

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# NERVES OF THE UPPER LIMB

# Cutaneous Innervation

# Pectoral Region, Axilla and Back

- **Supraclavicular nerves** (C3,4) from cervical plexus: skin of the anterior aspect of the pectoral region till the level of the sternal angle (2<sup>nd</sup> costal cartilage).
- **Anterior cutaneous branches of the intercostal nerves** skin from the midline to the mid-clavicular line.
- **Lateral cutaneous branches of the intercostal nerves** skin from the lateral side of the pectoral region.
- **Intercostobrachial nerve** (T2): skin of the axilla.
- **Dorsal rami of the spinal nerves** (T1-12): skin of the back.

# The Arm

- **Supraclavicular nerves** (C3,4) from cervical plexus: skin over the shoulder and upper half of deltoid.
- **Upper lateral cutaneous nerve of the arm** from the axillary nerve (C5,6): skin over the lower half of the deltoid.
- **Lower lateral cutaneous nerve of the arm** (C5,6) from the radial nerve (C5-T1): skin of the lateral surface of the arm below the deltoid.
- **Intercostobrachial nerve** (T2): skin of the axilla.
- **Medial Cutaneous nerve of the arm** (C8,T1): skin of the medial side of the arm.
- **Posterior cutaneous nerve of the arm** (C8) from the radial nerve (C5-T1): skin of the posterior surface of the arm.

# The Forearm

- **Lateral cutaneous nerve of the forearm**  
the continuation of the musculocutaneous nerve, supplies the lateral side of the forearm.
- **Medial Cutaneous nerve of the forearm**  
from the medial cord of brachial plexus and supplies the medial side of the forearm.
- **Posterior cutaneous nerve of the forearm**  
from the radial nerve and supplies the posterior aspect of the forearm.

# Palm of hand

- 1. The skin of the lateral 2/3 of the palm:** by the palmar cutaneous branch of median nerve.
- 2. The skin of the medial 1/3 of the palm:** by the palmar cutaneous branch of ulnar nerve.
- 3. Skin of the lateral 3.5 fingers:** by the cutaneous branches of the median nerve.
- 4. Skin of the medial 1.5 finger:** by the cutaneous branches of the ulnar nerve.

# Dorsum of hand

- 1. Superficial branch of radial nerve:** supplies the lateral  $\frac{2}{3}$  of the dorsum of the hand and the lateral 3.5 fingers (except nail beds).
- 2. Dorsal cutaneous branch of the ulnar nerve:** supplies the medial  $\frac{1}{3}$  of the dorsum of the hand and the medial 1.5 fingers (except nail beds).

# Dermatomes

# Brachial plexus

■ **Definition:** It is a network of nerves concerning with the nerve supply of upper limb.

■ **Origin:** from the ventral rami of C5,6,7,8 +T1.

■ **Composition and site:**

- **Root:** in the posterior triangle of the neck
- **Trunks:** in the posterior triangle of the neck.
- **Divisions:** behind the clavicle.
- **Cords:** in the axilla (related to 1<sup>st</sup> and 2<sup>nd</sup> parts of axillary artery).
- **Branches:** in the axilla (related to the 3<sup>rd</sup> part of axillary artery).

# Formation of the plexus

# ROOTS

- They are formed by the ventral rami of the 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> cervical and 1<sup>st</sup> thoracic spinal nerves.
- It may take origin from the 4<sup>th</sup> cervical nerve (prefixied plexus), or from the 2<sup>nd</sup> thoracic nerve (postfixed plexus).
- They lye in the posterior triangle of the neck.
- They unites together to form the trunks.

# Trunks

- They are formed by the roots of the plexus.
- They are 3 (upper, middle and lower).
- **Upper trunk (C5,6)** is formed by the union of the ventral rami of the 5<sup>th</sup> and 6<sup>th</sup> cervical nerves.
- **Middle trunk (C7)** is formed by the ventral ramus of the 7<sup>th</sup> cervical nerve alone.
- **Lower trunk (C8, T1)** is formed by the union of the ventral rami of 8<sup>th</sup> cervical and 1<sup>st</sup> thoracic nerves.
- They lie in the posterior triangle of the neck.
- Each trunk divides to give anterior and posterior division.

