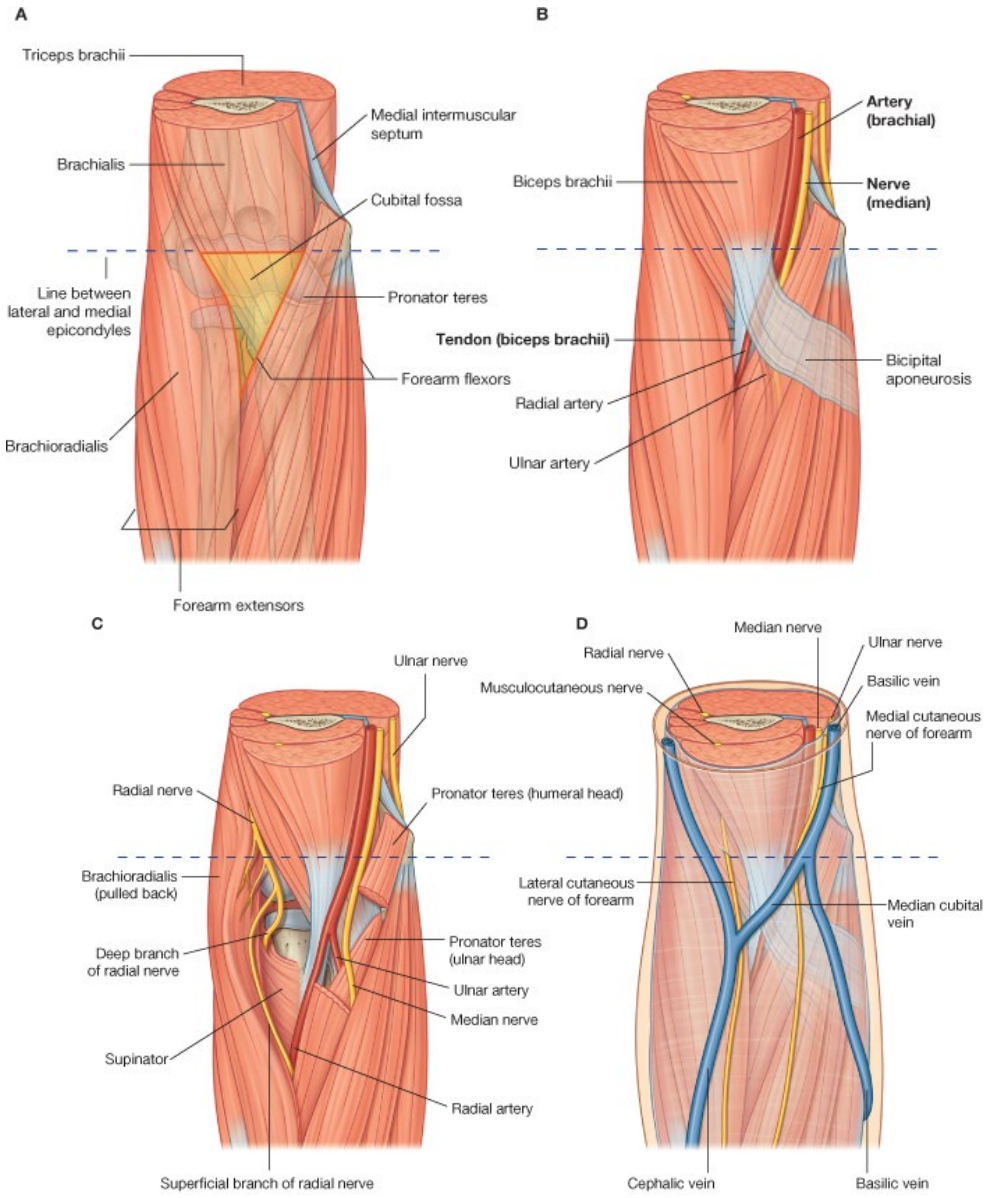
NEUROVASCULAR STRUCTURES IN THE ARM, HAND AND DIGITS

- Extensive collateral netweorks of BVs – laceration of one BV does not always impair blood supply.

CUBITAL FOSSA:

- **Brachioradialis** (lateral epicondyle) and **pronator teres** (medial epicondyle) converge on one another.
- 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.
- The floor of the cubital fossa is formed by:
    - **Head of supinator**
    - **Brachialis**
- This floor of muscles conceals the elbow joint for the most part.
- **Tendon of biceps brachii** dips into cubital fossa to insert into the radius – good landmark to palpate.
- **Bicipital aponeurosis** spreads over pronator teres, & blends with deep fascia over ulna side of forearm.



- **Brachial artery** lies **medial** to the biceps tendon in the cubital fossa
- **Median nerve** lies medial to the brachial artery

- Brachial artery splits into:
  - **Radial artery** – leaves through apex of cubital fossa
  - **Ulnar artery** – leaves with median nerve beneath pronator teres

- **Radial nerve** is apparent beneath the brachioradialis if it is strongly retracted.
- Radial nerve lies on the supinator head (anterior compartment at elbow)
- Radial nerve divides into 2 branches:
  - **Superficial branch** – leaves fossa travelling deep to brachioradialis
  - **Deep branch** – dips between 2 heads of the supinator to reach back of arm.

- **Ulna nerve** is not seen in front of elbow
- Higher up in arm it crosses from anterior compartment → posterior compartment, by passing through the medial intermuscular septum.
- Passes behind the medial epicondyle of the humerus – **can be palpated here, at medial side of elbow.**

POSITION OF NERVES THROUGH THE ARM:

MEDIAN NERVE:

Cubital fossa:
- Medial to the brachial artery
- Deep to pronator teres in the cubital fossa

Forearm:
- Travels beneath superficial muscles of **front** of forearm:
  - Pronator teres
  - Flexor carpi radialis
  - Palmaris longus
  - Flexor carpi ulnaris
- Travels **beneath sweeping bridge of flexor digitorum superficialis** (where it gives off a branch, the **anterior interosseous nerve**).
- Travels down forearm, stuck to the deep muscles by a little areolar tissue

Wrist:
- Emerges on:
  - Radial side of superficialis flexor tendons
  - Medial side of felxor carpi radialis
- **Passes with the flexor tendons through the osseofascial tunnel under flexor retinaculum** (but does not have a synovial sheath).
- Often covered by palmaris longus tendon.

