Workplace Safety and Insurance
Appeals Tribunal

Tribunal d'appel de la sécurité professionnelle
et de l'assurance contre les accidents du travail

Carpal Tunnel Syndrome

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This medical discussion paper will be useful to those seeking general information about the medical issue involved. It is intended to provide a broad and general overview of a medical topic that is frequently considered in Tribunal appeals.

Each medical discussion paper is written by a recognized expert in the field, who has been recommended by the Tribunal's medical counsellors. Each author is asked to present a balanced view of the current medical knowledge on the topic. Discussion papers are not peer reviewed. They are written to be understood by lay individuals.

Discussion papers do not necessarily represent the views of the Tribunal. A vice-chair or panel may consider and rely on the medical information provided in the discussion paper, but the Tribunal is not bound by an opinion expressed in a discussion paper in any particular case.

Every Tribunal decision must be based on the facts of the particular appeal. Tribunal adjudicators recognize that it is always open to the parties to an appeal to rely on or to distinguish a medical discussion paper, and to challenge it with alternative evidence : see *Kamara v. Ontario (Workplace Safety and Insurance Appeals Tribunal)* [2009] O.J. No. 2080 (Ont Div Court). For more information about these papers, please consult the *WSIAT Guide to Medical Information and Medical Assessors*.

Definition

Carpal tunnel syndrome (CTS) is the numbness, tingling, and weakness of the hand that is caused by compression of the median nerve as it travels through the carpal tunnel of the hand (Figures). It is classified as an *entrapment neuropathy*, and it is relatively common.

Epidemiology

CTS is the most diagnosed compressive nerve problem of the upper extremity and is generally viewed as being a very common medical condition. The self-reported symptoms of CTS show a prevalence in the general North American population of at least 1%. Studies of local populations in Scandinavia documenting physician-confirmed CTS symptoms, indicate that the prevalence is 2 to 4%. The literature also indicates that the prevalence among working individuals is somewhat lower, about 0.5%. This suggests that most cases of CTS occur in non-working individuals, and this reflects the experience of most experienced clinicians.

These findings contrast sharply with studies that estimate a higher prevalence of CTS among individuals in specific occupations such as workers in the grocery and meat packing industries, clerical workers performing data entry at computer keyboards, and individuals engaged in other repetitive or machine-based work. Many of these studies indicate that CTS is extremely prevalent, even epidemic in some cases. While it is possible that different work activities may expose workers to a variable risk of developing symptoms of CTS, an assessment of the independent effect of the workplace as an etiological factor is hampered by wide variations in the diagnostic criteria used to identify CTS. It is therefore difficult to compare different studies of the workers in different industries and would require a high level of scrutiny.

Pathophysiology

The pathophysiological basis for CTS is, in most instances, due to compression of the median nerve within the finite space of the carpal canal (Fig. 1). The contents of the carpal canal normally consist only of the median nerve, the flexor tendons to the digits, and the synovial lining of the tendons. The median nerve is compressed when the space available within the canal is decreased.

Conditions that cause synovial swelling are known to be associated with the development of CTS. Pregnancy and rheumatoid arthritis are two well-known examples. Conditions such as acromegaly and hypothyroidism may also be associated with CTS, but these conditions are rare, especially in the context of work-related symptoms of CTS. Anomalous anatomy, such as additional blood

vessels, muscles, or tendons within the canal may also result in decreased space and hence a higher likelihood or predisposition to the condition.

Abnormalities of the median nerve itself may also lower the threshold for symptomatic compression. Pressures within the carpal canal that might not otherwise cause symptoms of CTS may do so if the nerve is rendered particularly sensitive to pressure by another disease or condition. A common example of this is diabetes mellitus, which frequently affects peripheral nerve function. Peripheral nerves, including the median nerve, are a target of diabetes. In this sense, diabetes can be considered a pre-existing condition that predisposes the median nerve to symptoms under circumstances where this might not otherwise occur. Other diffuse peripheral nerve diseases may also play a role in the development of symptoms of CTS. There are also very rare conditions which will usually be known to be present in an individual before the symptoms of hand numbness are attributed to CTS.

A less clear, but related concept is that of a “double crush” to the nerve. The double-crush phenomenon is a suggestive hypothesis for the relationship between cervical spine disease, or other sites of nerve compression, and carpal tunnel syndrome. This concept states that a nerve with distinct compression at two or more locations synergistically increases symptom intensity. In the double crush syndrome, it is thought that sub-clinical compression of the median nerve at several points in its course between the spinal cord and the carpal tunnel, lowers the threshold for symptomatic compression at the level of the carpal canal. While this idea fits in with what is known about peripheral nerve function, it is rarely diagnosed in clinical cases of CTS. Overall, double crush syndrome is a controversial subject and proof of pathophysiology is difficult to establish.

