Diagnosis and Treatment of Cervical Root and Peripheral Nerve Lesions of the Upper Extremity: Carpal and Cubital Tunnel Syndromes

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1. Identify clinical features of carpal and cubital tunnel syndrome.

2. Distinguish the other causes of upper extremity pain and numbness that may mimic carpal tunnel syndrome.

3. Describe accepted conservative and surgical considerations in managing carpal and cubital tunnel syndromes.

INTRODUCTION

Physicians and nurse practitioners commonly encounter patients that complain of arm pain, tingling, and numbness or weakness associated with entrapment neuropathies. The neurosurgeon regularly sees patients harboring diseases such as cervical radiculopathy, spondyloytic myelopathy, cervical syringomyelia, and Chiari malformation who have undergone unnecessary treatments for carpal tunnel and cubital tunnel syndrome. This issue of Perspectives in Neuroscience will discuss carpal and cubital tunnel syndromes, decipher the differential diagnoses, and discuss current treatment options.

CARPAL TUNNEL SYNDROME

Historical Perspectives

James Paget in 1854 first described the findings of chronic median nerve compression in a patient having suffered a radius fracture at the level of the carpal tunnel ligament. But it was not until 1913 that the transverse carpal tunnel ligament, also known as the flexor retinaculum, was recognized by Mane and Foix as the compressive lesion causing distal median nerve compression symptoms.

The symptoms of distal median neuropathy - “coined” as carpal tunnel syndrome (CTS) in the literature - is described as the result of compression of the median nerve within the carpal canal. The anatomical relationship is described as a closed fibro-osseous space bounded by the carpal ligament on the volar surface of the palm (see Figure 1). By 1946, Love and Cannon at the Mayo Clinic began reporting successful surgical treatment of carpal tunnel syndrome by the direct sectioning of the retinaculum overlying the median nerve.
A great interest in carpal tunnel syndrome developed in the 1960s, as it was one of the first physiological disorders that could be identified by electromyelographic testing. CTS remains the most commonly diagnosed disorder in the EMG laboratories today. Furthermore, CTS’s relationship to occupation has evoked increased attention to preventative measures aimed at avoiding repetitive movements that may exacerbate carpal tunnel symptoms.

Clinical Signs and Symptoms

The classical constellation of symptoms are generally well known to the practitioner and often depend on the duration of compression of the median nerve. The most common presentation is the insidious onset of nocturnal paraesthesias described as an unpleasant burning in the index and middle finger as well as the thumb. In the early stages of the disease, the symptoms are relieved when the patient gets up and shakes their hands. Many patients will complain that driving, writing, or holding up a newspaper exacerbates the symptoms. Wrist pain and sensation of palm aching are also common features.

As the disease progresses, tactile sensation diminishes and the patient may lose two point discrimination particularly in the pads of the index and middle finger. Note that the surface of the palm is spared because the take off of the palmar cutaneous branch occurs proximal to the flexor retinaculum (see Figure 2).

Patients can acutely develop dense sensory loss and thenar atrophy. Axonal damage can sometimes occur rapidly and lead to permanent deficits if not recognized early in the clinical course. These patients may complain of hand clumsiness due to weakness of thumb opposition and abduction or loss of discriminating sensation due to additional injury to sensory fibers (see Table 1).

Etiological and Occupational Features

The success of flexor retinaculum sectioning for the treatment of carpal tunnel syndrome underscores the pathophysiological relationship of the median nerve to its surrounding tissue (see Figure 1). Any form of trauma or disease that physically affects the compartments where the median nerve lies can result in compression and thus carpal tunnel symptoms. Table 2 outlines the various etiologies associated with carpal tunnel syndrome.

Carpal tunnel syndrome is more common in women and most often presents in the fifth and sixth decades of life. It has also been thought to be related to occupations that require repetitive wrist motion or any prolonged compression at the heel of the hand. This is evidenced by the common complaints among factory workers, electrician’s, meat packers, and those that use their hand repetitively at work. The recent use of computers and keyboards has suggested a relationship specifically to carpal tunnel syndrome, but this currently remains a controversial issue.

