Carpal Tunnel Syndrome

Reid Abrams, MD
Chief, Hand & Microvascular Surgery
University of California, San Diego
Clinical Presentation

- CTS constellation of signs and symptoms
- No objective test, symptom or physical finding is pathognomonic
- Essential complaint: intermittent or constant numbness or tingling in the median nerve distribution
- Nocturnal symptoms
Clinical Presentation

- May be associated with volar wrist pain
- Pain may be focal or vague radiating as far proximal as the shoulder
- In severe cases may be associated with weakness and atrophy of the thenar muscles.
Clinical Presentation

- Sustained forceful or repetitive manual activities or extreme wrist positioning may precipitate symptoms
Clinical Presentation

- **Myths** to dispel
  - “My hand hurts, I must have CTS”
  - “My hand hurts when I use the computer, I must have CTS”
  - “Doc, I never use the computer, there’s no way I have CTS”
  - “I don’t want surgery because it doesn’t work”
Clinical Presentation

- **Myths to dispel**
  - Not all pain from repetitive trauma is CTS
  - Not all pain from keyboard use is CTS
  - Just because you don’t use a keyboard doesn’t mean you don’t have CTS
  - Treatment is usually successful
Epidemiology

- Most common nerve entrapment neuropathy
  - 0.1%-10% of general population
  - 15% of high risk occupations
- US medical costs $1 billion annually
  - 200,000 surgical procedures/yr
Epidemiology-Risk factors

- Obesity
- Gender (F:M; 3:1)
- Diabetes (14%-30%)
- Pregnancy (50%)
- Inflammatory arthritis
- Renal disease

- Acromegally
- Mucopolysaccharidosis
- Hypothyroidism
- Age (>50)
- Genetic factors (twin study)
- Smoking
- Occupational exposure
Carpal Tunnel Anatomy

- Extends from wrist crease to mid palm
- Traversed by 9 flexor tendons and Median nerve
- Bordered palmarly by TCL
- Guyon’s canal ulnarly adjacent
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Carpal Tunnel Anatomy

- Bordered on the back and both sides by carpal bones; on the palm side by the TCL
- Narrowest at hamate hook, capitate, trapezial ridge
Carpal Tunnel Anatomy

- Oval shape
- Width
  - 20mm @ narrowest portion
  - 25mm distal & proximal ends
- Volume
  - ~ 5-6ml
Median Nerve Anatomy

- Spinal roots C5,6,7,8 & T1
- Brachial plexus conjoined branches from med & lat cords
- Innervates most of the muscles in (F) forearm
- Innervates most of the muscles @ base of thumb
- Sensory: Thumb, IF, MF and 1/2 of RF
Pathophysiology

- CTS results when pressure in the carpal tunnel exceeds the tolerance of the median nerve.

- Consequences to the nerve depends on:
  - Acuity of pressure increase
  - Magnitude of pressure
  - Gradient of pressure change
## Pathophysiology

### Acute Nerve compression

<table>
<thead>
<tr>
<th>Blood Pressure (mm Hg)</th>
<th>Pathophysiological Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>20-30</td>
<td>Blocked axonal transport</td>
</tr>
<tr>
<td>60-80</td>
<td>Intraneural vascular occlusion</td>
</tr>
<tr>
<td>130-150</td>
<td>Conduction block</td>
</tr>
</tbody>
</table>
Pathophysiology

- Chronic compression similar effects to nerves as acute compression
- Thickening of nerve covering (epineurium)
- Myelin degeneration
Pathophysiology

- CT behaves like a closed compartment
  - Resting pressure
    - W/out CTS~2 mmHg
    - W/ CTS~30 mmHg
Pathophysiology

- Increased pressure with:
  - Extreme wrist positioning
    - Without CTS ~30 mmHg
    - With CTS >90 mmHg
  - Grip/pinch
    - Pinch 15N ~50 mmHg
  - Certain positions of forearm, wrist, and hand
    - 30-60 mmHg
    - Influence of incursion lumbricals and bellies of FDS
Pathophysiology

- Increased canal contents
  - Mass-ganglion
  - Anomalous muscle
  - Persistent median artery
  - Swelling from trauma
  - Inflammatory-RA, Gout, Amyloid (CRF)
  - Fluid homeostasis abnormality-Pregnancy, Hypothyroidism, Diabetes, CRF
Pathophysiology

- Mechanical factors
  - Cane and wheelchair users
  - Vibration
  - Occupational exposure
  - Canal distortion (e.g. DR fx malunion)
Diagnosis

- History
  - Nocturnal symptoms
  - Constant vs intermittent
  - Precipitants
  - Associated medical problems
Diagnosis

- Physical examination
  - Sensory examination
    - 2PD vs Semmes Weinstein
  - Thenar strength
    - Atrophy?
- Questionnaires/Hand diagram
Diagnosis

