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## Introduction

Carpal tunnel syndrome is the most commonly diagnosed compressive neuropathy of the upper extremity [1]. It is the third most common procedure performed by orthopedic surgeons, just behind knee and shoulder arthroscopy [2]. Patients with carpal tunnel syndrome may present to physicians from across all facets of medicine from primary care to specialized surgery. Despite its high prevalence and characteristic features, the diagnosis can at times be challenging. Not all patients present with typical symptoms, and multiple conditions can lead to carpal tunnel syndrome. There are multiple criteria for diagnosis, and patients often do not exhibit all signs and provocative maneuvers. Finally, surgeons should be keen to remember that not all hoof beats come from horses: there are many conditions which may mimic carpal tunnel syndrome.

The primary cause of carpal tunnel syndrome is median nerve compression from within the carpal canal [3]. This is verified by an increase in the internal pressure within the carpal tunnel. Any condition that decreases the available space or increases

the volume of the contents within the fixed capacity of the carpal canal can induce carpal tunnel syndrome. Although the majority of CTS is idiopathic, systemic conditions such as DM, hypothyroidism, or RA may predispose one to developing CTS. Hormonal changes as seen in pregnancy, collagen conditions, and acromegaly may also increase risk of CTS. Those with a disproportionately smaller canal due to abnormal development, a congenital condition, or secondary to trauma from a fracture will see higher pressures and may be at increased risk of developing carpal tunnel syndrome.

Carpal tunnel syndrome typically presents with symptoms of nocturnal paresthesias in the median nerve distribution and activity-related symptoms that often occur with prolonged grip [4]. Symptoms often occur when driving or holding a cellular phone, and patients are frequently woken from sleep with painful, numb hands. To resolve the paresthesias, patients note the need to lower and shake their hands.

The diagnosis of carpal tunnel becomes less clear as the subjectivity of complaints increases. Patients may complain of pain that radiates up the forearm or all the way to the shoulder. Symptoms may involve the entire hand, suggesting more than isolated median nerve involvement. Patients often have difficulty describing their symptoms and may not understand the difference between numbness, tingling, pain, and weakness. These symptoms are common with carpal tunnel syndrome, but can be present with many other conditions.

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In situations where the complaints are typical for carpal tunnel syndrome, and the classic provocative tests are positive, the diagnosis is straightforward, and the physician can be confident in his or her decision. When other complaints or clinical issues confound the presentation, the picture is murkier. The current American Academy of Orthopaedic Surgeons guidelines for the diagnosis of carpal tunnel syndrome recommend obtaining an accurate history and performing a physical examination evaluating personal characteristics: sensation, motor function, and provocative/discriminatory tests [5]. Additionally, electrodiagnostic testing is recommended when thenar atrophy and/or constant numbness is present, to differentiate among other potential etiologies, especially when surgical treatment is being considered. MRI, CT, and pressure-specified sensorimotor devices are not recommended for use in routine carpal tunnel syndrome.

When evaluating a patient with suspected median nerve neuropathy, physicians should consider the etiology of their patients' symptoms

prior to determining treatment. There are two main categories to consider: those conditions causing CTS and those conditions that may appear to be CTS, but are due to a different pathology. Although most commonly carpal tunnel syndrome is idiopathic, there are many conditions which can result in compressive neuropathy of the median nerve in the carpal tunnel, which are discussed elsewhere in this book. Table 5.1 lists categories of conditions that may mask as CTS.

## Conditions Masking as Carpal Tunnel Syndrome

The focus of this chapter will be those conditions that may fool the patient or the practitioner into thinking carpal tunnel syndrome is the primary problem. The differential diagnosis is broad, and it is helpful to divide potential etiologies into neurologic and non-neurologic conditions. Organizing in this manner may help optimize efficiency in diagnosis and avoid unnecessary testing/costs.

