CARPAL TUNNEL MANAGEMENT EASES SYNDROME DISCOMFORT
Practitioners should be vigilant to identify a possible work origin for the condition
By Douglas Rallo, JD, and Charles Frank, MD

Carpal tunnel syndrome is a complex of symptoms that result from compression of the median nerve in the carpal tunnel of the wrist. Pain, burning, or tingling paresthesias in the fingers and hand sometimes extend to the elbow.(1) CTS is defined not as a disease but as a syndrome because of symptoms that include hand pain and feelings of swelling, numbness, and tingling.(2) However, compression of the median nerve is the fundamental pathology in CTS.

Although CTS is seen in men, women between the ages of 40 and 60 constitute the majority of patients. Patients often complain that symptoms interfere with sleep, driving, writing, gripping, performing fine motor tasks, and the ability to comfortably conduct work activities. Most patients are awakened by pain or discomfort almost nightly. Additional symptoms include the hand falling asleep while holding a phone or steering wheel. Most patients complain that one hand is worse than the other. Physical signs include diminished cutaneous sensitivity to vibration, light touch, and pinprick in the distribution of the median nerve as well as abnormal two-point discrimination. Thenar muscle weakness and atrophy may also be present in advanced cases.

One researcher has described the following classification scheme for CTS:
• Classic/probable CTS: numbness, tingling, burning, or pain in at least two of digits 1, 2, or 3. Palm pain, wrist pain, or radiation proximal to the wrist;
• Possible CTS: tingling, numbness, burning or pain in at least one of digits 1, 2, or 3;
• Unlikely CTS: no symptoms in digits 1, 2, or 3, the palm, or the wrist.

Making a diagnosis

A variety of symptoms can cause upper extremity pain similar to that of CTS. These include C-6 radiculopathy, brachial plexus disorders, pronator teres syndrome, peripheral neuropathy, hand-arm vibration syndrome, tendinitis, osteoarthritis, and rheumatoid arthritis.

Paramount to making the diagnosis is evaluating the nature and characteristics of a patient's subjective complaints in combination with findings on clinical exam. Electrodiagnostic studies such as the EMG/NCV test can aid this process. While an earlier study claimed that electrodiagnostic tests were the "gold standard" for evaluating suspected carpal tunnel syndrome, research from a 2006 study concludes that "there is no gold standard for establishing a diagnosis of CTS." Prolongation of the distal motor or sensory latencies of the median nerve, slowing of the median sensory conduction velocity across the wrist, and electrical changes in the abductor pollicis brevis muscle are electrophysiologic findings that are highly suggestive of CTS.

The slower the current travels between two points on the patient's arm, the more likely it is that he or she meets electrodiagnostic criteria for CTS. The EMG portion of the EMG/NCV test involves placing a fine needle into the forearm and hand thenar muscles to produce a low-level shock. This helps to evaluate whether the patient's problem is due to CTS or another neuromuscular condition. A positive test may confirm the CTS diagnosis. While acknowledging that routine use of nerve conduction studies (NCS) before surgical treatment may be redundant or irrelevant, a 2004 study concluded that NCS can provide independent information when evaluating suspected CTS, especially when symptoms are mild or atypical, but that NCS will not help predict the outcome of nonsurgical management.

In cases where a diagnosis is not clear, a steroid injection into the carpal tunnel can—for many, though not all—help clarify one. An injection can also provide relief for as long as several months, although it is usually temporary. A return of symptoms usually indicates a need for surgery.

The physical exam is less helpful in substantiating a diagnosis. At most, it can yield only one or two clues to the diagnostic puzzle. The Phalen maneuver, for example, may be used to reproduce the patient's numbness and tingling. A positive test does not produce an increased ache in the wrist or arm, but numbness and tingling in the fingers, especially the thumb, index, or long finger. Occasionally, light touch will be normal in the little finger (innervated by the ulnar nerve), and abnormal in the thumb, index finger,

and long finger (innervated by the median nerve). A Tinel sign, performed by tapping the wrist directly over the median nerve, occasionally produces a tingling that radiates to the fingers. But this test rarely contributes to the CTS diagnosis. A number of studies have shown that the Phalen and Tinel tests sign lack specificity. Nonetheless, positive tests point to a CTS diagnosis.

