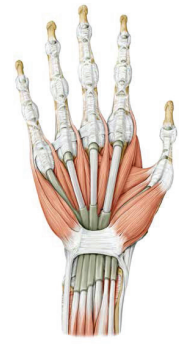


Flexor Compartment of the Forearm and Palm



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Learning Objectives

After reading this chapter, students should be able to identify, understand, and correlate the following:

Muscles:

- *Superficial group:* Pronator teres, flexor carpi radialis, palmaris longus, and flexor carpi ulnaris.
- *Intermediate group:* Flexor digitorum superficialis.
- *Deep group:* Flexor pollicis longus, flexor digitorum profundus, and pronator quadratus.
- *Nerves:* Median nerve and its branches, ulnar nerve and its branches, anterior interosseous nerve and cutaneous nerves (medial and lateral cutaneous nerves of the forearm).
- *Vessels:* Radial artery and its branches, ulnar artery and its branches, cephalic vein and basilic vein.

Introduction

The forearm extends from the elbow to the wrist. It has two bones, the radius laterally and the ulna medially. The deep fascia in this region (antebrachial fascia) forms an envelope around the muscles and sends in intermuscular septa that reach the radius and ulna. Between these two bones runs an interosseous membrane. Anterior to it is the *anterior or flexor compartment* and posterior to it is the *posterior or extensor compartment of the forearm*.

The muscles in the anterior compartment are grouped as follows:

1. Superficial group.
2. Intermediate group.
3. Deep group of muscles.

These muscles are supplied by median and ulnar nerves. Vessels in this compartment are the radial artery, ulnar artery, and anterior interosseous artery. These arteries supply the structures in the flexor compartment.

Surface Landmarks (Refer to Fig. 5.1)

1. Medial and lateral epicondyles of the humerus (refer to **Figs. 1.3** and **1.4**).
2. Radial head.

3. Ulnar head at the lower end.
4. Styloid processes of the radius and ulna.
5. Tendon of the flexor carpi radialis (lateral to which the radial arterial pulsations can be felt in a living subject).

Dissection and Identification

1. Remove the superficial and deep fascia along the anterior side of the forearm, preserving the cephalic and basilic veins. After an initial cut, separate the fascia from the underlying muscles by using your fingers, that is, blunt dissection.
2. Identify the *four* muscles of the superficial group (**Fig. 7.1**):
 - a. *Pronator teres* runs obliquely from its attachment to the lower part of the humerus and upper end of the ulna toward the radius midway down the shaft. The *median nerve* enters the forearm between the *two heads of the pronator teres muscle*.
 - b. *Flexor carpi radialis* is attached distally to the base of the second metacarpal.
 - c. *Palmaris longus* is attached distally to the *palmar aponeurosis*. It is believed that the palmar aponeurosis is a flattened tendon of the palmaris longus.

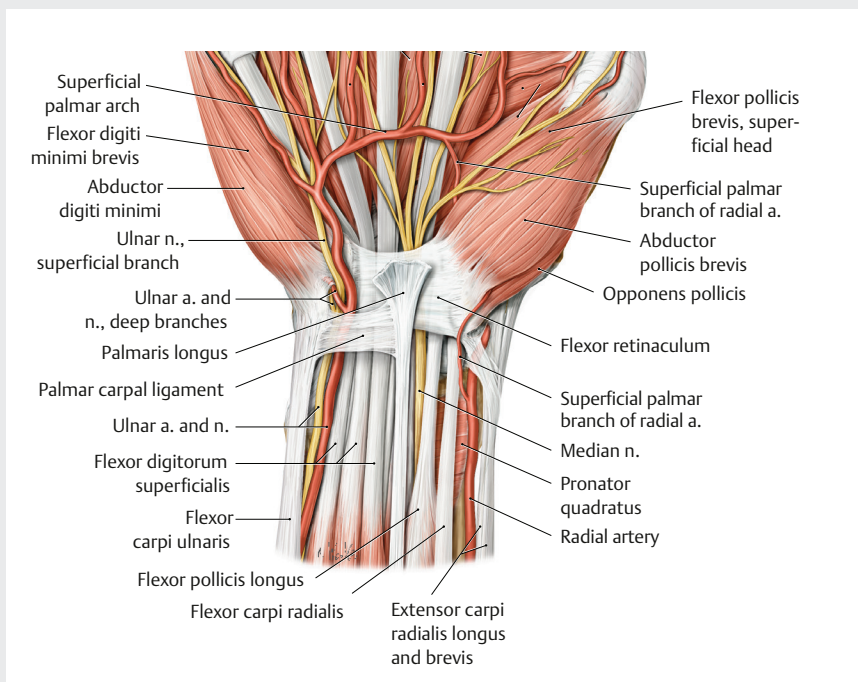


Fig. 7.1 Structures on the anterior aspect of the wrist. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

d. *Flexor carpi ulnaris* is attached distally to the pisiform bone. Pisiform is regarded as a sesamoid bone in the tendon of the flexor carpi ulnaris muscle. Distal to pisiform, the pisohamate and pisometacarpal ligaments are believed to be the morphologically degenerated parts of the flexor carpi ulnaris muscle.

3. Identify the *common flexor tendon* arising from the medial epicondyle of the humerus. This is the common origin (proximal attachment) of the superficial group of muscles.

The anterior aspect of the wrist shows the following structures (**Fig. 7.1**) from the lateral to the medial side:

1. Radial artery.
2. Tendon of the flexor carpi radialis.
3. Tendon of the palmaris longus.
4. Tendons of the flexor digitorum superficialis.
5. Ulnar artery.
6. Ulnar nerve.
7. Tendon of the flexor carpi ulnaris.

Feel the pulsations of the radial artery on your wrist lateral to the tendon of the flexor carpi radialis. The ulnar nerve and artery can be palpated close to the pisiform bone.

Muscles of the Flexor Compartment of the Forearm

Superficial Layer

An overview of different muscles of the flexor compartment of the forearm is given in **Tables 7.1** to **7.3**.

Table 7.1 Muscles of the superficial layer of the forearm (**Figs. 7.2** and **7.3**)

Name of muscle	Origin	Insertion	Nerve supply	Action/Function
Pronator teres	Humeral head: Medial epicondyle of the humerus Ulnar head: Coronoid process	Middle of the lateral surface of the radius	Median nerve	Pronation and flexion at the elbow joint
Palmaris longus		Palmar aponeurosis	Median nerve	Weakly flexes the wrist and tightens the palmar aponeurosis
Flexor carpi radialis	Common flexor origin of the medial epicondyle of the humerus	Base of the second metacarpal	Median nerve	Flexion and abduction at the wrist joint
Flexor carpi ulnaris		Fifth metacarpal, hook of the hamate, and pisiform bones	Ulnar nerve	Adduction and flexion at the wrist joint

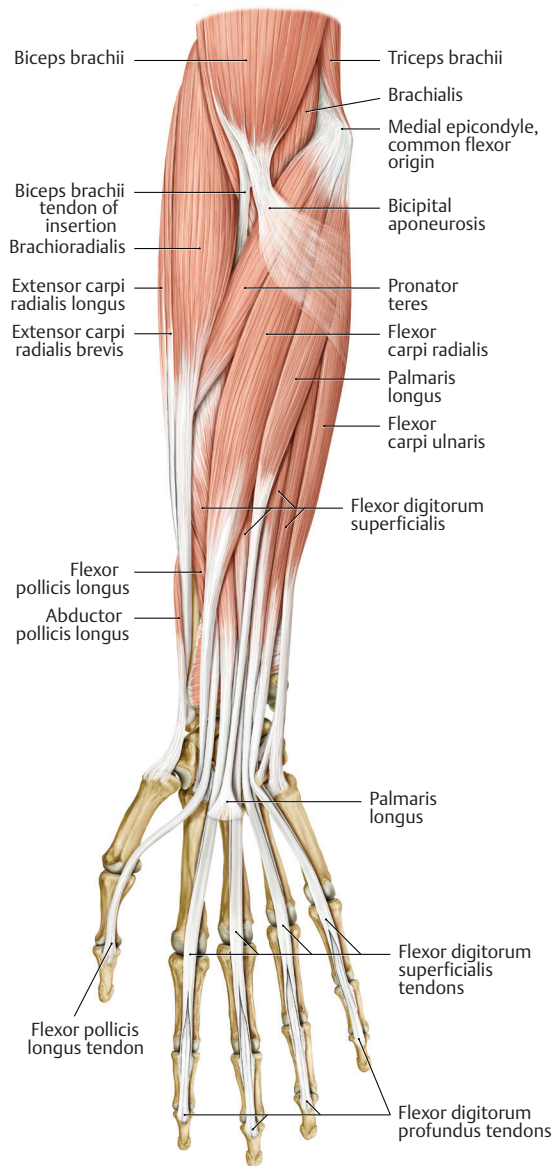


Fig. 7.2 Superficial layer of muscles of the flexor compartment of the forearm. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

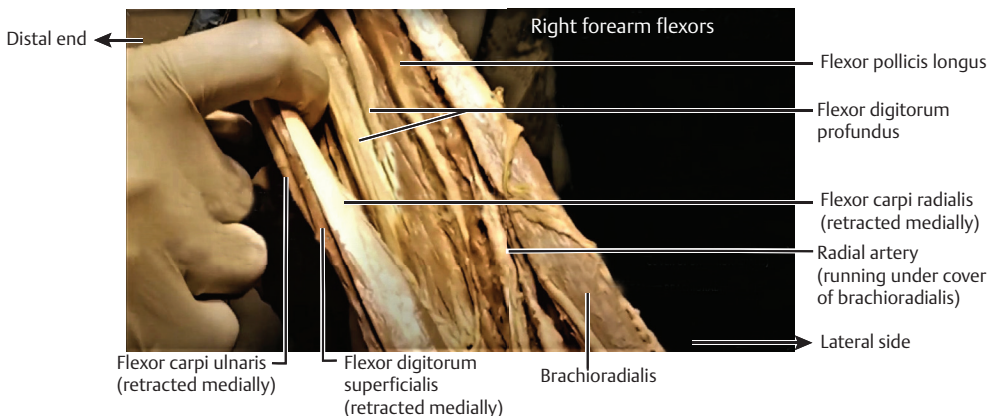


Fig. 7.3 Flexors of forearm.

