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It's All in the Wrist
Diagnosis and Management of Carpal Tunnel Syndrome

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Carpal tunnel syndrome (CTS) is the most common entrapment neuropathy accounting for 90% of similar disorders, occurring in 3.8% of the population, common in adults aged 40–60 years, and is associated with an average 32 lost days of work and lost productivity. In addition to occupational exposure, there are several common chronic disorders that can preclude CTS, obesity, diabetes mellitus, rheumatoid arthritis, pregnancy, metabolic syndrome, and thyroid disorder, to name a few. Therefore, it is important for the primary care provider to have knowledge in this syndrome. The purpose of the article is to inform the provider about the etiology, presentation, diagnosis, and treatment of CTS, as well as the implications for job-associated CTS.

Introduction

Compressive median neuropathy or carpal tunnel syndrome (CTS) is the most common entrapment neuropathy (Barcenilla, March, Chen, & Sambrook, 2012), accounting for 90% of similar disorders, and is therefore an important condition for the nurse practitioner to be able to assess and diagnose (Kleopa, 2015). It is estimated that CTS occurs in up to 3.8% of the general population, involves the main nerve to the hand, the median nerve, and is a result of compression of the median nerve as it passes from the forearm to the hand near the carpal ligament (Kleopa, 2015). Carpal tunnel syndrome occurs most frequently in individuals between the ages of 40 and 60 years and is seen more often in women than in men (Chammas et al., 2014). The purpose of this article is to inform nurse practitioners about the etiology, presentation, diagnosis, and treatment of CTS, as well as the implications for job-associated CTS.

Epidemiology and Etiology

There are several medical conditions, such as obesity, diabetes mellitus, rheumatoid arthritis, pregnancy, metabolic syndrome, thyroid disorders, renal failure, trauma, mass lesions, amyloidosis, sarcoidosis, multiple myeloma, and leukemia, that can preclude CTS (Gül Yurdakul et al., 2015; Iyer & Shetty, 2012; LeBlanc & Cestia, 2011; Osterman, Ilyas, & Matzon, 2012). However, the strongest predictor of CTS is occupational exposure, namely, repetitive hand movements, increased use of forceful hand maneuvers, and excessive exposure to vibration of the hand and the wrist (Barcenilla et al., 2012). One systematic review on musculoskeletal disorders caused by computer use found insufficient evidence that computer use causes CTS (Andersen, Fallentin, Thomsen, & Mikkelsen, 2011); however, the authors did find one review that reported increased CTS in individuals using a computer with a mouse for more than 20 hours per week (Andersen et al., 2011). In 2010, a National Health Interview Survey reported that 3.1% of working adults aged 18–64 years were affected by CTS in the previous 12 months, with incidence increasing with age and prevalence higher in women (Graham, 2008). In 2014, there were 365,580 work-related musculoskeletal disorders reported; 7,970 of these injuries were CTS, accounting for 32 missed days of work, the same amount of days missed as those reporting fractures (Centers for Disease Control and Prevention, 2011).

Pathophysiology

The median nerve is responsible for the sensation of the thumb, index finger, middle finger, and sometimes the ring finger. Because the median nerve enters the hand through a narrow, rigid tunnel formed by the bones of the wrist and the transverse carpal ligament, any injury, inflammation, or edema in this area can result in compression (see Figure 1). This compression in the tunnel can lead to numbness, tingling, pain, and weakness often associated with CTS (Iyer & Shetty, 2012). As noted in Table 1, CTS has been classified into three stages: early, intermediate, and advanced.

Presentation

Individuals with CTS often present with complaints of numbness or tingling of the fingers, especially the thumb, index finger, middle finger, and one-half of the ring finger. However, there can be symptoms throughout the entire

