Ministry of Defence

Synopsis of Causation

Carpal Tunnel Syndrome

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Disclaimer

This synopsis has been completed by medical practitioners. It is based on a literature search at the standard of a textbook of medicine and generalist review articles. It is not intended to be a meta-analysis of the literature on the condition specified.

Every effort has been taken to ensure that the information contained in the synopsis is accurate and consistent with current knowledge and practice and to do this the synopsis has been subject to an external validation process by consultants in a relevant specialty nominated by the Royal Society of Medicine.

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1. Definition

1.1 The carpal tunnel forms a cylindrical passageway in the wrist, through which pass the median nerve and nine flexor tendons supplying the fingers and thumb. The fibres of the median nerve originate in the lower cervical and upper thoracic spinal cord and supply sensory and motor innervation to parts of the forearm and hand. Carpal tunnel syndrome (CTS) results from the compression of the median nerve as it passes through the enclosed space of the carpal tunnel.

1.2 CTS is the most common entrapment neuropathy and is now one of the most commonly reported occupational diseases.

2. Clinical Features

2.1 The incidence of CTS in the general population is 1/1000 person-years. The population prevalence in two Dutch studies that relied on electrodiagnostic testing was approximately 5%.[1] Another study estimated prevalence at between 7 and 16% depending on the cut-off point chosen to define delayed median nerve conduction on electrodiagnostic testing.[2] The condition occurs most commonly between the ages of 30-60 years and is around three times more common in women than men.

2.2 The dominant hand is usually involved first, often followed by the other hand. The predominant symptom is one of tingling, burning, pins-and-needles (paraesthesia) and numbness on the palmar aspect of the 3½ digits that derive a nerve supply from the median nerve, i.e. the thumb, index and middle fingers plus the adjacent radial aspect of the ring finger. These symptoms frequently cause patients to awaken several hours after getting to sleep, and are relieved by shaking ("the flick sign") or rubbing the hand. Pain, described as deep, aching, or throbbing occurs diffusely in the hand and may radiate up the forearm and shoulder. Symptoms may be exacerbated by activities of daily living, such as holding a newspaper or book, grasping a steering wheel, or cutting meat.[3]

2.3 Examination may identify weakness of the thenar muscles, particularly weak thumb abduction strength. Thenar atrophy may be apparent later in the course of the condition. Sensory impairment may be detected by finding altered sensation to light touch or pinprick at the first 3 finger tips. However, some patients may have symptoms of CTS with a normal neurological examination.

2.4 A number of tests have been described as an aid to the diagnosis of CTS. The best-known tests are:

- **Tinel's (nerve percussion) test:** the wrist is held in extension whilst the median nerve is tapped lightly by means of gentle percussion over and just proximal to the transverse carpal ligament. A positive test produces a tingling sensation radiating from the wrist into the hand
- **Phalen's (wrist flexion) test:** the wrists are held in extreme but unforced flexion for 60 seconds. A positive test reproduces or worsens the patient's symptoms
- **Carpal compression test:** pressure is applied on the median nerve at the wrist with both thumbs. Numbness, paraesthesiae and/or pain may be indicative of CTS

Although they contribute useful evidence towards making a diagnosis, it is important to appreciate that both these tests, as well as all others described in this condition, may give rise to **false-positive** and **false-negative** results.

2.5 Although the diagnosis of CTS is one that is primarily made on clinical grounds, nerve conduction tests are useful in confirming the diagnosis. MRI may occasionally be used in difficult cases. Nerve conduction tests measure the conduction velocity and amplitude of motor and sensory fibres across the carpal tunnel. The characteristic abnormalities are slowing of conduction, and reduced amplitudes in more severe cases. Occasionally, these studies may be normal.[3]

2.6 The differential diagnosis of CTS must seek to rule out nerve compression caused by cervical disc herniation at C6 or C7, where sensory symptoms involve the dorsal rather

than the palmar aspect of the hand; thoracic outlet syndrome; and median nerve compression at the elbow and in the forearm. Small thalamic infarcts may produce sensory symptoms in the hand that mimic CTS, although the symptoms tend to be constant and may occur in association with perioral paraesthesiae. It has also been postulated that compression of the median nerve may occur simultaneously at the carpal tunnel and at a location earlier in its course, a situation that is referred to as “double crush syndrome”.

