

CLINICAL REVIEWS

Carpal Tunnel Syndrome As an Occupational Disease

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Background: Symptoms related to carpal tunnel syndrome (CTS) represent common patient complaints for many primary care physicians. However, there is a surprising lack of guidelines on diagnosing occupational CTS readily accessible to primary care physicians. This article aims to fill part of that void by reviewing historical aspects of occupational CTS, leading up to more current epidemiologic studies of the association of CTS with occupational ergonomic risk factors.

Methods: The English medical literature was reviewed on the relationship between CTS and occupational ergonomic risk factors. Recent legislative initiatives are discussed. Guidelines of diagnosing and managing occupational CTS are outlined.

Results: Many studies are divided regarding whether CTS is associated with highly repetitive/forceful/vibration work. However, a subset of patients presenting with symptoms related to CTS probably has occupational CTS. These patients can be objectively diagnosed and successfully treated and are able to return to work.

Conclusions: By being armed with knowledge regarding the background of CTS and by following simple diagnosis and treatment guidelines, the family practitioner should be able to manage many patients presenting with work-related CTS. (J Am Board Fam Pract 2003;16:533–42.)

Carpal tunnel syndrome (CTS) is the most well known nerve entrapment syndrome. Involving the median nerve, it is often described as an occupational disease and claimed as a basis for worker's compensation. To provide a perspective helpful in understanding the issues central to occupational CTS, this review will focus on the history of and aspects of epidemiologic research relating to occupational CTS. Armed with such knowledge, physicians will be better prepared to establish guidelines useful in determining whether CTS is directly and solely attributable to a patient's occupation.

A Historical Perspective

The need for occupational health as a field to prevent and treat occupational injuries and diseases has long been recognized, especially after the Workman's Compensation Act was first established in 1911. This law was a landmark in establishing the

need for safe working conditions and employment practices.¹ It has its roots in abusive employment practices and the tragedy of workers injured on the job who suffered not only from the injury but also from the loss of livelihood and ability to pay for the required medical care and provide for their families. Before the passage of the law, to recover the cost of medical care and lost wages from the employers, workers generally bore the responsibility of proving not only that the disease/injury was work-related but also that the employer's negligence directly caused the injury. This burden of proof required workers to hire costly legal representation and seek the corroborating testimony of coworkers who were often unwilling or uncooperative because of intimidation and the fear of losing employment themselves. As the result of factors such as these, less than one third of employees who brought negligence suits against employer received redress. The Workman's Compensation Act was therefore established as a compromise, "no-fault" solution: employers are required to pay for the medical care expenses of employees for work-related injuries or illnesses and reimburse part of each injured worker's lost wages. In return, employees waive the right to payments for pain and suffering.

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Any worker who suffers from occupational CTS should be eligible for worker's compensation.

Descriptions of occupational hand/wrist diseases (eg, "writer's cramp," "telegraphist's cramp," and "tailor's cramp") had already appeared in the medical literature of the early 1900s. They included signs and symptoms that we would recognize today as CTS.² In 1913, Marie and Foix³ noticed a "lesion" at the carpal tunnel in the wrist based on the autopsy findings and were the first to recommend surgical decompression. Learmouth then first performed surgical decompression in 1930.² In 1938, the term "carpal tunnel syndrome" was first used by Moersch.⁴ However, the pathology of CTS was not well understood until after the influential hand surgeon Dr. George Phalen presented his experience from treating 439 patients at the Cleveland Clinic during the 1950s and 1960s. Ironically, because most of his patients were middle-aged women and were therefore not employed outside the home, Dr. Phalen concluded that CTS was not an occupational disease but was instead "idiopathic." He did observe, however, that repeated, forceful grasping hand movements seemed to aggravate the symptoms.⁵

