

Carpal Tunnel Syndrome Review

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Fig 1:- Carpal tunnel syndrome

Abstract- Carpal tunnel syndrome (CTS) is a common medical condition that remains one of the most constantly reported forms of median nerve entrapment. CTS occurs when the median nerve is squeezed or compressed as it travels through the wrist. The pattern is characterized by pain in the hand, numbness, and tingling in the distribution of the median nerve. Risk factors for CTS include obesity, monotonous wrist exertion, gestation, hereditary factors, and rheumatoid inflammation. The diagnosis of CTS is conducted through medical assessments and electrophysiological testing, although idiopathic CTS is the most typical system of diagnosis for cases suffering from these symptoms. Occasionally weakness of hand and muscle is observed in certain advanced cases. Interestingly, the prevalence pattern is largely current in women and old age groups. Multitasking people prefer surgery to treat this condition, though intermittently conservative treatments, similar to remedial ultrasound, are recommended. In this review broad spectrum about environmental aspects and the nature of apparent exposures and the strategies which might reduce the burden of the Carpal tunnel syndrome are bandied This review of literature has provided an overview of CTS with an emphasis on anatomy, epidemiology, risk factors, pathophysiology, stages of CTS, diagnosis, and management options

Keywords: Carpal tunnel syndrome, multitasking, numbness, Carpal tunnel syndrome, obesity, carpal tunnel exercise, wrist joint movements.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common medical condition, which causes pain, numbness, and tingling in the hand and arm of the affected individual. CTS occurs when the median nerve is squeezed or compressed as it travels through the wrist. The symptoms for CTS may vary across cases. Similarly, they're classified into mild, moderate, and severe. These sensations may be felt in the thumb, index finger, middle finger, and half of the ring finger [1]. In general, people with this illness will have pain and numbness in the median nerve distribution, which encompasses the thumb, index finger, middle finger, and half of the ring finger [2]. Entrapment neuropathies are the most common mononeuropathies seen in clinical practice. Carpal tunnel syndrome (CTS) is the most common upper-limb entrapment neuropathy. CTS has been approached from many perspectives and using various methodologies[3]. It is distinguished by sensory and, less frequently, motor symptoms and indications in the median nerve's peripheral distribution. Trauma, Diabetes, Rheumatoid Arthritis, Acromegaly, Hypothyroidism, and Pregnancy are all documented causes of CTS. The link between CTS and work-related risk factors is a recurring theme of causality among workers, ergonomists, attorneys, and clinicians [4].

Epidemiology:

The most common entrapment neuropathy, CTS, is thought to affect 3.8% of the population overall. Based on clinical examination and electrophysiological testing, 1 in 5 participants who report symptoms including pain, numbness, or tingling in the hands are anticipated to have CTS, with idiopathic CTS being

the most common diagnosis in patients with these symptoms. Prevalence rates of over 276100,000 per time have been reported, with a frequency rate up to 9.2 in women and 6 in men. More common in ladies than in males, its circumstance is generally bilaterally with a peak age range of 40 to 60 times. although it occurs in all age groups. The frequency of CTS in the United Kingdom (UK) alone is 7- 16. much advanced than the 5 frequency in the United States(US [5]. The frequency situations may also vary across the different occupations and diligence, with diligence, similar as the fish processing diligence reporting the circumstance of CTS in their workers estimated at 73 [6]. These views on the circumstance rates of CTS illustrate the weight of the challenge, making it a significant area of concern, which would bear effective strategies for operation [1].

