

## Clinical Practice

*This Journal feature begins with a case vignette highlighting a common clinical problem. Evidence supporting various strategies is then presented, followed by a review of formal guidelines, when they exist. The article ends with the authors' clinical recommendations.*

## CARPAL TUNNEL SYNDROME

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A 64-year-old, right-handed, retired woman presents with intermittent numbness, tingling, and burning pain in the three radial digits of both hands. She has had these symptoms for three months, and they awaken her several times each night. She has no atrophy of the thenar muscles. Sensation to light touch is intact. How should she be evaluated and treated?

### THE CLINICAL PROBLEM

Hand, finger, or wrist symptoms account for 2.7 million office visits to physicians for new problems per year in the United States.<sup>1</sup> The differential diagnosis of discomfort of the hand and wrist includes entrapments of the nerves (such as carpal tunnel syndrome, entrapment of the ulnar nerve, and cervical radiculopathy), tendon disorders, overuse of muscles, nonspecific pain syndromes, and less common disorders. The prevalence of electrophysiologically confirmed, symptomatic carpal tunnel syndrome is about 3 percent among women and 2 percent among men, with peak prevalence in women older than 55 years of age.<sup>2</sup>

The carpal tunnel (Fig. 1) is located at the base of the palm, just distal to the distal wrist crease. It is bounded on three sides by the carpal bones, which create an arch, and on the palmar side by the fibrous flexor retinaculum, or transverse carpal ligament. Nine flexor tendons (two extending to each finger and one

to the thumb) traverse the carpal tunnel, along with the median nerve.

Carpal tunnel syndrome is caused by elevated pressure in the carpal tunnel<sup>3</sup>; this increased pressure produces ischemia of the median nerve, resulting in impaired nerve conduction and attendant paresthesia and pain. Early in the course, no morphologic changes are observable in the median nerve, neurologic findings are reversible, and symptoms are intermittent. Prolonged or frequent episodes of elevated pressure in the carpal tunnel may result in segmental demyelination and more constant and severe symptoms, occasionally with weakness. When there is prolonged ischemia, axonal injury ensues, and nerve dysfunction may be irreversible.<sup>3,4</sup>

A variety of conditions may be associated with carpal tunnel syndrome. These include pregnancy, inflammatory arthritis, Colles' fracture, amyloidosis, hypothyroidism, diabetes mellitus, acromegaly, and use of corticosteroids and estrogens.<sup>5,6</sup> Up to one third of cases of carpal tunnel syndrome occur in association with such medical conditions<sup>7</sup>; about 6 percent of patients have diabetes.<sup>6</sup> Carpal tunnel syndrome is also associated with repetitive activities of the hand and wrist, particularly with a combination of forceful and repetitive activities.<sup>8-10</sup> Occupations associated with a high incidence of carpal tunnel syndrome include food processing, manufacturing, logging, and construction work.<sup>8,11</sup>

