NEUROPATHIES AT THE WRIST

PRESENTED BY: CHARLES QUAGLIERI MD
DISCLAIMER

The views and opinions expressed in the written materials and in any of the presentations at this conference are those of the presenter and do not necessarily reflect the official policy or position of the Department of Business and Industry, Division of Industrial Relations. The Division does not warranty the materials’ completeness or accuracy.
Peripheral Nerve Fiber types

Three types of nerve fibers:

**Sensory:** Sensation.
**Motor:** Muscle strength.
**Autonomic:** Involuntary activity, such as sweating etc.

Sensory fibers
Motor fibers
Autonomic fibers
Pathophysiologic classification of nerve compression

<table>
<thead>
<tr>
<th>Severity</th>
<th>Pathophysiology</th>
<th>Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>Blood-nerve barrier breakdown</td>
<td>Symptoms, no signs on exam</td>
</tr>
<tr>
<td>Moderate</td>
<td>Demyelination</td>
<td>Symptoms, signs, and/or of weakness</td>
</tr>
<tr>
<td></td>
<td>Abnormal threshold</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>Axonal loss</td>
<td>Symptoms, signs, and muscle wasting</td>
</tr>
<tr>
<td></td>
<td>Decreased innervation</td>
<td></td>
</tr>
</tbody>
</table>
Acute versus Chronic Peripheral Nerve Injury

Acute injury:
- Sensation loss
- Muscle atrophy

Chronic injury:
- Numbness and tingling
- Sensation loss and muscle atrophy
Hand numbness and tingling

1. Peripheral nerves connect our brain/spinal cord to the other parts of your body.

2. A peripheral nerve injury can interfere with brain's ability to communicate with your hands.

3. Abnormal sensations caused by peripheral nerve dysfunction, common in nerve compression.
Signs and Symptoms

- Tingling in the fingers
- Numbness in the fingers
- Aching in the thumb, perhaps moving up as far as the neck
- Burning pain from the wrist to the fingers
- Change in touch or temperature sensation
- Clumsiness in hands
- Weakness of grip, ability to pinch and other thumb actions
- Swelling of hand and forearm
- Change in sweat functions of hand
Median nerve dermatomes
Nerve Compression Syndromes of the Hand

- **Median nerve**
  - Carpal tunnel syndrome
  - Pronator syndrome
  - Anterior interosseous syndrome  
    ------------ Most common

- **Ulnar nerve**
  - Cubital tunnel syndrome
  - Guyon canal syndrome  
    ------------ Second most common

- **Radial nerve**
  - Radial tunnel syndrome
  - Posterior interosseous syndrome
  - Superficial radial nerve syndrome
Nerve Compression Syndromes of the Hand

- **Median nerve**
  - Carpal tunnel syndrome
  - Pronator syndrome
  - Anterior interosseous syndrome
  
  --------------- Most common

- **Ulnar nerve**
  - Cubital tunnel syndrome
  - Guyon canal syndrome

  --------------- Second most common

- **Radial nerve**
  - Radial tunnel syndrome
  - Posterior interosseous syndrome
  - Superficial radial nerve syndrome
Sensory Nerve Innervation in the Hand

- **Median nerve:**
  Thumb, index, long, and radial side of the ring finger.

- **Ulnar nerve:**
  Small finger and ulnar aspect of the ring finger.

- **Radial nerve:**
  The radial aspect of the dorsum of the hand and thumb, index, and long finger.
What is carpal tunnel?

1. A narrow passageway on the palm side of the wrist.
2. Made up of bone, tendons, and ligaments.
3. Cross section area: $134.9 \pm 23.6 \text{ mm}^2$.
4. One nerve, nine tendons, and synovium.
5. Size of median nerve: $\approx 10 \text{ mm}^2$.
7. With repetitive wrist movement or constant pressure, the canal can become inflamed.

$\uparrow$ carpal tunnel pressure $\rightarrow$ median nerve compression $\rightarrow$ carpal tunnel syndrome
Anatomy

- Carpal Tunnel
  - Serves as a conduit for the median nerve and nine flexor tendons
  - The palmar radiocarpal ligament and the palmar ligament complex form the floor of the canal
  - The roof of the tunnel is formed by the flexor retinaculum (transverse carpal ligament)
  - The ulnar and radial borders are formed by carpal bones (trapezium and hook of hamate respectively)
  - Within the tunnel, the median nerve divides into a motor branch and distal sensory branches
Carpal Tunnel

- Deep to palmaris longus
- Contains median nerve and finger flexor tendons
- Most common overuse injury of the wrist
Carpal Tunnel Syndrome

