Focal and Entrapment Neuropathies and EMG
A Clinical Approach

Basic Concepts
- Nerves predisposed by a narrow anatomic pathway or superficial course are most susceptible
- May occur acutely, intermittently, repetitively or continuously
- Patients with any generalized neuropathic condition are at increased risk
- Also associated with certain systemic conditions
  - Diabetes
  - CRI
  - Hypothyroidism
  - Weight loss/cachexia

Pathophysiology
- Earliest histological change is usually demyelination
- Axonal loss with Wallerian degeneration may occur in more severe/prolonged cases
- Mechanism of injury thought to be either direct pressure vs. ischemia

Median Nerve
- Subject to entrapment in both the forearm and wrist
  - The carpal tunnel in the wrist is the most common site of entrapment neuropathy in the body
  - In the forearm, entrapment of the anterior interosseous nerve produces a distinct clinical syndrome
**Anatomy**

- C6-T1 roots
- Lateral and medial cords
- Lies adjacent to brachial artery in antecubital fossa
- Passes b/w heads of pronator teres and supplies finger and wrist flexors
- Gives off anterior interosseus n. to FDP 1&2, FPL, and Pronator quad
- Passes through the wrist in the carpal tunnel
- Supplies 1st and 2nd lumbricals, opponens pollicis, APB, FPB
- Sensory fibers to medial thumb, index, middle and lateral half of the ring finger

**Carpal Tunnel Syndrome**

- Lifetime risk is estimated at 10%
- Occupations requiring repetitive hand and wrist movements are predisposed
- Age, obesity, pregnancy, amyloidosis, hypothyroidism and various other systemic diseases also at increased risk
- Ganglion cysts, neurofibromas, schwannomas

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**Clinical Features**

- **Numbness:** Classically in median n. distribution but ½-2/3 in all digits. May be in 1-2 digits.
- **Pain:** Primarily wrist but may radiate proximally occ. to shoulders
- **Weakness:** Rare & late. Dropping object due to numbness. Atrophy only in severe cases
- **Provocative factors:** Sleep, sustained hand/arm positions, repetitive action of hand or wrist (typing, driving, holding a phone or newspaper)
- **Mitigating factors:** Changes in hand posture, shaking the hand (“flick” sign)

**Physical Exam**

- **Tinel’s sign:** elicitation of paresthesia in the nerve distribution by percussion at the entrapment site
  - Clinical utility is limited
  - Often present in normal individuals
- **Wrist Flexion/Phalen’s test:** wrist is placed in complete flexion for 30-60 sec
  - Similar to Tinel’s sign has low sensitivity and even lower specificity
- **Autonomic Features:**
  - 59% Swelling of fingers
  - 39% Dry hands
  - 33% Raynauds
  - Rare: Nail bed changes & finger tip ulceration
Electrodiagnostic Studies

- Useful for assessing the presence, severity and degree of demyelination vs. axonal loss
- Median sensory studies provide the most sensitive measure
  - Drop in sensory amplitude
  - Prolongation of transcarpal sensory latency
- Motor studies often are useful in helping to grade severity and determine prognosis
  - Primary demyelinating lesions are more reversible
  - Axonal loss decreased the chance of full recovery
- Needle EMG also helps determine the degree of axonal injury and rule out cervical radiculopathies

Treatment

- Mild and transient symptoms with primarily demyelinating electrophysiology can be treated with neutral position splinting
- Steroid injections are the second line of treatment if splinting fails
- Surgery is indicated for those patients failing the above or when significant axonal loss is present

Conduction Study in Carpal Tunnel Syndrome

Anterior Interosseous Syndrome

- Anterior interosseous n. is largest branch of the median
- Arises 5-8 cm distal to lateral epicondyle
- Presents with aching forearm pain
- Exam shows weakness of the FPL, FDP to the index and middle fingers and pronator quadratus
- Key finding is the “pinch sign”
  - Unable to make an “O” by touching the tips of the index finger and thumb
  - Due to impaired flexion of the distal phalanges
Anterior Interosseous Syndrome

- Causes include anomalous forearm anatomy, trauma, repetitive elbow flexion and pronation maneuvers, extrinsic pressure (from a cast), drug injections.
- Site of compression is uncertain
- Electrodiagnostic studies
  - Standard nerve conductions are normal.
  - EMG shows denervation in the FPL, FDP, and pronator quadratus.
  - Flexor carpi radialis is spared

