Peripheral Nerve Injuries

- Endoneurium is connective tissue covering axons and their wrapped Schwann cells (myelin sheath)
- Perineurium separates axons into individual bundles or fasicles
- Epineurium is the outer coat of the nerve trunk and its constituent fasicles
- Ischaemia from acute nerve compression results in reversible endoneurial anoxia and can cause numbness in 15 minutes
  - Loss of pain after 30 minutes
  - Weakness after 45 minutes
  - On release of pressure, sensation is restored in 30 seconds with accompanying paraesthesias which can last 15 minutes. Motor power returns within 10 minutes.
- Axonotmesis = more severe loss of conduction with preserved neuronal continuity, usually occurring after closed injuries.
  - Accompanied by Wallerian degeneration of axons distally, with Schwann cell proliferation.
  - Regeneration commences proximally at a speed of 1 to 3 mm/day.
  - If end organs fail to be reinervated by two years, the condition is irreversible.
- Neurontmesis = division of nerve trunk, or found in crush/traction injuries where Wallerian degeneration is accompanied by destruction of the endoneurium tubules.
  - Regeneration may occur but with fibres mingling with each other and proliferating Schwann cells, without finding the correct intact distal segment, despite surgical apposition.
- Clinical features:
  - Muscle atrophy
  - Cool, shiny skin
  - Trophic ulcers
  - Nail changes
  - Palpable neuroma
- Operative tips:
  - 10/0 suture without tension on suture line
  - If tourniquet used, release and control bleeding before closure
  - Splint limb in position with least tension on nerve, for 3 to 6 weeks
  - Conservative paring of edges needed if transaction is ragged.
- Factors affecting prognosis on nerve regeneration/repair:
  - Higher level of lesion
  - Pure motor/sensory nerves vs. mixed
  - Larger gap
  - Delay in suture
  - Extent of other soft tissue injuries
Brachial Plexus Birth Injuries

- **Risks:**
  - Difficult cephalic delivery of larger babies or use of forceps
  - Breech delivery during extraction of head
- **Tend to be more common on right side**
- **Erb’s Palsy**
  - Damage to C5 and C6
  - Paralysis of abductors and external rotators of shoulder, as well supinators of arm
  - Waiter’s tip position
  - Sensation intact
- **Klumpke’s Palsy**
  - C8 and T1 lesion
  - Sensory loss with paralysis of intrinsic hand muscles
  - Unilateral Horner’s syndrome
- **Natural history:**
  - Complete recovery spontaneously
  - Partial spontaneous recovery
  - Permanent especially if a unilateral Horner’s syndrome is present
- **Conservative rx**
  - Passive physiotherapy while waiting for limbs to recover
  - Operative rx – if no recovery by 3 months
    - Bridge any gaps with free sural nerve transplants
    - Neurotization by transferring spare nerves (accessory, long thoracic and intercostal) to distal segments of avulsed roots.
  - Osteotomies to correct any fixed deformities (e.g. derotation osteotomy of humeral head)

Brachial Plexus Birth Late

- **Upper plexus injuries**
- **Lower plexus injuries**
- **Features suggesting root avulsion:**
  - Severe pain
  - Paralysis of scapular muscles
  - Horner’s syndrome
  - Severe vascular injury
  - C-spine fracture
- **Treatment:**
  - Initial in stab injuries or open fractures, if clean cut.
  - Delayed treatment if too ill, or other more pressing injuries need stabilisation acutely.
  - Not attempted if clear signs of root avulsion
Long Thoracic Nerve

- Arises from C5, C6 and C7, to pass through apex of axilla behind other structures of brachial plexus, and supply serratus anterior
- Injured during shoulder and neck injuries
  - As well as 1st rib resection, radical mastectomy, or carrying heavy items on shoulder
- Features = winging of scapula or aching in arm
- Usually spontaneous recovery within 12 months
- Operative stabilisation by transferring pectoralis minor tendon onto lower part of scapula.

Spinal Accessory Nerve

- Arises from C3 and C4, to supply sternocleidomastoid muscle, before traversing superficially across posterior triangle of the neck to supply the upper part of trapezius.
- Can be injured during lymph node biopsies or accompany brachial plexus traction injuries.
- Features: shoulder pain and weakness in abduction.
  - Mild winging of scapula or resisted abduction, that disappears with forceful forward thrusting.
- Explore all stab injuries, but otherwise wait 4-6 weeks if uncertain about nerve integrity (holding arm in sling to prevent further drag/traction)
- Suprascapular Nerve
- Arises from C3 and C4, from the superior trunk of the brachial plexus, passing laterally across the posterior triangle of the neck and through the scapular notch. It supplies supraspinatus and infraspinatus.
- Damage by scapular fractures, carrying heavy loads on the shoulder or direct traction.
- Clinically – look for weakness initiating abduction, along with external rotation.
- Usually an axonotmesis with spontaneous recovery in 2-3 months.
  - In the absence of trauma may be caused by nerve entrapment, relieved by releasing the suprascapular ligament.
Axillary Nerve

