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Carpal Tunnel Syndrome

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2022/2023

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Abstract

Carpal tunnel syndrome (CTS) is the most common peripheral nerve entrapment syndrome. It is defined as a compression of the median nerve at the level of the wrist joint associated with decreased function of the nerve at that level. It can be either acute or chronic, with chronic being much more common. It is the most common nerve entrapment neuropathy, accounting for 90% of all neuropathies. Early symptoms of carpal tunnel syndrome include pain, numbness, and paresthesias. Carpal tunnel syndrome results from increased carpal tunnel pressure and subsequent compression of the median nerve. The most common causes of carpal tunnel syndrome include genetic predisposition, history of repetitive wrist movements such as typing, or machine work as well as obesity, autoimmune disorders such as rheumatoid arthritis, and pregnancy. In general, the pathophysiology of CTS results from a combination of compression and traction mechanisms. The diagnosis of CTS is based on clinical symptoms and strengthened by several examinations and workup (history, physical diagnosis, electrodiagnostic examination). The management of Carpal Tunnel Syndrome is divided into two, conservative therapy and operative or surgical therapy. In the case of mild CTS with conservative therapy is generally a good prognosis. Complications of carpal tunnel syndrome are divided into two groups: Complications due to Carpal Tunnel Syndrome and compliance due to Carpal tunnel surgery. For preventative patient advice to reduce repetitive movements.

Introduction

Carpal tunnel syndrome (CTS) is the most common peripheral nerve entrapment syndrome. It is defined as a compression of the median nerve at the level of the wrist joint associated with decreased function of the nerve at that level. It can be either acute or chronic, with chronic being much more common[1].

Carpal tunnel syndrome (CTS) is a clinical syndrome of numbness, tingling, burning, and/or pain associated with localized compression of the median nerve at the wrist. It is the most common nerve entrapment neuropathy, accounting for 90% of all neuropathies. Early symptoms of carpal tunnel syndrome include pain, numbness, and paresthesias. These symptoms may or may not be accompanied by objective changes in sensation and strength of median innervated structures in the hand[2].

These symptoms typically present, with some variability, in the thumb, index finger, middle finger, and the radial half (thumb side) of the ring finger. Pain also can radiate up the affected arm. With further progression, hand weakness, decreased fine motor coordination, clumsiness, and thenar atrophy can occur.

In the early presentation of the disease, symptoms most often present at night when lying down and are relieved during the day. With further progression of the disease, symptoms will also be present during the day, especially with certain repetitive activities, such as when drawing, typing, or playing video games. In more advanced diseases, symptoms can be constant.

Typical occupations of patients with carpal tunnel syndrome include those who use computers for extended periods of time, those who use equipment that has vibration such as construction workers, and any other occupation requiring frequent, repetitive movement[3-5].

Epidemiology

1. Frequency

In the United States, carpal tunnel syndrome (CTS) has an incidence of 1 to 3 persons per 1000 per year, with a prevalence of 50 per 1000, with similar incidence and prevalence in most developed countries[6].

2.Race

It most commonly affects Whites. Whites are two to three times more prone to get affected than Blacks[6].

3.Age

The peak age range for development of carpal tunnel syndrome (CTS) is 45-60 years. Only 10% of patients with CTS are younger than 31 years[6].

4.Gender(sex)

CTS is ten times more common in females as compared to males

The female-to-male ratio for carpal tunnel syndrome is 3-10:1[6].

5.Mortality/Morbidity

Carpal tunnel syndrome does not cause mortality, but it can lead to irreversible median nerve damage, with severe loss of hand function, if not treated[6].

Anatomy

The carpal tunnel is a narrow U-shaped structure on the wrist. The lower part of the carpal tunnel is formed by carpal bones. The canal roof is formed by strong fibrous connective tissue known as the retinaculum flexor (transverse carpal ligament) attached to the scaphoid, trapezium, ulnar, and pisiform tubes.

The median nerve plays a role in controlling the sensation of the thumb, index finger, fingers of the side of the palmar, and the muscles of the base of the thumb, which pass through the carpal tunnel. Another supporting structure is called the extensor retinaculum [7].

