

CSI: Kauai!

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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**

Combined Sensory Index



- 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

Combined Sensory Index



- This single summary variable is referred to as the
Combined Sensory Index (CSI)

Combined Sensory Index



- The CSI was developed to improve **sensitivity** and **specificity** of sensory testing in carpal tunnel syndrome
 - chance technical errors and extreme values are diluted resulting in improved reliability.

Combined Sensory Index



- 1998- took 53 subjects with clinical carpal tunnel syndrome
 - Median distribution sensory symptoms
 - Nocturnal paresthesiae
- These subjects were compared with two sets of controls.
 - Patients referred to the lab for a non carpal tunnel syndrome related complaints
 - Asymptomatic controls

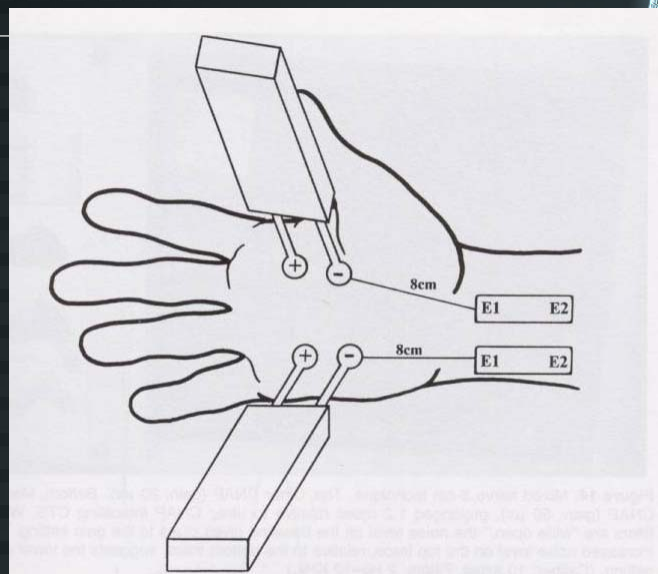
Combined Sensory Index



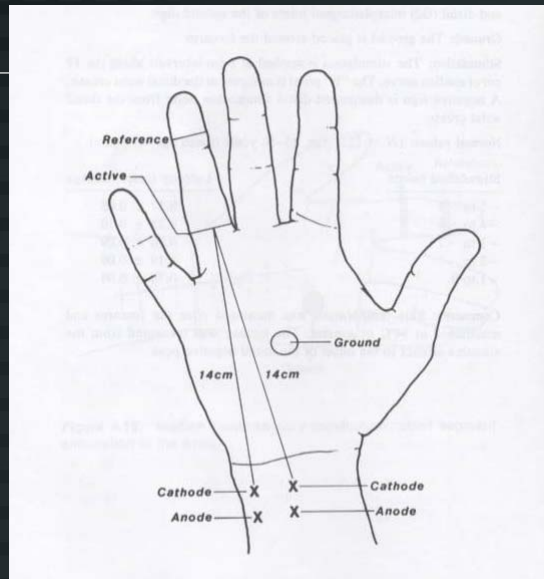
- Chose test components based on reported sensitivity-recommended in the AANEM minimonograph
 - Tests that have similar units of measure (latency difference between two sensory nerves)
 - This allows for direct comparison and/or addition

Combined Sensory Index

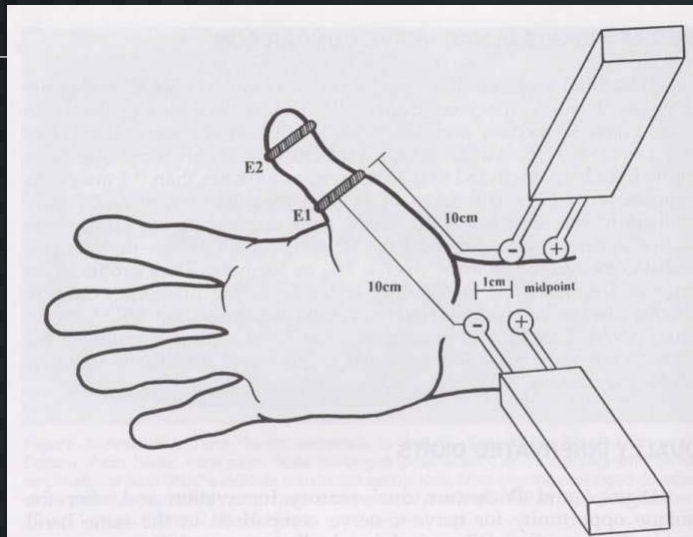
- Performed 3 studies on all subjects and controls



