The Diagnosis and Management of Carpal Tunnel Syndrome:

A Literature Review

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Abstract:

Background:

Carpal tunnel syndrome is one of the most common entrapment neuropathies of the upper extremity. Increased pressure of the carpal tunnel causes compression of the median nerve, which produces the classic symptoms of paresthesia and numbness in the median nerve distribution. The median nerve provides sensory and motor information to palmar aspect of the hand, specifically sensation to the thumb, first two fingers and half of the third; motor innervations to the abductor pollicis brevis and opponens pollicis. The symptoms of this condition can range greatly. Some patients experience only sensory deficits, while others experience both sensory and motor loss to the hand. This can occur in one extremity or bilaterally.

Methods:

Articles from peer-reviewed journals were searched through PubMed, EBSCO Host, and OvidSP. These articles ranged from the diagnosis to the management and treatment of the condition of carpal tunnel syndrome.

Results:

This database search produced 28 articles. These articles were all obtained from peer-reviewed journals.

Conclusion:

There is inconclusive evidence of a superior treatment option for carpal tunnel syndrome. Studies have shown support both for non-invasive treatments and for surgical
procedures. There is room for additional studies to be performed looking into the best treatment option for carpal tunnel syndrome.

**Introduction:**

Carpal tunnel syndrome is one of the most common entrapment neuropathies of the upper extremity. It is most prevalent in individuals over age 40, and tends to affect women more than men. Its cause is compression of the median nerve at the wrist through an increase of pressure in the carpal tunnel. The increased pressure can be the result of reduced dimension of the anatomical space or by increased volume of the contents of the tunnel. Carpal bones on three sides form this tunnel, with the carpal bones forming an arch. A fibrous tissue called the flexor retinaculum forms the fourth side of the tunnel. The flexor retinaculum attaches to both the pisiform and hamate bones on the ulnar side and to the scaphoid and trapezium on the radial side of the wrist. The median nerve passes through this space along with several tendons of the muscles in the forearm. The median nerve provides sensory and motor information to palmar aspect of the hand, specifically sensation to the thumb, first two fingers and half of the third; motor innervations to the abductor pollicis brevis and opponens pollicis.

Carpal tunnel syndrome is characterized by paresthesia in the areas of the median nerve distribution. Patients describe a wide range of symptoms varying from tingling, pins and needles, numbness, to pain or burning sensations of the hand. Often these symptoms are described as worse at night and may even cause the patient to wake from sleep. Because the median nerve carries both sensory and motor fibers, carpal tunnel syndrome may also present with weakness in the muscles of the hand particularly the
thumb. It is also common for the patient to state the shaking or changing of hand position improves their symptoms.

This paper will look at several reputable peer-reviewed journal articles to compare and discuss the diagnosis, management or treatment, and prevention of carpal tunnel syndrome.

**Methods:**

A search of relevant peer-reviewed articles on Carpal Tunnel Syndrome was performed in the library of Logan College of Chiropractic. Additionally, searches were made in PubMed, EBSCO Host, and OvidSP. Keywords relating to the disorder such as “carpal tunnel syndrome,” “median nerve entrapment,” “electrodiagnosis,” “treatment,” and “surgery” were included in the literature search. Articles were considered if their publish date and journal were reputable.

**Results:**

The search for peer-reviewed articles produced 28 articles, which were all full-text articles. Other articles were found but were not available in their full-text format and were therefore not included in this literature review.

**Discussion:**

**Diagnosis:**

The prevalence and symptoms of carpal tunnel syndrome have been discussed, but the cause for this condition can vary greatly depending on the patient. The
occurrence of carpal tunnel syndrome is associated with several activities such as prolonged repetitive work tasks like vibration or flexion and extension movements. These work activities can be seen in both blue and white-collar jobs. The U.S. Department of Labor, Bureau of Labor Statistics reported a tenfold increase in the number of conditions associated with repetitive trauma between the years of 1981-1991 with carpal tunnel syndrome being the most frequently diagnosed condition. Therefore a patient’s daily activities should always been taken into account when a doctor is diagnosing a condition. It has been theorized that typing on a keyboard and using a mouse may increase the incidence of carpal tunnel. These repetitive activities can result in awkward positioning of the wrists and forearms which has been shown to lead to carpal tunnel. A study was done looking at the effects of keyboard and mouse usage on the prevalence of carpal tunnel. The results of the study were inconsistent, however they showed that the prevalence of carpal tunnel syndrome was higher with increase mouse usage of 20 hours or more per week, and showed no increased risk with keyboard usage.

