Carpal tunnel syndrome

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Carpal tunnel syndrome is the most commonly diagnosed entrapment neuropathy. This review looks at the current body of evidence to help determine optimal practice for the diagnosis and management of this condition.

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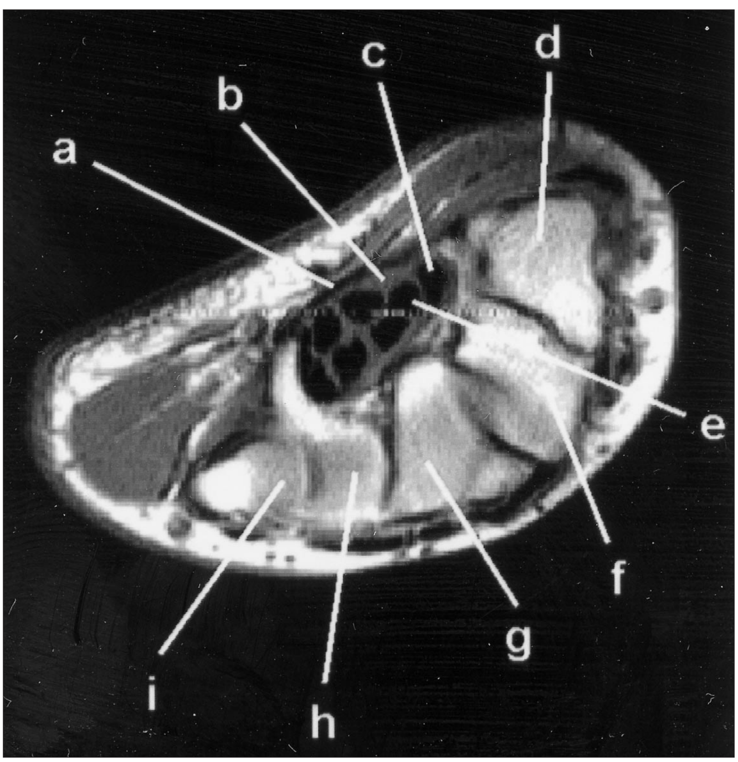
Carpal tunnel syndrome (CTS) is the constellation of symptoms and signs caused by compression of the median nerve within the carpal tunnel. These include sensory symptoms of paraesthesia, numbness and pain, as well as motor symptoms in a median nerve distribution. The paraesthesia and numbness may worsen at night. There is a spectrum of disease severity. The carpal tunnel consists of the median nerve and nine flexor tendons surrounded by the rigid carpal bones and flexor retinaculum. Within the tunnel, the median nerve divides into a motor branch that innervates the thenar muscles and distal sensory branches which supply the thumb, index, middle and radial half of the ring fingers. Palmar sensation is preserved in a classic case of CTS, as the sensory supply to this area does not pass through the carpal tunnel. The anatomy of the carpal tunnel is shown in cross section in *Figure 1*.

Figure 1. Axial T1-weighted image of a normal wrist demonstrating the contents and boundaries of the carpal tunnel. a = flexor retinaculum; b = median nerve; c = flexor carpi radialis; d = trapezium; e = flexor pollicis longus; f = trapezoid; g = capitate; h = hamate; i = base of fifth metacarpal.



EPIDEMIOLOGY

CTS usually presents between the third and fifth decades with a female to male ratio of three to one (Tanaka et al, 1994). CTS affects 0.5% of the general population (Tanaka et al, 1994). A population-based study reported a rate of 3% of symptomatic CTS confirmed on nerve conduction studies (NCS) (Atroshi et al, 1999). This suggests that a pool of patients with CTS exist who never present to clinicians.

PATHOGENESIS

The pathogenesis of CTS is unclear. Concordance for CTS in monozygotic and dizygotic twins has been found to be 0.35 and 0.25 respectively (a heritability estimate of 46%) (Hakim et al, 2001). This suggests that there may be an underlying predisposition, maybe caused by a smaller space in the carpal tunnel. Repetitive motion may be a trigger for the onset of symptoms in CTS, but one should investigate for underlying causes of secondary CTS (*Table 1*).

DIAGNOSIS

Clinical

In his original definition of CTS, Phalen (1951) required patients to have one or more of three bedside signs: a positive Phalen's test (maximal flexion of the wrist for 60 seconds), a positive Tinel's sign (tapping over the volar carpal ligament) and sensory changes limited to the median nerve distribution of the hand (reduced pinprick and light touch). Other observations in CTS include nocturnal paraesthesia, hypoaesthesia, reduced two-point discrimination or vibration in a median nerve distribution, thenar atrophy and weakness of thumb abduction (other thumb movements are not exclusively supplied by the recurrent motor branch of the median nerve). Another tool to aid the diagnosis of CTS is the Katz hand diagram (Katz et al, 1990). The patient uses this diagram to mark the specific location of their symptoms on the dorsal and palmar aspects of their hands and arms. The patient is also asked to specify the character of their symptoms as pain, numbness or tingling. The diagrams are then graded as classic, probable, possible or unlikely to be CTS.

