Carpal Tunnel Syndrome

Background

Carpal tunnel syndrome (CTS) refers to the compression of the median nerve as it travels through the carpal tunnel causing pain, paresthesias, and weakness in the median nerve distribution (Kothari, 2024). CTS is a common disorder, often seen in clinical practice with a prevalence of approximately 1 to 5 percent of the population and results in a significant number of lost days of work and productivity.

Pathophysiology

The median nerve provides sensation to the thumb, index finger, middle finger, and sometimes the ring finger. It travels down the forearm and enters the hand through a narrow tunnel formed by the bones of the wrist and the transverse carpal ligament. Injury, inflammation, or swelling in this area may cause compression of the median nerve which can result in symptoms of CTS.

Causes (Kothari, 2024)

- Injury, inflammation, swelling or thickening of the flexor tendons around the median nerves
- Fibrosis surrounding the flexor tendons
- Congenitally small anatomic space within the carpal tunnel
- Lesions, cysts, or neoplasms that compress the median nerve
- Systemic illnesses that cause edema or inflammation (e.g., rheumatoid arthritis)

Risk Factors (Kothari, 2024; Erickson, 2019)

Risk Factors for Carpal Tunnel Syndrome*		
Obesity	Osteoarthritis and rheumatoid arthritis	Genetic predisposition
Female gender	Hypothyroidism	Aromatase inhibitor use
Peri-menopause	Tendonitis	Trauma
Pregnancy – symptoms often resolve after delivery	Preexisting median mononeuropathy	Workplace factors (repetition, forceful exertion, vibration)
Diabetes mellitus	Connective tissue diseases	Repetitive hand/wrist use

**Assess patients for risk factors but note that the presence of only one does not rule-in CTS. Studies support that physical activity is associated with a decreased risk of developing CTS.*

Symptoms (Kothari, 2024a)

- Characteristic symptoms
  - Pain and paresthesia (numbness or tingling) of the fingers (thumb, index finger, middle finger, and one-half of the ring finger), entire hand, forearm, and possibly above the elbow to the shoulder
  - Weakness or clumsiness of the hand
  - Occurrence of any of these symptoms in the median distribution
- Provocative factors
  - Sleep
  - Sustained flexing or extending wrists or raising the arms (e.g., driving, reading, typing)
  - Repetitive movements of the hand or wrist

- Mitigating factors
    - Changes in hand position
    - Shaking the hand

Physical Examination

- Test sensation in all areas of the hand, forearm, and upper arm
- Evaluate weakness of the thumb both abduction and opposition

Common Diagnostic Tests (Kothari, 2024a)

No single test should be used to diagnose CTS. A combination of physical exam, diagnostic questionnaires and electrodiagnostic studies provide better accuracy to rule-in or rule-out CTS.

Tests Used to Facilitate the Diagnosis of Carpal Tunnel Syndrome		
Test	**Maneuver**	**Positive Test**
Phalen's	Hold wrist in a fixed flexion position for 1 minute	Development of or increase in paresthesia along median nerve
Tinel's test	Tap over the median nerve, proximal to or on top of the carpal tunnel	Tingling feeling or electrical shocks along the median nerve
Manual carpal compression test	Apply pressure over the transverse carpal ligament	Pain or paresthesia occurs within 30 seconds of applying pressure
Hand elevation test	Patient raises hands over head for one minute	Positive if it reproduces symptoms of CTS.
Upper limb neurodynamic test	Abduct and externally rotate the shoulder, and flex the elbow at 90 degrees. Then supinate the forearm, extend the wrist and fingers, and extend the elbow.	Positive test if CTS symptoms worsen with elbow extension.
Nerve Conduction Studies (NCS)	Motor conduction studies of the median nerve; quantifies disease severity and differentiates muscle conditions from neurological disorders	Slowed conduction velocities indicates CTS; more severe compression may result in motor or sensory nerve action potential amplitude; mild CTS may not show any conduction abnormalities
Electromyography (EMG)	Assess for changes in the muscles innervated by the median nerve; excludes other conditions such as polyneuropathy, plexopathy, and radiculopathy (pinched nerve)	Active denervation or chronic changes that may indicate denervation and reinnervation
Magnetic Resonance Imaging (MRI)	Use only in rare cases to rule out a mass or lesion; MRI should **not** be used routinely for CTS diagnosis.	Detects abnormalities of the median nerve, flexor tendons, vascular structures, and transverse carpal ligament

Treatment

Patient management is based on severity of CTS symptoms and degree of injury as found on electrodiagnostic studies.

