Peripheral Nerve Injuries

With all courtesy to our colleagues, Raslan and his team, a lot of our work is based on their Manual to Surgery Booklet.

This lecture is exactly copied from Raslan.

- **Important**
- Mentioned by doctors but not in slides
- Additional notes from Surgical Recall 6th edition or Raslan's booklet
- Not mentioned by the doctor

431 SURGERY TEAM

Done By:

Reem Alsuwailem

Abeer Al-Suwailem

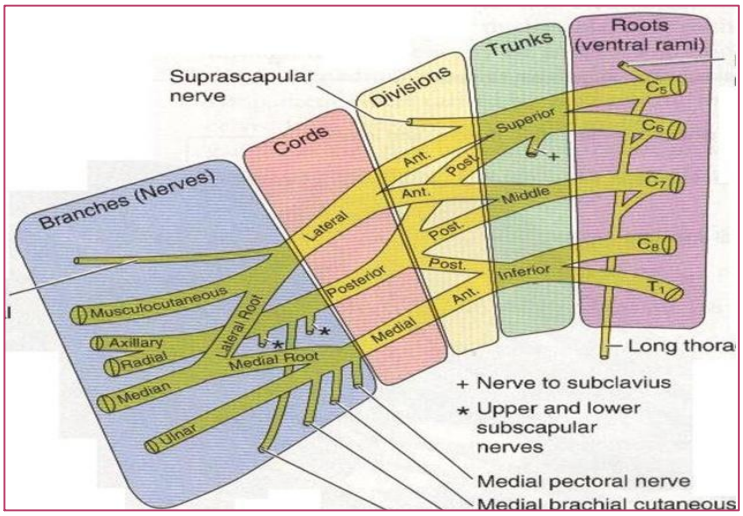
Leaders

Mohammed Alshammari

1 TYPES OF INJURIES

1.1.1 PERIPHERAL NERVE INJURIES

Axillary nerve
Musculocutaneous nerve
Median nerve
Ulnar nerve
Radial nerve



2 BRACHIAL PLEXUS INJURIES

2.1 BASIC ANATOMY

It is formed from the union of the anterior rami of the 5th,6th,7th,8th cervical and 1st thoracic nerves (C5, C6, C7,C8,T1)
The plexus is divided into **R**oots, **T**runks, **D**ivisions, **C**ords and terminal **B**ranches

2.2 CLASSIFICATION OF BRACHIAL PLEXUS INJURIES

Open injuries (stab wounds or gunshot wounds):

- Can be at any level (roots, trunks, divisions, etc.)
- Classified into:
  - **Supraclavicular** (roots, trunks, divisions)
  - **Infraclavicular** (divisions, cords, terminal branches)

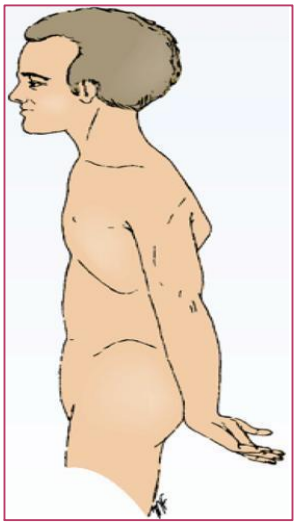
Closed injuries:

- More common than open injuries
- **Injury is most commonly at the roots level**
- Caused by car accidents, outstretching of the shoulder like when playing sports or during difficult deliveries where the baby is pulled in emergency situations

- **Examination of closed injuries: Nerves are not examined, Roots are examined by examining dermatomes (sensation) and myotomes (movement)**

Root	Dermatome	Myotome
C5	Shoulder tip + lateral arm	Shoulder abduction + external rotation
C6	Lateral forearm + thumb and index finger	Elbow flexion
C7	Middle finger	Wrist extension
C8	Ring and little finger + lower aspect of medial forearm	Making a fist
T1	Upper aspect of medial forearm + medial arm	Finger crossing