Anatomy :

The form and width of the CT are affected by wrist joint movements. The width of the tunnel narrows significantly during the usual range of wrist motion, and because the tunnel's bony walls are not stiff, the carpal bones move relative to each other with each wrist movement. Exion and extension both raise the CT pressure. The cross section of the CT's proximal aperture was observed to be considerably reduced with an existing wrist joint. This is most likely caused by radial shifting of the TCL and movement of the distal end of the capitates bone. In full extension, the lunate bone compresses the tube as it is pushed into the tunnel's interior [7]. The carpal tunnel is made up of a bony canal made up of carpal bones, with the ceiling made up of the fibrous but stiff transverse carpal ligament. The carpal tunnel houses the nine flexor tendons as well as the median, which enters the tunnel at the midline or slightly radially. Atypical presentations may be explained by anatomical differences in the median nerve. Sensory branches of the median nerve supply the three radial digits and the radial half-fourth digit, explaining why CTS symptoms manifest in these fingers. The median nerve's palmar sensory cutaneous branch supplies the cutaneous skin of the palm and arises approximately 6 cm proximal to the transverse.[1]

Risk factors for CTS:

Include repetitive hand movements in occupations that require typing, certain anatomical and

physiological characteristics (e.g., smaller carpal tunnel size), age (risk increases with age), gender (higher risk in women), pregnancy, medical conditions (e.g., obesity, diabetes, arthritis, metabolic syndrome), and previous trauma or injury to the wrist [8]. Circumstances that change the fluid equilibrium within the body are examples of extrinsic variables that increase the volume within the tunnel. Pregnancy, menopause, obesity, kidney disease, hypothyroidism, usage of oral contraceptives, and congestive heart failure are all risk factors. Lumps and tumor-like strains are intrinsic elements within the nerve that increase the occupied volume inside the tunnel. These could be the results of distal radius fractures, either directly or indirectly through post traumatic arthritis. These are important considerations because they have an effect on the median nerve without necessarily increasing interstitial pressure within the carpal tunnel. Diabetic persons are more likely to develop CTS because of nerve injury . In diabetic patients, the extent of incidence is 14% for patients without diabetes and 30% for patients with diabetic neuropathy, while the prevalence rate during pregnancy is estimated at 2% [1]. To determine the risk factors linked with CTS, a retrospective chart analysis of 818 individuals was conducted. Gender stratification was used for the patients: n = 707, or 86.4 % of the total, and n = 111, or 13.6%. In all groups, the average patient age was 54.5 years old (range: 16-85 years). The risk factors for CTS were divided into seven groups: anatomic, neuropathic, inflammatory, fluid balance change, distal radius fracture linked, occupational risk factor related, and idiopathic. The occupations of CTS patients were categorized into non risk and high risk categories [9].

Pathophysiology:

A combination of mechanical trauma, elevated intracarpal pressure, and ischemic damage to the median nerve within the carpal tunnel comprise the pathogenesis of CTS. In terms of elevated pressure, standard pressure is documented to fluctuate between 2 mmHg and 10 mmHg. Changes in wrist position can cause significant variations in fluid pressure within the carpal tunnel. As a result, the pressure increases by more than ten times during extension, while the pressure increases by eight times during wrist flexion [1]. Compressive syndromes combine the phenomena of compression and tension from a physiopathological

perspective. Anatomically, there are two locations where the median nerve is compressed: the first is at the level of the carpal tunnel's proximal limit, which is brought on by wrist flexion due to variations in the forearm fascia's thickness and stiffness as well as in the flexor retinaculum's proximal portion; the second is at the narrowest part, which is near the hamate hook [10]. The most well-known instance of a persistent compression neuropathy is CTS. There have been a few pressure-related human carpal tunnel investigations, but the majority of our knowledge about the pathophysiology of compression neuropathies comes from animal studies (Gelberman et al., 1988, Werner and Armstrong, 1997, Werner et al., 1983). The link between acute and chronic nerve injury presents a problem for data interpretation [11].

The median nerve's branching pattern in the forearm and hand, as well as its connections with several other nerves, exhibit a multitude of anatomical variations 13–23. Poisel classified median nerve variants and the branches' relationship to the transverse carpal ligament based on her examination of 100 cadavers' hands. Extra ligamentous (type I), subligamentous (type II), and transligamentous (type III) are the three categories he defined.

The variations can be classified into four types:

- 1) Variations of the course of the single thenar branch;
- 2) accessory branches at the distal carpal tunnel;
- 3) high division of the median nerve;
- 4) accessory branches proximal to the carpal tunnel. [12].

