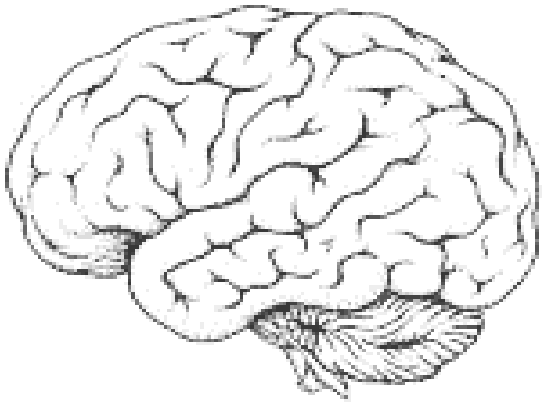
BAU-Medicine



Sheet no. 25

Lecture Date: 29.03.2021

Written by: Homam Ababneh

Edited by: Ruba Akasheh

اللهم اغفر له و ارحمه و اعف عنه و اكرم منزله". "اللهم أبدله داراً خيراً من داره و أهلاً خيراً من اهله ". "اللهم انقله من ضيق اللحود ومن مراتع الدود الى جناتك جنات الخلود". "لا إله إلا أنت يا حنان يا منان يا بديع السموات والأرض تغمد (رشيد) برحمتك يا أرحم الراحمين

If you come by any mistake (whether it be spelling, grammatical or scientific) while browsing this sheet, kindly report it to the Academic team Facebook account.

Upper Limb: Nerves

Clinical Anatomy

Brachial Plexus

- Ventral rami of C5-T1
- Formed in the posterior triangle of the neck
- Organization
  - **Roots**
    - C5-T1
  - **Trunks**
    - Upper C5-C6
    - Middle C7
    - Lower C8-T1
  - **Divisions**
    - Anterior and posterior divisions: (merge to give cords).
  - **Cords** (give terminal branches).
    - Lateral
      - Anterior divisions of middle & upper trunks
    - Medial
      - Anterior division of lower trunk
    - Posterior
      - All the posterior divisions

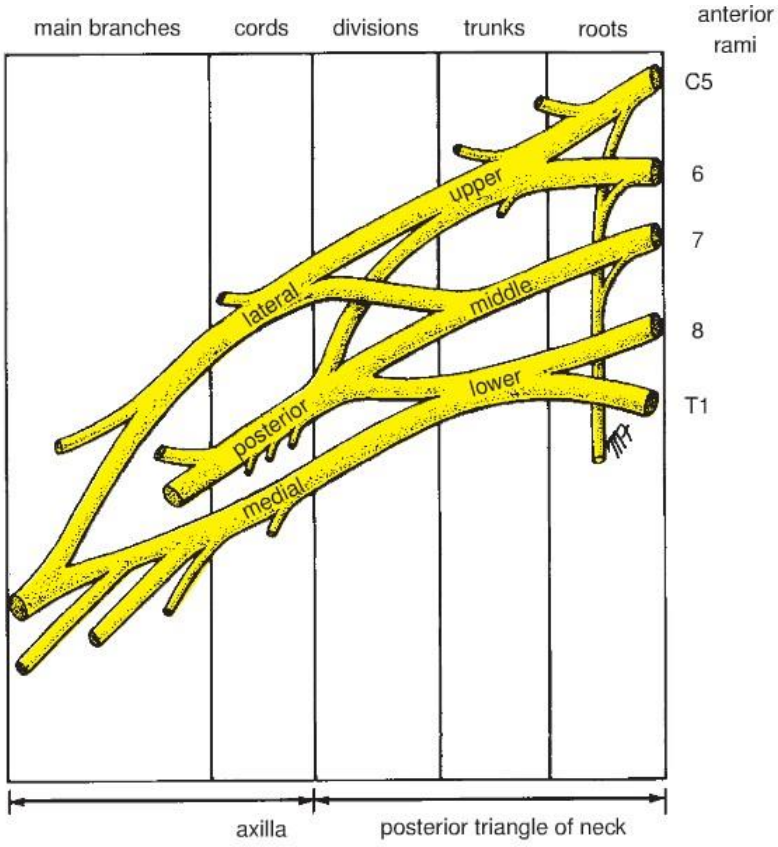
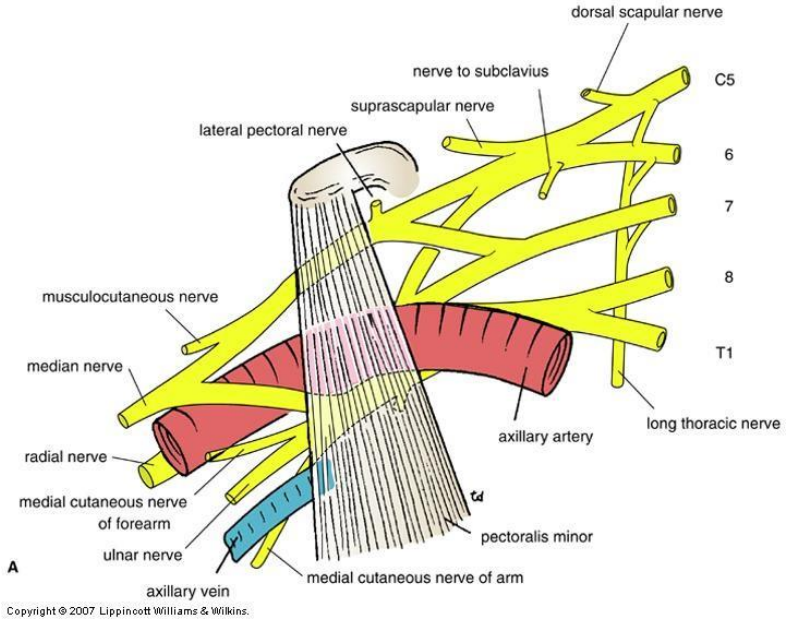
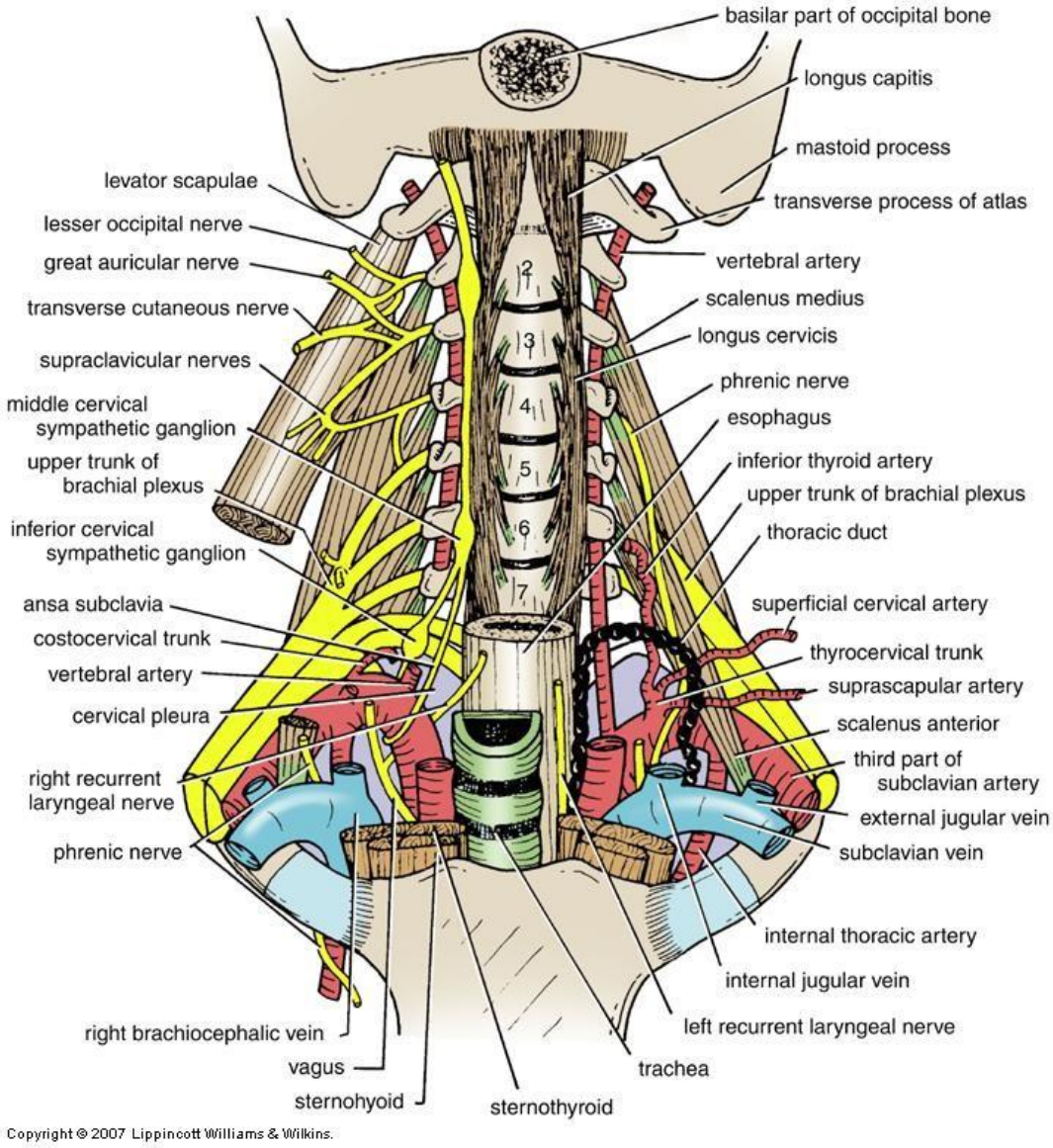


Figure 17-6 The formation of the main parts of the brachial plexus. Note the locations of the different parts.

Brachial Plexus: Relations

- Scalenus anterior and medius
- Axillary artery
- Axillary sheath





Sheet 1

- **Scalenus anterior and medius**: Brachial plexus originates in the cervical region, then the roots converge together anteriorly to scalenus medius and posteriorly to scalenus anterior.

  (So, it's located in between scalenus medius (posteriorly) and scalenus anterior (anteriorly)).
- Then, brachial plexus leaves the cervical region posteriorly to subclavian artery towards the axillary region.

  [The subclavian artery is behind/posterior to the scalenus anterior].

- **Axillary artery:** The cords of brachial plexus will surround the axillary artery (Within the axillary region).
- Axillary sheath: **Extra note:** The axillary sheath encloses axillary artery and the three cords of brachial plexus.

Brachial Plexus: Branches

- Roots
  - Dorsal scapular n.
  - Long thoracic n.
- Upper trunk
  - Suprascapular n.
  - Nerve to subclavius
- Lateral cord
  - Lateral pectoral n.
  - Musculocutaneous n.
  - Lateral root of median n.
- Posterior cord
  - Upper subscapular n.
  - Thoracodorsal n.
  - Lower supscapular n.
  - Axillary n. & radial n.
- Medial cord
  - Medial pectoral n.
  - Medial cutaneous n. of arm
  - Medial cotaneous n. of forearm
  - Ulnar n.
  - Medial root of median n.

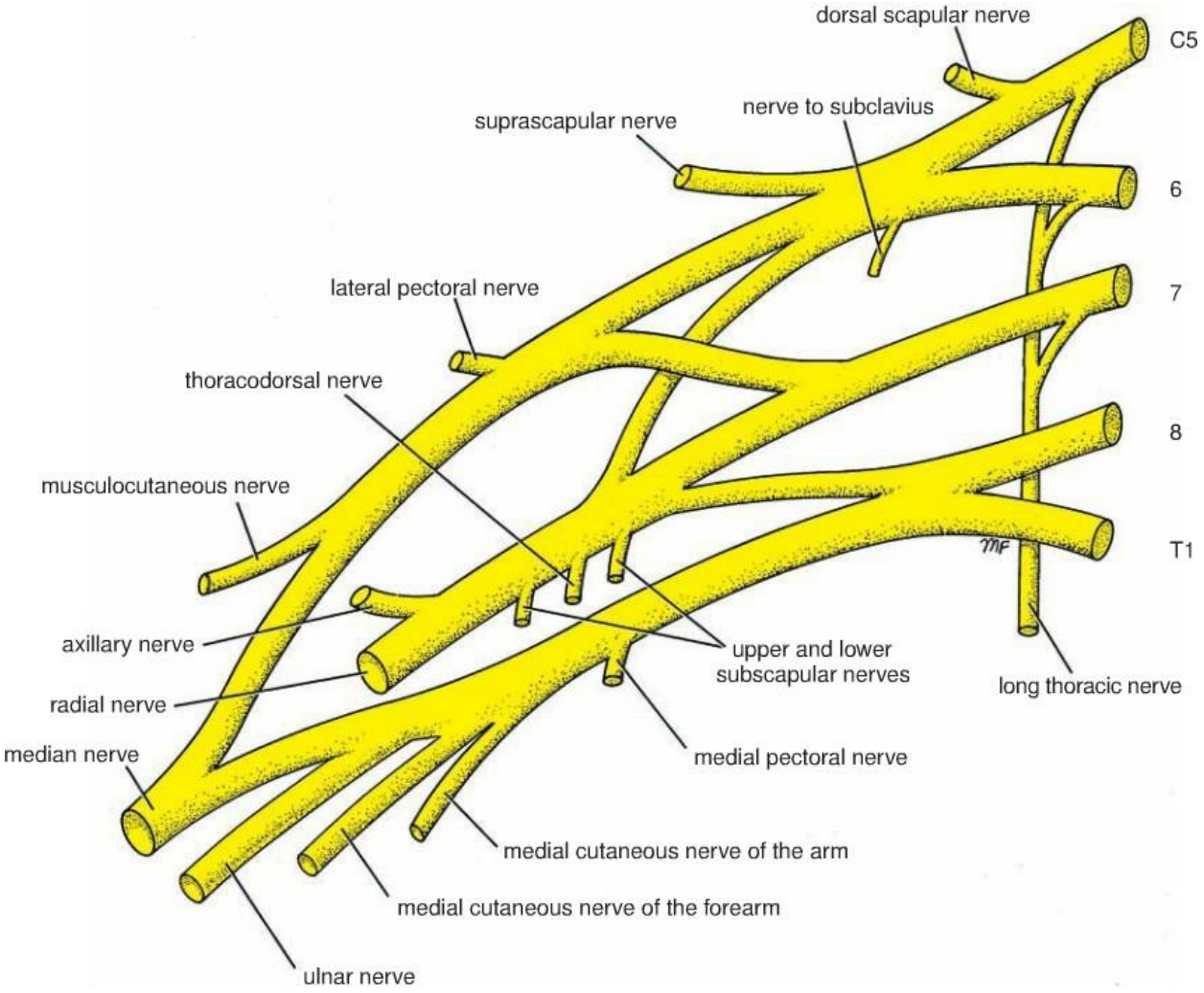


Figure 17-7 Roots, trunks, divisions, cords, and terminal branches of the brachial plexus.

