- The **coracoacromial ligament**; is an accessory ligament that protects the superior aspect of the joint extending from the coracoid process to the acromion over the tendon of supraspinatus.

The synovial membrane & related bursae [Figure.27]

The synovial membrane lines the fibrous capsule and covers the medial part of the surgical neck of the humerus. The membrane has three extensions;

- Anteriorly, the **subscapular bursa** extends between subscapularis muscle and the anterior aspect of the joint. The part below the coracoid process is the **subcoracoid bursa**.
- Posteriorly, the **infraspiantus bursa** extends between infraspinatus muscle and the posterior aspect of the joint.
- Laterally, the **synovial sheath** which surrounds the **long head of biceps tendon** within the joint extends a short distance around the tendon outside the joint.

Therefore, the fibrous capsule of the shoulder joint has three apertures for the three extensions of the synovial membrane:

- **Anterior aperture** for the **subscapularis bursa**.
- **Posterior aperture** for the **infraspinatus bursa**.
- One **aperture** between the lesser and greater tubercles for escape of the **long head of biceps** from the interior of the joint.

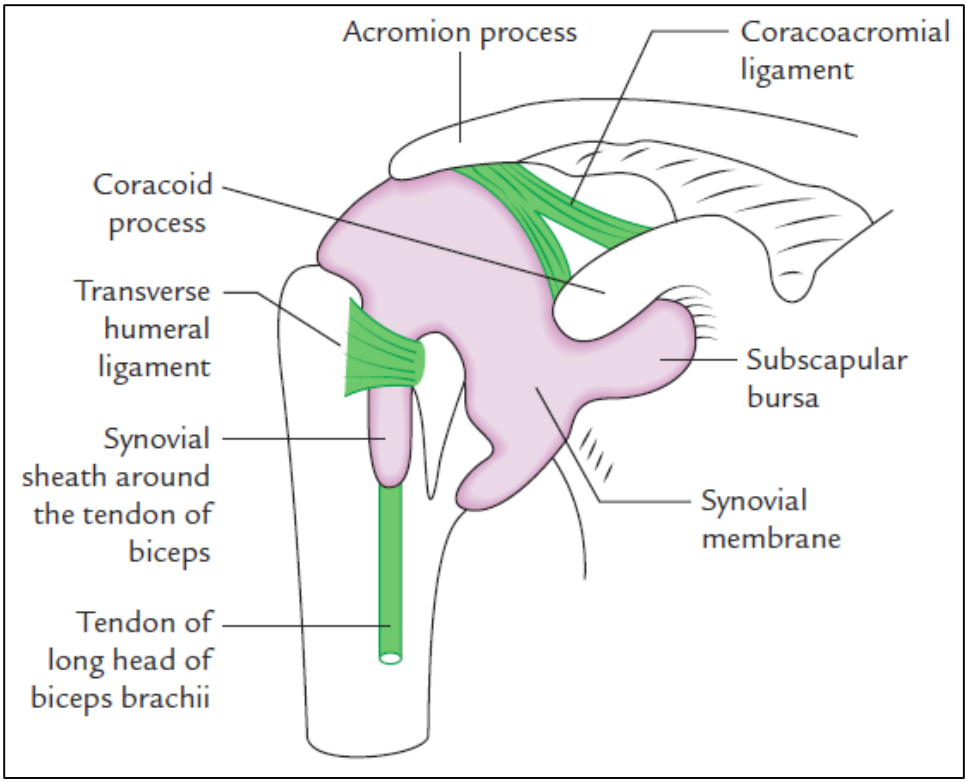


Figure 27: The synovial membrane of the shoulder joint (anterior view)

The **Subacromial bursa** is another bursa related to the shoulder joint but is not an extension of its synovial membrane. It lies between the coracoacromial ligament and acromion process above, and supraspinatus tendon and joint capsule below. It continues downwards beneath the deltoid, hence it is sometimes also referred to as ***subdeltoid bursa***. It is the largest synovial bursa in the body and facilitates the movements of supraspinatus tendon under the coracoacromial arch.

Blood and nerve supply

- The **arterial blood supply** is derived from the anastomosis around the surgical head of the humerus formed by the anterior and posterior circumflex humeral branches of the third part of the axillary artery and the suprascapular artery. The profunda brachii artery also participates in the articular anastomosis.

- The **articular nerves** are derived from the axillary, suprascapular and lateral pectoral nerves.

Relations

- **Anteriorly**; subscapularis, subscapular bursa, axillary vessels, terminal branches of the brachial plexus.

- **Posteriorly**; infraspinatus, infraspinous bursa, teres minor, deltoid.

- **Superiorly**; long head of biceps brachii (intracapsular), supraspinatus, subacromial bursa, coracoacromial ligament, deltoid.

- **Inferiorly**; long head of triceps, teres major, axillary nerve, posterior circumflex humeral vessels.

Movements

The shoulder joint has more freedom of mobility than any other joint in the body. Being a ball-and-socket joint, the shoulder joint is movable in all directions. The scapula does not lie in the coronal plane but is so oriented that its glenoid cavity faces forwards and laterally. Therefore, the plane of the shoulderlies obliquely at about 45° to the sagittal plane. This means that during flexion, the arm moves forwards and medially, and during extension it

moves backwards and laterally. Also, During abduction, the arm moves anterolaterally away from the trunk and during adduction the arm moves posteromedially towards the trunk.

MOVEMENTS OF THE SHOULDER JOINT			
Movement	**Muscles**	**Movement**	**Muscles**
Flexion	Deltoid Pectoralis major (clavicular part) Short head of biceps Coracobrachialis	**Adduction**	Pectoralis major Latissimus dorsi Teres major
Extension	Deltoid Latissimus dorsi (from flexion) Teres major (from flexion)	**Lateral rotation**	Deltoid Infraspinatus Teres minor
Abduction	Supraspinatus (initiator) Deltoid (completes abduction after 15°)	**Medial rotation**	Deltoid Pectoralis major Latissimus dorsi Teres major Subscapularis

Mechanism of shoulder abduction

The total range of abduction is 180° :

- Abduction up to 90° occurs at the glenohumeral joint.
- Abduction from 90° to 120° can occur only if the humerus is rotated laterally because when the upper end of humerus is elevated to 90° its greater tubercle impinges upon the under surface of the acromion and can only be released by lateral rotation of the arm.
- Abduction from 120° to 180° can occur if the scapula rotates laterally too.

Shoulder dislocation

Dislocation of shoulder joint mostly occurs inferiorly because the joint is least supported inferiorly. It often injures the axillary nerve because of its close relation to the inferior part of the joint capsule.

Clinically, it is described as anterior or posterior dislocation indicating whether the humeral head has descended anterior or posterior or to the infraglenoid tubercle of the scapula and long head of triceps.

The dislocation is usually caused by excessive extension or abduction with lateral rotation of the humerus.

The Arm

Arm compartments and muscles

The arm is surrounded by a layer of deep fascia that encloses its contents like a sleeve and sends septa between the muscle groups to facilitate their gliding on each other. The medial and lateral intermuscular septa pass to the medial and lateral supracondylar ridges of the humerus dividing the arm into an anterior "flexor" compartment and a posterior "extensor" compartment.

The muscles of the anterior compartment are the biceps brachii, brachilais and coracobrachialis which are all supplied by the musculocutaneous nerve. The muscle of the posterior compartment is triceps brachii which is supplied by the radial nerve.

Muscles of the Arm

	Muscle	Origin	Insertion	Action
Anterior Compartment	**Biceps brachii**	***Short head***; coracoid process ***Long head***; supraglenoid tubercle	Both heads unite in one tendon about the middle of the arm and insert to the radial tuberosity	Short head: flexion of shoulder Long head: stabilization of shoulder Both: flexion of elbow, & supination of the forearm when the elbow is flexed
	Coracobrachialis	Coracoid process	Middle of medial side of the shaft of humerus	Shoulder flexion
	Brachilais	Lower ½ of the anterior surface of the shaft of humerus	Coronoid process of ulna	Elbow flexion
Posterior Compartment	**Triceps brachii**	***Long head***; from the infraglenoid tubercle ***Lateral head***; from the posterior surface of the shaft of the humerus superior to the radial groove. ***Medial head***; from the posterior surface of the shaft of the humerus inferior to the radial groove.	The three heads unite in one tendon that inserts to the olecranon process of the ulna	Elbow extension The long head helps stabilizing the inferior aspect of the shoulder joint

The neurovascular bundle of the arm

This is a bundle of nerves and vessels enclosed by a deep fascial sheath that runs on the medial side of the anterior compartment of the arm. Above the insertion of coracobrachialis the bundle contains the brachial artery, the veane comitantes of the brachial artery, the basilic vein, median nerve, ulnar nerve, radial nerve and medial cutaneous nerve of the forearm.

1. The radial nerve is the first to leave the bundle passing posterior to the brachial artery to the posterior compartment through the triangular interval. This interval lies between the long 7 lateral heads of triceps and the lower border of teres major.
2. Then the ulnar nerve leaves the bundle by piercing the medial intermuscular septum to the posterior compartment.
3. Then, the basilic vein and medial cutaneous nerve of the forearm leave the bundle to the superficial fascia.

Therefore, at the distal $^{1}/_{3}$ of the arm the bundle contains only the brachial artery, the veane comitantes of the brachial artery and the median nerve. The musculocutaneous nerve enters the arm by piercing coracobrachialis, not as part of the neurovascular bundle.

The brachial artery [Figure.28]

Course

The brachial artery begins at the lower border of teres major as the continuation of the axillary artery, runs in the neurovascular bundle of the arm on the medial side of the anterior compartment, and then passes anterolaterally to end at the level of the neck of the radius by dividing into ulnar and radial arteries.

Important Relations

- **Anteriorly**; the artery is crossed by the median nerve in the middle part and the bicipital aponeurosis in the lower part of its course.
- **Laterally**; the median nerve and coracobrachialis muscle are lateral to the upper part of the artery while biceps tendon is lateral to its lower part.
- **Medially**; the ulnar nerve and basilic vein (above), median nerve (below)

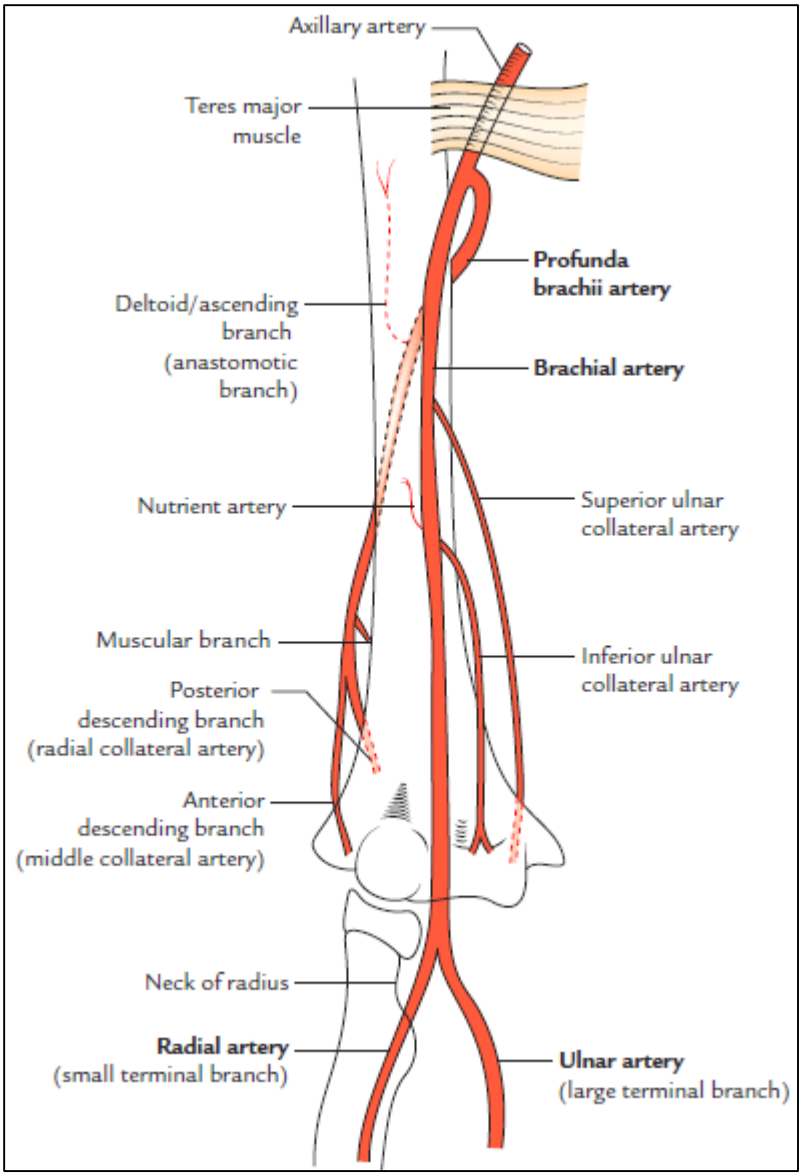


Figure 28: the brachial artery

Branches

- **Profunda brachii artery**; is the first and largest branch. It passes to the posterior compartment with the radial nerve where it supplies triceps muscle and gives a recurrent branch to the shoulder and the middle & radial collateral arteries to the elbow.
- **Superior ulnar collateral artery**; arises about the middle of the arm and pierces the medial intermuscular septum with the ulnar nerve where it descends posterior to the septum to anastomose with the posterior ulnar recurrent branch of the ulnar artery.
- **Inferior ulnar collateral artery**; arises 5cm proximal to the elbow and descends anterior to the medial intermuscular septum to anastomose with the anterior ulnar recurrent branch of the ulnar artery.
- **Nutrient artery of the humerus**.

- **Muscular branches**
- **Radial & Ulnar arteries (terminal branches)**

In the lab: Brachial pulse

The brachial pulse is commonly felt in the cubital fossa medial to the tendon of biceps and its pulsations are auscultated for *recording the blood pressure.* The biceps tendon is easily palpable on flexing the elbow.

The brachial veins

Two or three venae commitantes accompany the brachial artery. They begin opposite the neck of the radius by union of the radial and ulnar veins and ascend in the neurovascular bundle around the brachial artery to unite with the basilic vein at the lower border of teres major muscle and become the axillary vein. They receive tributaries that correspond to the branches of the brachial artery.

Nerves of the arm [Figure. 29, 30]

The musculocutaneous nerve (C5, C6, C7)

This nerve arises from the lateral cord of the brachial plexus and pierces and supplies the coracobrachialis muscle. It then runs in the arm between the biceps and brachialis muscles supplying both and emerges on the lateral side of biceps tendon to pierce the deep fascia just proximal to the elbow and continues as the lateral cutaneous nerve of the forearm which supplies the lateral ½ of the forearm. It also gives articular branches to the elbow joint.

The median nerve (C5-T1)

This nerve is formed by 2 roots; one from each of the medial and lateral cords of the brachial plexus anterior to the third part of the axillary artery. It enters the arm in the neurovascular bundle where it lies lateral to the upper $^1/_3$ of the brachial artery then crosses anterior to its middle $^1/_3$ and becomes medial to its lower $^1/_3$. It gives no named branches in the arm except for small vasomotor (sympathetic) fibers to the brachial artery.

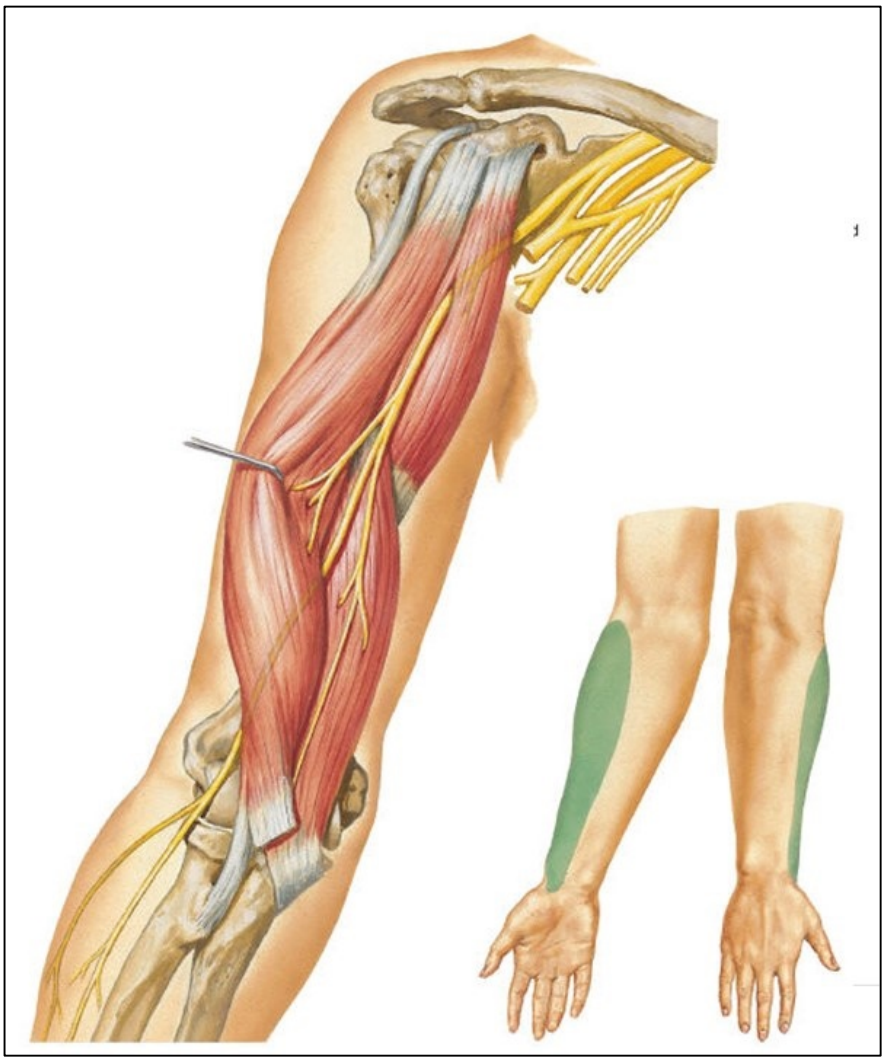


Figure 29: The musculocutaneous nerve & its area of cutaneous supply

The ulnar nerve (C7, C8, T1)

This nerve arises from the medial cord of the brachial plexus and runs with the medial cutaneous nerve of the forearm between the axillary vein medially and the axillary artery laterally. In the upper ½ of the arm, it runs in the anterior compartment medial to the brachial artery. Then it pierces the medial intermuscular septum and runs in the posterior compartment so that it leaves the arm by passing posterior to the medial epicondyle of the humerus. It gives articular branches to the elbow joint.

