International Journal of Medical Science and Clinical Research Studies

ISSN(print): 2767-8326, ISSN(online): 2767-8342

Volume 02 Issue 06 June 2022

Page No: 486-491

DOI: https://doi.org/10.47191/ijmscrs/v2-i6-08, Impact Factor: 5.365

Carpal Tunnel Syndrome: Anatomo-Clinical Review. Update of Diagnosis and Treatment

Pérez-Limón, Susana Gabriela[1], Jiménez-Gálvez, Mónica Paulina[2], Torres-Espinoza, José Carlos[3], Beltrán-Castro, Rubén[4], González-Muñoz, Samantha Emily[5], Zepeda-Torres, José María[6]

[1,2,3,4,5,6] Department of Traumatology and Orthopedics, Faculty of Medicine, Autonomous University of Guadalajara. Guadalajara, Jalisco, Mexico

ABSTRACT

Objective: carry out an anatomical-clinical review of updates on the diagnosis and treatment of SCT, comparing them and evaluating their advantages and disadvantages.

Methods: a bibliographic review of original articles in English extracted from different databases such as PubMed and Google Scholar was carried out. Books from the Access Medicine platform: Orthopedics, Diagnosis and Treatment, and a Medical Refresher Course were also used.

Results: the surgical treatment is superior and the one of choice for the SCT, since it improves the quality of life of the patient.

Conclusion: there are methods for the diagnosis of SCT such as electromyography or ultrasound, which provide valuable information. Although pharmacological or conservative treatment is considered a first-line therapy, it is important that it be individualized.

KEYWORDS: Diagnosis, Treatment, Traumatology, Orthopedics, Syndrome and Carpal Tunnel.

ARTICLE DETAILS

Published On:
10 June 2022

Available on:
https://ijmscr.org/

INTRODUCTION

Carpal Tunnel Syndrome (CTS) was first described in 1863 by Sir James Pages [1], as the most common compressive neuropathy of the upper extremity [2,3,4,5]. It is a painful disorder caused by increased pressure in the Carpal Tunnel due to compression of the median nerve (NM) between the ligament and other carpal tunnel structures, leading to gradual ischemia [4-8].

Its incidence is 10% in the general population and occurs in up to 15% of workers. Although CTS can affect any age group and both sexes[9] it is more common in women, particularly in the 65 to 74 years age range [8.9] . In 50 to 60% of cases the problem is bilateral [8,10].

CTS can occur as a result of various risk factors, such as obesity, diabetes mellitus, and alcohol abuse. Also occupational factors such as vibration, force strength of the hand and repetition are associated with a higher risk of developing this pathology [eleven] . However, most cases are idiopathic [1].

It can cause significant morbidity because it negatively affects daily activities by limiting work capacity and impacting the patient's general health and quality of life. Patients with this condition experience discomfort such as paresthesias, numbness throughout the NM distribution, decreased grip strength, and intermittent pain. Symptoms that appear at night are often clinically significant because they cause sleep disturbance [6,10].

Although multiple studies have been carried out, no consensus has been reached on the diagnostic criteria for CTS, currently they are based on an analysis of the patient's history, physical examination and the results of the electrophysiological study, which is considered the "golden standard".

Several authors have also recommended the use of USG as the first step in management since it can provide information on the possible causes of the disease and relevant anatomical information on the content of the Carpal Tunnel [12].

Treatment options for CTS include wrist splinting, therapeutic ultrasound, local corticosteroid injections, and carpal tunnel release surgery [1].

This bibliographic review aims to compare and evaluate the diagnostic methods and treatments that are currently used in

the follow-up of CTS in order to highlight both its advantages and disadvantages and to have an overview of what is the best management individually for the patient.