Dissection and Identification (Video 7.1)

The intermediate layer consists of *flexor digitorum superficialis* muscle. Reveal its tendons by using a pair of scissors (**Fig. 7.4**).

1. Cut the tendon of the *palmaris longus* ~5 cm above the wrist and reflect it upwards.
2. Cut across the tendon of the *flexor carpi radialis* ~5 cm above the wrist and reflect it upwards.

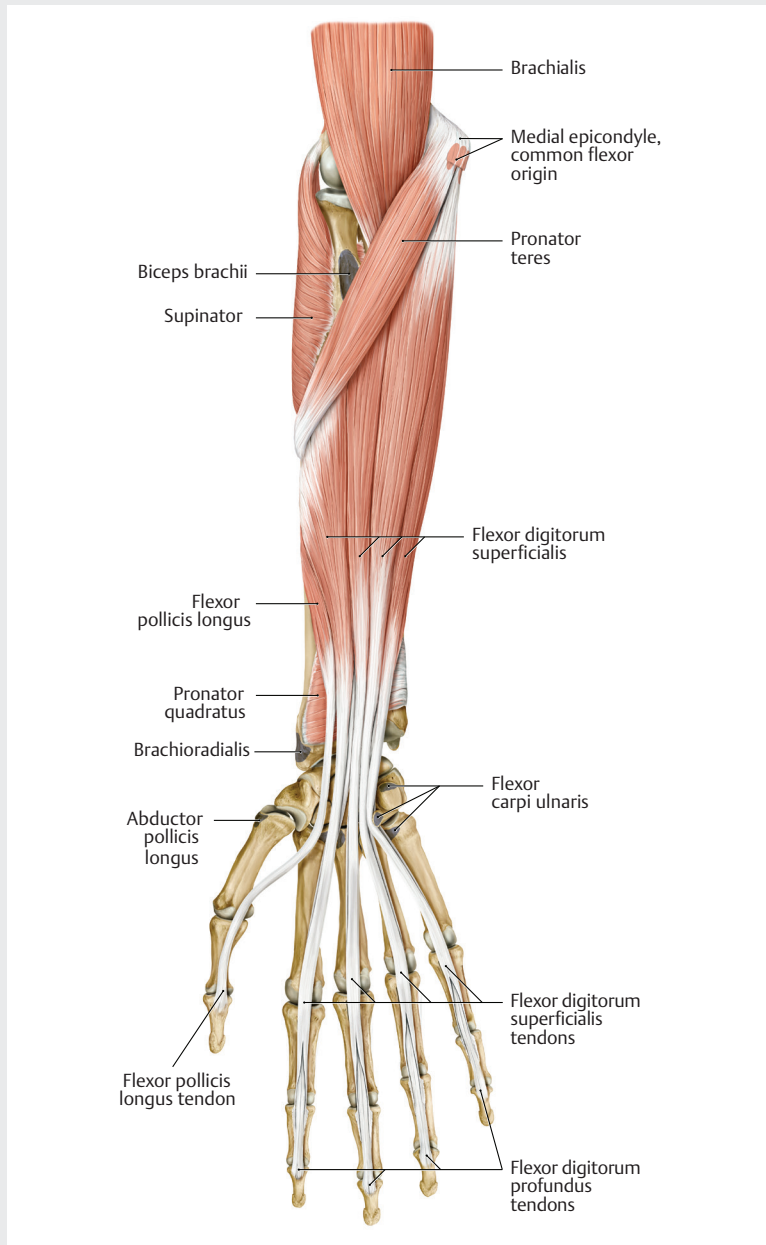


Fig. 7.4 Intermediate muscle layer of the flexor compartment of the forearm (pronator teres is also seen). (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

The flexor digitorum superficialis is attached proximally to the following:

1. Humerus via the common flexor origin.
2. Ulna at the upper end.
3. Linear attachment to an anterior oblique line of the radius. These attachments form a fibrous arch deep to which the ulnar artery and median nerve can be seen. The distal attachment of the four tendons is to the middle phalanges of two to five digits and shall be studied in Chapter 8.



Video 7.1 Flexor compartment of forearm and neurovascular structures.

Note the positions of the tendons of the *flexor digitorum superficialis* at the wrist with the *median nerve laterally* and *ulnar artery and nerve medially*.

Intermediate Layer

An overview of flexor digitorum superficialis muscle is given in **Table 7.2**.

Table 7.2 Muscles of the intermediate layer of the forearm (**Fig. 7.4**)

Name of muscle	Origin	Insertion	Nerve supply	Action/Function
Flexor digitorum superficialis	Radial head: Anterior border (superior part) Humeroulnar head: Common flexor origin on the medial epicondyle and coronoid process	Middle phalanges of the medial four digits	Median nerve	Flexion at the proximal interphalangeal and metacarpophalangeal joints of the medial four digits

The muscles of the deep layer of the forearm are given in **Table 7.3**. To explore deep group of muscles, the flexor digitorum superficialis is removed; the steps toward this are given in the following text.

Table 7.3 Muscles of the deep layer of the forearm (**Figs. 7.5 and 7.6**)

Name of muscle	Origin	Insertion	Nerve supply	Action/Function
Flexor digitorum profundus	Proximal three-fourths of the anterior and medial surfaces of the ulna along with the interosseous membrane	Lateral part: Bases of the distal phalanges of the second and third digits Medial part: Bases of the distal phalanges of the fourth and fifth digits	Lateral part: Anterior interosseous nerve from the median nerve Medial part: Ulnar nerve	Lateral part: Flexion at the second and third distal interphalangeal joints Medial part: Flexion at the fourth and fifth distal interphalangeal joints
Flexor pollicis longus	Anterior surface of the radius and interosseous membrane	Distal phalanx of the first digit (on the base of the thumb)	Anterior interosseous nerve from the median nerve	Flexion at the joints of the thumb
Pronator quadratus	Lower fourth of the ulna at the anterior surface	Lower fourth of the radius at the anterior surface	Anterior interosseous nerve from the median nerve	Pronation at the radioulnar joints

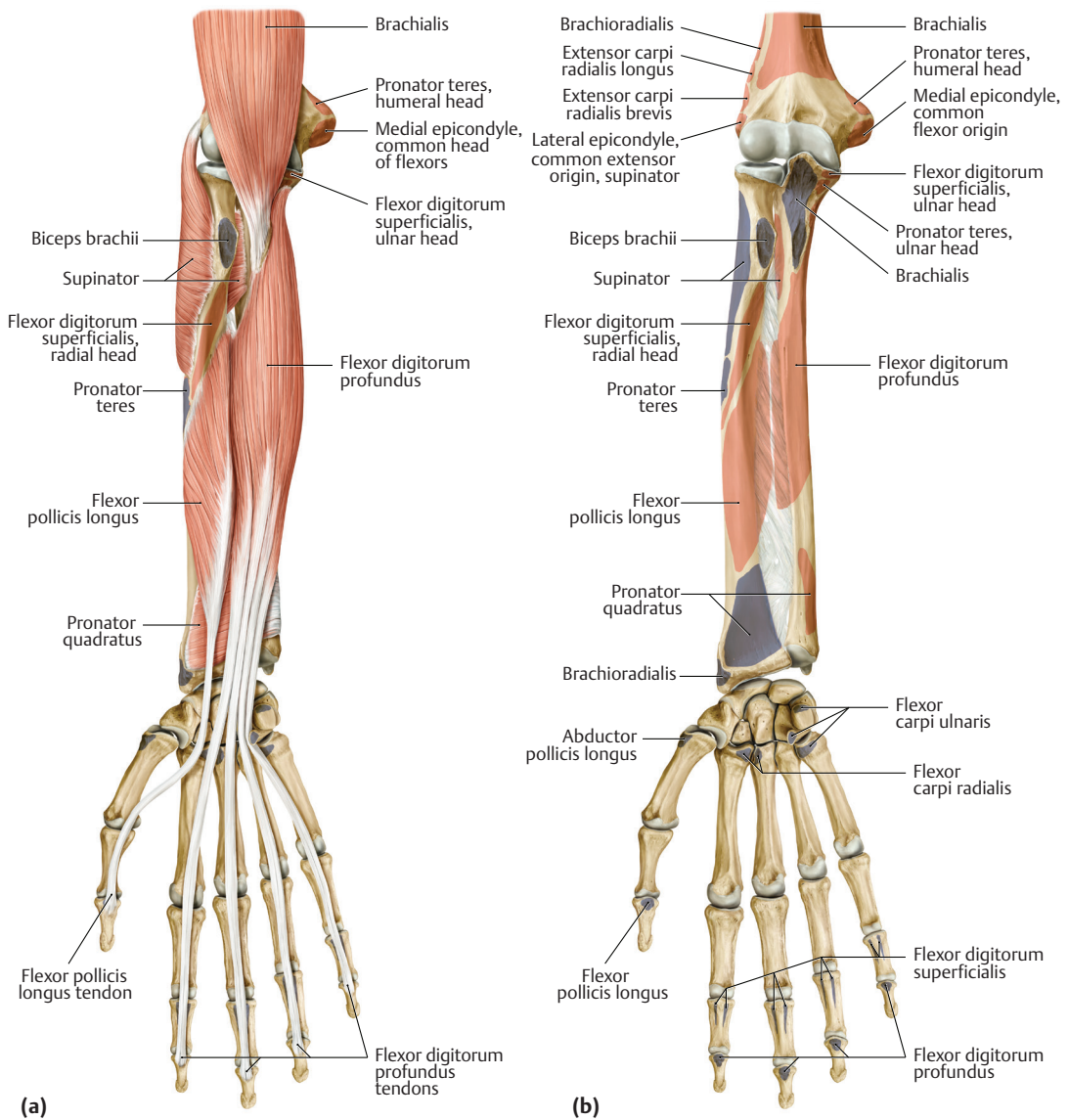


Fig. 7.5 (a) Muscles of the deep layer of the forearm. (b) Areas of bony attachments of the muscles of the deep layer of the forearm. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

