Terminal Latency Index: A distinctive diagnostic criterion for carpal tunnel syndrome

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ABSTRACT

Objectives: To determine the terminal latency index of the median nerve as one of the screening tests criterion in patients having clinically diagnosed carpal tunnel syndrome with borderline electro-diagnostic test results and to assess its sensitivity.

Methods: Ninety five cases (22 men and 73 women) aged 20 years to 70 years, diagnosed as carpal tunnel syndrome (79% idiopathic), but with normal conventional electro-diagnostic tests results were enrolled. The median nerve terminal latency index was determined in these patients and in matched controls.

Results: The mean terminal latency index for patients was 0.36 (SD ± 0.02) while for the controls, the value was 0.43 (SD ± 0.05). The difference was statistically significant (p<0.005). This finding stimulates us to calculate carefully the median nerve terminal motor latencies, amplitude of sensory action potentials and sensory conduction velocities and were also found to be statistically significantly different from the values obtained in controls, although they were reported within normal range.

Conclusion: It would therefore appear worthwhile to estimate the terminal latency index for all borderline cases of carpal tunnel syndrome for the better guidance of electromyographers.

Keywords: Median nerve entrapment, electro-physiological studies.


Carpal tunnel syndrome (CTS) is one of the most common neurologic disorders and has been extensively studied electrophysiologically. Most of the authors measured the motor, sensory latency of median nerve and comparison of the distal motor sensory latency of median nerve with those of the ulnar nerves. Kimura described the serial recording of latencies of sensory nerve action potential (SNAP) of the median nerve at 1cm increment across the wrist (inching technique). While others studied the comparison of orthodromic sensory latencies of the median and ulnar nerves stimulating them at the digit and the palm. Recently comparative studies of different techniques failed to single out the best one in detecting CTS at an early stage. Moreover, as many as 15% to 25% of symptomatic CTS may have normal study.

Shahani et al showed that the terminal latency index (TLI) which is defined as a comparison of the median nerve terminal latency with the conduction time in the proximal segment adjusted for distance is a sensitive test for entrapment syndromes. We
Table 1 - Median nerve conduction study.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Control Group (n = 38)</th>
<th>Study Group (n = 95)</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TLI (mean ± SD)</strong></td>
<td>0.43 ± 0.05</td>
<td>0.36 ± 0.02</td>
<td>&lt; 0.0005</td>
</tr>
<tr>
<td><strong>Terminal latency msec [mean ± SD]</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>3.27 ± 0.36</td>
<td>3.56 ± 0.36</td>
<td>&lt; 0.0025</td>
</tr>
<tr>
<td>Sensory</td>
<td>2.61 ± 0.40</td>
<td>2.76 ± 0.48</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Amplitudes (mean ± SD) mV</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CMAP</td>
<td>5.04 ± 2.17</td>
<td>5.36 ± 2.16</td>
<td>NS</td>
</tr>
<tr>
<td>SAP (µV)</td>
<td>(4.67 - 28) (0.31)</td>
<td>6.57 ± 4.01</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td><strong>Area (mean ± SD)</strong></td>
<td></td>
<td></td>
<td>P &lt; 0.005</td>
</tr>
<tr>
<td>CMAP (mV msec)</td>
<td>13.75 ± 6.94</td>
<td>13.84 ± 5.77</td>
<td>NS</td>
</tr>
<tr>
<td>SAP (µV msec)</td>
<td>12.49 ± 6.24</td>
<td>10.63 ± 5.67</td>
<td>NS</td>
</tr>
<tr>
<td><strong>CV (mean ± SD)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>56.57 ± 4.50</td>
<td>58.58 ± 6.78</td>
<td>NS</td>
</tr>
<tr>
<td>Sensory</td>
<td>55.15 ± 5.86</td>
<td>47.85 ± 7.42</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

NS = not significant.

designed a study to detect CTS in symptomatic patients who were reported normal on conventional electrophysiological study carried out in Clinical Neurophysiology Lab in KKUH. This study was designed to elucidate the possible role of TLI in detecting CTS cases.