- Arises from C5 and C6, and is a terminal branch of the posterior cord of the brachial plexus.
  - It traverses the quadrilateral space to enter the back of the arm, and supplies teres minor, before its medial branch supplies the posterior deltoid and the regimental patch area (upper lateral cutaneous brachial nerve).
  - The anterior branch then winds around the surgical neck of humerus to supply the anterior deltoid.
  - Skin landmark for this is 5 cm below acromion tip.
- Nerve bruising (axonotmesis) occurs during shoulder dislocations, fractures of surgical neck of humerus.
- Spontaneous recovery usually occurs by 3 months, beyond which the area should be explored.
  - If no recovery, limited abduction can be achieved with glenohumeral arthrodesis and residual scapular-thoracic movements.

Radial Nerve

- Arises from C5 to T1 via the main terminal branch of the posterior cord of the brachial plexus, runs in the spiral groove on the posterior aspect of the humerus.
  - Supplies elbow and forearm extensors, running anteriorly over lateral epicondyle of humerus
  - At the elbow, it divides into a superficial branch, and a deep branch (muscular only).
  - Deep branch winds around the lateral edge of the radius into the posterior fascial compartment of forearm, to give many muscular branches including the posterior interosseous nerve.
  - Variable skin distribution along extensor aspects of arm, but always supplies the 1st dorsal web space in the hand.
- Low lesions:
  - Found in fractures or dislocations of the elbow, or during surgical approaches to the proximal radius
  - Weak extension of MCP joints
- High lesions:
  - Fractures of humerus, or after prolonged tourniquet use.
  - Wrist drop and sensory loss around anatomical snuff box.
- Very high lesions:
  - Shoulder trauma, or Saturday night palsy or crutch palsy.
  - Wrist drop along with triceps weakness.
- Most injuries are a result of axonotmesis and will spontaneously improve by 3 months. The hand wrist should be splinted with the MCP-joints and wrist straight, and the thumb straight and abducted, but still allowing active use of hand.
  - Exploration or salage using tendon transfers if this fails.
Ulnar Nerve

- Arises from C8 and T1, as a terminal branch of the medial cord of the brachial plexus
  - Runs down the anterior aspect of triceps medial to the brachial artery
  - Runs behind the medial epicondyle superficially, and enters the forearm between the medial epicondyle and the olecranon between the two heads of FCU.
  - Accompanies the ulnar artery beneath FDP. At the wrist it runs superficial to the carpal tunnel, between the pisiform and hook of hammate in Guyon’s canal.

- Low lesions:
  - Lacerations by shards of glass
  - Numbness to medial 1½ digits, and partial claw hand, with hypothenar and interosseous wasting
  - Long distance cyclists pressing their wrist on handlebars can suffer from ulnar nerve entrapment in Guyon’s canal
  - Unexplained motor lesions of Ulnar nerve can be caused by a deep carpal ganglion

- High lesions:
  - Fractures and dislocations of the elbow
  - Ulnar paradox = no clawing from loss of medial half of FDP.
  - Ulnar neuritis from cubital tunnel syndrome, or pressure in bed bound patients.

- Treatment:
  - If conservative, he skin should be guarded against friction and thermal burns
  - Surgical exploration
  - Release of the aponeurosis over the 2 heads of FCU.
  - Anterior transposition can close gaps up to 5 cm

Median Nerve

- Arises from C5-T1 from the medial root of the medial cord, and the lateral root of the lateral cord of the brachial plexus.
  - Runs down the arm lateral to the brachial artery, and enters the elbow atop of brachialis.
  - Enters the forearm between the heads of Pronator Teres, and runs in between FDS and FDP.
  - In the carpal tunnel it lies between the tendons of FDS and FCR, with the superficial palmar branch given off proximal to the transverse carpal ligament, and running superficial to the carpal tunnel to supply the skin over the thenar eminence.
  - The anterior interosseous branch supplies the lateral half of FDP, FPL and pronator quadratus.

- Low lesions caused by carpal dislocation or lacerations of the wrist, resulting in loss in sensation over radial 3½ digits and thenar eminence wasting
- High lesions caused by forearm fractures or elbow dislocation, with loss of radial forearm fingers (pointing sign) and pronation.
- Anterior interosseous syndrome is rare entrapment beneath humeral head of pronator teres, with weak pinch grip (FPL and FDP), with no sensory involvement.
- After operative repair of transections, the arm should be splinted in flexion, and when later mobilised, wrist extension avoided.