

Peripheral Nerve Injury

Pathology of nerve injuries

- Nerves can be injured by ischemia, compression, traction, laceration or burning. Damage varies in severity from transient and quickly recoverable loss of function to complete interruption and degeneration.
1. **Transient ischemia**
 - Acute nerve compression causes numbness and tingling within 15 minutes, loss of pain sensibility after 30 minutes and muscle weakness after 45 minutes.
 - Relief of compression is followed by intense paresthesia lasting up to 5 minutes. Feeling is restored within 30 seconds and full muscle power after about 10 minutes.
 2. **Neurapraxia**
 - Reversible block to nerve conduction in which there is loss of sensation and muscle power, followed by spontaneous recovery after a few days or weeks.
 3. **Axonotmesis**
 - More severe form of injury in which there is interruption of the axons in a segment of nerve. It is seen typically after closed fractures and dislocations
 - The denervated motor endplates and sensory receptors gradually atrophy and if they are not re-innervated within 2 years they will never recover.
 - Axonal regeneration starts within hours of nerve damage.
 4. **Neurotmesis**
 - Division of the nerve trunk, such as may occur in an open wound
 - Will never recover without surgical intervention → Function may be adequate but is never normal.

Clinical features:

- Acute nerve injuries are easily missed, especially if associated with fractures or dislocations.
- Nerve loss in low energy injuries is likely to be due to neurapraxia, and in high-energy injuries and open wounds to axonotmesis or neurotmesis.
- Assuming that nerve regeneration occurs at the rate of 1 mm per day, one can estimate the expected time of recovery in muscles closest to the site of injury
- Tinel's sign: A classic sign of progressive nerve recovery is peripheral tingling provoked by percussing the nerve at the site of injury (where regenerating axons are most sensitive).
- Nerve conduction tests and electromyography may help to establish the level and severity of the injury, as well as the progress of nerve recovery.

Nerve injuries affecting the upper limb

Brachial plexus injuries

- Nerve roots from C5 to T1
- Stab wound or severe traction caused by a fall on the side of the neck or the shoulder.
- Supraclavicular lesions typically occur in motorcycle accidents.
- Infraclavicular lesions are usually associated with fractures or dislocations of the shoulder.
- Fractures of the clavicle rarely damage the plexus
- The injury may affect any level of the plexus.
 - Preganglionic lesions (i.e. disruption of nerve roots proximal to the dorsal root ganglion) cannot recover and are surgically irreparable. Postganglionic lesions can be repaired and are capable of recovery
- Clinical features
 - Clinical examination should establish: (a) the level of the lesion; (b) whether it is preganglionic or postganglionic; and (c) the type of damage
 - Level of the lesion
 - Upper plexus injuries (C5 and 6) → arm hangs close to the body and internally rotated. Sensation is lost along the outer aspect of the arm and forearm. → best prognosis
 - Total plexus lesions → paralysis and numbness of the entire limb.
 - Pure lower plexus injuries are rare
 - Preganglionic or postganglionic:
 - Features suggesting preganglionic root avulsion are:
 - Burning pain in an anesthetic hand
 - Paralysis of scapular muscles or diaphragm
 - Horner's syndrome
 - Severe vascular injury
 - Associated fractures of the cervical spine
 - Spinal cord dysfunction
 - Histamine test
 - Preganglionic root avulsion → +ve
 - Postganglionic lesion → -ve
 - CT, MRI
 - Type of damage
 - Neurapraxia and axonotmesis
 - Neurotmesis

Management

- Emergency surgery → penetrating wounds, vascular injury or severe (high-energy) soft-tissue damage, whether open or closed.

Obstetrical brachial plexus injuries:

- Obstetrical palsy is caused by excessive traction on the brachial plexus during childbirth "Prolonged labour and/or shoulder dystocia".