# Divisions

- They are formed from the trunks.
- They are 6 in number (3 anterior and 3 posterior).
- They lie behind the middle third of the clavicle (apex of the axilla).
- The divisions unite to form the cords of the brachial plexus.

# Cords

- They are formed by union of the divisions of the plexus.
- They are 3 (lateral, medial and posterior).
- **Lateral Cord (C5,6,7)** is formed by the union of the anterior divisions of the upper and middle trunks.
- **Medial Cord (C8, T1)** is formed by the anterior division of the lower trunk alone.
- **Posterior Cord (C5,6,7,8, T1)** is formed by the union of the posterior divisions of the upper, middle and lower trunks.
- They lie in the axilla (opposite 1<sup>st</sup> and 2<sup>nd</sup> parts of axillary artery).
- Each cord gives off the branches of the plexus.

# Relations of the Cords to the axillary artery

## ➤ Lateral Cord:

- Lateral to the 1<sup>st</sup> and 2<sup>nd</sup> parts of the artery.

## ➤ Medial Cord:

- Posterior to the 1<sup>st</sup> part of the artery.
- Medial to the 2<sup>nd</sup> part of the artery

## ➤ Posterior Cord:

- Lateral to the 1<sup>st</sup> part of the artery.
- Posterior to the 2<sup>nd</sup> part of the artery.

# Branches of the brachial plexus

# Branches of the Brachial plexus

## ■ From the Roots:

1. **Dorsal scapular nerve** (C5) supplies the levator scapulae and rhomboid muscles (major and minor).
2. **Long thoracic nerve** (C5,6,7) descends superficial to the serratus anterior muscle which it supplies.

## ■ From the trunks:

1. **Nerve to subclavius** (5,6) which sometimes gives off accessory phrenic nerve (C5).
2. **Suprascapular nerve** (C5,6) which supplies supraspinatus and infraspinatus muscles.

# Branches of the Brachial plexus

## ■ From the lateral cord:

- 1. Lateral pectoral nerve** (C5,6,7) pierces the clavipectoral fascia and supplies the pectoralis major muscle.
- 2. Musculocutaneous nerve** (C5,6,7) supplies coracobrachialis, biceps brachii and brachialis muscles and ends as the lateral cutaneous nerve of the forearm.
- 3. Lateral root of median nerve** (C5,6,7) which receives the medial root to form the median nerve on the lateral side of the axillary artery.

# Branches of the Brachial plexus

## ■ From the medial cord:

1. **Medial pectoral nerve** (C8, T1) supplies and pierces the pectoralis minor muscle then supplies the pectoralis major muscle.
2. **Medial cutaneous nerve of the arm** (C8, T1) supplies the skin of the medial side of the arm. It may communicate with the intercostobrachial nerve (T2).
3. **Medial cutaneous nerve of the forearm** (C8, T1) runs on the medial side of the axillary artery, it supplies the medial side of the forearm.

# Branches of the Brachial plexus

## ■ From the medial cord:

- 4. Ulnar nerve** (C7,8, T1) runs on the medial side of the axillary artery and supplies some muscles and skin of the forearm and hand.
- 5. Medial root of median nerve** (C8, T1) crosses in front of the 3<sup>rd</sup> part of axillary artery (from medial to lateral) to join the lateral root and forms the median nerve which supplies some muscles and skin of the forearm and hand

# Branches of the Brachial plexus

## ■ From the posterior cord:

1. **Upper subscapular nerve** (C5,6) supplies the upper part of the subscapularis muscle.
2. **Lower subscapular nerve** (C5,6) supplies the lower part of the subscapularis and the teres major muscles.
3. **Thoracodorsal nerve** (C6,7,8) supplies the latissimus dorsi muscle.
4. **Axillary nerve** (C5,6) and.
5. **Radial nerve** (C5,6,7,8, T1) are the two terminal branches of the posterior cord.