Clinical Diagnosis

The clinical diagnosis of carpal tunnel syndrome is highly dependent on the symptoms that the patient will report. Typically, it is characterized by an altered sensation in the thumb, index, and middle finger of the hand or may be described as a “pins and needles” paraesthesia. Frequently, the patient will also complain of a deep aching pain affecting the entire hand. In 10-15% of the cases, the pain will radiate up into the forearm, upper arm, and sometimes to the shoulder often confusing it with a C6 radiculopathy. In most cases, the patient will complain of more distinct worsening of their symptoms at night and find that shaking and massaging the hand seems to provide some relief. It is thought that the shaking and movement of the hand may improve venous return consequently reducing the pressure in the carpal tunnel itself.

The findings of carpal tunnel syndrome are well identified and referenced in Table 1. However, the signs found on examination are paramount in avoiding confusion of CTS with other forms of nerve or spinal cord compression (see Table 3). The Phalen’s test and Tinel’s test are the most common tests employed by the examining physician to diagnose CTS.

Although most cases of carpal tunnel syndrome are insidious in onset, the diagnosis and treatment of carpal tunnel syndrome must be prompt in order to avoid permanent damage in certain types of
cases. Those that present with a more rapid onset of dysasthesias in the hands associated with a positive Tinel and Phalen’s test or significant weakness of thumb opposition and active thenar fasciculations indicate damage to the median nerve and a surgical opinion should be sought. On the other hand, a good majority of carpal tunnel syndromes resolve spontaneously. Appropriate follow-up for those that are managed conservatively is necessary.

Electromyelography and nerve conduction studies are used to confirm the diagnosis of carpal tunnel syndrome, but they should not be used to establish the diagnosis as they are based on clinical examination and clinical judgment. Certainly, EMG studies have been helpful in differentiating carpal tunnel syndrome from cervical radiculopathy. Furthermore, the decision with regards to surgery should not rest solely on the findings of the electromyographer.

The earliest abnormality seen on EMG is prolonged sensory conductive latencies across the wrist. Normal conduction velocities through the carpal tunnel to the abductor pollicis brevis should be less than 4.0 milliseconds, but this number is prolonged in carpal tunnel disease. As the disease progresses, prolonged motor latency can be seen along with diminution of the compound action potential. A normal nerve conduction velocity is seen in 20-25% of carpal tunnel cases. Those that present with a more rapid onset of dysasthesias in the hands associated with a positive Tinel and Phalen’s test or significant weakness of thumb opposition and active thenar fasciculations indicate damage to the median nerve and a surgical opinion should be sought. On the other hand, a good majority of carpal tunnel syndromes resolve spontaneously. Appropriate follow-up for those that are managed conservatively is necessary.

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In the early forms of the disease, the EMG study may be equivocal. Often times it may be prudent to wait approximately 6-8 weeks and repeat the study if the clinical suspicion for carpal tunnel syndrome persists.

**MANAGEMENT CONSIDERATIONS**

**Non-Operative Treatment**

Decision-making in the treatment of carpal tunnel syndrome depends on the duration and severity of symptoms as well as etiologic factors. Those patients that present with systemic disease related to the CTS should have the primary disease addressed initially (see Table 2).

Approximately 50% of patients with CTS will respond to various modes of conservative management. Typically, patients with mild and intermittent duration of symptoms will respond successfully with conservative management. A common treatment regime consists of wrist splinting; keeping the wrist in slight extension for 4-6 weeks. It is also reasonable to offer patients corticosteroid injections into the carpal tunnel itself; however, this must be carried out with care to avoid direct injury to the median nerve by placing the needle to the ulnar side of the palmaris longus tendon. Recent studies have confirmed the improved efficacy of local injections over systemic oral steroids. Patients should be advised that it is common to experience discomfort in the wrist with transient worsening of their symptoms in the first 24 hours following the injection.

