Objectives

- Median nerve recovery after surgery
  - EDX
  - Symptoms
- Surgical complications
  - Early
  - Late
  - EDX post-op
- Surgical Techniques (a bit)
CTS Cochrane Review

- Randomized trials comparing surgery to non-surgical tx favor surgery at 1 year follow-up.
- More complications in the surgery group.
- “Risk” of second surgery is 4%.
- Not enough trial data to select treatment option.

Verdugo RJ, et al. Surgical vs non-surgical…
Cochrane Database Sust Rev 2008 Oct 4;(4):CD001552

CTS Steroid Injection-Outcome

- Improvement in median sensory latency (mean)
- Improvement in median motor amplitude (mean)
- 25% had normal EDX after Tx
- Maintained results for 6 months

Hagebeuk, E. Clinical and electrophysiological follow-up after local steroid…
Post-op CTS (n=30)
OSU Outcome 1968 in Severe CTS

- Immediate improvement - 26
- Limited improvement – 4 (13%)
- Re-operation performed - 2
  - Then – immediate relief

Note: Up to 1/3 still have EDx abnormalities

Melvin, et al, 1968 Arch.PM&R.49.503 (at OSU)

How Severe were the Cases of CTS? Based upon Pre-Op NCS

Preoperative Severity

<table>
<thead>
<tr>
<th>Severity Level</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>1</td>
</tr>
<tr>
<td>4.5-5.0</td>
<td>5</td>
</tr>
<tr>
<td>5.1-6.9</td>
<td>8</td>
</tr>
<tr>
<td>7.0-9.9</td>
<td>11</td>
</tr>
<tr>
<td>10.0+</td>
<td>5</td>
</tr>
</tbody>
</table>

Melvin et al, 1968 Arch.PM&R.49.503
Post op CTS 1 yr (n=30)

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>normal</td>
</tr>
<tr>
<td>tingling</td>
<td>sensory deficit</td>
</tr>
<tr>
<td>numbness</td>
<td>weakness</td>
</tr>
<tr>
<td>aching</td>
<td>Tinel +</td>
</tr>
<tr>
<td>weakness</td>
<td>tender scar</td>
</tr>
<tr>
<td>‘asleep’</td>
<td>atrophy</td>
</tr>
</tbody>
</table>

Melvin et al, 1968 Arch.PM&R.49.503

Post-Op Testing at 1 yr Shows Sensory Recovery

- But NOT to Normal

![Postop Sensory Distal Latencies](image)
Segmental Demyelination and Remyelination

- Myelin repair is not to normal thickness
- Breakdown of Myelin is followed by proliferation of Schwann cells
- Repair results in several shorter and thinner myelin segments
- Resulting in slower NCV

What if the symptoms do not go away, Or if they return?
**Post-op Complications**
- Recurrence
- Hematoma
- Infection
- Neuroma
- Adhesions
- Dysesthetic scar
- RSD (CRPS I)

**CASES**
- 200 secondary operations, 200 patients over 2 years.
- 198 had original operations elsewhere.

**FINDINGS**
- 54% incomplete release (distal)
- 23% constricting scar and tethering
- 8% nerve scarring
- 6.5% nerve injury-iatrogenic
- 2% benign tumors
- 7% no reason ID’d

Stütz. J Hand Surgery (British), 2006; 31B 1: 68–71
Median Nerve tethering in Post-op CTS

Tethered in scar

Nerve after release

**FIGURE 1.** Severe tethering of the median nerve resulted from scar adhesion. The nerve is enclosed in scar tissue.

**FIGURE 2.** Result after external neurolysis of the median nerve.

Recurrent and unrelieved CTS

- 13 iatrogenic nerve injuries
- 7 occurred in 30 endoscopic surg.
- 6 were from 170 open procedures
- Other complications occurred equally in endo vs. open cases

Stütz. J OPERATIVE NEUROSURGERY 2008; 62: ONS194

Stütz. J Hand Surgery (British), 2006; 31B 1: 68–71
Iatrogenic Nerve Injury in CTS