Predisposing and Risk factors

Women are three times more likely to have CTS than men. The prevalence and severity of the condition also increase with age. Additional risk factors include medical conditions such as diabetes mellitus, obesity, hypothyroidism, pregnancy, rheumatoid arthritis, poorer general physical condition, and a family history of the CTS. Work-related activities that expose workers to biomechanical constraints are also risk factors. These involve a high degree of forceful and repetitive hand exertion, the use of hand-operated vibratory tools, excessive bending (flexion and extension), or twisting of the wrist. Given that CTS is relatively common in the non-working population, a substantial number of cases of CTS can be attributed to demographic and medical factors and would have occurred regardless of exposure to work-place risk factors for CTS. If CTS cases are occurring in higher numbers in specific CTS-risk occupations compared to the general incidence, then a proportion of cases can be attributable to the work. The contribution that is attributable to the workplace should be assessed in light of the contribution of other personal risk factors such as age, sex, obesity, diabetes and/or other medical conditions).

Diagnosis

The cardinal symptom of CTS is a sensory disturbance, specifically numbness and/or tingling (termed paresthesia), in the anatomic distribution of the median nerve. This anatomic area includes the thumb, index, middle and half of the ring finger of the hand (Fig. 2). The numbness is primarily at the fingertips and not the palm. The presence of numbness or tingling somewhere in this area must be clearly identified for the diagnosis of CTS. The absence of a symptom of this nature would very strongly suggest against the diagnosis.

A significant problem for conditions of the hand is the way in which patients express the nature of their complaints. Clearly, numbness and tingling will usually be perceived as an uncomfortable sensation and may be described as pain, especially in a patient with a limited knowledge of English or poor health literacy. Nonetheless, it is incumbent on the physician to clearly establish the true nature of the symptoms by repeated and probing questioning.

Symptoms can be reported outside the median nerve area as well. For example, patients often complain of numbness of their entire hand, but symptoms of pain or a sensory disturbance outside of the median nerve distribution in any other part of the hand, upper extremity or neck may indicate an alternative diagnosis. These symptoms should be further explored, and while they may be useful in indicating an alternative diagnosis, they have no role in ruling in the diagnosis of CTS in the absence of the key symptom of numbness and/or tingling in the median nerve distribution.

Sensory disturbances commonly occur during sustained positions of the hands, such as when holding a book, phone, or steering wheel. Nighttime sensory changes are classic symptoms for CTS. Patients typically awaken and shake their hands attempting to restore normal sensation. Symptoms may also occur during repetitive motions of the hands, but the occurrence of the symptoms, whether it be with activity or positioning, does not imply that those are an etiology. This is an important concept since patients will typically blame an activity as the cause of their CTS when in fact the activity merely induces the symptoms.

Relief of symptoms by splinting is also compelling support for the diagnosis of CTS. Similarly, the response of the symptoms to an injection of the carpal canal with a corticosteroid medication may also be helpful in confirming the diagnosis. The reliability of these measures towards aiding the clinical diagnosis of CTS can be particularly helpful in the initial management of the problem.

In addition to the patient symptoms, physical examination findings are a key part towards establishing the diagnosis of CTS and for ruling out a number of other medical conditions that cause similar symptoms. Several physical examination findings have been described. These include provocative tests for median nerve compression including the Phalen test, Tinel test, and tenderness to palpation or compression over the median nerve. The neurological examination may include signs of median nerve denervation such as muscle

wasting (atrophy) and weakness of the abductor pollicis brevis muscle or loss of two-point discrimination in the distribution of the median nerve. Other tests of sensory function such as the perception of light touch, pin prick and joint position are not generally used in the diagnosis of CTS but may be relevant in ruling out other causes of hand numbness or tingling, such as polyneuropathies or pathology of the central nervous system.

Generally, some or all these findings are present in patients with CTS and, when this is the case, the diagnosis is clear and usually unequivocal. However, in a minority of cases, there will be a convincing history of CTS symptoms but no physical evidence of median nerve compression. In these cases, the diagnosis should not depend solely on the demonstration of physical signs of median nerve compression. Nonetheless, the absence of physical findings may mitigate against the diagnosis if the symptoms do not fit the classic pattern. Generally, most experts emphasize the characteristic symptoms of CTS much more heavily than the demonstration of physical findings.

