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## UNIT 1 PERIPHERAL NERVE INJURIES

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### 1.0 OBJECTIVES

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In a case of peripheral nerve palsy, you should be able to:

- Elicit a proper history to identify the peripheral nerve palsy and the cause of it's involvement, as well as the disability resulting from it.
- Undertake proper sequence of clinical examination and perform specific clinical tests pertaining to the peripheral nerve.
- Diagnose the peripheral nerve palsy and the level of injury or involvement of radial (very high, high or low level) and ulnar nerves (low or high level).
- Suggest appropriate investigations.
- Identify splints used in different peripheral nerve palsies.

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## 1.1 INTRODUCTION

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Peripheral nerve diseases may occur even in the elderly and may interfere with normal daily activities. Lower extremity nerve impairment may lead to increased risk of fall while upper extremity nerve palsy may result in poor quality of life.

Nerve palsy may be due to peripheral nerve injuries as a result of trauma, sharp cuts and lacerations causing or stretching of nerves due to fractures and dislocations. Nerve palsy may be non-traumatic due to Hansen's disease or even due to toxic drugs from injection palsy.

In a clinical case of nerve palsy, the relevant history and clinical examination is important for the diagnosis as well as the prognosis.

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## 1.2 HISTORY TAKING

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- **Pain:** It is the most common complaint following any event of injury. It should be studied under the headings of
  - o Site, onset, character, duration, radiation to any nearby joints, progression, severity, associated and relieving factors and any precipitating factors if associated.
- **Onset of symptoms:**
  - sudden onset (compression neuropathy, Saturday night palsy)
  - gradual onset (carpal tunnel syndrome, Hansen's disease)
- **Site:** Unilateral (usually injuries) and bilateral (Guillain Barre Syndrome) involvement of nerves may occur. The site and part affected of upper or lower extremity needs to be ascertained.
- **Loss of function:** The patient presents with complains such as inability to do certain actions and can also affect the activities of daily living. All the functions that have any problems should be enquired about and the conclusion carried out accordingly. eg holding a glass of water (claw hand), unable to lift his wrist and fingers (wrist drop, finger drop). Thus the loss of function may be due to :
  - o **Weakness:** Motor weakness may lead to clumsy actions, dropping objects while holding by upper extremity, clumsy gait or unable to walk or slippage of footwear
  - o **Sensory loss:** Loss of sensation in the prehensile grasp area due to median nerve injury and and trophic ulcers in sciatic nerve injury may be disabling along with the motor weakness.
  - o **Deformity:** Claw hand deformity due to ulnar or combined median and ulnar nerve palsy.

**NEGATIVE HISTORY:** To rule out the various causes of nerve palsy relevant negative history need to be elicited, which include:

Anaesthetic patches over the back (Hanson's disease), trauma (fibular neck fracture, tibial condyle fracture, compartment syndrome), injections (injection palsy may not be due to direct trauma from needle rather due to the toxic drugs injected in the vicinity of the nerve), tumour (example exostoses around proximal fibula), iatrogenic following surgery (acetabular fracture, discectomy), low back pain (disc prolapse), exposure to paints, working in ship yard (lead poisoning-motor neuropathy), diabetes mellitus (mononeuropathy), alcoholism, use of axillary crutches (Saturday night palsy), sitting cross legged, vitamin deficiency – beriberi, heavy metal poisoning (arsenic, antimony mixed neuropathy with more involvement of the lower extremity), drugs (isoniazide, streptomycin, ethambutol, vincristine, cisplatin), poisoning, motor neuron disease (fasciculation's with muscle weakness), Guillain Barre Syndrome (ascending weakness usually bilateral).

**Occupation History:** Agriculture (Leprosy), shipyard (lead poisoning)

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## 1.3 CLINICAL EXAMINATION

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The clinical examination includes inspection or looking at the involved extremity, palpation or having a feel and a relevant neurological assessment of the motor function and sensory impairment along with special tests for peripheral nerves.

### 1.3.1 Inspection

On inspection, the attitude of the limb, the wasting of muscles, skin changes due to sensory loss should be looked for along with gait abnormalities in case of lower limb involvement.