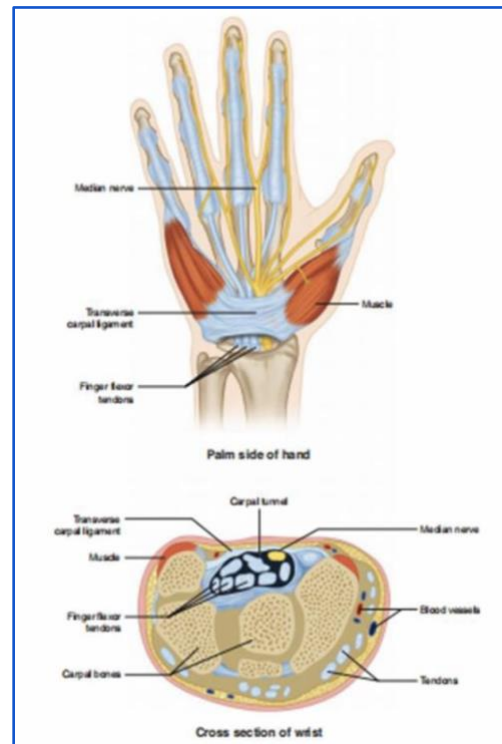


Fig. 1: Anatomy of Carpal Tunnel[8].

Etiology and Pathophysiology

● Etiology

Carpal tunnel syndrome results from increased carpal tunnel pressure and subsequent compression of the median nerve. The most common causes of carpal tunnel syndrome include genetic predisposition, history of repetitive wrist movements such as typing, or machine work as well as obesity, autoimmune disorders such as rheumatoid arthritis, and pregnancy.

The majority of CTS cases are idiopathic. Secondary CTS causes are divided into abnormalities of the container or content. Dynamic CTS can occur with manual work[9].

● The Increased Carpal Tunnel Pressure

Normal pressure in the carpal tunnel ranges from 2 to 10 mm Hg. There are several things that can increase the pressure in the carpal tunnel, known as wrist extension increases the pressure by 10 times, and wrist flexion can increase the pressure of the carpal tunnel by 8 times. Increased carpal tunnel pressure is thought to be the cause of the compression on the median nerve [9].

- **Microvascular Injury**

Increased pressure in the carpal tunnel can cause damage to blood vessels in the median nerve area, through the accumulation of proteins and inflammatory cells. Patients with vascular diseases such as Diabetes Mellitus, Peripheral Artery Disease cause circulatory disorders in the median nerve area, which can cause hypoxia and inflammation in the area [9].

- **Connective tissue disorders in the median nerve**

The connective tissue of the median nerve consists of Epineurium, Perineurium, and Endoneurium. The connective tissue is close to one another. If there is an integrity disturbance in the connective tissue it will cause injury. This can cause Carpal Tunnel Syndrome above. In the Poermemrany book, 2019 it is mentioned that the more age increases, the more work increases in an individual. Besides, the aging process can also damage the blood vessels and median nerve fibers that will reduce the function of the nerve[9].

- **Gender**

The Poor Memory book, 2019 states that women have 1.3 to 2.5 times higher prevalence of CTS than men. But this cause is not yet known certainly [10].

- **Obesity**

Obesity contributes indirectly to the occurrence of Carpal Tunnel Syndrome. Obesity is very closely related to blood vessel diseases such as Diabetes Mellitus. As previously mentioned, in patients with diabetes mellitus vascular disorders will occur including vascular disorders in the median nerve area [10].

- **Jobs**

Several jobs can be risk factors for Carpal Tunnel Syndrome. Work that is thought to be able to cause CTS is work that uses movement in the median nerve that is repetitive and lasts for a long time, causing an increase in pressure on the carpal tunnel and can cause injury to the median nerve [10].

Pathophysiology

In general, the pathophysiology of CTS results from a combination of compression and traction mechanisms. The compressive element of the pathophysiology includes a detrimental cycle of increased pressure, obstruction of overall venous outflow, increasing local edema, and compromise to the median nerve's intraneural microcirculation. Nerve dysfunction becomes compromised, and the structural integrity of the nerve itself further propagates the dysfunctional environment - the myelin sheath and axon develop lesions, and the surrounding connective tissues become inflamed and lose normal physiologic protective and supportive function. Repetitive traction and wrist motion exacerbate the negative environment, further injuring the nerve. In addition, any of the nine flexor tendons traveling through the carpal tunnel can become inflamed and compress the median nerve. Sensory fibers often are affected before motor fibers. Autonomic nerve fibers carried in the median nerve also may be affected[11].