THEORETICAL FRAMEWORK

Anatomy

The Carpal Tunnel is a very shallow U-shaped osteofibrous canal, made up of 4 edges, where 3 of them are the floor of the Tunnel and are formed by the carpal bones and the last edge or roof is by the flexor retinaculum of the hand. It is also a structure that measures 25 mm at its widest point in the cardinal line of Kaplan and 20 mm at its lowest point at the level of the hook hook. Ten structures in total pass through the Tunnel: nine flexor tendons and the NM that travel from the forearm to the hand. The NM is formed by fascicles of the medial part and lateral cords of the brachial plexus which when reaching the elbow, innervates the following muscles: the round pronator, the superficial flexor of the fingers, the long palmar and the radial flexor of the carpus. The sensation is mainly supplied to the 3 fingers innervated by the NM and half of the 4th finger, as well as to the tenar musculature and the lumbricales of the index and middle fingers. The ulnar nerve innervates in most individuals, half of the 4th finger, the 5th finger, the palmar and dorsal surfaces of the ulnar side of the hand [5,8,13].

Physiopathology

The NM is the one with the highest risk of injury in its short segment or internal portion of the Carpal Tunnel, located between the distal wrist, the flexion fold and the proximal metaphysis. The pressure of the Carpal Tunnel in the neutral position of the hand is 2.5 mmHg, increasing in the flexion and extension of the wrist, however it should not exceed 5 mmHg. The nerve is at risk of deterioration by reaching pressures of 20 to 30 mmHg within the compartment and decreased blood flow of the median artery, resulting in epineural perfusion with risk of ischemia. Prolonged elevation of pressure, as well as arterial and venous ischemia, lead to CTS with subsequent sensory demyelination followed by motor and finally with loss of sensory and motor axons [8,13].

Histomorphologically, there is non-inflammatory fibrosis in the subsynovial connective tissue (SSCT) surrounding the flexor tendons, being considered the hallmark between the development and progression of CTS; this tissue refers to the multilayer structure of the tissues between the visceral synovial sheath, flexor tendons and NM within the Carpal Tunnel. The SSCT by means of specific differential movements of the fingers, is damaged and suffers fibrosis followed by the interstitial accumulation of the fluid, leading to increased pressure in the Carpal Tunnel and restricting the nerve [8,13].

Clinical manifestations

CTS can arise spontaneously, its symptoms vary and are progressive. It begins with paresthesias in the first three fingers (thumb, index, middle and middle of the ring) because of the innervation of the NM and burning night pain that can radiate proximally to the forearm and sometimes to the shoulder, neck (Valleix phenomenon) and chest, which is reduced when shaking hands when waking up, the above can generate sleep disorders; subsequently intermittent pain is experienced that intensifies with palmar flexion or dorsiflexion of the wrist, and numbness in daytime activities such as driving, lifting or using the computer; the loss of sensation can cause the objects in your hand to fall involuntarily, generating a feeling of clumsiness. Symptoms are bilateral in 50% of patients. Prolonged compression of SL leads to permanent sensory loss and motor deficit. Atrophy of the muscles innervated by the NM is visible in severe chronic cases. It should be noted that due to neurological anatomical variation the symptoms do not always follow the exact distribution, so many patients develop symptoms in all fingers and all of the hand, forearm, arm or shoulder [4,5,6,8,10,11,13].

Tinel's sign: appearance of paresthesias or pain when hitting the wrist on the palmar face or percussion of the NM. Specificity between 67 and 87% [4,5,8,13].

Phalen's sign: pain or paresthesias in the NM with the wrist in a compressive forced posture, hyperextension or hyperflexion (flexion of the wrists at 90º for 60 s). Sensitivity of 70 to 89% and specificity of 48% [4,5,8,13].

Durcan test: pressure on the NM proximal to the wrist causes paresthesias or hypoesthesias after 30 s. Muscle weakness or atrophy, especially in the tenar eminence, can appear later than sensory disorders, as nerve compression worsens. It is the most specific and sensitive test, with 90 and 87%, respectively [4,5,8,13].

The strength of the short abductor muscle of the thumb can inform the degree of functional impairment, it is evaluated by instructing the patient to place the thumb perpendicular to the plane of the hand resisting attempts to push it towards the same plane [4,5,8,13].