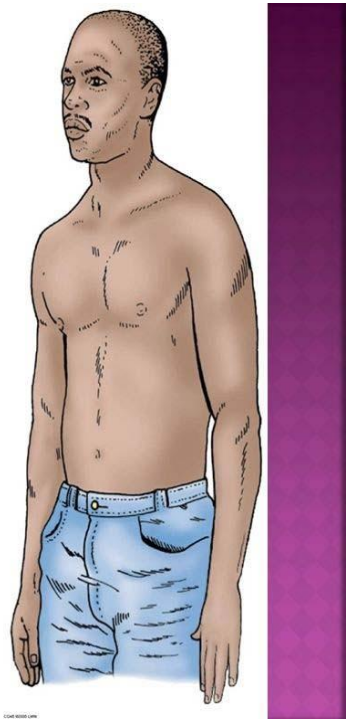
It's important to know trunks formed from which roots and different nerves from which roots are formed and areas they supply (roughly) to understand the clinical applications.

Table 17-2 Summary of the Branches of the Brachial Plexus and Their Distribution

Branches	Distribution
Roots	
Dorsal scapular nerve (C5)	Rhomboid minor, rhomboid major, levator scapulae muscles
Long thoracic nerve (C5, 6, 7)	Serratus anterior muscle
Upper trunk	
Suprascapular nerve (C5, 6)	Supraspinatus and infraspinatus muscles
Nerve to subclavius (C5, 6)	Subclavius
Lateral cord	
Lateral pectoral nerve (C5, 6, 7)	Pectoralis major muscle
Musculocutaneous nerve (C5, 6, 7)	Coracobrachialis, biceps brachii, brachialis muscles; supplies skin along lateral border of forearm when it becomes the lateral cutaneous nerve of forearm
Lateral root of median nerve (C5, 6, 7)	See medial root of median nerve
Posterior cord	
Upper subscapular nerve (C5, 6)	Subscapularis muscle
Thoracodorsal nerve (C6, 7, 8)	Latissimus dorsi muscle
Lower subscapular nerve (C5, 6)	Subscapularis and teres major muscles
Axillary nerve (C5, 6)	Deltoid and teres minor muscles; upper lateral cutaneous nerve of arm supplies skin over lower half of deltoid muscle
Radial nerve (C5, 6, 7, 8; T1)	Triceps, anconeus, part of brachialis, extensor carpi radialis longus; via deep radial nerve branch supplies extensor muscles of forearm: supinator, extensor carpi radialis brevis, extensor carpi ulnaris, extensor digitorum, extensor digiti minimi, extensor indicis, abductor pollicis longus, extensor pollicis longus, extensor pollicis brevis; skin, lower lateral cutaneous nerve of arm, posterior cutaneous nerve of arm, and posterior cutaneous nerve of forearm; skin on lateral side of dorsum of hand and dorsal surface of lateral three and a half fingers; articular branches to elbow, wrist, and hand
Medial cord	
Medial pectoral nerve (C8; T1)	Pectoralis major and minor muscles
Medial cutaneous nerve of arm joined by intercostal brachial nerve from second intercostal nerve (C8; T1, 2)	Skin of medial side of forearm
Medial cutaneous nerve of forearm (C8; T1)	Skin of medial side of arm
Ulnar nerve (C8; T1)	Flexor carpi ulnaris and medial half of flexor digitorum profundus, flexor digiti minimi, opponens digiti minimi, abductor digiti minimi, adductor pollicis, third and fourth lumbricals, interossei, palmaris brevis, skin of medial half of dorsum of hand and palm, skin of palmar and dorsal surfaces of medial one and a half fingers
Medial root of median nerve (with lateral root) forms median nerve (C5, 6, 7, 8; T1)	Pronator teres, flexor carpi radialis, palmaris longus, flexor digitorum superficialis, abductor pollicis brevis, flexor pollicis brevis, opponens pollicis, first two lumbricals (by way of anterior interosseous branch), flexor pollicis longus, flexor digitorum profundus (lateral half), pronator quadratus; palmar cutaneous branch to lateral half of palm and digital branches to palmar surface of lateral three and a half fingers; articular branches to elbow, wrist, and carpal joints

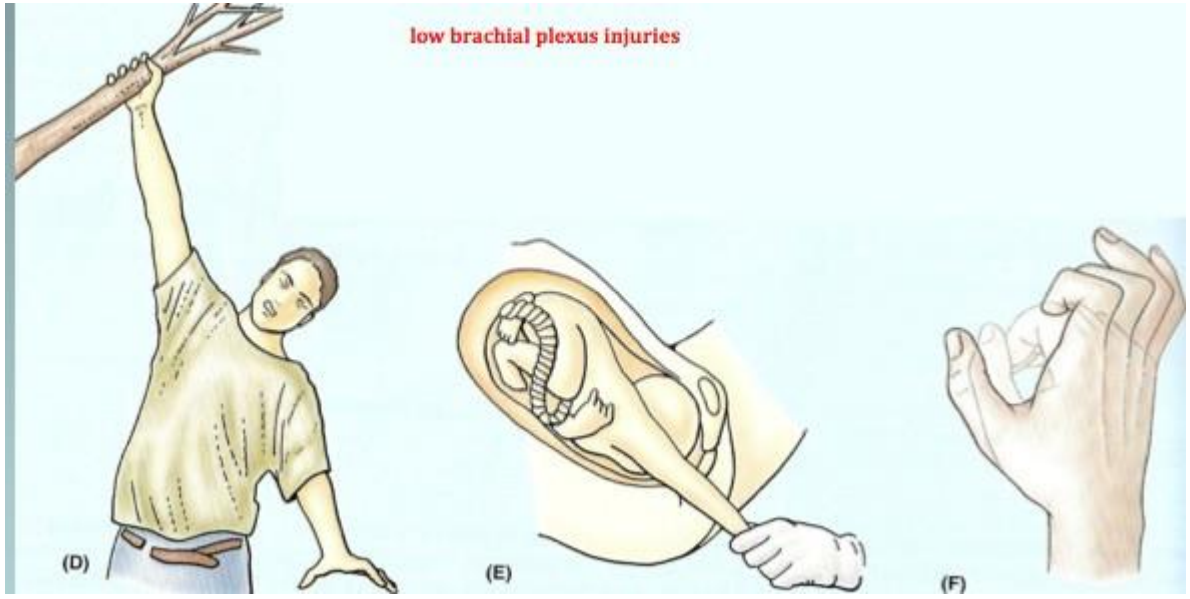
Upper lesions of the brachial plexus (ErboDuchenne Palsy)

- Increase the angle between the head and shoulder.
- Injury to **C5 & C6 roots** (Upper part of brachial plexus).
- Affected muscles:
  - **Supraspinatus & infraspinatus**: They are lateral rotators of arm, so, their paralysis will cause medial rotation of the upper limb.
  - subclavius, biceps brachii, coracobrachialis, deltoid, and teres minor
- Waiter's tip position;
  - **Limb hang by side:** due to paralysis of this group of muscles in general.
  - Medially rotated
  - **Pronated forearm**: due to paralysis of Biceps brachii.
- Loss of sensation down lateral side.



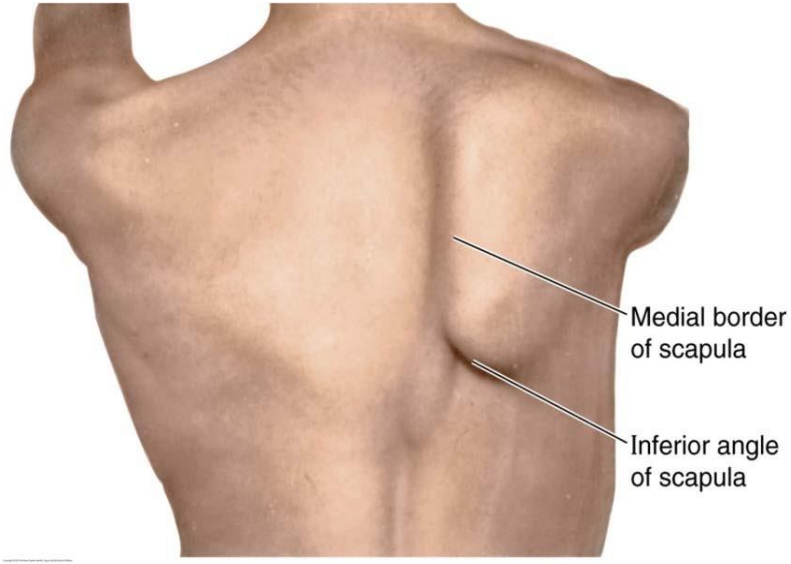
Lower lesions of the brachial plexus (Klumpke Palsy)

- Injury to **C8 & T1** (Lower part of brachial plexus).
- Excessive abduction of the arm.
- Affected muscles:
  - Small hand muscles: that move the fingers of the hand (mainly caused by a damage to the ulnar and part of the median nerves).
- **Claw hand (Due to paralysis of lumbricals; caused by ulnar nerve damage);**
  - Hyperextension of metacarpophalangeal joints.
  - Flexion of interphalangeal joints.
- Loss of sensation down medial side.



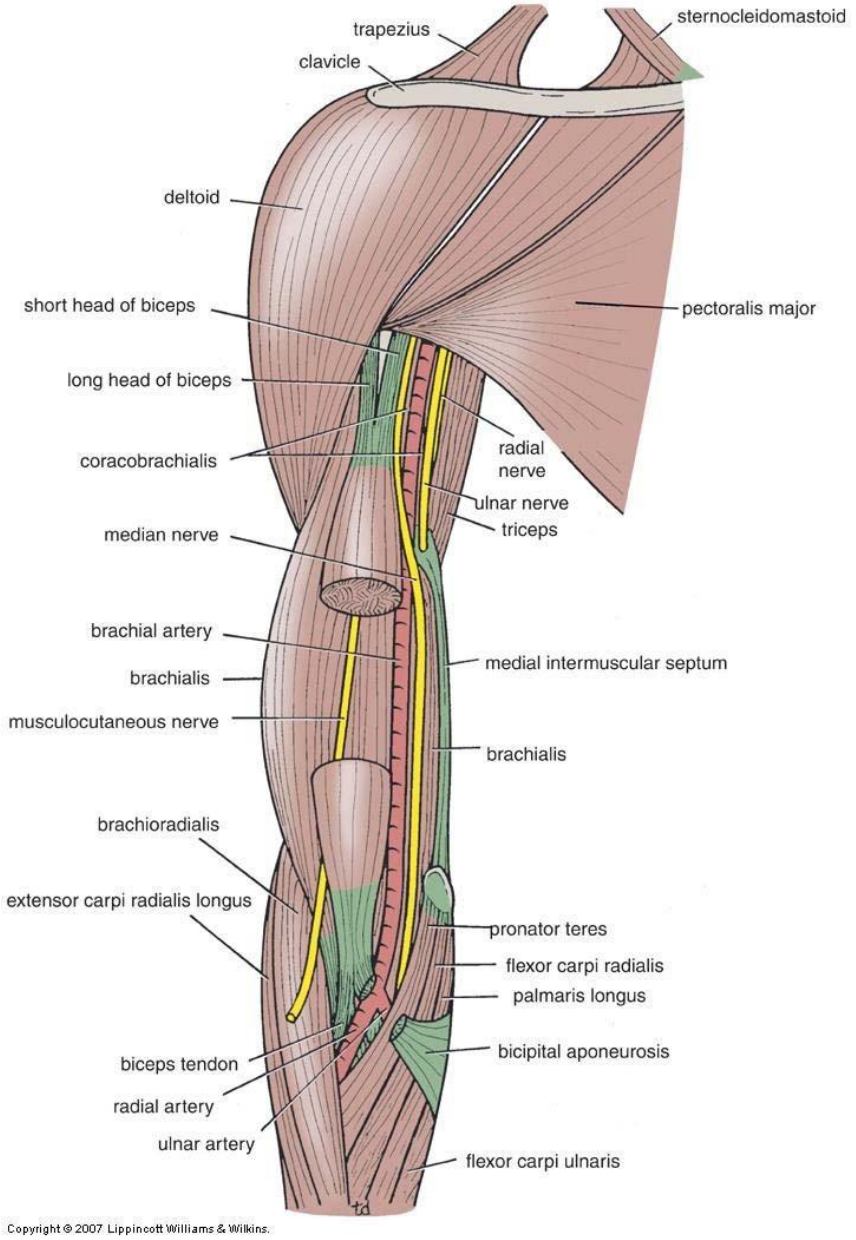
Long thoracic nerve injury

- Results from
  - Injury to posterior triangle of the neck
  - Injury in the chest wall
    - Radical mastectomy
- Paralysis of **serratus anterior muscle:** results in **adduction of scapula.** (Its normal action is abduction and lateral or outside rotation of scapula).
- Winged scapula
  - Difficult to raise hand above head.
  - Medial border and inferior angle moves laterally and posteriorly.



