CLINICAL TESTS FOR CARPAL TUNNEL SYNDROME: AN EVALUATION

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SUMMARY

Five clinical tests in common use for diagnosis of carpal tunnel syndromes have been shown to have little diagnostic value, either individually or in various combinations. No physical sign is useful in the diagnosis of this condition, which should be suspected on the basis of presenting symptoms and confirmed by electrodiagnosis using standard median nerve conduction tests.

KEY WORDS: Median nerve, Paraesthesiae, Electrodiagnosis.

The carpal tunnel syndrome (CTS) is characterized by unilateral or bilateral painful paraesthesiae of the hands, often in the median nerve distribution, occasionally with centripetal radiation of pain to the shoulders. It was first properly described in 1951 by G. S. Phalen [1], who later presented 17 years' experience with the diagnosis and treatment of 654 hands [2]. Some years later Phalen stated that the diagnosis was almost always made by noting one or more of three clinical signs: (a) hypoalgesia restricted to the median nerve distribution in the hand (72% patients); (b) tingling in the fingers produced by percussion over the median nerve at the wrist (66% patients); and (c) a positive wrist-flexion test (now known as Phalen's sign)—paraesthesiae in the median nerve distribution reproduced or exaggerated by holding the wrists in complete flexion for 30-60 s (77% patients) [3]. He went on to say that 'electrodiagnostic studies surely are not necessary in every patient with carpal tunnel syndrome'. In recent years it has become apparent that nerve conduction tests are at least desirable, and possibly essential, for correct evaluation of this condition. However, electrodiagnosis is not carried out by all physicians and surgeons suspecting the diagnosis.

METHOD

Patients attending the electrodiagnostic clinic with pain and paraesthesiae affecting the hands, many of whom had symptoms maximal at night or in the early morning suggestive of median nerve compression in the carpal tunnels, had five well-documented clinical tests for CTS carried out by one investigator (K.S.). These were: (1) demonstration of hypoalgesia in the median nerve distribution of the hands; (2) examination of wasting of the thenar muscles; (3) paraesthesiae induced in the median nerve distribution by forced flexion of the wrists (Phalen's test); (4) paraesthesiae induced by tapping the median nerve at the wrist (Tinel's sign); and (5) paraesthesiae induced by the application of an inflated sphygmomanometer cuff around the upper arm.

Immediately after clinical examination, standard electrodiagnostic tests for median nerve compression in the carpal tunnels were carried out at an ambient temperature of 32°C, using a Medelec MSC II machine. For motor conduction tests 30% supramaximal stimulation was applied to the median nerves at the wrists and conductions were studied by recording action potentials from the flexor pollicis brevis with surface electrodes, measuring the amplitude and duration of the action potentials and the latency from the stimulus artifact to the beginning of the wave. Sensory median nerve conductions were recorded by stimulating proximally at the wrist and recording digital potentials antidromically using surface electrodes and observing amplitude and latency. Sensory conduction velocities were calculated by measuring the distance from the stimulating electrode to the most proximal recording electrode, thus allowing accurate determination of sensory conduction velocity for the fastest fibres [4]. A significant degree of median-nerve compression was assumed when the motor terminal latency exceeded 4.5 ms, the sensory latency exceeded 2.7 ms or the sensory terminal conduction velocity was less than
45 m/s. A motor latency exceeding 5 ms was arbitrarily considered to indicate a moderately severe or severe degree of median nerve compression (termed ‘severe block’).

The clinical tests and various combinations of tests for carpal tunnel syndrome were then correlated with the electrodiagnostic findings in each case, using the statistical method detailed below.

**Statistical method**

A rapid visual impression of the degree of predictive capability of any test may be obtained by the presentation of the number of tests and corresponding proven diagnoses in the form of a 2 × 2 contingency table, as shown in Table I. The failure of the test to predict correctly may take either of two forms: ‘positive’ when there is no carpal tunnel syndrome, ‘negative’ when a carpal tunnel syndrome is present. The proportion of such errors is measured by b/N and c/N, respectively, and in a perfect test both would equal zero. Either type of error is a measure of the test’s inadequacy, but the latter (i.e. failure to detect proven CTS) is by far the more serious: the adequacy of the test will therefore be quantified by the proportion c/N. The object, then, is to devise a test by combining the results of the five available such that this proportion is minimized whilst not increasing the other error rate (b/N) unacceptably (since this would result in a high incidence of treatment of a non-existent condition).

All five tests are ‘positive’ tests, inasmuch as a positive result from any of them is an indication of the presence of CTS and not its absence. It is necessary therefore only to consider positive combinations of results of two or more tests in attempting to produce a new test with increased predictive capability. For example, it would make no sense, given the nature of the tests, to consider a new test which diagnosed CTS to be present only if Test 1 indicated CTS present and Test 2 CTS absent. Further, since it is required to make any new test as unlikely to miss a possible genuine cause as possible, it is only necessary to consider positive results in any of a number of individual tests, and not in all of them. For example, a new test that predicts the presence of CTS only if positive results are obtained to both Tests 1 and 2 is necessarily more likely to miss a genuine case than one dependent on the result of Test 1 or Test 2 alone.

