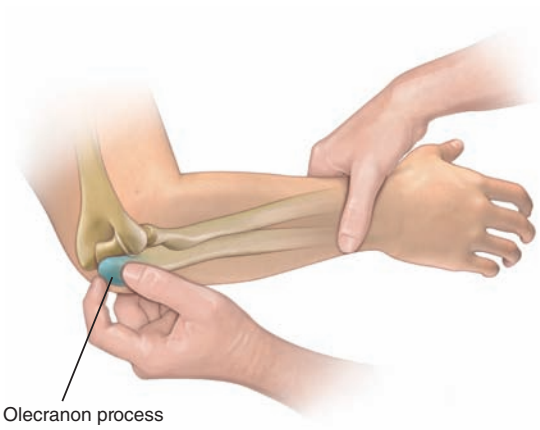


FIGURE 5.3A Olecranon process.

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Palpating the Olecranon Fossa

Positioning: client supine with elbow flexed

1. Locate the olecranon process of the ulna.
2. Slide your fingers proximally and deep into the depression that is the olecranon fossa.



FIGURE 5.3B Olecranon fossa.

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BONY LANDMARKS OF THE ELBOW, FOREARM, WRIST, AND HAND

Palpating the Lateral Epicondyle

Positioning: client supine with elbow flexed

1. Locate the olecranon process of the ulna.
2. Slide fingers laterally and anteriorly onto the large, rounded bump of the lateral epicondyle.

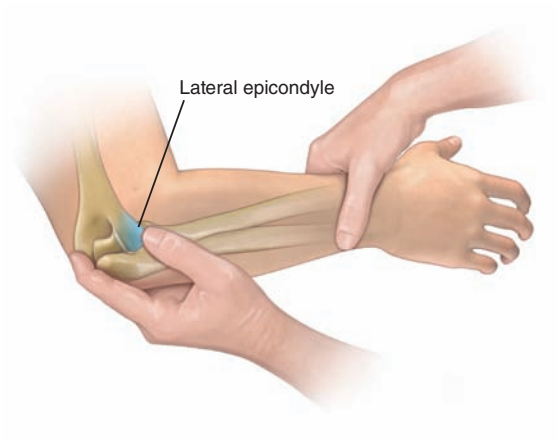


FIGURE 5.3C Lateral epicondyle.

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Palpating the Medial Epicondyle

Positioning: client supine with elbow flexed and forearm supinated

1. Locate the olecranon process of the ulna.
2. Slide fingers medially and anteriorly onto the large, rounded bump of the medial epicondyle of the humerus.

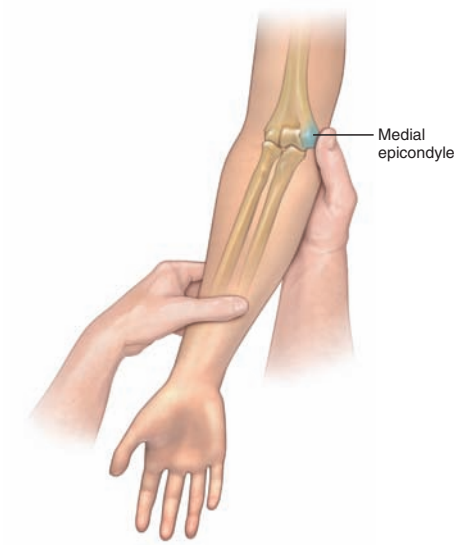


FIGURE 5.3D Medial epicondyle of the humerus.

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Palpating the Radial Head

Positioning: client supine with elbow bent and forearm neutral

1. Locate the lateral epicondyle of the humerus.
2. Slide fingers distally onto the smaller radial head while passively pronating and supinating the forearm, making it pivot under your fingers.

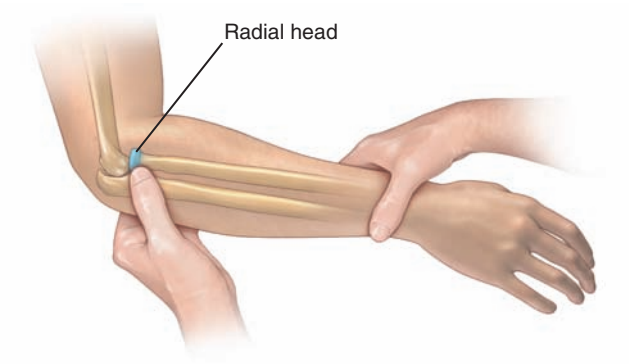


FIGURE 5.3E Radial head.

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Palpating the Ulnar Ridge

Positioning: client supine with elbow flexed and forearm neutral

1. Locate the olecranon process of the ulna.
2. Slide fingers distally following the sharp edge of the ulnar ridge toward the wrist.

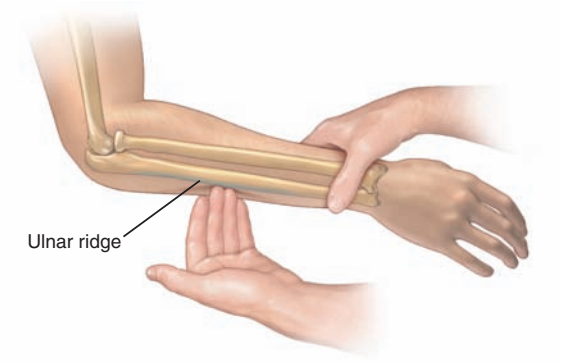


FIGURE 5.3F Ulnar ridge.

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BONY LANDMARKS OF THE ELBOW, FOREARM, WRIST, AND HAND

Palpating the Ulnar Styloid Process

Positioning: client supine with elbow relaxed and forearm pronated

1. Locate the medial edge of the wrist.
2. Slide fingers anteriorly onto the prominent bump of the ulnar styloid process.

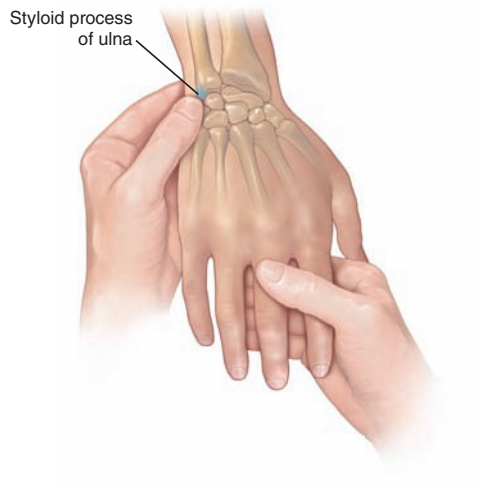


FIGURE 5.3G Ulnar styloid process.

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Palpating Lister's Tubercle

Positioning: client supine with elbow relaxed and forearm pronated

1. Locate the ulnar styloid process.
2. Slide fingers medially onto the deeper, smaller bump formed by Lister's tubercle.

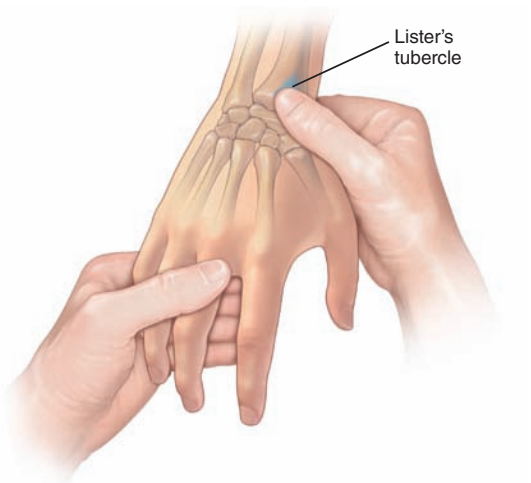


FIGURE 5.3H Lister's tubercle.

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Palpating the Radial Styloid Process

Positioning: client supine with elbow relaxed and forearm pronated

1. Locate Lister's tubercle of the radius.
2. Slide fingers medially and distally onto the rounded prominence of the radial styloid process.

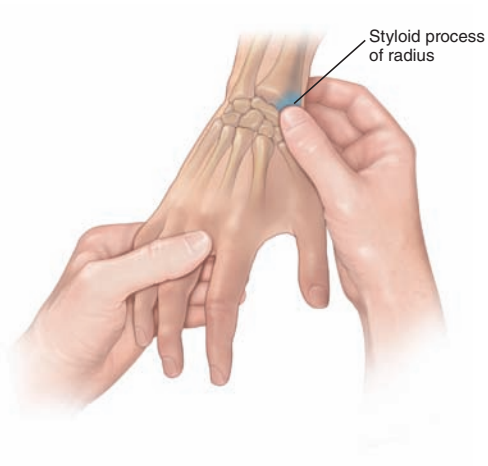


FIGURE 5.3I Radial styloid process.

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Dorsal Palpation of the Carpals

Positioning: client supine with elbow relaxed and forearm pronated

1. Using the thumbs of both hands, locate the radial and ulnar styloid processes.
2. Slide thumbs distally onto the dorsal surfaces of the carpal bones.

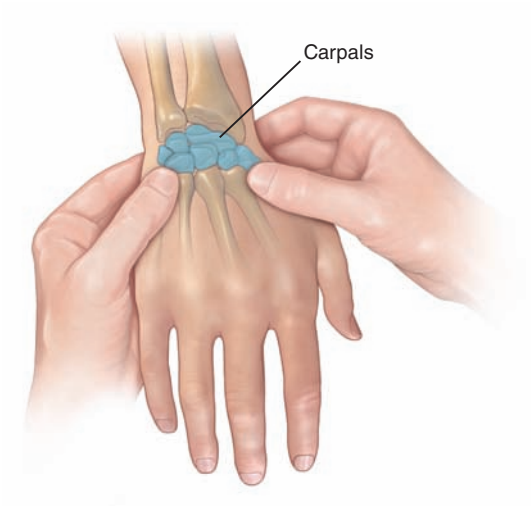


FIGURE 5.3J Dorsal carpals.

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BONY LANDMARKS OF THE ELBOW, FOREARM, WRIST, AND HAND

Palpating the Scaphoid

Positioning: client supine with elbow relaxed and forearm pronated

1. Using the thumb of one hand, locate the radial styloid process.
2. Passively deviate the wrist laterally and slide thumb distally and deep onto the flat surface of the scaphoid.

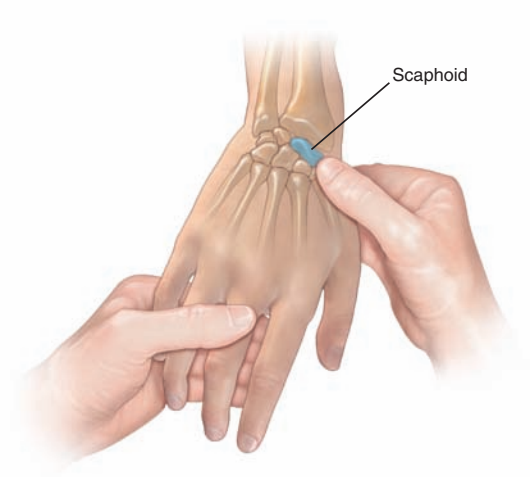


FIGURE 5.3K Scaphoid.

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Palpating the Metacarpals

Positioning: client supine with elbow relaxed and forearm pronated

1. Using the thumbs of both hands locate the knuckles.
2. Slide thumbs proximally along the long, slender shafts of the metacarpals.

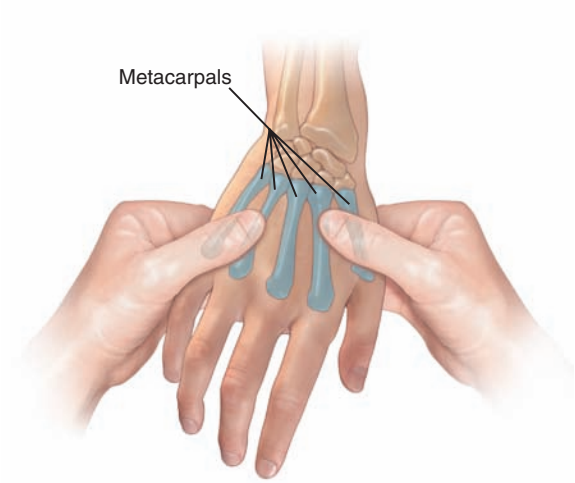


FIGURE 5.3L Metacarpals.

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Palmar Palpation of the Carpals

Positioning: client supine with elbow relaxed and forearm supinated

1. Using the thumbs of both hands, locate the thenar and hypothenar eminences of the palm.
2. Palpate deeply under and between these two soft structures onto the palmar surfaces of the carpals.

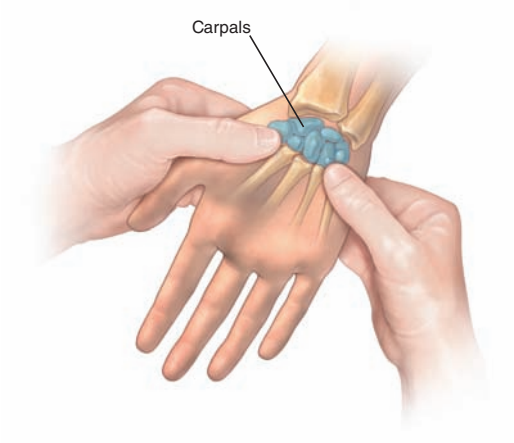


FIGURE 5.3M Palmar carpals.

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Palpating the Pisiform

Positioning: client supine with elbow relaxed and forearm supinated

1. With the thumb of one hand locate the hypothenar eminence.
2. Slide thumb proximally onto the small bump of the pisiform.

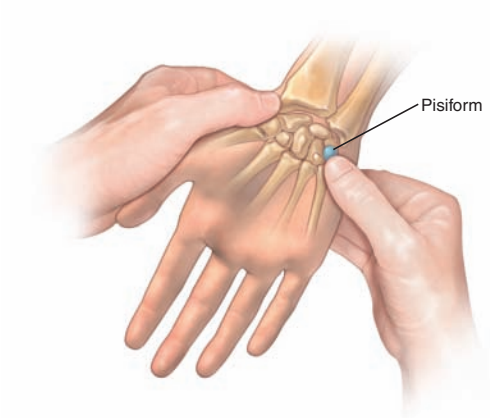


FIGURE 5.3N Pisiform.

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BONY LANDMARKS OF THE ELBOW, FOREARM, WRIST, AND HAND

Palpating the Hook of the Hamate

Positioning: client supine with elbow relaxed and forearm supinated

1. With the thumb of one hand locate the pisiform.
2. Slide thumb slightly laterally, distally, and deeply onto the small hook of the hamate.

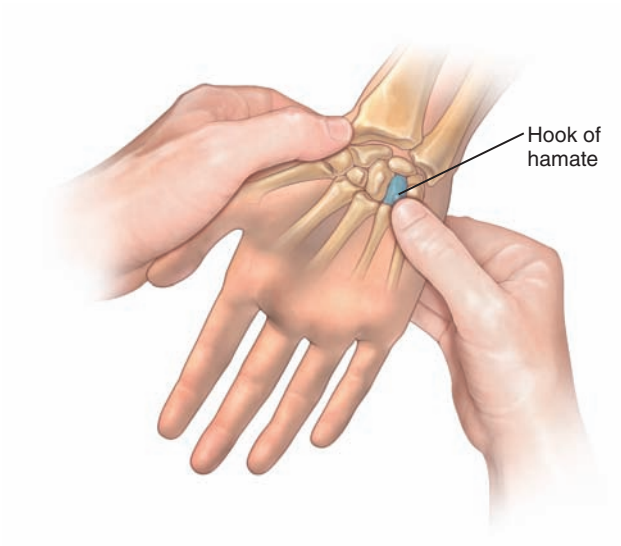


FIGURE 5.30 Hook of the Hamate.

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Palpating the Phalanges

Positioning: client supine with elbow relaxed and forearm supinated

1. Using a pincer grasp with both hands, locate the knuckles.
2. Slide grasp distally onto the fingers palpating the phalanges, proximal interphalangeal joints, and distal interphalangeal joints.



FIGURE 5.3P Phalanges.

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MUSCLE ATTACHMENT SITES

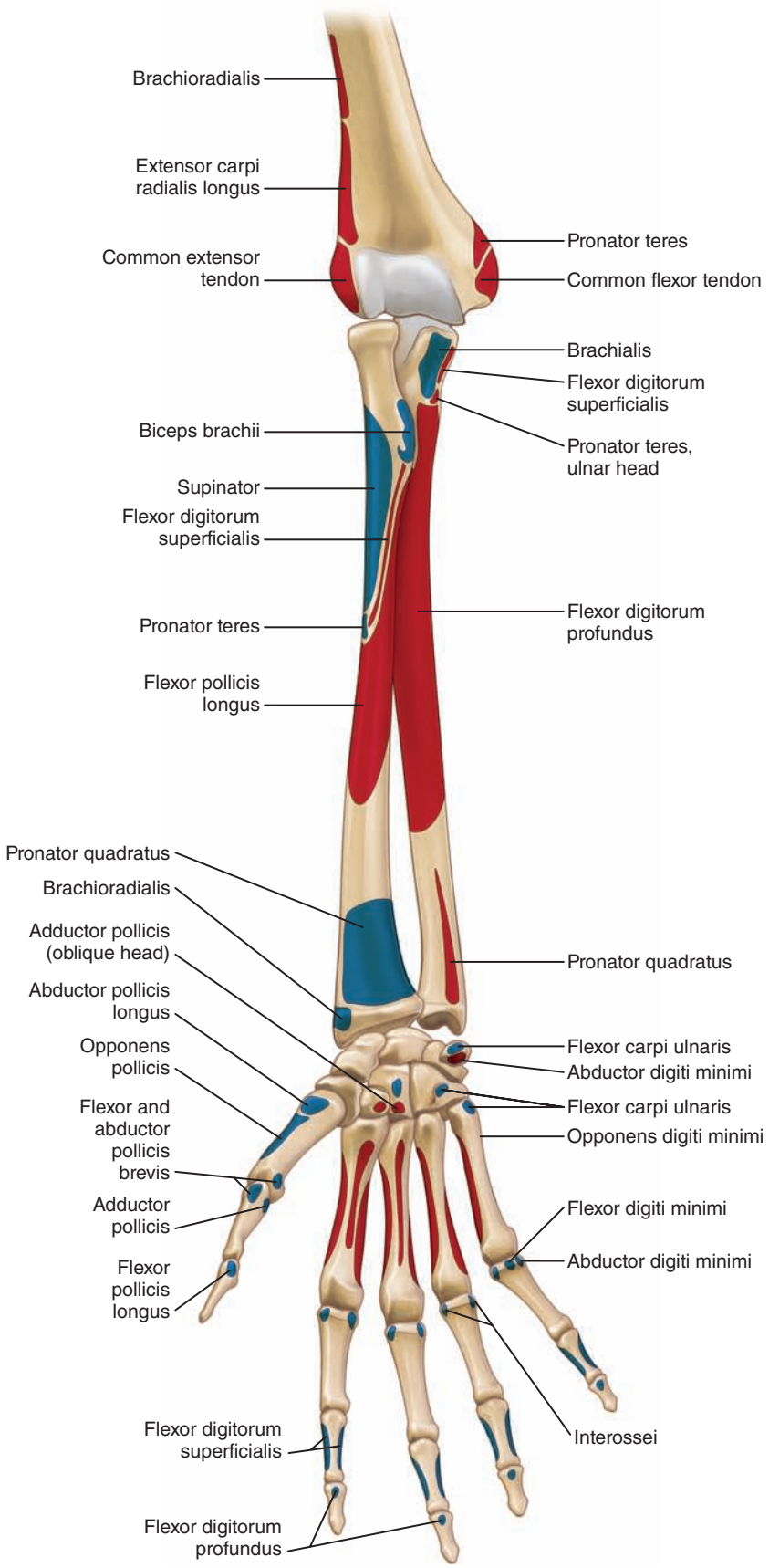


FIGURE 5.4A Arm muscle attachments: Anterior view. Primarily, muscles of the elbow, forearm, wrist, and hand originate (marked in red) on the humerus and proximal portions of the radius and ulna. Most insert (marked in blue) distally on the carpals, metacarpals, and phalanges. Muscles usually bring their more mobile, distal insertions toward their more stable, proximal origins as they shorten.

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MUSCLE ATTACHMENT SITES

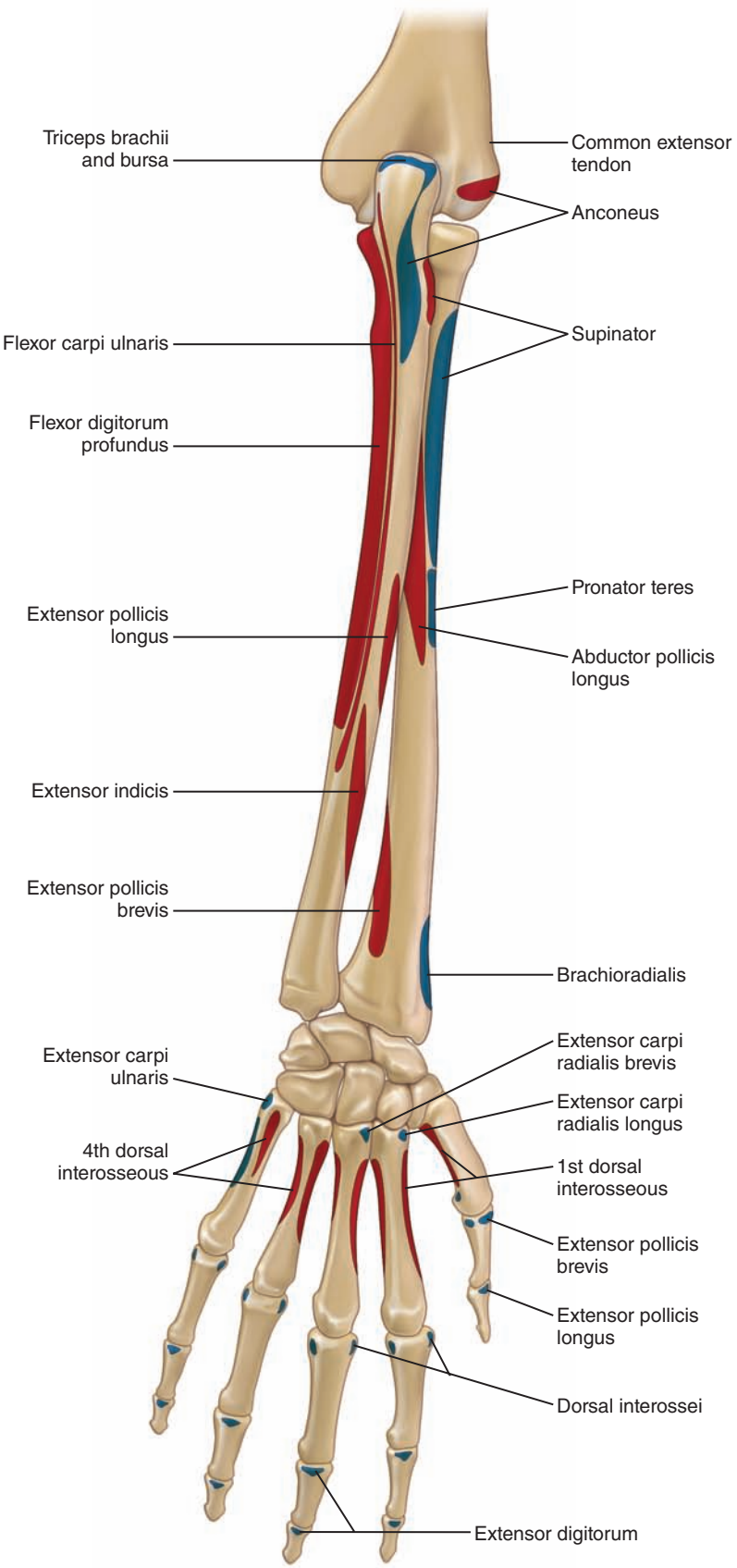


FIGURE 5.4B Arm muscle attachments: Posterior view.