# Clinical notes of brachial plexus

# Erb-Duchenne Palsy

- It is a lesion of the upper trunk:
- Due to excessive displacement of the head and depression of the shoulder.
- It gives a deformity called “waiter’s tip position”.
- The arm is hanged by the side and medially rotated.
- The forearm is extended and pronated.
- Loss of sensation on the lateral side of the arm.

# Klumpke Palsy

- It is a lesion of the lower trunk:
- Due to excessive abduction of the arm, or cervical rib.
- It affects the small muscles of the hand.
- The hand has a “**claw-shaped deformity**”, (extension of the metacarpophalangeal joints and flexion of the interphalangeal joints).
- Loss of sensations on the medial side of the forearm and arm.

# Winged Scapula

- Due to a lesion of the long thoracic nerve:
- Due to lesion in the posterior triangle of the neck or during mastectomy or incision in the medial wall of the axilla.
- The medial border of the scapula will protrude posteriorly as a wing.
- There will be difficulty in raising the arm above the head (abduction more than 90 degrees)

# Axillary Nerve (C5,6)

- **Origin:** from the posterior cord of the brachial plexus in the axilla (C5,6).
- **Course:** it lies on the subscapularis muscle behind the 3<sup>rd</sup> part of the axillary artery.
  - It turns backward through the quadrangular space with the posterior circumflex humeral artery.
  - It divides into anterior and posterior divisions.
- **Branches:**
  1. ***Articular branches:*** to the shoulder joint.
  2. ***Anterior division:*** to deltoid and covered its lower part.
  3. ***Posterior division:*** to deltoid, teres minor and upper lateral cutaneous nerve of the arm.

# Clinical notes

## ➤ Cause:

- It can be injured due to dislocation of shoulder joint, fracture neck humerus and bad crutch.

## ➤ Lesions:

1. Paralysis of deltoid and teres minor muscles.
2. Loss of skin sensation over the lower half of deltoid muscle.
3. Impairment of abduction of the shoulder joint.
4. Wasting of the deltoid causes flat shoulder.

**Radial Nerve**

**C5,6,7,8,T1**

# In the Axilla

- **Origin:** from the posterior cord of the brachial plexus in the axilla.
- **Course:**
  - ✓ It descends behind the 3<sup>rd</sup> part of axillary artery, then through the lower (lateral) triangular intermuscular space, it enters the posterior compartment of the arm.
  - ✓ It runs on the spiral groove of the humerus (from medial to lateral).
  - ✓ At the lower part of the arm, it emerges between brachialis and brachioradialis to pass a short course in the anterior compartment of the arm
  - ✓ It passes in front of the lateral epicondyle of the humerus to enter the forearm.
- **Branches:**  
Will be mentioned later on.

# In the Arm

## ➤ Course:

- ✓ It enters the posterior compartment of the arm by passing through the lateral triangular space.
- ✓ It runs on the spiral groove of the humerus (from medial to lateral) between the medial and lateral heads of the triceps.
- ✓ At the lower part of the arm, it pierces the lateral intermuscular septum and emerges between brachialis and brachioradialis to pass a short course in the anterior compartment of the arm (on the lateral side of the cubital fossa).
- ✓ it divides into its 2 (superficial and deep) terminal branches in front of the lateral epicondyle of the humerus.

# Branches of the Radial nerve

## ➤ In the axilla:

1. Muscular branch to the long head of triceps.
2. Muscular branch to the medial head of triceps.
3. Posterior cutaneous nerve of the arm.

## ➤ In the spiral groove:

1. Muscular branch to the lateral head of triceps.
2. Muscular branch to the medial head of triceps.
3. Muscular branch to the anconeus muscle.
4. Lower lateral cutaneous nerve of the arm.
5. Posterior cutaneous nerve of the forearm.

## ➤ In the groove between brachial and brachioradialis:

1. Muscular branch to the lateral part of brachialis.
2. Muscular branch to the brachioradialis.
3. Muscular branch to the extensor carpi radialis longus.
4. Articular branch to the elbow joint.

# In the Forearm

## ➤ Course and branches:

- It runs on the lateral side of the cubital fossa.
- In front of the lateral epicondyle, it divides into superficial and deep branches.

