

## THE HAND

### Nomenclature:

- consider that the hand has no lateral or medial side
- palmar or volar = front
- dorsal = back
- hand has a radial side and an ulnar side
  
- The fingers are named:
- 1st digit = thumb
- 2<sup>nd</sup> digit = index
- 3<sup>rd</sup> digit = middle (long)
- 4<sup>th</sup> digit = ring
- 5<sup>th</sup> digit = little (small)

### I. Muscles of the Palmar Surface:

- A. Each digit (except the thumb) has three flexible joints
  1. distal joints flexed by flexor digitorum profundi (there are 4 of them)
  2. middle (proximal interphalangeal joints (Abb: PIP) flexed primarily by flexor digitorum superficialis (there are 4 of them)
  3. metacarpal-phalangeal joint (Abb: MP joint) flexed primarily by small intrinsic (arise within the hand) flexors of the hand (there are 3 sets)

Clinical Correlation (CC): If you have a lesion of the palm, you can tell which muscles have been damaged by testing their actions:

1. Profundi are mass flexors of the distal phalanx – they act as a unit (very few people have independent flexion of distal phalanx – and then it is usually only the index finger).
2. Superficialis muscle acts independently at middle joint.

### I. Innervation:

- A. On the volar side, the muscles are innervated either by the median nerve or by the ulnar nerve.
  1. 1st rule of anatomy – skin overlying the muscles, is innervated by the nerve that innervates the underlying muscles.
  2. Ulnar nerve innervates 2 profundi (those of the ring and little finger) and the flexor carpi ulnaris (which functions to bend the wrist over to the ulnar side).
  3. All of the long flexors that come from the forearm to the hand are innervated by the median nerve, or a branch of the median nerve- these include:

- a. 2 profundi to middle and index finger
- b. 4 superficialis muscles
- c. flexor pollicis longus (innervated by anterior interosseous n. , a branch of the median nerve)
- d. flexor carpi radialis (wrist flexor on radial side)
- e. palmaris longus (15 to 18% do not have this muscle and some people have it only on one side)
- f. pronator teres
- g. pronator quadratus (innervated by the anterior interosseous [C8], a branch of median nerve)

N.B.: f and g above pronate the hand at the wrist – pronation is a median nerve function.

Clinical Correlation: The palmaris longus muscle is important clinically because it's tendon is used by surgeons to replace other tendons in surgery of the hand.

III. Down in the hand itself, there are many structures packed in a small amount of space.

A. 9 tendons

- 1. 4 superficialis
- 2. 4 profundi
- 3. flexor pollicis longus

B. Median Nerve:

- 1. can be found beneath the palmaris longus
- 2. absolutely the most important nerve of the hand
  - a. it moves the thumb
  - b. most importantly it supplies sensation
    - 1. without the median nerve, the hand would be “blind.”
    - 2. would be able to rotate or pronate the thumb – sometimes can be compensated for by cross-innervation from the ulnar nerve.

Clinical Correlation: There is a serious problem in patients with leprosy. They experience anesthesia of fingertips, even if very little is left in terms of motor function, you can maintain a certain degree of hand function, if the median nerve is spared.

C. Carpel Canal (Carpal tunnel)

- 1. 8 carpal bones form a concavity for tendons to pass through
- 2. transverse carpal ligament (flexor retinaculum) across the top – sheath of fibrous tissue

Clinical Correlation: Swelling due to arthritis, inflammation, or injury can lead to compression within carpal tunnel. If median nerve is compressed, within tunnel, pain and numbness results. Often it is necessary to do a surgical release to relieve compression. If the condition is neglected, permanent numbness and loss of motor function to the point of compression.

#### IV. Intrinsic Muscles of the Hand:

A. defined as muscles that arise and end in the hand.

1. they are short
2. they are important – provide fine mobility of fingers, allow manipulation
3. there are 20 intrinsic muscles of the hand.
  - 5 are innervated by the median nerve or branches
  - 15 are innervated by the ulnar nerve “ “

a. Intrinsic Muscles Innervated by the Median Nerve

- (1) abductor pollicis brevis – left thumb off the palm
- (2) opponens pollicis – draws the thumb toward the palm as it is being rotated
- (3) flexor pollicis brevis has two heads
  - superficial head – innervated by median nerve
  - deep head – innervated by deep branch of ulnar nerve (C8 & T1)
    - a. flexes the proximal phalanx of thumb, and continues to act, flexes the metacarpal bone and rotates it medially. In the latter movement it cooperates with opponens pollicis muscle.

N.B. These three muscles (abductor pollicis brevis, opponens pollicis and flexor pollicis brevis) are the key muscles involved in the rotation of the thumb across the palm. The movement takes place at both the metacarpophalangeal and carpometacarpophalangeal joints.