Electrodiagnostic testing has recognized value but is not mandated in the diagnosis of CTS since it does not necessarily serve as a reliable reference and is not the gold standard. Although this investigation is frequently considered as the benchmark for the diagnosis, this assumption is incorrect and the relative importance of electrodiagnostic testing over the history and physical examination should not be over-emphasized. There is significant evidence to indicate that these investigations are inconsistent and may not be accurate in diagnosing patients as having CTS or failing to identify CTS as the cause of symptoms. Furthermore, the results of electrodiagnostic testing do not consistently correspond with patients' symptoms nor do they necessarily predict the outcomes of treatment for CTS, especially those related to return-to-work.

The criteria by which the diagnosis of CTS is made, based on electrical testing, also varies from laboratory to laboratory. The results of testing are often summarized as normal or mild, moderate, or severe CTS, but these may be misleading as these categories are aggregations of normal nerve functions in the normal population or unknown comparative groups.

The most appropriate role for electrodiagnostic testing is as an adjunct to the clinical assessment in instances where the diagnosis is not clear. This may be the case when the clinical impression of CTS is ambiguous (e.g., if the history is atypical or difficult to obtain, or presence of a language barrier), if there are conflicting findings on the physical examination, or there is indifferent response to non-surgical treatment (splinting and/or corticosteroid injection). Under such circumstances, electrodiagnostic testing may be helpful towards establishing or ruling-out the probability of CTS as the correct diagnosis. In this sense, the test is used as an aid to the clinical assessment by representing another piece of data which must be interpreted in the context of the individual's symptoms and what physical findings may, or may not, be present. Importantly, the patient's history and physical exam findings should not be superseded by the findings of electrical testing. Any other way of utilizing this information assumes that the clinical assessment has no value.

Where the clinical findings are clearly indicative of CTS, or strongly suggest another diagnosis, there is little role for electrical testing. Electrodiagnostic tests should not be used as confirmatory evidence in these cases because there is a significant risk that the result will conflict with the clinical findings. When this occurs, electrodiagnostic tests are usually given an inappropriate emphasis in establishing the final diagnosis when, in fact experience has shown that the clinical judgment of the content expert is much more likely to be correct.

Ultrasound scanning has become a common diagnostic tool in the workup of peripheral nerve disorders. The most relevant sonographic features are nerve size (cross-sectional area) and structural integrity. Several peripheral neuropathies can show nerve enlargement. In mononeuropathies such as carpal tunnel syndrome, nerve enlargement develops only at specific sites of entrapment, while in polyneuropathy the nerve enlargement may be multifocal, regional, or even diffuse. Nerve ultrasound scanning can reliably identify chronic inflammatory neuropathies. However, as with neurodiagnostic testing, routine ultrasound scanning is not required if a patient's signs and symptoms are characteristic of the conditions. The tests do not have the specificity or sensitivity to be used for routine screening or to establish a diagnosis.

Finally, there are several conditions which may produce symptoms like those of CTS and alternative explanations for these symptoms must be sought, especially when standard and adequate treatment for CTS has not resulted in improvement. It is important, when reviewing a case, to determine whether these diagnoses have been considered as a plausible alternative explanation for the symptoms. Some examples would include conditions affecting the joints such as various types of arthritis, peripheral nerve diseases, common abnormalities of the nerves in the upper part of the limb, the neck or even the brain.

By far, the most common cause of failure in the treatment of CTS is an inaccurate diagnosis leading to therapy which may be appropriate for CTS, but which is inadequate for the condition that is actually causing the symptoms.

Treatment

The management of CTS generally begins with non-operative measures. Splinting the wrist in a neutral or slight extension with a prefabricated splint should be the mainstay of treatment initially. The patient should wear the splint when symptoms usually occur. This will typically be during sleep but may occasionally include daytime wear if there are significant symptoms with activities.

A corticosteroid injection into the carpal tunnel can also be useful in the non-operative management of CTS. This can be considered if splinting is partially, but not completely successful in reducing the symptoms, or if there is a contraindication to splint use. The effect of an injection is usually noted within 10 days and may be long-lasting although it

can also be transient. If there has been a satisfactory response followed by a relapse of symptoms, the prognosis for subsequent surgery to release the carpal tunnel is favourable.

The role of diuretics, anti-inflammatory medications, and vitamin supplements such as vitamin B6, is unproven. There is also little evidence for other modalities such as physical therapy, yoga, chiropractic care, or acupuncture in the routine care of CTS.