- Three patterns are seen:
 - (1) Upper root injury (Erb's palsy; C5, C6), typically in overweight babies with Shoulder dystocia at delivery, Upper root lesions often recover spontaneously. A reliable indicator is return of biceps activity by the third month, If there is no biceps recovery by 3 months, operative intervention should be considered
 - (2) Lower root injury (Klumpke's palsy; C8 and T1), usually after breech delivery of smaller babies; → arm supinated and the elbow flexed; there is loss of intrinsic muscle power in the hand.
 - (3) Total plexus injury.

Long thoracic nerve

- Serratus anterior palsy → winging of the scapula

Spinal accessory nerve

- Runs in the posterior triangle of the neck to innervate the upper half of the trapezius. The accessory nerve is a spinal nerve that supplies the sternocleidomastoid and trapezius muscles.
- The nerve then descends obliquely behind the Digastric and Stylohyoid to the upper part of the Sternocleidomastoid; it pierces this muscle, and courses obliquely across the posterior triangle of the neck, to end in the deep surface of the Trapezius.
- Injured in stab wounds and operations in the posterior triangle of the neck.

Axillary nerve (C5)

- Injured during shoulder dislocation or fractures of the humeral neck
- Deltoid weakness → impaired abduction

Radial nerve

- Injured at the elbow, in the upper arm or in the axilla.
- Low lesions → at the elbow, cannot extend the metacarpophalangeal joints
- High lesions → fractures of the humerus or after prolonged tourniquet pressure patients who fall asleep with the arm dangling (Saturday night palsy → obvious wrist-drop due to weakness of the wrist extensors and a small patch of sensory loss on the back of the hand at the base of the thumb
- Very high lesions → axilla ('crutch palsy'). The triceps muscle is wasted and paralyzed.
- Injuries caused by pressure (a crutch, tourniquet, Saturday night palsy, fractured humerus), the lesion is usually an axonotmesis and spontaneous recovery is the rule.

Ulnar nerve

- Near the wrist or near the elbow

- Low lesions → wrist, hypothenar wasting and the hand is clawed due to paralysis of the intrinsic muscles, Finger abduction is weak, and the loss of thumb adduction makes pinch difficult for Froment's test, Sensation is lost over the ulnar one and a half fingers.
- High lesions → elbow fractures, Curiously, the visible deformity is not marked, because the ulnar half of flexor digitorum profundus is paralyzed and the fingers are therefore less 'clawed'. Otherwise motor and sensory loss are the same as in low lesions.
- Ulnar paradox → The ulnar nerve also innervates the ulnar (medial) half of the flexor digitorum profundus muscle (FDP). If the ulnar nerve lesion occurs more proximally (closer to the elbow), the flexor digitorum profundus muscle may also be denervated. As a result, flexion of the DIP joints is weakened, which reduces the claw-like appearance of the hand. Simply put, as reinnervation occurs along the ulnar nerve after a high lesion, the deformity will get worse (FDP reinnervated) as the patient recovers - hence the use of the term "paradox". A simple way to remember this is: 'the closer to the Paw, the worse the Claw'

Median nerve

- Wrist or high up in the forearm.
- Low lesions → wrist, thenar eminence is wasted and thumb abduction and opposition are weak. Sensation is lost over the radial three and a half digits
- High lesions → forearm fractures or elbow dislocation, long flexors to the thumb, index and middle fingers are paralyzed

Nerve injuries affecting the lower limb

Femoral nerve

- Thigh injury, weakness of knee extension (quadriceps) and numbness of the anterior thigh and medial aspect of the leg. The knee jerk is depressed.

Sciatic nerve

- Traction and compression are more common and occur with local trauma
- Foot-drop, numbness and paresthesia in the leg and foot
- Deep (peroneal) component of the nerve is affected, paralysis is incomplete, and the signs are easily mistaken for those of a common peroneal nerve injury
- Sciatic nerve palsy is one of the recognized complications of hip replacement.
- Following hip surgery, symptoms and signs of 'peroneal nerve injury' are usually, in fact, due to partial sciatic nerve injury.

