THE

UPPER LIMB

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SURFACE ANATOMY & MARKINGS

SHOULDER

- **CLAVICLE**. Is easily palpable subcutaneously as it joins the sternum to the shoulder joint. The **supraclavicular nerves** [cutaneous] crossing it are also palpable.
- **ACROMION PROCESS**. Is the sharp bony edge at the **lateral side of the scapular spine**. Immediately below it lies the smooth buldge of the **deltoid muscle**, covering the **great tuberosity of the humerous**.
- The **CORACOID PROCESS** cannot be easily felt; it lies below the clavicle, at the junction between its middle and lateral third.
- **Spine of the scapula**: T3 level
- **Superior angle of the scapula**: T2 level
- **Medial border of scapula**: T2-T8 level
- **Head of humerus**: is felt in the axilla when the arm is abducted. **Arm abduction** involves abduction of the shoulder joint, elevation of the sternoclavicular joint and rotation of scapula.
- **Anterior fold of axilla**: pectoralis major muscle
- **Posterior fold of axilla**: teres major and latissimus dorsi muscles
- **DELTOID**: smooth contour of shoulder
- **SUBCLAVIAN ARTERY**: can be palpated against the first rib

ARM & FOREARM

- **HUMERUS**: is easily palpable on the medial aspect of the arm
- **BICHEPS & BRACHIORADIALIS** cover the anterior aspect of the arm
- **TRICEPS** is the posterior bulk of muscle
- **BRACHIAL ARTERY**: can be palpated on the medial aspect of humerus. Bifurcates at the level of the neck of radius, covered by the **bicipital aponeurosis** [**grace a Dieu**]
- **ELBOW**
- **Olecranon process** posteriorly
- **Medial and lateral epicondyles** of humerus

Their triangular relationship remains in supracondylar fractures but not in dislocation.

- The **head of radius** is the hollow point felt at the posterolateral surface of the extended elbow.
- **ULNA**: its posterior border is subcutaneous
- **BRACHIORADIALIS** muscle; lateral border of forearm
- **RADIAL ARTERY**: course along the medial groove formed by the tensed brachioradialis

WRIST

- **STYLOID PROCESS OF RADIUS** at the lateral border, ulna at its medial border
- **DORSAL TUBERCLE OF LISTER** at the posterior aspect [extensor] of the head of radius
- **SNUFF BOX** at the lateral border, bound by the **extensor pollicis longus** [medially] and **extensor pollicis brevis & abductor pollicis longus** laterally. The **scaphoid bone** can be felt within the box.

- The tendons of the **extensor digitorum** muscle are prominent on the extensor surface as they come to insert to the bases of the proximal phalanges.
- **Pisiform bone** at the base of the **hypothenar eminence**, into which inserts the flexor carpi ulnaris
- **Hook of hamate** just distal to pisiform
- **Scaphoid**, at the base of **thenar eminence**
- On the medial apest of the wrist the following structures can be felt [from lateral to medial border]:
    - **Styloid process** of radius
    - **Radial pulse**
    - **Flexor carpi radialis**
    - **Palmaris longus tendon** [absent in 20% of subjects]
    - **Flexor digitorum superficialis** [sublimis]
    - **Ulnar pulse**
    - **Flexor carpi ulnaris**

VENOUS NETWORK

- **Dorsal venous network of hand**
- **Cephalic vein** [lateral aspect of wrist, at the snuff box, just posterior to the radial styloid and lateral to the radial pulse. Ascends on the **radial border of the forearm**, moves on the anterior aspect, crosses the elbow, ascends on the **lateral border of biceps**, the **medial border of the deltoid;** it then follows the **deltopectoral groove** and pierces the fascia to join the axillary vein
- **Basilic vein**. On the **posteromedial aspect of forearm**, then the anterior aspect of elbow and **medial border of biceps**. **Pierces the deep fascia at the middle arm** where joins the commitantes brachial veins to become the **brachial / axillary** vein.
- **Median antecubital vein**. The most prominent superficial vein, in front of the elbow.

NERVES

- **PALPABLE**
- **Supraclavicular**: pass over the clavicle
- **Brachial plexus**: palpable over the head of humerus with the arm abducted
- **Median nerve**: palpable at the mid-upper arm, as it **crosses the brachial artery**. Lies first lateral, then medial to the brachial artery, crossing it at the midarm level, usually superficially but occasionally deep. Courses at the **median forearm plane**, between the **flexor carpi radialis** and **flexor digitorum superficialis**. At the wrist it passes **below the flexor retinaculum**.
- **Ulnar nerve**: palpable at the medial epicondyle groove. At the wrist it is lateral to the ulnar pulse and passes **above the flexor retinaculum**
- **Superficial radial nerve**: along the extensor pollicis longus at the wrist
- **RADIAL NERVE**: crosses the posterior mid-humerus
- **POSTERIOR INTEROSSEOUS NERVE** [branch of the radial]: winds around the radius, 3 fingers below radius head

THE MAMMARY GLAND [BREAST]

DEVELOPMENT

It develops from an **invagination of the chest wall ectoderm** which creates numerous branching ducts. At puberty alveoli sprout from the ducts and there is considerable fat infiltration of the gland. It atrophies in menopause

- **ANOMALIES**
- **Inverted nipple**
- **Supernummerary breasts or nipples** [along the vertical milk-line]
- **Amazia** [absence of breast]

MACROSCOPIC ANATOMY

- Covers the area between the **2nd to 6th ribs**.
- It consists of **15-20 pyramidal lobules** embeded in fat and separated by connective tissue [**suspensory ligaments of Cooper**]. Each lobule has a **lactiferous duct** which drains into the **nipple** [**papilla**]. The latter is surrounded by a pigmented area, the **areola,** which is lubricated by the **alveolar glands of Montgomery**. The upper lateral border of the mammary gland extends into the axilla, forming the **axillary tail of Spence**.

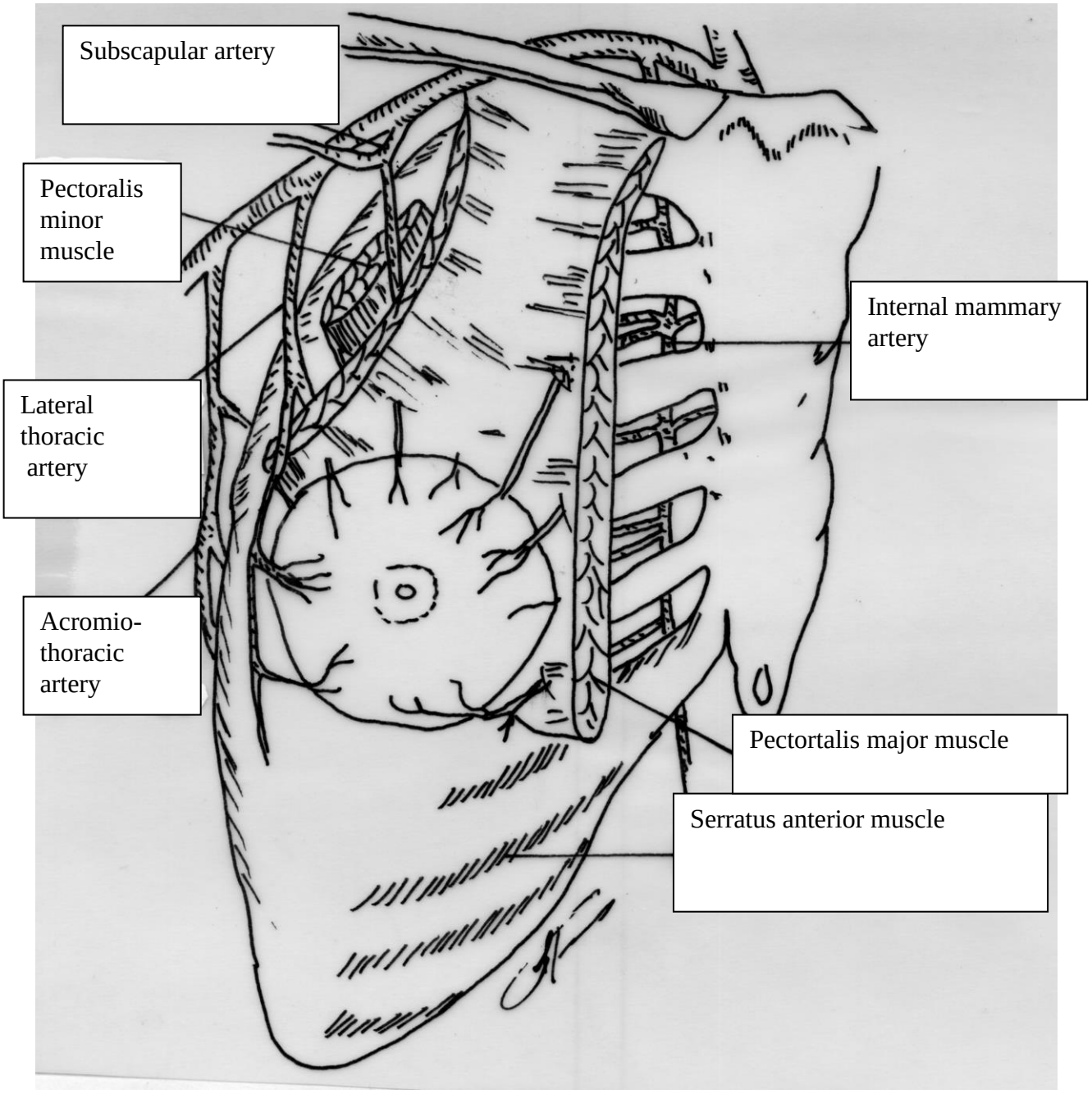
BLOOD SUPPLY

1. **Thoracoacromial artery** [branch of the axillary] at the medial border of pectoralis minor muscle.
2. **Lateral thoracic artery** [branch of the axillary] at the lateral border of pectoralis minor
3. **Perforating branches from the internal mammary** artery
4. **Perforating branches from the intercostal** arteries

LYMPH DRAINAGE

75% of breast lymphatics drain to the axillary nodes [20-30 nodes] while 25% drain to the parasternal [internal mammary] nodes

- **AXILLARY NODES**. They are subdivided into:
- **Anterior** [**pectoral**], at the lower border of pectoralis major
- P**osterior** [**subscapular**], along the subscapular vessels, on lattissimus dorsi and subscapularis muscle



- ***Anatomy & blood supply of breast***

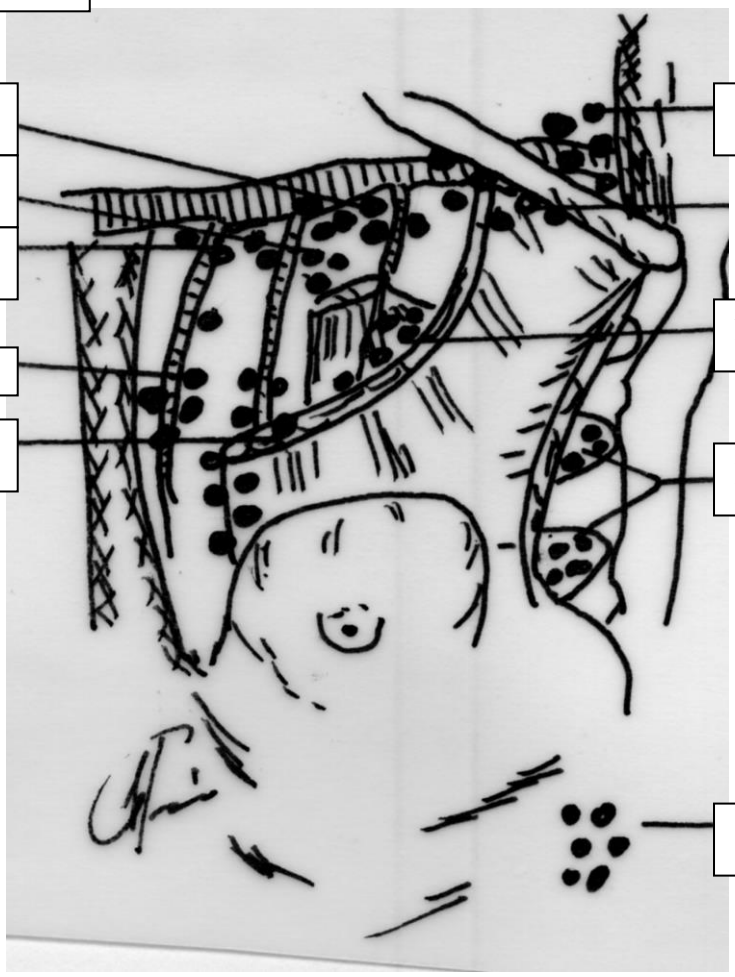
- **Lateral**, along the distal part of axillary vein
- **Central** , within the fat of the axilla, laterally to pectoralis minor muscle
- **Rotter**, underneath pectoralis minor
- **Apical**, medially to pectoralis minor

All these groups drain to the apical nodes which drain either to the **right jugular trunk** on the right [and then to the subclavian vein] or to the **thoracic duct** on the left.

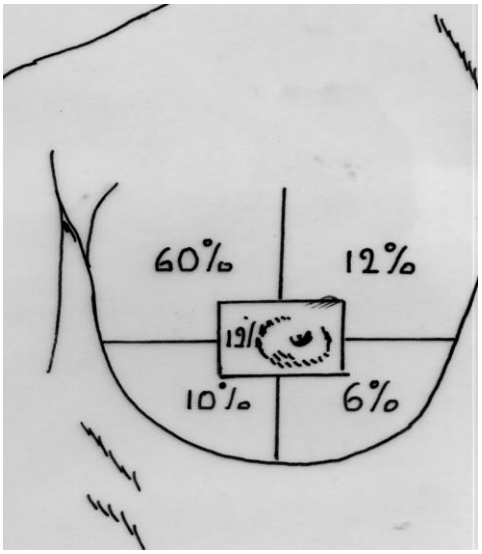
CLINICAL FEATURES

- **ABSCESS**: should be drained through a radial incision, to avoid cutting the lactiferous ducts
- **Dimpling of skin**: is a sign of infiltration of Cooper's ligament by an invading carcinoma. However, it may be present in chronic infection, trauma or, rarely, cystic mastitis.
- **Retraction of the nipple**: is caused by fibrous contraction of the lactiferous ducts by a scirrhous tumour.
- **TYPES OF MASTECTOMIES**
- **RADICAL MASTECTOMY**: The skin, breast, pectoralis major and minor and all the fat of the axilla are removed
- **MODIFIED RADICAL MASTECTOMY**. As with radical but the pectoralis major is left behind [his fascia is removed]
- **PATEY MASTECTOMY**. As with modified but the insertion of pectoralis minor to the coracoid process is divided to remove the Rotter ganglia
- **SIMPLE MASTECTOMY**. Only the breast gland is removed
- **EXTENDED SIMPLE MASTECTOMY**. Simple plus removal of periglandular fat
- **SUBCUTANEOUS MASTECTOMY**. The nipple remains in situ.
- **Quadrantectomy** $\pm$ axillary clearance or shampling
- **Lumpectomy** $\pm$ axillary clearance or shampling

Axillary groups



- ***Breast lymph node groups***



- ***Incidence of cancer***

BONES, JOINTS AND MUSCLES

THE SCAPULA

A triangular bone with its **inferior angle at T8** and its **superior angle at T2.** The orientation of the scapula and the coracoacromial arch **prevent superior dislocation of the humerus**; if the latter is dislocated it will pass onto the costal surface of the scapula.

- **SPINE OF THE SCAPULA**

On its posterior surface, **T3 level**. Is extended into the **acromion process**, where the **coracoacromial ligament** binds the acromion to the coracoid process. It divides the posterior surface into:

- **Supraspinatus fossa** [covered by the supraspinatus muscle]
- **Infraspinatus fossa** [infraspinatus muscle]

- **CORACOID PROCESS**

On the posterior surface of scapula, point of **insertion of pectoralis minor** muscle

- **Coracohumeral ligament**
- **Coracoacromial ligament**
- **Conoid ligament** [coracoclavicular joint]
- **Trapezoid ligament** [coracoclavicular joint]

- **GLENOID FOSSA**

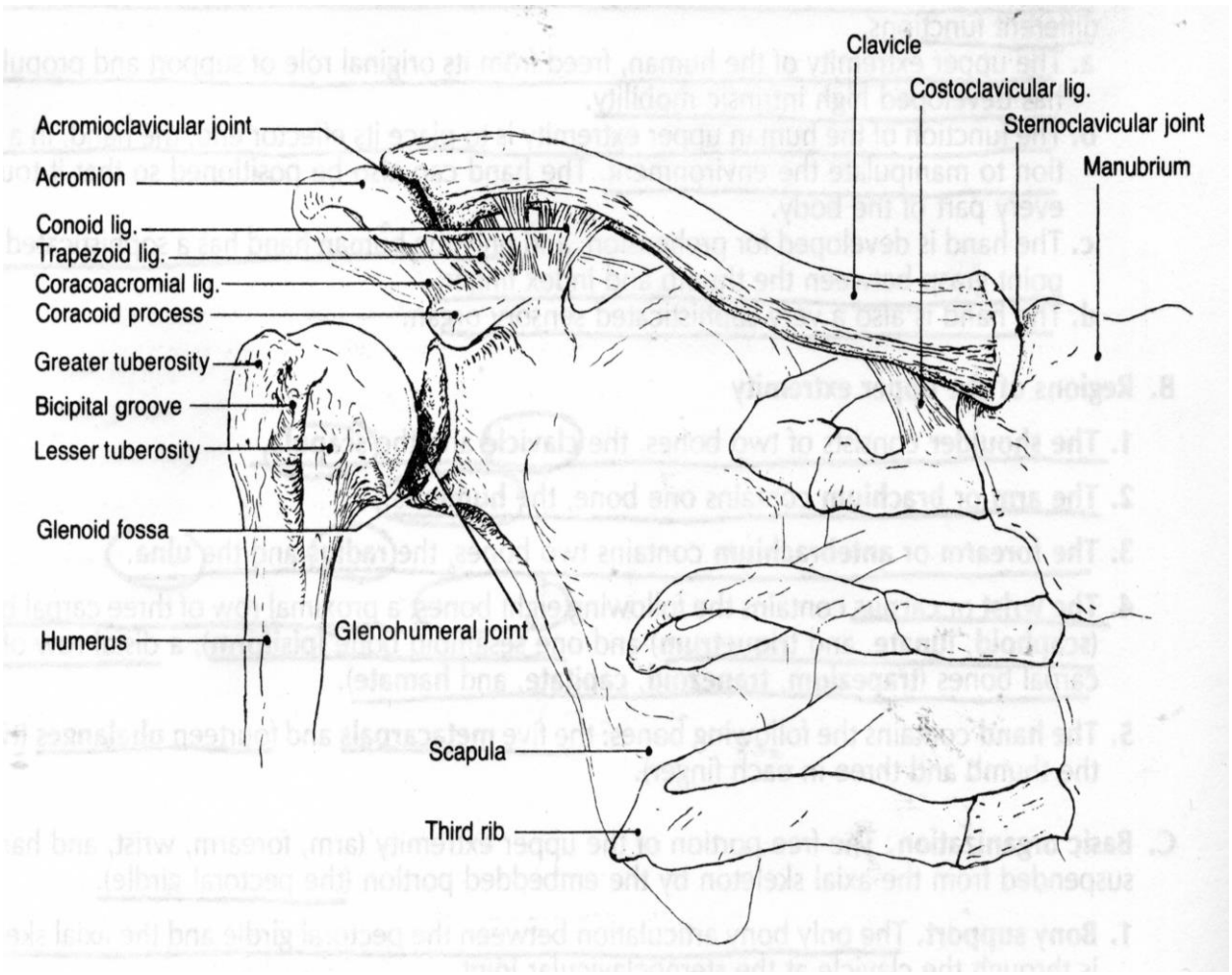
Articular socket articulating with the humerus. Is deepened by a fibrocartilage, the **glenoid labrum**.

- **Supraglenoid tubercle** $\rightarrow$ insertion of long head of biceps

Infraglenoid tubercle $\rightarrow$ insertion of long head of triceps brachii muscle

THE CLAVICLE

- Has no medullary cavity
- Is the first bone to ossify in fetus [5^{th} to 6^{th} week]
- Is the only long bone to develop from membrane and not cartilage [**intermembranous ossification**]
- Is **the most commonly fractured bone** of the body
- Behind the medial 3^{rd} of the clavicle pass the subclavian vessels and the trunks of the brachial plexus, separated only by the thin **subclavius muscle**.