Palm:

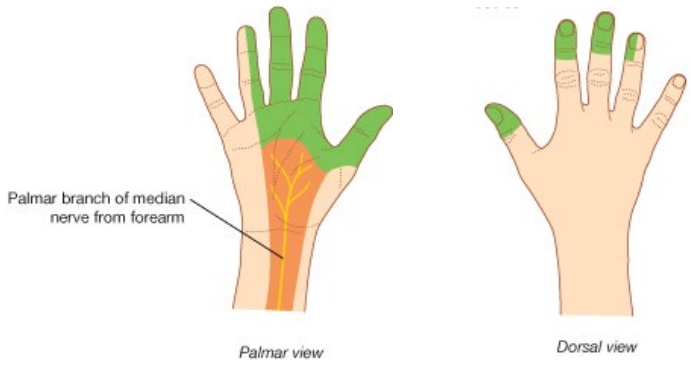
- After passing through the osseofascial tunnel the median nerve splits divides into:
    - **Lateral branch of median nerve**
    - **Medial branch of median nerve**
- <u>These 2 nerve supply sensation as far as the radial side of the ring finger</u>.

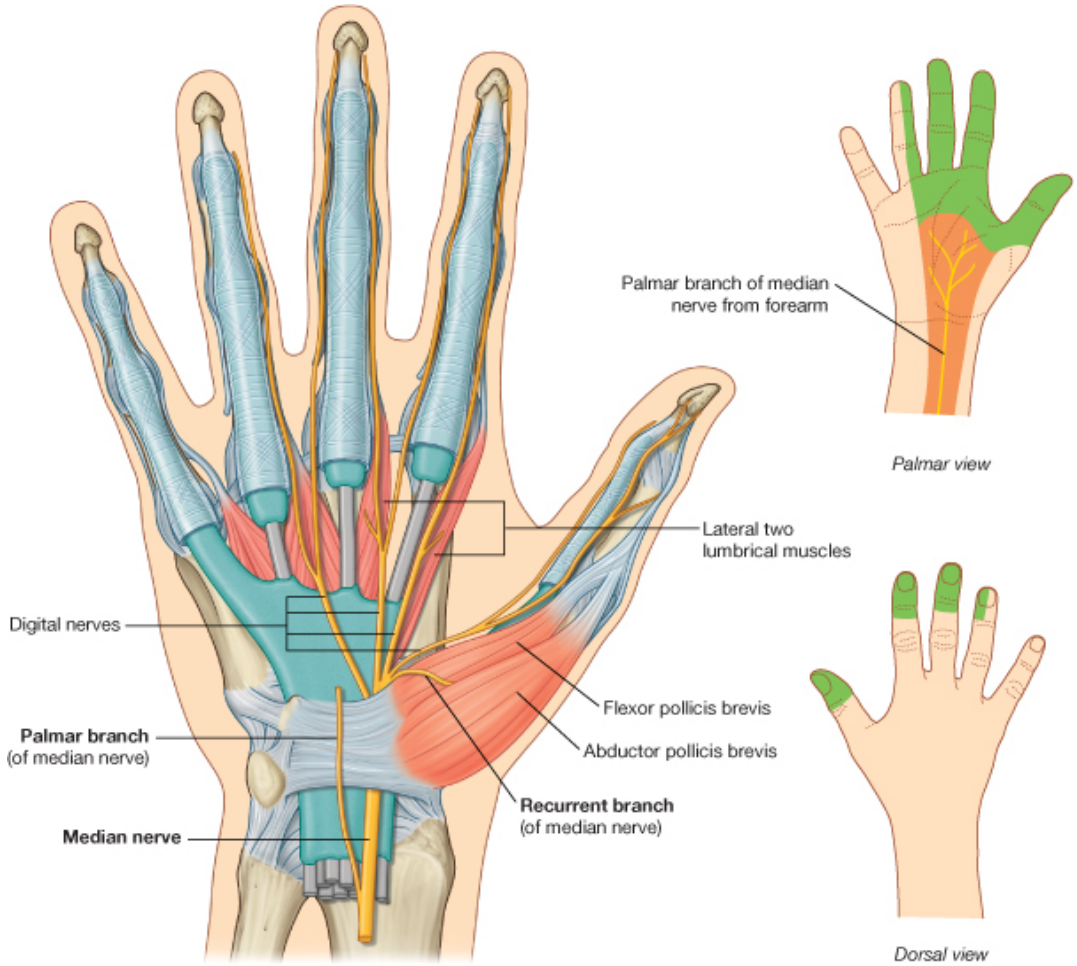
- **Lateral branch**:
    - Thenar muscles
    - 1st lumbrical muscle
    - <u>3 Digital nerves</u>: sensation from skin of:
        - Thumb
        - Radial side of index finger

- **Medial branch:**
- 2 branches which head towards the 2nd & 3rd interdigital clefts
- These branches give **digital nerves** which give sensation to:
    - Ulnar half of index finger
    - Middle finger
    - Radial half of ring finger.

- Sensation is greatest at pulp of finger & thumb.

- The **digital nerves**, as well as sensation from palmar skin of fingers/thumb, also carry sensation from **<u>nail bed</u> on dorsum of fingers and thumb**





What does it supply?

Forearm:

- Roof muscles:
  - Pronator teres
  - Flexor carpi radialis
  - Palmaris lingus
  - NOT the flexor carpi ulnaris (supplied by the ulnar nerve)
- Also supplies flexor digitorum superficialis.

- The **anterior interosseous branch**, which arises as the median nerve passes under the arch of the flexor digitorum superficialis, supplies the **deep muscles of the front of forearm**:
  - Flexor pollicis longus
  - Pronator quadratus
  - Flexor digitorum profundus

- Median nerve also gives a **small cutaneous nerve to the palm** to the palmar skin, just above the wrist.

Clinical anatomy of median nerve:

- Protected as it passes under osseofascial tunnel, and often under protection of the palmaris longus tendon.

- BUT may become compressed within osseofascial tunnel – especially in women
- Called **'carpal tunnel syndrome'.**
- Many causes:
    - Swelling of synovial sheaths of flexor tendons in rheumatoid arthritis
    - Retention of fluid in body tissues

- Laceration of the median nerve can occur if hand is, e.g. forced through glass window.