The radial Nerve (C5-T1)

This is the large terminal branch of the posterior cord of the brachial plexus. It runs posterior to the 3rd part of the axillary artery and enters the proximal part of the arm in the neurovascular bundle and is the first structure to leave it to the posterior compartment by passing through the triangular interval. It descends in the radial groove with the profunda

brachii vessels. In the distal part of the arm it pierces the lateral intermuscular septum and runs to the anterior compartment between the brachialis medially and the brachioradialis and extensor carpi radialis longus laterally. It leaves the arm by passing anterior to the lateral epicondyle of the humerus where it divides into deep and superficial branches.

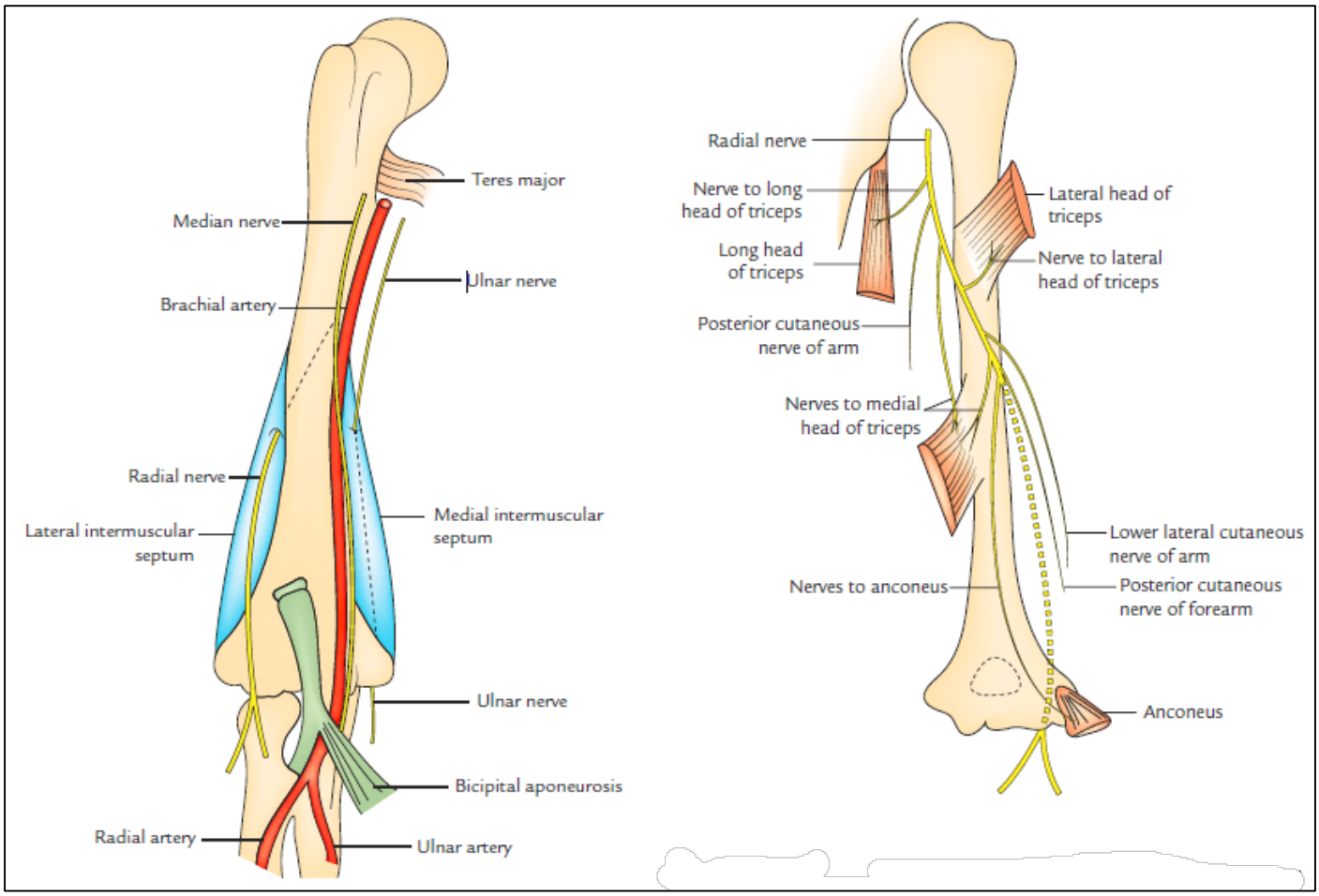


Figure 30: The median, ulnar & radial nerves in anterior (left) & posterior (right) views

Branches of the radial nerve

- **Branches in the axilla;**
  - Muscular to the long and medial heads of triceps.
  - Posterior cutaneous nerve of the arm.
- **Branches in the radial groove;**
  - Muscular to the lateral and medial heads of triceps.
  - Nerve to anconeus (muscular).
  - Lower lateral cutaneous nerve of the arm.
  - Posterior cutaneous nerve of the forearm.

- **Branches in the anterior compartment of the arm;**

➢ Muscular to brachioradialis, extensor carpi radialis longus and a small part of brachialis.

➢ Articular to the elbow.

The cubital fossa [Figure 31, 32]

This is an inverted triangular depression on the front of the elbow **[figure 31]**; at the distal part of the anterior arm. It is bound **medially** by pronator teres muscle, **laterally** by brachioradialis muscle and **superiorly** by a line drawn between the two humeral epicondyles. The **floor** is formed by brachialis muscle above and supinator muscle below. The **roof** consists of skin and superficial fascia containing the superficial cubital veins and the medial and lateral cutaneous nerves of the forearm.

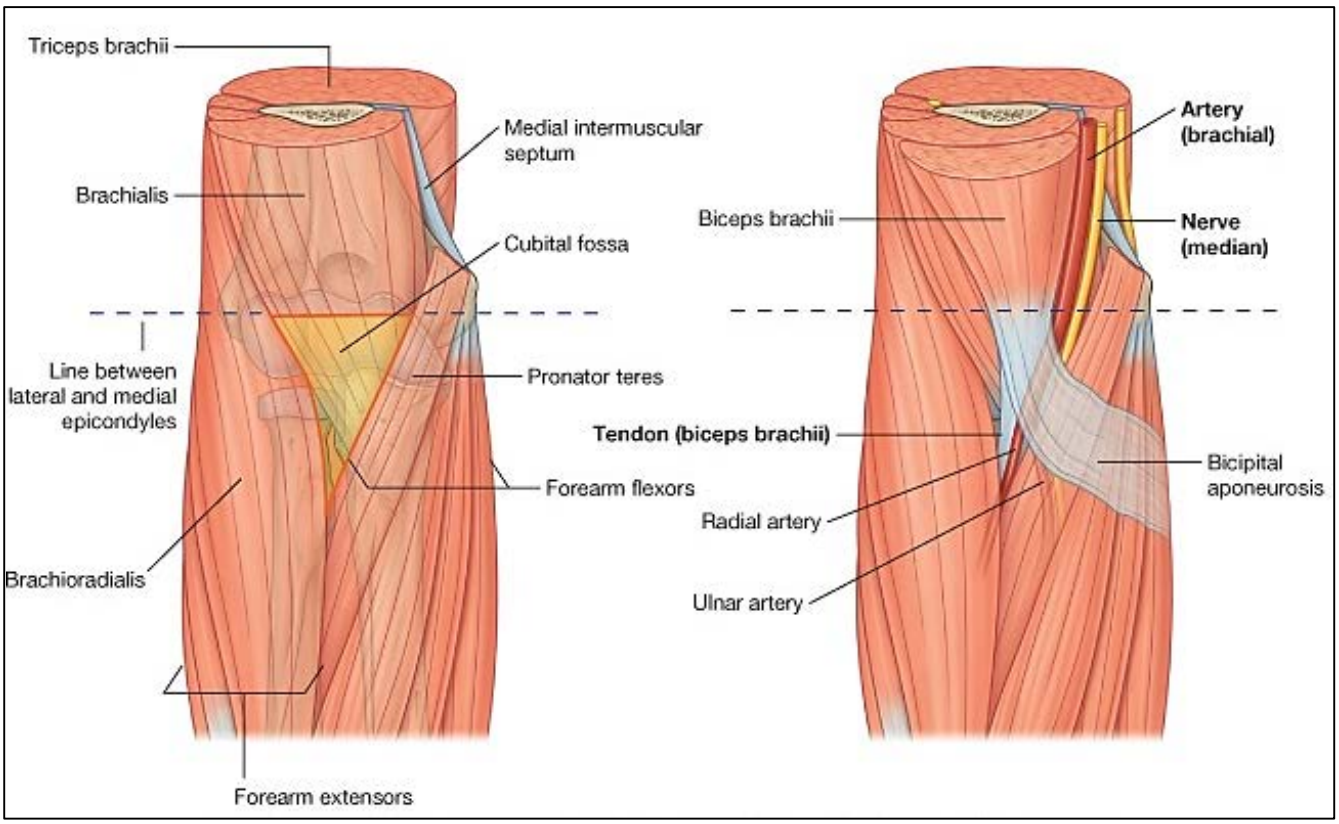


Figure 31: Boundaries & superficial contents of the right cubital fossa

- **Contents of the cubital fossa from medial to lateral** are;

  - **Median nerve**; supplying pronator teres muscle as it passes between its two heads.
  - **Brachial artery**; dividing into ulnar and radial branches.
  - **Tendon of biceps**; with the bicipital aponeurosis stretched over the median nerve and brachial artery. The **bicipital aponeurosis** is a flattened fascial extension of the tendon of biceps that attaches to the posterior border of the ulna. Because of this extension, the biceps is able to supinate the forearm when the elbow is flexed.
  - **Radial nerve**; dividing into deep and superficial branches.

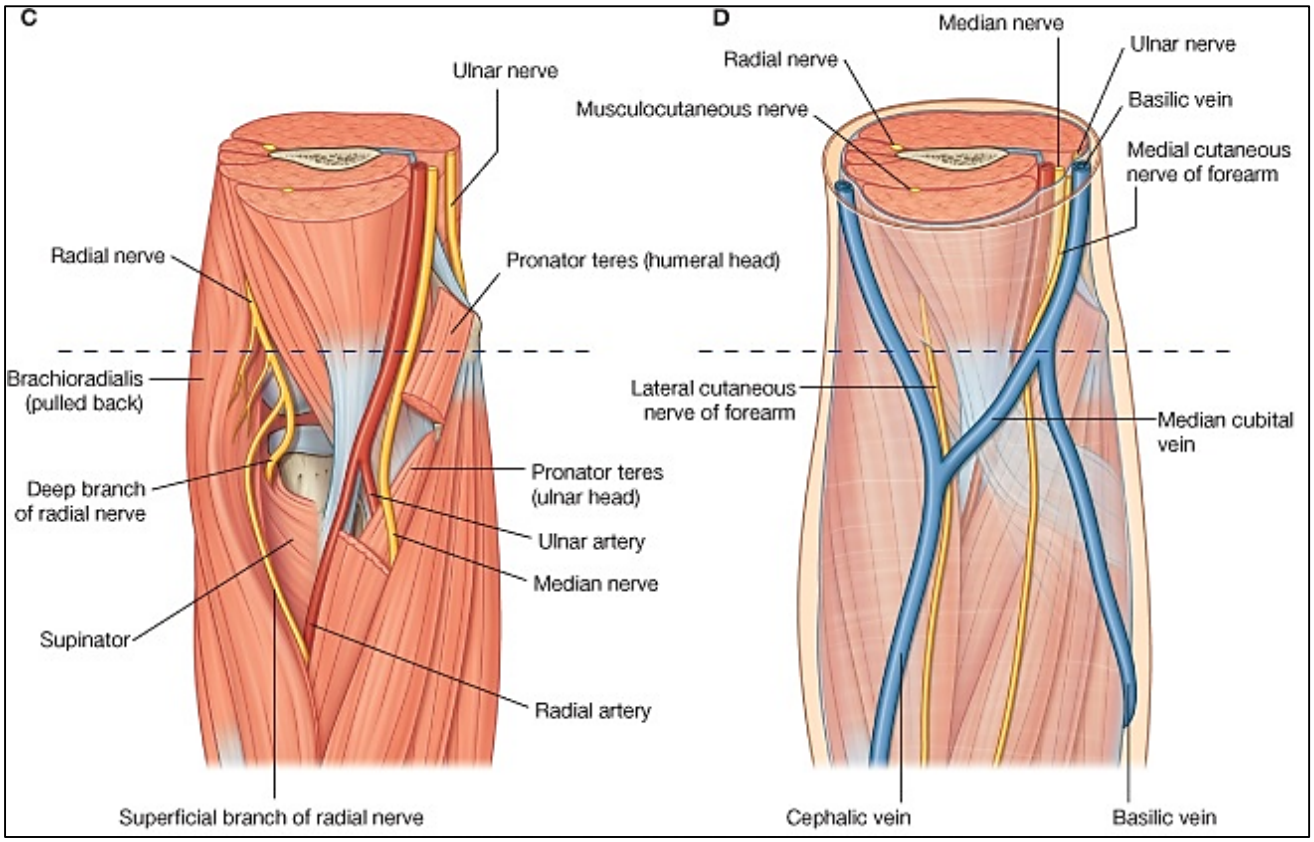


Figure 32: Roof (right) & deep contents (left) of the right cubital fossa

Cutaneous Innervation & Venous Drainage of the Upper Limb

Cutaneous nerves of the upper limb

The cutaneous nerves of the upper limb are derived from the ventral rami of spinal nerves derived from C3 to T2 spinal segments. The cutaneous nerves of the upper limb are described according to the regions they supply **[Figure 33].**

Cutaneous Areas of the upper limb

Region	Cutaneous area	Supplying nerve	Source
Root of the upper limb	Pectoral region down to the 2nd rib, shoulder over upper half of deltoid, scapular region down to spine	Supraclavicular nerves (C3, C4,C5)	Cervical plexus
Arm	Upper lateral part (over the lower ½ of deltoid)	Upper lateral cutaneous nerve of the arm	Axillary nerve
	Lower lateral part	Lower lateral cutaneous nerve of the arm	Radial nerve
	Lower medial part	Medial cutaneous nerve of the arm	Medial cord of brachial plexus
	Upper medial part	Intercostobrachial nerve	Ventral ramus of T2
	Posterior middle part	Posterior cutaneous nerve of the arm	Radial nerve
Forearm	Lateral ½ (anterior&posterior)	Lateral cutaneous nerve of the forearm	Musculocutaneous nerve
	Medial ½ (anterior&posterior)	Medial cutaneous nerve of the forearm	Medial cord of brachial plexus
	Posterior middle part	Posterior cutaneous nerve of the forearm	Radial nerve
Hand	Medial 1/3 of the palm & medial 1 ½ fingers (anterior & posterior)	Ulnar nerve	Medial cord of brachial plexus
	Lateral 2/3 of palm & lateral 3 ½ fingers anteriorly	Median nerve	Medial & lateral cords of brachial plexus
	Lateral 2/3 of dorsum of hand and bases of lateral 3 ½ fingers posteriorly	Superficial branch of radial nerve	Radial nerve

The area of skin supplied by a single spinal nerve/segment is termed ‘dermatome’. The cutaneous nerves contain fibres from more than one spinal nerve and each spinal nerve provides fibres to more than one cutaneous nerve. As a result, skin areas supplied by the cutaneous nerves do not correspond with dermatomes.