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LIGAMENTS OF THE ELBOW, FOREARM, WRIST, AND HAND

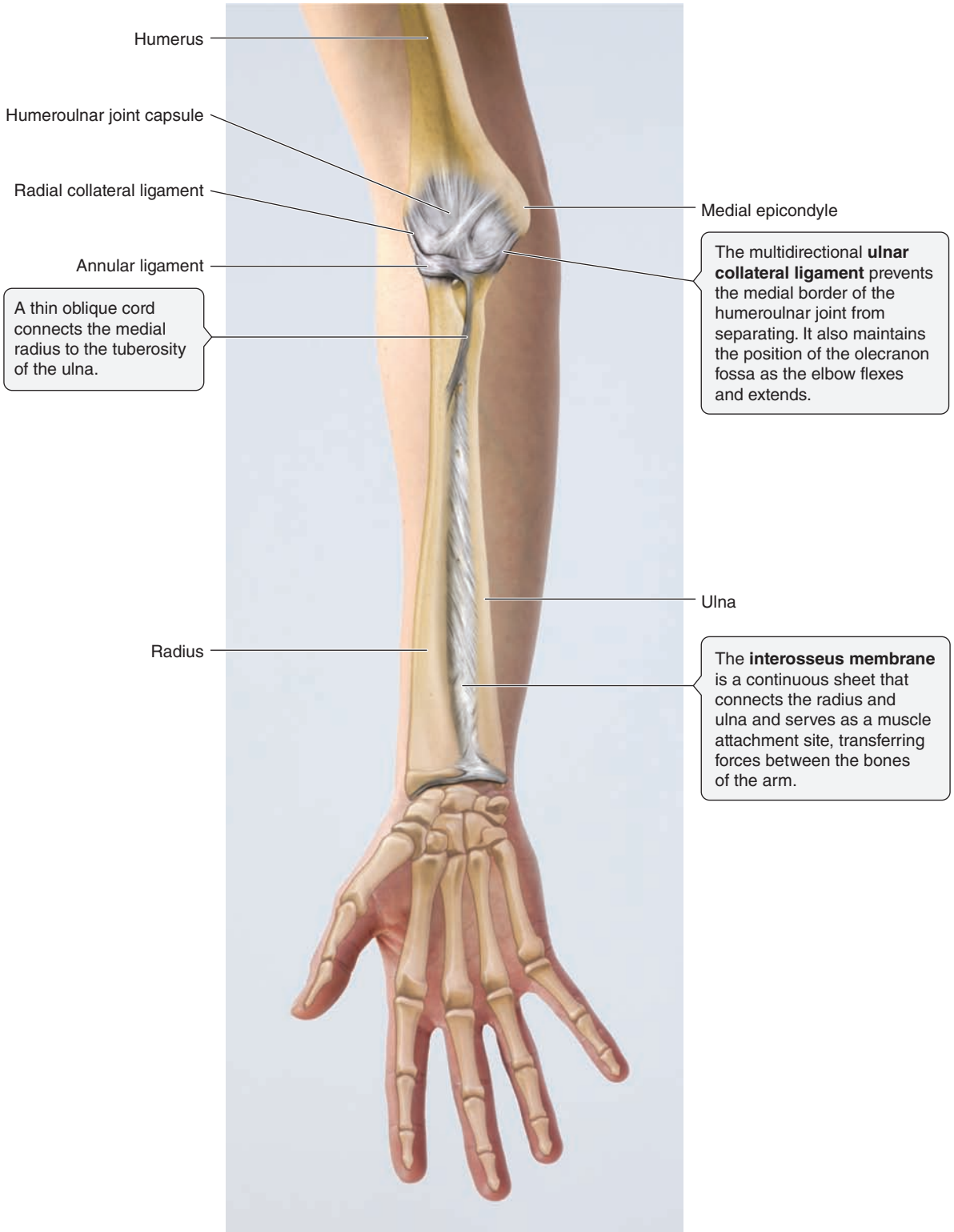


FIGURE 5.5A **Elbow ligaments:** Anterior view.

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LIGAMENTS OF THE ELBOW, FOREARM, WRIST, AND HAND

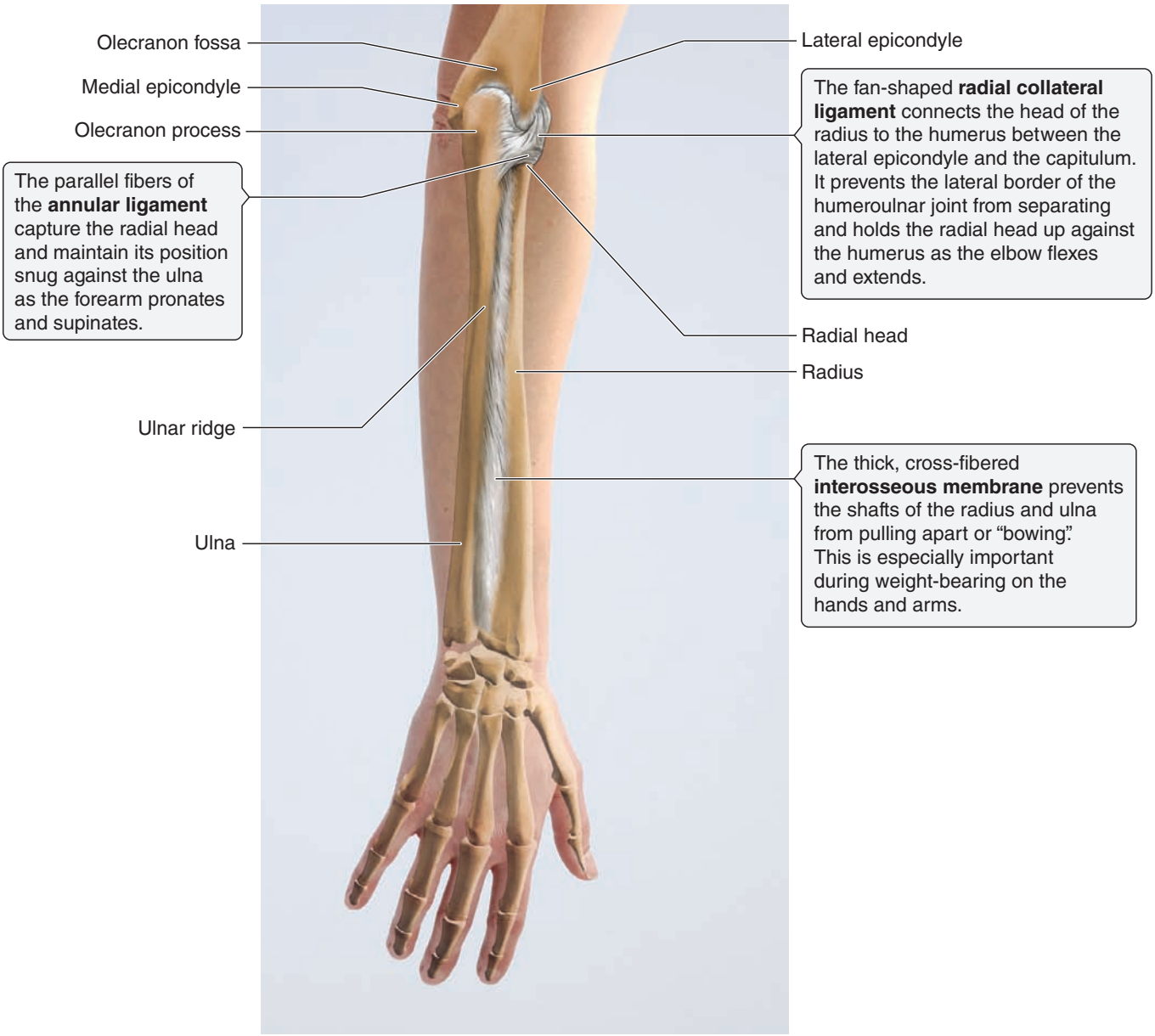


FIGURE 5.5B **Elbow ligaments:** Posterior view.

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LIGAMENTS OF THE ELBOW, FOREARM, WRIST, AND HAND

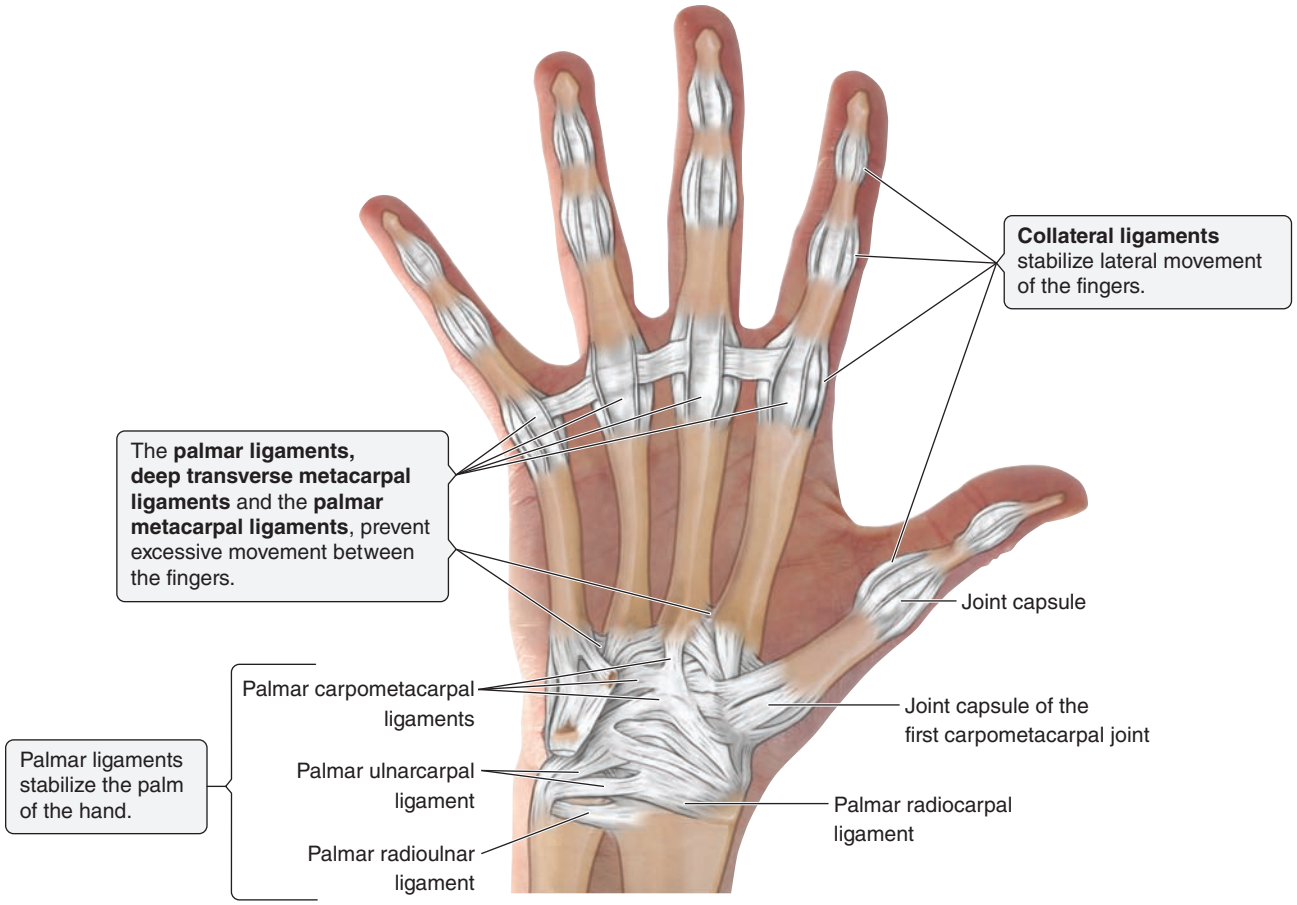


FIGURE 5.5C Hand and wrist ligaments: Anterior view.

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SUPERFICIAL MUSCLES OF THE ELBOW, FOREARM, WRIST, AND HAND

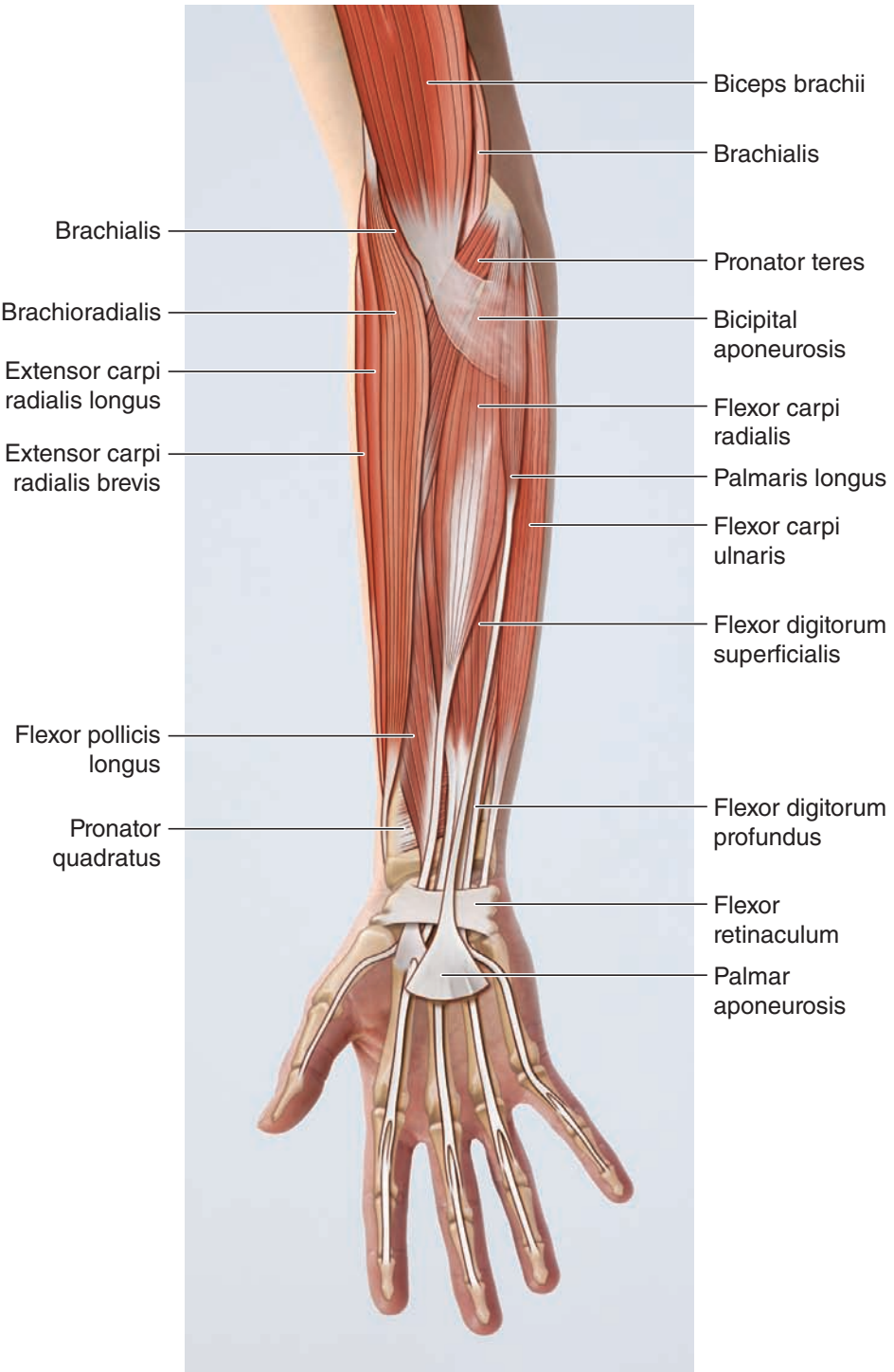


FIGURE 5.6A **Superficial muscles of the forearm and hand:** Anterior view. These large muscles have thick bellies near the elbow and taper to tendons in the wrist and hand. **Brachioradialis** and the wrist extensors lie laterally. **Pronator teres** lies proximally, deep to the bicipital aponeurosis and lateral to the flexor carpi radialis. **Flexor carpi radialis**, **palmaris longus**, and **flexor carpi ulnaris** span the medial forearm. Both the **bicipital aponeurosis** and the **palmar aponeurosis** are superficial on the anterior arm, as is the anchoring connective tissue of the **flexor retinaculum**. Superficial muscles tend to be stronger and more complex in their actions than their deeper counterparts (pronator quadratus and flexor digitorum profundus, shown in Figure 5.7A.

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SUPERFICIAL MUSCLES OF THE ELBOW, FOREARM, WRIST, AND HAND

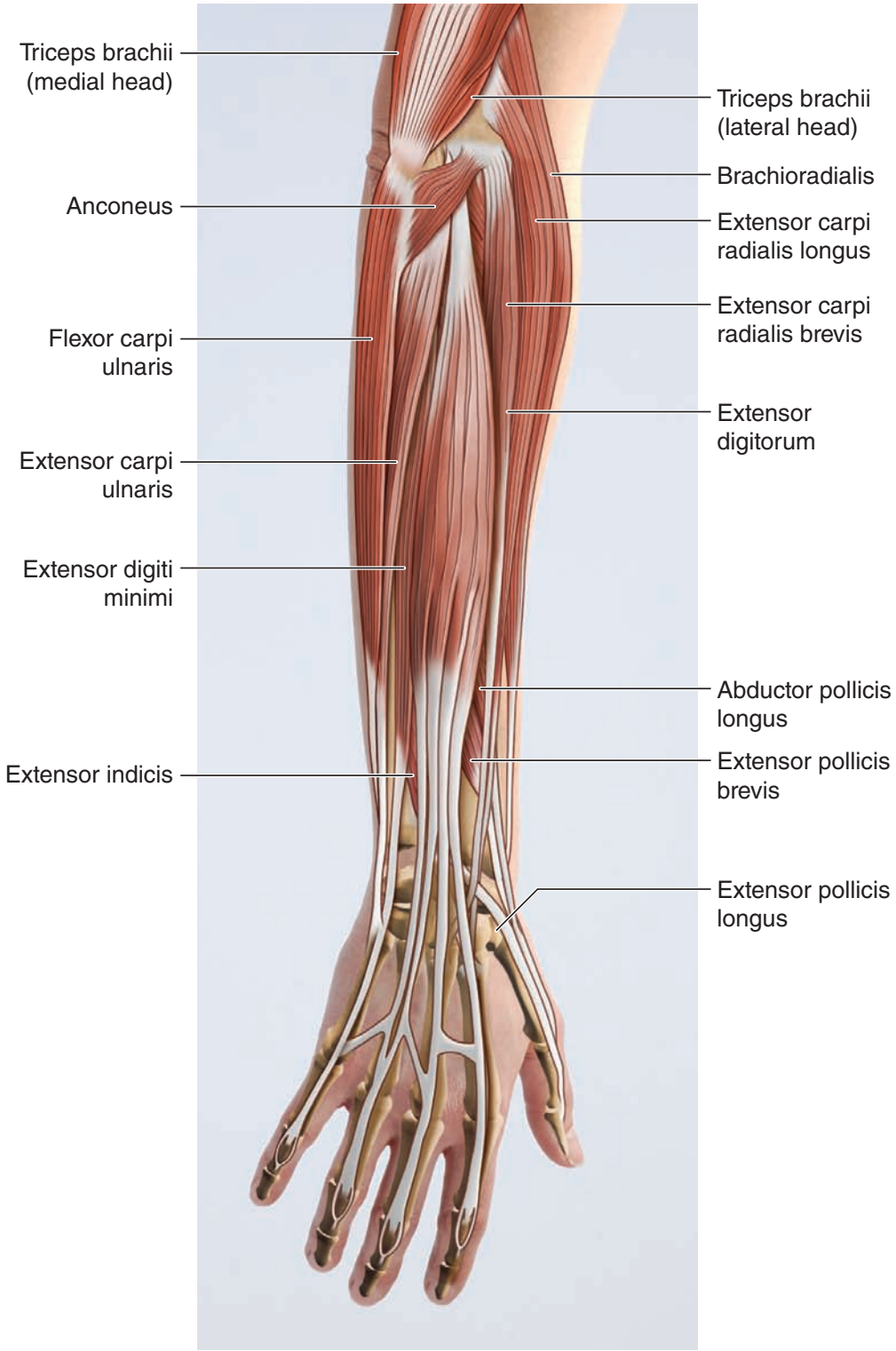


FIGURE 5.6B **Superficial muscles of the forearm and hand:** Posterior view. Large muscles such as the **extensor carpi ulnaris** and **extensor digitorum** dominate the posterior forearm. **Anconeus** shares a strong attachment on the ulnar shaft with flexor carpi ulnaris, which wraps around the medial forearm. **Extensor carpi radialis longus, extensor carpi ulnaris,** and **extensor digitorum** share attachments on the lateral epicondyle of the humerus and span the lateral forearm.

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DEEP MUSCLES OF THE ELBOW, FOREARM, WRIST, AND HAND

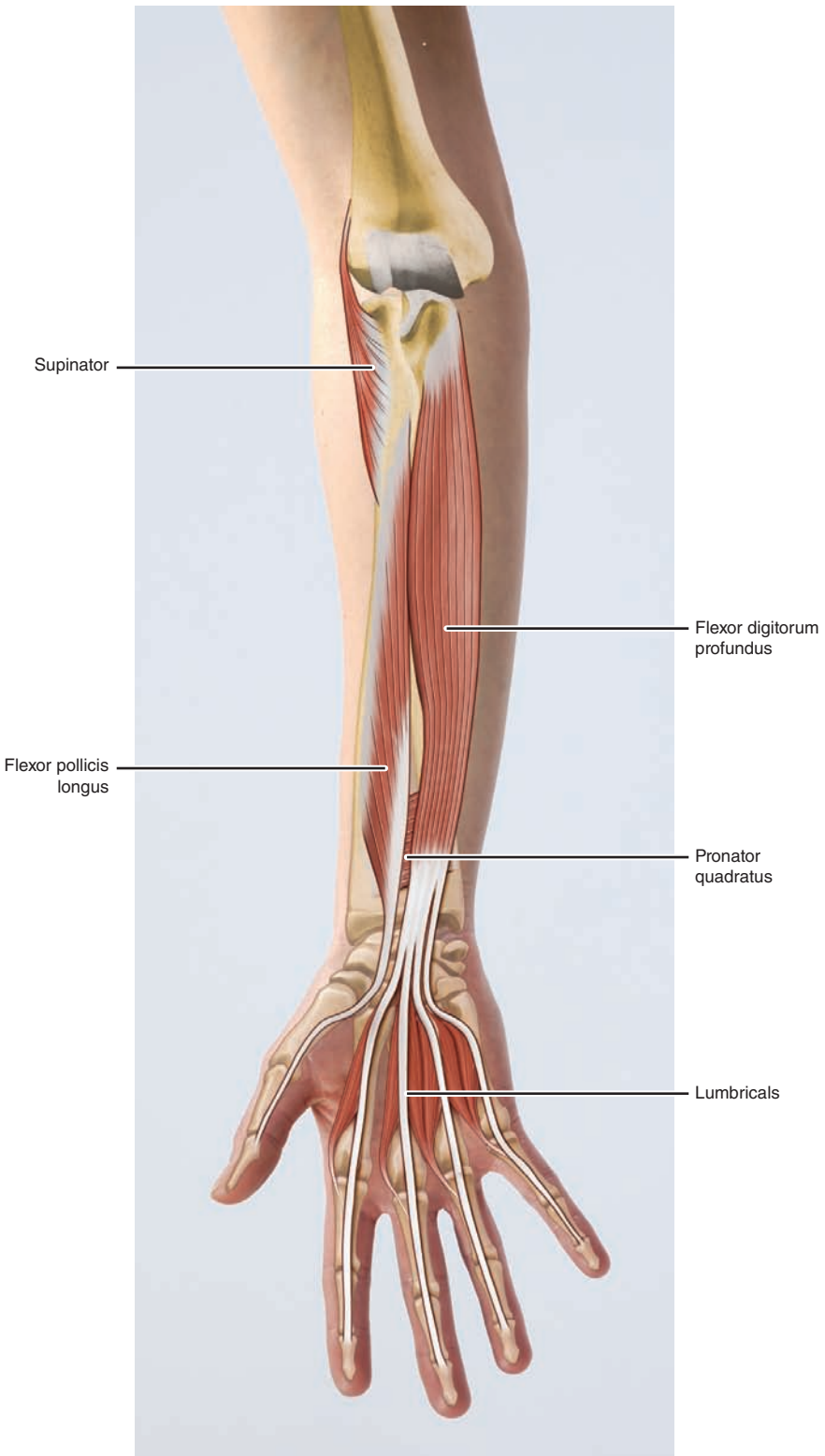


FIGURE 5.7A **Deep muscles of the forearm and hand:** Anterior view. Deep muscles of this region stabilize the elbow and forearm (**supinator** and **pronator quadratus**). They also create more subtle movements. Deep muscles in the hand control grasping activities (**flexor digitorum profundus** and **flexor pollicis longus**) and fine finger movements like segmented flexion and opening and closing of the hand (**lumbricals**).

