
NERVE INJURIES IN THE UPPER LIMB

Peripheral nerve injuries may result from either division (complete or partial) or compression of the nerve. In nerve division, the muscles supplied by the nerve will be paralyzed and sensation is lost (anesthesia) in the skin area supplied by the nerve *distal to the site of injury*. In nerve compression, the muscles supplied by the nerve become weakened not paralyzed and there will be abnormal sensation of pins and needles in the skin (parasthesia) *distal to the site of injury*. Proximal to the site of injury, the muscles and skin supplied by the nerve or its branches remain intact. *It is advisable to review the major nerves of the upper limb in plates IV and V at the end of the book before studying their injuries.*

Brachial plexus injuries

Complete lesions of all the roots of the brachial plexus are rare. Incomplete injuries are common and are usually caused by traction or pressure; they may affect the upper or lower parts of the plexus.

Upper lesions of the brachial plexus

These lesions result from depression of the shoulder on the same side of the affected limb and excessive displacement of the head to the opposite side. It usually occurs in newborns of difficult delivery or in adults after a blow to or a fall on the shoulder. The injury causes excessive traction or even tearing of **C5 and C6 roots** affecting the following nerves;

- The suprascapular nerve; causing paralysis of supraspinatus (the initiator of abduction) and infraspinatus (a lateral rotator of the shoulder).
- The nerve to subclavius; causing paralysis of the subclavius and loss of its function.
- The musculocutaneous nerve; causing paralysis and loss of the functions of biceps brachii (elbow flexion and supination and shoulder flexion), coracobrachialis (shoulder flexion) and most of brachialis (elbow flexion).
- The axillary nerve; causing paralysis of deltoid (mainly shoulder abduction is affected) and teres minor (a lateral rotator of the shoulder).

The combination of these motor effects cause the limb to hang limply by the trunk, medially rotated by the unopposed action of the sternocostal fibers of pectoralis major with the elbow extended and the forearm pronated (loss of supination); a combination known as **Erb-Duchenne Palsy (waiter's tip)**. Although supinator is not supplied by any of the mentioned nerves but it is also paralyzed since it is supplied by C6 fibers running through the radial nerve. In addition to the motor effects, there is sensory loss over the lateral side of the arm and forearm (C5 and C6 dermatomes). The paralysis of subclavius leads to loss of its protective effect to the sternoclavicular joint. Repeated hammering of the clavicle on the manubrium sterni will result in accelerated joint damage.

Lower lesions of the brachial plexus

These lesions are usually caused by excessive abduction of the arm as in a person falling from a height and clutching at an object to save themselves. They can also be produced by the presence of a cervical rib or the presence of enlarged lower deep cervical lymph nodes.

The **T1 fibers** are mainly affected. T1 fibers run in the ulnar and median nerves to supply all the small muscles of the hand. As these muscles become paralyzed the following features occur;

- The extensor action of the long extensors is unopposed by the flexor action of the lumbricals and interossei at the metacarpophalangeal joints causing hyperextension of these joints.
- The flexor action of flexor digitorum superficialis and flexor digitorum profundus is unopposed by the extensor action of the lumbricals and interossei at the interphalangeal joints causing flexion of these joints.

The combined metacarpophalangeal hyperextension and interphalangeal flexion gives the hand a **clawed appearance**.

There is sensory loss along the medial side of the arm (T1 dermatome) and if the C8 root is also affected the loss extends to the forearm, medial $\frac{1}{3}$ of the palm and medial $1\frac{1}{2}$ fingers (C8 dermatome).

Long thoracic nerve injury

This may be injured by blows or pressure on the posterior triangle of the neck or during radical mastectomy. Its damage causes paralysis of serratus anterior muscle resulting in failure to rotate the scapula laterally during abduction and loss of the muscle tone causes loss of its effect in holding the scapula against the rib cage. The patient suffers from difficulty in raising the arm above the head i.e. abduction of the shoulder above the horizontal plane. The medial border and inferior angle of the scapula protrude posteriorly; a condition known as **winging of the scapula**.

