Lab 6: Carpal Tunnel and Palmar Hand

Goals

1. Identify the bones associated with the wrist and hand.
2. Demonstrate and describe the movements of the thumb.
3. Clean and identify the palmar aponeurosis.
4. Identify the boundaries and contents of the ulnar canal and carpal tunnel.
5. Trace the long flexor tendons from the anterior forearm to the palmar surface of the digits.
6. Open one fibrous digital sheath and examine the relationships of tendons within it.
7. Identify the intrinsic muscles and neurovascular elements of the palm.

Osteology of the Hand

COMPLETE ANATOMY
BONY LANDMARKS OF THE HAND

COMPLETE ANATOMY
JOINTS OF THE HAND

Identify the eight **carpal bones**:

- **Scaphoid, Lunate, Triquetrum, Pisiform, Trapezium, Trapezoid, Capitate, and Hamate**
- Locate the **hook of the hamate** bone.

Safety Tip

There are plenty of clever mnemonics to help you remember these. Here is an oldie but goodie that Cougs might appreciate:

So Long To Pullman, Time To Come Home

Identify the five **metacarpal bones**. Each has a **base**, **shaft**, and **head**. They are numbered first to fifth, starting from the thumb side.

Identify the **phalanges** = the bones in the **digits**. Each digit has three phalanges (**proximal**, **middle**, and **distal**), except the thumb, which has two (proximal and distal).

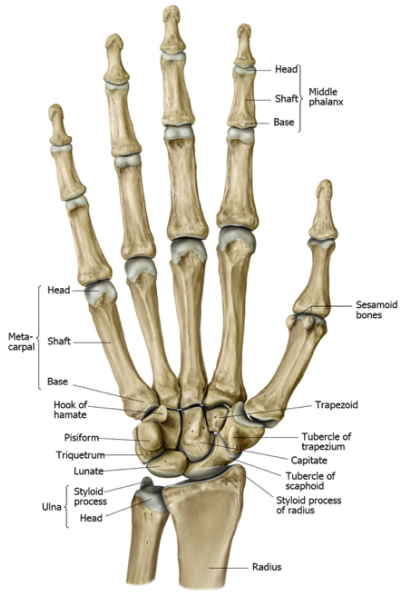


Figure 6.1. Palmar view. Right hand.

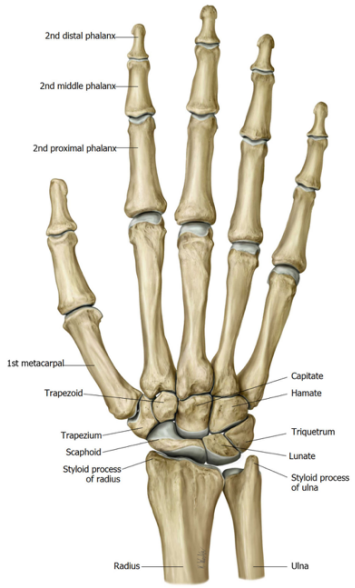


Figure 6.2. Dorsal view. Right hand.

Movements of the Thumb

Work with your team to demonstrate and describe the movements of the thumb in Figure 6.3.

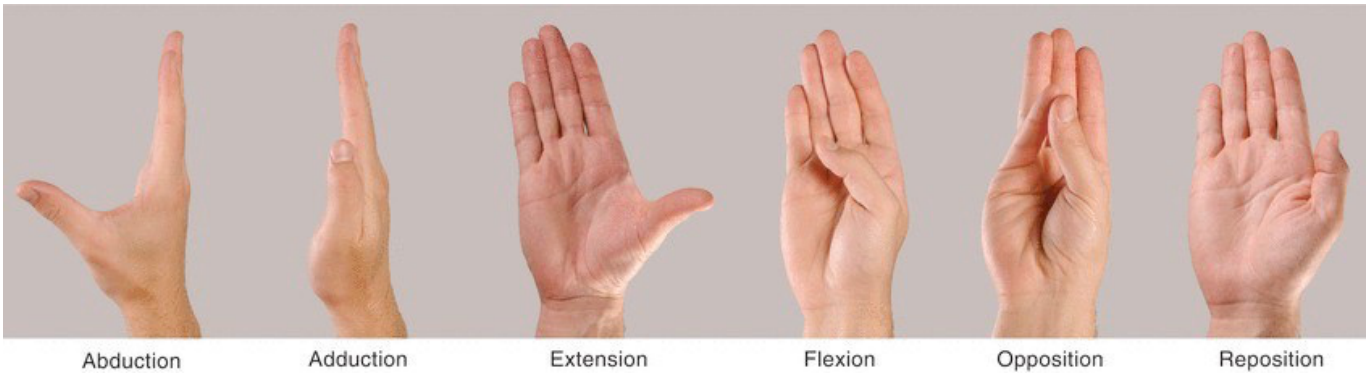


Figure 6.3. Moore, Clinically Oriented Anatomy, 8th ed.

Superficial Palm

COMPLETE ANATOMY
SUPERFICIAL STRUCTURES OF THE HAND

! Do this work on both hands.

Both sides: Remove the skin from the palmar surface of the hands and fingers.

Scrape away the fat on the palm until you see the shiny surface of the **palmar aponeurosis**. If present in your cadaver, identify the long tendon of the **palmaris longus in the forearm and trace it past the wrist to the palm**—it attaches distally to the palmar aponeurosis.

The palmar aponeurosis spreads out as fibrous bands onto the palmar surfaces of the digits.

The palmar aponeurosis protects the nerves and vessels of the palm. Around the edges of the palmar aponeurosis you will see some of the **digital branches of the ulnar and median nerves**—observe how they are vulnerable to superficial lacerations, as they are unprotected by the aponeurosis.

