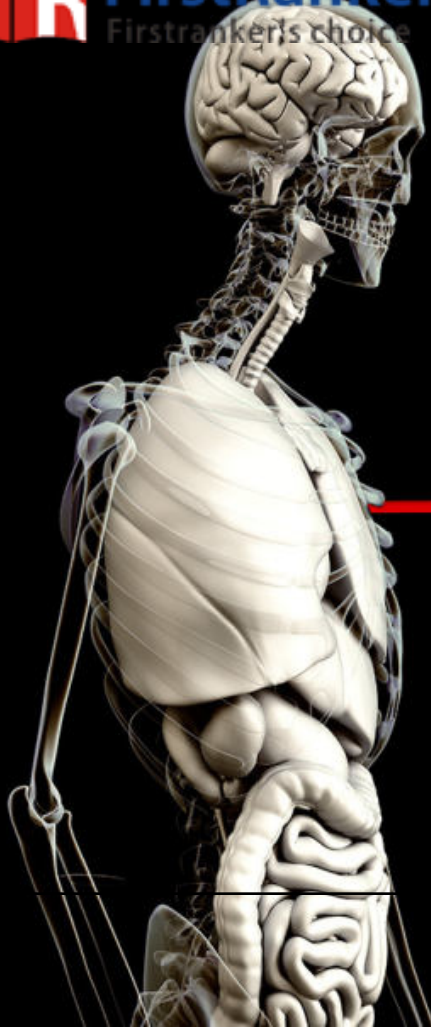
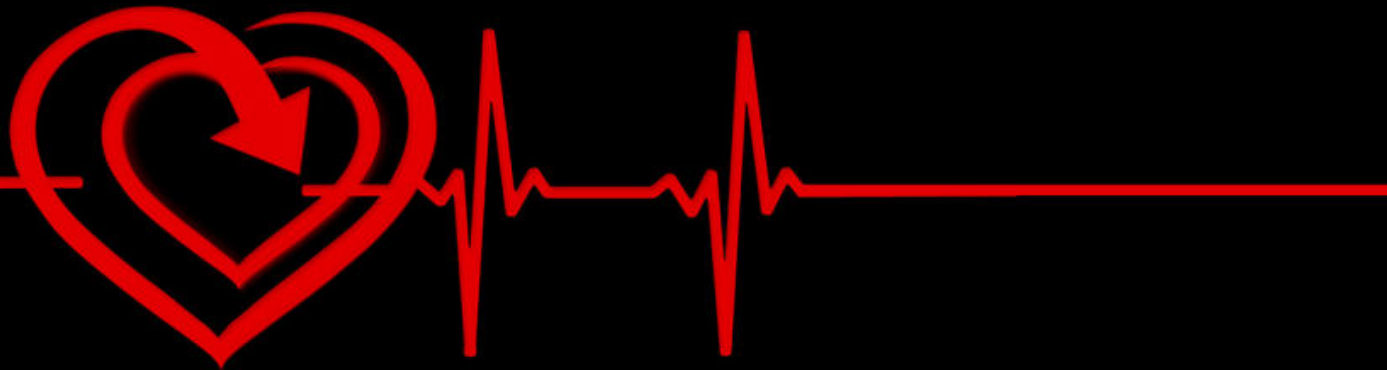


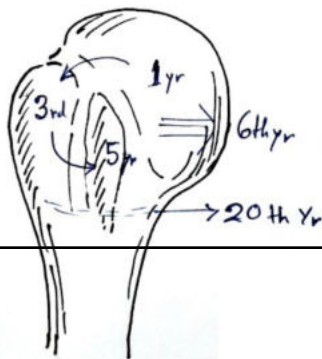
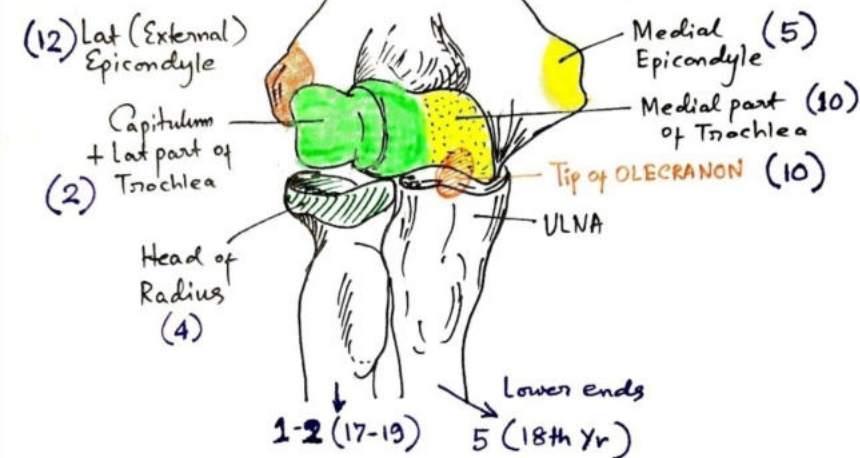


Special Anatomy Class

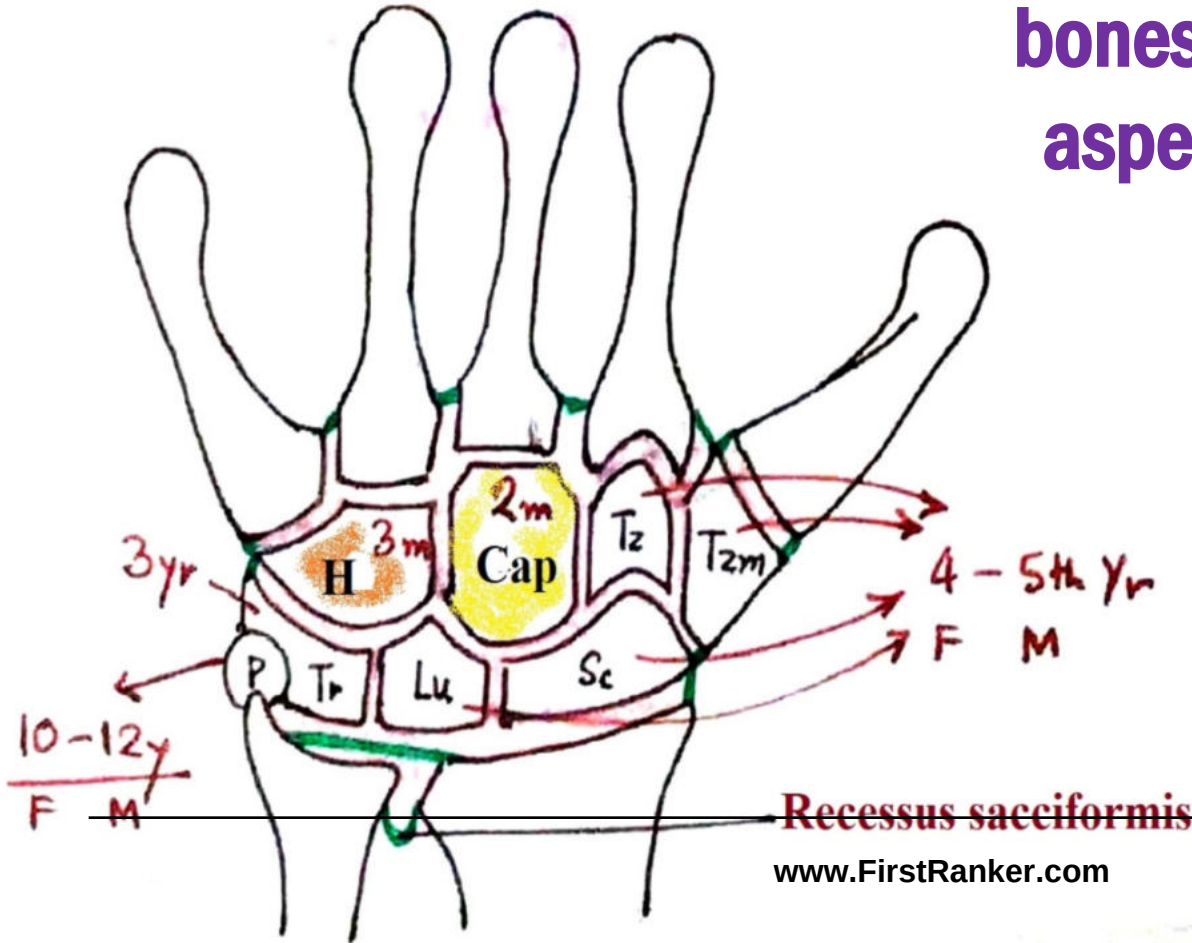


Dr. Partha Sarathi Ain.MD

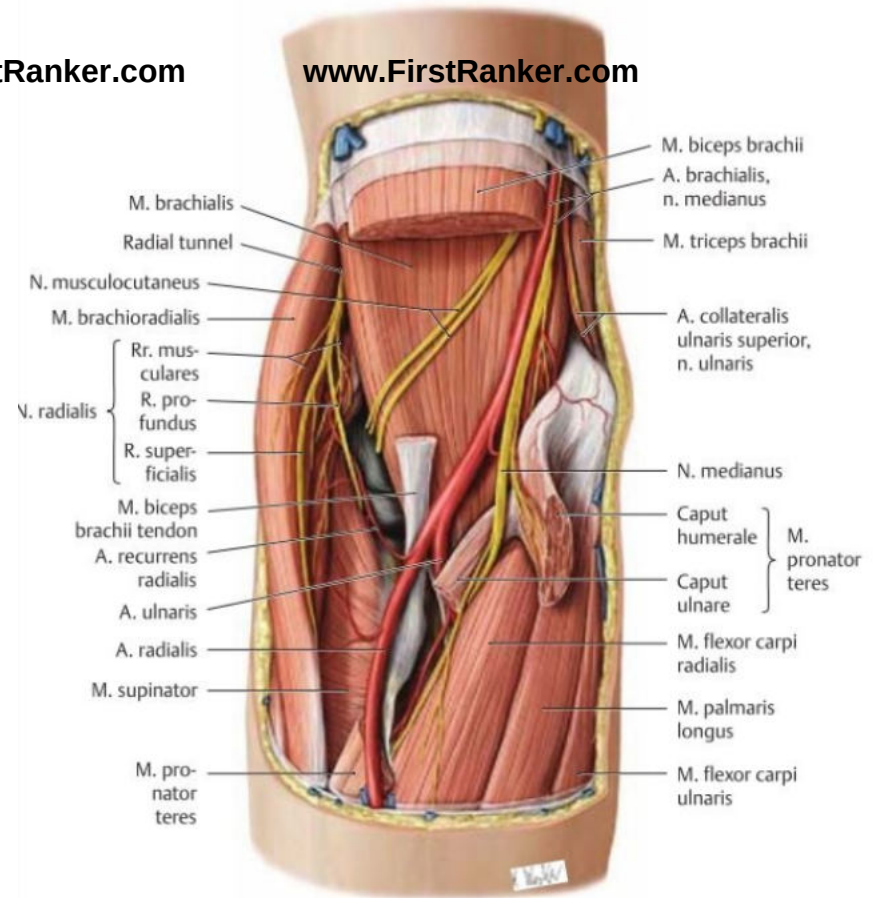
Ossification around elbow and head of the Humerus.