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DEEP MUSCLES OF THE ELBOW, FOREARM, WRIST, AND HAND

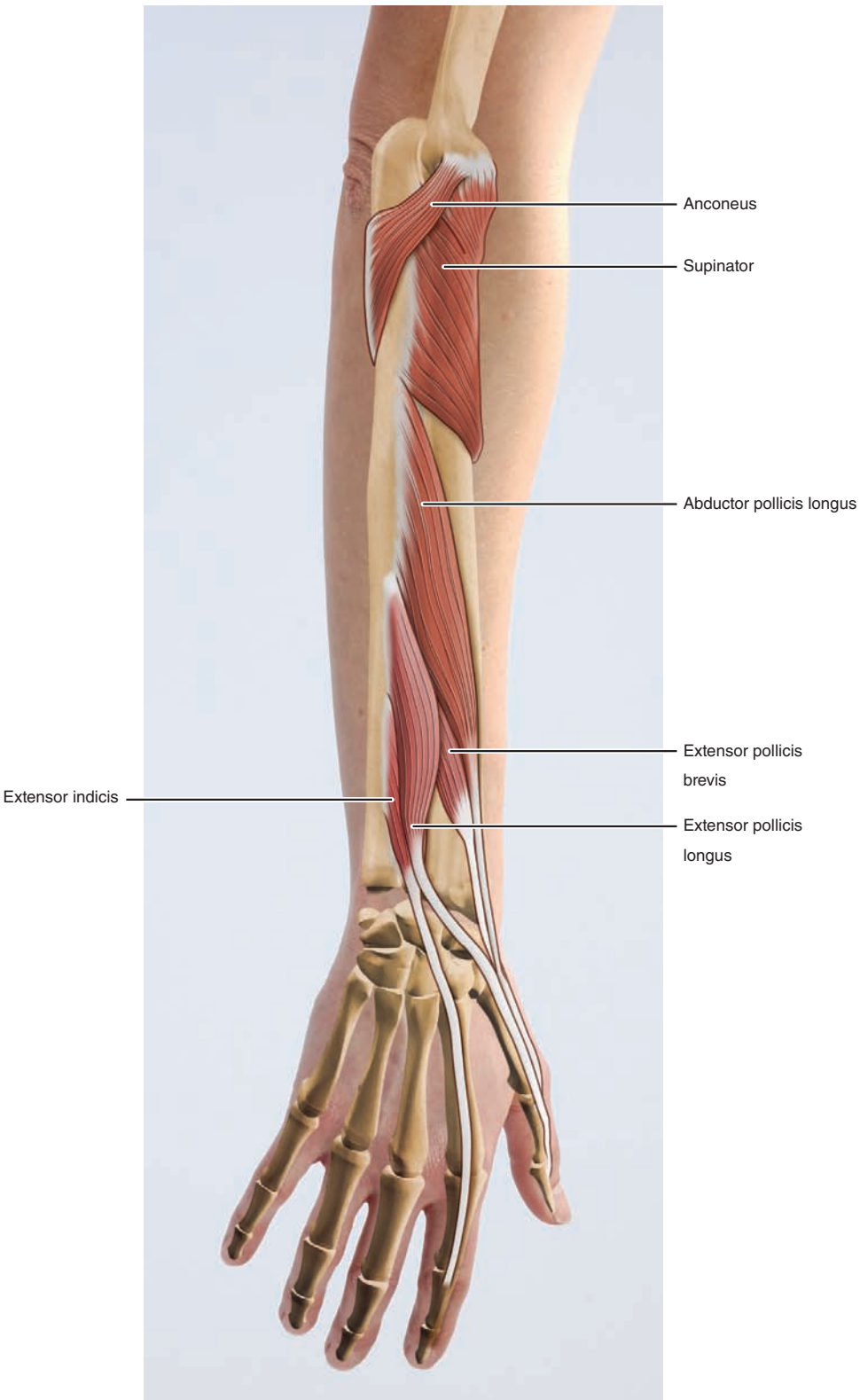


FIGURE 5.7B **Deep muscles of the forearm and hand:** Posterior view. The deep muscles of the posterior arm and hand wrap around the forearm and stabilize rotation (**supinator** and **anconeus**). Several deep muscles move the thumb (**abductor pollicis longus, extensor pollicis brevis** and **longus**) and index finger (**extensor indicis**).

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SPECIAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

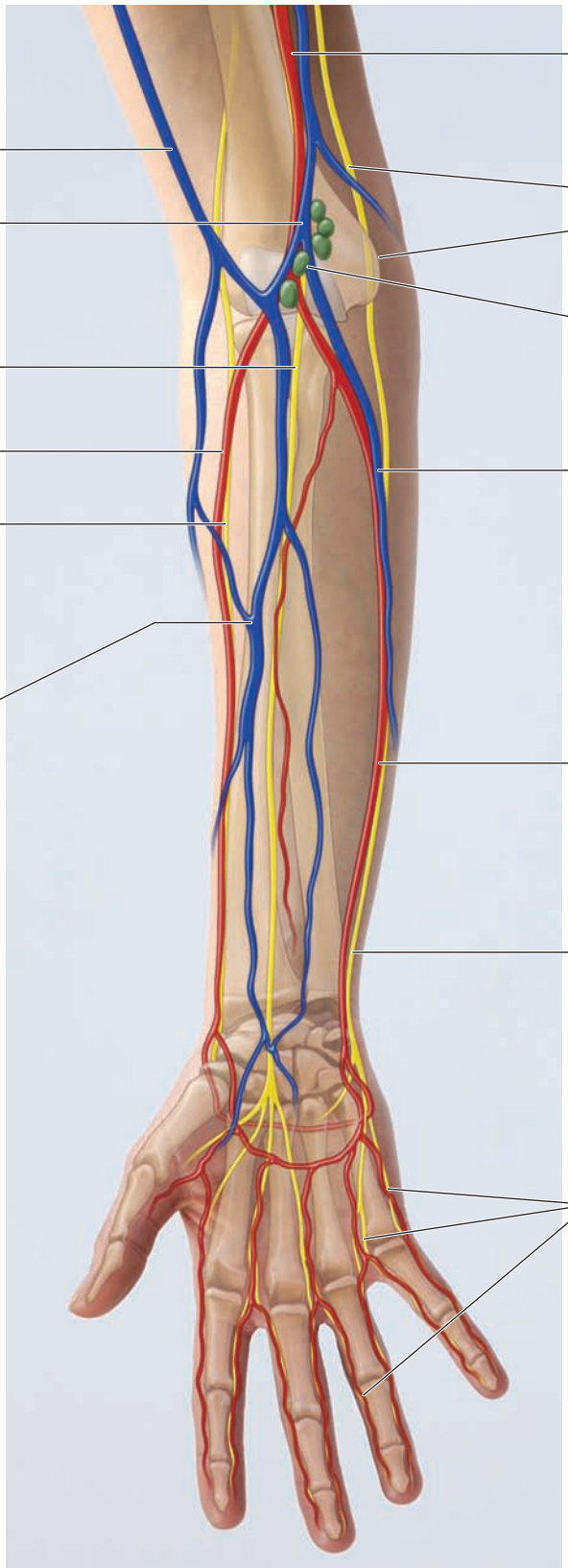


FIGURE 5.8A Lymph nodes, nerves, and blood vessels of the forearm, wrist, and hand: Anterior view.

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SPECIAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

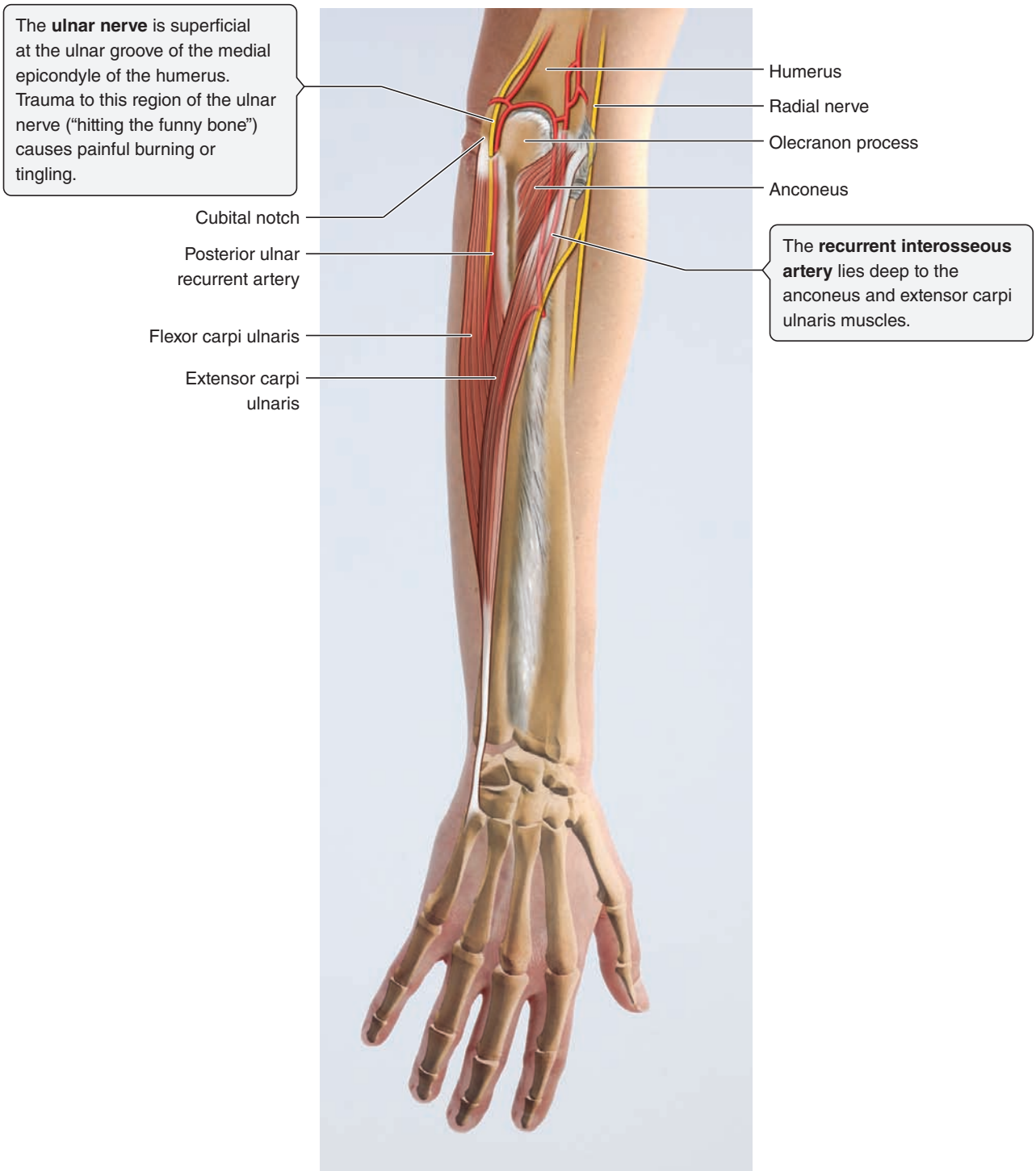


FIGURE 5.8B **Nerves and blood vessels of the elbow:** Posterior view.

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SPECIAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

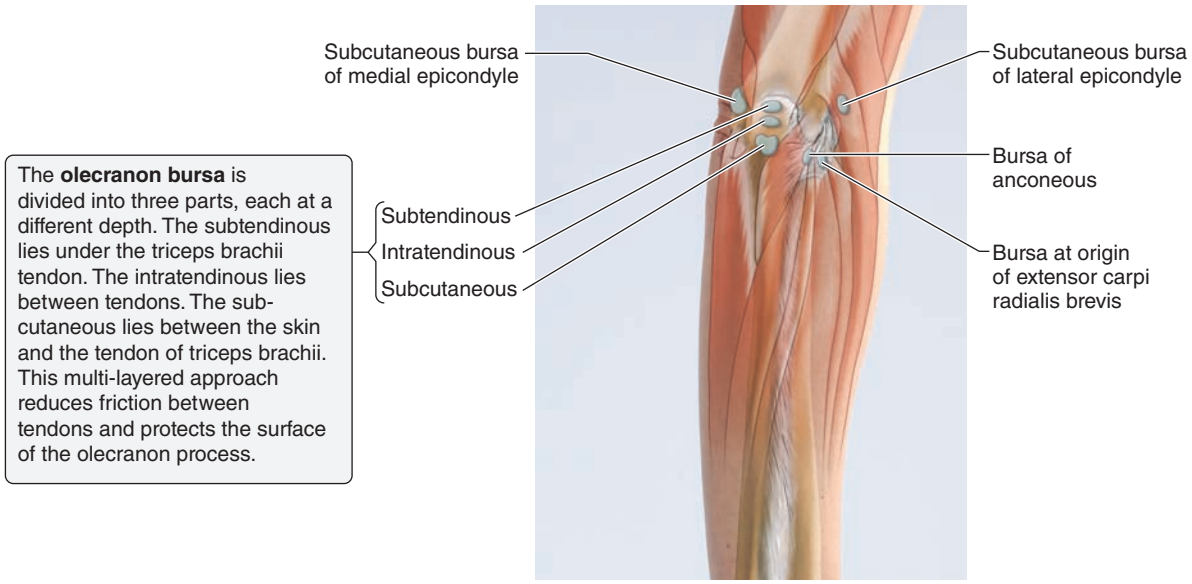


FIGURE 5.8C **Bursae of the elbow:** Posterior view.

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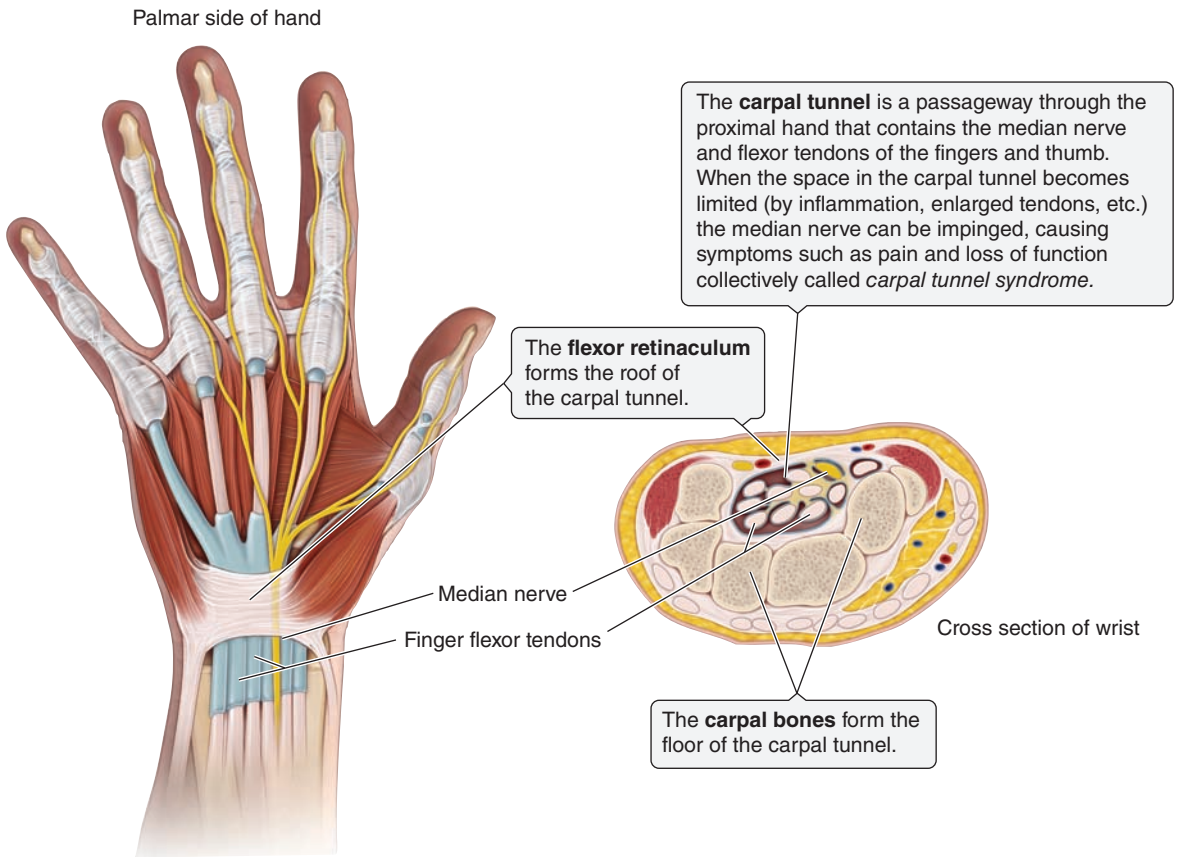


FIGURE 5.8D The carpal tunnel.

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SPECIAL STRUCTURES OF THE ELBOW, FOREARM, WRIST, AND HAND

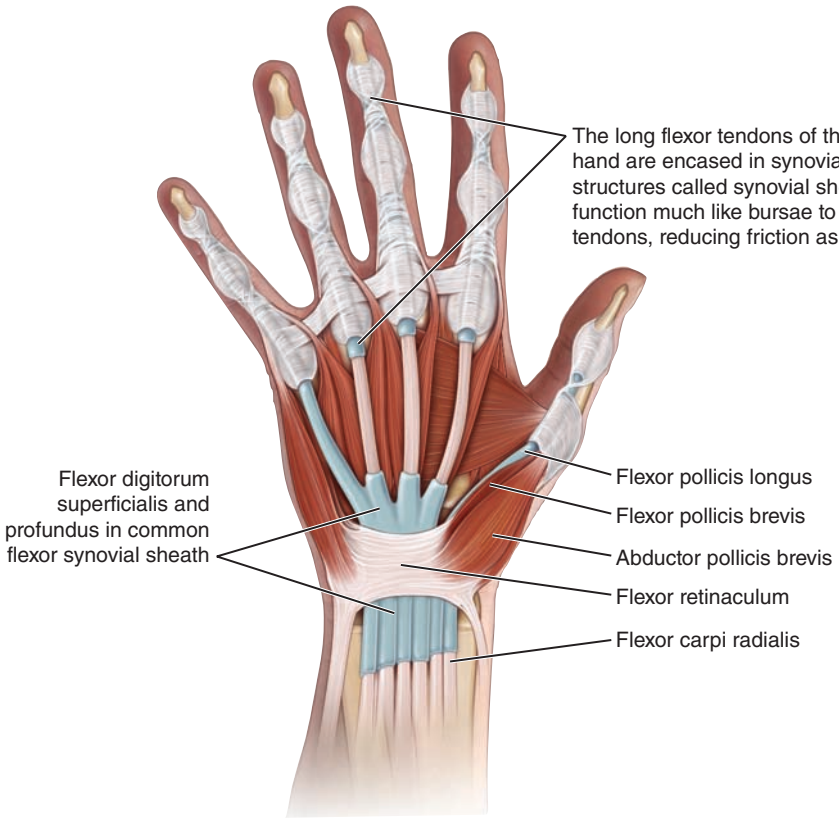


FIGURE 5.8E Flexor tendons and synovial sheaths of the hand: Anterior view.

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POSTURE OF THE ELBOW, WRIST, AND HAND

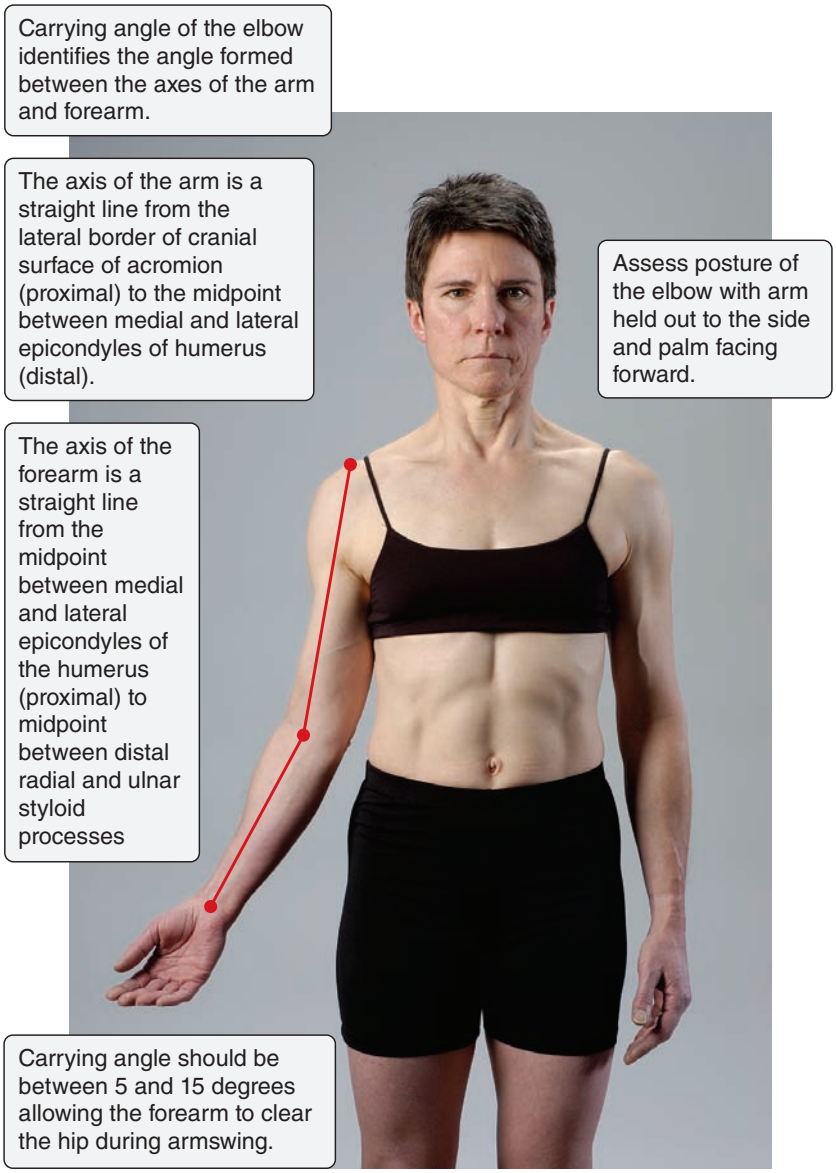


FIGURE 5.9 Assessing posture of the elbow: Anterior view.

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MOVEMENTS AVAILABLE: ELBOW AND WRIST

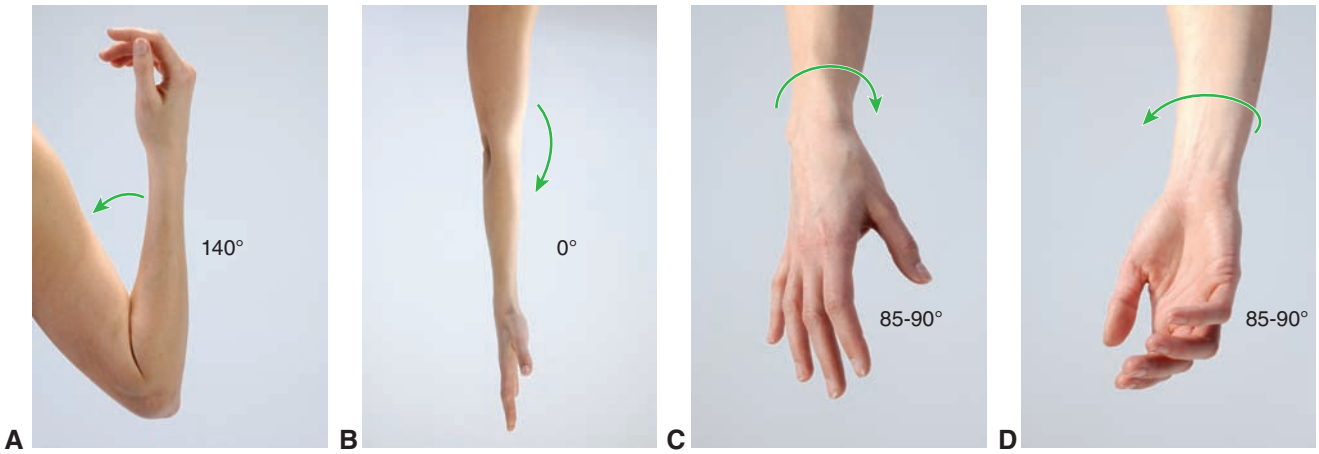


FIGURE 5.10 **A.** Elbow flexion, **B.** Elbow extension, **C.** Pronation, **D.** Supination.

