
EVIDENCE-BASED MEDICINE

Evidence-Based Interventional Pain Medicine
according to Clinical Diagnoses

19. Carpal Tunnel Syndrome

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■ **Abstract:** Carpal tunnel syndrome (CTS) is a common disorder. In the majority of cases, patients with CTS can be diagnosed by means of appropriate history taking. Nerve conduction examination of the nervus medianus is the most important additional diagnostic test and is the best predictor of symptom severity and functional status in idiopathic CTS. Treatment option depends on the severity of the symptoms and the degree of functional daily limitations. If few limitations are present, splinting or corticosteroid injections are preferred. Surgical interventions are reserved for the more severe conditions resulting in significant disability.

Interventional pain treatment such as pulsed radiofrequency could be an addition to the future treatment options for CTS. ■

Key Words: evidence-based medicine, carpal tunnel syndrome, interventional pain treatment

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INTRODUCTION

This review on carpal tunnel syndrome (CTS) is part of the series “Evidence-based Interventional Pain Medicine according to Clinical Diagnoses.” Recommendations formulated in this chapter are based on “Grading strength of recommendations and quality of evidence in clinical guidelines” described by Guyatt et al.,¹ and adapted by van Kleef et al.² in the editorial accompanying the first article of this series (Table 1). The latest literature update was performed in April 2010.

Carpal tunnel syndrome is a neurological disorder characterized by paresthesias, pain and numbness in the hands due to lesions (compression) and/or dysfunction of the nervus medianus.

In the Netherlands, the prevalence of CTS is estimated to be 9% in females and 0.6% in male. Incidence figures elsewhere show an overall incidence of 276/100,000 man-years.³ For females, the incidence amounts to 506/100,000 man-years, while for males, it is 139/100,000 man-years, with a male/female ratio of 1:3.6. Although uncommon in children or adolescents, the disorder could be caused by trauma or by an autosomal dominant hereditary factor and mucopolysaccharidoses in children. CTS is most prevalent

Table 1. Summary of Evidence Scores and Implications for Recommendation

Score	Description	Implication
1 A+	Effectiveness demonstrated in various RCTs of good quality. The benefits clearly outweigh risk and burdens	Positive recommendation
1 B+	One RCT or more RCTs with methodologic weaknesses, demonstrate effectiveness. The benefits clearly outweigh risk and burdens	
2 B+	One or more RCTs with methodologic weaknesses, demonstrate effectiveness. Benefits closely balanced with risk and burdens	
2 B±	Multiple RCTs, with methodologic weaknesses, yield contradictory results better or worse than the control treatment. Benefits closely balanced with risk and burdens, or uncertainty in the estimates of benefits, risk and burdens.	Considered, preferably study-related
2 C+	Effectiveness only demonstrated in observational studies. Given that there is no conclusive evidence of the effect, benefits closely balanced need with risk and burdens	
0	There is no literature or there are case reports available, but these are insufficient to suggest effectiveness and/or safety. These treatments should only be applied in relation to studies.	Only study-related
2 C-	Observational studies indicate no or too short-lived effectiveness. Given that there is no positive clinical effect, risk and burdens outweigh the benefit	Negative recommendation
2 B-	One or more RCTs with methodologic weaknesses, or large observational studies that do not indicate any superiority to the control treatment. Given that there is no positive clinical effect, risk and burdens outweigh the benefit	
2 A-	RCT of a good quality which does not exhibit any clinical effect. Given that there is no positive clinical effect, risk and burdens outweigh the benefit	

RCT randomized controlled trial.

between the ages of 40 to 60 years. Risk factors are obesity, diabetes, pregnancy, menopause, ovariectomy, and hysterectomy.⁴ CTS is frequently accompanied by hypothyroidism and rheumatoid arthritis.⁴

The carpal tunnel is a passage at the palmar side of the wrist; its floor is defined by a row of carpal bones and its roof by the ligamentum carpi transversum. The nervus medianus travels between these structures. The nervus medianus may become trapped in the carpal tunnel as a result of edema, inflammation of synovial sheaths, tumors or the deposition of metabolic products. In addition, the nervus medianus may become compressed when the shape of the carpal tunnel changes.⁵ This happens in conjunction with osteoarthritis, rheumatoid arthritis, acromegaly, or after trauma. CTS may also be related to repetitive strain injury (RSI), an injury caused by repeated movement of a particular body part often seen in workers whose physical routine is unvaried.

Treatment of RSI usually begins with attempts to change the conditions that caused the injury. Often, exercises and anti-inflammatory drugs are prescribed; in some cases surgery is necessary. Many workers' compensation cases and lawsuits relating to RSI have been brought against employers and product manufacturers. To avoid the high costs of RSI, some businesses have introduced ergonomic workstations and enforced rest periods.

