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## A New Diagnostic Test for Carpal Tunnel Syndrome\*

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**ABSTRACT:** A new test, called the carpal compression test, consists of application of direct pressure on the carpal tunnel and the underlying median nerve. The results of the Tinel percussion test, the Phalen wrist-flexion test, and the new test were evaluated in thirty-one patients (forty-six hands) in whom the presence of carpal tunnel syndrome had been proved electrodiagnostically, as well as in a control group of fifty subjects. For the diagnosis of carpal tunnel syndrome, the carpal compression test was found to be more sensitive and specific than the Tinel and Phalen tests.

Many tests have been used for the diagnosis of carpal tunnel syndrome<sup>1,3,5-7,12,18,19</sup>, and some have involved reproduction of symptoms by stimulation or compression of the median nerve. The most popular test has been the wrist-flexion (Phalen) test, which involves unforced, complete flexion of the wrist for sixty seconds<sup>12-14</sup>. This position of the wrist further compresses an already compressed median nerve.

The Tinel test, another popular technique, consists of gentle percussion of the median nerve at the wrist<sup>18</sup>. Paresthesias in the distribution of the median nerve indicate a positive response.

The new test that will be described consists of direct compression of the median nerve in the carpal tunnel for as long as thirty seconds. The results of this test were compared with those of the Phalen test and the Tinel test in thirty-one patients and fifty control subjects.

### Observations

From January 1987 to October 1990, we studied the cases of thirty-one patients who had idiopathic carpal-tunnel syndrome. In fifteen of them, the condition involved both hands. The study population consisted of eight men and twenty-three women. The patients ranged in age from twenty-two to seventy-nine years (average age, forty-five years). Carpal tunnel syndrome was suspected because of pain, numbness, and paresthesias in the distribution of the median nerve. The Phalen test, the Tinel test, and the new test were performed on these patients.

The new test consists of direct compression of the

median nerve running deep to the flexor retinaculum. With a device that was constructed by connection of a rubber atomizer-bulb to a pressure manometer from a sphygmomanometer (Fig. 1), a pressure of 150 millimeters of mercury (twenty kilopascals) was applied to the area of the carpal tunnel for as long as thirty seconds. Alternatively, the examiner exerted even pressure to the median nerve in the carpal tunnel with both thumbs (Fig. 2). The interval from the application of compression to the onset of numbness, pain, or paresthesias in the distribution of the median nerve distal to the level of the carpal tunnel was recorded.

All thirty-one patients not only had characteristic symptoms of carpal tunnel syndrome but also had definite abnormalities of nerve-conduction velocity<sup>11,16,19</sup> in one or both hands. Thus, the study group consisted of forty-six hands for which electrodiagnostic findings had been positive. One hand of each of fifty asymptomatic control subjects was also evaluated with the Phalen test, the Tinel test, and the carpal compression test.

In forty-four (96 per cent) of the forty-six hands, the motor-conduction latency of the median nerve was abnormal, and in forty-two (91 per cent) the sensory latency of the median nerve was abnormal. In forty (87 per cent) of the hands, both motor and sensory conduction were abnormal.

For forty (87 per cent) of the forty-six hands, the result of the new test was positive (Table I), with the average time to the onset of symptoms being sixteen seconds (range, five to twenty-nine seconds). The results (the number of positive responses and the time-interval to the onset of symptoms) were identical for the subjects who were tested with application of 150 millimeters of mercury (twenty kilopascals) of pressure with the bulb manometer and for those who were tested with application of direct pressure to the area of the carpal tunnel by the thumbs of the examiner.

The Phalen wrist-flexion test was positive for thirty-two (70 per cent) of the forty-six hands, and the average interval to the onset of symptoms was twenty-five seconds (range, five to forty-five seconds). The Tinel percussion test was positive for twenty-six (56 per cent) of the forty-six hands.