Diagnostic criteria of the American Academy of Neurology [3]:
1. Paresthesia, pain, swelling or clumsiness of the hand aggravated when sleeping, maintaining the posture of the hand or arm, or repetitive action of the hand that is relieved by a change in hand posture or by handshake.
2. Sensory impairment in the innervated territory of the NM of the hand.
3. Motor deficit or atrophy of the muscles innervated by the NM.
4. Positive Phalen maneuver and/or Tinel sign.
STC is considered if criterion 1 is positive plus one of the criteria 2 to 4.

Diagnosis

➢ **Ultrasound.**

Its classic triad consists of the flattening of the SL in the distal portion of the Carpal Tunnel, edema or increase of the NM area at the level of the pisiform, as well as bulging of the flexor retinaculum. The great advantage is that it provides information on the possible causes of the disease and pertinent anatomical information on the contents of the Carpal Tunnel. Sensitivity varies between 54% and 98%. It has advantages over magnetic resonance imaging due to the speed of its realization, non-invasive, low cost and being a dynamic examination in real time [4,8,12,14].

➢ **Electromyography.**

It is the standard diagnostic test for the diagnosis of CTS. It provides a quantitative measure of the conduction speed of the SL, which decreases when the Syndrome exists. It can provide information about focal mononeuropathy of NM in the wrist and can classify CTS from mild to severe. A distal motor latency of more than 3.5 to 4.0 ms is the best indicator of an STC. Its specificity is 95% and sensitivity between 49 and 84%. Can guide surgical treatment or determine the reason for failure when surgery is not satisfactory [1,4,6,8,13].

Treatment.

Treatments for CTS are variable and depend on the severity of the classic syndrome. Non-deficient CTS has been managed conservatively with immobilization or injections. When it is resistant to treatment, more aggressive treatment is necessary. Similarly, when CTS presents with a deficiency or in an acute severe form, surgical treatment, therapeutic ultrasound, corticosteroid injections, and carpal tunnel release surgery may be sought [13].

Early recognition of the problem and ergonomic education about risk factors are highly important prevention measures, since treatment success depends on them [8].

- **Pharmacological or conservative.**

Conservative management of CTS is generally considered first-line therapy unless the patient has a sensory disorder or motor deficit. Conservative management may encompass any or all of the following interventions. Firstly, immobilization of the wrist via a rigid splint is the most common initial therapy and prevents extreme movement by forcing the wrist into a neutral position in order to decrease edema and nerve friction. Initial treatment of CTS includes a splint that keeps the wrist in a neutral position at night [5,13].

Less often, a softer, more flexible brace is used. The trade-off for more movement is an increased risk of edema and compression. In coordination with these therapies, oral administration and supplementation have shown promise in case studies to help reduce edema, oral diuretics have marginal efficacy. Vitamin B6 is a coenzyme in neural function and has the potential to help patients with undiagnosed neuropathy. Oral steroids and NSAIDs may help relieve symptoms but do not treat the underlying CTS. Finally, certain physical exercises have been hypothesized to reduce MN pressure and have been shown to have a marginal therapeutic effect on a patient-by-patient basis that should be preferred based on individual preferences [13].

- **Injection therapy:**

Corticosteroids.

Corticosteroid injection into the carpal tunnel often decreases the inflammatory response around the flexor tendons and alleviates symptoms [5].

A single injection of corticosteroids shows superior clinical efficacy at 6 weeks and is cost-effective over 6 months compared to night casts, which should make it the treatment of choice for rapid and sustained symptom response in CTS mild or moderate presenting in primary care [10]. Although another study shows that perineural injection with 5% dextrose (D5W) only leads to a significant reduction in pain and disability, compared to corticosteroids, from the fourth month after injection. Considering the side effects of corticosteroids, we consider D5W to be a better option for perineural injection, for patients with mild to moderate CTS [7] .

Transient relief of symptoms after injection indicates a greater likelihood of a favorable outcome after surgical decompression [5].

Platelet rich plasma.

Alternatively, platelet-rich plasma (PRP) injections contain concentrated platelets and various growth factors that can help relieve symptoms. Mechanisms include axon growth, angiogenesis, and regeneration that could promote MN regeneration [13]. Single local injection of PRP will prove to be an effective and superior method to corticosteroid therapy for the treatment of mild to moderate CTS [5].