3. Aetiology

3.1 The aetiology of CTS is multifactorial, involving interaction of anatomical, physiological, mechanical, and psychosocial factors. Significant risk factors include female gender, obesity, and certain mechanical exposures in the workplace. Also implicated are psychosocial workplace factors and the individual's psychological wellbeing.

3.2 **Anatomical and physiological factors.** Any condition that reduces the capacity of the carpal tunnel, as with swelling or lesions of the surrounding tissues, or increases the volume of the contents of the tunnel may initiate symptoms. Thus many conditions that cause inflammation or fluid retention are associated with CTS. However, although CTS has been linked with conditions such as hypothyroidism, acromegaly, wrist fractures and rheumatoid arthritis, all of which appear in the list below, these associations are present in a small proportion only of those who have surgery for the condition.[1] Conditions that have been linked to CTS include the following:

3.2.1 **Local anatomical factors and space-occupying lesions**[3,4]

- Bony abnormalities of the carpal bones
- Forearm and wrist fractures (malaligned Colles fracture, scaphoid fracture)
- Dislocations and subluxations (scaphoid rotary subluxation, lunate volar dislocation)
- Post-traumatic arthritis (osteophytes)
- Local tumours (e.g. ganglion, neuroma, haemangioma, osteoid osteoma, lipoma, and xanthoma)
- Thickened transverse carpal ligament (familial)
- Anomalous median artery
- Anomalous muscles
- Haematoma (may be associated with haemophilia, anticoagulation therapy and trauma)

3.2.2 **Inflammatory conditions**[3,4]

- Tenosynovitis
- Rheumatoid arthritis: this a common association, with CTS generally being thought to occur as a result of rheumatoid flexor tenosynovitis
- Crystal-related arthropathies (gout, calcium pyrophosphate dihydrate disease, and hydroxyapatite disease)
- Infections involving the carpal bones or flexor tendons at the wrist (e.g. osteomyelitis, infection with *mycobacterium tuberculosis* and atypical *mycobacteria*, histoplasmosis, and coccidioidomycosis)
- Lyme disease (borreliosis)

3.2.3 **Hormonal factors**[1,3,4]

- Pregnancy: generally ascribed to fluid retention, CTS affects around 20% of pregnant women, usually in the third trimester. The symptoms usually resolve spontaneously following delivery
- Breast feeding

- Women who are in their first menopausal year
- Hysterectomy
- Women taking oral contraceptives or hormone replacement therapy

3.2.4 Metabolic and endocrine diseases[3,4]

- Diabetes mellitus: CTS was observed in 15-25% of diabetic patients in one study.[5] It is postulated that diabetic polyneuropathy predisposes nerves to damage by external pressure. Thickening of ligaments may also be involved
- Myxoedema: CTS occurs as a result of myxoedematous deposits in the wrist and may occur in as many as 10% of hypothyroid patients
- Acromegaly: CTS occurs in 30-50% of acromegalic patients, often bilaterally. Treatment of the pituitary lesion typically leads to a complete recovery of CTS

3.2.5 Connective tissue diseases[3,4]

- Lupus erythematosus
- Progressive systemic sclerosis (scleroderma)
- Polymyositis
- Polymyalgia rheumatica

3.2.6 Miscellaneous conditions[3,4]

- Renal failure: uraemia, which is commonly linked to peripheral neuropathy, also predisposes patients to entrapment neuropathy. CTS is particularly common in patients who are receiving long-term haemodialysis but less so with peritoneal dialysis. This is due to deposition of a protein (beta 2 macroglobulin)
- Amyloidosis – all varieties (primary, secondary, hereditary and associated with myeloma) may cause CTS