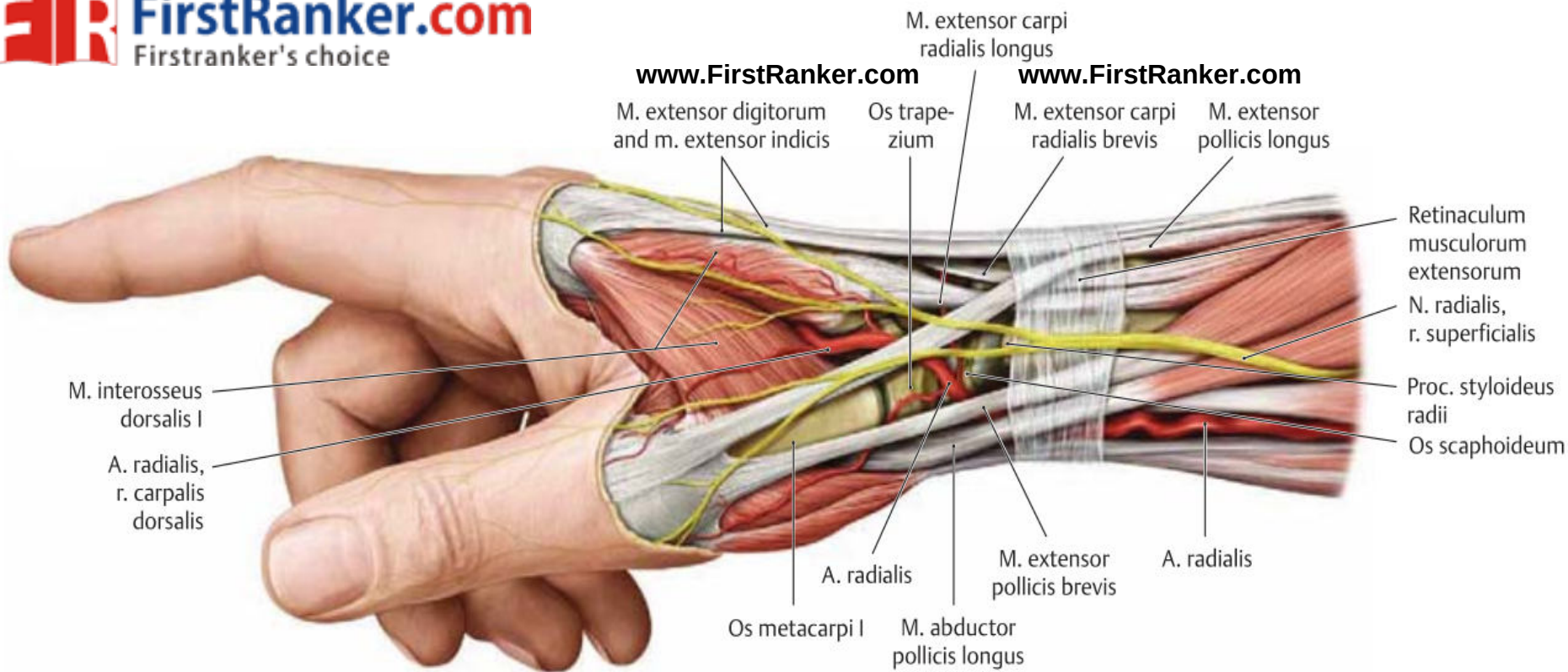


Ossification of Carpal bones (showing palmar aspect of Right hand)

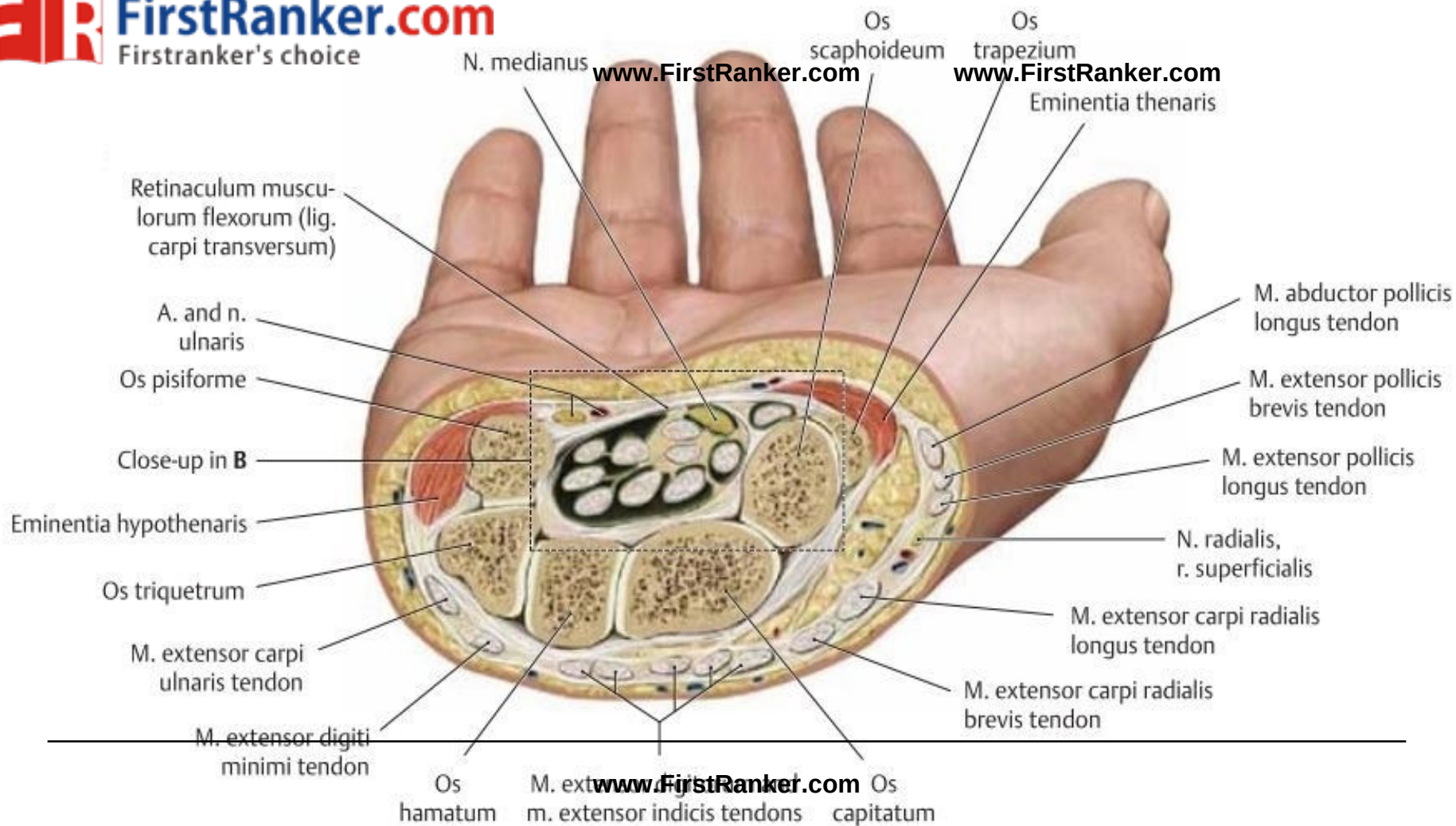


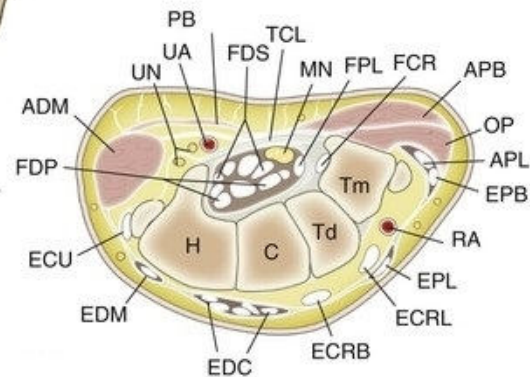
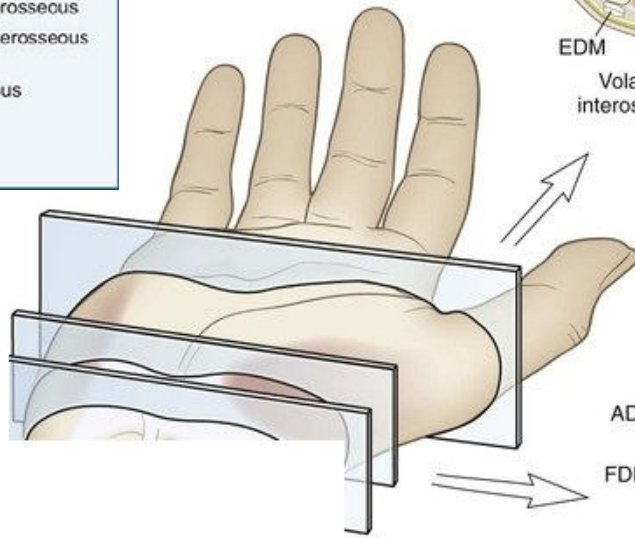
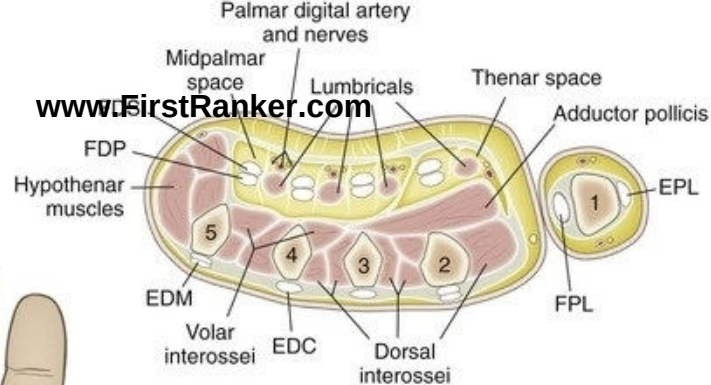
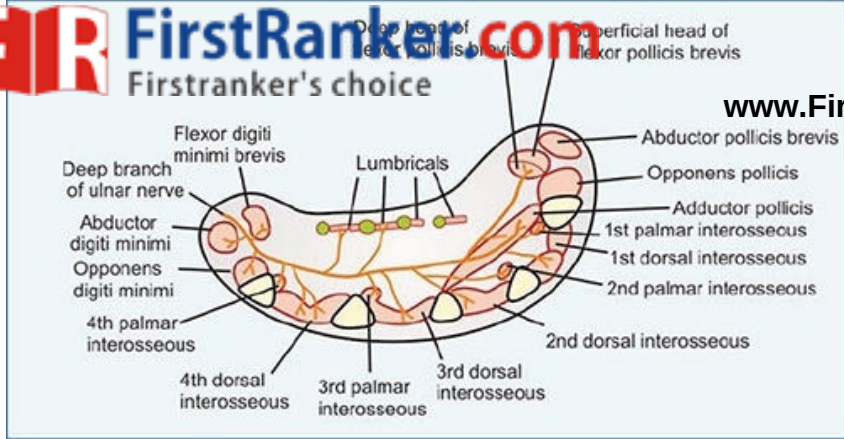
Median nerve through both heads of pronator Teres











ADM, Abductor digiti minimi
APB, abductor pollicis brevis
APL, abductor pollicis longus
ECRB, extensor carpi radialis brevis;
ECRL, extensor carpi radialis longus
ECU, extensor carpi ulnaris
EDC, extensor digitorum communis;
EDM, extensor digiti minimi;
EPB, extensor pollicis brevis;
EPL, extensor pollicis longus
FCR, flexor carpi radialis; **FCU**, flexor carpi ulnaris;
FDP, flexor digitorum profundus;
FDS, flexor digitorum superficialis; **FPL**, flexor pollicis longus;
C, Capitate; **H**, hamate; **L**, lunate; **MN**, median nerve; **OP**, opponens pollicis
P, pisiform; **PQ**, pronator quadratus; **RA**, radial artery; **S**, scaphoid;
Tq, triquetrum; **Tm**, trapezium; **Td**, trapezoid; **UA**, ulnar artery; **UN**, ulnar nerve.

The muscles of Arm (4)

MUSCLES OF HAND AT A GLANCE

Total muscles - 50 in numbers

Anterior group (3)

- Biceps brachii ----- supplied by **musculocutaneous nerve**.
Long head: supraglenoid tubercle
Short head: coracoid process along with Coracobrachialis.
- Coracobrachialis ----- supplied and pierced by **musculocutaneous nerve**.
- Brachialis ----- supplied by **musculocutaneous nerve & radial nv** (proprioception)

Posterior group (1)

Triceps brachii - supplied by **radial nerve**.

Long head –from infraglenoid tubercle of scapula

Lateral head –from oblique ridge on the posterior surface of humerus above spiral groove.

Medial head –from the posterior surface of humerus below spiral groove.

The muscle of Shoulder(6)

- Deltoid ----- supplied by **Axillary nerve**.
- Subscapularis ----- supplied by **Upper & Lower subscapular nerve** (Branch of Post Cord of brachial plexus)
- Supraspinatus ----- supplied by **Suprascapular nerve**.
- Infraspinatus ----- supplied by **Suprascapular nerve**.
- Teres minor ----- supplied by **Axillary nerve** via a branch that has **pseudoganglion** on it.
- Teres major ----- supplied by **Lower subscapular nerve**.