More recently, as a by-product of a series of strikes at meatpacking plants in the 1980s, renewed attention began to be focused on occupational CTS. The strikes were initially aimed at winning better wages and job security, but safety in the work environment became a key element of the negotiations between management and labor. As the negotiations progressed, differences arose on the issue of "occupational CTS" and subsequently drew public attention. Finally, during the course of inspections and investigations conducted by the US Occupation Safety and Health Administration (OSHA), it was discovered that 2 plants kept different sets of injury records to hide the true documentation and gain advantages during the contract negotiations. Furthermore, company managers were caught making false statements during the testimony at congressional hearings. These transgressions evaporated any residual sympathy the public may have had for management and its positions and also resulted in a record fine levied by OSHA. Any residual skepticism regarding the validity of work-related CTS arguably evaporated as well.²

Claims of occupational CTS have increased considerably in the 2 decades since then. According to

the US Bureau of Labor Statistics, 46,000 cases of injuries associated with repetitive trauma (CTS is considered one of the repetitive trauma disorders) were reported in 1986; cases in that category increased to 281,800 in 1992. These numbers represent 6.4 cases (1986) and 36.8 cases (1992) per 10,000 full-time workers.⁶ Therefore, the number and frequency of worker's compensation CTS claims increased by more than 500%, despite increased regulations and monitoring, and presumably improved workplace conditions. Currently, CTS leads to more lost workdays than any other workplace injury.

Epidemiological Studies Set the Stage

A considerable amount of research has been conducted on CTS since the first widespread labor disputes of the 1980s. Many of these studies have attempted to assess the relationship between wrist/hand exposures to physical load factors in the development of CTS. However, many of these earlier studies in the 1980s suffered from 2 main deficiencies, as outlined in previously published reviews:^{8,9}

1. Diagnosis of occupational CTS based on symptoms and physical examination alone. The physical examination for carpal tunnel syndrome has been consistently shown to be unreliable, with poor concordance between self-reported symptoms, physical examination findings (including the Tinel and Phalen tests), and nerve conduction velocity (NCV) results.^{10,11} Diagnosing occupational CTS ideally should include objective confirmation with electromyogram (EMG) and NCV studies.
2. Reliance on patient self-reporting to determine the degree of occupational exposure. Patient self-reporting of work conditions is often unreliable. For example, Spielholz et al¹² found that patients often are inaccurate when reporting specific workplace practices. Most authors agreed that use of direct observations and direct measurements of patients' exposure to workplace practices is the more reliable method in assessing the workplace exposure in relation to occupational CTS.¹³

For example, a frequently cited cross-sectional study by Silverstein et al^{14,15} found strongly positive association (odds ratio = 15; $P < .001$) between

Table 1. Cross-Sectional Studies That Found No Association between Occupational Exposure and CTS

| Study | No. of Patients | Setting of Study | Measurement of Occupational Exposure | CTS Diagnostic Criteria | Controlling of Confounding Factors | Findings | Comment |
|------------------------------------|-----------------|---|--------------------------------------|-------------------------|------------------------------------|---|---|
| Chiang et al ²² | 207 | Fish processing workers | Observation and EMG force recording | S, PE | Age, gender | No association with repetition on the exposure group | Excluded the subjects with medical condition that can cause CTS |
| English et al., 1995 ²⁴ | 1167 | Orthopedic clinic | Self-report | Not specified | Gender, height, weight | No association with wrist ergonomics | |
| Moore et al ²³ | 230 | Pork processing plant | Observation | S, PE, NCV | No | No association | Based on the medical records review |
| Nathan et al ¹⁷ | 471 | Employees from 27 occupations in 4 industries | Observation by investigators | NCV | Age, gender | No association between occupational hand activity and NCV finding | Case definition does not include symptom, physical examination |
| Schottland et al ¹⁹ | 178 | Poultry-processing plant | Employment status, not observation | NCV | Age, gender | No association between employment experience and the NCV finding | Case definition does not include symptom, physical examination |
| Steven et al ²⁷ | 257 | Orthopedic clinic | Not specified | S, PE, NCV | No | No association | |

CTS, carpal tunnel syndrome; EMG, electromyogram; S, self-report; PE, physical examination; NCV, nerve conduction velocity.

high repetition/high hand-grip force and the prevalence of CTS among 652 active workers. Unfortunately, the diagnosis of CTS was based on patient-volunteered symptoms and physical examination alone, without confirmation by NCV. Because neither symptoms nor physical examination have been found to be very accurate in detecting NCV-confirmed CTS, the actual association between workplace factors and CTS remained uncertain.