- Both carpal tunnel syndrome and laceration lead to:
    - **Loss of sensation** over thumb, index, middle finger (& radial side of ring finger)
    - **Loss of muscle action**
- Makes it difficult to pick up objects and feel their shape.
- **Nail beds are also numb.**

- Loss of nerve supply to the thenar muscles → **deformity**.
- Thenar eminence looses fullness and appears flat.
- Thumb lies flat, in same plane as rest of fingers.
- Loss of supply to the **opponens pollicis** means the thumb cannot be opposed:
    - Things cannot easily be picked up
    - Must use arkward 'trick' movement of using flexor pollicis longus.

- If the nerve is damaged just above the wrist, the **cutaneous nerve to the palm** branch of the median nerve may be damaged → numbness to radial half of the palm.

- The **lateral 2 lumbical muscles** are supplied by the median nerve, but loss of sensation to these muscles doesn't seem to cause deformity.

ULNAR NERVE:

Forearm:

- Enters forearm from behind the medial epicondyle.
- Passes between 2 heads of the flexor carpi ulnaris
- → lies on surface of deep muscles of front of forearm.
- Travels down forearm:
    - deep to the flexor carpi ulnaris
    - along medial edge of flexor digitorum superficialis

- Note that both the median and ulnar nerves are related to the flexor digitorum superficialis.

What does it supply?

Forearm:

- Flexor carpi ulnaris
- Flexor digitorum profundus

Wrist:

- Ulnar nerve becomes superficial at the radial side of the flexor carpi ulnaris tendon (where it inserts into the hamate & metacarpal V)
- Passes onto the **surface** of the flexor retinaculum (NOT through the osseofascial carpal tunnel)
- Lies on radial side of the pisiform bone as it passes over the retinaculum.

- Like the median nerve, the ulnar nerve gives rise to a **cutaneous nerve to the palm** just above the wrist.

- ALSO (unlike median nerve) gives a **dorsal cutaneous branch** well above the level of the wrist
    - Supplies sensation to ulnar side of dorsum of hands and fingers.

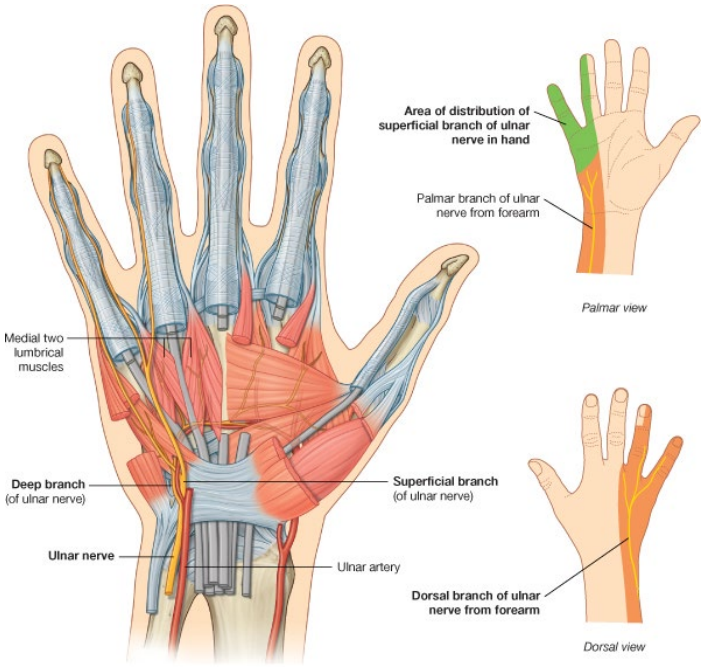
Hand:

- As ulnar nerve passes the pisiform bone, it divides into:
    - **Superficial branch of ulnar nerve**
    - **Deep branch of ulnar nerve**

- **Superficial branch:**
- Supplies only one muscle: palmaris brevis
- Sensation to:
    - Palmar side of little finger and ulnar side of ring finger
    - Nail beds of little finger and ulnar side of ring finger

- **Deep branch:**
- Skirts round hook of hamate
- Dips into palm between:
    - Flexor digiti minimi
    - Abductor digiti minimi
    - Travels over palmar surface of metacarpals, deep to long tendons

- Supplies:
    - All hypothenar muscles
    - All deep muscles of palm:
        - All Interosseous muscles
        - Adductor pollicis
        - **Medial** 2 lumbricals (lateral 2 are supplied by median nerve)



Median nerve: medial + lateral
Ulnar nerve: superficial + deep

Clinical anatomy of the ulnar nerve

- Damaged due to:
    - Lacerations of wrist
    - Damage to the elbow
- → loss of sensation and muscular function.

- Loss of sensation to:
    - Palmar and dorsal surfaces of little finger and ulnar half of ring finger + nail bed.

- The **hypothenar muscles will be paralysed & waste**
- Abductor digiti minimi muscle will not work – patient will be unable to abduct little finger.

- **Interosseous muscles** will be paralysed and waste
- → sunken appearance of interosseous spaces on back of hand.

- **First web of hand is thin** as adductor pollicis and 1st dorsal interosseous muscle are wasted.

- **Medial 2 lumbricals are paralysed**
- Balance between flexor and extensor tendons of the ring and little finger are lost → **claw hand**

- **Flexor carpi ulnaris** is also paralysed if the ulnar nerve is distrupted at elbow (actually makes the claw hand less bad)

RADIAL NERVE:

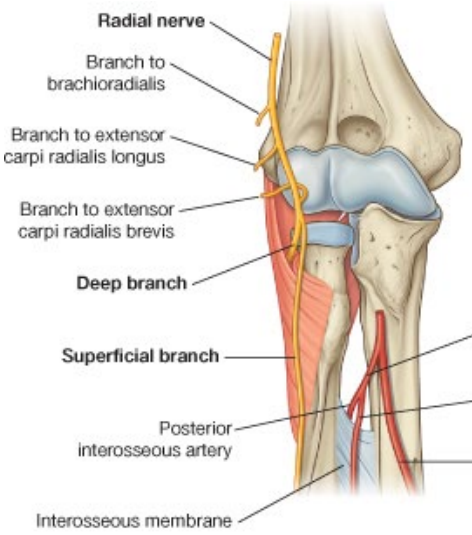
- Beneath the brachioradialis muscle in the cubital fossa.
- Lies on the supinator muscle head, which forms part of the floor of the cubital fossa.
- Divides at this point into:
    - **Superficial branch of the radial nerve**
    - **Deep branch of the radial nerve → posterior IO nerve**

- **Deep branch**:
- Passes between the two heads of the supinator muscle onto posterior aspect of arm
- On the back of the arm, it is renamed the **posterior interosseous nerve**
- Will supply ***all the extensor musculature of the forearm***.
- This includes the brachioradialis, which was originally an extensor.