- ***The shoulder[scapula, clavicle, humerus]***

- Posteriorly to the sternoclavicular joint lie the common carotid artery on the left and the innominate artery on the right. The internal jugular veins lie a bit laterally. These vessels are separated from the clavicle by the **strap muscles** [sternohyoid, sternothyroid, omohyoid]
- **FUNCTIONS**

1. Transmits forces from the upper limb to the axial skeleton
2. Acts as a strut, holding the arm free from the trunk, to be supported by the trapezius muscles
3. serves as attachment for muscles

- **FRACTURES**

Are caused by indirect forces and the fracture is usually between its middle and lower third. The trapezius is unable to support the arm which is held by the opposite. The inner fragment is slightly elevated by the act of sternomastoid while the owter is displaced downwards and drawn medially by the gravity and spasm of shoulder adductor muscles [teres].

- **STERNOCLAVICULAR JOINT**

Contains an **articular disk** and has **2 degrees of motion**. The head of the clavicle articulates with the side of the **manubrium** and is attached to the **first costal cartilage**. It is the only joint between the upper limb and axial trunk.

- **sternocolavicular ligament** [anterior and posterior part]
- **interclavicular ligament** [joins the heads of the two clavicles]
- **costoclavicular ligament**

- **ACROMIOCLAVICULAR JOINT**

The clavicle is attached to the coracoid process. The joint has an incomplete disk and has 2 degrees of motion. The ligaments form the **coracoacromial arch**.

- **acromioclavicular ligament**
- **coracoclavicular** ligament
    - **trapezoid**
    - **conoid**

THE HUMERUS

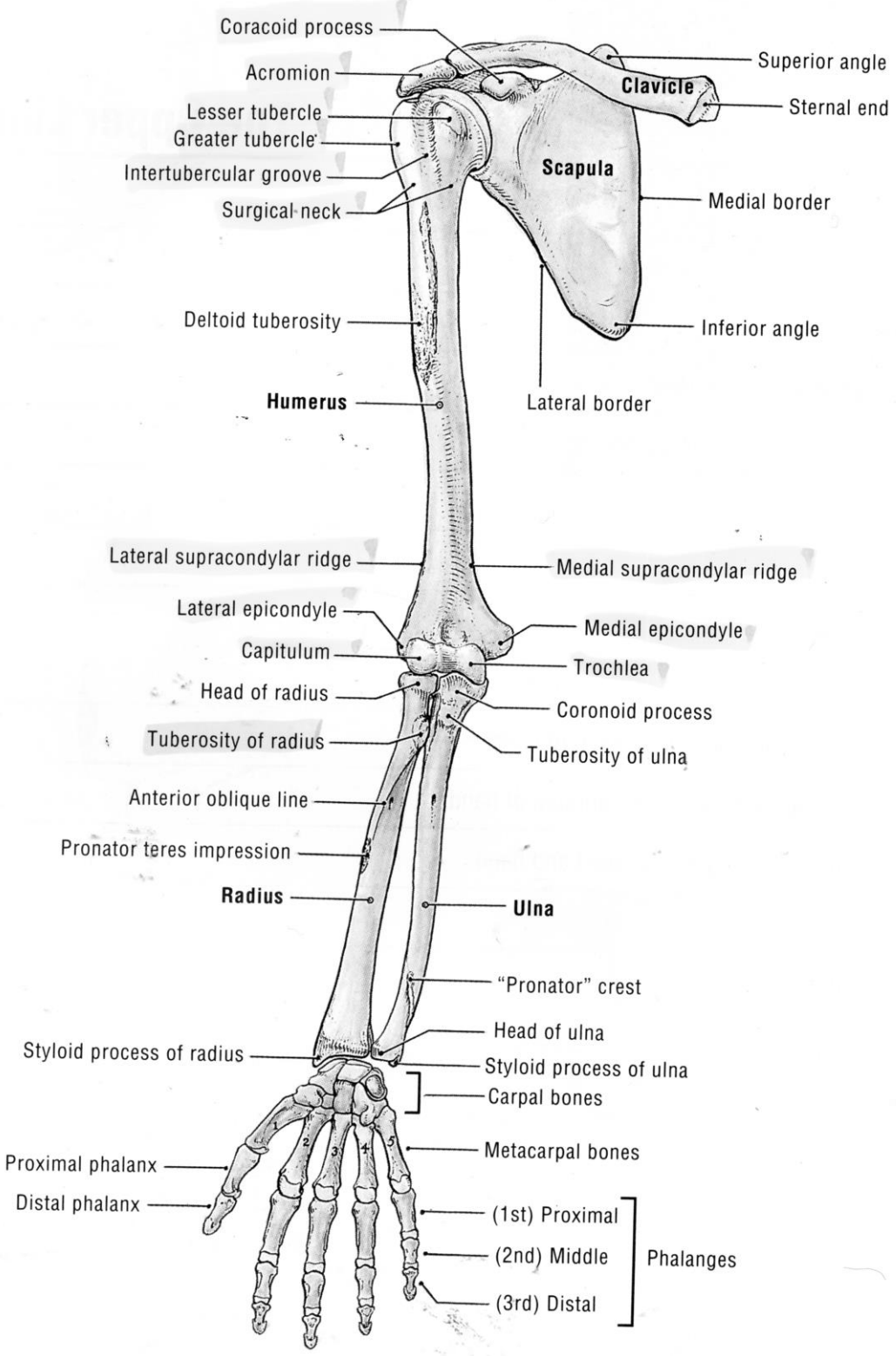
- **HEAD**

Spherical, facing medially upwards and backwards, articulating with the **glenoid fossa** of scapula.

- **anatomical neck**, just below the head
- **greater tubercle** [posterolaterally]. Insertion point for infraspinatus, supraspinatus and teres minor muscle.
- **biccipital groove** [intertubercular], where the long biceps tendon lies, covered by the **transverse humeral ligament**. The pectoralis major muscle inserts into the lip of the groove.
- **lesser tuberosity** [anteromedially], insertion point of subscapularis muscle
- **surgical neck**, narrow, in close relationship with the **circumflex axillary artery and nerve**

- **SHAFT OF HUMERUS**

Circular proximally while distally flattens anteroposteriorly and broadens transversely.



ANTERIOR VIEW: Bones of the upper limb

- **spiral groove** [posteriorly], insertion of medial and lateral heads of triceps
- **deltoid tuberosity** [at the lateral border]
- **groove for radial nerve**, where the nerve and the profunda brachial artery wind between the two heads of triceps

- **LOWER END**

45° angulated forward [the angle decreases in supracondylar fractures].

- **medial supracondylar ridge → medial epicondyle** [the largest, with a **groove for the ulnar nerve**]
- **lateral supracondylar ridge → lateral epicondyle** [extracapsular]
- **capitulum**, [laterally] rounded, articulates with the **head of radius** [2 degrees of motion for the **humeroradial joint**]
- **trochlea** [medially] spoon shaped, articulates with the **trochlear notch of ulna** with only 1 degree of motion for the **humero-ulnar joint**.
    - **coronoid fossa** [anteriorly]
    - **olecranon fossa** [posteriorly]

THE RADIUS

- **HEAD**

Cylindrical, forms the **humeroradial joint** with the capitulum. Its side articulates with the **radial notch of ulna** [**radioulnar joint** with only 1 degree of freedom]

- **NECK**

Short and narrow

- **Radial tuberosity** [biccipital] where the biceps tendon inserts

- **SHAFT**

Has an **anterior oblique line** for the insertion of hand flexors and an **impression for the pronator teres**.

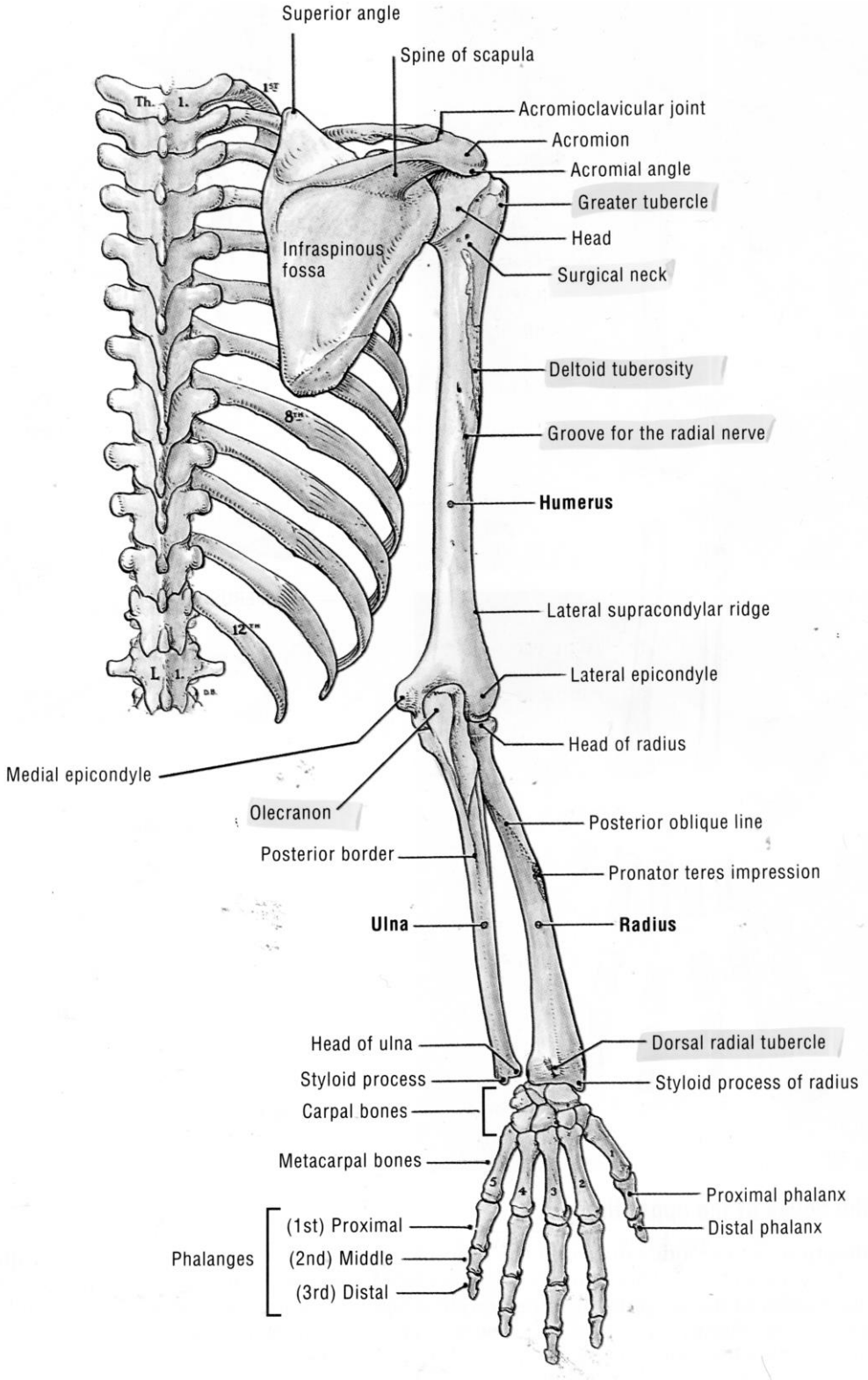
- **DISTAL END [HEAD]**

Is expanded and widens transversely, with **the radius** becoming the **primary bone** at the **wrist**.

- **Posteriorly**: **groove for extensor carpi radialis**
  dorsal radial tubercle
  groove of extensor pollicis longus
- **Laterally**: **styloid process**
- **Medially**: **ulnar notch** [distal radioulnar joint]
- **Antero-inferiorly**: **concave carpal articular surface** [radiocarpal joint with scaphoid and lunate bone]

THE ULNA

- **HEAD**
- **Olecranon process** [insertion point of triceps]
- **Trochlear fossa** [with a **semilunar trochlear notch**]
- **Coronoid process** [insertion of brachialis]



- ***POSTERIOR VIEW: bones of the upper limb***

All three above participate in the formation of the **humeroulnar joint**.

- **Radial notch** [at the lateral surface of head] which has a facet for the **proximal radioulnar joint**
- **SHAFT**

Tapers distally. Has a **crest** for the insertion of pronator teres and the **interosseous ligament** which connects radius and ulna.

- **DISTAL HEAD**

Triangular, covered by fibrocartilage and articulating with the wrist bones [triquetrum], forming the **ulnocarpal joint**
Articulates with **ulnar notch of radius** [**distal radioulnar joint**]
Has the **styloid process** [medially]

THE SHOULDER

Shoulder movement occurs at the **steroclavicular**, **acromioclavicular** and "**scapulothoracic**" joints. The **glenohumeral joint** which has 3 degrees of freedom is concerned with arm movement.

- **SHOULDER MUSCLES**

Are all the muscles functioning at the **pectoral girdle**.

POSTERIOR MUSCLES

- **Superficial**
  1. **Trapezius** [inserted at the **spine of the scapula**], innervated by the **accessory nerve [XI]**.
  2. **Latissimus dorsi** [**medial lip of biccipital groove**], innervated by the **scapulothoracic nerve [C6-8]**.
- **Deep**

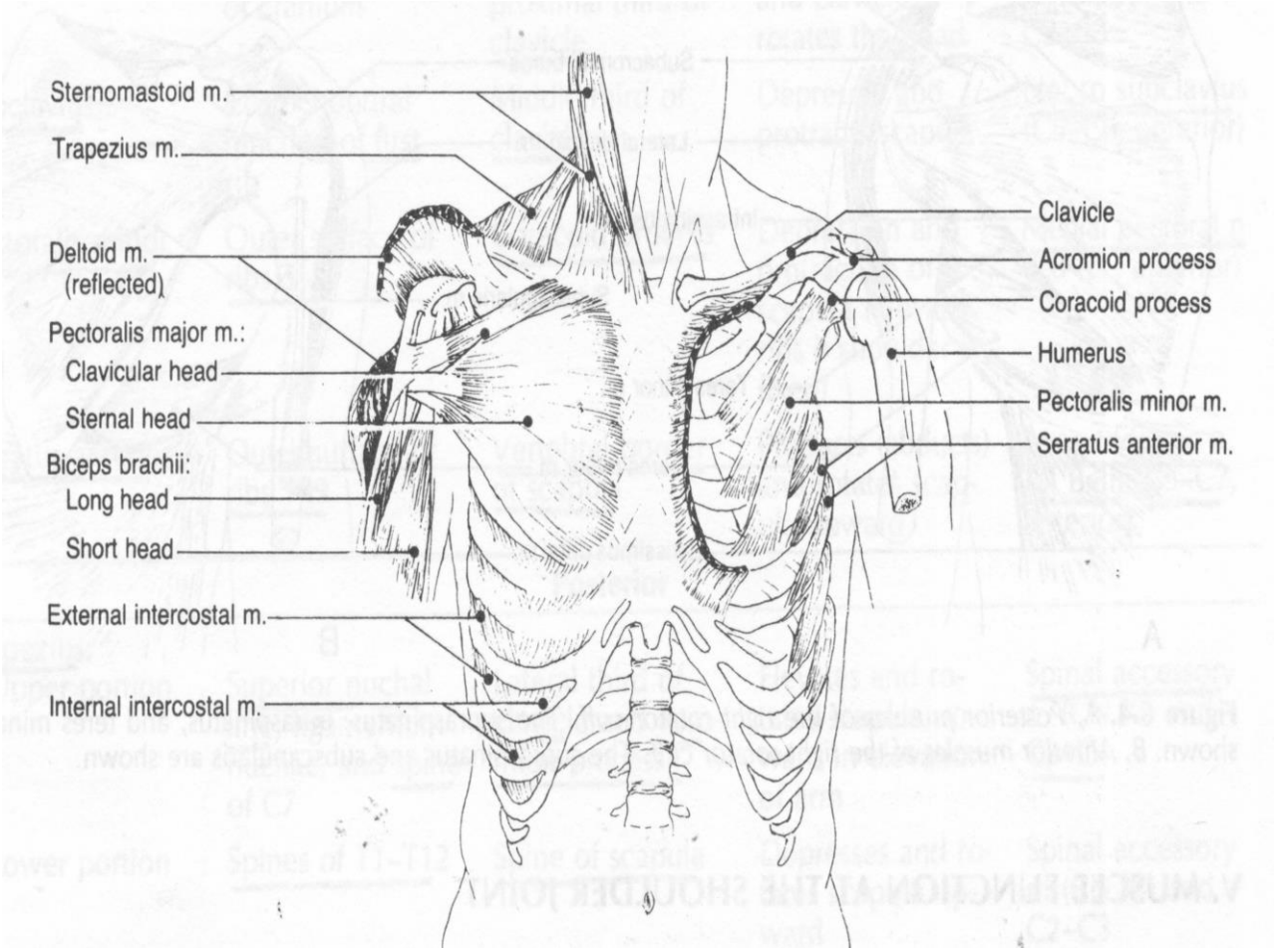
1. **Levator scapula** [superior angle of scapula]→ **nerve to levator scapula** [C_{3-4}]
2. **Rhomboid minor** [medial border of supraspinus scapula] → **dorsal scapular nerve**
3. **Rhomboid major** [medial border of infraspinus scapula] → **dorsal scapular nerve**

ANTERIOR MUSCLES

- **Superficial**
  1. **Sternomastoid** [accessory nerve, XI]
  2. **Pectoralis minor** [coracoid process] → C5-6
- **Deep**
  1. **Serratus anterior** [medial border of scapula] → **long thoracic nerve [Bells, C5-6]**
  2. **Subclavius** [1st rib & midclavicle] → **subclavius nerve** [C5-6]

- **GLENO-HUMERAL [SCAPULO-HUMERAL] JOINT**

Is a **ball/socket joint** with **3 degrees of freedom** [flexion/extension, rotation, adduction/abduction]. The **head of humerus** articulates with the **glenoid fossa** [and the glenoid labrum]



- ***The shoulder muscles***

- **JOINT CAPSULE**

Is lax and extends along the tendon of the long head of biceps and inferiorly to the coracoid process, forming the **subscapularis bursa**, between the glenoid cavity and subscapularis muscle tendon. Its anterior part has 3 thickenings, the **glenohumeral ligaments** [**superior, middle, inferior**], converging to the **supraglenoid tubercle** [with biceps muscle]. Extends also onto the bone diaphysis at the medial aspect of humerus.