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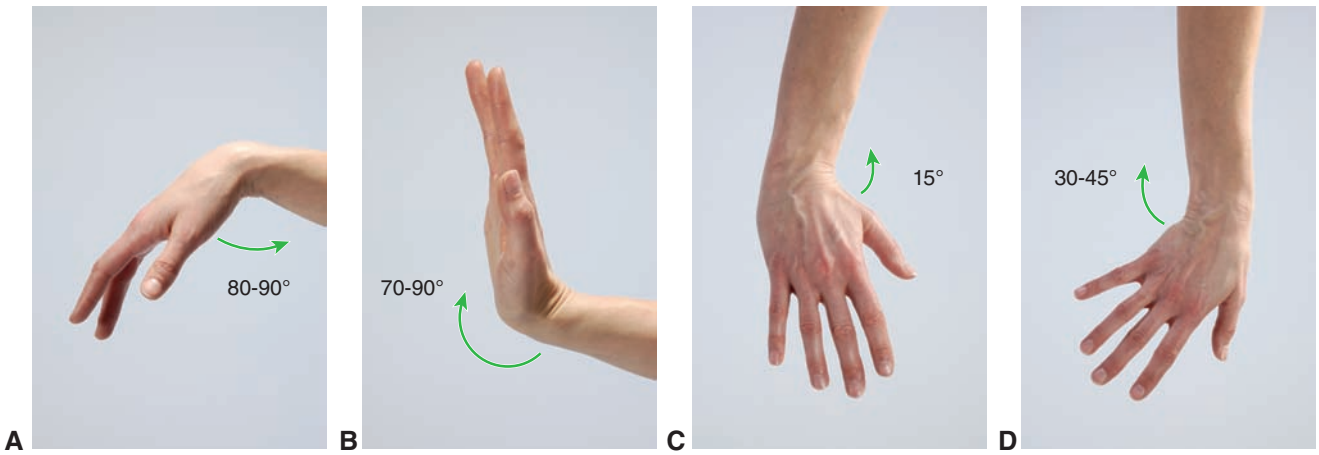


FIGURE 5.11 **A.** Wrist flexion, **B.** Wrist extension, **C.** Radial deviation, **D.** Ulnar deviation.

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MOVEMENTS AVAILABLE: HAND

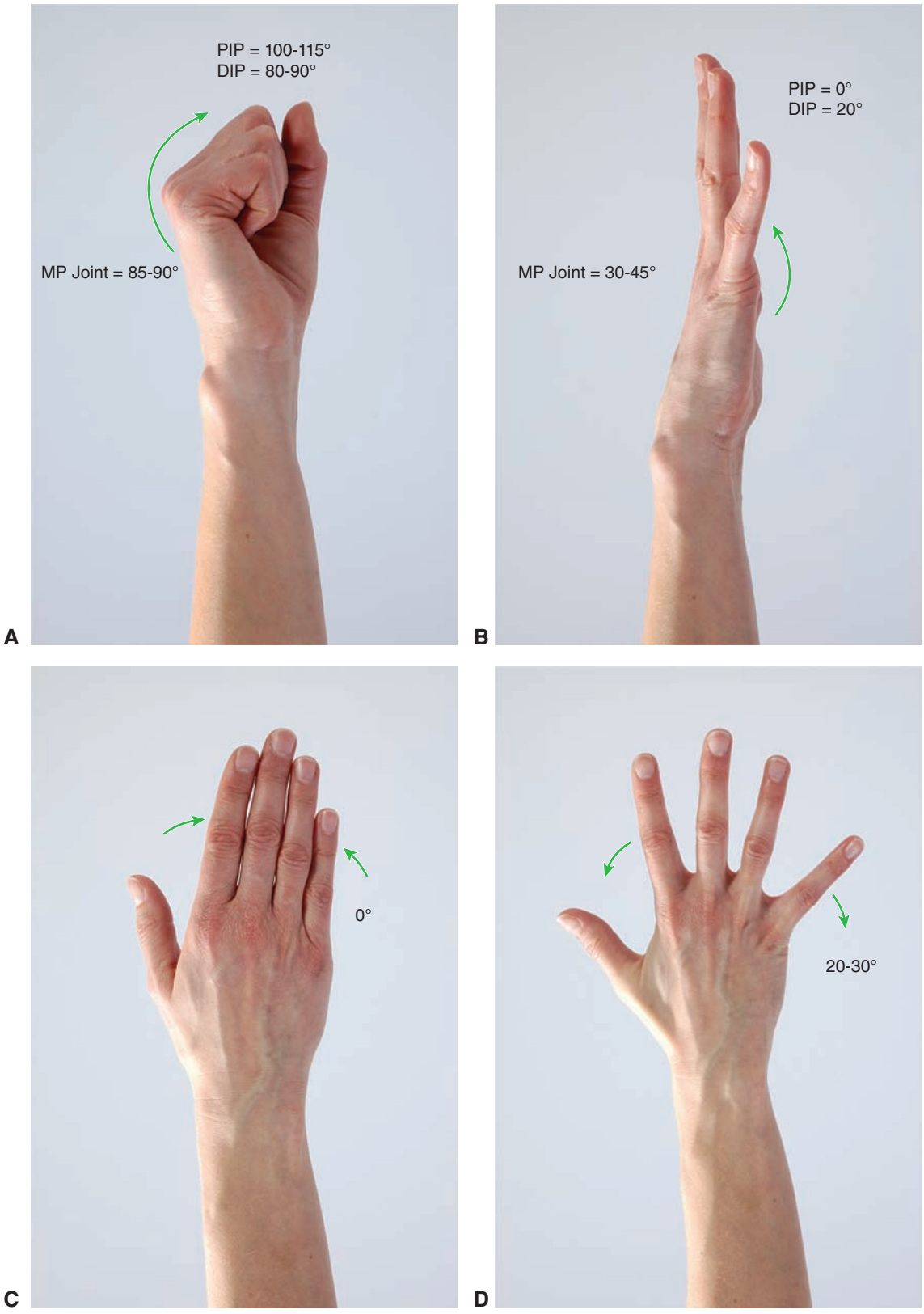


FIGURE 5.12 A. Finger flexion, B. Finger extension, C. Finger adduction, D. Finger abduction. Finger flexion and extension occur at the metacarpophalangeal (MP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints, whereas adduction and abduction occur only at the metacarpophalangeal joints.

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MOVEMENTS AVAILABLE: THUMB

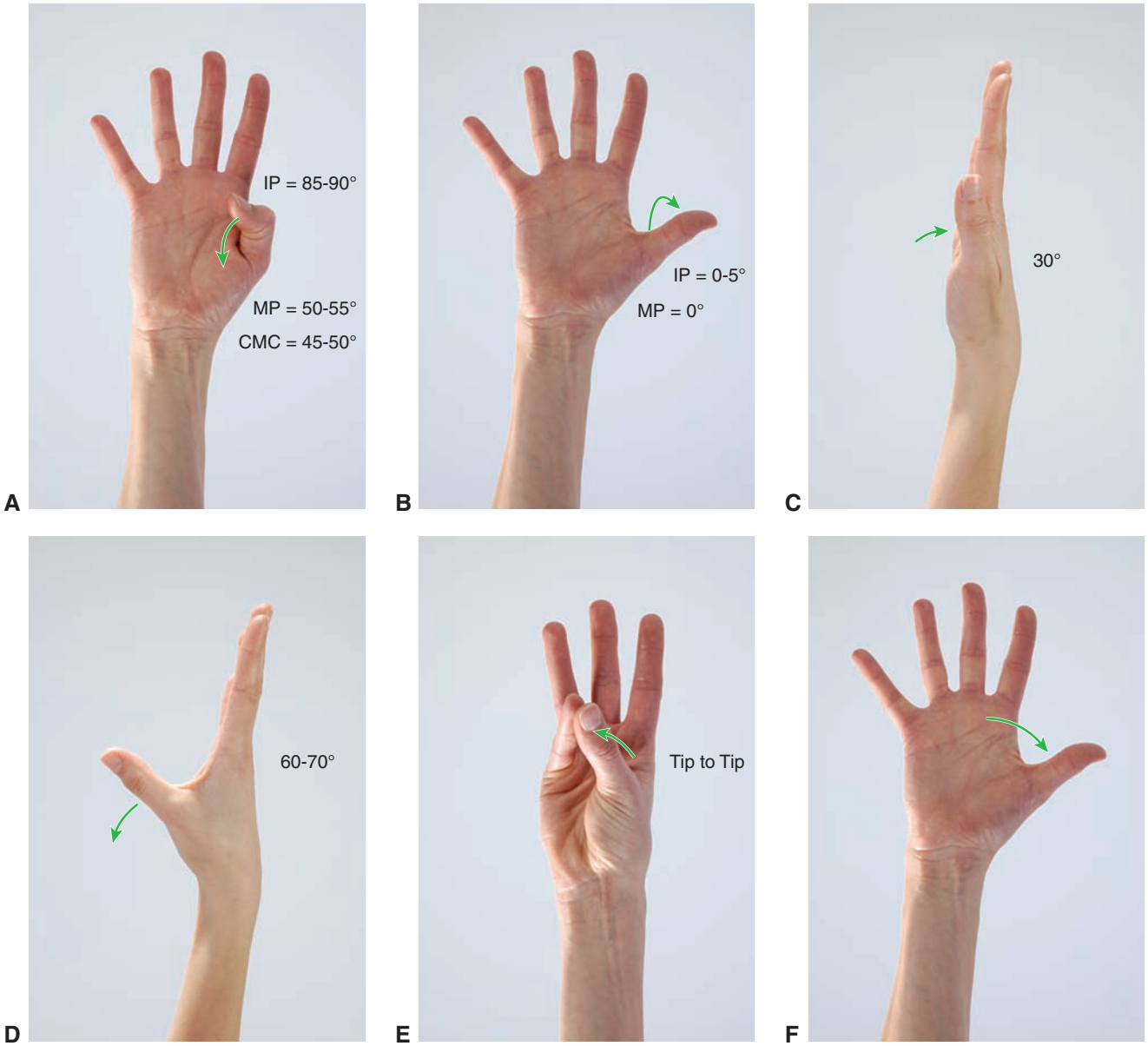


FIGURE 5.13 A. Thumb flexion, B. Thumb extension, C. Thumb adduction, D. Thumb abduction, E. Thumb opposition, F. Thumb reposition. Flexion and extension of the thumb occur at the carpometacarpal (CMC), metacarpophalangeal (MP), and interphalangeal (IP) joints, whereas adduction, abduction, opposition, and reposition occur only at the carpometacarpal joints.

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PASSIVE RANGE OF MOTION

Performing passive range of motion (PROM) in the elbow, forearm, wrist, and hand helps establish the health and function of inert structures such as joint capsules and ligaments as well as length of antagonist (opposite) muscle groups. The client should be lying comfortably on a massage or examination table. Ask the client to relax and allow you to perform the PROM exercises without "helping."

For each of the movements illustrated next, take the elbow, forearm, wrist, or hand through to endfeel while watching for compensation (extraneous movement) in the other joints or regions. Some motions, such as finger and thumb adduction, are limited by approximation (the body running into itself) and are therefore not included in evaluation of passive range of motion. Information about passive range of motion and endfeel can be found at the end of Chapter 3, *Myology*.

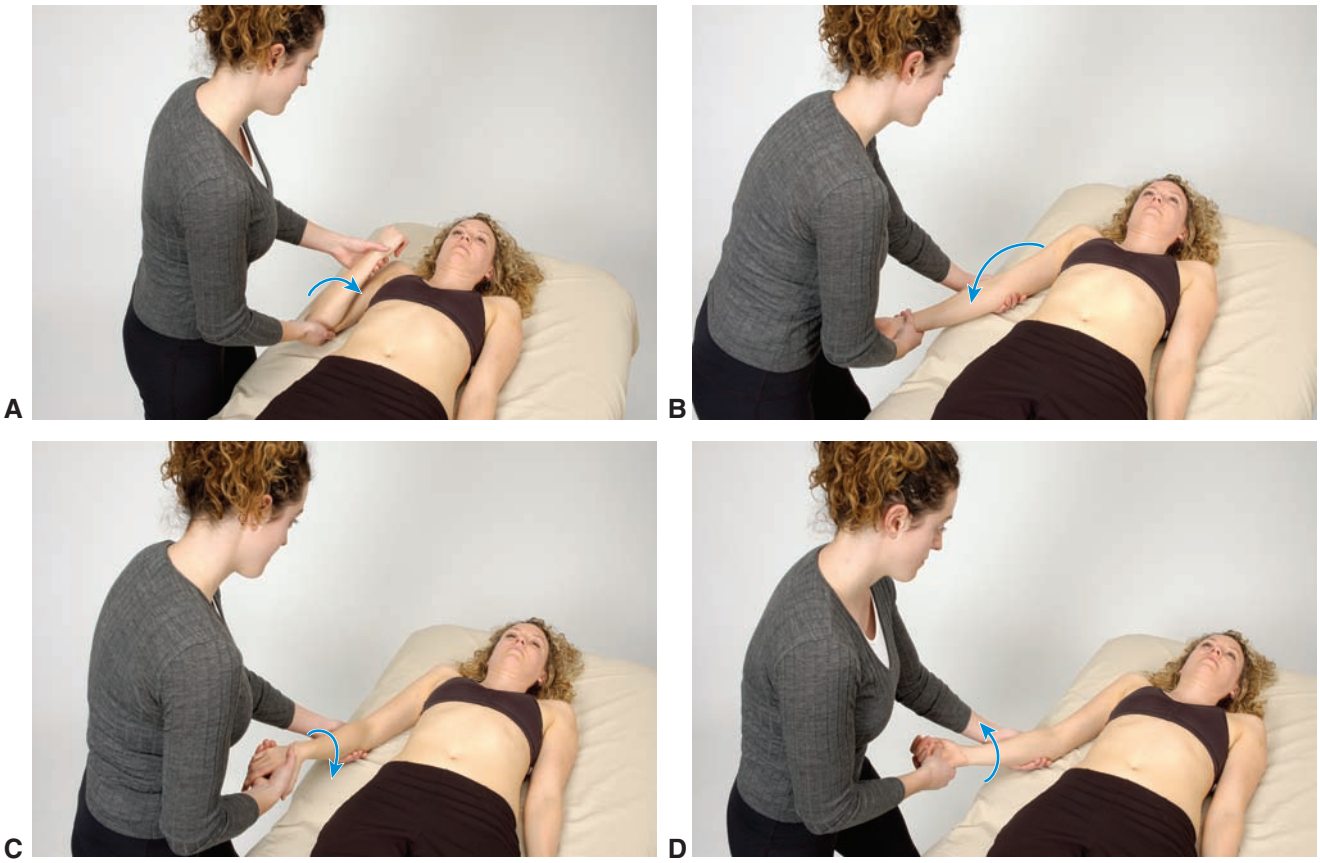


FIGURE 5.14 **A. Passive elbow flexion.** The blue arrow indicates the direction of movement. Stand at the side of the table and face the client's body. Hold the client's wrist with one hand and grasp the elbow with the other hand to stabilize the limb. Supinate the forearm while keeping the elbow extended. Then bend the elbow to move the client's forearm from the side of the body toward the upper arm. Assess the ROM of the joint capsule as well as the muscles that extend the elbow. **B. Passive elbow extension.** Stand at the client's side and support the wrist and elbow in the same way as for passive elbow flexion. With the client's forearm supinated and starting with the elbow flexed, bring the arm back down to the client's side straightening the elbow as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that flex the elbow. **C. Passive forearm pronation.** Stand at the client's side. Hold the client's wrist with one hand and grasp the elbow with the other hand to stabilize the limb. Start with forearm supinated or in palm-up position then gently rotate the client's arm into palm-down position as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that supinate the forearm. **D. Passive forearm supination.** Stand at the client's side. Hold the client's wrist with one hand and grasp the elbow with the other hand to stabilize the limb. Start with the client's forearm pronated in palm-down position then gently rotate the arm into palm-up position as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that pronate the forearm.

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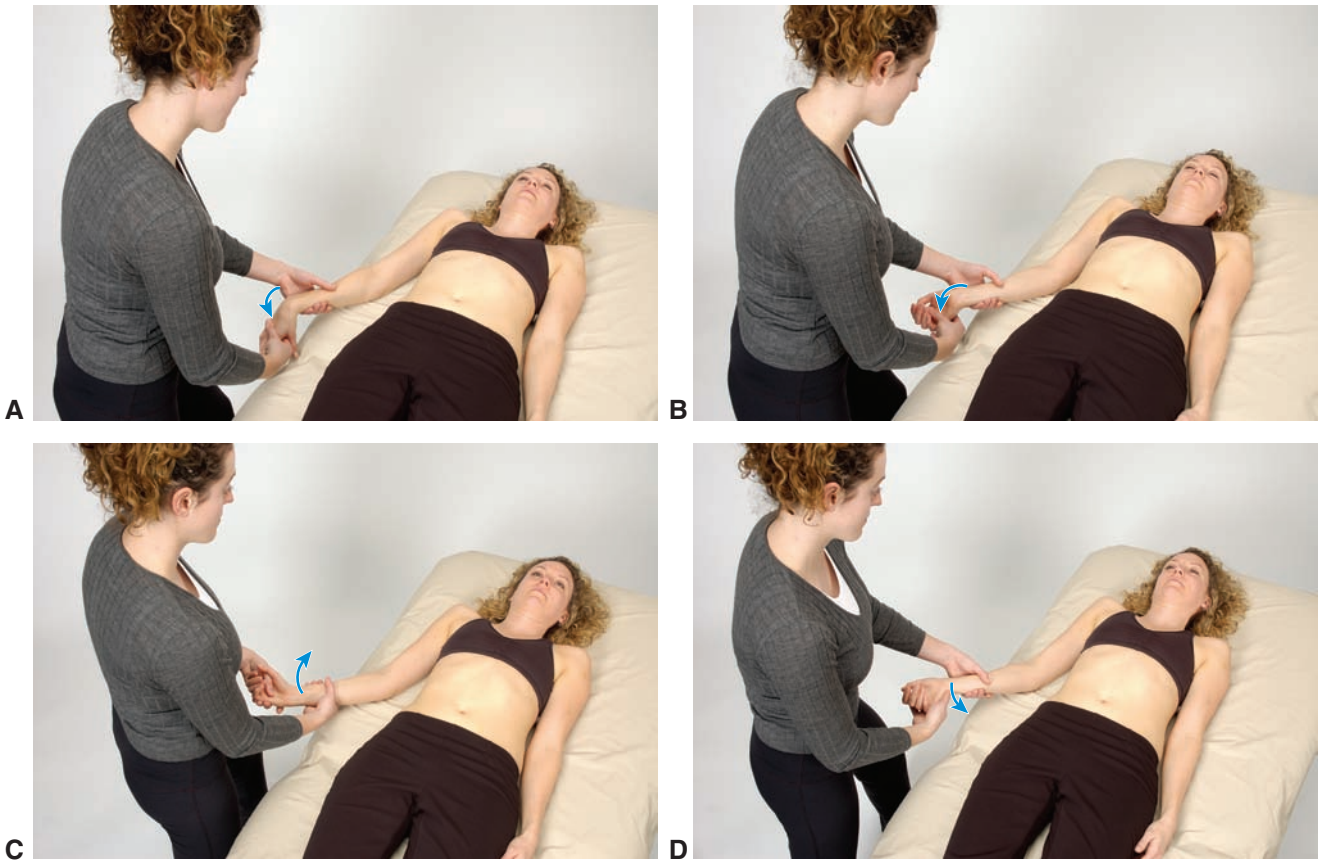


FIGURE 5.15 **A. Passive wrist flexion.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm pronated and gently bend the wrist and move the hand toward the floor as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that extend the wrist. **B. Passive wrist extension.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm supinated and gently bend the wrist and move the hand toward the floor as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that flex the wrist. **C. Passive radial deviation.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently bend the wrist and move the hand laterally as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that ulnarly deviate the wrist. **D. Passive ulnar deviation.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently bend the wrist and move the hand medially as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that radially deviate the wrist.

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FIGURE 5.16 **A. Passive finger flexion.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently bend the fingers into the hand as far as is comfortable. Assess the ROM of the joint capsules as well as the muscles that extend the fingers. **B. Passive finger extension.** Stand at the client's side. Hold the client's hand with one hand and grasp the forearm with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently bend the fingers back as far as is comfortable. Assess the ROM of the joint capsules as well as the muscles that flex the fingers. *Note: passive finger adduction and abduction are not included.* **C. Passive thumb flexion.** Stand at the client's side. Hold the client's thumb with one hand and grasp the wrist with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently bend the thumb and move the tip toward the palm as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that extend the thumb. **D. Passive thumb extension.** Stand at the client's side. Hold the client's thumb with one hand and grasp the wrist with the other hand to stabilize the limb. Start with the client's forearm supinated, then gently straighten the thumb, moving the tip away from the palm as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that flex the thumb. **E. Passive thumb abduction.** Stand at the client's side. Hold the client's thumb with one hand and grasp the wrist with the other hand to stabilize the limb. Start with the forearm supinated, then gently move the thumb away from the index finger as far as is comfortable. Assess the ROM of the joint capsule as well as the muscles that adduct the thumb. *Note: passive thumb adduction is limited by approximation and thus not included.*

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RESISTED RANGE OF MOTION

Performing resisted range of motion (RROM) helps establish the health and function of the dynamic stabilizers and prime movers in the elbow, forearm, wrist, and hand. Evaluating functional strength and endurance helps identify balance and potential imbalance between the muscles that bend and turn the arm as well as grasp and release objects. The client should be seated comfortably in a chair or on a massage or examination table. For each of the movements illustrated next, resist your client's movement while assessing strength and endurance. Also be sure and watch for compensation (muscle recruitment) in the other joints or regions. Procedures for performing and grading resisted ROM are outlined in Chapter 3, *Myology*.

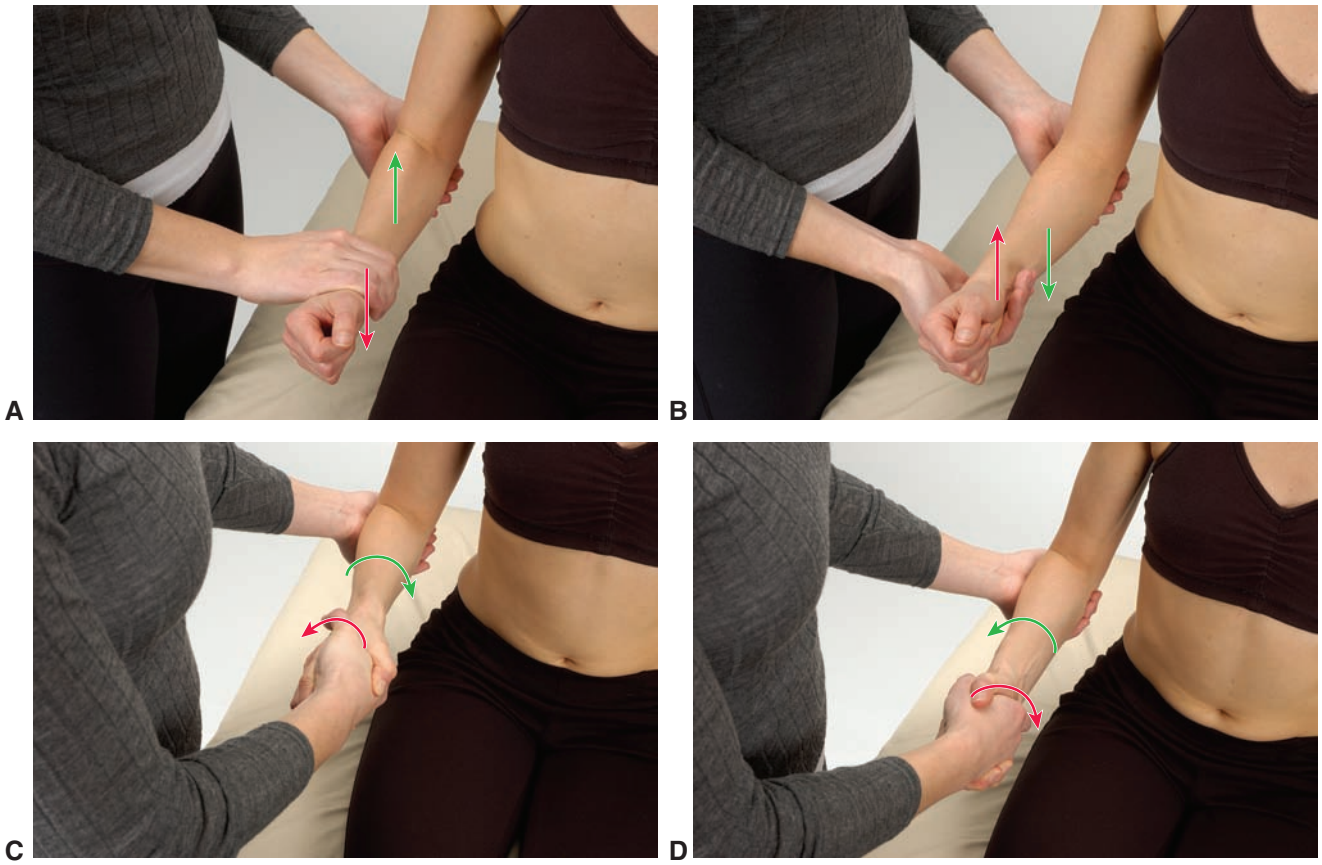


FIGURE 5.17 **A. Resisted elbow flexion.** The green arrow indicates the direction of movement of the client and the red arrow indicates the direction of resistance from the practitioner. Stand at the client's side. Place one hand under the client's elbow to stabilize the joint and place the other hand on top of the client's forearm. Instruct the client to meet your resistance by pulling the forearm up as you gently but firmly press the forearm down. Assess the strength and endurance of the muscles that flex the elbow. **B. Resisted elbow extension.** Stand at the client's side. Place one hand under client's elbow to stabilize the joint and the other underneath the client's forearm. Instruct the client to meet your resistance by pushing the forearm down as you gently but firmly press the forearm up. Assess the strength and endurance of the muscles that extend the elbow. **C. Resisted pronation.** Stand in front of the client. Place one hand under the client's elbow to stabilize the joint and grasp the client's hand with the other. Instruct the client to meet your resistance by turning the forearm palm down as you gently but firmly turn the forearm palm up. Assess the strength and endurance of the muscles that pronate the forearm. **D. Resisted supination.** Stand in front of the client. Place one hand under the client's elbow to stabilize the joint and grasp the client's hand with the other. Instruct the client to meet your resistance by turning the forearm palm up as you gently but firmly turn the forearm palm down. Assess the strength and endurance of the muscles that supinate the forearm.