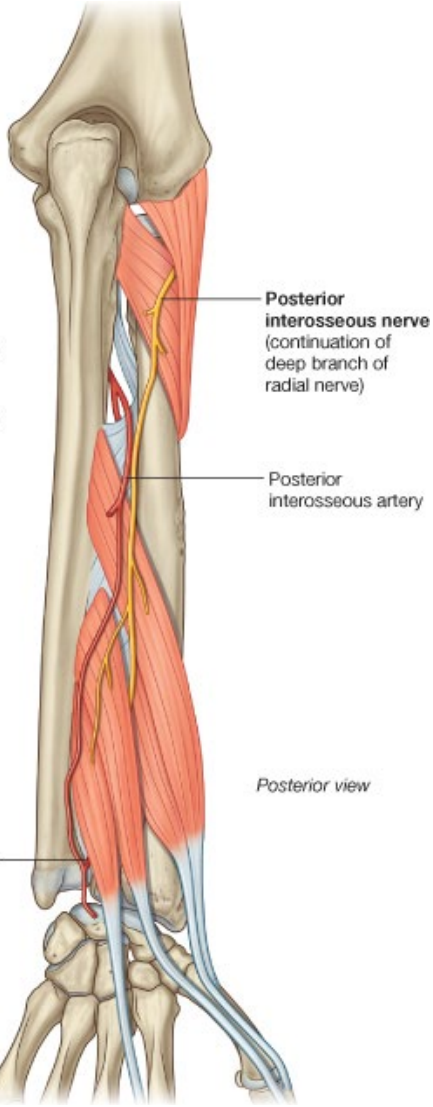
- The posterior interosseous nerve will accompany the posterior interosseous artery
- The neurovascular bundle travels down posterior forearm deep to the extensor digitorum – i.e. it travels **between the superficial and deep layers of the extensor compartment**.

- Middle of forearm, the posterior interosseous nerve dips again, so it lies on posterior aspect of the interosseous membrane.
- Meets the termination of the anterior interossous artery here.
- The posterior interosseous nerve and the anterior interosseous artery form a new neurovascular bundle here.
- New bundle passes deep to extensor digitorum through its tunnel in extensor osseofascial tunnel.

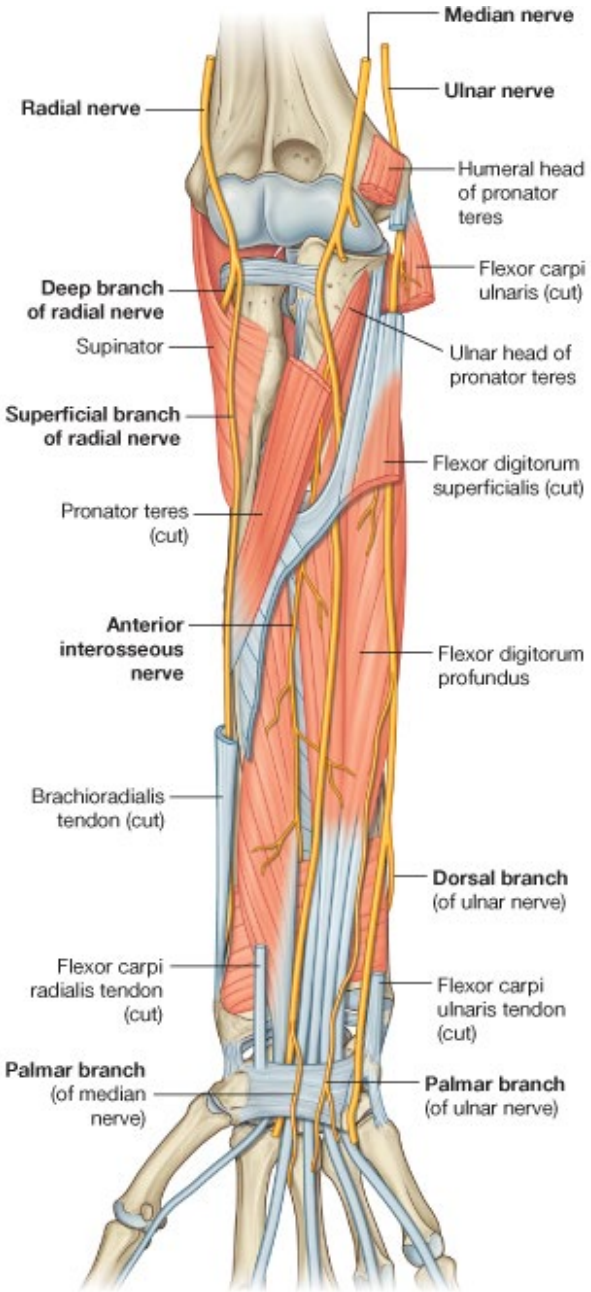
- The posterior interosseous nerve terminates in a swelling at the back of the wrist – supplies wrist joint & articular twigs.



Anterior view

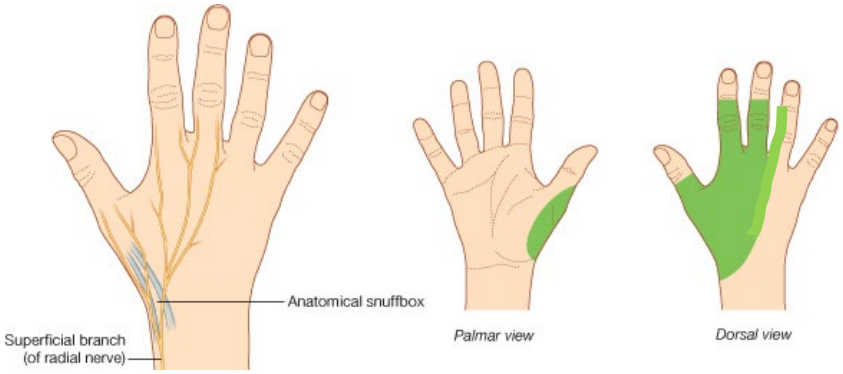


Posterior view



- **Superficial branch of radial nerve:**
- Cutaneous
- Travels down forearm with the radial artery
- Travels deep to the the brachioradialis
- At end of radius, winds around the back of the forearm → passes over anatomical snuff-box

- Supplies sensitivity to **dorsal side of hand**:
    - **Back of hand**
    - **Thumb**
    - **Index & middle fingers**
    - **Radial half of ring finger**
- Doesn't supply nail beds – supplied by the median nerve.