- **SUBACROMIAL BURSA**

Separates the **acromion** from the **supraspinatus tendon** which inserts to the great tuberosity. It extends below the deltoid, called the **subdeltoid bursa** [is the greatest bursa in the body]. As a result of continuous wearing away by the supraspinatus muscle, the subacromial bursa and the synovium may come into communication [25% after the age of 60]

- **DYNAMIC STABILITY**

The glenohumeral joint is quite unstable but is dynamically reinforced by the muscles acting on the arm which function as a ligament, forcing the head of humerus into the glenoid fossa. They can be grouped as:

1. "**Rotator cuff**"
2. **Long head of biceps**
3. **More distally related muscles** [deltoid, long head of triceps, pectoralis major, coracobrachialis, latissimus dorsi, teres major]

- **ROTATOR CUFF**

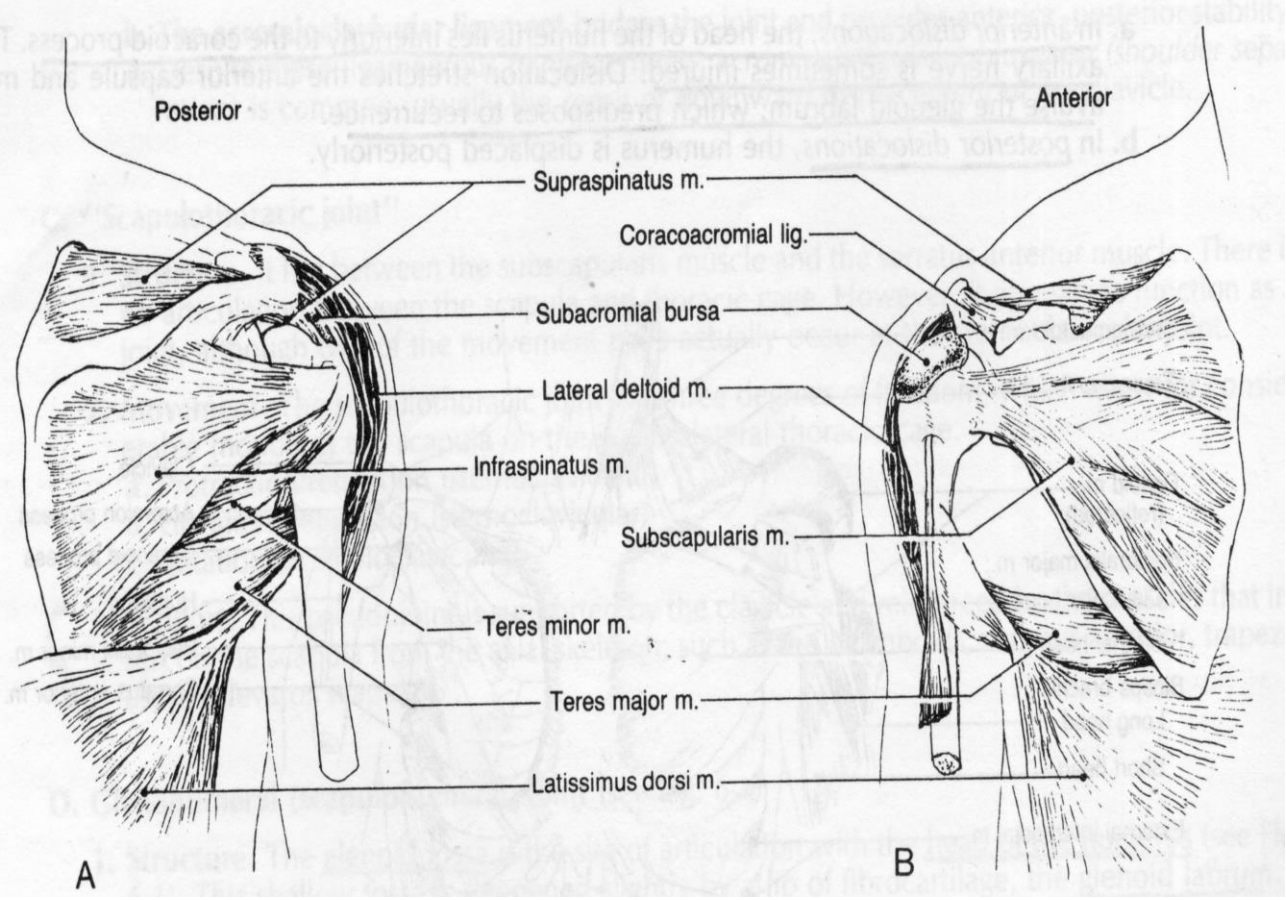
This name is given to the sheath of tendons of the short muscles of the shoulder which covers and blends with all but the inferior aspect of the joint.

1. **Supraspinatus**. Originates from the **supraspinus fossa**, passes below the acromion [separated by the subacromial bursa] and inserts into the **greater tubercle**. Is innervated by the **suprascapular nerve** [C5-6]. Initiates the abduction of humerus [15 degrees] so that the deltoid and scapular rotators can come into play.
2. **Infraspinatus**. Originates from the **infraspinous fossa** and inserts to the **greater tuberosity**. Is innervated by the **suprascapular nerve**.
3. **Teres minor**. Originates from the **medial border of scapula**, above its inferior angle and inserts to the **greater tuberosity**. Is innervated by the **subscapular nerve**.
4. **Subscapularis**. Originates from the **subscapular fossa** and inserts to the **lesser tuberosity**. Is innervated by the **subscapular nerve**.

- **MUSCLES ACTING ON THE ARM**

ANTERIOR

- **Superficial**
    - **Pectoralis major**. From the **clavicle, sternum and costal cartilages**, inserts to the **intertubercular sulcus**. Is innervated by the **lateral [C5-7] and medial pectoral nerves [C8-11]**
    - **Deltoid.** From the **clavicle** to the **deltoid tuberosity**. Innervated by the **axillary nerve [C5-6]**
- **Deep**
    - **Coracobrachialis**. From the **coracoid process** to the **midhumerus**. Innervated by the **musculocutaneous nerve [C5-7]**



- ***The rotator cuff muscles***

A:Posterior view ***B: Anterior view***

- **Biceps brachii**, innervated by the **musculocutaneous nerve**
    - **long head**: from **supraglenoid tubercle** to **radial tuberosity** and **biccipital fascia**
    - **short head**: from **coracoid process** to **radial tuberosity**

POSTERIOR

- **Superficial**
    - **Deltoid**: from **acromion and spine** to **deltoid tuberosity** [**axillary nerve [C5-6]**
    - **Latissimus dorsi**: from **spinous processes, ribs and iliac crest** to the **biccipital groove**. Innervated by the **thoracodorsal nerve [C6-8**]
- **Deep**
    1. **Supraspinatus**
    2. **Infraspinatus**
    3. **Teres minor**
    4. **Teres major**
    5. **Subscapularis**
    6. **Triceps brachii**

- **MOVEMENTS**

ADDUCTION / ABDUCTION

Initial 15 degrees are done by the supraspinatus. 10-100 degrees by the action of deltoid. More than that [elevation and upward rotation of scapula] by trapezius and serratus.

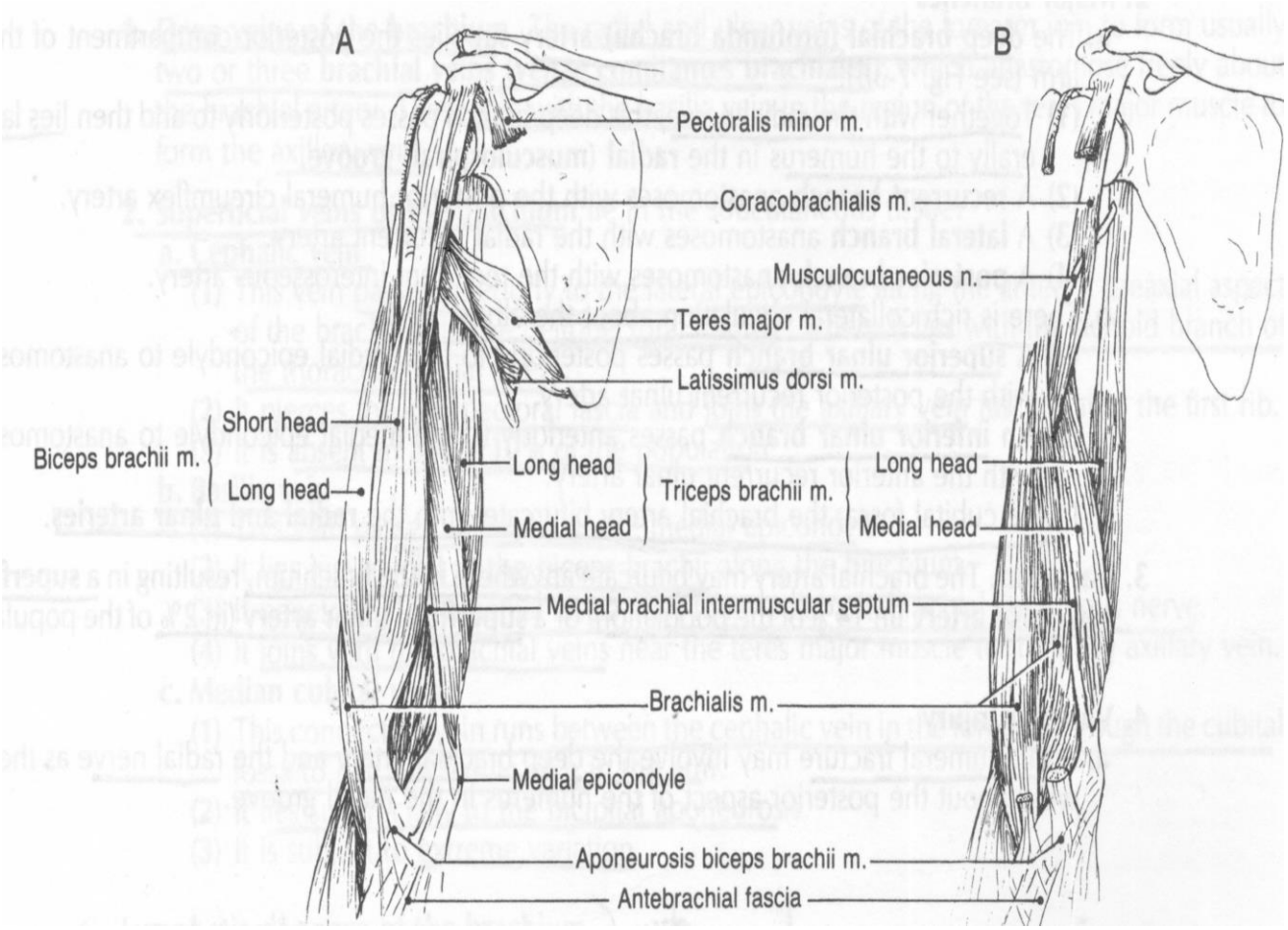
- **Abductors**
    1. **Supraspinatus**
    2. **Deltoid**
- **Adductors**
    1. **Pectoralis major**
    2. **Lattissimus dorsi**
    3. **Coracobrachialis**
    4. **Teres major**

FLEXION / EXTENSION

- **Flexors**
    1. **Pectoralis major**
    2. **Coracobrachialis**
    3. **Biceps**
    4. **Deltoid** [anterior fibres]
- **Extensors**
    1. **Teres major**
    2. **Latissimus dorsi**
    3. **Deltoid** [posterior fibres]
    4. **Long head of triceps**

ROTATION

- **Medial rotators**
    1. **Pectoralis major**
    2. **Latissimus dorsi**
    3. **Teres major**



- ***The muscles of the upper arm [extensor surface, superficial & deep layers]***

4. Subscapularis

5. **Deltoid** [anterior fibres]

- **Lateral rotators**
    1. **Infraspinatus**
    2. **Teres minor**
    3. **Deltoid** [posterior fibres]

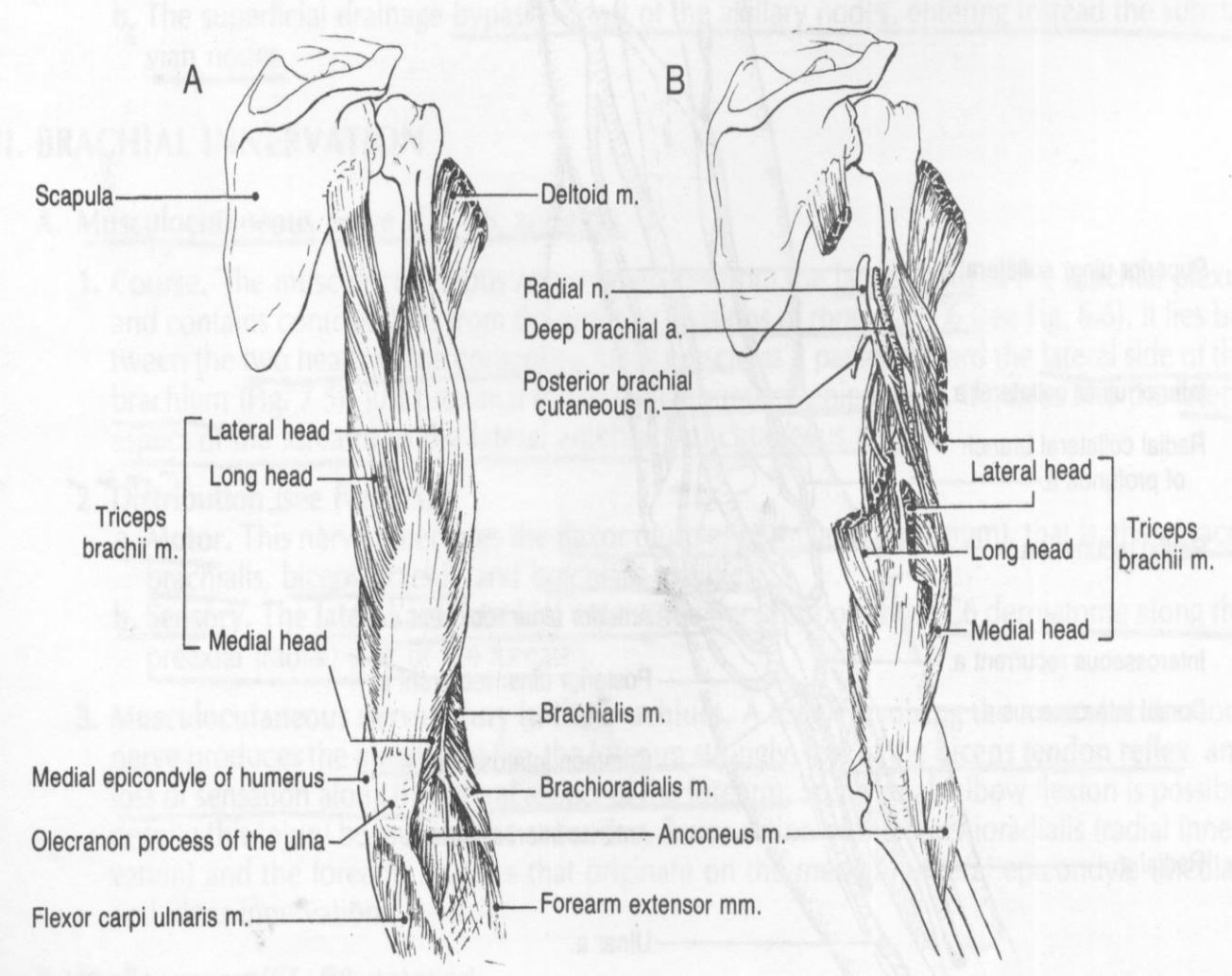
- **DISLOCATION OF SHOULDER**

Because of the shallow glenoid fossa and its unprotected by muscles inferior aspect, is the most commonly dislocated joint of the body. The usual cause is violent abduction.

- **Posterior dislocation**: rare, the head of humerus lies on infraspinatus muscle
- **Anterior dislocation**: the head slips away from the glenoid into a subcoracoid position and is held adducted by the shoulder girdle muscles and medially rotated by the subscapularis. The normal buldge of the deltoid is lost. The circumflex nerve may be torn.

REDUCTION

- **Kocher's method**: The elbow is flexed and the forearm is rotated outwards so thet the subscapularis is stretched. The elbow is then brought medially across the trunk, so the head slips back inplace.
- **Hippocrates method**: The foot is put in the axilla as a fulcum and traction with adduction of the forearm is exerted



- ***The muscles of the upper arm [extensor surface, superficial & deep layers]***

THE ELBOW

THE JOINT

Is a single synovial cavity containing 3 distinct articulations

- **HUMERO-ULNAR JOINT**
  - **Trochlea of humerus** articulates with **trochlear fossa of ulna**. Is a **hinge type joint** with one degree of freedom
  - **Medial collateral ligament [ulnar**], divided in anterior, posterior and oblique parts
- **HUMERO-RADIAL**
  - The **capitulum** articulates with the **head of radius**. A **ball-socket joint** with 2 degrees of freedom.
  - **Lateral [radial] collateral ligament**
  - **Annular ligament**
- **RADIO-ULNAR JOINT**
  - The **head of radius articulates** with the **radial notch at the head of ulna**. A **pivot type joint** with one degree of freedom.
  - **Annular ligament**, which bounds the radial head to the ulna
  - **Oblique cord**
  - **Interosseous membrane**
- **JOINT CAPSULE**

Is quite thin anteriorly and posteriorly, being in contact with the **radial nerve** [anteriorly] while the **ulnar nerve** is in contact with the medial collateral ligament.

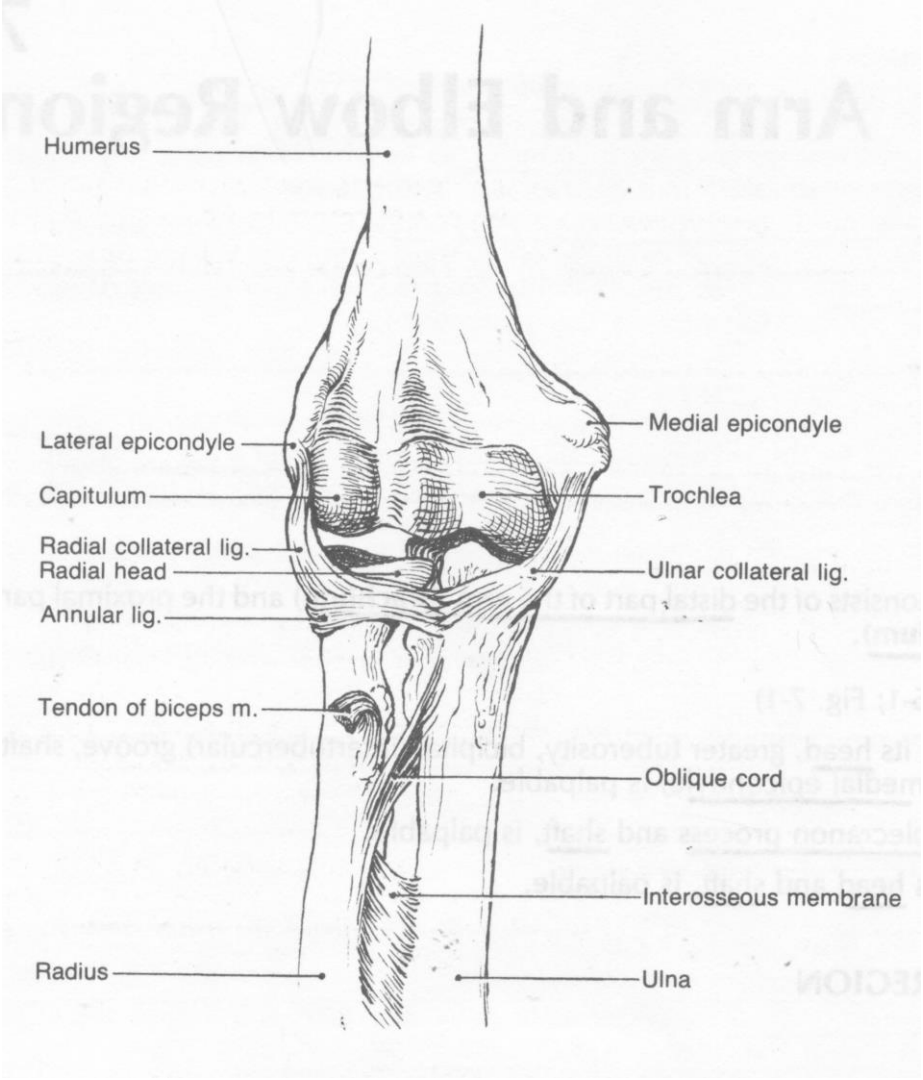
The capsule extends below the annular ligament to allow rotation of the joint. A **subcutaneous** and a **subtendinous [**below the triceps] **olecranon bursa** is formed.

The joint is easily approached through a **posterior vertical incision** on the triceps aponeurosis, above the olecranon

MOVEMENTS & MUSCLES

- **FLEXION [150°] / EXTENSION**
- **Flexor muscles**
  1. **Bicheps brachii**: from the **supraglenoid tubercle** and **coracoid process** to the **radial tuberosity**. Is innervated by the **musculocutaneous nerve** [C5-6]
  2. **Brachiali**s: from the **anterior aspect of midhumerus** to the **coronoid process** of ulna. [**musculocutaneous nerve**]
  3. **Brachioradialis**: from the **lateral surface of distal humerus** to the **radial styloid process**. Is innervated by the **radial nerve** [C5-T1]
  4. **Pronator teres** [weak flexion only]
  5. **Flexors of the forearm and wrist**
- **Extensors**

  1. Triceps brachii: originates from the **infraglenoid tubercle [long** head] and the **posterior aspect of humerus [medial and short head]** and inserts to the **olecranon**. Is innervated by the **radial nerve** [C5-T1].


