CQ HAND + UPPER LIMB
SPECIALIST ORTHOPAEDIC SURGEON

EVIDENCE SUMMARY

Carpal Tunnel Release

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Overview

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].

Anatomy & Pathophysiology

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].
- Severe carpal tunnel syndrome potentially needing surgical treatment occurs in a general population [2].
- The incidence of carpal tunnel syndrome requiring surgical decompression was reviewed over a 10.5-year period in 2,309 patients [3].
- Carpal tunnel syndrome with compression of the median nerve at the wrist is the most commonly diagnosed site of nerve compression in the upper extremity [12].
- Symptoms include paresthesia or numbness in the median nerve distribution, specifically affecting the thumb, index finger, middle finger, and radial side of the ring finger [12].
- Nocturnal paresthesias in the radial three digits of the hand are nearly pathognomonic for carpal tunnel syndrome [12].
- Paresthesias occur characteristically in fixed wrist activities such as reading a book or newspaper, driving, or using a computer keyboard or mouse [12].
- Patients rarely describe aching in the thenar eminence [12].
- With advanced nerve compression, weakness and atrophy of the abductor pollicis brevis and opponens pollicis muscles occur [12].

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- Patients typically adapt to the loss of thenar muscle function without functional impairments due to the slow onset of weakness [12].
- Carpal tunnel syndrome is a clinical diagnosis based on a combination of symptoms and characteristic physical findings [12].
- Electrodiagnostic studies are useful to stage the degree of nerve compression and assist in anticipating the time needed for recovery of nerve function [12].
- Patients with long-standing symptoms, severe atrophy of the thenar musculature, and dense sensory loss may not achieve complete recovery of sensation or thenar strength after release [12].
- Decrease in the size of the carpal tunnel can be caused by bony abnormalities of the carpal bones, acromegaly, or flexion or extension of the wrist [5].
- An increase in the contents of the canal can result from forearm and wrist fractures, dislocations and subluxations, posttraumatic arthritis, musculotendinous variants, aberrant muscles, local tumors, persistent medial artery, hypertrophic synovium, or hematoma [5].
- Neuropathic conditions associated with carpal tunnel syndrome include diabetes mellitus, alcoholism, double-crush syndrome, and exposure to industrial solvents [5].
- Inflammatory conditions associated with carpal tunnel syndrome include rheumatoid arthritis, gout, nonspecific tenosynovitis, and infection [5].
- Alterations of fluid balance associated with carpal tunnel syndrome include pregnancy, menopause, eclampsia, thyroid disorders (especially hypothyroidism), renal failure, long-term hemodialysis, Raynaud disease, obesity, lupus erythematosus, scleroderma, amyloidosis, and Paget disease [5].
- External forces associated with carpal tunnel syndrome include vibration and direct pressure [5].
- The palmar cutaneous branch of the median nerve lies in the interval between the palmaris longus and the flexor carpi radialis tendons [4].
- When severed, the palmar sensory branch frequently causes a painful neuroma that may later require excision from the scar [4].
- The flexor retinaculum includes the distal deep fascia of the forearm proximally, the transverse carpal ligament (TCL), and the aponeurosis between the thenar and hypothenar muscles [4].
- Fibers of the TCL can extend distally farther than expected [4].
- Potential anomalies in the carpal tunnel include connections between the flexor pollicis longus and index flexor digitorum profundus tendons, anomalous flexor digitorum superficialis, palmaris longus, hypothenar, and lumbrical muscle bellies, and median and ulnar nerve branches and interconnections [4].
- The superficial palmar arterial arch is located 5 to 8 mm distal to the distal margin of the TCL [4].
- The recurrence rate after primary carpal tunnel release is approximately 2% [8].
- Complications and failures after carpal tunnel release are estimated to be 3% to 19% [8].
- Unrelieved symptoms may lead to repeat operation in 12% of patients [8].
- Findings reported at reoperation include incomplete release of the TCL, re-formation of the flexor retinaculum, scarring in the carpal tunnel, median or palmar cutaneous neuroma, palmar cutaneous nerve entrapment, recurrent granulomatous or inflammatory tenosynovitis, and hypertrophic scar in the skin [8].

- Recurrent carpal tunnel syndrome was demonstrated more often in patients with diabetes [8].
- Incomplete release of the flexor retinaculum and scarring of the median nerve were common intraoperative findings in patients with recurrent symptoms [8].
- The TCL that reforms is indistinguishable from the native ligament [8].
- Reinnervation in patients with decreased conduction velocity and increased latency takes just a few months [9].
- Axonal regeneration takes much longer than reinnervation of conduction velocity [9].
- Following carpal tunnel decompression for mild or moderate nerve compression, there is a return of painless sensation to the digits innervated by the median nerve [9].
- Reinnervation of the thenar muscles takes longer, and return of motor function may not be complete in patients with severe carpal tunnel syndrome [9].
- Patients can expect restoration of full range of motion at the wrist [9].
- Rarely, patients with severe carpal tunnel syndrome and thenar atrophy experience a postoperative flare with complaints of pain, stiffness, and swelling likely caused by reinnervation hypersensitivity [9].
- Patients can experience pillar pain after carpal tunnel release, which is likely microneuroma related [9].
- The risk of pillar pain can be minimized by placing the incision in the watershed area between the median and ulnar palmar cutaneous nerves, approximately 6 mm ulnar to the thenar crease [9].
- Patients with normal preoperative electrodiagnostic studies have results significantly worse than patients without these findings [8].
- Patients who had filed for compensation have results significantly worse than patients without these findings [8].
- Patients with ulnar nerve symptoms have results significantly worse than patients without these findings [8].
- Temporary relief following a corticosteroid injection is a good prognostic sign when considering reoperation [8].
- Persistent symptoms and more than one prior carpal tunnel syndrome had higher odds of not changing or worsening postoperative pain [8].
- Higher preoperative pain, use of pain medication, and workers' compensation were significant predictors of higher postoperative average pain [8].
- MRI is not routinely used for diagnosis of carpal tunnel syndrome but has high soft-tissue contrast giving detailed images of bones and soft tissues [5].
- Ultrasound sensitivity for carpal tunnel syndrome has been reported to be over 97% when the median nerve diameter is greater than 10 mm^2 at the level of the pisiform [5].
- High-resolution ultrasonography has a sensitivity of 73% if the cutoff of 9.4 mm^2 at the inlet of the carpal tunnel is used in patients with negative electrodiagnostic studies but a clinical diagnosis of carpal tunnel syndrome [5].