**Table 5.1** Conditions that present with a clinical picture similar to carpal tunnel syndrome

Neurologic conditions	Non-neurologic conditions
<ul style="list-style-type: none"> <li>• Neoplastic               <ul style="list-style-type: none"> <li>– Intracranial neoplasm</li> <li>– Pancoast tumor</li> <li>– Peripheral nerve tumor</li> </ul> </li> <li>• Neurologic               <ul style="list-style-type: none"> <li>– Multiple sclerosis</li> <li>– Amyotrophic lateral sclerosis</li> <li>– Brachial plexopathy</li> <li>– Thoracic outlet syndrome</li> <li>– Parsonage-Turner syndrome</li> <li>– Pronator syndrome</li> <li>– Polyneuropathy</li> </ul> </li> <li>• Cervical               <ul style="list-style-type: none"> <li>– Cervical spondylosis and myelopathy</li> <li>– Cervical radiculopathy (C5, C6)</li> <li>– Syrinx</li> </ul> </li> <li>• Inflammatory               <ul style="list-style-type: none"> <li>– Churg-Strauss syndrome</li> <li>– Polyarteritis nodosa</li> </ul> </li> <li>• Traumatic               <ul style="list-style-type: none"> <li>– Median nerve laceration</li> <li>– Median nerve contusion</li> <li>– Median nerve ischemia</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Neoplastic               <ul style="list-style-type: none"> <li>– Melorheostosis</li> <li>– Myxofibrosarcoma of the forearm</li> <li>– Lipoma</li> </ul> </li> <li>• Vascular               <ul style="list-style-type: none"> <li>– Hand-arm vibration syndrome</li> <li>– Hypothenar hammer syndrome</li> <li>– Raynaud's phenomenon</li> <li>– Vascular shunt</li> </ul> </li> <li>• Degenerative               <ul style="list-style-type: none"> <li>– FCR/FCU tenosynovitis or calcific tendonitis</li> <li>– Osteoarthritis</li> <li>– Overuse syndrome</li> <li>– Fibromyalgia</li> </ul> </li> <li>• Inflammatory               <ul style="list-style-type: none"> <li>– Polymyalgia rheumatica</li> <li>– Gout</li> <li>– Pseudogout</li> <li>– Lupus</li> <li>– Rheumatoid arthritis</li> </ul> </li> <li>• Infectious               <ul style="list-style-type: none"> <li>– Herpes zoster</li> <li>– Mycobacterial</li> <li>– Gonococcal</li> </ul> </li> </ul>

## Neurologic Conditions

There are multiple neurologic conditions that present with symptoms similar to carpal tunnel. These can be divided into benign and malignant neurogenic tumors, primary neuropathic conditions, inflammatory, cervical, and traumatic etiologies.

## Tumors

Many types of tumors may present with symptoms that appear to be CTS. The most proximal site of compression was described by Dunkow et al. in 2004, when they reported on a glioblastoma causing symptoms of numbness and tingling in the median nerve distribution [6]. The patient presented with numbness in the left index, middle, and ring fingers and a positive Tinel's over the median nerve at the wrist, but a negative Phalen's test. Electrodiagnostic studies suggested cervical pathology; however, a cervical spine magnetic resonance (MR) scan excluded a cervical etiology. Symptoms progressed to involve the small finger, and the patient had decompression of median and ulnar nerves at the wrist with no improvement. Following development of wrist extensor weakness, MR of the brain showed a 5 cm parietal lobe tumor. This case highlights the importance of asking about central symptoms such as headaches, personality changes, nausea/vomiting, seizures, or memory loss.

Cervical spine neoplasms have also been implicated in creating carpal tunnel complaints. Tumors of the foramen magnum can present with hand numbness, weakness, and clumsiness before other neurologic findings are obvious. In a series of 57 patients, Yasuoka et al. found three patients were initially misdiagnosed with carpal tunnel syndrome [7]. These patients will often have other findings not typical of carpal tunnel syndrome including gait disturbances, hyperreflexia, neck pain, and a Babinski sign [8].

Tumors in the upper apices of the lungs, such as a Pancoast tumor, may encroach on the brachial plexus as the tumor becomes larger [9]. As the tumor escapes the confines of the thoracic

cavity, it invades the superior thoracic inlet and can compress the medial cord of the brachial plexus [10]. Sensory and motor deficits typically also involve the ulnar nerve distribution. Additionally, Horner's syndrome is present in up to 50% of patients, and many will also have constitutional symptoms such as fatigue, fever, or weight loss. Interestingly, pulmonary symptoms are uncommon early in the disease process.