#### Attitude of the limb

Nerve involvement in the **upper limb** may result in typical attitude of the limb. Hence the attitude of the limb at different joints starting with the level of both shoulders, position of the elbow, wrist and fingers should be assessed. For example:

**Radial Nerve Palsy** – there would be a **wrist drop** with the wrist in 90° palmar flexion, fingers in 45° flexion. Whereas a **low radial or posterior interosseous nerve palsy** would result only in finger drop not wrist drop.

**Median nerve palsy** - the thumb would be lying in the same plane as rest of the fingers (**ape thumb**), instead of the thumb being at right angle to the plane of other fingers when kept in anatomical position.

**Ulnar nerve palsy** – clawing of little and ring fingers (**intrinsic minus position**) may be visible with the attitude of hyperextension of the metacarpo-phalangeal (MCP) joints and flexion of the inter-phalangeal (IP) joint.

**Common peroneal nerve palsy** – **foot drop** may be seen with an attitude of equinus.



**Fig.1.1(A):** Wrist drop on the right side and dorsiflexed wrist on the left.



**Fig.1.1(B):** Ape thumb (thumb on left side lying in the same plane as rest of the fingers) with wasting of thenar eminence

- **Wasting of muscles :**

**Radial nerve** - wasting of forearm extensor muscles

**Median nerve** – wasting of thenar and hypothenar eminence

**Ulnar nerve** - wasting of intrinsic muscles of hand

**Axillary Nerve** – wasting of the deltoid with loss of rounded shoulder contour

**Sciatic nerve palsy** - wasting of thigh (hamstring) and calf muscles



**Fig.1.2A:** Wasting of the first dorsal interosseus muscle in ulnar nerve palsy



**Fig.1.2B:** Wasting of deltoid in axillary nerve paralysis with loss of round contour of shoulder

- **Skin:**

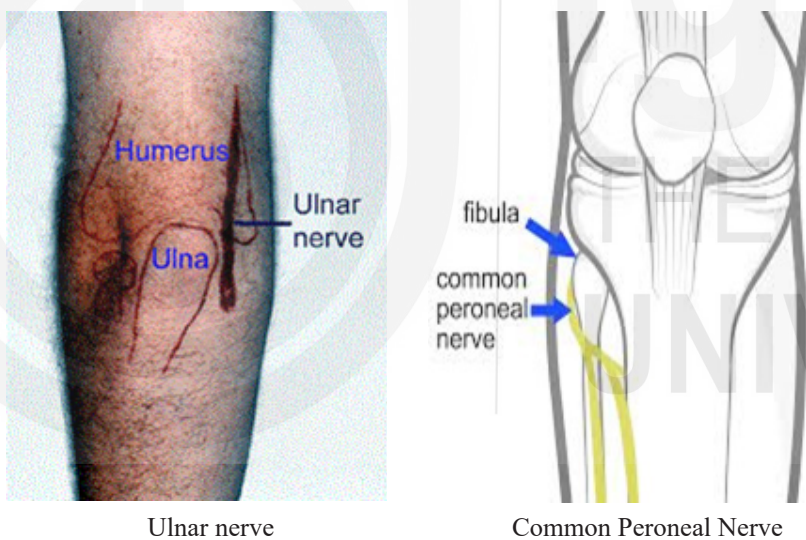
- Look for trophic ulcers, dryness of skin, brittle nails, loss of hairs in the sensory distribution of the nerve
- Any scars of injury

- **Gait:**High stepping (classically described for tabes dorsalis) or circumduction gait may be seen in common peroneal nerve palsy.

### 1.3.2 Palpation

The usual sequence of palpation is done to check for:

1. Any Local rise in **temperature** (usually cold compared to opposite limb)
2. **Tenderness**-superficial and deep
3. **Muscle Bulk** (compared to normal side)
4. **Tone** (suppleness of the muscle compared to normal site)
5. **Nerve** - Some of the peripheral nerves which are superficial at certain sites should be palpated to assess for any **tenderness, thickening or beading or rarely nerve abscess**. In cases of Hansen's disease the ulnar nerve, behind the medial epicondyle in elbow and the common peroneal nerve around the neck of fibula may be involved.
6. **Tinel sign**- The peripheral nerve should be gently tapped by a finger along it's course from distal to proximal level. In a positive Tinel sign, there is tingling and parasthesia along the course of the nerve, distal to the point at which it is tapped by the finger. This is a sign of nerve regeneration and recovery. A progressive Tinel sign over a course of few weeks is significant to clinically assess nerve recovery before motor or sensory recovery occurs.