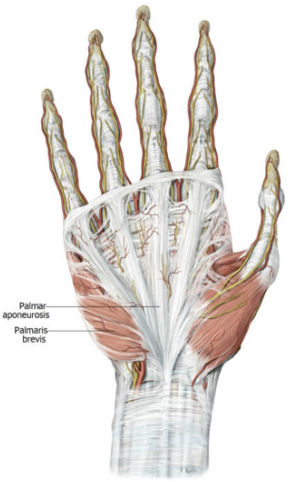


Figure 6.4.

Both sides: Next, cut and reflect the palmar aponeurosis.

Detach it from the tendon of the palmaris longus and carefully reflect it away from the palm of the hand distally, leaving it attached only by the thin digital expansions of the aponeurosis, such that it is hanging by only 2 or 3 bands from the distal ends of the digits.

As you do this, you will remove the relatively unimportant **palmaris brevis muscle** that inserts into the ulnar side of the palmar aponeurosis (see figure 6.4 above).

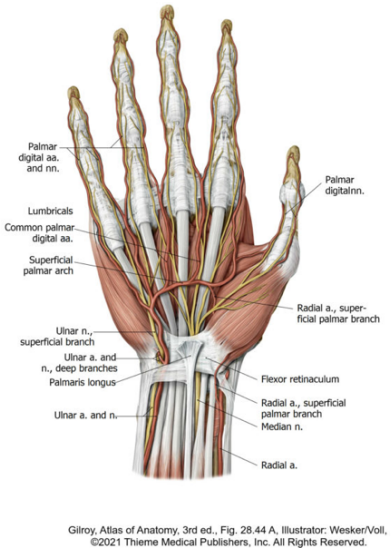
Below the palmar aponeurosis, in the palm of the hand, identify the arteries and nerves of the palmar hand. Be sure to find all the bolded structures from the descriptions below.

Arteries

COMPLETE ANATOMY
ARTERIES OF THE HAND

Superficial palmar arterial arch, crossing the palm of the hand from lateral to medial. It is the direct continuation of the **ulnar artery** in the hand. The superficial palmar arch is completed by the **superficial palmar branch of the radial artery** in the hand.

Branching from the superficial palmar arch are three **common palmar digital arteries**. Upon reaching the spaces between the bases of the fingers, these arteries split, giving rise to **proper palmar digital arteries** that continue distally along the medial and lateral borders of digits 2–5. The radial (lateral) border of digit 2 and the ulnar (medial) border of digit 5 receive proper palmar digital arteries directly from the superficial palmar arch, and not from the common palmar digital arteries. The thumb receives separate arteries from both the superficial and deep palmar arches. See Figure 6.5.



Gilroy, Atlas of Anatomy, 3rd ed., Fig. 28.44 A, Illustrator: Wesker/Voll, ©2021 Thieme Medical Publishers, Inc. All Rights Reserved.

Figure 6.5.

Nerves

COMPLETE ANATOMY
NERVES OF THE HAND

Common palmar digital nerves branch from both the **median** and **ulnar nerves** in the palm of the hand. Like the arteries, these divide at the bases of digits 2–5, giving off **proper palmar digital nerves** to the medial and lateral borders of these digits.

Note that the median nerve supplies digital nerves to the thumb, digit 2, digit 3, and half of digit 4. The ulnar nerve supplies nerves to half of digit 4 and all of digit 5.

The ulnar nerve splits into superficial and deep branches in the hand. ***The digital nerves to the 4th and 5th digits are branches of the superficial branch of the ulnar nerve.***

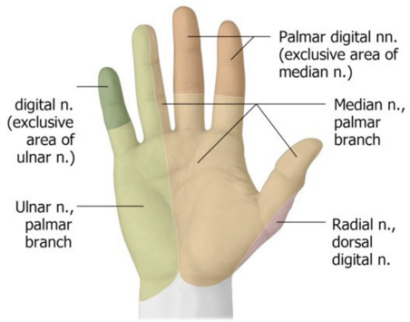


Figure 6.6.

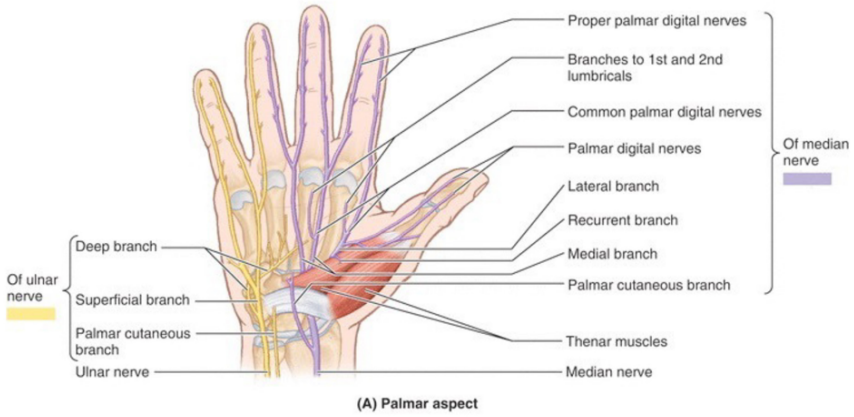


Figure 6.7.

Ulnar Nerve and Ulnar (Guyon's) Canal

Trace the **superficial palmar arterial arch** backwards to the wrist area. Note that the ulnar artery and accompanying **ulnar nerve** disappear under deep fascia of the palmar wrist. The ulnar artery and nerve enter the palm of the hand from the forearm through the **ulnar canal (Guyon's canal)**. See Figure 6.8. *This is located between the pisiform bone and the hook of the hamate bone. The roof of the ulnar canal is a thickened band of deep forearm fascia, and not the flexor retinaculum.* **The ulnar nerve and ulnar artery therefore DO NOT enter the hand through the carpal tunnel.**

Now—designate one hand as the superficial dissection and one hand as the deep dissection. Pay attention to the instructions below and do deep dissections only where instructed.