Peripheral nerve tumors such as a schwannoma can develop within the median nerve or its branches and cause carpal tunnel symptoms [11–13]. Although these are usually asymptomatic at first, as they enlarge, neurologic symptoms may develop. Schwannomas are most often benign, slow-growing, encapsulated lesions that are amenable to surgical excision. Unlike neurofibromas, schwannomas can be separated from the nerve avoiding injury to surrounding axons. In addition to symptoms of numbness/tingling, a palpable mass may be present as it enlarges. Padua et al. described five patients found to have schwannomas with presenting symptoms of carpal tunnel syndrome, three of whom had prior surgical treatment with persistent symptoms. They found ultrasound to be particularly helpful in these cases which tended to have some "incongruous aspects" [13]. Additionally, when a peripheral nerve tumor is suspected, MRI should be obtained to evaluate the characteristics of the mass prior to consideration of surgical excision or biopsy, as malignancy may be present.

## Neuropathies

Neuropathy is a broad category with many conditions that cause median nerve symptoms. Patients often have trouble deciphering which digits have sensory abnormalities and may misinterpret radial or ulnar neuropathy as carpal tunnel syndrome. Pronator syndrome is a compressive neuropathy involving the median nerve occurring at the elbow. Patients have numbness in the median nerve distribution as with carpal tunnel syndrome with the addition of numbness in the territory of the palmar cutaneous branch of the median nerve. Complaints of pain and numbness are more common during

activity with absence of nocturnal symptoms. Provocative tests include tenderness along the course of the median nerve across the elbow, pain with resisted pronation with the elbow in extension, and pain with resisted middle finger proximal interphalangeal joint flexion. Pronator syndrome is rare in comparison to CTS, but may coexist and should be considered in all patients presenting with carpal tunnel complaints [14].

Peripheral neuropathies have many potential causes including diabetes, nutritional deficiencies, human immunodeficiency virus, uremia, and vascular. Many cases are symmetric with symptoms commonly affecting the distal aspect of the longest nerve fibers, explaining typical onset of foot symptoms prior to those in the hand. Polyneuropathy may present with asymmetric symptoms though, especially in diabetics [15]. In these cases, it can be more difficult to differentiate from a compressive etiology. Diagnosis of peripheral neuropathy is based on a combination of neuropathic symptoms, signs, and electrodiagnostic studies, with signs being better than symptoms in making the diagnosis [16]. Signs of sensory loss occur in non-dermatomal, non-single nerve distribution patterns. Motor findings are atrophy and weakness of intrinsic muscles, with secondary joint deformity. Tendon reflexes are often diminished or absent. The electrodiagnostic study most helpful for confirming the diagnosis of a peripheral neuropathy is the nerve conduction study (NCS). Findings of an abnormality of any attribute of nerve conduction in two separate nerves, one of which must be the sural nerve, are the minimum criterion to support the diagnosis. If sural sensory and peroneal motor NCSs are normal, there is no evidence of a peripheral neuropathy [16]. If either is abnormal, NCS of at least the ulnar sensory, medial sensory, and ulnar motor nerves in both arms is performed. The addition of radial nerve studies is helpful particularly in those patients with suspected carpal or cubital tunnel syndrome, since compressive neuropathy may coexist with peripheral neuropathy.

Multiple sclerosis is an uncommon cause of failed carpal tunnel decompression [17]. Presenting symptoms are commonly central,

such as unilateral visual disturbance, hemifacial spasm, and vertigo [18]. Lhermitte's symptom, an electric-shock-like sensation that can run down the back, or into the arms and/or legs triggered by neck motion, is strongly linked to multiple sclerosis [19]. Other peripheral symptoms may occur, which may simulate carpal tunnel syndrome; however, patients do not have typical nocturnal or provocative daytime symptoms.

Lesions of the brachial plexus may also create symptoms that may be confused with carpal tunnel syndrome. The median nerve originates from the lateral and medial cords of the brachial plexus with contributions from C6 to T1. Traumatic causes of brachial plexopathy are typically high-energy and result from motorcycle or other motor vehicle accidents where the arm is subjected to a traction or crush injury. Patients with anterior shoulder dislocation may also have compressive injury to the plexus. "Burners" or "stingers" are traction injuries occurring when the head and neck are forcefully pushed sideways and down, affecting one arm. They occur during a fall to the head, as may occur during wrestling or most commonly during a football tackle. These traumatic causes are usually easily differentiated from CTS due to the history of injury, though in multi-trauma patients, injury to the shoulder and hand/wrist may coexist, and acute CTS should be excluded by clinical exam and/or pressure monitoring of the carpal tunnel.