A systematic review found that the only good predictors of abnormal nerve conduction studies consistent with CTS were hypoaesthesia in a median nerve distribution, a classic or probable Katz hand diagram and weak thumb abduction (D'Arcy and McGee, 2000). There is a consensus criteria for CTS, which has been developed for use in epidemiological studies (American Academy of Neurology, 1993). These acknowledge the lack of a gold standard and propose the use of a combination of clinical symptoms and signs in combination with electrodiagnostic findings.

Nerve conduction studies

NCS are the 'gold standard' diagnostic test for CTS. Diagnostic standards for NCS have been developed reporting a range of sensitivities and specificities varying from 49–84% and 95–99% respectively. They should, however, be taken in context with the clinical findings.

In order to determine sensitivities, the gold standard was clinical findings, i.e. symptoms suggestive of CTS and a positive Tinel's sign. This may be criticized as being rather teleological. If the NCS are done in asymptomatic patients with intermittent symptoms, one may well expect a false negative result. Another potential source of false negative NCSs is if the patient's symptoms are caused by small, unmyelinated nerve fibres that are not detected by surface electrodes (electrodiagnostic tests only detect larger myelinated fibres).

The low rate of false positives in these may also be subject to error. The normal range for NCSs is arbitrarily set at two standard deviations above the mean of observations for normal hands. However, NCS measurements do not follow a Gaussian distribution, and so this is an imprecise method of determining a normal range.

Successful surgical carpal tunnel release in the presence of normal NCSs is well recognized (Concannon et al, 1997), as well as the phenomenon of persistently abnormal NCSs in patients who undergo successful surgical carpal tunnel release (Bande et al, 1994).

NCSs may also be useful in detecting other causes of hand dysaesthesias, i.e. cervical radiculopathy, polyneuropathy or other causes of median nerve entrapment syndromes. Thus, NCSs are not an accurate prognostic indicator for CTS.

TABLE 1.
Causes of secondary carpal tunnel syndrome

Diabetes mellitus
Hypothyroidism
Arthropathies
Acromegaly
Obesity
Pregnancy
Trauma
Amyloid
Infections (e.g. tuberculosis)

Imaging

Imaging has yet to play a major role in the assessment of CTS. It is not routinely performed and tends to be reserved for cases where there may be additional clinical concern. Both magnetic resonance imaging and ultrasound are used to image the carpal tunnel. In CTS, the cross-sectional area of the median nerve at the wrist is increased in the proximal part of the carpal tunnel, the nerve is flattened in the distal part of the tunnel and there is volar bowing of the flexor retinaculum.

Imaging allows a visual inspection of the anatomy and occasionally allows other conditions such as tenosynovitis and ganglion cysts related to the flexor tendons to be diagnosed. Magnetic resonance imaging has the advantage of not being operator dependent, but ultrasound is cheaper, it allows dynamic images to be visualized and may demonstrate restriction of active median nerve movement. The authors have found that the reduced movement of the median nerve in the wrist correlates with a composite score of CTS symptoms and signs, including an assessment of nerve stretch (Chhaya et al, 2001).

TREATMENT

The natural history of CTS is not fully understood. One study suggests that almost a third of patients with CTS will have a spontaneous improvement in their symptoms with no intervention at all (Futami et al, 1992).

The use of primary prevention in the development of work-related CTS has been proposed. This may be achieved by the instigation of relatively simple measures. The use of conservative measures, such as a simple wrist splint or hand brace in the neutral position, has been shown to afford symptomatic benefit (Manente et al, 2001). The use of a wrist splint may also aid the diagnostic process if relief is given. Therapeutic ultrasound and yoga have been shown to be ineffective (Garfinkel et al, 1998; Oztas et al, 1998).