(4 & 5 lumbricals)

- a. radial side act as flexor of MP joint and extend IP joint
- b. All other intrinsic muscles of the hand are innervated by the ulnar nerve, These include:
  1. flexor pollicis brevis – deep head flexes the proximal phalanx of thumb, flexes metacarpal bone, rotates it medially.
  2. adductor pollicis – very strong – brings thumb against palm, used when adducted thumb is also flexed as in gripping.

Clinical Correlation: (adductor pollicis can adduct the thumb, but can not pronate the thumb. A patient with a lesion of the median nerve will be able to draw the thumb across

the palm (adduction), but will not be able to position the plane of the thumbnail parallel to the palm of the hand (pronation).

3. abductor digiti minimi abducts little finger away from 4<sup>th</sup>, thus it takes part in habitual spreading the digits when they are extended.
4. flexor digiti minimi brevis, flexes the little finger at the metacarpophalangeal joint.
5. opponens digiti minimi draws 5<sup>th</sup> metacarpal bone forward and rotates it laterally at metacarpophalangeal joint.
6. lumbricals of the 4<sup>th</sup> and 5<sup>th</sup> digits (Note lumbrical muscles link one tendon (flexor) to another (extensor)).

N.B. When the middle, ring or little finger is flexed fully at the MP joint and the proximal interphalangeal joint (PIP), its distal phalanx can neither be flexed or extended by voluntary effort so long as the other fingers are kept extended. The inability to extend the distal phalanx is due to the way extensor digitorum are inserted. The terminal phalanx can be extended only when the middle phalanx is also extended.

7. interossei (7) – 2 groups
  - a. volar (palmar): The first palmar interosseous flexes and adducts the proximal phalanx of the thumb.
  - b. dorsal: abduct the fingers (spreading the fingers apart) relative to a central axis through the middle finger. The interossei in conjunction with the lumbricals, flex the proximal phalanges; as a consequence of their insertion into dorsal digital expansions, they are able in certain conditions, - extend the middle and distal phalanges.
8. palmaris brevis – not important – has no function other than to wrinkle up palmar skin.

N.B. When one loses the function of a muscle, there may not be a way of controlling the unopposed force – this can be the result in a variety of deformities.

#### V. DORSAL ASPECT OF THE HAND

- A Everything on the dorsal aspect is innervated by the radial nerve (or a branch... posterior interosseous or deep radial nerve (both are the same))
1. abductor pollicis longus radial wrist deviator as well as an abductor of thumb. Acting with abductor pollicis brevis, abducts thumb with extensor pollicis. It extends the thumb at carpometacarpal joint.
  2. extensor pollicis brevis extends the proximal phalanx of the thumb in continued action, helps to extend metacarpal bone.

N.B.: In the lower part of the forearm, the abductor pollicis longus and extensor pollicis brevis become superficial by emerging between extensor carpi radialis brevis and

extensor digitorum. Muscle also forms boundary of anatomical snuff box with abductor pollicis longus.

3. extensor pollicis longus forms ulnar boundary of “snuff box” Extends the distal phalanx of the thumb, and acting in association with extensor pollicis brevis and abductor pollicis longus, it extends the proximal phalanx and the metacarpal. In continued action, owing to the obliquity of the course of its tendon, extensor pollicis longus, adducts the extended thumb and rotates thumb laterally.
4. four communis (extensor digitorum) tendons
5. extensor indicis proprius independent extensor of index finger
6. extensor digiti minimi-independent extensor of little finger

Clinical Correlation: A patient with a lesion of the extensor indicis proprius will not be able to extend the index finger, while keeping the others flexed. Similarly, the extensor digiti minimi can be tested in this manner.

A. Wrist Movements:

1. flexor carpi radialis longus (median nerves C6 and C7)
2. flexor carpi ulnaris (ulnar nerves C7 and C8)

N.B. Wrist Movement: With flexor carpi radialis and flexor digitorum superficialis.. The flexor carpi ulnaris flexes the wrist; with extensor carpi ulnaris it adducts the hand. Both flexor and extensor carpi ulnaris act as synergists to prevent abduction of the hand when the thumb is extended at the carpometacarpal joint.

Flexor carpi ulnaris also flexes the pisiform bone during abduction and flexion of the little finger.

When the wrist is flexed against resistance, notice that two tendons are prominent; flexor carpi radialis (laterally) and the palmaris longus in the mid line. Flexor carpi ulnaris (medially) can also be identified proximal to the pisiform bone.

B. Across the dorsum of the hand – radial to ulnar (review)

1. abductor pollicis longus: To base of 1st metacarpal, abducts thumb and extends it at the carpometacarpal joint; innervated by the posterior interosseous nerve (C7, C8) a branch of radial nerve
2. extensor pollicis brevis: To base of proximal phalanx of thumb. Extends thumb at MP and carpometacarpal joint. Nerve supply, posterior interosseous (C7, C8).
3. extensor pollicis longus: to base of distal phalanx of thumb. Extends thumb at IP, MP, CMP joints. Nerve supply posterior interosseous C7, C8, a branch of radial nerve.