- The diagnosis of carpal tunnel syndrome should be based on clinical acumen and physical examination in the vast majority of patients [5].
- Ancillary tests should be reserved for patients without clear presentations [5].
- Postoperative electrodiagnostic testing may be helpful in assessing recurrent symptoms [5].
- Reported false-negative rates of 10% limit the usefulness of certain testing types to determine treatment [5].
- Both compartment syndrome and acute carpal tunnel syndrome can develop after distal forearm fractures [14].
- The hallmark finding in acute carpal tunnel syndrome is pain out of proportion to the clinical findings [14].
- Compression of the median nerve may occur proximal to the elbow under the ligament of Struthers in patients who have a supracondylar process [11].
- The most common site of proximal median nerve compression is in the forearm at the level of the pronator [11].
- The intersection of the deep and superficial heads of the pronator teres are frequently cited as the cause of compression in pronator syndrome [11].
- Compression may also occur from the lacertus fibrosis and the tendinous leading edge of the flexor digitorum superficialis arch [11].
- Accessory and anomalous muscles identified as potential compressive structures include the accessory head of the flexor pollicis longus (Gantzer muscle), the palmaris profundus, and the flexor carpi radialis [11].
- The entrapment point of the pronator teres is located 3 to 7.5 cm distal to the humeral epicondylar line [11].
- The fibrous arch of the flexor digitorum superficialis is located 6.5 cm distal to the humeral epicondylar line in its most proximal position [11].
- Compression in the forearm can produce sensory disturbance in the median nerve distribution or motor dysfunction of the muscles innervated by the anterior interosseous nerve and median nerve [11].
- Anterior interosseous nerve syndrome is associated with a shoulder or arm pain prodrome in nearly all cases [11].
- Anterior interosseous nerve syndrome presents as an acute flaccid paralysis of the flexor pollicis longus with or without palsy of the flexor digitorum profundus-index and/or the pronator quadratus [11].
- Spontaneous recovery to some extent is documented in most individuals with anterior interosseous nerve syndrome, but complete functional recovery cannot be assured [11].
- In one study, over 60% of a 246-patient cohort had residual weakness or sensory symptoms after 3 or more years [11].
- Recent literature suggests the pathophysiology of anterior interosseous syndrome may include intrinsic constrictions of the anterior interosseous nerve fascicle at or above the elbow [11].

Classification

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].

Clinical Presentation

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].
- Carpal tunnel syndrome is the most common compression neuropathy of the upper extremity [10].
- The mean age at diagnosis of carpal tunnel syndrome is 50 years [10].
- Carpal tunnel syndrome is more common in women than men by nearly four times [10].
- By the age of 65 years, the prevalence of carpal tunnel syndrome is approximately 5.1% for women and 1.3% for men [10].
- Risk factors for carpal tunnel syndrome include obesity, pregnancy, hypothyroidism, diabetes mellitus, and menopause [10].
- The American Academy of Orthopaedic Surgeons (AAOS) guidelines list body mass index (BMI) and high hand repetition rate as factors with strong evidence of increased risk for development of carpal tunnel syndrome [10].
- Carpal tunnel syndrome classically presents with nocturnal paresthesias in a median nerve distribution [10].
- Symptoms of carpal tunnel syndrome gradually worsen as nerve injury progresses, leading to sensory loss and thenar muscle atrophy late in the disease course [10].
- Many patients with carpal tunnel syndrome report pain in the hand [10].
- Patients with carpal tunnel syndrome may report symptoms that are not directly referable to the median nerve [10].
- A positive Tinel sign at the wrist can aid in the diagnosis of carpal tunnel syndrome [10].
- The reported specificity of the Tinel sign at the wrist for carpal tunnel syndrome varies from 55% to 100% [10].
- Development of symptoms after a provocative Phalen maneuver can aid in the diagnosis of carpal tunnel syndrome [10].
- The reported specificity of the Phalen test for carpal tunnel syndrome varies from 54% to 98% [10].
- Nerve conduction studies assess focal demyelination by delayed conduction velocities of the median nerve at the wrist in carpal tunnel syndrome [10].
- Needle electromyography is used to differentiate carpal tunnel syndrome from other possible causes [10].
- Documenting muscle atrophy and fibrillations on needle EMG assists with identifying the severity of carpal tunnel disease and helps with prognostication [10].
- Thenar atrophy and abductor pollicis brevis weakness can often be detected on physical examination in carpal tunnel syndrome [10].