Modifications to the workplace may appear necessary in certain circumstances to accommodate a worker, regardless of whether the relationship between CTS and work is definitively established. As discussed later, a causal analysis considering various factors should be undertaken, but when the worker's symptoms have a close temporal relationship to both attendances and absences from work, and where the work consists of both high force and high repetition activity (see below), then there may be a need to address the workplace in the treatment of CTS. The goal of workplace modifications is targeted at reducing symptoms, but this incorrectly implies that the workplace was the etiology of the condition. Further, there is little valid published evidence to support this approach to treat CTS. The lack of adequate evidence is at least partially due to the inconsistency in diagnostic practices and case definitions, but the fact remains that a successful treatment of established CTS by modifying the workplace is only anecdotally reported.

The two main indications for surgical management of CTS are: (1) the failure of nonsurgical treatment; or (2) evidence of denervation in the hand as manifest by a loss of two-point discrimination or thenar (thumb) muscle atrophy. The way the procedure is done varies widely among surgeons and ranges from standard open surgical technique, mini-incision techniques, or endoscopic methods. The goal of all these procedures is to transect the transverse carpal ligament thus reducing the pressure and increasing the relative space within the carpal canal.

Normally, a satisfactory response to treatment would indicate that diagnosis was accurate. But the response to treatment to retrospectively validate the diagnosis, should be considered with caution. It has been repeatedly shown that a poor outcome from treatment does not necessarily mean that the treatment was inadequate, or the diagnosis was wrong. It is often because of severe nerve compression that does not recuperate following surgical release.

Prognosis

Without question, the prognosis for a complete relief of symptoms that have been correctly attributed to CTS and skillfully treated, is ordinarily excellent. Recurrences should be rare. The interaction between a return to the workplace and continued control of symptoms is unknown but should be a focus of further study. So far, there has not been an adequate study to allow generalizations to be made regarding the return-to-work following carpal tunnel release, especially in cases where the workplace is thought to have played an etiologic role in the development of CTS.

Special considerations

Causation and computer use

Surprisingly, the relationship between sensory symptoms and strenuous hand use is poorly defined and is also commonly misperceived. The literature indicates that the hand activity must be repetitive *and* forceful to be a part of the cause of CTS. Activities characterized by high frequency but *low* force, particularly the use of computer keyboards, remain contentious but have generally not been shown to be an important precipitating factor for developing CTS. Despite the overwhelming volume of information in the lay media to the contrary, data from two large cohorts in different countries showed no association between computer work and new onset of CTS in workers with different job types and with differing job exposures. The evidence shows that CTS is far more common among workers in non-computer jobs. In rare circumstances of intense and prolonged keyboarding, a majority of criteria for causality may be met if there is a clear temporal linkage between the development of symptoms and their relief, and/or if a relationship to a given exposure can be reliably and repeatedly identified. Other issues which should have an impact on establishing causality include the dose-response relationship. The duration of computer use at work is in fact commonly associated with the onset of any upper extremity or neck–shoulder symptoms, but this is rarely CTS despite commonly being assumed to be CTS. Finally, conversion from a standard to an ergonomic keyboard has not been shown to be of clear benefit for treating CTS.

Trauma to the area of the wrist

Where there has been significant injury to the area of the carpal tunnel and subsequent symptoms of numbness attributable to CTS, the main diagnosis of a direct median nerve injury should be considered. Although this may appear to be an artificial distinction, in fact it's an important one because the treatment that should ensue, and the expected prognosis may vary significantly.

For example, direct closed injury to the median nerve would be expected to have a satisfactory prognosis that can improve spontaneously, although this may take many months or even as long as a year. A carpal tunnel release in this context may be performed but may not necessarily change the rate of recovery. Normally, these injuries are manifested by the immediate onset of a sensory disturbance that does not vary except to slowly resolve as the median nerve recovers. A good example of a context in which this occurs is a fracture of the distal radius (or a scaphoid fracture, scapholunate ligament injury, or a perilunate dislocation of the wrist). The median nerve often suffers direct injury due to the displacement of the fracture fragments or dislocation, but usually recovers completely without any further treatment, even if the fracture remains unreduced.

A less-severe injury to the wrist, like a contusion, would be unlikely to cause either a direct median nerve injury or predispose the patient to developing symptoms of CTS due to compression of the median nerve.

Chronic trauma, arthritis, tendonitis and repetitive strain issues

CTS is often seen in association with several chronic conditions including osteoarthritis at the base of the thumb or wrist, or the malady of chronic tendon issues of the hand, wrist, and forearm (i.e., de Quervain's tenosynovitis, trigger finger, lateral epicondylitis). The correlation is based on concurrent demographic factors (e.g., age, gender) and an element of chronic inflammation. The conditions co-exist but do not cause each other.