In the majority of cases, the etiology is unknown; therefore, the pathophysiology of this disorder is also unclear. The same holds true for hormonal disorders

related to CTS for example in patients with hypothyroidism and in postmenopausal patients. In pregnant women, fluid retention is thought to cause compression symptoms. Congenital and acquired structural changes of the carpal tunnel result in constriction and therefore in compression of the nervus medianus.

I. DIAGNOSIS

I.A HISTORY

In cases of CTS, the symptoms generally consist of unilateral nocturnal paresthesias in the dermatome of the nervus medianus (digits I to III including, and half of digit IV). In addition, there may be pain in the hand, wrist, and forearm. If a patient awakens because of CTS, waving the hand may bring some pain relief. Atypical localization of the tingling sensations (ulnar area) is also seen; in these cases, the diagnosis CTS may be supported by the intermittent nature of the symptoms and by factors that exacerbate or relieve it. CTS is mainly unilateral, but it may be bilateral as well. Later on, the symptoms may occur during the day and may be accompanied by a subjective loss of strength.

I.B PHYSICAL EXAMINATION

Generally, the diagnosis CTS can be based on the typical pattern of symptoms that emerges when the

patient's history is taken.⁶ With regard to physical examination, the neurological defects are often not definitive. The same applies to various provocation tests (Hoffmann–Tinel, Phalen's test, etc.).

I.C ADDITIONAL TESTS

Nerve conduction examination of the nervus medianus at both hands of the patient can be considered⁴ and is the best predictor of symptom severity and functional status in idiopathic CTS.⁷ Presently, magnetic resonance imaging (MRI) of the wrist does not provide additional diagnostic information in cases of CTS,^{4,8} but can predict surgical benefit independently of nerve conduction studies.⁹ In patients with a clinical diagnosis of CTS, the accuracy of sonography is similar to that for EMG.¹⁰ When structural defects in the wrist are suspected, a radiograph of the wrist, MRI scan, or ultrasound scan may be considered.⁴

I.D DIFFERENTIAL DIAGNOSIS

With respect to differential diagnosis in patients with CTS, the following disorders should be considered: compression of the nervi digitales of the nervus medianus, proximal trauma, neuropathy of the nervus ulnaris, defects of the plexus cervicalis, defects of cervical spinal roots, polyneuropathy, neurovascular compression syndromes in the shoulder, multiple sclerosis and processes in the spinal cord.

II. TREATMENT OPTIONS

II.A CONSERVATIVE MANAGEMENT

In the majority of CTS patients, the disorder has a benign course and/or causes little functional hindrance.⁴ When CTS occurs during pregnancy the symptoms may resolve after birth.¹¹ The choice between conservative and surgical treatment is determined by the severity of the symptoms and physical limitations.⁴ In pregnant women, conservative treatment by means of a splint is preferred.^{4,12}

Recommended conservative treatments include behavior modification, medications including anti-inflammatory drugs and analgesics, immobilization via splinting or bracing, physical and occupational therapies, oral corticosteroids, and ultrasound.¹³ There are indications that local injections with corticosteroids

are less effective in the long-term than surgical interventions. The surgical option, open or endoscopic carpal tunnel surgery entails greater risks of complications.⁴ However, if the symptoms are most severe and if daily activities have become limited, surgical intervention is indicated.¹⁴

II.B INTERVENTIONAL MANAGEMENT

Local Injections of Corticosteroids

The guidelines of the Dutch Institute for Health Care Improvement (CBO) recommend local injections with methylprednisolone 40 mg or a combination of 25 mg hydrocortisone and 10 mg lidocaine. The Cochrane review identified two good quality randomized controlled trials, which showed that local injections with corticosteroids were clinically more effective than placebo during study periods of 4 weeks or less. Local injections with corticosteroids also were more effective than oral corticosteroids.^{15,16}

Pulsed Radiofrequency of the Nervus Medianus

A single case of pulsed radiofrequency (PRF) treatment of the nervus medianus has been described in a patient with recurring CTS due to scar formation after two previous operations for CTS symptoms. Symptoms decreased by 70%, and this effect lasted for 12 weeks.¹⁷ PRF—possibly under ultrasound guidance—could be considered, preferably in a study context. Without further evidence regarding the efficacy PRF for CTS, no recommendation for PRF in the treatment of CTS can be advanced.

II.C COMPLICATIONS OF INTERVENTIONAL MANAGEMENT

One of the major complications of steroid injection in CTS is iatrogenic injury to the nervus medianus. The safest location for a CTS injection is unclear. Some authors recommend steroid injection to be performed through the retinaculum flexorum.¹⁸

II.D EVIDENCE FOR INTERVENTIONAL MANAGEMENT

The available evidence for interventional pain management techniques is summarized in Table 2.