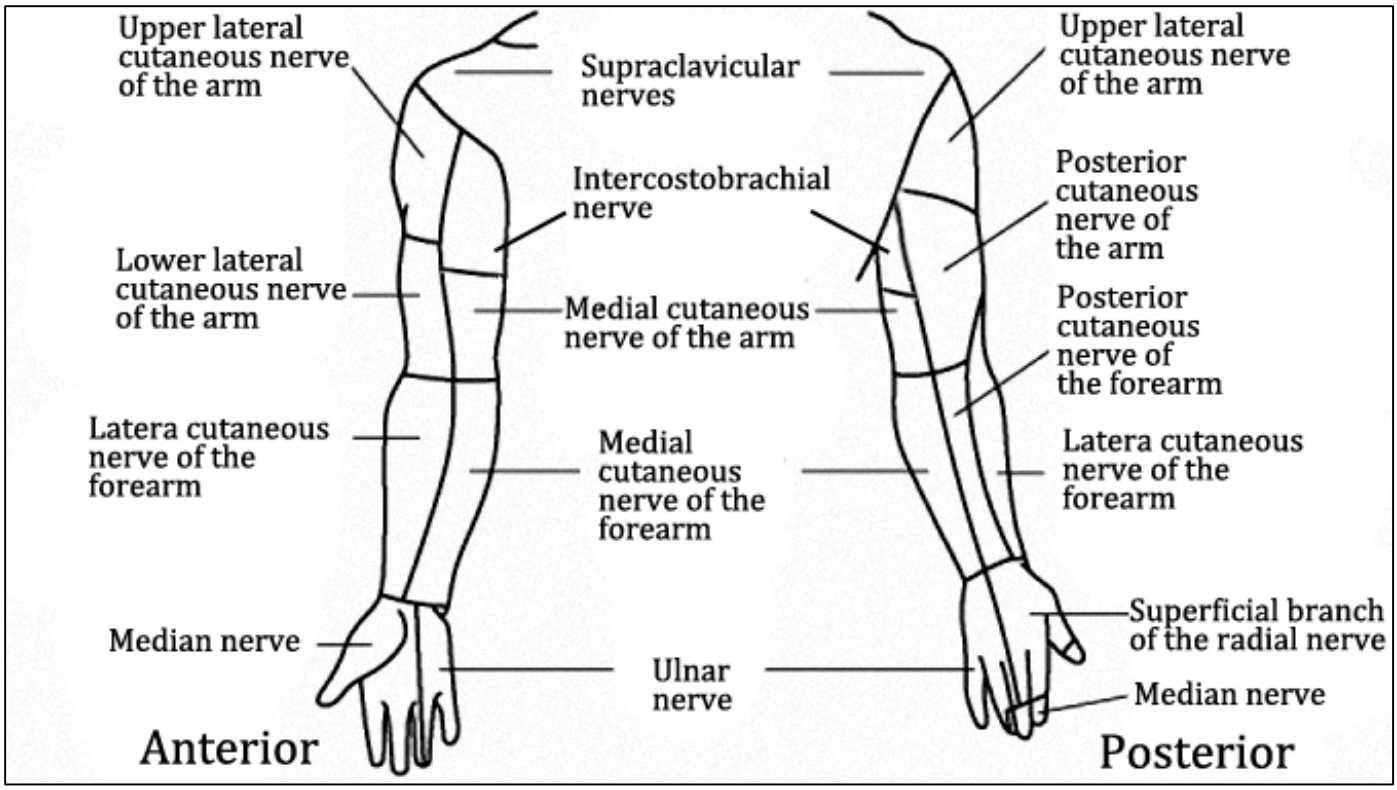


Figure 33: Cutaneous nerves of the upper limb

Dermatomes of the upper limb

A dermatome is the cutaneous area supplied by one spinal nerve, through both ventral and dorsal rami. Dermatomes of adjacent spinal nerves overlap markedly. The overlap is greater for light touch than for pain. Therefore, the area of total anesthesia (loss of touch sensation) and analgesia (loss of pain sensation) following section of peripheral nerves is always less than might be expected from their anatomical distribution. The skin of the upper limb may be divided into six dermatomes; their root values, skin

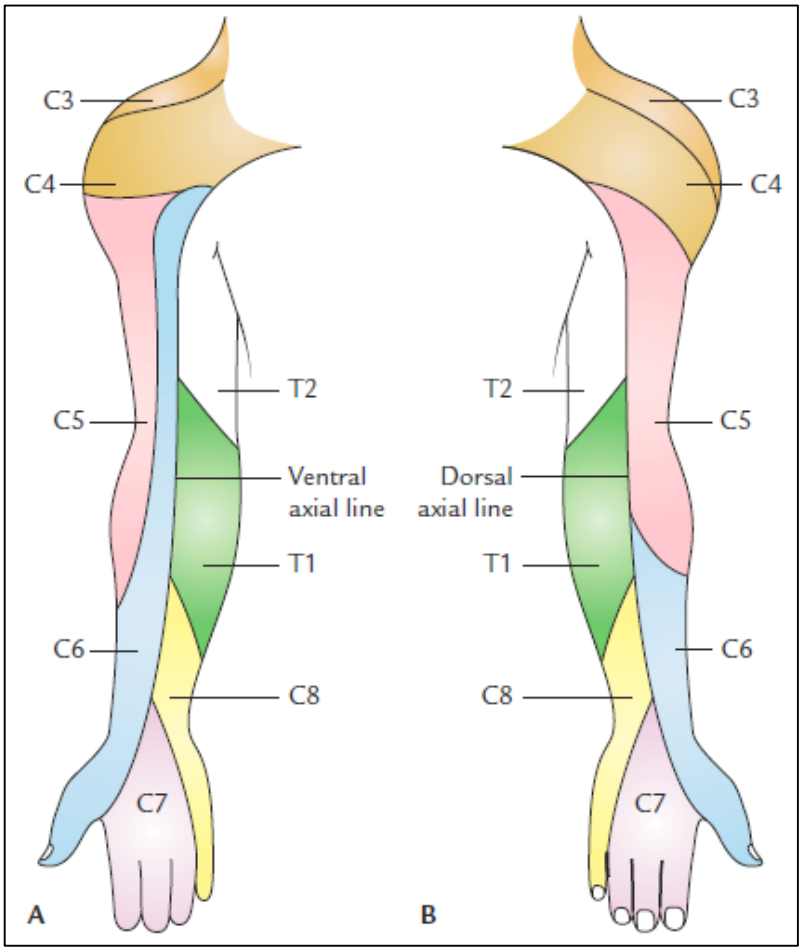


Figure 34: Dermatomes of the upper limb in anterior (A) & posterior (B) views

areas and testing areas (the area of the least overlap) are shown in the following table and in Figure 34.

DERMATOMES OF THE UPPER LIMB

Dermatome	Skin area	Testing area
C4	The shoulder area below the clavicle, over deltoid	Acromial area
C5	The lateral side of the arm & the proximal ½ of the forearm	upper lateral region of the arm
C6	The middle aspect of the arm & forearm anteriorly, the lateral aspect of the distal ½ of the forearm anteriorly & posteriorly and the whole thumb	Lateral side of forearm
C7	The middle part of the palm, the middle aspect of the forearm posteriorly, the middle 3 fingers (anteriorly & posteriorly)	Palmar pad of the index
C8	The little finger, the medial side of the hand & the medial side of the distal $^{1}/_{3}$ of the forearm (anteriorly & posteriorly)	Palmar pad of the little finger
T1	The medial side of the proximal $^{2}/_{3}$ of the forearm & distal ½ of the arm (anteriorly & posteriorly)	Medial aspect of the elbow
T2	Medial side of arm opposite the armpit	Axilla

Venous drainage of the upper limb

Like any other part of the body, the veins of the upper limb are divided into superficial and deep veins.

Superficial veins of the upper limb

The superficial veins lie in the superficial fascia and run with the cutaneous nerves. They tend to run away from the pressure sites, hence they are absent in the palms, medial border of the arm & back of the elbow.

The superficial veins of the upper limb **[Figure.35]** begin in the **dorsal venous arch** which is as an irregular network of veins on the dorsum of the hand and the distal part of the forearm. The arch receives blood from the palm & dorsum of the hand and is drained by a number of veins which unite to form the **basilic vein** medially and the **cephalic vein** laterally. These two veins ascend the forearm curving around the medial and lateral borders and then pass anteriorly to the superficial fascia of the cubital fossa.

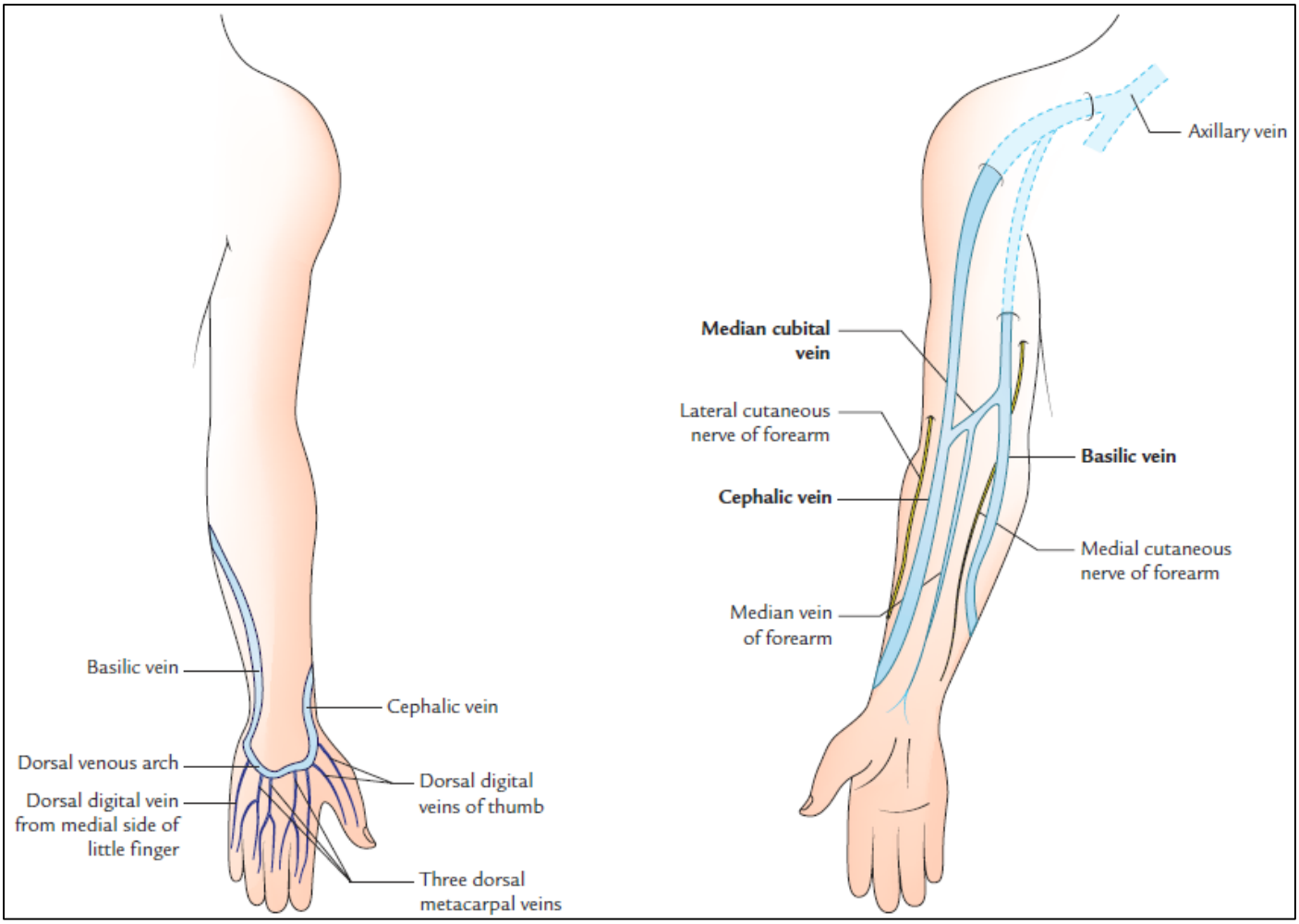


Figure 35: Superficial veins of the upper limb

In the cubital fossa the arrangement is variable **[Figure.36]**:

- Most commonly, a **median cubital vein** communicates the basilic and cephalic veins in an H-shaped arrangement; and most of the blood in the cephalic vein is transferred to the basilic vein. The median cubital vein is therefore a branch of the cephalic vein and a tributary of the basilic vein.
- Sometimes, a third vein, the **anterior median vein (antebrachial vein)** runs in the middle of the front of the forearm and joins the basilic vein or the median cubital vein.
- Less commonly, the median cubital vein is absent and the anterior median vein bifurcates into a medial branch; the **median basilic vein**; and a lateral branch; the **median cephalic vein**; which join the basilic to the cephalic vein instead of the median cubital vein. This creates and M shaped arrangement of veins.

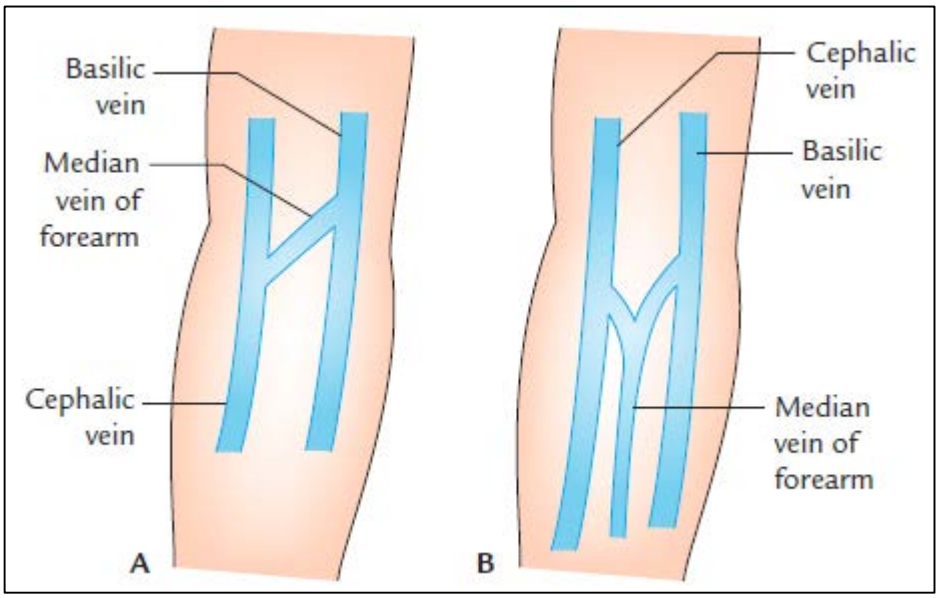


Figure 35: The H-shaped & M-shaped arrangement of superficial veins at the cubital fossa

Proximal to the cubital fossa, the basilic and cephalic veins ascend the medial and lateral sides of the arm respectively.

The basilic vein pierces the deep fascia about the middle of the arm and unites with the venae commitantes of the brachial artery to form the axillary vein at the lower border of teres major muscle.

The cephalic vein pierces the deep fascia at the lower border of pectoralis major and runs in the deltopectoral groove to the infraclavicular fossa where it passes deeply to pierce the clavipectoral fascia; cross the axillary artery and joins the axillary vein at the apex of the axilla.In the upper arm, the diameter of the cephalic & basilic veins exceeds that of the deep accompanying veins.

Deep Veins of the upper limb

Venae comitantes of the radial and ulnar arteries accompany the radial and ulnar arteries, respectively, and join to form the brachial veins. **The brachial veins are also small venae comitantes**, one on each side of the brachial artery. They join basilic vein vein at the lower border of the teres major muscle to form the axillary vein. The axillary vein traverses the axilla, receives the cephalic vein & becomes the subclavian vein at the outer border of the first rib.

Bones of the Forearm and Hand [Figure.36-38]

The ulna

The ulna is the medial bone of the forearm. It articulates with the humerus superiorly to form the elbow joint and with the radius proximally and distally to form the proximal and distal radio-ulnar joints.

The **proximal end** is modified into a **trochlear notch** which articulates with the trochlea of the humerus. The inferior edge of this notch is the **coronoid process** which is lodged in the coronoid fossa of the humerus during elbow flexion. The superior edge of the notch is the **olecranon process** which is received by the olecranon fossa of the humerus during elbow extension.

Posterolateral to the coronoid process lies the **radial notch**; a smooth articular surface for the head of the radius forming the proximal radio-ulnar joint. Just inferior to the radial notch is the **supinator fossa;** for the origin of supinator. The **ulnar tuberosity (sublime tubercle)** lies inferomedial to the coronoid process and marks the insertion of the brachialis muscle. Posteriorly, a **subcutaneous triangular area** lies inferior to the olecranon process and continues with the **posterior subcutaneous border** of the ulnar shaft that leads to its styloid process distally.

The **shaft** is convex medially and in its lower part has **3 borders**; anterior, lateral (interosseous) and posterior. The posterior border gives attachment of the deep fascia separating the flexor from the extensor compartments. The shaft has **3 surfaces** named in opposition to the borders; posterior, medial and anterior.

The **distal end** of the ulna is the **head** which is slightly expanded and has the **styloid process** projecting medially downwards from it. The head articulates laterally with the **ulnar notch of the radius** to form the distal radio-ulnar joint. The ulna does not articulate with the carpal bones at the wrist.

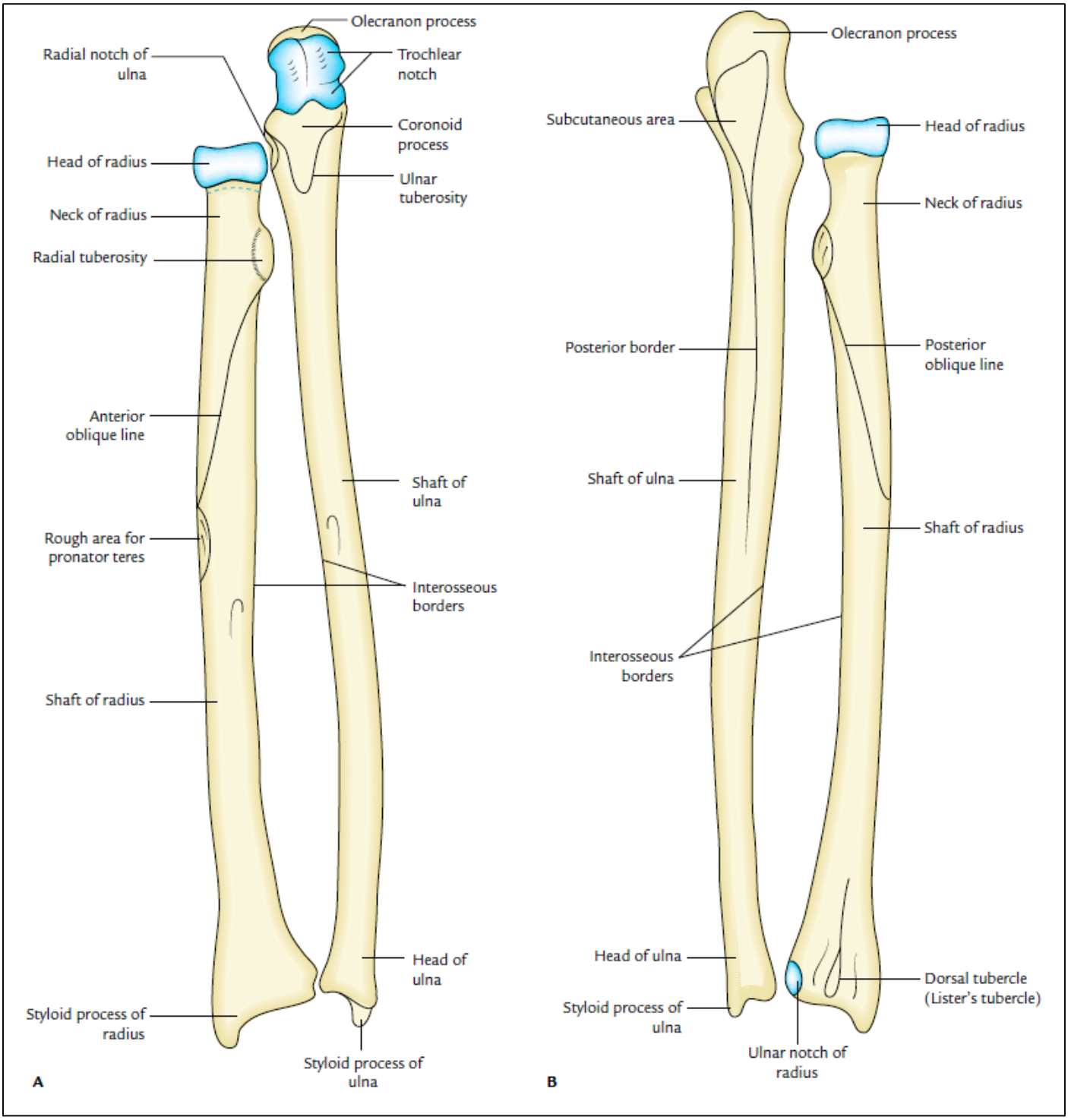


Figure 36: The radius and ulna in anterior (A) & posterior (B) views

The radius

The radius is the lateral bone of the forearm. It articulates with the humerus superiorly to form the elbow joint, with the ulna proximally and distally to form the proximal and distal radio-ulnar joints and with the carpal bones distally to form the wrist joint.