Subsequent studies in the 1990s used more rigorous methods to define CTS and occupational exposure but divergent results continued to be reported (Tables 1 and 2). For example, Stetson et al¹⁶ tested employees from a range of occupations. Industrial workers with exposure to repetitive hand exertion were found to have significantly smaller sensory amplitudes ($P < .05$) and longer motor and sensory latencies ($P < .001$) in tests of nerve conduction. On the other hand, Nathan et al¹⁷ failed to find an association between the specific type of occupational hand use and the prevalence or severity of impaired sensory conduction of the median nerve at the carpal tunnel in 471 industrial employees from 27 occupations. In a follow-up study¹⁸ 5 years later involving 67% of the original group of 471 employees, the same group of investigators reported that there continued to be no significant

change in the prevalence of median nerve neuropathy. Separately, Schottland et al¹⁹ measured nerve conduction velocity in poultry processing workers, randomly selecting 93 employees matched with 85 applicants for the same positions. No significant association was found between employment experience and the existence of slowed nerve conduction velocity.

A strong correlation between workplace factors and CTS was found by Osorio et al,²⁰ who evaluated the prevalence of CTS among 56 grocery store workers in relation to forceful and repetitive wrist motion. This study found a strong positive association (odds ratio = 6.7) between ergonomic physical factors and CTS prevalence.²⁰ Chiang et al^{21,22} also included NCV in the case definition of CTS in the cross-sectional studies on the prevalence of CTS with regard to occupational ergonomic risk factors among factory workers in Taiwan in early 1990. They divided 207 frozen food plant workers into 3 groups based on exposure to degree of repetition in their occupations and found a strong positive association between repetitive hand use and the prevalence of CTS (odds ratio = 7.40).²¹ However, in the subsequent study on fish processing workers by the same group of authors,²² no significant association was found between the prevalence of CTS and occupational wrist repetitive

Table 2. Cross-Sectional Studies That Found an Association between Occupational Exposure and CTS

| Author | No. of Patients. | Setting | Measurement of Occupational Exposure | CTS Diagnostic Criteria | Controlling of confounding factors | Result | Comment |
|---------------------------------|------------------|---|--------------------------------------|-------------------------|---|---|---|
| Chiang et al ²¹ | 207 | Two frozen food plants | Observation | S, PE, NCV | Age, gender, length of employment | Strongly positive association between repetition and CTS (OR = 7.40) | Excluded the subjects with medical condition that can cause CTS |
| Latko et al ²⁶ | 352 | Three companies | Observation | S, PE, NCV | Age, gender | Positive association with repetition (OR = 3.1) | |
| Osorio et al ²⁰ | 56 | Grocery store | Observation | S, PE, NCV | Age, gender, alcohol assumption and high-risk medical history | Strongly positive association (OR = 6.7) | |
| Silverstein et al ¹⁴ | 652 | Active workers in 39 jobs from 7 different industrial sites | Observation, (EMG) recordings | S, PE | Demographic information including age, gender, years on the job, etc | Strongly positive association between high force-high repetitive job and CTS prevalence (OR = 15) | CTS diagnosis was not confirmed by NCV |
| Stetson et al ¹⁶ | 345 | Industrial workers | Observation and workers interview | S, NCV | Age, height, skin temperature and finger circumference | Positive association between ergonomic factors and NCV finding | |
| Werner et al ²⁵ | 184 | Six work sites | Observation | S, NCV | Demographic, anthropometric, history of diabetes and psychosocial factors | Positive association | |

CTS, carpal tunnel syndrome; EMG, electromyogram; S, self-report; PE, physical examination; NCV, nerve conduction velocity.

movements (odds ratio = 1.1; 95% confidence interval = 0.7 to 1.8).