**Fig.1.3: Palpate for thickening of neve in Hansen's disease behind**

**A: Ulnar nerve behind medial epicondyle of humerus and**

**B: Common Peroneal Nerve behind the Neck of Fibula**

**Note :**

On History taking: Irritability of ulnar nerve may occur in neuritis, with twitches and shooting pain. This may occur in tardy ulnar nerve palsy in cubitus valgus deformity.

### 1.3.3 Muscle Involvement

The muscles supplied by the peripheral nerve should be assessed. While checking the muscle power the belly of the muscle or the tendon should be

**Miscellaneous  
Practicals**

palpated to confirm that the particular muscle being tested is contracting. This is necessary to assess Grade 1 muscle power. It is advisable to know the MRC grading of muscle power testing. Sometimes during paresis or paralysis of a muscle, patient may use other muscles and perform a trick movement hence it is important to ensure that the muscle being tested is palpated.

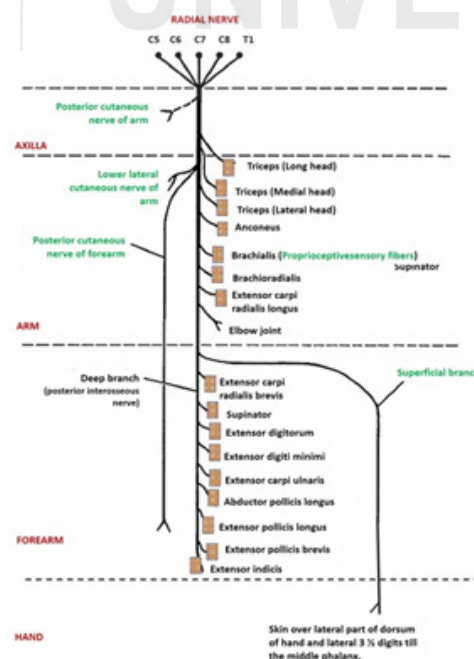
Muscle Power {Grading is 0 – no contraction, 1 – flicker of contraction, 2-contraction with gravity

eliminated, 3-against gravity, 4-with slight resistance, 5-full resistance}

- Grade 0: no contraction
  - Grade 1: flicker or trace of contraction
  - Grade 2: active movement with gravity eliminated
  - Grade 3: active movement against gravity
  - Grade 4: active movement against gravity and resistance
  - Grade 5: normal power
- Commonly Grade 4 is divided into 4–, 4 and 4+, denoting severe, moderate and mild weakness, and some use 5– to signify minimal weakness.

**Fig.1.4 : Medical Research Council (MRC) grading of muscle power**

The innervation of the muscles supplied by the peripheral nerves is useful to diagnose the level of the nerve injury. For example, the **Radial Nerve** supplies triceps, anconeus, brachialis, brachioradialis, supinator, extensor group of forearm muscles (ECRL and ECRB) and finger extensors (Abductor pollicis longus, Extensor pollicis brevis, extensor digitorum) and radial nerve palsy at the level of the mid-arm would lead to a **wrist drop** and a lesion more proximal (very high radial nerve palsy) would lead to triceps weakness as well. A low radial nerve injury to its branch the **posterior interosseous nerve (PIN)** would permit wrist dorsiflexion but not finger extension.



**Fig.1.5: Muscles and skin supplied by different branches of radial nerve**

In case of Median Nerve, the muscles supplied in the forearm are pronator teres, Flexor carpi radialis, Palmaris longus, Flexor digitorum superficialis, Flexor digitorum profundus, Flexor pollicis longus, Pronator quadratus and lateral half of Flexor digitorum profundus. In the hand, the muscles supplied are Abductor pollicis brevis, Flexor pollicis brevis, Middle and index lumbricals. (Note : The sensation to radial 3 and a half fingers should be checked).