The **proximal end** is the **head** which is a short cylinder with a concave proximal surface that articulates with the capitulum. The circumference of the head is surrounded by the **annular ligament** and articulates with the **radial notch of the ulna** to form the proximal radio-ulnar joint. The **neck** of the radius is the short constriction inferior to the head and just distal to that projects the **radial tuberosity** medially marking the insertion of the biceps muscle. From the radial tuberosity, anterior & posterior oblique lines descend on the corresponding surfaces of the shaft to mark muscular attachments.

The **shaft** of the radius is convex laterally and has **3 borders**; anterior, posterior, and medial (interosseous). It has **3 surfaces** also named in opposition to the borders; posterior, anterior and lateral.

The **distal end** is a well expanded cuboidal mass with a large **styloid process** projecting laterally and downwards. Medially is the **ulnar notch** for articulation with the head of the ulna at the distal radio-ulnar joint.

The interosseous membrane

The interosseous membrane is a strong fibrous sheet that passes from the medial border of the radius inferomedially to the lateral border of the ulna. The membrane holds the two bones together, increases the surface area for muscular attachments and transmits the forces applied to the radius onto the ulna to be transmitted upwards to the humerus.

Muscles attached to the radius and ulna

Muscles of the arm attach to the forearm bones and to the interosseous membrane as well. Brachialis, Biceps brachii, Triceps, Anconeus and Brachioradialis arise from the upper arm and forearm to be inserted into the forearm bones and act on the elbow and radio-ulnar joints. All the other muscles originate from the distal humerus and forearm bones to insert into the wrist or hand bones and move the wrist and fingers. Important landmarks for muscle attachments include:

- Biceps brachii insertion to radial tuberosity.
- Brachialis insertion to sublime tubercle of coronoid process.
- Triceps brachii insertion to upper part of olecranon process.

- Supinator origin from supinator fossa of ulna and insertion to lateral surface of radius opposite the radial tuberosity.
- Pronator teres insertion to middle of lateral surface of radius.
- Pronator quadratus insertion to anterior surface of distal radius.
- Brachioradialis insertion to lateral aspect of radial styloid process.

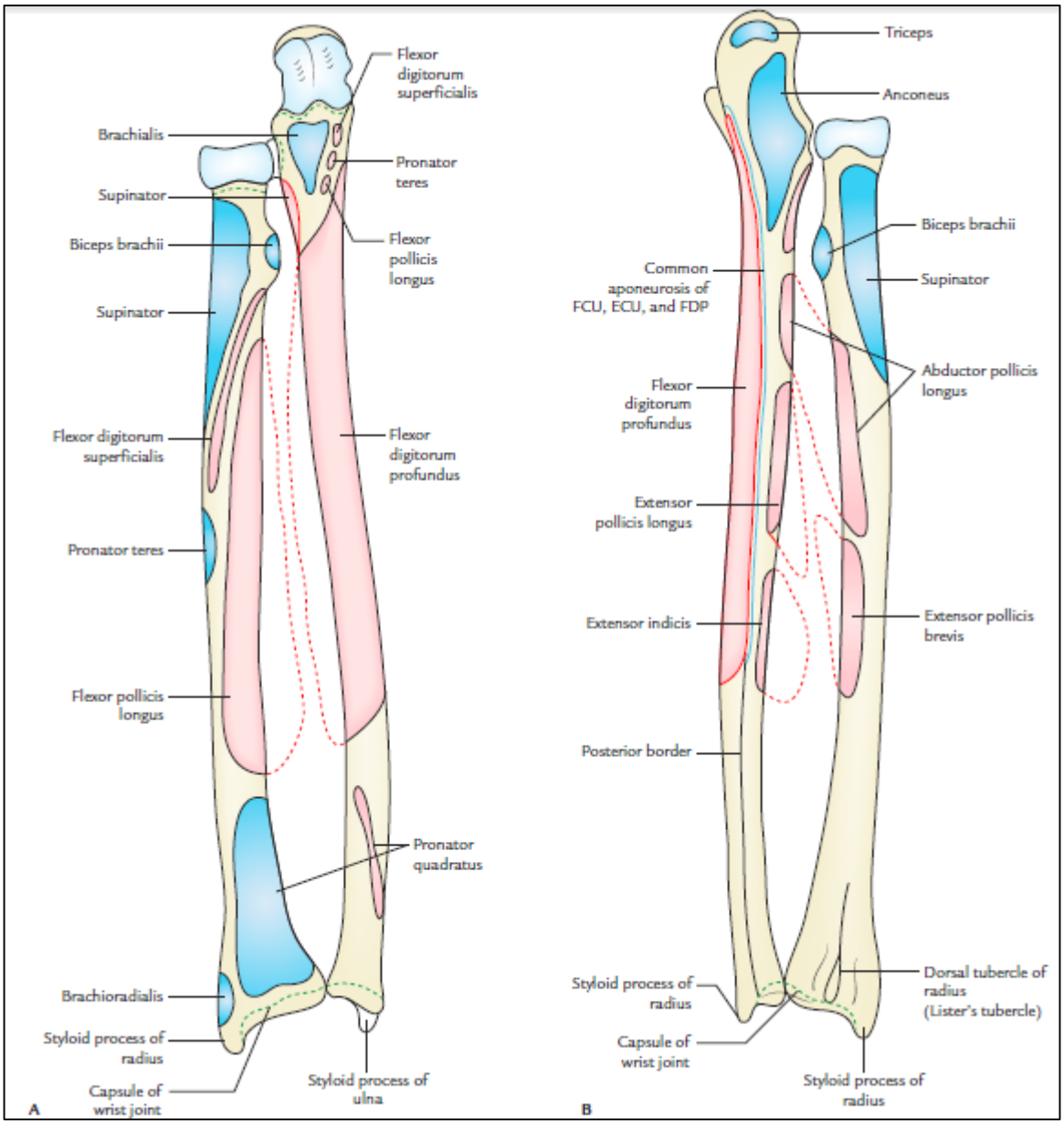


Figure 37: Muscle attachments to the radius & ulna in anterior (A) & posterior (B) views

Carpal bones

There are 8 carpal bones (wrist bones) arranged in two rows, proximal and distal. From lateral to medial they are;

- **The proximal row:** Scaphoid→Lunate→Triquetrum→Pisiform
- **The distal row→**Trapezium→Trapezoid→Capitate→Hamate

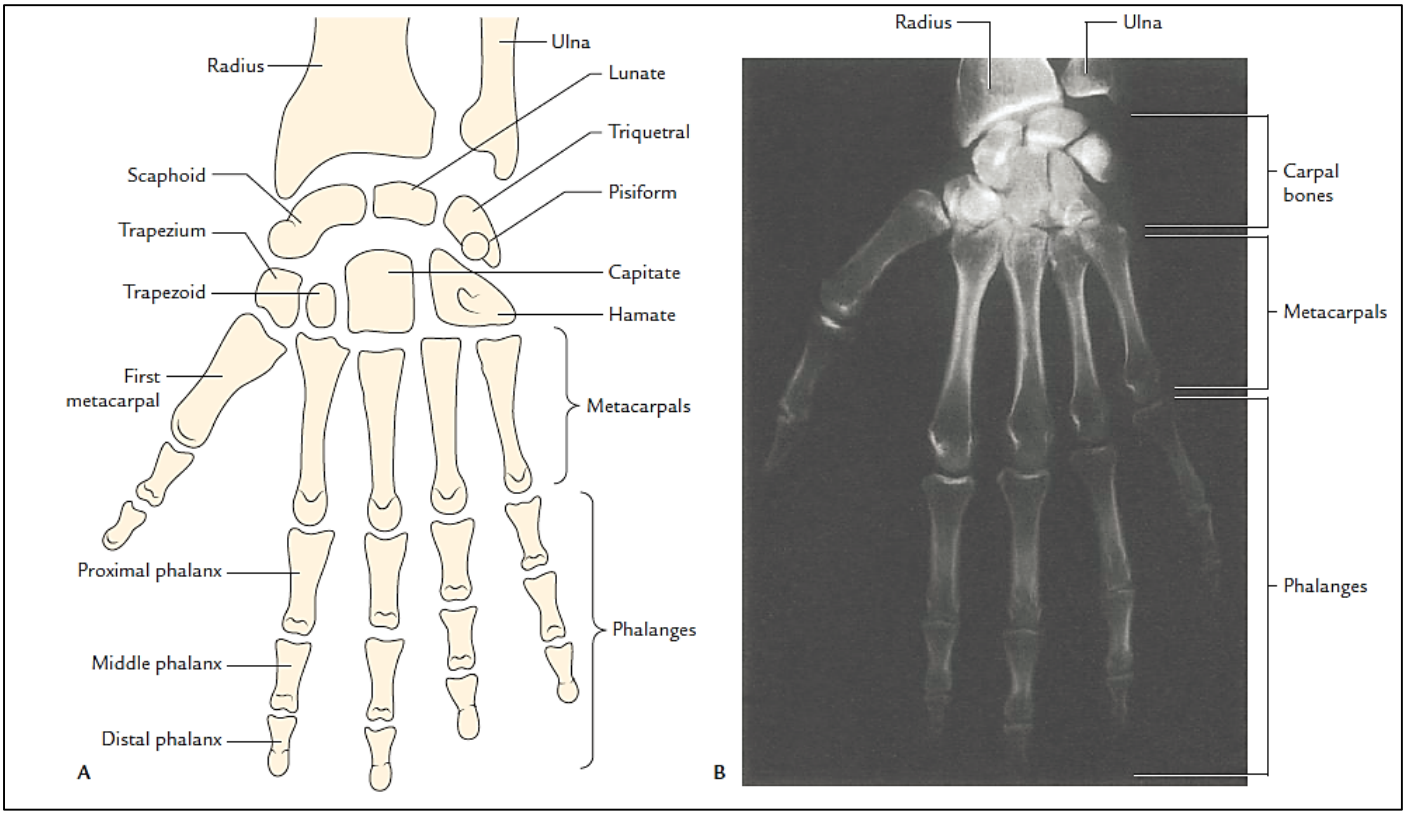


Figure 38: Bones of the hand

- The pisiform lies anterior to (*above*) the triquetrum.
- The trapezium and scaphoid have prominent tubercles while the hamate has a sharp hook.
- The scaphoid and lunate articulate with the distal end of the radius to form the wrist joint.
- The bones of each row articulate with each other and with the bones of the other row at the **intercarpal joints**.

The metacarpals & phalanges

The metacarpals are five short bones of the hand numbered 1-5 from lateral (metacarpal of the thumb) to medial (metacarpal of the little finger). Each metacarpal has a base that articulates with the carpals at the **carpometacrpal joints**, a short shaft and a head that articulates with the corresponding proximal phalanx at the **metacarpophalangeal joint**.

Each digit has three phalanges; proximal, middle and distal; except the thumb which has only 2 phalanges; proximal and distal. The joint between the proximal and middle phalanges is the **proximal interphalangeal joint** and that between the middle and distal phalanges is the **distal interphalangeal joint**.

The Forearm

The forearm is enclosed in sheath of deep fascia of the forearm (antebrachial fascia). It is attached to the posterior subcutaneous border of the ulna. From the deep surface fascia, septa pass between the muscles and some of these septa reach the bone. This deep fascia, together with interosseous membrane and fibrous intermuscular septa divide the forearm into anterior (flexor) and posterior (extensor) compartments.

Anterior compartment of the forearm

Muscles [Figure.39]

The muscles of the anterior compartment of the forearm are divided into 3 layers:

- The **superficial layer** includes; from medial to lateral; **flexor carpi ulnaris**, **palmaris longus**, **flexor carpi radialis** and **pronator teres**.
- The **middle layer** is represented **by flexor digitorum superficialis**.
- The **deep layer** includes **flexor digitorum profundus** medially, **flexor pollicis longus** laterally and **pronator quadratus** inferiorly behind them.

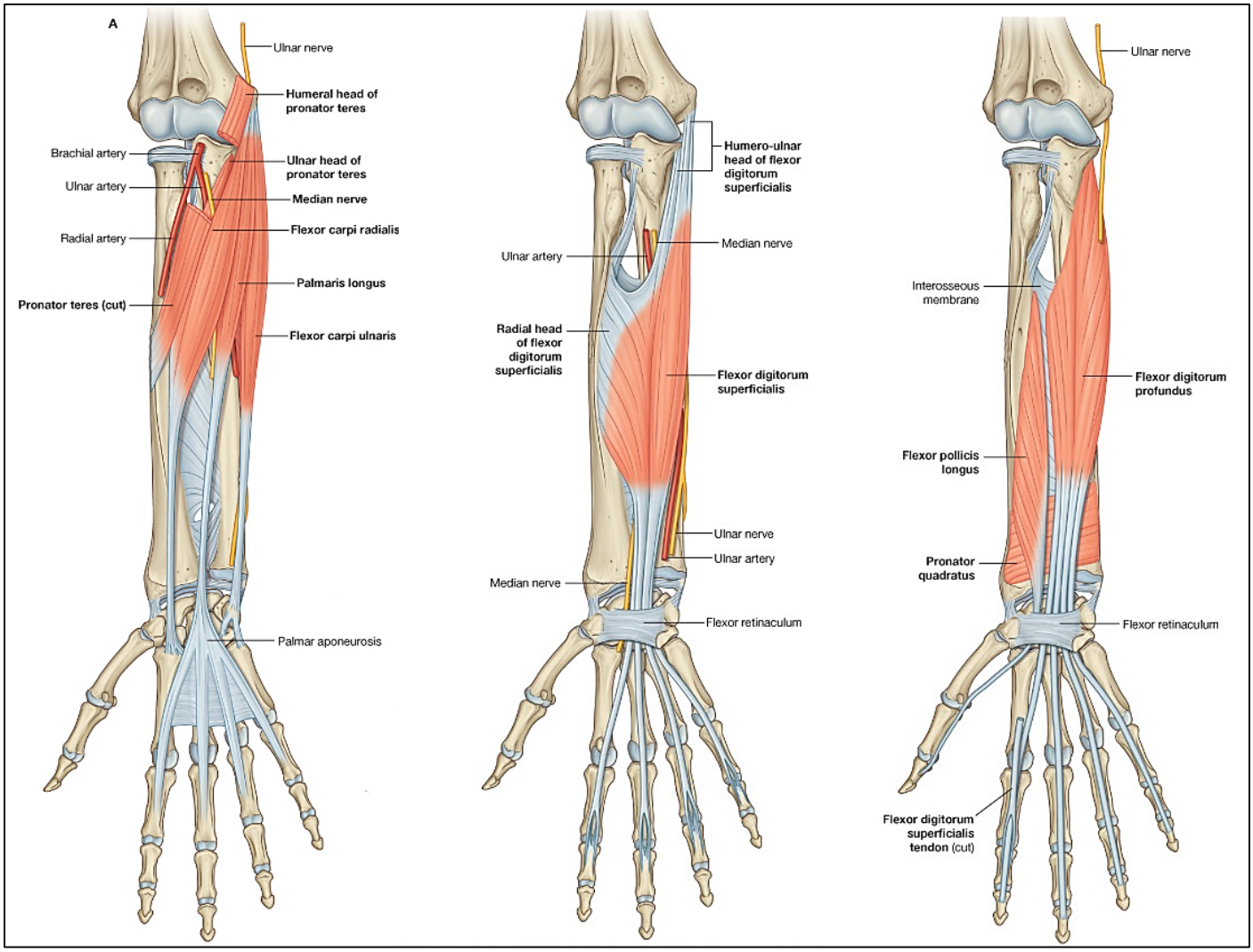


Figure 39: Muscles of the flexor compartment of the forearm; Superficial (left), middle, deep (right)

Instead of going through the details of muscular origin and insertion, it is more practical to distinguish important features of these muscles:

- The muscles of the superficial and middle layers all arise by a **common flexor tendon**, from the medial epicondyle of the humerus. Therefore, they cross the elbow joint and assist in elbow flexion.
- Palmaris longus is often absent. If present, its main action is to tense the palmar aponeurosis and palmar skin to facilitate hand maneuvers. It assists in wrist flexion.
- Pronator teres & flexor carpi ulnaris each has two heads, one of them is from the common flexor tendon.
- Flexor digitorum superficialis and flexor digitorum profundus each divide into 4 tendons before passing to the hand, the tendons pass to the phalanges of the medial 4 fingers. The tendons of flexor digitorum superficialis insert to the middle phalanges while the tendons of flexor digitorum profundus insert to the distal phalanges.
- All the muscles of the anterior compartment are supplied by the median nerve except flexor carpi ulnaris and the medial half (medial 2 tendons) of flexor digitorum profundus which are supplied by the ulnar nerve.
- The actions of the muscles of the flexor compartment of the forearm are summarized below.

