FRONT OF FOREARM & PALM OF HAND:

- 2 groups of muscles & tendons:
    - Front of forearm → palmar surface of wrist → palm of hand.
        - Pronate forarm
        - Flex wrist and fingers
    - Back of forearm → back of wrist → dorsum of hand
        - Supinators of forearms
        - Extensors of wrist and fingers

- Both compartments have a **superficial** and a **deep** layer:

- *Superficial stratum muscles:* arise from **humerus epicondyle**
    - Front of forearm: medial epicondyle
    - Back of foreaem: lateral epicondyle

- *Deep stratum muscles:* arise from **forearm bones** and **interosseous membrane**

- **NOTE** the pronator / supinator muscles always arise from a stable bone: ulna or humerus (not radius)

FRONT OF THE FOREARM AND PALM

SUPERFICIAL STRATUM:

- **5 muscles**
- All arise completely / in part from the **medial epicondyle – 'the common flexor origin'**
- **Pronators of arm**
- **Flexors of wrist, fingers & thumb**

Brachioradialis*:*

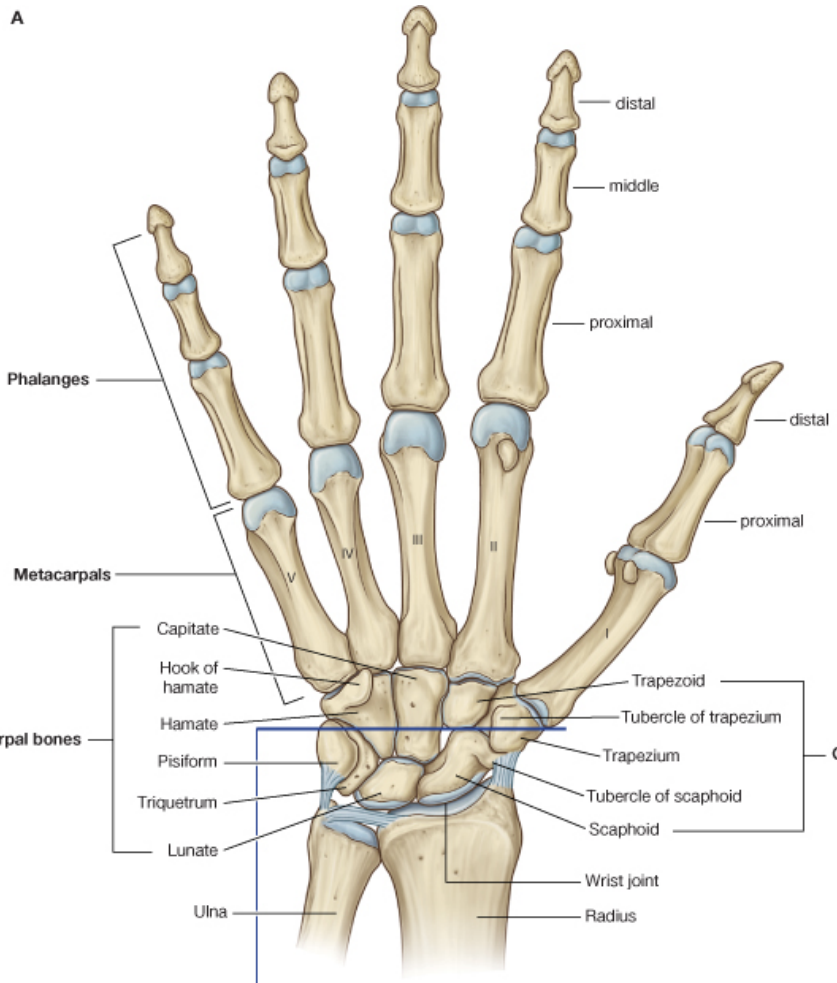
- Extra muscle which used to belong to the extensor muscle group, and Δ has radial nerve innervation.
- Has migrated around to front of forearm to become a flexor of elbow (doesn't reach wrist).
- Arises from lateral epicondyle of the humerus.
- Inserts into the disal radius – **radial styloid process**

Pronator teres:

- Prontates forearm
- Also a weak flexor of elbow joint
- Arises almost completely from medial epicondyle of humerus
- Small number of fibres arise from coronoid process of ulna.
- Inserts into lateral side of radius.
- Innervated by median nerve
- Forms medial border of cubital fossa.

Flexor carpi radialis

- Flexes radial side of wrist
- **Abducts** the wrist
- Supplied by the median nerve.
- Arises from medial epicondyle of humerus
- Body of muscle gives rise to tendon in lower forearm; tendon passes over front of wrist to insert into index metacarpal.
- Tendon is held in place on index metacarpal by fibrous band – **flexor retinaculum**.
- Flexor retinaculum is attached to carpal bones on either side – converting concavity of the carpus into **osseofascial tunnel**.
- Flexor retinaculum also maintains concavity or carpal arch.
- Flexor carpi radialis tendon travels through tunnel on groove in trapezium to reach index metacarpal.
- Deep fibres of the retinaculum create a private tunnel for the tendon in this groove.