Humerus
Lateral epicondyle
Capitulum
Radial collateral lig.
Radial head
Annular lig.
Tendon of biceps m.
Radius
Medial epicondyle
Trochlea
Ulnar collateral lig.
Oblique cord
Interosseous membrane
Ulna

- ***The elbow***

2. Anconeus: from the **lateral epicondyle** to the border of **olecranon** [radial nerve]
3. Supinator [weak extension

- **SUPINATION / PRONATION**
- **Pronators**
    1. **Pronator teres**: from the **medial epicondyle** and **head of ulna** the **lateral aspect of the midshaft of radius**. Innervated by the **median nerve**
    2. **Pronator quadratus**: joins the **shafts of radius and ulna** [**median nerve**]
    3. **Flexor carpi radialis**
- **Supinators**

    1. Biceps brachii: acts as supinator because of its insertion to the posterior aspect of radial tuberosity
    2. Supinator: from the **lateral epicondyle** to the **lateral surface of radius**. Innervated by the **radial nerve**.
    3. Extensor pollicis longus
    4. Abductor pollicis longus

- **GROUP MUSCLE INNERVATION**

Flexion:
- musculocutaneous
- radial
- [median]

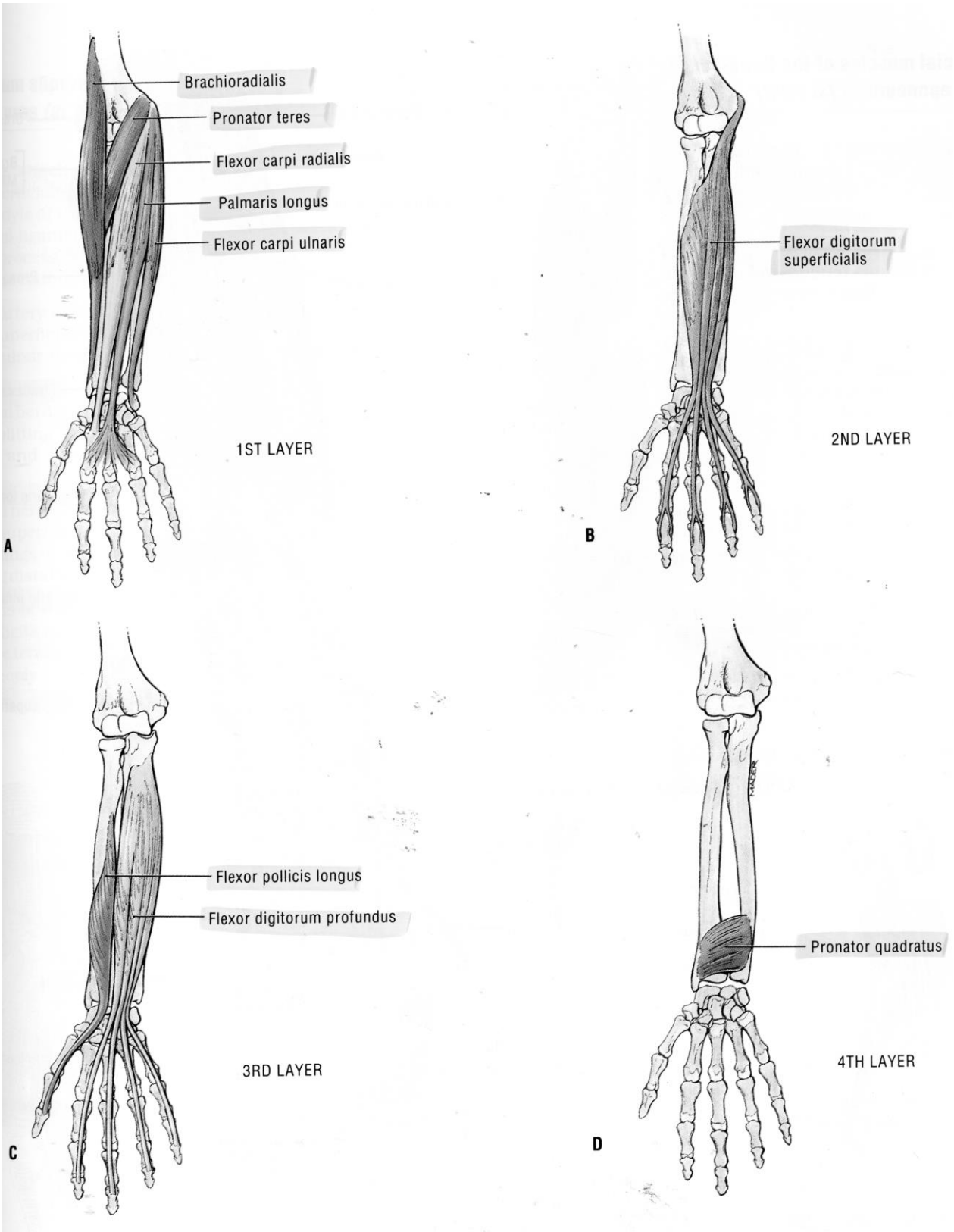
Extension
- radial

Pronation
- median
- radial

Supination
- radial
- musculocutaneous

CLINICAL FEATURES

1. **Aspiration of fluid** from elbow capsule: should be done posteriorly, on either side of olecranon
2. Pulled elbow in children. Due to sudden jerk of a pronated arm the head of radius is displaced because the annular ligament in children is vertical [fan-shaped in adults]. Reduction is easy by firm arm supination.
3. If there is a **fracture proximal to the radial insertion of pronator teres**, then the proximal fragment will be supinated [action of biceps] while the distal fragment will be pronated [action of pronator teres]
4. **Posterior dislocation of elbow**. Is caused by indirect force or fall on the hand. There is fracture of the coronoid process of ulna and loss of the triangular relationship between olecranon and epicondyles. Reduction is performed by distal traction and flexion of elbow.



- ***The muscles of the anterior [flexor] compartment of the forearm***

5. **Fall on the hand**.

- In a child, it may cause posterior displacement of distal radial epiphysis.
- In young adults it causes fracture of the shaft of both ulna and radius
- In elders it may cause **Colles fracture**. The radius fractures 2.5cm distal to the wrist. The distal fragment is displaced posteriorly and impacted by the shaft. Consequently, there is shortening of radius and the two styloids lie on the same line.
- **Fracture of olecranon process**. Is caused by either direct force or forcible contraction of triceps. **Operative repair is essential**.

MUSCLES OF THE FOREARM

- **EXTENSOR MUSCLES**

They are multijoint muscles, originating on the lateral aspect of distal arm and proximal forearm.

- **Superficial**

They originate from the **lateral supracondylar ridge, the lateral epicondyle or the proximal radius**. They are all innervated by the **radial nerve** [C5-T1]

1. **Brachioradialis**
2. **Extensor carpi radialis longus**
3. **extensor carpi radialis brevis**
4. **Extensor digitorum communis**
5. **Extensor digiti minimi**
6. **Extensor carpi ulnaris** [passes below the the extensor retinaculum]

- **Deep**

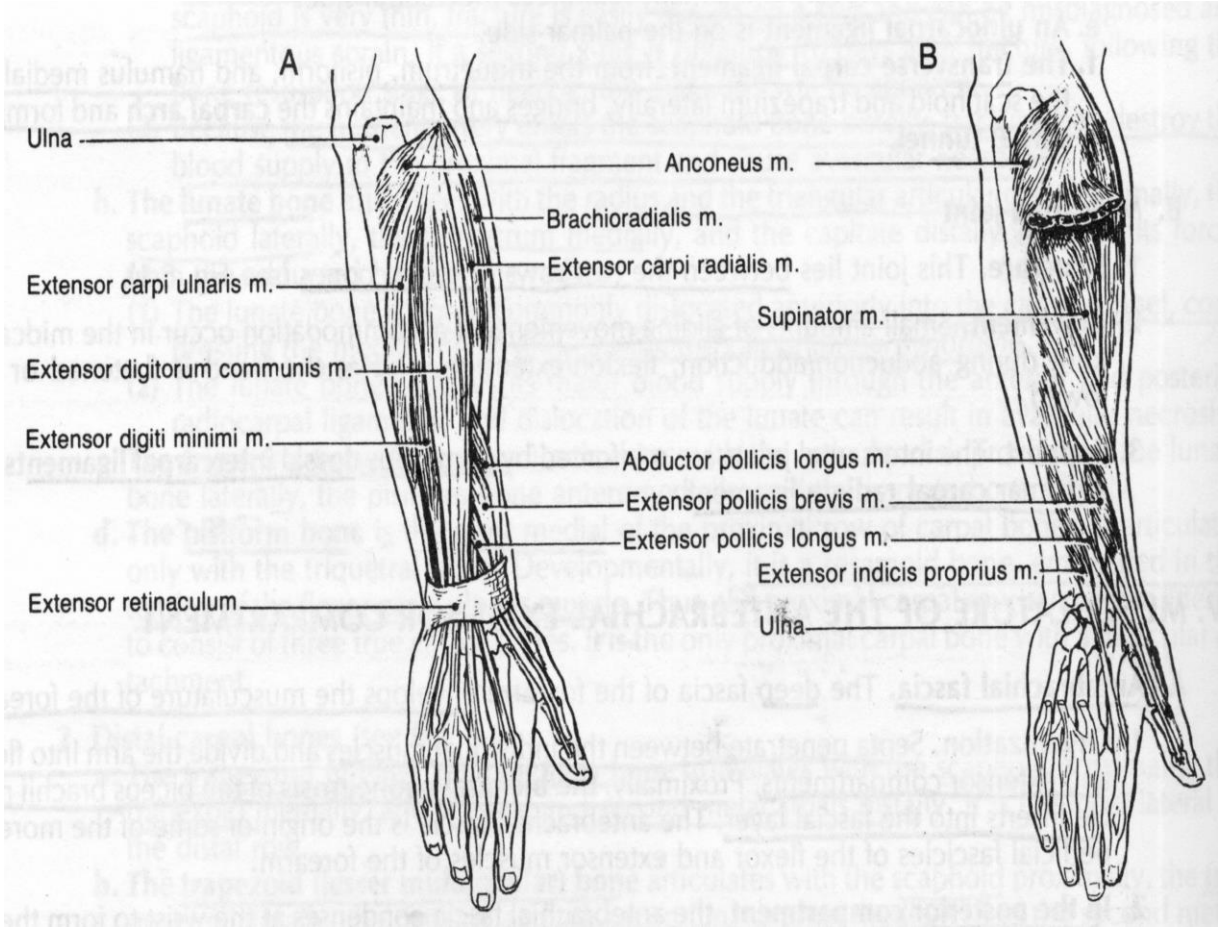
Originate from **mid-radius, interosseous membrane or ulna**. All are innervated by the **radial nerve.**

1. **Anconeus**
2. **Supinator**
3. **Abductor pollicis longus**
4. **Extensor pollicis brevis**
5. **Extensor pollicis longus**
6. **Extensor indicis**

- **FLEXOR FOREARM MUSCLES**
- **MOST SUPERFICIAL [1ST LAYER]**

Originate from **medial epicondyle, supracondyle ridge and proximal ulna**. Are innervated by the **median nerve**, with the exception of **brachioradialis [radial**] and **flexor carpi ulnaris [ulnar]**.

1. **Brachialis**
2. **Pronator teres**
3. **Flexor carpi radialis**
4. **Palmaris longus [missing in 13% of cases]**
5. **Flexor carpi ulnaris**



- ***The extensor forearm muscles***

- **INTERMEDIATE [2ND LAYER]**
    1. Flexor digitorum superficialis
- **DEEP [3RD] LAYER.**

Origin from **proximal ulna, interosseous membrane and midradius**. Innervated by the median nerve.

1. **Flexor pollicis longus**
2. **Flexor digitorum profundus**

- **DEEPEST [4TH] LAYER**
    1.Pronator quadratus [median nerve]

- **ANTEBRACHIAL FASCIA [DEEP]**

Envelops the muscles giving off **septa** and divides the arm [with the **interosseous membrane**] into **flexor and extensor compartments**. It is the origin of some of the superficial muscle fascicles. The **biccipital aponeurosis** inserts into the antebrachial fascia. In the posterior wrist it condenses to form the **extensor retinaculum** while anteriorly forms the **flexor retinaculum**.

THE BONES OF THE HAND

- **CARPUS**

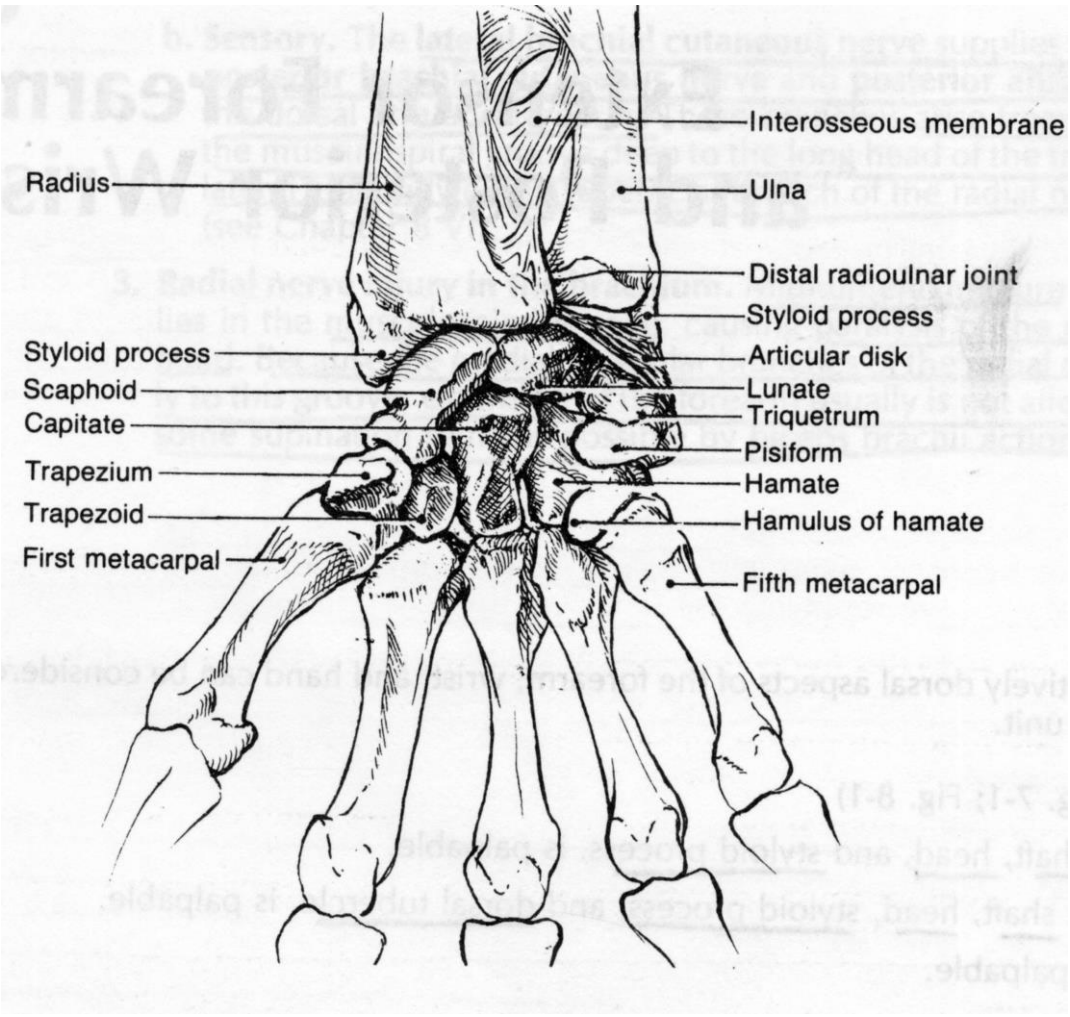
Consists of **two rows of 4 bones** in each, arched transversely. The palmar aspect of carpus is concave because of:

a. shape of the bones which broaden dorsally [with the exception of lunate]
b. presence of the tough **flexor retinaculum** which passes from the hook of hamate and pisiform [medially] to the tubercles of trapezium and scafoid.

- **BONES**
- **Proximal row of carpal bones**
    1. **Scafoid [insertion point of flexor carpi radialis]**
    2. **Lunate**
    3. **Triquetrum**
    4. **Pisiform** [insertion of flexor carpi ulnaris]
- **Distal row**
    1. Trapezium
    2. **Trapezoid**
    3. **Capitate**
    4. **Hamate** [has a hook process, the **hamulus**]
- **Metacarpal bones**

5 long bones, subdivided in **proximal base, shaft and distal head**.

- **Phalanges**
    1. 5 proximal phalanges
    2. **4 middle phalanges [not in thumb]**
    3. 5 distal



- ***The carpus bones***

- **CLINICAL FEATURES**
- **CARPAL TUNNEL SYNDROME**

The tunnel is formed by the **flexor retinaculum** [roof] and the **carpal arch** as its floor. Within it pass the **flexor muscles / tendons of the digits** and the **median nerve**. Any decrease in its diameter / size [i.e. old fracture, arthritis, idiopathic] is followed by the syndrome which is characterised by **numbness and motor weakness in the median nerve distribution**. There are **no sensory deficits** because the **superficial palmar sensory branch** of the nerve is given off proximally and does not pass below the retinaculum.

- **SCAPHOID FRACTURE**

Is caused by fall on the palm with the hand abducted. If the fracture affects its proximal end, aseptic necrosis may develop, because the nutrient vessels enter the bone from its waist. Is a quite easily missed fracture, often discovered on X-rays 10 days later.

- **PERILUNATE DISLOCATION OF CARPUS**

Fall on the hand may cause backward dislocation of the carpal arch along the lunate, which may reduce spontaneously.

- **VOLKMANN'S CONTRACTURE**

Follows ischaemia and subsequent fibrosis / contraction of long flexors and extensors of the forearm.

- the wrist is flexed [the flexors are bulkier than extensors]
- the metacarpo-phalangeal joints are extended [shrunken long extensors]
- the interphalangeal joints are flexed [contracted long flexors]

- **DEPUYTREN'S CONTRACTURE**

Is caused by fibrous contracture of the palmar fascia [deep fascia], paricularly of th 4^{th} and 5^{th} fingers.

- longitudinal thickening in the palm
- flexion of metacarpo-phalangeal joints
- flexion of proximal inter-phalangeal joint
- the distal interphalangeal joint is not affected

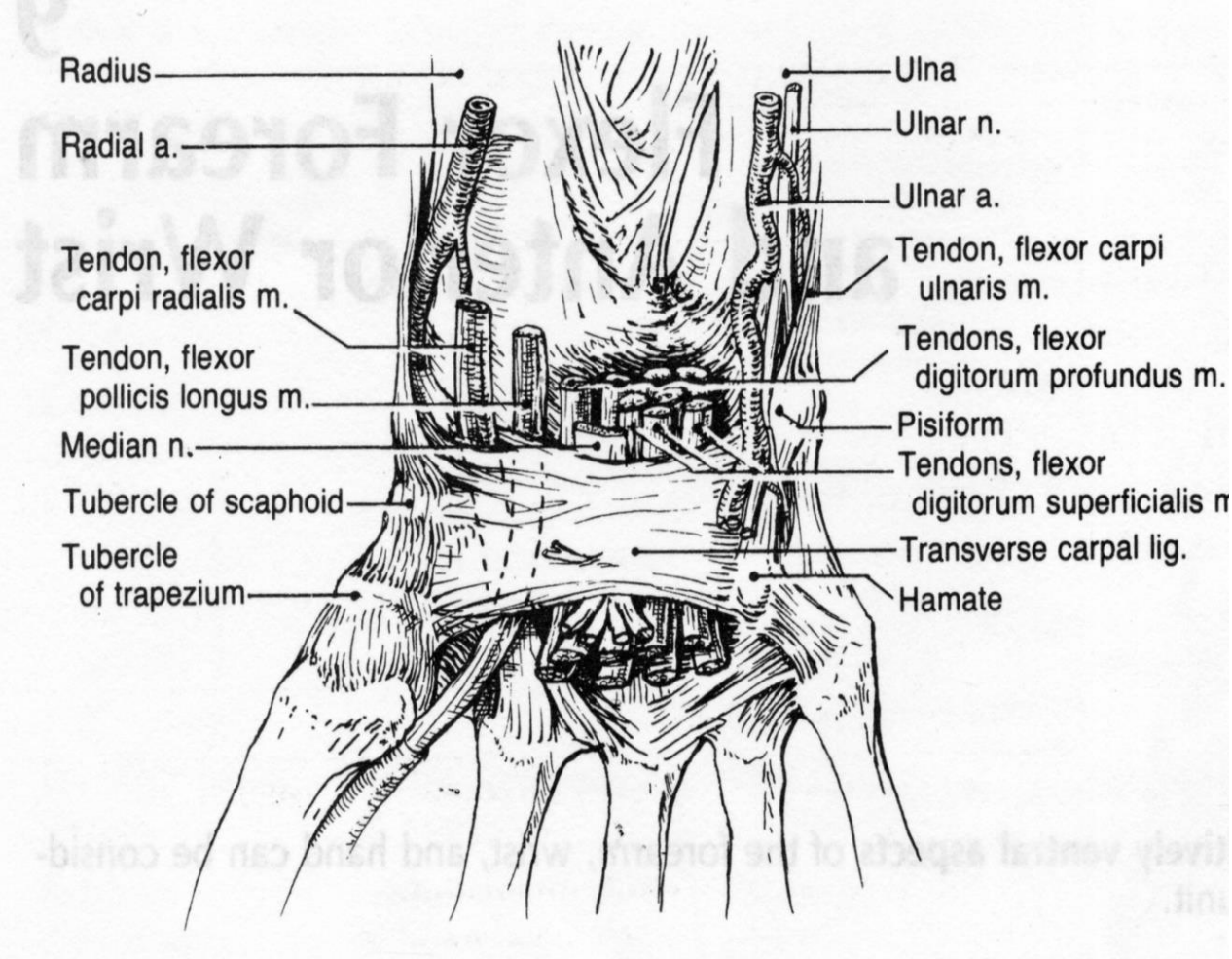
THE WRIST JOINT

- **RADIO-ULNAR JOINT**

The articular disk of the distal radio-ulnar joint covers the **head of ulna**, is concave proximally and is attached to the ulnar styloid. Articulates with the **scaphoid** and **lunate**; the **triquetrum** articulates only in hand adduction.