Methods. We studied retrospectively the electrodagnostic results of 95 patients (22 men and 73 women) whose ages ranged from 20 years to 70 [mean age: 40.18 ± 10.28] years referred to the Clinical Neurophysiology Lab, KKUH, Riyadh. All the patients had typical symptoms and signs of CTS such as pain and numbness of the hands, aggravated by use of the hands as well as nocturnal exacerbation which kept them awake at night. Physical examination showed typical distribution of sensory impairment without any atrophy and weakness of median-innervated thenar muscles. None of them had any evidence of other neuropathy. The following investigations were also carried out: fasting blood sugar, T3, T4, TSH, serum uric acid, serum Ca++, X-ray of the cervical spines and hands. Thirty-eight healthy adults with no characteristic clinical or both electrophysiological criteria for the diagnosis of CTS served as the control group.

The electrophysiological studies were performed using Mystro EMG machine. The hand temperature varied between 32° and 35°C during the tests. For motor conduction studies, the median nerve was stimulated at the wrist and at the elbow with supramaximal stimulus of square-wave pulse of 0.2 msec duration. The compound muscle action potential (CMAP) was recorded from abductor pollicis brevis (APB) in the usual belly-tendon montage. The wrist stimulation site was approximately 7.5 cm proximal to the active recording electrode. The distal motor latency was measured from the stimulus artifact to the beginning of the CMAP. The amplitude of the SNAP was calculated from the baseline to the negative peak of the response for the sensory nerve conduction studies. The median nerve was stimulated at the wrist at a distance of 13 cm from the active ring electrode placed around the base of the index finger and the reference electrode placed 3 cm distally. A 3 cm disc electrode taped to the dorsum of the hand served as the ground for both motor and sensory conduction studies.

Because there is no general agreements among the authors about the results of the electrodagnostic tests for CTS, we selected patients based on the following criteria: (1) the patients having definite clinical symptoms, (2) agreement of at least 4 out of 6 authors of this article on the diagnosis, (3) terminal latency index (TLI) less than the mean +2 SD of the control, (4) the distal motor latency of the median longer than the mean +2 SD of the control group. The median nerve study parameters were excluded from the study even if those were supported by 3 authors as positive tests values for CTS. Patients' results with above inclusive criteria were exposed to further analysis.

The terminal latency index (TLI) was calculated using the formula (Shahani et al)
is given below:

\[
\text{TLI} = \frac{\text{Terminal distance (mm)}}{\text{Conduction velocity (m/sec) \times Terminal latency (msec)}}
\]
In addition to TLI calculation, the mean and standard deviations (SD) of the terminal motor and sensory latencies, amplitude and area of CMAP, amplitude of sensory nerve action potentials (SNAPs) and sensory motor conduction velocities of the median nerve were determined for each patient and matched control.

A two-tailed students "t" test was used to compare the control and study groups. P value of ≤ 0.05 was taken as a significant change among the groups.

Results. Ninety-five clinically diagnosed CTS patients who had otherwise normal reports for electrodiagnostic tests and 38 control subjects were evaluated. The average age of the patients was 40.18 (range: 20 years to 70 years) and that of control was 42.74 (range: 20 years to 75 years). The age and sex distribution of the patients is shown in Figure 1. The woman/man ratio was approximately 3.3:1 and that for the control was 1:1. The putative etiologic factors are: 75 idiopathic, 12 diabetic, 3 arthritic, 3 cervical spondylotic and 2 hypothyroid).

Median nerve conduction studies. The nerve conduction results are shown in Table 1. The terminal motor latency index was calculated for both controls and the patients. The mean TLI in the patient group was 0.36 ± SD 0.02 which was significantly lower than the mean value of 0.43 ± 0.05 in controls (p < 0.0005).

The mean terminal motor latency was significantly longer than in controls (p < 0.0025). The SAP amplitude and sensory conduction velocities were also significantly lower in patients with CTS (p < 0.0005). On the other hand, the motor conduction velocity in the forearm and the amplitude of CMAP were within normal limits. The mean sensory latency of the median nerve is 2.76 ± SD 0.48 msec (control mean: 2.61 ± SD 0.40 msec). This prolonged latency was however not statistically significant (p > 0.05).

Comparison of TLI sensitivity with those of other median nerve conduction studies. The sensitivity of TLI, terminal motor latency, amplitude of SAP and sensory conduction velocity were further evaluated. A study was considered abnormal if the above test parameters are either greater than mean + 2 SD or less than mean-2 SD.