4. extensor carpi radialis longus: To base of index (2<sup>nd</sup>) metacarpal slightly to the radial side. Extends and abducts hand – tends to radially deviate the wrist (but only slightly when extending). (radial nerve C6 and C7)
5. extensor carpi radialis brevis: To base of 3<sup>rd</sup> metacarpal: extends and abducts the hand. When extending wrist, it brings wrist up in a central position. Nerve supply deep branch of radial (posterior interosseous) . Deep branch of radial – a branch of radial nerve .
6. extensor digitorum (communis) (4) To extensor expansions of the index, middle, ring, and little fingers (muscle divides into four tendons, which pass with extensor indicis proprius through a separate tunnel under extensor retinaculum. Tendons diverge to 4 fingers. The tendon to the index is accompanied by extensor indicis.]  
Nerve supply is the posterior interosseous nerve (C7 and C8).  
Extends the index, middle, ring and little fingers at their MP and IP joints and extends the hand.
7. extensor indicis proprius: To ulnar side of communis tendon (extensor expansion) of index finger. Extends index finger at MP and IP joints. Nerve supply, posterior interosseous (C7, C8)
8. extensor digiti minimi: To extension expansion (communis tendon) of little finger. Extends little force at MP and IP joints (nerve supply - posterior interosseous of radial nerve, C7, C8)
9. extensor carpi ulnaris: To base of 5<sup>th</sup> metacarpal. Extends and adducts the hand. Nerve supply posterior interosseous nerve (C7 and C8).
10. supinator located proximally in forearm

Clinical Correlation: The wrist is the key joint of the hand and its position will affect the functions of the muscles of the hand. For instance, extending the wrist can assist weak flexors of the fingers. This is used in reconstructing a badly damaged hand. When the wrist is extended, you independently extend the 3<sup>rd</sup> and 4<sup>th</sup> digits, because you can use your intrinsic muscles to help. The intrinsic muscles are the actual extensors of the two distal joints. Through a complicated arrangement, they are able to transfer their amount of action to extend the distal two joints. By extending the wrist, one allows the intrinsic muscles to come into play and help to independently extend the fingers.

Extensor carpi radialis longus and brevis act synergically with the flexors of the fingers, for example, when the fist is clenched. Working with the extensor carpi ulnaris, they extend the wrist; working with flexor carpi radialis, they abduct the hand.

VI. The Extensor Hood (see Hollinshead, pp 294-296)

- A. 1. Common extensors go out onto the proximal phalanx
2. At the proximal phalanx, there is an extensor hood
  - a. goes down and around MP joints
  - b. tethers common extensor to act as an extensor of the proximal phalanx
  - c. tendon blends into a fibrous sheath that runs out to the distal phalanx contributed by:
    1. tendon from interossei
    2. tendon from lumbrical (on radial side only)
    3. there is a ligament between these two tendons called the intrametacarpal ligament

-this whole structure terminates on the dorsal aspect of the distal phalanx

- d. secondary insertion at the base of the middle phalanx – aids in complete extension when the wrist is extended
- e. the axis of flexion is below the line of pull of the interossei and lumbricals tendons – consequently, - they act to extend the distal two joints.
- f. Ligament underneath hood that attaches to flexor tendon sheath – ligament of landsmeer (hard to see except in fresh specimen) – located just below the axis of flexion – function to resist hyperextension.

Clinical Correlation: Minor injuries to this hood arrangement can cause havoc with finger in terms of flexion and extension. Two examples:

1. Patient bangs dorsal aspect of the PIP joint. Swelling results – “tough” patient keeps working it – phalangeal head batters hood, eventually pushes up through hood – finger goes into a flexed deformity at the middle joint.

Dynamic tendon band of hood (common extension tendon + tendons from the lumbricals and interossei) is now below the axis of the joint (has dropped to the side) middle joint is hyperflexed, distal joint is hyperextended – very difficult to fix (if possible at all) – called the Boutinere Deformity.

2. Dynamic tendon band of hood rides up (usually associated with arthritis) – base of proximal phalanx moves down toward palm – get hyperextension at middle joint, hyperflexion of the distal joint – called swan neck deformity (telescoping of the finger) – not hard to repair as boutinere deformity.