In an especially meticulous study, Moore and Garg²³ used videotaped observations of workers in a pork processing factory to accurately measure and verify ergonomic physical factors and reviewed employees' medical records to obtain full details regarding upper extremity disorders (including CTS). They concluded that the association between CTS and ergonomic factors was not statistically significant (RR = 2.8, $P = .44$).²³

Studies published in recent years have continued to report divergent results. English et al (1995) studied 580 patients attending an orthopedic clinic and matched them with 996 control subjects. They found that subjects with upper extremity disorders were more likely to perform certain occupations

(for example, hairdressers, assembly line workers, machine operators, and electricians).²⁴ However, logistic regression analysis found negative association between CTS and wrist ergonomic factors (OR = 0.39). The study conducted by Werner et al.²⁵ found that the workers who complained of hand symptoms were more likely to have ergonomic risk factors compared with asymptomatic workers who had similar NCV findings ($P = .002$).²⁵ Latko et al²⁶ also found, in a study of 352 workers from 3 companies, that repetitive work is related to CTS (OR = 1.22 per unit of repetition; OR = 3.11 for high versus low repetition). More recently, Steven et al²⁷ published a study surveying Mayo Clinic employees who were identified as frequent computer users. Nine employees (3.5%) were diagnosed as having clinical CTS, confirmed

by NCV. Therefore, the authors concluded that the rate of CTS among the computer users was comparable with the estimated rate of CTS in the general population, suggesting that using a computer does not seem to increase the risk of developing CTS.

Attempting to Reach a Consensus

Because of the varying quality of published reports and often divergent results, a number of authors have attempted to apply specific criteria in reviewing and making sense of the literature. For example, Hagberg et al⁸ reviewed 15 cross-sectional studies (most of which were published between 1980 and 1990) that met predefined medical criteria. They concluded that physical exertion associated with occupational hand use probably did cause CTS.⁸ On the other hand, a meta-analysis by Vender et al⁹ reached the opposite conclusion. They selected 54 articles based on a high frequency of citation. Only 14 articles passed the defined medical review criteria (CTS was diagnosed based on symptoms, physical examination, and NCV). Five were eliminated because they were descriptive rather than analytical. Vender et al then reviewed the remaining 9 articles to determine whether they met the population, exposure, and outcome criteria. The authors found deficiencies in each article and therefore concluded that there was insufficient evidence that work is the sole cause of so called “cumulative trauma disorder.”⁹

In light of the potential effects legislated workplace rules have on economic and political activities in the country, the government has also attempted to clarify whether a definite relationship exists between workplace practices and CTS. In 1997, the National Institute for Occupational Safety and Health (NIOSH) conducted an intensive review on epidemiology research.¹³ NIOSH reviewed 30 cross-sectional studies, and 4 criteria were used to select studies for review. The criteria included (1) participation rate higher than 70% of all exposed workers, (2) direct observation/measurement instead of job title/self-report used to measure exposure status, (3) investigators blinded to case/exposure status, and (4) CTS definition based on physical examination and/or NCV. Notably, objective confirmation with NCV was not included as absolute criteria. Only 5 studies^{14,20–23} fulfilled these criteria. The conclusion of the review panel

was that there was “evidence” of positive association between highly repetitive/forceful work, vibration and CTS but there was “insufficient evidence” to support the association between extreme posture and CTS.