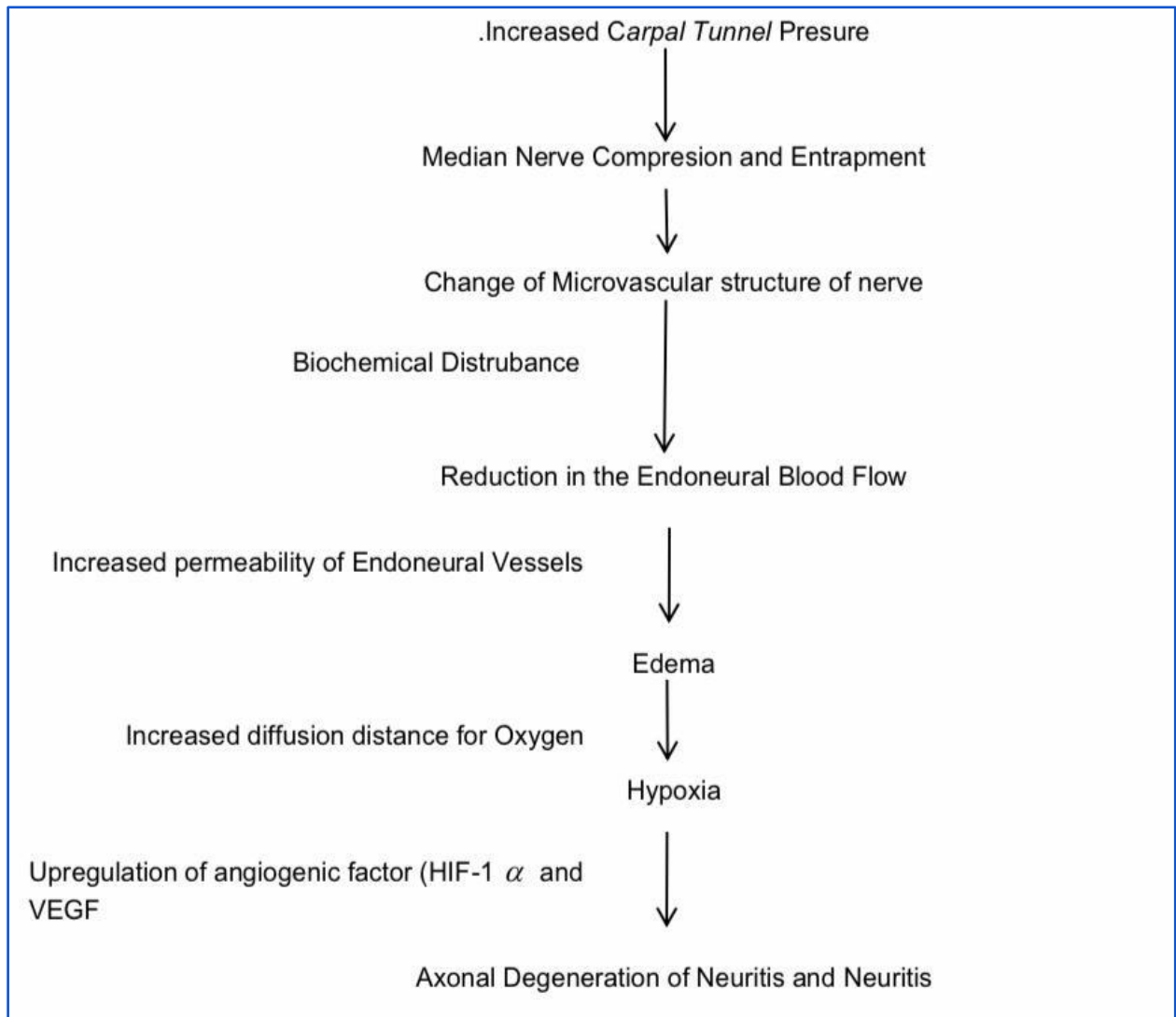


Fig. 2: Pathophysiology of Carpal Tunnel Syndrome[8].The pathophysiology of CTS involves a combination of mechanical trauma, increased pressure, and ischemic damage to the median nerve within the carpal tunnel.

Diagnosis

The diagnosis of CTS is based on clinical symptoms and strengthened by several examinations and workup:

- **History of present illness**

In the history of present illness can be found symptoms of pain, tingling, and numbness in the median nerve projections, burning sensation, decreased grip strength, and swollen finger sensation. It also can be obtained at night pain and weakness in the affected thumb [10].

