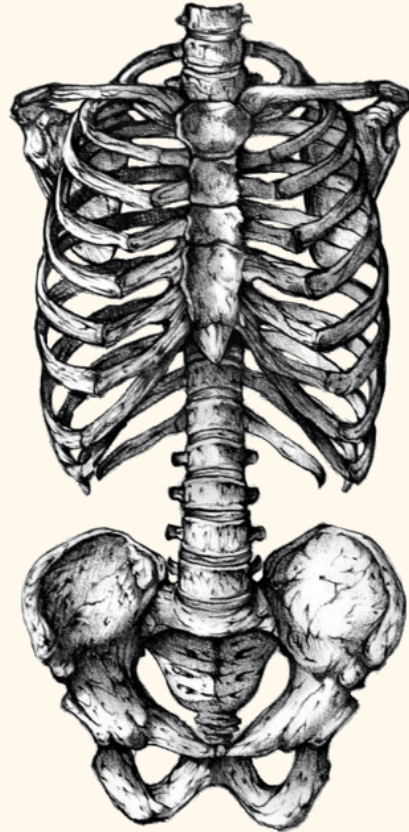


Lecture 16

PERIPHERAL NERVE INJURIES



Objectives

Not given

Compression neuropathy

- Chronic condition with sensory, motor, or mixed involvement.
- **First lost** → light touch – pressure – vibration.
- Last lost → pain - temperature.
- If mixed pathology, sensory function is affected first and then motor is affected “this is

because Motor fibers have thick myelin sheath”.

- Microvascular compression → **neural ischemia** → paresthesias → Intraneural edema → more microvascular compression → demyelination → fibrosis → axonal loss

1. Common conditions leading to compression neuropathy

Systemic	Anatomic	Inflammatory	Fluid Imbalance	Mass
<ul style="list-style-type: none"> - Diabetes. - Alcoholism. - Renal failure. 	<ul style="list-style-type: none"> - Fibrosis. - Anomalous tendon. - Fracture deformity 	<ul style="list-style-type: none"> - Rheumatoid arthritis. - Infection. - Gout - Tenosynovitis 	<ul style="list-style-type: none"> - Pregnancy. - Obesity. 	<ul style="list-style-type: none"> - Ganglion. - Lipoma. - Hematoma.

2. Symptoms:

- Numbness.
- Dropping of objects.
- Weakness.
- Night symptoms.
- Clumsiness.
- Rule out systemic causes.

3. Physical Exam:

- Examine individual muscle strength → grades 0 to 5 → pinch strength - grip strength
- Neurosensory testing:
 - Dermatomal distribution.
 - Peripheral nerve distribution

❖ Special Tests:

- **Semmes-Weinstein monofilaments** (for the fine touch):
 - First to be affected in compression neuropathy.
 - Sensing 2.83 monofilament is normal
- Two-point discrimination:
 - Performed with closed eyes.
 - Abnormal → Inability to perceive a difference between points > 6 mm .
 - Late finding.



4. Electrodiagnostic testing

- Electromyography (EMG) and Nerve Conduction Study (NCS).
- Sensory and motor nerve function can be tested.
- Objective evidence of neuropathic condition.
- Helpful in localizing point of compression.
- In the early disease, there is a High false-negative rate.

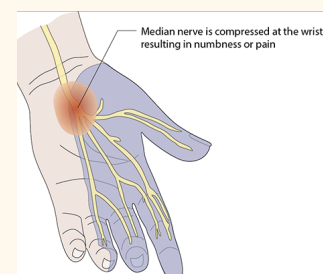
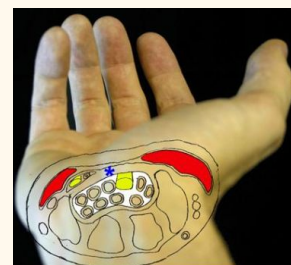
❖ NCS:

- Tests conduction velocity, distal latency and amplitude.
- Demyelination → ↓ conduction velocity + ↑ distal latency → axonal loss → ↓ potential amplitude.
- ❖ **EMG:**
 - Tests muscle electrical activity.
 - Muscle denervation → fibrillations - positive sharp waves.