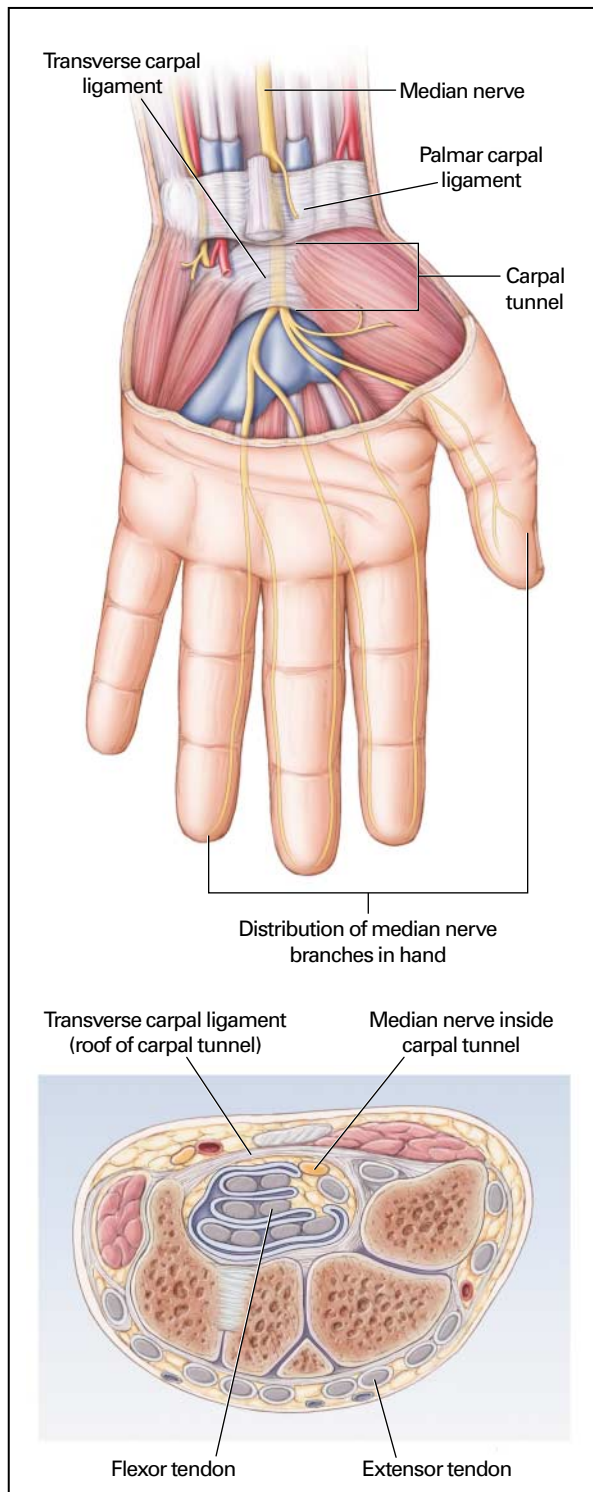
The natural history of carpal tunnel syndrome is variable. One 11-year study of workers with carpal tunnel syndrome showed that, although abnormalities of nerve conduction tend to worsen over time, the prevalence of carpal-tunnel symptoms diminishes.<sup>12</sup>

### STRATEGIES AND EVIDENCE

#### Diagnosis

A combination of electrodiagnostic studies (nerve-conduction studies and electromyography) and knowledge of the location and type of symptoms permits the most accurate diagnosis of carpal tunnel syndrome.<sup>13</sup> Symptoms consistent with carpal tunnel syndrome occur in up to 15 percent of the population,<sup>2</sup> and false negative<sup>14</sup> and false positive<sup>15,16</sup> results on electrodiagnostic testing have been well documented. Hence, both symptoms and electrodiagnostic studies must be interpreted carefully. Electrodiagnostic studies are most useful for confirming the diagnosis in suspected cases and ruling out neuropathy and other nerve entrapments.

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**Figure 1.** The Anatomy of the Carpal Tunnel.

**History**

Carpal tunnel syndrome generally produces pain, tingling, burning, numbness, or some combination of these symptoms on the palmar aspect of the thumb, index finger, middle finger, and radial half of the ring finger. Patients often report only on detailed questioning that no such symptoms affect the fifth finger. A diagram of symptoms in the hand can help patients to localize symptoms. A diagram of symptoms rated as classic or probable carpal tunnel syndrome according to a standard rating system had a sensitivity of 61 percent and a specificity of 71 percent for the diagnosis of carpal tunnel syndrome in a clinic-based sample.<sup>17</sup> The sensitivity was lower and the specificity higher when the diagram was used to screen workers for carpal tunnel syndrome.<sup>18</sup> A history of nocturnal symptoms has moderate sensitivity (51 to 77 percent) and specificity (27 to 68 percent).<sup>19</sup> Often, patients report that they shake the symptomatic hand or hands when symptoms are at their worst. This response, the “flick sign,” had both a sensitivity and a specificity that exceeded 90 percent in one study,<sup>20</sup> but it has not been evaluated further.