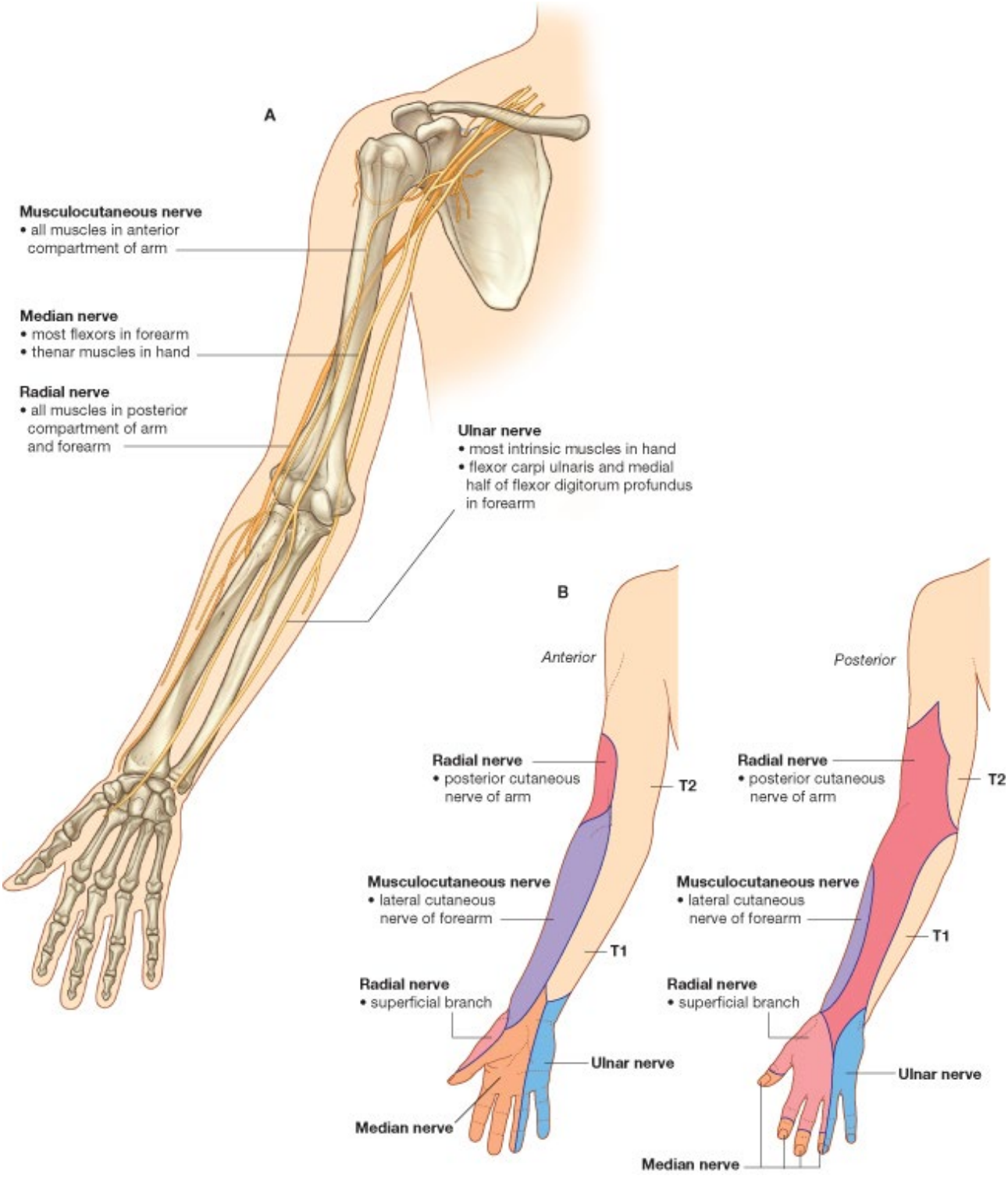


Clinical anatomy of the radial nerve:

- Radial nerve can be damaged in axilla by pressure from crutches / humerus fracture etc. (see previous notes)

- **Fractures / dislocation of radius head** can damage **posterious interosseous nerve** (supplying all extensor muscles of forearm)
- → **Wrist drop**.
- In wrist drop, the flexor muscles are too lax to flex properly.
- But extensor carpi radialis is still functional if posterior interosseous nerve is damaged, because nerve to this muscle arises from radial nerve before it divides.

- Damage to radial nerve affecting the superficial branch → **anaesthesia between thumb and 1st metacarpal.**


A
Musculocutaneous nerve
• all muscles in anterior compartment of arm
Median nerve
• most flexors in forearm
• thenar muscles in hand
Radial nerve
• all muscles in posterior compartment of arm and forearm
Ulnar nerve
• most intrinsic muscles in hand
• flexor carpi ulnaris and medial half of flexor digitorum profundus in forearm
B
Anterior
Radial nerve
• posterior cutaneous nerve of arm
T2
Musculocutaneous nerve
• lateral cutaneous nerve of forearm
T1
Radial nerve
• superficial branch
Ulnar nerve
Median nerve
Posterior
Radial nerve
• posterior cutaneous nerve of arm
T2
Musculocutaneous nerve
• lateral cutaneous nerve of forearm
T1
Radial nerve
• superficial branch
Ulnar nerve
Median nerve

POSITION OF BLOOD VESSELS THROUGH THE ARM:

- Vascular arrangement, esp in palm, is variable.
- Extensive collateral networks, means occlusion of even a large vessel may not cause impaired circulation.

- Blood supply to hand may only be completely stopped if severe swelling at elbow due to fracture of lower humerus in a child (supracondylar fracture)

RADIAL ARTERY:

ARM:

- One of the terminal branches of the brachial artery (which divides at apex of the cubital fossa)
- Radial artery leaves through the apex of the cubital fossa
- Passes along edge of anterior superficial muscles in company with the supeficial branch of the radial nerve.
- Both the superficial branch of radial nerve and the radial artery travel beneath the brachioradialis muscle (arises from lateral epicondyle and inserts into distal shaft of radius)

- Approaching the wrist, the radial artery becomes more exposed between the brachioradialis tendon and the flexor carpi radialis tendon.
- Can be felt here as the **radial pulse**.