Inflammatory tenosynovitis and CTS

Although inflammatory conditions of the tendons are frequently diagnosed, in most cases there is little or no evidence to support the presence of work-induced inflammation within the carpal tunnel. It is generally difficult to link the diagnosis of CTS to an inflammation of the tendons except in the context of conditions known to cause an extreme degree of inflammation like rheumatoid arthritis. This is rare in the context of CTS encountered in the workplace and is usually unambiguous when it does occur.

Exposure to vibration

The role of vibration exposure in the etiology of CTS is controversial. Certainly, reports in the literature suggest a relationship between activities of this nature in both sensory and vascular disturbances in the hands. CTS is not usually considered to be synonymous with other diagnostic labels like "vibration white finger". As described above, establishment of causality requires that there be a demonstration of temporal and dose-response relationships as well as a biologically plausible explanation. The available literature does not satisfy these criteria and a definitive relationship between exposure to vibration development and CTS has therefore not been proven. However, there is evidence to suggest that a plausible biological link between exposure to vibration and CTS does exist and therefore, given a reasonable duration and extent of exposure, there is reason to consider this possible etiological connection in certain cases. It is unknown as to how much exposure constitutes a threshold beyond which this relationship should be held to exist.

Exacerbation of pre-existing or intermittently symptomatic CTS

Where there is a pre-existing diagnosis of CTS which is claimed to be exacerbated by work activity, the same issues in establishing causality pertain as in establishing work-relatedness in general. CTS is known to be a condition that is characterized by both exacerbations and remissions and so the effect of modified work, absences from work and ergonomic modifications to the workplace are difficult to measure. Similarly, the status of an individual who has apparently been successfully treated for CTS and is contemplating a return to employment that may be thought to be a risk factor for CTS is unclear.

Prior treatment of CTS

Individuals who have been successfully treated by splinting or corticosteroid injection generally have a high chance of recurrence with or without aggravating factors including alleged workplace issues. The reason for the recurrence is that these treatments are temporary and also do not change the true etiological factors of age, gender, diabetes, compression, etc.

Individuals who have been successfully treated with surgery have a low chance of recurrence since the physical issue of the tight carpal tunnel has been released. However, it is common that these individuals have issues with local tenderness at the surgical site or mild residual issues that may impair full abilities.

Specific Questions

1. How is the diagnosis of CTS confirmed?

The diagnosis of carpal tunnel syndrome is based on a probability that is dependent on typical symptoms and specific findings on a physical examination. There are numerous patient questionnaires and scoring systems to determine the probability of having CTS. A higher number of symptoms is linked with a higher probability of a diagnosis of CTS. The probability is increased with more specific symptoms.

a) The most common physical findings are numbness and tingling (paresthesia) of the hand. The probability of carpal tunnel syndrome increases if the numbness and tingling are in the thumb, index, long, and half of the ring finger. The probability increases further if the symptoms are worse with specific positioning of the hand, for example holding a steering wheel or holding a book. The probability increases even further if the symptoms are at nighttime and particularly if they are relieved by using a wrist splint. Workers will often describe numbness and tingling in *all* of their fingers, and this must be differentiated from the specific distribution in CTS, or an additional diagnosis is possible. For example, cubital tunnel syndrome results in numbness and tingling of the other (ulnar) half of the ring finger and the entire small finger. Numbness and tingling involving the entire palm may be related to median nerve compression more proximal to the carpal tunnel such as the lacertus fibrosus or the pronator teres muscle. These sites of entrapment are much less common than entrapment at the carpal tunnel. Alternative diagnosis relating to issues at the cervical spine must also be considered if symptoms may involve specific positioning of the neck and shoulder regions.

b) Weakness of the hand is also a typical symptom of CTS. Physical examination may reveal atrophy of the thenar (thumb) muscles. Although atrophy may be a late finding, the presence of muscle atrophy increases the probability of CTS.

c) Physical examination findings that are specific to CTS further increase the probability of the condition. These include Tinel's testing (tapping over the nerve) and Phalen's test (wrist flexion) resulting in paresthesia along the distal course of the nerve.

d) An individual's demographics placing them in a group with high probability of CTS further increases the probability of the condition. Note that pain, osteoarthritis, the type of work, and diagnostic testing does not necessarily increase the probability of the condition. However, these factors can be taken to further increase or decrease the probability of the condition. The medical record, particularly if done by an experienced clinician, would contain the elements of the symptoms and physical examination specific to CTS to determine the probability of the condition.