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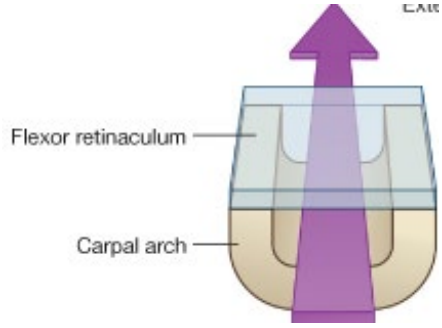
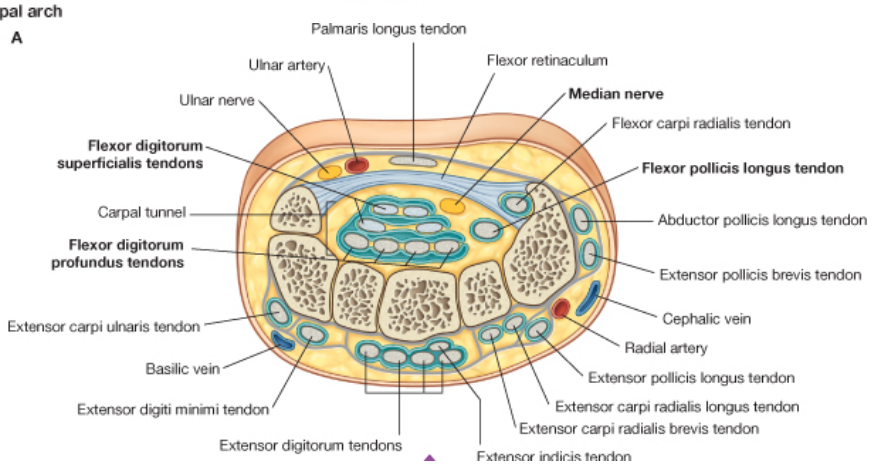




FDS + FDP share common synovial sheath under flexor retinaculum

Nature of tendons travelling through osseofascial tunnels:

- Tendon is surrounded by 2 layers of synovial membrane, which are continuous (as in synovial joint).
- Reduces friction.
- Inner membrane is closely applied to tendon.
- Outer membrane applied to tunnel wall.
- Layers are continuous proximally and distally – space created between them contains film of lubricating synovial fluid.

Palmaris longus:

- Delicate muscle, absent in 15% population
- Weak flexor of wrist
- Arises from medial epicondyle of humerus
- Inserts into dense fasica of palm of hand (palmar aponeurosis)
- Travels over *surface* of the flexor retinaculum – I.e. doesn't pass through the osseofascial tunnel. Δ no synovial sheath.
- Supplied by median nerve

Flexor carpi ulnaris:

- Flexes the wrist
- **Adducts** the wrist
- Weak flexor of elbow joint
- Supplied by the **ulnar nerve**
- Arises from:
    - Medial epicondyle
    - Olecranon
    - Posterior border of ulna
- Becomes tendinous
- At level of triquetrum the tendon contains a sesamoid bone – the **pisiform**
- **Pisiform is joined to the triquetrum by synovial joint.**
- Tendon finally inserts into hook of the hamate and metacarpal V by means of 2 ligaments:
    - **Pisohamate ligament**
    - **Pisometacarpal ligament**
- Doesn't pass through osseofascial tunnel - Δ no synovial membrane to tendon.
- Pisiform can be enucleated without distrubting function of ulnaris tendon.

Flexor digitorum superficialis:

- Lies slightly deeper than the above 4 muscles
- Flexion of the 4 fingers
- Has origin in all of; humerus, ulna, radius:
    - Humeroulnar head:
        - medial epicondyle of humerus
        - coronoid process of ulna
    - Radial head:

    - Anterior border of radius
- Firbrous arch spans between these 2 origins.
- Muscle becomes tendon in lower forearm – splits into 4 tendons which run to the 4 fingers.
- Pass *through* the osseofascial tunnel Δ have synovial sheath
- Grouped as 2 pairs as they pass through the tunnel:
    - Tendons to ring and middle finger: superficial
    - Tendons to index and little finge: deeper
- On reaching the palm they flatten out into a single row
- The tendons split into 2 and inserts into the **middle** phalanges.

- Synovial sheath of little finger tendon continues into little finger
- Common synovial sheath of the other 3 tendons ends at distal end of tunnel.
- There is variation in sheath arrangement, and sheath are clinically important as sites of infection after perforating wounds.

- As the tendons pass over palmar surface of fingers, held in place by **fibrous flexor sheaths.**
- Fibrous sheath is attached to the margins of the phalanges, and fuses with the distal phalange.
- Fibrous flexor sheath froms an osseofascial tunnel along each digit, through which the tendon passes.
- Δ each tendon is once more surrounded by SM sheath.
- In the case of the little finger, this sheath is continuous with the sheath surrounding the tendons in the osseofascial tunnel of the wrist.
- Synovial infection can occur if there is penetrating injury to the sunvial membranes in the fingers. This infection can spread more widely if the damage is to the little finger.

