

Carpal Tunnel Syndrome

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ABSTRACT

Carpal tunnel syndrome (CTS) is a collection of symptoms and signs caused by compression of the median nerve as it travels through the carpal tunnel. Symptoms include paresthesia and/or numbness in the median nerve distribution, aching in the thenar eminence, and weakness at later stages. CTS is the most common entrapment neuropathy with a prevalence of 1–5%, and even higher among females, manual workers, and the elderly. Therefore, many patients with signs and symptoms of CTS refer to their primary care physician who should recognize, diagnose, and provide initial treatment.

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KEY WORDS: carpal tunnel release, carpal tunnel syndrome, compression neuropathy, peripheral nerve entrapment

Carpal tunnel syndrome (CTS) is a collection of symptoms and signs caused by compression of the Median nerve as it travels through the carpal tunnel. Symptoms include paresthesia and/or numbness in the median nerve distribution, aching in the thenar eminence, and weakness in later stages [1,2]. CTS is the most common entrapment neuropathy with a prevalence of 1–5% or even higher among females, manual workers, and the elderly [3,4]. Therefore, many patients with signs and symptoms of CTS refer to their primary care physician who should recognize, diagnose and provide initial treatment.

CLINICAL PRESENTATION

The hallmark of CTS is paresthesia and/or numbness in the median nerve distribution (thumb, index, middle finger, and radial side of ring finger) that is worse at night. Paresthesia also occurs during fixed wrist activities such as driving, reading a book, and using a computer keyboard or mouse. Less often, patients describe aching in the thenar eminence. In more advanced cases that include motor involvement, patients may complain of weakness or clumsiness of the hands in activities such as opening a jar, buttoning a shirt, or turning a key [5,6]. CTS may also present in an acute setting, following a wrist fracture or dislocation, with similar clinical findings.

ANATOMY AND PATHOPHYSIOLOGY

The carpal tunnel's floor is formed by the carpal bones and its roof is formed by the flexor retinaculum. The median nerve passes through the carpal tunnel along with 9 flexor tendons of the fingers and thumb [Figure 1]. In extreme wrist flexion or extension, the pressure in the carpal canal is elevated and symptoms may worsen, such as during sleep or with repetitive manual labor [7]. The pathophysiology of CTS involves a combination of mechanical trauma, increased pressure, and ischemic damage to the median nerve within the carpal tunnel. A decrease in the cross-sectional area of the carpal tunnel can lead to pressure elevation that limits epineural blood supply.

RISK FACTORS

Both occupational and non-occupational risk factors for CTS are considered. Risk factors include female sex (1:3–1:7.4 ratio) [3,8], genetic predisposition, diabetes mellitus, amyloidosis, hypothyroidism, chronic renal failure, inflammatory arthritis, trauma to the wrist, osteoarthritis of the hand and wrist, alcoholism, obesity, and pregnancy (with a spontaneous resolution after delivery in most cases) [9,10].

It should be noted that CTS is an early red-flag symptom of amyloidosis and is present in 10.2% of men aged 50 years and older and women aged 60 years old and older undergoing surgery for idiopathic CTS. CTS classically presents bilaterally years before cardiac and multisystem involvement. A simple biopsy during carpal tunnel release surgery may allow for early recognition of this disease. The physician who makes the connection between CTS and amyloidosis creates an opportunity for timely intervention and can positively impact a patient's life, long after surgical intervention [11–14].

Work-related activities that require a high degree of force and repetition or the use of hand-operated vibratory tools significantly increase the risk of CTS [12]. Forceful hand exertion was found to be the most important factor in the development of CTS in workers [13].

DIAGNOSIS

The diagnosis of CTS is based on the patient's history, risk factors, characteristic symptoms, and physical examination findings.

CARPAL TUNNEL SYNDROME IS COMMON

Figure 1. Carpal tunnel anatomy as seen on an magnetic resonance imaging axial view (T2 SPAIR sequence). The carpal tunnel's floor is formed by the carpal bones dorsally and by the flexor retinaculum volarly.

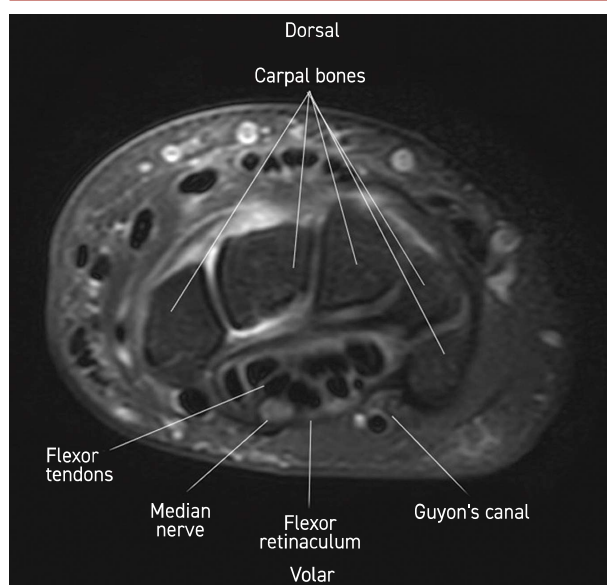


Figure 2. Thumb abduction test. The patient is instructed to raise the thumb perpendicular to the palm against downward pressure on the distal phalanx. The strength of the abductor pollicis brevis, which is innervated by the median nerve, is assessed and compared to the contralateral side.