Peroneal nerves

- Common peroneal nerve may be damaged in lateral ligament injuries when the knee is forced into varus, or by pressure from a splint or a plaster cast, or from lying with the leg externally rotated.
- The patient develops a drop-foot in which both dorsiflexion and eversion are weak, causing a tendency to trip and fall while walking. Sensation is lost over the front and outer half of the leg and the dorsum of the foot.

- Superficial branch → peroneal muscles are paralyzed, and eversion is lost, but dorsiflexion is intact, loss of sensation over the outer side of the leg and foot.
- Deep branch → anterior compartment syndrome, sensory loss around the first web space on the dorsum of the foot.

Approach to foot drop:

Determine if unilateral or bilateral:

- **Unilateral**
 - Determine site of lesion i.e. common peroneal nerve / sciatic nerve / L5 radiculopathy or anterior horn cell/ cortical lesion. Foot drop is not an uncommon presentation of motor neuron disease.
 - If weak ankle dorsiflexion and foot eversion, but strong ankle plantarflexion and foot inversion; numb dorsum of the foot; ankle jerk intact → lesion is at the common peroneal nerve (usually compression at fibula neck) and NOT sciatic nerve or L5 nerve root.
 - L5 segment lesion: weak ankle dorsiflexion, foot eversion, AND foot inversion. Proceed to test hip internal rotation / abduction. Weak hip internal rotation / abduction indicates L5 radiculopathy. 'Vague subjective numbness over dorsum of foot and lateral part of leg- 'present in L5 radiculopathy but not in L5 anterior horn cell disorder.
 - For SCIATIC nerve: weak ankle dorsiflexion/plantar flexion, foot inversion/eversion; absent ankle jerk, numb whole leg and foot. Knee flexion is often weak; but hip abduction, and internal rotation should be strong.
 - In a cortical lesion, UMN signs are present e.g. Babinski reflex.
 - Clinical discriminative utility of ankle jerk is not high because many patients with any of the above lesions may have co-existent peripheral neuropathy with loss of ankle jerks on both sides.
- **Bilateral**
 - Peripheral neuropathy
 - Bilateral radiculopathy- Bil L5 radiculopathy
 - Cauda equina syndrome (LMN lesion) / Conus medullaris syndrome (mixed UMN/LMN lesion)
 - Motor neuron disease
 - Spastic paraplegia--not just foot drop. Examination will reveal more extensive involvement of both LL.
 - Infrequently distal myopathy...not an important cause as it is rare.

Nerve entrapment syndromes

- The most common sites are the carpal tunnel at the wrist (median nerve) and the cubital tunnel at the elbow (ulnar nerve).
- Thoracic outlet, where the subclavian vessels and trunks of the brachial plexus cross the first rib between the scalenus anterior and medius muscles. In these cases, there may be vascular as well as neurological signs in the upper limb
 - The patient complains of unpleasant tingling or pain or numbness in the territory of the compressed Nerve.
 - The diagnosis may be confirmed by measuring nerve conduction velocity

Carpal tunnel syndrome

- Most common compressive neuropathy
- Compression of the median nerve beneath transverse carpal ligament

Ulnar nerve compression

- At the elbow
 - Behind the medial epicondyle
 - Occurs spontaneously, more commonly in middle-aged men (as opposed to carpal tunnel syndrome which is more common in women).
- At the wrist
 - In front of the wrist just radial to the pisiform
 - The cause is usually a ganglion from the underlying joint, but neurological symptoms may also be produced by external pressure – e.g. in cyclists who lean too heavily on their handlebarsDx → clinical +MRI

Thoracic outlet syndrome

- Compression of the lower trunk of the brachial plexus (C8 and T1) and subclavian vessels between the clavicle and the first rib.
- X-rays of the neck occasionally demonstrate a cervical rib or an abnormally long C7 transverse process.
- Demonstration of a cervical rib should not be taken as ‘proof positive’ of a thoracic outlet problem.
- X-rays of the lungs (is there an apical tumour?) and the shoulders (to exclude any local lesion).
- DDx:
 - Tumours of the lower cervical cord or cervical vertebrae
 - Cervical spondylosis
 - Pancoast’s syndrome