(Branch of upper trunk of Brachial Plexus)

muscles. are (8)

- They act on the elbow, wrist joints and the fingers.
- They form fleshy masses in the proximal part and become tendinous in the distal part of the forearm.
- They are arranged in three groups:

I-Superficial: 4

1. Pronator teres.
2. Flexor carpi radialis.
3. Palmaris longus.
4. Flexor carpi ulnaris.

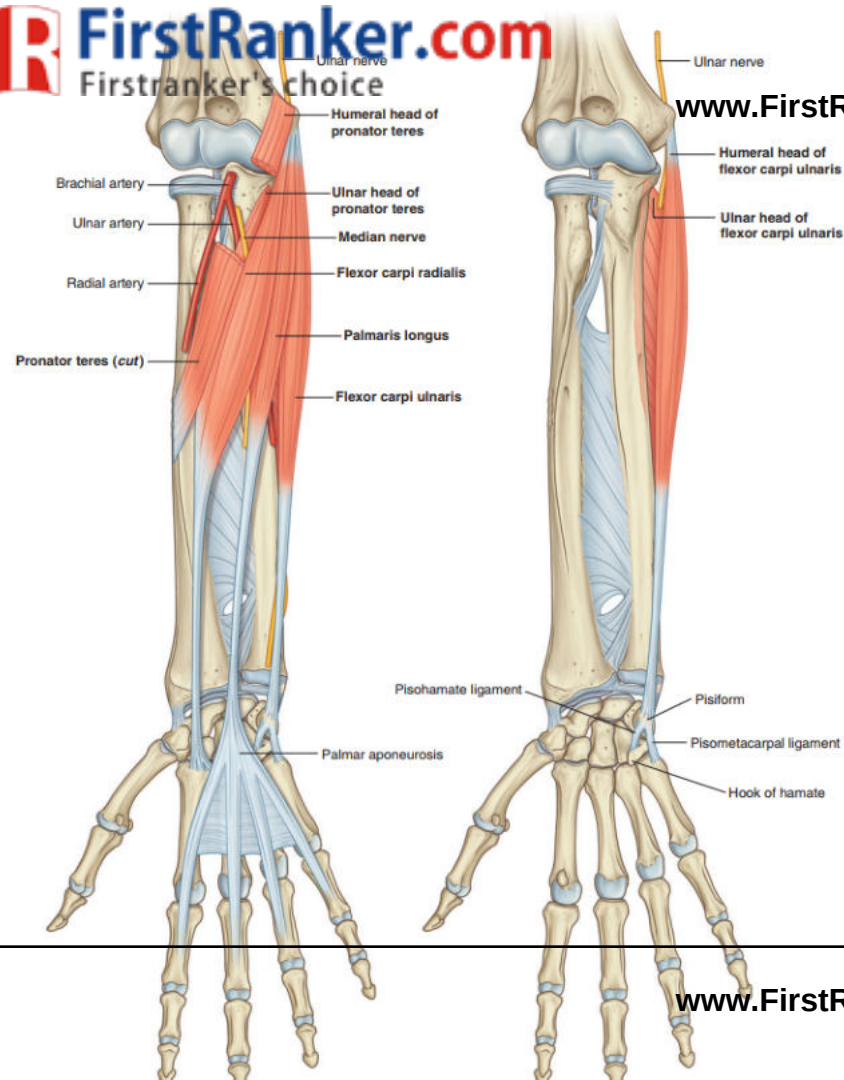
II-Intermediate: 1

- Flexor digitorum superficialis.



III- Deep: 3

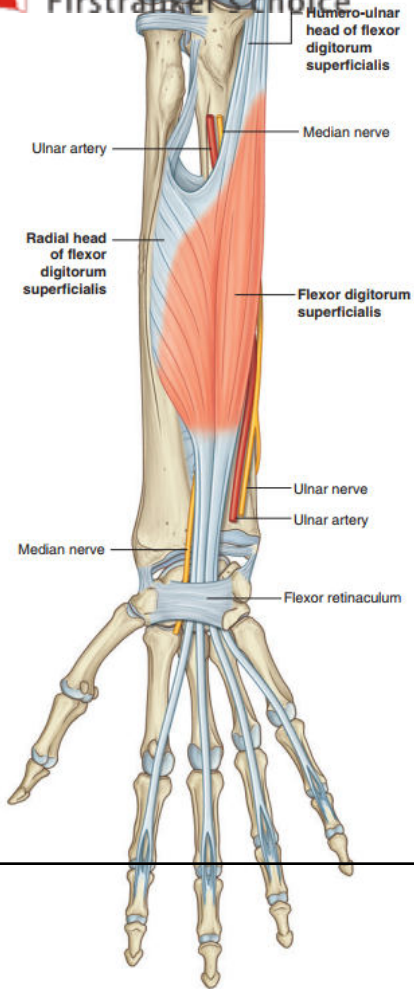
1. Flexor digitorum profundus.
2. Flexor pollicis longus.
3. Pronator quadratus.



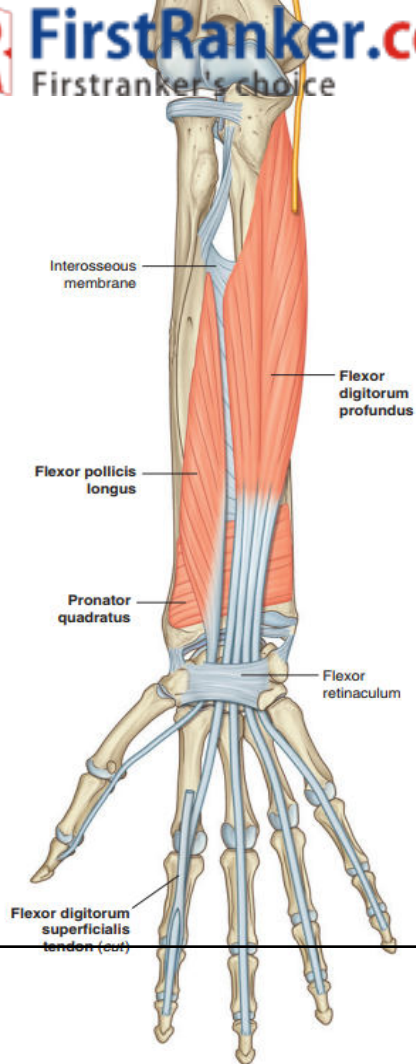
Superficial layer of forearm muscles.

A. Superficial muscles (flexor retinaculum not shown).

B. Flexor carpi ulnaris muscle.



Intermediate layer of forearm muscles.



Deep layer of forearm muscles.

Brachioradialis

Anconeus

Extensor carpi
radialis longus

Extensor carpi
radialis brevis

Extensor carpi ulnaris

Extensor digiti minimi

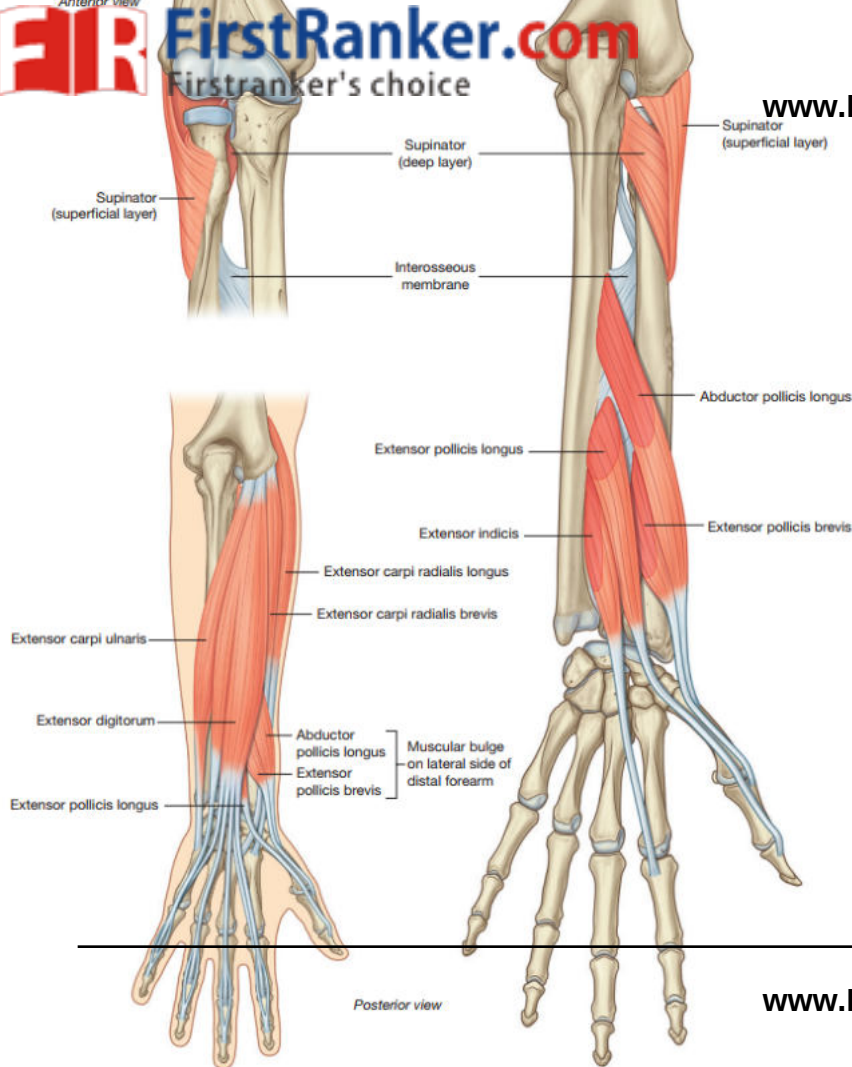
Extensor digitorum

Extensor retinaculum

Superficial layer of muscles in the posterior compartment of the forearm.

A. Brachioradialis muscle (anterior view).

B. Superficial muscles (posterior view).

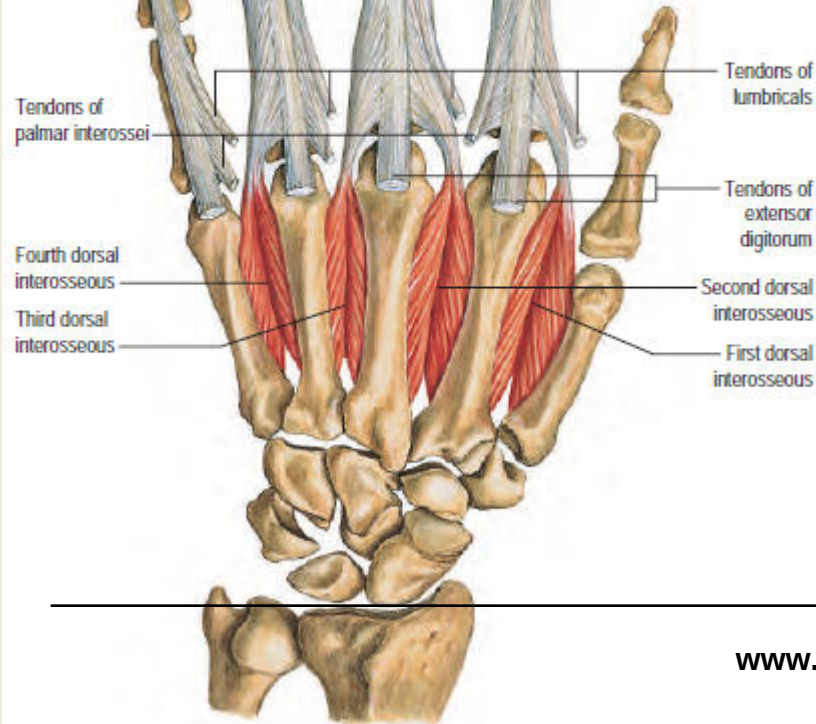


Deep layer of muscles in the posterior compartment of the forearm.

It is formed by the union of the tendons of: Extensor digitorum, **Extensor indicis, extensor digiti minimi, palmar & dorsal interossei** and **lumbricals** muscles.

All these tendons unite to form one tendon above the proximal phalanges. Then each divides into **3 slips**, a median one attached to middle phalanges and 2 lateral attached to the terminal phalanges.

Dorsal Interossei muscles



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Tendons of flexor digitorum superficialis

First lumbrical

Second lumbrical

Lumbrical muscles

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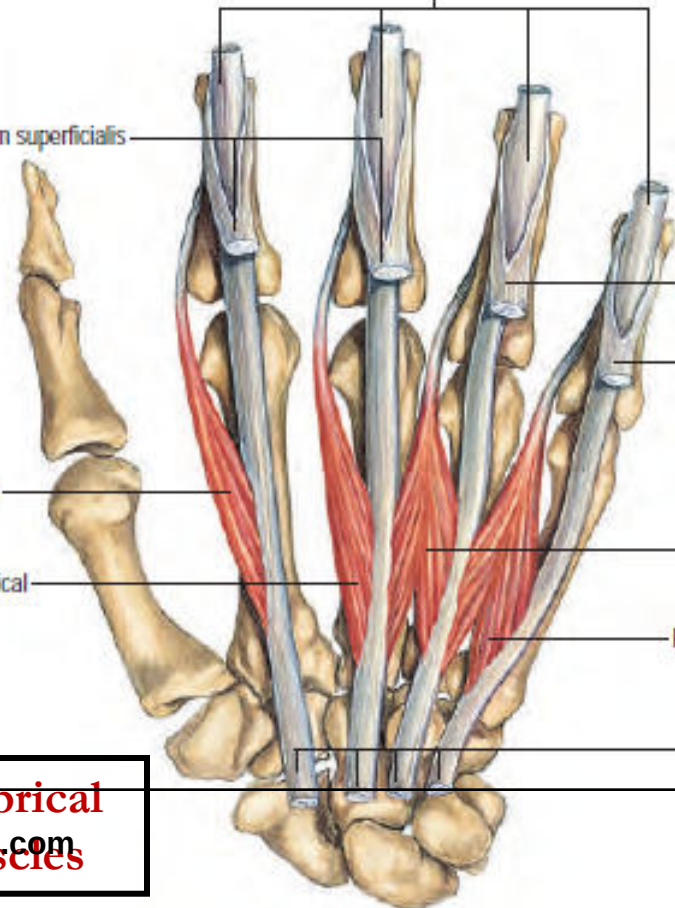
Tendons of flexor digitorum profundus

Tendons of flexor digitorum superficialis

Third lumbrical

Fourth lumbrical

Tendons of flexor digitorum profundus



The muscles of Hand (20)

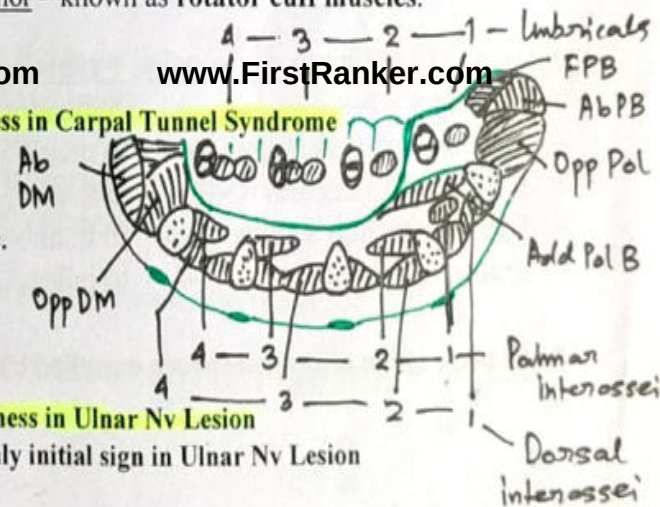
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Thenar (3 + Adductor pollicis)

- Abductor Pollicis brevis
 - Flexor Pollicis Brevis.
 - Opponens Pollicis.
 - Adductor Pollicis -----
- Composite muscle
----- supplied by **Median nerve**.
Deep head
----- supplied by **Ulnar nerve**.