Nerve compression and traction can cause difficulties with intraneural blood microcirculation, lesions at the myelin sheath and axonal level, and alterations to the supporting connective tissue. Lundborg²⁰ proposed the clinical-anatomical classification shown below:

- 1) *Early stage* - This stage is characterized by sporadic symptoms that occur only at night. Many causes can cause elevated nocturnal intratunnel pressure in idiopathic CTS: Increased pressure between 40 and 50 mmHg will disrupt the intraneural microcirculation's venous return, resulting in reduced oxygen delivery and venous stasis. A two-hour increase in pressure of 30 mm

Hg causes a progressive deterioration of both fast and slow axonal transport.

- 2) *Stage of intermediary* - There are both daytime and nighttime symptoms. Increased endoneurial fluid pressure results from persistent microcirculation abnormalities, including epineural and intrafascicular interstitial edema. The connective tissue thickens, especially in connection to the epineurium, and there is a lack of cell flow as a result of this interstitial edema.
- 3) *Advanced stage* - Symptoms are constantly present, especially signs of sensitive or motor deficiency, restated as dislocation of a lesser or lower number of axons (axonotmesis). Wallerian degeneration exists at the position of the disintegrated axons. The connective envelopes form the point for reactive stringy thickening. After release of the whim-whams, the recovery depends on whim-whams rejuvenescence, which takes several months and may be deficient [13].

Exercise:

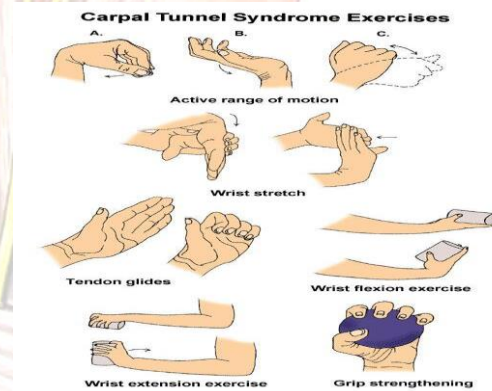


Fig 2:- Carpal Tunnel Syndrome Exercise.

Three exercises were employed in the study. The release exercise involved the participant raising his hands upward, shaking them briefly, and then spreading his fingers widely apart. He then let them relax before stretching them once more. Furthermore, a little pullback, holding, and releasing of the thumb were used to stretch the subject. In the wrist flexor stretching exercise, the participant held his arm out in front of him, palm facing up. He then slightly flexed his wrist and continued to do so with his other hand

until he felt a mild to moderate strain in his forearm. At least thirty seconds were spent on this segment [14].

Diagnosis :

Following test for diagnosis of CTS :

- *Ultrasonography:*

The cross-sectional area of the median whim-whams is nearly identified with CTS symptoms and inflexibility. A meta- analysis set up that cross-sectional area of 9 mm² or further is 87.3 sensitive and 83.3 specific for CTS Experience in performing ultrasonography for the opinion of CTS correlates with lesser inter-rater trustability when measuring the cross-sectional area. James Revellet.al.(2005) proposed a computer vision elastography by exercising the ultrasound sequences with the estimation of patch adaptive stir.

- *Artificial Intelligence and Machine learning approaches:*

This model can minimize the information loss. The recovery rate of the proposed model is within 2 of the original value that makes it a promising approach for enhancing the performance of natural networks. Pamela Mccauley Bellet.al.(2000) suggested a model of fuzzy linguistics to estimate the CTS pitfalls in an occupational atmosphere.

- *Diagnosis Using Wearable Technology:* Marcelli Wacet.al.(2020) proposed a strain monitoring system for elbows and wrists as a fairly invisible result and delivered a more visionary approach to avoid similar injuries.. The inadequate quantitative information is the one probable occasion to conduct more robust/scientific wrist movement as the raw data collection. MichelW. Completer'set.al.(2012) proposed a new approach to cipher the carpal lair pressure exercising the disposable/ low- cost pressure detectors [15] .