- **Surgical.**

In patients who have not responded to conservative measures, surgical division of the transverse carpal ligament may be helpful. This division can be accomplished through direct open exposure or through an endoscopic approach [5].

Although corticosteroids generally provide more immediate relief than surgical or conservative procedures, the benefit of injections diminishes over time; surgical relief provides the most effective results in the medium and long term [5].

The procedure consists of an incision in the transverse carpal ligament to enlarge the Carpal Tunnel. Previously, the surgery was done completely open, but now it is done using a mini-open or endoscopic approach. The mini-open technique cuts the roof of the Carpal Tunnel while the endoscopic technique is driven by a camera and increases the size of the Tunnel internally [5].

On the one hand, the open incision is made in the palm over the transverse carpal ligament, keeping it ulnar to the axis of the palmaris minor, along the longitudinal axis of the radial border of the ring finger. This incision avoids injury to the palmar cutaneous branch of the NM. After longitudinal incision in the palmar fascia, the transverse carpal ligament is identified and divided longitudinally under direct vision [5].

Endoscopic division of the transverse carpal ligament avoids a potentially painful palmar incision with a single access to

the wrist, at a site proximal to the palm, or with a combined proximal access and short mesopalmar access along the axis of the open incision. Both types of procedures are effective ways to treat CTS. The decision of which technique to use is based on the experience of the surgeon [5].

Wrist arthroscopy is also used in the surgical treatment of CTS in addition to conventional carpal tunnel release surgery, and each surgical approach has advantages and disadvantages. Wrist arthroscopy and small incision surgery significantly reduces damage to the skin, palmar aponeurosis, hand muscles, cutaneous nerves, and blood vessels, compared to conventional open carpal tunnel release surgery. Arthroscopic wrist surgery resulted in significantly less postoperative pain, leading to reduced length of hospital stay and better functional recovery compared to conventional surgery [15].

- **Alternative therapies:**

Laser therapy.

The goal of low-level laser therapy is to transfer energy through a beam to reduce the inflammatory response in a target tissue. By inducing the production of endorphins, serotonin, and other mediators, the goal is to reduce edema and even promote axonal regeneration [13].

Shock wave therapy.

Extracorporeal shock wave therapy is a relatively new treatment that has been used since the turn of the century for inflammatory musculoskeletal disorders and peripheral neuropathies. Mini-shock waves induce axonal regeneration through several pathways and have also shown efficacy in reducing chronic neuropathic pain. Eigenwaves can be delivered in a focused or radial pattern. Radio waves have the advantage of dispersing throughout an area, although to a lesser extent; which means that it does not require the exact location of the entrapment [13].

The treatment is applied individually and must be adapted to each patient [8].

DISCUSSION

Electrodiagnostic studies (EDX) are useful to measure in the diagnosis of STC, such as nerve conduction studies (NCS) and electromyography (EMG) studies. This technique is the most sensitive and precise, with a sensitivity of 80 to 92%, and a specificity of 80 to 99%, since it provides a quantitative measurement of the function of the MN, which can be used to guide the surgical treatment and the prognosis of the patient. It is said that STC diagnosis can be made based on clinical symptoms, but EDX will always be another standard to confirm it. In terms of their usefulness, these diagnostic tests, even though they are the gold standard, are not easily accepted by the patient, as they require special conditions and equipment, they also take a long time and may have a false positive or negative.

If there is a basis for a detailed medical history and a complete physical examination, EDX studies have a sensitivity of up to 95%, while in case of deficient or absent clinical characteristics, ultrasound may have a sensitivity of up to 100%, being also less invasive, faster, and less costly, with the great advantage that this study can provide information on changes in soft tissue lesions. as well as the cause of NM compression by facilitating the visualization of the surrounding organs. It has been concluded that the sensitivity and specificity of EDX is more inclined towards distal sensory latency, with an average specificity of 95. 8%, while distal motor latency has a specificity of 93.6%.