Occupational causes

In an attempt to assist practitioners in evaluating whether a patient's diagnosed CTS is work-related, Kao developed a patient questionnaire designed to elicit information on wrist flexion/extension, ulnar/radial deviation, wrist rotation, finger-tapping movements, and workday force and vibration activities. The number of "yes" answers in a subject's questionnaire was deemed directly proportional to the degree of risk.

However, the determination as to whether CTS has an occupational cause may require a more complex inquiry. Silverstein and colleagues, for example, conducted a cross-sectional investigation to determine whether forceful and repetitive job attributes were positively associated with the signs and symptoms of CTS. The study was limited to active workers who had at least one year on the job. High-repetition jobs were defined as those with either a cycle time of less than 30 seconds, or in which more than 50% of the cycle time involved performing the same kind of fundamental tasks. Low-repetition jobs were those with a cycle time of more than 30 seconds and for which less than 50% of the cycle time involved performing the same kind of fundamental tasks. High-force jobs were those with estimated average hand-force requirements of more than 4 kg, and low-force jobs were those with requirements below 1 kg.

The researchers concluded that CTS was strongly associated with high-force/high-repetition jobs and to a lesser degree with low-force/high-repetition jobs and high-force/low-repetition jobs. They also found that repetitiveness appeared to be a stronger risk factor than force. High force combined with high repetitiveness appears to increase the risk to more than five times that of either factor alone. Although vibration and awkward postures are generally thought to be important CTS risk factors, this study showed only vibration to be important.

In 2007, Palmer et al found reasonable evidence that regular and prolonged use of handheld vibratory tools increases the risk of CTS more than twofold. They also found substantial evidence of similar or even higher risks from prolonged and highly repetitive flexion and extension of the wrist, especially when a forceful grip was involved.

Fagarasanu and Kumar also point to the strong evidence of the effect of repetitive and/or forceful tasks on the musculoskeletal system indicated by a number of previous studies. According to the researchers, activities with the highest risk for CTS development are data entry, poultry and meat processing packaging, dentistry, use of vibratory tools, and cashiering. Among the risk factors associated with these activities are repetitive motion, force application, localized mechanical compression, awkward postures, cold environments, and lack of rest.

The National Institute of Occupational Safety and Health, in a 1997 review of the literature on occupational causes for CTS, concluded that highly repetitive work, forceful work, and hand/wrist vibration showed a positive association with the development of CTS. Evidence for an association between awkward postures and CTS was insufficient for an association.12 However, where risk factors existed in combination, the study found strong evidence of a positive correlation between exposure to the combined risks and CTS.

Mackinnon and Novak also concluded that scientific data supported a work-related premise for CTS. They concurred with the view that repetition is the most important risk factor, especially if the jobs being performed involve extreme wrist extension, wrist flexion, pinching, or ulnar deviation. The investigators also noted that forceful motions in conjunction with frequent repetition can further increase the risk for CTS.

Computer keyboard and mouse use

The controversy over keyboard use and CTS exploded in 2001 when a Mayo Clinic study suggested that the frequency of CTS among computer users is similar to estimates of CTS in the general population. The study evaluated 257 employees who used a computer at the clinic's facility in Scottsdale, AZ. CTS was clinically diagnosed in 27 employees (10.5%) who were consistent computer users. Nerve conduction studies confirmed the condition in nine employees (3.5%).

The Mayo Clinic study has been vigorously criticized as being methodologically flawed.15 First, it included only current workers, thereby excluding any employee whose CTS had already caused them to leave the job. The consequence of this "survivor effect" on the Mayo study could be significant. Because the number of electrodiagnostically confirmed CTS cases was small, leaving out employees who had left because of CTS could throw the percentages off by as much as a third. Second, it was an uncontrolled study.Third, subject selection was questionable as the authors did not explain how computer users were identified or how subjects were selected. Fourth, the authors conducted no formal assessment of exposure to ergonomic hazards from the computers used by the subjects. This failure to assess elements of the computer tasks performed, including work postures, obscured potential exposure-response relationships and could have led to unmeasured confounding.