5. Common peripheral nerve compressions

A. Median nerve compression at the wrist (Carpal Tunnel Syndrome)

- ❖ Most common compressive neuropathy.
- ❖ Anatomy of the carpal tunne:
 - Volar → TCL.
 - Radial → scaphoid tubercle + trapezium.
 - Ulnar → pisiform + hook of hamate.
 - Dorsal → proximal carpal row + deep extrinsic volar carpal ligaments.
- ❖ Carpal Tunnel Contents: median nerve + FPL + 4 FDS + 4 FDP = 10.
- ❖ Normal pressure → 2.5 mm Hg.
 - >20 mm Hg → ↓ ↓ epineural blood flow + nerve edema.
 - 30 mm Hg → ↓ ↓ nerve conduction.
- ❖ **Risk Factors:** obesity, pregnancy, diabetes, thyroid disease, chronic renal failure.
 - Others → RA, storage diseases, alcoholism, advanced age.
 - Repetitive strain injury.
- ❖ **Acute CTS:**
 - **Causes** → high-energy trauma, hemorrhage, infection.
 - Requires emergency decompression
- ❖ **Diagnosis:**
 - Symptoms:
 - Paresthesia and pain, often at night involving the volar aspect of thumb, index, middle fingers + radial half of ring finger.
 - Symptoms of late findings: Weakness - loss of fine motor control - abnormal two-point discrimination.
 - Physical examination:
 - Provocative tests:
 - **Durkan test** (direct compression on the median nerve) → Most sensitive.
 - Other: Tinel's test (tapping over the nerve),



Phalen's test.

- Affected first → light touch + vibration.
- Affected later → pain and temperature.
- Semmes-Weinstein monofilament testing → early CTS diagnosis.
- Thenar atrophy → severe denervation

➤ Electrodiagnostic testing:

- Not necessary for the diagnosis of CTS.
- Distal sensory latencies > 3.5 msec.
- Motor latencies > 4.5 msec

❖ Differential diagnoses:

- Cervical radiculopathy (C5-6).
- Brachial plexopathy.
- Thoracic outlet syndrome (TOS).
- Pronator syndrome.
- Ulnar neuropathy with Martin-Gruber anastomosis.
- Peripheral neuropathy of multiple etiologies.

❖ Treatment:

➤ Nonoperative:

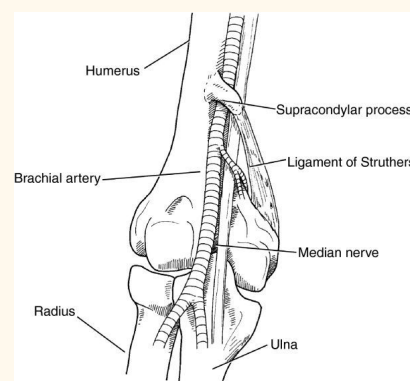
- Activity modification.
- Night splints.
- NSAIDs.
- Steroid injection.

➤ Operative:

- Open.
- Endoscopic
 - Short term(4-6 weeks): less early scar tenderness, improved short-term grip/pinch strength, better patient satisfaction scores.
 - Long-term: no significant difference, may have slightly higher complication rate, incomplete TCL release.
- Release outcome:
 - Pinch strength → 6 weeks.
 - Grip strength → 3 months.
 - Persistent symptoms after release →
 - ◆ Incomplete release.
 - ◆ Iatrogenic median nerve injury.
 - ◆ Missed double-crush phenomenon.
 - ◆ Concomitant peripheral neuropathy.
 - ◆ Wrong diagnosis
 - Revision success → identify underlying failure cause