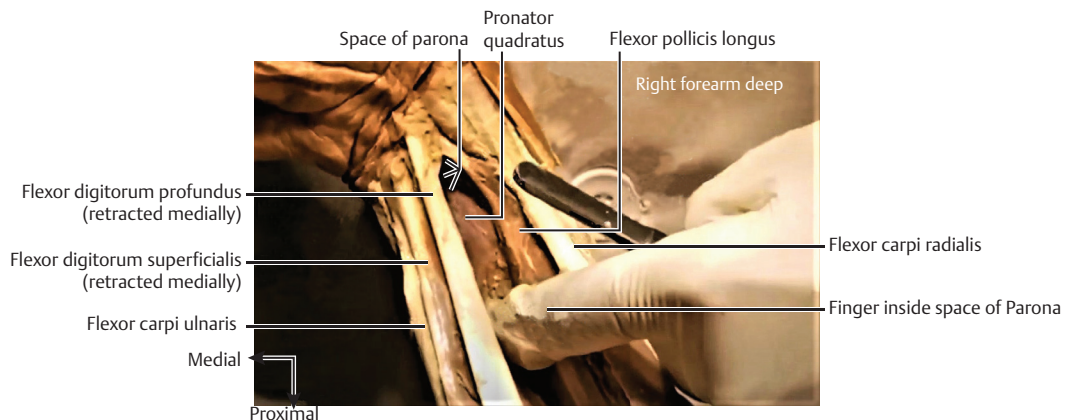


Fig. 7.6 Deep flexors of forearm.

Dissection and Identification

Nerves and vessels in the flexor compartment of the forearm (Fig. 7.7):

1. **Superficial division (sensory) of the radial nerve:** To find this, identify the *brachioradialis* on the lateral side of the upper part of the forearm. Reach the point where the *pronator teres* passes deep to this muscle. Insert your finger to clear the connective tissue at this intermuscular plane to find the *superficial division of the radial nerve*. Trace it distally as it courses deep to the brachioradialis.
2. Identify the *brachial artery* in the cubital fossa. Trace it downwards as it bifurcates into the *radial* and *ulnar artery*. Now using a probe and blunt dissection, trace the radial artery up to the wrist. The radial artery gives many unnamed branches to the muscles of the forearm.

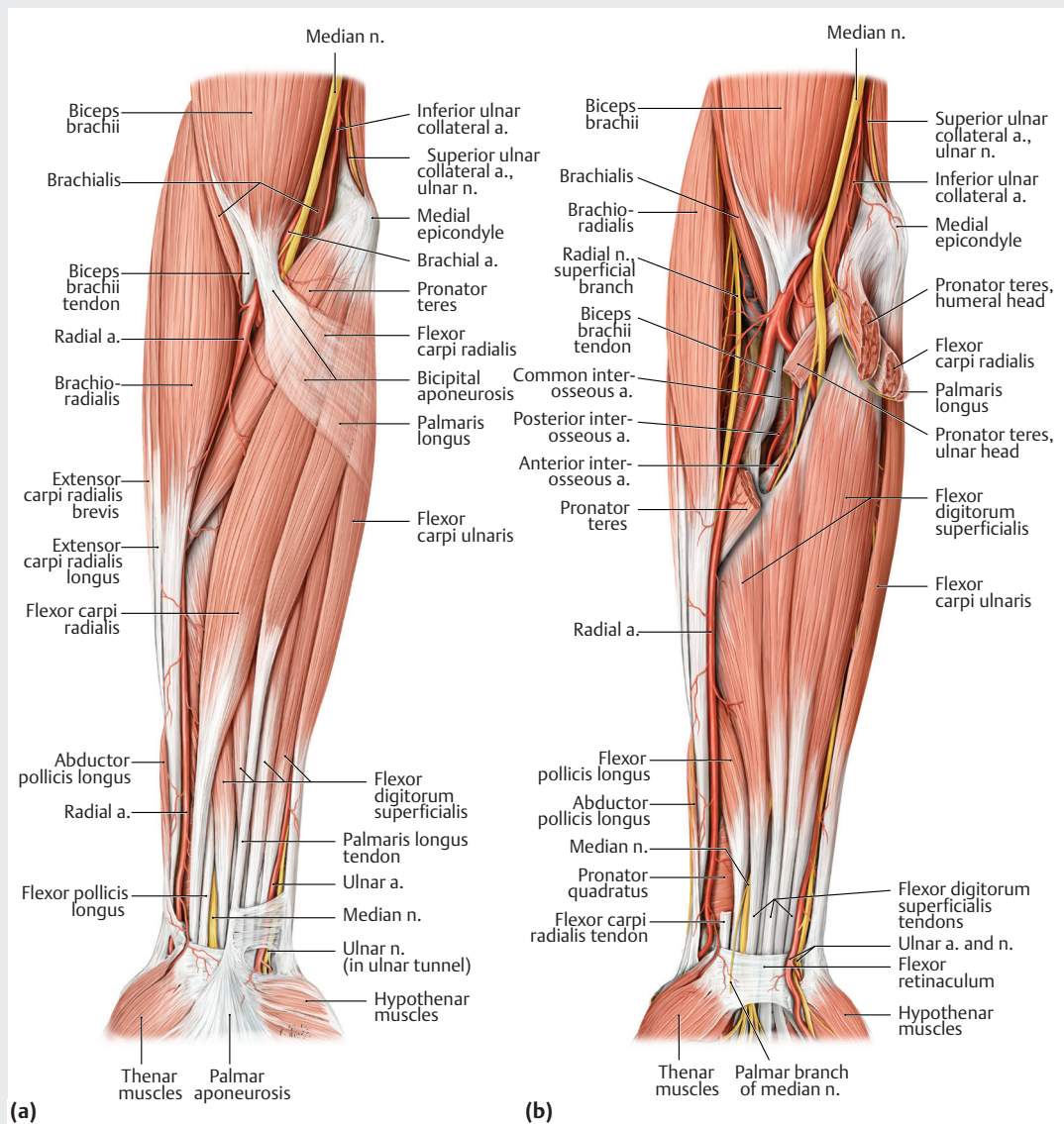


Fig. 7.7 Nerves and vessels of the forearm. (a) With muscles of the superficial layer intact and (b) with muscles of the intermediate layer intact. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

3. **Radial recurrent artery:** It arises from the radial artery and takes a recurrent course, that is, passes upwards between the brachioradialis and brachialis. It anastomoses with the radial collateral branch of the profunda brachii artery, thus forming a part of the cubital anastomosis.
4. **Median nerve:** In the cubital fossa, we have seen the median nerve medial to the brachial artery. It enters the flexor compartment of the forearm between the two heads of the pronator teres. It then courses deep to the flexor digitorum superficialis muscle.
5. To trace the median nerve further, the *flexor digitorum superficialis* is retracted medially after cutting the tendons of this muscle with a pair of scissors, little above the wrist and detaching the muscle from the anterior oblique line of the radius.
6. Use a probe to clean the median nerve from the loose connective tissue as the nerve is traced distally. Trace the *muscular branches* to the (a) pronator teres, (b) palmaris longus, (c) flexor carpi radialis, and (d) flexor digitorum superficialis muscles.
7. Identify the *anterior interosseous nerve* from the median nerve, which supplies the deep group of muscles of the flexor compartment.
8. Identify the *ulnar artery* in the cubital fossa. Observe that the artery passes posterior to the deep head of the pronator teres. To trace the artery, cut the deep head of the pronator teres with a pair of scissors protecting the artery. Clean the artery from the cubital fossa to the wrist.

Ulnar artery:

1. It passes posterior to the median nerve in the cubital fossa.
2. In the upper part of the forearm, it lies between the flexor digitorum superficialis and flexor digitorum profundus.
3. About one-third way down the forearm, it is joined by the ulnar nerve.
4. Both the ulnar artery and nerve lie deep to the flexor carpi ulnaris.
5. Both ulnar artery and nerve pass anterior to the flexor retinaculum (**Fig. 7.7**).

