Nerve Entrapment Syndromes

Introduction

- Chronic entrapment
- Commonly as the nerve passes through an osseoligamentous tunnel, or under an aponeurotic margin
- One side fixed, one moves → friction
  - More common in upper limb
- Inflamed or thickened nerve
- May see mass pressing on nerve – not true entrapment
- Secondary changes in muscles of nerve distribution

History

- Initially described by:
  - Astley Cooper 1820
  - James Paget 1850
- First surgical decompression
  - Learmonth 1930
- Common types
  - Carpal tunnel syndrome
  - Cubital tunnel - Ulnar nerve at the elbow
  - Guyon's canal – Ulnar nerve at the wrist
  - Suprascapular syndrome

Pathology

- Chronic blunt injury → ischemic changes
  - Edema
  - Dislocation of the nodes of Ranvier
- Structural changes to myelin sheath and axon
- Focal segmental demyelination is constant
- Complete recovery is due to remyelination
- Incomplete recovery due to Wallerian degeneration

Clinical

- Depends on nerve involved
- Irritative sensory symptoms
  - Pain and paresthesias
- Ablative sensory symptoms
  - Numbness
- Ablative motor signs
  - Weakness and atrophy
- If mixed nerve – sympathetic dystrophy
  - Dry, thin, hairless skin

Most peripheral entrapped nerves Sens. and Motor
- Notable exceptions:
  - Anterior interosseous nerve (motor)
  - Deep ulnar (motor)
  - Lateral femoral cutaneous (sensory)
  - Superficial branch of radial nerve (sensory)
Nerve entrapment syndromes

Normal Peripheral Nerve
- Peripheral nerve encased by epineurium
- Groups of axons encased by perineurium
- Fascicular appearance
- Profuse blood supply

Muscle signal intensity with entrapment/denervation
- Acute (< 1 month):
  - T1 - normal
  - STIR - ↑ SI
  - enhancement: +
- Subacute (1-6 months):
  - T1 - ± normal
  - STIR - ↑ SI
  - enhancement: ±
- Chronic (> 6 months):
  - T1 - ↑ SI
  - STIR - ↓ SI
  - enhancement - none

Nerve entrapment syndromes

Brachial Plexus
- Roots C5-T1
- Trunks
- Divisions
- Cords
- Branches
- Nerves

Erb-Duchenne Palsy
- Tearing of 5-6th roots
- Infants – delivery – shoulder dystocia.
- Adults Fall or blow to shoulder
- Affects –
  - Supracapular nerve C5-6
  - Musculocutaneous nerve C5-6
  - Axillary C5-6
- Waiters tip

Neurologic Thoracic Outlet Syndrome

Erb-Duchenne Palsy
- Glenoid hypoplasia
- Abnormally tapered acromion
- Hypoplastic Humeral Head
- Radial head/ulnar dislocation
Nerve entrapment syndromes

Neurologic Thoracic Outlet Syndrome

- Brachial plexus compression
  - True (Classic)
    - Congenital band or Cx rib - rare
  - Nonspecific
    - Compression or traction in cervicoaxillary canal
- Can have combined neurovascular
  - Usually traumatic

F:M 3.5:1

Sensory symptoms > motor
  - Motor intrinsic hand muscle atrophy
  - Principally arm pain, may be chest
  - Exacerbated by abduction

Klumpke Palsy

- Lower brachial plexus lesion
- Excessive abduction
- Breech delivery (rare)
- Clutching whilst falling
- Pancoast tumor
- Cervical rib
- Tear C8/T1
- Lumbricals and Interossei
- Claw hand.

Suprascapular nerve

- Upper limb overhead athletes
- Deep dull aching pain – sensory fibers to joint
- Weakness Abd and ER
- Hollow infraspinatus fossa.