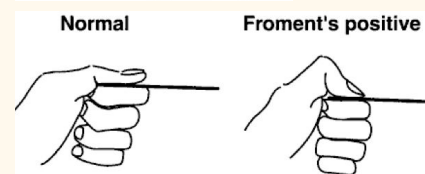
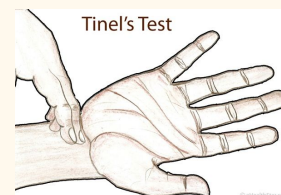
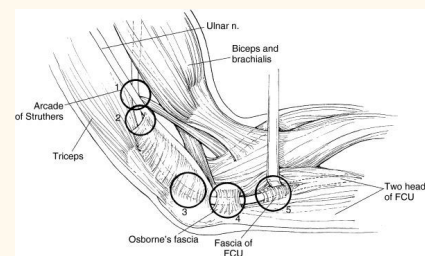
B. Median nerve compression at the arm (Pronator Syndrome)

- ❖ Median nerve compression at arm/forearm (5 potential sites of compression).
- ❖ **Symptoms:**
 - Aching pain over proximal volar forearm.
 - Sensory symptoms → palmar cutaneous branch.
 - Lack of night pain.
- ❖ **Diagnosis:**
 - History.
 - Physical examination.
 - NCS/EMG.
- ❖ **Treatment:**
 - Non-operative: splints/ NSAIDs. (don't give steroid injections)
 - Operative.



C. Ulnar nerve compression at the elbow (Cubital Syndrome)

- ❖ Second most common compression neuropathy of the upper extremity
- ❖ Cubital tunnel borders:
 - Floor → MCL and capsule.
 - Walls → medial epicondyle and olecranon.
 - Roof → FCU fascia and arcuate ligament of Osborne.
- ❖ **Symptoms** → paresthesias of ulnar **half of ring finger and small finger**.
- ❖ **Provocative tests:**
 - direct cubital tunnel compression.
 - Tinel's test.
- ❖ Froment sign → thumb IP flexion (by FPL which is supplied by median nerve) during key pinch (weak adductor pollicis which is supplied by ulnar nerve).
- ❖ Electrodiagnostic tests → diagnostic.



- ❖ **Treatment:**
 - Nonoperative treatment.
 - Activity modification (avoid putting their hands on hard object and prevent hyperflexion of the elbow).
 - Night splints → slight extension.
 - NSAIDs.
 - Surgical Release → Numerous techniques.
 - In situ decompression, Anterior transposition, Subcutaneous,

Submuscular, Intramuscular, Medial epicondylectomy.

- No significant difference in outcome between simple decompression and transposition.

D. Ulnar nerve compression at the wrist (Ulnar tunnel Syndrome)

❖ Compression neuropathy of ulnar nerve in the Guyon canal.

❖ **Causes:**

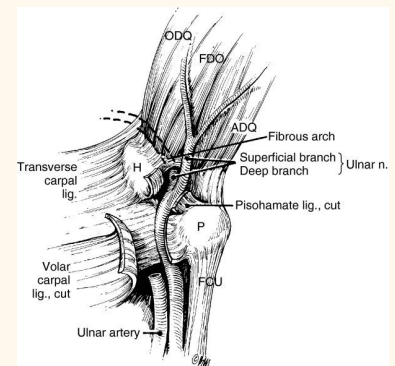
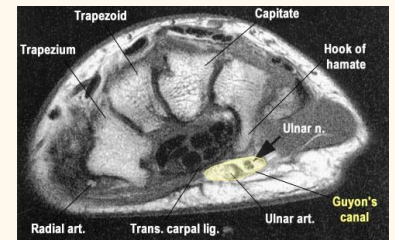
- Ganglion cyst : 80% of nontraumatic causes.
- Hook-of-hamate nonunion.
- Ulnar artery thrombosis or aneurysm.
- Lipoma

❖ **Imaging:**

- CT → hamate hook fracture.
- MRI → ganglion cyst or lipoma. (best test)
- Doppler ultrasonography → ulnar artery thrombosis or aneurysm.

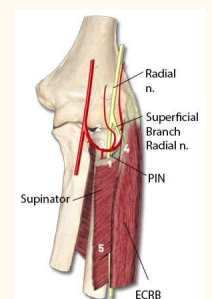
❖ **Treatment** → identify cause.