The first muscle to show weakness in Carpal Tunnel Syndrome



Hypothenar (3)

- Abductor digitiminimi.
 - Flexor digitiminimi.
 - Opponens digitiminimi.
- The first muscle to show weakness in Ulnar Nv Lesion
Loss of function may be the only initial sign in Ulnar Nv Lesion
----- supplied by **Ulnar nerve**.

Lumbricals (4) ----- 1st & 2nd supplied by **Median nerve** and 3rd & 4th supplied by **Ulnar nerve**.

Originate from FDP tendons of 2nd to 5th fingers.

1st & 2nd lumbricals are Unipinnate, 3rd & 4th lumbricals are Bipinnate.

Dorsal Interossei (4) ---- supplied by **Ulnar nerve**. Originate From adjacent metacarpals of 1st to 5th fingers. They are bipinnate in structure. They are **abductors**.

Palmar Interossei (4) ---- supplied by **Ulnar nerve**. Originate From base of metacarpals of 1st to 5th fingers, except 3rd.

1st & 2nd originate from **ulnar side** & 3rd & 4th originate from **radial side**. They are **adductors**

Palmaris Brevis ----- only muscle supplied by superficial branch of ulnar nerve.

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I-Superficial: 4

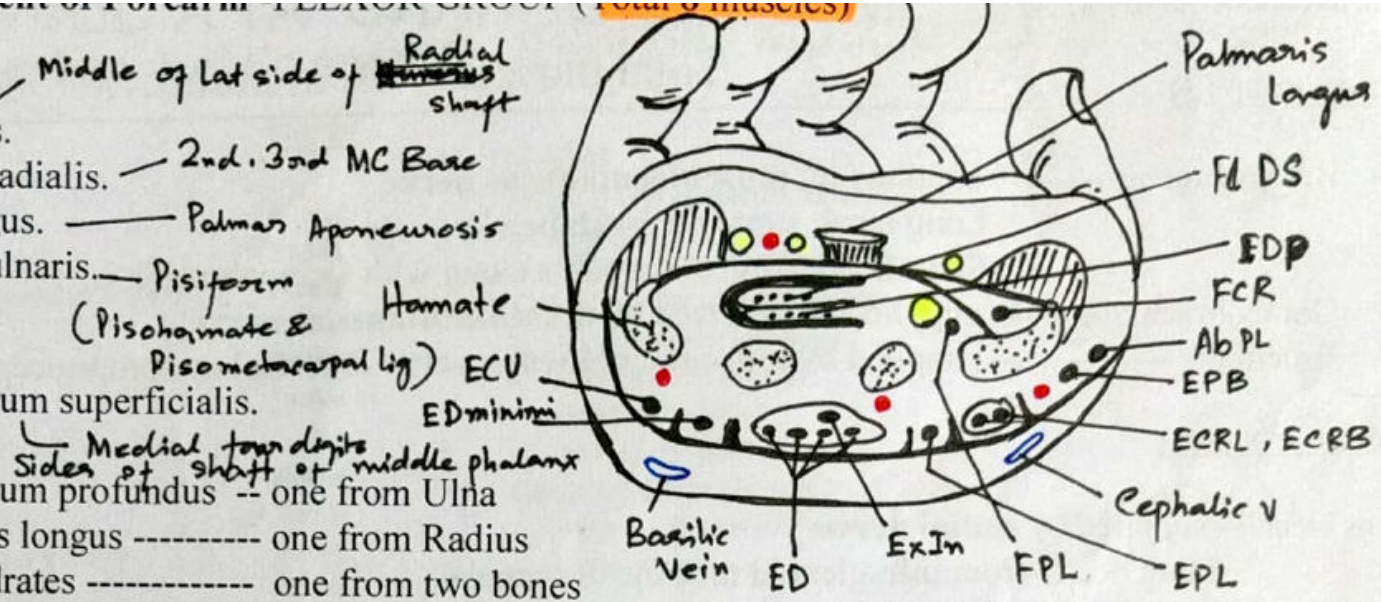
1. Pronator teres. — Middle of lat side of ~~Radius~~ ^{Radial shaft}
2. Flexor carpi radialis. — 2nd, 3rd MC Base
3. Palmaris longus. — Palmar Aponeurosis
4. Flexor carpi ulnaris. — Pisiform (Pisohamate & Pisometacarpal lig)

II-Intermediate: 1

- Flexor digitorum superficialis.

III- Deep: 3

1. Flexor digitorum profundus — one from Ulna
2. Flexor pollicis longus — one from Radius
3. Pronator quadrates — one from two bones



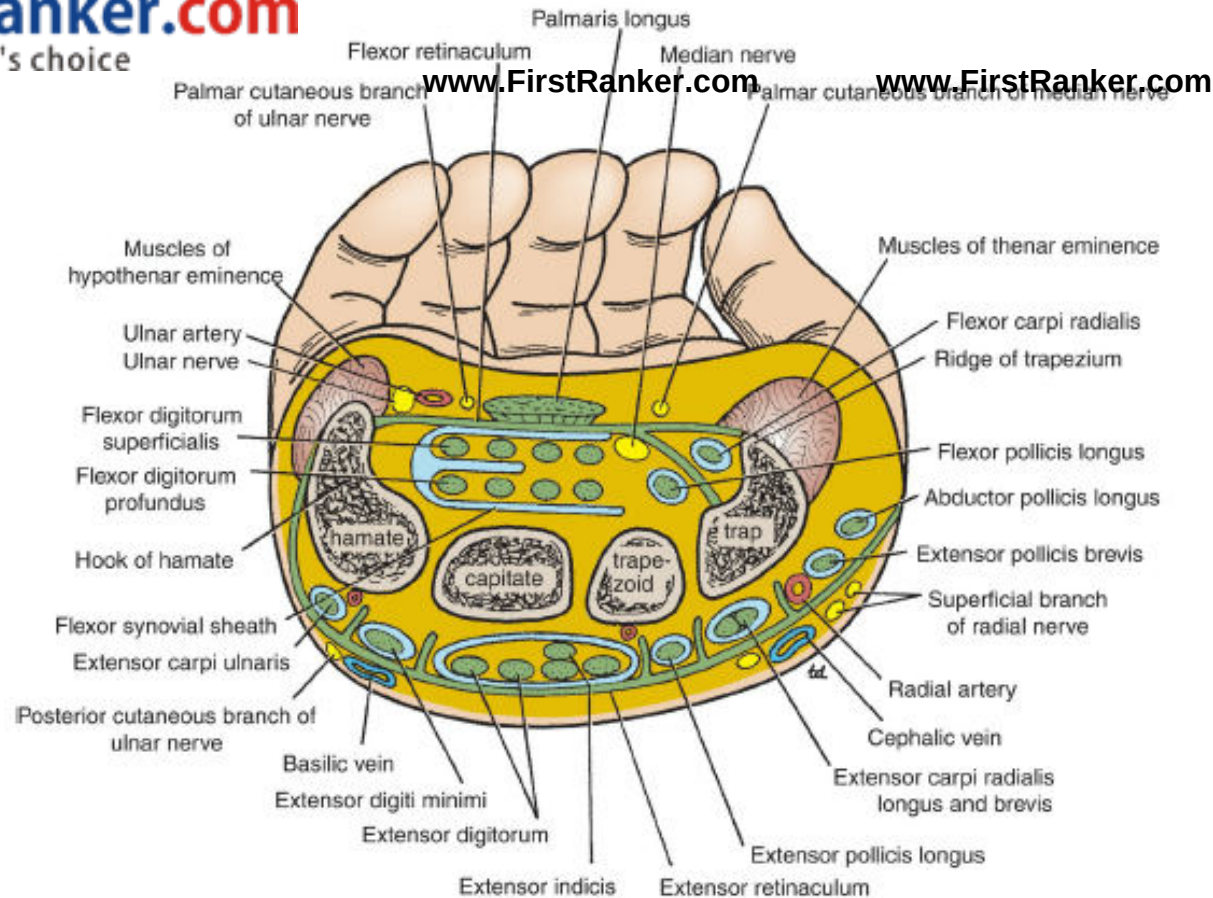


Figure 3.36 Cross section of the hand showing the relation of the tendons, nerves, and arteries to the flexor and extensor retinacula.

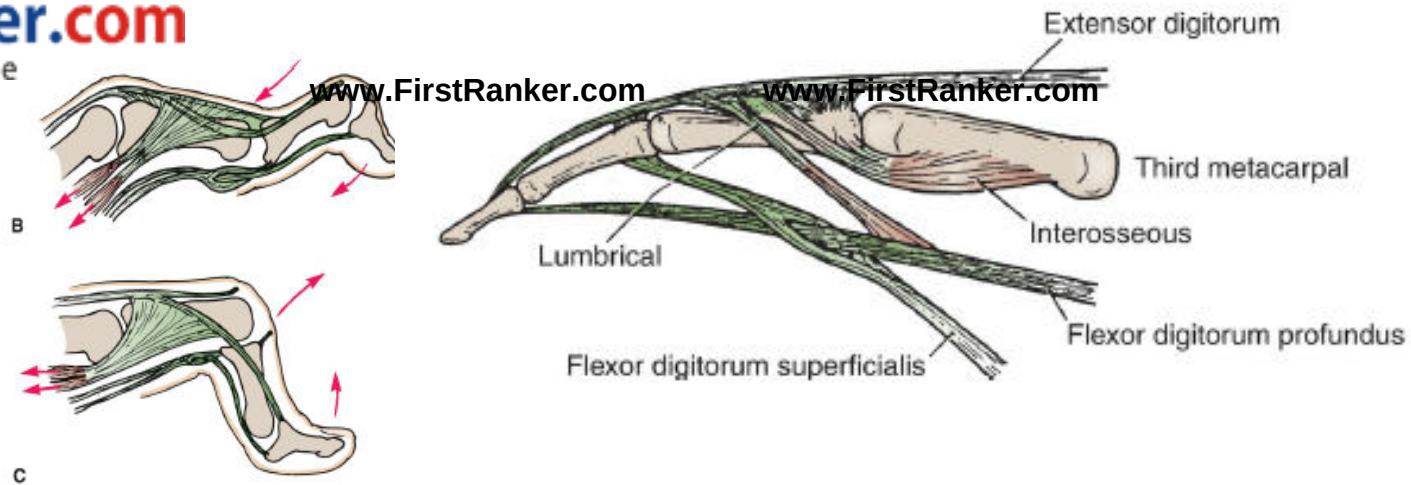


Figure 3.49 A. Posterior view of normal dorsal extensor expansion. The extensor expansion near the proximal interphalangeal joint splits into three parts: a central part, which is inserted into the base of the middle phalanx, and two lateral parts, which converge to be inserted into the base of the distal phalanx. **B.** Mallet or baseball finger. The insertion of the extensor expansion into the base of the distal phalanx is ruptured; sometimes, a flake of bone on the base of the phalanx is pulled off. **C.** Boutonnière deformity. The insertion of the extensor expansion into the base of the middle phalanx is ruptured. The arrows indicate the direction of the pull of the muscles and the deformity.



Posterior compartment of Forearm - EXTENSOR GROUP (Total 12 muscles in 3 groups)

Origin: Common Extensor Origin (front of the lateral epicondyle).

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Superficial group 5

- Extensor carpi radialis brevis - Common Extensor Origin (front of the lateral epicondyle)
- Extensor digitorum ----- Common Extensor Origin (front of the lateral epicondyle) — Base of distal Phalanx Medial 4 fingers
- Extensor digiti minimi ----- Common Extensor Origin (front of the lateral epicondyle)
- Extensor carpi ulnaris ----- Common Extensor Origin (front of the lateral epicondyle)
- Anconeus ----- Originates from the post surface of Lateral epicondyle. — Dorsal digital expansion of Little finger

Medial side, base of 5th MC Bone

→ Lat Surface of Olecranon process

Lateral group 2

- Brachioradialis ----- originates from Lateral supracondylar ridge — Base of Radial Styloid
- Extensor carpi radialis longus - originates from Lateral supracondylar ridge — Base of 2nd MC Bone

Deep group 5 (3 to thumb + 1 to index + supinator).