Suprascapular Nerve Injury

- Suprascapular nerve
  - Mixed motor and sensory
  - Motor: supraspinatus, infraspinatus
  - Sensory:
    - Coracohumeral & coracoacromial ligaments
    - AC and glenohumeral joints
    - Subacromial bursa
Entrapment syndromes

Suprascapular Nerve Palsy

Supraspinatus
Infraspinatus

Suprascapular Neurovascular bundle

Entrapment Neuropathy - Treatment

Aspiration of Spinoglenoid Cyst

37yo M painter with shoulder pain and weakness when lifting paint cans

Entrapment Neuropathy - Treatment

Aspiration of Spinoglenoid Cyst

63F Post spine surgery
Entrapment syndromes

Quadrilateral space

• Teres Minor
• Humerus
• Quadrilateral space
• Long head of Triceps

Entrapment syndromes

Quadrilateral space

• Compression of axillary nerve (and posterior humeral circumflex artery)
• Fibrous bands, mass, fx.
• Pain and paresthesias of lateral and posterosuperior aspect of shoulder
• Sxs. increase with abduction and ext. rotation
• Weakness and atrophy of deltoid and teres minor

Entrapment neuropathy - Axillary Nerve

Teres Minor and Deltoid Atrophy

Entrapment neuropathy - Median Nerve

Median Nerve

• C5-T1
• Ligament of Struthers
• Lacertus fibrosus
• Pronator Syndrome
  • Between heads of pronator
• Anterior Interosseous Syndrome
  • Within forearm
• Carpal Tunnel Syndrome

Entrapment neuropathy - Median Nerve

Ligament of Struthers

• Supracondyloid process present in 1%
Entrapment neuropathy - Median Nerve
Ligament of Struthers

- Bicipital aponeurosis
- Free proximal border
- Compression beneath in body builders

Entrapment neuropathy - Median Nerve
Lacertus Fibrosus

- Supplies pronator teres, FCR, palmaris longus, FDS
- Both motor and sensory
- Pronator syndrome: compression of median nerve at the proximal forearm, can occur at multiple sites
- Anterior Interosseous Nerve
  - Largest branch of median nerve
  - 5-8 cm distal to epicondyle, at level of pronator dives deep to run along anterior aspect of interosseous membrane
  - Motor only, no sensory (Kiloh-Nevin Syndrome)
- Supplies
  - Pronator quadratus
  - FPL
  - Radial aspect 2nd and 3rd FDP (4th-5th FDP supplied by ulnar n)

Entrapment neuropathy - Median Nerve
Normal Lacertus Fibrosus

- Median nerve enters forearm between humeral and ulna heads of pronator teres in 83%
- Pronator teres is in the superficial group of the forearm flexors
- Motor and sensory

Entrapment neuropathy - Median Nerve
Pronator Syndrome

- AKA Kiloh-Nevin Syndrome
- Purely motor
  - Pronator quadratus
  - Flexor Pollicis Longus
  - Flexor Digitorum Profundus 2+
- Passes deep to aponeurotic free border of FDS to lie between FPL and FDP

Median nerve Innervation

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Entrapment neuropathy

Median Nerve

- Radial a
- Ulnar a
- Brachial a
- Arcuate ligament of Fearn and Goodfellow
- Median nerve
- FDS and flexor pollicis longus

Anterior Interosseous nerve syndrome

- Transverse carpal ligament
- Ulna – Pisiform, Hamate
- Radial – Scaphoid, Trapezial ridge
- Palmar fascia attached to proximal TCL
  - Then fans out distally as aponeurosis
- TCL and proximal palmar fascia = Flexor Retinaculum
- Palmaris longus attaches to aponeurosis
  - Absent 25%
- Palmaris longus lies superficial to median nerve
Entrapment neuropathy - Median Nerve
Carpal Tunnel Syndrome - Anatomy

- Sensory branch for thenar eminence leaves proximal to retinaculum
- Motor branch to thenar muscles leaves distal to retinaculum
- Much variance

Entrapment neuropathy - Median Nerve
Carpal Tunnel Syndrome - Clinical

- Dull ache at wrist extending up to elbow
- Worse at night
- Paresthesia radial fingers and thumb
- AbPB weak, OPB later, FPB spared
- Phalen sign – Worse on forced flexion
- Tinel sign – Paresthesia on tapping