3.2.7 Genetic factors[1]

- There have been reports of a small number of families in which multiple members have developed bilateral CTS, with a pattern consistent with autosomal-dominant inheritance. A possible mechanism is that some families inherit a tendency to develop carpal tunnels that are structurally small, leading more readily to the development of symptoms in the presence of one or more adverse environmental factors
- Hereditary neuropathy with liability to pressure palsies (HNPP) is an autosomal-dominant condition characterised by recurrent and multiple compressive neuropathies, including the median nerve at the wrist. The gene abnormality is a deletion on chromosome 17p11.1-12
- The authors of a twin study have reported that up to 50% of the risk of developing CTS amongst women may be determined by genetic factors, and claim that this is the single strongest risk factor in women[6]

3.2.8 **Other factors**

- Obesity: a strong association exists, with one US study finding that the risk of CTS increased by 8% for each one unit increase in body mass index[7]
- Cigarette smoking has been quoted by several sources as a risk factor for CTS. However, one recent study, which confirmed a link with obesity, diabetes and hypothyroidism, failed to find a relationship between smoking and the development of CTS[8]

3.3 **Mechanical factors**

3.3.1 **Occupational exposure.** CTS is generally considered to be more common in individuals whose occupation requires substantial use of the hands, especially where it involves repeated, forceful flexion and extension of the fingers and wrist. However, an alternative view contends that a definite causal relationship has not yet been established for most occupations, as demonstrated by the fact that the incidence of work-related musculoskeletal disorders has not altered despite substantial investment in ergonomic workplace change.[9]

3.3.2 Individuals whose work involves much time at a keyboard e.g. typists and data entry clerks, musicians who keep the wrist in a flexed position, and meat cutters are considered particularly susceptible. However, one recent survey found no statistically significant association with keyboard use, although an association was detected between CTS and the use of a mouse device for more than 20 hours per week.[10]

3.3.3 **Workplace** mechanical factors that are implicated in the development of CTS involve:

- force
- repetition
- hand/wrist vibration
- awkward forearm, wrist and finger postures
- combinations of the above exposures

3.3.4 **Vibration.** Hand-arm vibration syndrome (HAVS) can mimic CTS and, in addition, the two conditions may co-exist.

3.3.5 **Sports.** Any sports activity that involves repetitive flexion or grasping can provoke symptoms. Cyclists and wheelchair athletes may have an increased incidence of CTS. However, participation in sports in general for at least 3 hours per week for at least 3 months of the year has been found in one study to convey a protective effect against the occurrence of CTS, possibly because it militates against obesity.

3.4 **Psychosocial factors.** In common with several other musculoskeletal disorders that affect the neck and upper limb, it is believed that psychosocial factors including home and workplace factors and the individual's mental health may be implicated in the development of CTS.

3.5 There remain some cases in which no underlying cause can be identified, and these are termed **"**idiopathic CTS".

3.6 Unfortunately, the literature allows few conclusions to be drawn about the relative importance of the various risk factors in the causation of CTS. Varying diagnostic criteria have been adopted in different studies, making comparisons difficult. Moreover, many of the studies devised to assess occupational and psychosocial factors have been based on self-reported symptoms of CTS. In future, a more uniform approach to diagnosis may help to clarify the role of workplace factors in the development of this condition.[1]

4. Prognosis

4.1 **Conservative measures** for treating CTS may suffice when symptoms are of short duration. The options include:

- **Avoidance** of obvious precipitating factors
- **Splinting:** a splint that keeps the wrist in a neutral position may be helpful, particularly in reducing symptoms that occur during the night
- **Ultrasound**
- **Carpal bone mobilisation**
- **Local injections of corticosteroid:** injection of the carpal tunnel can be helpful in individuals whose symptoms have been present for less than one year and who have no significant muscle weakness or wasting. Although most patients improve initially, up to 50% subsequently deteriorate within six months. Consideration may be given to one or two further injections, but frequent injections are contraindicated because of a danger of tendon rupture.
- **Oral steroids**, taken over a two-week period, have been found to be effective in a short-term trial[11]
- **Non-steroidal anti-inflammatory drugs** may help in cases where there is an underlying inflammatory lesion such as tenosynovitis.
- **Thiazide diuretics** are also used but there is no data to support this form of management