There is also evidence to support the association of carpal tunnel syndrome with inflammatory, connective tissue, or metabolic conditions. Some examples of these conditions, which might cause secondary carpal tunnel syndrome, are obesity, diabetes, hypothyroidism, rheumatoid arthritis, amyloidosis, pregnancy or renal failure. The common factor between all of these conditions is the inflammation or swelling, which is a symptom often experienced by individuals with these diseases. This inflammation compresses the area around the carpal tunnel, which causes an increase of pressure
around the nerve and tendons in this area. This decreases both the blood flow and nerve conduction that produces the paresthesia-like symptoms that many patients describe.

The cases of carpal tunnel syndrome that do not fall into any of these categories get labeled as idiopathic, or of unknown cause. Like previously stated, women are more commonly affected than men and the incidence of the disorder increases with age. In most cases of idiopathic carpal tunnel syndrome there is general edema and fibrous hypertrophy of the tunnel with minimal findings of inflammation. Although there is minimal inflammation in the area, the edema and hypertrophy of the structures in the tunnel can produce the same symptoms of carpal tunnel syndrome. A study was done that identified a strong genetic predisposition towards carpal tunnel syndrome. This study noted a positive family history in parents or siblings of one in four people with carpal tunnel syndrome. (27) There are more studies that need to be conducted before a definitive statement can be made as to a genetic component of the disorder, but if there is a correlation these individuals will be able to take precautionary measures similar to those in a highly repetitive wrist movement workplace to help prevent this condition from occurring.

Understanding other conditions that can present in a similar fashion to carpal tunnel syndrome is vital to a patient when they are reaching out to their physician. Knowing what questions to ask is an important part of the process of diagnosis. Cervical radiculopathies, particularly at C6/7 can present with similar symptoms of numbness and tingling down the arm into the hand. Ulnar nerve neuropathy or other generalized peripheral neuropathies also present with similar symptoms in different distributions.
Other more serious conditions that should be ruled out are multiple sclerosis, syringomyelia, Raynaud’s phenomenon, or brachial plexus injuries.

Diagnosis of carpal tunnel syndrome can be done through a thorough history taking along with orthopedic testing and electrodiagnostic tests. The two most widely accepted orthopedic tests are Phalen’s sign and Tinel’s sign. Phalen’s sign involves asking the patient to flex both wrists to 90 degrees and hold for one minute. By doing so it should provoke their symptoms of median nerve paresthesia. Tinel’s sign uses tapping of the carpal tunnel to provoke the median nerve paresthesia. Phalen’s sign has been shown to have a sensitivity that ranges from 10%-73% and specificity from 55%-86%. Tinel’s sign has a sensitivity ranging 8%-100% and a specificity from 55%-87%. (5) The reliability of both these orthopedic tests relies on the examiner to instruct and perform the procedures correctly.

Nerve conduction studies are the gold standard test for diagnosis of carpal tunnel syndrome. These studies allow the level of dysfunction of the median nerve to be examined and the severity of the dysfunction diagnosed. Nerve conduction studies are the most widely accepted form of diagnosis, however they do carry a small false negative rate. The measurement is taken by electrically stimulating a nerve at one point with data collection occurring at a separate point along the course the nerve takes. Often nerve conduction studies are used as a confirmation of the diagnosis of carpal tunnel syndrome. The use of orthopedic testing is often more beneficial in regards to saving both time and money.