Of the forty hands for which the carpal compression test was positive, thirty-one had a positive Phalen test and twenty-five, a positive Tinel test (Fig. 3). The result of the new test was negative for six hands, despite the electrodiagnostic findings having been abnormal. In four of these

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TABLE I  
RESULTS

| Test                  | Group That Had<br>Carpal Tunnel Syndrome |                   |       | Control Group          |                   |       | Sensitivity<br>(Per cent) | Specificity<br>(Per cent) |
|-----------------------|--|-------------------|-------|------------------------|-------------------|-------|---------------------------|---------------------------|
|                       | Pos./<br>Neg.<br>(No.)                   | Interval* (Secs.) |       | Pos./<br>Neg.<br>(No.) | Interval* (Secs.) |       |                           |                           |
|                       |  | Avg.              | Range |                        | Avg.              | Range |                           |                           |
| Carpal<br>compression | 40/6                                     | 16                | 5-29  | 5/45                   | 24                | 16/28 | 87                        | 90                        |
| Phalen                | 32/14                                    | 25                | 5-45  | 8/42                   | 44                | 26-55 | 70                        | 84                        |
| Tinel                 | 26/20                                    | —                 | —     | 10/40                  | —                 | —     | 56                        | 80                        |

\* The intervals were recorded for abnormal (positive) determinations.

hands, sensory conduction of the median nerve was absent and sensation to pinprick and two-point discrimination were diminished in the distribution of the median nerve. In these four hands, the motor-conduction latencies ranged from 4.7 to 10.8 milliseconds.

In the control group of fifty hands, the new test revealed paresthesias of the median nerve in five hands (10 per cent), the Phalen test was positive in eight (16 per cent), and the Tinel percussion test was positive in ten (20 per cent). Of the five subjects for whom the carpal compression test was positive, four had a positive Phalen test, two had a positive Tinel test (Fig. 4), and all five had normal motor and sensory findings on electrodiagnostic studies.

A release of the carpal tunnel was performed in thirty-eight of the forty-six hands in the study group. No complications occurred, and the symptoms were completely relieved in all thirty-eight hands. Of the eight remaining hands, two were scheduled for operative treatment and the remaining six hands were not operated on, either because the patient declined operative treatment or because the symptoms responded to conservative measures (use of a splint at night or modifications of the patient's job). In the operatively treated hands, no abnormal lesions or tumors were found on exploration of the carpal tunnel. There was a consistent finding of narrowing or an hourglass-type constriction of the median nerve deep to the flexor retinaculum.

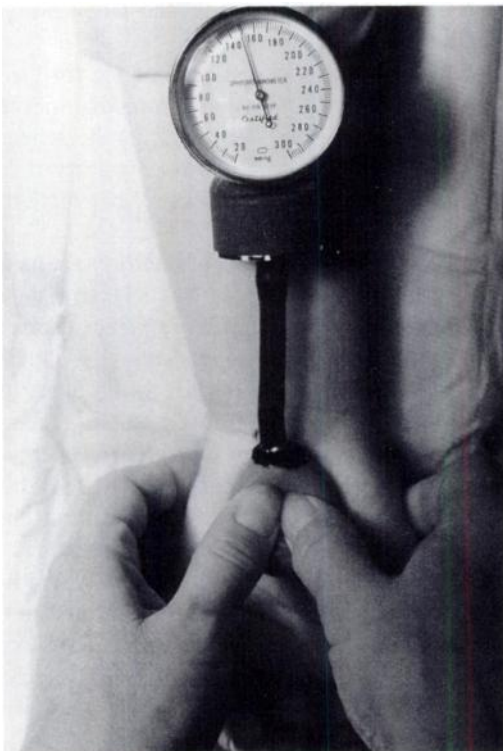


FIG. 1



FIG. 2

Fig. 1: The new test, which consists of direct compression of the median nerve running deep to the flexor retinaculum, is being performed with a device that consists of a rubber atomizer-bulb connected to a pressure manometer from a sphygmomanometer. A pressure of 150 millimeters of mercury (twenty kilopascals) is applied to the area of the carpal tunnel for as long as thirty seconds.

Fig. 2: The carpal compression test can also be performed by the examiner exerting even pressure, with both thumbs, to the median nerve in the carpal tunnel.

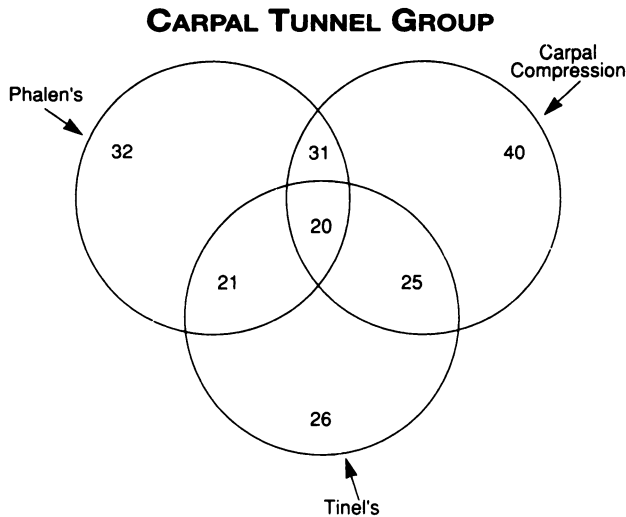


FIG. 3

Of the forty hands for which the carpal compression test was positive, thirty-one had a positive Phalen test and twenty-five had a positive Tinel test.