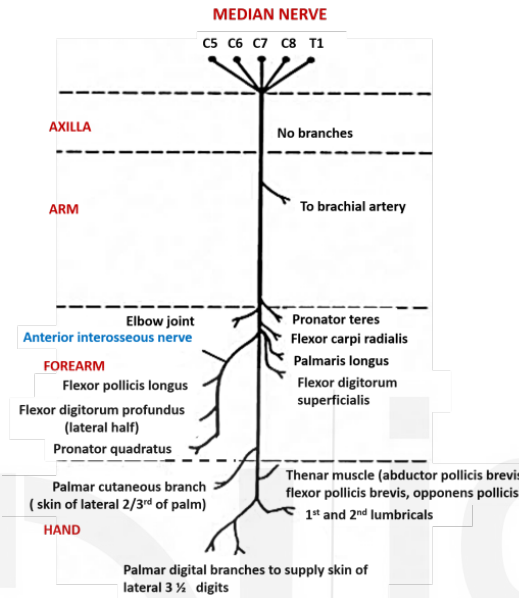


Fig.1.6: Muscles and skin supplied by different branches of the median nerve.

The Ulnar Nerve does not supply any muscle in the arm, at the elbow it sends a sensory branch to the joint. It supplies the Flexor carpi ulnaris, medial half of Flexor digitorum profundus, hypothenar muscles, dorsal and palmar interossei, medial 2 lumbricals, and Adductor pollicis. (Note : The sensation to volar aspect of little finger, medial half of ring finger, should be checked).

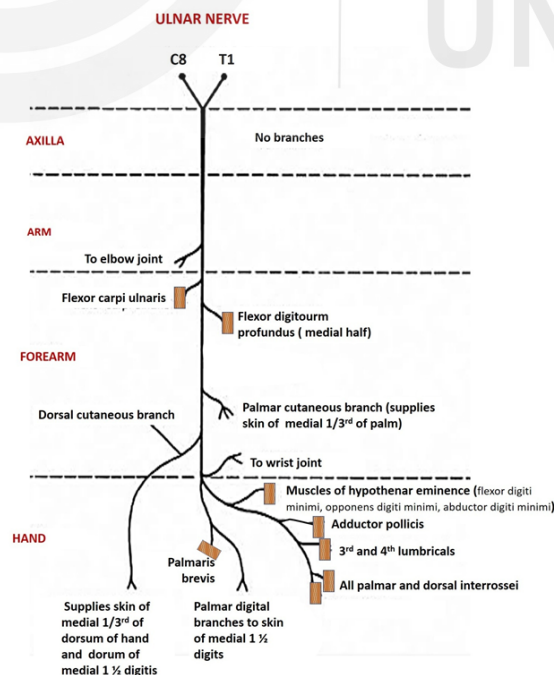


Fig.1.7: Muscles and skin supplied by different branches of the ulnar nerve.

### 1.3.4 Sensory Examination

The following modalities of sensation should be checked.

1. **Tactile sensation**-Pain sensations (by a blunt pin), light touch (by a wisp of cotton or wool), pressure by finger, 2 point discrimination (by a compass)
2. **Deep pain**
3. **Temperature**- Test tubes with hot and cold water may be used. The cold metallic part of a knee hammer may be used in winters.
4. **Vibration**-A tuning fork 256 Hertz should be kept on a bony prominence of the limb to detect the vibration sensation after striking the tuning fork.
5. **Proprioception**- The joint position should be checked after obstructing the vision of the patient or keeping his eyes closed. eyes while the patient responds whether joint is flexed or extended (as shown in the video of spine examination)
6. **Stereognosis**-Patient should be asked to identify an object by it's shape and size (eg: key chain, pen) with the eyes closed.