Neuralgic amyotrophy, or Parsonage-Turner syndrome, is a rare, likely autoimmune, disorder which causes pain and sensory and motor changes in peripheral nerves. Pain is the presenting symptom in 90% of cases, followed by weakness within 24 h in one third of patients, within 2 weeks in 70% of patients, and within 1 month in 85% [20]. Most commonly, the shoulder girdle muscles are involved, including the infraspinatus, supraspinatus, deltoid, biceps, and triceps, though weakness may be limited to the muscles supplied by a single nerve. Paresthesias and hypoesthesia are present in the majority of patients, again most frequently about the shoulder. Pure sensory neuralgic amyotrophy can occur, and when it does, it typically affects the median, medial antebrachial, and lateral antebrachial cutaneous nerves, potentially

mimicking carpal tunnel syndrome. The abrupt onset of the symptoms, significant pain, and weakness in muscles other than the thenars help distinguish patients with Parsonage-Turner syndrome from those with carpal tunnel.

## Cervical Disorders

Neck pain is a common condition, with 1 year prevalence rates of 4.8–79.5% (mean 25.8%) [21]. Underlying spondylosis, spondylolisthesis, and disc herniation may lead to nerve compression and symptoms of a peripheral compressive neuropathy. Cervical radiculopathy involves one or more nerve roots, creating pain, numbness, and weakness in a dermatomal distribution. Sixth cervical root compression, seen in 25% of patients, causes numbness in the thumb and index fingers, whereas seventh cervical root involvement (60% of patients) causes numbness in the middle finger [22]. Patients with C6 involvement most closely mimic carpal tunnel syndrome, but these patients do not typically exhibit abductor pollicis brevis atrophy as is seen in advanced carpal tunnel. Nocturnal symptoms are less frequent as well. In a study by Chow et al., 84% of patients with isolated carpal tunnel syndrome had nocturnal symptoms compared to only 10% in the group with isolated cervical spondylosis [23]. Additional findings in patients with C6 radiculopathy include weakness (elbow flexion, wrist extension, and forearm supination), diminished reflexes (brachioradialis and biceps), and cervical pain, loss of motion, and a positive Spurling's test (reproduction of symptoms by positioning the neck in extension, rotating toward the side of symptoms, and applying axial load).

Cervical myelopathy occurs secondary to spinal cord compression. It may result from disc herniation, spondylolisthesis, or a space-occupying lesion. The clinical picture in patients with myelopathy tends to be quite variable and requires a high index of suspicion. Crandall and Batzdorf described five broad categories of cervical myelopathy including “brachialgia and cord syndrome” which may present with symptoms of carpal tunnel syndrome [24]. Symptoms may be

non-dermatomal and often bilateral. Patients complain of diffuse numbness and the insidious onset of clumsiness, hand weakness, and worsened handwriting. As the condition advances, intrinsic atrophy progresses and may become severe. This constellation of findings was described as “myelopathy hand” by Ono et al. in 1987 [25]. They described two signs specific to the disorder. The “finger escape sign” is positive when after asking the patient to extend and adduct their fingers, the small finger drifts into abduction in less than 30 s. The “grip and release” test indicates myelopathy when the patient is unable to repeatedly open and close their fists at least 20 times in 10 s [22]. Myelopathic patients have weakness and spasticity, with exaggerated wrist flexion during finger extension and wrist extension during finger flexion.

Ziadeh and Richardson described the case of a patient with cervical syrinx who presented with symptoms of carpal tunnel syndrome [26]. The patient presented with a several year history of left thumb, index, and middle finger numbness. Symptoms were worse at night and with keyboard use. A night splint failed to control symptoms, as did physical therapy, ergonomic evaluation, and prescription anti-inflammatory medication. The patient denied weakness, clumsiness, or gait disturbance, but close physical evaluation demonstrated hyperreflexia and a positive Spurling's maneuver, highlighting the importance of a complete examination in all patients with presumptive diagnosis of carpal tunnel syndrome. A cervical spine MR demonstrated a syrinx from C1–C2 to T10–T11 with an Arnold-Chiari type I malformation.