Axillary nerve injury

This nerve is commonly injured in inferior dislocation of the shoulder or fractures of the surgical neck of the humerus. The following features occur;

- Failure to abduct the shoulder beyond 15-30° due to paralysis of deltoid. The little amount of abduction possible is the action of supraspinatus.
- Loss of sensation over the lower $\frac{1}{2}$ of deltoid muscle (area of the upper lateral cutaneous nerve of the arm).

Radial nerve injury

In the axilla

Damage to the radial nerve in the axilla is commonly caused by the pressure of the upper end of a badly fitting crutch pressing up into the armpit or by fractures and dislocations of the proximal end of the humerus. Such damage results in the following features:

Motor

- All the muscles of the posterior compartment of the forearm; long extensors of the wrist and fingers; are paralyzed causing the unopposed flexors to flex the wrist and fingers and **wrist drop** results. With the wrist flexed, the fingers cannot be flexed tightly for a firm grip. If the proximal

phalanges and wrist are passively extended by the other hand, the interphalangeal joints can be extended by the action of the lumbricals and interossei via the extensor expansion.

- Although brachioradialis and supinator are also paralyzed, **supination is still possible** in elbow flexion by the action of biceps brachii.
- The triceps and anconeus are paralyzed and elbow extension is lost.

Sensory:

- There is sensory loss of the lower lateral and posterior parts of the arm and in the narrow strip in the middle of the back of the forearm (lower lateral and posterior cutaneous nerves of the arm and posterior cutaneous nerve of the forearm).
- There is sensory loss over the dorsal $\frac{2}{3}$ of the hand and the roots of the lateral 3 $\frac{1}{2}$ fingers.

In the radial groove

Damage to the radial nerve in the radial groove is commonly caused by fractures of the shaft of the humerus (mainly the distal part) resulting in the following features;

Motor

- The effect on the long extensors, brachioradialis and supinator is the same as in injuries in the radial groove mentioned earlier.
- Triceps and anconeus are spared and elbow extension is not affected because their nerve supply arises proximal to the site of injury (branches to the long and medial heads of triceps arise in the axilla and branches to the lateral and medial heads and to anconeus arise in the proximal part of the radial groove).

Sensory

- There is sensory loss over the dorsal $\frac{2}{3}$ of the hand and the roots of the lateral 3 $\frac{1}{2}$ fingers.
- The lower lateral arm and posterior part of the forearm are spared since their nerves arise proximal to the site of injury.

Injury to the superficial branch of the radial nerve

This injury may result from stab wounds causing sensory loss over the area of the hand supplied by this nerve.

Injury to the deep branch of the radial nerve

The deep branch of the radial nerve may be injured in fractures or dislocations of the proximal end of the radius. Since the nerve is motor only there will be no sensory loss. Because Supinator, brachioradialis and extensor carpi radialis longus are supplied by the radial nerve or its deep branch at a more proximal level they will not be damaged. Extensor carpi radialis longus is a powerful extensor that will keep the wrist extended and wrist drop will not occur. However, there still will be weakness of the long extensors of the digits that is compensated by the actions of the lumbricals and interossei.

Median nerve injury

At the elbow

The median nerve may be injured at the elbow by supracondylar fractures of the humerus resulting in the following effects;

Motor

- All the muscles of the flexor compartment of the forearm; except flexor carpi ulnaris and the medial 2 tendons of flexor digitorum profundus; are paralyzed. As a result, the forearm is kept in supine position. Wrist flexion is weak but not lost because flexor carpi ulnaris flexes the wrist but also deviates it medially (due to loss of opposed lateral deviation by flexor carpi radialis).
- The little and ring fingers flex (normal medial 2 tendons of flexor digitorum profundus) more than the index and middle fingers at the interphalangeal joints. The interossei can perform weak flexion at the metacarpophalangeal joints of the index and middle fingers but the first 2 lumbricals are paralyzed. This causes the index and middle fingers to lag behind the ring and little fingers when an attempt is made to make a fist slowly.
- Flexion of the terminal phalanx of the thumb is lost due to paralysis of flexor pollicis longus.