- Ultrasonography allows rapid diagnosis of carpal tunnel syndrome by identification of enlarged, hypoechoic median nerve fascicles proximal to the carpal tunnel [10].
- MRI and/or ultrasonography imaging should be considered in patients with new, persistent, or recurrent symptoms after surgery to delineate the etiology of symptoms [10].
- Bony abnormalities of the carpal bones can decrease the size of the carpal tunnel [5].
- Acromegaly can decrease the size of the carpal tunnel [5].
- Flexion or extension of the wrist can decrease the size of the carpal tunnel [5].
- Forearm and wrist fractures, including Colles fracture and scaphoid fracture, can increase the contents of the carpal canal [5].
- Dislocations and subluxations, such as scaphoid rotary subluxation and lunate volar dislocation, can increase the contents of the carpal canal [5].
- Posttraumatic arthritis with osteophytes can increase the contents of the carpal canal [5].
- Musculotendinous variants, including aberrant muscles like lumbrical, palmaris longus, and palmaris profundus, can increase the contents of the carpal canal [5].
- Local tumors such as neuroma, lipoma, multiple myeloma, and ganglion cysts can increase the contents of the carpal canal [5].
- A persistent medial artery that is thrombosed or patent can increase the contents of the carpal canal [5].
- Hypertrophic synovium can increase the contents of the carpal canal [5].
- Hematoma due to hemophilia, anticoagulation therapy, or trauma can increase the contents of the carpal canal [5].
- Diabetes mellitus is a neuropathic condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Alcoholism is a neuropathic condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Double-crush syndrome is a neuropathic condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Exposure to industrial solvents is a neuropathic condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Rheumatoid arthritis is an inflammatory condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Gout is an inflammatory condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Nonspecific tenosynovitis is an inflammatory condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Infection is an inflammatory condition involved in the pathogenesis of carpal tunnel syndrome [5].
- Pregnancy is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Menopause is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Eclampsia is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].

- Thyroid disorders, especially hypothyroidism, are alterations of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Renal failure is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Long-term hemodialysis is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Raynaud disease is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Obesity is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Lupus erythematosus is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Scleroderma is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Amyloidosis is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Paget disease is an alteration of fluid balance involved in the pathogenesis of carpal tunnel syndrome [5].
- Vibration is an external force involved in the pathogenesis of carpal tunnel syndrome [5].
- Direct pressure is an external force involved in the pathogenesis of carpal tunnel syndrome [5].
- The diagnosis of carpal tunnel syndrome should be based on clinical acumen and physical examination in the vast majority of patients [5].
- Ancillary tests for carpal tunnel syndrome should be reserved for patients without clear presentations [5].
- Reports of MRI in carpal tunnel syndrome are promising, especially with newer techniques such as diffusion tensor imaging, but MRI is not routinely used for diagnosis [5].
- A major advantage of MRI is its high soft-tissue contrast, which gives detailed images of bones and soft tissues [5].
- Ultrasound sensitivity for carpal tunnel syndrome has been reported to be over 97% when the median nerve diameter is greater than 10 mm^2 at the level of the pisiform [5].
- High-resolution ultrasonography has been used to diagnose carpal tunnel in patients with negative electrodiagnostic studies but a clinical diagnosis, with a sensitivity of 73% if the cutoff of 9.4 mm^2 at the inlet of the carpal tunnel is used [5].
- The recurrence rate after primary carpal tunnel release is approximately 2% [8].
- Complications and failures after carpal tunnel release are estimated to be 3% to 19% [8].
- Unrelieved symptoms may lead to repeat operation in 12% of patients [8].
- Findings reported at reoperation for recurrent carpal tunnel syndrome include incomplete release of the transverse carpal ligament (TCL) [8].
- Findings reported at reoperation for recurrent carpal tunnel syndrome include re-formation of the flexor retinaculum [8].
- Findings reported at reoperation for recurrent carpal tunnel syndrome include scarring in the carpal tunnel [8].

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- Findings reported at reoperation for recurrent carpal tunnel syndrome include palmar cutaneous nerve entrapment [8].
- Findings reported at reoperation for recurrent carpal tunnel syndrome include recurrent granulomatous or inflammatory tenosynovitis [8].
- Findings reported at reoperation for recurrent carpal tunnel syndrome include hypertrophic scar in the skin [8].
- Patients with normal preoperative electrodiagnostic studies have results significantly worse than patients without this finding after carpal tunnel release [8].
- Patients who had filed for compensation have results significantly worse than patients without this finding after carpal tunnel release [8].
- Patients with ulnar nerve symptoms have results significantly worse than patients without this finding after carpal tunnel release [8].
- Temporary relief following a corticosteroid injection is a good prognostic sign when considering reoperation for recurrent carpal tunnel syndrome [8].
- Recurrent carpal tunnel syndrome was demonstrated more often in patients with diabetes [8].
- Incomplete release of the flexor retinaculum and scarring of the median nerve were common intraoperative findings in patients with recurrent carpal tunnel syndrome [8].
- Postoperative pinch strength, grip strength, and pain significantly improved from baseline in patients undergoing reoperation for recurrent carpal tunnel syndrome, apart from strength measures in the recurrent group [8].
- Persistent symptoms and more than one prior carpal tunnel syndrome had higher odds of not changing or worsening postoperative pain [8].
- Higher preoperative pain, use of pain medication, and workers' compensation were significant predictors of higher postoperative average pain [8].
- The TCL that reforms is indistinguishable from the native ligament, making determination of incomplete release not possible [8].
- Reinnervation in patients with decreased conduction velocity and increased latency will take just a few months following carpal tunnel decompression [9].
- Axonal regeneration (decreased CMAP) will take much longer than reinnervation following carpal tunnel decompression [9].
- Following carpal tunnel decompression for mild or moderate nerve compression, there will be return of "painless" sensation to the digits innervated by the median nerve [9].
- Reinnervation of the thenar muscles will occur following carpal tunnel decompression, although it takes longer [9].
- Return of motor function may not be complete in patients with severe carpal tunnel syndrome following decompression [9].

