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
    - \textit{Palmdiff}=Median-ulnar midpalmar orthodromic difference at 8cm
    - \textit{Ringdiff}=Median-ulnar ring finger antidromic differences at 14cm
    - \textit{Thumbdiff}=Median-radial thumb antidromic difference at 10cm

\[
\text{CSI} = \text{palmdiff} + \text{ringdiff} + \text{thumbdiff}
\]
Calculation of the **Combined Sensory Index**

| Normal | Palmdiff $\leq$ 0.3 ms | Ringdiff $\leq$ 0.4 ms | Thumbdiff $\leq$ 0.5 ms | CSI $\leq$ 0.9 ms |


<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmdiff</td>
<td>69.7%</td>
<td>96.9%</td>
<td>95.8%</td>
<td>76.8%</td>
</tr>
<tr>
<td>Ringdiff</td>
<td>74.2%</td>
<td>96.9%</td>
<td>96.2%</td>
<td>78.8%</td>
</tr>
<tr>
<td>Thumbdiff</td>
<td>75.8%</td>
<td>96.9%</td>
<td>96.2%</td>
<td>79.7%</td>
</tr>
<tr>
<td>One of three tests</td>
<td>84.8%</td>
<td>92.3%</td>
<td>91.8%</td>
<td>85.7%</td>
</tr>
<tr>
<td>Two of three tests</td>
<td>74.2%</td>
<td>98.5%</td>
<td>98.0%</td>
<td>79.0%</td>
</tr>
<tr>
<td>Three of three tests</td>
<td>56.1%</td>
<td>100%</td>
<td>100%</td>
<td>69.1%</td>
</tr>
<tr>
<td>CSI $\leq$ 0.9</td>
<td>83.1%</td>
<td>95.4%</td>
<td>94.8%</td>
<td>85.0%</td>
</tr>
<tr>
<td>CSI $\leq$ 1.1</td>
<td>81.8%</td>
<td>100%</td>
<td>100%</td>
<td>84.0%</td>
</tr>
</tbody>
</table>
Calculation of the **Combined Sensory Index**

<table>
<thead>
<tr>
<th>Normal</th>
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<tbody>
<tr>
<td>Palmdiff</td>
</tr>
<tr>
<td>Ringdiff</td>
</tr>
<tr>
<td>Thumbdiff</td>
</tr>
<tr>
<td>CSI</td>
</tr>
</tbody>
</table>


**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
• **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 > 0.9 ms = CTS

• **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>
<thead>
<tr>
<th>Initially Unobtainable</th>
<th>Subsequent Component Response Rate</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Ringdiff (%)</td>
</tr>
<tr>
<td>Ringdiff (n=56)</td>
<td>—</td>
</tr>
<tr>
<td>Thumbdiff (n=44)</td>
<td>11</td>
</tr>
<tr>
<td>Palmdiff (n=36)</td>
<td>6</td>
</tr>
</tbody>
</table>

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.

**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
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: Concomitant Disease

Think like a CLINICIAN when doing clinical work.
References


• Robinson LR, Mickleesen 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