- Supinator ----- Supinates only in elbow extended position.
- Abductor pollicis longus ----- to thumb --- insertion at base of 1st MC
- Extensor pollicis brevis ----- to thumb --- insertion at base of Proximal phalanx
- Extensor pollicis longus ----- to thumb --- insertion at base of Distal phalanx
- Extensor indices ----- to index — Dorsal digital expansion

■ All back of the arm muscles are supplied by deep branch of radial nerve, EXCEPT - ABE

- A. Anconeus.
- B. Brachioradialis
- E. Extensor carpi radialis longus.
- These 3 muscles are supplied by the radial nerve itself.

INSERTIONS :-

Extensor carpi radialis brevis:

Base of 2nd and 3rd metacarpal bone.

Extensor digitorum:

Extensor expansion of the medial 4 fingers.

Extensor digiti minimi:

Extensor expansion of the little finger.

Extensor carpi ulnaris:

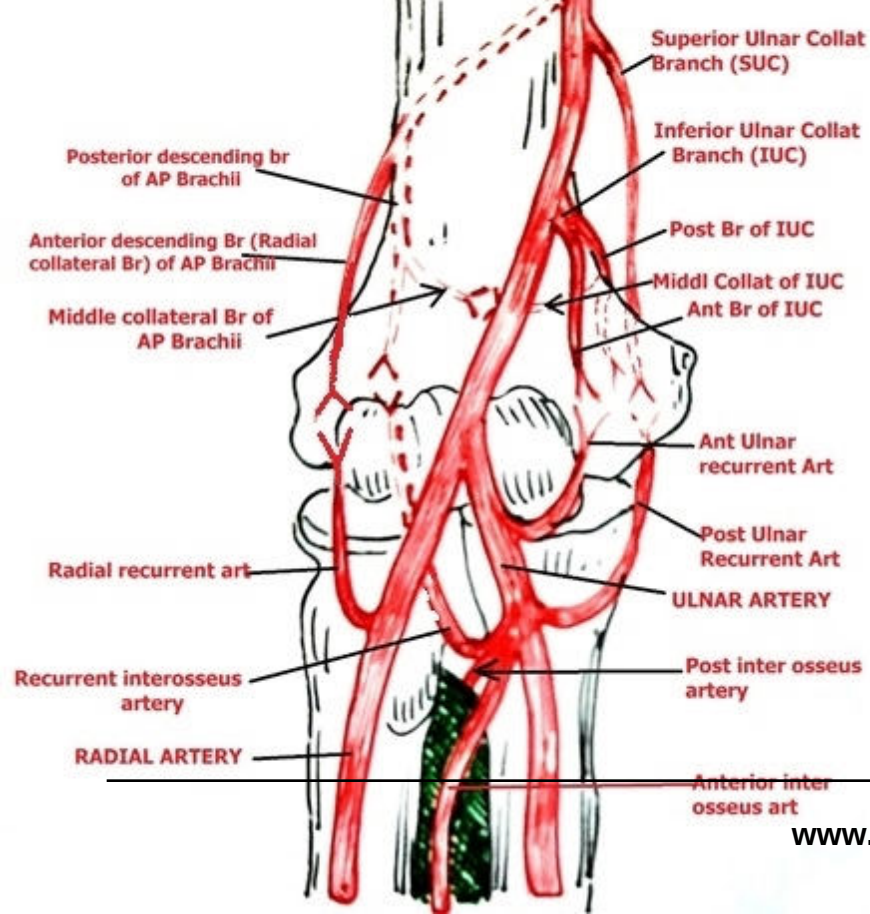
Base of the 5th metacarpal bone

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BRACHIAL ART

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1. **In front of the medial epicondyle**—Inferior ulnar collateral artery and a branch from superior ulnar collateral artery (both derived from the brachial artery),
with

anterior ulnar recurrent branch of the ulnar artery;

2. **Behind the medial epicondyle**—Superior ulnar collateral artery and a branch from inferior ulnar collateral artery, both derived from the brachial,

with

posterior ulnar recurrent branch of the ulnar artery;

3. **In front of the lateral epicondyle**—The radial collateral branch (anterior descending branch) of profunda brachii (from brachial),

with

the radial recurrent branch of radial artery;

4. **Behind the lateral epicondyle**—The posterior

descending branch of arterio profunda brachii,

with

the interosseous recurrent branch of the posterior interosseous artery (from ulnar artery);

5. **Above the olecranon fossa**—A transverse anastomosis between the middle collateral branch of profunda brachii, and a transverse branch from the posterior division of the inferior ulnar collateral artery.

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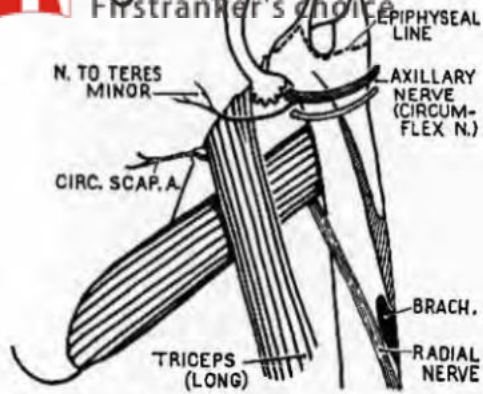
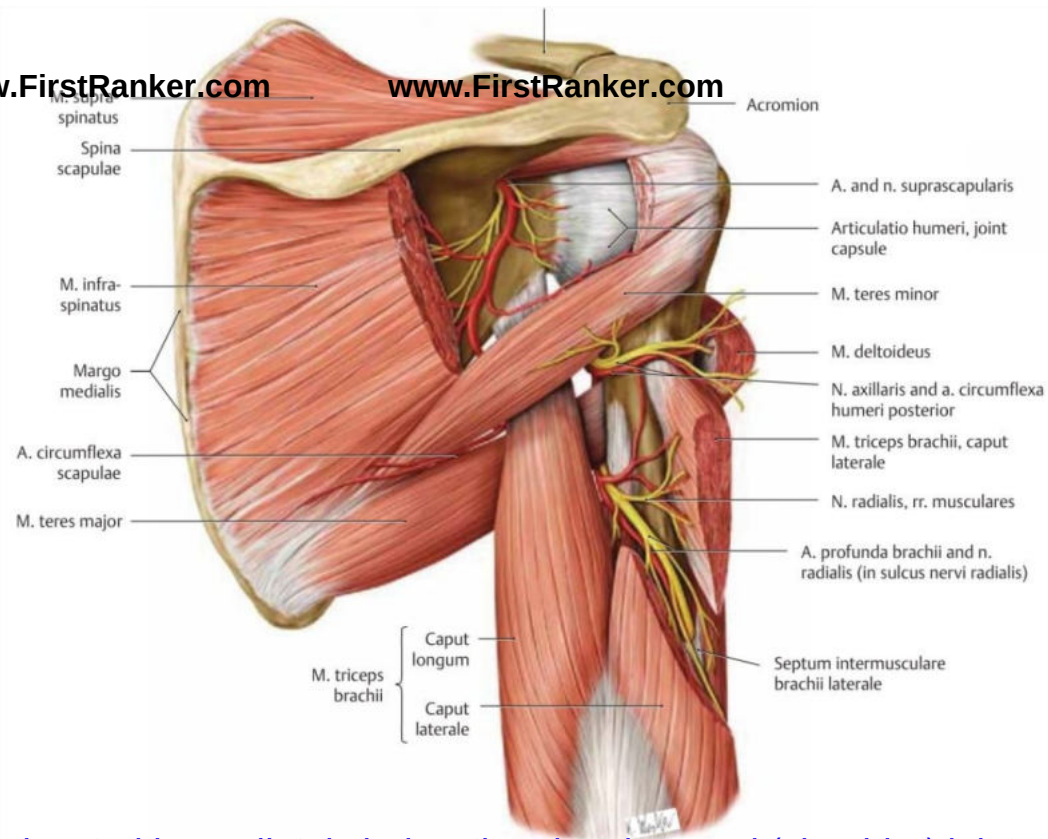


Figure 31.12. The triangular and quadrangular spaces.

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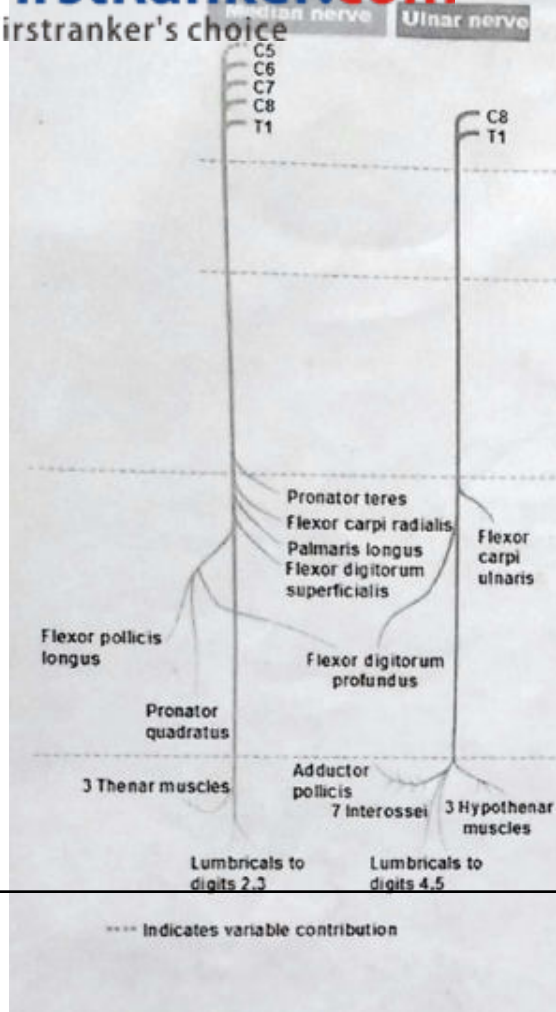
Quadrangular Space

The quadrangular space is an intermuscular space, located immediately below the glenohumeral (shoulder) joint. It is bounded above by the subscapularis and teres minor muscles and the capsule of the shoulder joint and below by the teres major muscle. It is bounded medially by the long head of the triceps and laterally by the surgical neck of the humerus. The significance of the quadrangular space is that the axillary nerve and the posterior circumflex humeral vessels

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Median Nerve (Labourer's nerve) Lesions :-

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- Loss of flexion at middle phalanges of all digits – due to FDS palsy.
- Loss of flexion at distal phalanges of index & middle fingers – due to FDP (Radial half) palsy.

- **Hand of Benediction** – paralysis of Long flexors in the anterior compartment of the arm (except the medial half of the flexor digitorum profundus and the flexor carpi ulnaris).

Lateral two lumbricals: Flexes at the MCP joints and extends at the IP joints of the index and middle fingers.

If the patient is asked to make a fist, they will be able to flex the little and ring fingers. This action is performed by the medial half of the flexor digitorum profundus and the medial two lumbricals.



- **Thenar atrophy and Thumb remains extended and adducted** – due to unopposed action of EPL & EPB and Add Pollicis (**Ape like or Simian Hand**)
- The forearm tends to rest in supination with the wrist in ulnar deviation
- Cutaneous sensation is lost – palmar surface of lateral 3½ digits and dorsal surface of the same digits over middle and distal phalanges. In thumb – only dorsal surface of distal phalanx is affected.
- **Pronator teres syndrome / AIN syndrome:-** Compression of the median nerve between the two heads of the pronator teres muscle or by the proximal free tendinous edge of radial attachment of FDS.

The patient cannot make 'OK' sign properly.



HAND OF BENEDICTION



Median Nerve Injury

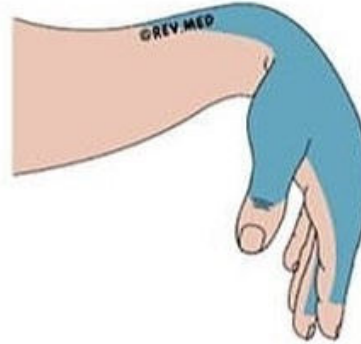
CONTEXT

Extension of 1st, 2nd,
3rd digits when trying
to make a fist

LOCATION

Proximal median nerve

WRIST DROP



Radial Nerve Injury

CONTEXT

Loss of elbow, wrist &
digits extension, decrease
in grip strength

LOCATION

Superficial branch of
Radial nerve

CLAW HAND



Ulnar Nerve Injury

CONTEXT

Hyperextension of
digits & flexion of 4th
& 5th digits or at rest

LOCATION

Distal ulnar nerve

pronator teres is a clinical indicator of the syndrome—the patient reports pain when attempting to pronate the forearm against resistance while extending the elbow simultaneously.