Musculocutaneous Nerve

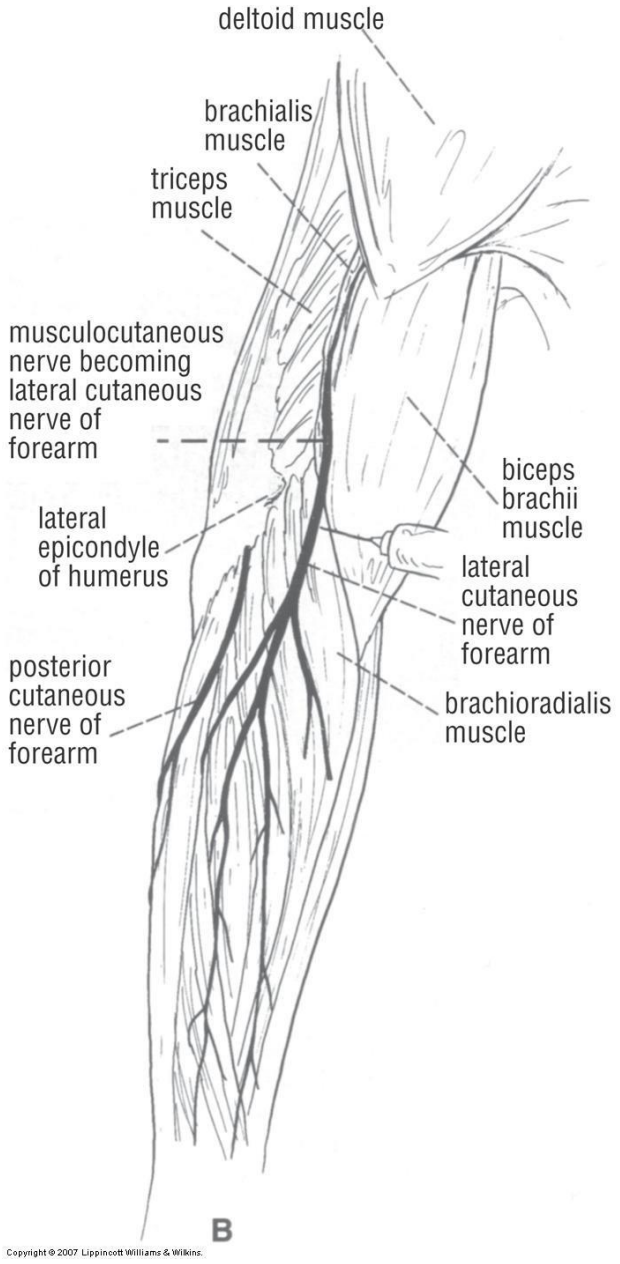
- **Relations**
  - Pierces coracobrachialis muscle.
  - Deep to biceps.
- **Branches**
  - ✓ Muscular nerve:
  - Innervate the anterior compartment of arm muscles (motor supply).
  - & a *cutaneous branch* that ends as:
  - ✓ Lateral cutaneous nerve of the forearm:
  - Will exit laterally from area between biceps and brachialis muscles, specifically lateral to biceps muscle.



Musculocutaneous Nerve Block

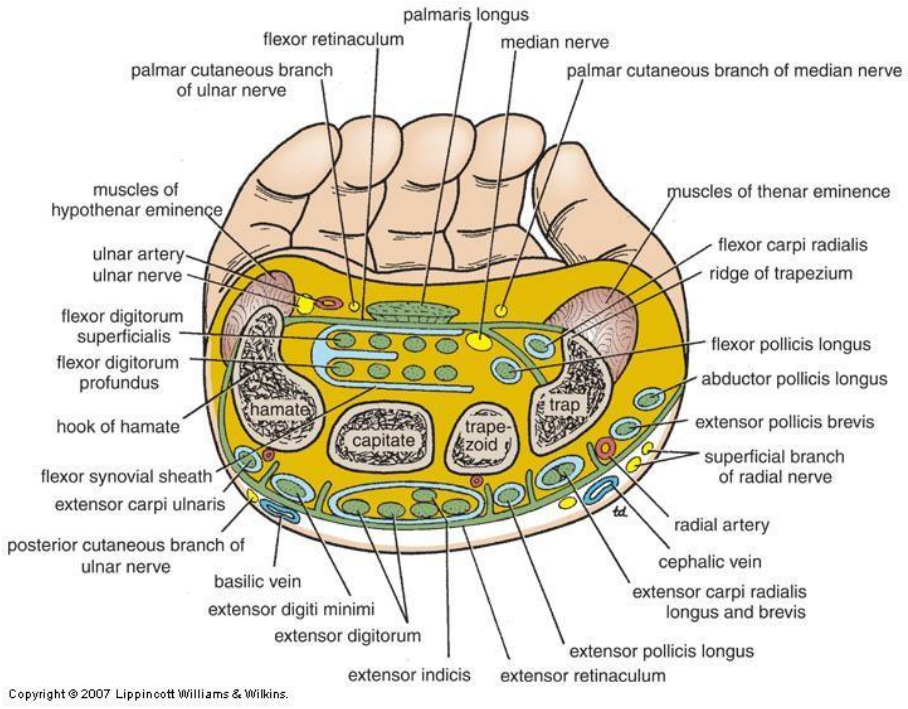
- Area: lateral side of the forearm (cutaneous).
- **Lateral cutaneous nerve block = Block anesthesia.**

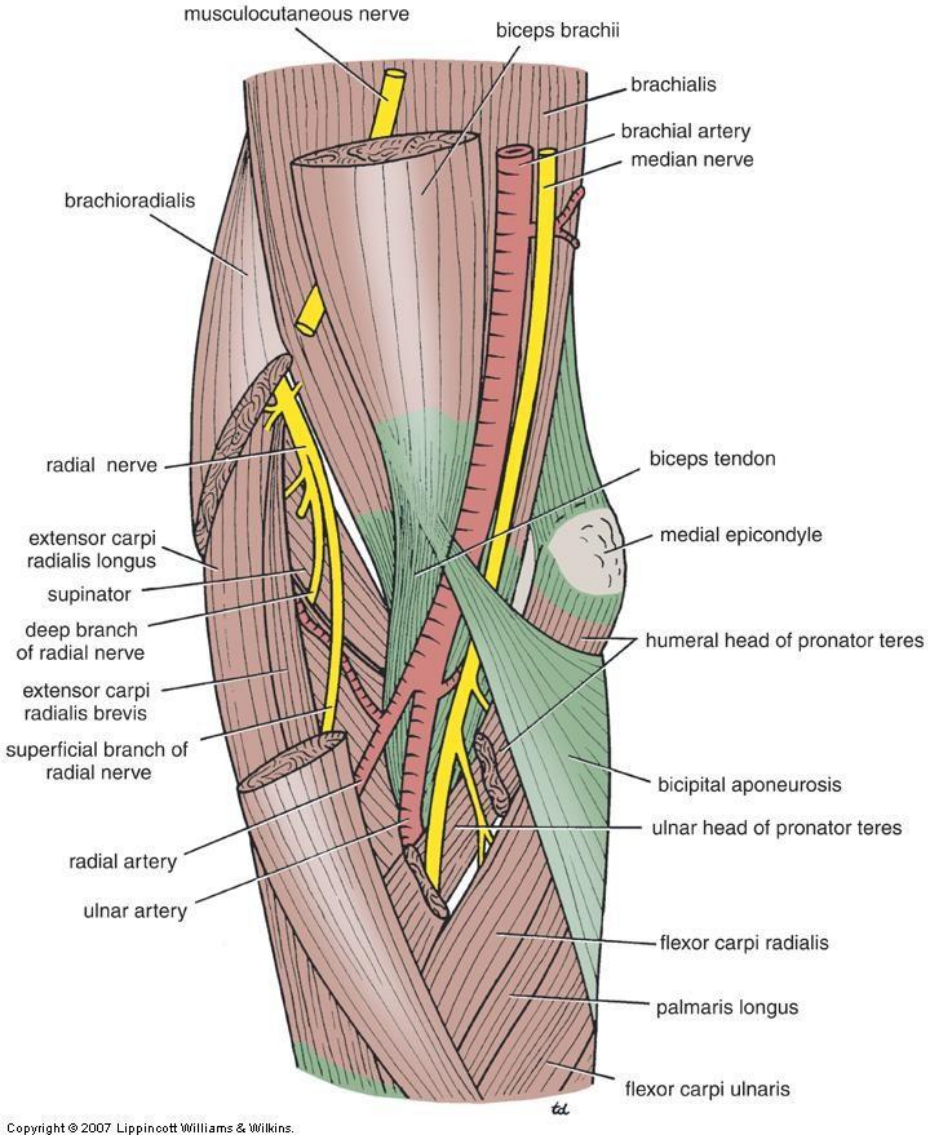
- Site of injection or where you can palpate:
  - Lateral to the tendon of the biceps muscle.
  - On a line between the humeral epicondyles.



Median Nerve

- Relations
  - In arm
    - Brachial artery.
  - In hand
    - Flexor retinaculum





Sheet 2

- In arm: Medial to **Brachial artery.** (Both are medial to **tendon of biceps brachii**).

When feel the pulsation of brachial artery in the cubital fossa, the median nerve will be just medial to it.

Lateral to medial:

BICEPS TENDON → BRACHIAL ARTERY → MEDIAN NERVE.

- In hand (wrist)

Median nerve is deep to **Flexor retinaculum.**

Recall: Carpal tunnel syndrome.

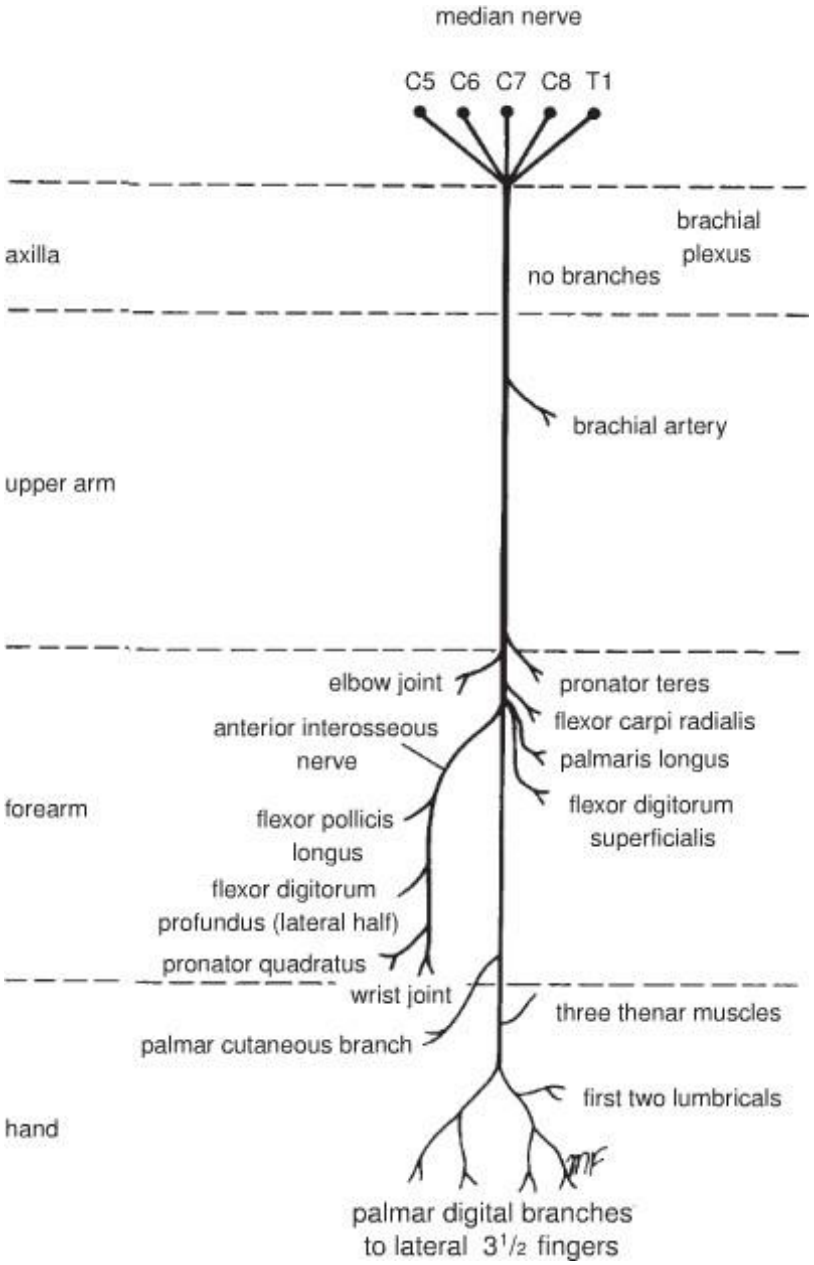
Median Nerve: branches

- Branches in forearm:
  - Muscular branches

    Anterior compartment of forearm.

    (Except **Flexor carpi ulnaris** and **medial half of Flexor digitorum profundus**, which are innervated by the **Ulnar nerve**).
  - Palmar cutaneous branch

- Branches in palm:
  - Muscular branches
    - Thenar muscles
  - Cutaneous branches



Sheet 3

- **Cutaneous branches (branches in palm):** innervate the lateral 2/3 of palm (lateral 3 and half fingers).
  1) **Palmar cutaneous branch:** branches before the median nerve enters under flexor retinaculum (carpal tunnel), so, it's above the flexor retinaculum.
  2) **Palmar digital branches:** branch after exiting through the tunnel and innervate fingers.

Refer to the figure on the slide before.

In case of **Carpal tunnel syndrome** the palmar cutaneous branch will not be affected, its effect is **needle prickling sensation** on fingers.