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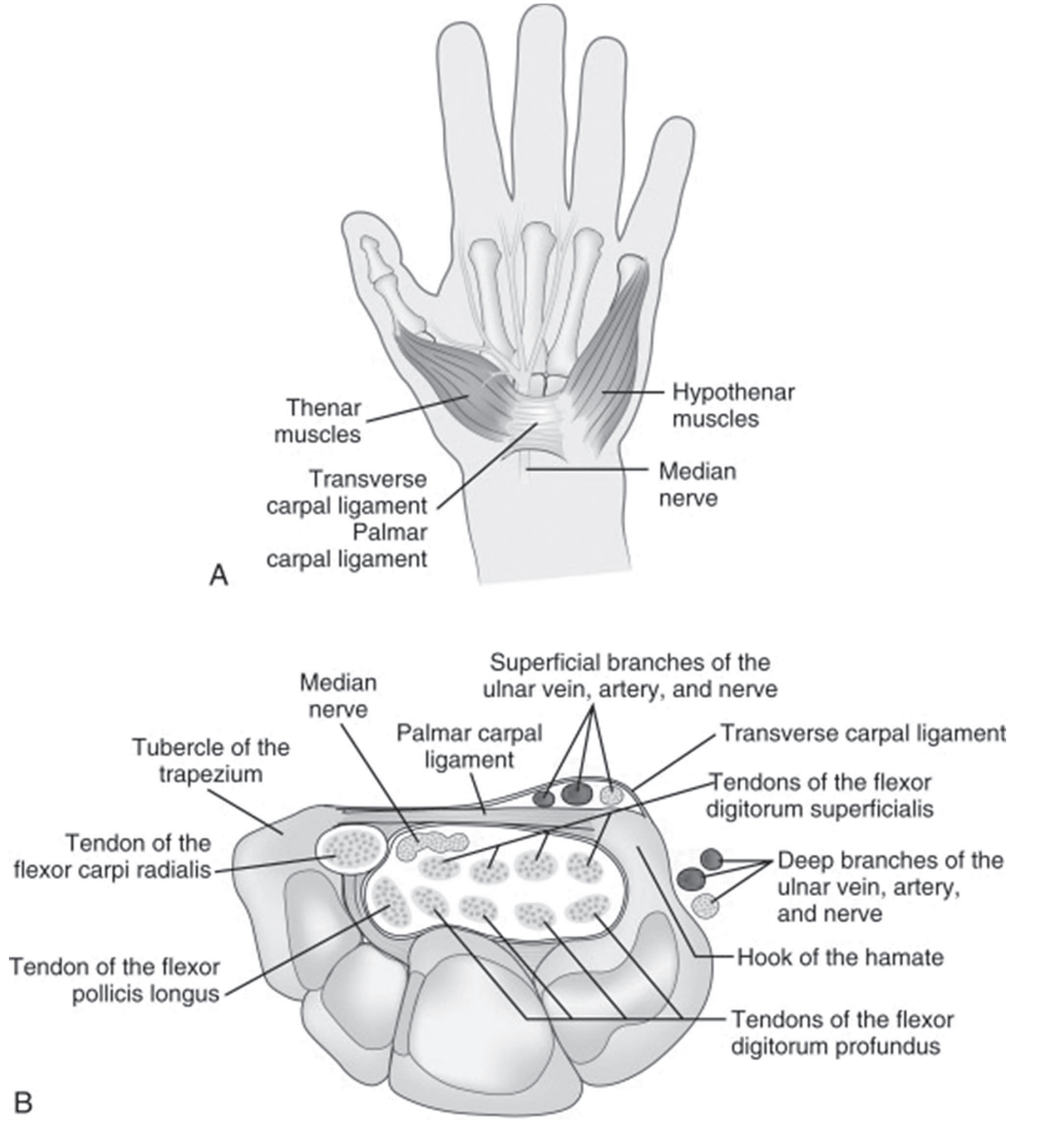

Figure 1. Anatomy of wrist and hand. Reprinted from *Ferri's Clinical Advisor* 2017, by Candice Yuvienco, pages 250-250.e4, Copyright © 2017, with permission from Elsevier.

hand, proximal to the wrist and into the arm and the shoulder (LeBlanc & Cestia, 2011). These symptoms are usually worse at night and into the early morning secondary to relaxation of the wrist into a flexed position during sleep. This positioning coupled with increased blood pressure in the early morning may place more pressure and narrowing at the carpal tunnel (Chammas et al., 2014; Newington, Harris, & Walker-Bone, 2015). Along with nighttime and early morning symptoms, reports of shaking of the hand or flicking of the wrist, known as the flick sign, are often given in the history. Although pain is not usually associated with CTS, some individuals may relate pain to severe paresthesia (Duckworth, Jenkins, & McEachan, 2014). Patients may also report a sensation of hand and finger swelling when not visible, as well as actual swelling with a noted loss of strength or grip in the affected hand (LeBlanc & Cestia, 2011).