Layer	Muscle	Action
Superficial	**Flexor carpi ulnaris**	Flexes and adducts the wrist joint
	Palmaris longus	Flexes wrist joint; tenses the skin of the palm
	Flexor carpi radialis	Flexes & abducts wrist Pronation
	Pronator teres	Pronation
Middle	**Flexor digitorum superficialis**	Flexes PIP joints of the index, middle, ring, and little fingers; can also flex MCP joints of the same fingers and the wrist joint
Deep	**Flexor digitorum profundus**	Flexes DIP joints of the index, middle, ring, and little fingers; can also flex MCP joints of the same fingers and the wrist joint
	Flexor pollicis longus	Flexes interphalangeal joint of the thumb; can also flex MCP joint of the thumb
	Pronator quadratus	Pronation

Arteries [Figure.40]

The ulnar artery

The ulnar artery begins opposite the neck of the radius as the larger deep medial terminal branch of the brachial artery. It descends inferomedially on the medial side of the forearm between pronator teres & flexor digitorum superficialis anteriorly; and flexor digitorum profundus posteriorly. The ulnar nerve is medial to it. It leaves the forearm by passing anterior to the flexor retinaculum of the wrist.

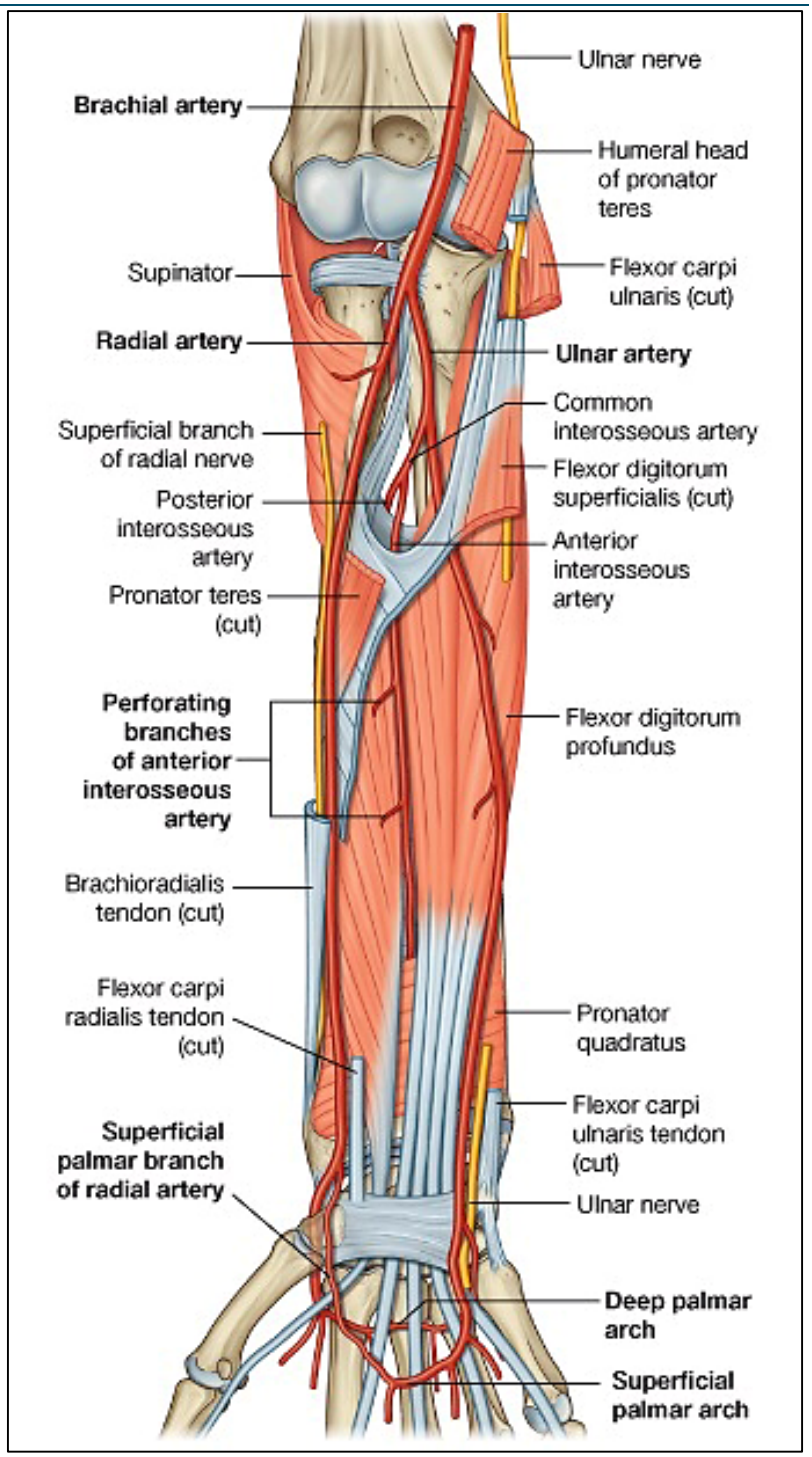


Figure 40: the radial & ulnar arteries in the forearm

The ulnar artery gives the following **branches** in the forearm:

- The **common interosseous artery**; is the first and largest branch. It passes to the proximal edge of the interosseous membrane where it divides into **anterior** and **posterior interosseous arteries**. The posterior interosseous artery gives the recurrent interosseous branch for anastomosis around the elbow and then passes to the posterior compartment of the forearm. The anterior interosseous artery gives off a long slender **median artery.** The anterior interosseous artery descends on the interosseous membrane till it reaches the proximal border of pronator quadratus muscle where it pierces the interosseous membrane to the posterior compartment and meets the terminal part of the posterior interosseous artery at the dorsal carpal rete.

- The **anterior and posterior recurrent ulnar arteries**; for anastomosis around the elbow.
- **Muscular branches**.
- The **palmar and dorsal carpal branches**; for anastomosis around the wrist joint.

The Radial artery

The radial artery begins as the smaller lateral more superficial terminal branch of the brachial artery, arising opposite the neck of the radius. It runs inferolaterally and superficially in the lateral side of the forearm covered with skin and fascia & overlapped by brachioradilais. The superficial branch of the radial nerve lies lateral to it.

It leaves the forearm by winding around the lateral ligament of the wrist to reach the dorsum of the hand.

The radial artery gives the following **branches** in the forearm:

- **Recurrent radial artery**; for anastomosis around the elbow joint.
- **Muscular branches**.
- **Palmar and dorsal carpal branches**; for anastomosis around the wrist joint.
- The **superficial palmar branch**; arises just proximal to the wrist and usually joins the ulnar artery in the hand to form the superficial palmar arch.

Nerves [Figure 41]

The superficial branch of the radial nerve

This nerve represents the continuation of the radial nerve in the anterior compartment. It runs between brachioradialis muscle anteriorly and the radial artery medially. In the distal part of the forearm it leaves the radial artery and winds laterally to become lateral to the tendon of brachioradilais muscle and reach the posterior surface of the wrist where it is distributed to the skin of the dorsal surface of the lateral $^{2}/_{3}$ of the hand the lateral 3 ½ fingers. The nerve gives no branches in the forearm.

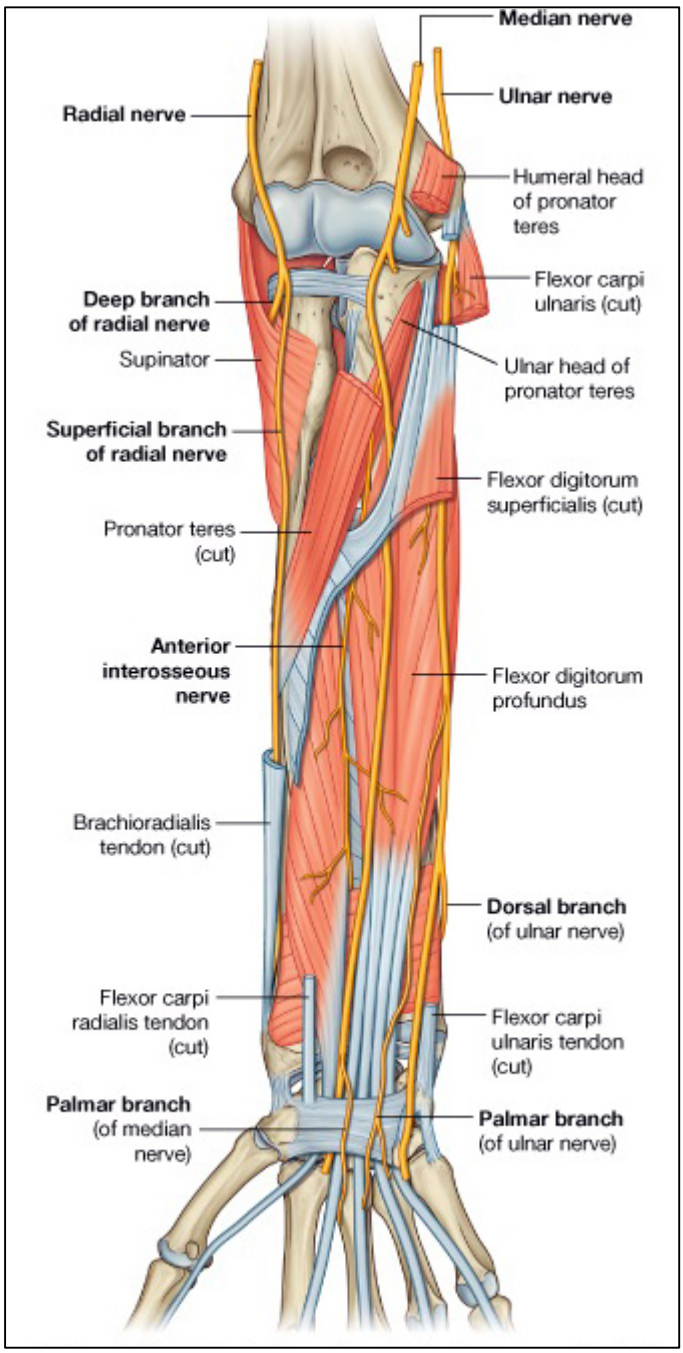


Figure 41: Nerves of the anterior compartment of the forearm

The ulnar nerve

This nerve leaves the arm by passing posterior to the medial epicondyle of the humerus and enters the forearm between the 2 heads of flexor carpi ulnaris and runs between it and flexor digitorum profundus; medial to the ulnar artery. At the wrist the ulnar nerve turns superficially between the tendons of flexor carpi ulnaris and flexor digitorum superficialis and leaves towards the hand by passing anterior to the flexor retinaculum, lateral to the pisiform.It gives the following **branches** in the forearm:

- **Articular branches** to the elbow and wrist joints.
- **Muscular branches** to flexor carpi ulnaris and the medial ½ of flexor digitorum profundus.
- **Dorsal cutaneous branch** arises an inch proximal to the wrist and descends to the dorsal surface of the medial $^{1}/_{3}$ of the hand and medial 1 ½ fingers.
- **Palmar cutaneous branch** arises just proximal to the wrist and runs to the palmar surface of the medial $^{1}/_{3}$ of the palm and medial 1 ½ fingers.

The median nerve

This nerve lies medial to the brachial artery in the cubital fossa where it gives muscular branches to the muscles of the superficial and middle layers, except flexor carpi ulnaris. Then, it runs between the two heads of pronator teres muscle and crosses anterior to the ulnar artery where it gives the anterior interosseous branch that supplies flexor pollicis longus, pronator quadratus and the lateral ½ of flexor digitorum profundus. The median nerve then runs in the middle of the forearm between flexor digitorum superficialis anteriorly and flexor digitorum profundus posteriorly. In the distal part of the arm it turns laterally, gives the palmar cutaneous branch and then passes to the hand posterior to the flexor retinaculum. It gives the following **branches** in the forearm:

- **Articular branches** to the elbow and wrist joints.
- **Muscular branches** to the muscles of the superficial and middle layers except flexor carpi ulnaris.
- The **anterior interosseous nerve**; runs on the interosseous membrane with the anterior interosseous artery. It supplies flexor pollicis longus, the lateral ½ of flexor digitorum profundus, pronator quadratus and gives articular branches to the wrist and distal radio-ulnar joints.
- The **palmar cutaneous branch**; arises before the median nerve enters the carpal tunnel. It runs anterior to the flexor retinaculum and supplies the skin of the palmar surface of the lateral $^{2}/_{3}$ of the palm.

Posterior compartment of the forearm

Muscles [Figure.42]

These muscles lie posterolateral to the posterior border of the ulna and are arranged in two layers:

- The **superficial layer** consists of two groups: The **posterior group** includes; from medial to lateral and from above downwards: anconeus, extensor carpi ulnaris, extensor digiti minimi & extensor digitorum. The **lateral group** includes extensor carpi radialis brevis, extensor carpi radialis longus and brachioradialis.
- The deep layer contains; above downwards: supinator, abductor policis longus, extensor policis longus and extensor indices.

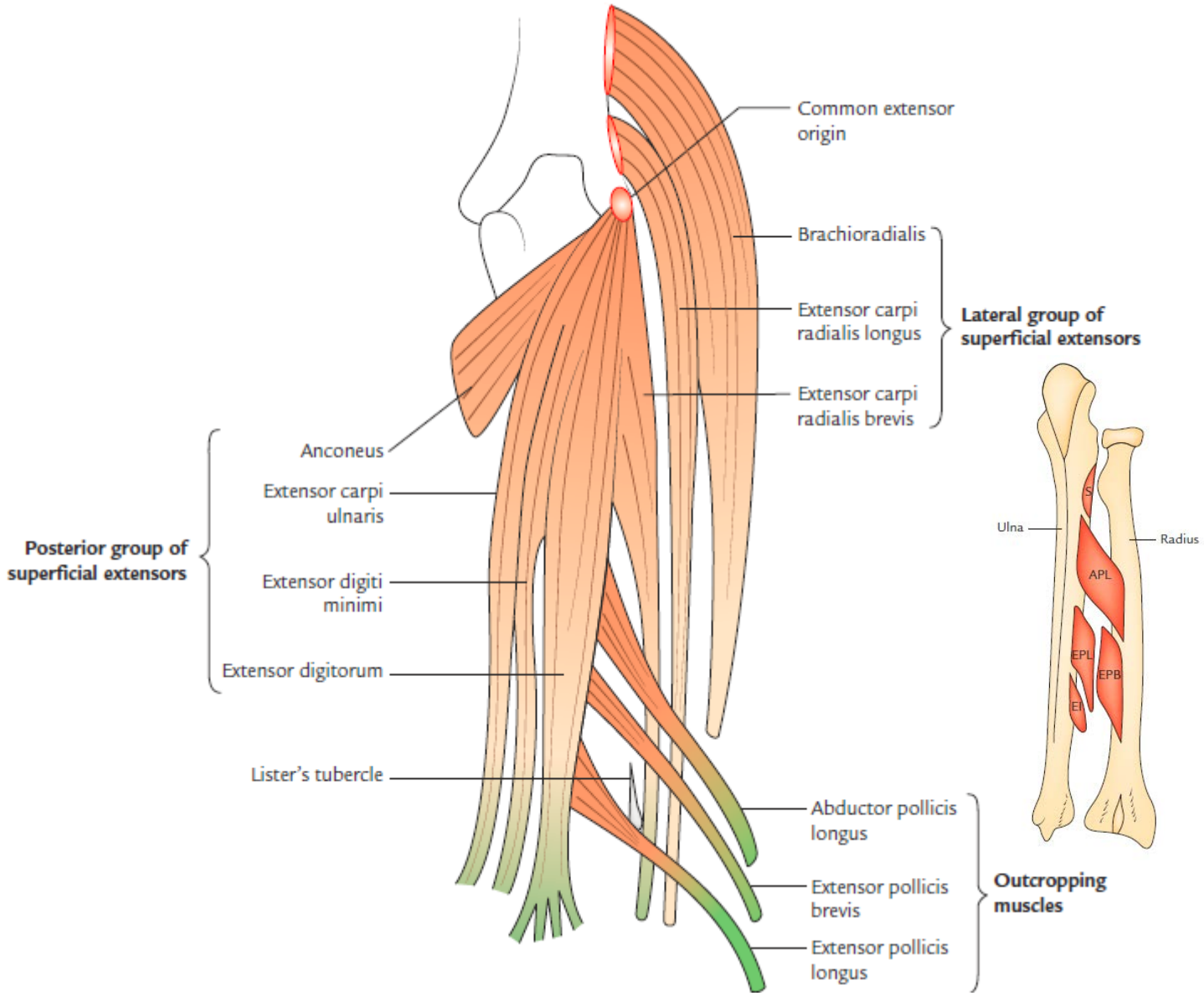


Figure 42: Muscles of the extensor compartment of the forearm

- The muscles of the superficial group all originate by the common extensor tendon from the lateral epicondyle and the lateral supracondylar line of the humerus. Since they cross the elbow they assist in elbow flexion, excpt anconeus which extends it.
- Supinator has two heads & the deep branch of the radial nerve passes between them.
- The long extensor tendons (digitorum, indices, policis, digiti minimi) are inserted to the dorsal expansion of the corresponding digits, extensor digitorum is distributed to the medial 4 digits.
- All the muscles of the posterior compartment are supplied by the deep branch (**posterior interosseous nerve**) of the radial nerve except anconeus, brachioradialis and extensor carpi radialis longus which are supplied directly by the radial nerve before it divides into superficial and deep branches.
- The actions of the extensor compartment muscles are summarized below.

