EDX and US of CTS

Jeffrey Strakowski, MD
Sensory pattern

Peripheral Nerve vs Dermatome
CSI Critique
Think like a CLINICIAN when doing clinical work.

Median nerve is compressed at the wrist, resulting in numbness or pain.
3 Things can Happen

- Some axons die
- Some axons block
- Some axons slow
Conduction Block

- When stimulated at wrist
  - Decreases CMAP
  - Decreased SNAP
  - Decreased CNAP
  - Reduced recruitment

Demyelination in CTS

- When stimulated at wrist
  - Increased latency
  - Increased SNAP negative spike duration
  - Decreased SNAP amplitude
Dead Axons

• WHEN STIMULATED DISTAL TO COMPROMISE
• Severely decreased amplitudes
  • SNAP
  • CNAP
  • CMAP

Prognosis

• Not related to latency or fibrillations
• Not related to recruitment
• Dependent on CMAP/SNAP/CNAP distal to the carpal ligament
SEVERITY OR PROGNOSIS

• ALBERS noted that prognosis in inflammatory polyneuritis is best determined by MOST distal stimulation
• Lesser et al reinforced the value of stimulation distal to carpal ligament

Screen for CTS

• Median & radial nerves to dig 1
• 95% of latencies will differ by <.3 ms
• Always note amplitude will be 3:1 median to radial
  • Sum will be >25 uV
Reference values for dig 1

1. N = 78
2. Medium nerve – 2.6 +/- .2 ms; 31 +/- .3 uV
3. Radial nerve – 2.4 +/- .2 ms; 12 +/- .1 uV
4. 95% difference =/<= .3 ms
Camel—A big animal with one or two humps on its back.

ARABIAN CAMEL

BACTRIAN CAMEL (ASIA)
How to Tell a Camel

The Dromedary has one hump,
The Bactrian has two.

It's easy to forget this rule,
So here is what to do.
Roll the first initial over
On its flat behind:

The Bactrian is different from
The Dromedary kind.

—J. Patrick Lewis
Dig 3 SNAP 7 & 14 cm

- Mean latency 1.6 ms; 3.1 ms (+/- .3ms)
- Mean amplitude 50 uV; 40 uV
- Cold increases amplitude and latency
- NB. Patients with Raynaud phenomenon or active sympathetics will have marked increases in ampl & latencies
Stimulation Proximal & Distal to Carpal Tunnel

- Sensory fibers: 14 cm; 7 cm rings separated by 4 cm on digit 3
- Distal amplitude is ≤/≥ 30% greater than wrist stimulation
- NB. Duration of negative spike is most sensitive to blocking in carpal tunnel.
SNAP to digit 3 values

1. Latency – 7 cm 1.6 ms; 14 cm 3.1 ms
2. Amplitude – 7 cm 65 uV; 14 cm 51 uV
3. Duration – 7 cm .9 ms; 14 cm 1.1 ms
4. NB. Phase cancellation makes distal amplitudes up to 30% greater

Numbers to remember

- SNAP will increase <30% at 7 cm stim
- Duration of negative spike is most SENSITIVE for slowing in carpal tunnel
  - 1.1 ms at wrist stim (14 CM)
  - .9 ms at mid palm stim (7 cm)
Digit 4 SNAP (14 cm)

- Amplitude – 30 uV w/median>ulnar
- Latency – 3.0 ms +/- .2 ms
- 95% difference =/<= .3 ms
Numbers to remember

- CMAP will increase 10% or less at mid palm stimulation
- NB. Shape of CMAP must be same or ulnar nerve was stimulated
- If uncertain re: normal amplitude; CMAP of hypothenar will be w/in 1 millivolt
LUMBR. I or II

12 cm

ULNAR } LATENCY } < .5ms
MED } DIFF.
EDX of CTS (ala Johnson)

- Screen “numb thumb”
- Median SNAP digit 3 at 7 and 14 cm
- CMAP thenar, proximal and distal to CT
- Ulnar SNAP to digit 5 (or compare median and ulnar to digit 4)
DON’T FORGET

• Amplitude
  • Amplitude
  • Amplitude
  • Amplitude
  • Amplitude
  • Amplitude
  • Amplitude

Combined Sensory Index
Robinson Technique

• The role of sensory studies in the electrodiagnostic approach to the patient with expected carpal tunnel syndrome.