### 1.3.5 Reflexes

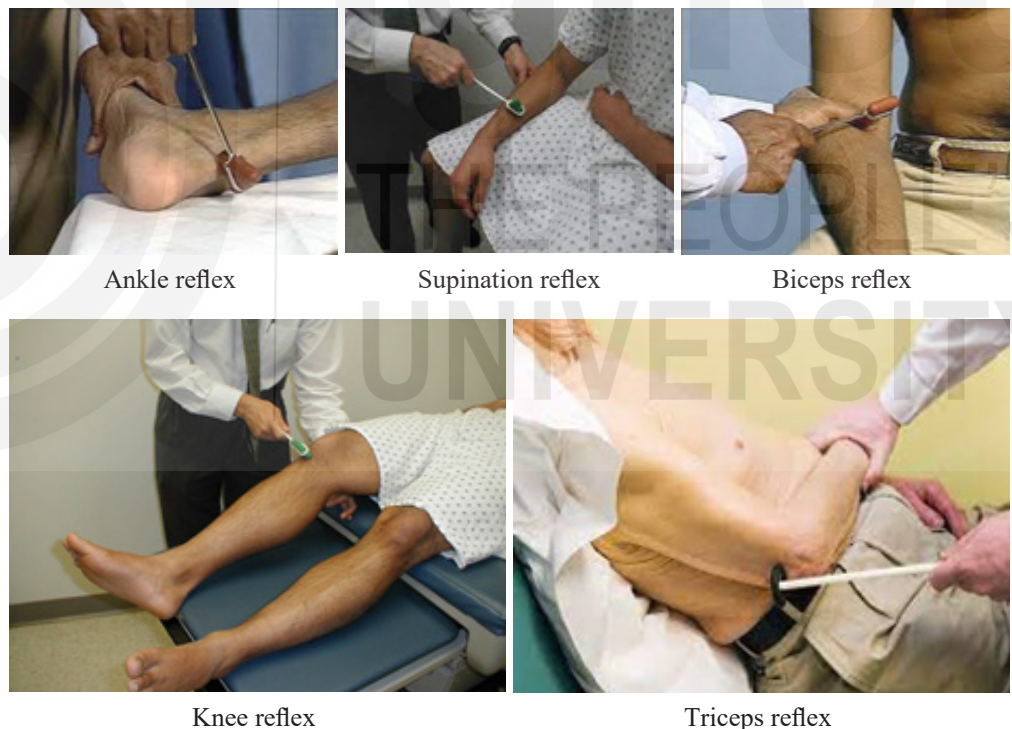


Fig.1.8:Deep tendon reflexes

### 1.3.6 Vasomotor Examination

Starch –iodine test(sweat test) or wrinkle test is performed to check for presence of wrinkles after soaking the part in water for assessment of the sympathetic function.

### 1.3.7 Movements

Active and Passive Movements- Complete range of motion of all joints, active and passive, of the involved extremity should be done in nerve palsy. The passive movements of the joints may be done by the examiner to check for joint suppleness and ensure there are no soft tissue contractures or joint deformities before the patient is asked to perform active movements.

### 1.3.8 Measurements

Linear: Length of particular limb, total and segmental measurement

Limb Circumference:-To know the wasting of muscles

### 1.3.9 Special Tests and Sequence of Assessment

**Radial Nerve: -**

To assess the level of the radial nerve palsy, check for the following muscles:

- extensor digitorum communis (EDC) by extension of metacarpophalangeal(MCP) joint of fingers
- extensor carpi radialis longus and brevis (ECRL & ECRB) by extension of the wrist
- brachioradialis by extension of flexed elbow kept in mid prone position and palpating the contraction of muscle belly of brachioradialis
- triceps by extension of the elbow

In a **low radial nerve or posterior interosseous nerve (PIN)** palsy only the finger and thumb extensors are paralyzed, the wrist can dorsiflex.

In a **high radial nerve palsy** the wrist dorsiflexors along with brachioradialis muscle is paralyzed.

In a very high radial nerve palsy, the triceps muscle is also paralyzed.

#### Significance of thumb and finger paralysis

To differentiate between radial nerve or PIN palsy, a simple screening test of extension of thumb can be performed. Normally with intact radial nerve and intact PIN, patient can extend the thumb, hitch hiker sign. A patient of PIN palsy will be unable to do hitch hiker sign or even extend the other fingers but will be able to dorsiflex the wrist. In a radial nerve palsy patient will be unable to even do the wrist extension.