Ultrasound and magnetic resonance are two alternative options to diagnose carpal tunnel syndrome. Magnetic resonance is used to look at the dimensions of the carpal
tunnel but is much more expensive, and therefore not commonly utilized. Magnetic resonance imaging is non-ionizing radiation, which decreases the risk to the patient when compared to x-ray or computerized tomography. Ultrasound can show structural anomalies but it is not able to uncover the level of nerve conduction impairment like the nerve conduction studies are able. The cross-sectional area of the median nerve is measured using sound waves and compared to normative values. (5) This could be a beneficial adjunct to conservative treatment of this condition. However, diagnostic ultrasound is operator and equipment dependent and therefore is not always a reliable diagnostic tool.

There are additional orthopedic tests, which should be performed to help rule out other conditions that can present similarly to carpal tunnel syndrome. Many of these conditions were previously discussed. Spurling’s maneuver is a test that can be used to rule out cervical radiculopathy. The physician performs this orthopedic test by placing increased pressure on the patient’s head to compress the neural foramen. By doing so this should reproduce their symptoms, which would indicate a diagnosis of nerve root compression. The most common cervical level for this to occur is at the sixth cervical vertebrae. Compression of a nerve root can produce symptoms that may mimic carpal tunnel syndrome. Wright’s, Adson’s, and Eden’s tests all can be used to rule out thoracic outlet syndrome. Wright’s test is performed through monitoring the patient’s radial pulse while the arm is along their side. The doctor will then abduct the patient’s arm to 180 degrees. If there is a change in the strength of the radial pulse this is positive for thoracic outlet syndrome. Adson’s and Eden’s tests are similar in that they both monitor the patient’s radial pulse. The difference is in the position of the patient’s arm, which allows
for the doctor to discern which muscle or muscles is producing the compression at the thoracic outlet. Tinel’s sign should also be performed at the tunnel of Guyon to rule out compression of the ulnar nerve. The distribution of the paresthesia differs with ulnar nerve compression however the physician should be sure to rule this condition out.

Treatment:

Once a diagnosis has been made, there are a variety of treatment options that a patient must discuss with their physician. These treatments range from the least invasive, splinting, medications, modalities and osseous manipulation or exercises, to the more invasive steroid injections or surgical intervention. While there is evidence to support most of these interventions, other studies have indicated spontaneous improvement without management. (18)

One of the more common non-invasive treatment options is splinting of the wrist. This removable brace keeps the wrist at a neutral angle without applying compression to the carpal tunnel. This allows the pressure in the carpal tunnel to be reduced. Typically these braces are too restrictive for use by the patient during the daytime, and therefore patients typically prefer to wear the brace at night while they are asleep.

There are many different versions of these braces. One study compared two versions of a wrist brace, the Volar-supporting orthosis and the carpal lock. The Volar-supporting orthosis restricts the metacarpal joints, wrist, and forearm movements. In comparison, the carpal lock allows for free movement of the metacarpal joints as well as the fingers and elbow. The study looked at the success of alleviating the participant’s symptoms through wearing the braces. The study found that both braces were successful in improving the participant’s symptoms. However, the carpal lock was found to be of
more comfort compared to the Volar-supporting orthosis. (28) This and several other studies have shown that immobilization of the wrist intermittently has been shown to reduce the symptoms of carpal tunnel syndrome. The benefit of this treatment is that it is completely non-invasive and safe to the patient. If their condition is not benefited by this treatment there is always the option of moving towards a more aggressive treatment, but a conservative treatment first is in to the benefit of the patient.