Muscle	Action
Anconeus	Accessory extensor of the elbow joint
Extensor carpi ulnaris	Extends and adducts the wrist
Extensor digiti minimi	Extends the little finger
Extensor digitorum	Extends the index, middle, ring, and little fingers; extends the wrist
Extensor carpi radialis brevis	Extends and abducts the wrist
Extensor carpi radialis longus	Extends and abducts the wrist
Brachioradialis	Moves the forearm to mid-pronation Accessory flexor of elbow joint when forearm is mid-pronated
Extensor indicis	Extends index finger
Extensor pollicis longus	Extends interphalangeal joint of the thumb; can also extend carpometacarpal and metacarpophalangeal joints of the thumb
Extensor pollicis brevis	Extends metacarpophalangeal joint of the thumb; can also extend the carpometacarpal joint of the thumb
Abductor pollicis longus	Abducts carpometacarpal joint of thumb; accessory extensor of the thumb
Supinator	Supination

Nerves & Arteries [Figure 43]

The nerve of this compartment is the **deep branch of the radial nerve**; the **posterior interosseous nerve**. It arises at the level of the lateral epicondyle and passes between the two heads of supinator to enter the posterior compartment and descends to reach and accompany the terminal branches of the posterior interosseous artery; running lateral to the artery. It ends on the back of the wrist by giving articular branches to the wrist and intercarpal joints.

The arteries of the compartment are the posterior interosseous artery and the terminal brance of the anterior interosseous artery. The **posterior interosseous artery** enters the posterior compartment just distal to the lower border of supinator and gives muscular branches and sends the recurrent interosseous branch for anastomosis around the elbow joint. It eventually reaches the dorsal carpal rete.

The **terminal part of the anterior interosseous artery** reaches the posterior compartment by piercing the interosseous membrane at the proximal border of pronator quadratus and joins the posterior interosseous artery at the dorsal carpal rete.

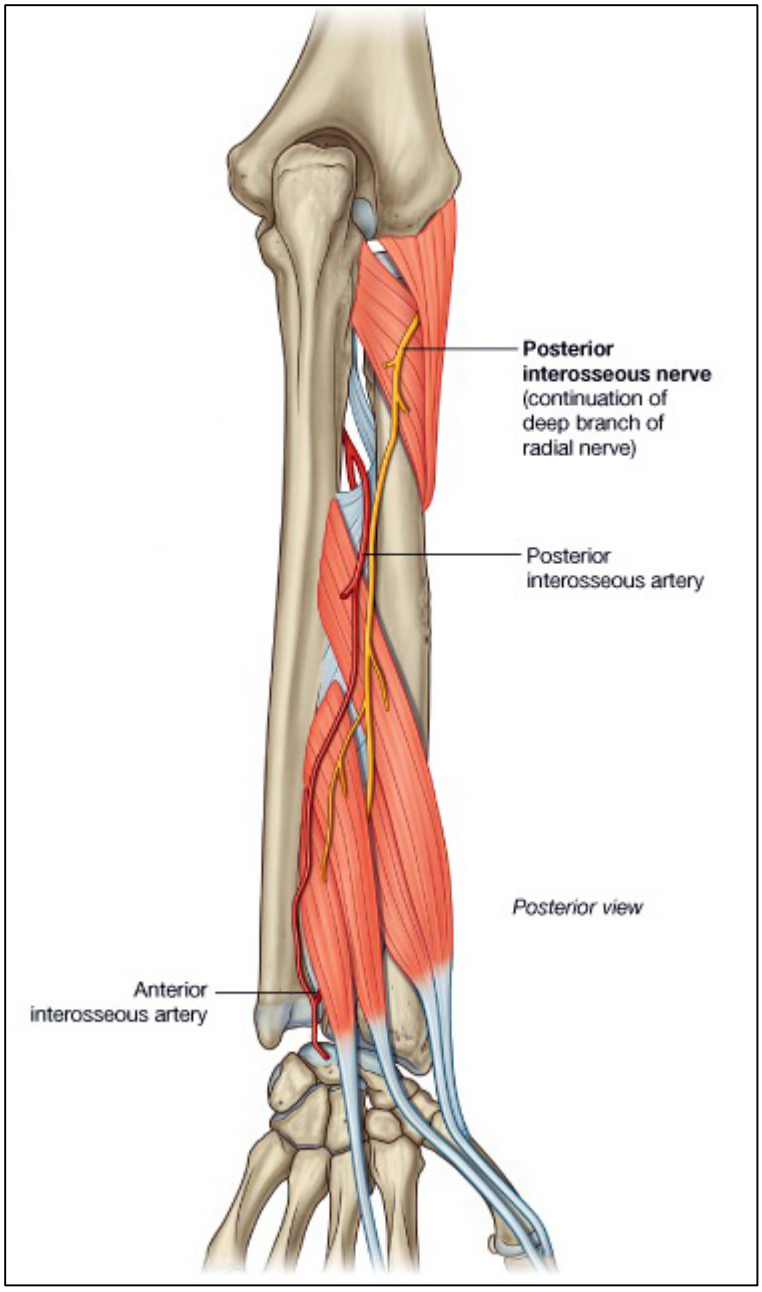


Figure 34: The posterior interosseous nerve & artery

Retinacula around the wrist [Figure.44]

The deep fascia of the forearm is thickened at the carpal bones anteriorly and posteriorly to form the flexor and extensor retinacula of the wrist, respectively. These retinacula hold the long flexor & extensor tendons and prevent them from springing away during wrist flexion & extension.

The flexor retinaculum

This is a strong fibrous band that is continuous proximally with the deep fascia of the forearm and distally with the palmar aponeurosis. It stretches across the curved bony gutter of the carpal bones turning it into the **osteofascial crapal tunnel**. The retinaculum is attached laterally to the tubercles of the trapezium and scaphoid and medially to the pisifrom and hook of the hamate. The attachment to the trapezium is to both sides of the groove lodging the tendon of flexor carpi radialis, forming a separate tunnel for that tendon.

- **Structures passing anterior (superficial) to the flexor retinaculum; from medial to lateral:** Ulnar nerve→ Ulnar artery→ Palmar cutaneous branch of the ulnar nerve→ Palmaris longus tendon→ Palmar cutaneous branch of the median nerve
- **Structures passing posterior (deep) to the flexor retinaculum; from medial to lateral:** The 8 tendons of flexor digitorum superficialis (anteriorly) and flexor digitorum profundus (posterior four)→ Median nerve→ Flexor pollicis longus tendon→Flexor carpi radialis tendon (in its own separate tunnel).

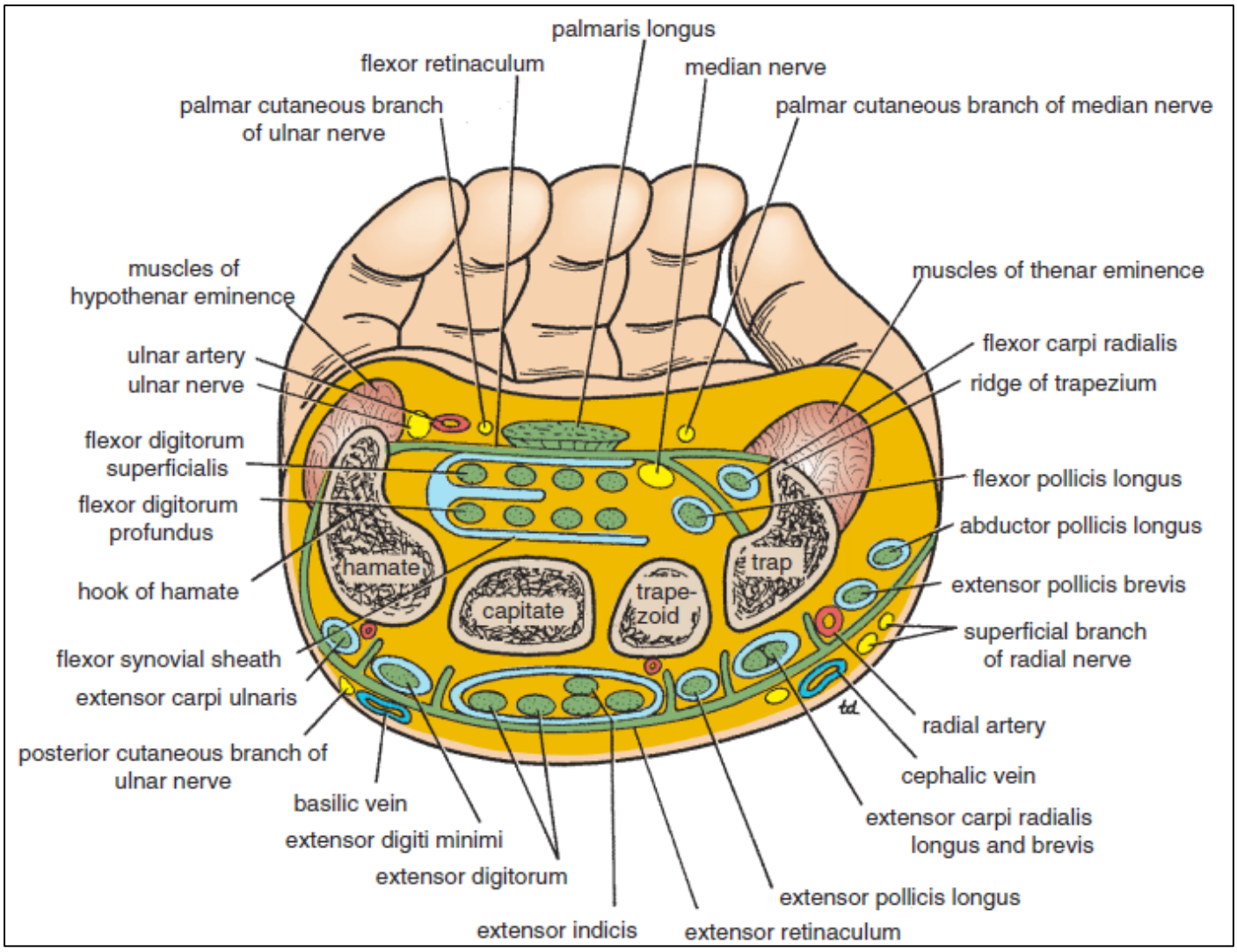


Figure 44: arrangement of structures at the wrist retinacula (cross section at the level of the distal raw of the carpal bones)

The extensor retinaculum of the wrist

This is a thickened strip of deep fascia that passes obliquely from the distal end of the radius laterally to the pisiform and hamate medially. It sends from its deep surface multiple fibrous septa to the grooves of the underlying distal radius and ulna separating these grooves into 6 tunnels for the passage of the long extensor tendons.

- **Structures passing posterior (superficial) to the extensor retinaculum; from medial to lateral:** Dorsal cutaneous branch of the ulnar nerve→ Basilic vein→ Cephalic vein → Superficial branch of the radial nerve
- **Structures passing anterior (deep) to the extensor retinaculum; from medial to lateral:**Extensor carpi ulnaris tendon→ Extensor digiti minimi tendon→ Extensor digitorum and extensor indicis tendons (in a common sheath)→ extensor pollicis longus tendon→ Extensor carpi radialis longus and extensor carpi radialis brevis tendons (in a common sheath→ Tendons of abductor pollicis longus & extensor pollicis brevis and the radial artery.

THE ANATOMICAL SNUFFBOX

The anatomical snuffbox **[Figure 45]** is a term given to the triangular depression formed on the posterolateral side of the wrist and the base of the 1st metacarpal bone by the extensor tendons passing into the thumb. The base of the triangle is at the wrist and the apex is directed towards the thumb. The depression is most apparent when the thumb is extended and has 2 borders and a floor.

Boundaries

- The **lateral border** is formed by the tendons of the abductor pollicis longus and extensor pollicis brevis.
- The **medial border** is formed by the tendon of the extensor pollicis longus.
- The **floor** is formed by the scaphoid and trapezium..

Contents

- The **radial artery** passes obliquely through the anatomical snuffbox, deep to the extensor tendons of the thumb and lies adjacent to the scaphoid and trapezium against which it may be pressed for pulsation.
- The terminal part of the **superficial branch of the radial nerve** passes subcutaneously over the snuffbox, lateral to the cephalic vein.

- The origin of the **cephalic vein** from the dorsal venous arch of the hand also runs subcutaneously over the snuffbox.

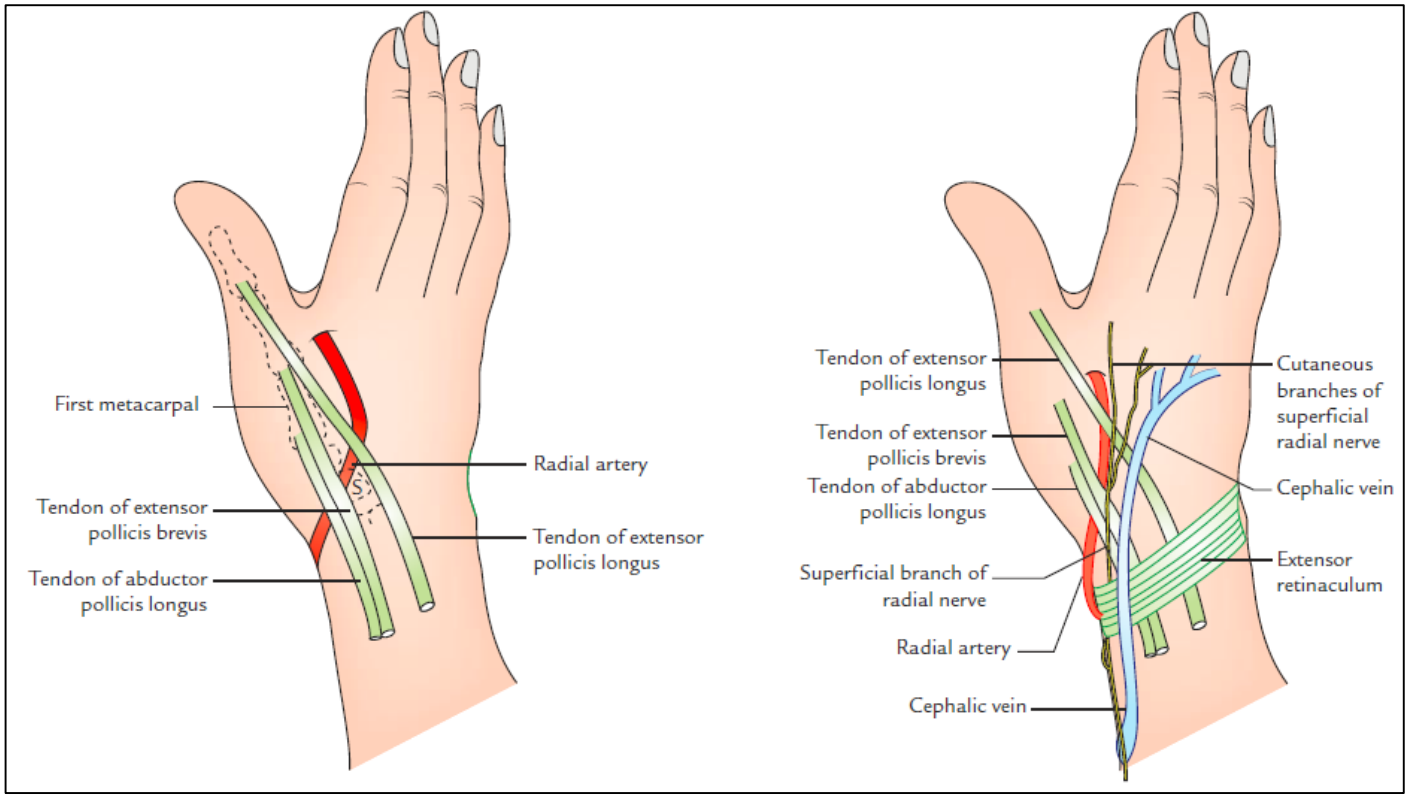


Figure 45: Boundaries and contents of the anatomical snuff box

Joints of the forearm

The elbow joint

Type and articulation

The elbow is a synovial **hinge** joint formed by the articulation between the trochlea and capitulum of the humerus with the trochlear notch of the ulna and head of the radius, respectively **[Figure.46, 47]**. It is a complex joint that is continuous with the proximal radio-ulnar joint. The elbow is a stable joint in adults for two reasons:

1. The pulley-shaped trochlea of humerus fits properly into the trochlear notch of ulna.
2. The strong collateral ligaments.

The fibrous capsule and ligaments

- The **fibrous capsule**; extends anteriorly from the upper margins of the coronoid and radial fossae above to the margins of the coronoid process and annular ligament below. Posteriorly, it extends from the margins of the olecranon fossa above to the upper margin and sides of the olecranon process and annular ligament below. The capsule and joint cavity are continuous below with that of the proximal radio-ulnar joint.

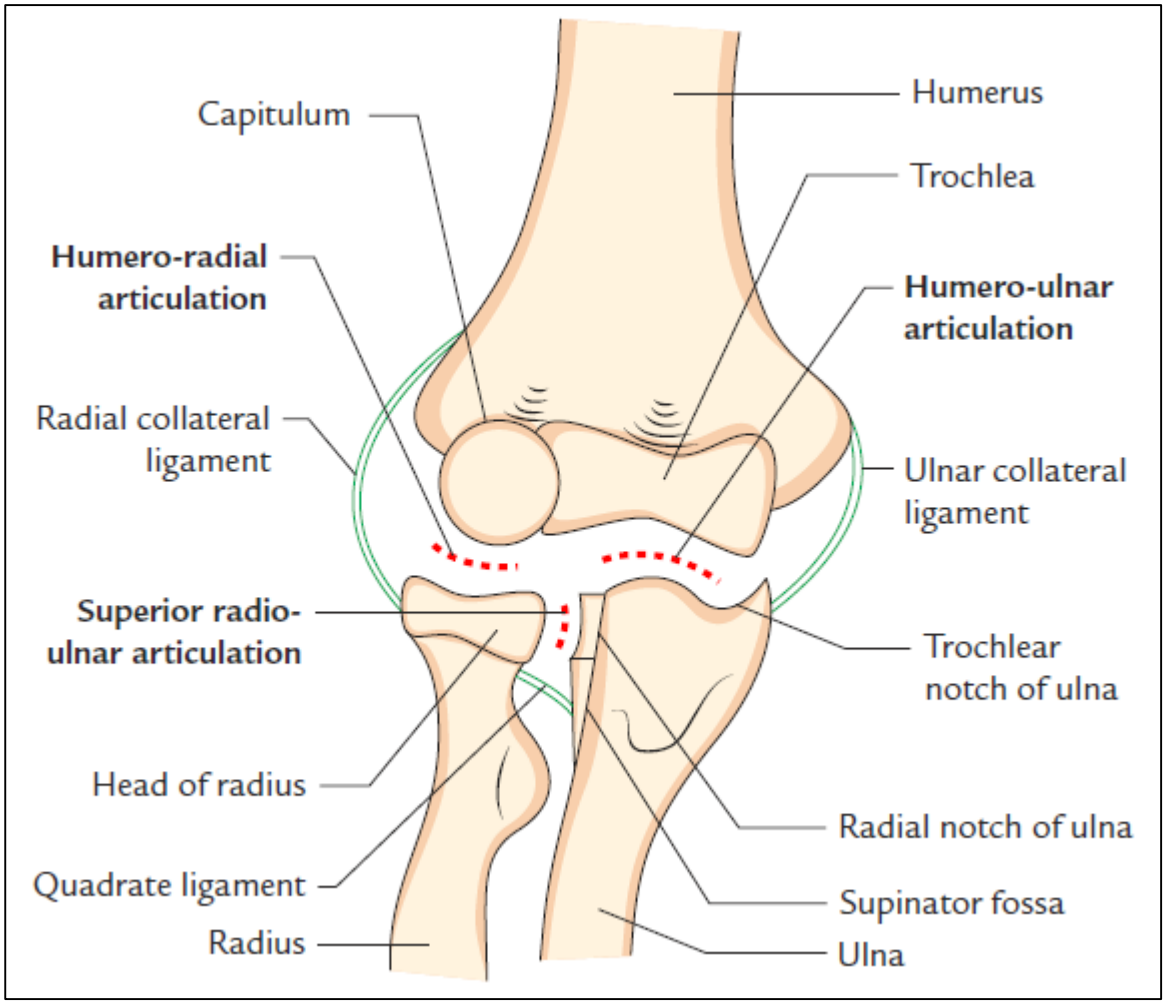


Figure 46: articulations of the elbow joint complex

- The **radial collateral ligament**; is a strong triangular band attached by its apex to the lateral epicondyle of the humerus and by its base to the lateral and posterior parts of the upper margin of the annular ligament.
- The **ulnar collateral ligament**; is a fan-shaped band with thickened anterior and posterior parts and a thin central part. The **anterior band** passes from the medial epicondyle of the humerus to the medial margin of the coronoid process. The **posterior band** passes from the medial epicondyle to the medial side of the olecranon process. A **transverse band** bridges across the interval between the olecranon and coronoid processes.

The synovial membrane & elated bursae

The synovial membrane lines the articular capsule but is separated from it over the olecranon, radial and coronoid fossae by tree fat pads. It is continuous with synovial membrane of the proximal radio-ulnar joint.

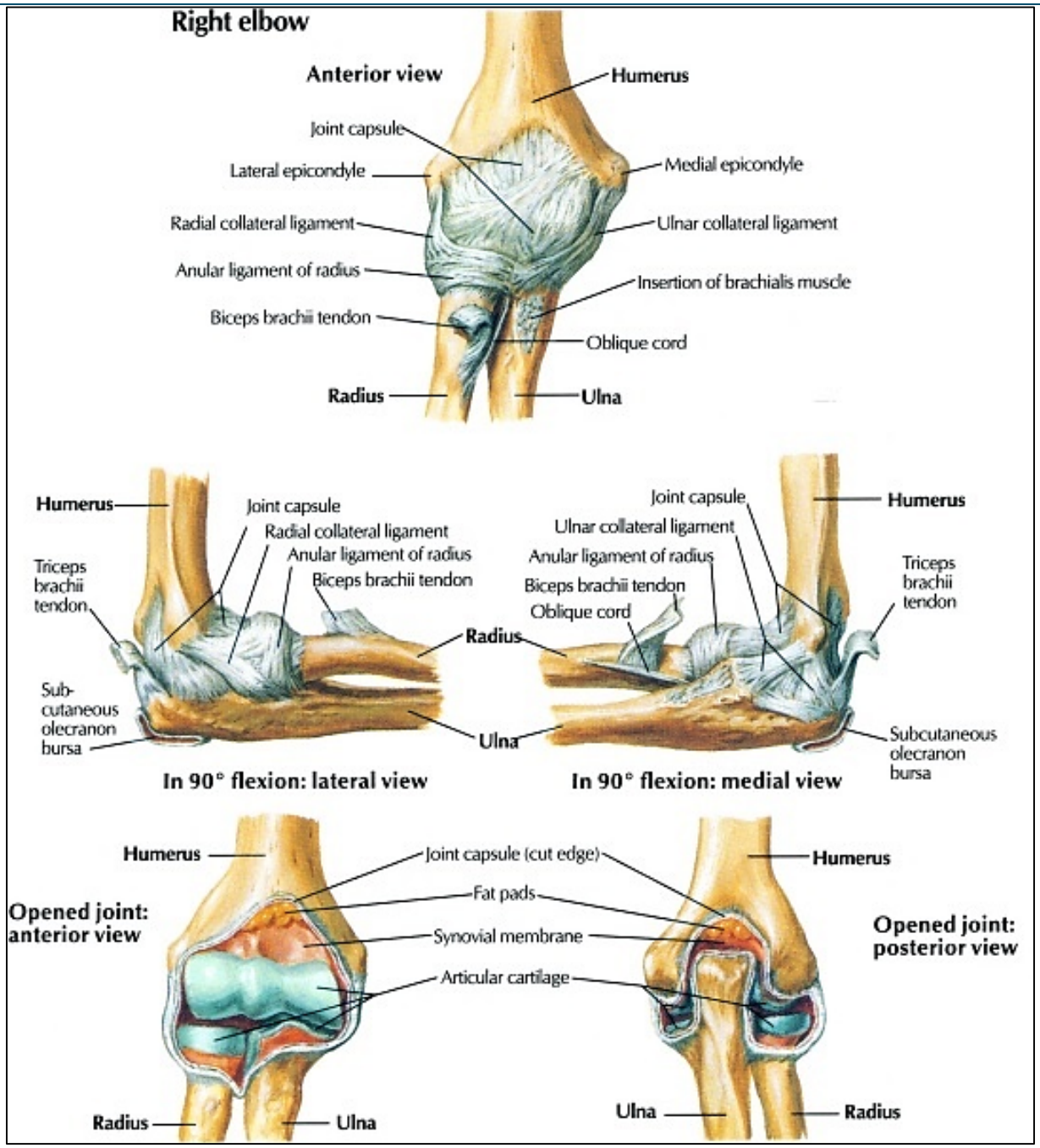


Figure 47: Capsule, ligaments & synovial cavity of the elbow joint complex

Four important bursae are related to the elbow joint: two in relation to the triceps insertion and two in relation to the biceps insertion.

1. Subtendinous olecranon bursa is a small bursa between triceps tendon and upper surface of the olecranon process.

2. Subcutaneous olecranon bursa, a large bursa betweenthe skin and subcutaneous triangular area on the posterior surface of the olecranon.

3. Bicipitoradial bursa, a small bursa separating biceps tendon from smooth anterior part of the radial tuberosity.

4. A small **bursa separating the biceps tendon from the fibrous capsule.**

Movements

Being a uniaxial joint, the elbow joint allows only flexion and extension.

Movement	Muscle
Flexion	Brachialis Biceps brachii Brachioradialis (in midpronation) Muscles which arise from the common flexor and extensor tendons (especially pronator teres)
Extension	Triceps brachii Anconeus

The carrying angle

The transverse axis of elbow joint is not transverse but oblique being directed downwards and medially. This is because medial flange of trochlea lies about 6 mm below its lateral flange. Consequently when the elbow is extended the arm and forearm do not lie in straight line, rather forearm is deviated slightly laterally.

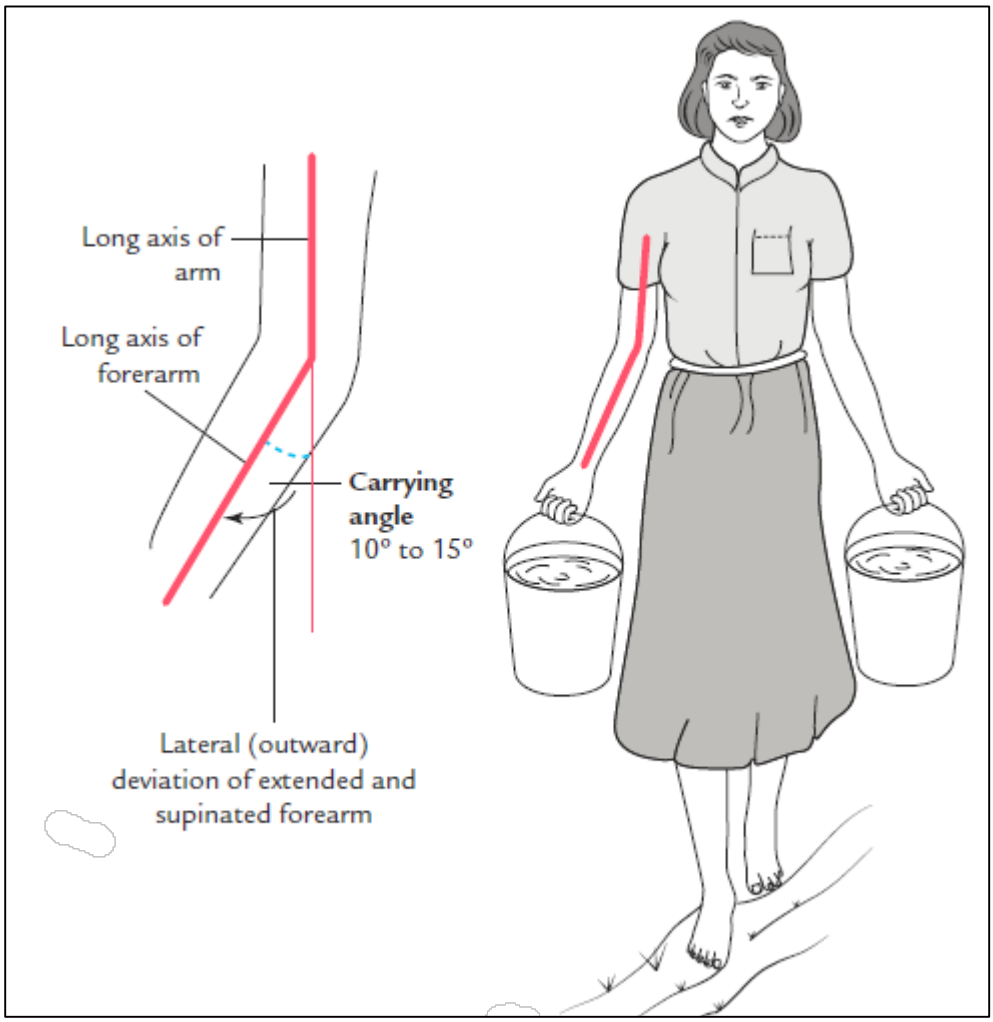


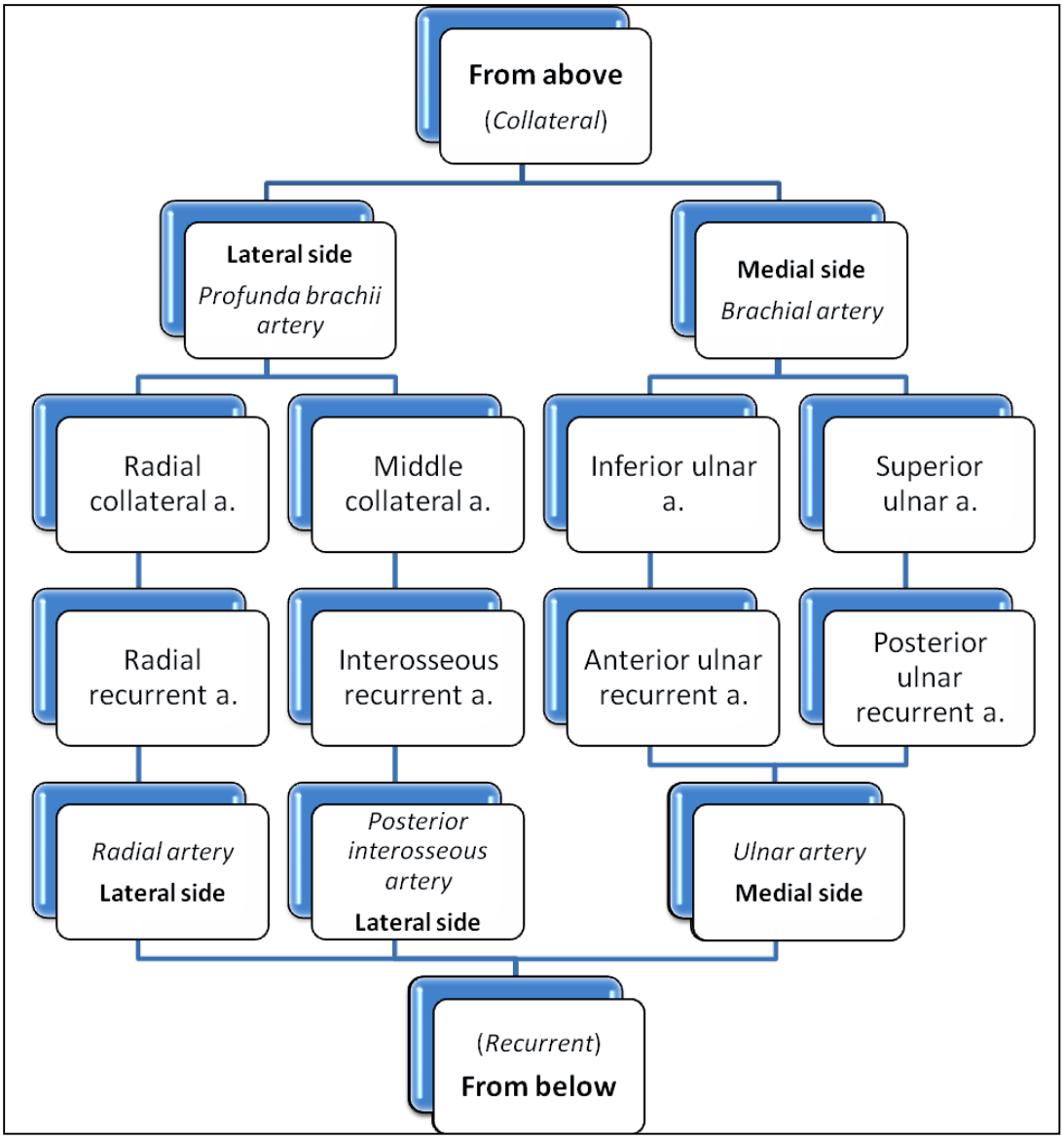
Figure 48: The carrying angle of the elbow

This angle of deviation of long axis of forearm from long axis of arm is termed **carrying angle [Figure 48]**, which ranges from 10-15 degrees (measured on the medial side) and is more pronounced in females.

The carrying angle disappears during pronation and full flexion of forearm. The forearm comes into line with the arm in the midprone position—the position in which the hand is mostly used.

Nerve and arterial supply

- Articular nerve branches are derived from all adjacent nerves; radial, median, ulnar.
- Arterial supply is provided by the rich anastomosis around the elbow **[figure 49]**. This anastomosis is formed by four pairs of arteries:



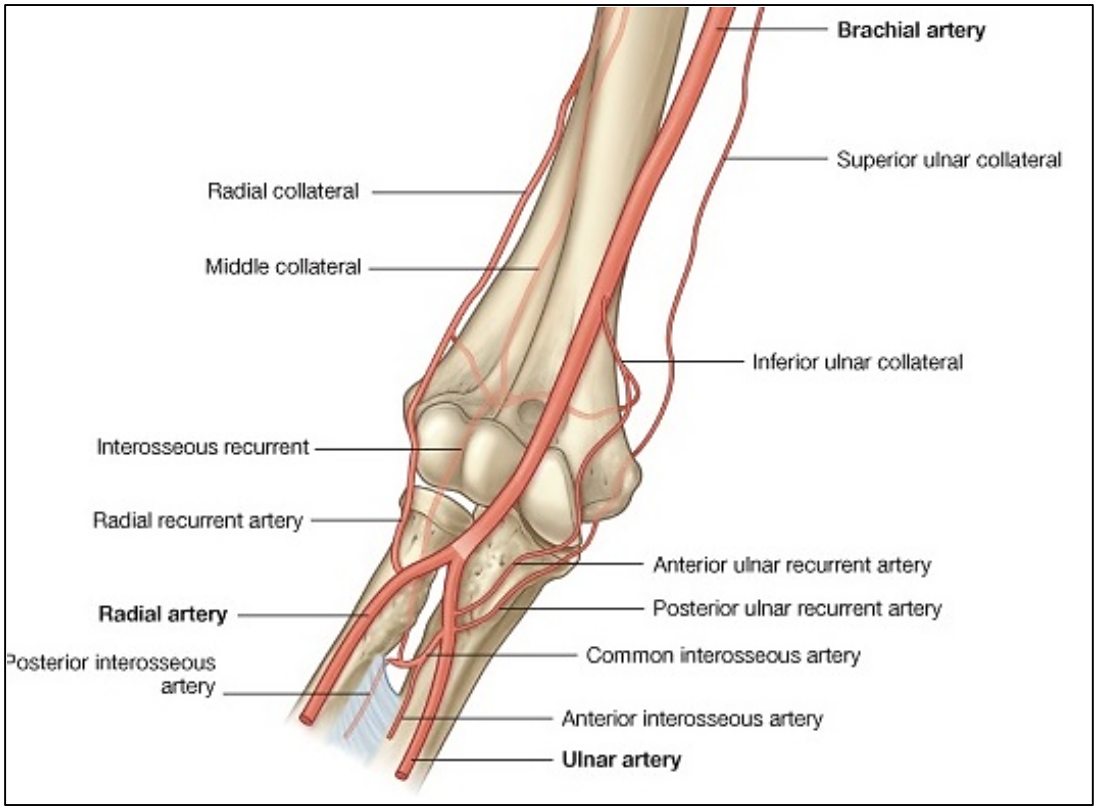


Figure 49: arterial anastomosis around the elbow joint

Relations

- **Anteriorly**; the cubital fossa contining brachialis muscle, median nerve, brachial artery, biceps tendon, and musculocutaneous nerve.
- **Posteriorly**; triceps tendon and bursa, anconeus muscle and the nerve to anconeus.
- **Medially**; ulnar nerve and common flexor tendon.
- **Laterally**; radial nerve, common extensor tendon and supinator muscle.