There are two distinct disadvantages to conservative management. First, delayed surgical treatment can likely lead to less than optimal results and it is recommended that patients undergoing conservative management be carefully monitored for failure to respond or worsening symptoms. Second, there is a relatively high long-term failure rate (65-90%) of patients undergoing conservative management. Between the 21-25% of patients that have not responded to the initial course of conservative management, second, and/or third line treatment often begins with corticosteroid injections, sectioning of the carpal tunnel ligament, and a repeat EMG test. On the other hand, a good majority of carpal tunnel syndromes resolve spontaneously.

Operative Treatment

Sectioning of the carpal tunnel ligament should be reserved for patients that:

1. Failed conservative management.
2. Rapid onset of symptoms associated with neurological deficit or numbness (blunting to pinprick; loss of 2 point discrimination); atrophy; and/or progressive hand dysfunction.
3. Have the circumstances of a typical CTS history with a negative EMG study. If a repeat EMG in 3-6 months remains negative and symptoms persist, it is reasonable to section the ligament for both diagnostic and palliative purposes.
It is just as important to avoid operative management on the patient who performs repetitive manual hand labor, who has an atypical history of CTS, and fits into the category of “overuse hand syndrome”. Patients with this type of clinical situation, along with patients that have CTS as a consequence of diabetic, endocrine, or alcohol related peripheral neuropathy, have a significantly diminished result with surgical treatment.

Fortunately, the relief of pain and improvement in motor and sensory function occurs in 90% of patients that are surgically treated. Those 10% that fall in the failure category may need re-evaluation due to misdiagnosis of a cervical radiculopathy or peripheral neuropathy. Again, it is stressed that using EMG findings alone in the failed result with surgical treatment.

Unfortunately, there is always that group of patients that are involved in liability issues that influence recovery and prolong return to work issues.

In summary, CTS is a common affliction that is frequently seen in the primary practice of medicine. The importance of typical CTS history and physical exam can not be over-emphasized as it will lead to improved diagnostic acumen and treatment.

CUBITAL TUNNEL SYNDROME

Etiology and Anatomy

The anatomical relationship of the ulnar nerve to the elbow, coursing behind the medial epicondyle and next to the olecranon, leaves the nerve more vulnerable to injury. Not surprisingly, the most common causes of ulnar neuropathy are due to impingement, entrapment, and friction of the ulnar nerve (see Figure 3). Unfortunately, ulnar neuropathy can lead to significant functional disability of the fine motor hand movements and, in the worst-case scenario, lead to a claw like deformity of the hand.

Entrapment occurs most commonly where the nerve lies in the cubital tunnel between the medial epicondyle and olecranon, but upper arm entrapment might also be seen at the arcade of Struthers which is a flat, aponeurotic band anterior to the medial head of the triceps. External trauma to the elbow, direct or repetitive motion injuries, proliferative synovitis affecting the actual size of the cubital tunnel housing the ulnar nerve, osteophytes, tumors, lipomas, and ganglions have all been implicated in ulnar neuropathies in this location.

Clinical Signs and Symptoms

Ulnar nerve entrapment is the second most common peripheral nerve entrapment following CTS. Symptoms of numbness, pins and needles sensation, and tingling in the 4th and 5th digits of the hand and medial aspect of the forearm sometimes provoked by elbow flexion are the most common sensory complaints. Pain occurring in a similar distribution may likely occur concomitantly. On direct exam, a decrease in two-point discrimination and vibratory sense may occur in the pads of the 4th and 5th digits.

Table 4.

<table>
<thead>
<tr>
<th>SENSORY</th>
<th>MOTOR</th>
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<tbody>
<tr>
<td>• Numbness medial forearm and 4th and 5th fingers of the hand</td>
<td>• Wasting interossei muscle of hand — predominant in the thumb web space</td>
</tr>
<tr>
<td>• Decreased pin sensation and palm in same distribution</td>
<td>• Weakness in fanning or abduction of the fingers</td>
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<td></td>
<td>• Loss of power grip</td>
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<tr>
<td></td>
<td>• Wartenberg’s sign—Weakness of adduction of the little finger</td>
</tr>
<tr>
<td></td>
<td>• Froment’s sign—Weakness of adductor of thumb, paper placed between thumb and forefinger of patient can easily be pulled away from the patient’s grip. The patient can compensate by bending distal phalanx of thumb (median nerve)</td>
</tr>
</tbody>
</table>

Motor findings can often precede the sensory findings particularly in the elderly with a diagnosis of “tardive ulnar palsy” (a delayed neuropathy related to an old trauma to the elbow in years prior to the onset of symptoms). Motor findings on exam are outlined in Table 4.