A Need for Better Studies

Because of the retrospective or cross-sectional nature of most studies on CTS, uncertainty regarding the temporal relationships between exposure and CTS often remains. For example, patients may have had undetected pre-existing conditions that influenced the subsequent development of CTS. Alternatively, had employees been examined or tested before employment, perhaps a degree of CTS would have been detected. Longitudinal studies to establish temporal relationships between specific workplace practices and the development of CTS could arguably provide definitive data regarding such practices indeed causing CTS. But it has been argued that periodically testing many employees in disparate workplaces in a longitudinal study would be prohibitively expensive. Furthermore, longitudinal studies are still not immune from certain methodological sources of error, such as the survivor effect. (The survivor effect results from the possibility that workers who developed CTS may have left employment, such that a falsely low prevalence of CTS is found when only the remaining workers are analyzed). For these reasons, it has been argued that well-designed cross-sectional studies could be sufficient to provide circumstantial evidence of a causal link.^{28,29}

It is worth mentioning that published studies have not consistently accounted for potentially confounding factors that could influence the development of CTS. Although most have controlled for advanced age and female sex—both identified to increase the risk of CTS—many other nonbiomechanical factors that have been associated with an increased risk of developing CTS but not directly attributable to workplace practices often are not taken into consideration.^{13,30} These include the diagnosis of metabolic disease (diabetes, thyroid disease), autoimmune systemic disease (rheumatoid arthritis, systemic lupus erythematosus, connective tissue disorder), hormone-related status (pregnancy/postpartum), and anthropometric factors (wrist dimension, size of carpal tunnel). It is conceivable that some or most of these factors in a

given patient may have contributed to the development of CTS. The lack of consistency has further contributed to the difficulty in comparing and judging the relative merit of studies with conflicting results.

Occupational CTS as National Policy

Occupational CTS is not a problem unique to the United States. In Australia, there was legal liberation toward accepting CTS [usually referred to as “repetition strain injury” (RSI) in Australia] as work-related injury in early 1980. Subsequently, from 1983 to 1986, it was noted that there seemed to be an “epidemic” of RSI. Increasing skepticism on the validity of RSI led to public discussion on how social/psychological factors can influence the diagnosis. After the Supreme Court of Australia ruled in a decision against the plaintiffs and found no evidence of RSI in an employee (*Cooper v Commonwealth of Australia*), the incidence of RSI declined significantly. For example, the number of reported RSI cases in South Australia fell from 1000 cases in 1984–1985 to 600 to 700 in 1986–1987. Some suggested that the court decision was the cause of the decline, although others attributed the decline to the improvement in the ergonomics at workplace.²

Late in the Clinton administration, OSHA proposed an ergonomics program that would have covered 102 million workers and mandated employers responsible for employees reporting work-related musculoskeletal disorders (WMSDs) by providing them free medical care, work restriction, wage replacement, and workstation ergonomics modification. This new ergonomics proposal generated considerable controversy. The business groups opposed the new proposed standard; they said the new regulation would have compensated workers sometimes more than the amount the state was already paying and they felt that the proposed standard defined WMSDs too loosely. Although the Clinton administration estimated it would cost only \$4.5 billion, business groups claimed making changes required by the ergonomic program would cost in excess of \$100 billion. Intense lobbying by business interests culminated in the failure of the ergonomic program to be approved by Congress in March 2001.³²

Determining Whether CTS Is Job-Related

The primary care physician often faces the task of determining whether a patient has CTS and, if so, whether it was caused by that person’s work. The following paragraphs outline a suitable approach to this seemingly difficult task. The approach includes confirming the diagnosis of CTS, establishing a history of occupational hand use, and excluding concurrent medical disease, because that could also be a risk factor for CTS.

Confirm the Diagnosis

NCV studies constitute an important aspect of the diagnosis of CTS. NCV are objective and sensitive; however, nerve conduction change occurs before a patient develops clinical symptoms of CTS that are severe enough to seek medical attention. Therefore, NCV studies must be correlated with clinical symptoms and by themselves are insufficiently specific to establish a diagnosis of CTS. Many asymptomatic employees can in fact be found to have abnormalities in nerve conduction. For example, Bingham et al³³ performed median NCV studies on 1021 applicants for industrial jobs; 17.5% of them showed change suggestive of neuropathy, but only 10% of those applicants with positive NCV acknowledged symptoms.