Blood supply to the 4 tendons of the flexor digitorum superificialis:
- V. important to have good blood supply
- If severe infaction stops blood supply → tendons will slough and rupture.

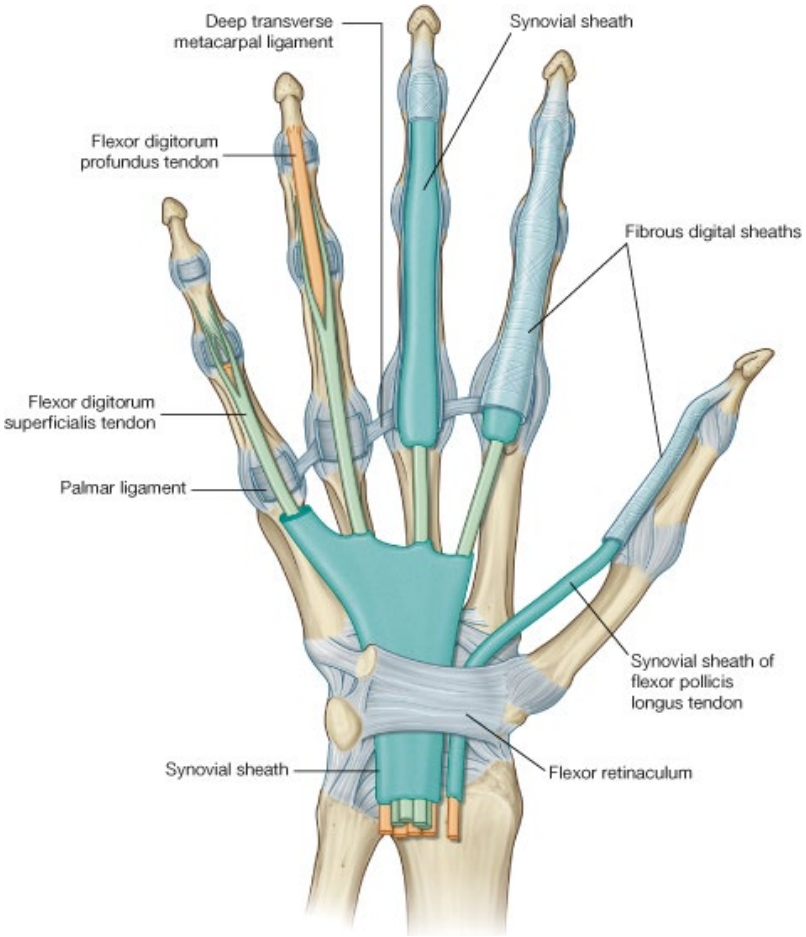
In wrist osseofascial tunnel:
- Tendons invaginate the synovial sheath – blood vessels can easily access the tendons.

In finger osseofascial tunnels:
- Synovial sheaths completely surround the tendons – blood vessels must peirce the sheaths.
- These blood vessels are surrounded by a little fibrous tissue.
- Blood vessels + fibrous tissue = **vincula**
- Short vincula (at tendon insertion) = **vincula brevia**
- Longer vincula = **vincula longa**.

Nerve supply to flexor digitorum superficialis:
- **Median nerve**

Action of the flexor digitorum superficialis:

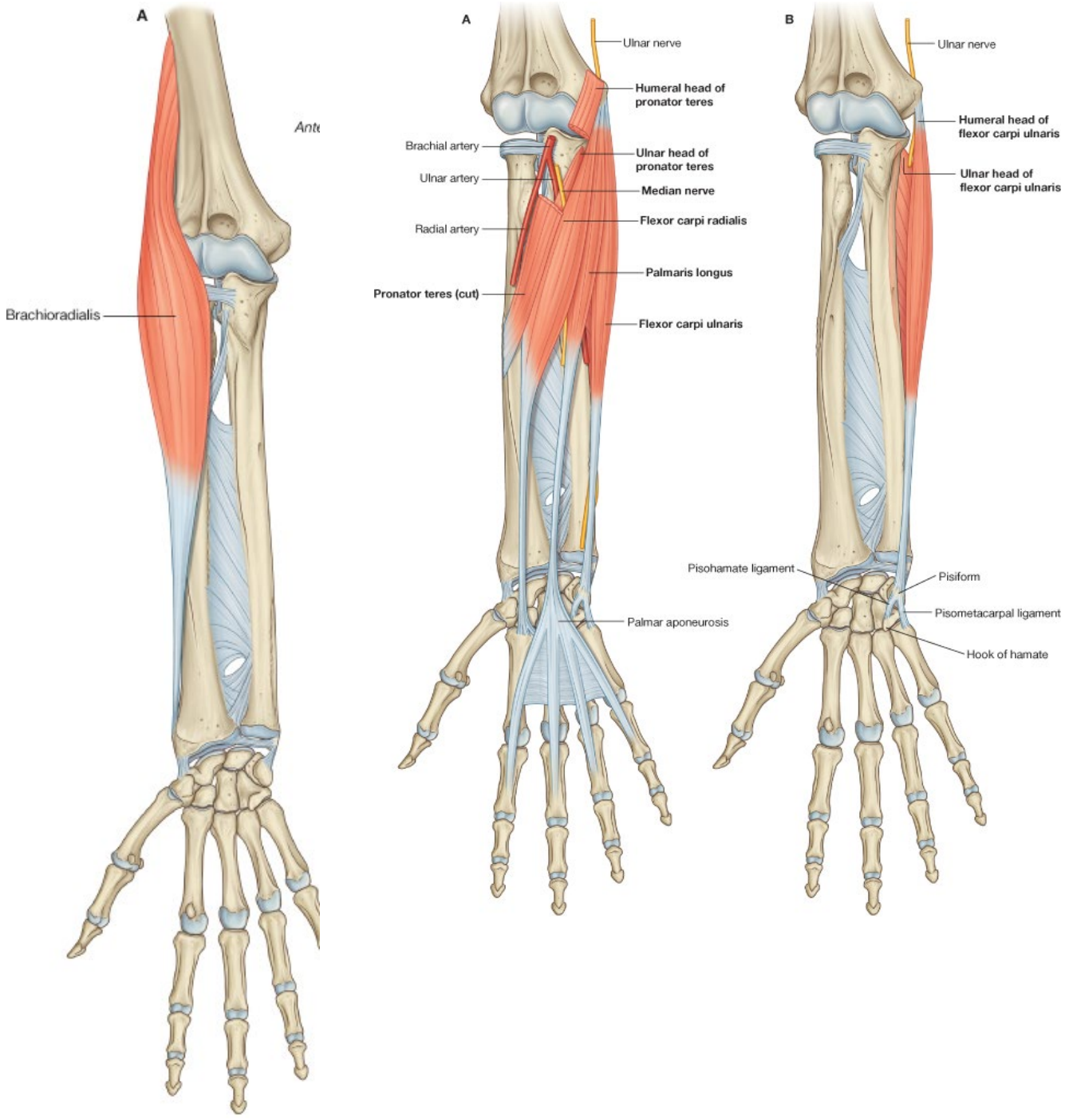
- **<u>Flexor</u>** of:
    - **Metacarpophalangeal joint**
    - **PIPJ**