**Physical Examination**

Loss of two-point discrimination in the median-nerve distribution (inability to distinguish between one sharp point on the fingertip and two) as well as thenar atrophy occur late in the course of carpal tunnel syndrome. These signs have low sensitivity and high specificity.<sup>17,19</sup> Tests of the patient’s ability to perceive varying degrees of vibratory stimulation<sup>21</sup> and direct pressure on the pulp of the finger<sup>22</sup> in the median-nerve distribution are technically demanding and have moderate sensitivity and specificity.

Several provocative tests may assist in the diagnosis. In Phalen’s maneuver, the patient reports whether flexion of the wrist for 60 seconds elicits pain or paresthesia in the median-nerve distribution.<sup>23</sup> Studies of Phalen’s maneuver report a wide range of values for sensitivity and specificity, from 40 to 80 percent.<sup>17,19,21,22,24</sup> Tinel’s sign is judged to be present if tapping lightly over the volar surface of the wrist causes radiating paresthesia in the digits innervated by the median nerve.<sup>22,23</sup> The sensitivity of Tinel’s sign ranges from 25 to 60 percent, although its specificity is higher (67 to 87 percent).<sup>17,19,21,22,24</sup> In the pressure provocation test,<sup>25</sup> the examiner’s thumb is pressed over the carpal tunnel for 30 seconds. In the tourniquet test, a blood-pressure cuff is inflated around the arm to above systolic pressure for 60 seconds. Both tests are deemed positive if they elicit radiating paresthesia in the median-nerve distribution. Estimates of sensitivity and specificity for both of these tests vary widely.<sup>20,26</sup>

Since findings on physical examination and the history have limited diagnostic value, they are most

useful when there is a reasonable clinical suspicion of carpal tunnel syndrome (as when a patient presents with hand symptoms). The history and physical examination have poor predictive value when the likelihood of carpal tunnel syndrome is low (as it is among participants in population-based or workplace screening programs).<sup>17</sup>

## Treatment

### Treating Associated Conditions

When carpal tunnel syndrome arises from rheumatoid arthritis or other types of inflammatory arthritis, treatment of the underlying condition generally relieves carpal-tunnel symptoms. Treatment of other associated conditions (such as hypothyroidism or diabetes mellitus) is also appropriate, although data are lacking on whether such treatment alleviates carpal tunnel syndrome. Similarly, it is not known whether stopping medications associated with carpal tunnel syndrome (such as corticosteroids or estrogen) leads to improvement, although taking such a step is also reasonable in the absence of contraindications.

### Splinting

More than 80 percent of patients with carpal tunnel syndrome report that a wrist splint alleviates symptoms,<sup>27</sup> generally within days. Splinting also reduces sensory latency,<sup>28</sup> suggesting that the intervention may alter the underlying course of carpal tunnel syndrome. Splints are more effective if they maintain the wrist in neutral posture rather than in extension.<sup>27</sup> Commercially available splints are acceptable, provided that they maintain such a neutral position.

### Medications

Nonsteroidal antiinflammatory medications, diuretics, and pyridoxine (vitamin B<sub>6</sub>) have each been studied in small, randomized trials, with no evidence of efficacy. One four-week randomized trial involving 91 patients had four treatment groups; one group received placebo, one received nonsteroidal antiinflammatory medication, one received a diuretic, and one received 20 mg of prednisolone daily for two weeks followed by 10 mg daily for another two weeks. The prednisolone group had a substantial reduction in symptoms, whereas the outcomes in the other medication groups did not differ from those in the placebo group.<sup>29</sup> In this small study, patients were not followed after the four-week course of treatment ended, nor did the study address the dose of corticosteroids needed to maintain a response. There were essentially no toxic effects of corticosteroids in this short-term trial, although risks including weight gain, hypertension, and hyperglycemia are recognized even with short-term treatment. Apart from this small, short-term study,

there have been no other placebo-controlled trials of nonsteroidal antiinflammatory medications.