Historically, medical treatments for CTS have consisted of non-steroidal anti-inflammatory drugs (NSAIDs), diuretics as well as oral and locally administered corticosteroid. A course of oral corticosteroids is more effective than either NSAIDs or diuretics (Chang et al, 1998). In turn, local steroid injections have been shown to be superior to oral steroids (Wong et al, 2001). Weaker, short-acting local injections of corticosteroids (hydrocortisone 25 mg) are as effective at 6-week and 6-month follow-up as more potent longer-acting preparations (triamcinolone). It is recommended that if local injection is advocated, low doses of shorter-acting corticosteroids should be administered in the treatment of CTS to avoid potential toxic effects (O'Gradaigh and Merry, 2000). The use of local steroid injection is the treatment of choice in CTS related to pregnancy. The site of injection should be around 1 cm proximal to the distal wrist flexion crease between the palmaris longus and flexor carpi radialis. The problem with this technique is that it is a blind procedure and the carpal tunnel is a small structure, so that the steroid is acting locally but may not actually be instilled into the tunnel.

There has been a Cochrane review on the use of local steroid injections (Marshall et al, 2000). This review identified two optimally conducted randomized controlled studies of local corticosteroid injection for the treatment of CTS. These trials (Ozdogan and Yazici, 1984; Dammers et al, 1999) both reported a clinical improvement of CTS symptoms at 1 month after local corticosteroid injection as compared with placebo. The pooled relative risk favouring treatment was 3.62 (95% confidence intervals 1.94–6.73). The duration of symptomatic relief is difficult to ascertain, as even in the study with 1 year follow-up the trial was unblinded at 1 month (Dammers et al, 1999). However, 50% of patients had required no further treatment at 1 year in concurrence with other published data. The majority of patients in one study had severe CTS (Dammers et al, 1999), both clinically and electrodiagnostically. Therefore, these results may not be applicable to milder cases of CTS. However, local corticosteroid injection has been shown to afford greater symptomatic relief and longer duration of effectiveness in milder cases (Gelberman et al, 1980). Intuitively and from surgical anecdotes the repeated use of local corticosteroid injection for the treatment of CTS should be avoided, as there is a risk of local toxic effects. However, the evidence base for this is lacking.

The treatment of choice for persistent, progressive or severe CTS is surgical decompression. Carpal tunnel release is the most commonly performed surgical procedure in the United States. An incision is made at the base of the palm of the hand and then through the palmar fascia. The median nerve is then moved out of the way and the transverse carpal ligament is cut and left open to relieve the pressure on the median nerve. In most cases, surgery results in significant improvement in symptoms, but some residual numbness, pain or weakness may persist. The reported success rates of surgery are 95% with a complication rate of <3% (Jimenez et al, 1998).

The optimal timing of surgery is difficult to determine. Release of the median nerve before the development of a more permanent neurological deficit would suggest that early release would result in a more favourable prognosis. There is some evidence to support this (Bland, 2001), but there is also evidence to suggest that the timing of surgery is irrelevant to the outcome (Longstaff et al, 2001).

Less invasive endoscopic procedures have been developed. The overall success rate of endoscopic decompression has been 96.5% with a complication rate of 2.7% and a failure rate of 2.6%. These rates are comparable with that of the open procedure. The endoscopic technique has the benefits of causing less pain with an earlier return to the activities of daily living and work. This has been confirmed in further studies (Mackenzie et al, 2001). The decision to perform an open or endoscopic procedure ultimately lies with the surgeon and depends upon their experience. When performed by experienced surgeons on carefully selected patients, both techniques yield excellent results.

A recent community-based study found that the overall prognosis for CTS was excellent. Factors that predicted a poor outcome were functional limitation at presentation, poor mental health status, excessive alcohol consumption and ongoing litigation (Katz et al, 2001).

CONCLUSIONS

CTS is the most commonly diagnosed peripheral neuropathy. Although the symptoms and signs of CTS are well described, the reliability and reproducibility of these are variable. NCS studies remain the gold standard for the confirmation of the diagnosis. However, NCS do have their limits as a diagnostic and prognostic tool. Treatment may vary from preventative measures for work-related CTS to conservative measures, such as wrist splints, to interventional medical procedures. Locally administered low dose hydrocortisone is the treatment of choice in pregnancy-related CTS. Surgical release may be open or endoscopic and will be determined by the experience of the surgeon performing the procedure. On the whole the prognosis for CTS is good. HM

Conflict of interest: none.

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KEY POINTS

- Carpal tunnel syndrome (CTS) is the result of compression of the median nerve within the carpal tunnel.
- It is the most commonly diagnosed peripheral neuropathy and is most common in middle-aged women.
- Causes of secondary CTS should be sought.
- The symptoms of CTS are protean, and the most reliable signs of CTS are weakness of thumb abduction, a positive Katz hand diagram and reduced pain sensation in a median nerve distribution.
- The clinical presentation, combined with electrodiagnostic findings, provides the most accurate diagnosis for CTS.
- Treatment should be tailored to the individual and the severity of CTS.
- The overall prognosis for CTS is good.