Grading Severity of CTS (Kothari, 2024b)	
Clinical Grading	**Signs and Symptoms**
Mild	• Tingling or discomfort in the median nerve distribution • No sensory loss or weakness, no sleep disruption, no difficulty with hand function or interference with activities of daily living (ADLs).
Moderate	• Persistent numbness/sensory loss in the median distribution or mild nocturnal symptoms at night that disrupt sleep. • Symptoms may interfere slightly with hand function, but the patient is able to perform all ADLs.
Severe	• Weakness in the median distribution or if symptoms are disabling and prevent the patient from one or two ADLs, or if nocturnal symptoms routinely disrupt sleep.

Nonsurgical Management (Kothari, 2024b)

Nonsurgical treatment should be implemented first-line for patients with mild CTS who haven't had electrodiagnostic studies and include splinting, glucocorticoids, physical and occupational therapy, yoga, and therapeutic ultrasound. A combination of therapies may be more effective than any single treatment. Improvement may take up to 6 months.

- Lifestyle modifications
  - Avoid repetitive motions.
  - Take frequent breaks.
  - Use ergonomic equipment.
  - Alternate job functions.
- Wrist splinting
  - Wrist splinting in neutral position and 0° extension with custom-fit wrist splints for night-time use and as needed for daytime symptoms
  - Minimum of 6 to 8 weeks; if symptoms persist after one month, continue splinting for another 1 to 2 months and add another therapy (oral or injection corticosteroid)
- Corticosteroid injections – should be the next option (before oral corticosteroids) if splinting is unsuccessful
  - Reduces tissue inflammation
  - Effective for short-term (one to three months) relief
  - Single injection of methylprednisolone, (20 to 40 mg) with 1% lidocaine
  - Contraindicated with Thenar muscle weakness and/or atrophy or advanced sensory loss
  - Limit frequency of injections for CTS to no more than once every six months per wrist; for recurrent symptoms after two injections, consider combining injections with splinting or other nonsurgical treatments
  - For patients whose symptoms continue despite nonsurgical therapy, refer for surgery.

    - Risks include worsening of median nerve compression, accidental injection into the median or ulnar nerve, and digital flexor tendon rupture
- Oral corticosteroids
    - Provide short-term relief
    - Use in patients who decline injection therapy
    - Prednisone 20 mg daily for 10 to 14 days
    - Do not use for more than 4 weeks due to adverse effects
- Exercises
    - Yoga may be beneficial for pain control.
    - Refer to physical and occupational therapists with certification in hand therapy
        - **Nerve and tendon gliding** – may restore normal movement of the median nerve
        - **Carpal bone mobilization** – movement of the bones and joints in the wrist
- Ultrasound therapy
    - Ultrasound promotes soft tissue healing and transdermal absorption of medications; however, evidence is limited
    - Deep, pulsed ultrasound may decrease pain and improve sensory loss, nerve conduction, and strength
    - Effectiveness may depend on duration of therapy
- Ineffective therapies: nonsteroidal anti-inflammatory drugs (NSAIDs), diuretics, vitamin B6, perineural dextrose injections, electrical, magnetic, and laser therapy have not proven beneficial for the treatment of CTS.

Surgical Management (Hunter & Simmons, 2024)

- Surgical approach: carpal ligament release may be performed as an open procedure, endoscopically, or using ultrasound-guided minimally invasive techniques.
    - When electrodiagnostic tests show severe and ongoing median nerve injury, surgery is recommended, unless the cause is temporary such as pregnancy.
    - Performed in outpatient setting under local anesthesia by a specialist
    - Postoperative Care:
        - Elevate hand until swelling resolves.
        - Encourage active motion of all fingers and wrist. Immobilization is not recommended and may affect rehabilitation.

References:

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