2.3 TYPES OF CLOSED BRACHIAL PLEXUS INJURIES



2.3.1 UPPER BRACHIAL PLEXUS LESION

Called **Erb's palsy (Erb-Duchenne Palsy)**
Injury to **C5, C6 and C7**
C5: loses the ability to abduct the shoulder and external rotation
C6: loses the ability to flex elbow
C7: loses the ability to extend the wrist

- **Clinically**:
  The patient will have (opposite to the normal function of the damaged nerves):
  Shoulder adduction
  Internal rotation
  Extension of the elbow
  Wrist flexion
  This is called **waiter's tip posture**

Associated injuries:

- Injury to the phrenic nerve which arises from the 3rd, 4th, and 5th cervical roots, so half of the diaphragm will be paralyzed
- In adults X-ray will show elevated hemi diaphragm
- In children the intercostals are not strong enough to compensate so the baby will have breathing problems (obstetric palsy)

2.3.2 LOWER BRACHIAL PLEXUS LESION

Called Klumpke's palsy
Injury to C8 and T1

- C8: loses the ability to make a fist
- T1: loses the ability to cross fingers

***Clinically*:** The patient will have simian hand and clawing of all fingers

Associated injuries:

- Sympathetic nerves to the face come from a branch of the first thoracic nerve T1
- If T1 is injured then sympathetic to the face are lost on one side and that will result in **Horner syndrome**, which is:
  Ptosis (dropping of the upper eyelid)

Miosis (constricted pupil)
Anhydrosis (inability to sweat)

2.3.3 TOTAL PALSY

Injury to all roots C5, C6, C7, C8, T1
Patient is unable to move entire limb: **flail limb**
Quick clinical hints:

- Upper lesion (C5, C6, C7) → Erb's palsy and phrenic nerve symptoms
- Lower lesion (C8, T1) → Klumpke's palsy and sympathetic sympto
- Total lesion (C5, C6, C7, C8, T1) → flail limb and both phrenic and sympathetic symptoms (Horner Syndrome)

3 PERIPHERAL NERVE INJURIES

3.1 AXILLARY NERVE

Isolated injuries to the Axillary nerve most commonly happens with **shoulder dislocation**
Supplies the **Deltoid** and **Teres minor** muscle
Clinical features:

- ***Motor*:**
  To the deltoid muscle so the patient will not be able to abduct his shoulder
  The patient can still initiate abduction (action of supraspinatus)
  It also supplies teres minor that does external rotation which is the same action of infraspinatus, so the patient can still externally rotate his arm
- ***Sensory***:
  Loss of sensation over the skin of the lateral arm on lower half of the deltoid

Summary: loss of abduction and **sensation** over the **lateral arm (deltoid)**

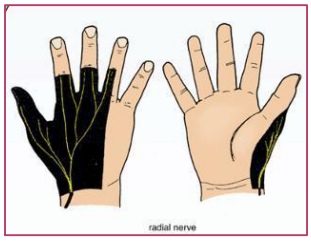
3.2 MUSCULOCUTANEOUS NERVE

Isolated injuries usually happen with stab wounds or gunshots
Supplies corachobrachilis, biceps , brachalis muscles
Clinical features:

- ***Motor:***
  Corachobrachilis and brachalis are not important clinically
  Biceps:
    Weak supination (because the supinator muscle can compensate)
    Loss of flexion
- ***Sensory:***
  Loss of sensation over the lateral forearm and the thumb

Summary: loss of elbow flexion and **sensation** over the lateral forearm + weak supination

3.3 RADIAL NERVE



Runs in the spiral groove so injuries happen in humours bone fractures

Distribution:

- Upper arm (axilla): supplies the triceps -strong extensor of the elbow
- Lower arm (above the elbow):
  - Brachioradialis
  - Extensor Carpi radialis longus – wrist extension
- Forearm:
  - Sensory branch: sensation over the three and a half fingers laterally on the dorsal side
  - Motor branch called the posterior interossous nerve: thumb and finger extension

Clinical features:

- Humours fracture in spiral groove with radial nerve injury:
  - Normal elbow (triceps is supplied higher, spared)
  - No wrist extension (drop wrist)
  - No thumb and finger extension
  - Numbness or loss of sensation
- Posterior interossous nerve injury:
  - Stab wound in the forearm
  - Elbow and wrist are normal
  - Thumb and finger extension are lost
    - Finger muscles:
      - metacarpophalengeal (MP) joints
        - Extension is by the radial nerve
        - Flexion is by the ulnar nerve by the interossie and lumbrical
      - Intraphalengeal joints (IP)
        - Extension is by the ulnar nerve by the interossie and lumbrical muscles
        - Flexion by the long flexors of the forearm

No sensory symptoms!!! Pure motor nerve

Saturday night palsy:

- Very high injury of the radial nerve due to compression of the nerve in the axilla
- Everything is affected (wrist, elbow, fingers, thumb and sensation)
- Called like this because drunk people sleep with an arm behind the chair that causes the compression

Summary:

- Remember where the lesion happened
- Injury to the radial nerve in the axilla: all motor and sensory functions are lost
- Injury to the nerve in the spiral groove: triceps is spared and everything else is lost
- Injury in the forearm to the posterior interossous nerve: elbow, wrist and sensation are normal.

3.4 FOREARM

3.4.1 MUSCLES

5 superficial muscles:

- Pronator teres pronation of the forearm
- Flexor carpi radialis wrist flexion
- Palmaris longus → wrist flexion
- Flexor carpi ulnaris → wrist flexion
- Flexor digitorum superficialis → flexion of the proximal Intraphalengeal joints (PIP) so flexes the middle phalynx

3 deep muscles:

- Flexor digitorum profundus
- Flexor pollicis longus
- Pronotor quadrates

3.4.2 NERVE SUPPLY

All of these muscles are supplied by the median nerve except 1 and a half are supplied by the ulnar nerve:

- Flexor carpi ulnaris
- Half of flexor digitorum profundus to the little and ring finger

The median nerve has 2 branches

- Superficial which supplies the superficial group
- Deep (anterior interossous nerve) which supplies the deep 2 and a half muscles (PURE MOTOR)

3.4.3 HAND MUSCLES

Hypothenar: opposition of the little finger
Thenar: opposition of thumb + adduction of the thumb (adductor pollicis)
Interossie: abduction and adduction of the fingers + MP flexion + IP extension
Lumbricals: MP flexion + IP extension

3.4.4 NERVE SUPPLY

The hand has 20 muscles

- 15 supplied by the ulnar nerve (3 hypothenar + 8 interossei (dorsal and palmar) + 2 lumbricals + adductor pollicis + Palmaris brevis)
- 5 by the median nerve (3 thenar + 2 lumbricals (1st and 2nd)

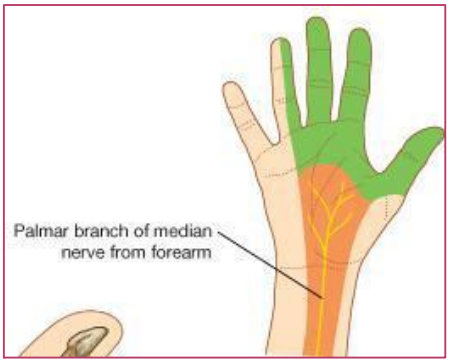
All the actions are from the ulnar nerve except 2 are from the median nerve:

- Opposition of the thumb
- Index and middle lumbricals

3.5 MEDIAN NERVE

Motor:

- Superficial flexors except flexor carpi ulnaris
- Deep flexors except half of flexor digitorum profundus to little and ring finger
- Thenar muscles



- Index and middle lumbricals

Sensory: lateral 3 and a half fingers on the palmer side

Clinically:

- Anterior interosseous nerve injury:

Affects the deep 2 and half muscles:

Half of Flexor digitorum profundus

Flexor pollicis longus

Pronotor quadrates (pronation is not lost because of pronator teres)

Sign: the patient "cannot make a perfect O" with the thumb, index and middle fingers because he can't flex the tips of index and middle finger (DIP joint: this is the action of the flexor digitorum profundus muscle)

