Compression Neuropathies of the Upper Extremity

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Financial disclosures

• I’m broke.
Objectives

• Review pathophysiology of compression neuropathies
• Review anatomy and function of the nerves of the upper extremity
• Identify compression neuropathies of the upper extremity based on anatomical findings and syndromes
Introduction

- Compression neuropathies of the upper extremity are common
- Usually near joints, where the nerve passes through a fibro-osseous or fibro-muscular tunnel
- Lead to altered function, morbidity, irreversible damage
Introduction

• Andreisek et al. – 51 patients with ambiguous physical exam findings
  – MRI identified a cause in 93%
  – Affected clinical management in 86%

• Rewarding for radiologists and surgeons – identification and treatment can lead to dramatic improvements
Microanatomy

- Nerves are composed of neuroectodermal and mesodermal tissue

- E-epineurium
- A-adventitia
- F-fascicle
- P-perineurium
- *-axon with endoneurium
1. Compression
2. ↓ lymphatic/venous drainage
3. Increased adventitial pressure and leakage of cytokines
4. Breakdown of blood-nerve barrier
5. Increased endoneurial pressure
6. ↓ axonal transport, demyelination, axonal injury/death, fibrosis
Pathophysiology

• Impaired venous drainage at 20 mmHg
• Delayed nerve injury at 30 mmHg for 2 hours
• Within 30 days - inflammatory reaction, fibrosis, demyelination, and axonal loss
• Injury follows a dose-response pattern
Nerve gliding

- Extraneural and intraneural nerve gliding are critical for nerve health
- Median and ulnar nerves can glide up to 7 and 10 mm at the elbow; 15 and 14 mm at the wrist
- Reduced gliding → ischemia
Imaging

• Focal flattening
• Nerve swelling
  – Hyperintensity on fluid-sensitive MRI
  – Hypoechogenicity on US
  – Predominantly proximal to site of compression
• Denervation myopathy
Denervation myopathy

• Poorly understood
• Muscle edema seen typically in 2 to 4 weeks, but has been described as early as 4 days
• Motor neuron exerts trophic effects mediated by contraction and trophic factors
• Denervation → myocyte growth arrest → atrophy
Radial nerve

• Sensory
  – posterior and lateral arm
  – posterior forearm
  – dorsal lateral palm and lateral three and a half digits.

• Motor
  – triceps brachii (except long head)
  – majority of the extensor muscles in the forearm.
Radial nerve
Triangular interval

• Radial nerve enters the posterior compartment of the arm via the triangular interval
Spiral groove

Deltoid tuberosity
AVOID

Median nerve
Brachial artery
Ulnar nerve
Radial nerve
Radial tunnel syndrome

• 1 case for every 100 case of CTS
• Radial tunnel is bounded by:
  – Supinator
  – Brachioradialis
    + ECRL/ECRB
  – Biceps tendon
Sites of compression

- Fibrous bands between the brachialis and brachioradialis
- Recurrent radial vessels (leash of Henry)
- Medial edge of the ECRB
- Arcade of Fröhse
- Distal edge of supinator
Posterior interosseous nerve syndrome vs Radial tunnel syndrome

• Posterior interosseous nerve syndrome:
  – Inability to extend fingers and thumb
  – ECRL function intact—the wrist extends and radially deviates
• Radial tunnel syndrome:
  – Pain distal to lateral epicondyle
  – Pain worsened by extending the elbow, pronating the forearm and flexing the wrist
  – Pain with resisted active supination or wrist extension
  – Pain with resisted middle finger extension at the MCP joint
  – No motor deficit
• Superficial branch of the radial nerves gives sensory to the dorsoradial hand
Wartenberg syndrome

- AKA cheiralgia parasthetica - pain radial 3.5 fingers
- Very rare compression of the superficial branch of the radial nerve
Can occur where the nerve transitions from deep to superficial between the ECRL and brachioradialis
Ulnar nerve

• sensory
  – articular innervation to elbow, wrist and hand
  – ulnar aspect of the hand, 5th finger, ulnar aspect of 4th finger
• motor
  – flexor carpi ulnaris, flexor digitorum profundus (medial half)
  – hypothenar muscles
  – 3rd and 4th lumbricals, interossei muscles, flexor pollicis brevis (deep head), adductor pollicis
Arcade of Struthers

- Aponeurotic band from the medial head of the triceps to the intermuscular septum, 8 cm proximal to the medial epicondyle
- Ulnar nerve passes under the arcade in 80% of individuals
Ulnar nerve entrapment at the Arcade of Struthers

<table>
<thead>
<tr>
<th>Level</th>
<th>Nerve area (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above elbow</td>
<td>14.89</td>
</tr>
<tr>
<td>At elbow</td>
<td>8.07</td>
</tr>
<tr>
<td>Below elbow</td>
<td>4.98</td>
</tr>
</tbody>
</table>
Cubital tunnel syndrome

- Second most common compression neuropathy in the upper extremity
- Sites:
  - Cubital tunnel
  - Arcade of Struthers
  - Medial intermuscular septum
  - Medial epicondyle
  - Deep flexor pronator aponeurosis
Physical exam

• Tinel's test along the course of the ulnar nerve
• Elbow flexion test.
• Pressure provocation test
Treatment