The use of therapeutic drugs for STC varies considerably depending on how and for whom it is used. When the non deficit STC is resistant to the conservative procedure, a more aggressive management is necessary, in these cases it is important to standardize and update the available treatments to achieve an optimal and early recovery. Therefore, the present review aimed to find the treatments that had a high value of evidence for the management of STC. For this purpose, a research was made for several articles that related to the subject in question, and after passing through a series of filters, we found only 12 articles and 3 books with information suitable for this study, which presented a level of evidence. However, based on the results seen from most of the articles reviewed, it can be said that the treatments found can be applied to decrease or relieve the symptoms, but they do not refer in any case to the decrease or elimination of the compression suffered by the MN, although perhaps the compression could have been decreased but unfortunately was not objective in any study permanently compared to the surgical treatment. These are mentioned below.

In a comprehensive review in 2019, the treatment that proved to be effective according to the results described above for this disease were oral supplements that have shown promise in case studies. To further help reduce edema, oral diuretics were marginally effective. Vitamin B6, which is a coenzyme in neural function and has the potential to help patients with undiagnosed neuropathy, was proposed. However, it agrees with other articles that surgical treatment leads to better long-term results.

In 4 of the reviewed articles, the authors compared surgical interventions with conservative treatment and corticosteroid injections. While corticosteroids generally provide more immediate relief than surgical procedures or conservative interventions, the benefit of injections decreases over time; surgical relief provides the most effective results in the medium and long term. Therefore, surgical interventions are the standard treatment in patients where there is a lack of response to conservative treatment.

Also, in the retrospective comparative study of wrist arthroscopy, small incision surgery and conventional surgery for the treatment of STC in 2019, speaks of the conventional open carpal tunnel liberation surgery that is associated with greater surgical trauma resulting in longer postoperative recovery times and resulting in greater complications postoperative treatment of conventional release surgery, which may affect postoperative quality of life. In this article,

three groups were compared, where the therapeutic method with the best results was the wrist arthroscopy group and the small incision surgery group compared to the conventional surgery group with 70% efficacy.

A randomized clinical trial showed that surgical decompression achieved superior, faster and longer-term improvement in contrast to non-surgical treatment, according to the results of 39 of 57 (68. 4%) patients were treated surgically and 18 (31. 6%) patients were treated non-surgically. Of those treated surgically, 88% showed significantly more favorable results compared to those treated non-surgically, where only 30% achieved a reduction in symptoms of STC.

It is concluded that surgical treatment is superior to any other choice for this disease, since it improves the patient's quality of life, reduces long-term costs of conservative treatments such as the use of drugs, physiotherapeutic therapy, use of splints, etc. Since these are based on scientific evidence, do not eliminate anatomical-physiological damage and subjectively decrease symptoms, compromising the functional capacity of patients.

CONCLUSION

CTS is the most common compressive neuropathy of the upper extremity characterized by discomfort such as paresthesias, numbness throughout the NM distribution, decreased grip strength, and intermittent pain.

In its diagnosis, various authors have provided advantages over existing diagnostic methods, considering electromyography as the standard test, since this study can provide a quantitative measure of the conduction velocity of the MN as well as classify its degree from mild to severe, the which mentions specificity of 95% and sensitivity between 49% and 84%. Another study mentioned that has shown great advantages is ultrasound, which provides information on the possible etiology and the anatomy that is compromised with respect to the content of the Carpal Tunnel; unlike electromyography, it has a sensitivity between 54% and 98%, in addition to presenting a notable advantage over magnetic resonance imaging as it is non-invasive, low cost, quick to perform and, in addition to being a dynamic examination in time real.

Regarding the treatment for CTS, it will depend on its severity; the pharmacological or conservative is considered a first-line therapy unless the patient has a sensory disorder or motor deficit. In patients who do not respond to conservative measures, surgical division of the transverse carpal ligament can be very useful. Although there are various treatments for CTS, it is important that the treatment be individualized and must be adapted to each patient.

REFERENCES

I. Osiak, K., Mazurek, A., Pękala, P., Koziej, M., Walocha, J. A., & Pasternak, A. (2021). *Electrodiagnostic Studies in the Surgical Treatment of Carpal Tunnel Syndrome—A Systematic Review*. Journal of clinical medicine, 10(12), 2691.