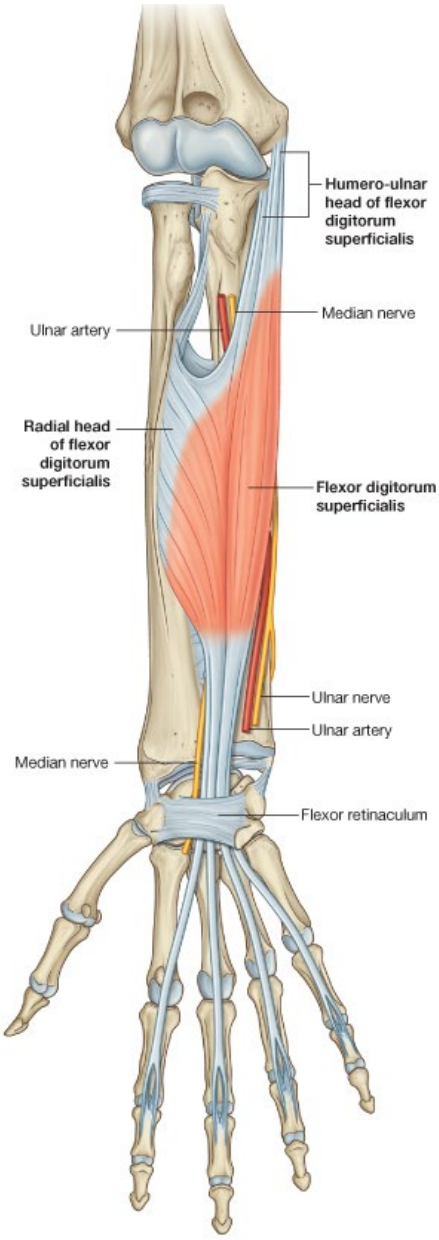


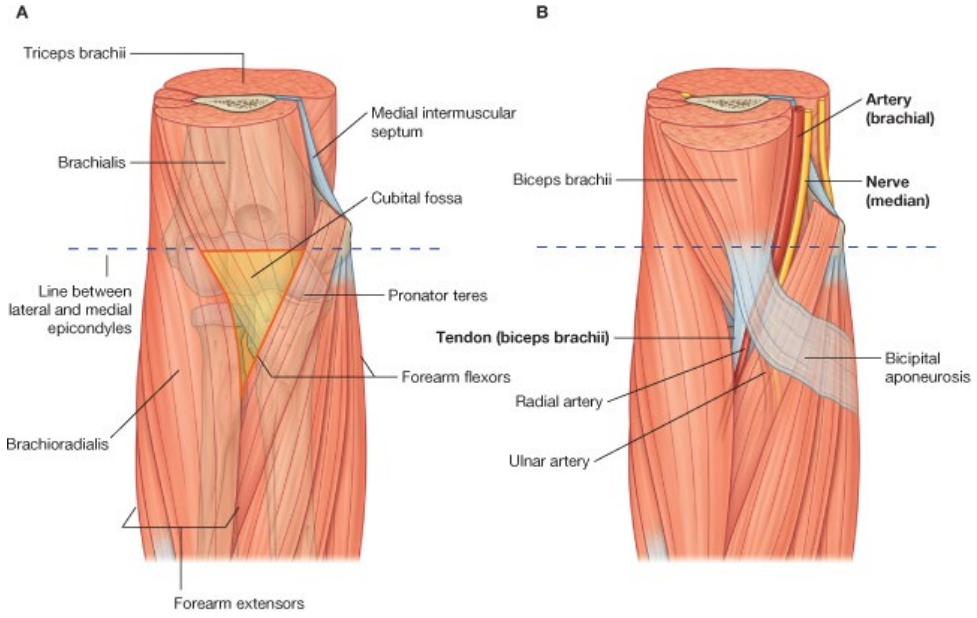
Synovial membrane of little finger is continuous with the membrane surrounding the tendons under the flexor retinaculum

CUBITAL FOSSA:

- <u>Brachioradialis and pronator teres converge on one another</u>.
- Intermuscular space between brachioradialis and pronator teres, in front of the elbow, is called the cubital fossa.
- Triangle, bounded by:
    - Brachioradialis
    - Pronator teres
    - Line drawn between humerus epicondyles.


A
Brachioradialis
A
Ulnar nerve
Humeral head of pronator teres
Brachial artery
Ulnar head of pronator teres
Ulnar artery
Median nerve
Radial artery
Flexor carpi radialis
Palmaris longus
Pronator teres (cut)
Flexor carpi ulnaris
Palmar aponeurosis
B
Ulnar nerve
Humeral head of flexor carpi ulnaris
Ulnar head of flexor carpi ulnaris
Pisohamate ligament
Pisiform
Pisometacarpal ligament
Hook of hamate


Humero-ulnar head of flexor digitorum superficialis
Median nerve
Ulnar artery
Radial head of flexor digitorum superficialis
Flexor digitorum superficialis
Ulnar nerve
Ulnar artery
Median nerve
Flexor retinaculum


A
Triceps brachii
Medial intermuscular septum
Brachialis
Cubital fossa
Line between lateral and medial epicondyles
Pronator teres
Forearm flexors
Brachioradialis
Forearm extensors
B
Artery (brachial)
Biceps brachii
Nerve (median)
Tendon (biceps brachii)
Bicipital aponeurosis
Radial artery
Ulnar artery

DEEP STRATUM:

- **3** muscles
- Muscles of the superficial stratum – *except* flexor carpi ulnaris – are supplied by the median nerve.
- All the muscles of the deep stratum are supplied by a branch of the median nerve – **anterior interosseous nerve** (FDP gets a contribution from ulnar nerve)
- Ulnar side if flexor digitorum profundus, also recieves supply from the ulna nerve.

Pronator quadratus:

- Action: pronates the forearm
- Origin: lower ¼ of ulna
- Insertion: passes obliquely to radius
- Innervation: anterior interosseous nerve

Flexor policus longus:

- Action: flex all joints of thumb
- Origin: front of the radius and interosseous membrane
- Insertion: becomes a tendon above the wrist which passes through osseofascial tunnel of the wrist, passes along the thumb and inserts into the terminal phalanx of the thumb.
- Tendon held against thumb by fibrous flexor sheath, and surrounded by synovial membrane.
- Innervation: anterior interosseous nerve.

Flexor digitorum profundus:

- Origin: Anterior & medial surface of ulna, and interosseous membrane.

- Gives rise to **4 tendons** which pass through the osseofascial tunnel in wrist.
- **Share a common synovial sheath with the tendons of flexor digitorum superficialis**.
- Tendons of the flexor digitorum profundus lie deep to those of the superficialis.
- Enter the fibrous flexor sheaths of the fingers deep to the superficialis tendons.
- Slip through the split superficialis tendon to insert into the **terminal phalanges of the digits**.

- Action: flexion of IP and MCP joints
- Innervation:
    - anterior interosseous nerve
    - Ulnar nerve (medial fibres)

Infection of synovial membrane & sheaths:

- Penetrating injury → infection of synovial membranes: **tenosynovitis**
- Infection → accumilation of pus → ↑pressure → occluded blood supply → tendons slough and rupture.