2. What are other causes of hand and wrist pain?

CTS is in and of itself not necessarily painful, or only minimally painful, but the paresthesia is oftentimes miscommunicated as pain. There are numerous other more painful conditions of the hand and wrist. A partial list would include osteoarthritis at the base of the thumb or the wrist, trigger finger, instability at the wrist, ligament damage of any of the digits or the wrist, a ganglion or other masses, acute or chronic tendonitis such as de Quervain's, inflammatory arthritis, hand-vibration syndrome, or neuropathies. Many of these conditions can be concurrent with CTS due to aging and the similar demographic profile of individuals that develop any of these conditions. However, there is rarely a cause-and-effect between any of these conditions and CTS with the exception of inflammatory arthritis or a severe osteoarthritis of the wrist.

3. What are predisposing factors to CTS?

a) Nonoccupational risk factors for CTS include: female sex, age, pregnancy, diabetes, hypothyroidism, obesity, renal failure, amyloidosis, acromegaly, inflammatory arthritis, and severe osteoarthritis of the wrist.

b) Occupational risk factors have been found to be significantly associated with the development of CTS. In the workplace, forceful repetitive *and* excessive wrist extension/flexion and gripping, and the sustained use of vibrational equipment have been shown to elevate pressure within the carpal tunnel, increasing the risk of CTS. Although it is difficult to draw generalizations from the majority of studies which can be applied to individual workers due to the variation in methodology and diagnostic criteria of CTS, workplaces that have been found to have increased risk of CTS are meat & fish processing, forestry workers using chainsaws, electronic assembly workers, furniture factory, garment & textile, metal casting industries, and appliance and automobile manufacturers. Additional specific occupations are listed below in (6). The majority of studies have found no association between CTS and repetitive computer/keyboard use as discussed in detail above.

4. What is the likelihood of CTS arising idiopathically and not related to work?

Population studies mentioned earlier tell us that CTS occurs in up to 4% of the population. If this prevalence is similar in a specific industry, then the majority of cases would not be work-related. If the prevalence of CTS is higher in a specific industry, this may be attributable to a specific demographic group (e.g., elderly women, and other demographic factors) within that industry, or a portion of the prevalence can be associated with the work itself. The likelihood of CTS being work-related would increase for specific occupations listed in 3.b. If work activities are suspected to be a cause of CTS in specific cases, a causal analysis could be useful. The causal analysis could include a temporal relationship between work activities and symptoms, a dose-response relationship between increased work and increased symptoms, a logical link between work and CTS, etc.

It is important to note that an onset of symptoms at work does not necessarily imply that work is the etiological factor. For example, a person in the high-risk demographic group could develop CTS issues regardless of the work environment or the type of work and could have or would have developed CTS in any situation.

5. Is CTS more common in the non-working population?

Yes, most cases of CTS are not work-related. CTS is a common condition with most risk factors being unrelated to work activities.

6. Is CTS related to any type of work?

Yes, CTS has been associated with work activities that involve extreme positioning of the wrist *and* high force, and/or sustained vibration. These tasks are typically repetitive. Based on epidemiological studies, the highest prevalence of CTS was noted for grinders, butchers, grocery store workers, frozen food factory workers, platers, dental hygienists, and workers with high-force, high-repetitive manual movements. However, specific threshold limit values or definitions for the number of repetitions, amount of force, or excessive use, remain difficult to define. Most recent evidence would indicate that keyboarding and data entry are not necessarily associated with a higher risk of developing CTS as discussed in detail above. However, as with many of these types of jobs, neck, shoulder, and elbow issues can result in pain and paresthesia that are often falsely described as being CTS and must be differentiated.

7. Can CTS be caused by strong blunt trauma?

Yes, blunt trauma directly to the nerve can cause injury or damage to the nerve itself. The CTS-like symptoms from direct trauma to the nerve can take a considerable time to improve. Trauma around the wrist such as with a distal radius fracture or perilunate dislocation, can result in significant swelling and pressure in the carpal tunnel or on the nerve and may require surgical release. Residual CTS issues may also take a considerable period of time to resolve following this type of trauma. In some cases, the nerve may not recover fully.

8. Does pain from CTS travel up the arm?

Generally, CTS is not a highly painful condition. However, patients may describe pain in different ways and either pain or various uncomfortable sensations that can occasionally radiate up the arm. These are not typical findings and do not increase the probability of having the diagnosis of CTS. If these types of pain are a considerable component of a worker's symptoms, an alternative diagnosis or concurrent illnesses such as osteoarthritis or polyneuropathy should be considered.