II. De Kleermaeker, F. G., Meulstee, J., Claes, F., Kasius, K. M., & Verhagen, W. I. (2017). *Treatment outcome in patients with clinically defined carpal tunnel syndrome but normal electrodiagnostic test results: a randomized controlled trial*. Journal of neurology, 264(12), 2394-2400.

III. Senna, M. K., Shaat, R. M., & Ali, A. A. A. (2019). *Platelet-rich plasma in treatment of patients with idiopathic carpal tunnel syndrome*. Clinical Rheumatology, 38(12), 3643-3654.

IV. Luke A, & Ma C (2021). *Lesiones musculoesqueléticas de las extremidades superiores*. Papadakis M.A., & McPhee S.J., & Rabow M.W.(Eds.), Diagnóstico clínico y tratamiento 2021. McGraw Hill.

V. Bednar M.S., & Light T.R., & Bindra R (2014). *Cirugía de mano*. Skinner H.B., & McMahon P.J.(Eds.), Diagnóstico y tratamiento en Ortopedia, 5e. McGraw Hill.

VI. Demino, C., & Fowler, J. R. (2021). *The sensitivity and specificity of nerve conduction studies for diagnosis of carpal tunnel syndrome: a systematic review*. Hand, 16(2), 174-178.

VII. Wu, Y. T., Ke, M. J., Ho, T. Y., Li, T. Y., Shen, Y. P., & Chen, L. C. (2018). *Randomized double-blinded clinical trial of 5% dextrose versus triamcinolone injection for carpal tunnel syndrome patients*. Annals of neurology, 84(4), 601-610.

VIII. Traumatología y Ortopedia. Ramos Herrera I, & Martínez Ceccopieri D, & Chávez A, & Centeno Flores M, & Valls R(Eds.), (2016). *CAM Curso de actualización médica*. McGraw Hill.

IX. Aghda, A. K., Asheghan, M., & Amanollahi, A. (2020). *Comparisons of electrophysiological and clinical findings between young and elderly patients with Carpal Tunnel Syndrome*. Revue Neurologique, 176(5), 387-392.

X. Chesterton, L. S., Blagojevic-Bucknall, M., Burton, C., Dziedzic, K. S., Davenport, G., Jowett, S. M., ... & Roddy, E. (2018). *The clinical and cost-effectiveness of corticosteroid injection versus night splints for carpal tunnel syndrome (INSTINCTS trial): an open-label, parallel group, randomised controlled trial*. The Lancet, 392(10156), 1423-1433.

XI. Albalawi, S. S. A., Aziz Alrahman, R. W., Althagafi, A. M., Alrahili, A. S., Alqahtani, S. S., Almutairi, S. M., ... & Sabah, A. M. (2018). *Evaluation of Carpal Tunnel Diagnosis, Management, and Outcome in Primary Health Care Center*. The Egyptian Journal of Hospital Medicine, 73(3), 6230-6237.

XII. Perţea, M., Ursu, S., Veliceasa, B., Grosu, O. M.,

Velenciuc, N., & Luncă, S. (2020). *Value of ultrasonography in the diagnosis of carpal tunnel syndrome—a new ultrasonographic index in carpal tunnel syndrome diagnosis: A clinical study*. Medicine, 99(29).

XIII. Urits, I., Gress, K., Charipova, K., Orhurhu, V., Kaye, A. D., & Viswanath, O. (2019). *Recent advances in the understanding and management of carpal tunnel syndrome: a comprehensive review*. Current pain and headache reports, 23(10), 1-8.

XIV. Lee, K. M., & Kim, H. J. (2016). *Relationship between electrodiagnosis and various ultrasonographic findings for diagnosis of carpal tunnel syndrome*. Annals of Rehabilitation Medicine, 40(6), 1040.

XV. Teng, X., Xu, J., Yuan, H., He, X., & Chen, H. (2019). *Comparison of wrist arthroscopy, small incision surgery, and conventional surgery for the treatment of carpal tunnel syndrome: a retrospective study at a single center*. Medical Science Monitor: International Medical Journal of Experimental and Clinical Research, 25, 4122.