Physical Examination

Physical examination of the hand includes inspection of the hand and the wrist looking for signs of trauma or acute injury such as abrasions or ecchymosis, bony abnormalities of rheumatoid arthritis such as boutonniere deformity, ulnar deviation of the wrist, or swan neck deformity. Deformities of the wrist suggestive of osteoarthritis should also be noted (LeBlanc & Cestia, 2011). Although thenar atrophy is often associated with severe, prolonged CTS, this alone is not a diagnostic finding

Table 1. Diagnosis and Management of Carpal Tunnel Syndrome

Stage	Symptoms	Etiology
Early	Intermittent symptoms that occur only at the night	• Fluid redistribution to upper limbs secondary to the supine position • Lack of muscle pump mechanism and inability to drain fluid from the carpal tunnel • Keeping the wrist in a flexed position, increasing pressure in the carpal tunnel • Increased blood pressure during the second half of the night
Intermediary	Both diurnal and nocturnal	• Microcirculation abnormalities resulting in increased fluid pressure • Edema causes thickening of the carpal tunnel envelope • Destruction of the myelin sheath
Advanced	Constant symptoms with motor deficit	• Increased disruption of axons • Increased fibrous thickening of the carpal tunnel envelope

Note. Data from "Carpal Tunnel Syndrome Part I (Anatomy, Physiology, Etiology and Diagnosis)," M. Chammas, J. Boretto, L. Burmann, R. Ramos, F. dos Santos Neto, and J Silva, 2014, *Brazilian Orthopedics Review, 49*(5), p. 7. Copyright 2014 by Sociedade Brasileira de Ortopedia e Traumatologia.

and cannot be used to rule out CTS if not present (American Academy of Orthopaedics, 2016).

The American Academy of Orthopaedic Surgeons (AAOS) released guidelines in early 2016 on clinical management of CTS. Clinicians have often used physical examination tests such as Phalen's test (holding the wrists in a position of fixed flexion for 1 minute with reproduction of paresthesia), Tinel's sign (tapping over the median nerve that produces paresthesia), and flick sign as methods to aid in diagnosing CTS (American Academy of Orthopaedics, 2016). Figures 2 and 3 demonstrate the testing maneuvers of both Tinel's sign and Phalen's test.

The AAOS guidelines state that there is strong evidence supporting not using these tests as independent physical examination maneuvers, as each of these tests, when used alone, has a poor or week association with diagnostic accuracy (American Academy of Orthopaedics, 2016). The AAOS guidelines state that there is moderate evidence in the use of diagnostic questionnaires and electrodiagnostic studies for the diagnosis of CTS. The diagnostics questionnaires recommended by the guidelines are the Katz hand diagram and the CTS-6. The Katz hand diagram is a self-administered tool that allows the individual to draw on a hand diagram where symptoms are located and then is scored on the basis of location inside and outside the median nerve distribution (Katz & Stirrat, 1990). The CTS-6 combines symptom history of numbness in the median nerve distribution along with nighttime symptoms and physical examination findings of thenar atrophy or weakness, positive Phalen's test, loss of 2-point discrimination, and positive Tinel's sign to aid in the diagnosis of CTS (Graham, 2008). See Table 2 for the comparison of sensitivity and specificity of provocative testing for CTS.