Another non-invasive treatment for carpal tunnel is the use of medications. Several medications have been used in the treatment of carpal tunnel syndrome. The most commonly prescribed are diuretics, nonsteroidal anti-inflammatory drugs, oral corticosteroids, and vitamin B₆. The use of diuretics, nonsteroidal anti-inflammatory drugs and oral corticosteroids are thought to help decrease the interstitial fluid pressure in the tunnel. By decreasing the pressure, it is thought the symptoms will also be diminished. Vitamin B₆ is a cofactor in neuronal protein synthesis; therefore supplementation of this vitamin may increase the metabolism of the median nerve and therefore help to alleviate the symptoms of this condition. (8) A study was done looking at the effectiveness of nonsteroidal anti-inflammatory drugs in the treatment of this condition. The study found no correlation between the use of splints or drugs and the patient’s age, sex, BMI, symptom duration or even nerve conduction studies. However, the intervention was well received with the participants. 74% of participants who took the drugs felt there was a decrease in their carpal tunnel symptoms. (24) The downside to the use of these medications is that when the patient ceases to take them, it is probable that their symptoms will return. There are also side effects to taking these medications. Nonsteroidal anti-inflammatory drugs if not taken properly can result in kidney, liver, or
intestinal damage. Oral corticosteroids can also cause side effects. These medications are not treating at one specific site in the body. The medications travel systemically throughout the body and therefore will have effects on other systems besides the area intended.

Chiropractic manipulation and exercises is another treatment option for carpal tunnel syndrome. Manipulation has been shown to alleviate the symptoms of paresthesia and numbness in carpal tunnel syndrome. The results in randomized control studies have been inconsistent, but experienced Chiropractic doctors have found that manipulation of the wrist has been beneficial to these patients. (17) Low force exercises have also been shown to be beneficial to some patients. The use of rubber tubing and bands to increase strength and stability of the upper extremity can be useful in alleviating and helping to prevent future symptoms of carpal tunnel syndrome. One article showed various modifications that can be taken to common upper extremity exercises. Theses modifications included the use of wrist braces with rubber tubing attached, to wrapping towels around the upper arm with tubing attached to remove the use of the wrist completely from the exercise. (21) These non-invasive options do not have overwhelming support in the literature to their success. However, many physicians have recommended and used these techniques in their treatment of carpal tunnel and have had success in the past.

Steroid injections have been used as a treatment for carpal tunnel. A single injection of a steroid into the carpal tunnel can provide relief for patients. It is imperative that the physician administering the treatment is familiar with the procedure due to the possible injury to the median nerve during the injection. For a patient who is considering
injections as an option, it is advised to find a provider who performs this procedure on a regular basis. There is sensitive anatomy in this location and an injection performed incorrectly could have serious consequences. The solution is a mixture of 2% xylocaine and 20 mg methylprednisolone. The injection is made just towards the ulnar side of the palmaris longus tendon. In 87% of cases patients reported relief of their symptoms with the injection. However only 22% of these patients remained symptom-free one year after their treatment. This would suggest that this treatment would need to be repeated to continue the relief of the patient’s symptoms. Steroid injections are not recommended as a long-term solution for the treatment of carpal tunnel syndrome. It is a common practice to give an injection a second or maybe third time, but more then this is not advisable. Diabetic patients should be monitored after their injection for elevation in blood glucose as a possible side effect to the treatment.

Several other passive therapies have been utilized in the treatment of carpal tunnel syndrome. Ultrasound, tendon gliding exercises, laser therapy, and iontophoresis have all been utilized as an adjunct or alternative therapy for carpal tunnel syndrome. In a study where ultrasound was compared with a sham ultrasound treatment, the ultrasound therapy showed significant improvement of symptoms at 2 weeks, 7 weeks, and 6 months post treatment. The idea behind tendon gliding exercises is that they enhance venous blood flow and decrease pressure within the carpal tunnel. Patients who perform these exercises on a regular basis have shown reduced symptoms, and many have not gone on for decompression surgery. Both laser therapy and iontophoresis have been controversial treatments. Laser therapy has shown success in the field but the FDA and state regulations are inconsistent so the availability of both treatments is low. Laser therapy
stimulates the tissue, blood flow and therefore healing of the area treated. It is a non-invasive and painless treatment and because of this could be a beneficial treatment for carpal tunnel patients.

If a non-invasive treatment is not successful, or not an option, there are several surgical options a patient has for treatment. There is both an open carpal tunnel release, endoscopic, and limited open carpal release option for surgery. These surgeries relieve the pressure in the carpal tunnel to allow for the pressure to be removed from the median nerve. The surgery is performed by dividing the flexor retinaculum, which removes any pressure being placed on the median nerve.