Deep Dissection Side

Deep dissection: Open the ulnar canal with scissors to reveal the ulnar nerve and artery.

Make the cut parallel to the artery and nerve. See Figure 6.8.

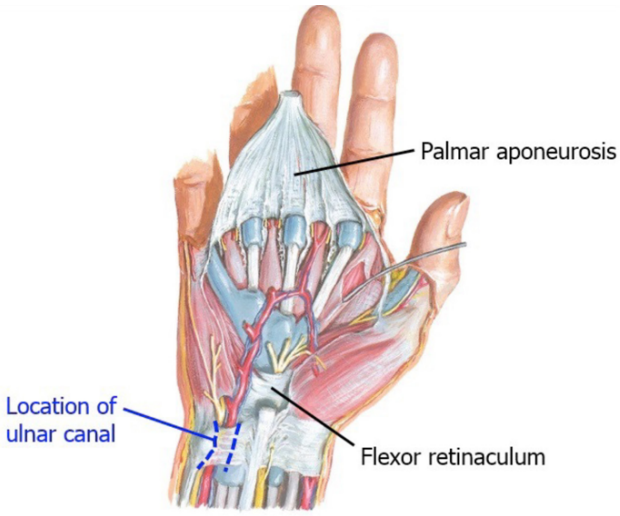


Figure 6.8. Netter, Atlas of Human Anatomy.

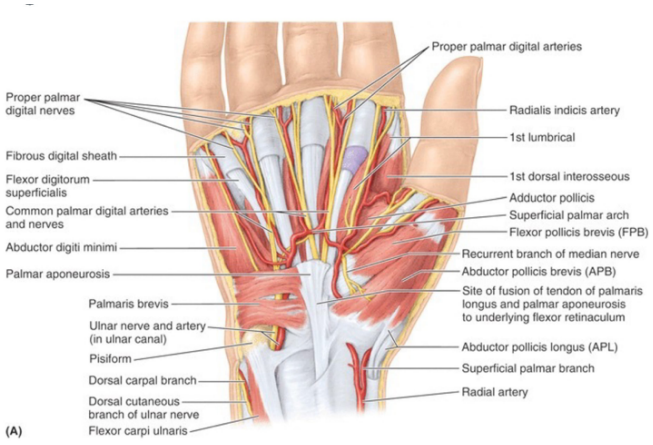


Figure 6.9. Moore, Clinically Oriented Anatomy, 8th ed.

Carpal Tunnel

COMPLETE ANATOMY
CARPAL TUNNEL

QUESTION
What is a retinaculum?

ANSWER
A retinaculum is a special modification of the deep fascia containing transverse collagen fibers. They function to hold tendons close to the joints they cross so they don't "bowstring" away when the joint is moved.

Clean off the **flexor retinaculum (transverse carpal ligament)**. ***This is the roof of the carpal tunnel.***

The flexor retinaculum attaches to the **hook of the hamate** and **pisiform bone** medially and to the **scaphoid and trapezium bones** medially.

Deep dissection: Open the carpal tunnel as instructed below.

Cut the **flexor retinaculum** to expose its contents: ***place a probe through the carpal tunnel and cut through the retinaculum above the probe so as to not injure the structures inside.***

10 structures pass through the carpal tunnel.

- Identify the **median nerve**.
- Identify the **9 flexor tendons** that run through the carpal tunnel. Within the tunnel, the tendons are surrounded by a **synovial sheath**, which lubricates the tendons so they slide without friction.

Which muscles do these nine tendons belong to?

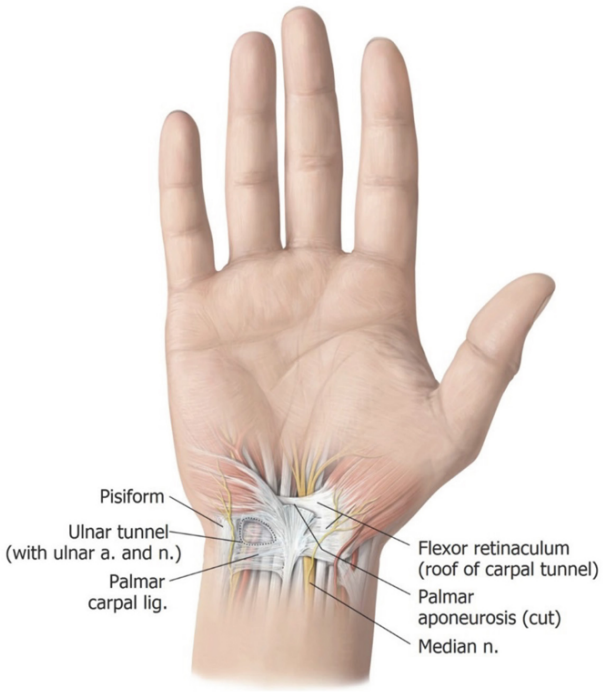


Figure 6.10.

Clinical correlation

Carpal tunnel syndrome is caused by pressure on the median nerve within the carpal tunnel. Its symptoms appear gradually, usually beginning with numbness and tingling of the thumb, index, and middle fingers. Weakness of thumb muscles may occur later. Interestingly, sensory symptoms don't occur in the center of the palm of the hand distal to the carpal tunnel as you might expect. The anatomic explanation for this is that the **palmar cutaneous branch of the median nerve** that supplies sensation to the palm of the hand branches from the median nerve in the distal forearm, proximal to the carpal tunnel. The palmar cutaneous branch ascends to the palm via the superficial fascia that is external to the flexor retinaculum. See Figure 6.12.