- Patients can expect restoration of full range of motion at the wrist following carpal tunnel release [9].
- Rarely, patients with severe carpal tunnel syndrome and thenar atrophy experience a postoperative flare with complaints of pain, stiffness, and swelling likely caused by reinnervation hypersensitivity [9].
- Patients can experience pillar pain after carpal tunnel release, which is likely microneuroma related [9].
- The risk of pillar pain can be minimized by placing the incision in the watershed area between the median and ulnar palmar cutaneous nerves, approximately 6 mm ulnar to the thenar crease [9].
- Patients with pillar pain are referred to hand therapy for scar massage and desensitization [9].
- Postoperative electrodiagnostic testing may be helpful in assessing recurrent symptoms after carpal tunnel release [5].
- The four commonly used tests for carpal tunnel syndrome (abnormal hand diagram, abnormal Semmes-Weinstein, positive Durkan compression, and night pain) do not increase the diagnostic value of each other [5].
- Reported false-negative rates of 10% limit the usefulness of certain testing types to determine treatment for carpal tunnel syndrome [5].

Investigations

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].
- Severe carpal tunnel syndrome potentially needing surgical treatment occurs in a general population [2].
- The mean age at diagnosis of carpal tunnel syndrome is 50 years [10].
- Carpal tunnel syndrome is more common in women than men by nearly four times [10].
- By the age of 65 years, the prevalence of carpal tunnel syndrome is approximately 5.1% for women and 1.3% for men [10].
- Risk factors for carpal tunnel syndrome include obesity, pregnancy, hypothyroidism, diabetes mellitus, and menopause [10].
- The American Academy of Orthopaedic Surgeons (AAOS) guidelines list body mass index (BMI) and high hand repetition rate as factors with strong evidence of increased risk for development of carpal tunnel syndrome [10].
- Carpal tunnel syndrome classically presents with nocturnal paresthesias in a median nerve distribution that gradually worsen as nerve injury progresses, leading to sensory loss and thenar muscle atrophy late in the disease course [10].
- Many patients report pain in the hand and may report symptoms not directly referable to the median nerve [10].
- A positive Tinel sign at the wrist can aid in diagnosis, with reported specificity varying from 55% to 100% [10].
- Development of symptoms after a provocative Phalen maneuver can aid in diagnosis, with reported specificity varying from 54% to 98% [10].

- Nerve conduction studies are a useful diagnostic tool in carpal tunnel syndrome as focal demyelination can be assessed by delayed conduction velocities of the median nerve at the wrist [10].
- Needle electromyography is considered an optional adjunct to nerve conduction studies, mostly used to differentiate carpal tunnel syndrome from other possible causes [10].
- Documenting muscle atrophy and fibrillations on needle EMG can assist with identifying severity of the disease and help with prognostication [10].
- Advances in ultrasonography technology allow rapid diagnosis of carpal tunnel syndrome by identification of enlarged, hypoechoic median nerve fascicles proximal to the carpal tunnel [10].
- MRI and/or ultrasonography imaging should be considered in patients who have new, persistent, or recurrent symptoms after surgery to delineate the etiology of the symptoms [10].
- The diagnosis of carpal tunnel syndrome should be based on clinical acumen and physical examination in the vast majority of patients, with ancillary tests reserved for patients without clear presentations [5].
- Reports of MRI in carpal tunnel syndrome are promising, especially with newer techniques such as diffusion tensor imaging, but MRI is not routinely used for diagnosis [5].
- Ultrasound sensitivity for carpal tunnel syndrome has been reported to be over 97% when the median nerve diameter is greater than 10 mm^2 at the level of the pisiform [5].
- In patients with negative electrodiagnostic studies but a clinical diagnosis of carpal tunnel syndrome, high-resolution ultrasonography has been used to diagnose carpal tunnel with a sensitivity of 73% if the cutoff of 9.4 mm^2 at the inlet of the carpal tunnel is used [5].
- Postoperative electrodiagnostic testing may be helpful in assessing recurrent symptoms [5].
- The diagnosis of carpal tunnel syndrome should be based on clinical acumen and physical examination in the vast majority of patients, and ancillary tests should be reserved for patients without clear presentations [5].
- Factors involved in the pathogenesis of carpal tunnel syndrome include a decrease in size of the carpal tunnel due to bony abnormalities, acromegaly, or flexion or extension of the wrist [5].
- Factors involved in the pathogenesis of carpal tunnel syndrome include an increase in contents of the canal due to forearm and wrist fractures, dislocations, subluxations, posttraumatic arthritis, musculotendinous variants, aberrant muscles, local tumors, persistent medial artery, hypertrophic synovium, or hematoma [5].
- Neuropathic conditions involved in the pathogenesis of carpal tunnel syndrome include diabetes mellitus, alcoholism, double-crush syndrome, and exposure to industrial solvents [5].
- Inflammatory conditions involved in the pathogenesis of carpal tunnel syndrome include rheumatoid arthritis, gout, nonspecific tenosynovitis, and infection [5].
- Alterations of fluid balance involved in the pathogenesis of carpal tunnel syndrome include pregnancy, menopause, eclampsia, thyroid disorders (especially hypothyroidism), renal failure, long-term hemodialysis, Raynaud disease, obesity, lupus erythematosus, scleroderma, amyloidosis, and Paget disease [5].
- External forces involved in the pathogenesis of carpal tunnel syndrome include vibration and direct pressure [5].