The proximal radio-ulnar joint

Type and articulation

This is a synovial **pivot** joint formed by the articulation between the circumference of the head of the radius with the annular ligament and radial notch of the ulna.

The fibrous capsule, ligaments and synovial membrane

- The **fibrous capsule** and **synovial membrane** are continuous with those of the elbow joint.
- The **annular ligament**; is a strong, slightly conical collar that is attached to the anterior and posterior margins of the radial notch of the ulna, encircling the head of the radius and keeping it in contact with the ulna. It is closely fit but not fused to the neck of the radius so that the head can turn freely within the ligament but cannot be pulled down out from

it. The annular ligament is strengthened by the radial ligament and fibrous capsule of the elbow joint.

- The **quadrate ligament**; is a weak sheet of fibers passing between the neck of the radius and the lower margin of the radial notch.

Movements

Movement	Muscle
Pronation	Pronator teres Pronator quadratus Flexor carpi radialis Brachioradialis (from full supination to midpronation)
Supination	Supinator Biceps brachii (in elbow flexion) Brachioradialis (from full pronation to midpronation)

The distal radio-ulnar joint

The distal radio-ulnar joint is also a synovial pivot joint formed by the articulation between the articular surface of the head of the ulna, with the ulnar notch on the distal end of the radius, and with a fibrous **articular disc**, which separates the radio-ulnar joint from the wrist joint.

The triangular-shaped articular disc is attached by its apex to the ulna between the styloid process and the articular surface of the head, and by its base to the radius between the ulnar notch and the articular surface for the carpal bones. The distal radio-ulnar joint allows the distal end of the radius to move anteromedially over the ulna during pronation.

The radiocarpal (wrist) joint

Type and articulation

The wrist joint is a synovial **ellipsoid** joint **[Figure 50]**formed by the articulation between the distal end of the radius and the articular disc of the distal radio-ulnar joint on one side with the scaphoid, lunate and triquetrum on the other side. In the anatomical position, only the scaphoid and part of the lunate are in contact with the radius and articular disc. The rest of the lunate and the scaphoid come into contact during wrist adduction.

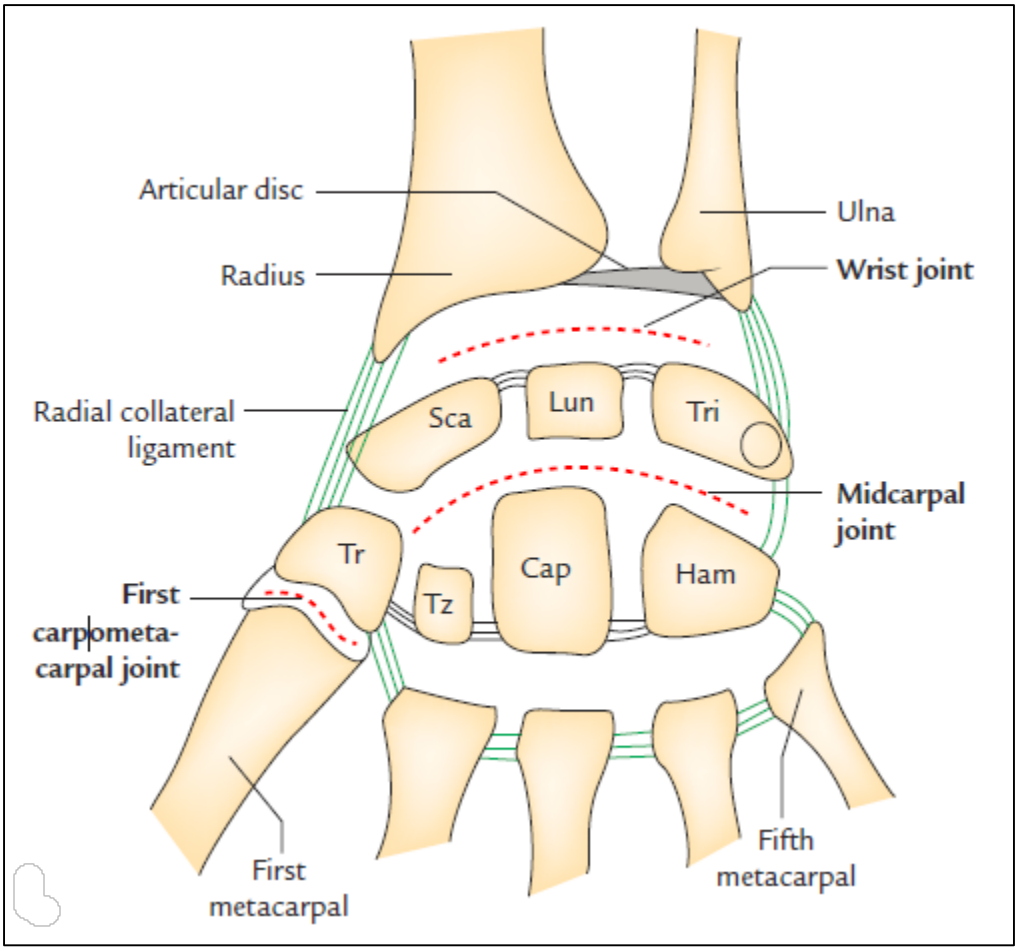


Figure 50: the wrist joint and carpal joint comlex

The fibrous capsule and ligaments

- The **fibrous capsule**; is attached superiorly to the distal ends of the radius and ulna and the articular disc between them. Distally, it is attached to the proximal row of the carpal bones except the pisiform.
- The **anterior and posterior radiocarpal ligaments**; are the thickened anterior and posterior fibers of the capsule passing obliquely downwards and medially.
- The **medial ligament**; is the thickened capsular part passing from the styloid process of the ulna to the triquetrum.
- The **lateral ligament**; is the thickened lateral capsular part passing from the styloid process of the radius to the scaphoid.

Nerve supply

Articular branches of the anterior and posterior interosseous nerves and the dorsal branch of the ulnar nerve supply the wrist joint.

Arterial supply

This is provided by a rich anastomosis of the carpal retes and the adjacent arteries.

- The **palmar carpal rete**; is formed by the palmar carpal branches of the ulnar and radial arteries with the recurrent palmar branches of the deep palmar arch.
- The **dorsal carpal rete**; is formed by the dorsal carpal branches of the radial and ulnar arteries, the recurrent dorsal branches of the deep palmar arch and the terminal parts of the anterior and posterior interosseous arteries.

Movements

Movement	Muscle
Flexion	Flexor carpi ulnaris Palmaris longus Flexor carpi radialis Flexor digitorum superficialis Flexor digitorum profundus Flexor pollicis longus
Extension	Extensor carpi ulnaris Extensor carpi radialis longus and brevis Extensor digiti minimi Extensor digitorum Extensor indices Extensor pollicis longus and brevis
Abduction (radial deiation)	Flexor carpi radialis Extensor carpi radialis longus and brevis Abductor pollicis longus
Adduction (ulnar deviation)	Flexor carpi ulnaris Extensor carpi ulnaris

Relations

- **Anteriorly**; the flexor retinaculum and related structures.
- **Posteriorly**; the extensor retinaculum and related structures.
- **Medially**; the dorsal cutaneous branch of the ulnar nerve.
- **Laterally**; the radial artery.

The Hand

The skin of the hand

The skin of the palm is thick and immobile because it is firmly attached to the underlying deep fascia (palmar aponeurosis). The palmar skin is rich with sweat glands but it has no hair and no sebaceous glands. It shows several longitudinal and transverse creases where the skin is firmly bound to the deep fascia. These flexion creases **[Figure.51]** include:

1. Flexion creases of the wrist (wrist creases): *The Proximal and Distal wrist creases* are produced as a result of folding of the skin due to repeated flexion of the wrist. The distal wrist crease corresponds to the proximal border of the flexor retinaculum.

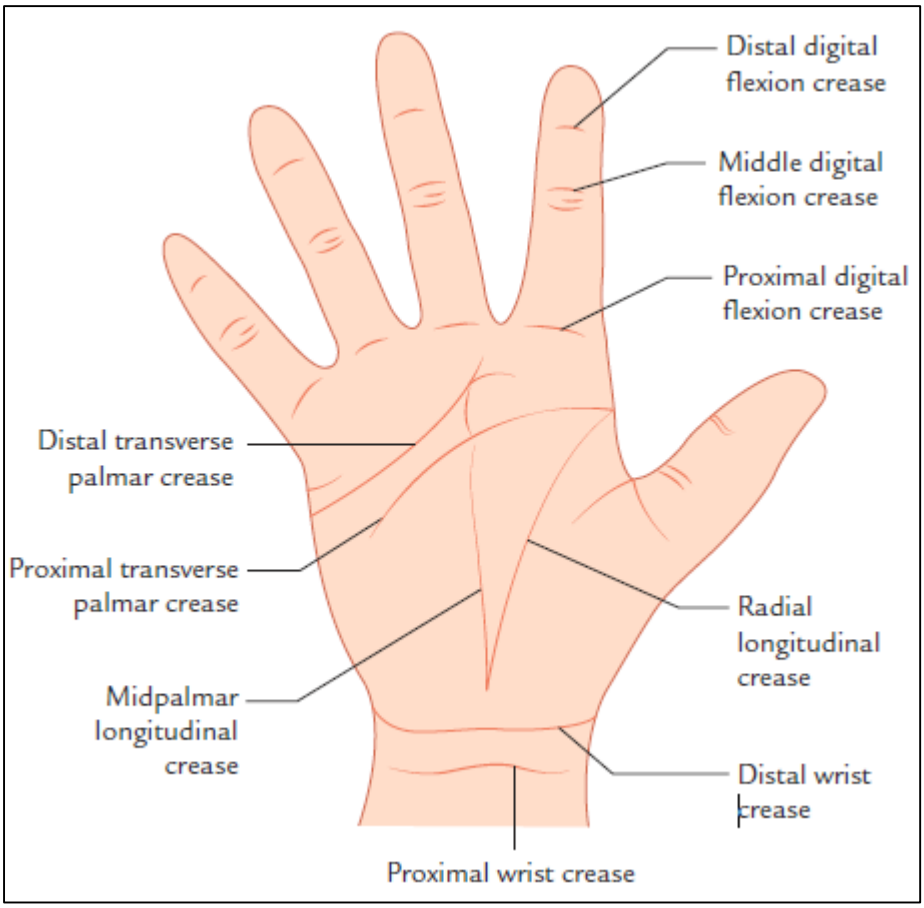


Figure 51: The flexion creases of the palm of the hand

2. Palmar flexion creases: Usually there are four major palmar creases—two horizontal and two longitudinal which together roughly form an M-shaped pattern:

(a) **Radial longitudinal crease:** partly encircles the thenar eminence (ball of the thumb) and is formed due to action of short muscles of the thumb.

(b) **Midpalmar longitudinal crease:** indicates the lateral limit of the hypothenar eminence (ball of the little finger). It is formed due to the action of short muscles of the little finger.

(c) **Proximal transverse palmar crease:** It starts at the lateral border of the palm in common with the radial longitudinal crease & extends medially and slight proximally across the palm.

(d) **Distal transverse palmar crease:** begins at or near the interdigital cleft between the index and little fingers and crosses the palm with slight distal convexity.

3. Digital flexion creases: Each of the medial four digits have three transverse flexion creases (proximal, middle & distal), while the thumb has two transverse creases (proximal & distal).

The skin on the dorsum of the hand is thin and loose when the hand is relaxed. The hairs are present on the dorsum of the hand and on the proximal parts of the digits, especially in males. The long extensor tendons and dorsal venous network are clearly visible through the skin.

The palmar aponeurosis and palmar fascial spaces

The **palmar aponeurosis** is a thick triangular part of the deep fascia of the hand **[Figure.52]** lying in the central part of the palm. It Helps to improve the grip of hand by fixing the skin and protects the underlying tendons, nerves, and vessels.

The apex of the aponeurosis is attached to the distal border of the flexor retinaculum where it receives the tendon of palmaris longus. The base lies at the level of the metacarpal heads where it divides into 4 slips. Each slip divides into 2 bands; one passes to the overlying skin and the other passes deeply to the root of the finger dividing further into 2 slips around the long flexor tendons and fusing on each side with the fibrous flexor sheath and the deep transverse metacarpal ligament.

The **medial border** of the palmar aponeurosis attaches to the 5^{th} metacarpal shaft as the **medial palmar septum.** The **medial (hypothenar) compartment** lies medial to the medial palmar septum and contains the small muscles of the little finger.

The **lateral border** of the aponeurosis attaches to the 1^{st} metacarpal shaft as the **lateral palmar septum.** The **lateral (thenar) compartment** lies lateral to the lateral palmar septum and contains the small muscles of the thumb except adductor pollicis.

A third septum; the **intermediate palmar septum**; passes from the deep surface of the aponeurosis to the 3^{rd} metacarpal bone dividing the area between the medial and lateral palmar septa into 2 spaces **[Figure.53]**:

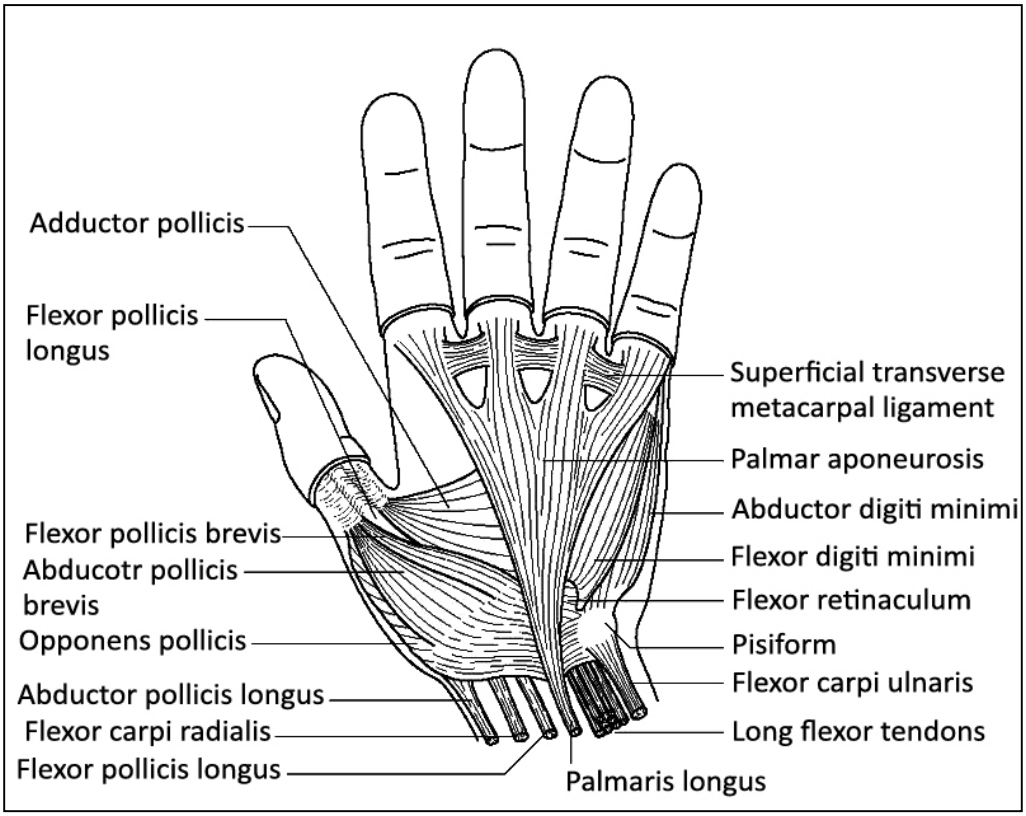


Figure 52: The palmar aponeurosis and the thenar & hypothenar muscles

- The **thenar space**; lies laterally (between the lateral and intermediate palmar septa) and is related posteriorly by the adductor pollicis and the first lumbrical muscles. The thenar compartment is lateral to this space. Anteriorly it is related by the nerves & vessels of the lateral 1 ½ fingers.
- The **mid-palmar space**; lies medially (between the medial and intermediate palmar septa) and is related anteriorly by the long flexor tendons (flexor digitorum superficialis and flexor digitorum profundus), the 2nd, 3rd and 4th lumbricals and blood vessels and nerves of the medial 3 ½ fingers. The hypothenar compartment is medial to this space. The interosseous muscles lie posterior to it

- Proximally, the two spaces are closed from the forearm by the walls of the carpal tunnel. Distally they are continuous with extensions over the lumbrical muscles (**lumbrical canals**).
- The **pulp spaces** of the fingers are other potential spaces that lie in the finger pulps as the deep fascia fuses with the periosteum of the distal phalanx via multiple septa.