Fig.1.9: Unable to perform Hitchhiker's sign in PIN and radial nerve palsy

### Significance of Brachioradialis

The brachioradialis muscle is supplied by the radial nerve proximal to the elbow joint at the distal fourth of the humerus. While testing the muscle power of the brachioradialis with elbow flexion in mid prone position, contraction of muscle belly of brachioradialis should be confirmed by palpating it.

The level of the radial nerve injury can be determined by the brachioradialis, which is intact in a low radial nerve palsy and lost it is a high radial nerve palsy.

In a recovering radial nerve palsy, brachioradialis is the first muscle to recover in case of axonotmesis. The recovery occurs at the rate of 1 mm. per day after a 3 weeks delay due to Wallerian degeneration.

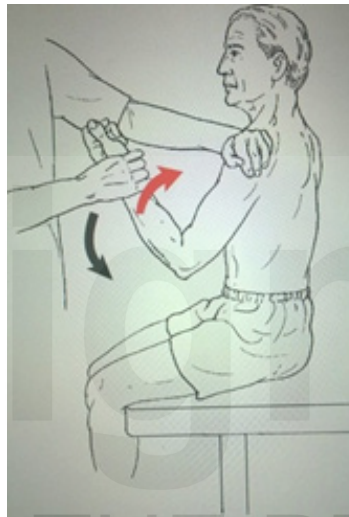


Fig. 1.10: Assessment of Brachioradialis

#### Check Your Progress 1

1. How to differentiate between very high, high and low radial nerve palsy?

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To differentiate between a high ulnar and a low ulnar nerve palsy the Flexor digitorum profundus of ring and little fingers and Flexor carpi ulnaris muscles are tested. These muscles are supplied by the ulnar nerve at the proximal forearm, hence if they are paralyzed it is a high ulnar palsy while they would be intact in a low ulnar palsy.

The **Ulnar paradox** is thus explained by **increased clawing of ring and little fingers in a low ulnar** nerve palsy since the flexor digitorum profundus (FDP) of ring and little finger are intact. On the other hand, a high ulnar nerve lesion causes a paralysis of the FDP resulting in less degree of ulnar claw hand deformity.

**Froments sign (Book Test):** The first palmar interossei and adductor pollicis are required to hold a book between the thumb and the hand. In ulnar nerve

paralysis, these muscles are paralyzed and the patient relies on Flexor pollicis longus to hold the book by flexing the thumb.

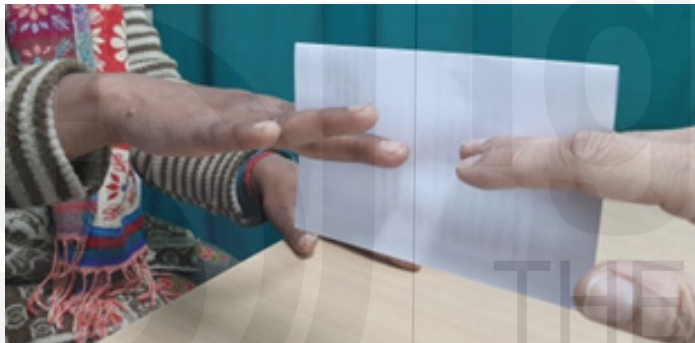


**Fig.1.11A: Book Test: Normal holding of book by adductor pollicis**



**Fig.1.11B: Ulnar nerve palsy – use of flexor pollicis longus (supplied by median nerve) as a compensatory mechanism to hold the book**

**Card test :-** loss of adduction due to paralysis of palmar interossei supplied by ulnar nerve causes the card to pulled out.



**Fig.1.12: Card Test**

**Egawa Test:-** Keeping the palm on a table the middle finger is moved on either side. It is not possible in ulnar nerve paralysis due to weakness of dorsal interossei.

**Median Nerve: -**

**Pen Test: -** Unable to touch the pen due to weakness of abductor pollicis brevis



**Fig.1.13 : Pen Test for abductor pollicis longus (median nerve)**

**Pointing Index (Oschner Clasp Test)** Long flexors of middle and index supplied by median nerve fail to flex when both hands clasped together.



**Fig.1.14: Pointing index (Oschner Clasp Test for Median Nerve)**

**Axillary Nerve:** Deltoid paralysis causes loss of shoulder abduction with wasting of contour of deltoid and sensory loss at regimental patch area.