- The palmar cutaneous branch of the median nerve lies in the interval between the palmaris longus and the flexor carpi radialis tendons [4].
- When severed, the palmar sensory branch frequently causes a painful neuroma that may later require excision from the scar [4].
- Fibers of the transverse carpal ligament (TCL) can extend distally farther than expected [4].
- The superficial palmar arterial arch is located 5 to 8 mm distal to the distal margin of the TCL [4].
- Tenosynovectomy occasionally may be indicated, especially in patients with rheumatoid arthritis [4].
- Potential anomalies in carpal tunnel release include connections between the flexor pollicis longus and the index flexor digitorum profundus tendons, anomalous flexor digitorum superficialis, palmaris longus, hypothenar, lumbrical muscle bellies, and median and ulnar nerve branches and interconnections [4].
- Endoscopic carpal tunnel release is contraindicated if the patient requires neurolysis, tenosynovectomy, Z-plasty of the TCL, or decompression of Guyon's canal [6].
- Endoscopic carpal tunnel release is contraindicated if the surgeon suspects a space-occupying lesion or other severe abnormality of the muscles, tendons, or vessels in the carpal tunnel [6].
- Endoscopic carpal tunnel release is contraindicated if the patient has localized infection, severe hand edema, or tenuous vascular status of the upper extremities [6].
- Revision surgery for unresolved or recurrent carpal tunnel syndrome is a contraindication for endoscopic carpal tunnel release [6].
- Anatomic variation in the median nerve, suggested by clinical findings of wasting in the abductor pollicis brevis without significant median sensory changes, is a contraindication for endoscopic carpal tunnel release [6].
- Previous tendon surgery or flexor injury that would cause scarring in the carpal tunnel is a contraindication for endoscopic carpal tunnel release [6].
- Limitation of wrist extension is a contraindication to an endoscopic procedure because the endoscopic instruments cannot be introduced into the carpal tunnel and remain juxtaposed to the dorsal surface of the TCL [6].
- If scope insertion is obstructed, the endoscopic procedure should be aborted [6].
- If a clear view cannot be obtained during endoscopic carpal tunnel release, the procedure should be aborted [6].
- The surgeon should not explore the carpal canal with the scope during endoscopic release [6].
- If the view is not normal during endoscopic carpal tunnel release, the procedure should be aborted [6].
- If an endoscopic release cannot be accomplished safely, the procedure should be converted to an open technique [6].
- The diagnosis of carpal tunnel syndrome can be made by clinical history, physical examination, and supportive diagnostic testing with exclusion of other possible disorders [10].
- Initial management for mild and/or moderate symptoms of carpal tunnel syndrome includes hand therapy, activity modification with splinting, and corticosteroid injection [10].

- Surgical decompression of the transverse carpal ligament is the benchmark procedure for the treatment of carpal tunnel syndrome [10].
- Techniques for division of the transverse carpal ligament include standard open carpal tunnel release, endoscopic release, ultrasonography-guided release, and thread carpal tunnel release [10].
- There has been no definitive difference in long-term functional outcome between open and endoscopic carpal tunnel release [10].
- Patients undergoing endoscopic release often have a more abbreviated recovery with less incisional pain compared to open release [10].
- Endoscopic carpal tunnel release is associated with an increased cost of the procedure compared to open release [10].
- Endoscopic carpal tunnel release is associated with a slightly higher rate of iatrogenic transient neurapraxia compared to open release [10].
- Postoperative complications of carpal tunnel release include nerve, arterial, or tendon injury with a 0.5% incidence [10].
- Postoperative complications of carpal tunnel release include complex regional pain syndrome with an incidence of 2.1% to 5% [10].
- Mini-open carpal tunnel release has been performed with a limited, targeted incision of 1.5 to 2 cm, with low complication rates and high rates of patient satisfaction [10].
- No approach has yet demonstrated superiority over other techniques currently in use in large, randomized controlled surgical trials [10].
- Recurrent symptoms after carpal tunnel release can occur and are thought to be due to scarring, tenosynovitis, and/or adhesive tethering [10].
- Rates of recurrent symptoms after carpal tunnel release may be as high as 4.5% [10].
- Recurrent symptoms should be differentiated from persistent symptoms, which may be due to an incompletely divided ligament during the index procedure or incorrect diagnosis [10].
- Repeat open median nerve neurolysis is often performed when symptoms recur, either by itself or in conjunction with local tissue flaps or wraps [10].
- Neither repeat open median nerve neurolysis alone nor in conjunction with local tissue flaps or wraps has demonstrated superiority for treatment of recurrent carpal tunnel symptoms [10].
- The incidence of recurrence after endoscopic carpal tunnel release has been studied [2].
- The outcome of reoperation for carpal tunnel syndrome has been studied [2].
- Electromyography, ultrasonography, computed tomography, and magnetic resonance imaging have been used in idiopathic carpal tunnel syndrome determined by clinical findings [3].
- Pre-operative electrodiagnostic testing predicts time to resolution of symptoms after carpal tunnel release [3].
- Ultrasound and electrodiagnostic testing have been compared for diagnosis of carpal tunnel syndrome using a validated clinical tool as the reference standard [3].