- **Median nerve injury at level of wrist:**
  - Common in patients who attempt suicide
  - Loss of opposition
  - Loss of sensation 3 and a half lateral
  - Lumbricals are lost but interossie do the job
  - They still can make an "o", bend the wrist and flex the PIP
- Carpal tunnel syndrome:
  - Loss of sensation first
  - If untreated weakness of opposition
- **Summary**:
  - Injury to median nerve at level of the wrist: loss of opposition and loss of sensation
  - Injury to anterior interosseous branch of median nerve: patient cannot make an O + normal sensation

3.6 ULNAR NERVE

- ***Motor:***
  - Flexor carpi ulnaris
  - Medial half of flexor digitorum profundus
  - Lumbricals + interossie + hypothenar + adductor pollicis
- ***Sensory:*** medial 1 and a half fingers front and back of the hand
- ***Clinically:***
  - Ulnar nerve injury:

loss of flexor carpi ulnaris and half of flexor digitorum profundus

loss of sensation

all of the hand muscles

cannot oppose the little finger

atrophy of hypothenar muscles

Cannot adduct or abduct the fingers

Ends up with ulnar **claw hand**

  - Ulnar nerve injury at the wrist:
    - Sensation is lost
    - All hand muscles:

* Hypothenar atrophy

* No opposition of the little finger

* Cannot adduct or abduct the fingers

- Loss of thumb adduction resulting in froment's sign
- Froment's sign: you ask the patient to hold a pen with his thumb but he cannot so he contracts the flexor pollicis longus because the adductor pollicis is lost

Summary of ulnar nerve injury:

- Ulnar claw
- Loss of sensation
- Hypothenar atrophy
- Positive froment's sign
- Cannot adduct or abduct the fingers

3.7 MEDIAN AND ULNAR NERVE INJURY AT THE WRIST

- Loss of intrinsic muscles
- Loss of sensation
- Clawing of all the fingers = ape hand (semian hand) * we can see it also in Klumpke's palsy

3.8 FEMUR AND SCIATIC NERVE INJURY

- Femur Nerve
  - Quadriceps Extension

- Sciatic Nerve

Upper femur fracture and hip fracture causes sciatic nerve injury.

  - Posterior tibial nerve
    - Sensory → sole of the foot
    - Motor → Flexion of the ankle and the toe

Clinically:

- Laceration of the medial malleolus
  - Loss of flexion of the ankle and toe
  - Loss of sensation of the sole of the foot (more serious b/c its where you step on)

  - Common peroneal nerve

Go around the nick of the fibula and supplies the lateral and anterior part of the leg

    - Sensory → dorsum of the foot
    - Motor → Extension of the ankle and the toe

Clinically:

- Fracture of the neck of the fibula
- Posture (sitting in a certain way for a long time)
  - Foot Drop

MCQS

1. **Erb's palsy:**
   a. C5 and C6
   b. C7 alone
   c. C8 and T1
   d. Total palsy
   e. Lower brachial plexus injury
2. **The abductor pollicis longus muscle is supplied by:**
   a. Median nerve
   b. Ulnar nerve
   c. Anterior interosseous nerve
   d. Radial nerve
   e. Axillary nerve
3. **The main action of the C6 root of the brachial plexus is:**
   a. Making a fist
   b. Crossing the fingers
   c. Elbow flexion
   d. Wrist extension
   e. Elbow extension
4. **The intrinsic muscles of the hand are supplied by:**
   a. C5
   b. C6
   c. C7
   d. C8
   e. T1
5. **Klumpke's palsy has all the following characteristics except:**
   a. Can result from motor cycle injury
   b. Anhidrosis
   c. Loss of dermatomes
   d. Phrenic nerve palsy
   e. Miosis
6. **A patient with posterior interosseous nerve palsy:**
   a. Unable to extend his wrist.
   b. Can extend the IPJs of the fingers.
   c. Can extend the MPJs of the fingers.
   d. The sensation over the radial half of the hand is lost.
   e. None of the above.