- **LIGAMENTS**

1. **Ulnar collateral ligament**: from ulnar styloid and pisiform to the 5^{th} metacarpal bone.
2. **Radial [lateral] collateral ligament**: from radial styloid to scaphoid, trapezium and 1^{st} metacarpal.
3. **Anterior radiocarpal [palmar ligament]:** from head of radius to the two rows of carpal bones.
4. **Posterior [dorsal[radiocarpal**
5. **Transverse carpal ligament** [≈ flexor retinaculum]



- ***The carpal tunnel on wrist flexor surface***

- **MOVEMENT**

As **condyloid type** of joint the wrist has **2 degrees of freedom**

1. Flexion / extension [150°]
2. Adduction [45°] / abduction [15°]
3. Circumduction

- **MID-CARPAL JOINTS**

Multi-level joint between the two rows of carpal bones with synovial folds projecting into the joints. Allows **only a small gliding movement**. Is supported by the **dorsal inter-carpal ligaments** and the **palmar carpal radiate ligament**.

- **MUSCLES ACTING ON THE WRIST**

FLEXORS

Are all the long muscles crossing the anterior aspect of wrist.

- Superficial
    1. **Flexor carpi radialis**
    2. **Palmaris longus**
- Intermediate
    1. **Flexor digitorum superficialis**
- Deep
    1. **Flexor carpi ulnaris**
- Deepest
    1. **Flexor digitorum profundus**
    2. **Flexor pollicis longus**

EXTENSORS

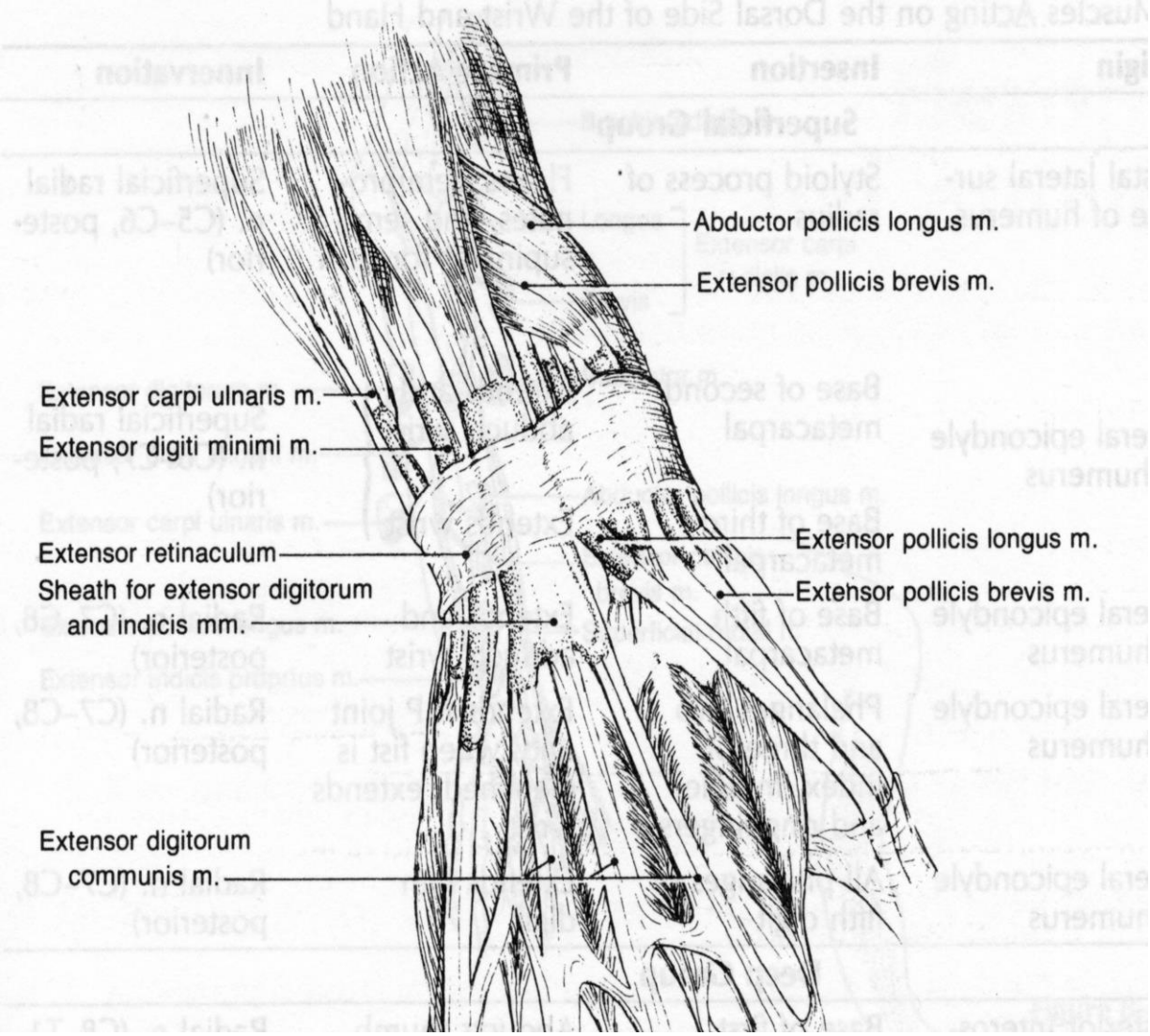
- Superficial
    1. **Extensor carpi radialis longus**
    2. **Extensor carpi radialis brevis**
    3. **Extensor carpi ulnaris**
- Intermediate
    1. **Extensor digitorum communis**
    2. **Extensor digiti minimi**
- Deep
    1. **Abductor pollicis longus**
    2. **Extensor pollicis brevis**
    3. **Extensor pollicis longus**
    4. **Extensor indicis**

ADDUCTORS

1. **Flexor carpi ulnaris**

ABDUCTORS

1. **Flexor carpi radialis**
2. **Extensor carpi radialis longus**
3. **Extensor carpi radialis brevis**
4. **Abductor pollicis longus**
5. **Extensor pollicis brevis**



- ***Muscles and tendons on ectensor wrist surfsace***

THE HAND

JOINTS OF THE HAND

- **CARPO-METACARPAL JOINT**

a. **Thumb and trapezium**: a saddle type joint with 2 degrees of freedom.
    - flexion / extension [75°], in a plane parallel to palm
    - abduction [45°] / adduction, in a plane vertical to palm
    - opposition [circumduction], bringing the thumb in contact with the small finger

b. **Carpus with 2nd to 5th metacarpals**. Condyloid shape joints with afew degrees of gliding movents and a small range of extension / flexion

- **METACARPO-PHALANGEAL JOINTS**

They are **condyloid type** joints, allowing only 60° of flexion / extension for the thumb while the other 5 have an 100° range of flexion / extension, 30° of adduction / abduction and circumduction [especially the index].

The joints are supported by:

1. The **palmar ligament**, a fibrocartilage plate hanging from the base of the proximal phalanx, which is connected on its sides with the
2. **Deep transverse metacarpal ligament**, which joins the heads of the metacarpals [not on the thumb]
3. **Collateral ligament**
    - **fan-shape part**
    - **cord part**, which is slack on extension and taut on flexion

When the joints are flexed spreading [abduction] of the fingers is impossible. The reason for this is that each metacarpal head, although rounded, flattens anteriorly and when the base of the phalanx moves on this flattened part side movements are inhibited. Moreover, the cord-like part of the collateral ligament becomes taut on flexion.

- **INTER-PHALANGEAL JOINTS**

They are pulley-shaped, hinged joints, allowing only flexion / extension. They have the same ligamentous arrangement as the metacarpo-phalangeal joints. Posteriorly, the joint capsule is replaced by an expansion of the extensor tendon fascia. On each side are the collateral ligaments.

MUSCLES ACTING ON THE HAND

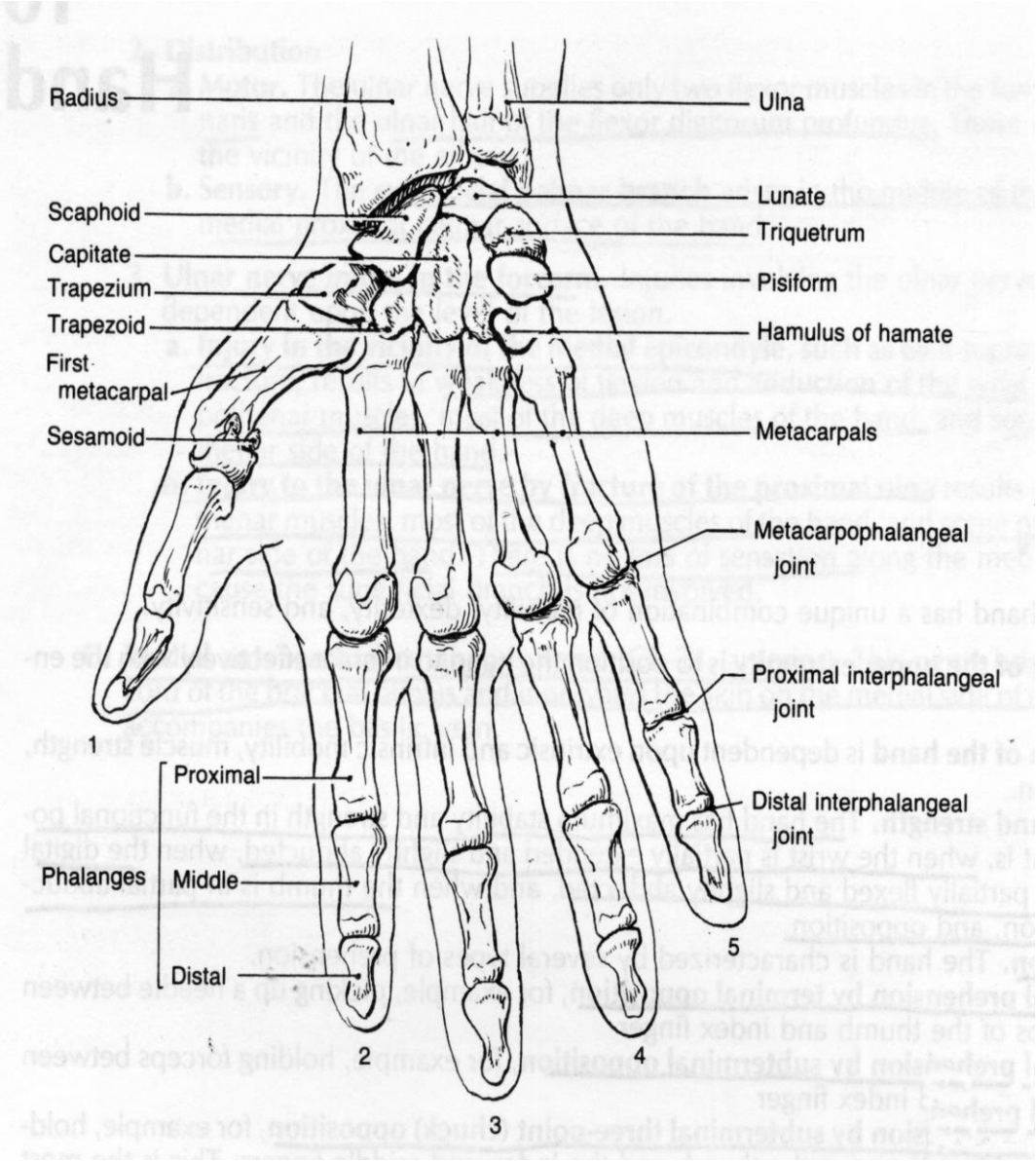
- **LONG FLEXORS**

1. **Flexor digitorum superficialis [sublimis]**: is inserted to the sides of the 4 middle phalnges and flexes the middle phalanx.

Flexor digitorum profundus: pierces the superficialis and inserts into the the base of the distal phalanx flexing it. Acting together with the superficialis they flex both fingers and wrist.

1. **Extensor digitorum longus**
2. **Extensor indicis**
3. **Extensor digiti minimi**

They are inserted into the base of the proximal phalanx, acting at the metacarpophalangeal joint. From there they spread distally as the **extensor expansion**, attached by a central slip to the middle phalanx and by two side slips to the distal phalanx.



- ***The bones of the hand***

- **LONG EXTENSORS**
- **INTRINSIC MUSCLES**

1. **Dorsal interossei**
2. **Palmar interossei**

[from the sides and fronts of metacarpals to the extensor expansion]

3. **Lumbricals**, from the flexor profundis tendon to the extensor retinaculum. They flex the metacarpophalangeal joints and are the only muscles to extend the interphalangeal joints. In conjunction with the abductor digiti minimi they adduct and abduct the fingers.

- **5TH FINGER**

1. **Abductor digitis minimi**
2. **Flexor digitis minimi**
3. **Oponens digiti minimi**

They are located in the **hypothenar eminence** and are inserted on the medial side of the proximal phalanx.

- **THE THUMB [POLLICIS]**
- **Short [intrinsic] muscles**
    1. **Abductor pollicis brevis**
    2. **Flexor pollicis brevis**
    3. **Opponens pollicic**

    They form the **thenar eminence** and are inserted to the base of the proximal phalanx.
    4. **Adductor pollicis**, joining the 1st to 2nd metacarpal
- **Long muscles**
    1. **Flexor pollicis longus**, inserted to the distal phalanx
    2. **Extensor pollicis longus**, inserted to the distal phalanx
    3. **Extensor pollicis brevis**, inserted to the proximal phalanx
    4. **Abductor pollicis longus**, inserted to the metacarpals

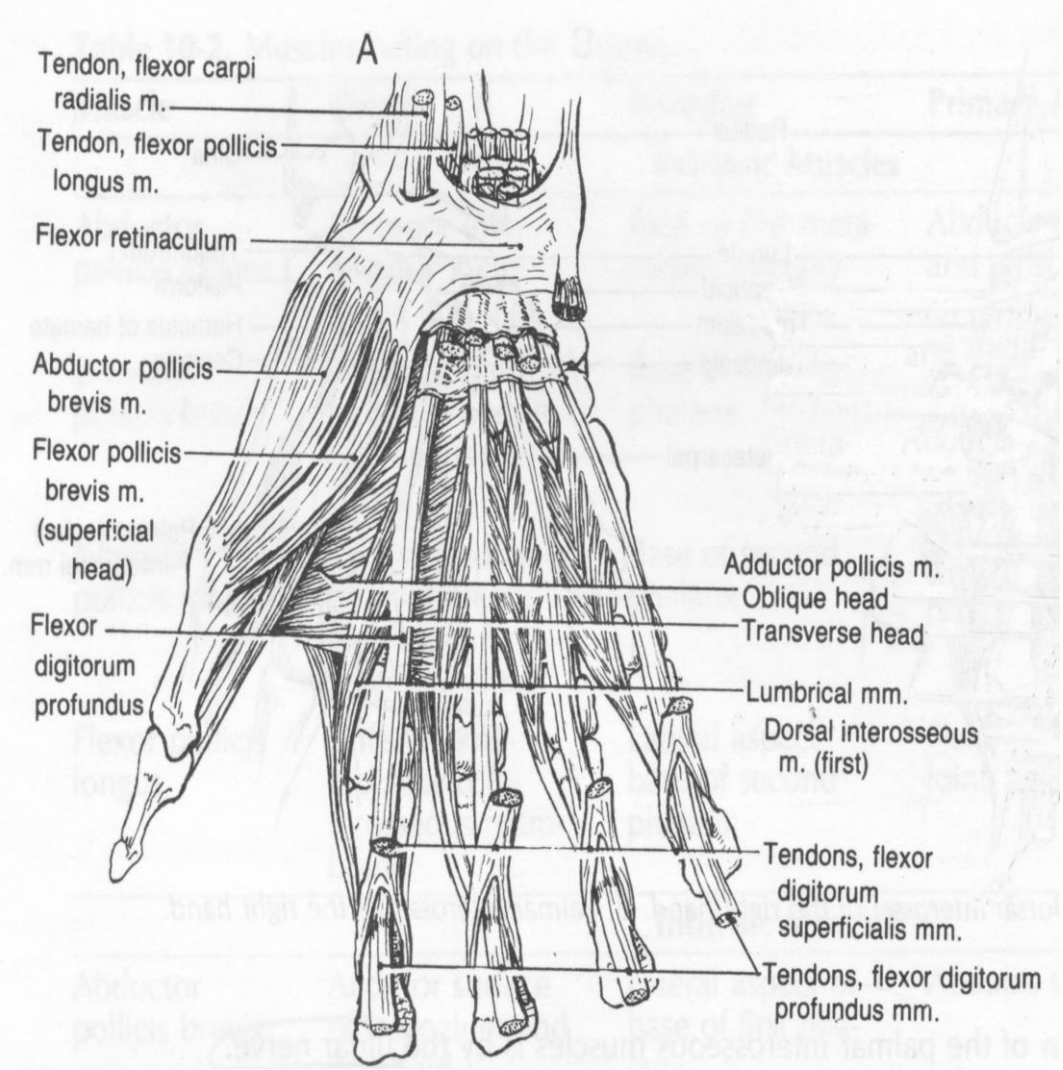
THE SPACES OF THE HAND

1. **Pulp spaces of the fingers [superficial]**
2. **Palmar synovial tendon sheaths** of 2nd, 3rd and 4th fingers
3. **Small dorsal synovial sheath of extensor tendons**, under the extensor retinaculum
4. **Subcutaneous space at the dorsum** of the hand
5. **Ulnar bursa**: synovial sheath of long flexor tendons that continues to the small finger
6. **Radial bursa**: synovial sheath of long flexor pollicis
7. **Mid-palmar space**
8. **Thenar space**

- **SUPERFICIAL PULP SPACE**

The finger tips are composed of **subcutaneous fat** packed between **fibrous septa** extending from the skin to the periosteum [there is **no space for expansion** during inflammation, and this is why fingertip infection causes **severe pain**].

The **blood vessels** traverse this space and may be thrombosed in case of inflammation [resulting in bone necrosis] with the exception of the base of the distal phalanx which receives a more proximal [before the pulp] trophic branch.



- ***The hand muscles***

At each skin crease the **skin is bound to the underlying fascia of the flexor sheath**, compartmentalising thus the pulps of each phalanx.; however, infection can spread proximally along the vessels.
Over the palm there is little subcutaneous space, with the skin almost bound to the **palmar fascia [aponeurosis]**. In contrast to that, the **skin over the dorsum is loose** and fluid can easily collect there, between the skin and the synovial sheaths of extensor tendons, which extend below the extensor retinaculum.