**Discussion**

In this study, a combination of tests was used to diagnose carpal tunnel syndrome. For one or both hands of all of the patients in the study population, carpal tunnel syndrome was confirmed by a positive result on nerve-conduction studies. In these hands, the carpal compression test was 87 per cent sensitive for diagnosing carpal tunnel syndrome. The specificity was 90 per cent, with 10 per cent of the results being false positive.

For six of forty-six hands, the carpal compression test was negative despite the result having been positive on electrodiagnostic testing. For four of the six hands, sensory conduction of the median nerve was absent, and two-point discrimination and sensation to pinprick were diminished in the distribution of the median nerve. A combination of sensory testing and the carpal compression test resulted in 96 per cent sensitivity in patients in whom carpal tunnel syn-

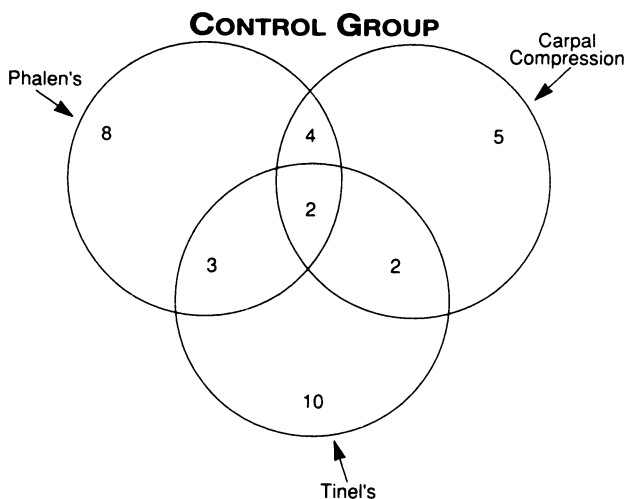


FIG. 4

Of the five control subjects for whom the carpal compression test was positive, four had a positive Phalen test and two had a positive Tinel test.

drome had been proved electrodiagnostically.

The sensitivity of the wrist-flexion (Phalen) test was 70 per cent, the specificity was 84 per cent, and 16 per cent of the results were false positive. The Tinel test was the least sensitive, with a 56 per cent rate of positive findings in patients in whom carpal tunnel syndrome had been confirmed by positive nerve-conduction studies. The Tinel percussion test was specific in 80 per cent of the hands, and the rate of false-positive results was 20 per cent.

Previous studies have been performed to assess the effects of elevated pressure on the median nerve in the carpal tunnel. Gelberman et al.<sup>4</sup> used the wick-catheter technique to measure changes in pressure with the wrist in various positions. Patients who had carpal tunnel syndrome had mean pressures of ninety-nine millimeters of mercury (13.2 kilopascals) with the wrist flexed and 110 millimeters of mercury (14.7 kilopascals) with the wrist extended. For control subjects, the measurements were thirty-one millimeters of mercury (4.1 kilopascals) with the wrist flexed and thirty millimeters of mercury (four kilopascals) with the wrist extended.

Lundborg et al. studied the effects of prolonged compression of the median nerve in sixteen volunteers who had no history of carpal tunnel syndrome. Compression with pressures of thirty to ninety millimeters of mercury (four to twelve kilopascals) for thirty to ninety minutes produced abnormal delays in nerve conduction and abnormal two-point discrimination. These investigators and others<sup>2,4,6,10,13,15</sup> have theorized that compression produces ischemia of the median nerve, resulting in paresthesias and reversible failure of nerve conduction. The earliest indicator of impaired function of a nerve due to compression was a delay in sensory conduction.

Gellman et al. performed sensibility testing with the Semmes-Weinstein monofilament test in patients who had carpal tunnel syndrome. They found the sensitivity of the test to be 91 per cent, but they also found a 21 per cent rate of false-positive results in a normal control population.