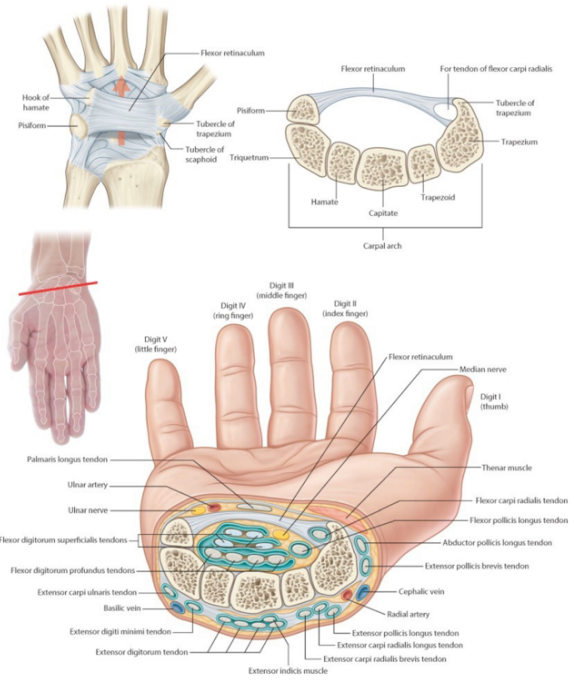


Figure 6.11. Gray's Atlas of Anatomy.

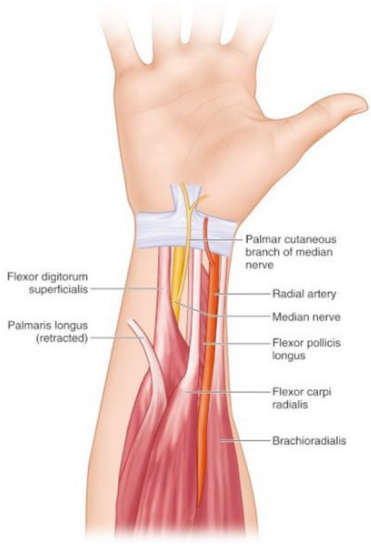


Figure 6.12.

Chalk Talk

Draw a cross section of the wrist (similar to Figure 6.13), noting the locations of the **ulnar nerve and artery** in Guyon's canal and the contents of the carpal tunnel: **median nerve**, tendons of **flexor digitorum superficialis**, **flexor digitorum profundus**, and **flexor pollicis longus**.

Is the tendon of the flexor carpi radialis within the carpal tunnel? If not, where is it in relation to the carpal tunnel?

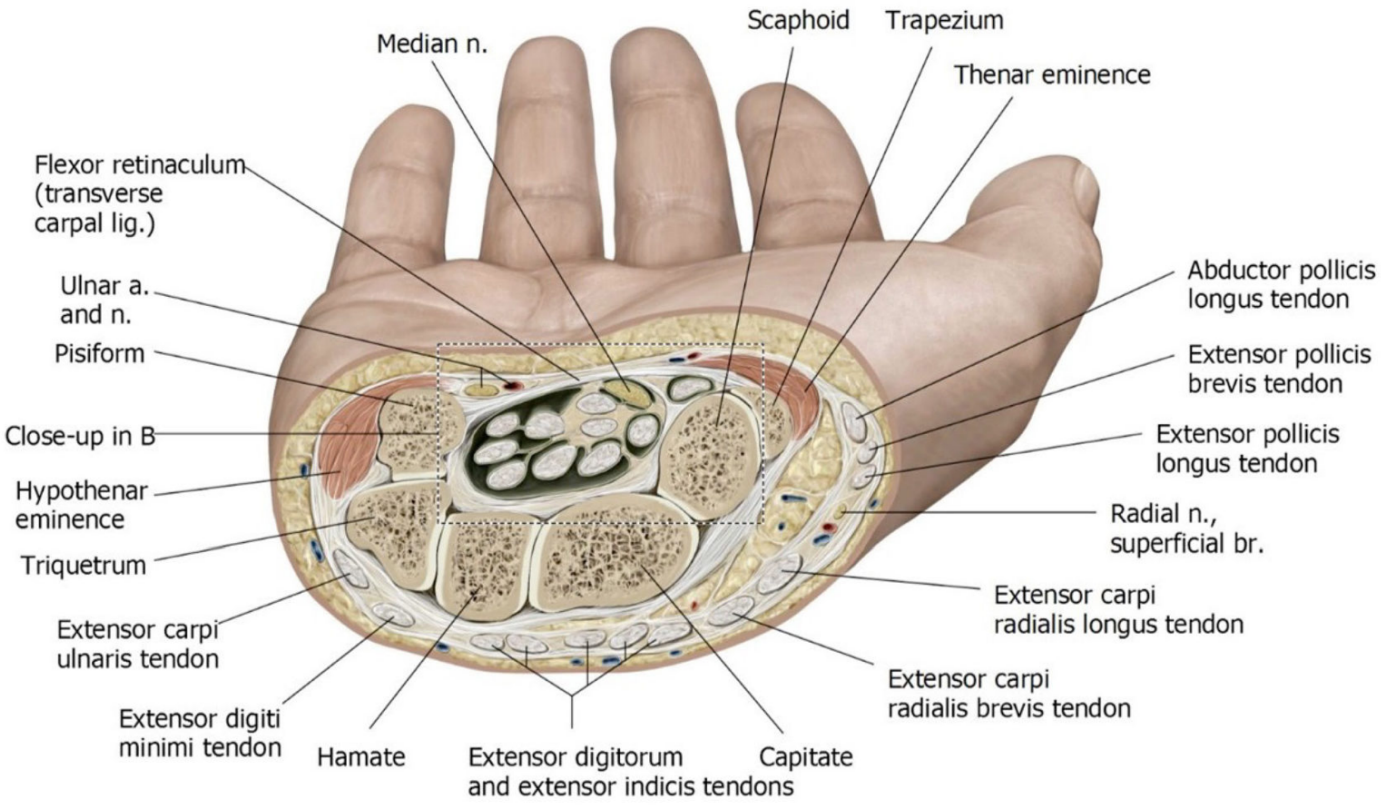


Figure 6.13.