- **ULNAR & RADIAL BURSAE, FLEXOR TENDONS SHEATHS**

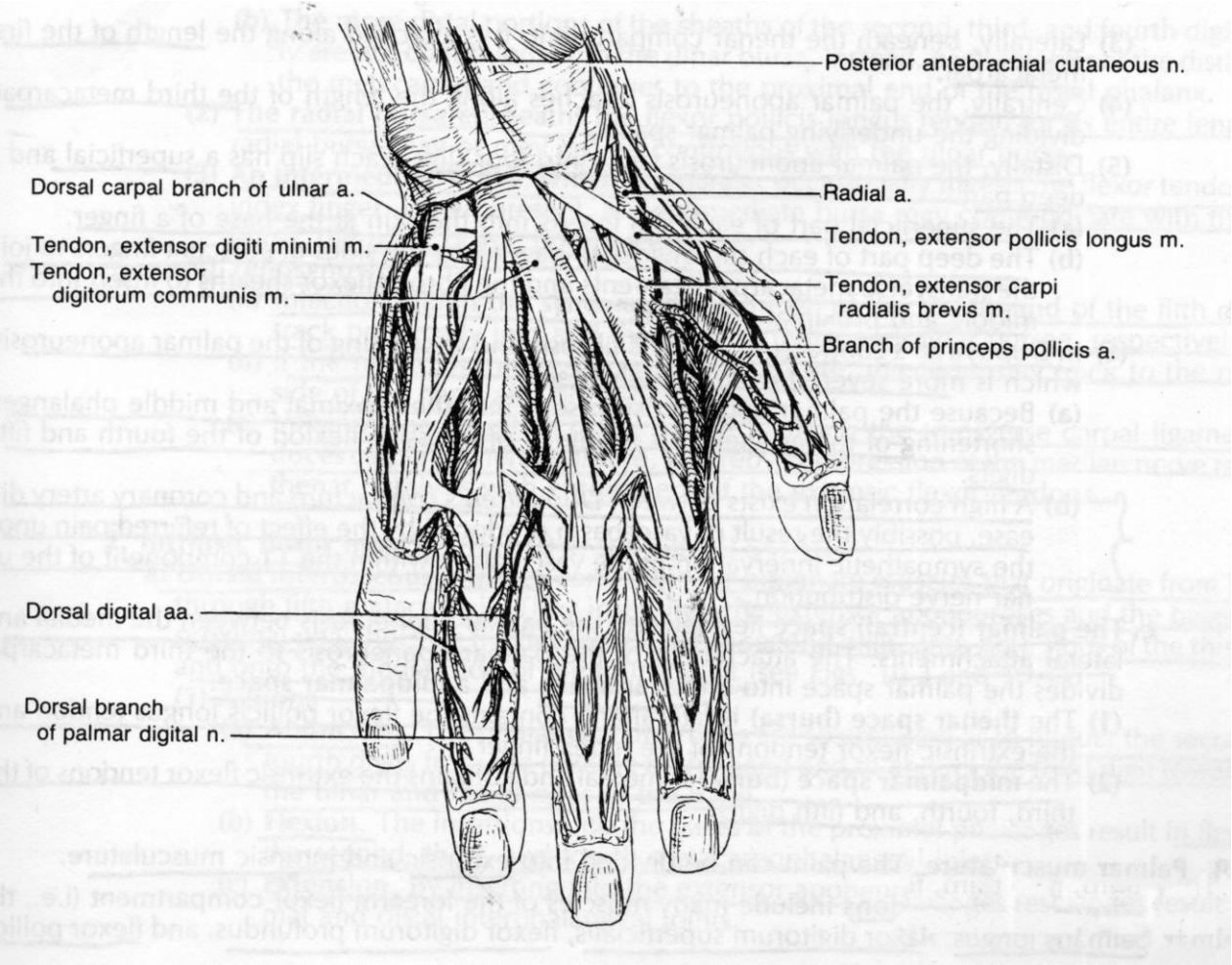
The flexor [carpal] tendons travel in a **fibro-osseous sheath** composed by the metacarpal bones, the phalanges and the joints [posteriorly].
Anteriorly, the **deep palmar fascia** condenses forming a tunnel [**palmar arch**] called the **fibrous flexor sheath**, which is tough but loose over the joints in order to allow movement. Distally, the sheath ends at the base of the distal phalanx.
Is lined by **synovial membrane** which is reflected around each tendon [the nutrient vessels travel through the mesotendon].
The synovial sheath of the thumb, formed along the flexor pollicis, extends from above the flexor retinaculum to the distal phalanx and is called the **radial bursa**.
The sheaths of the rest of the fingers are initially connected, but those of the 2^{nd} to 4^{th} stop at the metacarpal level. The 5^{th} finger sheath extends distally, forming the **ulnar bursa** [an expanded sheath enclosing all finger tendons in the palm, the sheath of flexor digitorum minimi and part of the superficial and deep flexor digitorum].
In **50% of subjects the radial and ulnar bursae communicate**. Infection of the phalanges of the 2^{nd}-4^{th} fingers may be confined in them, while infection of the thumb or small finger might spread to the wrist.

- **MID-PALMAR SPACE**

A small space lying behind the ulnar bursa and in front of the 3^{rd} - 5^{th} metacarpals and their interosseous muscles.

- **THENAR SPACE**

Is located behind the lateral part of the ulnar bursa and in front of adductor pollicis [which arises from the 3^{rd} metacarpal]. Posterior to this muscle are the 2^{nd} and 3^{rd} metacarpals as well as the 1^{st} and 2^{nd} dorsal and plantar interossei.



- ***The extensor part of the hand***

THE ARTERIES OF THE UPPER LIMB

SUBCLAVIAN ARTERY

Arises from the **brachiocephalic [innominate] trunk on the right** while on the **left** is a direct branch of the **aortic arch**.

- **COURSE**

Passes **beneath the clavicle**, **superiorly to the first rib**, with the subclavian vein located antero-inferiorly to the artery. It then passes between the rib insertions of **anterior and middle scalenus muscles**, becoming the axillary artery as it crosses the clavicle [from behind]

- **BRANCHES**

1. **Vertebral artery**
2. **Internal thoracic [mammary] artery**
3. **Thyreocervical trunk**
    - Inferior thyroid
    - Transverse cervical artery [absent in 50% of subjects]
        → Superficial branch [trapezius]
        → Descending, dorsal branch [levator scapula and rhomboid]
    - Suprascapular artery [in the supraspinous fossa]
4. **Costocervical trunk**
    - Cervical branches
    - Supreme thoracic [on the dome of pleura]
        → 1st & 2nd intercostals

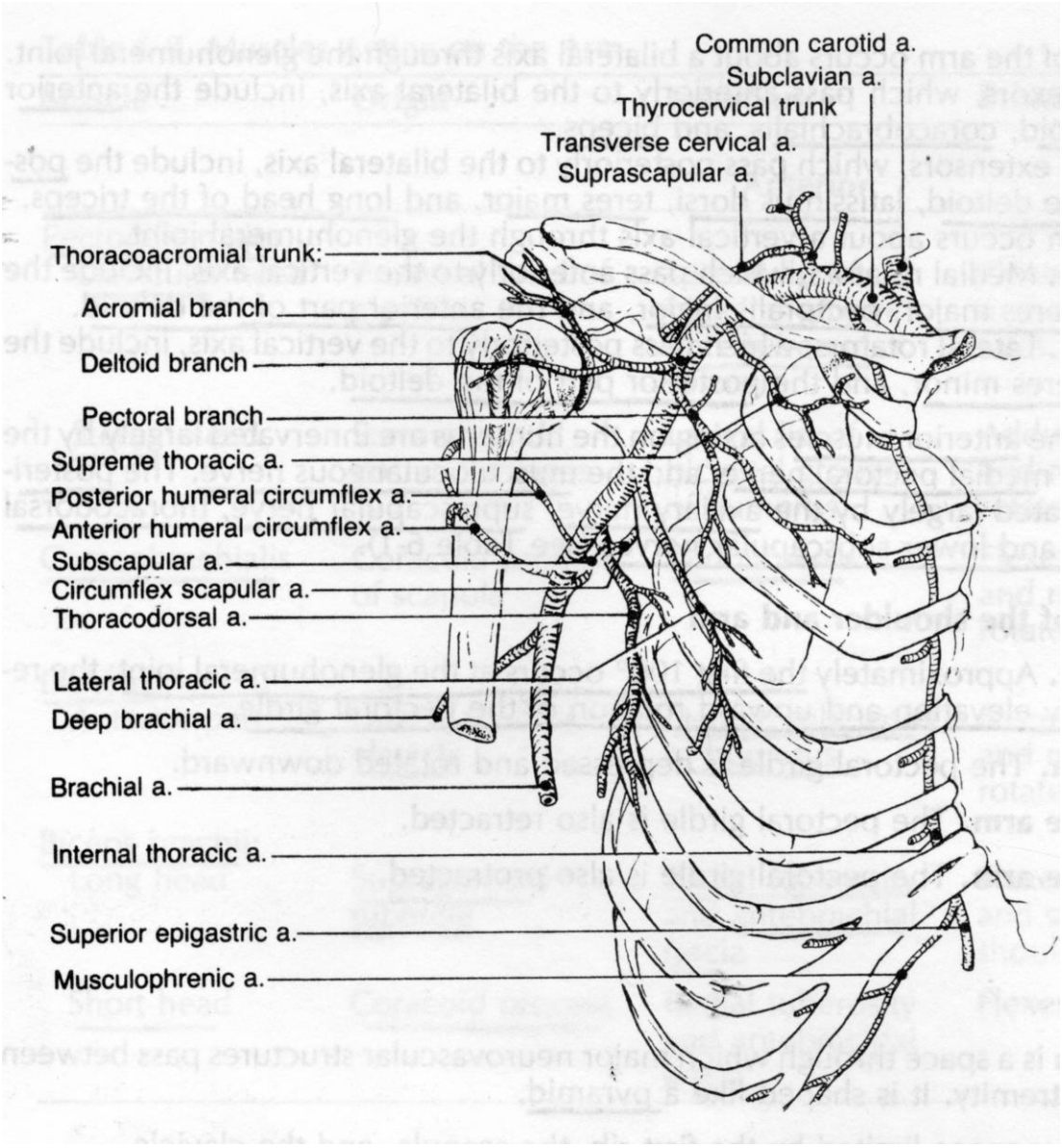
There are many communications around the scapula, anastomoses between the dorsal branch of the transverse cervical and the suprascapular, the circumflex scapular branch of the subscpular artery, the subscapular artery and the intercostals.

AXILLARY ARTERY

- **COURSE**

Commences at the **lateral border of the clavicle** [as a **continuation of the subclavian**] and ends at the level of the **posterior axillary fold [level of teres major**], where is now called **brachial artery**. The overlying **pectoralis minor dvides it in 3 parts**. The first two parts are covered by pectoralis major. Proximal to pectoralis minor the brachial plexus lies superiorly [above] and posteriorly [behind] the artery; distal to it the cords are placed around the brachial artery [lateral, medial and posterior cord].

- **BRANCHES**



- ***Subcavian & axillary aartery***

The 1st, 2nd and 3rd parts of the artery give off one, two and three branches respectively.

- **1st part:**
    1. **Supreme [superior] thoracic artery**
- **Middle [2nd] part:**
    2. **Thoracoacromial trunk**
        a. deltoid
        b. pectoral
        c. clevicular
        d. acromial artery
    2. **Lateral thoracic artery** [course at the lateral border of pectoralis minor]
- **Third [distal] part**:
    3. **Subscapular artery** [the largest branch]
        a. **circumflex scapular artery**
        b. **thoracodorsal artery** [continuation of subscapular]
    2. **Anterior humeral circumflex artery**
    3. **Posterior humeral circumflex artery**

BRACHIAL ARTERY

- **COURSE**

Commences as **continuation of the axillary artery at the level of teres major**. Descends a finger breadth's distance **medial to the coracoid process**, it then passes **superficially at the medial border of the arm**. As it descends it is in close relation to the medial border of **coracobrachialis** muscle proximally and the anterior aspect of **brachialis** muscle distally.

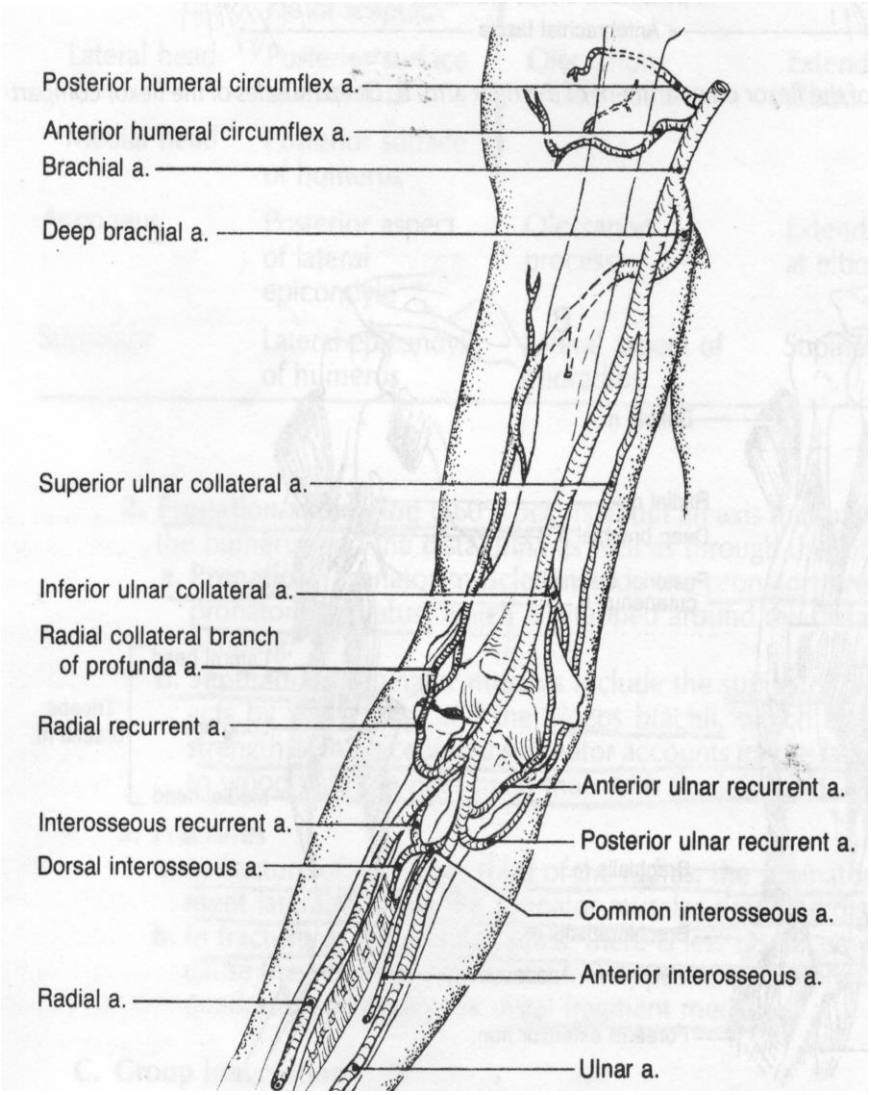
At the mid-arm the **median nerve crosses the artery superficially** and passes from the lateral to the medial side [occasionally it may cross deep to the artery].

In the **cubital fossa** the artery lies **deep to the biccipital aponeurosis**, having the biceps superolaterally, the brachialis inferolaterally and the pronator teres inferomedially. Posteriorly lies the bulk of brachialis muscle.

At the level of the **head of the radius** it ends **bi- trifurcating** to the forearm arteries. In **16% of subjects the bifurcation is higher**, resulting in a **superficial radial artery** in most cases [14%] and rarely in a superficial ulnar artery [2%]. In the forearm the median nerve lies medially and deeper to the brachial artery.

- **BRANCHES**

1. **Pofunda brachial artery [deep]**
   Winds to the posterior arm compartment, accompanying the radial nerve. Gives off a **recurrent [ascending] branch**, anastomosing with the **humoral circumflex artery**.
2. **Superior ulnar collateral artery**
   Accompanies the ulnar nerve
3. **Inferior ulnar collateral artery**
   Splits around the medial epicondyle and trochlea



- ***Brachial artery***

4. **Radial artery**

5. **Ulnar artery**
6. **Common interosseous artery** [15%]
    In most cases is a branch of the ulnar artery

RADIAL ARTERY

- **COURSE**

Starts at the **level of the head of radius**. It then **crosses the biceps tendon** and passes in a groove **between the brachioradialis and pronator teres** [posteriorly lies the supinator]. In the forearm it passes **between the brachioradialis and the flexor carpi radialis**. At the distal part of the arm the radial nerve lies alongside the artery. At the snuff-box level it pierces the interossous muscle and adductor pollicis to terminate as the major contribution to the **deep palmar arch**.

- **BRANCHES**

1. **Radial recurrent artery**
    At the lateral epicondyle level, anastomosing with the radial branch of profunda brachial artery.
2. **Superficial palmar branch**
    At the level of the wrist, contributing to the **superficial palmar arch**
3. **Dorsal carpal branch**
4. **Deep radial artery**, contributing to the **deep palmar arch**

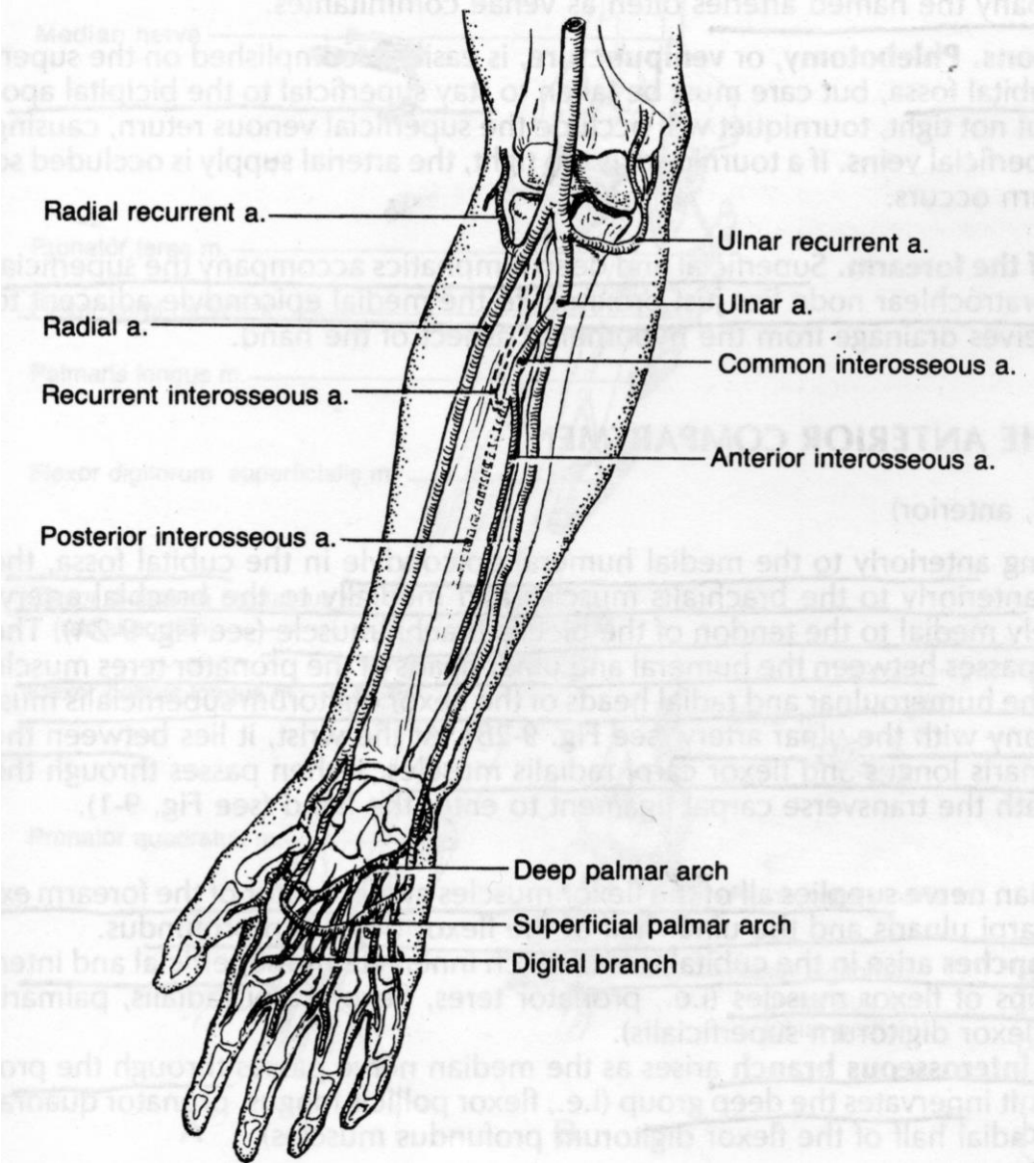
ULNAR ARTERY

- **COURSE**

Passes **deeply to the pronator teres** [the latter separating it from the median nerve] and the common flexor origin, **lying on the flexor digitorum profundus**. Is overlapped by the flexor carpi ulnaris.
In the distal half of the arm it becomes s**uperficial** and passes between the **flexor digitorum superficialis [sublimis] and the flexor carpi ulnaris**. It is accompanied by the ulnar nerve which lies medially. Passes superficially to the transverse wrist ligament [flexor retinaculum] to contribute to the **superficial palmar arch**.