Entrapment neuropathy - Median Nerve
Carpal Tunnel Syndrome - MRI

- Increased signal intensity of median nerve
- Swelling of median nerve proximally
- Flattening of median nerve distally
- Bowing of flexor retinaculum

Resnick, D. Bone & Joint Disorders 4th ed. pp 3047-9

Entrapment neuropathy - Median Nerve
Carpal Tunnel Syndrome

Thickened Inflamed Nerve

- Increased intensity of median nerve
- Swelling of median nerve proximally
- Flattening of median nerve distally
- Bowing of flexor retinaculum
Entrapment neuropathy - Median Nerve
Carpal Tunnel Syndrome - Causes

• Bursitis
• Osseous spur
• Mass

Robert Margulies

Entrapment neuropathy
Ulnar Nerve

• C8-T1

Entrapment neuropathy - Ulnar Nerve - Anatomy

• Upper arm, Medial side of brachial artery
• Pierces intermuscular septum mid arm
• Lies on distal medial head of Triceps
• Passes through Cubital Tunnel
• Passes under the strong aponeurotic arcade between the humeral and ulna heads of FCU
• Along forearm between superficial and deep finger flexors

Entrapment neuropathy - Ulnar Nerve - Cubital TS
Cubital tunnel syndrome - Anatomy

• Cubital tunnel anatomy
  • Anterior – medial epicondyle
  • Lateral – Olecranon
  • Floor – Posterior band of UCL
  • Posteromedial –
    • Cubital tunnel retinaculum
    • AKA Arcuate ligament

• Osborne’s ligament or fascia

Ulnar Neuritis

• Posterior band of medial collateral ligament
• Humeral head of FCU
• Ulna head of FCU
• Arcade of Osborne

Entrapment neuropathy - Ulnar Nerve – Sites of Compression

• 1st rib
• Klumpke
• Axilla
• Crutches
• Humerus
• Arcade of Struthers, 70% of pop.
 • Medial triceps to medial intermuscular septum
• Medial intermuscular septum – following anterior transposition
• Elbow
• Cubital tunnel syndrome
• FCU aponeurosis of Osborne
• Forearm
• Aponeurosis between FDS and FDP
• Hand
• Guyon’s canal
• Ulnar tunnel syndrome
**Entrapment neuropathy - Ulnar Nerve**

**Cubital tunnel syndrome**

- **Traumatic**
  - Single event or chronic repetition
- **Nontraumatic**
  - Work related
    - Rest on elbows
    - Elbow flexion/extension
    - Concert pianists Slammed by aponeurotic arch of FCU
- **Scarring and adhesion**
  - Cubital tunnel
  - Under Flexor carpi ulnaris aponeurosis

**Cubital tunnel syndrome - Clinical**

- Ring and little finger paresthesia
- Discomfort medial forearm
- Pain medial elbow
- Tapping nerve causes distress
- Occ. Weak finger add/abd
- Ulnar claw hand

**Entrapment neuropathy - Ulnar Nerve**

**Cubital tunnel syndrome - MRI**

- **Nerve**
  - Compressed, Thickened, Displaced
  - Inflamed and enhancing
- **Cause**
  - OA, Ganglion, Synovitis, Muscle

**Ulnar Neuropathy**

**Entrapment neuropathy - Ulnar Nerve - Cubital TS**

**Anconeus epitrochlearis**

- **Cubital tunnel retinaculum - 27 cadavers**
  - Absent (1)
  - Allows subluxation on flexion
  - Type 1a (17)
    - Taut in full flexion
    - Normal
  - Type 1b (6)
    - Taut in partial flexion
    - Causes dynamic nerve compression
  - Type 2 (3)
    - Replaced by Anconeus epitrochlearis
    - Static compression

- Cubital tunnel retinaculum probably a remnant of the anconeus epitrochlearis

**Cubital tunnel syndrome**

- Spontaneous subluxation of ulnar nerve from the cubital tunnel (15% of population) may exaggerate symptoms
Ulnar Nerve Subluxation in flexion