Median-ulnar midpalmar orthodromic difference at 8cm



Median-ulnar ring finger antidromic differences at 14cm



Median-radial thumb antidromic difference at 10cm

Combined Sensory Index



- Parameters used were:
 - Peak latency
 - Calculation of difference between peak latencies of two different sensory nerves
 - **Palmdiff**=Median-ulnar midpalmar orthodromic difference at 8cm
 - **Ringdiff**=Median-ulnar ring finger antidromic differences at 14cm
 - **Thumbdiff**=Median-radial thumb antidromic difference at 10cm

Combined Sensory Index



$$\text{CSI} = \text{palmdiff} + \text{ringdiff} + \text{thumbdiff}$$



Calculation of the **Combined Sensory Index**

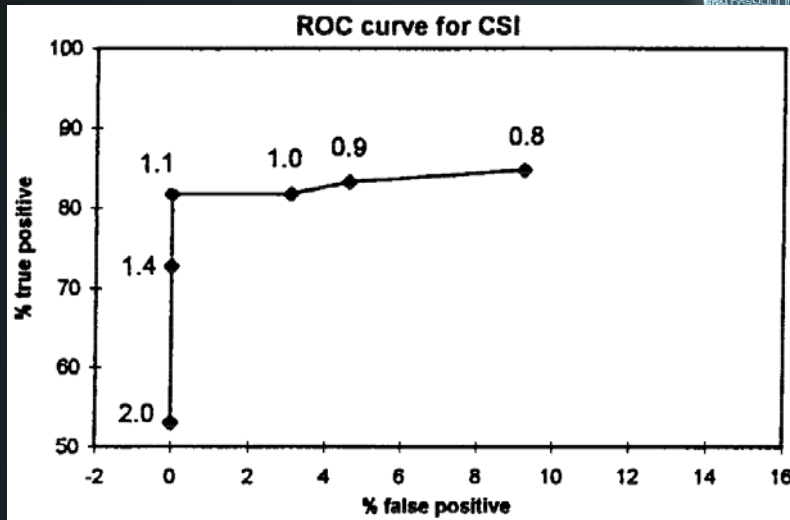
	<u>Normal</u>
Palmdiff	≤ 0.3 ms
Ringdiff	≤ 0.4 ms
Thumbdiff	≤ 0.5 ms
CSI	≤ 0.9 ms

Robinson LR, Micklesen PJ, Wang L: Strategies for analyzing nerve conduction data: Superiority of a summary index over single tests. Muscle Nerve 1998;21:1166-1171