- **BRANCHES**

1. **Anterior recurrent ulnar artery**
2. **Posterior collateral ulnar artery**
3. **Common interosseous artery**
    - **anterior interosseous**
    - **recurrent [proximal] interosseous**
    - **osterior [dorsal] interosseous**



- ***The ulbar & radial artery***

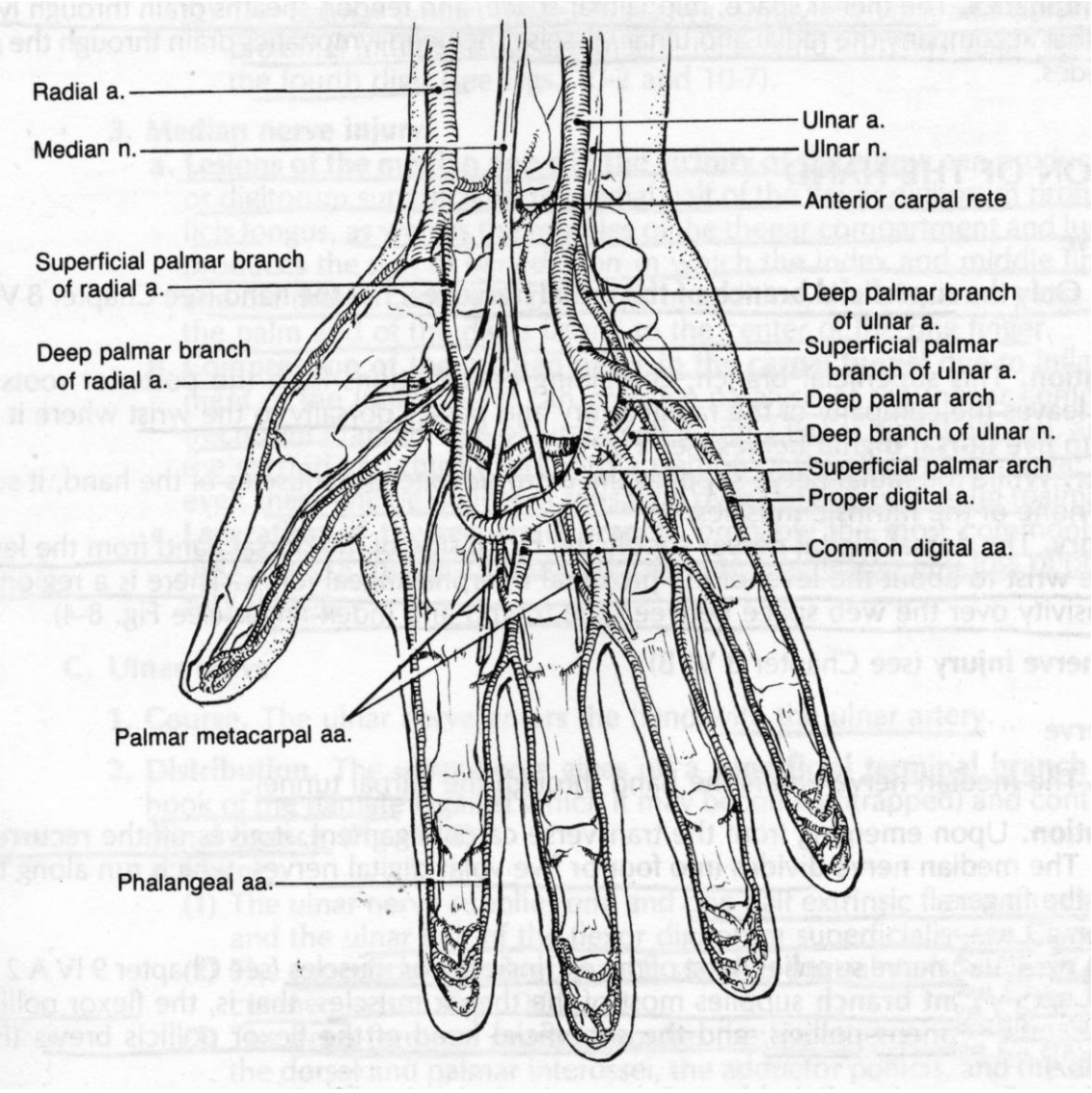
4. **Branch to deep palmar arch**
5. **Branch to superficial palmar arch**

ARTERIES OF THE HAND

- **RADIAL ARTERY**

- **Dorsal carpal branch**, at the dorsum of the hand, communicating with the ulnar dorsal carpal branch
- **Superficial palmar branch**, contributing to the **superficial palmar arch**
- **Deep radial artery**
  main contributor to **deep palmar arch** which gives off the
  metacarpal arteries, giving off the
  deep digital arteries which join with the superficial digital arteries from the superficial palmar arch to form the
  phalangeal arteries

- **ULNAR ARTERY**
- **Dorsal carpal branch**, anastomosing with the same radial branch
- **Main ulnar continuation**, major contributor to the **superficial palmar arch**, which gives off the
  superficial digital arteries
- **deep branch**, contributing to the **deep palmar arch**



- ***The hand vasculature***

NERVES OF THE UPPER LIMB

BRACHIAL PLEXUS

- **5 nerve roots** [**C5, C6, C7, C8 & T1**] give the **anterior ventral primary rami** which link into:
- **3 trunks**: **upper [superior**] from fusion of **C5 & C6**
  middle, the **C7** anterior root alone
  lower [inferior], from **C8 & T1** fusion, which split into:
- **6 divisions**, as each trunk splits into anterior and posterior division. These link up into:
- **3 cords**: **lateral** [from the **anterior divisions of upper and middle trunk**, **C5, C6 & C7**]
  medial [anterior division of **lower trunk, C8 & T1**]
  posterior [**union of all 3 posterior divisions, C5-T1**], which give:
- **5 main nerves**:
  1. **radial nerve** [main continuation of **posterior cord**, **C5-T1**]
  2. **axillary nerve** [**posterior cord**, **C5 & C6**]
  3. **musculocutaneous nerve** [**lateral cord**, **C5,C6 & C7**]
  4. **ulnar nerve** [**medial cord**, **C7, C8 & T1**]
  5. **median nerve** [from **lateral and medial cord**, **C6-T1**]

The roots lie between the **anterior and middle scalene muscles**
The trunks traverse the **posterior triangle of the neck**
The divisions lie **behind the clavicle**
The cords lie in the **axilla,** attached to the axillary artery

- **DERIVATIVES OF PLEXUS COMPONENTS**
- **ROOTS**

C5 [with C3 & C4] → **phrenic nerve**
→ **dorsal scapular nerve** [innervates **rhomboid** and **levator scapula**]
C5, C6, C7 → **long thoracic nerve** [**Bell's**, innervating **serratus anterior**]
T1 → **1st intercostal nerve**

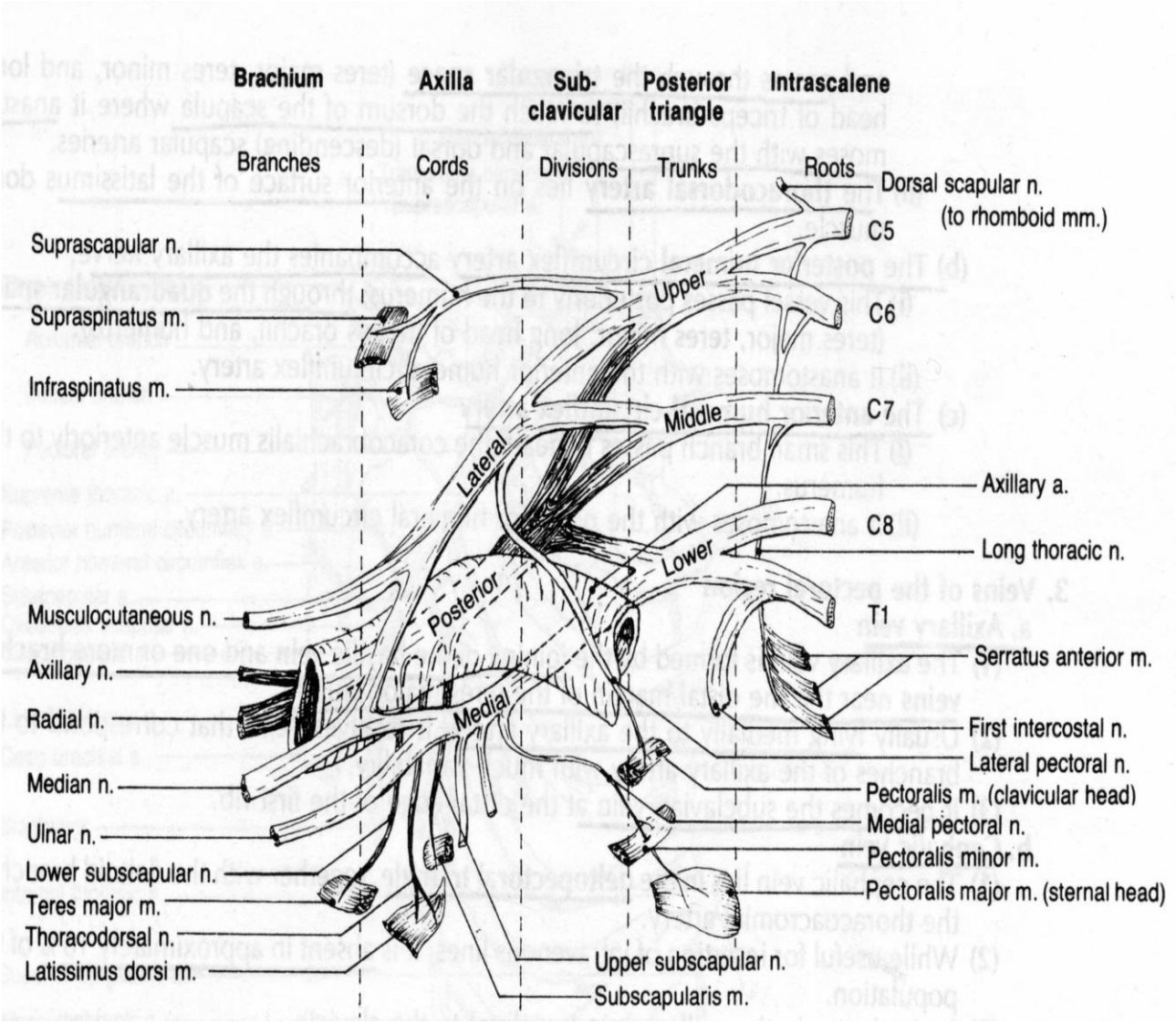
- **TRUNKS**

Upper → **suprascapular nerve**
→ **nerve to subclavious** muscle
Middle & lower give **no branches**

- **CORDS**

Lateral:

1. **musculocutaneous [C5-C7],** innervating coracobrachialis, biceps & brachialis
   a. **lateral cutaneous antebrachial nerve**



- ***The brachial plexus***

2. **lateral pectoral nerve**, innervating pectoralis muscles
3. **median nerve [C5-C7]**

Medial:

1. **median nerve [C8-T1],** innervating flexors and pronators of forearm
2. **medial cutaneous antebrachial nerve**
3. **medial brachial cutaneous nerve**
4. **medial pectoral nerve**
5. **ulnar nerve [C8-T1]** innervating the flexor muscles

Posterior:

1. **subscapular nerve**, innervating subscapularis and teres major
2. thoracodorsal nerve, innervating latissimus dorsi
3. **axillary nerve [circumflex nerve**], innervating deltoid and teres minor
4. **radial nerve [C5-T1]** innervating the extensors

- **SEGMENTAL CUTANEOUS SUPPLY OF THE UPPER LIMB**

C4 → skin over shoulder
C5 → radial side of upper arm
C6 → radial site of forearm and thumb
C7 → skin of hand [2nd - 4th fingers]
C8 → ulnar site of forearm and small finger
T1 → ulnar site of arm
T2 → skin of the axilla

PRINCIPAL NERVES OF THE UPPER LIMB

- **AXILLARY NERVE [C5-C6]**

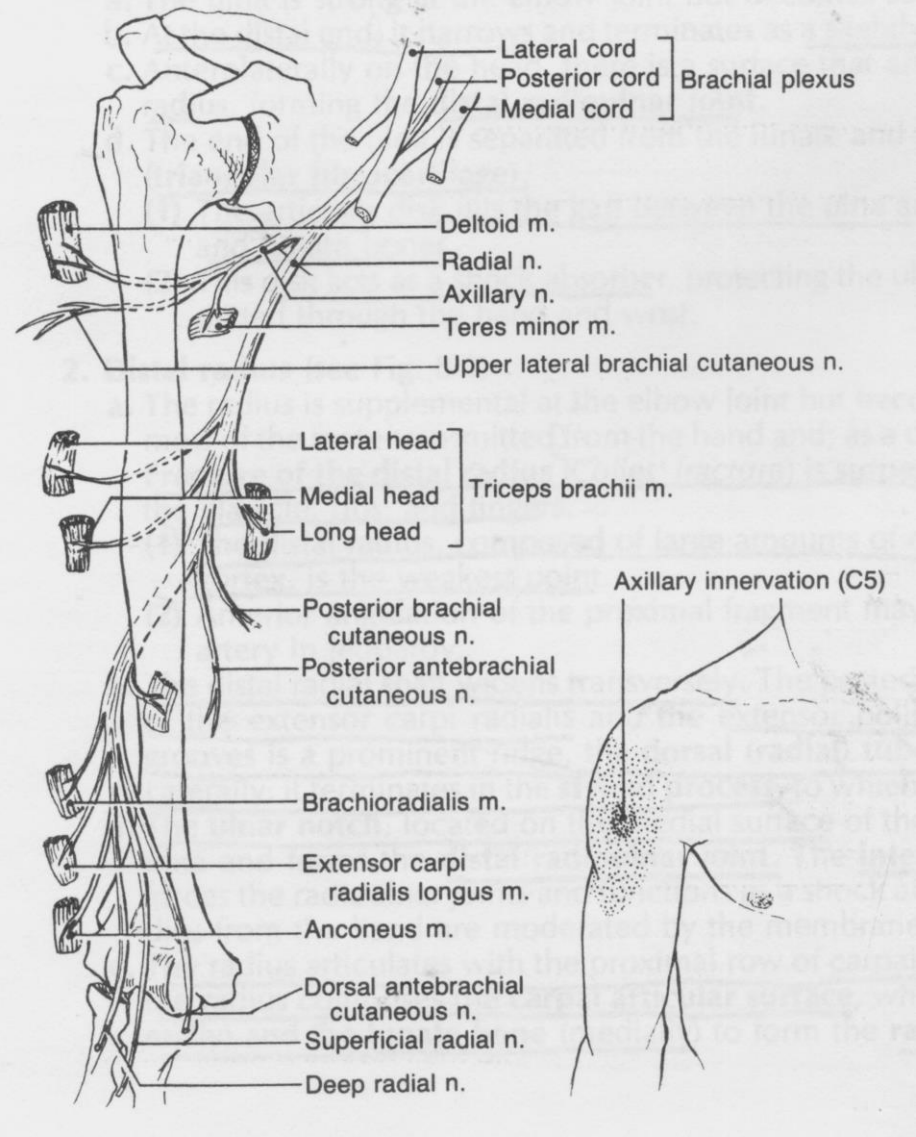
Arises from the **posterior cord**, being **posteriorly to the axillary artery** and lateral to the radial nerve. Passes in front of the **subscapular muscle** and through the **quadrangular space** [formed by teres minor, teres major, long head of triceps and humerus]. It then winds round the **surgical neck of humerus** accompanied by the **circumflex humeral vessels** to supply the posterior aspect of shoulder and arm.

- **MOTOR INNERVATION**
  - **Deltoid**
  - **Teres minor**
- **SENSORY INNERVATION**

A palm's area over the deltoid, via the **lateral cutaneous brachial nerve**.

- **FRACTURE AT THE NECK OF HUMERUS**:

May cause weakness in shoulder abduction [deltoid], wasting of deltoid and a small area of sensory deficit.



- ***Axillary and radial nerve in upper arm***

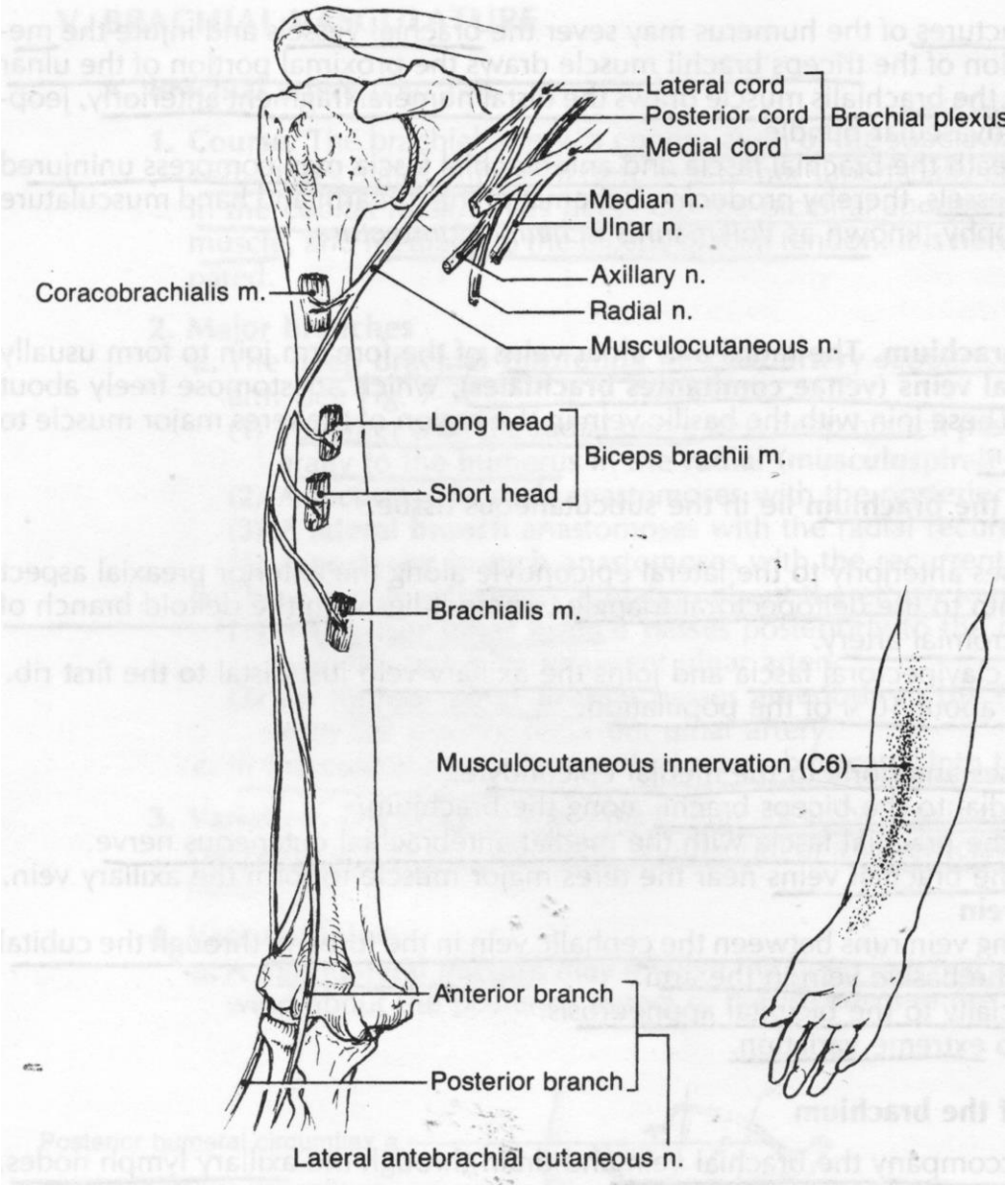
- **RADIAL NERVE [C5-T1]**

Is the continuation [main branch] of the **posterior cord**. At first it lies **behind the axillary artery**. It then passes posteriorly, between the long and medial heads of triceps, to continue in the **spiral groove at the back of hymerus**, lying between the medial and lateral heads of triceps, accompanied by the **profunda brachial artery**.
It passes **anterior to the lateral epicondyle** to enter the **anterior compartment of the forearm**, lying between the brachialis and brachioradialis muscles. At that point it gives off the **posterior interosseous radial nerve [deep]** which winds around the radius, pierces the supinator muscles and supplies the extensor forearm muscles. The remaining **superficial radial nerve** descends parallel to the brachioradialis, lying medially to it.
Above the wrist it divides into **cutaneous branches** which supply the **dorsal aspect of the first 3 ½ digits**. However, overlapping is such that if the nerve is severed only a small area of anaesthesia will be present, in the **web between thumb and index finger**.