### 1. The superficial branch of the radial nerve

- It runs under the brachioradialis muscle, on the lateral aspect of the radial artery.
- In the distal part of the forearm, it passes backward under the tendon on brachioradialis to reach the posterior surface of the hand and supplies the skin of its lateral 2/3 and the lateral 3.5 fingers (except nail beds).

## **2. The deep branch of the radial nerve**

- It arises from the radial nerve in front of the lateral epicondyle of the humerus.
- It pierces the supinator muscle, and winds around the neck of the radius (inside the supinator) to reach the posterior compartment of the forearm.
- It leaves the supinator (as the posterior interosseus nerve) and runs between the superficial and deep extensor muscles.
- **Branches of the deep branch:** muscular branches to extensor carpi radialis brevis, extensor digitorum, extensor digiti minimi, extensor carpi ulnaris and supinator.
- **Branches of the posterior interosseus nerve:** muscular branches to abductor pollicis longus, extensor pollicis brevis, extensor pollicis longus and extensor indicis and articular branches to the wrist and carpal joints.

# Injury of the Radial Nerve

# In the Axilla

## ➤ Causes:

1. Bad crutch.
2. Falling asleep with one arm over back of a chair.
3. Fracture of the proximal end of the humerus.

## ➤ Clinical findings:

1. **Paralysis:** of triceps, anconeus and all long extensor giving ***“Wrist drop” deformity.***
2. **Sensory loss:** of the posterior surface of the back of the arm, the back of the forearm, lateral 2/3 of the dorsum of the hand and lateral 3.5 finger (except nail beds).

# In the Spiral Groove

## ➤ Causes:

1. Fracture of the humerus at the spiral groove.
2. Pressure on the nerve during anesthesia.
3. Prolonged application of tourniquet.

## ➤ Clinical findings:

1. **Motor:** Paralysis of all long extensor giving *“Wrist drop” deformity.*
2. **Sensory loss** of the lateral 2/3 of the dorsum of the hand and lateral 3.5 finger (except nail beds).

# Injury of deep branch

## ➤ Causes:

1. Fracture of the distal end of the humerus.
2. Dislocation of the elbow joint.

## ➤ Clinical findings:

1. **Motor:** Paralysis of long extensor (except extensor carpi radialis longus and supinator. NO “Wrist drop” deformity.
2. NO Sensory loss.

# Injury of superficial branch

## ➤ Causes:

1. Stab wound of the nerve.

## ➤ Clinical findings:

1. **NO Motor paralysis.**
2. **Sensory loss** of the lateral 2/3 of the dorsum of the hand and lateral 3.5 finger (except nail beds).

# Musculocutaneous Nerve C5,6,7

# Musculocutaneous nerve

- **Origin:** from the lateral cord of the brachial plexus in the axilla (C5,6,7).
- **Course:** it runs downward and laterally, pierces the coracobrachialis muscle, then it passes between the biceps and brachialis and appears at the lateral margin of biceps to pierce the deep fascia and becomes superficial and descends on the lateral side of the forearm as the **lateral cutaneous nerve of the forearm**.
- **Branches:**
  1. ***Muscular branches:*** to coracobrachialis, biceps and majority of brachialis.
  2. ***Articular branches:*** to the elbow joint.
  3. ***Cutaneous branches:*** to the lateral and anterior sides of the forearm.

# Injury of musculocutaneous nerve

## ➤ Causes:

1. It is a rare case because the nerve is protected by the biceps muscle.

## ➤ Clinical findings:

1. **Motor:** Paralysis of coracobrachialis, biceps brachii and medial half of brachialis.
  - As a result flexion of the elbow will be weak and assisted by other flexors (muscle attached to medial epicondyle) and brachioradialis and extensor carpi radialis longus (in prone position)
2. **Sensory loss** of the lateral side of the fore arm.