Muscles of Thenar Eminence

COMPLETE ANATOMY
SUPERFICIAL MUSCLES OF THE HAND

The **thenar eminence** is the fleshy mass on the palmar surface of the hand at the base of the thumb.

Both sides: Clean and separate the three thenar muscles.

Review their actions and innervation.

1. **Abductor pollicis brevis**
2. **Flexor pollicis brevis**
3. **Opponens pollicis**

Identify the small **recurrent branch of the median nerve** = the motor branch that supplies the thenar muscles. It leaves the median nerve just distal to the flexor retinaculum. It is a short nerve that curls backward on itself (thus its name) to the enter the muscles of the thenar eminence.

Note how superficial the recurrent branch is on the thenar eminence. A relatively shallow laceration to this area could result in a great deal of disability.

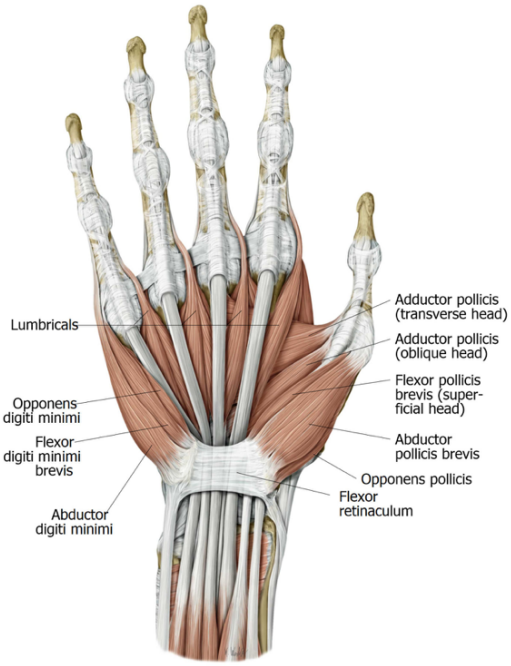


Figure 6.14.

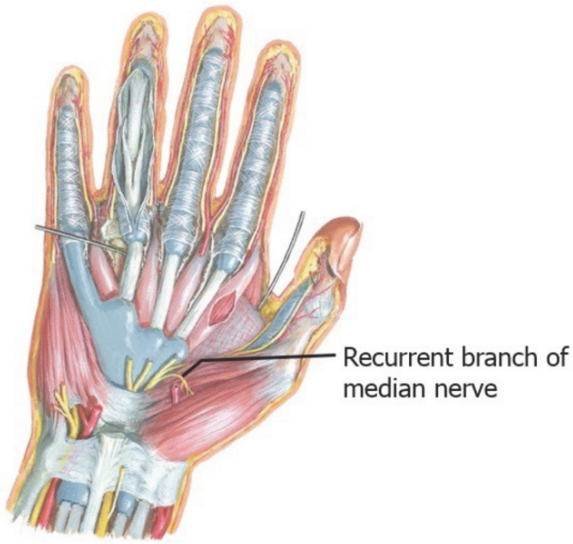


Figure 6.15. Netter, Atlas of Human Anatomy.

Muscles of Hypothenar Eminence

The **hypothenar eminence** is the fleshy outcropping on the palm of hand, along the medial border at the base of the 5th digit. (See Figure 6.14.)

Both sides: Clean and separate the three hypothenar muscles.

Review actions and innervation.

1. **Abductor digiti minimi**
2. **Flexor digiti minimi**
3. **Opponens digiti minimi**

The muscles of the hypothenal eminence are innervated by the deep branch of the ulnar nerve. Is this the same nerve that innervates the muscles in the thenar eminence?

Lumbrical Muscles

In the palm of the hand, identify the **four lumbrical muscles**.

What does the word *lumbrical* mean?

Note that they arise from the four tendons of the **flexor digitorum profundus**. How odd!

They insert into the **extensor hoods** (dorsal digital expansions) on the dorsal side of the digits.

How are the **lumbricals** innervated?

What are the actions of the lumbricals? They act on two joints: the metacarpophalangeal (MCP) joints and the interphalangeal (IP) joints.

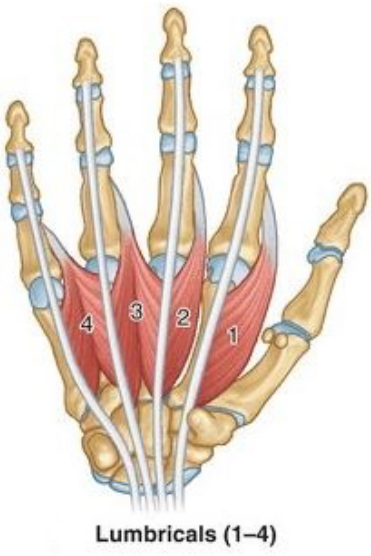


Figure 6.17.

Deep dissection: Cut away and remove any of the palmar aponeurosis that might still be attached to the palmar side of the digits and examine the fibrous digital sheaths.

The **fibrous digital sheaths** are located on the palmar surfaces of the digits. Each contains a tendon of the **flexor digitorum superficialis** (FDS) and the **flexor digitorum profundus** (FDP), plus the surrounding synovial sheaths to lubricate them. **The fibrous digital sheaths prevent "bowstringing" of tendons** when the digits (interphalangeal joints—IP joints) and knuckles (metacarpophalangeal joints—MCP joints) are flexed.

The tendon of the FDS attaches to the middle phalanx, while the tendon of the FDP attaches to the distal phalanx. Since the tendon of the FDP is deep to the tendon of the FDS, how can it reach the distal phalanx?