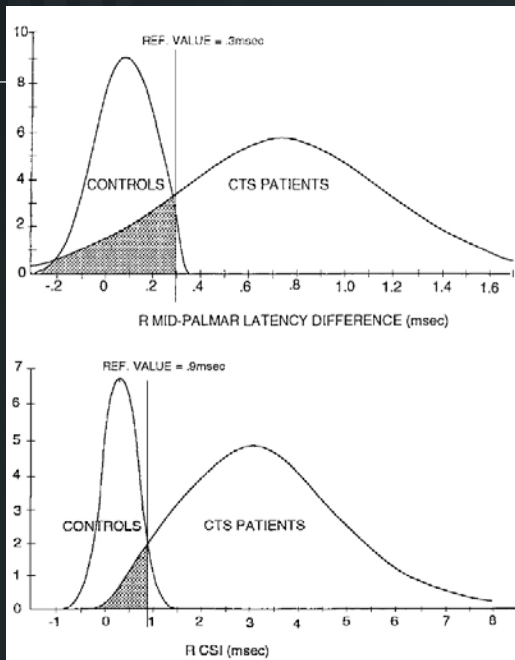


	Sensitivity	Specificity	PPV	NPV
Palmdiff	69.7%	96.9%	95.8%	76.8%
Ringdiff	74.2%	96.9%	96.2%	78.8%
Thumbdiff	75.8%	96.9%	96.2%	79.7%
One of three tests	84.8%	92.3%	91.8%	85.7%
Two of three tests	74.2%	98.5%	98.0%	79.0%
Three of three tests	56.1%	100%	100%	69.1%
CSI ≤ 0.9	83.1%	95.4%	94.8%	85.0%
CSI ≤ 1.1	81.8%	100%	100%	84.0%

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Calculation of the **Combined Sensory Index**

	<u>Normal</u>
Palmdiff	≤ 0.3 ms
Ringdiff	≤ 0.4 ms
Thumbdiff	≤ 0.5 ms
CSI	≤ 1.1 ms (correctly identifies all non-CTS subjects as non-CTS)

Robinson LR, Mickleson PJ, Wang L: Strategies for analyzing nerve conduction data: Superiority of a summary index over single tests. Muscle Nerve 1998;21:1166-1171

Combined Sensory Index

- In August of 2000 the **Test-Retest Reliability** of the CSI was studied
- Subjects were examined again using:
 - Median-ulnar midpalmar orthodromic difference at 8cm (palmdiff)
 - Media-ulnar ring finger antidromic differences at 14cm (ringdiff)
 - Median-radial thumb antidromic difference at 10cm (thumbdiff)

Combined Sensory Index



- **Subjects (32) were tested with this protocol on two separate occasions within one week.**
 - Same investigator
 - Blinded to the results

Combined Sensory Index

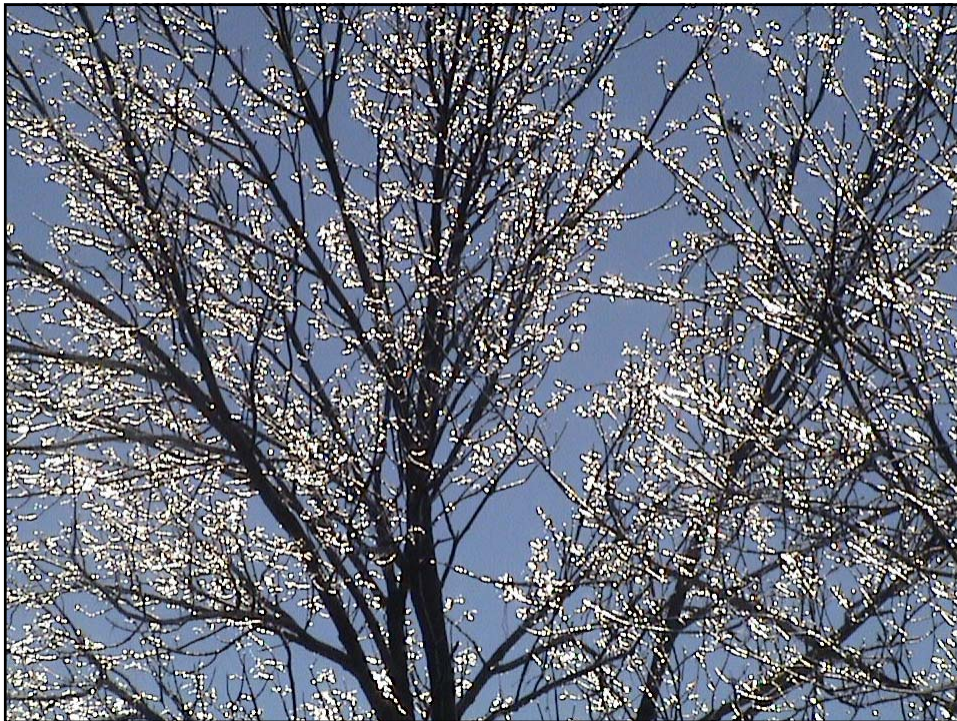


- **Compared the test-retest reliability of the CSI and its individual component sensory conduction.**

Combined Sensory Index



- Study showed that the CSI produced the highest intra-rater test-retest reliability (Spearman rho = 0.95):
 - Ring-diff: Spearman rho = 0.67
 - Thumb-diff: Spearman rho = 0.75
 - Palm-diff: Spearman rho = 0.74



Combined Sensory Index



- **Optimizing the number of tests used in the evaluation of the patient with suspected CTS**

AKA: Do we really need to do all three tests in the CSI?