- The benefit of carpal tunnel release in patients with electrophysiologically moderate and severe disease has been studied [3].
- Carpal tunnel release in patients with diabetes results in poor outcomes in long-term study [3].
- Endoscopic release for severe carpal tunnel syndrome in octogenarians has been studied [3].
- Risk factors for re-recurrent carpal tunnel syndrome in patients undergoing long-term hemodialysis have been studied [3].
- Does prior local corticosteroid injection prejudice the outcome of subsequent carpal tunnel decompression has been studied [3].
- Prognostic indicators for recurrent symptoms after a single corticosteroid injection for carpal tunnel syndrome have been studied [3].
- The value of some clinical provocative tests in carpal tunnel syndrome, including whether electrophysiology is needed and if outcome can be predicted, has been studied [2].
- A new diagnostic test for carpal tunnel syndrome has been proposed [2].
- The incidence of carpal tunnel syndrome requiring surgical decompression has been reviewed over a 10.5-year period of 2,309 patients [3].
- Surgery versus conservative therapy in carpal tunnel syndrome in people aged 70 years and older has been studied [3].
- A comparison of three diagnostic tests for carpal tunnel syndrome using latent class analysis has been performed [3].
- Predictors of the patient-centered outcomes of surgical carpal tunnel release have been studied [3].
- Outcomes following carpal tunnel release in patients receiving workers' compensation have been reviewed systematically [3].
- A cost analysis of carpal tunnel release surgery performed wide awake versus under sedation has been performed [3].
- Surgical ultrasound-guided carpal tunnel release has been studied [3].
- Predicting the outcome of revision carpal tunnel release has been studied [3].
- Results of endoscopic carpal tunnel release relative to surgeon experience with the Agee technique have been studied [3].
- Evaluation of the effectiveness and safety of ultrasound-guided percutaneous carpal tunnel release has been performed as a cadaveric study [3].
- Clinical course and prognostic factors in conservatively managed carpal tunnel syndrome have been reviewed systematically [3].
- Carpal tunnel release using the radial sided approach compared with the two-incision approach has been studied [3].
- Comparison of longitudinal open incision and two-incision techniques for carpal tunnel release has been performed [3].
- Effectiveness and safety of endoscopic versus open carpal tunnel decompression has been studied [3].

- Unusual causes of carpal tunnel syndrome, such as space occupying lesions, have been studied [3].
- Comparison of short wrist transverse open and limited open techniques for carpal tunnel release has been performed as a randomized controlled trial of two incisions [3].
- Electromyography, ultrasonography, computed tomography, magnetic resonance imaging in idiopathic carpal tunnel syndrome determined by clinical findings has been studied [3].
- Diagnosing carpal tunnel syndrome has been reviewed [3].
- Cost implications of varying the surgical technique, surgical setting, and anesthesia for carpal tunnel release surgery have been studied [3].
- Outcomes of open and endoscopic carpal tunnel release have been compared in a meta-analysis [3].
- Carpal tunnel release a randomized comparison of three surgical methods has been studied [3].
- Long-term outcomes of carpal tunnel release have been critically reviewed [3].
- A randomized controlled trial of Knifelight and open carpal tunnel release has been performed [2].
- Endoscopic carpal tunnel release in rheumatoid patients has been studied [2].
- Does splintage help pain after carpal tunnel release has been studied [2].
- Neurophysiological recovery after open carpal tunnel decompression: comparison of simple decompression and decompression with epineurotomy has been studied [2].
- Electrical studies as a prognostic factor in the surgical treatment of carpal tunnel syndrome have been studied [2].
- Complications related to carpal tunnel release have been studied [2].
- Minimal-incision open carpal tunnel decompression has been studied [2].
- Carpal tunnel release has been studied [2].
- Basal joint arthroplasty and carpal tunnel release through a single incision has been studied as an in vitro study [2].
- Return-to-work interval and surgery for carpal tunnel syndrome has been studied in a prospective series of 233 patients [2].
- Poor outcome for neural surgery (epineurotomy or neurolysis) for carpal tunnel syndrome compared with carpal tunnel release alone has been studied in a meta-analysis of global outcomes [2].
- Endoscopic carpal tunnel release: thirteen years' experience with the Chow technique has been studied [2].
- Endoscopic release of the carpal ligament: a new technique for carpal tunnel syndrome has been studied [2].
- Endoscopic release of the carpal ligament for carpal tunnel syndrome: 22-month clinical results have been studied [2].
- Endoscopic carpal tunnel release: two-portal technique has been studied [2].
- Endoscopic release of the carpal ligament for carpal tunnel syndrome: long-term results using the Chow technique have been studied [2].
- The hypothenar fat pad transposition flap: a modified surgical technique has been studied [2].