In another study, Atroshi et al³⁴ surveyed 2466 randomly selected persons in Sweden. Of the subjects that were surveyed, 15% had neuropathic symptoms and only 4% of the subjects with neuropathic symptoms had CTS. It was also found that 18% of the asymptomatic study subjects showed abnormal NCV.

These studies supported the concept that numbness or tingling in the hands is not sufficient to diagnose CTS, and abnormal NCV is not equivalent to clinical CTS. The diagnosis of CTS should be made by the combination of taking a thorough history and physical examination by experienced provider and should then be confirmed by electrophysiological studies (NCV).

Establish a History of Occupational Hand Use

This includes taking a detailed history of occupational hand use. To help determine whether a patient’s CTS is caused by work activities, the busy family physicians may find helpful the set of questions listed in Table 3. These questions, and the exposure cutoff limits they establish, have been

Table 3. Quick Guide to Estimating Risk of Work-Related CTS

Ask the patient, "In your current occupation . . ."

1. Is this the hand you primarily use to perform your current job?
 2. Do you bend the wrist up and down or from side to side repeatedly more than twice a minute (wrist flexion/extension, ulnar/radial deviation) or twist/rotate the wrist with palm facing up and then down more than twice a minute (wrist rotation)?
 3. Do you have repeated finger-tapping movement more than twice a minute?
 4. Do you spend more than 4 hours per day moving your hand/wrist in the same fashion?
 5. Do you grip or hold any object in the palm with a force greater than 12 lb while performing the activities listed in questions 2, 3, or 4?
 6. Do you hold tools that vibrate during most of your workday?
-

Scoring: the number of "Yes" answers is directly proportional to the degree of risk: 0 to 2, low risk for occupational CTS; 3 to 4, moderate risk; 5 to 6, high risk.

derived from published studies.^{14,21–24,35} This tool is to be used AFTER the diagnosis of CTS has been confirmed and will give family physicians a way of weighing the likelihood of the CTS' being work-related. The number of "Yes" answers is directly proportional to the degree of risk. For example, 2 or fewer "Yes" answers suggest low risk for occupational CTS (score 0 to 2), whereas 3 to 4 suggest moderate risk and 5 to 6 suggest high risk. If the answers to these questions suggest that the patient seems to have moderate to high ergonomic risk in developing occupational CTS, or if a significant degree of uncertainty remains, the family physician then can refer the patient to a physician specializing in Occupational Medicine to confirm the results of the evaluation or for treatment and definitive management. On occasion, an occupational physician may further substantiate the risk of work-related CTS by interviewing not only the patient, but also co-workers and supervisors, and by conducting an inspection of the workplace or directly observing the work performed by the patient.

Occupational CTS should occur more often in the hand that is used more often to perform the job. Occupational hand uses that are considered ergonomic risk factors for developing CTS include those involving highly repetitive awkward wrist movement, high handgrip and pinch force, and those associated with high vibration.¹³

Repetition as risk factor of developing CTS is often defined as "if the job had a repeated sequence of steps" that involves awkward wrist movement.¹⁴ In the epidemiological studies, high repetition is defined either by the frequency of the task or the percentage of time spent on the repetitive work. It is the most recognized risk factor. The job with high repetition is defined as the job that requires

awkward wrist movement of less than 30 seconds each time or more than 50% of the time spent on performing the same task that involves repetitive awkward wrist movement.^{14,21,22,35} Repetitive work is frequently performed in conjunction with high hand/fingers grip force. Most of the epidemiology studies investigated force together with repetition; therefore, it is not clear whether high hand/fingers grip force alone can cause occupational CTS. There were less clear exposure criteria in defining high hand/fingers grip force in the epidemiology studies. Some investigators used the weight of tool²³ or measured the forearm flexor muscles by EMG.^{14,22} For example, Silverstein et al¹⁴ defined high force as >6 kg. In determining whether there is occupational ergonomic risk factor in developing CTS, high hand/fingers grip force should be considered a co-risk factor with high repetition.