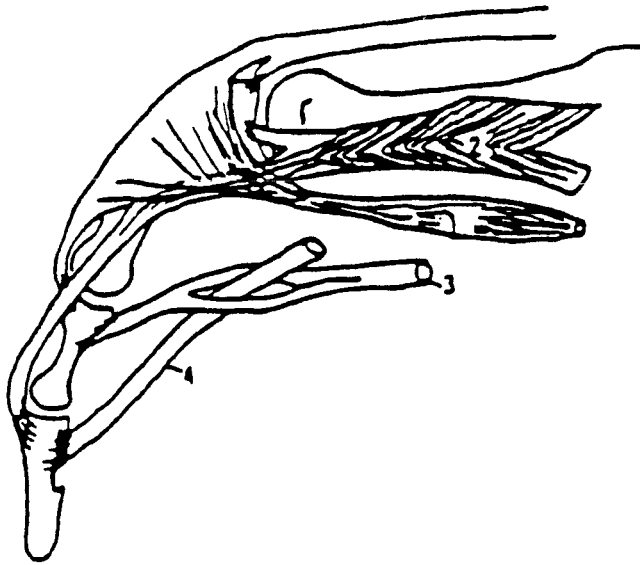
## VII. Flexor tendon sheath

- A. A tunnel of fibrous tissue on the volar aspect of the hand
- B.
  - 1. superficialis splits in two
  - 2. profundus runs between the two halves of the superficialis tendon
  - 3. the superficialis inserts on the sides of the volar aspect of the middle phalanx
- C. profundus inserts on the distal phalanx

Clinical Correlation: This is a tight space. Any injury (infection, cut, etc) can lead to significant scarring which will freeze the tendons in the canal. This used to be called “no man land” because doctors were reluctant to operate in this area during the time of acute injury for fear that there would be such scarring. With the advent of better instruments and techniques, doctors now can perform surgery in this area, but not without risk. The sheath runs from the middle of the proximal phalanx to the distal palmar crease (last crease in the hand). The tendons are very tightly applied to one another in this tunnel which holds these against the phalanges for efficiency of flexion.



## DETAILS OF EXTENSOR EXPANSION



- extensor digitorum communis tendon  
proximal attachment: capsule of  
M/P joint middle band: base of 2nd  
phalanx lateral bands: base of distal phalanx
1. lumbrical muscle
  2. interosseus muscle
  3. flexor superficialis tendon
  4. flexor profundus tendon

The extensor expansion or hood is fused to the capsule of the metacarpal phalangeal joints. Because of this, pull on the extensor tendons only extends this joint. The lumbricals and interossei muscles because they attach into the hood distal to the M/P joint pull on the distal part of the expansion and extend the interphalangeal joints. The palmar and dorsal interossei acting together check each others adduction and abduction. The contribution and precise action of the lumbricals is controversial.

## REVIEW QUESTIONS

1. What is a surface marking for the superficial palmar arterial arch? Of what artery is it a terminal branch? What is a surface marking for the deep arch? Of what artery is it a branch?
2. Trace the course of both the median and ulnar nerve in the hand.
3. What are the 4 different joints flexed by the flexor digitorum profundus?
4. What would be the sensory and motor loss of cutting the median nerve at the wrist? What single movement of the thumb would be lost? What remaining intact muscles would the patient use to perform the other 4 movements?
5. What movement would a patient not be able to perform if the ulnar nerve were cut at the wrist? Do you understand why?
6. With a deep puncture wound of the fifth digit on its palmar surface, how does infection spread to the thumb?

## REVIEW QUESTIONS

1. What parts of the clavicle and scapula can be palpated in the living subject?
2. What muscles act in forceable adduction of the arm? What muscles act in passive adduction of the arm (watch it)?
3. Where do you think the brachial plexus is most vulnerable?
4. If the upper trunk of the brachial plexus were damaged, what muscles would be affected? Which one least?
5. If the lower root of the brachial plexus were damaged, which major "long distance" nerve would be most affected? Which one least?
6. What nerve accompanies the thoraco-dorsal artery? Through what space does the posterior circumflex artery pass? What nerve accompanies it?
7. What functional loss will occur after damage to the axillary nerve? Do you think this nerve is vulnerable to injury?
8. How can blood bypass the first two stages of the axillary artery?
9. What is the purpose of a bursa? Which one in the shoulder is commonly inflamed? Why?
10. Which of the rotator cuff muscles is most susceptible to damage? How does the patient compensate for its loss?
11. What structures give support and protection to the shoulder joint?
12. Review all the muscles which aid in the movement of the shoulder.
13. What parts of the ulna can be easily palpated? Of the radius?
14. What is the relationship of the styloid process of the radius with that of the ulna? How does this limit wrist movements?
15. Where can you palpate the radial artery?
16. What would be the effects of a dislocated lunate bone?
17. What is the relationship of the median nerve to the biceps tendon?
18. Between what two muscles does the ulnar nerve traverse the forearm?
19. Against what muscles does the median nerve traverse the forearm?
20. In injection of the cubital vein, what structures might be accidentally damaged? What structure usually prevents this from happening?