- Raynaud's phenomenon in idiopathic carpal tunnel syndrome: postoperative alteration in its prevalence has been studied [2].
- The incidence of recurrence after endoscopic carpal tunnel release has been studied [2].
- Outcome of reoperation for carpal tunnel syndrome has been studied [2].
- Anatomy of the flexor retinaculum has been studied [2].
- Symptoms may return after carpal tunnel surgery [2].
- Management of recurrent carpal tunnel syndrome with microneurolysis and the hypothenar fat pad flap has been studied [2].
- Transection of the motor branch of the ulnar nerve as a complication of two-portal endoscopic carpal tunnel release has been reported as a case report [2].
- Pedicled fat flap coverage of the median nerve after failed carpal tunnel decompression has been studied [2].
- Carpal tunnel decompression: is lengthening of the flexor retinaculum better than simple division has been studied [2].
- Carpal tunnel syndrome and work has been studied [2].
- A new diagnostic test for carpal tunnel syndrome has been proposed [2].
- Value of some clinical provocative tests in carpal tunnel syndrome: do we need electrophysiology and can we predict the outcome has been studied [2].
- Transection of the motor branch of the ulnar nerve as a complication of two-portal endoscopic carpal tunnel release: a case report has been published [2].
- Pedicled fat flap coverage of the median nerve after failed carpal tunnel decompression has been studied [2].
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- Value of some clinical provocative tests in carpal tunnel syndrome: do we need electrophysiology and can we predict the outcome has been studied [2].

Treatment

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].
- Endoscopic carpal tunnel release using the single proximal incision technique has been described [2].
- A randomized prospective multicenter study of endoscopic release of the carpal tunnel has been conducted [2].
- A prospective study of complications and surgical experience with endoscopic carpal tunnel release has been published [2].

- A surgical technique to reduce scar discomfort after carpal tunnel surgery has been described [2].
- A randomized controlled trial comparing Knifelight and open carpal tunnel release has been performed [2].
- Neurophysiological recovery after open carpal tunnel decompression was compared between simple decompression and decompression with epineurotomy [2].
- Poor outcomes for neural surgery (epineurotomy or neurolysis) for carpal tunnel syndrome compared with carpal tunnel release alone were found in a meta-analysis of global outcomes [2].
- Thirteen years' experience with the Chow technique for endoscopic carpal tunnel release has been reported [2].
- The incidence of recurrence after endoscopic carpal tunnel release has been studied [2].
- The outcome of reoperation for carpal tunnel syndrome has been evaluated [2].
- Symptoms may return after carpal tunnel surgery [2].
- Management of recurrent carpal tunnel syndrome with microneurolysis and the hypothenar fat pad flap has been described [2].
- Pedicled fat flap coverage of the median nerve after failed carpal tunnel decompression has been described [2].
- Carpal tunnel decompression was compared regarding whether lengthening of the flexor retinaculum is better than simple division [2].
- A cost analysis of carpal tunnel release surgery performed wide awake versus under sedation has been conducted [3].
- Surgical ultrasound-guided carpal tunnel release has been described [3].
- Predicting the outcome of revision carpal tunnel release has been studied [3].
- Results of endoscopic carpal tunnel release relative to surgeon experience with the Agee technique have been reported [3].
- Whether prior local corticosteroid injection prejudices the outcome of subsequent carpal tunnel decompression has been investigated [3].
- Prognostic indicators for recurrent symptoms after a single corticosteroid injection for carpal tunnel syndrome have been identified [3].
- The effectiveness and safety of ultrasound-guided percutaneous carpal tunnel release has been evaluated in a cadaveric study [3].
- The clinical course and prognostic factors in conservatively managed carpal tunnel syndrome have been reviewed systematically [3].
- Evidence-based treatment decisions for carpal tunnel syndrome have been discussed [3].
- Carpal tunnel release using the radial sided approach was compared with the two-incision approach [3].
- Longitudinal open incision and two-incision techniques for carpal tunnel release were compared [3].
- The effectiveness and safety of endoscopic versus open carpal tunnel decompression have been analyzed [3].

- A randomized controlled trial compared short wrist transverse open and limited open techniques for carpal tunnel release [3].
- Predictors of patient-centered outcomes of surgical carpal tunnel release have been identified in a prospective cohort study [3].
- Outcomes following carpal tunnel release in patients receiving workers' compensation have been reviewed systematically [3].
- Surgery versus conservative therapy in carpal tunnel syndrome in people aged 70 years and older has been compared [3].
- Pre-operative electrodiagnostic testing predicts time to resolution of symptoms after carpal tunnel release [3].
- Ultrasound and electrodiagnostic testing were compared for diagnosis of carpal tunnel syndrome using a validated clinical tool as the reference standard [3].
- Carpal tunnel release in patients with diabetes results in poor outcomes in a long-term study [3].
- A clinical study of the modified thread carpal tunnel release has been conducted [3].
- Endoscopic release for severe carpal tunnel syndrome in octogenarians has been reported [3].
- Reoperation surgery for persistent and recurrent carpal tunnel syndrome and for failed carpal tunnel release has been described [3].
- Endoscopic carpal tunnel release was preferred over mini-open despite similar outcomes in a randomized trial [3].
- Whether carpal tunnel release provides long-term relief in patients with hemodialysis-associated carpal tunnel syndrome has been investigated [3].
- Complications of carpal tunnel release have been reviewed [3].
- Cost implications of varying the surgical technique, surgical setting, and anesthesia for carpal tunnel release surgery have been analyzed [3].
- Risk factors for re-recurrent carpal tunnel syndrome in patients undergoing long-term hemodialysis have been identified [3].
- Outcomes of open and endoscopic carpal tunnel release were compared in a meta-analysis [3].
- The benefit of carpal tunnel release in patients with electrophysiologically moderate and severe disease has been studied [3].
- A randomized comparison of three surgical methods for carpal tunnel release has been conducted [3].
- Palmar incisions should be well ulnar to the thenar crease to avoid the median nerve palmar cutaneous branch [4].
- A curved incision ulnar and parallel to the thenar crease is not advisable because the palmar cutaneous branch of the median nerve proximally may be more at risk of injury [4].
- The incision should be extended proximally to the flexor crease of the wrist, where it can be continued farther proximally if necessary [4].