Combined Sensory Index



- **Concept Framework**
 - Use one test if results conclusive
 - Use CSI if results are between endpoints
 - » ringdiff 0.1 - 0.4ms
 - » thumbdiff 0.2 - 0.6ms
 - » Palmdiff 0.0 – 0.3ms

Combined Sensory Index



- **Suggested Protocol** (using the tests with the best specificity and sensitivity first and using the least number of tests needed)
 - Use of one test if results conclusive
 - Use of CSI if results are between endpoints
 - 1) ringdiff 0.2 - 0.4ms
 - 2) thumbdiff 0.3 - 0.5ms
 - 3) Calculate CSI using palmdiff

CSI \geq 0.9 ms = CTS

Combined Sensory Index



- **Kaul 2002**
 - 240 consecutive veterans referred for CTS evaluation
 - 62 of these were identified as having an unobtainable median sensory response in one of the studies contained in the CSI
 - In addition to sensory studies
 - Motor to APB CMAP compared with Ulnar hypothenar CMAP both obtained at 8cm
 - Second lumbrical-interosseous CMAP

Combined Sensory Index



- **Results**

Table 1: Initial Absent Component With Subsequent Component Response Rate

Initially Unobtainable	Subsequent Component Response Rate				
	Ringdiff (%)	Thumbdiff (%)	Palmdiff (%)	2L-I (%)	Motordiff (%)
Ringdiff (n=56)	—	32	39	100	95
Thumbdiff (n=44)	11	—	25	100	93
Palmdiff (n=36)	6	8	—	100	92

Combined Sensory Index



Conclusion:

- When using the CSI if the initial median sensory response is unobtainable the 2L-I is the best choice for confirmatory evaluation of suspected CTS

Interpretation Caution: CMAP to APB was only performed at 8cm. No Mid-Palmar Stim performed

Combined Sensory Index



Summary:

The CSI provides an effective systematic way to maintain sensitivity and improve specificity over single sensory techniques. It also has good test-retest reliability.

Combined Sensory Index



Effect of temperature on CSI

Comparison of all three components of CSI at 32 and 27 degrees

- ring-diff** – most reliable
- thumb-diff** - reduced sometimes even to normal
- palm-diff** – increased
- CSI** – unchanged

(Kouyoumdjian-2005)