- Supplies the forearm muscles and elbow and wrist joint.

WRIST AND HAND:

- Passes around lower end of radius and crosses anatomical snuff-box
- Reaches 1st intermetacarpal cleft
- Dips between the two heads of the 1st dorsal interosseous muscle
- Gives of two branches at this point:
    - **Radialis indicis** - to the index finger
    - **Princeps pollicis** – to the thumb

- Radial artery continues between the two heads of the adductor pollicis muscle
- Arrives in intermediate compartment of palm, deep to all the long flexor tendons of the palm.
- On the surface of the metacarpals, beneath the long tendons, the radial artery here forms the **deep palmar arch**, by anastomosing with the deep branch of the ulnar artery on the ulnar side of the palm.

- **3 palmar metacarpal arteries** arise from the deep palmar arch.
- The palmar metacarpal arteris supply blood to the:
    - Metacarpals
    - Deep muscles of the palm
    - Reinforces blood supply to the fingers.

ULNAR ARTERY:

ARM:

- Other terminal branch of the brachial artery.
- Leaves the cubital fossa passing deep to the pronator teres.
- Passes down the forearm with the median nerve, beneath the arching origin of the flexor digitorum superficialis.
- But, whilst the median nerve continues straight down the midline, the ulnar artery reers to the ulnar side of deep surface of superficialis → joins the ulnar nerve.

- Supplies blood the the forearm muscles
- Supplies blood to vascular network around elbow joint.

- Main part of ulnar artery meets ulnar nerve at ulnar side of the flexor digitorum superficialis
- Both artery and nerve then pass onto surface of flexor retinaculum and divide into superficial and deep branches.

- **Deep branch:**
- Deep branches of the both the ulnar artery and nerve curve around the hook of the hamate
- Sink between the hypothenar muscles to gain deep plane of palm
- Deep branch of the ulnar artery then anasomoses with the termination of the radial artery to form the deep palmar arch.
- **Superficial branch**:
- Continues over the flexor retinaculum
- Arches in a superficial plane over the palm to form the **superficial palmar arch**.
- Superficial palmar arch is completed by anastomosing with a small branch of radial artery.
- The superficial palmar arch is more **superficial** and more **distal** to the deep palmar arch.
- Superficial palmar arch is normally at the level of the proximal palmar crease.
- Arteries pass from the arch to the digits
    - 5^{th} digital artery is undivided; travels on ulnar side of little finger with digital nerve
    - The others arise as common digital arteries which split in interdigital cleft into 2 arteries which supply ulnar side of one digit and the radial side of the adjacent digit.
- Each digital artery accompanies the digital nerves
- Digital arteries terminate in capillary network in pulp and nail bed.

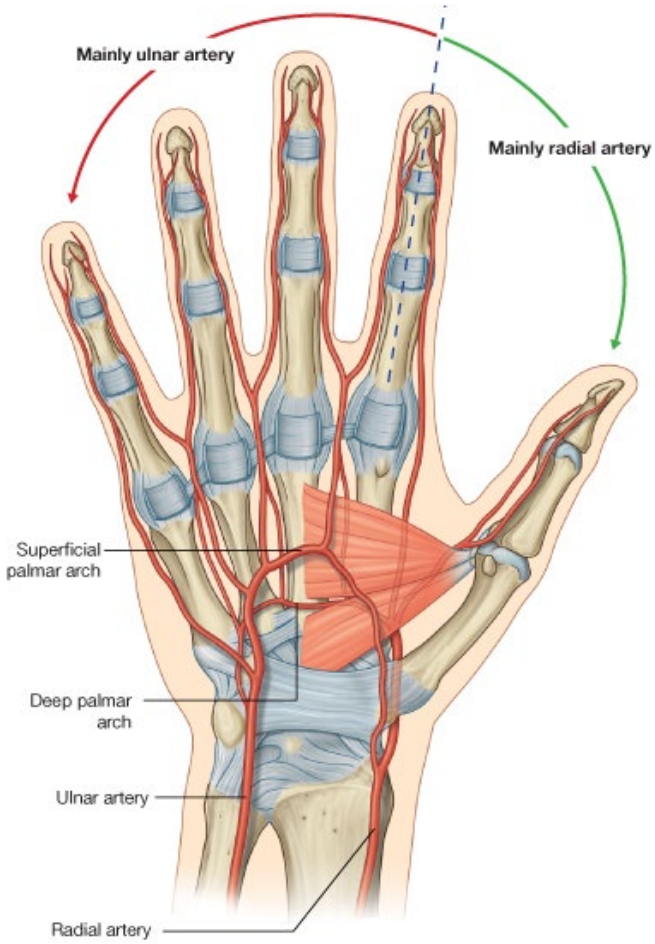
INTEROSSEOUS BRANCHES OF ULNAR ARTERY:

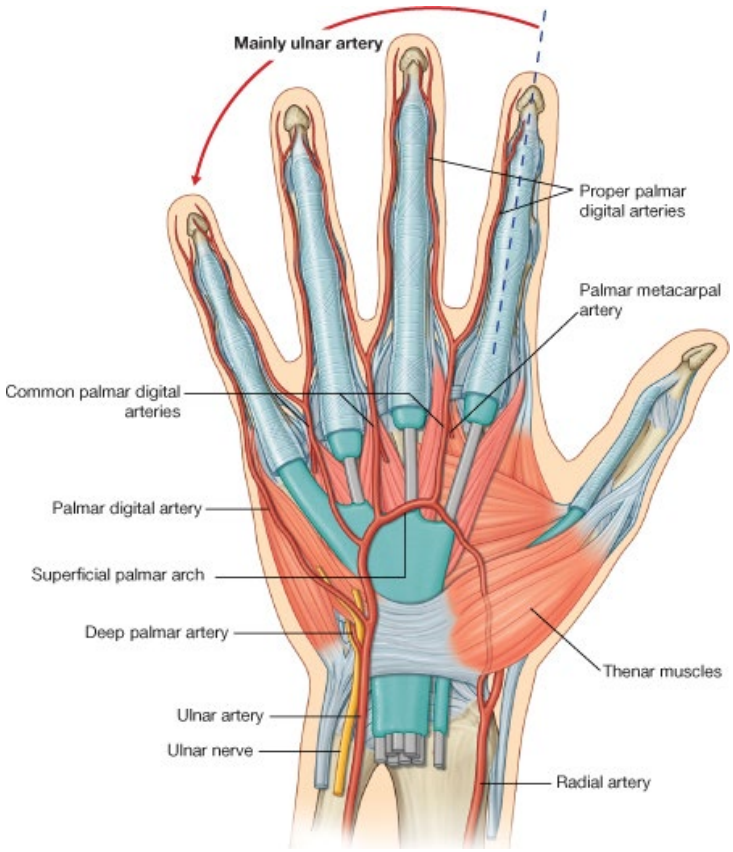
- Main branch of the ulnar artery is the **common interosseous artery.**
- At the upper part of the interosseous membrane, the common interosseous artery divides into:

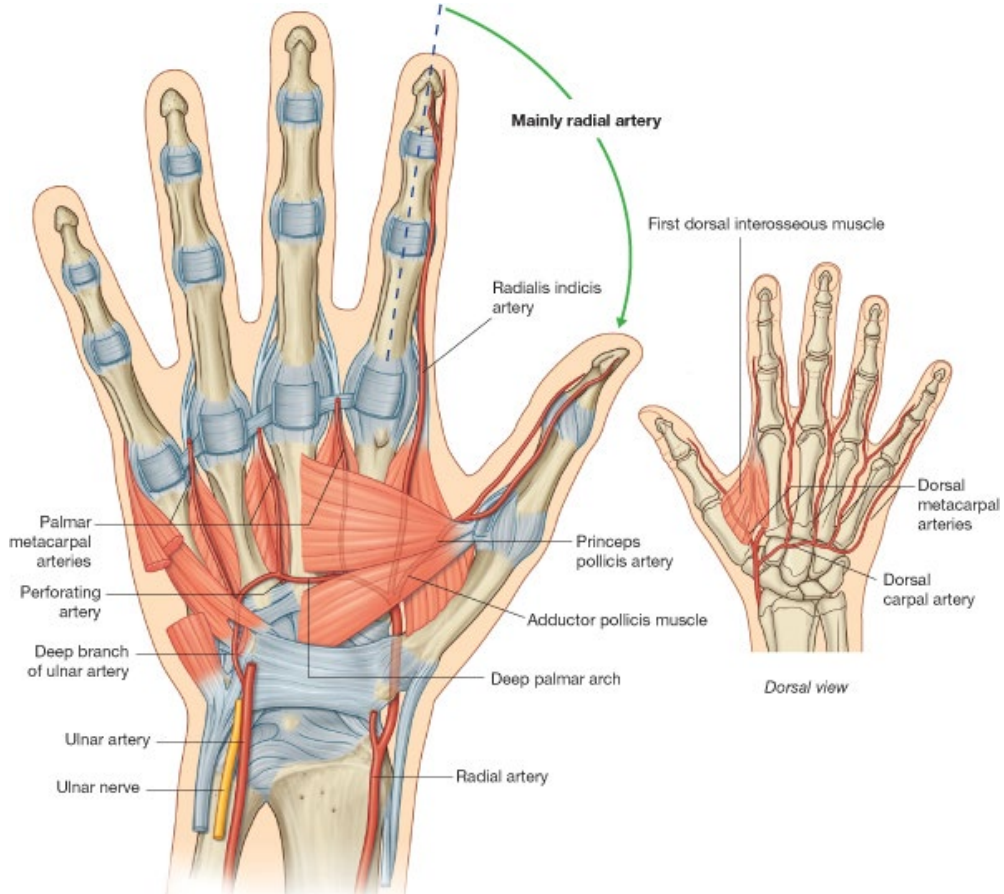
- **Posterior interosseous artery**
- Pierces interosseous membrane and supplies blood to muscles on posterior compartment of forearm.

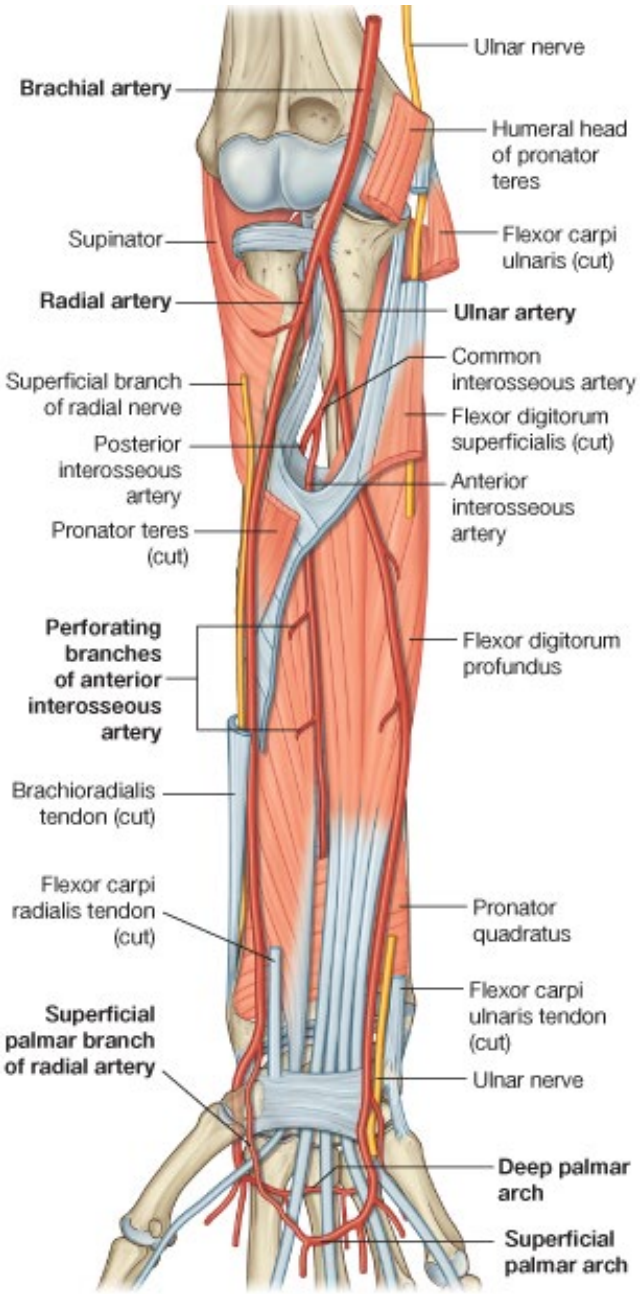
- **Anterior interosseous artery:**
- Descends with anterior interosseous branch of median nerve