Diagnosis

The combination of a history, physical examination, and tests such as Phalen's test and Tinel's sign can lead the nurse practitioner to the subjective consideration of CTS. However, CTS can be confused with other similar diseases such as compression of the nerve root in the cervical spine, hypothyroidism, pregnancy, or even bleeding into the carpal tunnel after trauma (Middleton & Anakwe, 2014). Therefore, diagnostic studies may be indicated in those patients with intermediate probability or atypical presentation (LeBlanc & Cestia, 2011; Middleton & Anakwe, 2014). The AAOS recommends the routine use of electrophysiological testing (nerve conduction studies [NCS] and/or needle electromyography [EMG]) as the diagnostic study for confirmation of the diagnosis of CTS (American Academy of Orthopaedics, 2016). Nerve conduction studies, which have a sensitivity of 56%–85% and specificity of 94% for CTS when paired with electromyography, are able to quantify and determine disease severity and can differentiate muscle conditions from neurological disorders (American Academy of Orthopaedics, 2016). A diagnosis of CTS can be considered when nerve conduction is slowed (LeBlanc & Cestia, 2011).

The American Association of Neuromuscular and Electrodiagnostic Medicine endorses, if available, the use of neuromuscular ultrasonography at the median nerve cross-sectional area in the wrist (Cartwright et al., 2012). This technique has been reported to have 88% sensitivity and 46% specificity when compared with clinical criteria (Washington State Department of Labor & Industries, 2014). It is crucial for the nurse practitioner, and clinicians in general, to ensure that reference standards and scanning protocols be established and completed by an experienced clinician (Cartwright et al., 2012).

The use of magnetic resonance imaging (MRI) to evaluate patients suspected of having CTS may be necessary for atypical cases if there is a concern for the appearance of the median nerve, space-occupying lesions, and other anatomical changes (Washington State Department of Labor & Industries, 2014). However, this is stated with caution that MRI alone for CTS has lower sensitivity and specificity than EMG studies, with a significant higher cost. Therefore, the MRI is not recommended by the AAOS or other organizations as first-line diagnostic confirmation (Washington State Department of Labor & Industries, 2014).

Treatment

Nonsurgical

Nonsurgical management should be offered to patients with mild to moderate CTS; these patients are likely to have normal to mildly abnormal NCS and EMG results (LeBlanc & Cestia, 2011). Nonsurgical management includes lifestyle modifications, wrist splinting, exercises, oral medications, and corticosteroid injections (LeBlanc & Cestia, 2011). Lifestyle modifications may include avoidance of

Figure 2. Phalen's test. Reprinted from *Primary Care*, by Wendy L. Halm, pages 932-936.e1, Copyright © 2017, with permission from Elsevier.

repetitive motions, taking frequent breaks, use of ergonomic equipment and alternate keyboards and alternating job functions (LeBlanc & Cestia, 2011). It is important to note that studies are limited and offer inconsistent evidence to support or refute the effectiveness of the interventions. They are, however, low risk to the patient and could be considered useful (LeBlanc & Cestia, 2011).

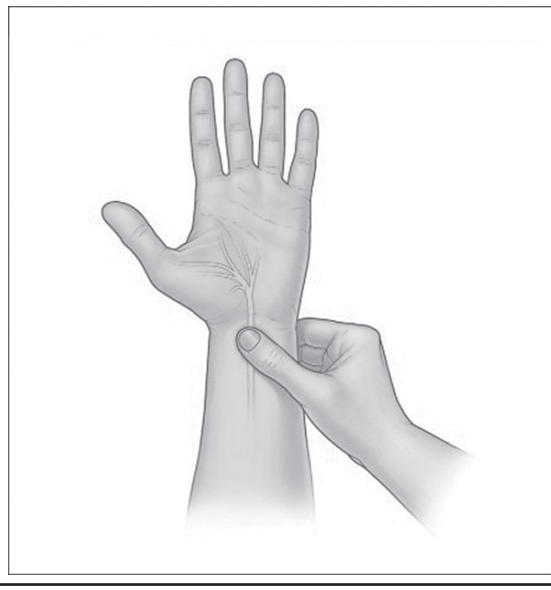

Figure 3. Provocative pressure test. Reprinted from *Primary Care*, by Wendy L. Halm, pages 932-936.e1, Copyright © 2017, with permission from Elsevier.

There is good evidence that wrist splinting in a neutral position with 0° extension may alleviate the symptoms of CTS (LeBlanc & Cestia, 2011; Middleton & Anakwe, 2014). Custom-fit wrist splints for nighttime-only use and as needed for daytime symptoms have been successful for noninvasive management (LeBlanc & Cestia, 2011). Most studies have shown that a minimum of 6–8 weeks is needed to see effectiveness of this modality (LeBlanc & Cestia, 2011; Washington State Department of Labor & Industries, 2014).