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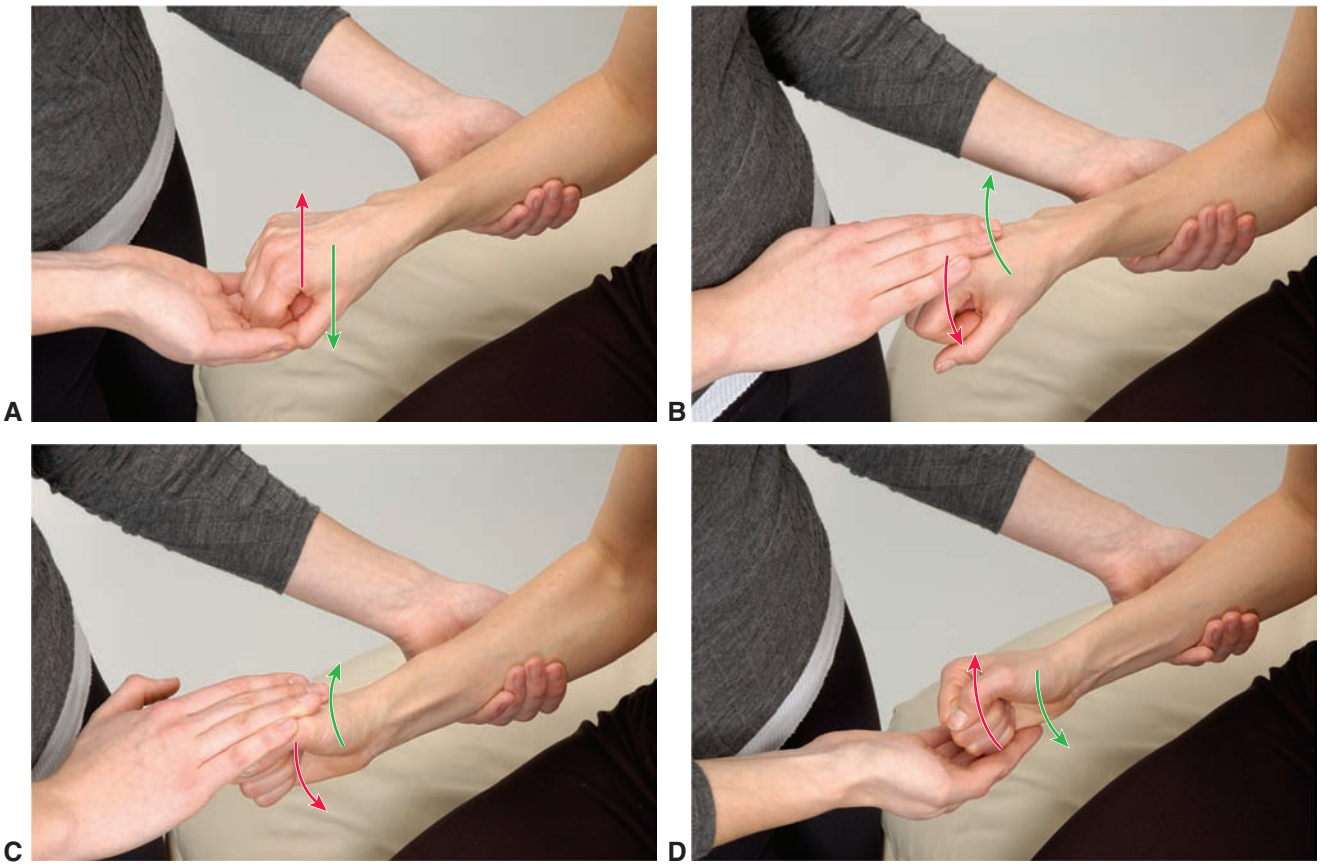


FIGURE 5.18 **A. Resisted wrist flexion.** Stand in front of the client. Place one hand under the client's forearm to stabilize it and the other on top of the client's pronated, closed hand. Instruct the client to meet your resistance by bending the wrist and pushing the closed hand down toward the floor as you gently but firmly push the hand up. Assess the strength and endurance of the muscles that flex the wrist. **B. Resisted wrist extension.** Stand in front of the client. Place one hand under the client's forearm to stabilize it and the other on top of the client's pronated, closed hand. Instruct the client to meet your resistance by bending the wrist and bringing the closed hand up toward the ceiling as you gently but firmly push the hand down. Assess the strength and endurance of the muscles that extend the wrist. **C. Resisted radial deviation.** Stand in front of the client. Place one hand under the client's forearm to stabilize it and the other on top of the client's neutral (thumb superior) closed hand. Instruct the client to meet your resistance by bending their wrist and bringing the closed hand up as you gently but firmly push it toward the floor. Assess the strength and endurance of the muscles that radially deviate the wrist. **D. Resisted ulnar deviation.** Stand in front of the client. Place one hand under the client's forearm to stabilize it and the other under the client's neutral (thumb superior) closed hand. Instruct the client to meet your resistance by bending their wrist and pushing the closed hand down as you gently but firmly push it toward the ceiling. Assess the strength and endurance of the muscles that ulnarly deviate the wrist.

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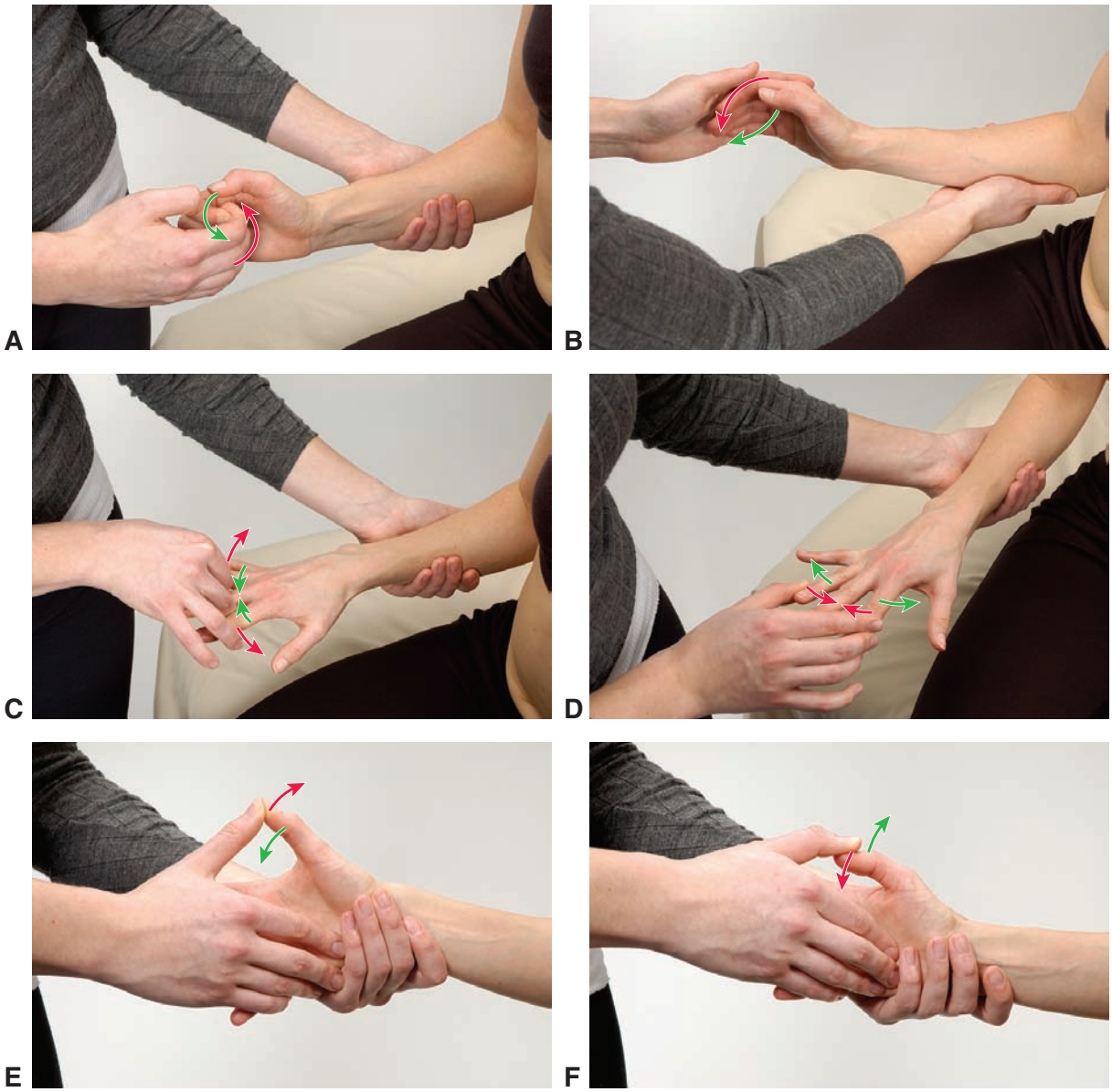


FIGURE 5.19 **A. Resisted finger flexion.** Stand in front of the client. Place one hand under the client's forearm to stabilize it. Place the fingers of your other hand on the pads of the client's fingertips. Instruct the client to meet your resistance by closing the fingers as you gently but firmly open them. Assess the strength and endurance of the muscles that flex the fingers. **B. Resisted finger extension.** Stand in front of the client. Place one hand under the client's forearm to stabilize it. Place the fingers of your other hand on the backs of the client's fingers. Instruct the client to meet your resistance by opening the fingers as you gently but firmly close them. Assess the strength and endurance of the muscles that extend the fingers. **C. Resisted finger adduction.** Stand in front of the client. Place one hand under the client's forearm to stabilize it. Place the fingers of your other hand on the inside edge of the client's fingers. Instruct the client to meet your resistance by bringing the fingers together as you gently but firmly pull them apart. Assess the strength and endurance of the muscles that adduct the fingers. **D. Resisted finger abduction.** Stand in front of the client. Place one hand under the client's forearm to stabilize it. Place the fingers of your other hand on the outside edge of the client's fingers. Instruct the client to meet your resistance by spreading the fingers as you gently but firmly push them together. Assess the strength and endurance of the muscles that abduct the fingers. **E. Resisted thumb flexion.** Stand in front of the client. Place one hand under the client's wrist to stabilize it. Place the pad of your other thumb on the pad of the client's thumb. Instruct the client to meet your resistance by closing the thumb as you gently but firmly open it. Assess the strength and endurance of the muscles that flex the thumb. **F. Resisted thumb extension.** Stand in front of the client. Place one hand under the client's wrist to stabilize it. Place the pad of your other thumb on the top of the client's thumb. Instruct the client to meet your resistance by opening the thumb as you gently but firmly close it. Assess the strength and endurance of the muscles that extend the thumb.

(*continues*)

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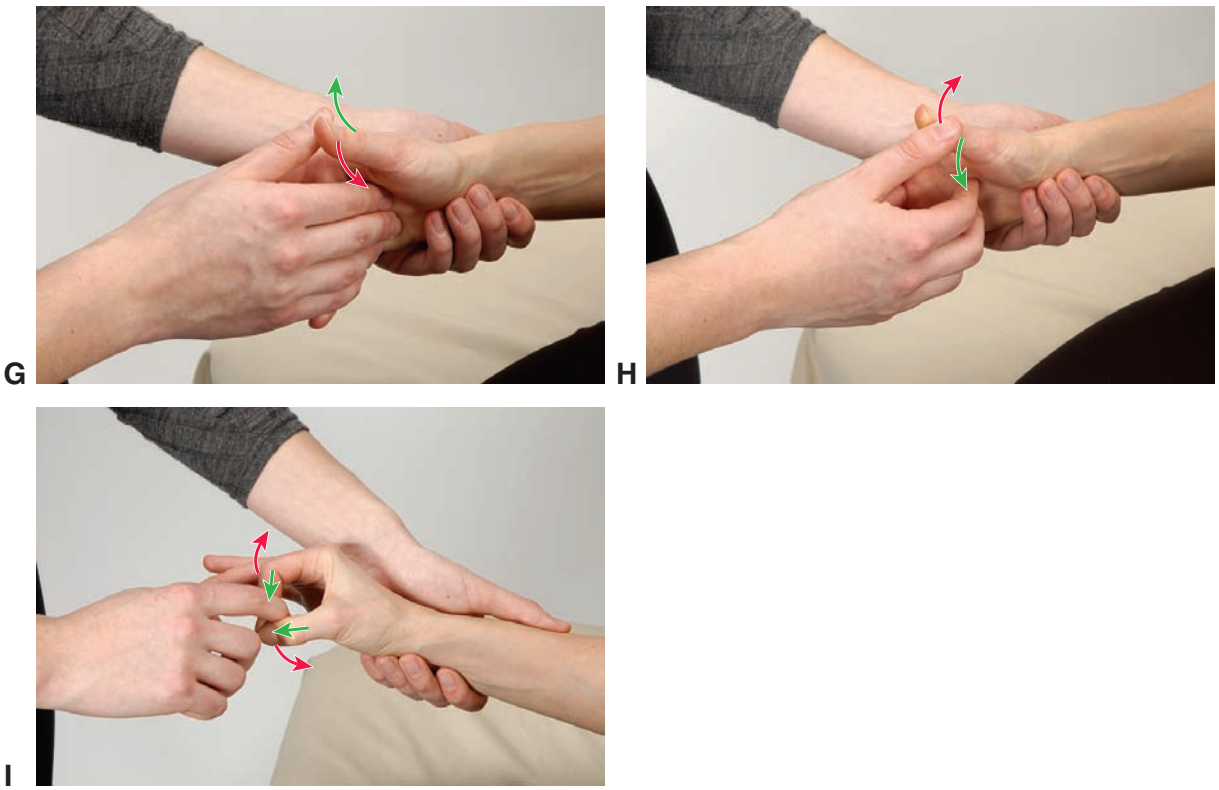


FIGURE 5.19 (*continued*) **G. Resisted thumb adduction.** Stand in front of the client. Place one hand under the client's wrist to stabilize it. Place the pad of your other thumb on the inside edge of the client's thumb. Instruct the client to meet your resistance by bringing the thumb toward the index finger as you gently but firmly push it away. Assess the strength and endurance of the muscles that adduct the thumb. **H. Resisted thumb abduction.** Stand in front of the client. Place one hand under the client's wrist to stabilize it. Place the pad of your other thumb on the outside edge of the client's thumb. Instruct the client to meet your resistance by pushing the thumb away from the index finger as you gently but firmly bring it closer. Assess the strength and endurance of the muscles that abduct the thumb. **I. Resisted thumb opposition.** Stand in front of the client. Place one hand under the client's wrist to stabilize it and instruct the client to make an "ok" sign with the index finger and thumb. Place the pad of your index finger at the joint of the circle and instruct the client to meet your resistance by keeping the fingertips together as you gently but firmly pull them apart. Assess the strength and endurance of the muscles that create opposition in the thumb.

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MUSCLE PROFILES

Brachialis

audio

brā-kē-ā′lis • "**brachium**" Latin *arm*

Attachments

O: Distal one-half of anterior surface of the humerus
I: Tuberosity and coronoid process of the ulna

Actions

- Flexes the elbow

Innervation

- Musculocutaneous and radial nerves
- C5–C6

Blood Supply

- Brachial and recurrent radial arteries

Functional Anatomy

Brachialis works primarily with biceps brachii and brachioradialis to flex the elbow. It differs from biceps brachii in that it attaches to the ulna rather than the radius; thus, it cannot rotate the forearm. Brachialis is unique in that it is a pure elbow flexor and maintains its leverage regardless of forearm position. Both biceps brachii and brachioradialis have varying strength depending upon the rotational position of the forearm.

Brachialis is strongly anchored to a broad section of the anterior humerus. This feature allows it to generate large amounts of force without being damaged. Powerful movements such as lifting, pulling, and performing chin-ups rely on brachialis. This muscle is particularly important when the forearm is pronated (palm down) because both biceps brachii and brachioradialis lose their mechanical advantage in this position. Both brachialis and biceps brachii are rapid flexors; that is, position on the arm generates quick movement through a large range of motion. The forces produced by brachialis and biceps brachii are distributed between the ulna and the radius, maximizing joint function and minimizing injury.

Palpating the Brachialis

Positioning: client supine with forearm pronated

1. Passively flex elbow to slack tissue.
2. On anterior arm, find the medial and lateral borders of the elbow flexors in a pincer grasp.

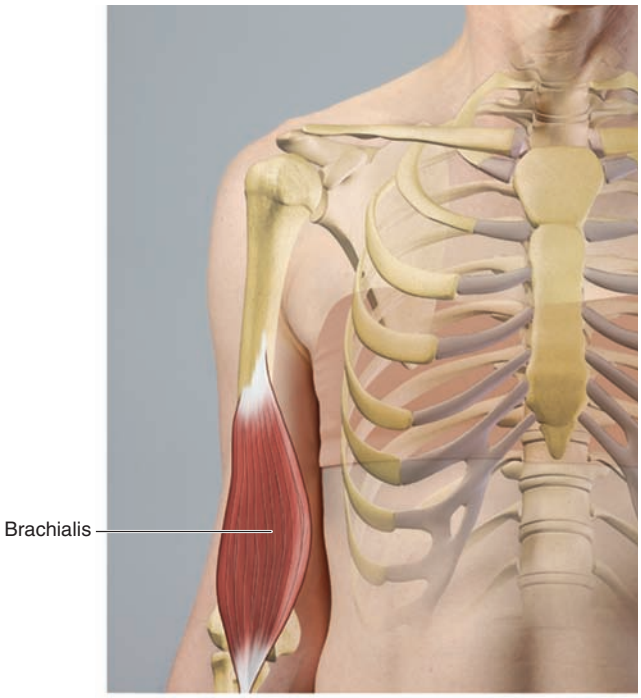


FIGURE 5.20 Brachialis.

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3. Gently slide fingers distally toward the elbow crease, stopping a few inches above.
4. Client gently resists elbow flexion to assure proper location.



FIGURE 5.21 Palpating the brachialis.

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Brachioradialis

audio

brā′kē ō rā dē ā′lis • "**brachium**" Latin *arm* "**radius**" Latin *spoke* or *ray*

Attachments

O: Proximal two-thirds of lateral supracondylar ridge of the humerus
I: Lateral side of radial styloid process

Actions

- Flexes the elbow
- Pronates the forearm from supinated to neutral
- Supinates the forearm from pronated to neutral

Innervation

- Radial nerve
- C5–C7

Blood Supply

- Recurrent radial artery

Functional Anatomy

Brachioradialis is different from its synergists, biceps brachii and brachialis. All three muscles flex the elbow, but brachioradialis has its origin near the joint rather than its insertion like the others. This arrangement makes brachioradialis very strong at the elbow joint and more effective in lifting and carrying heavy loads like buckets of water or grocery bags.

Brachioradialis is strongest when the forearm is in a neutral (thumb up) position. This position aligns its origin on the lateral edge of the humerus with its insertion on the radial styloid process. In fact, brachioradialis will assist with pronation and supination in an effort to return the forearm to that position. So, if you carry groceries or do arm curls with a supinated forearm, your biceps brachii will work the hardest. If you have a pronated forearm, your brachialis will work the hardest. But if you have a neutral (thumb up) forearm, your brachioradialis will work the hardest.

Palpating the Brachioradialis

Positioning: client supine with neutral forearm

1. Passively flex elbow to slack tissue.
2. Palpate the lateral forearm distal to the lateral epicondyle.
3. Pincer grasp muscle belly just distal to lateral epicondyle and follow toward insertion on radial styloid process.
4. Resist as client performs elbow flexion to assure proper location.



FIGURE 5.22 Brachioradialis.

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FIGURE 5.23 Palpating the brachioradialis.

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Flexor Carpi Radialis

audio

fleks′ōr kăr′ pī rā dē ă′lis • "**flexor**" Latin *bender* "**carpi**" Greek *wrist* "**radius**" Latin *spoke* or *ray*

Attachments

O: Medial epicondyle of the humerus
I: Base of 2nd and 3rd metacarpals, palmar side

Actions

- Flexes the wrist
- Radially deviates (abducts) the wrist
- Slightly flexes the elbow
- Slightly pronates the forearm

Innervation

- Median nerve
- C6–C7

Blood Supply

- Ulnar artery

Functional Anatomy

Flexor carpi radialis is the most lateral of the three superficial wrist flexors and lies just medial to the brachioradialis. This muscle serves a dual purpose in the wrist. First, along with several other muscles that originate from the medial epicondyle of the humerus, it flexes the wrist. It is particularly strong in this function when the forearm is supinated; for example, when we carry an object such as a small tray on a flat, upward facing palm. Strong wrist flexion from this supinated position is also necessary when bowling and throwing underhand, as with softball pitching.

The second function of flexor carpi radialis is to radially deviate (abduct) the wrist. Here it works with extensor carpi radialis longus and brevis as well as several muscles working on the thumb. The final movement when shoveling or throwing a discus activates flexor carpi radialis.

Palpating the Flexor Carpi Radialis

Positioning: client supine with forearm supinated

1. Passively flex elbow and wrist to slack tissue.
2. Locate belly of brachioradialis distal to lateral epicondyle with thumb.
3. Move thumb medially onto flexor carpi radialis, staying distal to the elbow crease.
4. Resist as client performs wrist flexion and radial deviation to assure proper location.