**Median Nerve**  
**C5,6,7,8,T1**

# In Axilla and Arm

- **Origin:** By 2 roots;
  1. Lateral root from the lateral cord of the brachial plexus (C5,6,7).
  2. Medial root from the medial cord of the brachial plexus (C8,T1).
- **Course:**
  - The medial root crosses the 3<sup>rd</sup> part of the axillary artery (from medial to lateral) to join the lateral root forming the median nerve (in the axilla).
  - The nerve descends on the lateral side of the brachial artery till the middle of the arm then it crosses the artery (from lateral to medial) and continues on its medial side.
  - At its lower part, it is crossed by the bicipital aponeurosis.
  - It continues in the cubital fossa.
- **Branches:**

**No branches in the axilla and arm.**

# In Cubital Fossa and Forearm

## ➤ Course:

- In the cubital fossa, it runs on the medial side of the brachial artery.
- It descends between the 2 head of pronator teres and runs between flexor digitorum superficialis and profundus.
- Its lower part, emerges from the lateral side of the flexor digitorum superficialis and becomes superficial (or covered by palmaris longus tendon).
- It enters the hand deep to the flexor retinaculum.

## ➤ Branches:

- 1. *Muscular branches:*** to pronator teres, flexor carpi radialis, palmaris longus and flexor digitorum superficialis.
- 2. *Articular branches:*** to the elbow joint.
- 3. *Anterior interosseous nerve.***
- 4. *Palmar cutaneous branches:*** passes superficial to the flexor retinaculum and supplies skin of the lateral 2/3 of the palm.

# Anterior interosseus nerve

- **Origin:** from the median nerve as it emerges between the 2 heads of the pronator teres.
- **Course:** It descends on the interosseus membrane (with the anterior interosseus artery) between the flexor pollicis longus and flexor digitorum profundus.
- **End:** the nerve ends on the anterior surface of the carpal bones.
- **Branches:**
  1. **Muscular branches** to flexor pollicis longus, pronator quadratus and the lateral half of flexor digitorum profundus.
  2. **Articular branches** to wrist, inferior radio-ulnar and intercarpal joints.

# In the Hand

- It enters the hand deep to the flexor retinaculum (inside the carpal tunnel).
- It runs deep the palmar aponeurosis and divides to give muscular and cutaneous branches.
- **Muscular branches:** to thenar muscle (abductor pollicis brevis, flexor pollicis brevis and opponens pollicis) and the lateral 2 lumbricals.
- **Cutaneous branches:** to the palmar surface of the lateral 3.5 fingers including their nail beds.

# Injury of the Median Nerve

# At the Elbow

## ➤ Causes:

- Supracondylar fracture of the humerus.

## ➤ Clinical findings:

1. **Paralysis:** of pronator muscles, all flexors of the wrist (except flexor carpi ulnaris), all flexors of the fingers (except medial half of flexor digitorum profundus).
2. **As a result:** the forearm will be in supine position, the hand will be in extension and adduction. No flexion of the thumb, index and middle fingers, but weak flexion of ring and little fingers. Paralysis and wasting of thenar muscles giving **“Ape-like hand” deformity**.
3. **Sensory loss:** of lateral 2/3 of the palm of the hand and anterior surface of the lateral 3.5 finger (including their nail beds).
4. **Vasomotor and trophic changes.**

# At the Wrist

## ➤ Causes:

- Stab wound just above the flexor retinaculum.

## ➤ Clinical findings:

1. **Paralysis:** of thenar and lateral 2 lumbrical muscles.
2. **As a result:** the thumb is laterally rotated and abducted and can not oppose other fingers. Wasting of thenar muscles giving ***“Ape-like hand” deformity.***
3. **Sensory loss:** of, lateral 2/3 of the palm of the hand and anterior surface of the lateral 3.5 finger (including their nail beds).
4. **Vasomotor and trophic changes.**

# Carpal Tunnel Syndrome

## ➤ Causes:

- Compression on the median nerve inside the carpal tunnel due to thickening of the synovial sheath of the flexor tendons or arthritis of the carpal bones.

## ➤ Clinical findings:

1. **Sensory manifestations:** Burning, or pins and needles sensation over the anterior surface of the lateral 3.5 finger (including their nail beds).
2. **Motor manifestations:** Weakness of the thenar muscles.

## ➤ Treatment:

- Decompression of the median nerve by making a longitudinal incision through the flexor retinaculum.