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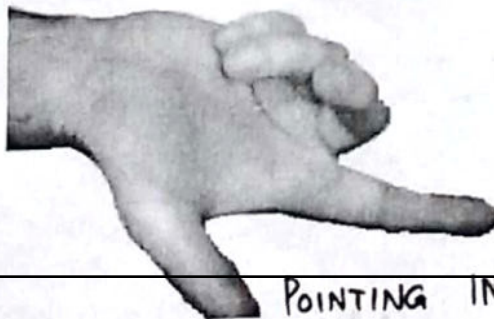
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Tinel's sign in the area around the pronator teres heads should be positive. **The key to discerning this syndrome from carpal tunnel syndrome is the absence of pain while sleeping.** *More recent literature collectively diagnose median nerve palsy occurring from the elbow to the forearm as pronator teres syndrome*

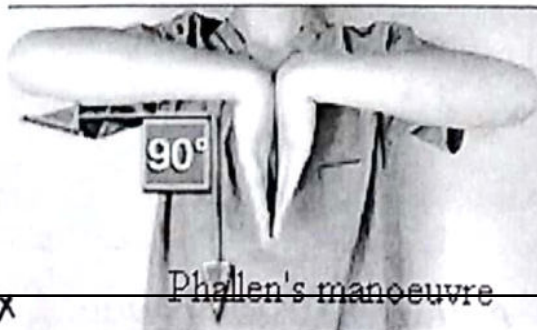
- ❖ **Pointing index finger** : - Due to paralysis of ^{the Nv supplying the part of FDS tendon to index.} 1st lumbrical. Attempt to make a fist causes inability to flex 1st MCP joint.

- ❖ **Carpal tunnel syndrome (CTS)** :- Painful condition caused by compression of the median nerve as it passes under the carpal tunnel. Weakness and wasting of thenar muscles with loss of power of opposition and cutaneous sensation of palmar surface of lateral 3½ digits and dorsal surface of the same digits over middle and distal phalanges. In thumb – only dorsal surface of distal phalanx is affected

Nerve conduction velocity tests through the hand are used to diagnosis CTS. Physical diagnostic tests include the Phalen maneuver or Phalen test and Tinel's sign.

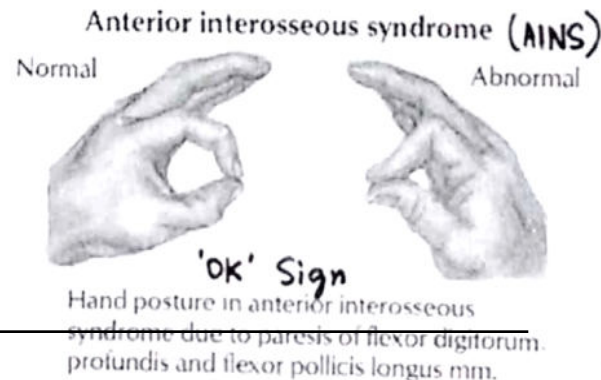


POINTING INDEX



Phalen's manoeuvre

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Anterior interosseous syndrome (AINS)

Normal

Abnormal

'OK' Sign

Hand posture in anterior interosseous syndrome due to paresis of flexor digitorum profundus and flexor pollicis longus mm.

Compression of the ulnar nerve at the elbow produces variable symptoms and/or syndromes. The areas are:

- Underneath Struthers' ligament (is an anatomical feature, consisting of a band of connective tissue that runs between the shaft of the humerus, and a projection at the same level)

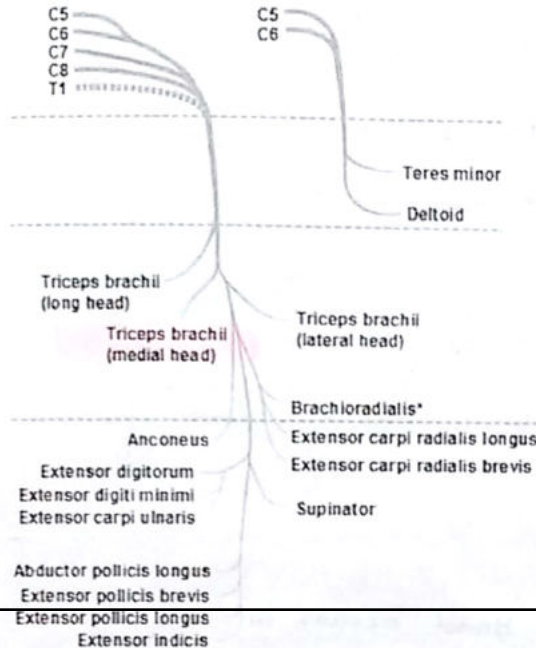
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- Passing by the bicipital aponeurosis (also known as lacertus fibrosus)
- Between the aponeurotic edge of deep head of the pronator teres
- By the aponeurotic arch forming the proximal free edge of Radial attachment of FDS.
- Compression in the carpal tunnel causes carpal tunnel syndrome.

Radial nerve

Axillary nerve



Radial Nerve Lesions :-

❖ Injury to the radial nerve has a variety of possible causes. These include:

- fracturing the humerus (a bone in the upper arm)
- sleeping with the upper arm in an awkward position
- pressure from leaning the arm over the back of a chair (called "Saturday night palsy" when caused by consuming too much alcohol and falling asleep in this position)
- using crutches
- falling on or receiving a blow to the arm
- long-term constriction of the wrist (for example, by wearing a tight bracelet or watch)

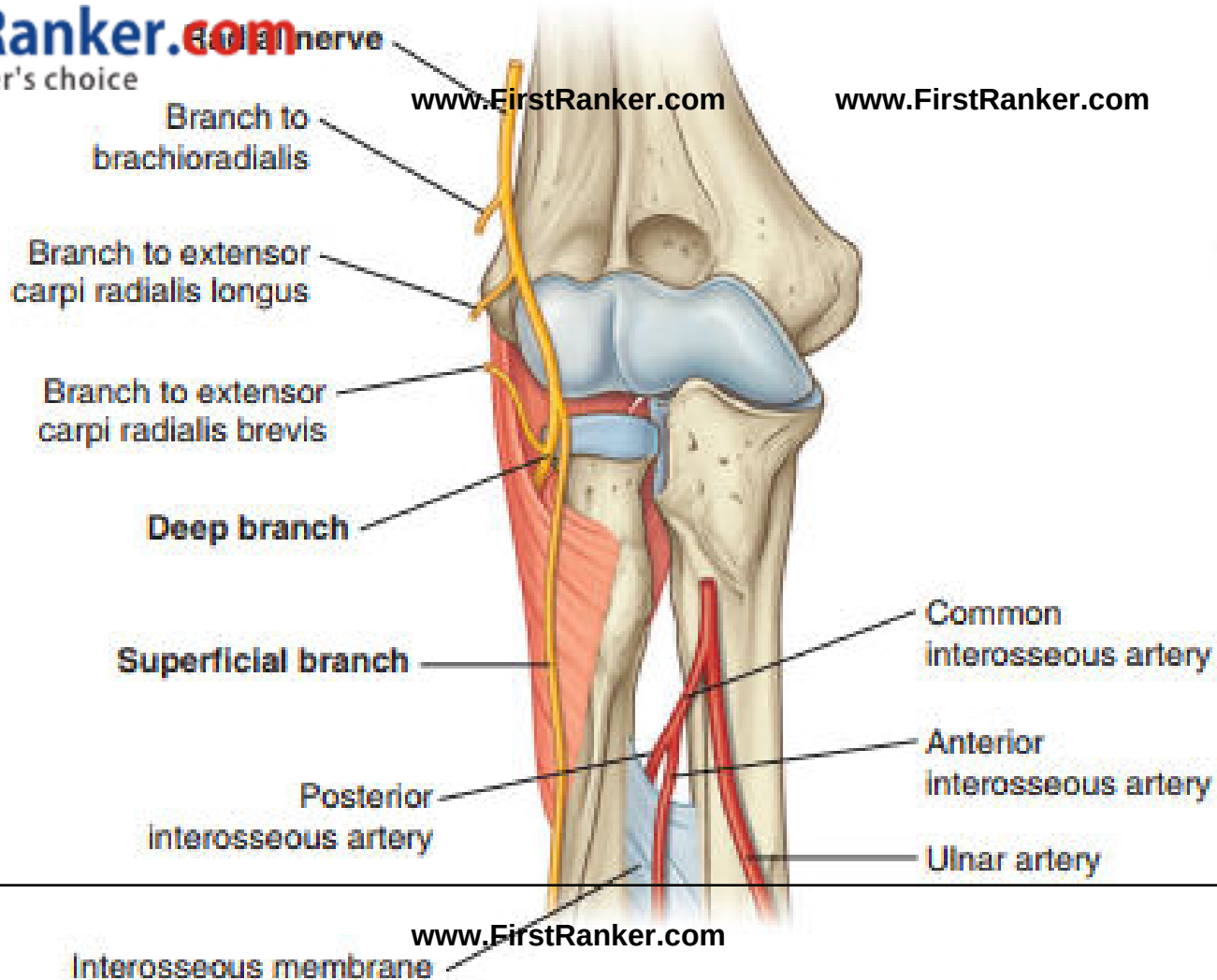
Injury at Spiral groove / Saturday night palsy:-



❖ Is a condition where a person cannot extend their wrist and it hangs flaccidly. – Wrist drop. This is due to paralysis of extensors of forearm.

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Supination of forearm is lost, it remains pronated.



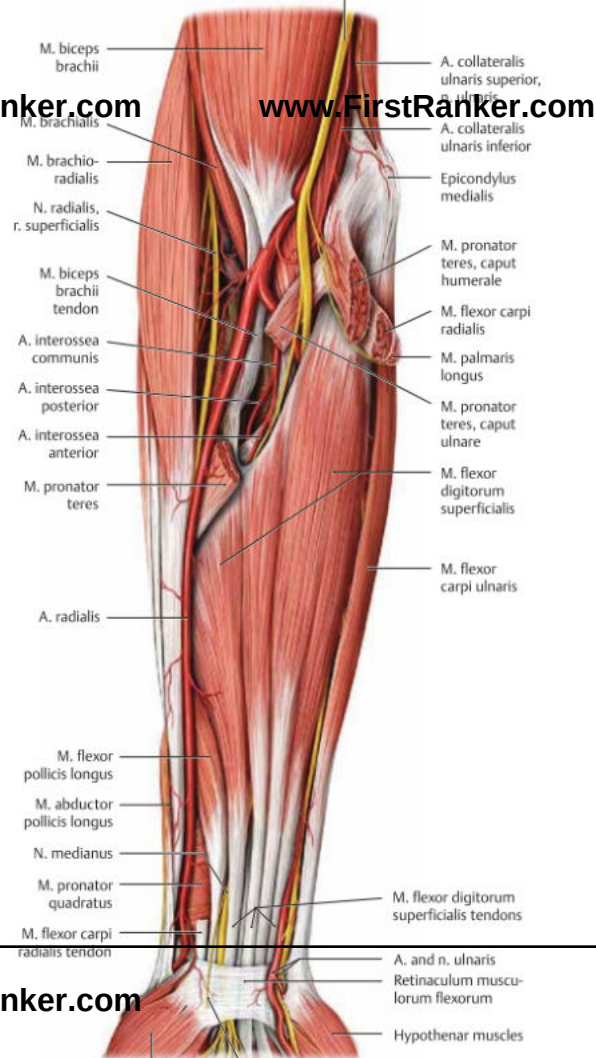
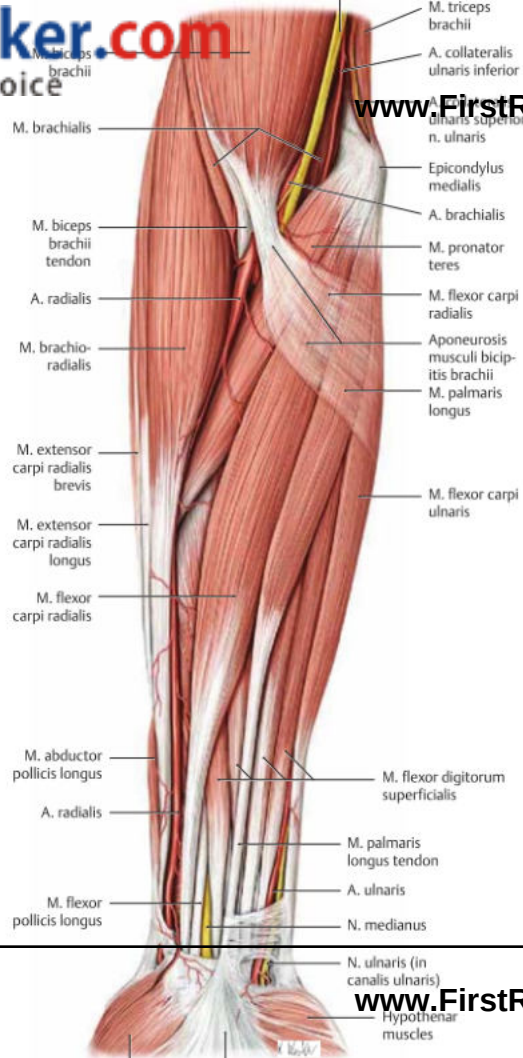
*Functionally brachioradialis acts as a flexor of the forearm. It develops from the posterior compartment and thus is innervated by a posterior division nerve.