## Inflammatory Conditions of the Nervous System

Inflammatory disease can not only be a cause of carpal tunnel syndrome but can also mimic carpal tunnel by creating neuropathy proximally. Disorders such as polyarteritis nodosa, lupus, and rheumatoid arthritis can develop vasculitis affecting the peripheral nerves and lead to upper extremity dysesthesia. A case highlighting this

etiology was presented by Sethi et al. in a patient with Churg-Strauss syndrome [27]. Churg-Strauss syndrome is an autoimmune condition causing asthma and inflammation of small- and medium-sized vessels leading to mononeuritis multiplex or polyneuropathy. In their case, the patient presented with right thumb, index, and middle finger numbness. Neurologic symptoms progressed with involvement of the contralateral hand and visual disturbance leading to consideration of alternative diagnoses.

Polymyalgia rheumatica can also cause symptoms of carpal tunnel syndrome. In a series of 177 patients, Salvarani et al. found 14% with carpal tunnel complaints [28]. Patients with polymyalgia rheumatica often have multiple distal musculoskeletal findings including edema, tenosynovitis, and joint pain which can help differentiate the disease from idiopathic carpal tunnel syndrome. Patients are usually over the age of 50 and have an elevated erythrocyte sedimentation rate and C-reactive protein. Response to oral corticosteroids is dramatic, while nonsteroidal anti-inflammatories are ineffective.

### Traumatic Neurologic Injuries

Traumatic injuries to the median nerve must always be considered when evaluating a patient with symptoms of carpal tunnel syndrome. Sharp lacerations from a piece of glass or a knife may be obvious. Less obvious situations may present with dysesthesias and a remote history of injury. Browett et al. reported on two patients who suffered injuries to their volar wrists from a piece of glass with no immediate neurologic symptoms [29]. One patient developed paresthesia in the median nerve distribution 3 days later, while symptoms took 3 months to occur in the other when while extending her wrist, the patient had the sudden onset of pain and numbness in her thumb. Findings at exploration in the latter patient confirmed partial laceration of the median nerve with a glass fragment embedded in the radial side.

Blunt trauma occurring anywhere in the extremity or neck can injure nerve fibers which terminate in the median nerve or the median

nerve itself. As these are typically associated with a significant trauma, the location of the injury is often known. However, acute carpal tunnel can coexist in patients with concomitant injury to the hand or wrist or develop from reperfusion injury. A detailed neurologic examination is critical in trauma patients to determine whether nerve damage is present as a result of the injury. In obtunded patients in which an examination isn't possible, close compartment monitoring is necessary, and prophylactic fasciotomies and carpal tunnel decompression are warranted in patients with prolonged arm ischemia due to vascular injury.

### Non-neurologic Disorders

Another set of conditions that can present symptoms of carpal tunnel syndrome are those of non-neurologic origin. Often, they impair nerve function by increasing pressure on the median nerve, while some directly affect blood flow to the nerve.

### Vascular Conditions

Symptoms of carpal tunnel syndrome may occur with a number of vascular conditions. Raynaud's disease, hypothenar hammer syndrome, and hand-arm vibration syndrome can all cause symptoms of numbness and tingling in the median nerve distribution [9, 30, 31]. In Raynaud's disease, patients complain of blanching or cyanosis in the fingers triggered by cold or other stressors. Numbness can coexist with the vascular changes and may be the primary complaint. Patients with carpal tunnel syndrome may also complain of coldness in the fingers which is thought to be caused by increased sympathetic activity during periods of increased median nerve compression. Treatment should be focused based on which factors most frequently trigger the symptoms, concentrating on Raynaud's for those with symptoms only occurring with cold exposure. Patients may also suffer from both conditions. In a group of 30

patients with carpal tunnel syndrome, Chung et al. [32] found 60% had concurrent Raynaud's disease based on objective impairment of arterial pulse following cold immersion.