TREATMENT:

1.Conservative Treatment:

Carpal tunnel syndrome (CTS) is a condition that occurs when the median nerve, which runs from the forearm into the hand, becomes compressed within the carpal tunnel of the wrist. Treatment options for carpal tunnel syndrome can vary depending on the severity of the condition and individual factors.

- *Wrist Splints:* Wearing a wrist splint to keep the wrist in a neutral position can help relieve symptoms, especially at night.

- *Physical Therapy:* Exercises and stretches can improve wrist and hand strength and flexibility.
- *Ergonomic Changes:* Making changes in your workplace to reduce wrist strain, such as using an ergonomic keyboard and mouse.[16]

2.Medications:

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs): These can help reduce pain and inflammation.

3.Corticosteroid Injections:

Corticosteroid injections into the carpal tunnel can provide temporary relief from symptoms.

4.Surgery:

Carpal Tunnel Release Surgery: In cases of severe or persistent symptoms, surgery to release the pressure on the median nerve may be recommended.

5.Alternative and Complementary Therapies:

Acupuncture, yoga, and other complementary therapies have been explored in some studies as potential treatments for Carpal Tunnel Syndrome [17].

Surgery :

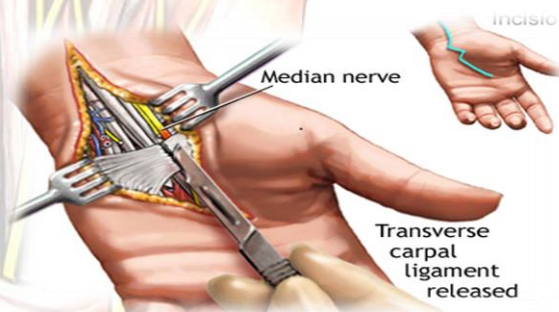


Fig 3:- Carpal Tunnel Syndrome Surgery

Carpal tunnel syndrome (CTS) is a common condition that can often be treated surgically when conservative measures fail to provide relief. Carpal tunnel release surgery is a procedure that aims to relieve the pressure on the median nerve as it passes through the carpal tunnel in the wrist.

Carpal Tunnel Release Surgery:

Procedure:

Carpal tunnel release surgery can be performed as an open or endoscopic procedure. During open surgery, a small incision is made in the palm of the hand to access the transverse carpal ligament, which is cut to relieve

pressure on the median nerve. Endoscopic surgery involves smaller incisions and the use of a thin, flexible tube with a camera to guide the surgeon.

Indications:

Surgery is considered when conservative treatments like wrist splints, physical therapy, and medications do not provide relief from CTS symptoms, such as numbness, tingling, and weakness in the hand and fingers.

Outcomes:

The success rate of carpal tunnel release surgery is generally high, with many patients experiencing a significant reduction in symptoms. However, the outcome can vary from person to person, and some individuals may require further rehabilitation.

Recovery:

Recovery time depends on the type of surgery performed and individual factors. Patients may need to immobilize the wrist and participate in physical therapy for a few weeks to regain strength and functionality.

Complications:

Like any surgical procedure, carpal tunnel release surgery carries potential risks, including infection, scarring, nerve damage, and recurrence of symptoms [18].

Causes :

Common Causes and Risk Factors of Carpal Tunnel Syndrome:

Anatomy:

The carpal tunnel is a narrow passageway in the wrist through which the median nerve passes. Any anatomical variation or abnormalities can increase the risk of CTS.

Repetitive Hand Use:

Activities that involve repetitive hand and wrist movements, such as typing, using vibrating tools, or assembly line work, can contribute to the development of CTS.

Trauma: Wrist injuries or fractures that cause swelling or changes in the wrist's anatomy can increase pressure on the median nerve and lead to CTS.

Medical Conditions:

Certain medical conditions, such as rheumatoid arthritis, diabetes, and thyroid disorders, can increase the risk of CTS.

Hormonal Changes:

Hormonal changes, such as pregnancy and menopause, can affect the body's connective tissues and may contribute to CTS.

Obesity:

Excess body weight can increase pressure on the median nerve in the carpal tunnel.

Genetics:

Some individuals may have a genetic predisposition to developing CTS [19].