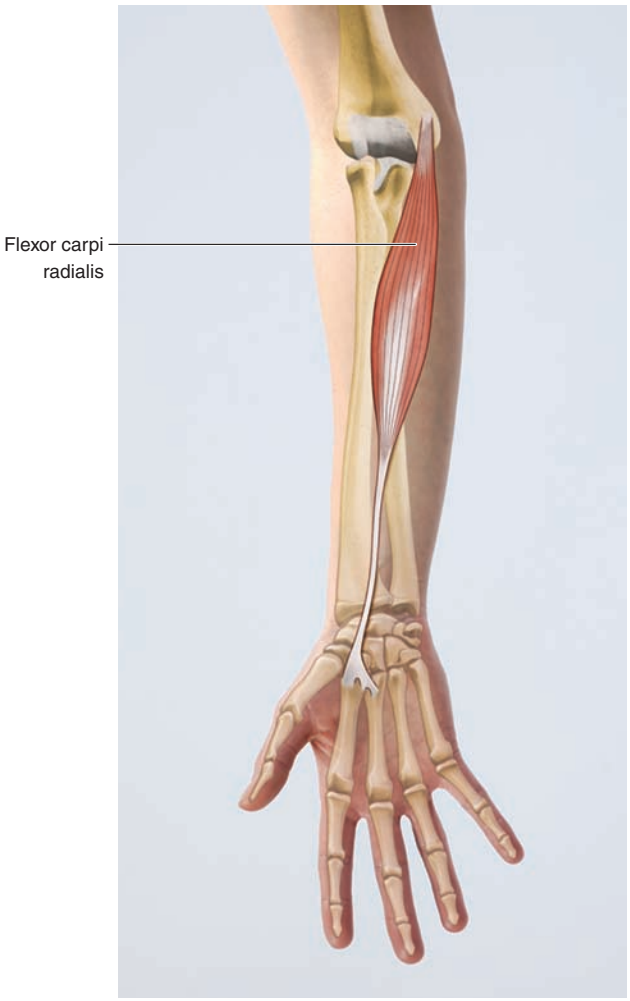


FIGURE 5.24 Flexor carpi radialis.

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FIGURE 5.25 Palpating the flexor carpi radialis.

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Palmaris Longus

audio

pahl′măr ēz lon'gŭs • "**palmaris**" Latin *palm* "**longus**" *long*

Attachments

O: Medial epicondyle of the humerus
I: Flexor retinaculum and palmar aponeurosis

Actions

- Tenses the palmar fascia
- Flexes the wrist
- Slightly flexes the elbow

Innervation

- Median nerve
- C7-C8

Blood Supply

- Ulnar artery

Functional Anatomy

Palmaris longus is centrally located on the anterior forearm between flexor carpi radialis and ulnaris. Because of this location, it does not abduct or adduct the wrist. The efforts of this muscle are focused on flexing the wrist and tensing the *palmar fascia*, a web of connective tissue that extends past the metacarpals, then fans out and becomes continuous with the synovial sheathes of digits 2–5. When under tension, this fascia helps close the hand. This function contributes to grasping and maintaining grip strength.

Because of its origin on the medial epicondyle of the humerus, palmaris longus contributes to elbow flexion; however, it is weak in this action compared with biceps brachii, brachialis, and brachioradialis. It may contribute to joint stability when the elbow is near full extension. This is a factor when golfing, throwing, and hitting overhead, such as in tennis or volleyball. All of these activities require powerful wrist flexion with the elbow near full extension.

Palpating the Palmaris Longus

Positioning: client supine with forearm supinated

1. Passively flex elbow and wrist to slack tissue.
2. Locate muscle belly of flexor carpi radialis with thumb.
3. Move thumb medially onto muscle belly of palmaris longus.
4. Client makes a fist and resists wrist flexion to assure proper location.



FIGURE 5.26 Palmaris longus.

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FIGURE 5.27 Palpating the palmaris longus.

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Flexor Carpi Ulnaris

audio

fleks′ ōr kăr′pī ŭl nā′ris • "**flexor**" Latin *bender* "**carpi**" Greek *wrist* "**ulna**" Latin *elbow*

Attachments

O: Humeral head: medial epicondyle
O: Ulnar head: medial aspect of olecranon process and proximal two-thirds of posterior border
I: Pisiform, hook of hamate, and base of 5th metacarpal on palmar side

Actions

- Flexes the wrist
- Ulnarly deviates (adducts) the wrist
- Slightly flexes the elbow

Innervation

- Ulnar nerve
- C7–T1

Blood Supply

- Ulnar artery

Functional Anatomy

Flexor carpi ulnaris is the most medial of the three superficial wrist flexors lying just medial to palmaris longus. Like flexor carpi radialis, flexor carpi ulnaris has a dual purpose in the wrist. First, it is a strong wrist flexor and, like flexor carpi radialis, is strongest when the forearm is supinated for carrying objects palm up and for underhand activities.

Second, flexor carpi ulnaris ulnarly deviates (adducts) the wrist. Here it is an antagonist to flexor carpi radialis. This movement is utilized when hammering, performing a tennis forehand, and throwing overhead when leading with the medial hand. Some baseball pitching and football throwing involve ulnar deviation of the wrist. Flexor carpi ulnaris also is a weak elbow flexor and more likely contributes to elbow stability during straight-arm activities.

Palpating the Flexor Carpi Ulnaris

Positioning: client supine with forearm supinated

1. Passively flex elbow and wrist to slack tissue.
2. Locate muscle belly of palmaris longus with thumb.
3. Move thumb medially onto muscle belly of flexor carpi ulnaris.
4. Resist as client performs wrist flexion and ulnar deviation to assure proper location.

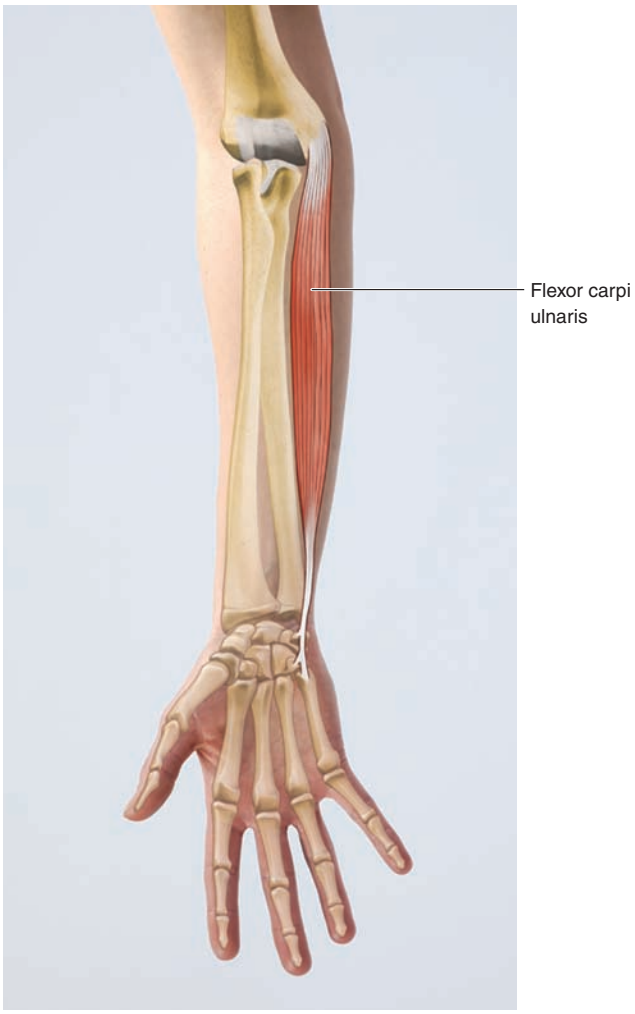


FIGURE 5.28 Flexor carpi ulnaris.

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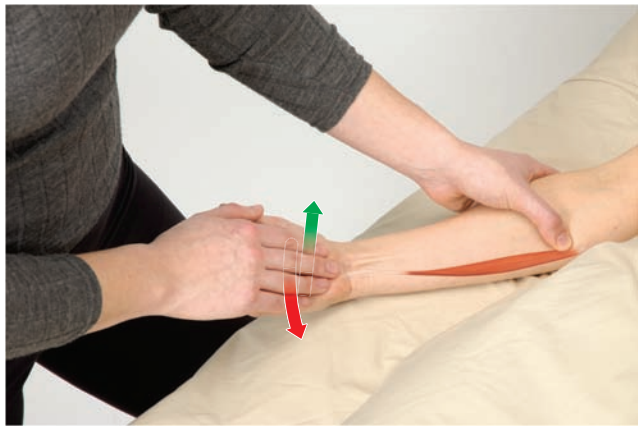


FIGURE 5.29 Palpating the flexor carpi ulnaris.

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Flexor Digitorum Superficialis

audio

fleks′ ōr dij i tō′ rŭm su′ pĕr fish ē ăl′ is • "**flexor**" Latin *bender* "**digit**" *finger or toe* "**superficialis**" *near the surface*

Attachments

O: Humeral head: medial epicondyle and ulnar collateral ligament
O: Ulnar head: medial aspect of coronoid process
O: Radial head: proximal one-half of anterior shaft distal to radial tuberosity
I: Sides of middle phalanges of digits 2–5 by four separate tendons

Actions

- Flexes proximal interphalangeal joints of digits 2–5
- Assists in flexing metacarpophalangeal joints of digits 2–5
- Assists in flexing the wrist and elbow

Innervation

- Median nerve
- C7–T1

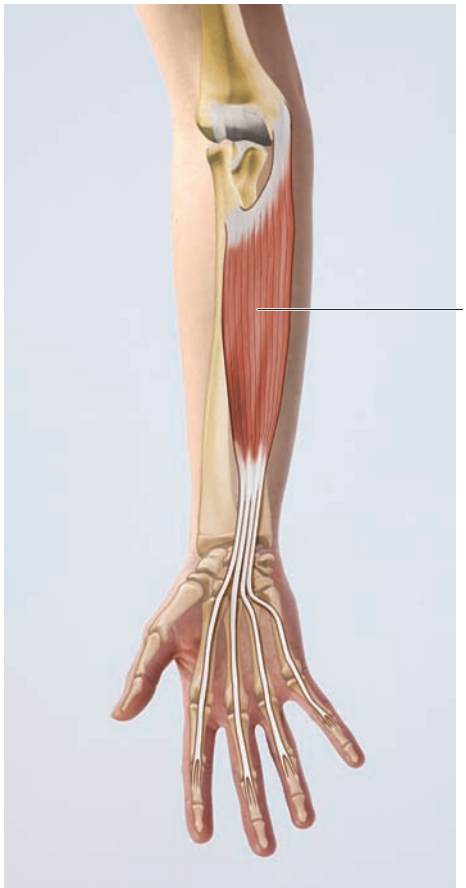


FIGURE 5.30 Flexor digitorum superficialis.

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Blood Supply

- Ulnar artery

Functional Anatomy

The main function of flexor digitorum superficialis is to flex the fingers at the middle joints. The tendons extend only to the middle phalanges, limiting their movement to the metacarpophalangeal and proximal interphalangeal joints. This flexion is utilized in grasping and gripping. All four tendons may be recruited together to make a fist or individually to play the piano or type.

Flexor digitorum superficialis spreads its origin across the humerus, radius, and ulna. This protects the muscle from damage when generating great force for grasping, holding, and carrying. Because of its origin on the medial epicondyle of the humerus, flexor digitorum superficialis is a weak elbow flexor. It combines efforts with flexor carpi radialis and ulnaris, as well as palmaris longus, to stabilize the elbow and flex the wrist.

Palpating the Flexor Digitorum Superficialis

Positioning: client supine with forearm supinated

1. Passively flex elbow and wrist to slack tissue.
2. Locate muscle belly of palmaris longus and slide thumb distally and deep.
3. Muscle belly of flexor digitorum superficialis is broad and deep to the superficial flexors.
4. Resist as client performs finger flexion and elbow flexion to assure proper location.

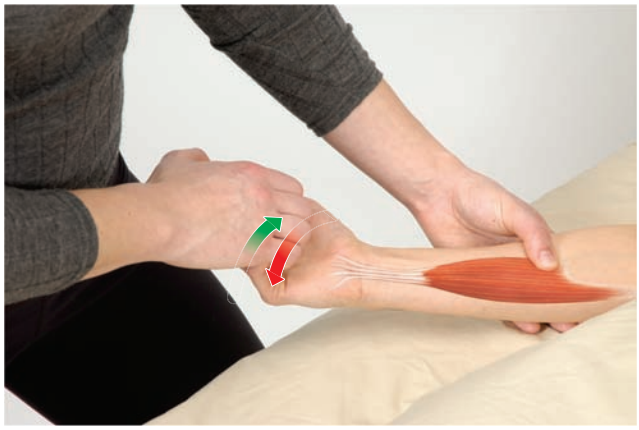


FIGURE 5.31 Palpating the flexor digitorum superficialis.

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Flexor Digitorum Profundus

audio

fleks′ ōr dij i tō ′rŭm prō fŭn′dŭs • "**flexor**"
Latin *bender* "**digit**" *finger or toe* "**profound**" *deep*

Attachments

O: Anterior and medial surfaces of proximal three-quarters of the ulna and interosseous membrane
I: Bases of distal phalanges of digits 2–5, palmar side by four separate tendons

Actions

- Flexes distal interphalangeal joints of digits 2–5
- Assists in flexing proximal interphalangeal joints of digits 2–5
- Assists in flexing metacarpophalangeal joints of digits 2–5
- Assists in flexing the wrist

Innervation

- Median nerve for digits 2 and 3
- Ulnar nerve for digits 4 and 5
- C8–T1

Blood Supply

- Ulnar and anterior interosseous arteries

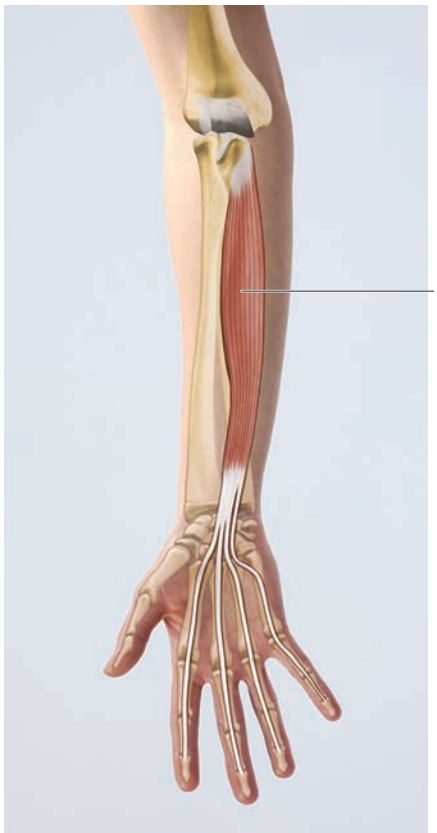


FIGURE 5.32 Flexor digitorum profundus.

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Functional Anatomy

Flexor digitorum profundus is one of two anterior forearm muscles that flex the fingers. Unlike flexor digitorum superficialis, the profundus extends to the distal phalanges. Its tendons dive deep to the split insertions of superficialis and attach to the base of the distal phalanges of digits 2–5. This feature makes flexor digitorum profundus the only muscle that flexes all segments of the fingers. Gripping with the fingertips, as when rock climbing or fingering the strings of a guitar, involves activation of this muscle alone.

Flexor digitorum profundus does not contribute to elbow flexion, but it does assist with wrist flexion. Here it assists flexor carpi radialis and ulnaris, palmaris longus, and flexor digitorum superficialis.

Palpating the Flexor Digitorum Profundus

Positioning: client supine with forearm supinated

1. Passively flex wrist to slack tissue.
2. Locate tendons of superficial wrist flexors and slide thumb between and deep.
3. Muscle belly of flexor digitorum profundus is broad and deep to the superficial flexor tendons.
4. Resist as client performs finger flexion to assure proper location.

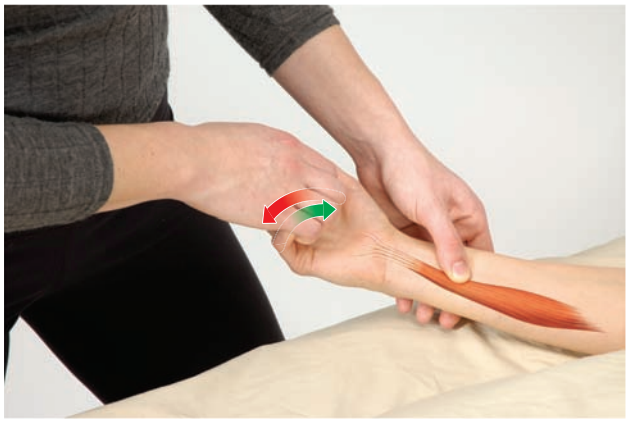


FIGURE 5.33 Palpating the flexor digitorum profundus.

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Flexor Pollicis Longus

audio

fleks′ ōr pōl′ i sis lōn′ gus • "**flexor**" Latin *bender* "**pollicis**" *thumb* "**longus**" *long*

Attachments

O: Anterior surface of body of the radius and interosseous membrane
I: Base of first distal phalanx, palmar side

Actions

- Flexes the thumb at carpometacarpal, metacarpophalangeal, and intercarpal joints
- Assists in flexing the wrist

Innervation

- Median nerve
- C8–T1

Blood Supply

- Anterior interosseous artery

Functional Anatomy

The primary function of flexor pollicis longus is to flex the thumb. This function is useful in grasping and gripping activities because the thumb flexes along with the fingers to make a fist or take hold of an object. Flexor pollicis longus extends to the distal phalanx of the thumb, allowing it to act on the carpometacarpal, metacarpophalangeal, and intercarpal joints. Tension of this muscle allows the thumb to wrap around objects such as a tennis racket or baseball.

Palpating the Flexor Pollicis Longus

Flexor pollicis longus is the deepest of the flexors. It lies underneath the superficial wrist flexors and is thus very difficult to access.

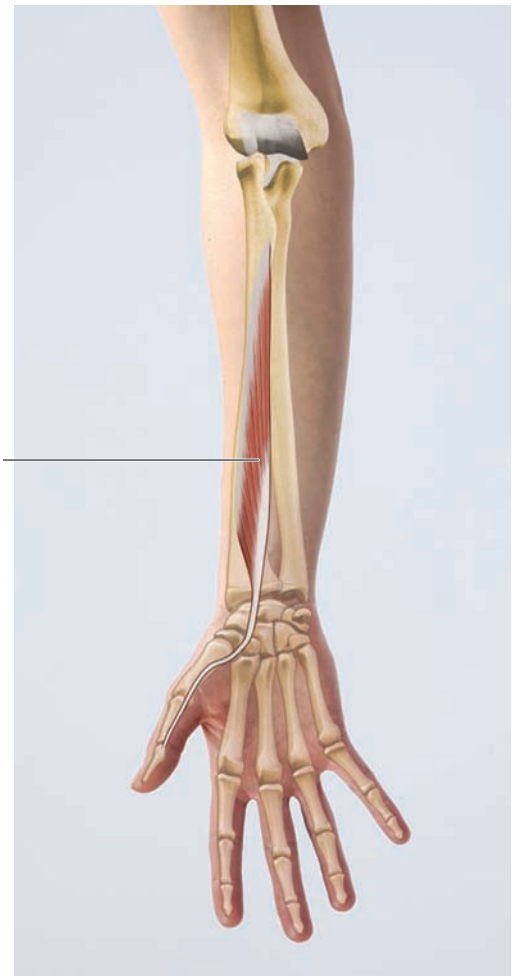


FIGURE 5.34 Flexor pollicis longus.

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Pronator Teres

audio

prō nā′tōr tē′res • "**pronare**" Latin *bend forward* "**teres**" *round*

Attachments

O: Humeral head: medial epicondyle
O: Ulnar head: medial aspect of coronoid process
I: Middle one-third of lateral radius

Actions

- Pronates the forearm
- Assists in flexing the elbow

Innervation

- Median nerve
- C6–C7

Blood Supply

- Ulnar and anterior recurrent ulnar arteries



FIGURE 5.35 Pronator teres.

© Wolters Kluwer.

Functional Anatomy

Pronator teres crosses the anterior forearm proximal and lateral to the flexor carpi radialis. This muscle rotates the forearm to pronate the palm. It also flexes the elbow. It is quite powerful in both of these motions. Using a screwdriver, wrench, or other turning tool requires strong contractions of pronator teres.

Pronator teres is vulnerable to injury during overhead activities such as throwing. The challenge occurs as it turns the forearm over to lead with the palm (pronation). Pronator teres must lengthen as the elbow extends while simultaneously contracting to turn the arm. This can lead to irritation of the medial epicondyle of the humerus where it originates.

Palpating the Pronator Teres

Positioning: client seated with forearm supinated

1. Passively flex elbow and pronate forearm to slack tissue.
2. Locate medial epicondyle with thumb.
3. Slide thumb distally and laterally onto belly of pronator teres.
4. Resist as client performs forearm pronation to assure proper location



FIGURE 5.36 Palpating the pronator teres.

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Pronator Quadratus

audio

prō nā′tōr kwa drā′tŭs • "**pronare**" Latin *bend forward* "**quadrat**" *square*

Attachments

O: Medial side and anterior surface of distal one-fourth of the ulna
I: Lateral side and anterior surface of distal one-fourth of the radius

Actions

- Pronates the forearm

Innervation

- Median nerve
- C8–T1

Blood Supply

- Anterior interosseous artery



FIGURE 5.37 Pronator quadratus.

© Wolters Kluwer.

Functional Anatomy

The transverse fibers of pronator quadratus lie distal on the forearm and deep to the flexor tendons. Pronator quadratus works with pronator teres to pronate the forearm. Since two joints (the proximal and distal radioulnar joints) work together to create pronation, muscles are needed at both joints to govern the movement. Pronator quadratus functions more strongly when the elbow is extended because this position decreases the mechanical advantage of pronator teres.

Palpating the Pronator Quadratus

Positioning: client supine with forearm supinated

1. Passively flex wrist and pronate forearm to slack tissue.
2. Locate radial styloid process with thumb.
3. Slide thumb medially and deep onto lateral edge of pronator quadratus. *(Note: avoid compressing the radial artery, which resides in this location.)*
4. Resist as client performs forearm pronation to assure proper location.



FIGURE 5.38 Palpating the pronator quadratus.

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Supinator

audio

sū′ pi nātōr • "**supinare**" Latin *place on back*

Attachments

O: Lateral epicondyle of the humerus and supinator crest of the ulna
I: Posterior, lateral, and anterior surfaces of proximal one-third of the radius

Actions

- Supinates the forearm
- Slightly extends the elbow

Innervation

- Radial nerve
- C5–C6

Blood Supply

- Recurrent interosseous artery



FIGURE 5.39 Supinator.

© Wolters Kluwer.

Functional Anatomy

Supinator lies deep to the forearm extensors on the lateral epicondyle of the humerus. It works with biceps brachii and brachioradialis to supinate the forearm. Unlike biceps brachii, supinator is strongest when the elbow is extending or extended. Some of its fibers attach to the lateral epicondyle of the humerus, allowing it to assist with this movement.

The supinator reverses the action of pronator teres and quadratus when turning a screwdriver or wrench. It also is activated when throwing a curve ball in baseball. Here, the elbow extends while the forearm supinates. This generates the characteristic spin of the curve ball.

Palpating the Supinator

Positioning: client supine with forearm neutral (thumb up)

1. Passively flex elbow to slack tissue.
2. Locate lateral epicondyle with thumb.
3. Follow muscle distally and slightly anteriorly onto radial head. *(Note: avoid compressing the radial nerve, which resides in this location.)*
4. Resist as client performs supination to assure proper location.

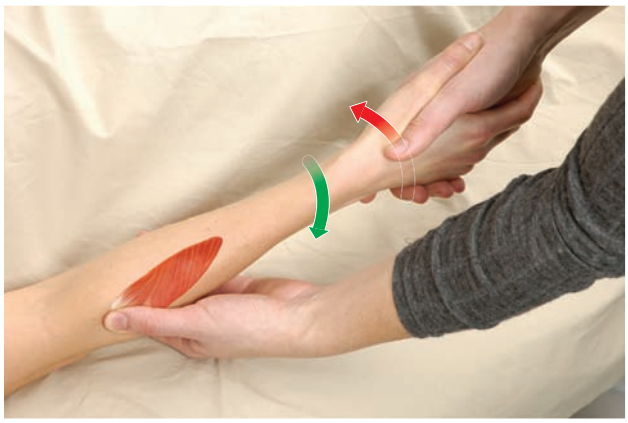


FIGURE 5.40 Palpating the supinator.

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Anconeus

audio

ang kō′ n ŭs • "**ancon**" Latin *elbow*

Attachments

O: Posterior surface of lateral epicondyle of the humerus and humeroulnar joint capsule
I: Lateral aspect of olecranon process and posterior surface of proximal body of the ulna

Actions

- Extends elbow
- Stabilizes ulna while forearm pronates and supinates

Innervation

- Radial nerve
- C7–T1

Blood Supply

- Deep brachial and recurrent interosseous arteries



FIGURE 5.41 Anconeus

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Functional Anatomy

The primary function of anconeus is to assist triceps brachii in extending the elbow. It is a comparatively small muscle that resides close to the humeroulnar joint. Anconeus also helps stabilize the ulna while the radius rotates. It anchors the olecranon process to the lateral epicondyle. This tether function prevents the ulna from moving out of the olecranon fossa during pronation and supination of the forearm.