- 6 Median Nerve
  - 4 partial
  - All endoscopic
- 3 Motor branch
  - (“Recurrent”)
  - 2 open
- 3 Palmar branch
  - All open

Stütz. J Hand Surgery (British), 2006; 31B 1: 68–71

Recurrent and unrelieved CTS

- Presentations (time to 2nd surgery)
- Early
  - Incomplete release (distal edge most common)-most had no relief, some lasted as long as 75 d before Sx’s-0 to 75d
  - Injury-35d to 1.5y
- Mid-
  - nerve fibrosis 28d to 3yr
  - Masses-1y to 2y
- Late-adherent scar-48d to 12 yr

Stütz. J Hand Surgery (British), 2006; 31B 1: 68–71
The Challenge of NCS Evaluation of Median Motor Recurrent Thenar Branch

- APBr
- Median
- Recurrent
- Branch Ulnar

Stimulation Proximal & Distal to Carpal Tunnel

- Distal Motor fibers
  - Wrist stimulation first at 8 cm
  - Recurrent branch to thenar in palm
  - Normal Amplitude increases by less than 20% compared with wrist stimulation

CAUTION – Shape of CMAP must be similar in both stimulation sites. With increase stimulation intensity Deep Palmar Ulnar nerve can be activated.

- Watch the muscle movement in the hand while stimulating.
Stimulation Proximal & Distal to Carpal Tunnel

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Stimulus point for recurrent Branch of median nerve
Thenar crease
Ring finger touch

Stim in the Palm allows observation of conduction block (Neurapraxia)
Stimulation in the palm

- 1st: Ulnar nerve stim and adduction of thumb
- Then, proximal move to adjust stim site
- 2nd Median recurrent thenar branch and abduction of thumb
- Watch the muscle move - not the monitor

Pin stimulus with monopolar needle
Conduction Block with abnormal DML

Incorrect placement of electrode

Motor lat @ 8 cm is 3.8ms (WNL)
Amp of CMAP @ 8 cm is 9.7mV (WNL)
NCV Forearm is 51m/s (WNL)
Amp increase in palm is 70% (only abnormality)
Stimulation Proximal and Distal to Carpal Tunnel

- Sensory fibers

Median Sensory Conduction Block

Record D 3
Upper- Palm Stim
Lower- Wrist Stim
Sensory Nerve Neurapraxia

- Wrist stim shows partial block of SNAP (A3)
- With palm stim the SNAP recorded at Digit 3 (A4)
- Abnormal if >40% increase (P v. Wr)
- Better prognosis since little axon loss

Post-op EMG in CTS

- 15/91 residual paresth, 31 with pain at 6 mon.
- Normal motor and sensory NCV was seen in only 21% at one year post-op
- 21% of sensory tests and 4% of motor were unchanged (still abnormal)
- NCV recovery and symptom improvement were not related to severity of pre-op abnormalities.
- Group includes 7 with absent CMAP

Prick. NEUROLOGY 2002;58:1603
Recovery in CTS
Todnem & Lundemo M&N 2000

- 151 hands seen for f/u EDX (92 pts)
- All EDX +
- 99 surgery
- 52 no surgery
- Mean f/u 14-15 mos.
- Operated hands had ↓SNAP amps and ↑motor latencies than non-op hands

Recovery in CTS
Sensory Conduction

- Sensory nerve CV values recovered to a similar degree in both older and younger groups
- NOT to normal!
- Older showed smaller amplitude pre-op and post-op
- Non-Op also improved!

Pre-op/Post-op; EO≥70yr, YO<70yr, NO=Non-operated
Recovery in CTS
Motor Conduction

- Motor latencies (and F waves) improved in Old and Young, but not to normal range.
- CMAP and forearm motor NCV did not change.

Pre-op/Post-op; EO≥70yr, YO<70yr, NO=Non-operated

Todnem & Lundemo M&N 2000

Recovery in CTS
Post-op

- Recovery of SNCV and DML values better in operative groups.
- Symptomatic recovery better in operative groups.
- Absent sensory response did NOT predict bad outcome.