Median nerve injury

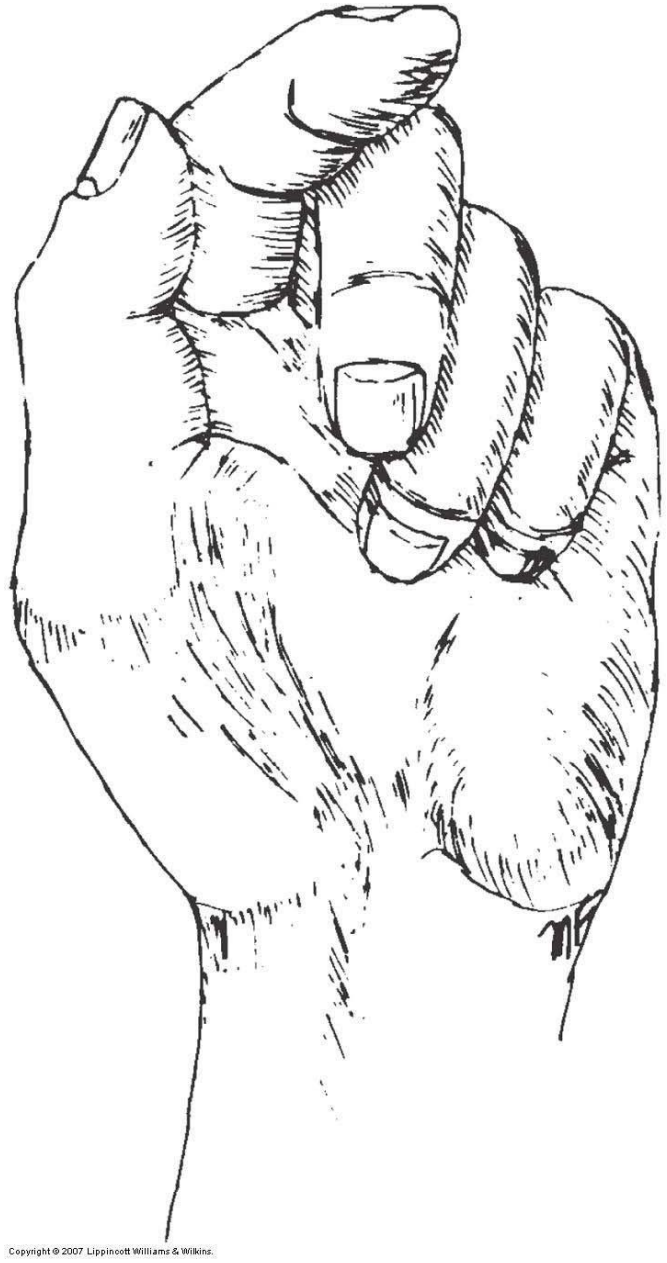
- **Injury at the elbow:**
  - Forearm kept in supine position.
  - Wrist flexion is weak NOT absent and accompanied by adduction.

  [**Remember**: muscles of the forearm aren't all innervated by the median nerve; the ulnar nerve innervates flexor carpi ulnaris and medial half of flexor digitorum profundus].

  - NO flexion at interphalangeal joints of 2nd and 3rd fingers and weak flexion at the metacarpophalangeal joints of these fingers.

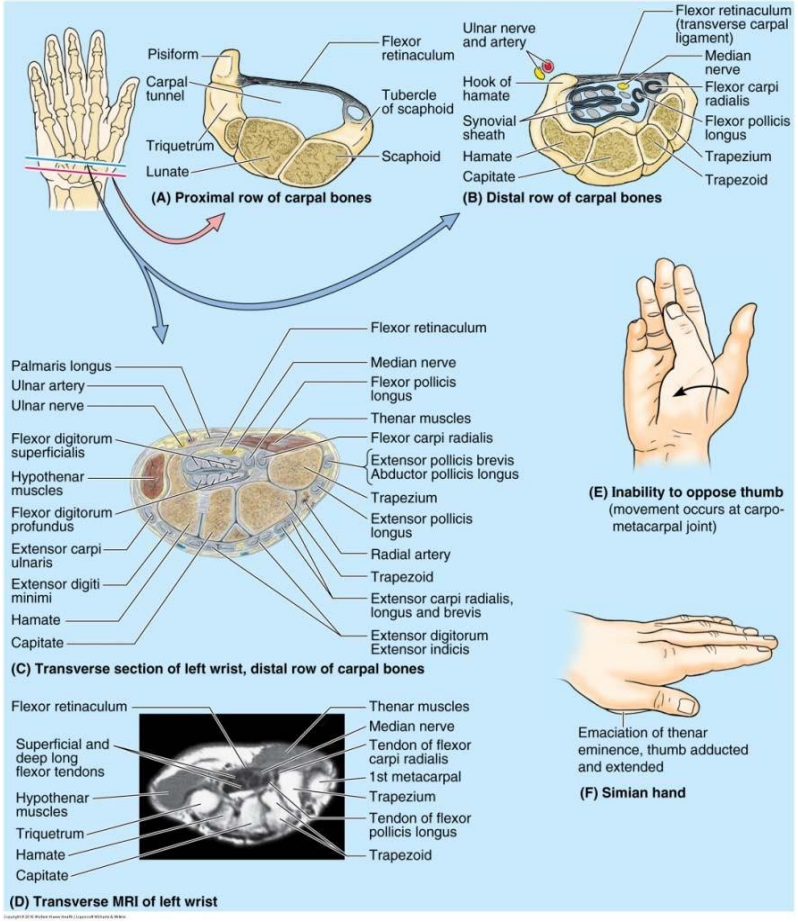
    [**Again**, the ulnar nerve has a role in the innervation of the other metacarpophalangeal joints].

  - Sensory loss at lateral half of the palm.



Median nerve injury

- **Injury at wrist**
  - Paralysis and atrophy of the thenar muscle.
  - Loss of opposition movement.
- **Carpal tunnel syndrome**
  - Compression of the median nerve by the content of the carpal tunnel.
  - Pain (pins and needles) along the distribution of the median nerve to the lateral 3 & ½ fingers.

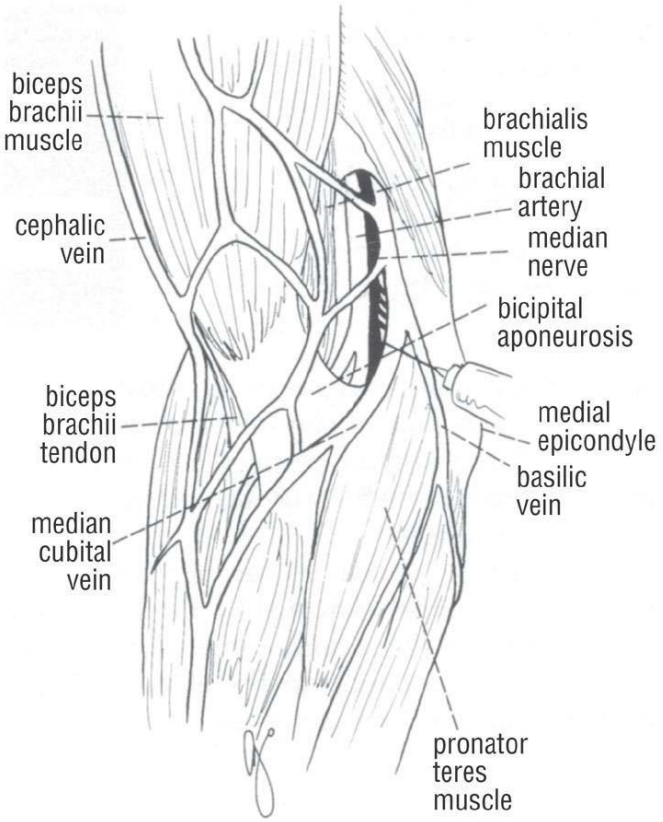


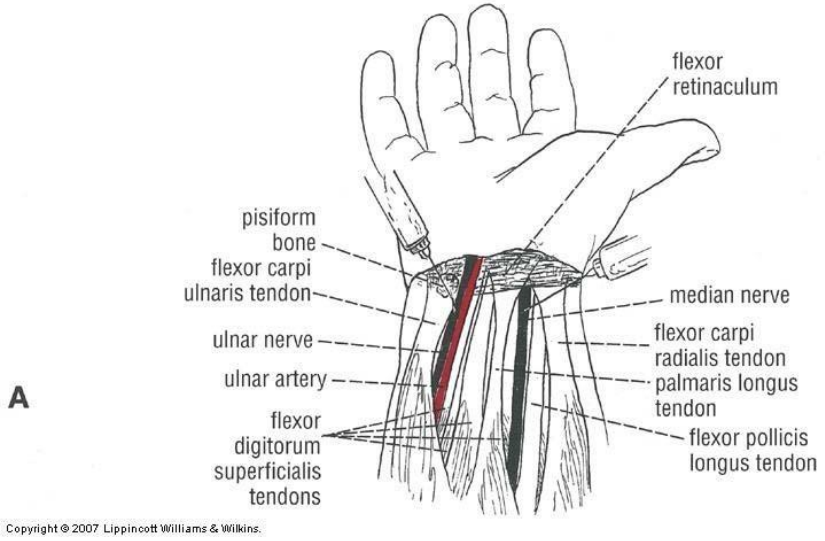
Median Nerve Block

- **Area**: lateral side of the palm and palmer 3½ digits and their nail beds.

- Block at elbow
  - Brachial artery palpated to the medial side of the biceps tendon on an extended elbow.
  - Medial to the palpated brachial artery (in the Cubital Fossa).

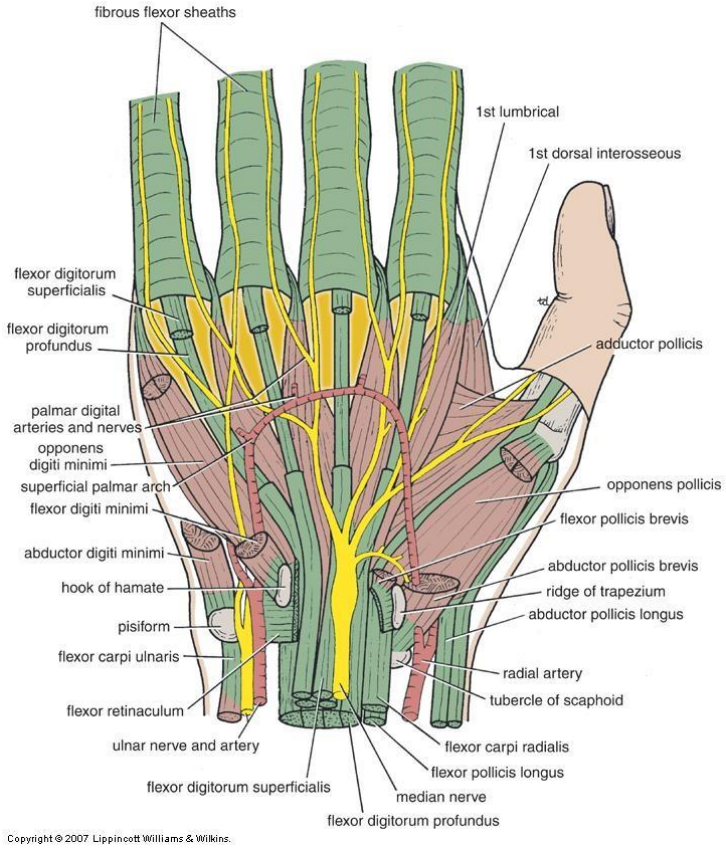
- Block at wrist
  - Between tendons of the palmaris longus and flexor carpi radialis muscles.
  - Proximal to the flexor retinaculum (proximal to distal transverse crease of wrist).

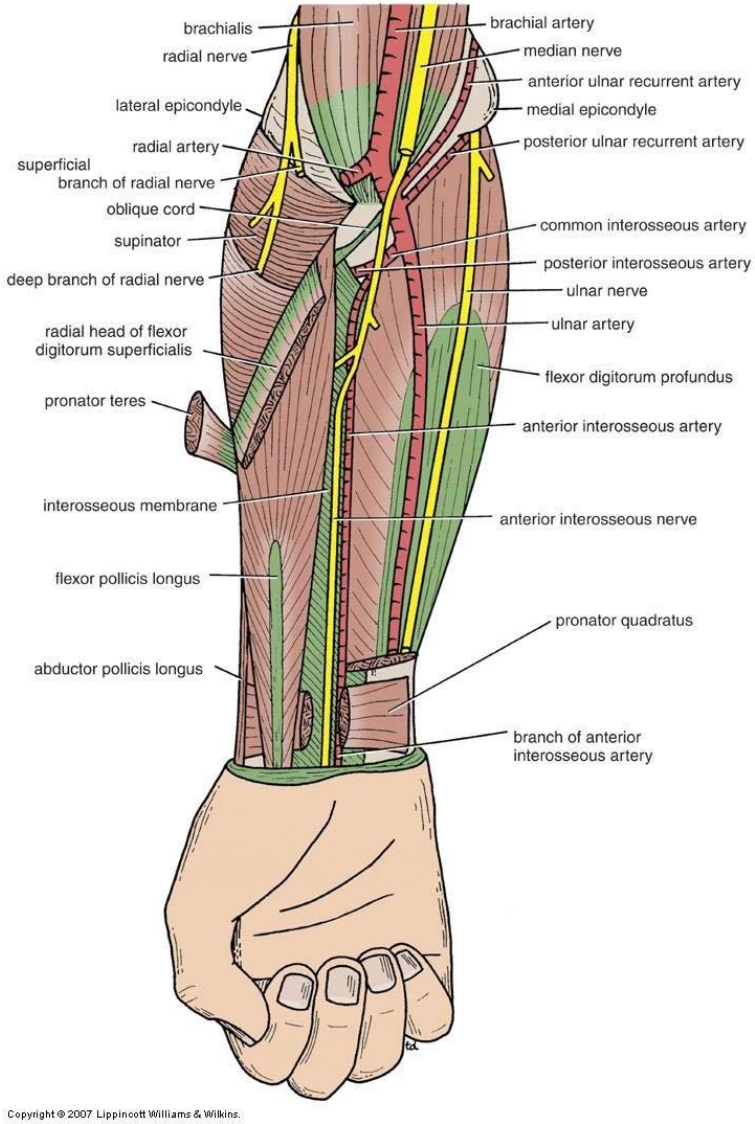




Ulnar Nerve

- Relations
  - In arm
    - Medial epicondyle
  - In hand
    - Flexor retinaculum
    - Pisiform