The clinician should ask about duration of symptoms, severity and character of symptoms, location of symptoms, radiation (eg, Do symptoms radiate from the shoulder?), progression of symptoms (better, worse, stable?), patient's lifestyle/activities, and any comorbidities. Table 1 describes classic features that may be obtained in a patient with CTS and may have clinical significance[1].

- **Physical Diagnostic**

The physical exam should note the patient's age, BMI, body habitus, range of motion of the wrist and hand, any deformities, swelling, atrophy, and skin trophic changes[1]. Provocation tests that can be used to diagnose CTS are **Phalen's test**, **Tinel's test**, **Flick's sign**, and **Thenar wasting**. Phalen's test was performed by asking the patient to do maximum hand flexion. This examination is said to be positive if within 60 seconds symptoms such as Carpal Tunnel Syndrome arise. Tinel's test was performed by percussion on the carpal tunnel with slightly dorsiflexion positions. This examination is said to be positive if there is radiating pain or paresthesias. Flick's sign was performed by asking the patient to flick their hands or move their fingers. This examination is said to be positive if the

complaint decreases or disappears. Thenar wasting can be done by examining the patient's palms and palpitations and finding the presence of atrophy of the thenar muscles [10].

Table 1: Provocative Testing for Carpal Tunnel Syndrome. Ref.[1]	
Provocative Test	Clinical Presentation in CTS
Phalen Test	Dorsum of hands placed together so that maximum wrist flexion is achieved. This is held for 60 seconds.
Reverse Phalen Test	Palms of hands placed together so that maximum wrist extension is achieved. This is held for 60 seconds.
Tinel sign	Pain or paresthesia in median nerve distribution elicited when examiner percussion from the palmar crease to the distal wrist crease.
Median nerve compression test	With the patient's wrist at neutral, the examiner places moderate pressure over the carpal tunnel for 30 seconds. Consider the most sensitive and specific provocative test for diagnosing CTS (Sensitivity 87%, Specificity 90%).

- **Electrodiagnostic Examination**

Electrodiagnostic examination can be used to support the diagnosis of Carpal Tunnel Syndrome. Examinations that can be done are EMG, and radiology examination. On EMG study it can be found that nerve velocity will decrease when the distal latency is prolonged, this shows that there is a disruption in nerve conduction in the wrist. A radiology study that can be done is a wrist X-ray to rule out the possibility of fractures, joint disorders, etc. In addition, an ultrasound can also be performed to see anatomical changes in the carpal tunnel. In cases that require surgical therapy, a CT scan and MRI can be done first [10].