Todnem & Lundemo. Muscle Nerve; 2000
CTS Post-Op
Open technique in palm

- Symptoms
  - Younger <55
    - 52% normal
    - 45% Improved
    - 3% No change
  - Older > 55
    - 25% normal
    - 60% improved
    - 14% no change
    - 1% worse

- EDX
  - Younger <55
    - 20% normal
    - 50% Improved
    - 30% No change
  - Older > 55
    - 5% normal
    - 45% improved
    - 48% no change
    - 2% worse


Very-Severe CTS with Absent Median CMAP

- 43/50 Hands had absent APBr CMAP
- All did have responses at 2nd lumbrical (small)
- Results 56% excellent, 32% good, & 12% fair
- Larger amplitude of 2nd-L CMAP predicted better outcome (Latency >10ms predicted poor outcome)

Lumbrical 2 Median Motor Nerve Response

Monitor temperature in post-op studies—may be unstable—Sympathetic fibers travel with Median nerve at wrist.
Palm stim with sterile needle to avoid contamination.

Mis-diagnosis* of CTS
A cause of persistent symptoms!

- Radiculopathy – C6 or C7
- Thoracic outlet syndrome
- Ulnar nerve entrapment
- Musculoskeletal
  - ‘Repetitive muscle strain’
  - Tenosynovitis (de Quervain syndrome)
  - ‘Traumatic’ fibrositis
  - Enthesitis

* Fully evaluate (Hx & PE) the post-op CTS referral
Open v Endoscopic
META Analysis

- There is no strong evidence supporting the need for replacement of standard open carpal tunnel release by existing alternative surgical procedures for the treatment of carpal tunnel syndrome.

- Scholten R, et al. Surgical treatment options for carpal tunnel syndrome.

  **Source**
  - Cochrane Database of Systematic Reviews. 4, 2009
  - 33 studies included in review

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Open v Endoscopic

- Long-term controlled study of endo v open release shows no benefit in short or long term, 5 years. Similar comp and re-op rate (5%) at 5 yrs.

- EMG-confirmed cases


Endoscopic CTS Release
Similar NCS Improvements

- Distal motor latency mean
  - 6.5ms pre-op
  - 4.3ms 12 mon. post
- Sensory amp
  - 2 µV pre
  - 8 µV 12 mon. post

Sensory and motor conduction block s/p “Attempted” ligament resection

Both sensory and motor responses show neurapraxia
CTS Recurrence

- If ligament section is incomplete
  - Stimulate wrist and mid-palm – CMAP will show conduction block (>20% Δ)
  - Stimulate 14 and 7 cm – SNAP digit 3 will show block in carpal tunnel (>40% Δ)
- Without a conduction block it is doubtful that recurrence has occurred
  - When in doubt follow with later EDX study to assess change over time

Successful CTS release, Median to APBr

- Top: wrist stim
- 2: Elbow
- Bottom: Palm
- Borderline distal latency
- CMAP temporal dispersion
- Palm stim Amplitude gain is < 2mV (=1.2 mV)
Take Home Message

- **Amplitudes** are most important!
- Ask about work and other activities
- **Monitor** CTS objectively by EDX
Median motor latency recovery after CTS surgery

Fig. 152. Recovery of normal motor latency after operative decompression of median nerve in patient with carpal tunnel syndrome. Position of stimulating and recording electrodes as in Fig. 151.

Ref: Gilliatt in Licht, 1961
References

- Prick. NEUROL 2002;58:1603
- Stutz. REVISION SURGERY AFTER CARPAL TUNNEL RELEASE –ANALYSIS OF THE PATHOLOGY IN 200 CASES DURING A 2 YEAR PERIOD. J Hand Surg (British and European Volume), 2006;31B:1: 68–71
- Stütz J OPERATIVE NEUROSURGERY 2008;62:ONS194