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- ❖ The digits are flexed at the proximal phalanges, but the middle and distal phalanges may be extended by Lumbricals and interossei.
- ❖ Extension of forearm is lost, as triceps is paralysed.
- ❖ Cutaneous anesthesia over relatively small area on the dorsum of the hand due to overlapping dermatomes.

- ❖ Radial nerve branch disorders at the elbow fall into two distinct clinical presentations: **Radial Tunnel Syndrome (RTS)** and **Posterior Interosseous Nerve Syndrome (PINS)**. In both cases the posterior interosseous nerve is entrapped or compressed within the radial tunnel by following ways –
 - By fibrous bands (which can tether the nerve to radiohumeral joint).
 - By a leash of blood vessels from radial recurrent artery, passing over the nerve.
 - By the Arcade of Frohse.
 - Sharp tendinous medial border of Ext Carpi Radialis Brevis.
- ❖ Radial nerve neuropathies at the elbow are considered the rarest of the compressive neuropathies in the upper limb.
- ❖ Identical anatomy is affected in both PINS and RTS, but the symptoms are quite unique. **Radial Tunnel Syndrome** is characterized by **pain or discomfort over the dorsolateral forearm and lateral elbow**, with or without pain in the humeral region. Patients **with RTS report pain or discomfort as their main complaint, rather than weakness.**
- ❖ **PIN (Post Interosseus Nerve) syndrome** - characterized by initial lateral forearm pain that progresses to neurological weakness of the ulnar wrist extensors, thumb extensors, finger extensor group. ECU paralysed, so attempt to extend the wrist causes Radial deviation of wrist due to action of ECRL & ECRB. Weakness of EPL causes thumb drop, beside weak extension of fingers (finger drop).
- **Posterior Interosseous Nerve syndrome** - characterized by initial lateral forearm pain that progresses to neurological weakness of the ulnar wrist extensors, thumb extensors, finger extensor group. ECU paralysed, so attempt to extend the wrist causes Radial deviation of wrist due to action of ECRL & ECRB. Weakness of EPL causes thumb drop, beside weak extension of fingers (finger drop). However, it has also been reported that PINS may develop in absence of pain (Hsu et al. 2012).



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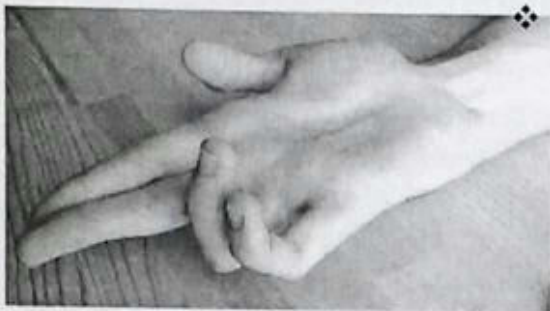
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Ulnar Nerve (Musician's nerve) Lesions

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- ❖ Sites –
 - Problems originating at the neck: thoracic outlet syndrome, cervical spine pathology, tight anterior scalene muscles
 - Brachial plexus abnormalities
 - Elbow pathology: fractures, growth plate injuries, cubital tunnel syndrome, flexor pronator aponeurosis, arcade of Struthers
 - Forearm pathology: tight flexor carpi ulnaris muscles
 - Wrist pathology: fractures, ulnar tunnel (Guyon's canal) syndrome, hypothenar hammer syndrome
 - Artery aneurysms or thrombosis
 - *Other:* Infections, tumors, diabetes, hypothyroidism, rheumatism, and alcoholism



❖ **Cubital Tunnel syndrome** : - Compression or division of Ulnar nerve behind medial epicondyle causes this.

❖ Due to paralysis of FCU, during an attempt to flex the wrist **FCR causes abduction of wrist joint.**

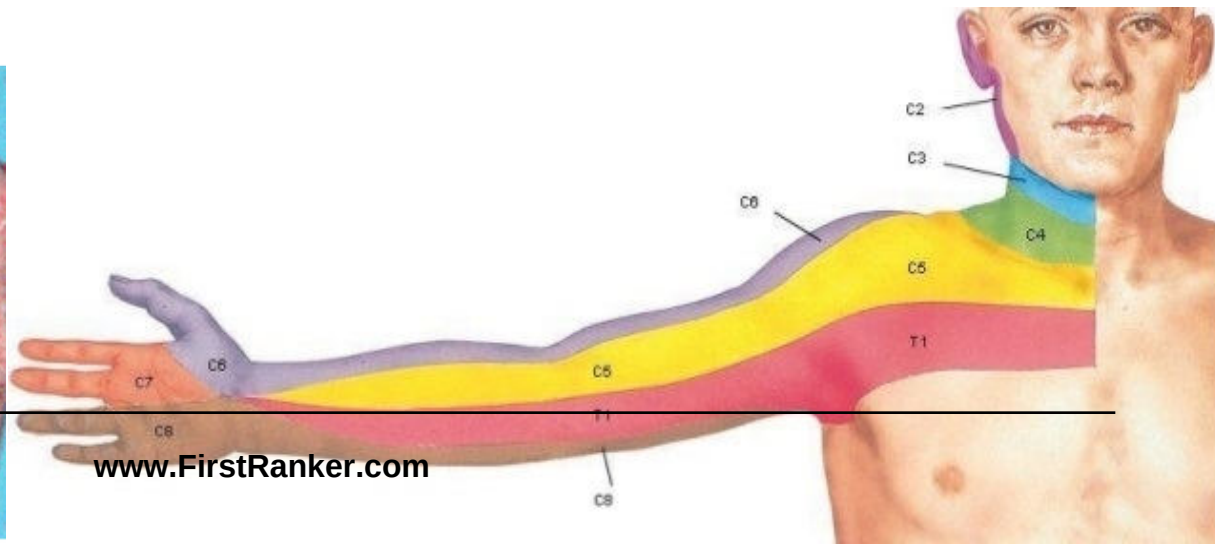
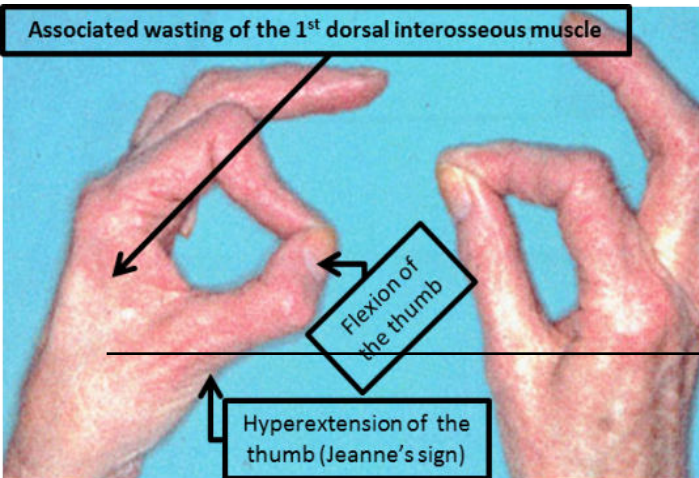
❖ Medial four fingers cannot be abducted or adducted due to paralysis of Dorsal & Palmar Interossei. Paralysis of 3rd & 4th Lumbricals causes extension of their MCP joints with active flexion IP joints due to normal FDS – this is k/as **CLAW HAND**. The medial part of FDP is also paralysed leading to extended distal phalanges of ring and little finger – this manifests less clawing of those fingers, though lesion is more severe than wrist lesion – this is known as **Ulnar Paradox**.

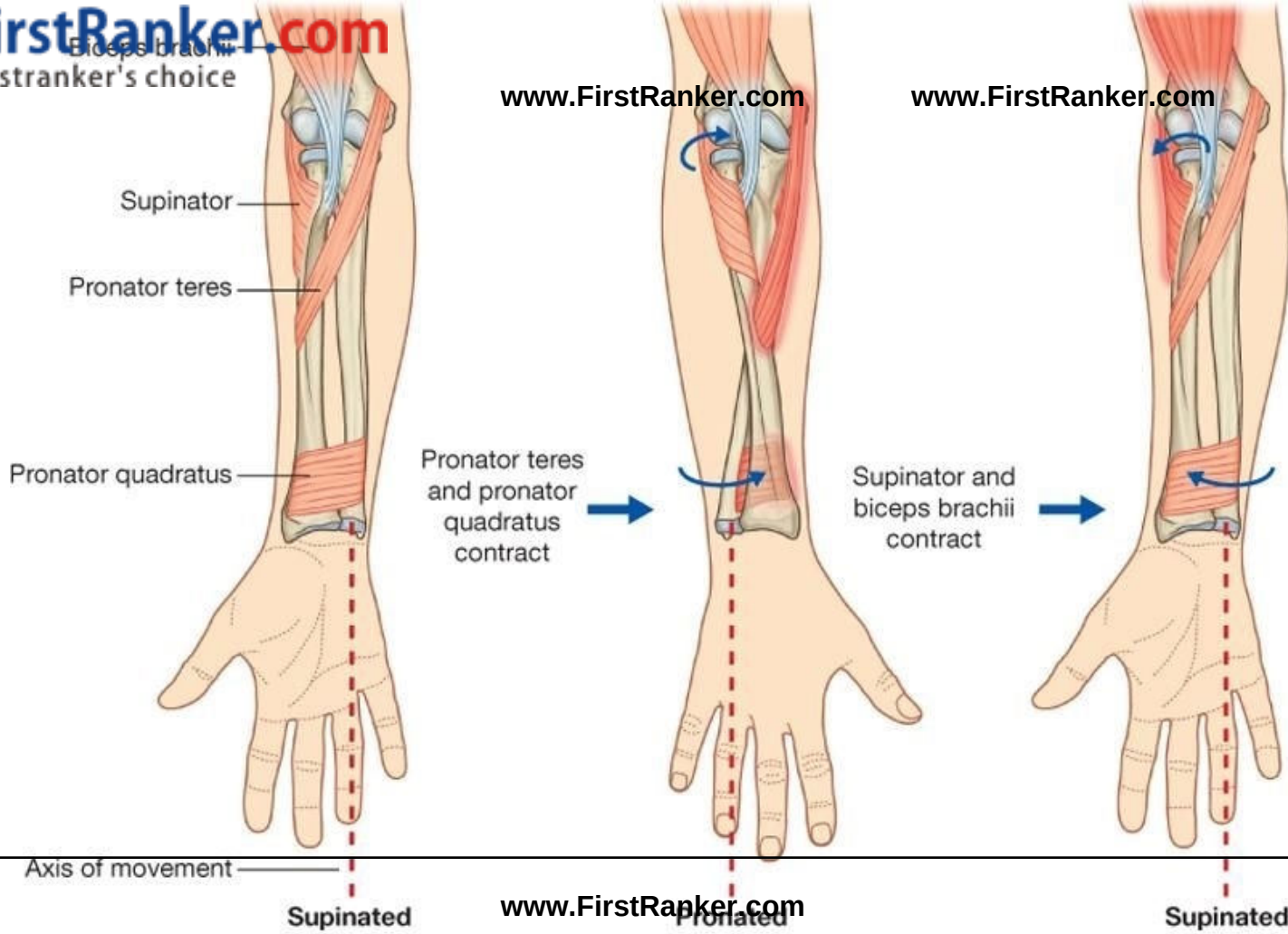
- ❖ The thumb cannot be adducted due to palsy of Adductor Pollicis.
- ❖ Wasting of Hypothenar muscles and loss of sensation over medial 1½ digits and adjoining medial side of hand.