Differential Diagnosis of Cubital Tunnel Syndrome

The most common mistake made in misdiagnosing cubital tunnel syndrome is missing a C8 radiculopathy. Although the sensory and motor findings may be similar, the pain is also more proximal in the shoulder and neck in a cervical radiculopathy. Less commonly, thoracic outlet syndrome and syringomyelia as well as motor neuron disease can mimic ulnar neuropathies. Sometimes confusion can be eliminated by employing EMG studies to establish the diagnosis. Furthermore, a good clinical history and exam to rule out syringomyelia (dissociated sensory loss and long tract signs), motor neuron disease and Lou Gehrig’s disease (amyotrophic lateralizing sclerosis - absence of sensory findings in the face of progressive motor deficits) should be carried out.

Treatment Options

Initially it was thought that the only treatment for cubital tunnel syndrome was surgery; however, there are some reports suggesting that symptomatic improvement can occur with elbow splints to avoid stretching of the ulnar nerve and avoiding repetitive activities that aggravate the symptoms in selected patients. The number of these reports are relatively limited because ulnar entrapment has been long recognized as a disease amenable to surgical treatment.

Surgical treatment varies from a simple decompressive procedure to transposition procedures employing subcutaneous, intramuscular and submuscular techniques and are dependent on surgeon preference and experience. The author prefers intramuscular transposition to allow removal of the nerve from the compressing agent and provide protection. Experienced surgeons can avoid devascularization of the nerve and subsequent profound ulnar weakness which is the main risk associated with...
Continuing Medical Education Questions

1. Which of the following signs or symptoms are carpal tunnel syndromes associated with?
   - a. Positive Tinel's
   - b. Positive Phalen's
   - c. Nocturnal numbness in the thumb, index, and middle finger
   - d. Thenar atrophy

2. Which of the following diseases predispose to carpal tunnel like symptoms?
   - a. Amyloid
   - b. Diabetes
   - c. Acromegaly
   - d. Pregnancy

3. Axonal damage can occur early in carpal tunnel syndrome and result in irreversible median nerve damage.
   - True
   - False

4. Carpal tunnel syndrome is:
   - a. More common in women
   - b. Associated with repetitive movements
   - c. More commonly presents in the 5th and 6th decade of life
   - d. Sometimes confused with a C6 radiculopathy

5. The final diagnosis of carpal tunnel syndrome depends on the results of the EMG study.
   - True
   - False

6. A positive Froment’s sign is associated with:
   - a. Ulnar neuropathy
   - b. Flexion of the distal phalanx of the thumb which is innervated by the median nerve
   - c. The patient grasping a piece of paper between thumb and index finger

7. Findings of ulnar nerve entrapment can include:
   - a. Wartenberg’s sign
   - b. Froment’s sign
   - c. Interosseous wasting

8. Tardive ulnar neuropathy can be easily distinguished from amyotrophic lateralizing sclerosis because of specific sensory changes characteristic of ulnar neuropathy.
   - True
   - False

Educational Activity Assessment

1. Did this issue meet the stated learning objectives?
   - Yes
   - No

2. On a scale of 1 to 5, with 5 being the highest, how do you rank the quality of this educational activity?
   - 5
   - 4
   - 3
   - 2
   - 1

3. Did you receive any evidence of bias for or against any commercial products? If yes, please explain.
   - Yes
   - No

4. On a scale of 1 to 5, with 5 being the highest, how do you rank the effectiveness of this activity, as it pertains to your practice?
   - 5
   - 4
   - 3
   - 2
   - 1

Please state any topics that you would like to see discussed in future issues of Perspectives in Neuroscience.
Both carpal and cubital tunnel syndromes are relatively easy to
diagnosis; however, careful evaluation to rule out other diseases
will significantly reduce chances of failed surgery and misdiagnosis.

SUGGESTED READING
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