### Local Corticosteroid Injection

Patients who remain symptomatic after modification of their activities and splinting are candidates for injection of corticosteroids into the carpal tunnel. A 25-gauge needle may be used to inject 1 ml of 1 percent lidocaine just to the ulnar side of the palmaris longus tendon, proximal to the wrist crease. The needle is aimed toward the carpal tunnel at a 30-degree angle of entry. If there is no paresthesia on injection of a small amount of lidocaine, the rest of the lidocaine is injected followed by the depot corticosteroid.

Injection of corticosteroids is superior to injection of placebo,<sup>30,31</sup> improving symptoms in more than 75 percent of patients.<sup>30,32-34</sup> Local injection of corticosteroids is also associated with improvement in median-nerve conduction.<sup>30,33,34</sup> Symptoms generally recur within one year.<sup>30,32</sup> Risk factors for recurrence include severe abnormalities on electrodiagnostic testing, constant numbness, impaired sensibility, and weakness or thenar muscular atrophy.<sup>30,32,34</sup> The risks of infection and nerve damage resulting from corticosteroid injection are considered to be low but have not been formally studied. Many clinicians limit the number of injections into the carpal tunnel (as they would for other sites) to about three per year in order to minimize local complications (such as rupture of tendons and irritation of the nerves) and the possibility of systemic toxic effects (such as hyperglycemia or hypertension). The optimal number of injections per year has not been studied. Preliminary data suggest that iontophoresis with corticosteroid cream (a method that involves the use of an electrical current to deliver medication to deeper structures) may provide an alternative to corticosteroid injection.<sup>35</sup>

In general, conservative treatment is more successful in patients with mild nerve impairment. In one study,<sup>32</sup> 89 percent of patients with severe carpal tunnel syndrome (constant numbness with weakness, atrophy, or sensory loss) had recurrence of the syndrome within one year after a conservative program that included splinting and injection of corticosteroids into the carpal tunnel. Among patients with mild carpal tunnel syndrome (intermittent numbness and normal sensory and motor findings on physical examination), 60 percent had recurrence of symptoms after such conservative treatment.

### Surgery

In general, the decision about whether to proceed with carpal-tunnel–release surgery should be driven by the preference of the patient. However, if a patient has symptoms and signs that are suggestive of axonal loss — constant numbness, symptoms for more than

one year, loss of sensibility, and thenar muscular atrophy or weakness — surgery should be seriously considered.

There are several surgical approaches to carpal-tunnel release. In the traditional open procedure, the surgeon makes an incision 5 to 6 cm long, extending distally from the distal wrist crease, and releases the transverse carpal ligament under direct visualization. For endoscopic release, a device with either two portals<sup>36</sup> or one portal<sup>37</sup> is used to release the transverse carpal ligament. The endoscopic techniques carry a higher risk than open carpal-tunnel release of injury to the median nerve.<sup>37-39</sup> Relief of symptoms is similar with the open and the endoscopic procedures,<sup>37,38</sup> and many studies report that patients return to work earlier after the endoscopic surgery.<sup>37-39</sup>

In recent years, many surgeons have adopted a “mini”-open release that uses an incision of 2.0 to 2.5 cm to release the transverse carpal ligament under direct visualization. This approach is used in an attempt to achieve earlier recovery while avoiding the complications associated with the endoscopic approach.<sup>40</sup> The efficacies of the “mini”-open, endoscopic, and traditional open techniques have not been compared in an adequately powered randomized trial.