In our study, the five control subjects who had a positive result on the new test had normal motor and sensory conduction. This raises the possibility of a false-negative electrical study and a diagnosis of subclinical carpal-tunnel syndrome in these five subjects. Electrodiagnostic studies have been considered the standard for diagnosis of carpal tunnel syndrome. However, false-negative findings on electromyography have been reported for as many as 27 per cent of hands that had a clinical diagnosis of carpal tunnel syndrome<sup>8,17</sup>.

In view of the high sensitivity and specificity of the new test, some patients who have typical signs and symptoms of carpal tunnel syndrome may be identified as candidates for operative treatment and thus avoid the expense and time that electrodiagnostic testing involves. The new test, whether performed with a pressure manometer or with direct pressure by the thumbs of the examiner on the flexor retinaculum, is a simple and inexpensive technique for screening for carpal tunnel syndrome.

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ERRATUM

In "A New Diagnostic Test for Carpal Tunnel Syndrome" (73-A: 535-538, April 1991), by Durkan, there were errors in the numbers in Figures 2 and 3 on page 537. The correct Venn diagrams should have appeared as follows:

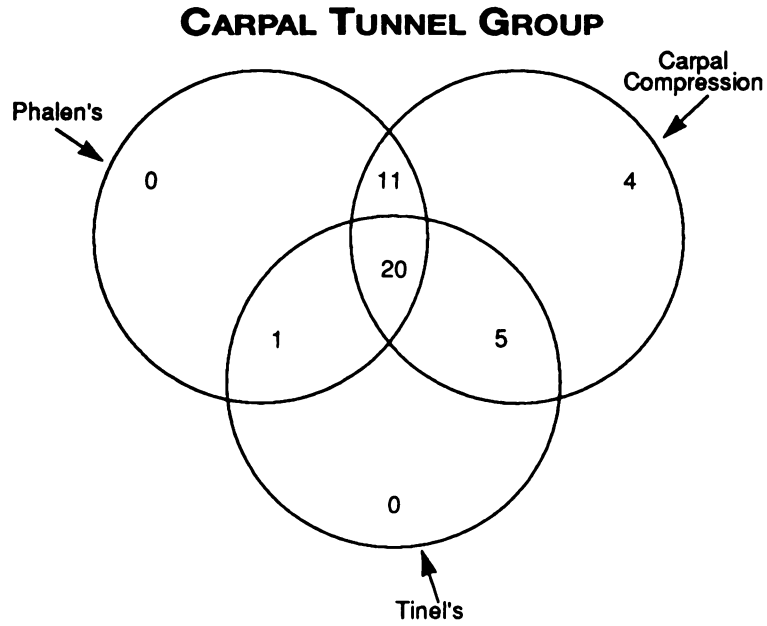


FIG. 3

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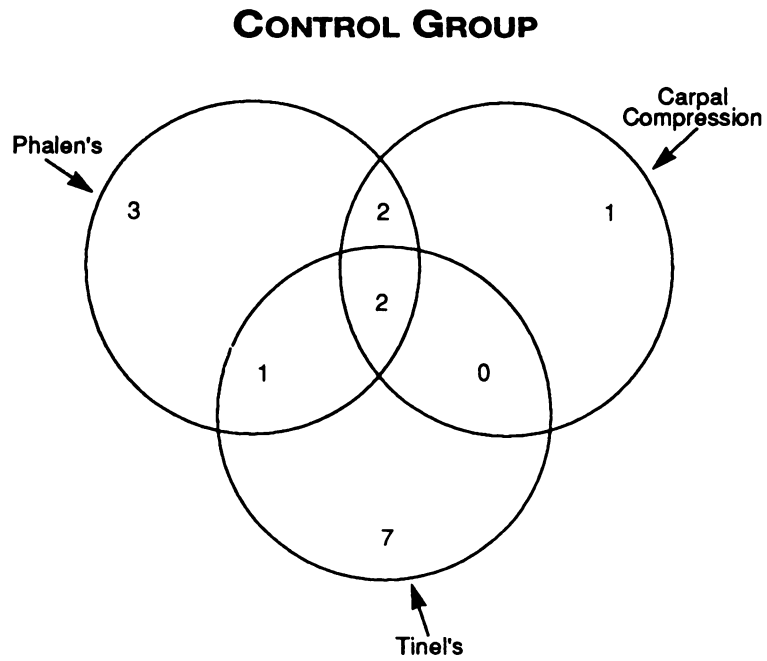


FIG. 4

Of the five control subjects for whom the carpal compression test was positive, four had a positive Phalen test and two had a positive Tinel test.