Goal of EDX Assessment

1. Localize the lesion to the extent possible
2. Assess SEVERITY (ie. axonal injury vs neurapraxia)
3. Rule out concomitant disease
Combined Sensory Index

- Digit I Median/Radial Sensory Comparison
- Digit II 12 cm
- Digit III 7cm/14cm
- Digit IV Median/Ulnar Comparison
- Trans Carpal CNAP median/ulnar comparison

CNAP Disclaimer

Combined Sensory Index

- There are chance findings and technical errors that simply make reliability too low when using single questions or single diagnostic tests.
  - Combining multiple observations will lessen the impact of random technical error
  - Combining multiple observations will lessen the impact of a chance observation of an extreme value
Robinson proposes the use of a single summary variable that incorporates data from three different tests in the evaluation of an individual with suspected Carpal Tunnel Syndrome.

Critique of the Original Study

- Generally very well done landmark study
- Temperature was not controlled
- No correlation with motor latencies
- Presumed gold standard based on clinical symptoms

Goal of EDX Assessment

1. Localize the lesion to the extent possible

2. Assess SEVERITY (ie. axonal injury vs neurapraxia

3. Rule out concomitant disease

CSI Critique: Localization

Limited application: The majority of cases are not subtle

Addresses only yes or no
CSI Critique: Localization

Ignores the contribution of the motor fibers

- The tests were selected, relatively at random, on the basis of reported single test sensitivity
- The duration of the negative spike is felt by some to be the most sensitive parameter
- Other reputable sources have suggested other sensory evaluations for high sensitivity
References

- Kaul MP, Pagel KJ, Dryden JD: When to use the combined sensory index. Muscle Nerve 2001;24:1078-1082

Jeffrey A. Strakowski, MD

Ultrasound Evaluation of the Median Nerve
Learning Objectives

• Review the sonographic appearance of a normal median nerve.
• Review the anatomy of the median nerve and its relevance to ultrasound evaluation.
• Review the method for identifying pathology on ultrasound.
• Discuss the correlation of ultrasound evaluation with electrodiagnosis.

Median Nerve - Carpal Tunnel syndrome
Median Nerve in the Forearm

Median Nerve at the Carpal Tunnel Inlet
Effective and Ineffective Measurement

Identify Cross Sectional Area

- *Per Von Holsbeek
- >15mm² diagnosis established
- <15mm² ---> EMG
Criteria for median neuropathy at the wrist (CTS)

1. Duke
   1. Area of ≥14 mm² at distal wrist crease
   2. Wrist-to-Forearm (WFR) >1.5
2. Wake Forest
   1. Area of ≥14 mm² at distal wrist crease
3. Universita Cattolica
   1. Area of > 10 mm² at distal wrist crease
   2. Wrist-to-Forearm (WFR) >1.5
   3. Correlates with NCS values for CTS

Direct Measurement of Cross Sectional Area
Longitudinal Diameter Measurement

Median Neuropathy: Longitudinal View
Measurement at the Forearm vs Wrist

Other Anatomic Considerations

- Flattening ratio (<3:1) *Buchberger
- Proximal swelling and tapering at the entrapment site
- Forearm to wrist cross-sectional area change
- Relative dynamic excursion
Assess for Anatomic Variants

- Bifid Median Nerve
- Persistent Median Artery
- Subluxing Flexor Digitorum Sublimis Muscle
- Encroaching Lumbrical
- Post-Operative Changes

Bifid Median Nerve
Persistent Median Artery

- Frequently seen in between bifid median n.
- Is a branch from the ulnar artery.
- Is not seen with all bifids
- Can be seen on the ulnar side of typical median nerve
- Seen in up to 20% in cadaveric study

Propeck et al. AJR, 2000

Encroaching Lumbrical
Encroaching Lumbrical

![Image of encroaching lumbrical](image1)

![Image of encroaching lumbrical](image2)
Bifid Median Nerve
Persistent Median Artery
Encroaching FDS
Encroaching FDS

Ganglion
Other Tumors

Post-surgical
Post-surgical scar

US as a screening tool
CTS Injection – Long Axis in-plane

Short Axis Out-of-Plane
Short Axis In-Plane

Carpal Tunnel Injection
Thank You!

[Cartoon Image]

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