- Provocative tests
  - Tinel’s sign
Diagnosis

- Provocative tests
  - Tinel’s sign
  - Phalen’s test
Diagnosis

- Provocative tests
  - Tinel’s sign
  - Phalen’s test
  - Durkan’s test
Diagnosis

- Electrodiagnostic studies
  - EMG
  - NCV
  - Objective
  - “Gold standard?”
Diagnosis

- Electrodiagnostic studies
  - (-) in 8%-22% with CTS by clinical criteria who have responded favorably to surgery
  - (+) in asymptomatic pts.
Diagnosis

- Electrodiagnostic studies
  - Utility controversial
    - Identify other sites of compression or peripheral neuropathy
    - H & P ambiguous
    - Severity
    - Post-surgical or refractory cases
Diagnosis

- Accuracy depends on...
  - Study population
  - Combination of Hx and PE findings
    - 86% chance of Dx of CTS if
      - (+) night pain, SW monofilment sensory test, Durkan’s test and hand diagram
    - 0.68% chance of CTS if all are (-)
    - EDS does not add any further to this combination
Diagnosis

- Differential diagnosis
  - Cervical root compression
  - Brachial plexus compression
  - Pronator syndrome
Treatment

- Effective non-surgical
  - Splinting
  - Nocturnal
  - Activity modification
  - Cortisone injection
    - Success in 80% short term; 20% 1 1/2 yrs
  - General conditioning & nerve gliding exercises
Treatment

● Equivocal or ineffective non-surgical
  ■ NSAIA
  ■ Vitamin B6
  ■ Ultrasound
  ■ Chiropractic
  ■ Magnet
  ■ Laser acupuncture
Treatment

- Surgical indications
  - Poor response to non-operative treatment
  - Constant or nearly constant numbness or tingling
  - Thenar (thumb muscles) atrophy or weakness
  - EMG showing denervation of thenar muscles
Treatment

- Surgical goals
  - Decompress median nerve
  - Avoid injury to
    - Median nerve and branches
    - Ulnar nerve
    - Superficial arch blood vessels
    - Tendons
  - Minimize dissection to reduce post-op pain, morbidity and scar entrapment
Treatment

- **Surgery**
  - Cut or lengthen the ligament on the front of the carpal canal
  - Increases canal cross-section by 25%
  - Explore for abnormal canal contents and remove if present
Treatment

- Open CTR incision
  - Extensile
Treatment

- Open CTR incisions
  - “Mini”

Radial border of the ring finger
Treatment

- Endoscopic CTR
  - 1 vs 2 portal
  - Risk?
Treatment

- In primary uncomplicated cases no benefit of...
  - Epineurotomy
  - Internal neurolysis
  - Tenosynovectomy
Treatment

- Ligament lengthening vs release
  - Influence on Post-op grip strength
**Outcome**

- **Conservative**
  - 15-20% short term success w/ NSAIA/splints (Kaplan; Banta)
  - Age >50, constant tingling, +Phalen’s, duration > 10 mo., tenosynovitis associated with poor prognosis (Kaplan et al)
  - Cortisone inj. 80% success, ↓22% after 1 1/2 yrs
Outcome

- **Surgery**
  - 70%-98% success
  - 1%-25% persistent stx or recurrence
  - Nocturnal stx resolve better than daytime stx
  - Pain and intermittent tingling resolve 1st, then numbness
  - Grip/Pinch-3-6 months
Outcome

- Surgery
  - Poor prognostic indicators
    - Age over 60
    - Long term constant numbness & muscle atrophy
    - Associated Diabetic peripheral neuropathy
Outcome

- Endoscopic vs open release
  - Final outcome is the same
  - Earlier RTW with ECTR
    - ECTR-14-18 days
    - OCTR-28-38 days (Brown et al, Trumble et al)
  - Less pain with ECTR early but no difference by 3 mo. (Trumble et al)
Outcome

- Recurrent CTS
  - Re-operation 80% success
**Conclusion**

- **Carpal tunnel is a canal at the wrist with finite dimensions**
  - Bordered by bone and ligament
  - Contains finger flexor tendons and the median nerve
- **Median nerve innervates**
  - Most of the thumb (thenar) muscles
  - Sensation to the thumb, index, long and 1/2 of the ring finger
Conclusion

- Carpal tunnel syndrome occurs when pressure on the median nerve causes dysfunction
- Essential symptom: Numbness or tingling
  - May have associated pain, weakness
  - Not all hand pain is CTS
Conclusion

- History and physical examination are keys to the diagnosis
  - Electro-diagnostic studies
- Treatment
  - Non-operative
    - Activity modification, splinting, injection
  - Surgery
    - For failed conservative treatment
    - Usually successful
Thank you