Sheet 4

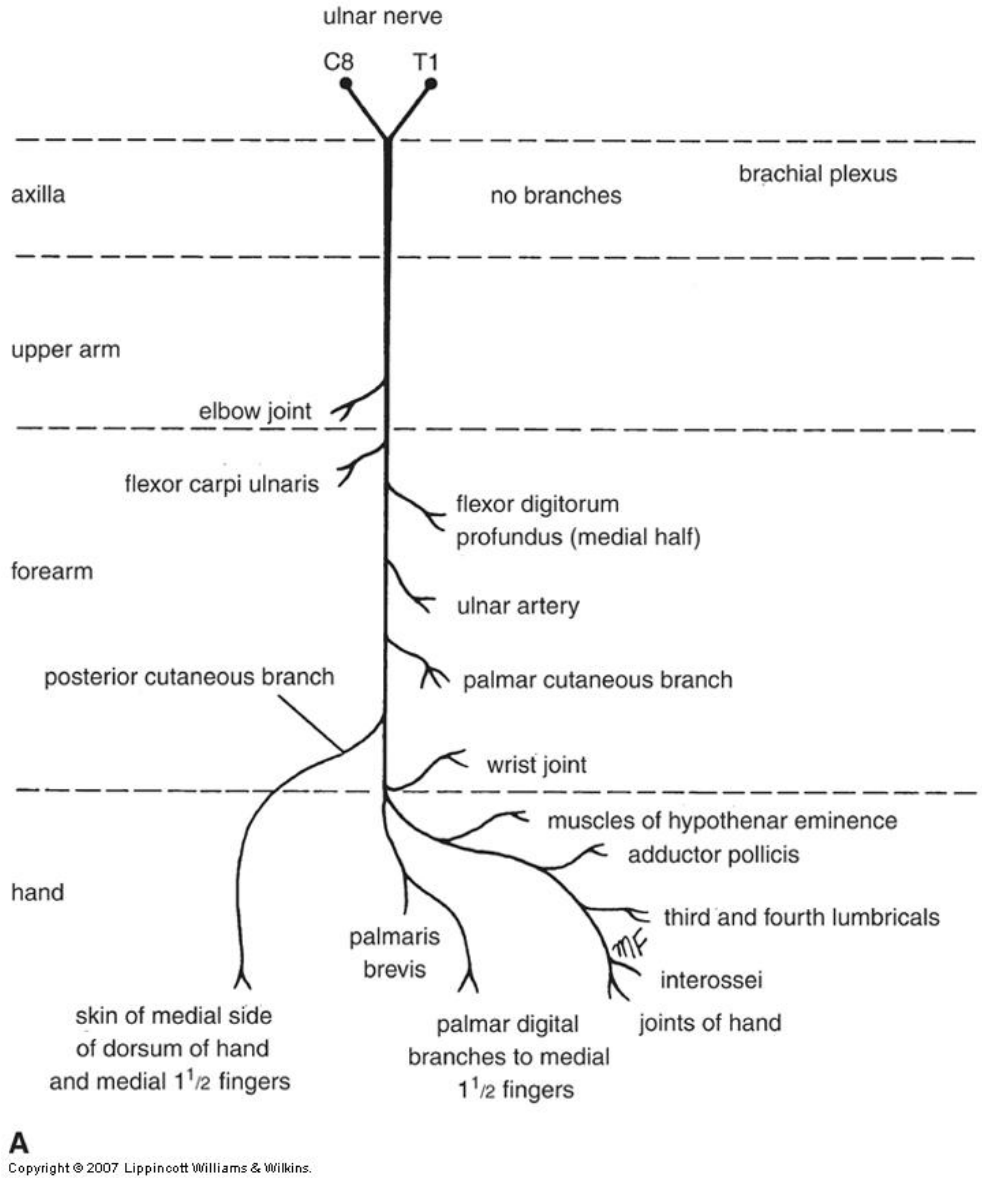
- **In arm** (Ulnar nerve is located posteriorly in the elbow region).
  - Posterior to **Medial epicondyle** (the nerve will be superficial in this area).
  - Then goes anteriorly (towards the forearm) anterior to **Flexor digitorum profundus** and deep to **Flexor carpi ulnaris** [In the forearm].
  - Then continues on the medial side until it reaches the hand.

- **In hand**
  - Above **Flexor retinaculum.**
  - Lateral to **Pisiform.**

Ulnar Nerve: branches

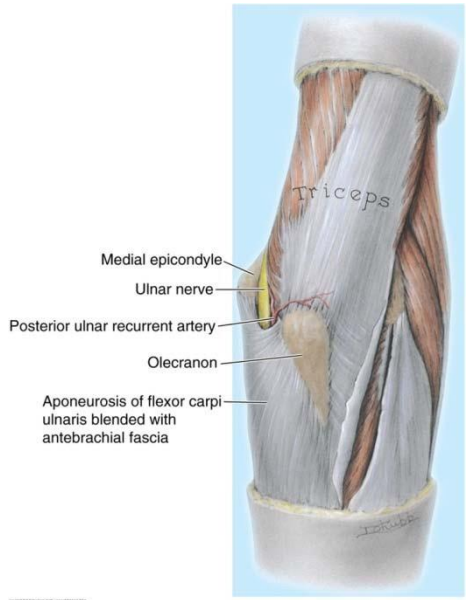
- **In forearm**
  - **Muscular branches**: innervates the **flexor carpi ulnaris** & **medial part of flexor digitorum profundus.**
  - **Cutaneous branches:** innervate medial side of the whole hand anteriorly (palmar side) and posteriorly.
    - Posterior cutaneous branch: innervates dorsal medial 1 and ½ fingers.
    - Palmar cutaneous branch: innervates palmar medial 1 and ½ fingers.

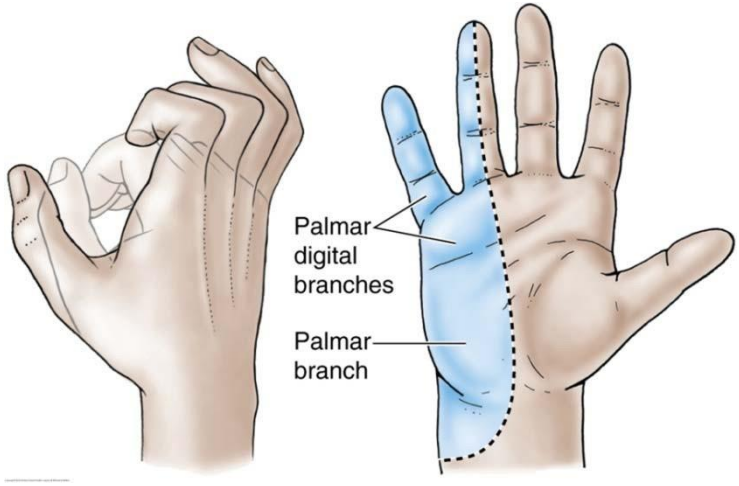
- **In hand;** the four **hypothenar** muscles;
  - **Superficial terminal branch**
    - Muscular branches: innervate the *palmaris brevis*.
    - Cutaneous branches.
  - **Deep terminal branch**
    - Muscular branches: innervate the other three hypothenar muscles.

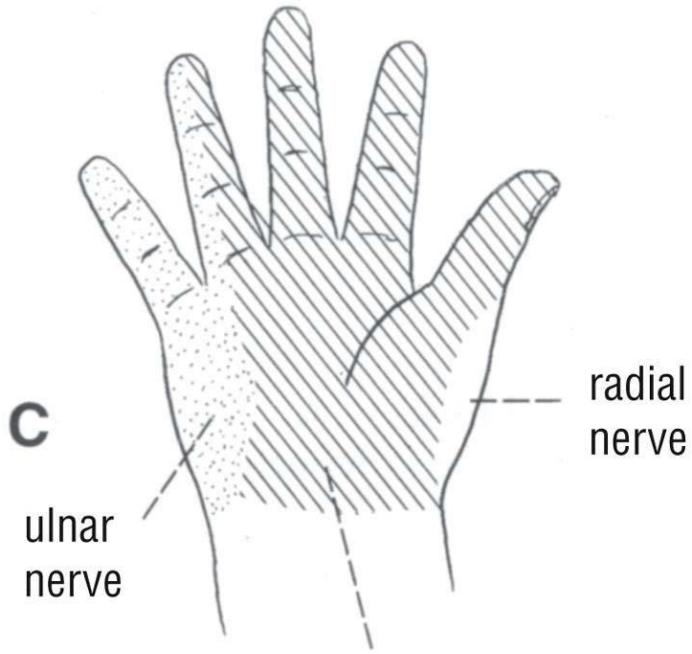


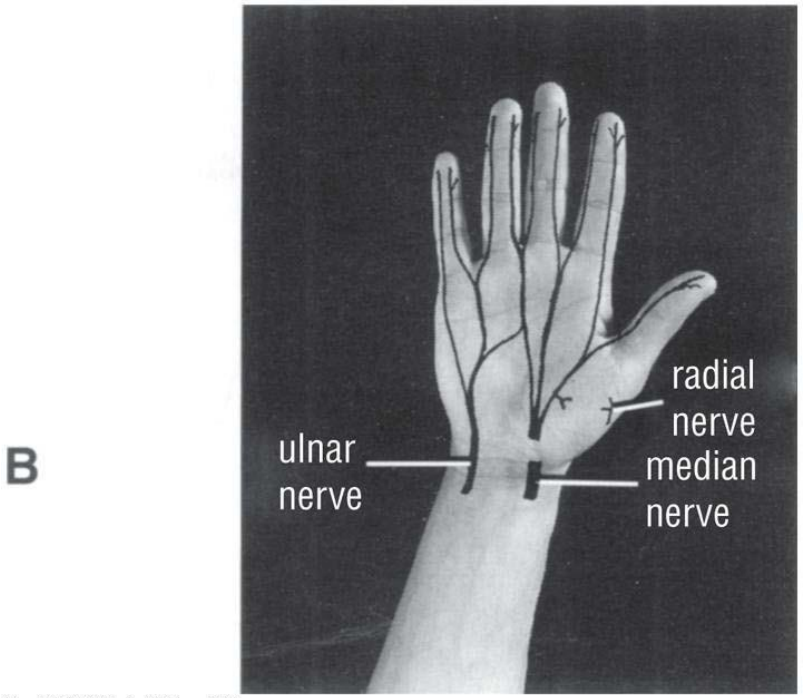
Ulnar nerve injury

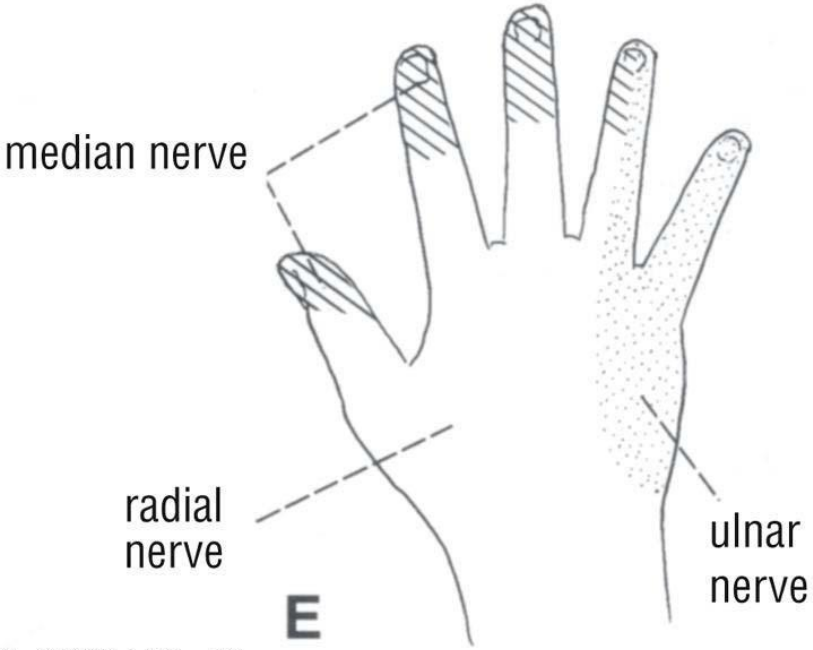
- **Injury at elbow**
  - Common site for ulnar injury is: posterior to the medial epicondyle (superficial at this area).
  - **Flexion** of wrist will be accompanied by **abduction** (flexor carpi radialis function {abduction} will over come the action of flexor carpi ulnaris muscle {adduction}).
  - Inability to adduct and abduct the fingers.
  - Claw deformity
  - Loss of sensation on the medial ⅓ of the hand.
- **Injury at wrist**
  - Claw hand
  - Loss of sensation on ⅓ of palmar side.