7. **Lateral cutaneous nerve of the forearm is a branch of which nerve:**
    a. Axillary
    b. Radial
    c. Musclocutaneous
    d. Ulnar
    e. None of the above
8. **in a patient with anterior interossous nerve palsy, what is false:**
    a. Can pronate the forearm
    b. Can flex the PIP of the index
    c. Have positive O sign
    d. Can flex the IPJ of the thumb
    e. All of the above are true

9. **After nerve injury, nerve recovery is at rate of:**
    a. 1 mm/day
    b. 2 mm/day
    c. 3 mm/day
    d. 4 mm/day
    e. 5 mm/day

ANSWER YES OR NO

1. **A patient cut his median nerve at the wrist:**
    a. Has he lost opposition of the thumb?
    b. Has he lost any sensation?
    c. Can he flex the tip of the index finger?
2. **A patient is known to have "Saturday night palsy" is there Loss of supination?**
3. **Can a patient with erb's palsy also have phrenic nerve palsy?**
4. **A patient has klumpke's palsy:**
    a. C5, c6, and c7 are completely intact?
    b. Only c8 or T1 are injured?
    c. Can move his shoulder, the elbow and the wrist?
    d. Can't make a fist?
    e. Can use his intrinsic muscles of the hand?
    f. Will have clewing of all fingers "simian hand"?
    g. Can have phrenic nerve palsy?
    h. Can have Horner's syndrome?
5. **patient has cut his median nerve at the level of his arm:**
    a. Can he flex his wrist?
    b. The patient will flex more in the radial deviation?
    c. Is the FDS completely paralyzed?
    d. Is the FDP completely paralyzed?
    e. Is there sensory loss?
    f. Can he still oppose his thumb?

g. Can he flex the tip of the thumb?
h. Can he flex the tip of the index finger?
i. Can he flex the tip of the little finger?
j. Can he flex the PIP of the little finger?
k. Does he have sensation of the volar aspect of the little finger?
l. Does he have sensation of the volar aspect of the thumb?
m. Can he flex the tip of the ring finger?
n. Can he flex the PIP joint of the ring finger?
o. Can he flex the PIP joint of the index finger?

6. **Can a patient with erb's palsy also have horner's syndrome?**
7. **Patient comes with a stab wound to the axilla which cut his radial nerve:**
    a. He's unable to extend his elbow
    b. He can extend the wrist
    c. He's unable to extend and radially abduct the thumb
    d. He's unable to extent the MP joints of the finger
    e. He will have wrist drop
    f. Can he extend the IP joints of the fingers
8. **Patient presents with superficial radial nerve injury (cut in the mid forearm) will only have sensory loss?**
9. **Patient presents with posterior interosseous nerve injury:**
    a. His triceps is paralyzed.
    b. He has loss of sensation over the dorsum of the thumb.
    c. He is unable to extend the elbow.
    d. Can he extend the wrist?
    e. Can he extend the thumb?
    f. His supinator muscle is paralyzed.
    g. Can he supinate the forearm?
    h. Will thumb radial abduction be lost?
    i. Will MP joint extension be lost?
    j. Will IP joint extension be lost?
    k. Can he extend the IP joint of the little finger?
    l. Is there loss of sensation?
10. **Can a patient with erb's palsy make a good fist?**
11. **A patient comes to the clinic with isolated axillary nerve injury.**
    a. Clinical examination is mainly the teres minor.
    b. He will not be able to initiate abduction.
    c. He will not be able to externally rotate.
12. **Patient has paralysis of the extensor digitorum:**
    a. Can he extend the IP joint of the thumb?
    b. Can he extend the IP joint of the index?
13. **Clinically, only two things are important when it comes to musclocutaneous nerve injury: biceps and lateral cutaneous nerve of the forearm.**
14. **A patient with injury to roots C5, C6, and C7:**
    a. Can't abduct or external rotate, so he will go into adduction internal rotation.
    b. Can't flex the elbow, so he will go into extension.
    c. Can extend the wrist.
    d. Will have complete claw hand.