Table 2. Summary of the Evidence for Interventional Management

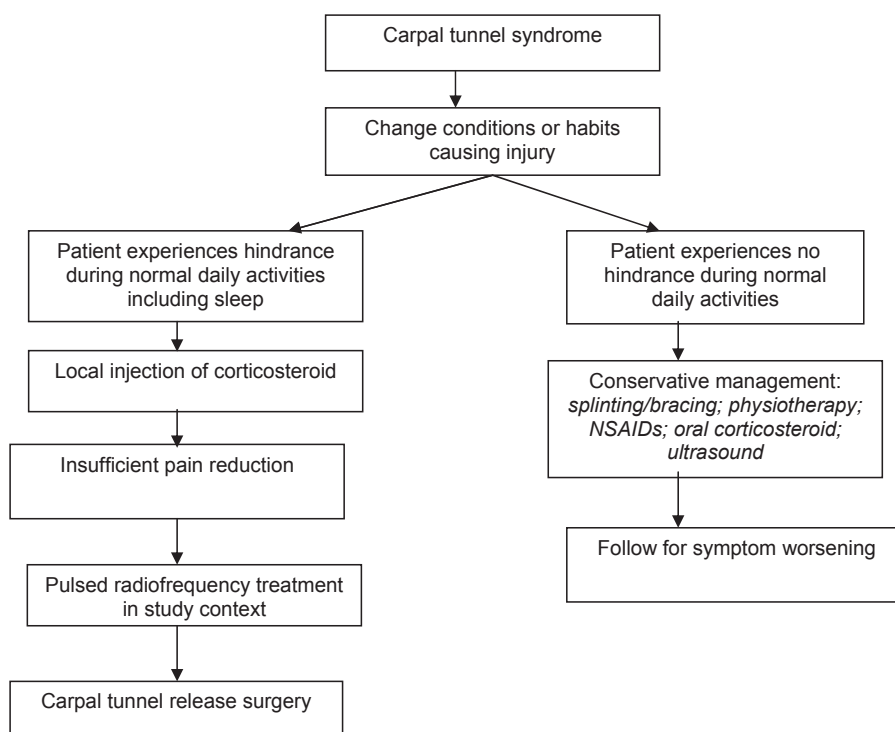
Technique	Evaluation
Local injections with corticosteroids	1B+
Pulsed radiofrequency treatment median nerve	0

III. RECOMMENDATIONS

In cases of CTS, the initial choice is conservative treatment, including behavior modification, medications including anti-inflammatory drugs and analgesics, immobilization via splinting or bracing, physical and occupational therapies, oral corticosteroids, and ultrasound. If the patient experiences hindrance of normal daily activity, interventional treatment with local injections with corticosteroids may be indicated. The long-term effect of this treatment has not been proven. PRF treatment of the nervus medianus should only be considered in a study context. In cases of severe physical limitations, surgical treatment of CTS is preferred.

III.A CLINICAL PRACTICE ALGORITHM

Figure 1 illustrates the clinical practice algorithm for the management of CTS.



III.B TECHNIQUE(S)

Injections With Corticosteroids

The recommended techniques for corticosteroid injections have been described in the guidelines of the Dutch Institute for Health Care Improvement. The injections are administered in or just proximal of the carpal tunnel, 3 to 4 cm proximally of the distal wrist fold.⁴

Injection in the tunnel: in these cases, the needle is inserted near the distal wrist fold at the ulnar side of the tendon of the musculus palmaris longus. The wrist is kept in slight dorsiflexion. The needle is inserted in the direction of the base of the middle finger at an angle of approximately 45° so that it reaches the carpal tunnel through the ligamentum carpi transversum. The needle should be retracted and reinserted 1 cm more proximally if the patient's fingers start tingling.

Alternatively, the needle can be inserted initially either in a more ulnar position in the tendon of the musculus palmaris longus or between the tendons of the musculus palmaris longus muscle and the musculus flexor carpi radialis. In the latter case, the needle should be inserted at an angle of 30°. When the needle tip is in the carpal tunnel, rather than in a tendon, the needle and injection will meet minimal resistance.⁴

Figure 1. Treatment algorithm for carpal tunnel syndrome.

During injection proximal of the carpal tunnel, the risk of damaging the nervus medianus is smaller if the needle is inserted 3 cm proximal of the distal wrist fold. This is because at that site the nerve is less fixated (more mobile) than it is inside the carpal tunnel. The 3-cm-long injection needle is inserted in a more ulnar position in relation to the tendon of the musculus palmaris longus or between the tendons of the musculus palmaris longus and the musculus flexor carpi radialis at an angle of 10° to 20°, toward the third interosseous space. The corticosteroid injected proximal to the tunnel reaches the tunnel through diffusion. Massaging the injection site is recommended as this facilitates spread.⁴

Pulsed Radiofrequency Treatment of the Nervus Medianus

In the only available case report, a patient received three ultrasound-guided PRF treatments, during the same session, at (1) the position of the anterior surface, (2) the medial aspect, and (3) the posterior surface of the nervus medianus. During each treatment, PRF current was applied for 90 seconds.