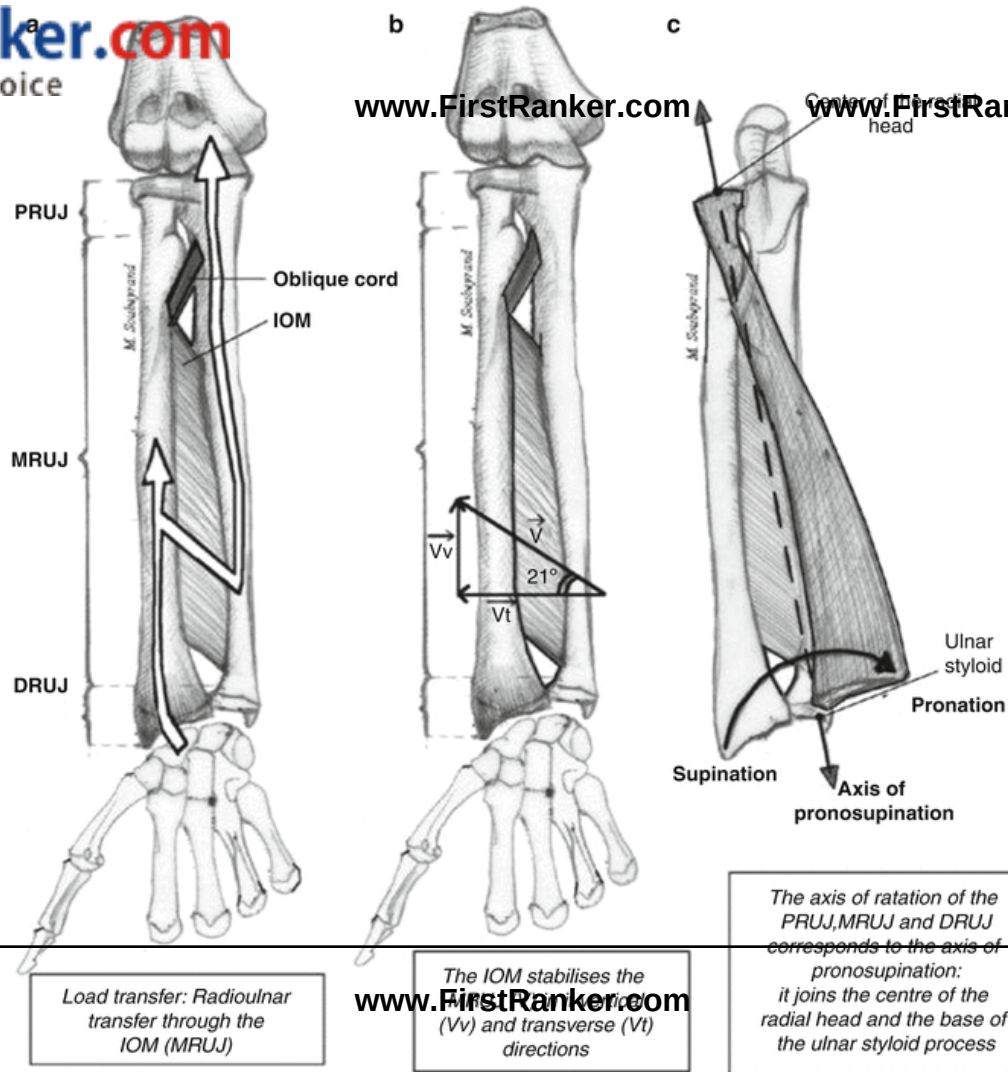
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Manifestation of ulnar nerve palsy **at or below the wrist** are same as the above except:-

- Adduction and abduction of the wrist will not be affected.
- The Clawing of ring and little finger becomes more visible.
- **Complete Claw hand occurs in Klumpke's Palsy.**





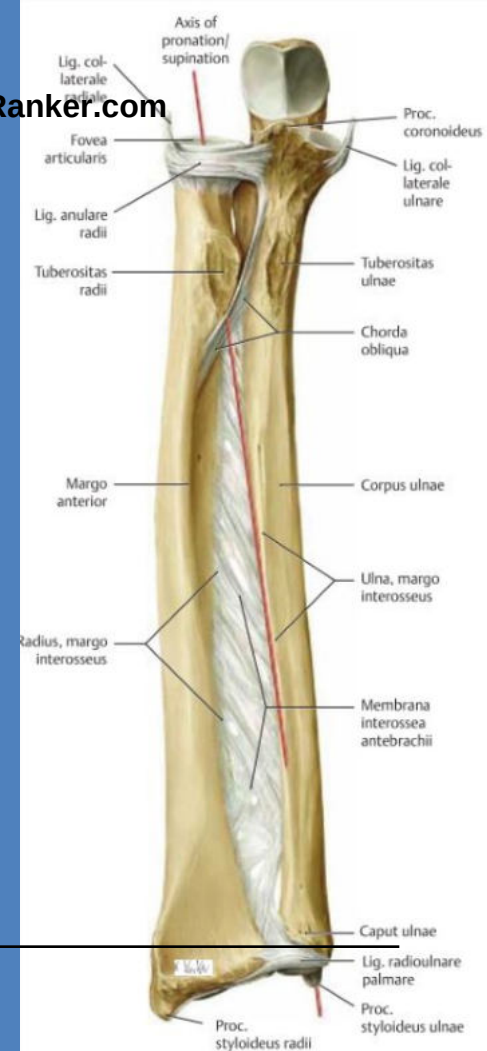


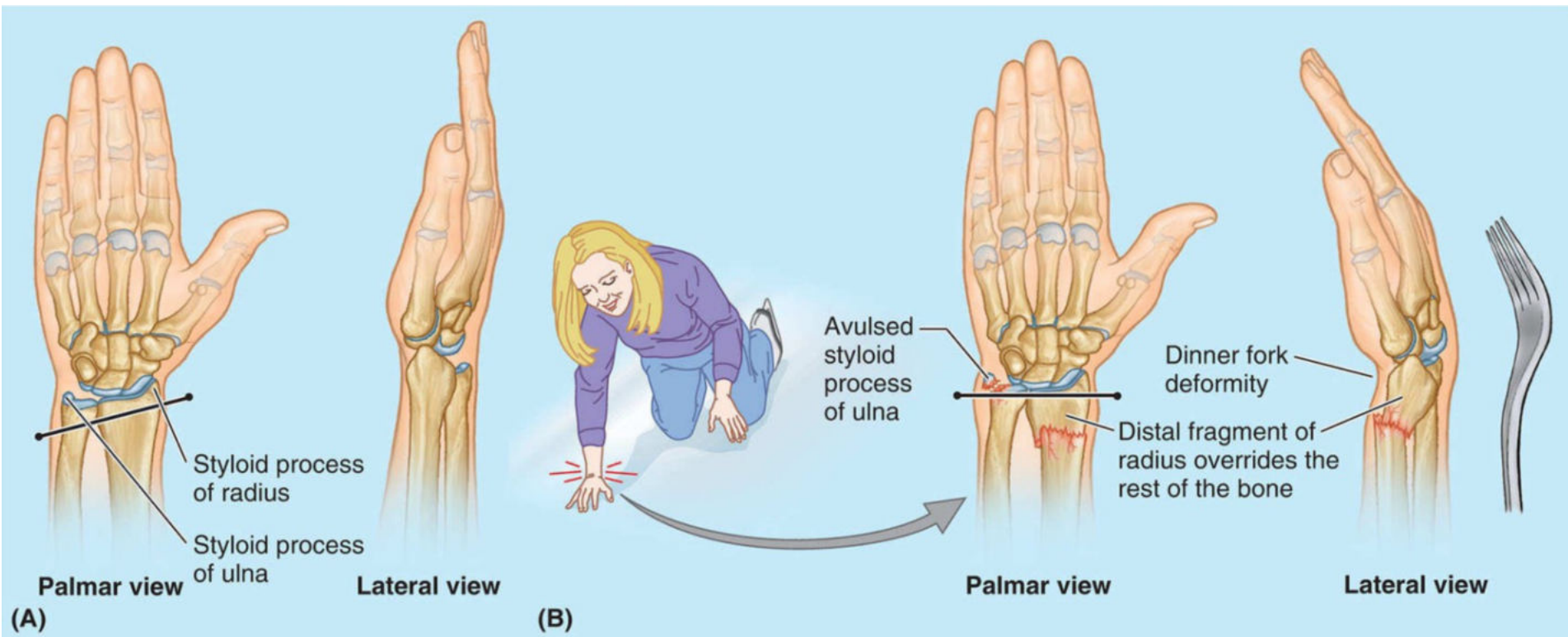
Load transfer: Radioulnar transfer through the IOM (MRUJ)

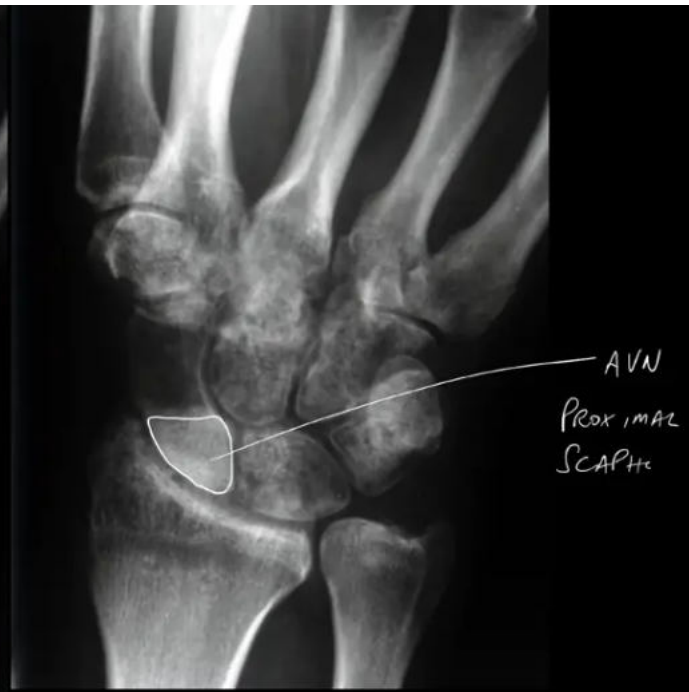
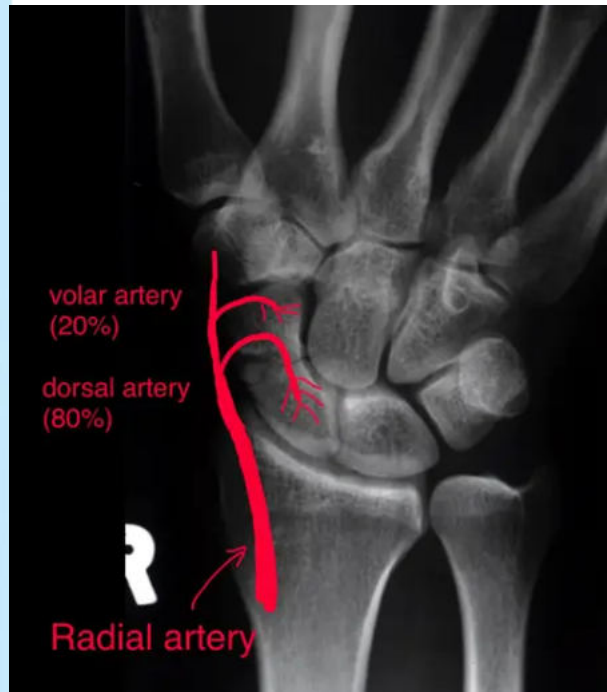
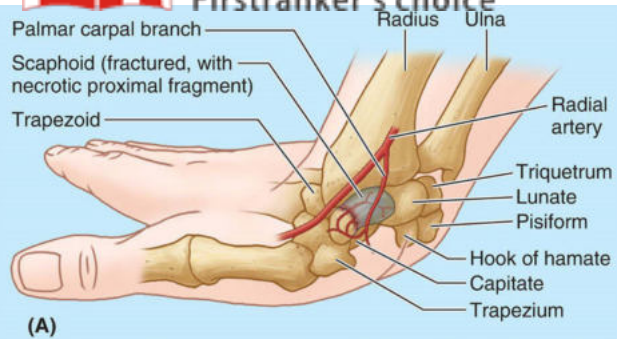
The IOM stabilises the forearm in the vertical (Vv) and transverse (Vt) directions

The axis of rotation of the PRUJ, MRUJ and DRUJ corresponds to the axis of pronosupination: it joins the centre of the radial head and the base of the ulnar styloid process

- ❖ Joint between shafts of radius & ulna held tightly together between proximal & distal articulations by an interosseus membrane (syndesmosis)
- ❖ Functions of Interosseus membrane:
 - D** – distribution of weight / load
 - P** - partitioning
 - A** – provides attachment of muscles
 - T** – transfixing two bones



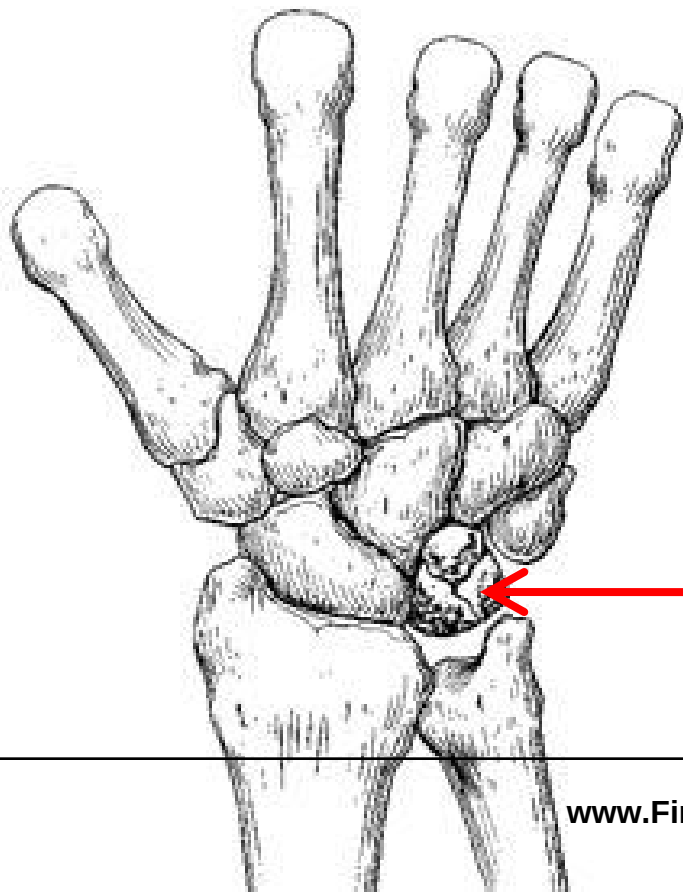




Kienbock's disease (Avascular necrosis of Lunate)

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Smith fracture

Colles fracture