# Ulnar Nerve

## C7,8,T1

# In upper part of arm

- **Origin:** from the medial cord of the brachial plexus in the axilla. It takes C7 fibers from the median nerve (through a communication between them).
- **Course:**
  - ✓ It descends on the medial side of the 3<sup>rd</sup> part of axillary artery, then upper part of brachial artery.
  - ✓ At the middle of the arm, it pierces the medial intermuscular septum and enters the posterior compartment of the arm.
  - ✓ It is accompanied by the superior ulnar collateral artery (a branch of the brachial artery).
  - ✓ It passes behind the medial epicondyle of the humerus to enter the forearm.
- **Branches:**  
**No branches in the axilla and arm.**

# In lower part of arm

## ➤ Course:

- ✓ It enters the posterior compartment of the arm by piercing the medial intermuscular septum at the middle of the arm (with the superior ulnar collateral artery).
- ✓ It descends to pass behind the medial epicondyle of the humerus.
- ✓ It enters the forearm by passing between the two heads of the flexor carpi ulnaris muscle.

## ➤ Branches:

- ✓ Articular branch to the elbow joint.

# In the forearm

## ➤ Course:

- It passes behind the medial epicondyle of the humerus, then crosses the medial collateral ligament of the elbow joint.
- It enters the anterior compartment of the forearm by passing between the 2 heads of flexor carpi ulnaris.
- It then descends vertically between the flexor carpi ulnaris and flexor digitorum profundus.
- It runs on the medial side of the ulnar artery.
- At the wrist, it becomes superficial, between the tendons of flexor carpi ulnaris and flexor digitorum superficialis.
- It enters the hand by passing superficial to the flexor retinaculum, between the pisiform (medially) and ulnar artery (laterally).

# In the forearm

## ➤ Branches:

- 1. Muscular branches:** to flexor carpi ulnaris and medial half of flexor digitorum profundus muscles.
- 2. Articular branches:** to the elbow joint.
- 3. Palmar cutaneous branches:** passes superficial to the flexor retinaculum and supplies skin of the medial 1/3 of the palm.
- 4. Dorsal cutaneous branches:** it supplies the skin of the medial 1/3 of the dorsal surface of the hand and the dorsal surface of the medial 1.5 fingers (except nail beds).

# In the hand

- It enters the hand superficial to the flexor retinaculum, between pisiform (medially) and ulnar artery (laterally).
- It then divides into superficial and deep branches.
- **Superficial branch:** supplies palmaris brevis muscles and give cutaneous innervation to palmar surface of the medial 1.5 fingers and their nail beds.
- **Deep branch:** passes through the hypothenar muscles, then turns laterally between the flexor tendons and the interossei, on the concavity of the deep palmar arch. It gives muscular branches to the 3 hypothenar muscles, all interossei, adductor pollicis and the medial 2 lumbricals.

# Injury of the Ulnar Nerve

# At the elbow

- **Causes:** fracture medial epicondyle of humerus.
- **Clinical findings:**
  1. **Paralysis:** of flexor carpi ulnaris, medial half of flexor digitorum profundus, palmaris brevis, hypothenar muscles, all interossei, medial 2 lumbricals and adductor pollicis.
    - **As a result** the patients can not abduct and adduct his fingers, adduct the thumb, and there is a **“claw hand” deformity**.
  2. **Sensory loss:** of the medial 1/3 of the palmar and dorsal surfaces of the hand and medial 1.5 fingers.
  3. **Vasomotor changes:** warming and drying of the medial 1/3 of the palmar and dorsal surfaces of the hand and medial 1.5 fingers.

# At the wrist

- **Causes:** stab or cut wound at the wrist.
- **Clinical findings:**
  1. **Paralysis:** of palmaris brevis, hypothenar muscles, all interossei, medial 2 lumbricals and adductor pollicis.
    - **As a result** the patients can not abduct and adduct his fingers, adduct the thumb, and there is a **“severe claw hand” deformity.**
  2. **Sensory loss:** of the medial 1/3 of the palm and anterior surface of the medial 1.5 fingers and their nail beds.
  3. **Vasomotor changes:** warming and drying of the medial 1/3 of the palm and anterior surface of the medial 1.5 fingers.

**THANK YOU**