- The incision should be angled toward the ulnar side of the wrist to avoid crossing the flexor creases at a right angle and to avoid cutting the palmar cutaneous sensory branch [4].
- The palmar cutaneous sensory branch lies in the interval between the palmaris longus and the flexor carpi radialis tendons [4].
- The incision should maintain longitudinal orientation so that it is generally to the ulnar side of the long finger axis or radial border of the ring fourth ray [4].
- When severed, the palmar sensory branch frequently causes a painful neuroma that may later require excision from the scar [4].
- If the palmar sensory branch is severed, it is not repaired but sectioned more proximally to be covered by the middle finger sublimis muscle [4].
- The palmar fascia is identified from the wrist flexion crease distally and the distal forearm antebrachial fascia proximally by subcutaneous blunt dissection [4].
- The palmar fascia is split to expose the underlying transverse carpal ligament (TCL), avoiding the median nerve beneath it [4].
- The TCL is carefully divided while avoiding damage to the median nerve and its recurrent branch, which may perforate the ligament and leave the median nerve on the volar side [4].
- Fibers of the TCL can extend distally farther than expected [4].
- A successful carpal tunnel release usually requires division of all components of the flexor retinaculum, including the distal deep fascia of the forearm proximally, the TCL, and the aponeurosis between the thenar and hypothenar muscles [4].
- Potential anomalies to be aware of include connections between the flexor pollicis longus and the index flexor digitorum profundus tendons, anomalous flexor digitorum superficialis, palmaris longus, hypothenar, lumbrical muscle bellies, and median and ulnar nerve branches and interconnections [4].
- Injury to the superficial palmar arterial arch should be avoided as it is located 5 to 8 mm distal to the distal margin of the TCL [4].
- The flexor tenosynovium should be inspected, and tenosynovectomy occasionally may be indicated, especially in patients with rheumatoid arthritis [4].
- Only the skin should be closed and the wound drained as needed [4].
- A light compression dressing and a volar splint may be applied postoperatively [4].
- The hand is actively used as soon as possible after surgery, but the dependent position is avoided [4].
- The dressing can usually be removed by the patient at home 2 or 3 days after surgery, and then gentle washing and showering of the hand is permitted [4].
- Gradual resumption of normal hand use is encouraged [4].
- Sutures are removed after 10 to 14 days [4].
- A splint may be continued for comfort as needed for 14 to 21 days [4].

Complications

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].
- Severe carpal tunnel syndrome potentially needing surgical treatment occurs in a general population [2].
- Electrical studies serve as a prognostic factor in the surgical treatment of carpal tunnel syndrome [2].
- Complications related to carpal tunnel release are documented in the literature [2].
- Poor outcomes for neural surgery (epineurotomy or neurolysis) for carpal tunnel syndrome are observed compared with carpal tunnel release alone [2].
- Recurrent carpal tunnel syndrome is a recognized clinical entity [2].
- The incidence of recurrence after endoscopic carpal tunnel release has been studied [2].
- Outcomes of reoperation for carpal tunnel syndrome have been evaluated [2].
- Symptoms may return after carpal tunnel surgery [2].
- Transection of the motor branch of the ulnar nerve is a complication of two-portal endoscopic carpal tunnel release [2].
- Raynaud's phenomenon in idiopathic carpal tunnel syndrome may undergo postoperative alteration in its prevalence [2].
- Carpal tunnel release in patients with diabetes results in poor outcomes in long-term studies [3].
- Surgery versus conservative therapy in carpal tunnel syndrome in people aged 70 years and older has been compared [3].
- Outcomes following carpal tunnel release in patients receiving workers' compensation have been systematically reviewed [3].
- Risk factors for re-recurrent carpal tunnel syndrome exist in patients undergoing long-term hemodialysis [3].
- Does prior local corticosteroid injection prejudice the outcome of subsequent carpal tunnel decompression is a studied question [3].
- Prognostic indicators for recurrent symptoms after a single corticosteroid injection for carpal tunnel syndrome have been identified [3].
- Pre-operative electrodiagnostic testing predicts time to resolution of symptoms after carpal tunnel release [3].
- Comparison of ultrasound and electrodiagnostic testing for diagnosis of carpal tunnel syndrome has been performed [3].
- Predicting the outcome of revision carpal tunnel release is a studied area [3].
- Results of endoscopic carpal tunnel release relative to surgeon experience with the Agee technique have been reported [3].
- Endoscopic release for severe carpal tunnel syndrome in octogenarians has been performed [3].
- Does carpal tunnel release provide long-term relief in patients with hemodialysis-associated carpal tunnel syndrome is a studied question [3].

- Complications of carpal tunnel release are documented in the literature [3].

Recovery

- Symptoms of pain, numbness, and tingling in the hands are common in the general population [1].

Key Evidence

- [L4] Symptoms of pain, numbness, and tingling in the hands are common in the general population. (10.1001/jama.282.2.153)

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