The Ulnar Nerve: Anatomy
- C8 and T1 roots
- Lower trunk, medial cord
- Courses b/w medial epicondyl of humerus and olecranon of ulnar, the “ulnar groove”
- Passes beneath aponeurotic connecting humeral and ulnar heads of FCU “cubital tunnel”
- Branches to FCU and FDP 3&4 arise near the elbow
- Proximal to the wrist arise the dorsal ulnar cutaneous n. above the ulnar styloid and the palmar cutaneous n. in the mid-distal forearm
- Enters the hand at the wrist through Guyon’s canal and innervates the majority of the intrinsic hand muscles, sensation to the palmar surface of the hand, ring and 5th fingers.

Ulnar Neuropathy at the Elbow
- Second most common entrapment neuropathy in adults
- Susceptibility primarily relates to the superficial course of the nerve at this site
  - Direct pressure
  - Prolonged elbow flexion decreases slack on the nerve and narrows the cubital tunnel
  - Nerve may sublux during flexion
- Causes: variations of cubital tunnel anatomy, boney changes at the elbow (arthritis or fracture), elbow trauma, elbow flexion during sleep, repetitive flexion/extension

Symptoms/Signs
- Numbness and tingling in the medial 4th and the 5th digits
- Pain and tenderness at the elbow, often radiating down the medial aspect of the arm
- Prolonged elbow flexion may exacerbate symptoms
- Clumsiness and loss of hand dexterity, weakened grasp
- Weakness of 5th digit abduction
- Claw hand deformity produced by weakness of the 4th and 5th lumbricals with sparing of the long finger flexors
Electrodiagnostic Studies

- Sensory nerve conductions can reveal loss of action potential amplitude reflecting loss of axons, but this is non-localizing
- Motor conductions are carried out with stimulation above and below the elbow
  - Slowing of conduction velocity across the elbow
  - Partial conduction block

Electrodiagnostics Cont.

- Needle EMG
  - Denervation of the FDP relative to the FCU
  - EMG of hand muscles is more likely to show abnormalities than forearm muscles.
- Conduction studies of the dorsal ulnar cutaneous nerve may be useful in differentiating between ulnar neuropathies at the wrist and elbow

Treatment

- Conservative management includes avoiding activities that compress or stretch the nerve
- Using protective elbow pads
- Surgical treatment for patients who remain symptomatic after 2-3 months of conservative management

Ulnar Entrapment at Wrist

- Ulnar nerve enters the hand via Guyon’s canal
  - Roof is the volar carpal ligament (continuation of deep forearm fascia)
  - Floor is formed by transverse carpal ligament and pisohamate ligament running from the pisiform bone to hook of the hamate
Clinical Features

- Wrist pain radiating into the digits or forearm
- Worse at night and exacerbated by wrist movement
- Occupational history of repetitive wrist movements (cyclists and tire workers)
- Mass lesions such as ganglion cysts are common cause
- Exam:
  - Motor deficits limited to the hand
  - Dorsal hand sensation should be normal

Lesions Classified into 5 Types

- I: Most common, occurs just proximal to or within Guyon’s canal
  - Weakness of all intrinsic hand muscles
  - Sensory loss in the 5th and ulnar side of 4th digit
  - Dorsal hand sensation is spared (dorsal ulnar cutaneous distribution) as is hypothenar eminence sensation (palmar cutaneous branch arises in forearm)
- II: Site of compression in Guyon’s canal involves only superficial terminal branch - sensation is lost to 5th and ulnar aspect of the right finger
- III-V: pure motor neuropathies

Electrodiagnostic Studies

- Lesions proximal to or within Guyon’s canal cause prolongation of distal motor latencies to the ADM and FDI accompanied by abnormalities in the sensory studies
- Lesion of the deep palmar branch (distal to the hypothenar branches) cause prolonged latency to the FDI with normal ADM and sensory studies
- Needle EMG shows denervation in the appropriate ulnar hand muscles

Treatment

- Avoidance of further trauma to the wrist
- Excision of the hook of the hamate if fracture is present
- Removal of any mass lesion in Guyon’s canal
Radial Nerve