Vibration is also believed to be an ergonomic risk factor associated with CTS. Fewer studies included vibration in the assessment of occupational risk factors; therefore, the exposure cutoff limit is also less clear. Chatterjee et al³⁶ used the frequency of between 31.5 and 62 Hz as criteria in studying rock drillers exposed to high vibration.

Exclude Concurrent Nonoccupational Medical Conditions Contributing to CTS

Pre-existing or concurrent medical conditions that are unrelated to employment but are risk factors in themselves for CTS should be excluded. It is well established that diabetes, hypothyroidism, gout, autoimmune diseases such as rheumatoid arthritis, lupus, and pregnancy/postpartum increase the risk of developing CTS.³⁷ Atcheson et al³⁷ collected medical information on 297 patients referred by worker's compensation carriers and found that one

third of the cases labeled as occupational CTS have concurrent medical conditions capable of causing CTS. The possibility that such conditions in themselves contributed to causing CTS must be excluded before one can conclude that the employee's occupation is the sole cause of CTS.

CTS Treatment Options, Outcomes and Disability

The traditional management of CTS has been conservative, with oral nonsteroidal or injected steroidal agents, coupled with splinting and alterations of activities. Surgery was reserved for those who fail conservative management. For example, the American Academy of Neurology recommends treating CTS with noninvasive options first and considering surgery if noninvasive treatment proves ineffective.³⁸ However, in recent years, with the development of more accurate ways of establishing the diagnosis and the increased proliferation of trained hand surgeons in the community, initial or early surgical management has gained support. Carpal tunnel surgery is now the fifth most common procedure performed among Medicare patients.³⁹ Until recently, the relative advantages of early versus delayed surgical intervention had not been rigorously tested. In a controlled trial, Gerritsen et al⁴⁰ randomized patients with symptomatic and electrophysiologically confirmed CTS to wrist splinting during the night for at least 6 weeks versus immediate open carpal tunnel release surgery, with outcome assessments at 3, 6, and 12 months after randomization.⁴⁰ Patients with a history of wrist trauma, predisposing concurrent medical conditions, and severe thenar muscle atrophy were excluded, thereby restricting entry to only those who would have a reasonable probability of benefiting from intervention. At 3 months after randomization, 80% of patients undergoing immediate surgery enjoyed treatment success (defined as being "completely recovered" or "much improved"), compared with 54% of the group initially undergoing splinting. At 18 months, the success rate was 90% of the surgical patients, compared with 75% of the splinting patients. By this time, however, 41% of the initial group of patients undergoing splinting had also undergone surgery.

This study coincided with other study that carpal tunnel release surgery in general results in good outcome.⁴¹ The results of this study also suggest

that patients can still be managed conservatively and surgery can be reserved for treatment failure; however, early surgical intervention may be pursued if the patient desires the probability of quicker improvement. Finally, it should be noted that in either case, the patient's length of medical leave is not expected to exceed 3 months. According to "Workplace Guidelines for Disability Duration," the maximum expected disability (out of work) duration before patients can return to "very heavy work" is 63 days if the patient *did not* have surgery and 84 days if patient underwent surgery—despite the quicker and more complete benefit that surgical patients typically enjoy.⁴²

Summary

Longitudinal studies have not been performed to directly assess and verify a causal relationship between occupational ergonomic risk factors and the development of CTS. Cross-sectional studies have found divergent results regarding the association between certain occupational ergonomic risk factors and CTS. In clinical practice, for specific cases of CTS to have a high probability of being work-related, specific occupational criteria should be met. The diagnosis of CTS should be verified by objective testing, such as nerve conduction velocity and electromyography test. In mild cases, CTS can be managed conservatively and surgery can be avoided.

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