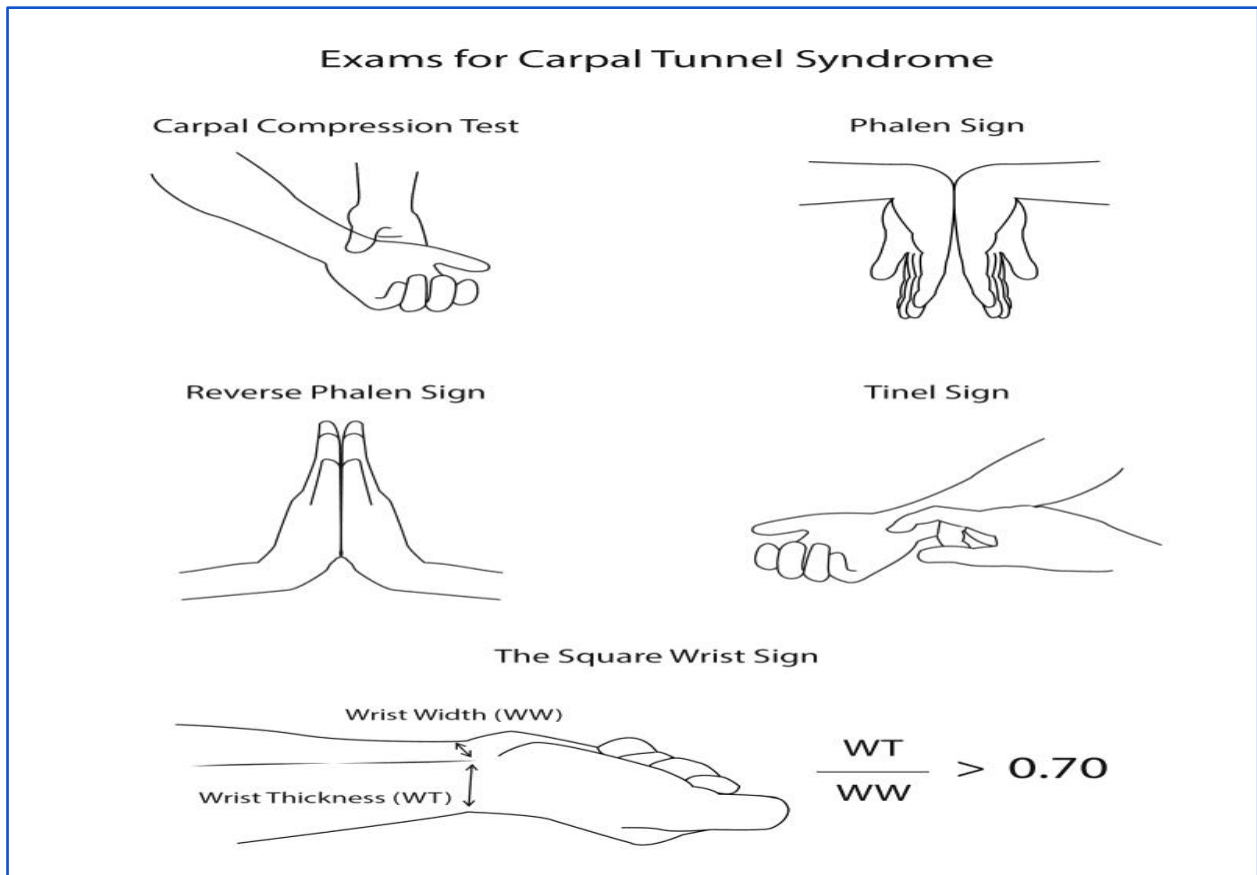


Fig.3: physical exam maneuver that test carpal tunnel syndrome [16].

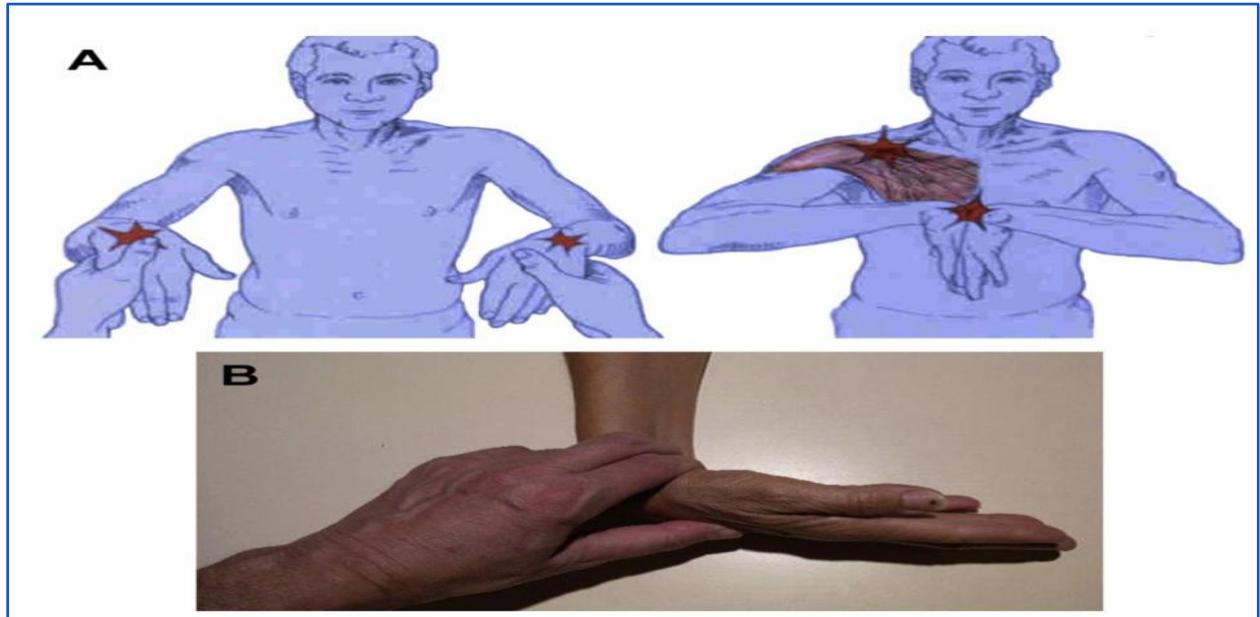


Fig.4 :Phalen test (A) performed properly (left) and improperly (right). The left image illustrates independent testing of each carpal tunnel.