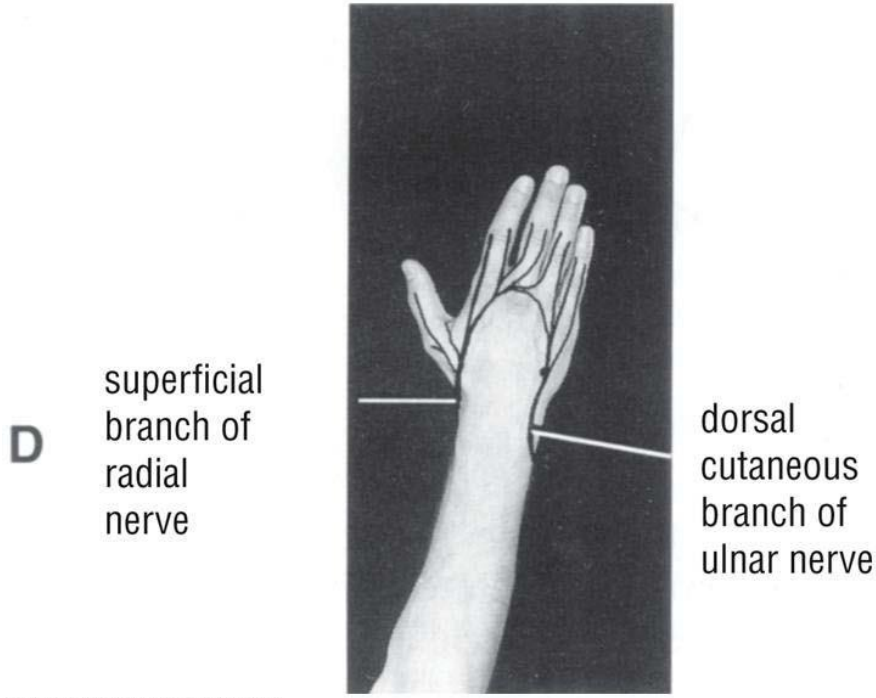












Ulnar Nerve Block

- **Block at elbow**

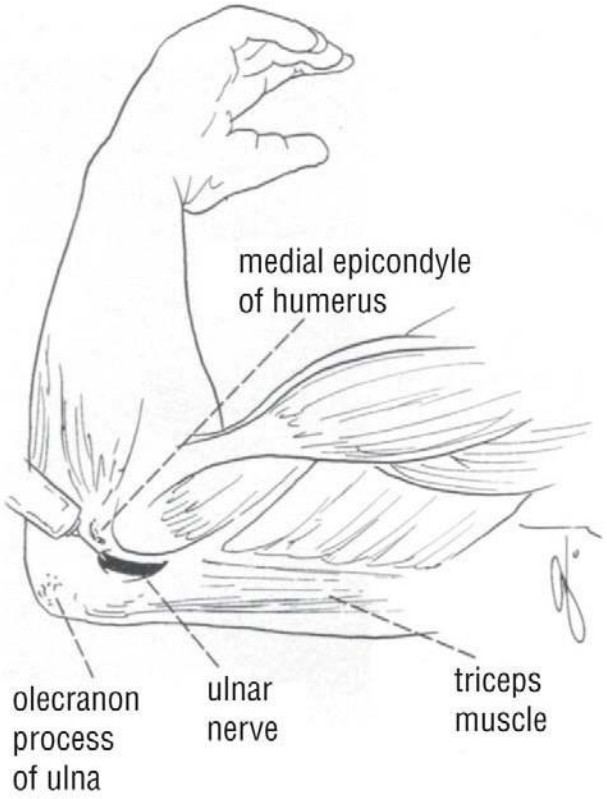
➢ Area: medial side of the hand

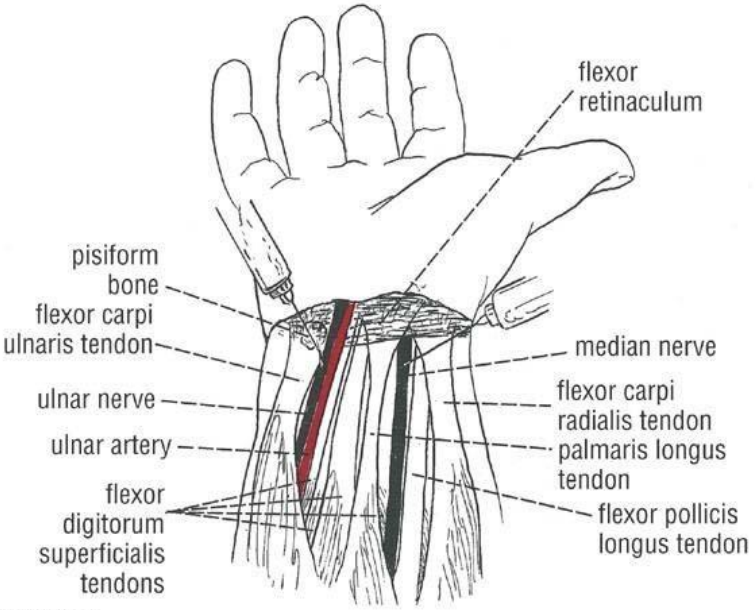
– Between olecranon process and medial epicondyle of humerus (Just posterior to medial epicondyle).

- **Block at wrist**

➢ Area: palmer side of the **medial** side of the hand.

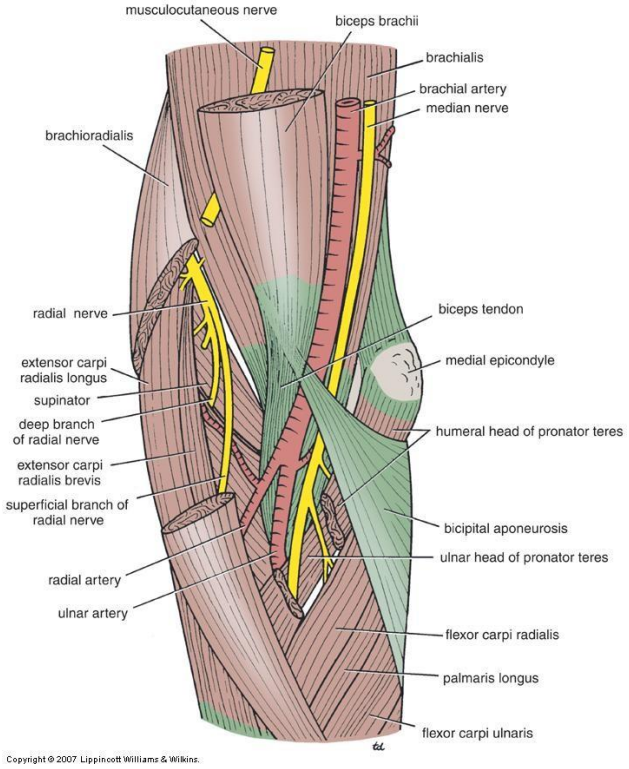
– Lateral to the tendon of the flexor carpi ulnaris at level of transverse crease of wrist (Just lateral to pisiform).

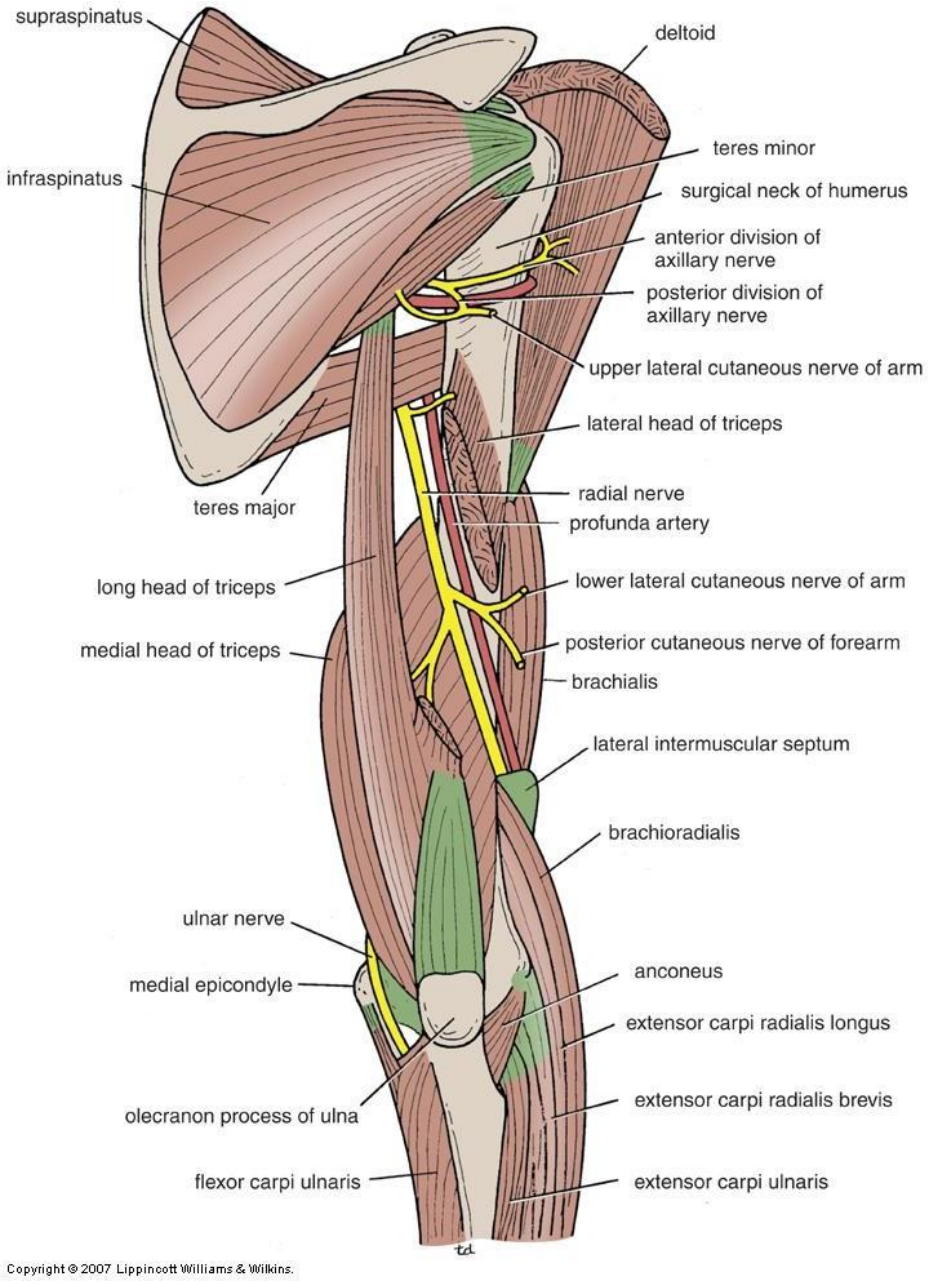




Radial Nerve

- Relations
  - in arm
    - Spiral groove
    - Profunda artery
    - Lateral epicondyle



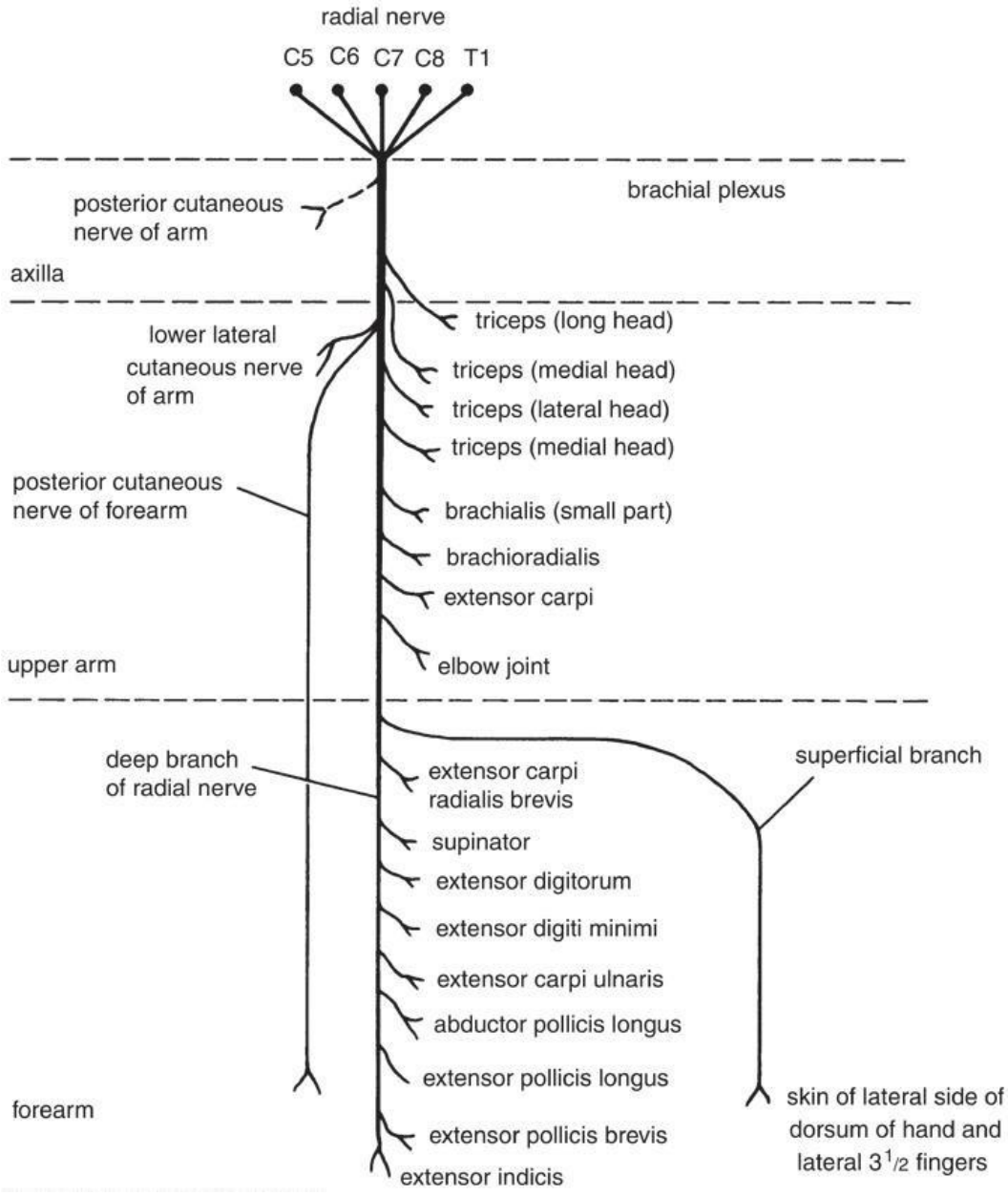


Sheet 5

– **In arm**
  - Radial nerve runs within the **Spiral groove**, from the axilla will head posteriorly.
  - Accompanies **Profunda brachii artery** within the spiral groove and from medial to lateral, then in the lateral side will move from the posterior to the anterior side (within cubital fossa).
  - Anterior to **Lateral epicondyle** in the cubital region.

Radial Nerve: branches

- **Muscular branches**
  - Posterior compartments of arm and forearm
- **Cutaneous branch**
  - Posterior cutaneous nerve of arm.
  - **Lower lateral cutaneous nerve of arm**: innervates inferior lateral side of the arm, while the superior lateral side will be innervated by **Axillary nerve.**
  - Posterior cutaneous nerve of forearm.
  - Superficial branch of radial nerve: innervates the lateral half of the hand.