- Carpal tunnel syndrome (CTS) is a collection of symptoms and signs that occurs following entrapment of the median nerve within the carpal tunnel. [2]
- Usual symptoms include numbness, paresthesias, and pain in the median nerve distribution.
- These symptoms may or may not be accompanied by objective changes in sensation and strength of median-innervated structures in the hand. [2]
Demographics of Carpal Tunnel Syndrome

1. Incidence: 1-3 per 1000 subjects per year.

2. Prevalence: ≈ 5 per 100 subjects in general population.
   14 per 100 in diabetics
   30 per 100 in diabetics with neuropathy

3. Women are three times more likely than men to develop CTS.

4. The dominant hand is usually affected first.

5. The estimated lifetime risk: 10% of adults.
Epidemiology

• Race
  – Whites at highest risk of developing CTS.
  – Very rare in some racial groups (e.g., nonwhite South Africans)[2]

• Sex
  – Female-to-male ratio is 3-10:1 [2]

• Age
  – The peak age range for development of CTS is 45-60 years. Only 10% of patients with CTS are younger than 31 years [2]
Carpal Tunnel

- The carpal tunnel is formed between the **carpal bones** of the wrist and the **transverse carpal ligament**.

- The ligament is an unyielding thick fibrous tissue which does not allow for changes in volume within the carpal tunnel. [1]
Symptoms of Carpal Tunnel Syndrome

1. Numbness/tingling in the index and middle fingers, followed by thumb, uncommon in the ring finger.
2. Night time awakening (Wrist flexion).
3. Thenar muscle wasting: classic but rare.
4. Dropping objects and weakness.
Causes

- CTS is associated with many different factors
  - **Demographic**: Increasing age, Female sex, Dominant hand, Race (white) [3]
  - **Genetic**: Square wrist, Thickened transverse ligament, Short stature
  - **Medical Condition**: Diabetes, Thyroid disease, Hereditary neuropathy, Arthritis [3]
  - **Occupation**: Due to repetitive movement
  - **Injury or trauma**
  - **Pregnancy**
- Most cases have no known cause
Tests and Diagnosis

- **History**
  Pattern of signs and symptoms
  Timing of the symptoms

- **Physical exam**
  Sensation
  Muscle strength
  Tinel’s sign
  Phalen test
  Durkan test
Diagnosis

- Motor examination
  - Wasting and weakness of the median-innervated hand muscles (LOAF muscles) may be detectable.
  - L - First and second lumbricals
  - O - Opponens pollicis
  - A - Abductor pollicis brevis
  - F - Flexor pollicis brevis
Diagnosis

• CTS is a clinical diagnosis [2]
• Sensory examination
  – Abnormalities in sensory modalities may be present on the palmar aspect of the first 3 digits and radial one half of the fourth digit
Tests

- **X-ray**
  Rule out arthritis or a fracture.

- **Electromyogram**
  1. To measure electrical discharges produced in muscles.
  2. To determine if muscle damage has occurred.

- **Nerve conduction study**
  1. To measure if electrical impulses are slowed in the carpal tunnel.
  2. To rule out other condition in the neck.
ElectroDiagnostic

- Electrodes are placed on the forearm and a mild electrical current is passed through the arm.
- Measurement of how fast & how well the median nerve responds indicates if there is damage to the nerve.
- ED tests can help:
  - identify peripheral neuropathy
  - locate other sites of compression
  - establish severity
Special Test

- No good clinical test exists to support the diagnosis of CTS.
  - Hoffmann-Tinel sign
    - Gentle tapping over the median nerve in the carpal tunnel region elicits tingling in the nerve's distribution.
  - Phalen sign
    - Tingling in the median nerve distribution is induced by full flexion (or full extension for reverse Phalen) of the wrists for up to 60 seconds
    - This test has 80% specificity but lower sensitivity.
Special Test

- **The carpal compression test**\(^6\)
  - This test involves applying firm pressure directly over the carpal tunnel, usually with the thumbs, for up to 30 seconds to reproduce symptoms.
  - Reports indicate that this test has a sensitivity of up to 89% and a specificity of 96%.

- **The square wrist sign**
  - The ratio of the wrist thickness to the wrist width is greater than 0.7.
  - This test has a modest sensitivity/specificity of 70%.
  - Several other tests have been advocated, but they rarely provide additional information beyond that which the Phalen and square wrist signs provide.
Risk Factors

1. **Anatomic factors.** 1. a wrist fracture or dislocation; 2. smaller carpal tunnel in women.