The study also compared its findings with studies involving the general population. Critics contend that another working population would have been more appropriate for comparison. Finally, some employees might have denied symptoms so as to avoid jeopardizing their employment or healthcare coverage, thereby biasing subject selection and any conclusions.

The Mayo authors have acknowledged the validity of some of the criticism and have agreed that additional research is needed to confirm their findings. Andersen et al two years later reported their findings on the contribution of mouse devices and computer keyboard usage to the risk of developing CTS. The Neck and Upper Extremity Disorders Among Technical Assistants study cohort, established in 2000, recruited participants from the Danish Association of Professional Technicians. Its members carried out technical drawing, administrative, graphical, and other office-based tasks. At baseline and one-year follow-up, participants completed a questionnaire, and those meeting specific criteria were offered a standardized clinical interview and physical examination of the neck and upper extremities

The NUDATA study found that keyboard use for 20 or more hours per week was slightly associated with tingling/numbness at baseline and follow-up. The authors concluded that use of a computer keyboard was an "unlikely" occupational risk for CTS, but could not exclude the possibility that very intensive and repetitive keyboard use could be a risk factor for the syndrome.

The study also concluded that the mouse device was associated with symptoms in the cross-sectional comparisons as well as in the follow-up analysis, but irregular exposure response patterns for the mouse or keyboard made it difficult to establish any threshold time values for the devices. This finding contradicts work by Pascarelli and Kella, who claimed that prolonged use of the mouse can lead to problems, especially with the right or left index fingers and the thumb, if the device is gripped tightly. And, in the opinion of one ergonomist, "the mouse is more prone to causing injury than the keyboard."

In their own analysis of typing activities, Fagarasanu and Kumar noted that although high force is not a factor in typing leading to CTS, the activity's elevated level of repetition makes it a major factor in the syndrome's pathogenesis. Confirming the NIOSH and Silverstein studies, Fagarasanu and Kumar concluded that in all work activities the risk of developing CTS is "highly increased where there is an association between different risk factors."

These researchers also concluded that such mental factors as stress are nonexistent as causative agents for CTS, but that such factors do affect pain levels in existing conditions.Finally, their conclusion that strong evidence supports work-related etiologies for CTS is supported by temporal associations: the occurrence of CTS after prolonged exposure and the decrease of these cases after ergonomic programs are implemented.

Ergonomic considerations

Fagarasanu and Kumar in 2003 noted that carpal tunnel pressure is lowest when the wrist is in a neutral position, the hand is relaxed with fingers flexed at 30º, and the forearm is in a semipronated position. This pressure was the most important factor in CTS pathogenesis for keyboard and mouse users.

Comparing the ergonomic features and benefits of various keyboards, the researchers noted that “split keyboards” have a set horizontal split angle and possibly a slight center raise of the left- and right-hand key segments, which allows the hand, wrist, and arms to be held in more neutral positions and which thereby reduce intracarpal pressure. More recently, Palmer et al did not find evidence of an important association between keyboard and computer work and the development of CTS. The existence of divergent and conflicting studies was noted by Kao in a 2003 clinical review, which suggested that longitudinal rather than retrospective cross-sectional studies be undertaken to provide definitive data on workplace etiologies for CTS.

Causation and treatment

At least four popular theories concerning causation exist. One is that repetitive mechanical compression causes changes in the nerve at the hand and wrist. This process can demyelinate the nerve (damage its outer coating) or cause axonal degeneration, which results in a loss of the nerve’s normal conduction tubes. The ischemic theory holds that in some manner the pressure in the carpal canal becomes too great, impeding adequate blood flow to nourish the nerve. This then leads to ischemia, which is manifested by numbness, tingling, and pain. A third theory is that the wrist’s carpal tunnel is anatomically too narrow and the nerve becomes compressed with repetitive activity or daily living.

Trauma is also a well-known cause of CTS. The mechanism of injury may be any traumatic event that increases the volume of the contents of the carpal tunnel, such as a Colles fracture, injury to the flexor tendons, or crushing injuries to the hand, even if the hand trauma is distal to the carpal canal. Auto accidents may also cause CTS when nerve compression is produced by momentary acute hyperflexion or hyperextension of the wrist(s) while tightly grasping the steering wheel or bracing for impact. The common thread to these traumatic CTS events is swelling that causes reduced vascular perfusion of the nerve. The decreased vascular flow results in symptoms of numbness, tingling, altered sensation (feeling that the hand is swollen), and pain.