The answer is elegant: the tendon of the FDS splits to allow the tendon of FDP to pass through and reach the distal phalanx. The gap in the FDS tendon where its splits is called a chiasm.

Deep dissection: With a scalpel and scissors, open the sheath of one finger (middle finger is easiest).

Note how the **flexor digitorum profundus tendon** attaches to the distal phalanx as it passes through the gap (chiasm) in the **flexor digitorum superficialis tendon** (attaches to the middle phalanx).

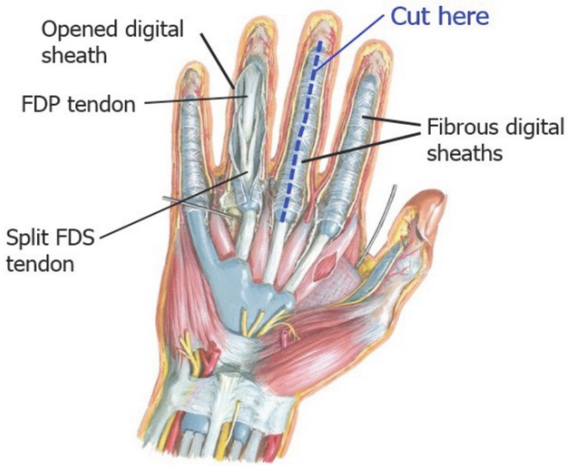


Figure 6.18. Netter, Atlas of Human Anatomy.

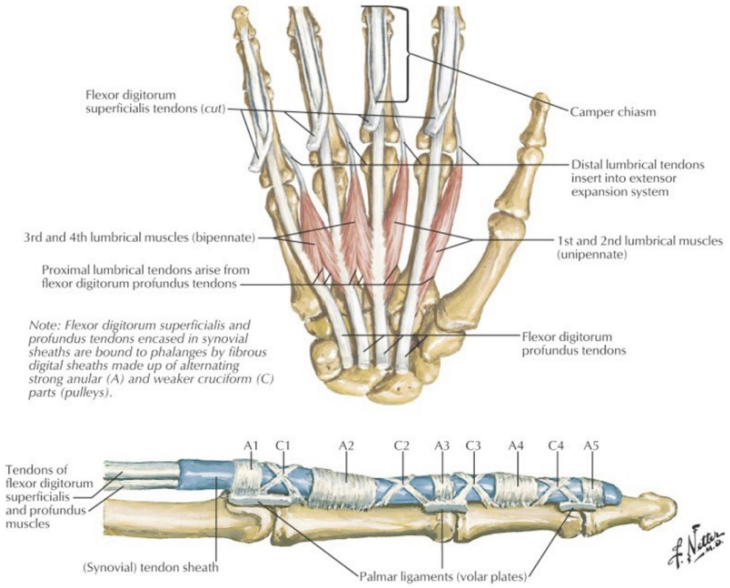


Figure 6.19. Netter, Atlas of Human Anatomy.

For you aspiring hand surgeons, the fibrous digital sheaths are constructed of a series of alternating ligamentous structures called **annular (A) pulleys** and cross-shaped **cruciform (C) pulleys**. See Figure 6.19.

Deep Dissection Side

COMPLETE ANATOMY
DEEP PALMAR HAND

Deep dissection: Cut the flexor tendons of FDS and FDP at the knuckles and reflect them proximally into the forearm. This will expose the deep palm.

Follow the ulnar nerve from the forearm into the ulnar (Guyon's) canal.

At the level of the pisiform bone, the ulnar nerve divides into two branches: superficial and deep.

The **superficial branch of the ulnar nerve** gives rise to the digital nerves—***thus it is sensory to the skin of the 5th digit and half of the 4th digit***.

The **deep branch of the ulnar nerve** is motor—it supplies the hypothenar muscles, the medial two lumbricals, the adductor policis and all the interosseous muscles (palmar and dorsal).

Deep dissection: Clean and follow the deep branch of the ulnar nerve.

Observe how the **deep branch of the ulnar nerve** passes between the **flexor digiti minimi brevis and abductor digiti minimi muscles.** It then curls around the hook of the hamate bone and passes across the palm of the hand, accompanied by the **deep palmar branch of the ulnar artery.**

See if you can find the **deep palmar arch**. ***The deep palmar arch is formed from the distal part of the radial artery in the hand, with a small contribution from the deep palmar branch of the ulnar artery.***