PHYSICAL EXAMINATION

Visual findings may include thenar atrophy. A classic sensory exam that is positive for CTS will include hypoesthesia or dysesthesia in the median distribution and the palmar aspect of the 3.5 radial fingers. It will spare the thenar eminence. The Semmes-Weinstein test is sensitive in detecting early disease. Objective weakness can occur in severe CTS and involves

muscles of the thenar eminence, which can be tested in palmar abduction [Figure 2], thumb opposition, grip, and pinch strength. Provocative maneuvers elicit CTS symptoms and include manual carpal compression/Durkan's test [Figure 3], Phalen's [Figure 4], and Tinel's tests [14,15].

ELECTRODIAGNOSTIC STUDIES

Electrodiagnostic studies include electromyography and nerve conduction studies (NCV), which are based on the nerve's functional parameters. Electrodiagnostic studies are not essential for primary diagnosis and allow an estimation of disease severity [6,16]. Nerve conduction studies for CTS with a distal motor latency above 4.5 ms and a sensory latency above 3.5 ms are considered abnormal [17]. However, a relative comparison of the median nerve response to another nerve segment (ulnar or radial), which does not travel through the carpal tunnel, was found to be more accurate in contrast to using normal values for the amplitude and latency of individual nerves [18]. Electromyography may show evidence of nerve injury, such as increased insertional activity, positive sharp waves, fibrillations at rest, and decreased motor recruitment.

IMAGING

Ultrasonography in CTS may show an enlarged median nerve in the carpal tunnel, thickening of the flexor retinaculum, and edema around flexor tendons in cross-sectional images [19]. A meta-analysis found that a median nerve cross-sectional area of 9 mm² or more was 87.3% sensitive and 83.3% specific for CTS [20,21]. Ultrasound or magnetic resonance imaging may be indicated for patients with a suspected structural abnormality such as a bone deformity, ganglion, or tumor that may compress the median nerve [22,23].

DIFFERENTIAL DIAGNOSES

Conditions which may present similarly to carpal tunnel syndrome include include cervical radiculopathy, pronator syndrome, De Quervain's tenosynovitis, carpometacarpal arthritis of the thumb, and peripheral neuropathy.

Cervical radiculopathy

Symptoms include neck pain that radiates toward the thumb and index finger with numbness and tingling in a dermatomal distribution. On physical exam, paresthesia and possible weakness in the distribution of C6 and C7 dermatomes and muscle groups and positive Spurling's and shoulder abduction tests may be found [23,24].

Proximal median nerve entrapment syndromes

Pronator syndrome and lacertus syndrome are compression neuropathies of the median nerve at the

**CARPAL TUNNEL SYNDROME DIAGNOSIS
AND INITIAL TREATMENT SUCH AS NIGHT SPLINTS
AND OCCUPATIONAL THERAPY SHOULD BE PROVIDED
BY THE PRIMARY CARE PHYSICIAN**

level of the elbow. When occurring concurrently with CTS, mild pronator and lacertus syndromes may be overlooked. Both syndromes include paresthesia in the distribution of the median nerve as seen in CTS with paresthesia over the distribution of the palmar cutaneous branch of the median nerve (thenar area of palm) and possible weakness of the flexor pollicis longus, flexor digitorum profundus of the index, and flexor carpi radialis muscles [25]. The provocation of symptoms with resisted pronation is suggestive of pronator syndrome [23]. External pressure over the median nerve at the level of the Lacertus fibrosus that elicits distinct pain and a positive Tinel's sign is suggestive of lacertus syndrome [26].

De Quervain's tenosynovitis

De Quervain's tenosynovitis is an inflammation of the first extensor tendon compartment, which presents with radial-sided wrist pain. Pain that involves the thumb during activity is typical. Physical examination findings include provocation of symptoms with Finkelstein's maneuver [27].

Carpometacarpal arthritis of the thumb

Symptoms of carpometacarpal arthritis of the thumb include pain with thumb movement, positive grind test, and radiography [27].

Peripheral neuropathy

A history of diabetes mellitus [23] and paresthesia in the glove-and-socks distribution is suggestive of neuropathy [28].