Branches:

1. **Common interosseous artery:** It arises from the ulnar artery ~3 cm below its origin from brachial artery. Soon, it divides into the *anterior interosseous artery* and *posterior interosseous artery*. They pass on respective sides of the interosseous membrane. Trace the anterior interosseous artery with the anterior interosseous nerve between the flexor digitorum profundus (medial) and flexor pollicis longus (lateral) muscles. The posterior interosseous artery passes into the posterior compartment to supply the muscles in that compartment. At this stage, do not follow it.
2. **Anterior ulnar recurrent artery:** It arises from the ulnar artery in the upper part of the forearm and then takes recurrent course; passing upwards, it anastomoses with the inferior ulnar collateral artery, a branch of the brachial artery.
3. **Posterior ulnar recurrent artery:** It arises from the ulnar artery and passes upwards and anastomoses with the superior ulnar collateral artery, branch of the brachial artery.
4. **Muscular branches:** There are several muscular branches supplying the muscles of the flexor compartment.
5. **Ulnar nerve:** Passing behind the medial epicondyle of the humerus, the ulnar nerve enters the forearm piercing the flexor carpi ulnaris and runs under the muscle. It supplies the flexor carpi ulnaris and medial (ulnar) half of the flexor digitorum profundus muscle. It passes anterior/superficial to the flexor retinaculum accompanied by the ulnar artery lateral to it. It supplies majority of the intrinsic muscles in the hand.

Nerves of the Forearm

Nerves of the forearm are summarized in **Table 7.4**.

Table 7.4 Nerves of the forearm

Name of nerve	Source with root value	Course in forearm
Median	By union of the medial and lateral roots from medial and lateral cords (C8–T1 and C6–C7, respectively)	Lies medial to the brachial artery at the elbow, descends down between the two heads of the pronator teres, then between the flexor digitorum superficialis and profundus, and at the wrist joint traverses carpal tunnel
Anterior interosseous	Median nerve	Runs in the anterior aspect of the forearm between the flexor digitorum profundus and flexor pollicis longus
Palmar cutaneous branch (median)	Median nerve	Crosses over the flexor retinaculum at the wrist and supplies the palmar skin in the center
Ulnar	Terminal branch of the medial cord (C8–T1, often C7)	Passes between the heads of the flexor carpi ulnaris, passing posterior to the medial epicondyle of the humerus, after traversing between the flexor carpi ulnaris and flexor digitorum profundus becomes superficial
Palmar cutaneous (ulnar)	Ulnar nerve	Runs down accompanying the ulnar artery and supplies medial one and half digit on the palmar aspect
Dorsal cutaneous branch of the ulnar nerve	Ulnar nerve	Descends between the flexor carpi ulnaris and ulna, subcutaneous supplying the dorsal skin of medial one and half digit
Radial	Terminal branch of the posterior cord (C5–C8)	Gives terminal branches superficial and deep at the lateral humeral epicondyle anteriorly
Posterior cutaneous nerve of the forearm	Radial nerve	Runs down on the lateral side of the arm followed by the posterior side of the arm and subsequently the wrist
Superficial branch of the radial nerve	Terminal branch of the radial nerve	Passes between the brachioradialis and pronator teres, crosses over the anatomical snuff box, and supplies the lateral three and half digits on the dorsum of the hand
Posterior interosseous nerve	Deep terminal branch of the radial nerve after emerging from supinator	Passes over the neck of the radius, enters the posterior compartment of the forearm piercing the supinator muscle, and runs down over the interosseous membrane with the accompanying artery
Lateral cutaneous nerve of the forearm	Musculocutaneous nerve	Emerges between the brachialis and biceps brachii, accompanies the cephalic vein, and runs down over the lateral aspect of the forearm
Medial cutaneous nerve of the forearm	Medial cord (C8–T1)	Becomes subcutaneous above the elbow and descends to the medial border of the forearm with the basilic vein

Clinical Notes

1. Pulsations of the radial artery can be palpated in front of the lower end of the radius just lateral to the tendon of the flexor carpi radialis muscle.
2. Pulsations of the ulnar artery can also be felt on careful palpation just lateral to the tendon of the flexor carpi ulnaris muscle.

Dissection of the Palm

Introduction

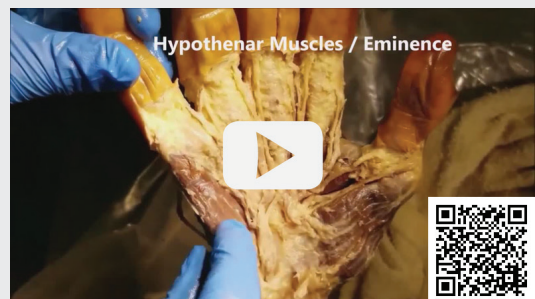
Deep to the skin of the palm, in the middle, the palmar fascia is thickened to form the *palmar aponeurosis*. It is thin over the *thenar* and *hypothenar eminence* formed by the *thenar* and *hypothenar muscles*, respectively. Deep to the palmar aponeurosis are tendons of the *flexor digitorum superficialis* and *profundus*. These muscles cause flexion of the digits. Deep to these are muscles causing adduction and abduction of the digits (interossei muscles).

Blood supply to the palm is furnished by two arterial arches, the *superficial palmar arch*, formed mainly by the ulnar artery, and the *deep palmar arch*, mainly derived from the radial artery. Nerves in this region are branches of the ulnar and median nerves.

Dissection and Identification (Figs. 7.8–7.11 and Video 7.2)

Skin incision (refer to **Fig. 2.1**):

1. In most cadavers, the hand is clenched. Make efforts to forcefully open it.
2. Make a vertical incision from the middle of the wrist to the base of the middle finger (incision E).
3. Take the transverse incision across bases of all the digits from the index to the little finger (incision F).
4. Make longitudinal incisions along the palmar surfaces of other digits, that is, from the index to the little fingers (incision G).
5. Remove the skin carefully from the palm and digits.
6. Immediately deep to the skin, there are digital vessels, nerves, and fibrous digital sheaths.
7. Clean the fat over the palmar aponeurosis. Distally, it leads to *four longitudinal bands*. They blend with the fibrous digital sheaths at the proximal phalanx of each digit from the second to the fifth.
8. Observe the thin palmar fascia over the hypothenar eminence and *palmaris brevis* muscle superficial to it. It stretches from the medial edge of the palmar aponeurosis to the skin of the hypothenar eminence.
9. Detach the *palmaris brevis* from the palmar aponeurosis and retract it medially.
10. Trace the *palmaris longus* tendon from the forearm to the palmar aponeurosis.
11. Detach the palmar aponeurosis carefully from the proximal to the distal side avoiding injury to the deeper structures. During this, use the *palmaris longus* tendon to pull the palmar aponeurosis and complete the removal. Avoid injury to the superficial palmar arch which is immediately deep to the aponeurosis. Preserve the branch of the median nerve to the supplying thenar muscles.



Video 7.2 Neurovascular structures in the palm.

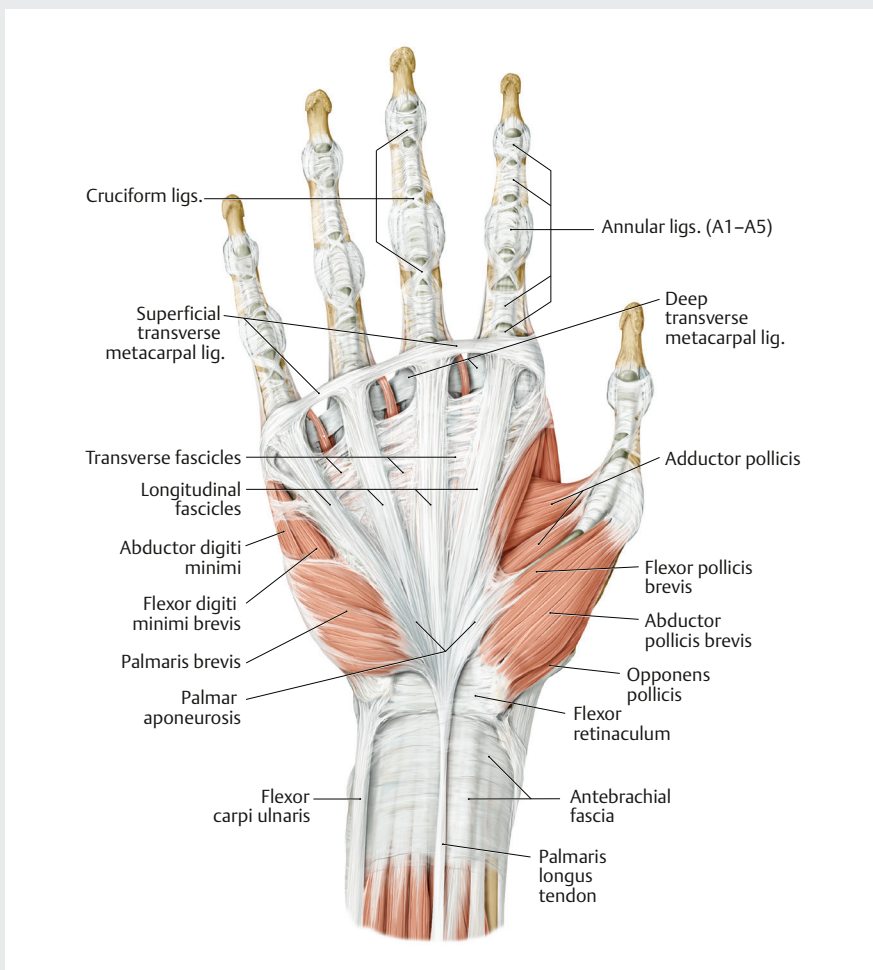


Fig. 7.8 Palmar aponeurosis. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

12. Trace the *ulnar artery* from the forearm into the palm using a probe as it passes lateral to the pisiform with the ulnar nerve. The *ulnar nerve* divides into the *superficial palmar branch* and *deep branch*.
13. The ulnar artery gives a superficial palmar branch that crosses from the medial to the lateral side to form the *superficial palmar arch* along with the superficial palmar branch of the radial artery.
14. *Common palmar digital arteries*: They arise from the convexity of the superficial palmar arch, pass toward the webs between fingers, and each then divides into *two palmar digital arteries* to supply adjacent sides of two digits. Trace the common palmar digital artery distally in proper digital arteries.
15. Trace the *ulnar nerve* lateral to the pisiform, using a probe. Dissect its *superficial branch* supplying the medial one-and-a-half digits, that is, the medial side of little finger and adjacent side of little and ring fingers.
16. The *deep branch of the ulnar nerve* dips between the muscles of the hypothenar muscles (abductor and flexor of digit 5). Do not trace it at this stage.