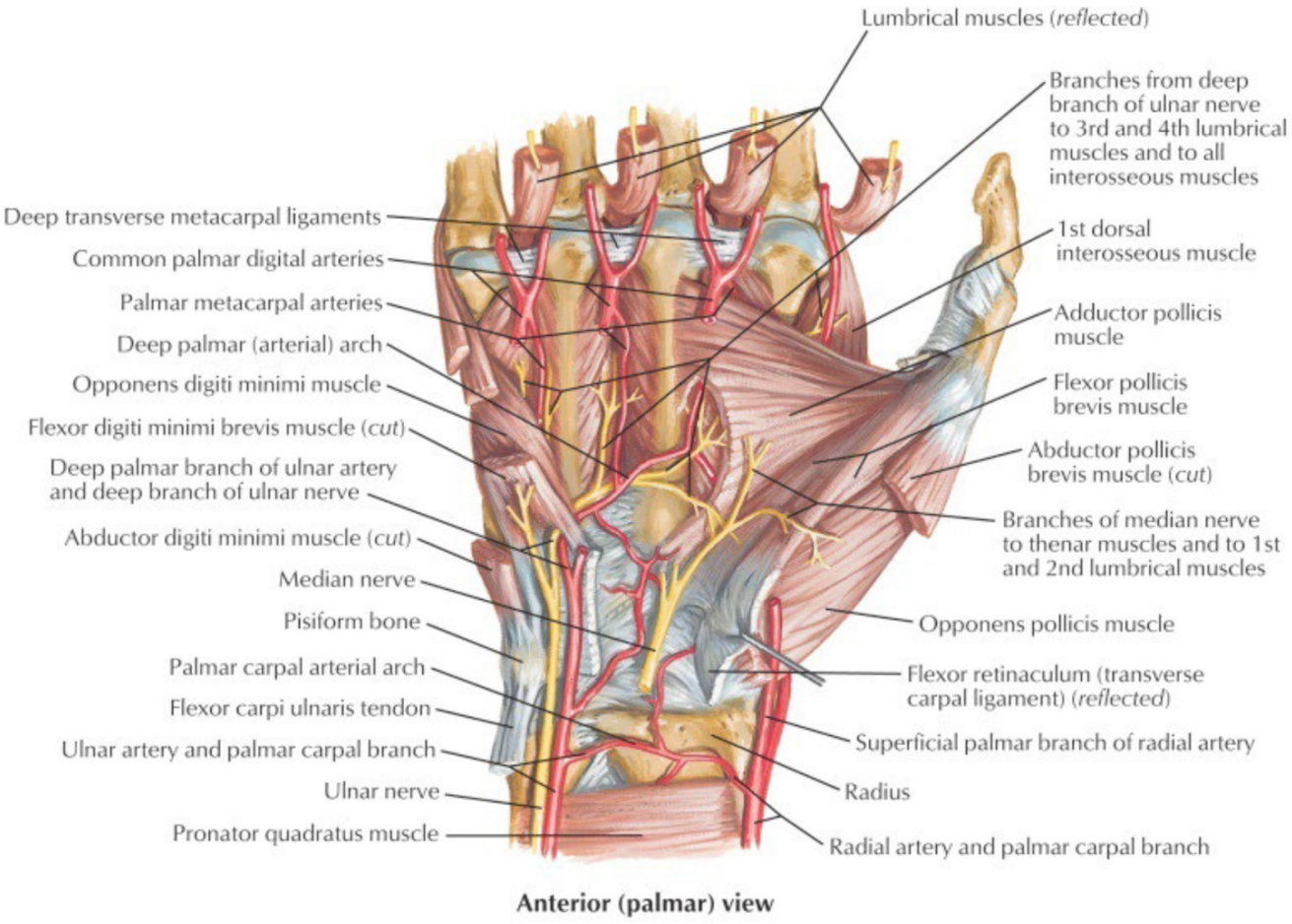
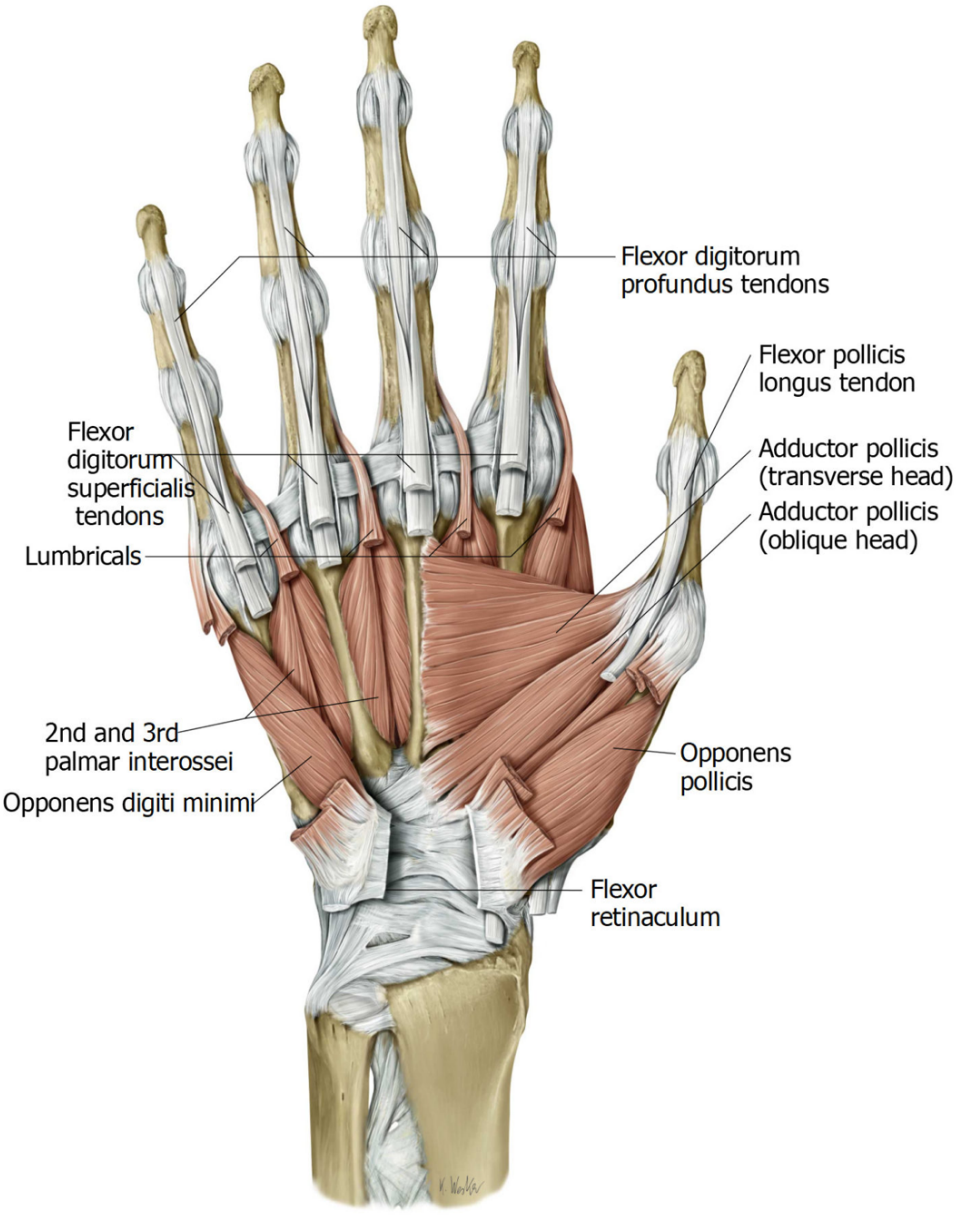


Figure 6.20. Netter, Atlas of Human Anatomy.