More than 70 percent of patients report being completely satisfied or very satisfied with the results of carpal-tunnel surgery (irrespective of whether they have undergone open or endoscopic surgery).<sup>41</sup> Similarly, 70 to 90 percent of subjects report being free of nocturnal pain after surgery.<sup>38,41</sup> There have been no randomized controlled trials comparing carpal-tunnel release with conservative therapy. After surgery, pain relief occurs within days, but hand strength does not reach preoperative levels for several months.<sup>42</sup> Tenderness of the surgical scar may also persist for up to a year after open release.<sup>41</sup> Patients with better general functional status and mental health have more favorable outcomes after carpal-tunnel release.<sup>41,43</sup>

Among workers undergoing carpal-tunnel release, involvement of an attorney (generally to dispute a decision about a workers' compensation claim) is associated with a worse surgical outcome.<sup>43</sup> Also, workers with less striking abnormalities on electrodiagnostic testing have worse outcomes.<sup>44</sup> This somewhat paradoxical finding may reflect the inclusion of cases in which symptoms arise from other disorders of the arm or hand, underscoring the importance of careful selection of patients for surgery.

#### **Alternative Therapies**

Acupuncture for carpal tunnel syndrome has not been evaluated in controlled studies. In a randomized trial, an intervention involving yoga-based stretching, strengthening, and relaxation in patients with carpal tunnel syndrome resulted in greater improvement in

grip strength and reduction of pain than did splinting.<sup>45</sup> In one study, chiropractic therapy for carpal tunnel syndrome was as effective for pain as splints and medication,<sup>46</sup> but data are limited.

#### **AREAS OF UNCERTAINTY**

The benefit of modifying the patient's activities remains uncertain. It is reasonable to suggest that patients minimize forceful hand and wrist activities at home and work, since these activities increase carpal-tunnel pressure in patients with carpal tunnel syndrome,<sup>47</sup> and that patients minimize any activities that exacerbate their symptoms. The effects of ergonomically designed equipment and frequent rest breaks on the incidence and course of carpal tunnel syndrome have not been studied rigorously. Rigorous studies are also needed to define the effectiveness of various medications, acupuncture, dietary supplements, chiropractic, and yoga, as well as the optimal timing of carpal-tunnel surgery and the results of carpal-tunnel release with a “mini”-open incision.

#### **GUIDELINES**

The “Clinical Guideline on Wrist Pain” from the American Academy of Orthopedic Surgeons recommends that patients with suspected carpal tunnel syndrome modify their activities for two to six weeks while they are treated with wrist splints and nonsteroidal antiinflammatory medication. If these therapies are ineffective, or if the patient has thenar-muscle atrophy or weakness, the guidelines recommend referral to a specialist for consideration of injection or surgery.<sup>48</sup> The practice guidelines of the American College of Occupational and Environmental Medicine<sup>49</sup> suggest a similar approach and emphasize the importance of avoiding occupational activities that cause bothersome symptoms.

#### **CONCLUSIONS AND RECOMMENDATIONS**

Patients with discomfort of the hand and wrist, such as the woman described in the vignette, should be evaluated with a detailed history of symptoms (which can be facilitated with a diagram of hand pain) and a physical examination that includes tests of sensory and motor-nerve function and provocative maneuvers. Findings on such examination have limited diagnostic value, however, and will not establish the diagnosis with certainty. If carpal tunnel syndrome seems likely, conservative management with splinting should be initiated. If splinting causes discomfort during the performance of some hand-intensive tasks, it is advisable either to avoid the activity or to perform it without the splint. We suggest that patients reduce activities at home and work that exacerbate symptoms. Although the effects of nonsteroidal antiinflammatory medications on carpal tunnel syndrome have not been

well studied, we generally suggest a trial of these agents if there are no contraindications. We do not recommend use of vitamin B<sub>6</sub> (because there is no evidence of efficacy) or oral corticosteroids (given the potential for toxic effects). We generally screen for and treat common underlying disorders — specifically, diabetes and hypothyroidism.

If the condition fails to improve, we recommend referral to a specialist with expertise in the diagnosis and management of carpal tunnel syndrome. If the diagnosis appears secure, the clinician should discuss the options of corticosteroid injection and surgical therapy with the patient. Injection is especially effective if there is no loss of sensibility or thenar-muscle atrophy and weakness and if symptoms are intermittent rather than constant. We perform electrodiagnostic studies if the diagnosis is uncertain, particularly if surgery is contemplated. For surgically treated patients, we favor the limited open incision for carpal-tunnel release.

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