2. **Nerve-damaging conditions.** Diabetes and alcoholism: ↑ risk of nerve damage.

3. **Inflammatory conditions.** RA or infection can affect the tendons and exert pressure on median N.

4. **Alterations in the balance of body fluids.** Certain conditions (pregnancy, menopause, obesity, thyroid disorders, or kidney failure) → fluid retention → pressure increase within carpal tunnel.

5. **Workplace factors.** Vibrating tools/ work requiring prolonged or repetitive flexing of the wrist → pressure increase within carpal tunnel.
<table>
<thead>
<tr>
<th>Job Tasks</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grasping and tugging fabric, pulling cloth</td>
<td>Production sewer, tailor, garment worker/stitcher</td>
</tr>
<tr>
<td>Milking cows</td>
<td>Farmer</td>
</tr>
<tr>
<td>Handling objects on conveyor belts</td>
<td>Assembly-line worker</td>
</tr>
<tr>
<td>Pushing down ratchet, using screwdriver</td>
<td>Mechanic</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>Gardener</td>
</tr>
<tr>
<td>Keyboarding / mouse use</td>
<td>Office workers</td>
</tr>
<tr>
<td>Knitting</td>
<td>Homemaker</td>
</tr>
<tr>
<td>Scrubbing</td>
<td>Janitor</td>
</tr>
<tr>
<td>Playing stringed instruments with bow</td>
<td>Musician</td>
</tr>
<tr>
<td>Using laser scanner at checkout</td>
<td>Cashier</td>
</tr>
<tr>
<td>Assembling small parts</td>
<td>Electronic industry worker</td>
</tr>
<tr>
<td>Pressing tool into palm</td>
<td>Painter, carpenter, stablehand</td>
</tr>
<tr>
<td>Using air-powered hand tools</td>
<td>Assembly worker</td>
</tr>
</tbody>
</table>
Nonsurgical Treatment

1. Activity modification

2. Nonsteroidal anti-inflammatory drugs (NSAIDs)

3. Wrist splinting

4. Corticosteroids
   Steroid injection
   Oral steroid
• **Splint**
  • Wrist splints are recommended for use either at night, or both day and night although they get in the way when doing daily activities. These help to keep wrist straight and reduce pressure on the compressed nerve.
  • Most individuals with mild-to-moderate carpal tunnel syndrome (CTS; according to electrophysiologic data) respond to conservative management, usually consisting of **splinting the wrist at nighttime for a minimum of 3 weeks.** [2]
Management (Non Surgical)

- **Physical Therapy**
  - Given CTS is associated with low aerobic fitness and increased BMI, it is inherent to provide the patient with an aerobic fitness program.
  - Stationary biking, cycling, or any other exercise that puts strain on the wrists probably should be avoided.
  - It may be possible to enlarge the carpal tunnel by specific stretching techniques. Such an exercise program may provide a new noninvasive treatment for CTS in the future.[2]
Management
Surgical

- Patients whose condition does not improve following conservative treatment and patients who initially are in the severe carpal tunnel syndrome should be considered for surgery.
- There are 2 types of surgery:
Open Carpal Tunnel Release

- The surgeon makes a 2-5 inch incision in the lower palm and wrist area. [8]
- The carpal ligament is opened. This frees the median nerve.
- The incision is closed with stitches. A bulky bandage is applied to the wound, with care taken to ensure that digit movement is NOT restricted.
- Effective release of TCL has been shown to increase carpal tunnel volume by 24% [6]
Endoscopic Carpal Tunnel Release

- A tiny, ½-inch incision is made on the palm side of the wrist.
- A fiber optic camera is passed through which allows the surgeon to view the inside of the carpal tunnel.
- Another tiny incision is made. Surgical tools are passed in and these instruments are used to release the carpal ligament and free the median nerve.
- After the camera and instruments are removed, a few stitches are necessary to close the incisions. A bulky bandage is placed over the wounds. [8]
Surgical Treatment

The goal of carpal tunnel surgery:
To relieve pressure on the median nerve by cutting the ligament pressing on the nerve.

Open surgery
Surgery involves making an incision in the palm of the hand over the carpal tunnel and cutting through the ligament to free the nerve.

Endoscopic surgery
A small incision in the wrist. Higher complication rate.
Pathophysiology

The tendons of the hands are wrapped with a lining that produce a synovium fluid which lubricates the tendons.

With repetitive movement of the hand, the lubrication system may malfunction.

This reduction in lubrication results in inflammation and swelling of the tendon area.