Muscles in the Deep Palm

COMPLETE ANATOMY
DEEP MUSCLES OF THE HAND

Identify the **adductor pollicis muscle** and its **two heads** (oblique and transverse). See Figure 6.21.



Gilroy, Atlas of Anatomy, 3rd ed., Fig. 27.19 A, Illustrator: Wesker/Voll,

Identify the three **palmar interosseous muscles**. These are on the palmar surfaces of the metacarpals in the deep hand. The four **dorsal interosseous muscles** are located between the metacarpals and are best seen on the dorsal side of the hand (next lab). See Figures 6.21 and 6.22.

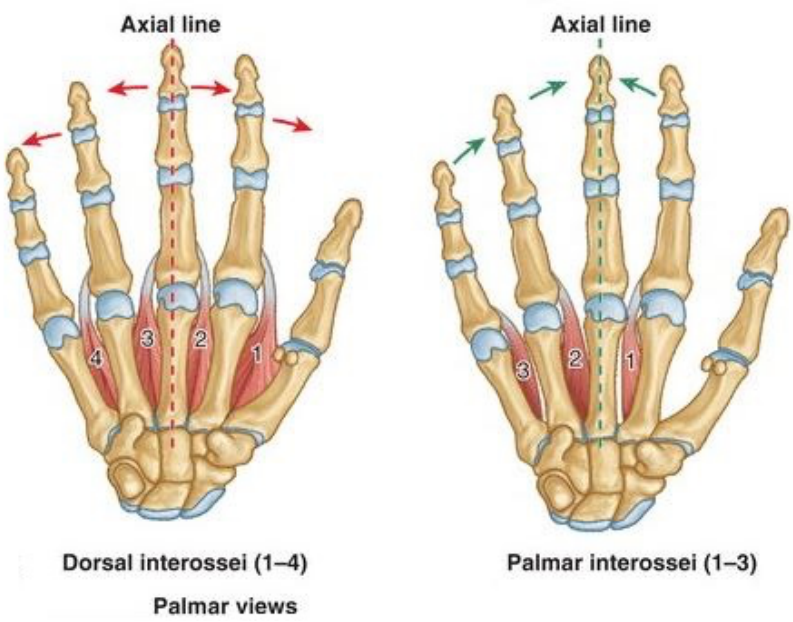


Figure 6.22.

Review the actions of the palmar and dorsal interosseous muscles. See Figure 6.22.

PAD = Palmar interosseous muscles ADduct
DAB = Dorsal interosseous muscles ABduct

CHECKLIST, LAB #6

REVIEW AND MAKE SURE YOU HAVE IDENTIFIED EACH OF THE STRUCTURES BELOW.

BONES

Carpal bones

- [ ] Scaphoid
- [ ] Lunate
- [ ] Triquetrum
- [ ] Pisiform
- [ ] Trapezium
- [ ] Trapezoid
- [ ] Capitate
- [ ] Hamate with hook
- [ ] Metacarpal bones = base, shaft, head
- [ ] Phalanges = proximal, middle, distal (except for thumb)

JOINTS

- [ ] Intercarpal
- [ ] Carpometacarpal (CMC)
- [ ] Metacarpophalangeal (MCP)
- [ ] Proximal and Distal Interphalangeal (PIP and DIP)

MUSCLES

- [ ] Abductor pollicis brevis m.
- [ ] Flexor pollicis brevis m.
- [ ] Opponens pollicis m.
- [ ] Adductor pollicis m.
- [ ] Abductor digiti minimi m.
- [ ] Flexor digiti minimi brevis m.
- [ ] Opponens digiti minimi m.
- [ ] Lumbrical muscles (4)
- [ ] Palmar interosseous muscles (3)
- [ ] Dorsal interosseous muscles (4)
- [ ] Tendons of flexor digitorum superficialis, flexor digitorum profundus, and flexor pollicis longus muscles in carpal tunnel

NERVES

- [ ] Median nerve
  - [ ] Median nerve in carpal tunnel
    - [ ] Recurrent branch of median nerve
    - [ ] Common palmar digital nerves (from median and ulnar nerves)
    - [ ] Proper palmar digital nerves (from median and ulnar nerves)
- [ ] Palmar cutaneous branch of median nerve (branches from median nerve proximal to carpal tunnel) —WISH LIST item

Ulnar nerve

- [ ] Superficial branch of ulnar nerve
- [ ] Deep branch of ulnar nerve (you're a superstar if you can find it!)
- [ ] Common palmar digital nerves (from median and ulnar nerves)
- [ ] Proper palmar digital nerves (from median and ulnar nerves)

VESSELS

- [ ] Superficial palmar arch (Ulnar artery + superficial palmar branch of radial artery)
- [ ] Deep palmar arch (Radial artery + deep palmar branch of ulnar artery)—this is a toughie to dissect
- [ ] Common palmar digital arteries
- [ ] Proper palmar digital arteries

OTHER

- [ ] Palmar aponeurosis
- [ ] Flexor retinaculum (transverse carpal ligament)
- [ ] Carpal tunnel
- [ ] Ulnar (Guyon's) canal
- [ ] Fibrous digital sheaths (on palmar surfaces of digits)