Tensing of anconeus during elbow extension may also protect the joint capsule. Here anconeus pulls the capsule inferiorly and away from the olecranon process as it moves into the olecranon fossa. This prevents the joint capsule from being pinched in the hinge of the humeroulnar joint.

Palpating the Anconeus

Positioning: client supine with forearm neutral (thumb up)

1. Passively flex the elbow to slack tissue.
2. Locate lateral epicondyle of humerus with thumb.
3. Slide thumb posterior and distal toward the olecranon process and onto anconeus.
4. Resist as client performs elbow extension to assure proper location.

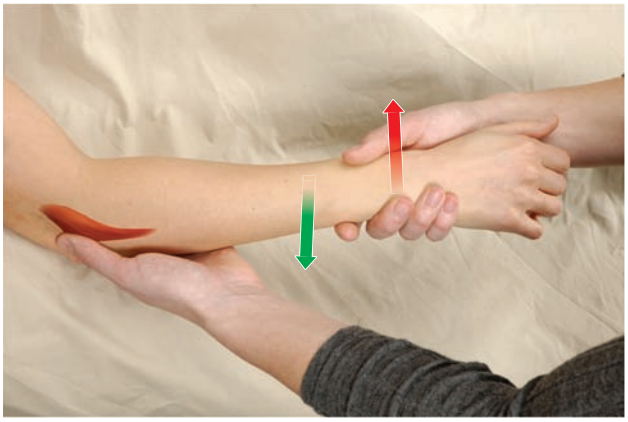


FIGURE 5.42 Palpating the anconeus.

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Extensor Carpi Radialis Longus

audio

eks ten′sōr kar′pī rā dē ă′lis lon′gŭs •
"**extensor**" Latin *extender* "**carpi**" Greek *wrist*
"**radius**" Latin *spoke* or *ray* "**longus**" *long*

Attachments

O: Distal one-third of lateral supracondylar ridge of the humerus
I: Base of 2nd metacarpal, dorsal side

Actions

- Extends the wrist
- Radially deviates (abducts) the wrist
- Assists in flexing the elbow
- Slightly supinates the forearm

Innervation

- Radial nerve
- C6–C7

Blood Supply

- Radial artery

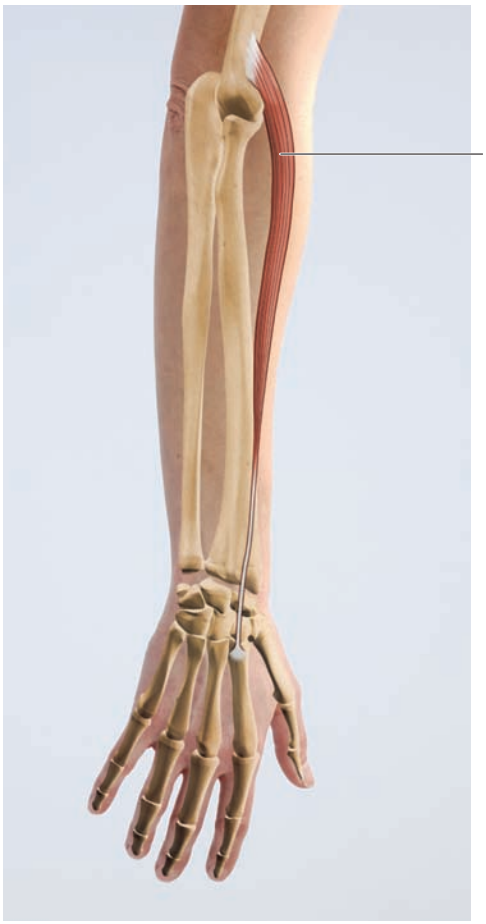


FIGURE 5.43 Extensor carpi radialis longus.

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Functional Anatomy

Extensor carpi radialis longus has a fairly broad attachment on the lateral supracondylar ridge of the humerus. It is the most lateral of the wrist extensors and lies posterior and medial to brachioradialis. Extensor carpi radialis longus, along with extensor carpi radialis brevis and extensor carpi ulnaris, is a powerful wrist extensor. It helps generate power when lifting with a pronated grip, such as when picking up a briefcase.

Extensor carpi radialis also works with extensor carpi radialis brevis and flexor carpi radialis to radially deviate or abduct the wrist. This movement is required for shoveling or throwing a discus.

Some fibers of extensor carpi radialis longus attach anteriorly on the supracondylar ridge of the humerus. This position gives the muscle some function in elbow flexion and forearm supination.

Palpating the Extensor Carpi Radialis Longus

Positioning: client supine with forearm neutral (thumb up)

1. Passively flex the elbow and radially deviate the wrist to slack tissue.
2. Locate lateral epicondyle of the humerus with thumb.
3. Slide thumb distally onto extensor carpi radialis longus. Be sure and remain lateral to the brachioradialis.
4. Resist as client performs wrist extension and radial deviation to assure proper location.

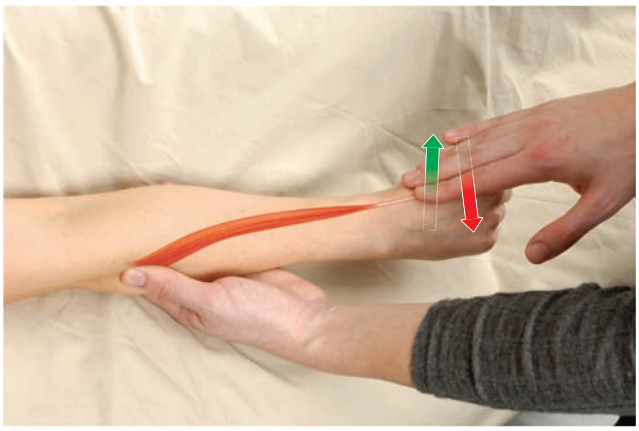


FIGURE 5.44 Palpating the extensor carpi radialis longus.

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Extensor Carpi Radialis Brevis

audio

eks ten'sōr kar'ī rā dē ă'lis brev'is •
"**extensor**" Latin *extender* "**carpi**" Greek *wrist* "**radius**" Latin *spoke* or *ray* "**brevis**" *short*

Attachments

O: Lateral epicondyle of the humerus
I: Base of 3rd metacarpal, dorsal side

Actions

- Extends the wrist
- Radially deviates (abducts) the wrist
- Assists in extending the elbow

Innervation

- Radial nerve
- C7–C8

Blood Supply

- Radial artery



FIGURE 5.45 Extensor carpi radialis brevis.

© Wolters Kluwer.

Functional Anatomy

Extensor carpi radialis brevis lies just medial to extensor carpi radialis longus and has a more specific origin on the lateral epicondyle of the humerus. It works closely with extensor carpi radialis longus to extend the wrist. Both create the powerful tennis backhand as well as the more subtle "flicking" action of throwing a Frisbee. This muscle also radially deviates (abducts) the wrist along with extensor carpi radialis longus and flexor carpi radialis.

Extensor carpi radialis brevis is one of several muscles that attach to the lateral epicondyle of the humerus. Overuse of these muscles can result in inflammation of this structure, called lateral epicondylitis or "tennis elbow." The extensor muscles are often less developed than the corresponding flexor muscles. This muscle imbalance can contribute to overuse injuries.

Palpating the Extensor Carpi Radialis Brevis

Positioning: client supine with forearm neutral (thumb up)

1. Passively flex the elbow and radially deviate the wrist to slack tissue.
2. Locate lateral epicondyle of the humerus with thumb.
3. Slide thumb distally onto extensor carpi radialis longus. Continue moving distally and slightly laterally onto extensor carpi radialis brevis.
4. Resist as client performs wrist extension and radial deviation to assure proper location.

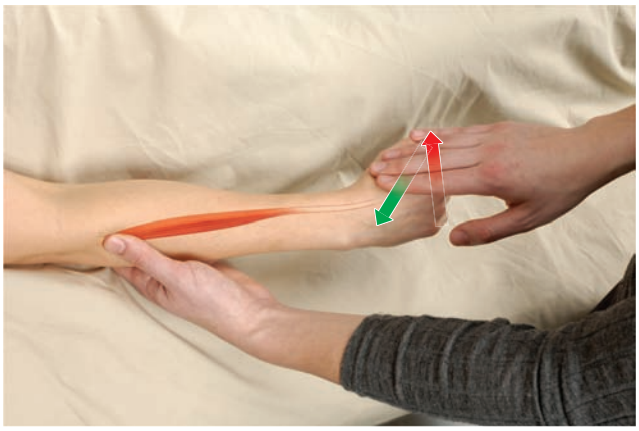


FIGURE 5.46 Palpating the extensor carpi radialis brevis.

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Extensor Carpi Ulnaris

audio

eks ten'sōr kar'pī ŭl nā'ris • "**extensor**"
Latin *extender* "**carpi**" Greek *wrist* "**ulna**" Latin *elbow*

Attachments

O: Lateral epicondyle of the humerus and middle one-third of posterior border of the ulna
I: Base of 5th metacarpal, dorsal side

Actions

- Extends the wrist
- Ulnarly deviates (adducts) the wrist
- Slightly extends the elbow

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Ulnar artery

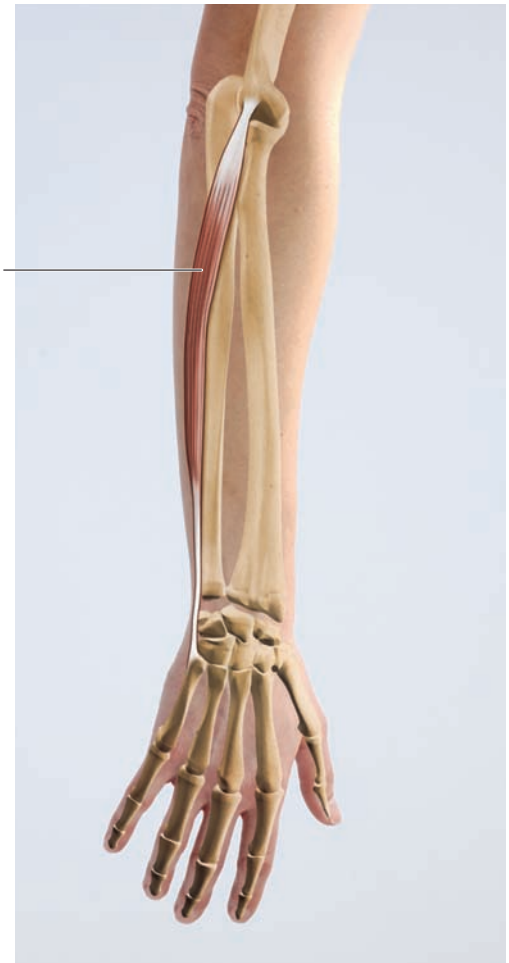


FIGURE 5.47 Extensor carpi ulnaris.
© Wolters Kluwer.

Functional Anatomy

Extensor carpi ulnaris is the most medial of the forearm extensor muscles. It is the medial equivalent to the lateral extensor carpi radialis brevis. It is a powerful wrist extensor as well as ulnar deviator (adductor). This muscle functions synergistically with flexor carpi ulnaris to ulnar deviate the wrist when chopping wood or hammering. Throwing, swinging a baseball bat, and golfing also require ulnar deviation of the wrist and a strong, functional relationship between extensor carpi ulnaris and flexor carpi ulnaris.

Palpating the Extensor Carpi Ulnaris

Positioning: client supine with forearm pronated

1. Passively flex the elbow and ulnar deviate the wrist to slack tissue.
2. Locate the olecranon process with thumb then follow distally along lateral edge of ulna.
3. Slide thumb anteriorly and laterally onto extensor carpi ulnaris.
4. Resist as client performs wrist extension and ulnar deviation to assure proper location.

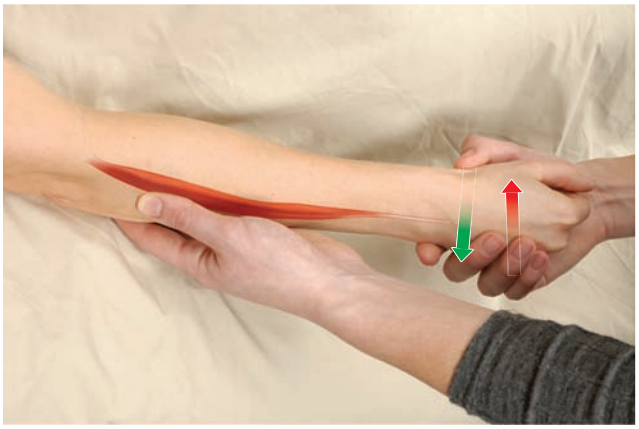


FIGURE 5.48 Palpating the extensor carpi ulnaris.
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Extensor Digitorum

audio

eks ten′sōr dij i tō′ rŭm • "**extensor**" Latin *extender* "**digit**" *finger or toe*

Attachments

O: Lateral epicondyle of the humerus
I: Middle and distal phalanges of digits 2–5, dorsal side

Actions

- Extends digits 2–5 at metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints
- Extends the wrist
- Slightly extends the elbow

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Interosseous recurrent and posterior interosseous arteries

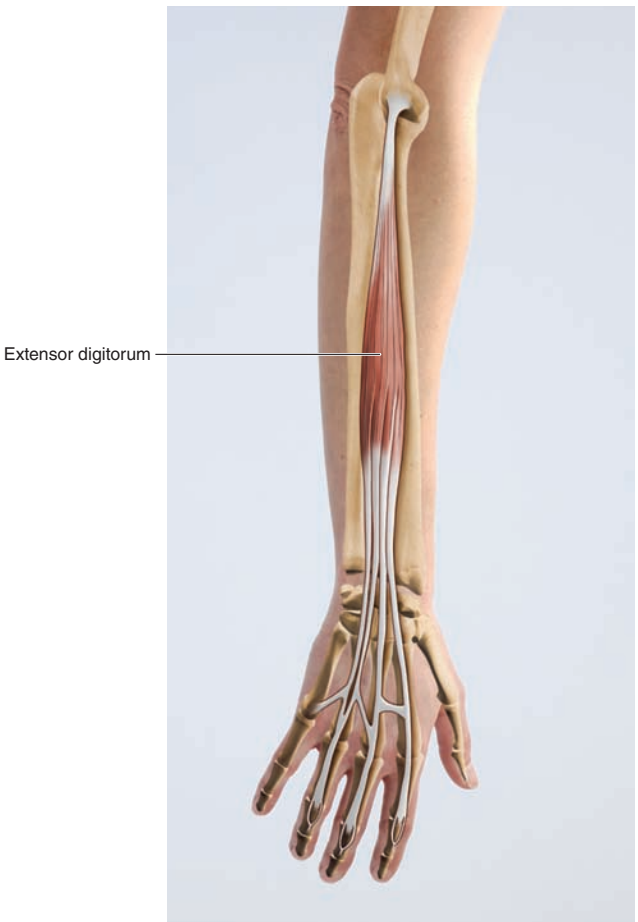


FIGURE 5.49 Extensor digitorum.

© Wolters Kluwer.

Functional Anatomy

Extensor digitorum is the most central of the posterior forearm extensor muscles, lying between extensor carpi radialis brevis and extensor carpi ulnaris. The main function of extensor digitorum is to extend the four fingers. Since less strength is required to open the hand than to close it and grip objects, it's not surprising that this single muscle, as compared to the two flexor muscles, accomplishes extension. Because extensor digitorum crosses the wrist and elbow, it also contributes to wrist extension and slight elbow extension.

The unequal strength between the finger flexors and extensors contributes to the slightly flexed resting hand posture. Caution must be exercised to maintain balanced strength and good ergonomics with repetitive activities like typing. This care helps avoid overuse injuries in the elbow, forearm, wrist, and hand.

Palpating the Extensor Digitorum

Positioning: client supine with forearm pronated

1. Passively flex the elbow and extend the wrist to slack tissue.
2. Locate the olecranon process with thumb then follow distally along lateral edge of ulna.
3. Slide thumb anteriorly and medially onto extensor carpi ulnaris then farther medially onto extensor digitorum.
4. Resist as client performs finger extension to assure proper location.

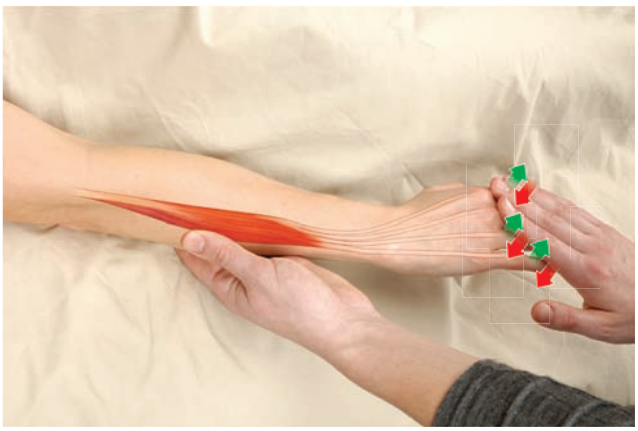


FIGURE 5.50 Palpating the extensor digitorum.

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Extensor Indicis

audio

eks ten'sōr in'di sis • "**extensor**" Latin *extender* "**indicis**" *pointer finger*

Attachments

O: Ulna, posterior surface of body, and interosseous membrane
I: Base of 2nd proximal phalanx and into tendon of extensor digitorum to the 2nd digit

Actions

- Extends 2nd digit at metacarpophalangeal joint and interphalangeal joints
- Extends the wrist
- Slightly supinates the forearm

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Posterior interosseous artery



FIGURE 5.51 Extensor indicis.

© Wolters Kluwer.

Functional Anatomy

The hand is capable of many fine movements through synchronization or isolation of muscle contractions. Extensor indicis allows the index finger to function independently from the other three fingers. Pointing, clicking a computer mouse, and writing all require individualized movement of the index finger.

Because extensor indicis originates on the ulna and traverses the posterior forearm and wrist, it is able to extend the wrist and supinate the forearm. These actions are slight compared to supinator, extensor carpi radialis longus and brevis, and extensor carpi ulnaris.

Palpating the Extensor Indicis

Positioning: client supine with forearm pronated

1. Passively extend wrist to slack tissue.
2. Locate the ulnar styloid process with thumb, then slide proximally and laterally onto extensor indicis.
3. Resist as client performs extension of the index finger to assure proper location.

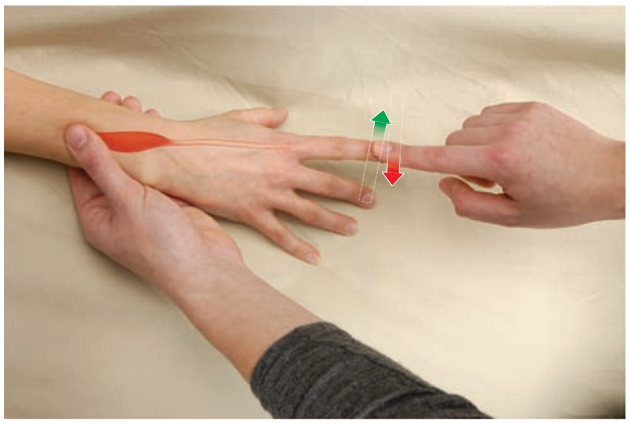


FIGURE 5.52 Palpating the extensor indicis.

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Extensor Digiti Minimi

audio

eks ten′sōr dij′i tī min′i mī • "**extensor**" Latin *extender* "**digiti**" *finger* "**minimi**" *smallest*

Attachments

O: Lateral epicondyle of the humerus
I: Base of 5th proximal phalanx, dorsal side

Actions

- Extends 5th digit at metacarpophalangeal and interphalangeal joints
- Extends wrist
- Slightly extends the elbow

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Interosseous recurrent artery

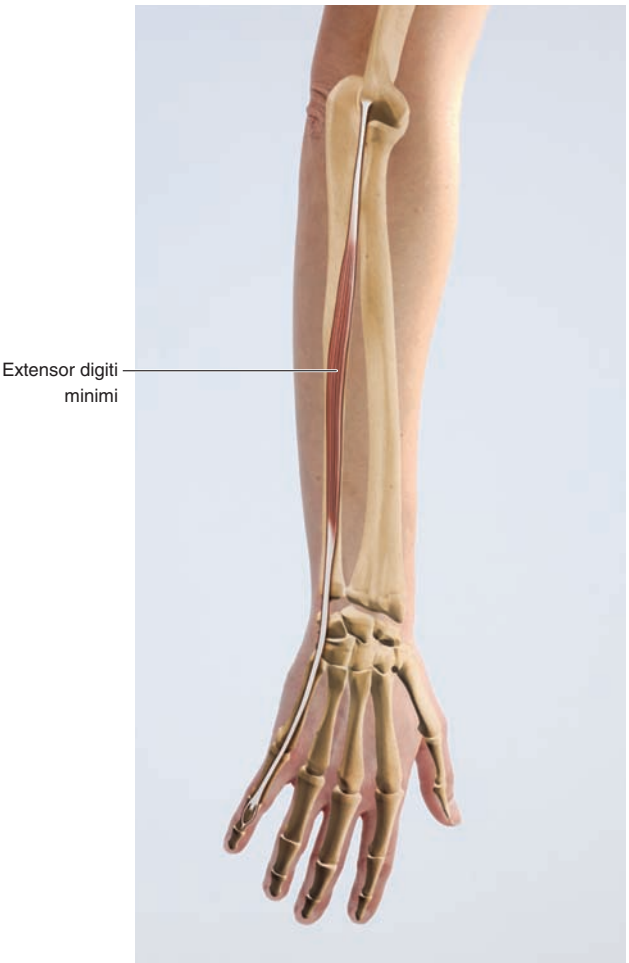


FIGURE 5.53 Extensor digiti minimi.

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Functional Anatomy

Extensor digiti minimi lies between extensor digitorum and extensor carpi ulnaris. It is primarily responsible for extending the pinky finger. Extensor digiti minimi assists extensor digitorum in this function but allows individualized movement of this digit in much the same way as extensor indicis does for the index finger. This individualized movement allows us to play musical instruments such as the guitar, violin, piano, and flute. It also contributes to fine motor skills such as typing.

Palpating the Extensor Digiti Minimi

Positioning: client supine with forearm pronated

1. Passively flex elbow and extend wrist to slack tissue.
2. Locate the olecranon process with thumb then slide distally along lateral edge of ulna.
3. Slide thumb medially past the extensor carpi ulnaris onto extensor digiti minimi.
4. Resist as client performs extension of the little finger to assure proper location.

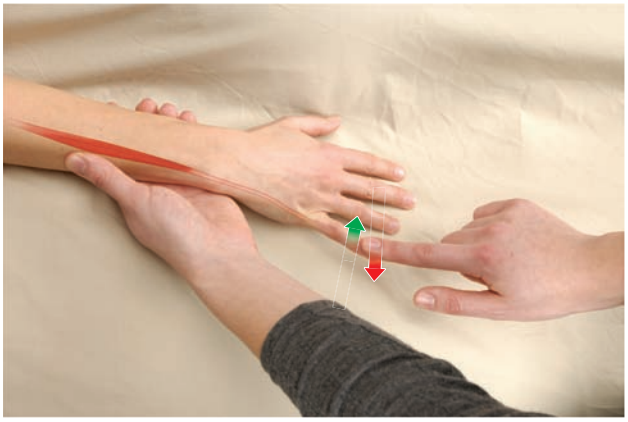


FIGURE 5.54 Palpating the extensor digiti minimi.

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Abductor Pollicis Longus

audio

ab dŭk′tōr pōl′ i sis lōn′gus • "**abduct**" Latin *lead away* "**pollicis**" *thumb* "**longus**" *long*

Attachments

O: Middle one-third of posterior surface of the ulna, radius, and interosseous membrane
I: Base of first metacarpal, dorsal side

Actions

- Abducts the first carpometacarpal joint
- Extends the first carpometacarpal joint
- Radially deviates (abducts) the wrist
- Slightly flexes the wrist

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Posterior interosseous artery

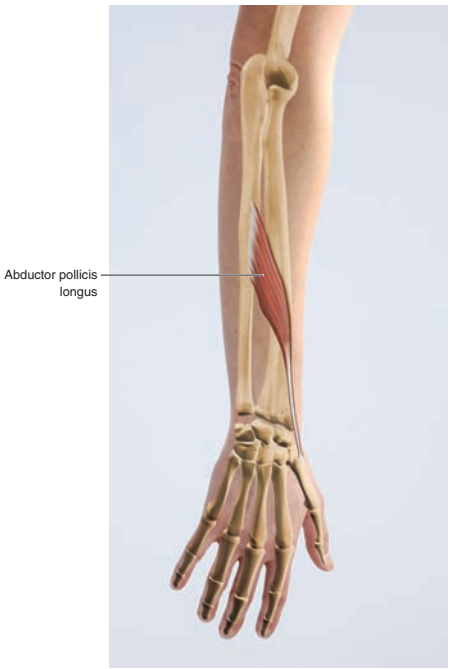


FIGURE 5.55 Abductor pollicis longus.