4.2 **Surgery** is indicated where there has been an inadequate response to conservative measures, where there are progressive or persistent neurological changes, or where there is muscle atrophy. Surgical release of the transverse carpal ligament is the definitive treatment. Surgery is undertaken through a palmar incision or, increasingly, by means of an endoscopic release, although in the latter case particular care and expertise is required to avoid the possibility of injury to the carpal tunnel structures. In cases where there is a marked tenosynovitis, e.g. in patents with rheumatoid arthritis, simple decompression of the carpal tunnel may not prove sufficient, and additional measures such as tenosynovectomy may prove necessary.

4.3 In around 85% of patients, the results of surgical division of the transverse carpal ligament are good and, in most cases, the benefits appear to endure. Patients with normal preoperative electrodiagnostic tests, who have claimed compensation, or who have ulnar nerve symptoms, have a worse outcome at surgery than patients without these findings. Persistent symptoms may lead to repeat operation in 12% of patients. Findings at re-operation indicate that the initial failure of surgical intervention may be attributable to one of a number of factors, including incomplete release of the transverse carpal ligament, scarring, and recurrent tenosynovitis. Following re-operation, around 25% of patients are completely satisfied, whilst 25% remain dissatisfied, some of whom proceed to a third operation.[4] In one Scandinavian study, 89% of patients returned to their previous work after surgery.[12] However, individuals whose occupations involve particular risk factors may need to be retrained for work that involves less intensive manual activities.[3]

4.4 Whenever an identifiable precipitating cause of CTS is identified, appropriate management should be instituted to treat the associated condition.

5. Summary

5.1 Carpal tunnel syndrome is the most common entrapment neuropathy and is now one of the most commonly reported occupational diseases.

5.2 The aetiology of CTS is multifactorial, involving interaction of anatomical, physiological, work-related and psychosocial factors. Links have been found between a large number of physical conditions and the development of CTS. Occupations that require substantial use of the hands have been implicated especially where repeated, forceful movements are involved.

5.3 Patients whose symptoms are of relatively short duration and who have not developed muscle weakness may respond to non-surgical treatment. Where surgical treatment is required, it provides relief in the majority of cases.

6. Related synopses

Tennis Elbow

Work Related Upper Limb Disorder

Raynaud's Phenomenon

7. Glossary

abduction	Movement away from the body.
acromegaly	A condition that results from excess production of growth hormone in the pituitary gland. Consequences include enlargement of bones of the extremities.
atrophy	Wasting, diminution in size.
carpal bones	Small bones in the wrist that articulate with the bones of the lower end of the forearm and those of the hand.
endoscopy	The visual inspection of any cavity of the body by means of an endoscope, a highly flexible viewing instrument that allows therapeutic procedures to be carried out through special channels.
idiopathic	Of unknown causation.
infarct	Area of tissue which dies following interruption of blood supply.
Lyme disease	A bacterial disease caused by the organism *Borrelia burgdorferi*, transmitted by the bite of an infected tick. The organism engenders an immunologically-mediated inflammatory response.
magnetic resonance imaging (MRI)	An investigation technique used to image internal structures of the body, particularly soft tissues.
myxoedema	A functional insufficiency of the thyroid gland leading to a deficiency of thyroid hormone.
osteophyte	A bony outgrowth or protuberance.
neuropathy	A functional disturbance or pathological change in the peripheral nervous system. Hence: *neuropathic*.
tenosynovectomy	Excision of the tendon sheath.
tenosynovitis	Inflammation of the tendon sheath.
thalamic	Pertaining to the thalamus, a collection of grey matter at the base of the brain, through which sensory impulses pass to the brain.
thenar	The prominence of the palm above the base of the thumb.

transverse carpal ligament	A strong fibrous band that binds down the flexor tendons of the digits and the median nerve and in so doing creates the carpal tunnel.
ulnar nerve	A major nerve of the upper limb, supplying sensory and motor innervation to parts of the hand and forearm.

8. References

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