It is evident from this that the minimum possible value of c/N will occur when the combined test consists of predicting a positive CTS if any of the five tests indicates that the condition is present. The problem therefore consists of trying to find a subset of the tests which delivers a corresponding proportion close to this limiting value, indicating that the tests which have been omitted are either of little diagnostic value or add little information not provided by the tests which have been included. No formal hypothesis tests have been employed in the above, since the object is to investigate the observed error rates from a variety of test procedures, and not to compare statistically the tables so obtained, either with each other or with a standard.

**RESULTS**

Seventy patients had the specified clinical and electrodiagnostic tests carried out on each arm, so that a total of 140 wrists were tested. Of these, median nerve conduction tests showed 49 to have definite CTS, 10 having evidence of ‘severe block’ (arbitrarily defined as the median nerve motor latency >5 ms). Ninety-one wrists showed no evidence of median nerve block.

Contingency tables were drawn up to summarize the results, with regard to each clinical test separately and various combinations of tests (Table II). These showed that no test, or combination of tests, was able to predict the final diagnosis. Moreover, a large number of wrists

<table>
<thead>
<tr>
<th>Test</th>
<th>+CTS</th>
<th>−CTS</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median nerve</td>
<td>+ 6</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>hypoalgcsia</td>
<td>+ 33</td>
<td>66</td>
<td>99</td>
</tr>
<tr>
<td>Thcnar wasting</td>
<td>+ 1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- 38</td>
<td>71</td>
<td>109</td>
</tr>
<tr>
<td>Phalen's sign</td>
<td>+ 4</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>- 35</td>
<td>61</td>
<td>96</td>
</tr>
<tr>
<td>Tinel's sign</td>
<td>+ 10</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>- 29</td>
<td>57</td>
<td>86</td>
</tr>
<tr>
<td>Sphygmo test</td>
<td>+ 8</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>- 31</td>
<td>62</td>
<td>93</td>
</tr>
</tbody>
</table>

* No. with ‘severe’ carpal tunnel syndrome in parentheses.
diagnosed as negative by each test were shown electrodiagnostically to have CTS, so that false negative tests were very common.

DISCUSSION

In spite of the fact that many physicians continue to regard the various clinical tests for carpal tunnel syndrome as useful parameters of this condition, this study demonstrates the lack of sensitivity and specificity of these tests, as none of the tests in isolation or combination was able to predict the diagnosis confidently. It should be noted that the statistical method used here incorporates a justification for not having to consider all possible combinations of the five tests. The criteria of a good test would be the presence of only a small incidence of failures to detect a proven carpal tunnel syndrome (negative tests with positive CTS). For each of the tests this was 33/110, 38/110, 35/110, 29/110 and 31/110, respectively, and for combinations of tests there was still a high incidence of undetected CTS (23/110 = 20%). When the ‘severe’ group of CTS was considered, the number of undetected cases was 3/7.

The value of clinical tests for carpal tunnel syndrome has been questioned by some workers [5, 6]. In 1915, Jules Tinel described a tingling sensation (fourmillement) in the distribution of an injured nerve on tapping its proximal stump and although he did not mention this in relation to entrapment neuropathies, it became known as Tinel’s sign [7]. Stewart and Eisen [6] found this positive in only 51% of hands with CTS and in 29% of controls (p = 0.10). They ascribed the popularity of this sign to Phalen whose patients did not have the benefit of electrodiagnostic confirmation. Tapping a normal ulnar nerve at the elbow often produces tingling in the ulnar-innervated fingers, as it may with normal median nerves at the wrist. Median nerve paraesthesiae induced by the sphygmomanometer compression test [8] is less often regarded as an important diagnostic pointer. Phalen’s test is often performed as a routine and, along with Tinel’s sign, relied upon as a guide to diagnosis before surgical decompression. However, it is worth noting that a recent study showed reversible changes in median nerve conduction velocity with wrist flexion in CTS patients [9].

If clinical tests for CTS are not helpful, how can the diagnosis be made? We believe that careful evaluation of the symptoms, rather than signs, is important [10]. However, the diagnosis should be confirmed by median nerve conduction tests whenever possible. These also provide a quantitative estimation of the severity of the block and can be a guide to the need for surgical decompression. The electrodiagnostic tests normally carried out comprise supramaximal stimulation of the median nerve at the wrist, measurement of the latency for motor units in the abductor pollicis brevis and measurement of sensory latencies from one of the median-innervated fingers to the wrist, either orthodromically or antidromically. Recently, sensory evoked potentials have been claimed to give more accurate results, but the standard electrodiagnostic tests we used are in widespread use and certainly give adequate results for normal clinical purposes. Transcutaneous palmar stimulation of the median nerve may be more rapid and comfortable [11] but the false-positive rate of this method has not been fully established [12].

REFERENCES

3. Phalen GS. Reflections on 21 years’ experience with the carpal tunnel syndrome. JAMA 1970;212:1365-7.