Summary:

- **Flexors of the fingers & thumb:**
    - **Flexor digitorum superficialis**
    - **Flexor digitorum profundus**
    - **Flexor pollicis longus**

- **Pronators of the forearm:**
  - **Pronator teres**
  - **Pronator quadratus**
- **Flexors of the wrist:**
  - **Flexor carpi radialis (+ abductor)**
  - **Flexor carpi ulnaris (+ adductor)**
  - **Palmaris longus**

SHORT MUSCLES OF FINGERS AND THUMB

- Long muscles: arise in forearm (described above)
  - Flexor digitorum superficialis
  - Flexor digitorum profundus
  - Flexor pollicis longus
- Short muscles: arise in hand itself.

Movements of hand:

- Interphalangeal joints (IP): flexion & extension
- Metacarpalphalangeal joints (MCP): flexion, extension, abduction, adduction
- Abduction & adduction are relative to **midline of the hand** – defined as passing through the middle finger.
- Power grip:
  - Thumb & thenar eminence on one side
  - Fingers and palm on other side of object.

SHORT MUSCLES:

- Arise in palm
- **Interosseous muscles**: deeply place between metacarpals
- **Lumbrical muscles**: connect flexor + extensor tendons
- **Thenar muscles**: fleshy mass on palmar surface of thumb metacarpal
- **Hypothenar muscles**: fleshy mass on palmar surface of little finger metacarpal

Interosseous muscles:

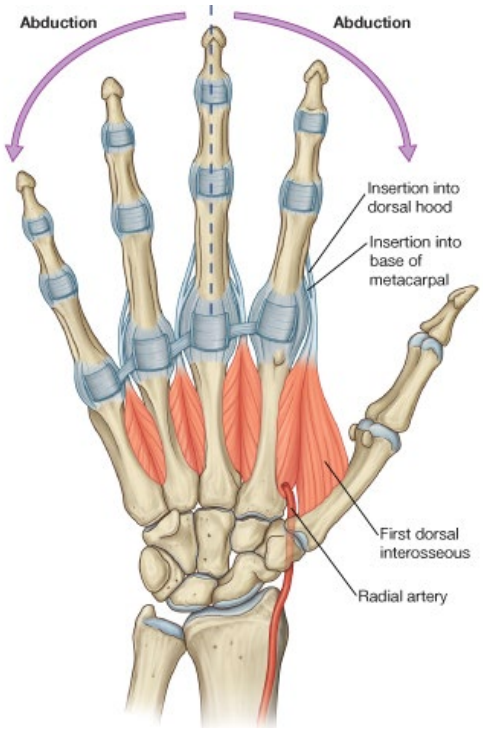
- Arise from metacarpal bones
- Two sets:
  - **4** dorsal muscles
  - **4** palmar muscles
- **Both supplied by ulnar nerve**

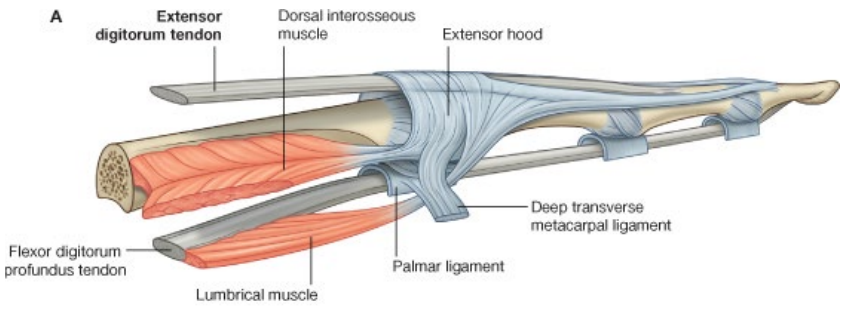
Dorsal interossei:

- Arise between adjacent metacarpals
- Give way to tendons which pass deep to ligaments uniting metacarpal heads of index, middle and ring fingers.
- Tendons then pass onto **dorsum** of middle 3 fingers and insert into the **extensor tendon** of the finger.

- *Action of dorsal interossei:*
  Act on the **middle 3 fingers**:

- **DAB$_3$**: Dorsal ABduct middle 3 fingers (abduct the MCP joints)
- **Flex a straight finger**:
  - Flex MCP joint
  - Extend IP joint

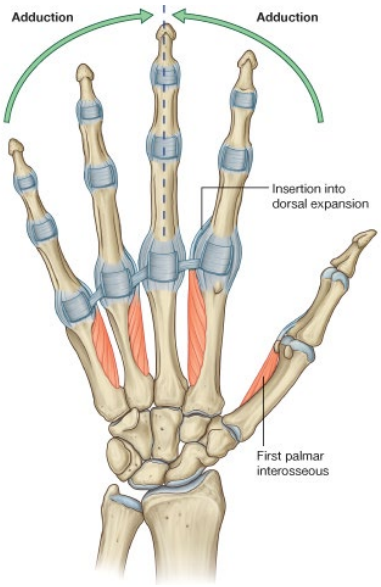




Palmar interossei:

- Arise from palmar aspect of metacarpals
- NOTE the middle finger metacarpal does not have palmar interossei (it doesn't need an adductor)
- As with the dorsal interossei, they pass deep to the metacarpal ligaments and insert into the extensor tendons on the dorsum of the thumb, index, ring and little fingers.
- The 1st palmar interoseous (on thumb) is small.