Entrapment neuropathy - Ulnar Nerve - Cubital TS
Ulnar Nerve Transposition

- Decompression In Situ
- Medial Epicondylectomy, with or without decompression
- Anterior Transposition

Ulnar nerve transposition

- Resection of retinaculum
- Detachment of common flexor tendon
- Division of medial intermuscular septum
- Creation of anterior tunnel for ulnar nerve

Guyon's canal syndrome
- Superficial to flexor retinaculum
- Lateral to pisiform/flexor carpi ulnaris
- Medial to ulnar artery
- Rooted by transverse carpal lig

- Superficial sensory hypothenar branch
  - Proximal to canal 65% - silent paralysis
  - In canal 35% - additional pain and numbness

- Deep motor branch
  - Paralysis – AddPol, Interossos, ulnar lumbricals
  - OpDM > FDM > AbDM
Entrapment neuropathy - Ulna Nerve

Ulnar Tunnel Syndrome

- Causes
  - Pressure
    - Tools, Bicycle, Crutches
  - Fracture hook of Hamate
    - Baseball, Golf

- Features
  - Compression or enlargement of nerve
  - Inflamed and enhancing

Muscle signal intensity with entrapment/denervation

Additional images and text are present, including:
- Variants
  - 10% of ulnar nerves lie radial to the hook of hamate outside the Guyon canal
- Masses
  - Ganglion
  - Lipoma
  - Synovitis
  - Fractures
    - Hook of hamate
  - Accessory muscle
  - Pisohamate coalition
  - Aneurysm
    - Hypothenar hammer syndrome

Guyon's Canal Syndrome

- C5-T1

Additional images and text are present, including:
- Images of ulnar nerve and Guyon's canal with labels.
Entrapment neuropathy

Radial Nerve

Axilla
- Cutsches, Saturday night palsy
- Passes laterally under long head of triceps
- Fibrous arch
- Lies on humerus between medial and lateral heads of triceps
- Fracture of Hohlen-Lewis
- Fractures of lateral
- Passes into anterior compartment through lateral intermuscular septum
  - Compression
  - Lies between brachialis/biceps and ECRB/L, brachioradialis at cubital fossa
  - Body builders
  - Intimal to anterior radiocapitellar joint
  - Synovial lesions
  - Divides
  - Motor – PIN
  - Sensory – Superficial radial nerve
  - PIN enters radial tunnel under arcade of Frohse
  - Leash of Henry (recurrent radial artery) cross over just proximal to arcade
  - Lies between deep and superficial heads
  - Supinator syndrome

Innervations

Radial nerve
- Triceps brachii
- Anconeus
- Brachioradialis
- ECRL

PIN
- ECRB
- ECU
- Supinator
- Ext dig min
- Ext ind
- Ext poll brev
- Abd poll long
- Ext poll long

Radial tunnel syndrome – PIN syndrome

- Compression of the PIN within the radial tunnel yields two distinct clinical entities:
  - Posterior Interosseous Nerve syndrome is characterized by motor deficits and EMG findings of denervation.
  - Radial tunnel syndrome manifests as pain over the proximal lateral forearm as the sole complaint. Motor deficits and EMG findings are typically absent. Delays diagnosis.
  - How? Perhaps different nerve fibers are affected. Perhaps radial tunnel is an early manifestation of PIN.

Radial tunnel syndrome?

- Radial tunnel syndrome can also present with inflammation of the posterior interosseous nerve.

Entrapment Syndromes - Radial Nerve - PIN

Resistant Tennis Elbow

- DDx for lateral epicondylitis
- Radial collateral ligament rupture.
- Radial tunnel syndrome
  - Lateral elbow pain from nervi nervorum

Entrapment Syndromes - Radial Nerve

Posterior Interosseous Syndrome

- Motor nerve
  - Occ. Dull ache lateral elbow
  - Nervi nervorum
  - Fatigue of forearm extensors
  - Weak forearm extensors
    - Weak MCPJ extension esp. 3-4
    - Preserved IPJ extension from lumbricals
  - Radial wrist extensors preserved - ECRL
  - Origin proximal to radial tunnel
Entrapment Syndromes - Radial Nerve