- At level of <u>pronator quadratus</u> it also pierces the interosseous membrane to reach the posterior compartment of the forearm.
- Helps supply blood to <u>back of the wrist and hand.</u>









VEINS OF THE ARM:

- Each of main arteries of arm is accompanied by a vein / pair of veins.
- Superficial network of veins on the back of the hand runs either:
    - Laterally: to form **cephalic vein**
    - Medially: to form **basilic vein**

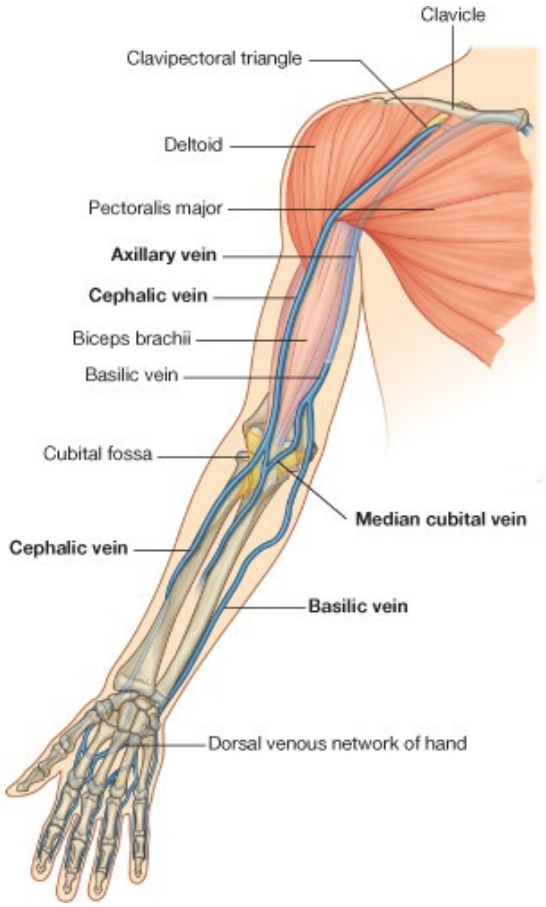
- **Cephalic vein:**
- Beginns superficially to radial styloid process.

- Travels in groove along lateral border of biceps muscle
- Pierces deep fascia and calvipectoral fascia in groove between deltoid and pec major.
- Enters **<u>axillary vein</u>**.

- **Basilic vein**:
- Runs on medial aspect of forearm
- Crosses elbow
- Pierces deep fascia of upper arm
- Runs in <u>posterior axillary fold</u>
- <u>Joins the axillary vein</u> high in the axilla

- Cephalic and basilic vein normally joined obliquely across the cubital fossa by the **median cubital vein**.

- These veins are often used for venapuncture / transfusion.



APPLIED ANATOMY OF THE FOREARM AND HAND:

FRACTURES OF BONES:

- **Supracondylar fracture** – humerus just above the epicondyles
    - Common in children
    - If arm is placed in right angle in sling, the swelling in region of cubital fossa may occlude the brachial artery.
    - Δ children with these fractures must have radial pulse montiored over first 24hrs.

- **Fractures of radius:**
- Fairly common

- *Neck or head of radius:*
    - Heals well unless head is dislocated / articular surface shattered.

- *Shaft of radius:*
    - Often accompanied by fracture of the ulna
    - In children: don't often fracture all the way through the bone → incomplete break called a **'greenstick type'** fracture.
    - In adults: usually fracture all the way through – bone ends must be carefully alligned. Misallignment affects pronation and supination.

- *Colles' fracture*:
    - Fracture of lower 1 inch of radius
    - Often associated with fracture of ulnar styloid process.
    - Common in old people who fall on outstretched hand.
    - Broken distal end of the radius is:
        - Tilted dorsally
        - Deviated to the radial side
        - Impacted into proximal part of bone.

- *Fractured radial epiphysis:*
    - In young people
    - Fracture at lower growth plate of radius

- **Fractures of the wrist:**
- Most common to fracture the **scaphoid**
- Scaphoid usually fractures across its waist.
- Common in young adults.
- Scaphoid can be palpated in base of anatomical snuff-box when the wrist is gently adducted.
- Scaphoid lies across the line of the midcarpal joint – forced movement across this line may cause scaphoid to crack.
- A cracked scaphoid takes a long time to heal.
- Fracture may block blood supply to proximal fragmen of scaphoid – it dies.

SPRAINS, RUPTURED TENDONS & MUSCLE INSERTIONS:

- Tendons can rupture without being cut:
    - E.g. tendon of extensor pollicis longus can fracture can rupture if it rubs over sharp edge of colles' fracture.

- **Tennis elbow** – tearing of fibres of the common extensor tendon at the lateral epicondyle, during exercise.

INFECTIONS:

- Pus can accumilate in areolar tissue of:
    - Deep palmar space
    - Superficial palmar space
    - Thenar space
- These are limited by fascial boundaries.

- *Deep infection of the palm:*
    - Cause by perforating injuries
    - When draining, must be careful to avoid tendons/nerves/vessels

- *Superficial space:*
    - Pus easily drained by surgical incision.

Tenosynovitis:

- **Synovial sheaths**.
- If infection is of tendon of finger as it runs along osseofascial tunnel of digit, the infection will remain localised for some time.
- The exception is infection of the synovial sheaths of the little finger or thumb:
    - The digital sheath of the little finger is continuous with the common synovial sheath, so infection can quickly spread to the common synovial sheath.
    - Infection fo the thumb digital sheath will spread along the sheath of flexor pollicis longus as far as the wrist.
- Pus must be carefully drained from the sheaths
- If not, blood supply to the sheaths may be occluded, and the tendons & sheaths may rupture.

SURGICAL INCISIONS IN THE FINGER:

- Drining infection is pulp of finger; incision should be from sides of the terminal phalanx, not the fingertip.
- Scar in fingertip is inconvenient and will make use of finger difficult.