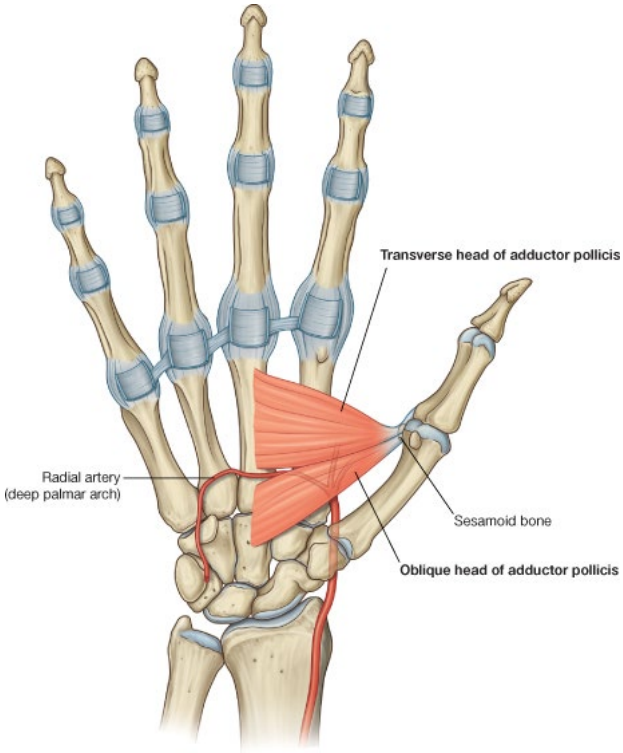
- *Action of palmar interossei:*
  Act on fingers and thumb *except* the middle finger:
  - **PAD: Palmar ADduct** the finger and thumb towards the midline
  - **Flex a straight finger**



Adductor pollicis:

- The 1st palmar interosseous is weak, and cannot successfully adduct the thumb on its own
- Δ adductor pollicis is situated in the palm to assist in adduction of the thumb.
- **Powerful adductor of thumb at MCP joint**
- A bit like a large palmar interosseous
- Arises from 2 heads, **oblique and transverse heads**:
  - Palmar surfaces of metacarpals II & III + capitate
- Heads unite and insert into:
  - Medial side of base of proximal phalanx of thumb

- The adductor pollicis is **superficial** to the first dorsal and palmar interosseous muscles.
- **Adductor pollicis is supplied by the ulnar nerve**.



Thenar muscles:

- Grouped on palmar surface of first metacarpal (thumb) – giving the **thenal eminence**
- Composed of 3 muscles:
  - **Abductor pollicis brevis**
  - **Flexor pollicis brevis**
  - **Opponens pollicis**
- All supplied by the **median nerve**.
- All 3 muscles blend into the same origin:
  - **Lateral aspect of flexor retinaculum**
  - **Scaphoid**
  - **Trapezium**

- **Flexor and abductor pollicis brevis:**
  - Insert into **lateral** aspect of proximal phalanx of thumb
  - Flex and abduct thumb at MCP joint

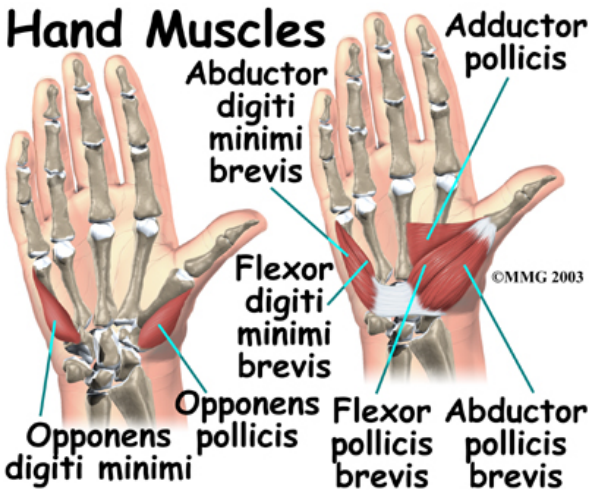
- **Opponens pollicis:**
  - Lies on deeps plane and inserts into **lateral aspect of** shaft of 1st (thumb) metacarpal
  - Rotates thumb to give **opposition**
  - Rotates the 1st metacarpal on the trapezium

Hypothenar muscles:

- 3 muscles on the palmar surface of the little finger:
  - **Abductor digiti minimi**
  - **Flexor digiti minimi**
  - **Opponens digiti minimi**
- All supplied by the **ulnar nerve**
- All 3 muscles arise from a common origin of:
  - **Pisiform**
  - **Hook of hamate**
  - **Medial end of flexor retinaculum**

- **Flexor and abductor digiti minimi:**
  - Insert into base of proximal phalanx of little finger
  - Flexion and abduction of little finger at MCP joint

- **Opponens digiti minimi:**
  - Inserts into outer aspect of shaft of the 5th metacarpal
  - Rotates shaft of 5th metacarpal, deepening the cup of the palm.