Posterior Interosseous Syndrome - Causes

- Arcade of Frohse
  - it is the most common site for entrapment of the nerve
  - fibrotendinous structure at proximal origin of supinator.
  - Variant present in 30-50% of population
- Leash of Henry
  - small recurrent vessels that cross the PIN

- Ganglions, synovitis and bursitis
  - at the radiocapitellar joint (#2) Often in annular peri-radial recess encircling neck/head
- Fibrous bands, thick tendons (commonly ECRB) – (#4)
- Radial head fx.
- Overuse (athletes or violinists)
- External compression (crutches)

Entrapment Syndromes - Radial Nerve

Posterior Interosseous Syndrome - Causes

- Injury
  - Penetrating or Fx
- Tumor
  - Direct compression
  - Entrapment between tumor and arcade of Frohse
  - Often in annular peri-radial recess encircling neck/head

Entrapment Neuropathy - Radial Nerve

Posterior Interosseous Nerve Syndrome

- 51 y.o. female with weakness of right hand extensors and radial deviated wrist

Anterior Elbow Ganglion

- Anterior Elbow Ganglion

- Anterior Elbow Ganglion

Courtesy: Lorenzo Pacelli
Entrapment Syndromes – Superficial Radial Nerve

Wartenberg’s Syndrome

- Sensory (superficial) branch of radial nerve
- Lies beneath brachioradialis until wrist
- Usually affected at level of wrist
- “Handcuff neuropathy”
- Numbness dorsal aspect radial hand

Entrapment neuropathy

Anterior Thigh Nerves

- Femoral Nerve
  - Causes of femoral nerve injury:
    - Following iliopsoas hematoma
    - Fracture of the acetabulum
    - Surgery

- Lateral Femoral Cutaneous Nerve
  - Meralgia paresthetica L1-2
  - Obesity, Pregnancy, Hyperextension
  - Sensory changes lateral thigh
  - Kinked under inguinal ligament

Entrapment neuropathy

Sciatic nerve

- Sciatic Nerve L4-S3
  - Piriformis Syndrome
  - Tumor
- Tibial nerve
  - Tarsal tunnel syndrome
  - Common peroneal nerve
    - Fibula tunnel

Entrapment neuropathy - Sciatic nerve

Piriformis Syndrome

- Pyramidal shaped muscle
- Sacrum to greater trochanter
- Through greater sciatic notch
- Osseoligamentous channel
- May be split by peroneal portion
Entrapment neuropathy - Sciatic nerve

Piriformis Syndrome

- Sciatic nerve compression below the sciatic foramen which clinically resembles disc extrusion.
- Pain without weakness
- Due to enlargement, inflammation or anatomical variations of the piriformis muscle and sciatic nerve relationship.

Entrapment syndromes

Common Peroneal Nerve

- L4-S2
- Popliteal fossa
- Fibular tunnel

Entrapment syndromes

Common Peroneal Nerve - Causes

- Habitual leg crossing
- Masses
  - Ganglia
- Fx
- Tight cast
Entrapment syndromes
Tibial Nerve – Popliteal Fossa
- L4-S1
- Popliteal fossa
- Tarsal tunnel syndrome
- Plantar nerves
- Digital nerves
- Sural nerves

Entrapment syndromes
Common Peroneal Nerve

Entrapment Syndromes - Tibial nerve
Tarsal Tunnel - Anatomy
- Floor - Talus, Calcaneus, QPM
- Roof - Flexor retinaculum, AbHM
- Anterior - FDL,
- Posterior FHL

- Divided into channels by septae
- 2 cm long, narrowest distally
- Contents - PTT, FDL, FHL, PTNVB
- TN => MCN, LPN, MPN*

Entrapment Syndromes - Tibial nerve
Tarsal Tunnel Syndrome
- AKA - Posterior or Medial TTS, Tibial neuropathy
- Commonest nerve compression syndrome in foot
- Pain and paresthesia plantar foot and toes
- Tibial nerve or branch
- In fibroosseous tunnel
- Deep to flexor retinaculum –laciniate ligament