4.2 TRUE OR FALSE

1. **Patient presents with injury to the anterior interosseous nerve:**
    a. Patient lost sensation at the tip of the thumb
    b. Patient lost sensation in the palm of the thumb.
    c. Patient's sensation is normal.
    d. Patient's pronation is normal.
    e. Patient cannot flex his wrist.
    f. Patient cannot oppose the thumb.
    g. Patient can flex the MP joint of the thumb.
    h. Patient can flex the IP joint of the thumb
    i. Patient can flex the tip of the index.
    j. Patient can adduct the thumb.
    k. Patient can flex the PIP joint of the index.
    l. Patient can flex the tip of the thumb.
    m. Patient can pronate the forearm.
    n. Patient cannot make a perfect O.
    o. Patient has no sensory loss in the hand.
    p. Patient cannot flex the little finger.
    q. Patient can flex the MP joint of the index finger.
    r. Patient cannot flex the PIP joint of the index finger.
    s. Patient can flex the tips of the index and middle fingers
2. **Patient who has cut his posterior interosseous nerve cannot supinate?**
3. **Patient cut his ulnar nerve at the wrist:**
    a. He can feel the back of his little finger
    b. He can flex his wrist
    c. He can flex the wrist in ulnar and radial deviation
    d. He cannot flex the tip of the index finger.
    e. He can flex the tip of the little finger.
    f. He can flex the PIP joint of the little finger.
    g. He can feel the palmar surface of the little finger.
    h. He can feel the dorsal surface of the little finger.
4. **Patient cut his median nerve at the level of his elbow:**
    a. He had lost the ability to oppose the thumb.
    b. He has sensory loss.
    c. He is still able to flex his wrist.
    d. Thumb tip flexion is normal.
    e. Pronation is lost.
5. **Complete loss of the ulnar nerve:**
    a. The caused by cutting the ulnar nerve at the wrist
    b. Is caused by cutting the ulnar nerve in the arm
    c. Loss of wrist flexion.
    d. Can't flex the wrist in ulnar deviation
    e. Can flex the tips of the fingers.
    f. Inability to flex the tips of the ring and little fingers.
    g. Able to flex the IP joints of the fingers
    h. There's no sensory loss.
    i. Can feel the back of the hand.
    j. Can't feel the the hand. of

k. Able to oppose the thumb and the little finger.
l. Is able to adduct and oppose the little finger.
m. Will have Froment's sign.
n. Is able to adduct and abduct the fingers.
o. Is able to flex the PIP joints of the little finger

6. **A patient cut his ulnar nerve in the mid-forearm:**
   a. He can feel the back of his hand.
   b. He can feel the front of his hand.
   c. He can adduct and abduct the fingers.
   d. He can adduct the thumb,
   e. He has Froment's sign.
   f. He cannot oppose the little finger.
   g. He cannot oppose the thumb.

MCQs: 1=a, 2=d, 3=c, 4=e, 5=d, 6=b, 7=c, 8=d, 9=a

Yes/No:

1= (a) yes, (b) yes, (c) yes
2= no
3= yes
4= (a) yes, (b) no, (c) yes, (d) yes, (e) no, (f) yes, (g) no, (h) yes
5= (a) yes, (b) no, (c) yes, (d) no, (e) yes, (f) no, (g) no, (h) no, (i) yes, (j) yes, (k) yes, (l) no, (m) yes, (n) yes, (o) no
6= no
7= (a) yes, (b) no, (c) yes, (d) no, (e) yes, (f) yes
8= yes
9= (a) no, (b) no, (c) no, (d) yes, (e) no, (f) yes, (g) yes, (h) yes, (i) yes, (j) no, (k) yes, (l) no
10= yes
11= (a) no, (b) no, he will be able to initiate abduction, (c) no, he will be able to externally rotate the arm
12= (a) yes, (b) yes
13= yes
14= (a) yes, (b) yes, (c) no, (d) no

True/False:

1= (a) F, (b) F, (c) T, (d) T, (e) F, (f) F, (g) T, (h) F, (i) F, (j) T, (k) T, (l) F, (m) T, (n) T, (o) T, (p) F, (q) T, (r) F, (s) F
2= F
3= (a) T, (b) T, (c) T, (d) F, (e) T, (f) T, (g) F, (h) T
4= (a) T, (b) T, (c) T, (d) F, (e) T
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6= (a) F, (b) F, (c) F, (d) F, (e) T, (f) T, (g) F