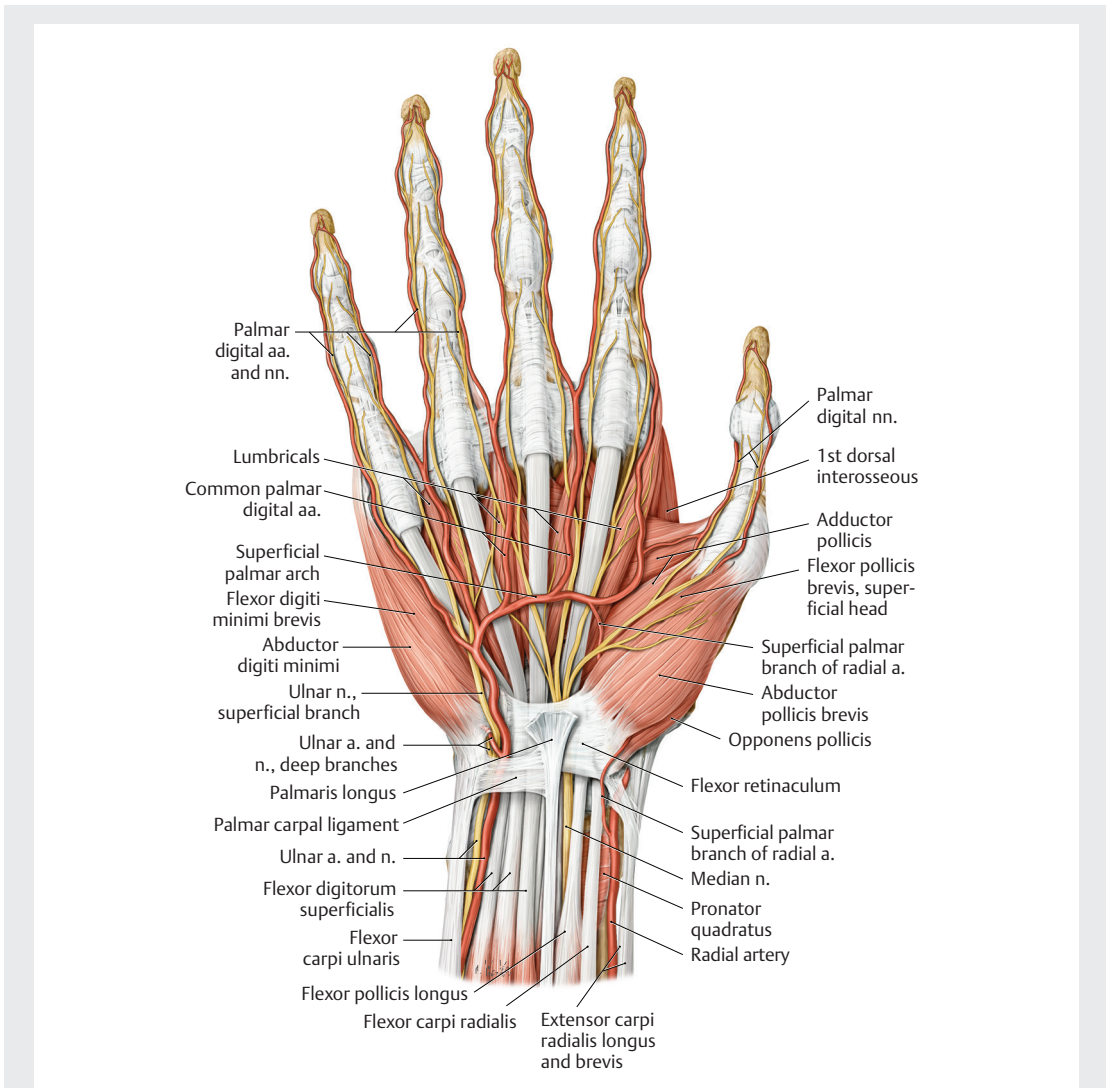


Fig. 7.9 Superficial palmar arch. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)



Fig. 7.10 Various structures in palm (muscles, vessels, and nerves). FDP, flexor digitorum profundus.

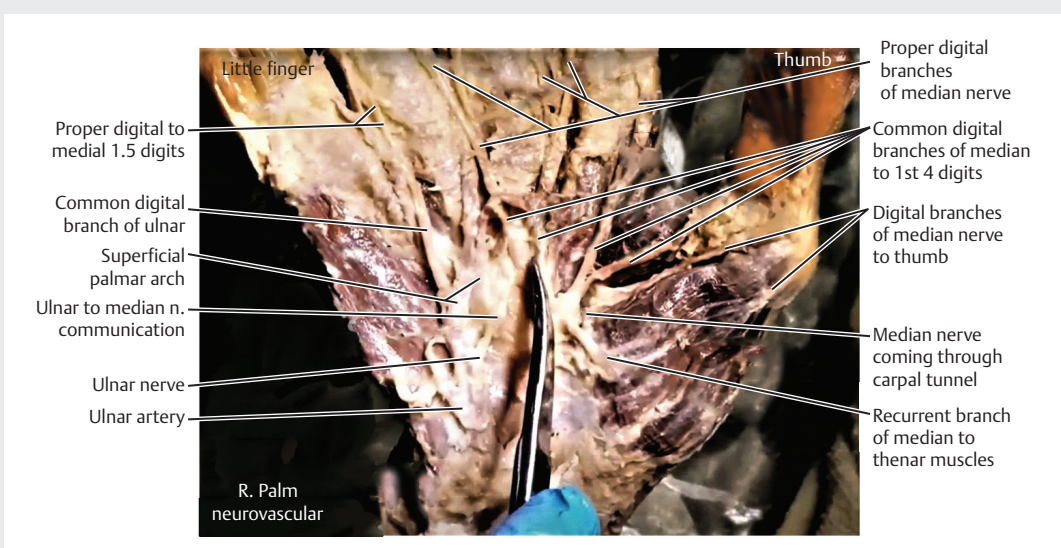


Fig. 7.11 Nerves and vessels in the palm.

Carpal Tunnel

1. It is an osseofibrous tunnel formed by the *flexor retinaculum* anteriorly and the *carpal bones* posteriorly (Fig. 7.12).
2. Note the attachment of the flexor retinaculum to the *tubercle of the scaphoid* and *crest of the trapezium* laterally and *pisiform bone* and *hook of the hamate* medially. It allows passage of the tendons of the long digital flexors, flexor pollicis longus along with the median nerve into the palm.

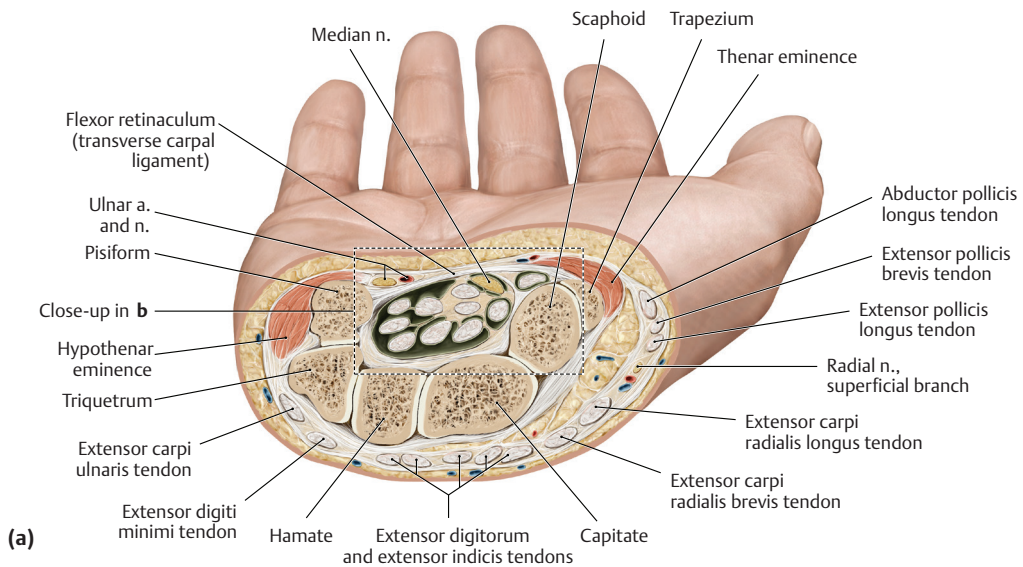
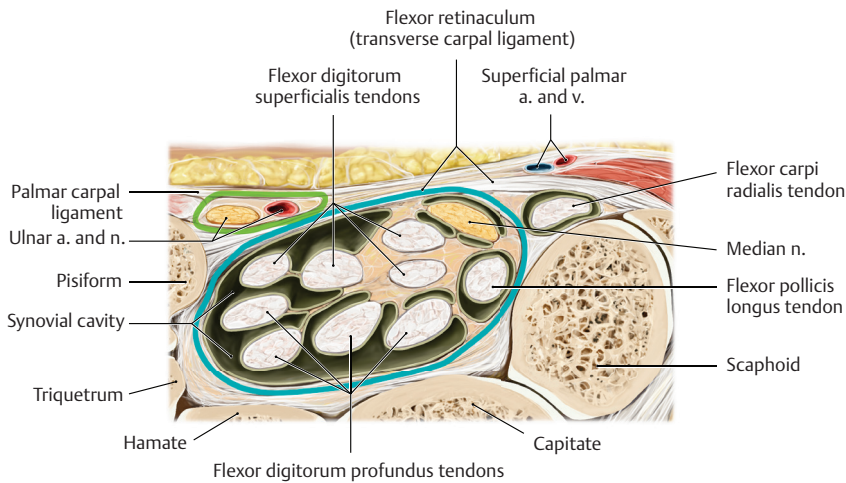


Fig. 7.12 Carpal tunnel. (a) Cross-section through the right wrist.