Entrapment Syndromes - Tibial nerve
Tarsal Tunnel Syndrome - Etiology
- Compression of nerve
  - Intrinsic
    - Ganglions, Varicosties, Lipomas
    - Neuilemmomas, Neurofibromas
    - Synovial sarcoma, Tenosynovitis
    - Accessory muscles
    - Fibrosis from trauma, Rheumatoid arthritis
  - Extrinsic
    - Trauma - Cedell fracture
    - Biomechanical - Jogger’s foot
Entrapment Syndromes - Tibial nerve – Tarsal Tunnel Syndrome

Neuroma

Posterior Process Medial tubercle (Cedell) fracture

- Rare injury
- Dorsiflexion-Pronation-avulsion by deltoid lig

- Complications
  - FHL entrapment
  - Subtalar OA
  - Nonunion
  - Tarsal tunnel syndrome

Jogger’s heel – Lateral Plantar Nerve

Supplies:

- Sensory:
  - Lateral calcaneal periosteum
  - Long plantar ligament

- Motor:
  - Quadratus Plantae
  - Abductor Digiti Quinti
  - Flexor Digitorum Brevis

Baxter’s Neuropathy

- AKA=Inferior Calcaneal Nerve Compression
- Branch of lateral plantar nerve

- Supplies:
  - Sensory:
    - Lateral calcaneal periosteum
    - Long plantar ligament
  
  - Motor:
    - Quadratus Plantae
    - Abductor Digiti Quinti
    - Flexor Digitorum Brevis

Baxter’s Neuropathy

- Compression can be due to:
  - Microtrauma
  - Calcaneal spur
  - Internal foot derangement
  - Plantar fasciitis
Entrapment Syndromes - Tibial nerve

Morton's Neuroma

- AKA - Interdigital Neuroma
- NOT a neoplasm
- Perineural fibrosis response in and about the plantar digital nerves
- Usually females 18:1, ? Shoes, ? Ischemia
- Most common between third and fourth toes
- Look for intermetatarsal bursitis…high SI on T2

Entrapment Syndromes - Tibial nerve

Morton's Neuroma - Anatomy

Joplin Heuter Hauser Morton Iselin

Entrapment Syndromes - Tibial nerve

Morton's Neuroma – Anatomy

• MR signal characteristics
  • Low signal on T1
    • Best seen on Cor T1
  • High signal on T2,
    • Isointense or mildly hypo to fat
    • Best seen with FS
  • Post IV Gad images often demonstrate peripheral enhancement. May increase sensitivity over T2FS
    • Separate fibrosis from bursa
  • Intermetatarsal bursitis often coexists with, or causes a Morton neuroma
    • Can be normal <3mm 1-3 spaces

Entrapment Syndromes - Tibial nerve

Morton’s Neuroma - MRI

• 90% accurate, PPV 100%, NPV 60%
• Diagnostic criteria — (Zanetti et al)
  a) Centered in NV bundle
  b) Intermetatarsal space
  c) Plantar side of intermetatarsal ligament
  d) Well demarcated
  e) SI = muscle on T1, <= fat on T2
• Intermetatarsal bursal fluid 67%
  - (Erikson et al)

Entrapment Syndromes - Tibial nerve

Morton’s Neuroma - MRI

- (Erikson et al) Radiology 1981;141:153
- Zanetti et al. Radiology 1997;203:18
Entrapment Syndromes - Tibial nerve
Morton’s Neuroma - Effect of Foot Positioning

- With prone imaging the neuroma is plantar to “virtual plantar cortical line”
- With supine & weight bearing imaging the neuroma migrates dorsally
- The shape & transverse measurement change
- This is important since neuromas >5mm have a much better surgical outcome
- Neuromas are most conspicuous on prone images


Entrapment Syndromes - Tibial nerve
Morton’s Neuroma - Ultrasound

- Round or ovoid hypoechoic mass
- Power Doppler for bursitis