Hand-arm vibration syndrome is characterized by neural and/or vascular symptoms in patients with a history of vibration exposure. Neural symptoms are due to damage to the nerves resulting in paresthesias, pain, sensory loss, and muscle wasting. Finger blanching and pain result from digital vessel spasm and progressive occlusion. Some patients will progress to trophic changes in the fingertips as is seen in other causes of vascular ischemia. Diagnosis is based on the presence of symptoms with a history of significant vibration exposure and should be considered in patients with a 5-year vibration exposure over 5000 h [31]. The importance of distinguishing between the two conditions was highlighted by Pelmear et al. who found that surgical treatment may make the hand-arm vibration syndrome patient worse due to further reduction in grip strength [33].

Proximal vascular conditions can compromise circulation to the median nerve resulting in symptoms of carpal tunnel syndrome. Arm and forearm fistulas placed for vascular access can create a steal phenomenon reducing blood flow distally [34, 35]. In a series of 271 patients undergoing carpal tunnel release, Seifert et al. found 24 patients developed carpal tunnel syndrome following placement of an arteriovenous shunt in the forearm [35]. All were successfully treated with carpal tunnel release. In more severe cases of steal syndrome, reduction of flow through the shunt is achieved by placement of a band, though ligation of the fistula may be necessary to prevent trophic changes and tissue loss [36].

## Arthritis

Symptoms of arthritis can sometimes mimic carpal tunnel syndrome especially in patients who have difficulty localizing and describing their symptoms. Patients may complain of pain and aching in the entire hand, wrist pain, and increased symptoms with use with either condition. It is usually easy to differentiate arthritic

symptoms from true carpal tunnel syndrome due to the lack of paresthesias, presence of joint deformity, and differing temporal relationship of symptoms. Many patients have coexisting symptoms of both conditions, however, and arthritic degeneration of the scaphotrapeziotrapezoidal joints, radiocarpal joint, and pancarpal joints can lead to mass effect leading to carpal tunnel syndrome. The size of the carpal tunnel can be reduced by osteophyte formation, synovial proliferation, and joint collapse [37].

## Tenosynovitis

Multiple forms of tenosynovitis can present in the hand and wrist. Most are clearly differentiated from carpal tunnel syndrome based on location, history, and physical examination. Localized forms of tenosynovitis are easiest to diagnose and fortunately most frequently seen. Typical findings are swelling and tenderness along the tendon sheath, pain with resistance, and warmth. Those occurring near the carpal tunnel include inflammation of the flexor carpi radialis, flexor carpi ulnaris, and first dorsal compartment tendons (extensor pollicis brevis and abductor pollicis longus). Calcific tendonitis causes severe pain, erythema, and swelling about the wrist and when occurring in a tendon within the carpal tunnel can precipitate acute carpal tunnel syndrome [38].

More diffuse tenosynovitis can be harder to differentiate from carpal tunnel syndrome. Patients may complain of numbness, burning pain in the hand and wrist, and weakness. Symptoms are most common with increasing activity, with nighttime numbness and awakening less frequent. Patients often associate occurrence of symptoms with job-related activity such as typing and writing. Several syndromes with subjective diagnostic criteria, including repetitive strain injury, overuse syndrome, fibromyalgia, and dystonia, have been described which may mimic carpal tunnel syndrome [39–41]. Management of these patients without objective evidence of carpal tunnel syndrome (positive electrodiagnostic studies, provocative testing for carpal tunnel, and loss of sensation in the median

nerve distribution) involves ergonomic evaluation, hand therapy, activity modification, and steroid injection into the carpal tunnel. If a patient does not respond to conservative care and has positive provocative findings of carpal tunnel syndrome, a diagnostic steroid injection into the carpal tunnel should be considered. Carpal tunnel syndrome can exist in patients with normal electrodiagnostic studies [42], and carpal tunnel release can be helpful in these patients, particularly if they have shown a positive response to steroid injection.