- **Palmaris brevis** is an additional small muscle which overlies the hypothenar muscles.
- Arises from flexor retinaculum
- Inserts into skin above ulnar border of palm
- Puckers the skin to deepen cup of palm
- Supplied by **ulnar nerve**

MOVEMENTS OF THE HAND:

- Functional division of the hand when holding an object is not the midline, but:
  - Thenar eminence and thumb on one side
  - Fingers, palm and hypothenar eminence on the other side.
- Thus for functional movements the terms abduction and adduction of the fingers becomes useless.
- Instead, movements of the MCP joints should be described in terms of:
  - **Radial deviation**
  - **Ulnar deviation**

1) In going to grip something (e.g. walking with hand out to shake someones hand):
   - Fingers are swung together towards ulnar side of limb, at MCP joint – **the fingers are ulnar deviated at the MCP joint:**
     - Interosseous muscles
     - Abductor digiti minimi
   - Thumb is swung towards radial side, at MCP joint – **the thumb is radially deviated at the MCP joint:**
     - Abductor pollicis brevis.

2) Palm is cupped:
   - Opponens pollicis and opponens digiti minimi rotate the 1st and 5th metacarpals so that the thumb is opposed and the palmar surface of thumb faces the palmar surface of the fingers.
   - Palm is cupped.

3) **'Power grip'**:
   - Long flexors (flexor digitorum superficialis & profundus) curl thumb and fingers around the object → power grip.

- The same ulnar deviation of the fingers and radial deviation of the thumb can be seen in a '**precision grip'**, when the pad of the thumb is opposed to the pad of a single finger.
- Precision grip is combination of:
  - **Abduction**
  - **Opposition**

- The fingers act together, and the thumb acts on its own.

LUMBRICAL MUSCLES:

- **4** delicate muscles
- Arise from radial side of flexor digitorum profundus tendons in the palm
- **First and second lumbricals = unipennate**
- **Second and third lumbricals = bipennate**
- Pass around to the dorsum of the corresponding finger and insert into the extensor tendon (extensor expansion) alond with the interossei tendons.
- I.e. they pass from palm to dorsum, from flexor to extenson tendons.

Action of lumbrical muscles:

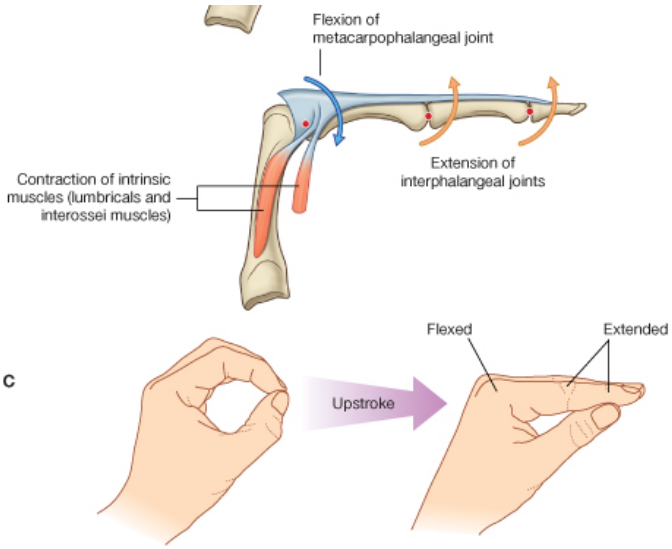
- Can **flex a straight finger** like the interosseous muscles.

- BUT *cannot* abduct / adduct the fingers like the interossei.
- Pass from flexor to extensor tendons, controlling tension in them to allow delicate movements.

- Lateral 2 lumbrical muscles are supplied by the **median nerve**

- Medial 2 lumbrical muscle are supplied by the **ulnar nerve**.

Flexion of a straight finger:



FASCIA OF THE HAND:
- Fascia invests the thenar and hypothenar eminences on either side of the hand
- Between these 2 raised eminences, there is a v. strong fascial sheet on the palm of the hand – the **palmar aponeurosis**.

Palmar aponeurosis:
- Triangular in shape
- Apex is fused with fibres of the flexor retinaculum
- Tendon of the **palmaris longus** (superficial stratum of forearm musculature) inserts into the apex of the palmar aponeurosis.
- Base of the aponeurosis divides into 4 fascial processes which insert into the fibrous sheaths which cover the flexor tendons.

- Removing the palmar aponeurosis reveals an **intermediate compartment** of the palm.
- Intermediate compartment contains:
    - Flexor tendons of the superficialis and profundus.
    - Blood vessels
    - Nerves
    - Deep, the adductor pollicis muscle covered with fascia.

- Δ 4 fascial compartments of the palm:
    - **Lateral compartment**: thenar eminence
    - **Medial compartment**: hypothenar eminence

    - **Intermediate compartment**: roofed by palmar aponeurosis
    - **Deep compartment**: containing adductor pollicis
- Infections of the palm are often limited to one of these fascial compartments.