• In situ decompression
• Subcutaneous transposition
• Intramuscular transposition
• Submuscular transposition
• Medial epicondylectomy.
Ulnar tunnel syndrome

- Ulnar tunnel aka Guyon’s canal is bounded by:
  - Transverse carpal ligament
  - Volar carpal ligament
  - Pisiform and piso-hamate ligament
  - Hook of hamate
• Lesions in zone 1 cause both motor and sensory symptoms.
Lesions in zone 2 cause motor deficits.
Lesions in zone 3 create sensory deficits.
What happens after noon...
Bowler’s thumb

- Traumatic neuropathy of the digital nerve on the ulnar side of the thumb
- Perineural fibrosis as nerve crosses over the sesamoid
- Parasthesias in thumb
Will bowling be an Olympic sport in 2020?

Tokyo organizers selected a shortlist of eight sports from a list of 26 that had applied for inclusion.
Median nerve

- **sensory:**
  - radial aspect of the palm
  - palmar aspect of the thumb, index, middle finger and radial half of the ring finger

- **motor:**
  - flexor compartment of the forearm
  - thenar muscles and first and second lumbricals
Supracondylar humeral spur and Struther’s ligament

- Present in 1-2%
- Possible contents: median nerve, ulnar artery, pronator teres m.
Cubital fossa
Pronator syndrome

- Compression of median nerve as it passes between the two heads of the pronator teres muscle or proximal edge of the FDS arch
- Aching pain in the proximal, volar forearm
- Paresthesias radiating into the median innervated fingers
- Pain on resisted pronation
Anterior interosseous nerve syndrome

- AIN arises from the median nerve as it courses beneath the flexor digitorum superficialis m.
- Innervates the deep muscles of the forearm (FPL, radial part of FDP, and pronator quadratus)
- Inability to make an “OK” sign
FPL
FDP (radial part)

Courtesy of Dr. Fliszar
Carpal tunnel syndrome

- Most common compression neuropathy of the upper extremity
- 1-5% of individuals in the US
- Carpal tunnel is bounded by:
  - carpal bones and transverse carpal ligament
- Palmar cutaneous nerve branches 5 cm proximal to the tunnel
- Median nerve branches into sensory and motor branches after the tunnel
- CTS is bilateral in half of cases
Causes

• Primary CTS – women aged 30-50 years
• Hypothyroidism
• Rheumatoid arthritis
• Distal radius fracture
• Pregnancy
• Repetitive strain
• Workers using vibratory tools
Symptoms

- Numbness and tingling in the median nerve distribution
- Nocturnal numbness
- Weakness and/or atrophy of the thenar musculature
- Tinel sign
- Phalen's test
- Loss of 2-point discrimination
Diagnosis

• Median nerve
• Secondary causes
• Quantitative:
  – Cross sectional area (CSA) of nerve
  – Swelling ratio (CSA at radius : CSA at pisiform)
  – Palmar bowing
<table>
<thead>
<tr>
<th></th>
<th>MRI</th>
<th></th>
<th>MRI</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sen</td>
<td>Spe</td>
<td>AUC (95% CI)</td>
<td>Cut-Point</td>
</tr>
<tr>
<td>CSAp (mm²), rest</td>
<td>0.74</td>
<td>0.88</td>
<td>0.84 (0.78–0.90)</td>
<td>10.9</td>
</tr>
<tr>
<td>Grasp*</td>
<td>0.74</td>
<td>0.86</td>
<td>0.84 (0.78–0.90)</td>
<td>10.3</td>
</tr>
<tr>
<td>Swelling ratio, rest*</td>
<td>0.80</td>
<td>0.59</td>
<td>0.76 (0.67–0.83)</td>
<td>1.3</td>
</tr>
<tr>
<td>Grasp*</td>
<td>0.76</td>
<td>0.63</td>
<td>0.73 (0.65–0.80)</td>
<td>1.3</td>
</tr>
<tr>
<td>Bowing of FR (mm), rest*</td>
<td>0.91</td>
<td>0.59</td>
<td>0.83 (0.77–0.89)</td>
<td>1.8</td>
</tr>
<tr>
<td>Grasp*</td>
<td>0.88</td>
<td>0.69</td>
<td>0.84 (0.78–0.90)</td>
<td>2.0</td>
</tr>
<tr>
<td>Flattening ratio, rest</td>
<td>0.60</td>
<td>0.69</td>
<td>0.65 (0.57–0.73)</td>
<td>2.2</td>
</tr>
<tr>
<td>Grasp</td>
<td>0.68</td>
<td>0.53</td>
<td>0.62 (0.54–0.73)</td>
<td>2.0</td>
</tr>
<tr>
<td>CSAp in rest and bowing of FR in grasp position</td>
<td>0.78</td>
<td>0.86</td>
<td>0.88 (0.82–0.93)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

CI, confidence interval; FR, flexor retinaculum; Sen, sensitivity; Spe, specificity.

*P < .05, comparison of the AUC between the MRI and sonography.
Amyloidosis
Conclusion

• Radiologists play an important role in the diagnosis and management of a small but significant subset of patients with compression neuropathies

• Anatomy is key to diagnosing compression neuropathies

• Secondary signs including denervation myopathy and clinical syndromes are useful
References