- **BRANCHES**
    1. **Lateral cutaneous brachial nerve**
    2. **Posterior brachial cutaneous nerve**
    3. **Posterior antebrachial cutaneous nerve**
    4. **Deep [posterior interosseous] radial nerve**
    5. **Superficial radial nerve**
- **MOTOR INNERVATION**
    1. **Triceps [all heads]**
    2. **Anconeus**
    3. **Brachioradialis**
    4. **Extensor carpi radialis**
    5. **ALL EXTENSORS OF FOREARM AND HAND**
        Extensor carpi radialis longus
        extensor carpi radialis brevis
        Extensor digitorum communis
        Extensor digiti minimi
        Extensor carpi ulnaris
        Extensor pollicis brevis
        Extensor pollicis longus
        Extensor indicis
    6. **Supinator**
    7. **Abductor pollicis longus**
- **SENSORY INNERVATION**
    dorsal aspect of the first 3 ½ digits
    web between thumb and index finger

- **MUSCULOCUTANEOUS NERVE [C5,C6, C7]**

Is the continuation of **lateral cord**. Pierces the coracobrachialis and descends **between the biceps and brachialis**. Passes on the lateral side of the arm, crosses over the lateral epicondyle



- ***The musculocutaneous nerve***

and runs on the lateral aspect of forearm, as the **lateral antebrachial cutaneous nerve** to supply the **skin of the lateral forearm [C6**].

- **MOROR INNERVATION**
    1. **Biceps**
    2. **Coracobrachialis**
    3. **Brachialis**
- **SENSORY INNERVATION**
    skin of the lateral forearm
- **INJURY**:

Will cause: inability to flex the forearm
loss of bicps tendon reflex
loss of sensation on the radial side of forearm

- **ULNAR NERVE [C7, C8, T1]**

Continuation of the **medial cord**, lying medially to the axillary and brachial artery. It then passes posteriorly, descending on the **anterior surface of triceps**, accompanied by the **superficial ulnar collateral artery**. Behind the **medial epicondyle it passes subcutaneously** to enter the forearm; it descends **beneath the flexor carpi ulnaris**, accompanied by the **ulnar artery** [lying laterally]. 5cm above the wrist it gives off the **lateral cutaneous branch**, supplying **the dorsal aspect of ulnar [last] 1 ½ fingers**. It passes **superficially to flexor retinaculum**, giving off a **deep terminal motor branch** [supplying the hypothenar and intrinsic hand muscles] and a **superficial cutaneous terminal b**ranch for the **palmar surface of ulnar 1 ½ fingers**.

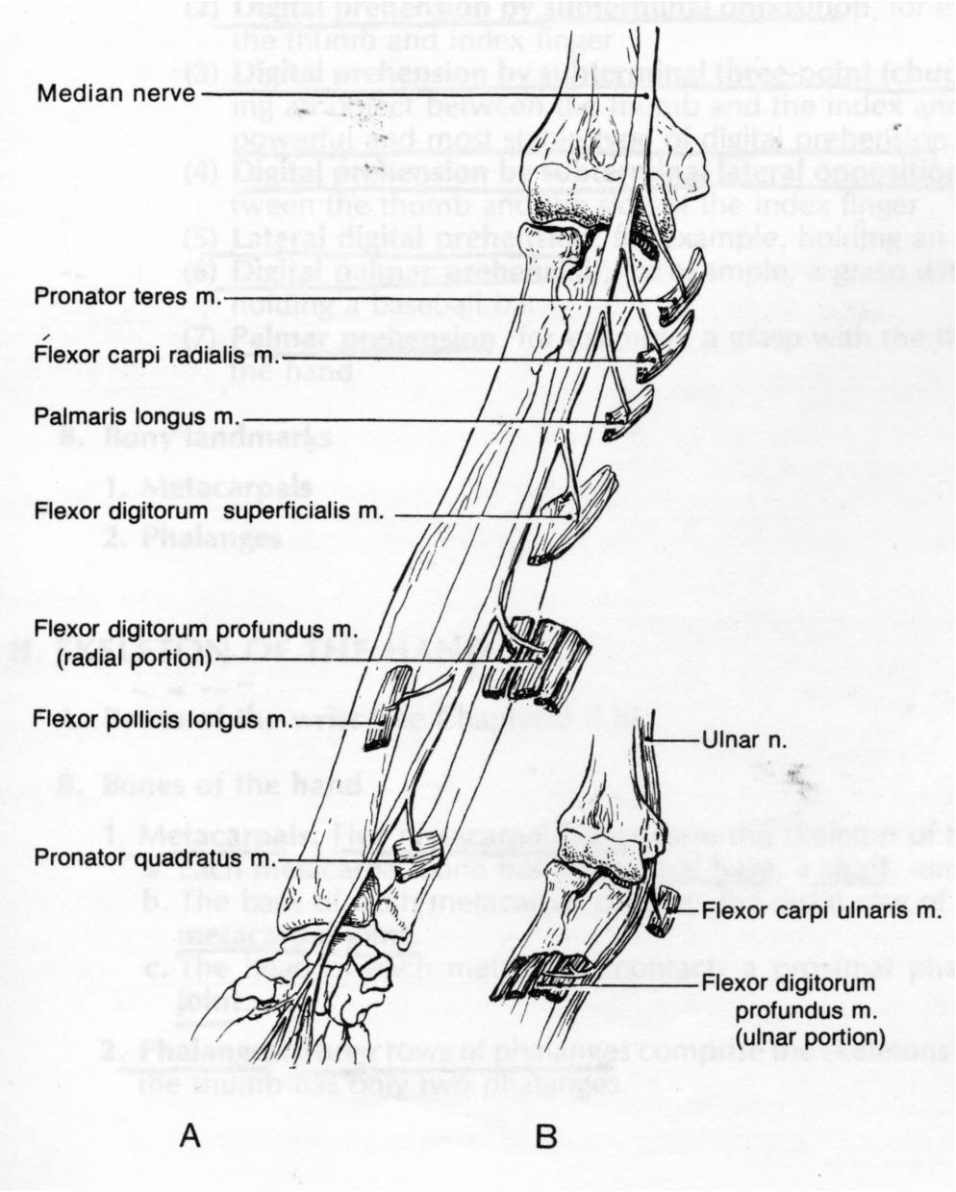
- **MOTOR INNERVATION**

[The ulnar nerve supplies all intrinsic hand muscles apart from those of the thenar eminence and the 1st and 2ndlumbricals which are supplied by the median nerve]

1. **Flexor carpi ulnaris**
2. **Medial 1 ½ of flexor digitorum profundus**
3. **Hypothenar muscles of digiti minimi**
    opponens
    abductor
    flexor
4. **Interossei muscles**
5. **3rd and 4th lumbricals**
6. **Adductor pollicis**

- **SENSORY INNERVATION**
    palmar surface of ulnar 1 ½ fingers
    dorsal aspect of ulnar [last] 1 ½ fingers

- **MEDIAN NERVE [C6, C7, C8, T1]**



- ***The median & ulnar nerves***

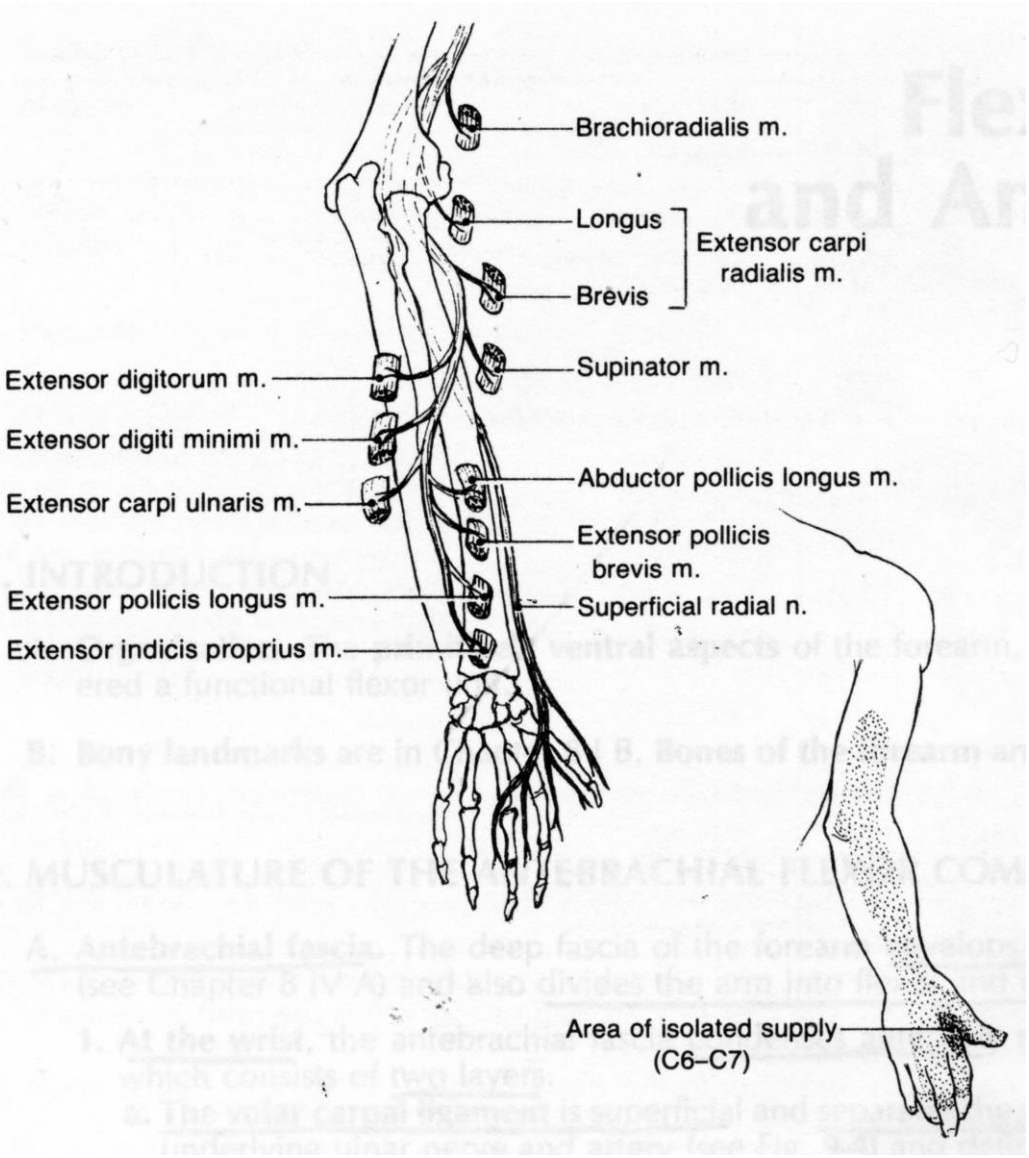
Is comprised from fibres from both **medial and lateral cord**, which unite **anterior to the 3rd part of axillary artery**. Runs down along the lateral side of brachial artery, **crossing it superficially at the midumerus** to pass on its medial side.
Enters the **forearm through the pronator teres**, which separates it from the ulnar artery [the latter lies behind the nerve and anterior to brachialis muscle]. There it gives off the **anterior interosseous nerve**.
In the forearm it lies on the **deep aspect of flexor digitorum superficialis**
At the wrist it becomes **superficial**, lying almost in the midline, medially to flexor carpi radialis. It gives off **cutaneous branches** to the palmar aspect of the radial 3 ½ digits before passing below the **transverse carpal ligament** [flexor retinaculum] to supply the thenar muscles.

- **MOTOR INNERVATION**
    1. All **forearm flexors** [apart from flexor carpi ulnaris and ulnar part of flexor digitorum profundus]
    2. **Pronators**
    3. **Thenar eminence muscles**
        abductor pollicis brevis
        opponens pollicis
        flexor pollicis brevis
    4. **1st and 2nd lumbricals**
- **SENSORY INNERVATION**
    Palm
    Palmar aspect of radial 3 ½ fingers
    Various area of dorsal 3 ½ fingers

UPPER LIMB DEFORMITIES CAUSED BY NERVE INJURIES

- **UPPER TRUNK INJURY [ERB-DUCHENNE PARALYSIS]**
- The **commonest** of brachial plexus injuries. May be caused by arm traction during birth or violent downward displacement of the arm or fall on the head and shoulder. The main force is applied on **C5 & C6 roots**.
- There is waste of the **deltoid, of the short shoulder muscles, biceps and brachialis**, which flex and supinate the forearm.
- The arm hangs limply on the side with the forearm pronated and the palm facing backwards, like a **waitor's tip position**.
- If the later pectoral nerve is also involved the patient would be **unable to reach the opposite shoulder.**

- **LOWER TRUNK INJURY [KLAMPKE'S PARALYSIS]**
- Caused by **violent upward arm displacement**, **shoulder dislocation**, apical lung tumors [**Pancoast tumor**: Horner's syndrome, ptosis, pupil constriction, enophthlmus due to traction or invasion of the cervical sympathetic chain, C8 & T1 ganglion] , **supernumerary rib** or **scalene syndrome**.



- ***The radial nerve in forearm & hand***

- **Injury of C8 & T1 roots**
- **Loss of ulnar flexion of the wrist** and waste of intrinsic hand muscles. The unopposed action of long flexors [on the inter-phalangeal joints] and extensors [metacarpophalangeal joints] produces a **claw appearance of the hand**, with extension of the metacarpophalangeal and flexion of interphalangeal joints.

- **SCALENE SYNDROME**

Pain and paraesthesia along the medial border of the arm and atrophy of the small muscles of the hand due to compression of the lower trunk between the anterior and middle scalenus muscles.

- **RADIAL NERVE INJURY**
- **INJURY IN THE AXILLA:**

  Crutch pulsy

  Saturday's night palsy [fallen asleep with the arm hanging on a chair]
- **FRACTURE OF THE SHAFT OF HUMERUS**:

  Affects the main nerve
  - **Wrist drop** [paralysis of all extensors] with **inability to grip**
  - **Small area of anaesthesia** [dorsal web space between thumb and index]
- **INJURY AT THE HEAD OF RADIUS:**

[fracture, dislocation, ill-placed surgical incision more than 3 fingers below the head of radius]

Affects the **deep radial [interosseous nerve**]. If only the deep nerve is affected the extensor carpi radialis will be left intact, maintaining some degree of extension.

- **ULNAR NERVE**

- Even complete division of the ulnar nerve leaves a **surprisingly efficient hand**
- **SITES OF INJURY**:

  Medial epicondyle of humerus [fracture, dislocation]

  Wrist laceration
- **FINDINGS**:

  Paralysis of **intrinsic hand muscles** [appart from 1st & 2nd lumbricals] and wasting of interossei with a **claw hand appearance**.

  Sensory loss over palmar and dorsal aspect of last 1 ½ fingers

  If injured at the elbow, the **flexor digitorum profundus to 4th and 5th fingers** is also affected, so clawing is less prominent.

- **MEDIAN NERVE**
- **ELBOW**

  Loss of pronation

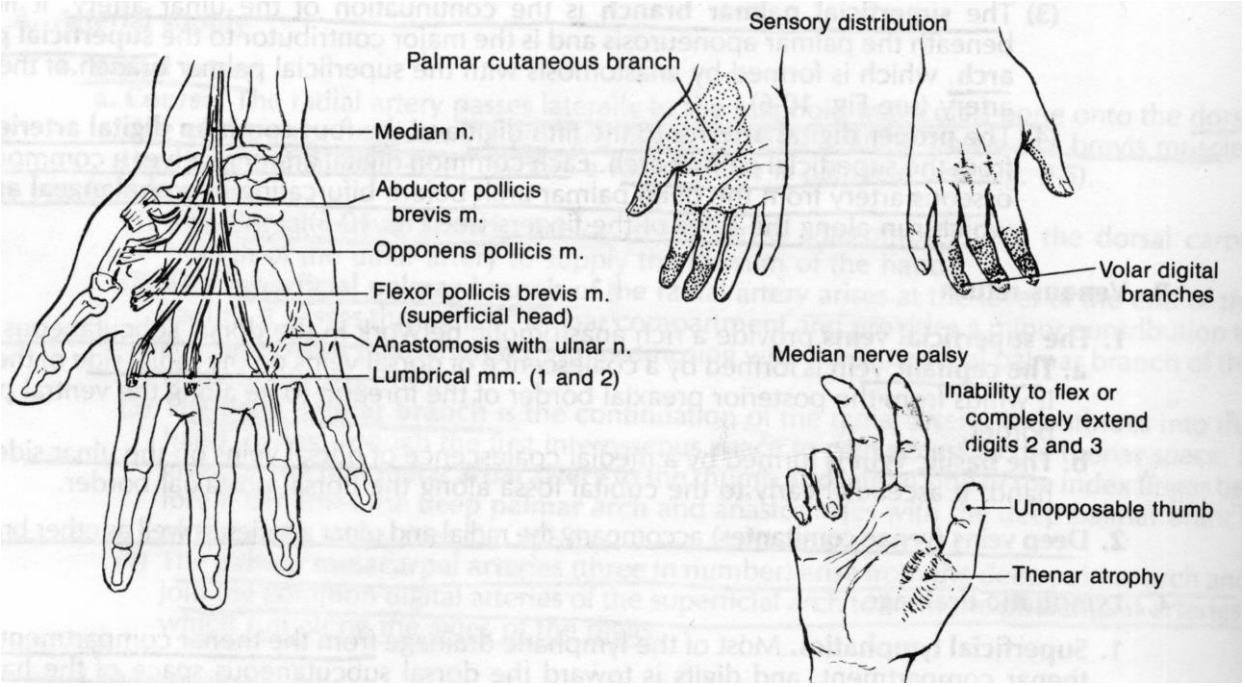
  Weak wrist flexion

  Ulnar deviation of carpus / hand
- **WRIST**

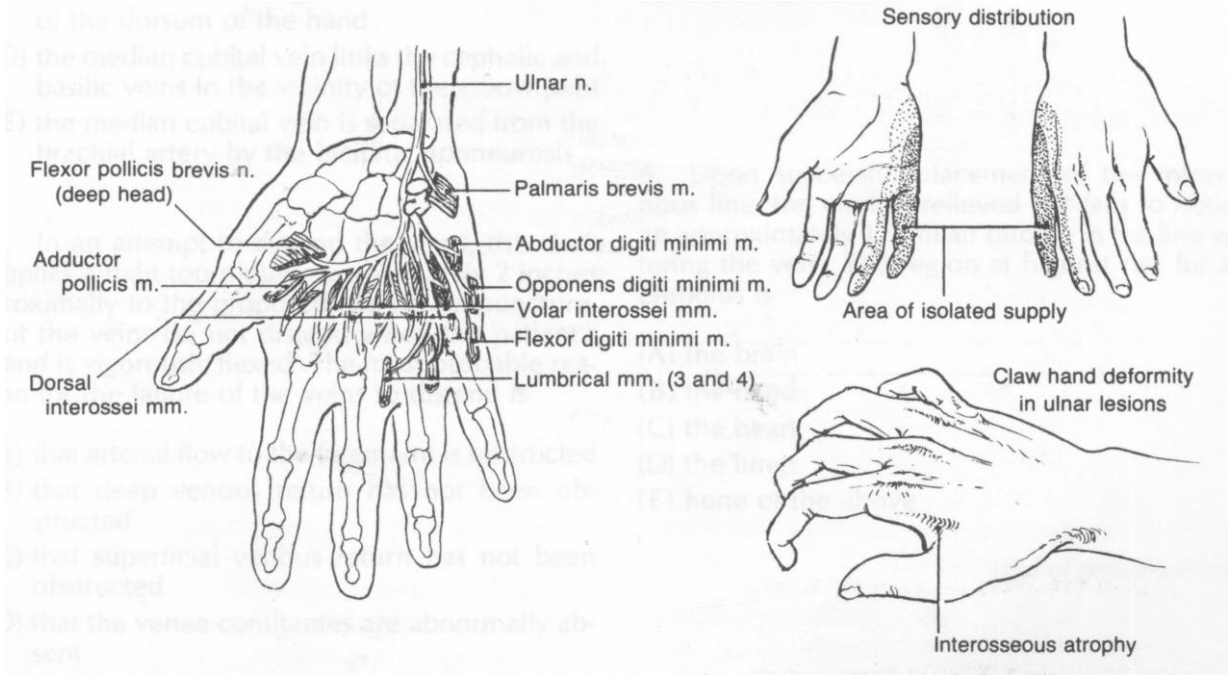
  Loss of sensation of thumb and next 2 ½ fingers

  Loss of palmar sensation

  Loss of motor innervation to thenar muscles with inability to oppose the thumb



- ***The median nerve in hand & deformities***



- ***The ulnar nerve in hand & deformities***