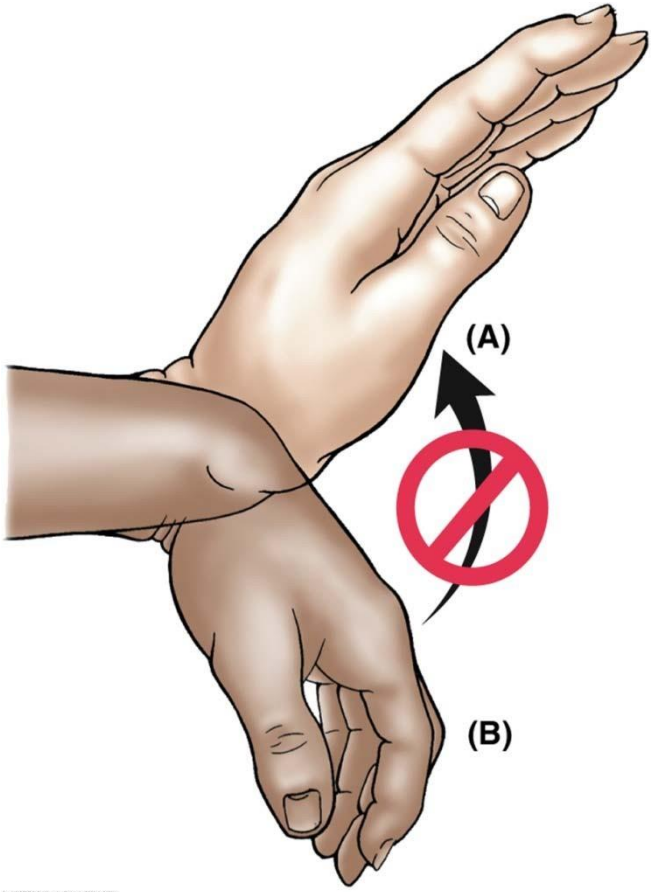
Radial nerve injury

Leads to inability to do **Extension**.

- **Injury in the axilla**
  - **Wrist-drop**
- **Injury in the spiral groove**
  - **Wrist-drop**

→ Both of these injuries lead to Wrist-drop due to: damage to the nerves that innervate all extensor muscles of the wrist.

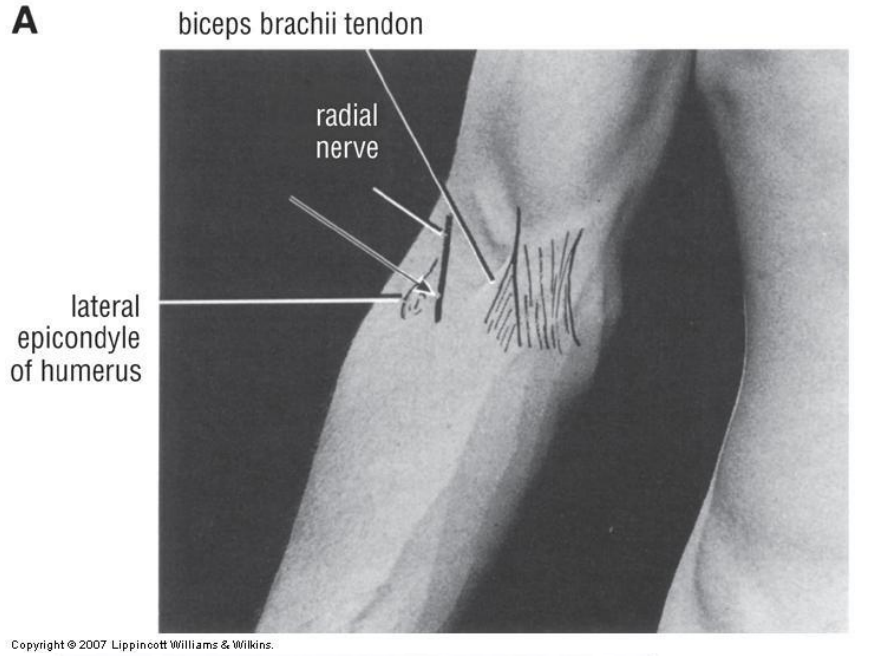
- **Injury to the deep branch**
  - **No wrist-drop**
  - Inability to extend the thumb and the metacarpophalangeal joints (test against resistance).
  - No loss of sensation
- **Injury to the superficial branch**
  - Limited anesthesia

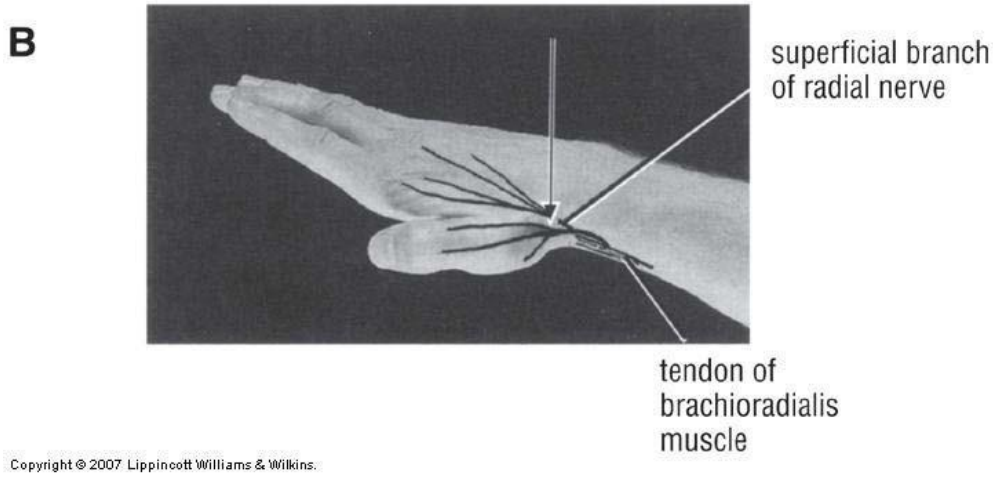


Radial Nerve Block

- Area: lateral dorsal side of the hand proximal to the lateral 1½ lateral nail beds.

- **Block at elbow**
  - Halfway between the tendon of the biceps muscle and the tip of the lateral epicondyle of humerus in extended elbow.
- **Block at wrist**
  - Lateral to the radial artery at the level of the proximal wrist transverse crease.

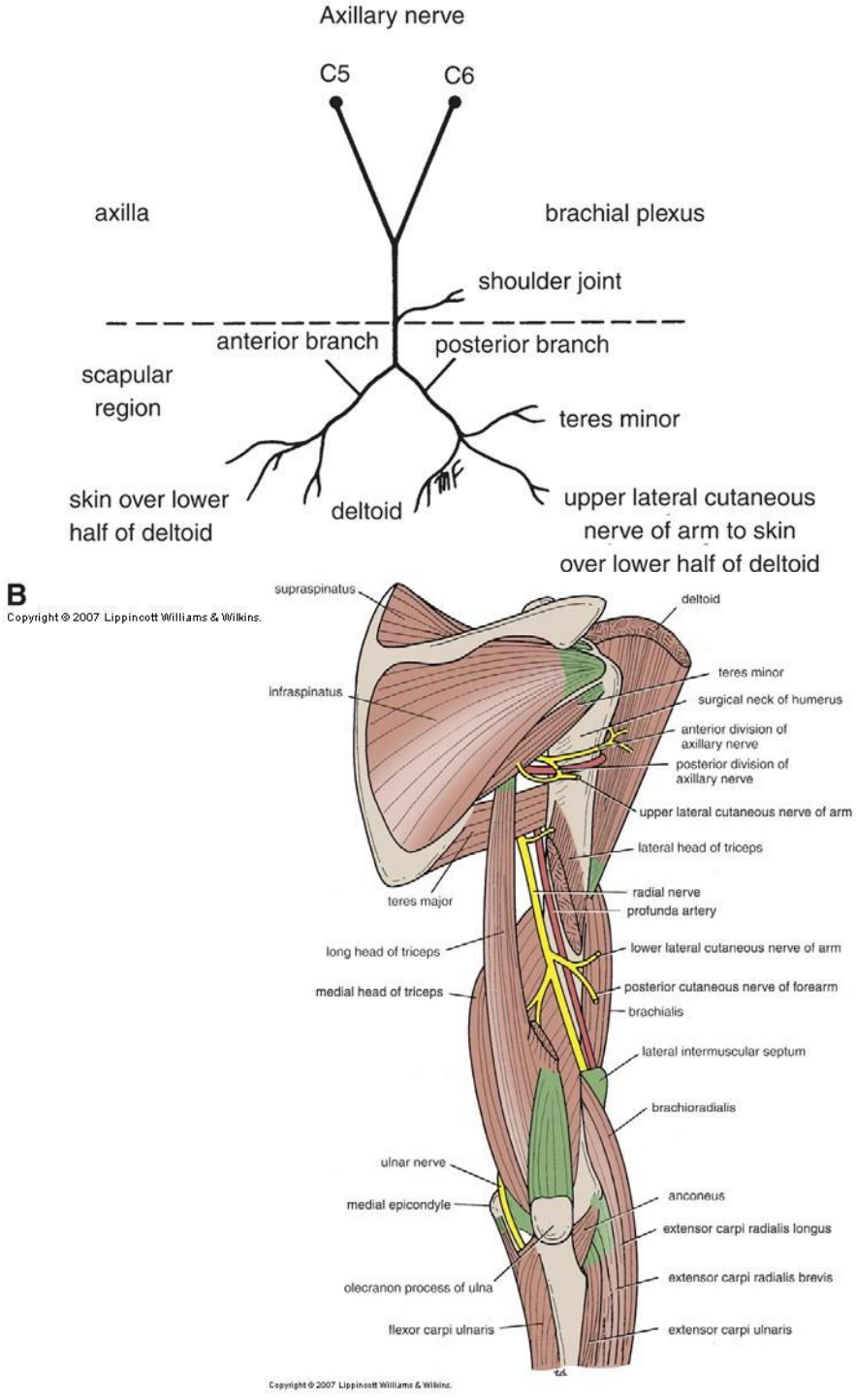




Axillary Nerve

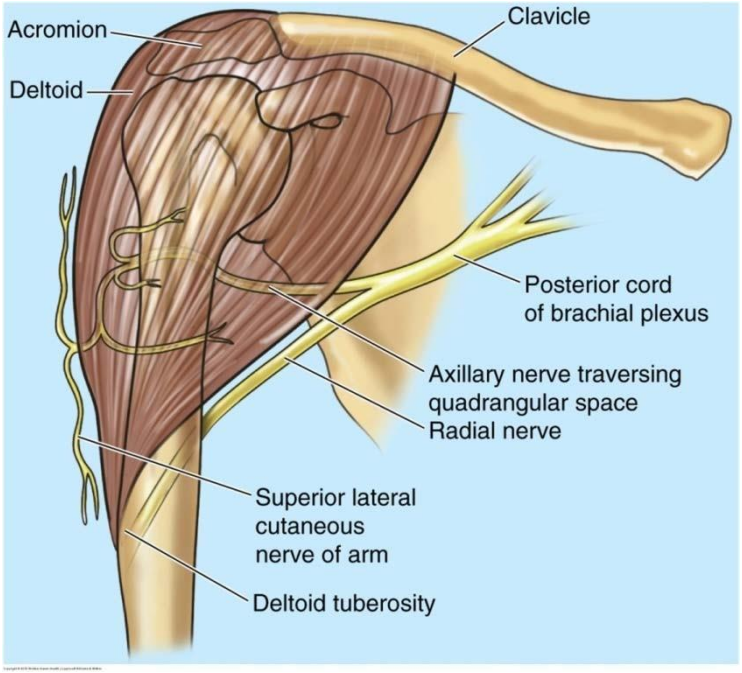
Innervate **deltoid** muscle & **teres minor** muscles.

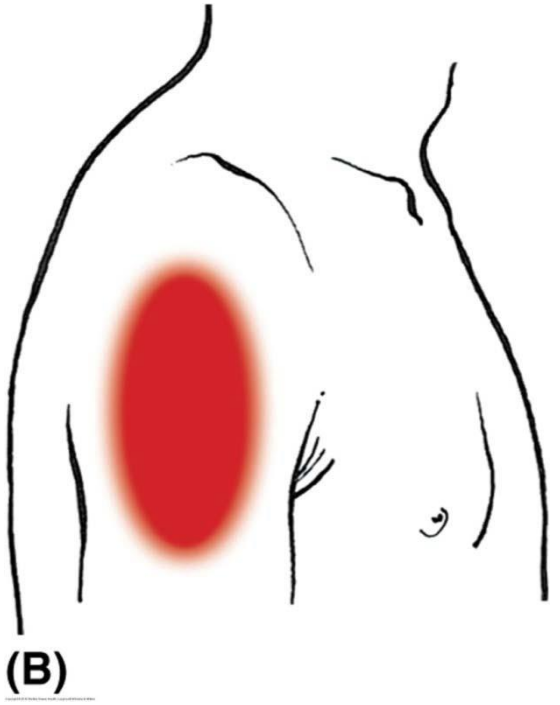
- **<u>Relations</u>**
  - Exists the axilla from **Quadrangular space.**
  - Accompanies **Posterior circumflex humeral vessels.**
- **<u>Branches</u>**
  - Anterior terminal branch.
  - Posterior terminal branch.
    - **Upper lateral cutaneous nerve of the arm:** innervate superior lateral side of the arm.



Axillary Nerve Injury

- Results from injury in the quadrangular space
  - Downward humeral dislocation
  - Humeral fracture at surgical neck
- **Deltoid muscle paralysis**: leads to limited abduction for the arm.
- Deltoid atrophy
- **Loss of sensation over the lower half of deltoid muscle**: Limited anesthesia of lateral side of shoulder; because of the overlapping of the cutaneous branches in this area.