Research indicates that some hands with CTS improve spontaneously in the absence of therapy. Duration of symptoms is the factor that is most predictive of untreated CTS evolution. However, Padua et al observed that hands with low initial CTS severity tended to get worse, but hands with initially severe impairment tended to improve.

Where improvement does not occur, initial treatment of mild to moderate CTS is usually nonsurgical, including cessation or reduction of the activities causing the condition (e.g., by providing light duty restrictions for occupational exposures), use of a splint while sleeping, and/or steroid injections, and simple stretching. Although there have been reports of the efficacy of oral steroids in the literature, a randomized, double-blind treatment study showed that local steroid injection was superior to oral corticosteroids in CTS patients. The duration of efficacy was reported to be at least 12 weeks, with minimal side effects and no withdrawal symptoms noted.

Formal physical therapy with ultrasound and iontophoresis has also been shown to be marginally efficient. Extended physical therapy (beyond a month) has proven not usually of value. In deciding whether to perform surgery, practitioners should consider the severity and duration of a patient’s symptoms and whether these will have an influence on the anticipated outcome. There is no agreement in the medical literature on the prognostic value of preoperative severity and duration of symptoms; some show a detrimental influence while others have found no effect.

A study by Ferdinand and MacLean in 2002 found no advantage to the endoscopic method; in particular, there was no reduction of scar discomfort in the postoperative period.

Rehabilitation

Postoperatively, the patient's wrist and hand are wrapped with a soft, mildly compressive sterile dressing. Most patients treat pain with limited narcotic medication for three or four days. Often, the numbness, tingling, and pain are reduced greatly even by the first night after surgery and may continue to improve for several weeks. Surgical decompression of the nerve often results in a patient's once again being able to sleep through the night and carry on comfortably with daily activities. Patients who may get very limited or no relief are those whose thumb muscles may have atrophied after years of nerve compression, who are diabetic, have concomitant nerve compression in their necks, or are elderly; for a small group, there is no known reason.

A patient is usually off work for two to six weeks after surgery. Those who use their hands forcefully throughout their workday may not return to work for at least two months. A few days after surgery, a lighter, removable dressing is applied, allowing the patient to shower. Generally, patients are restricted from pushing, pulling, or lifting more than 10 pounds for three or four weeks. Sutures are removed about two weeks after surgery. The transition to work is hastened with physical or occupational therapy over two or three weeks. This consists of scar massage, gentle stretching, and strengthening exercises.

All surgeries, including carpal tunnel surgery, have a range of patient responses and complications. Generally, however, carpal tunnel release surgery results in a good outcome. Although most patients do well, some have slight or no improvement in their pain, numbness, and tingling symptoms. Complications are infrequent and may include, though are not limited to, such things as pain in the scar area (pillar pain), infection, weakness, and a laceration of nerve or tendon. Usually, discomfort in the palm gradually gets better over three to six months. Again, in those who are doing poorly, up to two months of therapy may be helpful.

Due to normal and mild residual sensitivity in the palm from the incision, patients are usually 90% recovered by three months, with maximal medical improvement reached at three to six months. Rarely does this condition require repeat surgery. Revision surgery may be called for by the need for additional nerve decompression or for those who are scar formers. Recurrence does happen, though infrequently. Occasionally, due to persistence of symptoms, some patients will never be able to comfortably return to their former occupation, necessitating a permanent change of careers. However, this is rare. In most instances, the patient's length of medical leave from work is not more than three months. According to "Workplace Guidelines for Disability Duration," the maximum expected time off work before patients can return to "very heavy work" is 63 days if the patient did not have surgery and 84 days if the patient did have surgery.

Conclusion

With the incidence of carpal tunnel syndrome from workplace activities on the rise, practitioners should understand the nature of the syndrome and be vigilant to identify a possible work origin for the cases under consideration, as they may be called upon to render causation opinions in workers' compensation suits brought by their patients.

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