Combined Sensory Index



Critique of the Clinical Application of this Technique

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



CSI Critique: Localization



- 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

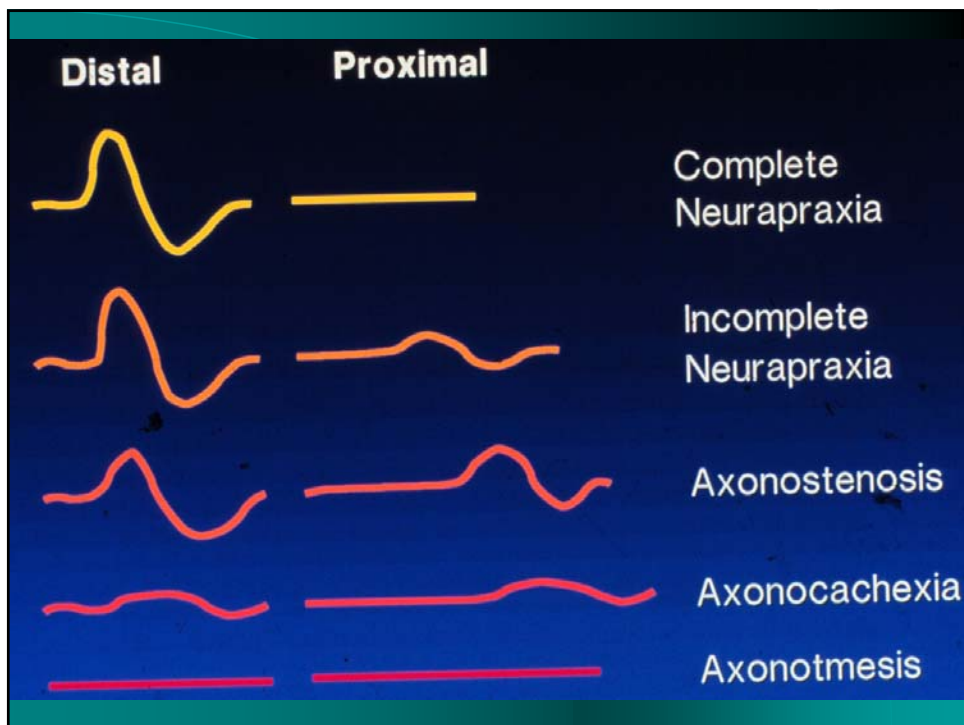
CSI Critique: Localization



Focal nerve lesions

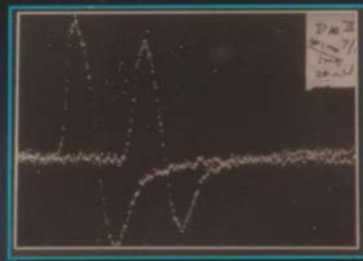


- MUST stimulate both proximal and distal to lesion
- To determine:
 - Exact diagnosis
 - Severity
 - Prognosis

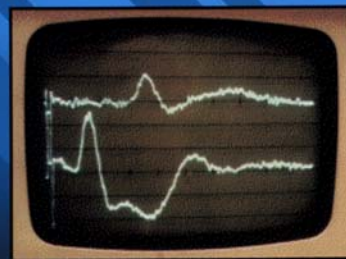
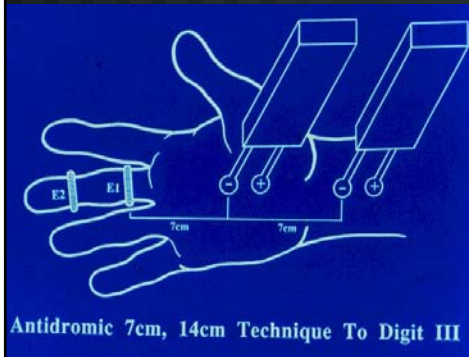


CSI Critique: Severity

- None of the tests selected assist with assessment of prognosis

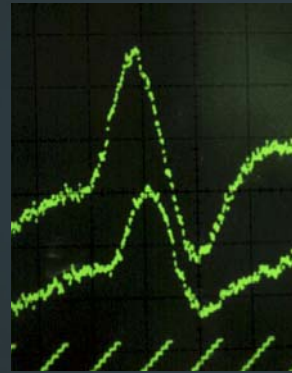


CSI Critique: Severity



Digit 3 7/14 cm
20 μ V 1 ms

*CSI Critique: ?Concomitan
Disease*



CSI Critique



Think like a **CLINICIAN** when
doing clinical work.



References

- Robinson LR, Micklesen PJ, Wang L: Strategies for analyzing nerve conduction data: Superiority of a summary index over single tests. *Muscle Nerve* 1998;21:1166-1171
- Lew HL, Wang L, Robinson LR: Test-retest reliability of combined sensory index: implications for diagnosing carpal tunnel syndrome. *Muscle Nerve* 2000;23:1261-1264
- Robinson LR, Micklesen PJ, Wang L: Optimizing the number of tests for carpal tunnel syndrome. *Muscle Nerve* 2000;23:1880-1882
- Kaul MP, Pagel KJ, Dryden JD: When to use the combined sensory index. *Muscle Nerve* 2001;24:1078-1082
- Kaul MP, Pagel KJ: Median Sensory Nonresponders in Carpal Tunnel Syndrome Workup. *Arch Phys Med Rehabil* 2002;83:1120-1122