- C5-C8 roots +/- T1(11%)
- Posterior cord -> Radial n
- Gives off branches to triceps
- Spiral Groove on posterior aspect of humerus
- Lateral arm near elbow it supplies wrist extensors (ECR), elbow flexors (brachioradialis and brachialis)
- At the elbow branched into posterior interosseous nerve and superficial radial nerve
- Superficial radial nerve moves anteriorly and laterally down the forearm and supplies cutaneous innervation to the dorsal hand
- Posterior interosseous enters the radial tunnel (lies on anterior prox radius, extends from the elbow joint to the supinator)
- PIN supplies extensor muscles of wrist and hand

Proximal Radial Lesions

- Trauma accounts for most lesions between the axilla and elbow
- Damage typically occurs near spiral groove
  - Humeral fractures
  - Intramuscular injections
  - Bullet/stab wounds
  - Prolonged pressure while unconscious
  - Ill fitting crutches
- Exam: triceps are usually spared, there is profound weakness of wrist and finger extension and sensory loss on the posterior hand and posterior arm

Electrodiagnostic Studies

- Findings consistent with conduction block are often seen with stimulation above the lesion
- Radial sensory conduction are usually normal unless the injury is severe resulting in axonal loss

Treatment

- Most lesions from acute compression recover in a few weeks
- Occupational therapy and cock-up splints help prevent contracture formation
- Lesions associated with humeral fractures often have poor recovery and may require surgical exploration
Distal Radial Nerve Lesions

- Compression of posterior Interosseous n. at the elbow can produce two distinct syndromes
  - Posterior interosseous syndrome: weakness of finger and wrist extension and forearm supination
    - Causes: Trauma, compression, repetitive pronation/supination, entrapment by the arcade of Frohse (fibrous opening in the superficial head of the supinator)
    - Pain in elbow and proximal forearm is common
    - Sensation remains intact
  - Radial tunnel syndrome: pain without weakness
    - May develop insidiously, following injury or after strenuous use of the elbow
    - Dull ache over the lateral elbow
    - Middle Finger test (distinguishes from lateral epicondylitis): patient extends middle finger against resistance producing pain along the course of the nerve

Treatment

- Usually conservative measures only
  - Avoid forceful repetitive elbow movements
  - NSAIDS
  - Elbow splinting
  - Surgical exploration may be necessary for persistent symptoms

Peroneal Nerve

- Most common focal neuropathy of the lower limbs
- L4-S1 roots
- Lumbosacral plexus
- Sciatic nerve (peroneal portion innervates the short head of biceps)
- Separates from tibial nerve and wraps around fibular head
- Divides into superficial peroneal n (to the evertors and skin of the lateral leg and dorsal foot) and the deep peroneal nerve (dorsiflexors)

Peroneal Nerve Entrapment

- Vulnerable both in the popliteal fossa and at the neck of the fibula
- Usually involves an external compressive force
  - Surgical positioning
  - Prolonged bed rest
  - Tight fitting casts
  - Frequent leg crossing
  - Extended squatting
- Direct trauma from lacerations, fibular fractures and knee surgery
- Compression from Baker’s cyst in the popliteal fossa
- Fibers of the deep peroneal nerve are more susceptible
**Clinical Features**

- Foot drop or varying degrees of ankle dorsiflexion and eversion weakness
- Sensory loss over the lower lateral calf and dorsal foot
- Ankle invertors are spared because these are tibial innervated
  - Important for distinguishing peroneal nerve injury from L5 radiculopathy in which both evertors and invertors are affected

**Electrodiagnostic Studies**

- Findings are variable depending on the degree of demyelination vs. axonal loss
  - Low amplitude or absent peroneal compound muscle action potential and/or superficial peroneal sensory potentials
  - Conduction block across the fibular head may occur in demyelinating lesions

**Treatment**

- Most patients with compressive injuries can be treated conservatively
  - Avoidance of leg crossing and squatting
  - Use of an AFO if there is significant weakness of dorsiflexion
  - Surgical exploration for direct traumatic lesions and in cases involving mass lesions

**Lateral Femoral Cutaneous N. Entrapment (Meralgia Paresthetica)**

- Lateral femoral cutaneous n. arises from L2-3 spinal nerves and emerges from the upper portion of the lumbar plexus along the lateral psoas muscle
- Enters the thigh under the most lateral aspect of the inguinal ligament
- Provides sensory innervation to the anterolateral thigh
Clinical Aspects

- Most common in obese individuals
- Also associated with tight clothing, heavy belts, prolonged sitting
- Presents as tingling paresthias and numbness in the anterolateral thigh, often worse with walking
- Treatment is aimed at avoiding exacerbating factors