IV. SUMMARY

Carpal tunnel syndrome is a common disorder. In the majority of cases, patients with CTS can be diagnosed by means of appropriate history taking, and by physical/neurological examination. Nerve conduction tests of the nervus medianus are the most important additional examinations. Which treatment is preferred depends on the severity of the symptoms and the limitations they cause. If few limitations are present, treatment by means of a splint or through corticosteroid injections is preferred.

REFERENCES

- Guyatt G, Gutterman D, Baumann MH, et al. Grading strength of recommendations and quality of evidence in clinical guidelines: report from an American college of chest physicians task force. *Chest*. 2006;129:174–181.
- van Kleef M, Mekhail N, van Zundert J. Evidence-based guidelines for interventional pain medicine according to clinical diagnoses. *Pain Pract*. 2009;9:247–251.
- Becker J, Nora DB, Gomes I, et al. An evaluation of gender, obesity, age and diabetes mellitus as risk factors for carpal tunnel syndrome. *Clin Neurophysiol*. 2002;113:1429–1434.
- Nederlandse Vereniging voor Neurologie. *Diagnostiek en behandeling van het carpale-tunnelsyndroom*. Alphen aan den Rijn: CBO; 2005.
- Kouyoumdjian JA, Zanetta DM, Morita MP. Evaluation of age, body mass index, and wrist index as risk factors for carpal tunnel syndrome severity. *Muscle Nerve*. 2002;25:93–97.
- Graham B. The value added by electrodiagnostic testing in the diagnosis of carpal tunnel syndrome. *J Bone Joint Surg Am*. 2008;90:2587–2593.
- Kaymak B, Ozcakar L, Cetin A, Candan Cetin M, Akinci A, Hascelik Z. A comparison of the benefits of sonography and electrophysiologic measurements as predictors of symptom severity and functional status in patients with carpal tunnel syndrome. *Arch Phys Med Rehabil*. 2008;89:743–748.
- Pinilla I, Martin-Hervas C, Sordo G, Santiago S. The usefulness of ultrasonography in the diagnosis of carpal tunnel syndrome. *J Hand Surg Eur Vol*. 2008;33:435–439.
- Jarvik JG, Comstock BA, Heagerty PJ, et al. Magnetic resonance imaging compared with electrodiagnostic studies in patients with suspected carpal tunnel syndrome: predicting symptoms, function, and surgical benefit at 1 year. *J Neurosurg*. 2008;108:541–550.
- Visser LH, Smidt MH, Lee ML. High-resolution sonography versus EMG in the diagnosis of carpal tunnel syndrome. *J Neurol Neurosurg Psychiatry*. 2008;79:63–67.
- Padua L, Aprile I, Caliandro P, Mondelli M, Pasqualetti P, Tonali PA. Carpal tunnel syndrome in pregnancy: multiperspective follow-up of untreated cases. *Neurology*. 2002;59:1643–1646.
- De Angelis MV, Pierfelice F, Di Giovanni P, Staniscia T, Uncini A. Efficacy of a soft hand brace and a wrist splint for carpal tunnel syndrome: a randomized controlled study. *Acta Neurol Scand*. 2009;119:68–74.
- American Academy of Orthopaedic Surgeons' Work Group Panel. Clinical practice guideline on the treatment of carpal tunnel syndrome. AAOS. 2010. [WWW document]. URL <http://www.aaos.org/guidelines> [accessed on October 23, 2010]
- Verdugo RJ, Salinas RA, Castillo JL, Cea JG. Surgical versus non-surgical treatment for carpal tunnel syndrome. *Cochrane Database Syst Rev*. 2008;4:CD001552.
- Marshall S, Tardif G, Ashworth N. Local corticosteroid injection for carpal tunnel syndrome. *Cochrane Database Syst Rev*. 2007;2:CD001554.
- Lee JH, An JH, Lee SH, Hwang EY. Effectiveness of steroid injection in treating patients with moderate and severe degree of carpal tunnel syndrome measured by clinical and electrodiagnostic assessment. *Clin J Pain*. 2009;25:111–115.
- Haider N, Mekasha D, Chiravuri S, Wasserman R. Pulsed radiofrequency of the median nerve under ultrasound guidance. *Pain Physician*. 2007;10:765–770.
- Racasan O, Dubert T. The safest location for steroid injection in the treatment of carpal tunnel syndrome. *J Hand Surg Br*. 2005;30:412–414.