(b)

Fig. 7.12 (b) Structures in the ulnar tunnel (*green*) and carpal tunnel (*blue*). (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

Dissection and Identification

1. Note the attachment of the flexor retinaculum (**Fig. 7.13**).
2. Insert a probe under the flexor retinaculum from the proximal to the distal side. Cut the retinaculum over the probe to open the carpal tunnel.
3. Identify the contents of the carpal tunnel. They are (a) the *median nerve*, (b) four tendons of the *flexor digitorum superficialis*, (c) four tendons of the *flexor digitorum profundus*, and (d) the tendon of the *flexor pollicis longus*.
4. Follow the median nerve through the carpal tunnel and identify the *recurrent branch of the median nerve* that supplies the three thenar muscles and lateral two lumbricals.
5. Now trace the *common palmar digital branches* of the median nerve. The median nerve supplies the lateral three-and-a-half digits. Each common palmar digital nerve divides into *two proper palmar digital nerves*. Study this cutaneous distribution of the median nerve using an illustration.
6. Follow the long flexor tendons passing through the carpal tunnel. In the hand, they pass posterior to the superficial palmar arch and digital nerve. They then enter the fibrous digital sheaths in the digits.
7. The flexor tendons are surrounded by the synovial sheaths described as follows:
 - a. *Ulnar bursa*: It surrounds the tendons of the flexor digitorum superficialis and profundus.
 - b. *Radial bursa*: It envelops the tendon of the flexor pollicis longus.
 - c. Three separate *digital synovial sheaths* for digits 2 to 4.
8. To trace the flexor tendons further, cut the superficial palmar arch in midline and retract the digital branches of the median and ulnar nerves on the respective sides. Make a longitudinal incision on the palmar surface of the fibrous digital sheath of digits 2 to 5. Now reflect the tendons of the flexor digitorum superficialis distally.

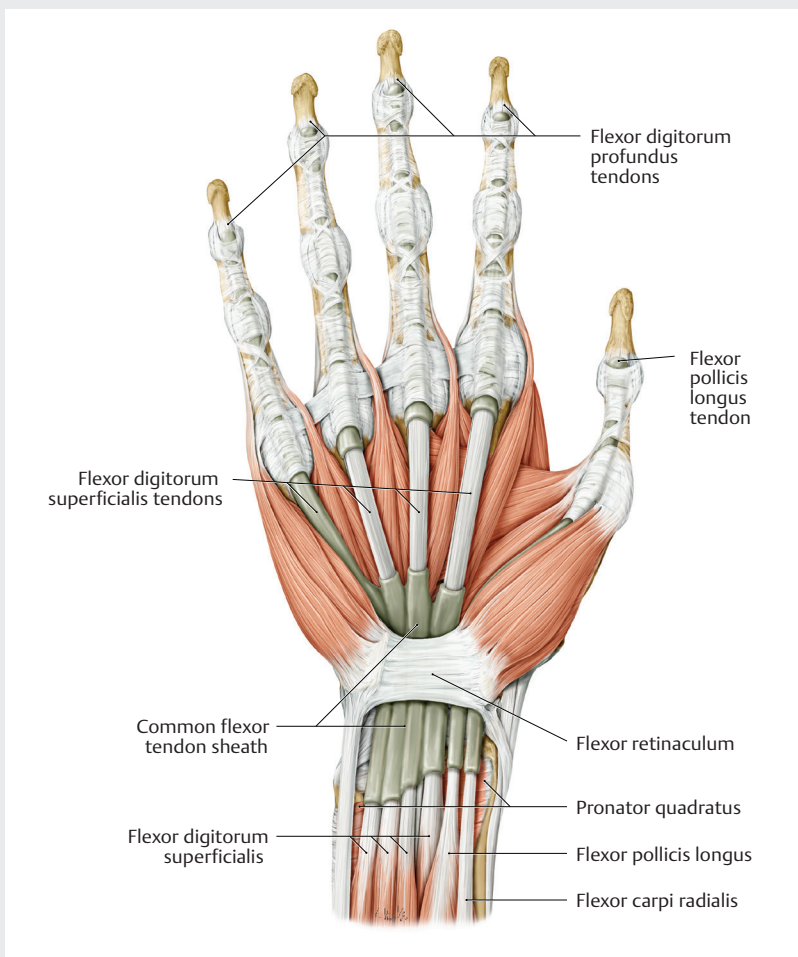


Fig. 7.13 Flexor retinaculum with carpal and digital tendon sheaths. *Removed:* Palmar aponeurosis, palmaris longus, antebrachial fascia, and palmaris brevis. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

9. In the palm, follow the tendons of the flexor digitorum profundus and identify the lumbricals associated with these tendons (**Fig. 7.14**). The lateral two lumbricals are unipennate and supplied by the median nerve, while the medial two are bipennate and supplied by the deep branch of the ulnar nerve. All the lumbricals are distally attached to the extensor expansion. All of them cause flexion of the metacarpophalangeal joints and extension at the interphalangeal joints.
10. Note the distal attachments of the flexor digitorum profundus and superficialis. In digits 2 to 5, the superficialis tendons split to permit the profundus tendon to pass through. The *superficialis* splits and is attached to the *sides of the middle phalanx*, while the *profundus tendon* is attached to the palmar surface of the *base of the distal phalanx* in each digit.
11. Trace the tendon of the *flexor pollicis longus* from the forearm through the carpal tunnel into the palm. It is distally attached to the distal phalanx of the thumb. Pull the tendon to confirm its distal attachment.

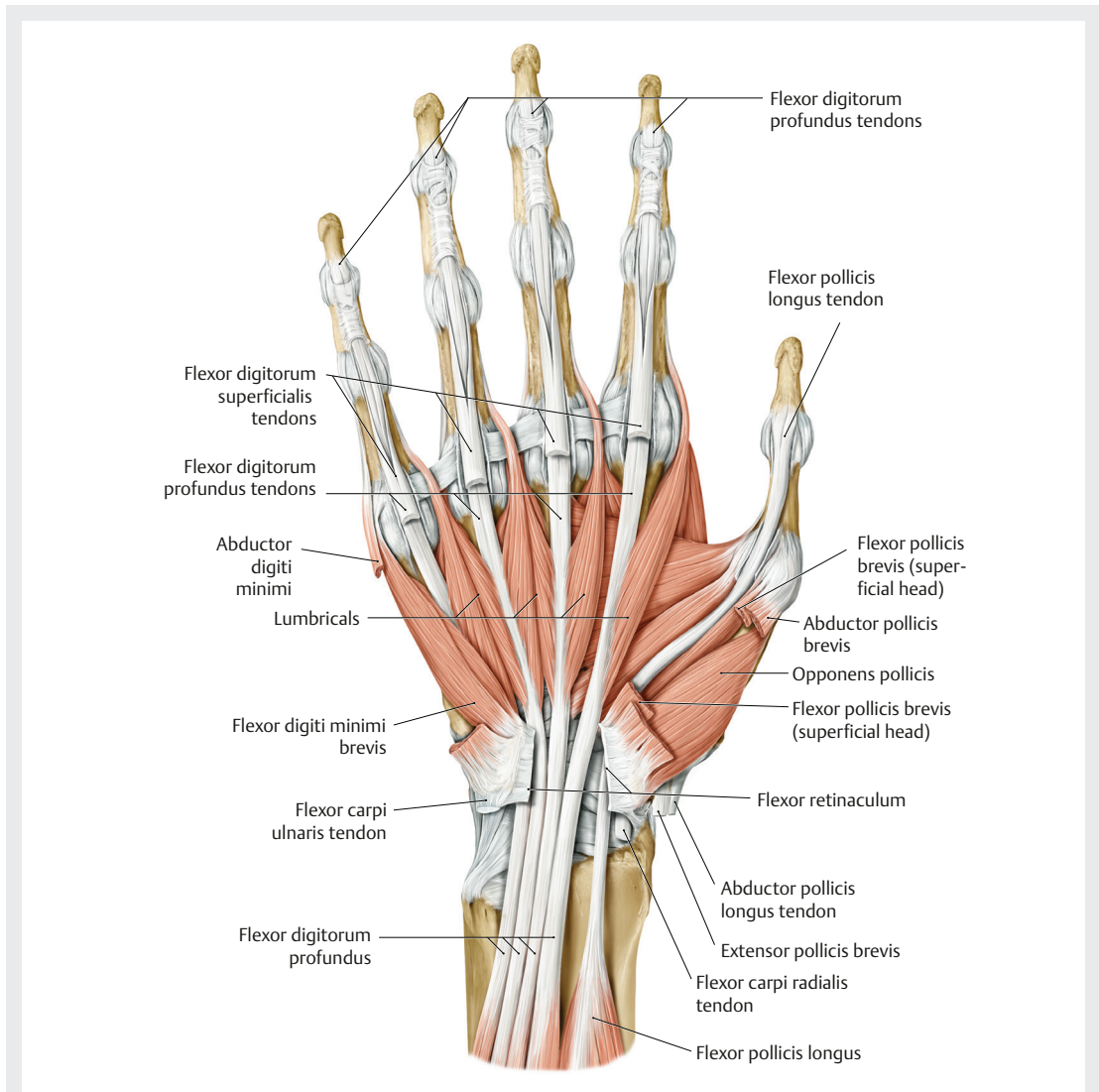


Fig. 7.14 Tendons of flexor digitorum profundus and lumbricals. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

Thenar muscles:

1. Using blunt dissection, remove the thin fascia over the thenar eminence to expose the thenar muscles. There are three muscles:
 - a. *Abductor pollicis brevis*: It stretches from the tubercle of the scaphoid to the lateral side of the proximal phalanx of the thumb. It is abductor of the thumb.
 - b. *Flexor pollicis brevis*: It stretches from the crest of the trapezium to the lateral side of the proximal phalanx of the thumb. It is medial to the abductor pollicis and causes flexion of the thumb.
 - c. *Opponens pollicis*: It lies deep to the other two muscles and stretches from the crest of the trapezium to the lateral side of the shaft of the first metacarpal bone. It causes opposition movement.

2. All the three muscles are supplied by the *recurrent branch of the median nerve*. Identify it passing across the flexor pollicis and disappearing under the abductor pollicis brevis. It can be traced by separating the abductor from the flexor pollicis using a probe.
3. Now elevate the abductor pollicis and cut it with a pair of scissors to expose the opponens pollicis. Note the attachment of the opponens pollicis to the first metacarpal (**Fig. 7.14**).

Hypothenar muscles:

1. Using blunt dissection, remove the thin fascia over the hypothenar muscles. Among the three muscles of this group, the abductor and flexor digiti minimi brevis lie superficial with the abductor being medial to the flexor digiti minimi. The opponens digiti minimi lies deep to these two muscles.
2. *Abductor digiti minimi brevis*: It is attached proximally to the pisiform and distally to the medial side of the proximal phalanx of little finger. It abducts the little finger.
3. *Flexor digiti minimi brevis*: It is proximally attached to the hook of the hamate; the muscle gains its distal attachment to the medial aspect of the base of the proximal phalanx of the little finger. It lies lateral to the abductor digiti minimi. It flexes the little finger.
4. *Opponens digiti minimi*: Proximally, it is attached to the hook of the hamate and distally to the medial border of the shaft of the fifth metacarpal bone.
5. Separate the abductor digiti minimi from the flexor digiti minimi using a probe. Trace them to their distal attachments and reflect the muscle distally. In the attempt, avoid damage to the deep branches of both the ulnar nerve and ulnar artery.

Palm:

1. To expose the deep structures of the palm, transect the flexor digitorum profundus in the lower forearm and reflect its tendons.
2. Identify and follow the *deep branch of the ulnar nerve* and the *deep palmar branch of the ulnar artery*, as they dip between the abductor and flexor digiti minimi. The deep branch of the ulnar nerve then pierces the opponens digiti minimi.
3. To trace the deep branch of the ulnar nerve, insert a probe between the flexor and abductor digiti minimi. Push it parallel to the nerve laterally and using a scalpel cut down to the probe to expose the nerve. Clean the nerve by blunt dissection.
4. The deep branch of the ulnar nerve passes over the interossei muscles and ends into the adductor pollicis muscle. It supplies all the interossei muscles (palmar as well as dorsal) and the adductor pollicis muscle.
5. Note the *deep palmar arch* that courses with the deep palmar branch of the ulnar nerve. It is formed by the *radial artery* as it enters the palm from the lateral side and completed by the deep palmar branch of the ulnar artery (**Fig. 7.15**).

Adductor pollicis muscle: Identify the *adductor pollicis muscle* and define its borders by blunt dissection. The muscle has two heads: oblique and transverse. The *oblique head* arises from the bases of the second and third metacarpals and adjacent carpals. The *transverse head* arises from the palmar surface of the shaft of the third metacarpal. Both heads unite and attach to the medial side base of the proximal phalanx of the thumb. The adductor pollicis is supplied by the deep branch of the ulnar nerve and causes adduction of the thumb.

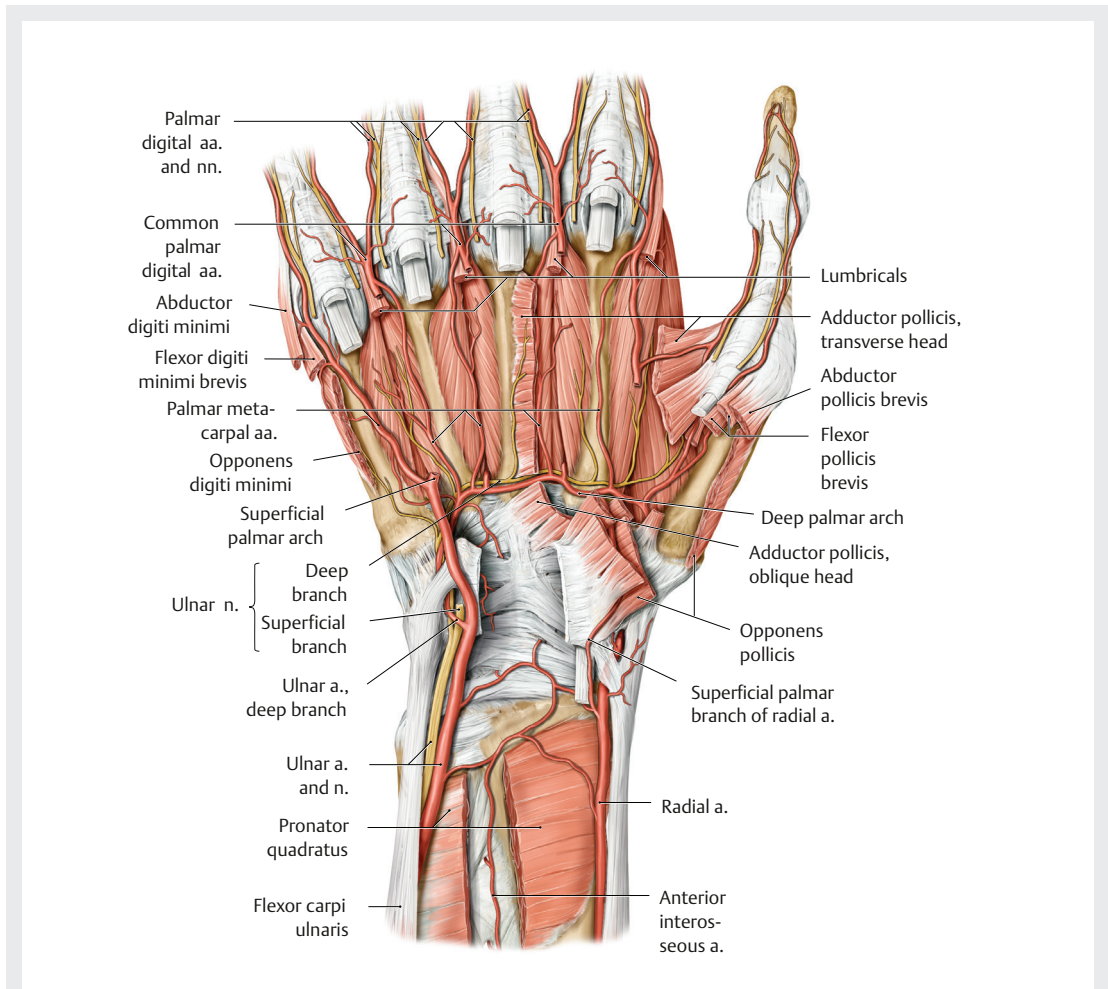


Fig. 7.15 Deep palmar arch. From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

Palmar interossei muscles: They are unipennate and are attached to the shaft of metacarpals: one and two on the ulnar side and four and five on the lateral side. Distally, they attach to the bases of the proximal phalanx and extensor expansion of the respective digit. They adduct the fingers. The first palmar interosseous is thin because the thumb is provided with adductor pollicis (**Fig. 7.16a**).

Dorsal interossei muscles (Fig. 7.16b): They are four in number. They are bipennate. They are numbered from the lateral to the medial side. They are attached to the adjacent sides of the metacarpals. Distally, they are attached to the bases of the proximal phalanx and extensor expansion of digits 2, 3, and 4. They cause abduction of the fingers.

All the interossei palmar and the dorsal muscles are supplied by the deep branch of the ulnar nerve. In addition, it also supplies the hypothenar muscles, medial two lumbricals, and adductor pollicis. The lateral two lumbricals and thenar muscles are supplied by the median nerve.