TREATMENT

When CTS is suspected or established, primary care physicians can counsel their patients on treatments that may be conservative

or surgical, depending on the severity of the disease. The patient should be referred to an orthopedic or hand surgeon be advised to avoid aggravating activity. A night wrist splint may be prescribed. Conservative treatment includes activity and lifestyle modifications (e.g., limitation of wrist movement and reduction of heavy work activities), night splints with the wrist in neutral (prefabricated splints usually have a slight extension and are not recommended), physical therapy techniques (e.g., carpal bone mobilization and nerve-gliding exercises), non-steroidal anti-inflammatory drugs, and

steroid injections [29]. Most patients have a transient improvement of symptoms after a steroid injection, which is a positive prognostic factor for successful carpal tunnel surgery [30]. However, because of its temporary relief of symptoms and the risk of nerve injury, corticosteroid injection is not routinely indicated [31,32].

Surgical treatment for CTR is often recommended after exhausting conservative treatment. The procedure involves sectioning of the transverse carpal ligament to relieve carpal tunnel pressure and decompress the median nerve. Studies have shown that CTR provides a lasting good outcome in 70–90% of cases, which is superior to splinting or injections [33–35]. The clinical severity of carpal tunnel syndrome prior to surgery is the most important factor in estimating symptom relief after surgical treatment [36]. CTR is considered a safe surgery with an overall serious complication rate (requiring admission to hospital or further surgery) of less than 0.1% [37]. The procedure is usually performed under local or regional anesthesia with an open, mini-open (short wrist incision), or by an endoscopic approach. Studies have shown that long-term functional outcome is not significantly different between open and endoscopic release [38,39]. The endoscopic technique shows

PATIENTS WITH NON-CLASSIC CLINICAL PRESENTATION, SEVERE OR PERMANENT SYMPTOMS, AND FAILED NON-SURGICAL MANAGEMENT SHOULD BE REFERRED TO A HAND SURGEON

SURGICAL TREATMENT FOR CARPAL TUNNEL SYNDROME IS EFFECTIVE AND SAFE

Figure 3. The carpal compression or Durkan's test is performed with the patient's forearm supinated by applying pressure over the carpal tunnel, between the thenar and hypothenar eminence for 30 seconds. Pain or paresthesia in the median nerve distribution indicates a positive result.

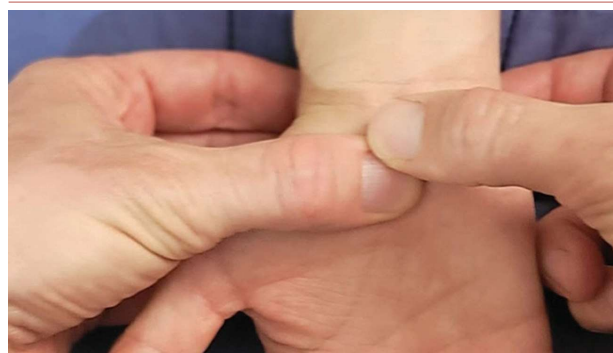
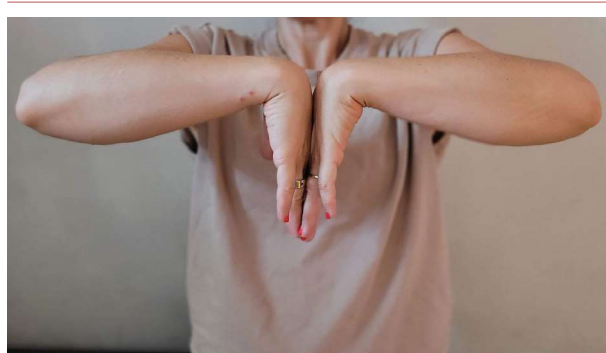


Figure 4. Phalen's test is performed with the patient's dorsal hand surfaces pushed against each other to provide hyperflexion of the wrist while the elbows remain flexed. Pain or paresthesia in the median nerve distribution while holding this position for 60 seconds indicates a positive result.



a shorter postoperative recovery period and reduced scar tenderness but is associated with higher rates of nerve damage than the open approach [40]. Surgery is performed in an ambulatory setting. Patients are discharged immediately following surgery with a bulky dressing that is changed after a couple of days. Stitches are removed after 2 weeks and physical therapy may be suggested to improve stiffness and restore range of motion.

CONCLUSIONS

CTS is a common compressive neuropathy. Patients are often referred to their primary care physician, who should recognize the symptoms, make a diagnosis, and provide initial treatment with night splints and occupational therapy. Patients with a non-classic clinical presentation or patients with severe/permanent symptoms who failed to respond to initial non-surgical management should be referred to a hand surgeon. Surgical treatment is effective and safe.

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