(B) The Phalen test combined with carpal compression test. examiner maintain wrist flexion while simultaneously applying firm digital pressure directly over the carpal canal. This maneuver is typically held for up to 30 seconds and less than 1 minute[13].



Fig.5: Median Nerve Compression Test. With the patient's wrist at neutral, the examiner places moderate pressure over the carpal tunnel for 30 seconds[1].



Fig.6: Strength testing of the thenar muscles. Opposition and abduction of the shorter muscles are tested simultaneously by applying resistance along the first metacarpal or at the first metacarpophalangeal joint[13].

Differential diagnosis

Table 2 :Differential diagnoses of CTS . Ref.[12].	
De Quervain Tendinopathy	Tenderness at the distal radial styloid
Peripheral Neuropathy	History of diabetes mellitus, bilateral, lower extremity involvement
Pronator Syndrome (median nerve compression at the elbow) Raynaud Syndrome	Forearm pain, sensory loss over the thenar eminence, weakness with thumb flexion, wrist extension, and forearm pronation

Ulnar Compression Neuropathy	Symptoms related to cold exposure, typical color change Paresthesias of the ring and little finger, positive Tinel sign, and compression test at the elbow wrist (Guyon canal)
Vibration white finger	Use of vibratory hand power tools, symptoms of Raynaud phenomenon
Wrist arthritis Carpometacarpal Arthritis	Painful wrist motion, radiographic findings
Cervical Radiculopathy (C6)	Painful thumb motion, positive grind test, radiographic findings Neck pain, numbness of the thumb and index finger only, positive Spurling test

Management

The management of Carpal Tunnel Syndrome is divided into two, conservative therapy and operative or surgical therapy. Conservative therapy includes resting the wrist, administering non-steroidal anti-inflammatory drugs, administering neuropathic drugs, placing the splint in a neutral position, steroid injection with Triamcinolon or Dexamethasone, administering vitamin B6 pyridoxine (100-300 mg/day), physiotherapy aimed at improvement wrist vascularization hand.

In addition, surgical therapy can be used if there are indications as follows: failure of conservative therapy with all modalities, atrophy of the thenar muscles, and severe sensory impairment[8][9][12][14].

Prevention

There are several efforts that can be done to prevent CTS or prevent recurrence of CTS, among others by reducing repetitive movements, rigid movements, or rotating hand tools at work, designing equipment to work so that the hands are in a neutral position at work, modifying workspace layout to facilitate variations in movement and change the method of work to occasionally take a short break [7].

Prognosis

In the case of mild CTS with conservative therapy is generally a good prognosis. If the situation does not improve with conservative therapy, surgery must be performed. In general the prognosis of surgery is properly goodh[14].

Complications

Complications of carpal tunnel syndrome are divided into two groups:

- **Complications due to Carpal Tunnel Syndrome**
 - Carpal tunnel syndrome may cause irreversible median nerve damage, leading to permanent impairment and disability.
 - Chronic wrist and hand pain with or without reflex sympathetic dystrophy.
 - CTS can cause atrophy and weakness of the muscles at the base of the thumb in the palm of the hand. This can lead to a lack of dexterity of the affected fingers.
 - Complications due to Carpal Tunnel Surgery.
- **Complications due to Carpal Tunnel Surgery**

- The most frequent complication is neuroma of the palmar cutaneous branch of the median nerve.
- Hypertrophic scars.
- Dysesthesias after multiple procedures to release the carpal tunnel.
- Wrist Joint stiffness.
- Failure to relieve symptoms[15].

Patient education

Patients suffering from carpal tunnel syndrome should be educated about the nature of the disease, precautions that they need to take, and rehabilitative activities. These include:

- Avoid repetitive hand motions, holding onto vibrating tools, heavy grasping and positioning, or working with your wrist bent down and out.
- Quit smoking
- Lose weight if overweight
- Reduce caffeine intake
- A wrist brace will sometimes decrease the symptoms. A brace keeps the wrist in a resting position, not bent back or bent down too far. A brace can be especially helpful for relieving the numbness and pain felt at night because it can keep your hand from curling under as you sleep. The wrist brace can also be worn during the day.
- Consult with a physical or occupational therapist. Therapists may check the workstation and the way the patient does his/her work tasks. Therapists would give suggestions regarding the use of healthy body alignment and wrist positions, helpful exercises, and tips on how to prevent future problems[15][16].

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