© Wolters Kluwer.

Functional Anatomy

Abductor pollicis longus, which is just distal to supinator, crosses diagonally from the ulna to the radius before inserting on the first metacarpal. This muscle, along with extensor pollicis longus and brevis (discussed next), creates the borders of a structure known as the *anatomical snuffbox*, which is located just distal and posterior to the radial styloid process. Its name comes from its use for holding finely ground tobacco (called *snuff*) prior to inhaling or snorting. Abductor pollicis longus, along with extensor pollicis brevis, forms the lateral border of this structure. The trapezium and scaphoid, two carpal bones, make up the floor of the anatomical snuffbox, and the radial artery passes within its borders.

When contracted, abductor pollicis longus pulls the thumb away from the palm of the hand. This motion is a combination of abduction and extension and occurs at the first carpometacarpal joint. Abduction and adduction of the thumb are unique in that they take place on the sagittal plane around the frontal axis. Here, flexion and extension occur on the frontal plane around a sagittal axis. Remember, the first carpometacarpal joint is the only saddle joint in the body and allows specialized movements for grasping and gripping. Abduction and extension of the thumb are critical movements for opening the hand and letting go of objects.

Because of its anterior position on the thumb, abductor pollicis longus is in a position to assist with wrist flexion as well as radial deviation. Along with the other anatomical snuffbox muscles, it is active during wrist activities such as shoveling, bowling, and golfing.

Palpating the Abductor Pollicis Longus

Positioning: client seated with forearm neutral (thumb up)

1. Passively ulnarly deviate the wrist to tension tissue.
2. Locate radial styloid process with thumb and slide distally onto tendon of abductor pollicis longus. Abductor pollicis longus helps make up the lateral border of the anatomical snuffbox.
3. Resist as client performs thumb abduction to assure proper location.

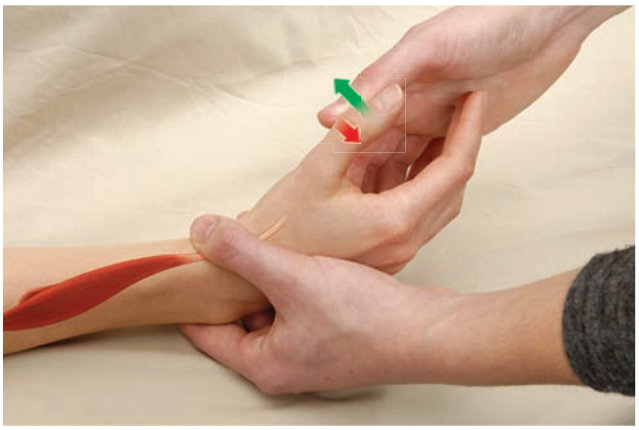


FIGURE 5.56 Palpating the abductor pollicis longus.

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Extensor Pollicis Brevis

audio

eks ten'sōr pōl' i sis brā'vēs • "**extensor**"
Latin *extender* "**pollicis**" *thumb* "**brevis**" *short*

Attachments

O: Distal one-third of posterior surface of the radius and interosseous membrane
I: Base of 1st proximal phalanx, dorsal side

Actions

- Extends the thumb at the carpometacarpal and metacarpophalangeal joints
- Abducts the thumb at the carpometacarpal joint
- Slightly radially deviates (abducts) the wrist

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Posterior interosseous artery



FIGURE 5.57 Extensor pollicis brevis.
© Wolters Kluwer.

Functional Anatomy

Extensor pollicis brevis crosses the posterior surface of the distal radius. It is one of three muscles that make up the anatomical snuffbox (see abductor pollicis longus), and it helps form the lateral border. Its main function is to extend the thumb at the carpometacarpal and metacarpophalangeal joints. This movement helps the hand open to grasp objects. It is also instrumental in letting those objects go.

Extensor pollicis brevis stretches across the back of the wrist and down the thumb, giving it some leverage to radially deviate (abduct) the wrist. This action is utilized in shoveling, bowling, and playing golf.

Palpating the Extensor Pollicis Brevis

Positioning: client supine with forearm neutral (thumb up)

1. Passively ulnarly deviate wrist to create tension in the tissue.
2. Locate radial styloid process with thumb and slide distally onto tendon of extensor pollicis brevis. Extensor pollicis brevis helps makes up the lateral border of the anatomical snuffbox.
3. Resist as client performs thumb extension to assure proper location.

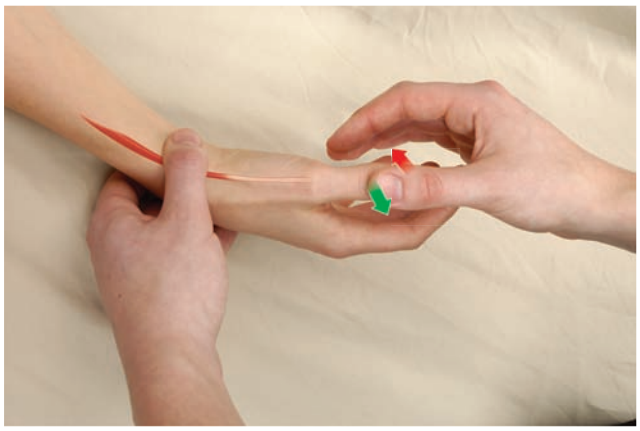


FIGURE 5.58 Palpating the extensor pollicis brevis.
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Extensor Pollicis Longus

audio

eks ten′sōr pōl′ i sis lōn′ gus • "**extensor**" Latin *extender* "**pollicis**" *thumb* "**longus**" *long*

Attachments

O: Middle one-third of posterior surface of the ulna and interosseous membrane
I: Base of 1st distal phalanx, dorsal side

Actions

- Extends the thumb at the carpometacarpal, metacarpophalangeal, and interphalangeal joints
- Slightly radially deviates (abducts) the wrist
- Slightly extends the wrist

Innervation

- Posterior interosseous nerve
- C7–C8

Blood Supply

- Posterior interosseous artery

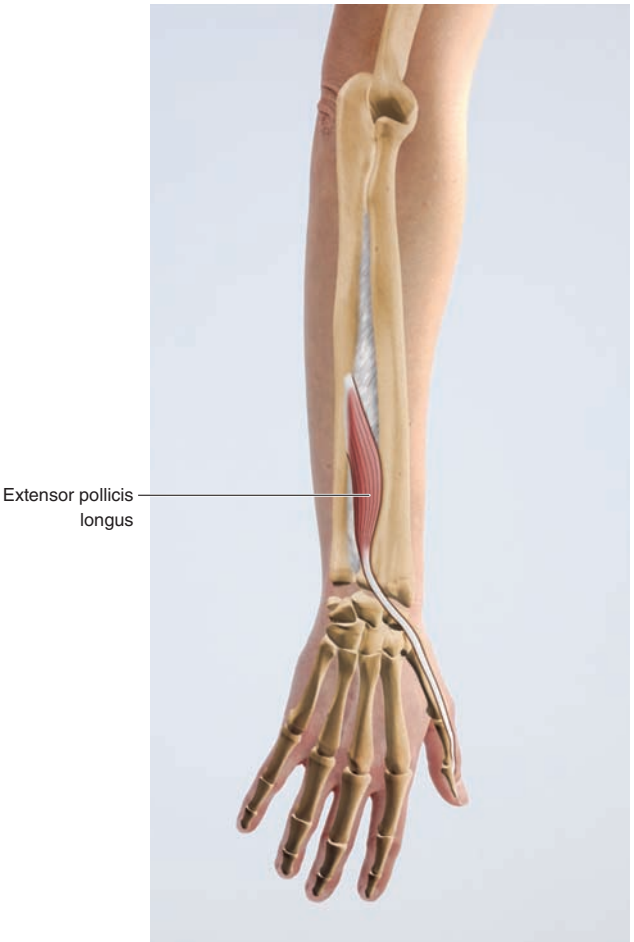


FIGURE 5.59 Extensor pollicis longus.

© Wolters Kluwer.

Functional Anatomy

Extensor pollicis longus spans the distal radioulnar joint and lies medial to extensor pollicis brevis. It is the third muscle of the anatomical snuffbox (see abductor pollicis longus) and forms its medial border. Extensor pollicis longus is a synergist to extensor pollicis brevis in extending the thumb and radially deviating the wrist. Together, these two muscles extend the thumb as the hand opens and releases objects and bend the wrist toward the thumb. This movement is part of household activities such as shoveling and sports activities such as bowling and the volleyball bump.

Because extensor pollicis longus attaches more proximally on the forearm than brevis, it is stronger in radial deviation and able to extend the wrist. This function is of particular importance in finely controlled movements such as at the end of a golf swing.

Palpating the Extensor Pollicis Longus

Positioning: client supine with forearm neutral (thumb up)

1. Passively ulnarly deviate wrist to create tension in the tissue.
2. Locate radial styloid process with thumb and slide laterally onto tendon of extensor pollicis longus.
3. Resist as client performs thumb extension to assure proper location.

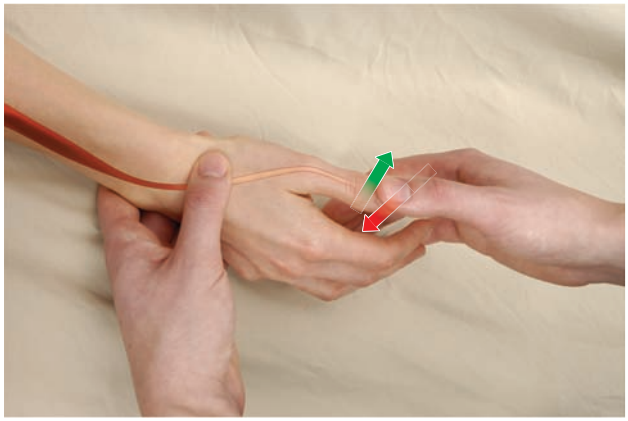


FIGURE 5.60 Palpating the extensor pollicis longus.

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FUNCTIONAL ASPECTS

INTRINSIC MUSCLES OF THE HAND

Muscle	Location	Action	Function
Opponens digiti minimi  © Wolters Kluwer.	Hypothenar eminence	Opposition of pinky finger	Grasping and pinching
Flexor digiti minimi brevis  © Wolters Kluwer.	Hypothenar eminence	Flexes pinky finger at metacarpophalangeal joint	Grasps round objects
Abductor digiti minimi  © Wolters Kluwer.	Hypothenar eminence	Abducts pinky finger	Wraps hand around round objects
Opponens pollicis  © Wolters Kluwer.	Thenar eminence	Opposition, flexion, and adduction of thumb	Grasping round objects and fine gripping like a pencil
Flexor pollicis brevis  © Wolters Kluwer.	Thenar eminence	Flexes and abducts first carpometacarpal joint and flexes first metacarpophalangeal joint, opposition	Pincer gripping and lateral gripping to hold a key or a card

(*continues*)

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INTRINSIC MUSCLES OF THE HAND

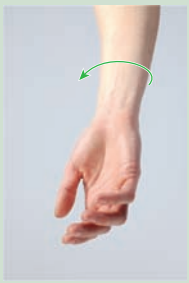
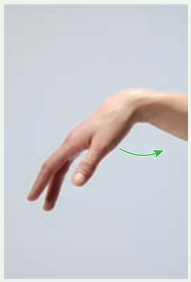
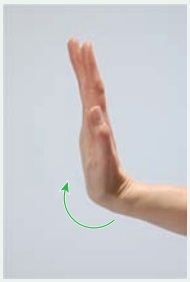
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Muscle	Location	Action	Function
Abductor pollicis brevis  © Wolters Kluwer.	Thenar eminence	Abducts thumb, opposition	Grasping round or cylindrical objects
Adductor pollicis  © Wolters Kluwer.	Central hand	Adducts the first carpometacarpal joint and flexes the first metacarpophalangeal joint	Grasping and making a fist
Interossei  © Wolters Kluwer.  © Wolters Kluwer.	Central hand *Palmar:* between 2nd and 3rd, 3rd and 4th, and 4th and 5th metacarpals and proximal phalanges *Dorsal:* Between all five metacarpals and proximal phalanges	*Palmar:* Flex MP joints, extend PIP joints, adduct digits 2, 4, and 5 *Dorsal:* Flex MP joints, extend PIP joints, abduct digits 2–4	Staggered finger flexing and closing (palmar) and spreading (dorsal) of fingers
Lumbricals  © Wolters Kluwer.	Central hand from tendons of flexor digitorum profundus to 2nd, 3rd, 4th, and 5th MP joints	Flex MP joints, extend PIP and DIP joints	Staggered finger flexion

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SYNERGISTS/ANTAGONISTS: ELBOW AND WRIST

Motion	Muscles Involved	Motion	Muscles Involved
Elbow flexion  © Wolters Kluwer.	*Biceps brachii (Ch 4) *Brachialis *Brachioradialis Flexor carpi radialis Palmaris longus Flexor carpi ulnaris Pronator teres Extensor carpi radialis longus	**Elbow extension**  © Wolters Kluwer.	*Triceps brachii (Ch 4) Anconeus Supinator Extensor carpi ulnaris Extensor digitorum Extensor digiti minimi Extensor carpi radialis brevis
Pronation  © Wolters Kluwer.	Brachioradialis *Flexor carpi radialis *Pronator teres *Pronator quadratus	**Supination**  © Wolters Kluwer.	*Biceps brachii (Ch 4) Brachioradialis *Supinator Extensor indicis Extensor carpi radialis longus
Wrist flexion  © Wolters Kluwer.	*Flexor carpi radialis Palmaris longus *Flexor carpi ulnaris Flexor digitorum superficialis Flexor digitorum profundus Flexor pollicis longus Abductor pollicis longus	**Wrist extension**  © Wolters Kluwer.	*Extensor carpi radialis longus *Extensor carpi radialis brevis *Extensor carpi ulnaris Extensor digitorum Extensor indicis Extensor digiti minimi Extensor pollicis longus
Radial deviation  © Wolters Kluwer.	*Flexor carpi radialis *Extensor carpi radialis longus Extensor carpi radialis brevis *Abductor pollicis longus *Extensor pollicis brevis Extensor pollicis longus	**Ulnar deviation**  © Wolters Kluwer.	*Flexor carpi ulnaris *Extensor carpi ulnaris

*Indicates prime movers.

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SYNERGISTS/ANTAGONISTS: HAND

Motion	Muscles Involved	Motion	Muscles Involved
Finger flexion  © Wolters Kluwer.	*Flexor digitorum superficialis (MPs and PIPs) *Flexor digitorum profundus (MPs, PIPs, and DIPs) *Flexor digiti minimi brevis (5th MP joint) *Lumbricals (MP joints) *Interossei (MP joints)	**Finger extension**  © Wolters Kluwer.	*Extensor digitorum (MPs, PIPs, and DIPs) *Extensor indicis (2nd MP, PIP, and DIP) *Extensor digiti minimi (5th MP, PIP, and DIP) Interossei (PIP joints) Lumbricals (PIP and DIP joints)
Finger adduction  © Wolters Kluwer.	*Palmar interossei (digits 2, 4, and 5)	**Finger abduction**  © Wolters Kluwer.	*Abductor digiti minimi (5th digit) *Dorsal interossei (digits 2–4)
Thumb flexion  © Wolters Kluwer.	*Flexor pollicis longus (CM, MP, and IP joints) *Flexor pollicis brevis (CM and MP joints) *Opponens pollicis Adductor pollicis (MP joint)	**Thumb extension**  © Wolters Kluwer.	*Abductor pollicis longus (CM joint) *Extensor pollicis brevis (CM and MC joints) *Extensor pollicis longus (CM, MC, and IP joints)
Thumb adduction  © Wolters Kluwer.	Opponens pollicis *Adductor pollicis (CM joint)	**Thumb abduction**  © Wolters Kluwer.	*Abductor pollicis longus (CM joint) Extensor pollicis brevis (CM joint) Flexor pollicis brevis *Abductor pollicis brevis
Thumb opposition  © Wolters Kluwer.	*Opponens digiti minimi *Opponens pollicis *Flexor pollicis brevis *Abductor pollicis brevis		

*Indicates prime movers.

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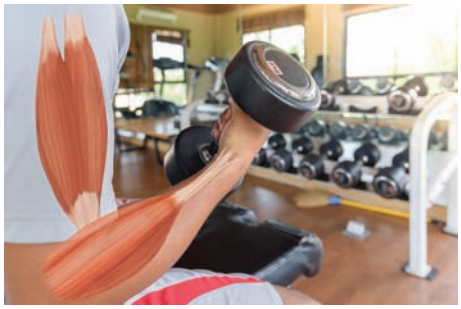
PUTTING IT IN MOTION

Muscles of the elbow, forearm, wrist, and hand work together to perform common movements such as lifting, grasping, twisting, and throwing. Coordinated effort is required for these complex movements to occur smoothly and efficiently. Proper balance between agonist and antagonist groups maintains proper alignment of joints as well as adequate control of powerful movements.



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Lifting. Several muscles in the elbow, wrist, and hand work together to help us lift and carry objects. When the forearm is pronated, the wrist extensors and elbow flexors work together. When the forearm is supinated, the wrist flexors are working. In either case, the finger flexors and intrinsic hand muscles are responsible for grasping and holding the object.



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Twisting. Movements such as turning a screwdriver, opening a bottle with a corkscrew, or rolling the hands in golf or baseball activate the pronators and supinators of the forearm. The biceps brachii and supinator turn the forearm from palm down to palm up. The pronator teres, pronator quadratus, and flexor carpi radialis turn the forearm from palm up to palm down.



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Shooting. The majority of force for shooting a basketball is produced in the lower body, trunk, and shoulders. The position of the arm and hand fine-tune the shot and help determine the motion and direction of the ball. Here, the pronator teres, pronator quadratus, and flexor carpi radialis pronate the forearm as the triceps brachii and anconeus extend the elbow. The finger flexors are helping to grip the ball, but the extensors must be activated for release. All of the wrist flexors remain active propelling the ball forward until it rolls off the fingertips.



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Grasping. A closer view of grasping reveals the coordinated efforts of muscles such as the palmaris longus, flexor digitorum superficialis, flexor digitorum profundus, flexor pollicis longus, flexor pollicis brevis, and opponens pollicis. Complex hand movements require activation of multiple muscle groups.

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Wrap-Up

Summary

- The elbow is comprised of three bones (humerus, radius, and ulna) and two joints (humeroulnar and proximal radioulnar), which allow it to hinge (flexion and extension) and rotate (pronation and supination).
- The wrist and hand contain several bones and joints including the radius, ulna, carpals, metacarpals, and phalanges. This complex architecture allows various movements in this region.
- Powerful muscles such as the brachialis and brachioradialis create strength for lifting and carrying objects.
- Many muscles that control movement in the wrist and hand reside close to the elbow, including the flexors and extensors of the wrist and fingers.
- Specialized muscles like the pronator teres, pronator quadratus, and supinator pivot the forearm, helping to position the hand and perform twisting motions.
- The thumb is unique and has a separate muscle group to control its movements, including pressing, grasping, and releasing.
- Muscles of the elbow, forearm, wrist, and hand work in harmony to create movements such as lifting, twisting, shooting, and grasping.

For Review

Answers to review questions can be found in Appendix A.

Multiple Choice

1. The two joints that allow the forearm to rotate are the
   A. humeroulnar and radiocarpal.
   B. humeroulnar and proximal radioulnar.
   C. humeroulnar and distal radioulnar.
   D. proximal and distal radioulnar.
2. The ulnar notch is located on the
   A. radius.
   B. humerus.
   C. ulna.
   D. scaphoid.
3. The ligament that maintains the position of the radial head during pronation and supination is called the
   A. ulnar collateral ligament.
   B. radial collateral ligament.
   C. annular ligament.
   D. transverse carpal ligament.
4. The nerve that lies within the carpal tunnel is the
   A. ulnar nerve.
   B. radial nerve.
   C. median nerve.
   D. brachial plexus.
5. The artery that is superficial on the lateral aspect of the wrist and can be used to take a person's pulse is the
   A. ulnar artery.
   B. radial artery.
   C. median artery.
   D. brachial artery.
6. The cubital lymph nodes are located
   A. in the axilla.
   B. in the carpal tunnel.
   C. near the medial elbow crease.
   D. near the lateral elbow crease.
7. The purpose of the synovial sheaths in the hand is
   A. to lubricate the tendons of fingers.
   B. to protect the olecranon process.
   C. to reduce friction at the medial and lateral epicondyles.
   D. to cushion the bones when grasping or holding objects.
8. The ligament that forms the roof of the carpal tunnel is called the
   A. ulnar collateral ligament.
   B. radial collateral ligament.
   C. annular ligament.
   D. flexor retinaculum.
9. The purpose of the interosseous membrane is to
   A. prevent medial separation of the humeroulnar joint.
   B. prevent lateral separation of the humeroulnar joint.
   C. prevent "bowing" or separation of the radius and ulna.
   D. maintain the position of the radial head.
10. The anatomical term for finger bones is
    A. carpals.
    B. phalanges.
    C. metacarpals.
    D. tarsals.

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Matching

Different muscle attachments are listed below. Match the correct muscle with its attachment.

11. _____Base of 1st distal phalange, dorsal side
12. _____Pisiform, hook of hamate, and base of 5th metacarpal on palmar side
13. _____Distal one-third of lateral supracondylar ridge of the humerus
14. _____Middle one-third of lateral radius
15. _____Base of 2nd and 3rd metacarpals, palmar side
16. _____Distal one-half of anterior surface of the humerus
17. _____Lateral side of radial styloid process
18. _____Anterior and medial surfaces of proximal threequartersof the ulna and interosseous membrane
19. _____Lateral aspect of olecranon process and posterior

surface of proximal body of the ulna

20. _____Middle and distal phalanges 2–5, dorsal side

A. Anconeus
B. Brachialis
C. Extensor carpi radialis longus
D. Pronator teres
E. Flexor digitorum profundus
F. Brachioradialis
G. Abductor pollicis longus
H. Flexor carpi radialis
I. Extensor digitorum
J. Flexor carpi ulnaris

Different muscle actions are listed below. Match the correct muscle with its action. Answers may be used more than once.

21. _____flexes the elbow
22. _____extends the elbow
23. _____pronates the forearm
24. _____supinates the forearm
25. _____flexes the wrist
26. _____extends the wrist
27. _____radially deviates the wrist
28. _____ulnarly deviates the wrist
29. _____flexes the fingers
30. _____extends the fingers

A. Brachioradialis
B. Extensor digitorum
C. Pronator quadratus
D. Flexor digitorum profundus
E. Extensor carpi ulnaris
F. Brachialis
G. Flexor carpi radialis longus
H. Anconeus
I. Palmaris longus
J. Flexor carpi ulnaris

Short Answer

31. Briefly describe why the elbow is able to flex and extend as well as rotate. What joints make this possible?

32. Make a list of all the muscles that have attachments to the lateral epicondyle of the humerus. Do the same for those attaching to the medial epicondyle of the humerus.

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33. Briefly contrast the thumb with the other digits. What motions are possible here, and which are unique? How are these unique movements possible?

TRY THIS!

Activity 1: Find a partner. Study the person's standing posture from the front. Write down or draw what you observe about their postural alignment paying special attention to their upper extremity. If you notice any deviations, use your knowledge of muscle functions and relationships to determine which muscles might be out of balance. See if you can figure out which muscles are tight. Switch partners and repeat the process. Compare your findings.

Activity 2: Find a partner and have them perform one of the skills identified in the *Putting It in Motion* segment. Identify the specific actions of the elbow, forearm, wrist and hand that make up this skill. Write them down. Use the synergist list to identify which muscles work together to create this movement. Make sure you put the actions in the correct sequence. See if you can discover which muscles are stabilizing or steering the joint into position and which are responsible for powering the movement.

Switch partners and perform a different skill from *Putting It in Motion*. Repeat the steps above. Confirm your findings with the *Putting It in Motion* segment on the Navigate2 digital offering included with your text. To further your understanding, practice this activity with skills not identified in *Putting It in Motion*.

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