Cutaneous Innervation of the Upper Limb

Musculoskeletal

Axillary

Radial

Ulnar

Median

Medial cord

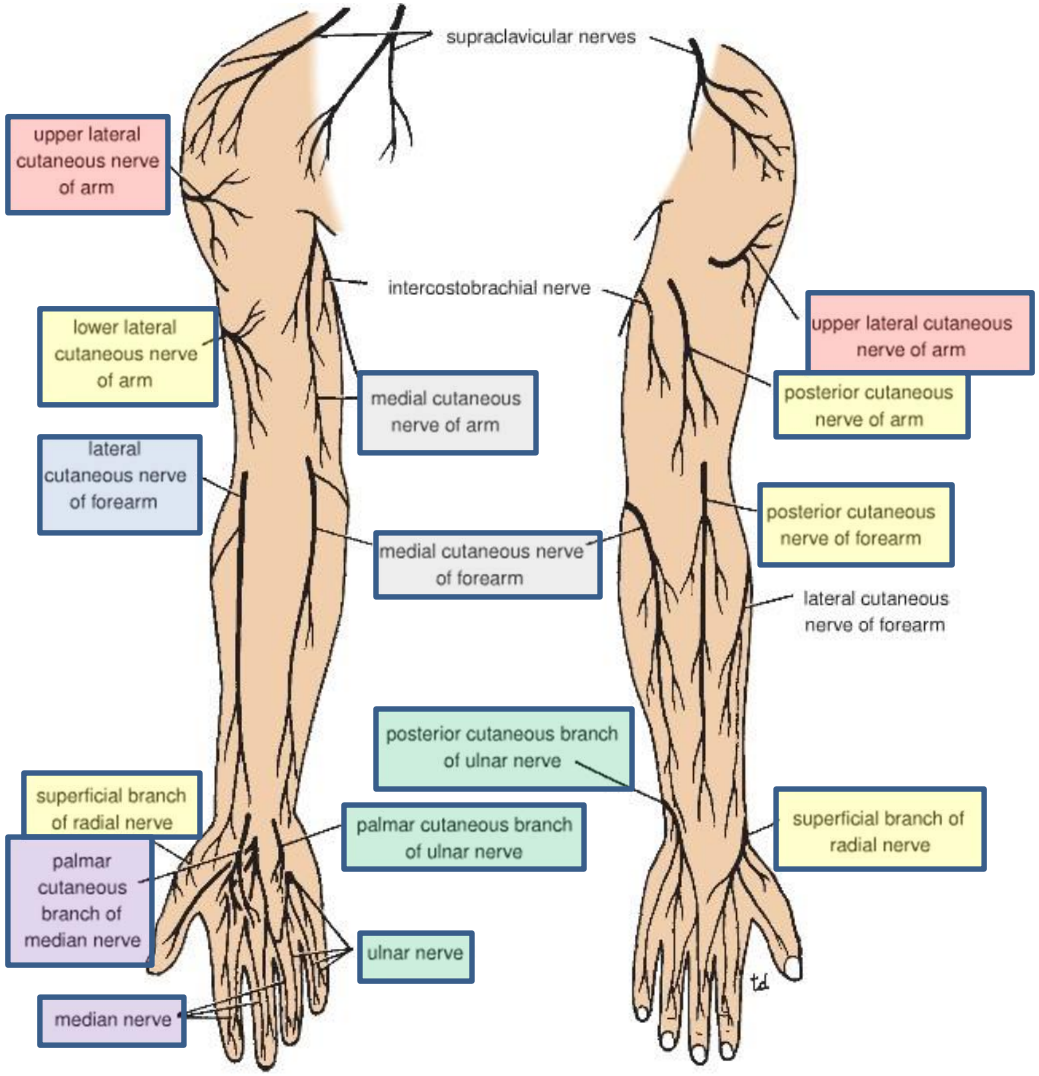
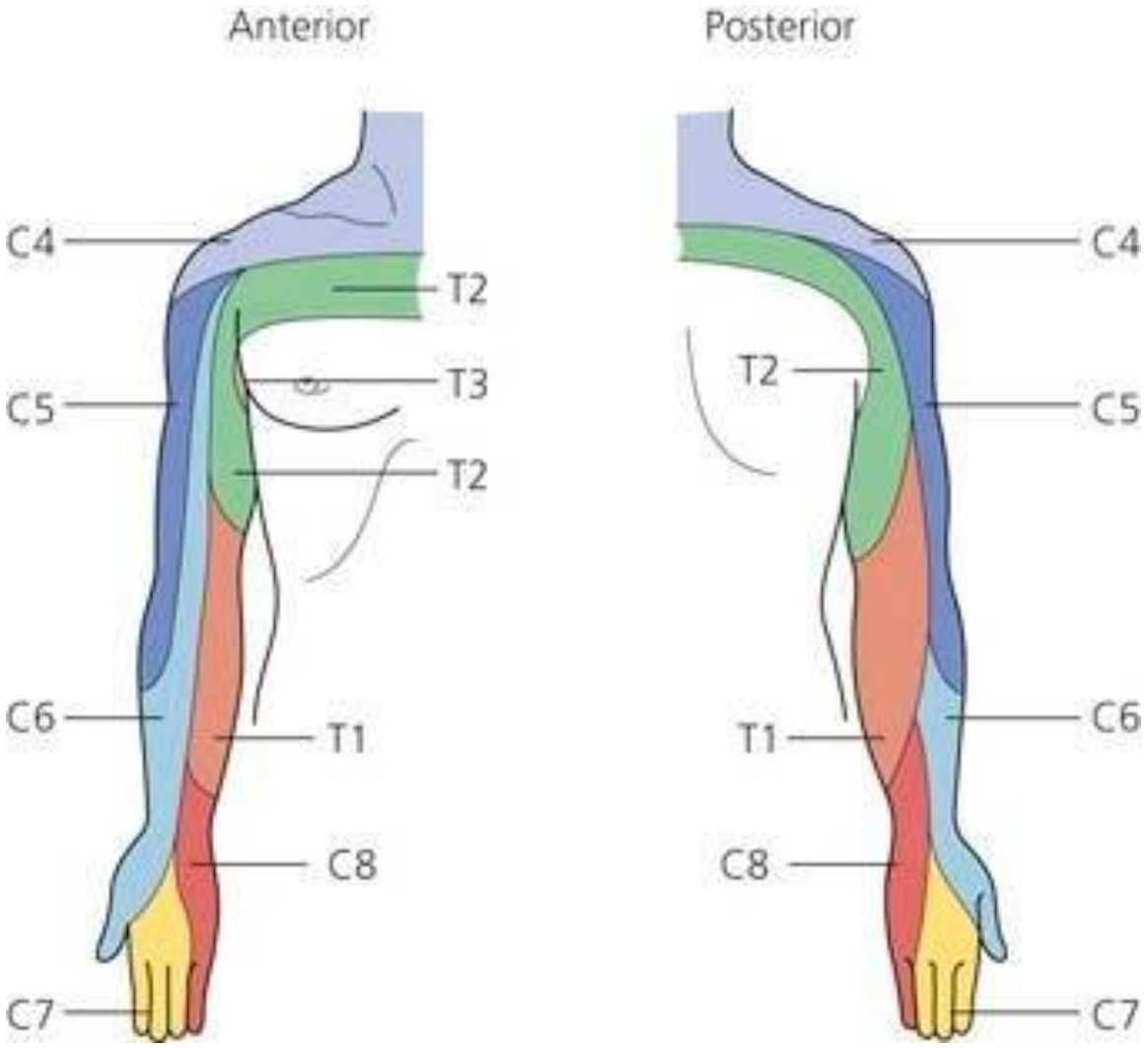


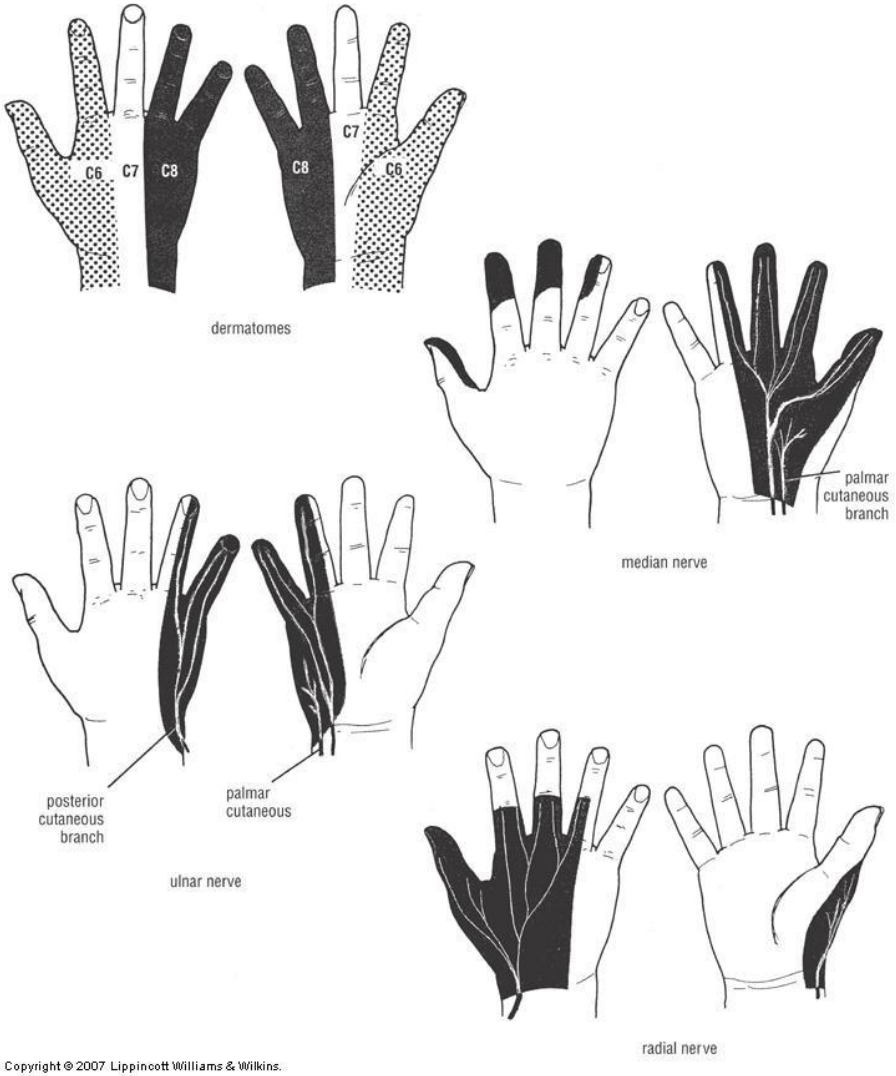
Figure 17-8 Cutaneous innervation of the upper limb.

Dermatomes of the Upper Limb

C4 + C5 + C6: lateral side
T2 + T1 + C8 + C7: medial side



Dermatomes & Cutaneous Nerves of the Hand



Dermatome Tests for the Upper Limb

TABLE 6.1. DERMATOMES OF UPPER LIMB

Spinal Segment/Nerve(s)	Description of Dermatome(s)
C3, C4	Region at base of neck, extending laterally over shoulder
C5	Lateral aspect of arm (i.e., superior aspect of abducted arm)
C6	Lateral forearm and thumb
C7	Middle and ring fingers (or middle three fingers) and center of posterior aspect of forearm
C8	Little finger, medial side of hand and forearm (i.e., inferior aspect of abducted arm)
T1	Medial aspect of forearm and inferior arm
T2	Medial aspect of superior arm and skin of axilla[a]

[a]Not indicated on the Keegan and Garrett (1948) dermatome map. However, pain experienced during a heart attack, considered to be mediated by T1 and T2, is commonly described as "radiating down the medial side of the left arm."

Tendon Reflexes & Segmental Innervation of the Upper Limb Muscles

- **Biceps brachii tendon reflex**
  - C5 & C6
    - Flexion of the elbow joint
    - Tapping on the biceps tendon
- **Triceps tendon reflex**
  - C6-C8
    - Extension of the elbow joint
    - Tapping on the triceps tendon
- **Brachioradialis tendon reflex**
  - C5-C7
    - Supination of the radioulnar joint
    - Tapping the brachioradialis tendon

The specific neurovascular manifestations of acute cervical disc herniation

IV disc level	Nerve root level	Manifestations	Reflexes
C2	C3	posterior neck numbness and pain radiating to the mastoid and ear	reflexes test normal
C3	C4	posterior neck numbness and pain radiating along the levator scapulae muscle and sometimes to the pectorals	reflexes test normal
C4	C5	lateral neck, shoulder, and arm pain and paresthesia, deltoid weakness and possible atrophy, hypesthesia of C5 root distribution over middle deltoid area (axillary nerve distribution).	reflexes test normal
C5	C6	pain radiating down the lateral arm and forearm into the thumb and index finger, hypesthesia of the lateral forearm and thumb	decreased biceps reflex, biceps and supinator weakness
C6	C7	pain radiating down the middle forearm to the middle fingers, hypesthesia of the middle fingers	decreased triceps and radial reflexes, triceps and grip weakness
C7	C8	possible pain radiating down the medial forearm and hand, ulnar hypesthesia, intrinsic muscle weakness of the hand. However, these symptoms are uncommon	reflexes test normal

Myotome Tests for the Upper Limb

To assess the function of muscles.
(The action AGAINST RESISTANT)

- Abduction of Arm (C_5)
  - Supraspinatus –Supraspinatus Nerve
  - Deltoid-Axillary Nerve
- Arm Adduction (C_7)
  - Pectoralis Major- Pectoral Nerves
  - Latissimus Dorsi- Thoracodorsal Nerve
- Forearm Flexion (C_{5-6})
  - Brachialis-Musculocutaneous
  - Biceps Brachii- Musculocutaneous

Myotome Tests for the Upper Limb

- Forearm Extension (C_7)
  - Triceps Brachii-Radial nerve
- Wrist Flexion ($C_{7,8}$ T_1)
  - Flexor Carpi Radialis- Median Nerve
  - Flexor Carpi Ulnaris-Ulnar Nerve
- Wrist Extension ($C_{7,8}$)
  - Extensor Carpi Radialis (Longus and Brevis)-Radial Nerve
  - Extensor Carpi Ulnaris- Posterior Interosseous Nerve

Myotome Tests for the Upper Limb

- Finger Flexion ($C_{7,8}T_1$)
  - Flexor Digitorum Superficialis-Median Nerve
  - Flexor Digitorum Profudus-Ulnar & Anterior Interosseous branch of Median
- Finger Extension (C_7)
  - Extensor Digitorum-Posterior Interosseous branch of Radial
- Thumb Abduction ($C_{7,8}$ T_1)
  - Abductor Pollicis Longus-Radial Nerve
  - Abductor Pollicis Brevis-Median Nerve

Myotome Tests for the Upper Limb

- Thumb Opposition (T_1)
  - Opponens Pollicis: Median Nerve.
- Finger Abduction (C_8,T_1)
  - Dorsal Interossei & Abductor Digiti Minimi-Ulnar Nerve.
- Finger Adduction (C_8,T_1)
  - Palmar interossei-Ulnar Nerve.
  - http://www.youtube.com/watch?v=rKiTwagLYck

❖ **To sum up the idea, you can assess either the integrity of spinal segments, specific nerves, or specific muscles by assessing the action of muscles against resistance.**