Symptoms:

Carpal tunnel syndrome (CTS) is a common condition that affects the hand and wrist. It occurs when the median nerve, which runs through a narrow passage in the wrist called the carpal tunnel, becomes compressed or irritated. This compression can lead to a range of symptoms. Here are some common symptoms of carpal tunnel syndrome:

Numbness and Tingling:

Individuals with CTS often experience numbness and tingling in the thumb, index, middle, and ring fingers. This sensation is typically most prominent at night.

Hand Weakness:

As the condition progresses, weakness in the affected hand may develop, making it difficult to perform fine motor tasks, such as holding small objects or buttoning a shirt.

Pain:

Many people with CTS report pain in the hand and wrist. This pain can sometimes radiate up the forearm and even into the upper arm or shoulder.

Burning Sensation: Some individuals describe a burning sensation in the affected hand and fingers[20].

Clumsiness: CTS can lead to a decreased ability to grasp and hold objects, which can result in a sense of clumsiness or dropping items.

Wrist and Hand Swelling: Swelling in the wrist and hand is another possible symptom, particularly during the later stages of CTS.

Symptoms at Night: CTS symptoms often worsen at night, causing individuals to wake up with discomfort or tingling in their hand.

It's important to note that these symptoms may vary in intensity and can affect one or both hands. The severity of CTS can also vary from person to person. If you suspect you have carpal tunnel syndrome or are experiencing these symptoms, it's important to consult a healthcare professional for a proper diagnosis and treatment.[17]

Drugs with effect and side effect :

Carpal tunnel syndrome (CTS) is typically managed through a combination of conservative treatments and, in some cases, surgical interventions. Medications are often used as part of conservative management to alleviate symptoms.

1. Non-Steroidal Anti-Inflammatory Drugs (NSAIDs):

Effect: NSAIDs, such as ibuprofen or naproxen, can help reduce pain and inflammation in the wrist and hand, providing temporary relief from CTS symptoms.

Side Effects: Common side effects of NSAIDs include stomach upset, gastrointestinal bleeding, and an increased risk of cardiovascular events. Prolonged use should be monitored by a healthcare professional.

2. Oral Steroids:

Effect: Oral steroids, such as prednisone, are sometimes prescribed to reduce inflammation and alleviate symptoms. They can provide short-term relief from pain and discomfort.

Side Effects:

Long-term use of oral steroids can have significant side effects, including weight gain, increased blood sugar levels, and mood disturbances. Short-term use for CTS is generally considered safe, but potential side effects should be discussed with a healthcare provider.

3. Corticosteroid Injections:

Effect: Corticosteroid injections directly into the carpal tunnel can provide more targeted and immediate relief from symptoms by reducing inflammation around the median nerve.

Side Effects: Possible side effects of corticosteroid injections include temporary pain at the injection site, skin discoloration, and in rare cases, nerve or tendon damage.

4. Pyridoxine (Vitamin B6):

Effect: Pyridoxine supplements have been used in some cases, as vitamin B6 deficiency can contribute to CTS. Supplementing with vitamin B6 may help reduce symptoms in cases of deficiency.

Side Effects: Excessive vitamin B6 intake can cause sensory neuropathy. It's essential to use this supplement under medical supervision to avoid potential side effects.

5. Gabapentin or Pregabalin:

Effect: These antiepileptic medications can help manage nerve pain and may be prescribed for CTS. They can provide relief from the tingling and burning sensations associated with the condition.

Side Effects: Common side effects may include dizziness, drowsiness, and weight gain. Individual responses to these medications vary, and side effects should be discussed with a healthcare provider.[21,22]

CONCLUSION

CTS is a common medical condition that remains one of the most frequently reported forms of median nerve compression. CTS occurs when the median nerve is squeezed or compressed as it travels through the wrist. The syndrome is characterized by pain in the hand, numbness, and tingling in the distribution of the median nerve. This review of literature has provided an overview of CTS with an emphasis on anatomy, epidemiology, risk factors, pathophysiology, stages of CTS, diagnosis, and management options.

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