Oral medications and steroid injections have been used for both initial and adjunctive treatment (Kleopa, 2015; LeBlanc & Cestia, 2011; Washington State Department of Labor & Industries, 2014). There is strong evidence that oral medications, specifically corticosteroids, provide short-term relief whereas corticosteroid injections have been shown to provide relief for up to 1 year (Kleopa, 2015; LeBlanc & Cestia, 2011; Washington State Department of Labor & Industries, 2014). Traditionally, 20 mg of triamcinolone acetonide without lidocaine, completed by an experienced practitioner, is generally the recommended dose placed beneath the flexor retinaculum within the carpal tunnel (Kleopa, 2015; LeBlanc & Cestia, 2011). It is important for the provider to note that patients with thenar muscle weakness and/or atrophy or advanced sensory loss are not candidates for injections, nor are multiple injections recommended (Kleopa, 2015). There is little evidence that nonsteroidal anti-inflammatory drugs, diuretics, and pyridoxine have been effective options for the management of CTS alone. These modalities may be effective in patients with inflammatory joint conditions or tendonitis (Kleopa, 2015; LeBlanc & Cestia, 2011).

Surgical

Carpal tunnel decompression is widely used and is a well-established surgical intervention (Kleopa, 2015; LeBlanc & Cestia, 2011). It can be considered in patients who do not respond to conservative management and have progressive symptoms and moderate to severe NCS/EMG results (Kleopa, 2015). There is strong evidence that the 5-year outcomes are high with decompression, with between 70% and 90% of patients reporting good long-term results (Middleton & Anakwe, 2014). This procedure is generally undertaken as an outpatient under local anesthesia and performed by a specialist.

Summary

Implications for Clinical Practice

Nurse practitioners frequently serve as primary care providers and are prepared to identify individuals at risk for CTS based on their medical and/or job-related duties. It is important to understand the clinical signs and symptoms of CTS, when to order further diagnostic measures, when to offer conservative management, and when to refer. Referral may include a specialist with expertise in NCS/EMG or surgical intervention and specialty care (Kleopa, 2015). Response to conservative measures may take at least 6 months to be effective and ensure clinical improvement (Kleopa, 2015). Therefore,

Table 2. Sensitivity and Specificity of Patient History, Common Diagnostic Tests, and Physical Examination Findings for Carpal Tunnel Syndrome

Test	Maneuver	Positive Test	Sensitivity	Specificity
Phalen's	Holding the wrists in a position of fixed flexion for 1 minute	Development or increase in paresthesia along median nerve distribution	68%	73%
Tinel's sign	Tapping over the median nerve	Feeling of tingling or electric shocks along median nerve distribution	50%	77%
Two-point discrimination	Ability to distinguish between two sharp objects at different points	>5-mm sensation between points considered abnormal	24%	95%
Flick	Patient reported	Waking at night and shaking (flicking) hands to relieve paresthesia and/or pain	47%	62%
Hand diagram	Patient reported	Patient draws on a picture of hand where symptoms are located; scored on the basis of location to the median nerve	75%	72%
Thenar atrophy	Physical examination finding	Loss of bulk to the abductor pollicis brevis muscle	12%	94%
Electromyography	Motor conduction studies of the median nerve	Latency of conduction	85%–90%	82%–85%

Note. Data from "Clinical Diagnosis of Carpal Tunnel Syndrome: A Systematic Review," by J. C. MacDermid and J. Wessel, 2004, *Journal of Hand Therapy, 17*(2), pp. 309–319. http://dx.doi.org/10.1197/j.jht.2004.02.015. Copyright 2004 by Hanley & Belfus.

in-depth education to patients regarding the nature of CTS, risk factors, exacerbating activities, diagnostic measures, and interventions in addition to the time frame for improvement can manage expectations and limitations. Clinicians can make great strides in improving their patient outcomes and knowledge of this common condition by providing accurate and timely patient education, ensuring utilization of evidence-based treatment modalities, and referring for specialty care when needed.

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