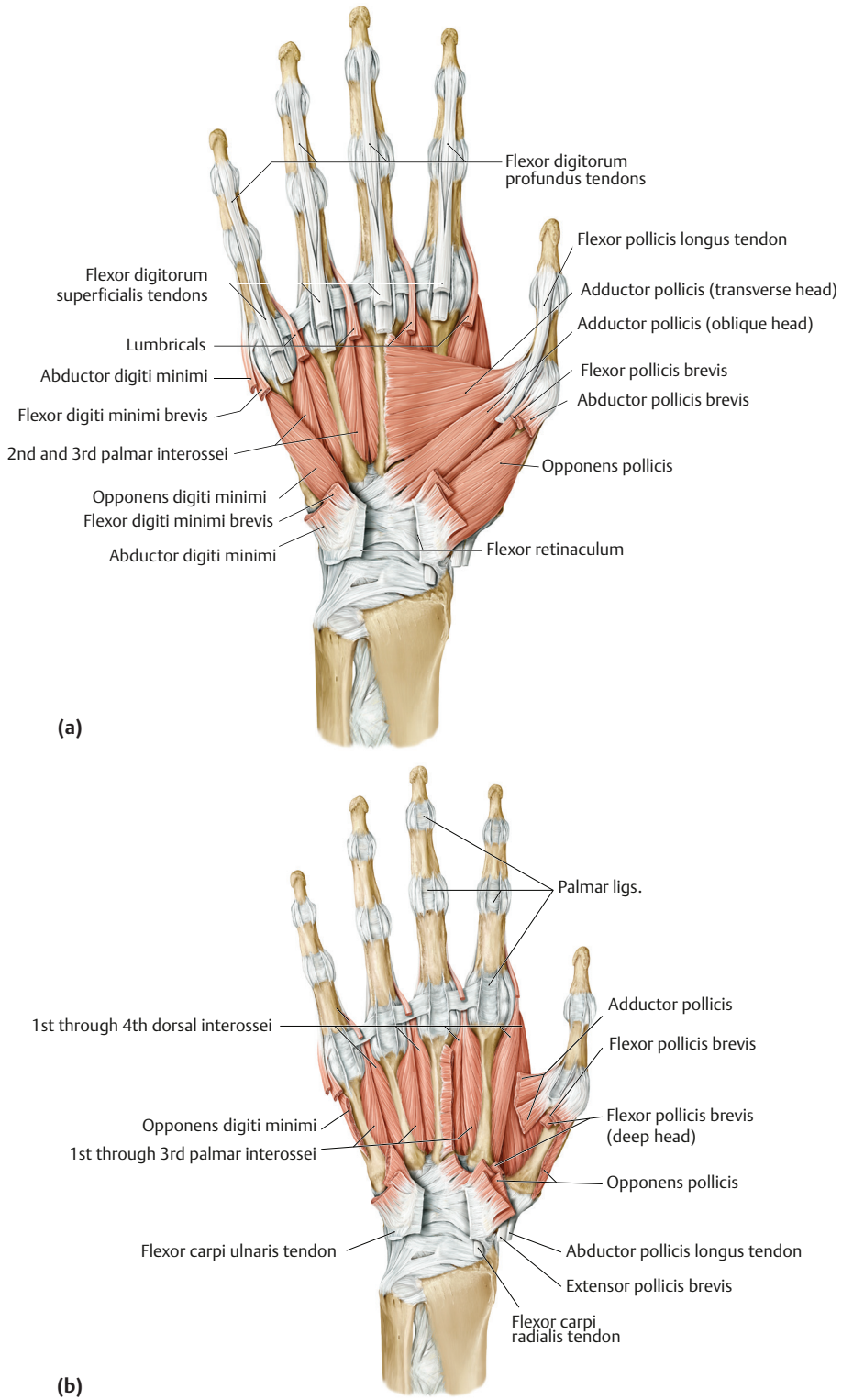


Fig. 7.16 Deep dissection of the palm. **(a)** Middle layer of muscles in the hand. **(b)** Heads of adductor pollicis removed to show deeper structures clearly. (From: Schuenke M, Schulte E, Schumacher U. THIEME Atlas of Anatomy. General Anatomy and Musculoskeletal System. Illustrations by Voll M and Wesker K. © Thieme 2020.)

Fascial Spaces in the Hand

The fascia in this region (along with the septae) is so displayed that it encloses the spaces. These are surgically important. The spaces may be infected and with the accumulation of pus these may warrant surgical intervention. According to their placement, they can be grouped as follows:

1. *Palmar spaces*: (a) Midpalmar space, (b) thenar space, (c) adductor space, and (d) pulp spaces of the fingers.
2. *Dorsal spaces*: (a) Subcutaneous space and (b) subaponeurotic space.
3. *Parona space* (in the forearm).

Midpalmar Space

Under the palmar aponeurosis on the medial side of the palm is the midpalmar space. Proximally, it extends up to the flexor retinaculum and communicates with the Parona space in the lower part of the forearm. Distally, it continues into the lumbrical canals (housing the second, third, and fourth lumbrical muscles).

Boundaries:

1. Anterior: Palmar aponeurosis.
2. Posterior: Interossei muscles and third to fifth metacarpals.
3. Medial: Medial palmar septum.
4. Lateral: Intermediate palmar septum.

Contents:

1. Superficial palmar arch.
2. Digital vessels and nerves for the third to fifth fingers.
3. Flexor digitorum superficialis and profundus tendons to the third to fifth fingers.
4. Lumbricals (second, third, and fourth).

The midpalmar space may be infected because of tenosynovitis of the middle or ring finger or as a sequel to infection of the web spreading through the lumbrical canal. The palmar concavity is lost and the swelling spreads even to the dorsum of the hand.

Treatment: The midpalmar space can be drained by an incision in the third or fourth web.

Thenar Space

It is roughly triangular and located at the outer part of the palmar hollow. Proximally, it extends up to the distal borders of the flexor retinaculum and communicates with the forearm space. Distally, it communicates with the subcutaneous space of the first web through the lumbrical canal.

Boundaries:

1. Anterior: Palmar aponeurosis.
2. Posterior: Fascia covering the transverse head of the adductor pollicis and the first dorsal interosseous muscle.
3. Medial: Intermediate palmar septum.
4. Lateral: Lateral palmar septum.

Contents:

1. Long flexor tendons (flexor digitorum superficialis and flexor digitorum profundus) to the index finger.
2. The first lumbrical muscle.
3. The digital vessels and nerve to the thumb as well as the radial side of the index finger.

Clinical Anatomy

The thenar space may be infected due to the spread of infection from the thumb or the index finger. It is characterized by a marked swelling in the first web. The thenar spaces can be drained by an incision in the first web.

Pulp Space

It is situated at the tip of the fingers and thumb. At the tips of the fingers and thumb, the subcutaneous fat is disposed in a compartment formed by the fibrous septae stretching from the skin to the periosteum of the terminal phalanx. The infection involving the pulp space is called *whitlow*. It leads to a throbbing pain owing to the unyielding nature of the fibrous tissue in this region. If not treated promptly by incision and drainage, it may lead to the necrosis of the terminal phalanx due to the occlusion of vessels. However, the basal part of the phalanx is retained because the artery supplying this portion is not occluded, due to the attachment of the flexor digitorum profundus tendon.

Synovial Sheaths in the Hand

The tendons destined to this region are surrounded by the synovial sheaths to a variable extent and infections involving these need surgical intervention, hence warrant attention. They are described in the following paragraphs.

Ulnar bursa: It surrounds the tendons of the flexor digitorum superficialis and profundus. It extends upwards for ~2 inches in the lower part of the forearm deep to the flexor retinaculum. Its lower extent is up to the middle of the metacarpals. At the lower end, it is continuous with the digital synovial sheath of the little finger. Usually, the infection of the ulnar bursa is secondary to the infection involving the little finger. This may spread upwards to the space of Parona in the lower part of the forearm and give rise to an hourglass swelling, that is, the swelling in the forearm and palm with the constriction in the middle caused by the flexor retinaculum. The bursa (infection) can be drained by an incision along the lateral margin of the hypothenar eminence.

Radial bursa: It surrounds the tendon of the flexor pollicis longus. It also extends into the lower part of the forearm, like the ulnar bursa. Distally, it extends up to the distal phalanx of the thumb. The infection of the thumb may spread to the radial bursa and then to the ulnar bursa because they communicate with each other behind the flexor retinaculum in some individuals. The radial bursa can be drained by an incision along the medial side of the thenar eminence. During this, one has to be careful because the branch of the median nerve to the thenar muscles is close to this site.

Digital synovial sheaths: They enclose long flexor tendons to the fingers. Note that the digital sheath of the little finger is continuous with the ulnar bursa. The digital sheaths of the index, middle, and ring fingers are, however, separate. They proximally end at the heads of the metacarpals. The digital synovial sheaths are drained by two transverse incisions, one at the crease of the distal interphalangeal joint and the other at the distal palmar crease, thus opening the digital sheath at both ends.

Parona space: This space is in the lower part of the forearm and clinically it is relevant to discuss it with the hand. It lies deep to the flexor tendons in front of the pronator quadratus. Proximally, it extends up to the origin of the flexor digitorum superficialis muscle. Distally, it extends till the upper border of the flexor retinaculum.

■ Clinical Note

The *Parona space* is a potential space in the distal forearm, deep to the long flexor tendons. It may be infected by the spread of an infection involving the ulnar bursa leading to an hourglass swelling with constriction caused by the flexor retinaculum. The space can be drained by an incision along the medial and lateral borders of the lower part of the forearm.