9. Can CTS-like symptoms be produced by conditions in the upper limb?

Yes, several conditions in the upper extremity can be misdiagnosed as CTS. Paresthesia in the digits, hand, or wrist can be produced by compression of the median nerve more proximally at several sites in the forearm, upper arm, or neck. Compression or inflammation of the other major nerves to the hand can be misconstrued as CTS.

10. a) What is the likelihood of developing CTS as a secondary condition?

CTS is more likely to be a concurrent issue as opposed to a secondary condition in conjunction with osteoarthritis of the hand or wrist, trigger finger and other common joint and tendon issues. In other words, it is rarely a cause-and-effect issue.

b) If CTS is present on one side what is the likelihood of developing it on the other side?

CTS is often seen as a bilateral condition. Symptoms rarely come on at precisely the same time and are oftentimes less severe on one side when compared to the other side. The main reason that individuals develop bilateral symptoms is that the demographic and general risk factors equally affected both hands.

11. If a worker has CTS on one side that is related to work, and develops it on the other side, is that proof of causation?

Typically, there is a higher likelihood that demographic factors and non- occupational risk factors are associated with bilateral CTS as opposed to occupational risk factors. Specific occupational risk factors should be carefully assessed, and causation should be individually determined for bilateral cases. The mere presence of bilateral CTS does not imply causation. As noted above, the onset of symptoms in the workplace does not implicate work as being a cause of the condition.

12. Can CTS make someone more likely to develop other conditions?

CTS may be associated with several systemic conditions such as polyneuropathy, and CTS may be concurrent with several other conditions such as tendinopathies or arthritis, but CTS does not cause other conditions. The only major issues that CTS *causes* is the numbness and/or weakness of the hand due to compression of the nerve itself.

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Appendix

These diagrams have been commissioned by the Tribunal in order to help the reader understand the anatomy of the carpal tunnel and the median nerve.