## Infectious

Several infectious causes may create symptoms of carpal tunnel syndrome either due to direct injury to the nerve or mass effect on the nerve. Mycobacterial infections are among the more common causes of infection-related carpal tunnel symptoms, although gonococcal tenosynovitis has been described as well [43]. In a series of 12 patients with *Mycobacterium tuberculosis*-related carpal tunnel, Hassanpour and Gousheh found half the patients had positive Tinel's sign or Phalen's sign, but all had significant swelling of the volar wrist [44]. Intraoperatively, the median nerve was found encased in thickened synovial tissue with associated rice bodies. Treatment, in addition to complete release of the transverse carpal ligament, should include radical tenosynovectomy and postoperative antibiotic therapy. Similar intraoperative findings have been described in cases of *Mycobacterium avium* complex infection as well [45]. Surgeons should have a high index of suspicion for possible mycobacterial infection in the presence of significant swelling and rice bodies and should send cultures specific for mycobacterial organisms which require special media (Lowenstein-Jensen or Middlebrook) incubated for 6–8 weeks at both 37 °C and 31 °C as some species require lower temperatures for isolation.

Another mycobacterial infection which can mimic carpal tunnel syndrome is *Mycobacterium leprae*. Koss et al. described a case of a young

college student who had immigrated from Cambodia with persistent symptoms following carpal tunnel release [46]. In addition to persistent numbness and thenar weakness, the patient also had anesthetic cutaneous lesions isolated to the median nerve territory. Exploration of the median nerve revealed a “large, woody, indurated nerve with fatty infiltration.”

Herpes zoster can also mimic carpal tunnel syndrome. Bekler et al. reported on a woman with severe pain in the median nerve distribution and weakness of the thenar muscles referred for surgical decompression [47]. The patient was noted to have dermal bulbous lesions in the first web and thenar region and was treated with observation and analgesics, with complete resolution of symptoms.

## Inflammatory

Acute and chronic carpal tunnel syndrome can result from multiple inflammatory causes. Gout and pseudogout can lead to either an acute tenosynovitis with resultant swelling and increased pressure in the carpal tunnel or chronic compression of the median nerve from a space-occupying lesion. In acute cases, initial management includes elevation, edema control, colchicine, and oral or injectable steroids. Very close monitoring is required, and surgical decompression justified if symptoms fail to improve within 24–28 h. Operative treatment in acute cases can be complicated by wound dehiscence and drainage [48]. In chronic cases, in addition to tenosynovial proliferation, uric acid and calcium pyrophosphate crystal deposits can form tophi and tumoral calcific masses, respectively [49–51]. These are best treated with both release of the transverse carpal ligament and excision of the mass.

Rheumatoid arthritis, polymyalgia rheumatica, and systemic lupus erythematosus patients also commonly develop carpal tunnel syndrome. Medical management of rheumatoid arthritis often successfully relieves symptoms as the acute inflammation diminishes, and surgical decompression is reserved for patients with persistent



symptoms. For patients with polymyalgia rheumatica, oral corticosteroids typically result in prompt improvement in symptoms [28].

## Neoplastic

Non-neurologic tumors should also be considered in the differential diagnosis of carpal tunnel syndrome. Multiple benign and malignant tumors can arise in the carpal tunnel creating a space-occupying lesion increasing pressure on the median nerve. Ganglia, lipomas, synovial chondromatosis, giant-cell tumor of tendon sheath, and vascular tumors are some of the benign tumors reported [52–55]. Malignant tumors must also be considered, with synovial cell sarcoma, squamous cell carcinoma, epithelioid sarcoma, and myxofibrosarcoma described [56–59].

Neoplasms outside of the carpal tunnel can also mimic carpal tunnel syndrome. De Vos et al. reported a case of melorheostosis, a rare progressive disorder in which there is thickening of cortical bone, in a patient referred for carpal tunnel syndrome. Instead, the patient was found to have melorheostosis of the distal humerus causing proximal median nerve dysfunction and was treated with neurolysis and resection of the sclerotic bone [60]. Myxofibrosarcoma of the forearm has also been found to cause median nerve symptoms [56].

## Summary

Many conditions, both neurologic and non-neurologic, exist that cause or mask as carpal tunnel syndrome. Particularly in patients who present with symptoms outside the typical spectrum of carpal tunnel complaints, clinicians must keep their minds open to alternate etiologies. Even in patients with typical symptoms, several conditions exist that mimic carpal tunnel syndrome. Having an understanding of these conditions should aid surgeons in making a more expedient diagnosis and referral to the proper specialist and avoid unnecessary surgical intervention.

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