Abnormally high carpal tunnel pressures exist in patients with CTS.

This pressure causes obstruction to venous outflow, back pressure, edema formation, and ultimately, ischemia in the nerve.
Complication

- Carpal tunnel syndrome may continue to increase median nerve damage, leading to permanent impairment and disability.
- Some individuals can develop chronic wrist and hand pain.[2]
Prognosis

- Carpal tunnel syndrome appears to be progressive over time and can lead to permanent median nerve damage.
- Whether any conservative management can prevent progression is unclear.
- Even with surgical release, it appears that the syndrome recurs to some degree in a significant number of cases possibly in up to one third after 5 years.
- Initially, approximately 90% of mild to moderate CTS cases respond to conservative management. Over time, however, a number of patients progress to requiring surgery.[2]
Carpal Tunnel Syndrome

- Compression median nerve at the carpal tunnel
- Patient will experience numbness, tingling, or burning sensation at the thumb, index, middle and radial half of the ring finger.
- If untreated – weakness or atrophy of the thenar muscles.
<table>
<thead>
<tr>
<th>Repetitive Task</th>
<th>Profession</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grabbing &amp; tugging cloth</td>
<td>Tailor, sewer</td>
</tr>
<tr>
<td>Handling objects on conveyor belt</td>
<td>Assembly-line worker</td>
</tr>
<tr>
<td>Hand weeding</td>
<td>Gardener</td>
</tr>
<tr>
<td>Using spray gun</td>
<td>Painter</td>
</tr>
<tr>
<td>Knitting</td>
<td>Homemaker</td>
</tr>
<tr>
<td>Turning keys</td>
<td>Locksmith</td>
</tr>
<tr>
<td>Typing</td>
<td>Clerical worker</td>
</tr>
<tr>
<td>Using scanner at checkout counter</td>
<td>Cashier</td>
</tr>
<tr>
<td>Scrubbing</td>
<td>Janitor</td>
</tr>
<tr>
<td>Stringed instruments</td>
<td>Musician</td>
</tr>
</tbody>
</table>
• Occupational Therapy
  • A physical therapist will observe and evaluate the dynamics and ergonomics or the working environment.
  • Ergonomics is the study and control of the effects of postures, stresses, motions, and other physical forces on the human body engaged in work. [7]
  • Physical therapist will show employees how to adjust their work area, handle tools, or perform tasks in a way that puts less stress on the body.
  • They may teach employees a number of exercises to increase flexibility of their arm/hand region while they are at work.[7]
  • Specific stretching/strengthening program for the hand and wrist may be useful in improving strength and dexterity (particularly following surgical treatment), although it can exacerbate symptoms.
Medication

- Short (1-2 wk) courses of regular NSAIDs can be of benefit, particularly if there is any suggestion of inflammation in the wrist region. Likewise, if edema is thought to be prominent, then a short course of a mild diuretic may be of benefit.

- NSAIDs provide pain relief and reduction of inflammation. Reducing inflammation in the structures passing through the carpal tunnel decreases pressure and provides some relief to the compressed nerve. [2]

- Conditions that cause edema may increase pressure in the carpal tunnel. Diuretics may be beneficial in reducing edema.

- Steroid injection into the carpal tunnel is of benefit, as is oral prednisone.

- Vitamin B-6 or B-12 supplements are of no proven benefit.

- Overuse of legal drugs (eg, caffeine, nicotine, alcohol) can contribute to CTS and should therefore be reduced.
Dermatomes

- Area of the skin that supplied by single spinal nerve.
- the area of the skin that provides sensory input to the dorsal roots of a pair of spinal nerves
- There are 8 cervical, 12 thoracic, 5 lumbar and 5 sacral spinal nerves that relays cutaneous sensation (pain, thermal, itch, touch etc) from particular region of the body to the brain
- Dermatomes are useful in neurology for finding the site of damage to the spine
Hand Dermatomes
Radial Nerve Dermatomes
Sensation Testing

Dorsal hand

Radial hand
Anatomy

- **Tunnel of Guyon**
  - A depression superficial to the flexor retinaculum, located between the hook of the hamate and the pisiform bones
    - The palmar (volar) carpal ligament, palmaris brevis muscle, and the palmar aponeurosis form its roof
    - Its floor is formed by the flexor retinaculum (transverse carpal ligament), pisohamate ligament, and pisometacarpal ligament
  - The tunnel serves as a passage way for the ulnar nerve and artery into the hand
References

3. http://www.bupa.co.uk/individuals/health-information/directory/c/carpal-tunnel accessed on 10 September 2011