- Nonoperative treatment:
 - Activity modification.
 - Splints.
 - NSAIDs
- Operative treatment → decompressing by removing underlying cause



E. Radial nerve Compression

- Radial nerve compression: rarely compressed and mainly motor symptoms.
- Radial Tunnel Syndrome:
 - Lateral elbow and radial forearm pain.
 - No motor or sensory dysfunction.



Peripheral nerve injury

1. Causes:

- **Compression** (acute fracture of the distal radius is associated with carpal tunnel syndrome).
- **Stretch** (after surgery, for example humorous surgery and the patient present post-op with drop-wrist due to stretching of the nerve).
- **Blast** (Gunshot wound or explosion).
- **Crush** (Heavy object fell down on the patient and usually present with multiple injuries).
- **Avulsion** (Gunshot wound when the bullet perpetrates the body it pulls some tissue with it or with retraction in the OR).
- **Transection** (Knife stab or iatrogenic in the OR).

2. Prognosis

Good prognostic factors	Poor prognostic factors
Young age → most important factor. Stretch/ sharp injuries. Clean wounds. Direct surgical repair.	Crush injuries. Infected or scarred wounds. Delayed surgical repair (>2 weeks).

3. Classification

	Neuropraxia	Axonotmesis	Neurotmesis
Never injury	Mild nerve stretch or contusion	Incomplete nerve injury.	Complete nerve injury.
Conduction	Focal conduction block	Focal conduction block	Conduction block
Wallerian degeneration	NO	Distal to injury	Distal to injury
myelin sheath (Epineurium, perineurium, endoneurium)	Intact	Disruption of axons	Disruption of all layers. Proximal nerve end forms neuroma.
Prognosis	excellent → full recovery	Recovery unpredictable	Worst prognosis

<i>Seddon Type</i>	<i>Degree</i>	<i>Myelin Intact</i>	<i>Axon Intact</i>	<i>Endoneurium Intact</i>	<i>Wallerian Degen.</i>	<i>Reversible</i>
Neurapraxia	1st	No	Yes	Yes	No	reversible
Axonotmesis	2nd	No	No	Yes	Yes	reversible
Neurotmesis	3rd	No	No	No	Yes	irreversible

4. Wallerian degeneration

- Dr. Augustus Waller (1816-1870) described the degeneration of peripheral nerves (biomechanical response).
- Starts in distal nerve segment.
- Degradation products → removed by phagocytosis.
- Myelin-producing Schwann cells → proliferate and align → form a tube → receive regenerating axons.
- Proximal axon forms sprouts → connect to the distal stump → migrate @ 1 mm/day.

5. Surgical repair

- Best performed within **2 weeks** of injury.
- Repair must be **free of tension** (any tension force will decrease blood supply).
- Repair must be within clean, well-vascularized wound bed.
- Nerve length may be gained by neurolysis or transposition (neurolysis: release the proximal and distal tension of the nerve).
- Direct end to end repair.
- Larger gaps → grafting.
- Autogenous → sural - medial/lateral antebrachial cutaneous nerves.
- Vascularized nerve graft.
- Growth factor augmentation → insulin-like and fibroblast → promote nerve regeneration.
- Chronic peripheral nerve injuries → neurotization and/or tendon transfers.
- Use of nerve transfers for high radial and ulnar nerve injuries gaining popularity

Questions mentioned by Dr. Hisham which he might ASK ABOUT in the exam (433):

- **Mention one of the important non-operative treatment for cubital tunnel syndrome?** Night splint.
- **Scenario for carpal tunnel syndrome and doctor will ask about treatment options** (you have to know the management for each degree mild, moderate and severe).
- **Someone presented with thenar muscle atrophy. How severe is the case?** Very severe (since the motor function is least to be affected).
- **What information you should tell CTS patient pre-op?** the pain might not go away.
- **A pregnant lady came to the clinic with carpal tunnel syndrome would you do surgery for her?** No, the symptoms may disappear by its own after the pregnancy.
- **Distal radius fracture patient started to feel numb what would you do for him?** Evaluate everything then take patient immediately for carpal tunnel release.

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