**Fig.1.15: Axillary Nerve Palsy -Loss of Shoulder Abduction**

### **Common Peroneal Nerve**

There is a loss of sensation on lateral border of foot along and first web space.

Motor paralysis is foot drop due to loss of dorsiflexion of foot. Plantar flexion is possible.

### **Sciatic Nerve**

There is a complete loss of sensation around foot except medial border till ball of great toe (supplied by saphenous nerve).

The motor paralysis includes a complete foot drop with loss of both planter and dorsiflexors of foot.

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## 1.4 DIAGNOSIS

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The diagnosis of a nerve palsy should include the anatomical, etio-pathological and type and extent of nerve involvement or damage.

Anatomical –Identify the peripheral nerve and the level of injury (high or low)

Etio-pathological – Trauma, tumor, tuberculosis, diabetic neuropathy, Hansens’s disease or any other cause.

Type of nerve involvement-In cases of nerve injury is it neurapraxia, axonotmesis or neurotmesis, or is it compressive neuropathy.

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## 1.5 INVESTIGATIONS

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- **Electro Diagnostic Studies**

**Nerve Conduction Study**including the nerve conduction velocities (NCV), the chronaxie and rheobase of the strength duration curve.

**Electromyography**of the muscles supplied by the nerves and identify denervation and re-innervation patterns.

- Diagnostic tests : for leprosy- nasal scrapings, ear lobe biopsy, blood levels for lead, Vit B12 levels.
- Routine investigations - Hemogram

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## 1.6 SPLINTS

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Various orthotic devices (splints) are used to prevent contractures resulting from peripheral nerve paralysis. *Pictures of the splints are given in the chapter of orthosis.*

In radial nerve paralysis, **for wrist drop, a cock up splint** is used, which may be static or dynamic.

In **ulnar nerve paralysis, a knuckle bender splint** is used to change the position of an intrinsic minus hand to an intrinsic plus hand (Keeping the MCP joints at 90 degree flexion and IP joints in full extension.

In **median nerve palsy, an opponens splint** is used to maintain the thumb in abduction.

In **common peroneal nerve palsy, a foot drop splint** is used to prevent equinus.

### Check Your Progress 2

1. What is Ulnar Paradox?

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2. What is intrinsic minus position and intrinsic plus of the hand?

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## 1.7 LET US SUM UP

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A relevant history is useful for detecting the cause of nerve palsy.

A detailed clinical examination is a must to diagnose the peripheral nerve involved and the level or site (high or low).

Tinel's sign is useful for axonotmesis.

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## 1.8 GLOSSARY

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Neurapraxia, axonotmesis, neurotmesis are the three types of nerve injuries classified by Seddon. The recovery pattern in neurapraxia is complete (like Saturday night palsy) where as the recovery in axonotmesis follows a motor march from proximal to distal at the rate of 1mm per day after a gap of 3 weeks for Wallerian degeneration.

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## 1.9 ANSWERS TO CHECK YOUR PROGRESS

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### Check Your Progress 1

In a **low radial nerve or posterior interosseous nerve (PIN)** palsy only the finger and thumb extensors are paralyzed (finger drop and not wrist drop), the wrist can dorsiflex.

In a **high radial nerve palsy** the wrist dorsiflexors along with brachioradialis muscle is paralyzed (wrist drop).

In a very **high radial nerve palsy**, the triceps muscle is also paralyzed.

### Check Your Progress 2

1. **Ulnar paradox is increased clawing of ring and little fingers in a low ulnar nerve palsy** since the flexor digitorum profundus (FDP) of ring and little finger are intact. On the other hand, a high ulnar nerve lesion causes a paralysis of the FDP resulting in less degree of ulnar claw hand deformity.
2. **Intrinsic minus position** is hyperextension of the metacarpophalangeal (MCP) joints and flexion of the interphalangeal (IP) joint. In the **intrinsic plus (or lumbrical plus)** hand the MCP joints are kept in 90 degree flexion and IP joints in full extension.

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## 1.10 REFERENCES AND FURTHER READINGS

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Moldaver J. Tinel's sign. Its characteristics and significance. J Bone Joint Surg Am 1978 Apr;60(3):412-4.