Based on the criteria it was found that the terminal latency index (TLI) had the highest sensitivity of 47% (Figure 2). The sensitivities of SCV and T latency were almost equal such as 26% and 25%. The SAP amplitude was the least sensitive.

Discussion. Of the 95 cases about 78 (79%) patients were suffering from idiopathic CTS. These patients did give the typical history compatible with
nerve entrapment. The conventional electrodagnostic tests employed being insensitive without lab controls values at hand, the results of these tests were thus reported as normal. The apparent insensitivity could be explained on the basis of hormonal fluctuation, as majority of our patients were women. As regards the other causative factors in the remaining 21% of our patients, our findings are in agreement with those of others.19,26

Our retrospective TLI study could positively identify about 47% of patients with strong clinical evidence of CTS who were reported normal. The positive TLI thus raised our awareness on conventional testing to evaluate the changes of the patients’ nerve conduction values which were previously overlooked. The significantly low TLI reflected the unequal conduction of the median nerve proximal to the site of the carpal tunnel which further supports its importance in detecting CTS early as described by others.17 However, 53% of the symptomatic patients has normal TLI (< mean ± 2 SD), which means the test may need some further refinement. The normal conduction time across the tunnel in these other cases may be due to the fact that CTS in its initial stage may be due to intermittent ischemia of the sensory axons.21 Probably repeated testing on a prospective basis may provide a limit as to when the electrophysiological testing becomes abnormal and could be used for prognostication.

The significant prolongation of terminal motor latency is consistent with the findings of others.17,22,23 The changes of SAP amplitude and sensory velocity of the median nerves are also supported by others.10,23,24

The sensory terminal latencies in our study group though slightly higher than in controls was not statistically significant which contradicts the earlier reports.20,26

In our study TLI, terminal motor latency, SAP amplitude and sensory conduction velocity of median nerve had significant abnormalities (p < 0.0005) which are supportive of CTS. If we consider our results as mean ± 2 SD as our upper and mean - 2 SD lower normal limits, TLI could identify maximum number of CTS patients and hence it is the most sensitive test. The sensitivity of TLI over other tests parameters has not been studied before, although newer test such as inching method10 and comparison of orthodromic sensory latencies of the median and ulnar nerves stimulating them at the digit and at the palm13,11 have been described. However, further study of the relationship of TLI and above parameters, with greater sample size would be of value with regard to the early diagnosis of borderline CTS patients.

The terminal motor latency and sensory conduction velocity are abnormal in 25% and 26% cases respectively indicating sensory-motor neuropathic changes. It has been reported that in some patients with no objective sensory or motor deficit, the nerve conduction studies commonly reveal abnormalities in the distal segment of the nerve.10,25

Taking into consideration the upper and lower limit of normal (mean ± 2 SD) it was recently (26)reported that CMAP amplitude change was most sensitive. They however, did not study TLI.

The sensitivity of the test parameters were changed when the tests results were compared beyond the lower and upper normal values.27 In this context CMAP amplitude becomes the most sensitive one and terminal motor latency is the next parameter. The sensory parameters became the least important (Figure 3). It should be mentioned here that the SAP amplitudes (μv) studied in our laboratory for both study and control groups were lower (Table 1) in comparison to those of others.27

In conclusion, TLI appears to be the most sensitive parameter in our study. Determination of TLI, which involved simple calculations made us identify 47% of our symptomatic patients who would have been missed or labelled as malingerers. Although measurement of other parameters should continue, TLI would appear to be a fast method for detecting cases for surgical intervention. The answer to the questions whether patients with positive TLI for CTS needs medical or surgical management remains to be explored. However, there are diverse opinions with regard to the surgical intervention of CTS.21,24,28 In our series, no further informations with regard to repeated hospital appointments, an electrophysiological evaluations and any surgical intervention were obtained. This could be due to the facts the attending doctors strongly negated the CTS diagnosis and that is why they went to another hospital for second opinion.

We, therefore, strongly recommend a careful handling of the electrophysiological parameters for borderline CTS cases especially with the calculation of TLI and repeated electro clinical evaluations for long-term follow up.

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References