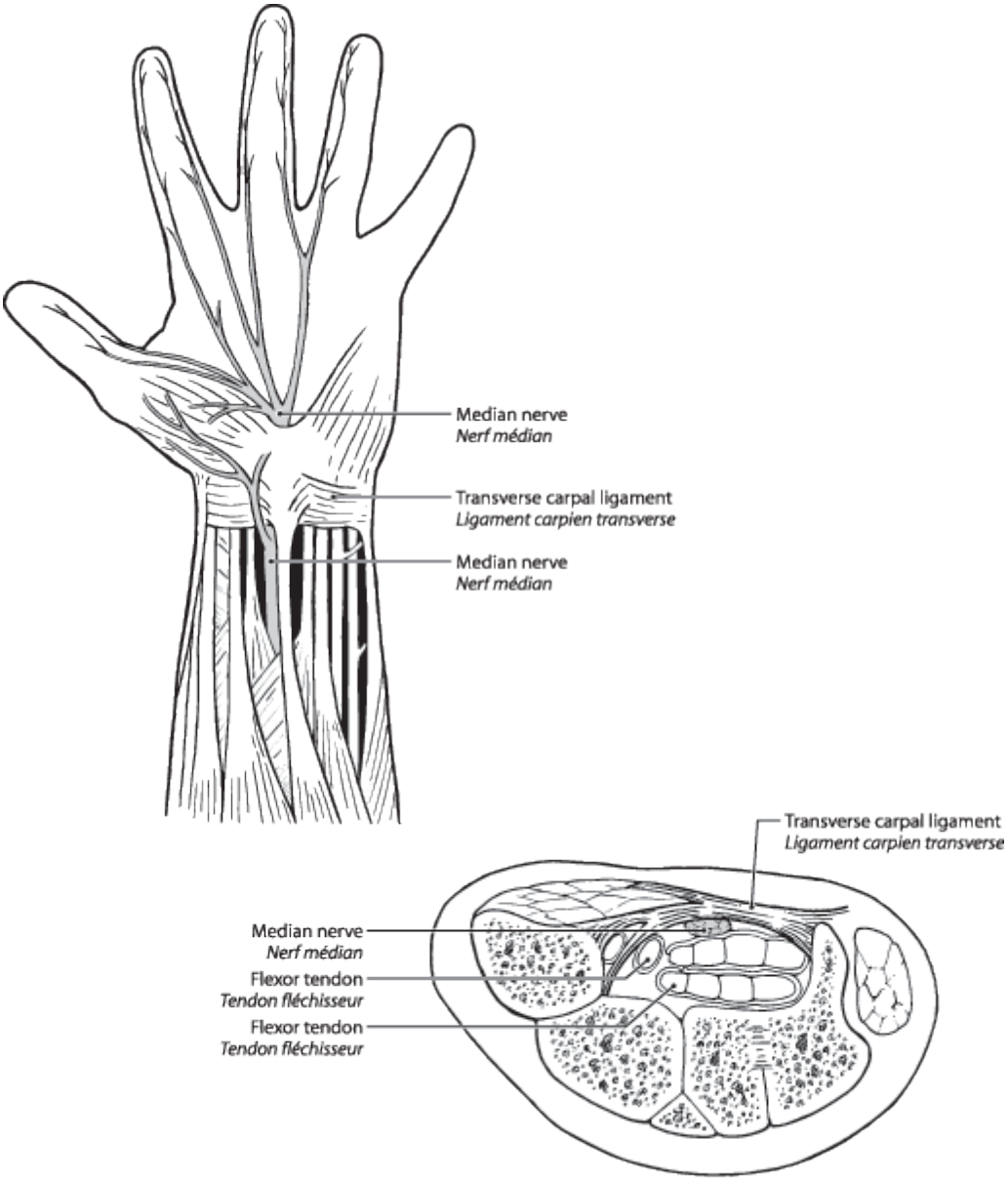
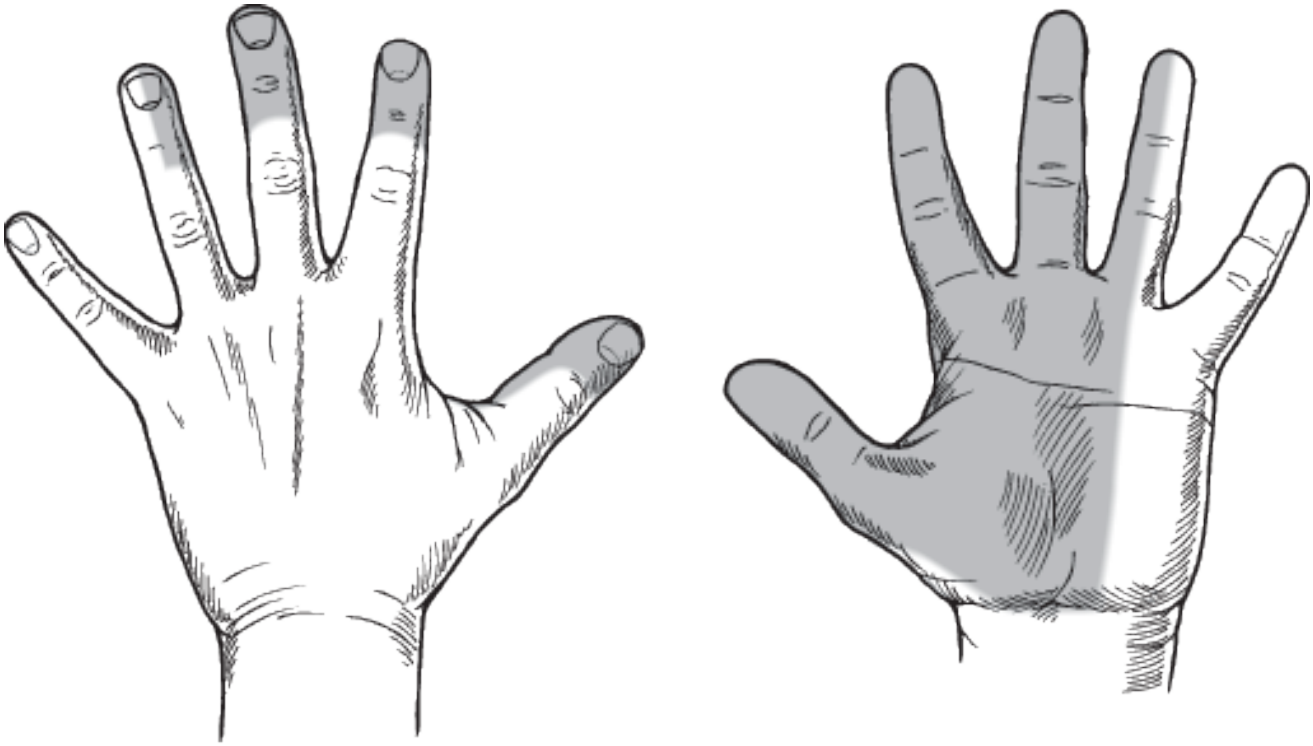


Figure 1. Anatomy of the median nerve as it passes within the carpal tunnel under the transverse carpal ligament. Compression of the nerve results in numbness and tingling of the thumb, index finger, long finger, and half of the ring finger.



Area of the skin supplied by the median nerve
Régions de la peau parcourues par le nerf médian

Figure 2. Area of the skin supplied by the median nerve.