*The median nerve is more commonly **compressed** at the wrist by excessive synovial fluid in the ulnar and radial bursae; a condition known as **carpal tunnel syndrome**. In this case, the thenar muscles will be weakened not paralyzed and the sensory loss will be limited to the fingers only. The skin of the lateral $\frac{2}{3}$ of the palm is spared because the palmar cutaneous branch of the median nerve runs anterior to the flexor retinaculum and thus escapes being compressed by the synovial sheaths.*

- The thenar muscles are paralyzed and wasted and the thenar eminence becomes flattened. The thumb is abducted; extended and laterally rotated and cannot be opposed to other fingers. The hand looks flattened and **apelike**.

Sensory

Sensory loss occurs in the skin of the lateral $\frac{2}{3}$ of the palm and the lateral $3\frac{1}{2}$ fingers extending on the dorsum of the fingers to the level of the proximal interphalangeal joints.

At the wrist

This is commonly caused by stab wounds or broken glass dividing the nerve as it passes posterior to the flexor retinaculum. The clinical findings are;

The apelike hand and damage to the thenar muscles as in damage at the elbow mentioned earlier. The muscles of the forearm are not affected and wrist movement is intact.

Sensory loss occurs in the skin of the lateral $\frac{2}{3}$ of the palm and the lateral $3\frac{1}{2}$ fingers extending on the dorsum of the fingers to the level of the proximal interphalangeal joints.

Ulnar nerve injury

At the elbow

Injury of the ulnar nerve at the elbow is common and is associated with fractures of the medial epicondyle of the humerus. The clinical findings include;

Motor

- Paralysis of flexor carpi ulnaris weakens wrist flexion and when the patient attempts to flex the wrist the movement is associated with lateral deviation due to the unopposed action of flexor carpi radialis.
- Paralysis of the medial 2 tendons of flexor digitorum profundus prevents flexion of the distal interphalangeal joints of the little and ring fingers.
- All the small muscles of the hand (including adductor pollicis) will be paralyzed; except the thenar muscles and the first 2 lumbricals which are supplied by the median nerve. The thumb cannot be adducted due to paralysis of adductor pollicis, the fingers cannot be abducted and adducted due to paralysis of the dorsal and palmar interossei and the metacarpophalangeal joints will be hyperextended while the interphalangeal joints will be flexed due to paralysis of the lumbricals and interossei. The resulting deformity is called the **claw-hand** deformity. The deformity is more prominent in the little and ring fingers because the first 2 lumbricals are not paralyzed. The distal interphalangeal joints of the index and middle fingers are flexed by the tension in the flexor digitorum profundus tendons.

Sensory

The entire skin area of ulnar nerve supply will show sensory loss i.e. the medial $\frac{1}{3}$ of the hand and medial $1\frac{1}{2}$ fingers anteriorly and posteriorly.

At the wrist

Because of its superficial position at the wrist, the ulnar nerve is commonly injured here by stab wounds or suicidal cuts. The effects are;

Motor

The claw hand deformity is similar to that seen in injuries at the elbow except that the distal interphalangeal joints of all fingers are flexed by the tension in the flexor digitorum profundus tendons since both parts of the muscle are functional.

Sensory

The main ulnar nerve and its palmar cutaneous branch are affected but the dorsal cutaneous branch is usually spared since it arises at a level more proximal to the injury. Therefore, the sensory loss is limited to the medial $\frac{1}{3}$ of the palm and the palmar surface of the medial $1\frac{1}{2}$ fingers extending dorsally to the level of the proximal interphalangeal joints.

Combined ulnar and median nerve injury

A combined injury to the ulnar and median nerves at the elbow causes a true claw hand of severe type. The wrist joint is hyperextended due to paralysis of all the flexors and the unopposed action of the extensors of the wrist joint. The metacarpophalangeal joints are hyperextended due to paralysis of the lumbricals and interossei. The long extensors cannot extend the interphalangeal joints but they hyperextend the metacarpophalangeal joints because the palmar plate with the attached dorsal expansion are drawn distally to the metacarpal heads. The interphalangeal joints are partially flexed due to the tension of the long flexors and not due to their tone since they are paralyzed. This severe type of claw hand may also be seen in injuries to the medial cord of the brachial plexus.