While the surgical option is considered effective in relieving symptoms, it is not without risk. As with any surgery there is a risk of infection, scar tenderness, persisting numbness and paresthesia. When the surgery fails to relieve the symptoms the patient is experiencing, this can most often be attributed to a misdiagnosis. There is also the possibility of surgical error or a delay in treatment to a point when median nerve function is beyond recovery. (14)

The most common surgical option is open carpal tunnel release. This procedure requires a relatively large incision, approximately 4 cm long. The palmar fascia and transverse carpal ligament must be incised as well to allow exposure of the median nerve. To complete the decompression the release is extended to the superficial palmar arterial arch. This is a delicate procedure and care must be taken to avoid injury to the motor branch and the cutaneous branches of the median nerve. A study was done looking into the success of surgery versus splinting. This particular study showed that treatment was successful for the surgery cases, and was more effective than splinting after 3, 6, 12, and
18 months. The surgery cases were defined as “completely recovered” or “much improved” while the splinting cases were only “much improved.” (11)

Another surgical option is the endoscopic carpal tunnel release. This procedure is less invasive than the open carpal tunnel release. The endoscopic technique was introduced to address problems some patients were having with the open release such as scar tenderness, and extended time away from work. In this procedure a small incision is made midway between the flexor carpi radialis and flexor carpi ulnaris tendons. A flap of fascia is then elevated to expose the tunnel. The transverse carpal ligament is sectioned to finish the decompression. (27) This technique is beneficial in that is has a shorter recovery time typically than the open release surgery. Both procedures have shown success in relieving symptoms, and both have failed in some cases to cure patients of their carpal tunnel symptoms.

The limited open carpal tunnel release procedure is similar to endoscopic surgery. It too was developed to decrease patient discomfort as well as speed up the recovery process for those who underwent the surgery. The limited open carpal release utilizes various instruments to perform the surgery. A small incision is made on the palm, which allows for direct visualization of the transverse carpal ligament. Again, this technique decompresses the tunnel while allowing for a shorter recovery time than the open carpal release. (8)

There are studies that have shown support both for surgery and against. As discussed before, there are risks involved with any surgical procedure. Specifically to carpal tunnel surgery there can be injury to the motor and cutaneous branches of the median nerve, scar formation, incomplete release of the transverse carpal ligament,
infection, and recurrence of the original symptoms. Reoccurrence of carpal tunnel syndrome occurs in 7-20% of surgical cases. Therefore, it is advisable for non-invasive treatment options to be exhausted before surgery becomes a recommendation to a patient. The American Academy of Neurology recommends non-invasive treatment of carpal tunnel syndrome first, and then open carpal tunnel release only if the non-invasive treatment is ineffective. (11)

**Conclusion:**

Many studies have looked at various ways to diagnose and to treat carpal tunnel syndrome. There are several orthopedic tests that are cost-effective ways to diagnose this condition. If a definitive diagnosis is required then there is the option of obtaining a nerve conduction study. This allows for the decreased level of median nerve conduction to be documented, as well as let the doctor be firm in his or her diagnosis.

The options of treatment for carpal tunnel syndrome are wide ranging. There are many non-invasive treatments that have been utilized with much success. These non-invasive treatments range from passive modalities, splints, exercises, to chiropractic manipulations. Some studies have shown that these treatments can be very beneficial to the patient, while others suggest that surgery is the best option for the treatment of this condition.

Similarly, there are studies that have shown that surgery is not always successful in relieving the symptoms of carpal tunnel syndrome. The prognosis varies from patient to patient. This is true regardless of the surgical procedure used. There are several options as to which surgical procedure that a patient chooses, with open release being the most recommended of the procedures.
With no clear evidence as to which treatment is the best option for carpal tunnel syndrome, it is clear that more research needs to be devoted to this condition. In the end it is the decision of the patient as to which treatment they choose. However, it could be said that exhausting every non-invasive avenue of treatment would be beneficial before resorting to the use of surgical procedure.
References:


